Introduction

It is the purpose of this Manual to present a collection of drawings, standards, procedures, notes, and details that are preferred by the Staff Bridge Branch of the Colorado Department of Transportation. This Manual is to serve as a guide in the preparation of plans for bridges, box culverts, and miscellaneous structures. It also provides pertinent data and information necessary to complete the detailing and checking phases of the project.

By adherence to the Manual it will be possible to achieve a uniformity and consistency in our drawings and procedures. It is intended that the examples and procedures shown in the following pages be used, unless special conditions warrant a deviation. In these cases, sound engineering judgment should be exercised.

This Manual is in no way intended to release the Designer, Detailer, or Checker from their responsibility, nor to restrict or hinder imagination and new ideas.

The CDOT Bridge Detailing Manual is a dynamic document that is intended to be continuously updated and improved. If you have any recommendations for improvement, please contact CDOT Staff Bridge.

Revision Log

This revision log is a record of all the revisions to the Bridge Detail Manual since May 1981. It shows the date of the current and previous versions of each Chapter, and the initials of the persons who wrote the Chapter for the Staff Bridge Engineer.

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1.1 Overview of the Design and Construction Process

The scope of engineering work from the design through the actual construction may be divided into six stages. A general knowledge of these stages in the design and construction of a structure is essential for the detailer to prepare a high-quality set of plans. The stages are as follows:

I. Preliminary Design

In this stage of the plan development, a structure type will be selected. Two or more alternate structure types will generally be considered at each site. Economy is usually the best substantiation for the final type selection. However, many other items shall be considered, such as: appearance, maintenance costs, construction details, traffic convenience during construction, time for construction, similarity to adjacent structures, availability of materials, features crossed, span lengths, vertical clearance. The type or types of Accelerated Bridge Construction (ABC) are determined during preliminary design.

The decisions made at this stage are very important, and time should be taken as necessary to assure a good start with valid criteria because the rest of the structure plans will be built around this information. Typically, a General Layout sheet and Typical Sections are developed for this design phase.

II. Final Design

This stage includes a detailed stress analysis and preparation of drawings and sketches necessary to illustrate to the detailer the general arrangement of the structure, member sizes, and any other information necessary to clearly interpret the designer's ideas.

III. Detailing

This consists of preparing drawings from the designer's notes. The drawings must be clear enough for suppliers to prepare the necessary fabrication drawings and support any quantity calculations. As part of the detailing process, quantities shall be calculated and results used for preparing the summary of quantities table.

IV. Checking

The design check and check set of quantity calculations shall be made using the detail drawings.

V. Fabrication

This includes cutting and bending of reinforcing steel, the building of the structural steel components, and the casting of precast-prestressed components.

VI. Construction

This consists of the actual building of the structure from the drawings. This phase of the work can be expedited by conscientious work during plan preparation.

1.2 General Steps of Detailing Procedures

When the detailer has received the design data for the preparation of the detailed drawings, the work may be divided into the following steps:

Step 1 Design Study: The detailer shall carefully study the design notes and material provided by the designer. It is important that the detailer understand the Engineer's design, as well as the probable step-by-step construction of the structure. The detailer is expected to carry out all instructions given in the design notes; nevertheless, any points that the detailer considers worthy of discussion must be brought to the attention of the designer.

Step 2 Bridge Geometry: The person preparing the Bridge Geometry input shall study the layout of the structure and roadway approaches, and while coding in the geometry input shall refer to the Bridge Geometry User's Manual provided by the Staff Bridge Branch.

Step 3 Planning the Drawings: In coordination with the designer, the detailer shall plan the drawings, determining what details and information are to be placed upon each sheet, the scales to be used and the number of sheets required.

Step 4 Preparation of the Drawings: This consists of the actual drafting procedure. The detailer and/or designer will prepare some sketches and computations as necessary to place accurate information on the drawings.

Step 5 Checking: Upon completion of the drawing set, copies are given to the designer, the design checker and the detail checker, along with all pertinent data necessary to perform a comprehensive check. All dimensions, stations, elevations, and details shall be checked for accuracy and consistency. A consistent method of markups shall be used. In a commonly used system, the checkers indicate possible corrections or additions that may be needed on the drawings in red. Correct information is highlighted in yellow by the designer or submitter of the comments. Marked up drawings should be initialed and dated. When the checking has been completed, the check prints shall be returned to the designer who will back check the mark-ups. The designer will confirm the items marked as incorrect are indeed incorrect and the corrections or additions are accurate prior to sending the set back to the detailer for revisions. The checker and designer shall also resolve any differences prior to sending the corrected set back to the detailer.

Step 6 Making Corrections: After verifying the redlined corrections indicated on the check prints, the detailer shall then make the changes. As the changes are being made, they shall be marked in blue highlighter prior to returning to the checker. Alternately, the check prints may be marked "changes made" with initials and date. This allows the designer to verify changes by highlighting the detailers blue with orange. The corrected drawings will then be reviewed against the check prints to verify the marked corrections have been incorporated correctly. If additional changes are still necessary, it’s usually cleanest/easiest to mark up a new set of prints rather than continuing to use the old marked up sets.

1.3 Corrections of Designer's Detail Notes

In the course of the detailing procedure, it may become necessary to make revisions to the design notes. It shall be the designer's responsibility to keep the design notes current. Computer aided drafting has increased the ability to speed up the detailing process, however the design should be as complete as possible before the detailer starts working on the project to minimize changes.

1.4 Structure Number

Structure numbers shall be assigned by the Asset Management Unit. Refer to the BRIAR Manual & Bridge Design Manual for additional details. Typically, these shall be requested as soon as practical in the design process and used on all drawing references. Structure numbers for other ancillary structures such as signals, high mast lights and sign structures are assigned in a similar manner.

1.5 Wall Structure Number

The Bridge Management Unit shall assign Wall Structure Numbers to both noise walls and structural retaining walls. For additional details, examples, wall qualification criteria, definitions, designation and naming procedures, refer to the BRIAR Manual, Bridge Design Manual, & Section 15.1 – Wall Details. Typically, these shall be requested when the wall geometry is finalized in the design process and shall be used on all drawing references.

1.6 Accuracy of Dimensions and Elevations

The degree of accuracy used on the drawings shall be as follows:

A) Structural dimensions to the nearest 1/8 inch with the following exceptions:
   1) Bearing device dimensions on abutments and piers to the nearest .001 foot.
   2) Top of concrete of the bearing seat to the nearest 1/16 inch.
   3) Stations to the nearest .01 foot.
   4) Foundation, Construction, Girder Layout dimensions (dimensions along tangents, etc.) to the nearest .01 foot.
   5) Steel girder dimensions to the nearest 1/16 inch.
   6) Dead load deflections to the nearest .0001 foot.
   7) Tip elevations of caissons, and estimated pile tips, shall be given to the nearest foot.
   8) Elevations for bottoms of footings shall be rounded to the nearest .01 foot.

B) Skew angles and bearings shall be given to the nearest second. Example: 69°38'13".

C) Other angles shall be given so that dependent dimensions meet the above criteria.

1.7 Responsibility for Plan Drawings

Drawings shall be prepared and checked in the design unit. The graphic presentation of the information on these drawings shall be the responsibility of the individual preparing the drawings. Any differences of opinion for graphical presentation between designer and detailer not clearly delineated in the Detailing Manual shall be brought to the attention of the unit leader for clarification.

1.8 Checking Plan Drawings

The designer, detailer, and detail checker are each responsible for contributing to an acceptable, error free set of contract plan drawings. A conscientious cooperation among all three parties is required to accomplish this.

It is important to correct all errors in the plan drawings before a project is advertised. This will avoid contract revisions, Contractor claims, added construction costs, and additional time charged to projects to address construction problems caused by plan errors.

Because of the importance of checking the plans, adequate time shall be allowed for this process, even in high priority rush jobs.

The following outlines the various responsibilities of the designer, detailer, and detail checker during the plan checking process:

A) The designer shall check the plans to assure that the design was correctly conveyed in the plans and is constructible.
   1) The detailer shall check every detail in the plans for neatness, correctness, completeness, constructability and clarity.
   2) The designer and detail checker shall back check the plans, after the detailer has made the revisions to the plans to assure all changes have been made.

Additional information and instructions for checking will be discussed in subsequent chapters of this manual.

1.9 Border Information

A) Title Block

The sheet title shall be a description of the details or information shown on the drawing. All letters in the sheet title shall be capitals. When a project descriptor is used, the information should not be in the Index of Drawings.

For projects with multiple project numbers / subaccount numbers, see the Project Manager for further guidance.

The structure number, first initial and the last name of the Designer and Detailer, project number, sub-account number, Subset initial (e.g., “B”, “W” etc.) & number, and total number of subset drawings shall be filled in on each sheet. The total number of sheets in the subset can be placed either in the CAD drawing or could be placed in the Acrobat PDF version of the file that is submitted with the final detail letter. The full version of Adobe Acrobat is required for this capability. The Sheet Number should be left blank so it can be filled in later by the Project Manager.

Sheet Subset Name	Subset Acronym
Bridge	B
Bridge 1	BA
Bridge 2	BB
Bridge 3	BC
Wall	W
Wall 1	WA
Wall 2	WB
Anti-Icing	ICE
Sign	S
Tunnel	T

Fig. 1.9-1 Sheet Subset Names and Acronyms

Culverts can be included in the Bridge sheet subset to help with construction and compartmentalize information. Page numbering systems to create subsets such as W101-1XX and W201-2XX shall not be used.

The original detailer should make corrections if possible. Do not change detailer name or initials if you make changes to someone else's drawing. This would be changed only if another detailer makes major revisions to a sheet. Only one detailer should be listed.

GENERAL LAYOUT				Project No./Code
				FBR 0703-357
Designer:	M. Yip	Structure Numbers	F-14-AZ	17671
Detailer:	R. Olmos			
Sheet Subset:	Bridge	Subset Sheets:	B03 of 23	Sheet Number

Fig. 1.9-2 Sample Title Block

B) Region Information

Provide the Resident Engineer information for the overall project. If there is no assigned Resident Engineer such as with repair plans, provide the Unit Leader information for the project or repair. The As-Constructed information to the right of the resident engineer information is not filled out by Staff Bridge.

Fig. 1.9-3 Sample Region Information

C) Sheet Revisions

When changes are required after the project has been advertised, it may be necessary to revise the drawings. The modifications made on the drawings shall be flagged and noted in the revision block on the modified sheet. Additional information may be found in the Project Development Manual and Section 121.2.3.2.1 of the Construction Manual. Verify with your Construction Engineer for preferences on revisions. The following information is in general conformance with these manuals.

The person initiating the revision shall give the date per Design Engineer, a brief notation indicating the nature of the revision, and the initiator’s initials. If the initiator is the detailer correcting typos or measurement or quantity errors, the detailer’s initials would be appropriate. If the revision involves engineering judgment, the Design engineer’s initials would be appropriate.

At the left of the revision date are flagging symbols. The revision number such as R-1, R-2 used during the Ad period, or FR-1, FR-2 used during construction shall be placed into the symbol. This symbol, with the revision number, shall be placed near the location on the drawing where the particular revision occurs. A revision cloud may be used to clarify the portions of revisions as well.

When a new drawing is added, the date and the notation "New Sheet" shall be placed in the revision block. Any sheets that are revised or replaced after the award of a project are given an X after the Sheet Number in the Title Block area such as 128X. Subset sheets will not be given the “X” designation. Since the overall sheet numbering is usually known at that time, the detailer should place this number on the sheet. Any sheets that are added are given letter numbers such as 128A, 128B, etc.. The original total number of sheets is not revised even though the actual total may be increased.

Coordination of revision dates with other departments shall be made through the Unit Leader. Figure 1.9-4 shows typical revision notes.

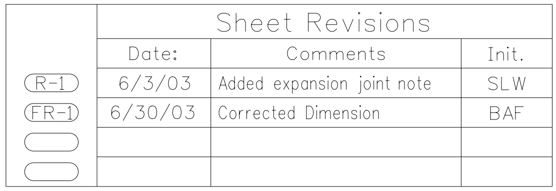


Fig. 1.9-4 Typical Revision Notes

D) Miscellaneous Information

The lower left-hand corner of the border contains miscellaneous information on print date, file name, scale as well as the responsible unit information. The scale should be filled out as appropriate. When all details or sections on a drawing layout are at the same scale, the scale information block on the border should be filled in or edited with the correct scale. If varying scales are used on the drawing, the scale information block on the border should be filled out with VARIES, NOT TO SCALE, NTS, NONE or other appropriate description. If a design is done by a consultant, the consultant information can be placed in the lower box.

A time stamp is useful for keeping track of different versions of the hard copy drawings during the detailing process. The preferred placement is at the left side of the drawing, displayed vertically as shown.

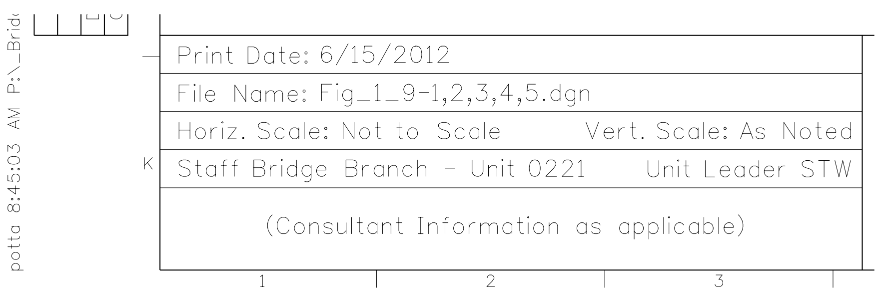


Fig. 1.9-5 Sample of Miscellaneous Information

E) Sheet Grid

The sheet grid as depicted in Fig. 1.9-5 is optional at the discretion of the detailer and/or designer. If the grid is used, it shall be used on all sheets of the subset.

F) Initial Block

Give the initials of the person who performed each of these functions, along with the date on which these functions were completed. The Initial Block shall be completely filled out on each sheet.

INITIALS	DESIGN	DATE	DETAIL	DATE	QUANTITY	DATE
By						
Checked By						

Fig. 1.9-6 Sample of Initial Block

1.10 File Naming Conventions

To assist the detailer and anyone else working on the drawings, a consistent file naming convention shall be used. The first two or, in rare cases, three characters in the filename should be the drawing number for the finished sheet in relation to the set, for example 01 for the first drawing, 02 for the second, etc. The rest of the filename should be a brief description of the drawing's contents. The file extension is typically a 3-letter code that is set by the software used to create the file. A complete filename looks something like this: "04GeneralLayout.xxx". In this case, "04" indicates that the file is the fourth file in the drawing set, it is the drawing titled General Layout. The xxx would be determined by the software used. Abbreviations of common terms may be acceptable so long as the meaning is clear. Although brevity is important in the drawing file name, it is possible to be too brief. Every attempt should be made to keep drawing file names between 10 and 25 characters not including the extension in order to fit in the border. For files with multiple borders (Bridge Deck Elevation sheets only) the file name should reflect the number of sheets, e.g. 22-27_ElevationSheets.dgn.

See the CDOT ProjectWise Manual for additional naming convention requirements.

1.11 Projectwise Directory Structure

A comprehensive directory structure shall be maintained throughout the project. Simplicity is the key to being able to maintain and back up all of the appropriate information. The Projectwise directory structure for projects with subaccounts is

TBD

Fig. 1.11-1 Projectwise Directory Structure

The internal ProjectWise directory structure for projects without subaccounts and other information is:

TBD

Fig. 1.11-2 Internal ProjectWise Directory Structure

Responsibility for maintaining the drawing files and directory structure rests solely on the design team. All production files should be kept in Projectwise. See the Projectwise Manual for additional details.

Duplication of files is highly discouraged. The detailer should not copy a file from one location to another for the sole purpose of making changes and then copy the modified file back to its original location. This practice creates unnecessary multiple copies and increases the risk of losing information. A notification system shall be used whose purpose is to notify each user when a requested file is in use by another user.

1.12 Structural Worksheets

Structural worksheets that are currently in use are available on the Bridge website. The intent of these worksheets is to mainly provide a starting point for generally used items on projects. It is necessary to modify them as needed to match project requirements. Some worksheet information are policy requirements and cannot be changed on a project without Staff Bridge approval. These policy requirements are identified on the worksheets. The website versions are the up-to-date versions and shall be used on new projects. Any permanent corrections, changes or improvements to the worksheets should be coordinated with the Bridge Project Support Unit. If project changes are made to the worksheet, add an asterisk to the last revision date. The revision dates are included on the left-hand side of the border and shall not be deleted

Revision Dates							
3/99	4/99	11/99	5/00	4/02	6/04	2/06	3/07

Fig. 1.12-1 Sample of Worksheet Revisions

Revision Dates							
7/09	4/11	10/13	4/15	6/19	7/19	6/20	3/23*

Fig. 1.12-2 Sample of Updated Worksheet Revisions

1.13 Structure Component Naming

To maintain the consistency between design drawings and information used in the inspection process and management of the finished structure, a similar naming convention for structural components shall be used. This includes girder naming as well as inventory stationing conventions. Girders and columns are lettered from left to right (looking in the direction of increasing milepoint). Bays in between girders or columns are labeled similarly. Bays and span numbers are typically not labeled for new construction. Diaphragms are labeled sequentially starting at 0 at the abutment or pier. Span number may be included in the girder description to clarify its location on the bridge as shown in Fig. 1.13-1. Chapter 9, Construction Layout, shows the standard naming convention for structural components. When project stationing is opposite of increasing inventory milepoint, the girders will be increasing alphabetically from right to left in order to match the final inspection notation. The piers and abutments will also increase numerically from right to left.

For widenings on the left side of an existing bridge, new girder lines shall be labelled with numeric characters added to the initial existing girder. If a girder is removed and replaced on a widening the same letter can be used but with a prime to indicate that it is a different girder than original, e.g. A’, B’. Similarly, when doubling a girder (e.g. sister beam), which generally occurs in Timber stringer bridges to achieve designed carrying capacity of an original split girder, the girder added shall be followed by prime of the original girder it is being added to (see also Fig. 1.13-4). For timber sister beams, the added girder may be on either side, depending on the span.

Where two bridges are merged together, the letter of the last girder followed by prime is used for the first girder between the two bridges and subsequent new girders, e.g. F’1, F’2, F’3. The second bridge girders use the same lettering convention, but with adding a 1 and the letter of the original girder to the end, e.g. 2A1A, 2B1B, etc. Where two bridges are merged together and widened, the rules stated previously for widenings apply.

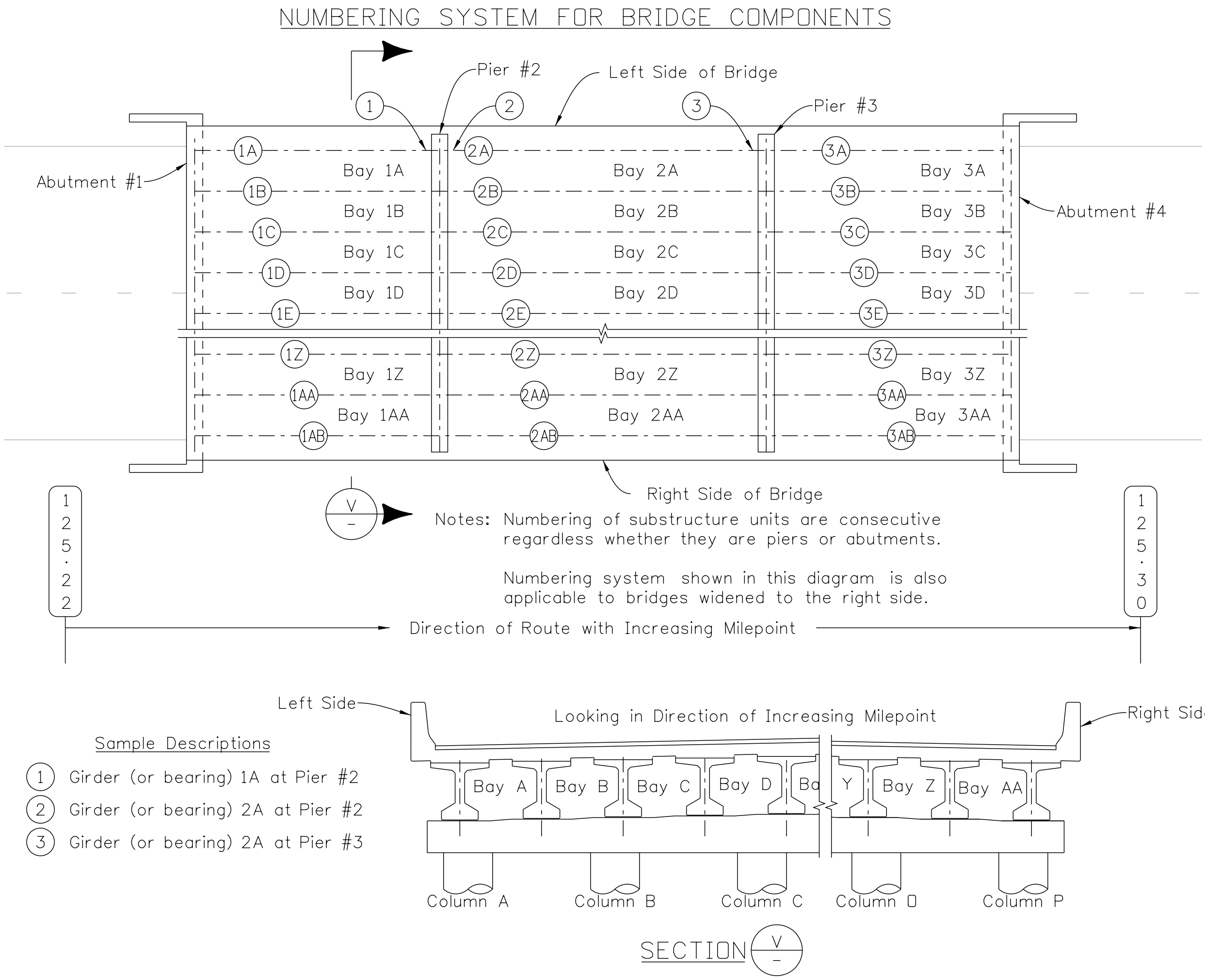


Fig. 1.13-1 Structure Component Naming Convention

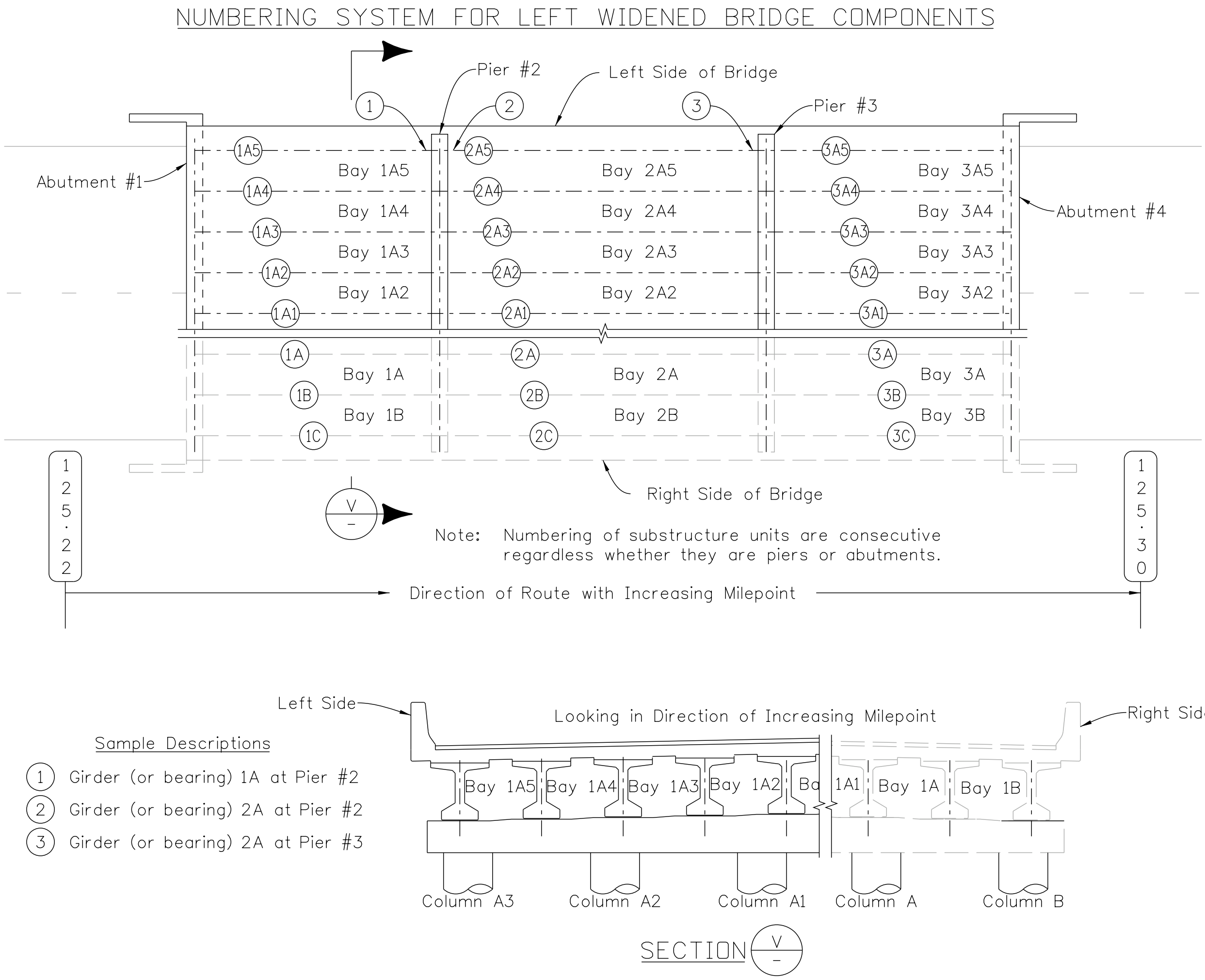


Fig. 1.13-2 Structure Component Naming Convention for Left Widened Bridges

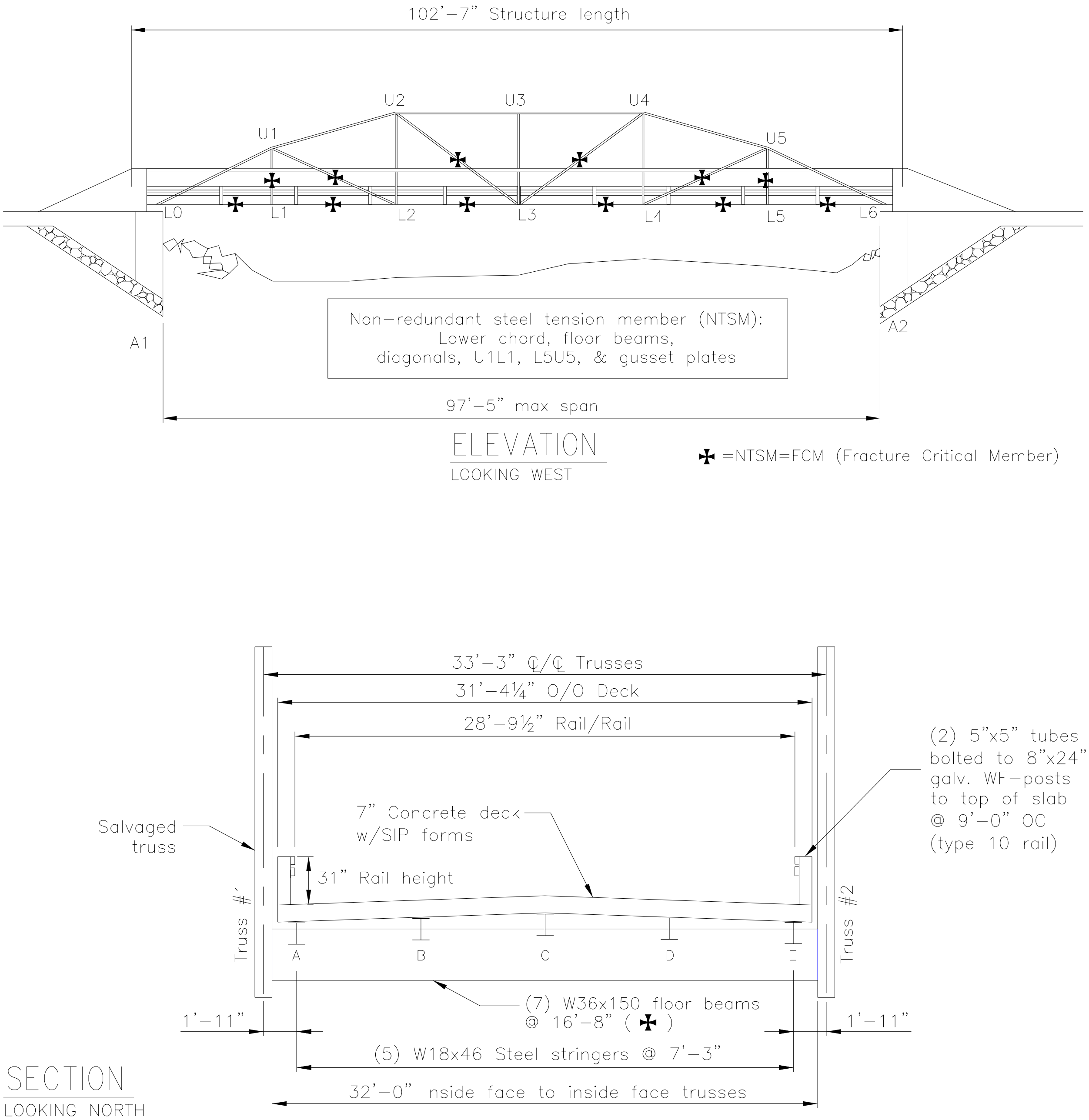


Fig. 1.13-3 Structure Component Naming Convention for Trusses

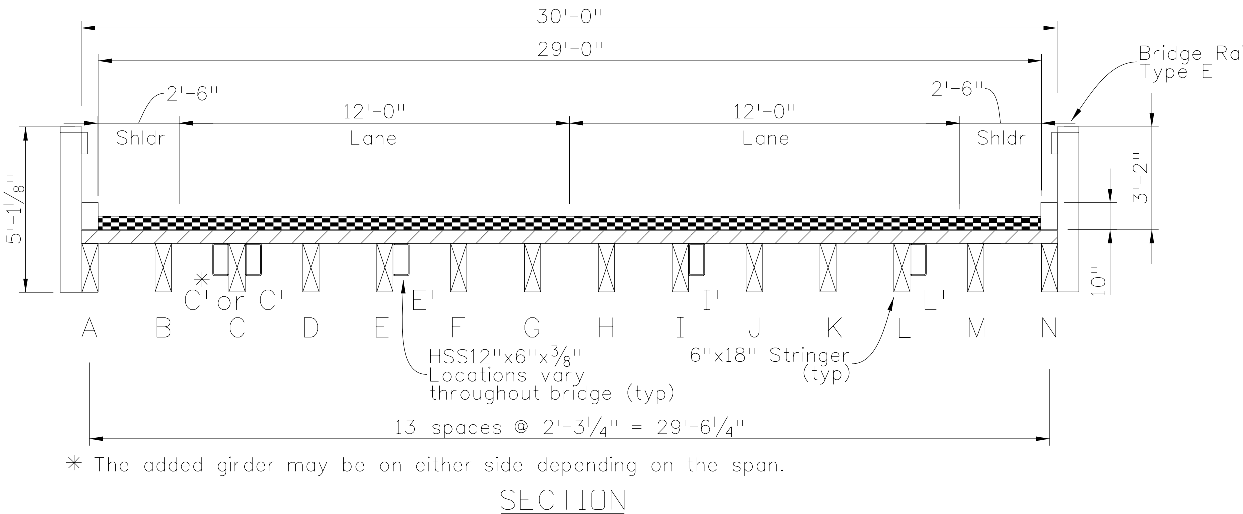


Fig. 1.13-4 Structure Component Naming Convention for Timber Sister Beams

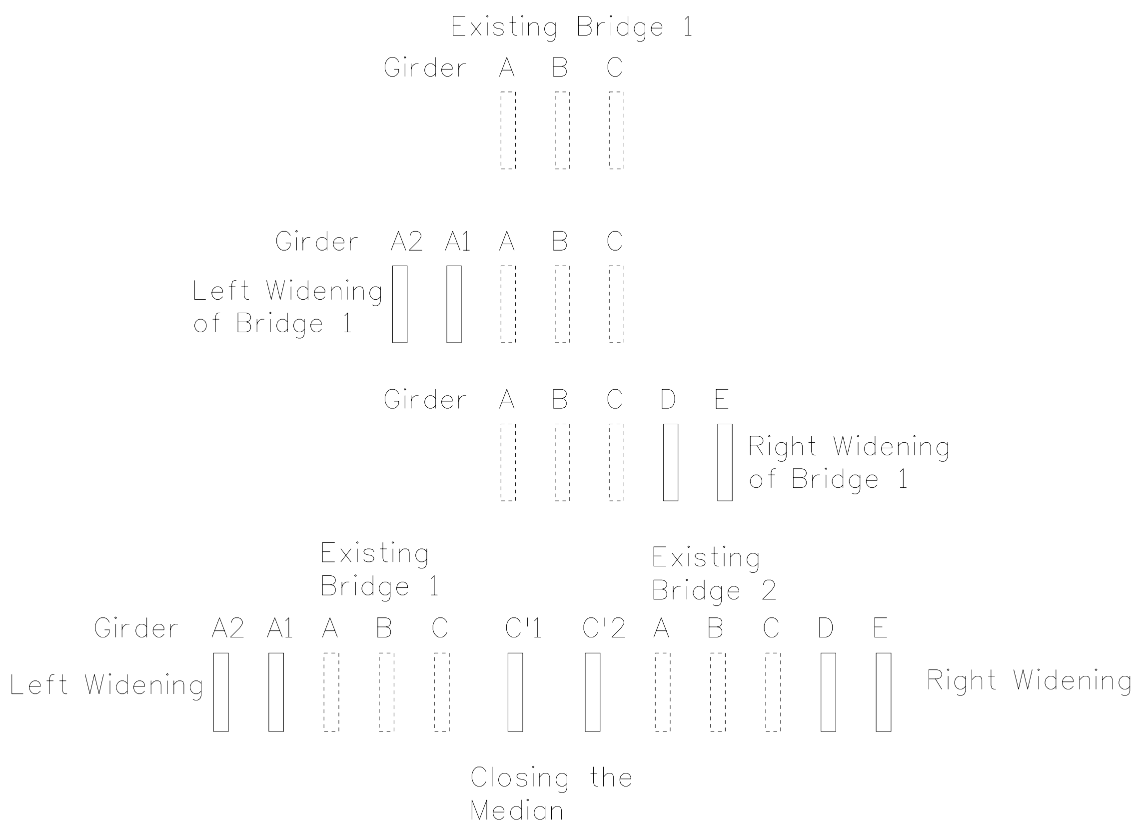


Fig. 1.13-5 Structure Component Naming Convention for Left & Right widening

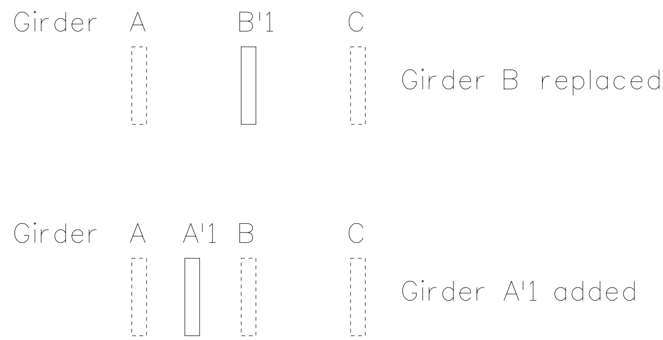


Fig. 1.13-6 Structure Component Naming Convention for New Girder Added or Replaced

1.14 Examples

Examples in this manual may contain old styles of girders, barrier, and other details. They may not meet all of the current detailing standards. All plan sets for new bridges shall use the latest worksheet and standards available.

2.1 Drawing Layout

Before beginning either a hand-drawn or an electronic drawing, the detailer should carefully study the object to be detailed to determine the necessary views and sections, as well as a scale, or scales for illustration, which will leave sufficient space on the drawing for dimensions and notes. More than one sheet may be required to depict some objects sufficiently. Drawings done previously of similar objects are a valuable resource.

For structural drawings, the preference is to use a 1" = 1' border with scaled references of the original linework that is drawn true scale.

Third angle Orthographic Projection (i.e. Plan, Elevation, and Section) is the preferred system for displaying structural details. Use as many views as needed to fully define the object. Perspective views, axonometric (3D) views and photographs may be used to illustrate or clarify a complex detail, but should not be used in lieu of the usual orthographic views.

All details throughout the plans shall be oriented consistently, with all views looking ahead station, except that Abutment 1 shall be drawn looking back station. Views used in the drawings will usually consist of a top view, a front view, and a right side view or section. Additional sections may be used to clarify the object and shall be cross referenced. The detailer should attempt to produce a drawing without the views being crowded or placed haphazardly on the drawing. By the same token, an enlarged scale for illustration should not be used solely to fill up a sheet.

When drawing an elevation view below the related plan view, the plan view should be oriented so as to be normal to the elevation view to aid in orthographic projection. Typical examples of this are seen in abutment, pier and wall sheets.

Avoid crossing dimension lines, leaders, and overlapping items to make plans legible.

2.2 Configuration Files

Hand-drawn drawings are created by following the guidelines presented in this chapter and the detailer's expertise. Electronic standards to mimic the hand drawn requirements are provided by CDOT to simplify the process of creating electronic drawings. Configuration files include standard text styles, dimension styles, levels/layers and plot settings. The configuration files are available for Consultants' use at https://www.codot.gov/business/designsupport/cadd . The goal of these files is to provide default settings which mimic standard practice. With a consistent electronic format, changes to the drawing or plotting can be accomplished easily by anyone, not just the original detailer. Consistent print format is important because it creates a consistent finished product. If changes or additions to the configuration files are required, please contact the CDOT Bridge Users Group.

2.3 Scales

In hand-drawn drawings it is critical that the detailer determine the proper scale and layout as described in Section 2.1 to avoid major changes or corrections. In electronic files, much of the linework can be generated in a “model” before determining the final drawing scale. All linework for details should be drawn true size where one drawing unit is equal to one foot, with the plan views of General Layouts drawn at the correct project coordinates if available. For projects where project coordinates are not used or needed, see Inspection Sketch. Once drawn correctly in the model, the referenced linework can be rotated and scaled in the drawing border without affecting the original linework.

Scales for illustrating views should be large enough to show the required details clearly on a finished 11 x 17 inch sheet (ANSI B size). Larger scales should be used for sections, so that reinforcing and other details are clear.

Standard architectural or civil scales are necessary to hand-draw a drawing and should be also used for referencing the linework to the finished drawing border in electronic drawings. This facilitates the creation of field drawn “as-built” plans and changes. Just fitting the detail to the drawing at no particular scale is not recommended unless dictated by time or space requirements. When all details or sections on a drawing layout are at the same scale, the scale information block on the border should be filled in or edited with the correct scale. If varying scales are used on the drawing, the scale information block on the border should be filled out with VARIES, NOT TO SCALE, NTS, NONE or other appropriate description.

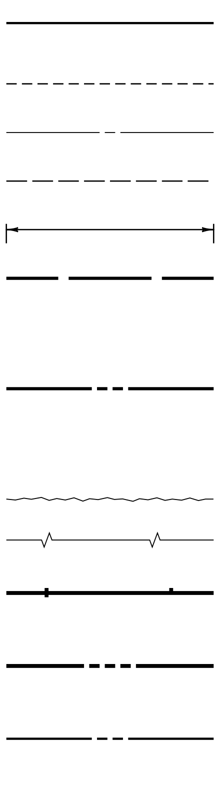
Suggested scales are 1” = 30’, 1” = 40’, 1” = 50’, 1” = 60’ for general layout drawing. Sections and details will generally be at larger scales and will follow architectural scales, e.g. 1/2"=1’-0”, 1/8” = 1’-0”, etc.

Note: Distances, offsets, text heights, etc. given in this chapter refer to drawings on an 11 x 17 inch sheet.

2.4 Strength and Contrast of Lines

The lineweight and visibility of lines can be precisely controlled either by hand or electronically. Varying the width of lines between different line types increases the clarity and ease of reading the drawings. Each linetype on a drawing has a definite meaning and is drawn in a certain way. The contrast between the different widths of lines should be distinct. Line types used include, but are not limited to the lines depicted in Figure 2.4-1.

In hand drawing methods, linetypes and weight are controlled by the detailer and his/her choice of the size of the pen or pencil. Although several methods are available in software generated drawings, linetypes and weight are preferred to be controlled by the level/layer upon which items are drawn. The printing configuration file will then determine the "look" of the hardcopy. The line widths shown below approximate the hand drawn widths and are intended to be the basis for printing configuration files. The use of grayed out linestyles on the final hardcopy may be used by the detailer to increase the readability of the drawings.



Linetype	Width	Description/Use
	0.012"	Visible Object Line or Profile Line - Used as the Visible Outline of the objects, should be an outstanding feature and consists of a continuous unbroken line
	0.008"	Hidden - Used to indicate hidden or invisible object lines and consists of evenly spaced short dashes
	0.004"	Centerline - Indicates a centerline of an object or objects and consists of long and short dashes, alternately spaced
	0.008"	Dashed - Used to indicate existing object lines and consists of evenly spaced medium length dashes
	0.006"	Dimensions and Extension Lines - Used to dimension an object and consists of unbroken lines (when possible)
	0.014"	Reinforcing Steel Line - Used to indicate reinforcing steel and consists of evenly spaced long dashes
	0.014"	Object Match Line, Section Cut Line - Identifies a Match Line or a Section Cut Line and consists of a broken line made by alternating longer dash lines with two short dash lines. Match lines are used when the detail is too large to be drawn, at a practical scale, in one place. Match lines should be tied in by using dimensions to some readily identifiable point on the structure or details. Each pair of match lines shall carry the same identification. For example: Match Line A or Match Line X. Current electronic files use continuous lines for section cut lines
	0.004"	Short Break Line - Used to indicate a short break in an object or a change in how it is depicted
	0.004"	Long Break Line - Used to indicate a longer break in an object
	0.016"	Survey Line or Projected Line - Indicates the Horizontal Control Line, Survey Line, Project of Projected Line. This line is continuous and should have perpendicular tick marks to indicate even stations.
	0.016"	Proposed Right of Way Line - Indicates the proposed boundary of the highway property and consists of a broken line made by alternating longer dash lines with three short dash lines
	0.010"	Existing Right of Way Line - Indicates the existing boundary of the highway property and consists of a broken line made by alternating longer dash lines with two short dash lines
	0.004"	Phantom Line - Used to show the relationship of portions of the existing structure to the new structure, as in the case of a widening or replacement structure.

Fig. 2.4-1 Hand Drawn Line Convention

Since we are using the inspection sketch linework model for multiple purposes (inspection repair, etc.) linework for existing bridges should use the continuous linetype instead of the dashed linetype (existing). Where it is necessary to show contrast between existing & proposed (widening projects), the existing portions may use the dashed linetype. The final inspection sketch linework showing the finished bridge shall use continuous linetype.

2.5 Text/Lettering

The font or lettering used on the drawing should be a simple single stroke lettering as shown in Figure 2.5-1. This type of lettering is preferred to eliminate unnecessary deviations that may cause misinterpretation of a meaning or dimension. The spacing of the letters should generally be proportionate to their width. In the case of tabular data and electronic files, a non-proportionate text style may be used to line up the data. In non-proportionate text styles, each letter or number takes up the same width regardless of the letter width.

The bulk of the lettering on the drawing should be illustrated at 0.07 inches high, including dimensioning text. Text/lettering should generally be placed horizontally.

In the case of a large block of notes, as on the General Information-Summary of Quantities sheet, 0.06 inch high text may be used if absolutely necessary to fit onto the sheet. Reduced width lettering may also be used in space restricted applications. Sentence case is preferred for all notes for readability.

The “initial blocks” at the left edge of the sheets, and bar bending diagrams should use 0.05 inch high lettering. Text for titles should be all capital letters, underlined, and 1½ times the normal text height (0.105 inches).

Depending on the configuration setup, these exact text styles and heights may not be supported. If not supported, choose the closest to these recommended heights.

Fig. 2.5-1 Vertical Single Stroke Lettering

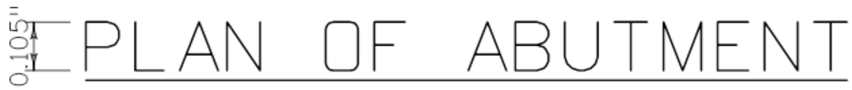


Fig. 2.5-2 Typical Example of Title

2.6 Accuracy of Dimensions and Elevations

The degree of accuracy used on the drawings shall be as follows:

A) Structural dimensions to the nearest 1/8 inch with the following exceptions:
   1) Bearing device location dimensions on skewed abutments and piers to .001 feet.
   2) Stations to the nearest .01 feet.
   3) Layout dimensions (dimensions along tangents, etc.) to the nearest .01 feet.
   4) Piling location dimensions rounded to the nearest .01 feet.
   5) Dead load and live load deflections to the nearest .001 feet.

B) Elevations to the nearest .01 feet with the following exceptions:
   1) Elevation of the top of concrete of the bearing seat to the nearest .005 feet.
   2) Elevations of bottom of footings, tip elevations of drilled shafts and estimated pile tips to the nearest .1 feet.

C) Skew angles and bearings shall match the accuracy of the roadway drawings. Angles to the nearest second are typically sufficient for construction accuracy. Example: 69°38'13" or 69°38'13.1".

D) Other angles such that dependent dimensions meet the above criteria.

E) Slopes given to the nearest hundredth of a percent. Example: 1.25%.

2.7 Dimensioning

Plans for bridges and other highway structures are a combination of Engineering and Construction drawings from which the structure is built. After the shape of an object has been described by the orthographic views, the importance of the drawing for the construction depends upon the dimensions and notes given. The dimensions shown on the drawing are not necessarily those used in making the drawing, but are those needed for the proper construction or functioning of the object. It should also be noted that not all dimensions shown on a drawing are for construction purposes, but many are given for convenient reference and checking by the Engineer. Dimensions are typically given in the format required by the construction personnel and necessary for accuracy, i.e. architectural dimensions (feet and inches) for objects constructed using tape measures including formwork and reinforcement placement, and decimal dimensions used for surveyed items including drilled shafts and footings.

Figure 2.7-1 illustrates the typical lines or line types used for dimensioning. A complete dimension consists of extension lines, dimension line, arrowheads and dimension text or numeral and provides the information required to define an object for construction or checking. The dimension line usually bears the numeral denoting the distance and shall contrast with the object lines. The dimension line is typically drawn parallel to the object line it dimensions.

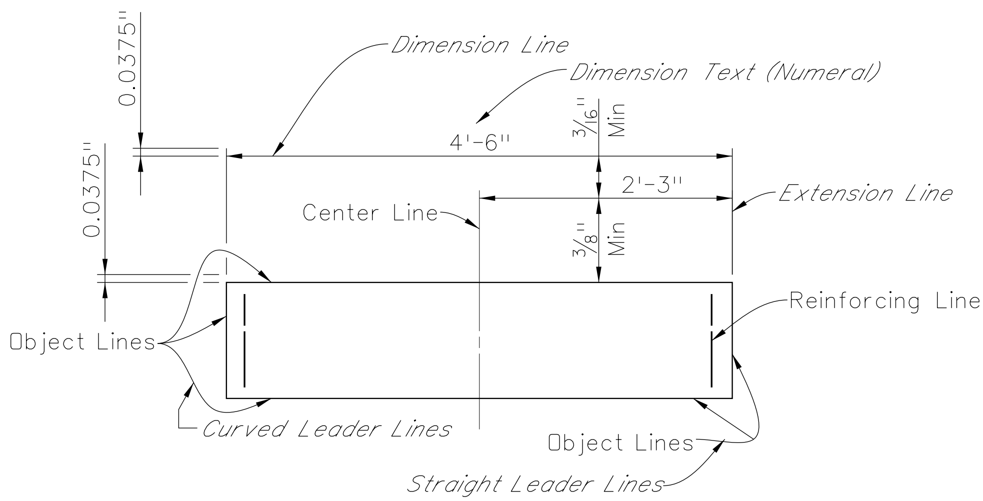


Fig. 2.7-1 Components of Dimensioning Object, Dimension, Extension, and Leader Lines as Illustrated for the Printed Sheet

The numeral is placed slightly above the line as shown in Figure 2.7-2 (a). It is permissible, if space is limited, to break the dimension line and insert the numeral as shown in Figure 2.7-2(b). In electronic files, it is not recommended to drop/explode/burst or change the text of dimensions, i.e. leave it as a dimension element. Since line work should be drawn true size, this recommendation should not cause problems. If possible, changes to the dimensions as shown in Figure 2.7-2(b) should be accomplished with the dimension style settings and not by dropping/exploding the dimension element.

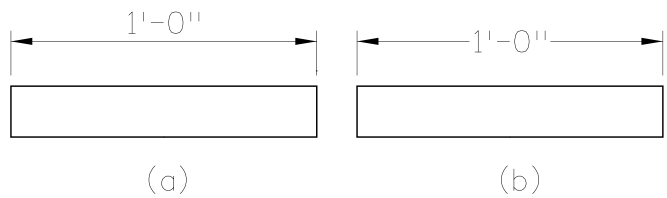


Fig. 2.7-2 Dimensions

The following statements are given as a guide for the dimensioning procedure:

A) Required accuracy and format of dimensions are discussed in Section 2.6. Typically, dimensions are given in feet and inches format (a'-b") with an accuracy to the nearest 1/8".

B) Dimension line spacing should be uniform throughout the drawing. The dimension lines should be at least 3/8" from the object outline. Parallel dimension lines shall be equally spaced at least 3/16" apart on the printed sheet as shown in Figure 2.7-1.

C) Extension lines shall extend 0.0375 inches beyond the point of the arrowhead on the dimension line, and have a gap of 0.0375 inches from the object as shown in Figure 2.7-1.

D) Directions from which the dimensions on a drawing are to be read are as follows (as depicted in Figure 2.7-3):
   1) The dimensions that are placed on a horizontal dimension line are to be read from the bottom of the drawing.
   2) The numerals that are placed on a vertical dimension line are to be read from the right side of the drawing.
   3) The numerals that are placed on an inclined line should be placed so they can be read horizontally by turning the drawing through the smallest possible angle.

4) All dimension numerals should be read in the direction of the dimension line.

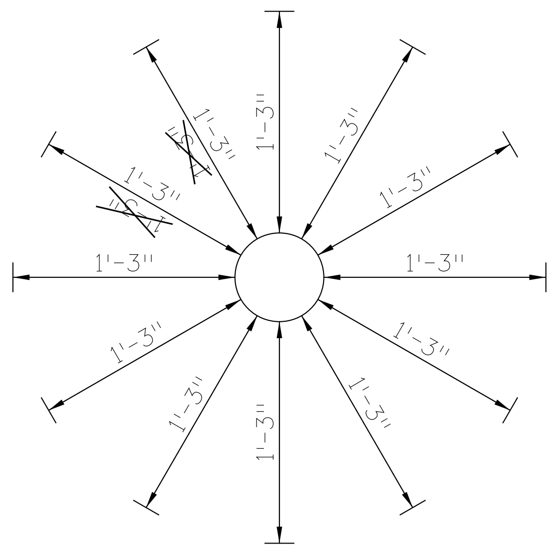


Fig. 2.7-3 Reading Directions for Dimensions

E) Centerlines shall be shown and marked.

F) Do not use a centerline as a dimension line. Centerlines may, however, be extended to serve as extension lines.

G) Dimension lines are terminated with arrowheads which assist the eye in determining the extent of the dimensions. Arrowheads should be of a uniform size on a drawing. The width to length ratio of the arrowheads should be 1 to 3, see Figure 2.7-4. Arrows may be solid elements, although typical scales will generally show them as solid whether or not the element is solid.

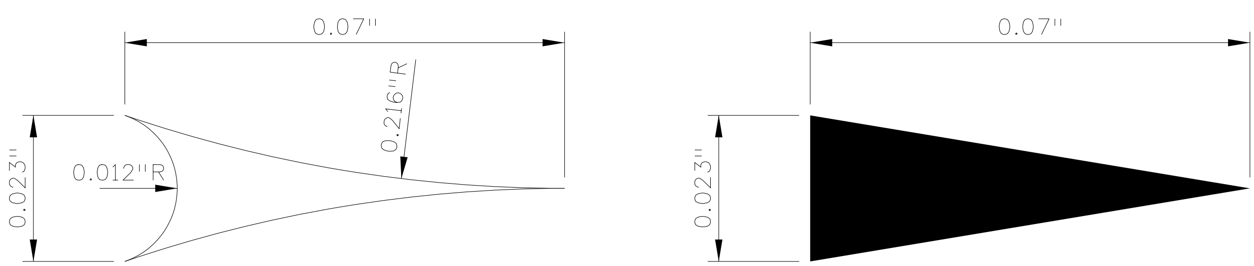


Fig. 2.7-4 Arrowheads

H) Each dimension should be given clearly, so that it can be interpreted in only one way.

I) Dimensions should not be duplicated or the same information be given in two different ways and no dimensions should be given except those needed to produce or inspect the part of the structure.

J) Dimensions should be given between points or surfaces that have a functional relation to each other or that control the location of mating pieces.

K) Dimensions should be shown in a way that will minimize calculation, preclude the need for scaling (measuring) from the hard copy, and assumption in the field.

L) Dimensions should be placed in the views where the features dimensioned are shown in their true shape.

M) Dimensions to hidden lines should be avoided wherever possible.

N) Long extension lines should be avoided.

O) Dimensions applying to two adjacent views should be placed between views, unless clarity is promoted by placing some of them outside.

P) Longer dimensions should be placed outside intermediate dimensions so that dimension lines do not cross extension lines.

Q) A dimension should be attached to only one view, not to extension lines connecting two views, e.g. plan and elevation views.

R) The dimension lines of stringed detail dimensions should be aligned as shown in Fig. 2.7-5.

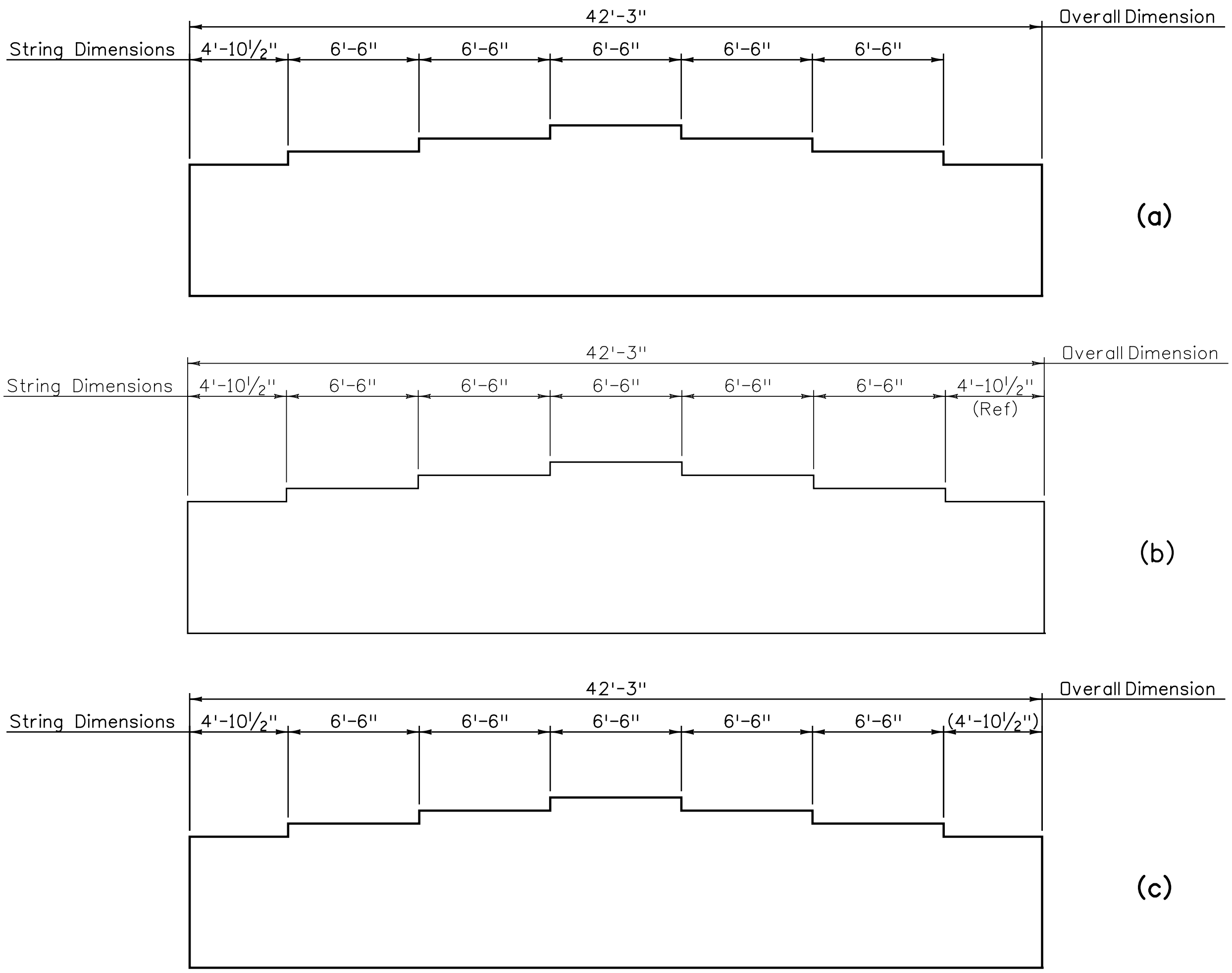


Fig. 2.7-5 String Dimensions

S) String dimensions shall add up to the total overall dimension. A complete chain of detail dimensions should be avoided; it is better to omit one as shown in Figure 2.7-5 (a). If one is not omitted, REF (reference) should be added to the least critical of the string dimensions as shown in Figure 2.7-5 (b). Another acceptable option is to enclose the overall dimension or a particular string dimension within parenthesis () as shown in Figure 2.7-5 (c) to show that a particular dimension may not be exact due to rounding errors.

T) A dimension line should never be drawn through an object line. Text/lettering should not be placed on any lines of the drawing. The extension line can be broken if necessary. If possible, locate dimensions to avoid the situations. Otherwise break object lines or extension lines to clarify the dimensions.

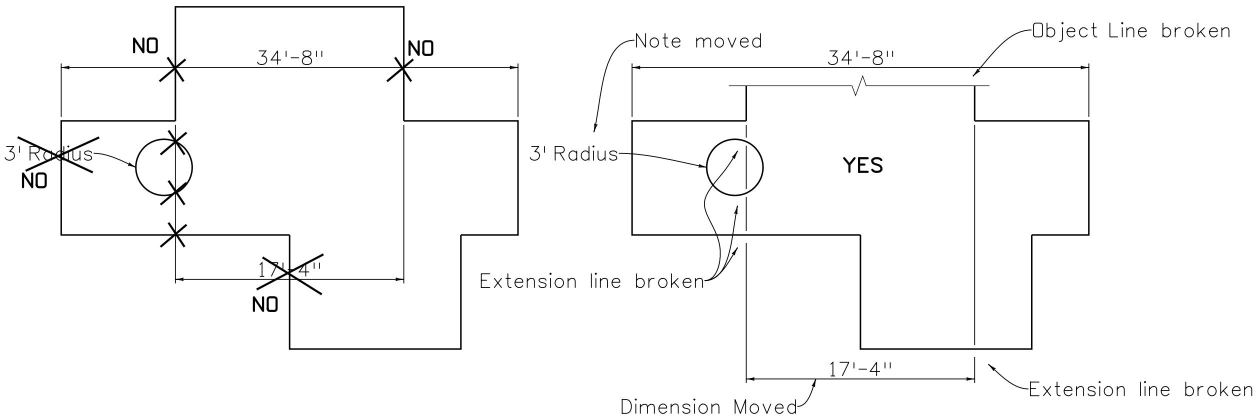


Fig. 2.7-6 Dimension and Object Lines

U) Leader lines shall be either straight lines or smooth curves (continuous) terminated with arrowheads as shown in Figure 2.7-1.

V) Some methods of showing compressed dimensions are shown in Figure 2.7-7. These techniques may be used in situations where the space is too tight for the numeral to fit between the extension lines.

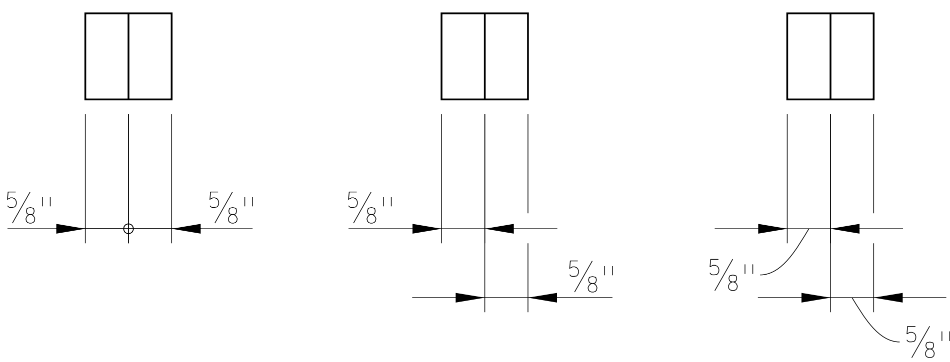


Fig. 2.7-7 Compressed Dimensions

W) To indicate a dimension at a certain point on the structure, See examples in Figure 2.7-8. The small circles may be used to emphasize the extremities of the line being measured.

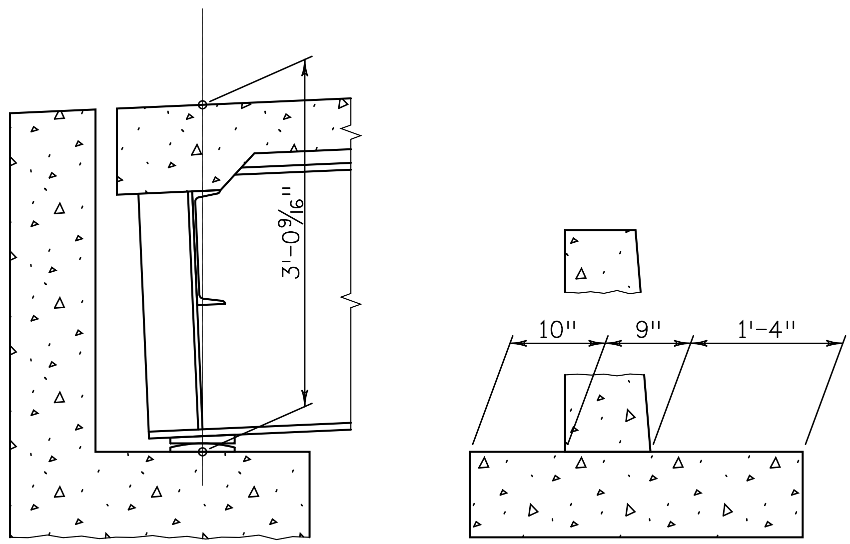


Fig. 2.7-8 Dimensioning to a Point

X) Double arrowheads on a dimension line are used in partial views, in congested areas, or when it is not necessary to show the line to its termination. Figure 2.7-9 (a) shows a dimension line with two arrowheads at one end, indicating that the dimension line is not shown full length.

The limits of the dimension shall be noted on the line along with the magnitude. Similarly, the dimension line in Figure 2.7-9 (b) is not shown in its entirety, but indicates that in this example it is to extend 20'-4", in which distance there will be 21 #5 bars spaced at 1'-0"

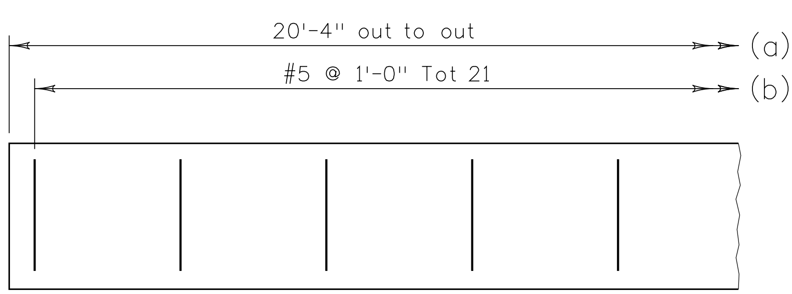


Fig. 2.7-9 Double Arrowheads

Y) Various methods for showing angles are shown in Figure 2.7-10. For ease of reading, the text should remain horizontal.

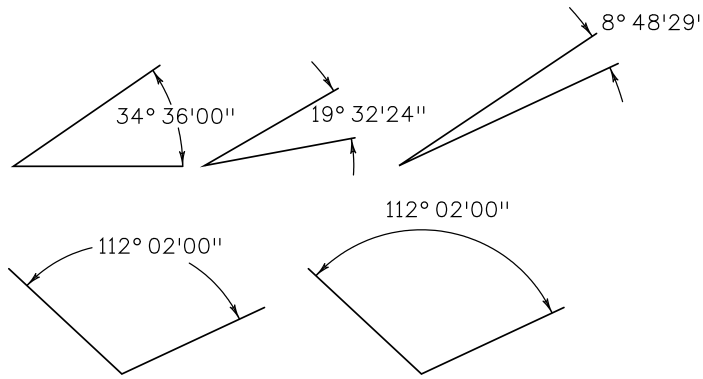


Fig. 2.7-10 Angles

Z) Angles shall be dimensioned to tangents of the arc, not to the arc itself.

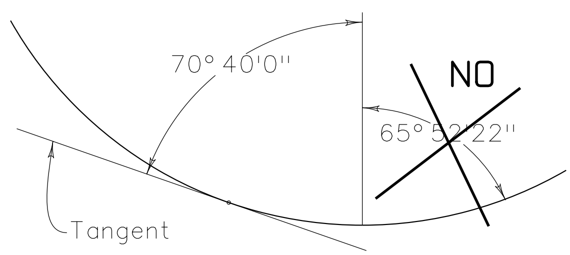


Fig. 2.7-11 Arc Tangents

AA) Angles and bearings shall be given without hyphens as shown:

13° 21’ 75° 00’ 13” N 18° 13’ 00” E S 41° 21’ 14” W

Trailing zeros may be omitted when dimensioning angles. In electronic files this will need to be done by either manually editing the dimension text or modifying the dimension style:

OK: 13° 21’ 00” Preferred: 13° 21’ OK: 75° 00’ 00” or 75° 00’ Preferred: 75°

BB) Radii may be shown as:

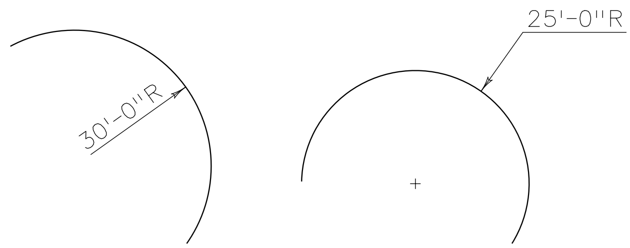


Fig 2.7-12 Radii

CC) Finish marks commonly found on bearing devices should be shown as:

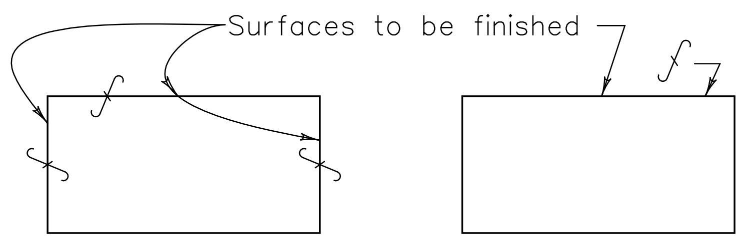


Fig. 2.7-13 Finish Marks

2.8 Patterns/Hatching

To clarify the details and simplify the construction process, a number of patterns/hatching are used to represent certain materials. The more common patterns are shown in Figure 2.8-1. In a section view patterns/hatching should be used when it will help clarify the details and not create a cluttered appearance when the drawing is printed or copied. The amount of patterning/ hatching is left to the judgment of the detailer. The concrete hatch pattern should not be used when reinforcing is the subject of the detail.

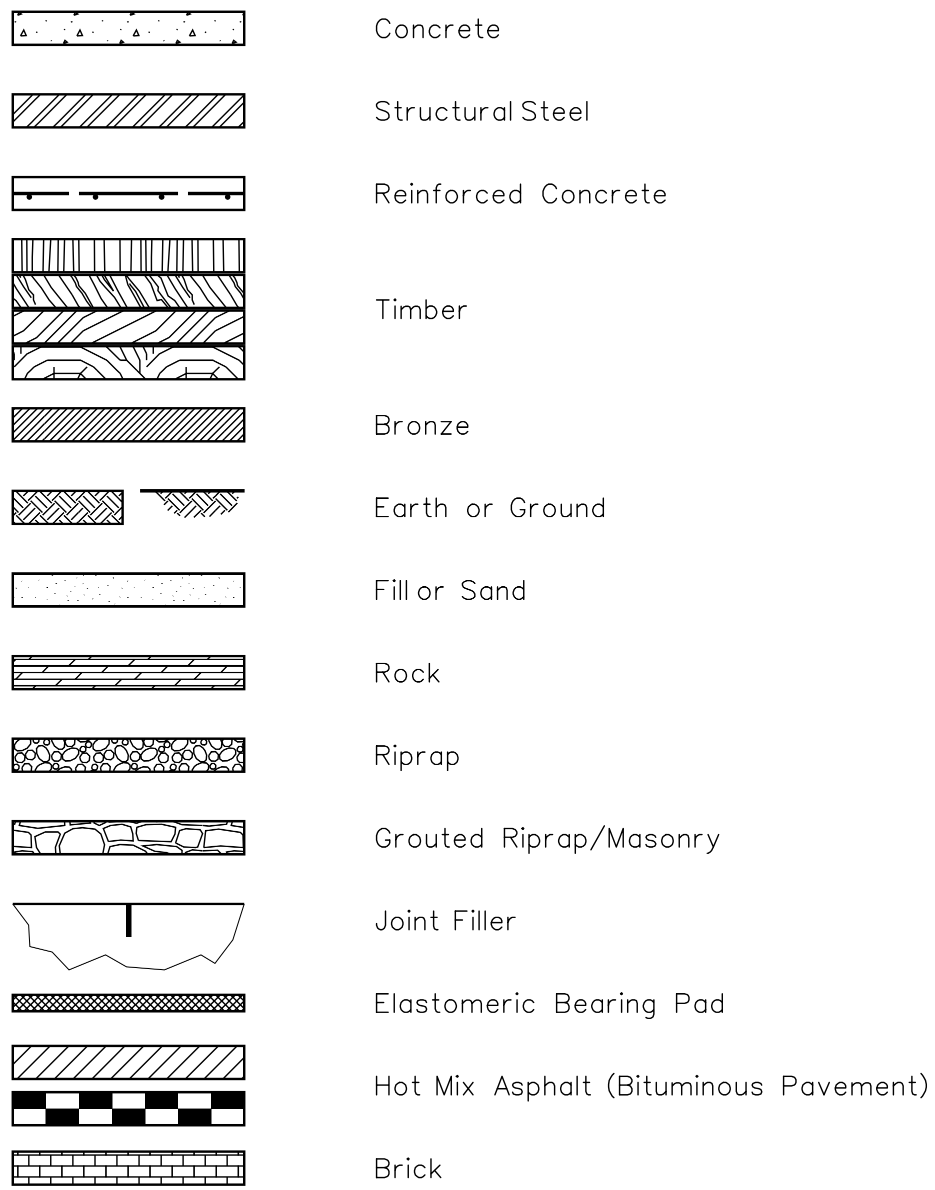


Fig. 2.8-1 List of Common Patterns Used

2.9 Architectural Treatment

Architectural treatments, such as shades or shadows, regardless of their intended effect, should be used sparingly on structural drawings. If pictorial views with shades and/or shadows are required, they should be kept separate from the structural details.

2.10 Definition of Bent and Skew Angle

The bent angle is defined to be the acute angle measured between a longitudinal line (Layout or Girder Line) and a transverse line (Bent or Reference Line). The bent angle may be in any quadrant.

The skew angle is defined to be the acute angle measured between a reference line and a line perpendicular to the layout line. See Figure 2.10-1.

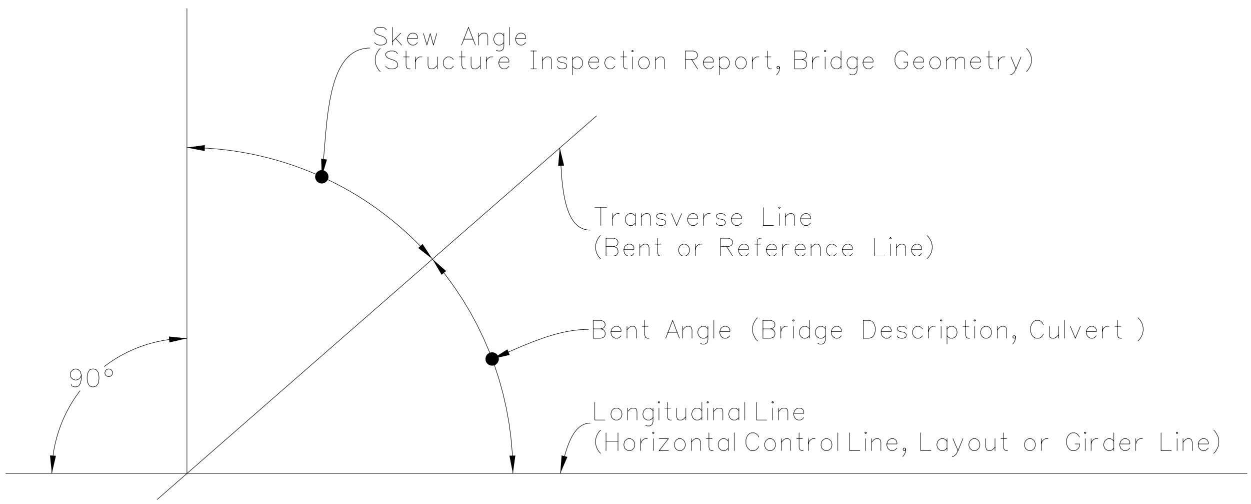


Fig. 2.10-1 Bent and Skew Angle

2.11 Section Cut Line and Identification

In Section 2.4, Figure 2.4-1 (Match Line, Section Line), the physical appearance of a section cut line is shown and described. This section describes its use and the characteristics of identification and location of the section.

Typically, sections are lettered and details are numbered.

The left portion of Figure 2.11-1 shows a partial plan view for a superstructure with concrete girders. A section “cut line” is shown extending through the plan. The arrowheads indicate the direction in which the section is being viewed. The circles that connect the arrows and the section “cut line” contain the section identification and the drawing number where the section can be found. If the drawing number is blank or a dash, the reference is found on the same drawing. A final drawing should not contain a sheet reference that contains the “B” prefix with no accompanying drawing number. An identification letter is placed in the upper half of the circle. In Figure 2.11-1, the drawing number is B7, the section cut is identified as “A”, and the B10 in the circle indicates that the section is detailed on Drawing Number B10. If the section had been detailed on Drawing Number B7 where it was cut, the drawing number in the circle would be a dash or left blank.

The right portion of Figure 2.11-1, shows a detail of Section A, which is on Drawing Number B10. The circle in the title shows that it is Section “A”, and B7 refers to Drawing Number B7, on which the cut line for Section “A” will be found. Bubble references are recommended on both sides of a section cut when the section markers are far away from each other and an arrow reference can be lost amongst the linework and text.

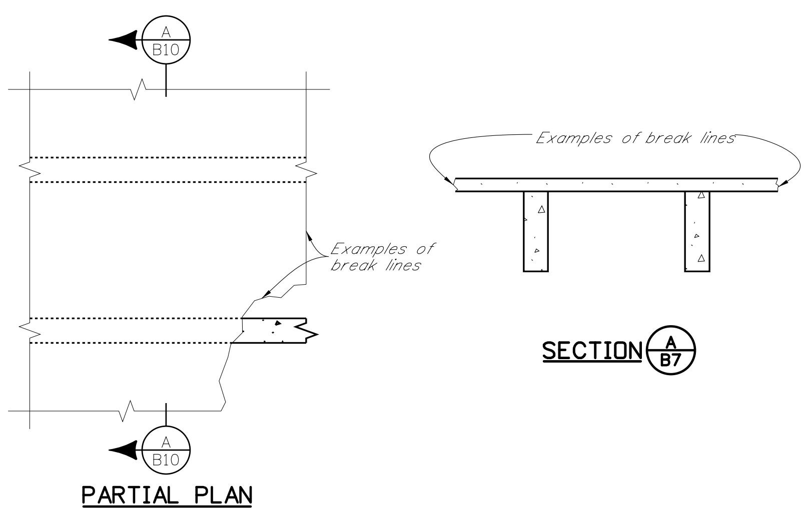


Fig. 2.11-1 Section Cut Example

Figure 2.11-2 shows an enlarged detail of a typical identification circle and arrow for a section cut line.

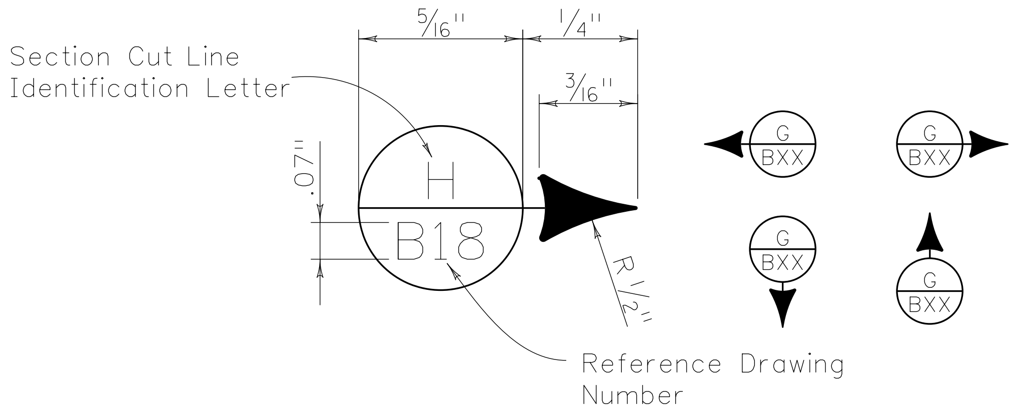


Fig. 2.11-2 Typical Section Arrow and Identification Circle

Figure 2.11-3 shows typical references in titles. A common section may be used for multiple sheets and the title would reflect the sheets that are referenced as shown in the right of Fig 2.11-3

Fig. 2.11-3 Typical Section Titles

The practice of having the Identification Letter on top is opposite of past practice at CDOT, but is consistent with industry standard. Both practices are acceptable as long as the drawing set is consistent and clear. The practice as shown above is preferred.

Figure 2.11-4 shows details of typical identification circle and arrow for identifying location and direction of isometric views or photographs and title examples.

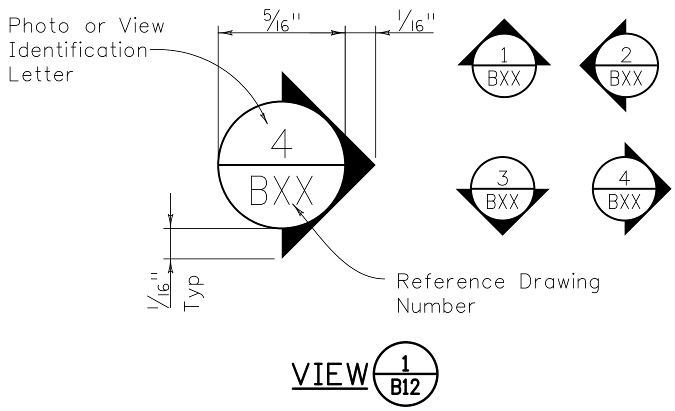


Fig. 2.11-4 Typical View Indicators

2.12 Detail Identification

Sometimes, for the sake of clarity, it is advisable to make an enlarged detail of a certain area in a view. Figure 2.12-1 shows an example. A circle is made to a diameter large enough to encompass the area that is to be shown in the enlarged detail. Inset in the line of this circle is an identification circle the same size as the identification circles used for the section cuts. The notation for the circle shall follow the same rules as for the identification circles used for section cuts. If the view and the enlarged detail are near together, they may be connected with a short leader line and the identification circles and detail title omitted. Typically, details are numbered and sections are lettered.

Figure 2.12-1 shows the enlarged detail “2”, with the proper identification circle in the title.

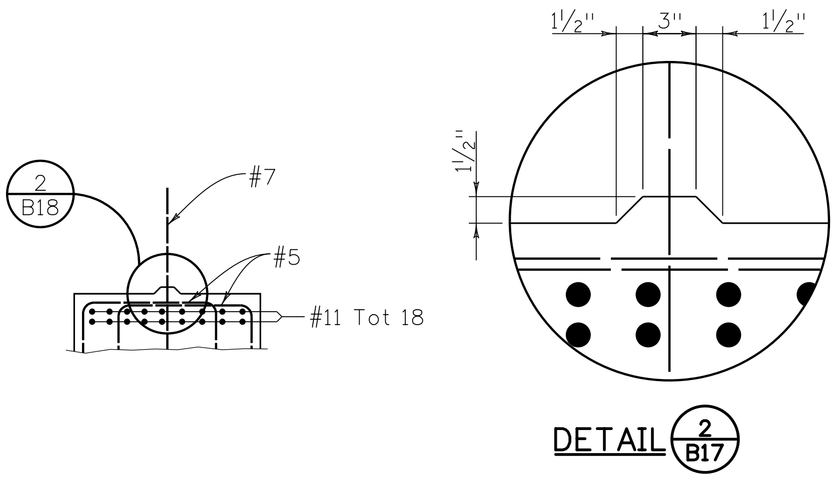


Fig 2.12-1 Enlarged Detail

2.13 Standard Abbreviations

A) Abbreviations shall never be used when the meaning may be in doubt.

B) Abbreviations should be avoided in titles, subtitles, and notes.

C) Acceptable abbreviations are shown in the M&S Standards. Appendix A contains historically used abbreviations.

2.14 Arrows

North Arrows are placed to aid in the orientation of the drawings to the structure location. Acceptable North arrows are shown in Figure 2.14-1.

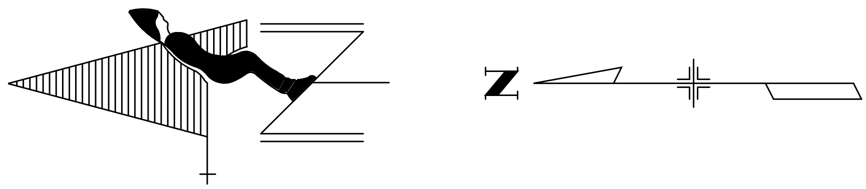


Fig. 2.14-1 Acceptable North Arrows

Directional Arrow for Water Flow. Any plan showing flow of water shall have an arrow indicating direction of flow. Figure 2.14-2 shows the arrows to be used in such cases.

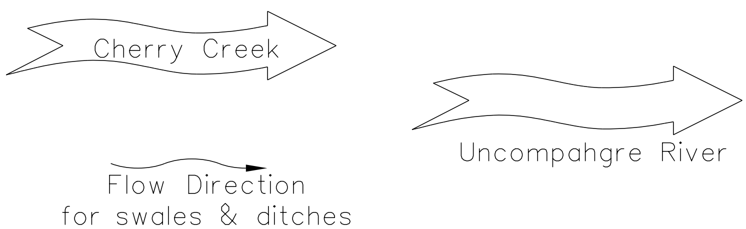


Fig. 2.14-2 Flow Arrows

2.15 Notes

Notes that are applicable to the entire structural set shall be included with the General Notes on the first sheet of the set. Notes that are sheet or item specific should be included on the appropriate sheets, i.e. notes specific to abutments should be on the abutments sheets. When there is insufficient room for a detailing note, symbols or numbered symbols may be used to place the note where there is sufficient space. The symbol legend, Note Key or Keyed Notes should be located in the lower right portion of the drawing for consistency purposes. Separate lists of keyed notes are not necessary and numbered symbols may reference notes on the sheet. In addition to insufficient space, multiple references to a note may be justification for their use. In general, the use of symbols and keyed notes should be avoided when possible.

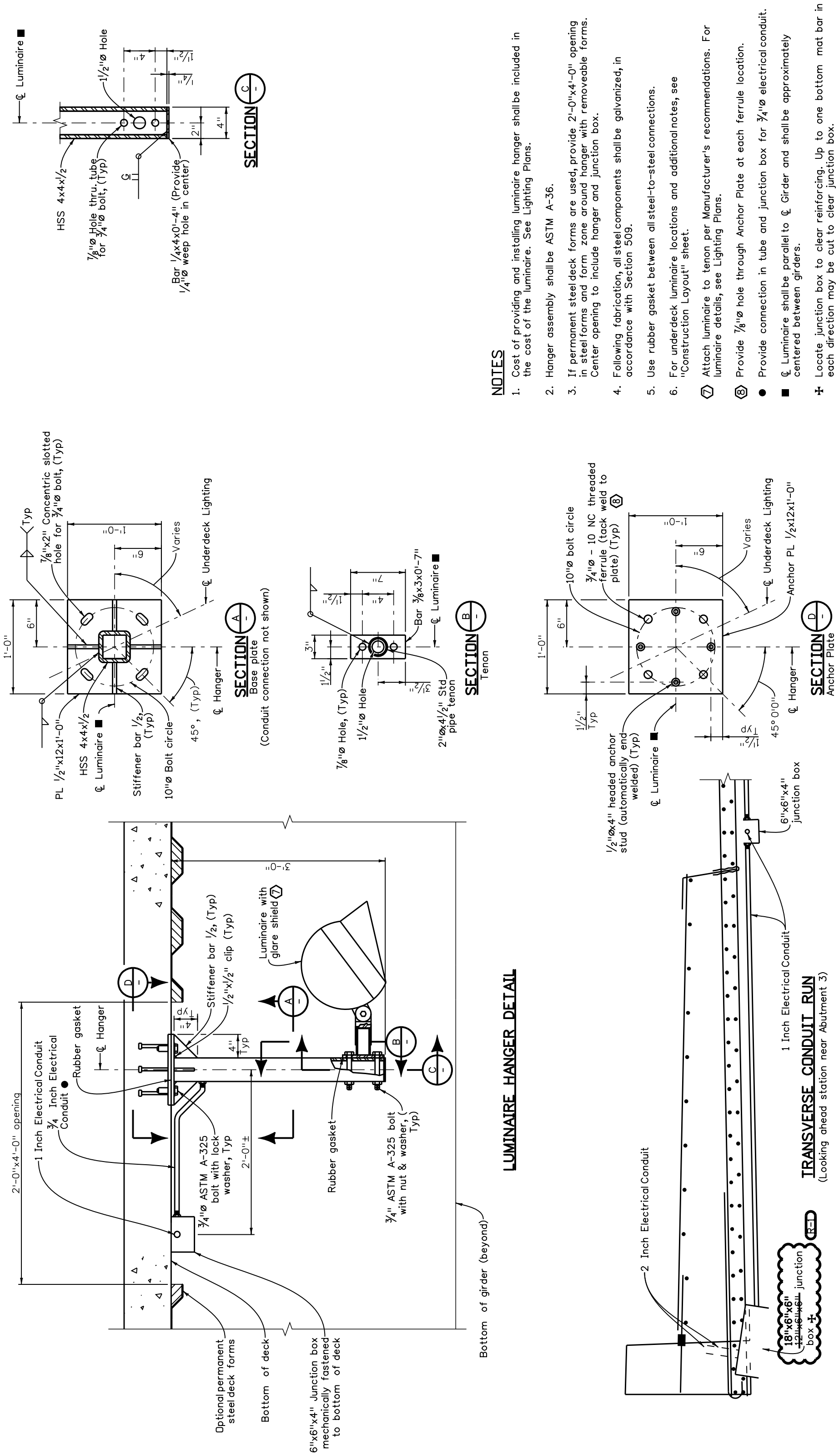


Fig. 2.15-1 Example of Preferred Notes

3.1 Purpose

To assure a clear, complete, and accurate set of structure plans.

3.2 Responsibility

The responsibility for compiling a set of plans lies with the Project Structural Engineer; however, each individual checker shall be responsible for the work assigned.

3.3 Procedures

Detail checking shall take place upon the completion of the necessary structural details. Details with which the checker agrees shall be crossed through with a yellow pencil or marker. Corrections or suggestions shall be made neatly with a red pencil or pen. All checking shall be done using prints of the latest design and details.

Design and constructability checking shall be performed as defined in the Design Manual.

3.4 Detail Check

The detail check shall be made independently based on the plan set by someone who is adequately experienced with the CDOT Bridge Detail Manual requirements and, preferably, unfamiliar with the project. All items in the plan set are to be checked in accordance with this manual, including:

A) Geometry Program
1) Input of the geometry program from the roadway sheets (horizontal and vertical alignment, roadway cross slopes).
2) Input of the geometry program for the structure layout (bent lines, girder lines, layout lines, skew, etc.).
3) Key points (away from the control line) by hand calculations of output.

B) Details – Verify the following:
1) Dimensions, stations, and elevations taken from geometry output
2) Hand calculated dimensions, stations, and elevations
3) Adequate room for placement of reinforcing, expansion joints, embedments, bearing devices, etc.
4) Reinforcing placements, lengths, sizes, shapes, etc.
5) Sufficient information to construct the structure

6) Bridge Working Drawings (structural worksheets) are revised to match project specifics
7) M & S Standards references
8) General considerations: foot and inch marks, arrowheads, required notes, spelling, dimensions add up, etc.
9) Section letter, detail number, sheet references

See other chapters of this manual for specific items to check for each sheet.

3.5 Quantity Check

The quantity check shall be made independently based on the plan set, preferably by someone unfamiliar with the project. Typically, the detailer performs one set of the quantity calculations as defined in the Design Manual. During the process of calculating quantities, it is not unusual to find that additional information or clarification is needed. If sufficient information is not on the plans to complete the quantity, the plan set shall be marked up for the proposed revisions. Once the quantity calculations are completed, the two sets of quantities shall be compared and any differences resolved. During this resolution process, it is determined which is the record quantity set.

During this comparison, the following items shall be considered:

- Both sets of quantities shall be within 1% of each other, per the following formula:

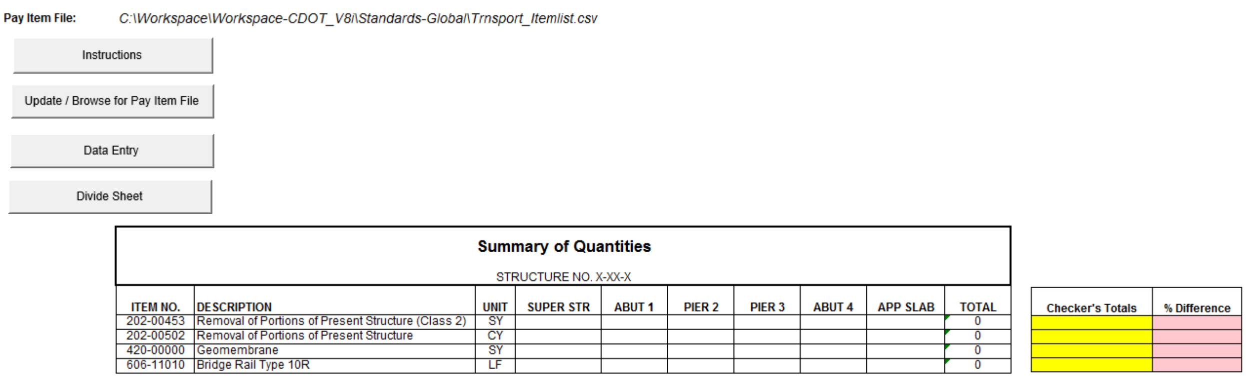
$$\%\,Difference = \frac{Record\ Set - \ Check\ Set}{Record\ Set}\,\%$$

- Excavation and backfill quantities may be within 10% difference.
- Quantities shall be checked for each structure or structure component for the Summary of Quantities sheet.
- Preliminary quantities based on volume (Lb/CY) or area (Lb/SF) or percentages shall never be used for final quantities.
- Areas and volumes may be measured from CAD program for only one of the calculation sets. The other set must use information found on the plan set.
  - Quantities from the two independent sets shall not be averaged.
  - Eight digit cost code item shall be used in tabulations.

- o A summary showing percentage differences shall be included in the calculations.

Differences shall be resolved and totals from the record set shall be shown in the plans (see examples in Chapter 5). Quantity differences between the two independent sets that cannot be resolved shall be referred to the Engineer of Record for resolution.

An example of a quantity form with quantity checks in Excel is available in ProjectWise under Project Templates (JPC#BRDG_Tabulation of Bridge.xls). The percentage differences are included in the spreadsheet (see Fig. 3.5-1). This Excel file can be copied and used outside of ProjectWise as well.


Pay Item File: *C:\Workspace\Workspace-CDOT_V8i\Standards-Global\Trnsport_Itemlist.csv*

Instructions

Update / Browse for Pay Item File

Data Entry

Divide Sheet

Summary of Quantities

STRUCTURE NO. X-XX-X

ITEM NO.	DESCRIPTION	UNIT	SUPER STR	ABUT 1	PIER 2	PIER 3	ABUT 4	APP SLAB	TOTAL	Checker's Totals	% Difference
202-00453	Removal of Portions of Present Structure (Class 2)	SY							0		
202-00502	Removal of Portions of Present Structure	CY							0		
420-00000	Geomembrane	SY							0		
606-11010	Bridge Rail Type 10R	LF							0		

Fig. 3.5-1 Example - Summary of Quantities with Checker's Totals (in Excel)

3.6 Review

When design and detail checks are completed, all changes, including those received from recipients of advanced plans and FOR plans, as applicable, shall be carefully reviewed and combined on one set of prints. This set shall be marked "Final Check Set", and all detail changes shall be made from this set.

3.7 Plan Preparation and Assembly

This is a last quality assurance (QA) that all checks have been done and the plan set is complete and assembled correctly. This should be the responsibility of the Project Structural Engineer or Lead Detailer.

As a minimum, the following items should be checked:

- o Plan sheets assembled according to the order shown in Chapter 5 of the Detailing Manual

- The total number of sheets in the subset is correct on each and every plan sheet
- The drawing number and title for each sheet matches the number and title shown in the Drawing Index
- The Final Project Construction Number and Project code are correct on each and every sheet
- The Border information is correct on each and every plan sheet as shown in Section 1.9
- All Section letters and Detail numbers are referenced correctly with correct cross reference drawing numbers
- Summary of Quantities match the record set

3.8 Archiving

All projects, either with a project number or just an in-house repair project, shall be archived in ProjectWise.

The Detailer shall be responsible for archiving all the drawings in the original CADD format, including reference drawings, photos, models and other drawing related data. If InRoads was used, then all InRoads generated files such as surfaces, alignments, templates, etc., shall also be archived.

Both sets of quantity calculations shall also be archived in the original format, along with any materials used in the calculations, e.g. InRoads surfaces, CAD sketches of areas, volume reports, hand calculations, spreadsheets in original format. If hand calculations were performed, they shall be scanned in pdf format and archived.

