

# BRIDGE RATING MANUAL STAFF BRIDGE BRANCH

2022

COLORADO DEPARTMENT OF TRANSPORTATION	Chapter: Introduction
STAFF BRIDGE	Effective: April 1, 2011
BRIDGE RATING MANUAL	Supersedes: April 1, 2002

#### INTRODUCTION

Each major structure in Colorado is rated to determine its safe live load capacity.

The purpose of this manual is to organize the rating process so that the procedures and results conform to the policies of the Colorado Department of Transportation. However, this manual should not overrule sound engineering judgment.

The user of this manual is expected to have current copies of the AASHTO LRFD Bridge Design Specifications, AASHTO Standard Specifications for Highway Bridges, the AASHTO Manual for Bridge Evaluation, and the Staff Bridge Design Manual, and be familiar with the applicable sections of these manuals.

Rating procedures for structure types not identified in this manual shall be developed by the rater and shall be subject to review and approval by the Staff Bridge Engineer.

The questions, "How much total live load can this bridge hold? and, "How does this bridge's capacity compare with other bridges?" are usually asked after a bridge is designed, constructed, or during service. The questions may be asked by:

- an engineer who has finished designing a bridge;
- a roadway official attempting to determine the quality of the bridges on the system;
- a funding agency which is deciding whether or not a bridge needs to be repaired or replaced; and
- a permit officer concerned about an overweight vehicle using a particular bridge.

In response to these questions a method for estimating the safe live load capacity of highway structures has been developed. This method involves the assignment of specific rating values to structures which define their live load capacity relative to selected standard vehicles. The four types of rating values used by the Colorado Department of Transportation are Inventory, Operating, Posting, and Overload Color Code.

All structures require an Inventory and an Operating rating value in terms of the HS20-44 or HL-93 loading which defines their long term high frequency load capacity, and ultimate permissible load capacity, respectively. If a structure is deficient for the maximum vehicle loads allowed by law, then its capacity is also assessed in terms of the Type "3", "3S2", and "3-2" Posting Vehicles. Structures on the state highway system are given an Overload Color Code rating which defines their capacity for loads heavier than the maximum legal loads, in terms of the Modified Tandem Vehicle, or the Colorado Permit Vehicle. Once computed, these values are recorded on a Rating Summary Sheet and kept in the structure's permanent file.

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After the rating is recorded it becomes one of the most important items in a structure's records. It is utilized in reviewing the sufficiency of new designs, evaluating the relative capacities of structures on a roadway system, prioritizing the expenditure of funds for repair or replacement, and preventing structural failures when routing overloads. In summary, it becomes an essential item for insuring the safety and cost efficient maintenance of the structures on a roadway system.

Rating values are normally calculated only for a bridge's superstructure, and then, only with respect to dead and live loads. Rating values are not routinely computed for structures with spans 20 feet or less. The last page of this introduction shows how the Inventory, Operating, and Posting rating values are calculated. See Section 1-16 for an explanation of how color code rating values are computed.

When a new structure is designed, or an existing structure is modified by design, the engineers who performed the design are responsible for providing a rating. In this case, the rating is an integral part of the design and is executed at the final design phase, but before construction commences. When an existing structure is modified by field changes, e.g., collision damage, or additional asphalt, the party responsible for bridge maintenance and inspection is also responsible for insuring that the bridge is promptly rerated. In all cases, the color code for the new or modified structure should be determined.

This manual presents policies, guidelines, and examples illustrating how ratings are to be calculated in the State of Colorado. When rating a highway structure, the specifications, policies, and guidelines that are to be used are those stipulated in the current AASHTO LRFD Bridge Design Specifications, AASHTO Standard Specifications for Highway Bridges, the AASHTO Manual for Bridge Evaluation, the Staff Bridge Design Manual and this manual. In order to effectively perform a rating, it is imperative that the rater obtain and become familiar with these manuals.

The calculation of rating values is defined in general by the following formulas which are taken from the AASHTO Manual for Bridge Evaluation:

#### • Load and Resistance Factor Rating (LRFR);

$$RF_{LRFR} = \frac{C - (\gamma_{DC})(DC) - (\gamma_{DW})(DW) \pm (\gamma_{P})(P)}{(\gamma_{LL}) \cdot (LL + IM)}$$

Rating in  $Tons = (RF_{IRFR}) \cdot W$ 

- C = Capacity =  $\phi_c \phi_s \phi R_n;$  where  $\phi_C \phi_s \ge$  0.85 for Strength Limit State
- $C = f_{\rm R}$  for service limit state
- DW = Dead load due to wearing surface and utilities

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$f_{ extsf{R}}$	= I	llowable Stress per LRFD cc	de
IM	= I	ynamic load allowance	
LL	= I	ive load	
Р	= I	ermanent loads other than d	ead loads
$RF_{LRFR}$	= F	ating factor for LRFR	
R <sub>n</sub>	= 1	ominal member resistance	
W	= V	eight (tons) of vehicle use	d to
	C	etermine live load effect.	
$\phi_{C}$	= (	ondition factor	
$\phi_s$	= 5	ystem factor	
φ	= I	RFD resistance factor	
$\gamma_{\scriptscriptstyle DC}$	= [	ead load factor for structu	ral components and
	ć	ttachments	
$\gamma_{\rm DW}$	= I	ead load factor for wearing	surface and utilities
$\gamma_{P}$	= I	oad factor for permanent lo	ad = 1.0
$\gamma_{{\scriptscriptstyle L}{\scriptscriptstyle L}}$	= I	ive load factor	

• Load Factor Rating (LFR) and Allowable Stress Rating (ASR)

$$RF_{LFR;ASR} = \frac{C - A_1 \cdot D}{A_2 \cdot L \cdot (1 + I)}$$

Rating in  $Tons = (RF_{LFR;ASR}) \cdot W$ 

$RF_{LFR;ASR}$	=	Rating factor for LFR or ASR
С	=	The capacity of the structural member
С	=	$f_{ m R}$ for ASR
D	=	Dead load on Structural Member
$f_{\rm R}$	=	Allowable Stress per the code
L	=	Live load effect on Structural Member
W	=	Weight (tons) of vehicle used to
		determine live load effect
I	=	The impact factor used with the live load effect
$A_1$	=	Factor for dead load
$A_2$	=	Factor for live load
$A_1 = A_2$	=	1.0 for ASR

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The HL-93 load rating for the Load and Resistance Factor Rating (LRFR) method is reported as a rating factor. All other ratings are reported as a rating in tons.

Effective July 1, 2002 CDOT will use the AASHTOWare Virtis computer application to perform bridge ratings. With the exception of post-tensioned superstructures, all ratings performed after July 1, 2002 for bridges in CDOT right-of-way shall be based on Virtis. In addition to post-tensioned superstructures, other bridges of unusual geometry or construction type may be waived from this requirement. Post-tensioned superstructures shall be rated as provided for by the CDOT Bridge Rating Manual.

All of the instructions and examples in the CDOT Bridge Rating Manual use the strip method of analysis (see AASHTO LRFD 4.6.2) and the AASHTO LFD live load distribution factors. Until otherwise provided for by the CDOT Bridge Rating Manual, curved superstructures and bridges designed by a refined method of analysis (LRFD 4.6.3) shall be rated using Virtis and the strip method unless
the Staff Bridge Branch Bridge Rating Program Engineer approves an exception. Equivalent distribution factors for composite dead loads and live loads shall
be used to obtain the appropriate rating at the sections required by the CDOT Bridge Rating Manual (see AASHTO LRFD 4.6.3.1, modified here as may be required for composite dead loads).

Rating requirement have changed with time. The following is a summary of the rating method requirements in this manual.

- All on-system and off-system bridges designed after October 1, 2010 are to be rated with LRFR.
- All on-system and off-system LRFD bridges rated or rerated after October 1, 2010 are to be rated with LRFR.
- All on-system and off-system ASD & LFD bridges rated or rerated after January 1, 1994 are to be rated with LFR, to the extent LFR is applicable to the structure type per the AASHTO specifications.
- All on-system and off-system ASD and LFD bridges on the NHS are to be rated with LFR, to the extent LFR is applicable to the structure type per the AASHTO specifications.
- When any on-system bridges that were constructed after 1985 are rated or rerated they shall receive a permit vehicle operating rating for interior and exterior girders with full impact and multilanes loaded.
- When any on-system bridges constructed before or during 1985 are rated or rerated they shall receive permit vehicle and modified tandem operating ratings with full impact and one lane loaded.

For the maintenance of the CDOT's Opis/Virtis database it is essential to use the most current version of Virtis. Ratings submitted to CDOT that are based on older versions will be rejected. Check with the CDOT Rating Engineer to verify the software version in use by CDOT.

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RATING SUMMARY SHEETS

# SECTION 1 GENERAL REQUIREMENTS

# 1.1 DEAD LOADS USED TO DETERMINE BRIDGE RATINGS

The dead load unit weights given in the current AASHTO LRFD Bridge Design Specifications and the current CDOT Bridge Design Manual shall be used, except where superseded by this Manual in Table 1-1.

Bridge decks with bare or asphalt wearing shall be rated for a minimum asphalt thickness of 3"; or an average asphalt thickness that is shown in the most current inspection report, whichever governs.

Bridge decks with Polyester Polymer Concrete (PPC) overlay shall be rated for a minimum overlay thickness of <sup>3</sup>/<sub>4</sub>"; or a thickness that is shown in the as-built plans, whichever governs. The overlay of PPC shall be omitted from the deck section properties.

The unit weight of fill soil on all buried structures shall be per Table 1-1, unless otherwise specified in the as-built plans. A pavement thickness of 6" above the buried structure shall be assumed if the roadway pavement thickness is unknown.

The uniform weight of permanent steel deck form shall be included if it is used for concrete decks placed between girders, and inside box girders.

Material Unit Unit Weight Asphalt lbs/ft<sup>3</sup> 146.67 Polyester Polymer Concrete (PPC) lbs/ft<sup>3</sup> 135.0 lbs/ft<sup>3</sup> 125.0 Fill Soil Permanent Steel Deck Form lbs/ft<sup>2</sup> 5.0 Reinforced Cast-in-Place Concrete lbs/ft<sup>3</sup> 150.0 **Reinforced Precast Concrete** lbs/ft<sup>3</sup> 163.0

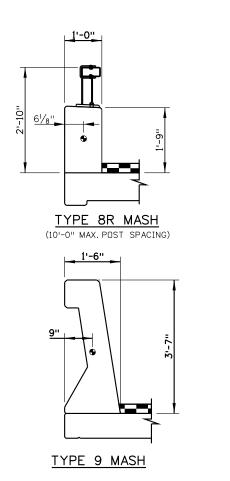
Table 1-1: Unit Weights of Materials

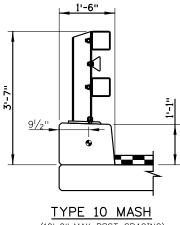
The weight of bridge rails to be used for rating shall be based on the most current as-built plans. Verifications of bridge rail weight shall be required, except values from Table 1-2 can be used for the MASH (Manual for Assessing Safety Hardware) bridge rails (i.e. Type 8R, Type 9 and Type 10), and the previous standard bridge rails (i.e. Type 3, Type 4, Type 7, Type 8, and Type 10).

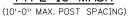
Rail Type	Structural Steel (lbs/ft)	Concrete Curb (*) (lbs/ft)	Total (lbs/ft)
Туре 3	45.4	142.6	187
Туре 4	N.A.	426.1	426
Туре 7	N.A.	481.8	482
Type 7, style C-C	N.A.	538.4	538
Туре 8	26.5	437.4	464
Type 8R MASH	19.5	262.5	282
Type 9 MASH	N.A.	483.8	484
Type 9, style CC MASH	N.A.	758.8	759
Type 10 MASH	45.8	243.7	290
Type 10 (10, 10M, 10R)	45.1	244.4	290

Table 1-2: Unit Weights of Standard Rail Systems

(\*) The concrete curb weights are computed from the Figure 1-1. The concrete curb weight shall be re-computed if the existing curb geometry is different.







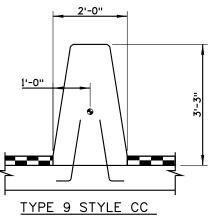
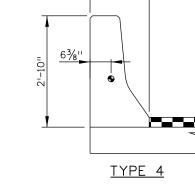


Figure 1-1 MASH Bridge Rails

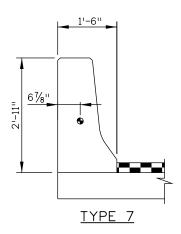
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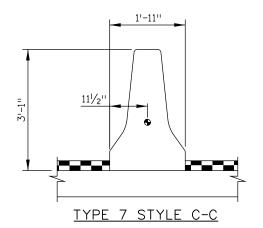


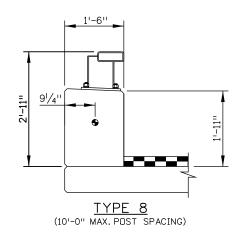


1'-6''



(6'-3" MAX. POST SPACING)





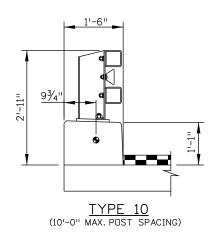


Figure 1-1 (Continued) Old Standard Bridge Rails

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# 1.2 LIVE LOADS USED TO DETERMINE BRIDGE RATINGS

Colorado Bridge Ratings are required at three different levels: Design Load Rating, Legal Load Rating, and Permit Load Rating and shall be reported on the Rating Summary Sheet. The vehicles of three levels are as specified hereon and in the current AASHTO Manual for Bridge Evaluation (MBE).

These three different levels shall be used to compute the load ratings for all structure types and for all 3 rating methods: Allowable Stress Rating (ASR), Load Factor Rating (LFR), and Load and Resistance Factor Rating (LRFR).

# 1.2.1 Design Load Rating Level

- A) For ASR and LFR methods: The HS20-44 Loading consisting of a Standard HS20 Truck or Standard Lane Load shall be used when computing the Inventory and Operating Load Ratings in US tons. See Figure 1-2.
- B) For LRFR method: The HL-93 Design Load shall be used when computing the Inventory and Operating Rating Factors. See Figure 1-3. Additional HL-93 Load Models:
  - 90% of Design Truck pair that is spaced a minimum of 50 feet between the lead axle of one truck and the rear axle of the other truck, combined with 90% of the Design Lane Load shall be used to compute the ratings factor at the pier(s) for negative moment.
  - For steel bridges, the fatigue truck shall be required to compute the Inventory Rating Factor. The fatigue truck consists of one design truck, similar to the truck in Figure 1-3, but with a constant spacing of 30 feet between the 32-kip axles.

## 1.2.2 Legal Load Rating Level

The Legal Vehicles are required to be used when computing the Operating Load Rating in US tons. The structure is required to be posted when the load rating is less than the gross vehicle weight limit.

- A) Colorado Legal Vehicles:
  - Colorado Legal Trucks of Type 3, Type 3S2, and Type 3-2 shall be used for bridges on State highway routes or Interstate business routes. See Figure 1-4.
  - Interstate Legal Trucks of Type 3, Type 3S2, and Type 3-2 are State-Specific Vehicles modified from the AASHTO and the Colorado Legal Loads. See Figure 1-5. These Interstate Legal trucks shall be used for bridges on Interstate highway routes or Interstate access ramps.

Legal Vehicles are composed of the maximum vehicle loads allowed by law in Colorado. The difference between the live loads in Figures 1-4, and 1-5, is due to the maximum legal loads allowed on Interstate highways being different from those allowed on other Colorado roadways.

- B) Specialized Hauling Vehicles (SHV):
  - Notional Rating Load (NRL). See Figure 1-6.
  - Single Unit Bridge Posting Loads of SU4, SU5, SU6 and SU7. See Figure 1-6.
- C) FAST Act's Emergency Vehicles (Fixing America's Surface Transportation Act):
  - Emergency Vehicles of EV2 and EV3 are Notional vehicles. See Figure 1-7.

NOTE: AASHTO Legal Loads of Type 3, Type 3S2 and Type 3-3, and AASHTO Lane-Type Legal Load Model are NOT required for load ratings.

Colorado has a grandfather provision under Federal law (23 CFR Part 658, Appendix C) to allow the Interstate Legal Trucks of Type 3, Type 3S2, and Type 3-2 supplanting the AASHTO Legal Loads of Type 3, Type 3S2 and Type 3-3 on the Interstate highways.

If the load rating factor for the NRL is 1.0 or greater, then there is no need to rate for the single-unit SU4, SU5, SU6 and SU7 Vehicles. See Subsection 1.14 for how to report the rating results.

Legal Vehicle Weight Limits:

- Maximum gross weight of vehicle that is legal on any Non-Interstate Colorado highways shall be satisfied with the Colorado Bridge Formula.
  - Gross Weight (lbs) =  $(L + 40) \times 1,000$  (C.R.S. 42-4-508 (1)(b)) Maximum gross weight of vehicle that is legal on any Interstate highways shall be satisfied with the Federal Bridge Formula B except Emergency Vehicles.
    - Gross Weight (lbs) = 500 (LN / N-1 + 12N + 36)

Where:

- L = the distance in feet between the outer axles of any two or more consecutive axles.
- N = the number of axles.

The Gross Vehicle Weight (GVW) of SU6 and SU7 do not meet the Colorado Bridge Formula. See Subsections 1.15.1 & 1.15.2 for how to post weight limits of SU6 & SU7 on non-interstate roads.

The GVW of EV2 and EV3 do not meet Federal Bridge Formula B, but could cover situations when emergency vehicles need access to Interstate Highways, or Reasonable Access.

# 1.2.3 Permit Load Rating Level

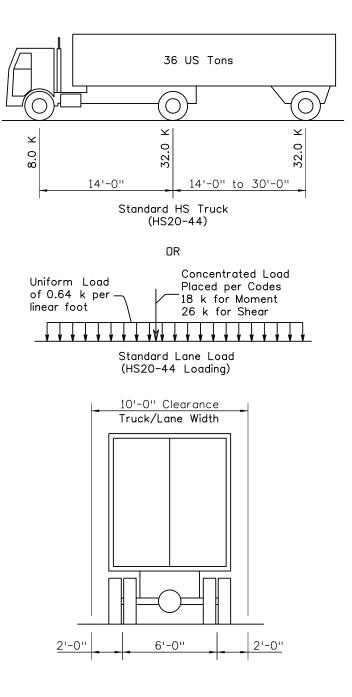
The Operating Load Ratings in US tons of the Permit Load Rating Vehicles shall be used to determine the Color Code of the bridge. See Subsection 1.16.

A) Colorado Permit Vehicle. See Figure 1-8.

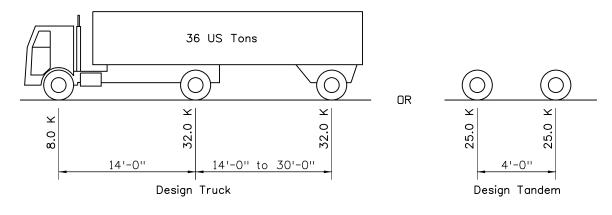
The Colorado Permit Vehicle is also required to be used for the design of new bridges for AASHTO LRFD Load Combination Strength II. Therefore, the Colorado Permit Trucks' configurations are currently used to institute the Colorado maximum allowable permit weight per axle group.

B) Colorado Modified Tandem Vehicle. See Figure 1-8.

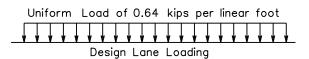
## **HS20-44 Loading** Used to determine the Inventory and Operating load ratings in US tons

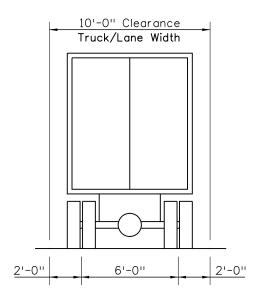






PLUS

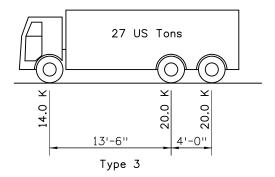


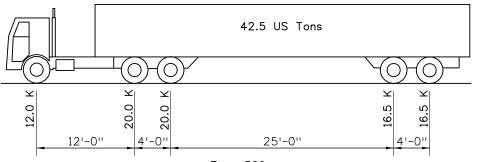




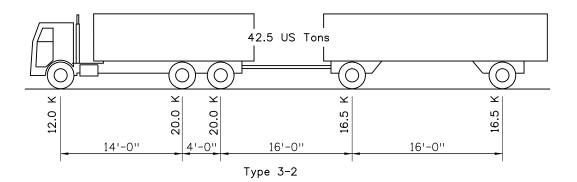
# **Colorado Legal Trucks**

Used to determine the Operating load ratings in US tons along Colorado State Highways Truck width: 10'-0" Axle gage width: 6'-0"





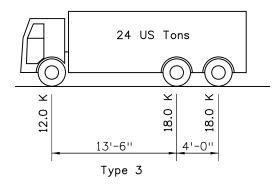


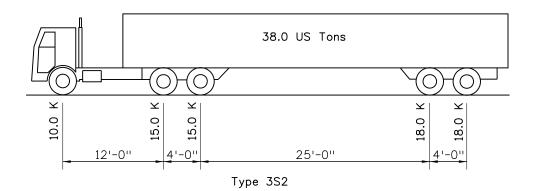


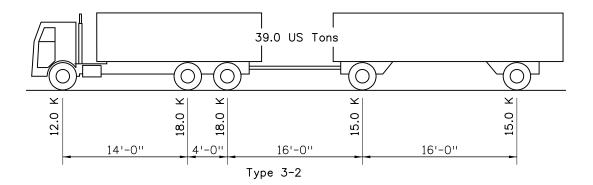
1-8

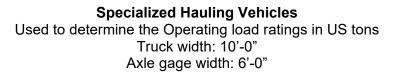
# Interstate Legal Trucks

Used to determine the Operating load ratings in US tons along Interstate Highways Truck width: 10'-0" Axle gage width: 6'-0"

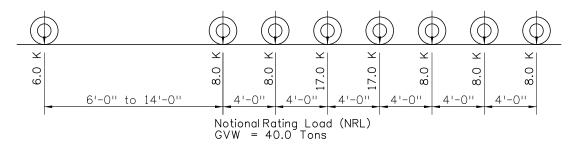




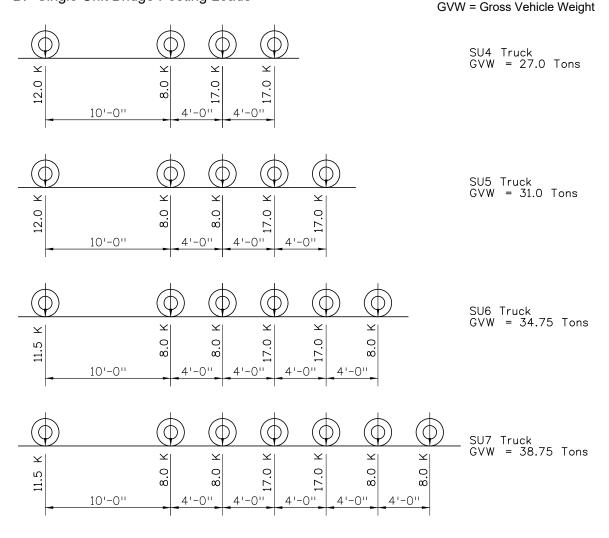




A. Notional Rating Load (NRL)

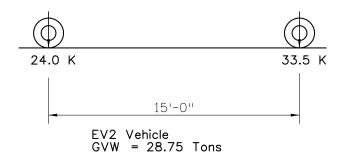


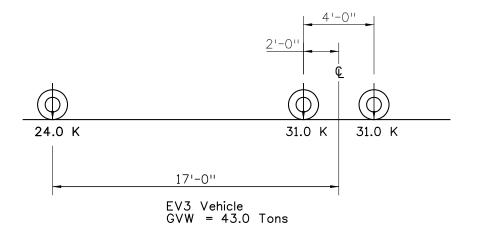
B. Single Unit Bridge Posting Loads



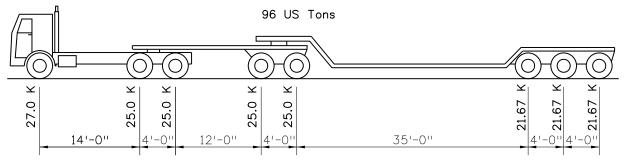


# Emergency Vehicles – Notional Vehicles Used to determine the Operating load ratings in US tons Truck width: 10'-0" Axle gage width: 6'-0"

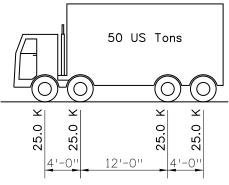




GVW = Gross Vehicle Weight







Colorado Modified Tandem Vehicle

Figure 1-8

1-12

# 1.3 IMPACT, LOAD FACTOR, AND DISTRIBUTION OF LIVE LOADS

The live load impact used for rating shall be as specified in the current AASHTO LRFD and Standard Specifications for Highway Bridges, as applicable, except as noted. The live load impact shall be applied for all bridge types, except to timber bridges.

The live load distribution factors used for rating shall be as specified in the current AASHTO LRFD and Standard Specifications for Highway Bridges, except as noted and elsewhere in the manual.

The load factors used for rating shall be as specified in the Standard Specifications for Highway Bridges and the current AASHTO Manual for Bridge Evaluation, except as noted and elsewhere in the CDOT Rating Manual.

- A) Based on CDOT historical practice of overload permit analysis using LFR method (e.g., gross vehicle weight over 200,000 lbs), when reduced vehicle speed to 10 mph is enforced, impact can be reduced by 67% when crossing the structure.
- B) Impact shall not be considered for timber bridges.
- C) For bridges constructed or rehabilitated after 1985, all ratings shall use multi-lane live loaded distribution factor. A single lane live load distribution factor for Permit Vehicles may be used with approval by the Bridge Rating Engineer.
- D) For bridges constructed in 1985 or earlier, or bridges with one-lane traffic, rating and re-rating for Legal Load vehicles and Colorado Permit vehicles may be performed using a single lane live load distribution factor. The vehicle may be assumed to occupy the center of a single driving lane without concurrent live loading in any other lane. Non-redundant (fracture-critical) structures shall only utilize multi-lane live loaded distribution factors due to the likelihood of failure of entire structure if one part fails. The design vehicle ratings shall be rated with multi-lane live load distribution factor.
- E) When bridge geometric constraints (e.g., span length, number of girder and girder spacing) are outside the range of live load distribution formulas specified in the AASHTO Specifications, the lever rule method or other software may be used to calculate the live load (single or multi-lane) distribution factors.
- F) When the lever rule method is used to determine distribution factors for exterior stringers, exterior deck girders, through girders, and trusses, place the first truck wheel 2'-0" from the front face of curb or railing. The transverse distance from centerline to centerline of the standard gage trucks shall be 12'-0" or the width of one traffic lane for narrow bridges.
- G) For any load rating methods, the placement of the wheel load shall be 1 foot from the face of the curb or railing for rating of deck overhang, and 2 feet for rating of girders.
- H) For LFR load ratings, when ratings for Legal or the Permit vehicles are less than the gross vehicle weight limits, the Rater may use the Distribution Factor-Line Girder setting in BrR (NSG analysis) to improve the load ratings with approval by the Bridge Rating Engineer. The NSG analysis shall not be used for culverts, timber, or fracturecritical structures.

- For LRFR load ratings, the refined distribution factor method is not allowed for load ratings of bridges, except if it is approved in advance by the Staff Bridge Rating Engineer.
- J) Live load distribution factors for two-girder bridge systems and trusses shall be calculated using the lever rule method.
- K) The distribution of non-composite and composite dead loads shall be as specified in the current CDOT Bridge Design Manual.
- L) For all bridge types, load factors for load rating shall comply with the AASHTO MBE, except a minimum live load factor of 1.3 for operating rating may be used for Emergency Vehicles on all levels of traffic volume for LRFR and LFR methods.
- M) For all buried pipe/arch culverts and CBCs, the LRFR live load factor for operating rating of 1.35 shall be used for design vehicle, 2.0 for legal loads, and 1.4 for permit loads on all levels of traffic volume. Only the single loaded lane with multiple presence factor of 1.0 may use for legal load and permit load ratings; while 1.2 is used for design load rating.
- N) The maximum and minimum depths of fill on CBCs may be determined at the roadway pavement areas. Distribution of wheel loads through earth fills shall be neglected where the depth of fill exceeds the limits as specified in the current AASHTO LRFD, Section 3.6.1.2.6. See Subsection 1.14 for how to report the rating results.
- O) The Emergency Vehicles may be performed using a single lane live load distribution factor for existing or new bridges.
- P) For reinforced and prestressed concrete structures, the service I & III limit states may ignore in ratings for the Legal and Permit Vehicles.
- Q) For timber structures with stagger stringers at piers, an average stringer spacing of the exterior bays on both sides may be used for ratings.
- R) For two-girder bridge systems, trusses, floor-beams, and culverts, an equivalent double-dolly truckload to a regular 10 feet wide truckload shall NOT be allowed for overload permit ratings.

## 1.4 STRUCTURAL ANALYSIS METHODS USED TO DETERMINE BRIDGE RATINGS

The load ratings shall include analysis of the superstructure for components defined as primary members such as girders, in-span hinges, stringers, deck, truss, floor-beams, truss connections, etc. The substructures / foundations will not be required for load ratings except as requested by the Bridge Inspection Engineer, being necessary due to vehicle impact and scour substructure elements, etc.

Major structures (i.e. total span length greater than 20 feet) are required to have load ratings, and minor structures (i.e. span length from 4 feet to less than or equal to 20 feet) will be required to have load ratings per Subsection 1.8.

- A) All bridges designed with LRFD method or designed after September 30<sup>th</sup>, 2010 shall be rated or re-rated with LRFR method.
- B) All existing ASD & LFD bridges designed before October 1<sup>st</sup>, 2010, except existing timber bridges, shall be rated or re-rated with LFR or LRFR methods.
- C) All timber bridges shall rated or re-rated with ASR method.
- D) All existing buried pipe/arch culverts may be rated or re-rated with LFR or LRFR methods. New buried culverts shall be rated with LRFR method.
- E) For multiple lines of buried pipe structure that meets the minimum spacing between pipes per AASHTO LRFD, Section 12.6.7, a single pipe instead of multi-pipe may be modeled for load rating analysis.
- F) All existing concrete and metal plank decks of bridges designed before October 1<sup>st</sup>, 2010, shall be rated or re-rated with LFR method. Bridges constructed with partial or full-depth precast pre-stressed concrete decks are not required for ratings except as requested.
- G) All concrete decks of bridges designed after September 30<sup>th</sup>, 2010 are not required to be rated except as requested. New metal plank decks shall be rated with LRFR method.
- H) All decks shall be rated for design trucks only.
- When existing bridges are re-decked, the girders shall be re-rated with the same method used to design the new deck, except if approved in advance by the Bridge Rating Engineer.
- J) When existing LFD or ASD bridges are widened with LRFD method, the widened portion shall be rated with LRFR method, and the original part may be re-rated with LFR method.
- K) For precast pre-stressed concrete girders, the transformed section properties and the AASHTO refined method for losses may be used for load ratings.
- L) For multi-span precast pre-stressed concrete continuous girders that are designed with LRFD method, the degree of continuity at pier(s) shall be determined in accordance with the current CDOT Bridge Design Manual, Section 5.7.3.
- M) For LRFD reinforced and pre-stressed concrete bridges constructed after December 2001, the load ratings for shear shall be required. *Commentary: Per CDOT-Staff Bridge's Technical Memorandum dated Jan.* 31<sup>st</sup>, 2000, all structures shall be designed and checked with the LRFD design method beginning in January 2002.
- N) For existing reinforced and pre-stressed concrete bridges constructed in December 2001 or earlier, when the LFR load-rating factor for shear is less than 1.0, the bridges may be rated with LRFR Modified Compression Field Theory (MCFT) method.

- O) For existing reinforced and pre-stressed concrete bridges constructed in December 2001 or earlier, the load ratings for shear shall be required for bridges that have visible signs of shear distress; or if the Colorado NBI condition coding is less than 5. The shear load rating may be ignored by the Bridge Rating Engineer approval for bridges that have no visible signs of shear distress, and the Colorado NBI condition coding is 5 or greater.
- P) For all steel bridges, the load ratings for shear shall be required.
- Q) For ASD and LFD steel bridges, the field splices and pin connections are not required for ratings, except as requested by the Inspection Unit due to severe corrosion or section loss by vehicular hit.
- R) All LRFD steel bridges shall include field splices and pin connections in ratings.
- S) Pedestrian bridges that are designed to carry maintenance or emergency vehicles shall be rated in accordance with the current CDOT Bridge Design Manual. The pedestrian load shall not be considered concurrently with the vehicle load.
- T) For roadway bridges with sidewalk, the use of pedestrian load shall not exceed the value given in AASHTO Standard Specifications, Section 3.14.1.1. If the sidewalk is not protected by a traffic barrier, the sidewalk loadings shall be considered for two cases:
  - Vehicles on the sidewalk without pedestrian load.
  - Full pedestrian load on the sidewalk without vehicle load.
- U) For a curved bridge with straight girders, and variable overhangs, the bridge may be modeled with maximum overhang on one side and minimum overhang on the other.
- V) Existing ASD or LFD multi-span continuous bridges designed with simple span made continuous that have load ratings for negative moments less than the gross vehicle weight limits may be rated or re-rated for single span by applying a hinge at the pier location or by using single span models with approval in advance by the Bridge Rating Engineer.
- W) If a curved bridge can be designed as straight segments, as per the requirements of the AASHTO LRFD Section 4.6, the horizontally curved girders may be rated as straight girders with a span length based on the arc length of the longest interior girder. This engineering judgment shall be approved in advance by the Bridge Rating Engineer.
- X) For LRFR method, the frequency of the permit vehicle properties will be selected for unlimited crossing, and the loading condition will be selected for mixed with traffic.
- Y) For complex structures such as curved, and varying skews at supports that cannot be modeled in the BrR program, a 3-D finite element model or appropriate software may be used for rating with approved in advance by the Bridge Rating Engineer.
- Z) Any engineering judgment that is made for structural analysis shall be approved in advance by the Bridge Rating Engineer.

AA) For CBCs constructed before 1992, the loading data that is specified in the corresponding M-Standards, as-built plans, or in the corresponding design specifications may be used for LFR, or LRFR ratings.

#### 1.5 MATERIAL PROPERTIES USED TO DETERMINE BRIDGE RATINGS

For all structures, the material properties used for the rating shall be based on the material grade or design stresses specified in the plans. When plans are not available or do not specify material grade or design stresses, the Rater must then use their best judgment to determine the appropriate material properties based on the information available. Normally, this decision is based on the year the bridge was constructed.

The year of construction may also be determined by engineering judgement by using comparable structures with known plans or other similarly constructed bridges such as parallel bridges.

Table 1-3 shows the material properties based on year of construction, used by the Colorado Department of Transportation. This material property table is based on the predominant grade of materials used by the Colorado Department of Transportation during the years indicated.

After making a thorough investigation into all possible sources of information concerning an existing structure, if the rater is still unable to determine the grade of material used, or year of construction, then a conservative estimate of the construction year should be made. Then, the material property in Table 1-3 can be used.

For steel structures, it is possible that the year of construction and the year of member fabrication do not coincide; e.g., when salvaged members have been utilized. In this case, the year of fabrication shall be used in determining the steel yield stress ( $F_y$ ).

For metal and plastic pipe/arch culverts, the material properties shall use default values from the CANDE rating software.

# Year of Construction for CDOT Bridge Rating

(When the Actual Grade of the Material is Unknown)

#### LFR and LRFR Ratings

Er it and Ett it it it at ingo				
	Year of Construction	LFR or LRFR	AS	SR
Material		F <sub>y</sub> or f <sub>c</sub>	Inventory	Operating
	Construction	(psi)	(psi)	(psi)
			0.55 F <sub>y</sub>	0.75 F <sub>y</sub>
	Prior to 1905	26,000	14,000	19,500
Structural Steel - Bending	1906 to 1936	30,000	16,000	22,500
Structural Steel - Denuing	1937 to 1963	33,000	18,000	24,500
	After 1963	36,000	20,000	27,000
				0.45 F <sub>y</sub>
	Prior to 1905	26,000	8,500	11,500
Structural Steel - Web Shear	1906 to 1936	30,000	9,500	13,500
Structural Steer - Web Shear	1937 to 1963	33,000	11,000	15,000
	After 1963	36,000	12,000	16,000
	Prior to 1954	33,000	18,000	25,000
Reinforcing Steel	1955 to 1971	40,000	20,000	28,000
	After 1971	60,000	24,000	36,000
	Prior to 1959	2,500	1,000	1,500
	1960 to 1976	3,000	1,200	1,900
Structural Concrete	1977 to 1981	4,000	1,600	2,200
	After 1981	4,500	1,800	2,450
Prestressed Concrete	Based on the Actual Grade of Material Used			
Prestressing Steel Strands	Base	ed on the Actual G	Grade of Material U	sed
Allowable Stress Ratings (ASR)	1			
Material	All Years of	Inventory	Operating	
Materia	Construction	(psi)	(psi)	
	Bending (F <sub>b</sub> )	1,600	2,128	
Timber (Douglas Fir	Shear ( $F_v$ ) *	113	150	
1				

\* Use when more than 75% of the total number of stringers have NO splits or shear critical cracks.

Shear (F<sub>v</sub>) \*\*

Shear (F<sub>v</sub>) \*\*\*

\*\* Use when 25% or more of the total number of stringers are repaired for splits or shear critical cracks.

\*\*\* Use when 25% or more of the total number of stringers are not repaired for splits or shear critical cracks.

98

85

130

113

c

*c* Agreeing to Anthony J. Lamanna, Arda Akbiyik, James C. ray, and Gerardo I. Velazquez (May 2007), "Feasibility Investigation into Strengthening of Timber Bridge Stringers". Use approximately a 44% increase of operating shear strength after timber stringers with horizontal splits or cracks are repaired.

Table 1-3

Select Structural)

## 1.6 AVAILABLE RATING COMPUTER PROGRAMS

#### A) BrR Software:

CDOT requires the use of AASHTOWare Bridge Rating (BrR) software to perform load ratings for bridges and reinforced concrete box culverts (CBC).

https://www.aashtowarebridge.com/bridge-rating-and-design/

The main advantages of the program are:

- Its utility for automated batch analysis.
- Easily updated load rating when the condition of a structure changes or with new live loads requirements.
- The BrR software is currently used for CDOT Oversize Overweight Permitting and Routing (COOPR) program.

Due to limitations of the BrR software or for other reasons, such as post-tensioned bridges other than the post-tensioned multi-cell box girders, steel box girders, flexible culverts, or complex structures, hand calculations or other software that complies with AASHTO codes may be used to determine the load ratings with approval in advance by the Bridge Rating Engineer.

The BrR software is the AASHTO analytical engine for Load and Resistance Factor Rating (LRFR), Load Factor Rating (LFR), and Allowable Stress Rating (ASR). This software supports two or three dimensional bridge descriptions.

The BrR software can perform load ratings for most common bridge types. The software allows the user to define many bridge alternatives (models) with different structure types to the same bridge.

The BrR software can select the desired analysis type from the Analysis Settings window for CDOT's bridge ratings:

- Line Girder setting (Standard Analysis) is required for all ASR, LFR or LRFR load ratings.
- Distribution Factor-Line Girder setting (NSG) can be used for non-standard gage vehicles, or improving the LFR load ratings for legal or permit vehicles as stated in Subsections 1,3 (H), 1.15.1 & 1.16.
- 3D Finite Element Method setting (FEM) may be used for complex structures (i.e. curved bridges) with approval in advance by the Bridge Rating Engineer.

The BrR tolerance feature can be set by clicking on the CONFIGURATION BROWSER / SYSTEM DEFAULTS / TOLERANCE in the interface WINDOW. Failure to set the tolerance values will cause errors during the analysis. When a newer version of the software is installed, the BrR tolerances must be reset on each user's computer. The following tolerance values shall be used with bridge ratings located in CDOT's jurisdiction:

<u>US Unit</u>	<u>Tolerance</u>	<u>SI Unit</u>	<u>Tolerance</u>
ft.	0.01	m	0.003048
in.	0.25	mm	6.35
mi.	0.01	km	0.01

For structures that designed in SI unit, the Raters should perform the rating in the SI unit. Advantageously, the BrR load rating outputs will automatically report in US unit.

When rating a structure in BrR, the structure number provided by the Bridge Asset Management Unit (Staff Bridge) will be used for the Structure ID Number. The following naming convention shall be used to organize the explorer window in BrR. Overload critical bridges used for routing will be assigned the prefix (Z). Only structures on the critical list (e.g. older posted and color coded bridges) should be assigned the prefix (Z). When a rating is in progress or when re-rating a structure, BrR users will add a (7) as the prefix. Once a rating is completed and sent to the Bridge Rating Unit, the Staff Bridge Rating Coordinator will remove any prefix before placing in the BrR global database. Therefore, any structure without a prefix is the final rated structure. Examples:

F-17-BY: a final accepted rated structure

7F-17-BY: a structure being re-rated or a new rating in progress.

ZF-17-BY: a structure on the critical list used for overload routing.

Before finalizing the rating package for submittal, BrR users shall verify with the Staff Bridge Rating Coordinator that the correct version of the software is used in the analysis. This ensures proper maintenance of CDOT'S BrR database for future use. Ratings submitted to CDOT that are based on older versions will be rejected.

Consultants working with CDOT, or various City and County agencies within the State of Colorado, can obtain BrR at a discounted rate from the AASHTO; however, a written certification is required from CDOT Staff Bridge Rating Engineer.

B) CANDE Software:

CANDE software is a program that requires two parts of analysis including CANDE modeling & CANDE toolbox. CANDE Modeling software is used to model half of culvert in 2D finite element (levels 1 & 2 analysis), and CANDE Toolbox software uses to convert the half culvert model to full culvert model (level 3 analysis), and compute the Rating factor (RF) for any vehicles. Both parts shall be used together to rate the buried pipe/arch culverts for all shapes and materials including reinforced concrete, metal and plastic.

The CANDE software can be downloaded for free at the following address:

http://www.candeforculverts.com/download.html

Buried pipe/arch culverts that are rated with the LRFR method shall use the latest version of CANDE software.

See BRM Section 14A for culvert rating example with CANDE.

CANDE software is an AASHTO sponsored culvert analysis and design software. Programs other than the CANDE must be approved in advance by the CDOT Bridge Rating Engineer.

C) Staff Bridge Software Library:

Below is a current list of computer rating software available from the Staff Bridge Branch Software Library available online at:

https://www.codot.gov/business/engineeringapplications/available-software.html

Any questions regarding the software, including software access, should be directed to the Staff Bridge Rating Engineer.

- 1) PLANK-Corrugated Steel Plank Rating: Rates asphalt filled, corrugated metal plank decks placed perpendicular to traffic.
- 2) SLAB-Concrete Slab Rating: Rates slabs continuous over three or more supports with reinforcing placed perpendicular to traffic. The slab must be supported by longitudinal girders, and cannot be pre-stressed.
- 3) Timber Bridge Rating: Rates plank timber decks with asphalt filled placed perpendicular to traffic. Do not use this program for timber stringer rating.
- D) Other Structural Software:

When BrR is not applicable for load ratings, other structural software that complies with the AASHTO codes may be used to support the hand calculations with Staff Bridge Rating Engineer's approval. The following software programs are used by CDOT:

CSI Bridge SAP2000 LARSA MDX LEAP BRASS MathCad Excel, and Other software as approved

# 1.7 LOAD RATING OF BRIDGES WITHOUT PLANS

Structural dimensions and material properties are needed to perform load ratings. However, existing bridges built years ago may not have the construction plans (as-built plans).

The Rater shall cooperate with the Bridge Asset Management Unit to search for the asbuilt plans and any design/rating calculation notes that are available in the ProjectWise database, bridge Briar server, or structure paper inspection folder; and shall make a notification to the Bridge Rating Coordinator if the bridge's information is not available.

Alternatively, the as-built plans may be determined by engineering judgement of comparable structures with known Standard plans, or plans of other similarly constructed bridges such as parallel bridges.

When the as-built plans cannot be located, the following may be used to determine the load carrying capacity:

## 1.7.1 Bridge Ratings with Field Investigation and Year of Construction

Steel or timber structures may be rated with BrR software using field dimensions, and year of construction:

- Measurable superstructure dimensions such as span length, girder dimension, girder spacing, diaphragm dimensions and locations, deck width, deck overhang, and deck thickness.
- Based on year of construction, the material properties can be determined by using Table 1-3.

# 1.7.2 Bridge Ratings Based on Physical Inspection

A) Load Capacity Ratings through Engineer Judgment for existing On-system Concrete Bridges:

As per AASHTO Manual for Bridge Evaluation, 3<sup>rd</sup> Edition 2018 Section 6.1.4: "A concrete bridge with unknown details need not be posted for restricted loading if it has been carrying normal traffic for an appreciable period of time and shows no distress. The bridge shall be inspected regularly to verify satisfactory performance"; therefore, the concrete bridges without as-built plans, evaluated with a Colorado NBI condition coding of 5 or better for girders, and showing no signs of distress due to load, can be considered having sufficient live load capacity for the design vehicles.

History of CDOT's design vehicles according to year of construction:

< 1944	H20 Design Vehicle	
1944 to Dec., 1993	HS20 Design Vehicle	
Jan., 1994 to Dec., 2001	HS25 Design Vehicle	
Jan., 2002 to present	HL93 Design Vehicle	
	÷	

The Rater uses the appropriate design vehicle above to back-calculate for reinforced steel area:

- 1. Determine the material properties based on year of construction by using Table 1-3.
- 2. Measurable superstructure dimensions such as span length, girder dimension, girder spacing, diaphragm dimensions and locations, deck width, deck overhang, and deck thickness.
- 3. Based on the field girder dimensions, determine the cracking moment ( $M_{CR}$ ) of the concrete girders.
- 4. Determine the factored moment (LL + DL) using the multi-lane design vehicle with full impact.
- 5. Estimate the reinforcing area or pre-stressed steel area based on the greater of the factored moment (LL + DL) and the cracking moment.
- 6. The estimated reinforcing or pre-stressed steel area and field dimensions shall be used for load rating with BrR software.
- B) Field Inspection Load Ratings for Concrete Culverts and off-system bridges: When an existing major Concrete Box Culvert (CBC), concrete arch/pipe, masonry arch, concrete deck, or off-system concrete bridge without as-built plans that is evaluated with a Colorado NBI condition coding of 5 or better (item 59 for bridges, or item 62 for culverts); shows no signs of distress due to load, and no change of earth fills or dead loads for an appreciable period of time, the Professional Engineer registered in the State of Colorado can assign maximum load ratings as followings:
  - Assign inventory load rating = 36 tons, and operating load rating = 40 tons for the Design Vehicle.
  - Assign weight limits for the Legal Vehicles by using Table 1-4. Omit the Single-Unit and Emergency Vehicles on the Rating Summary Sheet (RSS).

• Assign load rating = 96 tons for the Permit Vehicle. Value not necessary for offsystem structures.

When there are signs of distress, change of earth fill, or deterioration on the structure rating components, an appropriate judgment should be made to reduce live load carrying capacities as guidance in sections 8.4 & 14.2.

# 1.7.3 Non-Destructive Test Loading in the Field

For concrete bridges or concrete culverts, when the amount of reinforcing steel is unknown and the Colorado NBI condition coding is less than 5, or shows signs of distress due to load, a non-destructive diagnostic load test in the field shall be required to estimate the reinforcing area based on the field strain data. The estimated steel area and field dimension shall be used for load rating with BrR software. For other methods of determining the steel area, CDOT is not currently confident with scanning. Destructive load tests are not advised per stability concerns.

Notes for bridges without plans:

1. For steel bridges, if the top flanges of the steel girders are embedded into the bottom of the concrete deck, the steel girders and concrete deck should be considered as non-composite slab-girder.

Commentary: per CDOT historic practical design for simplest steel girder types of non-composite sections, when the top flanges of the steel girders do not have shear studs, the top flanges shall be embedded into the bottom of the concrete deck for receiving full lateral bracing.

- 2. For concrete bridges, the concrete girders and concrete deck shall be considered as composite slab-girder.
- 3. For concrete bridges with no visible shear distress, the non-destructive test loading for shear is not required.
- 4. The existing multi-span continuous bridges may be rated as a single span as specified in Subsection 1.4.

## 1.8 MINOR STRUCTURE LOAD RATINGS

- A minor structure such as a bridge, culvert or cattle/deer guard is a structure where the total crossing length, parallel to the centerline of the roadway, is 4.0 ft. to 20.0 ft. The following shall be considered for load ratings:
  - A) All existing minor structures will not require load ratings, except when the structural physical condition does not ensure the safe use of such a structure for vehicles.
    - Load ratings are required for all existing minor bridges or culverts with a Colorado NBI condition coding of 4 or lower for item 59, superstructure or item 62, culvert. The Bridge Inspector shall review the bridge inspection report, and make a request as needed. The load rating shall be completed within 60 days after the Rating Engineer receives the notice.
  - B) All new or widened minor structures shall require load ratings as follows:
    - Steel pipes, steel arches, reinforced concrete pipes, reinforced concrete arches, cast-in-place CBCs, and precast CBCs that do not meet minimum requirements for section modulus, material properties, or construction details from the CDOT M-Standards or ASTM Standards.
    - New Cattle/Deer guards within CDOT ROW not meeting the minimum M-standard requirements will require a rating unless they service private roads or accesses.

- All girder, slab, and truss bridges.
- C) Load ratings are not required for minor structures when the earth fill depth exceeds the limit as specified in the AASHTO LRFD, Section 3.6.1.2.6:
- I
- For single span structures, load ratings are not required where the depth of fill is more than 8.0 ft. and exceeds the span length.
- For multiple spans structures, load ratings are not required where the depth of fill exceeds the distance between inside faces of end walls or abutments.

## 1.9 OFF-SYSTEM STRUCTURE LOAD RATINGS

There is no different load rating performance between on-system and off-system bridges. The current AASHTO Manual for Bridge Evaluation, and the CDOT Bridge Rating Manual (except the Overload Color Code Rating, Subsection 1.16) shall be applied to the off-system structure ratings.

## (SUBSECTION 1.10 RESERVED FOR FUTURE USE)

#### 1.11 SUMMARY OF RATING PROCEDURE (IN-HOUSE)

#### 1.11.1 Purpose

The purpose of the rating process is twofold. First, it determines and documents the maximum safe inventory and operating live load capacities of bridges. Second, the rating process can help find possible miscalculations or omissions in new superstructure designs. The design can then be corrected and the plans revised before the structure is built.

#### 1.11.2 Responsibility

The Rater is the person selected to compute the ratings of a bridge. The Rater is responsible for gathering all of the required materials, making all of the necessary calculations, and completing the rating package as outlined in Subsection 1.13. The Rater must also ensure that the most up-to-date Rating Summary Sheet, computer program manuals, and any other materials required to perform bridge ratings are used.

The Checker is the person responsible for verifying that the rating is accurate, that follows established procedures, and that the rating package is complete. If the Checker finds any inaccuracies or omissions, the Checker will return the rating package to the Rater for corrections.

Either the Rater, the Checker or the Engineer responsibly in charge must be a Colorado Registered Professional Engineer and shall stamp the Rating Summary Sheet (RSS).

#### 1.11.3 Procedure

See Figures 1.9, 1.10, 1.11 and 1.12 for flow charts of the following:

**Rating:** The Rater makes the necessary sketches and calculations to show how the structure was modeled, dead loads were derived, and how other computer input was defined. The rater shall indicate the source of the structural data. The only sources of information used for rating shall be Advanced Plans, Construction

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Plans, As-Constructed Plans, and Field Surveys. The ratings are then completed using the proper rating procedure for the type of structure being assessed.

For new or rehabilitated bridges, if any load rating value is not equal to or greater than the rating factor limit of 1.0 or the gross vehicle weight limit, the bridge should be investigated to determine whether or not a re-design is needed. To finish the rating documentation and complete the rating package, the Rater shall do all of the following:

- A) Completely fill in all of the required forms.
- B) Initial and date the computer output.
- C) When rating a new design, on a separate sheet of paper, document the construction status for BMS (Bridge Management System) and state if the rating is for a new bridge or for the reconstruction of an existing bridge. This sheet is to be kept with the Rating Summary Sheet.
- D) Bind the rating package together.
- E) Forward the rating package to the Checker.

**Checking:** The Checker shall verify all calculations and ratings, e.g., proper modeling of the structure, accurate calculations, and proper computer input. If the rating is not complete, it shall be returned to the Rater. The Checker shall sign and date all of the rating material including RSS, load rating result outputs from computer programs, and QA/QC check list form once the rating is accepted as complete and accurate.

**Final Step:** When the rating and checking is completed, the rating package shall be forwarded to the Bridge Rating Unit by the Rater via email. The Rating unit will review the package and if the documentation is incomplete or has errors, the package will be returned to the Rater. The completed rating package shall be archived and updated into the BrR & BrM (Bridge Management) database by the Bridge Rating Unit.

If the load rating is for a new bridge or bridge rehabilitation, the completed rating package shall be sent to the Bridge Rating Unit at Final Submittal and placed in ProjectWise prior to Advertisement in accordance with the current CDOT Bridge Design Manual.

For a description of what shall be included in the rating package, see Section 1.13.

# 1.11.4 Rating Engineer (Rating Program Manager)

The Staff Bridge Rating Engineer is responsible for the following: managing the BrR global database for all structures, testing the new versions of the BrR software for updating the BrR database, provide assistance to in-house staff and Consultants on bridge rating issues, update the CDOT Rating Manual; coordinate BrDR migration, coordinate bridge rating software needs; and act as a liaison for Office of Information Technology (OIT) on bridge rating related matters.

If the rating of an existing structure requires posting or color code, the Bridge Rating Engineer shall report to the State Bridge Engineer for final determination and will notify the Region RTD, Region Maintenance Superintendent and the Permit Office. The Bridge Rating Engineer shall be the signing authority on RSS for posted or color coded structures based on the Bridge Engineer decision.

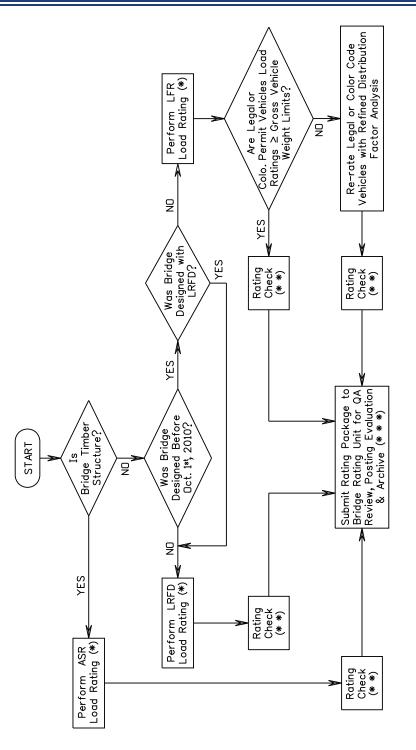
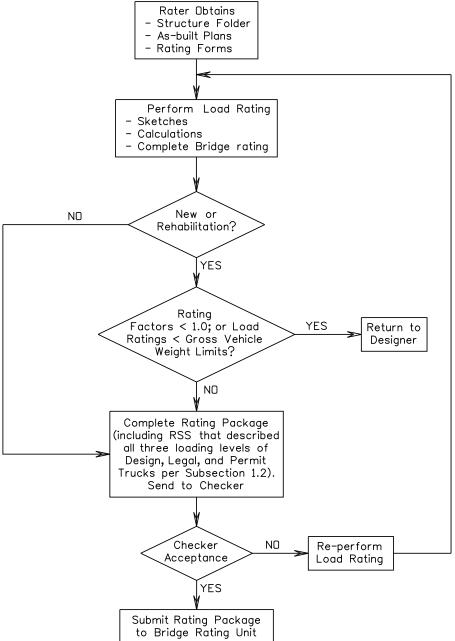
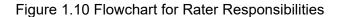


Figure 1.9 Flowchart for Load Rating

- (\*) Rater Responsibilities, see Figure 1.10
- (\*\*) Checker Responsibilities, see Figure 1.11
- (\* \* \*) Bridge Rating Unit Responsibilities, see Figure 1.12





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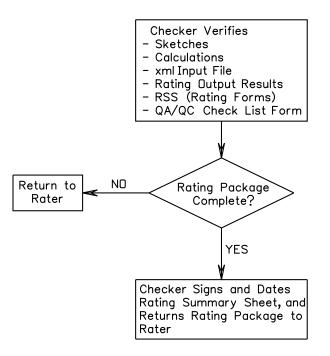


Figure 1.11 Flowchart for Checker Responsibilities

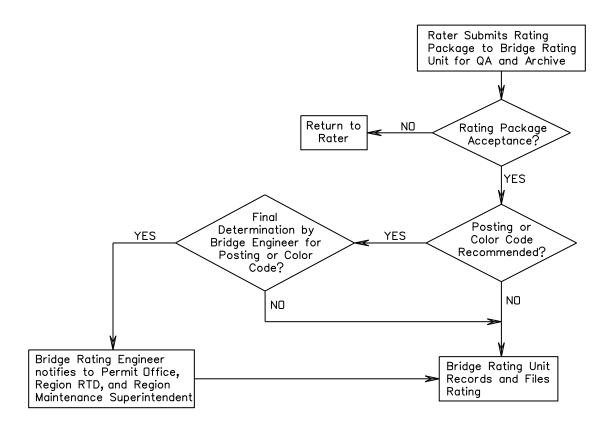


Figure 1.12 Flowchart for Bridge Rating Unit Responsibilities

#### 1.12 SUMMARY OF RATING PROCEDURE (CONSULTANTS)

The rating procedure for consultants is similar to the procedure described for Staff Bridge Design's "In-House" ratings. The differences arise in preparing for rating, defining responsibilities, and in directing lines of communications. Nonetheless, a complete description of the process, with defined responsibilities and definitions follows.

See Figure 1.9, 1.10, 1.11 & 1.12 for flow charts of the following:

**Rating:** For ratings performed by Consultants, the term Rater, as used in this subsection, relates to an individual who is an agent of the hired consultant. This person will be responsible for structure ratings and will be the point of contact with the Colorado Department of Transportation Staff Bridge Design. The Staff Bridge Design contact for the Rater will be arranged at the outset of the contract. Any rating questions or requests should be communicated between the consultant's rater and the identified Staff Bridge Design contact.

The Rater will be responsible for gathering all the required materials, performing all the necessary calculations, and completing the rating package as stipulated in Subsection 1.13.

The Rater must have the most up-to-date computer program manuals, Rating Summary Sheets, and any other materials required to perform bridge ratings. The Rater can do this by simply checking with their Staff Bridge Design contact.

The formal rating analysis now begins. The Rater shall make the necessary calculations and sketches to show how the structure was modeled, how dead loads were derived, and to identify any other pertinent information. The rater shall indicate the source of the structural data. The only sources of information used for rating shall be, advance plans, construction plans, as-constructed plans, and field surveys. At no time shall design notes be used to rate a structure.

After this information is compiled, the Rater shall then use the appropriate analysis and computer programs to determine the structural capacity of the bridge. Subsection 1.6 in this manual covers the appropriate structural type for a description of the computer programs and analysis to be used.

If the rating is for an existing bridge, completely constructed and in service, then all the rating documents shall be completed, signed, and dated by the Rater, and then forwarded to the Checker.

If the rating is for a new design, the Rater shall check to see that the new design is adequate. If any load rating value is not equal to or greater than the rating factor limit of 1.0 or the gross vehicle weight limit, the cause should be identified and the structural designer contacted for a possible redesign. Otherwise, all the rating material shall be completed, signed, and dated by the Rater and forwarded to the Checker.

The Consulting firm's name shall also appear on all submitted sheets of the rating package.

**Checking:** The term Checker, as used in this subsection, refers to a person who is an agent of the hired consultant. The Checker has the responsibility for verifying that the rating calculations, structure modeling, and computer inputs are proper and accurate. If the Checker finds any errors or omissions, the Checker shall return the rating to the Rater for corrections. Once the rating is complete, the Checker shall sign and date all rating materials before forwarding them for the final step.

Either the Rater, the Checker or the Engineer responsibly in charge must be a Colorado Registered Professional Engineer and shall stamp the Rating Summary Sheet.

**Final Step:** The rating package shall be submitted by the Consultant to the appropriate Staff Bridge Design contact via e-mail. This ensures that the contact is aware of the rating submittal.

If the load rating is for a new bridge or bridge rehabilitation, the completed rating package shall be sent to the Bridge Rating Unit at Final Submittal and placed in ProjectWise prior to Advertisement in accordance with the current CDOT Bridge Design Manual.

The package of materials received by the Staff Bridge Design contact will then be transmitted to the Bridge Rating Unit for recording. Bridge Rating Unit DOES NOT verify the accuracy of bridge ratings. If the information is not complete at this step, the rating will be returned to Staff Bridge Design's contact for completion. The contact will have the Rater complete the rating documentation before returning it to the Bridge Rating Unit. The completed rating package will be recorded and filed by the Bridge Rating Unit. For a description of what shall be included in the rating package, see Subsection 1.13.

If the rating is for an off-system bridge, a duplicate submittal of the rating package shall be delivered to the applicable entity by the Rater if requested or required by the entity.

#### 1.13 RATING PACKAGE REQUIREMENTS

The following defines what the minimum requirements are for a complete rating package submittal. The rating examples contained in this manual further illustrate what is described below.

- A) For a completed Rating Summary Sheet, refer to Subsection 1.14 of this manual for a description on how this sheet shall be filled out. The summary sheet should be printed on colored paper to designate the analysis method used. See Appendix A for copies of these forms.
- B) A set of calculation sheets showing the derivation of dead loads, live load distribution factors, sketches for how the structure was modeled, engineering judgment, computer input information, emails, and other relevant considerations. Where applicable, the calculation sheets should show how any deterioration or damage was modeled. Indicate from what source the information was gathered. The only sources of rating information shall be, Advance Plans, Construction Plans, As-constructed Plans, Field Surveys, and the most updated Structure Inspection Report. Design notes are not acceptable. One copy of pertinent plan sheets used during the rating process, preferably 8.5"x14", shall be included with the rating package (includes new structures and existing structures rerated for designed changes).

- C) BrR users shall use the tabular report format to generate the output report to be included in the rating package. For users of other computer programs, output from each of the programs used to rate a structure shall be included in the rating package.
- D) To enable CDOT to reproduce an analysis of the structure in the future, all rating packages shall include rating input files in electronic format as follows:

1) File names shall be based on Structure Number (i.e. H-02-FK.PDF or H02FK.SLB or H02FK.XML).

2) File extensions should generally refer to the rating package used (i.e. \*.SLB refers to SLAB Rating Program and \*.xml refers to BrR Rating Program).

3) The electronic file submittal must be placed in ProjectWise unless otherwise specified by the Rating Engineer.

This is required for all bridges, regardless of what software is used for rating.

- A) A rating for the bridge deck, except for LRFR rating, shall accompany each package.
- B) When the rating is for a new design, on a separate sheet of paper, state the status of construction for the project and state if the rating is for a new bridge or for the reconstruction of an existing bridge. This sheet is to be kept with the Rating Summary Sheet.
- C) The Rater and Checker's signature, date, and a Colorado PE seal from either the Rater, Checker or the Engineer in responsible charge are required on the Rating Summary Sheet. For other items in the rating package (e.g., calculation sheets, first page of each set of computer output), the Rater and Checker's initial and date are required. In addition, the structure number is required to be shown on all items in the rating package.
- D) All of the items that compose the rating package shall be placed in an inspection file folder and an electronic rating folder that is clearly labeled with the structure number. Each structure rated shall have its own folder with a complete rating package. This requirement includes structures whose rating results or calculations duplicate those used for another structure.

#### 1.14 REPORTING THE RESULTS OF RATING CALCULATIONS

The results of rating calculations are to be reported by the Rater on the appropriate CDOT Rating Summary Sheet (Timber/ASD Rating Summary or Load Factor Rating Summary) or Load and Resistance Factor Rating Summary). See Figures 1.13, 1.14, and 1.15. The electronic editable of these forms are also available in the Appendix A for Rater's use.

- Yellow paper shall designate use of the AASHTO ASD method.
- Green paper shall designate use of the AASHTO LFD method.
- Blue paper shall designate use of the AASHTO LRFR method.

For load rating of a special vehicle that is not specified in the Rating Summary Sheet such as maintenance H5 truck used for pedestrian bridge, the Rater may modify the Rating Summary Sheet.

For structures that do not need to be rated, such as the case when the depth of fill exceeds the limits, or structures that no required ratings for the single-unit trucks when the NRL rating factor is 1.0 or greater. The Raters may use the Gross Vehicle Weight (GVW) as shown in the Figures 1-1 to 1-8 of Subsection 1.2 to report on the RSS. The inventory and operating of the design vehicles may be reported as 36 tons and 40 tons respectively for LFR methods, and RFs of 1.0 and 1.1 for LRFR method.

The Rating Summary Sheet is retained in the structure folder as a record of the adequacy of the structure. The following items are to be observed when filling out the sheet.

- A) The sheet is to be filled out in black ink.
- B) All lettering should be clearly printed.
- C) Crossing out of incorrect data will not be permitted. If an error is made, fill out a new RSS.
- D) The sheet must be signed and dated by both the Rater and Checker. Do not initial the sheet. When rating is performed by a consultant, the name of the consulting firm shall also be shown. The sheet must be PE-sealed by either the Rater, Checker or Engineer in responsible charge registered in the State of Colorado.
- E) When the bridge is re-rated, the old Rating Summary Sheet shall be crossed out, and still kept in the inspection structure folder.

Information to be shown by the Rater on the Rating Summary Sheet:

- A) Record the structure number, state highway number, BrR BID number (to be filled in at a later date in the Rating Unit), abbreviation of structure type and, when appropriate, the parallel structure number. In addition to entering the state highway number, if the structure is located on a divided highway and carries traffic in one direction only, indicate the direction of traffic (EB, SB, etc.). Indicate if the structure carries ramp traffic.
- B) Within the Summary Sheet, record the Inventory and Operating ratings obtained for each element requiring an analysis, show controlling load ratings in the comments box. All ratings shall be reported in truncated tenths of a US ton, or truncated hundredth of a rating factor if applicable (see also section 15-9 for LRFR reporting).
  - 1) Stringers or Girders
    - a) When an exterior girder is rated, both the interior and the exterior girder ratings shall be shown. The columns of the Summary Sheet shall be marked to identify the interior and exterior girders.
    - b) When the refined distribution factor method is used for the legal loads or permit vehicles to avoid the posting or color code action, the controlling load ratings of interior girder or exterior girder shall be shown on a separated column named "NSG". The exterior girder load rating of the permit vehicles does not need to be recorded on this column.
    - c) For rolled steel beams, state the girder type and size.
    - d) When applicable, state if the girder is an original girder or a girder installed during structure widening.

Note: If a structure is widened with girders that are different from the original in either cross-section or material properties, both the original and the widened girders shall be rated and the critical original and critical widened girder loads shown on the summary sheet.

- 2) Decks
  - a) For all existing decks designed before October 1<sup>st</sup>, 2010, and new metal / timber plank decks, record load ratings for design truck only.
    - Transversely mild steel reinforced concrete deck slab that are continuous over more than 3 supporting girders shall not be used to control the overall bridge load rating.
    - The load rating of other deck types (e.g. timber decks, metal plank decks, etc.) may be used to control the bridge load rating.
  - b) For new concrete decks, no need to record load ratings except as requested.
- 3) Trusses
  - a) Record the critical member ratings, gusset plate, floor beam or stringer ratings in the appropriate columns of the Rating Summary Sheet.
  - b) Label the truss members shown in the report using standard truss notation. See Section 10A.
- C) If a posting vehicle analysis is required for Colorado Legal Vehicles, record the posting ratings in the chart portion of the summary sheet only. For State on-system Highway bridges, the State Bridge Engineer will make the determination of actual posting load and the pictorial trucks will then be filled in. For bridges that are not on the state system, the appropriate entity officials will determine structure load postings for structures under their jurisdiction.
- D) Indicate the amount of surfacing used in the rating calculations.
- E) The Comments section of the Rating Summary Sheet should contain the following information, when applicable:
  - 1) State if the individual critical member rates considerably below the other structure members, and is not representative of the entire structure.
  - 2) State any reductions in cross-section or allowable stresses used to rate the member and the reason for the reduction.
  - 3) The recommended color code for on-system bridges. The State Bridge Engineer must approve any color code recommendations of black, orange, and yellow.
- 4) State reason for rating: New structure or Rerating due to asphalt changes / dead load changes/ Damage per Inspection, etc.
  - F) If an original structure rated by LFR method, and the widening part is rated by LRFR, both Rating Summary Sheets of LFR and LRFR need to be filled out appropriately.
  - G) When rating timber members, the "Comments" section of the Rating Summary Sheet shall contain the allowable stresses for moment and shear used to rate the structure. A statement should be made to indicate if the rating was controlled by moment or shear.

TIMBER RATING SUMMARY       State Highway #         Rited using:	
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Structural Member         Tons           Inventory	
Tons         Inventory	
Inventory	
Operating         Image: Colorade 22 tons           Type 3 truck         Image: Colorade 22 tons           Type 3 truck         Image: Colorade 22 tons           Type 3 Truck (96T)         Image: Colorade 22 tons           Modified Tandem (50T)         Image: Colorade 22 tons	
Type 3S2 truck	
Type 3S2 truck	
Type 3-2 truck       Image: Colorado 27 tent         Type SU4 truck (27T)       Image: Colorado 27 tent         Type SU5 truck (31T)       Image: Colorado 27 tent         Type SU7 truck (96T)       Image: Colorado 27 tent         Modified Tandem (50T)       Image: Colorado 27 tent         Type 3 Truck       Image: Colorado 27 tent         tons       Image: Colorado 27 tent	
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Type SU6 truck (35T)       Image: Superstand Sup	
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September 2022

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Type SU5 truck (31T)								
Type SU6 truck (35T)								
Type SU7 truck (39T)								
NRL (40T)							-	
EV2 (28.75T)								
EV3 (43T)								
Permit Truck (96T)								
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Operating		10	16			
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Type SU7 truck (39T)	2				2	
NRL (40T)						
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EV2 (28.75T)						
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# 1.15 POSTING AND CLOSURE OF A BRIDGE DUE TO RATING REPORT OF LEGAL LOAD VEHICLES

#### 1.15.1 Posting Legal Load Vehicles

Posting vehicles are used to determine the maximum legal load vehicles that will be allowed to travel on bridges. The posting for legal load vehicles are composed of the maximum vehicle loads currently permitted by law. Consequently, the Posting Ratings are a means for ensuring the safe use of bridges by vehicles that do not exceed the legal loads.

The legal load vehicles for posting are as follows:

- A) Colorado or Interstate Legal Loads Type 3, Type 3S2 and Type 3-2.
- B) Single-Unit trucks SU4, SU5, SU6 and SU7.
- C) Emergency vehicles EV2 and EV3.

The maximum weight limits for Colorado legal vehicles, Single-Unit Truck and Emergency Truck are shown in Tables 1-4, 1-5 and 1-6 respectively.

Postings for the Single-Unit trucks SU4, SU5, SU6 and SU7 loads are not required if the load rating for the NRL vehicle has the capacity of 40 tons or greater. Otherwise, load ratings for the single-unit SU4, SU5, SU6 and SU7 loads shall be performed to determine which single-unit vehicles will be restricted from crossing the structure. Currently, the gross vehicle weights of SU6 and SU7 do not meet the Colorado Bridge Formula. Therefore, maximum gross weight limits for posting of SU6 & SU7 on non-interstate roads shall supersede with values that are determined by the Colorado Bridge Formula. See Table 1-5.

The deck slab ratings are not to be used in the determination of legal load postings.

The posting load for Emergency Vehicles shall only be required for bridges on the Interstate highways, and within one-road-mile of the reasonable access.

NOTE: Reasonable access is the access between the Interstate highways and the facilities for food, fuel, repairs, and rest, which includes the Interstate access ramps, and the State's roads.

Based on successful of CDOT historical practice, a safe posting load as specified in the MBE, equation 6A.8.3-1 should not use.

The posting load for Legal vehicles shall be based on the lowest load rating in truncated US tons of any primary members such as girders, in-span hinge, stringers, truss, floorbeam, and truss connections, etc.

When the operating rating factor of any legal load vehicle falls below 0.3, then the bridge shall be restricted for all legal load vehicles.

For possibilities of adjustment to the distribution of live load to increase load ratings and avoid the posting action, see Subsection 1.3 (H).

For structures that do not use 1.3 (H), when the operating ratings of the legal loads are greater than or equal to 95%, the structure can be exempted from posting requirements.

The State Bridge Engineer will make a final determination for posting. The decision for bridge posting shall be based on the bridge physical condition, visible distress, structure redundancy, and traffic volume. If a structure rating indicates a need for posting, the Bridge Rating Engineer is the signing authority for structure posting, and shall notify to the Permit Office, Region RTD and Region Maintenance Superintendent. The Region Maintenance or bridge owner has 30 days to install the posting signs after receiving the formal letter.

	US Units	Non-interstate Road	Interstate Hwy
Type 3 Vehicle	Tons	27.0	24.0
Type 3S2 Vehicle	Tons	42.5	38.0
Type 3-2 Vehicle	Tons	42.5	39.0

Table 1-4: Maximum Weight Limit for Type 3, Type 3S2, and Type 3-2 Legal Trucks.

	US Units	Non-interstate Road	Interstate Hwy
SU4	Tons	27.0	27.0
SU5	Tons	31.0	31.0
SU6	Tons	33.0 (*)	34.75
SU7	Tons	35.0 (*)	38.75

 Table 1-5:
 Maximum Weight Limit for Single-Unit Trucks

(\*) Use maximum gross weight limits computed from the Colorado Bridge Formula for noninterstate roads.

	US Units	Non-interstate Road	Interstate & Reasonable Access Roads
EV2	Tons	N/A	28.75 (**)
EV3	Tons	N/A	43.0 (**)

Table 1-6: Maximum Weight Limit for Emergency Trucks.

(\*\*) Does not meet Federal Bridge Formula B, but they could cover situations when Emergency Vehicles need access to Interstate Highways, or Reasonable Access.

#### 1.15.2 Posting Signs

The posting signs shall comply with the MUTCD (Manual on Uniform Traffic Control Devices) requirements, and CDOT's Sign Design Manual, latest edition.

Figure 1.16 shows examples for weight limit posting signs of Colorado/Interstate Legal Vehicles, Specialized Hauling Legal Vehicles, and Emergency Vehicles, which are appropriate for conventional roads, expressways, and freeways using different letter heights of 3.0", 5.0", and 6.0" respectively.

- Conventional road is a road that allows direct access to homes and businesses along it, or a low-volume highway of less than 400 Annual Average Daily Traffic (AADT).
- Expressway is a highway that allows partial control of access.
- Freeway is an Interstate highway that allows full control of access.

1

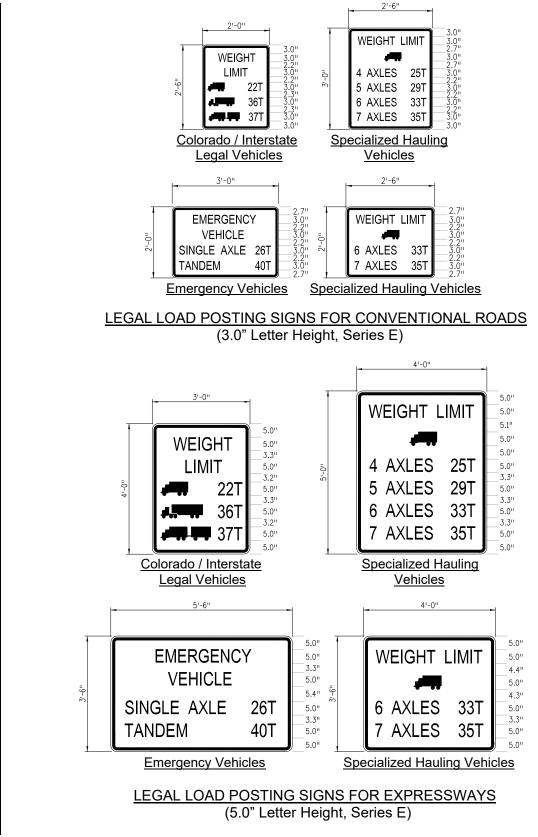
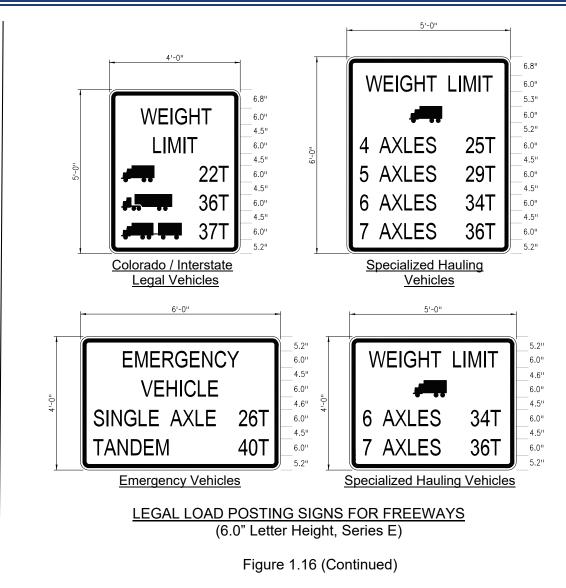


Figure 1.16



#### 1.15.3 Closure of a Bridge Due to a Rating Report of Legal Load Vehicles

When the operating load rating of any Legal Load vehicle type not capable of carrying a minimum gross live load weight of three tons, the bridge must be closed.

The Rating Engineer and the Inspection Engineer shall review the rating package and the inspection report accordingly before making a recommendation to the State Bridge Engineer to close or restrict the bridge. An appropriate Plan of Action (POA) for closing the bridge shall be determined by the State Bridge Engineer that follows the procedures of the Structure Management Manual (SMM).

#### 1.16 OVERLOAD COLOR CODE RATING

The Overload Color Code ratings are used to determine the routes, and the maximum group axle weights of the permit vehicles that will be allowed to travel on Colorado bridges.

The Colorado Permit Load Rating Vehicles (Colorado Permit Vehicle and Colorado Modified Tandem Vehicle) need to be used to determine the Overload Color Code.

The Overload Color Code shall be based on the primary element ratings such as interior girders, in-span hinges, truss members, exterior/interior stringers of a truss structure, floorbeams, truss connections, etc. The deck slab and the exterior girder ratings are not to be used in the determination of Color Code.

When a bridge that was constructed or rehabilitated after 1985 is rated or re-rated, it shall receive a Colorado Permit Vehicle operating rating with full impact and multi-lanes loaded as per Subsection 1.3.

When a bridge that was constructed in 1985 or earlier is rated or re-rated, it may receive Colorado Permit Vehicle operating rating with full impact and one lane loaded as specified in the Subsection 1.3.

When a bridge with span length of 60' or less that was constructed in 1985 or earlier is rated or re-rated, it may receive Colorado Permit Vehicle and Colorado Modified Tandem operating ratings with full impact and one lane loaded as specified in the Subsection 1.3. If the Overload Color Code based on the Colorado Permit Vehicle rating causes more severe restriction on the bridge, the Colorado Modified Tandem Vehicle rating may be used to determine for bridge's color code.

When existing LFD bridges are widened with the LRFD method, the permit vehicle load ratings of the original structure part shall be used to determine the Overload Color Code.

For possibilities of adjustment to the distribution of live load to increase load ratings and avoid the color code action, see Subsection 1.3 (H).

Overload Color Code is not applicable to off-system structures.

The Overload Color Codes Table is shown below:

Table 1-7: Overload Color Codes

	Unit	White	Yellow	Orange	Black
	-				
Permit Vehicle	US tons	96 ≤ X	96 > X ≥ 88.5	88.5 > X ≥ 80.5	80.5 > X
Modified Tandem Vehicle	US tons	50 ≤ X	50 > X ≥ 46	46 > X ≥ 42	42 > X

X = Operating load rating value of Colorado Permit Vehicle or Modified Tandem Vehicle.

The State Bridge Engineer will make a final determination for the structure color code. The decision for bridge color shall be based on the bridge physical condition, visible distress, structure redundancy, and traffic volume. If a structure rating indicates a need for colors of BLACK, ORANGE, or YELLOW, the Bridge Rating Engineer will be notified for approval and generation of a formal letter to the Permit Office, Region RTD and Region Maintenance Superintendent. The Bridge Rating Engineer shall be the signing authority on RSS for color coded structure based on the State Bridge Engineer decision.

#### 1.17 RE-RATING EXISTING / NEW BRIDGES

When the condition of a structure changes such as the condition state, dead load, new live loads requirements, or rehabilitations, a re-rating of the structure may be required. Examples when re-rating may be considered:

- Bridge damaged by vehicular hits.
- Bridge deterioration due to severe corrosion / section loss in steel elements, cracking / spalling in concrete superstructure, or split / decay in timber stringers.
- Additional loads of sidewalk, railing, barrier, utilities, fill or deck overlay, etc.
- Deck replacement, widening, adding new girders.
- Section loss reported on gusset plates.
- New Federal regulation or specification requiring new live loads such as Notional Rating Load (NRL) Vehicles, Single-Unit vehicles, and Emergency Vehicles.

Specifically, the requirements for re-rating of the structures are as followings:

- A) When requested from the Inspection Unit after the bridge inspection report, or the accident report was reviewed by a senior Inspection Engineer, due to reduced structural capacity at critical locations. The load re-rating shall be completed in-house, within the Staff Bridge Rating Unit within 60 days after the Rating Engineer receives notice.
- B) For any structural design work on an existing bridge that has not yet been rated with the BrR program, the bridge shall be re-rated by the Design Engineer or Staff Bridge Rating Unit.
- C) For changes of dead load due to a structural work on the existing structure that is rated with BrR program, if the operating load rating for any vehicle changes more than 3.0%; or affects the posting and the color code, the BrR input file and the Rating Summary Sheet (RSS) shall be updated by the Design Checker or Designer.

- D) When two parallel structures are connected by a median closure project, the bridge shall be re-rated by the Design Checker or Designer.
- E) For culvert extension, bridge widening, or rehabilitation, the bridge shall be re-rated by the Design Checker or Designer.
- F) For structure under construction revised by a Value Engineering Change Proposal (VECP), or a Contract Modification Order (CMO), the proposed structure shall be rated / re-rated by the Contractor's Engineer, or the Engineer of record.
- G) A re-rating is required for a change in thickness of asphalt overlay greater than or equal to 3".
- H) If 25% of the total number of timber girders or stringers are split, cracked, or repaired, a new load rating based on reduction of allowable stresses is required.

## **SECTION 3**

## Bridge Decks

Section	Subject	<u>Page No.</u>
3-1	Introduction to Rating Bridge Decks.	3.2
3-2	Concrete Slab Ratings.	3.3
	Cantilever Portions of Concrete Bridge Decks	3.7
	Slab Example	3.8
3-3	Corrugated Steel Plank Ratings	3.12
	Plank Example	3.14

### 3-1 Introduction to Rating Bridge Decks

This section covers the rating of bridge decks.

Reinforced concrete decks supported by longitudinal girders, with main reinforcement placed perpendicular to traffic, and asphalt filled metal plank decks placed perpendicular to traffic will be rated with the CDOT computer programs discussed in subsections 3-2 and 3-3.

When design plans are available, use the applicable concrete strength and steel yield stress or use the values shown in table 100-1 (Year of Construction - Allowable Bending Stress Table) for the appropriate year of construction. See Subsection 100-4.

When plans are not available for a concrete deck, and the deck shows no signs of failure, then the assignment of rating values will not be required. However, if the condition of the deck indicates probable failure, then rating values shall be assigned as stipulated in subsection 600-5. The rater shall indicate on the rating summary sheet that plans are not available for the deck.

Transverse nail laminated and transverse plank timber decks are to be rated using the guidelines in Section 300, Timber Bridges.

All other types of bridge decks will be rated in compliance with the applicable guidelines within this manual and the AASHTO code. Hand computations will be acceptable.

For reinforced concrete slabs with main reinforcement parallel to traffic, see Section 600 - Concrete Bridges, for rating directions.

Reinforced concrete deck slabs meeting the following conditions shall be rated with the SLAB computer program by the load factor method using current AASHTO Specifications:

A. The slab must be supported by longitudinal girders or stringers with the main slab reinforcement placed perpendicular to the girders or for skews less than or equal to 20°.

Skew is defined as the deviation in degrees of the reinforcement from perpendicular to the girders. The reinforcement may have a different skew than the structure.

B. The slab must be continuous over three or more supports. See the current Staff Bridge Design Memo 601 for descriptions of effective span and general deck slab design information.

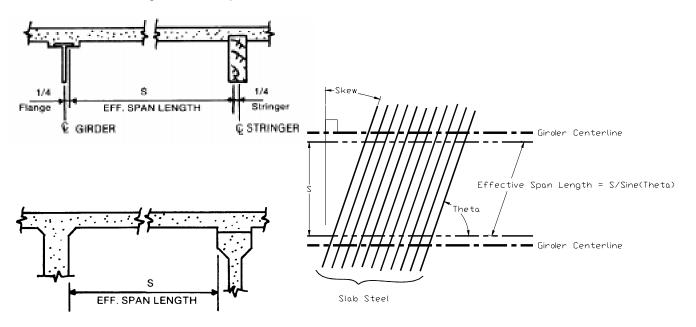
A load factor rating example is shown in this subsection.

#### Description of Input for Concrete Slab Rating Program

<u>Column</u>	Description	<u>Units</u>	Data Type
	Load Type orado Trucks (use for bridges cat erstate Trucks (use for bridges ca		One Numeric Character blorado Highways, i.e. SH287) terstate Highways, i.e. I70 or I25)
		ther desi	Seven Alpha or Numeric Characters ignation for the structure such as county
9 - 11 Used to	Rater designate who the rater is. Typ	ically the	Three Alpha or Numeric Characters e initials are used.
	Highway Number designate the Highway Number	(i.e. 170	Three Alpha or Numeric Characters = 70 or SH287 = 287).
15 - 20 The Ba structur	<b>4 1</b>	idge BR	Six Alpha or Numeric Characters IAR Unit and uniquely identifies the
21 - 41 Any ade	Comments ditional information needed to def	fine the s	21 Alpha or Numeric Characters slab (i.e. 70 Degree Skew).

- <u>Column</u> <u>Description</u> <u>Units</u> <u>Data Type</u>
- 42 46 Effective Span Length (feet) Five Numeric Characters The effective span length input as an integer to three decimal places, see the drawings below. The rater shall exercise care in determining the effective span length for slabs having main reinforcement placed at angles other than 90 degrees measured from the centerline of girder. For these cases, the effective span shall be the distance calculated parallel to the main reinforcing steel.

Use all decimal places even if they are zeros because the program does not recognize blank input as a zero..

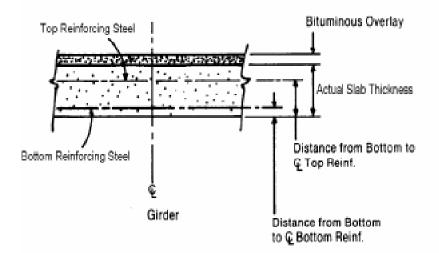


#### (inch) Five Numeric

#### Characters

	i ne actual slab thickness inp	ut as an integer to three decimal
	places, see the drawing on the	ne following page.
52 - 56	Distance to Top Reinforcing Steel	(inch) Five Numeric Characters
	The distance from the from the	ne bottom of the slab to the center
	line of the top reinforcing stee	el as an integer to three decimal
	places, see the drawing on the	ne following page.
57 - 59	Top Reinforcing Steel Area	(sq.in.) Three Numeric Characters
	The area of the top reinforcin	g steel over the girders as an
	integer to two decimal places	, see the drawing on the following
	page.	

<u>Column</u>	Description	<u>Units</u>	Data Type
60 - 63	Bituminous Overlay The average asphalt thickness places, see the drawing below.	as an in	Four Numeric Characters teger to two decimal
64 - 67	f' <sub>c</sub> for Concrete The value of concrete strength Construction - Allowable Bendi of construction.		Four Numeric Characters he plans or table 1-1 (Year of s Table) for the appropriate year
68 - 72	F <sub>y</sub> for Reinforcing Steel The value of steel yield stress i Construction - Allowable Bendi of construction.		Five Numeric Characters the plans or table 1-1 (Year of s Table) for the appropriate year
73 - 74	Leave Blank for Load Factor For a load factor analysis, the r input.	ater sha	ll leave "N" blank for program
75 - 77	Distance to Bottom Steel The distance from the bottom of bottom reinforcing steel, taken girders shown as an integer to drawing below.	of the slai at a poin	t midpoint between the
78 - 80	Bottom Reinforcing Steel Area The area of the bottom reinforc girders shown as an integer to drawing below.	ing steel	•



Typically the bottom and top steel areas are the same.

#### Description of Output for Concrete Slab Rating Program

#### I. Input Data

The input data coded by the rater is printed. The reported value of N is the calculated value for load factor analysis.

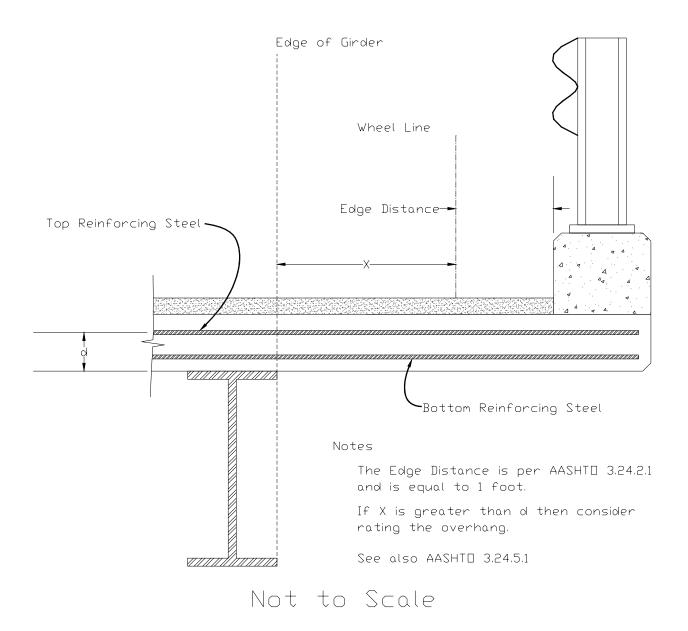
#### II. Output Results

- A. Total dead load moment for the portion being analyzed.
- B. Live load plus impact moment due to HS 20 loading.
- C. Gross vehicle weight of HS 20 truck.
- D. Calculated concrete and reinforcing steel stresses based on a HS20 vehicle.
- E. Total member capacity at inventory and operating level.
- F. Member capacity for live load plus impact at inventory and operating level.
- G. Ratings in tons at inventory and operating level.
- H. Ratings for posting vehicles when operating rating is less than 36.0 tons. The program analyzes either the Colorado Legal Loads or the Interstate Legal Loads depending on user input. Ratings for posting vehicles are determined from the operating capacity.

#### Guideline for Rating Cantilever Portions of Concrete Bridge Decks

Usually, deck overhangs at the exterior girder do not control the slab rating. However, the rater should use judgment in determining if the overhang should be rated. A criteria that <u>may</u> be used is:

Rate the cantilever portion of the concrete bridge deck if the wheel load can be applied outside the exterior girder by a distance equal to or greater than the distance from the bottom of the slab to the centerline of the top reinforcement, see the following drawing.



CDOT Staff Bridge Rating Manual Example CONCRETE SLAB RATING			
DESCRIPTION	INPUT	UNITS	CARD IMAGE COLS.
LOAD TYPE:			1
1 = Colo. Trucks 2 = Interstate			
	.2		
STRUCTURE NUMBER:	E1.7H.Y		2 - 8
RATER:	,M,A,N		9 - 11
HIGHWAY NUMBER:			12 - 14
BATCH I.D.:	H.7.3.0.0.2		15 - 20
COMMENTS:	M.E.D.I.A.N. ,C.L.0.5		21 - 41
	U.R.E.		-
EFFECTIVE SPAN LENGTH:		FEET	42 - 46
ACTUAL SLAB THICKNESS:	, ,8.0,0,0	INCHES	
Distance to Top Reinforcing Steel	, .6.1,8,8	INCHES	52 - 56
Top Reinforcing Steel Area:	,0.6,1	In2/Ft	57 - 59
ASPHALT OVERLAY:		INCHES	60 - 63
Concrete Strength (f'c):	4,5,0,0	P.S.I.	64 - 67
Steel Yield Strength (Fy):	,6,0,0,0,0	P.S.I.	68 - 72
Leave Blank for Load Factor:		Es/Ec	73 - 74
Distance to Bottom Reinforcing Steel:	1.8,1	INCHES	75 - 77
Bottom Reinforcing Steel Area:	0.6	In2/Ft	78 - 80
1/4 S 1/4 S Flange EFF. SPAN LENGTH Stringer & GIRDER & STRINGER			
Slab Steel	θ Compression Steel	Distance	ituminous Overlay Slab thickness (max.) ance from Bottom to op Reinf. e from Bottom tom Reinf.

#### 3-2 Concrete Slab Load Factor Rating Example

Computer Program Output

SLAB RATING Version 1.0 DATE: 95/03/21

STRUCTURE NO. E-17-HY RATER: MAN STATE HWY NO. = 70 BATCH ID= H73002 DESCRIPTION: MEDIAN CLOSURE LOAD FACTOR RATING-COMP STEEL NOT USED---LOAD FACTOR RATING

INPUT DATA	
EFF. SPAN(FT)= 9.667	EFF. DEPTH(INS)= 6.188
REINF.(SQ.IN) = .61	EFF: DEFIN(INS) = 0.100
SLAB TK(IN) = $8.000$	WEARING SURFACE(IN) = 4.00
CONC. STRENGTH(PSI) INV= 4500. STEEL YIELD (PSI) INV=60000.	
N= 8.	
D1= 1.81 AS1= .6	1
DEAD LOAD MOMENT 1.38 K-FT	
LL+I MOMENT 6.07 K-FT	
GROSS WEIGHT 36.0 TONS	
	INVENTORY OPERATING
ACTUAL CONCRETE STRESS (PSI)	1500.48 2325.40
ACTUAL REINF. STEEL STRESS (PSI)	27987.38 43374.04
ACTUAL COMP. STEEL STRESS (PSI)	
MEMBER CAPACITY (K-FT)	
MEMBER CAPACITY (LL+I) (K-FT)	
RATING (TONS)	38.60 64.33

Manual calculations to convert from U.S. Tons to Metric Tons

Inventory = 38.60 \* 2000 / 2204.6 = 35.0 metric tons

Operating = 64.33 \* 2000 / 2204.6 = 58.4 metric tons

#### 1300-2 Concrete Slab Load Factor Rating Example

Given Information:				
Structure Number:	E-17-HY	LOAD TYPE: $L_t = 2$		
Rater:	MAN		1 = Colorado Trucks	
Higway Number:	70	2 =	2 = Interstate Trucks	
Batch I.D.:	H73002	Effective	Effective Span Length (feet) = $L = 9.667$	
Comments:	Median Closure	Actual S	Slab Thickness (inches) =	T := 8.000
Asphalt Thickness (	inches) = HI	MA := 4		
Reinforcing Steel:				
Area (in²/ft)			Location from the botto	m of the slab (inches)
Top Mat Over the	e Supports=	A <sub>t</sub> = 0.61	Top Mat Location =	D <sub>t</sub> := 6.188
Bottom mat betw	een the supports	= A <sub>b</sub> := 0.61	Bottom Mat Location =	D <sub>b</sub> := 1.81
Reinforcing Steel Yi	eld Strength(psi) =	= f <sub>v</sub> := 60000		
Concrete Compress		5		
Calculations:				
Deadload:				
Distributed Dead	load:			
Concrete:	W <sub>c</sub> :=	$\frac{\mathrm{T}}{\mathrm{12}}$ 150	W <sub>c</sub> = 100	
Asphalt:	W <sub>a</sub> :=	$\frac{\text{HMA}}{12} \cdot 144$	W <sub>a</sub> = 48	
Total (lbs/foc	nt) —	12 V <sub>c</sub> + W <sub>a</sub>	W = 148	
Deadload Momer Note: 0.8	nt (ft-k): M <sub>dl</sub> ≔ is the Continuity F	$\frac{W \cdot L^2}{8} \cdot 0.8 \cdot \frac{1}{1000}$	M <sub>dl</sub> = 1.383	
Live Load Moment:		$\frac{2+2}{32} \cdot 0.8 \cdot 1.3$	$M_{11} = 6.067$	
	ne impact factor load formula is fro	om AASHTO 3.	24.3.1	

#### 1300-2 Concrete Slab Load Factor Rating Example (Continued)

Resisting Moment over the Support (ft-kips):

Steel Tension (pounds) = 
$$T_t := A_t \cdot f_y$$
  $T_t = 3.66 \cdot 10^4$   
Concrete Compression Block (inches) =  $a_t := \frac{T_t}{(0.85 \cdot f_c \cdot 12)}$   $a_t = 0.797$ 

Strength Reduction Factor:  $\phi = 0.9$ 

$$\mathbf{M}_{\mathbf{u}} \coloneqq \mathbf{\phi} \cdot \frac{\mathbf{T}_{\mathbf{t}} \cdot \left( \mathbf{D}_{\mathbf{t}} - \frac{\mathbf{a}_{\mathbf{t}}}{2} \right) \cdot \frac{1}{12}}{1000} \qquad \qquad \mathbf{M}_{\mathbf{u}} = 15.892$$

Final Rating:

Inventory Rating (metric tons) = 
$$\frac{M_u - 1.3 \cdot M_d l}{2.17 \cdot M_{11}} \cdot 36 \cdot \frac{2000}{2204.6} = 34.963$$

Operating Rating (metric tons) = 
$$\frac{M_u - 1.3 \cdot M_{dl}}{1.3 \cdot M_{1l}} \cdot 36 \cdot \frac{2000}{2204.6} = 58.361$$

## 3-3 Corrugated Steel Plank Rating

The Plank Rating Program investigates corrugated metal flooring based on a one-inch strip transverse to traffic. Currently, the Plank Rating Program will only produce a working stress rating which satisfies the AASHTO specifications, except the program assumes a 20-inch by 20inch tire contact area. However, the program can be used to generate the Deadload and Liveload Moments. The values produced by the program can then be used to generate a Load Factor Rating using the appropriate factors and formulas. The hand calculation rating analysis in this subsection illustrates the methods used by the program except for the final step which produces a Load Factor Rating.

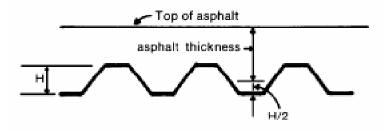
Description of Input for the Plank Rating Program

<u>Column</u>	Description	<u>Units</u>	Data Type
1 - 7	Structure Number Use the Colorado structure number or of county or city structure number.	ther des	7 Alpha or Numeric Characters signation for the structure such as the
8 - 10	Rater Used to designate who the rater is. Typ	ically the	3 Alpha or Numeric Characters e rater's initials are used.
11 - 13 Use	State Highway Number ed to designate the highway number (i.e.	170 = 70	3 Alpha or Numeric Characters ), SH287 = 287, CR113 = 113).
	Batch I.D. e Batch I.D. is a 6 digit Alphanumeric cod quely identifies the structure.	e assigr	6 Alpha or Numeric Characters ned by the Staff Bridge BRIAR unit which
20 - 40 Any	Comments y additional comments needed to define t	he plank	21 Alpha or Numeric Characters k or the structure.
41 - 44 Inp	Span Length ut the span length as an integer to 2 deci	` '	4 Numeric Characters ces, see the drawing below.
		-	Use all decimal places even if they are zeros because the program does not recognize blank input as zeros

Span Length-

#### 3-3 Corrugated Steel Plank Rating

- 45 48 Section Modulus (in<sup>3</sup>/in)4 Numeric Characters Input the section modulus as an integer to 3 decimal places.
- 49 51 Weight of Plank (lb/ft<sup>2</sup>) 4 Numeric Characters Input the weight of the plank as an integer to 1 decimal place.
- 51 54 Leave Blank 4 Numeric Characters This field is normally used for the inventory stress of a Working Stress Rating. However for a Load Factor Rating, leave this field blank.
- 55 57 Steel Yield Strength (ksi) 4 Numeric Characters This field is normally used for the operating stress of a Working Stress Rating. However for a Load Factor Rating, input the steel yield strength as an integer to 1 decimal place.
- 58 61 Asphalt Thickness (inch) 4 Numeric Characters Input the asphalt thickness as an integer to 2 decimal places, see the drawing below.



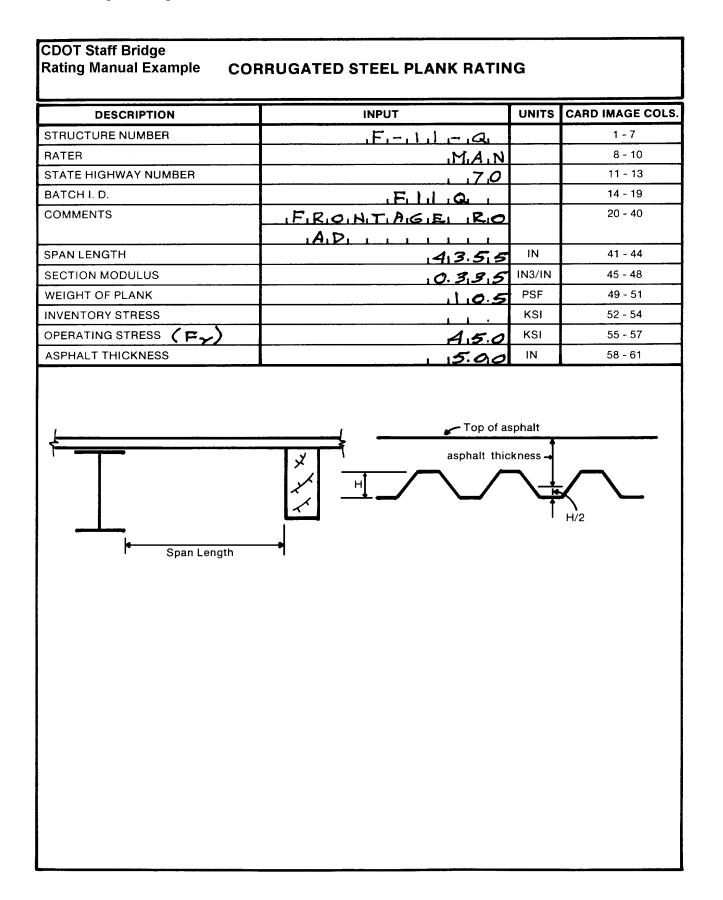
Description of **Output** for the Plank Rating Program

I. INPUT DATA

The input data coded by the rater is printed.

- II. OUTPUT RESULTS
  - A. Live load plus impact moment due to HS 20 loading.
  - B. Dead load moment for the strip being analyzed.
  - C. Capacity for live load plus impact at inventory level.
  - D. Capacity for live load plus impact at operating level.
  - E. Inventory rating in tons.
  - F. operating rating in tons.
  - G. Posting ratings based on the Colorado legal loads when operating rating is less than 36.0 tons.

The Plank Rating Program will be updated to produce a Load Factor Rating directly at a future date. When the update is accomplished, this section of the rating manual will be reissued.



#### 1300-3 Corrugated Steel Plank Rating Example

**Computer Program Output** 

STEEL BRIDGE PLANK RATING DATE: 3/21/95

STRUCTURE NO: F-11-Q RATER: MAN BATCH ID: FllQ STATE HWY NO: 70 COMMENT: FRONTAGE ROAD NET SPAN LENGTH (IN) = 43.55 SECTION MODULUS (IN3/IN) = .335 PLANK WEIGHT (PSF) = 10.5 INVENTORY STRESS (KSI) .0 OPERATING STRESS (KSI) 45.0 ASPHALT THICKNESS (IN) 5.00 LL-1 MOMENT (IN-K) = 6.978(LL MOMENT BASED ON A WHEELPRINT 20IN X 201N) .093 DL MOMENT (IN-K) = INVENTORY LL-1 MOMENT CAPACITY (IN-K) = -.093 OPERATING LL-1 MOMENT CAPACITY (IN-K) = 14.982 INVENTORY RATING (TONS) -.48

Note: The computer program is **only** being used to generate the Live Load and Dead Load Moments. The moment rating can then be determined from the computer values by using the appropriate Load Factor formulas and factors.

Manual calculations to produce a Load Factor rating in Metric Tons

OPERATING RATING (TONS)77.29

Resisting Moment Capacity = Fy\*S = 0.335 \* 45 = 15.075 in-kips/in

Inventory =  $\frac{15.075 - 1.3 * 0.093}{2.17 * 6.978}$  \* 36 \*  $\frac{2000}{2204.6}$  = 32.3 metric tons Operating =  $\frac{15.075 - 1.3 * 0.093}{1.3 * 6.978}$  \* 36 \*  $\frac{2000}{2204.6}$  = 53.8 metric tons Plank Rating

Structure F-11-Q	
Information from the field:	
Plank: Gird	er:
Thickness is 5/32 of an inch	Spacing (feet): S $p = 4.5$
Distance between corrugations is 12"	Type: W30x99
Height of corrugations is 4"	
Average Asphalt Thickness (inches): T = 7.0	
Information derived from field information:	
From AISC 8th Edition: Girder Flange Width (inches):	b <sub>f</sub> := 10.45
From AISI 4th Edition: Type A - 4¼x12x9ga. Plank	
Steel Yield Stress (ksi): F <sub>y</sub> = 45 Moment of	of Inertia (ir.4/ft) I := 8.83
Weight of Plank (lbs/ft²): $W_p = 10.5$ Section M	lodulus (ir <sup>3</sup> /ft) S := 4.02
Calculations:	
Effective Span (inches): $L := S_p \cdot 12 - b_f$	L = 43.55
Distributed Deadload (lbs/in/in): $W := \left(\frac{T}{12} \cdot 144 + W_p\right) \cdot \frac{1}{144}$	W = 0.656
Continuity Factor (AASHTO 3.24.3.1) = $C_f = 0.8$	
Deadload Moment (in-kips/in): $M_{dl} := \frac{W \cdot L^2}{8 \cdot 1000} \cdot C_{f}$	$M_{dl} = 0.124$
Distributed Live Load (kips/in/in):	
$W_{11} := \frac{16}{20 \cdot 20}$ $W_{11} = 0.04$	5 kips ire oot Print 20 Inches
Live Load Reaction (kips/in):	oot Print 20 Inches sed by
$R := W_{ll} \cdot \frac{20}{2}$ $R = 0.4$	
Live Load Moment (in-kips/in):	20 Inches —
$M_{max} = R \cdot \frac{L - 20}{2} + \frac{R}{2} \cdot 10$ $M_{max} = 6.71$	

Impact Factor =  $I_f = 1.3$ 

$$M_{III} = C_{f} I_{f} M_{max} \qquad M_{III} = 6.978$$

#### 3 - 3 Plank Rating Example (continued)

Calculations (continued):

Member Capacity (in-kips/inch):

$$M_{cap} = F_y \cdot \frac{S}{12}$$
  $M_{cap} = 15.075$ 

CDOT Assumes the plank to be braced Noncompact which eliminates the need to do a Servicablity Rating because plastic properties are not used.

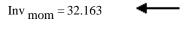
Moment Rating (metric tons):

Inventory

Inv mom := 
$$\frac{M_{cap} - 1.3 \cdot M_{dl}}{2.17 \cdot M_{lll}} \cdot 36 \cdot \frac{2000}{2204.6}$$

Operating

Opr mom := 
$$\frac{M_{cap} - 1.3 \cdot M_{dl}}{1.3 \cdot M_{HI}} \cdot 36 \cdot \frac{2000}{2204.6}$$



 $Opr_{mom} = 53.688$ 

STAFF BRIDGEEffective: April 1, 2011BRIDGE RATING MANUALSupersedes: April 1, 2002	COLORADO DEPARTMENT OF TRANSPORTATION	Section: 8
BRIDGE RATING MANUAL Supersedes: April 1, 2002	STAFF BRIDGE	Effective: April 1, 2011
	BRIDGE RATING MANUAL	Supersedes: April 1, 2002

SECTION 8 - REINFORCED CONCRETE STRUCTURES

#### 8-1 INTRODUCTION TO RATING REINFORCED CONCRETE BRIDGES

This section covers the rating of reinforced concrete girders and slabs reinforced longitudinally. This section does not cover prestressed concrete members. All reinforced concrete girders and slabs are to be rated using the policies and guidelines in section 1, and subsections 8-2 and 8-3.

The rating of reinforced concrete decks supported by girders is discussed in Section 3.

The following discussion and examples assume the load factor method is being used for rating.

When there are no plans available for the reinforced concrete member being rated, the requirements in subsection 8-4 will govern the rating.

The types of bridges covered by this section are:

CBG - Concrete Box Girder CBGC - Concrete Box Girder Continuous CS - Concrete Slab CSC - Concrete Slab Continuous CSG - Concrete Slab and Girder CSGC - Concrete Slab and Girder Continuous

#### 8-2 POLICIES AND GUIDELINES FOR RATING CONCRETE BRIDGES

#### I. General

- A. All longitudinally reinforced concrete members shall be rated by the Virtis program using the guidelines in subsection 8-3.
- B. Concrete girders with considerable stress/strain effects due to horizontal curvature, skew, temperature, or other influences shall be modeled as simple, straight beams on pin or roller supports. The Virtis output results can then be supplemented with hand calculations to consider any of these significant influences, as necessary.
- C. All bridges shall be rated using the Load Factor Method.
- D. When plans are available, use the minimum yield strength values given in the plans; otherwise, values used in Section 1 for the applicable year of construction may be followed. If the condition of the girder indicates that full strength should not be used, the rating should be reduced as appropriate.

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- E. All new concrete structures constructed after December 2001 shall be rated for shear at the controlling sections. Except for timber structures, shear rating will not be required for all other structures including rerating of existing structures.
- F. All new concrete structures constructed after December 2001, moment rating shall be performed at standard section locations (i.e. 0.5 point for a simple span structure or the 1.4 point, 2.0 point, 2.5 point, etc. for a three span structure) and any controlling rebar cut-off section location. All other structures including rerating of existing structures shall be performed at standard section locations.
- G. When rating a cast-in-place concrete box girder bridge, separate out the boxes into I shapes and rate a typical interior and exterior girder. Dead loads and live load shall be applied as appropriate.

# II. Girders Requiring Rating

- A. Interior Girders A rating is required for the critical interior girder. More than one interior girder may require an analysis due to variation in span length, girder size, girder spacing, differences in loads, moments, concrete strength and/or reinforcing, etc.
- B. Exterior Girders An exterior girder shall be rated under the following guidelines:
  - 1. When the section used for an exterior girder is different than the section used for an interior girder.
  - 2. When the overhang is greater than S/2.
  - 3. When the plans indicate that the curb and floor slab were poured monolithically, the live load distribution factor for the exterior girder should be calculated and compared to the live load distribution factor (LLDF) for the interior girders. If the LLDF for the exterior girder is equal to or greater than 75% of the LLDF for the interior girders, the exterior girder shall be rated.
  - 4. When the rater determines the rating would be advantageous in analyzing the overall condition of a structure.

## III. Calculations

A. A set of calculations, separate from computer output, shall be submitted with each rating. These calculations shall include derivations for dead loads, derivations for live load distribution factors, and any other calculations or assumptions used for rating.