“All PDFs with text or numerical data shall be 300 dpi, page aligned, text searchable, compressed and in conformance with ISO PDF/A-1b archival specification. CDOT employees are to refer to LMS My Learning for Smart Scanning training; all others are to contact DOT_Records_Mgmt@state.co.us for training on Smart Scanning and Electronic Signatures.”

3.9 Field Information Package

See Bridge Design Manual, Policies and Procedures, Section 4 for information on the Field Information Package.

3.10 Electronic Checking Standards

Currently CDOT does not use an automatic standards checker. This section provides best practices for drawing production to facilitate their common use between detailers as well as future use for the life of a bridge.

1. A sheet model should be used for printing purposes.
2. Use View 1 for plot ready views. Save settings when exiting a file so border view is entirely visible.
3. Border cells should be placed at a 1”=1’ scale and reference files scaled to fit into the border.
4. Delete preliminary or extraneous linework from models, e.g. extra profiles, preliminary sections.
5. Bridge linework should be in correct geographic location and rotation.
6. Linework should be centrally located in the file so a fit view shows actually linework instead of dots.
7. Bridge Models should have geographic coordinate system imported from survey files.
8. See Chapter 17, section 17.3 for additional requirements for Inspection Sketches.

Best practices help with batch printing as well such as use View 1 for plot ready views. Some practices were to keep files clean of outdated or not used linework. Standalone files for inspection sketches, i.e. no exterior references.

4.1 Purpose

The purpose of this chapter is to establish a uniform procedure for presenting reinforcing steel in structural details.

4.2 Reinforcing Steel

Bar lists shall not be included in the plans. Bending diagrams shall be included with the details.

Reinforcing lengths shall be rounded to the nearest 1”.

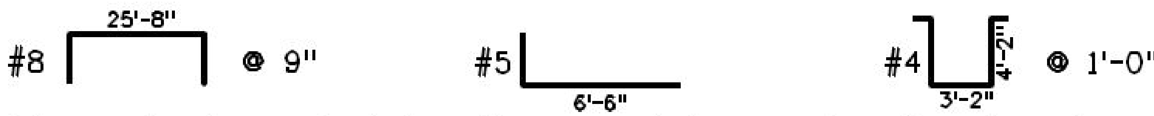
4.3 Reinforcing Steel Details

Reinforced concrete details shall be drawn in accordance with the designer’s notes and current standard practice.

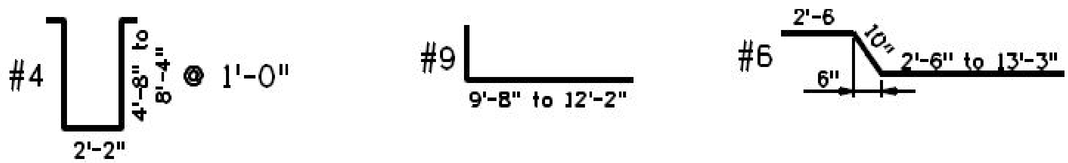
Adequate information shall be shown on each sheet so that the dimensions and shapes of the bars detailed may be readily determined without referring to other detail sheets.

As much of the reinforcing as possible shall be called out in section or sections, and details shown in other views as required to clearly indicate the location of the individual bars. It shall be clear where the first bar starts and the last bar ends. For complex bar arrangements, it may be necessary to draw a detail for each individual mat or portion of reinforcing.

Bent bars shall be called out with a bending diagram giving dimensions for fabrication. Some examples are:



A bar series is required when the concrete has varying dimensions, e.g.:



All bent bars shall be dimensioned, except standard hooks and angles.

Fig. 4.3-1 Bar Bending Diagrams

Straight bars where the length is controlled by concrete dimensions and end clearances may be called out as, e.g.: #4 Cont. @ 1'-0", #6 Cont., #4 (Tot. 5).

Straight bars where the length is not controlled by concrete dimensions shall be called out as shown in figures 4.3-2 and 4.3-3 and the bar shall be located with a dimension to its end from easily identifiable locations such as centerline piers, centerline columns, end of pier caps, etc.

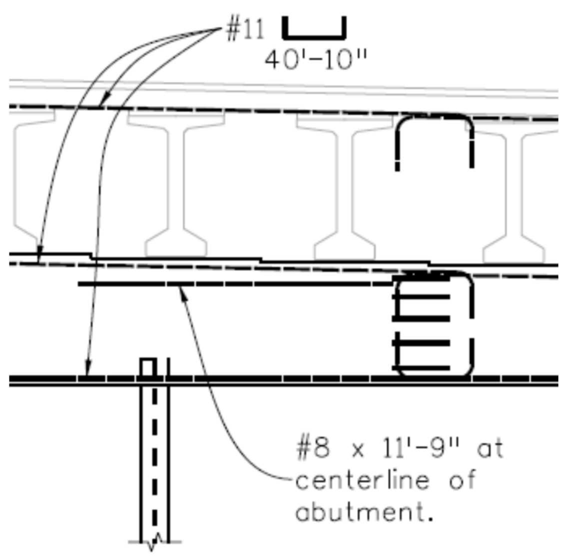


Fig. 4.3-2 Example 1: Rebar not controlled by concrete dimensions

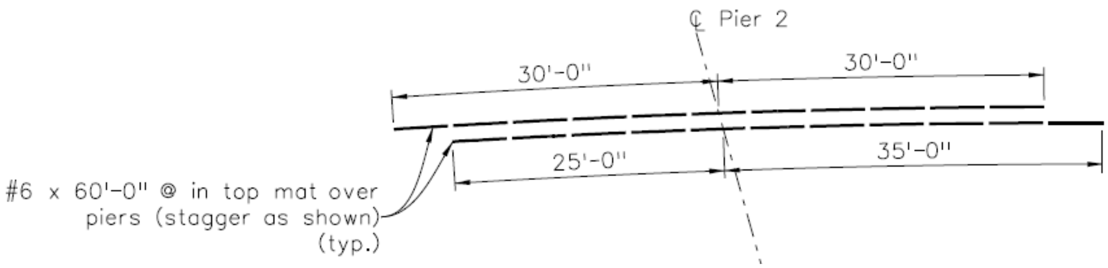


Fig. 4.3-3 Example 2: Rebar not controlled by concrete dimensions

4.4 Non Coated and Epoxy Coated Reinforcing

Reinforcing shall be non coated or epoxy coated, per the Bridge Design Manual. If both non coated and epoxy coated reinforcing is used in the structure, place an Ⓝ or an Ⓔ next to the reinforcing which has the fewest number of bars. A note "Ⓝ denotes non coated reinforcing steel" or "Ⓔ notes epoxy coated reinforcing steel" shall be added to the general notes.

4.5 Reinforcing Spacing

The designer shall furnish the detailer with the reinforcing bar spacing in the design notes. Bar spacing shall be given in inches or feet and inches.

4.6 Reinforcing Hooks

Unless otherwise noted, standard hooks of 90°, 135°, and 180° will be in accordance with the Specifications and need not be dimensioned on the plans. The designer shall furnish the detailer with the dimensions for non-standard hooks. These dimensions shall be shown on the plans.

4.7 Reinforcing Splices

The minimum splice lengths shall be as shown in the table on worksheet B-100-1, General Information - Summary of Quantities for Class B splices. Non-standard splices or other class splices shall be depicted in the drawing details. These lengths shall not be used if more than ½ of the splices overlap at any one point.

Splice length between bars of different sizes shall be governed by the smaller bar.

Splices for column reinforcing, main longitudinal girder reinforcing, pier cap reinforcing, and stirrup splices shall be detailed on the plans. Splices shall be alternated, staggered, or rotated to prevent rows of splices from being adjacent to each other. Splice locations and lengths shall be shown if these splices are other than minimum lap. Other nominal bars may be indicated as “continuous” without detailing the splice length or location.

Splice locations shall be determined using 40’-0” lengths for #4 and #5 bars and 60’-0” lengths for #6 bars and larger. This does not preclude the use of 60’-0” stock length #4 and #5 bars.

Lapped splices shall not be used for bars larger than #11. For bars larger than #11, welded splices or other positive connections shall be used.

To avoid field issues, stirrups for a given element should be made the same length, when possible.

Typical splices shall be drawn as slightly offset lines.

Joggles or abrupt bends shall not be shown unless required by design.

4.8 Reinforcing Cover

The minimum cover from the surface of the concrete to the face of any reinforcement bar shall be 2 inches except as listed below:

- Bottom of slab …………………………………………………….…... 1”
- Interior surface of box girder webs and diaphragms ………….…... 1”
- Bottom of lower slab in box girder …………………………….……… 1½”
- Stirrups and ties in T-beams ………………………….……….……….. 1½”
- Diaphragms designed as T beams …………………….…….….……. 1½”
- Pier caps monolithic with girder webs ……………………….….…. 1½”
- Top of deck slab with asphalt & waterproofing membrane …..…… 2”
- Top of deck slab without asphalt ……………………………..……... 3”
- Concrete deposited directly against earth ………………………….. 3”

Fit and clearance of reinforcing shall be carefully checked by calculations, full scale drawings, or other accurate means. Allowance shall be made for the deformations (ridges) on the reinforcing steel. Some interference may be acceptable if the bars will fit with minor movement (1/4 bar diameter or less) from the location shown on the plans.

Some common interferences are:

- Between slab reinforcing and reinforcing in abutments and pier caps.
- Vertical dowels projecting through mats of main reinforcing in pier caps and girder stems.
- Reinforcing for expansion devices and deck steel.

Skews will tend to aggravate problems of reinforcing fitting.

4.9 Bundled Bars

Bundled bars shown in the plan and elevation shall be shown as in Fig. 4.9-1.

A note / legend shall be added to clarify the symbol  in the plans.

Figure 4.9-1 Bundled Bars for Plan & Elevation

Bundled bars are shown in a Section View in Figure 4.9-2.

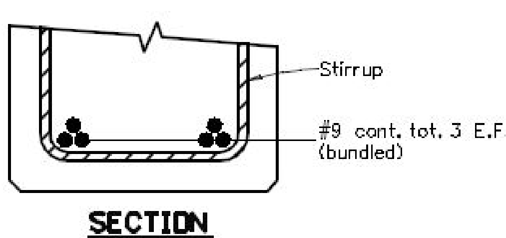


Figure 4.9-2 Bundled Bars in Section

4.10 Dowels

The length of embedment and/or projection for bars used as dowels shall be determined by the designer and shown in the design notes and on the drawings. If bent bars are used for footing dowels, the bends shall be standard hooks, and shall rest on the bottom reinforcing mat in the footing.

4.11 Bars in Section

Figure 4.11-1 is a section through a hypothetical member showing some accepted methods for calling out reinforcing steel.

Some observations:

A) Sections shall be illustrated to a large enough scale to clearly show reinforcing details.

B) Stirrups and other bars shown in profile shall be drawn with a single bold line at scales below ½”=1’. At scales ½”= 1’ and larger, it may be advantageous to draw them with scale bends and double filled or hatched lines, see fig. 4.9-1.

C) Bars shown end-on shall be drawn as filled circles. At scales ½”=1’ and larger the filled circles shall be drawn to scale. At smaller scales, the filled circles can be enlarged to clarify the detail.

D) Arrowheads or circles shall be the preferred method of callout for bars shown end-on. Arrowheads shall point directly to the bar.

E) For end-on bars, give the bar call out and limiting factors Example: #5 (Between girders).

F) Sections cut at specific locations along a member will often be preferred over a typical section for complex reinforcing patterns.

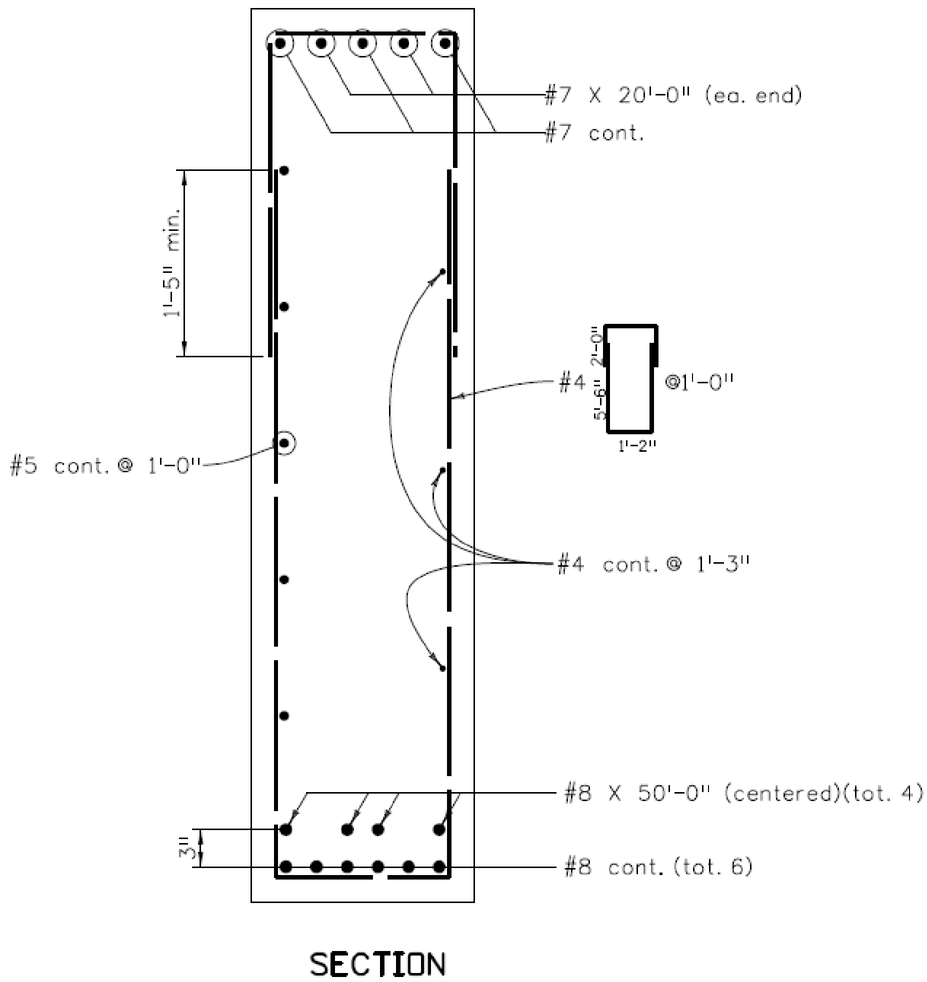


Figure 4.11-1 Bars in Section (Example)

4.12 Reinforcing Quantities

Splice lengths shall be included when determining reinforcing quantities. Estimates or the use of a percentage of the quantities to account for splices will not be acceptable.

Two independent sets of quantities shall be calculated. One set will be prepared by the detailer and one set by the design/detail checker. After differences are resolved, totals from the record set shall be shown on the plans. Extended totals for both sets of quantities shall be within one percent of each other. Quantities from the two independent sets shall not be averaged.

A spread sheet can facilitate quantity calculations. Samples of spread sheets may be found at: http://www.coloradodot.info/library/bridge/bridge-manuals/bridge-detail-manual
.

5.1 Purpose

The purpose of this drawing is to present complete and accurate general information and summary of quantities.

5.2 Responsibility

This drawing shall be prepared and checked in the design unit. The graphic presentation of information on this drawing shall be the responsibility of the individual preparing the drawing.

5.3 General Notes and Design Data

The Designer and Detailer shall prepare this data for each project. Structural Worksheet B-100-1 shall be used as a guide. If design criteria varies over the bridge, areas shall be designated in plans. Only those notes and data which are applicable to the project shall be used. The section cut symbol as described in Chapter 2 should be shown on this drawing.

Notes that are sheet or item specific shall be included on the appropriate sheet, e.g. notes specific to abutments shall be on the abutment sheets.

5.4 Summary of Quantities

A complete summary of quantities with appropriate sub-notes shall be placed on the drawing. The item numbers, descriptions, units, quantities, and totals shall be verified from the summary sheet and shall be given in the order shown in the Colorado Department of Transportation Item Book. These quantities shall be prepared as outlined in the Colorado Department of Transportation Bridge Design Manual Subsection 18.2 Computation of Quantities and Subsection 18.3 Bid Items and Quantities. In the past only 3 digit item codes were used, but for all current projects the full eight digit cost item code shall be used. Each bridge shall have its own total column. When this table becomes too big to fit on a sheet with the notes and index of drawings it may be placed on a sheet by itself.

Spreadsheet versions of this table that are embedded, linked or pasted as a picture into the sheet are acceptable. Arial Font is preferred. In this case, the guidelines below may not be applicable. See Appendix B – Microstation Configuration Details for additional information.

The following guidelines as shown in Fig. 5.4-1 are suggested starting points when constructing the Summary of Quantities table:

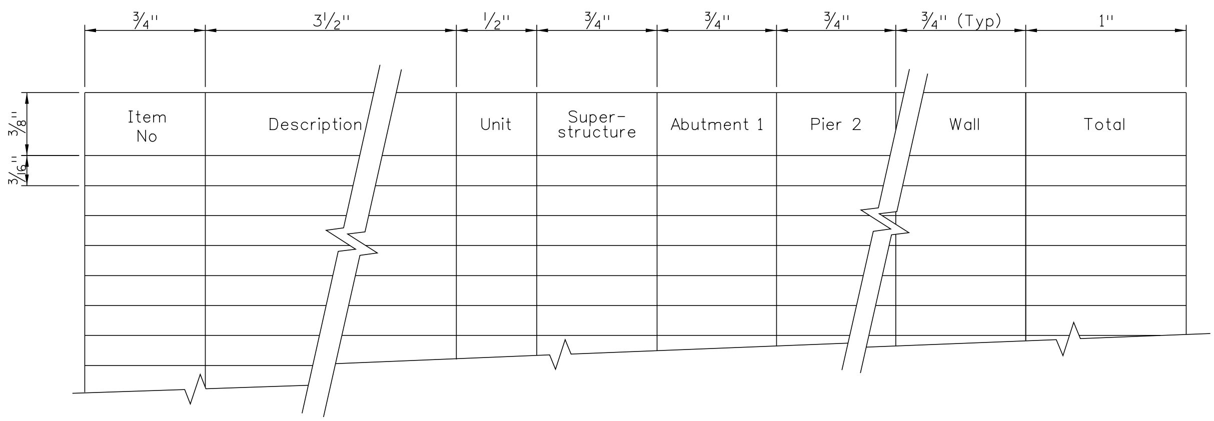


Fig. 5.4-1

The sample column headings pertain to a new bridge project. For repair work, walls, etc. the column headings would be changed to fit the specific job. Substructure elements are to be numbered as follows: Abutment 1, Pier 2, Pier 3, ..., Pier n-1, Abutment n.

Historically, the practice was to have blank lines between each cost item, two blank lines left after the last 403 and 502 cost items, and a minimum of 6 blank lines left at the bottom of the table. These extra lines were left for the Region to use as needed for as-builts. Except for the blanks between each cost item, the other blank lines are generally not necessary.

5.5 Index of Drawings

A complete index of drawings, in sequence, shall appear on the drawing with the appropriate reference drawing number. The title in the index shall be the same as the title given in the title block of each drawing.

Drawings for new bridges or structures should be generally arranged in the following sequence as applicable. This sequence provides the information to approximate the construction sequence. See specific chapters for additional drawing details.

GENERAL INFORMATION & SUMMARY OF QUANTITIES
GENERAL LAYOUT
ENGINEERING GEOLOGY
BRIDGE HYDRAULIC INFORMATION

CONSTRUCTION LAYOUT
CONSTRUCTION PHASING
FOOTING, PILING AND CAISSON LAYOUT
ABUTMENT DETAILS
WINGWALL DETAILS
PIER DETAILS
BEARING DETAILS
GIRDER LAYOUT (if required)
GIRDER DETAILS (Precast or Steel)
DECK / SUPERSTRUCTURE DETAILS
GIRDER DETAILS (Cast-in-Place)
EXPANSION DEVICE DETAILS (if in the superstructure)
PRECAST PANEL DECK FORMS
DRAIN DETAILS (if in the superstructure)
EXCAVATION AND BACKFILL DETAILS (if different than M-standards)
STRUCTURE BACKFILL DETAILS (as appropriate)
BRIDGE RAIL DETAILS
LIGHTING DETAILS
FENCE DETAILS
APPROACH SLAB DETAILS
EXPANSION DEVICE DETAILS (if in the approach slab)
DRAIN DETAILS (if in the approach slab)
SLOPE PAVING DETAILS
BRIDGE DECK ELEVATIONS

For repair plans, the index should include sheets for General Information, Summary of Quantities, Layouts and details as required.

5.6 Bridge Description

The area reserved for the bridge description contains room for approximately six (6) lines of notes using 0.07 inch text height. Lines one (1) through three (3) shall be used for the bridge description which should include the number of spans, span type, span lengths and bridge type. Following is a list of the more commonly used bridge descriptions as they are to appear on the drawing. Often it shall become necessary to describe special designs not listed below; the special descriptions shall be verified from Appendix “C” of the Colorado Department of Transportation Structure Inventory Coding Guide or the Field Log of Structures books. Span is defined as span perpendicular to centerline of box, for concrete box culverts.

SAMPLE DESCRIPTIONS:

3 Span (40'-0", 60'-0", 40'-0") Bridge, Concrete slab and Girder.

1-Simple Span (65'-0") Bridge, Concrete Slab and Girder Prestressed.

3 Span (43'-0", 129-0", 43'-0") Bridge, Concrete Slab and Prestressed Concrete I Girder.

3 Span (74'-6", 125'-0", 122'-6") Bridge, Concrete Slab and Prestressed Concrete U Girder.

3 Span (42'-6", 50'-0", 42'-6") Bridge, Concrete Slab and Prestressed Concrete Box Girder, side by side.

2-Span (75'-0", 75'-0") Bridge, CIP Concrete Box Girder, Multiple.

4-Span (40'-0", 70'-0", 70'-0", 40'-0") Bridge, Welded Girder, Composite.

2-Cell (18'-0" X 7'-0" X 200'-0") Concrete Box Culvert.

Lines four (4) through six (6) shall complete the bridge description as follows:

Line (4) Over or Under ____________________________
Line (5) ____________________ Roadway Curb to Curb. ____________Bent Angle
Line (6) ____________________Curbs or Walks. Type _________ Bridge Rail.

Line 4

- Show proper notation in regard to structure being "over" or "under" a crossing.
- If the bridge is on the project line and goes over a crossroad, then the word "over" is correct.
- If the project line goes under a bridge or a crossroad, the word "under" shall be used.

Examples:

1) If the project line is on I 25 going under 86th Avenue, the correct notation would be "under 86th Avenue".
2) If the project line is on 86th Avenue going over I 25, the correct notation would be "over I 25".

Line 5

- Give “Roadway curb-to-curb” dimension in feet and inches 40’-6”.
- Give “Bent Angle” as detailed on the plans.

Line 6

- Give “Curb” or “Walk” dimensions in feet and inches 1’-3”, 5’-0”.

5.7 Work Description (for Repair Projects)

The work description shall describe what work is being done, e.g. type of rail replacement; joint replacement; etc.

5.8 Title Block

This drawing is titled “GENERAL INFORMATION & SUMMARY OF QUANTITIES” and shall be so indicated in the title block.

GENERAL NOTES

Except as shown on the plans, structure excavation and backfill shall be in accordance with M-206-2.

Expansion joint material shall meet AASHTO Specification M213.

All exposed concrete bridge surfaces shall receive a Class 1, surface finish, to one foot below the ground line.

The following structural steel shall be AASHTO M270 Grade 36 (ASTM A-36): diaphragms, expansion devices and miscellaneous steel as noted.

The following structural steel shall be AASHTO M270 Grade 50 (ASTM A-572): piling and bridge railing posts and base plates.

All bolts shall be ⅞" diameter, high strength, unless otherwise noted.

Leveling pads are unlaminated bearings. They shall be cut or molded from AASHTO elastomer grade 3, 4, or 5 as described in tables 705-1 and 705-2 with a durometer (shore "A") hardness of 60.

Grade 60 reinforcing steel is required.

Reinforcing steel at superstructure (deck, approach slabs, abutments and wingwalls above bearing seat elevation) shall be galvanized coated.

Reinforcing steel at substructure (abutments and wingwalls below bearing seat elevation) shall be uncoated.

All the provisions for bridge deck concrete shall also apply to approach slab concrete.

The Contractor shall be responsible for the stability of the structure during construction.

Precast deck forms are required.

Mechanically Stabilized Backfill shall be used at abutments.

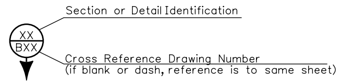
For structure number installation, see Standard S-614-12.

All longitudinal and transverse dimensions are measured horizontally and include no correction for grade.

The information shown on these plans concerning the type and location of underground utilities is not guaranteed to be accurate or all inclusive. The Contractor is responsible for making his own determination as to the type and location of underground utilities as may be necessary to avoid damage thereto. The Contractor shall contact the Utility Notification Center of Colorado at 811 (1-800-922-1987) at least 3 days (2 days not including the day of notification) prior to any excavation or other earthwork.

Existing Bridge Rail type 10R recently installed to be removed and salvaged and delivered to CDOT R2 Maintenance.

Know what's below. Call before you dig.



DESIGN DATA

AASHTO LRFD Bridge Design Specifications, 8th Edition (2017)

Design Method: Load and Resistance Factor Design

Live Load: HL-93 (design truck or tandem, and design lane load)
Dead Load: Assumes 36 lbs. per sq. ft. for bridge deck overlay
Assumes 5 lbs. per sq. ft. for permanent steel deck forms

Reinforced Concrete:
Class D Concrete: f'c = 4,500 psi

Precast Prestressed Concrete Girders:
Class PS concrete f'c = (see details)
Prestressing Steel f's = 270,000 psi

Reinforcing Steel: fy = 60,000 psi

Structural Steel:
AASHTO M270 (ASTM A709) Grade 36 fy = 36,000 psi
AASHTO M270 (ASTM A709) Grade 50 fy = 50,000 psi

SEISMIC DESIGN CRITERIA

Earthquake Design method:
Force Based (General Procedure per LRFD 3.10.2.1)
Latitude = 39.0721° N
Longitude = 105.9742° W

AASHTO Spectrum for 7% PE in 75 years (1000yr Return Period)

Period (sec)	Sa (g)
0.0	0.077 PGA - Site Class D
0.2	0.160 Ss - Site Class D
1.0	0.042 S1 - Site Class D

Spectral Response Accelerations:
As = Fpga*PGA, SDs = Fa*Ss, and SD1 = Fv*S1
Fpga = 1.600, Fa = 1.600, Fv = 2.400

Period (sec)	Sa (g)
0.0	0.123 As - Site Class D
0.2	0.256 SDs - Site Class D
1.0	0.101 SD1 - Site Class D

Operational Class:
Seismic Zone or Seismic Design Category:
Zone= 1 or Category= A

Response Modification Factors:
R-Factor: 1.5 (Substructure type), R-Factor: 1.0 (Connections)

INDEX OF DRAWINGS

BRIDGE DESCRIPTION

Simple span (90'-0" along HCL) bridge, concrete prestressed I girder (CPG) on US285 over S Fork S Platte River.
44'-0" Roadway curb to curb, Bent angle 90°.
1'-6" curbs, Type 10MASH bridge rail with BR10M-GR3 transition.

GENERAL INFORMATION

Example 5-1

SUMMARY OF QUANTITIES

Item No	Description	Unit	H-13-H				Total
			Superstructure	Abut 1	Abut 2	Approach Slabs	
202-00400	Removal of Bridge	EA	1				1
206-00000	Structure Excavation	CY		210	210		420
206-00065	Structure Backfill (Flow-Fill)	CY		6.5	6.5		13
206-00100	Structure Backfill (Class 1)	CY		330	330		660
206-00200	Structure Backfill (Class 2)	CY		80	80		160
403-34721	Hot Mix Asphalt (Grading SX) (75) (PG 58-28)	TON	75			33	108
408-01100	Joint Sealant	LF				176	176
502-00460	Pile Tip	EA		7	7		14
502-00500	Complete Joint Penetration (CJP) Splice	EA		7	7		14
502-02010	Dynamic Pile Test	EA		1	1		2
502-11274	Steel Piling (HP 12x74)	LF		276	295		571
515-00124	Waterproofing (Membrane)(Spray Applied)	SY	453			196	649
601-03040	Concrete Class D (Bridge)	CY	168	24	24	81.9	298
602-00000	Reinforcing Steel	LB		5440	5440		10,880
602-00010	Reinforcing Steel (Galvanized)	LB	38495			11965	50,460
606-01400	Transition Type BR10M-GR3	EA	4				4
606-11035	Bridge Rail Type 10 MASH	LF	265				265
613-01200	2 Inch Electrical Conduit (Plastic)	LF	600				600
618-01145	Prestressed Concrete I (CBT 45)	LF	364				364

NOTES:

1. See Roadway plans for additional quantities related to embankment protection at abutments.
2. The 4 pull boxes (24"x36"x24") shown in the general layout shall not be paid separately, but shall be included in the work for pay item 613 - Electrical Conduit.

SUMMARY OF QUANTITIES

Example 5-2

GENERAL NOTES

Structure excavation and backfill shall be in accordance with M-206-1 for concrete box culvert and cast-in-place retaining walls.

All exposed concrete surfaces shall receive a Class 1 final finish to one foot below the ground line.

Expansion joint material shall meet AASHTO Specification M213.

Grade 60 reinforcing steel is required.

All construction joints not shown on the plans shall be approved by the Engineer.

All construction joints shall be thouroughly cleaned before fresh concrete is placed.

Backfill shall not begin untill top slab has reached the design strength f'c.

Wingwalls shall be constructed in accordance with standard M-601-20.

All exposed concrete corners shall be chamfered ¾ inch.

All dimensions are perpendicular to the centerline of the box.

All transverse reinforcing shall be normal to the centerline of the box.

The Contractor shall be responsible for the stability of the structure during construction.

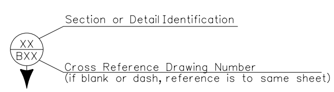
For structure number installation, see Standard S-614-12.

Stations, Elevations, and Dimensions contained in these plans are calculated from a recent field survey. The Contractor shall verify all dependent dimensions in the field before ordering or fabricating any material.

All longitudinal and transverse dimensions are measured horizontally and include no correction for grade.

The information shown on these plans concerning the type and location of underground utilities is not guaranteed to be accurate or all inclusive.
The Contractor is responsible for making his own determination as to the type and location of underground utilities as may be necessary to avoid damage thereto. The Contractor shall contact the Utility Notification Center of Colorado at 811 (1-800-922-1987) at least 3 days (2 days not including the day of notification) prior to any excavation or other earthwork.

Know what's below. Call before you dig.



INDEX OF DRAWINGS

B01 GENERAL INFORMATION. SUMMARY OF QUANTITIES
B02 GENERAL LAYOUT
B03 GENERAL LAYOUT
B04 BOX CULVERT EXTENSION DETAILS

BRIDGE DESCRIPTION

024G331948BL:
Replace a 2-span steel girder bridge (H-19-C) with a 2 cell x 8' x 8' x 107.2' CBC
Carrying US24 ML over a draw at mile marker 331.948
Angle between CL Roadway and CL CBC = 76°

024G332060BR:
18' Extension at outlet of the existing 1 cell x 8' x 4' x 56' CBC (built in 1935, 4' extension at inlet in 1968)
Carrying US24 ML over a draw at mile marker 332.06
Angle between CL Roadway and CL CBC = 0°

SUMMARY OF QUANTITIES

Item No	Description	Units	024G331948BL					024G332060BR			Total Project
			CBC & Headwalls	Wingwalls	Channel Protection		Total	CBC & Headwalls	Wingwalls/ By Others	Total	
					Inlet	Outlet					
202-00026	Removal of Slope and Ditch Paving	SY			310		**310**				**310**
202-00150	Removal of Wall (CBC Wingwalls)	EA							2	**2**	**2**
202-00400	Removal of Bridge	EA					**1**				**1**
206-00000	Structure Excavation	CY	95	75	50	10	**230**	30	25	**55**	**285**
206-00200	Structure Backfill (Class 2)	CY	270	130			**400**	20	20	**40**	**440**
206-01781	Shoring (Area 1)	LS	1				**1**				**1**
206-01782	Shoring (Area 2)	LS	0.5				**0.5**	0.5		**0.5**	**1**
515-00120	Waterproofing (Membrane)	SY	252				**252**				**252**
601-03030	Concrete Class D (Box Culvert)	CY	224	40	9	12	**285**	16	7	**23**	**308**
602-00000	Reinforcing Steel	LB	23405	4115	685	890	**29095**	3825	775	**4600**	**33695**
602-00020	Reinforcing Steel (Epoxy Coated)	LB	20355				**20355**				**20355**

See Drainage Channel Plan sheet for additional channel protection quantities.

DESIGN DATA

AASHTO, LRFD 9th Edition, 2020, with current interims

Design Method: Load and Resistance Factor Design

Reinforced Concrete: Class D Concrete (Box Culvert): $f'c$ = 4,500 psi
Reinforcing Steel: fy = 60,000 psi

Live Load CBC: HL-93 (design truck or tandem, and design lane load)

Dead Load CBC: 125 lbs. per cu. ft. for soils
146.67 lbs. per cu. ft. for asphalt

Wingwall Loading:
At-rest earth fluid pressure for concrete stem design = 55 pcf for 2 (min) : 1 sloped backfill
Active earth fluid pressure for concrete footing design = 40 pcf for 2 (min) : 1 sloped backfill
Live load surcharge = 2'
Minimum resistance for soil bearing = 5.5 ksi
Soil bearing resistance factor = 0.45

GENERAL INFORMATION &
SUMMARY OF QUANTITIES

Example 5-3

GENERAL NOTES

All work shall be done in accordance with the Colorado Department of Transportation 2017 Standard Specifications for Road and Bridge Construction and as noted in the drawings.

Unless otherwise noted, dimensions contained in these plans are calculated from the "As Constructed Plans". These dimensions may be adjusted to meet the existing structure. The Contractor shall verify all dependent dimensions in the field before ordering or fabricating any material.

The Contractor shall be responsible for the stability of the structure during all phases of construction.

The Contractor may stockpile repair material at own risk. All unused material shall remain property of the Contractor. CDOT will not repurchase leftover materials or pay any restocking fees.

The Contractor shall protect pedestrians and traveling public from any falling debris during the construction work. Any debris which falls on paths or roadways shall be removed immediately. This work will not be measured and paid for separately, but shall be included in the cost of the work.

One inch of pavement shall be removed from the structure as indicated in the plans and replaced with two inches of hot mix asphalt to the grade and cross slope on the existing concrete deck.

Vary asphalt thickness or adjust as necessary to eliminate ponding condition at the NE corner of the bridge.

Before removal, the Contractor shall verify the existing HMA thickness on the bridge deck and approach slabs in accordance with the Special Provision Removal of Asphalt Mat (Planing).

The transition between final grade of HMA on the bridge to the final grade on the approaches shall be transitioned at 1" per 25 ft.

Repair quantities are approximate. Final location shall be determined by the Engineer. Payment will be for the actual area repaired and material used as approved by the Engineer. Rehabilitation quantities in addition to plan quantities will be measured and paid for at the unit price for the appropriate bid item.

All longitudinal and transverse dimensions are measured horizontally and include no correction for grade.

LEGEND

XX
BXX

Section or Detail Identification

Cross Reference Drawing Number
(if blank or dash, reference is to same sheet)

INDEX OF DRAWINGS

B01 GENERAL INFORMATION SUMMARY OF QUANTITIES
B02 PLAN & GIRDER REPAIR DETAILS
B03 ABUTMENT, PIER & CURB REPAIR DETAILS
B04 BRIDGE EXPANSION JOINT (ASPHALTIC PLUG)

SUMMARY OF QUANTITIES

Item No	Description	Unit	Quantity	As-Built
▲ 202-00240	Removal of Asphalt Mat (Planing)	SY	1,150	
202-00505	Removal of Portions of Present Structure	SF	45	
403-34871	Hot Mix Asphalt (Grading SX) (100) (PG 76-28)	TON	125	
518-01001	Bridge Expansion Joint (Asphaltic Plug)	LF	147	
519-01000	Epoxy Resin (Injection)	LF	120	
601-06102	Concrete (Patching)	CF	15	
602-00000	Reinforcing Steel	LB	40	

▲ For information only. See Roadway Plans.

CONCRETE REMOVAL AND PATCHING NOTES

The Contractor shall sawcut around the removal area to a depth of 1 inch prior to removal operations as directed by the Engineer. All saw residue material shall be properly contained and not allowed to run off.

Care shall be taken in removing concrete from reinforcing steel to prevent damage. Any reinforcing steel that is cut, damaged or removed due to Contractor actions, as determined by the Engineer, shall be replaced at the Contractor's expense.

Clean and prepare existing concrete surfaces and reinforcing for placement of new concrete, in accordance with Sections 202 and 601 of the Specifications prior to placement of new concrete.

After removal of concrete, all exposed rebar shall be cleaned of all loose concrete by chipping and/or sandblasting, and this shall be included in the cost of the work.

Rebuild all concrete surfaces to the original dimensions as directed by the Engineer.

DESIGN DATA

AASHTO LRFD Design Specifications, Eighth Edition.

Concrete Patching Material:
Concrete (Patching): See Special Provision
Reinforcing Steel: Fy = 60,000 psi

BRIDGE DESCRIPTION

SH 115 ML over US 50 at MP 13.957.
2-Span concrete slab and prestressed concrete girder (CPG).
249'-0" Length BF abut to BF abut.
44'-6" out to out witdth, 31° skew.
New rail type 10R in 2012.
Built in 1973.

WORK DESCRIPTION

1. Mill 1" asphalt and place 2" new asphalt.
2. Place Bridge Expansion Device (Asphalt Plug) at both abutments and pier.
3. Repair damaged concrete area located at the right corner of Abutment 3.
4. Repair damaged concrete area located at forward right end wall of Pier 2 and at Pier cap.
5. Expoxy inject the cracks in web of girder 2F.

GENERAL INFORMATION &
SUMMARY OF QUANTITIES

Example 5-4

SUMMARY OF QUANTITIES

NOTE	ITEM NO	DESCRIPTION	UNIT	SUPERSTRUCTURE	ABUTMENT 1	PIER 2	PIER 3	PIER 4	PIER 5	ABUTMENT 6	APPROACH SLABS	URBAN DESIGN	TOTAL
9	202-00401	REMOVAL OF BRIDGE (SPECIAL)	EA										1
	202-00400	REMOVAL OF BRIDGE	EA										1
	206-00000	STRUCTURE EXCAVATION	CY		1,095	82	80	62	50	909			2,278
	206-00100	STRUCTURE BACKFILL (CLASS 1)	CY		1,286					1,067			2,353
	206-00200	STRUCTURE BACKFILL (CLASS 2)	CY			66	65	50	40				221
	206-01781	SHORING (AREA 1)	LS	1									1
12	206-01782	SHORING (AREA 2)	LS	1									1
	206-00360	MECHANICAL REINFORCEMENT OF SOIL	CY		1,214					1,026			2,240
	403-34751	HOT MIX ASPHALT (GRADING SX)(75)(PG 64-28)	TON	541							56		597
	503-00030	DRILLED CAISSON (30 INCH)	LF		185					145			330
	503-00048	DRILLED CAISSON (48 INCH)	LF			132	132	168	132				564
	504-04420	PRECAST PANEL FACING	SF		428								428
	512-00101	BEARING DEVICE (TYPE I)	EA		14					14			28
	514-00201	PEDESTRIAN RAILING (STEEL)(SPECIAL)	LF									727	727
	515-00120	WATERPROOFING (MEMBRANE)	SY	3,339							346		3,685
	518-01004	BRIDGE EXPANSION DEVICE (0 - 4 INCH)	LF		120					120			240
3	601-03040	CONCRETE CLASS D (BRIDGE)	CY	1,563	152	122	119	117	115	149	287	80	2,704
	601-40005	CUT STONE VENEER (ASHLER)	SF									1,777	1,777
	601-40400	STRUCTURAL CONCRETE STAIN	SY	981	116	259	252	256	256	183		1,215	3,518
13 4	602-00020	REINFORCING STEEL (EPOXY COATED)	LB	357,133	19,419	30,047	30,047	30,047	30,047	19,419	40,776	8,183	565,118
	604-25000	VANE GRATE INLET (SPECIAL)	EA								2		2
	606-11032	BRIDGE RAIL TYPE 10M (SPECIAL)	LF	769									769
2	613-00075	3/4 INCH ELECTRICAL CONDUIT	LF						120				120
7 8	613-01200	2 INCH ELECTRICAL CONDUIT (PLASTIC)	LF									1,378	1,378
5	613-01300	3 INCH ELECTRICAL CONDUIT (PLASTIC)	LF									355	355
6	613-01400	4 INCH ELECTRICAL CONDUIT (PLASTIC)	LF									441	441
2	613-13000	LUMINAIRE (LED)	EA						6				6
10	613-15200	RECESSED LIGHT (SPECIAL)	EA									44	44
	618-01992	PRESTRESSED CONCRETE BOX (DEPTH LESS THAN 32 INCHES)	SF	44,840									44,840
11	621-00411	STRUCTURE TEMPORARY ACCESS ROAD (LOCATION 1)	LS										1
11	621-00412	STRUCTURE TEMPORARY ACCESS ROAD (LOCATION 2)	LS										1

SUMMARY OF QUANTITIES

NOTES:

1. Riprap, topsoil and Geotextile quantities are shown in the Drainage Plans.
2. For Lighting at Pier 5.
3. Includes 7.36 CY for railing terminus columns at abutments and 29.42 CY for columns at piers and 43.28 CY for plinths.
4. Includes 345 LB for railing terminus columns at abutments and 5,502 LB for columns at piers and 2,176 LB for plinths.
5. Irrigation sleeve (PVC Conduit) in median.
6. Irrigation sleeve (PVC Conduit) in right edge of deck.
7. Two electrical conduits in left edge of deck, one electrical conduit in median, one electrical conduit in right edge of deck.
8. One irrigation sleeve in right edge of deck
9. Removal of Pedestrian bridge.
10. Includes 16 for stone columns and 28 for plinths.
11. See Structure Selection Report for Structure Temporary Access Road (Location 1 and 2) for conceptual details.
12. To facilitate phase I bridge and landscaping wall construction at the east abutment.
13. Quantity includes 2% for splices not shown in the plans.

Example 5-5

6.1 Purpose

This drawing is to be a general layout in plan, longitudinal section, and typical transverse section of the structure, showing the physical aspects and features of the structure and surrounding terrain.

For General Layouts of walls, see Chapter 15.1. See Chapter 16 for General Layout requirements for repairs.

6.2 Responsibility

This drawing shall be prepared and checked in the design unit. The graphic presentation of information on this drawing shall be the responsibility of the individual peparing the drawing.

6.3 Scales

Standard Architectural and Civil scales shall be used that are suitable to make the plan view, elevation and typical section legible on a standard sheet. For additional information see Chapter 2.3.

Plan view & Elevation should match. Scale for Typical Section is generally larger.

6.4 Orientation of Details

The PLAN shall be placed, if possible, at the upper left of the sheet with the layout line parallel to the border. The ELEVATION shall be projected below the PLAN when possible. Elevations should include vertical scales. The PLAN and ELEVATION shall be oriented to match roadway plans, with stationing increasing from left to right. Sections shall be placed to the right of the PLAN and ELEVATION. Generally, sections should be taken from the PLAN and ELEVATION rather than from secondary views or other sections. If space is limited, the sections or additional details may be shown on another sheet. The preference is to show all details on one sheet if scale of details is readable.

6.5 Plan

All items underneath the proposed bridge shall not be shown unless it is critical to construction and not shown elsewhere in the plan set.

Listed below are items to be shown in the plan view of this drawing (as applicable):

A) Horizontal Control Line: Projected Line, Survey Line, Centerline Roadway, Centerline Median, Centerline Structure, or others.
B) Profile Grade Line or Lines; label and dimension to Horizontal Control Line.
C) Alignment Information: Horizontal Curve Data, bearings, and station marks at 100 feet of upper and lower roadways. Give the station tie at centerline intersection.
D) Bent angle of bridge.
E) Label the Back Face of Abutments and Centerline of Piers.
F) Stations at Back Face of Abutments and Centerline of Piers along Horizontal Control Line.
G) Horizontal roadway dimensions of upper and lower roadways including traveled lane widths, shoulder widths, ditches, toe of slope, sidewalks, etc. for the current and future alignments.
H) For structures over Railroads, give the minimum horizontal clearance measured perpendicular from centerline of railroad tracks to piers and retaining walls adjacent to the tracks in English units.
I) The direction and name of the nearest town(s). They should be placed outside of the bridge. This may be optional where in urban areas.
J) The name and direction of flow for streams and canals. Use standard directional arrow for water flow.
K) Show channel improvement dimension (Net Channel Width), per the Hydraulics Report.
L) Label each proposed structure that shows in the general layout with its final structure number or ID.
M) Show approach slabs & sleeper headers, if required.
N) Location of minimum vertical clearance over Roadways, Railroads and Pathways.
O) Show existing and proposed contour lines, when they are available. 1’ or 2’ contour intervals should be used depending on the scale and congestion of the drawing. Existing contours may be eliminated if it is too confusing or congested.
P) Show abutment subdrain outlet. If special details are required, they can be shown elsewhere.
Q) Show shoring at preliminary FIR level plans. Shoring should be removed from final plans to reduce clutter.
R) Standard North Arrow.
S) All known utilities.
T) Show type of slope protection. If slope paving is used, show outline and define limits. If riprap is used, partial limits may be shown if the hydraulic sheets provide details. Make reference to appropriate sheet numbers.
U) Direction and rate of fill or cut slopes. Show approximate location of toe and top of slopes.

V) Show existing structures (dashed), label with structure number, and note if the existing structure is to be removed.
W) Title the General Layout plan view "PLAN".
X) Show guardrail and transitions.
Y) Show ROW (right of way) limits, if available. It is not necessary to change scale or limits of plan in order to show.

6.6 Longitudinal Section / Elevation

Listed below are items to be shown in the Longitudinal Section/Elevation of this drawing. (as applicable)

A) Show elevation lines at 2 feet intervals along each side and identify the elevations at 20 feet intervals. Smaller intervals may be used.
B) Label stations across the bottom at 100 feet.
C) Show span lengths and total overall length and where measured if located away from where section is taken.
D) Label Back Face Abutments, Centerline Piers, and Centerline Bearings.
E) Show Finished Grade Elevations at the back face of abutments and at centerline of piers and note where located, if other than where section is taken.
F) If the bridge is on a straight grade, show grade and the station and elevation of the nearest PI.
G) If the bridge is on a vertical curve, use a profile grade diagram showing the grade back, grade ahead, the station and elevation of the PI, the length of the vertical curve, and the location of the structure. This diagram shall be titled "PROFILE GRADE". Refer to Fig. 6.5-1.

Note: Depth of structure shall be approximately 1 to 2 times the text

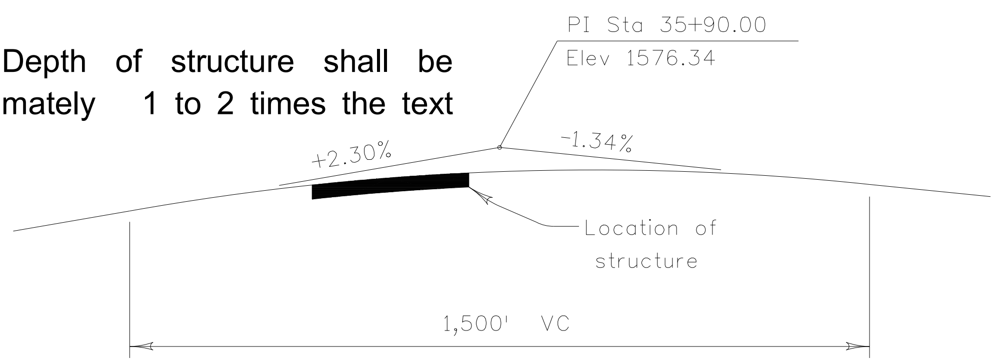


Figure 6.5-1 Typical Profile Grade Diagram

H) Show the pile, caisson, or spread footing drawn to the correct elevation, when applicable. Breaklines are acceptable.
I) Show the slope protection.

J) Show the "Existing Ground Line" (dashed) and indicate where located if other than where section is taken.

K) Note "fixed" or "expansion" bearings (F or E) at Piers and Abutments.

L) Show minimum actual vertical clearance to roadway or railroad below.

M) Show design high water elevation and verify from Hydraulics report.

N) On stream crossings, show the drainage area and design discharge if the Hydraulics section does not supply a "BRIDGE HYDRAULIC INFORMATION" drawing.

O) Channel changes and Roadway improvements shall be crosshatched and noted as “Unclassified Excavation (Included in Roadway Quantities)”.

P) Show approximate limits of scour.

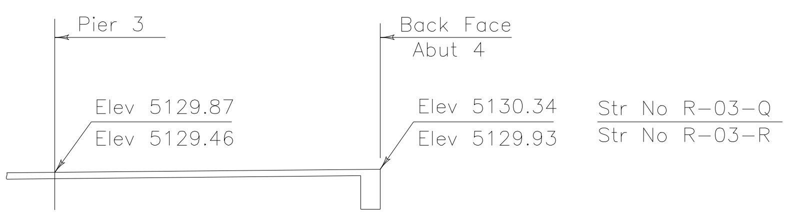
Q) Title the longitudinal section "<u>SECTION</u>" with a note immediately below giving the line where the section was taken; such as "Taken at Horizontal Control Line" or "Taken at Profile Line". If the section is outside of the bridge, label the view as “<u>ELEVATION</u>”.

R) For parallel structures of the same type, a single longitudinal section will suffice. This section, titled "<u>SECTION</u>" is taken for one structure with a note giving the line where the section was taken and the structure number. Also note that the parallel structure is similar.

Example: "Taken at Profile Line Str No R-03-Q, Str No R-03-R is similar except as noted."

Span lengths, elevations, and other features which differ will be shown and labeled for each structure.

S) When fencing limits or other aesthetics need to be shown, an elevation of the bridge may be preferred over a section.



Parallel structures of differing types will require a separate longitudinal section for each structure. The structure number will be included as part of the title such as "<u>SECTION STR NO R-03-Q</u>".

6.7 Typical Section

Typical section is not required for CBC's, unless it is non-standard or it needs to show additional details (waterproof membrane limits, side inlets, etc.). Showing the typical section is preferred.

Listed below are items to be shown in the Typical Section of this drawing (as applicable):

A) Width of curbs, sidewalks, traveled lanes, shoulders, etc. and total width out to out.
B) Label Projected Line or Horizontal Control Line.
C) Location of Profile Line.
D) Roadway slope or superelevation.
E) Show bridge rails or rub rail and indicate type. Show height of rub rail above traveled way.
F) Type of girder.
G) Structure depth.
   1) Prestressed girders and rolled beams; give depth of girder.
   2) Cast-in-place T-beams and box beams; give depth from top of concrete deck to bottom of beam.
   3) Welded plate girders; give depth of web.
   4) Parabolic girders of all types, give maximum and minimum depth.
H) Show portion of typical pier above the finished ground line, when applicable. Do not show abutment or pier dimensions.
I) For parallel structures, show a section for each structure.
J) Show Conduits and Utilities. Identify which conduits are for future use.
K) Show limits of Structural Concrete Coating, Stains or other aesthetics.
L) Show Fence Chain Link or pedestrian railing, with height.
M) Show Hot Mix Asphalt and Waterproofing Membrane, or Polyester Concrete overlay as appropriate.
N) Title "<u>TYPICAL SECTION</u>".

6.8 Title Block

The title block shall be titled "GENERAL LAYOUT". The primary structure number or numbers and the first initial and last name of the designer and detailer shall be filled in on each sheet, i.e. structures with general layouts of their own need not be included in the border list.

If two sheets are used, the first sheet shall be called "GENERAL LAYOUT" and the second sheet shall be titled as appropriate, e.g. "TYPICAL SECTION".

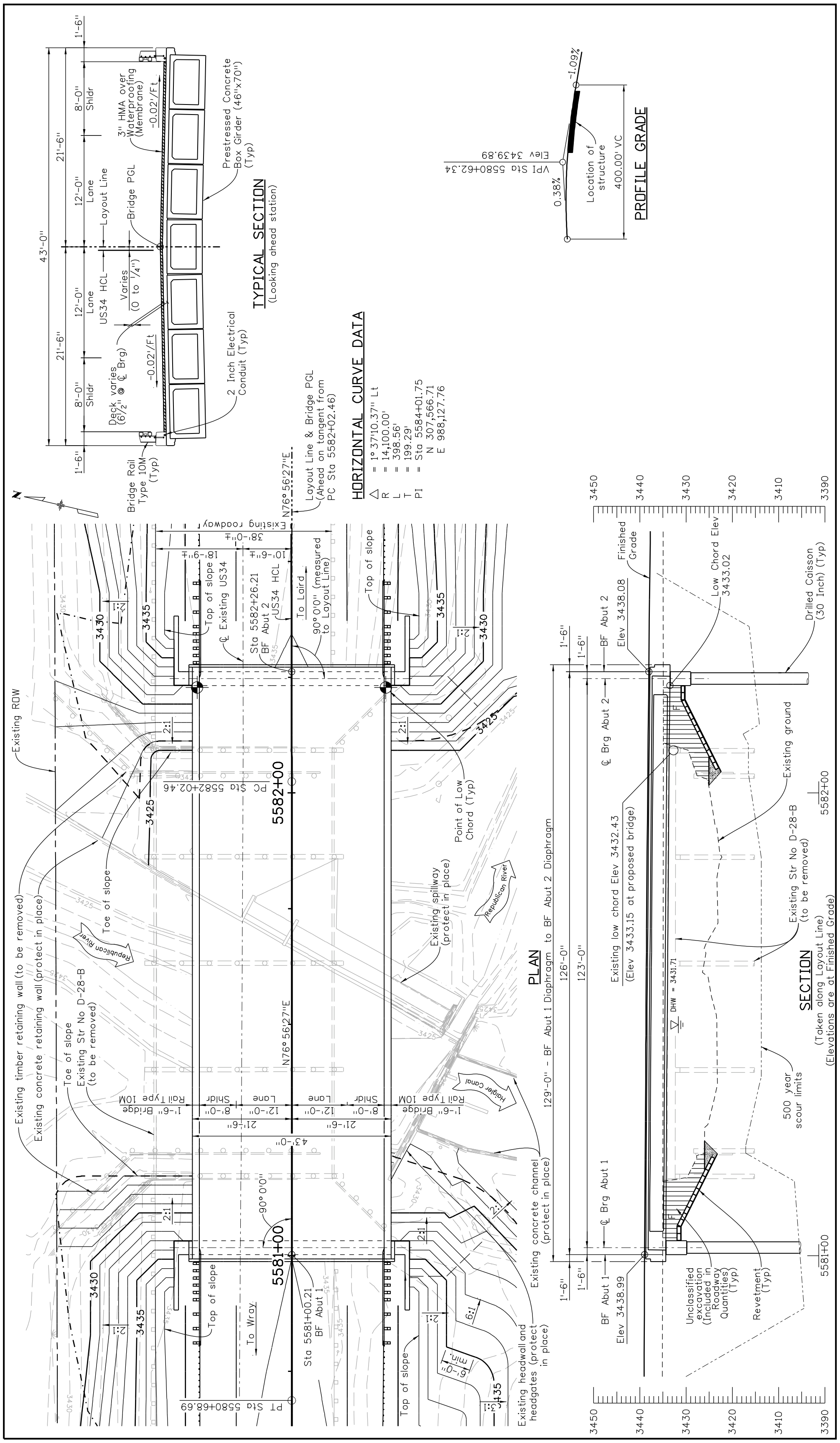
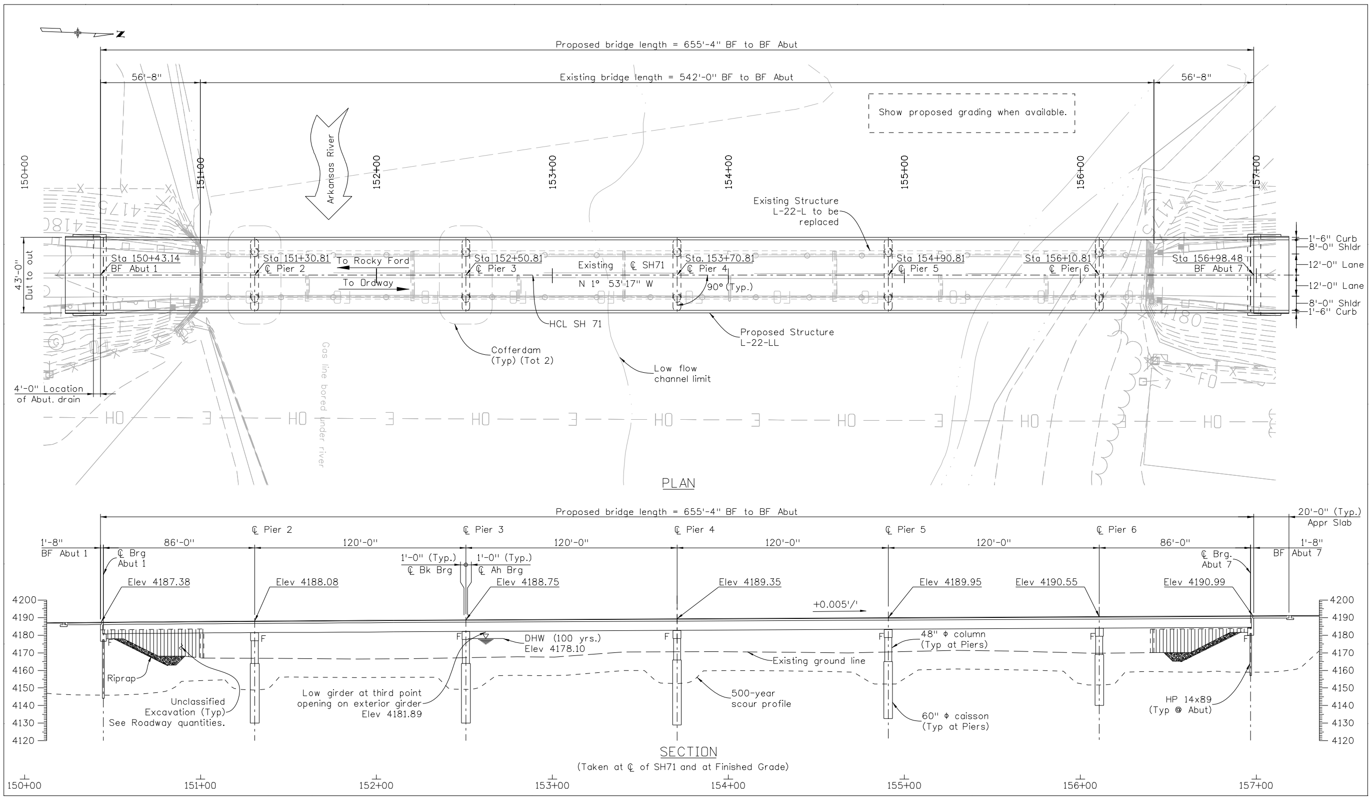


Figure 6-1 Example



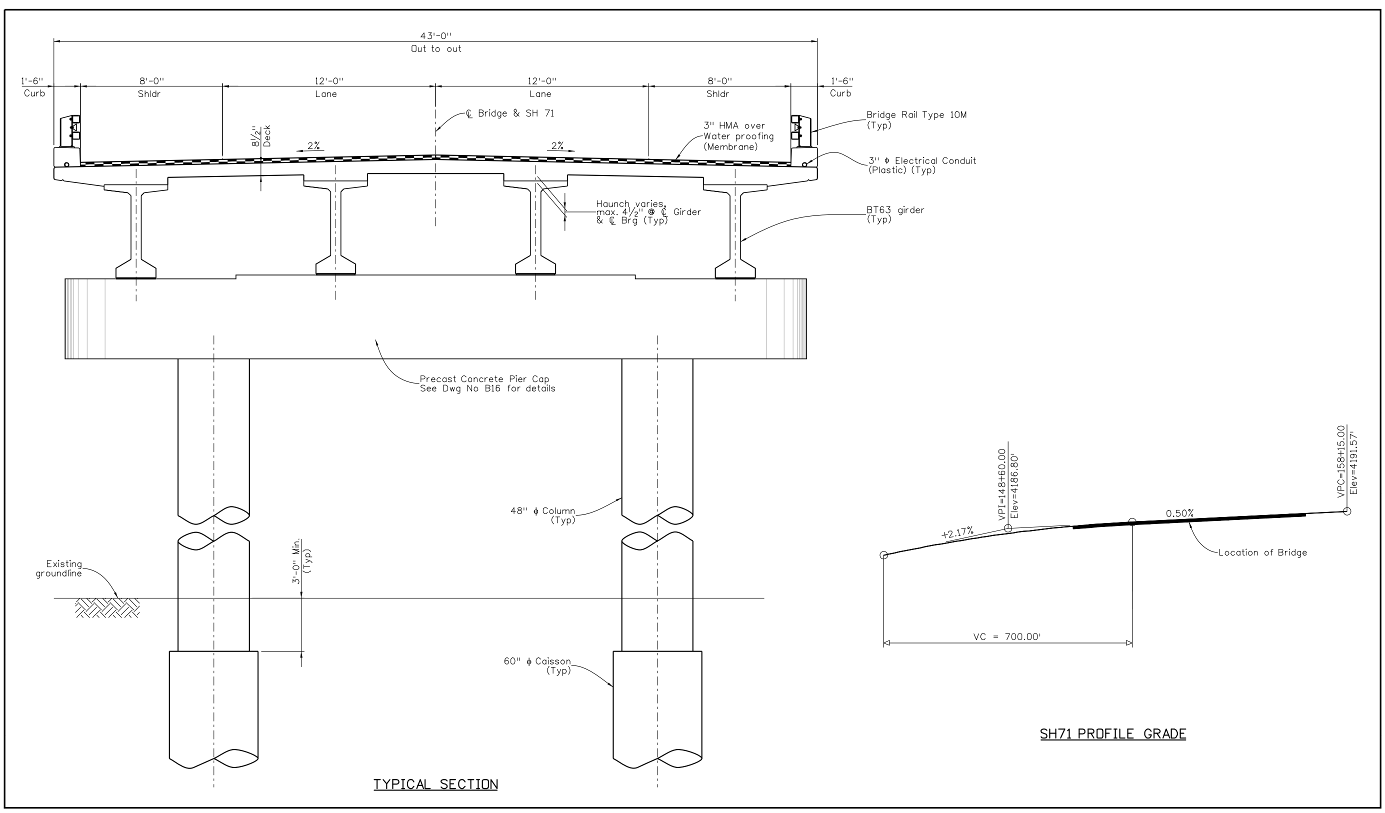


Figure 6-2 Example

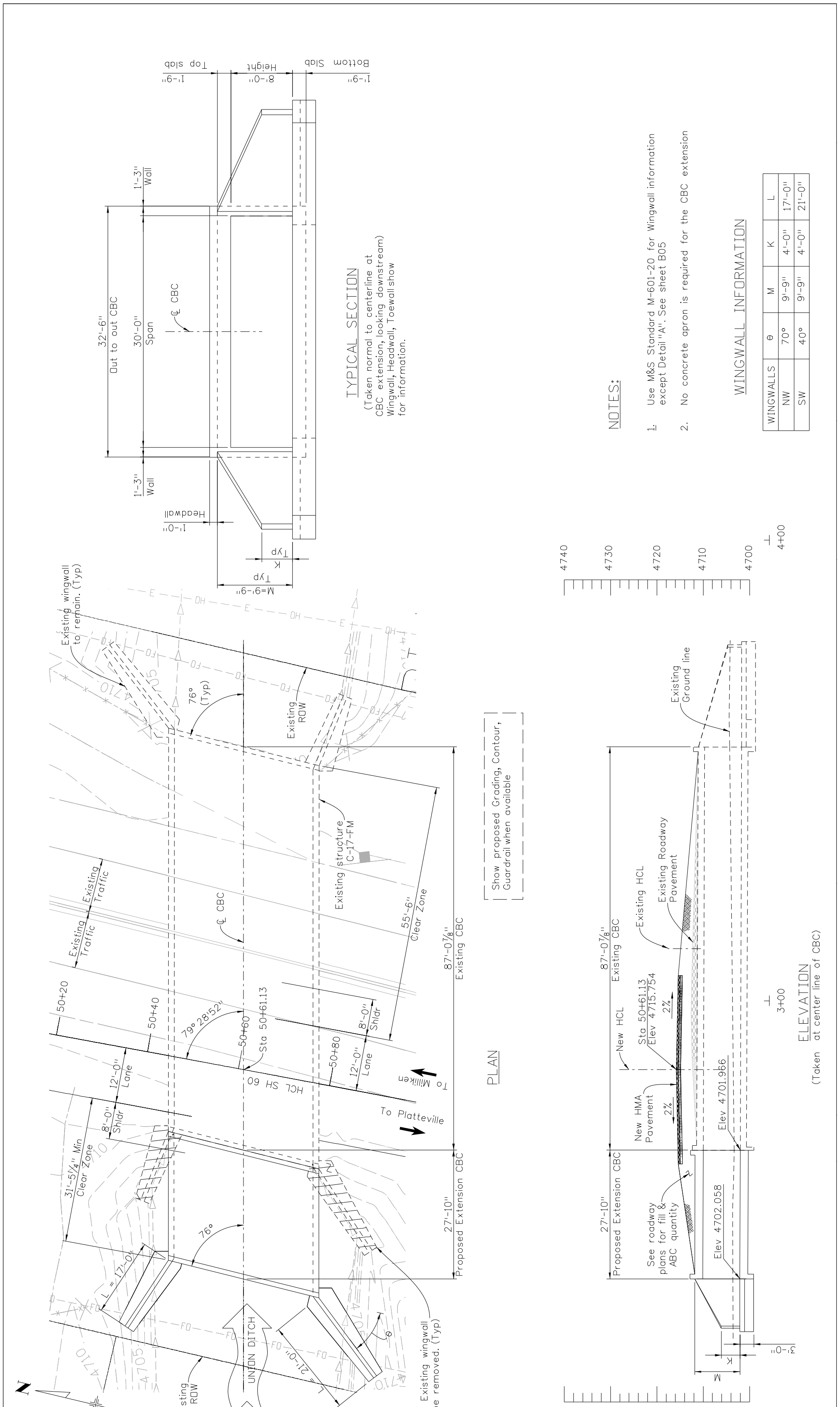
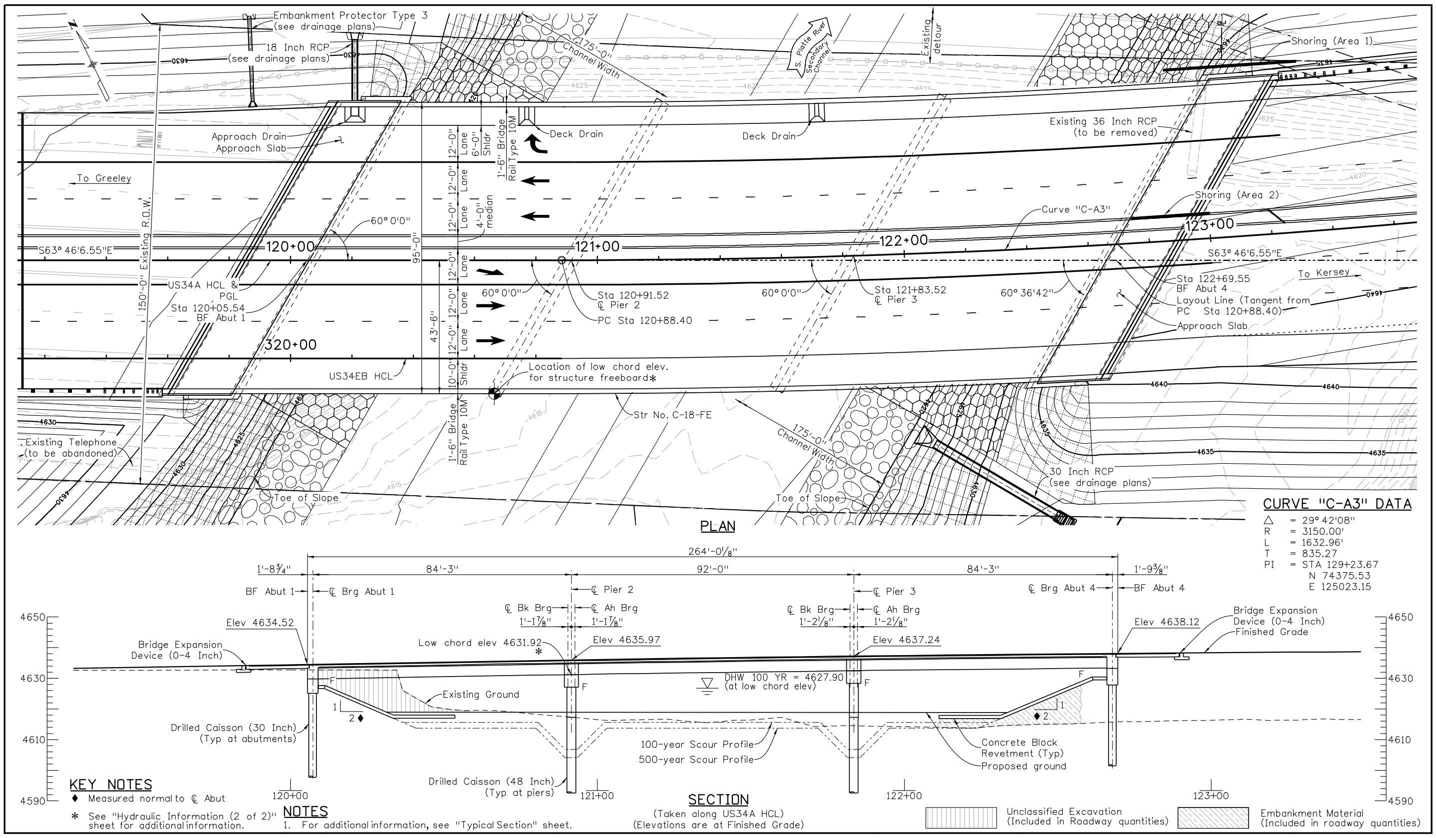


Figure 6-3 Example



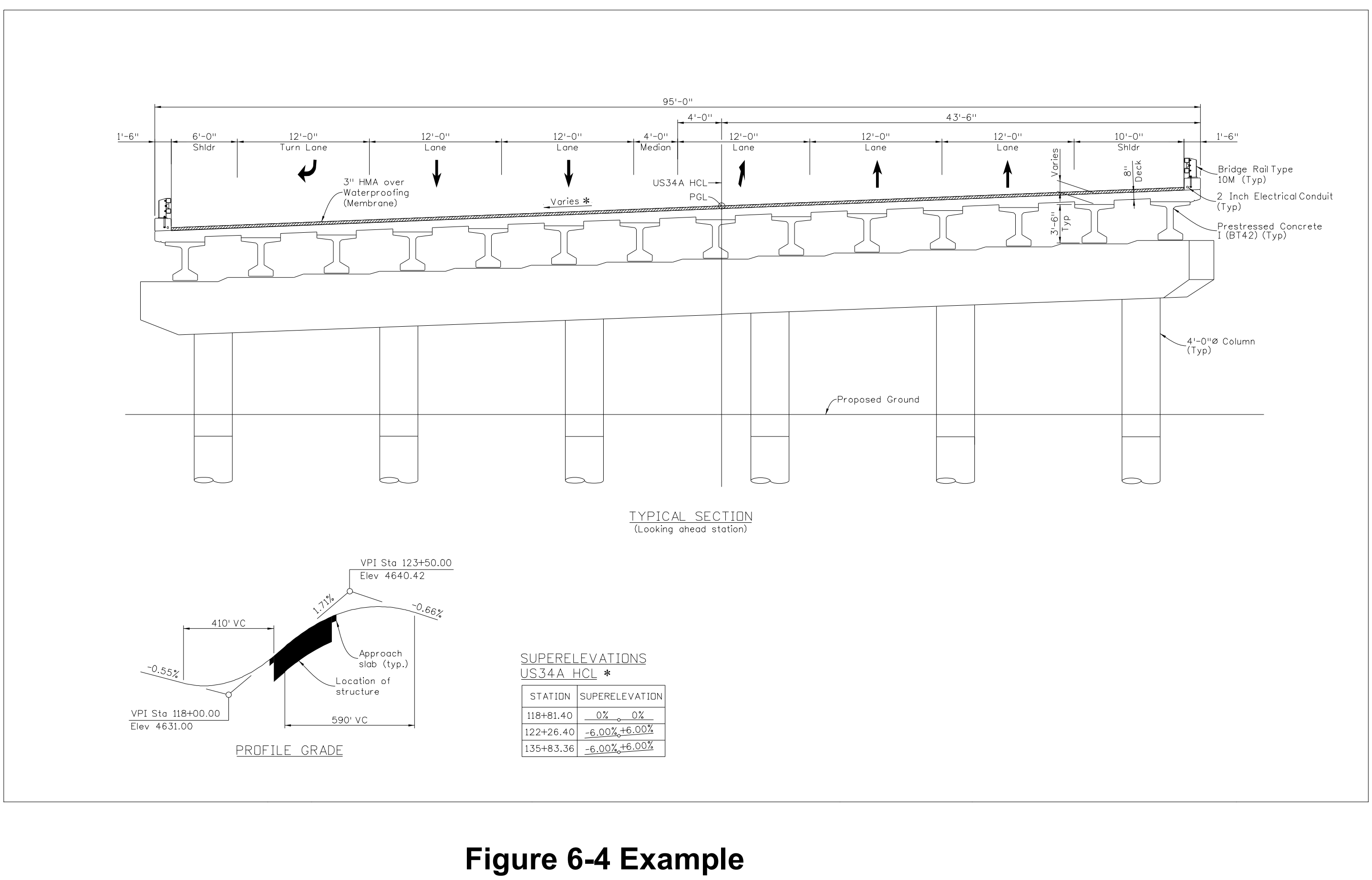
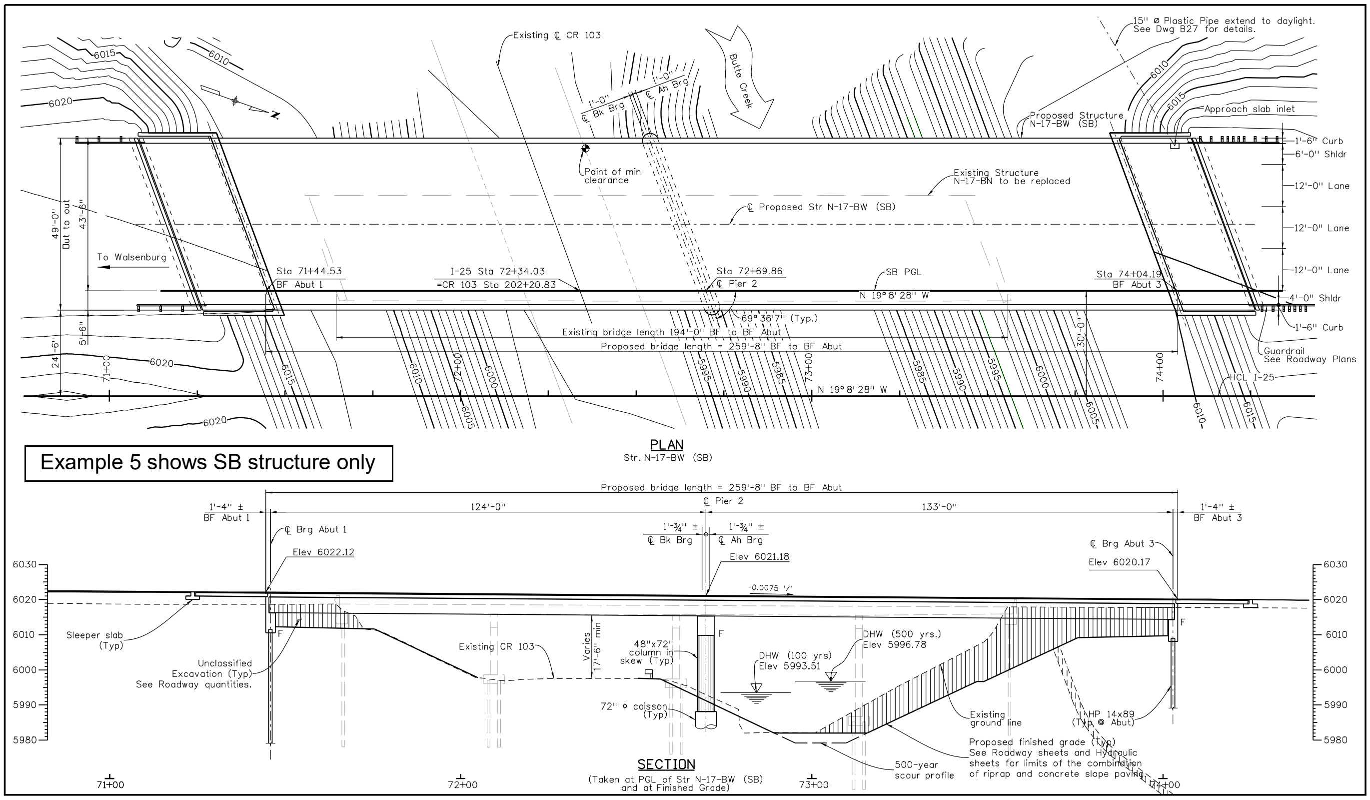


Figure 6-4 Example



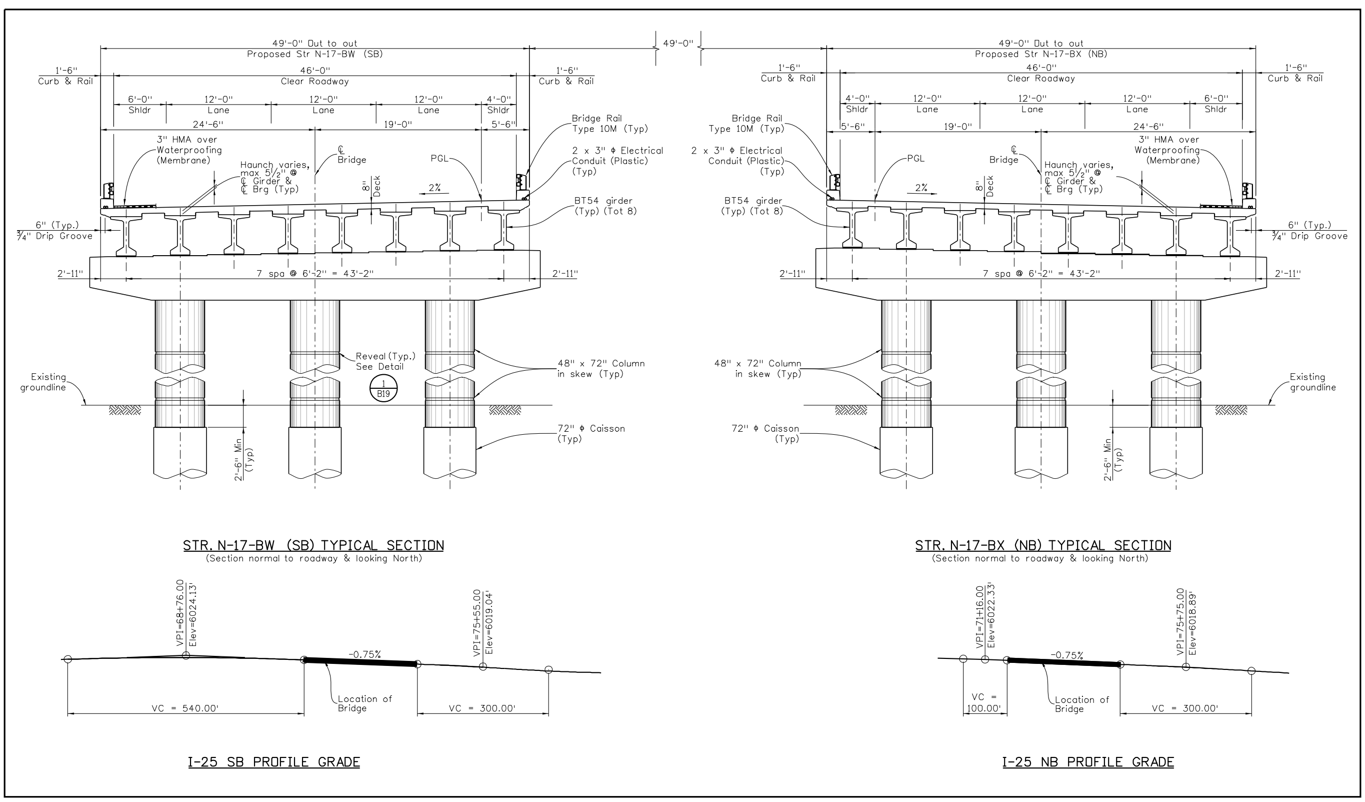
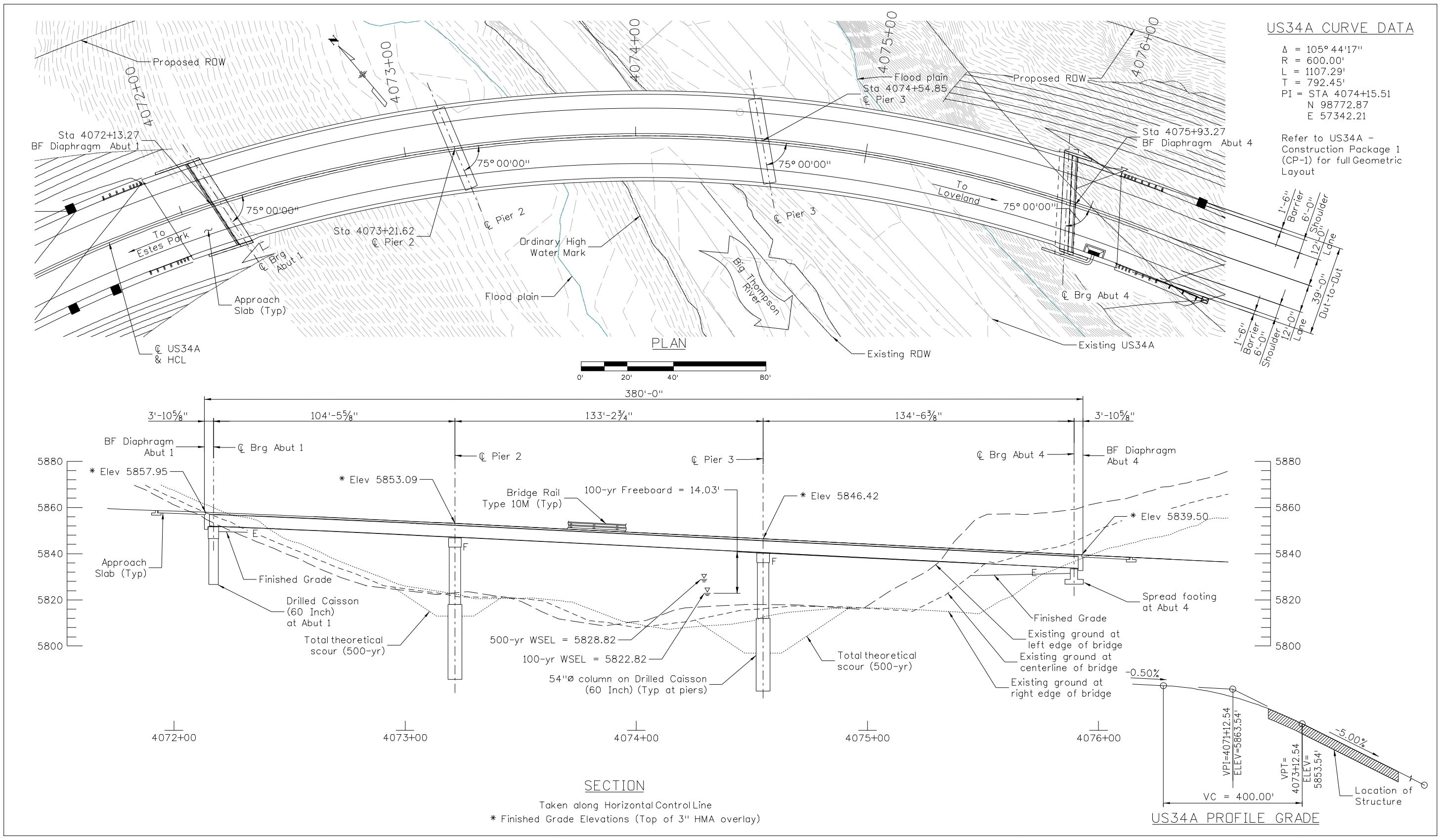


Figure 6-5 Example



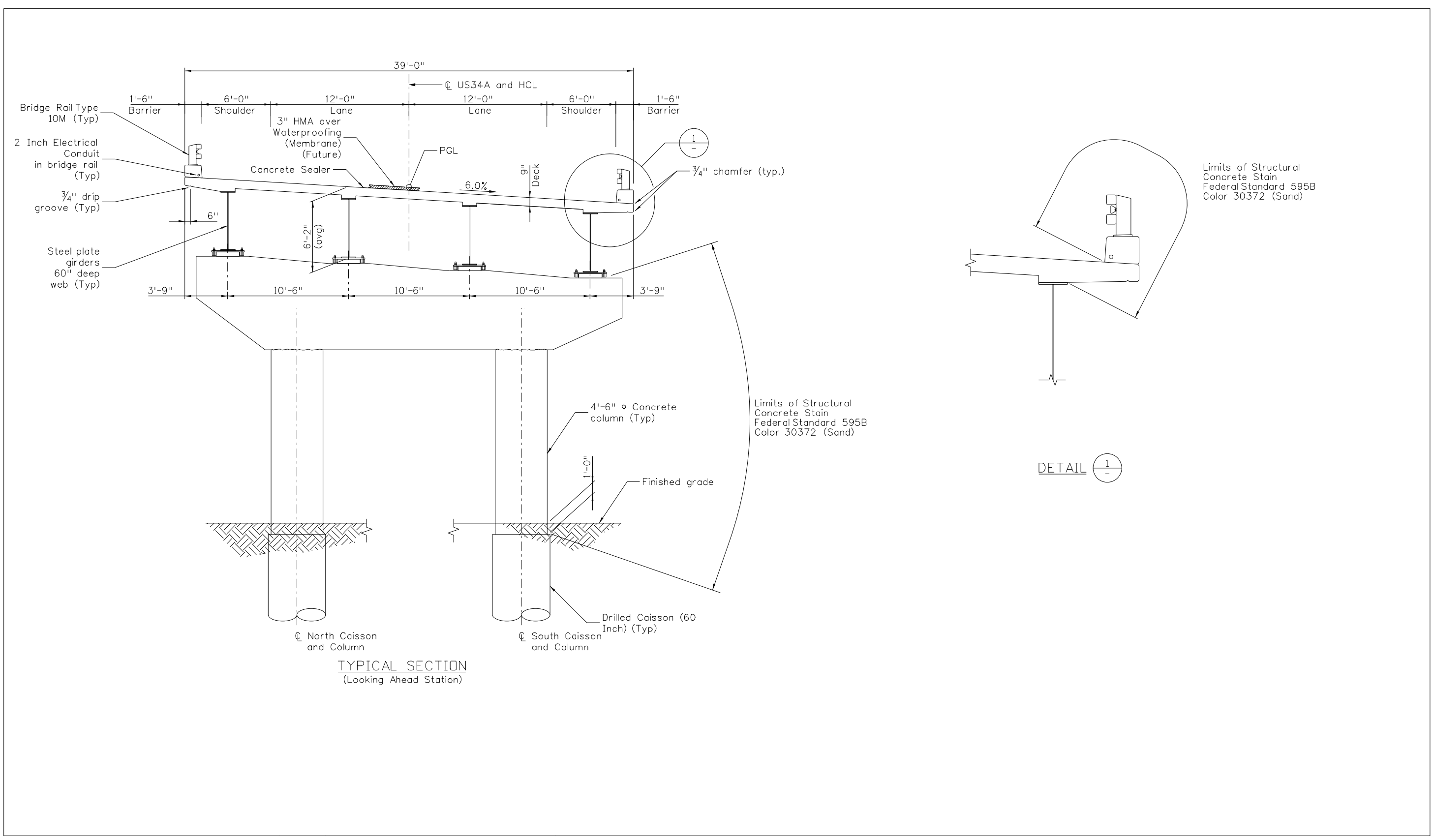
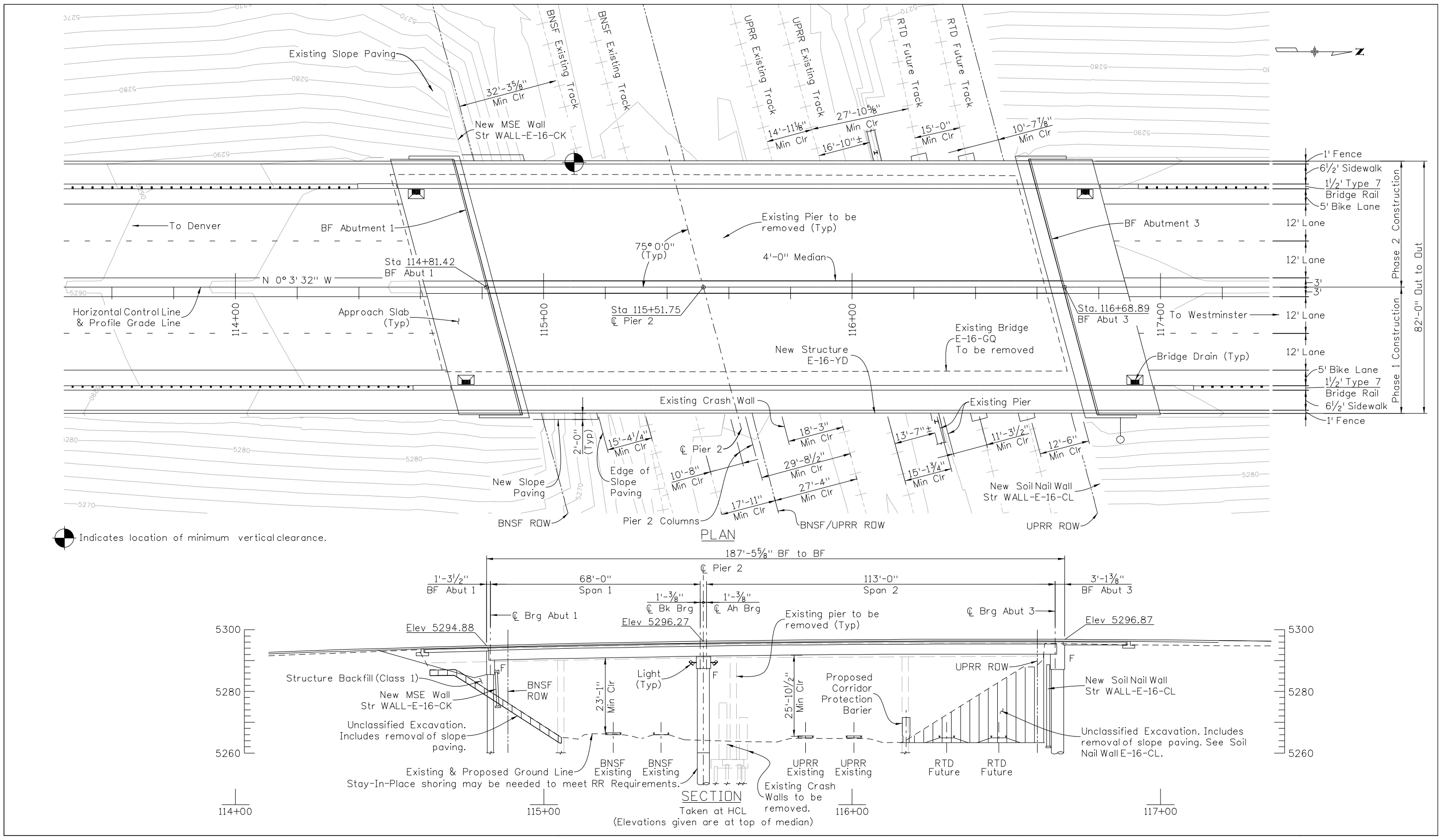


Figure 6-6 Example



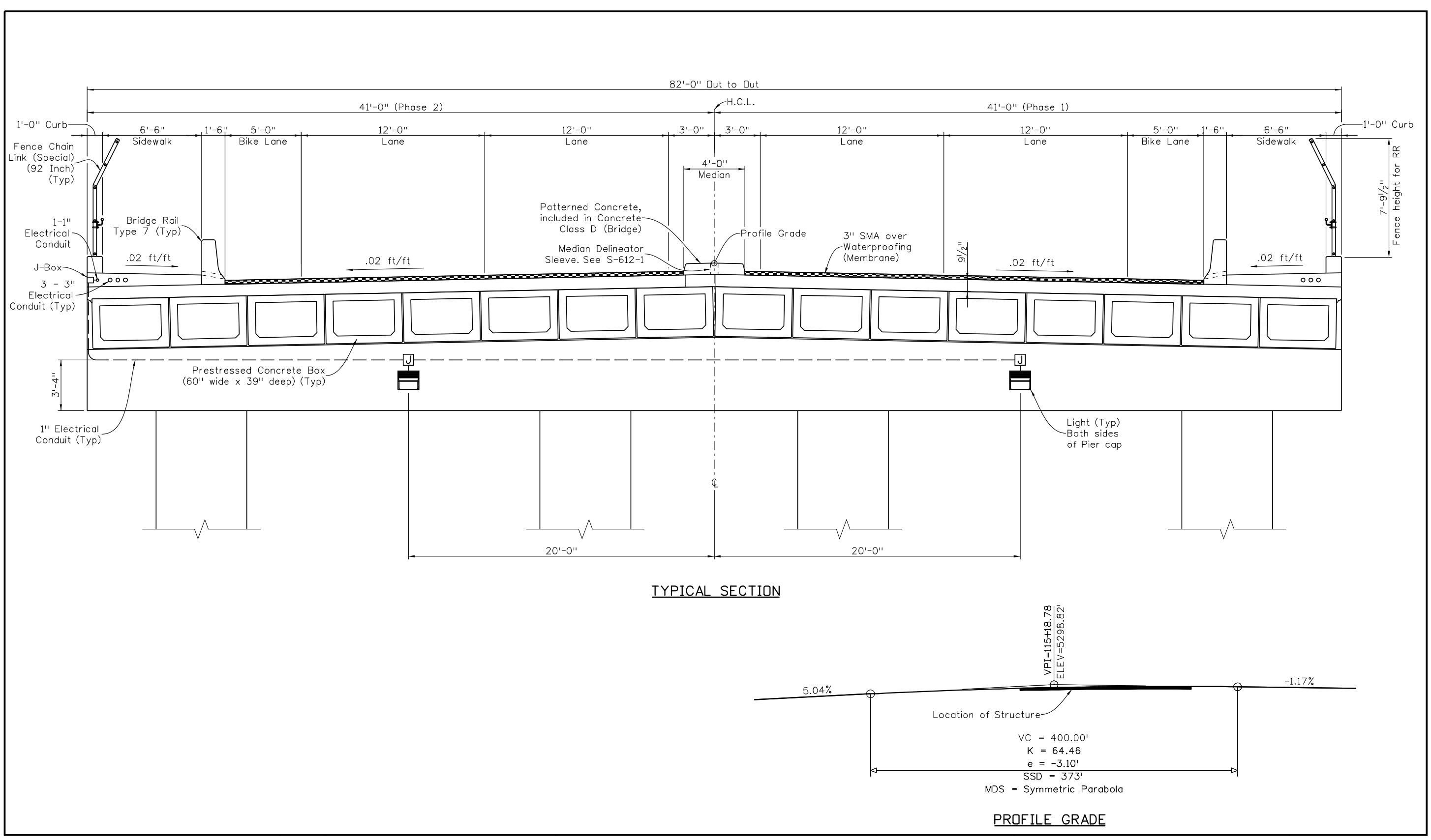


Figure 6-7 Example

Engineering Geology

7.1 Purpose

The purpose of this drawing is to give a graphic portrayal of the geological conditions at the site of the structure (bridge, culvert, wall, etc.). This drawing is used to illustrate the outline, stationing, and location of the structure, the locations and results of test borings and proposed elevations of footing, piling or caissons.