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```
B. Dead Loads
```

- The final sum of all the individual weight components for dead load calculations may be rounded up to the next 5 pounds.
- Dead loads applied after a cast-in-place concrete deck has cured shall be distributed equally to all girders and, when applicable, treated as composite dead loads. Examples include asphalt, curbs, sidewalks, railing, etc.
- 3. Use 5 psf for the unit weight of formwork when it is likely the formwork will remain in place. An example is closed cell construction, such as cast-in-place concrete box girders.
- 4. Dead loads applied before a cast-in-place concrete deck has cured shall be distributed to the applicable individual supporting girders and treated as non-composite loads. Examples of this type of dead load are deck slabs, girders, fillets, and diaphragms. The weight of diaphragms may be treated as point loads or as an equivalent uniform dead load for the span.

EXAMPLE: For two diaphragms (P) at 1/3 points

 $(PL)/3 = M = (wL \times L)/8$ 

equivalent uniform load . . . . w = (8P)/3L

5. The method of applying dead loads due to utilities is left to the rater's discretion.

## IV. Rating Reporting/Package Requirements

The rater and checker shall complete the rating documentation as described in Section 1 of this manual. Any variation from the original design assumptions shall be added to the Rating Summary Sheet as applicable. The rating package requirements shall be per Section 1-13 of this manual and as amended herein:

**Consultant designed projects** - Before finalizing the rating package and when VIRTIS is used as the analysis tool, the Rater shall verify with the Staff Bridge Rating Engineer that the version number of the program being used is identical to CDOT'S version number. Data files created using a lower version of the program shall be rejected. It is required for the CDOT data archive, since the data base management feature inside the program would not work satisfactorily. After the analysis is completed, the rater shall save the data file. When saving is finalized, the rater shall export the data file in \*.bbd format (i.e., O-18-BY.bbd format; bbd = Bridgeware Bridge Data File) on an IBMcompatible 3.5" PC Disk for delivery with the rating package. Also, the version number used during analysis shall be typed on the diskette label. This ensures proper importation of bridge data archive by the Staff Bridge at a later date.

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# 8-3 GUIDELINES FOR USING THE VIRTIS RATING PROGRAM

The VIRTIS computer program performs the analysis and rating of simple span and multi-span concrete girder bridges. It uses the BRASS ASD or the BRASS LFD engine for analysis. This program was developed in accordance with the AASHTO STANDARD SPECIFICATIONS, 16TH EDITION AND THE AASHTO MANUAL FOR CONDITION EVALUATION OF BRIDGES.

A maximum of thirteen (13) spans can be modeled using the program. Linear, none or parabolic girder web depth variation over the length of a defined cross-section can be modeled using the Virtis. When a structure model is finalized, it can be rated using the ASD or the LFD method. The LRFD rating module is currently being developed and will be available in the future. When a structure model is being generated and before any analysis can be performed, it is recommended that Virtis users save the data to memory periodically. This can be accomplished by using the File and Save feature of this program.

The library explorer can be used to save commonly used items (beam shapes, nonstandard vehicles, materials, appurtenances etc.) and this eliminates the need for all users to define the same items repeatedly throughout the program. Once a new girder shape is defined or copied from the library, Virtis automatically computes the required section properties and beam constants.

Dead load due to the girder self-weight, deck slab and appurtenances (i.e. rails, median barrier etc.) are calculated automatically by the program. Dead load due to the haunch, wearing surface and stiffener weight (for steel bridges) is defined by the user. For a detailed description of the girder loads, refer to the Opis/Virtis Help Menu index item - dead loads. During modeling a structure, help menu can also be activated by using the F1 key when the user requires clarification on a particular item in the GUI window.

In the Live Load Distribution Factor window, when the compute button is used to calculate the DF's automatically by the program, Virtis users shall verify that these numbers are accurate and matches their calculated numbers.

All Colorado BT girder shapes, the Colorado permit vehicle, the Colorado posting trucks and the Interstate posting trucks have been added to the Virtis library explorer and may be copied by the user. The Staff Bridge Rating Engineer shall be responsible for updating existing information or adding new information (i.e. beam shapes, vehicles etc.) to the library explorer.

The configuration browser provides access to the configuration features of Virtis. It may be employed to provide specific access privileges, i.e. read, write, delete etc., to the users. This feature is extremely powerful, since Virtis/Opis uses and shares the bridge data from one common source. Therefore, it is required that users of this program create a folder from the bridge explorer window (EXAMPLE: MY FOLDER OR YOUR LAST NAME) before creating the model for a new structure.

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## 8-4 RATING CONCRETE BRIDGES WITH UNKNOWN REINFORCING STEEL

It is anticipated that all bridges designed after January 1994 will have as constructed plans.

When there are no plans or other documentation for a particular concrete structure, its numerical rating shall be determined by a Professional Engineer Registered in the State of Colorado. This rating shall be based on its live load history, the condition of the bridge, a complete and comprehensive inspection of the structure and directions from the AASHTO Manual for Bridge Evaluation. If the structure shows no signs of distress due to load, the Engineer can assign it a maximum inventory rating of 36 tons.

When there are signs of capacity-reducing distress or deterioration, an appropriate judgment should be made and an inventory rating less than 36 tons shall be given to the concrete structure. The process is the same for operating rating; only difference is that a maximum rating of 40 tons can be assigned. No distress condition shall have a maximum permit vehicle operating rating of 96 tons. A rating is not required for concrete bridge decks with unknown reinforcing steel where the bridge deck is supported by girders or stringers.

A Rating Summary Sheet is required for these bridges. For bridges owned or maintained by the Colorado Department of Transportation, the Staff Bridge Engineer will approve this type of rating and sign the Rating Summary Sheet.

### 8-5 CONCRETE GIRDER BRIDGE RATING EXAMPLES

Two examples are presented in this section. First, Structure 0-18-BY is a five (5) span concrete-tee girder bridge with a skew of  $-30^{\circ}$  degrees. It has four (4) concrete-tee girders. Since all piers have expansion joints, only the span with the most critical condition as reported in the field inspection report will be modeled in this example. Only the interior girder has been modeled for this structure. The second structure, L-18-AV, is a 4-span continuous concrete-tee girder bridge with a skew of  $-27.3^{\circ}$  degrees. It has seven (7) concrete-tee girders. For simplicity, only the interior girder has been modeled for this structure.

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Slab Rating Program Input, Structure No. O-18-BY

🐃 WinSlab Input				_ 🗆 🗙	
Structure Number:	0-18-BY	Rater:	МН		
Batch ID:		Comments:	LFD		
Highway Number:	25	Load Type:	2=Interstate 🗮		
 Deadload	Bituminous Ove	erlay (in): 2			
Geometry				:	
Effective Span (ft):	8.083	Actual Slab Thickne (in.):	<sup>ess</sup> 7.5		
Reinforcing Steel: Area (sqin) Distance (in) For definitions of input					
Top: 0.83		5.688	values please rel CDOT Bridge Ra		
Bottom: 0.83	}	1.31			
Materials Properties					
Concrete f'c (PSI):	3000	Steel Fy (PSI):	40000		
or Inv Fc (Working	Stress)	or Inv Fs (Workin	g Stress)		
Modular Ratio (Leave blank for load factor): 00					
OK Cancel Apply Output to File					

Effective Span Length: Per AASHTO Article 3.24.1.2(a)

(Clear span) \*1/cos30° = (8.67-1.67) \*1/cos30° = 8.083'

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# Slab Rating Program Output, Structure No. 0-18-BY

WinSlab Rating Version 1 Date: 12/13/2001

Structure NO. O-18-BY Rater: MH State HWY NO. = 25 Batch ID= Description: LFD

LOAD FACTOR RATING-COMP STEEL NOT USED

INPUT DATA

Bituminous Overlay(ir	n)=	2.000		
Eff. Span(ft) =		8.083	Slab Thickness(in)=	7.500
Top Reinf. (sq.in)=		0.83	Eff. Depth(in) =	5.688
Bottom Area(sq.in)=		0.83	Bottom Dist.(in)=	1.31
Conc. Strength(PSI) 1	Inv =	3000	Oper. =	3000
Steel Yield (PSI)	Inv =	40000	Oper. =	40000
Modular Ratio =		9		
Dead Load Moment 0.77 K-Ft	t			
LL+I Moment 5.24 K-Ft	t			
Gross Weight 36.0 Tons	3			
		Inventory	Operating	
Actual Concrete Stress	(PSI)	997.12	1579.66	
Actual Reinf. Steel Stress	(PSI)	18433.86	29203.39	
Actual Comp. Steel Stress	(PSI)	5304.24	8403.10	
Member Capacity	(K-Ft)	12.81	12.81	
Member Capacity (LL+I)	(K-Ft)	11.81	11.81	
Rating	(Tons)	37.43	62.39	

Virtis Bridge Rating Example, Structure No. 0-18-BY

#### Effective slab width: Per AASHTO Article 8.10.1.1

0.25(L) = 0.25(57\*12) = 171" 12t+ Web Thickness = (12\*7.5) + 20 = 110" C.L. - C.L. of girder= 8.6667' = 104" Controls

## Dead Load:

Abutment Diaphragm = Weight Varies

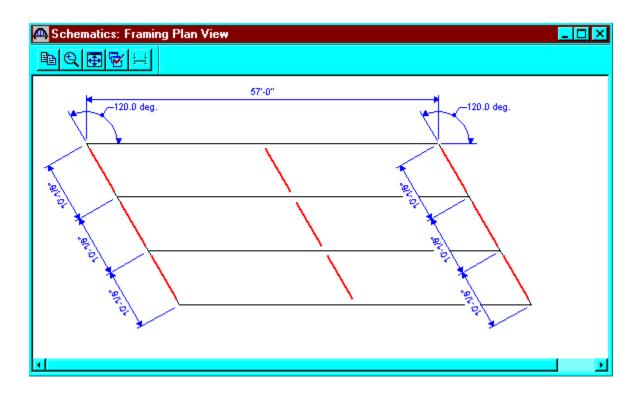
Use 6.2 kips

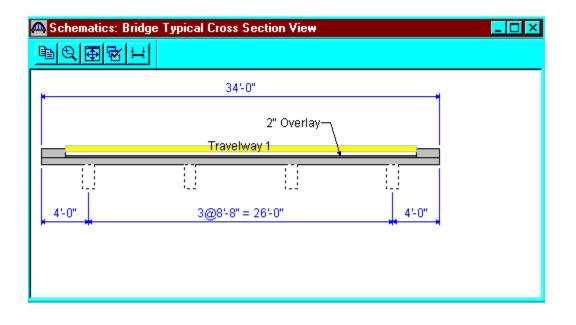
### Distribution Factor:

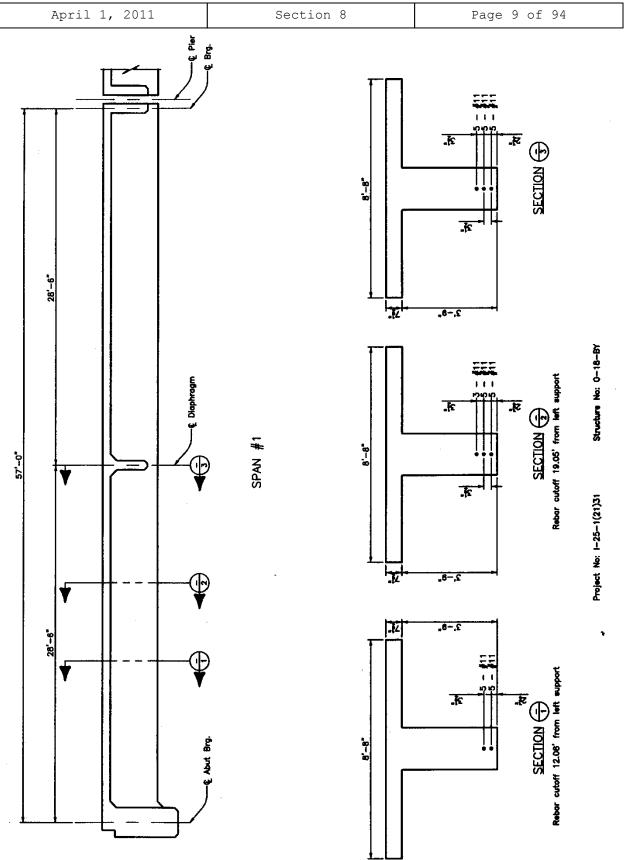
Multi-Lane = S/6 = 8.667/6 = 1.444

Single Lane = 1 + 2.667/8.667 = 1.308

Virtis Bridge Rating Example, Structure No. 0-18-BY (contd.)







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From the bridge explorer, create a new bridge and enter the following information.

🕰 0-18-BY				
Bridge ID: D-18-BY	NBI Structure	ID (8): 0-18-8Y		nplate sign Only
Description Description	on (cont'd) Alternatives Gl	obal Reference Point		
Name:	CSG		Year Built	1959
Description:	5-Span Concrete Tee-Beam Model as 1-Span Concrete		int at piers;	
	· ·			
Location:			Length:	ft
Facility Carried (7):		Route N	Number: -1	
Feat. Intersected (6):		N	Mi. Post:	
Units:	US Customary 💽	Recen	ADTT:	
			OK Apply	Cancel

Click OK. This saves the data to memory and closes the window.

NOTE: Since Virtis uses a common/shared database, it is required that users of this program create a folder from the bridge explorer window (EXAMPLE: MY FOLDER OR YOUR LAST NAME) before creating the model for a new structure.

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To add a new concrete material, click on Materials, Concrete, in the tree and select File/New from the menu (or right click on Concrete and select New). Click the Copy from Library button and select the Colorado Concrete from the library. Click OK and the following window will open. Click OK to save this concrete material to memory and close the window.

🙈 Bridge Mat	erials - Concrete					_ 🗆 ×
<u>N</u> ame:	Class A(US)	De <u>s</u> o	ription: Colorad	lo Concrete		
			0.000			
	Compressive strength at 28	days (f'c) =	3.000	ksi		
	Initial compressive stre	ngth (f'ci) =		ksi		
	<u>C</u> oefficient of thermal e	expansion =	0.0000060000	1/F		
	<u>D</u> ensity (for de	ad loads) =	0.150	kcf		
	Density (for modulus of	elasticity) =	0.150	kcf		
	Modulus of elas	sticity ( <u>E</u> c) =	3122.00	ksi		
	I <u>n</u> itial modulus of	elasticity =	0.00	ksi		
	<u>P</u> ois:	son's ratio =	0.200			
	Co <u>m</u> position of	concrete =	Normal	-		
	Modulus	of <u>r</u> upture =	0.411	ksi		
	<u>S</u> h	ear factor =	1.000			
	Co	opy from <u>L</u> ibra	ary Ol	< /	Apply	Cancel

Using the same techniques, create the following Reinforcing Steel Material to be used for the girder.

🕰 Bridge Mat	erials - Reinforcing Steel				
<u>N</u> ame:	Grade 40	<u>D</u> esc	cription: 40 ksi rei	inforcing steel	
		Material Proper	ties		
	Specified yield	strength (Fy) =	40.000	ksi	
	Modulus of	elasticity ( <u>E</u> s) =	29000.00	ksi	
	Littimate :	strength (F <u>u</u> ) =	70.000	ksi	
		ype Plain Epo <u>xy</u> <u>G</u> alvanized <u>O</u> ther	1		
		Copy from <u>L</u> ib	orary OK	Apply	Cancel

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To enter the appurtenances to be used within the bridge, expand the explorer tree labeled Appurtenances. Right mouse click on Parapet in the tree, and select New. Fill in the parapet properties as required. Click OK to save the data to memory and close the window.

🗛 Bridge Appurtenances - Parapet	_ 🗆 ×
Name:     Bridge Rail       Description:     Curb & side mounted Metal Rail	
All dimensions are in inches	ties
Copy from Library OK Apply	Cancel

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Double click on Impact/Dynamic Load Allowance in the tree. The Bridge Impact window shown below will open. Accept the default values by clicking OK.

🕰 Bridge Impact / Dynamic Loa	d Allowance 📃 🗖 🔀
Standard Impact Factor For structural components where AASHTO 3.8.1, choose the impac	
Standard AASHTO impact	l = <del></del> L + 125
O Modified impact =	times AASHTO impact
C Constant impact override =	*
LRFD Dynamic Load Allowance-	
Eatigue and fracture limit states:	15.0 %
<u>A</u> ll other limit states:	33.0 %
ОК	Apply Cancel

Click on Factors, right mouse click on LFD and select New. The LFD-Factors window will open. Click the Copy from Library button and select the 1996 AASHTO Standard Specifications from the library. Click Apply and then OK to save data to memory and close the window.

actors - LFD							_
<u>N</u> ame: 1	996 AASH	TO Std. Specific	cations				
Description: A E	ASHTO SI dition, 199	tandard Specific 6 including 1997	ations for Highwa 7 Interim Specific	ay Bridges, 16th ations			
oad Factors	Resistance	Factors					
Load Group	Gamma- Factor	D	(L.D.5	(LuDes	CF	Е	
INV	1.300	1.000	(L+I)n 1.670	(L+I)p 0.000	1.000	1.000	
OPG	1.300	1.000	1.000	0.000	1.000	1.000	
4							·
			Copy from I	Library	OK /	Apply Ca	ancel

We will now skip to Structure Definition. Bridge Alternatives will be added after we enter the Structure Definition.

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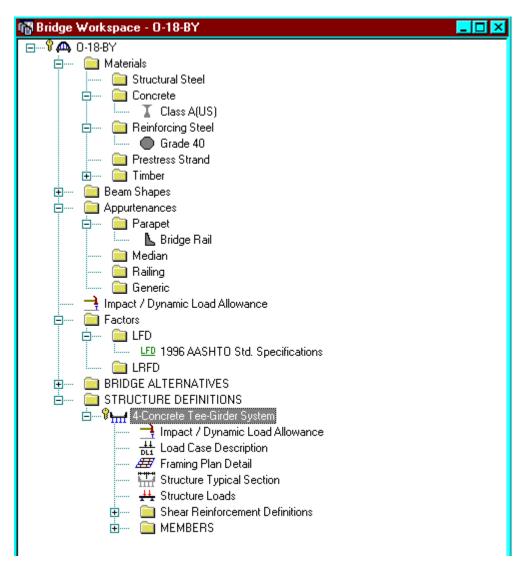
Double click on STRUCTURE DEFINITION (or click on STRUCTURE DEFINITION and select File/New from the menu or right mouse click on STRUCTURE DEFINITION and select New from the popup menu) to create a new structure definition. The following dialog box will appear.

ew Structure Definition					
Structure Type	Description				
Girder-line Girder system	A structure definition describing one of more girders. The girders do NO A structure definition describing one of more girders. The girders do hav				
T					
	OK Cancel				

Select Girder System and the following Structure Definition window will open. Enter the appropriate data as shown below. Press F1 while on this tab to view the help topic describing the use of this information.

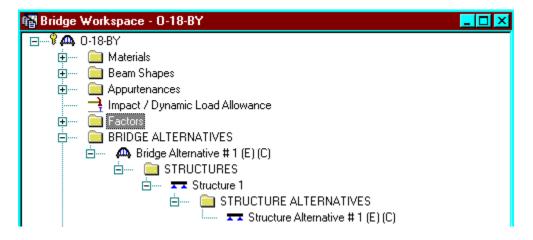
🕰 Girder System Structur	e Definition		
Definition Analysis Engi <u>N</u> ame: <u>D</u> escription:	4-Concrete Tee-Girder System		
Units: Number of <u>s</u> pans: Number of girders:	US Customary	Enter Span Lengths Along the Reference Line: Span Length (ft) 1 57.00	For PS only Average <u>h</u> umidity: % Member Alt. Types Steel P/S V R/C Timber
		ОК	Apply Cancel

The partially expanded Bridge Workspace tree is shown below:



We now go back to the Bridge Alternatives and create a new Bridge Alternative, a new Structure, and a new Structure Alternative.

The partially expanded Bridge Workspace tree is shown below:



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Click Load Case Description to define the dead load cases. The load types are presented in a single row separated by a comma. The first type applies to the LFD design and the second type applies to the LRFD design and it corresponds with the load types presented in the AASHTO Specifications. The completed Load Case Description window is shown below.

Load Case Description	n						
Load Case Name	Description	Stage		Туре	Time* (Days )		
Bridge Rail		Composite (long term) (Stage 2)	-	D,DC 🔽			
HBP		Composite (long term) (Stage 2)	_	D,DW			
Prestressed members only			N	ew	Duplicat	•	Delete

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Double click on Framing Plan Detail to describe the framing plan. Enter the appropriate data to describe the framing plan.

				_ 🗖
Number of spans =	1 Nur	nber of girders = 4		
Perpendic	cular to girder			
Girder Bay	Start of Girder	End of Girder		
1	8.67	8.67		
	8.67	8.67		
3	8.67	8.67		
		OK	Apply	Cancel
	Girder Spacin Perpendic Along sup Girder Bay	Girder Spacing Orientation Perpendicular to girder Along support Girder Bay Girder Bay Girder Bay Cirder Sp (t) Start of Girder 1 8.67 2 8.67	Girder Spacing Orientation Perpendicular to girder Along support Girder Bay Girder Bay Girder Girder 1 8.67 8.67 2 8.67 8.67 3 8.67 8.67 3 8.67 8.67 3 8.67 8.67 3 8.67 8.67	Girder Spacing Orientation Perpendicular to girder Along support Girder Bay Girder Bay Girder Bay Cirder Bas 1 8.67 8.67 2 8.67 8.67 3 8.67 8.67 3 8.67 8.67

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If the bridge has diaphragms, switch to the Diaphragms tab and enter the appropriate data. Click OK to save to memory and close the window.

ayout Di	aphragms		N	umber of spa	ans = 1	Number of girde	rs = 4	
Girder Bay	e 1	•	Copy Bay To		Diaphragm Wizard			
Support Number		vistance ft) Right Girder	Diaphragm Spacing (ft)	Number of Spaces	Length (ft)	End Dis (fi Left Girder		Weight (kip)
1 🔽	0.00	0.00	0.00	1	0.00	0.00	0.00	6.2000
1 🔽	0.00	0.00	28.50	1	28.50	28.50	28.50	3.1000
1 🔽	28.50	28.50	28.50	1	28.50	57.00	57.00	6.2000
<u>.</u>								
						New	Duplicate	e Delete

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Double click on Structure Typical Section in the Bridge Workspace tree to define the structure typical section. Input the data describing the typical section as shown below.

Structure Typical Section				
	eft edge of deck to ion reference line	Distance from right edge structure definition refer		
	Deck + thickness	Structure Definition Reference Line	7	
	+			
Left overhang 🔔 🚽			Right overhang	
Deck Deck (Cont'd) Parapet Media	n Railing Generic	Sidewalk Lane Posit	tion Wearing Surface	
Structure definition reference line is	within 🔽	the bridge deck.		
Distance from left edge of deck to structure definition reference line =	Start 17.00 ft	End 17.00 ft		
Distance from right edge of deck to structure definition reference line =	17.00 ft	17.00 ft		
Left overhang =	4.00 ft	4.00 ft		
Computed right overhang =	4.00 ft	4.00 ft		
			OK Apply	Cancel

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The Deck(Cont'd) tab is used to enter information about the deck concrete and thickness. The material to be used for the deck concrete is selected from the list of bridge materials described previously.

A Structure Typical Section			_	
	ce from left edge of deck to ire definition reference line	Distance from right edge of deck to structure definition reference line		
	Deck ⊥thickness	Structure Definition Reference Line		
Left overhang 🚽 🚃	N N	– <del>–</del> ––→ Bi	ght overhang	
Deck Deck (Cont'd) Parapet	Median Railing Gener	ic Sidewalk Lane Position Wearing \$	Surface	
<u>D</u> eck concrete	Class A(US)	•		
<u>T</u> otal deck thickness	; 7.5000 in			
Deck <u>c</u> rack control parameter				
Sustained modular ratio factor	2.000			
		OK	Apply Cance	el

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# Parapets:

Add two parapets as shown below.

itructu	ure Typical S	ec	tion												_
				E	ack		J	]	Front						
eck	Deck (Cont'd)	Œ	<sup>o</sup> arapet	Median	Railing	G	eneric	Side	walk	Lane f	Positi	on Wearing Su	irface		
	Name			Load C	ase		Measur	re To		e of De Measur From		Distance At Start (ft)	Distance At End (ft)	Front F Orienta	
Bridg	je Rail	-	Bridge F	Rail		-	Back	-	Left	Edge	-	0.00	0.00	Right	-
Bridg	je Rail	-	Bridge F	Rail		-	Back	-	Righ	t Edge	-	0.00	0.00	Left	-
												New	Duplicate	De	lete
												OK	Apply		Cancel

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Lane Positions:

Select the lane position tab and use the Compute… button to compute the lane positions. A dialog showing the results of the computation opens. Click apply to apply the computed values. The Lane Position tab is populated as shown below.

🗛 S	tructure Ty	pical Section				_ 🗆 ×
	Deck Deck	(A)		efinition Reference Line Travelway 2	Surface	
	Travelway Number	Distance From Left Edge of Travelway to Structure Definition Reference Line At Start (A) (ft)	Distance From Right Edge of Travelway to Structure Definition Reference Line At Start (B) (ft)	Distance From Left Edge of Travelway to Structure Definition Reference Line At End (A) (ft)	Distance From Right B Travelway to Struc Definition Reference At End (B) (ft)	ture
	1	-15.00	15.00	-15.00		15.00
	Com	pute		New OK	Duplicate Apply	Delete

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Enter the following wearing surface information on the Wearing Surface tab.

🕰 Structure Typical Section				_ 🗆 ×
	ce from left edge of deck to re definition reference line Deck thickness t	Distance from right edge structure definition refere Structure Definition Reference Line		
Left overhang	<u>↓</u> •		Right overhang	
Deck Deck (Cont'd) Parapet	t Median Railing Generi	ic   Sidewalk   Lane Positi	on Wearing Surface	
Wearing surface material:	НВР			
Description:	Hot Bituminous Material			
Wearing <u>s</u> urface thickness =	2.0000 in			
Wearing surface d <u>e</u> nsity =	144.000 pcf			
Load <u>c</u> ase:	НВР	•	Copy from Library	
			OK Apply	Cancel

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Double click on the Structure Loads tree item to define the DL Distribution. Select the required DL Distribution. Click OK to save this information to memory and close the window.

niform Temperature   Gradient Temperature   Wind   DLDistri	bution		
Stage 1 Dead Load Distribution			
By tributary area			
C By transverse simple-beam analysis			
C By transverse continuous-beam analysis			
$\mathbf{C}$ User input results from independent 3 <u>D</u> elastic analysis			
- Stage 2 Dead Load Distribution			
Uniformly to all girders			
O By tributary <u>a</u> rea			
O By transverse simple-beam analysis			
O By transverse continuous-beam analysis			
O User input results from independent 3D elastic analysis			
	ОК	Apply	Cance

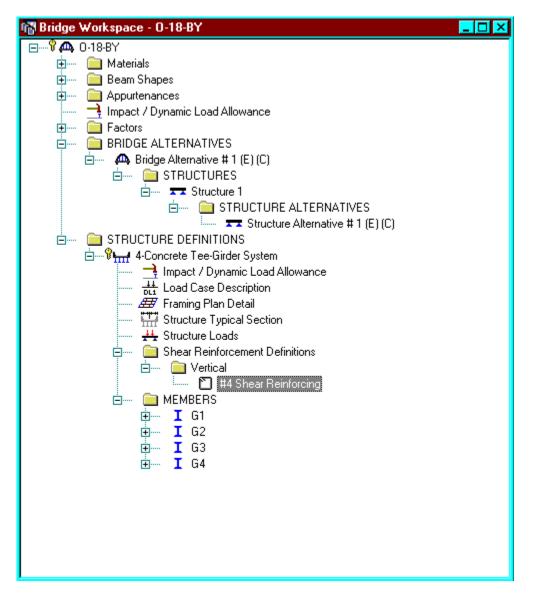
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Define the vertical shear reinforcement by double clicking on Vertical (under Shear Reinforcement Definition in the tree). Define the reinforcement as shown. The I shape shown is for illustrative purposes only. Click OK to save to memory and close the window.

🕰 Shear	Reinforcement Definition - Vertical			
<u>N</u> ame:	#4 Shear Reinforcing			
		Material:	Grade 40	J
		Bar size:	4 🔹	
		Number of legs:	2.00	
		Inclination (alpha):	90.0 Degrees	
	Vertical Shear Reinforcement			
			OK Apply	Cancel

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The partially expanded Bridge Workspace tree is shown below:



```
Describing a member:
```

The member window shows the data that was generated when the structure definition was created. No changes are required at this time. The first Member Alternative that we create will automatically be assigned as the Existing and Current Member alternative for this member.

🕰 Member				_ 🗆 🗡
<u>M</u> ember name:	G2	<u>L</u> ink	with: None	•
Description:				<u> </u>
				<b>*</b>
	Existing Current Member A		1	
	Interior 52	.5" RC Tee Bea		
Number of spans:	1 -	Span Span No Length	Pedestrian load:	Ib/ft
		(ft)		
		1 57.00		
			OK Apply	Cancel

Defining a Member Alternative:

Double click MEMBER ALTERNATIVES in the tree to create a new alternative. The New Member Alternative dialog shown below will open. Select Reinforced Concrete for the Material Type and Reinforced Concrete Tee for the Girder Type.

New Member Alternative	e	×
Material Type:	Girder Typ	e:
Reinforced Concrete	Reinforce	d Concrete Te
]	OK	Connect
	OK	Cancel

Click OK to close the dialog and create a new member alternative.

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The Member Alternative Description window will open. Enter the appropriate data as shown below.

Member Alternative: Interior 52.	5" RC Tee Beam	
Description Factors Engine Im	port	
Description:		Material Type:       Reinforced Concrete         Girder Type:       Reinforced Concrete Tee         Member units:       US Customary
Girder property input method © Schedule based © Cross-section based	End bearing locations Left: 7.5000 in Right: 7.5000 in	Analysis Module ASD: BRASS ASD ADD ADD ADD ADD ADD ADD ADD ADD ADD
Additional Self Weight Additional sel <u>f</u> weight = Additional self <u>w</u> eight =	Default rating m kip/ft LFD	LFD: Ignore shear
Crack control parameter (Z)	kip/in	

Shear computation method: Check this box if the AASHTO LFD shear specifications should be ignored in the analysis.

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Double click on Supports to define support constraints for the girder. Enter the following support constraints. Click OK to save data to memory and close the window.

						_ 🗆 ×
General	zĸ	•× <u>~</u> 1			2	
Summert	Quint	Translation Con	straints	Rotation Constraints		
Support Number	Support · Type	х	Y	Z		
1	Pinned 🔽	V	V			
2	Roller 🔽		V			
				ОК	Арріу	Cancel

Double click on Live Load Distribution to enter live load distribution factors. Click the Compute from Typical Section button to compute the live load distribution factors. The distribution factors are computed based on the AASHTO Specifications, Articles 3.23. Click Apply and then OK to save data to memory and close the window.

Lanes		Distribution (VVhee			
Loaded	Shear	Shear at Supports	Moment	Deflection	
1 Lane	1.308	1.308	1.308	0.500	
Multi-Lane	1.444	1.846	1.444	1.000	
Compute from	<u></u> 1				

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Double click on Cross Sections in the tree to create the cross section that defines the girder geometry. The Cross Section window is shown below. Define cross section 1 as shown below. Click apply and then the Reinforcement tab.

Cross Sections			_ 🗆 ×
Name: Cross Section 1	<u>Type:</u> Reinforce	d Concrete Tee	
Dimensions Reinforcement			
		Top Flange	1
Tributary width: 104.0000 in	7.5000 in	Material: Class A(US)	
	<u>+ </u>	Modular Ratio: 9.0	
	⊥	Eff. width (Std): 104.0000 in	
	52.5000 in	Eff. width (LRFD):	
		Eff. thickness: 7.5000 in	
  ←i	<u>↓</u>	Other Parts	1
20.0000 in		Material: Class A(US)	
A =	4.0000 in	Modular Ratio: 9.0	
		OK Apply Car	ncel

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Define reinforcements for Cross Section 1. Click OK to save data to memory and close the window.

Cross Sections           Name:         Cross Section 1	_ □ > 
Dimensions Reinforcement Distance from top T	Row Bar Size Bar Count Distance Material
	Bottom of Girder ▼ 11 ▼ 5.000 2.7500 Grade 40 Bottom of Girder ▼ 11 ▼ 5.000 6.2500 Grade 40
$\frac{1}{1} \underbrace{\bullet \bullet \bullet}_{\text{Distance from bottom}}$	<
	New Duplicate Delete
	OK Apply Cancel

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Using the same techniques, create cross section 2, cross-section 3 and define their associated reinforcement patterns.

ame: Cross Section 2	<u>T</u> ype: Reinfo	rce	d Conci	rete	Гее			
Dimensions Reinforcement Distance from top of Deam	Row		Bar S	ize	Bar Count	Distance (in)		Material
	Bottom of Girder	-	11	-	5.000	2.7500	Grade 40	
	Bottom of Girder	-	11	-	5.000	6.2500	Grade 40	
	Bottom of Girder	-	11	-	3.000	9.7500	Grade 40	
$\frac{1}{4}$								
	<b>1</b>							Ŀ
					New		Duplicate	Delete

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Cross Sections           Name:         Cross Section 3           Dimensions         Reinforcement	
↓ Distance from top ↓ of beam ★ ●••••••••••••••	Row Bar Size Bar Count Distance Material
	Bottom of Girder 🔽 11 🔽 5.000 2.7500 Grade 40
	Bottom of Girder 🔽 11 🔽 5.000 6.2500 Grade 40
	Bottom of Girder 🔽 11 🔽 5.000 9.7500 Grade 40
⊥ Distance from bottom of beam	✓           New         Duplicate         Delete
	OK Apply Cancel

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The Cross Section Ranges window is shown below. Define the ranges over which the cross sections apply.

Cross Section	Ra	nges									_ 🗆 🗵
Ţ ₽	SI	tart Distance		Length		End					
Section Section											
Start Section	-	End Section Cross Section 1	Ţ	Variation	۱ ب	Num		Distance (ft) 0.000	(ft)	Distance (ft) 12.800	
Cross Section 2	•	Cross Section 7 Cross Section 2		-	-	1	•	12.800	6.250	19.050	
Cross Section 3	-	Cross Section 3	-	None	•	1	-	19.050	18.900	37.950	
Cross Section 2	-	Cross Section 2	-	None	•	1	-	37.950	6.250	44.200	
Cross Section 1	-	Cross Section 1	-	None	•	1	-	44.200	12.800	57.000	
New Duplicate Delete											
									OK	Apply	Cancel

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Shear reinforcement locations are described using the Shear Reinforcement Ranges window shown below.

	<b></b>		Start Distance	<mark>∢</mark> Spa	acing			
Name		oport mber	L LIISTADCE	Number of Spaces	Spacing (in)	Length (ft)	End Distance (ft)	
#4 Shear R 💌	1	-	0.00	1	18.0000	1.50	1.50	
#4 Shear R 🔽	1	-	1.50	5	6.0000	2.50	4.00	
#4 Shear R 🔽	1	-	4.00	4	9.0000	3.00	7.00	
#4 Shear R 🔽	1	-	7.00	4	12.0000	4.00	11.00	
#4 Shear R 🔽	1	-	11.00	13	15.0000	16.25	27.25	
#4 Shear R 🔽	1	-	27.25	1	30.0000	2.50	29.75	
#4 Shear R 🔽	1	-	29.75	13	15.0000	16.25	46.00	
#4 Shear R 🔽	1	-	46.00	4	12.0000	4.00	50.00	
#4 Shear R 🔽	1	-	50.00	4	9.0000	3.00	53.00	
#4 Shear R 🔽	1	-	53.00	6	6.0000	3.00	56.00	
#4 Shear R 💌	1	-	56.00	1	4.0000	0.33	56.33	
					1	lew Du	plicate D	elete

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Define points of interest	using the Points	of Intere	st window shown below.
A Point of Interest			
Distance from leftmost support: 12.80 ft	or <u>S</u> pan: Span 1	✓ <u>Fraction</u> : 0	.224561 Side C Left © Right
Shear Engine		1	% Shear:
Vertical Shear Reinf. Material: Grade 40	Horiz. Shear Reinf.	Shear o	listance:
Bar size:		Computation	
# of legs:			Sx: L
Area: I			Theta:
Spacing:		LFD 🗖 Ig	nore shear
		OK	Apply Cancel

The Point of Interest window enables the user to enter points of interest in addition to those that are automatically generated by the program.

15 bar diameter = 15\*(11/8) = 1.712' Clear Span/20 = (57-1.83)/20 = 2.75' Effective Depth = 46.25/12 = 3.85' Use 3.8'

First rebar cutoff from left support = 12.8' Second rebar cutoff from left support = 19.05'

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Point of Interest			
Distance from leftmost support: 19.05 ft Shear Engine	or <u>S</u> pan: Span 1 💌	Eraction: 0.334	211 Side C Left C Right
Override schedule     Vertical Shear Reinf.	Horiz Shear Beinf	% Sh Shear distar	
Material:       Grade 40         Bar size:       Image: Imag		- LRFD Computation Met	hod:
		OK	Apply Cancel

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Point of Interest			
Distance from leftmost support: 5.02 ft	or <u>S</u> pan: Span 1 💌	Eraction: 0.08807	0 Side C Left ⊙ <u>R</u> ight
Shear Engine		% Shea	r:
Vertical Shear Reinf. Material: Grade 40 Bar size: # of legs: Area: Inclination: Spacing:		Shear distance LRFD Computation Metho S Bet Thet LFD	
		OK [	Apply Cancel

Shear Check: d = 52.5''-6.25'' = 46.25'' = 3.85'Shear at a distance 'd' from the free edge of the left support + 1.167' = 3.85' + 1.167' = 5.02'

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Point of Interest			
Distance from leftmost support: 52.98 ft Shear Engine	or <u>S</u> pan: Span 1	→ Eraction: 0	929474 Side C Left © Right
Override schedule		,	% Shear:
Vertical Shear Reinf. Material: Grade 40 Bar size: # of legs: Area: Inclination: Spacing:	Horiz. Shear Reinf.	Computation	Iistance:
		OK	Apply Cancel

Shear Check: d = 52.5''-6.25'' = 46.25'' = 3.85'Shear at a distance 'd' from the free edge of the right support + 0.167' = 3.85' + 0.167' = 4.02'Therefore, Distance from the left support = 57.0'-4.04' = 52.98'

Open the Member Alternative Description window and click the Engine tab as shown below.

lember Alternative Description	_ 🗖
Member Alternative: Interior 52.5" RC Tee Beam	
Description Factors Engine Import	
Configure engine properties for analysis module: BRASS LFD	
Analysis Load Sequence: Computed based on loadings and comp Points of Interest Control: 3 - Same as 1 plus generate user-define Wheel Advancement: 100	Properties
است المحمد ا	

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Click the Properties button to edit the engine properties for BRASS LFD.

BRASS-Standard Member Alternative Properties	×
Analysis	OK
Load Sequence:	Cancel
Computed based on loadings and composite regions.	
POI Control:	
1 - Generate points of interest at all tenth points along TOP spans	
Wheel advancement denominator: 100	

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To perform a rating, select the View Analysis Settings button on the toolbar to open the window shown below. Select the required vehicles to be used in the rating and click OK.

🕰 Analysis Settings						_ 🗆 ×
O Design Review	Rating	Rating	Method:	LFD		•
Vehicles Output Engine	e Description Traffic Direction: Both directions	I,	/ehicle Sun	nmary:	Advanc	:ed
	osting Type 3 osting Type 3-2 osting Type 3S2	Add to Rating >> Remove from Analysis <<	 ⊡ Op	Vehicles ventory - HS 20-44 berating - HS 20-44 - Colorado Permi	t Vehicle	
Reset Clear	Open Template	Save Template		ж 🛕	pply (	Cancel

The results of the LFD rating analysis are as follows.

Live Load	Live Load Type	Design Method	Inventory Load Rating Ton	Operating Load Rating Ton	Inventory Rating Factor	Operating Rating Factor	Inventory Location ft		Operating Location ft	Operating Location Span-(%)	Limit State		Op Lim
IS 20-44	Axle	ļ	48.57	81.11	1.349	2.253		1 - ( 50.0)	·		) ULTIMATE MOMENT CA	APACIT ULTIMA	ATE M
IS 20-44	Lane		70.55	117.82	1.960		28.50				) ULTIMATE MOMENT CA		
olorado Permit Vehic	ie Axle	LFD		139.40		1.451			28.50	1 - ( 50.0	)	ULTIM/	ATEN

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Description         Table Continuent         Table Continuent		MENT OF TRANSPORT				Structure # State highway #	0-18	-BY(S.B.)	
Applait thickness:       50 mm ( 2 m)         Bruchure trype       CSG         Patalist structure trype       CSG         Patalist structure trype       CSG         Patalist structure trype       CSG         Inventory       43.6 ( 48 )       33.6 ( 37 )       ( )         Inventory       43.6 ( 48 )       33.6 ( 37 )       ( )       ( )         Inventory       43.6 ( 48 )       33.6 ( 37 )       ( )       ( )         Unventory       43.6 ( 48 )       33.6 ( 37 )       ( )       ( )         Unventory       43.6 ( 48 )       33.6 ( 37 )       ( )       ( )         Unventory       43.6 ( 48 )       33.6 ( 37 )       ( )       ( )         Unventory       43.6 ( 48 )       33.6 ( 37 )       ( )       ( )         Unventory       43.6 ( 48 )       33.6 ( 37 )       ( )       ( )         Unventory       43.6 ( 48 )       33.6 ( 37 )       ( )       ( )         Unventory       43.6 ( 48 )       33.6 ( 37 )       ( )       ( )         Unventory       ( )       ( )       ( )       ( )       ( )         Type 37 truck       ( )       ( )       ( )       ( )       ( )         Unventori								I-25	
Intenstate legalizeds         CSG           Parallel structure #         0-18-CD (N.B.)           Structural member         INTERIOR GIRDER         SLAB           Inventory         43.6         48         33.6         37         (         (           Operating         73.6         81         56.4         62         (         (           Type 3 truck         (	Asphalt thickness:		in.)						
Structural member         INTERIOR GIRDER         SLAB           Metric tons (Tons)         Inventory         43.6 (48) 33.6 (37) () ()         ()           Inventory         43.6 (48) 33.6 (37) () ()         ()         ()           Operating         73.6 (31) 56.4 (62) () ()         ()         ()           Type 3 truck         ()         ()         ()         ()           Type 3 truck         ()         ()         ()         ()           Type 3-2 truck         ()         ()         ()         ()           Type 3-2 truck         ()         ()         ()         ()           Permit truck         126.3 (139)         ()         ()         ()           Type 3-2 truck         ()         ()         ()         ()           Inverse 21 and totols of tons)           Metric tons         Tons         Metric tons         Tons         Metric tons         Tons           Metric tons         Tons         Metric tons         Tons         Metric tons         Tons           Control Member: Deck; Rated for 2" HBP         Cod Capacity: 62 Tons         Girder: Only Interior Girder Rated; Rated for 2" HBP         Co	_ •						0-1		)
Metric tons (Tons)           Inventory         43.6 (48)         33.6 (37)         ()         (           Operating         73.6 (81)         56.4 (62)         ()         (           Type 3 truck         ()         ()         ()         (           Type 31 truck         ()         ()         ()         ()           Type 32 truck         ()         ()         ()         ()           Type 3-2 truck         ()         ()         ()         ()           Type 3-2 truck         ()         ()         ()         ()           Permit truck         126.3 (139)         ()         ()         ()           Type 3 Truck         126.3 (139)         ()         ()         ()           Type 3 Truck         126.3 (139)         ()         ()         ()           Type 3 Truck         126.3 (139)         ()         ()         ()           Metric tons         Tons         Metric tons         Tons         Metric tons         Tons           Control Member: Deck; Rated for 2" HBP         Coad Capacity: 62 Tons         Girder: Only Interior Girder Rated; Rated for 2" HBP         Color Code: White           Project No: I-25-1(21)31         Project No: I-25-1(21)31         Exted for 2"									• )
Inventory       43.6       (48)       33.6       (37)       ()       (         Operating       73.6       (81)       56.4       (62)       ()       (         Type 3 truck       ()       ()       ()       ()       (       ()       ()         Type 3 truck       ()       ()       ()       ()       ()       ()       ()         Type 3-2 truck       ()       ()       ()       ()       ()       ()       ()         Permit truck       126.3       ()       ()       ()       ()       ()       ()         Type 3 truck       ()       ()       ()       ()       ()       ()       ()         Permit truck       126.3       ()       ()       ()       ()       ()       ()         Type 3 truck       ()       ()       ()       ()       ()       ()       ()         Type 3 truck       126.3       ()       ()       ()       ()       ()       ()         Construct       126.3       ()       10       ()       ()       ()       ()       ()       ()       ()         Construct       126.3       ()       139	Structural member	INTERIOR GIRDER	SL	AB					
Operating       73.6       (81)       56.4       (62)       ()         Type 3 truck       ()       ()       ()       ()         Type 352 truck       ()       ()       ()       ()         Type 3-2 truck       ()       ()       ()       ()         Type 3-2 truck       ()       ()       ()       ()         Permit truck       126.3       (139)       ()       ()       ()         Type 3 Truck       ()       ()       ()       ()       ()         Type 3 Truck       126.3       (139)       ()       ()       ()         Type 3 Truck       126.3       (139)       ()       ()       ()         Type 3 Truck       126.3       (139)       ()       ()       ()         Type 3 Truck       126.3       ()       ()       ()       ()         Type 3 Truck       126.3       ()       ()       ()       ()         Type 3 Truck       126.3       ()       ()       ()       ()       ()         Type 3 Truck       126.3       ()       ()       ()       ()       ()       ()         Type 3 Truck       126.7       ()       )		Metric tons (Tons)							
Type 3 truck       ( ) ( ) ( ) ( ) ( )         Type 352 truck       ( ) ( ) ( ) ( ) ( )         Type 3-2 truck       ( ) ( ) ( ) ( ) ( ) ( )         Type 3-2 truck       ( ) ( ) ( ) ( ) ( ) ( ) ( )         Permit truck       126.3 ( 139 ) ( ) ( ) ( ) ( ) ( ) ( ) ( ) ( ) ( )	Inventory	43.6 ( 48 )	33.6	( 37	)	(	)	(	)
Type 3S2 truck () () () () () () () () () () () () ()	Operating	73.6 ( 81 )	56.4	<b>(</b> 62	)	(	)	(	)
Type 3-2 truck () () () () () () () () () () () () ()	Type 3 truck	( )		()	)	(	)	(	)
Permit truck 126.3 (139) () () () () () () () () () () () () ()	Type 3S2 truck	( )		()	)	(	)	(	)
Type 3 Truck Historial 21 8 matric tons (24 tons) Colorado 24.5 matric tons (27 tons) Metric tons Tons Metric tons (42.5 ton) Metric tons Tons Metric tons (42.5 ton) Comments Control Member: Deck; Rated for 2" HBP Load Capacity: 62 Tons Girder: Only Interior Girder Rated; Rated for 2" HBP Color Code: White Project No: I-25-1(21)31	Type 3-2 truck	( )		()	)	(	)	(	)
Import Interstate 21.8 metric tons (24 tons)       Import Interstate 24.5 metric tons (30 tons)         Import Colorado 24.5 metric tons (27 tons)       Import Colorado 38.6 metric tons (42.5 tons)         Import Colorado 24.5 metric tons (27 tons)       Import Colorado 38.6 metric tons (42.5 tons)         Import Colorado 24.5 metric tons (27 tons)       Import Colorado 38.6 metric tons (42.5 tons)         Import Colorado 24.5 metric tons (27 tons)       Import Colorado 38.6 metric tons (42.5 tons)         Import Colorado 24.5 metric tons (27 tons)       Import Colorado 24.5 metric tons (42.5 tons)         Import Colorado 24.5 metric tons (27 tons)       Import Colorado 24.5 metric tons (42.5 tons)         Import Colorado 24.5 metric tons       Import Colorado 24.5 metric tons (42.5 tons)         Import Colorado 24.5 metric tons       Import Colorado 24.5 metric tons (42.5 tons)         Import Colorado 24.5 metric tons       Import Colorado 24.5 metric tons (42.5 tons)         Import Colorado 24.5 metric tons       Import Colorado 24.5 metric tons (42.5 tons)         Import Colorado 24.5 metric tons       Import Colorado 24.5 metric tons (42.5 tons)         Control Member: Deck; Rated for 2" HBP       Import Colorado 24.5 metric tons (42.5 tons)         Girder: Only Interior Girder Rated; Rated for 2" HBP       Import Colorado 24.5 metric tons (42.5 tons)         Color Code:       White         Project No: 1-25-1(21)31       Import Colorado 24.5 metric tons	Permit truck	126.3 ( 139 )	I	()	)	(	)	(	)
Comments Control Member: Deck; Rated for 2" HBP Load Capacity: 62 Tons Girder: Only Interior Girder Rated; Rated for 2" HBP Color Code: White Project No: I-25-1(21)31	Interstate 21.8 metric	tons (24 tons)	Interstate 34.5 m	etric tons (38 to	ns) tons)	S.4 me Colorade	e atric tons (39 o	9 tons)	0
Control Member: Deck; Rated for 2" HBP Load Capacity: 62 Tons Girder: Only Interior Girder Rated; Rated for 2" HBP Color Code: White Project No: I-25-1(21)31	Metric tons Tons	) s Metric	tons (	) Tons		Metric to	(((((	) Tons	
Rated by Date Checked by Date	Control Member: De Load Capacity: 62 Girder: Only Interior Color Code: White	Fons r Girder Rated; Rated		P					
Previous adjitions are obsolete and may not be used CDOT Form #1187a	Rated by	Date		Checked by	,				

Previous editions are obsolete and may not be used

Slab Rating Program Input, Structure No. L-18-AV

💐 WinSlab	Input		
Structure Nu	imber: L-18-AV	Rater:	MH
Batch ID:		Comments:	
Highway Nu	mber: 25	Load Type:	1=Colorado 🚍
Deadload	Bituminous	Overlay (in): 2	
Geometry			
Effective Sp	an (ft): 8,44	Actual Slab Thic (in.):	kness 6.5
Reinforcin	g Steel:		
	Area (sqin)	Distance (in)	For definitions of input values please refer to the
Тор:	0.75	5.156	CDOT Bridge Rating Manual
Bottom:	0.75	1.34	
Materials I	Properties		
Concrete f'c	(PSI): 3000	Steel Fy (PSI):	40000
or Inv Fc (V	Working Stress)	or Inv Fs (Wor	king Stress)
Modular Rat	io (Leave blank for	load factor): 00	
OK	Ca	ncel	Uutput to File

Effective Span Length: Per AASHTO Article 3.24.1.2(a)

(Clear span)\*1/cos27.3° = (9.00-1.50)\*1/cos27.3° = 8.440'Distance to Top Steel = 5.156''Distance to Bottom Steel = 1.344''Top Steel Area: #6 @ 12 = 0.440#5 @ 12 = 0.310  $\Sigma = 0.750$  in\*in Bott. Steel Area: #6 @ 12 = 0.440#5 @ 12 = 0.310 $\Sigma = 0.750$  in\*in

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Slab Rating Program Output, Structure No. L-18-AV
WinSlab Rating Version 1
                        Date: 1/14/2002
Structure NO. L-18-AV Rater: MH
                                     State HWY NO. = 25
    Batch ID=
                    Description:
LOAD FACTOR RATING-COMP STEEL NOT USED
 *** Warning: Slab thickness violates old AASHTO 1.5.40(B)***
INPUT DATA
      Bituminous Overlay(in) =
                               2,000
      Eff. Span(ft) =
                               8.440
                                             Slab Thickness(in) = 6.500
      Top Reinf. (sq.in)=
                              0.75
                                           Eff. Depth(in) = 5.156
      Bottom Area(sq.in) =
      Bottom Area(sq.in) = 0.75
Conc. Strength(PSI) Inv = 3000
                                            Bottom Dist.(in) = 1.34
                                                               3000
                                            Oper. =
      Steel Yield (PSI) Inv = 40000
                                            Oper. =
                                                               40000
      Modular Ratio =
                                  9
Dead Load Moment 0.75 K-Ft
LL+I Moment
                5.43 K-Ft
                36.0 Tons
Gross Weight
                                 Inventory
                                             Operating
Actual Concrete Stress (PSI)
                                 1051.42
                                              1650.22
Actual Reinf. Steel Stress (PSI) 18660.60
                                              29288.22
                                             6760.66
Actual Comp. Steel Stress (PSI)
                                 4307.46
                                  10.50
                                              10.50
Member Capacity
                         (K-Ft)
Member Capacity (LL+I)
                         (K-Ft)
                                    9.52
                                                 9.52
    Rating
                         (Tons)
                                  29.15
                                               48.58
```

Virtis Bridge Rating Example, Structure No. L-18-AV

## Effective slab width: Per AASHTO Article 8.10.1.1

0.25(L) = 0.25(41\*12) = 123" 12t+ Web Thickness = (12\*6.5) + 18 = 96.0" Controls C.L. - C.L. of girder= 9.00' = 108"

## Dead Load:

Intermediate Diaphragm = (0.67)\*(2.00)\*(9.00-1.50)\*(1/Cos27.3°)\*(0.150) = 1.696 kips Use 1.7 kips

Abutment Diaphragm = ((4.81)\*(1)\*(7.5)+(2.1)\*(1)\*(7.5))\*1/Cos27.3°\*0.150 = 8.75 kips Use 9.0 kips

Pier Diaphragm = (2)\*(6.5)\*(7.5)\*(1/Cos27.3°)\*(0.15) = 16.50 kips Use 16.50 kips

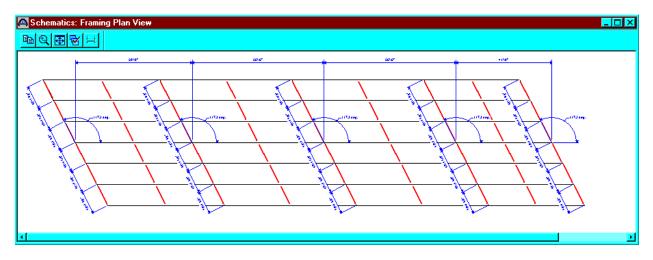
## Distribution Factor:

Multi-Lane = S/6 = 9.00/6 = 1.500

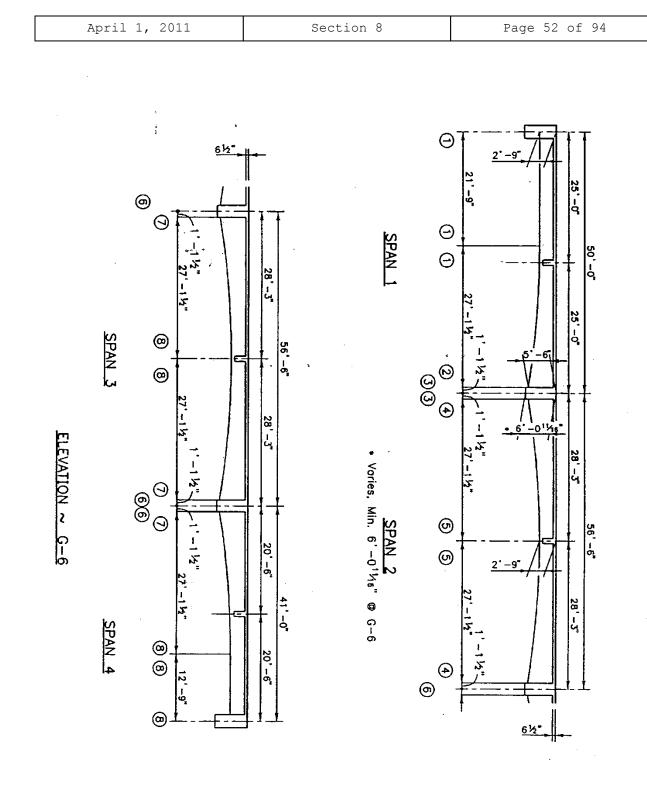
Single Lane = 1 + 3.00/9.00 = 1.333

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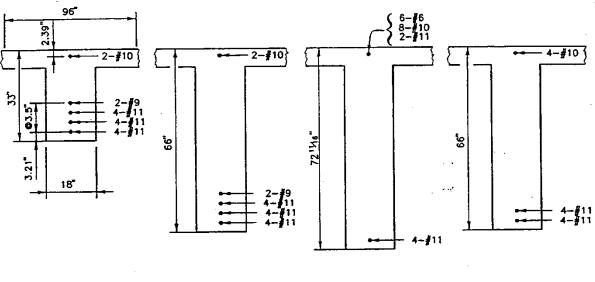
## Virtis Bridge Rating Example, Structure No. L-18-AV (contd.)



Schematics: Br	idge Typical C	ross Section Vi	ew			_ 🗖
			62'-0"			
	31'-0"		#	2" Overlay	31'-0"	
	Travelway 1	1			avelway 2	
4'-0"			6@9'-0" = 54'-0"			4'-0"



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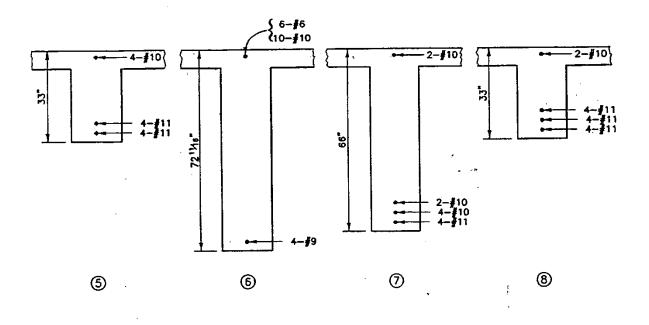












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From the bridge explorer, create a new bridge and enter the following information.

🚇 L-18-AV				_ 🗆	×
Bridge ID: L-18-AV	NBI Structure I	d (8): L-18-AV		emplate esign Only	
Description Description	n (cont'd)   Alternatives   Glo	bal Reference Point			
Name:	CSGC		Year Bui	ilt: 1958	
Description:	4- Span Concrete Tee-Beam	Continuous Structure		<u> </u>	
				<b>v</b>	
Location:			Length:	ft	
Facility Carried (7):		Route	Number: -1		
Feat. Intersected (6):		I	Mi. Post:		
Units:	US Customary 🔽	Recer	nt ADTT:		
			ОК Арр	ly Cancel	

Click OK. This saves the data to memory and closes the window.

NOTE: Since Virtis uses a common/shared database, it is required that users of this program create a folder from the bridge explorer window (EXAMPLE: MY FOLDER OR YOUR LAST NAME) before creating the model for a new structure.

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To add a new concrete material, click on Materials, Concrete, in the tree and select File/New from the menu (or right click on Concrete and select New). Click the Copy from Library button and select the Colorado Concrete from the library. Click OK and the following window will open. Click OK to save this concrete material to memory and close the window.

🕰 Bridge Materials -	Concrete					_ 🗆 🗡
<u>N</u> ame: Class.	A(US)	De <u>s</u> o	ription: Cold	orado Concrete		
	Compressive strength at 28	days (f'c) =	3.000	ksi		
	Initial compressive stre	ength (f'ci) =		ksi		
	Coefficient of thermal e	expansion =	0.00000600	1/F		
	<u>D</u> ensity (for de	ead loads) =	0.150	kcf		
	Density (for modulus of	elasticity) =	0.150	kcf		
	Modulus of ela:	sticity ( <u>E</u> c) =	3122.00	ksi		
	l <u>n</u> itial modulus o	f elasticity =	0.00	ksi		
	<u>P</u> ois	son's ratio =	0.200			
	Co <u>m</u> position of	concrete =	Normal	•		
	Modulus	of <u>r</u> upture =	0.411	ksi		
	<u>S</u> h	ear factor =	1.000			
	C	opy from <u>L</u> ibra	ary	OK	Apply	Cancel

Using the same techniques, create the following Reinforcing Steel Material to be used for the girder.

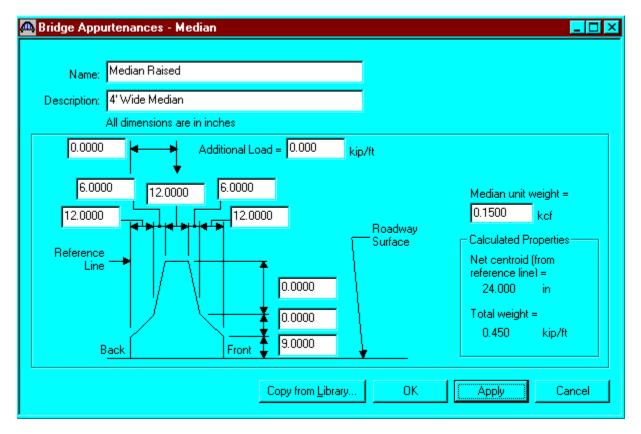
🕰 Bridge Mat	erials - Reinforcing Steel				
<u>N</u> ame:	Grade 40	<u>D</u> esc	cription: 40 ksi rei	inforcing steel	
		Material Proper	ties		
	Specified yield	strength (Fy) =	40.000	ksi	
	Modulus of	elasticity ( <u>E</u> s) =	29000.00	ksi	
	Littimate :	strength (F <u>u</u> ) =	70.000	ksi	
		ype Plain Epo <u>xy</u> <u>G</u> alvanized <u>O</u> ther	1		
		Copy from <u>L</u> ib	orary OK	Apply	Cancel

To enter the appurtenances to be used within the bridge, expand the explorer tree labeled Appurtenances. Right mouse click on Parapet in the tree, and select New. Fill in the parapet properties as required. Click OK to save the data to memory and close the window.

🗛 Bridge Appurtenances - Parapet	
Name: Bridge Rail Description: Curb & Type 10R Rail All dimensions are in inches	
15.5000 Additional Load = 0.033 kip/ft 0.0000 24.0000 0.0000 Reference Line 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000	Parapet unit weight = 0.1500 kcf Surface Calculated Properties Net centroid (from reference line1 = 12.448 in Total weight = 0.258 kip/ft
Copy from Library	OK Apply Cancel

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Right mouse click on Median in the tree, and select New. Fill in the median properties as required. Click OK to save the data to memory and close the window.



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Double click on Impact/Dynamic Load Allowance in the tree. The Bridge Impact window shown below will open. Accept the default values by clicking OK.

🕰 Bridge Impact / Dynamic Loa	id Allowance 📃 🗖 🔀
For structural components where AASHTO 3.8.1, choose the impar	
Standard AASHTO impact	I = <u>50</u> L + 125
O Modified impact =	times AASHTO impact
O Constant impact override =	%
LRFD Dynamic Load Allowance	
Eatigue and fracture limit states:	15.0 %
<u>A</u> ll other limit states:	33.0 🕺
ОК	Apply Cancel

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Click on Factors, right mouse click on LFD and select New. The LFD-Factors window will open. Click the Copy from Library button and select the 1996 AASHTO Standard Specifications from the library. Click Apply and then OK to save data to memory and close the window.

actors - LFD							_
<u>N</u> ame: 1	996 AASH	TO Std. Specific	cations				
Description: A E	ASHTO SI dition, 199	tandard Specific 6 including 1997	ations for Highwa 7 Interim Specific	ay Bridges, 16th ations			
oad Factors	Resistance	Factors					
Load Group	Gamma- Factor	D	(L.D.5	(Li Dis	CF	Е	
INV	1.300	1.000	(L+I)n 1.670	(L+I)p 0.000	1.000	1.000	
OPG	1.300	1.000	1.000	0.000	1.000	1.000	
4							·
			Copy from I	Library	OK /	Apply Ca	ancel

We will now skip to Structure Definition. Bridge Alternatives will be added after we enter the Structure Definition.

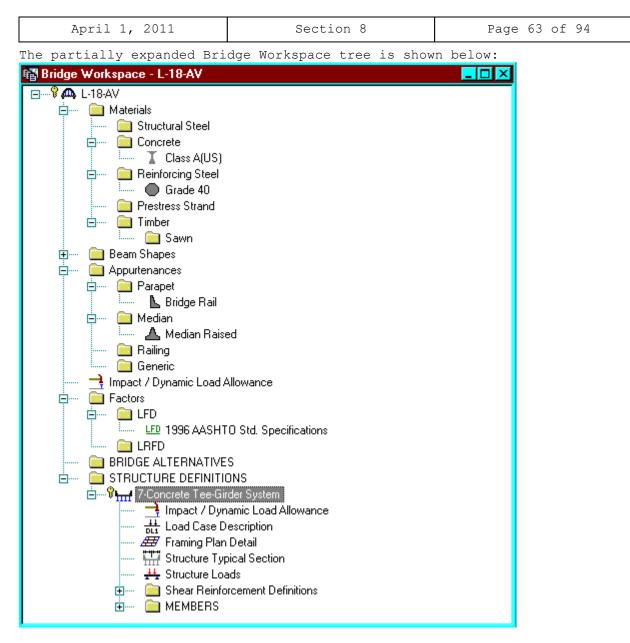
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Double click on STRUCTURE DEFINITION (or click on STRUCTURE DEFINITION and select File/New from the menu or right mouse click on STRUCTURE DEFINITION and select New from the popup menu) to create a new structure definition. The following dialog box will appear.

w Structure Definit	tion
Structure Type	Description
Girder-line Girder system	A structure definition describing one of more girders. The girders do NO A structure definition describing one of more girders. The girders do hav
<b>1</b>	► Cancel

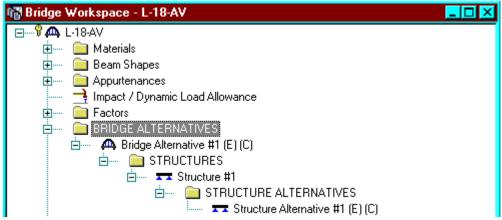
Select Girder System and the following Structure Definition window will open. Enter the appropriate data as shown below. Press F1 while on this tab to view the help topic describing the use of this information.

🕰 Girder System Structu	re Definition			_ 🗆 🗡
Definition Analysis Eng	ine			
<u>N</u> ame:	7-Concrete Tee-Girder System			
<u>D</u> escription	: 4-Span Structure			×
<u>U</u> nits:	US Customary 🔽		an <u>L</u> engths Reference Line	For PS only
Number of <u>s</u> pans:	4	Span	Length	Average <u>h</u> umidity:
Number of girders:	7 🔺	1	(ft) 50.00	*
		2	56.50	Member Alt. Types
	<b>N</b> 1.	3	56.50	Steel
	Deck type:	4	41.00	P/S
	Concrete	1		Timber
			OK	(Apply Cancel



We now go back to the Bridge Alternatives and create a new Bridge Alternative, a new Structure, and a new Structure Alternative.

The partially expanded Bridge Workspace tree is shown below:



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Click Load Case Description to define the dead load cases. The load types are presented in a single row separated by a comma. The first type applies to the LFD design and the second type applies to the LRFD design and it corresponds with the load types presented in the AASHTO Specifications. The completed Load Case Description window is shown below.

Load Case Name	Description	Stage		Туре	,	Time* (Days )	
Bridge Rail		Composite (long term) (Stage 2)	-	D,DW	-		
1BP		Composite (long term) (Stage 2)	•	D,DW	-		
Median Raised		Composite (long term) (Stage 2)	-	D,DW	-		

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Double click on Framing Plan Detail to describe the framing plan. Enter the appropriate data to describe the framing plan.

Structu	ıre Framin	g Plan Details							_ 🗆
			Num	nber of spans	= 4	Number of g	jirders = 7	,	
Layout	Diaphragn	ns							
		Skew	-	F Girder Spa	cing Orient	ation ———			
	Support	(Degrees)		O Perper	ndicular to g	jirder			
	1	-27.3000		O Along	support				
	2	-27.3000							
	3	-27.3000				r Spacing	-		
	4	-27.3000		Girder Bay	Start of	(ft) End of			
	5	-27.3000			Girder	Girder			
				1	9.00	9.00			
				2	9.00	9.00			
				3	9.00	9.00			
				4	9.00	9.00	-		
				5	9.00	9.00	-		
					0.001	0.001			
							OK	A sector	Connect
							OK	Apply	Cancel

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If the bridge has diaphragms, switch to the Diaphragms tab and enter the appropriate data. Click OK to save to memory and close the window.

	,		Сору Вау То		Wizard			
Support	Start Di (ff		Diaphragm	Number	Length	End Dis (ff		Weight
Number	Left Girder	.) Right Girder	Spacing (ft)	of Spaces	(ff)	Left Girder	.) Right Girder	(kip)
1 🔽	0.00	0.00	0.00	1	0.00	0.00	0.00	9.0000
1 🔽	0.00	0.00	25.00	1	25.00	25.00	25.00	1.7000
1 🔽	25.00	25.00	25.00	1	25.00	50.00	50.00	8.2500
2 🔽	0.00	0.00	0.00	1	0.00	0.00	0.00	8.2500
2 🔽	0.00	0.00	28.25	1	28.25	28.25	28.25	1.7000
2 🔽	28.25	28.25	28.25	1	28.25	56.50	56.50	8.2500
3 🔽	0.00	0.00	0.00	1	0.00	0.00	0.00	8.2500
3 🔽	0.00	0.00	28.25	1	28.25	28.25	28.25	1.7000
3 🔽	28.25	28.25	28.25	1	28.25	56.50	56.50	8.2500
4 🔽	0.00	0.00	0.00	1	0.00	0.00	0.00	8.2500
4 🔽	0.00	0.00	20.50	1	20.50	20.50	20.50	1.7000
4 🔽	20.50	20.50	20.50	1	20.50	41.00	41.00	9.0000
New Duplicate Delete								

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Double click on Structure Typical Section in the Bridge Workspace tree to define the structure typical section. Input the data describing the typical section as shown below.

🕰 Structure Typical Sec	ction						_ 🗆 🗡
		eft edge of deck tion reference lin		e from right eo e definition rel	dge of deck to ference line		
	Ż	Deck ↓thickness		ure Definition ence Line	`́		
Left overhang		+				Right overhang	
Deck Deck (Cont'd)	Parapet Media	an   Railing   Ge	eneric Sidewa	alk   Lane Po	sition Wearing	g Surface	
Structure definition ref	ference line is	within	✓ the brid	ge deck.			
Distance from left edg structure definition refe		Start 31.00 ft	E 31.0	End DO ft			
Distance from right ed structure definition ref		31.00 ft	31.0	00 ft			
Lef	t overhang =	4.00 ft	4.00	) ft			
Computed righ	nt overhang =	4.00 ft	4.00	) ft			
					OK	Apply	Cancel

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The Deck(Cont'd) tab is used to enter information about the deck concrete and thickness. The material to be used for the deck concrete is selected from the list of bridge materials described previously.

Structure Typical Section					_ 🗆 ×
	ance from left edge of deck to sture definition reference line Deck	Distance from right edge of dec structure definition reference lin Structure Definition Reference Line			
	thickness thickness				
Left overhang	→ → Nedian   Bailing   Gener	ic   Sidewalk   Lane Position   W		t overhang face l	
Deck Deck Control Parap	ert meulant nailingt denei	ic   Sidewaik   Lane Fosition   M	reaning Jun		
<u>D</u> eck concre	te: Class A(US)	•			
<u>T</u> otal deck thickne	ss: 6.5000 in				
Deck <u>c</u> rack control paramet	ter: 130.000 kip/in				
Sustained modular ratio fact	tor: 2.000				
			ОК	Apply	Cancel

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Parapets:

Add two parapets as shown below.

Structure Typical Se	Back		Front - walk   Lane Posi	tion   Wearing S	urface	
Name	Load Case		Edge of Deck Dist. Measured From	Distance At Start (ft)	Distance At End (ft)	Front Face Orientation
Bridge Rail	🚽 Bridge Rail	🗾 Back 📃		0.00	0.00	Right 🗾
Bridge Rail	Bridge Rail	🗾 Back 📃	Right Edge 🔽	0.00	0.00	Left 🗾
				New OK	Duplicate	Delete

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Median:

Add one median as shown below.

A S	itructure Typical S	ection						
ſ	Deck   Deck (Cont'd	) Parapet Media	Back		Front	n ) Wearing Sur	face	
	Name	Load Case		Edge of Deck Dist. Measured From	Distance At Start (ft)	Distance At End (ft)	Front Face Orientation	
	Median Raised  💌	Median Raised 🔽	Back 🔽	Left Edge  🔽	29.00	29.00	Right 🔽	
						New	Duplicate	Delete
						OK	Apply	Cancel

Lane Positions:

Select the lane position tab and use the Compute… button to compute the lane positions. A dialog showing the results of the computation opens. Click apply to apply the computed values. The Lane Position tab is populated as shown below.

Deck Deck	(A)		efinition Reference Line Travelway 2	Surface
Travelway Number	Distance From Left Edge of Travelway to Structure Definition Reference Line At Start (A) (ft)	Distance From Right Edge of Travelway to Structure Definition Reference Line At Start (B) (ft)	Distance From Left Edge of Travelway to Structure Definition Reference Line At End (A) (ft)	Distance From Right Edge of Travelway to Structure Definition Reference Line At End (B) (ft)
1	-29.00 2.00	-2.00 29.00	-29.00 2.00	-2.00
	pute		New OK	Duplicate Delete

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Enter the following wearing surface information on the Wearing Surface tab.

Structure Typical Section				<u>_ 0 ×</u>
	nce from left edge of deck to ture definition reference line Deck thickness	Distance from right edge structure definition referent Structure Definition Reference Line		
Left overhang	+ 			ing
Deck Deck (Cont'd) Parape	et Median Railing Generi	c   Sidewalk   Lane Positio	on Wearing Surface	
Wearing surface material:	HBP			
<u>D</u> escription:	Hot Bituminous Material			
Wearing <u>s</u> urface thickness =	2.0000 in			
Wearing surface density =	144.000 pcf			
Load <u>c</u> ase:	HBP	•	Copy from <u>L</u> ibrary	
			ОК А	pply Cancel

Double click on the Structure Loads tree item to define the DL Distribution. Select the required DL Distribution. Click OK to save this information to memory and close the window.

iform Temperature Gradient Temperature Wind DLDis	ribution		
Stage 1 Dead Load Distribution	]		
By tributary area			
O By transverse simple-beam analysis			
O By transverse continuous-beam analysis			
${f C}$ . User input results from independent 3 <u>D</u> elastic analysis			
Stage 2 Dead Load Distribution	]		
Uniformly to all girders			
O By tributary <u>a</u> rea			
O By transverse simple-beam analysis			
O By transverse continuous-beam analysis			
O User input results from independent 3D elastic analysis			
	J		

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Define the vertical shear reinforcement by double clicking on Vertical (under Shear Reinforcement Definition in the tree). Define the reinforcement as shown. The I shape shown is for illustrative purposes only. Click OK to save to memory and close the window.

🗛 Shear Reinforcement Definition - Vertical	
Name: #4 Shear Reinforcing	
	Material: Grade 40 💌
	Bar size: 4
Numb	per of legs: 2.00
	on (alpha): 90.0 Degrees
Vertical Shear Reinforcement	
	OK Apply Cancel

The partially expanded Bridge Workspace tree is shown below:

📸 Bridge Workspace - L-18-AV
📩 🧰 Materials
🧰 Structural Steel
🕀 🚥 Concrete
🕀 🚥 Reinforcing Steel
🧰 Prestress Strand
🗄 🚞 Timber
📺 🧰 Beam Shapes
🖕 🧰 Appurtenances
📺 ····· 🧰 Parapet
🕀 🚥 Median
🧰 Railing
📖 🧰 Generic
📑 Impact / Dynamic Load Allowance
😟 🧰 Factors
BRIDGE ALTERNATIVES
Impact / Dynamic Load Allowance
Load Case Description
🖽 Framing Plan Detail 🔛 Structure Typical Section
Hin Structure Typical Section
Structure Loads     Structure Loads     Structure Loads
im I G1
I G2

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```
Describing a member:
```

The member window shows the data that was generated when the structure definition was created. No changes are required at this time. The first Member Alternative that we create will automatically be assigned as the Existing and Current Member alternative for this member.

🕰 Member		_ 🗆 ×
Member name:	: G2	
<u>D</u> escription:		
	<b></b>	
	Existing Current Member Alternative Name Description	
	✓ Interior Variable Depth RC	
<u>N</u> umber of spans:	: 4	ft
	1 50.00	
	2 56.50	
	3 56.50	
	4 41.00	
	ОК (Аррју Саг	ncel

Defining a Member Alternative:

Double click MEMBER ALTERNATIVES in the tree to create a new alternative. The New Member Alternative dialog shown below will open. Select Reinforced Concrete for the Material Type and Reinforced Concrete Tee for the Girder Type.

New Member Alternative		×
Material Type:	Girder Typ	e:
Reinforced Concrete	Reinforce	d Concrete Te
г	01/	
	OK	Cancel

Click OK to close the dialog and create a new member alternative.

The Member Alternative Description window will open. Enter the appropriate data as shown below.

Member Alternativ	e Descriptior	1			_ 0
Member Alternativ	e: Interior Varia	able Depth RC	Tee Beam		
Description Factors	Engine Imp	ort			
Description:	ased	Leit	g locations 5000 in 5000 in	Girder Type: Re	inforced Concrete Tee inforced Concrete Tee Customary • odule BRASS ASD • BRASS LFD • BRASS LFD •
Additional Self We Additional sel <u>f</u> we Additional self <u>w</u> e Crack control para Bottom of beam:	eight = eight = emeter (Z)	kip/ft &	Default rati <u>ng</u> n LFD	LRFD:	Iputation method General Procedure 🔽 Ignore shear
				ок ( 🦳	Apply Cancel

Shear computation method: Check this box if the AASHTO LFD shear specifications should be ignored in the analysis.

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Double click on Supports to define support constraints for the girder. Enter the following support constraints. Click OK to save data to memory and close the window.

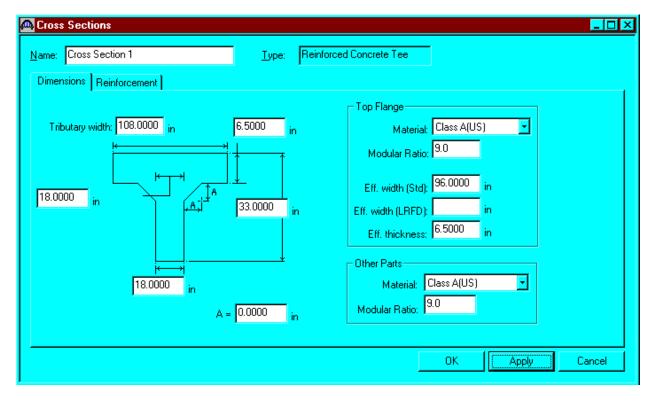
Supports General	z	→X <u>~</u> 1		 2
Support	Support	Translation Constraints		Rotation Constraints
Number	Туре	х	Y	Z
	Pinned 🔽			
	Roller 🔽			
3	Roller 🔽			
4	Roller 🔽			
5	Roller 🔽			
			<u> </u>	Apply Cancel

Double click on Live Load Distribution to enter live load distribution factors. Click the Compute from Typical Section button to compute the live load distribution factors. The distribution factors are computed based on the AASHTO Specifications, Articles 3.23. Click Apply and then OK to save data to memory and close the window.

Lanes		Distribution (Whee				
Loaded	Shear	Shear at Supports	Moment	Deflection		
1 Lane	1.333	1.333	1.333	0.286		
Multi-Lane	1.500	1.889	1.500	0.857		
Compute fron Typical Secti	n					

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Double click on Cross Sections in the tree to create the cross section that defines the girder geometry. The Cross Section window is shown below. Define cross section 1 as shown below. Click apply and then the Reinforcement tab.



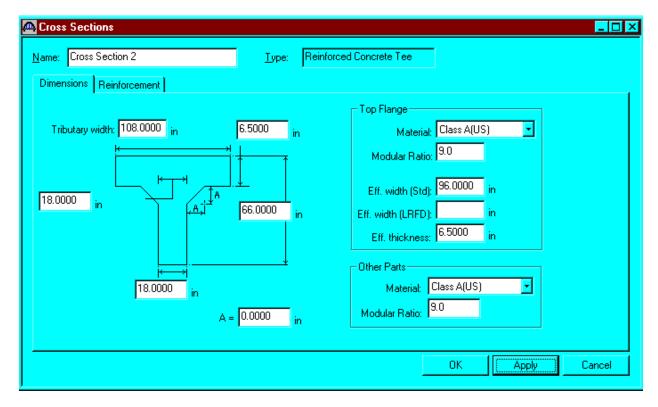
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Define reinforcements for Cross Section 1. Click OK to save data to memory and close the window.

Cross Sections           Name:         Cross Section 1	<u>Iype:</u> Reinforce	ed	Concrete 1	Tee		
Dimensions Reinforcement	Row	T	Bar Size	Bar Count	Distance (in)	Material
		1		4.000	3.2100	Grade 40 🔽
		1	_	4.000		Grade 40
		1 9		4.000		Grade 40 🗾 Grade 40 🔽
		1				Grade 40
¥ ू • • • The stance from bottom of beam						
				New		Duplicate Delete
					OK	Apply Cancel

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Using the same techniques, create cross sections 2 thru 8, and define their associated reinforcement patterns.



Cross Section 2	<u>Type:</u> Reinforce	ed	l Concrete 1	Гее		
nsions Reinforcement						
- Distance from top of beam	Row		Bar Size	Bar Count	Distance (in)	Material
	Bottom of Girder 📘	-	11 🔽	4.000	3.2100	Grade 40 📃
	Bottom of Girder 📘	-	11 🔽	4.000	6.7100	Grade 40 📃
	Bottom of Girder	-	11 🔽	4.000	10.2100	Grade 40 🔽
	Bottom of Girder	-	9 🔽	2.000	13.7100	Grade 40 📃
	Bottom of Girder	-	10 🔽	2.000	63.6100	Grade 40 📃
<u>+</u>						
↑ Distance from bottom of beam						
of Deam						
				New		Duplicate Delete

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Γ

Cross Sections				
Lame: Cross Section 3	<u>T</u> ype: Reinfo	rced Concrete Tee		
Dimensions Reinforcement				
		_ Top Flange		
Tributary width: 108.0000 in	6.5000 in	Material:	Class A(US) 🔄	
<u>;←</u> >i	+ +	Modular Ratio:	9.0	
	. <u>↓</u>	Eff. width (Std):	96.0000 in	
	72.6875 in	Eff. width (LRFD):	in	
		Eff. thickness:	6.5000 in	
└ <u></u>	Į	Uther Parts		
18.0000 in		Material:	(lass A(US) 🔽	
	0.0000 in	Modular Ratio: 9	.0	
			OK Apply	Cancel

Cross Sections  Name: Cross Section 3	
Dimensions Reinforcement	Row Bar Size Bar Count Distance Material
	Bottom of Girder         11         4.000         3.2100         Grade 40         Image: Constraint of Constraints           Bottom of Girder         11         2.000         70.2975         Grade 40         Image: Constraints
	Bottom of Girder         10         8.000         70.2975         Grade 40         Image: Constraint of Constraints           Bottom of Girder         6         6.000         70.2975         Grade 40         Image: Constraints
$ \begin{array}{c c}                                    $	
ot beam	
	New Duplicate Delete
	OK Apply Cancel

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Cross Sections	Tura Reinford	ed Concrete Tee		
Lame: Cross Section 4	<u>I</u> ype: Reinford			
Tributary width: 108.0000 in	6.5000 in	Eff. width (LRFD):		
i <del>k → j</del> 18.0000 in A =	0.0000 in	Other Parts Material: Clas Modular Ratio: 9.0	ss A(US) ▼	
			OK Apply	Cancel

ne: Cross Section 4	<u>T</u> ype: Reinforc	ed Concrete	Tee		
imensions Reinforcement					
Distance from top	Row	Bar Size	Bar Count	Distance (in)	Material
· •	Bottom of Girder	11 🔽	4.000	3.2100	Grade 40 🔽
	Bottom of Girder	11 🔽	4.000	6.7100	Grade 40 🔽
	Bottom of Girder	10 🔽	4.000	63.6100	Grade 40 🔽
⊥ Distance from bottom of beam					
			Nev	/	Duplicate Delete

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Cross Sections		<b>_</b> 🗆 ×
Name: Cross Section 5	<u>I</u> ype: Reinforced Concrete Tee	
Dimensions Reinforcement		
Tributary width: 108.0000 in (18.0000 in )	H Modular Ratio: Eff. width (Std): 33.0000 in Eff. width (LRFD): Eff. thickness:	96.0000 in 6
<del>←→ </del>  18.0000 in  A	= 0.0000 in Other Parts	Class A(US)
		OK Apply Cancel

Cross Sections           Name:         Cross Section 5           Dimensions         Reinforcement	<u>I</u> ype: Reinfor	ce	d Concrete 1	Тее			
Distance from top of beam 	Row		Bar Size	Bar Count	Distance (in)	Material	
	Bottom of Girder	-	11 🔽	4.000	3.2100	Grade 40	
	Bottom of Girder	-	11 🔽	4.000		Grade 40	
	Bottom of Girder	•	10 🔽	4.000	30.6100	Grade 40	
↓ ★ Distance from bottom of beam				New	· 1	Duplicate D	elete
					OK	Apply	Cancel

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	•	

Cross Sections				
Name: Cross Section 6	<u>Type:</u> Reinforced Co	ncrete I ee		
Tributary width: 108.0000 in 6.9	5000 in	Modular Ratio:	Class A(US)	
i←→i 18.0000 in A = 0.		Eff. thickness:	3.5000 in ass A(US)	
			OK Apply	Cancel

Cross Sections     Name: Cross Section 6	<u>Iype:</u> Reinforce	ed Cor	ncrete 1	Гее			
Dimensions Reinforcement					Distance		
$\frac{1}{4}$	Row		Size	Bar Count	(in)	Materia	
	Bottom of Girder	9	_	4.000	3.2100	Grade 40	<u> </u>
	Bottom of Girder 👱	10	-	10.000	70.2975	Grade 40	
	Bottom of Girder 🔄	6	-	6.000	70.2975	Grade 40	▼
⊥ ↑ Distance from bottom of beam							
				New		Duplicate	Delete
					OK	Apply	Cancel

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Cross Sections				_ 🗆
ame: Cross Section 7	<u>T</u> ype: Reinfo	rced Concrete Tee		
Dimensions Reinforcement				
		Top Flange		
Tributary width: 108.0000 in	6.5000 in	Material: Cla	iss A(US) 🔄	
<u> </u> €		Modular Ratio: 9.0		
	<u>,                                     </u>	Eff. width (Std): 96.	0000 in	
	66.0000 in	Eff. width (LRFD):	in	
		Eff. thickness: 6.5	000 in	
	¥	Other Parts		
18.0000 in		Material: Class	A(US)	
,	A = 0.0000 in	Modular Ratio: 9.0		
			DK Apply	Cancel

Cross Sections           Name:         Cross Section 7		ed	d Concrete 1	[ee		
Dimensions Reinforcement	T)ber [					
→ Distance from top ↓ of beam ★ ◆ • • • • • • • • • • • • • • • • • •	Row		Bar Size	Bar Count	Distance (in)	Material
	Bottom of Girder	-	11 🔽	4.000	3.2100	Grade 40 🔽
	Bottom of Girder		10 🔽	4.000	6.7100	Grade 40 🔽
	Bottom of Girder		10 🔽	2.000	10.2100	Grade 40 🔽
	Bottom of Girder	-	10 🔽	2.000	63.6100	Grade 40 🔽
$ \begin{array}{c}                                     $						
				New		Duplicate Delete
					OK	Apply Cancel

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Cross Sections				_ 🗆 ×
Name: Cross Section 8	<u>T</u> ype: Reinfo	rced Concrete Tee		
Dimensions Reinforcement				
		_ Top Flange		
Tributary width: 108.0000 in	6.5000 in	Material:	Class A(US) 🔄	
<u> ←</u>  ·	<u>† †</u>	Modular Ratio:	9.0	
	<u> </u>	Eff. width (Std):	96.0000 in	
	33.0000 in	Eff. width (LRFD):	in	
		Eff. thickness:	6.5000 in	
  ←	¥	Other Parts		
18.0000 in		Material:	Class A(US)	
A =	0.0000 in	Modular Ratio: 9	.0	
			OK Apply	Cancel

Cross Sections	<u> </u>	ed C	Concrete T	ee		
Dimensions Reinforcement Distance from top Top beam	Row	B	ar Size	Bar Count	Distance (in)	Material
	Bottom of Girder 📘	11	<b>_</b>	4.000	3.2100	Grade 40 🔽
	Bottom of Girder 🔽	11		4.000	6.7100	Grade 40 🔽
	Bottom of Girder 📘	11	-	4.000	10.2100	Grade 40 🔽
	Bottom of Girder 🔽	10	) 🔽	2.000	30.6100	Grade 40 🔽
⊥ Distance from bottom of beam						
				New		Duplicate Delete
					OK	Apply Cancel

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The Cross Section Ranges window is shown below. Define the ranges over which the cross sections apply.

			-			-					
Ť	S	tart Distance	St. Se	Lengt art ection	h	End Secti	on				<u> </u>
Start Section		End Section		VVeb Variatio	'n	Supp Numi		Start Distance (ft)	Length (ft)	End Distance (ft)	
cross Section 1	-	Cross Section 1	-	None	-	1	-	0.000	21.750	21.750	
ross Section 1	-	Cross Section 2	-	Parabolic	-	1	-	21.750	27.125	48.875	
ross Section 2	•	Cross Section 3	-	Linear	-	1	-	48.875	1.125	50.000	
cross Section 3	-	Cross Section 4	-	Linear	-	2	-	0.000	1.125	1.125	
cross Section 4	-	Cross Section 5	-	Parabolic	-	2	-	1.125	27.125	28.250	
ross Section 5	-	Cross Section 4	-	Parabolic	-	2	-	28.250	27.125	55.375	
ross Section 4	-	Cross Section 6	-	Linear	-	2	-	55.375	1.125	56.500	
cross Section 6	-	Cross Section 7	-	Linear	-	3	-	0.000	1.125	1.125	
cross Section 7	-	Cross Section 8	-	Parabolic	-	3	-	1.125	27.125	28.250	
ross Section 8	-	Cross Section 7	-	Parabolic	-	3	•	28.250	27.125	55.375	
ross Section 7	-	Cross Section 6	-	Linear	-	3	•	55.375	1.125	56,500	
Cross Section 6	•	Cross Section 7	-	Linear	-	4	-	0.000	1.125	1.125	
Cross Section 7	-	Cross Section 8	-	Parabolic	-	4	-	1.125	27.125	28.250	
Cross Section 8	•	Cross Section 8	•	None	•	4	•	28.250	12.750	41.000	
									New	Duplicat	e Delete
									OK	Appl	y Cancel

Open the Member Alternative Description window and click the Engine tab as shown below.

Member Alternative Description	_ 🗖
Member Alternative: Interior Variable Depth RC Tee Beam	
Description Factors Engine Import	
Configure engine properties for analysis module: BRASS LFD	-
Analysis Load Sequence: Computed based on loadings and comp Points of Interest Control: 1 - Generate points of interest at all tent Wheel Advancement: 100	Properties
ОК (Арр	ly Cancel

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Click the Properties button to edit the engine properties for BRASS LFD.

BRASS-Standard Member Alternative Properties	×
Analysis	OK
Load Sequence:	Cancel
Computed based on loadings and composite regions.	
POI Control:	
1 - Generate points of interest at all tenth points along TOP spans	
Wheel advancement denominator: 100	

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To perform a rating, select the View Analysis Settings button on the toolbar to open the window shown below. Select the required vehicles to be used in the rating and click OK.

Analysis Settings					_	
O Design Review	Rating	Rating	Method:	LFD		-
Vehicles Output Engir	ne Description					
Vehicle Selection:	Traffic Direction: Both directions	J,	/ehicle Sur	nmary:	Advanced	
Colorado F Colorado F	Permit Vehicle Posting Type 3 Posting Type 3-2 Posting Type 352 333	Add to Rating	 ⊡- Op	Vehicles ventory - HS 20-44 perating - HS 20-44 - Colorado Permit V	/ehicle	
Reset Clear	Open Template	Save Template		ОК <u>А</u> рр	oly Cance	el

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The results of the LFD rating analysis are as follows.

Member: G2

RATING FACTOR REPORT ANALYSIS POINT NO. 17: LOAD LEVELS	205.00 TRUCK DESCRIPTION
1: 1.30( 1.00 * D +	
•	
2: 1.30( 1.00 * D +	1.00 * L ) 2. Truck: AASHTO H 20-S 16 Loading, 1944 Ed
	3. Truck: 96 Tons Vehicle
LOA	D LEVEL 1 LOAD LEVEL 2 LOAD LEVEL 3 LOAD LEVEL 4

POS. MOMENT	Τ	_		
TRUCK 1	01.23 <b>44.28</b>	02.05 <b>73.8</b> T	N/A	N/A
TRUCK 2	01.67	02.80	N/A	N/A
TRUCK 3	01.09	01.83	N/A	N/A
CRITICAL	01.09	01.83 175.7 <sup>T</sup>	N/A	N/A
NEG. MOMENT				
TRUCK 1	01.79	02.99	N/A	N/A
TRUCK 2	01.49	02.50	N/A	N/A
TRUCK 3	01.17	01.96	N/A	N/A
CRITICAL	01.17	01.96	N/A	N/A
POS. SHEAR				
TRUCK 1	N/A	N/A	N/A	N/A
TRUCK 2	N/A	N/A	N/A	N/A
TRUCK 3	N/A	N/A	N/A	N/A
CRITICAL	N/A	N/A	N/A	N/A
NEG. SHEAR				
TRUCK 1	N/A	N/A	N/A	N/A
TRUCK 2	N/A	N/A	N/A	N/A
TRUCK 3	N/A	N/A	N/A	N/A
CRITICAL	N/A	N/A	N/A	N/A

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Image: Section of the section of th				Structure #       L-18-AV         State highway #       I25 Overpass         Batch I.D.       Structure type         CSGC       Parallel structure #				
	Metric tons (Tons)	L						
Inventory	40.0 ( 44 )	26.4 (	29 )	(	)	(	)	
Operating	67.3 ( 74 )	44.5 (	49 )	(	)	(	)	
Type 3 truck	( )	(	)	(	)	(	)	
Type 3S2 truck	( )	(	)	(	)	(	)	
Type 3-2 truck	( )	(	)	(	)	(	)	
Permit truck	160.0 ( 176 )	(	)	(	)	(	)	
Type 3 Truck Interstate 21.8 metric Colorado 24.5 metric	toris (24 tons)	Type 3S2 T Interstate 34.5 met Colorado 38.6 metr	ric tons (38 tons)	s) Interst 35.4 r Colora	metric tons (39 to	(and	0	
Metric tons Tons	) s Metric	tons To	) ns	Metric t	((	) Tons		
Load Capacity: 49 Girder: Only Interior Color Code: White Project No: I 002-3(	r Girder Rated; Rate	d for 2" HBP over I-25						
Rated by	Date	C	hecked by			Date		

COLORADO DEPARTMENT OF TRANSPORTATION Sect	ion: 9A
	ctive: April 1, 2002 rsedes: July 1, 1995

SECTION 9A - PRESTRESSED CONCRETE GIRDER BRIDGES

#### 9A-1 INTRODUCTION TO RATING PRESTRESSED CONCRETE GIRDER BRIDGES

This section together with section 1, presents the policies and guidelines for rating prestressed concrete girders. Policies are itemized in subsection 9A-2, while supporting guidelines are summarized in subsections 9A-2, 3, 4, and 5.

The types of girders covered by this section include precast pretensioned girders as described below:

CPG - Concrete Prestressed Girder
 CPGC - Concrete Prestressed Girder Continuous
 CDTPG - Concrete Double-Tee Prestressed Girder
 CBGP - Concrete Box Girder Prestressed
 CBGCP - Concrete Box Girder Continuous Prestressed

#### 9A-2 POLICIES AND GUIDELINES FOR RATING PRESTRESSED CONCRETE GIRDER BRIDGES

### I. General

- A. Prestressed concrete girders, either simple span, or simple spans made continuous, shall be rated using the VIRTIS computer program. Refer to subsection 9A-3 for information on this program.
- B. When the LFD method is used for rating girders, unless a more rational methodology like the modified compression field theory in the AASHTO LRFD code is adopted for use, prestressed girders shall not be rated for shear. However, during the design process, all prestressed girders shall be checked for shear using the appropriate AASHTO code.
- C. Double-tee structures without a poured in place composite deck or a full depth diaphragm shall use the live load distribution factor as prescribed in the AASHTO LRFD Specifications. The exterior girder distribution factor shall be calculated using the lever rule.
- D. Double-tee structures with a poured in place composite deck or a full depth rigid diaphragm/bracing system with a rotational stiffness roughly equal to a poured in place deck, the live load distribution factor for Concrete T-Girders as prescribed in Table 3.23.1 of the AASHTO Standard Specifications for Highway Bridges, 16<sup>th</sup> Edition, shall be used.
- E. When using the AASHTO LRFD Multi-Beam live load distribution factor and load restrictions are required, a rational method may be used for the live load distribution factor calculation, including the use of the LDFAC program.

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- F. The rater shall be responsible for determining whether stress-relieved or low-relaxation strands were used in the bridge. If it is not possible to discern what type of strand was used, then the rater shall assume that stress-relieved strands were used prior to December, 1983, and low-relaxation strands thereafter.
- G. Prestressed concrete girder bridges with complex geometric alignment i.e., flared girder bridges or girders with a variable overhang, shall be modeled as simple, straight beams on pin or roller supports. The Virtis program output results can then be supplemented by hand calculations to consider any significant influences, as necessary.
- H. For effective slab widths, the b in the equation (12t+b) shall be the width of the top flange of the girder, not the web.

## II. Girders Requiring Rating

- A. Interior Girders A rating is required for the critical interior girder. More than one interior girder may require an analysis due to variation in span length, girder size, girder spacing, number of prestressing strands, differences in loads or moments, concrete strength, etc.
- B. Exterior Girders An exterior girder shall be rated under the following guidelines:

1. When the section used for an exterior girder is different than the section used for an interior girder.

2. When the overhang is greater than S/2.

3. The exterior unit of a multi-beam structure should be rated if it does not have a cast-in-place composite slab. For this case the dead loads due to sidewalks, curbs and railing shall be applied to only the exterior unit.

4. When the rater determines the rating would be advantageous in analyzing the overall condition of a structure.

#### III. Calculations

- A. A set of calculations, separate from computer output, shall be submitted with each rating. These calculations shall include derivations for dead loads, derivations for live load distribution factors, and any other calculations or assumptions used for rating. The rater shall also indicate whether stress-relieved or low-relaxation strands were used in the rating calculations.
- B. Dead Loads

1. The final sum of all the individual weight components for dead load calculations may be rounded up to the nearest 5 pounds.

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2. Dead loads applied after a cast-in-place concrete deck has cured shall be distributed equally to all girders and, when applicable, treated as composite dead loads. Examples include asphalt, curbs, sidewalks, railing, etc.

3. Dead loads applied before a cast-in-place concrete deck has cured shall be distributed to the applicable individual supporting girders and treated as non-composite loads. Examples of this type of dead load are deck slabs, girders and diaphragms.

4. Use 5 psf for the unit weight of formwork when it is likely the formwork will remain in place.

5. The method of applying dead loads due to utilities is left to the rater's discretion.

# IV. Simple and Continuous Span Bridges

Simple span prestressed girders shall be rated as simple span members for all loads( i.e. DL1, DL2, LL+I loads). Span length shall be taken as the distance between the centerline of bearing at abutments or supports.

Simple span prestressed girders made continuous for composite dead loads and live load plus impact, shall be rated as continuous members for these loads. Span lengths shall be taken as the distance from centerline of bearing at the abutment to centerline of pier, and centerline of pier to centerline of pier as applicable.

The negative moment analysis at centerline of piers shall be based on the Ultimate Strength (Load Factor) method. The girder's primary negative moment reinforcement and only the top layer of the slab's distribution reinforcement, within the effective slab width, shall be used in the analysis.

Prestressed girder end blocks, if present, shall not be used in the analysis.

Simple span prestressed girders made continuous for composite dead loads and live load plus impact, and if the specified compressive strength of concrete (28 days of age) used in the girders changes from span to span, only the girder with the least compressive strength shall be used to model the entire structure.

# V. Rating Reporting/Package Requirements

The rater and checker shall complete the rating documentation as described in Section 1 of this manual. The rating package requirements shall be per Section 1-13 of this manual and as amended herein:

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**Consultant designed projects** - Before finalizing the rating package and when VIRTIS is used as the analysis tool, the Rater shall verify with the Staff Bridge Rating Coordinator that the version number of the program being used is identical to CDOT'S version number. Data files created using a lower version of the program shall be rejected. It is required for the CDOT data archive, since the data base management feature inside the program would not work satisfactorily. After the analysis is completed, the rater shall save the data file. When saving is finalized, the rater shall export the data file in \*.bbd format (i.e., F-17-IE.bbd format; bbd = BRIDGEWare Bridge Data File) on an IBM- compatible 3.5" PC Disk for delivery with the rating package. Also, the version number used during analysis shall be typed on the diskette label. This ensures proper importation of bridge data archive by the Staff Bridge at a later date.

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# 9A-3 GUIDELINES FOR USING THE VIRTIS RATING PROGRAM

The VIRTIS computer program performs the analysis and rating of simple span and multispan prestressed girder bridges. It uses the BRASS ASD or the BRASS LFD engine for analysis. This program was developed in accordance with the AASHTO STANDARD SPECIFICATIONS, 16TH EDITION AND THE AASHTO MANUAL FOR CONDITION EVALUATION OF BRIDGES.

A maximum of thirteen (13) spans and twelve (12) girder lines can be modeled using the program. When a structure model is finalized, it can be rated using the ASD or the LFD method. The LRFD rating module is currently being developed and will be available in the future. When a structure model is being generated and before any analysis can be performed, it is recommended that Virtis users save the data to memory periodically. This can be accomplished by using the File and Save feature of this program.

The library explorer can be used to save commonly used items (beam shapes, non standard vehicles, materials, appurtenances etc.) and this eliminates the need for all users to define the same items repeatedly throughout the program. Once a new girder shape is defined or copied from the library, Virtis automatically computes the required section properties and beam constants.

Dead load due to the girder self weight, deck slab and appurtenances (i.e. rails, median barrier etc.) are calculated automatically by the program. Dead load due to the haunch, wearing surface and stiffener weight (for steel bridges) are defined by the user. For a detailed description of the girder loads, refer to the Opis/Virtis Help Menu index item - dead loads. During modeling a structure, help menu can also be activated by using the F1 key when the user requires clarification on a particular item in the GUI window.

In the Live Load Distribution Factor window, when the compute button is used to calculate the DF's automatically by the program, Virtis users shall verify that these numbers are accurate and are equal to their calculated numbers.

For prestressed girder bridges, in addition to using the BRASS LFD engine for analysis, all serviceability checks/rating per Article 6.6.3.3 of the AASHTO Manual For Condition Evaluation Of Bridges shall be performed using the BRASS ASD engine.

All Colorado BT girder shapes, the Colorado permit vehicle, the Colorado posting trucks and the Interstate posting trucks have been added to the Virtis library explorer and may be copied by the user. The Staff Bridge Rating Coordinator shall be responsible for updating existing information or adding new information (i.e. beam shapes, vehicles etc.) to the library explorer.

The configuration browser provides access to the configuration features of Virtis. It may be employed to provide specific access privileges, i.e. read, write, delete etc., to the users. This feature is extremely powerful, since Virtis/Opis uses and shares bridge data from one common source. Therefore, it is required that users of this program create a folder from the bridge explorer window (EXAMPLE: MY FOLDER OR YOUR LAST NAME) before creating the model for a new structure.

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# 9A-4 RATING PRESTRESSED CONCRETE GIRDER BRIDGES DESIGNED BY LOAD FACTOR METHOD

All ratings should be performed in accordance to the AASHTO Manual For Condition Evaluation of Bridges and the appropriate Articles of AASHTO Bridge Design Specifications. The capacity of prestressed concrete members should be evaluated for strength requirements (at both Inventory and Operating level) stated in the AASHTO Design Specifications Article 9.17. At the Inventory level, Serviceability requirements should also be considered. The basic rating equation (6-1a) of the Manual For Condition Evaluation of Bridges may be used if checking the crack serviceability limit state with  $A_1=1.0$ ,  $A_2=1.0$ , and C=M<sup>\*</sup><sub>cr</sub>. Typically, prestressed concrete members used in bridge structures will meet the minimum reinforcement requirements of Article 9.18.2.1 of the AASHTO Design Specifications. While there is no reduction in the flexural strength of the member in the event that these provisions are not satisfied, an owner, as part of the flexural rating may choose to limit live loads to those that preserve the relationship between  $\phi M_n$  and  $M^*_{cr}$  by adjusting the capacity value "C" in the rating equation (6-1a). Thus when  $\phi M_n < 1.2 M_{cr}^*$ , the adjusted "C" becomes  $(k)(\phi)(M_n)$  where  $k = (\phi M_n)/(1.2M_{cr}^*)$ . Non Prestressed Reinforcement may be considered as per AASHTO Specifications Article 9.19.

The following equations regarding Load Factor rating of pretensioned and postensioned concrete members are furnished:

## INVENTORY RATING

$$RF = \frac{6\sqrt{F'_{C} \pm F_{D} \pm F_{P} \pm F_{S}}}{F_{LL+I}}$$
 Equation (1) Concrete Tension

$$RF = \frac{.6F'_{C} \pm F_{D} \pm F_{P} \pm F_{S}}{F_{LL+I}}$$
 Equation (2) Concrete Compression

$$RF = \frac{.4F'_{C} \pm 1/2(F_{D} \pm F_{P} \pm F_{S})}{F_{LL+I}}$$
 Equation (3) Concrete Compression

$$RF = \frac{0.8F_{Y}^{*} \pm F_{D} \pm F_{P} \pm F_{S}}{F_{LL+I}}$$
 Equation (4) Prestressing Steel Tension

$$RF = \frac{\phi R_n \pm 1.3D \pm 1.0S}{2.17L}$$
 Equation (5) Flexural & Shear Strength

OPERATING RATING

$$RF = \frac{\phi R_n \pm 1.3D \pm 1.0S}{1.3L}$$
 Equation (6) Flexural & Shear Strength

$$RF = \frac{0.9F_{Y}^{*} \pm F_{D} \pm F_{P} \pm F_{S}}{F_{LL+I}}$$
 Equation (7) Prestressing Steel Tension

RF	= Rating Factor
$F'_{C}$	= Concrete Compressive Strength
$F_D$	= Unfactored dead load stresses
$F_P$	= Unfactored stress due to prestress force after all losses
$F_{S}$	= Unfactored stress due to secondary prestress forces
$F_{LL+I}$	= Unfactored live load stress including impact
$\Phi R_n$	= Nominal strength of section $(\varphi M_n \text{ or } \varphi V_n)$ satisfying the ductility
	limitations of Article 9.18 and Article 9.20 of the AASHTO Standard
	Specifications. Both moment $(\varphi M_n)$ and shear $(\varphi V_n)$ should be evaluated.
D	= Unfactored dead load moment or shear
S	= Unfactored prestress secondary moment or shear
L	= Unfactored live load moment or shear including impact
$F_{Y}^{*}$	= Prestressing steel yield stress
$M^*_{cr}$	= Cracking Moment per AASHTO article 9.18

# NOTE:

Equation (7) can control rating when at least one strand is near the extreme tension fiber and the C.G. of the prestressing is near the neutral axis.

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## 9A-5 RATING PRESTRESSED CONCRETE GIRDER BRIDGES WITHOUT PLANS

When there are no plans or other documentation for a particular prestressed concrete structure, its numerical rating shall be determined by a Professional Engineer Registered in the State of Colorado. This rating shall be based on a complete and comprehensive inspection of the structure and directions from the AASHTO MANUAL FOR CONDITION EVALUATION OF BRIDGES 1994, Second Edition. If the structure shows no signs of distress due to load, the Engineer can assign it a maximum inventory rating of 36 tons, and operating rating of 40 tons. For all structures in the State Highway System and designed after January 1994, with the exception of LRFD designed bridges, a no distress condition shall have a minimum Inventory rating of 45 tons and an Operating rating of 75 tons. For LRFD designed bridges, i.e., structures designed after January 1998, a no distress condition shall have a minimum permit vehicle operating rating of 105 tons.

When there are signs of capacity-reducing distress or deterioration, an appropriate judgment should be made and ratings proportionally less shall be given to the prestressed concrete structure.

For bridges owned or maintained by the Colorado Department of Transportation, the Staff Bridge Engineer will approve this type of rating. For bridges owned or maintained by a city or county, a recommended rating shall be approved by the City and County Engineer and shown on the Rating Summary Sheet.

The processes and responsibilities of the Rater and Checker will still follow those described in Section 1 with the following two additions. First, as just described, the Staff Bridge Engineer shall, or appropriate city/county official should, review the recommended rating. Secondly, the rating summary sheet shall state that the structure was rated by inspection.

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## 9A-6 PRESTRESSED CONCRETE GIRDER BRIDGE RATING EXAMPLES

Three examples are presented in this section. First, Structure I-09-Q is a simple span composite concrete prestressed girder bridge with a skew of  $33^{\circ}$  degrees. It has seven (7) BT-72 girders. Only the interior girder has been modeled for this structure. The second structure, F-17-IE, is a 3-span composite concrete prestressed girder bridge with a skew of  $52^{\circ}$  degrees. It has four (4) G-54 girders. For simplicity, only the interior girder has been modeled for this structure. The third structure, L-26-BR, is a simple span prestressed girder bridge with a skew of 0°. It has no poured in place composite deck. Due to limitations on the number of girders that Virtis can analyze, only twelve (12) girders (i.e., 6 Double-tee girder Units) have been used to model the structure. For modeling simplicity, only half of a Double-tee interior girder has been modeled for this structure.

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# Colorado BT girder shapes included:

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# Colorado BT girder shapes included:

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Slab Rating Program Input, Structure No. I-09-Q

💐 WinSlab Inpu	t		
Structure Number:	1-09-Q	Rater:	MH
Batch ID:		Comments:	LFD
Highway Number:	135	Load Type:	1=Colorado 🚍
Deadload	Bituminous Ov	erlay (in): 2	
Geometry			
Effective Span (ft):	4.3	Actual Slab Thickr	ness 8
Reinforcing Ste Are	el: ea (sgin)	in.): Distance (in)	For definitions of input
Top: 0.5		5.188	values please refer to the CDOT Bridge Rating Manual
Bottom: 0.5	53	1.31	
Materials Prope	rties		
Concrete f'c (PSI):	4500	Steel Fy (PSI):	60000
or Inv Fc (Workin	g Stress)	or Inv Fs (Worki	ng Stress)
Modular Ratio (Lea	ave blank for loa	d factor): 00	
ОК	Cance	el Apply	Output to File

Effective Span Length: Per AASHTO Article 3.24.1.2(b)

Clear distance between flanges + 1/2 flange width = 30''+1/2(43)=51.5''=4.3'

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#### Slab Rating Program Output, Structure No. I-09-Q

WinSlab Rating Version 1 Date: 10/12/2001 Rater: MH State HWY NO. = 135 Structure NO. I-09-Q Batch ID= Description: LFD LOAD FACTOR RATING-COMP STEEL NOT USED INPUT DATA Bituminous Overlay(in)= 2.000 Eff. Span(ft)= 4.300 Slab Thickness(in) = 8.000 Top Reinf. (sq.in)= 0.53 Eff. Depth(in) = 5.188 Bottom Area(sq.in)= 0.53 Bottom Dist.(in)= 1.31 Conc. Strength(PSI) Inv = 4500 Oper. = 4500 Steel Yield (PSI) Inv = 60000 Oper. = 60000 Modular Ratio = 8 Dead Load Moment 0.23 K-Ft LL+I Moment 3.28 K-Ft Gross Weight 36.0 Tons Inventory Operating Actual Concrete Stress (PSI) 2268.79 1384.70 Actual Reinf. Steel Stress (PSI) 26715.30 43772.27 3069.34 Actual Comp. Steel Stress (PSI) 5029.03 Member Capacity (K-Ft) 11.55 11.55 Member Capacity (LL+I) (K-Ft) 11.25 11.25 Rating (Tons) 57.05 95.09

Virtis Bridge Rating Example, Structure No. I-09-Q

#### Effective slab width: Per AASHTO Article 9.8.1.1

0.25(L)= 0.25(156\*12)= 468" 12t+ b = 12\*8+ 43= 139" C.L. - C.L. of girder= 6.0833'=73" Controls

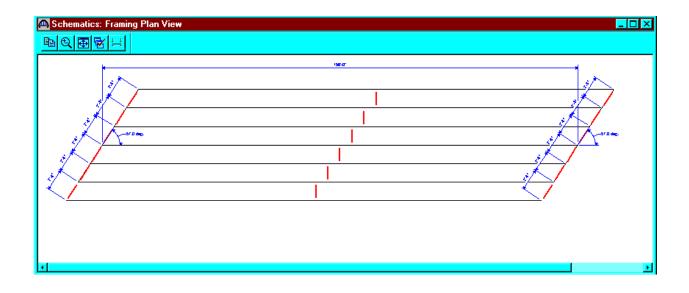
#### Dead Load:

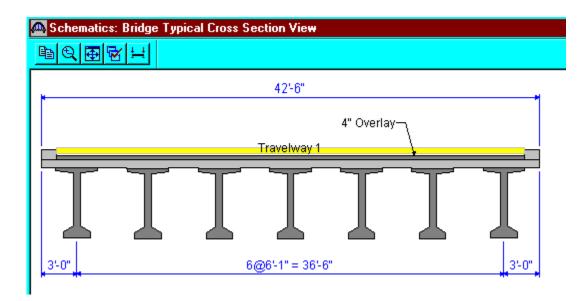
Intermediate Diaphragm = (26/1000)\*(73-7)/12 = 0.143 kip Use 0.150 kip

Abutment Diaphragm = ((2.67)\*(80.5/12)\*6.0833\*(1/sin57°) - (864/144)\*(21/12)\* (1/sin57°))\*(0.150)= 17.6 kips Use 18.0 kips

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Virtis Bridge Rating Example, Structure No. I-09-Q (contd.)





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From the bridge explorer, create a new bridge and enter the following information.

🕰 I-09-Q		<u> </u>
Bridge ID: 105:0 Description Descriptio	NBI Structure ID (8): I-09-Q I Temp Desig	
Name: Description:	CPG BT72 Example Year Built: Batch ID. L94001 SH 135	
Location:	MacHasan: Rated Length:	<b>▼</b>
Facility Carried (7): Feat. Intersected (6): Units:	US Customary Recent ADTT:	
	ОК Арріу	Cancel

Click OK. This saves the data to memory and closes the window.

NOTE: Since Virtis uses a common/shared database; it is required that users
 of this program create a folder from the bridge explorer window
 ( EXAMPLE: MY FOLDER OR YOUR LAST NAME) before creating the model for a
 new structure.

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To add a new concrete material, click on Materials, Concrete, in the tree and select File/New from the menu (or right click on Concrete and select New). Click the Copy from Library button and select the Colorado Deck Concrete from the library. Click OK and the following window will open. Click OK to save this deck concrete material to memory and close the window.

🕰 Bridge Materials - Concrete				
Name: Class D	De <u>s</u> cripti	on: Colorado De	ck Concrete	
Compressive strength at 28	days (f'c) = 4.5	<sup>DO</sup> ks	ai	
Initial compressive stre	ngth (f'ci) =	ks	si	
<u>C</u> oefficient of thermal e	x pansion = 0.0	000060000 1/	Έ	
Density (for de	ad loads) = $0.1$	50 ka	sf	
Density (for modulus of	elasticity) = 0.1	50 ka	sf	
Modulus of elas	ticity (Ec) = $406$	i6.57 ks	si -	
I <u>n</u> itial modulus of	elasticity =	k	si	
Pois:	son's ratio = 0.2	00		
Co <u>m</u> position of	concrete = No	rmal	•	
Modulus	of <u>r</u> upture = 0.5	09 ka	si	
<u>S</u> he	ear factor = 1.0	00		
	Copy from <u>L</u> ibrary.	ОК	Apply	Cancel

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Using the same techniques, create a new concrete material to be used for the girder.

🕰 Bridge Materials - Concrete	
Name: Beam Concrete	Description:
Compressive strength at 28 da	days (('c) = 8.300 ksi
Initial compressive streng	ngth (f'ci) = 6.500 ksi
<u>C</u> oefficient of thermal exp	xpansion = 0.0000060000 1/F
Density (for dead	ad loads) = 0.150 kcf
Density (for modulus of el	elasticity) = 0.150 kcf
Modulus of elastic	icity (Ec) = 5523.49 ksi
I <u>n</u> itial modulus of el	elasticity = 4888.00 ksi
Poisso	on's ratio = 0.200
Composition of co	concrete = Normal
Modulus of	f rupture = 0.691 ksi
<u>S</u> hea	ar factor = 1.000
Сор	py from Library OK Apply Cancel

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Using the same techniques, create the following Reinforcing Steel Materials and Prestress Strands Materials. The windows are shown in the following pages.

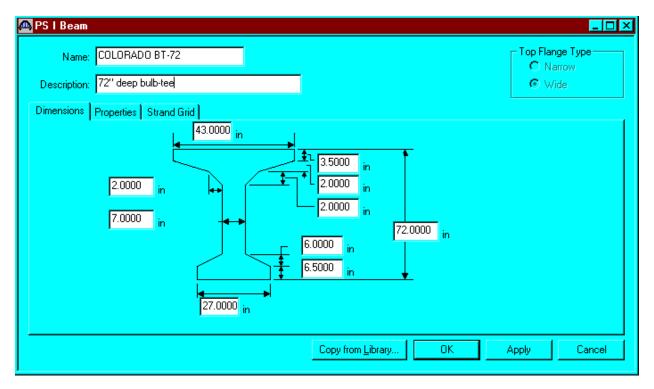
🗛 Bridge Materials - Reinforcing Steel		_ 🗆 🗙
Name: Grade 60	Description: 60 ksi reinforcing steel	
N	Material Properties	
Specified yield s	strength (Fy) = 60.000 ksi	
Modulus of el	elasticity ( <u>E</u> s) = 29000.00 ksi	
Ultimate st	<i>thength (F<u>u</u>) =</i> 90.000 ksi	
	pe ● Plain ● Epo <u>xy</u> ● <u>G</u> alvanized ● <u>O</u> ther	
	Copy from Library OK Apply Ca	ancel 🗾 💌

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🗠 Bridge Materials - PS Strand		
<u>N</u> ame: 1/2" (7W-270) De <u>s</u>	cription: 1/2"/Sever	n Wire/fpu = 270
Strand <u>d</u> iameter =	0.5000 ii	n
Strand <u>a</u> rea =	0.153 ii	n^2
Strand <u>type</u> =	Low Relaxation	•
<u>U</u> ltimate tensile strength (Fu) =	270.000 k	si
Yield strength (Fy) =	243.000 k	si
<u>M</u> odulus of elasticity (E) =	28500.00 k	si
Transfer l <u>e</u> ngth (Std) =	25.0000 i	n
Transfer length (LRFD) =	30.0000 ii	n
Unit <u>w</u> eight per length =	0.520	b/ft
	Epoxy coated	
Copy from Libr	ary OK	Apply Cancel

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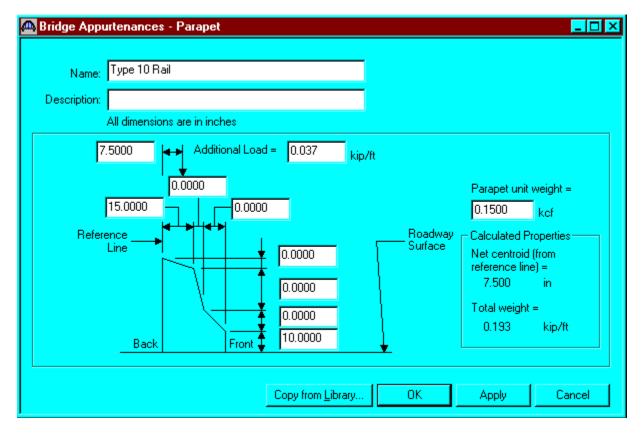
Expand the tree labeled Beam Shapes to enter a prestressed beam shape to be used in the analysis. Click on Prestressed Beam Shapes and I Beams in the tree and select File/New from the menu (or right mouse click on I Beam and select New). Click on the copy from library button or fill in the blanks.



Click OK to save to the memory and close the window.

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To enter the appurtenances to be used within the bridge, expand the explorer tree labeled Appurtenances. Right mouse click on Parapet in the tree, select New and click copy from Library button. Select the Jersey Barrier and click OK. The parapet properties are copied to parapet window as shown below. Click OK to save the data to memory and close the window.



The default impact factors and the standard LFD factors will be used, so we will skip to Structure Definition. Bridge Alternatives will be added after we enter the Structure Definition.

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This window shows the LFD load factors.

Factors -	LFD							- 🗆
<u>N</u> am	ie: 19	196 AASH	ITO Std. Specific	cations				
<u>D</u> escriptio	n: 🗛 Ed	ASHTO S dition, 199	tandard Specific 16 including 1997	ations for Highwa 7 Interim Specifica	y Bridges, 16th ations	-		
Load Facto	ors R	esistance	e Factors					
Lo: Gro		Gamma Factor	D	(L+I)n	(L+I)p	CF	E	-
INV		1.300	1.000	1.670	0.000	1.000	1.000	
OPG		1.300	1.000	1.000	0.000	1.000	1.000	
-1								J
				Copy from L	.ibrary	ОК	Apply Ca	ancel

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Double click on STRUCTURE DEFINITION (or click on STRUCTURE DEFINITION and select File/New from the menu or right mouse click on STRUCTURE DEFINITION and select New from the popup menu) to create a new structure definition. The following dialog box will appear.

lew Structure Definit	ew Structure Definition				
Structure Type	Description				
Girder-line Girder system	A structure definition describing one of more girders. The girders do NO A structure definition describing one of more girders. The girders do hav				
	OK Cancel				

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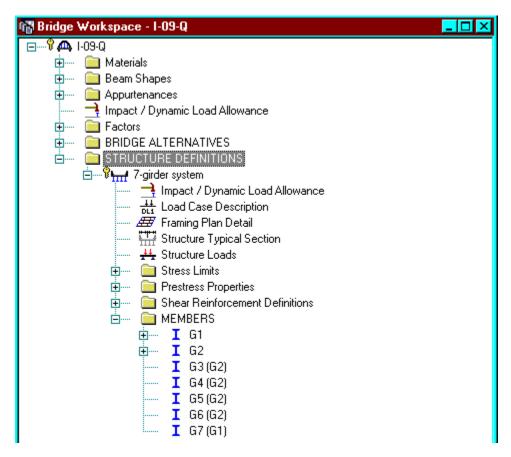
Select Girder System and the following Structure Definition window will open. Enter the appropriate data as shown below. Press F1 while on this tab to view the help topic describing the use of this information.

🕰 Girder System Structur	e Definition		<u>- 🗆 ×</u>
Definition Analysis Engi	ne		1
<u>N</u> ame:	7-girder system		
<u>D</u> escription:			×
<u>U</u> nits:	US Customary 💽	Enter Span <u>L</u> engths Along the Reference Line:	For PS only
Number of <u>s</u> pans:	1 📑	Snan Length	Average <u>h</u> umidity: 60.000
Number of girders:	7 📑	(ft) 1 156.00	50.000 %
	Deck type: Concrete		Member Alt. Types Steel P/S R/C Timber
		OK	Apply Cancel

Span length for a simple span prestressed girder structure shall be per Section 9A-2 IV.

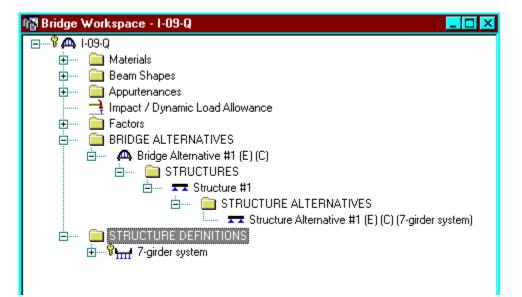
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The partially expanded Bridge Workspace tree is shown below:



We now go back to the Bridge Alternatives and create a new Bridge Alternative, a new Structure, and a new Structure Alternative.

The partially expanded Bridge Workspace tree is shown below:



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Click Load Case Description to define the dead load cases. The load types are presented in a single row separated by a comma. The first type applies to the LFD design and the second type applies to the LRFD design and it corresponds with the load types presented in the AASHTO Specifications. The completed Load Case Description window is shown below.

						<b>T</b> : •		
Load Case Name	Description	Stage		Туре	•	Time* (Days )		
parapets		Composite (long term) (Stage 2)	-	D,DC	•			
future wearing surface		Composite (long term) (Stage 2)	-	D,DW	-			
Haunch Load		Non-composite (Stage 1)	-	D,DC	•			
Prestressed members on	ly.							

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Double click on Framing Plan Detail to describe the framing plan. Enter the appropriate data to describe the framing plan.

🕰 Structure Framing Plan Details	_ 0	×
Layout Diaphragms	Number of spans = 1 Number of girders = 7	
Support         Skew (Degrees)           1         33.0000           2         33.0000	<ul> <li>Girder Spacing Orientation</li> <li>Perpendicular to girder</li> <li>Along support</li> </ul>	
	Girder Spacing (ft) Girder Bay Start of End of Girder Girder	
	1 6.08 6.0	
	2 6.08 6.0	
	3 6.08 6.0	
	4 6.08 6.0 5 6.08 6.0 ▲	
	OK Apply Cancel	

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If the bridge has diaphragms, switch to the Diaphragms tab and enter the appropriate data. Click OK to save to memory and close the window.

<sub>yout</sub> Dia	phragms		N	umber of sp	ans = 1	Number of girde	ers = 7	
àirder Bay:		•	Copy Bay To	]	Diaphragm Wizard			
Support Number —	(f		Diaphragm Spacing	Number of	Length (ft)	End Dis (fi	t)	Weight (kip)
1 🔽	Left Girder 0.00	Right Girder 0.00	(ft) 0.00	Spaces 1	0.00	Left Girder 0.00	Right Girder 0.00	18.0000
1 🔽	0.00	3.95	78.00	1	78.00	78.00	81.95	0.1500
1 🔽	156.00	156.00	0.00	1	0.00	156.00	156.00	18.0000
New Duplicate Delete								

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Double click on Structure Typical Section in the Bridge Workspace tree to define the structure typical section. Input the data describing the typical section as shown below.

🕰 Structure Typical Section						_ 🗆 🗡
	ance from left edge of cture definition reference		Distance from rig structure definitio			
	Deck ↓thickn	ess	Structure Defir Reference Lin		<u> </u>	
Left overhang				Ţ	;∽] Bight	t overhang
Deck Deck (Cont'd) Parap	bet Median Railing	Generic	Sidewalk Lan	e Position   W		
Structure definition reference	ce line is within	-	the bridge deck.			
<u>Distance from left edge of o</u> structure definition reference		ft	End 21.25	ft		
Distance from right edge of structure definition reference		ft	21.25	ft		
Left over	rhang = 3.00	ft	3.00	ft		
Computed right ove	rhang = 3.00	ft	3.00	ft		
			OK	A	pply	Cancel

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The Deck(Cont'd) tab is used to enter information about the deck concrete and thickness. The material to be used for the deck concrete is selected from the list of bridge materials described previously.

🕰 Structure Typical Se	ection	_ 🗆 ×
	Distance from left edge of deck to structure definition reference line structure definition reference line	
	Deck thickness	
Left overhang	P k→ → Right overhang	
Deck Deck (Cont'd)	Parapet Median Railing Generic Sidewalk Lane Position Wearing Surface	
<u>D</u> eck	concrete: Class D	
<u>T</u> otal deck t	thickness: 8.0000 in	
Deck <u>c</u> rack control p		
Sustained modular ra	atio factor: 2.000	
	OK Apply 0	Cancel

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Parapets:

Add two parapets as shown below.

🗛 <mark>S</mark>	tructure Typica	l Section							<u> </u>
	Deck   Deck (Coni	('d) Parapet	Back Median Ra	I	Front	ane Position   We	earing Surface ]		
	Name		Case		Edge of Deck Dist. Measured From	Distance At Start (ft)	Distance At End (ft)	Front Face Orientation	
	Type 10 Rail 🔽	parapets	-	Back 🔽	Left Edge 🔽	0.00		Right 🔽	
	Type 10 Rail 🔽	parapets		Back 🔽	Right Edge 🔽	0.00	0.00	Left 🔽	
						New	) Duplica	ate D	elete
							ОК	Apply	Cancel

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## Lane Positions:

Select the lane position tab and use the Compute... button to compute the lane positions. A dialog showing the results of the computation opens. Click apply to accept the computed values. The Lane Position tab is populated as shown below.

🕰 Structure 1	ypical Section				- 🗆 ×
Deck Dec	(A) Travelway		efinition Reference Line Travelway 2	] Surface ]	
Travelwa Number	Distance From Left Edge of			Distance From Right Edge of Travelway to Structure Definition Reference Line At End (B) (ft)	
1	-20.00	20.00	-20.00	20.00	
	mpute		New OK	Duplicate Delete	cel

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Enter the following wearing surface information on the Wearing Surface tab.

🕰 Structure Typical Section	. 🗆 🗙
Distance from left edge of deck to structure definition reference line Deck thickness tructure Definition	
Left overhang	
Deck Deck (Cont'd) Parapet Median Railing Generic Sidewalk Lane Position Wearing Surface	
Wearing surface material: Bituminous	
Description:	
Wearing <u>s</u> urface thickness = 4.0000 in	
Wearing surface density = 144.000 pcf	
Load <u>c</u> ase: future wearing surface Copy from Library	
OK Apply Cano	;el

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Double click on the Structure Loads tree item to define the DL Distribution. Select the required DL Distribution. Click OK to save this information to memory and close the window.

niform Temperature Gradient Temperature Wind DLDis	tribution		
- Stage 1 Dead Load Distribution	]		
C By transverse simple-beam analysis			
C By transverse continuous-beam analysis			
$ \mathbf{C} $ User input results from independent 3D elastic analysis			
- Stage 2 Dead Load Distribution © <u>U</u> niformly to all girders	-		
O By tributary <u>a</u> rea			
C By transverse simple-beam analysis			
O By transverse continuous-beam analysis			
C User input results from independent 3D <u>e</u> lastic analysis			

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A Stress Limit defines the allowable concrete stresses for a given concrete material. Double click on the Stress Limits tree item to open the window. Select the "Beam Concrete" concrete material. Default values for the allowable stresses will be computed based on this concrete and the AASHTO Specifications. A default value for the final allowable slab compression is not computed since the deck concrete is typically different from the concrete used in the beam. Click OK to save this information to memory and close the window.

🔤 Stress Limit Sets - Concrete 📃 🗖 💈				_ 🗆 🗡	
Name: Beam stress limits					
Description:					
Concrete Material: Beam Concrete		•			
	LFD		LRFD		
Initial allowable compression:	3.900	ksi	3.900	ksi	
Initial allowable tension:	0.200	ksi	0.200	ksi	
Final allowable compression:	4.980	ksi	4.980	ksi	
Final allowable tension:	0.547	ksi	0.547	ksi	
Final allowable DL compression:	3.320	ksi	3.735	ksi	
Final allowable slab compression:	2.400	ksi		ksi	
Final allowable compression: (LL + 1/2(Pe + DL))	3.320	ksi	3.320	ksi	
			OK	Apply C	ancel

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Double click on the Prestress Properties tree item to open a window in which to define the prestress properties for this structure definition. Define the Prestress Property as shown below. Since we are using the AASHTO method to compute losses, only information in the "General P/S Data" tab is required. Click OK to save to memory and close the window.

🚇 Prestress Properties			- 🗆 ×
Name: AASHTO Losses	]		
General P/S Data Loss Data - Lump Sum L	Loss Data - PCI		
P/S strand material: 1/2" (7W-270)	•	Jacking stress ratio: 0.750	
Loss method: AASHTO	•	P/S transfer stress ratio:	
		Iransfer time: 24.0 Hour	s
Loss Data - AASHTO			
Percentage DL: 0.0 %			
		OK Apply	Cancel
		ОК Арруу	Cancer

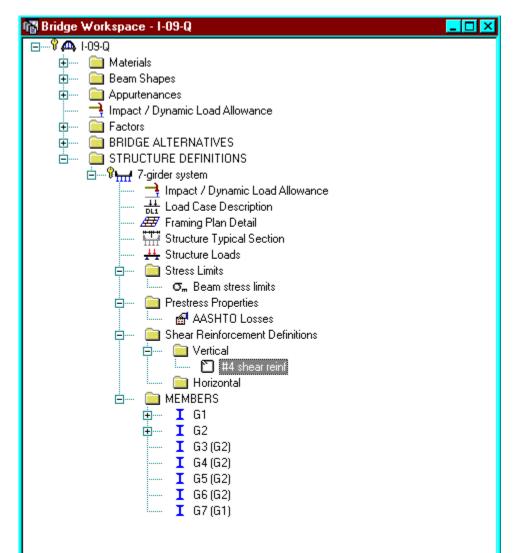
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Define the vertical shear reinforcement by double clicking on Vertical (under Shear Reinforcement Definition in the tree). Define the reinforcement as shown. The I shape shown is for illustrative purposes only. Click OK to save to memory and close the window.

🖾 Shear Reinforcement Definition - Vertical		_ 🗆 ×
Name: #4 shear reinf		
	Material: Grade 60 🔽	
	Barsize: 🛛 🗹	
	Number of legs: 2.00	
	Inclination (alpha): 90.0 Degrees	
Vertical Shear Reinforcement		
	(COK Apply C	Cancel

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The partially expanded Bridge Workspace tree is shown below:



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## Describing a member:

The member window shows the data that was generated when the structure definition was created. No changes are required at this time. The first Member Alternative that we create will automatically be assigned as the Existing and Current Member alternative for this member.

🕰 Member					_ 🗆 ×
Member name:	G2	L	ink with:	None	
<u>D</u> escription:				<u> </u>	
				<b>•</b>	
	Existing Current Member A	Alternative Name Descrip	tion		
	Interior M	ember			
Number of spans:	1 🚊	Span Span No Length		Pedestrian load: 0.000	lb/ft
		(ft)			
		1 156.00			
					I
			0	K Apply	Cancel

Double click MEMBER ALTERNATIVES in the tree to create a new alternative. The New Member Alternative dialog shown below will open. Select Prestressed (Pretensioned) Concrete for the Material Type and PS Precast I for the Girder Type.

New Member Alternative	×
Material Type:	Girder Type:
Prestressed (Pretension 🔽	PS Precast I
_	OK Caract
	OK Cancel

Click OK to close the dialog and create a new member alternative.

Defining a Member Alternative:

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The Member Alternative Description window will open. Enter the appropriate data as shown below. The Schedule-based Girder property input method is the only input method available for a prestressed concrete beam.

Member Alternative Description	_ 0
Member Alternative: Precast P/S Interior Member	
Description Factors Engine Import	
Description:	Material Type: Prestressed (Pretensioned     Girder Type: PS Precast I     Member <u>u</u> nits: US Customary
Girder property input method Schedule based C Cross-section based	Analysis Module ASD: BRASS ASD FILFD: BRASS LFD FILBFD: BRASS LRFD FILBFD: FILBFD: FILBFD: FILBFD: FILBFD: FILBFD: FILBFD: FILBFD
	efault rating method: FD Shear computation method LRFD: General Procedure LFD: Ignore shear
Crack control parameter (Z) Bottom of beam: kip/in	
	OK Apply Cancel

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Double click on Member Loads to define other girder dead loads not calculated by the program automatically. Dead load due to haunch not included in the section properties calculation is entered here.

🕰 Loads - Membe	r i i i i i i i i i i i i i i i i i i i					_ 🗆 ×
Uniform Distribut	ed Concentrated	Settlement	<u>+</u> + ,	k k k	<u> </u>	
Load Case Nam Span			T			
All Spans 👤	0.048					
				New	Duplicate	Delete
				OK	Apply	Cancel

Calculated average haunch = 2.5" Haunch used for section properties = 1.43"

Dead Load/Girder = (2.5-1.43)/12\*(43/12)\*(0.15) = 0.048 k/ft

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Double click on Supports to define support constraints for the girder. Enter the following support constraints. Click OK to save data to memory and close the window.

Supports	z	×∠			<u>~</u> 2	
General Support Number	Elastic Support	Translation Con	istraints Y	Rotation Constraints Z		
1	Pinned 💌 Roller 💌					
			<u> </u>	<u>ОК</u>	Apply	Cancel

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The Compute from Typical Section button on the Live Load Distribution window to calculate the distribution factors cannot be used until we have selected the beam shape in the Beam Details window. At this point, Virtis/Opis does not know if we have spread or adjacent beams. We will select the beam shape now in the Beam Details window and then come back to the Live Load Distribution window. Double click on Beam Details in the tree to describe the beam details. Enter the following beam details information.

pan			Girder		Prestress					n Projection
mber	Beam Shape		Material		Properties		Use Creep	n	Left End (in)	Right End (in)
1	COLORADO BT-72	-	Beam Concrete	•	AASHTO Losses 📃	-	No 🔽	5.8000002	5.0000	5.0000

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Note that the Stress Limit Ranges are defined over the entire length of the precast beam.

eam Det	ails	Clab Interface )			
Span Number	Name	Start Distance (ft)	Length (ft)	End Distance (ft)	
1 🔽	Beam stress limits 📘	0.00	156.83	156.83	
					New Duplicate Delete

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The defaults on the Slab Interface tab are shown below and are acceptable.

🚇 Beam Details	
Span Detail Stress Limit Ranges Slab Interface	
Interface type: Intentionally Roughened	
Default interface width to beam widths 🔽	
Interface width:	
Cohesion factor: 0.100 ksi	
Cohesion factor: 0.100 ksi Friction factor: 1.000	
Friction factor: 1.1.1.1	
0	K Apply Cancel
	K Apply Cancel

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Double click on Live Load Distribution to enter live load distribution factors. Click the Compute from Typical Section button to compute the live load distribution factors. The distribution factors are computed based on the AASHTO Specifications, Articles 3.23 and 3.28. Click Apply and then OK to save data to memory and close the window.

Distribution Factor Lanes (Wheels)					
Loaded	Shear	Shear at Supports	Moment	Deflection	
1 Lane	0.869	1.014	0.869	0.286	
Multi-Lane	1.106	1.014	1.106	0.857	
Compute from Typical Section					

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Expand the tree under Strand Layout and open the Span 1 window. This window allows you to define a prestress strand layout for a prestressed concrete beam span. Prestress strand layout can be described either by the actual strand locations or the prestress force (jacking force) and eccentricity (center of gravity) of the group of strands. Select P and CGS only for the Description Type. Enter the following Strand Layout information for Span 1. Press F1 while on this tab to view the strand layout help topic describing the use of this information.

🙈 Strand Layout - Spai	n 1
围负围欧正	
Description Type P and CGS only	C Strands in rows
Left harp pt. dist. (X1):	75 ft
Left harp pt. radius:	0.0001 in
Right harp pt. dist. (X2):	75 ft
Right harp pt. radius:	0.0001 in
Force:	2090.00 kip
Left CGS:	21.0000 in
Mid CGS:	5.0000 in
Right CGS:	21.0000 in
<u> </u>	Cancel

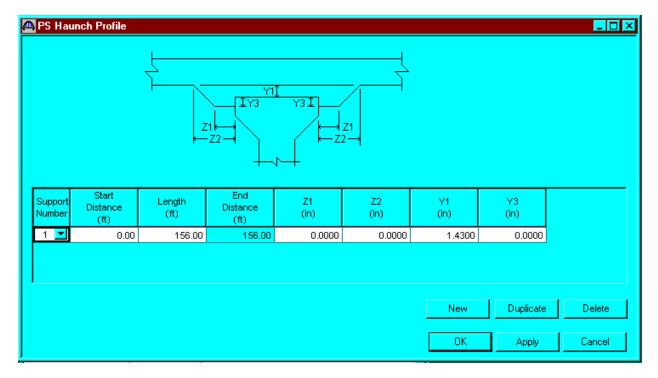
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Open the Deck Profile window and enter the date describing the structural properties of the deck.

Deck	Profile								_
·· L	PS Precast I Concrete Reinf	orcement							
	Material	Support Number	Start Distance (ft)	Length (ft)	End Distance (ft)	Structural Thickness (in)	Effective Flange Width (Std) (in)	Effective Flange Width (LRFD) (in)	n
Clas	sD 🔽	1	0.00	156.00	156.00	8.0000	73.0000		7.600
						N	ew Dup	licate De	lete

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Double click on Haunch Profile in the tree to define the haunch profile for the girder.



Note: Only the haunch thickness to be used in section properties calculation is input here. The program calculates dead load due to this haunch automatically.

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The Shear Reinforcement Ranges are entered as described below. The vertical shear reinforcement is defined as extending into the deck on this tab. This ensures composite action between the beam and the deck. Data does not have to be entered on the Horizontal tab to indicate composite action since we have defined that by extending the vertical bars into the deck.

rtica	ii) +	Horizontal )	Sta	art Distanc	e <mark>Pa</mark> Spa	acing				
Sp: Num		Name		Extends into Deck	Start Distance (ft)	Number of Spaces	Spacing (in)	Length (ft)	End Distance (ft)	-
1	-	#4 shear reinf	-	<u> </u>	0.17	1	0.0000	0.00	0.17	
1	-	#4 shear reinf	-		0.17	6	3.0000	1.50	1.67	
1	-	#4 shear reinf	-		1.67	11	4.0000	3.67	5.33	
1	-	#4 shear reinf	-		5.33	11	6.0000	5.50	10.83	
1	-	#4 shear reinf	-		10.83	11	9.0000	8.25	19.08	
1	-	#4 shear reinf	-		19.08	11	12.0000	11.00	30.08	
1	-	#4 shear reinf	-		30.08	1	14.0000	1.17	31.25	
1	-	#4 shear reinf	-		31.25	63	18.0000	94.50	125.75	
1	-	#4 shear reinf	-		125.75	11	12.0000	11.00	136.75	
1	-	#4 shear reinf	-		136.75	11	9.0000	8.25	145.00	
1	-	#4 shear reinf	-		145.00	11	6.0000	5.50	150.50	
1	-	#4 shear reinf	-		150.50	11	4.0000	3.67	154.17	
1	Ŧ	#4 shear reinf	-		154.17	6	3.0000	1.50	155.67	· ·
								New Du	uplicate D	)elete

The description of an interior beam for this structure definition is complete.

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The BRASS LFD engine data for the member alternative is shown below.

Member Alternative Description
Member Alternative: Precast P/S Interior Member
Description Factors Engine Import
Configure engine properties for analysis module: BRASS LFD
Analysis Load Sequence: Computed based on loadings and comp Points of Interest Control: 3 - Same as 1 plus generate user-define Wheel Advancement: 100 P/S modeling method: Centerline of simple-span bearing Use P/S beam overhangs. Use maximum moment in span to compute fcir. Omit strands for moment capacity if within Distance from top of girder (+M): 0.000000 (in) Distance from bottom of girder (-M): 0.000000 (in)
OK Apply Cancel

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# The results of the LFD/ASD rating analysis are as follows:

	Live Load	Live Load Type	Design Method	Inventory Load Rating Ton	Operating Load Rating Ton	Inventory Rating Factor	Operating Rating Factor	Inventory Location ft		Operating Location ft	Loc	rating ation n-(%)	Inventory Limit State	Operating Limit State
IS 2	0-44	Axle	LFD	86.38	144.25	2.399	4.007	93.60	1 - ( 60.0)	93.60			ULTIMATE MOME	ULTIMATE MOME
IS 2	0-44	Lane	LFD	82.73	138.16	2.298	3.838	78.00	1 - ( 50.0)	78.00	1 - (	(50.0)	ULTIMATE MOME	ULTIMATE MOME
olo	rado Permit Vehicle	Axle	LFD		182.97		1.905			62.40	1 - (	′ 40 M		ULTIMATE MOME

e Limit State
NGE BOTTOM FLANGE
NGE BOTTOM FLANGE

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COLORADO DEPARTI LOAD FACTOR Rated using	Structure #I - 09 - QState highway #135Batch I.D.						
Asphalt thickness: Colorado legal k Interstate legal k	Structure type Parallel structure #		CPG				
Structural member	INTERIOR GIRDER BT 72	SL	AB				
	Metric tons (Tons)						
Inventory	26.4 ( 29 )	51.8	( 57 )	(	)	(	)
Operating	125.4 ( 138 )	86.4	( 95 )	(	)	(	)
Type 3 truck	( )		( )	(	)	(	)
Type 3S2 truck	( )		( )	(	)	(	)
Type 3-2 truck	( )		( )	(	)	(	)
Permit truck	166.4 ( 183 )		( )	(	)	(	)
Interstate 21.8 metric	Type 3 Truck       Type 3S2 Truck         Interstate 21.8 metric tons (24 tons)       Colorado 24.5 metric tons (27 tons)         Colorado 24.5 metric tons (27 tons)       Colorado 38.6 metric tons (42.5 tons)         Colorado 000       Colorado 000						Õ
Metric tons Tons	) s Metri	c tons	) Tons	Metric	tons ((	) Tons	
Methodols       Ions       Methodols       Ions         Comments       Control Member: Deck; Rated for 2" HBP       Load Capacity: 95 Tons         Girder: Only Interior Girder Rated; Haunch included in the section properties calculations; BT 72 Girders; Rated for 4" HBP       Color Code: White         Project No: STR(CX) 0135(14)       Project No: STR(CX) 0135(14)							
Rated by	Date		Checked by	d may not be used		Date CDOT Form #1	

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## Slab Rating Program Input, Structure No. F-17-IE

🐃 WinSlab Input			
Structure Number:	F-17-IE	Rater:	МН
Batch ID:		Comments:	ER SW RAMP
Highway Number:	470	Load Type:	1=Colorado 🚍
Deadload	Bituminous Ove	erlay (in): 4.0	
Geometry			
Effective Span (ft):	9.167	Actual Slab Thickne (in.):	8.500
Reinforcing Stee Are	el: a (sqin)	Distance (in)	For definitions of input
Top: 0.9	6	5.625	values please refer to the CDOT Bridge Rating Manual
Bottom: 0.9	6	1.375	
Materials Proper	ties		
Concrete f'c (PSI):	4500	Steel Fy (PSI):	40000
or Inv Fc (Working	g Stress)	or Inv Fs (Workin	g Stress)
Modular Ratio (Lea	ve blank for load	d factor):	
OK	Cance	l Apply	Output to File

Effective Span Length: Per AASHTO Article 3.24.1.2(a)

Clear distance between flanges = 11.5'-2.333'=9.167'

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5.625

4500

40000

### Slab Rating Program Output, Structure No. F-17-IE

WinSlab Rating Version 1 Date: 9/18/2001 State HWY NO. = 470Rater: MH Structure NO. F-17-IE Description: RAMP A OVER SW RAMP Batch ID= LOAD FACTOR RATING-COMP STEEL NOT USED INPUT DATA Bituminous Overlay(in)= 4.000 9.167 Eff. Span(ft)= Slab Thickness(in) = 8.500 Top Reinf. (sq.in)= 0.96 Eff. Depth(in) = Bottom Area(sq.in)= 0.96 Bottom Dist.(in)= 1.38 Conc. Strength(PSI) Inv = Oper. = 4500 Steel Yield (PSI) Inv = 40000 Oper. = Modular Ratio = 8 Dead Load Moment 1.30 K-Ft LL+I Moment 5.81 K-Ft Gross Weight 36.0 Tons Inventory Operating Actual Concrete Stress (PSI) 1220.64 1892.62 Actual Reinf. Steel Stress (PSI) 19354.22 30008.88 5294.17 8208.66 Actual Comp. Steel Stress (PSI) Member Capacity 15.00 (K-Ft) 15.00 Member Capacity (LL+I) 13.31 (K-Ft) 13.31 Rating (Tons) 38.09 63.48

#### Virtis Bridge Rating Example, Structure No. F-17-IE

#### Effective slab width: Per AASHTO Article 9.8.1.1

0.25(L) = 0.25(52.72\*12) = 158.16"0.25(L)= 0.25(65.00\*12)= 195.00" 0.25(L) = 0.25(49.96\*12) = 149.88" 12t+ b = 12\*8.5+ 28= 130.00" Controls C.L. - C.L. of girder= 11.5'=138.00"

### Dead Load:

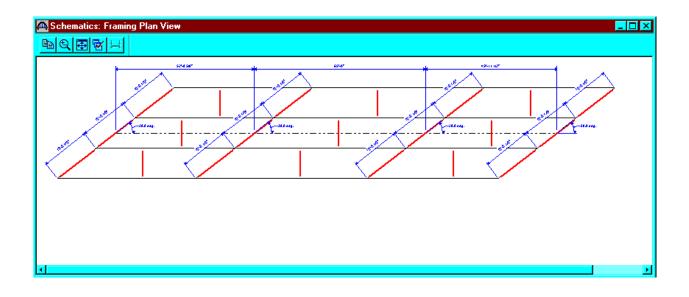
Intermediate Diaphragm = ((2)\*(8/12)\*(11.5) - (630/2)\*(1/144)\*(0.67))\*(0.15)= 2.09 kips Use 2.1 kips

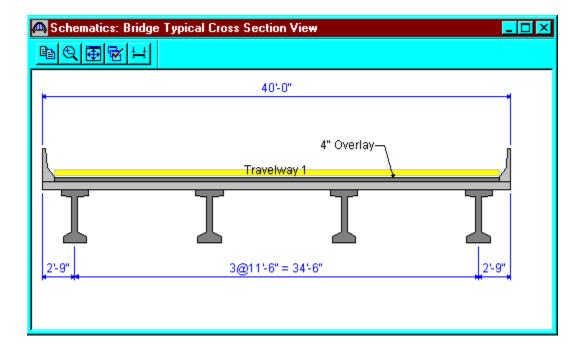
Abutment Diaphragm = ((2.58)\*(56.5/12)\*(11.5)\*(1/sin38°) - (630/144)\*(18/12)\*  $(1/\sin 38^\circ))*(0.150) = 32.4$  kips Use 32.0 kips

```
Pier Diaphragm = ((3.50)*(56.5/12)*(11.5)*(1/sin38°) - (630/144)*(29/12)*
                      (1/sin38°))*(0.150)= 43.6 kips
                                           Use 44.0 kips
```

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Virtis Bridge Rating Example, Structure No. F-17-IE (contd.)





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From the bridge explorer, create a new bridge and enter the following information.

🕰 F-17-IE				_ 🗖	×
Bridge ID: F-17-IE Description Descripti	NBI Structure			iplate ign Only	
Name:	CPGC		Year Built	1983	
Description:	3-Span Concrete Prestresse	ed Girder continuous Bridge		*	
Location:		Le	ength:	ft	
Facility Carried (7):		Route Nu	mber: -1		
Feat. Intersected (6):		Mi.	Post:		
Units:	US Customary 🔽	Recent A	DTT:		
		01	< Apply	Cancel	

Click OK. This saves the data to memory and closes the window.

NOTE: Since Virtis uses a common/shared database; it is required that users
 of this program create a folder from the bridge explorer window
 ( EXAMPLE: MY FOLDER OR YOUR LAST NAME) before creating the model for a
 new structure.

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To add a new concrete material, click on Materials, Concrete, in the tree and select File/New from the menu (or right click on Concrete and select New). Click the Copy from Library button and select the Colorado Deck Concrete from the library. Click OK and the following window will open. Click OK to save this deck concrete material to memory and close the window.

🗛 Bridge Materials - Concrete		
Name: Class D(US) Deg	cription: Colorado I	Deck Concrete
Compressive strength at 28 days (f'c) =	4.500	ksi
Initial compressive strength (f'ci) =		ksi
<u>C</u> oefficient of thermal expansion =	0.0000060000	1/F
Density (for dead loads) =	0.150	kcf
Density (for modulus of elasticity) =	0.150	kcf
Modulus of elasticity (Ec) =	4066.84	ksi
I <u>n</u> itial modulus of elasticity =	0.00	ksi
<u>P</u> oisson's ratio =	0.200	
Co <u>m</u> position of concrete =	Normal	•
Modulus of <u>r</u> upture =	0.509	ksi
<u>S</u> hear factor =	1.000	
Copy from Libr	ary OK	Apply Cancel

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Using the same techniques, create a new concrete material to be used for the girder.

🗛 Bridge Materials - Concrete				
Name: PS 4.0 ksi Deg	cription: f'ci = 4.0 ksi			
Compressive strength at 28 days (f'c) =	4.000 ksi			
Initial compressive strength (f'ci) =	4.000 ksi			
<u>C</u> oefficient of thermal expansion =	0.0000060000 1/F			
<u>D</u> ensity (for dead loads) =	0.150 kcf			
Density (for modulus of elasticity) =	0.150 kcf			
Modulus of elasticity ( <u>E</u> c) =	3834.25 ksi			
Initial modulus of elasticity =	3834.25 ksi			
<u>P</u> oisson's ratio =	0.200			
Composition of concrete =	Normal			
Modulus of <u>r</u> upture =	0.480 ksi			
<u>Shear factor =</u>	1.000			
Copy from Library OK Apply Cancel				

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Using the same techniques, create the following Reinforcing Steel Materials and Prestress Strands Materials. The windows are shown in the following pages.

🕰 Bridge Mate	erials - Reinforcing Steel				_ 🗆 ×
<u>N</u> ame:	Grade 40		ription: 40 ksi rein	nforcing steel	
	N Specified yield s	/laterial Proper trength (Fy) =	ties 40.000	ksi	
		asticity ( <u>E</u> s) =	29000.00	ksi	
		irength (F <u>u</u> ) =	70.000	ksi	
		oe ● <u>P</u> lain ● Epo <u>xy</u> ● <u>G</u> alvanized ● <u>O</u> ther	1		
	ſ	Constrantin	rary I	Analy [	Carrord
		Copy from <u>L</u> ib		Apply	Cancel

📾 Bridge Materials - Reinforcing Steel	<u> </u>
Name: Grade 60 <u>D</u> escription: 60 ksi reinforcing steel	
Material Properties	
Specified yield strength (Fy) = 60.000 ksi	
Modulus of elasticity ( <u>E</u> s) = 29000.00 ksi	
Ultimate strength (Fu) = 90.000 ksi	
Type	
Copy from Library OK Apply	Cancel

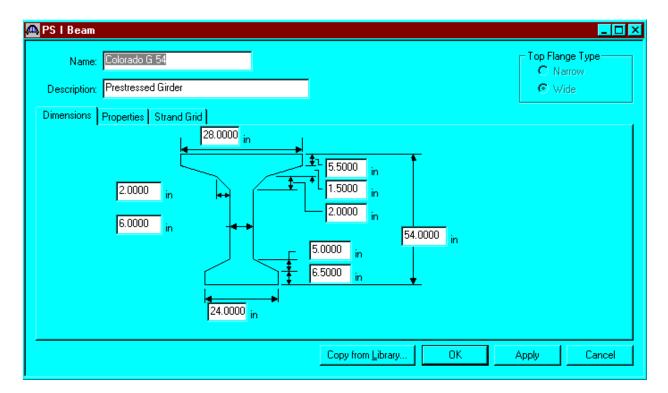
🕰 Bridge Ma	sterials - Reinforcing Steel	- 🗆 ×
<u>N</u> ame	e: Grade 270 Description: Pier +ve reinforcing	
	Material Properties	
	Specified yield strength (Fy) = $229.500$ ksi	
	Modulus of elasticity ( <u>E</u> s) = 28500.00 ksi	
	<i>Ultimate strength (F<u>u</u>) =</i> 270.000 ksi	
	Type	
	Copy from Library OK Apply Car	icel

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🗛 Bridge Materials - PS Strand		<u>- 🗆 ×</u>	
<u>N</u> ame: 1/2'' (7W-270) SR Dege	cription: Stress rel	ieved 1/2''/Seven Wire/fpu = 270	
Strand <u>d</u> iameter =	0.5000	in	
Strand <u>a</u> rea =	0.153	in^2	
Strand <u>type</u> =	Stress Relieved	•	
<u>U</u> ltimate tensile strength (Fu) =	270.000	ksi	
Yield strength (Fy) =	229.500	ksi	
<u>M</u> odulus of elasticity (E) =	28500.00	ksi	
Transfer l <u>e</u> ngth (Std) =	25.0000	in	
Transfer length (LRFD) =	30.0000	in	
Unit <u>w</u> eight per length =	0.520	lb/ft	
	Epoxy coated		
Copy from Library OK Apply Cancel			

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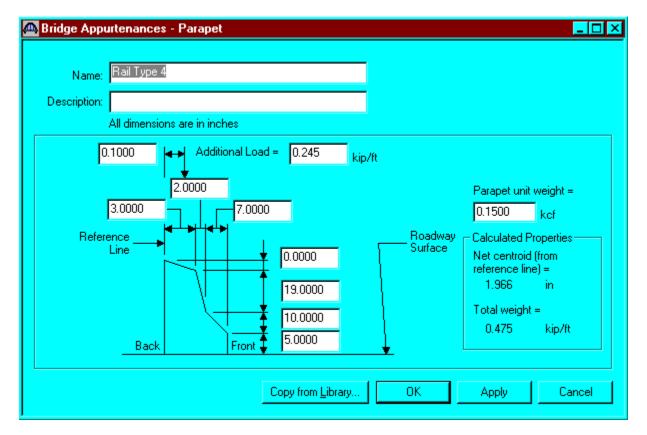
Expand the tree labeled Beam Shapes to enter a prestressed beam shape to be used in the analysis. Click on Prestressed Beam Shapes and I Beams in the tree and select File/New from the menu (or right mouse click on I Beam and select New). Click on the copy from library button or fill in the blanks.



Click OK to save to the memory and close the window.

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To enter the appurtenances to be used within the bridge, expand the explorer tree labeled Appurtenances. Right mouse click on Parapet in the tree, select New and click copy from Library button. Select the Jersey Barrier and click OK. The parapet properties are copied to parapet window as shown below. Click OK to save the data to memory and close the window.



The default impact factors and the standard LFD factors will be used, so we will skip to Structure Definition. Bridge Alternatives will be added after we enter the Structure Definition.

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This window shows the LFD load factors.

Factors - L	_FD						_ 🗆
<u>N</u> ame	: 1996 A4	\SHTO Std. Specif	ications				
<u>D</u> escriptior	n: AASHTI Edition,	D Standard Specifi 1996 including 199	cations for Highwa 7 Interim Specific	ay Bridges, 16th ations	-		
Load Factor	s Resista	ince Factors					
Loa Grou			(L+I)n	(L+I)p	CF	E	T
INV	1.30	0 1.000	1.670	0.000	1.000	1.000	
OPG	1.30	0 1.000	1.000	0.000	1.000	1.000	
<b>I</b>							I
			Copy from	Library	OK	Apply	Cancel

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Double click on STRUCTURE DEFINITION (or click on STRUCTURE DEFINITION and select File/New from the menu or right mouse click on STRUCTURE DEFINITION and select New from the popup menu) to create a new structure definition. The following dialog box will appear.

Girder-line Girder system	<ul> <li>A structure definition describing one of more girders. The girders do</li> </ul>
	A structure definition describing one of more girders. The girders do
under system	A structure deminion describing one of more glidels. The glidels do

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Select Girder System and the following Structure Definition window will open. Enter the appropriate data as shown below. Press F1 while on this tab to view the help topic describing the use of this information.

🕰 Girder System Structur	e Definition		
Definition Analysis Engi <u>N</u> ame:	ne 4 Prestressed Girder System		
<u>D</u> escription:			
<u>U</u> nits:	US Customary	Enter Span <u>L</u> engths Along the Reference Line:	For PS only
Number of <u>spans</u> :	3 📑	Span Length	Average <u>h</u> umidity:
Number of girders:	4 💌	(ft) 1 52.72 2 65.00	Member Alt. Types
	Deck type: Concrete	3 49.96	☐ Steel ☑ P/S ☐ R/C ☐ Timber
		OK	Apply Cancel

Span lengths for a prestressed girder structure made continuous for live loads shall be per Section 9A-2 IV.

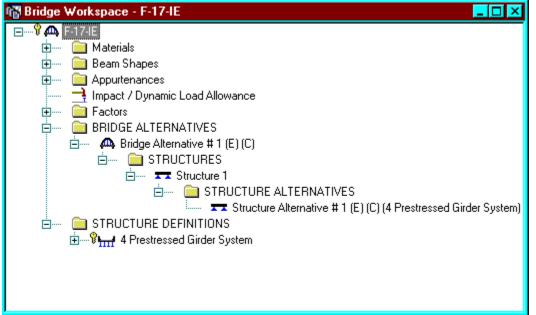
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The partially expanded Bridge Workspace tree is shown below:

The partially expanded bridge workspace	CICC	тD	DIIOWII	DCIOW
🙀 Bridge Workspace - F-17-IE				_ 🗆 ×
🖃💡 🕰 F-17-IE				
📺 🚥 Materials				
📺 🚥 💼 Beam Shapes				
📺 🚥 🦲 Appurtenances				
🔤 📑 Impact / Dynamic Load Allowance				
📺 🚥 Factors				
🖨 🗝 BRIDGE ALTERNATIVES				
🗄 🗝 🕅 🖬 4 Prestressed Girder System				
Impact / Dynamic Load Allowance				
Framing Plan Detail				
Structure Typical Section				
Structure Loads				
😟 🗰 💼 Shear Reinforcement Definitions				
<b>I</b> G3 (G2)				
I G4(G1)				
<b>1</b> u+(u)				
1				

We now go back to the Bridge Alternatives and create a new Bridge Alternative, a new Structure, and a new Structure Alternative.

The partially expanded Bridge Workspace tree is shown below:



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Click Load Case Description to define the dead load cases. The load types are presented in a single row separated by a comma. The first type applies to the LFD design and the second type applies to the LRFD design and it corresponds with the load types presented in the AASHTO Specifications. The completed Load Case Description window is shown below.

Load Case Descripti	on							_	
Load Case Name	Description	Stage		Тур	e	Time* (Days )			
HBP		Composite (long term) (Stage 2)	-	D,DW	-				
Bridge Rail		Composite (long term) (Stage 2)	-	D,DC	-				
Haunch load		Non-composite (Stage 1)	-	D,DC	-				

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Double click on Framing Plan Detail to describe the framing plan. Enter the appropriate data to describe the framing plan.

	ming Plan Detail		Number of spans =	3 Nur	mber of girders =	4	
ut Diaph	ragms		•	·	-	•	
		_	– Girder Spaci	ing Orientation—			
Suppo	ort Skew (Degrees)			licular to girder			
1	52.0000		C Along su				
2	52.0000			-PP			
3	52.0000			Girder Sp			
4	52.0000		Girder Bay	(ft)	) End of		
				Start of Girder	Girder		
			1	11.50	11.50		
			2	11.50	11.50		
			3	11.50	11.50		
					OK	Apply	Cance
					- OK		

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If the bridge has diaphragms, switch to the Diaphragms tab and enter the appropriate data. Click OK to save to memory and close the window.

Girder B	ay: 1	•	Сору Вау То		Diaphragm Wizard			
Suppor Number	t ()	istance ft)	Diaphragm Spacing	Number of	Length (ft)	End Dis (fi	t)	Weight (kip)
	Left Girder	Right Girder	(ft)	Spaces		Left Girder	Right Girder	
1 🔽		0.00	0.00	1	0.00	0.00	0.00	32.0000
1 🔽		32.50	0.00	1	0.00	17.78	32.50	2.1000
2 🗾	0.00	0.00	0.00 0.00	1	0.00	0.00	0.00	44.0000
2 🗾	24.10	39.50 0.00	0.00	1	0.00	24.78 0.00	39.50 0.00	2.1000
3 -		32.70	0.00	1	0.00	18.00	32.70	2.1000
3 🔽		49.96	0.00	. 1	0.00	49.96	49.96	32.0000
		·				<b>`</b>		

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Double click on Structure Typical Section in the Bridge Workspace tree to define the structure typical section. Input the data describing the typical section as shown below.

🕰 Structure Typical Sect	ion							_ 🗆 ×
	Distance from structure defini		e line					
Left overhang 🖡	¥					¦, Bight	t overhang	
Deck Deck (Cont'd) P	arapet Medi	an Railing	Generic	Sidewalk	Lane Position	h Wearing Surl	face	
<u>S</u> tructure definition refe	rence line is	within	•	the bridge o	leck.			
Distance from left edge structure definition refer		Start 20.00	ft	End 20.00	ft			
Distance from right edg structure definition refer		20.00	ft	20.00	ft			
<u>L</u> eft	overhang =	2.75	ft	2.75	ft			
Computed right	overhang =	2.75	ft	2.75	ft			
						OK	Apply	Cancel

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The Deck(Cont'd) tab is used to enter information about the deck concrete and thickness. The material to be used for the deck concrete is selected from the list of bridge materials described previously.

A Structure Typical Section	- 🗆 ×
Distance from left edge of deck to structure definition reference line Deck thickness	
Left overhang	
Deck Deck (Cont'd) Parapet Median Railing Generic Sidewalk Lane Position Wearing Surface	
Deck concrete: Class D(US)	
I otal deck thickness: 8.0000 in	
Deck <u>c</u> rack control parameter: kip/in	
Sustained modular ratio factor: 2.000	
OK Apply (	Cancel

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Parapets:

Add two parapets as shown below.

🐴 Structure Typical	Section						_ 🗆 ×
Deck Deck (Cont	Back - 'd) Parapet Median Rai		Front	ane Position   Wi	saring Surface		
Name	Load Case		Edge of Deck Dist. Measured From	Distance At Start (ft)	Distance At End (ft)	Front Face Orientation	
Rail Type 4 📃	Bridge Rail 📃 🔽	Back 🔽	Left Edge 🔽	0.00	0.00	Right 🗾	
Rail Type 4 🛛 💌	Bridge Rail 📃 🔽	Back 🔽	Right Edge 🔽	0.00	0.00	Left 🔽	
New Duplicate Delete							
					ОК /	Apply Car	ncel

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		5

## Lane Positions:

Select the lane position tab and use the Compute… button to compute the lane positions. A dialog showing the results of the computation opens. Click apply to accept the computed values. The Lane Position tab is populated as shown below.

<b>A</b> 9	Structure Ty	pical Section				- 🗆 ×
	Deck Deck	(A)	H H	efinition Reference Line Travelway 2	] Surface	
	Travelway Number				Distance From Right Edge of Travelway to Structure Definition Reference Line At End (B) (ft)	
	1	-19.00	19.00	-19.00	19.00	
_	Com	pute		New OK	Duplicate Delete	cel

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🕰 Structure Typical Se	ction						<u> </u>
	Distance from lef structure definitio		structure de	om right edge of finition reference Definition			
		Deck ↓thickness ↑	Reference	e Line	<u> </u>		
Left overhang	⊢ <u>∐</u>				∐ ⊯ Right	overhang	
Deck Deck (Cont'd)	Parapet Median	Railing Generi	ic Sidewalk	Lane Position	Wearing Surl	ace	
<u>W</u> earing surface m	naterial: HBP						
<u>D</u> esc	cription:						
Wearing <u>s</u> urface thick	kness = 4.0000	in					
Wearing surface de	<u>ensity =</u> 144.000	pof					
Loa	d <u>c</u> ase: HBP		•		Copy from Libra	ary	
					OK	Apply	Cancel

Enter the following wearing surface information on the Wearing Surface tab.

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Double click on the Structure Loads tree item to define the DL Distribution. Select the required DL Distribution. Click OK to save this information to memory and close the window.

niform Temperature Gradient Temperature Wind DLDis	tribution		
- Stage 1 Dead Load Distribution	]		
C By transverse simple-beam analysis			
C By transverse continuous-beam analysis			
$ \mathbf{C} $ User input results from independent 3D elastic analysis			
- Stage 2 Dead Load Distribution © <u>U</u> niformly to all girders	-		
O By tributary <u>a</u> rea			
C By transverse simple-beam analysis			
O By transverse continuous-beam analysis			
C User input results from independent 3D <u>e</u> lastic analysis			

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A Stress Limit defines the allowable concrete stresses for a given concrete material. Double click on the Stress Limits tree item to open the window. Select the "PS 4.0 ksi" concrete material. Default values for the allowable stresses will be computed based on this concrete and the AASHTO Specifications. A default value for the final allowable slab compression is not computed since the deck concrete is typically different from the concrete used in the beam. Click OK to save this information to memory and close the window.

🙈 Stress Limit Sets - Concrete					_ 🗆 🗡
<u>N</u> ame: 4 Ksi Beam Conci	ete				
Description:					
Concrete Material: PS 4.0 ksi		•			
	LFD		LRFD		
Initial allowable compression:	2.400	ksi	2.400	ksi	
Initial allowable tension:	0.190	ksi	0.190	ksi	
Final allowable compression:	2.400	ksi	2.400	ksi	
Final allowable tension:	0.380	ksi	0.380	ksi	
Final allowable DL compression:	1.600	ksi	1.800	ksi	
Final allowable slab compression:		ksi		ksi	
Final allowable compression: (LL + 1/2(Pe + DL))	1.600	ksi	1.600	ksi	
			OK	Apply C	Cancel

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Double click on the Prestress Properties tree item to open a window in which to define the prestress properties for this structure definition. Define the Prestress Property as shown below. Since we are using the AASHTO method to compute losses, only information in the "General P/S Data" tab is required. Click OK to save to memory and close the window.

A Prestress Properties	
Name: 1/2" SR AASHTO Loss	
General P/S Data Loss Data - Lump Sum Loss Data - PCI	1
P/S strand material: 1/2" (7W-270) SR	Jacking stress ratio: 0.740
Loss method: AASHTO	P/S transfer stress ratio:
	Iransfer time: 24.0 Hours
Loss Data - AASHTO Percentage DL: 0.0 %	
	OK Apply Cancel

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Define the vertical shear reinforcement by double clicking on Vertical (under Shear Reinforcement Definition in the tree). Define the reinforcement as shown. The I shape shown is for illustrative purposes only. Click OK to save to memory and close the window.

🕰 Shear Reinforcement Definition - Vertical	<u> </u>
Name: #4 Stirrups	
Material: Grade 40	•
Bar size: 4	
Number of legs: 2.00	
Inclination (alpha): 90.0 Degrees	
Vertical Shear Reinforcement	
	Cancel

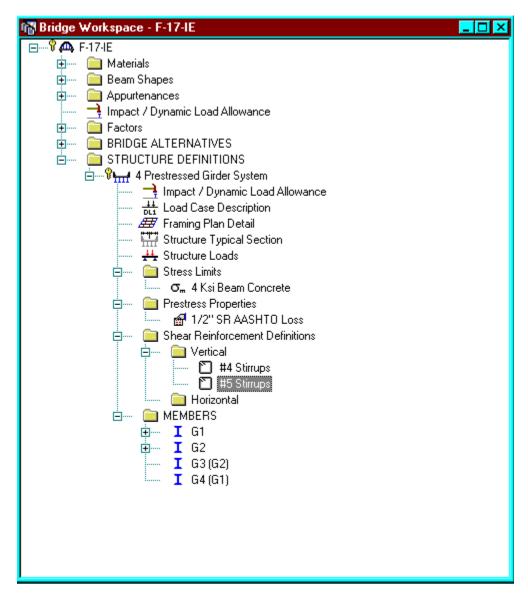
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Using the same techniques, define another vertical Shear Reinforcement Definition.

🕰 Shear	Reinforcement Definition - Vertical	- 🗆 ×
<u>N</u> ame:	#5 Stirrups	
	Material: Grade 40	
	Bar size: 5	
	Number of legs: 2.00	
	Inclination (alpha): 90.0 Degrees	
	Vertical Shear Reinforcement	
	OK Apply Can	cel

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The partially expanded Bridge Workspace tree is shown below:



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# Describing a member:

The member window shows the data that was generated when the structure definition was created. No changes are required at this time. The first Member Alternative that we create will automatically be assigned as the Existing and Current Member alternative for this member.

🕰 Member					_ 🗆 🗙
Member name:	G2		Link with:	None	
<u>D</u> escription:				<u> </u>	
				<b>-</b>	
	Existing Current Member	Alternative Name De:	scription		
	Interior	G54 Colorado Gird			
<u>N</u> umber of spans:	3 📮	Span Span No. Length (ft)		Pedestrian load: 0.000	Ib/ft
			.72		
			6.00		
		3 49	.96		
		_ I			
				IK Apply	Cancel

Defining a Member Alternative:

Double click MEMBER ALTERNATIVES in the tree to create a new alternative. The New Member Alternative dialog shown below will open. Select Prestressed (Pretensioned) Concrete for the Material Type and PS Precast I for the Girder Type.

New Member Alternative	×
Material Type:	Girder Type:
Prestressed (Pretension 🔽	PS Precast I
Г	OK Cancel

Click OK to close the dialog and create a new member alternative.

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The Member Alternative Description window will open. Enter the appropriate data as shown below. The Schedule-based Girder property input method is the only input method available for a prestressed concrete beam.

Member Alternative Descript	on					_ 🗆
Member Alternative: Interior G	54 Colorado Girder					
Description Factors Engine I	mport					
Description: Girder property input method Schedule based C Cross-section based		×	Member	Type: PS	i Customary 🔽	
Additional Self Weight Additional self weight = Additional self weight = Crack control parameter (Z) Bottom of beam:	kip/ft %	Default rati <u>ng</u> me	ethod:	LRFD:	nputation method General Proced Ignore shear	
		[	OK		Apply	Cancel

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Double click on Member Loads to define other girder dead loads not calculated by the program automatically. Dead load due to haunch not included in the section properties calculation is entered here.

🕰 Loads - Member	
Uniform Distributed Concentrated Settlement Load Case Name: Haunch load Span Uniform Load (kip/ft)	
All Spans 🗾 0.058	
	New Duplicate Delete
	OK Apply Cancel

Calculated average haunch = 2.0" Haunch used for section properties = 0.0"

Dead Load/Girder = (2.0-0.0)/12\*(28/12)\*(0.15) = 0.058 k/ft

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Double click on Supports to define support constraints for the girder. Enter the following support constraints. Click OK to save data to memory and close the window.

Suppor	ts Z	2	× <u>∽</u> 1			<u>~</u> 2	
Supp	ort Supp	ort	Translation Con	ostraints	Rotation Constraints		
Numb			x	Y	Z		
1	Pinned	-		V			
2	Roller	-		V			
3	Roller	-		V			
4	Roller	-					
					ОК	Apply	Cancel

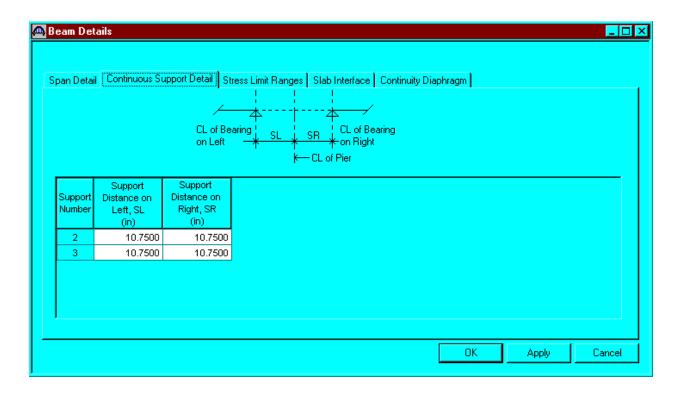
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The Compute from Typical Section button on the Live Load Distribution window to calculate the distribution factors cannot be used until we have selected the beam shape in the Beam Details window. At this point, Virtis/Opis does not know if we have spread or adjacent beams. We will select the beam shape now in the Beam Details window and then come back to the Live Load Distribution window. Double click on Beam Details in the tree to describe the beam details. Enter the following beam details information.

Span		Girder	Prestress			Bean	n Projection
Vumber	Beam Shape	Material	Properties	Use Creep	n	Left End (in)	Right End (in)
1	Colorado G 54 🛛 💆	PS 4.0 ksi 📃 🔽	1/2" SR AASHTO Loss 🔽	Yes 🔽	7.767	3.0000	3.0000
2	Colorado G 54 🛛 🔽	PS 4.0 ksi 📃 🔽	1/2" SR AASHTO Loss 🔽	Yes 🔽	7.767	3.0000	3.0000
3	Colorado G 54 🛛 🔽	PS 4.0 ksi 📃 🔽	1/2" SR AASHTO Loss 🔽	Yes 🔽	7.767	3.0000	3.0000

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The Continuous Support Detail tab is only shown for a multi-span structure. The following data describes the distances from the centerlines of bearing to the centerlines of the piers.



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Note that the Stress Limit Ranges are defined over the entire length of the precast beam.

Span		Start	Length	End	 	
Numbe	r Name	Distance (ft)	(ft)	Distance (ft)		
1 📘	🛿 4 Ksi Beam Concrete 📘	0.00	52.32	52.32		
2 📘	4 Ksi Beam Concrete 🔽	0.00	63.71	63.71		
3 📘	🛿 4 Ksi Beam Concrete  💌	0.00	49.56	49.56		

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The defaults on the Slab Interface tab are shown below and are acceptable.

μ.	Beam Details	_ 🗆 ×
1	Span Detail Continuous Support Detail Stress Limit Ranges Slab Interface Continuity Diaphragm	
	Interface type: Intentionally Roughened 🔽	
	Default interface width to beam widths 🔽	
	Interface width:	
	Cohesion factor: 0.100 ksi	
	Friction factor: 1.000	
	OK Apply Ca	ancel

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The Continuity Diaphragm tab is only displayed for multi-span structures. The data on this tab defines the cast-in-place diaphragms used to make the structure continuous for live load. Press F1 while on this tab to view the continuity diaphragm help topic describing the use of this information.

Span Left Support							Right S	upport					
Num		r Material		Distance (in)	Bar Count		Bar Size		Material		Distance (in)	Bar Count	Bar Size
1	•							•	Grade 270	-	2.0000	3.000	5 🗾
2	-	Grade 270	-	2.0000	3.000	5		-	Grade 270	-	2.0000	3.000	5 🔽
3	-	Grade 270	-	2.0000	3.000	5		-		•			<b>•</b>
□ Ignore positive moment at supports in ratings													

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Now double click on Live Load Distribution in the tree to enter the live load distribution factors. Click the Compute from Typical Section button to compute the live load distribution factors. The distribution factors are computed based on the AASHTO Specifications, Articles 3.23 and 3.28. Click Apply and then OK to save data to memory and close the window.

ive Load Di itandard LR							
Lanes		Distribution (Whee					
Loaded	Shear	Shear at Supports	Moment	Deflection			
1 Lane	1.478	1.478	1.478	0.500			
Multi-Lane	2.091	2.261	2.091	1.350			
Compute fro Typical Sect	m tion						
				OK	Арр	v _	Cancel

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Expand the tree under Strand Layout and open the Span 1 window. This window allows you to define a prestress strand layout for a prestressed concrete beam span. Prestress strand layout can be described either by the actual strand locations or the prestress force (jacking force) and eccentricity (center of gravity) of the group of strands. Select P and CGS only for the Description Type. Enter the following Strand Layout information for Span 1. Press F1 while on this tab to view the strand layout help topic describing the use of this information.

🕰 Strand Layout - Spa	n 1	_ 🗆 🗡
<b>略负围密</b> 出		
Description Type P and CGS only	O Strands in rows	
Left harp pt. dist. (X1):	22 ft	
Left harp pt. radius:	0.0001 in	
Right harp pt. dist. (X2):	22 ft	
Right harp pt. radius:	0.0001 in	
Force:	490.00 kip	
Left CGS:	17.0000 in	
Mid CGS:	2.8400 in	
Right CGS:	17.0000 in	
ОК И	Apply Cancel	

Using the same techniques, define the strand layout for span 2 and span 3.

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🙈 Strand Layout - Spa	n 2	_ 🗆 🗙
副负围或正		
Description Type P and CGS only	C Strands	in rows
Left harp pt. dist. (X1):	<b> </b> 28	ft
Left harp pt. radius:	0.0001	in
Right harp pt. dist. (X2):	28	ft
Right harp pt. radius:	0.0001	in
Force:	737.00	kip
Left CGS:	17.0000	in
Mid CGS:	3.0800	in
Right CGS:	17.0000	in
ОК А	vpply	Cancel

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🙈 Strand Layout - Spa	n 3	
副负围欧亚		
Description Type P and CGS only	C Strands	s in rows
Left harp pt. dist. (X1):	21	ft
Left harp pt. radius:	0.0001	in
Right harp pt. dist. (X2):	21	Ω.
Right harp pt. radius:	0.0001	in
Force:	437.00	kip
Left CGS:	17.0000	in
Mid CGS:	2.5900	in
Right CGS:	17.0000	in
<u> </u>	pply	Cancel

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Open the Deck Profile window and enter the date describing the structural properties of the deck.

Material	Support Number	Start Distance (ft)	Length (ft)	End Distance (ft)	Structural Thickness (in)	Effective Flange Width (Std) (in)	Effective Flange Width (LRFD) (in)	n
lass D(US) 🛛 📘	1 🔽	0.00	167.68	167.68	8.5000	130.0000		7.130

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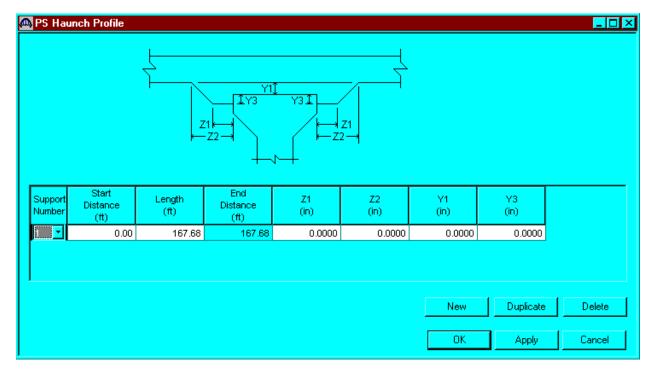
The deck reinforcement in the negative moment regions is described as follows.

Material	Support Numbe	Start Distance (ft)	Length (ft)	End Distance (ft)	Bar Count	Bar Size	Distance (in)	Row		
Grade 40 🔽	1 1		167.60	167.60	7.000	5 🔽	3.5600	Top of Slab	-	
Grade 60 🔽	1 1	22.72	51.00		4.000				-	
Grade 60 🔽	1 1	30.72	51.00	81.72	4.000	8 🔽	3.7500	Top of Slab	-	
Grade 60 🔽	2 🔽	37.00	51.00	88.00	4.000	8 🔽	3.7500	Top of Slab	-	
Grade 60 🔽	2 🔽	44.00	51.00	95.00	4.000	8 🔽	3.7500	Top of Slab 📘	-	

Note: Only the top layer of the slab's distribution reinforcement is used in the analysis.

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Double click on Haunch Profile in the tree to define the haunch profile for the girder.



Note: Only the haunch thickness to be used in section properties calculation is input here. The program calculates dead load due to this haunch automatically.

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The Shear Reinforcement Ranges are entered as described below. The vertical shear reinforcement is defined as extending into the deck on this tab. This ensures composite action between the beam and the deck. Data does not have to be entered on the Horizontal tab to indicate composite action since we have defined that by extending the vertical bars into the deck.

ertica		Horizontal )	Sta	art Distanc	e <mark>þ</mark> espa	acing				
Sp: Num		Name		Extends into Deck	Start Distance (ft)	Number of Spaces	Spacing (in)	Length (ft)	End Distance (ft)	<u>*</u>
1	-	#5 Stirrups	-	<u>s</u>	0.16	1	0.0000	0.00	0.16	
1	-	#5 Stirrups	-		0.16	6	3.0000	1.50	1.66	
1	-	#4 Stirrups	-		1.66	10	9.0000	7.50	9.16	
1	-	#4 Stirrups	-	V	9.16	34	12.0000	34.00	43.16	
1	-	#4 Stirrups	-		43.16	10	9.0000	7.50	50.66	
1	-	#4 Stirrups	-		50.66	6	3.0000	1.50	52.16	
2	-	#5 Stirrups	-		0.16	1	0.0000	0.00	0.16	
2	-	#5 Stirrups	-		0.16	6	3.0000	1.50	1.66	
2	-	#4 Stirrups	-		1.66	10	9.0000	7.50	9.16	
2	-	#4 Stirrups	-		9.16	22	12.0000	22.00	31.16	
2	-	#4 Stirrups	-	V	31.16	1	16.6800	1.39	32.55	
2	-	#4 Stirrups	-		32.55	22	12.0000	22.00	54.55	
2	-	#4 Stirrups	-		54.55	10	9.0000	7.50	62.05	-
								New Du	uplicate [	)elete

The description of an interior beam for this structure definition is complete.

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The BRASS LFD engine data for the member alternative is shown below.

Member Alternative Description
Member Alternative: Interior G54 Colorado Girder
Description Factors Engine Import
Configure engine properties for analysis module: BRASS LFD
Analysis Load Sequence: Computed based on loadings and comp Points of Interest Control: 3 - Same as 1 plus generate user-define Wheel Advancement: 100 P/S modeling method: Centerline of simple-span bearing Use P/S beam overhangs. Use maximum moment in span to compute fcir. Omit strands for moment capacity if within Distance from top of girder (+M): 0.000000 (in) Distance from bottom of girder (-M): 0.000000 (in)
OK Apply Cancel

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## The results of the LFD/ASD rating analysis are as follows:

Ento	Load		Design Method	Inventory Load Rating Ton	Operating Load Rating Ton	Inventory Rating Factor	Operating Rating Factor	Inventory Location ft	Inventory Location Span-(%)	Operating Location ft	Operating Location Span-(%)	Inventory Limit State	Operating Limit State
S 20-44		Axle	LFD	52.01	86.86	1.445	2.413	144.47	3 - ( 53.5)	144.47	3 - ( 53.5)	ULTIMATE MOME	ULTIMATE MOME
S 20-44		Lane	LFD	48.31	80.68	1.342	2.241	51.82	1 - ( 98.3)	51.82	1 - ( 98.3)	ULTIMATE MOME	ULTIMATE MOME
olorado Pe	ermit Vehicle	Axle	LFD		105.61		1.100			51.82	1 - ( 98.3)	)	ULTIMATE MOME

Limit State	Inventory Limit State	Location Span-(%)	Operating Location ft	Inventory Location Span-(%)	Inventory Location ft	Operating Rating Factor	Inventory Rating Factor	Operating Load Rating Ton	Inventory Load Rating Ton	Design Method	Live Load Type	Live Load
BOTTOM FLANGE	TENSION STEEL	3 - ( 53.5)	144.47	2 - ( 95.9)	115.03	1.753	1.270	63.12	45.73	ASD	Axle	IS 20-44
TENSION STEEL	TENSION STEEL	1 - ( 98.3)	51.82	1 - ( 98.3)	51.82	1.777	1.047	63.96	37.69	ASD	Lane	IS 20-44

Note: LFD method controls both the Inventory and the Operating rating.

April	1.	2002	
	- <i>'</i>		

	MENT OF TRANSPORT R RATING SUMM			icture # le highway #	F-17	- IB 70		
Kaled using Asphalt trickness Colorado legal Interstale legal	102mm(4		Stru	Batch I D Structure type CPGC Peral kei structure #				
Structural member	INTERIOR GIRDER G 54	SLAD						
	Metric tons (Tons)							
Inventory	43.6 ( 49 )	34.5 ( 3	۹)	(	)	(	)	
Operating	73.6 ( Bi )	57.3 ( 6	з)	(	)	(	)	
Type 3 truck	( )	(	)	(	)	(	)	
Type 3S2 truck	( )	(	)	(	)	(	)	
Type 3-2 truck	( )	(	)	(	)	(	)	
Permit truck	96.3 ( 106 )	(	)	(	)	(	)	
		Type 3S2 Truck Particle is 6 rates to Closed it interests Closed it interests Closed it interests Closed it interests Closed it interests Closed it interests Closed it interests	H CBE MARKET	Cites Visiti		0	0	
Load Capacity: 63 Girder: Only Interio	or Girder Rated; Haur rs; Rated for 2" HBP e		d in the s	ection prop	erties calc	ulations;		
Rated by	Dole	Cheo	ked by			Date		

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#### Virtis Bridge Rating Example, Structure No. L-26-BR

Use average web = 6.0" Girder flange = ½(Total flange width) = ½(86.0) = 43.0" 4x4 ~ W4xW4 WWF, assumed shear reinforcing: #3 single leg bar @ 12" c/c Dead Load:

Intermediate Diaphragm = 0.150 kip/diaphragm
%(diaphragm) = 0.075 kip

Abutment Diaphragm = ((2.50)\*(44.5/12)\*(3.5833) - (507.5/144)\*(20/12)) \*(0.150)= 4.1 kips Use 4.1 kips

## Distribution Factors:

#### • AASHTO LRFD Table 4.6.2.2.2b-1

 $K = \sqrt{(1+\mu)*I/J} = \sqrt{(1+0.2)*(90584)/(12345)} = 2.96$   $C = K^*(W/L) = 2.96^*(72/59.5) = 3.58 > K \quad \therefore C = K = 2.96$   $NL = 6 \text{ Lanes Assumed} \qquad L = 59.5'$   $D = 11.5 - NL + 1.4^*NL^*(1-0.2C)^*(1-0.2C)$   $= (11.5 - 6) + 1.4^*6^*(1-0.2^*2.96)^*(1-0.2^*2.96) = 6.898$  S/D = (43/12)/(6.898/2) = 1.039 Wheel Lines NL = 1 Lane  $D = (11.5 - 1) + 1.4^*1^*(1-0.2^*2.96)^*(1-0.2^*2.96) = 10.733$  S/D = (43/12)/(10.733/2) = 0.668 Wheel Lines

### • AASHTO Standard Specifications, Table 3.23.1

Assumed full depth rigid diaphragm. Distribution Factor = S/6 = (7.167/2)/6 = 0.597 (Multi Lanes) Distribution Factor = 0.547 (Single Lane)

#### LDFAC Program

Assumed 8" poured in place composite deck. Distribution Factor = 0.673 (Multi Lanes) Distribution Factor = 0.542 (Single Lane)

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LDFAC Version 1.0 (Release Version)

# Dbl\_Tee

Geometry Data:

Bridge Type		Beam & Slab
Width of Curb	[ft]	0.0000
Element Density		12
Number of Spans		1
Span Length(s)	[ft]	
59.5000		
Skew Angles	[degrees]	
0.0000	0.0000	

Live Load Generator Data

Truck Nar	ne					HS20TR
Multiple	Presence	Factor	-	1	Truck	1.00
Multiple	Presence	Factor	-	2	Trucks	1.00
Multiple	Presence	Factor	-	3	Trucks	0.90
Multiple	Presence	Factor	-	4	Trucks	0.75

Point-of-Interest Data

Туре	Span #	Span Loc. [ft]	Rel. Span Loc.
Shr	1	0.00	0.00
+Mom	1	30.00	0.50
-Mom	1	60.00	1.00

Beam and Slab Data:

Slab Thickness Young' Modulus	[in] [ksi]	8.0000 3823.0000
Poisson's Ratio		0.2000
Exterior Girder Area A	[in^2]	507.50
Exterior Girder Moment I	[in^4]	90584.00
Exterior Girder Moment J	[in^4]	12345.00
Exterior Centroidal Offset	[in]	16.2500
Interior Girder Area A	[in^2]	507.50
Interior Girder Moment I	[in^4]	90584.00
Interior Girder Moment J	[in^4]	12345.00
Interior Centroidal Offset	[in]	16.2500
Girder Modular Ratio n		7.0000
Left Girder Overhang	[in]	21.5000
Right Girder Overhang	[in]	21.5000
Total Number of Girders		20

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Girder Spacing Values 43.0000 43.0		0000 43.0000 43.0000
43.0000 43.0000 43.0000 43.0000	43.000043.000043.000043.0000	43.0000 43.0000 43.0000 43.0000
43.0000		

LDFAC Version 1.0 - Release Version Out-of-Limits Results for Formula Are Marked With an Asterisk \*

1 - Span Straight Beam & Slab Bridge with HS20TR Load

Multi-Lane Load Distribution Results

Poin	t-of-Ir	nterest	: Data	Analysis Results		Formula Results			
No.	Туре	Sp#	5p%	Interior	Exterior	Interior	Exterior		
1	Shr	1	0	0.86074	0.86148	0.97668	0.76099		
2	+Mom	1	50	0.67364	0.71775	0.88385	0.88385		
3	-Mom	1	100	N/A	N/A	N/A	N/A		

LDFAC Version 1.0 - Release Version Out-of-Limits Results for Formula Are Marked With an Asterisk \*

1 - Span Straight Beam & Slab Bridge with HS20TR Load

Single-Lane Load Distribution Results

Poin	t-of-Ir	nterest	Data	Analysis	Analysis Results		Results
No.	Туре	Sp#	Sp*	Interior	Exterior	Interior	Exterior
1	Shr	1	0	0.76917	0.86148	0.83889	1.00000
2	+Mom	1	50	0.54238	0.68849	0.57662	1.00000
3	-Mom	1	100	N/A	N/A	N/A	N/A

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From the bridge explorer, create a new bridge and enter the following information.

🕰 L-26-BR					_ 🗆 ×
Bridge ID: L-26-BR	NBI Structure	ID (8): L-26-BR		Template Design Only	
Description Descriptio	n (cont'd) Alternatives GI	obal Reference Point			
Name:	CDTPG		Year	Built 1982	
Description:	1-Span Concrete Double-Te	ee Prestressed Girder			A
					<b>T</b>
Location:			Length:	ft	
Facility Carried (7):		Route	Number: -1		
Feat. Intersected (6):			Mi. Post:		
Units:	US Customary 🗾	Rece	nt ADTT:		
			OK /	Apply	Cancel

Click OK. This saves the data to memory and closes the window.

NOTE: Since Virtis uses a common/shared database; it is required that users
 of this program create a folder from the bridge explorer window
 ( EXAMPLE: MY FOLDER OR YOUR LAST NAME) before creating the model for a
 new structure.

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To add a new concrete material, click on Materials, Concrete, in the tree and select File/New from the menu (or right click on Concrete and select New). Fill in the data for the beam concrete material as shown below. Click OK to save this beam concrete material to memory and close the window.

🕰 Bridge Materials - Concrete		
Name: PS 6.0 ksi Deg	cription: f <sup>r</sup> ci = 4.5 ks	si
Compressive strength at 28 days (f'c) =	6.000	ksi
Initial compressive strength (f'ci) =	4.500	ksi
<u>C</u> oefficient of thermal expansion =	0.0000060000	1/F
<u>D</u> ensity (for dead loads) =	0.150	kcf
Density (for modulus of elasticity) =	0.150	kcf
Modulus of elasticity ( <u>E</u> c) =	4695.98	ksi
Initial modulus of elasticity =	4066.84	ksi
<u>P</u> oisson's ratio =	0.200	
Composition of concrete =	Normal	•
Modulus of <u>r</u> upture =	0.588	ksi
<u>S</u> hear factor =	1.000	
Copy from Lib	rary OK	Apply Cancel

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Using the same techniques, create the following Reinforcing Steel Materials and Prestress Strands Materials. The windows are shown in the following pages.

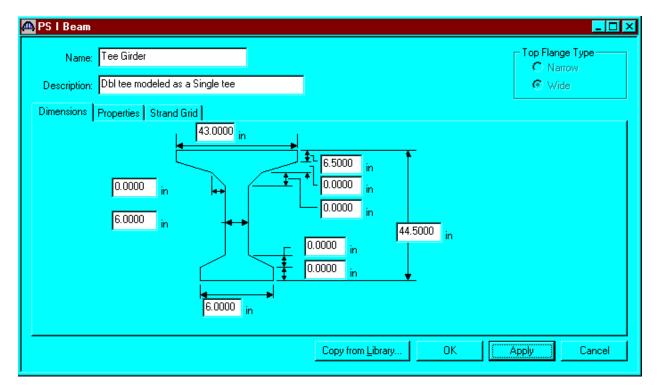
🕰 Bridge Mal	erials - Reinforcing Steel					_ 🗆 ×
<u>N</u> ame	Grade 40	<u>D</u> esc	ription: 40 ks	i reinforcing steel		
		Material Propert	ties			
	Specified yi	ield strength (Fy) =	40.000	ksi		
	Modulus	of elasticity ( <u>E</u> s) =	29000.00	ksi		
	Littima	ite strength (F <u>u</u> ) =	70.000	ksi		
		- Type	I			
		Copy from Lib	rary	ОК А	Apply C	ancel

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A Bridge Materials - PS Strand		
<u>N</u> ame: 172'' (7W-270) SR De <u>s</u>	cription: Stress reli	ieved 1/2''/Seven Wire/fpu = 270
Strand <u>d</u> iameter =	0.5000	in
Strand <u>a</u> rea =	0.153	in^2
Strand <u>type</u> =	Stress Relieved	-
<u>U</u> ltimate tensile strength (Fu) =	270.000	ksi
Yield strength (Fy) =	229.500	ksi
<u>M</u> odulus of elasticity (E) =	28500.00	ksi
Transfer l <u>e</u> ngth (Std) =	25.0000	in
Transfer length (LRFD) =	30.0000	in
Unit <u>w</u> eight per length =	0.520	lb/ft
	Epoxy coated	
Copy from L	ibrary Ok	Cancel

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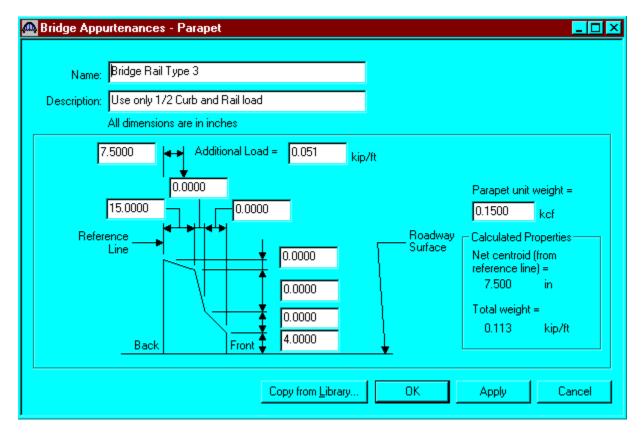
Expand the tree labeled Beam Shapes to enter a prestressed beam shape to be used in the analysis. Click on Prestressed Beam Shapes and I Beams in the tree and select File/New from the menu (or right mouse click on I Beam and select New). Fill in the data for the beam (Modeled as a Single-Tee beam). Click the Properties tab, then the compute button and then OK.



Click OK to save the data to memory and close the window.

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To enter the appurtenances to be used within the bridge, expand the explorer tree labeled Appurtenances. Right mouse click on Parapet in the tree, select New and fill in the data for the Bridge Rail Type 3 (Note: Since the girder is modeled as a single-Tee, use only ½ the curb and rail load). Click OK to save the data to memory and close the window.



The default impact factors and the standard LFD factors will be used, so we will skip to Structure Definition. Bridge Alternatives will be added after we enter the Structure Definition.

This window shows the LFD load factors.

Factors - LFD <u>N</u> ame: 1		TO Std. Specifi	cations		_		
Description: AASHTO Standard Specifications for Highway Bridges, 16th Edition, 1996 including 1997 Interim Specifications							
Load Factors	Resistance	Factors					•1
Load Group	Gamma – Factor	D	(L+I)n	(L+I)p	CF	E	
INV OPG	1.300 1.300	1.000 1.000	1.670 1.000	0.000 0.000	1.000 1.000	1.000 1.000	
			Copy from	Library	ОК	Apply Ca	ncel

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Double click on STRUCTURE DEFINITION (or click on STRUCTURE DEFINITION and select File/New from the menu or right mouse click on STRUCTURE DEFINITION and select New from the popup menu) to create a new structure definition. The following dialog box will appear.

New Structure Definit	ion 🔉
Structure Type	Description
Girder-line Girder system	A structure definition describing one of more girders. The girders do NO A structure definition describing one of more girders. The girders do hav
4	• • • • • • • • • • • • • • • • • • •
	(OK) Cancel

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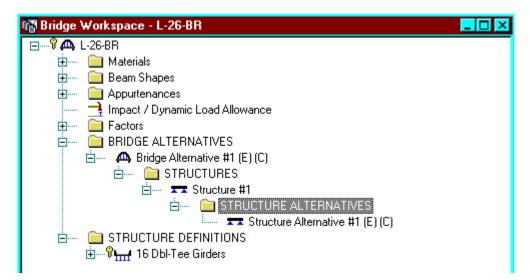
Select Girder System and the following Structure Definition window will open. Enter the appropriate data as shown below. Press F1 while on this tab to view the help topic describing the use of this information.

🕰 Girder System Structur	e Definition				_ 🗆 ×
Definition Analysis Engi	ne				
<u>N</u> ame:	Dbl-Tee Girders				
<u>D</u> escription:	Only 12 Girder lines can be an dbl-tee units. Note, live load D	alyzed by BRAS F to be entered	)S. Modeled u manually.	ısing 6 🔺	
<u>U</u> nits:	US Customary 🔽	Enter Span <u>L</u> Along the Be	engths ference Line:	For PS on	y
Number of <u>s</u> pans:	1 💻	_	ength	Average <u>k</u> 60.000	
Number of girders:	12 🛨	1	(ft) 59.50		%
	Deck type: Concrete			Member A	el S
			OK	Apply	Cancel

Span length for a simple span prestressed girder structure shall be per Section 9A-2 IV.

We now go back to the Bridge Alternatives and create a new Bridge Alternative, a new Structure, and a new Structure Alternative.

The partially expanded Bridge Workspace tree is shown below:



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Click Load Case Description to define the dead load cases. The load types are presented in a single row separated by a comma. The first type applies to the LFD design and the second type applies to the LRFD design and it corresponds with the load types presented in the AASHTO Specifications. The completed Load Case Description window is shown below.

	Load Case Description						
Load Case Name	Description	Stage		Тура	e (Da		
Parapets		Non-composite (Stage 1)	-	D,DC			
Future Wearing Surface		Non-composite (Stage 1)	-	D,DC	-		
diaphragm load		Non-composite (Stage 1)	-	D,DC	-		
*Prestressed members only							
*Prestressed members only			N	ew	Du	plicate	Delete
*Prestressed members only			N	ew	Du	plicate	Delete

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Double click on Framing Plan Detail to describe the framing plan. Enter the appropriate data to describe the framing plan.

Structure Framing Plan Details				
Layout Diaphragms	Number of spans	= 1	Number of	girders = 12
Support         Skew (Degrees)           1         0.0000           2         0.0000	Girder Spa Perper Along :	ndicular to		
		Girde	er Spacing (ft)	-
	Girder Bay	Start of Girder	End of Girder	
	1	3.58	3.58	
	2	3.58	3.58	
	3	3.58	3.58	
	4	3.58	3.58	
	5	3.58	3.58	•
		OK	Apply	Cancel

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If the bridge has diaphragms, switch to the Diaphragms tab and enter the appropriate data. Click OK to save to memory and close the window.

iyout	Di	aphragms		N	umber of sp	ans = [1	Number of girde	ers = 12	
Girder	r Bay	r. 1		Copy Bay To	]	Diaphragm Wizard			
Supp Numi		Start Di (f	t)	Diaphragm Spacing	Number of	Length (ft)	End Dia (f	t)	Weight (kip)
- som		Left Girder	Right Girder	(ft)	Spaces	(19	Left Girder	Right Girder	Codes
1	-	0.00	0.00	0.00	1	0.00	0.00	0.00	4.1000
1	-	0.00	0.00	29.75	1	29.75	29.75	29.75	0.0700
1	-	29.75	29.75	29.75	1	29.75	59.50	59.50	4.1000
							N	ew Dupli	cate Delete

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Double click on Structure Typical Section in the Bridge Workspace tree to define the structure typical section. Input the data describing the typical section as shown below.

A	Structure Typical Section				
Γ		n left edge of deck to inition reference line	Distance from right edg		
		Deck ↓thickness	Structure Definition Reference Line	7	
		1			
	Left overhang , , , , , , , , , , , , , , , , , , ,	dian   Railing   Gene	eric   Sidewalk   Lane Posi	tion Wearing Surface ]	
	Structure definition reference line is	within	✓ the bridge deck.		
	Distance from left edge of deck to structure definition reference line =	Start 21.50 ft	End 21.50 ft		
	Distance from right edge of deck to structure definition reference line =	21.50 ft	21.50 ft		
	Left overhang =	1.79 ft	1.79 ft		
	Computed right overhang =	1.79 ft	1.79 ft		
				ОК Арріу	Cancel

The Deck(Cont'd) tab is used to enter information about the deck concrete and thickness. This structure does not have a concrete deck, so leave the information on this tab blank.

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Parapets:

Add two parapets as shown below.

🕰 Structure Typic	al Sec	tion											_ 🗆 ×
Deck Deck (Co	n'd T	Parapet		ack	Ge	meric   Sic		Front - walk   Lane F	Positi	on Wearing St	ırface		
Name			Load Ca					Edge of De Dist. Measur From	sk 🛛	Distance At Start (ft)	Distance At End (ft)	Front Face Orientation	
Bridge Rail Type	93 🔽	Parapet	8		-	Back 📘	•	Left Edge	-	0.00	0.00	Right 🔽	]
Bridge Rail Type	3 🔼	Parapet	s		-	Back 🧧	•	Right Edge	-	0.00	0.00	Left 🔽	
										New OK	Duplicate Apply	Delete Car	

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## Lane Positions:

Select the lane position tab and use the Compute... button to compute the lane positions. A dialog showing the results of the computation opens. Click apply to accept the computed values. The Lane Position tab is populated as shown below.

🕰 SI	tructure Ty	pical Section			_ 🗆	×
D	eck Deck	(A) Travelway 1		efinition Reference Line Travelway 2	] Surface	
	Travelway Number	Troucleuou to Structure	Distance From Right Edge of Travelway to Structure Definition Reference Line At Start (B) (ft)	Distance From Left Edge of Travelway to Structure Definition Reference Line At End (A) (ft)	Distance From Right Edge of Travelway to Structure Definition Reference Line At End (B) (ft)	
	1	-20.25	20.25	-20.25	20.25	
	Com	ipute		New OK	Duplicate Delete	

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A Structure Typical Section						
	n left edge of deck to nition reference line		m right edge o finition referenc			
	Deck ↓thickness	î′ I← Structure   Referenc	Definition e Line			
	<b>†</b>		-			
Left overhang			-	Rigi	nt overhang	
Deck Deck (Cont'd) Parapet Med	lian Railing Generi	ic Sidewalk	Lane Position	Wearing Su	uface	
Wearing surface material: HBP						
Description:						
Wearing <u>s</u> urface thickness = 2.500	D in					
Wearing surface density = 144.0	DO pcf					
Load <u>c</u> ase: Future	Wearing Surface	•		Copy from Lib	rary	
				OK	Apply	Cancel

Enter the following wearing surface information on the Wearing Surface tab.

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Double click on the Structure Loads tree item to define the DL Distribution. Select the required DL Distribution. Click OK to save this information to memory and close the window.

Structure Loads				_ 🗆 >
Uniform Temperature Gradient Temperature Wind DL Distri	ibution ]			
By tributary area				
C By transverse <u>s</u> imple-beam analysis				
C By transverse continuous-beam analysis				
C User input results from independent 3D elastic analysis				
Stage 2 Dead Load Distribution				
C By tributary <u>a</u> rea				
C By transverse simple-beam analysis				
C By transverse continuous-beam analysis				
C User input results from independent 3D <u>e</u> lastic analysis				
		0K	Apply	Cancel

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A Stress Limit defines the allowable concrete stresses for a given concrete material. Double click on the Stress Limits tree item to open the window. Select the "PS 6.0 ksi" concrete material. Default values for the allowable stresses will be computed based on this concrete and the AASHTO Specifications. A default value for the final allowable slab compression is not computed since the deck concrete is typically different from the concrete used in the beam. Click OK to save this information to memory and close the window.

🕰 Stress Limit Sets - Concrete					_ 🗆 🗡
<u>N</u> ame: Beam Stress Limit	\$				
Description:					
Concrete Material: PS 6.0 ksi		•			
	LFD		LRFD		
Initial allowable compression:	2.700	ksi	2.700	ksi	
Initial allowable tension:	0.200	ksi	0.200	ksi	
Final allowable compression:	3.600	ksi	3.600	ksi	
Final allowable tension:	0.465	ksi	0.465	ksi	
Final allowable DL compression:	2.400	ksi	2.700	ksi	
Final allowable slab compression:		ksi		ksi	
Final allowable compression: (LL + 1/2(Pe + DL))	2.400	ksi	2.400	ksi	
			ОК	Apply	Cancel

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Double click on the Prestress Properties tree item to open a window in which to define the prestress properties for this structure definition. Define the Prestress Property as shown below. Since we are using the AASHTO method to compute losses, only information in the "General P/S Data" tab is required. Click OK to save to memory and close the window.

🗛 Prestress Properties	
Name: AASHTO Losses	
General P/S Data Loss Data - Lump Sum Loss Data	- PCI
P/S strand material: 1/2" (7₩-270) SR	Jacking stress ratio: 0.712
Loss method: AASHTO	P/S transfer stress ratio:
	Transfer time: 24.0 Hours
Loss Data - AASHTO Percentage DL: 0.0 %	
	OK Apply Cancel

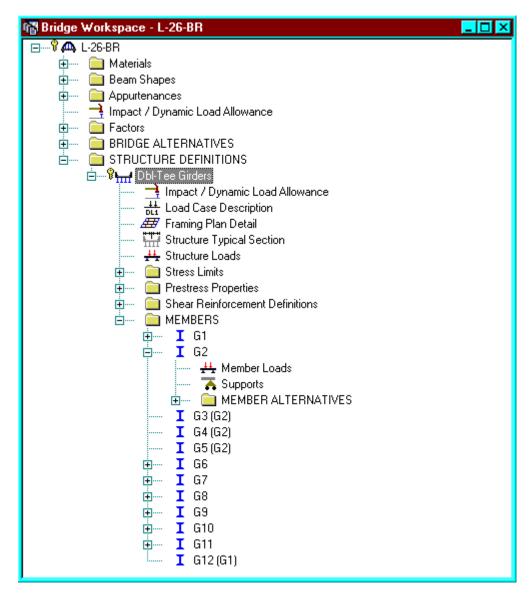
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Define the vertical shear reinforcement by double clicking on Vertical (under Shear Reinforcement Definition in the tree). Define the reinforcement as shown. The I shape shown is for illustrative purposes only. Click OK to save to memory and close the window.

🗛 Shear Reinforcement Definition - Vertical	_ 🗆 ×
Name: #3 Shear Reinf	
Material: Grade 40	
Bar size: 3	
Number of legs: 1.00	
Inclination (alpha): 90.0 Degrees	
Vertical Shear Reinforcement	
	Cancel

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The partially expanded Bridge Workspace tree is shown below:



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#### Describing a member:

The member window shows the data that was generated when the structure definition was created. No changes are required at this time. The first Member Alternative that we create will automatically be assigned as the Existing and Current Member alternative for this member.

🕰 Member	n de la constante de la constan	
<u>M</u> ember name:	G2	
<u>D</u> escription:		
	Existing Current Member Alternative Name Description	
	PS Tee Girder	
Number of spans:	1 ≝ Span Span Length Pedestrian load: 0.000 lb/ft	
	1 59.50	
	OK Apply Cance	

Defining a Member Alternative:

Double click MEMBER ALTERNATIVES in the tree to create a new alternative. The New Member Alternative dialog shown below will open. Select Prestressed (Pretensioned) Concrete for the Material Type and PS Precast I for the Girder Type.

New Member Alternative	×
Material Type:	Girder Type:
Prestressed (Pretension 🔽	PS Precast I 🗾
L L L L L L L L L L L L L L L L L L L	OK Cancel
	<u>Cit</u>

Click OK to close the dialog and create a new member alternative.

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The Member Alternative Description window will open. Enter the appropriate data as shown below. The Schedule-based Girder property input method is the only input method available for a prestressed concrete beam.

Member Alterna	ative Descripti	on					- 🗆
Member Altern	ative: PS Tee G	ìirder					
Description Fac	tors Engine Ir	mport					
Description:			×	Girde	al Type:  Pre er Type:  PS er <u>u</u> nits:  US		ioned
Girder property Schedul	e based				Analysis M <u>A</u> SD: <u>L</u> FD: L <u>R</u> FD:		•
Additional Self Additional se Additional se	l <u>f</u> weight =	kip/ft	Default rating me	ethod:	LRFD:	nputation method General Procedur Z Ignore shear	e 🔹
Crack control Bottom of bea		kip/in					
			[	OK		Apply C	ancel

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Double click on Member Loads to define other girder dead loads not calculated by the program automatically. Dead load due to intermediate diaphragm located at centerline of the girder is entered here.

_oads - Me	ember				_
	<i>ح</i> ا	Distance	Py Px		+y ♥ +x
		entrated Settler	ment ]		
Load Case	Name: diapł	nragm load	<u>-</u>		
Support Number	Distance (ft)	Px (kip)	Py (kip)	M (kip.ft)	
1 🔽	29.75	0.00	0.07	0.00	
				New	Duplicate Delete
				0	K Apply Cancel

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Double click on Supports to define support constraints for the girder. Enter the following support constraints. Click OK to save data to memory and close the window.

🕰 Supports						<u>- 🗆 ×</u>
General	Z K	• • • X			<u>~</u> 2	
Support	Connect	Translation Con	straints	Rotation Constraints		
Support Number	Support Type	х	Y	Z		
1	Pinned 🔽	V	V			
2	Roller 🔽		<b>v</b>			
				OK	Apply	Cancel

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The Compute from Typical Section button on the Live Load Distribution window to calculate the distribution factors cannot be used until we have selected the beam shape in the Beam Details window. At this point, Virtis/Opis does not know if we have spread or adjacent beams. We will select the beam shape now in the Beam Details window and then come back to the Live Load Distribution window. Double click on Beam Details in the tree to describe the beam details. Enter the following beam details information.

(in) 0 5.0000	

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Note that the Stress Limit Ranges are defined over the entire length of the precast beam.

eam Del	tails						_
pan Detai	Stress Limit Ranges	ilab Interface					
Span Number	Name	Start Distance (ft)	Length (ft)	End Distance (ft)			
1 🔽	Beam Stress Limits 🛛 🔽	0.00	60.33	60.33			
					New	Duplicate	Delete
					ОК	Apply	Cancel

Since we do not have a concrete deck for this structure definition, we do not need to enter any information on the Slab Interface tab.

Click OK to save the Beam Details data to memory and close the window.

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Now double click on Live Load Distribution in the tree to enter the following live load distribution factors. Click OK to save data to memory and close the window.

Lanes		Distributio (Whe			
Loaded	Shear	Shear at Supports	Moment	Deflection	
1 Lane			0.547		
Multi-Lane			0.597		
Compute fron Typical Secti					

Note: The AASHTO live load distribution factor for concrete T-Girder used in the analysis.

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Expand the tree under Strand Layout and open the Span 1 window. This window allows you to define a prestress strand layout for a prestressed concrete beam span. Prestress strand layout can be described either by the actual strand locations or the prestress force (jacking force) and eccentricity (center of gravity) of the group of strands. Select P and CGS only for the Description Type. Enter the following Strand Layout information for Span 1. Press F1 while on this tab to view the strand layout help topic describing the use of this information.

🙈 Strand Layout - Spa	n 1	
<b>陶 및 田 당 日</b>		
Description Type P and CGS only	O Strand	s in rows
Left harp pt. dist. (X1):	24	ft
Left harp pt. radius:	0.0001	in
Right harp pt. dist. (X2):	24	ft
Right harp pt. radius:	0.0001	in
Force:	268.26	kip
Left CGS:	22.0000	in
Mid CGS:	4.0000	in
Right CGS:	22.0000	in
ок [	Apply	Cancel

Since this structure does not have a cast in place deck, the Deck Profile and the Haunch Profile information is not required.

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The Shear Reinforcement Ranges are entered as described below.

Numper	ital Name	Distance xtends into Deck	Start Distance	acing			End	
Number	Name	into	Distance	Number of	Creation		End	
1 🔽 #3 Sh	ear Reinf 🔽		(ft)	Spaces	Spacing (in)	Length (ft)	Distance (ft)	
			1.67	57	12.0000	57.00	58.66	
						New Du	uplicate	Delete
					[	ОК	Apply	Cancel

The description of an interior beam for this structure definition is complete.

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The BRASS LFD engine data for the member alternative is shown below.

Member Alternative Description	
Member Alternative: PS Tee Girder	
Description Factors Engine Import	
Configure engine properties for analysis module: BRASS LFD	
Analysis Load Sequence: Computed based on loadings and comp Points of Interest Control: 1 - Generate points of interest at all tent Wheel Advancement: 100 P/S modeling method: Centerline of simple-span bearing Use P/S beam overhangs. Use maximum moment in span to compute fcir. Omit strands for moment capacity if within Distance from top of girder (+M): 0.000000 (in) Distance from bottom of girder (-M): 0.000000 (in)	]
OK Apply Cance	el

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#### The results of the LFD/ASD rating analysis are as follows:

		-			£	1			0 11				
Live Load	Live Load Type	Design Method	Inventory Load Rating Ton	Operating Load Rating Ton	Inventory Rating Factor	Operating Rating Factor	Inventory Location ft		Operating Location ft	Opera Loca Span-	tion	Inventory Limit State	Operating Limit State
IS 20-44	Axle	LFD	30.47	50.88	0.846	1.413	29.75	1 - ( 50.0)	29.75	1-(3	50.0)	ULTIMATE MOME	ULTIMATE MOME
IS 20-44	Lane	LFD	43.96	73.41	1.221	2.039	29.75	1 - ( 50.0)	29.75	1-(\$	50.0)	ULTIMATE MOME	ULTIMATE MOME
olorado Permit Vehic	e Axle	LFD		86.06		0.896			29.75	1-65	50 M)		ULTIMATE MOME

🕰 Analysis Results - I	PS Tee Gii	rder										
Report Type Rating Results Summa	ry <mark>-</mark>	]										
Live Load	Live Load Type	Design Method	Inventory Load Rating Ton	Operating Load Rating Ton	Inventory Rating Factor	Operating Rating Factor	Inventory Location ft	Inventory Location Span-(%)	Operating Location ft	Operating Location Span-(%)	Limit State	Operating Limit State
HS 20-44	Axle		29.17	31.09	0.810	0.864	29.75	1 - ( 50.0)	29.75	1 - ( 50.0)	BOTTOM FLANGE	BOTTOM FLANGE
HS 20-44	Lane	ASD	42.08	44.86	1.169	1.246	29.75	1 - ( 50.0)	29.75	1 - ( 50.0)	BOTTOM FLANGE	BOTTOM FLANGE
BRASS-GIRDER - Versi	ion 5.08.03	- May, OS	9, 2001									
												Close

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110111 1, 2002		Page 140 OL 140

COLORADO DEPARTI LOAD FACTOR Rated using Asphalt thickness:		Structure # L-26-BR State highway # 50 Batch I.D.						
Colorado legal k Interstate legal k	bads	_ ,		Structure type         CDTPG           Parallel structure #				
Structural member	INTERIOR GIRDER DBL-TEE							
	Metric tons (Tons)							
Inventory	26.4 ( 29 )		( )	(	)	(	)	
Operating	46.4 ( 51 )		( )	(	)	(	)	
Type 3 truck	( )		( )	(	)	(	)	
Type 3S2 truck	( )		( )	(	)	(	)	
Type 3-2 truck	( )		( )	(	)	(	)	
Permit truck	78.2 ( 86 )		( )	(	)	(	)	
Type 3 Truck Interstate 21.8 metric Colorado 24.5 metric	tons (24 tons)	Type 3S2 Interstate 34.5 m Colorado 38.6 m	Truck netric tons (38 tons) etric tons (42.5 ton	s)	ype 3-2 Tr terstate 5.4 metric tons (3 blorado .6 metric tons (4	39 tons)		
		- <b>'00</b> r	00	<b>••••</b> ••	0		Ö	
Metric tons Tons Comments	s Meti	ic tons	Tons	Metr	ic tons	Tons		
Load Capacity: 51 Girder: Only Interior								
Color Code: Orang	ge							
Project No: FC 050	- 5(16)							
Rated by	Da	te	Checked by			Date		

Previous editions are obsolete and may not be used

CDOT Form #1187a 1/95

# SECTION 9B

DOCT TENCIONED	CONCRETE	CIDDED	DDIDCEC
POST-TENSIONED	CUNCKEIE	UKDEK	DRIDUES

	SUBJECT.	Page No.
9 <b>B</b> -1	INTRODUCTION TO RATING POST-TENSIONED CONCRETE GIRDER BRIDGES	9B.2
9B-2	POLICIES AND GUIDELINES FOR RATING POST-TENSIONED CONCRETE GIRDER BRIDGES	9B.3
9B-3	GUIDELINES FOR USING STAFF BRIDGE COMPUTER PROGRAMS	9B.5
9B-4	RATING POST-TENSIONED CONCRETE GIRDER BRIDGES DESIGNED BY LOAD FACTOR METHOD	9B.6
9B-5	POST-TENSIONED CONCRETE GIRDER BRIDGE RATING EXAMPLES	9B.7
9B-5a	CSGCP EXAMPLE	9B.8
9B-5b.	CBGCP EXAMPLE	9B.48

### 9B-1 INTRODUCTION TO RATING POST-TENSIONED CONCRETE GIRDER BRIDGES

This section, with section 1, presents the policies and guidelines for rating post-tensioned concrete girder bridges.

The types of girders covered by this section include cast-in-place, post-tensioned girders as described below:

- A. CBGP Concrete Box Girder Prestressed
- B. CSGCP Concrete Slab and Girder Continuous Prestressed
- C. CSGP Concrete Slab and Girder Prestressed
- D. CBGCP Concrete Box Girder Continuous

Prestressed

#### <u>9B-2 POLICIES AND GUIDELINES FOR RATING POST-TENSIONED CONCRETE GIRDER</u> <u>BRIDGES</u>

- I. GENERAL
  - A. It is recommended that the rater use the FRAME computer program (CALFRAME) also called BDS to analyze post-tensioned girders. Refer to subsection 9-3 and the FRAME (BDS) users' manual for guidelines on the use of this program.
  - B. The rater will be responsible for determining whether stress-relieved or lowrelaxation strands were used in the bridge. If it is not possible to determine what type of strand was used, then the rater is to assume that stress-relieved strands were used prior to December, 1983, and low-relaxation strands thereafter. Posttensioned concrete girder bridges with considerable horizontal curvature, skew, or other influences which increases the amount of stress/strain on the structure, may be modeled as simple, straight beams on pin or roller supports. The FRAME program (or BDS)output results can then be supplemented by hand calculations to account for these effects, as necessary.

#### II. GIRDERS REQUIRING RATING

- A. Interior Girders A rating is required for the critical interior girder. More than one interior girder may require an analysis due to variation in span length, girder size, girder spacing, number of post-tensioning strands, differences in loads or moments, etc.
- B. Exterior Girders An exterior girder shall be rated under the following guidelines.
  - 1. When the section used for an exterior girder is different from the section used for an interior girder.
  - 2. When the overhang is greater than S/2.
  - 3. When the rater determines the rating would be advantageous in analyzing the overall condition of a structure.
- C. In lieu of rating individual girders, the rater may use the entire superstructure

cross-section for the rating analysis.

#### III. CALCULATIONS

A. A set of calculations, separate from computer output, shall be submitted with each rating. These calculations shall include derivations for dead loads, derivations for live load distribution factors, and any other calculations or assumptions used for rating. The rater may also indicate whether stressrelieved or low-relaxation strands were used in the rating calculations.(may not make much difference except for balanced cantilever segmental).

The examples in Section 9B-5 of this manual show the minimum calculations required to rate a post-tensioned concrete girder bridge. These calculation sheets are to be filed in the structure folder.

- B. Dead Loads
  - 1. The final sum of all the individual weight components for dead load calculations may be rounded up to the next 5 pounds.
  - 2. Dead loads applied after a cast-in-place concrete deck has cured shall be distributed equally to all girders and, when applicable, treated as composite dead loads. Examples include asphalt. curbs. sidewalks. railing. etc.
  - 3. Use 7 psf (or as appropriate per Colo. Standard Specs & Design manual)for the unit weight of formwork for a distance equal to center-to-center of exterior girder measured along the top slab it is for stay in place forms. For closed cell construction, such as cast-in-place concrete box girders. No additional weight will be used for stay-in-place steel deck forms.
  - 4. Dead loads applied <u>before a cast-in-place concrete deck has</u> <u>cured</u> shall be distributed to the applicable individual supporting girders and treated as noncomposite loads. Examples of this type of dead load are deck slabs, girders, diaphragms, and fillets. In the case of continuous shoring these dead loads are typically applied at the time of the post-tensioning.
  - 5. The method of applying dead loads due to utilities is left to the rater's discretion.
- C. Continuous Bridges

Secondary moment effects due to post-tensioning shall be included in rating calculations.

## IV. REPORTING RATINGS

The rater and checker shall complete the rating documentation as described in Section 2, of this manual. The rater shall include the Batch I.D, computer runs and all relevant information for the structure being rated.

#### 9B-3 GUIDELINES FOR USING STAFF BRIDGE COMPUTER PROGRAMS

- I. CODING FRAME (CALFRAME "BDS")
  - A. Composite dead loads are coded as "Trial 01" loads.
  - B. Noncomposite dead loads are coded as "Trial 00" loads except that the program will calculate dead load moments due to slabs and girders from the coded structure geometry.
  - C. When using FRAME and coding prestressed data, the jacking force shown on the plans is to be entered into the P-JACK columns of card type 600 (7315 for the old FRAME program) when rating the entire cross-section. Additionally, a note similar to the following may appear in the plans, P-JACK SPECIFIED AT THE JACKING ENDS INCLUDES FRICTION AND ELASTIC SHORTENING LOSSES AND PROVISIONS FOR AN ADDITIONAL XX KSI IN LONG TERM LOSS IN STRESS". The value XX from this note should be coded into the LOSSES column of card type 600 (7315). For the long term losses, the rater has the option to use AASHTO's lump sum losses or calculate them based on AASHTO's loss equations.

NOTE:

Cal-Frame (BDS) program uses your input numbers for sorting purposes, therefore (0.00 is not taken as equal to 00.00 or 6.0 and 6.00 may not be interpreted the same) it may produce errors in the output when a consistent decimal format is not followed. Specific data should be repeated for each member on each input card when it is different from default values.

## II. CONTINUOUS BRIDGES

When using FRAME, the secondary moment(s) should be calculated using the program output as shown in the examples.

## <u>9B.4 RATING POST TENSIONED CONCRETE GIRDER BRIDGES DESIGNED By</u> LOAD FACTOR

All POSTENSIONED structures should be checked for serviceability requirements at the inventory level and checked for strength requirements for both inventory and operating levels, All as stated in the AASHTO Design Specifications (Article 9.17). The inventory rating value shall be the smaller of the serviceability or the strength requirement rating results. The operating shall be 5/3 of the strength requirement rating for all LFD operating ratings When checking the serviceability limit state the DL and the LL are unfactored in the rating equation.

# 9B-5 POST-TENSIONED CONCRETE GIRDER BRIDGE RATING EXAMPLES

This section includes examples for rating of the Post-Tensioned bridges that are already under service. The examples are structures located on interstate 76 and 70.

#### 9B-5a CSGCP EXAMPLE

This is a 3 span Concrete Slab Girder Continuous Post-Tensioned structure. It consists of three horizontal members and two vertical members. Members have left and right end joint associated with them and are connected together by specifying the appropriate joint numbers. BDS or the new version of California Frame program is used to model the structure. The Colorado Permit Truck with (8) Axles for a total of 192,000 lbs (96 tons) is utilized for the purpose of Color coding of this structure and as a means to provide an example.

Rated using Asphalt thickness: Colorado legal (1) Interstate legal	oads	in.)	State highway # 76 Batch I.D. J83005 Structure type CSGCP Parallel structure # E - 16 - I0			0
Structural member	GIRDER	SLAB				
	Metric tons (Tons)					
Inventory	34.0(37.5)	34.4 (37.	.9)	(	)	(
Operating	59.4 (65.5)	57. 4 <b>(</b> 63	.2)	(	)	(
Type 3 truck	( )	(	)	(	)	(
Type 3S2 truck	( )	(	)	(	)	(
Type 3-2 truck	( )	(	)	(	)	(
Permit truck	87.8(%.8)		)	(	)	(
Type 3 Tru Hearing 21.8 mm Colorado 24.5 mm O		Type 3S2 Truc Linearchate 34.5 matric to Colorado 38.6 matric to OOO	ns (38 tons)	L Intern 354 Cotor	metric tons (39 ton rado metric tons (42.5 to OC	
Comments	PROJ 176-1(8	4)	· · · · · · · · · · · · · · · · · · ·			
	Designated C Basedon nation		overloo permit	d map : Truck @	WHI oper	TE.
				· · · · · · · · · · · · · · · · · · ·		
			ecked by			Date
Rated by D. t.	s signature	ate 🔬 Chi		er's Sign		A CONTRACTOR OF THE OWNER OF THE

DEPARTMENT OF HIGHWAYS DIVISION OF HIGHWAYS STATE OF COLORADO DOH Form 709 July, 1985	CONCRETE SLAB RATING		
DESCRIPTION	INPUT	UNITS	CARD IMAGE COLS.
LOAD TYPE:			1
1 = Colo. Trucks 2 = Interstate	.2		
STRUCTURE NUMBER:	E 1. 6 I.N		2 - 8
RATER:	,M ,M,		9 - 11
HIGHWAY NUMBER:	7,6		12 - 14
BATCH I.D.:	1,8,3,0,0,5		15 - 20
COMMENTS:	$E_{-}, I_{-}, G_{-}, I_{-}, P_{-}, A_{-}, R_{-}$		21 - 41
EFFECTIVE SPAN LENGTH:		FEET	42 - 46
ACTUAL SLAB THICKNESS:	8.5.0.0	INCHES	47 - 51
EFFECTIVE DEPTH:	5.6,2,5	1	52 - 56
TOP STEEL AREA:	0.9.6	1	57 - 59
ASPHALT OVERLAY:	4.0.0		60 - 63
INV Fc (f'c load factor):	4,5,0,0		64 - 67
INV Fs (Fy load factor):	.4,0,0,0,0		68 - 72
INV MODULAR RATIO:		Es/Ec	73 - 74
(load factor method: leave blank)			
DEPTH TO BOTT. REIN .:	,1.3,8	INCHES	5 75 - 77
BOTT . STEEL AREA:	,0.9,6		78 - 80
1/4 S Flange EFF. SPAN LENGTH & GIRDER	1/4 © STRINGER	S EFF SPAN	
S Eff Span Length	Girder $= \frac{S}{SIN\Theta}$ Compression Steel Girder Girder Girder	<b>ç</b>	Bituminous Overlay Slab thickness (max.) istance from Bottom to Top Reint. Effective Depth)

Girder

Distance from Bottom to & Bottom Reinf.

Slab Steel

1.0	
NG Version	15/02/24
B RATING	DATE: 5
SLAB	

STRUCTURE NO. E-16-IN RATER: MM STATE HWY NO. = 76 BATCH ID- 183005 DESCRIFTION: E-16-IO PAR & SIMILAR LOAD FACTOR RATING-COMP STEEL NOT USED---LOAD FACTOR RATING-COMP STEEL NOT USED

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				1895.24 30011.93 8158.58 13.30
625	N) = 4.00 4500. 40000.			189 3001 815 1 1
EFF. DEPTH(INS)= 5.625	WEARING SURFACE (IN) = 4.00 4500. OPER= 4500. 40000. OPER= 40000.			OPERATING 1222.95 19365.92 5264.52 15.00 13.30
		AS196	1.31 K-FT 5.82 K-FT 36.0 TONS	INVENTORY S (PSI) TRESS (PSI) RESS (PSI) (K-FT)
9.200	.96 500 SI) INV- SI) INV-	AS		INVF STRESS EEL STRES EL STRESS (LL+I)
EFF.SPAN(FT)=	REINF. (SQ. IN) = .96 SLAB TK(IN) = 8.500 CONC. STRENGTH(PSI) STEEL YIELD (PSI)	ß	DEAD LOAD MOMENT LL+I MOMENT GROSS WEIGHT	INVEN' ACTUAL CONCRETE STRESS ACTUAL REINF, STEEL STRESS ACTUAL COMP. STEEL STRESS MEMBER CAPACITY MEMBER CAPACITY (LL+1)
EFF. SP	REINF. ( SLAB TK CONC. S STEEL	N= 8. D1= 1.38	DEAD LOAD MO LL+I MOMENT GROSS WEIGHT	ACTUAL ACTUAL ACTUAL MEMBER MEMBER

Rater's Synatum & Date

Checker's Signature & DATE

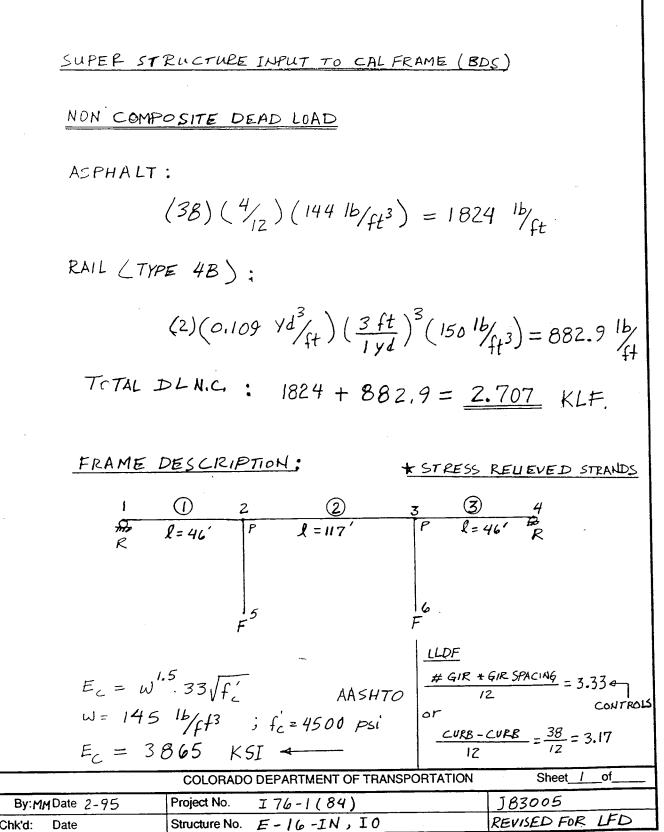
63.23

37.94

( TONS )

RATING

COLORADO DEPARTMENT OF TRANSPORTATION DESIGN COMPUTATIONS



CDOT Form #1034 1/93

COLORADO DEPARTMENT OF TRANSPORTATION DESIGN COMPUTATIONS

	INVENTOR	Y RATING	G (STRE	ESSES):				
	STRESES	FROM C.	ALFRAM	1 ( <b>B</b> DS)	EUN PG	. 14,16,	38,46	
	RATING	$= \frac{CAP}{A_2(LL)}$	- A,DL +I)	,	A,=A2 =1			
						00 Psi		ے ک ا { د
	CAP =	$= 6\sqrt{f_c}$	= 6	√4500	= -	402 PS	( 9.15.2	.45
		POINT	мом	LL+I <sub>K20</sub>	PSI DL+P	CAPACITY	TON RATING INV	
	TOP		i		+727		85.5	
	BOTT.	2.5	(+)	-1255	+904	- 402	37.5	
	INV <sub>TOP</sub> =	<u> 1800 - 7</u> 452	27_*	= 36 = 1	85.5	TON.		
	INV <sub>BOT</sub> =	- 402 - - 12 :	904 55	*36 =	37.5	TON		
-					PSI		TON	
		POINT	MOM	LL+I <sub>HS2</sub>	DL+P	CAPACITY	, RATING INV.	
	TOP	3.0	$\langle - \rangle$	- 303	+441	-402	100.0	
	Bott.	3.0	()	+735	+949	+1800	41.7	
	L							
		COLO	RADO DEF	PARTMENT	F TRANSPOR	RTATION	Sheet_2	_of
	1Date 2/95	Project N		$\frac{6-1(84)}{51}$	To		J 83005 REV. FOR 4	FD.
Chk'd:	Date	Structure	NO. E	-16-IN,	LU			erm #1034 1/9

COLORADO DEPARTMENT OF TRANSPORTATION DESIGN COMPUTATIONS

$$INV_{TOP} = \frac{-402 - 441}{-303} * 36 = 100.0 \quad TONS.$$

$$INV_{BOT} = \frac{1800 - 949}{735} * 36 = 41.7 \quad TONS.$$

$$INVENTORY \notin OPERATING RATINGS (LOAD FACTOR MOMENTS):$$

$$FROM \ CALFRAME (BDS) \ PG. \ 8, 11, 14, 16, 30.$$

$$\frac{RATING @ 2.5 \ LOCATION}{A_{S}^{*}} = 33.9 \ In^{2}$$

As in bottom half of section = 7.4 
$$in^2$$
  
As in top half of section = 27.3  $in^2$ 

Ms = PJ \* (DEM's; from calframe & interpolate for each point)

$$M_{s_{2.5}} = 6865 \pm 0.813 = 5581.2 \ k-ft$$

$$M_{S_{3,0}} = 6865 \times 0.813 = 5,581.2$$
 K-ft

	COLORADO DEPARTMENT OF TRANSPORTATION	Sheet 3_of
By:MM Date 2-95	Project No. 176-1 (84)	J83005
hk'd: Date	Structure No. E -16-1N,	REVISED FOR 4FD

			ĸ	-ft	ir	٦.	То	N	
P	OINT	MDLØ	MDL1	MLL+IHRO	Ms	d	Ь	INV.	OPR.
	2.5			+3236		38	492	70.1	116.8
	3.0	-8385	+	- 4716					63.8

AT 2.5 Check Point

$$F_{Su}^{*} = f_{S}^{'} * \left\{ 1 - 0.5 \left[ (A_{S}^{*} * f_{S}^{'}) - (A_{S_{ToP}}^{-} A_{S_{BOT}}) \cdot f_{Y} \right] / (f_{L}^{'} * b * d) \right\}$$

$$F_{Su}^{*} = 270 \left\{ 1 - 0.5 \left[ (33.9 * 270) - (27.3 - 7.4) * 60 \right] / (4.5 * 492 * 38) \right\}$$

$$F_{Su}^{*} = 257.23 \text{ KSI}$$

$$a = \left[ F_{Su}^{*} * A_{S}^{*} - (A_{S_{TOP}}^{-} A_{S_{BOT}}) * f_{Y}^{*} \right] / (0.85 f_{L}^{'} b^{'}) \leq \binom{(0.3d)}{\beta} = 13.82 \right]$$

$$a = \left[ 257.23 * 33.9 - (27.3 - 7.4) * 60 \right] / (4.5 * 8.5 * 492)$$

$$a = 4.0^{''} < 8.5^{''} < 0.3d_{\beta} = 13.82$$

$$M_{\eta} = \left[ A_{S}^{*} * F_{Su}^{*} + (A_{S_{BOT}}^{*} * f_{Y}^{*}) \right] \cdot \left[ d - \frac{a}{2} \right]$$

$$M_{\eta} = \left[ (33.9 * 257.23) + (7.4 * 60) \right] \cdot \left[ 38 - 4.0 / 2 \right] \div 12$$

$$M_{\eta} = 27,492.3 \text{ K-ft}$$

	Sheet_4_ot	
BymMDate 2-95	Project No. 176-1(84)	J83005
Chk'd: Date	Structure No. E - 16 - IN, IO	REV. FOR LFD.
		CDOT Form #1034 1/93

Chk'd:

Date

$$INV = \frac{0.95 M_{M} - 1.3 (MDL4 + MDL1) \pm 1.0 + M_{5}}{(2.16607 * M_{L+1})}$$

$$INV = \frac{0.95 \times 27492.3 - 1.3 (3B31 + 1463) - 5581.2}{2.16667 * 3236} * 36$$

$$INV = 70.1 \text{ Ton}$$

$$OPR = \frac{5}{3} (INV) = 116.8 \text{ Ton}$$

$$AT 3.0 \text{ check Point}$$

$$F_{su} = 270 \{ 1-0.5[(33.9 \times 270) + (27.3 - 7.4) \times 60] / (4.5 \times 60 \times 60) \}$$

$$F_{su} = 188.3 \text{ KSI}$$

$$a = [188.2 \times 33.9 + (27.3 - 7.4) \times 60] / (4.5 \times 6.85 \times 60)$$

$$a = 33.0 > 0.3 d/_{B} = 21.82 \text{ over an } E \text{ in } F_{c} = 100 \text{ over a } F_{c} = 221 \text{ over a } F_{c} = 100 \text{ over a } F_{c} =$$

REV. FOR LFD. CDOT Form #1034 1/93

E-16-IN, IO

Structure No.

## COLORADO DEPARTMENT OF TRANSPORTATION DESIGN COMPUTATIONS

Rechecking locati	on 2.5 (u	sing AASHTO Section	ons 9.17, 9.18 and 9.19)
-For flexural stre		ر. 	
		4″	$-492'' - A_{s} = 27.3 \text{ in}^{2}$
1* 24		/	
$P^* = \frac{34}{492 \times 38} =$	0.001819		
			$d_t = 35^{\circ} d = 38^{''}$
$P = \frac{7.4}{492 \times 35} =$	0.00043	46"	
492 <b>*</b> 35			
∧1 2 <b>7</b> 3			
$P' = \frac{27.3}{492 * 34} =$	0.001632	$A_{5} = 7.4 m^{2}$	
		$r_{s} = r_{s} = m$	$A_{S}^{*} = 34 \ln^{2}$
f <sub>c</sub> = 4500 p	S L	8 <sup>*</sup> = 0.40	for stress relieved.
$f_y = f'_y = 60$ H	KSL		$0.05(f_c'-4.0)$
f <sub>s</sub> ' = 270 к	í si		, φ=0.95
$E^{*} = C' \Sigma_{L} X$	1 P*fs	$dt = a f + \sqrt{7}$	<b>H H L L L L L L L L L L</b>
$r_{Su} = F_S \left[ I - \frac{1}{B_1} \right]$	$\left({+}\right)$	$\frac{d}{d} \left[ \frac{f_{a}}{f_{a}} \right] \qquad (A$	*fsu +Аsfsy)/(0.85f2́Ь) <t td="" ок<=""></t>
$F_{su}^{*} = 270 \left[ 1 - \frac{0.4}{0.82} \right]$	<u>(0.00/819</u>	<u>*270</u> + <u>35</u> * 0.0043	$\left(\frac{60}{4.5}\right) = 255.0 \ ksc$
		Per AASHTO (9-24)	
S/Pfsy ) dt /P*	$f_{\pi}$		
$\left(\frac{f'_{f}}{f'_{f}}\right)_{d} + \left(\frac{f'_{f}}{f'_{f}}\right)_{d}$	$\left(\frac{1}{r}\right) - \left(\frac{r}{r}\right)$	$\neq \leq 0.36 B_{i} = 0.30$	⇒ 0.0879 <0.3 0K
1 b A*E	ي. بر بال *	P*fst d+ Pfulling	AASHTO
$\varphi M_n = \varphi \left\{ A_s r_s \right\}$	u a [ 1 - 0.6 (	$f_c = \frac{f_c}{f_c} + \frac{g_c}{f_c} + \frac{g_c}{f$	$d_{t}\left[1-0.6\left(\frac{d}{d_{t}}\frac{P^{*}F_{su}^{*}}{F_{c}^{'}}+\frac{P}{f_{sy}}\right)\right]\right] \xrightarrow{AASHTO}{\underline{9-13a}}$
$M_u = \Phi M_n =$	25530	K-ft	
@ 25 M	- 2021 1	-1463 = 5294.0	K - £+
		-	<-ft .
	= 5581.	-	•
M <sub>LL+</sub>	I = 3236	k	:-ft
Rthur 255	530.0 - 1.3	(5294,0) - 5581.2	- +36 = 67.0 TON
·-TINK	2.166	(5294,0) - 5581.2 7 * 3236	
R OPR = (67	.0) * 5/		= 111.8 TON
. * ANSWERS CLOSE	13	EST RESULTS.	
By:MMDate		I76-1(84)	Project code (SAS): REV. LFD 95
Chk'd: Date	Structure no.	E-16-IN, IO	Sheet 6 of

CDOT Form #1034 1/95

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COLORADO DEPARTMENT OF TRANSPORTATION DESIGN COMPUTATIONS

Rating @ 3.6 will similarly be:  

$$R_{ENV} = 47 \text{ TON} \quad \ \ R_{OPR} = 91 \text{ Tan}$$
  
Permit truck Rating: (LL #4 BDS.Calframe Fun Poge 29(31))  
(LL+I) @ 2.5 =+5266 K.ft  
(LL+I) @ 3.0 = -9220 K.ft  
@ 2.5  
 $R_{OPR} = \frac{25530 - 1.3 (5294.0) - 5581.2}{1.3 \times 5266} \times 96 = 180.9 \text{ Ton}$   
 $R_{CRR} = \frac{20.593.6 - 1.3 (11.554) + 5581.2}{1.3 \times 9220} \times 96 = 89.36 \text{ Ton}$   
 $R_{OPR} = \frac{20.593.6 - 1.3 (11.554) + 5581.2}{1.3 \times 9220} \times 96 = 89.36 \text{ Ton}$   
 $R_{OPR} = 89.36 \times \frac{6.5}{6.0} = 96.8 \text{ TonS}$   
 $Color = WHITE$   
\* note: Location 3.0 Can also be rated similar to procedure  
 $used to rote location 2.5 (Using AASHTO suctions 9.17, 9.18, 9.19),$   
non prestressed steel (only in Compression) was added to reflect  
Actual Conditioned interface.  
By:MMDate U-95 [Projection: I76-1(24)]

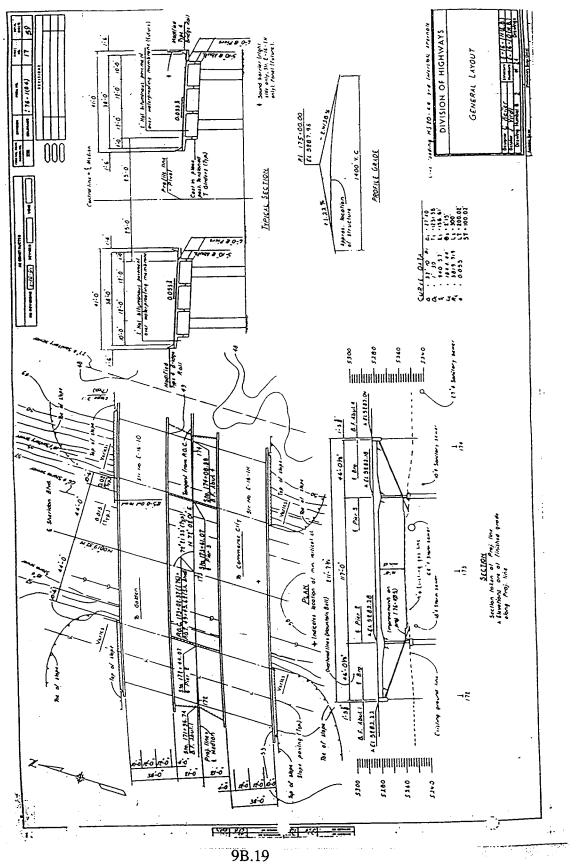
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Sheet 7 of

Structure no. E-16-IN, IO

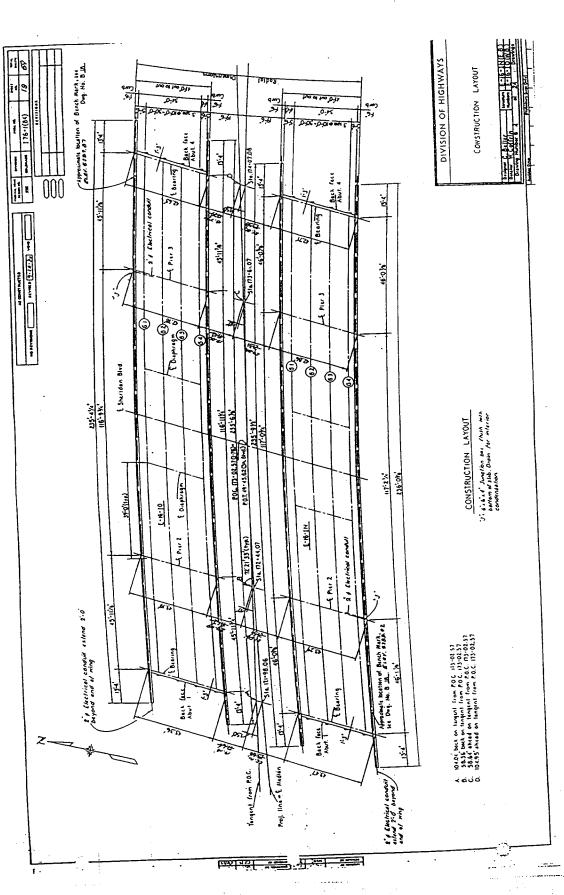
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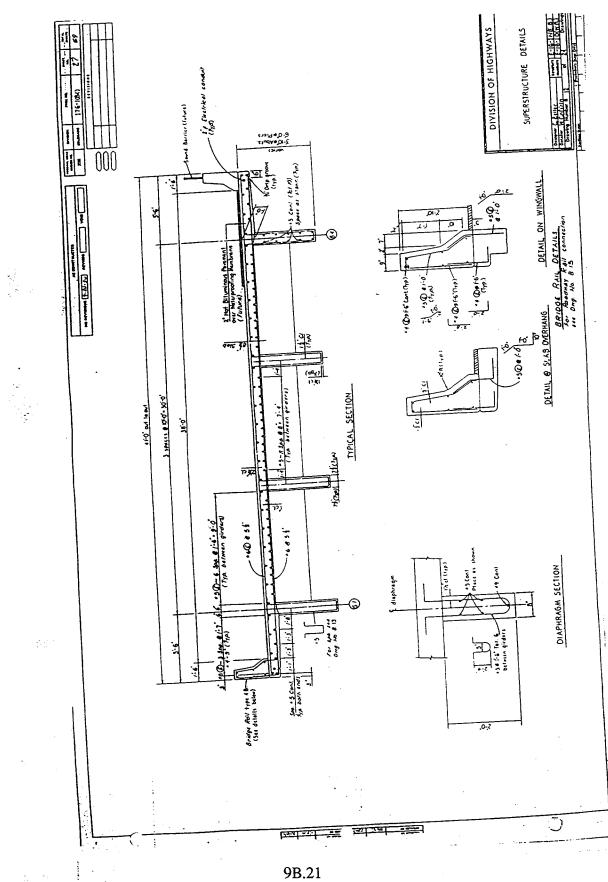
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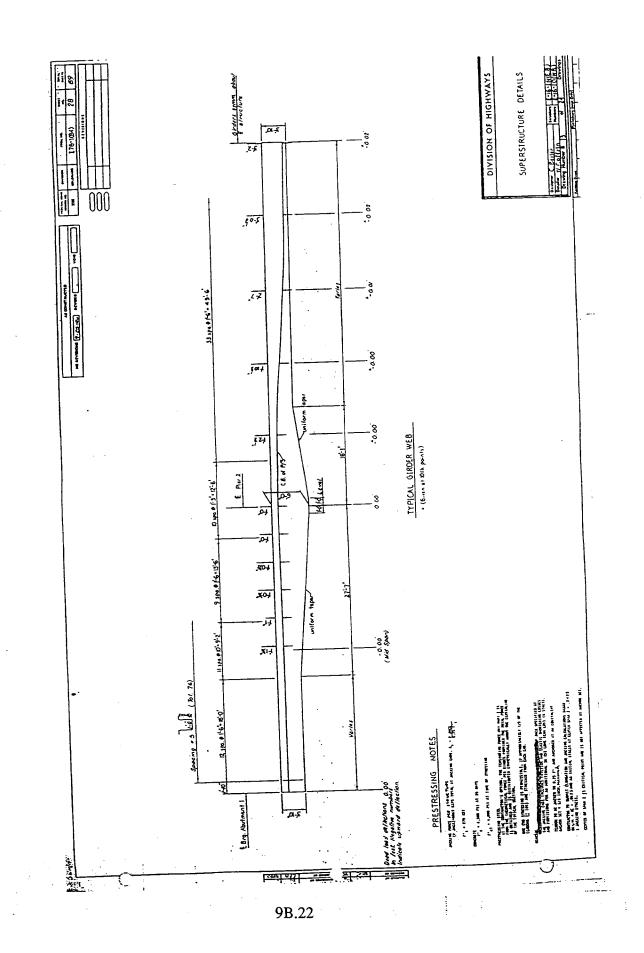
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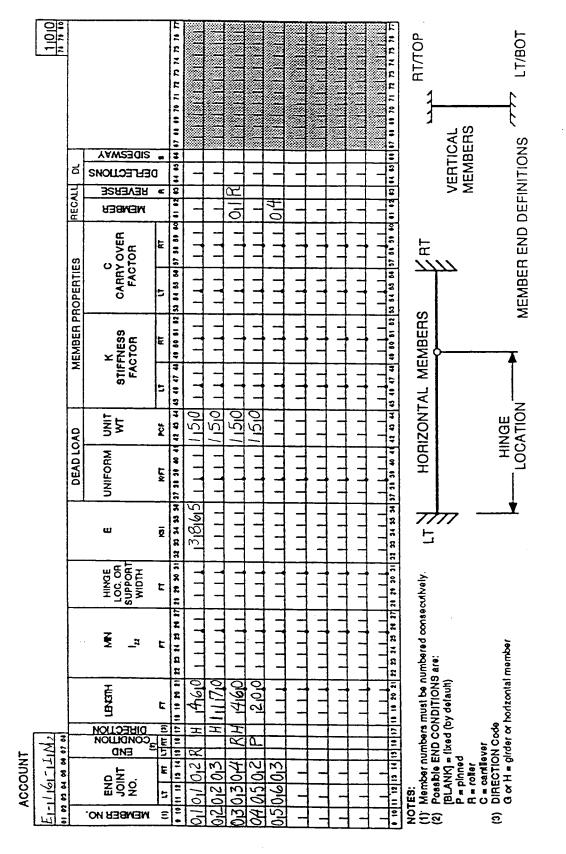
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SUPERSTRUCTURE DATA 200 FORM

9B.26

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July 1995

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### CDOT:BRIDGE RATING MANUAL

9B.28

July 1995

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	LANE	UNIFORM LOAD	10 20 20 21 3			1016140			1111			1111			ES: LIVELOAD DATA - For AASHTO H920-44 Loading, leave TRUCK and LANE data blank for L.L. No. 1. When this data is given, it replaces the H920-44 Loading. An entry for the NUMBER OF LIVE LOAD LANES overrides that given on MEMBER DATA (400 form). Data entries for L.L. No.'s 2 and 3 produce separate results in addition to L.L. No. 1
		٩	11 11 14 16	-		1312.0	4	4 1 1		4 1 1	4 1 1		1		D HS20-44 No. 1. W ng. LIVE LOAC 0 form). nd 3 prod
	(E)	á	E 2	-		3,0,0	4	1		-	4	4			VASHT r L.L. Load R OF 1 TA (40
	TRUCK (1 LANE)	م"	540		2,4,0	13/2.0					1				ES: LIVE LOAD DATA - For AASHTO H and LANE data blank for L.L. No. It replaces the MS20-44 Loading. An entry for the NUMBER OF LIV given on MEMBER DATA (400 f Data entries for L.L. No.'s 2 and addition to L.L. No. 1
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ACCOUNT		۵_			2,4,0		-	1			1	1.1			NOTES: (1) LIVELOAD DATA - For AASHTO HS20-44 Loading, leave TRUCK and LANE data blank for L.L. No. 1. When this data is given, it replaces the HS20-44 Loading. (2) An entry for the NUMBER OF LIVE LOAD LANES overrides that given on MEMBER DATA (400 form). (3) Data entries for L.L. No.'s 2 and 3 produce separate results in addition to L.L. No. 1
		ON UAD LEV	<u> </u>	1-	10	M	1	L	<u>.</u>	<u> </u>	I	<b>I</b>	<u> </u>	-1	

# 401 FORM • • LIVE LOAD TRUCK AND LANE DATA

9B.30

500 • • DATA LIVE LOAD GENERATOR MEMBER

FORM

	ACCOUNT E1-11 (61-1/1)	1					51010.
1	NUMBE	NUMBER OF LIVE LOAD LANES	OAD L	ANES	*		
ON 8	SUPER	SUPERSTRUCTURE	SL 9TRU(	SUB- STRUCTURE	ROTO		
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1	10 11 12 13 14 15	10 17 18 10 20	a u 18	2	10 10 10 10 10 10 10 10 10 10 10 11 11 1	7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	
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	NOTES						

NOTES: (1) FRAME DESCRIPTION data with the horizontal members numbered consecutively starting

- 3
- with 01 must accompany this data. When the NUMBER OF LL LANES is given, it must be given for the left end of Superstructure Member 01. Thereafter, it is assumed to be constant until another entry is made. Substructure Member 01 defaults to 1.0 when left blank. If a Cooper loading is to be given, % of impact to be applied to each member must be given. It will be used for Cooper loading only. C

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	CLASS E-10 ENGINE LUADING ONE TRACK OF TWO RAILS <u> </u>
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	on hy th 97 ax 97 ax 01 he 01 mr 16.
ACCOUNT E - 1 16 - 1 16 - 1 101 P1 01 P2 D2 P2 P2 P2 P2 02 P2 P2 P2 P2 02 P2 P2 P2 P2 P2 02 P2 P2 P2 P2 P2 P2 P2 02 P2	using only Up to 97 describe 1 NO. In coli 1 thru 16.

9B.32

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PRESTRESS DATA (1) : 600 FORM

* * 1	***************************************
*	IAI-BDS *
*	Bridge Design System * *
*	By: Imbsen and Associates, Inc. *
*	VERSION 4.0.1 25-AUG-93 *
***	
* * *	********************** Licensed to: Colorado DOT ********************************
1	LISTING OF THE SORTED INPUT FILE
+	
CARD	1 2 3 4 5 6 7 8
NUMBER	123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890
+	
1	E-16-IN, Structure E-16-IN ; CSGCP ; SH-76 ; Proj#I-761(84) ;M.MOHSENI 2/95 000
2 3	E-16-IN,010102R H 460 3865 150 100 E-16-IN,020203 H1170 3865 150 100
4	E-16-1N,030304 RH 460 3865 150 01R 100
5	E-16-IN,040502 P 200 150 100
6 7	E-16-IN,050603 150 04 100 E-16-IN,01 00 410 380 850 000 215015000015000 49 912 49 912 01 200
8	E-16-IN,01 18401 200
9 10	E-16-IN,01 450 410 600 850 000 215015000015000 49 912 49 912 02 200 E-16-IN,01 46002 200
	E-16-1N,02 0002 200
	E-16-IN,02 1002 200
	E-16-IN,02 16101 200 E-16-IN,02100901 200
15	E-16-IN,02116002 200
	E-16-IN,02117002 200 E-16-IN,03 0002 200
18	E-16-1N,03 0002 200 E-16-1N,03 1002 200
	E-16-IN,03 27601 200
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22	E-16-IN,04 20006 201
	E-16-IN,05 00006 201 E-16-IN,05 20006 201
	E-16-IN,0002 5400P 390 DIAPHRAGM 300
26	E-16-IN,0002         5400P         780         DIAPHRAGM         300           E-16-IN,0101         2707U         00         460         ASPHALT AND RAILS         300           E-16-IN,0102         2707U         001170         ASPHALT AND RAILS         300           E-16-IN,0103         2707U         00         460         ASPHALT AND RAILS         300
27 28	E-16-IN,0101 2707U 00 460 ASPHALT AND RAILS 300 E-16-IN,0102 2707U 001170 ASPHALT AND RAILS 300
29	E-16-IN,0103 2707U 00 460 ASPHALT AND RAILS 300
30 31	E-16-IN,01 3333 3333 27 27 400 E-16-IN,02 3333 3333 27 27 400
32	E-16-IN,03 3333 3333 27 27 400
33 34	E-16-IN,1 HS20-44 TRUCK 401 E-16-IN,2 240 40 240 MILITARY LOAD 401
35	E-16-IN,01 3333 3333 27 27 LIVE LOAD DISTRIBUTIONS FOR PERMIT TRUCK 500
36 37	E-16-IN,02 3333 3333 27 27 500
37	E-16-IN,03 3333 3333 27 27 500 E-16-IN,4 216 40 217 02501
39	E-16-IN,4 270140 250 40 250120 250 40 250350 217 40 08 COLD PERMIT 01501
40 41	E-16-IN,0110101005025 110 110 100 25 20 B 5 51 686545538601 600 E-16-IN,0110102205020 100 317 100 25 20 B 5 51 686545538601 600
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1	12345678901234567890123456789012345678901234567890123456789012345678901234567890
1IAI-BDS	Version 4.0.13 Licensed to: Colorado DOT Run time: 07-JUL-95
16:13:47	
Structure OFRAME DES	E-16-IN ; CSGCP ; SH-76 ; Proj#I-761(84) ;M.MOHSENI 2/95
UPICAME DEC	END SUPPORT CARRY OVER
MEM	JT. COND OR DEAD LOAD K FACTORS RECALL LT RT LT RT DIR SPAN I HINGE E UNI SEC LT RT LT RT MEM
	LT RT LT RT DIR SPAN I HINGE E UNI SEC LT RT LT RT MEM
1	1 2 R H 46.0 0.00 0.0 3865. 0.000 .150 0.00 0.00 0.00 0.00
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4	5 2 P 20.0 0.00 0.0 3250. 0.000 150 0.00 0.00 0.00 0.00
5 1 T A T - PD 9	6 3 0.0 0.00 0.0 3250. 0.000 .150 0.00 0.00 0.00 0.0 04
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	E-16-IN ; CSGCP ; SH-76 ; Proj#I-761(84) ;M.MOHSENI 2/95 PROPERTIES - INPUT
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01010	

**July 1995** 

+/- CODE V/D Y AREA E-STORE STORE H Ζ IZZ E 1 0.0 0.0 0.0 41.0 3.80 8.50 0.00 2 15. 0 15. 0.00 0 15. 0.00 4.9 9. 12. 4.9 9. 12. 3865. 01 1 18.4 01 \*\* RECALL ONLY 0.0 0.0 41.0 6.00 8.50 0.00 2 15. 0 15. 0.00 0 15. 0.00 4.9 9. 12. 4.9 9. 12. 3865. 1 45 0 02 \*\* RECALL ONLY 46.0 02 OSECTION PROPERTIES - OUTPUT OMEM NO LOC. DEPTH Z-BAR Y-BAR AREA IZZ IYY E 2.79 2.79 0 1 0.0 3.80 3.80 20.50 20.50 46.47 46.47 50.04 6523.55 3865.00 0 1 18.4 50.04 6523.55 3865.00 45.0 20.50 4.25 57.47 189.37 7895.40 0 1 6.00 3865.00 0 1 45.0 0 1 46.0 6.00 20.50 4.25 57.47 189.37 7895.40 3865.00 OMEMBER 1 PROPERTIES 0 LENGTH: 46.0 MIN E\*I: 0.193E+06 STIFF: 4.686 LT 10.071 RT C.O.: 0.810 LT 0.377 RT OSECTION PROPERTIES - INPUT 0MEM RE NO LOC. CALL Z D TOP BOT NO W T W FACT T W FACT L EX IN Y W L EX IN E STORE +/- CODE V/D Н 7. Y AREA TZZ E E-STORE STORE \*\* RECALL ONLY 2 0.0 02 \*\* RECALL ONLY 2 1.0 02 \*\* RECALL ONLY 2 16.1 01 \*\* RECALL ONLY 2 100 9 01 \*\* RECALL ONLY 2 116.0 02 \*\* RECALL ONLY 2 117.0 02 Version 4.0.13 Licensed to: Colorado DOT Run time: 07-JUL-95 1IAI-BDS 16:13:48 Page 3 Structure E-16-IN ; CSGCP ; SH-76 ; Proj#I-761(84) ;M.MOHSENI 2/95 **OSECTION PROPERTIES - OUTPUT** OMEM LOC. DEPTH Z-BAR NO Y-BAR AREA IZZ IYY Е 0.0 0 2 6.00 20.50 4.25 57.47 189.37 7895.40 3865.00 20.50 20.50 20.50 20.50 189.37 0 2 1.0 6.00 4.25 57.47 7895.40 3865.00 2.79 0 2 3.80 46.47 50.04 16.1 6523.55 3865.00 0 2 100.9 3.80 2.79 46.47 57.47 50.04 6523.55 3865.00 0 2 116.0 0 2 117.0 6.00 4.25 189.37 7895.40 3865.00 6.00 20.50 4.25 57.47 189.37 7895.40 3865.00 OMEMBER 2 PROPERTIES 0 LENGTH: 117.0 MIN E\*I: 0.193E+06 STIFF: 5.814 LT 5 814 RT C O : 0 596 LT 0 596 RT OSECTION PROPERTIES - INPUT OMEM RE NO LOC. CALL Z Y D TOP BOT NO W T W FACT T W FACT L EX IN W L EX IN Е STORE +/- CODE V/D Z н Y AREA TZZ E E-STORE STORE \*\* RECALL ONLY 3 0.0 02 \*\* RECALL ONLY 3 1.0 02 \*\* RECALL ONLY 3 27.6 01 \*\* RECALL ONLY 3 46.0 01 OSECTION PROPERTIES - OUTPUT OMEM NO LOC. DEPTH Z-BAR Y-BAR AREA IZZ IYY Е 03 0.0 6.00 20.50 4.25 57.47 189.37 7895.40 3865.00 1.0 6.00 20.50 20.50 189.37 4.25 2.79 03 57.47 7895.40 3865.00 27.6 3.80 03 46.47 50.04 6523.55 3865.00 3.80 2.79 03 46.0 20.50 46.47 50.04 6523.55 3865.00 0MEMBER 3 PROPERTIES 0 LENGTH: 46.0 MIN E\*I: 0.193E+06 STIFF: 10.071 LT 4.686 RT C.O.: 0.377 LT 0.810 RT OSECTION PROPERTIES - INPUT 0MEM RE NO LOC. CALL Z Y W D TOP BOT NO W T W FACT T W FACT L EX IN L EX IN E STORE +/- CODE V/D Н Z Y AREA T 7.7 E E-STORE STORE 4 0 0 1 2 00 8 00 0 00 0 00 0 00 0 00 3250 00 0 06 Licensed to: Colorado DOT 1IAI-BDS Version 4.0.13 Run time: 07-JUL-95 16:13:48 Page 4 Structure E-16-IN ; CSGCP ; SH-76 ; Proj#I-761(84) ;M.MOHSENI 2/95 OSECTION PROPERTIES - INPUT OMEM RE NO LOC. CALL Z Y W D TOP BOT NO W T W FACT T W FACT L EX IN L EX IN E STORE +/- CODE V/D H Ζ Y AREA IZZ E E-STORE STORE \*\* RECALL ONLY 4 20.0 06 **OSECTION PROPERTIES - OUTPUT** OMEM NO LOC. IZZ חבסבט Z-BAR Y-BAR AREA TYY Е 4.00 1.00 16.00 5.33 85.33 3250 00 4.00 1.00 16.00 5.33 85.33 3250.00 OMEMBER 4 PROPERTIES

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0 LENGTH: 20.0 MIN E\*I: 0.173E+05 STIFF: 4.000 LT 4.000 RT C.O.: 0.500 LT 0.500 RT OSECTION PROPERTIES - INPUT OMEM RE NO LOC. CALL Z Y D TOP BOT NO W T W FACT T W FACT L EX IN L EX IN W E STORE +/- CODE V/D Н Z Y AREA IZZ Е E-STORE STORE 5 0.0 06 \*\* RECALL ONLY 5 20.0 06 \*\* RECALL ONLY **OSECTION PROPERTIES - OUTPUT** OMEM NO LOC. DEPTH Z-BAR Y-BAR AREA IZZ IYY Ε 4.00 0.00 05 05 0.0 1.00 16.00 5.33 85.33 3250.00 20.0 4.00 1.00 16.00 5.33 85.33 3250.00 OMEMBER 5 PROPERTIES 0 LENGTH: 20.0 MIN E\*I: 0.173E+05 STIFF: 4.000 LT 4.000 RT C.O.: 0.500 LT 0.500 RT Version 4.0.13 Licensed to: Colorado DOT Run time: 07-JUL-95 1IAI-BDS 16:13:48 Page Structure E-16-IN ; CSGCP ; SH-76 ; Proj#I-761(84) ; M.MOHSENI 2/95 OFRAME PROPERTIES END SUPPORT CARRY OVER DISTRIBUTION MEM JТ COND OR FACTORS FACTORS SPAN MIN E\*I Е NO LT RT LT RT DIR HINGE LTRT LTRT /---/ /------/ /----/ /----/ /----/ /----/ /----/ /----/ /-----1 1 2 R н 46.0 0.1934E+06 0.0 3865. 0.810 0.000 0.000 0.754 0.596 2 2 3 н 117.0 0.1934E+06 0.0 3865. 0.596 0.246 0.246 0.1934E+06 0.0 0.000 0.810 0.754 3 R 46.0 0.000 3 4 Η 3865. 2 Ρ 0.0 0.000 4 5 20.0 0.1733E+05 3250. 0.500 0.000 0.000 0.000 0.500 б 3 Ρ 20.0 0.1733E+05 0.0 3250. 0.000 0.000 5 0\*\*\*\*\* IF MEMBER IS HORIZONTAL SUPPORT OR HINGE FIELD EQUALS LOCATION OF HINGE FROM LEFT END OF MEMBER \*\*\*\*\* \*\*\*\*\* IF MEMBER IS VERTICAL SUPPORT OR HINGE FIELD EQUALS SUPPORT WIDTH USED FOR MOMENT REDUCTION \*\*\*\*\* Run time: 07-JUL-95 1IAI-BDS Version 4.0.13 Licensed to: Colorado DOT 16:13:48 Page 6 Structure E-16-IN ; CSGCP ; SH-76 ; Proj#I-761(84) ; M.MOHSENI 2/95 0LOAD DATA TRIAL 0 FIXED END MOMENTS LOAD RIGHT DEFLT COMMENTS W OR P LINE MEM CODE А В LEFT 5.400 P 2 39.0 0.0 0. DTAPHRAGM 0. 5.400 0.0 2 Ρ 78.0 Ο. Ο. DIAPHRAGM OFIXED END MOMENTS TRIAL 0 FIXED END MOMENTS FIXED END MOMENTS MEM MEM MEM FIXED END MOMENTS LTLTNO LTRT NO RT NO RT Ο. 1 -2650. 2 -9142. -9142. 3 -2650. Ο. 0. 4 0 5 0 0. Version 4.0.13 Licensed to: Colorado DOT Run time: 07-JUL-95 1 TAT-BDS 16:13:48 Page 7 Structure E-16-IN ; CSGCP ; SH-76 ; Proj#I-761(84) ;M.MOHSENI 2/95 0SIDESWAY DIAGNOSTICS 0 RESULTS OF 1 INCH SWAY TO THE RIGHT VERTICAL SHEAR (KIPS) MOMENTS (FT-KIPS) MEMBER LT RT BASED ON E = 3250. KSI. 78 0 -1560 0 Δ 78.0 -1560. Ο. 5 Licensed to: Colorado DOT 1 TAT-BDS Version 4.0.13 Run time: 07-JUL-95 16:13:48 Page 8 Structure E-16-IN ; CSGCP ; SH-76 ; Proj#I-761(84) ;M.MOHSENI 2/95 \*\*\* FRAME DOES NOT SWAY WITH THIS LOADING \*\*\* 0 HORIZONTAL MEMBER MOMENTS TRIAL 0 MEM .7 PT .8 PT .9 PT RIGHT -4196. -5418. -6813. -8385. .2 PT NO LEFT .1 PT .3 PT .4 PT .5 PT .6 PT .7 PT 0 1 -454. Ο. -153. -902. -1497. -2241. -3139. -3951. 0 2 -8385. -546. 1902. 3354. 3831. 3354. 1902. -546. -3951. -8385. 4 03 -8385. -6813. -5418. -4196. -3139. -2241. -1497. -902. -454. -153. 0. ← OHORIZONTAL MEMBER STRESSES TRIAL 0 BOTTOM FIBER 176. 59. 350 581. 639 0. 732 845 977 0 1 1124 1306 0 2 1306. 974. -738. 212. -1301. -1486. -1301. -738. 212. 974. 1306. 1306. 1124. 977. 845. 03 732. 639. 581. 350. 176. 59. 0. OHORIZONTAL MEMBER STRESSES TRIAL 0 TOP FIBER -63. -76. 0 1 Ο. -21. -126. -209. -238. -280. -332. -391. -458. -538. -538. -370. 0 2 265. 468. 535. 468. 265. -76. -370. -538. 03 -538 -458 -391 -332. -280. -238. -209. -126. -63. -21 0. OVERTICAL MEMBER MOMENTS TRIAL 0 0. 0. 0. 0. 0 4 Ο. 0. 0. 0. 0. Ο. Ο. 0 5 Ο. Ο.

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July 1995

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16:13:	49 Page	13										
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16:13:	3 DS V 50 Page	21. 29. Version 4.0 <i>14</i> St	ructure	E-16-IN ;	CSGCP ;	SH-76 ;	Proj#I-761		10HSENI 2/	95	cime: 07-JUL-	-95
16:13: Oll NO OMEM	3 DS V 50 <i>Page</i>	21. 29. Version 4.0 <i>14</i> St	ructure NEG	E-16-IN ; ATIVE LIV	CSGCP ; TE LOAD MO	SH-76 ; MENT ENV	Proj#I-761 ELOPE AND	ASSOCIATE	MOHSENI 2/	95		-95
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16:13: 0LL NO 0MEM NO 0 1 SHEAR 0 2 SHEAR 0 3 SHEAR 0 3 SHEAR 0 3 SHEAR 0 3 SHEAR 0 3 SHEAR 0 3 SHEAR 0 3 SHEAR 0 2 0 3 SHEAR 0 1 0 2 0 3 SHEAR 0 3 SHEAR 0 1 0 2 0 3 SHEAR 0 3 SHEAR 0 1 0 2 0 3 SHEAR 0 3 SHEAR 0 3 SHEAR 0 1 0 2 0 3 SHEAR 0 3 SHEAR 0 3 SHEAR 0 1 0 2 0 3 SHEAR 0 3 SHEAR 1 SHEAR	3 DS V 50 Page . 1. LEFT 0. 0. -4716. 201.1 -4716. 102.5 0. 735. 735. 735. 0. -303. -303. DS V 50 Page . 1. LEFT 0. -13101. -13101.	21. 29. 29. Version 4.0 14 St .1 PT -472. -102.5 -2514. 161.4 -4245. 102.5 183. 620. 700. HBER STRESS -236. -246. -410. -246. -246. -410.	ructure NEG .2 PT -943. -102.5 -908. 16.4 -3773. 102.5 ES LL MA 366. 352. 680. ES LL MA -132. -127. -272. .13 ructure DEA .2 PT -1397. -1454. -9191.	E-16-IN ; ATIVE LIV .3 PT -1415. -102.5 -389. 9.0 -3301. 102.5 X NEG EC 549. 151. 665. X NEG TCC -197. -54. -261. Licensed E-16-IN ; D LOAD PI .3 PT -2316. 1513. -7497.	CSGCP ; TE LOAD MC .4 PT -1887. -102.5 -284. 9.0 -2830. 102.5 TTOM FIBE 732. 110. 660. PP FIBER -263. -40. -253. I to: Colc CSGCP ; US NEGATI .4 PT -3384. 3070. -5968.	SH-76; MENT ENV .5PT -2358. -102.5 -224. 0.0 -2358. 102.5 SR 673. 87. 673. -251. -31. -251. orado DOT SH-76; VVE LIVE .5PT -4599. 3607. -4599.	Proj#I-76: ELOPE AND .6 PT -2830. -102.5 -284. 102.5 660. 110. 732. -253. -40. -263. Proj#I-76: LOAD MOMEN .6 PT -5968. 3070.	ASSOCIATH .7 PT -3301. -102.5 -389. -9.0 -1415. 102.5 665. 151. 549. -261. -54. -197. U(84) ; M.N VT ENVELOP .7 PT -7497. 1513.	MOHSENI 2/ ED SHEARS .8 PT -3773. -102.5 -908. -16.4 -943. 102.5 680. 352. 366. -272. -132. MOHSENI 2/ ZE .8 PT -9191.	95 .9 PT -4245. -102.5 -2514. 102.5 700. 620. 183. -285. -236. -66. Run F 95 .9 PT -11057. -6465.	RIGHT -4716. -102.5 -4716. -201.1 0. 735. 735. 0. -303. -303. 0. time: 07-JUL- RIGHT -13101.	=
16:13: OLL NO OMEM NO 0 1 SHEAR 0 2 SHEAR 0 3 SHEAR 0 HORIZO 0 1 0 2 0 3 0 HORIZO 0 1 16:13: 0 LL NO 0 MEM NO 0 1 0 2 0 3 0 HORIZO 0 3 0 HORIZO 0 1 0 2 0 3 0 HORIZO 0 1 0 2 0 3 0 HORIZO 0 HORI	3 DS V 50 Page . 1. LEFT 0. 0.0 -4716. 201.1 -4716. 102.5 ONTAL MEM 0. -303. -303. DS V 50 Page . 1. LEFT 0. -13101. ONTAL MEM	21. 29. 29. 29. 29. 29. 29. 29. 29. 29. 29	ructure NEG .2 PT -943. -102.5 -908. 16.4 -3773. 102.5 ES LL MA 366. 352. 680. ES LL MA -132. -127. -272. .13 ructure DEA .2 PT -1397. -1454. -9191. ES FOR D	E-16-IN ; ATIVE LIV .3 PT -1415. -102.5 -389. 9.0 -3301. 102.5 X NEG BC 549. 151. 665. X NEG TC -197. -54. -261. Licensed E-16-IN ; D LOAD PI .3 PT -2316. 1513. -7497. VL+LL MAX	CSGCP ; TE LOAD MC .4 PT -1887. -102.5 -284. 9.0 -2830. 102.5 TTTOM FIBE 732. 110. 660. P FIBER -263. -40. -253. I to: Colc CSGCP ; US NEGATI .4 PT -3384. 3070. -5968. NEG BOTTC	SH-76; MENT ENV .5PT -2358. -102.5 -224. 0.0 -2358. 102.5 ER 673. -251. -31. -251. Drado DOT SH-76; VE LIVE .5PT -4599. 3607. -4599. M FIBER	Proj#I-76: ELOPE AND .6 PT -2830. -102.5 -284. -9.0 -1887. 102.5 660. 110. 732. -253. -40. -263. Proj#I-76: LOAD MOMEN .6 PT -5968. 3070. -3384.	ASSOCIATH .7 PT -3301. -102.5 -389. -9.0 -1415. 102.5 665. 151. 549. -261. -54. -197. NT ENVELOP .7 PT -7497. 1513. -2316.	MOHSENI 2/ ED SHEARS .8 PT -3773. -102.5 -908. -16.4 -943. 102.5 680. 352. 366. -272. -127. -132. MOHSENI 2/ DE .8 PT -9191. -1454. -1397.	95 .9 PT -4245. -102.5 -2514. -161.4 -472. 102.5 700. 620. 183. -285. -285. -66. Run 9 95 .9 PT -11057. -6465. -625.	RIGHT -4716. -102.5 -4716. -201.1 0. 735. 735. 0. -303. -303. 0. time: 07-JUL- RIGHT -13101. -13101. 0.	=