7.2 Responsibility

This drawing is prepared by the Geotechnical Engineer or Engineering Geologist of record, typically the CDOT Soils & Geotechnical Services or a Geotechnical Consultant. It shows the foundation data from the field investigation. The responsibility for the accuracy of the geological information presented on this drawing rests with the Geotechnical Engineer or Engineering Geologist.

7.3 Scales

Suggested zoom scales for presenting the Plan and Elevation views in paper space are as follows: 1” = 30’, 1” = 40’, 1” = 50’, 1” = 60’. For longer walls, a smaller scale may be used.

7.4 Plan and Elevation

Whether a Geotechnical Consultant firm or CDOT Soils & Geotechnical Services is preparing the Engineering Geology sheet, a copy of the electronic file of the structure’s General Layout (plan, longitudinal section, and typical transverse section), drawn at the correct project coordinates, shall be shared with them for their use.

The detailer may use the bridge worksheet B-GEO-1 Engineering Geology for assistance.

7.5 Check Items

Listed below are items that must be checked to see that they appear on the drawing.

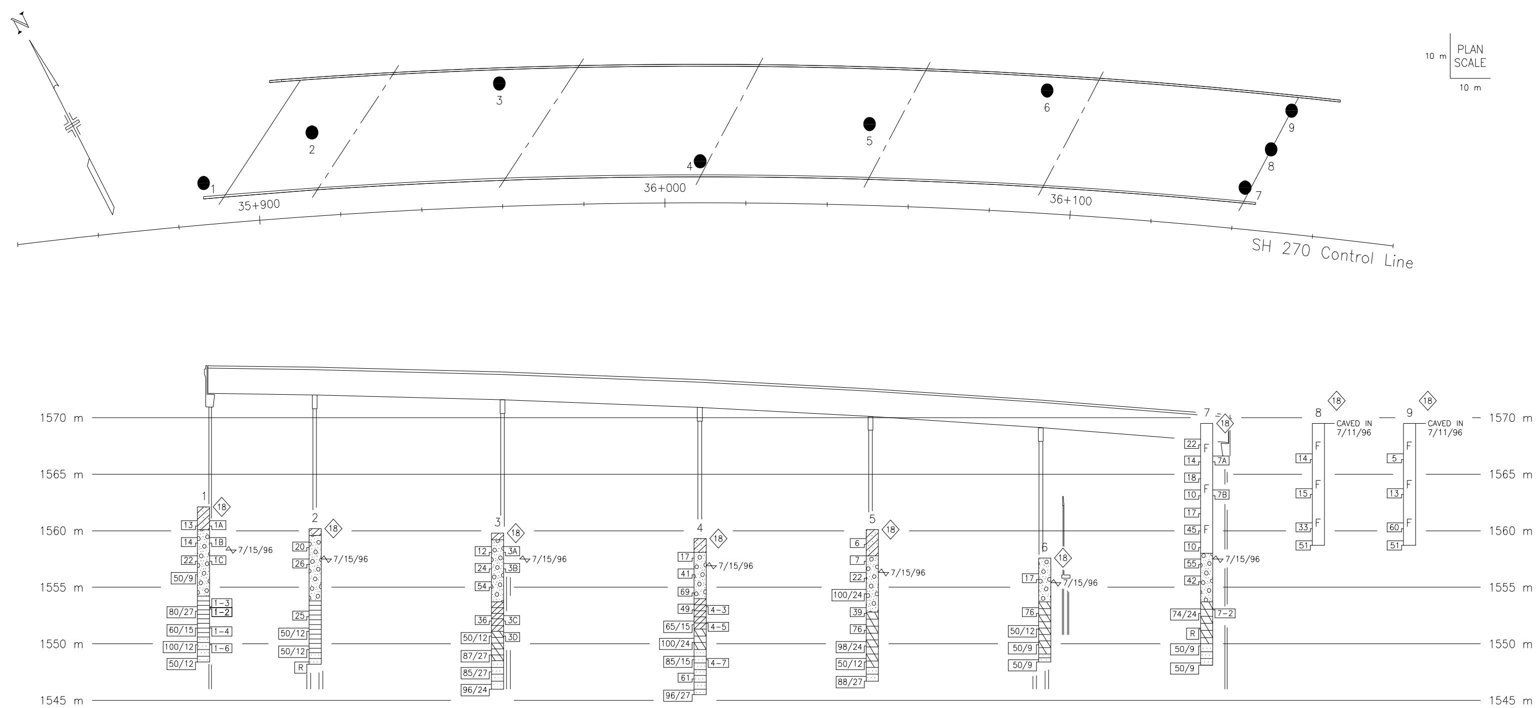
A) Standard North Arrow.
B) Show the outline of the structure in both the Plan and Elevation views.
C) Show footings on the Elevation view, at their correct elevations.
D) Show piling and caissons, on the Elevation view, to their correct tip elevations.
E) Stations along Station Line.
F) Elevation reference on both left and right sides of the Elevation view.

G) Station Line terminology (Survey Line, Projected Line, etc.).
H) Project and Subaccount Number.
I) Check title block for information indicated in Section 7.6.
J) Initial and date blocks filled in.

7.6 Title Block

This drawing is titled “ENGINEERING GEOLOGY”. The feature intersected should be shown under “Engineering Geology”.

The structure number or numbers and the first initial and last name of the Geologist and the person preparing the drawing shall be filled in.

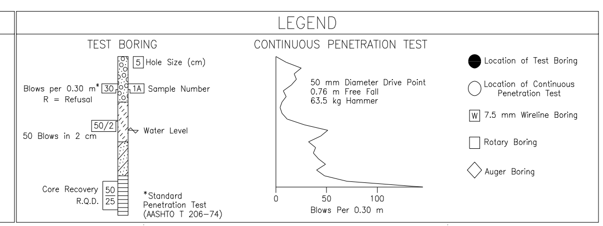


SUMMARY OF TEST RESULTS												
Sample Number	Depth (meters)	Classification		Grading Analysis (AASHTO) Percent				Atterberg Limits			Water Content w %	Dry Unit Weight γ kg/m³
		Corps of Engrs. or Visual	AASHTO	Gravel	Coarse Sand	Fine Sand	Silt and Clay	Liquid Limit L_W	Plastic Limit P_W	Plastic Index I_W		
1A	1.2–1.7	Sandy Clay	A–7–6(15)	4	4	28	64	47	20	27	9.2	
1B	2.7–3.2	Sand	A–3(0)	7	33	56	4	NV	NP	NP	1.6	
1C	4.3–4.7	Silty Sand	A–2–4(0)	10	34	38	18	NV	NP	NP	16.0	
3A	1.2–1.7	Gravelly Sand	A–1–b(0)	27	39	30	4	NV	NP	NP	0.1	
3B	2.7–3.2	Gravelly Sand	A–1–b(0)	24	37	33	6	NV	NP	NP	14.4	
3C	7.3–7.8	Sandy Clay	A–7–6(17)	0	3	21	76	45	23	22	20.1	
3D	8.8–9.1	Clay	A–7–6(22)	0	3	9	88	47	24	23	16.0	
7A	2.9–3.4	Sandy Clay	A–6(4)	18	13	25	44	40	23	17	12.4	
7B	5.9–6.4	Gravelly Sandy Clay	A–6(3)	22	20	18	40	37	19	18	10.4	
7C	12.0–12.2	Sandy Gravel	A–1–a(0)	67	14	14	5	NV	NP	NP	1.4	
1–2	8.9–9.0	Clay	A–6(15)	0	2	16	82	40	22	18	18.6	
1–3	8.8–8.9	Clay	A–7–6(19)	0	1	9	90	42	22	20	19.8	
1–4	10.6–10.7	Clay	A–7–6(21)	3	3	7	87	47	25	22	16.7	
1–6	12.1–12.2	Sandy Clay	A–4(1)	0	1	47	52	29	24	5	19.3	
4–3	5.9–6.0	Clay	A–6(15)	0	0	5	95	39	25	14	20.3	
4–5	7.4–7.5	Clay	A–7–6(21)	0	0	6	94	44	24	20	14.7	
4–8	10.6–10.7	Sandy Silt	A–4(0)	0	2	57	41	NV	NP	NP	18.1	
7–2	16.6–16.7	Clay	A–7–5(30)	0	0	3	97	56	30	26	21.9	

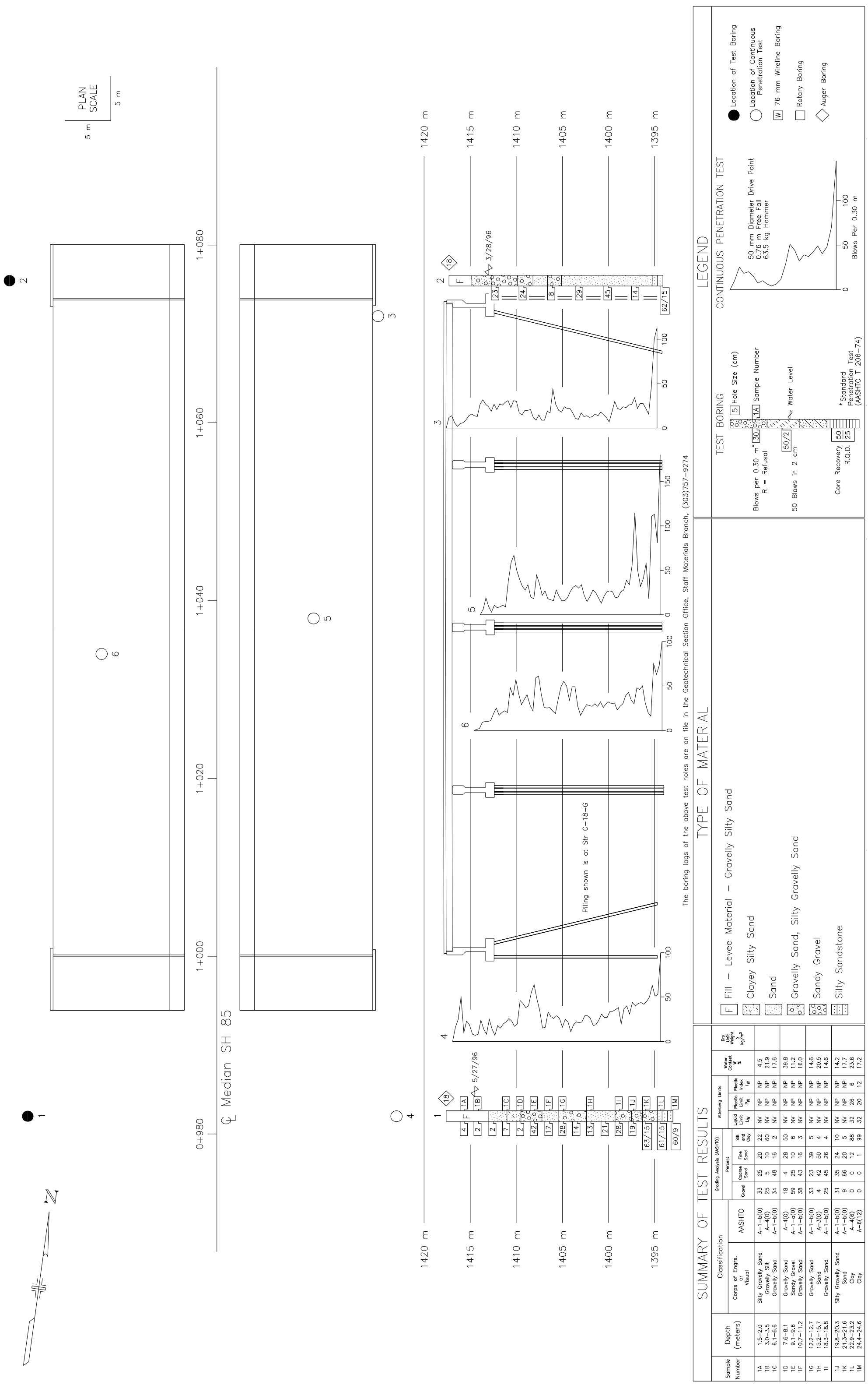
The boring logs of the above test holes are on file in the Geotechnical Section Office, Staff Materials Branch, (303)757–9274

TYPE OF MATERIAL

F Embankment Fill – Sandy Clay
Clayey Sand / Sandy Clay
Gravelly Sand / Sandy Gravel
Bedrock – Claystone
Bedrock – Silty Shale / Claystone
Bedrock – Silty Shale
Bedrock – Sandstone / Shale



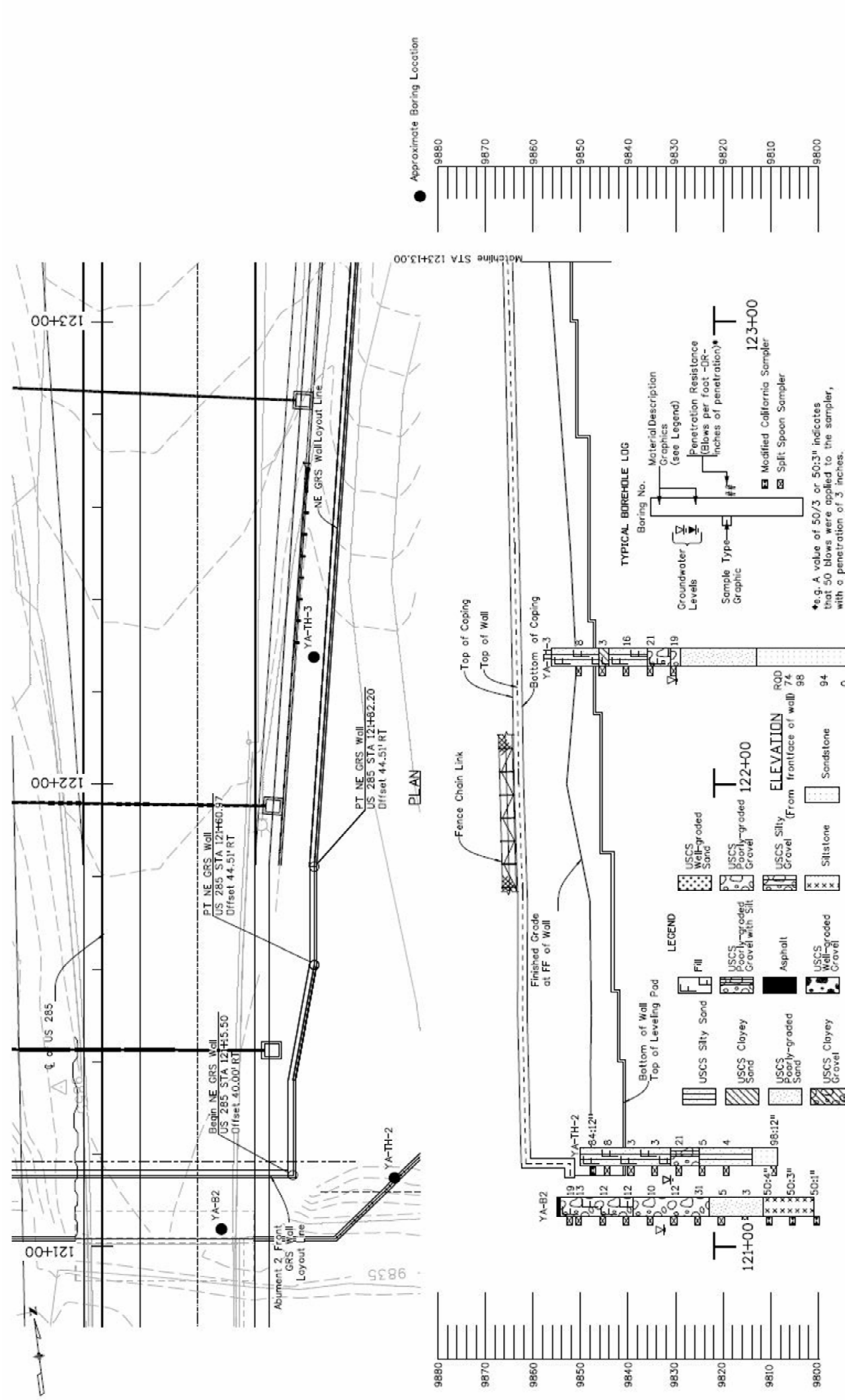
Example 7-1



SUMMARY OF TEST RESULTS

Sample Number	Depth (meters)	Classification: Corps of Engrs. or Visual	Classification: AASHTO	Grading Analysis (AASHTO) Percent: Gravel	Coarse Sand	Fine Sand	Silt and Clay	Atterberg Limits: Liquid Limit L_W	Plastic Limit P_W	Plastic Index I_W	Water Content W %	Dry Unit Weight γ kg/m³
1A	1.5–2.0	Silty Gravelly Sand	A–1–b(0)	33	25	20	22	NV	NP	NP	4.5	
1B	3.0–3.5	Gravelly Silt	A–4(0)	25	5	10	60	NV	NP	NP	21.9	
1C	6.1–6.6	Gravelly Sand	A–1–b(0)	34	48	16	2	NV	NP	NP	17.6	
1D	7.6–8.1	Gravelly Sand	A–4(0)	18	4	28	50	NV	NP	NP	39.8	
1E	9.1–9.6	Sandy Gravel	A–1–a(0)	59	25	10	6	NV	NP	NP	11.2	
1F	10.7–11.2	Gravelly Sand	A–1–b(0)	38	43	16	3	NV	NP	NP	16.0	
1G	12.2–12.7	Gravelly Sand	A–1–b(0)	33	23	39	5	NV	NP	NP	14.6	
1H	15.2–15.7	Sand	A–3(0)	4	42	50	4	NV	NP	NP	20.5	
1I	18.3–18.8	Gravelly Sand	A–1–b(0)	25	45	26	4	NV	NP	NP	14.6	
1J	19.8–20.3	Silty Gravelly Sand	A–1–b(0)	31	35	24	10	NV	NP	NP	14.2	
1K	21.3–21.6	Sand	A–1–b(0)	9	66	20	5	NV	NP	NP	17.7	
1L	22.9–23.2	Clay	A–4(6)	0	0	12	88	32	26	6	23.6	
1M	24.4–24.6	Clay	A–6(12)	0	0	1	99	32	20	12	17.2	

Example 7-2



Approximate Boring Location
PLAN
ELEVATION
(From frontface of wall)
TYPICAL BOREHOLE LOG
LEGEND
Begin NE GRS Wall
US 285 STA 121+15.50
Offset 40.00' RT
PT NE GRS Wall
US 285 STA 121+60.97
Offset 44.51' RT
PT NE GRS Wall
US 285 STA 121+82.20
Offset 44.51' RT
NE GRS Wall Layout Line
Abutment 2 Front of GRS Wall Layout Line
Matchline STA 123+13.00
Fence Chain Link
Top of Coping
Top of Wall
Bottom of Coping
Finished Grade at FF of Wall
Bottom of Wall
Top of Leveling Pad
Boring No.
Material Description Graphics (see Legend)
Penetration Resistance (Blows per foot -OR- inches of penetration)*
Groundwater Levels
Sample Type Graphic
Modified California Sampler
Split Spoon Sampler
*e.g. A value of 50/3 or 50:3" indicates that 50 blows were applied to the sampler, with a penetration of 3 inches.
USCS Silty Sand
USCS Clayey Sand
USCS Poorly-graded Sand
USCS Clayey Gravel
Fill
USCS Poorly-graded Gravel with Silt
Asphalt
USCS Well-graded Gravel
USCS Well-graded Sand
USCS Poorly-graded Gravel
USCS Silty Gravel
Siltstone
Sandstone
121+00
122+00
123+00
YA-B2
YA-TH-2
YA-TH-3
US 285

Example 7-3

8.1 Purpose

This drawing or set of drawings, is to indicate all pertinent hydraulic information necessary in the design of a structure or structures at a given location.

8.2 Responsibility

This drawing is prepared by the Hydraulic Section or a Hydraulics Consultant. The responsibility for the accuracy of the hydraulic information presented on this drawing rests with the Hydraulics Engineer.

8.3 Check Items

Listed below are items to be checked in reviewing this drawing.

A) Net and excavated channel width and elevation.
B) Riprap limits, size, thickness, and upper and lower riprap elevations.
C) Design year and 500 year scour lines.
D) Highwater surface elevations (500, 100 year flood).
E) Centerline of channel and direction of flow.

See CDOT Drainage Design Manual (chapters 4, 9 and 10) for additional information.

8.4 Title Block

This drawing is titled “BRIDGE HYDRAULIC INFORMATION”, and shall be so indicated in the title block. In addition to the above, the following information shall be placed in the proper locations of the title block:

A) Initials of, or first initial and last name of the Designer and Detailer preparing the drawing.
B) Structure Number or Numbers.
C) Bridge drawing number.

8.5 Additional Details

There may be instances when additional details are required, such as bank protection, channel changes, etc. If possible, these details should be shown on this drawing; however, if additional drawings are required, they should directly follow the “BRIDGE HYDRAULIC INFORMATION” drawing.

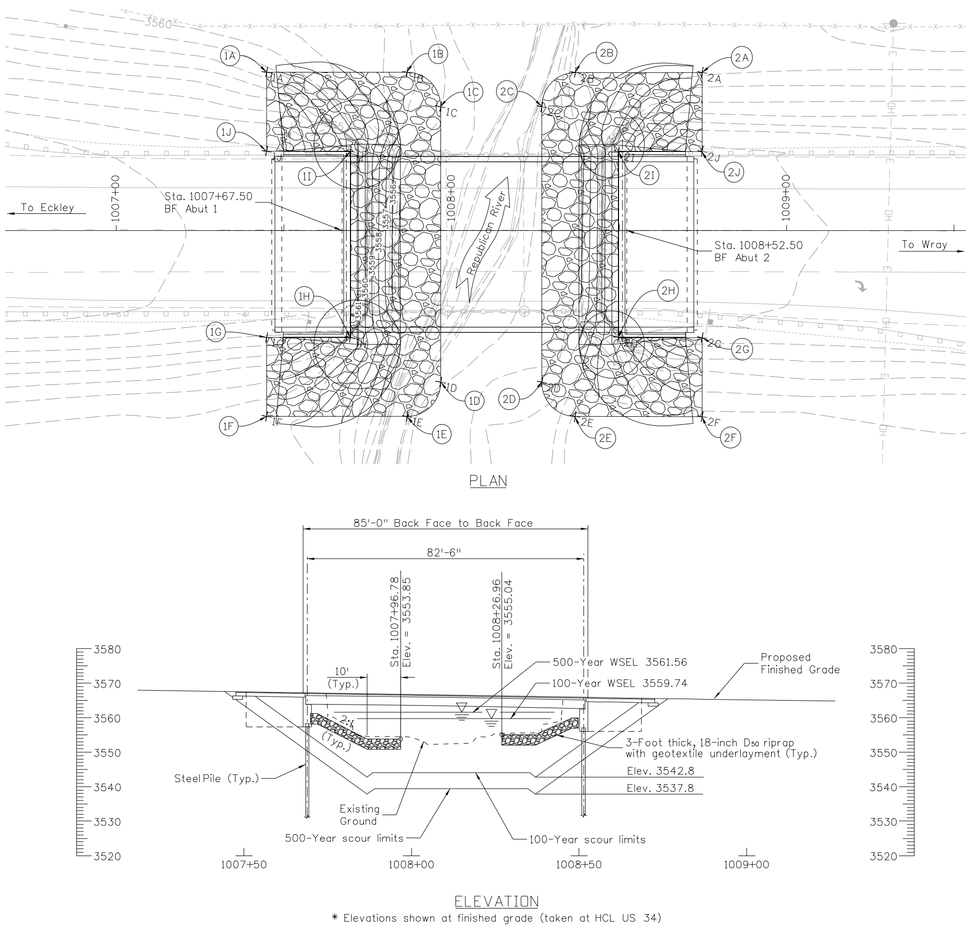


TABLE OF RIPRAP LOCATIONS

Position Label (XX)	Northing	Easting
1A	1287033.527	3905430.614
1B	1287040.624	3905471.946
1C	1287032.460	3905483.494
1D	1286953.842	3905496.993
1E	1286942.294	3905488.829
1F	1286935.197	3905447.497
1G	1286957.757	3905443.624
1H	1286961.993	3905468.255
1I	1287015.190	3905459.121
1J	1287010.967	3905434.488
2A	1287055.523	3905558.723
2B	1287049.115	3905521.403
2C	1287037.567	3905513.239
2D	1286958.949	3905526.738
2E	1286950.785	3905538.286
2F	1286957.193	3905575.606
2G	1286979.753	3905571.733
2H	1286975.531	3905547.100
2I	1287028.690	3905537.972
2J	1287032.963	3905562.597

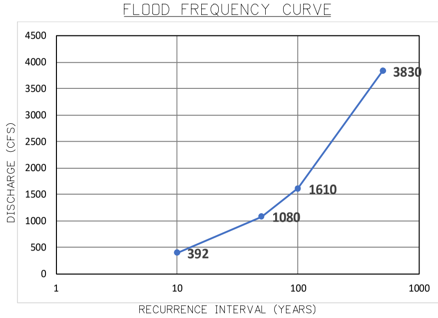
NOTES

1. All riprap slopes are 2:1 (perpendicular to abutment).
2. The contractor is responsible for any and all cost associated with the installation of the riprap; including, but not limited to, dewatering. The cost for the installation will not be measured or paid for separately but included in the cost of riprap.
3. See roadway plans for riprap, geotextile, and unclassified excavation quantities.

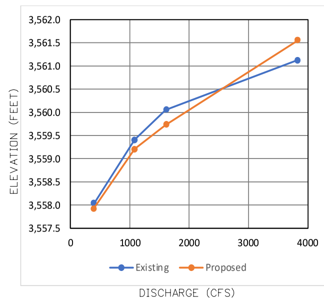
Example 8-1

BRIDGE HYDRAULIC INFORMATION

FLOOD FREQUENCY CURVE



STAGE - DISCHARGE CURB



COMPARISON OF HYDRAULICS DURING 100-YEAR EVENT

TYPE	VELOCITY (FPS)	FREEBOARD (FT)	WS ELEV. (FT)
EXISTING	5.35	2.36	3560.06
PROPOSED	6.19	2.68	3559.74

* REQUIRED FREEBOARD = 1.22 FT

COMPARISON OF HYDRAULICS DURING 500-YEAR EVENT

TYPE	VELOCITY (FPS)	FREEBOARD (FT)	WS ELEV. (FT)
EXISTING	5.71	1.29	3561.13
PROPOSED	5.78	0.86	3561.56

NOTE: WSEL FROM LOCATION OF MAXIMUM BACKWATER

SCOUR ANALYSIS RESULTS

TYPE	DEPTH (FT)	
	100-YEAR	500-YEAR
CONTRACTION SCOUR	7.7	12.3
ABUTMENT SCOUR	8.9	13.9
TOTAL SCOUR	8.9	13.9
SCOUR ELEV. (NAVD-88)	3542.8	3537.8

100-YEAR RECURRENCE INTERVAL

FLOW UPSTREAM OF BRIDGE: = 1610 CFS

DRAINAGE AREA: = 645 Sq Mi

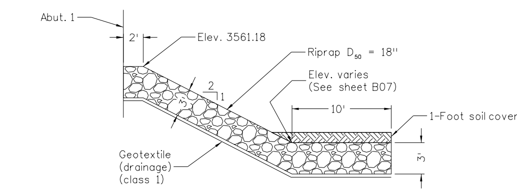
CHANNEL DESCRIPTION

BOTTOM MATERIAL SIZE: = CLAY☐ SILT☒ SAND☒ GRAVEL☐ COBBLES☐ OTHER ____

STREAM FORM: = STRAIGHT☐ MEANDERING☒ BRAIDED☐

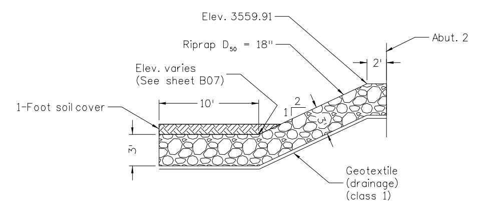
MANNING'S "n" FOR DESIGN: CHANNEL 0.030 OVERBANK 0.035

DEBRIS POTENTIAL: LOW



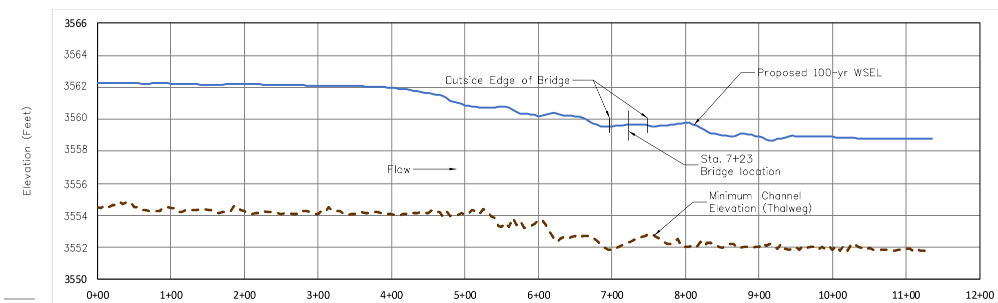
RIPRAP GEOMETRY DETAIL

ABUTMENT 1
N.T.S.



RIPRAP GEOMETRY DETAIL

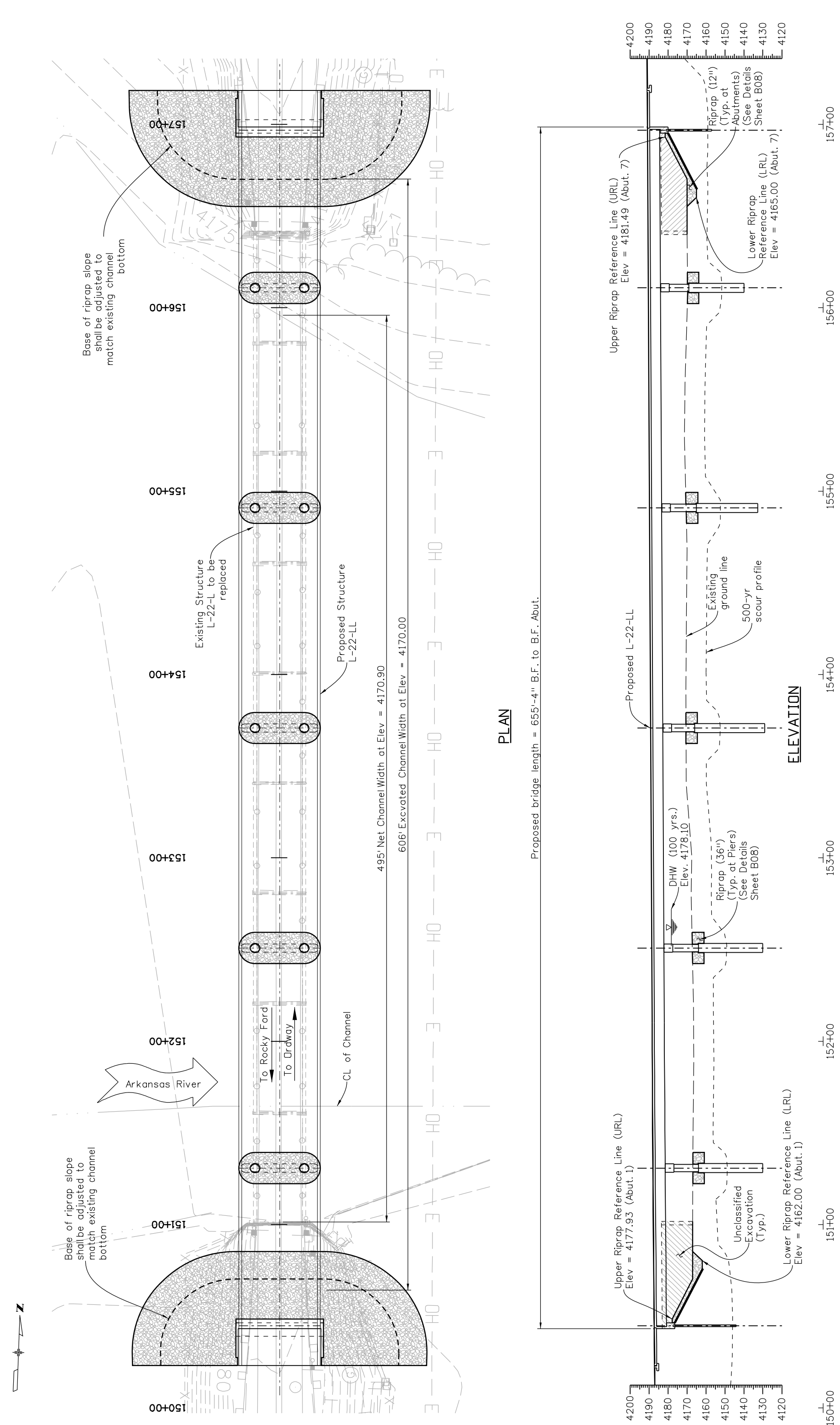
ABUTMENT 2
N.T.S.



CL CHANNEL (REPUBLICAN RIVER)

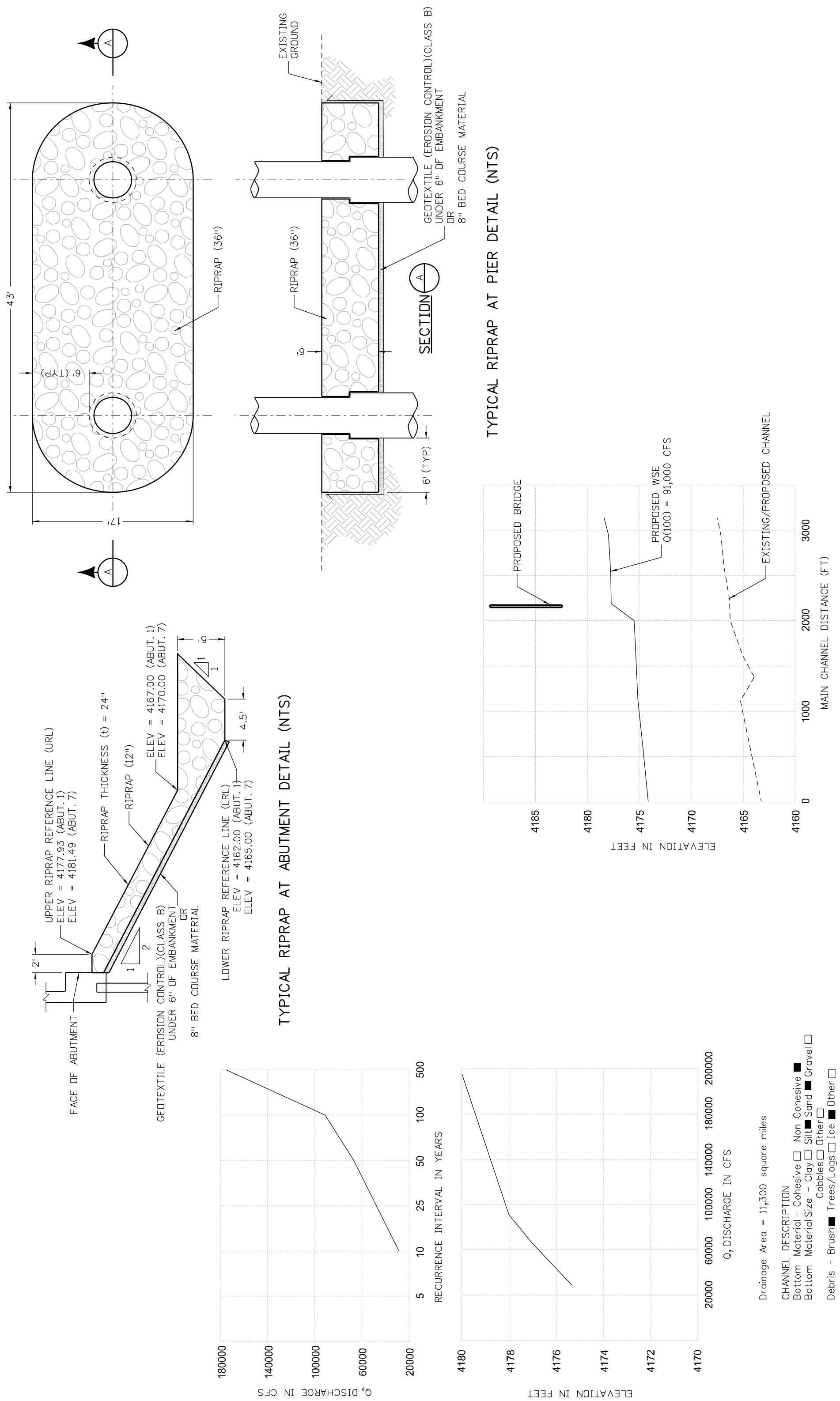
N.T.S.

Example 8-2



PLAN
ELEVATION
Base of riprap slope shallbe adjusted to match existing channel bottom
Existing Structure L-22-L to be replaced
Proposed Structure L-22-LL
495' Net Channel Width at Elev = 4170.90
606' Excvated Channel Width at Elev = 4170.00
Proposed bridge length = 655'-4" B.F. to B.F. Abut.
Arkansas River
To Rocky Ford
To Ordway
CL of Channel
150+00
151+00
152+00
153+00
154+00
155+00
156+00
157+00
Upper Riprap Reference Line (URL) Elev = 4181.49 (Abut. 7)
Riprap (12") (Typ. at Abutments) (See Details Sheet B08)
Lower Riprap Reference Line (LRL) Elev = 4165.00 (Abut. 7)
Existing ground line
500-yr scour profile
Proposed L-22-LL
DHW (100 yrs.) Elev. 4178.10
Riprap (36") (Typ. at Piers) (See Details Sheet B08)
Upper Riprap Reference Line (URL) Elev = 4177.93 (Abut. 1)
Unclassified Excavation (Typ.)
Lower Riprap Reference Line (LRL) Elev = 4162.00 (Abut. 1)
4200
4190
4180
4170
4160
4150
4140
4130
4120

Example 8-3



TYPICAL RIPRAP AT PIER DETAIL (NTS)
SECTION A
RIPRAP (36")
EXISTING GROUND
GEOTEXTILE (EROSION CONTROL)(CLASS B) UNDER 6" OF EMBANKMENT OR 8" BED COURSE MATERIAL
43'
17'
6' (TYP)
TYPICAL RIPRAP AT ABUTMENT DETAIL (NTS)
UPPER RIPRAP REFERENCE LINE (URL)
ELEV = 4177.93 (ABUT. 1)
ELEV = 4181.49 (ABUT. 7)
RIPRAP THICKNESS (t) = 24"
RIPRAP (12")
ELEV = 4167.00 (ABUT. 1)
ELEV = 4170.00 (ABUT. 7)
LOWER RIPRAP REFERENCE LINE (LRL)
ELEV = 4162.00 (ABUT. 1)
ELEV = 4165.00 (ABUT. 7)
FACE OF ABUTMENT
PROPOSED BRIDGE
PROPOSED WSE Q(100) = 91,000 CFS
EXISTING/PROPOSED CHANNEL
MAIN CHANNEL DISTANCE (FT)
ELEVATION IN FEET
RECURRENCE INTERVAL IN YEARS
Q, DISCHARGE IN CFS
Drainage Area = 11,300 square miles
CHANNEL DESCRIPTION

Example 8-4

9.1 Purpose

This drawing is to show a plan of the superstructure showing pertinent information necessary for construction of the structure.

9.2 Responsibility

This drawing shall be prepared and checked in the design unit. The graphic presentation of information on this drawing shall be the responsibility of the individual preparing the drawing.

9.3 Scales

Standard Architectural and Civil scales should be used that are suitable to fit the details to a standard sheet.

9.4 Combining Details

The “Construction Layout” and the “Footing and Piling Layout” may be placed on the same sheet if practical. Other details may be placed on this sheet; i.e., drain details, etc.

If the “Construction Layout” is combined with other details, it should occupy the top half of the sheet. Other configurations may be used depending on the type of structure or structures. (Left half, upper left corner, etc.)

9.5 Horizontal Control Line

The horizontal control line shall be shown and labeled consistently with the plans. For twin structures the horizontal control line shall be shown and labeled for each structure such as: “Proj. Line - Str. No. G-18-L”.

9.6 Layout Line

For structures on tangent, the layout line and the horizontal control line will coincide, and shall be labeled such as “Survey Line”, “Proj. Line”, etc.

For structures located on a curve, the layout line may be:

A) Ahead Tangent: The tangent ahead of the point of intersection (PI) of the curve.
B) Back Tangent: The tangent back of the PI of the curve.

C) A chord between two specified points.
D) A tangent to the horizontal control line at some given point (POC) on the horizontal control line.

The layout line shall be shown and labeled such as "Tangent from TS Sta. 31+48.08", "Chord from POC Sta. 38+41.00 to PT Sta. 39+78.00", "Tangent from POC Sta. 382+10.00", etc.

Bearings shall be given for all layout lines, to the nearest second.

9.7 Stationing

Stationing shall be shown on the horizontal control line where it intersects with the centerline of bearing at abutments and centerline of piers. Stationing shall be given to two decimal places.

9.8 Centerlines

The following centerlines shall be shown and labeled:

A) Centerlines of bearings at abutments and piers.
B) Centerlines of piers.
C) Centerlines of all girders (shown and dimensioned to bottom of girder).
D) Centerline of roadway, median, etc., where required.
E) Centerlines of diaphragms if not shown elsewhere on the plans.

9.9 Dimensions

All dimensions shall be given in feet and inches (to the nearest 1/8 inch) except as noted.

A) The following dimensions shall be shown for all structures:
   1) End of wingwall to end of wingwall along outside of deck.
   2) End of wingwall to Centerline Abutment Bearings, Centerline Abutment Bearings to Centerline Piers, Centerline Piers to Centerline Piers, etc. along outside edge of deck.
   3) Back Face Abutments to Centerline Bearings. (Use design dimension - normal to Centerline Bearing or parallel to girder.)
   4) Centerline Pier Bearings to Centerline Piers. (Use design dimension - normal to Centerline Pier or parallel to girders.)
   5) Normal (radial) from Horizontal Control Line to Centerline Girders. (Except straight girders on curved structures - see below.)

6) Normal (radial) from Horizontal Control Line to inside of curbs, inside of curbs to outside of deck, etc.
7) Normal (radial) outside of deck to outside of deck.
8) Normal (radial) Horizontal Control Line to Profile Grade Line.
9) Location of Centerline Diaphragms (if shown).

Dimensions along edge of deck, 1) and 2) above, need not be repeated if they are the same on both sides of the structure. For girders sloped with the cross slope, a note shall be added clarifying where the locations are dimensioned, e.g. “All dimensions are horizontal. Girder Spacing Dimensions are at the bottom of girder and the extension of girder centerline.”

B) For structures on a curve with curved girders, the following dimensions shall be added to the above:
1) Along layout line from point of tangent to centerline of abutments and piers. (Nearest hundredth of a foot) (A note similar to “538.12 ft. back on tangent from ST Sta. 1281+48.00” shall be used if the point of tangent cannot be shown on the drawing.)
2) From layout line to Horizontal Control Line along centerline of abutment bearings and piers (nearest hundredth of a foot).
3) From layout line to outside of deck along centerline of abutments and piers.

C) For structures on a curve with straight girders the following dimensions shall be added to (A) and (B) above:
1) Length of chords. (if used)
2) Location of chords if not located on Horizontal Control Line. (Nearest hundredth of a foot)
3) Girder offsets from chords.
4) For flared girders, dimension from horizontal control line along centerline of bearings. (Nearest hundredth of a foot)
5) Length of girders. (CL to CL Bearings)
6) Offsets from centerline of outside girders to outside of deck at 10th points (100 ft. spans or less) or 20th points (spans of more than 100 ft.) along girders. Offsets may be tabulated.

When girders are sloped with the cross slope which is typical for side by side boxes and tub or U girders, the assumptions on the location of the centerline becomes more critical. Additional sheets are not necessary but notes on location assumptions will be necessary. For cross slopes of 2% or less, the differences are usually within construction tolerances, but assumptions should still be listed. The location difference between top and bottom of girder is primarily dependent on the girder height although the cross slope feeds into it as well. It is preferred to show the girder centerlines at the bottom of girder since this information can be used to determine cap and bearing elevations. With location assumption information the Contractor will be able to determine information at other locations on the girders and deck. Since bridge geometry sheets are primarily used to set haunch elevations and verify deck setting, longitudinal lines that support that effort such as web edges and panel edges may be helpful. Additional bridge geometry runs with alternate layout line locations may be necessary for these alternate locations.

Figure 9.9-1 shows how with sloped girders, defining the location of where dimensions are located is critical. The centerline of girder at the bottom could be 4 ½" different from the centerline girder at top of deck. The difference between slope distances and horizontal distances can be seen as well. Figure 9.9-1 is drawn with a cross slope of 8% and 4' tall girders. Figure 9.9-2 show the same girders at 2%.

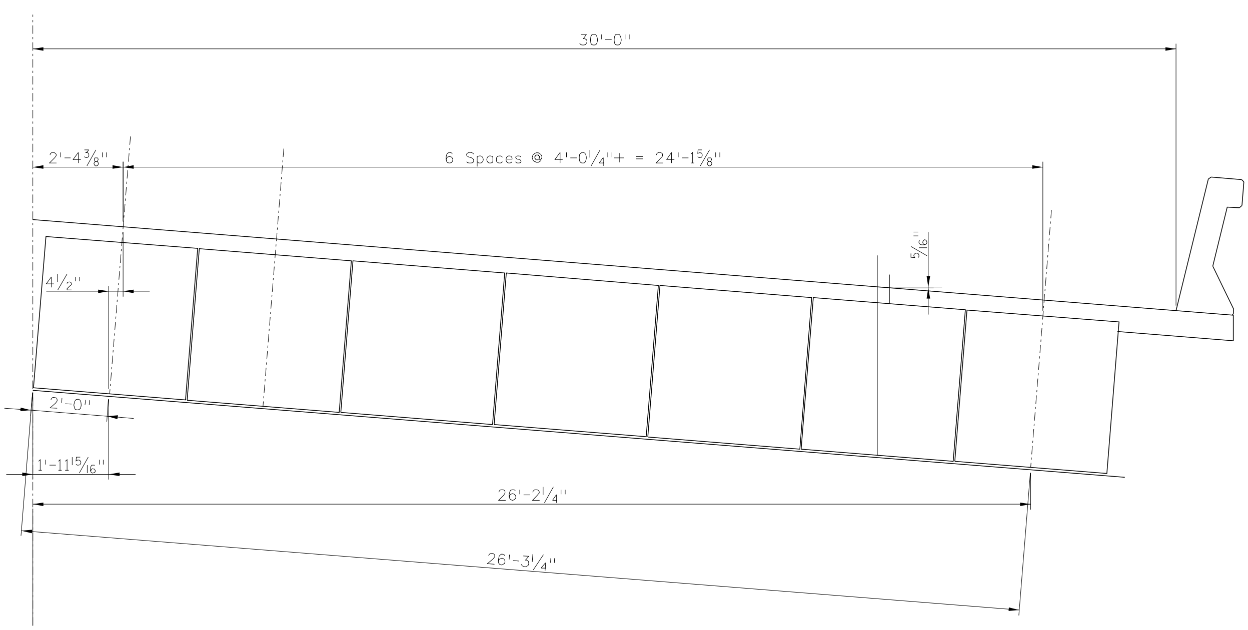


Figure 9.9-1

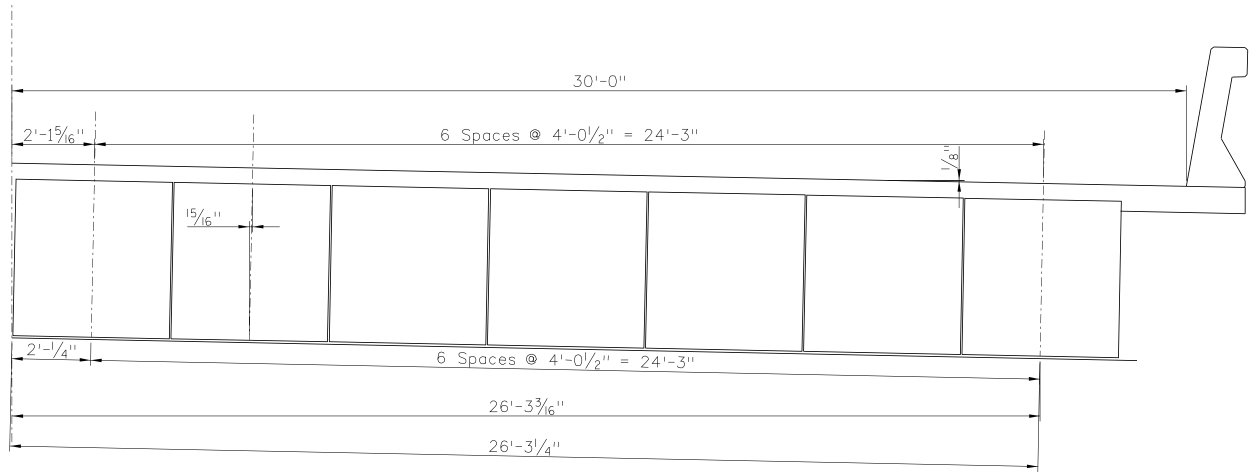


Figure 9.9-2

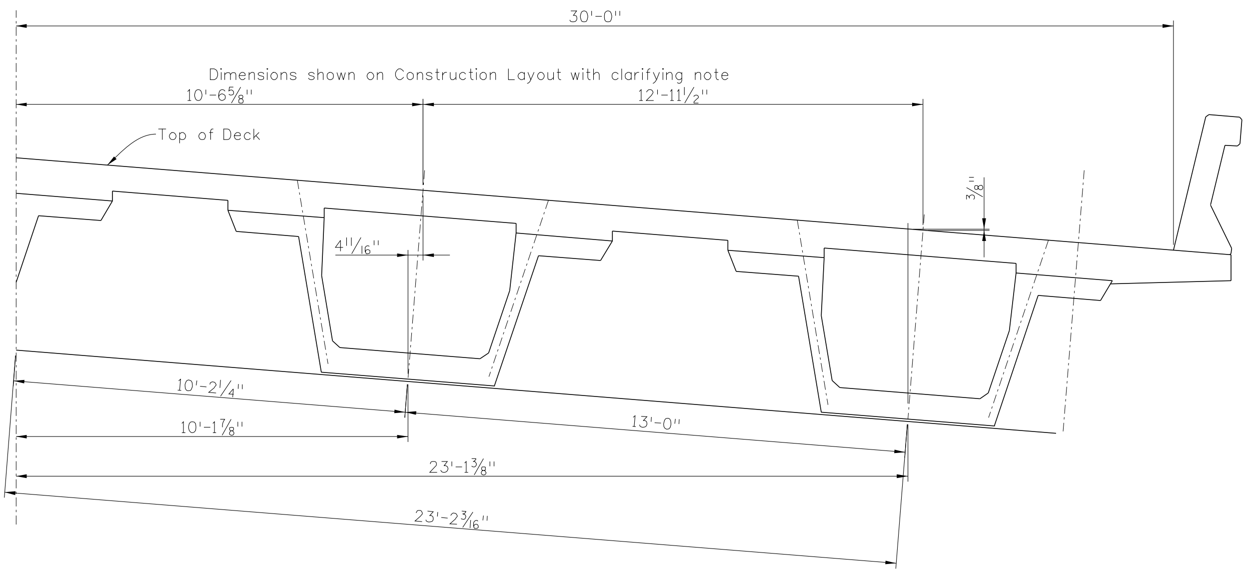


Figure 9.9-3

9.10 Angles

Angles shall be shown to the nearest second:

A) Angles between Layout Line and centerlines of abutments and piers.
B) Angles between straight girders and centerline of bearings, if girders are not parallel to the Layout Line.

9.11 BENCH MARK

Most new bridges do not have a bench mark. Older bridges may have benchmarks. If required, contact Project Manager to coordinate with Survey group.

9.12 ELECTRICAL CONDUIT & JUNCTION BOXES

Electrical conduit shall be shown on this drawing if required.

Use a minimum of 1-1/2” electrical conduit for longitudinal runs and 3/4” electrical conduit for transverse runs.

Location of junction boxes shall be shown on this drawing as required.

See CDOT Bridge Design Manual Section 2.8 for maximum length between junction boxes.

9.13 Drains

Drains shall be shown and located on this drawing as required. A detail may be required for clarity.

9.14 Check Items

The following is a summary of information to be shown on the drawing, as required. Additional information may be shown according to the individual structure.

A) Standard North Arrow
B) Label horizontal control line and give bearing, if structure is on tangent.
C) For structures on a curve, label and give the bearing of the layout line and point of tangency, or the end points for a chord.
D) Stationing
E) All centerlines
C) All necessary dimensions
D) Curb offsets
E) All required angles
F) Electrical conduits & junction boxes
G) Drains
H) Title the plan “CONSTRUCTION LAYOUT”. For plans with more than one structure, add the structure number to the title.
I) Label back face of abutments, centerline of bearings and centerline of piers.
J) Dimension widths of curbs and sidewalks
K) Project number in proper locations.

L) Typical notes
M) Complete title block
N) Spacing and location of type 10 rail posts
O) Spacing and location of fencing
P) Label girders (see section 1.13 in Chapter 1 for naming convention)
Q) Note for girder locations for girders sloped with cross slope

9.15 Title Block

This drawing is titled "CONSTRUCTION LAYOUT" and shall be so indicated in the title block.

If other details are combined on this drawing, they should be so indicated in the title. Examples: If the "Piling Layout" is placed on a drawing with the "Construction Layout", the title of the sheet would be:

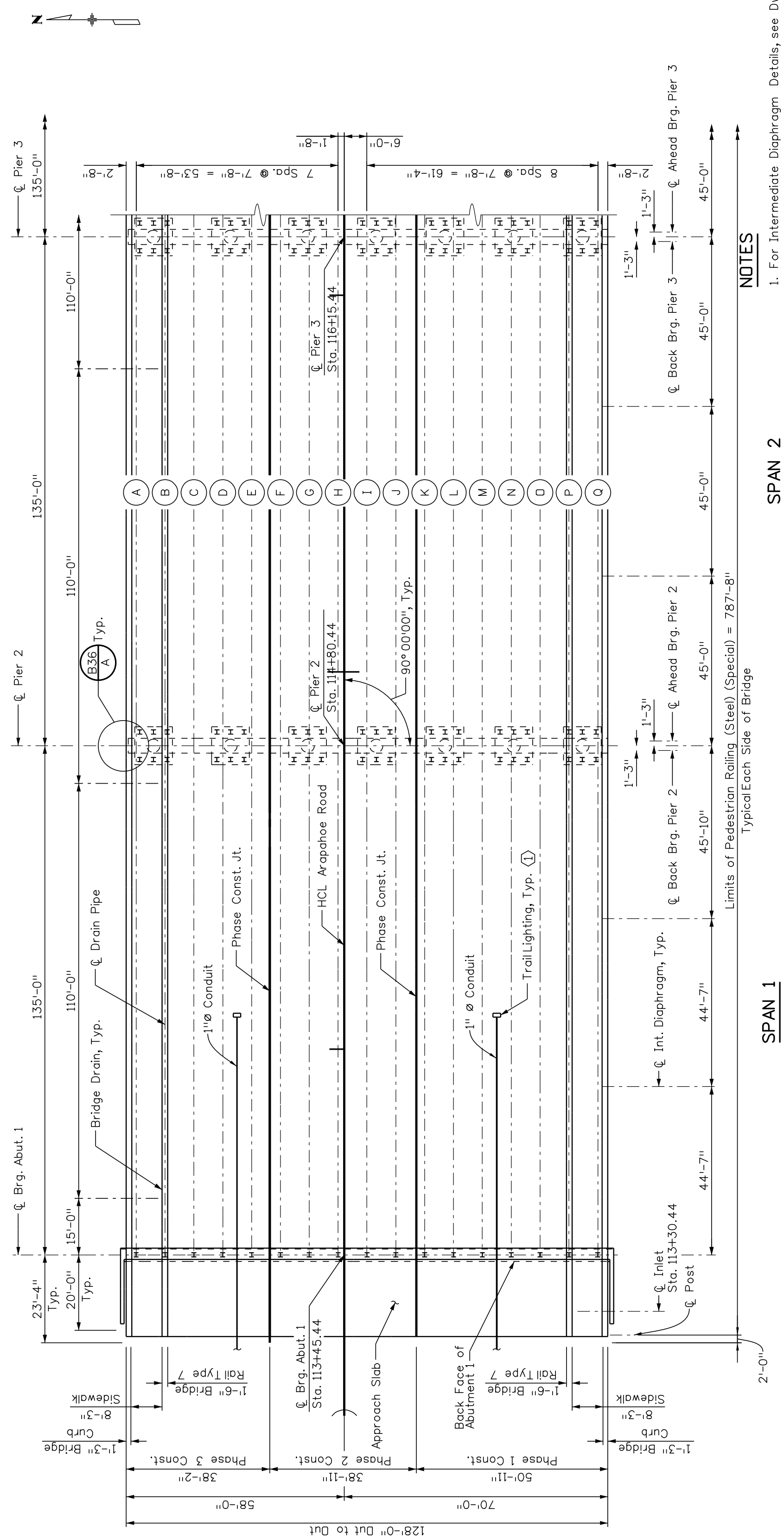
CONSTRUCTION LAYOUT

PILING LAYOUT

9.16 Typical Notes

The following notes shall appear on the drawings, as applicable:

A) Edge Offsets Note: All edge offsets are placed at 10th points (or 20th points) normal to the girder.



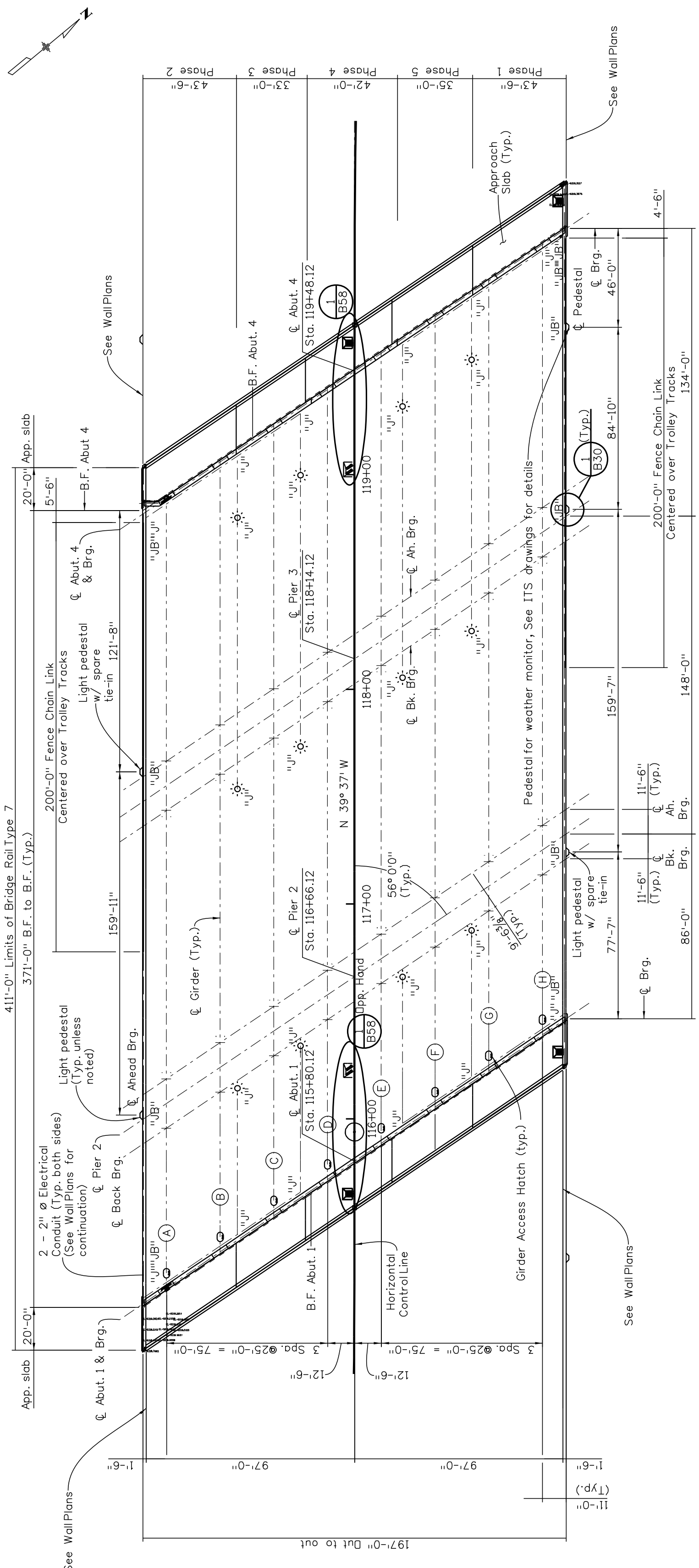
CONSTRUCTION LAYOUT

NOTES

1. For Intermediate Diaphragm Details, see Dwg. No. B42.
2. For Girder Details, see Dwg. No. B41.
3. For Wingwall Layout and Details, see Dwg. No B22
4. For Approach Slab Details, see Dwg. No. B50.
5. Electrical Conduit in Barriers and Deck:
   2 – 2"ø Conduit in the interior barriers.
   1 – 3"ø Conduit in the exterior curbs.
   1"ø Conduit for street lights & trail lights
   ¾" Conduit for step lights
6. For other size conduit used see quantity & payment on

KEY NOTES:

(1) For Path lighting under bridge deck, Contractor to coordinate with lighting designer. For conduit sizes and length, see lighting plans.



CONSTRUCTION LAYOUT

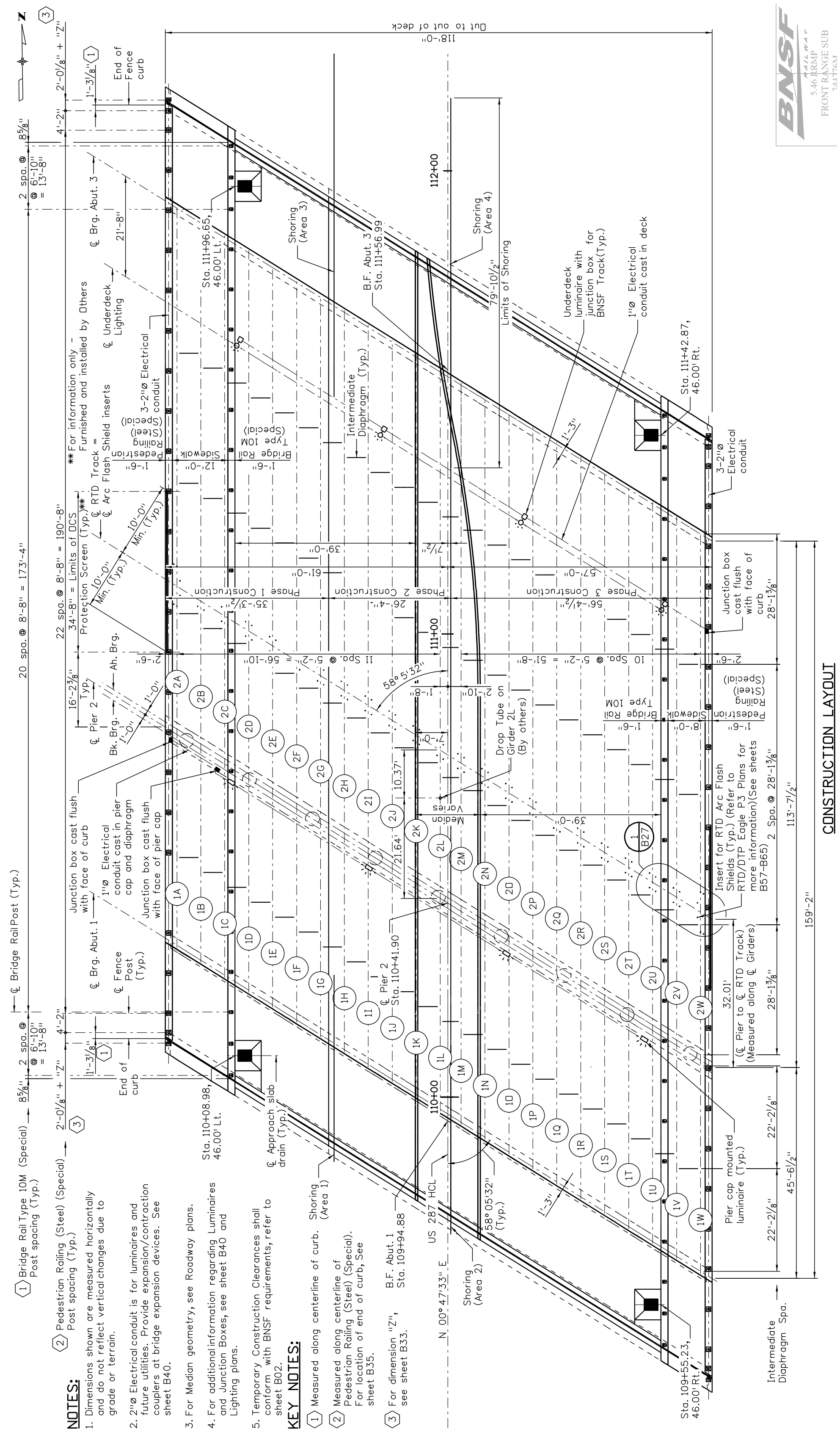
Notes:

1. All exposed Electric Conduit shall be Galvanized rigid metal.
2. Junction box shall be flush to front face of Bridge Rail and provided with a water tight cover. Drain for interior condensation.
3. For pull box information, see light pedestal drawings No B30 & B31.

☼ Hidden Luminaire Location. See Lighting Plans for Details

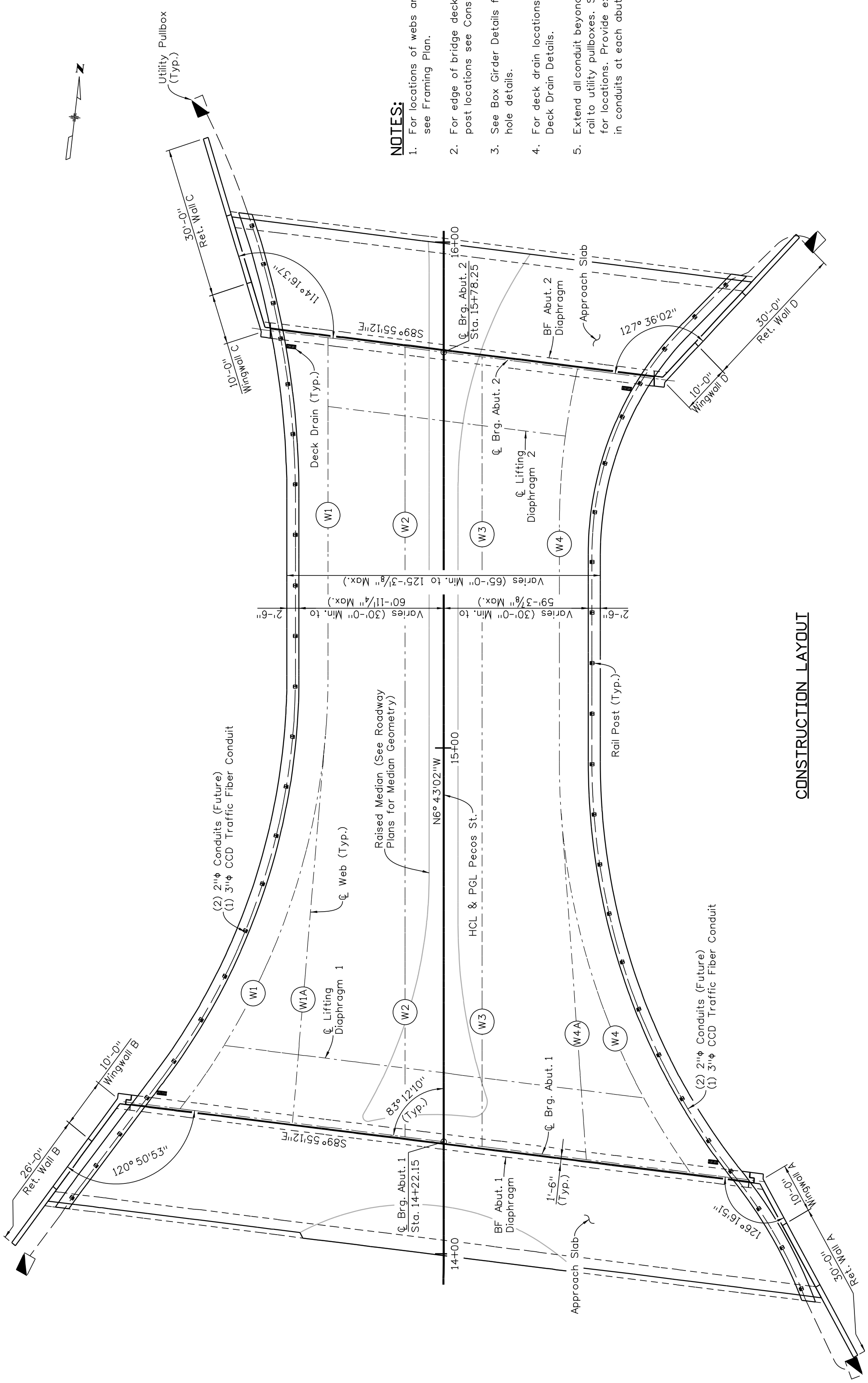
"J" = 6"x6"x4" Junction Box flush with bottom of slab. Drain for interior condensation.

"JB" = 8"x18"x8½" Barrier Junction Box

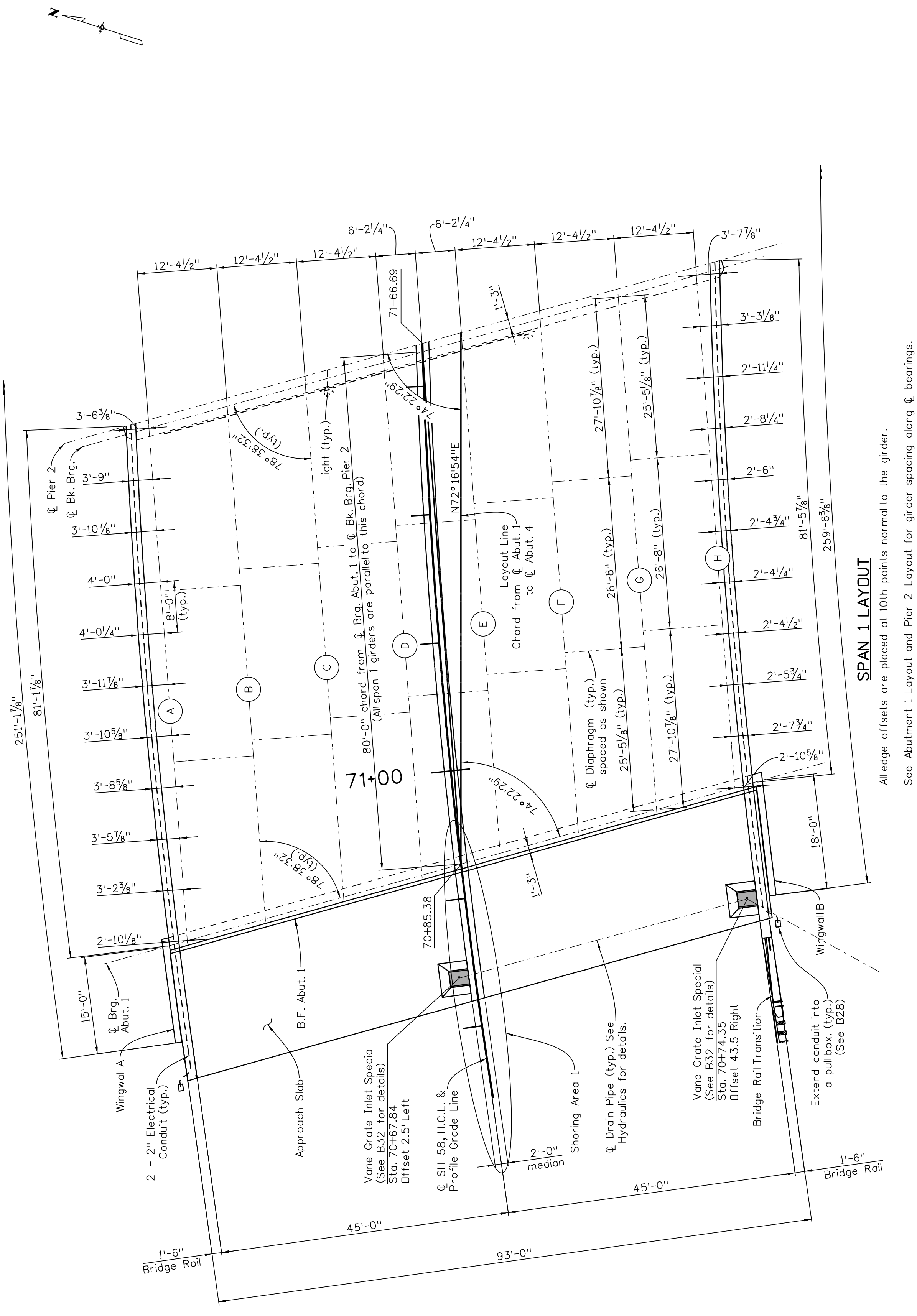

CONSTRUCTION LAYOUT
NOTES:
1. Dimensions shown are measured horizontally and do not reflect vertical changes due to grade or terrain.
2. 2"ø Electrical conduit is for luminaires and future utilities. Provide expansion/contraction couplers at bridge expansion devices. See sheet B40.
3. For Median geometry, see Roadway plans.
4. For additional information regarding Luminaires and Junction Boxes, see sheet B40 and Lighting plans.
5. Temporary Construction Clearances shall conform with BNSF requirements, refer to sheet B02.
KEY NOTES:
1 Measured along centerline of curb.
2 Measured along centerline of Pedestrian Railing (Steel) (Special). For location of end of curb, see sheet B35.
3 For dimension "Z", see sheet B33.
1 Bridge Rail Type 10M (Special) Post spacing (Typ.)
2 Pedestrian Railing (Steel) (Special) Post spacing (Typ.)
** For information only - Furnished and installed by Others

NOTES:

1. For locations of webs and access openings see Framing Plan.
2. For edge of bridge deck geometry and rail post locations see Construction Layout (2 of 2).
3. See Box Girder Details for ventilation and drain hole details.
4. For deck drain locations and details see Deck Drain Details.
5. Extend all conduit beyond end of bridge rail to utility pullboxes. See Utility Plans for locations. Provide expansion sleeve in conduits at each abutment.



CONSTRUCTION LAYOUT



SPAN 1 LAYOUT
All edge offsets are placed at 10th points normal to the girder.
See Abutment 1 Layout and Pier 2 Layout for girder spacing along ℄ bearings.
80'-0" chord from ℄ Brg. Abut. 1 to ℄ Bk. Brg. Pier 2
(All span 1 girders are parallel to this chord)
Layout Line
Chord from ℄ Abut. 1 to ℄ Abut. 4
N72°16'54"E
71+00
71+66.69
70+85.38
℄ Pier 2
℄ Bk. Brg.
℄ Brg. Abut. 1
B.F. Abut. 1
Approach Slab
Wingwall A
Wingwall B
2 - 2" Electrical Conduit (typ.)
Vane Grate Inlet Special
(See B32 for details)
Sta. 70+67.84
Offset 2.5' Left
Sta. 70+74.35
Offset 43.5' Right
℄ SH 58, H.C.L. & Profile Grade Line
2'-0" median
Shoring Area 1
℄ Drain Pipe (typ.) See Hydraulics for details.
Bridge Rail Transition
Extend conduit into a pull box. (typ.) (See B28)
℄ Diaphragm (typ.) spaced as shown
Light (typ.)
78°38'32" (typ.)
74°22'29"
1'-6" Bridge Rail
45'-0"
93'-0"
251'-1⅞"
81'-1⅞"
259'-6⅜"
81'-5⅞"
12'-4½"
6'-2¼"
3'-7⅞"
3'-6⅜"
15'-0"
18'-0"
1'-3"
8'-0" (typ.)
27'-10⅞" (typ.)
25'-5⅛" (typ.)
26'-8" (typ.)
A
B
C
D
E
F
G
H

Foundation Layout

10.1 Purpose

This drawing shall show a plan view of all footings, piling, or drilled shafts (caissons) for a given structure or structures, and shall present all information necessary for locating their positions in the field.

10.2 Responsibility

This drawing shall be prepared and checked in the design unit. The graphic presentation of the information on this drawing shall be the responsibility of the individual preparing this drawing.

10.3 Scales

Standard Architectural and Civil scales shall be used that are suitable to make the plan view, elevation and typical section legible on a standard sheet. For additional information see Chapter 2.3.

Scales for the distances measured along the “layout” or “work” lines from “bent line” to “bent line”, or along “bent line”, may be represented with broken dimension lines.

For the definitions of “layout line”, “work line”, and “bent line”, see Sections 10.5, 10.6, and 10.8, respectively.

10.4 Orientation of Details

If the “Foundation Layout” details are to occupy one drawing, they are to be proportioned to the sheet.

If this layout is combined with the “Construction Layout”, it is preferred to have it occupy the bottom half of the drawing; however, if the physical characteristics of the structure or structures deem it necessary, it may be positioned in a different manner. An example of this is shown in Figure 10-2 Example 2.

10.5 Layout Line

A “layout line”, as used on this drawing, is defined as a line along which and from which all the basic distances, lines, and angles are measured for the purpose of locating the footings, piling, and drilled shafts. This line shall be identified by its proper name. Examples: Centerline Roadway, Survey Line, Centerline of Median, etc.

If the structure is on a horizontal curve, the “layout line” may be a tangent line to the curve. If this tangent line is not related to the PI, it would be identified as follows: “Tangent to POC Station 10 + 10.50”. If the “layout line” is one of the tangents related to the PI of the horizontal curve, it would be identified in one of the following two ways, depending upon which tangent is used as the “layout line” in the particular instance.

(1) “Back tangent to PT Station 49+54.70”.
(2) “Ahead tangent to PT Station 49+54.70”.

If the structure is on a spiral, the “layout line” may be a line tangent to the spiral at the TS or ST

The “layout line” is always a straight line, even though a structure may be on a horizontal curve or spiral. The bearing of all “layout lines” shall be shown. In Figure 10.5-1 the “layout line” is tangent to the curve at the POC, Station 259+96.61, and its bearing is N 00º 00’ 00” E. The “layout line” may be chord between two specified points.

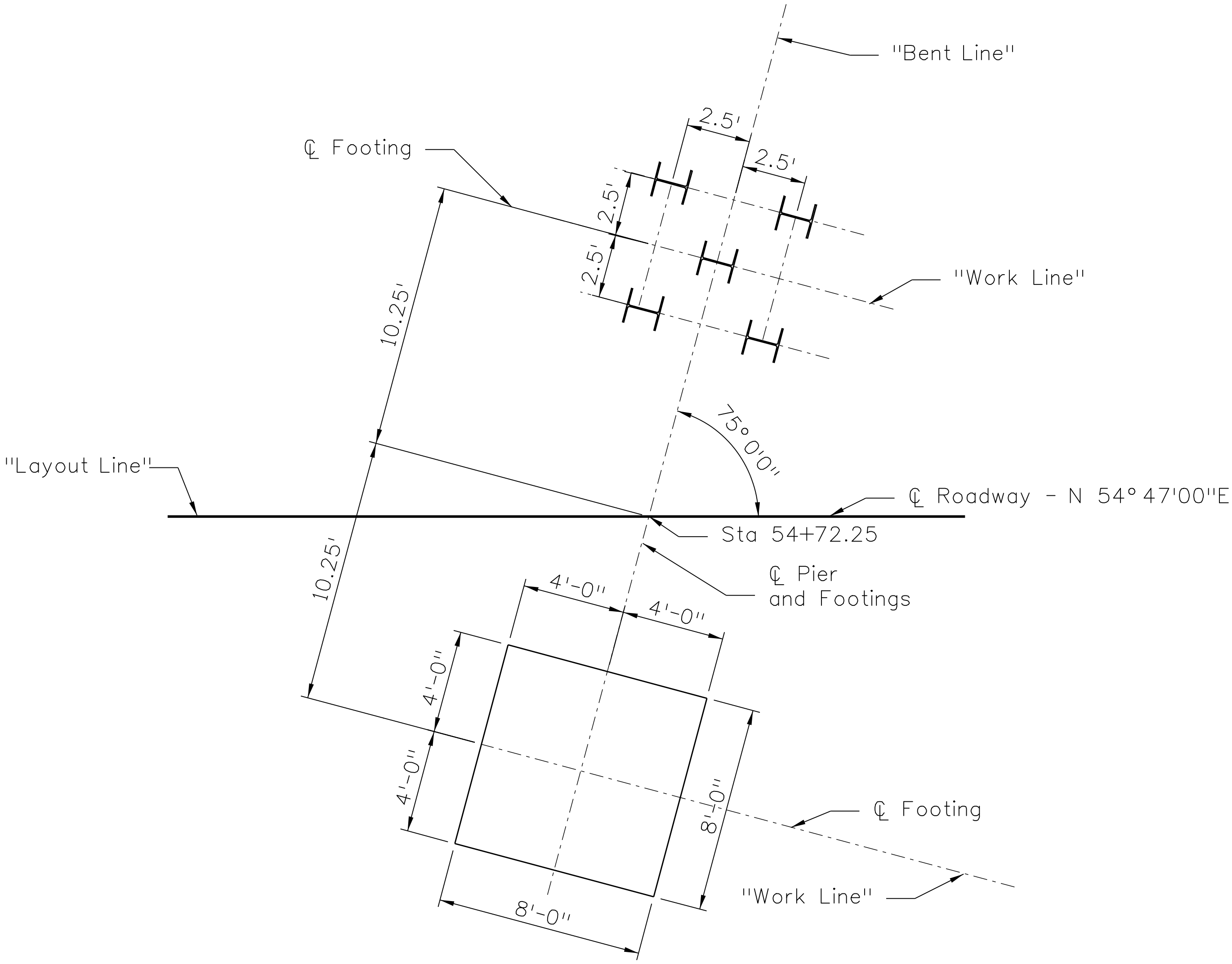


Fig. 10.5-1 Detail of Layout, Bent, and Work Lines

Note: Dimensions are in feet and inches for measurements that are done in the field (e.g. formwork) and dimensions that are used by survey are left in decimal feet.

10.6 Work Line

A “work line”, as used on this drawing, is defined as an auxiliary line to the “layout line”, along which and from which distances and angles are measured for the purpose of locating the footings, piling, and drilled shafts. This line is offset from the “layout line” by means of dimensions along the “bent lines”.

In Figure 10-4, the distance of 14.13’ (Pier 2) measured to the edge of the footing from the tangent (layout line), locate lines which are centerlines of the pier footings. These lines can be considered “work lines”, as distances are measured along and from these lines to locate the bounds of the footings.

In Figure 10.5-1 two “work lines” are shown. They are located a distance of 10.25’ up from the “layout line” and 10.25’ down from the “layout line” along the centerline of pier and footing (bent line), and are identified as “Centerline of Footing”. In this case, these “work lines” are not parallel to the “layout line”, but are normal to the “bent line”. Distances are measured normal to and along these lines to locate the centerline of the piling and the bounds of the footings. In the example, distances of 2.50’ measured each side of the “bent line” along the “work line” locate the

centerline of piling parallel to the “bent line”. Distances of 2.50’ measured along these centerlines each side of the “work line” locate the centerlines of the piling that are parallel to the “work line”. In a similar manner, the bounds of the footings are also located.

10.7 Reference Points

The “reference point” is defined as a given point on the “layout line”, from which all points are located. Each “reference point” shall be identified with a station.

The “layout line” may also be the tangent line. The “reference point” on this line can occur at the POC. From this point, the distances can be measured ahead and back along the “layout line”.

10.8 Bent Lines

A “bent line” is defined as a line that intersects the “layout line”. Along these “bent lines” are measured the distances for locating the footings, piling, or drilled shafts.

These “bent lines” shall be identified as “Centerline of Piling”, “Centerline of Pier 2”, “Centerline of Footings”, etc.

In Figure 10.5-1, a graphic example for the locations of a footing or piling at a pier when the “bent line” is skewed is shown.

A note such as: “Pier Pile Spacing is Typical”, makes it unnecessary to repeat the dimensions in the other footings.

10.9 Horizontal Control Lines

If the structure is located on a horizontal curve and utilizes a “layout line” as discussed in 10.5, the “horizontal control line” need only be shown to locate the layout line as shown in Figure 10-4.

The “horizontal control line” shall be shown and identified by its proper name: “Survey Line”, “Centerline of Roadway”, or “Centerline of Median”, etc.

10.10 Stationing

A station shall be given at the “reference point” on the “layout lines”, as previously discussed in Section 10.7. In the case of a double row of piling, the abutment centerline of bearing shall be defined and the piling offset shall be dimensioned normal to the centerline of bearing.

All stations on the “Footing, Drilled Shaft, and Piling Layout” shall be given to two decimal places. Example: Sta. 259+96.61.

10.11 Dimensions

Dimensions shall be shown from the “reference point” on the “layout line” to the “bent lines”.

An example of this is shown in Figure 10.5-1, where distances are measured each way from the “reference point” to the “bent lines”.

A “tie in” dimension shall be shown from the nearest piling to the “layout” or “work” line.

Dimensions shall be shown that are measured along or normal to the “bent lines” from the “layout” or “work” lines for the purpose of locating footings, piling, or drilled shafts.

Refer to Figures 10.5-1 and 10-1 through 10-4 for other pertinent dimensions.

All dimensions on the drawing, except footing dimensions, shall be in feet and decimals of a foot, to two decimal places. Footing dimensions shall be given in feet and inches.

10.12 Piling And Drilled Shaft

The following information shall be shown in the plans:

A) Sizes - The size of the piling / drilled shaft shall be shown on the drawing
B) Maximum Load - The maximum (both factored and service) pile load and footing or drilled shaft pressure shall be shown on the drawing
C) Batter - The drawings shall show the amount and direction of battered piling
D) Type - End Bearing or Friction Piling
E) Pile Reinforcing Tips - For detail, see Figure 10.12-1 below
F) Estimated tip elevations, including minimum embedment
G) Cutoff elevation
H) Estimated bedrock elevation
I) Predrilling
J) CJP minimum splice elevation
K) A location to record the as-built tip elevation of each pile / drilled shaft
L) The assumed strength limit resistance factor for geotechnical axial resistance
M) The steel grade
N) The minimum number of drilled shafts at each pier / abutment to be tested using non-destructive integrity testing (e.g. crosshole sonic logging (CSL)

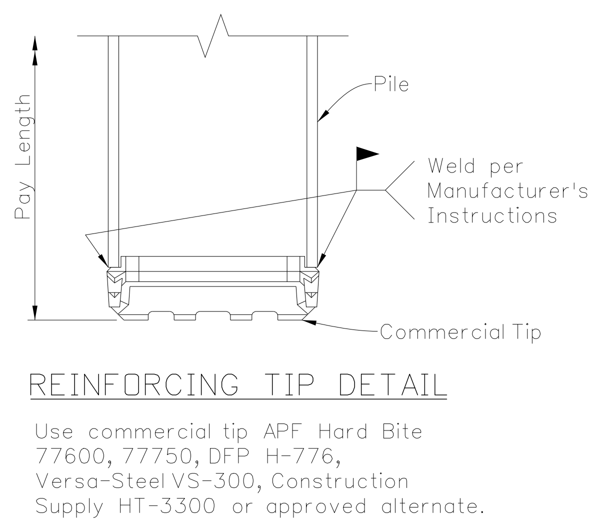


Fig. 10.12-1 Reinforcing Tip Detail

10.13 Angles

The angles that the “bent lines” make with the “layout” or “work lines” shall be shown on this drawing, as shown in Figures 10.5-1 and the examples found at the end of this chapter.

10.14 Check Items

Listed below is a summary of items that shall appear on the drawing, when applicable. Additional information shall appear, as required.

A) Project number in proper location.
B) Standard North Arrow.
C) Proper identification of “layout line” or “work line” as discussed in Sections 10.5 and 10.6, respectively.
D) Bearing of “layout line”.
E) Proper identification of “horizontal control line” or lines as discussed in Section 9.5 of the preceding chapter.
F) “Work lines” referenced to “layout line” by means of dimensions.
G) Stationing as discussed in Section 10.10.
H) “Bent lines”, properly identified, as discussed in Section 10.8.
I) Dimensions along “layout line” for locating intersection points of “bent lines”, as discussed in Section 10.11.
J) Indicate angles that are generated between the “layout” or “work” lines and the “bent lines”.
K) Dimensions necessary for locating all footings, piling, and drilled shafts as discussed in Section 10.11.
L) Indicate all spread footings, piling, or drilled shafts.
M) Give piling size, type, maximum pile load, and estimated tip elevations (see Section 10.12 for additional items)
N) Indicate the size of the spread footings.
O) Identify centerlines of piling, drilled shafts, and footings.
P) Title the plan in accordance with the particular condition.
Q) Check for typical notes, as indicated in Section 10.16.
R) Check title block for information indicated in Section 10.15.
S) Show existing utilities and/or obstructions
T) Show river flow limits when applicable
U) Show the 811 stamp

10.15 Title Block

This drawing is titled “FOOTING AND PILING LAYOUT”, “FOOTING LAYOUT”, “DRILLED SHAFT LAYOUT”, “PILING LAYOUT”, etc., and shall be so indicated in the title block. If other details are combined on this drawing, they shall be so indicated in the title also. Example: If the “Construction Layout” is placed on the drawing with the “Footing and Piling Layout”, the title of the drawing would be “CONSTRUCTION LAYOUT - FOOTING AND PILING LAYOUT”.

The structure number or numbers, and the first initial and last name of the Designer and Detailer shall be filled in on each sheet.

10.16 Typical Notes

The following notes shall appear on the drawing, when applicable.

A) Dimensions Notes - The piling and footing dimensions shown are at the bottom of the concrete.
B) Piling - A notation shall be made on the drawing indicating the piling size.
C) Piling Load Note – Maximum Pile Load = _________Tons (or Kips)
D) Type - A notation shall be made on the drawing indicating if the Piling is either End Bearing or Friction.
E) Show the maximum Footing Pressure, when applicable.
F) Estimated Tip Elevation.