16:13:1 OLL NO OMEM NO 0 1 SHEAR 0 2 SHEAR 0 3 SHEAR 0HORIZO 0 1 0 2 0 3 0HORIZO 0 3 1IAI-BJ 16:13:1 0LL NO 0MEM NO 0 1 0 2 0 3 0HORIZO	3 DS V 50 Page . 1. LEFT 0. 0. -4716. 201.1 -4716. 102.5 0. 735. 735. 735. 0. -303. -303. DS V 50 Page . 1. LEFT 0. -13101. -13101.	21. 29. 29. 29. 29. 29. 29. 29. 29. 29. 29	ructure NEG .2 PT -943. -102.5 -908. 16.4 -3773. 102.5 ES LL MA 366. 352. 680. ES LL MA -132. -127. -272. .13 ructure DEA .2 PT -1397. -1454. -9191. ES FOR D	E-16-IN ; ATIVE LIV .3 PT -1415. -102.5 -389. 9.0 -3301. 102.5 X NEG BC 549. 151. 665. X NEG TC -197. -54. -261. Licensed E-16-IN ; D LOAD PI .3 PT -2316. 1513. -7497. 0L+LL MAX 898.	CSGCP ; TE LOAD MC .4 PT -1887. -102.5 -284. 9.0 -2830. 102.5 TTTOM FIBE 732. 110. 660. P FIBER -263. -40. -253. I to: Colc CSGCP ; US NEGATI .4 PT -3384. 3070. -5968. NEG BOTTC	SH-76; MENT ENV .5PT -2358. -102.5 -224. 0.0 -2358. 102.5 ER 673. 87. 673. -251. -31. -251. orado DOT SH-76; VE LIVE .5PT -4599. 3607. -4599. M FIBER 1312.	Proj#I-76: ELOPE AND .6 PT -2830. -102.5 -284. -9.0 -1887. 102.5 660. 110. 732. -253. -40. -263. Proj#I-76: LOAD MOMEN .6 PT -5968. 3070. -3384.	ASSOCIATH .7 PT -3301. -102.5 -389. -9.0 -1415. 102.5 665. 151. 549. -261. -54. -197. NT ENVELOP .7 PT -7497. 1513. -2316. 1511.	MOHSENI 2/ D SHEARS .8 PT -3773. -102.5 -908. .16.4 -943. 102.5 680. 352. 366. -272. -127. -132. MOHSENI 2/ DE .8 PT -9191. -1454. -1397. 1657.	95 .9 PT -4245. -102.5 -2514. 102.5 700. 620. 183. -285. -236. -66. Run F 95 .9 PT -11057. -6465.	RIGHT -4716. -102.5 -4716. -201.1 0. 735. 0. -303. -303. 0. time: 07-JUL- RIGHT -13101. -13101. 0. 2041.	=
16:13: OLL NO OMEM NO 0 1 SHEAR 0 2 SHEAR 0 3 SHEAR 0 HORIZO 0 1 0 2 0 3 0 HORIZO 0 3 1IAI-BI 16:13: 0LL NO 0MEM NO 0 1 0 2 0 3 0 HORIZO 0 1 0 2 0 3 0 HORIZO 0 1 0 2 0 3 0 HORIZO 0 1 0 2 0 3 0 HORIZO 0 0 3 0 HORIZO 0 0 3 0 HORIZO 0 NO 0 1 0 2 0 J 0 2 0 J 0 J 0 J 0 J 0 J 0 J 0 J 0 J	3 DS V 50 Page . 1. LEFT 0. 0.0 -4716. 201.1 -4716. 201.1 -4716. 201.1 -4716. 0. 735. 735. 735. 0NTAL MEM 0. -303. -303. -303. DS V 50 Page . 1. LEFT 0. -3101. -13101. 0NTAL MEM 0. 2041. 2041.	21. 29. 29. 29. 4 29. 29. 29. 29. 29. 29. 29. 29. 29. 29.	ructure NEG .2 PT -943. -102.5 -908. 16.4 -3773. 102.5 ES LL MA 366. 352. 680. ES LL MA -132. -127. -272. .13 ructure DEA .2 PT -1397. -1454. -9191. ES FOR D 542. 564. 1657.	E-16-IN ; ATIVE LIV .3 PT -1415. -102.5 -389. 9.0 -3301. 102.5 X NEG EC 549. 151. 665. X NEG TCC -197. -54. -261. Licensed E-16-IN ; D LOAD PI .3 PT -2316. 1513. -7497. bL+LL MAX 898. -587. 1511.	CSGCP ; TE LOAD MC .4 PT -1887. -102.5 -284. 9.0 -2830. 102.5 TTOM FIBE 732. 110. 660. PFIBER -263. -40. -253. I to: Colo CSGCP ; US NEGATI .4 PT -3384. 3070. -5968. NEG BOTTO 1312. -1191. 1391.	SH-76; MENT ENV .5PT -2358. -102.5 -224. 0.0 -2358. 102.5 ER 673. 87. 673. -251. -31. -251. 0rado DOT SH-76; VE LIVE .5PT -4599. 3607. -4599. M FIBER 1312. -1399. 1312.	Proj#I-76: ELOPE AND .6 PT -2830. -102.5 -284. -9.0 -1887. 102.5 660. 110. 732. -253. -40. -263. Proj#I-76: LOAD MOMEN .6 PT -5968. 3070. -3384. 1391.	ASSOCIATH .7 PT -3301. -102.5 -389. -9.0 -1415. 102.5 665. 151. 549. -261. -54. -197. 1(84) ;M.N VT ENVELOF .7 PT -7497. 1513. -2316. 1511. -587.	MOHSENI 2/ ED SHEARS .8 PT -3773. -102.5 -908. -16.4 -943. 102.5 680. 352. 366. -272. -127. -132. MOHSENI 2/ DE .8 PT -9191. -1454. -1397.	95 .9 PT -4245. -102.5 -2514. -161.4 -472. 102.5 700. 620. 183. -285. -236. -66. Run 95 .9 PT -11057. -6465. -625. 1825.	RIGHT -4716. -102.5 -4716. -201.1 0. 735. 0. -303. -303. 0. time: 07-JUL- RIGHT -13101. -13101. 0. 2041.	=
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OLL NO. 1. OMEM LEFT	.1 PT	POS .2 PT	ITIVE LIVE .3 PT				ASSOCIATEI		.9 PT	RIGHT
NO 0 1 0.	939.	1572.	1917.	2081.	2032.	1942.	1635.	1166.	479.	347.
SHEAR 0.0	204.1	170.8	138.9	104.9	-103.4	-135.4		-199.8	-228.7	
0 2 347.	344.	1100.	2172.		3236.	2985.	2172.	1100.	344.	
SHEAR -9.0	78.1	133.8	176.2	137.2	96.0	-137.2	-176.2	-133.8	-78.1	
0 3 347.	479.	1166.	1635.	1942.	2032.		1917.	1572.		
SHEAR -7.5	228.7	199.8	169.5		103.4	-104.9	-138.9	-170.8	-204.1	0.0
0HORIZONTAL MEN 0 1 0.	-364.	-610.	-744.	-807.		-453.	-329.	-210.	-79.	-54.
0 2 -54.	-85.	-427.			-1255.		-842.	-427.	-85.	-54.
0 3 -54.	-79.	-210.			-580.	-807.	-744.	-610.	-364.	0.
OHORIZONTAL MEN										
010.	131.	219.	268.						32.	22.
0 2 22.	32.	154.	303.	417.	<mark>452</mark> .				32.	22. <del>C</del>
0 3 22.	32.		129.	173.	216.	290.	268.	219.	131.	0. cime: 07-JUL-95
1IAI-BDS V	Version 4.0	J.13	Licensed	10. 00101	ado D01				Rull	TIME: 07-00E-95
16:13:50 Page	17									
- 5 -		ructure 1	E-16-IN ;	CSGCP ; S	н-76 ; р	roj#I-761	(84) ;M.MC	DHSENI 2/	95	
OLL NO. 1.							IT ENVELOPE			
OMEM LEFT	.1 PT	.2 PT	.3 PT	.4 PT	.5PT	.6 PT	.7 PT .	8 PT	.9 PT	RIGHT
NO 0 1 0.	786.	1118.	1016.	584.	-209.	-1196.	-2561.	-4252.	-6334.	-8038.
0 2 -8038.		554.	4074.	584. 6339.		6339.	4074.	-4252. 554.	-0334. -3607.	-8038.
0 3 -8038.	-6334.		-2561.		-209.	584.		1118.	786.	0.
OHORIZONTAL MEN			L+LL MAX P	OS BOTTOM						
0 1 0.	-305.	-434.	-394.	-226.	60.	279.		767.	1045.	1252.
0 2 1252. 0 3 1252.	889. 1045.	-215. 767.	-1580. 516.		-2741.		-1580. -394.	-215. -434.	889. -305.	1252. 0.
0 3 1252. OHORIZONTAL MEN						-220.	-394.	-434.	-305.	υ.
	110.	156.	142.		-22.	-107.	-202.		-426.	-516.
0 2 -516.	-338.	77. -307.	568.	885.	986.	885.	568.	77.	-338.	-516.
0 3 -516.				-107.	-22.	81.	142.	156.	110.	0.
1IAI-BDS V	Version 4.0	0.13	Licensed	to: Color	ado DOT				Run t	ime: 07-JUL-95
16:13:50 Page	18									
		ructure 1	E-16-IN ;	CSGCP ; S	н-76 ; р	roj#I-761	(84) ;M.MC	) HSENI 2/	95	
OLL NO. 1.							CIATED MOME			
OMEMBER 1 LEFT				.4 PT	.5 PT					
0POS. V 238.5 MOM. 0.		170.8 1572.		108.5 1997.	79.9 1838.					
MOM. 0. NEG. V -102.5		-104.2		-126.2	-144.2			-202.0		
MOM. 0.			556.	501.	299.					
RANGE 341.0		275.0	247.8	234.7	224.1			224.6		
OLL NO. 1.		.2 PT	LIVE LOAD				CIATED MOME			
OMEMBER 2 LEFT		.2 PT	.3 PT	.4 PT	.5 PT			.8 PT		
0POS. V 277.6 MOM1749.		229.6 859.	193.6 2096.	153.3 2891.	112.3 3095.					
NEG. V -9.0		-18.7		-74.1	-112.3					
MOM. 347.		1055.	1953.	2724.	3095.					-1749.
RANGE 286.6		248.3		227.4	224.6			248.3	266.9	286.6
OLL NO. 1. OMEMBER 3 LEFT							CIATED_MOME			
OMEMBER 3 LEFT	r .1 PT		.3 PT	.4 PT			.7 PT			
0POS. V 256.1 MOM408.		202.0 -1250.			144.2 299.				102.9 -472.	
NEG. V -7.5		-1230.		-52.8	-79.9					
MOM. 347.	488.	833.	1130.				1917.			0.
RANGE 263.6		224.6	217.1	215.6	224.1	234.7			306.0	5 341.0
1IAI-BDS V	Version 4.0	0.13	Licensed	to: Color	ado DOT				Run t	cime: 07-JUL-95
16:13:50 Page	19									
5 55 ruge		tructure 1	E-16-IN ;	CSGCP ; S	н-76 ; р	roj#I-761	(84) ;M.MC	) HSENI 2/	95	
0LL NO. 1.			D LOAD PLU			ENVELOPE	3	,		
OMEMBER 1 LEFT			.3 PT	.4 PT	.5 PT					r right
0POS. V 221.3			25.5	-36.9	-98.3					4 -353.9
NEG. V -119.8 OLL NO. 1.	8 -151.8		-222.3 D LOAD PLU			-375.0		-486.2	-550.9	9 -617.5
OLL NO. 1. OMEMBER 2 LEFT	г.1 РТ	.2 PT		.4 PT	AD SHEAR .5 PT			.8 PT	.9 P	r right
0POS. V 704.9				234.8	112.3				-323.8	
NEG. V 418.3		231.4		7.4				-479.6		
OLL NO. 1.			D LOAD PLU							
OMEMBER 3 LEFT				.4 PT						
0POS. V 617.5 NEG. V 353.9				375.0 159.4	322.4		-25.5		151.8	
	Version 4.0					50.5	20.0			ime: 07-JUL-95
16:13:50 Page		cructure 1	E-16-IN ;	CSGCP ; S	н-76 ; р	roj#I-761	(84) ;M.MC	)HSENI 2/	95	
0LL NO. 1.			LIVE LOAD	SUPPORT	RESULTS					
0			AXIAL LC	DAD			GITUDINAL			
			MOME				MOMEN			
OSUPPORT JT.		LOAD	TOP	BOT.		LOAD	TOP	BOT.		
		L93.2	0.	0.		0.0	0.	0.		

0 SUPPORT	JT. 1						
	POSITIVE	193.2	0.	0.	0.0	0.	0.
	NEGATIVE	-83.1	0.	0.	0.0	0.	0.
OMEMBER	4						
	POSITIVE	331.8	0.	0.	0.0	0.	0.

	NEGATIVE	-13.4	0.	0.		0.0	0.	0.			
OMEMBER	5										
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0 THE	NEGATIVE RATIO OF SUE	-83.1 STRUCTURE /	0. SUPERSTRU	0. JCTURE LOA			0.	0.			
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16:13:50 OLL NO. 2 OMEM L NO	Page 23 2. LEFT .1 PT	Structure POS .2 PT	E-16-IN ; SITIVE LIV .3 PT	: CSGCP ; /E LOAD MO .4 PT	SH-76 ; E MENT ENVE .5PT	LOPE AND .6 PT	ASSOCIATE .7 PT	D SHEARS .8 PT	.9 PT		
16:13:50 OLL NO. 2 OMEM L	Page 23	Structure POS .2 PT . 1361.	E-16-IN ; SITIVE LIV .3 PT 1723.	CSGCP ; /E LOAD MO .4 PT 1894.	SH-76 ; E MENT ENVE	LOPE AND	ASSOCIATE	D SHEARS		RIGHT 276. 6.0	
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Structure E-16-IN ; CSGCP ; SH-76 ; Proj#I-761(84) ;M.MOHSENI 2/95

OLL NO.	2.							LATED MOMEI	NTS		
OMEMBER		.1 PT					.6 PT			.9 PT	RIGHT
OPOS. V	196.1		147.9	124.9				43.8			6.0
MOM.	0.	790. 1	361.	1723.	1894.	1890.	1725.	1411.	960.	382.	276.
NEG. V	-70.7			-70.7	-84.8	-106.6	-127.2	-146.7		-182.9	-199.7
MOM.		325	650.	-976.	1830.	1890.			1112.		-87.
RANGE			218.6			188.8			191.4		205.7
OLL NO.								ATED MOMEI			
OMEMBER			.2 PT					.7 PT		9 DT	RIGHT
OPOS. V			167.5			91.7		39.2			7.2
MOM.				1865.		2629.					276.
NEG. V							-119.7		-167.5	-182.7	-191.8
MOM.				1837.							-290.
RANGE	199.0	189.9	187.0	185.0	183.8	183.4	183.8	185.0	187.0	189.9	199.0
OLL NO.	2.				SHEAR ENV	ELOPES I	AND ASSOCI	LATED MOMEI	NTS		
OMEMBER	3 LEFT	.1 PT	.2 PT	.3 PT	.4 PT	.5 PT	.6 PT	.7 PT	.8 PT	.9 PT	RIGHT
0POS. V	199.7	182.9		146.7	127.2	106.6	84.8	70.7	70.7	70.7	70.7
MOM.	-87.	573. 1	112.	1519.				-976.		-325.	0.
NEG. V								-124.9			-196.1
MOM.					1725.			1723.			0.
RANGE		192.2	101 /	100 6	100 7	100 0	107 0	195.6	219 6	242.5	266.8
		192.2	191.4	190.0	109.7	- DO. 0	107.0	195.0	210.0		
IIAI-BDS	Versi	on 4.0.13	L1	.censea t	co: Colora	ido DUT				Run tir	me: 07-JUL-95
16:13:50	Page 26									_	
								(84) ;M.MOI	HSENI 2/9	95	
OLL NO. 2							ENVELOPE				
OMEMBER				.3 PT						.9 PT	
0POS. V	178.9	122.5	66.6	11.5	-42.6	-96.0	-149.7	-203.7	-258.2	-313.0	-355.4
NEG. V	-87.9 -		152.0	-184.1				-394.3			-561.1
OLL NO.											
OMEMBER	2 LEFT	.1 PT	.2 PT	.3 PT	.4 PT	.5 PT	.6 PT	.7 PT	.8 PT	.9 PT	RIGHT
0POS. V			417.6	314.3				-129.3			-420.1
	420.1		230.6	129.3	17.5	_01 7	_ 201 - C	-314.3	-417.6		-420.1
	4∠∪.⊥ ว								-41/.0	-919.9	-019.1
OLL NO. 3				JOAD PLUS	5 LIVE LOA	AD SHEAR	ENVELOPE				
OMEMBER				.3 PT	.4 PT	.5 PT	.6 P.I.	.7 PT	.8 PT	.9 PT 120.0	RIGHT
0POS. V			449.5		339.4	284.8	230.3	184.1	152.0	120.0	
NEG. V			258.2	203.7	149.7	96.0	42.6	-11.5	-66.6	-122.5	
1IAI-BDS	Versi	on 4.0.13	Li	.censed t	co: Colora	do DOT				Run tin	me: 07-JUL-95
16:13:50	Page 27	7									
		Struc	ture E-1	6-IN ; C	CSGCP ; SH	I-76 ; P:	roj#I-761(	84) ;M.MO	HSENI 2/9	95	
							- 5				
OLL NO.	2		T.T	VE LOAD	SUPPORT R	ESULTS					
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		LOAD	) <u> </u>	OP	BOT.	1	LOAD	TOP	BOT.		
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OMEMBER OMEMBER OSUPPORT O THE IIAI-BDS 16:13:50 OLIVE LOJ O OLIVE LOJ O MEM NO. 1 2 3 3 0 LIVE LOAD NO 1 4. 2	POSITIVE NEGATIVE 4 POSITIVE NEGATIVE 5 POSITIVE NEGATIVE JT. 4 POSITIVE RATIO OF S Versi Page 28 AD DIAGNOST AD GENERATO NUMBER SUPERSTRUC LT.END RT 	158. -57. 186. -10. 186. -10. 188. -57. UBSTRUCTU on 4.0.13 Struc UBSTRUCTU on 4.0.13 Struc USS VR OF LIVE L TURE SU -END LT 	9 3 0 7 9 3 RE / SUF 5 1 1 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 2 2 2 2 2 2 2 2 2 2 2 2	0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	0. 0. 0. 0. 0. 0. 0. 0. CURE LOADI CO: COLORA CSGCP ; SH RESIST U POSITI 	ING IS 0 Ido DOT I-76 ; P: ING MOMI INIT STE IVE NE INIT STE IVE NE INIT STE ING MOMI	0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	0. 0. 0. 0. 0. 0. 0. 0. 0. (84) ;M.MOI PLOT M S ENV. 0 0 0 0 0 0 0 0 0 0 0 0 0	0. 0. 0. 0. 0. 0. 0. HSENI 2/9 PLOT SCALE 0 RRL IMP2	95 INFLU- ENCE LINES GEI NO I ACT COMB ( CC	N  NO CARD DNTROL
OMEMBER OMEMBER OSUPPORT O THE IIAI-BDS 16:13:50 OLIVE LOX O ULIVE LOX O MEM NO. 1 2 3 0 LIVE LOAD NO 1 4. 1 0	POSITIVE NEGATIVE 4 POSITIVE NEGATIVE 5 POSITIVE NEGATIVE RATIO OF S Versi Page 28 AD DIAGNOST AD GENERATO NUMBER SUPERSTRUC LT.END RT 	158.         -57.         186.         -10.         186.         -10.         186.         -10.         186.         -10.         186.         -10.         186.         -10.         186.         -10.         186.         -10.         186.         -10.         Structure         On 4.0.13         Structure         VICS         OF LIVE L         TURE SU         *.2333 2         .333 2	9 3 0 7 9 3 RE / SUF 3 RE / SUF 5 1 1 1 2 1 1 1 2 2 5 1 1 1 1 1 1 1 1 1 1 1 1 1	0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	0. 0. 0. 0. 0. 0. 0. 0. CURE LOADI COLORA CO	ING IS 0 Ido DOT I-76 ; P: ING MOMI INIT STEI IVE NEG INIT STEI IVE NEG INIT STEI IVE NEG ING IS 0 ING	0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	0. 0. 0. 0. 0. 0. 0. HSENI 2/9 PLOT SCALE 0 RRL IMP2	D5 INFLU- ENCE LINES GEI NO I ACT COMB (C) S	N  NO CARD DNTROL
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OMEMBER OMEMBER OSUPPORT O THE IIAI-BDS 16:13:50 OLIVE LOJ O OLIVE LOJ O MEM NO. 1 2 3 0 LIVE LOAD NO 1 4. 2 3 0 LIVE	POSITIVE NEGATIVE 4 POSITIVE NEGATIVE 5 POSITIVE NEGATIVE RATIO OF S Versi Page 28 AD DIAGNOST AD GENERATO NUMBER SUPERSTRUC LT.END RT 	<pre>158. -57. 186. -10. 186. -10. 186. -10. 158. -57. UUBSTRUCTU on 4.0.13 3 Struc VICS OF LIVE L TURE SU -END LT </pre>	9 3 0 7 9 3 RE / SUF 3 RE / SUF 5 10 10 10 10 10 10 10 10 10 10	0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	0. 0. 0. 0. 0. 0. 0. 0. CURE LOADI COLODI COLODI COLODI COLODI COLODI 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	NG IS 0 Ido DOT I-76 ; P: NIT STE: VE NE( 25 D5 25.0 35.0 211 D11 0.0 0.1 27 D17 0.0 0.1	0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	0. 0. 0. 0. 0. 0. 0. HSENI 2/9 PLOT SCALE 0 RRL IMP2	D5 INFLU- ENCE LINES GEI NO I ACT COMB (C) S	N  NO CARD ONTROL 01
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OMEMBER OMEMBER OSUPPORT O THE IIAI-BDS 16:13:50 OLIVE LOJ O OLIVE LOJ O MEM NO. 1 2 3 0 LIVE LOAD NO 1 4. 2 3 0 LIVE LOAD NO 1 0 0 1 0 0 1 0 0 1 0 0 1 0 0 1 0 0 0 0	POSITIVE NEGATIVE 4 POSITIVE NEGATIVE 5 POSITIVE NEGATIVE RATIO OF S Versi Page 28 AD DIAGNOST AD GENERATOO NUMBER SUPERSTRUC LT.END RT 	<pre>158. -57. 186. -10. 186. -10. 186. -10. 158. -57. UBSTRUCTU on 4.0.13 3 Struc iCS OF LIVE L TURE SU .END LT  TR P2 D2 25.0 4.0 P8 D8 21.7 0.00 P14 D14 0.0 0.0 P26 D26</pre>	9 3 0 7 9 3 RE / SUF 3 RE / SUF 5 COAD LANE BESTRUCTU C.END 	0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	TING IS 0 I-76 ; P: TING MOMI INIT STEI VE NEW 25 D5 25.0 35.0 211 D11 0.0 0.1 17 D17 0.0 0.2 23 D23 0.0 0.2 29 D29	0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	0. 0. 0. 0. 0. 0. 0. 0. 0. (84) ;M.MOI PLOT M S ENV. 0 0 0 0 0 0 0 0. 0. 0. 0.	0. 0. 0. 0. 0. 0. 0. HSENI 2/9 PLOT SCALE 0 RRL IMP2	D5 INFLU- ENCE LINES GEI NO I ACT COMB (C) S	N  NO CARD ONTROL 01
OMEMBER OMEMBER OSUPPORT O THE IIAI-BDS 16:13:50 OLIVE LOJ O OLIVE LOJ O MEM NO. 1 2 3 0 LIVE LOAD NO 1 4. 2 3 0 LIVE LOAD NO 1 0 0 1 0 0 1 0 0 1 0 0 1 0 0 1 0 0 0 0	POSITIVE NEGATIVE 4 POSITIVE NEGATIVE 5 POSITIVE NEGATIVE JT. 4 POSITIVE RATIO OF S Versi Page 28 AD DIAGNOST AD GENERATO NUMBER SUPERSTRUC LT.END RT 	<pre>158. -57. 186. -10. 186. -10. 186. -10. 158. -57. UBSTRUCTU on 4.0.13 3 Struc iCS OF LIVE L TURE SU .END LT  TR P2 D2 25.0 4.0 P8 D8 21.7 0.00 P14 D14 0.0 0.0 P26 D26</pre>	9 3 0 7 9 3 RE / SUF 3 RE / SUF 5 COAD LANE BESTRUCTU C.END 	0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	TING IS 0 I-76 ; P: TING MOMI INIT STEI VE NEW 25 D5 25.0 35.0 211 D11 0.0 0.1 17 D17 0.0 0.2 23 D23 0.0 0.2 29 D29	0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	0. 0. 0. 0. 0. 0. 0. 0. 0. (84) ;M.MOI PLOT M S ENV. 0 0 0 0 0 0 0 0. 0. 0. 0.	0. 0. 0. 0. 0. 0. 0. HSENI 2/9 PLOT SCALE 0 RRL IMP2	D5 INFLU- ENCE LINES GEI NO I ACT COMB (C) S	N  NO CARD ONTROL 01

IMPACT FACTO 0 MEM NO	RS CALCULATED BY E IMPACT %	PROGRAM						
1 2	29. 21.							
3 1IAI-BDS	29. Version 4.0.13	Licensed to: Col	lorado DOT				Pup +	ime: 07-JUL-95
IIAI-BDS		Licensed to. co.	torado DOI				Ruff L	Ture: 01-201-32
16:13:52 Page		E E-16-IN ; CSGCP	; SH-76 ; P	roi#I-761	(84) ; M M	OHSENT 2/	95	
OLL NO. 4.	NE	EGATIVE LIVE LOAD N	MOMENT ENVE	LOPE AND	ASSOCIATE	D SHEARS		
OMEM LEFT	*** SPEC .1 PT .2 PT	CIAL TRUCK WITH .3 PT .4 PT	8 AXLES WA: .5PT			IVE LOAD .8 PT		RIGHT
NO 0 1 0.	-9221844.	-27663688.	-4610.	-5532.	-6454.	-7376.	-8298.	-9220.
SHEAR 0.0	-200.4 -200.4	4 -200.4 -200.4	4 -200.4	-200.4	-200.4	-200.4	-200.4	-200.4
0 2 -9220. SHEAR 426.7	-45981320. 340.1 209.4			-422. -13.3	-578. -13.3	-1320. -209.4	-4598. -340.1	-9220. -426.7
03 <mark>-9220</mark> .	-82987376.	-64545532.	-4610.	-3688.	-2766.	-1844.	-922.	0. <del>&lt;</del>
SHEAR 200.4 OHORIZONTAL ME		4 200.4 200.4 MAX NEG BOTTOM FII		200.4	200.4	200.4	200.4	0.0
0 1 0. 0 2 1437.	358. 715.			1290.	1300.	1330.	1369.	1437.
0 2 1437. 0 3 <b>1437</b> .	1134. 512. 1369. 1330.	224. 164. 1300. 1290.	103. 1315.	164. 1430.	224. 1073.	512. 715.	1134. 358.	1437. 0. <del>&lt;</del>
0HORIZONTAL ME 0 1 0.	MBER STRESSES LL M -129257.	MAX NEG TOP FIBER -386515.		-494.	-510.	-532.	-558.	-592.
0 2 -592.	-431184.	-8159.		-494.			-431.	-592.
0 3 <mark>-592</mark> . 1IAI-BDS	-558532. Version 4.0.13	-510494. Licensed to: Co	-490.	-515.	-386.	-257.	-129.	0. <del>(</del> . .ime: 07-JUL-95
		Licensed to. co.	IOLAGO DOI				Kull t	IIIIe: 07-001-95
16:13:52 Page		E E-16-IN ; CSGCP	; SH-76 ; P:	roi#I-761	(84) ;M.M	OHSENI 2/	95	
OLL NO. 4.	DE	EAD LOAD PLUS NEGA	FIVE LIVE L	DAD MOMEN	T ENVELOP	Е		
OMEM LEFT		CIAL TRUCK WITH .3 PT .4 PT	8 AXLES WAS .5PT					RIGHT
NO 0 1 0.	-10752298.	-36685185.	-6851.	-8671.	-10650.	-12795	-15111.	-17605.
0 2 -17605.	-85491866.	1324. 2932.	3566.	2932.	1324.	-1866.	-8549.	-17605.
	-1511112795. MBER STRESSES FOR	-106508671. DL+LL MAX NEG BOT	-6851. TOM FIBER	-5185.	-3668.	-2298.	-1075.	0.
010.	417. 891.	1422. 2011.	1955.	2021.	2146.	2306.	2494.	2743.
0 2 2743. 0 3 2743.	2108. 724. 2494. 2306.	-5131137. 2146. 2021.	-1383. 1955.	-1137. 2011.	-513. 1422.	724. 891.	2108. 417.	2743. 0.
0 HORIZONTAL ME	MBER STRESSES FOR -150321.	DL+LL MAX NEG TOU -512724.		-774.	-842.	-923.	-1015.	-1130.
0 2 -1130.	-801260.	185. 409.	498.	409.	185.	-260.	-801.	-1130.
0 3 -1130. 1IAI-BDS	-1015923. Version 4.0.13	-842774. Licensed to: Col	-728. lorado DOT	-724.	-512.	-321.	-150. Run t	0. ime: 07-JUL-95
16,12,52	21							
16:13:52 Page	Structure	E E-16-IN ; CSGCP					95	
OLL NO. 4.		DSITIVE LIVE LOAD N CIAL TRUCK WITH	MOMENT ENVE: 8 AXLES WA				* * *	
OMEM LEFT	.1 PT .2 PT	.3 PT .4 PT				.8 PT		RIGHT
NO 0 1 0.	1337. 2176.	2719. 2836.	3000.	2712.	2148.	1350.	647.	515.
SHEAR 0.0	290.7 175.7			-176.4	-230.3	-212.9	-237.3 359.	11.2
0 2 515. SHEAR -13.3	359. 1075. -13.3 164.6	5 213.9 127.3		4856. -127.3	3279. -213.9	1075. -164.6	359. 13.3	515. <del>(</del> 13.3
0 3 515. SHEAR -11.2	647. 1350. 237.3 212.9			2836. -102.6	2719. -120.6	2176. -175.7	1337. -290.7	0. 0.0
OHORIZONTAL ME	MBER STRESSES LL M	MAX POS BOTTOM FIN	BER					
0 1 0. 0 2 -80.	-519844. -89417.			-632. -1883.	-433. -1272.	-243. -417.	-107. -89.	-80. -80. <del>C</del>
0 3 -80.	-107243.	-433632.	-856.	-1100.	-1055.	-844.	-519.	0.
0 HORIZONTAL ME	MBER STRESSES LL N 187. 304.	MAX POS TOP FIBER 379. 396.		242.	170.	97.	43.	33.
02 33.	34. 150.	458. 678.	735.	678.	458.	150. 304.	34.	33.
0 3 33. 1IAI-BDS	43. 97. Version 4.0.13			396.	379.	304.	187. Run t	0. ime: 07-JUL-95
16:13:52 Page	32							
0LL NO. 4.	Structure	E E-16-IN ; CSGCP EAD LOAD PLUS POSI					95	
OMEM LEFT	*** SPEC	CIAL TRUCK WITH	8 AXLES WA	S REQUEST	ED THIS L			RIGHT
NO								
0 1 0. 0 2 -7869.	1184. 1723. -3592. 528.	1817. 1339. 5181. 8210.		-427. 8210.	-2048. 5181.	-4069. 528.	-6165. -3592.	-7869. -7869.
0 3 -7869.	-61654069.	-2048427.	759.	1339.	1817.	1723.	1184.	0.
010.	-459668.			100.	413.	733.	1017.	1226.
0 2 1226. 0 3 1226.	886205. 1017. 733.			-3184. -519.	-2009. -705.	-205. -668.	886. -459.	1226. 0.
OHORIZONTAL ME	MBER STRESSES FOR	DL+LL MAX POS TOP	P FIBER					
0 1 0. 0 2 -505.	165. 240. -337. 74.			-38. 1146.	-162. 723.	-294. 74.	-414. -337.	-505. -505.
5.2 505.			12,0.		,23.	, 1.	557.	

0 3 -505414. 1IAI-BDS Version 4.0		-38. 81. to: Colorado DO		254.	240.	165. 0. Run time: 07-JUL-95
16:13:52 Page 33						
	tructure E-16-IN ; LIVE LOA	CSGCP ; SH-76 ; D SHEAR ENVELOPE				5
	*** SPECIAL TRUCK		WAS REQUESTE			
OMEMBER 1 LEFT .1 PT OPOS. V 348.3 290.7					.8 PT 20.4	.9 PT RIGHT 11.2 11.2
MOM. 0. 1337.	2165. 2519.			1576.	946.	464. 515.
NEG. V -200.4 -200.4	-200.4 -200.4	-235.5 -282	.8 -324.0	-358.9	-387.9	-429.0 -482.5
MOM. 0922.				-3660.		-33765294.
RANGE 548.8 491.2 OLL NO. 4.	435.7 383.0 LIVE LOA *** SPECIAL TRUCK	D SHEAR ENVELOPE				440.2 493.7
OMEMBER 2 LEFT .1 PT			~ ~ ~			.9 PT RIGHT
0POS. V 543.3 462.5					13.3	13.3 13.3
MOM82083775.	253. 2783.				203.	359. 515.
NEG. V -13.3 -13.3				-308.8	-381.1	-462.5 -543.3
MOM. 515. 359. RANGE 556.6 475.9	203. 1772. 394.5 347.0			2783. 347.0	253. 394.5	-37758208. 475.9 556.6
0LL NO. 4.		D SHEAR ENVELOPE				475.9 556.6
	*** SPECIAL TRUCK		WAS REQUESTE			* *
OMEMBER 3 LEFT .1 PT						.9 PT RIGHT
0POS. V 482.5 429.0					200.4	200.4 200.4
MOM52943376.				-2766.	-1844.	-922. 0.
NEG. V -11.2 -11.2 MOM. 515. 464.			.7 -132.8 . 2443.		-235.3	-290.7 -348.3 1337. 0.
RANGE 493.7 440.2			. 2443. .6 368.2		2165. 435.7	1337. 0. 491.2 548.8
	0.13 Licensed			505.0	455.7	Run time: 07-JUL-95
	11001100a	00 00101000 20	-			
	tructure E-16-IN ;			84) ;M.MO	HSENI 2/9	5
0LL NO. 4.		US LIVE LOAD SHE				
	*** SPECIAL TRUCK .2 PT .3 PT				VE LOAD * .8 PT	
OMEMBER 1 LEFT .1 PT OPOS. V 331.1 241.4					-263.8	.9 PT RIGHT -311.0 -350.2
NEG. V -217.7 -249.7					-672.1	-751.2 -844.0
0LL NO. 4.		US LIVE LOAD SHE		00011	0,211	,5112 01110
ŕ	*** SPECIAL TRUCK		WAS REQUESTE	D THIS LI	VE LOAD *	* *
OMEMBER 2 LEFT .1 PT				.7 PT		.9 PT RIGHT
0POS. V 970.5 795.3					-236.7	-319.4 -413.9
NEG. V 413.9 319.4				-477.3	-631.2	-795.3 -970.5
0LL NO. 4.	DEAD LOAD PL *** SPECIAL TRUCK	US LIVE LOAD SHE		ד ד סדעיד חי		* *
OMEMBER 3 LEFT .1 PT						.9 PT RIGHT
0POS. V 844.0 751.2	672.1 606.4			313.9		249.7 217.7
		536.3 461		313.9	281.8	
0POS. V 844.0 751.2	263.8 198.6	536.3 461 138.5 78	.0 380.9 .5 12.7	313.9	281.8	249.7 217.7
0POS. V 844.0 751.2 NEG. V 350.2 311.0 1IAI-BDS Version 4.0	263.8 198.6	536.3 461 138.5 78	.0 380.9 .5 12.7	313.9	281.8	249.7 217.7 -241.4 -331.1
0POS. V 844.0 751.2 NEG. V 350.2 311.0 IIAI-BDS Version 4.0 16:13:52 Page 35	263.8 198.6 0.13 Licensed	536.3 461 138.5 78 to: Colorado DO	.0 380.9 .5 12.7 r	313.9 -69.1	281.8 -153.9	249.7 217.7 -241.4 -331.1 Run time: 07-JUL-95
0POS. V 844.0 751.2 NEG. V 350.2 311.0 IIAI-BDS Version 4.0 16:13:52 Page 35	263.8 198.6	536.3 461 138.5 78 to: Colorado DO	.0 380.9 .5 12.7 r	313.9 -69.1	281.8 -153.9	249.7 217.7 -241.4 -331.1 Run time: 07-JUL-95
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OPOS. V 844.0 751.2 NEG. V 350.2 311.0 IIAI-BDS Version 4.0 16:13:52 Page 35 OLL NO. 4. O USUPPORT JT. 1 POSITIVE 2 NEGATIVE -1 OMEMBER 4 POSITIVE 6 NEGATIVE -1 OMEMBER 5 POSITIVE 6 NEGATIVE -1 OMEMBER 5 OSUPPORT JT. 4 POSITIVE -1 OMEMBER 5 OSUPPORT JT. 4 POSITIVE -1 OMEMBER 5 NEGATIVE -1 OSUPPORT JT. 4 POSITIVE -1 OTHE RATIO OF SUBSTRI IIAI-BDS Version 4.0 16:13:52 Page 36	263.8 198.6 0.13 Licensed tructure E-16-IN ; *** SPECIAL TRUCK LIVE LOA MAX. AXIAL L AXIALMOM LOAD TOP 282.2 0. 162.4 0. 611.8 0. -19.9 0. 611.8 0. -19.9 0. 611.8 0. 19.9 0. 611.8 0. 19.9 0. 611.8 1. Licensed	536.3 461 138.5 78 to: Colorado DO CSGCP ; SH-76 ; WITH 8 AXLES D SUPPORT RESULT OAD ENT BOT. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0	.0 380.9 .5 12.7 F Proj#I-761( WAS REQUESTE S MAX. LONG AXIAL LOAD 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.	313.9 -69.1 84) ;M.MC CD THIS LI SITUDINAL MOMEN TOP 0. 0. 0. 0. 0. 0. 0. 0. 0.	281.8 -153.9 HSENI 2/9 VE LOAD * MOMENT T BOT. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	249.7 217.7 -241.4 -331.1 Run time: 07-JUL-95 5 ** Run time: 07-JUL-95
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OPOS. V 844.0 751.2 NEG. V 350.2 311.0 IIAI-BDS Version 4.0 16:13:52 Page 35 OLL NO. 4. O USUPPORT JT. 1 POSITIVE 2 NEGATIVE -1 OMEMBER 4 POSITIVE 6 NEGATIVE -1 OMEMBER 5 POSITIVE 6 NEGATIVE -1 OMEMBER 5 OSUPPORT JT. 4 POSITIVE -1 OMEMBER 5 OSUPPORT JT. 4 POSITIVE -1 OMEMBER 5 NEGATIVE -1 OSUPPORT JT. 4 POSITIVE -1 OTHE RATIO OF SUBSTRI IIAI-BDS Version 4.0 16:13:52 Page 36	263.8 198.6 0.13 Licensed tructure E-16-IN ; *** SPECIAL TRUCK MAX. AXIAL L AXIALMOM LOAD TOP 282.2 0. 162.4 0. 611.8 0. -19.9 0. 611.8 0. -19.9 0. 611.8 0. 282.2 0. 162.4 0. UCTURE / SUPERSTRU 0.13 Licensed tructure E-16-IN ;	536.3 461 138.5 78 to: Colorado DO CSGCP ; SH-76 ; WITH 8 AXLES D SUPPORT RESULT OAD ENT BOT. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0	.0 380.9 .5 12.7 F Proj#I-761( WAS REQUESTE S MAX. LONG AXIAL LOAD 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.	313.9 -69.1 84) ;M.MC CD THIS LI SITUDINAL MOMEN TOP 0. 0. 0. 0. 0. 0. 0. 0. 0.	281.8 -153.9 HSENI 2/9 VE LOAD * MOMENT T BOT. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	249.7 217.7 -241.4 -331.1 Run time: 07-JUL-95 5 ** Run time: 07-JUL-95
0POS. V       844.0       751.2         NEG. V       350.2       311.0         1IAI-BDS       Version 4.0         16:13:52       Page 35         OLL NO. 4.       0         0       7         0SUPPORT JT. 1       1         0SUPPORT JT. 1       1         0MEMBER       4         0MEMBER       4         0MEGATIVE       -1         0MEMBER       5         0SUPPORT JT. 4       POSITIVE         0MEMBER       -10         0SUPPORT JT. 4       POSITIVE         0SUPPORT JT. 4       -10         0SUPPORT JT. 4       -10         0SUPPORT JT. 4       -10         0SUPPORT JT. 4       -10         1IAI-BDS       Version 4.0         16:13:52       Page 36         0       St         0       PRESTRESS COMBINATION	263.8 198.6 0.13 Licensed tructure E-16-IN ; *** SPECIAL TRUCK MAX. AXIAL L AXIALMOM LOAD TOP 282.2 0. 162.4 0. 611.8 0. -19.9 0. 611.8 0. -19.9 0. 611.8 0. 282.2 0. 162.4 0. UCTURE / SUPERSTRU 0.13 Licensed tructure E-16-IN ; ION DATA	536.3 461 138.5 78 to: Colorado DO CSGCP ; SH-76 ; WITH 8 AXLES D SUPPORT RESULT OAD ENT BOT. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0	.0 380.9 .5 12.7 F Proj#I-761( WAS REQUESTE S MAX. LONG AXIAL LOAD 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.	313.9 -69.1 84) ;M.MC CD THIS LI SITUDINAL MOMEN TOP 0. 0. 0. 0. 0. 0. 0. 0. 0.	281.8 -153.9 HSENI 2/9 VE LOAD * MOMENT T BOT. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	249.7 217.7 -241.4 -331.1 Run time: 07-JUL-95 5 ** Run time: 07-JUL-95
0POS. V       844.0       751.2         NEG. V       350.2       311.0         1IAI-BDS       Version 4.0         16:13:52       Page       35         0LL NO. 4.       0       1         0SUPPORT JT. 1       POSITIVE       1         0MEMBER       4       9         0MEMBER       5       POSITIVE       6         NEGATIVE       -1       0       1         0MEMBER       5       POSITIVE       6         NEGATIVE       -1       0       0         0SUPPORT JT. 4       POSITIVE       2       1         0SUPPORT JT. 4       POSITIVE       1       2         0       THE RATIO OF SUBSTRUE       1       0       16:13:52       Page       36         0       PRESTRESS COMBINATION       36       35       35         0       NO PRESTRESS COMBINATION       10       10       10       10	263.8 198.6 0.13 Licensed tructure E-16-IN ; *** SPECIAL TRUCK LIVE LOA MAX. AXIAL L AXIALMOM LOAD TOP 282.2 0. 162.4 0. 611.8 0. -19.9 0. 611.8 0. -19.9 0. 611.8 0. 19.9 0. 611.8 0. 19.9 0. 611.8 0. 19.9 0. 611.8 1. UCTURE / SUPERSTRU 0.13 Licensed tructure E-16-IN ; ION DATA NATION DATA GIVEN	536.3 461 138.5 78 to: Colorado DO CSGCP ; SH-76 ; WITH 8 AXLES D SUPPORT RESULT OAD ENT BOT. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0	.0 380.9 .5 12.7 F Proj#I-761( WAS REQUESTE S MAX. LONG AXIAL LOAD 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.	313.9 -69.1 84) ;M.MC CD THIS LI SITUDINAL MOMEN TOP 0. 0. 0. 0. 0. 0. 0. 0. 84) ;M.MC	281.8 -153.9 HSENI 2/9 VE LOAD * MOMENT T BOT. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	249.7 217.7 -241.4 -331.1 Run time: 07-JUL-95 5 ** Run time: 07-JUL-95
0POS. V       844.0       751.2         NEG. V       350.2       311.0         1IAI-BDS       Version 4.0         16:13:52       Page 35         OLL NO. 4.       0         0       7         0SUPPORT JT. 1       1         0SUPPORT JT. 1       1         0MEMBER       4         0MEMBER       4         0MEGATIVE       -1         0MEMBER       5         0SUPPORT JT. 4       POSITIVE         0MEMBER       -10         0SUPPORT JT. 4       POSITIVE         0SUPPORT JT. 4       -10         0SUPPORT JT. 4       -10         0SUPPORT JT. 4       -10         0SUPPORT JT. 4       -10         1IAI-BDS       Version 4.0         16:13:52       Page 36         0       St         0       PRESTRESS COMBINATION	263.8 198.6 0.13 Licensed tructure E-16-IN ; *** SPECIAL TRUCK MAX. AXIAL L AXIALMOM LOAD TOP 282.2 0. 162.4 0. 611.8 0. -19.9 0. 611.8 0. -19.9 0. 611.8 0. 19.9 0. 6282.2 0. 162.4 0. UCTURE / SUPERSTRU 0.13 Licensed tructure E-16-IN ; ION DATA NATION DATA GIVEN 1 ' RESULTS USED FO.	536.3 461 138.5 78 to: Colorado DO CSGCP ; SH-76 ; WITH 8 AXLES D SUPPORT RESULT OAD ENT BOT. 0. 0. 0. 0. 0. 0. 0. 0. CTURE LOADING IS to: Colorado DO CSGCP ; SH-76 ; SO DEFAULTS WERE R P/S DESIGN AND	.0 380.9 .5 12.7 F Proj#I-761( WAS REQUESTE S MAX. LONG AXIAL LOAD 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.	313.9 -69.1 84) ;M.MC CD THIS LI SITUDINAL MOMEN TOP 0. 0. 0. 0. 0. 0. 0. 0. 84) ;M.MC	281.8 -153.9 HSENI 2/9 VE LOAD * MOMENT T BOT. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	249.7 217.7 -241.4 -331.1 Run time: 07-JUL-95 5 ** Run time: 07-JUL-95
0POS. V       844.0       751.2         NEG. V       350.2       311.0         1IAI-BDS       Version 4.0         16:13:52       Page 35         OLL NO. 4.       0         0       1         0SUPPORT JT. 1       1         POSITIVE       0         0MEMBER       4         POSITIVE       6         NEGATIVE       -1         0MEMBER       5         POSITIVE       6         NEGATIVE       -1         0MEMBER       5         0SUPPORT JT. 4       2         NEGATIVE       -1         0SUPPORT JT. 4       2         POSITIVE       -1         0SUPPORT JT. 4       2         NEGATIVE       -1         0       THE RATIO OF SUBSTRUE         1AI-BDS       Version 4.0         16:13:52       Page 36         St       0         0       PRESTRESS COMBINATION         0       NO PRESTRESS COMBINATION         0       NO PRESTRESS COMBINATION         0       LIVE LOAD NUMBER '1	263.8 198.6 0.13 Licensed tructure E-16-IN ; *** SPECIAL TRUCK MAX. AXIAL L AXIALMOM LOAD TOP 282.2 0. 162.4 0. 611.8 0. -19.9 0. 611.8 0. -19.9 0. 611.8 0. 19.9 0. 6282.2 0. 162.4 0. UCTURE / SUPERSTRU 0.13 Licensed tructure E-16-IN ; ION DATA NATION DATA GIVEN 1 ' RESULTS USED FO.	536.3 461 138.5 78 to: Colorado DO CSGCP ; SH-76 ; WITH 8 AXLES D SUPPORT RESULT OAD ENT BOT. 0. 0. 0. 0. 0. 0. 0. 0. CTURE LOADING IS to: Colorado DO CSGCP ; SH-76 ; SO DEFAULTS WERE R P/S DESIGN AND	.0 380.9 .5 12.7 F Proj#I-761( WAS REQUESTE S MAX. LONG AXIAL LOAD 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.	313.9 -69.1 84) ;M.MC CD THIS LI SITUDINAL MOMEN TOP 0. 0. 0. 0. 0. 0. 0. 0. 84) ;M.MC	281.8 -153.9 HSENI 2/9 VE LOAD * MOMENT T BOT. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	249.7 217.7 -241.4 -331.1 Run time: 07-JUL-95 5 ** Run time: 07-JUL-95
OPOS. V 844.0 751.2 NEG. V 350.2 311.0 IIAI-BDS Version 4.0 16:13:52 Page 35 OLL NO. 4. O OSUPPORT JT. 1 POSITIVE 2 NEGATIVE -1 OMEMBER 4 POSITIVE 6 NEGATIVE -1 OMEMBER 5 POSITIVE 6 NEGATIVE -1 OMEMBER 5 POSITIVE 6 NEGATIVE -1 OMEMBER 5 POSITIVE 6 NEGATIVE -1 OMEMBER 5 POSITIVE 6 NEGATIVE -1 O THE RATIO OF SUBSTRUMENTION 16:13:52 Page 36 State O PRESTRESS COMBINATION O NO PRESTRESS COMBINATION O NO PRESTRESS COMBINATION O LIVE LOAD NUMBER '1 ALSO WILL BE CHECKE	263.8       198.6         0.13       Licensed         tructure E-16-IN ;         *** SPECIAL TRUCK `         LIVE LOA         MAX. AXIAL L         AXIALMOM         LOAD TOP         282.2       0.         162.4       0.         611.8       0.         -19.9       0.         611.8       0.         -19.9       0.         282.2       0.         162.4       0.         UCTURE / SUPERSTRU         0.13       Licensed         tructure E-16-IN ;         ION DATA         NATION DATA GIVEN H         ' RESULTS USED FO         ED TO DETERMINE TH	536.3 461 138.5 78 to: Colorado DO CSGCP ; SH-76 ; WITH 8 AXLES D SUPPORT RESULT DAD ENT BOT. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0	.0 380.9 .5 12.7 F Proj#I-761( WAS REQUESTE S MAX. LONG AXIAL LOAD 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.	313.9 -69.1 84) ;M.MC 2D THIS LI SITUDINAL MOMEN TOP 0. 0. 0. 0. 0. 0. 0. 0. 84) ;M.MC LOADS, IF	281.8 -153.9 HSENI 2/9 VE LOAD * BOT. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	249.7 217.7 -241.4 -331.1 Run time: 07-JUL-95 5 ** Run time: 07-JUL-95 5
0POS. V       844.0       751.2         NEG. V       350.2       311.0         1IAI-BDS       Version 4.0         16:13:52       Page 35         OLL NO. 4.       0         0       1         0SUPPORT JT. 1       1         POSITIVE       0         0MEMBER       4         POSITIVE       6         NEGATIVE       -1         0MEMBER       5         POSITIVE       6         NEGATIVE       -1         0MEMBER       5         0SUPPORT JT. 4       2         NEGATIVE       -1         0SUPPORT JT. 4       2         POSITIVE       -1         0SUPPORT JT. 4       2         NEGATIVE       -1         0       THE RATIO OF SUBSTRUE         1AI-BDS       Version 4.0         16:13:52       Page 36         St       0         0       PRESTRESS COMBINATION         0       NO PRESTRESS COMBINATION         0       NO PRESTRESS COMBINATION         0       LIVE LOAD NUMBER '1	263.8       198.6         0.13       Licensed         tructure E-16-IN ;         *** SPECIAL TRUCK '         LIVE LOA         MAX. AXIAL L         AXIALMOM         LOAD         282.2       0.         162.4       0.         611.8       0.         -19.9       0.         282.2       0.         162.4       0.         611.8       0.         -19.9       0.         282.2       0.         162.4       0.         0.13       Licensed         UCTURE / SUPERSTRU         0.13       Licensed         tructure E-16-IN ;         ION DATA         NATION DATA GIVEN :         1' RESULTS USED FO         ED TO DETERMINE TH         ES ARE BEING USED	536.3 461 138.5 78 to: Colorado DO CSGCP ; SH-76 ; WITH 8 AXLES D SUPPORT RESULT DAD ENT BOT. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0	.0 380.9 .5 12.7 F Proj#I-761( WAS REQUESTE S MAX. LONG AXIAL LOAD 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.	313.9 -69.1 84) ;M.MC 2D THIS LI SITUDINAL MOMEN TOP 0. 0. 0. 0. 0. 0. 0. 0. 84) ;M.MC LOADS, IF	281.8 -153.9 HSENI 2/9 VE LOAD * BOT. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	249.7 217.7 -241.4 -331.1 Run time: 07-JUL-95 5 ** Run time: 07-JUL-95 5

L.L. LOAD FACTOR: 2.17 OR 1.30

PHI FACTOR FOR SHEAR : 0.90

PHI FACTOR FOR MOMENT: 0.95

0       LL NO. 1       ULTIMATE MOMENT APPLIED = 1.30 X (DL+ADL) + 2.17 X (LL+I) + 1.00 X (P/S SEC. MOMENT)         0       LL NO. 2       ULTIMATE MOMENT APPLIED = 1.30 X (DL+ADL) + 2.17 X (LL+I) + 1.00 X (P/S SEC. MOMENT)         0       LL NO. 4       ULTIMATE MOMENT APPLIED = 1.30 X (DL+ADL) + 1.30 X (LL+I) + 1.00 X (P/S SEC. MOMENT)         0       LL NO. 1       ULTIMATE SHEAR APPLIED = 1.30 X (DL+ADL) + 2.17 X (LL+I) + 1.00 X (P/S SEC. SHEAR)         0       LL NO. 2       ULTIMATE SHEAR APPLIED = 1.30 X (DL+ADL) + 2.17 X (LL+I) + 1.00 X (P/S SEC. SHEAR)         0       LL NO. 4       ULTIMATE SHEAR APPLIED = 1.30 X (DL+ADL) + 2.17 X (LL+I) + 1.00 X (P/S SEC. SHEAR)         0       LL NO. 4       ULTIMATE SHEAR APPLIED = 1.30 X (DL+ADL) + 1.30 X (LL+I) + 1.00 X (P/S SEC. SHEAR)         1IAI-BDS       Version 4.0.13       Licensed to: Colorado DOT
16:13:52
0INPUT PRESTRESSED DATA OTRIAL 1 FRAME 1 PATH 01 0 MEM
NO.         LLT/X         LLP/Y         LRT/Z         YLT/TYPE         YLP/SLOPE         YRT         U         K           0         1         0.00         0.50         0.25         1.10         1.00         0.25         0.0002
0 2 0.20 0.50 0.20 1.00 3.17 1.00 0.25 0.0002 0 3 0.25 0.50 0.00 1.00 1.10 1.10 0.25 0.0002
0XLT(FT) =0.0STEEL STRESS(KSI) =270. JACKING % =0.75 JACKING ENDS =B0ANCHOR SET(IN); LEFT =0.625 RIGHT =0.625 CONC. STRENGTH(PSI) =4500. ALLOW. TENSION(PSI) =-402.0P-JACK(KIPS) =6865. SHORTENING PERCENT=50 TOTAL LOSSES(KSI) =38 RELATIVE HUMIDITY % =60.0LOW-LAX =NOPLOT PATHS =NOPLOT STRESSES =NO
OCABLE PATH OFFSETS OMEMBER LEFT .1 PT .2 PT .3 PT .4 PT .5 PT .6 PT .7 PT .8 PT .9 PT RIGHT
0 1 1.10 1.10 1.10 1.10 1.10 1.10 1.09 1.07 1.03 1.01 1.00 0 2 1.00 1.22 1.87 2.59 3.03 3.17 3.03 2.59 1.87 1.22 1.00
0 3 1.00 1.01 1.03 1.07 1.09 1.10 1.10 1.10 1.10 1.10 1.10 1.10
0 1 0.094 0.094 0.094 0.094 0.094 -0.034 -0.171 -0.324 -0.489 -0.642 -0.751 0 2 -0.751 -0.006 0.862 1.586 2.020 2.164 2.020 1.586 0.862 -0.006 -0.751 0 3 -0.751 -0.642 -0.489 -0.324 -0.171 -0.034 0.094 0.094 0.094 0.094 0.094
OFORCE         COEFFICIENTS           0         1         0.697         0.698         0.699         0.700         0.701         0.702         0.704         0.705         0.707         0.709         0.710
0 2 0.710 0.721 0.732 0.739 0.747 0.754 0.747 0.739 0.732 0.721 0.710 0 3 0.710 0.709 0.707 0.705 0.704 0.702 0.701 0.700 0.699 0.698 0.697 0THE POINT OF NO MOVEMENT FOR PRESTRESSING IS IN SPAN 2, 58.50 FEET FROM THE LEFT END OF THE SPAN
0THE FOLM OF NO NOVEMENT FOR PRESERVESTING IS IN SPAN 2, 50.50 FEET FROM THE LEFT END OF THE SPAN         0THE LEFT ANCHOR SET LENGTH IS 103.99         0THE FORCE COEF. AT THE LEFT END IS 0.697
01NITAL FORCE COEFF. AT POINT OF NO MOVEMENT = 0.942
0 ***** CONSIDER ONE END JACKING AS TWO END JACKING IS NOT VERY ECONOMICAL IN THIS PROBLEM. ***** 11AI-BDS Version 4.0.13 Licensed to: Colorado DOT Run time: 07-JUL-95
16:13:53 Page 38
Structure E-16-IN ; CSGCP ; SH-76 ; Proj#I-761(84) ;M.MOHSENI 2/95 OSECONDARY MOMENT DUE TO PJACK = 1 OTRIAL 1 FRAME 1 PATH 01
Structure E-16-IN ; CSGCP ; SH-76 ; Proj#I-761(84) ;M.MOHSENI 2/95 OSECONDARY MOMENT DUE TO PJACK = 1 OTRIAL 1 FRAME 1 PATH 01 FEM'S DUE TO SECONDARY EFFECTS BEFORE BALANCING
Structure E-16-IN ; CSGCP ; SH-76 ; Proj#I-761(84) ;M.MOHSENI 2/95         OSECONDARY MOMENT DUE TO PJACK = 1         OTRIAL 1 FRAME 1 PATH 01         FEM'S DUE TO SECONDARY EFFECTS BEFORE BALANCING         MEMBER       LEFT END         RIGHT END       MEMBER         0       1       0.000         -0.231       2       0.951       3         -0.231       0.000
Structure E-16-IN ; CSGCP ; SH-76 ; Proj#I-761(84) ;M.MOHSENI 2/95 OSECONDARY MOMENT DUE TO PJACK = 1 OTRIAL 1 FRAME 1 PATH 01 FEM'S DUE TO SECONDARY EFFECTS BEFORE BALANCING MEMBER LEFT END RIGHT END MEMBER LEFT END RIGHT END MEMBER LEFT END RIGHT END 0 1 0.000 -0.231 2 0.951 3 -0.231 0.000 0 DEM'S DUE TO SECONDARY EFFECTS UNIT = K-FT 0 1 0.000 0.813 2 0.813 0.813 3 0.813 0.000 €
Structure E-16-IN ; CSGCP ; SH-76 ; Proj#I-761(84) ;M.MOHSENI 2/95 OSECONDARY MOMENT DUE TO PJACK = 1 OTRIAL 1 FRAME 1 PATH 01 FEM'S DUE TO SECONDARY EFFECTS BEFORE BALANCING MEMBER LEFT END RIGHT END MEMBER LEFT END RIGHT END MEMBER LEFT END RIGHT END 0 1 0.000 -0.231 2 0.951 0.951 3 -0.231 0.000 0 DEM'S DUE TO SECONDARY EFFECTS UNIT = K-FT 0 1 0.000 0.813 2 0.813 0.813 3 0.813 0.000 €
Structure E-16-IN ; CSGCP ; SH-76 ; Proj#I-761(84) ;M.MOHSENI 2/95 OSECONDARY MOMENT DUE TO PJACK = 1 OTRIAL 1 FRAME 1 PATH 01 FEM'S DUE TO SECONDARY EFFECTS BEFORE BALANCING MEMBER LEFT END RIGHT END MEMBER LEFT END RIGHT END MEMBER LEFT END RIGHT END 0 1 0.000 -0.231 2 0.951 0.951 3 -0.231 0.000 0 DEM'S DUE TO SECONDARY EFFECTS UNIT = K-FT 0 1 0.000 0.813 2 0.813 0.813 3 0.813 0.000 0 DEM'S DUE TO SECONDARY EFFECTS IN COLUMN UNIT = K-FT 0 4 0.000 0.000 5 0.000 0.000 0P/S MOMENT COEF. *** FRAME DOES NOT SWAY WITH THIS LOADING. *** ADJUSTED FOR LOSSES & SECONDARY MOMENTS BUT NO SHORTENING
Structure E-16-IN ; CSGCP ; SH-76 ; Proj#I-761(84) ;M.MOHSENI 2/95 OSECONDARY MOMENT DUE TO PJACK = 1 OTRIAL 1 FRAME 1 PATH 01 FEM'S DUE TO SECONDARY EFFECTS BEFORE BALANCING MEMBER LEFT END RIGHT END MEMBER LEFT END RIGHT END MEMBER LEFT END RIGHT END 0 1 0.000 -0.231 2 0.951 3 -0.231 0.000 0 DEM'S DUE TO SECONDARY EFFECTS UNIT = K-FT 0 1 0.000 0.813 2 0.813 0.813 3 0.813 0.000 ( 0 DEM'S DUE TO SECONDARY EFFECTS IN COLUMN UNIT = K-FT 0 4 0.000 0.000 5 0.000 0.000 0 P/S MOMENT COEF. *** FRAME DOES NOT SWAY WITH THIS LOADING. *** ADJUSTED FOR LOSSES & SECONDARY MOMENTS BUT NO SHORTENING MEM NO LEFT .1 PT .2 PT .3 PT .4 PT .5 PT .6 PT .7 PT .8 PT .9 PT RIGHT
Structure E-16-IN ; CSGCP ; SH-76 ; Proj#I-761(84) ;M.MOHSENI 2/95         OSECONDARY MOMENT DUE TO PJACK = 1         OTRIAL 1 FRAME 1 PATH 01         FEM'S DUE TO SECONDARY EFFECTS BEFORE BALANCING         MEMBER LEFT END RIGHT END MEMBER LEFT END RIGHT END MEMBER LEFT END RIGHT END         0       1       0.000       -0.231       2       0.951       3       -0.231       0.000         0       1       0.000       0.813       2       0.813       0.813       3       0.813       0.000         0       1       0.000       0.813       2       0.813       0.813       3       0.813       0.000       €         0       1       0.000       0.813       2       0.813       0.813       3       0.813       0.000       €         0       1       0.000       0.813       2       0.813       0.813       3       0.000       €         0       4       0.000       0.000       5       0.000       0.000       €       €         *** FRAME DOES NOT SWAY WITH THIS LOADING. ***         ADJUSTED FOR LOSSES & SECONDARY MOMENTS BUT NO SHORTENING         MEM       NO       LEFT       .1 PT
Structure E-16-IN ; CSGCP ; SH-76 ; Proj#I-761(84) ;M.MOHSENI 2/95         OSECONDARY MOMENT DUE TO PJACK = 1         OTRIAL 1 FRAME 1 PATH 01         FEM'S DUE TO SECONDARY EFFECTS BEFORE BALANCING         MEMBER LEFT END RIGHT END MEMBER LEFT END RIGHT END MEMBER LEFT END RIGHT END 0 1 0.000 0.813 2 0.951 0.951 3 -0.231 0.000         0 1 0.000 0.813 2 0.813 0.813 3 0.813 0.000 €         0 1 0.000 0.813 2 0.813 0.813 3 0.813 0.000 €         0 1 0.000 0.813 2 0.813 0.813 3 0.813 0.000 €         0 1 0.000 0.813 2 0.813 0.813 3 0.813 0.000 €         0 1 0.000 0.813 2 0.813 0.813 3 0.813 0.000 €         0 1 0.000 0.813 2 0.813 0.813 3 0.813 0.000 €         0 MEM'S DUE TO SECONDARY EFFECTS IN COLUMN UNIT = K-FT         0 JEM'S DUE TO SECONDARY EFFECTS IN COLUMN UNIT = K-FT         0 MEM'S DUE TO SECONDARY EFFECTS IN COLUMN UNIT = K-FT         0 MEM'S DUE TO SECONDARY MOMENTS BUT NO SHORTENING         *** FRAME DOES NOT SWAY WITH THIS LOADING. ***         ADJUSTED FOR LOSSES & SECONDARY MOMENTS BUT NO SHORTENING         MEM       NO         NO LEFT .1 PT .2 PT .3 PT .4 PT .5 PT .6 PT .7 PT .8 PT .9 PT RIGHT         0 1 -0.0659 0.0153 0.0965 0.1778 0.2590 0.4307 0.6084 0.7979 0.9963 1.1868 1.3466
Structure E-16-IN ; CSGCP ; SH-76 ; Proj#I-761(84) ;M.MOHSENI 2/95         OSECONDARY MOMENT DUE TO PJACK = 1         OTRIAL 1 FRAME 1 PATH 01         FEM'S DUE TO SECONDARY EFFECTS BEFORE BALANCING         MEMBER LEFT END RIGHT END MEMBER LEFT END RIGHT END MEMBER LEFT END RIGHT END         0       1       0.000       -0.231       2       0.951       3       -0.231       0.000         0       1       0.000       -0.813       2       0.951       3       -0.231       0.000         0       1       0.000       -0.813       2       0.951       3       -0.231       0.000         0       1       0.000       0.813       2       0.951       3       -0.231       0.000         0       1       0.000       0.813       2       0.813       0.813       3       0.813       0.000         0       4       0.000       0.000       5       0.000       0.000       0.000       €         0       4       0.000       5       0.000       0.000       €       0.000       €       0.000       €       0.000       €       0.000       €       €        €       €       E
Structure E-16-IN ; CSGCP ; SH-76 ; Proj#I-761(84) ;M.MOHSENI 2/95         OSECONDARY MOMENT DUE TO PJACK = 1         OTRIAL 1 FRAME 1 PATH 01         FEM'S DUE TO SECONDARY EFFECTS BEFORE BALANCING         MEMBER LEFT END RIGHT END MEMBER LEFT END RIGHT END MEMBER LEFT END RIGHT END 0 1 0.000 -0.231 2 0.951 0.951 3 -0.231 0.000         0       DEM'S DUE TO SECONDARY EFFECTS UNIT = K-FT         0       1 0.000 0.813 2 0.813 0.813 3 0.000 €         0       DEM'S DUE TO SECONDARY EFFECTS IN COLUMN UNIT = K-FT         0       4 0.000 0.000 5 0.000 0.000         0       DEM'S DUE TO SECONDARY EFFECTS IN COLUMN UNIT = K-FT         0       4 0.000 0.000 5 0.000 0.000         0       DEM'S DUE TO SECONDARY EFFECTS IN COLUMN UNIT = K-FT         0       4 0.000 0.000 5 0.000 0.000         0       DEM'S DUE TO SECONDARY EFFECTS IN COLUMN UNIT = K-FT         0       4 0.000 0.000 5 0.000 0.000         0       DEM'S DUE TO SECONDARY EFFECTS IN COLUMN UNIT = K-FT         0       A 0.000 0.000 5 0.000 0.000         01       -0.0559 0.0153 0.0965 0.1778 0.2590 0.4307 0.6084 0.7979 0.9963 1.1868 1.3466         01       -0.0659 0.0153 0.0965 0.1778 0.2590 0.4307 0.6084 0.7979 0.9963 1.1868 1.3466         03       1.3466 1.1868 0.9963 0.7979 0.6084 0.4307 0.2590 0.1778 0.1818 0.8172 1.3466         03       1.3466 1.1868 0.
Structure E-16-IN ; CSGCP ; SH-76 ; Proj#I-761(84) ;M.MOHSENI 2/95         OSECONDARY MOMENT DUE TO PJACK = 1         OTRIAL 1 FRAME 1 PATH 01         FEM'S DUE TO SECONDARY EFFECTS BEFORE BALANCING         MEMBER       LEFT END RIGHT END MEMBER         LEFT END RIGHT END MEMBER       LEFT END RIGHT END RIGHT END MEMBER         0       0.000         0       1         0       1         0       0.0153         0.0965       0.1778
Structure E-16-IN ; CSGCP ; SH-76 ; Proj#I-761(84) ;M.MOHSENI 2/95           OSECONDARY MOMENT DUE TO PJACK = 1           OTRIAL 1 FRAME 1 PATH 01           FEM'S DUE TO SECONDARY EFFECTS BEFORE BALANCING           MEMBER LEFT END RIGHT END MEMBER LEFT END RIGHT END MEMBER LEFT END RIGHT END 0 1 0.000 -0.231 2 0.951 3 -0.231 0.000           0 1 0.000 0.813 2 0.813 0.813 3 0.813 0.813 0.000 €           0 1 0.000 0.813 2 0.813 0.813 3 0.813 0.813 €           0 4 0.000 0.000 5 0.000 0.000           0 5 0.000 0.000 5           0 4 0.000 0.000 5           0 0 0.000 5           0 0 0.000 5           0 0 0.000 5           0 0 0.000 5           0 0 0.000 5           0 0 0.000 5           0 0 0.000 5           0 0 0.000 5           0 0 0.000 5           0 0 0.000 5           0 0 0.000 5           0 0 0.000 5           0 0 0.000 5           0 0 0.000 5           0 0 0.000 5           0 0 0.000 5           0 1 -0.0659 0.0153 0.0965 0.1778 0.2590 0.4307 0.6084 0.7979 0.9963 1.1868 1.3466           0 2 1.3466 0.8172 0.1818 -0.3589 -0.6960 -0.8201 -0.6960 -0.3589 0.1818 0.8172 1.3466           0 3 1.3466 1.1868 0.9963 0.7979 0.6084 0.4307 0.2590 0.1778 0.0965 0.0153 -0.0659           1IAI-BDS Version 4.0.13 Licensed to: Colorado DOT
Structure E-16-IN ; CSGCP ; SH-76 ; Proj#I-761(84) ;M.MOHSENI 2/95           OSECONDARY MOMENT DUE TO PJACK = 1         0           OTRIAL 1 FRAME 1 PATH 01         FEM'S DUE TO SECONDARY EFFECTS BEFORE BALANCING           MEMBER LEFT END RIGHT END MEMBER LEFT END RIGHT END MEMBER LEFT END RIGHT END DEM'S DUE TO SECONDARY EFFECTS UNIT = K-FT           0         1         0.000         -0.231         2         0.951         3         -0.231         0.000           0         1         0.000         -0.813         2         0.813         3         0.813         0.000           0         0         0.000         0.813         2         0.813         3         0.813         0.000         €           0         0         0.000         0.813         2         0.813         3         0.813         0.000         €           0         0         0.000         0.000         0.000         €
Structure E-16-IN ; CSGCP ; SH-76 ; Proj#I-761(84) ;M.MOHSENI 2/95           OSECONDARY MOMENT DUE TO PJACK = 1           UTRIAL 1 FRAME 1 PATH 01           FEM'S DUE TO SECONDARY EFFECTS BEFORE BALANCING           MEMBER LEFT END RIGHT END MEMBER LEFT END RIGHT END MEMBER LEFT END RIGHT END           0         0.000           0         0.000           0         0.000           0         0.000           0         0.000           0         0.000           0         0.000           0         0.000           0         0.000           0         0.000           0         0.000           0         0.000           0         0.000           0         0.000           0         0.000           0         0           0         0.000           0         0.000           0         0.000           0         0.000           0         0.000           0         0.000           0         0.000           0         0.000           0         0.005           0         0.053           0
Structure E-16-IN ; CSGCP ; SH-76 ; Proj#I-761(84) ;M.MOHSENI 2/95           OSECONDARY MOMENT DUE TO FJACK = 1           OTRIAL 1         FRAME 1           PATH 01           FEM'S DUE TO SECONDARY EFFECTS BEFORE BALANCING           MEMBER         LEFT END           NEMBER         LEFT END           NEM 2         0.951           0         0.000           0         0.000           0         0.000           0         0.000           0         0.000           0         0.000           0         0.000           0         0.000           0         0.000           0         0.000           0         0.000           0         0.000           0         0.000           0         0.000           0         0.000           0         0.000           0         0.000           0         0.0153           0.0
Structure E-16-IN ; CSGCP ; SH-76 ; Proj#I-761(84) ;M.MOHSENI 2/95           OSECONDARY MOMENT DUE TO PJACK = 1           ITEND TO ETO PJACK = 1           SECONDARY EFFECTS BEFORE BALANCING           MEMBER LEFT END RIGHT END MEMBER LEFT END RIGHT END           0 0.000 0.231 2 0.951 3 -0.231 0.000           DEM'S DUE TO SECONDARY EFFECTS UNIT = K-FT           0 1 0.000 0.813 2 0.813 0.813 3 0.813 0.000 (0)           0 0.813 0.000 0.000 0.000 0.000 0.000 (0)           DEM'S DUE TO SECONDARY EFFECTS IN COLUMN UNIT = K-FT           0 0.000 0.000 0.000 0.000 0.000 (0)           0.813 0.813 0.813 0.000 (0)           0.000 0.000 0.000 0.000 (0)           DEM'S DUE TO SECONDARY EFFECTS IN COLUMN UNIT = K-FT           0.000 0.000 0.000 (0)           0.000 0.000 0.000 (0)           0.0813 0.0965 0.000 (0)           0.0813 0.0965 0.1778 0.2590 0.4307 0.0604 0.7979 0.9963 1.1868 1.3466           0.1353 0.0965 0.1778 0.2590 0.4307 0.2590 0.1778 0.0965 0.0153 -0.0659           ILAT IN COLUMNS DUE TO SHORTENING - FJACK=1           OTH A FEM           OLOSSES & Structure E-16-IN ; CSGCP ; SH-76 ; Proj#I-761(84) ;M.MOHSENI 2/95           OFEMS DELTAS IN COLUMNS DUE TO SHOR

16:13:53 Page 40 Structure E-16-IN ; CSGCP ; SH-76 ; Proj#I-761(84) ; M.MOHSENI 2/95 DELTAS IN COLUMNS DUE TO SHORTENING - PJACK=1 OFEMS OTRIAL = 1 FRAME =1 PATH =01 0 MEM FEM FEM DELTA TOP OF COL LT. END RT. END (POSITIVE TO RIGHT) --- UNIT = FT NO 0 -0.01509158 0.00000000 0 00000161 4 0 5 0.01509158 0.00000000 -0.00000161 0\*\*\*\*\* POINT OF NO MOVEMENT FOR STRUCTURE SHORTENING IS, 58.5 FEET FROM THE LEFT END OF SPAN 2 \* \* \* \* \* \*\*\*\*\* INFORMATION PROVIDED ABOVE ALSO CAN BE USED AS AN AID TO DETERMINE THE MOVEMENT RATING "MR". Version 4.0.13 Licensed to: Colorado DOT Run time: 07-JUL-95 1IAI-BDS 16:13:53 Page 41 Structure E-16-IN ; CSGCP ; SH-76 ; Proj#I-761(84) ; M.MOHSENI 2/95 OTRIAL 1 FRAME 1 PATH 01 OHORIZONTAL MEMBER STRESSES PRESTRESS ONLY BOTTOM FIBER AFTER ALL LOSSES (PSI) MEM .8 PT LEFT .1 PT .2 PT .3 PT .4 PT .5 PT .6 PT .7 PT .9 PT RIGHT NO -152. 0 1 891. 676. 460. 245. 30. -306. -459. -610. -741. -851. -851. 2620. 2620. -692. 0 2 -692. 267. 1714. 2958 1714 267. -851 03 -851 -741 -610 -459 -306 -152 30 245 460 676 891 OHORIZONTAL MEMBER STRESSES PRESTRESS ONLY TOP FIBER AFTER ALL LOSSES (PS1) 731. 810. 967. 1040. 1077. 1117 1151 1183 0 1 652. 889. 1006. 1217. 0 2 1183. 925. 414. 100. -12. 100. 414. 925. 1217. 1183. 1151. 1040. 0 3 1183. 1117. 1077. 1006. 967. 889. 810. 731. 652. 1IAI-BDS Version 4.0.13 Licensed to: Colorado DOT Run time: 07-JUL-95 16:13:53 Page 42 Structure E-16-IN ; CSGCP ; SH-76 ; Proj#I-761(84) ;M.MOHSENI 2/95 OTRIAL 1 FRAME 1 PATH 01 OHORIZONTAL MEMBER MOMENTS DUE TO P/S MEM .1 PT .2 PT NO LEFT .3 PT .4 PT .5 PT .6 PT .7 PT .8 PT .9 PT RIGHT 0 1 -452. 105. 663. 1220. 1778. 2957. 4177. 5477. 6839. 8147. 9245. 0 2 9245. 5610. 1248. -4778. -5630. -4778. 1248. -2464. -2464. 5610. 9245. 4177. 03 9245. 6839. 5477. 8147. 2957. 1778. 1220 663. 105. -452. OVERTICAL MEMBER MOMENTS DUE TO P/S MEM .4 PT .5 PT LEFT .2 PT .6 PT NO .1 PT .3 PT .7 PT .8 PT .9 PT RIGHT -73. 73. -83. -52. 0 4 -104. -93. 93. -62. -21. -10. -41. -31. 0 0 5 104. 83. 62. 52. 41. 31. 21. 10. Ο. OTANGENTIAL ROTATIONS - RADIANS - CLOCKWISE POSITIVE 
 SPAN
 LT. END
 RT. END

 1
 0.000926
 -0.001692

 4
 -0.000277
 0.000138
 SPAN LT. END 3 0.00169 SPAN LT. END RT. END RT. END 2 -0.001692 0.001692 -0.000138 0 0.001692 -0.0009265 4 -0.0002770.000138 0.000277 0 OHORIZONTAL MEMBER DEFLECTIONS IN FEET AT 1/ 4 POINTS FROM LEFT END - DOWNWARD POSITIVE 0.000 0.011 0.000 -0.092 MEMBER 1 E= 3865. MEMBER 2 E= 3865. 0 0.017 0.014 0.000 0 -0.165 -0.0920 000 Ω MEMBER 3 E= 3865 0 0 0 0 0 014 0 017 0 011 0 000 OVERTICAL MEMBER DEFLECTIONS IN FEET AT 1/ 4 POINTS FROM LEFT END. -0.001 MEMBER 4 E= 3250. MEMBER 5 E= 3250. 0.000 -0.001 -0.001 0 000 0 0.000 0.001 0.001 0.001 0.000 Version 4.0.13 Licensed to: Colorado DOT 1IAI-BDS Run time: 07-JUL-95 16:13:53 Page 43 Structure E-16-IN ; CSGCP ; SH-76 ; Proj#I-761(84) ; M.MOHSENI 2/95 OTRIAL 1 FRAME 1 OHORIZONTAL MEMBER STRESSES FOR ALL P/S PATHS BEFORE LOSSES BOTTOM FIBER (PSI) MEM .1 PT .4 PT .7 PT NO LEFT .2 PT .3 PT .5 PT .6 PT .8 PT .9 PT RIGHT 0 1 -926. 1131. 861. 591. 321. 51. -180. -376. -570. -760. -1065. 0 2 -860. 345. 2154. 3277. 3687. 3277. 2154. 345. -860. -1065.-1065.-926. -570. -376. 51. 591. 0 3 -1065. -760. -180. 321. 861. 1131. OHORIZONTAL MEMBER STRESSES FOR ALL P/S PATHS BEFORE LOSSES TOP FIBER (PSI) 828. 926. 1025. 1123. 1221. 1270. 1313. 1360. 1409 1452 1491 0 1 1491 0 2 1530 1159 518 125 -12 125 518 1159 1530 1491 1270. 03 1409. 1360. 1313. 926. 1491. 1452. 1221. 1123. 1025. 828. Run time: 07-JUL-95 1 TAT-BDS Version 4.0.13 Licensed to: Colorado DOT 16:13:53 Page 44 Structure E-16-IN ; CSGCP ; SH-76 ; Proj#I-761(84) ; M.MOHSENI 2/95 1 FRAME 1 OTRIAL. OHORIZONTAL MEMBER STRESSES FOR ALL P/S PATHS AFTER ALL LOSSES BOTTOM FIBER (PSI) MEM NO LEFT .1 PT .2 PT .3 PT .4 PT .5 PT .6 PT .7 PT .8 PT .9 PT RIGHT 0 1 460. 30. 891. 676. 245. -152. -306. -459. -610. -741. -851. -851. 1714. 2620. 267. -692. -851. 0 2 -692. 267. 2958. 2620. 1714. 0 3 -851. -741. -610. -459. -306. -152.30. 245. 460. 676. 891. 0 HORIZONTAL MEMBER STRESSES FOR ALL P/S PATHS AFTER ALL LOSSES TOP FIBER (PSI) 731. 810. 889. 1040. 1077. 1117. 1151. 1183. 652. 967. 1006. 0 1 0 2 1183. 1217. 925. 414. 100. 100. 414. 925. 1217. -12. 1183. 03 1183. 11.51. 1117. 1077 1040 1006 967 889 810. 731 652 1 TAT-BDS Version 4.0.13 Run time: 07-JUL-95 Licensed to: Colorado DOT 16:13:53 Page 45 Structure E-16-IN ; CSGCP ; SH-76 ; Proj#I-761(84) ; M.MOHSENI 2/95 OTRIAL 1 FRAME 1

OHORIZONTAL MEMBER STRESSES DL + P/S BEFORE ALL LOSSESBOTTOM FIBER (PSI)

NTTN/							
MEM NO LEFT .1 PT	.2 PT .3 PT	.4 PT .	5 PT .6 PT	.7 PT	.8 PT	.9 PT	RIGHT
0 1 1131. 920. 0 2 241. 115.	767. 671. 557. 1416.	632. 1976.	459. 355 2201. 1976		216. 557.	198. 115.	241. 241.
0 2 241. 115. 0 3 241. 198.	216. 275.	355.	459. 632		767.	920.	1131.
0HORIZONTAL MEMBER STR 0 1 828. 905.	ESSES DL + P/S BEF 961. 997.		ESTOP FIBER (1 1032. 1033		1018.	994.	953.
0 2 953. 1159.	1082. 783.	593.	523. 593		1018.	1159.	953.
0 3 953. 994.	1018. 1028.		1032. 1012	. 997.	961.	905.	828. time: 07-JUL-95
1IAI-BDS Version	4.0.13 License	d to: Colora	100 001			Run	LIME: 07-JUL-95
16:13:53 Page 46	Structure E-16-IN			761(04)	MOUGENT		
OTRIAL 1 FRAME 1 OHORIZONTAL MEMBER STR			2		MOHSENI 2	795	
MEM NO LEFT .1 PT	.2 PT .3 PT	.4 PT .	5 PT .6 PT	.7 PT	.8 PT	.9 PT	RIGHT
0 1 891. 735.	636. 595.	610.	488. 425	. 386.	367.	383.	455.
0 2 455. 283. 0 3 455. 383.	479. 976. 367. 386.	1319. 425.	1472. 1319 488. 610		479. 636.	283. 735.	455. 891.
OHORIZONTAL MEMBER STR	ESSES DL + P/S AFT	ER ALL LOSSE	S TOP FIBER (1	PSI)			
0 1 652. 710. 0 2 645. 847.	747. 763. 849. 680.	758. 568.	768. 760 523. 568		726. 849.	693. 847.	645. 645.
0 3 645. 693.	726. 746.	760.	768. 758	. 763.	747.	710.	652.
0 HORIZONTAL MEMBER STR 0 1 891. 758.		+ P/S AFTER 835.	ALL LOSSES BO 735. 708		(PSI) 741.	811.	949.
0 2 949. 653.		823.	904. 823		558.	653.	949. <del>&lt;</del>
0 3 949. 811.	741. 712.	708.	735. 835		704.	758.	891.
0 HORIZONTAL MEMBER STR 0 1 652. 702.	ESSES DL + ADDED DL 722. 714.	+ P/S AFTER 678.	676. 652		SI) 576.	519.	441.
0 2 441. 706.	820. 781.	746.	<mark>727</mark> . 746	. 781.	820.	706.	441. <del>&lt;</del>
0 3 441. 519. 1IAI-BDS Version	576. 618. 4 0 13 License	652. d to: Colora	676. 677	. 714.	722.	702. Run	652. time: 07-JUL-95
	1.0.15 License	a co- corora				itali	CIMC: 07 001 99
16:13:53 Page 47	Structure E-16-IN	: CSCCD : SH	-76 : Proi#I-'	761(84) :M	MOUSENT 2	/95	
OTRIAL 1 FRAME 1 OHORIZONTAL MEMBER STR MEM			-			./ 55	
NO LEFT .1 PT	.2 PT .3 PT	.4 PT .	5 PT .6 PT	.7 PT	.8 PT	.9 PT	RIGHT
0 1 891. 394. 0 2 895. 568.	9514. 131146.	28. -334.	156. 255 -351334		531. 131.	732. 568.	895. 895.
0 2 895. 508. 0 3 895. 732.	531. 383.	255.	156. 28		95.	394.	891.
0 HORIZONTAL MEMBER STR 0 1 652. 833.	ESSES DL + ADDED DL 941. 982.				PSI) 660.	551.	463.
0 2 463. 739.	974. 1084.	968. 1163.	892. 825 1179. 1163		974.	739.	463.
0 3 463. 551.	660. 747.	825.	892. 968		941.	833.	652.
0 HORIZONTAL MEMBER STR 0 1 891. 941.			1408. 1368		1422.	1512.	1684.
0 2 1684. 1273.	910. 847.	933.	991. 933		910.	1273.	1684.
0 3 1684. 1512. OHORIZONTAL MEMBER STR	1422. 1377. ESSES DL + ADDED D		1408. 1567 LL+ I + P/S I		1070. ER (PSI)	941.	891.
0 1 652. 636.	590. 517.	414.	425. 399	. 357.	304.	234.	138.
0 2 138. 471. 0 3 138. 234.	694. 726. 304. 357.	707. 399.	696. 707 425. 414		694. 590.	471. 636.	138. 652.
0**** MIN PJACK = 6	870. KIPS CONC STRE	NGTH AT 28 D	DAYS = 4210.	PSI AT STR	ESSING =	4001. P	SI ****
1IAI-BDS Version	4.0.13 License	d to: Colora	ido DOT			Run	time: 07-JUL-95
16.10.50 5 40							
16:13:53 Page 48	Structure E-16-IN	; CSGCP ; SH	[-76 ; Proi#I-'	761(84) ;M.	MOHSENI 2	/95	
OTOTAL PE MOMENTS FOR			- 5	. ,	_		
MEM NO LEFT .1 PT	.2 PT .3 PT	.4 PT .	5 PT .6 PT	.7 PT	.8 PT	.9 PT	RIGHT
0 1 -452. 105.	663. 1220.	1778. 2	957. 4177.	5477.	6839.	8147.	9245.
0 2 9245. 5610. 0 3 9245. 8147.		-47785 4177. 2	6304778. 957. 1778.	-2464. 1220.	1248. 663.	5610. 105.	9245. -452.
0 4 -10493.	-8373.	-62.	-5241.	-31.	-21.	-10.	0.
0 5 104. 93. OTOTAL P/S DEFLECTION	83. 73.	62.	52. 41.	31.	21.	10.	0.
0TANGENTIAL ROTATIONS	- RADIANS - CLOCKWI						
SPAN LT. END 0 1 0.000926	RT. END SPAN -0.001692 2		RT. END 0.001692		. END .001692	RT. END -0.00092	6
0 4 -0.000277	0.000138 5	0.000277	-0.000138	5 U	.001092	-0.00092	0
OHORIZONTAL MEMBER DEF						E	
			0.017 0.014 0.165 -0.092				
0 MEMBER 3 E=	3865. 0.000	0.014 0	0.017 0.012				
OVERTICAL MEMBER DEFLE 0 MEMBER 4 E=	CTIONS IN FEET AT 1 3250. 0.000						
0 MEMBER 5 E=	3250. 0.000	0.001 0	0.001 0.002				
1IAI-BDS Version	4.0.13 License	d to: Colora	do DOT			Run	time: 07-JUL-95
16:13:53 Page 49							
OTOTAL TOP PF FOR TRIA	Structure E-16-IN	; CSGCP ; SH	[-76 ; Proj#I-'	761(84) ;M.	MOHSENI 2	/95	
MEM			_	_			
NO LEFT .1 PT	.2 PT .3 PT	.4 PT .	5 PT .6 PT	.7 PT	.8 PT	.9 PT	RIGHT

0 1 0. 0. 0 2 4878. 4947. 0 3 4878. 4865. 0TOTAL BOTTOM PF FOR 0 1 4787. 4794. 0 2 0. 0. 0 3 0. 0. 1IAI-BDS Version	0. 4853. TRIAL 4800. 5025. 0.	0. 0. 0. 0. 4843. 4830. 4806. 4813. 5073. 5129. 0. 0. Licensed to: Co	4819. 0. 4819. 0. 5180. 0. lorado DOJ	4830. 0. 0. 5129. 4813.	4843. 0. 0. 5073. 4806.	4853. 0. 0. 5025. 4800.	4865. 4947. 0. 0. 0. 4794. Run ti	4878. 4878. 0. 0. 4787. ime: 07-JUL-95
16:13:53 <i>Page 50</i> 0	Structure E	TOTAL LOSS (K	LONG TERM	LOSSES		MOHSENI 2	/95	
MEM NO LEFT .1 PT 0 1 32.8 32. 0 2 31.7 33. 0 3 31.7 32. 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	8 32.8 7 35.8 0 32.2	.3 PT .4 PT 32.9 33.0 40.8 45.8 32.3 32.5 SHEAR DE	.5 PT 32.6 48.4 32.6 SIGN - AAS	.6 PT 32.5 45.8 33.0 SHTO 1980	.7 PT 32.3 40.8 32.9	.8 PT 32.2 35.8 32.8	.9 PT 32.0 33.7 32.8	RIGHT 31.7 31.7 32.8
0 LEFT MEMBER: 1 0V-CABLE 0. SECONDARY 121. VU 608. VC 984. REQD WEB 60. AS(IN)/FT 0.60 *	121. 12 475. 34 698. 95 60. 6	0. 0. 1. 121. 5. 344.	4 PT .5 0. 121. 447. 734. 60. 0.60 *	1. 121. 568. 817. 60.	17. 121. 682. 862. 60.	34. 121. 789. 892. 60.	121. 12 891. 101 915. 93 60. 6	L7. 2. 21. 121.
MEMBER:         2           0V-CABLE         23.           SECONDARY         0.           VU         1468.           VC         1337.           REQD         EB         60.           AS(IN)/FT         1.02	1199. 94 1315. 97 60. 6	0. 0. 7. 721.	127. 0. 480. 354. 60. 0.98	0. 244. 250. 60.	0. 480. 354. 60.	0. 721. 549. 60.	0. 947. 119 976. 131 60. 6	
MEMBER: 3 0V-CABLE 2. SECONDARY -121. VU 1146. VC 937. REQD WEB 60. AS(IN)/FT 1.17	-12112 1010. 89 932. 91 60. 6		17. -121 682. 862. 60. 0.60 *	568. 817. 60.	447. 734. 60.	344. 857. 60.	950. 69 60. 6	$\begin{array}{cccccccccccccccccccccccccccccccccccc$
0NOTE: * AFTER REQD 11AI-BDS Version		ADDITIONAL WEB Licensed to: Co			TER AS(IN	)/FT INDI		4UM REQD. ime: 07-JUL-95
16:13:53 Page 51	Structure E	-16-IN ; CSGCP	; SH-76 ;	Proj#I-76	1(84) ;M.1	MOHSENI 2	/95	
MOMENT (K-FT) 0 ***** ULTI	ULT MOM UL' APPLD P/ (K-FT) (K MATE MOMENT N	AASHTO ULTIMATE T MOM AVERAGE S CAP FSU -FT) (KSI) IOT CALCULATED B	NEUTRAL AXIS (IN) ECAUSE USE	MILD ST REQD (SQ.IN ER DID NOT	REIN ) IN	BINED FORCEMENT DEX RSTRUCTUR:	ULT MOM MILD CAE (K-FT) E SECTIONS	ULT MOM TOTAL CAP (K-FT)
0		ISE '250' DATA C.	ARD TENDON ELC AS	NGATION AVE ST	PFCC	TENDON LEI	NCTH FL	ONGATION
(K 0 01 6 0NOTE: TENDON LENGTH	IPS) 870. 7 INCLUDES 4 FE	(KSI) 5. 270. ET FOR JACKS.	(SQ IN) 33.93	(KSI 199.3)	)	(FT) 213.00	*	(IN) L8.20
0 MODULUS USED F 1IAI-BDS Version		IS 28000. KSI Licensed to: Co	lorado DOT	[			Run ti	ime: 07-JUL-95
16:13:53 Page 52	Structure E	-16-IN ; CSGCP	; SH-76 ;	Proj#I-76	1(84) ;M.1	MOHSENI 2	/95	
0		'APP	ROXIMATE Ç =======	QUANTITY'				
0		** CONCRETE SU	PER	397 (	C.Y. ***			
	*** THE SUPERSTRU WEIGHT OF CON	** CONCRETE SU ** P/S TRIAL CTURE CONCRETE CRETE SUPPLIED AT ALL THE DEAD	QUANTITY 1 ON THE FRA	24090 : IS BASED O AME DESCRI	PTION CAR	* * T		
	THE CONCRETE	SUBSTRUCTURE QU	ANTITY IS	BASED ON	TRIAL 0 O	NLY.		
1END OF JOB - 022086 0 IN	WAS ENTERED A LENGTH FROM A ICREMENTED CPU	TITIES FOR STRAN ND IN THAT ORDE NCHOR TO ANCHOR TIME (SECONDS) CK TIME (SECOND	R. STRANI • = 1.					

### 9B-5b CBGCP EXAMPLE

This is a 2 span Concrete Box Girder Continuous Post-Tensioned structure. It consists of two horizontal members and three vertical members. Members have left and right end joint associated with them and are connected together by specifying the appropriate joint numbers. BDS or the new version of California Frame program is used to model the structure.

CDOT BRIDGE	RATING	MANUAL
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July 1995

	MENT OF TRANSPOR			Structure # G-04-AL State highway # 70					
lated using Asphalt thickness: 🖄 Colorado legal k 🗋 Interstate legal k	Structure	Batch LD. C81009 Structure type CBGCP Parallel structure #							
Structural member	GIRDER	SLAB					,, <u>,,,</u> ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		
	Metric tons (Tons)								
nventory	34.0 <b>(</b> 37.4)	) 30.36 (33	.42)	(	)	(	)		
Operating	60.9 <b>(</b> 67.1)	50.6 (55.	71)	(	)	(	)		
Type 3 truck	(	) (	)	.(	)	(	)		
Type 3S2 truck	(	) (	)	(	)	(	)		
Type 3-2 truck	(	) (	)	(	)	. (	)		
Permit truck	148.9 (164.0	)) (	)	(	)				
Type 3 Truc Type 3 Truc Colorado 21.5 metri Colorado 21.5 metri	ic tons (24 tons)	Type 3S2 Truck Interstate 34.5 metric ten Colorado 38.6 metric ten	s (38 tons)	JLA Intern 354 Color	metric tons (39 tons	N			
	ns M	etrictons Tons		Metric	tons	) Tons			
Comments		<u></u>							
PR0j	<u> </u>	<u> </u>							
Desi	gnated color	for overl	ord ma	p; WH	ITE				
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Rated by Raten	's Signature	Date Chew D2te	checker	rs Sla	nature	Date	٤,		

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DEPARTMENT OF HIGHWAYS DIVISION OF HIGHWAYS STATE OF COLORADO DOH Form 709 July, 1985	CONCRETE SLAB RATING		
DESCRIPTION	INPUT	UNITS	CARD IMAGE COLS.
LOAD TYPE: 1 = Colo. Trucks 2 = Interstate			1
STRUCTURE NUMBER:	G0.4A.L	-	2 - 8
RATER:	, M.M.		9 - 11
HIGHWAY NUMBER:	7.0		12 - 14
BATCH I.D.:	,C,8,1,0,0,9		15 - 20
COMMENTS:			21 - 41
EFFECTIVE SPAN LENGTH:	, ,7.5,0,0	FEET	42 - 46
ACTUAL SLAB THICKNESS:	8.2,5,0	INCHES	47 - 51
EFFECTIVE DEPTH:	5.4.3.8	INCHES	52 - 56
TOP STEEL AREA:	,0.7.4		57 - 59
ASPHALT OVERLAY:	3.5,0	INCHES	60 - 63
INV Fc (f'c load factor):	,3,0,0,0	P.S.I.	64 - 67
INV Fs (Fy load factor):	4,0,0,0,0	P.S.I.	68 - 72
INV MODULAR RATIO: (load factor method: leave blank)		Es/Ec	73 - 74
DEPTH TO BOTT REIN .:	1.3.1	INCHES	5 75 - 77
BOTT. STEEL AREA:	.0.7.4	In2/Ft	78 - 80
1/4 S Flange EFF. SPAN LENGTH & GIRDER		S EFF. SPAN	LENGTH
S Eff Span Length	Girder = S SINO Girder Girder Girder Girder	Ģ (Ē Distar	Bituminous Overlay Slab thickness (max.) istance from Bottom to Top Reinf. Effective Depth) the from Bottom bottom Reinf.

### 9B.50

## SLAB RATING Version 1.0 DATE: 95/03/06

STRUCTURE NO. G-04-AL RATER: MM STATE HWY NO. = 70 BATCH ID= C81009 DESCRIPTION: RATING LOAD FACTOR RATING-COMP STEEL NOT USED---LOAD FACTOR RATING-COMP STEEL NOT USED

5.4.5 m......

	438	)= 3.50 3000.	. 000					1566.78	29316.04	7283.99	00.II	9.94
	EFF. DEPTH(INS) = 5.438	SURFACE (IN OPER-	OPER- 40000					OPERATING 1000.54	18721.07	4651.52	11.00	9.94
INPUT DATA	0		INV- 40000.	AS1= .74		4.94 K-FT	36.0 TONS	INVENTORY	RE33		(K-FT)	-I) (K-FT)
TUPUT		REINF, (SQ.IN) = .74 SLAB TK(IN) = 8.250 CONC. STRENGTH(PSI)	STEEL YIELD (PSI) N= 9.	1	DEAD LOAD MOMENT	LL+I MOMENT	GROSS WEIGHT	gwo awaronoo	ACTUAL CONCRETE SIMUSS ACTUAL REINF STEEL SIRESS			

55.71

33.42

(IONS)

RATING

Kater's signature

COLORADO DEPARTMENT OF TRANSPORTATION DESIGN COMPUTATIONS

INFORMATION FOR PATING From Advanced Plans: Live Load distribution factor =  $\frac{\text{Width}}{7.0} = \frac{34.5}{7} = 4.9286$  wheel lines Dead Loads Asphalt 2/12 \* 32 \* 144 # = 768 PLF (From Design plans) curbs 8/12 \* 1.25 \* 150 \* 2 = 250 61,12# +2 = 122 1140 plf Rail Diaphragms (intermediate) (4'-8'-(84'+4')); 2 = 1.8229'  $3_{12} = 21.875'$  x = 5.5' = .4557[8'-6''-(6.1847'+6''+5.5)]\*2+(8'-6''-1-0'')=21.5526' $21.5526 \times 3.5 \times 8/12 = 50.29 \text{ ft}^3$  $f_{1} = (7.5' \times 4) + (3.5' \times 6) + (6.5' \times 2) = 64' \times (\frac{1}{2} \times \frac{3 \times 3''}{144}) = 2.0 \text{ ft}_{s_{1}d_{e}}$ Weight = 54.29 \* 150 = 8143.5 lbs. USE 8.14 Kips Formwork - 7#/ft2 \* 8.5 \*3 = 178.5 PLF = 0.179 KLF Exterior girder Web 2 of 9 Sheet 1 COLORADO DEPARTMENT OF TRANSPORTATION C81009 ITO-1(75)57 Project No. By:MMDate 3/95 REV. From TCF NOTES 5-81 LFD REV. Structure No. G-04-AL Chk'd: Date

CDOT Form #1034 1/5

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July 1995

### COLORADO DEPARTMENT OF TRANSPORTATION DESIGN COMPUTATIONS

,	FRAME DESCRIPTION:
	BDS (calframe) IS RUN with abutments coded as vertical members.
	ELev. Leftout Abut. 1 back face 4907.6743 9.4743 use
	ELev. Leftout Abut. 1 back face 4907.6743 Elev. Bottom of Abut. 4898.2 Leftout Abut. 3 back face 4908.1448 Elev. Buttom of Abut, 4898.6 9.5448' 9.5448'
	Y <sub>b</sub> = 2.77' (From design notes, section property Calcs)
	4.6667'-2.77 = 1.8967'
	9.5 - (1.8967' + 0.5') = 7.10'
	1 2 2 3
	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$
	(3)
	4P (4) 6P
	5* F
	$T = 2^{4} (-1)^{3} (-1)^{4} = 4^{4}$
	$I = 34.0(2.5)^3/12 = 44.3 \text{ ft}^4$
	Live Load input
	Live Load lanes = 34.5/(7+2) = 2.4643
<b> </b>	COLORADO DEPARTMENT OF TRANSPORTATION Sheet 2 of 9
Bv:N	ImDate REV.         3-95         Project No.         I 70 - 1 (75) 57         C81009
Chk'd:	Date Structure No. G-04-AL REV. LFD From TCF NOTES 5-81
<u>.</u>	CDOT Form #1034 1

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COLORADO DEPARTMENT OF TRANSPORTATION DESIGN COMPUTATIONS

> Frame Description (cont.) Member 4 length: Bottom of footing elev. 78.0 footing depth 2.0 80.0 Top of column elev. (0.76 + 0.41)/2 + 103.0 = 103.585 + 2.0Assumed 2.0' for Yb 105.585 <u>- 80.0</u> 25.585'  $E = 150^{1.5} 33\sqrt{4500} = 4066$  KSI SUPERSTRUCTURE. E = 150<sup>1.5</sup> 33 (3000 = 3320 KSi PIER WALLS (SUBSTRUCTURE) I, (PIER WALL) - - - - - - × (q pier2)  $4.05 \times 2_{12}^{3} \times 2 = 5.4 \text{ ft}^{4}$ 4-6" Δ. 81/4 <u>4.5'-0.5154'= 3.9846'</u> USE 4.0' - 0.5154' 12 Live Load to substructure: curb to curb = 32/12' = 2.6 use 2 lanes. 2 lanes/2 columns = 1 lane/column Sheet 3 of 9 COLORADO DEPARTMENT OF TRANSPORTATION 3/95 REV Project No. I70 -1(75)57 C 81009 By: MM Date FROM TOF NOTES 5-81

CDOT Form #1034 1/93

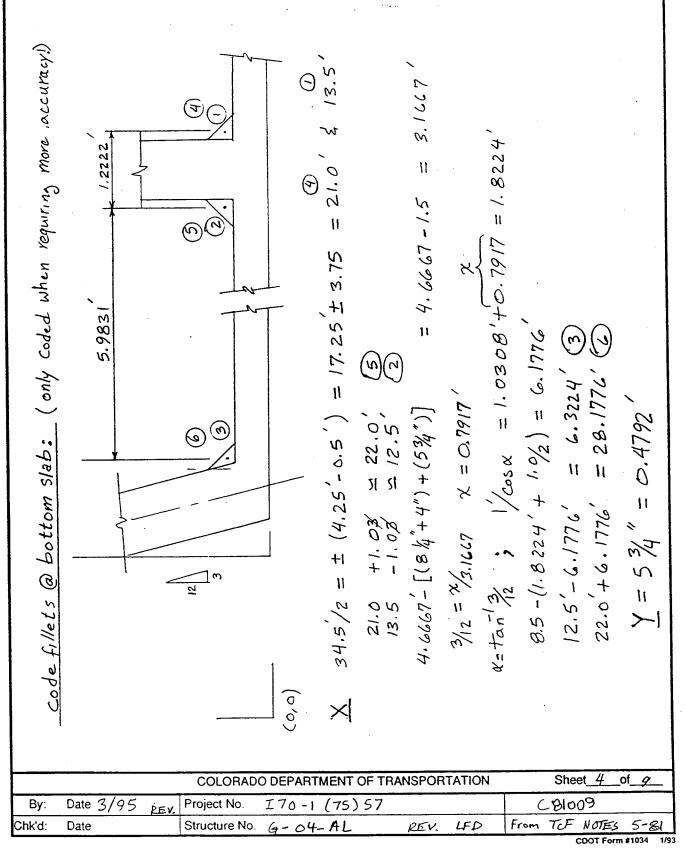
G-04-AL

Structure No.

Chk'd:

Date

REV. LFD



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COLORADO DEPARTMENT OF T		
INVENTORY	RATING	
@ 1.0 or 3	o point:	
Bottom F	iber (Psi) To	op Fiber (Psi)
5	17 DL+ADDED DL+P/S	456
$6\sqrt{f_c'} = 6\sqrt{4500} = -4$	02 FbCAP.	1,800 = 0.4(4500)
- 402 - 577 = - 5	79	1 <sub>,</sub> 344 = 1800 - 456
-8'	$f_{L} = f_{L} + f_{L$	59
11.2	5 E for Capill/full	22.8
405	1 - * 36 tons	820
0.4(4500) = 1,800	F6 CaP	$-402 = 6\sqrt{4500}$
1,800-577 = 1,223		- 858 = - 402 - 456
381	$f_{b}LL(-)$	- 261
3,21	E FLCAP/FLL	3.29
115.6	* 36 tons	118.3
•	on the relation of prestress force	
	it will not be necessary to rate :	The 1.0 or 3.0
points	for operating capacity.	
	COLORADO DEPARTMENT OF TRANSPORTATION	Sheet_5_of_9
By:MM Date 2-95	Project No. 170-1(75)57	681009
Chk'd: Date	Structure No. G-04-AL	REV. LFD. CDOT Form #1034 1/

CDOT Form #1034 1/93

COLORADO DEPARTMENT OF TRANSPORTATION DESIGN COMPUTATIONS

	OWER HUNGLERY PATHICS	
	POINT INVENTORY RATING:	P Fiber (Psi)
<u>Bottom Fiber (1</u> 361	$\frac{101}{DL + ADDED DL + P/s}$	655
-402		1,800 -
-763	F6 LL CAP	lj 45
- 380	$(\widehat{+})$ $f_{\Sigma}$ LL (+)	260
2.0	Fb CAP LL Fb LL	4.4
72.0 —		158.5
1,800	F <sub>b</sub> cap	-402
1,439	fb LL Cap	- <i>ļ</i> 057
66	€ f <sub>b</sub> LL (-)	- 45
21.8 —	fb cap LL fb LL	23,49
	* 36	
2.0 POINT	INV. PATING	
Bottom Fib	er	Top Fiber
1,189	DL + DLC + P/S	-102
$0.4 f_c = 1,800$ -	F6 CAP	$402  6\sqrt{f_c}$
1800-1189= 701	FULL CAP	-300 = -402 - 102
421	$ \begin{array}{c} \widehat{I} \\ \widehat{F} \\ \Sigma \end{array} + \begin{array}{c} f_{b} LL(-) \\ \Sigma \end{array} $	- 289
1.66 59.9	fbll CaP/FbLL *36 tons	1.038 - 37.4 CONTROLS
	COLORADO DEPARTMENT OF TRANSPORTATION	Sheet 4 of 9
By:MMDate 2/95	Project No. I 70 -1 (75) 57	C81009
Chk'd: Date	Structure No. G-04-AL	CDOT Form #1034 1/93

### COLORADO DEPARTMENT OF TRANSPORTATION DESIGN COMPUTATIONS

OPERATING	EATING & INVENTORY RATING	
Rating @ 1	1.5 or 2.5 Point:	
Values from	Calframe (BDS) output:	
	member moment (trial 0) = 5	,230 K-ft
	member moment (trial 1) = 7	
	ive load + Impact moment = 3	092 K-ft
	tress in prestressing steel, $F_{SU}^{\star} = 2$	
	moment P/s capacity, $M_n = 2$	4,316 K-ft
	moment due to P/s, Ms = 3	
Rating	·	
OPR = 0	<u>.95 Mn - 1.3 (M<sub>DL</sub> + M<sub>DLC</sub>) - 1.0 M</u> 1.3 M <sub>LL+I</sub>	<u>\$</u> *36
$INV = \frac{3}{2}$	3/ OPR 5 OPR	
OPR = -	0.95 (24,316) - 1.3.(5230+735) -	3725 *36
	1.3 * 3092	
OPR =	104.1 Tons	
INV =	$\frac{3}{5} \times 104.1 = 62.4$ Tons.	
	COLORADO DEPARTMENT OF TRANSPORTATION	Sheet 7_of 9_
By:MMDate 2/95	Project No. 170 -1 (75) 57	C81009
hk'd: Date	Structure No. G-04-AL	REV. LFD CDOT Form #1034 1/93
		Carchi Horm #1034 1/93

CDOT Form #1034 1/93

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OPERATING & INVENTORY RATING	
Rating at 2.0 POINT	
	( 0 12 20
From Calframe (BDS) OUT PUT: Pg.	
Horizontal member moment (trial o)	= -10,458 K-ft
Horizontal member moment (trial 1)	=-1469 K-ft
Negative Live Load + Impact moment	=-3432 K-ft
Average stress in prestressing steel, F <sup>*</sup> <sub>su</sub> (at ultimate Load)	= 256.57 Ksi
ultimate moment P/s Capacity, Mn	= 22,593 K-ft
secondary moment due to P/s, Ms	
Rating	
$OPR = \frac{0.95 M_n - 1.3 (M_{DL} + M_{DL}) + 1.0 M_s}{1.3 M_{LL+I}}$	- * 36
$OPR = \frac{0.95(22,593) - 1.3(10,458 + 146)}{1.3(3432)}$	<del>9)+2355</del> *36
OPR = 67.1 TONS.	Controls
$INV = \frac{3}{5}(OPR) = \frac{40.2}{5}$ TONS.	
COLORADO DEPARTMENT OF TRANSPORTAT	ION Sheet_8_of_9_
MMDate 3/95 Project No. 170-1(75)57	C81009
1: Date Structure No. G-04-AL	REV. LFD.

CDOT Form #1034 1/93

hk'd:

Permit truck Rating: (LL No. 4 BDS RUN) M<sub>LL+I</sub> @ 1.0 = 5689 K-ft M<sub>LL+I</sub> @ 2.0 = 3739 K-ft - $M_{LL+J} @ 2.5 = 5123 K-ft$ @ 1.5, 2.5 Location ;  $R_{OPR} = \frac{23,100 - 1.3(5230 + 735) - 3725}{1.3 + 5123} + 96 = 167.5 \text{ Tors}$ @ Z,O Location:  $R_{OPR} = \frac{21,463.35 - 1.3(11.927) + 2355}{1.3 + 3739} + 2355 + 96 = 164.0 \text{ Tons}$ @ 1.0 Location:  $R_{OPR} = \frac{0.95 \times 19309 - 1.3(7816) + 5095}{1.3 \times 5689} \times 96 = 172.3 \text{ Tons}$ COLOR = WHITE ROPR Permit = 164.0 Tons. Q\_ 2.0 oject code (SA#) By: MMDate Project no. 170-1(75)57 Structure no. G - 04 - AL Sheet 2 of 9 Date CDOT Form #1034 1/95

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# Input Forms

FORM

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COMMENTS

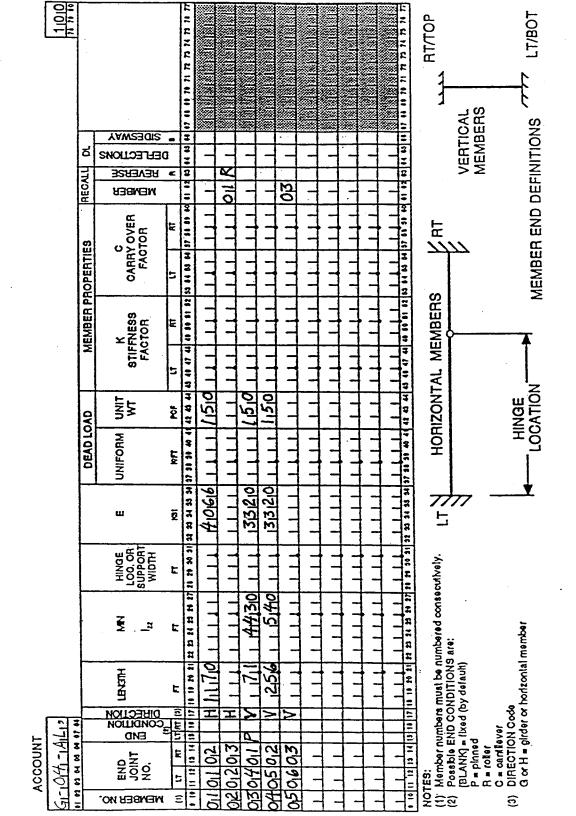
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NOTES: (1) First line of comments will appear at the top of each page of output (2) Additional lines may be used if required

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July 1995

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FRAME DESCRIPTION : 100 FORM

9B.62

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FORM

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SUPERSTRUCTURE DATA :

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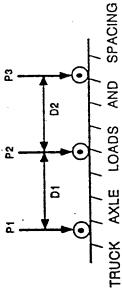
LIVE LOAD TRUCK AND LANE DATA ACCOUNT	E DATA : 401 FORM	SORT NO.		COMMENTS		3 3 3 3 3 3 3 3 3 3 4 4 4 4 4 4 4 4 4 4	HS20-44. TRWCK	I MILLINARY ILOPIDI (ALTERMATED) ILI ILI									32 39 39 49 41 45 47 48 49 47 48 49 47 48 49 47 48 49 47 48 49 47 47 47 47 47 47 47 47 47 47 47 47 47	P1 P2 P3
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# FORM 401 • AND I ANF DATA NOTAT DAO 1

NOTES: (1) LIVELOAD DATA - For AASHTO H920-44 Loading, laave TRUCK and LANE data blank for L.L. No. 1. When this data is given. It replaces the HS20-44 Loading.

An entry for the NUMBER OF LIVE LOAD LANES worldes that ghen on MEMBER DATA (400 form). 3

Data entries for L.L. No.'s 2 and 3 produce separate results in addition to L.L. No. 1 <u></u>



CDOT BRIDGE RATING MANUAL

500 • • LIVE LOAD GENERATOR MEMBER DATA

FORM

OUNT 					COMMENTS	(3)         (3) <th(3)< th=""> <th(3)< th=""> <th(3)< th=""></th(3)<></th(3)<></th(3)<>	ILINE LOAD DISTRIBIATION IFACTOR, IFOR DERMETT TRUCK											
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FRAME DESCRIPTION data with the horizontal members numbered consecutively starting

with 01 must accompany this data. When the NUMBER OF LL. LANES is given, it must be given for the left end of Superstructure Member 01. Thereafter, it is assumed to be constant until another entry is made. Substructure Member 01 delautis to 1.0 when left blank. e 8

H a Cooper loading is to be given, % of impact to be applied to each member must be given. It will be used for Cooper loading only.  $\widehat{\mathbf{c}}$ 

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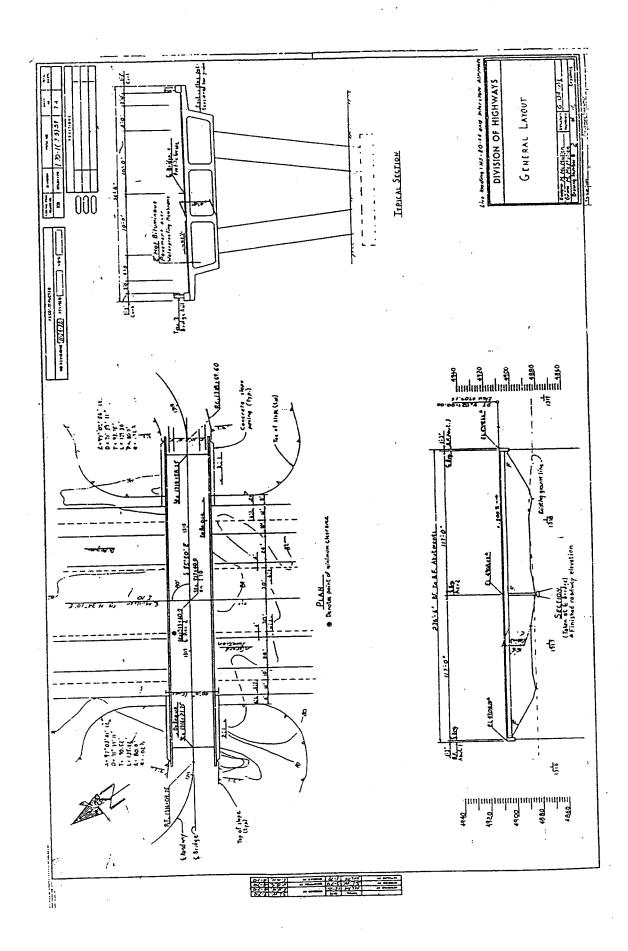
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PRESTRESS DATA (1) : 600 FORM

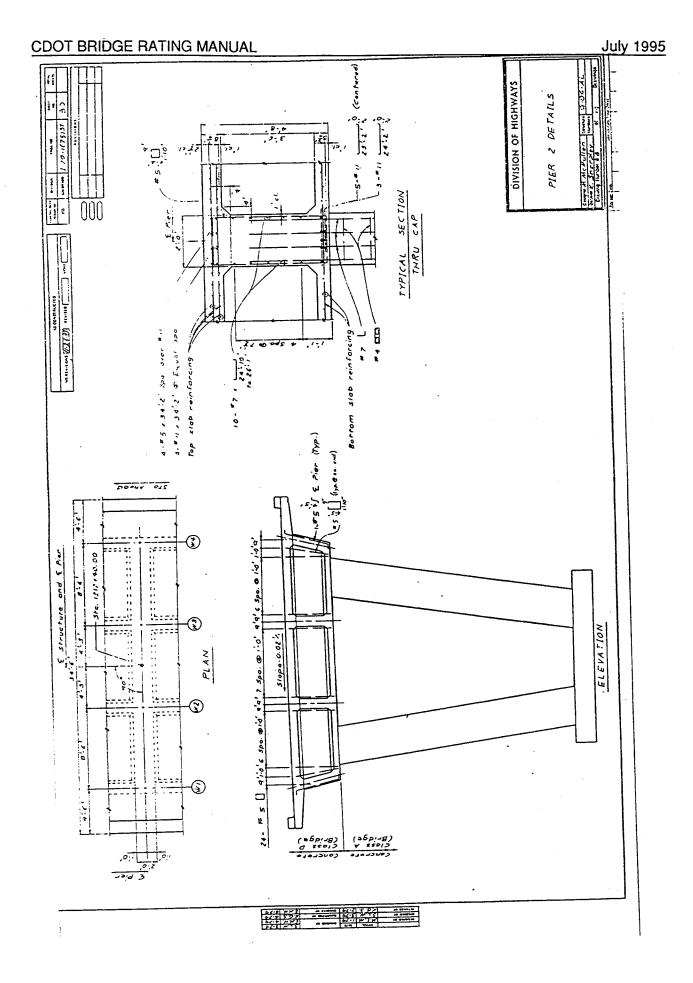
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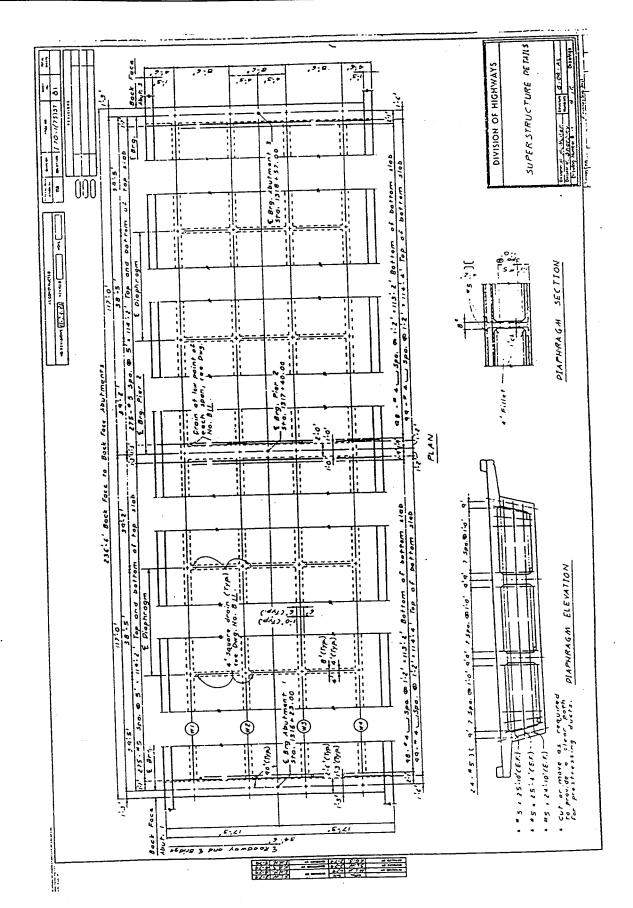


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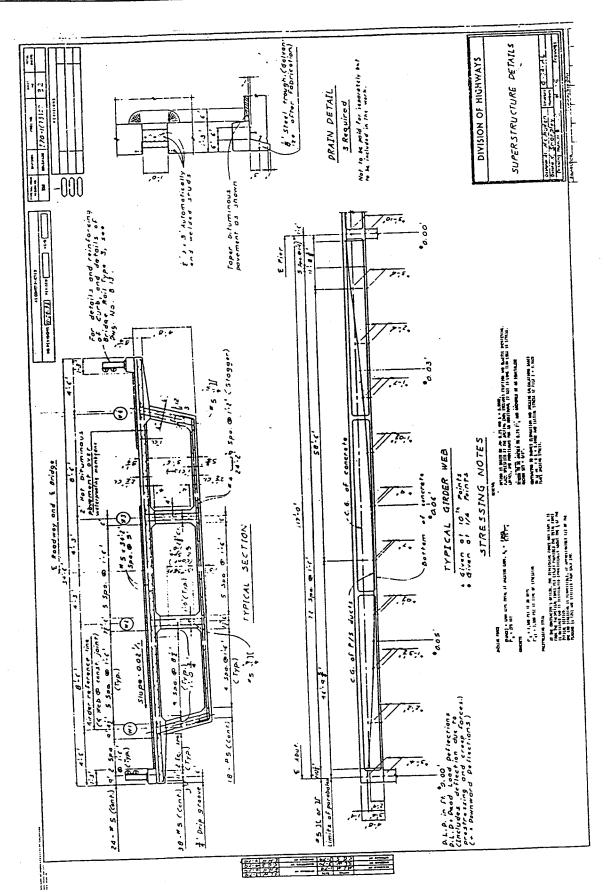


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	* Bridge Design System *	
	* By: Imbsen and Associates, Inc. *	
	* VERSION 4.0.1 25-AUG-93 *	
16 17 18 19 20 21 22 23	<pre>* VERSION 4.0.1 25-AUG-93 * * *********************************</pre>	000 100 100 100 200 201 201 201 201 201
23 24	G-04-AL,02 2464 2464 20 20 G-04-AL,1 HS20-44 TRUCK	400 401
30	G-04-AL,01         2464         2464         20         LIVE LOAD DISTRIBUTION FACTOR FOR PERMIT TRUCK           G-04-AL,02         2464         20         G-04-AL,02         2464         20           G-04-AL,02         2464         20         250120         250         40         250350         217         40         08         PERMIT TRUCK         01           G-04-AL,0110101         4010         133         408         083         25         20         5         51         520945527	500
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OFRAME DESCRIPTION	1 4.0.13 Licensed to: Colorado DOT Run time: 12-JUL-95 16:18:34 J STRUCTURE G-04-AL; SH-70; CBGCP; PROJ#170-1(75)57; M.M.	
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4 5 2 5 6 3	V         25.6         5.40         0.0         3320.         0.000         .150         0.00         0.00         0.00           V         0.0         0.00         0.00         .000         .000         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00 <td></td>	
1IAI-BDS Version OSECTION PROPERTIES -	1 4.0.13 Licensed to: Colorado DOT Run time: 12-JUL-95 16:18:34 STRUCTURE G-04-AL; SH-70; CBGCP; PROJ#I70-1(75)57; M.M. INPUT	Page 2
OMEM RE NO LOC. CALL Z STORE		X IN E
+	-/- CODE V/D H Z Y AREA IZZ E E-ST	ORE STORE
	-         5         0.33         0.33         22.00         0.48         0.00         0.00         4066.00         0           -         6         0.33         0.33         12.50         0.48         0.00         0.00         4066.00         0           -         6         0.33         0.33         12.50         0.48         0.00         0.00         4066.00         0           -         6         0.33         0.33         21.00         0.48         0.00         0.00         4066.00         0           -         6         0.33         0.33         28.18         0.48         0.00         0.00         4066.00         0	

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1IAI-BDS Version 4.0.13	Licensed to: RE G-04-AL; SH-70				:35 Page	3
OFRAME PROPERTIES	RE G-04-AL; SH-70					
END MEM JT COND NO LT RT LT RT DIR ///////////////	SPAN MIN E*I	SUPPORT OR HINGE	FAC E LT	Y OVER	FACTORS LT RT	
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4 5 2 V 5 6 3 P V 0***** IF MEMBER IS HORIZONTA	7.1 0.1471E+0	5 0.0 3 6 0.0 3	320. 0.500 320. 0.500	0.000 0 0.000 0	.000 0.000 .000 0.740	****
***** IF MEMBER IS VERTICAL						
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	RE G-04-AL; SH-70					-
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RESULTS OF 1 INCH SWAY TO TH VERTICAL SHEAR (KIPS)		)				
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VERTICAL SHEAR (KIPS) MEMBER 3 3181.0 4 249.2 5 3181.0 1IAI-BDS Version 4.0.13 STRUCTU	MOMENTS (FT-KIPS LT RT 0. 225 -2783. 35 0. 225	BASED ON 85. 97. 85. Colorado DOT ; CBGCP; PROJ#I	Run time: 12-5		5 Page 6	
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VERTICAL SHEAR (KIPS) MEMBER 3 3181.0 4 249.2 5 3181.0 1IAI-BDS Version 4.0.13 STRUCTU 0 HORIZONTAL MEMBER MOMENTS T MEM NO LEFT .1 PT .2 P 0 1 -68532235. 129 0 2 -10458511986 OHORIZONTAL MEMBER STRESSES	MOMENTS (FT-KIPS LT RT 0. 225 -2783. 35 0. 225 Licensed to: RE G-04-AL; SH-70 *** SIDESWAY INCL RIAL 0 T .3 PT .4 8. 3746. 50 4. 2305. 43 TRIAL 0 BOTTO	BASED ON 85. 97. 85. Colorado DOT ; CBGCP; PROJ#I JDED. *** PT .5 PT 48. <b>5230</b> . 27. 5230. M FIBER	Run time: 12-2 70-1(75)57; M.M .6 PT .7 PT 4327. 2305 5048. 3746	1. .8 PT .9 1 864 . 1298	PT RIGHT 5119. <mark>-10458</mark> 22356853.	÷
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VERTICAL SHEAR (KIPS) MEMBER 3 3181.0 4 249.2 5 3181.0 1IAI-BDS Version 4.0.13 STRUCTU 0 HORIZONTAL MEMBER MOMENTS T MEM NO LEFT .1 PT .2 P 0 1 -68532235. 129 0 2 <b>-10458</b> 511986 OHORIZONTAL MEMBER STRESSES 0 1 841. 27415 0 2 1284. 628. 10 OHORIZONTAL MEMBER STRESSES 0 1 -576188. 10 0 2 -8794307	MOMENTS (FT-KIPS LT RT 0. 225 -2783. 35 0. 225 Licensed to: RE G-04-AL; SH-70 *** SIDESWAY INCL RIAL 0 T .3 PT .4 8. 3746. 50 4. 2305. 43 TRIAL 0 BOTTO 94606 62835 TRIAL 0 TOP 9. 315. 4 3. 194. 3	BASED ON 85. 97. 85. Colorado DOT ; CBGCP; PROJ#I JDED. *** PT .5 PT 48. <mark>5230</mark> . 27. 5230. 47. 5230. 47. 642. 51642. FIBER 24. 440.	Run time: 12-0 70-1(75)57; M.N .6 PT .7 PT 4327. 2305 5048. 3746 -531283. -620460.	4. .8 PT .9 2 864 . 1298 . 106. 159. 73.	PT RIGHT 5119. <mark>-10458</mark> 22356853. 628. 1284. 274. 841. -430879.	÷
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VERTICAL SHEAR (KIPS) MEMBER 3 3181.0 4 249.2 5 3181.0 1IAI-BDS Version 4.0.13 STRUCTU 0 HORIZONTAL MEMBER MOMENTS T MEM NO LEFT .1 PT .2 P 0 1 -68532235. 129 0 2 -10458511986 OHORIZONTAL MEMBER STRESSES 0 1 841. 27415 0 2 1284. 628. 10 OHORIZONTAL MEMBER STRESSES 0 1 -576188. 10 0 0HORIZONTAL MEMBER MOMENTS TRI 0 2 .8794307 OVERTICAL MEMBER MOMENTS TRI 0 3 0685137 0 4 0. 0. 0 5 0. 685. 137 OHORIZONTAL MEMBER SHEARS TR 0 1 441.1 348.3 255 0 2 502.8 410.0 317 OVERTICAL MEMBER SHEARS TRI	MOMENTS (FT-KIPS LT RT 0. 225 -2783. 35 0. 225 Licensed to: RE G-04-AL; SH-70 *** SIDESWAY INCL RIAL 0 T. 3 PT .4 8. 3746. 50 4. 2305. 43 TRIAL 0 BOTTO 94606 62835 TRIAL 0 TOP 9. 315. 4 3. 194. 3 AL 0 1205627 0. 0. 1. 2056. 27 IAL 0 .6 162.8 6 .2 224.5 12 L 0	BASED ON 85. 97. 85. Colorado DOT ; CBGCP; PROJ#I UDED. *** PT .5 PT 48. 5230. 27. 5230. M FIBER 20642. 31642. FIBER 24. 440. 64. 440. 413426. 0. 0. 41. 3426. 1.9 -30.8 3.6 30.8	Run time: 12-0 70-1(75)57; M.M 4327. 2305 5048. 3746 -531283 -620460. 364. 194 424. 315 -41124797. 0. 0. 4112. 4797. -123.6 -224.5 -61.9 -162.8	4. .8 PT .9 2 864 . 1298 . 106. 159. 73. . 109. 5482 0. . 5482. . 0. . 5482.  317.2 - 255.6 -	PT RIGHT 511910458 22356853. 628. 1284. 274. 841. -430879. -188576. 61676853. 0. 0. 6167. 6853. 410.0 -502.8 348.3 -441.1	<b>€</b>
VERTICAL SHEAR (KIPS) MEMBER 3 3181.0 4 249.2 5 3181.0 1IAI-BDS Version 4.0.13 STRUCTU 0 HORIZONTAL MEMBER MOMENTS T MEM NO LEFT .1 PT .2 P 0 1 -6853 -2235. 129 0 2 <b>-10458</b> -511986 0HORIZONTAL MEMBER STRESSES 0 1 841. 27415 0 2 1284. 628. 10 0HORIZONTAL MEMBER STRESSES 0 1 841. 27415 0 2 1284. 628. 10 0HORIZONTAL MEMBER STRESSES 0 1 -576188. 10 0 2 -8794307 0VERTICAL MEMBER STRESSES 0 1 0685137 0 4 0. 0. 0 5 0. 685. 137 0 4 0. 0. 0 5 0.2 502.8 410.0 317 0VERTICAL MEMBER SHEARS TRIA 0 3 -965.2 -965.2 -965.2	MOMENTS (FT-KIPS LT RT 0. 225 -2783. 35 0. 225 Licensed to: RE G-04-AL; SH-70 *** SIDESWAY INCL RIAL 0 T .3 PT .4 8. 3746. 50 4. 2305. 43 TRIAL 0 BOTTO 94606 62835 TRIAL 0 BOTTO 9. 315. 4 3. 194. 3 AL 0 1205627 0. 0. 1. 2056. 27 IAL 0 6. 162.8 6 .2 224.5 12 L0 .2 -965.2 -96 .0 0.0	BASED ON B5. 97. 85. Colorado DOT ; CBGCP; PROJ#I JDED. *** PT .5 PT 48. <b>5230</b> . 27. 5230. 47. 5230. 27. 5230. 47. 5230. 20642. 31642. FIBER 24. 440. 64. 440. 413426. 0. 0. 41. 3426. 1.9 -30.8 3.6 30.8 5.2 -965.2 0.0 0.0	Run time: 12-0 70-1(75)57; M.N .6 PT .7 PT 4327. 2305 5048. 3746. -531283. -620460. 364. 194. 424. 315. -41124797. 0. 0. 4112. 4797. -123.6 -224.5 -61.9 -162.8 -965.2 -965.2 0.0 0.0	4. .8 PT .9 2 864 1298 106. -159. 73. 109. 5482 0. 5482. 5 -317.2 - 8 -255.6 - 2 -965.2 - 0.0	PT RIGHT 511910458 22356853. 628. 1284. 274. 841. -430879. -188576. 61676853. 0. 0. 6167. 6853. 410.0 -502.8 348.3 -441.1 965.2 -965.2 0.0 0.0	<b>E</b>
VERTICAL SHEAR (KIPS) MEMBER 3 3181.0 4 249.2 5 3181.0 1IAI-BDS Version 4.0.13 STRUCTU 0 HORIZONTAL MEMBER MOMENTS T MEM NO LEFT .1 PT .2 P 0 1 -6853 -2235. 129 0 2 <b>-10458</b> -511986 0HORIZONTAL MEMBER STRESSES 0 1 841. 27415 0 2 1284. 628. 10 0HORIZONTAL MEMBER STRESSES 0 1 841. 27415 0 2 1284. 628. 10 0HORIZONTAL MEMBER STRESSES 0 1 -576188. 10 0 2 -8794307 0VERTICAL MEMBER STRESSES 0 1 0685137 0 4 0. 0. 0 5 0. 685. 137 0 4 0. 0. 0 5 0.2 502.8 410.0 317 0VERTICAL MEMBER SHEARS TRIA 0 3 -965.2 -965.2 -965.2	MOMENTS (FT-KIPS LT RT 0. 225 -2783. 35 0. 225 Licensed to: RE G-04-AL; SH-70 *** SIDESWAY INCL RIAL 0 T. 3 PT .4 8. 3746. 50 4. 2305. 43 TRIAL 0 BOTTO 94606 62835 TRIAL 0 TOP 9. 315. 4 3. 194. 3 AL 0 1205627 IAL 0 .6 162.8 6 .2 224.5 12 L 0 .2 -965.2 -96 .0 0.0 .2 965.2 96	BASED ON B5. 97. 85. Colorado DOT ; CBGCP; PROJ#I JDED. *** PT .5 PT 48. <b>5230</b> . 27. 5230. 47. 5230. 27. 5230. 47. 5230. 20642. 31642. FIBER 24. 440. 64. 440. 413426. 0. 0. 41. 3426. 1.9 -30.8 3.6 30.8 5.2 -965.2 0.0 0.0	Run time: 12-0 70-1(75)57; M.N .6 PT .7 PT 4327. 2305 5048. 3746. -531283. -620460. 364. 194. 424. 315. -41124797. 0. 0. 4112. 4797. -123.6 -224.5 -61.9 -162.8 -965.2 -965.2 0.0 0.0	4. .8 PT .9 2 864 1298 106. -159. 73. 109. 5482 0. 5482. 5 -317.2 - 8 -255.6 - 2 -965.2 - 0.0	PT RIGHT 511910458 22356853. 628. 1284. 274. 841. -430879. -188576. 61676853. 0. 0. 6167. 6853. 410.0 -502.8 348.3 -441.1 965.2 -965.2 0.0 0.0	<b>E</b>
VERTICAL SHEAR (KIPS) MEMBER 3 3181.0 4 249.2 5 3181.0 1IAI-BDS Version 4.0.13 STRUCTU 0 HORIZONTAL MEMBER MOMENTS T MEM NO LEFT .1 PT .2 P 0 1 -68532235. 129 0 2 -10458511986 0HORIZONTAL MEMBER STRESSES 0 1 841. 27415 0 2 1284. 628. 10 0HORIZONTAL MEMBER STRESSES 0 1 -576188. 10 0 2 -8794307 0 VERTICAL MEMBER MOMENTS TRI 0 3 0685137 0 4 0. 0. 0 5 0. 685. 137 0HORIZONTAL MEMBER SHEARS TRI 0 1 441.1 348.3 255 0 2 502.8 410.0 317 0VERTICAL MEMBER SHEARS TRIA 0 3 -965.2 -965.2 -965 0 4 0.0 0.0 0 5 965.2 965.2 965.2 965 0 VERTICAL MEMBER REACTIONS T	MOMENTS (FT-KIPS LT RT 0. 225 -2783. 35 0. 225 Licensed to: RE G-04-AL; SH-70 *** SIDESWAY INCL RIAL 0 T .3 PT .4 8. 3746. 50 4. 2305. 43 TRIAL 0 BOTTO 94606 62835 TRIAL 0 TOP 9. 315. 4 3. 194. 3 AL 0 1205627 0. 0. 1 2. 2056. 27 IAL 0 .6 162.8 6 .2 224.5 12 L0 .2 -965.2 -96 RT	BASED ON B5. 97. 85. Colorado DOT ; CBGCP; PROJ#I JDED. *** PT .5 PT 48. <b>5230</b> . 27. 5230. 47. 5230. 27. 5230. 47. 5230. 20642. 31642. FIBER 24. 440. 64. 440. 413426. 0. 0. 41. 3426. 1.9 -30.8 3.6 30.8 5.2 -965.2 0.0 0.0	Run time: 12-0 70-1(75)57; M.N .6 PT .7 PT 4327. 2305 5048. 3746. -531283. -620460. 364. 194. 424. 315. -41124797. 0. 0. 4112. 4797. -123.6 -224.5 -61.9 -162.8 -965.2 -965.2 0.0 0.0	4. .8 PT .9 2 864 1298 106. -159. 73. 109. 5482 0. 5482. 5 -317.2 - 8 -255.6 - 2 -965.2 - 0.0	PT RIGHT 511910458 22356853. 628. 1284. 274. 841. -430879. -188576. 61676853. 0. 0. 6167. 6853. 410.0 -502.8 348.3 -441.1 965.2 -965.2 0.0 0.0	<b>E</b>
VERTICAL SHEAR (KIPS) MEMBER 3 3181.0 4 249.2 5 3181.0 IIAI-BDS Version 4.0.13 STRUCTU 0 HORIZONTAL MEMBER MOMENTS T MEM NO LEFT .1 PT .2 P 0 1 -68532235. 129 0 2 -10458511986 OHORIZONTAL MEMBER STRESSES 0 1 -68532235. 129 0 2 -10458511986 OHORIZONTAL MEMBER STRESSES 0 1 841. 27415 0 2 1284. 628. 10 0HORIZONTAL MEMBER STRESSES 0 1 -576188. 10 0 0HORIZONTAL MEMBER MOMENTS TRI 0 2 .8794307 OVERTICAL MEMBER MOMENTS TRI 0 3 0685137 0 4 0. 0. 0 5 0. 685. 137 OHORIZONTAL MEMBER SHEARS TRI 0 1 441.1 348.3 255 0 2 502.8 410.0 317 OVERTICAL MEMBER SHEARS TRIA 0 3 -965.2 -965.2 -965 0 4 0.0 0.0 0 0 5 965.2 965.2 965 OVERTICAL MEMBER REACTIONS T OMEM LT NO REACTION R	MOMENTS (FT-KIPS LT RT 0. 225 -2783. 35 0. 225 Licensed to: RE G-04-AL; SH-70 *** SIDESWAY INCL RIAL 0 T3 PT .4 8. 3746. 50 4. 2305. 43 TRIAL 0 BOTTO 94606 62835 TRIAL 0 BOTTO 9. 315. 4 3. 194. 3 AL 0 1205627 0. 0. 1 2. 2056. 27 IAL 0 .6 162.8 6 .2 224.5 12 L0 .2 -965.2 -96 .0 0.0 .2 965.2 96 RT	BASED ON B5. 97. 85. Colorado DOT ; CBGCP; PROJ#I UDED. *** PT .5 PT 48. <b>5230</b> . 27. 5230. 47. 5230. 47. 5230. 47. 642. 5230. 41642. FIBER 24. 440. 64. 440. 413426. 0. 0. 41. 3426. 1.9 -30.8 3.6 30.8 5.2 -965.2 0.0 0.0 5.2 965.2 MEMBER	Run time: 12-0 70-1(75)57; M.N .6 PT .7 PT 4327. 2305 5048. 3746. -531283. -620460. 364. 194. 424. 315. -41124797. 0. 0. 4112. 4797. -123.6 -224.5 -61.9 -162.8 -965.2 -965.2 0.0 0.0	4. .8 PT .9 2 864 1298 106. -159. 73. 109. 5482 0. 5482. 5 -317.2 - 8 -255.6 - 2 -965.2 - 0.0	PT RIGHT 511910458 22356853. 628. 1284. 274. 841. -430879. -188576. 61676853. 0. 0. 6167. 6853. 410.0 -502.8 348.3 -441.1 965.2 -965.2 0.0 0.0	<b>E</b>
VERTICAL SHEAR (KIPS) MEMBER 3 3181.0 4 249.2 5 3181.0 1IAI-BDS Version 4.0.13 STRUCTU 0 HORIZONTAL MEMBER MOMENTS T MEM NO LEFT .1 PT .2 P 0 1 -68532235. 129 0 2 <b>-10458</b> 511986 0HORIZONTAL MEMBER STRESSES 0 1 -68532235. 129 0 2 <b>-10458</b> 511986 0HORIZONTAL MEMBER STRESSES 0 1 841. 27415 0 2 1284. 628. 10 0HORIZONTAL MEMBER STRESSES 0 1 -576188. 10 0 02 -8794307 0VERTICAL MEMBER MOMENTS TRI 0 3 0685137 0 4 0. 0. 0 5 0. 6855. 137 0HORIZONTAL MEMBER SHEARS TRI 0 1 441.1 348.3 255 0 2 502.8 410.0 317 OVERTICAL MEMBER SHEARS TRIA 0 3 -965.2 -965.2 -965 0 4 0.0 0.0 00 0 5 965.2 965.2 965 0 4 0.0 0.0 00 0 5 965.2 965.2 965 0 VERTICAL MEMBER REACTIONS T MEM LT NO REACTION R 3 441.1 4 1005.5	MOMENTS (FT-KIPS LT RT 0. 225 -2783. 35 0. 225 Licensed to: RE G-04-AL; SH-70 *** SIDESWAY INCL RIAL 0 T. 3 PT .4 8. 3746. 50 4. 2305. 43 TRIAL 0 BOTTO 94606 62835 TRIAL 0 TOP 9. 315. 4 3. 194. 3 AL 0 1205627 0. 0. 1. 2056. 27 IAL 0 .6 162.8 6 .2 224.5 12 L 0 .2 -965.2 -96 RTAL 0 RT EACTION	BASED ON 85. 97. 85. Colorado DOT ; CBGCP; PROJ#I UDED. *** PT .5 PT 48. <b>5230</b> . 27. 5230. 47. 5230. 47. 642. FIBER 20642. 31642. FIBER 24. 440. 64. 440. 413426. 0. 0. 41. 3426. 1.9 -30.8 3.6 30.8 5.2 -965.2 0.0 0.0 5.2 965.2 MEMBER WEIGHT	Run time: 12-0 70-1(75)57; M.N .6 PT .7 PT 4327. 2305 5048. 3746. -531283. -620460. 364. 194. 424. 315. -41124797. 0. 0. 4112. 4797. -123.6 -224.5 -61.9 -162.8 -965.2 -965.2 0.0 0.0	4. .8 PT .9 2 864 1298 106. -159. 73. 109. 5482 0. 5482. 5 -317.2 - 8 -255.6 - 2 -965.2 - 0.0	PT RIGHT 511910458 22356853. 628. 1284. 274. 841. -430879. -188576. 61676853. 0. 0. 6167. 6853. 410.0 -502.8 348.3 -441.1 965.2 -965.2 0.0 0.0	<b>E</b>

1IAI-BDS Version 4.0.13						7
OTANGENTIAL ROTATIONS - RADIANS -	-04-AL; SH-70; CLOCKWISE POSIT	IVE			OTRIAL O	
SPAN         LT. END         RT. END           0         1         0.000766         0.000000           0         4         0.000000         0.000000	SPAN LT. EL 2 0.000	ND RT.E	END SPAN 0766 3	LT. END -0.000383	RT. END 0.000766	
0 4 0.000000 0.000000	5 0.000	383 -0.000	)766			
OHORIZONTAL MEMBER DEFLECTIONS IN0MEMBER 1E= 4066.00MEMBER 2E= 4066.0					VE	
0 MEMBER 2 E= 4066. 0 OVERTICAL MEMBER DEFLECTIONS IN F				0.000		
0 MEMBER 3 E= 3320. 0	.000 -0.001	-0.001	-0.001	0.000		
0 MEMBER 4 E= 3320. 0 0 MEMBER 5 E= 3320. 0	.000 0.000 .000 0.001	0.001	0.000	0.000 0.000		
11AI-BDS Version 4.0.13	Licensed to: Co	lorado DOT	Run tim	ne: 12-JUL-95	16:18:35 Page	8
STRUCTURE G 0LOAD DATA TRIAL 1	-04-AL; SH-70; C	BGCP; PROJ#1	170-1(75)57;	М.М.		
LOAD	A B	FIXED E	END MOMENTS	0000		
1 1.140 U	A B 0.0 117.0 0.0 117.0	LEF"1" 0.	0.	ASPHAL	T; CURBS; RAIL	
2 1.140 U OFIXED END MOMENTS TRIAL 1	0.0 117.0	0.	0.	ASPHAL	T; CURBS; RAIL	
MEM FIXED END MOMENTS	MEM ETY	ראס אסאפא מאפא	ITT C	MEM ET	XED END MOMENTS	
NO LT RT	MEM FIX NO L'	r Ri	[	NO	LT RT	
1 -13001300.	2 -13 5	00130		3	0. 0.	
4 0. 0.	5	0.	0.			
1IAI-BDS Version 4.0.13	Licensed to: Co -04-AL; SH-70; C				16:18:35 Page	9
0 ***	FRAME DOES NOT S					
HORIZONTAL MEMBER MOMENTS TRIAL MEM						
NO LEFT .1 PT .2 PT 0 1 -963311. 184.	.3 PT .4 PT 524 707	.5 PT	.6 PT .7 P	PT .8 PT	.9 PT RIGHT	59. <del>C</del>
0 2 -1469716120.	321. 606.	735.	707.	524. 184.	-31196	3.
OHORIZONTAL MEMBER STRESSES         TRIA           0 1         118.         38.         -23.           0 2         180.         88.         15.	-6487.	-90.	-74.	-39. 15.	88. 18	0.
OHORIZONTAL MEMBER STRESSES TRIA	L 1 TOP FIB	ER				
0 1 -8126. 15. 0 2 -1246010.	44. 59.	62.	51. 59	2710.	-6012	4.
OVERTICAL MEMBER MOMENTS TRIAL	1					
0 3 096193. 0 4 0. 0. 0.	-289385. 0. 0. 289. 385.	-481. 0.	-578 0.	0. 0.	0.	3. 0.
OHORIZONTAL MEMBER SHEARS TRIAL	1			674. 770.		
0 1 62.4 49.0 35.7 0 2 71.0 57.7 44.3	22.3 9.0	-4.3	-17.7 -	-31.0 -44.3	-57.7 -71	.0
OVERTICAL MEMBER SHEARS TRIAL 1						
0 3 -135.6 -135.6 -135.6 0 4 0.0 0.0 0.0	0.0 0.0	0.0	0.0	0.0 0.0	0.0 0	
0 5 135.6 135.6 135.6 OVERTICAL MEMBER REACTIONS TRIAL		135.6	135.6 1	35.6 135.6	135.6 135	.6
0MEM LT RT NO REACTION REACT	ME					
		IGHI				
3 62.4 62 4 142.0 142						
5 62.4 62	.4					
1IAI-BDS Version 4.0.13	Licensed to: Co -04-AL; SH-70; C				:18:35 Page	10
OTRIAL 1			L/U-1(/5)5/,	141.141.		
0TANGENTIAL ROTATIONS - RADIANS - SPAN LT. END RT. END	CLOCKWISE POSIT	IVE ND RT.E	end span	I LT. END	RT. END	
SPAN         LT. END         RT. END           0         1         0.000108         0.000000           0         4         0.000000         0.000000	2 0.000	000 -0.000 054 -0.000	)108 3	-0.000054	0.000108	
OHORIZONTAL MEMBER DEFLECTIONS IN	FEET AT 1/ 4 PO	INTS FROM LE	EFT END - DC	WNWARD POSITI	VE	
0 MEMBER 1 E= 4066. 0 0 MEMBER 2 E= 4066. 0				0.000		
0 VERTICAL MEMBER DEFLECTIONS IN F 0 MEMBER 3 E= 3320. 0	EET AT 1/ 4 POIN .000 0.000	IS FROM LEFT 0.000	F END. 0.000	0.000		
0         MEMBER         3         E=         3320.         0           0         MEMBER         4         E=         3320.         0           0         MEMBER         5         E=         3320.         0	.000 0.000	0.000	0.000	0.000		
					16.10.25	
1IAI-BDS Version 4.0.13 STRUCTURE G					10.18:35 Page	11
OLIVE LOAD DIAGNOSTICS						
0 0SUPERSTRUCTURE LIVE LOAD						
0 NUMBER OF LIVE LOAD L	ANES RE	SISTING MOME	ENT OF	PLOT PLOT	INFLU-	
0 NUMBER OF LIVE LOAD L MEM SUPERSTRUCTURE SUBSTRU NO. LT.END RT.END LT.END	RT.END PO	SITIVE NEG	GATIVE	M S SCALE ENV.	ENCE LINES GEN	
1 2.464 2.464 2.0 2 2.464 2.464 2.0 0LIVETRUCK	2.0	0. 0	0. 0	0 0	NO NO	
OLIVETRUCK		LANE		NO. LIVE		

July 1995

LOAD NO.	Pl	Dl	P2 D2	P3	UNIFORM		SHEAR RIDER IMP	LL PACT LNS.	LOAD SIDESWAY		
1.	8.0	14.0 3	2.0 1	4.0 32.0	0.640	18.0	26.0 YE	s 0.00	NO		
	COMMI	ENTS: HS2	0-44 TR	UCK							
+					WITHOUT	ALTERNA	TIVE				
2.	24.0	4.0 2	4.0	0.0 0.0	0.000	0.0	0.0 YE	s 0.00	NO		
	COMMI	ENTS: MIL	ITARY A	LTERNATE LC	AD						
IMPAC 0		RS CALCUL IMPAC %		PROGRAM							
	1 2	21. 21.									
1IAI-BD	s v	Version 4	.0.13	License	d to: Colc	rado DOT	' Run	time: 12	-JUL-95 1	6:18:35	Page 12
OLL NO	-	S	TRUCTUR	E G-04-AL; NEGATIVE LI .3 PT	SH-70; CBG	CP; PROJ	#170-1(75)	57; M.M.	D GHENDG		
OMEM NO	LEFT	.1 PT	.2 PT	.3 PT	.4 PT	.5PT	.6 PT	.7 PT	.8 PT	.9 PT	RIGHT
0 1	-3107.	-1542.	-397	41. .6 -21.3	-290.	-540.	-789.	-1039.	-1289.	-1916.	-3432.
											-155.2 -3107. ← -147.2
SHEAR 0HORIZO	155.2 NTAL MEN	98.7 MBER STRE	21 SSES LL	.3 21.3 MAX NEG E	21.3 BOTTOM FIBE	21.3 R	21.3	21.3	-73.6	-121.5	-147.2
							97. 36	128.	158.	235.	<mark>421</mark> . ← 381.
OHORIZO	NTAL MEN	MBER STRE	SSES LL	MAX NEG I	OP FIBER						
0 1 0 2	<mark>-261</mark> . -289.	-130. -161.	-33 -108	-3. -87.	-24. -66.	-45. -45.	-66. -24.	-87.	-108. -33.	-161. -130.	<mark>-289</mark> . ← -261.
1IAI-BD	s v	Version 4	.0.13	License	d to: Colc	rado DOT	Run	time: 12	-JUL-95 1	6:18:35	Page 13
OLL NO.	1.	S	TRUCTUR	License E G-04-AL; DEAD LOAD F	SH-70; CBG PLUS NEGATI	CP; PROJ VE LIVE	#I70-1(75) LOAD MOMEN	57; M.M. T ENVELOP	Έ		
0MEM NO	LEFT	.1 PT	.2 PT	DEAD LOAD F .3 PT	.4 PT	.5PT	.6 PT	.7 PT	.8 PT	.9 PT	RIGHT
	-9960.	-3777.	901	. 3705. . 1266.	4758.	4690.	3537.	1266.	-2153.	-7035.	-13890.
OHOR T ZO	NTAL ME	MBER STRE	SSES FO	R DI.+T.T. MAX	NEG BOTTO	M FIBER					
0 2	1706.	864.	264	455. 155.	-434.	-576.	-434.	-155.	-111.	464.	1223.
0 HORIZO	NTAL MEN -837.	MBER STRE -317.	SSES FO	R DL+LL MAX . 311. . 106.	400.	FIBER 394.	297.	106.	-181.	-591.	-1168.
0 2	-1168.	-591.	-181	. 106.	297.	394.	400.	311.	76.	-317.	-837.
				License E G-04-AL;						6:18:35	Page 14
OLL NO.	1. LEET	1 DT	2 57	E G-04-AL; POSITIVE LI .3 PT	VE LOAD MC	MENT ENV	ELOPE AND	ASSOCIATE	D SHEARS	9 DT	RIGHT
NO	708.										
0 1 SHEAR	-21.3	50.6	154	.9 132.9	108.1	3092. 81.6		2577. -116.7	1726. -141.8	588. -164.2	0.0
0 2 SHEAR	0. 0.0					<mark>3092</mark> . -81.6		2102. -132.9	1143. -154.9	554. -50.6	
0HORIZO 0 1	NTAL MEN -87.	MBER STRE -68.	SSES LL -140	MAX POS E 258.			-373.	-216	_212	-72	0. 🗲
0 2	0.	-72.	-212		-373.	-380.	-342.	-258.	-140.		
0 1	59.	47.	96	. 177.	234.		255.		145.		
0 2	0.	49.	145			<mark>260</mark> .			96.		
1IAI-BD	S V	Version 4	.0.13	License E G-04-AL;	ed to: Colc SH-70; CBG	rado DOT	Run #T70-1(75)	time: 12	-JUL-95 1	6:18:35	Page 15
OLL NO. OMEM NO	1. LEFT	.1 PT	.2 PT	E G-04-AL; DEAD LOAD F .3 PT	LUS POSITI .4 PT	VE LIVE .5PT	LOAD MOMEN .6 PT	T ENVELOP .7 PT	РЕ .8 РТ	.9 PT	RIGHT
	-6145.	-1681.	2441	. 5848. . 4882.	7836.	8322.	7363.	4882.	862.	-4531.	-10458.
OHORIZO	NTAL MEN	MBER STRE	SSES FO	R DI.+I.I. MAX	POS BOTTO	M FIBER					
0 2	755. 1284.	206. 556.	-300 -106	718. 599.	-962. -904.	-1022. -1022.	-904. -962.	-599. -718.	-106. -300.	556. 206.	1284. 755.
0HORIZO 0 1	NTAL MEN -517.	MBER STRE -141.	SSES FO	R DL+LL MAX	POS TOP	FIBER					
0 2	-879.	-381.	72	. 492. . 410.	619.	700.	659.	492.	205.	-141.	
0.1.1 110	1	S	TRUCTUR	License E G-04-AL; LIVE LC	SH-70; CBG	CP; PROJ	#I70-1(75)	57; M.M.			Page 16
OMEMBER	1 LEF	г.1 Р	T .2	PT .3 F	РТ .4 РТ	.5 P	т.6 рт	.7 PI	.8 PT	.9 PI	
0POS. V MOM.	204.0 -1133.			0.5 147. 2. 2059.	2 121.5 2724.						

NEG V	-21.6 -22	2 0 -25 4	-36 7	-52.8	-77 2	-103 4	-130 1	-155 9	) –179 f	-199	6
MOM.	454. 116 226.2 21	2. 1174.	1712.	2524.	2932.	2950.	2535.	1710.	558.	-773	
OLL NO.	1.	2.1 195.9	LIVE LOAD	SHEAR EN	VELOPES	AND ASSOC	IATED MOM	ENTS	100.4	199	.0
OMEMBER OPOS. V	1. 2 LEFT .1 199.6 179 -773. 559	PT .2 PT 9.6 155.9	.3 PT 130.1	.4 PT 103.4	.5 PT 77.2	'.6 PT 52.8	.7 PT 36.7	.8 P1 25.4	.9 PI 22.0	' RIG	,НТ 6
MOM.	-773. 55	3. 1710.	2535.	2950.	2932.	2524.	590.	235.	1162.	454	•
MEG. V MOM.	0.0 -0 0. 69 199.6 18	5.9 -22.1 5. 1365.	-43.8 2239.	-68.5 2811.	-94.9 2984.	2724.	-147.2 2059.	-170.5	-190.1	-1133	. 6
1IAI-BDS	Version	4.0.13 STRUCTURE G-	Licensed -04-AL; SH	to: Colora -70; CBGCI	ado DOT ?; PROJ#	Run 170-1(75)	time: 12- 57; M.M.	-JUL-95 1	6:18:35	Page	17
OLL NO. 1 OMEMBER	1. 1 LEFT .1	DEAI PT .2 PT	.3 PT	S LIVE LO .4 PT	AD SHEAR .5 PT	E ENVELOPE	.7 PT	.8 PI	.9 PI	RIG	HT
OPOS. V	645.7 53 419.5 32	8.4 426.1	310.0	183.5	64.0	-55.1	-180.6	-295.1	-403.1	-502	. 8
OLL NO. 1	419.5 320 1.	DEAI	LOAD PLU	9.2 S LIVE LO	AD SHEAR	ENVELOPE	-354.0	-4/3.2	-589.5	-702	.4
OMEMBER OPOS. V	1. 2 LEFT .1 702.4 58 502.8 40	PT .2 PT 9.5 473.2	.3 PT 354.6	.4 PT 227.0	.5 PT 108.0	'.6 PT -9.2	.7 PT -126.1	.8 P1 -230.2	.9 PI -326.3	RIG -419	ΗT .5
NEG. V	502.8 40	3.1 295.1	180.6	55.1	-64.0	-183.5	-310.0	-426.1	-538.4	-645	.7
		STRUCTURE G-	-04-AL; SH	-70; CBGC	?; PROJ#	170-1(75)	57; M.M.		6:18:35	Page	18
OLL NO. 3	3		LIVE LOAD	SUPPORT 1	RESULTS						
0		MAX. - AXIAL	AXIAL LO MOME	AD NT		MAX. LON AXIAL -	GITUDINAL MOMEN	MOMENT NT			
OMEMBER	3	LOAD	TOP	BOT.		LOAD	TOP	BOT.			
UNEMBER	3 POSITIVE NEGATIVE	166.1	-919.	0.	-	17.3	574.	0.			
0member	NEGATIVE 4	-17.5	581.	0.	1	.19.5	-2522.	0.			
OMEMBER	4 POSITIVE NEGATIVE 5	255.2 0.0	0. 0.	0. 0.	1 1	.27.1 .27.1	199. -199.	-100. 100.			
UNEMBER	POSITIVE NEGATIVE	166.1	919.	0.	1	19.5	2522.	0.			
0 THE	NEGATIVE RATIO OF SUB:	-17.5 STRUCTURE / S	-581. SUPERSTRUC	0. TURE LOAD	ING IS 0	17.3	-574.	0.			
1IAI-BDS	Version	4.0.13	Licensed	to: Colora	ado DOT	Run	time: 12-	-JUL-95 1	6:18:35	Page	19
OLL NO. 2 OMEM 1	2. LEFT .1 PT	.2 PT	ATIVE LIVE .3 PT	LOAD MOM	ENT ENVE	LOPE AND	ASSOCIATEI .7 PT	O SHEARS .8 PT	.9 PT	RIGHT	
NO 0 1 -:	21371075	-285.	-28.	-200.	-371.	-543.	-714.	-886.	-1057.	-1398.	
SHEAR	98.0 80	.6 44.8	-14.7	-14.7	-14.7	-14.7	-14.7	-14.7	-14.7	-86.	3
U Z SHEAR	98.0 80 13981057 86.3 14	886. .7 14.7	-/14. 14.7	-543. 14.7	-371. 14.7	-200. 14.7	-28. 14.7	-285. -44.8	-1075. -80.6	-2137. -98.	0
OHOR LZON.	TAL MEMBER STI	RESSES LL MAX	( NEG BOT	TOM FIRER							
0 2	262. 132 172. 130	109.	88.	67.	46.	25.	3.	35.	132.	262.	
0 1	TAL MEMBER STI -18090 -11789	24.	-2.	-17.	-31.	-46.	-60.	-74.	-89.	-117.	
	Version 2.								6:18:35	Page	20
			.3 PT						.9 PT	RIGHT	
NO 0 1	89903310	. 1013.	3718.	4849.	4859.	3784.	1591.	-1750.	-6176.	-11856.	
0 2 -1	89903310 18566176	1750.	1591.	3784.	4859.	4849.	3718.	1013.	-3310.	-8990.	
0 1	TAL MEMBER STI 1104. 406 1456. 758	124.	-457.	-595.	-597.	-465.	-195.	215.	758.	1456.	
OHOR TZON	TAL MEMBER STI	RESSES FOR DI	+T.T. MAX N	EG TOP F	IBER						
0 1	-756278 -997519	. 85.	313.	408.	408.	318. 408	134.	-147.	-519.	-997. -756	
IIAI-BDS	Version	4.U.13 STRUCTURE G-	LICENSED -04-AL; SH	-70; Colora	ado DOT ?; PROJ#	Run (75)I70-1	тіте: 12- 57; М.М.	-ј06-95 ]	.b:18:35	Page	21
OLL NO. 2 OMEM	2. LEFT .1 PT	POSI 2 PT	TIVE LIVE	LOAD MOM	ENT ENVE	LOPE AND	ASSOCIATEI 7 PT	SHEARS	9 PT	RIGHT	
NO											
0 1 SHEAR	486. 419 -14.7 66	1072.	1720. 108.7	2196. 92.2	2421. 74.5	2376. -80.1	2048. -97.9	1461. -114.6	692. -129.3	0. 0.	0
0 2 SHEAD	486. 419 -14.7 66 0. 692 0.0 57	. 1461. 9 43 2	2048.	2376.	2421.	2196.	1720. -108 7	1072.	419.	486.	7
OHOR T ZON'	TAL MEMBER STI	RESSES I.I. MAY		TOM FIBER							
U 1 0 2	-6051 085	132. 179.	-211. -251.	-270. -292.	-297. -297.	-292. -270.	-251. -211.	-179. -132.	-85. -51.	0. -60.	
0 HOR T ZON'	TAL MEMBER STI	RESSES LL MAX	C POS TOP	FIBER							
0 2	41. 35 0. 58	. 123.	172.	200.	204.	185.	145.	⊥23. 90.	35.	0. 41.	
1IAI-BDS	Version	4.0.13	Licensed	to: Colora	ado DOT	Run	time: 12-	-JUL-95 1	6:18:36	Page	
011 100	2	STRUCTURE G	-04-AL; SH	-70; CBGC	P; PROJ#	170-1(75)	57; M.M.				-
OMEM 1	2. LEFT .1 PT	DEAI .2 PT	.3 PT	.4 PT	5PT	.6 PT	.7 PT	.8 PT	.9 PT	RIGHT	
NO											

9B.79

0 1												
0 1 -	-6366	1816.	2370.	5466. 4352.	7244.	7651.	6703.	4352.	597.	-4427.	-10458.	
OHORTZON	TAL MEMBE	R STRESS	ES FOR DI	+T.T. MAX P	OS BOTTOM	FIBER						
0 1	782.	223.	-291.	-671. -534.	-890.	-939.	-823.	-534.	-73.	544.	1284.	
0 2	1284.	544.	-73.	-534.	-823.	-939.	-890.	-671.	-291.	223.	782.	
0 1	-535.	-153.	199.	HLL MAX P 459. 366.	609.	1BER 643.	563.	366.	50.	-372.	-879.	
0 2	-879.	-372.	50.	366.	563.	643.	609.	459.	199.	-153.	-535.	
				Licensed								
IIAI-BDS	s Ver	SION 4.0 STR	.13 UCTURE G-	Licensed	to: Color -70; CBGC	ado DOT P; PROT#1	Run 70-1(75)	time: 12- 57; мм	JUL-95 I	6:18:36	Page	23
OLL NO.	2.	0110	0010102 0	LICENSED 04-AL; SH LIVE LOAD .3 PT 108.7	SHEAR EN	VELOPES A	AND ASSOCI	LATED MOME	NTS			
OMEMBER	1 LEFT	.1 PT	.2 PT	.3 PT	.4 PT	.5 PT	.6 PT	.7 PT	.8 PT	.9 PT	RIGH	HT
UPOS. V MOM	141.8 -205	134.4 376	123.1	108.7	92.2 2196	74.5 2421	56.4 2356	2003	22.8	9.1	0.	.0
NEG. V	-14.7	-14.7	-15.4	1720.	-44.7	-62.1	-80.1	-97.9	-114.6	-129.3	-141.	.0
MOM.	486.	315.	1056.	1682. 137.5	2165.	2413.	2376.	2048.	1461.	692.	-142.	•
OLL NO	156.5 2	149.1	138.4	L37.5	136.9 SHEAR EN	I36.6 VELOPES A	AND ASSOCI	136.8 TATED MOME	137.4	138.3	141.	.0
OMEMBER	2 LEFT	.1 PT	.2 PT	LIVE LOAD .3 PT 97.9 2048.	.4 PT	.5 PT	.6 PT	.7 PT	.8 PT	.9 PT	RIGH	ΗT
OPOS. V	141.0	129.3	114.6	97.9	80.1	62.1	44.7	28.8	15.4	14.7	14.	.7
MOM. NEG V	-142.	-9 1	1461. -22.8	2048.	-56 4	2413. -74 5	2165. _92_2	1682. -108 7	1056. -123 1	315. -134 4	486. -141	8
MOM.	0.	656.	1408.	-38.9 2003.	2356.	2421.	2196.	1720.	1072.	376.	-205.	
RANGE	141.0	138.3	137.4	136.8	136.5	136.6	136.9	137.5	138.4	149.1	156.	.5
1 T A T _ D D G	Vor	aion 1 0	12	Licensed	to: Color	ado DOT	Pup	timo: 12_	TIT _ 05 1	6 • 1 9 • 26	Dago	21
IIAI-BDS	o ver	SION 4.0 STR	UCTURE G-	·04-AL; SH	-70; CBGC	P; PROJ#1	170-1(75)	57; M.M.	00L-95 I	0.10.30	Page	24
OLL NO.	2.		DEAI	LOAD PLU	S LIVE LO	AD SHEAR	ENVELOPE					
OMEMBER	1 LEFT	.1 PT	.2 PT	.3 PT	.4 PT	.5 PT	.6 PT	.7 PT	.8 PT	.9 PT	RIGH	HT
NEG. V	426.4	333.7	240.2	134.0	17.2	-92.9	-203.7	-322.4	-431.9	-539.3	-643.	.8
OLL NO.	2.		DEAI	LOAD PLU	S LIVE LO	AD SHEAR	ENVELOPE					
OMEMBER	2 LEFT	.1 PT	.2 PT	.3 PT	.4 PT	.5 PT	.6 PT	.7 PT	.8 PT	.9 PT	RIGH	HT
NEG. V	502.8	400.9	294.4	Licensed 04-AL; SH 0 LOAD PLU .3 PT 271.5 134.0 0 LOAD PLU .3 PT 322.4 185.6	67.2	-43.7	-154.1	-271.5	-378.6	-482.7	-582.	.9
liai-bds	8 Ver	sion 4.0	.13	Licensed 04-AL; SH	to: Color	ado DOT	Run	time: 12- 57:мм	JUL-95 1	6:18:36	Page	25
OLL NO.	2.			LIVE LOAD	SUPPORT	PFCIILTC						
						11000110						
0		۵	MAX.	AXIAL LO	AD	1120112	MAX. LONG	JITUDINAL	MOMENT			
0		A	MAX. XIAL - OAD	AXIAL LO MOME TOP	AD NT BOT.	RESOLIS 4 I	MAX. LONG AXIAL LOAD	GITUDINAL MOMEN TOP	MOMENT T BOT.			
0 Omember	3	A	MAX. XIAL - OAD	AXIAL LO MOME TOP	AD NT BOT.	//////////////////////////////////////	MAX. LONG AXIAL LOAD	GITUDINAL MOMEN TOP	MOMENT IT BOT.			
0 Omember	3 POSITI NEGATI	A L VE 1 VE -	MAX. XIAL - OAD 15.1 11.9	AXIAL LO MOME TOP -167. 395.	AD NT BOT. 0.	/ [ -1	MAX. LONG AXIAL LOAD L1.9 79.6	GITUDINAL MOMEN TOP 395. -1735.	MOMENT IT BOT. 0.			
0 Omember Omember	POSITI NEGATI	VE 1 VE -	15.1 11.9	-167. 395.	0. 0.	-1 7	L1.9 79.6 -	395. -1735.	0. 0.			
	POSITI NEGATI	VE 1 VE -	15.1 11.9	-167. 395.	0. 0.	-1 7	L1.9 79.6 -	395. -1735.	0. 0.			
OMEMBER	POSITI NEGATI 4 POSITI NEGATI	VE 1 VE -	15.1 11.9	AXIAL LO MOME TOP -167. 395. 14. 0.	0. 0. -7. 0.	1 - 7 3 8	11.9 79.6 - 31.9 31.9	395. -1735. 137. -137.	0. 0. -69. 69.			
	POSITI NEGATI 4 POSITI NEGATI 5 POSITI	VE 1 VE - VE 1 VE 1	15.1 11.9 15.7 0.0 15.1	-167. 395. 14. 0. 167.	0. 0. -7. 0.	1 - 7 3 8	11.9 79.6 - 31.9 31.9	395. -1735. 137. -137.	0. 0. -69. 69.			
OMEMBER OMEMBER	POSITI NEGATI 4 POSITI NEGATI 5 POSITI NEGATI	VE 1 VE - VE 1 VE 1 VE 1 VE -	15.1 11.9 15.7 0.0 15.1 11.9	-167. 395. 14. 0. 167. -395.	0. 0. -7. 0. 0.	1 - 7 8 7 1 -	11.9 79.6 - 31.9 31.9 79.6 11.9	395. -1735.	0. 0. -69. 69.			
OMEMBER OMEMBER	POSITI NEGATI 4 POSITI NEGATI 5 POSITI NEGATI	VE 1 VE - VE 1 VE 1 VE 1 VE -	15.1 11.9 15.7 0.0 15.1 11.9	-167. 395. 14. 0. 167.	0. 0. -7. 0. 0.	1 - 7 8 7 1 -	11.9 79.6 - 31.9 31.9 79.6 11.9	395. -1735. 137. -137.	0. 0. -69. 69.			
OMEMBER OMEMBER O THE	POSITI NEGATI 4 POSITI 5 POSITI NEGATI 2 RATIO OF	VE 1 VE - VE 1 VE 1 VE 1 VE - SUBSTRU SIBSTRU	15.1 11.9 15.7 0.0 15.1 11.9 CTURE / S .13	-167. 395. 14. 0. 167. -395. SUPERSTRUC Licensed	0. 0. -7. 0. 0. TURE LOAD to: Color	-1 7 8 8 7 1 1NG IS 0. ado DOT	L1.9 79.6 31.9 31.9 79.6 L1.9 .812 Run	395. -1735. 137. -137. 1735. -395. time: 12-	0. 0. -69. 69. 0.	6:18:36	Page	26
OMEMBER OMEMBER O THE 1IAI-BDS	POSITI NEGATI 4 POSITI NEGATI 5 POSITI NEGATI 2 RATIO OF 5 Ver	VE 1 VE - VE 1 VE 1 VE - SUBSTRU SIBSTRU SION 4.0 STR	15.1 11.9 15.7 0.0 15.1 11.9 CTURE / S .13	-167. 395. 14. 0. 167. -395. SUPERSTRUC	0. 0. -7. 0. 0. TURE LOAD to: Color	-1 7 8 8 7 1 1NG IS 0. ado DOT	L1.9 79.6 31.9 31.9 79.6 L1.9 .812 Run	395. -1735. 137. -137. 1735. -395. time: 12-	0. 0. -69. 69. 0.	6:18:36	Page	26
OMEMBER OMEMBER O THE 1IAI-BDS	POSITI NEGATI 4 POSITI 5 POSITI NEGATI 2 RATIO OF	VE 1 VE - VE 1 VE 1 VE - SUBSTRU SIBSTRU SION 4.0 STR	15.1 11.9 15.7 0.0 15.1 11.9 CTURE / S .13	-167. 395. 14. 0. 167. -395. SUPERSTRUC Licensed	0. 0. -7. 0. 0. TURE LOAD to: Color	-1 7 8 8 7 1 1NG IS 0. ado DOT	L1.9 79.6 31.9 31.9 79.6 L1.9 .812 Run	395. -1735. 137. -137. 1735. -395. time: 12-	0. 0. -69. 69. 0.	6:18:36	Page	26
OMEMBER OMEMBER O THE 1IAI-BDS	POSITI NEGATI 4 POSITI NEGATI 5 POSITI NEGATI 2 RATIO OF 5 Ver	VE 1 VE - VE 1 VE 1 VE - SUBSTRU SIBSTRU SION 4.0 STR	15.1 11.9 15.7 0.0 15.1 11.9 CTURE / S .13	-167. 395. 14. 0. 167. -395. SUPERSTRUC Licensed	0. 0. -7. 0. 0. TURE LOAD to: Color	-1 7 8 8 7 1 1NG IS 0. ado DOT	L1.9 79.6 31.9 31.9 79.6 L1.9 .812 Run	395. -1735. 137. -137. 1735. -395. time: 12-	0. 0. -69. 69. 0.	6:18:36	Page	26
OMEMBER OMEMBER O THE LIAI-BDS OLIVE LC O OLIVE LC	POSITI NEGATI 4 POSITI NEGATI 5 POSITI NEGATI 2 RATIO OF 3 Ver DAD DIAGNO	VE 1 VE - VE 1 VE 1 VE - SUBSTRU SUBSTRU SION 4.0 STR STICS	15.1 11.9 15.7 0.0 15.1 11.9 CTURE / S .13 UCTURE G-	-167. 395. 14. 0. 167. -395. SUPERSTRUC Licensed 04-AL; SH	0. 0. -7. 0. 0. TURE LOAD to: Color -70; CBGC	-] 7 8 9 1 1 NG IS 0. ado DOT P; PROJ#1 BUTION FF	<pre>11.9 79.6 31.9 31.9 79.6 11.9 .812 Run t70-1(75)5</pre>	395. -1735. -137. -137. 1735. -395. time: 12- 7; M.M.	0. 0. -69. 69. 0. 0. JUL-95 1		Page	26
OMEMBER OMEMBER O THE LIAI-BDS OLIVE LC O OLIVE LC	POSITI NEGATI 4 POSITI NEGATI 5 POSITI NEGATI 2 RATIO OF 3 Ver DAD DIAGNO	VE 1 VE - VE 1 VE 1 VE - SUBSTRU SUBSTRU SION 4.0 STR STICS	15.1 11.9 15.7 0.0 15.1 11.9 CTURE / S .13 UCTURE G-	-167. 395. 14. 0. 167. -395. SUPERSTRUC Licensed 04-AL; SH	0. 0. -7. 0. 0. TURE LOAD to: Color -70; CBGC	-] 7 8 9 1 1 NG IS 0. ado DOT P; PROJ#1 BUTION FF	<pre>11.9 79.6 31.9 31.9 79.6 11.9 .812 Run t70-1(75)5</pre>	395. -1735. -137. -137. 1735. -395. time: 12- 7; M.M.	0. 0. -69. 69. 0. 0. JUL-95 1		Page	26
OMEMBER OMEMBER 0 THE 1IAI-BDS 0LIVE LC 0 0LIVE LC 0 0LIVE LC 0 0 MEM NO.	POSITI NEGATI 4 POSITI NEGATI 5 POSITI NEGATI 3 RATIO OF 3 Ver DAD DIAGNO DAD GENERA NUMBE SUPERSTR LT.END	VE 1 VE - VE 1 VE 1 VE - SUBSTRU SUBSTRU SION 4.0 STR STICS TOR R OF LIV UCTURE RT.END	15.1 11.9 15.7 0.0 15.1 11.9 CTURE / S .13 UCTURE G- E LOAD LA SUBSTRUC LT.END	-167. 395. 14. 0. 167. -395. SUPERSTRUC Licensed 04-AL; SH LIVE LO NNES CTURE RT.END	0. 0. -7. 0. 0. TURE LOAD to: Color -70; CBGC AD DISTRI RESIS POSIT	-] 7 8 9 1NG IS 0. ado DOT P; PROJ#1 BUTION FF TING MOME UNIT STEE IVE NEC	11.9 79.6 31.9 31.9 79.6 11.9 .812 Run 170-1(75)! ACT SMT OF EL SATIVE	395. -1735. 137. -137. 1735. -395. time: 12- 57; M.M. PLOT M S ENV.	0. 0. -69. 69. 0. 0. JUL-95 1: JUL-95 1: PLOT 5 SCALE	INFLU- ENCE LINES G	EN	26
OMEMBER OMEMBER 0 THE 1IAI-BDS 0LIVE LC 0 0LIVE LC 0 0LIVE LC 0 0 MEM NO.	POSITI NEGATI 4 POSITI NEGATI 5 POSITI NEGATI 3 RATIO OF 3 Ver DAD DIAGNO DAD GENERA NUMBE SUPERSTR LT.END	VE 1 VE - VE 1 VE 1 VE - SUBSTRU SUBSTRU SION 4.0 STR STICS TOR R OF LIV UCTURE RT.END	15.1 11.9 15.7 0.0 15.1 11.9 CTURE / S .13 UCTURE G- E LOAD LA SUBSTRUC LT.END	-167. 395. 14. 0. 167. -395. SUPERSTRUC Licensed 04-AL; SH LIVE LO NNES TURE	0. 0. -7. 0. 0. TURE LOAD to: Color -70; CBGC AD DISTRI RESIS POSIT	-] 7 8 9 1NG IS 0. ado DOT P; PROJ#1 BUTION FF TING MOME UNIT STEE IVE NEC	11.9 79.6 31.9 31.9 79.6 11.9 .812 Run 170-1(75)! ACT SMT OF EL SATIVE	395. -1735. 137. -137. 1735. -395. time: 12- 57; M.M. PLOT M S ENV.	0. 0. -69. 69. 0. 0. JUL-95 1: JUL-95 1: PLOT 5 SCALE	INFLU- ENCE LINES G	EN	26
OMEMBER OMEMBER 0 THE 1IAI-BDS 0LIVE LC 0 0LIVE LC 0 0LIVE LC 0 0 MEM NO.	POSITI NEGATI 4 POSITI NEGATI 5 POSITI NEGATI 3 Ver DAD DIAGNO DAD GENERA NUMBE SUPERSTR LT.END	VE 1 VE - VE 1 VE 1 VE 1 VE 1 SUBSTRU SUBSTRU SION 4.0 STICS TOR R OF LIV UCTURE R OF LIV UCTURE RT.END	15.1 11.9 15.7 0.0 15.1 11.9 CTURE / S .13 UCTURE G- E LOAD L <sup>2</sup> SUBSTRUC LT.END	-167. 395. 14. 0. 167. -395. SUPERSTRUC Licensed 04-AL; SH LIVE LO NES TURE RT.END	0. 0. -7. 0. 0. TURE LOAD to: Color -70; CBGC AD DISTRI RESIS POSIT	-] 7 8 8 9 1 1 NG IS 0. ado DOT 9; PROJ#1 9; PROJ#1 9 TING MOME UNIT STEE IVE NEC	11.9 79.6 31.9 31.9 79.6 11.9 .812 Run 170-1(75)! ACT SMT OF EL SATIVE	395. -1735. -137. 1735. -395. time: 12- 7; M.M. PLOT M S ENV.	0. 0. -69. 69. 0. 0. JUL-95 1: JUL-95 1: PLOT 5 SCALE	INFLU- ENCE LINES G	EN	26
OMEMBER OMEMBER 0 THE 1IAI-BDS 0LIVE LC 0 0LIVE LC 0 0LIVE LC 0 0 MEM NO. 	POSITI NEGATI 4 POSITI NEGATI 5 POSITI NEGATI 3 Ver DAD DIAGNO DAD GENERA NUMBE SUPERSTR LT.END	VE 1 VE - VE 1 VE 1 VE 1 VE 1 SUBSTRU SUBSTRU SION 4.0 STICS TOR R OF LIV UCTURE R OF LIV UCTURE RT.END	15.1 11.9 15.7 0.0 15.1 11.9 CTURE / S .13 UCTURE G- E LOAD L <sup>2</sup> SUBSTRUC LT.END	-167. 395. 14. 0. 167. -395. SUPERSTRUC Licensed 04-AL; SH LIVE LO NNES CTURE RT.END	0. 0. -7. 0. 0. TURE LOAD to: Color -70; CBGC AD DISTRI RESIS POSIT	-] 7 8 8 7 1 1NG IS 0. ado DOT P; PROJ#1 BUTION FF TING MOME UNIT STEE IVE NEC	11.9 79.6 31.9 79.6 11.9 .812 Run 170-1(75)5 ACT SNT OF EL 3ATIVE	395. -1735. -137. 1735. -395. time: 12- 7; M.M. PLOT M S ENV.	0. 0. -69. 69. 0. 0. JUL-95 1: JUL-95 1: PLOT ; SCALE	INFLU- ENCE LINES G	EN 	26
OMEMBER OMEMBER O THE IIAI-BDS OLIVE LC O OLIVE LC O MEM NO. 	POSITI NEGATI 4 POSITI NEGATI 5 POSITI NEGATI 3 Ver DAD DIAGNO DAD GENERA NUMBE SUPERSTR LT.END	VE 1 VE - VE 1 VE 1 VE 1 VE - SUBSTRU SIDSTRU SION 4.0 STR STICS TOR R OF LIV UCTURE RT.END  2.464 2.464	15.1 11.9 15.7 0.0 15.1 11.9 CTURE / S .13 UCTURE G- E LOAD LA SUBSTRUC LT.END  2.0 2.0	-167. 395. 14. 0. 167. -395. SUPERSTRUC Licensed 04-AL; SH LIVE LO NES TURE RT.END  2.0 2.0	0. 0. -7. 0. 0. TURE LOAD to: Color to: Color POSIT POSIT 	-] 7 8 8 9 1 1NG IS 0. ado DOT 9; PROJ#1 BUTION FF TING MOME UNIT STEE IVE NEC 	<pre>11.9 79.6 31.9 31.9 79.6 11.9 812 Run 170-1(75)5 ACT EL GATTVE 0.</pre>	395. -1735. 137. -137. 1735. -395. time: 12- 57; M.M. PLOT M S ENV. 0	0. 0. -69. 69. 0. 0. JUL-95 10 PLOT SCALE 	INFLU- ENCE LINES G NO	EN  NO	26
OMEMBER OMEMBER 0 THE 1IAI-BDS 0LIVE LC 0 0LIVE LC 0 MEM NO.  1 2 0 LIVE LOAD	POSITI NEGATI 4 POSITI NEGATI 5 POSITI NEGATI 2 RATIO OF 3 Ver DAD DIAGNO DAD GENERA NUMBE SUPERSTR LT.END 2.464 2.464	VE 1 VE 1 VE 1 VE 1 VE 1 VE 1 SUBSTRU SUBSTRU SION 4.0 STR STICS TOR R OF LIV UCTURE RT.END  2.464 2.464	15.1 11.9 15.7 0.0 15.1 11.9 CTURE / S .13 UCTURE G- E LOAD LA SUBSTRUC LT.END  2.0 2.0 TRUCK OF	-167. 395. 14. 0. 167. -395. SUPERSTRUC Licensed 04-AL; SH LIVE LO NES TURE RT.END	0. 0. -7. 0. 0. TURE LOAD to: Color -70; CBGC AD DISTRI RESIS POSIT 	-] 7 8 8 7 1 1NG IS 0. ado DOT 9; PROJ#1 BUTION F# TING MOME UNIT STEE IVE NEC	11.9 79.6 11.9 79.6 11.9 .812 Run 170-1(75)5 ACT ENT OF BL GATIVE 	395. 1735. 137. 137. 1735. -395. time: 12- 57; M.M. PLOT M S ENV. 0 OVER	0. 0. -69. 69. 0. 0. JUL-95 1: PLOT SCALE 0 RRL IMP2	INFLU- ENCE LINES G NO ACT COMB	EN  NO	26
OMEMBER OMEMBER 0 THE 1IAI-BDS 0LIVE LC 0 0LIVE LC 0 0LIVE LC 0 0 MEM NO. 	POSITI NEGATI 4 POSITI NEGATI 5 POSITI NEGATI 2 RATIO OF 3 Ver DAD DIAGNO DAD GENERA NUMBE SUPERSTR LT.END  2.464 2.464 2.464	VE 1 VE 2 VE 1 VE 1 VE 2 SUBSTRU SUBSTRU SION 4.0 STR STICS TOR R OF LIV UCTURE RT.END 2.464 2.464 2.464 2.464	15.1 11.9 15.7 0.0 15.1 11.9 CTURE / S .13 UCTURE G- E LOAD LA SUBSTRUC LT.END  2.0 2.0 TRUCK OF 2 P3 4.0 25.(	-167. 395. 14. 0. 167. -395. SUPERSTRUC Licensed 04-AL; SH LIVE LO NES TTURE RT.END  2.0 2.0 2.0 2.0 12.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0	0. 0. 0. 0. 0. 0. 0. 0. TURE LOAD to: Color to: Color POSIT RESIS POSIT 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	-] 7 8 8 9 1 1NG IS 0. ado DOT 9; PROJ#1 BUTION FF TING MOME UNIT STEE IVE NEC 	<pre>11.9 79.6 - 31.9 31.9 79.6 11.9 .812 Run 170-1(75) ACT ENT OF EL GATIVE</pre>	395. -1735. 137. -137. 1735. -395. time: 12- 57; M.M. PLOT M S ENV. 0 0 VER 5 LOAD 4.0 8.	0. 0. -69. 69. 0. 0. JUL-95 1: PLOT SCALE 0 RRL IMP:	INFLU- ENCE LINES G NO ACT COMB	en  NO CARD	26
OMEMBER OMEMBER 0 THE 1IAI-BDS 0LIVE LC 0 0LIVE LC 0 0LIVE LC 0 0 MEM NO. 	POSITI NEGATI 4 POSITI NEGATI 5 POSITI NEGATI 3 CATO OF 3 Ver DAD DIAGNO DAD GENERA NUMBE SUPERSTR LT.END 2.464 2.464 2.464 P1 D1 27.0 14.00 P7 D7	VE 1 VE 2 VE 1 VE 1 VE 1 VE 1 SUBSTRU SIDSTRU SIDSTRU SIDSTRU STICS TOR R OF LIV UCTURE RT.END  2.464 2.464 2.464  P2 D 25.0 P8 D	15.1 11.9 15.7 0.0 15.1 11.9 CTURE / S .13 UCTURE G- E LOAD LA SUBSTRUC LT.END  2.0 2.0 TRUCK OH 2 P3 4.0 25.0 8 P9	-167. 395. 14. 0. 167. -395. SUPERSTRUC Licensed 04-AL; SH LIVE LO NES TTURE RT.END  2.0 2.0 2.1 12.0 25 D9 P1	0. 0. 0. -7. 0. 0. TURE LOAD to: Color to: Color -70; CEGC AD DISTRI RESIS POSIT 	-] 7 8 8 7 1 1NG IS 0. ado DOT 9; PROJ#1 8 0000 7 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	<pre>11.9 79.6 31.9 31.9 79.6 11.9 812 Run 170-1(75)5 ACT SNT OF EL 3ATIVE 0. 0. 0. P6 D6 21.7 4 P12 D1</pre>	395. -1735. 137. -137. 1735. -395. time: 12- .7; M.M. PLOT M S ENV. 0 OVER 5 LOAD 4.0 8. .2	0. 0. -69. 69. 0. 0. JUL-95 1: PLOT SCALE 0 RRL IMP:	INFLU- ENCE LINES G NO ACT COMB	EN NO CARD CONTROL	26
OMEMBER OMEMBER 0 THE 1IAI-BDS 0LIVE LC 0 0LIVE LC 0 MEM NO.  1 2 0 LIVE LOAD NO 4. 0	POSITI NEGATI 4 POSITI NEGATI 5 POSITI NEGATI 3 CATO OF 3 Ver DAD DIAGNO DAD GENERA NUMBE SUPERSTR LT.END 2.464 2.464 2.464 P1 D1 27.0 14.00 P7 D7	VE 1 VE 1 VE 1 VE 1 VE 1 VE 1 VE 1 SUBSTRU SIDSTRU SIDSTRU STICS TOR R OF LIV UCTURE RT.END  2.464 2.464  P2 D 25.0 P8 D 0.0	15.1 11.9 15.7 0.0 15.1 11.9 CTURE / S .13 UCTURE G- E LOAD LA SUBSTRUC LT.END  2.0 2.0 TRUCK OF 2 P3 4.0 25.( 8 P9 0.0 0.0	-167. 395. 14. 0. 167. -395. SUPERSTRUC Licensed 04-AL; SH LIVE LO NES TTURE RT.END  2.0 2.0 2.0 2.0 12.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0	0. 0. 0. -7. 0. 0. 0. TURE LOAD to: Color -70; CBGC AD DISTRI RESIS POSIT 	-] 7 8 8 7 1 1NG IS 0. ado DOT 9; PROJ#1 BUTION F# TING MOME UNIT STEE IVE NEG 	<pre>11.9 79.6 31.9 31.9 79.6 11.9 79.6 11.9 812 Run 170-1(75)5 ACT ENT OF EL SATIVE 0. 0. 0. P6 D6 0. 21.7 4 P12 D6 0. 0. </pre>	395. -1735. 137. -137. 1735. -395. time: 12- 57; M.M. PLOT M S ENV. 0 0 0 0 0 0 0 0 0 0 0 0 0	0. 0. -69. 69. 0. 0. JUL-95 1: PLOT SCALE 0 RRL IMP:	INFLU- ENCE LINES G NO ACT COMB	EN NO CARD CONTROL	26
OMEMBER OMEMBER 0 THE 1IAI-BDS 0LIVE LC 0 0LIVE LC 0 MEM NO. 	POSITI NEGATI 4 POSITI 5 POSITI NEGATI 5 CRATIO OF 3 Ver 0AD DIAGNO 0AD GENERA NUTHE SUPERSTR LT.END 2.464 2.464 P1 D1 27.0 14.0 P7 D7 0.0 0.00 P13 D13 0.0 0.00	VE 1 VE 2 VE 1 VE 1 VE 1 VE 2 SUBSTRU SIDSTRU SIDSTRU SIDSTRU SIDSTRU STICS TOR R OF LIV UCTURE RT.END 2.464 2.464 2.464 2.464 2.464 0.0 P8 D 0.0 P14 D 0.0	15.1 11.9 15.7 0.0 15.1 11.9 CTURE / S .13 UCTURE G- E LOAD LA SUBSTRUC LT.END  2.0 2.0 TRUCK OF 2 P3 4.0 25.( 8 P9 0.0 0.( 14 P15 0.0 0.(	-167. 395. 14. 0. 167. -395. SUPERSTRUC Licensed 04-AL; SH LIVE LO NES TURE RT.END  2.0 2.0 2.0 2.1 12.0 25 D9 P1 0.0.0 0	0. 0. 0. -7. 0. 0. TURE LOAD to: Color to: Color to: Color AD DISTRI RESIS POSIT 	-] 7 8 8 7 1 1NG IS 0. ado DOT 9; PROJ#1 8 1VI NOME 1VI NEC 	<pre>11.9 79.6 31.9 31.9 79.6 11.9 .812 Run 170-1(75)5 ACT SNT OF EL ACT 0. 0. P6 D6 0 21.7 4 P12 D1 0 0.0 0 P18 D1 0 0.0 0</pre>	395. -1735. 137. -137. 1735. -395. time: 12- 57; M.M. PLOT M S ENV. 0 0 VER 5 LOAD 4.0 8. 12. 0.0	0. 0. -69. 69. 0. 0. JUL-95 1: PLOT SCALE 0 RRL IMP:	INFLU- ENCE LINES G NO ACT COMB	EN NO CARD CONTROL	26
OMEMBER OMEMBER 0 THE 1IAI-BDS OLIVE LC 0 ULIVE LC 0 MEM NO. 	POSITI NEGATI 4 POSITI NEGATI 5 POSITI NEGATI 2 RATIO OF 3 Ver DAD DIAGNO DAD GENERA NUMBE SUPERSTR LT.END 2.464 2.464 2.464 P1 D1 27.0 14.0 P7 D7 0.0 0.0 P13 D13 0.0 0.0 P19 D19	VE 1 VE - VE 1 VE 1 VE 1 VE 1 VE 1 SUBSTRU SIDSTRU SIDSTRU SIDSTRU STICS TOR R OF LIV UCTURE RT.END  2.464 2.464 2.464  P2 D 25.0 P8 D 0.0 P14 D 0.0 P12 D	15.1 11.9 15.7 0.0 15.1 11.9 CTURE / S .13 UCTURE G- E LOAD LA SUBSTRUC LT.END  2.0 2.0 TRUCK OF 2 P3 4.0 25.0 8 P9 0.0 0.0 14 P15 0.0 0.0 20 P21	-167. 395. 14. 0. 167. -395. SUPERSTRUC Licensed 04-AL; SH LIVE LO NES TTURE RT.END 2.0 2.0 2.0 2.1 12.0 25 D9 P1 0.0.0 0 D15 P1 0.0.0 0 D21 P2	0. 0. 0. -7. 0. 0. TURE LOAD to: Color -70; CEGC AD DISTRI RESIS POSIT  0 ADING - 04. 0 D10 .0 4.0 0 D10 .0 0.0 6 D16 .0 0.0 2 D22	-] 7 8 8 7 1 1NG IS 0. ado DOT 9; PROJ#1 8 1 1NG MOME UNIT STEF 1 1 1 1 1 2 5.0 35.0 9 11 D11 0.0 0.0 17 17 D17 0.0 0.0 2 23 D23	<pre>H1.9 79.6</pre>	395. -1735. -137. 137. -137. 1735. -395. time: 12- 7; M.M. PLOT M S ENV. 0 0 0 0 0 0 0 0 0 0 0 0 0	0. 0. -69. 69. 0. 0. JUL-95 1: PLOT SCALE 0 RRL IMP:	INFLU- ENCE LINES G NO ACT COMB	EN NO CARD CONTROL	26
OMEMBER OMEMBER 0 THE 1IAI-BDS OLIVE LC 0 0LIVE LC 0 MEM NO. 1 2 0 LIVE LOAD NO 4. 0 0 0	POSITI NEGATI 4 POSITI NEGATI 5 POSITI NEGATI 5 CRATIO OF 3 Ver DAD DIAGNO DAD GENERA NUMBE SUPERSTR LT.END  2.464 2.464 2.464 P1 D1 27.0 14.00 P7 D7 0.0 0.0 P13 D13 0.0 0.0	VE 1 VE 1 VE 1 VE 1 VE 1 VE 1 VE 5 SUBSTRU SIDSTRU SIDSTRU STICS TOR R OF LIV UCTURE RT.END  2.464 2.464 2.464  P2 D 25.0 P8 D 0.0 P14 D 0.0 P20 D 0.0	15.1 11.9 15.7 0.0 15.1 11.9 CTURE / S .13 UCTURE G- E LOAD LA SUBSTRUC LT.END  2.0 2.0 2.0 TRUCK OF 2 P3 4.0 25.( 8 P9 0.0 0.( 14 P15 0.0 0.( 20 P21 0.0 0.( 20 P21) 0.0 0.( 20	-167. 395. 14. 0. 167. -395. SUPERSTRUC Licensed 04-AL; SH LIVE LO NES TURE RT.END  2.0 2.0 2.0 2.1 12.0 25 D9 P1 0.0.0 0	0. 0. 0. -7. 0. 0. TURE LOAD to: Color -70; CBGC AD DISTRI RESIS POSIT 	-] 7 8 8 7 1 1NG IS 0. ado DOT 9; PROJ#1 BUTION F# TING MOME UNIT STEE IVE NEC  0.	<pre>11.9 79.6 31.9 31.9 79.6 11.9 79.6 11.9 812 Run 170-1(75)5 ACT EL SATIVE 0. 0. 0. 0. P6 D6 21.7 4 P12 D1 0.0.0 P18 D1 0.0.0 P24 D2 20 0.0 0</pre>	395. -1735. 137. -137. 1735. -395. time: 12- 57; M.M. PLOT M S ENV. 0 0 0 0 0 0 0 0 0 0 2 10 10 10 10 10 10 10 10 10 10	0. 0. -69. 69. 0. 0. JUL-95 1: PLOT SCALE 0 RRL IMP:	INFLU- ENCE LINES G NO ACT COMB	EN NO CARD CONTROL	26
OMEMBER OMEMBER 0 THE 1IAI-BDS OLIVE LC 0 0LIVE LC 0 MEM NO. 1 2 0 LIVE LOAD NO 4. 0 0 0	POSITI NEGATI 4 POSITI 5 POSITI NEGATI 5 CRATIO OF 5 Ver 0AD DIAGNO 0AD GENERA NUMBE SUPERSTR LT.END 2.464 2.464 P1 D1 27.0 14.0 P7 D7 0.0 0.00 P13 D13 0.0 0.0 P19 D19 0.0 0.00 P25 D25	VE 1 VE 2 VE 1 VE 1 VE 1 VE 2 SUBSTRU SIDSTRU SIDSTRU SIDSTRU STICS TOR R OF LIV UCTURE RT.END 2.464 2.464 2.464 2.464 2.464 0.0 P2 D 25.0 P8 D 0.0 P14 D 0.0 P20 D 0.0 P26 D	15.1 11.9 15.7 0.0 15.1 11.9 CTURE / S .13 UCTURE G- E LOAD LA SUBSTRUC LT.END  2.0 2.0 TRUCK OF 2 P3 4.0 25.0 8 P9 0.0 0.0 (14 P15 0.0 0.0 (20 P21 0.0 0.0 (26 P27	-167. 395. 14. 0. 167. -395. SUPERSTRUC Licensed 04-AL; SH LIVE LO INES TURE RT.END 2.0 2.0 2.0 2.0 2.0 10. 2.0 2.0 2.0 2.0 0.0 0.0 0.0 0	0. 0. 0. -7. 0. 0. 0. TURE LOAD to: Color to: Color to: Color AD DISTRI RESIS POSIT 	-1 7 8 8 7 1 1NG IS 0. ado DOT 7; PROJ#1 8 97 PROJ#1 1 1NG MOME UNIT STEE 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	<pre>H1.9 79.6 - 31.9 31.9 79.6 11.9 .812 Rum 170-1(75) ACT ENT OF EL GATIVE</pre>	395. -1735. 137. -137. 1735. -395. time: 12- 57; M.M. PLOT M S ENV. 0 0 0 0 0 0 0 0 0 0 0 0 0	0. 0. -69. 69. 0. 0. JUL-95 1: PLOT SCALE 0 RRL IMP:	INFLU- ENCE LINES G NO ACT COMB	EN NO CARD CONTROL	26

IMPACT FACTORS CALCULATED BY PROGRAM 0 MEM IMPACT NO %

 $\begin{array}{ccc}1&&21.\\2&&21.\end{array}$ 

OLL NO. 4.	STR	UCTURE G-	Licensed 04-AL; SH	to: Color -70; CBGG	rado DOT CP; PROJ#:	Rur [70-1(75)	time: 12 57; M.M.	-JUL-95 1	6:18:36	Page 27	,
	STR .1 PT	NEGA .2 PT	TIVE LIVE .3 PT	LOAD MON .4 PT	MENT ENVEL .5PT	LOPE AND .6 PT	ASSOCIATE .7 PT	D SHEARS .8 PT	.9 PT	RIGHT	
NO 0 1 -5689.	-2708.	-647.	-74.	-527.	-981.	-1434.	-1887.	-2340.	-2793.	-3739.	
SHEAR 278. 0 2 -3739.	4 222.9	131.3	-38.7	-38.7	-38.7	-38.7	-38.7	-38.7	-38.7	-256.1	
0 2 -3739. CUEND 256	-2793.	-2340.	-1887.	-1434. 20 7	-981.	-527.	-74.	-647.	-2708.	-5689.	
SHEAR 256. OHORIZONTAL M	IEMBER STRESS	SS LL MAX	NEG BOT	1.0M P.IBER	2						
				65.	120.	176.	232. 9.	287.	343.	459.	
0 2 459.	332. 343.	287.	232.	176.	120.	65.	9.	79.	332.	699.	
OHORIZONTAL M	EMBER STRESS	ES LL MAX	NEG TOP	FIBER							
0HORIZONTAL M 0 1 -478. 0 2 -314.	-228.	-54.	-6.	-44.	-82.	-121.	-159.	-197.	-235.	-314.	
1IAI-BDS	Version 4.0	.13	Licensed	to: Color	rado DOT	Rur	time: 12	-JUL-95 1	6:18:36	Page 28	3
	STR	UCTURE G-	04-AL; SH	-70; CBG	CP; PROJ#:	E70-1(75)	57; M.M.			<u>j</u>	
OLL NO. 4. OMEM LEFT		DEAD	LOAD PLU	S NEGATIV	VE_LIVE LO	DAD MOMEN	IT_ENVELOP	E			
	.1 PT	.2 PT	.3 PT	.4 PT	.5PT	.6 PT	.7 PT	.8 PT	.9 PT	RIGHT	
NO 0 1 -12542	-4942	651	3672	4521	4250	2893	418	-3204	-7912	-14197	
0 1 -12542. 0 2 -14197.	-7912.	-3204.	418.	2893.	4250.	4521.	3672.	651.	-4942.	-12542.	
	FMDFD CTDFCC	FC FOD DI	TT MAY M	TO DOTTO	A ETDED						
0 1 1540. 0 2 1743.	607.	-80.	-451.	-555.	-522.	-355.	-51.	393.	971.	1743.	
0 2 1743.	971.	393.	-51.	-355.	-522.	-555.	-451.	-80.	607.	1540.	
0 1 _1054	LEMBER STRESS _415	ES FOR DL	THE MAX N	280 EG TOP I	STREK 357	243	35	-269	-665	-1193.	
0 1 -1054. 0 2 -1193.	-665.	-269.	35.	243.	357.	380.	309.	55.	-415.	-1054.	
1IAI-BDS											1
OLL NO. 4. OMEM LEFT	STR	UCTURE G-	U4-AL; SH	-70; CBG	CP; PROJ#:	E'/0-1(75)	57; M.M.				
OMEM LEFT	1 DT	2 PT	3 PT	4 pt	5PT	LOPE AND	7 PT	8 PT	9 pT	RIGHT	
NO											
0 1 1285. SHEAR -38. 0 2 0. SHEAR 0.	832.	1649.	3329.	4596.	<mark>5123</mark> .	5044.	4188.	2607.	742.	0. 🗲	E
SHEAR -38.	7 -38.7	169.7	149.7	100.7	49.3	-67.3	-118.8	-193.2	-129.2	0.0	
020.	742.	2607.	4188.	5044.	<mark>5123</mark> .	4596.	3329.	1649.	832.	1285. <del>《</del>	É-
0 HORIZONTAL M 0 1 -158. 0 2 0.	-102	-202	-409 BOT	-564	-629	-619	-514	-320	-91	0	
0 2 0.	-91.	-320.	-514.	-619.	-629.	-564.	-409.	-202.	-102.	-158.	
OHORIZONTAL M	EMBER STRESS	ES LL MAX	POS TOP	FIBER							
0 1 108.	70.	139.	280.	386.	431.	424.	352.	219.	62.	0.	
020.	62.	219.	352.	424.	431.	386.	280.	139.	70.	108.	
1IAI-BDS	Version 4 0	13	Licensed	to: Color	rado DOT	Rur	time: 12	TITL-95 1	6:18:36	Page 30	,
11111 000	STR	UCTURE G-	04-AL; SH	-70; CBG	CP; PROJ#:	E70-1(75)	57; M.M.	002 99 1	20 20 50	rage so	
OLL NO. 4. OMEM LEFT		DEAD	LOAD PLU	S POSITIV	JE LIVE LO	DAD MOMEN	IT ENVELOP	E			
OMEM LEFT	.1 PT	2 PT	2 חיית 2	4 PT							
NO			.5 FI	•••••	.5PT	.6 PI	./ ₽1	.8 P.I.	.9 PT	RIGHT	
0 1 -5568											
0 1 -5568. 0 2 -10458.											
0 1 -5568. 0 2 -10458. 0HORIZONTAL M	-1403. -4377. EMBER STRESS	2947. 1743. ES FOR DL	7075. 6493. +LL MAX P	9645. 9371. OS BOTTO	10353. 10353. 4 FIBER	9371. 9645.	6493. 7075.	1743. 2947.	-4377. -1403.	-10458. -5568.	
OHORIZONTAL M	-1403. -4377. EMBER STRESS	2947. 1743. ES FOR DL	7075. 6493. +LL MAX P	9645. 9371. OS BOTTO	10353. 10353. 4 FIBER	9371. 9645.	6493. 7075.	1743. 2947.	-4377. -1403.	-10458. -5568.	
0 HORIZONTAL M 0 1 684. 0 2 1284.	-1403. -4377. EMBER STRESS 172. 537.	2947. 1743. ES FOR DL -362. -214.	7075. 6493. +LL MAX P -869. -797.	9645. 9371. OS BOTTO -1184. -1151.	10353. 10353. 4 FIBER -1271. -1271.	9371. 9645.	6493. 7075.	1743. 2947.	-4377. -1403.	-10458. -5568.	
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11AI-BDSVersion 4.0.13Licensed to: Colorado DOTRun time: 12-JUL-95 16:18:36Page33STRUCTURE G-04-AL;SH-70;CBGCP;PROJ#I70-1(75)57;M.M.

OLL NO. 4	1.	MAY	LIVE LOAD	SUPPORT RE	SULTS	ONCEPTIOENAL	MOMENT			
0	3	AXIAL LOAD	TOP	NT BOT.	AXIAL LOAD	MOME TOP	BOT.			
OMEMBER	3 POSITIVE NEGATIVE	297.1 -31.4	-3460.	0. 0.	-31.4 226.0	1043. -4618.	0. 0.			
OMEMBER	4 POSITIVE NEGATIVE									
OMEMBER	DOSITIVE POSITIVE NEGATIVE									
0 THE	NEGATIVE RATIO OF SUBS	-31.4 TRUCTURE /	-1043. SUPERSTRUC	0. FURE LOADING	-31.4 G IS 0.812	-1043.	0.			
1IAI-BDS	Version				DOT R PROJ#I70-1(7		-JUL-95 16:	18:36	Page .	34
0 PRI	ESTRESS COMBIN	ATION DATA								
0 LIV	PRESTRESS COM /E LOAD NUMBER SO WILL BE CHE	'l' RESULI	S USED FOR	P/S DESIGN	AND OTHER LI		F PRESENTED	,		
	E FOLLOWING VAL D.L. LOAD FAC		ING USED II	N THE CALCU	LATION OF MOM	ENT & SHEAF	REQUIREMEN	TS.		
	L.L. LOAD FAC	FOR: 2.17	OR 1.30							
	PHI FACTOR FO	r shear : C	0.90							
	PHI FACTOR FO	R MOMENT: C	0.95							
0 LL 0 LL 0 LL 0 LL 0 LL 0 LL	NO.         1         ULT           NO.         2         ULT           NO.         4         ULT           NO.         1         ULT           NO.         2         ULT           NO.         4         ULT           NO.         4         ULT	IMATE MOMEN IMATE MOMEN IMATE MOMEN IMATE SHEAR IMATE SHEAR IMATE SHEAR	T APPLIED : T APPLIED : APPLIED : APPLIED : APPLIED : APPLIED :	= 1.30 X (D) = 1.30 X (D)	L+ADL) + 2.17 L+ADL) + 2.17 L+ADL) + 1.30 L+ADL) + 2.17 L+ADL) + 2.17 L+ADL) + 2.17 L+ADL) + 1.30	X (LL+I) + X (LL+I) + X (LL+I) + X (LL+I) + X (LL+I) + X (LL+I) + X (LL+I) +	1.00 X (P/ 1.00 X (P/ 1.00 X (P/ 1.00 X (P/ 1.00 X (P/ 1.00 X (P/ 1.00 X (P/	S SEC. 1 S SEC. 1 S SEC. 1 S SEC. 1 S SEC. 1 S SEC. 1 S SEC. 1	MOMENT) MOMENT) MOMENT) SHEAR) SHEAR) SHEAR)	
	Version ·	4.0.13	Licensed	to: Colorad	DOT R	un time: 12				35
	RESTRESSED DATA L FRAME 1	7	-04-AL; SH	-70; CBGCP;	PROJ#170-1(7	5)5/; M.M.				
0 NO 0	D. LLT/X 1 0.00 2 0.10	LLP/Y 0.40 0.60	LRT/Z 0.10 0.00	YLT/TYPE 1.33 0.83	YLP/SLOPE 4.08 4.08	YRT U 0.83 1.33	K 0.25 0.00 0.25 0.00	02		
0XLT(FT) 0ANCHOR S 0P-JACK(H	= 0.0 XRT(1 SET(IN); LEFT (IPS) = 5209 = YES PLOT 1	FT) = 0.0 = 0.625 RI . SHORTEN	) STEEL ST GHT = 0.62 IING PERCENT	RESS(KSI) = 5 CONC.ST F= 50 TO	270. JACKIN RENGTH(PSI) = FAL LOSSES(KS	G % = 0.75 4500. ALI	JACKING EN	DS = B (PSI) =	-402. = 70.	
OCABLE PA OMEMBER	ATH OFFSETS LEFT .1 P	г.2 рт	.3 PT	.4 PT	.5 PT .6 P	т.7рт	.8 PT	.9 PT	RIGHT	
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0 1 -0 0 2 -1	0.568 0.635 L.068 -0.526	1.495			.074 1.749 .074 2.182				-1.068 -0.568	
0 1 0 0 2 0		0.785	0.779	0.772 0	.765 0.772 .765 0.760	0.750	0.741		0.776 0.722	
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	FORCE COEFF. A									
0 SECONDAR	Version RY MOMENT DUE 1	STRUCTURE G FO PJACK =	B-04-AL; SH		o DOT R PROJ#I70-1(7		-JUL-95 16:	18:37	Page .	36
					RY EFFECTS BE					
MEMBER 0 1 0	R LEFT END 1.321		2	0.281				RIGHT	END	
0 1			2 DEM'S DUE	0.452 TO SECONDAD	0.978 RY EFFECTS IN	COLUMN	UNIT = K-F		-	
0 3 OP/S MOME	0.000 ENT COEF.				0.000 Ad load was s		0.000	-0.97	8	
MEM					NDARY MOMENTS		RTENING			

0 1 1.3878 0.4610 -0.2342 -0.6877 -0.8897 -0.8722 -0.6877 -0.3300 0.2 0 2 1.2810 0.9213 0.2049 -0.3300 -0.6877 -0.8722 -0.8897 -0.6877 -0.2 0***** WARNING - THIS FRAME WILL NOT SHORTEN SO COEFF. WILL NOT BE ADJUSTED FOR SH 0***** WARNING - THIS FRAME WILL NOT SHORTEN SO COEFF. WILL NOT BE ADJUSTED FOR SH	ORTENING. ****
<pre>1IAI-BDS Version 4.0.13 Licensed to: Colorado DOT Run time: 12-JUL STRUCTURE G-04-AL; SH-70; CBGCP; PROJ#I70-1(75)57; M.M.</pre>	-95 16:18:37 Page 37
OTRIAL 1 FRAME 1 PATH 01 OHORIZONTAL MEMBER STRESSES PRESTRESS ONLY BOTTOM FIBER AFTER ALL LOSSES (PSI) MEM	
NO         LEFT         .1 PT         .2 PT         .3 PT         .4 PT         .5 PT         .6 PT         .7 PT         .8           0 1         -382.         217.         668.         965.         1101.         1094.         980.         756.         4           0 2         -276.         -35.         419.         756.         980.         1094.         1101.         965.         6	PT .9 PT RIGHT 1935276. 68. 217382.
OHORIZONTAL MEMBER STRESSES PRESTRESS ONLY TOP FIBER AFTER ALL LOSSES (PS1)           0 1         1113.         714.         416.         224.         142.         154.         240.         401.         6           0 2         1104.         958.         640.         401.         240.         154.         142.         224.         4	
1IAI-BDS Version 4.0.13 Licensed to: Colorado DOT Run time: 12-JUL STRUCTURE G-04-AL; SH-70; CBGCP; PROJ#I70-1(75)57; M.M.	
OTRIAL 1 FRAME 1 PATH 01 OHORIZONTAL MEMBER MOMENTS DUE TO P/S MEM	
NO         LEFT         .1 PT         .2 PT         .3 PT         .4 PT         .5 PT         .6 PT         .7 PT         .8           0 1         7229.         2401.         -1220.         -3582.         -4634.         -4543.         -3582.         -1719.         106           0 2         6673.         4799.         1067.         -1719.         -3582.         -4543.         -4634.         -3582.         -122	7. 4799. 6673.
OVERTICAL MEMBER MOMENTS DUE TO P/S MEM NO LEFT 1 PT 2 PT 3 PT 4 PT 5 PT 6 PT 7 PT 8	PT .9 PT RIGHT
NO         LEFT         .1         PT         .2         PT         .3         PT         .4         PT         .5         PT         .6         PT         .7         PT         .8           0.3         0.         509.         1019.         1528.         2038.         2547.         3057.         3566.         407           0.4         0.         0.         0.         0.         0.         0.         0.           0.5         0.         -509.         -1019.         -1528.         -2038.         -2547.         -3057.         -3566.         -407	6. 4585. 5095. 0. 0. 0.
UTANGENTIAL ROTATIONS - RADIANS - CLOCKWISE POSITIVE	
SPAN         LT. END         RT. END         SPAN         LT. END         RT. END         SPAN         LT. END           0         1         -0.000569         0.000000         2         0.000000         0.00002           0         4         0.000000         0.0000285         0.000569         3         0.0002           0         4         0.000000         5         -0.000285         0.000569         0.000086           0HORIZONTAL MEMBER DEFLECTIONS IN FEET AT 1/4         4         POINTS FROM LEFT END - DOWNWARD POS	
	TITAR
0 MEMBER 1 E= 4066. 0.000 -0.032 -0.047 -0.023 0.000 0 MEMBER 2 E= 4066. 0.000 -0.023 -0.047 -0.032 0.000 0VERTICAL MEMBER DEFLECTIONS IN FEET AT 1/ 4 POINTS FROM LEFT END.	11176
0 MEMBER 1 E= 4066. 0.000 -0.032 -0.047 -0.023 0.000 0 MEMBER 2 E= 4066. 0.000 -0.023 -0.047 -0.032 0.000	11176
0         MEMBER 1         E= 4066.         0.000         -0.032         -0.047         -0.023         0.000           0         MEMBER 2         E= 4066.         0.000         -0.023         -0.047         -0.032         0.000           0         VERTICAL MEMBER DEFLECTIONS IN FEET AT 1/4 POINTS FROM LEFT END.         0         0         0.000         0.001         0.000           0         MEMBER 3         E= 3320.         0.000         0.000         0.001         0.000           0         MEMBER 4         E= 3320.         0.000         0.000         0.000         0.000           0         MEMBER 5         E= 3320.         0.000         0.000         0.000         0.000           0         MEMBER 5         E= 3320.         0.000         0.000         0.000         0.000           0         MEMBER 5         E= 3320.         0.000         0.000         -0.001         0.000           1IAI-BDS         Version 4.0.13         Licensed to: Colorado DOT         Run time: 12-JUL           STRUCTURE G-04-AL; SH-70; CBGCP; PROJ#I70-1(75)57; M.M.         NM.	
0         MEMBER 1         E= 4066.         0.000         -0.032         -0.047         -0.023         0.000           0         MEMBER 2         E= 4066.         0.000         -0.023         -0.047         -0.032         0.000           0         VERTICAL MEMBER DEFLECTIONS IN FEET AT 1/4 POINTS FROM LEFT END.         0         0         0.000         0.001         0.000           0         MEMBER 3         E= 3320.         0.000         0.000         0.000         0.000           0         MEMBER 4         E= 3320.         0.000         0.000         0.000         0.000           0         MEMBER 5         E= 3320.         0.000         0.000         0.000         0.000           0         MEMBER 5         E= 3320.         0.000         0.000         0.000         0.000           0         MEMBER 5         E= 3320.         0.000         0.000         -0.001         0.000           1IAI-BDS         Version 4.0.13         Licensed to: Colorado DOT         Run time: 12-JUL	
0       MEMBER 1       E= 4066.       0.000       -0.032       -0.047       -0.023       0.000         0       MEMBER 2       E= 4066.       0.000       -0.023       -0.047       -0.032       0.000         0       WEMBER 2       E= 4066.       0.000       -0.023       -0.047       -0.032       0.000         0       WEMBER 2       E= 3320.       0.000       0.000       0.001       0.000         0       MEMBER 3       E= 3320.       0.000       0.000       0.000       0.000         0       MEMBER 4       E= 3320.       0.000       0.000       0.000       0.000         0       MEMBER 5       E= 3320.       0.000       0.000       -0.001       0.000         0       MEMBER 5       E= 3320.       0.000       0.000       -0.001       0.000         1IAI-BDS       Version 4.0.13       Licensed to: Colorado DOT       Run time: 12-JUL STRUCTURE G-04-AL; SH-70; CBGCP; PROJ#I70-1(75)57; M.M.         0TRIAL 1       FRAME 1       OHORIZONTAL MEMBER STRESSES FOR ALL P/S PATHS BEFORE LOSSES BOTTOM FIBER (PSI) MEM         NO       LEFT       1       PT       .3       PT       .4       PT       .5       PT       .6       PT       .7 <td>-95 16:18:37 <i>Page 39</i> PT .9 PT RIGHT</td>	-95 16:18:37 <i>Page 39</i> PT .9 PT RIGHT
0       MEMBER 1       E= 4066.       0.000       -0.032       -0.047       -0.023       0.000         0       MEMBER 2       E= 4066.       0.000       -0.023       -0.047       -0.032       0.000         0       WEMBER 2       E= 4066.       0.000       -0.023       -0.047       -0.032       0.000         0       WEMBER 3       E= 3320.       0.000       0.000       0.001       0.000       0.000         0       MEMBER 4       E= 3320.       0.000       0.000       0.000       0.000       0.000         0       MEMBER 5       E= 3320.       0.000       0.000       0.000       0.000       0.000         0       MEMBER 5       E= 3320.       0.000       0.000       -0.001       0.000         0       MEMBER 5       E= 3320.       0.000       0.000       -0.001       0.000         1IAI-BDS       Version 4.0.13       Licensed to: Colorado DOT       Run time: 12-JUL         STRUCTURE G-04-AL; SH-70; CBGCP; PROJ#I70-1(75)57; M.M.       OTRIAL       1       FRAME 1         0HORIZONTAL MEMBER STRESSES FOR ALL P/S PATHS BEFORE LOSSES BOTTOM FIBER (PSI)       MEM         NO       LEFT       .1 PT       .2 PT       .3 PT       .4	-95 16:18:37 Page 39 PT .9 PT RIGHT 8843324. 91. 260448.
0       MEMBER 1       E= 4066.       0.000       -0.032       -0.047       -0.023       0.000         0       MEMBER 2       E= 4066.       0.000       -0.023       -0.047       -0.032       0.000         0       WEMBER 2       E= 4066.       0.000       -0.023       -0.047       -0.032       0.000         0       WEMBER 3       E= 3320.       0.000       0.000       0.001       0.000       0.000         0       MEMBER 4       E= 3320.       0.000       0.000       0.000       0.000       0.000         0       MEMBER 5       E= 3320.       0.000       0.000       0.000       0.000       0.000         0       MEMBER 5       E= 3320.       0.000       0.000       -0.001       0.000         0       MEMBER 5       E= 3320.       0.000       0.000       -0.001       0.000         1IAI-BDS       Version 4.0.13       Licensed to: Colorado DOT       Run time: 12-JUL         STRUCTURE G-04-AL; SH-70; CBGCP; PROJ#I70-1(75)57; M.M.       OTRIAL       1       FRAME 1         0HORIZONTAL MEMBER STRESSES FOR ALL P/S PATHS BEFORE LOSSES BOTTOM FIBER (PSI)       MEM         NO       LEFT       .1 PT       .2 PT       .3 PT       .4	-95 16:18:37 Page 39 PT .9 PT RIGHT 8843324. 91. 260448.
0       MEMBER 1       E= 4066.       0.000       -0.032       -0.047       -0.023       0.000         0       MEMBER 2       E= 4066.       0.000       -0.023       -0.047       -0.032       0.000         0       MEMBER 2       E= 4066.       0.000       -0.023       -0.047       -0.032       0.000         0       MEMBER 3       E= 3320.       0.000       0.000       0.001       0.001       0.000         0       MEMBER 4       E= 3320.       0.000       0.000       0.000       0.000       0.000         0       MEMBER 5       E= 3320.       0.000       0.000       -0.001       0.000         0       MEMBER 5       E= 3320.       0.000       0.000       -0.001       0.000         0       MEMBER 5       E= 3320.       0.000       0.000       -0.001       0.000         0       MEMBER 5       E= 3320.       0.000       0.000       -0.001       0.000         1IAI-BDS       Version 4.0.13       Licensed to: Colorado DOT       Run time: 12-JUL         STRUCTURE 6-04-AL; SH-70; CBGCP; PROJ#I70-1(75)57; M.M.       MEM         0       1 -448.       260.       791.       1137.       1294.       1284. <td>-95 16:18:37 Page 39 PT .9 PT RIGHT 8843324. 91. 260448. 49. 1120. 1295. 90. 842. 1315.</td>	-95 16:18:37 Page 39 PT .9 PT RIGHT 8843324. 91. 260448. 49. 1120. 1295. 90. 842. 1315.
0       MEMBER 1       E= 4066.       0.000       -0.032       -0.047       -0.023       0.000         0       MEMBER 2       E= 4066.       0.000       -0.023       -0.047       -0.032       0.000         0       MEMBER 2       E= 3320.       0.000       -0.000       0.001       0.001       0.000         0       MEMBER 4       E= 3320.       0.000       0.000       0.001       0.000       0.000         0       MEMBER 4       E= 3320.       0.000       0.000       0.000       0.000       0.000         0       MEMBER 5       E= 3320.       0.000       0.000       -0.001       0.000         0       MEMBER 5       E= 3320.       0.000       0.000       -0.001       0.000         0       MEMBER 5       E= 3320.       0.000       0.000       -0.001       0.000         0       MEMBER 5       E= 3320.       0.000       0.000       -0.001       0.000         1IAI-BDS       Version 4.0.13       Licensed to: Colorado DOT       Run time: 12-JUL         STRUCTURE 6-04-AL; SH-70; CBGCP; PROJ#I70-1(75)57; M.M.       MEM         01       -448.       260.       791.       1137.       1294.       1137.	-95 16:18:37 Page 39 PT .9 PT RIGHT 8843324. 91. 260448. 49. 1120. 1295. 90. 842. 1315.
0       MEMBER 1       E= 4066.       0.000       -0.032       -0.047       -0.032       0.000         0       MEMBER 2       E= 4066.       0.000       -0.023       -0.047       -0.032       0.000         0       MEMBER DEFLECTIONS IN FEET AT 1/4 POINTS FROM LEFT END.         0       MEMBER 3       E= 3320.       0.000       0.000       0.001       0.000         0       MEMBER 4       E= 3320.       0.000       0.000       0.000       0.000       0.000         0       MEMBER 5       E= 3320.       0.000       0.000       0.000       0.000       0.000         0       MEMBER 5       E= 3320.       0.000       0.000       -0.001       0.000         0       MEMBER 5       E= 3320.       0.000       0.000       -0.001       0.000         0       MEMBER 5       E= 3320.       0.000       0.000       -0.001       0.000         0       MEMBER 5       E= 3320.       0.000       0.000       -0.001       0.000         0       MEMBER 5       E= 3320.       0.000       0.000       -0.001       0.000         0       ITAL       I FRME 1       0.000       STRUCTURE G-04-AL; SH-70; CBGCP; PROJ#I70-1(75)57;	-95 16:18:37 Page 39 PT .9 PT RIGHT 8843324. 91. 260448. 49. 1120. 1295. 90. 842. 1315. -95 16:18:37 Page 40 PT .9 PT RIGHT
0       MEMBER 1       E= 4066.       0.000       -0.032       -0.047       -0.032       0.000         0       MEMBER 2       E= 4066.       0.000       -0.023       -0.047       -0.032       0.000         0       MEMBER 2       E= 3320.       0.000       -0.000       0.001       0.001       0.000         0       MEMBER 4       E= 3320.       0.000       0.000       0.001       0.000       0.000         0       MEMBER 4       E= 3320.       0.000       0.000       0.000       0.000       0.000         0       MEMBER 5       E= 3320.       0.000       0.000       -0.001       -0.001       0.000         0       MEMBER 5       E= 3320.       0.000       0.000       -0.001       -0.000       0.000         0       MEMBER 5       E= 3320.       0.000       0.000       -0.001       -0.000         0       MEMBER 5       E= 3320.       0.000       0.000       -0.001       -0.000         11A1-BDS       Version 4.0.13       Licensed to: Colorado DOT       Run time: 12-JUL       MEM         MEM       NO       LEFT       1 PT       2 PT       .3 PT       .4 PT       .5 PT       .6 PT	-95 16:18:37 Page 39 PT .9 PT RIGHT 8843324. 91. 260448. 49. 1120. 1295. 90. 842. 1315. -95 16:18:37 Page 40 PT .9 PT RIGHT 1935276.
0       MEMBER 1       E= 4066.       0.000       -0.032       -0.047       -0.032       0.000         0       MEMBER 2       E= 4066.       0.000       -0.023       -0.047       -0.032       0.000         0       MEMBER 2       E= 3320.       0.000       -0.000       0.001       0.001       0.000         0       MEMBER 4       E= 3320.       0.000       0.000       0.001       0.000       0.000         0       MEMBER 4       E= 3320.       0.000       0.000       0.000       0.000       0.000         0       MEMBER 5       E= 3320.       0.000       0.000       -0.001       -0.001       0.000         0       MEMBER 5       E= 3320.       0.000       0.000       -0.001       -0.000       0.000         0       MEMBER 5       E= 3320.       0.000       0.000       -0.001       -0.000         0       MEMBER 5       E= 3320.       0.000       0.000       -0.001       -0.000         11A1-BDS       Version 4.0.13       Licensed to: Colorado DOT       Run time: 12-JUL       MEM         MEM       NO       LEFT       1 PT       2 PT       .3 PT       .4 PT       .5 PT       .6 PT	-95 16:18:37 Page 39 PT .9 PT RIGHT 8843324. 91. 260448. 49. 1120. 1295. 90. 842. 1315. -95 16:18:37 Page 40 PT .9 PT RIGHT 1935276. 68. 217382.

1IAI-BDS Version 4.0	).13 Licens	ed to: Colora	do DOT RI	un time: 12-	-JUL-95	16:18:37	Page	41
STH OTRIAL 1 FRAME 1 OHORIZONTAL MEMBER STRESS	RUCTURE G-04-AL; SES DL + P/S BE							
MEM								
NO LEFT .1 PT 0 1 393. 534.	.2 PT .3 PT .3 PT .631. 677.	.4 PT . 674.	641. 617.	.7 PT 601.	.8 PT 594.	.9 PT 586.		
0 2 960. 586.	594. 601.	617.	641. 674.	677.	631.	534.	393.	
0HORIZONTAL MEMBER STRESS	SES DL + P/S BE	FORE ALL LOSS	ESTOP FIBER (PS	SI)	677	690	415	
0 1 739. 654. 0 2 415. 690.	677. 664.	645.	621. 645. 592.	578.	677. 599.	654.	415. 739.	
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1IAI-BDS Version 4.0	Licens RUCTURE G-04-AL;				-JUL-95	16:18:37	Page	42
OTRIAL 1 FRAME 1								
0HORIZONTAL MEMBER STRESS MEM	SES DL + P/S AF	TER ALL LOSSE	S BOTTOM FIBER	(PSI)				
NO LEFT .1 PT	.2 PT .3 PT	.4 PT .	5 PT .6 PT	.7 PT	.8 PT	.9 PT	RIGHT	
0 1 459. 491.	509. 505. 525. 473.	481.	452. 449.	473.	525.	594.	1008.	
		TED ATT TOGOT		at )				
0 1 537. 526. 0 2 225. 528.	525. 539.	567.	594. 603.	594.	567.	528.	225.	
OHORIZONTAL MEMBER STRESS	SES DL + ADDED D	I. + D/S AFTER	ALL LOSSES BOT	TTOM FIBER	(DGT)			
0 1 577. 530.	486. 441.	394.	361. 375.	434.	540.	682.	1189.	
0 1 577. 530. 0 2 1189. 682. 0HORIZONTAL MEMBER STRESS	540. 434.	375.	<mark>361</mark> . 394.	441.	486.	530.	<mark>577</mark> .	. ←
0 1 456. 500.	5ES DL + ADDED D. 541. 583.	L + P/S AFTER 626.	655. 654.	P FIBER (PS. 621.	L) 557.	467.	102.	
0 1 456. 500. 0 2 <mark>102</mark> . 467.	557. 621.	654.	<mark>655</mark> . 626.	583.	541.	500.	<mark>456</mark> .	. 🗲
1IAI-BDS Version 4.0	) 10 Timer	- d + - · · · · ] - · · ·			TTTT 0.5	16.10.27	Deme	12
	RUCTURE G-04-AL;				-006-92	10.18.3/	Page	43
OTRIAL 1 FRAME 1				·	( <b>)</b>			
OHORIZONTAL MEMBER STRESS MEM	SES DL + ADDED D	L + MAX POS I	L + I + P/S BO	OTTOM FIBER	(PSI)			
NO LEFT .1 PT	.2 PT .3 PT	.4 PT .	5 PT .6 PT	.7 PT	.8 PT	.9 PT	RIGHT	
0 1 490. 462. 0 2 1189. 609.	346. 183. 328. 117.	52.	-18. 2. -18. 52.	117. 183.	328. 346.	609. 462.	1189. 490.	
0 2 1189. 009. OHORIZONTAL MEMBER STRESS				OP FIBER (PS	ST)			
0 1 515. 546. 0 2 102. 517.	637. 760.	860.	915. 909.	838.	702.	517. 546.	102. 515.	
0 2 102. 517. OHORIZONTAL MEMBER STRESS	702. 838. SES DL + ADDED D	909. L + MAX NEG L	915. 860. L + I + P/S B(					
0 1 959. 719.	535. 446.	430.	428. 472.	561.	698.	917. 719.	1610.	
0 2 1610. 917. OHORIZONTAL MEMBER STRESS	SES DI. + ADDED	DI. + MAX NEG	428. 430.					
0 1 195. 370. 0 2 -187. 306.	507. 580.	602.	610. 588.	534.	449.	306.	-187.	
0 2 -187. 306.	449. 534.	588.	610. 602.	580.	507.	370.	195.	
0**** MIN PJACK = 5210	. KIPS CONC STR	ENGTH AT 28 D	AYS = 4025.1	PSI AT STRES	GSING =	1833. P	SI ****	
0**** MIN PJACK = 5210	). KIPS CONC STR	ENGTH AT 28 D	AYS = 4025.1	PSI AT STRES	SSING =	1833. P	SI ****	
1IAI-BDS Version 4.0	).13 License	ed to: Colora	do DOT Ri	un time: 12·				
1IAI-BDS Version 4.( STR	0.13 Licens RUCTURE G-04-AL;	ed to: Colora	do DOT Ri	un time: 12·				
lIAI-BDS Version 4.( STR OTOTAL PE MOMENTS FOR ALL MEM	).13 Licens RUCTURE G-04-AL; L MEMBERS.	ed to: Colora SH-70; CBGCF	do DOT Ri ; PROJ#I70-1(7!	un time: 12 5)57; M.M.	-JUL-95	16:18:37	Page	
1IAI-BDS Version 4.( STR OTOTAL PE MOMENTS FOR ALI MEM NO LEFT .1 PT	0.13 Licens RUCTURE G-04-AL; MEMBERS. .2 PT .3 PT	ed to: Colora SH-70; CBGCF .4 PT .	do DOT Ri ; PROJ#I70-1(7! 5 PT .6 PT	un time: 12- 5)57; M.M. .7 PT	-JUL-95 .8 PT	16:18:37 .9 PT	Page RIGHT	
1IAI-BDS Version 4.( STI OTOTAL PE MOMENTS FOR ALI MEM NO LEFT .1 PT 0 1 7229. 2401.	0.13 Licens RUCTURE G-04-AL; MEMBERS. .2 PT .3 PT -12203582.	ed to: Colora SH-70; CBGCF .4 PT . -46344	do DOT R1 ; PROJ#I70-1(7 5 PT .6 PT 5433582.	un time: 12 5)57; M.M. .7 PT -1719.	-JUL-95 .8 PT 1067.	16:18:37 .9 PT 4799.	Page RIGHT	
1IAI-BDS         Version         4.0           OTOTAL PE MOMENTS FOR ALI         STR           MEM         NO         LEFT         .1         PT           0         1         7229.         2401.         -           0         2         6673.         4799.           0         3         0.         509.	0.13 Licens, RUCTURE G-04-AL; MEMBERS. .2 PT .3 PT -12203582. 10671719. 1019. 1528.	ed to: Colora SH-70; CBGCF .4 PT . -46344 -35824 2038. 2	do DOT Rt ; PROJ#I70-1(7) 5 PT .6 PT 5433582. 5434634. 547. 3057.	un time: 12- 5)57; M.M. .7 PT -1719. -3582. 3566.	-JUL-95 .8 PT 1067. -1220. 4076.	.9 PT 4799. 2401. 4585.	Page RIGHT 6673. 7229. 5095.	
LIAI-BDS         Version         4.0           OTOTAL         PE         MOMENTS         FOR         ALI           MEM         NO         LEFT         .1         PT           0         1         7229.         2401.         -           0         2         6673.         4799.         -           0         3         0.         509.         0           0         4         0.         0.         -	0.13 Licens RUCTURE G-04-AL; MEMBERS. .2 PT .3 PT -12203582. 10671719. 1019. 1528.	ed to: Colora SH-70; CBGCE .4 PT . -46344 -35824 2038. 2 0.	do DOT R ; PROJ#I70-1(7) 5 PT .6 PT 5433582. 5434634. 547. 3057. 0. 0.	un time: 12- 5)57; M.M. .7 PT -1719. -3582. 3566. 0.	-JUL-95 .8 PT 1067.	.9 PT 4799. 2401. 4585. 0.	<i>Page</i> RIGHT 6673. 7229.	
1IAI-BDS         Version 4.0           STI           0TOTAL PE MOMENTS FOR ALI           MEM           NO         LEFT           0 1         7229           0 2         6673.           0 3         0.           0 4         0.           0 5         0.           0 5         0.           0 5         0.	0.13 Licens RUCTURE G-04-AL; MEMBERS. .2 PT .3 PT -12203582. 10671719. 1019. 1528. 0. 0. -10191528. % TRIAL	ed to: Colora SH-70; CBGCF -46344 -35824 2038. 2 0. -20382	do DOT Ri ; PROJ#I70-1(7) 5 PT .6 PT 5433582. 5434634. 547. 3057. 0. 0. 5473057.	un time: 12- 5)57; M.M. .7 PT -1719. -3582. 3566. 0.	-JUL-95 .8 PT 1067. -1220. 4076. 0.	.9 PT 4799. 2401. 4585. 0.	Page RIGHT 6673. 7229. 5095. 0.	
1IAI-BDS         Version         4.0           OTOTAL PE MOMENTS FOR         ALI           MEM         NO         LEFT         .1         PT           0         1         7229.         2401.         -           0         2         6673.         4799.         0         3         0.         509.           0         4         0.         0.         0.         0         5         0.         -509.         -           0         5         0.         -509.         -         0         0         5         0.         -         00         5         0.         -         00         0.         0.         5         0.         -         0         0         0.         0.         0.         0.         0.         0.         0.         0.         0.         0.         0.         0.         0.         0.         0.         0.         0.         0.         0.         0.         0.         0.         0.         0.         0.         0.         0.         0.         0.         0.         0.         0.         0.         0.         0.         0.         0.         0.         0. <td< td=""><td>0.13 Licens AUCTURE G-04-AL; MEMBERS. .2 PT .3 PT -12203582. 10671719. 1019. 1528. 0. 0. -10191528. R TRIAL ADDIANS - CLOCKW</td><td>ed to: Colora SH-70; CBGCE .4 PT . -46344 -35824 2038. 2 0. -20382 ISE POSITIVE</td><td>do DOT Ri ; PROJ#I70-1(7) 5 PT .6 PT 5433582. 5434634. 547. 3057. 0. 0. 5473057.</td><td>un time: 12- 5)57; M.M. -7 PT -1719. -3582. -3566. 0. -3566.</td><td>-JUL-95 .8 PT 1067. -1220. 4076. 0. -4076.</td><td>16:18:37 .9 PT 4799. 2401. 4585. 0. -4585.</td><td>Page RIGHT 6673. 7229. 5095. 0. -5095.</td><td></td></td<>	0.13 Licens AUCTURE G-04-AL; MEMBERS. .2 PT .3 PT -12203582. 10671719. 1019. 1528. 0. 0. -10191528. R TRIAL ADDIANS - CLOCKW	ed to: Colora SH-70; CBGCE .4 PT . -46344 -35824 2038. 2 0. -20382 ISE POSITIVE	do DOT Ri ; PROJ#I70-1(7) 5 PT .6 PT 5433582. 5434634. 547. 3057. 0. 0. 5473057.	un time: 12- 5)57; M.M. -7 PT -1719. -3582. -3566. 0. -3566.	-JUL-95 .8 PT 1067. -1220. 4076. 0. -4076.	16:18:37 .9 PT 4799. 2401. 4585. 0. -4585.	Page RIGHT 6673. 7229. 5095. 0. -5095.	
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1IAI-BDS         Version 4.0           STI           OTOTAL PE MOMENTS FOR ALI           MEM           NO         LEFT         1 PT           0 1         7229.         2401.           0 2         6673.         4799.           0 3         0.         509.           0 4         0.         0.           0 5         0.         -509.           OTOTAL P/S DEFLECTION FOI         OTANGENTIAL ROTATIONS - H           SPAN         LT. END         H           0         1         -0.000569         0           0         4         0.000000         0           0HORIZONTAL MEMBER DEFLEC         MEMBER 1         E = 400           0         MEMBER 2         E = 400           0         MEMBER 2         E = 400	0.13 Licenso RUCTURE G-04-AL; MEMBERS. .2 PT .3 PT -12203582. 10671719. 10191528. R TRIAL RADIANS - CLOCKW RT. END SPAN 0.000000 2 0.000000 5 TTIONS IN FEET AT 56. 0.000 ENS IN FEET AT 20. 0.000	ed to: Colora SH-70; CBGCF -46344 -35824 20382 0. -20382 ISE POSITIVE LT. END 0.000000 -0.000285 F1/4 POINTS -0.023 -0 -0.023 -0 1/4 POINTS F 0.000 00	do DOT Ri ; PROJ#I70-1(7) 5 PT .6 PT 5433582. 5434634. 547. 3057. 0. 0. 5473057. RT. END 0.000569 FROM LEFT END .047 -0.023 .047 -0.032 ROM LEFT END. .001 0.001	un time: 12- 5)57; M.M. -7 PT -1719. -3582. 0. -3566. 0. -3566. SPAN LT. 3 0.0 - DOWNWARD 0.000 0.000 0.000	-JUL-95 .8 PT 1067. -1220. 4076. 0. -4076. END 000285	16:18:37 .9 PT 4799. 2401. 4585. 0. -4585. RT. END -0.00056	Page RIGHT 6673. 7229. 5095. 0. -5095.	
1IAI-BDS         Version 4.0           STI           OTOTAL PE MOMENTS FOR ALI           MEM           NO         LEFT         .1 PT           0 1         7229.         2401.         -           0 2         6673.         4799.         -           0 3         0.         509.         -           0 4         0.         0.         -           0 5         0.         -509.         -           0 70TAL P/S DEFLECTION FOR         OTANGENTIAL ROTATIONS - H         SPAN           DTANGENTIAL ROTATIONS - I         SPAN         LT. END         H           0         1         -0.000569         0         0           0 HORIZONTAL MEMBER DEFLEC         0         MEMBER 1         E= 400           0 MEMBER 1         E= 400         0         0           0 MEMBER 2         E= 400         0         0           0 MEMBER 3         E= 332         3         2	0.13 Licenso RUCTURE G-04-AL; MEMBERS. .2 PT .3 PT -12203582. 10671719. 10191528. R TRIAL RADIANS - CLOCKW RT. END SPAN 0.000000 2 0.000000 5 TTIONS IN FEET AT 56. 0.000 ENS IN FEET AT 20. 0.000	ed to: Colora SH-70; CBGCF -46344 -35824 20382 0. -20382 ISE POSITIVE LT. END 0.000000 -0.000285 F1/4 POINTS -0.023 -0 -0.023 -0 1/4 POINTS F 0.000 00	do DOT Ri ; PROJ#I70-1(7) 5 PT .6 PT 5433582. 5434634. 547. 3057. 0. 0. 5473057. RT. END 0.000569 FROM LEFT END .047 -0.023 .047 -0.032 ROM LEFT END. .001 0.001	un time: 12- 5)57; M.M. -7 PT -1719. -3582. 0. -3566. 0. -3566. SPAN LT. 3 0.0 - DOWNWARD 0.000 0.000 0.000	-JUL-95 .8 PT 1067. -1220. 4076. 0. -4076. END 000285	16:18:37 .9 PT 4799. 2401. 4585. 0. -4585. RT. END -0.00056	Page RIGHT 6673. 7229. 5095. 0. -5095.	
IIAI-BDS         Version 4.0           STI           OTOTAL PE MOMENTS FOR ALI           MEM           NO         LEFT           1         7229.           0         1           0         1           0         1           0         2           0         2           0         3           0         5           0         5           0         5           0         5           0         5           0         5           0         1           0         1           0         1           0         1           0         1           0         1           0         1           0         1           0         1           0         1           0         1           0         1           0         1           0         1           0         1           0         1           0         1           0         1 </td <td>D.13         License           RUCTURE         G-04-AL;           MEMBERS.        </td> <td>ed to: Colora SH-70; CBGCF -46344 -35824 20382 0. -20382 ISE POSITIVE LT. END 0.000000 -0.00285 F 1/ 4 POINTS -0.032 -0 -0.023 -0 1/ 4 POINTS F 0.000 0 0.000 0 0.000 -0 ed to: Colora</td> <td>do DOT R1 ; PROJ#I70-1(7) 5 PT .6 PT 5433582. 5434634. 547. 3057. 0. 0. 5473057. RT. END 0.000569 FROM LEFT END. .047 -0.023 .047 -0.032 ROM LEFT END. .001 0.001 .000 0.000 .001 -0.001 do DOT R1</td> <td>un time: 12- 5)57; M.M. -7 PT -1719. -3582. 0. -3566. SPAN LT. 3 0.0 - DOWNWARD 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000</td> <td>-JUL-95 .8 PT 1067. -1220. 4076. 0. -4076. END 000285 POSITIV</td> <td>16:18:37 .9 PT 4799. 2401. 4585. 0. -4585. RT. END -0.00056</td> <td>Page RIGHT 6673. 7229. 00. -5095.</td> <td></td>	D.13         License           RUCTURE         G-04-AL;           MEMBERS.	ed to: Colora SH-70; CBGCF -46344 -35824 20382 0. -20382 ISE POSITIVE LT. END 0.000000 -0.00285 F 1/ 4 POINTS -0.032 -0 -0.023 -0 1/ 4 POINTS F 0.000 0 0.000 0 0.000 -0 ed to: Colora	do DOT R1 ; PROJ#I70-1(7) 5 PT .6 PT 5433582. 5434634. 547. 3057. 0. 0. 5473057. RT. END 0.000569 FROM LEFT END. .047 -0.023 .047 -0.032 ROM LEFT END. .001 0.001 .000 0.000 .001 -0.001 do DOT R1	un time: 12- 5)57; M.M. -7 PT -1719. -3582. 0. -3566. SPAN LT. 3 0.0 - DOWNWARD 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	-JUL-95 .8 PT 1067. -1220. 4076. 0. -4076. END 000285 POSITIV	16:18:37 .9 PT 4799. 2401. 4585. 0. -4585. RT. END -0.00056	Page RIGHT 6673. 7229. 00. -5095.	
1IAI-BDS         Version 4.0           OTOTAL PE MOMENTS FOR ALI           MEM           NO         LEFT         1 PT           0 1         7229.         2401.         -           0 2         6673.         4799.         -           0 3         0.         509.         -           0 4         0.         0.         -           0 5         0.         -509.         -           0 TOTAL P/S DEFLECTION FOR         OTOTANGENTIAL ROTATIONS - F         -           0 1         -0.000569         0         -           0 1         -0.000000         0         -           0 HORIZONTAL MEMBER DEFLECTION         -         0           0 HOMBER 1         E= 400         -         -           0 MEMBER 2         E= 400         -         -           0 MEMBER 3         E= 332         -         -           0 MEMBER 4         E= 332         -         -           0 MEMBER 5         E= 332         -         -           1IAI-BDS         Version 4.0         -	D.13         License           RUCTURE         G-04-AL;           MEMBERS.           .2         PT         .3           .1220.         -3582.           1067.         -1719.           1019.         1528.           R         RIAL           ADDIANS         - CLOCKW           RT.         END         SPAN           D.000000         2           D.000000         5           TIONS IN FEET AT           26.         0.000           CONS IN FEET AT           20.         0.000           20.         0.000	ed to: Colora SH-70; CBGCF -46344 -35824 20382 0. -20382 ISE POSITIVE LT. END 0.000000 -0.00285 F 1/ 4 POINTS -0.032 -0 -0.023 -0 1/ 4 POINTS F 0.000 0 0.000 0 0.000 -0 ed to: Colora	do DOT R1 ; PROJ#I70-1(7) 5 PT .6 PT 5433582. 5434634. 547. 3057. 0. 0. 5473057. RT. END 0.000569 FROM LEFT END. .047 -0.023 .047 -0.032 ROM LEFT END. .001 0.001 .000 0.000 .001 -0.001 do DOT R1	un time: 12- 5)57; M.M. -7 PT -1719. -3582. 0. -3566. SPAN LT. 3 0.0 - DOWNWARD 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	-JUL-95 .8 PT 1067. -1220. 4076. 0. -4076. END 000285 POSITIV	16:18:37 .9 PT 4799. 2401. 4585. 0. -4585. RT. END -0.00056	Page RIGHT 6673. 7229. 00. -5095.	44
IIAI-BDS         Version 4.0           STI           OTOTAL PE MOMENTS FOR ALI           MEM           NO         LEFT           1         7229.           0         1           0         1           0         2           0         2           0         2           0         3           0         5           0         5           0         5           0         5           0         5           0         1           0         1           0         1           0         5           0         5           0         1           0         1           0         1           0         1           0         1           0         1           0         1           0         1           0         1           0         1           0         1           0         1           0         1           0         1 </td <td>0.13       License         RUCTURE       G-04-AL;         -       MEMBERS.         .2       PT       .3         -1220.       -3582.         1067.       -1719.         1019.       -1528.         R TRIAL       SPAN         2.000000       5         D.000000       2         D.000000       5         TTIONS IN FEET AT         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000</td> <td>ed to: Colora SH-70; CBGCE .4 PT . -46344 -35824 20382 0. -20382 ISE POSITIVE LT. END 0.000000 0.0000285 T 1/ 4 POINTS F 0.002 -0 () 4 POINTS F 0.000 C 0.000 C 0.0</td> <td>do DOT Ri ; PROJ#I70-1(7) 5 PT .6 PT 5433582. 5434634. 547. 3057. 0. 0. 5473057. RT. END 0.000569 FROM LEFT END. .047 -0.023 .047 -0.022 ROM LEFT END. .001 0.001 .000 0.000 .001 -0.001 do DOT Ri ; PROJ#I70-1(7)</td> <td>un time: 12- 5)57; M.M. -7 PT -1719. -3582. -3566. 0. -3566. SPAN LT. 3 0.0 - DOWNWARD 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000</td> <td>-JUL-95 .8 PT 1067. 1220. 4076. </td> <td>16:18:37 .9 PT 4799. 2401. 4585. 0. -4585. RT. END -0.00056 VE</td> <td>Page RIGHT 6673. 7229. 5095. 0. -5095.</td> <td>44</td>	0.13       License         RUCTURE       G-04-AL;         -       MEMBERS.         .2       PT       .3         -1220.       -3582.         1067.       -1719.         1019.       -1528.         R TRIAL       SPAN         2.000000       5         D.000000       2         D.000000       5         TTIONS IN FEET AT         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000	ed to: Colora SH-70; CBGCE .4 PT . -46344 -35824 20382 0. -20382 ISE POSITIVE LT. END 0.000000 0.0000285 T 1/ 4 POINTS F 0.002 -0 () 4 POINTS F 0.000 C 0.000 C 0.0	do DOT Ri ; PROJ#I70-1(7) 5 PT .6 PT 5433582. 5434634. 547. 3057. 0. 0. 5473057. RT. END 0.000569 FROM LEFT END. .047 -0.023 .047 -0.022 ROM LEFT END. .001 0.001 .000 0.000 .001 -0.001 do DOT Ri ; PROJ#I70-1(7)	un time: 12- 5)57; M.M. -7 PT -1719. -3582. -3566. 0. -3566. SPAN LT. 3 0.0 - DOWNWARD 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	-JUL-95 .8 PT 1067. 1220. 4076. 	16:18:37 .9 PT 4799. 2401. 4585. 0. -4585. RT. END -0.00056 VE	Page RIGHT 6673. 7229. 5095. 0. -5095.	44
IIAI-BDS         Version 4.0           OTOTAL PE MOMENTS FOR ALI           MEM           NO         LEFT         1 PT           0 1         7229.         2401.         -           0 2         6673.         4799.         -           0 3         0.         509.         -           0 4         0.         0.         -           0 5         0.         -509.         -           0 70TAL P/S DEFLECTION FOD         OTANGENTIAL ROTATIONS - P         -           SPAN         LT. END         F           0 1         -0.000569         0           0 4         0.000000         -           0 HORDER 1         E = 400         0           0 MEMBER 2         E = 400         0           0 MEMBER 3         E = 332         0           0 MEMBER 3         E = 332         0           0 MEMBER 4         E = 332         0           0 MEMBER 5         E = 332         1           1AI-BDS         Version 4.0         STI           0TOTAL TOP PF FOR TRIAL         MEM           MEM         NO         LEFT         .1 PT	0.13       Licenson         RUCTURE       G-04-AL;	ed to: Colora SH-70; CBGCF -46344 -35824 20382 0. -20382 ISE POSITIVE LT. END 0.000000 -0.000285 F 1/ 4 POINTS -0.032 -C -0.023 -C 1/ 4 POINTS 0.000 C 0.000 C 0.00	do DOT R1 ; PROJ#I70-1(7) 5 PT .6 PT 5433582. 5434634. 547. 3057. 0. 0. 5473057. RT. END 0.000569 0.000569 0.000569 FROM LEFT END. .047 -0.032 ROM LEFT END. .001 0.001 .000 0.000 .001 -0.001 do DOT R1 ; PROJ#I70-1(7) 5 PT .6 PT	un time: 12- 5)57; M.M. .7 PT -1719. -3582. 3566. 0. -3566. SPAN LT. 3 0.0 - DOWNWARD 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000000	-JUL-95 .8 PT 1067. -1220. 4076. 0. -4076. END 000285 POSITIV -JUL-95 .8 PT	16:18:37 .9 PT 4799. 2401. 4585. 0. -4585. RT. END -0.00056 VE 16:18:37 .9 PT	Page RIGHT 6673. 7229. 5095. 0. -5095. 9 Page RIGHT	44
IIAI-BDS         Version 4.0           OTOTAL PE MOMENTS FOR ALI           MEM           NO         LEFT         1 PT           0 1         7229.         2401.         -           0 2         6673.         4799.         -           0 3         0.         509.         -           0 4         0.         0.         -           0 5         0.         -509.         -           0 70TAL P/S DEFLECTION FOD         OTANGENTIAL ROTATIONS - P         -           SPAN         LT. END         F           0 1         -0.000569         0           0 4         0.000000         -           0 HORDER 1         E = 400         0           0 MEMBER 2         E = 400         0           0 MEMBER 3         E = 332         0           0 MEMBER 3         E = 332         0           0 MEMBER 4         E = 332         0           0 MEMBER 5         E = 332         1           1AI-BDS         Version 4.0         STI           0TOTAL TOP PF FOR TRIAL         MEM           MEM         NO         LEFT         .1 PT	0.13       License         RUCTURE       G-04-AL;         -       MEMBERS.         .2       PT       .3         -1220.       -3582.         1067.       -1719.         1019.       -1528.         R TRIAL       SPAN         2.000000       5         D.000000       2         D.000000       5         TTIONS IN FEET AT         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000	ed to: Colora SH-70; CBGCF .4 PT . -46344 -35824 2038. 2 0. -20382 ISE POSITIVE LT. END 0.000000 -0.00285 F 1/ 4 POINTS -0.032 -C -0.023 -C 1/ 4 POINTS - 0.000 C 0.000 C 0.00	do DOT Ri ; PROJ#I70-1(7) 5 PT .6 PT 5433582. 5434634. 547. 3057. 0. 0. 5473057. RT. END 0.000569 FROM LEFT END. .047 -0.023 .047 -0.022 ROM LEFT END. .001 0.001 .000 0.000 .001 -0.001 do DOT Ri ; PROJ#I70-1(7)	un time: 12- 5)57; M.M. .7 PT -1719. -3582. 3566. 0. -3566. SPAN LT. 3 0.0 - DOWNWARD 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000000	-JUL-95 .8 PT 1067. 1220. 4076. 	16:18:37 .9 PT 4799. 2401. 4585. 0. -4585. RT. END -0.00056 VE 16:18:37 .9 PT	Page RIGHT 6673. 7229. 5095. 0. -5095.	44
LIAI-BDS         Version 4.0           STI           OTOTAL PE MOMENTS FOR ALI           MEM           NO         LEFT         .1 PT           0 1         7229.         2401.            0 2         6673.         4799.            0 3         0.         509.            0 4         0.         0.            0 5         0.         -509.            0 70TAL P/S DEFLECTION FOI         0             0 1         -0.000569             0 1         -0.0000569             0 MEMBER 1         E= 400         0            0 MEMBER 1         E= 400             0 MEMBER 1         E= 332             0 MEMBER 3         E= 332             0 MEMBER 4         E= 332             0 MEMBER 5         E= 332             0 MEMBER 5         E= 332             0 MEMBER 5 <td< td=""><td>0.13       Licenson         RUCTURE       G-04-AL;        </td><td>ed to: Colora SH-70; CBGCF -46344 -35824 20382 0. -20382 ISE POSITIVE LT. END 0.000000 -0.000285 T / 4 POINTS -0.023 -0 0.000 C 0.000 C 0.</td><td>do DOT Ri ; PROJ#I70-1(7) 5 PT .6 PT 5433582. 5434634. 547. 3057. 0. 0. 5473057. RT. END 0.000569 FROM LEFT END. .047 -0.023 .047 -0.022 ROM LEFT END. .001 0.001 .000 0.000 .001 -0.001 do DOT Ri ; PROJ#I70-1(7) 5 PT .6 PT 0. 0. 0. 0.</td><td>un time: 12- 5)57; M.M. -7 PT -1719. -3582. 0. -3566. SPAN LT. 3 0.0 - DOWNWARD 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000</td><td>-JUL-95 .8 PT 1067. 1220. 4076. 0. 200285 POSITIV -JUL-95 .8 PT 0. 0.</td><td>16:18:37 .9 PT 4799. 2401. 4585. 0. -4585. RT. END -0.00056 VE 16:18:37 .9 PT 4124. 0.</td><td>Page RIGHT 6673. 7229. 5095. 0. -5095. 9 9 Page RIGHT 4043. 3758.</td><td>44</td></td<>	0.13       Licenson         RUCTURE       G-04-AL;	ed to: Colora SH-70; CBGCF -46344 -35824 20382 0. -20382 ISE POSITIVE LT. END 0.000000 -0.000285 T / 4 POINTS -0.023 -0 0.000 C 0.000 C 0.	do DOT Ri ; PROJ#I70-1(7) 5 PT .6 PT 5433582. 5434634. 547. 3057. 0. 0. 5473057. RT. END 0.000569 FROM LEFT END. .047 -0.023 .047 -0.022 ROM LEFT END. .001 0.001 .000 0.000 .001 -0.001 do DOT Ri ; PROJ#I70-1(7) 5 PT .6 PT 0. 0. 0. 0.	un time: 12- 5)57; M.M. -7 PT -1719. -3582. 0. -3566. SPAN LT. 3 0.0 - DOWNWARD 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	-JUL-95 .8 PT 1067. 1220. 4076. 0. 200285 POSITIV -JUL-95 .8 PT 0. 0.	16:18:37 .9 PT 4799. 2401. 4585. 0. -4585. RT. END -0.00056 VE 16:18:37 .9 PT 4124. 0.	Page RIGHT 6673. 7229. 5095. 0. -5095. 9 9 Page RIGHT 4043. 3758.	44
LIAI-BDS         Version 4.0           STI           OTOTAL PE MOMENTS FOR ALI           MEM           NO         LEFT           1         7229.           0         1           0         1           0         1           0         1           0         2           0         2           0         2           0         3           0         5           0         5           0         5           0         5           0         5           0         5           0         5           0         1           0         1           0         1           0         1           0         1           0         MEMBER           1         E           0         MEMBER           1         E           0         MEMBER           0         MEMBER           0         MEMBER           0         MEMBER           0         MEMBER           <	0.13       Licenson         RUCTURE       G-04-AL;         .2       PT       .3         1220.       -3582.         1067.       -1719.         1019.       1528.         RTRIAL       RADIANS - CLOCKW         RT.       END       SPAN         0.000000       2         0.000000       5         TTIONS IN FEET AT       66.         0.000       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         20.       0.000         21.       3         22       7.         24       7. <td< td=""><td>ed to: Colora SH-70; CBGCF -46344 -35824 20382 0. -20382 ISE POSITIVE LT. END 0.000000 -0.000285 T / 4 POINTS -0.023 -0 0.000 C 0.000 C 0.</td><td>do DOT R1 ; PROJ#I70-1(7) 5 PT .6 PT 5433582. 5434634. 547. 3057. 0. 0. 5473057. RT. 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<pre>DTABL LOSS (EST) - SE + SE - (CF + CHS) DTABL LOSS (EST) - SE + SE - (CF + CHS) DTABL LOSS (EST) - SE + SE - (CF + CHS) DTABL LOSS (EST) - SE + SE - (CF + CHS) - JP T = SET DTABL LOSS (EST) - SE + SE - (CF + CHS) - JP T = SET DTABL LOSS (EST) - JP T - (F T - (F T - JP T</pre>	liai-bds 0	Versic			SH-70; C		T Run ti J#I70-1(75)57; LOSSES		16:18:37	Page 46
NO         LEFT         1.1 EFT         1.2 EFT         1.3 EFT         1.4 FT         1.5 ET         1.6 ET         1.2 C.1         1.2 C.1 </td <td></td> <td></td> <td></td> <td>TOTA</td> <td></td> <td></td> <td></td> <td>RS</td> <td></td> <td></td>				TOTA				RS		
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UC         1107.         916.         725.         637.         333.         237.         431.         638.         832.         1023.         1217.           VC         100.         1270.         166.         697.         402.         273.         431.         638.         832.         103.         1217.         903.         903.         903.         903.         903.         903.         903.         903.         903.         903.         903.         903.         903.         903.         903.         903.         903.         903.         903.         903.         903.         903.         903.         903.         903.         903.         904.         90.         904.         904.         904.         904.         904.         904.         904.         904.         904.         904.         904.         904.         904.         904.         904.         904.         904.         904.         904.         904.         904.         904.         904.         904.         904.         904.         904.         904.         904.         904.         904.         904.         904.         904.         904.         904.         904.         904.         904.         90	0V-CABLE	425.	334.	226.	115.	3.	74. 149.	225.	302. 35	
RED 0F WIB       48.       48.       48.       48.       48.       48.       48.       48.       48.       48.       48.       48.       68.       48.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.       68.	VU	1107.	916.	725.	537.	333.	237. 431.	638.	832. 102	3. 1217.
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ONDET: * AFTER REQU MEE INDICATES ADDITIONAL MEE NIDTH REQL. * AFTER AS(IN)/FT INDICATES MINIMUM REQL.       131.1.6.05       Version 4.0.13       Licanaed Lu: Colorado DOT       Fun time: 1.2-JUL-95 16:18:37       Page 47         0       SECOND LICANS       SLICANAED LICANS       FUN TIME COMPANY       FUN TIME COMPANY       FUN TIME COMPANY       FUN TIME COMPANY         0       SECOND LICANS       MULTINAT EXPLOYING       NULL NAM       FUN TIME COMPANY       FUN TIME COMPANY         0       SECOND LICANS       MULTINAT EXPLOYING       NULL NAM       FUN TIME COMPANY       FUN TIME COMPANY         0       SECOND LICANS       MULTINAT EXPLOYING       NULL NAM       NULL NAM       FUN TIME COMPANY         0       SECOND LICANS       MULTINAT EXPLOYING       NULL NAM       NULL NAM       FUN TIME COMPANY         0       SECOND LICANS       VERSION AND AND AND AND AND AND AND AND AND AN										
SERUCTURE G-04-LL: SH-70: CBOCP: PROJHI70-1(75)577 M.M.           NASHTO ULTIMUM VUERAGE NEUTRAL NILD STEEL COMSINED ULT MOM VUERAGE NEUTRAL REQD           UKMENT AL PLD         PS (SO P         PSUID         VIERAGE NEUTRAL NEUDSTEEL         COMSINED NILD CAR (K-PT)         ULT MOM VUERAGE NEUTRAL NEUDSTEEL           UKMENT AL VALUE (K-PT)         (K-FT)         (K-FT)         (K-T)         (K-T)         (K-PT)           UKMENT AL VALUE (K-PT)         (K-T)         (K-T)         (K-T)         (K-T)         (K-T)           UKMENT AL VALUE (K-PT)         (K-T)         (K-T)         (K-T)         (K-T)         (K-T)           UKMENT AL VALUE (K-T)         (K-T)         (K-T)         (K-T)         (K-T)         (K-T)           UKMENT AL VALUE (K-T)         (K-T)         (K-T)         (K-T)         (K-T)         (K-T)           0.0.127         4273.         14385.         23582.         261.95         5.16         0.00         0.077         0.23882.           0.1.6         FT.         3725.         18189.         24316.         262.95         13031.         12315.         255.7           0.1.6         FT.         3725.         22598.         22593.         256.57         6.88         0.00         0.107         0.22593.										
0 SECOND ULT MOM ULT MOM AVERAGE NEUTRAL MILD STEEL COMBINED ULT MOM ULT MOM (K-FT) (	1IAI-BDS	Versic		G-04-AL;	SH-70; C	BGCP; PRO			16:18:37	Page 47
(K-FT)         (K-FT)<				ULT MOM	AVERAGE	NEUTRAL				
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0       PATH NO.       P-JACK       % JACK       FY       AS       AVE STRESS       TENDON LENGTH       ELONGATION         (KIPS)       (KSI)       (SQ IN)       (KSI)       (FT) *       (IN)         0       01       5210.       75.       270.       25.73       193.82       238.00       19.77         ONOTE:       TENDON LENGTH INCLUDES 4 FEET FOR JACKS.       0       MODULUS USED FOR P/S STEEL IS 28000. KSI       1141-BDS       Version 4.0.13       Licensed to: Colorado DOT       Run time: 12-JUL-95 16:18:37       Page 49         STRUCTURE G-04-AL;       SH-70; CEGCP; PROJ#I70-1(75)57; M.M.					SH-70; C	BGCP; PRO	J#I70-1(75)57;		16:18:37	Page 48
(KIPS)       (KSI)       (SQ IN)       (KSI)       (FT) *       (IN)         0       01       5210.       75.       270.       25.73       193.82       238.00       19.77         ONOTE:       TENDON LENGTH INCLUDES 4 FEET FOR JACKS.       0       MODULUS USED FOR P/S STEEL IS 28000. KSI         1IAI-BDS       Version 4.0.13       Licensed to: Colorado DOT       Run time: 12-JUL-95 16:18:37       Page       49         0       STRUCTURE G-04-AL; SH-70; CBGCP; PROJ#170-1(75)57; M.M.            49         0              49         0		. F	-JACK	% JACK	FY	AS	AVE STRESS	TENDON LE	INGTH ELC	NGATION
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*****       CONCRETE SUB       0 C.Y. *****         0       *****       P/S TRIAL       20465 LBS. *****         0       THE SUPERSTRUCTURE CONCRETE QUANTITY IS BASED ON THE UNIT         WEIGHT OF CONCRETE SUPPLIED ON THE FRAME DESCRIPTION CARD.       IT ASSUMES THAT ALL THE DEAD LOAD IS GIVEN IN TRIAL 0.         THE CONCRETE SUBSTRUCTURE QUANTITY IS BASED ON TRIAL 0 ONLY.       THE CONCRETE SUBSTRUCTURE QUANTITY IS BASED ON TRIAL 0 ONLY.         THE P/S QUANTITIES FOR STRAND ONLY ARE FOR EACH TRIAL, THAT       WAS ENTERED AND IN THAT ORDER. STRAND USE IS BASED ON THE         LENGTH FROM ANCHOR TO ANCHOR.       LENGTH FROM ANCHOR TO ANCHOR.	0									
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1END OF JOB - 022086			WAS ENTERE	D AND IN	THAT ORDE	R. STRAN				
			5				INCREMENTED C	LOCK TIME (SEC	CONDS)= 5	

COLORADO DEPARTMENT OF TRANSPORTATION	Section: 10
STAFF BRIDGE	Effective: July 1, 2002
BRIDGE RATING MANUAL	Supersedes: July 1, 1995

SECTION 10 - STEEL BRIDGES

#### 10-1 INTRODUCTION TO RATING STEEL BRIDGES

This section together with Section 1, presents the policies and guidelines for rating steel girders. Policies are covered in subsection 10-2, while supporting guidelines are presented in subsections 10-2, 3, and 4.

The types of girders covered by this section are:

CI	Concrete on I-Beam				
CIC	Concrete on I-Beam Continuous				
CIK	Concrete on I-Beam Composite				
CICK	Concrete on I-Beam Continuous and Composite				
SBG	Steel Box Girder				
SBGC	Steel Box Girder Continuous				
SDG	Steel Deck Girder				
SDGC	Steel Deck Girder Continuous				
SSD	Steel Stringer - Concrete Deck				
SSE	Steel Stringer - Earth Filled				
SSM	Steel Stringer - Metal Plank Floor				
SSMC	Steel Stringer Continuous - Metal Plank Floor				
SSS	Steel Stringer - Timber Floor				
SSSC	Steel Stringer Continuous - Timber Floor				
STG	Steel Through Girder				
WG	Welded Girder				
WGC	Welded Girder Continuous				
WGK	Welded Girder Composite				
WGCK	Welded Girder Continuous and Composite				

#### 10-2 POLICIES AND GUIDELINES FOR RATING STEEL BRIDGES

#### I. General

- A. All steel girders (except for girders in Truss Bridges) shall be rated by the VIRTIS program or one acceptable to the CDOT Bridge Branch.
- B. Steel girders with considerable stress/strain effects due to horizontal curvature, skew, temperature, or other influences shall be modeled as simple, straight beams on pin or roller supports. The VIRTIS output results can then be supplemented with hand calculations to consider any of these significant influences, as necessary. Also, when appropriate, steel girders having or lacking horizontal curvature effects and depending on the type of girder to be analyzed, DESCUS I or DESCUS II may also be used to perform the rating.
- C. All steel bridges shall be rated by the load factor method.
- D. Use the minimum design yield strength value (Fy) and the minimum compressive strength of concrete (F'c) from plans.

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- E. For SSE, SSM and SSS structure types, it is acceptable to disregard AASHTO's allowable stress reduction formula for unsupported compression flanges. If the condition of the girder indicates that full yield strength should not be used, the rating stresses should be reduced as appropriate.
- F. Steel box girder template has not been incorporated in the current version of Virtis 4.0.4. However, steel box girders can be rated using ½ the single-girder parameters in the analysis. The live load distribution factor and the dead load shall be adjusted accordingly.

#### II. Girders Requiring Rating

- A. Interior Girders A rating is required for the critical interior girder. More than one interior girder may require an analysis due to variation in span length, girder size, girder spacing, differences in loads or moments, grade of structural steel, etc.
- B. Exterior Girders An exterior girder shall be rated under the following guidelines.

1. When the section used for an exterior girder is different than the section used for an interior girder.

2. When the overhang is greater than S/2.

3. When the plans indicate that the curb and floor slab were poured monolithically, the live load distribution factor for the exterior girder should be calculated and compared to the live load distribution factor (LLDF) for the interior girders. If the LLDF for the exterior girder is equal to or greater than 75% of the LLDF for the interior girders, the exterior girder shall be rated.

4. When the rater determines the rating would be advantageous in analyzing the overall condition of a structure.

#### III. Calculations

- A. A set of calculations, separate from computer output shall be prepared and submitted with each rating. These calculations shall include derivations for dead loads, derivations for live load distribution factors, and any other calculations or assumptions used for rating.
- B. Dead Loads

1. The final sum of all the individual weight components for dead load calculations may be rounded up to the next 5 pounds.

2. Dead loads applied after a cast-in-place concrete deck has cured shall be distributed equally to all girders and, when applicable, treated as composite dead loads. Examples include asphalt, curbs, sidewalks, railing, etc.

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3. Use 5 psf for the unit weight of permanent steel bridge deck forms.

4. Dead loads applied before a cast-in-place concrete deck has cured shall be distributed to the applicable individual supporting girders and treated as non-composite loads. Examples of this type of dead load are deck slabs, girders, stiffeners, splices and diaphragms. The weight of diaphragms may be treated as point loads or as an equivalent uniform dead load for the span under consideration.

EXAMPLE: For two diaphragms (P) at 1/3 points

 $(PL)/3 = M = (wL \times L)/8$ 

Equivalent uniform load . . . w = (8P)/3L

5. The method of applying dead loads due to utilities is left to the rater's discretion.

#### IV. Rating Reporting/Package Requirements

The rater and checker shall complete the rating documentation as described in Section 1 of this manual. Additionally, yield strength (Fy) of structural steel used in the analysis and any variation from the original design assumptions shall be added to the Rating Summary Sheet. The rating package requirements shall be per Section 1-13 of this manual and as amended herein:

<u>Consultant designed projects</u> - Before finalizing the rating package and when VIRTIS is used as the analysis tool, the Rater shall verify with the Staff Bridge Rating Coordinator that the version number of the program being used is identical to CDOT'S version number. Data files created using a lower version of the program shall be rejected. It is required for the CDOT data archive, since the data base management feature inside the program would not work satisfactorily. After the analysis is completed, the rater shall save the data file. When saving is finalized, the rater shall export the data file in \*.bbd format (i.e., F-17-IE.bbd format; bbd = BRIDGEWare Bridge Data File) on an IBM- compatible 3.5" PC Disk for delivery with the rating package. Also, the version number used during analysis shall be written on the diskette label. This ensures proper importation of bridge data archive by Staff Bridge at a later date.

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#### 10-3 GUIDELINES FOR USING THE VIRTIS RATING PROGRAM

The VIRTIS computer program performs the analysis and rating of simple span and multi-span steel girder bridges. It uses the BRASS ASD or the BRASS LFD engine for analysis. This program was developed in accordance with the AASHTO STANDARD SPECIFICATIONS, 16TH EDITION AND THE AASHTO MANUAL FOR CONDITION EVALUATION OF BRIDGES.

A maximum of thirteen (13) spans can be modeled using the program. Linear or parabolic girder web depth variation over the length of a defined cross-section can be modeled using Virtis. When a structure model is finalized, it can be rated using the ASD or the LFD method. The LRFD rating module is currently being developed and will be available in the future. When a structure model is being generated and before any analysis can be performed, it is recommended that Virtis users save the data to memory periodically. This can be accomplished by using the File and Save feature of this program.

The library explorer can be used to save commonly used items (beam shapes, non standard vehicles, materials, appurtenances etc.) and this eliminates the need for all users to define the same items repeatedly throughout the program. Once a new girder shape is defined or copied from the library, Virtis automatically computes the required section properties and beam constants.

Dead load from the girder self weight, deck slab and appurtenances (i.e. rails, median barrier etc.) are calculated automatically by the program. Dead load from the haunch, wearing surface and stiffener weight (for steel bridges) is defined by the user. For a detailed description of the girder loads, refer to the Opis/Virtis Help Menu index item - dead loads. When a structure is being modeled, the help menu can be activated by using the F1 key if the user requires clarification on a particular item in the GUI window.

In the Live Load Distribution Factor window, when the compute button is used to calculate the DF's automatically by the program, Virtis users shall verify that these numbers are accurate and matches their calculated numbers.

All Colorado BT girder shapes, W-beam shapes, the Colorado permit vehicle, the Colorado posting trucks, and the Interstate posting trucks have been added to the Virtis library explorer and may be copied by the user. The Staff Bridge Rating Coordinator shall be responsible for updating existing information or adding new information (i.e. beam shapes, vehicles, etc.) to the library explorer.

The configuration browser provides access to the configuration features of Virtis. It may be employed to provide specific access privileges, i.e. read, write, delete etc., to the users. This feature is extremely powerful, since Virtis/Opis uses and shares the bridge data from one common source. Therefore, it is required that users of this program create a folder from the bridge explorer window (EXAMPLE: MY FOLDER OR YOUR LAST NAME) before creating the model for a new structure.

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#### 10-4 RATING STEEL BRIDGES WITHOUT PLANS

It is possible that the only information a rater may have to rate an old steel bridge is field measurements of the members and the directions of the AASHTO MANUAL FOR CONDITION EVALUATION OF BRIDGES 1994, Second Edition. A convenient source of beam information is the book titled "Historical Record-Dimensions and Properties-Iron and Steel Beams 1873 to 1952", published by the American Institute of Steel Construction (AISC). This book can help the rater determine the approximate year the beams were rolled. The rater can then determine the section properties and the allowable stresses to be used to rate the steel beams.

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#### 10-5 STEEL GIRDER BRIDGE RATING EXAMPLE

One example is presented in this section. Structure N-17-BP is a two (2) span continuous composite welded girder bridge with a skew of  $0^{\circ}$  degrees. Note that the girder web varies linearly near the pier. For simplicity, only the interior girder has been modeled for this structure.

One curved welded girder example using Descus-I will be presented at a later date.

Also, one curved welded box girder example using Descus-II will be presented at a later date.

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Slab Rating Program Input, Structure No. N-17-BP

💐 WinSlab Inpu	ıt		<b>_</b> 🗆 🗙	
Structure Number:	N-17-BP	Rater:	МН	
Batch ID:		Comments:	LFD	
Highway Number:	25	Load Type:	2=Interstate 🚍	
 Deadload	Bituminous Ov	odau (in):	<u> </u>	
	Dicuminous ov	erlay (in): 4		
Geometry				
Effective Span (ft):	8.25	Actual Slab Thickn fin.):	ess 8.5	
Reinforcing Ste				
Are	ea (sqin)	Distance (in)	For definitions of input values please refer to the	
Top: 0.8	31	5.625	CDOT Bridge Rating Manual	
Bottom: 0.8	31	1.38		
Materials Prope	rties			
Concrete f'c (PSI):	4500	Steel Fy (PSI):	40000	
or Inv Fc (Workin	g Stress)	or Inv Fs (Workir	ng Stress)	
Modular Ratio (Leave blank for load factor): 00				
OK Cancel Apply Output to File				

Effective Span Length: Per AASHTO Article 3.24.1.2(b)

Clear distance between flanges + 1/2 flange width = (105-12)+1/2(12)=93.0''=8.25'

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### Slab Rating Program Output, Structure No. N-17-BP

WinSlab Rating Version 1 Date: 2/20/2002 Structure NO. N-17-BP Rater: MH State HWY NO. = 25 Batch ID= Description: LFD LOAD FACTOR RATING-COMP STEEL NOT USED INPUT DATA Bituminous Overlay(in) = 4.000 Eff. Span(ft) =8.250 Slab Thickness(in) = 8.500 Top Reinf. (sq.in) = 0.81 Eff. Depth(in) = 5.625 Bottom Area(sq.in) = 0.81 Bottom Dist.(in) = 1.38 Conc. Strength(PSI) Inv = 4500 Oper. = 4500 Steel Yield (PSI) Inv = 40000 Oper. = 40000 Modular Ratio = 8 Dead Load Moment 1.05 K-Ft 5.33 K-Ft LL+T Moment Gross Weight 36.0 Tons Inventory Operating Actual Concrete Stress (PSI) 1141.11 1775.74 19303.62 30039.23 Actual Reinf. Steel Stress (PSI) Actual Comp. Steel Stress (PSI) 4306.93 6702.21 Member Capacity (K-Ft) 12.81 12.81 Member Capacity (LL+I) (K-Ft) 11.45 11.45 Rating (Tons) 35.68 59.47