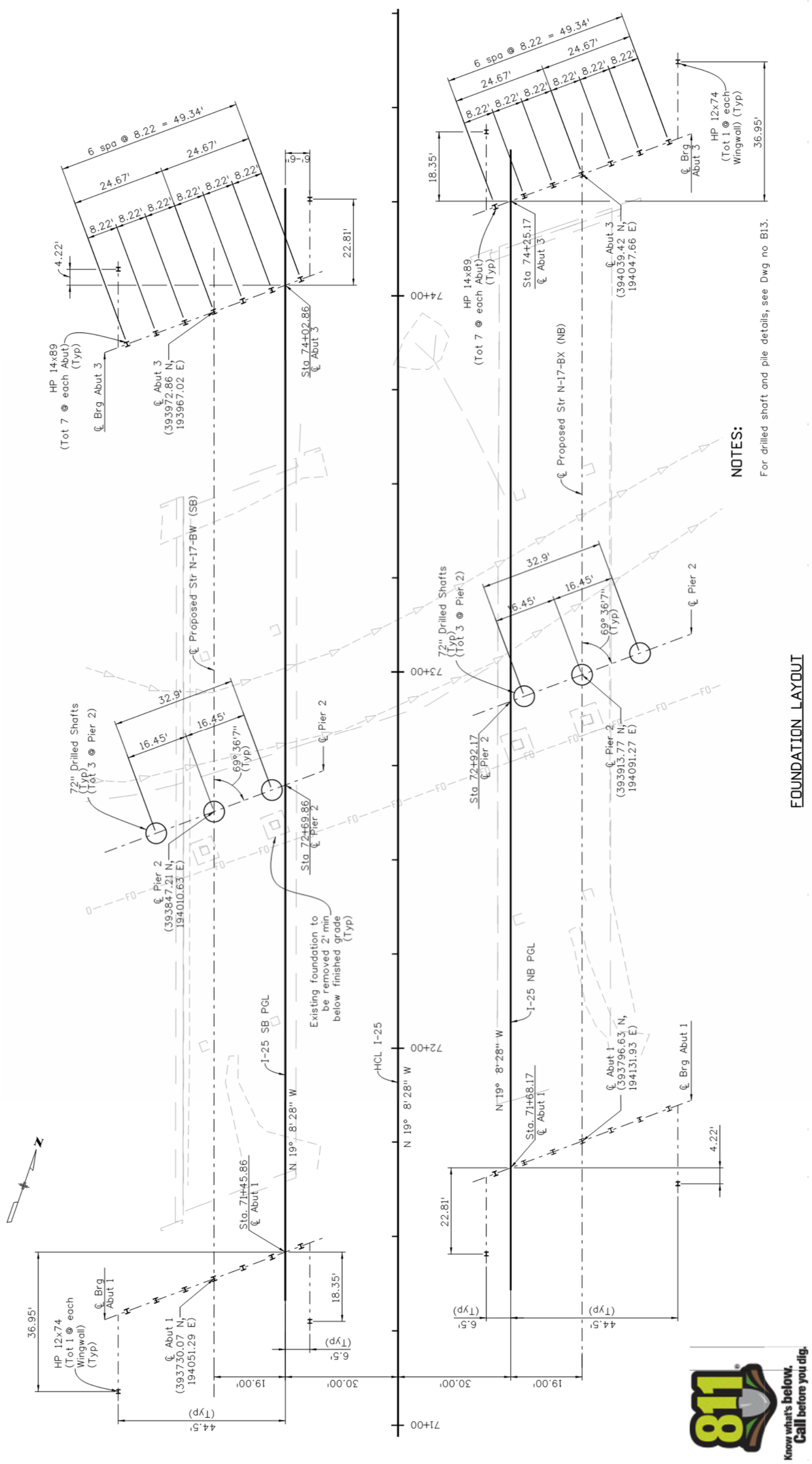


Fig. 10-1 Example 1

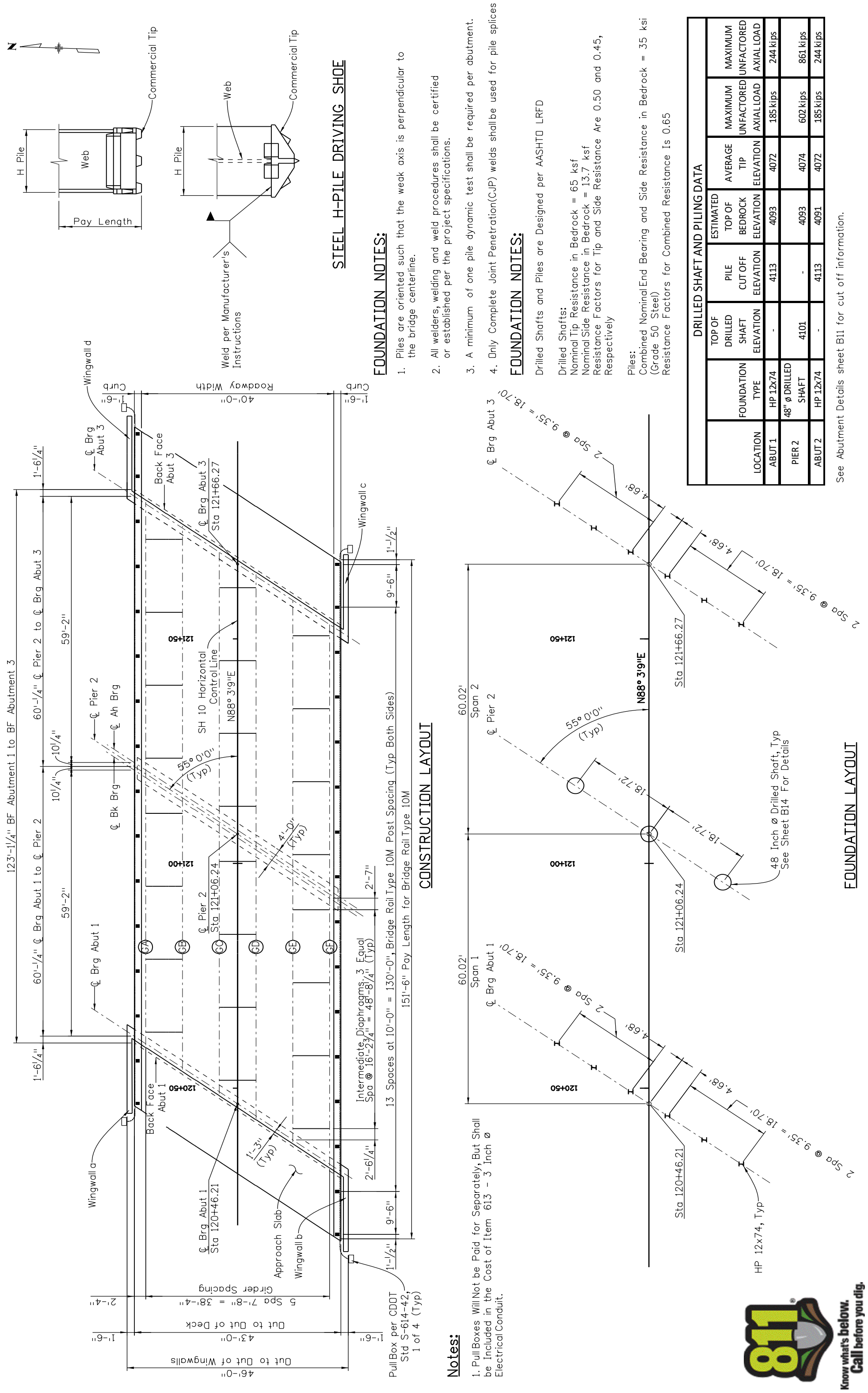
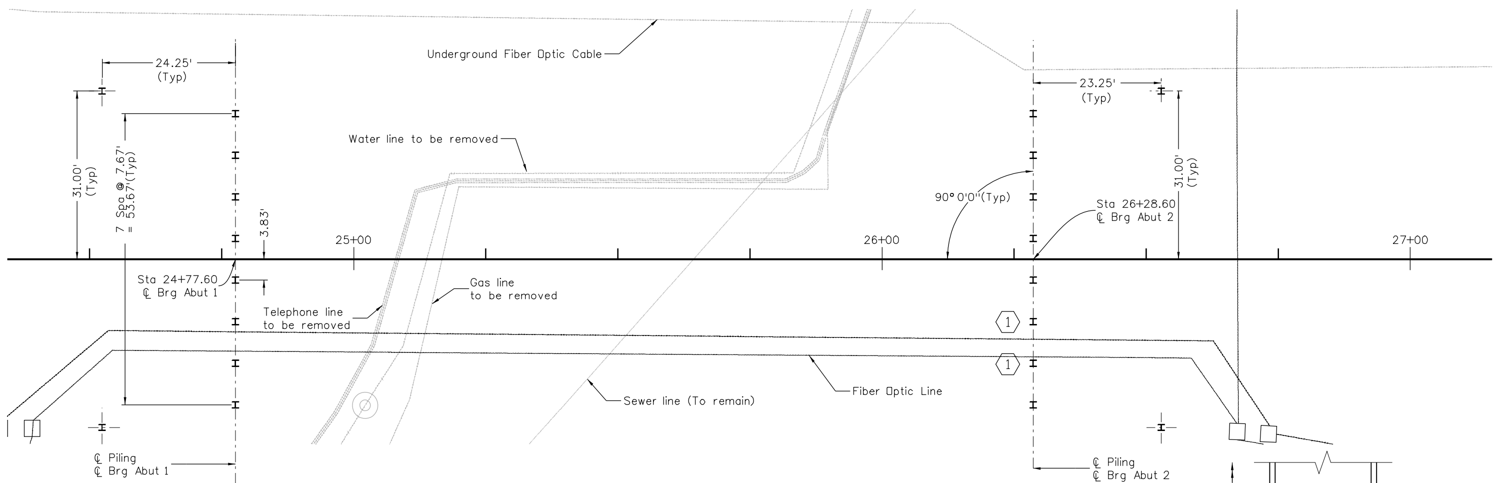
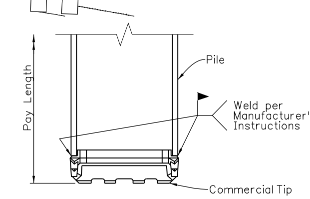


Fig. 10-2 Example 2



PILING LAYOUT



REINFORCING TIP DETAIL

Use commercial tip APF Hard Bite 77600, 77750, DFP H-776, Versa-Steel VS-300, Construction Supply HT-3300 or approved alternate.

(Scale: None)

KEYED NOTE

1 Pile Cutoff Elevation 7195.416 ft

PILE DATA

Location	Max Service Load (Kip)	Max load (Factored) (Kip)	Tip Elevation	Cutoff Elevation	Top of Predrilling Elevation	Bottom of Predrilling Elevation	Pile size	Min bedrock Embedment (Ft)	# Piles	Actual Tip Elevation
Abutment 1	277.4	411.7	7153.0	7196.0	7195.0	7170.0	HP 14X89	16.00	8	
Abutment 2	287.0	424.7	7159.4	7195.5	7194.5	7177.0	HP 14X89	16.55	8	
Wingwalls Abut 1	35.2	44.0	7178.0	7193.5	-	-	HP 14X89	0.00	2	
Wingwalls Abut 2	35.2	44.0	7177.5	7193.0	-	-	HP 14X89	0.00	2	

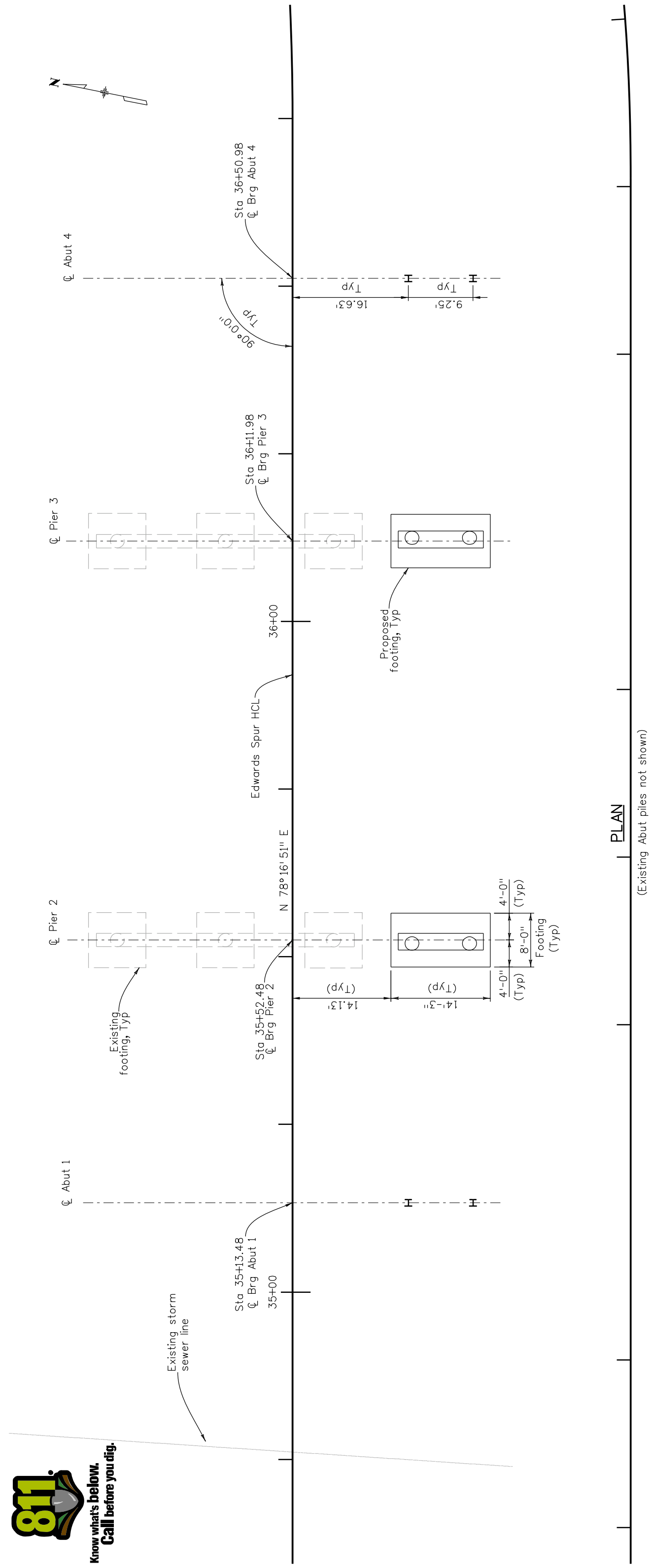
See Abutment Details sheet B12 for cutoff information.

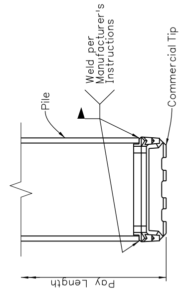
NOTES:

1. Piling shall be placed in 16"φ drilled holes up to bedrock. Drilled holes are not required for wing wall piles.
2. All steel piles shall be (AASHTO M270, Grade 50) HP 14 X 89 with a protective cast-steel pile point driven by an open-ended diesel hammer with a manufacturer's rated energy of 70 to 75 k-ft. The protective pile point installation shall be included under pay item 502, "Steel Piling (Install only)".
3. On site observation of pile driving to confirm the bearing strata and determine the exact elevation at which the competent bedrock or dense gravel exists, and to check for pile crimping, buckling and alignment by a representative of the geotechnical engineer will be provided.
4. A minimum of one pile dynamic load test shall be required per abutment using CDOT's Pile Driving Analyzer(PDA). Final tip elevations and quantities shall be determined by using the minimum embed length criteria of the PDA measurements. The contractor shall submit pile tip and hammer parameters to CDOT Geotechnical Branch (303-398-6604) a minimum of ten calendar days prior to beginning of any pile driving work.
5. The contractor's Field Engineer shall record actual pile tip elevations in the pile data table for as-constructed plans.
6. Pile tips are not required for wing wall piles.

Know what's below. Call before you dig.

Fig. 10-3 Example 3





REINFORCING TIP DETAIL

Use commercial tip APF Hard Bite 77600, 77750, DFP H-776, Versa-Steel VS-300, Construction Supply HT-3300 or approved alternate.

Scale: None

PILE DATA

Location	Max Service Load (kips)	Max load (Factored) (kips)	Tip Elevation	Cutoff Elevation	Pile size	Min Length (Ft)	# Piles	Actual Tip Elevation
Abutment 1	89.0	113.0	7230.00	7250.50	HP 12X53	19.50	2	
Abutment 4	89.0	113.0	7230.00	7255.50	HP 12X53	19.50	2	

See Abutment Details sheet B12 for cutoff information.

NOTES:

1. All steel piles shall be (AASHTO M270, Grade 50) HP 12 X 53 with a protective cast-steel pile point driven by an open-ended diesel hammer with a manufacturer's rated energy of 70 to 75 k-ft. The protective pile point shall be paid for under pay item 502, "Pile Tip."
2. On site observation of pile driving to confirm the bearing strata and determine the exact elevation at which the competent bedrock or dense gravel exists, and to check for pile crimping, buckling and alignment by a representative of the geotechnical engineer will be provided.
3. A minimum of one pile dynamic load test shall be required per abutment using CDOT's Pile Driving Analyzer(PDA). The contractor shall submit pile tip and hammer parameters to CDOT Geotechnical Branch (303-398-6604) a minimum of ten calendar days prior to beginning of any pile driving work.
4. The contractor's Field Engineer shall record actual pile tip elevations in the pile data table for as-constructed plans.

Fig. 10-4 Example 4

11.1 Purpose

These drawings are to present graphically all pertinent information necessary in the field construction of this segment of the structure.

11.2 Responsibility

These drawings shall be prepared and checked in the design unit. The graphic presentation of information on these drawings shall be the responsibility of the individual preparing the drawings.

11.3 Scales

Scales shall be used that are suitable to make the details legible when the drawing is reduced. Suggested scales for presenting the details of the abutment are as follows:

A) Plan and Elevations - 1”=10’, 1”=20’, 1”=30’.
B) Sections and details - 1/8"=1’-0”, 1/4” = 1’-0”, 1/2"=1’-0”, 3/4"=1’-0”, etc.
C) The Elevation of an opposite hand detail may be drawn to a smaller scale.

11.4 Orientation of Details

The PLAN of the abutment shall be placed, if possible, at upper left of the drawing, with the back face of the abutment toward the top of the sheet.

The ELEVATION of the abutment shall be projected below the PLAN. The ELEVATION view of Abutment 1 shall be shown as looking back station. When possible, the abutment TYPICAL SECTION shall be placed to the right of the abutment PLAN and ELEVATION. If space is limited, sections or auxiliary views may be shown on another sheet. Wingwall details shall be shown on another sheet.

11.5 Opposite Hand Details

The reference to “opposite hand” or reverse details shall be avoided. Two preferred methods are as follows:

A) Redetail opposite hand abutment.
B) Detail the ELEVATION of the opposite hand abutment to a smaller scale.

11.6 Wingwall Length (U-Type)

The detailer shall check the elevation at the bottom of the footing and the wingwall length to ensure that it meets the criteria outlined in the ELEVATION view of Figure 11.6-1.

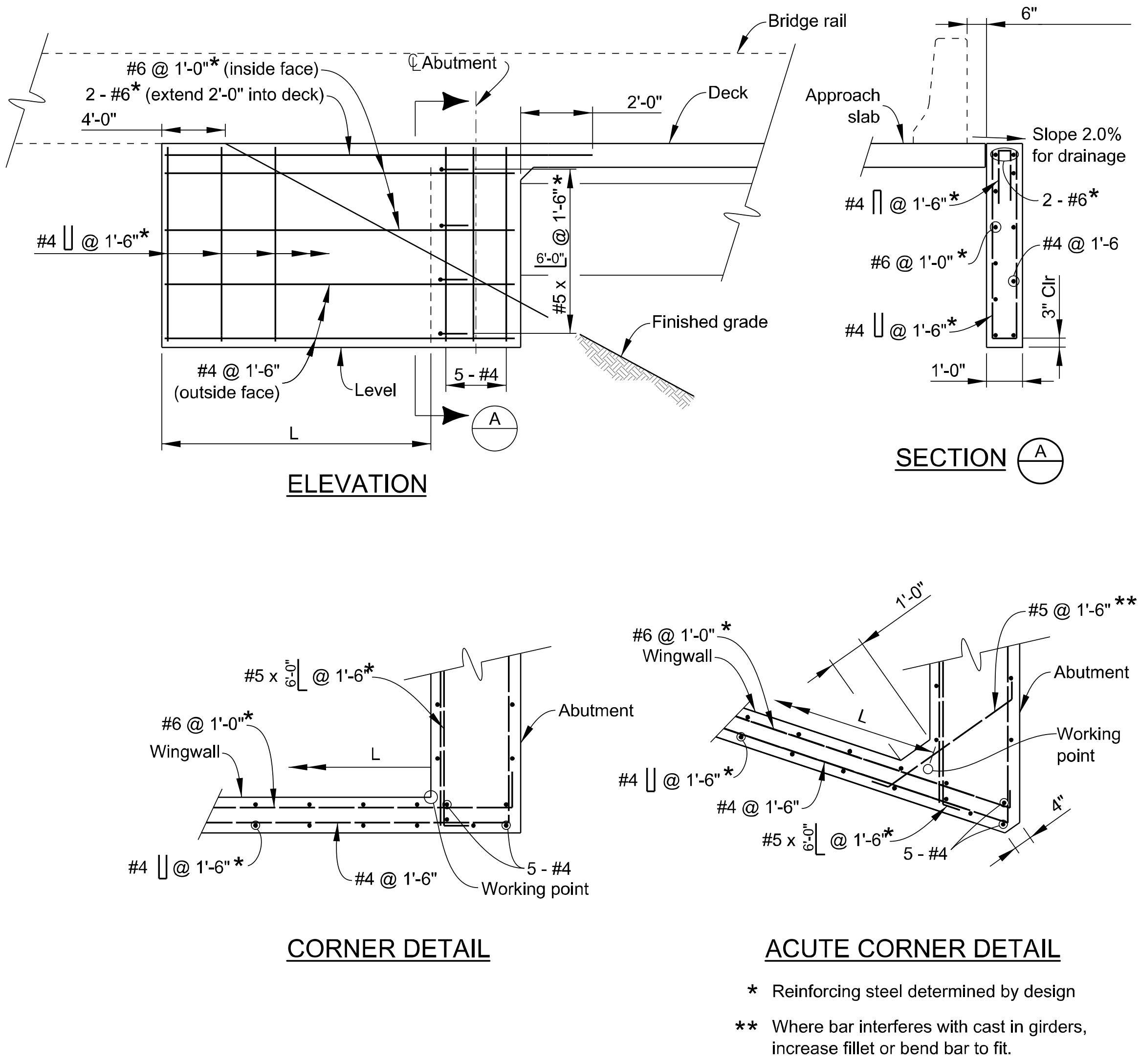


Fig. 11.6-1 Wingwall Details

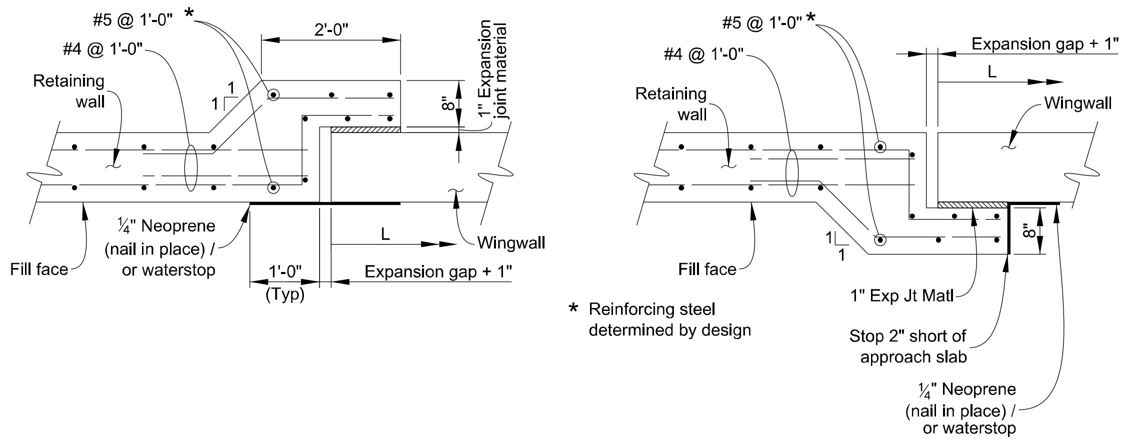


Fig. 11.6-2 Wingwall to Retaining Wall Connection Detail

11.7 Wingwall Designation

Wingwalls shall be designated with abutment number and as right and left, ie. Wingwall A1 right, Wingwall A17 left, etc. Right and left sides are determined by looking in the direction of increasing milepost from the centerline of bearing on Abutment 1. See figure 1.13-1 and 11.7-1 for more information.

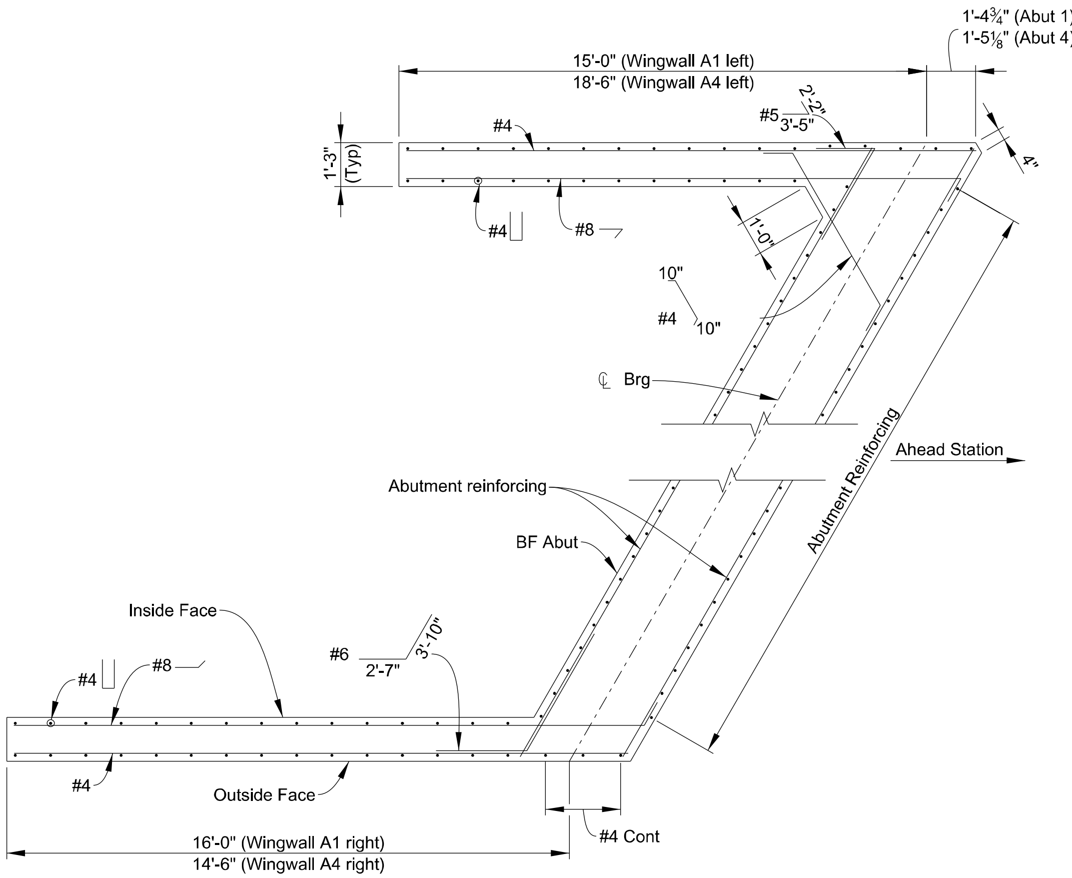


Fig. 11.7-1 Wingwall Designation

11.8 Size of Bearing Seat

The bearing seat is the shelf on the face of a bridge abutment that supports the end of the span. To avoid spalling of the concrete surface from heavy loads, the edge of the masonry plate or bearing/leveling pad shall be no closer than 3 inches to the vertical face of the concrete bearing seat.

Because it is important to maintain, as nearly as possible, 2 inches clear from the bearing seat to the reinforcing steel, the cap between bearing seats should be sloped rather than stepped.

Figure 11.8-1 shows the sloped cap and minimum clearances around bearing plates.

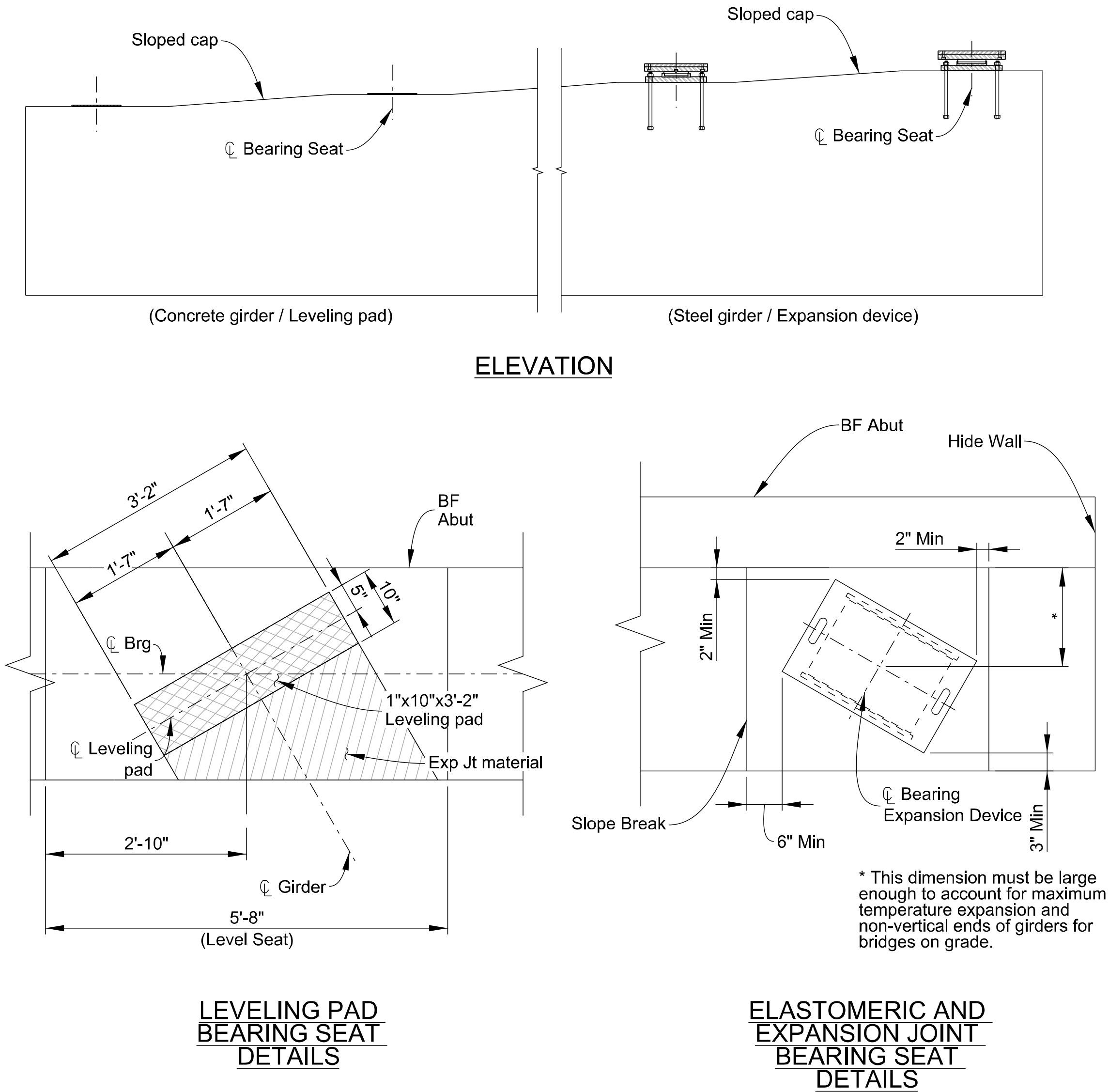


Fig. 11.8-1 Bearing Seat Details

11.9 Horizontal Control Line

The horizontal control line shall be shown on the PLAN and labeled consistently with the plans. Example: “HCL”, “Survey Line,” “Project Line,” etc.

11.10 Layout Line

For structures on tangent, the layout line and the horizontal control line will coincide.

For structures located on a curve, the layout line shall be shown on the PLAN and labeled consistently with the plans. Example: “Tangent from TS Sta 31+41.08,” “Chord from POC Sta 38+41.00 to PT Sta 39+78.00,” “Tangent from POC Sta 382+10.00,” etc.

11.11 Stationing

A station shall be placed at the intersection of the horizontal control line with the centerline of bearings.

All stations on the “Abutment Details” shall be given to two decimal places.

The direction of stationing shall be indicated on the plan view as “Station Ahead.”

11.12 Centerlines

Centerlines shall be identified and shown as discussed in the following sections:

A) Location - Centerlines shall be shown at the following locations, when applicable:
  1) Plan View
    a) Centerline of all girders
    b) Centerline of bearings
    c) Centerline of roadway
    d) Typical centerline of anchor bolts or bearing pads.
  2) Section through Abutment
    a) Centerline of bearings
    b) Identification – The centerlines shown on the abutment details shall be identified in the following ways:
      i) Centerline of Girder – A circle containing the girder letter is placed at the end of each outside girder centerline, as shown in the PLAN views of the abutments in the graphic examples. If the bridge is a simple multi-span bridge, a circle containing the span number and girder letter is preferred, ie. 1A, 2D, 3C, etc. For continuous or single span bridges, a circle containing only the girder letter shall be used. These girder letters shall correspond to those shown on the “Construction Layout.”
      ii) Other Centerlines - When it is applicable to identify some of the other centerlines, it should be done by using their particular names. Example: Centerline Bearings, Centerline Anchor Bolts, etc.

11.13 Elevations

All elevations shown on the “Abutment Details” shall be to two decimal places. Example: Elev 47.25, except bottom of footings, which shall be to one decimal place. Example: Elev 4647.3.

A) Location - Elevations shall be shown on the ELEVATION view of the abutment at the following locations, when applicable:
   1) Top of bearing seats, except cast-in-place girder.
   2) Bottom of abutment footing, bottom of wingwalls, and bottom of retaining wall footings, note if level. Except in extreme situations, the height of abutments and wingwalls shall be constant.

11.14 Dimensions

A sufficient number of dimensions shall be shown on the details to provide adequate information necessary in the checking of the plans and the construction of the abutment.

For clarification a work point may be accentuated by a small circle with a line extended through the work point or points.

All dimensions shall be given in feet and inches (to the nearest 1/8 inch) except as noted.

A) Plan of Abutment
   1) For structures on a curve, a reference shall be made to the intersection of the Layout Line and the centerline of abutment bearings. Example: “538.12’ back on tangent from TS Sta 31+41.08,” “143.69’ ahead on tangent from POC Sta 382+10.00,” etc.
   2) Outside of deck to outside of deck, along centerline of bearings.
   3) Horizontal Control Line to outside of deck, along centerline of bearings, for structures on tangent alignment.
   4) Layout Line to outside of deck, along centerline of bearings, for structures located on a curve.
   5) Horizontal Control Line to centerline of the adjacent girders, along centerline of bearings for structures on tangent alignment (nearest thousandth of a foot.)
   6) Layout Line to centerline of adjacent girders, along centerline of bearings, for structures located on a curve (nearest thousandth of a foot).
   7) Centerline of girder to centerline of girder, along centerline of bearings (nearest thousandth of a foot for steel girders and nearest hundredth of a foot for concrete girders).

8) Layout Line to Horizontal Control Line, along centerline of bearings, for structures located on a curve (nearest hundredth of a foot).
9) Structures which are skewed or structures located on a curve, show the wingwall offset from outside of bridge deck at centerline of bearings to outside of bridge deck at the end of wingwalls, parallel to centerline of bearings.
10) Locate abutment stirrups and give the spacing, along the centerline of bearings.
11) Centerline of girder to centerline of anchor bolts, measured normal to the centerline of girder.
12) Typical bearing seat width.
13) Centerline of utility blockout to centerline of nearest girder and width of blockout, measured normal to the centerline of blockout. (Note: Utility blockouts are not used for future utilities)
14) Length of wingwalls from centerline of bearing to end of wingwall, along outside of deck.
15) Hidewall width.

B) Elevation of Abutment
  1) Bearing seat to centerline of utility blockout.

C) Typical Section Through Abutment
  1) Projection of piling into the concrete.
  2) The vertical distance, from the top of concrete deck to the bearing seat measured at the centerline of girder and centerline of bearings (to the nearest 1/16 inch).

Slab, haunch, bearing device, and cast-in-place girders shall be measured vertically.

Welded plate girders, wide flange girders, and precast girders, shall be measured normal to the girder.

In some instances, the roadway grade may be severe enough to make a difference in the vertical dimension. If this difference is equal to or greater than 1/16 inch, it shall be included in the dimension.

An example of the preceding statements is shown in Figure 11.14-1.

When using elastomeric bearing pads which are greater than 1-1/2 inch, the designer shall calculate the vertical adjustment for dead load, which shall be reflected in the dimension W.

The following note is required if the compression of the pad is 1/8 inch or larger:

▲ "Dimension reflects 1/8 inch compression of the elastomeric bearing pad due to dead load deflection."

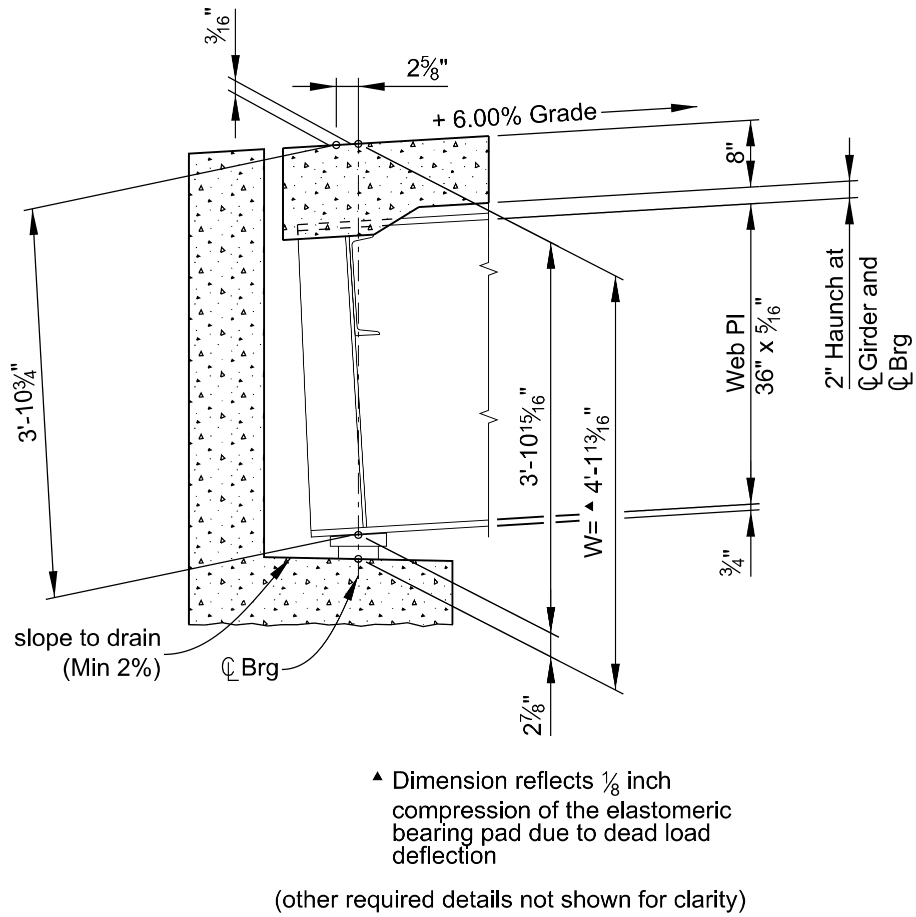


Fig. 11.14-1 Dimensions with Bridge On Severe Grade

3) Width and depth of notch for approach slab
4) Abutment with constant width
   a) Back face of abutment to centerline of bearing
   b) Centerline of bearing to front face of abutment
   c) Back face of abutment to front face of abutment
5) Abutment with spread footing
   a) Back of footing to back face of abutment
   b) Back face of abutment to front face of parapet
   c) Front face of parapet to centerline of bearing
   d) Centerline of bearing to front face of abutment

e) Front face of abutment to front face of footing
f) Footing width
g) Footing thickness

6) Minimum footing cover
7) Minimum berm width
8) Clearance to bottom reinforcing steel

D) Wingwall Details

1) End of wingwall to centerline of abutment bearings along outside edge of deck
2) Width of curb or concrete bridge rail
3) Width of wingwall
4) Width of deck cantilever
5) Thickness of slab at outside of deck
6) Fillet dimension at the acute wingwall of abutments where the skew angle is less than 70°
7) Dimension from the end of wingwall to the intersection of slope; “4’-0” (Min)” generally
8) Clearance to bottom reinforcing steel

11.15 Angles

The following angles shall be shown to the nearest second in the PLAN view of the abutment, when applicable:

A) Skew angle (nearest second)
B) Angles that the girders generate with the centerline for abutment bearings, if they are different than the skew angle (nearest minute)
C) Angles that the wingwalls generates with the centerline of abutment bearings, if they are different than the skew angle (nearest minute)

11.16 Anchor Bolts

When applicable, anchor bolts shall be shown in the PLAN of the abutment or in a separate detail. The skew angle shall be shown to the nearest minute. See anchor bolt note.

11.17 Leveling Pads

Leveling pads are plain elastomeric pads used for locked-in-girder at integral substructures and will require an additional, enlarged detail showing the location of the leveling pad and the limits of the expansion joint material around it. The skew angle shall be shown to the nearest minute. For additional information, see the CDOT Bridge Design Manual Section 14.5.7.

11.18 Piling

When applicable, piling shall be shown, but not dimensioned, in the PLAN, ELEVATION, and SECTION of the abutment.

11.19 Reinforced Concrete Details

The reinforced concrete details shall be made in accordance with the design notes and current standard practice. Wingwalls will generally be designed in accordance with the CDOT Bridge Design Manual Section 11.3.6.

As much of the reinforcing as possible should be called out in section and details shown to clearly indicate the location of the individual bars as required in the other views. It should be clear where the first bar starts and the last bar ends. The length of embedment or projection for dowels, and rebar splice lengths shall be determined by the designer and shown on the plans. All stirrups should be made the same length, making splices in legs over length.

All reinforcing steel in the abutment and wingwalls shall be epoxy coated, with the exception of reinforcing steel which is entirely within a spread footing. This steel may be non epoxy-coated and so indicated with the symbol (N).

The statements listed below are to be followed when applicable:

A) Fit and clearance of reinforcing shall be carefully checked by calculations, large scale drawings, or other accurate means. Allowance should be made for the deformations (ridges) on the reinforcing steel.

   Some of the common areas of interference are:

   1) Slab reinforcing and abutment reinforcing
   2) Wingwall reinforcing and abutment reinforcing
   3) Wingwall reinforcing and girders, for structures with skews less than 70º

   Skews will tend to aggravate problems of reinforcing fitting.

B) Utility blockouts shall be shown and located in the PLAN and ELEVATION views of the abutment. An additional detail, showing the #5 stirrups spaced 6 inches clear of the back face and 4 inches clear of the front face will be required. For additional information, see the CDOT Bridge Design Manual Section 2.8.

C) On wingwall details “inside face” and “outside face” are preferred over “NF”, “FF” when calling out reinforcing.

Refer to the appropriate section of Chapter 4 for additional information concerning bar clearances, spacing, splicing, embedment, projections, etc.

11.20 Miscellaneous Concrete Details

The following details shall be shown on the drawing when applicable:

A) The footings shall be shown in the PLAN, ELEVATION, and SECTION views of the abutment.

B) Approach slabs will be required on all vehicular bridges, except bridges with GRS abutments that do not have an expansion device. The approach slab shall be anchored to the abutment and details shown accordingly. Approach slab notches shall be provided on all abutments, even if an approach slab will not be placed with the original construction. Check to see that there is adequate (2” Min) concrete cover between the notch for the approach slab and the end of girders, this problem is aggravated by the skew and the roadway grade. If a problem does occur, it can usually be solved by adding a corbel to the back face of the abutment.

C) Sidewalks shall be continued beyond the abutments to the ends of wingwalls.

D) Waterstop should be used between wingwalls and retaining walls.

E) Avoid expansion devices when possible. If an expansion device is required it shall be designed between the end of the approach slab and the roadway approach, not at the abutment. For additional information, see Staff Bridge Structural Worksheet set B-518.

F) A 1 1/2” x 1 1/2” fillet will be required at the back face of the abutment if the abutment concrete is at finished grade and there is no approach slab, or if there is no asphalt and no approach slab.

G) The division of concrete classes shall be shown on the TYPICAL SECTION and on the wingwall retaining wall ELEVATION. If the division is shown on the wingwall section a note will be required to better define where this change occurs. “Construction joint is at the exterior bearing seat elevation.”

11.21 Check Items

Listed below is a summary of items that shall be checked and appear on the drawing, when applicable. Additional information shall appear, as required.

A) Project number in proper location
B) Horizontal Control Line, in the PLAN view
C) Layout Line, in the PLAN view
D) Stationing
E) Location and identification of centerlines
F) Elevations
G) All necessary dimensions
H) Skew angle of bridge and other pertinent angles
I) Anchor Bolts or Leveling Pads
J) Show footings in the PLAN view as well as in the ELEVATION and SECTION
K) Check all intersecting planes of reinforcing steel for the proper clearances
L) Check expansion device to insure that it fits properly at the abutment
M) Check bearing plates, anchor bolts, and girders to insure that they fit properly at the abutment (See Figures 11.8-1 and 11.14-1)
N) Title PLAN, ELEVATION, and SECTIONS in accordance with their particular conditions
O) Label back face abutments in the PLAN and TYPICAL SECTION
P) Label centerline of bearings
Q) Check for typical notes
R) Check title block for information
S) Splice Lengths

11.22 Title Block

This drawing is titled “ABUTMENT DETAILS” and shall be so indicated in the title block. The abutment numbers shall be included in the title, such as “ABUTMENT 1 AND 3 DETAILS.”

If other details are combined on this drawing, they shall be indicated in the title. Example: If the “Pier Details” are placed on this drawing with the “Abutment Details,” the title shall be “ABUTMENT 1 AND 3 DETAILS - PIER 2 DETAIL.”

The structure numbers and the first initial and last name of the designer and detailer shall be filled in on each sheet.

11.23 Typical Notes

The following notes shall appear on the drawing when applicable:

A) Utility Blockout Note - “Centerline ___________X___________ Blockout. Cut longitudinal reinforcing and move stirrups to clear.”

B) Anchor Bolt Note - “Anchor Bolt ________” Ø X _____ Long (Project _____”)”

C) Abutments with expansion devices - “Concrete above the construction joint shall be placed after the slab has been poured. Top of abutment backwall to match slope and grade of the roadway.
For details of expansion device, see Dwg No B _____.”

D) Abutment with elastomeric bearing pads greater than 1 1/2” - “Dimension reflects _____, compression of the elastomeric bearing pad due to dead load deflection.”

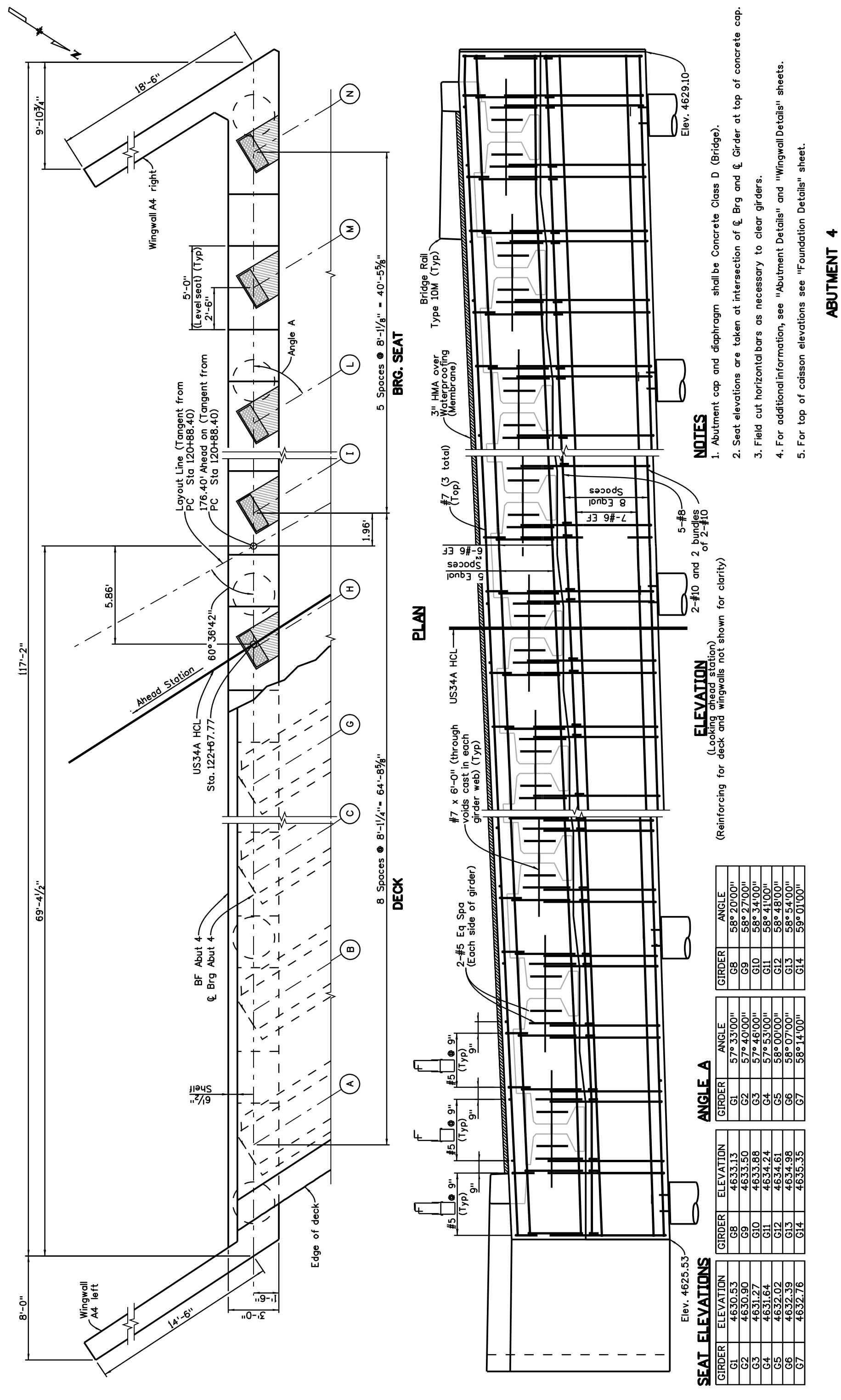
E) Cast-in-place Post Tensioned Bridges “Slope paving in front of abutments to be placed after stressing.”

F) Precast girders
   1) “4” Fillet (Typ between girders)”
   2) “Field bend or cut reinforcing to provide 2” Clr at bearing seats”
   3) “Slab and portion of abutment above bearing seat to be poured monolithically”

G) Wingwall Details
   1) “For details and reinforcing of Bridge Rail Type ___, see Dwg No B _____”
   2) “Match cantilever”
   3) “Construction joint is at the exterior bearing seat elevation”

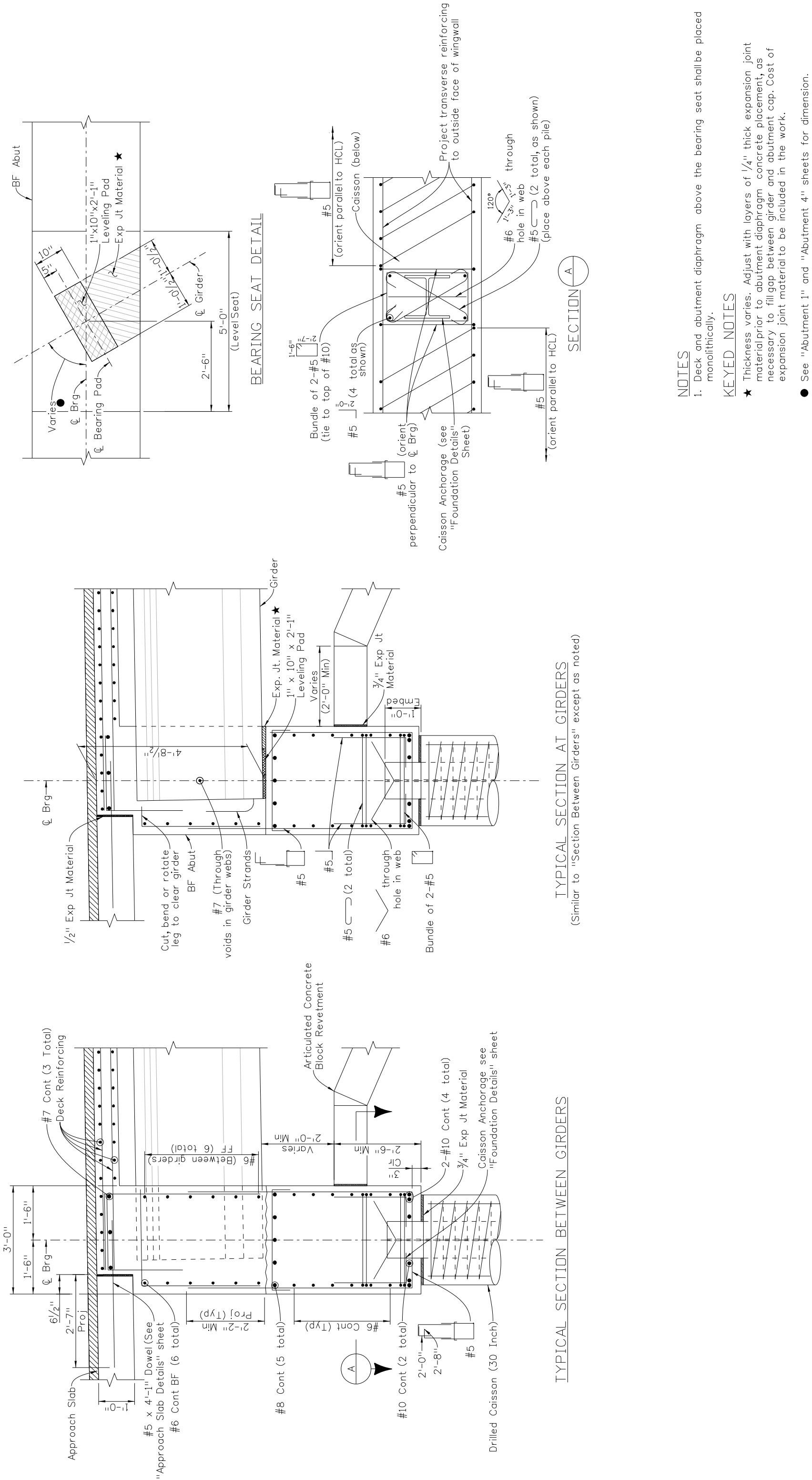
H) When a detail is shown on another sheet a note referencing to the sheet should be given
   1) “For wingwall details, see Dwg No B _____”
   2) “For bearing details, see Dwg No B _____”
   3) “For utility blockout details, see Dwg No B_____”

I) Splice Lengths (Designer to show splice lengths per specification requirements)

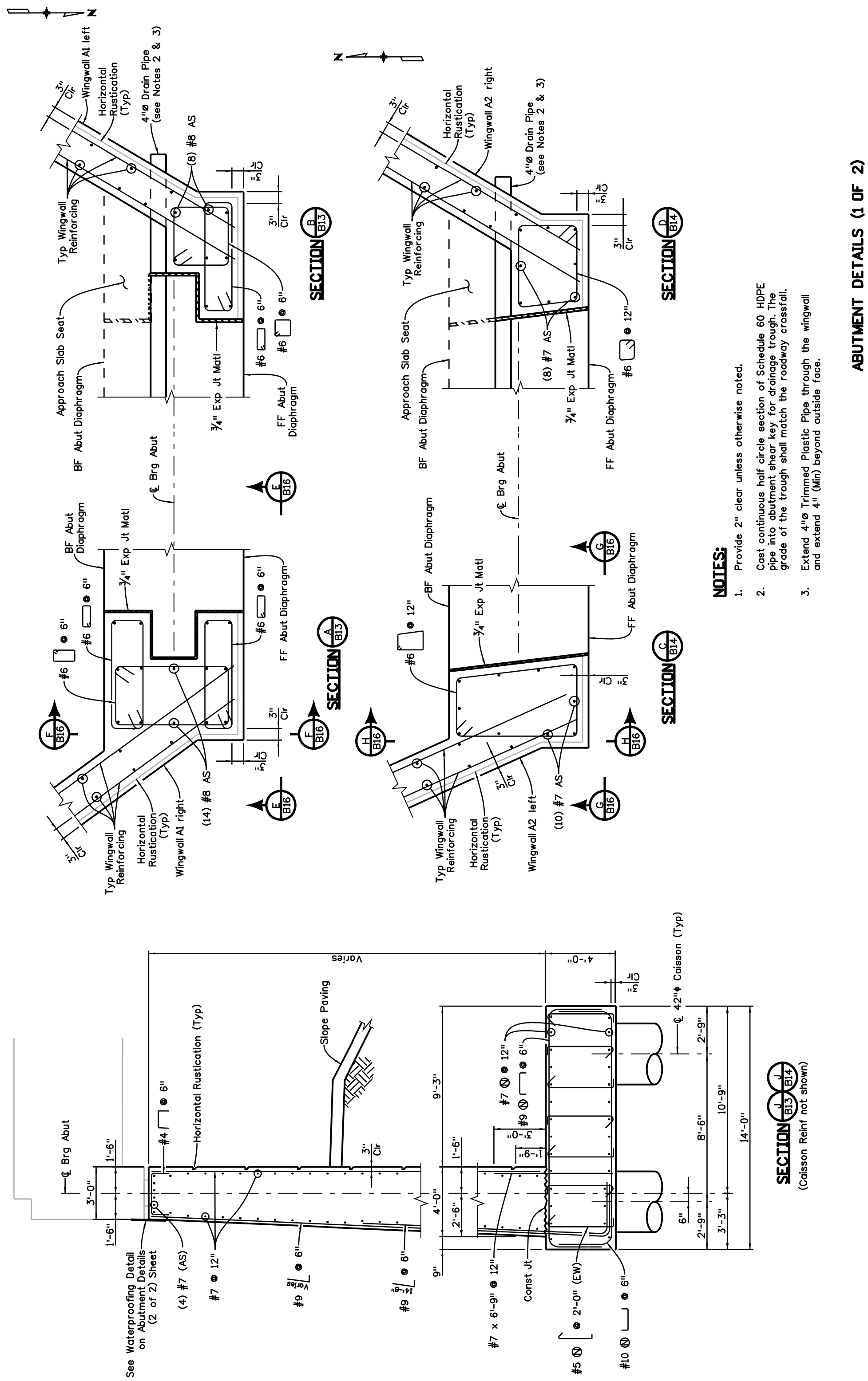


PLAN
ELEVATION
(Looking ahead station)
(Reinforcing for deck and wingwalls not shown for clarity)
NOTES
1. Abutment cap and diaphragm shall be Concrete Class D (Bridge).
2. Seat elevations are taken at intersection of ℄ Brg and ℄ Girder at top of concrete cap.
3. Field cut horizontal bars as necessary to clear girders.
4. For additional information, see "Abutment Details" and "Wingwall Details" sheets.
5. For top of caisson elevations see "Foundation Details" sheet.
ABUTMENT 4
SEAT ELEVATIONS
GIRDER	ELEVATION	GIRDER	ELEVATION
G1	4630.53	G8	4633.13
G2	4630.90	G9	4633.50
G3	4631.27	G10	4633.88
G4	4631.64	G11	4634.24
G5	4632.02	G12	4634.61
G6	4632.39	G13	4634.98
G7	4632.76	G14	4635.35
ANGLE A
GIRDER	ANGLE	GIRDER	ANGLE
G1	57° 33'00"	G8	58° 20'00"
G2	57° 40'00"	G9	58° 27'00"
G3	57° 46'00"	G10	58° 34'00"
G4	57° 53'00"	G11	58° 41'00"
G5	58° 00'00"	G12	58° 48'00"
G6	58° 07'00"	G13	58° 54'00"
G7	58° 14'00"	G14	59° 01'00"

Example 11-1

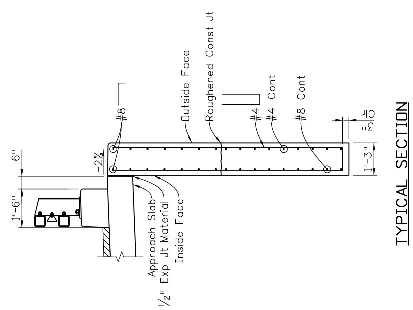

BEARING SEAT DETAIL
SECTION A
TYPICAL SECTION AT GIRDERS
(Similar to "Section Between Girders" except as noted)
TYPICAL SECTION BETWEEN GIRDERS
NOTES
1. Deck and abutment diaphragm above the bearing seat shall be placed monolithically.
KEYED NOTES
★ Thickness varies. Adjust with layers of 1/4" thick expansion joint material prior to abutment diaphragm concrete placement, as necessary to fill gap between girder and abutment cap. Cost of expansion joint material to be included in the work.
● See "Abutment 1" and "Abutment 4" sheets for dimension.

Example 11-2



SECTION A B13
SECTION B B13
SECTION C B14
SECTION D B14
SECTION J B13 J B14
(Caisson Reinf not shown)
NOTES:
1. Provide 2" clear unless otherwise noted.
2. Cast continuous half circle section of Schedule 60 HDPE pipe into abutment shear key for drainage trough. The grade of the trough shall match the roadway crossfall.
3. Extend 4"ø Trimmed Plastic Pipe through the wingwall and extend 4" (Min) beyond outside face.
ABUTMENT DETAILS (1 OF 2)

Example 11-3



ELEVATION SUMMARY

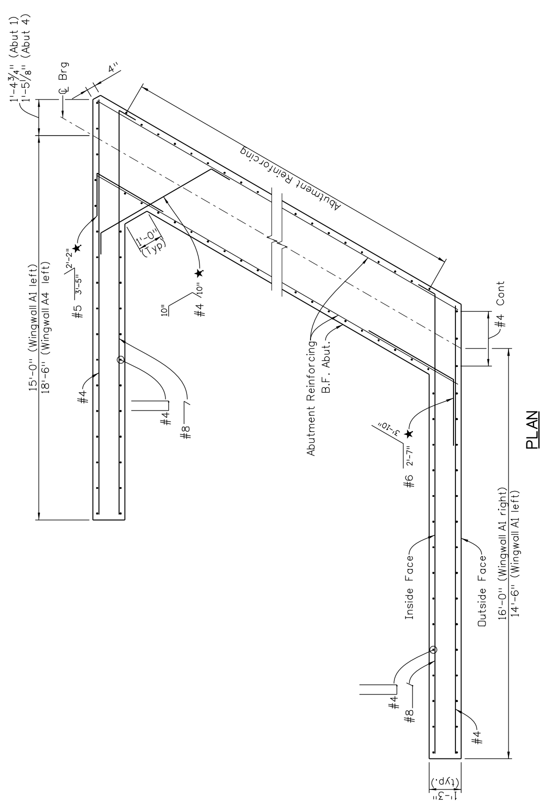
WINGWALL	ELEV. A	ELEV. B	ELEV. C	ELEV. D
A	4633.51	4633.64	4628.77	4623.77
B	4634.47	4634.84	4629.93	4624.93
C	4635.35	4635.25	4630.53	4625.53
D	4640.59	4640.42	4635.35	4629.10

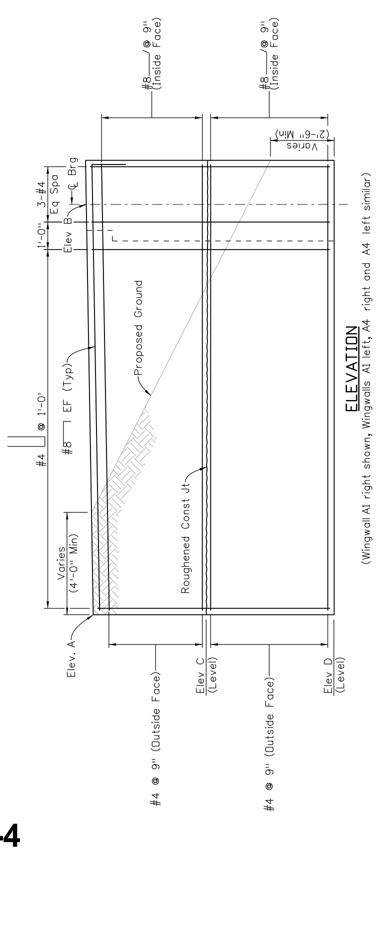
NOTES

1. Wingwall elevations are taken at Outside Face.
2. Concrete shall be Concrete Class D (Bridge).

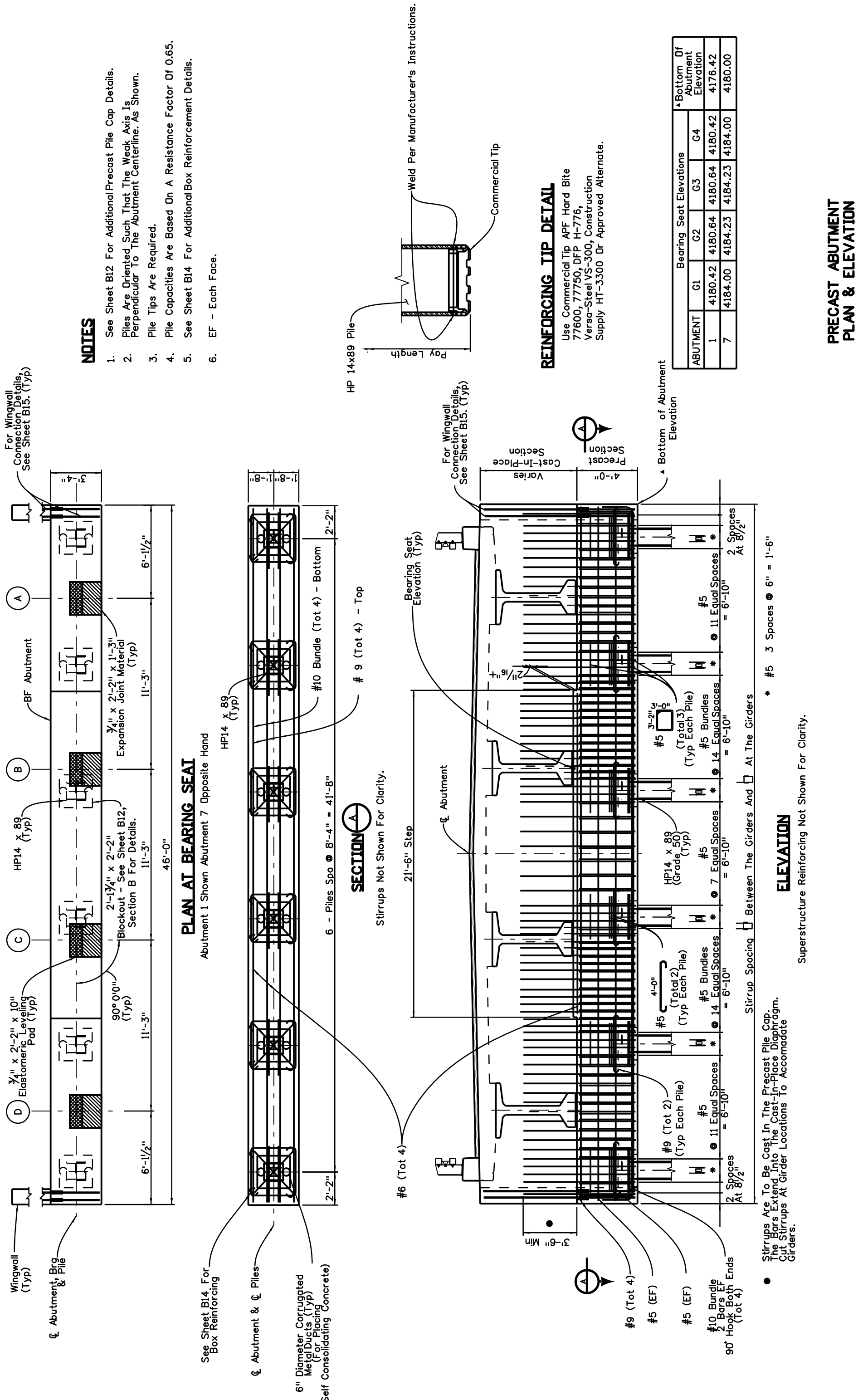
KEYED NOTES

★ Space with abutment reinforcing.



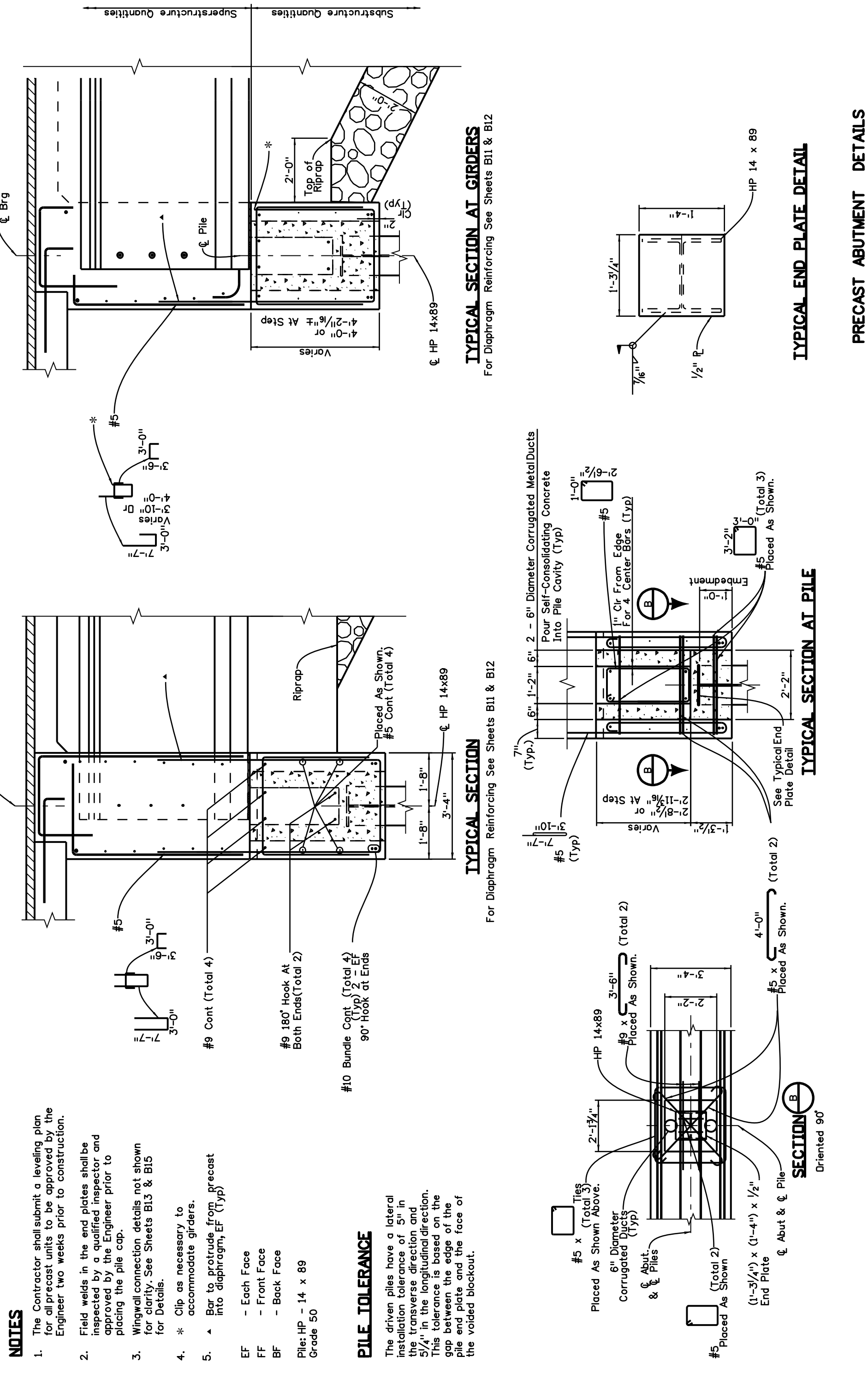


Example 11-4



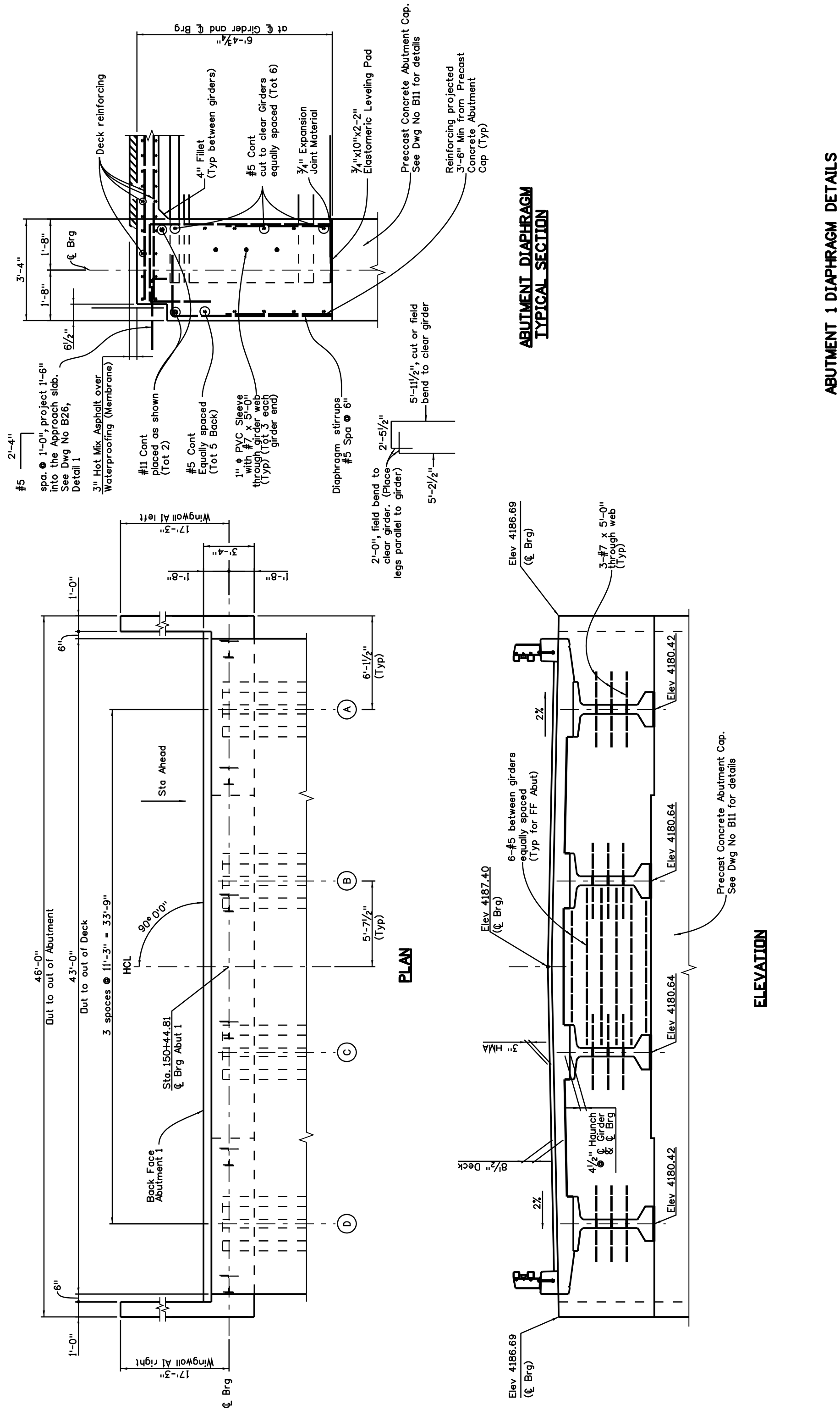
ABUTMENT	Bearing Seat Elevations G1	G2	G3	G4	▲Bottom Of Abutment Elevation
1	4180.42	4180.64	4180.64	4180.42	4176.42
7	4184.00	4184.23	4184.23	4184.00	4180.00

Example 11-5



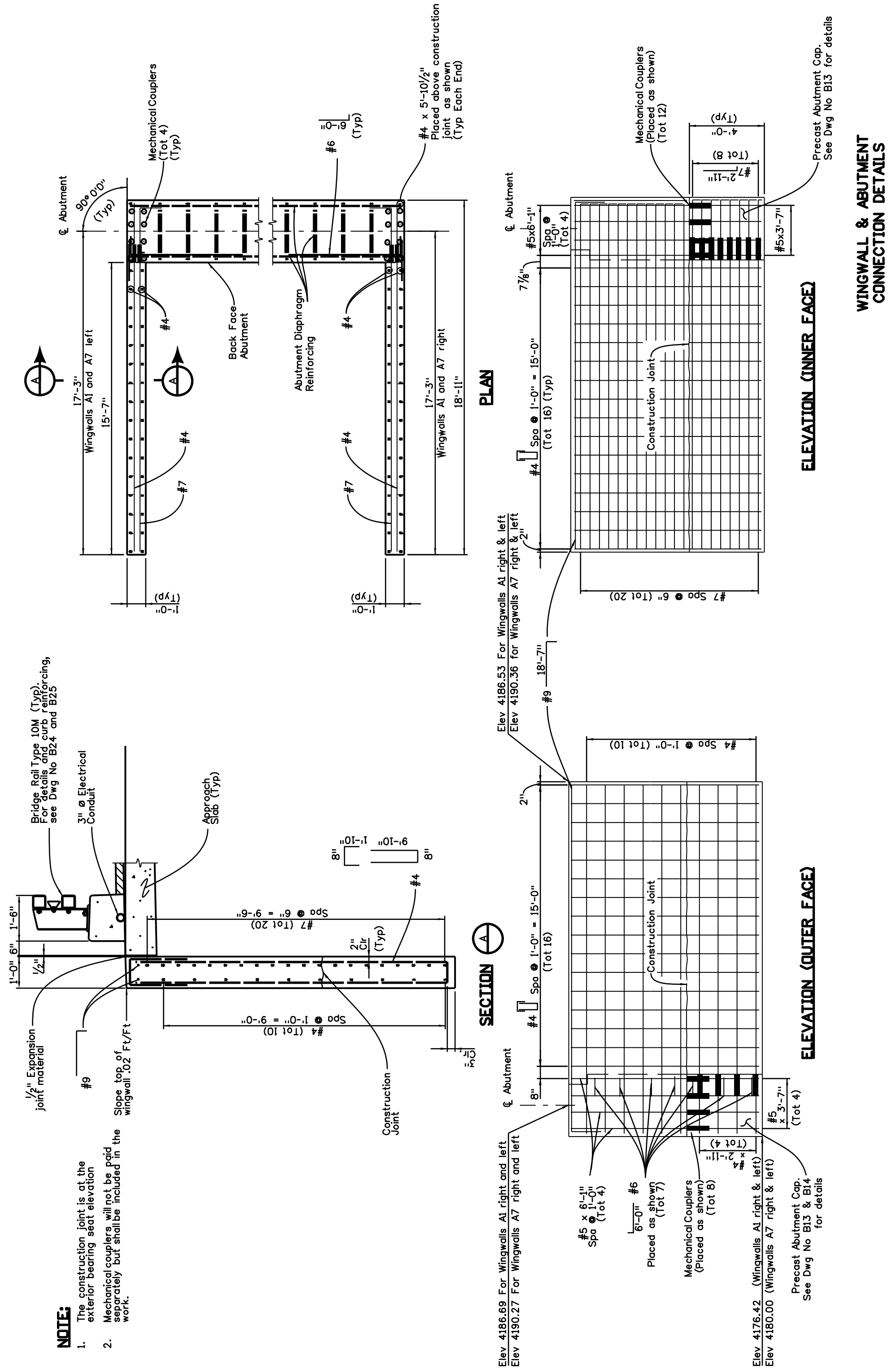
PRECAST ABUTMENT DETAILS
TYPICAL SECTION AT GIRDERS
For Diaphragm Reinforcing See Sheets B11 & B12
TYPICAL SECTION
For Diaphragm Reinforcing See Sheets B11 & B12
TYPICAL SECTION AT PILE
TYPICAL END PLATE DETAIL
SECTION B
Oriented 90°
Superstructure Quantities
Substructure Quantities
NOTES
1. The Contractor shall submit a leveling plan for all precast units to be approved by the Engineer two weeks prior to construction.
2. Field welds in the end plates shall be inspected by a qualified inspector and approved by the Engineer prior to placing the pile cap.
3. Wingwall connection details not shown for clarity. See Sheets B13 & B15 for Details.
4. * Clip as necessary to accommodate girders.
5. ▲ Bar to protrude from precast into diaphragm, EF (Typ)
EF - Each Face
FF - Front Face
BF - Back Face
Pile: HP - 14 x 89 Grade 50
PILE TOLERANCE
The driven piles have a lateral installation tolerance of 5" in the transverse direction and 5¼" in the longitudinal direction. This tolerance is based on the gap between the edge of the pile end plate and the face of the voided blockout.

Example 11-6



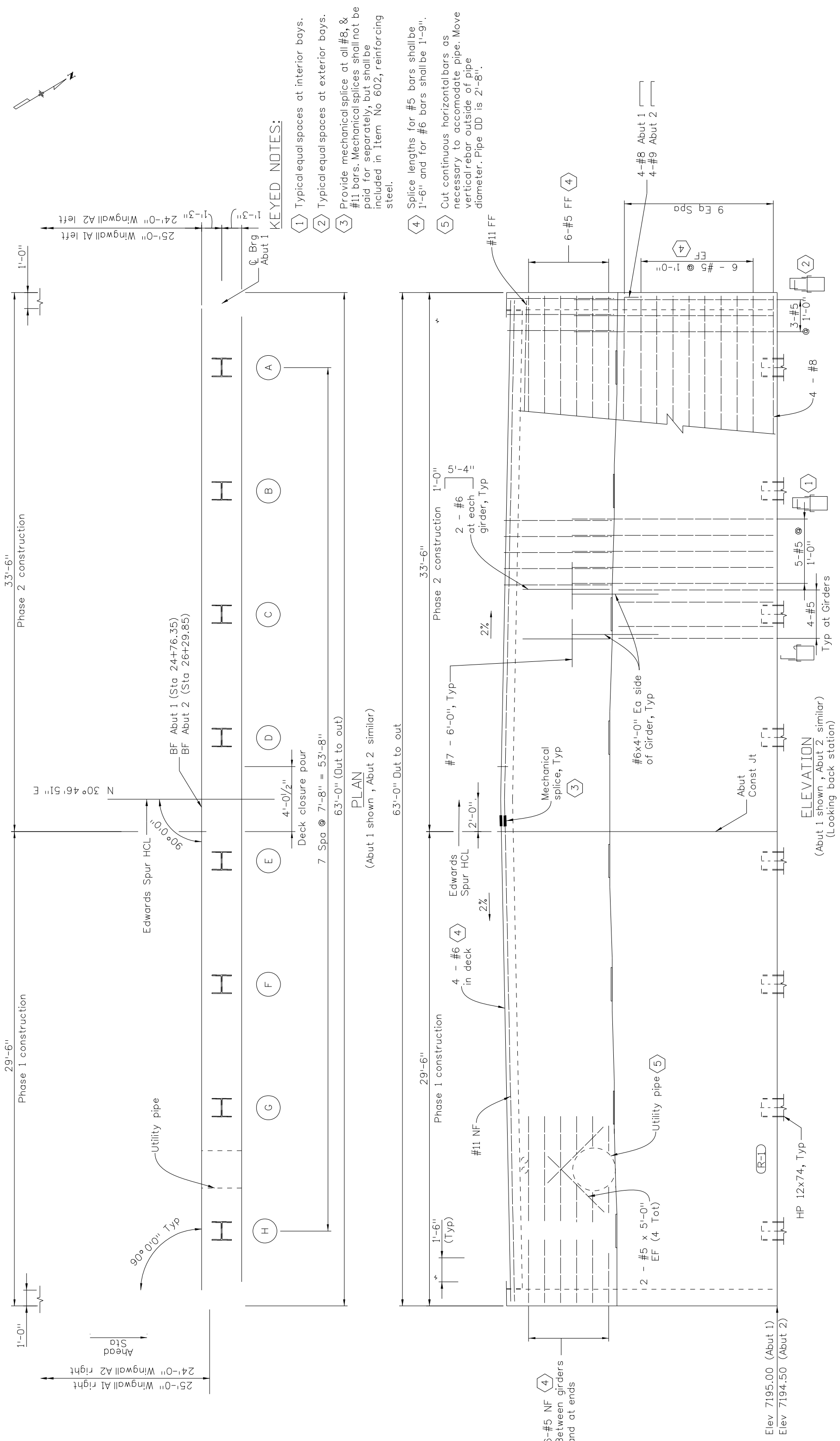
ABUTMENT 1 DIAPHRAGM DETAILS
ABUTMENT DIAPHRAGM TYPICAL SECTION
PLAN
ELEVATION

Example 11-7



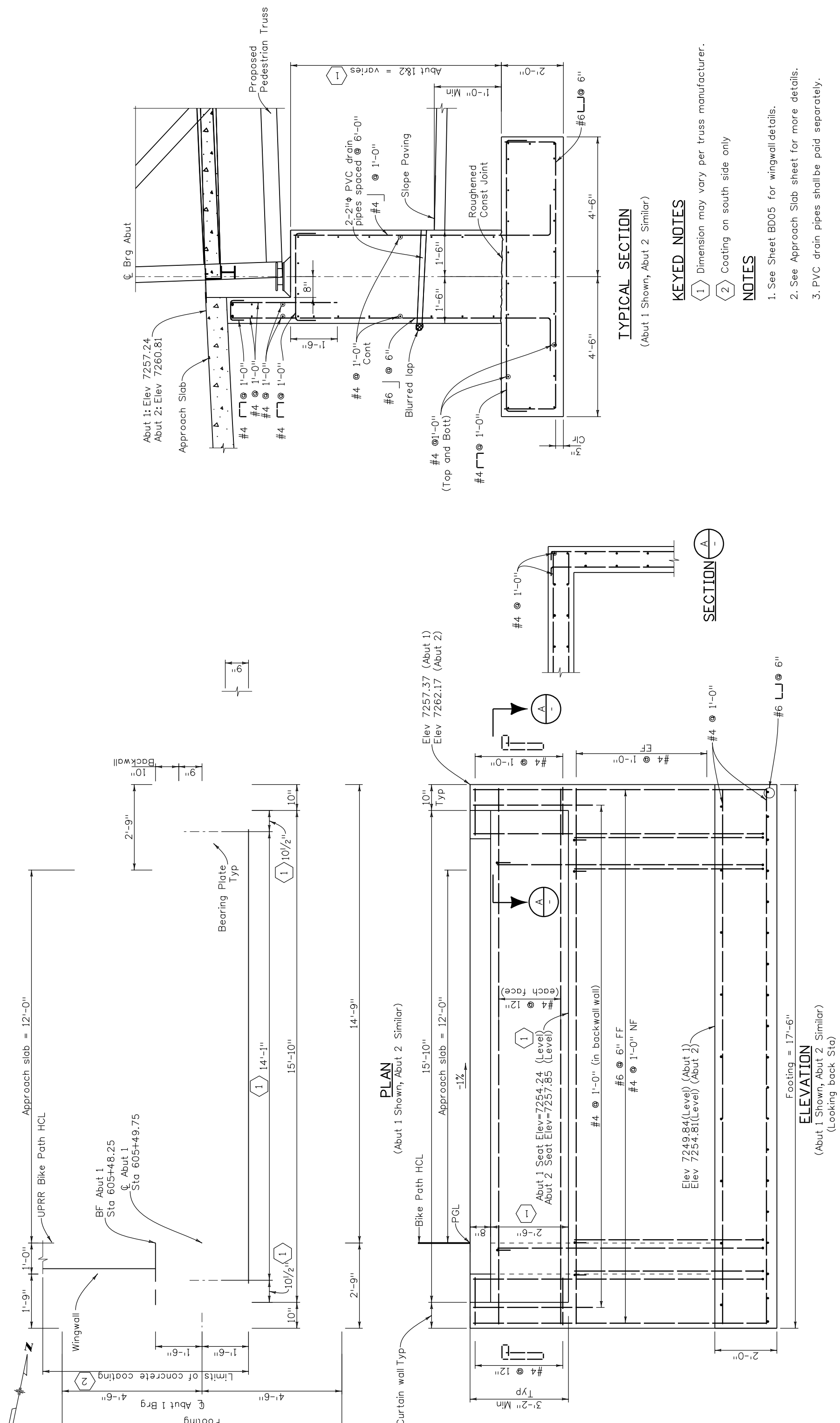
PLAN
SECTION A
ELEVATION (INNER FACE)
ELEVATION (OUTER FACE)
WINGWALL & ABUTMENT CONNECTION DETAILS
NOTE:
1. The construction joint is at the exterior bearing seat elevation
2. Mechanical couplers will not be paid separately but shall be included in the work.
Mechanical Couplers (Tot 4) (Typ)
Back Face Abutment
Abutment Diaphragm Reinforcing
Wingwalls A1 and A7 left
Wingwalls A1 and A7 right
Construction Joint
Precast Abutment Cap. See Dwg No B13 for details
Precast Abutment Cap. See Dwg No B13 & B14 for details
Bridge Rail Type 10M (Typ). For details and curb reinforcing, see Dwg No B24 and B25
3" ⌀ Electrical Conduit
Approach Slab (Typ)
½" Expansion joint material
Slope top of wingwall .02 Ft/Ft
Elev 4186.53 For Wingwalls A1 right & left
Elev 4190.36 for Wingwalls A7 right & left
Elev 4186.69 For Wingwalls A1 right and left
Elev 4190.27 For Wingwalls A7 right and left
Elev 4176.42 (Wingwalls A1 right & left)
Elev 4180.00 (Wingwalls A7 right & left)

Example 11-8



KEYED NOTES:
1 Typical equal spaces at interior bays.
2 Typical equal spaces at exterior bays.
3 Provide mechanical splice at all #8, & #11 bars. Mechanical splices shall not be paid for separately, but shall be included in Item No 602, reinforcing steel.
4 Splice lengths for #5 bars shall be 1'-6" and for #6 bars shall be 1'-9".
5 Cut continuous horizontal bars as necessary to accomodate pipe. Move vertical rebar outside of pipe diameter. Pipe OD is 2'-8".
PLAN
(Abut 1 shown , Abut 2 similar)
ELEVATION
(Abut 1 shown , Abut 2 similar)
(Looking back station)

Example 11-9



Example 11-10

Pier Details

12.1 Purpose

These drawings are to present graphically all pertinent information necessary in the field construction of this segment of the structure.

12.2 Responsibility

The graphic presentation of information on these drawings shall be the responsibility of the individual preparing the drawings in addition to the designer.

12.3 Scales

Scales shall be used that are suitable to make the details legible when the drawing is reduced. Suggested scales for presenting the details of the piers are as follows:

A) Plan and Elevations - 1”=10’, 1”=20’, 1”=30’.
B) Sections - 1/8"=1’-0”, 1/4” = 1’-0”, 1/2"=1’-0”, 3/4"=1’-0”, etc.
C) The Elevation of an opposite hand detail may be drawn to a smaller scale.

12.4 Orientation of Details

The PLAN of the pier shall be placed, if possible, at upper left of the drawing.

The ELEVATION of the pier shall be projected below the PLAN. When possible, the pier TYPICAL SECTION shall be placed to the right of the pier PLAN and ELEVATION. If space is limited, the sections or auxiliary views may be shown on another sheet.

Generally, sections should be taken from the PLAN and ELEVATION rather than from auxiliary views or other sections.

12.5 Opposite Hand Details

Piers are shown as ahead station and “opposite hand” details shall be avoided where possible. If needed, two preferred methods are as follows:

A) Re-detail opposite hand pier.
B) Detail the ELEVATION of the opposite hand pier to a smaller scale.

12.6 Horizontal Control Line

The horizontal control line shall be shown on the PLAN and labeled consistently with the plans. Example: “HCL”, “Survey Line”, “Project Line”, etc.

12.7 Layout Line

For structures on tangent, the layout line shall coincide with the horizontal control line.

For structures located on a curve, the layout line shall be shown on the PLAN and labeled consistently with the plans. Example: “Tangent from TS Sta 31+48.00”, “Chord from POC Sta 38+41.08 to PT Sta 39+78.00”, “Tangent from POC Sta 382+10.00”, etc.

12.8 Stationing

A station shall be placed at the intersection of the horizontal control line with the centerline of the pier.

All stations on the “Pier Details” shall be given to two decimal places.

The direction of stationing shall be indicated on the plan view as “Station Ahead”.

12.9 Centerlines

Centerlines shall be identified and shown as discussed in the following subsections:

A) Location - Centerlines shall be shown at the following locations, when applicable.
   1) Plan View
      a) Centerline of pier
      b) Centerline of all girders
      c) Centerline of all bearings
      d) Centerline of roadway
      e) Centerline of columns and footings
      f) Typical centerline of anchor bolts or bearing pads.
   2) Elevation View
      a) Centerline of caissons
      b) Centerline of columns and footings
   3) Section Through Pier
      a) Centerline of bearings
      b) Centerline of caissons
      c) Centerline of columns and footings

B) Identification - The centerlines shown on the pier details shall be identified in the following ways:
   1) Centerline of Girder - A circle containing the girder letter shall be placed at the end of each outside girder centerline, as shown in the PLAN views of the abutments in the graphic examples. If the bridge is a simple multi-span bridge, a circle containing the span number and girder letter is preferred, ie. 1A, 2D, 3C, etc. For continuous or single span bridges, a circle containing only the

girder letter shall be used. These girder number shall correspond to those shown on the “Construction Layout”.

2) Other Centerlines - When it is applicable to identify some of the other centerlines, it should be done by using their particular names. Examples: Centerline Bearing, Centerline Anchor Bolts, Centerline Columns, Centerline Footings, etc.

12.10 Elevations

All elevations shown on the “Pier Details” shall be to two decimal places. Example: 80.25; except bottom of footings, which shall be to one decimal place. Example: Elev 5280.3.

The elevations given at the bottom of footings shall consist of all the significant figures preceding the decimal point. The other elevations on the drawing shall display only two digits preceding the decimal point. Example: Elev 80.28.

A) Location - Elevations shall be shown on the ELEVATION view of the pier at the following locations, when applicable:
1) Top of bearing seats.
2) End of pier cap on the bottom face.
3) Top of columns at the centerline of column.
4) Bottom of footings or wall.
    a) The basic footing elevation are provided on the design notes. The detailer shall make sure that the footing elevations correspond to the information described in the design notes. The top of the footing should be kept 2 feet minimum below ground line. The bottom of footings shall be held as close to 6 feet below the stream bed as possible. In order that pier columns may have the same height, it is permissible to vary the bottom footing elevations where possible, as long as these elevations do not differ by more than 1’-0”.

12.11 Pier Cap Slopes

The top of the pier cap should be sloped, rather than stepped, between bearing seats to maintain, as nearly as possible, the 2-inch clearance to pier cap reinforcing steel.

12.12 Dimensions

A sufficient number of dimensions shall be shown on the details to provide adequate information necessary in the checking of the plans and the construction of the pier.

The following list of common dimension, in feet and inches (to the nearest 1/8 inch), shall be shown on the details (except as noted).

A) Plan View of Pier
   1) Outside of pier cap to outside of pier cap, along centerline of pier.
   2) Layout line to outside of pier cap, along centerline of pier.
   3) Typical girder spacing (given in decimals to a thousandth of a foot).
   4) Layout line to nearest girder, along centerline of bearings (given in decimals to a thousandth of a foot).
   5) Horizontal control line to layout line, along centerline of pier, for structures on a horizontal curve (given in decimals to hundredth of a foot).
   6) Centerline of pier to centerline of bearing.
   7) Outside of pier footing to outside of pier footing, along centerline of pier.
   8) Outside of pier footing to layout line.
   9) Bearing seats.

B) Typical Section Through Pier
   1) Cap width, tie to centerline of pier.
   2) Minimum cap height.
   3) Wall or column width or diameter.
   4) Wall or column height, if constant height.
   5) Footing width and height, when applicable, tie to centerline pier.
   6) Pile projection into footing
   7) Top of footing to bottom layer of reinforcing

12.13 Angles

The following angles shall be shown in the PLAN view of the pier, when applicable.

A) Skew angle (nearest second).

B) Angles that the girders generate with the centerline of pier or centerline of bearings, if they are different than the skew angle.

12.14 Anchor Bolts

When applicable, anchor bolts or bearing pads shall be shown in the PLAN of the pier or in a separate detail. The skew angle shall be shown to the nearest minute. See anchor bolt note.

12.15 Piling

When applicable, piling shall be shown but not dimensioned in the PLAN, ELEVATION, and SECTION THROUGH PIER.

12.16 Pier Nose Angle

The following statements pertain to pier nose angles, and are to be used when applicable:

A) Nose angles shall be shown in the ELEVATION and SECTION.
B) The size and length of the angle shall be shown in a separate detail, as described in the designer's notes.
C) Angles are to be placed on the upstream side of the bridge only. See typical pier nose angle note.

12.17 Reinforced Concrete Details

The reinforced concrete details shall be made in accordance with the design notes and current standard practice. The statements listed below are to be followed when applicable.

A) The footings shall be shown in the PLAN, ELEVATION, and SECTION views of the pier.
B) All construction keys shall be raised.
C) On parabolic T-girders, with a hinge action at the piers, the concrete key shall be placed up on the top or bottom of the column or wall and dimensioned.
D) When detailing columns, the following notation shall be added to the column ties: "Rotate Splices".
E) The clearance on intersecting planes of steel shall be checked. It is important to make sure that the vertical column bars that are projected into the pier cap will clear the horizontal bars in the bottom of the cap. It is also important to make sure all reinforcing called out fits within the designed area. Due to the problem of incorporating the necessary reinforcing in pier caps for continuous parabolic T-girder and concrete box girder bridges, special attention shall be given to the amount of reinforcing steel in the cap. This amount should be reviewed to ensure that there is ample clearance. Allowance should be made for the deformations (ridges) on the reinforcing steel. Do not show any of the superstructure on the pier detail drawings. The pier diaphragm and superstructure should be shown on the superstructure drawings. The expansion material may be shown on the pier details.
F) A section view of the pier cap showing reinforcement placement accounting for the column reinforcing is required. Including a shaded depiction of the extended column reinforcing is preferred. Alternately, a plan view of the column reinforcing showing the longitudinal cap reinforcing threading through the bars would be acceptable.

G) When cutting off bars in cantilever pier caps, the reinforcing steel shall extend into the cap to achieve the minimum development length required.

H) Show only the first two vertical and horizontal lines of reinforcement to avoid the detail appearing cluttered.

Refer to the appropriate section of Chapter 4 for additional information concerning bar clearances, spacing, splicing, embedment, projections, etc.