Virtis Bridge Rating Example, Structure No. N-17-BP

#### Effective slab width: Per AASHTO Article 10.38.3.1

0.25(L)= 0.25(114.167\*12)= 342.5" 12\*(t) = (12\*8.5)= 102" Controls C.L. - C.L. of girder= 8.75'= 105"

# Distribution Factor:

Interior Girder (Multi-Lane) = S/5.5 = 8.75/5.5 = 1.591
Interior Girder (Single-Lane) = S/7.0 = 8.75/7.0 = 1.250
Exterior Girder = [(8.75+0.5)+3.25]/8.75 = 1.428

#### Dead Load:

HBP = 4''

Curb = (8/12)\*(1.25)\*(150) = 125 lb/ft

Rail: Assumed 38 Posts @ 70.55 Lbs each Posts = 38\*(70.55)/228.33 = 11.74 Lb/ft Channel = 40.68 Lb/ft 3A Rail = 7.81 Lb/ft

 $\Sigma$  = 60.23 Lb/ft ~ 0.060 Kip/ft

### Interior (D-2 on plan sheet) Diaphragms:

Angles L3x3x5/16 @ 6.1 lb/ft Length = 2(8.75)+2(5.71)=28.92'Weight = (28.92)\*(6.1) = 176.41 Lbs Stiffener Plate 5x5/16x4.5'Weight = 2(5.32)(4.5) = 47.88 Lbs  $\Sigma = 224.29$  Lbs ~ 0.225 Kips

# Pier (D-2 on plan sheet) Diaphragm:

Angles L3x3x5/16 @ 6.1 lb/ft Length = 2(8.75)+2(5.71)=28.92'Weight = (28.92)\*(6.1) = 176.41 Lbs Stiffener Plate 9x1x7.135'Weight = 2(30.625)(7.135) = 437.04 Lbs  $\Sigma = 613.40$  Lbs ~ 0.614 Kips

# End (D-1 on plan sheet) Diaphragms:

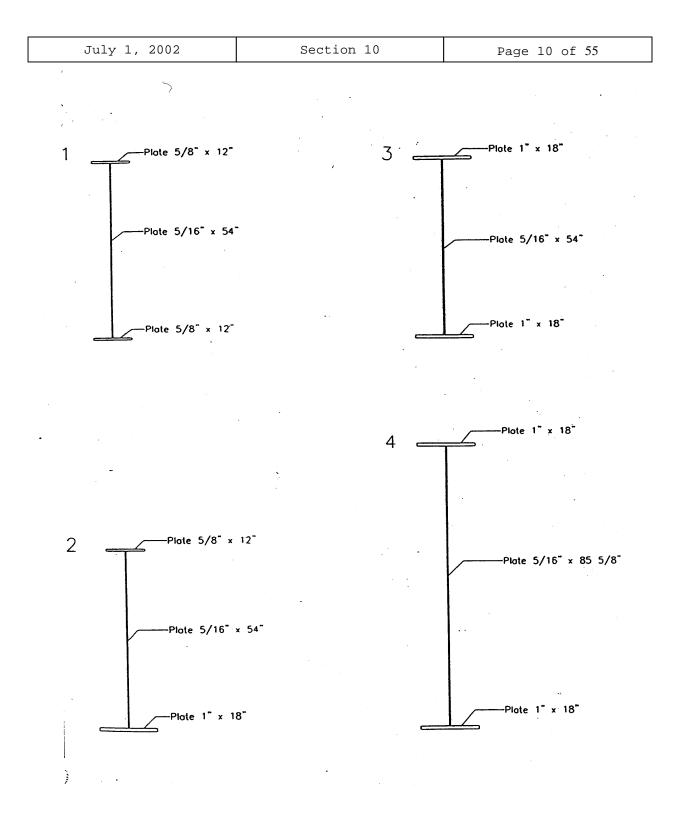
Angles L3.5x3.5x5/16 @ 7.2 lb/ft Length = 2(9.839)=19.68'Weight = (19.68)\*(7.2) = 141.70 Lbs Stiffener Plate 6.5x5/8x4.5'Weight = 2(13.817)(4.5) = 124.3 Lbs  $\Sigma = 266.0$  Lbs ~ 0.266 Kips

### Intermediate Stiffeners:

Assumed length = depth of web = 54"; Neglect longer stiffeners in girder taper Stiffener Plate 5x5/16x4.5' @ 5.32Lbs/ft = 23.94 Lbs each 21 Stiffeners/Span = 21\*(23.94)/114.167 = 4.4 Lbs/ft

# Longitudinal Stiffeners:

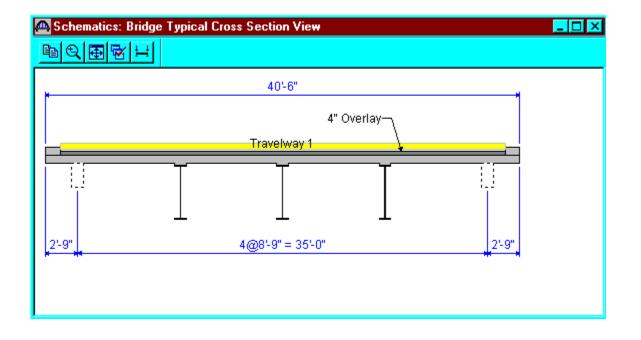
Stiffener Plate 4.5x5/16 = 4.79 Lbs/ft Stiffener Plate 3.5x5/16 = 3.72 Lbs/ft Average Weight = 4.2 Lbs/ft  $\Sigma$  Transverse + Longitudinal Stiffeners = 4.4+4.2 = 8.6 Lbs/ft ~ 0.009 Kip/ft



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# Virtis Bridge Rating Example, Structure No. N-17-BP (contd.)

🕰 S	chematics	: Framing Pla	an View								_ 🗆 🗙
Pa	Q 🖽 🕅	¥ ∺									
	+		052		_,	•		0.92			×
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2				2						2	
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From the bridge explorer, create a new bridge and enter the following information.

🗛 N-17-BP				_ 🗆 🗡
Bridge ID: N-17-BP Description Descriptio	NBI Structure	ID (8): N-17-BP	☐ Tem ☑ Desi	plate ign Only
Name:	WGCK Structure		Year Built:	
Description:	2-Span WGCK structure ov Asphalt thickness 4''.	er Huerfano River. This s	structure is 231' long an	d 38' wide. 🔺
Location:			Length: 231.00	
Facility Carried (7):	1-25		Number: -1	
Feat. Intersected (6): Units:	US Customary		Mi. Post: 1 <sup>03.4</sup> nt ADTT:	
			OK Apply	Cancel

Click OK. This saves the data to memory and closes the window.

NOTE: Since Virtis uses a common/shared database, it is required that users of this program create a folder from the bridge explorer window (EXAMPLE: MY FOLDER OR YOUR LAST NAME) before creating the model for a new structure.

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To add a new structural steel material, click on Materials, Structural Steel, in the tree and select File/New from the menu (or right click on Structural Steel and select New). Click Copy from Library button and select the appropriate structural steel from the library. Click OK and the following window will open. Click OK to save this structural steel material to memory and close the window.

🕰 Bridge Materials	- Structural Steel				_ 🗆 ×
<u>N</u> ame: AST	M A588 - <= 4'', Fy = 50 ksi	De <u>s</u> cription:	ASTM A58	8 - 4'' and under, Fy=50 ks	si
	ł	Material Properties			
	Specified minimum yield :	strength (Fy) = 50.0	00	ksi	
	Specified minimum tensile :	strength (F <u>u)</u> = 70.0	00	ksi	
	Coefficient of therma	al expansion = $0.00$	00065000	1/F	
		<u>D</u> ensity = 0.49	00	kcf	
	Modulus of	elasticity ( <u>E)</u> = 2900	00.00	ksi	
	Co	opy from Library	OK	Apply	Cancel

Using the same techniques, create the following Concrete Materials and Reinforcing Steel Materials. The windows are shown in the following page.

🕰 Bridge Materials - Concrete		
Name: Class D(US) Des	cription: Colorado	Deck Concrete
Compressive strength at 28 days (f'c) =	4.500	ksi
Initial compressive strength (f'ci) =		ksi
<u>C</u> oefficient of thermal expansion =	0.0000060000	1/F
<u>D</u> ensity (for dead loads) =	0.150	kof
Density (for modulus of elasticity) =	0.150	kcf
Modulus of elasticity (Ec) =	3824.00	ksi
Initial modulus of elasticity =	0.00	ksi
<u>P</u> oisson's ratio =	0.200	
Co <u>m</u> position of concrete =	Normal	
Modulus of <u>r</u> upture =	0.503	ksi
<u>Shear factor =</u>	1.000	
Copy from Libr	ary OK	(Apply Cancel

🕰 Bridge Materials - Reinforcing Steel	
<u>N</u> ame: Grade 60	Description: 60 ksi reinforcing steel
h	laterial Properties
Specified yield s	rength (Fy) = 60.000 ksi
Modulus of el	asticity ( <u>E</u> s) = 29000.00 ksi
Ultimate st	<i>ength (F<u>u</u>)</i> = 90.000 ksi
	e Plain DEpo <u>xy</u> D <u>G</u> alvanized D <u>O</u> ther
	Copy from Library OK Apply Cancel

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To enter the appurtenances to be used within the bridge, expand the explorer tree labeled Appurtenances. Right mouse click on Parapet in the tree, and select New. Fill in the parapet properties as required. Click OK to save the data to memory and close the window.

🕰 Bridge App	urtenances - Parapet	
Name: Description:	Bridge Rail Type 3 2-Rails All dimensions are in inches	
	7.5000 Additional Load = 0.060 kip/ft 0.0000 15.0000 ence Line Back Front 8.0000	Parapet unit weight = 0.1500 kcf Calculated Properties Net centroid (from reference line) = 7.500 in Total weight = 0.185 kip/ft
	Copy from Library	OK Apply Cancel

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Double click on Impact/Dynamic Load Allowance in the tree. The Bridge Impact window shown below will open. Accept the default values by clicking OK.

🗛 Bridge Impact / Dynamic Load Allowance 📃 🔲 🗙				
C Standard Impact Factor				
For structural components where impact is to be included per AASHTO 3.8.1, choose the impact factor to be used:				
Standard AASHTO impact I =  L + 125				
<u>M</u> odified impact = times AASHT0 impact				
O Constant impact override = 🛛 🛛 🖇				
LRFD Dynamic Load Allowance				
Eatigue and fracture limit states: 15.0 %				
All other limit states: 33.0 🕺				
OK Apply Cancel				

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Click on Factors, right mouse click on LFD and select New. The LFD-Factors window will open. Click the Copy from Library button and select the 1996 AASHTO Standard Specifications from the library. Click Apply and then OK to save data to memory and close the window.

Fac	tors - LF	D						_ 🗆
	<u>N</u> ame:	1996 AASHTO Std. Specifications						
<u>D</u> e:	scription:	AASHTO Sta Edition, 1996	andard Specific 5 including 1997	ations for Highw 'Interim Specific	vay Bridges, 16th 2 cations			
Load	d Factors	Resistance	Factors					
[	Load	Gamma						
	Group	Factor	D	(L+I)n	(L+l)p	CF	E	в
1	INV	1.300	1.000	1.670	0.000	1.000	1.000	1.000
- [	OPG	1.300	1.000	1.000	0.000	1.000	1.000	1.000
	<u>.</u>				1			
					Copy from Library.	ОК	Apply	Cancel

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Double click on SUPERSTRUCTURE DEFINITION (or click on SUPERSTRUCTURE DEFINITION and select File/New from the menu or right mouse click on SUPERSTRUCTURE DEFINITION and select New from the popup menu) to create a new structure definition. The following dialog box will appear.

Nev	v Structure Definiti	on 🔀
	Structure Type	Description
	Girder-line Girder system	A structure definition describing one of more girders. The girders do NO A structure definition describing one of more girders. The girders do hav
	4	
		(OK] Cancel

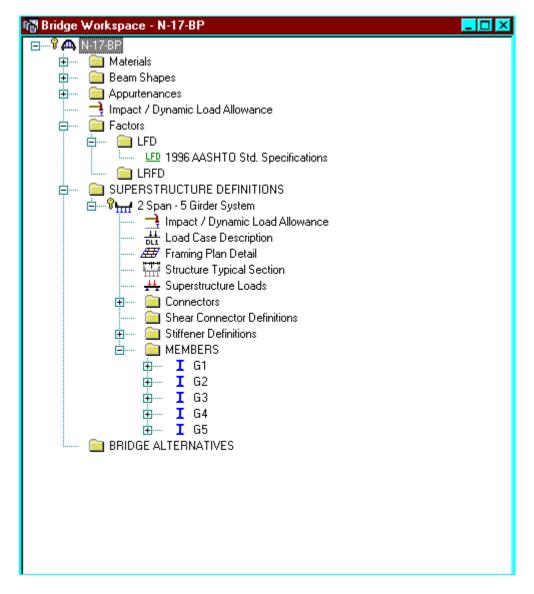
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Select Girder System and the following Structure Definition window will open. Enter the appropriate data as shown below. Press F1 while on this tab to view the help topic describing the use of this information.

🕰 Girder System Supers	structure Definition			_ 🗆 ×
Definition Analysis				
<u>N</u> ame:	2 Span - 5 Girder System			Frame Structure Simplified Definition
<u>D</u> escription:	Spans 114'-2'', 114'-2''		×	
Default <u>U</u> nits:	US Customary	Enter Span <u>L</u> engths Along the Reference		- For PS only
Number of <u>s</u> pans:	2	Line:		Average <u>h</u> umidity:
Number of girders:	5 📑	Span Length (ft)		%
	Deck type: Concrete	1 114.17 2 114.17		Member Alt. Types Steel P/S R/C Timber
			ОК [[	Apply Cancel

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The partially expanded Bridge Workspace tree is shown below:



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The Analysis tab in the Girder System Superstructure Definition window is used to override system default factors. Since default factors are used here, click OK to save the data to memory and close the window.

🕰 Girder System Superstructure Definition	_	□×
Definition Analysis		
Factor Override		
LFD factors:		
	OK Apply Cancel	

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Click Load Case Description to define the dead load cases. The load types are presented in a single row separated by a comma. The first type applies to the LFD design and the second type applies to the LRFD design and it corresponds with the load types presented in the AASHTO Specifications. The completed Load Case Description window is shown below.

								_ [	
Load Case Name	Description	Stage		Тура		Time* (Days )			
HBP		Composite (long term) (Stage 2)	-	D,DW					
Bridge Rail Type 3		Composite (long term) (Stage 2)	-	D,DC	-				
*Prestressed members only		efault Load Descriptions	N	ew		Duplic	ate	Delete	
*Prestressed members only			N	ew		Duplic	ate	Delete	

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Double click on Framing Plan Detail to describe the framing plan. Enter the appropriate data to describe the framing plan.

a	Structure Frami	ing Plan Detail:	;					
	Layout Diaphrag	gms )	Number	r of spans :	= 2	Number of (	girders = 5	
	Support	Skew (Degrees) 0.0000 0.0000	6	àirder Spac ● Perpen ● Along s	dicular to g			
	3	0.0000			Girde	er Spacing (ft)		
			GI	irder Bay -	Start of Girder	End of Girder		
				1	8.75	8.75		
				2	8.75	8.75		
				3	8.75	8.75		
L	· ·			4	8.75	8.75		
						ок		Cancel
						UK .	COPPY	Cancer

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Switch to the Diaphragms tab to enter diaphragm spacing. Enter the following diaphragms data for Girder Bay 1:

àirder Bay	л <mark>1</mark>	•	Сору Вау То		Diaphragm Wizard			
Support	Start D (f		Diaphragm Spacing	Number of	Length	End Dis (f		Load
Number	Left Girder	Right Girder	(ft)	Spaces	(ft)	Left Girder	Right Girder	(kip)
1 🔽	0.00	0.00	0.00	1	0.00	0.00	0.00	0.2660
1 🔽	0.00	0.00	22.83	4	91.33	91.33	91.33	0.2250
2 🔽	0.00	0.00	0.00	1	0.00	0.00	0.00	0.6140
2 🔽	0.00	0.00	22.83	4	91.33	91.33	91.33	0.2250
2 🔽	91.33	91.33	22.83	1	22.83	114.17	114.17	0.2660
New Duplicate Delete								

Click the Copy Bay To button to copy the diaphragms entered for Bay to the other bays. The following dialog box will appear. Click Apply to copy the diaphragms to girder bay 2. Repeat the same techniques for girder bay 3 and 4.

Copy Diaphragm Bay		×
Select the new bay:	2	•
C	Apply	Cancel

Select OK to close Structure Framing Plan Details window.

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Double click on Structure Typical Section in the Bridge Workspace tree to define the structure typical section. Input the data describing the typical section as shown below.

🕰 Structure Typical Sec	tion					_ 🗆 ×
	Distance from left e superstructure defir		Distance from right e superstructure definit Superstructure De Reference Line	ion ref. line		
Left overhang					ght overhang	
Deck Deck (Cont'd) Superstructure definiti		Railing Generic within	• the bridge deck		Surface	
Distance from left edg superstructure definition		Start 20.25 ft	20.25	ft		
Distance <u>f</u> rom right ed superstructure definitio		20.25 ft	20.25	ft		
	Left overhang =	2.75 ft	2.75	ft		
Compute	d right overhang =	2.75 ft	2.75	ft		
				ОК	Apply	Cancel

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The Deck (Cont'd) tab is used to enter information about the deck concrete and thickness. The material to be used for the deck concrete is selected from the list of bridge materials described previously.

🗛 Structure Typical Section	_ 🗆 ×
Distance from left edge of deck to superstructure definition ref. line Deck thickness thickness	
Left overhang	
Deck Deck (Cont'd) Parapet Median Railing Generic Sidewalk Lane Position Wearing Surface	
Deck concrete: Class D(US)	
Total deck thickness: 8.5000 in	
Deck <u>c</u> rack control parameter: 130.000 kip/in	
Sustained modular ratio factor: 3.000	
ОК (Арру) С	ancel

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Parapets:

Add two parapets as shown below.

🕰 Stru	icture Typical Se	ection											_ 🗆
Dec	Back     Front       Deck     Deck (Cont'd)     Parapet     Median     Railing     Generic     Sidewalk     Lane Position     Wearing Surface												
	Name		Load Ca:					Edge of Der Dist. Measur From	ck	Distance At Start (ft)	Distance At End (ft)	Front F Orients	
Br	idge Rail Type 3 🚦	🚽 Brid	e Rail Type 3		•	Back	-	Left Edge	-	0.00	0.00	Right	-
Br	idge Rail Type 3 📘	🚽 Brid	e Rail Type 3		•	Back	-	Right Edge	-	0.00	0.00	Left	-
	New Duplicate Delete OK Apply Cancel												

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# Lane Positions:

Select the lane position tab and use the Compute... button to compute the lane positions. A dialog showing the results of the computation opens. Click Apply to accept the computed values. The Lane Position tab is populated as shown below.

🕰 Structure T	ypical Section			_ 🗆 ×			
Deck Deck	(Cont'd) Parapet Mediar		ture Definition Reference Line	e			
Travelway Number	Distance From Left Edge of Travelway to Superstructure Definition Reference Line At Start (A) (ft)	Distance From Right Edge of Travelway to Superstructure Definition Reference Line At Start (B) (ft)	Distance From Left Edge of Travelway to Superstructure Definition Reference Line At End (A) (ft)	Distance From Right Edge of Travelway to Superstructure Definition Reference Line At End (B) (ft)			
1	-19.00	19.00	-19.00	19.00			
Lanes av	LRFD Fatigue         Lanes available to trucks:         Override Truck fraction:         Compute         New         Duplicate         Delete         OK         Apply         Cancel						

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Enter the following wearing surface information on the Wearing Surface tab.

🕰 Structure Typical Sect	tion			_ 🗆 ×
	Distance from left edge of deck to superstructure definition ref. line Deck thickness	Distance from right edge o superstructure definition re Superstructure Definitio Reference Line	if. line	
Left overhang		-	Right overhang	
Deck Deck (Cont'd) P	Parapet   Median   Railing   Generic	c   Sidewalk   Lane Positio	n Wearing Surface	
Wearing surface ma	aterial: BituminousPavement			
<u>D</u> escrij	iption:			
Wearing <u>s</u> urface thickne	ness = 4.0000 in			
Wearing surface d <u>e</u> n	nsity = 144.000 pcf			
Load	<u>c</u> ase: HBP	•	Copy from Library	
			ОК (Арріу	Cancel

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Double click on the Structure Loads tree item to define the DL Distribution. Select the required DL Distribution. Click OK to save this information to memory and close the window.

niform Temperature   Gradient Temperature   Wind   DLDist	ribution		
Stage 1 Dead Load Distribution     Stage 1 Dead Load Distribution     By tributary area	]		
C By transverse simple-beam analysis			
C By transverse continuous-beam analysis			
$^{\circ}$ User input results from independent 3 <u>D</u> elastic analysis			
- Stage 2 Dead Load Distribution © Uniformly to all girders	]		
C By tributary <u>a</u> rea			
C By transverse simple-beam analysis			
C By transverse continuous-beam analysis			
C User input results from independent 3D elastic analysis			
	J		

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Expand the Stiffener Definitions tree item and double click on Transverse. Define the stiffener as shown below. Click OK to save to memory and close the window.

🕰 Transverse Stiffener Definition	
Image: Transverse Stiffener Definition         Name: Diaphragm conn. Plates D2         Stiffener Type         Single         Plate         Thickness       0.3125         Material       ASTM A588 - <= 4", Fy = 50 ksi	Top Gap: 5.0000 in 5.0000 in Bottom Gap: in in i
Lop Web Bottom	OK Apply Cancel

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Name: Transve	rse Stiffener		
-Stiffener Type-		Top Gap:	
Single		in in	
C Pair			
- Plate		5.0000 in	$\leftrightarrow$
Thickness	0.3125 in		
Material	ASTM A588 - <= 4'', Fy = 50 ksi 🔽	Bottom Gap:	
-Welds			
Ζαρ			
<u>W</u> ab	·		
<u>B</u> ottom	▼		

Similarly, define bearing stiffeners by double clicking on Bearing in the tree. Click OK to save to memory and close the window.

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	g Stiffener Abut. D1	in	<del>≯                                    </del>	
Plate Thickness	0.6250 in	1.0000 in		
Material	ASTM A588 - <= 4", Fy =	501- 6.5000 in		
Welds ap				
<u>W</u> ab		1.0000 in		
<u>B</u> ottom		in	<del>≯₭ <u>≯</u>₭</del> 1.0000 in	

🕰 Bearing Stiffe	ener Definition			_ 🗆 🗡
Name: Bearin	ng Stiffener Pier D3	in	<del>≯K ≯K</del> <sup>1.0000</sup> in	
- Plate	1.0000 in	1.0000 in		
Material	ASTM A588 - <= 4'', Fy = 50 I ▼	9.0000 in	$\longleftrightarrow$	
-Welds		1.0000 in		
<u>W</u> eb <u>B</u> ottom	·			
		in in	<u>オキ オキ  1.0000</u> in	
			OK Apply	Cancel

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# Describing a member:

The member window shows the data that was generated when the structure definition was created. No changes are required at this time. The first Member Alternative that we create will automatically be assigned as the Existing and Current Member alternative for this member.

🕰 Member						_ 🗆 🗵
Member name:	G2		Link with:	None	•	
<u>D</u> escription:						
	Eviction Current	Member Alternative Name	Description		<b>_</b>	
	Existing Current	Member Alternative Name	Description			
Number of commu	2 🖂				Pedestrian load:	
<u>N</u> umber of spans:	2 🗶	Span Span No. Length	-		Eedestrian load.	lb/ft
		(ft) 1 114.17				
		2 114.17				
					OK Apply	Cancel

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Double click on Supports to define support constraints for the girder. Support constraints were generated when the structure definition was created and are shown below. Click OK to save data to memory and close the window.

Supports				
	z	•× <u>~</u> 1		2
ieneral	Elastic			
Support Number	Support Type	Translation X	Constraints Y	Rotation Constraints Z
1	Pinned 🔽 Roller 🔽		ব	
3	Roller 🔽		<u>।</u>	
			40	Apply Cancel

Defining a Member Alternative:

Double click MEMBER ALTERNATIVES in the tree to create a new alternative. The New Member Alternative dialog shown below will open. Select steel for the Material Type and Plate for the Girder Type.

New Member Alternative	×
Material Type:	Girder Type:
Steel 🔽	Plate 🔽
Г	OK Cancel

Click OK to close the dialog and create a new member alternative.

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Member Alternative: Plate Gird	ler	
Description Factors Engine I	mport	
Description:	×.	Material Type: Steel Girder Type: Plate Default Units: US Customary 💽
Girder property input method Schedule based C Cross-section based	End bearing locations Left: 6.0000 in Right: 6.0000 in	Analysis Module ASD: BRASS ASD LFD: BRASS LFD LBFD: BRASS LFD
Additional Self Load Additional sel <u>f</u> load = 0.0 Additional self l <u>o</u> ad =	09 kip/ft LFD	ethod:

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Now re-open the Member G2 window, we will see this Member Alternative designated as the existing and current member alternative for this Member.

🕰 Member						
Member name:	G2		Link with:	None	•	
Description:					A	
					<u>v</u>	
		Member Alternative Name Plate Girder	Description			
		Flate Officer				
<u>N</u> umber of spans:	2 🛓	Span Span	-		Pedestrian load:	lb/ft
		Span Span No. Length (ft)				
		1 114.17				
		2 114.17				
					ОК Арруу	Cancel

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Double click on Live Load Distribution to enter live load distribution factors. Click the Compute from Typical Section button to compute the live load distribution factors. The distribution factors are computed based on the AASHTO Specifications, Articles 3.23. Click Apply and then OK to save data to memory and close the window.

Lanes		Distribution (Whee				
Loaded	Shear	Shear at Supports	Moment	Deflection		
1 Lane	1.250	1.314	1.250	0.400		
Multi-Lane	1.591	1.857	1.591	1.080		
	m					

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Double click on Girder Profile in the tree to describe the girder profile. The window is shown below with the data describing the web.

Begin Depth (in)	Depth Va	ary	End Depth (in)	Thickness (in)	Suppo Numbe		Length (ft)	End Distance (ft)	Material	Weld at Right
54.0000	None	-	54.0000	0.3125	1	0.00	102.17	102.17	ASTM A588 - <= 4", Fy = 50 ksi 🗾	•
54.0000	Linear	-	85.6250	0.3125	1	102.17	12.00	114.17	ASTM A588 - <= 4", Fy = 50 ksi 🗾	<b>_</b>
85.6250	Linear	-	54.0000	0.3125	2	0.00	12.00	12.00	ASTM A588 - <= 4", Fy = 50 ksi 🗾	<b>_</b>
54.0000	None	-	54.0000	0.3125	2	12.00	102.17	114.17	ASTM A588 - <= 4", Fy = 50 ksi 🗾	-

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Describe the flanges as shown below.

Begin Width (in)	End Width (in)	Thickness (in)	Supp Numb			th Distance (ft)	Material	Weld	Weld at Right	
	12.00	0.6250	1		00 83.0		ASTM A588 - <= 4", Fy = 50 ksi 🔽	-	-	
18.00	18.00	1.0000	1	- 83	00 31.1	7 114.17	ASTM A588 - <= 4", Fy = 50 ksi 🔽	-	-	
18.00	18.00	1.0000	2	<b>-</b> 0	00 31.1	7 31.17	ASTM A588 - <= 4", Fy = 50 ksi 🗾	-		
12.00	12.00	0.6250	2	- 31	17 83.0	0 114.17	ASTM A588 - <= 4", Fy = 50 ksi 🗾	-		

Begin	End	Thickness	Sum	oort	Start	Length	End			Weid at	
Width (in)	VVidth (in)	(in)	Num	ber	Distance (ft)	(ft)	Distance (ft)	Material	Weld	Right	
12.00	12.00	0.6250	1	-	0.00	12.00	12.00	ASTM A588 - <= 4", Fy = 50 ksi 🔽	-		
18.00	18.00	1.0000	1	-	12.00	102.17	114.17	ASTM A588 - <= 4", Fy = 50 ksi 🔽	-		
18.00	18.00	1.0000	2	-	0.00	102.17	102.17	ASTM A588 - <= 4", Fy = 50 ksi 🔽			
12.00	12.00	0.6250	2	-	102.17	12.00	114.17	ASTM A588 - <= 4", Fy = 50 ksi 🔽			

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Double click on Deck Profile and enter data describing the structural properties of the deck. The deck concrete and reinforcement windows are shown below.

eck Concrete R	einti	orcen	ient	Shear Connect	tors					
Material		Sup; Num		Start Distance (ft)	Length (ft)	End Distance (ft)	Structural Thickness (in)	Effective Flange Width (Std) (in)	Effective Flange Width (LRFD) (in)	n
Class D(US)	-	1	-	0.00	87.75	87.75	8.5000	102.0000	105.0000	
Class D(US)	-	1	-	87.75	52.83	140.58	8.5000	102.0000	105.0000	
Class D(US)	-	2	-	26.42	87.75	114.17	8.5000	102.0000	105.0000	
							N	ew Dup	licate De	lete

Material	Support Numbe	Start r Distance (ft)	Length (ft)	End Distance (ft)	Bar Count	Bar Size	Distance (in)	Row		
Grade 60 🔽	1 🗖	68.67	45.50	114.17	7.000	8 🔽	3.7500	Top of Slab 📃 🔽	[	
Grade 60 📘	1 1	68.67	45.50	114.17	6.000	5 🔽	3.5625	Top of Slab 📃 🔽		
Grade 60 🔽	2 🔽	0.00	45.50	45.50	7.000	8 🔽	3.7500	Top of Slab 🔽		
Grade 60 📘	2 🗖	0.00	45.50	45.50	6.000	5 🔽	3.5625	Top of Slab 📃 🔽		

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Composite regions are described using the Shear Connectors tab as shown below.

Sup Nur		Start Distance (ft)	Length (ft)	End Distance (ft)	Connector ID		Number per Row	Number of Spaces	Transverse Spacing (in)	
1	-	0.00	28.00	28.00	7/8" Dia x 6 in Studs	-	2	28	9.0000	
1	-	28.00	51.25	79.25	7/8" Dia x 6 in Studs	-	2	41	9.0000	
1	-	79.25	8.50	87.75	7/8" Dia x 6 in Studs	-	2	17	9.0000	
2	-	26.42	8.50	34.92	7/8" Dia x 6 in Studs	-	2	17	9.0000	
2	-	34.92	51.25	86.17	7/8" Dia x 6 in Studs	-	2	41	9.0000	
2	-	86.17	28.00	114.17	7/8" Dia x 6 in Studs	•	2	28	9.0000	
									New	v Duplicate Delete

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Double click on Haunch Profile in the tree to define the haunch profile. Check the box 'embedded flange' if the top flanges of the girder is embedded in the concrete haunch.

🕰 Haunch Profile								
Haunch Type:	🗹 Em	bedded flange						
	1 1 1		<u>71</u> Z1 Z2 ↓	<u>Z1</u> Z2				
	Support Number	Start Distance (ft)	Length (ft)	End Distance (ft)	Z1 (in)	Z2 (in)	Y1 (in)	
	1 🔽	0.00	83.00	83.00	6.0000	6.0000	1.8750	
<b>│</b> │ <u>`</u> <sub>└</sub> <u>∓</u> →	1 🔽	83.00	31.17	114.17	6.0000	6.0000	1.5000	
	2 🔽	0.00	31.17	31.17	6.0000	6.0000	1.5000	
	2 🔽	31.17	83.00	114.17	6.0000	6.0000	1.8750	
						New	Duplicate	Delete
						OK	Apply	Cancel

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Regions where the hardened concrete deck slab is considered to provide lateral support for the top flange are defined using the Lateral Support window.

🕰 La	iteral Supp	port			
	 ₽	Start Distar		_ength	
	Support Number	Start Distance (ft)	Length (ft)	End Distance (ft)	
	1 <b>•</b> 2 <b>•</b>	0.00 0.00	114.17 114.17	114.17 114.17	
		0.00	114.17	117.17	New Duplicate Delete
					OK Apply Cancel

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Define stiffener locations using the Stiffener Ranges window shown below.

🗅 Stiffener Ranges							_ 🗆
Transverse Stiffener Ranges	T	Spacing <sub>▶</sub>	s]				
Name	Support Number	Start Distance (ft)	Number of Spaces	Spacing (in)	Length (ft)	End Distance (ft)	
	ners betwee hragms	en		New	Duplica	ate Delete	•
					OK A	Apply Ca	ancel

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Click on the Apply at Diaphragms... to open the following dialog box. Select the Diaphragm connection Plates D2 as the stiffener to be applied at interior diaphragms.

Diaphragm Connection Plates	×
Apply the following stiffener definitions to the diaphragm locations:	
End Diaphragms and Diaphragms At Piers	
Bearing Stiffener: Bearing Stiffener Abut. D1	
- Interior Diaphragms	1
Iransverse Stiffener: Diaphragm conn. Plates D2	
Apply	Cancel

Selecting Apply button will create the following transverse stiffener locations.

Start Dista	ance	•	<mark>∢Spacing</mark> ▶				
ansverse Stiffener Ranges   Lo	ongitudi	inal	Stiffener Range:	5			
Name	Supp Numk		Start Distance (ft)	Number of Spaces	Spacing (in)	Length (ft)	End Distance (ft)
Diaphragm conn. Plates D2 🔽	1	-	22.833000	1	0.0000	0.00	22.83
Diaphragm conn. Plates D2 🔽	1	•	22.833000	3	273.9960	68.50	91.33
Diaphragm conn. Plates D2 🔽	2	•	22.833000	1	0.0000	0.00	22.83
Diaphragm conn. Plates D2 🔽	2	•	22.833000	3	273.9960	68.50	91.33
	ners bei ragms.		en		New	Duplica	te Delete

This structure has intermediate transverse stiffeners between diaphragms. Click on the Stiffeners between Diaphragms... button to open the following window.

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Enter the appropriate stiffener data i.e., the number of equal spaces between diaphragms and the stiffener definition.

Girder Support Start Distance (ft) Spacing (ft) End Distance (ft) Number of Contract (ft) Contract (	
Both Sides 1 🔽 0.00 22.83 22.83 5 Transverse Stiffener	-
Both Sides 1 🔽 22.83 22.83 45.67 4 Transverse Stiffener	-
Both Sides 1 🔽 45.67 22.83 68.50 4 Transverse Stiffener	-
Both Sides 1 🔽 68.50 22.83 91.33 4 Transverse Stiffener	-
Both Sides 1 🔽 91.33 22.84 114.17 8 Transverse Stiffener	-
Both Sides 2 🔽 0.00 22.83 22.83 8 Transverse Stiffener	-
Both Sides 2 🔽 22.83 22.83 45.67 4 Transverse Stiffener	-
Both Sides 2 🔽 45.67 22.83 68.50 4 Transverse Stiffener	-
Both Sides 2 🔽 68.50 22.83 91.33 4 Transverse Stiffener	-
Both Sides 2 🔽 91.33 22.83 114.17 5 Transverse Stiffener	-

Click the Apply button.

July 1, 2002	Section 10	Page 49 of 55
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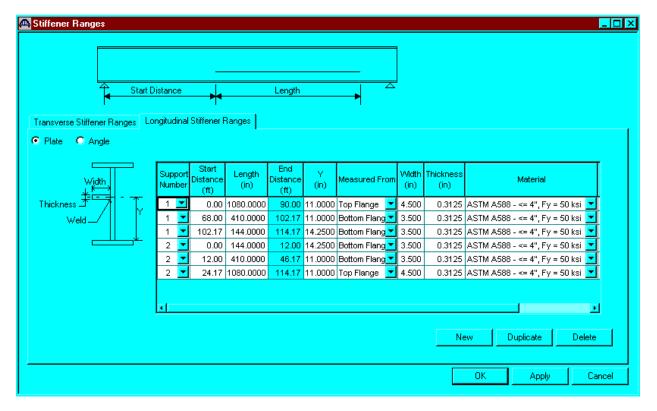
The populated Transverse Stiffener Ranges window is shown below. Click on the Apply button to save the data to memory.

			Spacing					
ansverse Stiffener Ranges ] [ Name	Sup	dina port nber	Start Distance	s Number of Spaces	Spacing (in)	Length (ft)	End Distance (ft)	<u> </u>
Transverse Stiffener	- 1	•	0.00	4	54.7992	18.27	18.27	
Diaphragm conn. Plates D2 📘	- 1	-	22.83	1	0.0000	0.00	22.83	
Transverse Stiffener	- 1	-	22.83	3	68.4990	17.12	39.96	
Diaphragm conn. Plates D2	- 1	-	22.83	3	273.9960	68.50	91.33	
Transverse Stiffener	- 1	-	45.67	3	68.4990	17.12	62.79	
Transverse Stiffener	- 1	-	68.50	3	68.4990	17.12	85.62	
Transverse Stiffener	- 1	-	91.33	7	34.2570	19.98	111.32	
Transverse Stiffener	2	-	0.00	7	34.2495	19.98	19.98	
Diaphragm conn. Plates D2 📘	2	-	22.83	1	0.0000	0.00	22.83	
Transverse Stiffener	2 2	-	22.83	3	68.4990	17.12	39.96	
Diaphragm conn. Plates D2	2	-	22.83	3	273.9960	68.50	91.33	
Transverse Stiffener	2	-	45.67	3	68.4990	17.12	62.79	
Transverse Stiffener	2	-	68.50	3	68.4990	17.12	85.62	•
	eners b Ihragm		een		[	New	Duplicate	Delete

Click on the Longitudinal Stiffener Ranges tab to define the limits of longitudinal stiffeners.

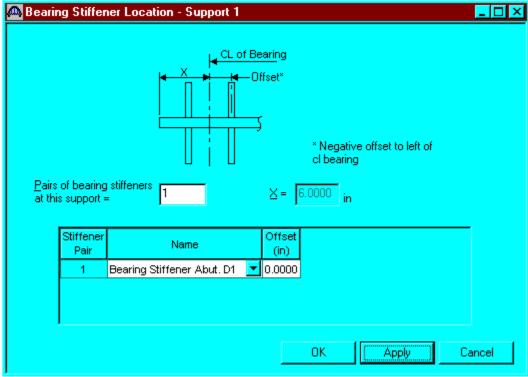
July 1, 2002	Section 10	Page 50 of 55
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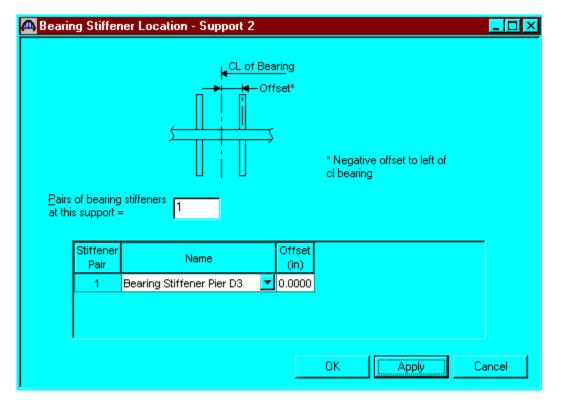
Enter the appropriate stiffener data and click the Apply button to save the data to memory and close the window.



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Bearing stiffener definitions were assigned to locations when we used the Apply at Diaphragms... button on the Transverse Stiffener Ranges window. Open the window by expanding the Bearing Stiffener Locations branch in the tree and double clicking on each support. The assignment for support 1, 2 and 3 are shown below.





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🕰 Bearing Stiffe	ner Location - Support 3	_ 🗆 ×
<u>P</u> airs of bearin at this support		
Stiffene Pair	r Offset (in)	
1	Bearing Stiffener Abut. D1 🔽 0.0000	
	ОК Арріу С	ancel

July 1, 2002	Section 10	Page 53 of 55
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Select Plate Girder (E)(C) in the Bridge Workspace tree; open the schematic

for the girder profile by selecting the View Schematic toolbar button 🗖 or the Bridge/Schematic from the menu.

🕰 Schematics: Profile View						<b>_</b>
Top Flange Transitions	*			PL 5/8"x12">	(83'-0"	
Web Transitions					5/16"x54"x102'-2	1/32"
Stiffener Spacing	4 SPA.@ 4'-6 13/16"=18'-3	1/4" <u>4'-6 3/4"</u>	3 SPA.@ 5'-8 1/2"=	17'-1 1/2" <del> </del>	3 SPA.@ 5'-8	1/2"=17'-1 1/2"''-6" 5'
Shear Connector Spacing	28 SPA.(	@1'-0"			41 SPA	0
Top Flange Lat. Support	*					114'-2"
					5/16"x54" We	b I
Bottom Flange Transitions	PL 5/8"x12"x12'-0"					PL 1"x18"x102
Span Lengths	#					114'-2"
×I	Notes: * All flange length dimensions : * Transverse stiffener pairs sho * Single transverse stiffener sh * Bearing stiffeners shown in g * Dimensioning starts and end * X denotes cross frame location	own in red. Iown in blue. Ireen. Is at CL bearings.	ong flange may differ).			

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Page 144

#### The results of the control LFD rating analysis are as follows:

Wyoming Department of Transportation, Bridge Design Division Date 04/10/2002

Member: G2

RATING FACTOR REPORT

 RATING FACTOR REPORT

 ANALYSIS POINT NO. 5: 104.00

 LOAD LEVELS
 TRUCK DESCRIPTION

 1: 1.30( 1.00 \* D + 1.67 \* L)
 1. Truck: AASHTO H 20-S 16 Loading, 1944 Ed

 2: 1.00( 1.00 \* D + 1.67 \* L)
 2. Truck: AASHTO H 20-S 16 Loading, 1944 Ed

 3: 1.30( 1.00 \* D + 1.00 \* L)
 3. Truck: 96 Tons Vehicle

 4: 1.00( 1.00 \* D + 1.00 \* L)
 4. SPECIAL-LOAD

---- STRENGTH ----------------LOAD LEVEL 1 ----- LOAD LEVEL 2 ----- LOAD LEVEL 3 ----- LOAD LEVEL 4

è

FLEXURE					
TRUCK 1	01.22	N/A	02.04	N/A	I = 1.22 (36) = 43.9 TONS
TRUCK 2	01.45	N/A	02.42	N/A	
TRUCK 3	00.68	N/A	01.13	N/A	0 = 2.04 (36) = 73.4 TONS
CRITICAL	00.68	N/A	01.13	N/A	0 - 0 - 10 - 13 - 10 - 3
REINFORCEM	ENT				
TRUCK 1	N/A	N/A	N/A	N/A	Permit = 1.13 (96) = 108.5 TONS
TRUCK 2	N/A	N/A	N/A	N/A	refmit = 100 (10) = 10015 1043
TRUCK 3	N/A	N/A	N/A	N/A	
CRITICAL	N/A	N/A	N/A	N/A	
SHEAR					
TRUCK 1	01.58	N/A	02.65	N/A	
TRUCK 2	02.00	N/A	03.35	N/A	
TRUCK 3	01.12	N/A	01.87	N/A	
CRITICAL	01.12	N/A	01.87	N/A	
BEARING					
TRUCK 1	N/A	N/A	N/A	N/A	
TRUCK 2	N/A	N/A	N/A	N/A	
TRUCK 3	N/A	N/A	N/A	N/A	
CRITICAL	N/A	N/A	N/A	N/A	

July 1, 2	2002		Section	n 10	Page 55 of 55				
COLORADO DEPARTI LOAD FACTOR Rated using					Structure #N-17-BP (N.B.)State highway #I-25Batch I.D.				
Asphalt thickness: Colorado legal k Interstate legal k	4	in.)		Structure type WGCK Parallel structure # N-17-AM (S.				)	
Structural member	INTERIOR GI	RDER	SLAB						
·····									
Inventory	40.0 <b>(</b>	44 )	32.7 (	36 )		(	)	(	)
Operating	66.4 (	73 )	53.6 (	59 )		(	)	(	)
Type 3 truck	(	)	(	)		(	)	(	)
Type 3S2 truck	(	)	(	)		(	)	(	)
Type 3-2 truck	(	)	(	)		(	)	(	)
Permit truck	98.2 ( 1	.08 )	(	)		(	)	(	)
Type 3 Truck Interstate 21.8 metric Colorado 24.5 metric	tons (24 tons)	0	Type 3S2 Tru Interstate 34.5 metric Colorado 38.6 metric t	tons (38 tons)		L Intersta 35.4 m Colorad	netric tons (39	tons)	0
Metric tons Tons	) s	Metric	((	) ;		Metric to	(	) Tons	
<sup>Comments</sup> Control Member: Deck; Rated for 4" HBP Load Capacity: 59 Tons Girder: Only Interior Girder Rated; Rated for 4" HBP									
Color Code: White									
Project No: I25-1(88 Note: Although Virti analysis, she									
Rated by		Date		ecked by				Date	
		Previ	ious editions are ob	solete an	d may not b	e used		CDOT Form #11	87a 1/95

## SECTION 10A TRUSS BRIDGES

## 

#### **10A-1 INTRODUCTION TO RATING TRUSS BRIDGES**

This section covers the general policies and guidelines for rating all truss bridges. Due to the fact that the majority of truss bridges are structural steel, this section also covers the details necessary to rate steel truss bridges .

Steel truss members shall be rated using the policy and guidelines in subsections 10A-2 and 10A-3.

Steel stringer and floor beam members shall be rated using the policy and guidelines in subsections 10A-2 and 10A-3, along with the applicable policy and guidelines in Section 10.

Timber truss bridges shall be rated using the pertinent policies and guidelines in this section and Section 13.

Bridge decks shall be rated in accordance with Section 3.

Subsections 10A-3 and 10A-4 give guidelines and examples for rating steel truss bridges with the BARS computer program.

The types of bridges covered in detail by this section are:

- A. SDT Steel D Deck Truss
- B. SLT Steel Low Truss
- C. STT Steel Through Truss

#### 10A-2 POLICIES AND GUIDELINES FOR RATING TRUSS BRIDGES

#### I. GENERAL

- A. All truss bridge ratings shall be performed in accordance with Sections 1 of this manual, and the AASHTO code except where amended within this manual.
- B. All structural steel members (truss members, floor beams, and stringers) shall be rated with the BARS computer program.
- C. Treated timber members shall be rated using the applicable portions of this section and Section 13. Hand computations will be acceptable for rating timber truss members and timber floor beams.
- D. Structural steel stringers and floor beams shall be rated using the applicable portions of this section and Section 10.
- E Members designed by the working stress method shall be rated by the working stress method.
- F. When design plans are available, giving design stresses, use the applicable inventory and operating stresses. Otherwise, the default values used in the BARS program for the applicable year of construction may be used. It is possible that the year of construction and the year of steel member fabrication are not coincident; e.g., when salvaged members have been utilized. In this case, the year of steel fabrication shall be used in determining allowable stresses.
- G. Truss members shall be identified on all rating material using the standard notation as shown in the BARS Users' Manual and in the AASHTO MANUAL FOR MAINTENANCE INSPECTION OF BRIDGES.
- H. The reduction in capacity of steel compression members with batten plate construction, as stipulated in the AASHTO MANUAL FOR MAINTENANCE INSPECTION OF BRIDGES, shall be used. However, this reduction does not need to be used due to the presence of lacing, perforated plates, or tie plates when lacing connects the flanges between the tie Plates.

#### II. MEMBERS REQUIRING RATING

- A. Truss Members A rating is required for all members that make up a truss, even though only the critical truss member is recorded on the Rating Summary Sheet. When a truss is symmetrical about its midspan centerline, then all the members on only one side of the centerline require a rating. A rating is not required for portal, or sway bracing, members.
- B. Interior Floor Beams A rating is required for the critical interior floor beam. In order to determine the critical floor beam, more than one interior floor beam may require analysis due to variations in cross-sectional size, grade of material, loads. or any other determining factor.
- C. End Floor Beams A rating is required for an end floor beam when its crosssectional size is different from that used for the interior floor beams, or when it will give a lower rating value than an interior floor beam.

- D. Interior Stringers A rating is required for the critical interior stringer. In order to determine the critical stringer, more than one interior stringer may require analysis due to variations in cross-sectional size, grade of material, span length. loads, or any other determining factor.
- E. Exterior Stringers A rating is required for an exterior stringer when its crosssectional size is different from that used for the interior stringers, or when it will give a lower rating value than interior stringer.

### **III. CALCULATIONS**

- A. A set of calculations, separate from computer output, shall be submitted with each rating. These calculations shall include: a diagram of the truss as modeled for analysis, with members labeled; derivations for member section properties, with supporting sketches; derivation of dead loads; derivation of live load distribution factors; and any other calculations or assumptions used for rating.
- B. Live load distribution factors shall be calculated using the vehicle placement guidelines stipulated in Section 1.
- C. Dead Loads
  - 1. S
  - The final sum of all the individual weight components for dead load calculations may be rounded up to the next 5 pounds.
  - 2. Dead loads supported by stringers, and applied after a cast-in-place concrete deck has cured, shall be distributed equally to all stringers. Possible examples include asphalt and curbs.
  - 3. Dead loads supported by stringers, and applied before a cast-in-place concrete deck has cured (or applied when the deck is not cast-in-place concrete), shall be distributed to the applicable individual supporting stringer. Examples include stringer weight and deck, but not necessarily overlay. weight.
  - 4. The method for applying dead loads due to utilities is left to the rater's discretion.

### IV. REPORTING RATINGS

- A. The rater and checker shall complete the rating documentation as described in Section 1 of this manual. In addition to Section 1, the following items shall be observed when filling out the Rating Summary Sheet.
  - 1. Comment on the allowable stress used for inventory if different from the AASHTO allowable.
  - 2. In the truss portion of the rating summary sheet the rating for only the most critical truss member shall be recorded. The critical truss member for one rating value (inventory, operating, posting, or color code) may be different from the truss member that is critical for another rating value. Therefore, the rater shall designate the most critical member and its rating, as appropriate, for each truss rating value entered on the Rating Summary Sheet.

#### **10A-3GUIDELINES FOR USING THE BARS RATING PROGRAM**

To effectively use BARS the rater must become familiar with the Data Preparation Instructions Manual, hereafter referred to as the BARS Manual. The following information for coding the BARS input forms is meant only to supplement the BARS Manual. The discussion for data input is arranged in the order which each card type should appear in the input file.

- I. BARS INPUT
  - A. When creating a BARS input file all references to member descriptions, section codes, and span lengths shall be consistent amongst all card types.
    - 1. For member descriptions and section codes, 01 (zero one) is not the same as bl (blank one). For example, if a member is identified as LOIUOI on card type 64, this designation (LOIUOI) must be used on all other applicable card types, whereas the designations LbIUbl, LlbUOl, or any other combination inconsistent with LOIUOI, are not to be used.
    - 2. For a given span length, the method used to input feet and inches must be consistent so that the decimal portion of the length is exactly the same on all card types in which the span length is referenced.
  - B. Card Type 01 One card type 01 is required for each BATCH I.D. Leave columns 3 through 8 blank. Columns 9 through 14 CANNOT be left blank.
  - C. Card Type 03 Got required for all ratings
    - 1. Card type 03 is required when an Interstate structure requires a posting analysis. In this case, the Interstate posting vehicles shall be coded on card type 03 and referred to as "I3", "I3S2", and "I3-2" in columns 10 13. These load names must also be coded in columns 46 57 of card tome 01.
    - 2. Card type 03 is ignored if the operating rating for all bridge members being rated is greater than or equal to 36.0 tons (the HS 20 gross weight), unless this program decision is overridden on card type 01.
  - D. Card Type 02 Structure Header and Description
    - 1. The year of construction defines the allowable stresses the program will use. Code in a value that produces the appropriate allowable stresses. If this value is different than the actual year of construction, note the actual year on card type 06.
    - 2. The width entered in columns 59-68 is actual roadway width and may not be greater than the span length of any floor beam member which is being rated.
    - 3. Columns 71-80 should be ignored if the HS 20 vehicle is used for determining the inventory and operating ratings.
  - E. Card Type 05 Structure Location and Permanent Identification Factors.
    - 1. Fill in columns 3 20.
    - 2. Columns 66 73 shall contain the highway number.
    - 3. Columns 74 80 shall contain the direction of traffic carried by the bridge if traffic is going in only one direction.

- F. Card Type 06 Comments. This card is used for comments and the following information is required. (see Rating Examples).
  - 1. Project number and feature intersected.
  - 2 Thickness and type of surfacing on deck. Note which legal loading applies. Colorado or Interstate Loading.
  - 3. If a new bridge is being rated, note the structure number of the bridge being replaced; nearest city or town; parallel structure number, and note "SIMILAR" if the parallel structure is identical insofar as the rating for one structure is identical to the rating of the parallel structure.
  - 4. Identify stringer and beam members chosen for rating; e.g., "BO1 = INT. BEAM (W36x150)". Truss members do not need to be identified. Note if yield stresses used were other than those built into the program. Note the actual year of construction if different from the year entered on card type 02.
- G. Card Type 08 through Card Type 12 Flexural Members
  - 1. Designate floor beams and stringers by coding in column 9 a "B" or an "S", respectively. Stringers may not be coded as continuous members.
  - 2. On card type 08, when entering data for a floor beam, code in the center-tocenter spacing of floor beams for the value of "S" in columns 61 - 65. If it is an end floor beam, code an "X" in column 66. For stringers, code the distribution factor-as computed from the AASHTO manual for the value of "E" in columns 61 - 65.
  - 3. For more information on card types 08 through 12, see subsection 10-3.
- H. Card Type 60 General Specifications For Truss Analysis
  - 1. In some cases, it may be necessary to use columns 10 19 to override the allowable stresses designated by the date on card type 02. If so, the BARS rating output shall contain the correct operating allowable stresses. This output does not need to be corrected for the true inventory allowable stresses. However, the inventory stresses used in this case shall be noted on the Rating Summary Sheet under the comments section.
  - 2. Do not enter the center-to-center truss spacing to allow the program to compute the truss live load distribution factor. Instead, calculate the distribution factor (E) as shown in subsection 1-3 and enter it directly in columns 30 \_ 34.
  - 3. Formally a rating is required for all truss members, even though only the critical member is recorded on the Rating Summary Sheet. When a truss is symmetrical about its midspan centerline, then all the members on only one side of the centerline require a rating.
- I. Card Type 61 Truss Geometry
  - 1. For the purposes of column 14, a through truss is any truss where the bottom chord directly supports the bridge deck, and a deck truss is any truss where the top chord directly supports the bridge deck.

- 2. To prevent errors in processing, be certain that the sum of the panel lengths is exactly equal to the overall span length (or one-half overall span for a symmetrical truss) entered on card type 61. without any rounding errors.
- J. Card Type 63 and 64 Truss Member Section Properties
  - 1. Card type 63 is used when the overall section properties of all truss members are known. Card type 64 is used when the overall section properties are not known, and the rater decides to have the program compute them. The input data for section properties shall be shown on the hand calculation sheets submitted with the rating.
  - 2. The reduction of section properties due to bolt and rivet holes must be taken into account when analyzing members subject to tensile stresses. Therefore. the effective area of bolt and rivet holes, as computed according to AASHTO Specifications, shall be used when calculating a member's net area on card type 63, or shall be entered as one of the member's cross sectional elements on card type 64. bolt and rivet holes do not effect gross sectional properties. Consequently, they do not reduce a member's capacity for compression.
  - 3. Defects, or reductions in a member's cross-section, usually due to corrosion or collision damage, reduce both gross and net section properties. Therefore, the affect of defects shall be taken into account for all members in which they occur. The section properties of defects shall be used when computing all of the member's section properties shown on card type 63. Or, on card type 64, the defects shall be entered as elements of the member's cross-section.
  - 4. The BARS program considers all members to have pinned end conditions for- all calculations, except when determining the effective length factor (K). The entry in column 49 and 60 on card types 63 and 64, respectively, will only be used for determining "K". If the end of a member is restrained by only pin friction, then enter an "X" in column 49 or 60, and "K" will be set equal to 0.875. If the end of a member is partially restrained by a bolted or riveted connection, leave column 49 or 60 blank, and "K" will be set equal to 0.75. See Appendix of AASHTO Standard Specifications for Highway Bridges for columns.
  - 5. The value of "F" is used to take into account the reduced strength of batten plate columns (see AASHTO Manual for Maintenance Inspection of Bridges Formulas For Steel Columns). It only applies when members are subject to compressive forces. The governing center-to-center spacing of the batten plates, i.e. tie plates, on one or both sides of a member should be used in determining "F". It is not necessary to apply this reduction due to the presence of lacing bars, perforated plates, or the tie plates which have lacing between them. In these cases, the value of "F" should be left blank.
- K. Card Type 65 Superimposed Dead Loads on Trusses
  - 1. When the unloaded chords (the chords that are not directly supporting the deck) of the trusses on each side of the bridge are not interconnected with portals, or sway bracing, it is acceptable to apply all of the bridge's dead load as point loads at the panel points on the loaded chord.

### II. BARS OUTPUT

- A. The impact values for tension and compression assigned to a truss member are the result of the program applying the appropriate portion of the span length, as determined from the member's influence diagram, into the AASHTO impact formula. When LC is the length of the influence diagram that applies to compression, and LT is the length of the influence diagram that applies to tension, LC plus LT equal the total span length of the truss. LC is used in the impact formula for determining the value of impact for compression, and LT is used for determining the impact for tension.
- B. The HS 20 inventory and operating rating values assigned to structural members on the BARS output are the result of the program multiplying the rating factors by 20 to give ratings relative to the HS 20 designation. The rating values to be entered on the Rating Summary Sheet must be in tons. Therefore, the HS 20 ratings reported by the program must be multiplied by 1.8 (where 36/20 = 1.8 and 36 = gross weight of HS 20 vehicle in tons) to obtain the corresponding ratings in tons; i.e., (HS 20 rating) X 1.8 = (rating in tons).

<u>10A-4</u>

TRUSS BRIDGE RATING EXAMPLE (SLT)

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#### CDOT BRIDGE RATING MANUAL

July 1995

STAFF BRIDGE DESIGN WORK SHEET (01200) 30 REV JULY, 1981

PARALLEL STRUCTURE NUMBER	STATE HWY NO STRUCTURE NO/ BATCH I.D	N-16-L		
	RADO LEGAL IG SUMMARY ( TRUSS		/2 I 31.8 ///T. STRINGER <del>- OR</del> 	STEEL PLANK SLAB
HS 20 (36 TONS) INVENTORY	20.4	37.1	42.7	34.6
HS 20 (36 TONS) OPERATING	38.0	55.0	67.3	46.8
TYPE 3 (27 TONS) OPERATING				

TYPE 3-2(42.5 TONS) OPERATING OVERLOAD COLOR CODE

TYPE 3S2(42.5 TONS) OPERATING

200-6 200-6 200-6 TONS TONS TONS OTC ЭG TYPE 3-2 TYPE 3 TYPE 352 COMMENTS; 5" ASPHALT OVERLAY

500

Subsection

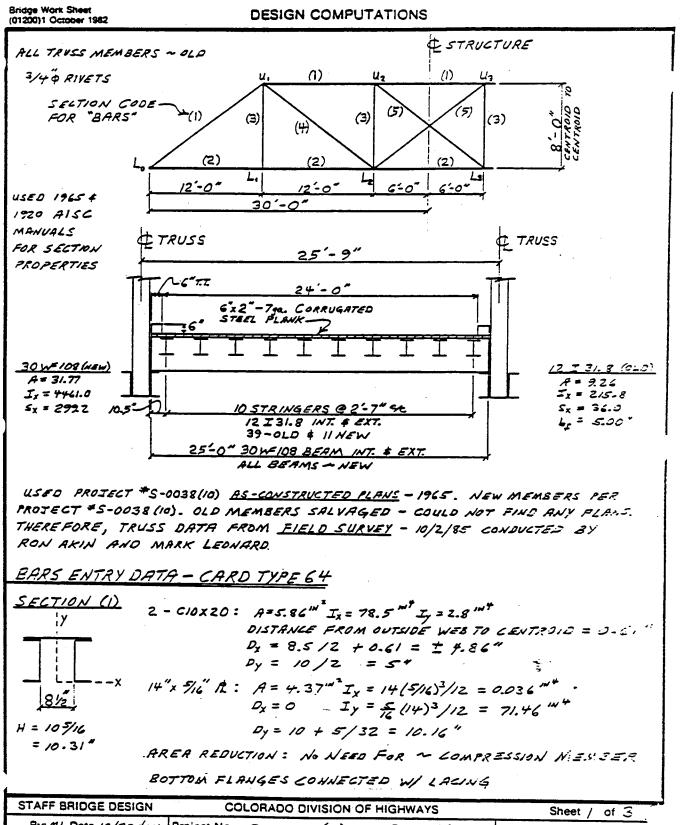
see

Subsection

see

Subsection

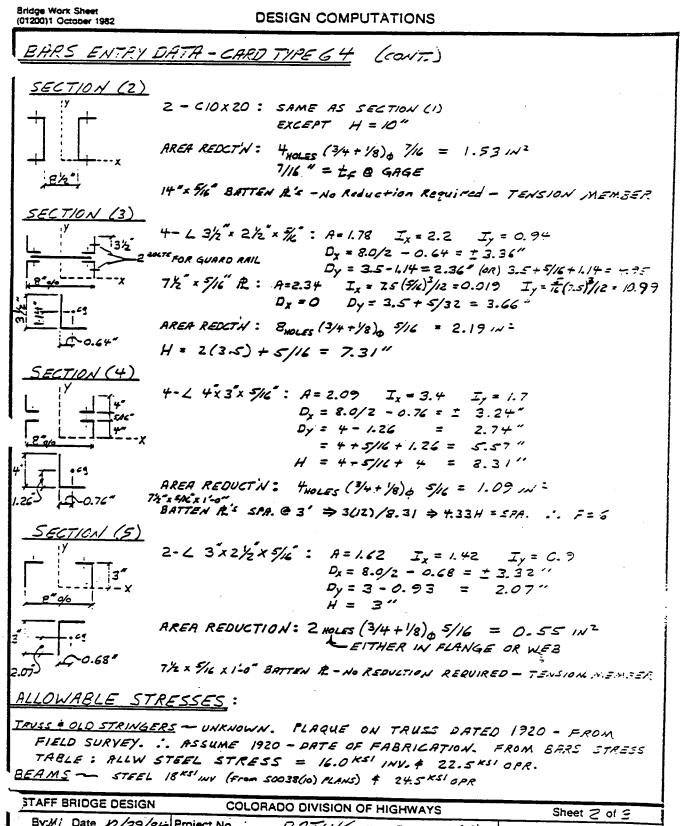
PROJECT NO. 5-0038 (10) Date Checken's Signature DATE: Date RATERI Rateri Cartatize



By: ML. Date 10/29/84	Project No.	5-0038 (10)	RATING	1
Chk'd: 1/Gc Date 11 - 2 - 85	Structure No.	N-16-L		075-025

and a second second

10A.12



STAFF BRIDGE DESIGN		RADO DIVISION OF	HIGHWAYS	Sheet 2 of 2
By:#1 Date 10/29/8		RATING	5-0038(10)	1
Chk'd: VGC Date //-2-85	Structure No.	N-16-L		075-025
A page and the first of the second				

۰-

Bridge Work Sheet (01200)1 October 1982	DESIGN COMPUTATIONS	
SUPER IM POSED	DEAD LOAD (NOTE: GUARD RAIL ON TRUSSES	) (5" OVER LAT
ASPHA	199. Corry. Steel Plank = 10.7 <sup>PSF</sup> (PER ARMCO CAT. LT FILLER = 144 (1 <sup>+)</sup> ave /12 = 12 <sup>PSF</sup> C + FILLER = 22.7 pSF	. <del>1</del> 106)
<u>INT. STRINGER</u> :	$\begin{array}{llllllllllllllllllllllllllllllllllll$	
	SWAY BRACING SUPPORTED & MID-SPAN BY STRINGS HOWEVER, RESULTING POINT LOAD IS NEGLIG	-
	IZI 31.8 OVERLAY = (5/12) ( <sup>31</sup> /2(12) + 4.5/12) /44 = 100 DECK = 22.7 (31/2(12) + 10.5/12) = 49.2 CUR8 = 6(6) 50 / 144 = <u>12.3</u> ILL. D.F. = (31-19.5) / 31 = 0.371 INT # EXT STRINGER - SAME SIZE. INT. STRINGER NO NEED TO RATE EXT. STRINGER.	A 10
INT. BEAM :	30 w 108 P = (214 + 31.8) <sup>RE</sup> 12' = 2.9 <sup>K</sup> /WT.STRING = (162 + 31.8) 12 = 2.3 <sup>K</sup> /EXT.STRING	
<u>EXT. BEAM</u> :	30 WF 108 SAME SIZE AS INT. BEAM. INT BEAM CONTROL. NO NEED TO RATE EXT. BEAM.	٤.
	$NT. STRINGERS = 214^{NLF} (12') + STRINGERS 5 BAYS = 57EXT. STRINGERS = 162^{RE} (12')   STRINGER 5 BAYS = 97SALVAGED STEEL = 43.530 / 2 = 21NEW STEEL = 26330 / 2 = 1396.1/S = 19.2K / INT. PANEL POINT 96$	. 7
CP = C L.L. DF. =	$\frac{4}{25.75} + \frac{10}{2} / 25.75$ $\frac{2.155}{2} = \frac{2.155}{2} + \frac{10}{2} / 25.75$	$\frac{2}{5} \neq \frac{1}{78} = \frac{1}{5}$
STAFF BRIDGE DESIGN		Sheet 3 of 3
By:ML Date /0/29/2 Chk'd: 1/4c Date 11-2-85		5-085

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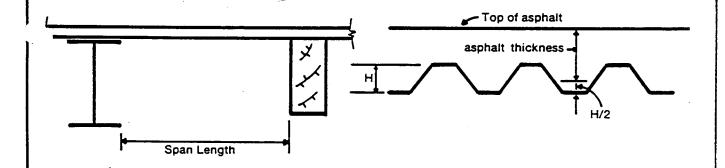
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#### DEPARTMENT OF HIGHWAYS DIVISION OF HIGHWAYS STATE OF COLORADO DOH Form 711 July, 1985

## CORRUGATED STEEL PLANK RATING

DESCRIPTION	INPUT	UNITS	CARD IMAGE COLS.
STRUCTURE NUMBER	$N_{1} = 1/16_{1} = 1/1$		1 - 7
RATER	MIAIL		8 - 10
STATE HIGHWAY NUMBER	1.6.9		11 - 13
BATCH I. D.	D17,5,0,8,5		14 - 19
COMMENTS	DIVIER ITIURIKIEIY		20 - 40
	$C_1R_1E_1E_1K_1$		
SPAN LENGTH	1216.010	IN	41 - 44
SECTION MODULUS	1 ./1612	IN3/IN	45 - 48
WEIGHT OF PLANK	,/,0.7	PSF	49 - 51
INVENTORY STRESS	1210.0	KSI	52 - 54
OPERATING STRESS	1217.0	KSI	55 - 57
ASPHALT THICKNESS	1 16.010	IN	58 - 61



STEEL BRIDGE PLANK RATING

DATE: 85/03/14.

Rutice Signature & Date Chuchere Signature & Deter

STRUCTURE NO: N-16-L RATER: MAL BATCH ID: D75085 STATE HWY NO: 69 COMMENT: OVER TURKEY CREEK

NET SPAN LENGTH (1N) = 26.00 SECTION MODULUS (1N3/1N) = .162 PLANK WEIGHT (PSF) = 10.7 INVENTORY STRESS (K81) = 20.0 OPERATING STRESS (K81) = 27.0 ASPHALT THICKNESS (1N) = 6.00

LL+I MOMENT (IN-K) = 3.328 (LL MCMENT BASED ON A WHEELPRINT 201N X 201N) DL MOMENT (IN-K) = .039 INVENTORY LL+I MOMENT CAPACITY (IN-K) = 3.201 OPERATING LL+I MOMENT CAPACITY (IN-K) = 4.335

INVENTORY RATING (TONS) = 34.63

OPERATING RATING (TONS) = 45.89

July 1995

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## **CDOT BRIDGE RATING MANUAL**

#### July 1995

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# CDOT BRIDGE RATING MANUAL

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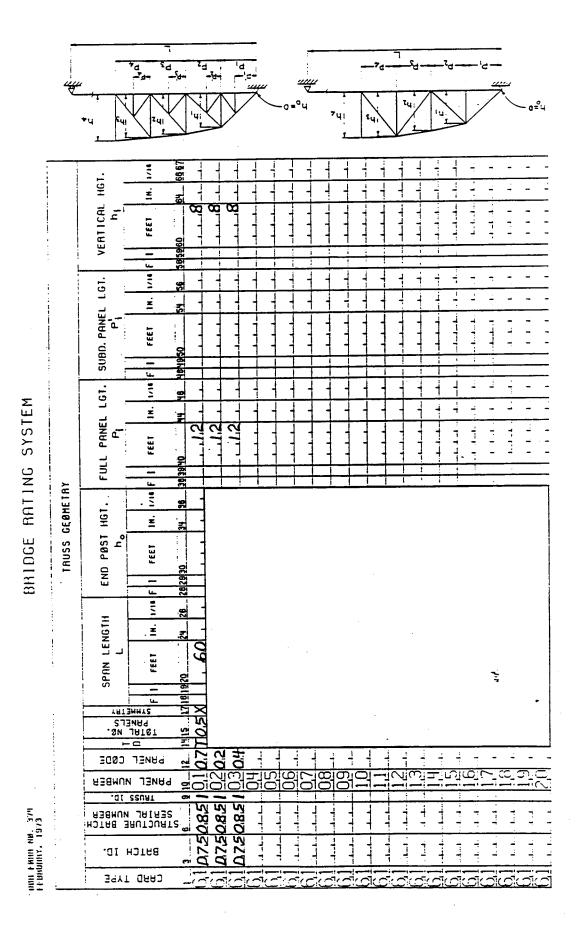
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# CDOT BRIDGE RATING MANUAL

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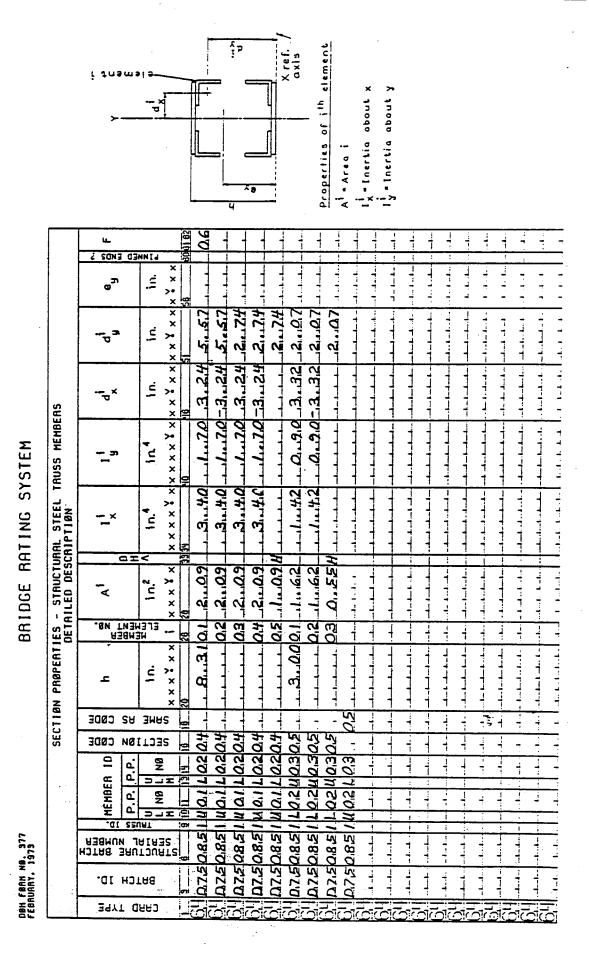


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# BRIDGE RATING SYSTEM

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# CDOT BRIDGE RATING MANUAL



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#### \* SECTION PROPERTIES-STRUCTURAL STEEL TRUSS MEMBERS DETAILED DESCRIPTION \* DY EY PINNED F TRUSS MEMBER SECTION SAME H I A D IX IY DX CODE AS Н I.D. I.D. ENDS 0.00 7.31 0.00 0.00 0.94 0.94 U 1-U 2 5300--64 1 0 1 0 0.00 0.00 0.00 0.00 0.00 0 4700--64 4800--64 U 1-L 1 U 1-L 1 1 2 1.78 2.20 3.36 4.95 0.00 1 1 3 0 0 0 3 4900--64 U 1-L 1 U 1-L 1 2.20 2.20 0.94 0.94 3.36 -3.36 1 1 3 0.00 3 4 5 6 1 1.78 2.36 0.00 0 0 0 0 0 0 0 0 0 0 5000--64 3 0.00 1.78 2.36 0.00

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1	L 0-L 1	2	0	10.00	1	5.86		78.50	2.80	4.86	5.00	0.00	0
1	L 0-L 1	2	0	0.00	2	5.86		78.50	2.80	-4.86	5.00	0.00	0
1	L 0-L 1	2	0	0.00	3	1.53	Н	0.00	0.00	0.00	5.00	0.00	0
1	L 1-L 2	0	2	0.00	0	0.00		0.00	0.00	0.00	0.00	0.00	0
1	L 2-U 3	5	0	3.00	1	1.62		1.42	0.90	3.32	2.07	0.00	0
1	L 2-U 3	5	0	0.00	2	1.62		1.42	0.90	-3.32	2.07	0.00	0
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10A.32

1		SUMMARY OF RATING CALCULATIONS INVENTORY AND/OR OPERATIN		2 BARS RELEAS	5.5
	INPUT CODING	STRUCTURE N-16-	L	D/P STR. I.I	D D75-085
+	DATE 8/ 7/95	INVENTORY	OPERATING	BY MARI	LEONARD
+		LIVE LOAD RATING	LIVE LOAD RATIN	IG	
+		HS20 HS 11.34	HS20 HS 21.	13	
0	YEAR OF CONSTR. 1920 LENGTH 61	LT COUNTY CONSTR. RTE. .83 FEET CONSTR. SEC. .00 FEET CONSTR. STA.	2 055 0+ . SH-69	MICROFILM REE DESIGN PL COMPUTATI CORRESPONI	ANS
0	ANALY	YST REMARKS			
		PROJECT NO. S-0038(10), ACTU TRUSSES AND MOST STRINGERS S ASSUME SALVAGED STEEL FABRIC STRINGER 1 INT. 112X31.8 (RE RATED WITH 6 INCHES ASPHALT OVER TURKEY CREEK NEAR FARIS	CALVAGED FROM BEAVER CATED 1920 FOR ALLW. CUSED), FLOOR BEAM F OVERLAY AND COLORAL	CREEK STRESSES 01 W30X108 (NEW)	
+ + 0	INVENTORY RATING SUMMARY		C	PPERATING RATING SUMMAN	RY
+	TRUSS ID. 1		I	RUSS ID.	1
+	CRITICAL MEMBER ID. L 2 1	L 3		CRITICAL MEMBER ID.	L 2 L 3
+	LIVE LOAD DESIGNATION HS20			LIVE LOAD DESIGNATION	1 HS20
0 +	AXIAL FO	RCE		AXI	AL FORCE
+	( K:	IPS)			(KIPS)
+	MEMBER CAPACITY 16	3.0		MEMBER CAPACITY	229.3
+	DL EFFECT 80	6.4		DL EFFECT	86.4
0 +	CAPACITY FOR (LL+I) 70	6.6		CAPACITY FOR (LL+I)	142.9
+	ACTUAL (LL+I) 13	5.2		ACTUAL (LL+I)	135.2
+	INVENTORY RATING HS 11	. 34		OPERATING RATING	HS 21.13

1	s	UMMARY OF RATING CALCULATIONS INVENTORY AND/OR OPERATI		BARS RELEASE 5.5
	INPUT CODING	STRUCTURE N-16	-L	D/P STR. I.D D75-085
+	DATE 8/ 7/95	INVENTORY	OPERATING	
	BY MARK LEONARD	LIVE LOAD RATING	LIVE LOAD RATING	
+		HS20 HS 20.59	HS20 HS 30.44	
0	STRUCTURE DESCRIPTION IDENTIFICATION N-16-L TYPE SLT YEAR OF CONSTR. 1920 LENGTH 61.83 FEE ROADWAY WIDTH 24.00 FEE NUMBER OF SPANS 1	LOCATION DISTRICT COUNTY CONSTR. RTE. T CONSTR. SEC. T CONSTR. STA. KEY RTE. MARKED RTE.	2 055 0+ . SH-69	MICROFILM REEL NUMBERS DESIGN PLANS COMPUTATIONS CORRESPONDENCE
0	ANALYST REM	IARKS PROJECT NO. S-0038(10), ACT TRUSSES AND MOST STRINGERS ASSUME SALVAGED STEEL FABRI STRINGER 1 INT. 112X31.8 (R RATED WITH 6 INCHES ASPHALT OVER TURKEY CREEK NEAR FARI	SALVAGED FROM BEAVER CREEK CATED 1920 FOR ALLW. STRES EUSED), FLOOR BEAM B01 W30 OVERLAY AND COLORADO TRUC	SES X108 (NEW)
+	INVENTORY RATING SUMMARY -		OPERAT	ING RATING SUMMARY
0 +	MEMBER ID. B 1		MEMBE	RID. B1
+	SPAN 1		1 SPA	Ν 1
++++	CRITICAL C.P. DIST. 11.8 FEET		CRITIC	AL C.P. DIST. 11.8 FEET
+	LIVE LOAD DESIGNATION HS20.		LIVE L	DAD DESIGNATION HS20
0	SHEAR			SHEAR
	(KIPS)			(KIPS)
+	MEMBER CAPACITY 448.0		MEMBER	CAPACITY 610.9
+	DL EFFECT 107.2		DL EFF	ECT 107.2
0 +	CAPACITY FOR (LL+I) 340.7		CAPACI	TY FOR (LL+I) 503.6
+	ACTUAL (LL+I) 330.9		ACTUAL	(LL+I) 330.9
0 +	INVENTORY RATING HS 20.59		OPERAT	ING RATING HS 30.44

1		SUMMARY OF RATING CALCULATIONS INVENTORY AND/OR OPERATING		BARS RELEASE	5.5
	INPUT CODING DATE 8/ 7/95	STRUCTURE N-16-1	L	D/P STR. I.D.	D75-085
+	BY MARK LEONARD	INVENTORY	OPERATING		
+	DI MARK BROWARD	LIVE LOAD RATING	LIVE LOAD RATING		
+		HS20 HS 23.71	HS20 HS 34.60		
0	STRUCTURE DESCRIPTION IDENTIFICATION N-16-L TYPE SLT YEAR OF CONSTR. 1920 LENGTH 61.83 ROADWAY WIDTH 24.00 NUMBER OF SPANS 1	COUNTY CONSTR. RTE.	2 055 0+ . SH-69	MICROFILM REEI DESIGN PLAT COMPUTATION CORRESPONDI	1S 1S
0	ANALYST	REMARKS			
		PROJECT NO. S-0038(10), ACTUU TRUSSES AND MOST STRINGERS SJ ASSUME SALVAGED STEEL FABRIC STRINGER 1 INT. I12X31.8 (REI RATED WITH 6 INCHES ASPHALT ( OVER TURKEY CREEK NEAR FARIS:	ALVAGED FROM BEAVER CRE ATED 1920 FOR ALLW. STF USED), FLOOR BEAM B01 W OVERLAY AND COLORADO TF	EK ESSES 30X108 (NEW)	
+ 0	INVENTORY RATING SUMMARY		OPER	ATING RATING SUMMAN	RY
+			MEME	ER ID.	S 1
	MEMBER ID. S 1				
+	MEMBER ID. S 1 SPAN 1		SPAN	T	1
+ +		ET		TICAL C.P. DIST.	
+ + +	SPAN 1	ET	CRII		6.0 FEET
	SPAN 1 CRITICAL C.P. DIST. 6.0 FEI		CRII	ICAL C.P. DIST.	6.0 FEET
+ 0	SPAN 1 CRITICAL C.P. DIST. 6.0 FEI LIVE LOAD DESIGNATION HS20		CRII	ICAL C.P. DIST.	6.0 FEET HS20
+ 0	SPAN 1 CRITICAL C.P. DIST. 6.0 FEN LIVE LOAD DESIGNATION HS20 SHEAR		CRII	ICAL C.P. DIST.	6.0 FEET HS20 SHEAR
+ 0	SPAN 1 CRITICAL C.P. DIST. 6.0 FEI LIVE LOAD DESIGNATION HS20 SHEAR (KIPS	)	CRI1 LIVE MEN	TICAL C.P. DIST.	6.0 FEET HS20 SHEAR (KIPS)
+ 0	SPAN 1 CRITICAL C.P. DIST. 6.0 FEN LIVE LOAD DESIGNATION HS20 SHEAR (KIPS MEMBER CAPACITY 48.	)	CRIT LIVE MEN DL	YICAL C.P. DIST. 2 LOAD DESIGNATION BEER CAPACITY	6.0 FEET HS20 SHEAR (KIPS) 67.5 5.5
+ 0 + + + +	SPAN 1 CRITICAL C.P. DIST. 6.0 FEI LIVE LOAD DESIGNATION HS20 SHEAR (KIPS MEMBER CAPACITY 48. DL EFFECT 5.5	)	CRIT LIVE MEN DL CAE	TICAL C.P. DIST. C LOAD DESIGNATION BER CAPACITY EFFECT	6.0 FEET HS20 SHEAR (KIPS) 67.5 5.5

1	INPUT CODING		RATING RESULTS FOR VENTORY AND/OR OPERATI STRUCTURE N-16		BARS RELEASE 5.5 D/P STR. ID D75-085
+		INVENTOR	ΥY	OPERATING	
+	DATE 8/ 7/95	LIVE LOAD	RATING	LIVE LOAD RATING	
+		HS20 HS	11.3	HS20 HS 21.1	
+	BY MARK LEONARI	)			
	STRUCTURE DESCRIPTION-		LOCATION		MICROFILM REEL NUMBERS
	IDENTIFICATION TYPE YEAR OF CONSTR. LENGTH ROADWAY WIDTH NUMBER OF SPANS	SLT 1920 61.83 FEET	DISTRICT COUNTY CONSTR. RTE. CONSTR. SEC. CONSTR. STA. KEY RTE. MARKED RTE.	2 055 0+ . SH-69	DESIGN PLANS COMPUTATIONS CORRESPONDENCE
		ANALYST REMARKS PROJECT NO. S-0038(10) TRUSSES AND MOST STRIN ASSUME SALVAGED STEEL STRINGER 1 INT. 112X31 RATED WITH 6 INCHES AS OVER TURKEY CREEK NEAR	GERS SALVAGED FROM BE FABRICATED 1920 FOR A 8 (REUSED), FLOOR BE SPHALT OVERLAY AND COI	EAVER CREEK ALLW. STRESSES EAM B01 W30X108 (NEW)	

+	INVENTORY RATING SUMMARY	ζ.	OPERATING RATING SUMMA	RY
+ +		L 2L 3 HS20	CRITICAL MEMBER ID LIVE LOAD DESIGNATION	
+	AXIA	- FORCE	AXIAL	FORCE
+		(KIPS)		(KIPS)
+	MEMBER CAPACITY	163.0	MEMBER CAPACITY	229.3
+	DL EFFECT	86.4	DL EFFECT	86.4
+	CAPACITY FOR (LL+I)	76.6	CAPACITY FOR (LL+I)	142.9
+	ACTUAL (LL+I)	135.2	ACTUAL (LL+I)	135.2
+	INVENTORY RATING HS	5 11.34	OPERATING RATING	HS 21.13

1

----- RATING -----

DETAIL TRUSS DATA

DATE 08/07	/95													D75-085
SPAN LENGT	H (FT.)	60.000						C-C T	RUSS = 0	.000 FT.	TRUSS I LL DIST			.155
		TRUSS GEO	METRY						DEAD LOAD					
		-I.FNGTH		H		1		U	PPER CHORD PPER CHORD ED TO PANE	= 0	.0 LBS/F1 .0 LBS/F1			
PANEL PAN NO. COE		LEFT SU	JBDIV.		TOTAL		LOWER CH	IORD		ER CHORD				
0 1 7	FT.	F1		FT. 0.000 8.000			FT. 0.000	KIPS 9.601	FT.	KII	?S		DL01	L00U01 U01U02
2 2		0 0.		8.000 8.000 8.000	0.00	0 :	12.000 24.000 36.000	19.200				L0	1L01 1L02 2L02	U01L02 L02L03
	12.00 12.00		.000	8.000 0.000	0.00 0.00		48.000 50.000	19.200 9.600					2U03 2U03	U02L03 U03L03
TRUCK LOAD	USED FOR													
INVENTC	RY HS20													
1					DET	ATI. TRII	SS MEMBEF	ПАТА						
DATE 08/07					221						TRUSS 1	.D.	1	D75-085 L00L01
EFFECT EFFEC	тн			GROSS SE IY				 AREA	NET SE IX	CTION IY		E(Y)	END	FACT.
LENX LEN FT. FT.		SQ.IN.	IN**4	IN**4	IN.	IN.	IN.	SQ.IN.	IN**4	IN**4	IN.	IN.	COND.	
12.000 12.00	0 10.00	11.72	157	282	5.00	3.66	4.91	10.19	156	282	5.00	0.00	R	0.8
**** MEMBER I	NFLUENCE	LINES												
LOAD ON LOWER CHORD	X-DIST Y-ORDI	(FT.) NATE	0.00	12.00 1.20	60.00				POS AREA NEG AREA	36.00 0.00				
LOAD ON UPPER CHORD	X-DIST Y-ORDI	(FT.)			60.00				POS AREA NEG AREA	36.00				
**** AL						AL FORCI	e on meme	ER DUE			/AILABLE	CAPACI	ry for	LL+IMPACT
P INVENTORY 1	SI 6000. 1	COMP PSI 2938. 5875.	TENS KIPS 163.0 229.3	151.6			TENS KIPS 57.6	COMP KIPS				TENS KIPS 105.4 171.7	COM KI 209 243	.2
OPERAIING 2	2500. 1	.5675.	229.3	100.1	-							1/1./	243	
***** LIVE LOA		TRU					LANE							
LIVE LOAD	KIPS	NIPS		LOC.NO. 1 WHEEL FT.	DIR	KIPS	LL KIPS		LOC CONC LOAD FT.		FACT.		ACITY	RATING VALUE
INV HS20 T				40.000	R	61.1 0.0	48.1 0.0		12.000 0.000		1.107	3	9.8	HS 22.1
OPER HS20 I C	95.3 0.0	75.0 0.0		40.000 0.000	R	61.1 0.0	48.1 0.0		12.000 0.000		1.802	2 6	4.9	HS 36.0
DATE 08/07	/95				DET.	AIL TRU	SS MEMBEF	DATA			D/P STF	UCTURE	т.р.	D75-085
											TRUSS I TRUSS M			L00U01
***** MEMBER P EFFECT EFFEC				GROSS SE					NET SE IX			E(Y)	END	FACT.
LENX LEN FT. FT.	Y						IN.		IN**4				COND.	
14.422 14.42	2 10.31	16.09	241	353	3.91	3.88	4.69	16.09	241	353	3.91	0.00	R	0.8
**** MEMBER I														
LOAD ON LOWER CHORD	X-DIST Y-ORDI	(FT.) NATE	0.00	12.00 -1.44	60.00 0.00				POS AREA NEG AREA					
	X-DIST	· (FT)	0 00	12 00	60 00				POS AREA NEG AREA					
**** AL						AL FORCI	e on meme	ER DUE			/AILABLE	CAPACI	ry for	LL+IMPACT
	ENS	COMP	TENS	COMP			TENS	COMP				TENS	COM	D
-	SI	DOT	VIDO	KIPS 207.2			KIPS	KIPS				KIPS		

\*\*\*\*\* LIVE LOAD AND RATING CALCULATIONS--IMPACT FACTOR = 0.270 (COMP.) = 0.000 (TENS.)

	LIVE LOAD	LL+IME KIPS	? LL KIPS		LOC.NO. 1 WHEEL FT.		LL+IMP KIPS	LL KIPS		LOC CONC LOAD FT.			CAP		RATING VALUE
INV OPER	HS20 T C HS20 T C	0.0 114.5 0.0 114.5	0.0 90.1 0.0 90.1		$0.000 \\ 40.000 \\ 0.000 \\ 40.000$	R	0.0 89.2 0.0 89.2	0.0 70.2 0.0 70.2		0.000 12.000 0.000 12.000		1.205		13.4 58.2	HS 24.1 HS 32.4
						DIR									
	TE 08/07/					DE1.	AIL IRUS	S MEMBER	DATA			D/P STR TRUSS I TRUSS M	.D.	1	D75-085 L01L02
	MEMBER PR I EFFECT				GROSS S	ECTION DY	 RX		 AREA	NET SE IX	CTION IY	DY	E(Y)	END	FACT.
	I LEVILCI X LENY FT.			IN**4	IN**4		IN.	IN.		IN**4	IN**4	IN.	IN.	COND.	
12.000	0 12.000	10.00	11.72	157	28	2 5.00	3.66	4.91	10.19	156	282	5.00	0.00	R	0.8
***** 1	MEMBER IN	FLUENCE	LINES												
LOAD ( LOWER (		X-DIST Y-ORDI	f (FT.) INATE	0.00	12.00 1.20	60.00 0.00				POS AREA NEG AREA	36.00 0.00				
LOAD ( UPPER (		X-DIST Y-ORDI	f (FT.) INATE	0.00	12.00 1.20	60.00				POS AREA NEG AREA	36.00				
* * * * *							AL FORCE	ON MEMB	BER DUE			AILABLE	CAPACI	TY FOR	LL+IMPACT
INVENTO		I 000. 1	COMP PSI L2938. L5875.	TENS KIPS 163.0 229.3		6		TENS KIPS 57.6	COMP KIPS				TENS KIPS 105.4 171.7	COM KIP 209 243	.2
***** ]	LIVE LOAD					FACTOR =									
	LIVE LOAD	LL+IME KIPS		JCK LOAD	LOC.NO. 1 WHEEL FT.	DIR	LL+IMP KIPS		LOAD	LOC CONC LOAD FT.			SAFE CAP	LOAD	RATING VALUE
INV	HS20 T C	95.3 0.0	75.0 0.0		40.000 0.000		61.1 0.0	48.1 0.0		12.000 0.000		1.107	3	89.8	HS 22.1
OPER 1	HS20 T C	95.3 0.0	75.0 0.0		40.000 0.000		61.1 0.0	48.1 0.0		12.000 0.000		1.802	6	54.9	HS 36.0
						DET.	AIL TRUS	S MEMBER	DATA						
DA	TE 08/07/	95				DET.	AIL TRUS	S MEMBER	DATA			D/P STR TRUSS I TRUSS M	.D.	1	D75-085 L02L03
**** P	MEMBER PR	OPERTIES				ECTION				NET SE		TRUSS I TRUSS M	.D. IEMBER	1 I.D.	L02L03
***** 1 EFFEC: LEN2	MEMBER PR I EFFECT X LENY	OPERTIES H	AREA	IX	IY	ECTION DY	RX	 RY	 AREA	IX	IY	TRUSS I TRUSS M  DY	.D. MEBER E(Y)	1	L02L03 FACT.
***** ) EFFEC LEN2 FT.	MEMBER PR I EFFECT X LENY	OPERTIES H IN.		IX	IY IN**4	ECTION DY IN.			 AREA			TRUSS I TRUSS M	.D. IEMBER	1 I.D. END	L02L03 FACT.
***** P EFFEC LEN2 FT. 12.000	MEMBER PR T EFFECT X LENY FT. 0 12.000	OPERTIES H IN. 10.00	AREA SQ.IN. 11.72	IX IN**4	IY IN**4	ECTION DY IN.	RX IN.	RY IN.	AREA SQ.IN.	IX IN**4	IY IN**4	TRUSS I TRUSS M DY IN.	.D. HEMBER E(Y) IN.	1 I.D. END COND.	L02L03
***** P EFFEC LEN2 FT. 12.000	MEMBER PR T EFFECT X LENY FT. 0 12.000 MEMBER IN ON	OPERTIES H IN. 10.00 FLUENCE	AREA SQ.IN. 11.72 LINES F (FT.)	IX IN**4 157 0.00	IY IN**4 28 24.00	ECTION DY IN.	RX IN.	RY IN.	AREA SQ.IN.	IX IN**4	IY IN**4	TRUSS I TRUSS M DY IN.	.D. HEMBER E(Y) IN.	1 I.D. END COND.	L02L03
***** ] EFFEC: LEN2 FT. 12.000 ***** ] LOAD ( LOWER ( LOAD (	MEMBER PR T EFFECT X LENY FT. 0 12.000 MEMBER IN CHORD CHORD	OPERTIES H IN. 10.00 FLUENCE X-DIST Y-ORDI X-DIST	AREA SQ.IN. 11.72 LINES C (FT.) INATE C (FT.)	IX IN**4 157 0.00 0.00 0.00	IY IN**4 28 24.00 1.80 24.00	ECTION DY IN. 2 5.00 60.00 0.00 60.00	RX IN.	RY IN.	AREA SQ.IN.	IX IN**4 156 POS AREA	IY IN**4 282 54.00 0.00 54.00	TRUSS I TRUSS M DY IN.	.D. HEMBER E(Y) IN.	1 I.D. END COND.	L02L03
***** P EFFEC: LEN2 FT. 12.000 ***** P LOAD ( LOAD ( UPPER ( *****	MEMBER PR T EFFECT X LENY FT. 0 12.000 MEMBER IN ON CHORD ON CHORD	OPERTIES H IN. 10.00 FLUENCE X-DIST Y-ORDI X-DIST Y-ORDI	AREA SQ.IN. 11.72 LINES F (FT.) INATE F (FT.) INATE	IX IN**4 157 0.00 0.00 0.00 0.00	IY IN**4 28 24.00 1.80 24.00 1.80	ECTION DY IN. 2 5.00 60.00 0.00 60.00 0.00	RX IN. 3.66	RY IN. 4.91	AREA SQ.IN. 10.19	IX IN**4 156 POS AREA NEG AREA NEG AREA	IY IN**4 282 54.00 0.00 54.00 0.00	TRUSS I TRUSS M DY IN. 5.00	E.D. EMBER E(Y) IN. 0.00	1 I.D. END COND. R	L02L03
***** P EFFEC: LEN2 FT. 12.000 ***** P LOAD ( LOAD ( UPPER ( *****  INVENT(	MEMBER PR I EFFECT X LENY FT. 0 12.000 MEMBER IN CHORD CHORD ALL FS	OPERTIES H IN. 10.00 FLUENCE X-DIST Y-ORDI X-DIST Y-ORDI OWABLE S I OWABLE S I 0000. 1	AREA SQ.IN. 11.72 LINES F (FT.) INATE F (FT.) INATE STRESS / COMP PSI COMP PSI L2938.	IX IN**4 157 0.00 0.00 0.00 0.00 MEMBER TENS KIPS 163.0	IY IN**4 28 24.00 1.80 24.00 1.80 CAPACIT COMP	ECTION DY IN. 2 5.00 60.00 0.00 60.00 0.00 Y / AXI. 6	RX IN. 3.66	RY IN. 4.91	AREA SQ.IN. 10.19 MER DUE COMP KIPS	IX IN**4 156 POS AREA NEG AREA POS AREA NEG AREA TO DEAD LO.	IY IN**4 282 54.00 0.00 54.00 0.00	TRUSS I TRUSS M DY IN. 5.00	E.D. EMBER E(Y) IN. 0.00 CAPACI TENS KIPS 76.6	1 I.D. END COND. R	L02L03 FACT. 0.8 : LL+IMPACT PS: .0
***** P EFFEC LEN2 FT. 12.000 ***** P LOAD ( LOAD ( UPPER ( *****  INVENT( OPERAT:	MEMBER PR T EFFECT X LENY FT. 0 12.000 MEMBER IN CHORD ON CHORD ON ALL PS ORY 166 ING 22	OPERTIES H IN. 10.00 FLUENCE X-DIST Y-ORDI X-DIST Y-ORDI OWABLE S NS I 0000. 1 5000. 1 AND RAT LL+IM	AREA SQ.IN. 11.72 LINES F (FT.) INATE F (FT.) INATE STRESS / COMP PSI L2938. L5875. FING CALCU	IX IN**4 157 0.00 0.00 0.00 MEMBER TENS KIPS 163.0 229.3 JLATIONS JCK LOAD	IY IN**4 28 24.00 1.80 24.00 1.80 CAPACIT 000 KIPS 151. 186. IMPACT IMPACT 1000000000000000000000000000000000000	ECTION DY IN. 2 5.00 60.00 0.00 9 / AXI. 6 1 FACTOR = DIR	RX IN. 3.66 AL FORCE 0.000 ( LL+IMP	RY IN. 4.91 TENS KIPS 86.4 COMP.) LANE LL	AREA SQ.IN. 10.19 EVER DUE COMP KIPS = 0.2700 : LOAD	IX IN**4 156 POS AREA NEG AREA POS AREA NEG AREA TO DEAD LO (TENS.) LOC CONC LOAD	IY IN**4 282 54.00 0.00 54.00 0.00 AD / AV	TRUSS I TRUSS M DY IN. 5.00 /AILABLE	LD. IEMBER E(Y) IN. 0.00 CAPACI TENS KIPS 76.6 142.9 SAFE SAFE CAP	1 I.D. END COND. R TY FOR COM KIP 238 272 238 272 238 272 238 272 238 272 238 272	L02L03 FACT. 0.8 : LL+IMPACT PS: .0
***** P EFFEC LEN2 FT. 12.000 ***** P LOAD ( LOAD ( UPPER ( *****  INVENT( OPERAT:	MEMBER PR T EFFECT X LENY FT. 0 12.000 MEMBER IN CHORD ON CHORD ALL TE PS ORY 16 ING 22 LIVE LOAD LIVE LOAD	OPERTIES H IN. 10.00 FLUENCE X-DIST Y-ORDI X-DIST Y-ORDI OWABLE S NS 000. 1 500. 1 LL LL+IME KIPS 135.2	AREA SQ.IN. 11.72 LINES F (FT.) INATE F (FT.) INATE STRESS / COMP PSI L2938. L5875. FING CALCU	IX IN**4 157 0.00 0.00 0.00 0.00 MEMBER TENS KIPS 163.0 229.3 JLATIONS JCK LOAD	IY IN**4 28 24.00 1.80 24.00 1.80 CAPACIT COMP KIPS 151. 186. IMPACT LOC.NO.	ECTION DY IN. 2 5.00 60.00 0.00 60.00 0.00 Y / AXI. 61 FACTOR = DIR L	RX IN. 3.66 AL FORCE 0.000 ( LL+IMP KIPS 91.6	RY IN. 4.91 ON MEME TENS 86.4 COMP.)	AREA SQ.IN. 10.19 WER DUE COMP KIPS = 0.2700 : LOAD	IX IN**4 156 POS AREA NEG AREA POS AREA NEG AREA TO DEAD LO	IY IN**4 282 54.00 0.00 54.00 0.00 AD / AV	TRUSS I TRUSS M DY IN. 5.00 /AILABLE RATING FACT.	D. IEMBER E(Y) IN. 0.00 CAPACI TENS KIPS 76.6 142.9 RAF SAFE CAP	1 I.D. END COND. R TTY FOR COM KIP 238 272 238 272 240 200 200 200 200 200 200 200 200 20	L02L03 FACT. 0.8 LL+IMPACT PS .0 .5 RATING
***** ]	MEMBER PR T EFFECT X LENY FT. 0 12.000 MEMBER IN ON CHORD ON ALL DN ALL PS ORY 16 ING 22 LIVE LOAD LIVE LOAD LIVE LOAD HS20 T C HS20 T	OPERTIES H IN. 10.00 FLUENCE X-DIST Y-ORDJ X-DIST Y-ORDJ OWABLE S I 0000. 1 500. 1 LL+IME KIPS 135.2 0.0 135.2	AREA SQ.IN. 11.72 LINES C (FT.) INATE C (FT.) INATE STRESS / COMP PSI 12938. L5875. FING CALCU C LL KIPS 106.5	IX IN**4 157 0.00 0.00 0.00 MEMBER TENS KIPS 163.0 229.3 JLATIONS JCK LOAD	IY IN**4 28 24.00 1.80 24.00 1.80 CAPACIT COMPACT 186. IMPACT LOC.NO. 1 WHEEL FT. 10.001	ECTION DY IN. 2 5.00 60.00 0.00 60.00 0.00 Y / AXI. 61 FACTOR = DIR L L	RX IN. 3.66 AL FORCE 0.000 ( LL+IMP KIPS 91.6 0.0 91.6	RY IN. 4.91 TENS KIPS 86.4 COMP.) LANE LL KIPS 72.1 0.0	AREA SQ.IN. 10.19 WER DUE COMP KIPS = 0.270 : LOAD	IX IN**4 156 POS AREA NEG AREA POS AREA NEG AREA TO DEAD LO. (TENS.) (COAD FT. 24.000	IY IN**4 282 54.00 0.00 54.00 0.00 AD / AV	TRUSS I TRUSS M DY IN. 5.00 /AILABLE RATING FACT.	LD. IEMBER E(Y) IN. 0.00 CAPACI TENS 76.6 142.9 RA SAFE CAP TC Y 2	1 I.D. END COND. R TY FOR COM KIP 238 272 XTING - : LOAD PACITY INS 20.4	L02L03 FACT. 0.8 LL+IMPACT P S .0 .5 RATING VALUE

				0	GROSS SECT	FION				NET S	ECTION				
EFFECT	EFFECT	H	AREA	IX	IY	DY	RX	RY	AREA	IX	IY	DY	E(Y)	END	FACT.
LENX	LENY													COND.	
FT.	FT.	IN.	SQ.IN.	IN**4	IN**4	IN.	IN.	IN.	SQ.IN.	IN**4	IN**4	IN.	IN.		
14.422	14.422	3.00	3.24	2	37	0.93	0.94	3.40	2.69	2	37	0.93	0.00	R	0.8

#### 10A.38

----- RATING -----

****	MEMBE	R INF	LUENCE	LINES												
LOAD LOWER			X-DIS Y-ORD	T (FT.) INATE	0.00		36.00 -0.72	60.00 0.00			POS AREA NEG AREA	10.82 10.82				
LOAD UPPER			X-DIS Y-ORD	T (FT.) INATE	0.00	24.00 0.72	36.00 -0.72	60.00 0.00			POS AREA NEG AREA	10.82 10.82				
*****		ALLO	WABLE	STRESS /	MEMBER	CAPACIT	Y / AX	IAL FORC	e on memb	ER DUE	TO DEAD LOAD	D / AV	AILABLE	CAPACITY	FOR	LL+IMPACT
		TEN PSI		COMP PSI	TENS KIPS	COME			TENS KIPS	COMP KIPS				TENS KIPS	COM KIP	
INVENT OPERAT		160 225		0. 0.	43.0 60.5	0. 0.				0.	0			43.0 60.5	0 0	
****					CK LOAD				LANE	LOAD				RATI		
	LIV LOA		LL+IM	P LL KIPS		LOC.NO. 1 WHEEI FT.			LL		LOC CONC LOAD FT.			G SAFE I . CAPAC TONS	ITY	
			KIP5	KIPS		F1.		KIPS	KIP5		FI.			TONS	•	
INV	HS2	0 T C	45.8 0.0			-4.000		36.0 0.0			24.000 0.000		0.94	) 33.	8	HS 18.8
OPER	HS2	D T C	45.8 0.0			-4.000		36.0 0.0			24.000		1.32	2 47.	6	HS 26.4
1																
מת	TE 08	/07/9	5				DE	TAIL TRU	SS MEMBER	DATA			יייפ ק/ח	RUCTURE 1	D	D75-085
DE	115 00	/0//9	5										TRUSS	I.D. 1 MEMBER I.		U01L01
			PERTIE				ECTION -				NET SEC					
	T EF X LE		H IN.	AREA SO.IN.	IX TN**4	IY IN**4		RX IN.	RY IN.	AREA		IY IN**4	DY IN.	E(Y) IN.	END COND.	FACT.
8.00			7.31	-	20		5 3.65		3.17	7.27	20	95	3.65	0.00	R	0.8
LOAD LOWER	ON	R INF	LUENCE X-DIS Y-ORD	T (FT.)	0.00	0.00	12.00 1.00	24.00	60.00 0.00		POS AREA NEG AREA	12.00				
LOAD UPPER			X-DIS Y-ORD	T (FT.)	0.00	60.00					POS AREA NEG AREA	0.00				
*****	CHORD						Y / AX	IAL FORC	e on memb	ER DUE	TO DEAD LOAD		AILABLE	CAPACITY	FOR	LL+IMPACT
		TEN		COMP	TENS	COME			TENS	COMP				TENS	COM	
INVENI OPERAI		PSI 160 225	00.	PSI 12500. 15375.	KIPS 116.3 163.6	KIPS 118. 145.	3		KIPS 19.2	KIPS				KIPS 97.1 144.4	KIP 137 164	.4
****	LIVE	LOAD		TING CALCU										RATI	NC	
	LIV LOA		LL+IM		CR DOAD	LOC.NO. 1 WHEEI	DIR		LL	LOAD	LOC CONC LOAD		RATIN	G SAFE I . CAPAC	OAD	RATING
		_	KIPS			FT.		KIPS	KIPS		FT.			TONS		
INV	HS2	C	44.8 0.0			-16.000		47.2 0.0			12.000 0.000		2.05	9 74.	1	HS 41.2
OPER 1	HS2	D T C	44.8 0.0	34.5 0.0		-16.000	L	47.2 0.0	36.3 0.0		12.000 0.000		3.06	0 110.	2	HS 61.2
							DE	TATI. TRII	SS MEMBER	рата						
	TE 08						22	11112 1110					TRUSS	RUCTURE I I.D. 1 MEMBER I.		
	MEMBE		PERTIE						 RY	AREA	NET SEC	TION	DY	E(Y)	END	FACT.
LEN	X LE	ИY		SQ.IN.							IN**4			IN.	COND.	111011
14.42	2 14	.422	8.31	8.36	30	ç	4 4.16	1.90	3.36	7.27	27	94	3.94	0.00	R	0.8
****	MEMBE	R INF	LUENCE	LINES												
				T (FT.)	0.00	12.00 -0.36	24.00 1.08	60.00 0.00			POS AREA NEG AREA	24.34 2.70				
LOAD UPPER	ON CHORD		X-DIS Y-ORD	T (FT.) INATE	0.00	12.00 -0.36	24.00 1.08	60.00 0.00			POS AREA NEG AREA					
*****								IAL FORC			TO DEAD LOAD	D / AV	AILABLE			
INVEN1 OPERA1	ORY ING	TEN PSI 160 225		PSI	TENS KIPS 116.3 163.6	COME KIPS 86. 106.	5		TENS KIPS 34.6	COMP KIPS				TENS KIPS 81.7 129.0		S .3

\*\*\*\*\* LIVE LOAD AND RATING CALCULATIONS--IMPACT FACTOR = 0.300 (COMP.) = 0.294 (TENS.)



LOAD KIPS KIPS	LOC.NO. DIR 1 WHEEL FT.	LL+IMP LL KIPS KIPS	LOC CONC LOAD FT.	RATING SAFE LOAD RATING FACT. CAPACITY VALUE TONS
INV HS20 T 80.4 62.2 C 16.2 12.4	52.000 R -16.000 L	60.9 47.1 15.6 12.0	24.000	1.016 36.6 HS 20.3
OPER HS20 T 80.4 62.2 C 16.2 12.4	52.000 R -16.000 L	60.9 47.1 15.6 12.0	24.000 12.000	1.603 57.7 HS 32.1
DATE 08/07/95	וס	TAIL TRUSS MEMBER DA	TA	D/P STRUCTURE I.D. D75-085 TRUSS I.D. 1 TRUSS MEMBER I.D. U01U02
***** MEMBER PROPERTIES	GROSS SECTION ·		NET SECTION	
EFFECT EFFECT H AREA LENX LENY FT. FT. IN. SO.IN.		RX RY ARI	EA IX IY .IN. IN**4 IN**4	DY E(Y) END FACT. COND. IN. IN.
12.000 12.000 10.31 16.09	241 353 3.92	3.88 4.69 16	.09 241 353	3.91 0.00 R 0.8
***** MEMBER INFLUENCE LINES				
LOAD ON X-DIST (FT.) LOWER CHORD Y-ORDINATE	0.00 24.00 60.00 0.00 -1.80 0.00		POS AREA 0.00 NEG AREA 54.00	
LOAD ON X-DIST (FT.) UPPER CHORD Y-ORDINATE	0.00 24.00 60.00 0.00 -1.80 0.00		POS AREA 0.00 NEG AREA 54.00	
***** ALLOWABLE STRESS /	MEMBER CAPACITY / A	IIAL FORCE ON MEMBER I	DUE TO DEAD LOAD / AV	AILABLE CAPACITY FOR LL+IMPACT
TENS         COMP           PSI         PSI           INVENTORY         16000.         13000.           OPERATING         22500.         15938.	TENS         COMP           KIPS         KIPS           257.4         209.2           362.0         256.4		COMP KIPS 86.4	TENS         COMP           KIPS         KIPS           343.8         122.8           448.4         170.0
***** LIVE LOAD AND RATING CALCU	ILATIONSIMPACT FACTOR			RATING
LIVE LL+IMP LL LOAD KIPS KIPS	LOC.NO. DIR 1 WHEEL FT.	LL+IMP LL KIPS KIPS	LOC CONC LOAD FT.	RATING SAFE LOAD RATING FACT. CAPACITY VALUE TONS
INV HS20 T 0.0 0.0 C 135.2 106.5	0.000 ` 10.001 L	0.0 0.0 91.6 72.1	0.000 24.000	0.908 32.7 HS 18.2
OPER HS20 T 0.0 0.0 C 135.2 106.5	0.000 ` 10.001 L	0.0 0.0 91.6 72.1	0.000 24.000	1.257 45.3 HS 25.1
1				
DATE 08/07/95	ום	TAIL TRUSS MEMBER DA	TA	D/P STRUCTURE I.D. D75-085 TRUSS I.D. 1 TRUSS MEMBER I.D. U02L02
	GROSS SECTION		NET SECTION	
	IX IY DY	RX RY ARI	NET SECTION EA IX IY .IN. IN**4 IN**4	DY E(Y) END FACT. COND. IN. IN.
EFFECT EFFECT H AREA LENX LENY	IX IY DY	RX RY ARI IN. IN. SQ	EA IX IY	DY E(Y) END FACT. COND.
EFFECT EFFECT H AREA LENX LENY FT. FT. IN. SQ.IN.	IX IY DY IN**4 IN**4 IN.	RX RY ARI IN. IN. SQ	EA IX IY .IN. IN**4 IN**4	DY E(Y) END FACT. COND. IN. IN.
EFFECT EFFECT H AREA LENX LENY FT. FT. IN. SQ.IN. 8.000 8.000 7.31 9.46	IX IY DY IN**4 IN**4 IN.	RX RY ARI IN. IN. SQ 1.48 3.17 7	EA IX IY .IN. IN**4 IN**4	DY E(Y) END FACT. COND. IN. IN.
EFFECT EFFECT H AREA LENX LENY FT. FT. IN. SQ.IN. 8.000 8.000 7.31 9.46 ***** MEMBER INFLUENCE LINES LOAD ON X-DIST (FT.)	IX IY DY IN**4 IN**4 IN. 20 95 3.69 0.00 24.00 36.00 0.00 0.40 -0.40	RX RY ARI IN. IN. SQ 1.48 3.17 7 60.00 0.00 60.00	EA IX IY .IN. IN**4 IN**4 .27 20 95 POS AREA 6.00	DY E(Y) END FACT. COND. IN. IN.
EFFECT EFFECT H AREA LENX LENY FT. FT. IN. SQ.IN. 8.000 8.000 7.31 9.46 ***** MEMBER INFLUENCE LINES LOAD ON X-DIST (FT.) LOWER CHORD Y-ORDINATE LOAD ON X-DIST (FT.) UPPER CHORD Y-ORDINATE	IX IY DY IN**4 IN**4 IN. 20 95 3.69 0.00 24.00 36.00 0.00 0.40 -0.40 0.00 12.00 24.00 0.00 0.20 -0.60	RX RY ARI IN. IN. SQ 1.48 3.17 7 60.00 0.00 60.00 0.00	EA IX IY .IN. IN**4 IN**4 .27 20 95 POS AREA 6.00 NEG AREA 6.00 POS AREA 1.50 NEG AREA 13.50	DY E(Y) END FACT. COND. IN. IN.
EFFECT EFFECT H AREA LENX LENY FT. FT. IN. SQ.IN. 8.000 8.000 7.31 9.46 ***** MEMBER INFLUENCE LINES LOAD ON X-DIST (FT.) LOWER CHORD Y-ORDINATE LOAD ON X-DIST (FT.) UPPER CHORD Y-ORDINATE ***** ALLOWABLE STRESS / 	IX IY DY IN**4 IN**4 IN. 20 95 3.69 0.00 24.00 36.00 0.00 0.40 -0.40 0.00 12.00 24.00 0.00 0.20 -0.60	RX         RY         ARI           IN.         IN.         SQ           1.48         3.17         7           60.00         0.00           60.00         0.00           61.48         0.00           61.48         0.00           61.48         0.00           61.48         0.00           61.48         0.00           61.48         0.00           61.48         0.00           61.48         0.00           61.48         0.00           61.48         0.00           61.48         0.00           61.48         0.00           61.48         0.00           61.48         0.00           61.49         0.00           61.41         0.00           61.41         0.00           61.41         0.00           61.41         0.00           61.41         0.00           61.41         0.00           61.42         0.00	EA IX IY .IN. IN**4 IN**4 .27 20 95 POS AREA 6.00 NEG AREA 6.00 POS AREA 1.50 NEG AREA 13.50	DY E(Y) END FACT. COND. IN. IN. 3.65 0.00 R 0.8
EFFECT EFFECT H AREA LENX LENY FT. FT. IN. SQ.IN. 8.000 8.000 7.31 9.46 ***** MEMBER INFLUENCE LINES LOAD ON X-DIST (FT.) LOWER CHORD Y-ORDINATE LOAD ON X-DIST (FT.) UPPER CHORD Y-ORDINATE ***** ALLOWABLE STRESS / TENS COMP PSI PSI INVENTORY 16000. 12500. OPERATING 22500. 15375. ***** LIVE LOAD AND RATING CALCU	IX IY DY IN**4 IN**4 IN. 20 95 3.69 0.00 24.00 36.00 0.00 0.40 -0.40 0.00 12.00 24.00 0.00 0.20 -0.60 MEMBER CAPACITY / AN TENS COMP KIPS KIPS 116.3 118.3 163.6 145.4	RX RY ARI IN. IN. SQ 1.48 3.17 7 60.00 0.00 60.00 60.00 COMP.) = 0	EA IX IY .IN. IN**4 IN**4 .27 20 95 POS AREA 6.00 NEG AREA 6.00 POS AREA 1.50 NEG AREA 13.50 DUE TO DEAD LOAD / AVI COMP KIPS 0.0	DY E(Y) END FACT. COND. IN. IN. 3.65 0.00 R 0.8 ALLABLE CAPACITY FOR LL+IMPACT TENS COMP KIPS KIPS 116.3 118.3 163.6 145.4
EFFECT EFFECT H AREA LENX LENY FT. FT. IN. SQ.IN. 8.000 8.000 7.31 9.46 ***** MEMBER INFLUENCE LINES LOAD ON X-DIST (FT.) LOWER CHORD Y-ORDINATE LOAD ON X-DIST (FT.) UPPER CHORD Y-ORDINATE ***** ALLOWABLE STRESS / TENS COMP PSI PSI INVENTORY 16000. 12500. OPERATING 22500. 15375. ***** LIVE LOAD AND RATING CALCU	IX IY DY IN**4 IN**4 IN. 20 95 3.69 0.00 24.00 36.00 0.00 0.40 -0.40 0.00 12.00 24.00 0.00 0.20 -0.60 MEMBER CAPACITY / AU TENS COMP KIPS KIPS I16.3 118.3 163.6 145.4	RX RY ARI IN. IN. SQ 1.48 3.17 7 60.00 0.00 60.00 CON MEMBER I TENS ( KIPS I = 0.300 (COMP.) = 0 LANE LO	EA IX IY .IN. IN**4 IN**4 .27 20 95 POS AREA 6.00 NEG AREA 6.00 POS AREA 1.50 NEG AREA 13.50 DUE TO DEAD LOAD / AVI COMP KIPS 0.0	DY E(Y) END FACT. COND. IN. IN. 3.65 0.00 R 0.8 ALLABLE CAPACITY FOR LL+IMPACT TENS COMP KIPS KIPS 116.3 118.3
EFFECT EFFECT H AREA LENX LENY FT. FT. IN. SQ.IN. 8.000 8.000 7.31 9.46 ***** MEMBER INFLUENCE LINES LOAD ON X-DIST (FT.) LOWER CHORD Y-ORDINATE LOAD ON X-DIST (FT.) UPPER CHORD Y-ORDINATE ***** ALLOWABLE STRESS / TENS COMP PSI PSI INVENTORY 16000. 12500. OPERATING 22500. 15375. ***** LIVE LOAD AND RATING CALCU LIVE LL+IMP LL LOAD	IX IY DY IN**4 IN**4 IN. 20 95 3.69 0.00 24.00 36.00 0.00 0.40 -0.40 0.00 12.00 24.00 0.00 0.20 -0.60 MEMBER CAPACITY / AN TENS COMP KIPS KIPS 116.3 118.3 163.6 145.4 HATIONSIMPACT FACTOR ICK LOAD	RX RY ARI IN. IN. SQ 1.48 3.17 7 60.00 0.00 60.00 60.00 0.00 1IAL FORCE ON MEMBER I TENS ( KIPS I = 0.300 (COMP.) = 0 LANE LOI	EA IX IY .IN. IN**4 IN**4 .27 20 95 POS AREA 6.00 NEG AREA 6.00 POS AREA 1.50 NEG AREA 13.50 DUE TO DEAD LOAD / AV. COMP KIPS 0.0 .000 (TENS.) AD	DY E(Y) END FACT. COND. IN. IN. 3.65 0.00 R 0.8 AILABLE CAPACITY FOR LL+IMPACT TENS COMP KIPS KIPS 116.3 118.3 163.6 145.4
EFFECT EFFECT H AREA LENX LENY FT. FT. IN. SQ.IN. 8.000 8.000 7.31 9.46 ****** MEMBER INFLUENCE LINES LOAD ON X-DIST (FT.) LOWER CHORD Y-ORDINATE LOAD ON X-DIST (FT.) UPPER CHORD Y-ORDINATE ****** ALLOWABLE STRESS / TENS COMP PSI PSI INVENTORY 16000. 12500. OPERATING 22500. 15375. ****** LIVE LOAD AND RATING CALCU LIVE LL+IMP LL LOAD KIPS KIPS INV HS20 T 25.4 19.5	IX IY DY IN**4 IN**4 IN. 20 95 3.69 0.00 24.00 36.00 0.00 0.40 -0.40 0.00 12.00 24.00 0.00 0.20 -0.60 MEMBER CAPACITY / AN TENS COMP KIPS KIPS 116.3 118.3 163.6 145.4 HATIONSIMPACT FACTOR ICK LOAD LOC.NO. DIR 1 WHEEL FT. -4.000 L	RX RY ARI IN. IN. SQ 1.48 3.17 7 60.00 0.00 60.00 60.00 CIAL FORCE ON MEMBER I TENS (0 KIPS I LL+IMP LL KIPS KIPS 19.9 15.3	EA IX IY .IN. IN**4 IN**4 .27 20 95 POS AREA 6.00 POS AREA 6.00 POS AREA 1.50 NEG AREA 13.50 DUE TO DEAD LOAD / AV. COMP KIPS 0.0 .000 (TENS.) AD LOAD FT. 24.000	DY E(Y) END FACT. COND. IN. IN. 3.65 0.00 R 0.8 ALLABLE CAPACITY FOR LL+IMPACT TENS COMP KIPS KIPS 116.3 118.3 163.6 145.4  RATING SAFE LOAD RATING FACT. CAPACITY VALUE TONS
EFFECT EFFECT H AREA LENX LENY FT. FT. IN. SQ.IN. 8.000 8.000 7.31 9.46 ****** MEMBER INFLUENCE LINES LOAD ON X-DIST (FT.) LOWER CHORD Y-ORDINATE LOAD ON X-DIST (FT.) UPPER CHORD Y-ORDINATE ****** ALLOWABLE STRESS / TENS COMP PSI PSI INVENTORY 16000. 12500. OPERATING 22500. 15375. ****** LIVE LOAD AND RATING CALCU LIVE LL+IMP LL LOAD KIPS KIPS INV HS20 T 25.4 19.5 C 25.4 19.5	IX IY DY IN**4 IN**4 IN. 20 95 3.69 0.00 24.00 36.00 0.00 0.40 -0.40 0.00 12.00 24.00 0.00 0.20 -0.60 MEMBER CAPACITY / AN TENS COMP KIPS KIPS 116.3 118.3 163.6 145.4 HATIONSIMPACT FACTOR ICK LOAD LOC.NO. DIR 1 WHEEL FT. -4.000 L 64.000 R -4.000 L	RX RY ARI IN. IN. SQ 1.48 3.17 7 60.00 0.00 60.00 CIAL FORCE ON MEMBER I TENS ( KIPS I LL+IMP LL KIPS KIPS 19.9 15.3 19.9 15.3 19.9 15.3	EA IX IY .IN. IN**4 IN**4 .27 20 95 POS AREA 6.00 POS AREA 6.00 POS AREA 1.50 NEG AREA 1.50 NEG AREA 1.50 DUE TO DEAD LOAD / AV. COMP KIPS 0.0 .000 (TENS.) AD LOC CONC LOAD FT. 24.000 36.000 24.000	DY E(Y) END FACT. COND. IN. IN. 3.65 0.00 R 0.8 ALLABLE CAPACITY FOR LL+IMPACT TENS COMP KIPS KIPS 116.3 118.3 163.6 145.4 RATING SAFE LOAD RATING FACT. CAPACITY VALUE TONS 4.581 164.9 HS 91.6
EFFECT EFFECT H AREA LENX LENY FT. FT. IN. SQ.IN. 8.000 8.000 7.31 9.46 ***** MEMBER INFLUENCE LINES LOAD ON X-DIST (FT.) LOWER CHORD Y-ORDINATE LOAD ON X-DIST (FT.) UPPER CHORD Y-ORDINATE ***** ALLOWABLE STRESS / TENS COMP PSI PSI INVENTORY 16000. 12500. OPERATING 22500. 15375. ***** LIVE LOAD AND RATING CALCU LIVE LL+IMP LL LOAD KIPS KIPS INV HS20 T 25.4 19.5 C 25.4 19.5 C 25.4 19.5	IX IY DY IN**4 IN*4 IN. 20 95 3.69 0.00 24.00 36.00 0.00 0.40 -0.40 0.00 12.00 24.00 0.00 0.20 -0.60 MEMBER CAPACITY / AU TENS COMP KIPS KIPS 116.3 118.3 163.6 145.4 ULATIONSIMPACT FACTOR ICK LOAD L CC.NO. DIR 1 WHEEL FT. -4.000 L 64.000 R -4.000 L 64.000 R	RX RY ARI IN. IN. SQ 1.48 3.17 7 60.00 0.00 60.00 CIAL FORCE ON MEMBER I TENS ( KIPS I LL+IMP LL KIPS KIPS 19.9 15.3 19.9 15.3 19.9 15.3	EA IX IY .IN. IN**4 IN**4 .27 20 95 POS AREA 6.00 NEG AREA 6.00 POS AREA 1.50 NEG AREA 13.50 DUE TO DEAD LOAD / AVI COMP KIPS 0.0 .000 (TENS.) AD	DY E(Y) END FACT. COND. IN. IN. 3.65 0.00 R 0.8 ALLABLE CAPACITY FOR LL+IMPACT TENS COMP KIPS KIPS 116.3 118.3 163.6 145.4 RATING SAFE LOAD RATING FACT. CAPACITY VALUE TONS 4.581 164.9 HS 91.6
EFFECT EFFECT H AREA LENX LENY FT. FT. IN. SQ.IN. 8.000 8.000 7.31 9.46 ***** MEMBER INFLUENCE LINES LOAD ON X-DIST (FT.) LOWER CHORD Y-ORDINATE LOAD ON X-DIST (FT.) UPPER CHORD Y-ORDINATE ***** ALLOWABLE STRESS / TENS COMP PSI PSI INVENTORY 16000. 12500. OPERATING 22500. 15375. ***** LIVE LOAD AND RATING CALCU LIVE LL+IMP LL LOAD KIPS KIPS INV HS20 T 25.4 19.5 C 25.4 19.5 OPER HS20 T 25.4 19.5 C 25.4 19.5 1 DATE 08/07/95 ***** MEMBER PROPERTIES	IX IY DY IN**4 IN*4 IN. 20 95 3.69 0.00 24.00 36.00 0.00 0.40 -0.40 0.00 12.00 24.00 0.00 0.20 -0.60 MEMBER CAPACITY / AU TENS COMP KIPS KIPS 116.3 118.3 163.6 145.4 ULATIONSIMPACT FACTOR ICK LOAD L CC.NO. DIR 1 WHEEL FT. -4.000 L 64.000 R -4.000 L 64.000 R	RX       RY       ARI         IN.       IN.       SQ         1.48       3.17       7         60.00       0.00         60.00       0.00         GO       IN.         FILL       TENS         IN.       TENS         IN.       SUPPO         I	EA IX IY .IN. IN**4 IN**4 .27 20 95 POS AREA 6.00 NEG AREA 6.00 POS AREA 1.50 NEG AREA 13.50 DUE TO DEAD LOAD / AVI COMP KIPS 0.0 .000 (TENS.) AD	DY E(Y) END FACT. COND. IN. IN. 3.65 0.00 R 0.8 ALLABLE CAPACITY FOR LL+IMPACT TENS COMP KIPS KIPS 116.3 118.3 163.6 145.4 

#### 10A.40

*****		INFLUENC	CE LINES	0.00	24.00	36.00	60.00			POS AREA	10.82				
LOWER	CHORD	Y-OF	RDINATE	0.00	-0.72	0.72	0.00			NEG AREA	10.82				
LOAD UPPER	CHORD	Y-OF	IST (FT.) RDINATE E STRESS /	0.00 0.00		36.00 0.72	0.00	ON MEMB	, मात जन्म	POS AREA NEG AREA	10.82 10.82	ATT.ABT.F	CADACT	דע דַרַק	T.T.+ TN
		TENS	COMP	TENS	COMP	1 / 14	Ind Foner	TENS	COMP				TENS	COM	
INVENT OPERAT		PSI 16000. 22500.	PSI 0. 0.	KIPS 43.0 60.5	KIPS 0.	0		KIPS	KIPS 0.				KIPS 43.0 60.5	KIP 0	S
****	LIVE L		RATING CALC												
	LIVE LOAD	LL+I		UCK LOAD	LOC.NO. 1 WHEEL FT.	DIR	LL+IMP KIPS	LL KIPS	: LOAD	LOC CONC LOAD FT.		RATING FACT.		LOAD ACITY	RATIN
INV	HS20	т 45. С 0.			64.000 0.000		36.0 0.0	27.7 0.0		36.000 0.000		0.940	3	3.8	HS 18
OPER	HS20	т 45. С 0.			64.000 0.000		36.0 0.0	27.7 0.0		36.000 0.000		1.322	4'	7.6	HS 26
L															
DA	TE 08/	07/95				DE	TAIL TRUS	S MEMBER	DATA			D/P STR TRUSS I	.D.	1	
****	MEMBER	PROPERTI			00000 0					NET SE		TRUSS M	IEMBER :	I.D.	U02U0
	T EFF X LEN F	Y	AREA	IX IN**4	IY IN**4	DY	RX IN.	RY IN.	AREA	NEI SE IX IN**4		DY TN.	E(Y) IN.	END COND.	FACI
		000 10.3		241			3.88	4.69	16.09	241	353	3.91	0.00	R	0.8
****	MEMBER	INFLUENC	CE LINES												
LOAD LOWER			IST (FT.) RDINATE		36.00 -1.80	60.00 0.00				POS AREA NEG AREA	0.00 54.00				
LOAD UPPER			IST (FT.) RDINATE	0.00	36.00 -1.80	60.00 0.00				POS AREA NEG AREA	0.00 54.00				
****	i	ALLOWABLE	STRESS /	MEMBER	CAPACIT	Y / AX	IAL FORCE	ON MEME	ER DUE	TO DEAD LC	AD / AV	AILABLE	CAPACI	FY FOR	LL+IN
INVENT OPERAT		TENS PSI 16000. 22500.	COMP PSI 13000. 15938.	TENS KIPS 257.4 362.0		2		TENS KIPS	COMP KIPS 86.				TENS KIPS 343.8 448.4	COM KIP 122 170	S .8
****	LIVE L	DAD AND R	ATING CALC	ULATIONS	TMPACT	FACTOR	= 0.270 (	COMP.)	= 0.000	(TENS.)					
	LIVE LOAD	 LL+1	IMP LL		LOC.NO. 1 WHEEL		LL+IMP	LL		LOC CONC LOAD				LOAD ACITY	
INV	HS20	КІР Т 0. С 134.	0.0		FT. 0.000 50.560		KIPS 0.0 91.6	KIPS 0.0 72.1		FT. 0.000 36.000		0.915	TOI	2.9	HS 18
OPER	HS20		0.0		0.000		0.0 91.6	0.0 72.1		0.000		1.267	4	5.6	HS 25
L															
	TE 08/	07/95				DE	TAIL TRUS	S MEMBER	DATA			D/P STR TRUSS I			D75-0
****	MEMBER	PROPERTI	IES									TRUSS M			U03L0
	T EFF			IX	GROSS SI IY		RX	RY	AREA	NET SE IX	CTION IY	DY	E(Y)	END COND.	FACT
FT. 8.00	F			IN**4 20	IN**4 9		IN. 1.48	IN. 3.17	SQ.IN. 7.27	IN**4 20	IN**4 95	IN. 3.65	IN. 0.00	R	0.8
****	MEMBER	INFLUENC	CE LINES												
LOAD		X-DI	IST (FT.) RDINATE		24.00 -0.40	36.00 0.40	60.00 0.00			POS AREA NEG AREA	6.00 6.00				
LOWER			IST (FT.) RDINATE		36.00 -0.60	48.00 0.20	60.00 0.00			POS AREA NEG AREA	1.50 13.50				
LOWER LOAD UPPER	CHORD														
LOAD			STRESS /	MEMBER	CAPACIT	Y / AX	IAL FORCE	ON MEME	ER DUE	TO DEAD LC	AD / AV	AILABLE	CAPACI	FY FOR	LL+IN

* * * * *	LIVE LOAD			IONSIMPACT FACTO LOAD					RATING
	LIVE LOAD	LL+IMP	LL	LOC.NO. DIR 1 WHEEL	LL+IMP	LL	LOC CONC LOAD		AFE LOAD RATING CAPACITY VALUE
		KIPS	KIPS	FT.	KIPS	KIPS	FT.		TONS
INV	HS20 T C	25.4 25.4	19.5 19.5	64.000 R -4.000 L	19.9 19.9	15.3 15.3	36.000 24.000	4.579	164.9 HS 91.6
OPER	HS20 T C	25.4 25.4		64.000 R -4.000 L	19.9 19.9	15.3 15.3	36.000 24.000	6.440	231.8 HS128.8
1				DE	TAIL DATA FOR	FLEXURAL M	EMBER		
	TE 08/07/ NO. SPANS T SYMMETR	= 1						MEMBER I.D. MATERIAL-	
			VA COD S	E DL DUE TO	LENGTH	DISTRIBUTED			CONCENTRATED DL(S)
SPAN L	ENGTH RNG	. LENGTH	SEC.NO. T	T W(LT) W(RT)	SPAN W(	LT) W(RT)	* *		r P *
NO. 1 2	FT. NO. 5.000 1			B LBS/FT LBS/FT 108.1 108.1	NO. LBS	/FT LBS/FT	FT. FT.	NO. 1 1 1	KIPS FT. 2.3 0.875 3.3 3.458 3.3 6.042
								1 1 1	3.3 8.625 3.3 11.208 3.3 13.792
								1 1 1	3.3 16.375 3.3 18.958 3.3 21.542 2.3 24.125
CHECK P	OINTS RAT	ED			SPAN DIS FR NO. LT SPR FT.		SPAN DIS FRM FU NO. LT SPRT M FT.	UNC	2.3 21.123
					1 0.00 1 11.75 1 25.00	0 X 0			

10A.42

1 DETAIL DATA FOR FLEXURAL MEMBER D/P STRUCTURE I.D. D75-085 MEMBER I.D.--S01 MATERIAL--SS DATE 08/07/95 NO. SPANS = 1 LL DIST FACT = 0.574NOT SYMMETRICAL SUPERIMPOSED CONCENTRATED DL(S) DIST. FROM LT SUPPORT\*\*\*\* SUPERIMPOSED DISTRIBUTED DL(S) LENGTH DISTRIBUTED\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* VAR DL DUE TO CODE MEM. WEIGHT W(LT) W(R DIST. FROM LT SUPPORT\*\*\* PAN W(LT) W(RT) \* S SPAN LENGTH RNG. LENGTH SEC.NO. T T \* \* W(RT) SPAN SPAN FT. NO. FT. 12.000 1 12.000 LT RT 01 01 РB LBS/FT LBS/FT NO. LBS/FT 1 276.0 LBS/FT 276.0 FT. FТ NO. KIPS FT. 31.5 31.5 0.000 12.000 CHECK POINTS RATED --SPAN DIS FRM FUNC SPAN DIS FRM FUNC NO. LT SPRT M VL VR FT. NO. LT SPRT M VL VR FT. 0.000 1 Х Х 1 6.000 1 12.000 Х 1 DETAIL DATA AT MOMENT CHECK POINT FOR STRUCTURAL STEEL FLEXURAL MEMBER BARS RELEASE 5.5 DATE 08/07/95 D/P STRUCTURE I.D. D75-085 MEMBER I.D.--B01 C.P. LOCATION 1.47 \*\*\*\*\* SECTION PROPERTIES IN RANGE 1 OF SPAN 1 \_\_\_\_\_\_ APEA-------SECTION MODULUS------NET AREA---GROSS С BOTTOM IX IX TOP TOP BOTTOM BEND - BEND Н BEND + BEND - BEND (BOT) + BEND AREA + BEND - BEND SQ.IN. 31.77 SQ.IN. 31.77 SQ.IN. 31.77 IN. 14.91 IN\*\*3 299.2 TN\*\*4 TN\*\*4 IN\*\*3 IN\*\*3 TN\*\*3 TN 0.00 4461.0 4461.0 299.2 299.2 299.2 \*\*\*\*\* INFLUENCE LINE (SIMPLE SPAN) \*\*\*\*\* ALLOWABLE \*\*\*\*\* MOMENT CAPACITY STRESS TOP TOP TOP BEND - BEND BOTTOM BOTTOM X-DIST (FT.) 0 000 11 750 25.000 POS AREA = + BEND BEND 1.000 PSI FT-KIPS FT-KIPS FT-KIPS FT-KIPS Y-ORDINATE 0.000 0.000 448.0 INVENTORY 17966.8 448.0 448.0 448.0 \*\*\*\*\* ORDINATES OF AND AREAS UNDER INFLUENCE LINE (CONTINUOUS SPAN) 610.9 0.0 0.0 OPERATING 24500.3 610.9 610.9 610.9 POST VEH1 POST VEH2 0.0 0.0 SPAN SPAN SPAN 0.0 0.0 SPAN SPAN SPAN т 0 0.0 0.0 E N T 1 DOST VEH3 0.0 0.0 0.0 0.0 0.0 2 POST SPEC 0.0 0.0 0.0 0.0 0.0 3 \*\*\*\* \* TOTAL DL MOMENT EFFECT Η 4 \* \* \* \* \* AVAIL.CAPAC.FOR LL+IMPACT 5 TOP TOP BOT BOT P 6 +BEND -BEND +BEND BEND 0 7 FT-KIPS F-KPS F-KPS F-KPS F-KPS I 8 107.2 TNVENTORY 340.7 555 2 340.7 555.2 N 9 OPERATING 503.6 718.1 503.6 718.1 т 0 VEH. 1 0.0 AREA 0.0 0.0 0.0 TOTALS VEH. 2 0.0 0.0 0.0 0.0 POS AREA 0.0 0.0 VEH. 3 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 NEG AREA 0.0 0.0 0.0 0.0 0.0 0.0 0.0 SPECIAL 0.0 0.0 0.0 0.0 \*\*\*\*\* Live load and rating calculations (impact factor = 0.300 for +bend and = 0.000 for -bend) ----TRUCK LOAD---------LANE LOAD--LIVE LL+IMP LL LOC.NO. DIR AXLE LL+IMP LLLOC.CONC LOC.CONC RATING SAFE LOAD RATING 1 WHEEL CAPACITY LOAD SPACE LOAD LOAD 2 FACT. VALUE FT-KIPS FT-KIPS FT-KIPS FT-KIPS FT FT FT FT TONS INV HS20 +BEND 0.000 0.0 0.000 1.030 HS 20.6 330.9 254.6 R 0.0 0.0 37.1 -BEND 0.0 0.0 0.000 0.0 0.0 0.0 0.000 0.000 R OPER HS20 +BEND 330.9 254.6 0.000 R 0.0 0.0 0.0 0.000 1.522 54.8 HS 30.4 0.0 0.0 0.000 0.0 0.0 0.000 -BEND R 0.0 0.000 +BEND 0.0 0.0 0.000 0.000 0.0 POST -BEND 0.0 0.0 0.000 POST +BEND 0 0 0 0 0 000 0 000 0 0 -BEND 0.0 0.0 0.000 +BEND 0.0 0.0 0.000 0.000 0.0 POST -BEND 0.0 0.0 0.000 POST SPEC +BEND 0.0 0.0 0.000 0.000 0.0 -BEND 0.0 0.0 0.000 1 DETAIL DATA AT MOMENT CHECK POINT FOR BARS RELEASE 5.5

DATE 08/07/95

STRUCTURAL STEEL FLEXURAL MEMBER

D/P STRUCTURE I.D. D75-085 MEMBER I.D.--S01

1

S01 SS 1 0.000 L 1 6.000 L 1 12.000 L

B01 SS 1 0.000 R 1.4 15.5 51.6 T 0.0 T 51.6 T 0.0 T 1 25.000 L -1.4 -15.5 0.0 T -51.6 T 0.0 T -51.6 T

 $\begin{array}{ccc} 0.2 & 1.7 \\ 0.0 & 0.0 \\ 0.2 & 1.7 \end{array}$ 

DATE 08/07/95

			C.P. LOCATION
H AREA BEND BE IN. SQ.IN. SQ.IN. SQ. 0.00 9.26 9.26 5 ***** INFLUENCE LINE (SIMPLE SPAN) X-DIST (FT.) 0.000 6.000 Y-ORDINATE 0.000 3.000	IX IX IX ND + BEND - BEND IN. IN**4 IN**4 .26 215.8 215.8 12.000 POS AREA = 0.000	INVENTORY 16000.0	BOTTOM BOTTOM + BEND - BEND IN**3 IN**3 36.0 36.0
H 4 5 BOT P 6 BEND 0 7		***** TOTAL DL ** MOMENT EFFECT FT-KIPS	**** AVAIL.CAPAC.FOR LL+IMPACT TOP TOP BOT +BEND -BEND +BEND - F-KPS F-KPS F-KPS F-