12.18 Check Items

Listed below is a summary of items that shall be checked and appear on the drawing, when applicable. Additional information shall appear, as required.

A) Project number in proper location.
B) Label Horizontal Control Line in the PLAN view.
C) Layout Line, in the PLAN view.
D) Stationing.
E) Location and identification of centerlines.
F) Elevations.
G) All necessary dimensions.
H) Skew angle of bridge and other pertinent angles.
I) Anchor Bolts and note.
J) Show footings in the PLAN view as well as in the SECTION and ELEVATION.
K) Pier nose angle.
L) Check all intersecting planes of reinforcing steel for the proper clearances.
M) Check bearing plates to insure that they fit properly at the piers. See Figure 11-2
N) Bearing pads (leveling pads may be shown on these pier details).
O) Title PLAN, ELEVATION, and SECTION in accordance with their particular conditions.
P) Check for typical notes.
Q) Check title block for information.
R) Limits of concrete coating/stain shown.
S) Haunch dimensions, if applicable.
T) Jacking details for future jacking when applicable.

12.19 Title Block

This drawing is entitled “PIER DETAILS” and shall be so indicated in the title block. The pier numbers may be included in the title, such as “PIER 2 AND 3 DETAILS”.

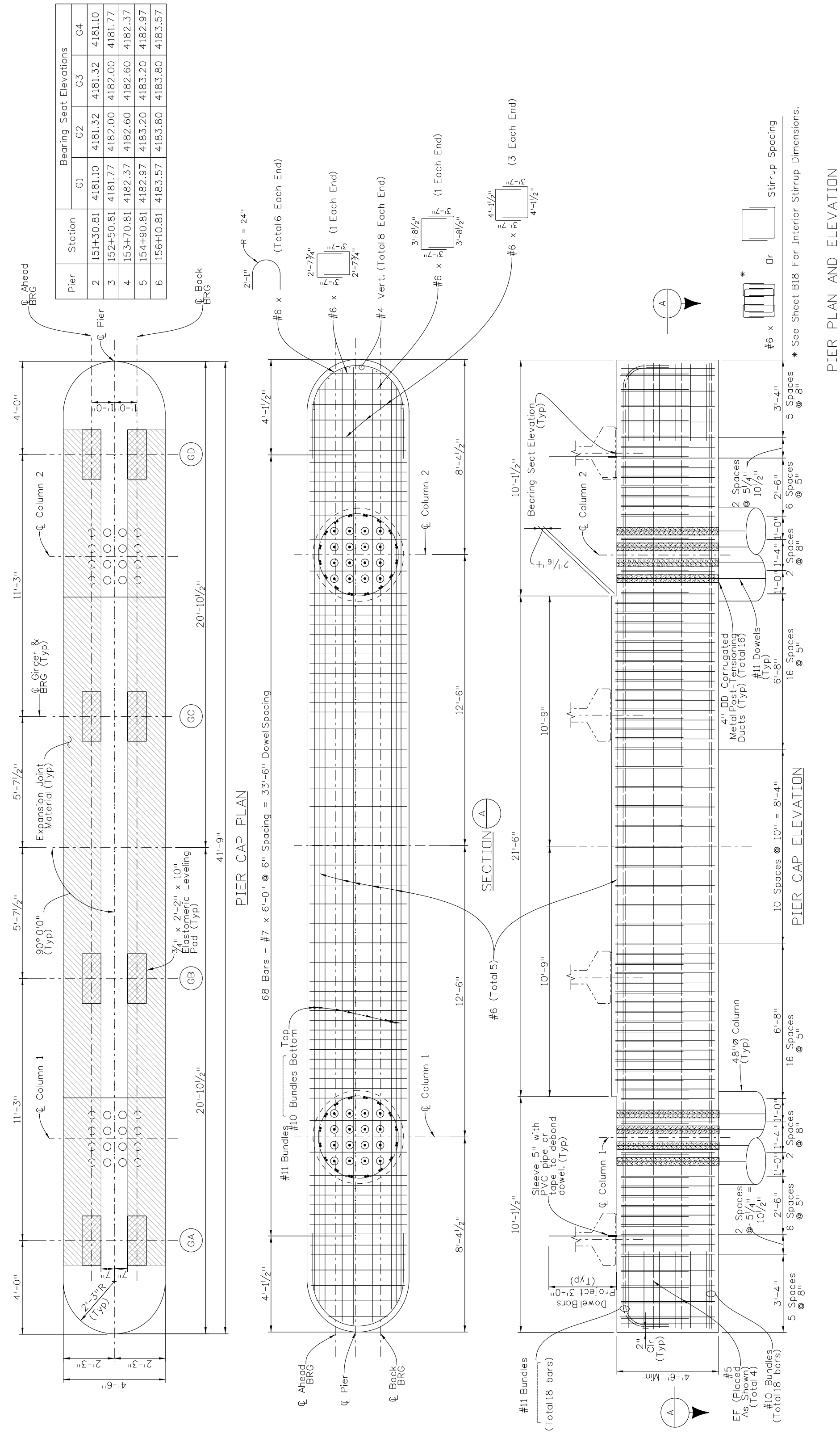
If other details are combined on this drawing, they shall be indicated in the title. Example: If the “Abutment Details” are placed on this drawing with the “Pier Details”, the title shall be “ABUTMENT DETAILS - PIER DETAILS”.

The structure number and the first initial and last name of the designer and detailer shall be filled in on each sheet.

12.20 Typical Notes

The following notes shall appear on the drawing when applicable:

A) Anchor Bolt Note - “Anchor Bolt _____” Φ X _____ Long.
B) (Project _____)”
C) Column Tie Bar Note - “Rotate Splices”
D) Pier Nose Angle Note - “Pier nose angle on upstream end only.”
E) Pour crash wall monolithically with pier wall.
F) Column reinforcing projection Note – “Column reinforcing (____ projection into cap)”



Pier	Station	G1	G2	G3	G4
2	151+30.81	4181.10	4181.32	4181.32	4181.10
3	152+50.81	4181.77	4182.00	4182.00	4181.77
4	153+70.81	4182.37	4182.60	4182.60	4182.37
5	154+90.81	4182.97	4183.20	4183.20	4182.97
6	156+10.81	4183.57	4183.80	4183.80	4183.57

Example 12.1

NOTES

1. Provide 2'-0" Extra Length For Spiral Cage And Vertical Bars To Account For Variation In Bedrock Elevation. Field Cut As Needed And Use Mechanical Splice To Secure The Ends Of The Spiral Cage As Shown In The Caisson Details.
2. Spiral Cage Shall Use Mechanical Splices To Form A Continuous Spiral.
3. Steel Casing Shall Be Used. It Shall Be Included In Item 503-00060 Drilled Caisson.
4. Caisson Design Is Based On Side Shear And End Bearing With An End Bearing Resistance Factor Of 0.5 And A Side Shear Resistance Factor Of 0.5.
5. Proper Placement Of Precast Members Is Critical. The Use Of Jigs And Templates Are Encouraged. Excavation Between Caissons is Necessary To Accommodate Jigs and Templates.
6. The Contractor Shall Survey The Tops Of Each Precast Member After Placement. The Tops Of Member Elevations And Orientation Shall Be Verified At Each Phase Of Construction Prior To Adding Additional Elements. Adustments To Elevations Shall Be Made By Adjusting Grout Pad Thicknesses. The Use Of Shims Or Leveling Bolts Is Recommended.
7. The Length Of Dowel Bars Protruding From the Top Of The Caisson Depends On The Grout Pad Thickness And The Manufacturer's Recommendations For Embedment Into The Mechainical Grout Coupler. The Contractor Shall Determine This Length Prior To Pouring The Caisson.
8. In Order To Maintain Min. Clearance Between The Reinforcing and the Mechanical Grout Couplers, The Coupler Diameter (Out To Out) Should Be Limited To 3½" Max.
9. The Contractor shall submit a leveling plan for all precast units to be approved by the Engineer two weeks prior to construction.
10. The six ties specified for the dowel cages in the caissons and columns are suggested only. The ties are non-structural. The intent is to provide integrity during cage placement.
11. Final top of column elevations should include grout pad thicknesses. Precast column lengths should take into account allowances for ½" minimum grout pad thicknesses at the top and bottom of the columns.
12. As a minimum, the dowel bars into the cap shall extend the full height of the caps. The bars should extend through the cap and then cut flush with the top of the cap. The use of ultra high preformance concrete may be used as a grout alternative to shorten dowel development length. If this method is used the Contractor shall submit the shortened dowel length to the Engineer for approval prior to construction.

TOLERANCES

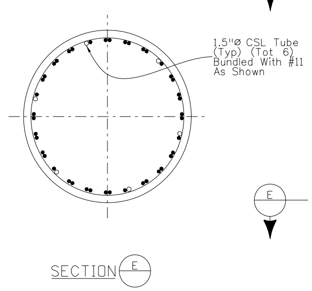
The Centerline Of The Caisson Dowel Cage Shall Be Within ± 1 ½" In Any Direction From That Shown On The Plans.

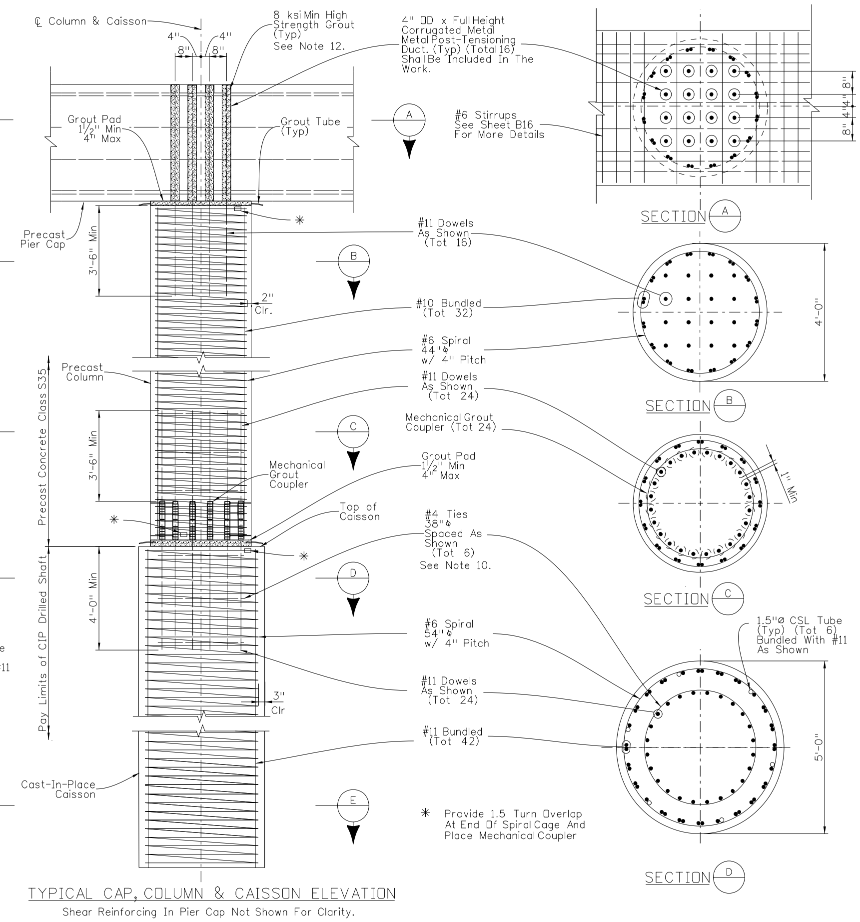
A 1½" Column Tolerance Is The Sum Of The Gaps At Top And Bottom Of The Columns. The Gap At The Bottom Of The Column Is Between The #11 Dowel Bars And The Inside Face Of The Mechanical Grout Couplers. The Gap At The Top Column Is Between The Face Of The #11 Dowel Bars And The Inside Face Of The 6" Duct In The Cap.

Tolorance At The Top Of The Column Is Based On The Selection Of The Mechanical Grout Coupler. The Assumed Tolerance Due To The Mechanical Couplers Is ¼".

Location	Bottom Of Cap Elevations (Ft)
Pier 2	4176.60
Pier 3	4177.27
Pier 4	4177.87
Pier 5	4178.47
Pier 6	4179.07

See Note 11.



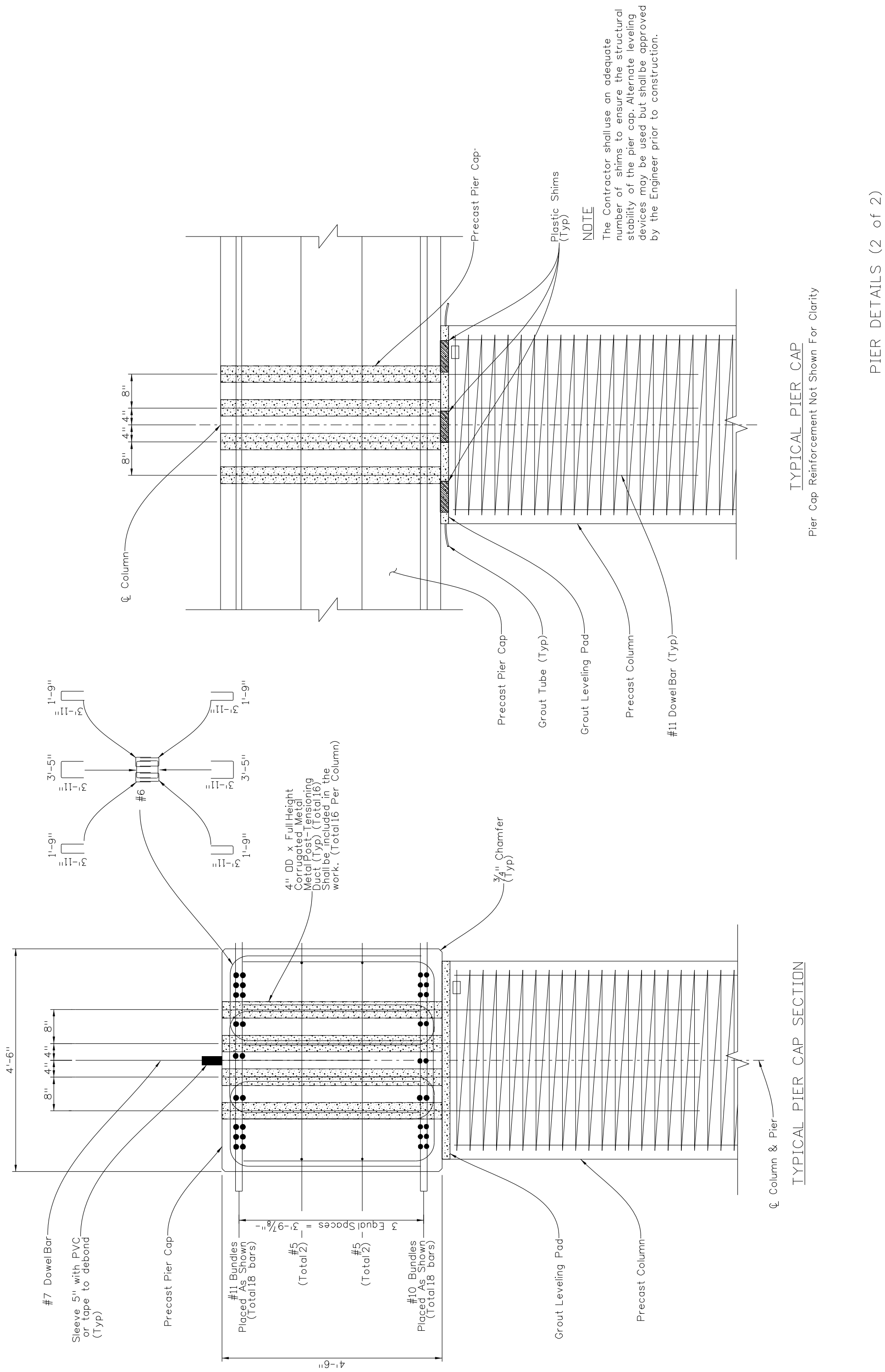


TYPICAL CAP, COLUMN & CAISSON ELEVATION

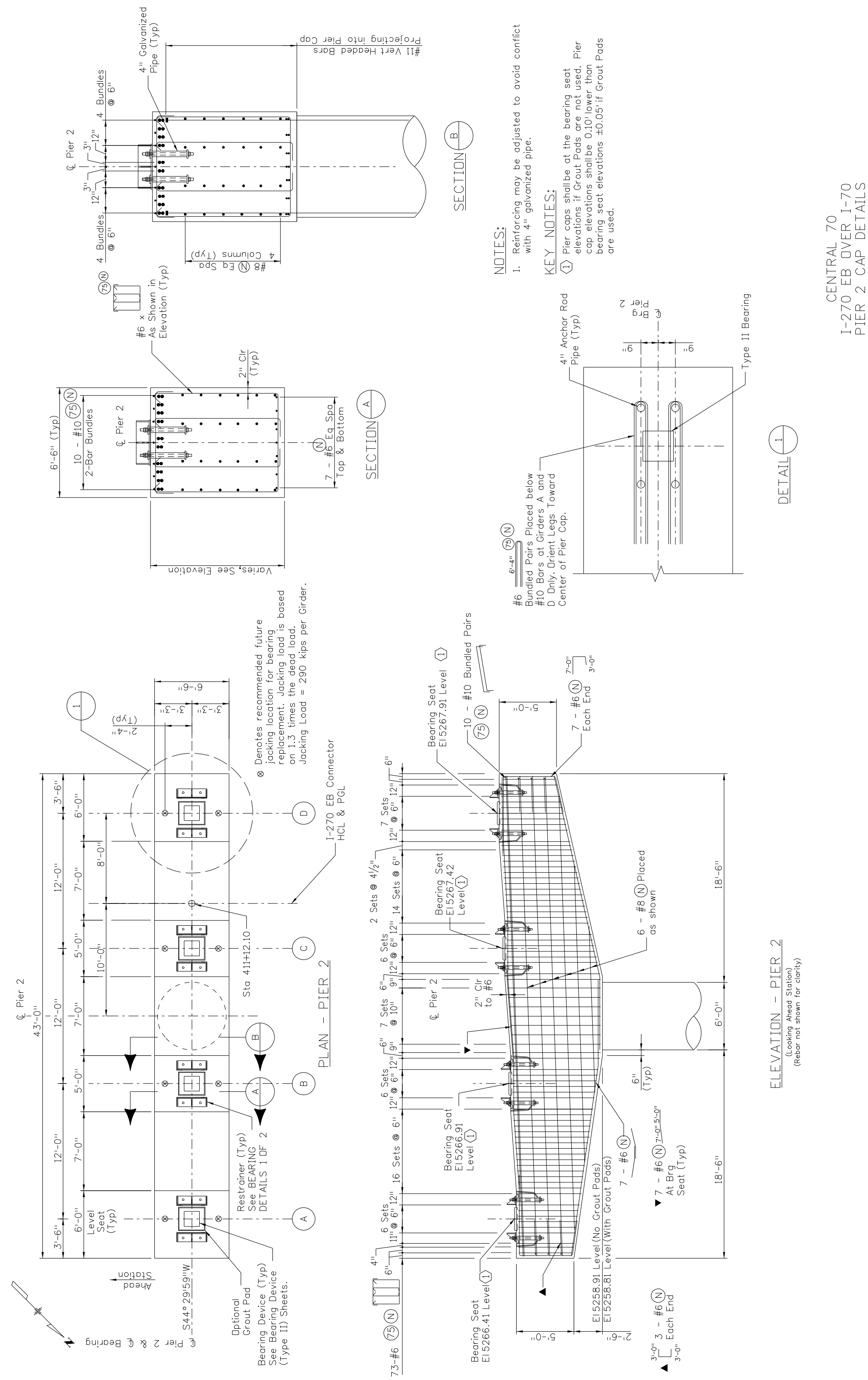
Shear Reinforcing In Pier Cap Not Shown For Clarity.

PIER DETAILS (1 OF 2)

Example 12.2

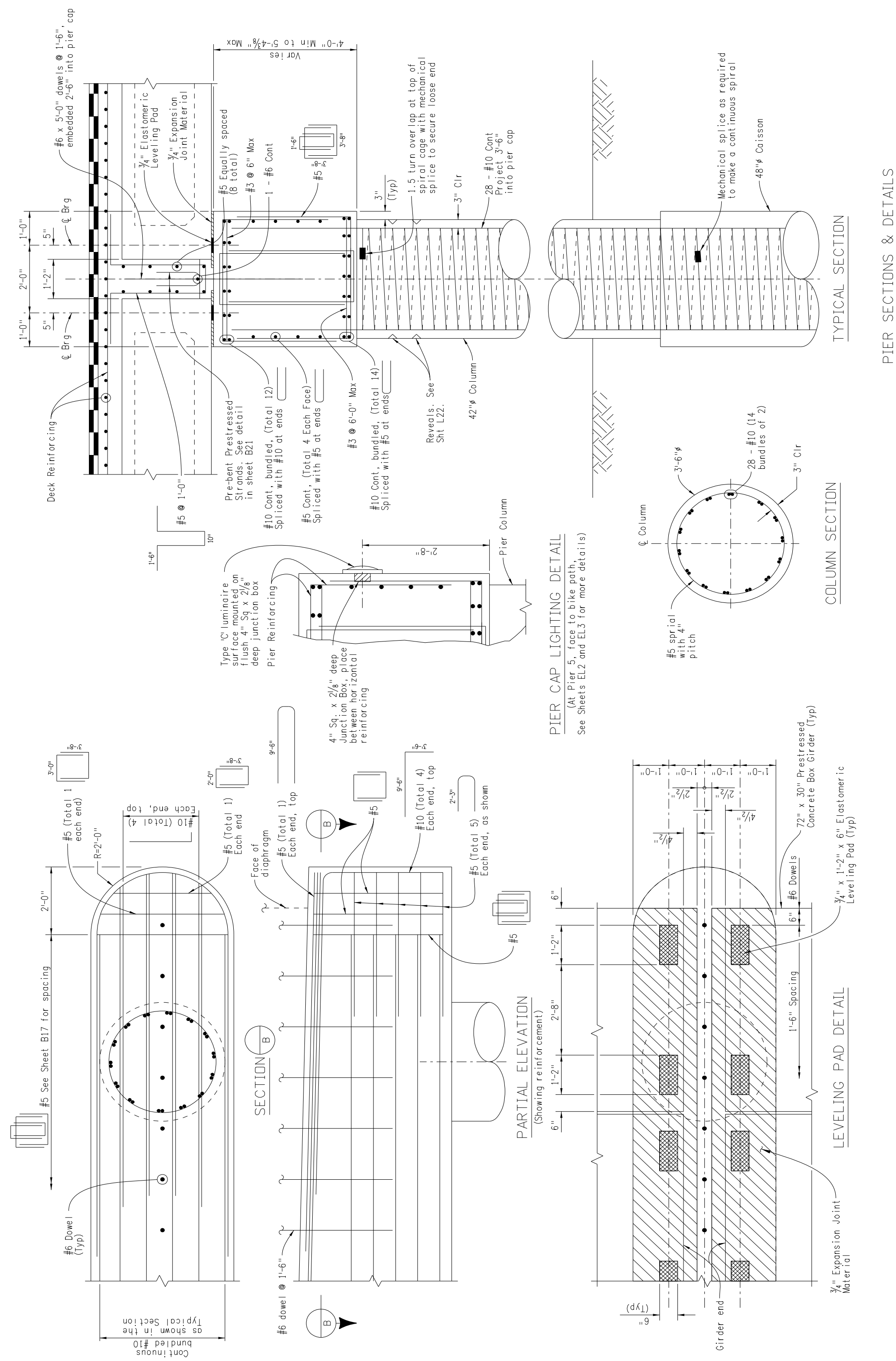

PIER DETAILS (2 of 2)
TYPICAL PIER CAP
Pier Cap Reinforcement Not Shown For Clarity
NOTE
The Contractor shall use an adequate number of shims to ensure the structural stability of the pier cap. Alternate leveling devices may be used but shall be approved by the Engineer prior to construction.
Precast Pier Cap
Plastic Shims (Typ)
℄ Column
Grout Tube (Typ)
Grout Leveling Pad
Precast Column
#11 Dowel Bar (Typ)
8" 4" 4" 8"
#6
1'-9" 3'-11"
3'-5"
4" OD x Full Height Corrugated Metal Post-Tensioning Duct (Typ) (Total 16) Shall be included in the work. (Total 16 Per Column)
¾" Chamfer (Typ)
TYPICAL PIER CAP SECTION
℄ Column & Pier
4'-6"
#7 Dowel Bar
Sleeve 5" with PVC or tape to debond (Typ)
#11 Bundles Placed As Shown (Total 18 bars)
#5 (Total 2)
#10 Bundles Placed As Shown (Total 18 bars)
3 Equal Spaces = 3'-9⅞"

Example 12.3



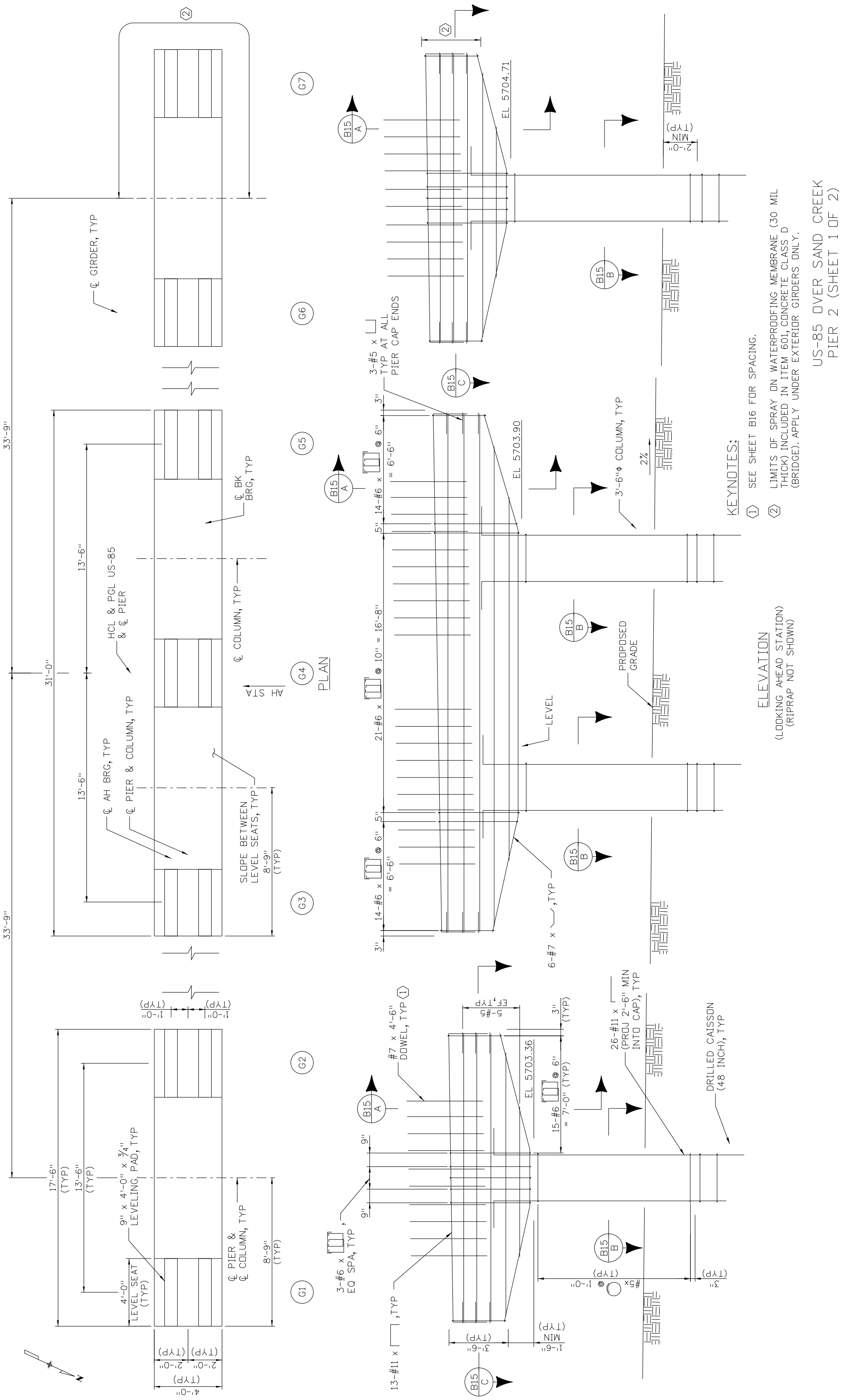
SECTION A
SECTION B
PLAN - PIER 2
ELEVATION - PIER 2
(Looking Ahead Station)
(Rebar not shown for clarity)
DETAIL 1
NOTES:
1. Reinforcing may be adjusted to avoid conflict with 4" galvanized pipe.
KEY NOTES:
1 Pier caps shall be at the bearing seat elevations if Grout Pads are not used. Pier cap elevations shall be 0.10' lower than bearing seat elevations ±0.05' if Grout Pads are used.
CENTRAL 70
I-270 EB OVER I-70
PIER 2 CAP DETAILS

EXAMPLE 12.4



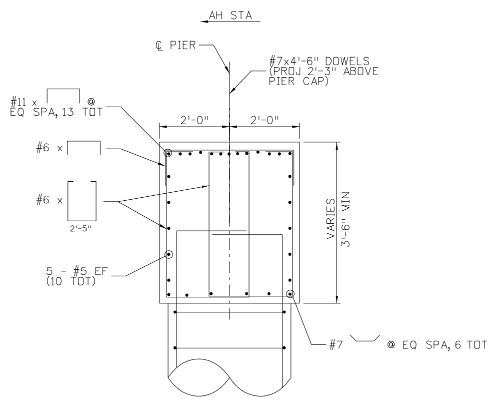
TYPICAL SECTION
PIER SECTIONS & DETAILS
COLUMN SECTION
PIER CAP LIGHTING DETAIL
(At Pier 5, face to bike path,
See Sheets EL2 and EL3 for more details)
SECTION B
PARTIAL ELEVATION
(Showing reinforcement)
LEVELING PAD DETAIL

EXAMPLE 12.5

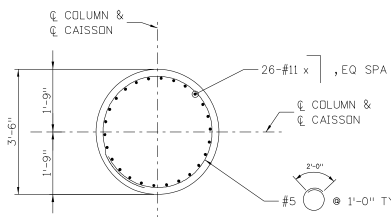


PLAN
ELEVATION
(LOOKING AHEAD STATION)
(RIPRAP NOT SHOWN)
KEYNOTES:
1 SEE SHEET B16 FOR SPACING.
2 LIMITS OF SPRAY ON WATERPROOFING MEMBRANE (30 MIL THICK) INCLUDED IN ITEM 601, CONCRETE CLASS D (BRIDGE). APPLY UNDER EXTERIOR GIRDERS ONLY.
US-85 OVER SAND CREEK
PIER 2 (SHEET 1 OF 2)

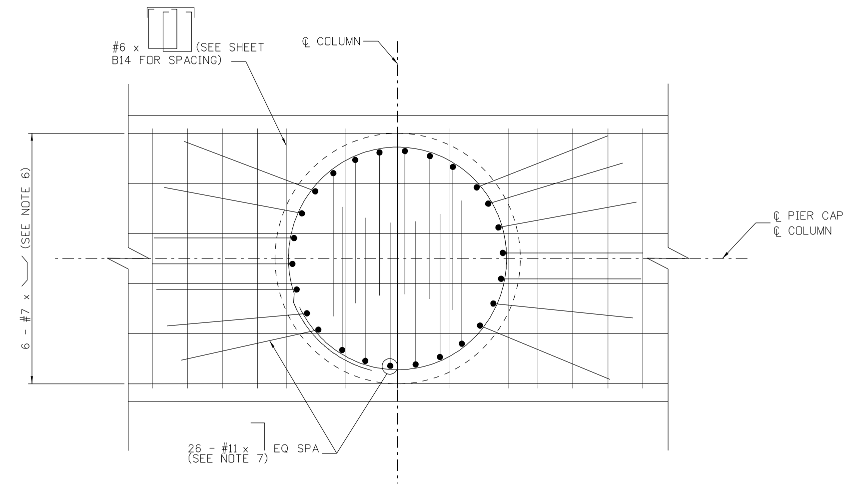
EXAMPLE 12.6



SECTION B14/A
SCALE: 3/8"=1'-0"



SECTION B14/B
SCALE: 3/8"=1'-0"



SECTION B14/C
(EXTERIOR COLUMN SHOWN, OTHER COLUMNS SIMILAR)
SCALE: 3/4"=1'-0"

NOTES:

1. PIER SHALL BE CONCRETE CLASS D (BRIDGE).
2. BEAM SEAT ELEVATIONS ARE AT TOP OF CONCRETE BELOW LEVELING PAD AT ℄ PIER.
3. ELEVATIONS SHOWN SHALL BE VERIFIED AT TIME OF CONSTRUCTION BY THE ENGINEER.
4. FOR CAISSON LAYOUT, SEE SHEET B09.
5. FOR LEVELING PAD DETAILS, SEE SHEET B16.
6. #7 BARS MAY BE SHIFTED ONLY AS NECESSARY TO AVOID INTERFERENCE WITH #11 COLUMN BARS.
7. TOP HORIZONTAL LEG OF #11 COLUMN BARS SHALL BE TURNED TOWARD CENTER OF COLUMN WHERE 2" CLEAR COVER TO PIER CAP CANNOT BE PROVIDED.

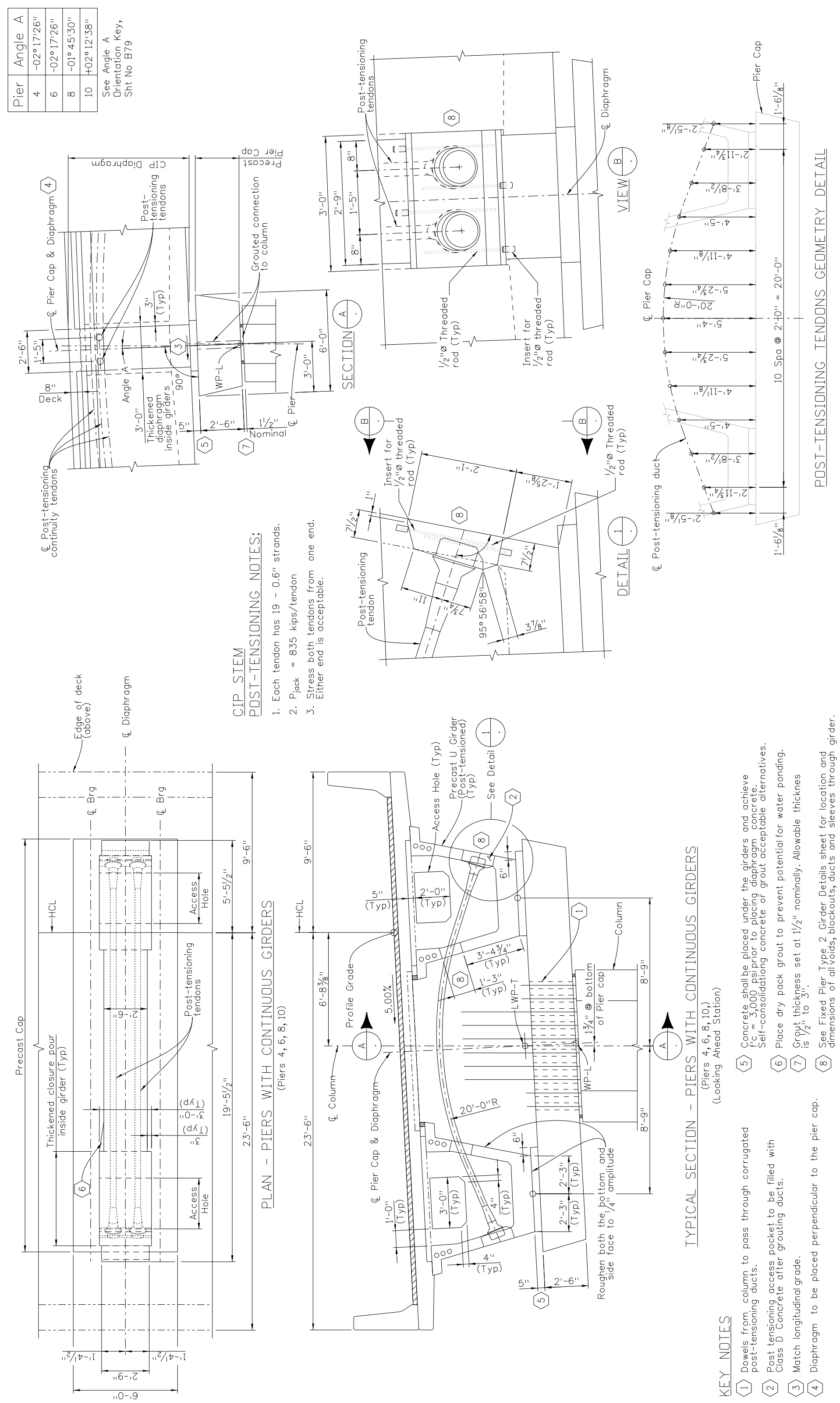
TOP OF CONCRETE ELEVATIONS TABLE

STRUCTURE	G1	G2	G3	G4	G5	G6	G7
PIER 2	5708.31	5708.58	5708.85	5709.12	5709.39	5709.66	5709.93

US-85 OVER SAND CREEK
PIER 2 (SHEET 2 OF 2)

SA

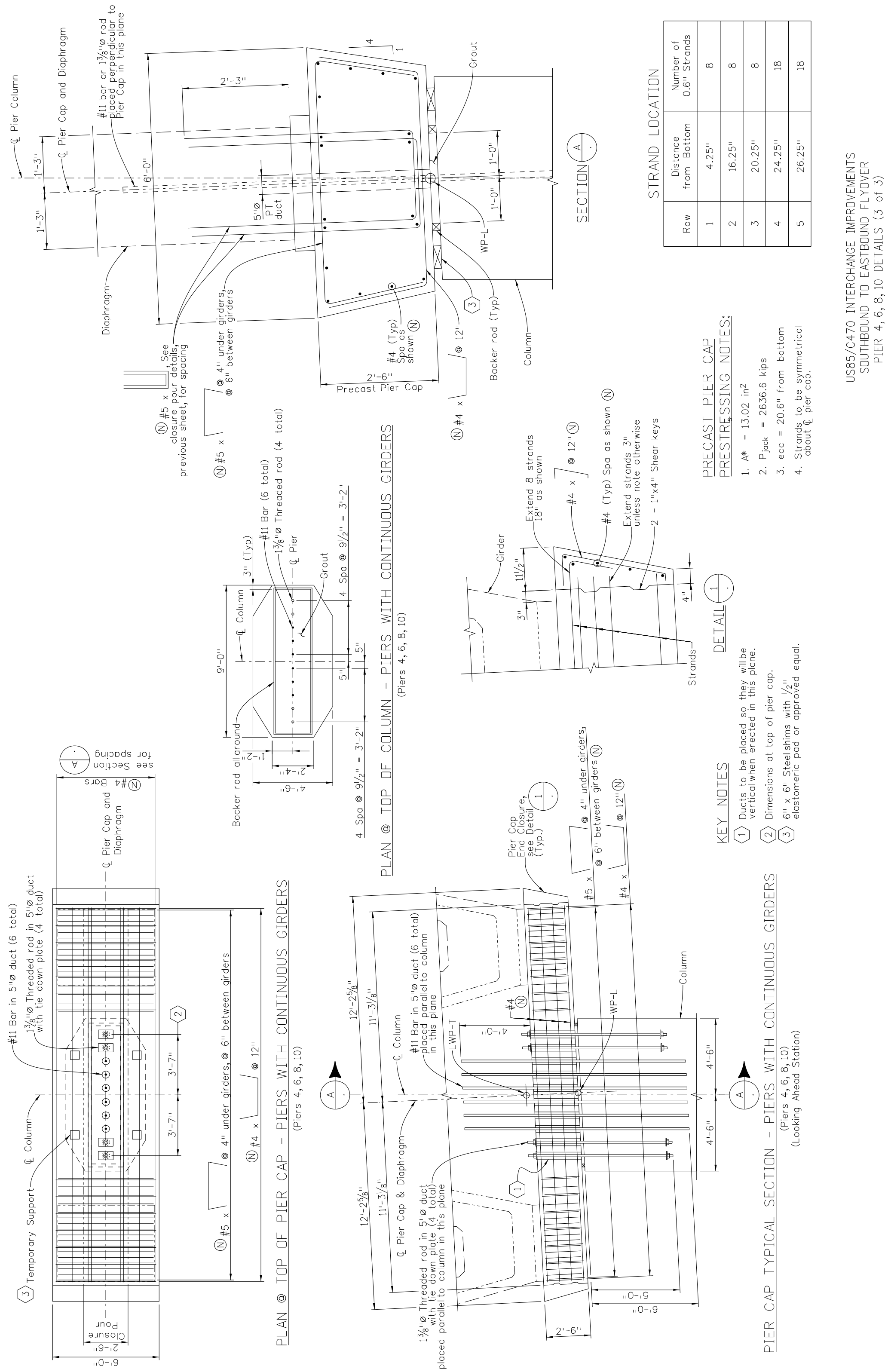
EXAMPLE 12.7



Pier	Angle A
4	-02°17'26"
6	-02°17'26"
8	-01°45'30"
10	+02°12'38"

See Angle A Orientation Key, Sht No B79
SECTION A
DETAIL 1
VIEW B
CIP STEM POST-TENSIONING NOTES:
1. Each tendon has 19 - 0.6" strands.
2. P_{jack} = 835 kips/tendon
3. Stress both tendons from one end. Either end is acceptable.
PLAN - PIERS WITH CONTINUOUS GIRDERS
(Piers 4, 6, 8, 10)
TYPICAL SECTION - PIERS WITH CONTINUOUS GIRDERS
(Piers 4, 6, 8, 10,)
(Looking Ahead Station)
POST-TENSIONING TENDONS GEOMETRY DETAIL
US85/C470 INTERCHANGE IMPROVEMENTS
SOUTHBOUND TO EASTBOUND FLYOVER
PIER 4, 6, 8, 10 DETAILS (1 of 3)
KEY NOTES
1 Dowels from column to pass through corrugated post-tensioning ducts.
2 Post tensioning access pocket to be filled with Class D Concrete after grouting ducts.
3 Match longitudinal grade.
4 Diaphragm to be placed perpendicular to the pier cap.
5 Concrete shall be placed under the girders and achieve f'c = 3,000 psi prior to placing diaphragm concrete. Self-consolidating concrete or grout acceptable alternatives.
6 Place dry pack grout to prevent potential for water ponding.
7 Grout thickness set at 1½" nominally. Allowable thicknes is ½" to 3".
8 See Fixed Pier Type 2 Girder Details sheet for location and dimensions of all voids, blockouts, ducts and sleeves through girder.

EXAMPLE 12.8



SECTION A
STRAND LOCATION
Row	Distance from Bottom	Number of 0.6" Strands
1	4.25"	8
2	16.25"	8
3	20.25"	8
4	24.25"	18
5	26.25"	18
PRECAST PIER CAP PRESTRESSING NOTES:
1. A* = 13.02 in²
2. Pjack = 2636.6 kips
3. ecc = 20.6" from bottom
4. Strands to be symmetrical about ℄ pier cap.
US85/C470 INTERCHANGE IMPROVEMENTS
SOUTHBOUND TO EASTBOUND FLYOVER
PIER 4, 6, 8, 10 DETAILS (3 of 3)
PLAN @ TOP OF COLUMN - PIERS WITH CONTINUOUS GIRDERS
(Piers 4, 6, 8, 10)
DETAIL 1
KEY NOTES
1 Ducts to be placed so they will be vertical when erected in this plane.
2 Dimensions at top of pier cap.
3 6" x 6" Steel shims with 1/2" elastomeric pad or approved equal.
PLAN @ TOP OF PIER CAP - PIERS WITH CONTINUOUS GIRDERS
(Piers 4, 6, 8, 10)
PIER CAP TYPICAL SECTION - PIERS WITH CONTINUOUS GIRDERS
(Piers 4, 6, 8, 10)
(Looking Ahead Station)

EXAMPLE 12.9

13.1.1 Purpose

These drawings are to present graphically all pertinent information needed by the Fabricator and Contractor for construction of the cast-in-place concrete deck and girders of the structure.

13.1.2 Responsibility

The graphic presentation of information on these drawings shall be the responsibility of the individual preparing the drawings in addition to the designer.

13.1.3 Scales

Scales shall be used that are suitable to make the details legible when the drawing is reduced. Suggested scales for presenting the details of the girders and deck are as follows:

A) Plan, Elevation and Sections - 1”=10’, 1”=20’, 1”=30’.
B) Details - 1/8"=1’-0”, 1/4” = 1’-0”, 1/2"=1’-0”, 3/4"=1’-0”, etc.

13.1.4 Orientation Of Details

The PLAN of the deck shall be placed, if possible, at upper left of the drawing.

The TYPICAL SECTION shall be placed below the deck PLAN. If space is limited, the sections or auxiliary views may be shown on another sheet.

Generally, sections should be taken from the PLAN rather than from auxiliary views or other sections.

13.1.5 Horizontal Control Line

The horizontal control line is not necessary for the plan view unless reinforcing is controlled by it.

13.1.6 Order Of Sheets

As with the rest of the set, the sheets are provided in the order of construction. The Girder Worksheets (post-tensioning details, etc.) will be first, followed by the Deck Reinforcing Plan with any required sections and details. Subsequent detail sheets and worksheets for pier diaphragm, bridge rail, fencing, lighting, etc. shall be added after these sheets to complete the required details.

13.1.7 Dimensions

A sufficient number of dimensions shall be shown on the details to provide adequate information necessary in the checking of the plans and the construction of the deck and associated details. Dimensions of reinforcing shall only be provided if not controlled by concrete limits, e.g. negative moment steel.

13.1.8 Girder Worksheets

The Girder worksheets (post-tensioning, etc.) shall be provided with additions as required to show the appropriate design. Any changes to the default reinforcing shall be shown here as required by the design. Any item that is required for design of the girder or placement shall be shown in this sheet.

Leveling pad or bearing information should be placed on previous sheets but any bearing items needed in the cast in place girder should be shown.

Post-tensioning ducts shall be shown in the girders as required. Post-tensioning information should be shown in the deck/girder detail sheets.

13.1.9 Deck Reinforcing Details

The information for laying out the reinforcing for the deck shall be provided. The Reinforcing Plan view may be schematic as true scale detailing is generally not possible. A section view of the deck is often helpful in describing the reinforcing in addition to the plan view.

Some points which may require additional attention:

A) Special reinforcement may be required, especially in areas where the slab is in tension or in large skew areas.
B) Reinforcement governed by outside concrete and clearance dimensions should not be dimensioned or totaled, e.g. 30 - #5 @ 3” spacing. This information would be too similar to bar tables which have been discontinued.
C) The outside edges of the deck should be the same thickness as the interior deck, and the underside of the overhang tapered to one inch below the top of the girder.
D) Drip groove shall be shown in details.

E) Bottom longitudinal reinforcing in the overhang should be located to correspond with the bridge rail requirements.

13.1.10 Additional Deck Details

Add additional deck details and worksheets as required to show all details for the completion of the deck pour and associated reinforcing. These sheets may include barrier worksheets, lighting, utility hanger, sidewalks, medians, deck drains, deck post-tensioning and other details. Since the pier and abutment diaphragm is typically poured monolithically with the deck, the required details shall be shown within the deck detail sheets or in prior sheets such as the abutment. Any required deck pour schedules or schemes would be shown in this section as well.

13.1.11 Checking

Listed below is a summary of items that shall be checked and appear on the drawing, when applicable. Additional information shall appear, as required.

A) Title PLAN and SECTION in accordance with their particular conditions
B) Reinforcing Splice lengths provided
C) Skew angle of bridge and other pertinent angles
D) Barrier sections or references
E) Drip groove shown and dimensioned
F) Check title block for information

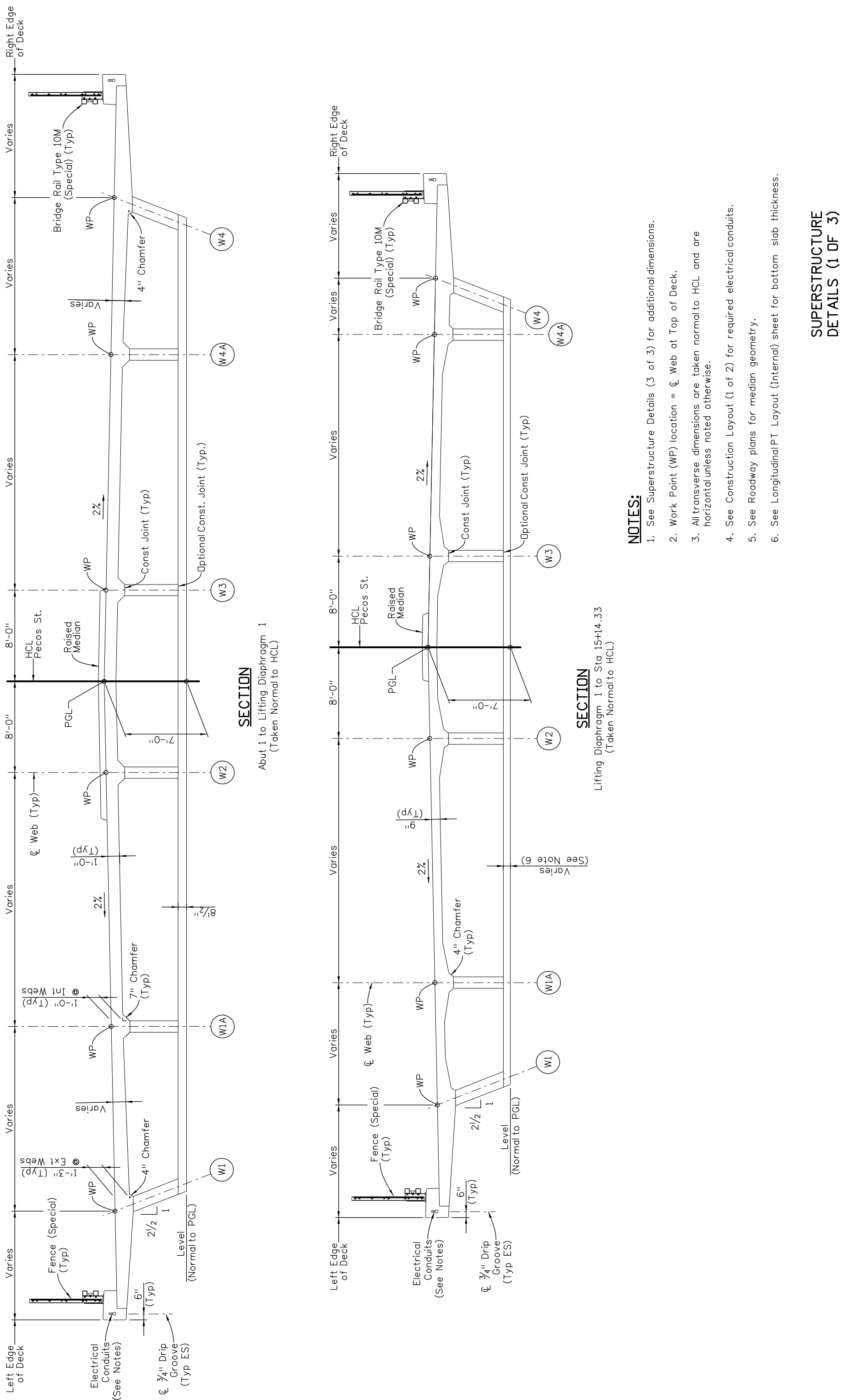
For post-tensioned structures, the following information shall be included:

A) Jacking force
B) Area of prestressing steel
C) Minimum concrete strength at jacking and at 28 days
D) Center of gravity of prestressing force path
E) Jacking ends
F) Anchor sets
G) Friction constants
H) Long-term losses assumed in the design
I) Strand and duct size assumed in the design
J) Net long-term deflections and expected cambers
K) Estimated haunches at midspans (for spliced girders only)

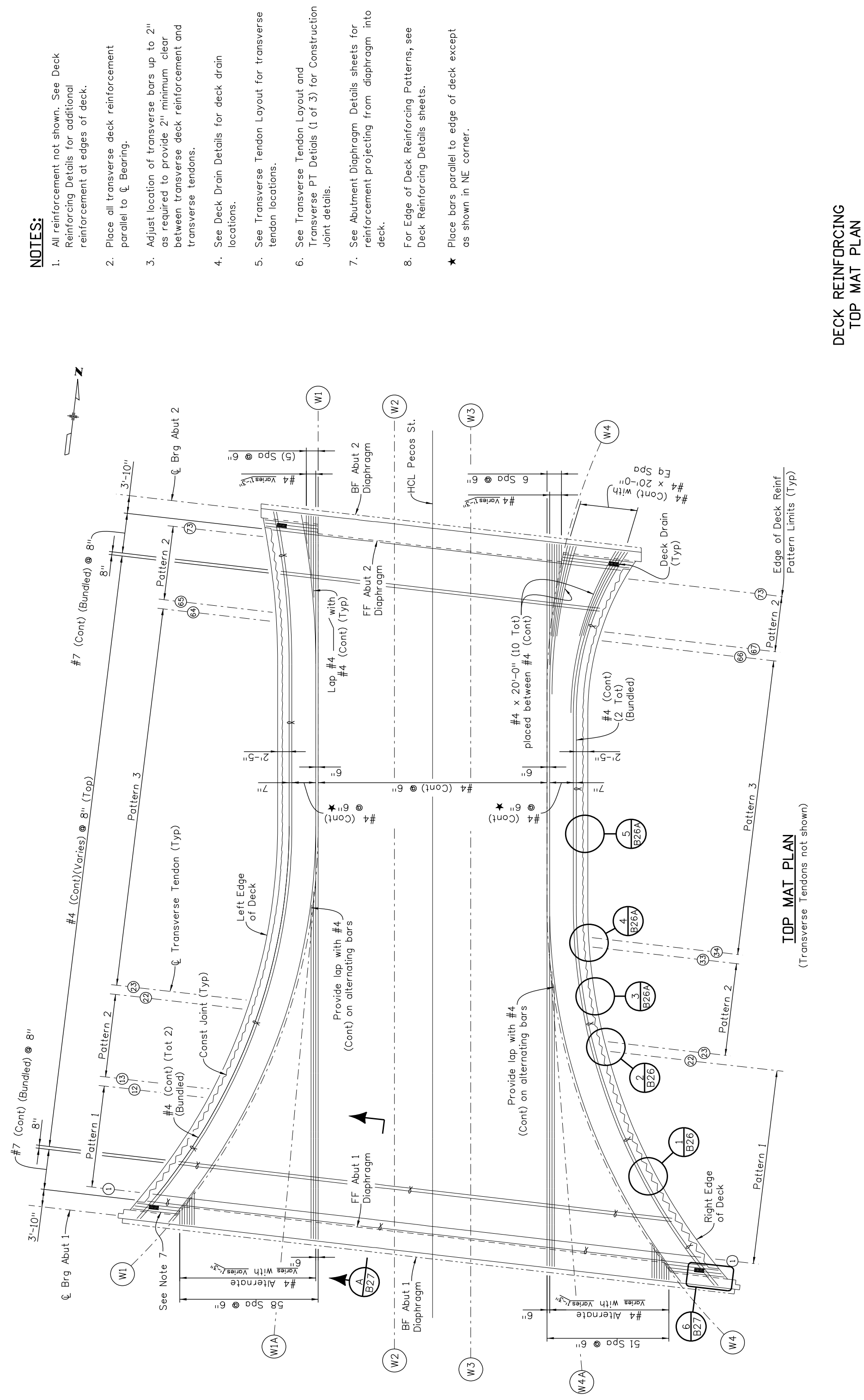
13.1.12 Title Block

This drawing is titled “DECK PLAN”, “DECK TYPICAL SECTION” , “SUPERSTRUCTURE DETAILS” or similar and shall be so indicated in the title block.

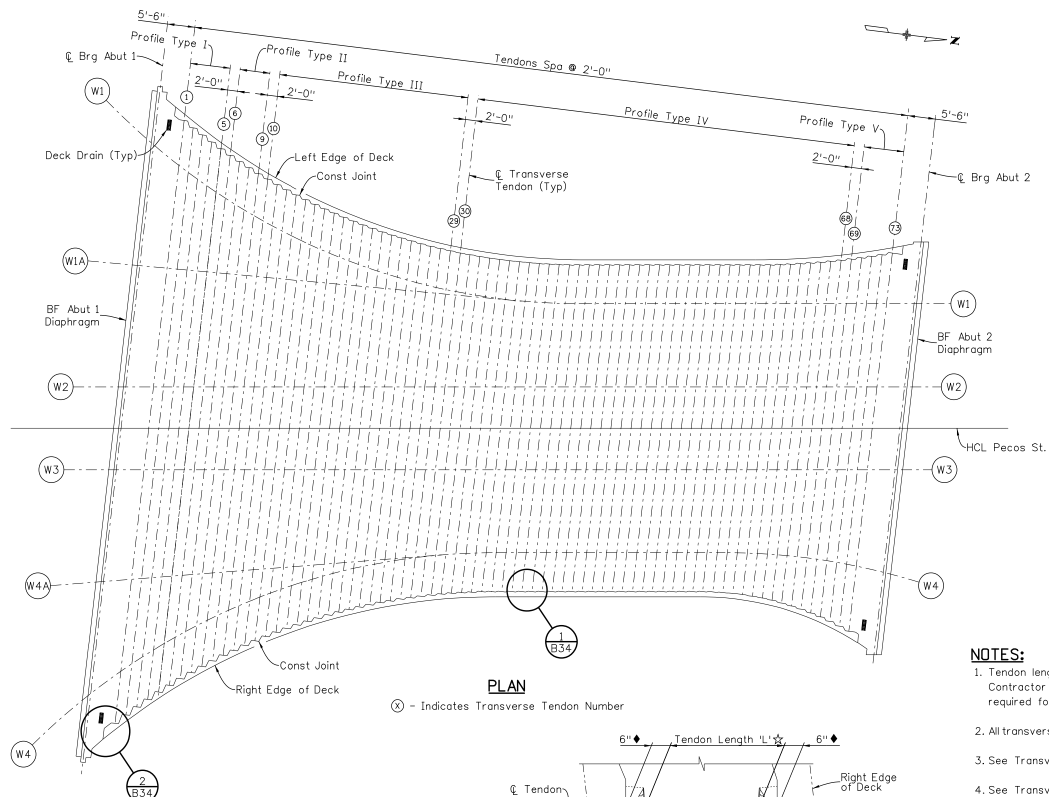
If other details are combined on this drawing, they shall be indicated in the title. Example: If the “Barrier Details” are placed on this drawing with the “Deck Details”, the title shall be “DECK DETAILS - BARRIER DETAILS”.



Example 13.1-1

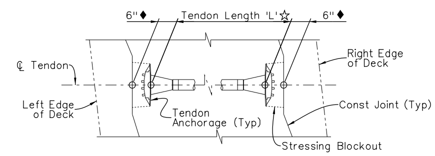


Example 13.1-2



PLAN

ⓧ - Indicates Transverse Tendon Number



TENDON LENGTH DETAIL

TRANSVERSE POST-TENSIONING SCHEDULE

Tendon Number	Profile Type	Tendon Length 'L' (ft.) ☆	Tendon Number	Profile Type	Tendon Length 'L' (ft.) ☆
1	I	116.10	30	IV	65.68
2	I	113.02	31	IV	65.08
3	I	110.07	32	IV	64.55
4	I	107.24	33	IV	64.09
5	I	104.53	34	IV	63.69
6	II	101.92	35	IV	63.35
7	II	99.43	36	IV	63.08
8	II	97.04	37	IV	62.87
9	II	94.74	38	IV	62.72
10	III	92.55	39	IV	62.60
11	III	90.45	40	IV	62.52
12	III	88.43	41	IV	62.47
13	III	86.51	42-58	IV	62.45
14	III	84.67	59	IV	62.50
15	III	82.92	60	IV	62.61
16	III	81.25	61	IV	62.82
17	III	79.66	62	IV	63.11
18	III	78.15	63	IV	63.49
19	III	76.71	64	IV	63.97
20	III	75.35	65	IV	64.53
21	III	74.07	66	IV	65.19
22	III	72.86	67	IV	65.94
23	III	71.72	68	IV	66.78
24	III	70.65	69	V	67.72
25	III	69.65	70	V	68.76
26	III	68.72	71	V	69.90
27	III	67.86	72	V	71.14
28	III	67.07	73	V	72.48
29	III	66.34			

NOTES:

1. Tendon lengths provided are for information only. The Contractor is responsible for verifying the tendon lengths required for transverse post-tensioning.

2. All transverse tendons shall be placed parallel to ℄ Bearing.

3. See Transverse PT Details (1 of 3) for additional information.

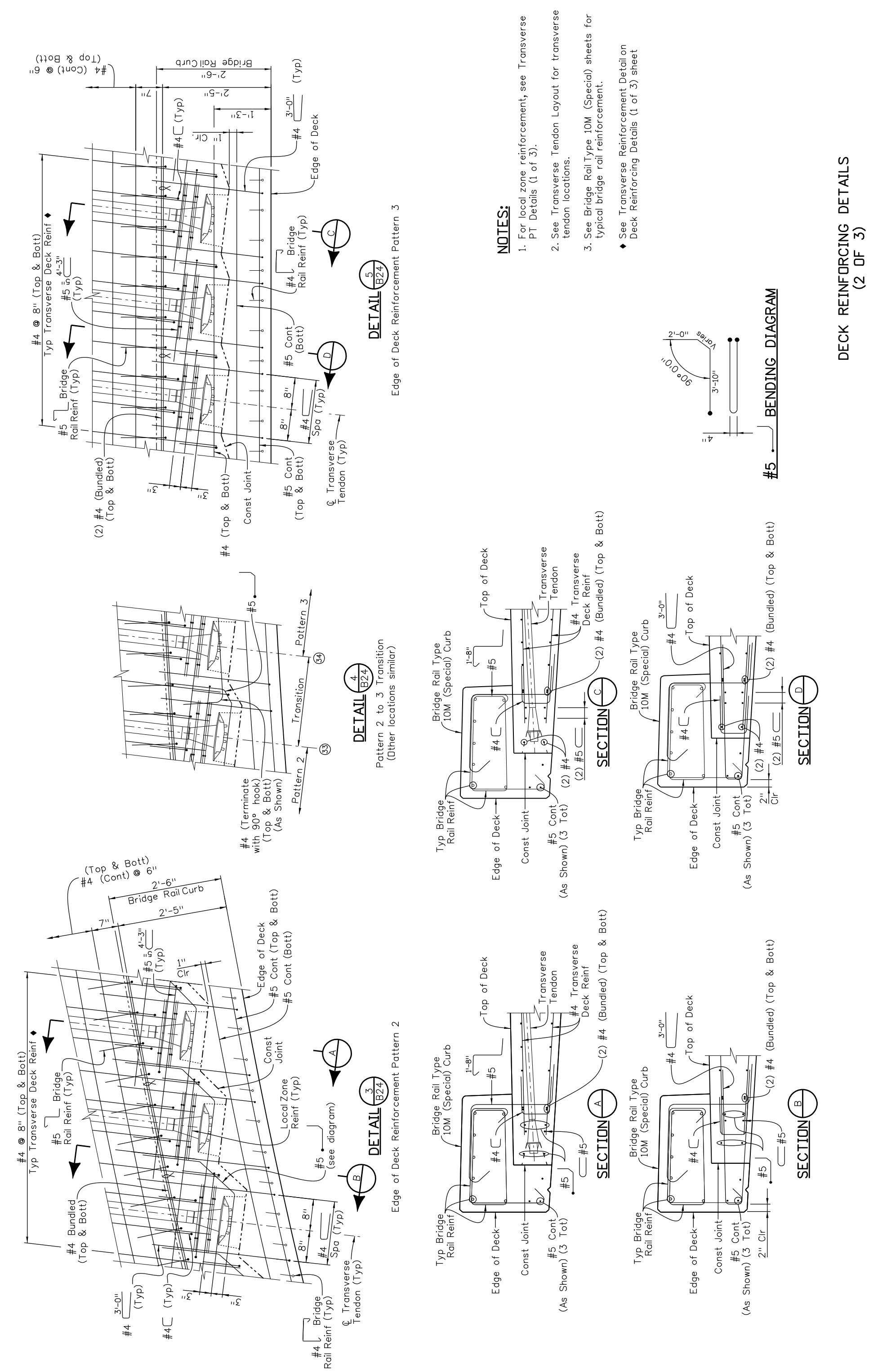
4. See Transverse PT Details (2 of 3) and (3 of 3) for tendon profiles.

☆ Tendon Length 'L' is measured in plan along ℄ tendon and does not account for additional length due to tendon profile.

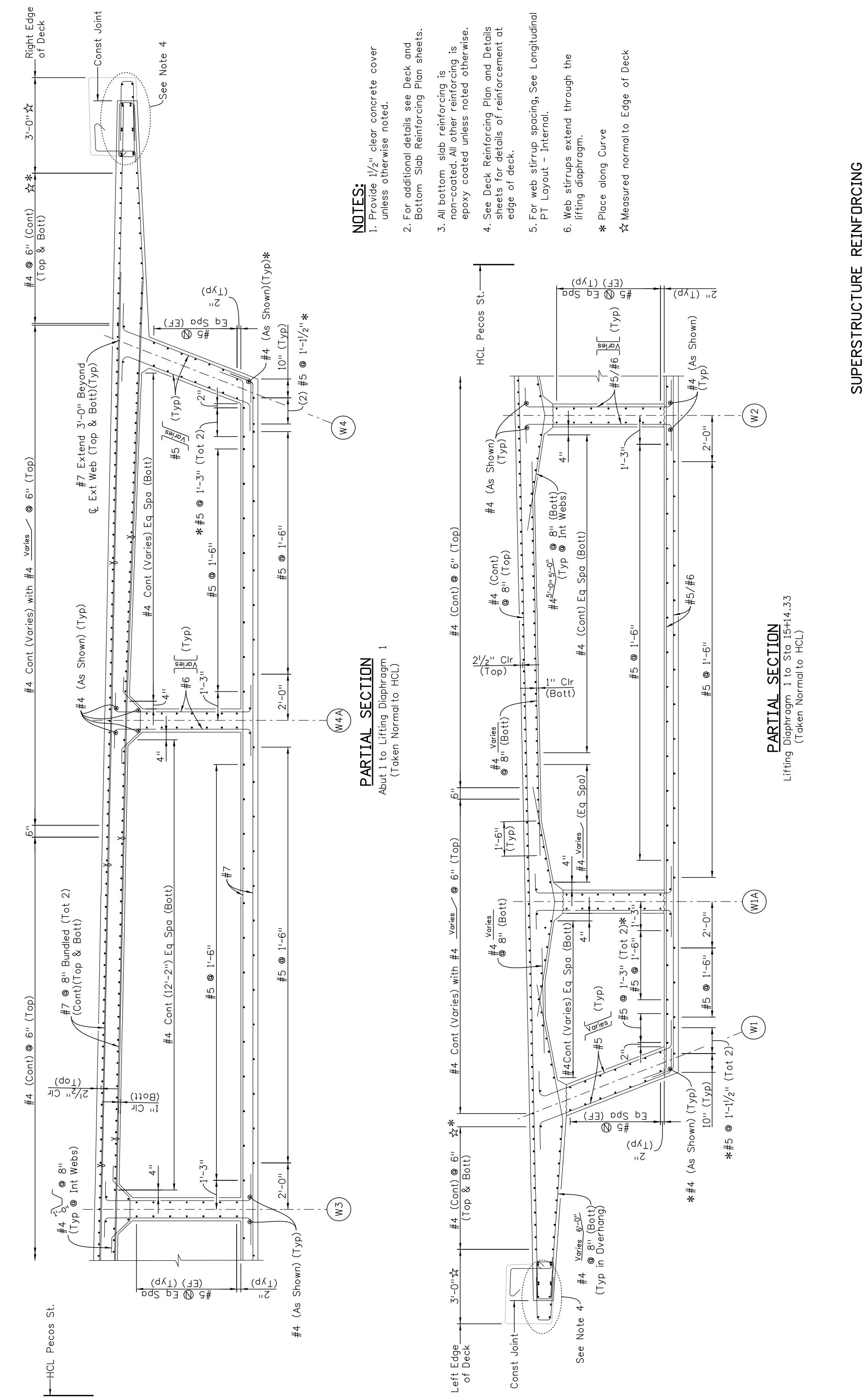
♦ Assumed depth of pocket former. Actual dimensions may vary.

TRANSVERSE
TENDON LAYOUT

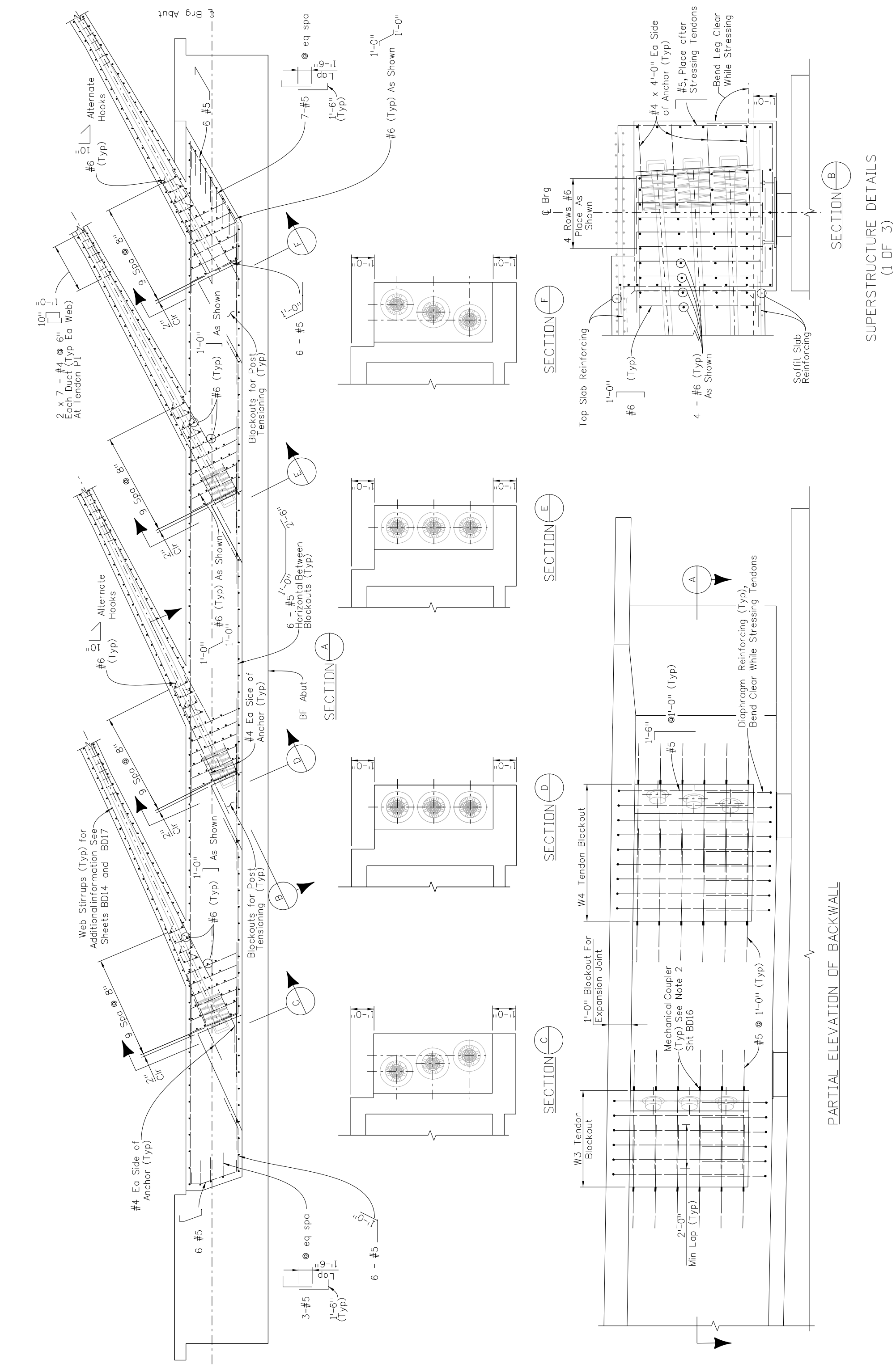
Example 13.1-3



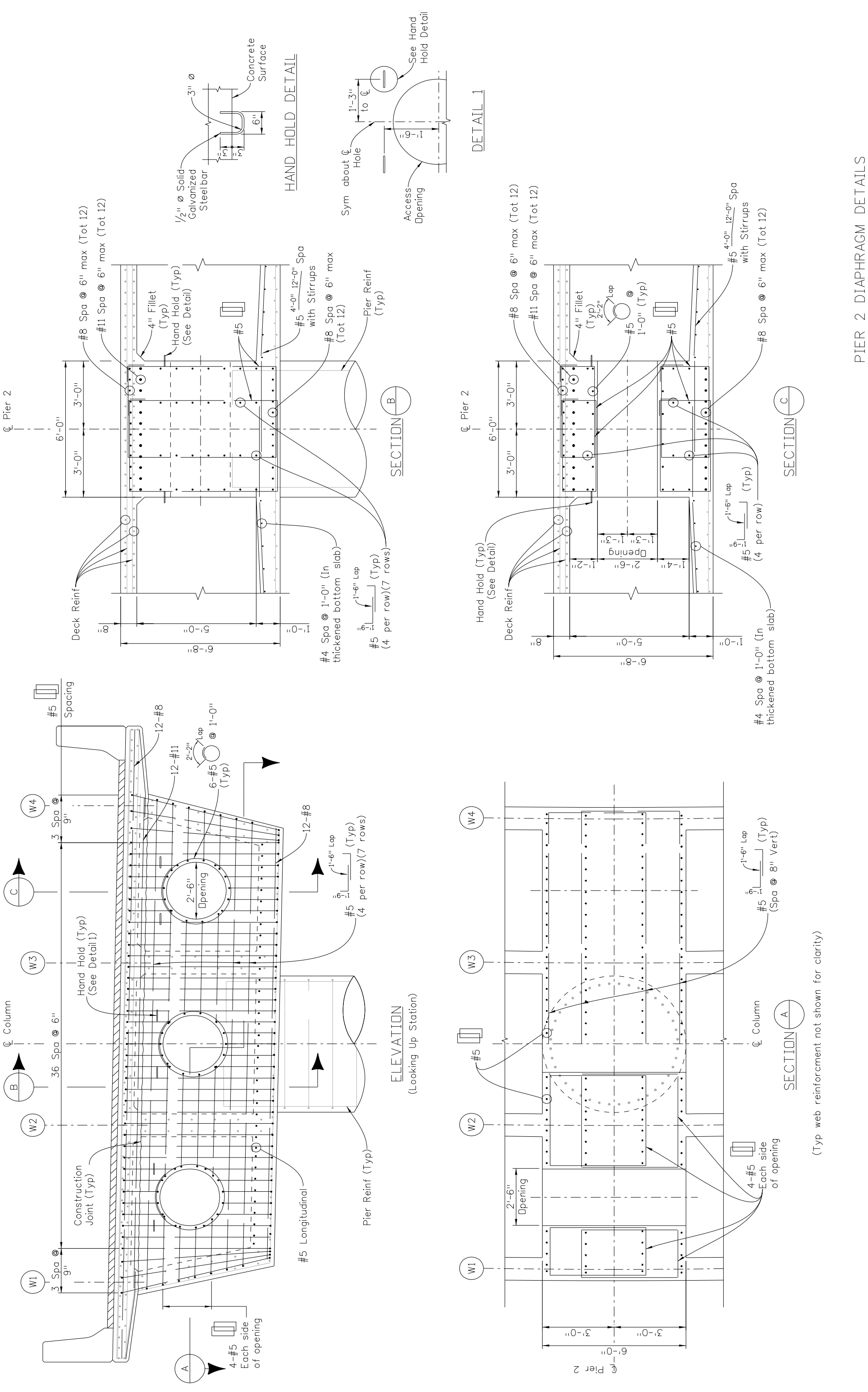
Example 13.1-4



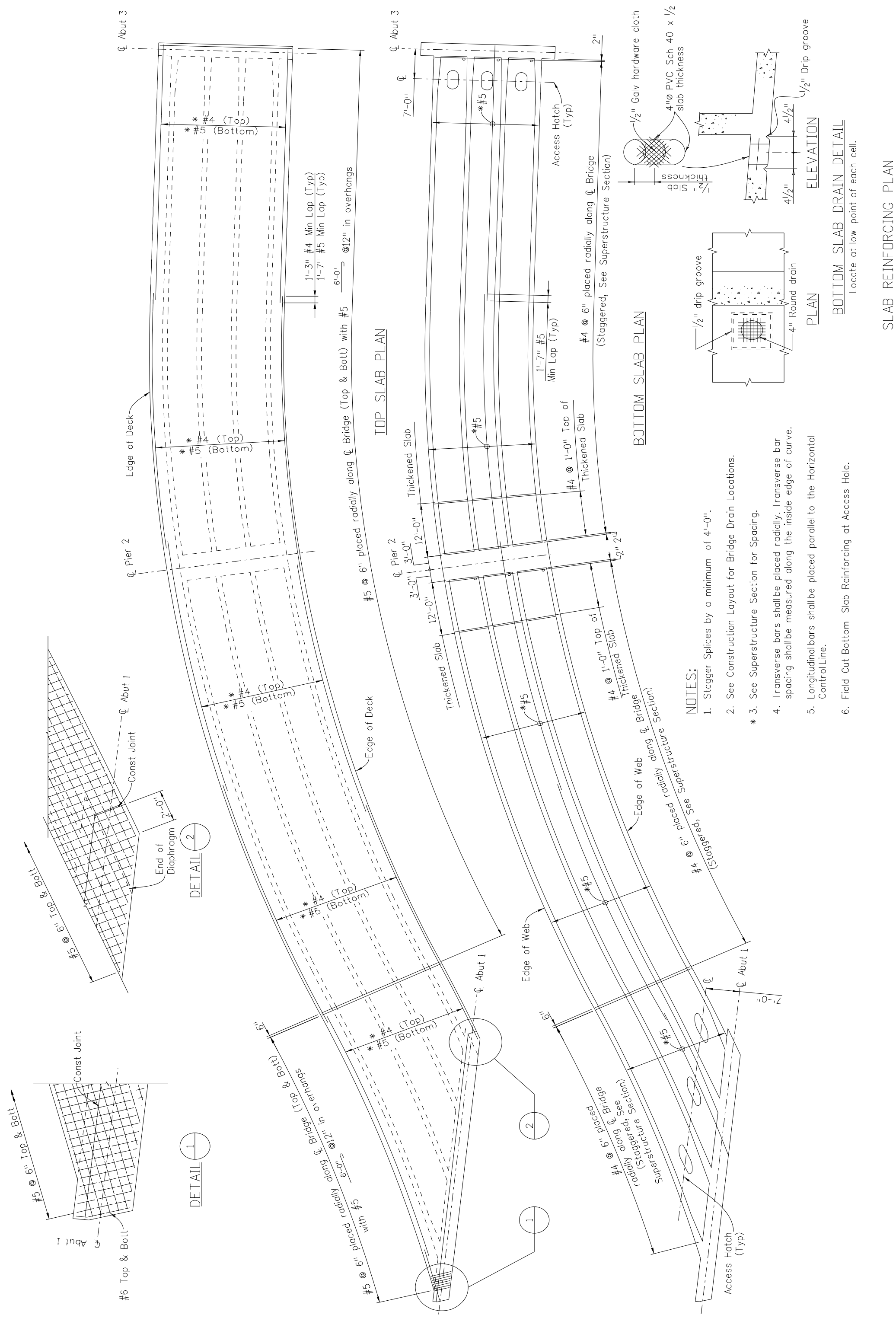
Example 13.1-5



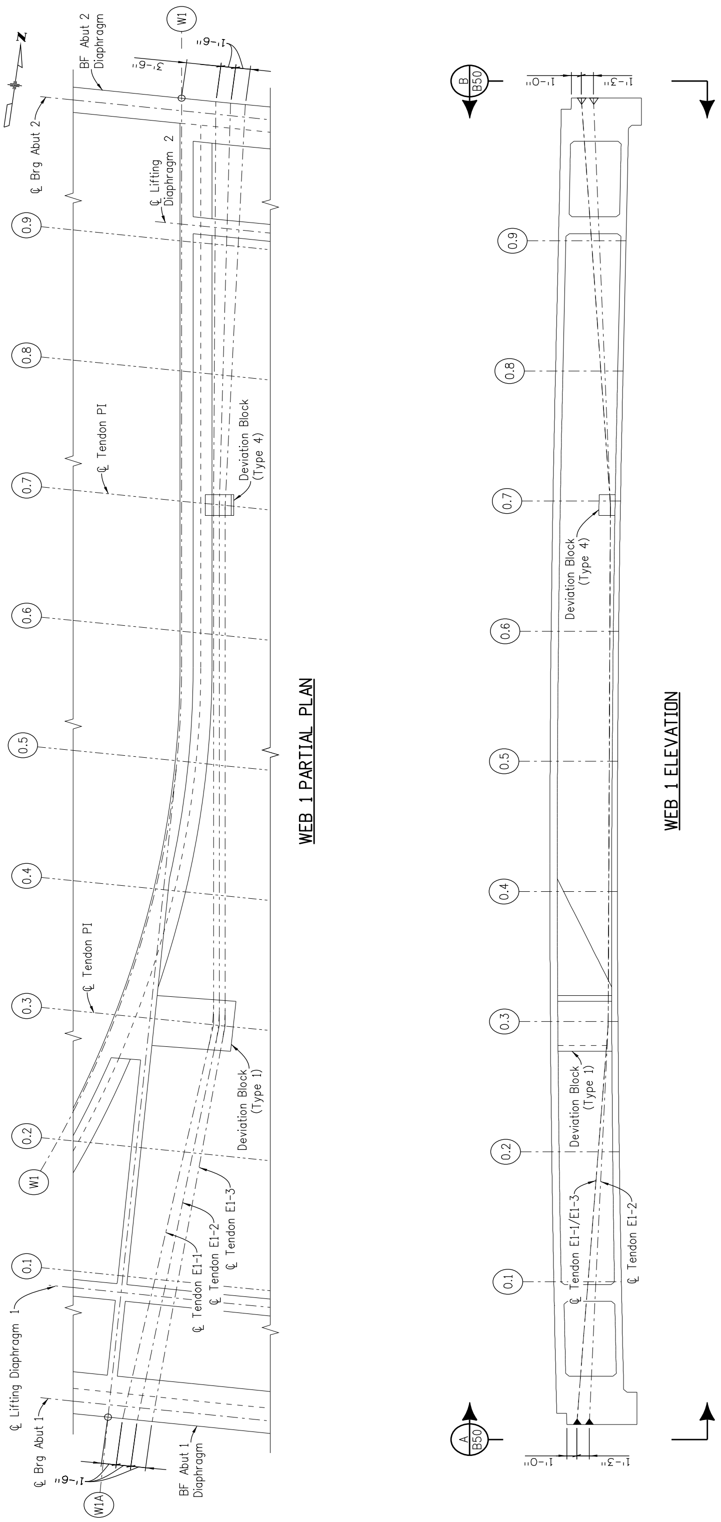
Example 13.1-6



Example 13.1-7



Example 13.1-8



DESIGN:

Design is based on K=0 and μ=0.25. P(FINAL) at the jacking ends includes friction, anchor set of 0.375", elastic shortening, and provisions for an additional 27 KSI long term loss in stress.

P(JACK)	=	834.9 kips total at jacking end of each external tendon.
A_s* MINIMUM	=	4.123 square inches for each external tendon.
f'_s	=	270 ksi
f'_c	=	5800 psi at 28 days field compressive strength
f'_{ci}	=	4800 psi at stressing

The Contractor shall submit elongation and jacking calculations based on KL+$\mu\alpha$ (including anchor set if any) and initial stress (initial stress ratio times jacking stress before long term losses) at each tenth point.

STRESSING SEQUENCE:

All external longitudinal tendons shall be jacked from Abut. 1 end following abutment diaphragm PT bar stressing operations.

No more than $\frac{1}{2}$ of the prestressing force associated with any web (including external tendons) may be stressed before an equal percentage of force is stressed in the adjacent webs.

At no time during the stressing operations will more than $\frac{1}{6}$ of the total prestressing force be applied eccentrically about the centerline of the structure.

LEGEND:

▷ Non-Stressed Anchor

▶ Stressed Anchor

E3-2 — Tendon Number *; 3 — Associated Web; E - External, I - Internal

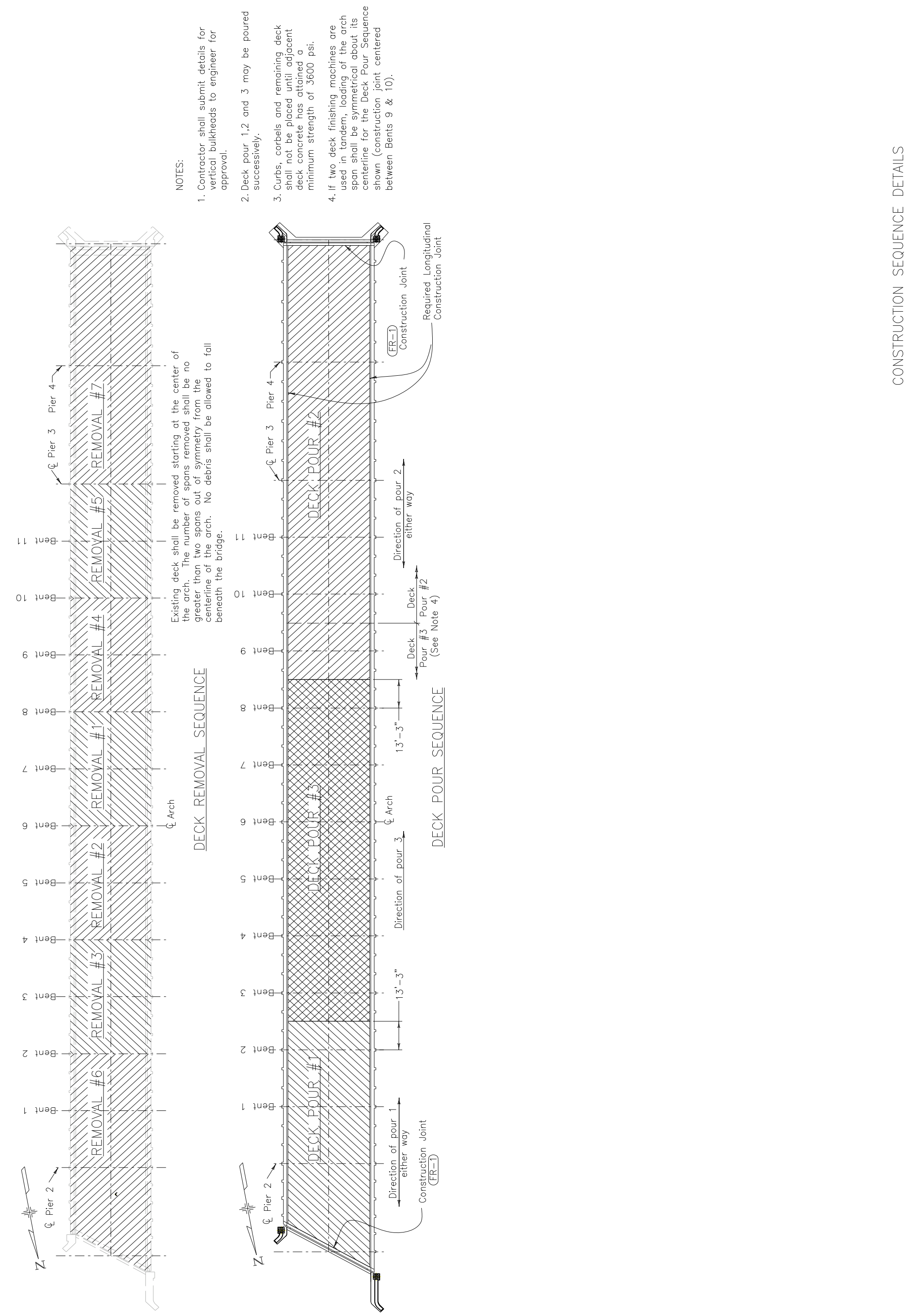
* External tendons are numbered individually from left to right looking ahead station. Internal tendons are numbered individually, from bottom to top.

NOTES:

1. See Framing Plan sheet for tenth point and web locations.
2. See Longitudinal PT Details for anchorage information.
3. All external tendons shall be 19 strand 0.6"ø low-relaxation strand tendons.
4. External tendons shall be supported between diaphragms and deviation blocks to prevent sag or displacement of duct during placing, stressing, and grouting.

LONGITUDINAL PT LAYOUT
EXTERNAL (1 OF 3)

Example 13.1-9



Example 13.1-10

Steel Superstructure Details

13.2.1 Purpose

These drawings are to present the details of the structural steel required by the fabricator and contractor for construction of the structure.

13.2.2 Responsibility

The drawings shall be prepared and checked in the design unit. The graphic presentation of the information shall be the responsibility of the individual preparing the drawing.

13.2.3 Structural Steel (General)

The grades of structural steel usually used for highway structures are:

A) AASHTO M-183 (ASTM A-36) is used for all steel fabrication unless otherwise noted.
B) AASHTO M-223 (ASTM A-572) is higher strength than AASHTO M-183.
C) AASHTO M-222 (ASTM A-588) is higher strength than AASHTO M-183.
D) Considered corrosion resistant, it does not require periodic painting.

The above structural steels are available in the following basic designations:

A) Rolled shapes, some of which are:

1)	W Shape (wide flange)	W 24 X 76
2)	S Shape (I beam)	S 24 X 100
3)	Channel	C 12 X 20.7
4)	Angles (equal and unequal leg)	L 6 X 4 X 5/8
5)	HP Shape (piling)	HP 12 X 53
6)	Structural Tee	WT 12 X 38

In the previous examples (except angles), the letters designate the shape, the first number designates the nominal depth in inches, and the second number, the weight in pounds per foot.

B) Plates (PL 1/2 X 36)

For highway structures, plates will generally be flat rolled stock over eight inches wide and 1/4 inch or more thick. Edges of members designated as plates will be assumed to be cut. Plate is generally available in widths up to 200 inches with thickness in the following increments:

1/32 in. from 1/4 in. to 1/2 in.

1/16 in. from 1/2 in. to 1 in.

1/8 in. from 1 in. to 3 in.

1/4 in. over 3 in.

C) (Bar 6 X 1/2)

For highway structures, bars will generally be flat rolled stock eight inches and less in width and 1/4 inch or more thick. Edges of member designated as bars will be assumed to be rolled. Bar stock is generally available in 1/4 inch increments in width and 1/8 inch increments in thickness.

13.2.4 Welding

Welding is the fusion or uniting of two pieces of metal by application of heat and the addition of filler metal of a composition similar to the pieces being joined. For highway structures, the heat is applied by an electric arc, and the weld metal is deposited into the work from an electrode.

The processes usually used include:

A) Manual Shielded Metal Arc: Used for small jobs and field welding, uses an arc between the work and a coated electrode moved manually along the work.
B) Submerged Arc: Used for most long, continuous shop welds. Uses an arc between the work and a bare wire electrode moved by automatic or semi-automatic methods. The arc is shielded by means of a granular flux placed loosely around the electrode.
C) Gas metal Arc: Similar to submerged arc but uses an inert gas to shield the electrode.

Weld Types:

A) Fillet Welds:

Welds of roughly triangular cross section joining surfaces at or approximately at right angles to each other. The joint may be a T-joint, corner joint, or lap joint.

B) Groove Welds:

Welds made in a groove between adjacent surfaces or ends of two parts to be jointed. The parts may be arranged for a butt joint, T-joint, or corner joint. The edges of the joint may be square, beveled, V shaped, U shaped, or J shaped on one or both sides. See Fig. 13.2-1.

13.2.5 Welding Symbols

The welding symbols showing welds for highway structures follow the standard as established by the American Welding Society (AWS). Only a few of many possible combinations will actually be used in the structure details.

The three fundamental parts of a weld symbol are:

A) The arrow which points to the seam or joint to be welded. The arrow may appear on either or both ends of the reference line.
B) The reference line along which the weld data is placed.
C) The basic weld data which indicated the type, size, and extent of the weld required.

A tail showing notes, specifications, or references may be used as required, in addition to the above. If a prequalified weld designation is used in the tail, the basic weld data, (c) above, is not required.

Figure 13.2-1 shows the arrangement of items which may be used as part of a welding symbol. All dimensions are given in inches, but the inch marks are deleted.

A brief description of the items follows:

A) Size: The depth of preparation for a groove weld or the size of a fillet weld. If no size is shown, complete penetration for a groove weld; or a minimum size for a fillet weld is required.
B) Penetration (Effective throat): The depth of weld metal deposited into the material.
C) Finish: The method of finish; G (grind), C (chip), etc.
D) Contour: The shape of the finished joint.

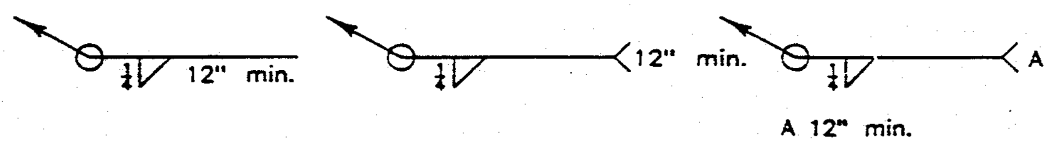
E) Groove Angle: The angle of the groove in the base metal.

F) Root Opening: The minimum distance between the pieces to be joined.

G) Basic Symbol: Designates the shape of the weld. See Fig. 13.2-1 for example of the more common basic symbols.

Note that vertical portions of the basic symbol appear on the left side.

H) Length: The total length of a single weld or the length of an individual weld in a series (stitch weld). If no length is given, the weld is the full length of the joint. In the case where a minimum length of fillet weld is required, such as between the angle and gusset plate in a diaphragm, the weld shall be as shown:

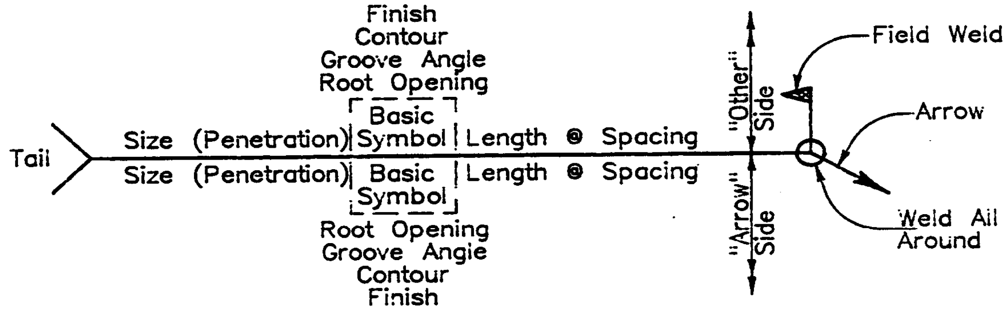


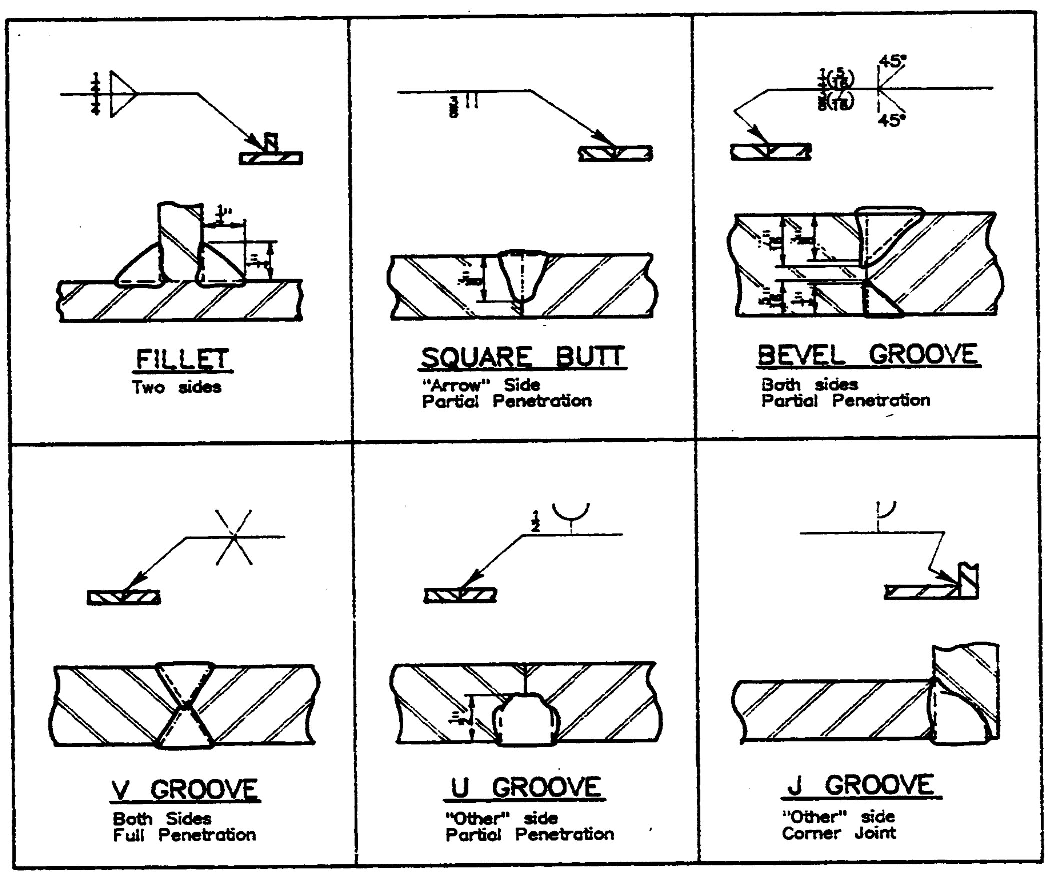
with the length in the tail or on the reference line. A reference letter or number in the tail may be used to indicate a minimum length note elsewhere on the drawing.

I) Field Weld: Designates a weld made in the field. The flag points away from the arrow.

J) Weld All Around: The weld shall be continuous between all surfaces of the two parts to be joined.

K) Information on either the “Arrow” side or “Other” side of the reference line is valid only for that side of the joint.





11/14/85 (EARL)WELDS

FIGURE 13.2–1 WELD SYMBOLS

13.2.6 Fillet Welds

The major portion of the steel in highway structures will be fillet welded.

Minimum fillet weld sizes shall be determined by the thicker of the two parts shown.

Thickness of Part (in.)	Minimum Fillet Weld (in.)
Through 1/2	3/16
Over 1/2 thru 3/4	1/4
Over 3/4 thru 1-1/2	5/16
Over 1-1/2 thru 2-1/4	3/8
Over 2-1/4 thru 6	1/2
Over 6	5/8

The minimum size seal weld shall be 3/16 fillet weld.

The weld limits for T-joints shall be as shown in Fig. 13.2-2. Note that the condition requiring a single fillet weld should be avoided.

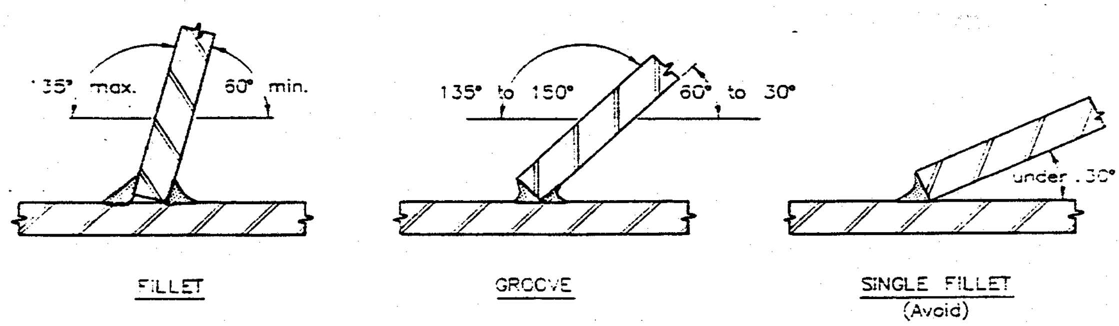


FIG. 13.2-2 T JOINT WELD LIMITS

13.2.7 Field Welds

Field welds are welds made at the job site and are seldom used for new construction. Their primary applications are in repair and widening of existing structures.

13.2.8 Bolted Connections

Most connections between steel parts made in the field will be made using high strength bolts.

The symbol used on the details for a field bolted connection shall be a large solid dot with a note indicating bolt size, if other than the size shown in the General Notes.

The minimum distance from the edge of a part to the center of a bolt shall be as follows:

Bolt Size	Sheared or Flame Cut Edge	Rolled or Planed Edge Except	Flanges of Rolled Beams and Channels
1 in.	1-3/4 in.	1-1/2 in.	1-1/4 in.
7/8 in.	1-1/2 in.	1-1/4 in.	1-1/8 in.
3/4 in.	1-1/4 in.	1-1/8 in.	1 in.
5/8 in.	1-1/8 in.	1 in.	7/8 in.

Maximum edge distance shall be 8 times the thickness of the thinnest outside plate but shall not exceed 5 inches.

Bolt Size	Absolute Minimum	Preferred Minimum
1 in.	3 in.	3-1/2 in.
7/8 in.	2-5/8 in.	3 in.
3/4 in.	2-1/4 in.	2-1/2 in.
5/8 in.	1-7/8 in.	2-1/4 in.

13.2.9 Scales

Scales shall be chosen to give sufficient room for the required dimensions and to fit the detail to the sheet. More than one sheet may be required for Framing Plans and Girder Elevations.

Some suggested scales:

A) Framing Plan: 1/8” = 1’-0, 3/16” = 1’-0, 1/4”=1’-0”.
B) Girder Elevation: Horizontal, 1/8” = 1’-0, 3/16” = 1’-0”, 1/4” = 1’-0. Vertical, 1/4” = 1’-0”, 3/8” = 1’-0”, 1/2” = 1’0”.
C) Diaphragms, Stiffeners, Splices, bracing, etc.

13.2.10 Combining Details

Details may be combined on the various sheets as is convenient. The Framing Plan and associated Girder Elevation will usually be shown on the same sheet, as space permits.

Some other possible combinations are:

A) Diaphragms, Vertical Stiffeners, Lateral Braces
B) Splices, Longitudinal Stiffeners, Miscellaneous Details
C) Diaphragms and Splices
D) Splices and Stiffeners

Details of a similar nature such as diaphragms, splices, or stiffeners should be kept on the same sheet as much as possible.

13.2.11 Framing Plan

A) The <u>FRAMING PLAN</u> is a diagram showing the location of the following members, as applicable:
   1) Girder Webs: Designate as G1, etc. consistently with the “Construction Layout.”
   2) Diaphragms: The various types of diaphragms should be designated as D1, D2, D3, etc.
   3) Splices
   4) Vertical Stiffeners: Show the location but not the type (S1, S2, etc.). The type will be shown in subsequent details.
   5) Lateral Bracing: Show approximate relationship to vertical stiffeners. Dimensions, possibly excepting minimums, will not be required.

B) The following dimensions will be shown on the FRAMING PLAN, as applicable:
   1) Girder spacing, centerline to centerline (normal to girders).
   2) Centerline girder to centerline girder along centerline of abutment bearing for skewed structures.
   3) Spacing of vertical stiffeners. (This may be shown in the girder elevation, if desired, if the spacing is the same for all girders.)
   4) Dimensions between diaphragms, or from diaphragms to splices.

C) For long structures, two or more sheets will be needed to provide adequate space for the FRAMING PLAN.

   For smaller structures using rolled shapes for girders, the diaphragm spacing may be shown on the CONSTRUCTION LAYOUT and the FRAMING PLAN omitted.

13.2.12 Girder elevation

A) The GIRDER ELEVATION is an elevation of the girder showing the following, as applicable:
   1) Flange plate sizes and lengths.
   2) Web plate size and length.
   3) Shear connector locations.
   4) Longitudinal stiffener size and location.
   5) Welds.
   6) Tension and compression areas in the flanges. This will also serve to delineate the areas in which the transverse stiffeners are cut away from the flanges.

B) The following dimensions shall be shown as applicable:
   1) Centerline abutment bearing to centerline abutment bearing.
   2) End of girder to Centerline Abutment Bearing.
   3) Centerline Abutment Bearing to Centerline Splice.
   4) Centerline Splice to Centerline Pier bearing.
   5) Centerline Splice to Centerline Splice.
   6) Flange splice (change in width and/or thickness) to Centerline Splice or Centerline Bearing.
   7) Tension and Compression areas of flange.
   8) Distance from flange to longitudinal stiffener.
   9) Ends of longitudinal stiffener from Centerline Splice or Centerline Bearing if other than the minimum distance.
   10) Dimension as required for cutting varying web dimensions (fish belly).
   11) Dimensions which vary between girders because of curvature, varying bent angles, or other considerations may be shown in tabular form.

C) A tabulation showing dead load deflections for the girder only, slab only, and total shall be shown with the GIRDER ELEVATION if “Camber and Dead Load Deflection” sheets are not used.

13.2.13 Diaphragm Details

A) The DIAPHRAGM DETAILS show a plan and elevation view of the diaphragms and crossframes. Complete diaphragm details are not required. The following details show general design features:
   1) Size and orientation of member (with acceptable alternates).
   2) Thickness of gusset and attachment plates.
   3) Size and required length of weld for each typical connection.
   4) Correct number of bolts shown for each typical connection.
   5) Number, size, and spacing of shear connectors.
   6) Location with respect to Girder flange (intermediate diaphragm) or top of deck (end diaphragm).
   7) Total depth (intermediate).

B) Notes to be included with the Diaphragm Details:
   1) The intermediate diaphragm bolted connections shall be torqued before the concrete slab has been placed. Holes in gusset plates shall be slotted vertically 1” X 13/16” (for 3/4” Ø HS bolts) (1-1/8” X 15/16” for 7/8” Ø HS bolts).
   2) Seal remaining contact surfaces between members and gusset plates with 3/16” fillet weld.

13.2.14 Transverse Stiffener Details

The details showing the Transverse (Vertical) Stiffeners shall include an elevation of each different type (usually 3) keyed to the GIRDER ELEVATION.

The following items shall be shown:

A) Width and thickness.
B) Cutaway dimension from tension flange.
C) Clip (cut, snip, chip, etc.) at compression flange.
D) Size and location of welds.
E) Show the longitudinal stiffener if it appears at a given stiffener type.

Holes for diaphragm bolts need not be shown on the stiffener details.

13.2.15 Bearing Stiffener Details

The details for the bearing stiffeners require much the same detail as the transverse stiffeners with the following exceptions:

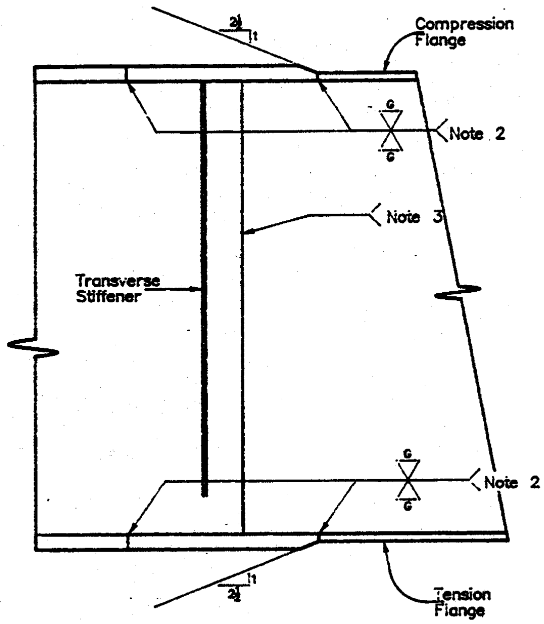
A) The stiffeners are ground to bear or full penetration welded against the bottom flange and welded to the top flange at the ends of the girder.
B) Where the girder is continuous over a pier, the stiffener shall be ground to bear or full penetration welded against the bottom flange and tight fit to the top flange.

13.2.16 Lateral Bracing Details

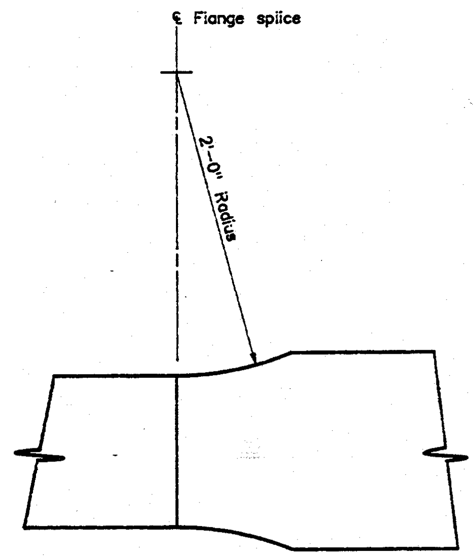
The details for the lateral bracing shall include:

A) Member size and orientation with acceptable alternates.
B) Gusset plate thickness, orientation, and location.
C) Welds.
D) Bolts.
E) Call out for minimum practical dimension from stiffeners, splices, other lateral braces, etc.

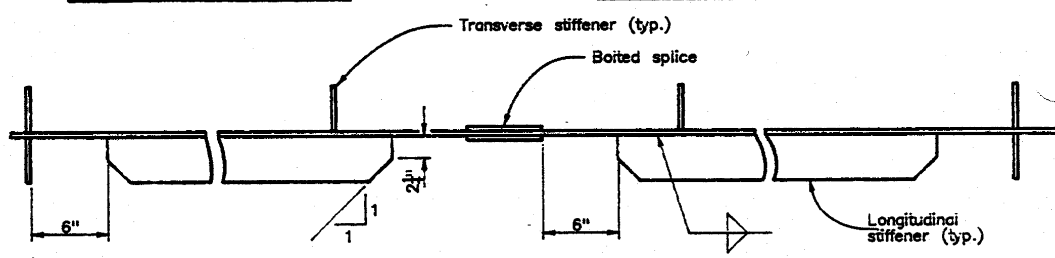
4



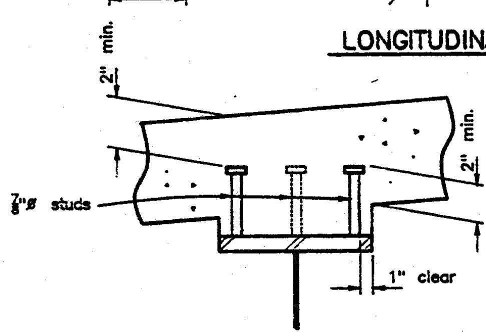
FABRICATION DETAIL



FLANGE WIDTH TRANSITION



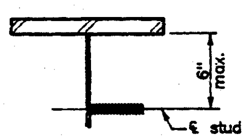
LONGITUDINAL STIFFENER DETAILS



SHEAR CONNECTOR DETAILS

NOTES:

1. Complete web to flange fillet welds after welding flange and web butt welds.
2. Grind all flange butt welds.
3. Web butt joints shall be full penetration groove welds. Where welds on a girder interfere with longitudinal stiffeners, the weld area shall be ground flush.
4. Stiffeners near a field splice may be field welded.
5. Girder ends and bearing stiffeners shall be vertical except that they may be normal to grade for grades less than 2%.



⅞" ø max. studs to be used for falsework support when specified by the contractor. Contractor to determine size and spacing. Studs shall be removed and ground flush upon removal of falsework.

FALSEWORK SUPPORT

3/6/96 DUBOIS:EARLIST.LDET

FIGURE 13.2-3 STEEL DETAILS

13.2.17 Splice Details

The splice details shall include:

A) All plate sizes, including filler plates.
B) Bolts spacing and size.

13.2.18 Miscellaneous Details

Figure 13.2-3 shows details which shall be included as applicable:

A) FABRICATION DETAIL shall be included for welded plate structures show limitations for various types of web and flange shop splices.
B) LONGITUDINAL STIFFENER DETAILS shall be included when the design requires longitudinal stiffeners. The details shall show:
   1) Minimum dimension to vertical stiffeners, splices, etc. (usually 6”).
   2) Shape of end of stiffener.
   3) Bulk of vertical stiffeners on opposite side of web.
C) SHEAR CONNECTOR DETAILS show clearances, minimum, and number and size of stud actually used. A detail or note shall be used to show acceptable alternates.
D) FALSEWORK SUPPORT shows size and location of studs used for attachment of concrete forms to the girder. The note is required.
E) FLANGE WIDTH TRANSITION is shown when a flange splice is required between plates of varying width.
F) FABRICATION NOTES shall be as shown of Figure 13.2-3.

13.2.19 Camber and Dead Load Deflections

This sheet uses the output of the CAMBER computer program to provide the dimensions the shop requires for cutting the girder web so that the structure will conform to the vertical alignment upon completion. The blocking dimensions are used by the shop to assemble the girders in the finished configuration so that the undersized field splice holes will be accurately reamed.

For structures with no skew or horizontal curvature, only one girder need be input with a heading such as “Girders 1 thru 5”. Other structures (skewed and/or curved) will require separate input for each girder, unless the skew and curvature (vertical and horizontal) are small.

For a description of the program write-up, see Staff Bridge Design Memo 830-5.

The translucent output (including the dead load deflection) is taped on to blank sheets and handled the same as Bridge Geometry sheets. Title the sheets, “CAMBER AND DEAD LOAD DEFLECTIONS.”

13.2.20 Slab

The details for the slab are essentially the same as described elsewhere for other types of structures.

Some points which may require additional attention:

A) Special reinforcement may be required, especially in areas where the slab is in tension.
B) The outside edges of the deck should be the same thickness as the deck, and the underside of the overhang tapered to the bottom of the top girder flange.
C) Bottom longitudinal reinforcing in the overhang shall match the curb stirrups as shown on the curb details.
D) Haunches between the slab and girder shall be the width of the top flange for composite designs, and extended four inches on each size of the flange for noncomposite designs. The dept of the haunch shall be from the bottom of the slab to the bottom of the top flange and noted on the plans “Haunch varies “____” at Centerline Bearing and Centerline Girder.”
E) If expansion devices are required, they will be referred to the Standards Unit.
F) An end block detail at the end of the slab will be required for expansion joints. The configuration shall agree with the expansion device details and the detail notes. Title, <u>“SECTION.”</u>
G) Special attention should be given to the placement of the reinforcing near the expansion device.
H) For structures on skew where the end diaphragms are not parallel to the end of the slab, the bottom of the end block shall be made a uniform width sufficient to extend over the flange of the end diaphragm.

13.2.21 Bearing Details

Bearings will usually be shown on standard sheets obtained from the Standards Unit. All blanks on the sheet shall be filled in and unnecessary portions removed. A special detail may be required for unusual requirements, hinges in girders, etc.

Clearances between bearing plates and parapets, and girder flanges and parapets, shall be carefully checked. Required cuts on the corners shall be shown in the details. If the cuts are very large, redesign may be necessary.

13.2.22 Railing Details

Railing will usually be shown on standard sheets obtained from the Standards Unit. Special details may be required for architectural considerations, unusual requirements, etc.

13.2.23 Title Blocks

All title blocks and initial blocks shall be filled in on each sheet. The individual drawings shall be titled according to content. Do not use “MISCELLANEOUS DETAILS” unless you mean it.

13.2 Detailing and Checking Procedures Volume II

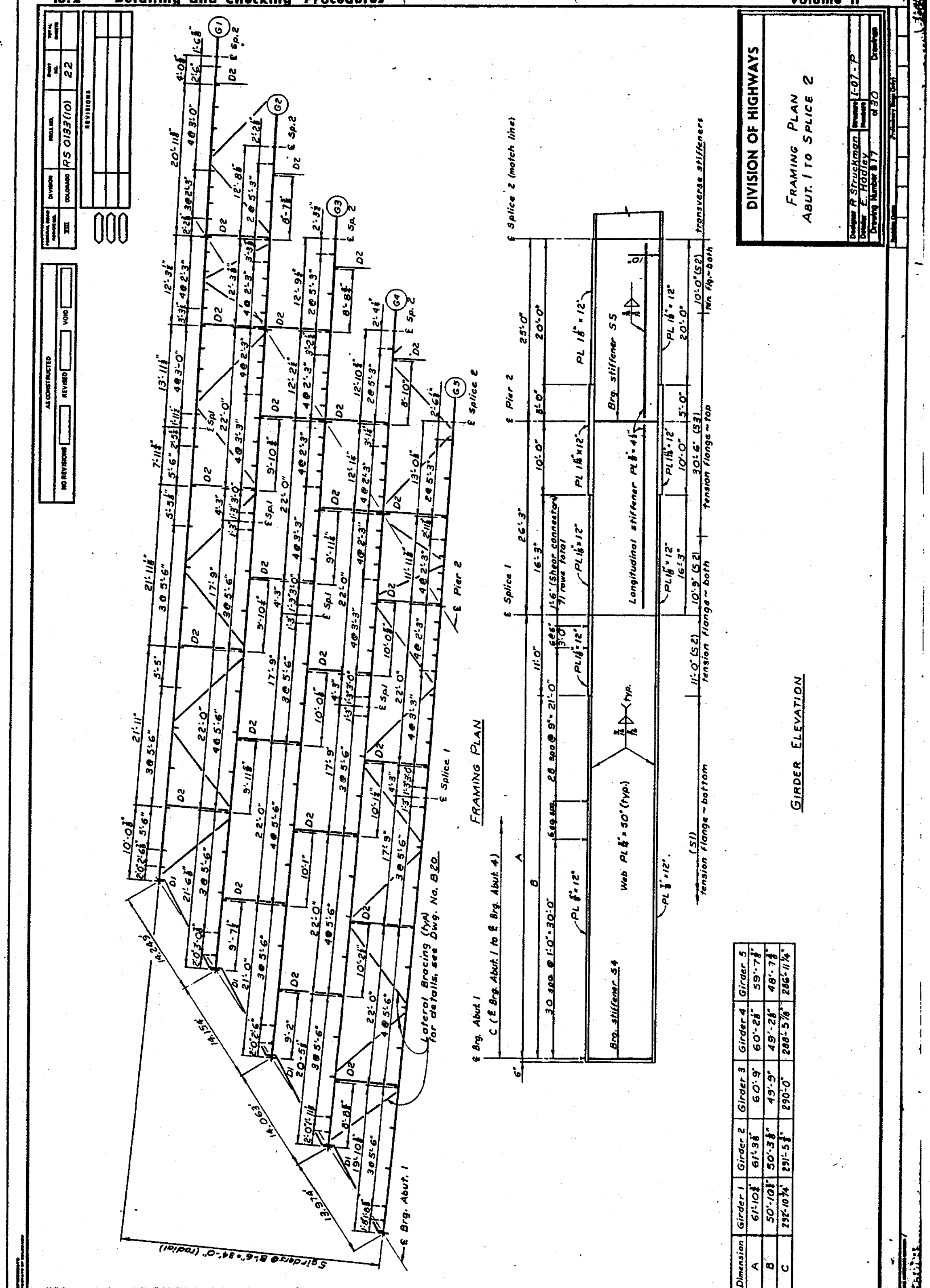


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Fig. 13-2-4

Volume II

Steel Superstructures 13.2

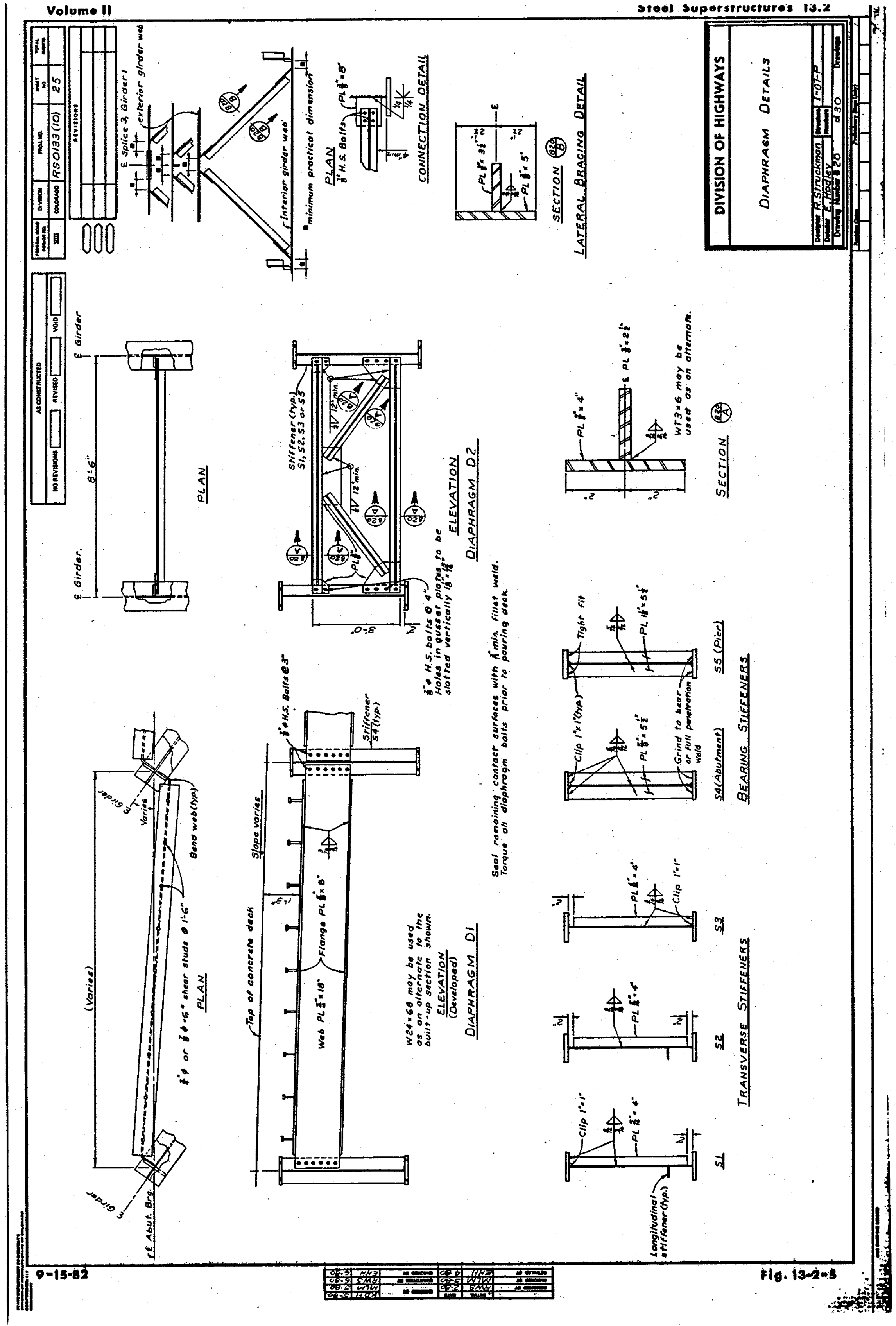

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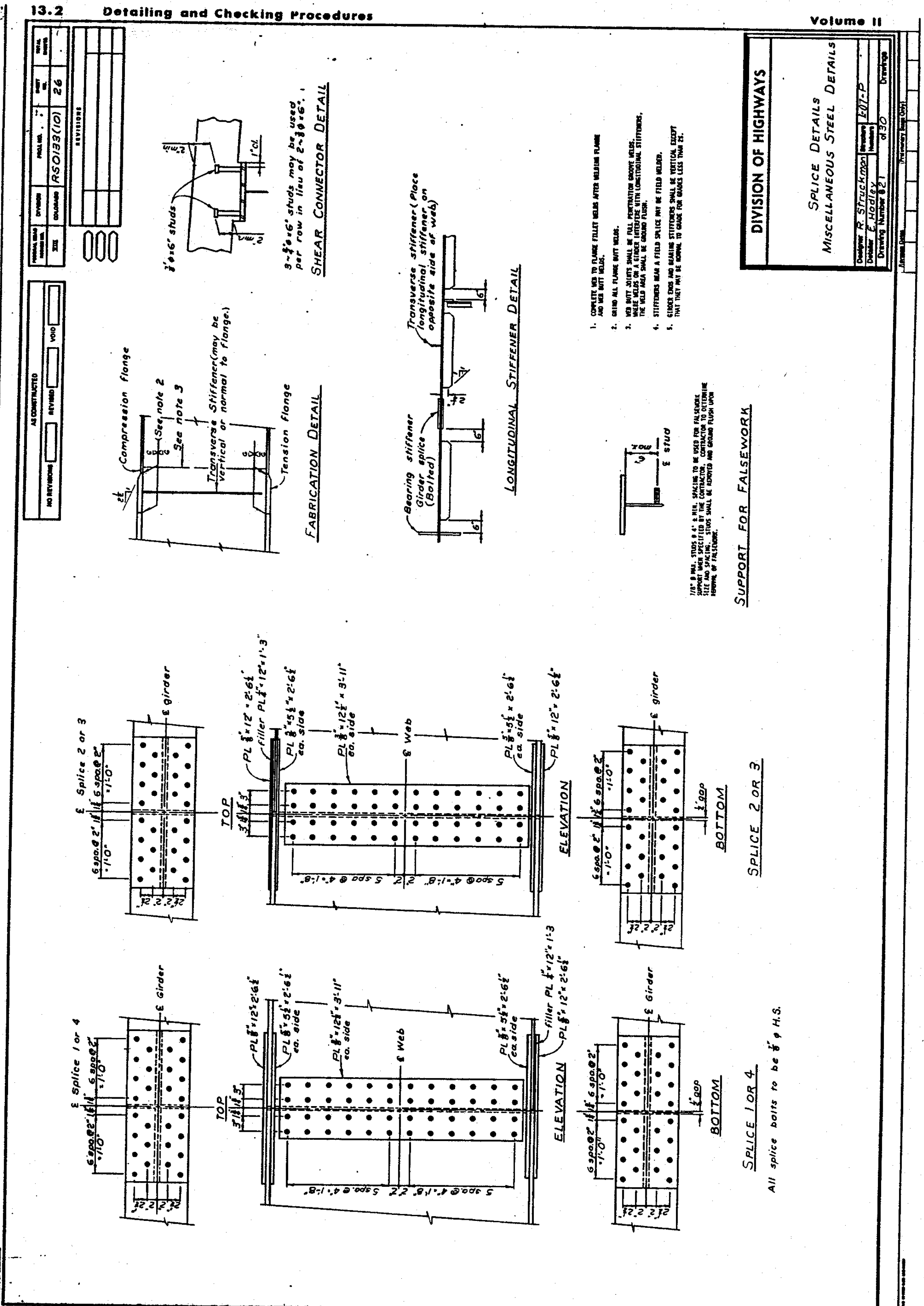
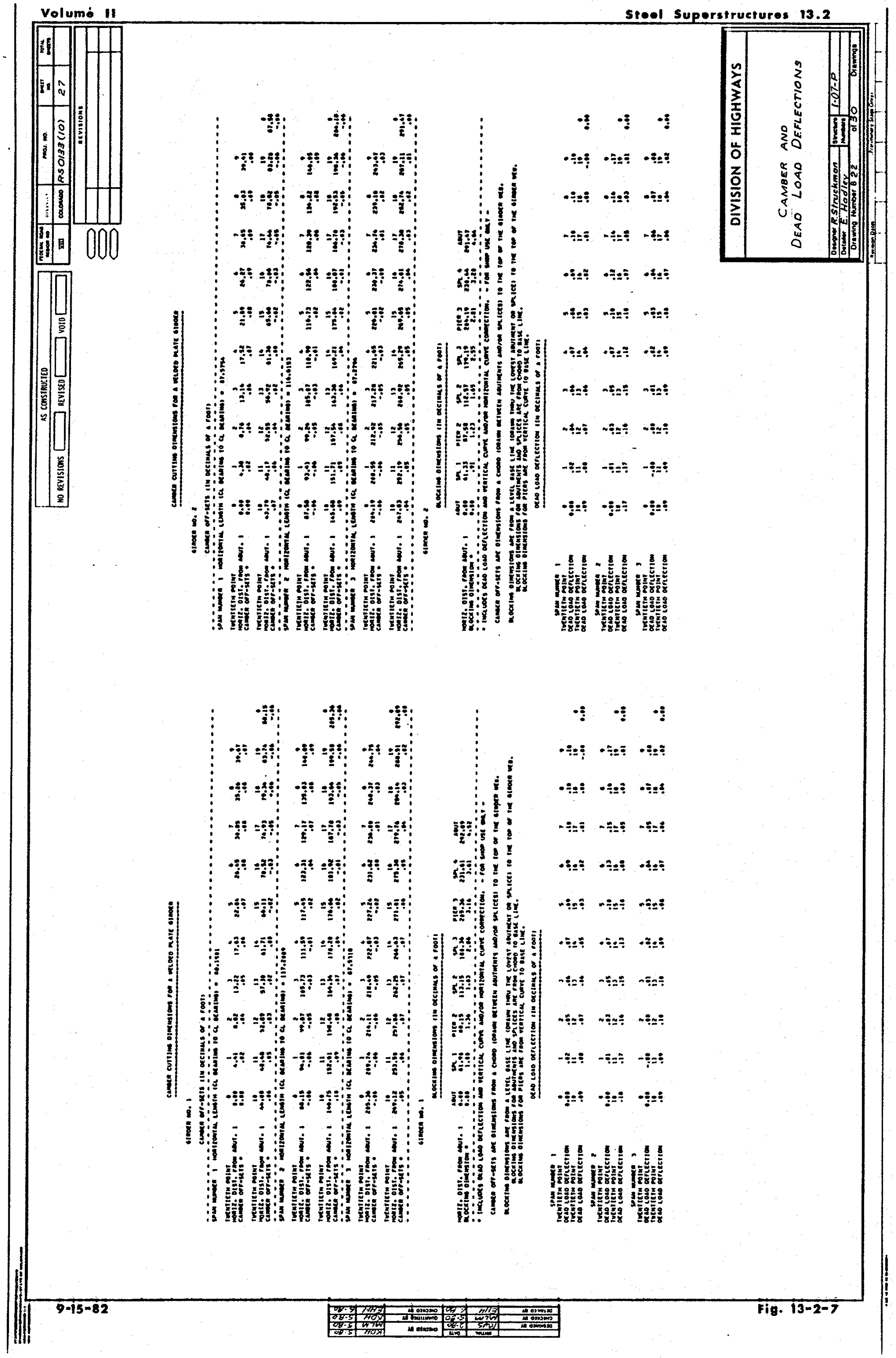
Fig. 13-2-5



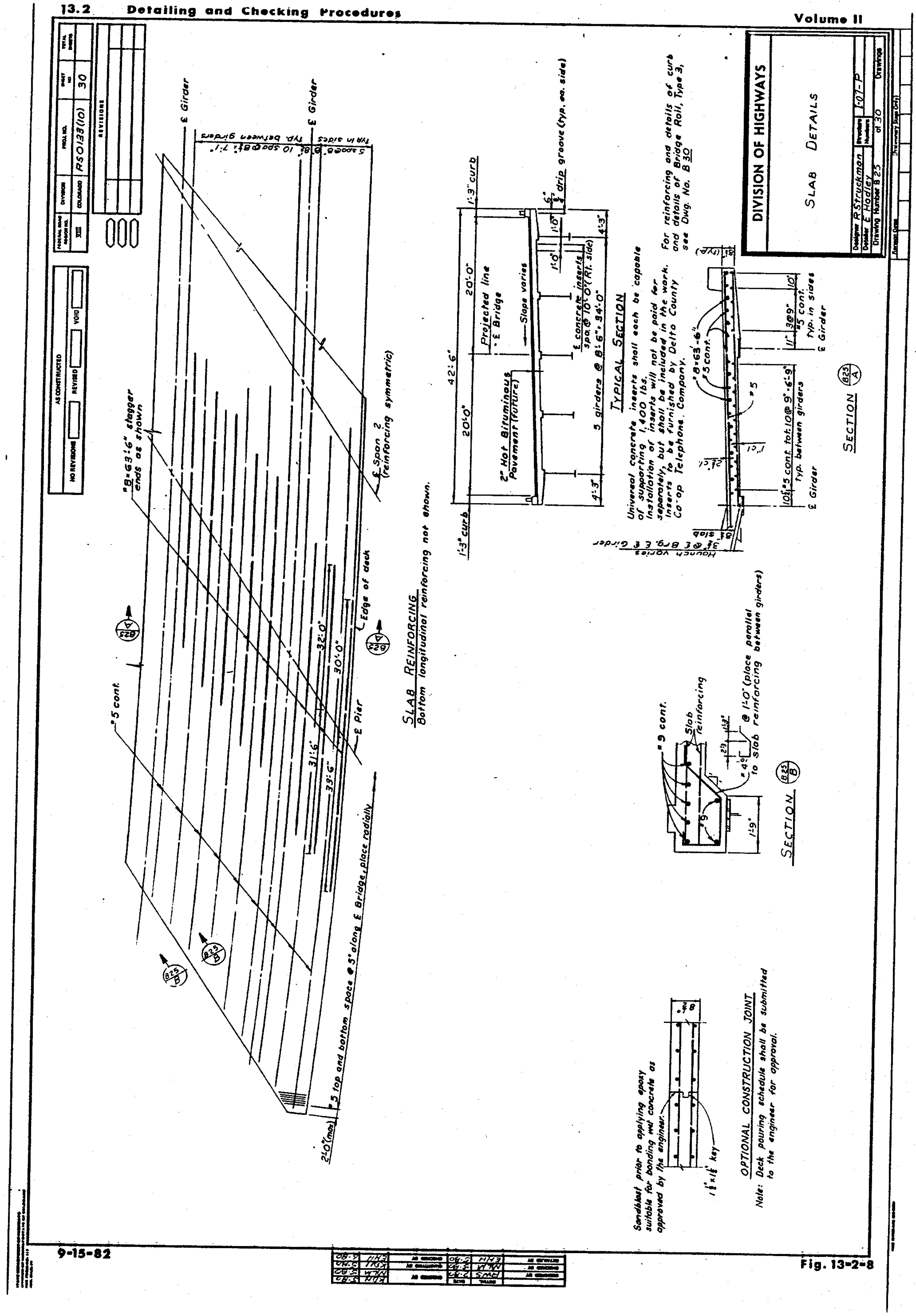
DIVISION OF HIGHWAYS
SPLICE DETAILS
MISCELLANEOUS STEEL DETAILS
SHEAR CONNECTOR DETAIL
FABRICATION DETAIL
LONGITUDINAL STIFFENER DETAIL
SUPPORT FOR FALSEWORK
TOP
ELEVATION
BOTTOM
SPLICE 2 OR 3
SPLICE 1 OR 4



Volume II
Steel Superstructures 13.2
AS CONSTRUCTED
NO REVISIONS
REVISED
VOID
COLORADO
RS 0133 (10)
27
REVISIONS
CAMBER CUTTING DIMENSIONS FOR A WELDED PLATE GIRDER
GIRDER NO. 1
GIRDER NO. 2
BLOCKING DIMENSIONS (IN DECIMALS OF A FOOT)
DEAD LOAD DEFLECTION (IN DECIMALS OF A FOOT)
DIVISION OF HIGHWAYS
CAMBER AND
DEAD LOAD DEFLECTIONS
Designer R. Struckman
Detailer E. Hadley
Structure Numbers I-07-P
Drawing Number B 22 of 30 Drawings
9-15-82
Fig. 13-2-7

13.2 Detailing and Checking Procedures

Volume II



9-15-82

Fig. 13-2-8

13.3.1 Purpose

These drawings are to present graphically all pertinent information needed by the Fabricator and Contractor for construction of the concrete deck and girders of the structure.

13.3.2 Responsibility

The graphic presentation of information on these drawings shall be the responsibility of the individual preparing the drawings in addition to the designer.

13.3.3 Scales

Scales shall be used that are suitable to make the details legible when the drawing is reduced. Suggested scales for presenting the details of the girders and deck are as follows:

A) Plan, Elevation and Sections - 1”=10’, 1”=20’, 1”=30’.
B) Details - 1/8"=1’-0”, 1/4” = 1’-0”, 1/2"=1’-0”, 3/4"=1’-0”, etc.

13.3.4 Orientation Of Details

The PLAN of the deck shall be placed, if possible, at upper left of the drawing.

The TYPICAL SECTION shall be placed below the deck PLAN. If space is limited, the sections or auxiliary views may be shown on another sheet.

Generally, sections should be taken from the PLAN rather than from auxiliary views or other sections.

13.3.5 Horizontal Control Line

The horizontal control line is not necessary for the plan view unless reinforcing is controlled by it.

13.3.6 Order Of Sheets

As with the rest of the set, the sheets are provided in the order of construction. The Precast Girder Worksheets (slabs, tubs, CBTs, boxes, etc. as appropriate) will be first, followed by the Deck Reinforcing Plan with any required sections and details.

Subsequent detail sheets and worksheets for pier diaphragm, bridge rail, fencing, lighting, etc. shall be added after these sheets to complete the required details.

13.3.7 Dimensions

A sufficient number of dimensions shall be shown on the details to provide adequate information necessary in the checking of the plans and the construction of the deck and associated details. Dimensions of reinforcing shall only be provided if not controlled by concrete limits, e.g. negative moment steel.

13.3.8 Girder Worksheets

The precast Girder worksheets (slabs, tubs, CBTs, boxes) shall be provided with additions as required to show the appropriate design in the Girder Schedule Table. Any changes to the default reinforcing shall be shown here as required by the design. Any item that is required for design of the girder or placement shall be shown in this sheet. Debonding length schedules and which strands are expected to be debonded shall be provided in this drawing as well. Debonding may be shown in section view as well. Locations of inserts such as PVC should be shown as to avoid reinforcing and prestressing strands. Lifting loops and overhang details are provided by the fabricator during the shop drawing process.

Leveling pad or bearing information should be placed on previous sheets but any bearing items needed in the precast girder should be shown. Shims to address rocking issues are typically shown in these drawings as well.

Post-tensioning ducts shall be shown in the girders as required. Post-tensioning information should be shown in the deck/girder detail sheets.

Any reinforcing for the barrier that extends into the girders shall be shown in the girder sheets so they can be placed at the fabrication plant.

13.3.9 Deck Reinforcing Details

The information for laying out the reinforcing for the deck shall be provided. The Reinforcing Plan view may be schematic as true scale detailing is generally not possible. A section view of the deck is often helpful in describing the reinforcing in addition to the plan view.

Some points which may require additional attention:

A) Special reinforcement may be required, especially in areas where the slab is in tension or in large skew areas.

B) Reinforcement governed by outside concrete and clearance dimensions should not be dimensioned or totaled, e.g. 30 - #5 @ 3" spacing. This information would be too similar to bar tables which have been discontinued.

C) The outside edges of the deck should be the same thickness as the interior deck, and the underside of the overhang tapered to one inch below the top of the girder. For side by side box overhangs a minimum slope of 1/2% should be used to tie into the box should be considered. Since camber is variable, details should be considered at minimum and maximum camber to identify any issues

D) Drip groove shall be shown in details.

E) Bottom longitudinal reinforcing in the overhang shall match the curb stirrups as shown on the curb details.

F) Haunches between the slab and girder shall be the width of the top flange for composite designs. The depth of the haunch shall be from the bottom of the slab to the bottom of the top flange and noted on the plans "Haunch varies "____" at Centerline Bearing and Centerline Girder."

13.3.10 Additional Deck Details

Add additional deck details and worksheets as required to show all details for the completion of the deck pour and associated reinforcing. These sheets may include barrier worksheets, lighting, utility hanger, sidewalks, medians, deck drains, deck post-tensioning and other details. Since the pier and abutment diaphragm is typically poured monolithically with the deck, the required details shall be shown within the deck detail sheets or in prior sheets such as the abutment. Any required deck pour schedules or schemes would be shown in this section as well.

Provide partial depth precast panel worksheets if they are an acceptable work method. If they are optional, their cost is included in the work otherwise they shall be paid for separately. If full depth precast panels are used, provide all required details.

13.3.11 Checking

Listed below is a summary of items that shall be checked and appear on the drawing, when applicable. Additional information shall appear, as required.

A) Title PLAN and SECTION in accordance with their particular conditions

B) Reinforcing Splice lengths provided

C) Skew angle of bridge and other pertinent angles

D) Barrier sections or references

E) Drip groove shown and dimensioned

F) Check title block for information

G) Jacking force

H) Area of prestressing steel
I) Minimum concrete strength at jacking and at 28 days
J) Center of gravity of prestressing force path
K) Final force
L) Dead load deflection
M) Expected cambers (release and before deck pour)
N) Estimated haunch at midspan (estimated deck thickness for side-by-side box girders)
O) Debonding schedule

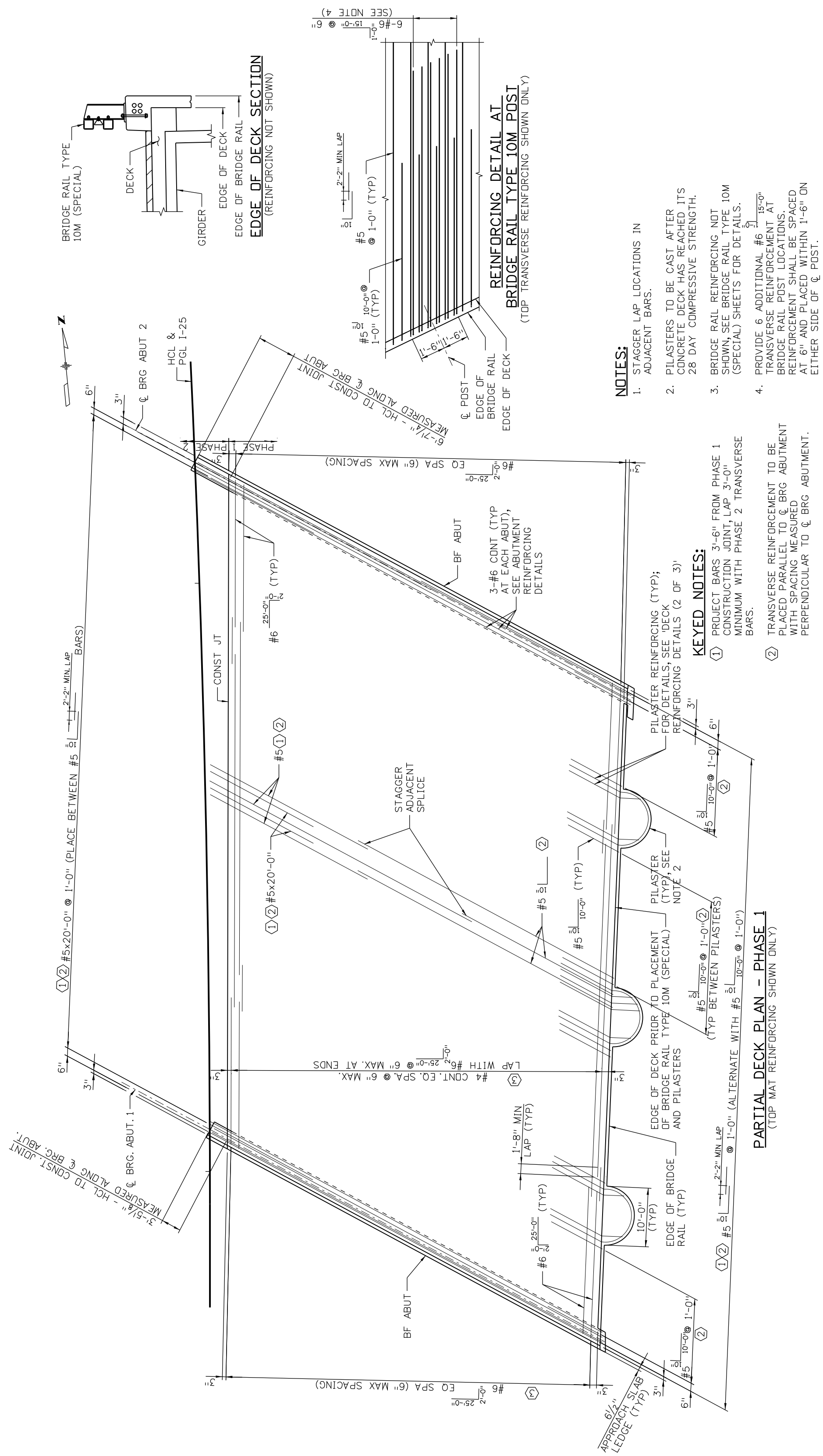
13.3.12 Title Block

This drawing is titled “DECK REINFORCING DETAILS” or similar and shall be so indicated in the title block.

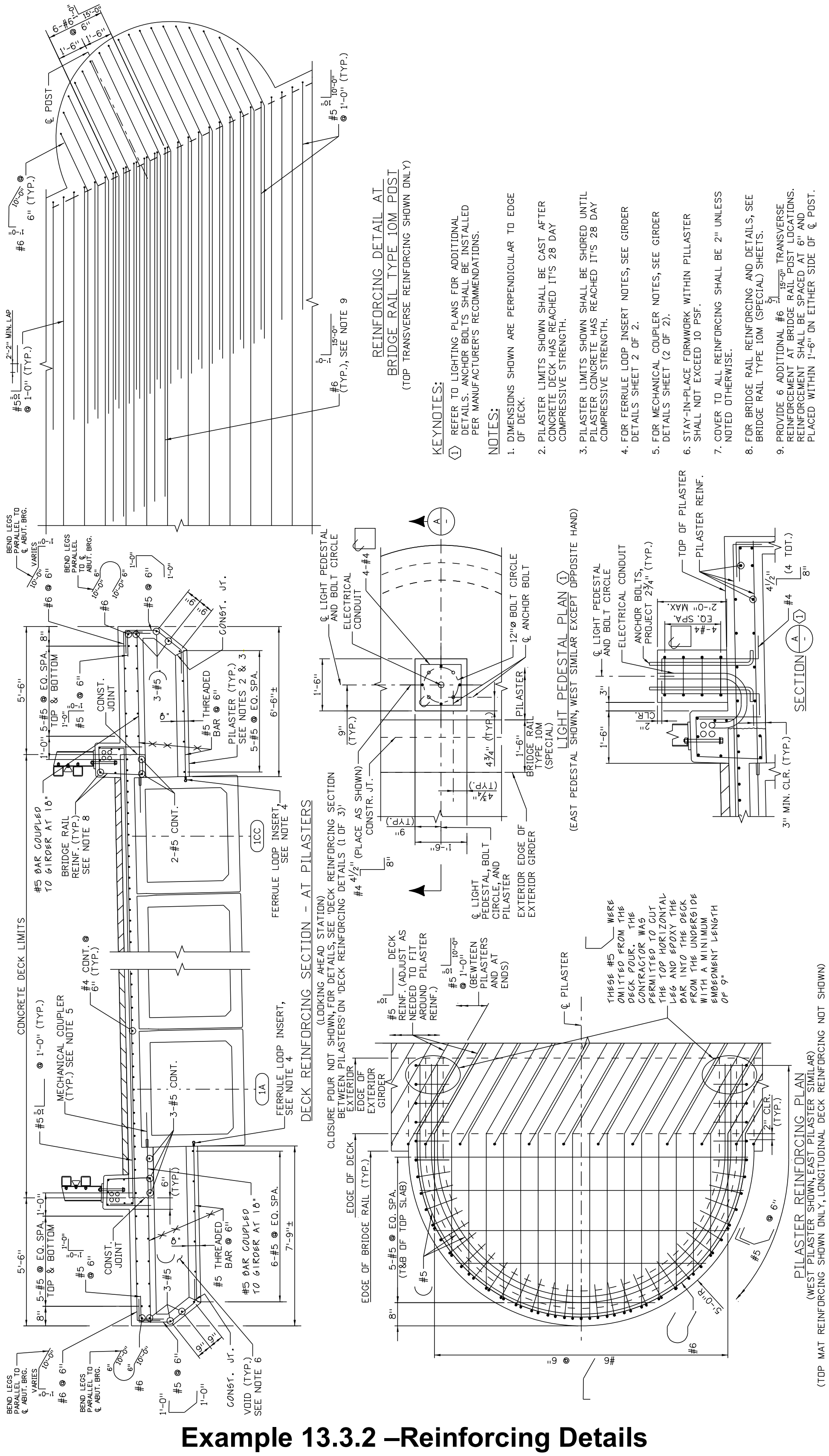
If other details are combined on this drawing, they shall be indicated in the title. Example: If the “Barrier Details” are placed on this drawing with the “Deck Details”, the title shall be “DECK DETAILS - BARRIER DETAILS”.

13.3.13 Examples

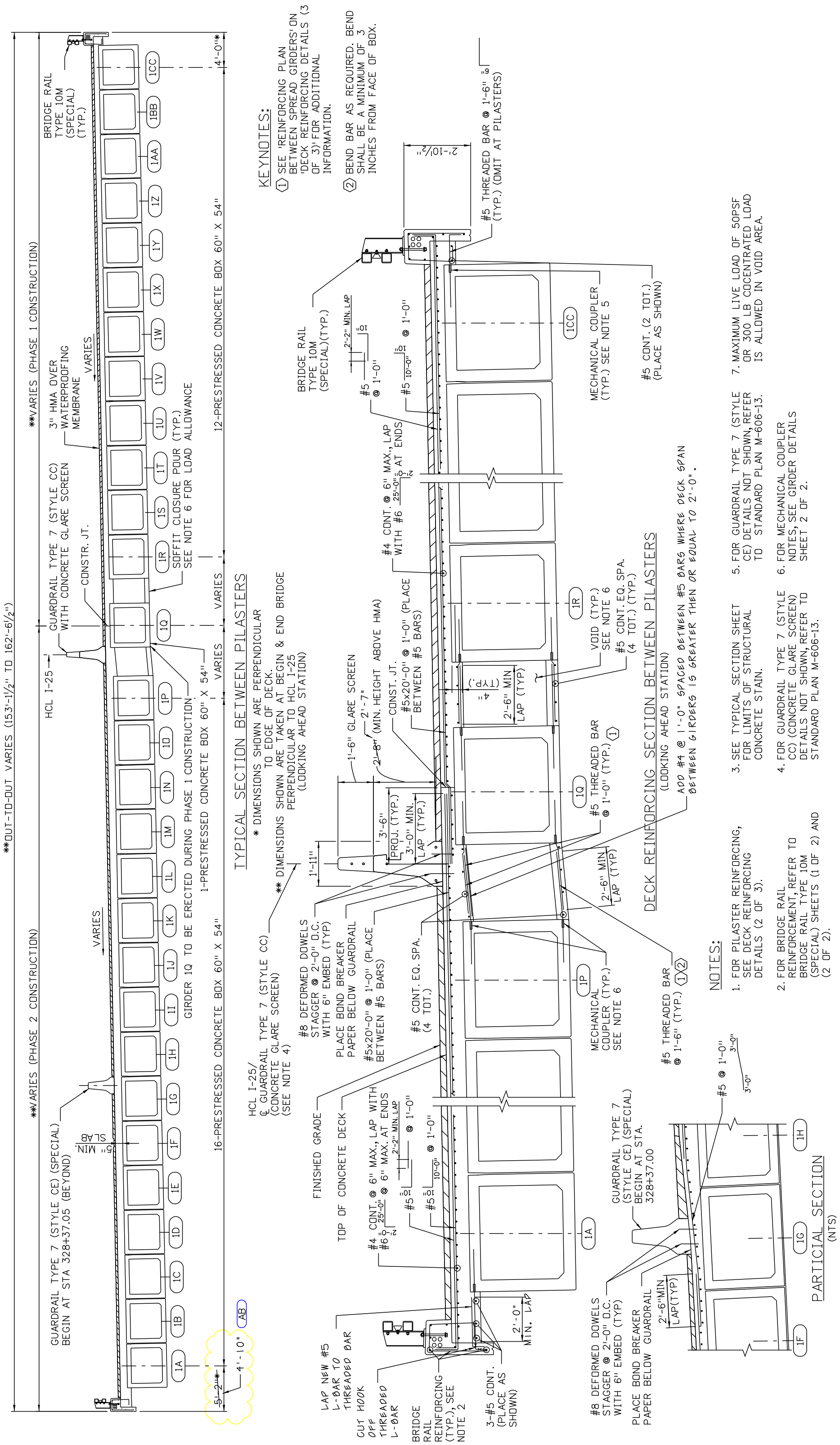
Examples may contain old styles of girders, barrier and other details. All plan sets for new bridges shall use the latest worksheets and standards available.



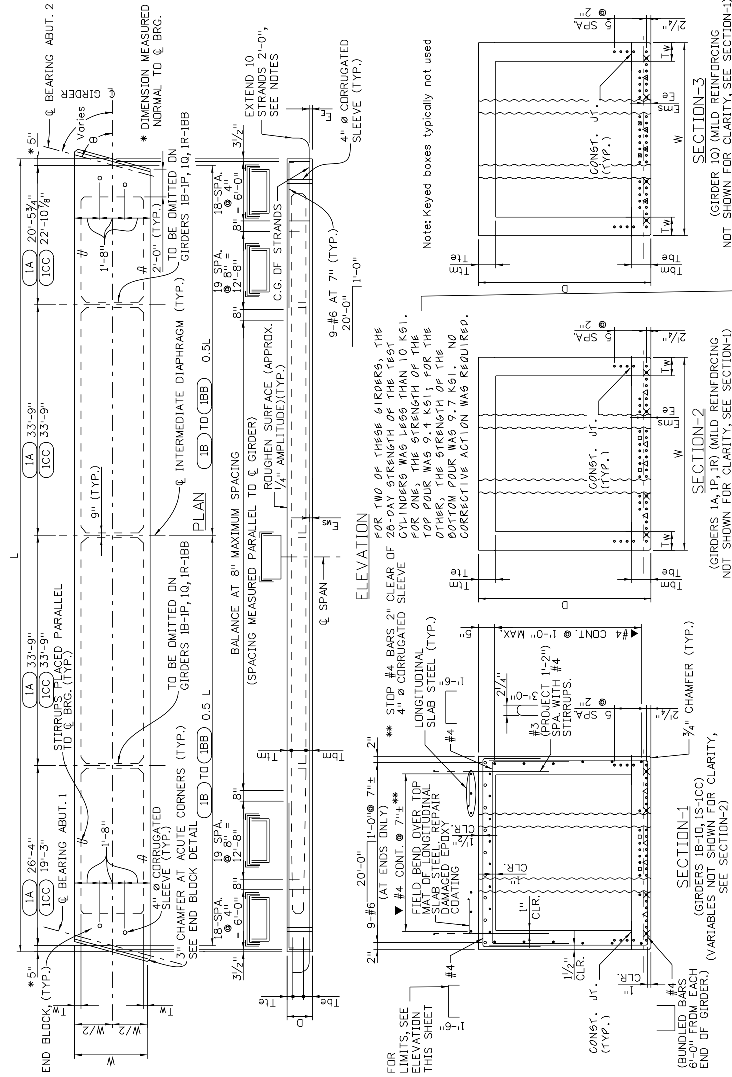
Example 13.3.1 –Deck Plan



Example 13.3.2 –Reinforcing Details



Example 13.3.3 –Deck Reinforcing



SPAN NO.	GIRDER NO.	L (FT)	W (IN.)	D (IN.)	Θ (DEG.)	Tw (IN.)	Tbm (IN.)	Ttm (IN.)	Tbe (IN.)	Tte (IN.)	Lt (FT)	A_s^* (SQ IN)	DEBONDED STRANDS (PERCENT)	E_E (IN.)	E_{MS} (IN.)	F_j (KIPS)	F_f (KIPS)	CONCRETE STRENGTH f'_{ci} (psi)	CONCRETE STRENGTH f'_c (psi)	Δ_i (IN.)	PREDICTED GIRDER RELEASE CAMBER (IN.)	PREDICTED GIRDER FINAL CAMBER (IN.)
1	1A, 1P	115'-3 1/4"	60"	54"	59° 59'58"	6"	6"	5 1/2"	6"	5 1/2"	0	9.98	21.7	4.08	4.08	2021	1610	6,000	10,000	1.64	2.27	4.55
1	1B-1O	115'-3 1/4"	60"	54"	59° 59'58"	6"	6"	5 1/2"	6"	5 1/2"	0	9.11	23.8	4.06	4.06	1845	1496	6,000	10,000	1.02	1.92	3.78
1	1Q	112'-10"	60"	54"	62° 13'24"	6"	6"	5 1/2"	6"	5 1/2"	0	10.85	20.00	4.09	4.09	2197	1721	6,000	10,000	1.86	2.63	5.38
1	1S-1CC	110'-6 3/4"	60"	54"	64° 32'32"	6"	6"	5 1/2"	6"	5 1/2"	0	9.11	23.8	4.06	4.06	1845	1496	6,000	10,000	0.79	1.93	3.86
1	1R	110'-6 3/4"	60"	54"	64° 32'32"	6"	6"	5 1/2"	6"	5 1/2"	0	9.98	21.7	4.08	4.08	2021	1610	6,000	10,000	1.32	2.27	4.61

NOTES:

WHEN APPROVED BY THE ENGINEER, A MINIMUM OF TACK WELDING WILL BE PERMITTED ON ASTM A706 UNCOATED REINFORCING STEEL.

REINFORCING PROJECTING FROM THE TOP OF THE GIRDER AND REINFORCING WITHIN EIGHT FEET OF AN EXPANSION DEVICE IN THE BRIDGE DECK SHALL BE EPOXY COATED. DAMAGED COATING ON GIRDER REINFORCING NEED NOT BE REPAIRED. THE MINIMUM COVER FOR REINFORCING STEEL IS 1".

AT GIRDER ENDS NOT EMBEDDED IN CONCRETE DIAPHRAGMS, CUT STRANDS OFF 1" BELOW THE SURFACE OF THE CONCRETE AND FINISH WITH AN APPROVED EPOXY GROUT. AT GIRDER ENDS EMBEDDED IN CONCRETE DIAPHRAGMS, CUT STRANDS TO PROJECT 3", EXCEPT AS SHOWN. DO NOT MAKE COSMETIC REPAIRS (DAMAGE LESS THAN 1 " DEEP) TO THE PARTS OF THE GIRDERS EMBEDDED IN CONCRETE.

USE LOW RELAXATION STRANDS MEETING THE REQUIREMENTS OF ASTM A-416 GRADE 270. THE MINIMUM CLEAR DISTANCE BETWEEN GROUPS OR INDIVIDUAL STRANDS SHALL BE 2.3(d_s) BUT NOT LESS THAN 1 ". THE MINIMUM COVER FOR PRESTRESSING STEEL IS 1 ".

CONCRETE SHALL BE CLASS PS.

ENTRAINED AIR IS NOT REQUIRED FOR GIRDER CONCRETE.

END BLOCKS SHALL BE USED ON ALL GIRDERS UNLESS OTHERWISE NOTED.

USE " CHAMFER ON ALL CORNERS, EXCEPT AS NOTED.

PREDICTED GIRDER FINAL CAMBER IS THE CAMBER FOR THE GIRDER ALONE AT 90 DAYS. THE CONTRACTOR SHALL LIMIT THE CAMBER GROWTH TO A VALUE NOT TO EXCEED THE PREDICTED CAMBER PLUS 1" PRIOR TO THE DECK POUR BY WEIGHTING, SCHEDULING FABRICATION, POST TENSIONING, OR OTHER MEANS AND MUST REPORT TO THE ENGINEER VALUES OF CAMBER WHICH EXCEED THE PREDICTED CAMBER PLUS 1". REMEDIAL MEASURES, AS APPROVED BY THE ENGINEER, SHALL BE TAKEN IF THE PREDICTED CAMBER PLUS 1" IS EXCEEDED. THE APPROVED REMEDIAL MEASURES SHALL BE FREE OF ANY ADVERSE IMPACT. THE COSTS ASSOCIATED WITH ALL REMEDIAL MEASURES SHALL BE BORNE BY THE CONTRACTOR.

SIDE BY SIDE BOXES WITH THE SAME STRAND PATTERN PLACED OVER ROADS OR PEDESTRIAN FACILITIES SHALL NOT HAVE CAMBERS OF ADJACENT BOXES DIFFER BY MORE THAN 1" BEFORE THE DECK POUR. PRIOR TO PLACING DECK REINFORCING, THE CONTRACTOR SHALL ADJUST THIS DIFFERENTIAL TO WITHIN THIS LIMIT BY SORTING THE BOXES TO MINIMIZE DIFFERENTIALS, OR BY PULLING THE HIGH BOXES DOWN AND LOW BOXES UP.

DEPTH (D) TOLERANCE SHALL BE + ", - ".

THE CONTRACTOR IS RESPONSIBLE FOR DETERMINING NECESSARY BRACING REQUIREMENTS, AND FOR PROVIDING ADEQUATE BRACING FOR THE SPECIFIC WIND AND WEATHER CONDITIONS TO BE ENCOUNTERED FOR EACH SPECIFIC PROJECT.

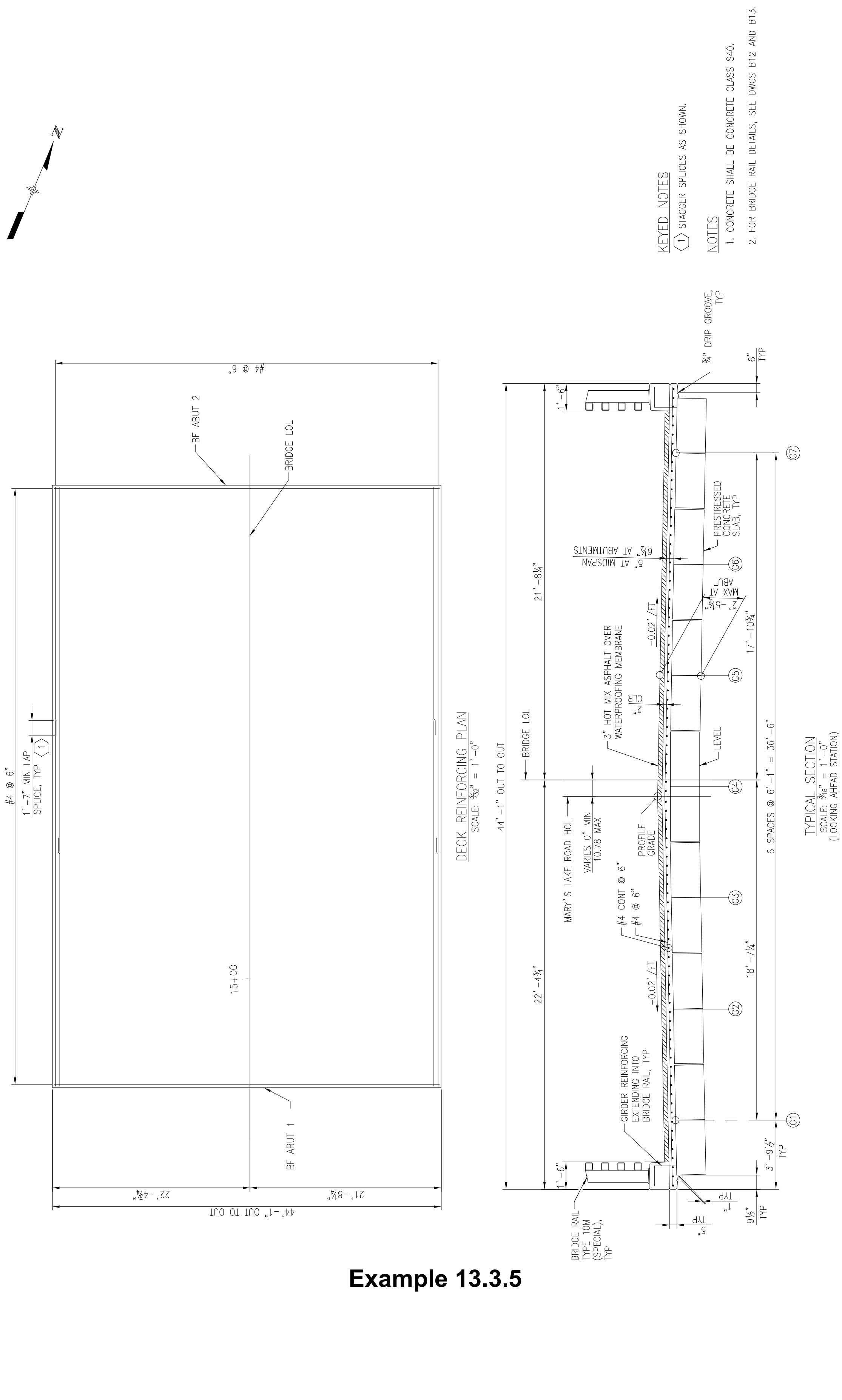
DEBONDING OF STRANDS SHALL EXTEND FROM GIRDER ENDS, SEE SYMBOLS BELOW FOR DEBONDING LENGTH.
X = 10 FEET △ = 6 FEET □ = 2 FEET

EXTERIOR STRAND SHALL NOT BE DEBONDED AND SHOULD BE PLACED ADJACENT TO ANCHOR STIRRUPS.

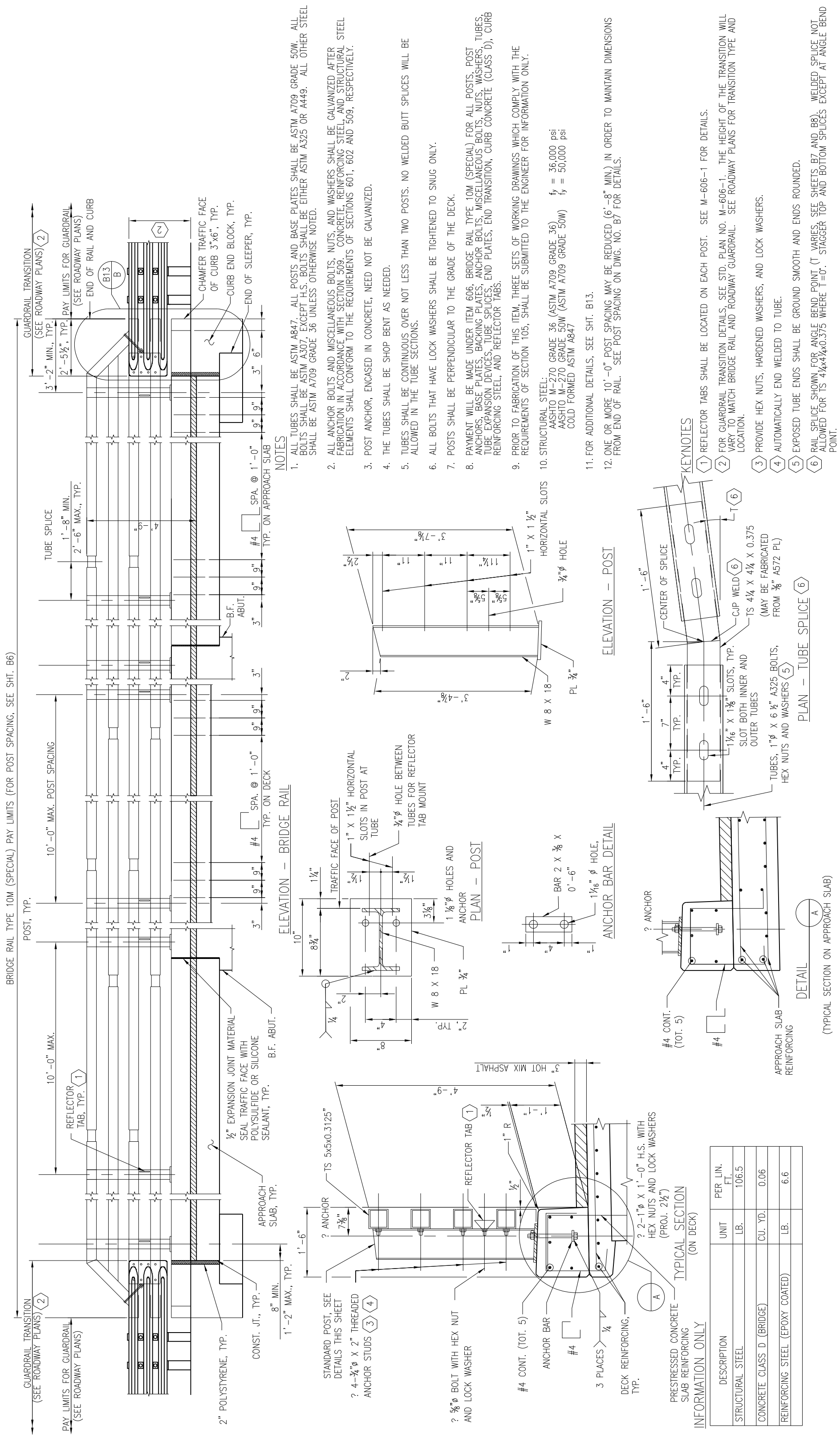
A_s^* = MINIMUM AREA OF THE PRESTRESSING STEEL.
d_s = NOMINAL STRAND DIAMETER.
f'_s = ULTIMATE STRENGTH OF PRESTRESSING STEEL.
F_j = JACKING FORCE PER GIRDER.
F_f = FINAL FORCE PER GIRDER AFTER ALL LOSSES.
f'_{ci} = REQUIRED CONCRETE STRENGTH AT RELEASE OF PRESTRESS FORCE.
f'_c = REQUIRED CONCRETE STRENGTH AT 28 DAYS OF AGE.
L = LENGTH OF GIRDER ALONG THE GRADE OF THE GIRDER.
Δ_i = IMMEDIATE DEFLECTION AT CENTERLINE OF SPAN DUE TO CAST-IN-PLACE SLAB, ASPHALT, CURBS AND RAILS.
Θ = BRIDGE SKEW ANGLE
Ems = DISTANCE MEASURED FROM BOTTOM OF GIRDER TO C.G. OF STRAND GROUP AT MID-SPAN.
Ee = DISTANCE MEASURED FROM BOTTOM OF GIRDER TO C.G. OF STRAND GROUP AT ENDS.
x,△,□ = DEBONDED STRAND. SEE NOTES FOR DEBONDED LENGTH.

▼ LIGHTLY TENSIONED STRANDS MAY BE USED AS AN ALTERNATE.

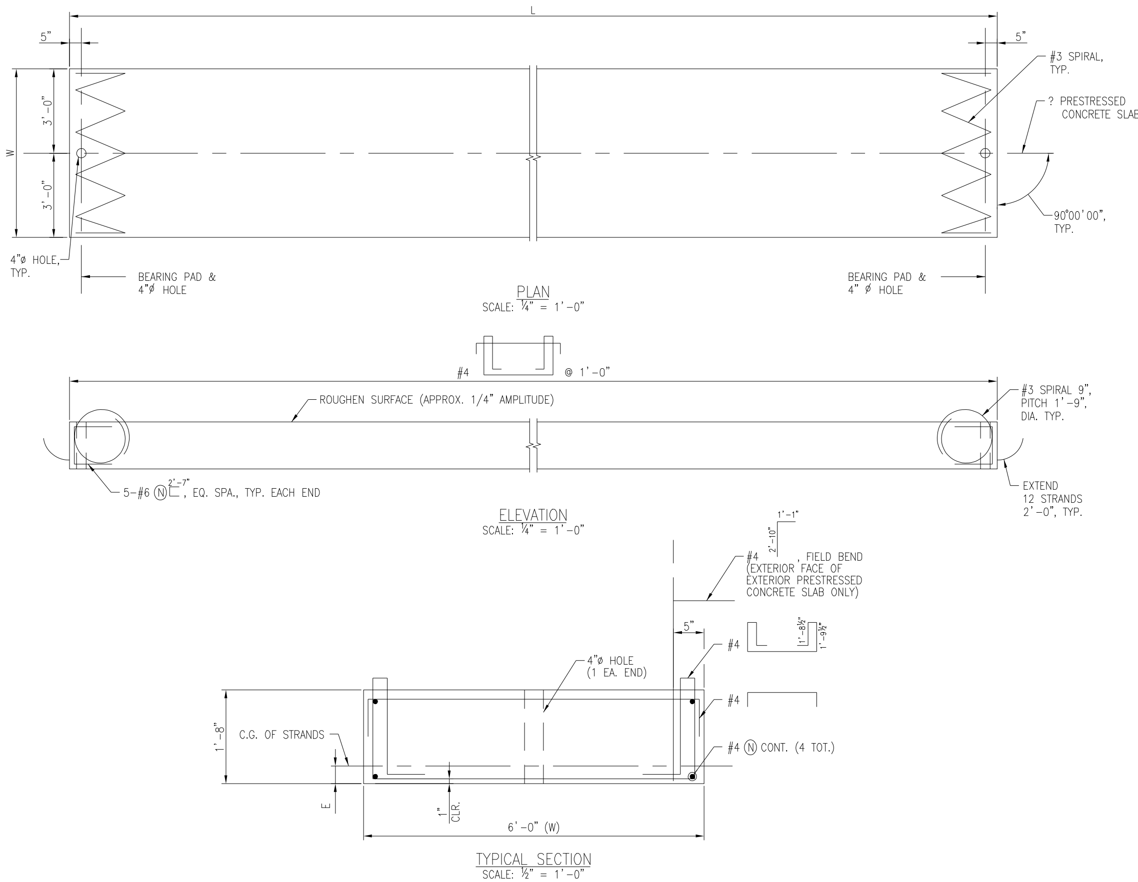
Example 13.3.4 – Prestressed Girder



Example 13.3.5



Example 13.3.6



PRESTRESSED CONCRETE SLAB SCHEDULE

GIRDER NO.	L (FEET)	A_s (SQUARE INCH)	E (INCH)	F_j (KIPS)	F_f (KIPS)	CONCRETE STRENGTH		Δ (INCH)	PREDICTED CAMBER (INCH)	DEBOND STRANDS (%)
						f'_{ci} (KSI)	f'_c (KSI)			
G1 TO G7	64.50	10.416	3.92	2109	1796	5.70	6.50	0.90	2.38	25

NOTES

1. ALL WORK NECESSARY TO FABRICATE AND INSTALL THE INTEGRAL PARTS OF THE PRESTRESSED CONCRETE SLAB (INCLUDING THE BEARING PADS), AS SHOWN ON THE PLANS, SHALL BE INCLUDED IN THE BID PRICE FOR ITEM NO. 618, PRESTRESSED CONCRETE SLAB (D>13"), WITH A PAY UNIT OF SQ. FEET WHICH SHALL BE MEASURED BY DIMENSION LxW.

2. WHEN APPROVED BY THE ENGINEER, A MINIMUM OF TACK WELDING WILL BE PERMITTED ON ASTM A706 UNCOATED REINFORCING STEEL.

3. REINFORCING PROJECTING FROM THE TOP OF THE PRESTRESSED CONCRETE SLAB SHALL BE EPOXY COATED. DAMAGED COATING ON PRESTRESSED CONCRETE SLAB REINFORCING NEED NOT BE REPAIRED.

4. THE MINIMUM COVER FOR REINFORCING STEEL IS 1".

5. AT PRESTRESSED CONCRETE SLAB ENDS, CUT STRANDS TO PROJECT 3", EXCEPT AS SHOWN. DO NOT MAKE COSMETIC REPAIRS (DAMAGE LESS THAN 1½" DEEP) TO THE PARTS OF THE PRESTRESSED CONCRETE SLABS EMBEDDED IN CONCRETE.

6. USE LOW RELAXATION STRANDS MEETING THE REQUIREMENTS OF ASTM A416 GRADE 270. THE MINIMUM CLEAR DISTANCE BETWEEN GROUPS OR INDIVIDUAL STRANDS SHALL BE 2.3(d_s) BUT NOT LESS THAN 1¼". THE MINIMUM COVER FOR PRESTRESSING STEEL IS 1½".

7. CONCRETE SHALL BE CLASS PS.

8. ENTRAINED AIR IS NOT REQUIRED FOR PRESTRESSED CONCRETE SLAB CONCRETE.

9. USE ½" CHAMFER ON ALL CORNERS, EXCEPT AS NOTED.

10. PREDICTED CAMBER IS THE CAMBER FOR THE PRESTRESSED CONCRETE SLAB ALONE AT 90 DAYS. THE CONTRACTOR SHALL LIMIT THE CAMBER GROWTH TO A VALUE NOT TO EXCEED THE PREDICTED CAMBER PLUS 1" PRIOR TO THE DECK POUR BY WEIGHTING, SCHEDULING FABRICATION, POST TENSIONING, OR OTHER MEANS AND MUST REPORT TO THE ENGINEER VALUES OF CAMBER WHICH EXCEED THE PREDICTED CAMBER PLUS 1". REMEDIAL MEASURES, AS APPROVED BY THE ENGINEER, SHALL BE TAKEN IF THE PREDICTED CAMBER PLUS 1" IS EXCEEDED. THE APPROVED REMEDIAL MEASURES SHALL BE FREE OF ANY ADVERSE IMPACT. THE COSTS ASSOCIATED WITH ALL REMEDIAL MEASURES SHALL BE BORNE BY THE CONTRACTOR.

11. PRODUCT DIMENSIONAL TOLERANCES SPECIFIED IN MNL-116 SECTION 6.4 SHALL APPLY AS SPECIFICATION TOLERANCE, EXCEPT THAT THE DEPTH TOLERANCE SHALL BE +½", -¼".

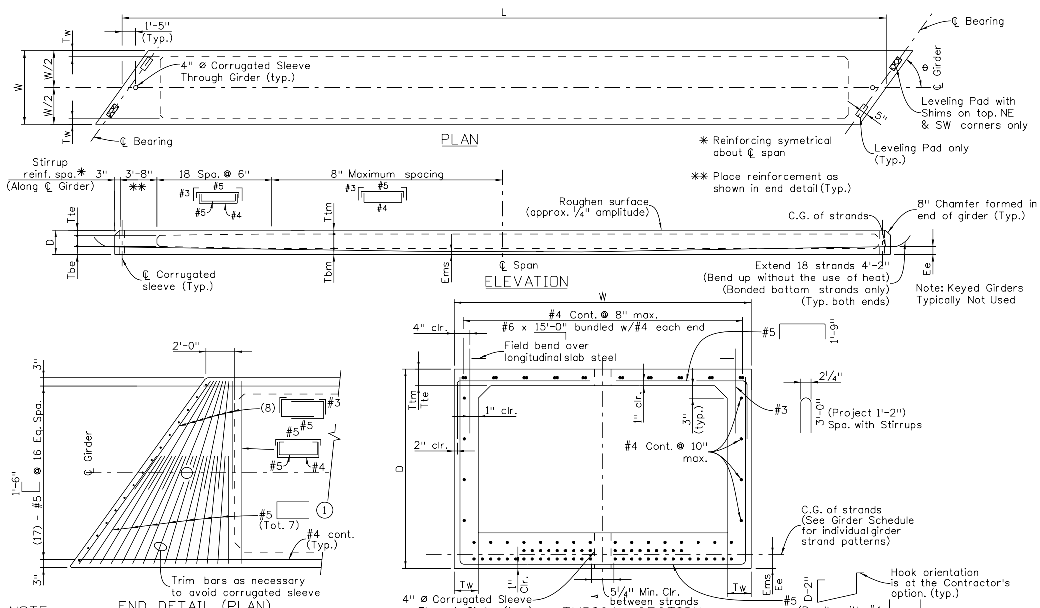
12. SIDE BY SIDE SLABS PLACED OVER ROADS OR PEDESTRIAN FACILITIES SHALL NOT HAVE CAMBERS OF ADJACENT GIRDERS DIFFER BY MORE THAN 1" BEFORE THE DECK POUR. PRIOR TO PLACING DECK REINFORCING, THE CONTRACTOR SHALL ADJUST THIS DIFFERENTIAL TO WITHIN THIS LIMIT BY SORTING THE GIRDERS TO MINIMIZE DIFFERENTIALS, OR BY PULLING THE HIGH BOXES DOWN AND LOW BOXES UP.

13. THE CONTRACTOR IS RESPONSIBLE FOR DETERMINING NECESSARY BRACING REQUIREMENTS, AND FOR PROVIDING ADEQUATE BRACING FOR THE SPECIFIC WIND AND WEATHER CONDITIONS TO BE ENCOUNTERED FOR EACH SPECIFIC PROJECT.

ABBREVIATIONS

A_s = MINIMUM AREA OF THE PRESTRESSING STEEL
d_s = NOMINAL STRAND DIAMETER
F_j = JACKING FORCE PER PRESTRESSED CONCRETE SLAB
F_f = FINAL FORCE PER PRESTRESSED CONCRETE SLAB AFTER ALL LOSSES
f'_{ci} = REQUIRED CONCRETE STRENGTH AT RELEASE OF PRESTRESS FORCE
f'_c = REQUIRED CONCRETE STRENGTH AT 28 DAYS OF AGE
L = LENGTH OF PRESTRESSED CONCRETE SLAB ALONG THE GRADE OF THE PRESTRESSED CONCRETE SLAB
W = WIDTH OF THE PRESTRESSED CONCRETE SLAB
Δ = DEFLECTION AT CENTERLINE OF SPAN DUE TO CAST-IN-PLACE SLAB, DIAPHRAGMS, ASPHALT, CURBS, AND RAILS

Example 13.3.7 – Prestressed Concrete Slab



NOTE:

① (insert between each stirrup, place as shown extending 6" min. beyond ℄ girder)

GIRDER SCHEDULE

Span No.	Girder No.	L (Feet)	W (Inch)	D (Inch)	θ (Deg.)	Tw (Inch)	Tbm (Inch)	Ttm (Inch)	Tbe (Inch)	Tte (Inch)	A_s* (Square Inch)	Debonded Strands	E_E (Inch)	E_{MS} (Inch)	F_j (KIPS)	F_f (KIPS)	Concrete Strength f'_{ci} (PSI)	Concrete Strength f'_c (PSI)	Δi (Inch)	Predicted Release Camber (Inch)	Predicted Camber (Inch)
Note:	Girders shall now be lettered																				
1	1,9	91.80	72	54	54.25	6	8	6	8	6	7.378	N/A	3.07	3.07	1494	1328	6500	8500	0.40	1.35	1.54
	2-8	91.80	72	54	54.25	6	8	6	8	6	7.378	N/A	3.07	3.07	1494	1324	6500	8500	0.36	1.35	1.54
	10,16	91.80	72	54	54.25	6	8	6	8	6	7.378	N/A	3.07	3.07	1494	1335	6500	8500	0.46	1.35	1.54
	11-15	91.80	72	54	54.25	6	8	6	8	6	7.378	N/A	3.07	3.07	1494	1325	6500	8500	0.36	1.35	1.54
2	1,9	131.90	72	54	54.25	6	8	6	8	6	13.888	SEE TABLE	3.81	3.81	2812	2387	6500	8500	1.65	4.05	4.49
	2-8	131.90	72	54	54.25	6	8	6	8	6	13.888	SEE TABLE	3.81	3.81	2812	2376	6500	8500	1.43	4.05	4.49
	10,16	131.90	72	54	54.25	6	8	6	8	6	14.756	SEE TABLE	3.90	3.90	2988	2530	6500	8500	1.83	4.60	5.16
	11-15	131.90	72	54	54.25	6	8	6	8	6	13.888	SEE TABLE	3.81	3.81	2812	2375	6500	8500	1.41	4.05	4.49
3	1,9	80.55	72	54	54.25	6	8	6	8	6	6.076	N/A	3.11	3.11	1230	1103	6500	8500	0.24	0.93	1.07
	2-8	80.55	72	54	54.25	6	8	6	8	6	6.076	N/A	3.11	3.11	1230	1100	6500	8500	0.21	0.93	1.07
	10,16	80.55	72	54	54.25	6	8	6	8	6	6.076	N/A	3.11	3.11	1230	1107	6500	8500	0.27	0.93	1.07
	11-15	80.55	72	54	54.25	6	8	6	8	6	6.076	N/A	3.11	3.11	1230	1101	6500	8500	0.21	0.93	1.07

NOTES:

All work necessary to fabricate and install the integral parts of the girder (including the intermediate diaphragms, if any, and leveling pads), as shown on the plans, shall be included in the bid price for Item No. 618, Prestressed Concrete Box (Depth greater than 48"), with a pay unit of Sq. Ft. measured by L x W.

When approved by the Engineer, a minimum of tack welding will be permitted on ASTM A706 uncoated reinforcing steel.

Reinforcing projecting from the top of the girder and reinforcing within eight feet of an expansion device in the bridge deck shall be epoxy coated. Damaged coating on girder reinforcing need not be repaired. The minimum cover for reinforcing steel is 1". At girder ends not embedded in concrete diaphragms, cut strands off 1" below the surface of the concrete and finish with an approved epoxy grout. At girder ends embedded in concrete diaphragms, cut strands to project 3", except as shown. Do not make cosmetic repairs (damage less than 1 1/2" deep) to the parts of the girders embedded in concrete.

Use low relaxation strands meeting the requirements of ASTM A-416 Grade 270. The minimum clear distance between groups or individual strands shall be 2.3(d_s) but not less than 1 1/4". The minimum cover for prestressing steel is 1 1/2".

A_s*= minimum area of the prestressing steel.
d_s = nominal strand diameter.
f'_s = ultimate strength of prestressing steel.
F_j = jacking force per girder.
F_f = final force per girder after all losses.
f'_{ci} = required concrete strength at release of prestress force.
f'_c = required concrete strength at 28 days of age.
L = length of girder along the grade of the girder.
Δi = initial deflection at centerline of span due to cast-in-place slab, bridge rails, chain link fence, and SMA wearing surface.
Θ = bridge skew angle

Concrete shall be Class PS.

Entrained air is not required for girder concrete.

End blocks shall be used on all girders unless otherwise noted.

Use 1/2" chamfer on all corners, except as noted.

Predicted camber is the camber for the girder alone at 90 days. The Contractor shall limit the camber growth to a value not to exceed the predicted camber plus 1" prior to the deck pour by weighting, scheduling fabrication, post tensioning, or other means and must report to the Engineer values of camber which exceed the predicted camber plus 1". Remedial measures, as approved by the Engineer, shall be taken if the predicted camber plus 1" is exceeded. The approved remedial measures shall be free of any adverse impact. The costs associated with all remedial measures shall be borne by the Contractor.

Side by side boxes shall not have cambers of adjacent boxes differ by more than 1" before the deck pour. Prior to placing deck reinforcing, the Contractor shall adjust this differential to within this limit by sorting the boxes to minimize differentials, or by pulling the high boxes down and low boxes up.

Depth (D) tolerance shall be +1/2", -1/4".

The Contractor is responsible for determining necessary bracing requirements, and for providing adequate bracing for the specific wind and weather conditions to be encountered for each specific project.

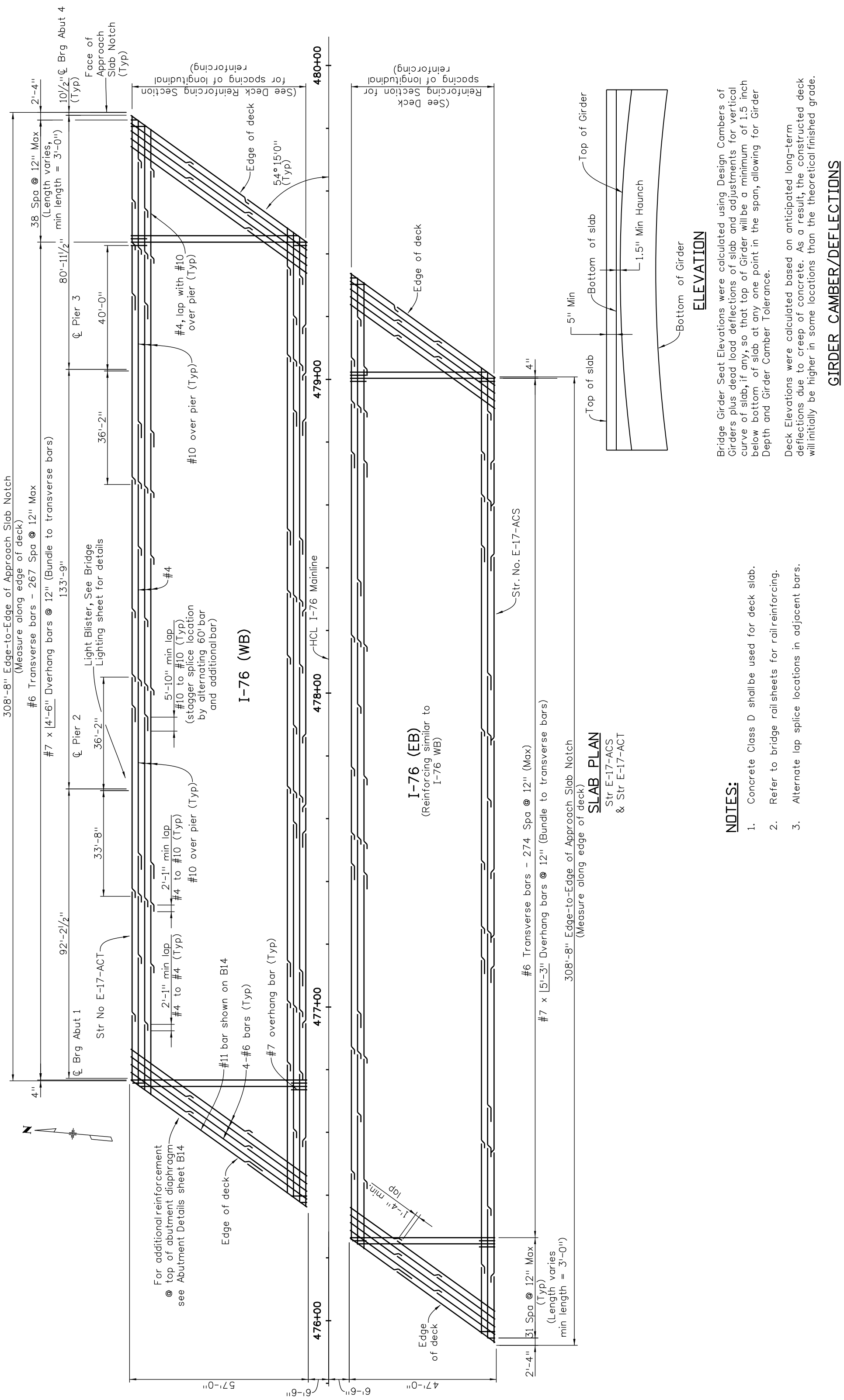
All shims shall be Tack-welded together in a shim stack.