KPS I 8		5.5 INVENT	CORY 42.5 53.5 42.5
53.5 N 9		OPERAT	TING 62.0 73.0 62.0
73.0 T 0	AI	REA VEH. 1	0.0 0.0 0.0
0.0	TO	TALS VEH. 2	2 0.0 0.0 0.0
0.0 POS AREA 0.0 0.0 0.0	0.0 0.0 0.0	0.0 VEH. 3	8 0.0 0.0 0.0
0.0 NEG AREA 0.0 0.0 0.0 0.0	0.0 0.0 0.0	0.0 SPECIA	AL 0.0 0.0 0.0
	DIR AXLE LL+IMP LL SPACE FT. FT-KIPS FT-KIPS	DAD LOC.CONC LOC.CONC LOAD LOAD 2 S FT. FT.	RATING SAFE LOAD RATING FACT. CAPACITY VALUE TONS 1.186 42.7 HS 23.7
-BEND 0.0 0.0 0.000	L 0.0 0.0 0.0	0.000 0.000	
OPER HS20 +BEND 35.8 27.6 -8.000	L 0.0 24.4 18.8	6.000	1.730 62.3 HS 34.6
-BEND 0.0 0.0 0.000	L 0.0 0.0 0.0	0.000 0.000	
POST +BEND 0.0 0.0 0.000 -BEND 0.0 0.0 0.000			0.000 0.0
POST +BEND 0.0 0.0 0.000 -BEND 0.0 0.0 0.000			0.000 0.0
POST +BEND 0.0 0.0 0.000 -BEND 0.0 0.0 0.000			0.000 0.0
POST SPEC +BEND 0.0 0.0 0.000 -BEND 0.0 0.0 0.000			0.000 0.0

SUMMARY OF SHEAR ANALYSIS

11.9 T 0.0 T 11.9 T 0.0 T 6.0 T 6.0 T 6.0 T 6.0 T 0.0 T 12.1 T 0.0 T 12.1 T

D/P STRUCTURE I.D. D75-085

#### 13.1 INTRODUCTION TO RATING TIMBER BRIDGES RATINGS

This section covers the rating of timber stringers and decks. All timber members will be rated using the policies and guidelines in Section 1.

All timber stringers shall be rated using the AASHTOWare Bridge Rating program BrR. The timber decks shall be rated with CDOT Timber Bridge Rating program that is available from the Staff Bridge Branch Software Library.

All other types of timber stringers and decks will be rated in compliance with the applicable guidelines within this manual and the AASHTO codes.

Examples are presented for the three-stringer types listed below, as well as transverse nail laminated timber decks, and transverse plank timber decks.

Timber structures are repaired with the sister beam method using guidelines in Subsection 13.8.

For rating non-timber decks, see Section 3.

An important aspect of rating timber bridges is that the rating should reflect the actual condition of the members, as reported from field inspections. The guidelines for evaluating and accounting for the condition of timber members are shown in Subsection 13-3.

The types of stringers covered by this section are:

- TS Timber Stringer Timber Deck
- TTD Treated Timber Stringer Concrete Deck
- TTS Treated Timber Stringer Timber Deck

#### 13.2 POLICIES AND GUIDELINES FOR RATING TIMBER STRINGERS

#### 13.2.1 General

- A) Allowable stress method shall be used to rate timber structures.
- B) Timber stringers shall be rated using the BrR program. Nail laminated and plank decks shall be rated using the TIMBER computer program as mentioned in Subsection 13.6.
- C) When plans are not available, timber stringers may be rated with BrR software using field dimension in accordance Section 1.7.1.

September 2022

- D) When plans are not available, the allowable stress values in Section 1.5 Table 1-3 for Douglas Fir-Larch Select Structural can be used.
- E) The allowable stress value for shear may be increased by a modification factor of 1.33. This factor will always be used for stringers without splits and in good condition. If a beam or stringer is split horizontally, the increase factor is not allowed; see Subsection 13.3.
- F) Adjustment factors for timber deck and stringer may be defaulted by using the BrR compute button.
- G) For structures constructed after year 1960, the allowable stresses shall be modified according to the AASHTO STANDARD SPECIFICATIONS FOR HIGHWAY BRIDGES.
- H) For existing timber bridges, CDOT used lumber that has not been dressed / surfaced. The stringers may be considered as the full-sawn lumber sizes. The stringer sizes as presented in the design plans, or CARDEX may be used for ratings rather than dry dimensions, except the actual dimensions are verified by the inspectors.

Commentary: The full-sawn lumber is the same size as the stated nominal size. (Timber Bridges Design, page 3-40, Construction, Inspection, and Maintenance, 1990 – Michael A. Ritter, United States Department of Agriculture, Forest Service).

I) The rater shall evaluate and account for the condition of timber members as specified in Subsection 13.3.

# 13.2.2 Stringers Requiring Rating

- A) Interior Stringers A rating is required for the critically loaded interior stringer combined with the worst condition. Factors that influence condition are splits, broken, and repaired stringers, and wood condition. More than one interior stringer may require an analysis due to variation in span length, stringer size, stringer spacing, differences in loads or moments, etc.
- B) Exterior Stringers An exterior stringer shall be rated when the section used is different than the section used for an interior stringer.

#### 13.2.3 Dead Loads

- A) When rating timber bridges with timber decks use the maximum asphalt thickness obtained along a transverse cross section taken at midspan, rather than the average thickness, for dead load calculations.
- B) For timber or metal plank decks, dead loads due to railing curbs, and wheel guards shall not be distributed to all stringers, but shall be considered to be carried by the exterior stringer.
- C) The method of applying dead loads due to utilities is left to the rater's discretion.

# 13.2.4 Rating Reporting / Package Requirements

The rater and checker shall complete the rating documentation as described in Section 1 of this manual. Any variation from the original design assumptions shall be added to the Rating Summary Sheet as applicable. The rating package requirements shall be per Section 1.13 of this manual and as amended herein:

<u>Consultant designed projects</u> – Before finalizing the rating package and when BrR is used as the analysis tool, the Rater shall verify with the Staff Bridge Rating Coordinator that the version number of the program being used is identical to CDOT'S version number. Data files created using a lower, or higher version of the program shall be rejected, except if approved in advance by the Bridge Rating Engineer. It is required for the CDOT data archive, since the data base management feature inside the program would not work satisfactorily. After the analysis is completed, the rater shall save the data file. When saving is finalized, the rater shall export the data file in \*.xml format (i.e., O-18-BY.xml format).

## **13.3 EVALUATING CONDITION OF TIMBER MEMBERS**

#### 13.3.1 Broken Stringers

- A) In a broken stringer the wood is completely separated. The separation must extend a distance equal to or greater than one-fourth the depth of the stringer.
- B) For a broken stringer, the rater shall assume that the stringer is not there. Use stringer spacing equal to 1.5 times the actual spacing for dead load and live load distribution calculations.

## 13.3.2 Cracked Stringers

- A) A cracked stringer is similar to a broken stringer. A cracked stringer must be separated completely through the stringer in a lateral or transverse direction (at or nearly at 90 degrees to the longitudinal axis of the stringer); however, the separation must not extend vertically into the stringer more than one-fourth the depth of the stringer.
- B) The rater will evaluate the crack as follows, depending upon its location in the stringer:
  - 1. In the 1/4 span closest to the support the rater shall use the allowable shear stress values given in AASHTO without the shear increase factor from subsection 13.2.
  - 2. In the center-half of the span, the rater shall calculate the effective or reduced section depth, corresponding to the crack location on the beam, in order for the TIMBER computer program to determine the bending moment capacity.

# 13.3.3 Split Stringers

- A) To be a split, it must penetrate completely through the stringer and may or may not extend the full length of the stringer.
- B) A split will not reduce a member's bending capacity.

C) For stringers that are split the allowable shear stress values given in AASHTO shall be used without the shear increase factor from Subsection 13-2.

## 13.3.4 Checked Stringers

- A) A check is a separation of the wood along the fiber direction resulting from stresses set up in wood during seasoning, and usually extends across the rings of annual growth.
- B) Checks in a stringer may be on either or both sides.
- C) A check will not be considered to reduce the load carrying capacity of a timber member.

# 13.3.5 Shaked Stringers

- A) A shake is the result of the growth in the tree and may easily be mistaken as a check.
- B) A shake will not be considered to reduce the load carrying capacity of a timber member.

# 13.3.6 Decay

- A) Decay can reduce a member's load capacity.
- B) A reduced section will be rated for shear or bending strength depending on the location.

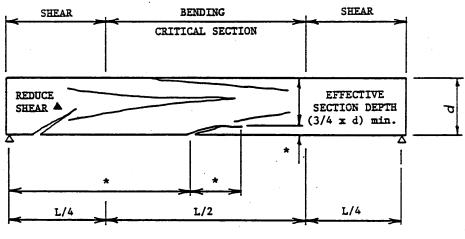
# 13.3.7 Aging

A) No adjustment in the allowable stresses for timber is necessary for reasons of aging alone. This is in accordance with ASTM D 245, April 10, 2000.

#### EVALUATING CONDITION OF TIMBER MEMBERS

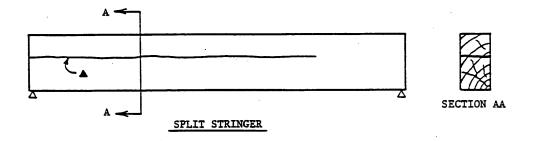


BROKEN STRINGER

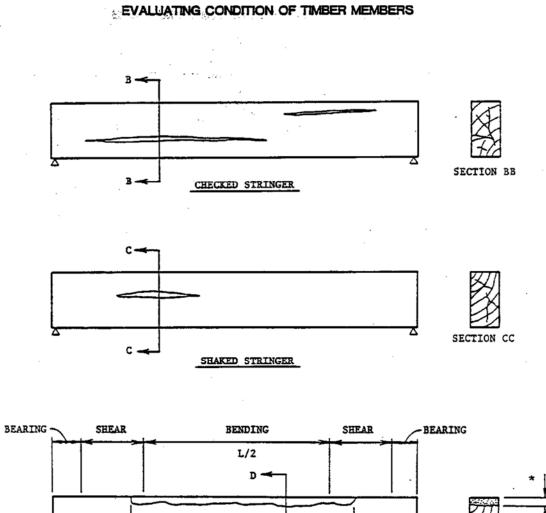


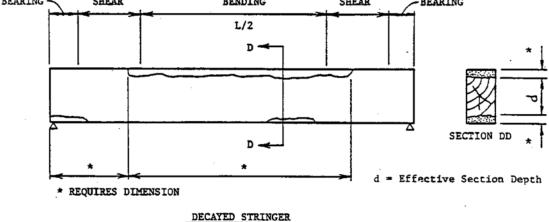
\* REQUIRES DIMENSION

CRACKED STRINGER



 $\blacktriangle$  Use allowable shear value  $({\rm F}_{_{\rm V}})$  without 1.33 increase in these areas.





### 13.4 GUIDELINES FOR USING THE BrR RATING PROGRAM

The BrR computer program performs the analysis and rating of simple span timber bridges. BrR uses the Madero ASD analysis engine. This program was developed in accordance with the AASHTO STANDARD SPECIFICATIONS and the AASHTO MANUAL FOR CONDITION EVALUATION OF BRIDGES.

The program will not rate sawn timber decks, glue laminated stringers, glue laminated flooring, flooring placed longitudinally, splined or doweled flooring, multiple layered decks, nor nontimber decks. For required modification to the allowable stresses, see Subsection 13.2 and 13.3.

The library explorer can be used to save commonly used items (beam shapes, non standard vehicles, materials, appurtenances etc.) and this eliminates the need for all users to define the same items repeatedly throughout the program. Once a new girder shape is defined or copied from the library, BrR automatically computes the required section properties and beam constants.

The program does consider uniform dead loads other than those caused by the stringers, deck, and overlay. In the case where other dead loads are present that would substantially affect the rating, they shall be accounted for during the analysis.

In the Live Load Distribution Factor window, when the compute button is used to calculate the DF's automatically by the program, BrR users shall verify that these numbers are accurate and matches their calculated numbers.

Timber structures should rate using ASD for three stringer conditions (**no split stringer**, **split stringer**, **and repaired split stringer**) based on updated section 1 in CDOT BRM, as shown below:

- A) For no split stringer (more than 75% of the total number of stringers have NO splits or shear cracks) should use inventory bending stress 1600 psi and 113 psi for inventory parallel shear stress.
- B) For split stringers (more than 25% of the total number of the stringers are not repaired or have shear cracks) should use inventory bending stress 1600 psi and inventory parallel shear stress 85.0 psi.
- C) For repaired split stringer by lag bolts (more than 25% of the total number of stringers are repaired) should use inventory bending stress 1600 psi and 98 psi for inventory parallel shear stress.

In rating summary sheet rater should report all interior stringer capacity for three above condition, with referring for current stringer condition split/no split or repaired.

One example is presented for structure A-27-A, a two span bridge having treated timber stringers with timber decks. For simplicity, only one span has been modeled using the above conditions of the members as reported in the field inspection report.

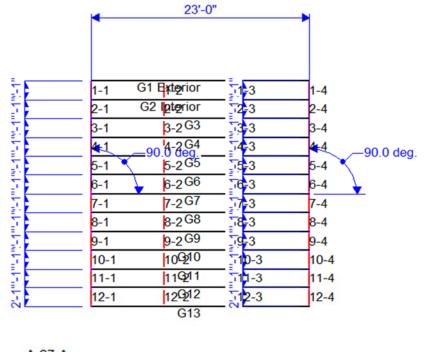
13-7

#### 13.5 BRIDGE RATING EXAMPLE

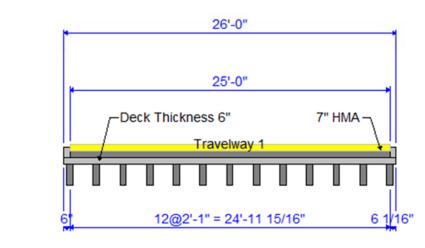
#### TIMBER STRUCTURE EXAMPLE, STRUCTURE NO. A-27-A

A-27-A

-1 - No split Structure Definition # 1 US 385 ML / DRAW 06/24/19



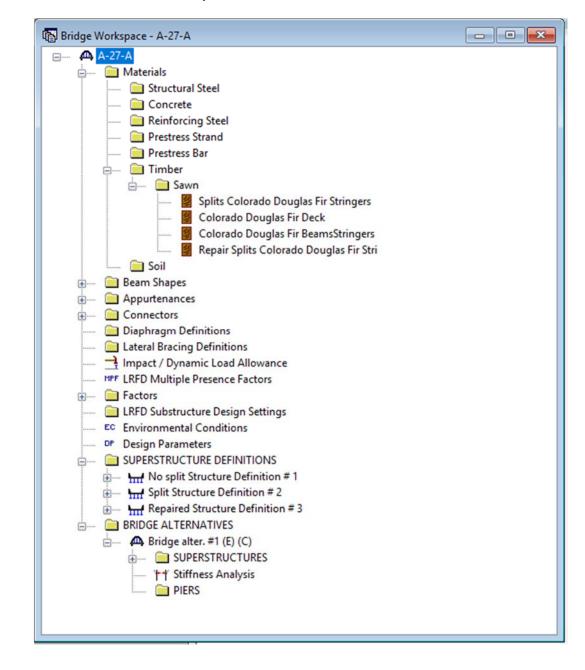
A-27-A -1 - No split Structure Definition # 1 US 385 ML / DRAW 06/24/19



A-27-A			- 8
Bridge ID: A-27-A	NBI Structure ID (8):	-27-A Template	Iv Defined 🗌 Culverts
Description Description	on (cont'd) Alternatives Global Re	eference Point Traffic Custom Agency	Fields
Name:	-1	Year Built:	1949
Description:	Initial rating was implemented in Viri Re-rated in virtis for system definitio Re-rated by AI for split/ repair more	n, J.W.G 12/2005 ajp 5/06	~
Location:	18 MI S OF JULESBURG/I	Length: 48.00	]ft
Facility Carried (7):	US 385 ML	Route Number: 0385D	]
Feat. Intersected (6):	DRAW	Mi. Post: 291.48	]
Default Units:	US Customary $\sim$		

Click OK. This saves the data to memory and closes the window.

To add three a new timber material, click on Materials, Timber, and Sawn in the tree and select File/New from the menu (or right click on Sawn and select New). Click the Copy from Library button and select the Colorado Douglas Fir Beams Stringers from the library. Click OK and the following window will open. The ASD Tabulated Design Values in this window are based on dry conditions and do not include any adjustment factors based on usage conditions. Make necessary corrections to the allowable bending and shear stress values for No Split, Split and Repaired conditions. Click OK to save these timber materials to memory and close the window.



Name: Ilorado D	ouglas Fir BeamsStringers	Description: No Splits, Commercial Grade
Grading method:	Visual ~	1
Species:	Douglas Fir-Larch 🗸	ASD Tabulated Design Values
Commercial grade:	Select Structural	Bending: 1.600 ksi
Size classification:	Beams and Stringers ~	Tension (parallel): 0.950 ksi
Grading rules agency:	Unknown ~	Shear (parallel): 0.113 ksi
Density:	0.05 kcf	Compr. (perp.): 0.625 ksi
Modulus of elasticity:	1600.00 ksi	Compr. (parallel): 1.100 ksi

For No split stringer condition materials properties

		scription: Splits, Commerc	
Grading method:	Visual $\checkmark$		
Species:	Douglas Fir-Larch $\checkmark$	ASD Tabulated De	sign Values
Commercial grade:	Select Structural 🗸	Bending:	1.600 ksi
Size classification:	Beams and Stringers $\checkmark$	Tension (parallel):	0.950 ksi
Grading rules agency:	Unknown ~	Shear (parallel):	0.085 ksi
Density:	0.05 kcf	Compr. (perp.):	0.625 ksi
Modulus of elasticity:	1600.00 ksi	Compr. (parallel):	1.100 ksi

For split stringer condition materials properties

Name: pair Split	s Colorado Douglas Fir Stri	Description	n: Repaired, Comr	mercial Grade	
Grading method:	Visual	~			
Species:	Douglas Fir-Larch	~ /	ASD Tabulated De	sign Values	
Commercial grade:	Select Structural	~	Bending:	1.600	ksi
Size classification:	Beams and Stringers	~	Tension (parallel):	0.950	ksi
arading rules agency:	Unknown	~	Shear (parallel):	0.098	ksi
Density:	0.05 kcf		Compr. (perp.):	0.625	ksi
Modulus of elasticity:	1600.00 ksi		Compr. (parallel):	1.100	ksi

Inventory shear stress for repaired split stringer = \*130 / 1.33 = 98 psi (\* see Section 1, Table 1-3)

Follow the same procedure to copy from the Materials library. Change the name of material and size classification. Click OK to save this timber deck material to memory and close the window.

Grading method:	Visual ~			
Species:	Douglas Fir-Larch 🗸 🗸	ASD Tabulated De	sign Values	
Commercial grade:	Select Structural ~	Bending:	1.600	ksi
Size classification:	2" • 4" thick, 5" • 6" wide 🛛 🗸	Tension (parallel):	0.950	ksi
Grading rules agency:	Unknown ~	Shear (parallel):	0.113	ksi
Density:	0.05 kcf	Compr. (perp.):	0.625	ksi
Modulus of elasticity:	1600.00 ksi	Compr. (parallel):	1.100	ksi

Add a new timber beam shape by clicking on Beam Shapes, Timber, and Rectangular in the tree and selecting File/New from the menu (or double clicking on Rectangular). Enter the final beam dimensions to be used to calculate section properties on the dimensions tab. Dressed dimensions shall not be used. Click OK to save the data to memory and close the window.

	n - Rectangular
Description:	
Dimensions	Properties
	Copy To Library Copy from Library OK Apply Cancel

Click the Properties tab, and then Compute. Click OK to save the data to memory and close the window.

Name: 6"×20"			
Description:			
Dimensions Properties			
Area:	120.00	in^2	
Nominal load:		lb/ft	
Moment of inertia:	4000.0	in^4	
CG from bottom:	10.0000	in	
Section modulus, top:	400.0	in^3	
Section modulus, bottom:	400.0	in^3	
Nominal width:	6.00	in	
Nominal depth:	21.0000	in	Compute
<b>C</b>	y To Library	Copy from Library OK	Apply Cance

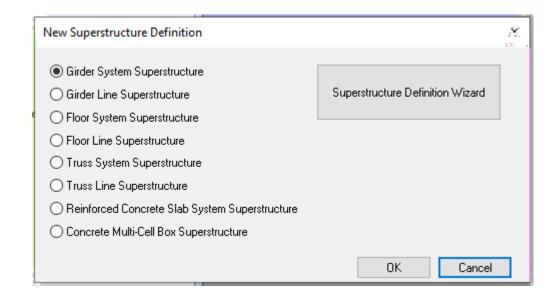
Expand the tree labeled Appurtenances to enter the bridge appurtenances information to be used in the analysis. To define a generic railing, double click on Generic in the tree and input the generic railing dimensions. Click OK to save date to memory and close the window.

Name	Type 3 Modified Railing	
Description		
А	I dimensions are in inches	
Distance f	om edge to centroid = 3.0000	
	Reference Line Barrier load = 0.066 kip/ft Width = 6.0000	
E	ffective wind height = 10.0000 Back Front	

Expand the Connectors tree item to create a nail definition. Double click on Nail. Define the nail and click OK to save to memory.

Name: 20 Pennywei	De De	scription:	
	Length: 4.0000	in	
	Diameter: 0.1920	in	
	Pennyweight: 20d	~	

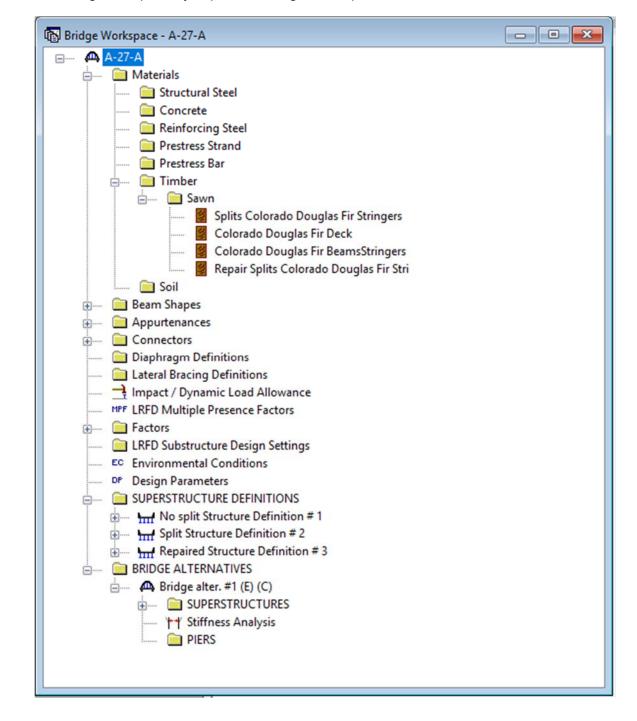
Now that we have created a nail definition, this can be applied to nails in the deck. Reopen the Structure Typical Section: Deck (cont'd) tab. Select the 20 Pennyweight nail definition as the nail on that tab. Click OK to save to memory and close the window. Double click on STRUCTURE DEFINITION (or click on STRUCTURE DEFINITION and select File/New from the menu or right mouse click on STRUCTURE DEFINITION and select New from the popup menu) to create a new structure definition. The following dialog box will appear.



Select Girder System and the following Structure Definition window will open. Enter the appropriate data as shown below.

Name:	I No solit Stru-	cture Definition # 1			Frame Structure	
					Simplified Definition	
Description:				^	Deck type: Timber	
Default Units:	US Customa	ary V Enter Span Lengths Along the Reference		~	For PS only	
Number of spans:	1	Line:			Average humidity:	
Number of girders:		Span Length (ft)	T		~ ~	
					Member Alt. Types Steel P/S R/C	
Horizontal Curvature Ak	100 <b>5</b> -101-1010-10				Steel	
Horizontal curvatur	re	be Line Distance from PC to first support line:		ft	Steel P/S R/C	
Horizontal curvatur     Superstructure Align	re			ft	Steel P/S R/C	
Horizontal curvatur     Superstructure Align     Orved	nment	Distance from PC to first support line:			Steel P/S R/C	
Horizontal curvatur Superstructure Align © Curved Tangent, curved	re nment d, tangent	Distance from PC to first support line: Start tangent length: Radius:		R	Steel P/S R/C	
Horizontal curvatur     Superstructure Align     Orved	re mment d, tangent d	Distance from PC to first support line: Start tangent length: Radius: Direction:	Left V	R	Steel P/S R/C	
Horizontal curvatur Superstructure Align Curved Tangent, curved Tangent, curved	re mment d, tangent d	Distance from PC to first support line: Start tangent length: Radius: Direction: End tangent length:	Left ~	ft ft	Steel P/S R/C	
Horizontal curvatur Superstructure Align Curved Tangent, curved Tangent, curved	re mment d, tangent d	Distance from PC to first support line: Start tangent length: Radius: Direction: End tangent length: Distance from last support line to PT:	Left ~	ft ft ft	Steel P/S R/C	
Horizontal curvatur Superstructure Align Curved Tangent, curved Tangent, curved	re mment d, tangent d	Distance from PC to first support line: Start tangent length: Radius: Direction: End tangent length:	Left ~	ft ft	Steel P/S R/C	

Following is the partially expanded Bridge Workspace tree:



Click Load Case Description to define the dead load cases. The load types are presented in a single row separated by a comma. The first type applies to LFD design and the second type applies to LRFD design and it corresponds with the load types presented in the AASHTO Specifications. The completed Load Case Description window is shown below.

Load Case Name	Description	Stage			Туре		Time* (Days)		
HMA		Non-composite (Stage 1)	~	D,DW		$\sim$		]	
Rail		Non-composite (Stage 1)	$\sim$	D,DC		$\sim$		]	

Double click on Framing Plan Detail to describe the framing plan. Enter the appropriate data to describe the framing plan. If the bridge has diaphragms, switch to the Diaphragms tab and enter the appropriate data. Click OK to save to memory and close the window.

	Number of spans = 1 Number of girders = 13	
Layout Diaphragms		
	Girder Spacing Orientation	
Skew	Perpendicular to girder	
Support (Degrees)	O Along support	
1 0.0000		
2 0.0000		
	Girder Spacing	
	Girder (ft) Bay Start of End of	
	Girder Girder	
	1 2.08 2.08	
	2 2.08 2.08	
	3 2.08 2.08	
	4 2.08 2.08	
	5 2.08 2.08 6 2.08 2.08	
	7 2.08 2.08	
	8 2.08 2.08	
	9 2.08 2.08	
	10 2.08 2.08	
	11 2.08 2.08	
	12 2.08 2.08	
	OK	Apply C

The Deck tab is used to enter information about the deck. BrR only supports transverse timber decks. Select the type of deck as Nail-Laminated. The timber material to be used for the deck is selected from the list of bridge materials described above. A Nail definition has not been created yet, so leave the field blank for now. The Deck LL distribution width in the direction normal to the flooring span shall be per AASHTO Standard Specifications, Article 3.25.1.1. For this structure, this value is equal to 21.0 inches (15 inches plus thickness of floor).

Description Factors Engine Default rating method: ASD Analysis Module ASD: Madero ASD	Deck Rating Parameters
Timber deck type:Nail-Laminated DeckTimber material:Douglas Fir-Larch (no sTotal deck thickness:6.0000 inLamination thickness:3.0000 inDeck LL distribution width:21.0000 inNail:20 Pennyweight	plit) V Nominal thick.: 3.0000 in Nominal width: 6.0000 in

13-25

For the Factors tab of the Deck window, factors may be defaulted by using the BrR
compute button. In Colorado, dry moisture condition is used.

Description Factors Engin	е		
ASD Factors OPER Timber 1.33			
- Timber Adjustment Factors Moi:	s sture condition for shear/flexure	Dry	~
	Moisture condition for bearing	Dry	~
	Moisture condition for modulus	Dry	~
Shear factor:	1.00	Flat use factor: 1.00	]
Wet service (flexure):	1.00 Repe	itive use factor: 1.00	]
Wet service (shear):	1.00 Load	duration factor: 1.15	]
Wet service (bearing):	1.00		
Wet service (modulus):	1.00		
Size factor (flexure):	1.00		Compute
		ОК	Apply Cancel

Double click on Structure Typical Section in the Bridge Workspace tree to define the structure typical section. Input the data describing the typical section as shown below.

		superst	e from right ed ructure definitio erstructure Del erence Line	on ref. line		
Left overhang				↓ ₩	Right overhang	
Deck Parapet Railing Generic Lane Superstructure definition reference line is	Position	Striped Lane	es Wearing S the bridge de			
Distance from left edge of deck to superstructure definition reference line =	Start 13.00		End 13.00	ft		
Distance from right edge of deck to superstructure definition reference line =	13.00	ft	13.00	ft		
Left overhang =	0.50	ft	0.50	ft		
Computed right overhang =	0.50	ft	0.50	ft		

The Generic tab is used to enter information about the appurtenances. Click New to add a row to the table. Enter the following data.

		ick	<b>€</b> F	ront	ape			
Deck Parapet Railing	Generic			Lanes Wearing Edge of Deck	Distance At	Distance At	Front Face	
Name		Load Ca	se Measure To	Dist. Measured From	Start (ft)	End (ft)	Orientation	
Type 3 Modified Railing	~	Rail	- Back -	Right Edge 🗸	0.00	0.00	Left 🗸	
Type 3 Modified Railing	~	Rail	Back 🗸	Left Edge 🖂	0.00	0.00	Right 🗸	

Select the Lane Position tab. Enter the values shown below or click the Compute...button to automatically compute the lane positions. A dialog box showing the results of the computation opens. Click the apply button to apply the computed values.

	(A) Travelway 1		e Definition Reference Line velway 2	
Deck Parap	Distance From Latt Edge of	and the second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second se	aring Surface Distance From Left Edge of	Distance From Right Edge of
Travelway Number	Distance From Left Edge of Travelway to Superstructure Definition Reference Line At Start (A) (ft)		Travelway to Superstructure Definition Reference Line At End (A) (ft)	
1	-12.50	12.50	-12.50	12.50
	gue ailable to trucks:	Compute	New	Duplicate Delete

Enter the following wearing surface information and click OK to save to memory and close the window.

	from left edge of dec cture definition ref. lir		from right edge of d cture definition ref. li		
Î	Deck thickness	Defere	structure Definition	Í	
		i			
Left overhang				Right overhang	
Deck Parapet Railing Ger	eric I and Position	Striped Lanes	Wearing Surface		
			in caring canado		
Wearing surface material:	Asphalt				
Description:	Asphalt				
Wearing surface thickness =	7.0000 in	Thickness	field measured (DW	′ = 1.25 if checked)	
Wearing surface density =	146.670 pcf				
Load case:	DW	~		Copy from Library	

#### Describing a member:

The member window shows the data that was generated when the structure definition was created. No changes are required at this time. The first Member Alternative that we create will automatically be assigned as the Existing and Current Member alternative for this member.

Member name:	G2 Interior		Link with:	None	$\sim$	
Description:					^	
					$\sim$	
	Existing Curren	Member Alternative Name		Description		
	<	Timber beam interior			>	
Number of spans:	1	Span Span No. Length (ft)				
		1 23.00				

Defining a Member Alternative: Double click MEMBER ALTERNATIVES in the tree to create a new alternative. The New Member Alternative dialog will open. Select Timber for the Material Type and Rectangular Sawn Timber for the Girder Type. Only Timber is available for the Material Type since a timber deck type was selected on the Structure Definition window. Timber decks are limited to timber beams in BrR.

Material Type:	Girder Type:
Steel Timber	Rectangular Sawn Timber
	0K Cancel

Enter the following data for the Member Alternative. Click OK to save to memory and close the window.

Description Alter	natives Vehic	de Path Engine	Substructures		
Descript	ion:			 	
Reference Line	,	- Market - Market - Market - Market - Market - Market - Market - Market - Market - Market - Market - Market - M			
Distance	e = 0.000	ft			
Offse	t = -0.000	ft			
Angle	e = 0.00	Degrees			
Starting Station	n =	ft			

Support constraints were generated when the structure definition was created and are shown below.

eneral	Z 1 Elastic 3D General 3D Elastic			2	
Support	Support	Support Translation Constraints		Rotation Constraints	
Number	Туре	х	Y	Z	
1	Pinned 🗸				
	Roller				
2					

Use the Compute from Typical Section button to compute the live load distribution factors. Refer to AASHTO Table 3.23.1, Article 3.23.1.2 and Article 13.6.5.2.

andard LRF	D					
Distribution F	Factor Input Metho					
Use Sim	plified Method (	Use Advanced	d Method OL	Ise Advanced M	ethod with 1994	4 Guide Specs
	bution factors to be	Distribution	Factor		e tranic	
Lanes Loaded	Shear	(Wheel Shear at Supports	s) Moment	Deflection		
1 Lane	0.508	1.000	0.417	0.154		
Multi-Lane	0.545	1.000	0.490	0.308		
Compute fr	iom View (					

Open the Beam Details window by double clicking on Beam Details in the Bridge Workspace tree. The Beam Details window is shown below.

General	Adjustmen	t Factors	Support Length	ns		
Be	am shape:	6''×20'		$\sim$		
	Material:	Colorado	o Douglas Fir Be	∼ ne		
	projection 6.0000	in	Right: 6.0	000 in		

The Adjustment Factors tab of the Beam Details window allows you to enter adjustment factors to modify the tabulated design values entered on the Bridge Materials – Timber – Sawn window. The tabulated design values modified by these adjustment factors produce the design allowable stresses. In Colorado, dry moisture condition is used. Adjustment factors may be defaulted by using the BrR compute button.

General Adjustment Fa	ctors Support Ler	ngths				
	Moisture condition	for shear/flexure:	Dry		$\sim$	
	Moisture cor	ndition for bearing:	Dry		$\sim$	
	Moisture cond	dition for modulus:	Dry		$\sim$	
Shear facto	or: 1.000	ſ	Flat use factor:	1.00		
Wet service (flexure	e): 1.000	Repetit	ive use factor:	1.00		
Wet service (shea	r): 1.000	Load	luration factor:	1.150		
Wet service (bearing	<sub>j):</sub> 1.00					
Wet service (modulu:	s): 1.000					
Size factor (flexure	e): 0.945					Compute
				ОК	Apply	Cancel

Enter the following data for the Support Lengths tab. Click OK to save to memory and close the window.

	Descine Length	Descise MEM	_		
Number	(in)	(in)			
1	12.0000	6.0000			
2	12.0000	6.0000			
	Number 1	Number         (in)           1         12.0000	1 12.0000 6.0000	Number         (in)         (in)           1         12.0000         6.0000	Number         (in)         (in)           1         12.0000         6.0000

To perform a rating analysis, select the Bridge Analysis Settings button on the toolbar to open the window shown below. Select ASD as the Rating Method, select HS 20-44 vehicle or other vehicles to be used in the rating and click OK.

O Design Review	Rating	Rating Method	ASD ~
Analysis Type:			
Line Girder	~		
Lane/Impact Loading Type	e:		
As Requested	~	Apply Preference Setting	None
Vehicles Output Engine	Description		
		Traffic Direction:	Refresh Temporary Vehicles Advance
8		Both directions V	
Vehicle Selection:		. Add to	Vehicle Summary:
- EV3 - H 15-44 - H 20-44 - HS 15-44 - HS 20 (SI) - HS 20-44 - NRL - SU4 - SU5 - SU6 - SU7 - Type 3 - Type 3-3 - Type 3-3 - Type 3S2 - Agency - Colorado Leg - Colorado Leg	gal Type 3-2 gal Type 3S2 rmit Vehicle gal Type 3 gal Type 3-2	>> Remove from Analysis <<	

Select the output tab of the Analysis Settings window. Check specific boxes next to the desired output report and click the Engine tab.

O Design Review   Rating	Rating Method: ASD ~
Analysis Type:	
Line Girder $\sim$	
Lane/Impact Loading Type:	
As Requested $\sim$	Apply Preference Setting: None
/ehicles Output Engine Description	AASHTO Engine Reports:
<ul> <li>ASD Critical Loads Report</li> <li>ASD Critical Stresses Report</li> <li>Dead Load Action Report</li> <li>Live Load Action Report</li> </ul>	Miscellaneous Reports:  Girder Properties  Summary Influence Line Loading  Detailed Influence Line Loading  Capacity Summary  Capacity Detailed Computations  FE Model for DL Analysis  FE Model for LL Analysis  FE Model for LL Analysis  LL Influence Lines FE Model  LL Influence Lines FE Actions  LL Distrib. Factor Computations
Select All Clear All	Select All Clear All

Select the analysis engine and click the Properties tab.

	Rating Method:	ASD ~
Analysis Type:		
Line Girder $\checkmark$		
Lane/Impact Loading Type:		
As Requested $\sim$	Apply Preference Setting:	None ~
Vehicles Output Engine Description		
Configure engine properties for analysis module:	Madero ASD	~
Generate formatted output. Generate standard output for action		^ Propertie
	aders. eport. factor calculation outp ation output. putput. tion output.	out.

Select the desired Output Options and click OK.

Format: Formatted Output Abbreviated Action Table Load CombinationTable Reports: Influence Function Rep	Headers	Calculations: Load Calculations Timber Adjustment Factor Calculations Rating Factor Calculations Stress Calculations Connection Calculations	Canc
Ction Report	0 - Minimum	output (basic bridge structure)	

Click the Description tab, provide a general narrative description of the analysis event and click OK.

O Design Review	Rating	Rating Method:	ASD	~
Analysis Type:				
Line Girder	~			
Lane/Impact Loading T	ype:			
As Requested	~	Apply Preference Setting:	None	~
Analysis Event Descrip BrDR new analysis ev	120 Million			
<				>

## 13.6 CDOT BRIDGE TIMBER RATING PROGRAM DESCRIPTION

The TIMBER computer program performs the complete analysis and rating of simple span timber bridges. The program was developed in accordance with the AASHTO Standard Specifications and the AASHTO Manual for Condition Evaluation of Bridges.

The program will not rate flooring placed longitudinally, splined or doweled flooring, multiple layered decks, nor nontimber decks. In accordance with subsection 13.2, the program does not modify the user input values for allowable stresses.

The program does not consider dead loads other than those caused by the stringers, deck, and overlay. In the case where other dead loads are present that would substantially affect the rating, they shall be accounted for during the analysis.

In the TIMBER program, the nail laminated and plank timber decks shall be rated for non-continuous between stringers while the BrR program rates for continuous. Conventionally, the TIMBER program shall be used for conservative.

The asphalt overlay depth is used to compute the dead load, using the asphalt unit weight of 146.67 pcf. When the timber bridge has gravel overlay (unit weight = 120 pcf) the depth entered should be the equivalent depth of asphalt to gravel. This is done by taking the actual depth of gravel, dividing it by 1.2, and entering the result into the required depth column. The actual depth of gravel shall be shown on the Rating Summary Sheet.

The following information appears as output from the program.

# 13.6.1 Stringer (For Information Only)

The Bridge Rating Program shall not use for stringer rating. The BrR program shall be used for timber stringer ratings.

- A) Total dead load moment and shear for the stringer being rated.
- B) Live load moment and shear due to HS 20 truck.
- C) Stringer rating for bending and shear for Inventory and Operating stress levels.
- D) Live load moment and shear due to all three Colorado posting trucks.
- E) Posting ratings for bending and shear for all three Colorado posting trucks. If all posting rating values are greater than the respective posting truck weights, and the operating rating is greater than or equal to 36 tons, then the posting ratings are not printed.
- F) The Overload Color Code Rating for the stringer being rated is based on either shear or bending, depending on which controls.

### 13.6.2 Decking

- A) Deck rating for nail laminated and plank floors at Inventory and Operating stress levels. Only design vehicle deck load ratings shall be reported in the RSS.
- B) Posting ratings for all three Colorado posting trucks do not need to report in the RSS.
- C) The Overload Color Code Rating is not a function of the deck rating.

# 13.7 TIMBER BRIDGE DECK RATING EXAMPLES

# Timber Rating Program Input:

4-27-A	Rater:	AI
1030	No. of Lanes:	2
385		
7		
Laminated 🚊	Deck Thickness (in):	6
6	Stringer Depth (in):	20
2.083	Effective Span Length (ft):	23
s		
14	Inv. Shear Stress	113
	1030 385 7 Laminated : 6 2.083	1030       No. of Lanes:         385       385         7       Deck Thickness (in):         6       Stringer Depth (in):         2.083       Effective Span Length (ft):

Timber Rating Program Output:

Batch: 1030 Timber Bridge Rating Date: 6/13/2019 Rater: AI Structure Number: A-27-A State Highway: 385 Number of Lanes: 2 Floor Type: Laminated Effective Span Length: 23.000 ft. Stringer Spacing: 2.083 ft. Stringer Width: 6.000 in. Stringer Depth: 20.00 in. Floor Thickness: 6.00 in. Bituminous Overlay Thickness: 7.00 in. Allow. Stress in Bending: 1600.0 PSI Allow. Shear Stress: 113.0 PSI HS-20 Truck (Gross Wt. 36 Tons) Deadload Moment: 17.77 KIP-ft. Liveload Moment: 45.09 KIP-ft. Deadload Shear: 1.75 KIPS Liveload Shear: 8.34 KIPS Inventory Operating Rating Rating Deck Rating 134.5 Tons 179.1 Tons Stringer 28.4 Tons 42.4 Tons Bending 31.5 Tons 44.3 Tons Shear 70.93 KIP-ft Moment Capacity 53.33 KIP-ft Shear Capacity 9.04 KIPS 12.02 KIPS + + + Overload Information + + + + Color Code = White + + + + 1-Axle (KIPS) = 44.388 + + 2-Axles(4-0) = 53.245+ + 3-Axles(4-0) = 57.788+ + 4-Axles(4-0) = 67.282+ + + These Loads Assume 1-Lane + + Distribution Factor + 

TIMBER RAT		NSPORTATION		Structure #	-	A-1	27-A
Rated using:				Batch I.D.	nay m		385 1030
Asphalt thickness:	7 in.			Structure T	vne		TTS
Colorado legal		tulti-lane for Legal & Perm ingle lane for Legal & Perm		Parallel St			NONE
_	_	Split Int Girder					NONE
Structural Member	Tons	spile inc olider			De	ск	
Inventory	27.6	21.8	21	.8	134	1.5	
Operating	40.5	32.6	39	.3	179	9.1	
Type 3 truck	35.3	27.9	33	. 6		_	
Type 3 S2 truck	54.4	43.0	51				
Type 3-2 truck	56.1	44.4	53				
Type SU4 truck (27T)		28.9	34				
Type SU5 truck (31T)		31.0	37	.4			0
Type SU6 truck (35T)		34.8	40	.1			
Type SU7 truck (39T)		38.8	44	.7			
NRL (40T)	46.3	39.1	46	.2			
EV2 (28.75T)	36.2	28.6	34	.5			
EV3 (43T)	36.8	29.1	35	.1			
Permit Truck (96T)	84.9	70.9	84	.7			
Modified Tandem (50T)	50.0	39.5	47	.6			
Type 3 Truck Interstate 24 tons / Colorado tons	27 toas	Type 3S2 Truck Interstate 38 tees / Colocado 42: tons	S tons	E.	Type 3- Interstate 39	-2 Truck teas / Colorad tons	io 42.5 tons
Comments: Allowable Bending Allowable Split She Allowable Repaired Color Code:YELLC Re-rated per reque girders are splits ar Rated with BrR v6.4	ar stress =85 Split Shear street W Based on mo st from the Insp nd/or repaired.	psi ess =97.74 ps odified tandem f ection Team. M	or Repa			FE Seol	
Rated by: (Print name and sign	)	Date: C	ucked by: (i	Print nome one	[ coig ]		Date:

### **13.8 GUIDELINES FOR SISTER BEAM RATING**

The term "Sister Beam" is used when a new steel beam/section or a new timber stringer is added to an existing timber structure, and placed adjacent to or side-by-side an existing damaged or deteriorated timber stringer, to add structural capacity or carry the existing stringer load.

Adding a Sister-Beam to an existing structure is a major rehabilitation and should be designed and rated using LRFD and LRFR methods respectively.

AASHTOWare BrR software should be used for the rating.

The existing timber stringers shall be rated using ASD method with single lane loaded for Legal Load vehicles and Colorado Permit vehicles. The new sister-beam/s shall be rated using LRFR method with single lane loaded for Legal Load vehicles and Colorado Permit vehicles. The Live Load Impact shall be considered for the sister-beam, but not for the timber stringer. The entire structure should be rated in both ASD and LRFR for the existing stringers and new sister-beam/s respectively.

Substructure does not need to be rated except as requested by the Bridge Inspection Engineer.

The Rating Summary sheet shall show both the existing stringers and the new sisterbeam ratings and denote the controlling one.

Major and Minor timber structures with sister-beam/s should be rated the in same manner in accordance with this section.

Damaged / Deteriorated stringer covers stringers that have been evaluated as broken, checked, cracked, split, or decayed stringer. Existing timber stringers condition evaluation should follow Subsection 13-3 and 13-4.

The rater and checker shall complete the rating documentation as described in Section 1 of the Bridge Rating Manual. Any variation from the original design assumptions shall be added to the Rating Summary Sheet as applicable. The rating package requirements shall be per Section 1.13 and Section 1.14 of the Bridge Rating Manual and as amended herein.

The Designer should review the superstructure rating to make sure it meets the design's load path and assumptions.

#### 13.8.1 LIVE LOAD DISTRIBUTION

Matching the existing stringers deflection, stiffens, and load path should be considered when adding a structural support or a sister beam. To maintain the existing structure behavior and load path, the new sister beam is usually designed to match the existing stringers deflection, stiffness, depth, etc.

The load sharing between the new sister-beam and the damaged / deteriorated existing stringer can be calculated in different way. Different load sharing calculation could result

in different LLDF between the new and other existing stringers. The designer should be consulted in verifying the intent of the design, the LLDF calculation methodology, and the final load distribution factors.

Based on the provided load sharing example in this section and other load sharing calculations, in most cases, the damaged/deteriorated stringer carries about 10% to 20% of the load while the new sister-beam carries the rest. On the long term, the damaged/deteriorated stringer might continue to lose its capacity and the new sister-beam may be required to carry all the dead and live load. To minimize repetitive ratings, the new rating should ignore any capacity of the damaged/deteriorated stringer and apply all the load to the new beam, unless otherwise approved in advance by CDOT Staff Bridge Rating Engineer.

For consistency among ratings and for simplification purposes, distribution factors should be calculated based on average girder spacing since the spacing can differ. (In reality, the spacing might have not changed much considering the damaged/deteriorated timber stringer still exist).

The existing sound timber stringers should be the controlling stringers in the rating. The design should be re-evaluated if otherwise.

Service-II Limit State is intended to control the yielding of steel and slip-critical connections. It is considered to be midway between Service-I and Strength-I Limit States. Service-II usually does not control non-composite, non-compact steel sections. Accordingly, Service-II rating maybe ignored when rating steel sister-beam structures, (Reference AASHTO LRFD 9<sup>th</sup> edition and MBE 3 Edition).

Below is an example calculation of live load sharing between a split timber stringer and a new steel sister-beam. The rater and designer should convene to insure consistency between the rating and the design intent.

Sharing Live Load

The spacing between the sister beam and the split timber stringer is close (side by side). Therefore, the deflection of sister beam shall be the same as the split timber stringer.

Sister beam:	Split timber:
$P_{S} \cdot L^{3}$	$Deflection_T = \frac{P_T \cdot L^3}{48 \cdot E_T \cdot L}$
$Deflection_S = \frac{I_S \cdot L}{48 \cdot E_S \cdot I_S}$	$Deflection_T = \frac{1}{48 \cdot E_T \cdot I_T}$

$$Deflection_S = Deflection_I$$

 $P_S$  +  $P_T$  = 100% of wheels load. It is shared between split timber stringer & sister beam.

$P_{S} \cdot L^{3}$	$P_T \cdot L^3$	or	$P_S$	$P_T$
$48 \cdot E_{S} \cdot I_{S}$	$\overline{48 \cdot E_T \cdot I_T}$		$E_S \cdot I_S$	$E_T \cdot I_T$

Timber stringer:  $h_T = 20 \cdot in$   $b_T = 6 \cdot in$  Sister beam: HSS 12 x 8 x 5/16

 $E_S \coloneqq 29000 \cdot ksi$   $E_T \coloneqq 1600 \cdot ksi$ 

 $I_{S} \coloneqq 224 \cdot in^{4} \qquad \qquad I_{T} \coloneqq \left(b_{T} \cdot \frac{\left(\frac{h_{T}}{2}\right)^{3}}{12}\right) \qquad \qquad I_{T} = 500 \ in^{4} \qquad (\text{Worst case when the split is at mid-high})$ 

 $P_{S} \coloneqq 100\% \cdot \frac{\left(E_{S} \cdot I_{S}\right)}{\left(E_{S} \cdot I_{S} + E_{T} \cdot I_{T}\right)} \qquad P_{S} = 0.89$ 

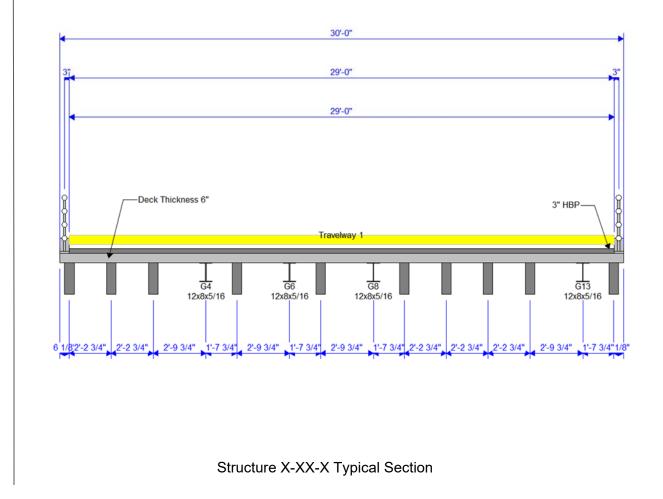
 $P_T = 100\% - P_S$   $P_T = 0.11$ 

The steel sister beams shall be rated with the LRFR mehod. Use AASHTO Table 4.6.2.2.2a-1 to determind the moment and shear LLDF for interior steel beam with plank wood deck.

Type of Deck	Applicable Cross- Section from Table 4.6.2.2.1-1	One Design Lane Loaded	Two or More Design Lanes Loaded	Range of Applicability
Plank	a, l	S/6.7	\$/7.5	S≤5.0
5≔2.229167 ft				
Single lane: LLDF <sub>SL</sub> :	$=\frac{S}{P_s} \cdot P_s$	LLDF <sub>SI</sub>	,=0.296 (Wł	neels)
	6.7		-	
Multi lane: LLDF <sub>ML</sub>	S p	LIDE	o acr (wh	a a la )
Multi lane: LLDF <sub>ML</sub>	=	LLDFM	L = 0.265 (Wh	neels)

# 13.9 SISTER BEAM RATING EXAMPLE, STRUCTURE X-XX-X.

Structure X-XX-X AASHTOWare BrR Rating is presented below as an example. This structure is a 1-Span 23'-0" c-c timber stringer with steel sister beam for Girder number 4, 6, 8, and 13. The structure is 30'-0" out-to-out with original stringer spacing of 2'-2 <sup>3</sup>/4" c-c. The existing timber stringers are 6" wide x 20" deep Colorado Douglas Fir. The new Sister beam is 12x8x5/16 HSS steel section placed adjacent (side-by-side) the existing damaged or deteriorated stringer with spacing of 7" c-c. The damaged/deteriorated timber stringers are not modeled since it is assumed that the new sister-beam is carrying 100% of the load. Distribution factors should be calculated based on average girder spacing since the spacing can differ. The Live Load Impact shall be considered for the sister-beam, but not for the timber stringer. See Section 13.5 Example for more information

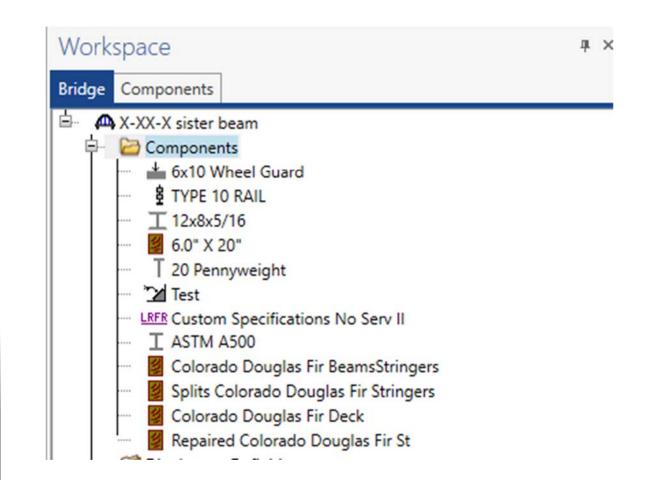


idge ID: X-XX-X sist	ter beam	NBI structure	e ID (8): X-XX-X sister b		Template	tely defined	Superstructure Culverts Substructures
Description Desc	cription (cont'd)	Alternatives	Global reference point	Traffic	Custom agency field	ls	
Name:	-1			]	Year built:	1938	
Description:	for legal and pe	rmit loads have	r girders and hss sister bea been ignored on the sister to go fully plastic				
ocation:	SIA Item 9				Length:	23.00	ft
acility carried (7):	SIA item 7				Route number:	00	
eat. intersected (6):	SIA item 6				Mi. post:	0.00	
efault units:	US Customary	~					

The Description should include CDOT/the Consultant company's name, the rater and checker initials, and date of completion.

The fields under the "Global reference point" and "Traffic" tabs should be completed matching the latest structure inspection and appraisal (SIA) report information.

The Components folder contains bridge components that are applicable to the entire bridge like appurtenances, beam shapes, specifications, and materials properties, see capture below:



New Superstructure Definition	
Girder system superstructure	
Girder line superstructure	Superstructure definition wizard
Floor system superstructure	
Floor line superstructure	
<ul> <li>Truss system superstructure</li> </ul>	
O Truss line superstructure	
Reinforced concrete slab system superstructure	
O Concrete multi-cell box superstructure	



Complete the new Girder System Superstructure Definition information:

Two superstructure definitions should be created, one for the ASD Timber stringer rating, and the other for the LRFD Steel beam rating. The information below is shown for the steel beam rating only.

Definition Analysis	s Specs	Engine		
Name:	Steel System w	/ Timber Girders		Modeling
Description	timber stringer from an adjace	em applies only to the steel sister beam s. Since the assumption is the steel string nt split stringer, the LLDFs have been rec	ger takes 100% of the I calcuated (see spreads)	load With frame structure simplified definition heet
t		am Rating") by multiplying by a ratio of this system is rated using LRFR	steel stiffness to timbe	er Deck type: Timber Deck
Default units:	JS Customary	Enter span lengths     along the reference		For PS/PT only
Number of spans:	1 🗘	line		Average humidity:
	20 🗸	Span Length (ft)		Member alt. types
		• 1 23.00		Steel
				□ P/S □ R/C
				☑ Timber
				P/T
Horizontal curvature	e along referer	ice line		
Horizontal curva	ture	Distance from PC to first support line:	ft	
Superstructure a	lignment	Start tangent length:	ft	
Curved		Radius:	ft	
<ul> <li>Tangent, curve</li> </ul>		Direction:	Left 🗸	
() Transit		End tangent length:	ft	
Tangent, curve     Curved tange		Distance from last support line to PT:	ft	
<ul> <li>Tangent, curve</li> <li>Curved, tange</li> </ul>		Design speed:	mph	
			p.i	
		Superelevation:	%	

HBP         Non-composite (Stage 1)         D,DW            Rail         Non-composite (Stage 1)         D,DC	
Rail Non-composite (Stage 1)	

		N	umber of sp	ans = 1	Number of girders = 14
ayout Diaphragms Lateral	Bracing Ra	nges			
		Spacing Orier			
Suggest Skew		rpendicular to	girder		
Support (Degrees)	⊖ Alo	ng support			
1 0.0000					
2 0.0000					
	Circles	Girder Sp	acing		
	Girder Bay	(ft) Start of	End of		
		Girder	Girder		
	1	2.23	2.23		
	2	2.23	2.23		
	3	2.81	2.81		
	4	1.65	1.65		
	6	2.81	2.81		
	7	2.81	2.81		
	8	1.65	1.65		
	9	2.23	2.23		
	10	2.23	2.23		
	11	2.23	2.23		
	12	2.81	2.81		
	13	1.65	1.65		

Description Factors	ingine	
Default rating method	ASD	
Analysis module ASD: Madero ASD		
Timber deck type:	Nail-Laminated Deck	
Timber material	Colorado Douglas Fir B 🔽	
Total deck thickness:	6.0000 in Nominal thick: 3.0000 in	
Lamination thickness:	3.0000 in Nominal width: 6.0000 in	
Deck LL distribution width:	21.0000 in	
Nail:	20 Pennyweight	

Distance from left edge of deck t superstructure definition ref. line	o Distance from ri superstructure o	ight eo definiti	ige of deck to on ref. line					
Deck thickness	Le Superstructu		finition [ [	*				
.eft overhang			  +	↓ Right overhang				
Deck Parapet Railing Generic	Lane position	Str	iped lanes	Wearing surface	)			
Superstructure definition reference line i	s within		✓ the bridge	ge deck.				
	Start		End					
Distance from left edge of deck to superstructure definition reference line:	15.00	ft	15.00	ft				
Distance from right edge of deck to superstructure definition reference line:	15.00	ft	15.00	ft				
Left overhang:	0.51	ft	0.51	ft				
Computed right overhang:	0.51	ft	0.51	ft				

#### Complete Structure Typical Section information:

Complete each girder Supports information: A Supports Х 2 1 7 General Elastic 3D General **3D Elastic** Translation constraints Rotation constraints Support Support number type Х Y Ζ V V Þ 1 Pinned \* 2 • 1 Roller OK Cancel Apply

13-59

🕰 Default Materia	ls		_	
Member alterna	tive name: EXT GIRDER			
Deck timber:	Colorado Douglas Fir Deck	~		
Beam timber:	Colorado Douglas Fir BeamsStringers	~		
	20 Pennyweight			

OK Apply

Cancel

Beam Details	mber Stringers			-	0
General Adjust	ment factors Suppo	rt lengths			
Beam shape: 6.0 Material: Sp Beam projectio Left: 12.0000 Right: 12.0000	its Colorado Dougla 🔽 nin	3			
r New Steel Member Alternative Des member alternative: Rolla			OK	Apply	] [ (
Description Specs	Factors Engine Import		eel		
Girder property input Schedule based Cross-section base	Left: 6.0000	Default units:	lulti Girder System S Customary		

CDOT Bridge Rating Manual

Standard Distribu	ution Factor	Input M	ethod			
٥Us	e Simplified	Method	OUs	e Advanced M	ethod	
Action: Suppor Number		↓ Length (ft)	End	Distributio (Lar 1 Lane	Contract and a second second second second second second second second second second second second second second	
1 🗸	0.00	23.000	23.00	0.333	0.297	

Rating results are shown below for the existing sound timber stringers in ASD and the new sister-beam in LRFR.

Rated using: Asphalt thickness:	3 in.			Batch I.D	Intectionation	
Colorado legal	loads	Multi-lane for Legal & Pe Single lane for Legal & Pe	rmit Vehicles rmit Vehicles	Structure Parallel S	Man particular and a second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second se	TS
Structural Member	Timber					
Structural Member	Timber					
Inventory	34.56	ALL STREET			Section and the	
Operating	49.17					
Type 3 truck	42.04					
Type 3S2 truck	66.17					
Type 3-2 truck	66.17					
Type SU4 truck (27T)	41.71					
Type SU5 truck (31T)	44.63					
Type SU6 truck (35T)	44.83					
Type SU7 truck (39T)	52.22					
NRL (40T)	53.91					
EV2 (28.75T)	44.15					
EV3 (43T)	43.19	NAL STREET				
Permit Truck (96T)	98.92					
Modified Tandem (50T)	61.51					
Type 3 Truck Extensise 24 tons / Colored 42.0 tons		Type 3S2 Truck Interstate 38 tens / Colecado 66.1 tons		Æ	Type 3-2 Truc Interstate 39 tens / Color 66.1 tons	k rado 42.5 tens
Comments: Allowable Bending Allowable Split She Color Code: White	ear Stress = 113				PE 300	

Rated using: Asphalt thickness: Colorado legal Interstate legal		Multi-lane for Legal & Perr ingle lane for Legal & Perr	nit Vehicles nit Vehicles	Batch LD Structure Parallel St	rype TS w	Stee	l Sister-
Structural Member	Steel 12x8						
	Rating Factor						
Inventory	32.79						
Operating	42.51						
	Tons		10000100100				
Type 3 truck	42.08						
Type 3S2 truck	66.23	- and the second second second second second second second second second second second second second second se					
Type 3-2 truck	66.23						
Type SU4 truck (27T)	41.75						
Type SU5 truck (31T)	44.67						
Type SU6 truck (35T)	52.27						
Type SU7 truck (39T)	52.27						
NRL (40T)	53.96		Sector Sector			18.91	
Lane-Type Legal							
EV2 (28.75T)	44.19		No.				
EV3 (43T)	43.23						
Permit Truck (96T)	124.84						
Modified Tandem (50T)	78.60			30			
Type 3 Truck Interstate 24 tons / Colorado 42.1 O		Type 3S2 Truck Interstate 38 tens / Colorado 42.5 66.2 tons		E.	Type 3-2 Interstate 39 to 66.2		42.5 toes
Comments: Steel Sister Beam Color Code: White		5/16.				2 3801	
Rated by: (Print nome and sig		Date: Ch		rint nome on		ACCESSION ON A CONTRACT	Date:

# SECTION 14 CONCRETE BOX CULVERT

### 14.1 INTRODUCTION TO RATING CONCRETE BOX CULVERTS

This section covers the rating of cast-in-place (CIP) concrete and pre- cast box culverts. All concrete box culverts are to be rated using the policies and guidelines of the Bridge Rating Manual, Section 1 and Subsections 14-2 and 14-3.

The rating of other culverts is discussed in Section 14A.

When there are no plans available for the concrete box culverts being rated, the requirements in Subsection 1.7, and 14.2 (III) shall be used.

For CBC extension projects, the rating process shall follow the CDOT Bridge Rating Manual, Section 1-17.

The types of rigid culverts covered by this section are:

- CBC Concrete Box Culvert
- PCBC Concrete Box Culvert, Pre-Cast

The types of culverts not covered by this section are:

- AAC Aluminum Arch Culvert
- CAC Concrete Arch Culvert
- RCPC Reinforced Concrete Pipe Culvert
- RAC Rubble Arch Culvert
- SAC Steel Arch Culvert
- TBC Timber Box Culvert
- TTC Timber Culvert
- CMP Corrugated Metal Pipe

# 14.2 POLICIES AND GUIDELINES FOR RATING CONCRETE BOX CULVERTS

#### 14.2.1 General

- A. All existing ASD & LFD CBCs shall be rated or rerated with LFR or LRFR methods, All LRFD CBCs shall be rated with LRFR method
- B. All major concrete box culverts (i.e. length greater than 20' between inside faces of outside walls) shall be rated by the AASHTOWARE BrR program. The Rater shall verify with the Staff Bridge Rating Coordinator that the version number of the program being used is identical to CDOT'S version number. Data files created using a lower, or higher version of the program shall be rejected, except if approved by the Bridge Rating Engineer. Programs other than AASHTOWARE BrR must be approved in advance by the Bridge Rating Engineer. If CDOT standard plans (i.e. M-601-1, M-601-2 and M-601-3) are used in the design, the BrR xml files for each type and size of CBC are available and can be provided by Staff Bridge if requested.
- C. Inventory and operating Design Load Rating levels shall be performed for the HS20-44 loading when LFR method is used and the HL93 loading when LRFR method is used. Also, the Legal Load Rating and Permit Load Rating levels shall comply with BRM subsection 1.2.

Note: For LFR live load distribution factors refer to "The AASHTO Standard Specifications", "The AASHTO Manual for Bridge Evaluation", and the "AASHTO LRFD/LRFR/LFD Culvert Method of Solution Manual."

For LRFR live load distribution factors refer to "The AASHTO LRFD Specifications", "The AASHTO Manual for Bridge Evaluation", the "AASHTO LRFD/LRFR/LFD Culvert Method of Solution Manual."

D. When the depth of the fill exceeds 8.0 feet and exceeds the clear span for a single-cell culvert or exceeds the distance between interior faces of the outer walls for a multiple-cell culvert, live load analysis is not required. For how to report the load ratings, see the BRM subsection 1.14, but an xml file still required. The controlling depth of fill shall be recorded on the Rating Summary Sheet with the notation "live load is negligible".

#### 14.2.2 Calculations

- A. A set of calculations, separate from computer output, shall be submitted with each rating package. These calculations shall include derivations for dead loads and any other calculations or assumptions used for rating.
- B. Dead Loads
  - 1. The final sum of all the individual weight components for dead load calculations may be rounded up to the next 5 pounds.
  - 2. Dead loads include fill, curbs, sidewalks, railing, etc.
- C. Use the minimum design yield strength value Fy and the minimum compressive strength of concrete F'c from plans if not shown refer to Section 1.5.

#### 14.2.3 Guidelines for using Engineering Judgement / Visual Rating

When performing visual ratings, either the Rating Engineer or the Rating Checker shall be a Colorado Registered Professional Engineer.

The following provides guidelines for visual ratings:

Step 1: Pull the structure folder.

Step 2: Look for plans in the folder that are sufficient to perform the rating analysis. If the folder has plans that completely detail the reinforcement as well as notes that call out a specific design fill height together with all corresponding sheets from the M-Standard (if the culvert was designed using the CDOT M-Standard); the structure shall be rated using the AASHTOWARE BrR (formerly Virtis, preferred software), Brass Culvert or other approved program.

Step 3: Look at the fill height, item 66T on the SIA Sheet, and inspection sketch. Live load contribution through fill will be assumed as per the Bridge Rating Manual section 14.2.1(D).

Step 4: Look at the condition state, item 62 on the SIA sheet. In general NBI condition rating of 6 and above will not require a reduction in live load carrying capacity.

Step 5: Review the inspection notes and photos. Look for signs of live load deterioration such as:

- Essential repairs with any load restrictions.
- Transverse cracking that is breaking up, delaminating or spalling. Transverse cracking is cracking normal to the culvert span. These cracks could indicate a reduced shear or flexural capacity.
- Guidance on crack width will be taken from the Pontis coding guide. The Pontis coding guides states a crack width 3/32" or less will not significantly reduce strength. Cracks greater than 3/32" will warrant further analysis. Cracking longitudinal to the culvert span is typically due to shrinkage and differential settlement. Cracking longitudinal to the culvert span will not warrant further investigation.
- Pending essential repairs that affect the structural integrity.
- Exposed rebar located in high moment and shear regions.
- Spalling not caused by debris impact.
- Spalling caused by debris impact in a high shear or high moment region.
- Excessive deflection noted in top/bottom slab and walls during inspection.
- Essential repairs with severe scour and settlement.

If clarification of inspection notes is necessary, the Rater or Rating Checker shall meet with the inspector to clear up any questions.

Step 6: If no live load carrying capacity reduction is warranted, fill out and sign the rating summary sheet. The numerical value will be based on section 1.7.2(B). The following notes should appear on the rating summary sheet.

- Total structure length (Inside face to inside face of exterior walls).
- Fill height (shown in tenth of feet).
- Plans availability (yes, no or partial).

- Describe any load induced damage (if none, state none).List any pending essential repairs (if none, state none).
- NBI condition state coding for Item 62.
- Describe any damage that has a direct effect on load rating capacity (if none, state none). Also note the inspection date the distress as first identified.
- Color Code assignment.
- When Fill Height controls live load rating, use this note "Live load is negligible per section 14-2 of the CDOT Bridge Rating Manual."
- "Visually Rated" will be noted in the Comments section of the Rating Summary Sheet.

Step 7: If live load reduction is required based the criteria in Step 5, the rater shall assign a reduced load rating as described in the Step 6. The rater shall document a color code recommendation along with the fill height, location and magnitude of distress. For onsystem structures, this documentation shall be submitted to the Staff Bridge Rating Unit. The Staff Bridge Rating Unit will coordinate a review panel. At a minimum, this review panel shall consist of the Staff Bridge Engineer, Staff Bridge Rating Engineer and Staff Bridge Inspection Engineer. This panel will make the final decision on any live load restrictions.

Step 8: Turn the structure folder and rating summary sheet over to the checker for review. The checker shall verify compliance with steps 2 through 6 above. If satisfactory and in agreement, the checker shall sign the summary sheet. If it is not satisfactory, the checker will send comments to the rater and find agreement prior to signing.

Step 9: The checker shall follow the CDOT Bridge Rating Archiving Policy Memo before submitting the rating package to the Bridge Rating Unit.

The foregoing applies to off-system structures except for the review panel in step 7, the color code in step 6 and step 9.

# 14.3 RATING REPORTING AND PACKAGING REQUIREMENTS

#### 14.3.1 Rating Reporting / Package Requirements

- A. A copy of the AASHTOWare BrR reinforcement schematic drawing showing the elevation and applied loads shall be included with the rating package.
- B. The rater and checker shall complete the rating documentation (i.e. the rating QA checklist) as described in Section 1 of the Bridge Rating Manual. Any variation from the original design assumptions shall be added to the Rating Summary Sheet as applicable. The rating package requirements shall be per Section 1.13 of the Bridge Rating Manual and as amended here.

#### 14.3.2 Consultant Requirements

- A. Consultant designed projects Before finalizing the rating package and when AASHTOWare BrR is used as the analysis tool, the Rater shall verify with the Staff Bridge that the version number of the program being used is identical to CDOT'S version number. Data files created using a lower, or higher version of the program shall be rejected, except if approved by the Bridge Rating Engineer.
- B. When the rating is finalized, the rater shall save the input files in ".xml" format. The file name shall include the structure number of the rated CBC (i.e., O-14-BY.xml). The rating package including input program file, Rating Summary Sheet and necessary computations in pdf shall be transmitted electronically to Staff Bridge for archiving.

#### 14.4 CONCRETE BOX CULVERT RATING EXAMPLES

Two examples are presented in this section. First, Structure X-01-X is a 3-cell culvert with 3 feet of asphalt and fill. The structure has a 6 inch asphalt overlay. This structure is rated using a HS20-44 truck and lane live load, Colorado Permit Vehicle, Colorado Legal Type 3, 3S2, 3-2 vehicles, NRL, SU4 thru SU7 and EVs vehicles.

The second structure, X-02-X, is a single-cell culvert with a skew of 10° degrees. The culvert has 6 feet of fill. It also carries a 4 inch asphalt roadway. This structure is rated using a HL-93 truck and lane live load, Colorado Permit Vehicle, Colorado Legal Type 3, 3S2, 3-2 vehicles, NRL, SU4 thru SU7 and EVs vehicles.

#### 14.4.1 AASHTOWare BrR Program - Version 7.2

Example 1 (LFR) – Structure No. X-01-X

From the Bridge Explorer, select File New New Bridge to create a new bridge and then enter the following description information.

ridge ID: X-01-X		NBI structure	HD (8): X-01-X		E Templ		etely defined	Culv	erstruc erts structu
Description Desc	ription (cont'd)	Alternatives	Global reference point	Traffic	Custom age	ncy field	ds		
Name:	Culvert Example				Year bu	ilt:	1982		
Description:	3-cell reinforced 3" asphalt. 45 pl s								
Location:	Town CO				Length		36.00	ft	
Facility carried (7):	US X				Route r	umber:	US X		
Feat. intersected (6):	Creek Y				Mi. pos	t:	100.00		
Default units:	US Customary	$\sim$							

Bridge ID: X-01	v				Template	Super	struc
	-^	NBI structure	ID (8): X-01-X		Bridge completely defined	d 🗹 Culver	rts
						Subst	ructi
Description	Description (cont'd)	Alternatives	Global reference point	Traffic	Custom agency fields		
District (2):			~				
County:			~				
Owner (22):	State Highway Ager	су	~				
Maintainer:	State Highway Ager	су	~				
Admin area:			~				
NHS Indicator:	1 On the NHS		~				
Functional clas	s: 11 Urban Interstate		~				

	_		Template	Superstr
Bridge ID: X-01-X	NBI structure ID (8): X-01-X		Bridge completely defined	Culverts
Description Description (cont'o	l) Alternatives Global reference point	Traffic Custo	m agency fields	
Truck PCT:	15 %			
ADT:	22000			
Directional PCT:	50.0 %			
Recent ADTT:	1650 Compute			
Design ADTT:				
Exp. annual $ADTT_{SL}$ growth rate:				
Fatigue importance factor:	Main Arterial, Interstate, Other	~		
	Importance factor override			
(ADTT <sub>SL</sub> ) <sub>0</sub> :				
(ADTT <sub>SL</sub> ) <sub>PRESENT</sub> :				
(ADTT <sub>SL</sub> ) <sub>LIMIT</sub> :				
	BrR 🖌 BrD 🔄 BrM			
Bridge association				
Bridge association				

Close the window by clicking OK. This saves the data to memory and closes the window.

Check In Workspace   Workspace # ×   Bridge Schematic   Bridge Manage     Report     Bridge     Bridge     Report     Bridge     Bridge </th <th>Brie Brie</th> <th>dge Workspace - X-</th> <th>01-X</th> <th></th> <th>ANALYSIS</th> <th></th> <th></th> <th></th> <th></th> <th>?</th> <th>-</th> <th>□ &gt;</th>	Brie Brie	dge Workspace - X-	01-X		ANALYSIS					?	-	□ >
Check In Workspace   Workspace # ×   Bridge Schematic   Bridge Manage     Report     Bridge     Bridge     Report     Bridge     Components     Culvert Definitions     Culvert Definitions     Culvert Definitions     Culvert Definitions     Culvert Definitions     Bridge AlternAtives     Report	BRIDGE WORKSPACE	WORKSPACE	TOOLS	VIEW	DESIGN/RATE							
Workspace       # ×         Bridge       Components         Image: Components       Image: Components         Image: Components       Image: Components         Image: Components       Image: Components         Image: Components       Image: Components         Image: Components       Image: Components         Image: Components       Image: Components         Image: Components       Image: Components         Image: Components       Image: Components         Image: Components       Image: Components         Image: Components       Image: Components         Image: Components       Image: Components         Image: Components       Image: Components         Image: Components       Image: Components         Image: Components       Image: Components         Image: Components       Image: Components         Image: Components       Image: Components         Image: Components       Image: Components         Image: Components       Image: Components         Image: Components       Image: Components         Image: Components       Image: Components         Image: Components       Image: Components         Image: Components       Image: Components         Image: Componen	Check In	Revert	· • •	· ·				ate [				
Bridge       Components         Image: Components       Image: Components         Image: Components       Image: Components         Image: Components       Image: Components         Image: Components       Image: Components         Image: Components       Image: Components         Image: Components       Image: Components         Image: Components       Image: Components         Image: Components       Image: Components         Image: Components       Image: Components         Image: Components       Image: Components         Image: Components       Image: Components         Image: Components       Image: Components         Image: Components       Image: Components         Image: Components       Image: Components         Image: Components       Image: Components         Image: Components       Image: Components         Image: Components       Image: Components         Image: Components       Image: Components         Image: Components       Image: Components         Image: Components       Image: Components         Image: Components       Image: Components         Image: Components       Image: Components         Image: Components       Image: Components		Bridge				Ma	nage					
Components Diaphragm Definitions CULVERT DEFINITIONS BRIDGE ALTERNATIVES	Workspace		ųх	Schemati	C		ф	×	Report			ųх
CULVERT DEFINITIONS	iden A X-01-X ···· Ø Componen ···· Ø Diaphragm	Definitions										
BRIDGE ALTERNATIVES	····· 📁 Diaphragm ····· 📁 Lateral Brad	Definitions cing Definitions										
Analysis *												
Analysis *												
Analysis *												
Analysis *												
				Analysis								<b>4</b> ×

# The Bridge Workspace tree after the bridge is created is shown below:

To enter the materials for the culvert, click on the Components and expand the tree for Materials. Double-click on the Concrete folder to create a new concrete material. Enter the following values.

Workspace # ×	🕰 Bridge Materials - Concrete			_		>
Bridge Components	Name: Class D (US)					
🖻 🧭 Appurtenances	Description: Colorado Deck Concrete					
<ul> <li>Image: Image between the second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second secon</li></ul>	Compressive strength at 28 days (f'c):	4.500	ksi			
⊕ Ø Factors ₩ Ø LRFD Substructure Design Settings	Initial compressive strength (f'ci):		ksi			
🖶 🔁 Materials	Composition of concrete:	Normal 🗸				
Concrete     Prestress Bar	Density (for dead loads):	0.150	kcf			
📁 Prestress Strand	Density (for modulus of elasticity):	0.150	kcf			
	Poisson's ratio:	0.200				
📁 Structural Steel	Coefficient of thermal expansion ( $\alpha$ ):	0.000060000	1/F			
🗄 🧭 Timber	Splitting tensile strength (fct):		ksi			
	Compute					
	Std modulus of elasticity (Ec):	3824.00	ksi			
	LRFD modulus of elasticity (Ec):	3824.00	ksi			
	Std initial modulus of elasticity:	0.00	ksi			
	LRFD initial modulus of elasticity:	0.00	ksi			
	Modulus of rupture:	0.503	ksi			
	Shear factor:	1.000				
	Copy to	library Copy f	rom library OK App	ły	Cance	el

When plans are available, use the minimum concrete strength and yield strength values given in the plans. If plan values are not known, values given in Section 1 of the Bridge Rating Manual for the applicable year of construction may be followed.

Double-click on the Reinforcing Steel folder to create a new reinforcement material. Click on the Copy from Library button to copy the Grade 60 reinforcement material to the bridge.

Name:	Grade 60				
Description:	60 ksi reinforci	ng steel			
Material prop	perties				
Specified yie	ld strength (fy):	60.000	ksi		
Modulus of e	elasticity (Es):	29000.00	ksi		
Ultimate stre	ngth (Fu):	90.000	ksi		
Туре —					
Plain					
О Ероху					
Galvan	ized				

Name:	Standard Soil 1			
Description:	Standard Soil 1			
Soil unit loa	d:	120.000	pcf	
Saturated so	oil unit load:	125.000	pcf	
At-rest later	al earth pressure coefficient (LRFD/LRFR):	0.50		
Active latera	I earth pressure coefficient (LRFD/LRFR):	0.33		
Passive later	al earth pressure coefficient (LRFD/LRFR):	3.00		
Maximum la	teral soil pressure (LFD):	60.000	pcf	
Minimum la	teral soil pressure (LFD):	30.000	pcf	

Standard Soil 1 uses for LFD and LRFD Specifications. Standard Soil 2 uses for ASD Specification. Double-click on the CULVERT DEFINITIONS folder to create a new culvert definition. Enter the Culvert Definition name as show below. The first Culvert Alternative that we create will automatically be assigned as the Existing and Current Culvert Alternative for this Culvert Definition.

Bridge Components				
□	Name:	Culvert X-01-X		
Components     Image: Image is a state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state o		3 cell CBC		
Clateral Bracing Definitions     CULVERT DEFINITIONS     BRIDGE ALTERNATIVES     Default units: US Customary				
BRIDGE ALIERNATIVES	Default units:	US Customary	92 	
	Existing	Current Culvert alternative name	Description	

# щ× Schematic # × Report ų× Workspace Bridge Components Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image: Image Diaphragm Definitions Dateral Bracing Definitions Lateral bracing Definitions CULVERT DEFINITIONS □ CulvertX-01-X □ Linpact/Dynamic Load Allowar □ ↓ Impact/Dynamic Load Allowar □ ↓ Toefault Materials H Roadway Plan View Culvert Loads CULVERT ALTERNATIVES BRIDGE ALTERNATIVES Analysis щ × < >

#### Expand the tree for Culvert Definition X-01-X.

Double-click on the CULVERT ALTERNATIVES folder to create a new culvert alternative for Culvert X-01-X. Enter the data as show below.

lvert alternativ	es: Culve	ert Alt 1						
Description	Specs	Factors	Control	options	)			
Description:	3-cell rei	nforced cor	icrete box	(LFR exar	nple)		Culvert type: RC Box	
Default units	:		U	IS Custon	hary	~	Construction type	
Top slab exte	rior surfac	e exposure:	factor: 0	.75			Cast-in-place Precast	
Bot. slab exte	erior surfac	ce exposure	factor:				O Precast	
Wall exterior	surface ex	cposure fact	tor:				Default rating method: LFD	
Interior surfa	ce exposu	re factor:						
Soil								
						, _L	FD EH load factor	
Installa	tion metho	od:	ļ	Embank	ment 🗸		At-rest 🔾 Active	
Side	fill condition	on					FD/LRFR earth pressure coefficient	
	Compact		ompact				At-rest	
Soil-str	ucture inte	eraction fact	tor (LRFD):				Active	
		eraction fact				(	Passive	
50II-stri	Jcture inte	raction fact	or (LFD):					

# Expand the tree for Culvert Alt 1.

Double-click on RC Box Culvert Geometry in the tree. Enter the data as shown below. Click Ok to save the data to memory and close the window.

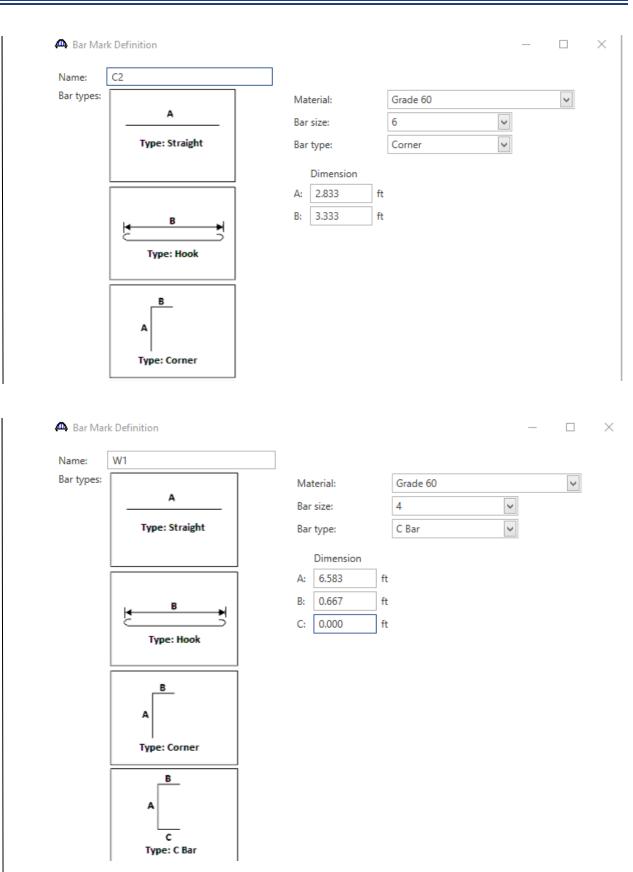
Number of cells:	3 💭 5.000 ft	Bottom slab present Horiz. construction joint height:	0.00	in	
Cell Width (ft)				-	
1 12.000					
2 12.000					
3 12.000					
	Haunch Width Haunch Depth	Haunches Top haunch width: Top haunch depth: Bottom haunch width:	4.00 4.00 4.00	] in ] in ] in	
Cell Height		Bottom haunch depth:	4.00	in	

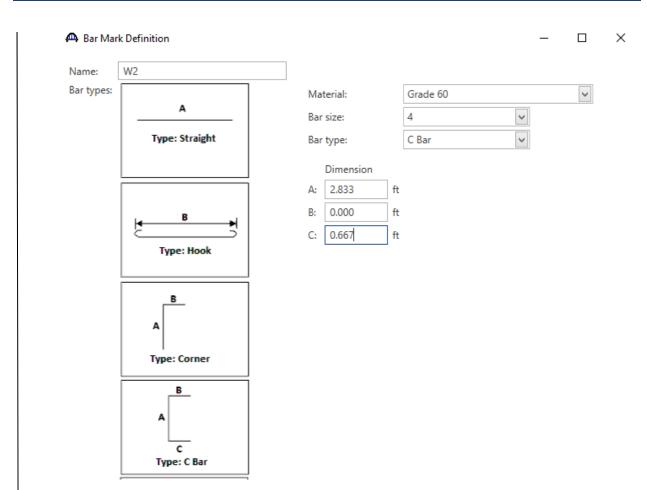
🕰 End Conditions	_		×
<ul> <li>Moment release at top of walls</li> <li>Moment release at bottom of walls</li> <li>Provide side sway support</li> </ul>			
Provide spring support			
Subgrade modulus: pci			
OK	Apply	Cancel	

Double-click on the Bar Mark Definitions folder in the tree to create a new bar mark definition for Culvert Alt 1.

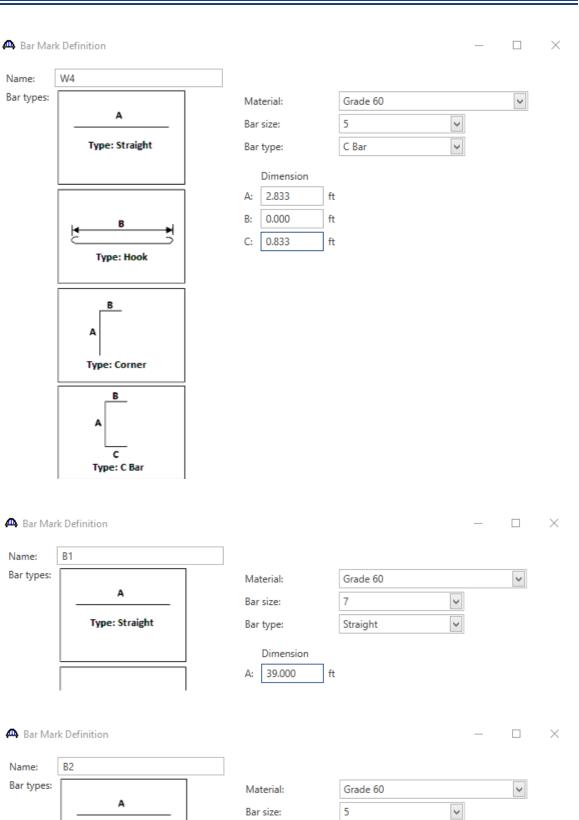
Enter the data for C1 as shown below. Click Ok to save the data to memory and close the window. Repeat the process for all bars (C2, W1, W2, W3, W4, B1, B2, T1, and T2) as shown.

Name: (	C1				
Bar types:	А	Material:	Grade 60		~
		Bar size:	5	~	
	Type: Straight	Bar type:	C Bar	~	
L		Dimension			
ſ		A: 6.583 fi			
	l <del>∢ B</del> →	B: 2.750 fi			
	Type: Hook	C: 0.000 fi	t		
	Type: Hook				
Ī	в				
	A				
	Type: Corner				
Ī	B				
	A				
	C Type: C Bar				
	B A I C				
	Type: Bent				
	  ← A Type: WWR				





Name: \	W3				
Bar types:	А	Material:	Grade 60		~
	Type: Straight	Bar size: Bar type:	5 C Bar	~	
		Dimension			
Γ		A: 6.583	ft		
	B J	B: 0.833	ft		
		C: 0.000	ft		
	Type: Hook				
	A				
	Type: Corner				
Ī	B				
	A				



Bar type:

Dimension A: 39.000 Straight

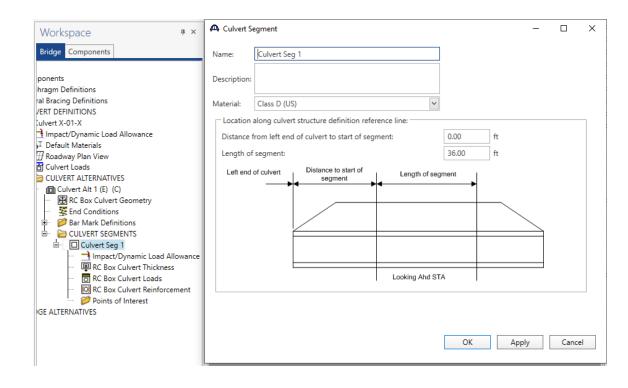
ft

Type: Straight

v

Name:	T1				
Bar types:		Material:	Grade 60		~
	A	Bar size:	7	~	
	Type: Straight	Bar type:	Straight	~	
		Dimension			
🕰 Bar Marl	k Definition	A: 39.000	ft	_	
🕰 Bar Marl Name:	k Definition	A: 39.000	ft	_	
r		A: 39.000	ft Grade 60	_	
Name:				-	
Name:	T2	Material:	Grade 60	>	

Double-click on the CULVERT SEGMENTS folder to create a new culvert segment for Culvert Alt 1. A culvert alternative may have one or more culvert segments. Enter the data as shown below.



RC Box Culvert Thickness

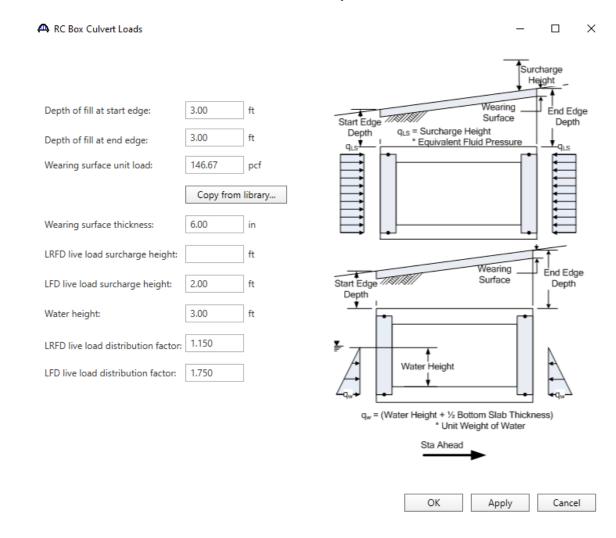
Expand the tree for Culvert Seg 1. Double-click on RC Box Culvert Thickness in the tree. Enter the slab and wall thicknesses as shown below. Click OK to save the data to memory and close the window.

	Cell	Top slab thickness (in)	Bottom slab thickness (in)	
Þ	1	9.50	11.00	
	2	9.50	11.00	
	3	9.50	11.00	

	Wall	Thickness (in)	
	1	10.00	A
	2	10.00	
	3	10.00	
Þ	4	10.00	

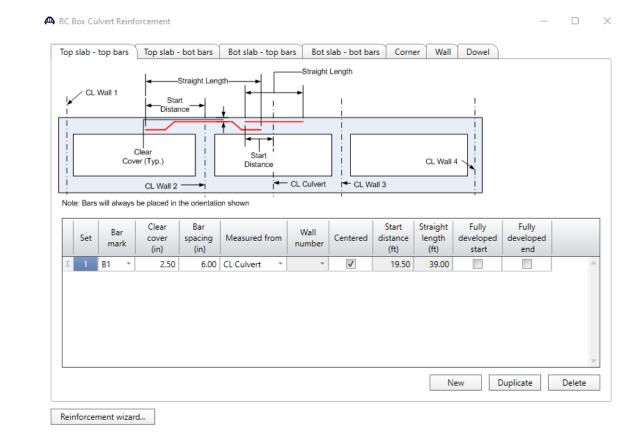
 $\times$ 

Double-click on RC Box Culvert Loads in the tree. Enter the culvert loads for Culvert Seg 1 as shown below. The wearing surface thickness includes the equivalent for the rail dead load. Click OK to save the data to memory and close the window.



Use water height half the rise of the culvert.

Double-click on RC Box Culvert Reinforcement in the tree. Enter the reinforcement data as shown below for each location. Click Ok to save the data to memory and close the window.



OK	Apply	Cancel
----	-------	--------

Top slab - top bars       Top slab - bot bars       Bot slab - top bars       Bot slab - bot bars       Corner       Wall       Dowel			Ilvert Reinf	orcement								
Length       Distance       Straight Length         Clear       Start       Start         Cover (Typ.)       Left Face Wall       CL Culvert         Note: Bars will always be placed in the orientation shown         Set       Bar       Clear         (in)       Resured from       Cell/Wall         Centered       Start       Straight         Fully       Fully         developed       end	Тор	slab -	top bars	Top slab ·	bot bars	Bot slab - top ba	ars Bot s	slab - bot ba	ars Corn	er Wall	Dowel	
Note: Bars will always be placed in the orientation shown       Set     Bar cover (in)     Bar (in)     Measured from (in)     Cell/Wall number     Centered     Start distance (ft)     Straight developed developed end		-	Ler C	ear		nce		• •	Start	.ength		
mark (in) (in) number (ft) (ft) start end	Not		Bar	be placed in Clear	the orientat	tion shown	Cell/Wall		Start	Straight	Fully	
1 12 * 1.50 6.00 CL Culvert * * V 19.50 39.00				(in)	(in)				(ft)	(ft)	start	

OK Apply Cancel

Cancel

	slab -	top bars	Top slab -	bot bars	Bot slab - top b	ars Bot s	lab - bot ba	ars Corne	er Wall	Dowel		
No	te: Bar	s will alway	s be placed i	n the orienta	ation shown							
			Left Face	Wall Ri	ght Face Wall	- CL Culvert		i	- CL Cel	I		
	•	—Straight I	Start Distance	Clear Cover (T Cover (T Cover (T Cover (T	yp.)			Start istance	Length	<b></b>		
	Set	Bar mark	Clear cover (in)	Bar spacing (in)	Measured from	Cell/Wall number	Centered	Start distance (ft)	Straight length (ft)	Fully developed start	Fully developed end	
Þ	1	B2 ~	1.50	6.00	CL Culvert *	-	<b>v</b>	19.50	39.00			
											Duplicate	D

ОК

Apply

#### 🕰 RC Box Culvert Reinforcement

– 🗆 🗙

	— CL		CL Wall 2 lear rr (Typ.)		Start Central Straight		+ CL W	'all 3	CL Wall			
	Set	Bar mark	Clear cover (in)	Straight Len Bar spacing (in)	gth	Wall number	Centered	Start distance (ft)	Straight length (ft)	Fully developed start	Fully developed end	
÷.	1	B1 ₹	3.00	6.00	CL Culvert *	Ŧ	$\checkmark$	19.50	39.00			
									N	lew D	Duplicate	Dele

#### 🕰 RC Box Culvert Reinforcement

– 🗆 🗙

op siai	b - top b	ars	Top slab ·	- bot bars	Bot slab -	top bars B	Bot sla	b - bot bar	s Corner	Wall Do	owel	
			C Bars					Corner E	Bars			
Ш	Wall C	ear	Slab Cle	or			CL	ab Clear	Well Olean	8		
-	Cove		Cover	ai	ما	CL Culvert		Cover	Wall Clear Cover	→ <b>←</b>		
	_					_	-	+	-	-		
			1				!	1				
						-	÷l +	Wall Clear Cover				
					Il Clear			Cover				
					over					1		
							1					
				-		_	1	-				
					CL Interio	or Wall	1					
Note: E	Bars will a	lway	s be placed in	n the orientati	on shown							
	Ba		Wall clear	Slab clear	Bar			Wall	Fully	Fully		
Note: Bar	t mai		cover	cover	spacing	Location	n	Number	developed	developed		
		~	(in)	(in)	(in)				vert	horz		
1	C2	-	2.00	3.00	6.00	Bottom Right	t -	1 *				
2	C2	Ŧ	2.00	3.00	6.00	Bottom Left	-	4 *				
2		* *	2.00 2.00	3.00 2.50	6.00 6.00	Bottom Left Right	* *	4 * 1 *				
	C1					Right		-				
3	C1 C1	Ŧ	2.00	2.50	6.00	Right Left	•	1 *				
3	C1 C1 W1	*	2.00 2.00	2.50 2.50	6.00 6.00	Right Left Right	*	1 ~ 4 ~				
3 4 5	C1 C1 W1 W1	* * *	2.00 2.00 8.50 8.50	2.50 2.50 2.50 2.50	6.00 6.00 6.00 6.00	Right Left Right Left	*	1 · 4 · 1 ·			· · ·	
3 4 5 6 7	C1 C1 W1 W1 W2	* * *	2.00 2.00 8.50 8.50 8.50	2.50 2.50 2.50 2.50 2.50 55.50	6.00 6.00 6.00 6.00 6.00	Right Left Right Left Right	*	1 ~ 4 ~ 1 ~ 4 ~ 1 ~			· · · ·	
3 4 5 6 7 8	C1 C1 W1 W1 W2 W2 W2	* * *	2.00 2.00 8.50 8.50 8.50 8.50	2.50 2.50 2.50 2.50 55.50 55.50	6.00 6.00 6.00 6.00 6.00 6.00	Right Left Right Left Right Left	*	1 * 4 * 1 * 4 * 1 * 4 * 1 *				
3 4 5 6 7 8 9	C1 C1 W1 W1 W2 W2 W2 W3	* * * *	2.00 2.00 8.50 8.50 8.50 8.50 8.50 1.50	2.50 2.50 2.50 2.50 55.50 55.50 2.50	6.00 6.00 6.00 6.00 6.00 6.00 6.00	Right Left Right Left Right Left Left	* * * *	1 * 4 * 1 * 4 * 1 * 4 * 2 *				
3 4 5 6 7 8 9 10	C1 C1 W1 W1 W2 W2 W2 W2 W3 W3	* * * *	2.00 2.00 8.50 8.50 8.50 8.50 1.50 1.50	2.50 2.50 2.50 55.50 55.50 2.50 2.50 2.5	6.00 6.00 6.00 6.00 6.00 6.00 6.00 6.00	Right Left Right Left Left Left Left Left	* * * * *	1 * 4 * 1 * 4 * 1 * 4 * 2 * 3 *				
3 4 5 6 7 8 9 10 11	C1 C1 W1 W1 W2 W2 W2 W3 O W3 W3	* * * * *	2.00 2.00 8.50 8.50 8.50 1.50 1.50 1.50	2.50 2.50 2.50 2.50 55.50 55.50 2.50 2.5	6.00 6.00 6.00 6.00 6.00 6.00 6.00 6.00	Right Left Right Left Left Left Left Left Right	* * * * *	1 * 4 * 1 * 4 * 1 * 4 * 2 * 3 * 2 *				
3 4 5 6 7 8 9 10 11 12	C1 C1 W1 W1 W2 W2 W3 O W3 U W3 Q W3	* * * * *	2.00 2.00 8.50 8.50 8.50 1.50 1.50 1.50 1.50	2.50 2.50 2.50 55.50 55.50 2.50 2.50 2.5	6.00 6.00 6.00 6.00 6.00 6.00 6.00 6.00	Right Left Right Left Left Left Left Left Right Right	* * * * *	1     ~       4     ~       1     ~       4     ~       1     ~       4     ~       2     ~       3     ~				
3 4 5 6 7 8 9 10 11 12 13	C1 C1 W1 W1 W2 W2 W3 W3 W3 W3 W3 W3 W3 W3 W3 W3	* * * * * *	2.00 2.00 8.50 8.50 8.50 1.50 1.50 1.50 1.50 1.50	2.50 2.50 2.50 55.50 2.50 2.50 2.50 2.50	6.00 6.00 6.00 6.00 6.00 6.00 6.00 6.00	Right Left Right Left Left Left Left Left Right Right Left Left	* * * * * * * *	1     ~       4     ~       1     ~       4     ~       1     ~       4     ~       2     ~       3     ~       2     ~       3     ~       2     ~       3     ~       2     ~				
3 4 5 6 7 8 9 10 11 12	C1 C1 W1 W1 W2 W2 W2 W3 W3 V3 V3 V3 V3 V3 V3 V3 V3 V3 V4 V4 V4	* * * * * *	2.00 2.00 8.50 8.50 8.50 1.50 1.50 1.50 1.50	2.50 2.50 2.50 55.50 55.50 2.50 2.50 2.5	6.00 6.00 6.00 6.00 6.00 6.00 6.00 6.00	Right Left Right Left Left Left Left Right Right Left Right Left Right		1     ~       4     ~       1     ~       4     ~       1     ~       4     ~       2     ~       3     ~				

Reinforcement wizard...

OK Apply

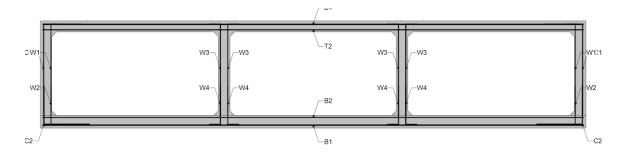
Duplicate

Delete

Cancel

New

Select Bridge Schematic to review the reinforcement data.



The description of the three-cell reinforced concrete box culvert is now complete.

Select File | Save to save the file in BrR.

Double-click on Bridge Alternatives to create a Bridge Alternative name. Enter the Alternative name as show below.

ternative name: X-01- Description Substru Description: Horizontal curvatur Reference line length: Start bearing Starting station: Bearing: Bridge alignment © Curved	ictures	Global positioning Distance: Offset: Elevation: Start tangent length:	ft ft ft	ft
Description: Horizontal curvature Reference line length: Start bearing Starting station: Bearing: Bridge alignment	re ft C End bearing ft	Distance: Offset: Elevation:	ft ft ft	ft
Bridge alignment	N 90^ 0' 0.00" E	Start tangent length:		ft
		Start tangent length:		ft
<ul> <li>Tangent, curved,</li> <li>Tangent, curved</li> <li>Curved, tangent</li> </ul>	tangent	Curve length: Radius: Direction: End tangent length:	Left V	ft ft ft
Superstructure	Culvert wizard			
wizard				Canc
		Superstructure Culturer without	Superstructure	Superstructure wizard Culvert wizard

Click Ok to save the data to memory and close the window.

Double-click on Culverts to create a culvert name. Enter the Culvert name as show below.

Bridge Components	🕰 Culvert	_		$\times$
<ul> <li>A X-01-X</li> <li>Components</li> <li>Diaphragm Definitions</li> <li>Zateral Bracing Definitions</li> <li>CULVERT DEFINITIONS</li> </ul>	Name: Culvert X-01-X Description Alternatives			
□ Culvert X-01-X □ ☐ Impact/Dynamic Load Allowance □ ↓ Default Materials	Description:			
∰ Roadway Plan View 窗 Culvert Loads	Reference Line			
ー CULVERT ALTERNATIVES ー 面 Culvert Alt 1 (E) (C)	Distance: ft			
🕀 RC Box Culvert Geometry	Offset: ft			
Stand Conditions ⊕ 100 Bar Mark Definitions	Angle: 0.00 Degrees			
BRIDGE ALTERNATIVES	Starting station: ft			
CULVERTS				
	ОК	Apply	Canc	el

Click Ok to save the data to memory and close the window.

Double-click on Culvert Structure Alternatives to create a culvert name. Enter the Culvert Structure Alternative name as show below.

Bridge Components						
X-01-X	A Culvert Structu	re Alternative		_		$\times$
🧭 Components				_		
📁 Diaphragm Definitions	Name:	Culvert				
📁 Lateral Bracing Definitions						
CULVERT DEFINITIONS	Description:					
En Culvert X-01-X	Description					
📑 Impact/Dynamic Load Allowance						
🗗 Default Materials	Culvert definition:	Culvert X-01-X	`	-		
👭 Roadway Plan View			Long Long Long Long Long Long Long Long			
Culvert Loads						
CULVERT ALTERNATIVES						
⊡ Culvert Alt 1 (E) (C)						
End Conditions						
Bar Mark Definitions						
E CULVERT SEGMENTS						
i □ Culvert Seg 1						
BRIDGE ALTERNATIVES						
🛓 🗛 X-01-X (E) (C)						
🗄 🗁 CULVERTS			OK Ap	vlv	Cance	-
🗄 🔲 Culvert X-01-X				.,	Curree	
CULVERT STRUCTURE ALTERNATIVES						

Click Ok to save the data to memory and close the window.

To perform LFD Design Load Rating, open the Analysis setting window by selecting Bridge | Analysis Settings. Select LFD as the Rating Method and specify the vehicles. Under Vehicles  $\rightarrow$  Advanced.. select Single Lane Loaded for Colorado Permit Vehicle and Modified Tandem.

BrB	Bridge Workspace - X-01-X	ANALYSIS			? –		×
BRIDGE WORKSPA	CE WORKSPACE TOOLS VIEW	DESIGN/RATE					^
Analysis Analyze	Analysis Settings				_		×
Settings Analysis	O Design review   Rating		Rating method:	LFD	~		
Schematic	Analysis type: Line Girder	~					
Workspace Bridge Compo	Lane / Impact loading type: As Requested	~	Apply preference setting	g: None	~		
🖻 🕰 X-01-X	Vehicles Output Engine Descrip	otion					
🕀 🧭 Con	Traffic direction: Both directions	~	Refresh	Temporary vehicles	Advanced		
📁 Late	Vehicle selection	,	Vehicle summa	*			_
	<ul> <li>Standard</li> <li>Alternate Military Loading</li> <li>EV2</li> <li>EV3</li> <li>H 15-44</li> <li>H 20-44</li> <li>HS 15-44</li> <li>HS 20-44</li> <li>SU5</li> <li>SU4</li> <li>SU5</li> <li>SU6</li> <li>SU7</li> <li>Type 3-3</li> <li>Type 3-3</li> <li>Colorado Legal Type 3</li> <li>Colorado Legal Type 3</li> <li>Colorado Legal Type 3-2</li> <li>Colorado Legal Type 3-2</li> <li>Colorado Legal Type 3-2</li> <li>Colorado Legal Type 3-2</li> <li>Interstate Legal Type 3-2</li> <li>Interstate Legal Type 3-2</li> <li>Interstate Legal Type 3-2</li> <li>Interstate Legal Type 3-2</li> <li>Interstate Legal Type 3-2</li> <li>Interstate Legal Type 3-2</li> <li>Interstate Legal Type 3-2</li> <li>Interstate Legal Type 3-2</li> <li>Interstate Legal Type 3-2</li> <li>Interstate Legal Type 3-2</li> <li>Interstate Legal Type 3-2</li> </ul>		☐-Invent I	ory 20-44 ting 20-44 2 3 1 1 4 5 6			
<	Reset Clear Open te	mplate Save t	emplate	ОК	Apply	Can	cel

Click Ok to save the analysis settings to memory and close the window.

Select Culvert Seg 1 in the tree. Select Bridge | Analyze to start the rating process. Click Ok to close the Analysis Progress window after the analysis is completed.

# Select Bridge | Tabular Report to open the Analysis Results window.

Print Print												
eport type:	Lane/Im	pact loading type -	Display	Format								
Rating Results Summary	Y As r	requested O Detai	led Single	rating level per r	w v							
Live Load	Live Load Type	Rating Method	Rating Level	Load Rating (Ton)	Rating Factor	Component	Location (ft)	Location (%)	Limit State	Impact	Lane	
Colorado Legal Type 3	Axle Load	LFD	Operating	76.11	2.819	Top Slab 3	0.81	6.789	Shear	As Requested	As Requested	
Colorado Legal Type 3-2	Axle Load	LFD	Operating	120.51	2.836	Top Slab 3	0.81	6.789	Shear	As Requested	As Requested	
Colorado Legal Type 3S2	Axle Load	LFD	Operating	118.89	2.797	Top Slab 3	0.81	6.789	Shear	As Requested	As Requested	
Colorado Permit Vehicle	Axle Load	LFD	Operating	209.31	2.180	Top Slab 3	0.81	6.789	Shear	As Requested	As Requested	
EV2	Axle Load	LFD	Operating	76.81	2.672	Top Slab 3	0.81	6.789	Shear	As Requested	As Requested	
EV3	Axle Load	LFD	Operating	79.70	1.853	Top Slab 3	0.81	6.789	Shear	As Requested	As Requested	
HS 20-44	Axle Load	LFD	Inventory	60.29	1.675	Top Slab 3	0.81	6.789	Shear	As Requested	As Requested	
HS 20-44	Axle Load	LFD	Operating	98.34	2.732	Top Slab 3	0.81	6.789	Shear	As Requested	As Requested	
Modified Tandem	Axle Load	LFD	Operating	109.04	2.181	Top Slab 3	0.81	6.789	Shear	As Requested	As Requested	
NRL	Axle Load	LFD	Operating	167.98	4.200	Top Slab 3	0.81	6.789	Shear	As Requested	As Requested	
SU4	Axle Load	LFD	Operating	96.40	3.570	Top Slab 3	0.81	6.789	Shear	As Requested	As Requested	
SU5	Axle Load	LFD	Operating	119.28	3.848	Top Slab 3	0.81	6.789	Shear	As Requested	As Requested	
SU6	Axle Load	LFD	Operating	136.90	3.939	Top Slab 3	0.81	6.789	Shear	As Requested	As Requested	
SU7	Axle Load	LFD	Operating	157.98	4.077	Top Slab 3	0.81	6.789	Shear	As Requested	As Requested	

Fill out the Rating Summary Sheet using policies and guidelines in the Bridge Rating Manual, Section 1. The results of the LFD rating analysis are as follows.

Rated using: Asphalt thickness: Colorado legal Interstate legal	loads 🗹	Multi-lane for Legal & Pe Single lane for Legal & Per		Batch I.D Structure Parallel S	Туре	XXXX CBC NA
Structural Member	3-CELL CBC					
-	Tons					
Inventory Operating	60.2 98.3					
Operating	50.5					
Type 3 truck	76.1					
Type 3S2 truck	118.8					
Type 3-2 truck	120.5					
Type SU4 truck (27T)	96.4					
Type SU5 truck (31T)	119.2					
Type SU6 truck (35T)	136.9					
Type SU7 truck (39T)	157.9					
NRL (40T)	167.9					
EV2 (28.75T)	76.8					
EV3 (43T)	79.7					
Permit Truck (96T)	209.3					
Modified Tandem (50T)	109.0					
	27 1055	Type 3S2 Truck Interstate 38 tons / Colorado 42 tons	3 1005 1 007	f.	Type 3-2 Tr Interstate 39 bons / O	as
Comments: Total structure leng Fill height 3'-0" ; As NBI Item 62 conditi Load induced dam: Color Code = White Rated with BrR v7.	phalt 6". on state level = age present = N e	8 ; Plans availa lo ; Pending es	able = Ye sential re			

### 14.4.2 AASHTOWare BrR Program, Example 2 (LRFR) – Structure No. X-02-X

From the Bridge Explorer, select File | New | New Bridge to create a new bridge and then enter the following description information.

Bridge ID: X-02-X		NBI structure	e ID (8): X-02-X		Template	etely defined	Superstruc
Description Desc	ription (cont'd)	Alternatives	Global reference point	Traffic	Custom agency field	ds	
Name:	Culvert Example	2			Year built:	2016	
Description:	CIP single cell 1 10 degrees skev 4" aspahlt; 6 ft.	v; 3 inch haunch	ed concrete box culvert wit h	th no borro	m slab		
Location:	Town, CO				Length:	50.00	ft
Facility carried (7):	US X				Route number:	US X	
Feat. intersected (6):	Creek Y				Mi. post:	200.00	
Default units:							
Default units:	US Customary	~					
verault units:	US Customary						

Close the window by clicking OK. This saves the data to memory and closes the window.

To enter the materials for the culvert, expand the tree for Materials. Double-click on the Concrete folder to create a new concrete material. Enter the following values.

-	erials - Concrete				
Name:	Class D (US)				
Description:	Colorado Deck Concrete	2			
Compressive	strength at 28 days (f'c):	4.500	ksi		
Initial compre	essive strength (f'ci):		ksi		
Composition	of concrete:	Normal			
Density (for d	lead loads):	0.150	kcf		
Density (for n	nodulus of elasticity):	0.150	kcf		
Poisson's rati	0:	0.200			
Coefficient of	thermal expansion (α):	0.0000060000	1/F		
Splitting tens	ile strength (fct):		ksi		
	Compute				
Std modulus	of elasticity (Ec):	3824.00	ksi		
LRFD modulu	is of elasticity (Ec):	3824.00	ksi		
Std initial mo	dulus of elasticity:	0.00	ksi		
LRFD initial m	odulus of elasticity:	0.00	ksi		
Modulus of r	upture:	0.503	ksi		
Shear factor:		1.000			

When plans are available, use the minimum concrete strength and yield strength values given in the plans. If plan values are not known, values given in Section 1 of the Bridge Rating Manual for the applicable year of construction may be followed.

Double-click on the Reinforcing Steel folder to create a new reinforcement material. Click on the Copy from Library button to copy the Grade 60 reinforcement material to the bridge.

Name:	Grade 60				
Description:	60 ksi reinforci	ing steel			
Material pro	perties				
Specified yie	eld strength (fy):	60.000	ksi		
Modulus of	elasticity (Es):	29000.00	ksi		
Ultimate stre	ength (Fu):	90.000	ksi		
Туре —					
Plain					
О Ероху					
Galvar	nized				

Double-click on the Soil folder to create a new soil material. Click on the Copy from Library button to copy the Standard Soil 1 material to the bridge.

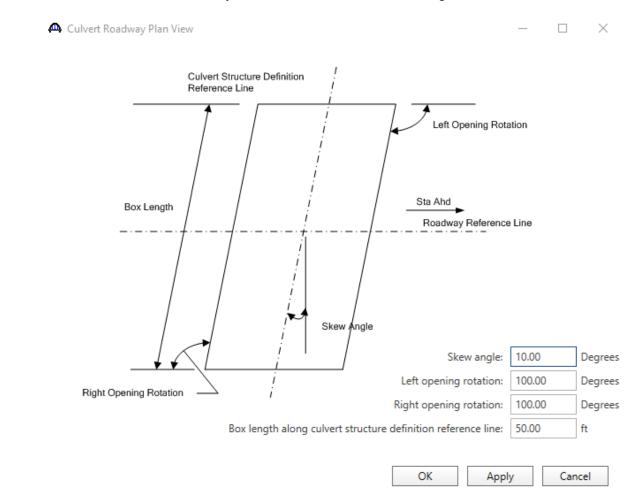
Name:	Standard Soil 1			
Description:	Standard Soil 1			
Soil unit load	i:	120.000	pcf	
Saturated so	il unit load:	125.000	pcf	
At-rest latera	al earth pressure coefficient (LRFD/LRFR):	0.50		
Active latera	earth pressure coefficient (LRFD/LRFR):	0.33		
Passive later	al earth pressure coefficient (LRFD/LRFR):	3.00		
Maximum la	teral soil pressure (LFD):	60.000	pcf	
Minimum lat	eral soil pressure (LFD):	30.000	pcf	

Standard Soil 1 for LFD and LRFD Specification. Standard Soil 2 for ASD Specification. Double-click on the CULVERT DEFINITIONS folder to create a new culvert definition. Enter the Culvert Definition name as show below. The first Culvert Alternative that we create will automatically be assigned as the Existing and Current Culvert Alternative for this Culvert Definition.

Nam	ne:	Culvert X	-02-X			
		single cel	I CBC			
Desc	ription:					
Defa	ult units:	US Custo	mary 💙			
	Existing	Current	Culvert alternative name	Description		