DEBONDING TABLE

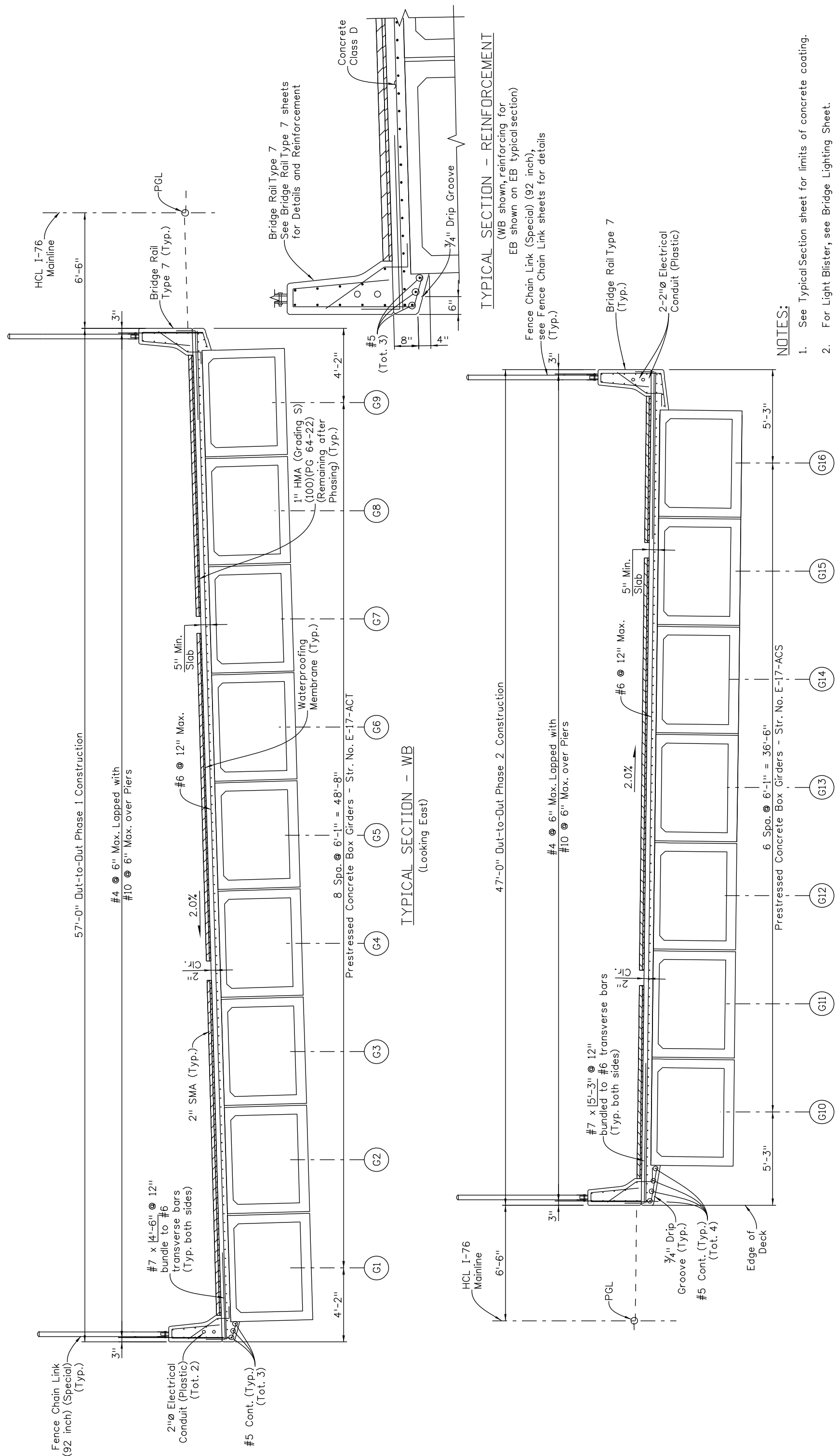
Span	Girder No.	Row	y_{cg} (inches)	Total No. 0.6" Strands	No. Debonded Strands Each 2 ft	4 ft	6 ft
2	1-9, 11-15	1	2.25	30	2	4	
		2	4.25	18			
		3	6.25	16	2		
	10,16	1	2.25	30		4	4
		2	4.25	20			
		3	6.25	18			

Ycg = location of center of gravity of strands of row considered from bottom of precast girder

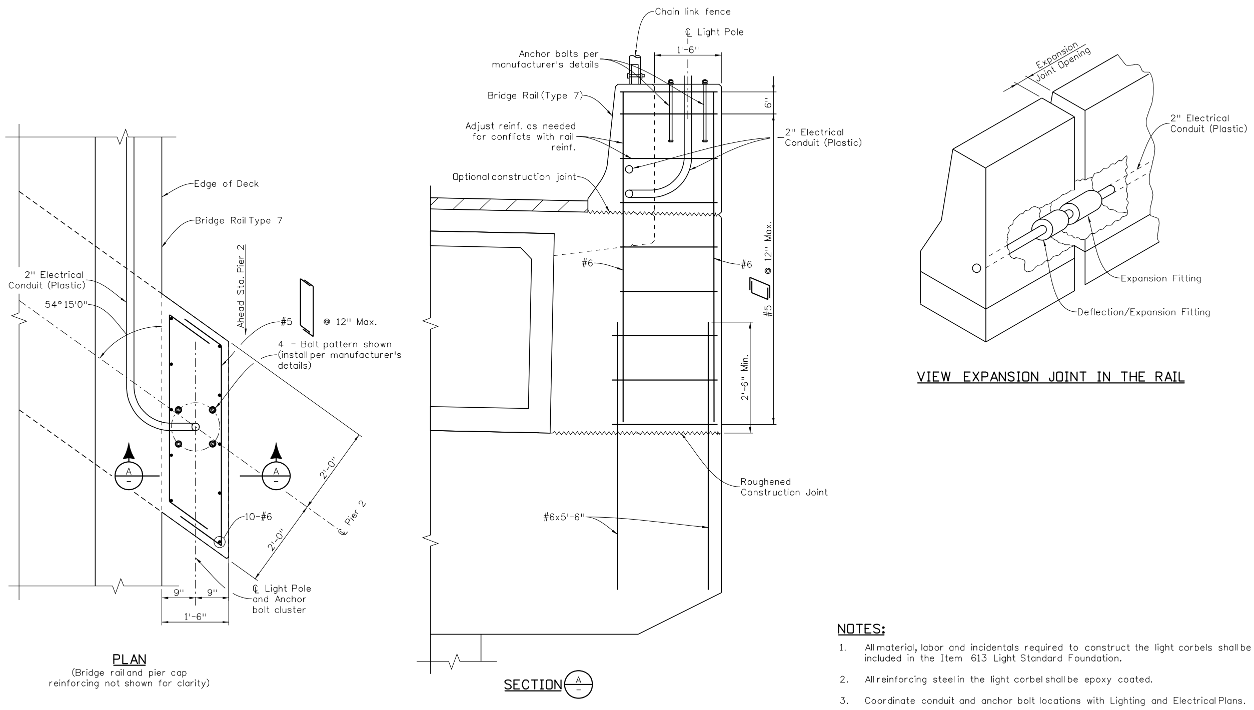
Example 13.3.8 – Prestressed Concrete Box



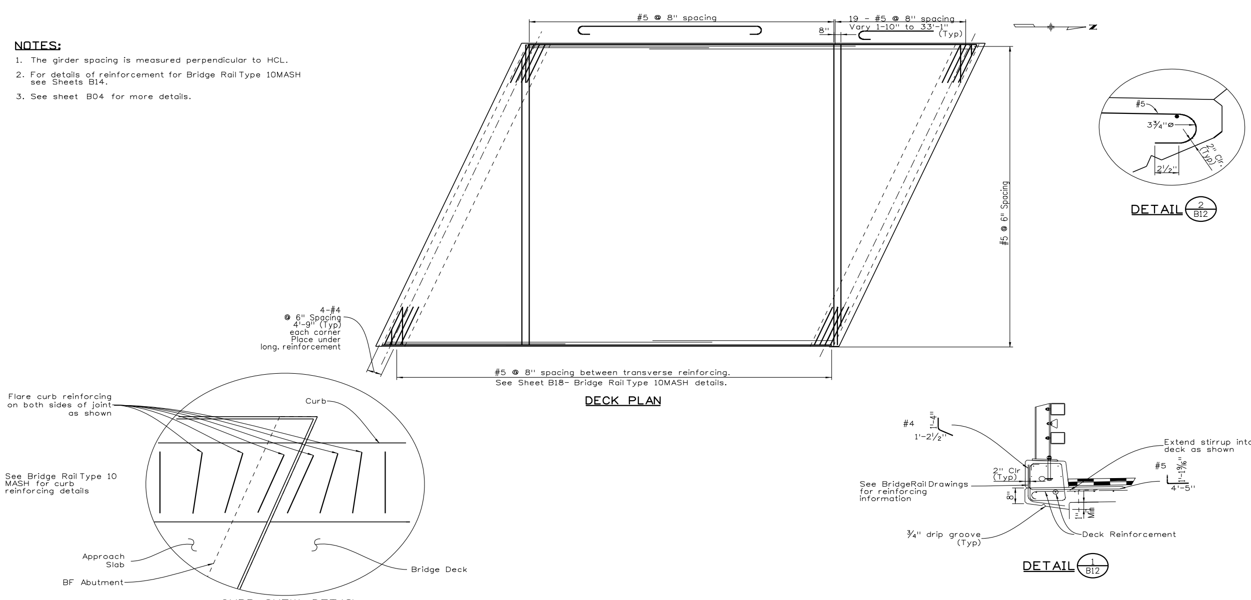
Example 13.3.9 – Prestressed Concrete Box and Deck Reinforcing



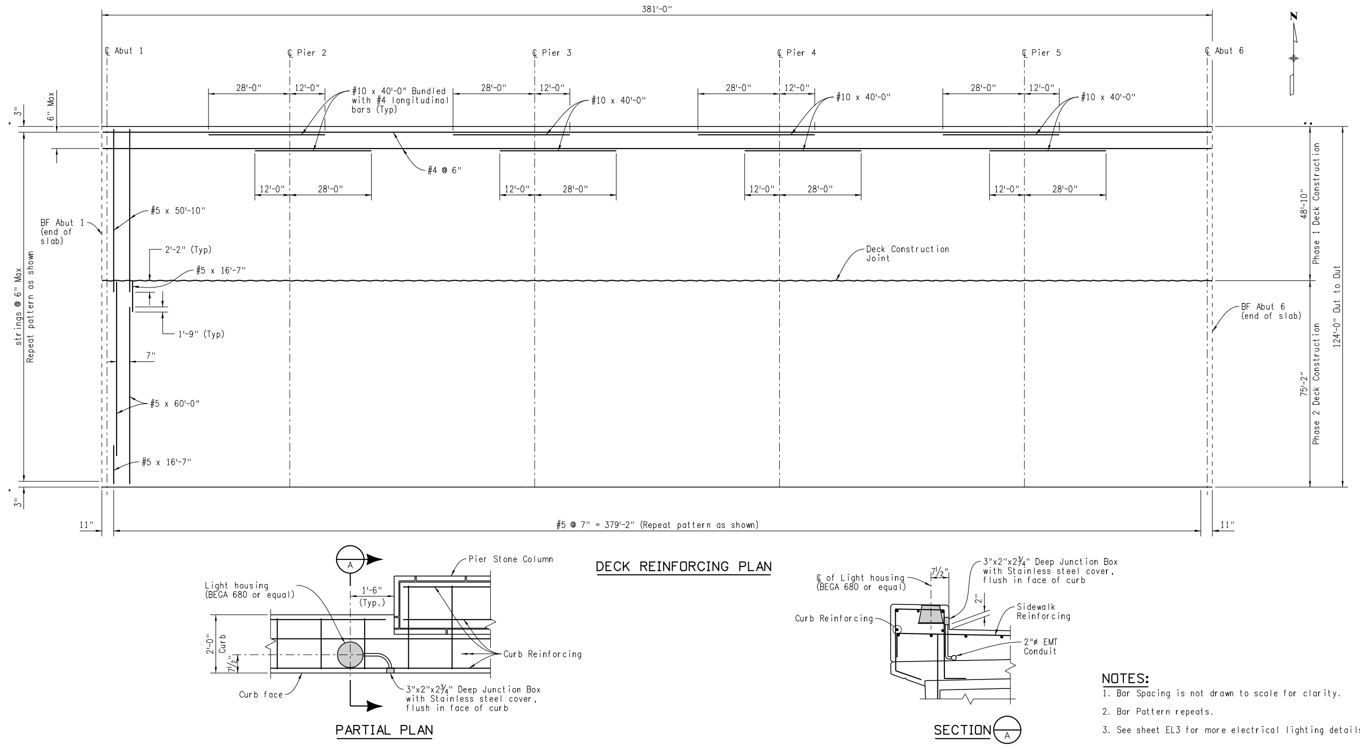
Example 13.3.10



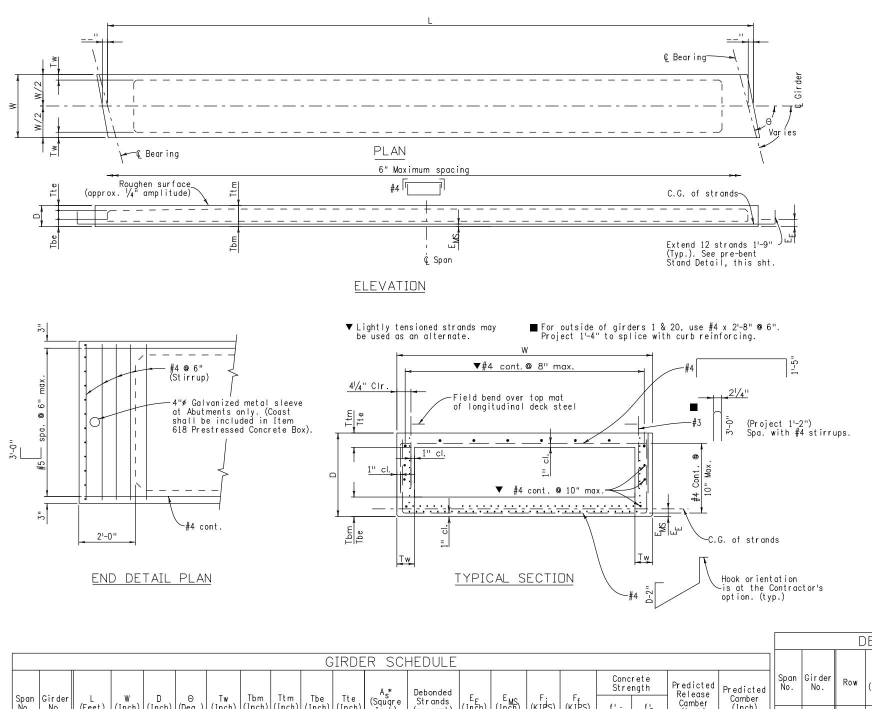
Example 13.3.11



Example 13.3.12



Example 13.3.13



NOTES:

All work necessary to fabricate and install the integral parts of the girder including the leveling pads, expansion joint material around leveling pad, 4" ø galvanized metal sleeve and non-shrink grout, as shown on the plans, shall be included in the bid price for Item No. 618, Prestressed Concrete Box (Depth Less Than 32 Inches), with a pay unit of Sq. Ft. measured by L x W.

When approved by the Engineer, a minimum of tack welding will be permitted on ASTM A706 uncoated reinforcing steel.

Reinforcing projecting from the top of the girder and reinforcing within eight feet of an expansion device in the bridge deck shall be epoxy coated. Damaged coating on girder reinforcing need not be repaired. The minimum cover for reinforcing steel is 1" Welded wire fabric may be used with D20 wires in lieu of the #4 bars shown.

At girder ends not embedded in concrete diaphragms, cut strands off 1" below the surface of the concrete and finish with an approved epoxy grout. At girder ends embedded in concrete diaphragms, cut strands to project 3", except as shown. Do not make cosmetic repairs (damage less than 1½" deep) to the parts of the girders embedded in concrete.

Use low relaxation strands meeting the requirements of ASTM A-416 Grade 270. The minimum clear distance between groups or individual strands shall be 2.3(d_s) but not less than 1¼". The minimum cover for prestressing steel is 1½".

A_s^* = minimum area of the prestressing steel.
d_s = nominal strand diameter.
f'_s = ultimate strength of prestressing steel.
F_j = jacking force per girder.
F_f = final force per girder after all losses.
f'_{ci} = required concrete strength at release of prestress force.
f'_c = required concrete strength at 28 days of age.
L = length of girder along the grade of the girder.
Δ = deflection at centerline of span due to cast-in-place slab, diaphragms, asphalt, curbs, rails, and walks.
Θ = bridge skew angle

Concrete shall be Class PS.

Entrained air is not required for girder concrete.

End blocks shall be used on all girders unless otherwise noted.

Use ½" chamfer on all corners, except as noted.

Predicted camber is the camber for the girder alone at 90 days. The Contractor shall limit the camber growth to a value not to exceed the predicted camber plus 1" prior to the deck pour by weighting, scheduling fabrication, post tensioning, or other means and must report to the Engineer values of camber which exceed the predicted camber plus 1". Remedial measures, as approved by the Engineer, shall be taken if the predicted camber plus 1" is exceeded. The approved remedial measures shall be free of any adverse impact. The costs associated with all remedial measures shall be borne by the Contractor.

Side by side boxes placed over roads or pedestrian facilities shall not have cambers of adjacent boxes differ by more than 1" before the deck pour. Prior to placing deck reinforcing, the Contractor shall adjust this differential to within this limit by sorting the boxes to minimize differentials, or by pulling the high boxes down and low boxes up.
Depth (D) tolerance shall be +½", -¼".

The Contractor is responsible for determining necessary bracing requirements, and for providing adequate bracing for the specific wind and weather conditions to be encountered for each specific project.

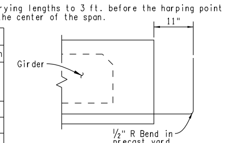
Debonding shall extend in uniformly varying lengths to 3 ft. before the harping point shown, but not closer than 17 feet to the center of the span.

GIRDER SCHEDULE

Span No.	Girder No.	L (Feet)	W (Inch)	D (Inch)	Θ (Deg.)	Tw (Inch)	Tbm (Inch)	Ttm (Inch)	Tbe (Inch)	Tte (Inch)	A_s^* (Square Inch)	Debonded Strands (percent)	E_E (Inch)	E_{MS} (Inch)	F_j (KIPS)	F_f (KIPS)	Concrete Strength f'_{ci} (PSI)	Concrete Strength f'_c (PSI)	Predicted Release Camber (Inch)	Predicted Camber (Inch)
1 & 5	All	62.583	72	30	90	6	6	4	6	4	5.21	25	3.25	3.25	1054.6	933.8	6,500	8,500	0.663	1.163
2 - 4	All	82.833	72	30	90	6	6	4	6	4	7.38	23.5	3.19	3.19	1494	1292.1	6,500	8,500	1.29	2.23

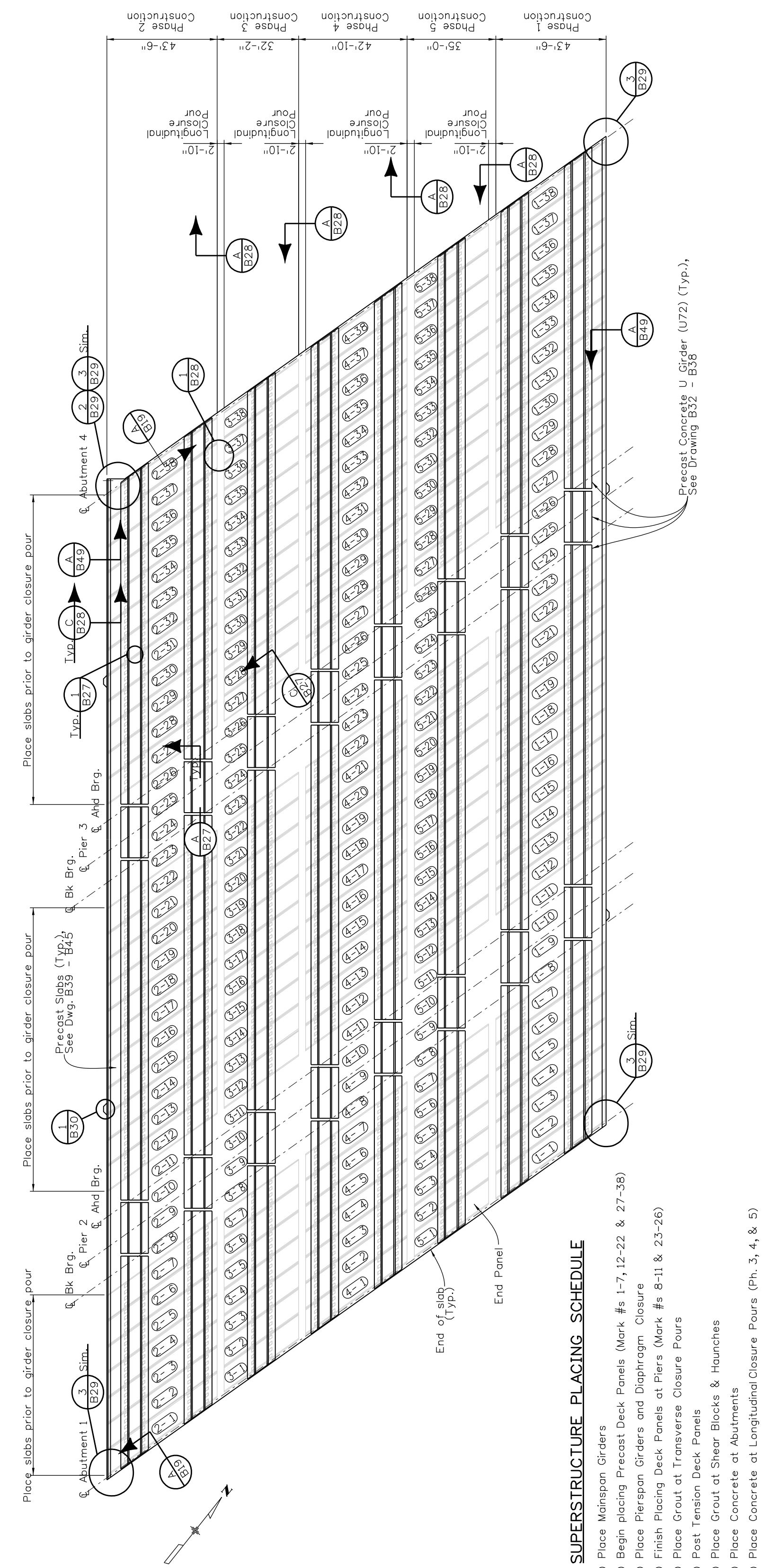
DEBONDING TABLE

Span No.	Girder No.	Row	y_* (inches)	Total No. 0.6" Strands	No. Debonded Strands Each 2 ft	No. Debonded Strands Each 4 ft	No. Debonded Strands Each 6 ft
1 & 5	All	1	2.25	30	2	4	4
1 & 5	All	1	4.25	18	2		
2 - 4	All	1	2.25	34		4	4
2 - 4	All	1	4.25	32	2	4	

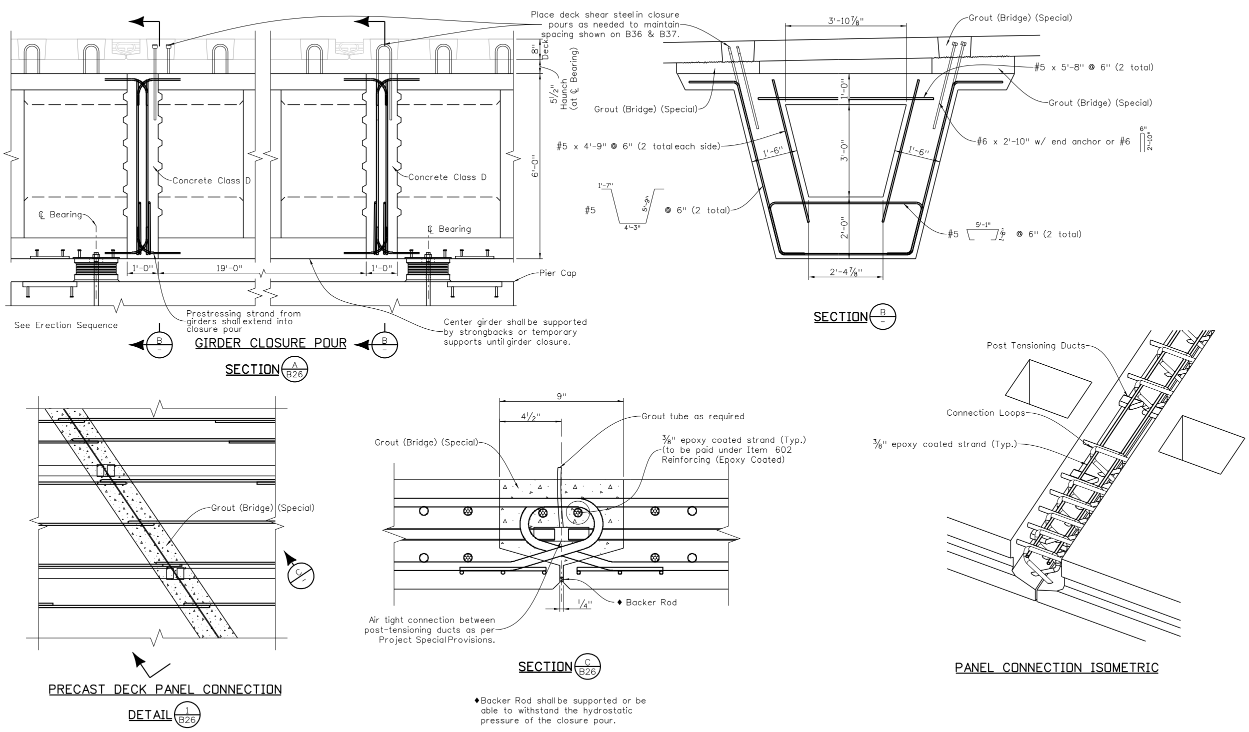


PRE-BENT STRAND DETAIL

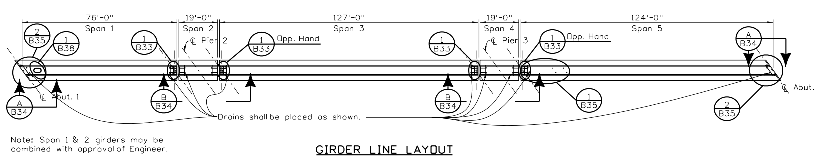
Example 13.3.14



Example 13.3.15 – Precast Prestressed Concrete Deck Details



Example 13.3.16 – Precast Prestressed Deck Details



GIRDER LINE LAYOUT

See Typical Girder Section, Sheet B33 for dimensions.

PHASE 1, 2 & 4 GIRDER SCHEDULE - GIRDERS A, B, D, E, G & H

Span No.	L (Ft.)	Fw (In.)	D (In.)	Θ (Deg.)	Tw (In.)	Tb (In.)	Lh (Ft.)	A_s* In²	Debond Strands (percent)	E_E (In.)	E_{MS} (In.)	F_j (KIPS)	F_f (KIPS)	Concrete Strength f'_{ci} (PSI)	Concrete Strength f'_c (PSI)	Δ (In.)	Predicted Release Camber (Inch)	Predicted Camber (Inch)	
1	76	32	72	56/90	7.5	8.1	-	6.51	33.3	3.46	3.46	1318.3	1193.2	6750	9000	0.31	0.47	0.83	★◑
2	19	32	72	90	7.5	8.1	-	2.604	0	33.88	33.88	527.3	489.4	6750	9000	0.01	0.0	0.0	
3	127	32	72	90	7.5	8.1	19.1	16.492	2.6	14.82	4.64	3339.6	2819.0	6750	9000	2.27	2.71	4.78	✻
4	19	32	72	90	7.5	8.1	-	2.604	0	33.88	33.88	527.3	489.4	6750	9000	0.01	0.0	0.0	
5	124	32	72	90/56	7.5	8.1	18.6	16.492	2.6	14.82	4.64	3339.6	2825.9	6750	9000	2.13	2.81	4.98	✻

PHASE 3 & 5 GIRDER SCHEDULE - GIRDERS C & F

Span No.	L (Ft.)	Fw (In.)	D (In.)	Θ (Deg.)	Tw (In.)	Tb (In.)	Lh (Ft.)	A_s* In²	Debond Strands (percent)	E_E (In.)	E_{MS} (In.)	F_j (KIPS)	F_f (KIPS)	Concrete Strength f'_{ci} (PSI)	Concrete Strength f'_c (PSI)	Δ (In.)	Predicted Release Camber (Inch)	Predicted Camber (Inch)	
1	76	32	72	56/90	7.5	8.1	-	6.51	33.3	3.46	3.46	1318.3	1197.6	6750	9000	0.37	0.47	0.83	★◑
2	19	32	72	90	7.5	8.1	-	2.604	0	33.88	33.88	527.3	489.4	6750	9000	0.01	0.0	0.0	
3	127	32	72	90	7.5	8.1	19.1	18.662	14.0	13.78	4.79	3779.1	3132.4	6750	9000	2.71	3.16	5.61	✠
4	19	32	72	90	7.5	8.1	-	2.604	0	33.88	33.88	527.3	489.4	6750	9000	0.01	0.0	0.0	
5	124	32	72	90/56	7.5	8.1	18.6	18.228	20.2	12.74	4.56	3691.2	3081.8	6750	9000	2.55	3.06	5.43	▲

★ In the bottom row, debond 2 strands for 10 feet, 2 strands for 11 feet, 2 strands for 12 feet and 2 strands for 14 feet. In the second row from bottom, debond 2 strands for 10 feet.

◑ Debonded strands shall be in area required by access hatch. See Section A on B38.

✻ In the third row from bottom, debond 2 strands for 8 feet.

✠ In the bottom row, debond 3 strands for 8 feet. In the third row from bottom, debond 3 strands for 16 feet, 4 strands for 24 feet and 2 strands for 32 feet.

▲ In the bottom row, debond 6 strands for 8 feet, 1 strand for 16 feet. In the third row from bottom, debond 5 strands for 16 feet, 4 strands for 24 feet.

NOTES:

All work necessary to fabricate and install the integral parts of the girder (including the internal diaphragms, if any, and leveling pads), as shown on the plans, shall be included in the bid price for Item No. 618, Precast Concrete U Girder (U72) (Pre-Tensioned) with a pay unit of Lin. Ft. measured by the dimension L.

When approved by the Engineer, a minimum of tack welding will be permitted on ASTM A706 uncoated reinforcing steel.

Reinforcing projecting from the top of the girder and reinforcing within eight feet of an expansion device in the bridge deck shall be epoxy coated. Damaged coating on girder reinforcing need not be repaired. The minimum cover for reinforcing steel is 1".

At girder ends not embedded in concrete diaphragms, cut strands off 1" below the surface of the concrete and finish with an approved epoxy grout. At girder ends embedded in concrete diaphragms, cut strands to project 3", except as shown. Do not make cosmetic repairs (damage less than 1½" deep) to the parts of the girders embedded in concrete.

Use low relaxation strands meeting the requirements of ASTM A-416 Grade 270. The minimum clear distance between groups or individual strands shall be 2.3(d_s) but not less than 1¼". The minimum cover for prestressing steel is 1½".

A minimum of two harping points shall be used per girder. Harped strands shall be well distributed at the girder ends, starting within 4" of the top of the girder and distributed such that there is no space between strands greater than 1'-0" at the end of the girder. As an alternate the Contractor may place #4 x 10'-0" in the sides of the end of the web parallel to the harped strands such that there is no space greater than 1'-0".

A_s*= minimum area of the prestressing steel.
d_s = nominal strand diameter.
f'_s = ultimate strength of the prestressing steel.
F_j = jacking force per girder.
F_f = final force per girder after all losses.
f'_{ci} = required concrete strength at release of prestress force.
f'_c = required concrete strength at 28 days of age.
L = length of girder along the grade of the girder.
Δ = deflection at centerline of span due to precast slab, diaphragms, asphalt, curbs, rails, and walks.
P = Projection. 7¼" in the middle 1/3 of the member varying to the specified haunch at the bearing plus 5".
Θ = bridge skew angle
E_e = strand eccentricity at end of panel
E_{ms} = strand eccentricity at midspan

Concrete shall be Class PS.

Entrained air is not required for girder concrete.

End diaphragms shall be installed prior to transfer on all girders unless otherwise noted. All permanent diaphragms not embedded in concrete shall be galvanized.

Use ½" chamfer on all corners, except as noted.

Predicted camber is the camber for the girder alone at 90 days. The Contractor shall limit the camber to a value not to deviate from the predicted camber by more than (0.0005 x L + 0.5")
at the time of the deck pour by weighting, scheduling fabrication, post tensioning, changing storage support points, or other means and must report to the Engineer values of camber which exceed the predicted camber plus this tolerance. Remedial measures, as approved by the Engineer, shall be taken if the predicted camber plus the allowed tolerance is exceeded. The approved remedial measures shall be free of any adverse impact. The costs associated with all remedial measures shall be borne by the Contractor.

Dimensional tolerances for precast "U" girders shall be those tolerances specified in MNL-116 as shown for I girders with the following exceptions: Flange widths and widths between flanges ±1/16"/ft width, ±¼" minimum. Variation from specified plan end squareness or skew, ±⅛"/ft width of each flange or overall width.

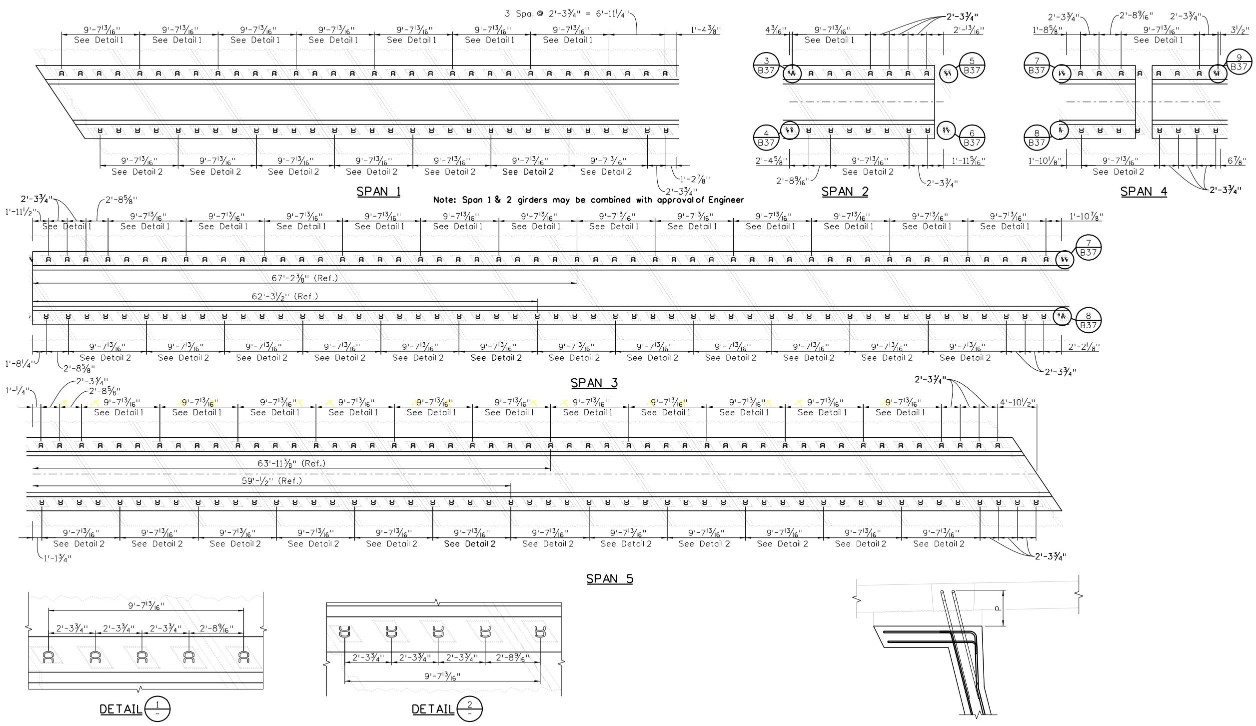
When used, debonding shall extend in uniformly varying lengths to 3 ft. before the harping point shown, but not closer than 17 ft. to the center of the span.

All formwork used to form haunches, diaphragms, etc. shall be removed from the girders at the conclusion of work. Removal and cleanup shall be included in the cost of the work.

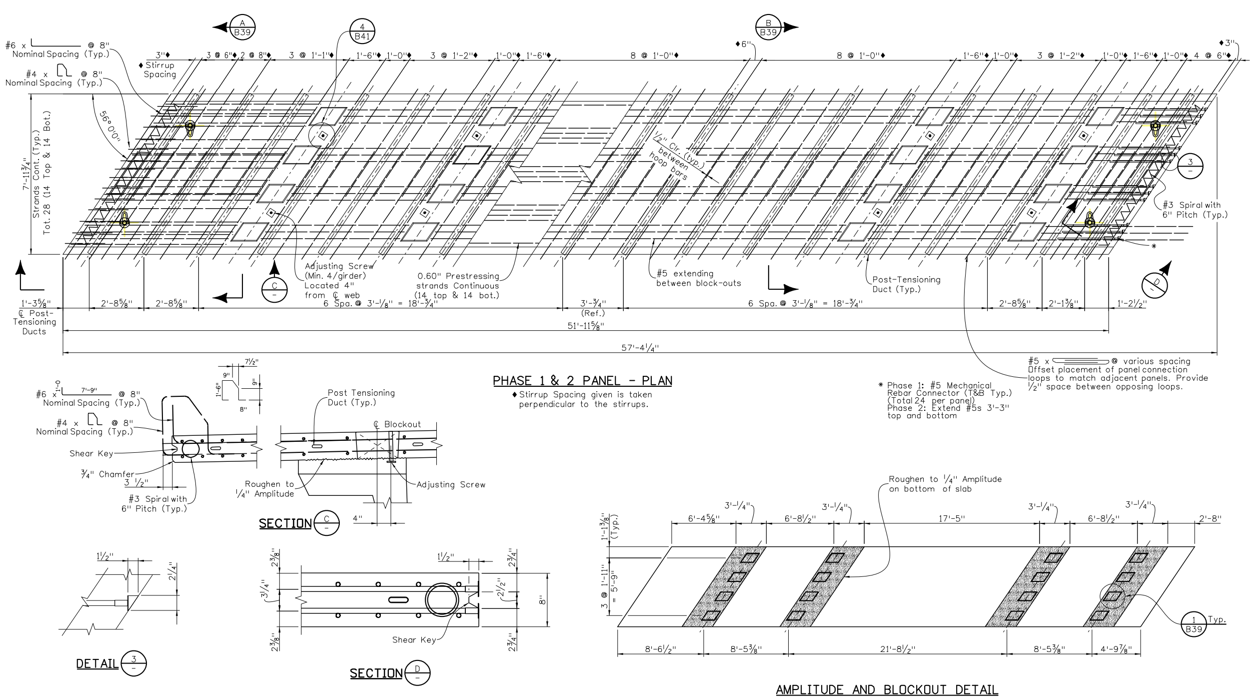
Final force in girders does not include losses for Elastic Shortening (Transformed Properties).

Span 1 girders exceed the maximum debonding defined in the AASHTO code. This is acceptable per proposed Design Manual changes.

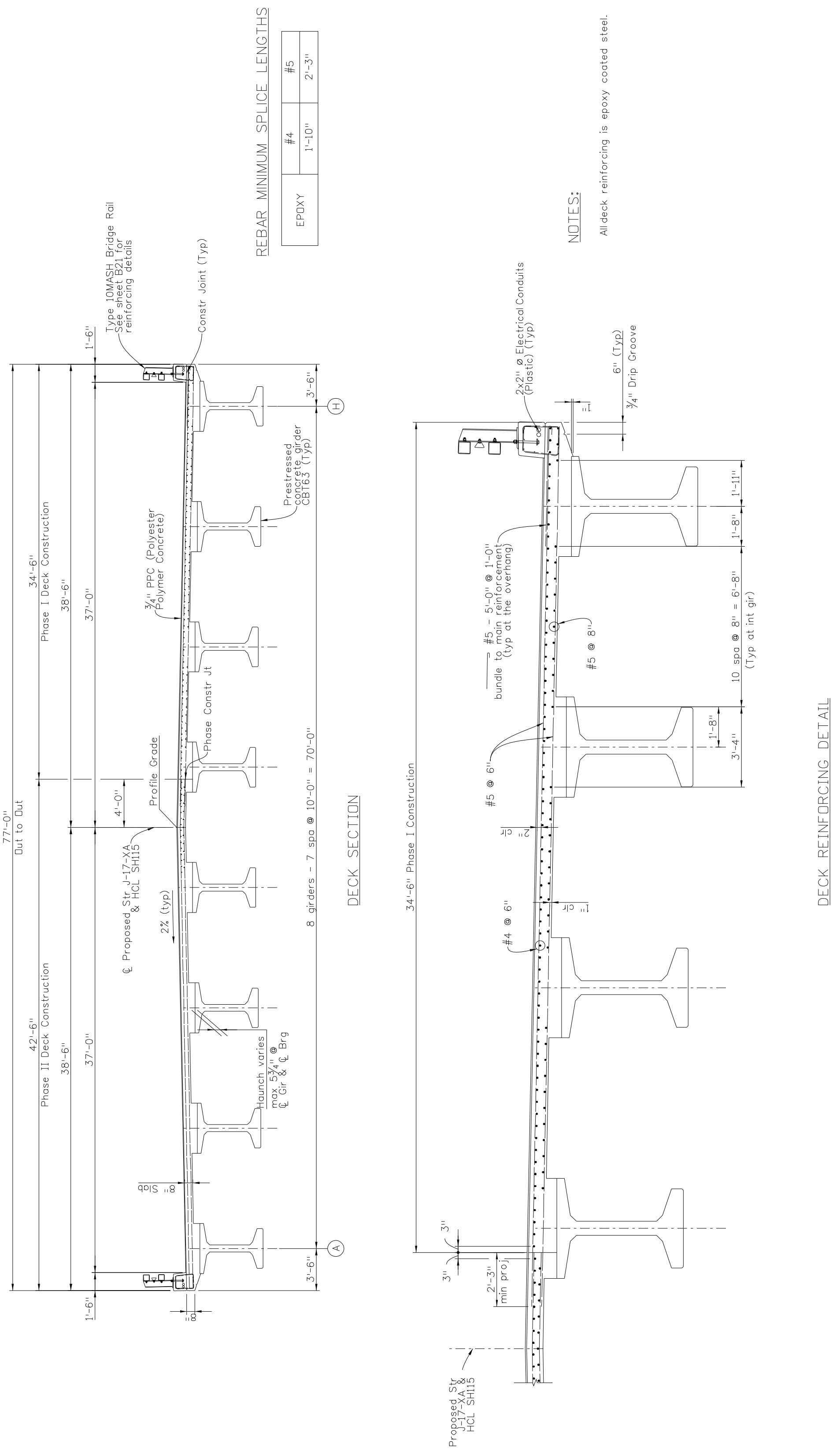
Example 13.3.17 – Prestressed Concrete Girder Details



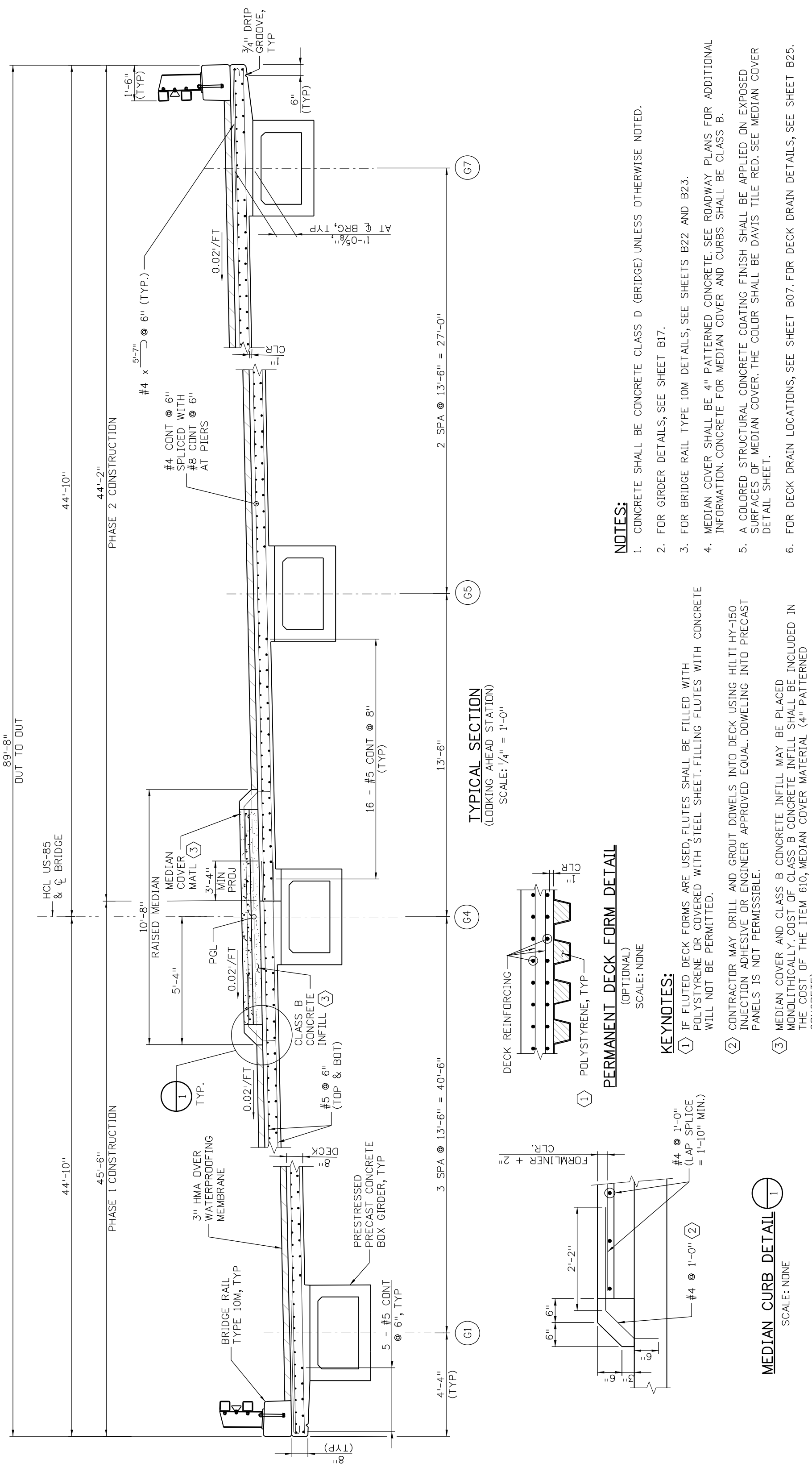
Example 13.3.18 – Prestressed Concrete Girder Details



Example 13.3.19 – Prestressed Concrete Details



Example 13.3.20 – Prestressed Concrete CBT Girder



Example 13.3.21 – Prestressed Concrete Box Girder

14.1 Purpose

This set of drawings is to provide three-dimensional points on the bridge deck through the use of horizontal and vertical control lines, offsets, coordinates. A starting point for a new project is the CDOT Bridge Worksheet B-100-3 which contains the required general notes at the bottom of the sheet. If using CDOT Bridge Geometry software, please refer to the CDOT Bridge Geometry Manual.

14.2 Responsibility

This set of drawings shall be prepared and checked in the Design Unit. The graphic presentation of information shall be the responsibility of the individual preparing the drawings. The accuracy of the information shown shall be the responsibility of the individual preparing the Bridge Geometry (or any other software) input for the computer.

14.3 Text / Lettering

The information described in 14.4 through 14.13 shall be placed on the drawing to be legible. If Bridge Geometry software is used, this information can be extracted from the pcf (project coordinate file) file. Monospac821 BT font should be used to align the tables, text height should be .07” and width should be .056” (new text style 07_ENG-80-BridgeGeo in the CDOT MicroStation configuration). Width may be adjusted to fit available space.

14.4 Project Information

The drawing shall contain project coordinates, bearings, units (English or metric) as well as the run, date and time and the software used.

Project coordinates are a coordinate system closely related to the State Plane coordinate system.

```
STRUCTURE ID:  E-16-EV                    BRIDGE GEOMETRY (WIN2.1.0e)                 13/06/01 13:20

State of Colorado                                        DESCRIPTION
Department of Transportation
Staff Bridge Design                                      Units: feet;
Bridge Geometry Project Coordinate Converter             Project: FBR 0142-055; Subaccount: 18085;
Version 1.00                                             Designer: H. Bui; Detailer: L. Waldron;
                                                         Location: SH 14 over Cache-LaPoudre River;
Run date & time = Sat Jun 01 13:21:38 2013
                                                         SH 14  Poudre Bridge in Ft. Collins
Input Northing Offset =  142618.800000                   Replaces B-16-D at M.P. 135.88 on SH 14
Input Easting Offset =  169548.500000                    This is a straight bridge
Input Bearing =  S 89 55 41.0500 E
```

Fig. 14.4.1 Project Information - Example

14.5 Horizontal Alignment Data

The drawing shall contain curve and tangent information in the format shown in Fig. 14.5.1. The information shall include the offset from horizontal control line (HCL) to profile control line (PCL) and from PCL to pivot line. In most cases, all three lines are the same (no offset).

```
HORIZONTAL ALIGNMENT DATA

     TS    170+24.0900      T     620.2948
     SC    172+28.0900      Ls    204.0000        SA    6 05 15.64
     PI    176+44.3848      Lc    745.0449     DELTA   56 38 31.00 RT       Dc    5 58 05.92       RADIUS     960.000000
     CS    179+73.1349      Ls    204.0000        SA    6 05 15.64
     ST    181+77.1349      T     620.2948
```

Fig. 14.5.1 Horizontal Alignment Data - Example

14.6 Vertical Alignment Data

The drawing shall contain elevation at grades and points of interest (PCs, PTs, PIs), stationing of PCs. PTs, PIs and percent grades in the format shown in Fig. 14.6.1.

VERTICAL ALIGNMENT DATA

ELEVATION AT PI	ELEVATION AT GRADE		STATION		ELEVATION AT GRADE	ELEVATION AT PI	PERCENT GRADE
							-1.033333
			170+10.0000	PC	7347.3800		
			171+60.0000	PI	7345.7187	7345.8300	
			173+10.0000	PT	7343.8350		
							-1.330000
	7333.9930	PC	180+50.0000				
7332.6630	7332.9933	PI	181+50.0000				
	7332.6544	PT	182+50.0000				
							-0.008644

Fig. 14.6.1 Vertical Alignment Data - Example

14.7 Cross Slopes and Transitions

The drawing shall contain cross slopes and transitions in the format shown in Fig. 14.7.1.

TABLE OF ROADWAY CROSS-SLOPES (SUPERELEVATION: E=0.0800)

STATION	SLOPE LEFT	SLOPE RIGHT	VC LENGTH
(ON TANGENT)	0.0200	-0.0200	140.00 (MAX)
162+75.0000	-0.1077	0.1077	140.00 -U-
166+75.0000	-0.1077	0.1077	140.00 -U-
170+75.0900	0.0200	-0.0200	140.00
172+28.0900	0.0800	-0.0800	140.00 -U-
179+73.1300	0.0800	-0.0800	140.00 -U-
181+26.1349	0.0200	-0.0200	140.00

Fig. 14.7.1 Cross Slopes Data – Example

14.8 Layout Line Data

The layout line data shall be shown on the drawing in the format shown in Fig. 14.8.1.

LAYOUT LINE DATA

LAYOUT LINE DEFINED TO BE COINCIDENT WITH HORIZONTAL CONTROL

	HCL STA	OFFSET	X	Y
LAYOUT LINE INTERSECTS REF LINE AT	103+50.0000	0.00000000	0.0000	0.0000

Fig. 14.8.1 Layout Line Data - Example

The Layout line is a straight line that is the ordinate for the location of points on the structure. It should be located such that it lies as much as practical within the bounds of the structure. For structures on or mostly on a tangent, the tangent will suffice for the Layout line. For structures located mostly on a curve, a chord or tangent will probably be required for the layout line. Some possible chord lines are shown in Fig. 14.8.2.

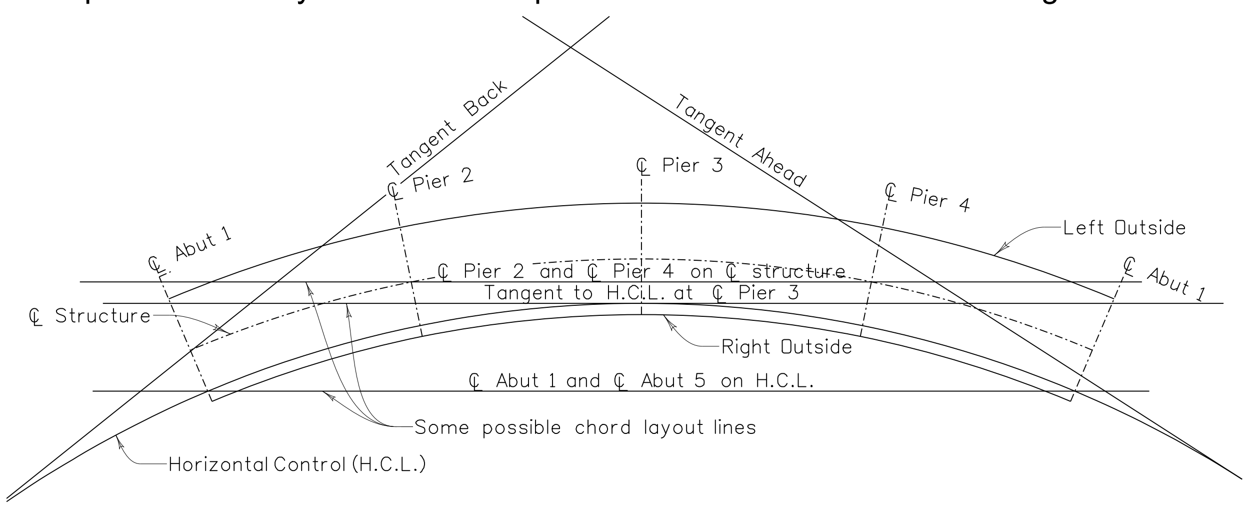


Fig. 14.8.2 Chord Layout Lines - Examples

14.9 Dead Load Deflection Data

The dead load deflection data shall be shown on the drawing in the format shown in Fig. 14.9.1.

The number of deflection points is typically given at tenth points, with the intent of having elevation data at approximately every 15 feet. Twentieth points may be required for longer spans, i.e. > 150'.

DEAD LOAD DEFLECTION DATA

DEFLECTIONS AT TENTH POINTS FROM FITTED CURVE

FOR BENT LINE: CL A1 07 CARD(S): 1 GIRDER LINES REFERENCED BY: A

	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0		
													A4= 0.00000
INCH	0.0000	0.1458	0.2801	0.3873	0.4560	0.4797	0.4560	0.3873	0.2801	0.1458	0.0000	INCH	A3= 0.00000
FOOT	0.0000	0.0121	0.0233	0.0323	0.0380	0.0400	0.0380	0.0323	0.0233	0.0121	0.0000	FOOT	A2= 1.87004
													A1=-1.87004
SLOPE	0.120945										-0.120945	SLOPE	A0=-1.45134

Fig. 14.9.1 Dead Load Deflection Data – Example

14.10 Bent Lines (Transverse Lines)

Bent lines are transverse lines which run generally across the structure.

Some examples:

A) Reference line
The Reference line is a transverse line from which all other transverse lines, with the exception of the roadway approaches, are measured. The point where the Layout line crosses the Reference line is the 0,0 point for the Bridge Geometry software. A preference would be the centerline of bearing of Abutment 1 or other recognizable location.

B) Centerline of bearing
C) Centerline of piling
D) Centerline of pier
E) Back face of abutment
F) End of wingwall
G) Centerline of splice
H) Fractional points - The number of fractional points is typically given at tenth points, with the intent of having elevation data at approximately every 15 feet. Twentieth points may be required for longer spans, i.e. > 150'
I) Middle of approach slabs (when not provided elsewhere on plans)
J) End of approach slabs (when not provided elsewhere on plans)
K) Expansion joint (when not at conventional locations)

A summary of all bent lines shall be shown on the drawing in the format shown in Fig. 14.12.1. Information shall include (see also the Bridge Geometry Manual):

- a station at the HCL,
- offset,
- elevation,
- project coordinates X and Y,
- Northing and Easting,
- bent length,
- skew,
- girder length and
- cross-slope information (data).

14.11 Longitudinal Lines (Girder Lines)

Girder lines are longitudinal lines which run lengthwise to the structure and are generally parallel to the HCL.

Some examples:

A) Horizontal Control Lines (HCL)
B) Crown line, if different than HCL
C) Layout line, if different than HCL
D) Girder Lines (at centerline bottom of girder)
E) Wing wall faces
A) Edges of the deck
B) Construction phase lines
C) Curb line or flowline
D) Centerline of structure

Each longitudinal line will display bent line and fraction point information as described in 14.10.

Dead load deflections will be provided for the girder lines at a minimum, and for phase lines and edge lines as required.

Not all longitudinal lines need to be extended through the approach slabs.

14.12 Display of Bent Lines and Longitudinal Lines

If unusual longitudinal lines are used, a section view may be added to the drawing to clarify.

BENT LINE DESCRIPTION	INTERSECTION POINT STATION	OFFSET	ELEVATION		FROM LAYOUT LINE OFFSET X	ORDINATE Y	PROJECT COORDINATES NORTHING	EASTING	BENT LINE LENGTH FROM Y-AXIS	SKEW D M S	GIRDER LINE LENGTH FROM REF LINE
* HORIZONTAL CONTROL LINE *			AT FINISHED GRADE								
End Appr 1	18+34.8500	0.0000	9214.0480		0.0000	-21.2500	796011.6723	1554484.3362	0.0000	0 00 00.00	-21.2500
MiddAppr1	18+44.8500	0.0000	9214.0179		0.0000	-11.2500	796021.6227	1554483.3417	0.0000	0 00 00.00	-11.2500
BF Abut 1	18+54.8500	0.0000	9213.9878		0.0000	-1.2500	796031.5731	1554482.3471	0.0000	0 00 00.00	-1.2500
CL Brg A1	18+56.1000	0.0000	9213.9840	10	0.0000	0.0000	796032.8169	1554482.2228	0.0000	0 00 00.00	0.0000
CL Brg A2	19+46.1000	0.0000	9213.7131	1	0.0000	90.0000	796122.3707	1554473.2718	0.0000	0 00 00.00	90.0000
BF Abut 2	19+47.3500	0.0000	9213.7093		0.0000	91.2500	796123.6145	1554473.1475	0.0000	0 00 00.00	91.2500
MiddAppr2	19+57.3500	0.0000	9213.6792		0.0000	101.2500	796133.5649	1554472.1529	0.0000	0 00 00.00	101.2500
EndWing2	19+62.6000	0.0000	9213.6634		0.0000	106.5000	796138.7889	1554471.6308	0.0000	0 00 00.00	106.5000
End Appr 2	19+67.3500	0.0000	9213.6491	0.0	0.0000	111.2500	796143.5153	1554471.1584	0.0000	0 00 00.00	111.2500

Fig. 14.12.1 Summary of Bent Lines at Horizontal Control Line (Longitudinal Line) – Example 1

Int Gir C			PARALLEL TO HORIZONTAL CONTROL				0.250000 FEET BELOW FINISHED GRADE					
BENT LINE	STATION	OFFSET	ELEVATION	ELEV+DL	X	Y	NORTHING	EASTING	BENT LNTH	SKEW	GIRDER LNTH	CRS-SLP
End Appr 1	18+34.8500	6.0000	9213.6780		6.0000	-21.2500	796012.2690	1554490.3065	6.0000	0 00 00.00	-21.2500	-0.020000
MiddAppr1	18+44.8500	6.0000	9213.6479		6.0000	-11.2500	796022.2194	1554489.3119	6.0000	0 00 00.00	-11.2500	-0.020000
BF Abut 1	18+54.8500	6.0000	9213.6178		6.0000	-1.2500	796032.1698	1554488.3174	6.0000	0 00 00.00	-1.2500	-0.020000
CL Brg A1	18+56.1000	6.0000	9213.6140	213.6140	6.0000	0.0000	796033.4136	1554488.1931	6.0000	0 00 00.00	0.0000	-0.020000
F-1	18+65.1000	6.0000	9213.5869	213.6295	6.0000	9.0000	796042.3690	1554487.2980			9.0000	-0.020000
F-2	18+74.1000	6.0000	9213.5598	213.6380	6.0000	18.0000	796051.3244	1554486.4029			18.0000	-0.020000

Fig. 14.12.2 Bent Lines at CL Gir C (Longitudinal Line) – Example 2

X-points are special bent lines representing varying distances (shown as bent lengths) from straight girder lines to the curved edge of deck. A note should also be added to the drawing to clarify X points.

RIGHT OUT			PARALLEL TO HORIZONTAL CONTROL						AT FINISHED GRADE			
BENT LINE	STATION	OFFSET	ELEVATION	ELEV+DL	X	Y	NORTHING	EASTING	BENT LNTH	SKEW	GIRDER LNTH	CRS-SLP
X-0	9+49.5445	25.0000	4997.9954		24.9185	2.0653	82614.2869	504607.6037	4.3342		-0.4327	-0.060000
CL ABUT 1	9+50.0000	25.0000	4998.0000		24.8751	2.4958	82613.9693	504607.3098	25.0000	0 00 00.00	0.0000	-0.060000
X-1	9+59.6603	25.0000	4998.0966		24.0472	11.6356	82607.2974	504601.0085	3.4628		9.1773	-0.060000
X-2	9+69.7596	25.0000	4998.1976		23.3706	21.2059	82600.4539	504594.2843	2.7862		18.7717	-0.060000
X-3	9+79.8466	25.0000	4998.2985		22.8879	30.7762	82593.7557	504587.4318	2.3035		28.3543	-0.060000
X-4	9+89.9253	25.0000	4998.3993		22.5985	40.3464	82587.2024	504580.4513	2.0142		37.9291	-0.060000
X-5	10+00.0000	25.0000	4998.5000		22.5021	49.9167	82580.7936	504573.3430	1.9177		47.5000	-0.060000
X-6	10+10.0747	25.0000	4998.6033		22.5985	59.4870	82574.5294	504566.1070	2.0142		57.0709	-0.059896
X-7	10+20.1534	25.0000	4998.7269		22.8879	69.0573	82568.4098	504558.7433	2.3035		66.6457	-0.058985
X-8	10+30.2404	25.0000	4998.8740		23.3706	78.6275	82562.4351	504551.2516	2.7862		76.2283	-0.057135
X-9	10+40.3397	25.0000	4999.0449		24.0472	88.1978	82556.6057	504543.6315	3.4628		85.8227	-0.054341
CL ABUT 2	10+50.0000	25.0000	4999.2303		24.8751	97.3376	82551.1747	504536.2338	25.0000	0 00 00.00	95.0000	-0.050788
X-10	10+50.4555	25.0000	4999.2396		24.9185	97.7681	82550.9221	504535.8825	4.3342		95.4327	-0.050599

Fig. 14.12.3 Varying Bent Lengths (X-points) – Example 3

14.13 Roadway Approaches Data

Roadway approach information is intended to afford a reference for correcting mis-alignments between roadway and bridge elevations and alignment. They may also be used to set the elevations for the approach slabs.

Roadway approach information shall be shown in the drawing in the format shown in Figure 14.13.1. For each approach (left/ right), the information shall include:

- Station
- Offset
- Elevation
- Cross-slope

A sketch of approach information shall be provided, similar to CDOT Bridge Worksheet B-100-2. The sheet shall be revised to indicate finished grade for roadway approach data.

* ROADWAY APPROACHES *

STATION	OFFSET	ELEVATION	CROSS-SLOPE
1770+50	-18.0000	3407.2221	-0.020000
1770+60	-18.0000	3407.2721	-0.020000
1770+70	-18.0000	3407.3221	-0.020000
1770+80	-18.0000	3407.3721	-0.020000
1770+90	-18.0000	3407.4221	-0.020000
1771+00	-18.0000	3407.4721	-0.020000
1771+10	-18.0000	3407.5221	-0.020000
1771+20	-18.0000	3407.5721	-0.020000
1771+30	-18.0000	3407.6221	-0.020000

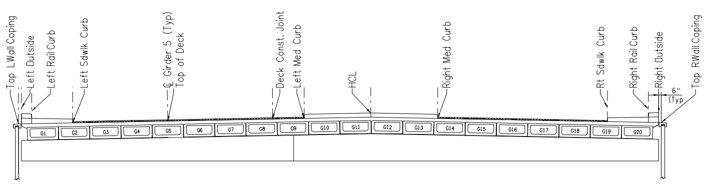
Fig. 14.13.1 Roadway Approaches Data – Example

14.14 Deck Section Schematic

A schematic showing the longitudinal lines depicted in 14.11 & 14.12 shall be provided, like in Example 14-1.

The schematic shall specifically show where the centerlines of girder elevations are located on the deck. If additional elevations are provided in the bridge geometry sheet other than top of deck, those elevations shall be depicted in the schematic, like in example 14-6. See Bridge Detail Manual Chapter 9, section 9.9 for further information.

```
 STRUCTURE ID:  E-16-EV                    BRIDGE GEOMETRY (WIN2.1.0e)                 13/06/01 13:20

State of Colorado                                          DESCRIPTION
Department of Transportation
Staff Bridge Design                                        Units: feet;
Bridge Geometry Project Coordinate Converter               Project: FBR 0142-055; Subaccount: 18085;
Version 1.00                                               Designer: H. Bui; Detailer: L. Waldron;
                                                           Location: SH 14 over Cache-LaPoudre River;
Run date & time = Sat Jun 01 13:21:38 2013
                                                           SH 14  Poudre Bridge in Ft. Collins
Input Northing Offset =  142618.800000                     Replaces B-16-D at M.P. 135.88 on SH 14
Input Easting Offset =  169548.500000                      This is a straight bridge
Input Bearing =  S 89 55 41.0500 E


 HORIZONTAL ALIGNMENT DATA

      HORIZONTAL TANGENT

 VERTICAL ALIGNMENT DATA

         ELEVATION   ELEVATION                          ELEVATION    ELEVATION    PERCENT
           AT PI      AT GRADE         STATION          AT GRADE      AT PI        GRADE
                                                                                 -1.299260
         4950.3400   4950.3400  PI    10+50.0000
                                                                                 -1.299260
                                      17+01.1400  PI   4941.8800    4941.8800
                                                                                 -1.299260

 TABLE OF ROADWAY CROSS-SLOPES   (SUPERELEVATION:  E= -NC- )

                STATION           SLOPE LEFT        SLOPE RIGHT         VC LENGTH

            (ON TANGENT)            -0.0200           -0.0200              0.00 (MAX)

       OFFSET PROFILE CONTROL TO PIVOT POINT =    0.0000  FEET

LIMITS OF VALID ELEVATION AND CROSS-SLOPE DATA             BEGIN             END
                                                           0+00.0000       * UNLIMITED *

 LAYOUT LINE DATA

       LAYOUT LINE DEFINED TO BE COINCIDENT WITH HORIZONTAL CONTROL

                                                         HCL STA       OFFSET           X           Y
                  LAYOUT LINE INTERSECTS REF LINE AT    11+44.5900    0.00000000       0.0000      0.0000

 BENT LINES TO DEFINE OFFSETS FOR FLARED GIRDER LINES
                                                INITIAL BENT:  Med Tpr
                                                TERMINAL BENT:  BF Abut 6
```



SECTION

```
DEAD LOAD DEFLECTION DATA
                                  DEFLECTIONS AT TENTH POINTS FROM FITTED CURVE

        0.0      0.1      0.2      0.3      0.4      0.5      0.6      0.7      0.8      0.9      1.0

    FOR BENT LINE:  CL Brg A1              07 CARD(S):  1        GIRDER LINES REFERENCED BY:  A
                                                                                                          A4= 0.00000
INCH   0.0000   0.1098   0.2118   0.2936   0.3462   0.3643   0.3462   0.2936   0.2118   0.1098   0.0000   INCH      A3= 0.00000
FOOT   0.0000   0.0092   0.0177   0.0245   0.0288   0.0304   0.0288   0.0245   0.0177   0.0092   0.0000   FOOT      A2= 1.48095
                                                                                                          A1=-1.48095
SLOPE  0.090576                                                                          -0.090576 SLOPE          A0=-1.08691

    FOR BENT LINE:  Ahd Brg P2             07 CARD(S):  1        GIRDER LINES REFERENCED BY:  A
                                                                                                          A4= 0.00000
INCH   0.0000   0.2898   0.5736   0.8077   0.9606   1.0137   0.9606   0.8077   0.5736   0.2898   0.0000   INCH      A3= 0.00000
FOOT   0.0000   0.0241   0.0478   0.0673   0.0801   0.0845   0.0801   0.0673   0.0478   0.0241   0.0000   FOOT      A2= 5.22004
                                                                                                          A1=-5.22004
SLOPE  0.229149                                                                          -0.229149 SLOPE          A0=-2.74979

    FOR BENT LINE:  Ahd Brg P3             07 CARD(S):  1        GIRDER LINES REFERENCED BY:  A
                                                                                                          A4= 0.00000
INCH   0.0000   0.2898   0.5736   0.8077   0.9606   1.0137   0.9606   0.8077   0.5736   0.2898   0.0000   INCH      A3= 0.00000
FOOT   0.0000   0.0241   0.0478   0.0673   0.0801   0.0845   0.0801   0.0673   0.0478   0.0241   0.0000   FOOT      A2= 5.22004
                                                                                                          A1=-5.22004
SLOPE  0.229149                                                                          -0.229149 SLOPE          A0=-2.74979

    FOR BENT LINE:  Ahd Brg P4             07 CARD(S):  1        GIRDER LINES REFERENCED BY:  A
                                                                                                          A4= 0.00000
INCH   0.0000   0.2898   0.5736   0.8077   0.9606   1.0137   0.9606   0.8077   0.5736   0.2898   0.0000   INCH      A3= 0.00000
FOOT   0.0000   0.0241   0.0478   0.0673   0.0801   0.0845   0.0801   0.0673   0.0478   0.0241   0.0000   FOOT      A2= 5.22004
                                                                                                          A1=-5.22004
SLOPE  0.229149                                                                          -0.229149 SLOPE          A0=-2.74979

    FOR BENT LINE:  Ahd Brg P5             07 CARD(S):  1        GIRDER LINES REFERENCED BY:  A
                                                                                                          A4= 0.00000
INCH   0.0000   0.1098   0.2118   0.2936   0.3462   0.3643   0.3462   0.2936   0.2118   0.1098   0.0000   INCH      A3= 0.00000
FOOT   0.0000   0.0092   0.0177   0.0245   0.0288   0.0304   0.0288   0.0245   0.0177   0.0092   0.0000   FOOT      A2= 1.48095
                                                                                                          A1=-1.48095
SLOPE  0.090576                                                                          -0.090576 SLOPE          A0=-1.08691

        0.0      0.1      0.2      0.3      0.4      0.5      0.6      0.7      0.8      0.9      1.0


 BENT LINE  :           INTERSECTION POINT              :   FROM LAYOUT LINE   :    PROJECT COORDINATES    BENT LINE               : GIRDER LINE   ROADWAY
DESCRIPTION :                                           :   OFFSET    ORDINATE :   NORTHING      EASTING  LENGTH FROM     SKEW     : LENGTH FROM   CROSS-
            :    STATION      OFFSET   ELEVATION        :     X          Y     :                             Y-AXIS     D  M  S    :  REF LINE        SLOPE

    * HORIZONTAL CONTROL  LINE *       AT FINISHED GRADE

End Appr 1    11+24.5900    0.0000   4949.3709    4        0.0000   -20.0000   142618.8251  169528.5000    0.0000    0 00 00.00     -20.0000
BF Abut 1     11+44.5900    0.0000   4949.1110    1        0.0000     0.0000   142618.8000  169548.5000    0.0000    0 00 00.00       0.0000
CL Brg A1     11+46.3400    0.0000   4949.0883    10       0.0000     1.7500   142618.7978  169550.2500    0.0000    0 00 00.00       1.7500
FF Abut 1     11+47.5900    0.0000   4949.0721             0.0000     3.0000   142618.7962  169551.5000    0.0000    0 00 00.00       3.0000
End WW W      11+47.5900    0.0000   4949.0721    (   )    0.0000     3.0000   142618.7962  169551.5000    0.0000    0 00 00.00       3.0000
Bk Brg P2     12+08.0900    0.0000   4948.2860    1        0.0000    63.5000   142618.7203  169611.9999    0.0000    0 00 00.00      63.5000
CL Pier 2     12+09.0900    0.0000   4948.2730             0.0000    64.5000   142618.7190  169612.9999    0.0000    0 00 00.00      64.5000
Ahd Brg P2    12+10.0900    0.0000   4948.2600    10       0.0000    65.5000   142618.7178  169613.9999    0.0000    0 00 00.00      65.5000
Bk Brg  P3    12+92.0900    0.0000   4947.1946    1        0.0000   147.5000   142618.6148  169695.9999    0.0000    0 00 00.00     147.5000
CL Pier 3     12+93.0900    0.0000   4947.1816             0.0000   148.5000   142618.6136  169696.9999    0.0000    0 00 00.00     148.5000
Ahd Brg P3    12+94.0900    0.0000   4947.1686    10       0.0000   149.5000   142618.6123  169697.9999    0.0000    0 00 00.00     149.5000
Bk Brg P4     13+76.0900    0.0000   4946.1032    1        0.0000   231.5000   142618.5094  169779.9998    0.0000    0 00 00.00     231.5000
CL Pier 4     13+77.0900    0.0000   4946.0903             0.0000   232.5000   142618.5081  169780.9998    0.0000    0 00 00.00     232.5000
Ahd Brg P4    13+78.0900    0.0000   4946.0773    10       0.0000   233.5000   142618.5069  169781.9998    0.0000    0 00 00.00     233.5000
Med Tpr       14+32.4400    0.0000   4945.3711    (   )    0.0000   287.8500   142618.4386  169836.3498    0.0000    0 00 00.00     287.8500
Bk Brg P5     14+60.0900    0.0000   4945.0119    1        0.0000   315.5000   142618.4039  169863.9998    0.0000    0 00 00.00     315.5000
CL Pier 5     14+61.0900    0.0000   4944.9989             0.0000   316.5000   142618.4027  169864.9998    0.0000    0 00 00.00     316.5000
Ahd Brg P5    14+62.0900    0.0000   4944.9859    10       0.0000   317.5000   142618.4014  169865.9997    0.0000    0 00 00.00     317.5000
FF Abut 6     15+22.5900    0.0000   4944.1998             0.0000   378.0000   142618.3254  169926.4997    0.0000    0 00 00.00     378.0000
CL Brg A6     15+23.8400    0.0000   4944.1836    1        0.0000   379.2500   142618.3239  169927.7497    0.0000    0 00 00.00     379.2500
BF Abut 6     15+25.5900    0.0000   4944.1609    4        0.0000   381.0000   142618.3217  169929.4997    0.0000    0 00 00.00     381.0000
End Appr 6    15+45.5900    0.0000   4943.9010    0.0      0.0000   401.0000   142618.2966  169949.4997    0.0000    0 00 00.00     401.0000
```

NOTES:

1. Elevations are at top of bridge deck, 3" below Finished Grade.
2. Positive roadway cross slope is upward from the profile grade line.
3. These stations, coordinates, offsets and lengths define the layout of the structure in a two dimensional horizontal plane. Elevations define the final grade of the finished concrete deck. Fabrication of structural components through the direct use of this information is not intended or advisable.

Example 14-1

```
Version 1.00

Run date & time = Thu Sep 24 15:04:13 2015

Input Northing Offset =  48397.214400
Input Easting Offset =  76072.091700
Input Bearing =  S 5 6 20.0000 E

 STRUCTURE ID:  C-17-ft            BRIDGE GEOMETRY (WIN2.1.0e)            15/09/24 14:53            PAGE   1

 DESCRIPTION

                  Units: feet;
                  Project: FBR 060A-020; Subaccount: 21146;
                  Designer: S. HUSON; Detailer: H. NGUYEN;
                  Location: SH60;
                 OVER SOUTH PLATTE RIVER
                 7 SPAN  BT63 GIRDERS CONCRETE SLAB1

 HORIZONTAL ALIGNMENT DATA

     HORIZONTAL TANGENT

 VERTICAL ALIGNMENT DATA

      ELEVATION   ELEVATION                        ELEVATION   ELEVATION   PERCENT
        AT PI      AT GRADE        STATION          AT GRADE     AT PI      GRADE

                                                                          1.000000
                                 38+12.5100  PC   4721.5000
                                 40+12.5100  PI   4722.5000   4723.5000
                                 42+12.5100  PT   4721.5000
                                                                         -1.000000

 TABLE OF ROADWAY CROSS-SLOPES   (SUPERELEVATION:  E= -NC- )

                STATION          SLOPE LEFT      SLOPE RIGHT       VC LENGTH

             (ON TANGENT)          -0.0200         -0.0200          75.00 (MAX)

      OFFSET PROFILE CONTROL TO PIVOT POINT =    0.0000  FEET

 LIMITS OF VALID ELEVATION AND CROSS-SLOPE DATA          BEGIN            END
                                                      * UNLIMITED *    * UNLIMITED *

 LAYOUT LINE DATA
```

```
    LAYOUT LINE DEFINED TO BE COINCIDENT WITH HORIZONTAL CONTROL

                                                      HCL STA       OFFSET          X         Y
              LAYOUT LINE INTERSECTS REF LINE AT     36+18.7600    0.00000000      0.0000    0.0000

DEAD LOAD DEFLECTION DATA
                        DEFLECTIONS AT TENTH POINTS FROM FITTED CURVE

        0.0     0.1     0.2     0.3     0.4     0.5     0.6     0.7     0.8     0.9     1.0

   FOR BENT LINE:  CL A1              07 CARD(S):  1       GIRDER LINES REFERENCED BY:  A
                                                                                                 A4= 0.00000
INCH   0.0000  0.1458  0.2801  0.3873  0.4560  0.4797  0.4560  0.3873  0.2801  0.1458  0.0000  INCH   A3= 0.00000
FOOT   0.0000  0.0121  0.0233  0.0323  0.0380  0.0400  0.0380  0.0323  0.0233  0.0121  0.0000  FOOT   A2= 1.87004
                                                                                                 A1=-1.87004
SLOPE  0.120945                                                                     -0.120945 SLOPE   A0=-1.45134

   FOR BENT LINE:  CL P2              07 CARD(S):  1       GIRDER LINES REFERENCED BY:  A
                                                                                                 A4=-150.909
INCH   0.0000  0.7801  1.3452  1.9593  2.5050  2.7738  2.6472  2.1693  1.5116  0.8275  0.0000  INCH   A3= 317.174
FOOT   0.0000  0.0650  0.1121  0.1633  0.2088  0.2312  0.2206  0.1808  0.1260  0.0690  0.0000  FOOT   A2=-211.726
                                                                                                 A1= 46.1848
SLOPE  0.955936                                                                     -0.895606 SLOPE   A0=-11.4712

        0.0     0.1     0.2     0.3     0.4     0.5     0.6     0.7     0.8     0.9     1.0

DEAD LOAD DEFLECTION DATA (CONT)
                        DEFLECTIONS AT TENTH POINTS FROM FITTED CURVE

        0.0     0.1     0.2     0.3     0.4     0.5     0.6     0.7     0.8     0.9     1.0

   FOR BENT LINE:  CL P3              07 CARD(S):  1       GIRDER LINES REFERENCED BY:  A
                                                                                                 A4= 0.00000
INCH   0.0000  0.8009  1.5493  2.1510  2.5389  2.6727  2.5389  2.1510  1.5493  0.8009  0.0000  INCH   A3= 0.00000
FOOT   0.0000  0.0667  0.1291  0.1793  0.2116  0.2227  0.2116  0.1793  0.1291  0.0667  0.0000  FOOT   A2= 11.1955
                                                                                                 A1=-11.1955
SLOPE  0.657653                                                                     -0.657653 SLOPE   A0=-7.89184

   FOR BENT LINE:  CL P4              07 CARD(S):  1       GIRDER LINES REFERENCED BY:  A
                                                                                                 A4= 0.00000
INCH   0.0000  0.8039  1.5538  2.1562  2.5444  2.6783  2.5444  2.1562  1.5538  0.8039  0.0000  INCH   A3= 0.00000
FOOT   0.0000  0.0670  0.1295  0.1797  0.2120  0.2232  0.2120  0.1797  0.1295  0.0670  0.0000  FOOT   A2= 11.1317
                                                                                                 A1=-11.1317
SLOPE  0.660848                                                                     -0.660848 SLOPE   A0=-7.93018

   FOR BENT LINE:  CL P5              07 CARD(S):  1       GIRDER LINES REFERENCED BY:  A
                                                                                                 A4= 0.00000
INCH   0.0000  0.8040  1.5544  2.1575  2.5461  2.6801  2.5461  2.1575  1.5544  0.8040  0.0000  INCH   A3= 0.00000
FOOT   0.0000  0.0670  0.1295  0.1798  0.2122  0.2233  0.2122  0.1798  0.1295  0.0670  0.0000  FOOT   A2= 11.1718
                                                                                                 A1=-11.1718
SLOPE  0.660628                                                                     -0.660628 SLOPE   A0=-7.92754

        0.0     0.1     0.2     0.3     0.4     0.5     0.6     0.7     0.8     0.9     1.0
```

Note: Elevations are at top of concrete deck 3 Inches below Finished Grade.	Positive Roadway Cross Slope is Upwards from the Profile Grade Line.	These Stations, Coordinates, Offsets and Lengths define the layout of the structure in a two dimensional horizontal plane. Elevations define the final grade of the finished concrete deck. Fabrication of structural components through the direct use of this information is not intended or advisable.

Example 14-2

```
DESCRIPTION

                              SH 270 FLYOVER - RAMP K
                              SH 270
                              NOTE: 'ELEV+DL' ARE DECK SCREED ELEVATIONS TO
                  COMPENSATE FOR SUPERSTRUCTURE DEAD LOAD DEFLECTION.

HORIZONTAL ALIGNMENT DATA

   PC   238+44.9922     T     824.1178
   PI   246+69.1100     Lc   1357.6679      DELTA  81 52 58.00 LT      Dc   6 01 52.08      RADIUS    950.000000
   PT   252+02.6601     T     824.1178

VERTICAL ALIGNMENT DATA
     ELEVATION   ELEVATION                       ELEVATION    ELEVATION    PERCENT
       AT PI      AT GRADE        STATION         AT GRADE      AT PI       GRADE
                                                                           3.784505
                              241+25.0000  PC   5211.5544
                              243+60.0000  PI   5216.0271    5220.4480
                              245+95.0000  PT   5211.6582
                                                                          -3.740351
     5199.1280   5201.9333 PC  248+55.0000
                 5199.2288 PI  249+30.0000
                 5196.7259 PT  250+05.0000
                                                                          -3.202754

TABLE OF ROADWAY CROSS-SLOPES   (SUPERELEVATION:  E=0.0560)
             STATION           SLOPE LEFT       SLOPE RIGHT         VC LENGTH
           (ON TANGENT)          0.0200           -0.0200           45.00 (MAX)

            236+10.2463          0.0200           -0.0200           45.00
            238+63.6249         -0.0560            0.0560           45.00
            251+27.9801         -0.0560            0.0560           45.00
            253+81.3587          0.0200           -0.0200           45.00

     OFFSET PROFILE CONTROL TO PIVOT POINT =    0.0000  FEET

LIMITS OF VALID ELEVATION AND CROSS-SLOPE DATA          BEGIN            END
                                                     235+05.0000      250+05.0000
 LAYOUT LINE DATA
     LAYOUT LINE DEFINED AS CHORD BETWEEN BENT LINES:  CL PIER 7
                                                 AND:  *REF LINE*

     LAYOUT LINE DEFINED AS CHORD ON HORIZONTAL CONTROL LINE
       A CURVE PARALLEL TO HORIZONTAL CONTROL AT OFFSET        -74.9921
                   IS TANGENT TO LAYOUT LINE AT STATION     242+70.0000
                                        Y FROM REF LINE     369.947425

                                                       HCL STA        SKEW        Y FROM REF LINE
          LAYOUT LINE INTERSECTS HORIZONTAL CONTROL AT  238+90.0000  -22 55 05.92     0.00000000
                                                        246+50.0000   22 55 05.92   739.894850
                                                       HCL STA       OFFSET            X          Y
                    LAYOUT LINE INTERSECTS REF LINE AT  238+90.0000   0.00000000      0.0000     0.0000

 TYPE 4  GIRDER LINE DATA
(OFFSET VARIES WITH SUPER)

     LINE OF CONSTANT OFFSET IS GIRDER LINE:  PROFILE GRADE LINE
                                       0.0000 FEET FROM HORIZONTAL CONTROL

     AVERAGE CROSS-SLOPE CALCULATED BETWEEN STATION   235+31.7500
                                        AND STATION   249+51.2500

     AVERAGE CROSS-SLOPE = 0.045014 FT/FT (RIGHT OF PROFILE CONTROL LINE)


DEAD LOAD DEFLECTION DATA
                         DEFLECTIONS AT TENTH POINTS FROM FITTED CURVE

        0.0      0.1      0.2      0.3      0.4      0.5      0.6      0.7      0.8      0.9      1.0

    FOR BENT LINE:  CL BRG A1                 07 CARD(S):  1        GIRDER LINES REFERENCED BY:  A
                                                                                                        A4=-20.1135
INCH    0.0000   1.4881   2.7116   3.5150   3.8064   3.5789   2.9171   1.9900   1.0284   0.2884   0.0000  INCH   A3= 27.7951
FOOT    0.0000   0.1240   0.2260   0.2929   0.3172   0.2982   0.2431   0.1658   0.0857   0.0240   0.0000  FOOT   A2= 19.4841
                                                                                                        A1=-11.6214
SLOPE  1.299418                                                                          -0.004059 SLOPE    A0=-15.5930
```

```
DEAD LOAD DEFLECTION DATA (CONT)
                         DEFLECTIONS AT TENTH POINTS FROM FITTED CURVE

        0.0      0.1      0.2      0.3      0.4      0.5      0.6      0.7      0.8      0.9      1.0

    FOR BENT LINE:  CL PIER 2                 07 CARD(S):  1        GIRDER LINES REFERENCED BY:  A
                                                                                                        A4=-66.9032
INCH    0.0000   0.4329   1.5196   2.7750   3.7358   4.0793   3.6948   2.7060   1.4458   0.3830   0.0000  INCH   A3= 132.735
FOOT    0.0000   0.0361   0.1266   0.2312   0.3113   0.3399   0.3079   0.2255   0.1205   0.0319   0.0000  FOOT   A2=-14.3885
                                                                                                        A1=-58.8466
SLOPE -0.024397                                                                           0.074138 SLOPE    A0=0.292764
                         DEFLECTIONS SHOW SIGNIFICANT UPLIFT

    FOR BENT LINE:  CL PIER 3                 07 CARD(S):  1        GIRDER LINES REFERENCED BY:  A
                                                                                                        A4=-67.1669
INCH    0.0000   0.5517   1.8015   3.2157   4.2922   4.6823   4.2635   3.1644   1.7408   0.5040   0.0000  INCH   A3= 134.772
FOOT    0.0000   0.0460   0.1501   0.2680   0.3577   0.3902   0.3553   0.2637   0.1451   0.0420   0.0000  FOOT   A2=-10.2599
                                                                                                        A1=-56.6429
SLOPE  0.040930                                                                           0.017574 SLOPE    A0=-.491164
                         DEFLECTIONS SHOW SIGNIFICANT UPLIFT

    FOR BENT LINE:  CL PIER 4                 07 CARD(S):  1        GIRDER LINES REFERENCED BY:  A
                                                                                                        A4=-68.2296
INCH    0.0000   0.4679   1.6563   3.0361   4.1045   4.5084   4.1195   3.0600   1.6790   0.4802   0.0000  INCH   A3= 137.401
FOOT    0.0000   0.0390   0.1380   0.2530   0.3420   0.3757   0.3433   0.2550   0.1399   0.0400   0.0000  FOOT   A2=-13.0508
                                                                                                        A1=-56.2067
SLOPE -0.035131                                                                           0.027966 SLOPE    A0=0.421577
                         DEFLECTIONS SHOW SIGNIFICANT UPLIFT

    FOR BENT LINE:  CL PIER 5                 07 CARD(S):  1        GIRDER LINES REFERENCED BY:  A
                                                                                                        A4=-70.5563
INCH    0.0000   0.4803   1.6782   3.0623   4.1277   4.5221   4.1212   3.0531   1.6716   0.4795   0.0000  INCH   A3= 140.292
FOOT    0.0000   0.0400   0.1399   0.2552   0.3440   0.3768   0.3434   0.2544   0.1393   0.0400   0.0000  FOOT   A2=-13.5806
                                                                                                        A1=-56.2094
SLOPE -0.023911                                                                           0.018703 SLOPE    A0=0.286936
                         DEFLECTIONS SHOW SIGNIFICANT UPLIFT

    FOR BENT LINE:  CL PIER 6                 07 CARD(S):  1        GIRDER LINES REFERENCED BY:  A
                                                                                                        A4=-16.8661
INCH    0.0000   0.3117   1.1285   2.1875   3.2078   3.9381   4.1926   3.8745   2.9868   1.6323   0.0000  INCH   A3= 48.2393
FOOT    0.0000   0.0260   0.0940   0.1823   0.2673   0.3282   0.3494   0.3229   0.2489   0.1360   0.0000  FOOT   A2=-13.4111
                                                                                                        A1=-34.9982
SLOPE -0.010310                                                                          -1.409360 SLOPE    A0=0.123725
                         DEFLECTIONS SHOW SIGNIFICANT UPLIFT

    FOR BENT LINE:  CL BRG 7R                 07 CARD(S):  1        GIRDER LINES REFERENCED BY:  A
                                                                                                        A4= 0.00000
INCH    0.0000   0.7069   1.2764   1.6056   1.6566   1.4477   1.0450   0.5536   0.1087  -0.1325   0.0000  INCH   A3=-7.22202
FOOT    0.0000   0.0589   0.1064   0.1338   0.1380   0.1206   0.0871   0.0461   0.0091  -0.0110   0.0000  FOOT   A2= 27.0799
                                                                                                        A1=-8.85024
SLOPE  0.602738                                                                           0.314563 SLOPE    A0=-7.23285
                         DEFLECTIONS SHOW SIGNIFICANT UPLIFT

    FOR BENT LINE:  CL PIER 8                 07 CARD(S):  1        GIRDER LINES REFERENCED BY:  A
                                                                                                        A4=-19.0238
INCH    0.0000   0.7552   1.9475   3.2766   4.4420   5.1890   5.3426   4.8262   3.6681   1.9928   0.0000  INCH   A3= 48.5373
FOOT    0.0000   0.0629   0.1623   0.2731   0.3702   0.4324   0.4452   0.4022   0.3057   0.1661   0.0000  FOOT   A2=-6.91796
                                                                                                        A1=-38.8403
SLOPE  0.373723                                                                          -1.727449 SLOPE    A0=-4.48468
```

BRIDGE DECK ELEVATIONS

BENT LINE DESCRIPTION OR FRACTIONAL POINT DESIGNATION	INTERSECTION POINT				COORDINATES FROM LAYOUT LINE		BENT LINE LENGTH FROM Y-AXIS	SKEW D M S	GIRDER LINE LENGTH FROM REF LINE	ROADWAY CROSS-SLOPE
	STATION	OFFSET	ELEVATION	ELEV+DL	OFFSET X	ORDINATE Y				
HORIZONTAL CONTROL LINE										
BF ABUT 1	235+29.0000	0.0000	5188.9988		-155.2009	-325.9182	-172.1423	0 00 00.00	-361.0890	+/-.020000
CL BRG A1	235+31.7500	0.0000	5189.1020	10	-154.0113	-323.4308	-170.8228	0 00 00.00	-358.2500	+/-.020000
CL PIER 2	236+90.0000	0.0000	5195.0918	10	-85.5580	-180.7634	-94.8507	0 00 00.00	-210.0000	+/-.032922
CL PIER 3	238+90.0000	0.0000	5202.6608	10	0.0000	0.0000	0.0000	0 00 00.00	0.0000	+/-.056000
CL PIER 4	240+90.0000	0.0000	5210.2298	10	37.9924	191.0585	39.3471	0 00 00.00	200.0000	+/-.056000
CL PIER 5	242+90.0000	0.0000	5215.6194	10	74.7815	389.4459	74.7981	0 00 00.00	400.0000	+/-.056000
CL PIER 6	244+90.0000	0.0000	5214.7930	10	45.6380	587.9863	50.9933	0 00 00.00	600.0000	+/-.056000
CL BRG 7L	246+48.2500	0.0000	5209.6664	1	6.6800	738.2884	0.7377	0 00 00.00	758.2500	+/-.056000
CL PIER 7	246+50.0000	0.0000	5209.6010	1	0.0000	739.8949	0.0000	0 00 00.00	760.0000	+/-.056000
CL BRG 7R	246+51.7500	0.0000	5209.5355	10	-6.6839	741.3061	-0.7421	0 00 00.00	761.7500	+/-.056000
CL PIER 8	247+90.0000	0.0000	5204.3645	10	-63.9057	864.3673	-74.7230	0 00 00.00	900.0000	+/-.056000
CL BRG A9	249+51.2500	0.0000	5198.4992	1	-158.9825	994.2528	-210.9325	0 00 00.00	1061.2500	+/-.056000
BF ABUT 9	249+54.0000	0.0000	5198.4059	0.0	-160.7925	996.5629	-213.8751	0 00 00.00	1064.0000	+/-.056000
LAYOUT LINE										
BF ABUT 1	235+29.0000	172.1423	5185.5559		0.0000	-400.3872	0.0000	25 37 58.04	-400.3872	-0.020000
CL BRG A1	235+31.7500	170.8228	5185.6864		0.0000	-397.3371	0.0000	25 37 58.04	-397.3371	-0.020000
CL PIER 2	236+90.0000	94.8507	5195.4640		0.0000	-221.8129	0.0000	25 37 58.04	-221.8129	+0.032922
CL PIER 3	238+90.0000	0.0000	5202.6608		0.0000	0.0000	0.0000	22 55 05.92	0.0000	+/-.056000
CL PIER 4	240+90.0000	-39.0471	5206.9032		0.0000	202.1436	0.0000	10 51 21.75	202.1436	-0.056000
CL PIER 5	242+90.0000	-74.7981	5211.4307		0.0000	388.3714	0.0000	-1 12 22.42	388.3714	-0.056000
CL PIER 6	244+90.0000	-50.9933	5211.8474		0.0000	576.2826	0.0000	-13 16 36.59	576.2826	-0.056000
CL BRG 7L	246+48.2500	-0.7377	5209.6251		0.0000	737.7963	0.0000	-22 48 45.96	737.7963	-0.056000
CL PIER 7	246+50.0000	0.0000	5209.6010		0.0000	739.8949	0.0000	-22 55 05.92	739.8949	+/-.056000
CL BRG 7R	246+51.7500	0.7421	5209.5771		0.0000	741.7963	0.0000	-23 01 25.88	741.7963	+0.056000
CL PIER 8	247+90.0000	74.7230	5208.5490		0.0000	903.2562	0.0000	-31 21 42.84	903.2562	+0.056000
CL BRG A9	249+51.2500	210.9325	5210.3114		0.0000	1132.9188	0.0000	-41 05 13.58	1132.9188	+0.056000
BF ABUT 9	249+54.0000	213.8751	5210.3830		0.0000	1137.3888	0.0000	-41 15 10.66	1137.3888	+0.056000

NOTES:

THESE STATIONS, COORDINATES, OFFSETS, AND LENGTHS DEFINE THE LAYOUT OF THE STRUCTURE IN A TWO DIMENSIONAL HORIZONTAL PLANE. ELEVATIONS DEFINE THE FINAL GRADE OF THE FINISHED CONCRETE DECK. FABRICATION OF STRUCTURAL COMPONENTS THROUGH THE DIRECT USE OF THIS INFORMATION IS NOT INTENDED OR ADVISABLE.