•	Existing	Current	Culvert alternative name Culvert Alt 1	Description 1-cell reinforced concret		-
•	-					
•	-					
•	-					

Expand the tree for Culvert Definition X-02-X.

Double-click on the Roadway Plan View to enter the skew angles as shown below.



Double-click on the CULVERT ALTERNATIVES folder to create a new culvert alternative for Culvert X-02-X. Enter the data as shown below.

vert alternativ	es: Culvert Alt 1				
Description	Specs Factors Conti	rol options			
Description:	1-cell reinforced concrete b	ox culvert (LRFR exam	ple)	Culvert type: RC Box	
Default units		US Customary	~	Construction type	
Top slab exte	rior surface exposure factor:	0.75		Cast-in-place	
Bot. slab exte	rior surface exposure factor:			O Precast	
Wall exterior	surface exposure factor:			Default rating method: LRFR	
Interior surfa	ce exposure factor:				
Soil					
				RFD EH load factor	
Installat	ion method:	Embankment	1	At-rest 🔾 Active	
Side	ill condition			RFD/LRFR earth pressure coefficient	
• c	ompact Ouncompact			At-rest	
Soil-stru	cture interaction factor (LRF	D):	_	Active	
Soil-stru	cture interaction factor (LFD	):	C	) Passive	

# Expand the tree for Culvert Alt 1.

Double-click on RC Box Culvert Geometry in the tree. Enter the data as shown below. Click Ok to save the data to memory and close the window.

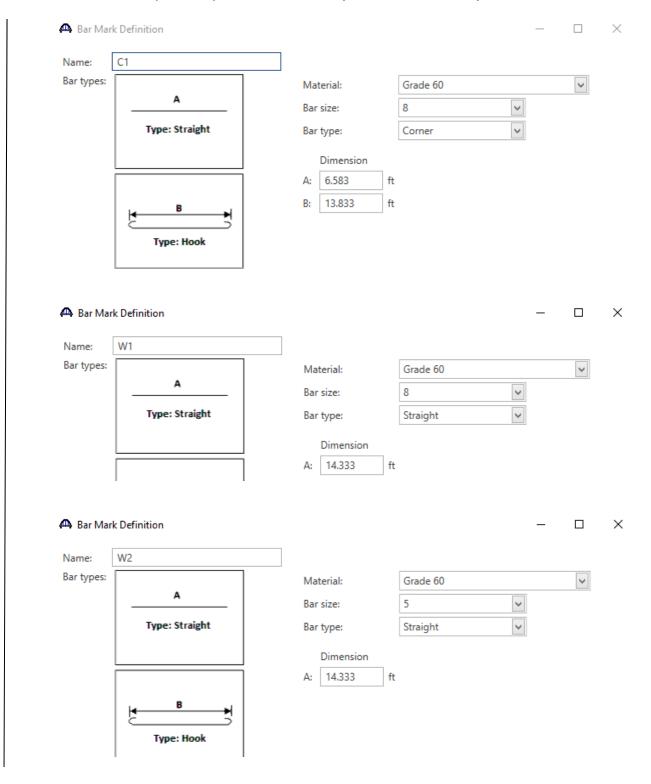
		45.00	٦.		
.000 ft	Horiz. construction joint height:	15.00	in		
					Π
unch Width	✓ Haunches				
— Haunch Denth	Top haunch width:	3.00	in		
— Haunch Depui	Top haunch depth:	3.00	in		
	Bottom haunch width:		in		
	Bottom haunch depth:		in		
	bottom naunen aeptn.				
	bottom naunen deptn.				
	000 ft unch Width — Haunch Depth	000 ft Horiz. construction joint height: unch Width I Haunches — Haunch Depth Top haunch width: Top haunch depth:	000 ft Horiz. construction joint height: 15.00 unch Width ✓ Haunches — Haunch Depth Top haunch width: 3.00 Top haunch depth: 3.00	000       ft       Horiz. construction joint height:       15.00       in         unch Width       ✓       Haunches         — Haunch Depth       Top haunch width:       3.00       in         Top haunch depth:       3.00       in	000       ft       Horiz. construction joint height:       15.00       in         unch Width       ✓       Haunches         — Haunch Depth       Top haunch width:       3.00       in         Top haunch depth:       3.00       in

Double-click on End Conditions. Leave uncheck box if reinforcement is rigid. Spring support may be used if subgrade modulus is known. Click Ok to save the data to memory and close the window.

🕰 End Conditions		_		×
Moment release at top o	f walls			
Moment release at botto	om of walls			
Provide side sway suppo	rt			
Provide spring support				
Subgrade modulus:	pci			
	OK A	pply	Cance	el 👘

Double-click on the Bar Mark Definitions folder in the tree to create a new bar mark definition for Culvert Alt 1.

Enter the data for C1 as shown below. Click Ok to save the data to memory and close the window. Repeat the process for all bars (W1, W2, T1, and T2) as shown.



Name: T	1				
Bar types:		Material:	Grade 60		~
	A	Bar size:	5	$\sim$	
	Type: Straight	Bar type:	Straight	~	
		Dimension			
🛱 Bar Mark I	Definition	A: 22.166	ft	_	
_	Definition	A: 22.166	ft	_	
_	2	A: 22.166	ft Grade 60	_	
Name: T				-	
Name: T	2	Material:	Grade 60	>	

Double-click on the CULVERT SEGMENTS folder to create a new culvert segment for Culvert Alt 1. A culvert alternative may have one or more culvert segments. Enter the data as show below.

Name:	Culvert Seg 1				
Description					
Material:	Class D (US)	~			
- Location	along culvert structure definition reference	e line:			 
Distance	from left end of culvert to start of segmen	5	0.00	ft	
Length o	f segment:		50.00	ft	
Left end	of culvert Distance to start of segment	Length of seg	ment		
		Looking Ahd ST	A		

OK	Apply	Cancel
----	-------	--------

Expand the tree for Culvert Seg 1. Double-click on RC Box Culvert Thickness in the tree. Enter the slab and wall thicknesses as shown below. Click OK to save the data to memory and close the window.

#### A RC Box Culvert Thickness

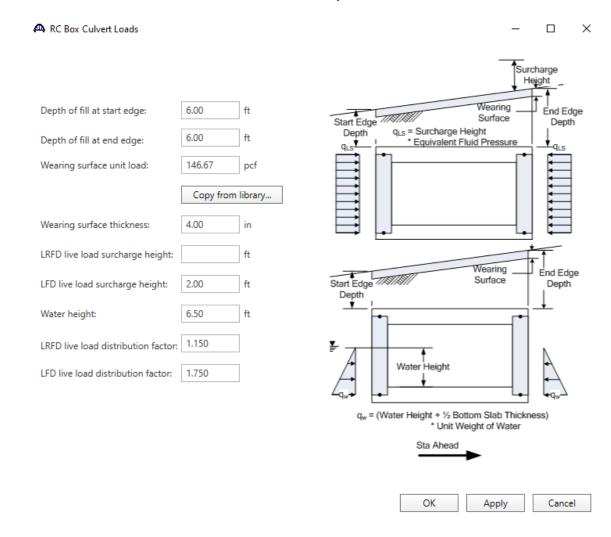
 
 Cell
 Top slab thickness (in)
 Bottom slab thickness (in)

 1
 15.00

	Wall	Thickness (in)	
÷	1	15.00	
	2	15.00	

Х

Double-click on RC Box Culvert Loads in the tree. Enter the culvert loads for Culvert Seg 1 as shown below. The wearing surface thickness includes the equivalent for the rail dead load. Click OK to save the data to memory and close the window.



Use water height half the rise of the culvert.

Double-click on RC Box Culvert Reinforcement in the tree. Enter the reinforcement data as shown below for each location. Click Ok to save the data to memory and close the window.

CL Wall 1       Start       Staright Length         Oclear       Clear       Start         Cover (Typ.)       CL Wall 2       CL Wall 3         Note: Bars will always be placed in the orientation shown       Start       Staright       Fully       Fully         Set       Bar       Clear       Sart       Start       Staright       Fully       Fully         I       T1       2.00       12.00       CL Culvert       V       11.08       22.17       Image: Clear in the indication in the indication indication in the indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication indication inditeration indication indication indication inditeration indication		Top slab - bot bars	Bot slab - top ba	ars Bot s	slab - bot ba	rs Corne	er Wall	Dowel		
Image: Cover (Typ.)       Image: CL Wall 2         Obstance       CL Wall 2         Image: CL Wall 2       Image: CL Culvert         Image: Cl Wall 2       Image: Cl Wall 3         Image: Cl Wall 2       Image: Cl Wall 3         Image: Cl Wall 2       Image: Cl Wall 3         Image: Cl Wall 4       Image: Cl Wall 4         Image: Cl Wall 4	CL Wall 1	Start	ngth	Straight	Length			!		
Note: Bars will always be placed in the orientation shown       Set     Bar cover spacing (in)     Measured from (in)     Wall number     Centered (ft)     Start distance (ft)     Fully developed developed end       1     T1     *     2.00     12.00     CL Culvert     *     Image: Centered (ft)		er (Typ.)	Distance	CL Culvert		all 3	CL Wall	4		
Set     Bar mark     cover (in)     spacing (in)     Measured from     Wall number     Centered     distance     length     developed     developed                 1             11	Note: Bars will always		tion shown		i			;_		
▶ 1 T1 ▼ 2.00 12.00 CL Culvert ▼ ▼ ▼ 11.08 22.17 □	Set	cover spacing	Measured from		Centered	distance	length	developed	developed	
	) 1 T1 - ▼	2.00 12.0	0 CL Culvert 🔹	-	V		22.17			_
New Duplicate De										

Straight       Straight Length         Other       Straight Length         Set Bars will always be placed in the orientation show:         Set Bars       Clear         Set Cover       Straight Cover         (n)       Generation         Set Bars       Clear         Set Cover       Straight Cover         (n)       Generation         New       Duplicate	Top slab - top bars	Top slab -	bot bars	Bot slab - top b	ars Bot s	lab - bot ba	ars Corn	er Wall	Dowel		
Clear (Typ.)       Start       Straight Length         Unit Cover (Typ.)       Start       Straight Length         Vote: Bars will always be placed in the orientation shown         Set       Bar (Clear (m) (m) (m) (m) (m) (m) (m) (m) (m) (m)					Straight	Length					
Cover (Typ.)       Start       Start       Distance         Distance       CL Culvert       Distance       CL Culvert         Vote: Bars will always be placed in the orientation shown         Set       Bar       Clear       Bar         mark       (in)       (in)       Measured from       Cell/Wall       Centered       Start.       Straight       Fully         in       T.2       1.00       6.00       CL Culvert       V       V       11.08       22.17         New       Duplicate       New       Duplicate       OK       Apply         C Box Culvert Reinforcement       OK       Apply         C Box Culvert Reinforcement       Start       Corner       Wall       Dowel         Note: Bars will always be placed in the orientation shown        Clear       Start       Start         Left Face Wall       Top slab - bot bars       Bot slab - top bars       Corner       Wall       Dowel         Note: Bars will always be placed in the orientation shown         Start       Start       Start       Start       Start       Start       Dowel         Note: Bars will always be placed in the orientation shown          Start       Start						-	Straight l	.ength	-		
Cover (Typ.)       Start       Start       Distance         Distance       CL Culvert       Distance       CL Culvert         Vote: Bars will always be placed in the orientation shown         Set       Bar       Clear       Bar         mark       (in)       (in)       Measured from       Cell/Wall       Centered       Start.       Straight       Fully         in       T.2       1.00       6.00       CL Culvert       V       V       11.08       22.17         New       Duplicate       New       Duplicate       OK       Apply         C Box Culvert Reinforcement       OK       Apply         C Box Culvert Reinforcement       Start       Corner       Wall       Dowel         Note: Bars will always be placed in the orientation shown        Clear       Start       Start         Left Face Wall       Top slab - bot bars       Bot slab - top bars       Corner       Wall       Dowel         Note: Bars will always be placed in the orientation shown         Start       Start       Start       Start       Start       Start       Dowel         Note: Bars will always be placed in the orientation shown          Start       Start									٢		
Left Face Wall       Right Face Wall       CL Culvert       CL Cell         Note: Bars will always be placed in the orientation shown       Start       Straight       Fully       Fully         Set       Bar       Clear       Bar       Clear       Bar       Fully       Fully         Note:       Bar       Clear       Bar       Clear       Bar       Clear       Bar       Fully       Fully         1       T2       1.00       6.00       CL Culvert       Image:				Start							
Note: Bars will always be placed in the orientation shown         Set       Bar mark       Clear cover       Bar (in)       Cell/Wall (in)       Centered       Start distance       Fully length       Fully developed       Fully end         1       12       1.00       6.00       CL Culvert       V       V       11.08       22.17       V         Leinforcement wizard       New       Duplicate       OK       Apply         CBox Culvert Reinforcement       OK       Apply         Note: Bars will always be placed in the orientation shown       OK       Apply         CBox Culvert Reinforcement       —       —       —         op slab - top bars       Top slab - bot bars       Bot slab - bot bars       Corner       Wall       Dowel         Note: Bars will always be placed in the orientation shown		Left Face V	Vall R		- CL Culvert		į	CL Cell			
Set       Bar mark       cover       spacing (in)       Measured from       Centered       distance       length       developed         1       T2       1.00       6.00       CL Culvert       v       V       11.08       22.17         New       Duplicate         New       Duplicate         OK       Apply	Note: Bars will alway:	s be placed in	the orienta	ition shown							
Set       mark       Cover       spacing       Measured from number       Centered       distance       ienight       developed       developed         >       1       T2       1.00       6.00       CL Culvert       *       Image: Centered       distance       ienight       developed       developed         >       1       T2       1.00       6.00       CL Culvert       *       Image: Centered       distance       ienight       developed       developed         New       Duplicate       Image: Centered       I	Bar	Clear			Cell/Wall						
New       Duplicate         New       Duplicate         Iteinforcement wizard       OK         Apply       OK         C Box Culvert Reinforcement       —         op slab - top bars       Top slab - bot bars       Bot slab - top bars         C Box Culvert Reinforcement       —         op slab - top bars       Top slab - bot bars       Bot slab - top bars         Note: Bars will always be placed in the orientation shown       —         Image: Start       —       —         Start       —       —         Start       —       —         Start       —       —         Start       —       —         Start       —       —         Start       —       —         Start       —       —         Start       —       —         Start       —       —         Start       —       —         Start       —       —         Start       —       —         Start       —       —         Start       —       —         Start       —       —         Mark       Cover       —	L Det L			Measured from		Centered					
Letinforcement wizard       OK       Apply         C Box Culvert Reinforcement       —         op slab - top bars       Top slab - bot bars       Bot slab - top bars       Corner       Wall       Dowel         Note: Bars will always be placed in the orientation shown       —       —       —       —         Left Face Wall       Right Face Wall       — CL Culvert       — CL Cell       —         Use: Bars will always be placed in the orientation shown       —       —       —       —         Start       Clear       Start       —       —       —         Straight Length       —       —       —       —       —         Set       Bar       Clear       Bar       Clear       Bar       Centered       Start       Straight       Fully       developed         Set       Bar       Clear       Bar       Centered       distance       (ft)       iength       developed	▶ 1 T2 -	1.00	6.00	CL Culvert 🔹	-	$\checkmark$					
OK       Apply         C Box Culvert Reinforcement       —         App slab - top bars       Top slab - bot bars       Bot slab - top bars       Corner       Wall       Dowel         Note: Bars will always be placed in the orientation shown       —       —       —       —         Image: Clear Straight Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Clear Cle									Nev	w Du	plicate
C Box Culvert Reinforcement - op slab - top bars Top slab - bot bars Bot slab - top bars Bot slab - bot bars Corner Wall Dowel Note: Bars will always be placed in the orientation shown Left Face Wall Right Face Wall + CL Culvert + CL Cell Start Distance + CL Cell + Distance + CL Cell + Distance + CL Cell + Distance + CL Cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + CL cell + Distance + C											
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op slab - top bars       Top slab - bot bars       Bot slab - top bars       Bot slab - bot bars       Corner       Wall       Dowel         Note: Bars will always be placed in the orientation shown <ul> <li>Left Face Wall</li> <li>Right Face Wall</li> <li>Clear</li> <li>Start</li> <li>Start</li> <li>Staright Length</li> <li>Start</li> <li>Staright Fully</li> <li>Fully</li> <li>Fully</li> <li>Fully</li> <li>developed end</li> </ul> Set         Bar         Clear         Bar         Celar         Start         Start         Straight developed developed end										ОК	Apply
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Left Face Wall       Right Face Wall       CL Culvert       CL Cell         Straight       Straight       Start       Clear         Distance       Cover (Typ.)       Start       Start         Straight Length       Start       Straight Length       Start         Set       Bar       Clear       Bar       Centered       Start       Start         Set       Bar       Clear       Bar       Measured from       Centered       Start       Start       Fully         Image: Set       Bar       Cover       Spacing       Measured from       Centered       Start       Start       Fully         Image: Set       Bar       Cover       Spacing       Measured from       Centered       Start       Start       end	C Box Culvert Reinf	orcement								ОК	Apply
Start     Start     Start       Distance     Cover (Typ.)       Start     Start       Straight Length     Start       Set     Bar       Clear     Bar       (in)     Measured from       Centered     Start       (ft)     Start       (ft)     Start			bot bars	Bot slab - top b	ars Bot s	lab - bot ba	rs Corne	er Wall		OK	Apply
Start     Start     Start       Distance     Cover (Typ.)       Start     Start       Distance     Start       Straight Length     Start       Set     Bar       Cover     spacing       (in)     Measured from       Centered     Start       (ft)     length       developed     end	op slab - top bars	Top slab -			ars Bot s	lab - bot ba	rs Corne	er Wall		OK	Apply
Start     Clear       Distance     Cover (Typ.)       Straight Length     Start       Distance     Straight Length       Start     Straight Length       Set     Bar       Cover     spacing       (in)     Measured from       Cell/Wall     Centered       Start     Start       Imark     Cover       (in)     Measured from	op slab - top bars	Top slab - s be placed in	n the orienta	ation shown		lab - bot ba			Dowel	ОК	Apply 
Straight Length     Start     Straight Length       Set     Bar cover spacing (in)     Measured from (in)     Cell/Wall number     Centered     Start distance (ft)     Fully developed developed end	op slab - top bars	Top slab - s be placed in	n the orienta	ation shown	CL Culvert				Dowel	ΟΚ	Apply
Set     Bar mark     Clear cover (in)     Bar spacing (in)     Measured from (in)     Cell/Wall number     Centered     Start distance (ft)     Straight developed developed end     Fully developed developed end	op slab - top bars	Top slab - rs be placed in Left Face V Start	Mall Ri	ation shown ight Face Wall in Straight Straight r Length	CL Culvert		Start		Dowel	ΟΚ	Apply
Set         Dar mark         cover (in)         spacing (in)         Measured from (in)         Cell/Wall number         Centered (stance (ft)         distance (ft)         length (ft)         developed start         developed end	op slab - top bars	Top slab - rs be placed in Left Face V Start	Mall Ri	ation shown ight Face Wall in Straight Straight r Length	CL Culvert		Start		Dowel	ΟΚ	Apply _
mark (in) (in) number (ft) (ft) start end	op slab - top bars	Top slab - s be placed in Left Face V Start Distance	Wall Ri Clear Cover (T	ation shown ight Face Wall Straight Length yp.)	CL Culvert		Start istance	CL Cell	Dowel	ΟΚ	Apply
▶ 1 B2 ▼ 1.00 3.00 CL Culvert ▼ ▼ ▼ 11.08 22.17 □	op slab - top bars Note: Bars will alway	Top slab - rs be placed in Left Face V Start Distance Length	Wall Ri Clear Cover (T Start Distanc Bar	ation shown	- CL Culvert		Start istance Straight	CL Cell	Dowel	Fully	Apply
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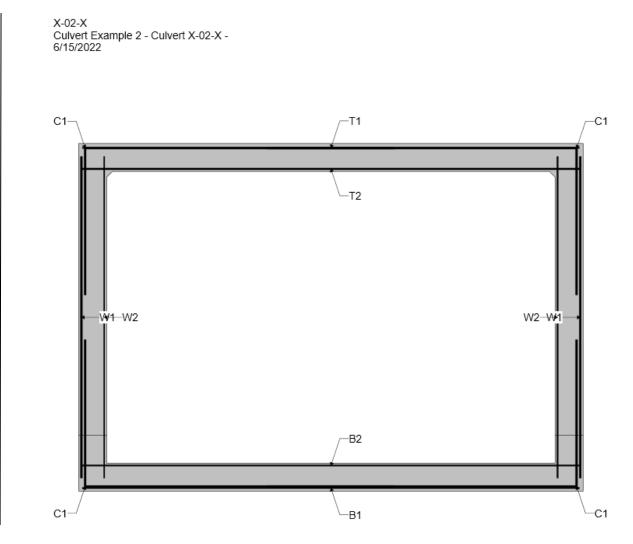
Top slab	- top bars	Top slab -	- bot bars	Bot slab -	top bars Bot	t slab - bot ba	rs Corne	er Wall	Dowel			
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▶ 1	B1 -	2.00		CL Culvert	-	- <b>V</b>	11.08	22.17				
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RC Box	Culvert Rein	rd								ОК	Apply	C
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	Culvert Rein	forcement	bot bars	Bot slab -	top bars Bot	slab - bot ba	rs Corne	er Wall	Dowel	ОК	Apply	
	- top bars	forcement Top slab - C Bars		Bot slab -	top bars Bot	slab - bot ba Corner		er Wall		ОК	Apply	
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Apply

#### A RC Box Culvert Reinforcement \_ Top slab - top bars Top slab - bot bars Bot slab - top bars Bot slab - bot bars Corner Wall Dowel Straight Length Horizontal Straight Construction Length Joint Start CL Culvert Start Distanc Distance Clear Cover Clear Bar Start Fully Fully Straight Bar Wall Location Measured from Set cover spacing Centered distance length developed developed Number mark (in) (in) (ft) (ft) start end 1 W1 13.00 6.00 Right \* 1 CL Culvert $\checkmark$ 7.17 14.33 \* 2 \* 1 \* 2 2 W1 + 13.00 6.00 Left + CL Culvert $\checkmark$ 7.17 14.33 -3 $\checkmark$ W2 + 1.00 12.00 Right + CL Culvert + 7.17 14.33 + 4 W2 1.00 12.00 Left 2 -CL Culvert $\checkmark$ 7.17 14.33 New Duplicate Delete

Reinforcement wizard...

OK Apply Cancel



Select Bridge Schematic to review the reinforcement data.

The description of the single-cell reinforced concrete box culvert is now complete.

Select File Save to save the file in BrR.

Cubata at an	
escription Substructures	
escription:	
Horizontal curvature	Global positioning
eference line length: ft	Distance: ft
Start bearing O End bearing	Offset: ft
tarting station: ft	Elevation: ft
earing: N 90^ 0' 0.00" E	
Bridge alignment	Start tangent length: ft
Curved	Curve length: ft
<ul> <li>Tangent, curved, tangent</li> <li>Tangent, curved</li> </ul>	Radius: ft
Curved, tangent	Direction: Left V
-	End tangent length: ft
	End tangent length:

Click Ok to save the data to memory and close the window.

Double-click on Culverts to create a culvert name. Enter the Culvert name as show below.

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ference Line	iption:				
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Click Ok to save the data to memory and close the window.

Name:	Culvert		
Description:			
Culvert definitio	on: Culvert X-02-X	~	

OK Apply
----------

# To perform LRFR Design Load Rating, open the Analysis setting window by selecting Bridge Analysis Settings. Select LRFR as the Rating Method and specify the vehicles.

O Design review   Rating		Rating me	thod:	LRFR	~	
Analysis type: Line Girder	>					
ane / Impact loading type: As Requeste	d v	Apply pre	ference setting:	None	~	
Vehicles Output Engine Desc	ription					 
Traffic direction: Both directions	~	[	Refresh	Temporary vehicles	Advanced	
Vehicle selection		N N	/ehicle summar	у		
		Add to >> Remove from <<		cles gn load rating nventory 		

Click Ok to save the analysis settings to memory and close the window.

Select Culvert Seg 1 in the tree. Select Bridge | Analyze to start the rating process. Click Ok to close the Analysis Progress window after the analysis is completed.

## Select Bridge | Tabular Report to open the Analysis Results window.

Analysis Results - Culvert S Print Print	eg 1										_	
port type:		act loading type	Display Fo Single rat	rmat ting level per row	Y							
Live Load	Live Load Type	Rating Method	Rating Level	Load Rating (Ton)	Rating Factor	Component	Location (ft)	Location (%)	Limit State	Impact	Lane	
HL-93 (US)	Axle Load	LRFR	Inventory	55.17	1.533	Bottom Slab 1	10.00	50.000	Flexure	As Requested	As Requested	
HL-93 (US)	Axle Load	LRFR	Operating	71.52	1.987	Bottom Slab 1	10.00	50.000	Flexure	As Requested	As Requested	
HL-93 (US)	Tandem	LRFR	Inventory	56.59	1.572	Top Slab 1	10.00	50.000	Flexure	As Requested	As Requested	
HL-93 (US)	Tandem	LRFR	Operating	73.36	2.038	Top Slab 1	10.00	50.000	Flexure	As Requested	As Requested	
Colorado Legal Type 3	Axle Load	LRFR	Legal	55.71	2.063	Top Slab 1	10.00	50.000	Flexure	As Requested	As Requested	
Colorado Legal Type 3-2	Axle Load	LRFR	Legal	87.68	2.063	Top Slab 1	10.00	50.000	Flexure	As Requested	As Requested	
Colorado Legal Type 3S2	Axle Load	LRFR	Legal	86.32	2.031	Bottom Slab 1	10.00	50.000	Flexure	As Requested	As Requested	
EV2	Axle Load	LRFR	Legal	54.40	1.892	Bottom Slab 1	10.00	50.000	Flexure	As Requested	As Requested	
EV3	Axle Load	LRFR	Legal	57.24	1.331	Top Slab 1	10.00	50.000	Flexure	As Requested	As Requested	
NRL	Axle Load	LRFR	Legal	78.69	1.967	Bottom Slab 1	10.00	50.000	Flexure	As Requested	As Requested	
SU4	Axle Load	LRFR	Legal	55.63	2.060	Bottom Slab 1	10.00	50.000	Flexure	As Requested	As Requested	
SU5	Axle Load	LRFR	Legal	59.95	1.934	Bottom Slab 1	10.00	50.000	Flexure	As Requested	As Requested	
SU6	Axle Load	LRFR	Legal	65.23	1.877	Bottom Slab 1	10.00	50.000	Flexure	As Requested	As Requested	
SU7	Axle Load	LRFR	Legal	74.70	1.928	Bottom Slab 1	10.00	50.000	Flexure	As Requested	As Requested	
Colorado Permit Vehicle	Axle Load	LRFR	Permit	217.75	2.268	Bottom Slab 1	10.00	50.000	Flexure	As Requested	As Requested	
Modified Tandem	Axle Load	LRFR	Permit	113.41	2.268	Bottom Slab 1	10.00	50.000	Flexure	As Requested	As Requested	

AASHTO Culvert LRFR Engine Version 7.2.0.3001

Analysis preference setting: None

Close

Fill out the Rating Summary Sheet using the policies and guidelines in the Bridge Rating Manual, Section 1.

Rated using: Asphalt thickness: Z Colorado legal la Interstate legal la		Multi-lane for Legal & Pe Single lane for Legal & Pe		Batch I.D. Structure 7 Parallel St	Туре	XXXX CBC NA
Structural Member	CBC					
	Rating Factor	·				
Inventory	1.53					
Operating	1.98					
	Tens					
Type 3 truck	55.7		-			
Type 3S2 truck	86.3					
Type 3-2 truck	87.6					
Type SU4 truck (27T)	55.6					
Type SU5 truck (31T)	59.9					
Type SU6 truck (35T)	65.2					
Type SU7 truck (39T)	74.7					
NRL (40T)	78.6					
Lane-Type Legal	199.0					
EV2 (28.75T)	54.47					
EV3 (43T)	57.2					
Permit Truck (96T)	217.7					
Modified Tandem (50T)	113.4					
Type 3 Truck		Type 3S2 Truck Intersite 38 tons / Colorado 45 tons	-3 tons	ſ,	Type 3-2 7 Interstate 39 toos	
Comments: Total structure lengi Fill height 6'-0" ; Asj NBI Item 62 condition Load induced dama Damage that has a Color Code = White Rate with BrR v7.2.	ohalt 4 inch on state level = ge present = N direct effect or	: 8 ; Plans avail No ; Pending es n load rating = N	able = Ye sential re			

#### SECTION 14A CULVERTS

#### **14A.1 INTRODUCTION TO RATING CULVERTS**

This section covers the load rating of culverts, flexible and rigid other than concrete box culverts. Culverts include, but are not limited to: metal pipe, metal plate pipe, pipe arch, long span plate structure, thermoplastic pipe, steel reinforced thermoplastic pipe, and fiberglass pipe. This section also covers rigid pipes such as concrete pipes. Culverts are to be rated using the policies and guidelines of the Bridge Rating Manual, Section 1 and Subsections 14A.2 and 14A.3.

The load rating of concrete box culverts is covered in section 14.

When there are no plans available for the culverts, the requirements in Subsection 1.5 of CDOT Bridge Rating Manual, CDOT M&S Standards, or AASHTO Specifications may be used if proven to be representative of the culvert. Field measurements may also be used.

The types of flexible culverts covered by this section are:

- AAC Aluminum Arch Culvert
- CMP Corrugated Metal Pipe (Steel/Aluminum)
- CPP Corrugated Plastic Pipe
- SAC Steel Arch Culvert/Multiplate Arch Culvert
- SPP Smooth Plastic Pipe

The other types of rigid culverts also covered by this section are:

- RCPC Reinforced Concrete Pipe Culvert
- CAC Concrete Arch Culvert

#### 14A.2 POLICIES AND GUIDELINES FOR RATING CULVERTS

#### 14A.2.1 General

- A) A culvert shall be rated or re-rated based on AASHTO Load and Resistance Factor Rating (LRFR) using latest version on CANDE (Culvert Analysis and Design) software. Programs other than CANDE must be approved in advance by the CDOT Bridge Rating Engineer.
- B) A major culvert is defined as a culvert or a group of culverts that have a span length of greater than 20 feet measured parallel to the centerline of roadway from outside of the first pipe to the outside of the last pipe. A group of culverts are culverts with distance between them of less than or equal to the radius of the smallest culvert in the group.

- C) A minor culvert is defined as a culvert or a group of culverts that have a span length of less than or equal 20 feet but greater than or equal to 4 feet measured parallel to the centerline of roadway from outside of the first pipe to the outside of the last pipe.
- D) Inventory and operating ratings shall be performed for HL-93 as applicable. Additionally, an operating rating shall be performed for appropriate Legal Loads (Colorado or Interstate Type 3, 3-2, and 3S2), NRL, EVs, Colorado Permit Vehicle, and Modified Tandem. Rating for SHVs shall be performed if the rating factor (RF) for the NRL vehicle is less than 1.0. Truck configurations for the legal loads, NRL, SHVs, EVs, Colorado Permit Vehicle, and Modified Tandem can be obtained from Chapter 1 of the CDOT Rating Manual.
- E) For live loads and impact factors refer to AASHTO Specifications, AASHTO Manual for Bridge Evaluation, and CDOT Bridge Rating Manual Section 1.
- F) "For single-span culverts, the effects of live load may be neglected where the depth of fill is more than 8.0 ft. and exceeds the span length. For multiple span culverts, the effects may be neglected where the depth of fill exceeds the distance between inside faces of end walls." AASHTO LRFD 8th edition, section 3.6.1.2.6. When these conditions are met, the capacity adequacy shall be verified for dead load and other superimposed loads. The rater shall also verify and document that the fill height meets CDOT M&S Standard fill height limitations.
- G) The structure Inspection and appraisal report shall be investigated for the culvert condition. Reducing section properties due to loss of cross section or damage shall be investigated and accounted for by a professional engineer. Findings and recommendation shall be discussed with the Staff Bridge contact and the Bridge Rating engineer prior to finalizing the rating. If approved, the findings and recommendation shall be clearly documented in the rating package.
- H) Refined analysis and/or soil interaction analysis may be used if rating shows that posting or color coding per section 1.15 or 1.16 is required. Geotechnical engineering may be required to provide soil interaction properties.
- For multiple lines of buried pipe structure that meets the minimum spacing between pipes per AASHTO LRFD, Section 12.6.7, a single pipe instead of multi-pipe may be modeled for load rating analysis.

#### 14A.2.2 Calculations

- A) A set of calculations, separate from computer output, shall be submitted with each rating package. These calculations shall include derivations for dead loads, derivation of live load, and any other calculations or assumptions used for the rating.
- B) Dead Loads
  - 1. The final sum of all the individual weight components for dead load calculations may be rounded up to the next 5 pounds.
  - 2. Dead loads shall include fill, pavement, curbs, sidewalks, railing, etc.
  - 3. Fill Dead loads shall be calculated based on 125 lb/ft<sup>3</sup>.
- C) Use the minimum design yield strength value F<sub>y</sub> from plans or AASHTO Specifications.

#### 14A.3 RATING REPORTING AND PACKAGING REQUIREMENTS

#### 14A.3.1 Rating Reporting/Package Requirements

- A) A copy of the schematic drawing or sketch showing the elevation and applied loads shall be included with the rating package. Rating procedure shall be per section 1.11 or 1.12 as applicable.
- B) The rater and checker shall complete the rating documentation as described in Section 1 of the Bridge Rating Manual. Any variation from the original design assumptions shall be added to the Rating Summary Sheet as applicable. The rating package requirements shall be per Section 1.13 and Section 1.14 of the Bridge Rating Manual and as amended herein.

#### 14A.3.2 Consultant Submittal Requirements

- A) Consultant designed/rated culverts: Before finalizing the rating package and when a computer program is used as the analysis tool, the rater shall verify with Staff Bridge that the program being used is acceptable to CDOT. Unapproved program data files may be rejected.
- B) When the rating is finalized, the rater shall save the input and output files. The files name shall include the structure number of the rated culvert. The rating package including the program input and output files, the rating summary sheet, and necessary computations shall be transmitted electronically (.xlsx, .xml, etc.) and in PDF format to Staff Bridge for review and archiving.

## 14A.4 INTRODUCTION TO CANDE SOFTWARE

CANDE is a public domain 2D finite element software for analysis and design of culverts and buried structures (corrugated metal, reinforced concrete, and thermoplastics). CANDE can rate or design buried structures by Load Resistance Factor Design (LRFD) or Allowable Stress Design (ASD) methodologies.

There are three levels for analysis: Level 1, 2 and 3 as shown in Fig 14A-1. CANDE will generate a mesh automatically for half of the culvert then by using the Tool Box application can convert to a level 3 mesh (full culvert).

CANDE analyzes different types of culverts (steel, concrete, and plastic) for various design criteria as shown in Table 14A-1.

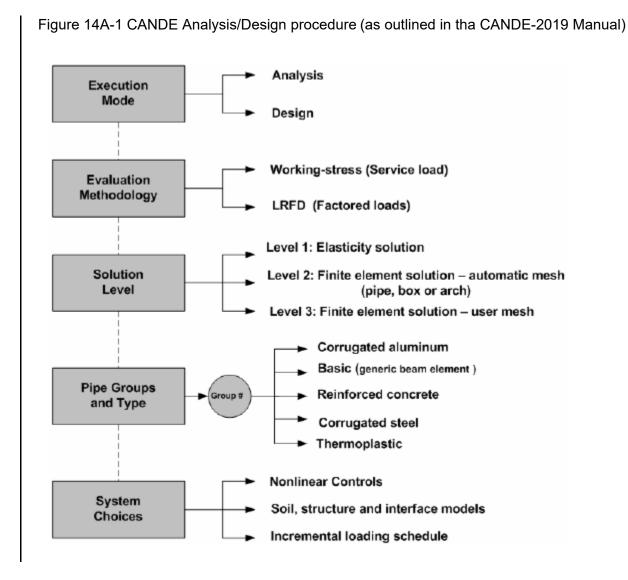
Culvert properties such as: (culvert type, soil types, culvert wall thickness, fill materials density, thickness, etc.) must be defined in CANDE but to receive a rating for the culvert, the user must use the Tool Box attached to CANDE software.

## 14A.5 INTRODUCTION TO CANDE TOOL BOX SOFTWARE

The CANDE Tool Box is an application that supplements the CANDE software to rate culverts. It has the ability to define wearing surface thickness, convert analysis level, define design, legal and permit trucks with varies load factors, and to obtaining rating factors.

Table 14A-1: Design/Analysis CANDE criteria

Buried structure Type	Analysis/Design Criteria
	Thrust Yielding
Corrugated Metal	Buckling
	Seam Failure
	<ul> <li>Plastic hinging</li> </ul>
	Steel Yielding
Reinforced Concrete	Concrete Crush
	Shear failure
	Radial Tension
	Thrust Yielding
Plastic	Bucking
	Combined Strain
	Tension Strain



The following information was obtained from CDOT standards and AASHTO Standard Specification Section 12:

Table 14A-2: Materials Specifications

Pavement Unit weight	146.67	pcf
Soil Unit Weight	125	pcf
Soil Stiffness factor K	0.22	
Steel Pipe material Modulus of Elasticity, E <sub>m</sub>	29,000,000	psi
Pipe material Min. Tensile Strength, f <sub>u</sub>	45,000	psi
Pipe material Min. Yield Point, Fy	33,000	psi
Capacity Modification Factor for Wall Area and Buckling, $\Phi_{\text{b}}$	1.0	
Capacity Modification Factor for Seam Strength, $\Phi_s$	0.67	
Elastic Young modulus for steel	29,000,000	psi
Poisson's ratio for steel	0.3	
Yield stress for steel	33,000	psi
Steel Density	490	pcf
Elastic Young modulus for aluminum	10,000,000	psi
Poisson's ratio for Aluminum	0.33	
Yield stress for Aluminum	24,000	psi
Aluminum Density	170	pcf
Compressive Strength of Concrete, $f'c$	Based on the actual grade	ksi
Concrete Density	150	pcf
Poisson's ratio for concrete	0.17	
Elastic Young modulus for concrete	$120 * (Density)^2$	psi
Plastic Elastic Young modulus for short-term loading	See attached table	
Plastic Ultimate stress limit for short-term loading	See attached table	
Plastic Elastic Young modulus for long-term loading	See attached table	
Plastic Ultimate stress limit for long-term loading	See attached table	
Poisson's ratio for plastic	0.3	

Table 14A-3: Plastic Materials Specifications

Type of plastic	Effective Young'	s Modulus (PE)	Ultimate strength (PU)		
	Short-Term (ksi)	Long-term (ksi)	Short- Term (ksi)	Long- term (ksi)	
HDPE –High Density Polyethylene	110	22	3	0.9	
PVC –Polyvinyl Chloride	400	140	6	2.6	
PP –Polypropylene	135	31	3.1	1	

Corrugation	Section			Corruga	tion thick	ness (in)		
Profile	Properties	0.040	0.052	0.064	0.079	0.109	0.138	0.168
	PA in <sup>2</sup> /in	0.03800	0.05070	0.06340	0.07920	0.11090	0.14270	0.17480
1-1/2 x 1/4	PI in <sup>4</sup> /in	0.00025	0.00034	0.00044	0.00057	0.00086	0.00121	0.00164
	PS $in^{3}/in$	0.00172	0.00225	0.00280	0.00347	0.00479	0.00624	0.00785
	PA in <sup>2</sup> /in	0.03880	0.05160	0.06460	0.08070	0.11300	0.14530	0.17780
2-2/3 x 1/2	PI in <sup>4</sup> /in	0.00112	0.00150	0.00189	0.00239	0.00342	0.00453	0.00573
	$PS$ in $^{3}/in$	0.00415	0.00543	0.00670	0.00826	0.01123	0.01420	0.01716
	PA in <sup>2</sup> /in	0.04450	0.05930	0.07420	0.09280	0.13000	0.16730	0.20480
3 x 1	PI in <sup>4</sup> /in	0.00515	0.00689	0.00866	0.01088	0.01546	0.02018	0.02509
	PS in <sup>3</sup> /in	0.00990	0.01310	0.01628	0.02017	0.02788	0.03547	0.04296
	PA in <sup>2</sup> /in	0.00000	0.00000	0.06620	0.82670	0.11580	0.14900	0.18220
5 x 1	PI in <sup>4</sup> /in	0.00000	0.00000	0.00885	0.01109	0.01565	0.02032	0.02509
	PS in <sup>3</sup> /in	0.00000	0.00000	0.01664	0.02056	0.02822	0.03571	0.04296
Corrugation	Section			Corruga	tion thick	ness (in)		
Profile	Properties	0.110	0.140	0.170	0.188	0.218	0.249	0.280
	PA in <sup>2</sup> /in	0.12970	0.16690	0.20410	0.22830	0.26660	0.30420	0.34330
6 x 2	PI in⁴/in	0.06041	0.07816	0.09616	0.10800	0.12691	0.14616	0.16583
	PS in <sup>3</sup> /in	0.05726	0.07305	0.08863	0.09872	0.11444	0.12998	0.14546
Corrugation	Section	Corru	gation					
Profile	Properties		ess (in)					
		0.318	0.380					
	PA in <sup>2</sup> /in	0.38930	0.46780					

Table 14A-4: Section Pro	nerties for Standard	Steel Corrugation Sizes
Table 14A-4. Section FIO	perlies for Stanuaru	Sleer Corrugation Sizes

*PS* in<sup>3</sup>/in 0.16393 0.19496

0.135 0 0 0.14533 0.00453	0.164 0 0 0 0.17775 0.00573
0 0 0.14533 0.00453	0 0 0.17775 0.00573
0 0.14533 0.00453	0 0.17775 0.00573
0.14533 0.00453	0.17775 0.00573
0.00453	0.00573
	_
0.04407	
0.01427	0.01726
0.17400	0.20483
0.02017	0.02508
0.03554	0.04309
0.14533	0.17775
0.01910	0.02340
0.03366	0.04021
	0.14533

Corrugation	Section	Corrugation thickness (in)								
Profile	Properties	0.100	0.125	0.150	0.175	0.200	0.225			
	PA in <sup>2</sup> /in	0.11700	0.14583	0.17500	0.20408	0.23325	0.26242			
9 x 2 ½	PI in <sup>4</sup> /in	0.08310	0.10400	0.12490	0.14590	0.16700	0.18820			
	PS in <sup>3</sup> /in	0.06392	0.07924	0.09426	0.10908	0.12370	0.13813			

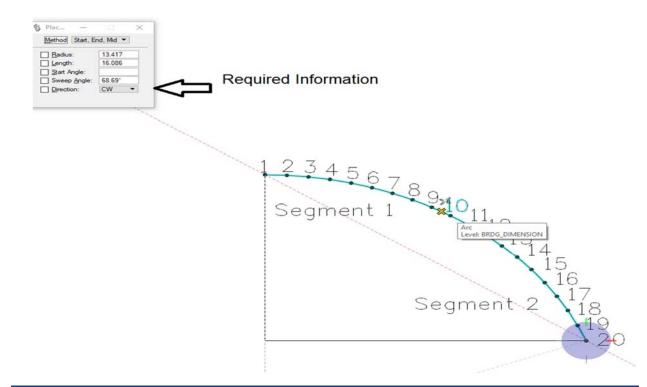
Corrugation Profile	Section Properties	Corrugation thickness (in)		
		0.250		
	PA in <sup>2</sup> /in	0.29175		
9 x 2 ½	PI in <sup>4</sup> /in	0.20940		
	PS in <sup>3</sup> /in	0.15229		

# 14A.6 ARCH GEOMETRIC DATA DEFINITION PROCEDURE IN CANDE

## 14A.6-1: Two Segment Arch Definition

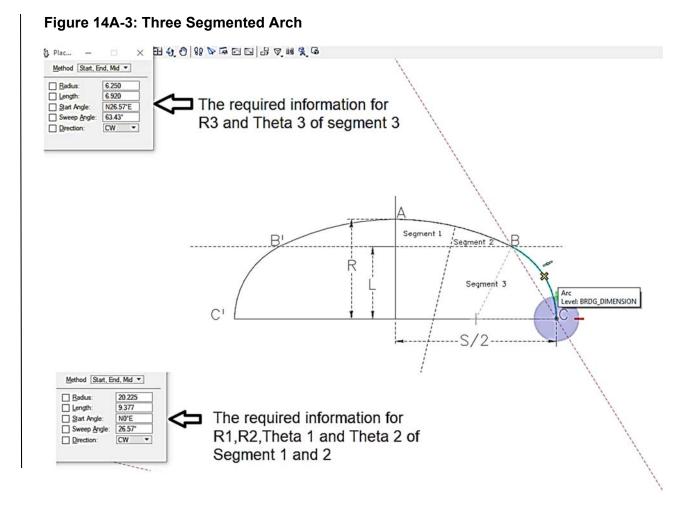
- 1. Draw a horizontal line in MicroStation with length S (Pipe Span Length) as detailed in the Culvert Field Measurement Form
- 2. From the center of that line, draw a vertical line with length R (Pipe Rise)
- 3. Create an arc using the "Start, End, Mid" method and make sure the arc's radius centers on the drew vertical line.
- 4. Record the radius and sweep angle from the "Place arc" command box
- 5. In the "Arch Segments and Angles" section of CANDE, input the value of the radius previously recorded in the "R1" and "R2" fields. Divide the sweeping angle by 2 and record those values in "Angle for R1 segment" and "Angle for R2 segment".
- 6. Go to Material Definition 4 (Interface 1) and input 90° and change the coefficient of friction to 0.3 (the minimum value)
- 7. Go to Material Definition 5 (Interface 2) under the Material Control Parameters change the Material Name to "Interface #19" and change the Material ID to 19. This is the last interface of the nodes generated by CANDE. The program will calculate all the interface angles in between. Using the equation  $\theta(i) = 90 - (i - 1) * \frac{\Delta}{m-1}$  where i = 1, 2, ..., m and m= total number of nodes (should always be 20 for a two-segmented arch) and delta = sweep angle, calculate the interface angle at the 20th node. Input this value into the "Angle from x-axis to normal interface" field of Material Definition 5 and change the coefficient of friction to 0.3.

# Figure 14A-2: Two Segmented Arch



## 14A.6-2: Three Segment Arch Definition

- 1. Draw a horizontal line in MicroStation with length S (Pipe Span Length) as detailed in the Culvert Field Measurement Form
- 2. From the center of that line, draw a vertical line with length R (Pipe Rise)
- 3. From the center of that line, draw another vertical line with length L (Vertical rise of side segment)
- 4. Create an arc for segment 1 and 2 using the "Start, End, Mid" method and make sure the arc's start from B' to B point (as shown in the attached drawing).
- 5. Record the radius and sweep angle from the "Place arc" command box for Arch of segment 1 and 2
- 6. In the "Arch Segments and Angles" section of CANDE, input the value of the radius previously recorded in the "R1" and "R2" fields. Divide the sweeping angle by 2 and record those values in "Angle for R1 segment" and "Angle for R2 segment".
- 7. Create an arc using the "Start, End, Mid" method and make sure the arcs from point B to point C.
- 8. Record the radius and sweep angle from the "Place arc" command box.
- In the "Arch Segments and Angles" section of CANDE, input the value of the radius previously recorded in the "R3" and sweeping angle. Record those values in "Angle for R3 segment" and "Angle for R3 segment".
- 10. To activate R3 and Theta 3 values define "vertical rise of side segment" in "Arch and footing dimension definition" equal to "L" length.
- 11. Go to Material Definition 4 (Interface 1) and input 90° and change the coefficient of friction to 0.3 (the minimum value)
- 12. Go to Material Definition 5 (Interface 2) under the Material Control Parameters change the Material Name to "Interface #19" and change the Material ID to 19. This is the last interface of the nodes generated by CANDE. The program will calculate all the interface angles in between. Using the equation where i = 1, 2, ..., m and m= total number of nodes (should always be 20 for a two-segmented arch) and delta = sweep angle, calculate the interface angle at the 20th node. Input this value into the "Angle from the x-axis to normal interface" field of Material Definition 5 and change the coefficient of friction to 0.3.



## 14A.7 CULVERT RATING EXAMPLES

#### 14A.7.1 Example 1: Corrugated Metal Pipe (CMP)

The example presented in this section is based on LRFR method. The rating is for Structure P-11-C, 2-Cells Corrugated Metal Pipe (CMP) pictured below.

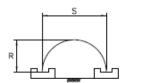
CANDE has two options for pipe rating, first option pipe only and second option pipe with soil interface. It is recommend to rate pipe without soil interface being more conservative.



## COLORADO DEPARTMENT OF TRANSPORTATION STAFF BRIDGE CORRUGATED METAL CULVERT FIELD MEASUREMENT FORM

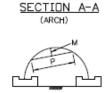
#### STRUCTURE # P-11-C

Material Type (Steel, aluminum, etc.)			STEEL				
Galvanized (Yes or No)			YES	-			
Number of Cells			2				
Are all cells the same size and shape? (Yes or No)	)		YES				
Document any differences:							
Top Wall Thickness - t1 (in) = (See Det	ail B)		1/4"				
Bottom Wall Thickness - t2 (in) = (See det	tail B)		1/4"				
Minimum Wall Thickness (in) =	-		1/4"				
Corrugations Pitch - c (in) = (See De	tail B)		6"				
Corrugations Depth - d (in) = (See De	tail B)		2"			•	
Number of Bolts per longitudinal foot of splice? Is it double or single row?				5			
Bolt Diameter (in)			3/4"				
Pipe Span length - S (in) = See Section	n A-A for appro	priate type	10'-10'	·			
Pipe Rise - R (in) = See Sectio	n A-A for appro	priate type	7'-8"				
Maximum Normal Curvature top radius (Rt) dime	ensions (See De	tail D)	M=	(in)	P= 36	(in)	
Pavement Thickness (in) =							
Fill Height (in) =			102"				
Is there noticeable settlement in the roadway over the culvert? Yes or No							
Is there noticeable differential settlement or rotation in the the culvert? Yes or No (Detail C)							
Is there noticeable sag or damage inside the culv	ert? Yes or No (	If yes, take a photo)	NO				
Noticeable Sag Dimensions (See Detail D)	Location =		M=	(in)	P=	(in)	
Inspector Initials :	•	Date:					

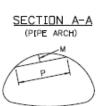




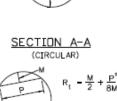
No t2 values exist for this section



(ARCH)



(PIPE ARCH)

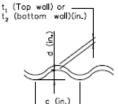




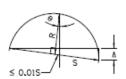
(CIRCULAR)

Colculate maximum existing normal curvature top radius (R<sub>s</sub>) by taking measurments around the upper periphery of the culvert using a ruler of length "P" to obtain value of "M". This should be done at selected stations along length of culvert (particularly at locations with normal curvature and at location with noticeable sag)

DETAIL D Top Rodius Rt



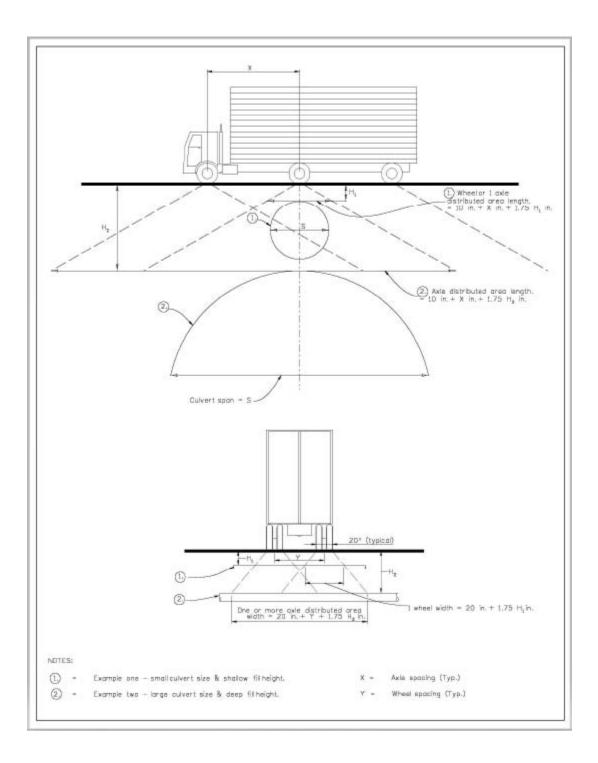
DETAIL B (METAL CORRUGATION & GAGE INFORMATION )



The rotation of the structure, 9, may be determined as: 

DETAIL C

DIFFERENTIAL SETTLEMENT



	Control Information	
Type of analysis  Analysis  Design  Method of analysis/design  ERFD  Service  Solution level  Elasticity (Level 1)  Solution level  Elasticity (Level 1)  Solution level  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1)  Elasticity (Level 1) Elasticity (Level 1) Elasticity (Level 1) Elasticit	Level 2 Specific Canned mesh type Soil mesh pattem Pipe mesh Box mesh Arch mesh Interface elements (pipe only) Pipe-soil Trench-instu None	CANDE 2007 Input Wizard
FEM-auto mesh (Level 2)     FEM-user mesh (Level 3)      Use the auto-generate option for     the interface elements      Number of pipe element groups     (Level 3 only)  P-11-C	MOD-Make changes to the basic mesh Image: Wight of the basic mesh         Image: Wight of the basic mes	You will enter some basic information about your model and CANDE will prepare a starter input document that you can customize for your particular model. After you complete the input for each screen in the Input Wizard, press the 'Next' button until you have reached the end. Once completed, press the 'Finish' button to enter the CANDE input menus. <u>Control Information</u> On the control information screen, enter key information regarding the type of model method of analysis etc.

- In Main input control parameter: Interface element "None" soil interface neglected, if soil information available rater may use "pipe-soil" option.
- Solution level used "level 2" and converted to "level 3" by Tool Box.
- LRFD analysis type used per section 1.6-B.

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Master Control - A     Master Control 1     Master Control 2     Pipe Definition 1     Pipe Definition 1     Steel Section Properties     Steel Joint Properties (2)     Steel Joint Properties (2)     Steel Statements - C     Control Parameters (Level 2-Pipe)     Major Geometry and Loading Parameter     Control Variables (Level 2-Pipe)     Backpacking for Embankment Mesh/I     Control Parameters for Changes to Noo     Material Definition 1 (in situ. Dedding Ja     Material Definition 1 matures (Material     Storpic Linear Elastic Parameters     LRFD Load Factors	1 \$1 -30 1 0 0 0 0	Heading for output Number of culvert element groups Maximum number of iterations/step Culvert ID (Process 12-50) Process ID (Process 12-50) Subdomain ID (Process 12-50)
Menu Selected: Master Control 1	Done	.:

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Master Control - A     Master Control 1     Master Control 2     Pripe Definition - B     Pripe Definition 1     Steel Section Properties     Steel Joint Properties (2)     Steel Hesistance Factors (LRFD)     Solution Level Statements - C     Control Parameters (Level 2-Pipe)     Major Geometry and Loading Parameter     Control Variables (Level 2-Pipe)     Backpacking for Embankment Mesh/1     Control Parameters for Changes to Noc     Material Definition 1 (in stu-bedding.bar     Material Definition 3 (in stu-bedding.bar     Material Definition 3 (in stu-bedding.bar     Material Definition 3 (in stu-bedding.bar     Material Definition 3 (in stu-bedding.bar     Material Definition 3 (in stu-bedding.bar     Material Definition 3 (in stu-bedding.bar     Material Definition 3 (in stu-bedding.bar     Material Definition 3 (in stu-bedding.bar     Material Definition 3 (in stu-bedding.bar     Material Definition 3 (in stu-bedding.bar     Material Definition 3 (in stu-bedding.bar     Material Definition 3 (in stu-bedding.bar     Material Definition 3 (in stu-bedding.bar     Material Definition 3 (in stu-bedding.bar     Material Definition 3 (in stu-bedding.bar     Material Definition 3 (in stu-bedding.bar     Material Definition 3 (in stu-bedding.bar     Material Definition 3 (in stu-bedding.bar     Material Definition 3 (in stu-bedding.bar     Material Definition 3 (in stu-bedding.bar     Material Definition 3 (in stu-bedding.bar     Material Definition 3 (in stu-bedding.bar     Material 3 (in stu-bedding.bar     Material 3 (in stu-bedding.bar     Material 3 (in stu-bedding.bar     Material 3 (in stu-bedding.bar     Material 3 (in stu-bedding.bar     Material 3 (in stu-bedding.bar     Material 3 (in stu-bedding.bar     Material 3 (in stu-bedding.bar     Material 3 (in stu-bedding.bar     Material 3 (in stu-bedding.bar     Material 3	Pipe material type         Aluminum         Basic         Concrete         Plastic         Steel         Canned mesh type         Pipe mesh         Box mesh         Arch mesh			
Menu Selected: Master Control 2	Done			

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Show Help Show input		(Steel) B-1 erties and Contro	I
Master Control - A	Young's modulus for steel	2900000	psi
Master Control 2	Poisson's ratio	0.3	
□··· Pipe Definition - B □··· Pipe Definition 1	Yield stress of pipe	33000	psi
Steel Material and Control Paramet Steel Section Properties	Yield stress of pipe seam		psi
Steel Joint Properties	Density of steel	0.284	lb/in^3
Steel Joint Properties (2) Steel Resistance Factors (LRFD)	Modulus of upper portion of bilinear model	-	psi
Solution Level Statements - C     Control Parameters (Level 2-Pipe)     Major Geometry and Loading Paramete     Control Variables (Level 2-Pipe)     Backpacking for Embankment Mesh/1     Control Parameters for Changes to Noc     Material Definition Statements - D     Material Definition 1 (in situ bedding ba     Material Control Parameters(Materia     Isotropic Linear Elastic Parameters     LRFD Load Factors	Ma O Ear O	nt slip No Yes Yes, show trace terial behavior Linear stress/strain Bilinear stress/strain ge deformation mode Small deformation Large deformation Large def/buckling	
< >>			
Menu Selected: Steel Material and Control Paran	neters Done		

Material properties (Young Modulus, passion ratio, yield stress and steam stress of pipe) values exist by default in CANDE software help menu, rater may modify these inputs.

Detail of deformation modes available in "CANDE solution methods" for this example "small deformation mode" has been used.

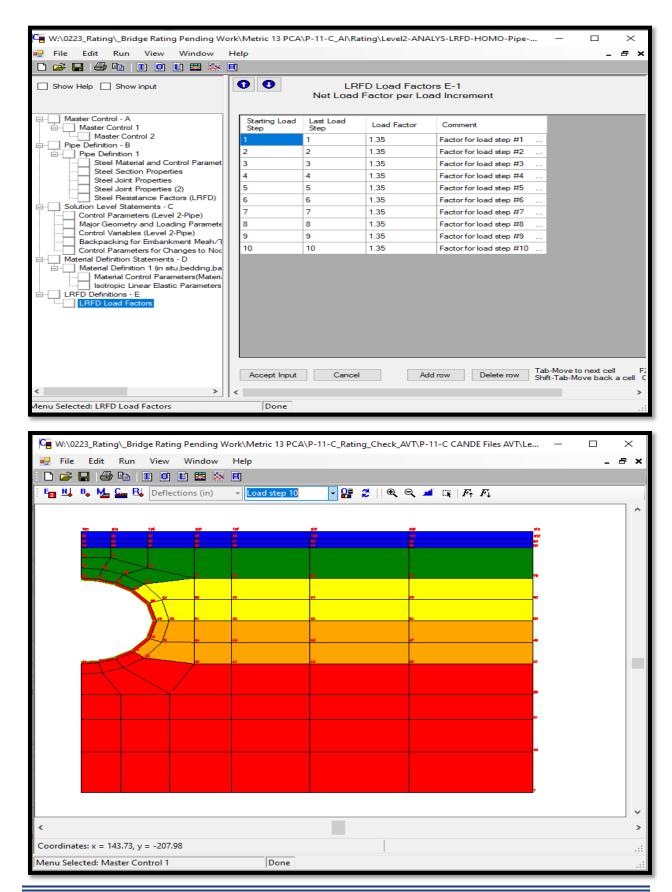
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Master Control - A     Master Control 2     Master Control 2     Prepe Definition - B     Seel Joint Properties (2)     Seel Austinal and Control Parameters     Seel Joint Properties (2)     Seel Resistance Factors (LRED)     Seel Resistance Factors (LRED)     Seel Resistance Factors (LRED)     Maging Geometers (Meater)     Control Parameters (Meater)     Maging Geometers (Meater)     Maging Control Parameters (Meater)     Material Definition 1 in situ.bedding.ba		
Show Help Bhow input     Master Control - A     Master Control - A     Master Control 2     Pipe Definition 1     Steel Material and Control Paramet     Steel Social Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Social Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Steel Joint Properties     Joint Properties     Joint Properties     Joint Properties     Joint Properties     Joint Properties     Joint Properties     Joint Properties     Joint Properties     Joint Properties     Joint Properties     Joint Properties     Joint Properties     Joint Properties     Joint Properties     Joint Properties     Joint Properties     Joint Properties     Joint Properties     Joint Properties     Joint Properties     Joint Properties     Joint Properties     Joint Properties     Joint Properties     Joint Properties     Joint Prope		
Section Properties  Area of pipe wall / unit length O.06041 in ^4/in Section Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties Steel Joint Properties St		
Area of pipe wail / unit length       0.050/1       in * 2/in         Pripe Definition - B       Master Control 2       in * 4/in         Steel Meterial and Control Parameters       Steel Soint Properties       0.05726       in * 3/in         Steel Joint Properties       Steel Joint Properties       in * 3/in       in * 3/in         Steel Joint Properties       Steel Joint Properties       in * 3/in         Major Geometry and Loading Parameter       Control Parameters (Level 2-Pipe)       in * 3/in         Major Geometry and Loading Parameter       Control Parameters for Changes to Noc       in * 3/in         Material Definition Statements - D       Accept Input       Cancel         Material Definition Statements - D       Accept Input       Cancel	Show Help Show input	
Image: Control 2         Prope Definition 1         Steel Material and Control Parameter         Steel Section Properties         Steel Joint Properties         Steel Joint Properties         Steel Arameters (Level 2-Pipe)         Material Definition 1 (in situ-Bedding Jae         Image: Properties (Control Parameters for Changes to Noc         Image: Properimage: Properimage: Properties (Control Parameters (Prop		Area of pipe wall / unit length 0.1297 in^2/in
Section modulus of pipe wall / unit length       0.05726     in ^3./in       Steel Material and Control Parameter     Section modulus of pipe wall / unit length     0.05726     in ^3./in       Steel Section Properties     Steel Section Properties     in ^3./in       Steel Material Definition 1     Steel Section Properties     in ^3./in       Solution Level Statements - C     Control Parameters (Level 2-Pipe)     Section modulus of pipe wall / unit length     in ^3./in       Backpacking for Embankment Mesh/ Control Parameters for Changes to Noc     Section modulus of pipe wall / unit length     in ^3./in       Material Definition 1 (in situ-bedding bain Material Definition 1 for situ-bedding bain Material Control Parameters     Accept Input     Cancel       KFD Definitions - E     LRFD Load Factors     Accept Input     Cancel		
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	Menu Selected: Steel Section Properties	Done

Area of Pipe wall, Moment of Inertia and section modulus inputs available in help menu (Table 14A-5).Based on material types (Steel or Aluminum) and pipe Corrugation pitch and depth from field measurement form.

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Show Help Show input	Material (Steel) B-2b Joint Properties
Master Control - A     Master Control 1     Master Control 1     Pipe Definition - B     Pipe Definition 1     Steel Material and Control Parameter     Steel Joint Properties	Thrust stress at initial joint slippage       4950       psi         Thrust stress at initial joint yielding       33000       psi         Ratio of slipping modulus to elastic steel modulus       0       0         Ratio of yielding zone modulus to elastic steel modulus       0.5       0         Ratio of yielding zone modulus to elastic steel modulus       0       0         Slot travel length       1       in         Number of joints in this pipe group       6       •         Vary joint travel length       •       0         Offerent lengths       •       0         Accept Input       Cancel       •
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Menu Selected: Steel Joint Properties	Done .:
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	Material (Steel) B-3
Master Control - A     Master Control 1     Master Control 1     Master Control 2     Pipe Definition 1     Pipe Definition 1     Steel Material and Control Parameter     Steel Joint Properties (2)     Steel Joint Properties (2)     Steel Resistance Factors (LRFD)     Solution Level Statements - C     Control Parameters (Level 2-Pipe)     Major Geometry and Loading Parametet     Control Parameters (Level 2-Pipe)     Material Definition 1 (in stu_bedding.ba     Material Definition 1 (in stu_bedding.ba     Material Control Parameters(Materia     Material Control Parameters(Materia)     MaterialCo	Material (Steel) B-3 Resistance Factors for LRFD  Resistance factor for thrust stress yielding Resistance factor for global buckling Resistance factor for seam strength Resistance factor for plastic penetration Allowable deflection at service load

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Show Help 🔲 Show input	Level 2 - C-2     Major Geometry and Loading Parameters     Pipe Mesh
Master Control - A     Master Control 1     Master Control 1     Pipe Definition - B     Pipe Definition 1     Steel Material and Control Parameter     Steel Joint Properties (2)     Solution Level Statements - C     Control Parameters (Level 2-Pipe)     Major Geometry and Loading Parametet     Control Parameters (Level 2-Pipe)     Major Geometry and Loading Parametet     Control Parameters for Changes to Noc     Material Definition 1 (in situ.bedding.bailton isotropic Linear Elastic Parameters     LRFD Load Factors	Average vertical diameter of pipe       92       in         Ratio of horizontal to vertical diameter       1.413          Height of soil cover       8       ft         Density of soil above truncated mesh       120       lb/ft^3
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Kenu Selected: Major Geometry and Loading P	arameter Done:
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Menu Selected: Major Geometry and Loading P T W:\0223_Rating\_Bridge Rating Pending W File Edit Run View Window	ork\Metric 13 PCA\P-11-C_Al\Rating\Level2-ANALYS-LRFD-HOMO-Pipe       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       —       …       …       …       …       …       …       …       …       …       …       …       …       …       …       …       …       …       …       …       …       …       …       …       …       …       …       …       …       …       …
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	Help _ & ×
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Master Control - A	Material ID 1
Master Control 1	Model Type 1-Isotropic-Linear Elastic V
Pipe Definition - B	Density 120 Ib/ft^3
Steel Material and Control Paramet	Material name
Steel Joint Properties Steel Joint Properties (2)	
Steel Resistance Factors (LRFD)	
Control Parameters (Level 2-Pipe)	Accept Input Cancel Delete
Major Geometry and Loading Paramete	
Backpacking for Embankment Mesh/1 Control Parameters for Changes to Noc	
Material Definition Statements - D	
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LRFD Load Factors	
Menu Selected: Material Control Parameters(M	aterial I)  Done
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Show Help Show input	Material Definition (Isotropic) - D-2 Elastic Parameters
Show Help Show input	Material Definition (Isotropic) - D-2 Elastic Parameters Young's modulus 1450 psi
Show Help Show input	Material Definition (Isotropic) - D-2 Elastic Parameters
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Show Help Show input      Master Control - A     Master Control 1     Master Control 2     Pipe Definition 1     Pipe Definition 1     Steel Material and Control Parameter     Steel Joint Properties     Steel Joint Properties (2)     Steel Resistance Factors (LRFD)     Solution Level Statements - C     Control Parameters (Level 2-Pipe)     Major Geometry and Loading Parameter     Control Variables (Level 2-Pipe)     Material Definition 1 (in situ_bedding.ba     Material Definition 1 (in situ_bedding.ba)     Materia	Material Definition (Isotropic) - D-2 Elastic Parameters Young's modulus 1450 psi Poisson's ratio 0.4
Master Control - A     Master Control 1     Master Control 2     Pipe Definition 1     Pipe Definition 1     Steel Material and Control Parameter     Steel Section Properties     Steel Joint Properties (2)     Steel Resistance Factors (LRFD)     Solution Level Statements - C     Control Parameters (Level 2-Pipe)     Major Geometry and Loading Parameter     Control Variables (Level 2-Pipe)     Material Definition 1 (in situ_bedding.ba     Material Definition 1 (in situ_bedding.ba)     Material Definition 1 (in situ_	Material Definition (Isotropic) - D-2 Elastic Parameters Young's modulus 1450 psi Poisson's ratio 0.4
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CDOT Bridge Rating Manual

October 2021

The CANDE Tool Box is used to convert mesh level 2 to level 3, update wearing surface thickness and unit weight, simulate various (design load, legal load, and permit load) and perform load rating calculations as shown below.

The rater must define each truck (legal and permit) configuration using option 3 in the Tool Box to get a rating for legal and permit trucks.

The rater must use live load factors specified in Section 1.3-M in CDOT Rating Manual 1.35 for design vehicle, 2.0 for legal load and 1.4 for permit load.

CANDE tool Box manual guide available in CANDE website:

https://www.candeforculverts.com/cande-tool-box.html

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- C ×

WELCOME TO CANDE TOOL BOX PROGRAM \*\*\*
Version January 1, 2018

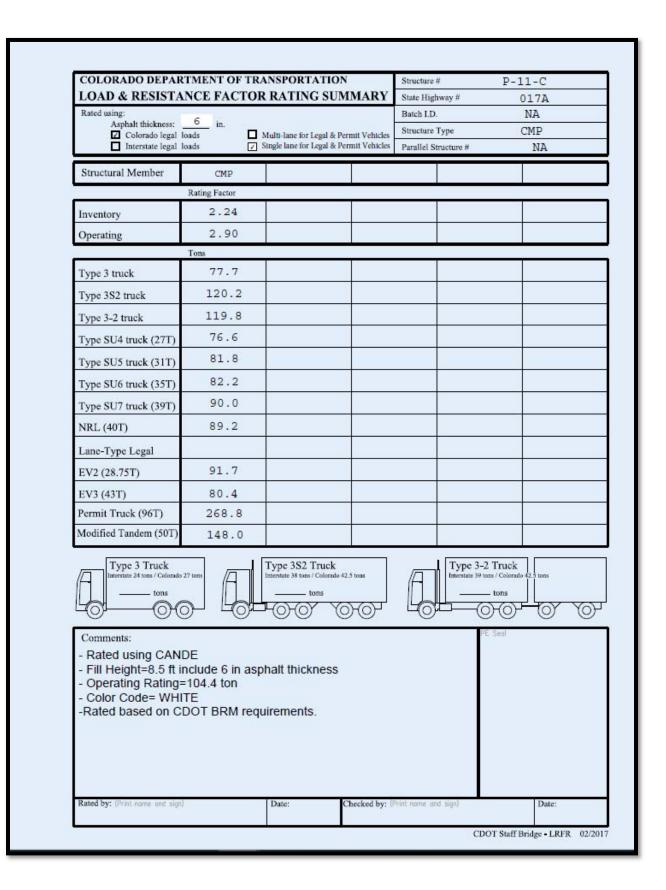
Select menu number for the desired action:
1 -- Convert Level-2 input file to full-mesh Level-3 file.
2 -- Insert pavement on mesh-surface of Level-3 file.
3 -- Simulate moving vehicle over surface of Level-3 file.
5 -- Perform load rating calculations on any existing run.
blank -- Exit program.
Enter the menu number below:

V

Below are rating results obtained from the CANDE output report for Inventory tandem design vehicle The process is slightly different for legal and permits trucks because the user must define the truck weight and axle spacing individually for each a truck. For more pipe rating examples visit the CANDE website.

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(1,1) CANDE FILE NAME: HL-93-Truck-INV-P-11-C-CMP.out	
Find USER-DEFINED KEY LOAD STEPS FOR LOAD RATING ANALYSIS:	
Find Next * Load step used for dead/earth load RF reference = 5	
* Load step beginning live-load search range = 6 * Load step terminating live-load search range = 11	
- Load step terminating investoral search range = in	
The master control and pipe-type dat     The master control and pipe-type dat     The master control and pipe-type dat     The master control and pipe-type dat     The master control and pipe-type dat     The master control and pipe-type dat	
* Controlling load-rating factor RF = 0.90	
<pre>* Controlling local-node number = 16 * Controlling live-load step number = 11</pre>	
* Safety assessment of culvert = BORDERLINE UNSAFE	
LOWEST RATING FACTORS PER DESIGN CRITERION AT CONTROLLING LOAD STEP AND NODE:	
DESIGN-CRITERION LOAD LOCAL DEAD-LOAD LIVE-LOAD EFFECTIVE *RATING	
(Strength) STEP NODE DEMAND DEMAND CAPACITY FACTOR *MATERIAL THRUST (psi) 8 16 3580.00 7520.00 33000.00 3.91	
*BUCKLING THRUST (psi) 8 16 3560.00 7520.00 42445.00 5.17	
*BUCKLING THRUST (psi) 8 16 3580.00 7520.00 42445.00 5.17 *SEAM THRUST (psi) 8 16 3580.00 7520.00 22110.00 2.46 *PLASTIC-PENETRATE (%) 11 16 0.00 100.00 90.00 0.90	
*PLASTIC-PENETRATE (%) 11 16 0.00 100.00 90.00 0.90	
DEFINITIONS AND RELATIONS FOR EACH CRITERION "n":	
* Rating Factor (n) = $(Capacity(n) - Dead(n))/Live(n)$	
* Total Demand(n) = Dead(n) + Live(n) at specified node	
<pre>* Dead(n) = Dead load demand for criterion n (factored) * Live(n) = Live load demand for criterion n (factored)</pre>	
<ul> <li>Live(n) = Live load demand of criterion n (actored)</li> <li>Capacity(n) = Capacity for criterion n (factored)</li> </ul>	
ADDITIONAL DIAGNOSTICS FOR ALL NODES	
<pre></pre>	~
Menu Selected: Master Control 1 Done	:

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Find Find Next Output Table of Contents The master control and pipe-type dat The master control and pipe-type dat	LOAD RATING SUMMARY FOR PIPE-GROUP = 1, PIPE TYPE = STEEL CANDE FILE NAME: HL-93-Truck-OPR-P-11-C-CMP.out USER-DEFINED KEY LOAD STEPS FOR LOAD RATING ANALYSIS: * Load step used for dead/earth load RF reference = 5 * Load step beginning live-load search range = 6 * Load step terminating live-load search range = 11 BOTTOM LINE FINDINGS FOR LOAD RATING OF CULVERT * Controlling design criterion = PLASTIC-PENETRATE (%) * Controlling load-rating factor RF = 1.03 * Controlling load-rating factor RF = 1.03 * Controlling live-load step number = 11 * Safety assessment of culvert = BORDERLINE SAFE	
	LOWEST RATING FACTORS PER DESIGN CRITERION AT CONTROLLING LOAD STEP AND NODE: DESIGN-CRITERION LOAD LOCAL DEAD-LOAD LIVE-LOAD EFFECTIVE *RATING (Strength) STEP NODE DEMAND DEMAND CAPACITY FACTOR *MATERIAL THRUST (psi) 8 16 3580.00 5800.00 33000.00 5.07 *BUCKLING THRUST (psi) 8 16 3580.00 5800.00 42445.00 6.70 *SEAM THRUST (psi) 8 16 3580.00 5800.00 22110.00 3.19 *PLASTIC-PENETRATE (%) 11 16 0.00 87.77 90.00 1.03 DEFINITIONS AND RELATIONS FOR EACH CRITERION "n": * Rating Factor(n) = (Capacity(n) - Dead(n))/Live(n) * Total Demand(n) = Dead(n) + Live(n) at specified node * Dead(n) = Dead demand for criterion n (factored) * Live (n) = Live load demand for criterion n (factored)	
< >> Menu Selected: Master Control 1	* Capacity(n) = Capacity for criterion n (factored) ADDITIONAL DIAGNOSTICS FOR ALL NODES	•



# 14A.7.2 Example 2: Steel Arch Rating (SAC)



#### COLORADO DEPARTMENT OF TRANSPORTATION STAFF BRIDGE CORRUGATED METAL CULVERT FIELD MEASUREMENT FORM

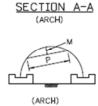
Material Type (Steel, aluminum, etc.)	STEEL
Galvanized (Yes or No)	YES
Number of Cells	1
Are all cells the same size and shape? (Yes or No)	NA
Document any differences:	
Top Wall Thickness - t1 (in) = (See Detail B)	1/4"
Bottom Wall Thickness - t2 (in) = (See detail B)	1/4"
Minimum Wall Thickness (in) =	1/4"
Corrugations Pitch - c (in) = (See Detail B)	8"
Corrugations Depth - d (in) = (See Detail B)	1.5"
Number of Bolts per longitudinal foot of splice ? Is it double or single row ?	3
Bolt Diameter (in)	1.25"
Pipe Span length - S (in) = See Section A-A for appropriate type	35'-4.75"
Pipe Rise - R (in) = See Section A-A for appropriate type	10'-6.5"
Maximum Normal Curvature top radius (Rt) dimensions (See Detail D)	M=1.25 (in) P= 36 (in)
Pavement Thickness (in) =	2"
Fill Height (in) =	36"
Is there noticeable settlement in the roadway over the culvert? Yes or No	NO
Is there noticeable differential settlement or rotation in the the culvert? Yes or No (Detail C)	NO
Is there noticeable sag or damage inside the culvert? Yes or No (If yes, take a photo)	NO
Noticeable Sag Dimensions (See Detail D) Location =	M= (in) P= (in)
Inspector Initials : LM Date: 1/7/2019	

#### STRUCTURE # C-21-BG

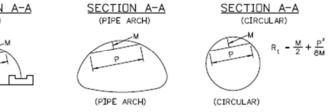
R



No t2 values exist for this section



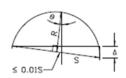




Calculate maximum existing normal curvature top radius (R<sub>2</sub>) by taking measurments around the upper periphery of the culvert using a ruler of length "P" to obtain value of "M". This should be done at selected stations along length of culvert (particularly at locations with normal curvature and at location with noticeable sag)

DETAIL D Top Radius Rt t<sub>1</sub> (Top wall) or \_\_\_\_\_ t<sub>2</sub> (bottom wall)(in.) Ē c (in.)

> DETAIL B (METAL CORRUGATION & GAGE INFORMATION )



The rotation of the structure, e, may be determined as:  $\theta = ton^{-1}(\frac{\Delta}{S})$ 

DETAIL C

DIFFERENTIAL SETTLEMENT

Control Information         Type of analysis       Design         Method of analysis/design       Exrel 2 Specific         © LRPD       Service         Service       Arch mesh         © LRPD       Arch mesh         Service       Pipe endsh         © Hefface elements (pipe only)       Felf-Mauto mesh (Level 2)         © FEM-auto mesh (Level 3)       MOD-Make changes to the basic mesh         © Number of nobes to change       Number of nobes to change         © Number of nobes of new loading/boundary conditions       Number of new loading/boundary conditions         New Input file       Heading for output	Main Input Control Parameters			- 0 3
<ul> <li>Analysis</li> <li>Design</li> <li>Method of analysis/design</li> <li>LRFD</li> <li>Service</li> <li>Solution level</li> <li>Basticity (Level 1)</li> <li>FEM-auto mesh (Level 2)</li> <li>FEM-user mesh (Level 3)</li> <li>Use the auto-generate option for the interface elements</li> <li>MoDP-Make changes to the basic mesh</li> <li>Number of nodes to change</li> <li>Number of pipe element groups (Level 3 only)</li> <li>Number of pipe element groups</li> <li>Number of new loading/boundary conditions</li> <li>Meang for output</li> </ul>		Control Information		
<ul> <li>● LRFD</li> <li>● Service</li> <li>Solution level</li> <li>● Basticity (Level 1)</li> <li>● FEM-auto mesh (Level 2)</li> <li>● FEM-auto mesh (Level 3)</li> <li>✓ Use the auto-generate option for the interface elements</li> <li>● MoD-Make changes to the basic mesh</li> <li>● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ●</li></ul>	<ul> <li>Analysis</li> <li>Design</li> </ul>	Canned mesh type Pipe mesh Box mesh	Embankment     Trench	2007
Solution level       Image: Solution level         Basticity (Level 1)       Trench-insitu         FEM-auto mesh (Level 2)       None         FEM-user mesh (Level 3)       MOD-Make changes to the basic mesh         Image: Work of pipe elements       MOD-Make changes to the basic mesh         Image: Wumber of pipe element groups       Image: Wumber of new loading/boundary conditions         New Input file       Heading for output		0.11111	O Homogenous	Input Wizard
key information regarding the type of model, method of applying, atc	Basticity (Level 1)     Elevel 2)     FEM-auto mesh (Level 2)     FEM-user mesh (Level 3)     Use the auto-generate option for     the interface elements	MOD-Make changes to the MOD-Make changes to the Number of node	es to change ients to change	Wizard! You will enter some basic information about your model and CANDE will prepare a starter input document that you can customize for your particular model. After you complete the input for each screen in the Input Wizard, press the 'Next' button until you have reached the end. Once completed, press the 'Finish' button to enter the CANDE input menus. Control Information
Next >>         Finish         Cancel         Press 'F1' for help	New Input file	Heading for output		key information regarding the type of
	<< Prev Next >> Finish	Cancel Press 'F1' f	or help	
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CDOT Bridge Rating Manual

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Material Control Parameters(Ma ~					
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Show Help Show input	Material (Steel) B-3     Resistance Factors for LRFD				
Master Control - A     Master Control 1     Master Control 2     Pipe Definition - B     Pipe Definition 1     Steel Material and Control Para     Steel Section Properties     Steel Resistance Factors (LRF     Solution Level Statements - C     Control Parameters (Level 2-Arch)     Piot and Print Control (Level 2-Arch)     Piot and Print Control (Level 2-Arch)     Piot and Print Control (Level 2-Arch)     Arch Segments and Angles (Level     Control Parameters for Changes to     Material Definition 1 (n stu)     Material Definition 1 (n stu)     Material Definition 2 (footing)     Material Definition 2 (footing)     Material Control Parameters(Ma     Isotropic Linear Elastic Parame     Material Control Parameters(Ma     Isotropic Linear Elastic Parameters(Ma     Duncan and Duncan/Selig Mo     Duncan and Duncan/Selig Mo     Duncan and Duncan/Selig Mo     Material Definition 4 (Interface 1)     Material Definition 4 (Interface 1)     Material Control Parameters(Ma	Resistance factor for thrust stress yielding       1         Resistance factor for global buckling       1         Resistance factor for seam strength       0.67         Resistance factor for plastic penetration       0.9         Allowable deflection at service load       5       7,				
Interface Angles					

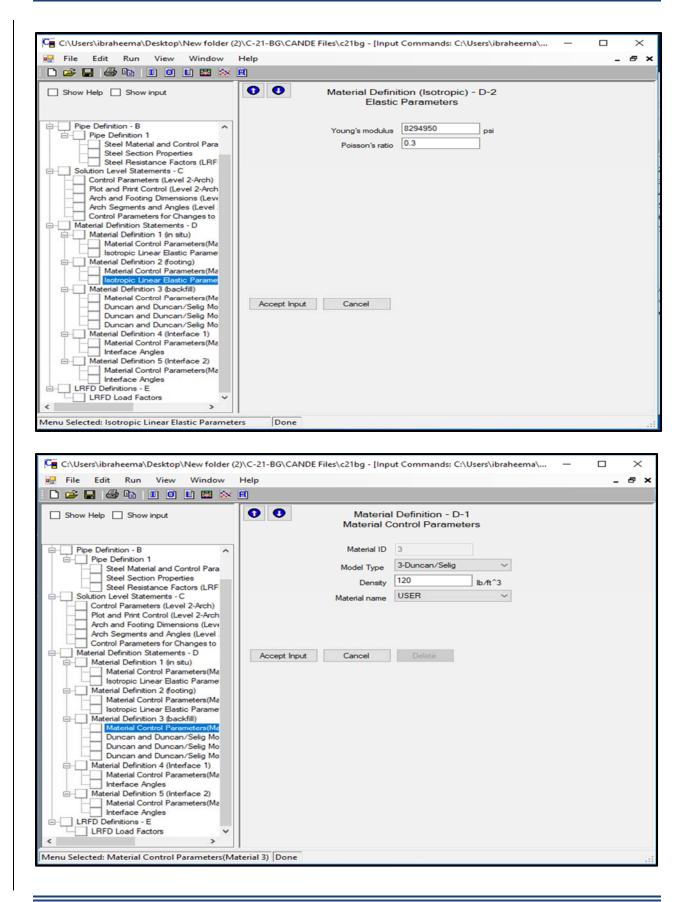
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Material Definition 2 (footing)     Material Control Parameters(Ma     Isotropic Linear Elastic Parameters)	Density of soil above truncated arch	120	] lb/ft^3	
Material Definition 3 (backfill)     Material Control Parameters(Ma     Duncan and Duncan/Selig Mo	Trench depth Trench width	0	ft ft	
Duncan and Duncan/Selig Mo     Duncan and Duncan/Selig Mo     Material Definition 4 (Interface 1)     Material Control Parameters(Ma     Interface Angles     Material Definition 5 (Interface 2)     Material Control Parameters(Ma      S	Slope of trench wall Accept Input Cancel	0		
Menu Selected: Plot and Print Control (Level 2-A	rch) Done			

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Show Help Show input	Level 2 -     Arch and Footing     Arch Me	Dimensions	
Master Control - A     Master Control 1	Total rise of arch structure	102.5 in	
Master Control 2	One-half of arch span at footing level	150 in	
Pipe Definition - B	Vertical rise of side segment	0 in	
Steel Material and Control Para Steel Section Properties	Footing depth	24 in	
Steel Resistance Factors (LRF	Outside footing width	15 in	
Solution Level Statements - C Control Parameters (Level 2-Arch)	Inside footing width	15 in	
Plot and Print Control (Level 2-Arch     Arch and Footing Dimensions (Level     Arch Segments and Angles (Level     Control Parameters for Changes to	Spacing factor for mesh grid around arch	1	
Material Definition Statements - D     Material Definition 1 (in situ)     Material Control Parameters(Ma     Isotropic Linear Elastic Parame     Material Definition 2 (footing)     Material Definition Parameters(Me			
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Show Help Show input	Level 2 - C-4 Arch Segments and Arch Mesh	-	
Master Control - A	Radius of top arc (segment 1) - R1	161.472	in
Master Control 2	Angle for R1 segment	34.2339069	degrees
Pipe Definition - B	Radius of second segment - R2	161.472	in
Steel Material and Control Para Steel Section Properties	Angle for R2 segment	34.2339069	degrees
Steel Resistance Factors (LRF	Radius of third segment - R3	.def.	in
Solution Level Statements - C	Angle for R3 segment	.def.	degrees
Plot and Print Control (Level 2-Arch	Base angle of R3 segment	.def.	degrees
Arch and Footing Dimensions (Leve Arch Segments and Angles (Level	Nodes assigned to segment 1	.def.	
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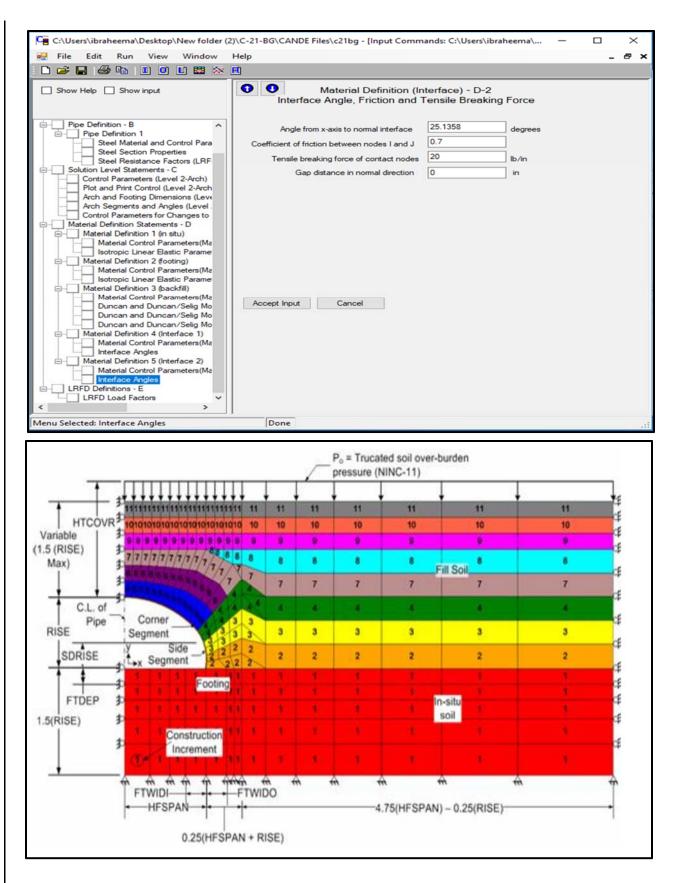
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Pipe Definition - B Pipe Definition 1 Steel Material and Control Para Steel Section Properties Steel Resistance Factors (LRF	Young's modulus 435113.2 psi Poisson's ratio 0.25	
Solution Level Statements - C Control Parameters (Level 2-Arch) Plot and Print Control (Level 2-Arch) Arch and Footing Dimensions (Level Arch Segments and Angles (Level Control Parameters for Changes to Material Definition Statements - D Material Definition 1 (in situ) Material Control Parameters(Ma		
Botropic Linear Bastic Parame     Material Definition 2 (footing)     Material Control Parameters(Ma     lootropic Linear Elastic Parame     Material Definition 3 (backfill)     Material Control Parameters(Ma     Duncan and Duncan/Selig Mo     Duncan and Duncan/Selig Mo	Accept Input Cancel	
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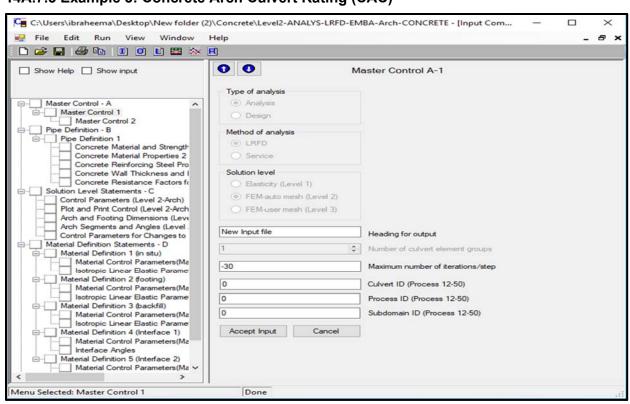


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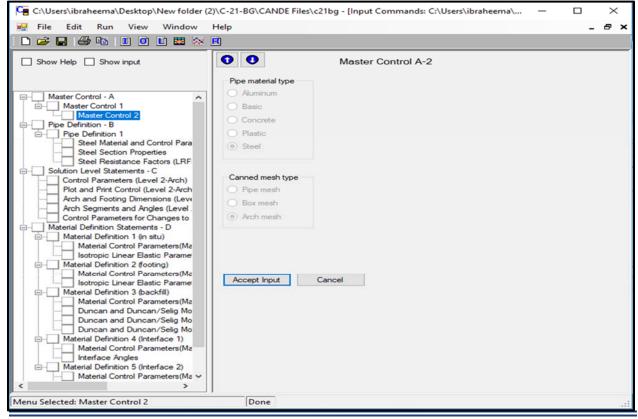
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Show Help Show input	Material Definition (Dund Fundament				
Pipe Definition - B     Pipe Definition 1     Steel Material and Control Para     Steel Section Properties     Steel Section Properties     Steel Section Properties     Steel Resistance Factors (LRF     Gottion Level Statements - C     Control Parameters (Level 2-Arch)     Piot and Print Control (Level 2-Arch)     Piot and Print Control (Level 2-Arch)     Piot and Print Control (Level 2-Arch)     Raterial Definition 1 (in aitu)     Material Definition 1 (in aitu)     Material Definition 1 (in aitu)     Material Definition 2 footing)     Material Definition 2 footing)     Material Definition 3 (backfill)     Material Definition 3 (backfill)     Material Definition 4 (Interface 1)     Material Definition 5 (Interface 1)     Material Definition 5 (Interface 2)     Material Definition 5 (Interface 3)     Material Definition 5 (Interface 4)     Material 4)     Material 4)	LRFD stiffness control Moduli averaging ratio	0.5			
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Pipe Definition - B	Angle from x-axis to normal interface	90 degrees			
Steel Section Properties	Coefficient of friction between nodes I and J	0.7			
Steel Resistance Factors (LRF)	Tensile breaking force of contact nodes	20 lb/in			
Control Parameters (Level 2-Arch) Piot and Print Control (Level 2-Arch) Arch and Footing Dimensions (Level Control Parameters for Changes to Material Definition 1 (in situ) Material Definition 1 (in situ) Material Control Parameters(Ma Isotropic Linear Elastic Parame Material Definition 2 (footing) Material Definition 3 (backfill) Material Definition 3 (backfill) Material Definition 3 (backfill) Material Control Parameters(Ma Isotropic Linear Elastic Parame Material Definition 3 (backfill) Material Control Parameters(Ma Duncan and Duncan/Selig Mo Duncan and Duncan/Se	Gap distance in normal direction	0 in			
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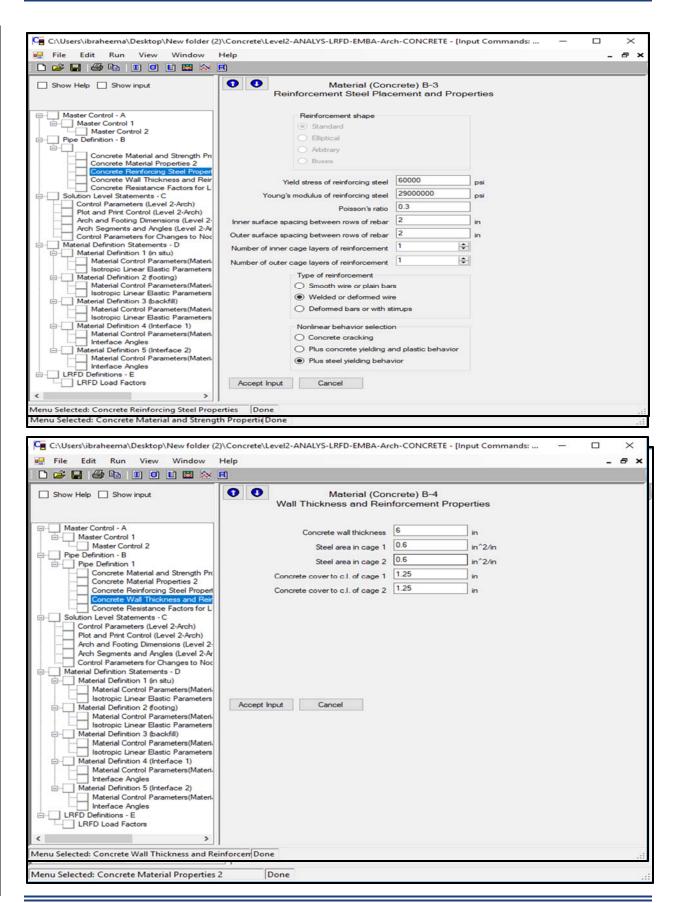




# 14A.7.3 Example 3: Concrete Arch Culvert Rating (CAC)



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Master Control - A     Master Control 1     Master Control 2     Pipe Definition - B     Concrete Material and Strength Pri     Concrete Material Properties 2     Concrete Material Properties 2     Concrete Walt Thickness and Reir     Control Parameters (Level 2-Arch)     Arch and Footing Dimensions (Level 2-Arch)     Arch and Footing Dimensions (Level 2-Arch)     Arch and Footing Dimensions (Level 2-Arch)     Material Control Parameters (Materi-     Isotropic Linear Elastic Parameters     Material Control Parameters(Materi-     Isotropic Linear Elastic Parameters     Material Definition 2 (footing)     Material Definition 5 (Interface 1)     Material Control Parameters(Materi-     Isotropic Linear Elastic Parameters     Material Definition 5 (Interface 1)     Material Control Parameters(Materi-     Interface Angles     LRFD Definitions - E     LRFD Load Factors	Accept Input Cancel	0.9 0.75 0.9 0.01

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Pipe Definition 1	Footing depth 2		lin	
Concrete Material Properties 2 Concrete Reinforcing Steel Propert	Outside footing width		] in	
Concrete Wall Thickness and Reir	Inside footing width		lin	
Concrete Resistance Factors for L Solution Level Statements - C	Spacing factor for mesh grid around arch			
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Isotropic Linear Elastic Parameters     Material Definition 2 (footing)	Accept Input Cancel			
Material Control Parameters(Material Isotropic Linear Elastic Parameters				
Material Definition 3 (backfill)				
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Material Definition 4 (Interface 1)				
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Material Definition 5 (Interface 2)				
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CDOT Bridge Rating Manual

Steel arch rating results vs concrete arch

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- Steel Arch
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LOWEST RATING FACTORS PER	DESIG	N CRITE	RION AT CON	TROLLING LOAD	STEP AND NOI	DE:	
*MATERIAL THRUST (psi) *BUCKLING THRUST (psi)			DEAD-LOAD DEMAND 2440.00 2440.00 2440.00	9560.00	31881.00	*RATING FACTOR 3.20 3.08 3.20	
*PLASTIC-PENETRATE (%)	27	5	0.00	100.00	90.00	0.90	
<pre>*PLASTIC-PENETRATE (%) 27 5 0.00 100.00 90.00 0.90 DEFINITIONS AND RELATIONS FOR EACH CRITERION "n": * Rating Factor(n) = (Capacity(n) - Dead(n))/Live(n) * Total Demand(n) = Dead(n) + Live(n) at specified node * Dead(n) = Dead load demand for criterion n (factored) * Live(n) = Live load demand for criterion n (factored) * Capacity(n) = Capacity for criterion n (factored)</pre>							

# - Concrete Arch

LOWEST RATING FACTORS PER	DESIG	N CRITE	RION AT CONT	TROLLING LOAD	STEP AND NOI	DE:	
DESIGN-CRITERION	LOAD	LOCAL	DEAD-LOAD	LIVE-LOAD	EFFECTIVE	*RATING	
(Strength)	STEP	NODE	DEMAND	DEMAND	CAPACITY	FACTOR	
*STEEL YIELDING (psi)	24	29	0.00	6820.09	54000.00	7.92	
*CONCRETE CRUSHING (psi)	24	29	0.00	1236.16	3000.00	2.43	
*SHEAR FAILURE (lbs/in)	21	27	0.00	405.95	754.70	1.86	
*RADIAL-TENSION FAIL (psi)	19	20	0.00	27.32	54.60	2.00	
<pre>DEFINITIONS AND RELATIONS FOR EACH CRITERION "n": * Rating Factor(n) = (Capacity(n) - Dead(n))/Live(n) * Total Demand(n) = Dead(n) + Live(n) at specified node * Dead(n) = Dead load demand for criterion n (factored) * Live(n) = Live load demand for criterion n (factored) * Capacity(n) = Capacity for criterion n (factored)</pre>							

Asphalt thickness: 2 in. Colorado legal loads I Multi-lane for Legal & Permit Vehicles			Batch LD Structure Parallel S	Туре		INDE BAC	
Structural Member	SAC						
	Rating Factor		1				
Inventory	3.08						
Operating	3.72						
	Tons						
Type 3 truck	78.7						
Type 3S2 truck	143.3						
Type 3-2 truck	131.8						
Type SU4 truck (27T)	84.2						
Type SU5 truck (31T)	92.1						
Type SU6 truck (35T)	100.5						
Type SU7 truck (39T)	113.1						
NRL (40T)	122.0						
Lane-Type Legal							
EV2 (28.75T)	103.2						
EV3 (43T)	89.9						
Permit Truck (96T)	383.0						
Modified Tandem (50T)	162.5						
Type 3 Truck Interstate 24 teas / Colorad tons	27 tons	Type 3S2 Truck Interstate 38 tons / Colorado 42.	5 tons	f.	≌⊙	tons	
Comments:       PE Sed         -Rated using CANDE       -In Situ soil modeled as isotropic soil         -Backfill modeled using Duncan/Selig model       -Color Code: WHITE         -Color Code: WHITE       -Asphalt thickness taken per inspection         Rated by: (Print nome and sign)       Date:         Checked by: (Print nome and sign)       Date:							

14A-41

CDOT Bridge Rating Manual

COLORADO DEPARTMENT OF TRANSPORTATION STAFF BRIDGE BRIDGE RATING MANUAL	Section: 15 Effective: April, 1, 2011 Supersedes: None
SECTION 15 - LOAD AND RESIS	TANCE FACTOR RATING (LRFR)

## 15-1 GENERAL LRFR POLICY

This section covers the Load and Resistance Factor Rating (LRFR) method. The LRFR method is required for all structures designed after October 1, 2010 using the AASHTO LRFD Bridge Design Specifications (LRFD). Refer to Section 1-4 in this manual for additional guidance on when the LRFR method is required.

The load rating for structures using the LRFR method shall be in accordance with the current AASHTO LRFD Bridge Design Specifications and, the AASHTO Manual for Bridge Evaluation except where superseded by this manual.

The rating shall include both moment and shear for all interior and exterior girders.

Excluding post-tensioned structures, rigid frames and culverts, the AASHTOWare Virtis software shall be used for all ratings using the LRFR method. The analysis engine for LRFR shall be the Virtis engine. The rating procedure for both in-house and consultant ratings shall be as described in Sections 1-11 and 1-12 on this manual. The rating package requirements shall be as described in Section 1-13 of this manual, except no deck rating is required for structures rated with LRFR.

The requirements for rerating due to design and field changes shall be as stated in Sections 1-17 and 1-18.

## 15-2 DEAD LOADS

Dead loads used for the LRFR method will be calculated in accordance with Section 1-1 of this manual.

# 15-3 LIVE LOADS

For Load and Resistance Factor Ratings (LRFR), the live load to be used for rating shall be as specified in the current AASHTO LRFD Bridge Design Specifications, the AASHTO Manual for Bridge Evaluation and the CDOT Staff Bridge Rating Manual.

#### 15-4 IMPACT AND DRISTRIBUTION OF LIVE LOAD

The live load impact used for rating shall be as specified in the current AAHSTO LRFD Bridge Design Specifications except as noted in Section 1-3 of this manual. Full impact shall be used for all ratings: HL-93 inventory, HL-93 operating, posting, and overload color code ratings.

For overload permit analysis (i.e., gross vehicle weight over 200,000 lbs) when reduced vehicle speed is enforced, impact may be reduced when crossing the structure.

|--|

#### 15-4 IMPACT AND DRISTRIBUTION OF LIVE LOAD (CONTINUED)

The live load distribution factors used for rating shall be as specified in the current AAHSTO LRFD Bridge Design Specifications and AASHTO Manual for Bridge Evaluation except as noted in Section 1-3 of this manual.

#### 15-5 MATERIAL PROPERTIES USED TO DETERMINE BRIDGE RATINGS

Material properties shall be as specified on the as built plans. When as built plans are not available, Table 1-1 of this manual maybe used.

#### 15-6 LOAD FACTORS, CONDITION FACTORS AND SYSTEM FACTORS

The load factors used in the rating analysis shall be as specified in the current AASHTO Manual for Bridge Evaluation.

The ADTT used to select the Live Load factors shall be taken from the Structure Inspection and Appraisal sheet (SIA Sheet). The ADTT used in the analysis shall be recorded in the comments section of the Rating Summary Sheet. The value should be obtained using the following equation:

 $ADTT = ADT \times (% Truck/100)$ 

Where: ADT is item 29 and % Truck is item 109.

If the ADTT is unknown the most conservative table value should be used.

The condition factor for new bridges shall be taken as 1.0.

When re-rating existing structures using the LRFR method, the actual member condition as reported in the most recent inspection shall be used. The condition factor shall be adjusted as specified in the AASHTO Manual for Bridge Evaluation.

The system factor shall be as specified in the current AASHTO Manual for Bridge Evaluation.

## **15-7 POSTING VEHICLE RATINGS**

When performing posting vehicle ratings, Section 1-15 shall be used as a guide except as amended in the following paragraphs.

If a structure rating indicates a need for posting (i.e. operating rating factor less than 1.0), the Staff Bridge Engineer will be notified for approval and generation of a formal letter to the Permit Office, Region RTD and Region Maintenance Superintendent.

Whenever the operating rating factor or the permit truck rating factor for a structural member is less 1.0 the live load distribution factor may be adjusted using more refined analysis such as grid analysis. If the operating rating factor is still less than 1.0, the structural member shall be rated for the posting trucks. The inventory rating

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#### 15-7 POSTING VEHICLE RATINGS (CONTINUED)

shall not be adjusted from the values prescribed by the AASHTO LRFD Design Specifications.

The posting rating shall be computed using the Posting Vehicles shown in Figures 1-2, or 1-3. For mainline Interstate routes, or Interstate access ramps, the Posting Vehicles shown in Figure 1-3, shall be used. For all other routes, including Interstate business routes, the Posting Vehicles shown in Figure 1-2, shall be used.

Posting Vehicles are composed of the maximum vehicle loads allowed by Colorado law. The difference between the live loads in Figures 1-2, and 1-3, is due to the maximum legal loads allowed on Interstate highways being different from those allowed on other Colorado roadways.

The Notional Rating Load (NRL) and Lane Type Legal truck for spans greater than 200 feet as specified in the AASHTO Bridge Evaluation Manual shall be included in the posting analysis.

#### 15-8 OVERLOAD COLOR CODE

The Overload Color Code rating shall be computed using the live load defined in Section 1-16. For span up to 200 feet, only the permit vehicle shall be considered present in the lane. For spans greater than 200 feet and when checking negative moments in continuous span bridges, an additional lane load shall be applied, see section 6A.4.5.4.1 of the Manual for Bridge Evaluation. For distribution of live load see Section 15-4 of this manual. Structures rated using LRFR shall use multi-lane live load distribution to determine overload color code.

#### 15-9 REPORTING LRFR RATING RESULTS

When using the LRFR method, the reported value for the HL-93 load shall be the rating factor. For all other vehicles the reported values shall be in tons.

The results of rating calculations are to be reported by the Rater on the Rating Summary Sheet, CDOT Form 1187a Load and Resistance Factor Rating Summary, see Appendix A for copies of these forms and Section 1– 13 for more detail. All ratings shall be reported to tenths of a ton or tenths of a rating factor for the HL-93 loading at inventory and operating levels.

COLORADO DEPARTMENT OF TRANSPORTATION	Section:	Appendix				
STAFF BRIDGE	Effective:	February 28, 2019				
BRIDGE RATING MANUAL	Supersedes:	February 10, 2017				
ADDENDIY - A						

APPENDIX – A

Appendix - A has three editable Rating Summary Sheets (RSS) and they are listed as follows:

CDOT Staff Bridge - ASR (ASR\_Summary\_Sheet\_Feb2019\_YELLOW.pdf)
CDOT Staff Bridge - LFR (LFR\_Summary\_Sheet\_Feb2019\_GREEN.pdf)
CDOT Staff Bridge - LRFR (LRFR\_Summary\_Sheet\_Feb2019\_BLUE.pdf)

COLORADO DEPARTMENT OF TRANSPORTATION				Structure #			
TIMBER RAT	FING SUMN	IARY		State Highway #			
Asphalt thickness in					Batch I.D.		
Colorado legal loads Multi-lane for Legal & Permit Vehicles					Туре		
Interstate legal	loads Si	ingle lane for Legal & Pern	nit Vehicles	Parallel S	tructure #		
Structural Member							
	Tons		1			1	
Inventory							
Operating							
Type 3 truck							
Type 3S2 truck							
Type 3-2 truck							
Type SU4 truck (27T)							
Type SU5 truck (31T)							
Type SU6 truck (35T)							
Type SU7 truck (39T)							
NRL (40T)							
EV2 (28.75T)							
EV3 (43T)							
Permit Truck (96T)							
Modified Tandem (50T)							
Type 3 Truck     Type 3S2 Truck       Interstate 24 tons / Colorado 27 tons     Interstate 38 tons / Colorado 42.5 tons       tons     tons							
Comments:					PE Seal		

Rated by: (Print name and sign)	Date:	Checked by: (Print name and sign)	Date:

COLORADO DEPARTMENT OF TRANSPORTATION				Structure			
LOAD FACTOR RATING SUMMARY					State Highway #		
Rated using: Asphalt thickness:	in.				Batch I.D.		
Colorado legal	loads N	Multi-lane for Legal & Per	mit Vehicles		Structure Type		
Interstate legal	loads S	Single lane for Legal & Perr	mit Vehicles	Parallel St	Parallel Structure #		
Structural Member							
	Tons						
Inventory							
Operating							
Type 3 truck							
Type 3S2 truck							
Type 3-2 truck							
Type SU4 truck (27T)							
Type SU5 truck (31T)							
Type SU6 truck (35T)							
Type SU7 truck (39T)							
NRL (40T)							
EV2 (28.75T)							
EV3 (43T)							
Permit Truck (96T)							
Modified Tandem (50T)							
Type 3 Truck       Type 3S2 Truck         Interstate 24 tons / Colorado 27 tons       Interstate 38 tons / Colorado 42.5 tons         tons       tons         Comments:       PE Sed							
Comment.							

Rated by: (Print name and sign)	Date:	Checked by: (Print name and sign)	Date:
Comments:			PE Seal

COLORADO DEPAI				Structure	#	
LOAD & RESISTA	ANCE FACTO	R RATING SU	MMARY	State High	nway #	
Rated using: Asphalt thickness:	loads Multi-lane for Legal & Permit Vehicles		Batch I.D.			
Colorado legal			Structure Type			
Interstate legal	loads	Single lane for Legal &	Permit Vehicles	Parallel S	tructure #	
Structural Member						
	Rating Factor					
Inventory						
Operating						
	Tons					
Type 3 truck						
Type 3S2 truck						
Type 3-2 truck						
Type SU4 truck (27T)						
Type SU5 truck (31T)						
Type SU6 truck (35T)						
Type SU7 truck (39T)						
NRL (40T)						
Lane-Type Legal						
EV2 (28.75T)						
EV3 (43T)						
Permit Truck (96T)						
Modified Tandem (50T)						
Type 3 Truck		Type 3S2 Truck			Type 3-2 Truck	
Interstate 24 tons / Colorad	o 27 tons	Interstate 38 tons / Colorado	9 42.5 tons	A	Interstate 39 tons / Colorad	lo 42.5 tons
tons					tons	
	9 0-		90	$\bigcirc$		
Comments:					PE Seal	
Rated by: (Print name and sig	n)	Date:	Checked by: (F	Print name an	nd sign)	Date:

COLORADO DEPARTMENT OF TRANSPORTATION	Section: Append
STAFF BRIDGE	Effective: Januar
BRIDGE RATING MANUAL	

APPENDIX - B

Appendix - B has a Rating QAQC Checklist

CDOT Staff Bridge - (QAQC\_Checklist 2021 10.pdf)

# APPENDIX B: RATING OR RE-RATING QA/QC CHECKLIST

(to be filled by Rater with concurrence from Checker who will also initial and sign on check Item 14)

1. Structure Number	
Verify plans available: 🛛 Yes	□ No
If no plans:	$\Box$ Rating based on Physical inspection
	□ Rating based on non-destructive test loading

- $\Box$  2. Verify overlay thickness and/or fill depth
- $\square$  3. Verify, if applicable, previously calculated loads and pertinent information
- □ 4. Verify LLDF's (live load distribution factors)
   Include □ Hand calc. □ BrR calc. □ CANDE calc. or Other software calc.

 $\Box$  5. The "Description" area of the Bridge ID window in BrR shall have the following information: Provide reason(s) for rating/re-rating, company name, rater initials, checker initials and date.

- $\Box$  6. Verify that "Traffic" area of the Bridge ID window in BrR is filled
- □ 7. Verify that "Global Reference Point" area of the Bridge ID window in BrR is filled
- □ 8. System analysis or □ Line analysis used in BrR If Line analysis used, explain here: \_\_\_\_\_

□ 9. Completed steps required per Fig. 1-9 of CDOT Bridge Rating Manual

□ 10. Completed steps required per Section 1.13 of CDOT Bridge Rating Manual

□ 11. Reported the rating results per Section 1.14 of CDOT Bridge Rating Manual, including posting requirements (per Section 1.15) and color code requirements (per Section 1.16)

□ 12. Completed Rating Summary Sheet (RSS) per section 1.14 of CDOT Bridge Rating Manual

 $\Box$  13. Verify that the load rating results are initialed and dated by both the rater and checker

 $\Box$  14. Initial and date this checklist

Rater initials and date	
Checker initials and date	

□ 15. Send rating package in electronic format to CDOT Bridge contact / Rating Unit