Example 14-3

Left Flowline — PARALLEL TO HORIZONTAL CONTROL — 0.250000 FEET BELOW FINISHED GRADE

BENT LINE	STATION	OFFSET	ELEVATION	ELEV+DL	X	Y	NORTHING	EASTING	BENT LNTH	SKEW	GIRDER LNTH	CRS-SLP
End Appr 1	18+34.8500	-22.0000	9213.3580		-22.0000	-21.2500	796009.4842	1554462.4453	-22.0000	0 00 00.00	-21.2500	-0.020000
MiddAppr1	18+44.8500	-22.0000	9213.3279		-22.0000	-11.2500	796019.4347	1554461.4507	-22.0000	0 00 00.00	-11.2500	-0.020000
BF Abut 1	18+54.8500	-22.0000	9213.2978		-22.0000	-1.2500	796029.3851	1554460.4562	-22.0000	0 00 00.00	-1.2500	-0.020000
CL Brg A1	18+56.1000	-22.0000	9213.2940		-22.0000	0.0000	796030.6289	1554460.3319	-22.0000	0 00 00.00	0.0000	-0.020000
F-1	18+65.1000	-22.0000	9213.2669		-22.0000	9.0000	796039.5843	1554459.4368			9.0000	-0.020000
F-2	18+74.1000	-22.0000	9213.2398		-22.0000	18.0000	796048.5396	1554458.5417			18.0000	-0.020000
F-3	18+83.1000	-22.0000	9213.2127		-22.0000	27.0000	796057.4950	1554457.6466			27.0000	-0.020000
F-4	18+92.1000	-22.0000	9213.1856		-22.0000	36.0000	796066.4504	1554456.7515			36.0000	-0.020000
F-5	19+01.1000	-22.0000	9213.1585		-22.0000	45.0000	796075.4058	1554455.8564			45.0000	-0.020000
F-6	19+10.1000	-22.0000	9213.1315		-22.0000	54.0000	796084.3612	1554454.9613			54.0000	-0.020000
F-7	19+19.1000	-22.0000	9213.1044		-22.0000	63.0000	796093.3165	1554454.0662			63.0000	-0.020000
F-8	19+28.1000	-22.0000	9213.0773		-22.0000	72.0000	796102.2719	1554453.1711			72.0000	-0.020000
F-9	19+37.1000	-22.0000	9213.0502		-22.0000	81.0000	796111.2273	1554452.2760			81.0000	-0.020000
CL Brg A2	19+46.1000	-22.0000	9213.0231		-22.0000	90.0000	796120.1827	1554451.3809	-22.0000	0 00 00.00	90.0000	-0.020000
BF Abut 2	19+47.3500	-22.0000	9213.0193		-22.0000	91.2500	796121.4265	1554451.2566	-22.0000	0 00 00.00	91.2500	-0.020000
MiddAppr2	19+57.3500	-22.0000	9212.9892		-22.0000	101.2500	796131.3769	1554450.2620	-22.0000	0 00 00.00	101.2500	-0.020000
EndWing2	19+62.6000	-22.0000	9212.9734		-22.0000	106.5000	796136.6009	1554449.7399	-22.0000	0 00 00.00	106.5000	-0.020000
End Appr 2	19+67.3500	-22.0000	9212.9591		-22.0000	111.2500	796141.3273	1554449.2675	-22.0000	0 00 00.00	111.2500	-0.020000

Ext Gir A — PARALLEL TO HORIZONTAL CONTROL — 0.250000 FEET BELOW FINISHED GRADE

BENT LINE	STATION	OFFSET	ELEVATION	ELEV+DL	X	Y	NORTHING	EASTING	BENT LNTH	SKEW	GIRDER LNTH	CRS-SLP
End Appr 1	18+34.8500	-18.0000	9213.4380		-18.0000	-21.2500	796009.8821	1554466.4255	-18.0000	0 00 00.00	-21.2500	-0.020000
MiddAppr1	18+44.8500	-18.0000	9213.4079		-18.0000	-11.2500	796019.8325	1554465.4309	-18.0000	0 00 00.00	-11.2500	-0.020000
BF Abut 1	18+54.8500	-18.0000	9213.3778		-18.0000	-1.2500	796029.7829	1554464.4364	-18.0000	0 00 00.00	-1.2500	-0.020000
CL Brg A1	18+56.1000	-18.0000	9213.3740	213.3740	-18.0000	0.0000	796031.0267	1554464.3120	-18.0000	0 00 00.00	0.0000	-0.020000
F-1	18+65.1000	-18.0000	9213.3469	213.3858	-18.0000	9.0000	796039.9821	1554463.4169			9.0000	-0.020000
F-2	18+74.1000	-18.0000	9213.3198	213.3942	-18.0000	18.0000	796048.9375	1554462.5218			18.0000	-0.020000
F-3	18+83.1000	-18.0000	9213.2927	213.3953	-18.0000	27.0000	796057.8928	1554461.6267			27.0000	-0.020000
F-4	18+92.1000	-18.0000	9213.2656	213.3863	-18.0000	36.0000	796066.8482	1554460.7317			36.0000	-0.020000
F-5	19+01.1000	-18.0000	9213.2385	213.3654	-18.0000	45.0000	796075.8036	1554459.8366			45.0000	-0.020000
F-6	19+10.1000	-18.0000	9213.2115	213.3321	-18.0000	54.0000	796084.7590	1554458.9415			54.0000	-0.020000
F-7	19+19.1000	-18.0000	9213.1844	213.2869	-18.0000	63.0000	796093.7144	1554458.0464			63.0000	-0.020000
F-8	19+28.1000	-18.0000	9213.1573	213.2316	-18.0000	72.0000	796102.6697	1554457.1513			72.0000	-0.020000
F-9	19+37.1000	-18.0000	9213.1302	213.1690	-18.0000	81.0000	796111.6251	1554456.2562			81.0000	-0.020000
CL Brg A2	19+46.1000	-18.0000	9213.1031	213.1031	-18.0000	90.0000	796120.5805	1554455.3611	-18.0000	0 00 00.00	90.0000	-0.020000
BF Abut 2	19+47.3500	-18.0000	9213.0993		-18.0000	91.2500	796121.8243	1554455.2367	-18.0000	0 00 00.00	91.2500	-0.020000
MiddAppr2	19+57.3500	-18.0000	9213.0692		-18.0000	101.2500	796131.7747	1554454.2422	-18.0000	0 00 00.00	101.2500	-0.020000
EndWing2	19+62.6000	-18.0000	9213.0534		-18.0000	106.5000	796136.9987	1554453.7200	-18.0000	0 00 00.00	106.5000	-0.020000
End Appr 2	19+67.3500	-18.0000	9213.0391		-18.0000	111.2500	796141.7251	1554453.2476	-18.0000	0 00 00.00	111.2500	-0.020000

Int Gir B — PARALLEL TO HORIZONTAL CONTROL — 0.250000 FEET BELOW FINISHED GRADE

BENT LINE	STATION	OFFSET	ELEVATION	ELEV+DL	X	Y	NORTHING	EASTING	BENT LNTH	SKEW	GIRDER LNTH	CRS-SLP
End Appr 1	18+34.8500	-6.0000	9213.6780		-6.0000	-21.2500	796011.0755	1554478.3660	-6.0000	0 00 00.00	-21.2500	-0.020000
MiddAppr1	18+44.8500	-6.0000	9213.6479		-6.0000	-11.2500	796021.0259	1554477.3714	-6.0000	0 00 00.00	-11.2500	-0.020000
BF Abut 1	18+54.8500	-6.0000	9213.6178		-6.0000	-1.2500	796030.9764	1554476.3769	-6.0000	0 00 00.00	-1.2500	-0.020000
CL Brg A1	18+56.1000	-6.0000	9213.6140	213.6140	-6.0000	0.0000	796032.2202	1554476.2525	-6.0000	0 00 00.00	0.0000	-0.020000
F-1	18+65.1000	-6.0000	9213.5869	213.6295	-6.0000	9.0000	796041.1755	1554475.3574			9.0000	-0.020000
F-2	18+74.1000	-6.0000	9213.5598	213.6380	-6.0000	18.0000	796050.1309	1554474.4624			18.0000	-0.020000
F-3	18+83.1000	-6.0000	9213.5327	213.6393	-6.0000	27.0000	796059.0863	1554473.5673			27.0000	-0.020000
F-4	18+92.1000	-6.0000	9213.5056	213.6309	-6.0000	36.0000	796068.0417	1554472.6722			36.0000	-0.020000
F-5	19+01.1000	-6.0000	9213.4785	213.6104	-6.0000	45.0000	796076.9971	1554471.7771			45.0000	-0.020000
F-6	19+10.1000	-6.0000	9213.4515	213.5767	-6.0000	54.0000	796085.9524	1554470.8820			54.0000	-0.020000
F-7	19+19.1000	-6.0000	9213.4244	213.5309	-6.0000	63.0000	796094.9078	1554469.9869			63.0000	-0.020000
F-8	19+28.1000	-6.0000	9213.3973	213.4754	-6.0000	72.0000	796103.8632	1554469.0918			72.0000	-0.020000
F-9	19+37.1000	-6.0000	9213.3702	213.4127	-6.0000	81.0000	796112.8186	1554468.1967			81.0000	-0.020000
CL Brg A2	19+46.1000	-6.0000	9213.3431	213.3431	-6.0000	90.0000	796121.7740	1554467.3016	-6.0000	0 00 00.00	90.0000	-0.020000
BF Abut 2	19+47.3500	-6.0000	9213.3393		-6.0000	91.2500	796123.0178	1554467.1772	-6.0000	0 00 00.00	91.2500	-0.020000
MiddAppr2	19+57.3500	-6.0000	9213.3092		-6.0000	101.2500	796132.9682	1554466.1827	-6.0000	0 00 00.00	101.2500	-0.020000
EndWing2	19+62.6000	-6.0000	9213.2934		-6.0000	106.5000	796138.1921	1554465.6606	-6.0000	0 00 00.00	106.5000	-0.020000
End Appr 2	19+67.3500	-6.0000	9213.2791		-6.0000	111.2500	796142.9186	1554465.1881	-6.0000	0 00 00.00	111.2500	-0.020000

CL Bridge & US285 HC — PARALLEL TO HORIZONTAL CONTROL — 0.250000 FEET BELOW FINISHED GRADE

BENT LINE	STATION	OFFSET	ELEVATION	ELEV+DL	X	Y	NORTHING	EASTING	BENT LNTH	SKEW	GIRDER LNTH	CRS-SLP
End Appr 1	18+34.8500	0.0000	9213.7980		0.0000	-21.2500	796011.6723	1554484.3362	0.0000	0 00 00.00	-21.2500	
MiddAppr1	18+44.8500	0.0000	9213.7679		0.0000	-11.2500	796021.6227	1554483.3417	0.0000	0 00 00.00	-11.2500	
BF Abut 1	18+54.8500	0.0000	9213.7378		0.0000	-1.2500	796031.5731	1554482.3471	0.0000	0 00 00.00	-1.2500	
CL Brg A1	18+56.1000	0.0000	9213.7340		0.0000	0.0000	796032.8169	1554482.2228	0.0000	0 00 00.00	0.0000	
F-1	18+65.1000	0.0000	9213.7069		0.0000	9.0000	796041.7723	1554481.3277			9.0000	
F-2	18+74.1000	0.0000	9213.6798		0.0000	18.0000	796050.7277	1554480.4326			18.0000	
F-3	18+83.1000	0.0000	9213.6527		0.0000	27.0000	796059.6830	1554479.5375			27.0000	
F-4	18+92.1000	0.0000	9213.6256		0.0000	36.0000	796068.6384	1554478.6424			36.0000	
F-5	19+01.1000	0.0000	9213.5985		0.0000	45.0000	796077.5938	1554477.7473			45.0000	
F-6	19+10.1000	0.0000	9213.5715		0.0000	54.0000	796086.5492	1554476.8522			54.0000	
F-7	19+19.1000	0.0000	9213.5444		0.0000	63.0000	796095.5045	1554475.9571			63.0000	
F-8	19+28.1000	0.0000	9213.5173		0.0000	72.0000	796104.4599	1554475.0620			72.0000	
F-9	19+37.1000	0.0000	9213.4902		0.0000	81.0000	796113.4153	1554474.1669			81.0000	
CL Brg A2	19+46.1000	0.0000	9213.4631		0.0000	90.0000	796122.3707	1554473.2718	0.0000	0 00 00.00	90.0000	
BF Abut 2	19+47.3500	0.0000	9213.4593		0.0000	91.2500	796123.6145	1554473.1475	0.0000	0 00 00.00	91.2500	
MiddAppr2	19+57.3500	0.0000	9213.4292		0.0000	101.2500	796133.5649	1554472.1529	0.0000	0 00 00.00	101.2500	
EndWing2	19+62.6000	0.0000	9213.4134		0.0000	106.5000	796138.7889	1554471.6308	0.0000	0 00 00.00	106.5000	
End Appr 2	19+67.3500	0.0000	9213.3991		0.0000	111.2500	796143.5153	1554471.1584	0.0000	0 00 00.00	111.2500	

Int Gir C — PARALLEL TO HORIZONTAL CONTROL — 0.250000 FEET BELOW FINISHED GRADE

BENT LINE	STATION	OFFSET	ELEVATION	ELEV+DL	X	Y	NORTHING	EASTING	BENT LNTH	SKEW	GIRDER LNTH	CRS-SLP
End Appr 1	18+34.8500	6.0000	9213.6780		6.0000	-21.2500	796012.2690	1554490.3065	6.0000	0 00 00.00	-21.2500	-0.020000
MiddAppr1	18+44.8500	6.0000	9213.6479		6.0000	-11.2500	796022.2194	1554489.3119	6.0000	0 00 00.00	-11.2500	-0.020000
BF Abut 1	18+54.8500	6.0000	9213.6178		6.0000	-1.2500	796032.1698	1554488.3174	6.0000	0 00 00.00	-1.2500	-0.020000
CL Brg A1	18+56.1000	6.0000	9213.6140	213.6140	6.0000	0.0000	796033.4136	1554488.1931	6.0000	0 00 00.00	0.0000	-0.020000
F-1	18+65.1000	6.0000	9213.5869	213.6295	6.0000	9.0000	796042.3690	1554487.2980			9.0000	-0.020000
F-2	18+74.1000	6.0000	9213.5598	213.6380	6.0000	18.0000	796051.3244	1554486.4029			18.0000	-0.020000
F-3	18+83.1000	6.0000	9213.5327	213.6393	6.0000	27.0000	796060.2798	1554485.5078			27.0000	-0.020000
F-4	18+92.1000	6.0000	9213.5056	213.6309	6.0000	36.0000	796069.2351	1554484.6127			36.0000	-0.020000
F-5	19+01.1000	6.0000	9213.4785	213.6104	6.0000	45.0000	796078.1905	1554483.7176			45.0000	-0.020000
F-6	19+10.1000	6.0000	9213.4515	213.5767	6.0000	54.0000	796087.1459	1554482.8225			54.0000	-0.020000
F-7	19+19.1000	6.0000	9213.4244	213.5309	6.0000	63.0000	796096.1013	1554481.9274			63.0000	-0.020000
F-8	19+28.1000	6.0000	9213.3973	213.4754	6.0000	72.0000	796105.0567	1554481.0323			72.0000	-0.020000
F-9	19+37.1000	6.0000	9213.3702	213.4127	6.0000	81.0000	796114.0120	1554480.1372			81.0000	-0.020000
CL Brg A2	19+46.1000	6.0000	9213.3431	213.3431	6.0000	90.0000	796122.9674	1554479.2421	6.0000	0 00 00.00	90.0000	-0.020000
BF Abut 2	19+47.3500	6.0000	9213.3393		6.0000	91.2500	796124.2112	1554479.1178	6.0000	0 00 00.00	91.2500	-0.020000
MiddAppr2	19+57.3500	6.0000	9213.3092		6.0000	101.2500	796134.1616	1554478.1232	6.0000	0 00 00.00	101.2500	-0.020000
EndWing2	19+62.6000	6.0000	9213.2934		6.0000	106.5000	796139.3856	1554477.6011	6.0000	0 00 00.00	106.5000	-0.020000
End Appr 2	19+67.3500	6.0000	9213.2791		6.0000	111.2500	796144.1121	1554477.1286	6.0000	0 00 00.00	111.2500	-0.020000

Ext Gir D — PARALLEL TO HORIZONTAL CONTROL — 0.250000 FEET BELOW FINISHED GRADE

BENT LINE	STATION	OFFSET	ELEVATION	ELEV+DL	X	Y	NORTHING	EASTING	BENT LNTH	SKEW	GIRDER LNTH	CRS-SLP
End Appr 1	18+34.8500	18.0000	9213.4380		18.0000	-21.2500	796013.4625	1554502.2470	18.0000	0 00 00.00	-21.2500	-0.020000
MiddAppr1	18+44.8500	18.0000	9213.4079		18.0000	-11.2500	796023.4129	1554501.2524	18.0000	0 00 00.00	-11.2500	-0.020000
BF Abut 1	18+54.8500	18.0000	9213.3778		18.0000	-1.2500	796033.3633	1554500.2579	18.0000	0 00 00.00	-1.2500	-0.020000
CL Brg A1	18+56.1000	18.0000	9213.3740	213.3740	18.0000	0.0000	796034.6071	1554500.1336	18.0000	0 00 00.00	0.0000	-0.020000
F-1	18+65.1000	18.0000	9213.3469	213.3858	18.0000	9.0000	796043.5625	1554499.2385			9.0000	-0.020000
F-2	18+74.1000	18.0000	9213.3198	213.3942	18.0000	18.0000	796052.5179	1554498.3434			18.0000	-0.020000
F-3	18+83.1000	18.0000	9213.2927	213.3953	18.0000	27.0000	796061.4732	1554497.4483			27.0000	-0.020000
F-4	18+92.1000	18.0000	9213.2656	213.3863	18.0000	36.0000	796070.4286	1554496.5532			36.0000	-0.020000
F-5	19+01.1000	18.0000	9213.2385	213.3654	18.0000	45.0000	796079.3840	1554495.6581			45.0000	-0.020000
F-6	19+10.1000	18.0000	9213.2115	213.3321	18.0000	54.0000	796088.3394	1554494.7630			54.0000	-0.020000
F-7	19+19.1000	18.0000	9213.1844	213.2869	18.0000	63.0000	796097.2947	1554493.8679			63.0000	-0.020000
F-8	19+28.1000	18.0000	9213.1573	213.2316	18.0000	72.0000	796106.2501	1554492.9728			72.0000	-0.020000
F-9	19+37.1000	18.0000	9213.1302	213.1690	18.0000	81.0000	796115.2055	1554492.0777			81.0000	-0.020000
CL Brg A2	19+46.1000	18.0000	9213.1031	213.1031	18.0000	90.0000	796124.1609	1554491.1826	18.0000	0 00 00.00	90.0000	-0.020000
BF Abut 2	19+47.3500	18.0000	9213.0993		18.0000	91.2500	796125.4047	1554491.0583	18.0000	0 00 00.00	91.2500	-0.020000
MiddAppr2	19+57.3500	18.0000	9213.0692		18.0000	101.2500	796135.3551	1554490.0637	18.0000	0 00 00.00	101.2500	-0.020000
EndWing2	19+62.6000	18.0000	9213.0534		18.0000	106.5000	796140.5791	1554489.5416	18.0000	0 00 00.00	106.5000	-0.020000
End Appr 2	19+67.3500	18.0000	9213.0391		18.0000	111.2500	796145.3055	1554489.0691	18.0000	0 00 00.00	111.2500	-0.020000

Note: Elevations are at top of concrete deck 3 Inches below Finished Grade.

Positive Roadway Cross Slope is Upwards from the Profile Grade Line.

These Stations, Coordinates, Offsets and Lengths define the layout of the structure in a two dimensional horizontal plane. Elevations define the final grade of the finished concrete deck. Fabrication of structural components through the direct use of this information is not intended or advisable.

Example 14-4

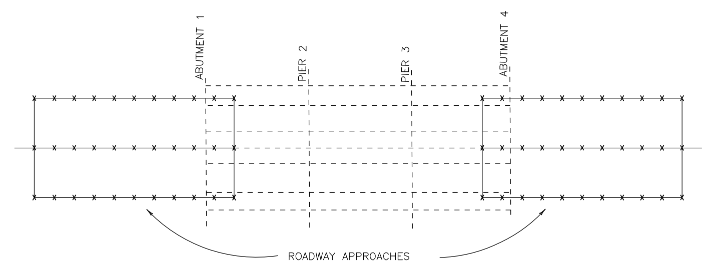
* ROADWAY APPROACHES *

STATION	OFFSET	ELEVATION	CROSS-SLOPE	STATION	OFFSET	ELEVATION	CROSS-SLOPE
33+50	-12.0000	4716.6349	-0.020000	45+00	-12.0000	4718.3851	-0.020000
33+60	-12.0000	4716.7349	-0.020000	45+10	-12.0000	4718.2851	-0.020000
33+70	-12.0000	4716.8349	-0.020000	45+20	-12.0000	4718.1851	-0.020000
33+80	-12.0000	4716.9349	-0.020000	45+30	-12.0000	4718.0851	-0.020000
33+90	-12.0000	4717.0349	-0.020000	45+40	-12.0000	4717.9851	-0.020000
34+00	-12.0000	4717.1349	-0.020000	45+50	-12.0000	4717.8851	-0.020000
34+10	-12.0000	4717.2349	-0.020000	45+60	-12.0000	4717.7851	-0.020000
34+20	-12.0000	4717.3349	-0.020000	45+70	-12.0000	4717.6851	-0.020000
34+30	-12.0000	4717.4349	-0.020000	45+80	-12.0000	4717.5851	-0.020000
34+40	-12.0000	4717.5349	-0.020000	45+90	-12.0000	4717.4851	-0.020000
34+50	-12.0000	4717.6349	-0.020000	46+00	-12.0000	4717.3851	-0.020000
34+60	-12.0000	4717.7349	-0.020000	46+10	-12.0000	4717.2851	-0.020000
34+70	-12.0000	4717.8349	-0.020000	46+20	-12.0000	4717.1851	-0.020000
34+80	-12.0000	4717.9349	-0.020000	46+30	-12.0000	4717.0851	-0.020000
34+90	-12.0000	4718.0349	-0.020000	46+40	-12.0000	4716.9851	-0.020000
35+00	-12.0000	4718.1349	-0.020000	46+50	-12.0000	4716.8851	-0.020000
33+50	0.0000	4716.8749		45+00	0.0000	4718.6251	
33+60	0.0000	4716.9749		45+10	0.0000	4718.5251	
33+70	0.0000	4717.0749		45+20	0.0000	4718.4251	
33+80	0.0000	4717.1749		45+30	0.0000	4718.3251	
33+90	0.0000	4717.2749		45+40	0.0000	4718.2251	
34+00	0.0000	4717.3749		45+50	0.0000	4718.1251	
34+10	0.0000	4717.4749		45+60	0.0000	4718.0251	
34+20	0.0000	4717.5749		45+70	0.0000	4717.9251	
34+30	0.0000	4717.6749		45+80	0.0000	4717.8251	
34+40	0.0000	4717.7749		45+90	0.0000	4717.7251	
34+50	0.0000	4717.8749		46+00	0.0000	4717.6251	
34+60	0.0000	4717.9749		46+10	0.0000	4717.5251	

34+70	0.0000	4718.0749		46+20	0.0000	4717.4251	
34+80	0.0000	4718.1749		46+30	0.0000	4717.3251	
34+90	0.0000	4718.2749		46+40	0.0000	4717.2251	
35+00	0.0000	4718.3749		46+50	0.0000	4717.1251	
33+50	12.0000	4716.6349	-0.020000	45+00	12.0000	4718.3851	-0.020000
33+60	12.0000	4716.7349	-0.020000	45+10	12.0000	4718.2851	-0.020000
33+70	12.0000	4716.8349	-0.020000	45+20	12.0000	4718.1851	-0.020000
33+80	12.0000	4716.9349	-0.020000	45+30	12.0000	4718.0851	-0.020000
33+90	12.0000	4717.0349	-0.020000	45+40	12.0000	4717.9851	-0.020000
34+00	12.0000	4717.1349	-0.020000	45+50	12.0000	4717.8851	-0.020000
34+10	12.0000	4717.2349	-0.020000	45+60	12.0000	4717.7851	-0.020000
34+20	12.0000	4717.3349	-0.020000	45+70	12.0000	4717.6851	-0.020000
34+30	12.0000	4717.4349	-0.020000	45+80	12.0000	4717.5851	-0.020000
34+40	12.0000	4717.5349	-0.020000	45+90	12.0000	4717.4851	-0.020000
34+50	12.0000	4717.6349	-0.020000	46+00	12.0000	4717.3851	-0.020000
34+60	12.0000	4717.7349	-0.020000	46+10	12.0000	4717.2851	-0.020000

* ROADWAY APPROACHES *

STATION	OFFSET	ELEVATION	CROSS-SLOPE	STATION	OFFSET	ELEVATION	CROSS-SLOPE
34+70	12.0000	4717.8349	-0.020000	46+20	12.0000	4717.1851	-0.020000
34+80	12.0000	4717.9349	-0.020000	46+30	12.0000	4717.0851	-0.020000
34+90	12.0000	4718.0349	-0.020000	46+40	12.0000	4716.9851	-0.020000
35+00	12.0000	4718.1349	-0.020000	46+50	12.0000	4716.8851	-0.020000

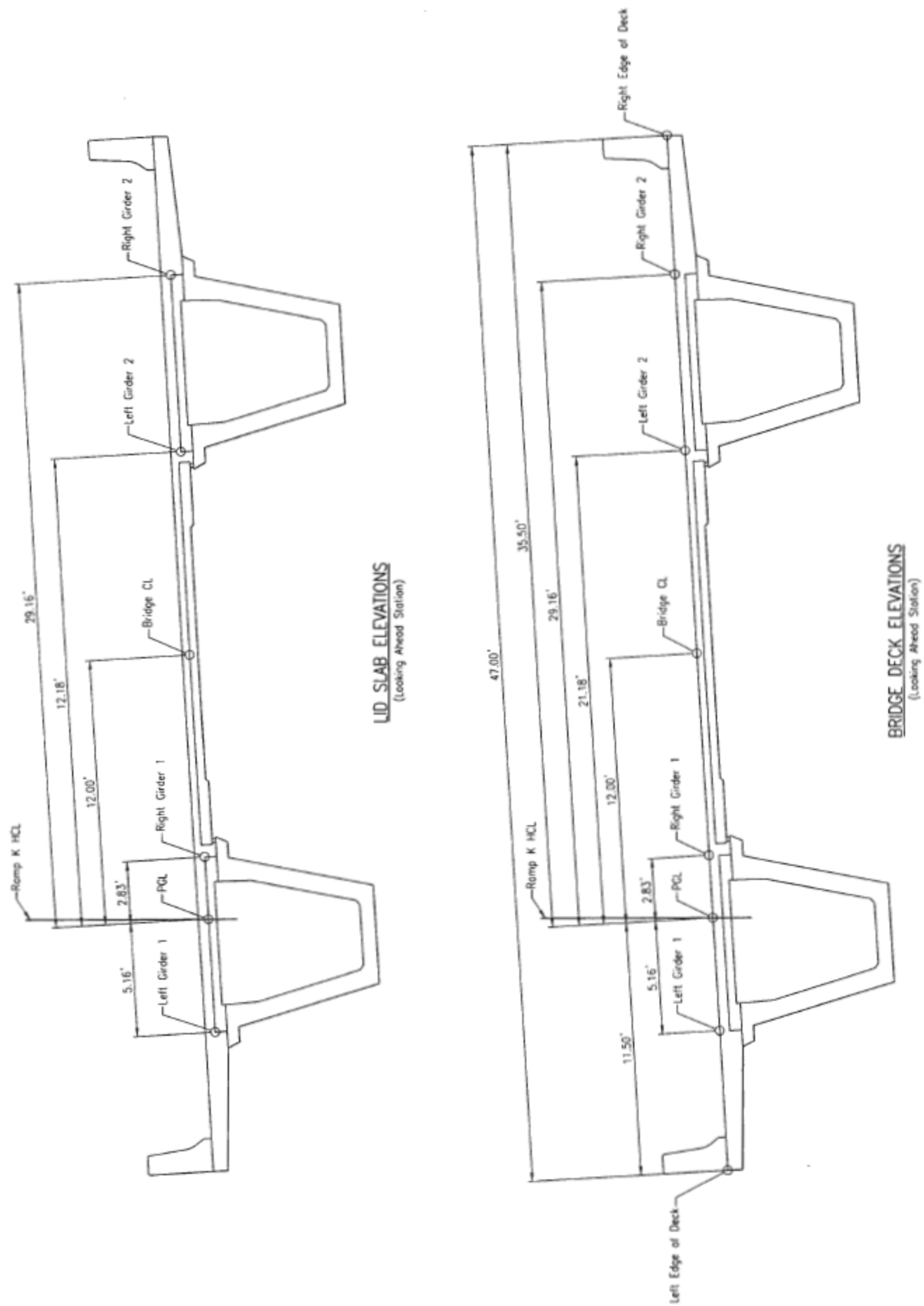


* TANGENT ALIGNMENT

* THESE DRAWINGS ARE SCHEMATICS ONLY AND DO NOT NECESSARILY REFLECT THE ACTUAL BRIDGE LAYOUT.

Note: Elevations are at Finished Grade.	Positive Roadway Cross Slope is Upwards from the Profile Grade Line.	These Stations, Coordinates, Offsets and Lengths define the layout of the structure in a two dimensional horizontal plane. Elevations define the final grade of the finished concrete deck. Fabrication of structural components through the direct use of this information is not intended or advisable.

Example 14-5



LID SLAB ELEVATIONS
(Looking Ahead Station)
Right Girder 2
Left Girder 2
Bridge CL
Right Girder 1
PGL
Left Girder 1
Ramp K HCL
29.16'
12.18'
12.00'
2.83'
5.16'
BRIDGE DECK ELEVATIONS
(Looking Ahead Station)
Right Edge of Deck
Left Edge of Deck
47.00'
35.50'
29.16'
21.18'
12.00'
11.50'

Example 14-6

15.1.1 Purpose

These drawings are to graphically present all pertinent information necessary for the construction of walls as well as depict constructability and ROW issues. Some of these wall types include:

A) Cast-in-Place (CIP)
B) Mechanically Stabilized Earth (MSE)
C) Soil Nail
D) Caisson
E) Sound Barrier
F) Other types – Sheet Pile, Gabion, gravity, semi-gravity, etc.

Close cooperation with the Roadway design group is essential for proper layout of the walls. The Wall Layout is an iterative process between the Roadway and Bridge groups. Preliminary layout from Roadway is used to begin the wall design which determines excavation limits and other critical items. These items can then be used by Roadway to revise the layout as necessary based on recommendations and input from the Bridge group. The following figure depicts a possible constructability issue between an off-ramp wall and the adjacent County Road. By depicting the excavation limits and other items in the drawings, constructability issues can be identified and resolved early in the design process. Costly construction issues and field revisions can thereby be avoided.

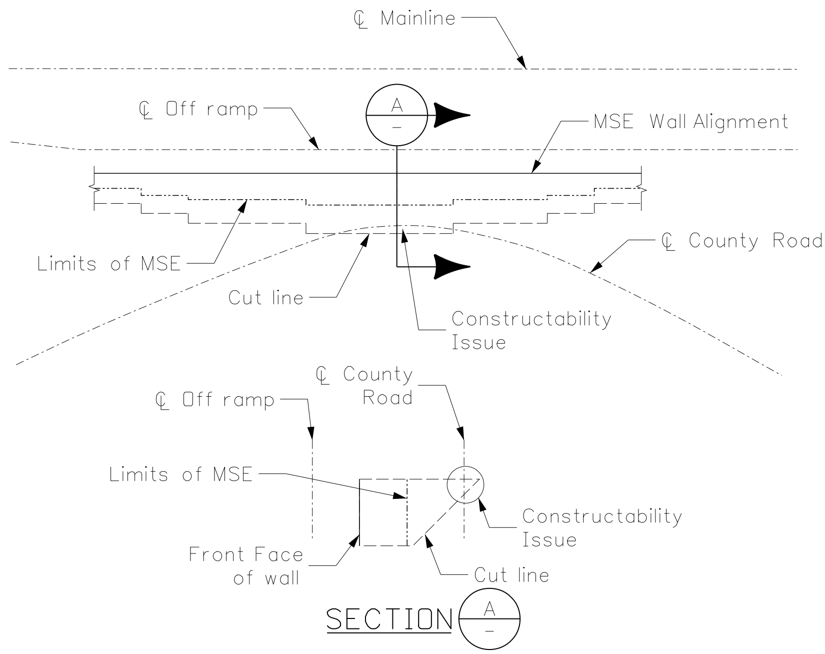


Fig. 15.1.1-1 Wall Conflict Example

15.1.2 Responsibility

These drawings shall be prepared and checked in the Design Unit. The graphical presentation of information on these drawings shall be the responsibility of the individual preparing the drawings.

15.1.3 Scales

Standard Architectural and Civil scales shall be used that are suitable to make the details legible on a standard sheet.

15.1.4 Orientation of Details

The PLAN of the wall shall be placed, if possible, at the upper left of the sheet with the layout line parallel to the border. The ELEVATION of the wall shall be projected below the PLAN when possible. Elevations should include vertical scales. The PLAN and ELEVATION shall be oriented so the front face of the wall will be shown in the ELEVATION whether the resulting stationing is shown increasing or decreasing on the sheet. Sections shall be placed to the right of the PLAN and ELEVATION. If space is limited, the sections or additional details may be shown on another sheet. Generally, sections should be taken from the PLAN and ELEVATION rather than from secondary views or other sections.

15.1.5 Control

The horizontal control line (HCL) for the wall shall be identified including all angle points, intersection angles, etc. Whether the wall is top controlled or bottom controlled shall be made clear. The wall layout can be controlled using its own horizontal control line, by using stations and offset from the mainline HCL or by using coordinates. The vertical control should be depicted in the elevation views. If the vertical control is based on the roadway vertical profile, reference elevations should be included in the elevation views for aiding construction as well as quantity calculations.

15.1.6 Dimensions

A sufficient number of dimensions and elevations shall be shown on the details to provide adequate information necessary in the checking of the plans and the construction and/or design of the wall. Quantities should be able to be verified based on plan dimensions. Length and location of wall steps should account for wall panel length and staggers as well as assumed corner dimensions.

15.1.7 Worksheets

The use of the Bridge Worksheets is encouraged, but the designer shall verify the dimensions and applicability of the worksheet for the required application.

15.1.8 Check Items for All Wall Types

Listed below is a summary of items that shall be checked and appear on the drawing for all wall types as applicable. See specific wall types in sections 15.1.9 through 15.1.14 for additional information as required. Wall drawings should show sufficient information in order to check shop drawing information provided by the Contractor. Additional information shall be shown as required for the project as well as for the individual wall type.

CHECK ITEMS

A) Identify Horizontal Control Line.
B) Identify Vertical Control Line or information.
C) Identify concrete coating (color) limits and/or rustications.
D) Identify limits of concrete sealer.
E) Delineate approximate construction or excavation limits.
F) Show assumed wall steps in elevation view. Length and location of wall steps should account for assumed wall panel or block length and staggers as well as assumed corner dimensions.

G) Show weep hole/drain hole locations in elevation views.
H) Show surface drainage plan to avoid water coming over the wall.
I) Locate interferences or special details such as light supports.
J) Depict and show interferences for wall in elevation views such as drains, abutments.
K) Provide isometric views for difficult intersections such as at abutments or angle points as required to clarify the areas.
L) Show all known utilities and utility crossings.
M) Show utility details of conduits entering/exiting walls.
N) Show locations of changes in typical section.
O) Show proposed grade at front face of wall and top of wall as applicable.
P) Show existing grade at front face of wall and indicate if other than front face.
Q) Show bedrock or soil information which affect wall design.
R) If walls are not associated with a bridge plan set, the name and direction of the nearest town shall be provided at the beginning and end of the wall.
S) Show finished contour lines when they are available.
T) Show standard North Arrow
U) Show type of slope protection above and/or below the wall as applicable.
V) Show direction and rate of fill or cut slopes. Show approximate location of toe and top of slopes.
W) Show existing and proposed structures, label with structure number, and note if the existing structure is to be removed.
X) Provide matchlines for walls which extend to multiple sheets. Matchlines should be placed to avoid critical section changes or alignment changes in the wall.
Y) Show ROW limits if available.
Z) Provide Design information and constraints, e.g. Ground Water levels, allowable bearing capacity, allowable differential settlement, fill material properties, allowable long-term wall settlement, tolerance on vertical and horizontal position of the wall control line.

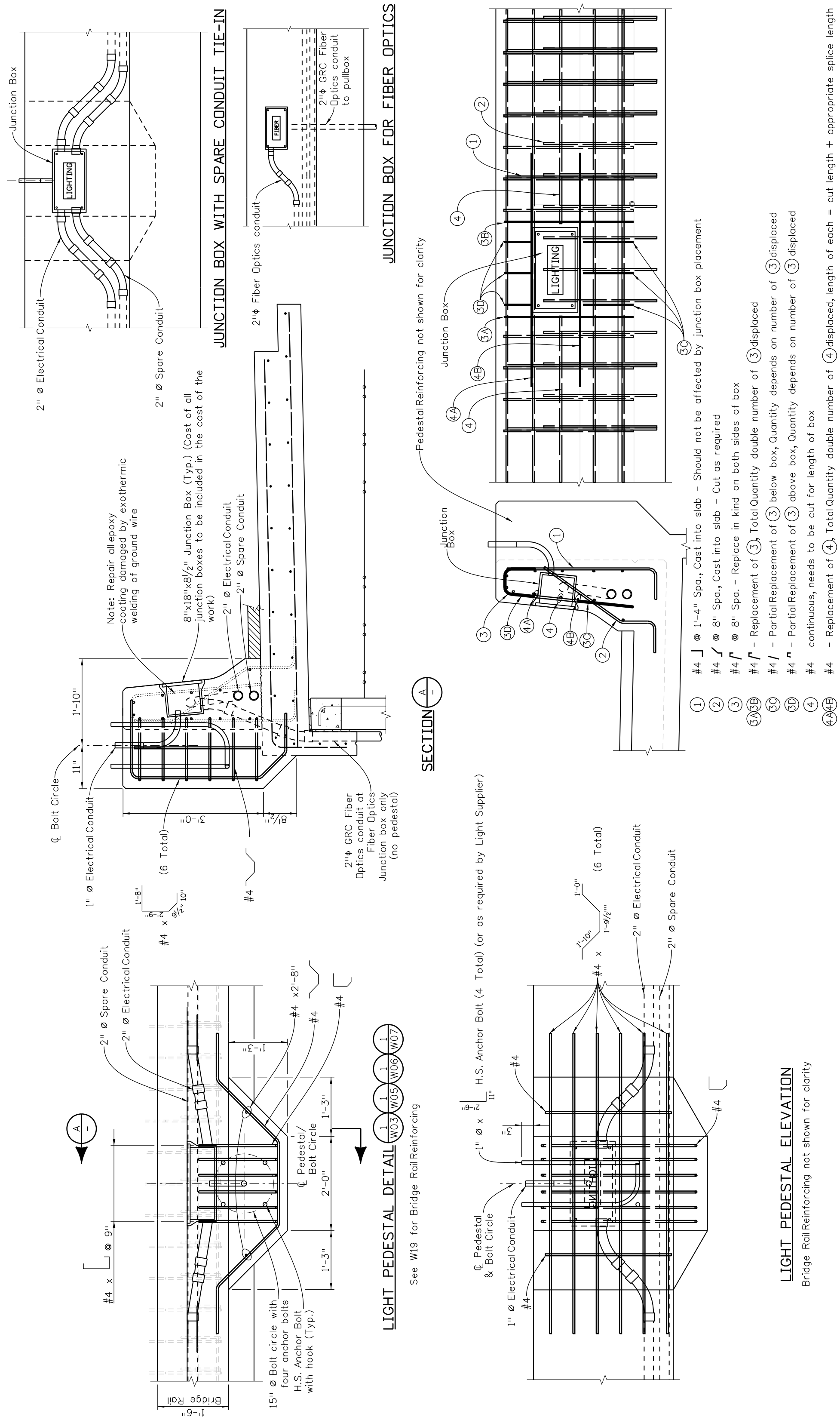


Fig. 15.1.8-1 Light Pedestal Example

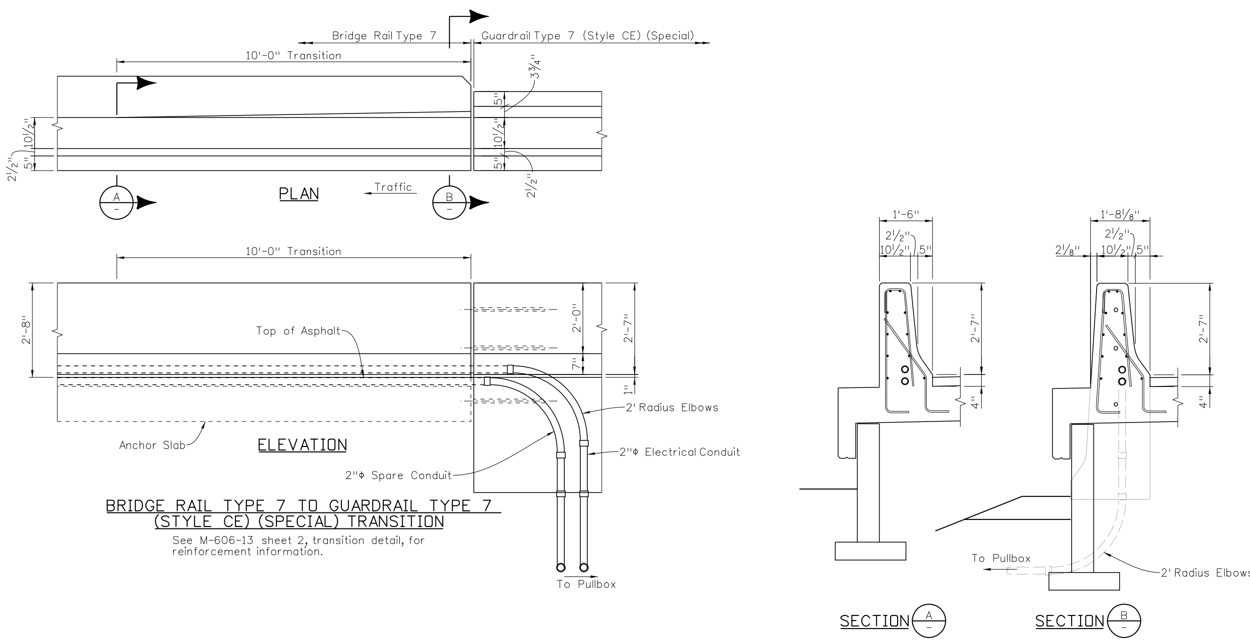


Fig. 15.1.8-2 Conduit Detail Example

15.1.9 Cast-In-Place Wall Examples & Check Items

Listed below is a summary of items that shall be checked and appear on the drawing in addition to the General Items listed in Section 15.1.8. Additional information shall appear, as required. The wall examples shown here are a guide only; each wall shall be evaluated for applicability of examples and worksheets on a case by case basis.

CHECK ITEMS

A) Layout and depict weakened plane and expansion joints in elevation views.

B) Show Footer layouts.

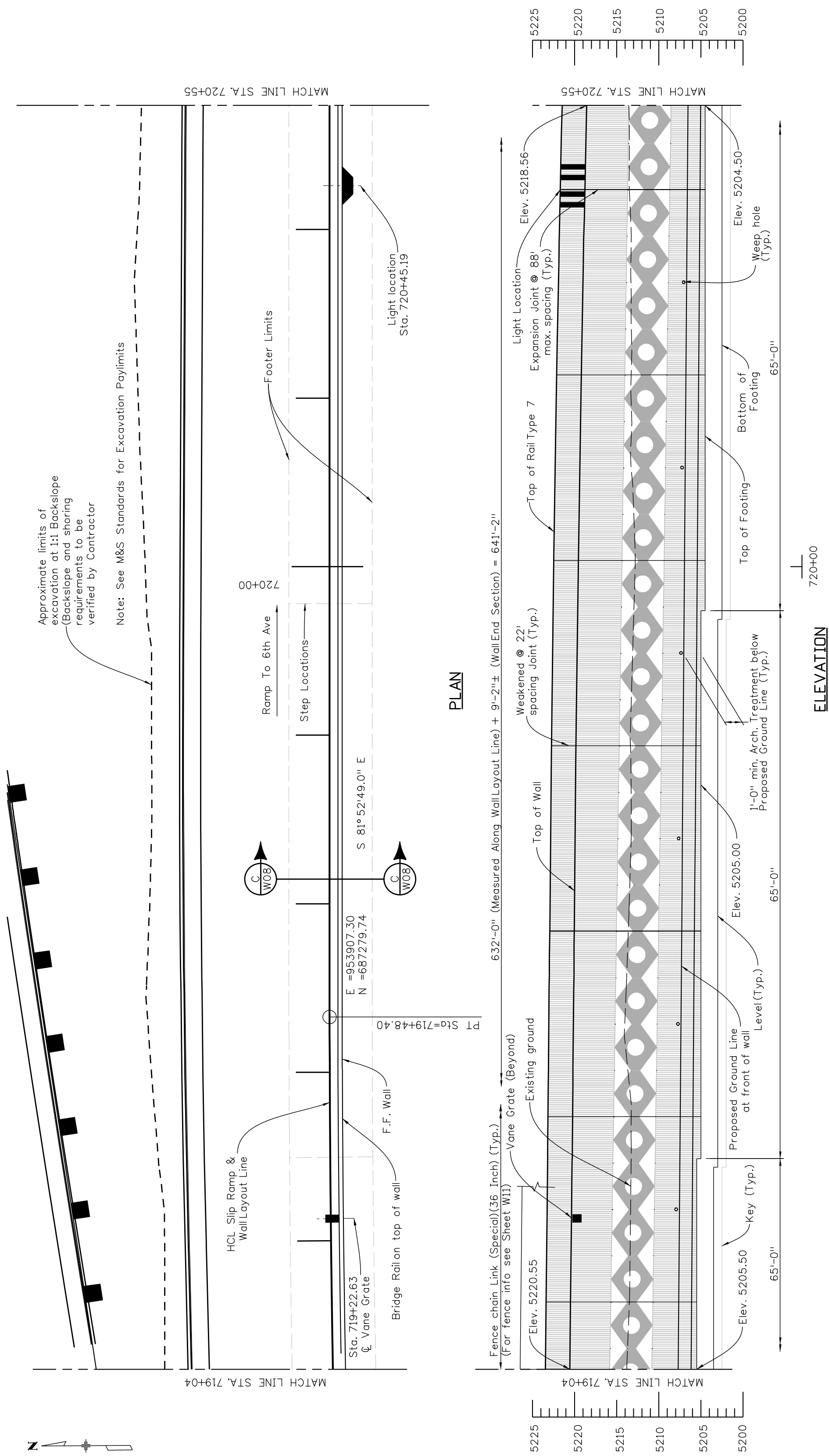
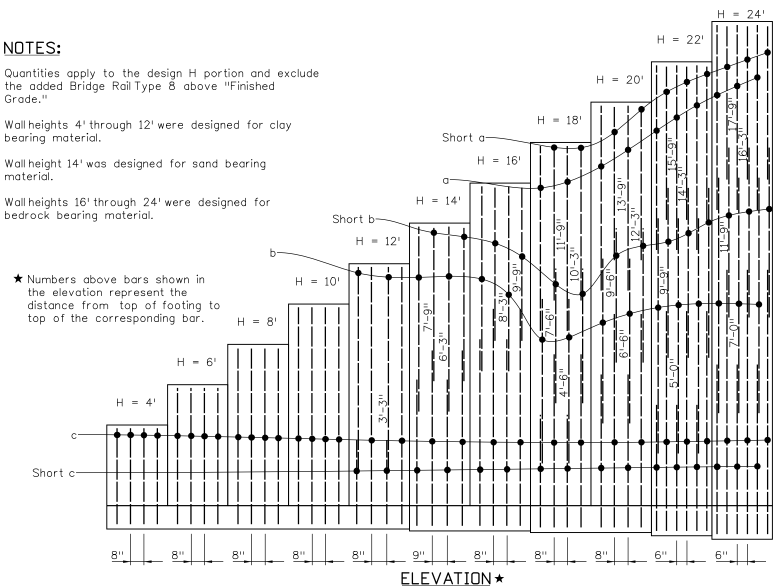


Fig. 15.1.9-1 Cast In Place Example



NOTES:

Quantities apply to the design H portion and exclude the added Bridge Rail Type 8 above "Finished Grade."

Wall heights 4' through 12' were designed for clay bearing material.

Wall height 14' was designed for sand bearing material.

Wall heights 16' through 24' were designed for bedrock bearing material.

★ Numbers above bars shown in the elevation represent the distance from top of footing to top of the corresponding bar.

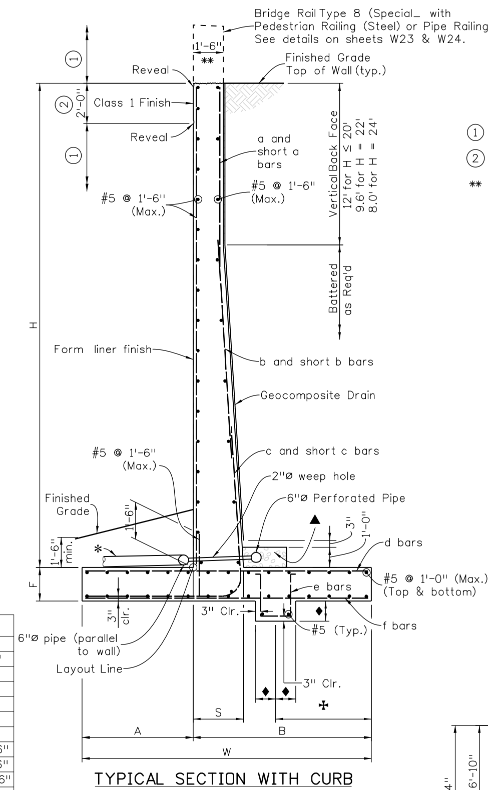
TABLE OF REINFORCING STEEL DIMENSIONS AND DATA

	H	4' ⑤	6' ⑤	8'	10'	12'	14'	16'	18'	20'	22'	24'
	W	3'-9"	5'-9"	8'-0"	11'-6"	14'-3"	9'-3"	9'-4"	10'-4"	11'-8"	13'-0"	14'-4"
	A	1'-0"	1'-9"	3'-0"	7'-0"	10'-6"	2'-8"	3'-0"	3'-6"	4'-2"	4'-10"	5'-6"
	B	2'-9"	4'-0"	5'-0"	4'-6"	3'-9"	6'-7"	6'-4"	6'-10"	7'-6"	8'-2"	8'-10"
	F	1'-0"	1'-0"	1'-2"	1'-2"	1'-4"	1'-4"	1'-4"	1'-4"	1'-7"	1'-9"	2'-0"
	S	1'-6"	1'-6"	1'-6"	1'-6"	1'-6"	1'-7"	1'-8"	1'-9"	1'-10½"	2'-2"	2'-6"
	Batter	-	-	-	-	-	½:12	½:12	½:12	½:12	⅝:12	¾:12
	a bars	-	-	-	-	-	-	-	#5 @ 8"	#5 @ 8"	#5 @ 6"	#5 @ 6"
	b bars	-	-	-	-	#5 @ 16"	#5 @ 9"	#5 @ 8"	#6 @ 8"	#6 @ 8"	#6 @ 6"	#6 @ 6"
	c bars	#5 @ 8"	#5 @ 8"	#5 @ 8"	#5 @ 8"	#7 @ 8"	#7 @ 9"	#8 @ 8"	#9 @ 8"	#10 @ 8"	#10 @ 6"	#10 @ 6"
	d bars	#5 @ 8"	#5 @ 8"	#5 @ 8"	#5 @ 8"	#7 @ 8"	#6 @ 9"	#7 @ 8"	#8 @ 8"	#9 @ 8"	#9 @ 6"	#9 @ 6"
	e bars	#4 @ 12"	#4 @ 12"	#5 @ 12"	#5 @ 8"	#6 @ 8"	#5 @ 12"	#5 @ 12"	#5 @ 12"	#5 @ 12"	#5 @ 6"	#5 @ 6"
	f bars	#5 @ 8"	#5 @ 8"	#5 @ 8"	#5 @ 8"	#7 @ 8"	#7 @ 9"	#7 @ 8"	#9 @ 8"	#9 @ 8"	#9 @ 6"	#9 @ 6"
③	Stem Bars	8	10	14	16	18	22	24	26	30	32	34
	Factored Toe Press	1.52	1.52	1.56	1.59	1.54	3.21	5.22	5.55	5.75	5.91	6.15
④	Steel lb/ft	41.3	55.1	75.68	104.65	186.18	121.13	161.28	203.00	265.12	365.28	409.42
④	Conc. CY/ft	.394	.579	.823	1.086	1.403	1.312	1.436	1.612	1.925	2.292	2.765

③ Total number of longitudinal #5 bars in stem.

④ These quantities do not include additional concrete and reinforcing at footing steps. See W25 for details.

⑤ Wall hieght not designed for collision.



♦ 8" for H ≤ 10'
1'-0" for H ≥ 12'

✠ W/4 for H ≤ 10'
W/3 for H ≥ 12'

* Outlet wall drainage into roadway edge drain at low points and at 200' maximum spacing. See Roadway typical sections. To be included in the work.

▲ 1.0 CF Filter Material (Class B) wrapped in Geotextile (Drainage)(Class 1). 2"Ø weep holes at 20' intervals (22' max.) shall be connected to 6"Ø perforated pipe. To be included in the work.

① Color 16307 Machinery Gray

② Color 23420 Khaki

** Does not include form liner thickness

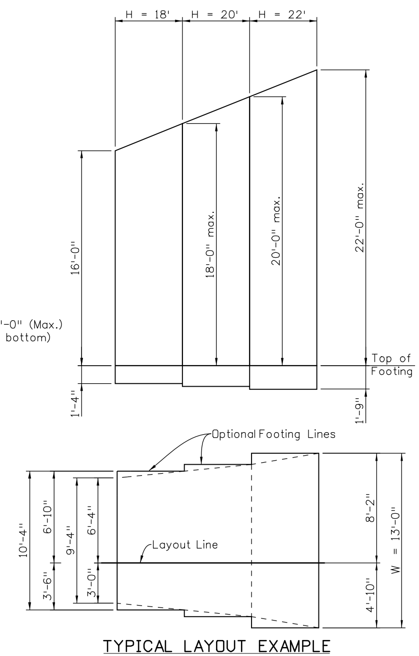


Fig. 15.1.9-2 Cast In Place Example

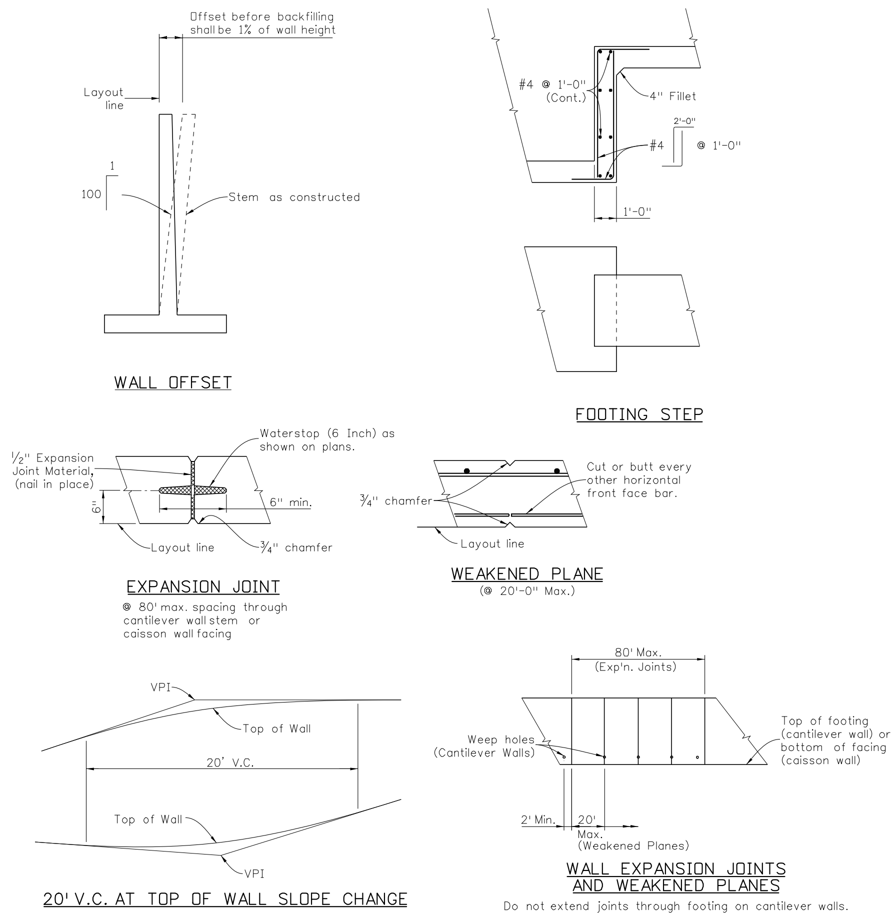


Fig. 15.1.9-3 Cast In Place Details

15.1.10 MSE Wall Examples & Check Items

Listed below is a summary of items that shall be checked and appear on the drawing in addition to the General Items listed in Section 15.1.8. Additional information may appear as necessary to fully depict required work. The wall examples shown here are a guide only; each wall shall be evaluated for applicability of examples and worksheets on a case by case basis.

<u>Check Items</u>

A) Delineate approximate limits of MSE area (strap lengths) in the plan view.

B) Define top of block or panel height at 20' intervals (max.) or define using curve or vertical profile. Elevations shown on the elevation are preferred, but the elevation information may be presented in table form as well.

C) Show assumed/conceptual plan for water collector system and wall outlets.

D) Depict and show interferences for wall straps in elevation views such as drains and abutments.

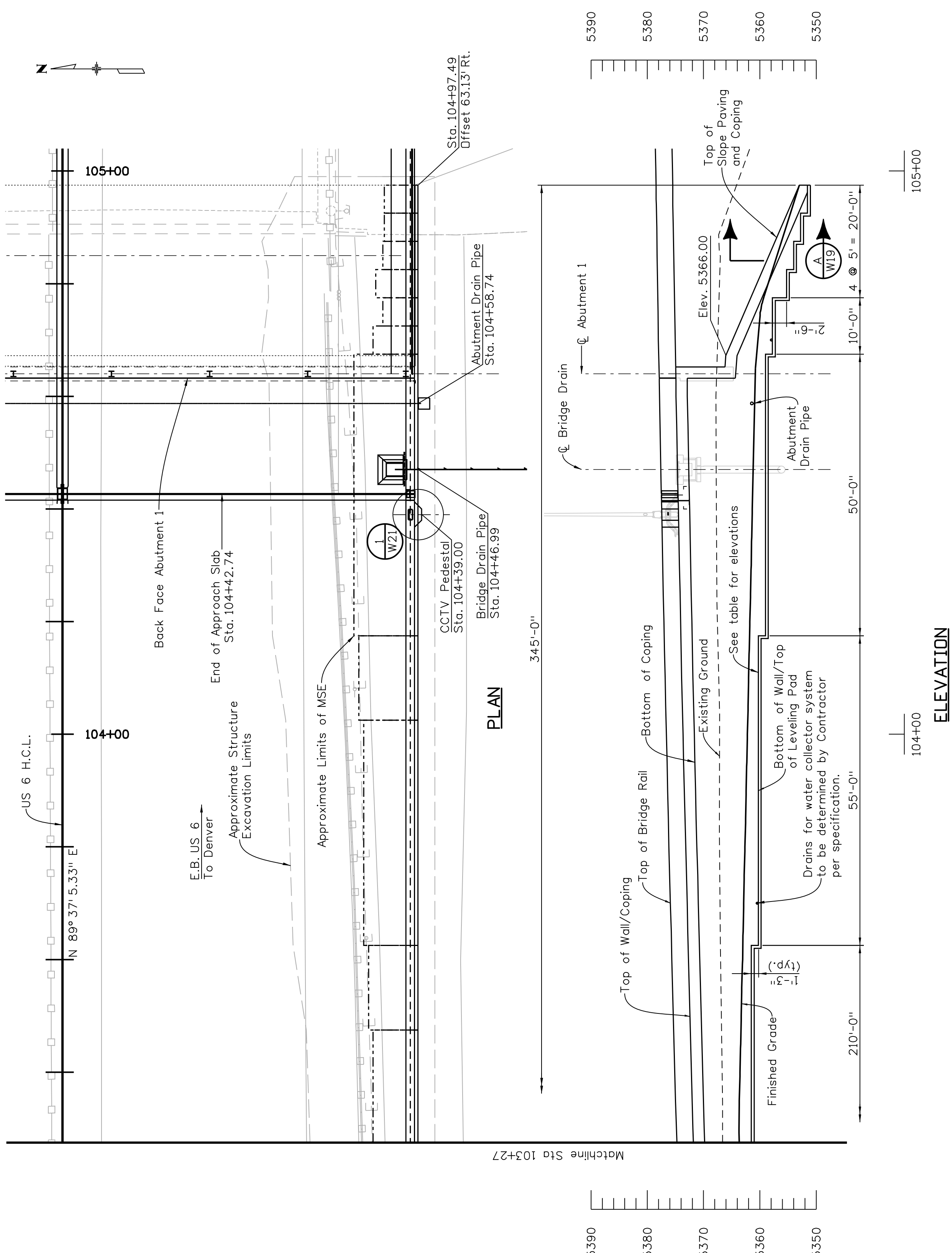


Fig. 15.1.10-1 MSE Wall Example 1

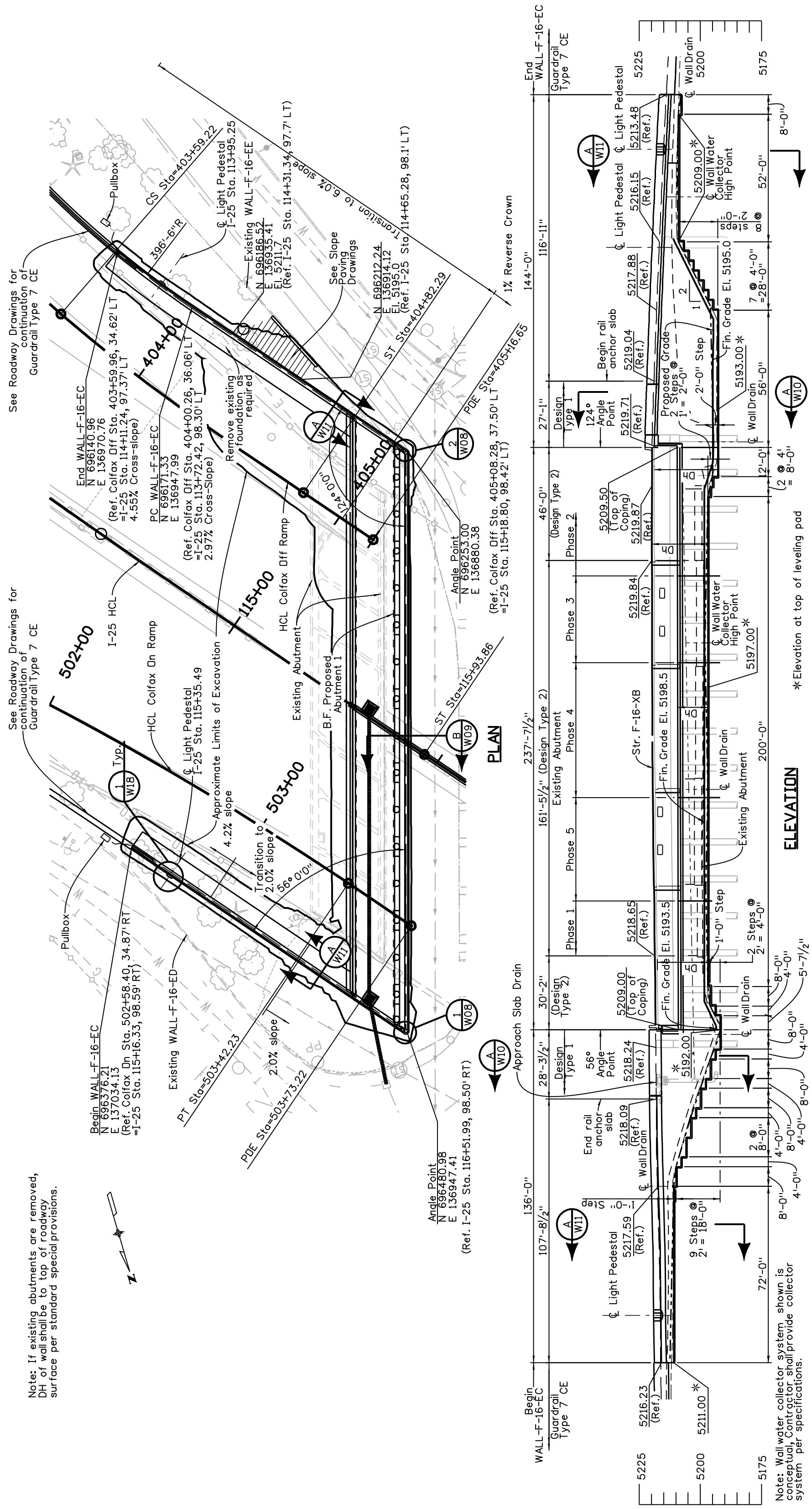


Fig. 15.1.10-2 MSE Wall Example 2

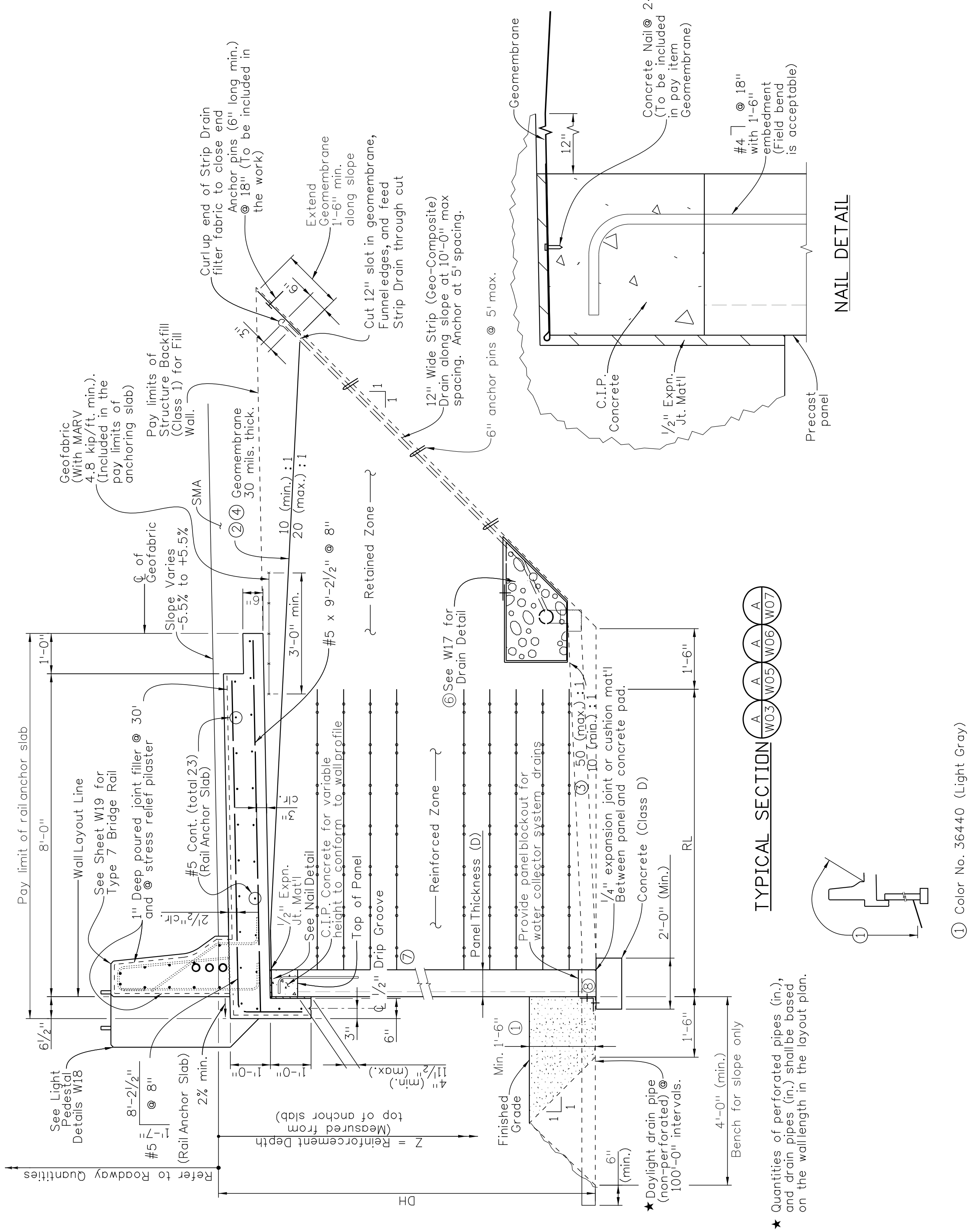


Fig. 15.1.10-3 MSE Wall Section Example

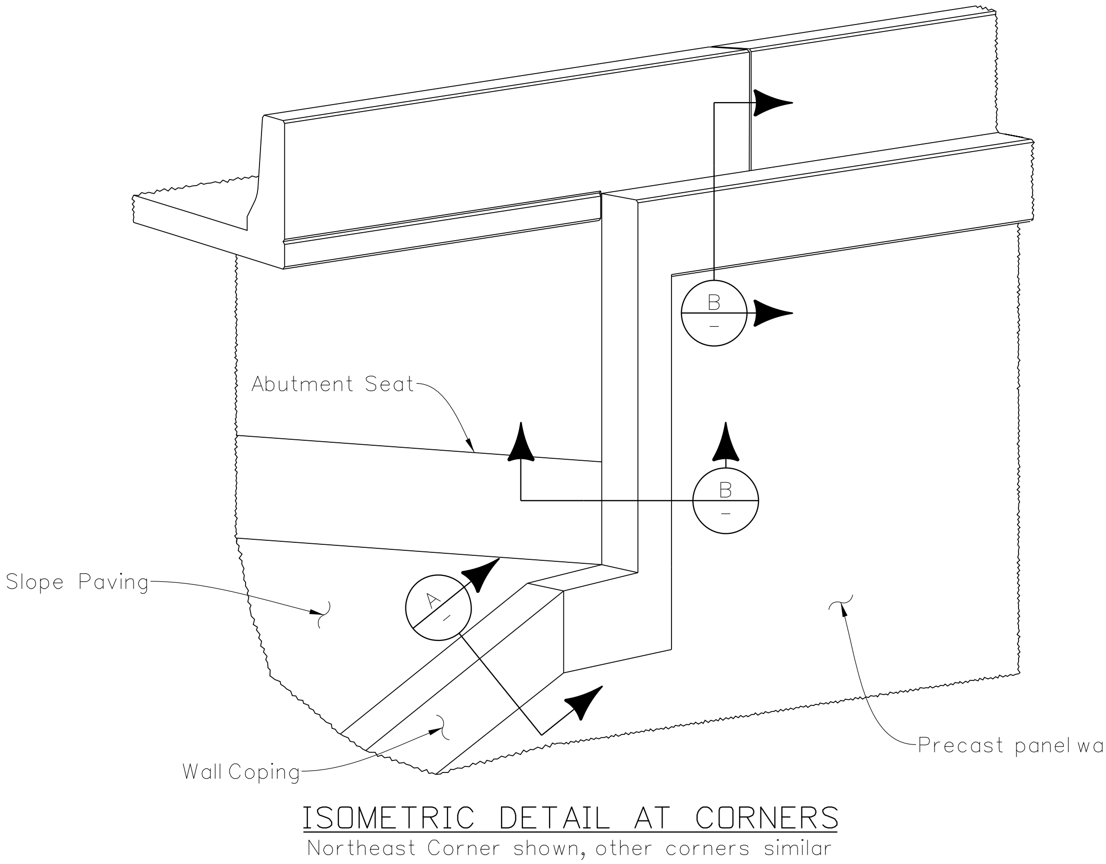


Fig. 15.1.10-4 Additional Detail Example

15.1.11 Soil Nail Wall Examples & Check Items

Listed below is a summary of items that shall be checked and appear on the drawing in addition to the General Items listed in Section 15.1.8. Additional information may appear as necessary to fully depict required work. The wall examples shown here are a guide only; each wall shall be evaluated for applicability of examples and worksheets on a case by case basis.

CHECK ITEMS

A) Define spacing (vertical and horizontal), size and length of soil nails.
B) Depict limits of nails in plan view.
C) Locate interferences for soil nails.
D) Check overhead clearance or limitations for soil nail equipment.
E) Show test nail, proof nail and verification nail locations.
F) Verify soil nail angle is provided.
G) Show special conflict details as necessary.
H) Provide design criteria such as bond strength.

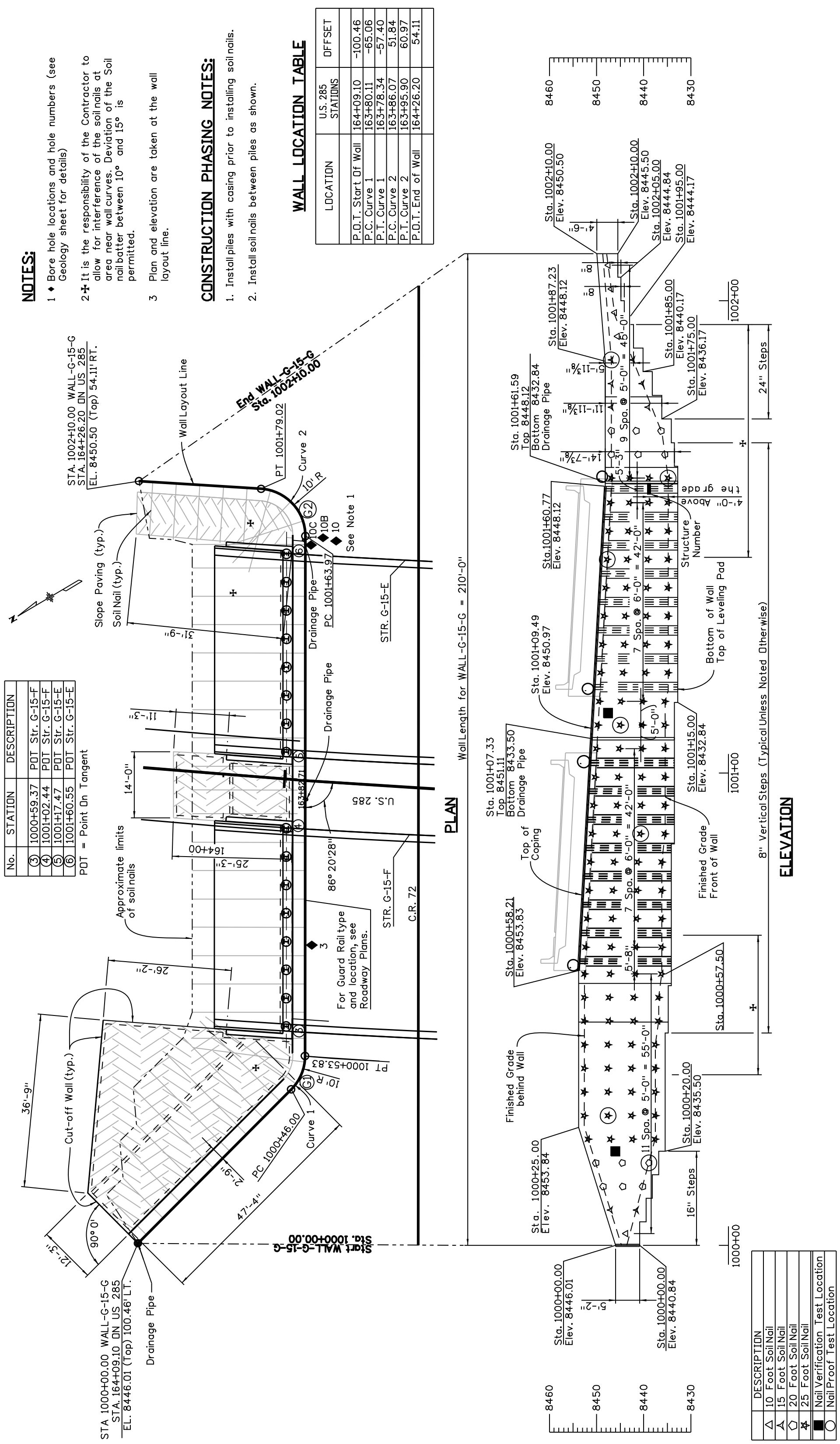


Fig. 15.1.11-1 Soil Nail Wall Example

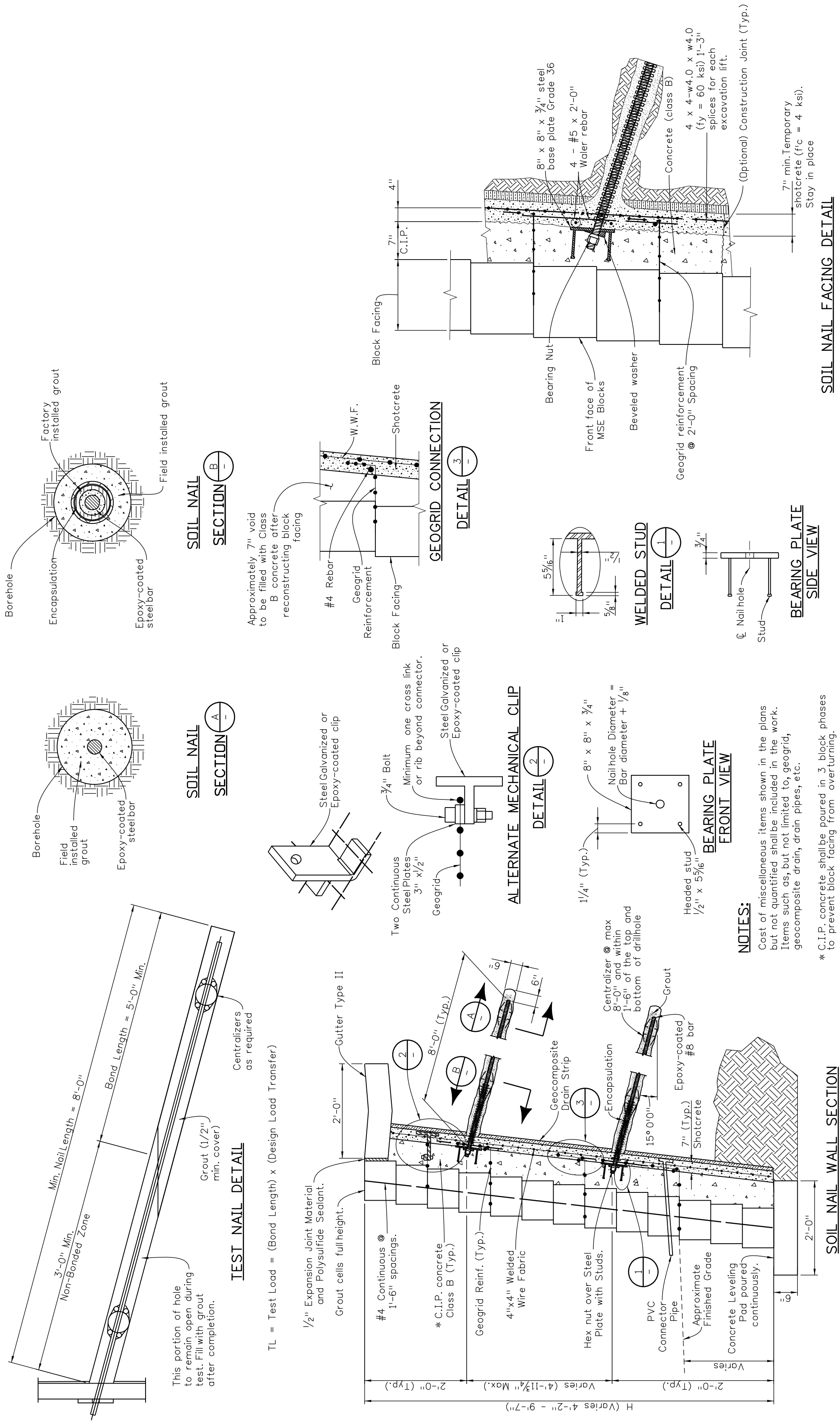


Fig. 15.1.11-2 Soil Nail Details Example

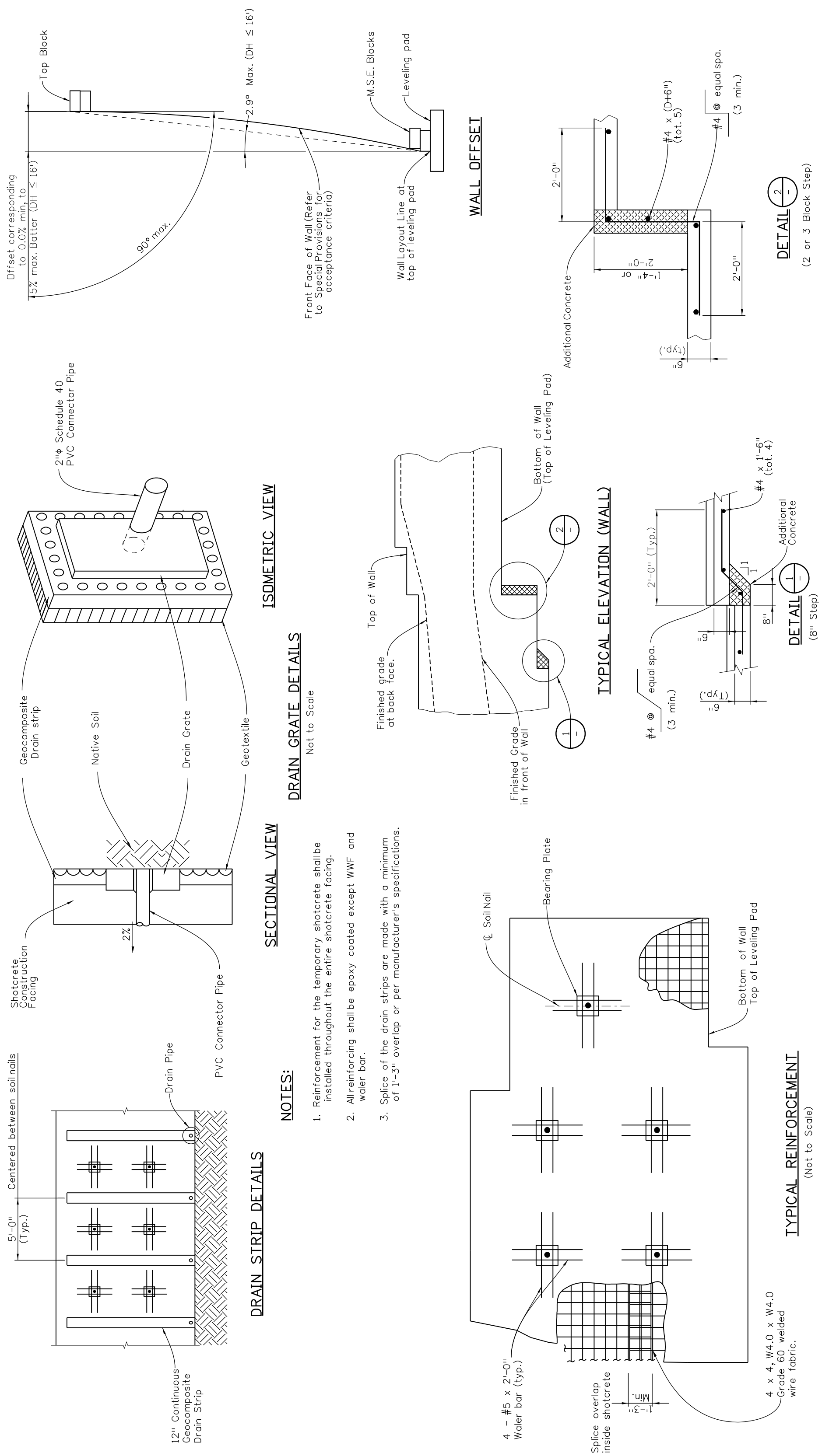


Fig. 15.1.11-3 Soil Nail Details Example 2

15.1.12 Caisson Wall Examples & Check Items

Listed below is a summary of items that shall be checked and appear on the drawing in addition to the General Items listed in Section 15.1.8. Additional information shall appear, as required. The wall examples shown here are a guide only; each wall shall be evaluated for applicability of examples and worksheets on a case by case basis

CHECK ITEMS

A) Provide Facing wall connections.
B) Provide “In-between” caisson details.
C) Include Drilling/placement notes for secant caissons.

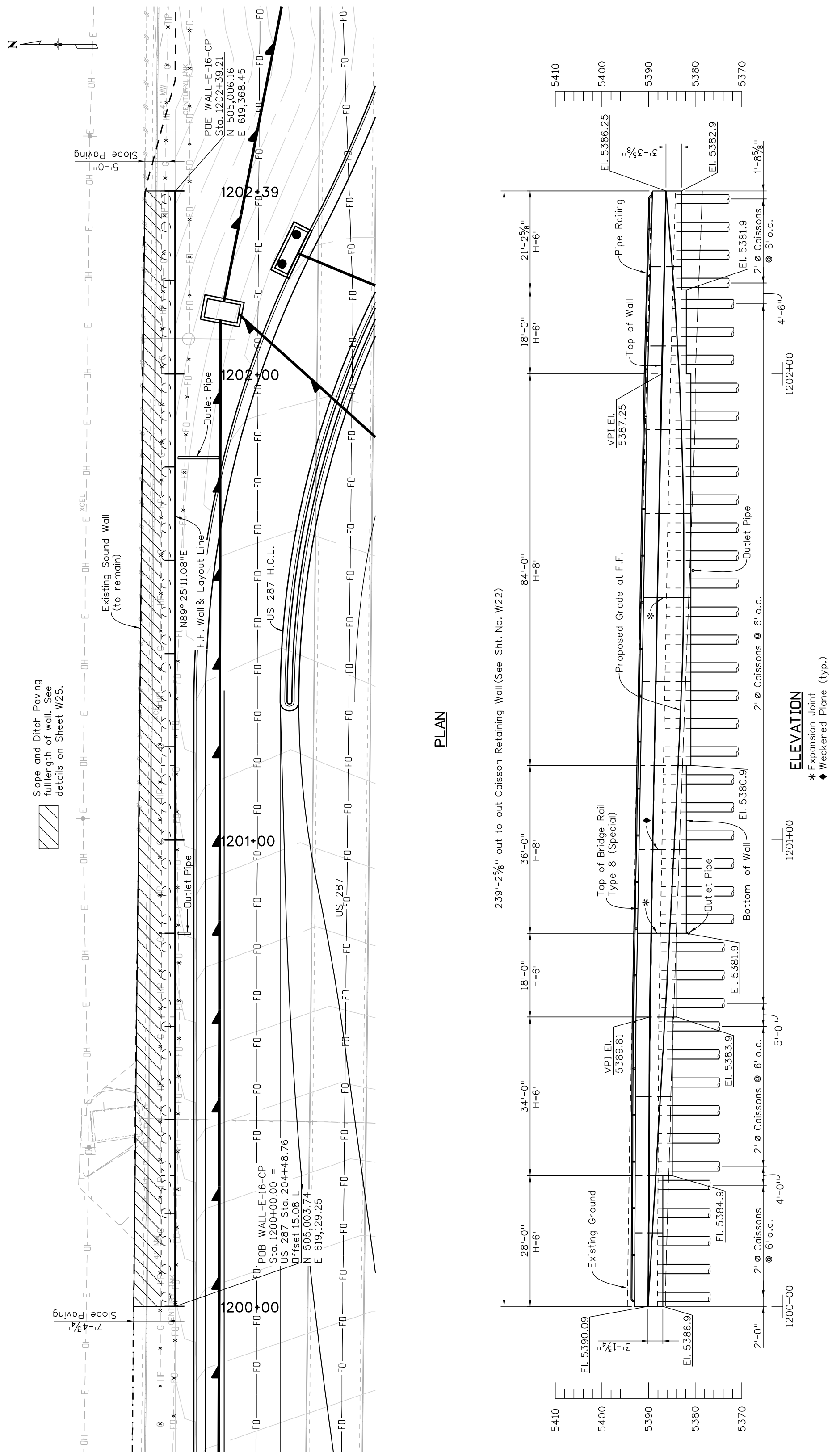
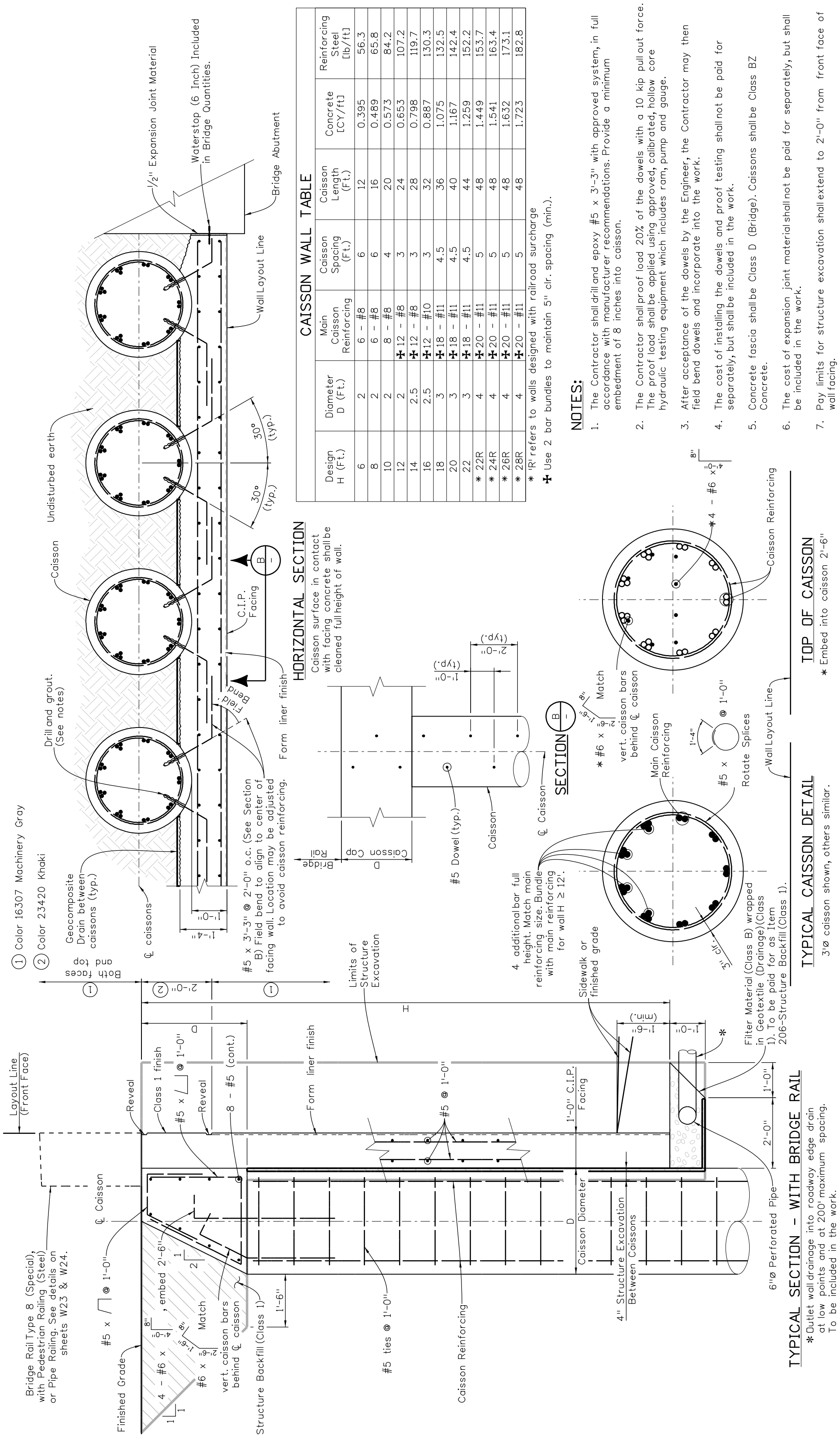


Fig.15.1.12-1 Caisson Wall Layout Example



Design H (Ft.)	Diameter D (Ft.)	Main Caisson Reinforcing	Caisson Spacing (Ft.)	Caisson Length (Ft.)	Concrete [CY/ft]	Reinforcing Steel [lb/ft]
6	2	6 - #8	6	12	0.395	56.3
8	2	6 - #8	6	16	0.489	65.8
10	2	8 - #8	4	20	0.573	84.2
12	2	✚ 12 - #8	3	24	0.653	107.2
14	2.5	✚ 12 - #8	3	28	0.798	119.7
16	2.5	✚ 12 - #10	3	32	0.887	130.3
18	3	✚ 18 - #11	4.5	36	1.075	132.5
20	3	✚ 18 - #11	4.5	40	1.167	142.4
22	3	✚ 18 - #11	4.5	44	1.259	152.2
* 22R	4	✚ 20 - #11	5	48	1.449	153.7
* 24R	4	✚ 20 - #11	5	48	1.541	163.4
* 26R	4	✚ 20 - #11	5	48	1.632	173.1
* 28R	4	✚ 20 - #11	5	48	1.723	182.8

CAISSON WALL TABLE

* 'R' refers to walls designed with railroad surcharge
✚ Use 2 bar bundles to maintain 5" clr. spacing (min.).

NOTES:

1. The Contractor shall drill and epoxy #5 x 3'-3" with approved system, in full accordance with manufacturer recommendations. Provide a minimum embedment of 8 inches into caisson.
2. The Contractor shall proof load 20% of the dowels with a 10 kip pull out force. The proof load shall be applied using approved, calibrated, hollow core hydraulic testing equipment which includes ram, pump and gauge.
3. After acceptance of the dowels by the Engineer, the Contractor may then field bend dowels and incorporate into the work.
4. The cost of installing the dowels and proof testing shall not be paid for separately, but shall be included in the work.
5. Concrete fascia shall be Class D (Bridge). Caissons shall be Class BZ Concrete.
6. The cost of expansion joint material shall not be paid for separately, but shall be included in the work.
7. Pay limits for structure excavation shall extend to 2'-0" from front face of wall facing.

Fig.15.1.12-2 Caisson Wall Section Example

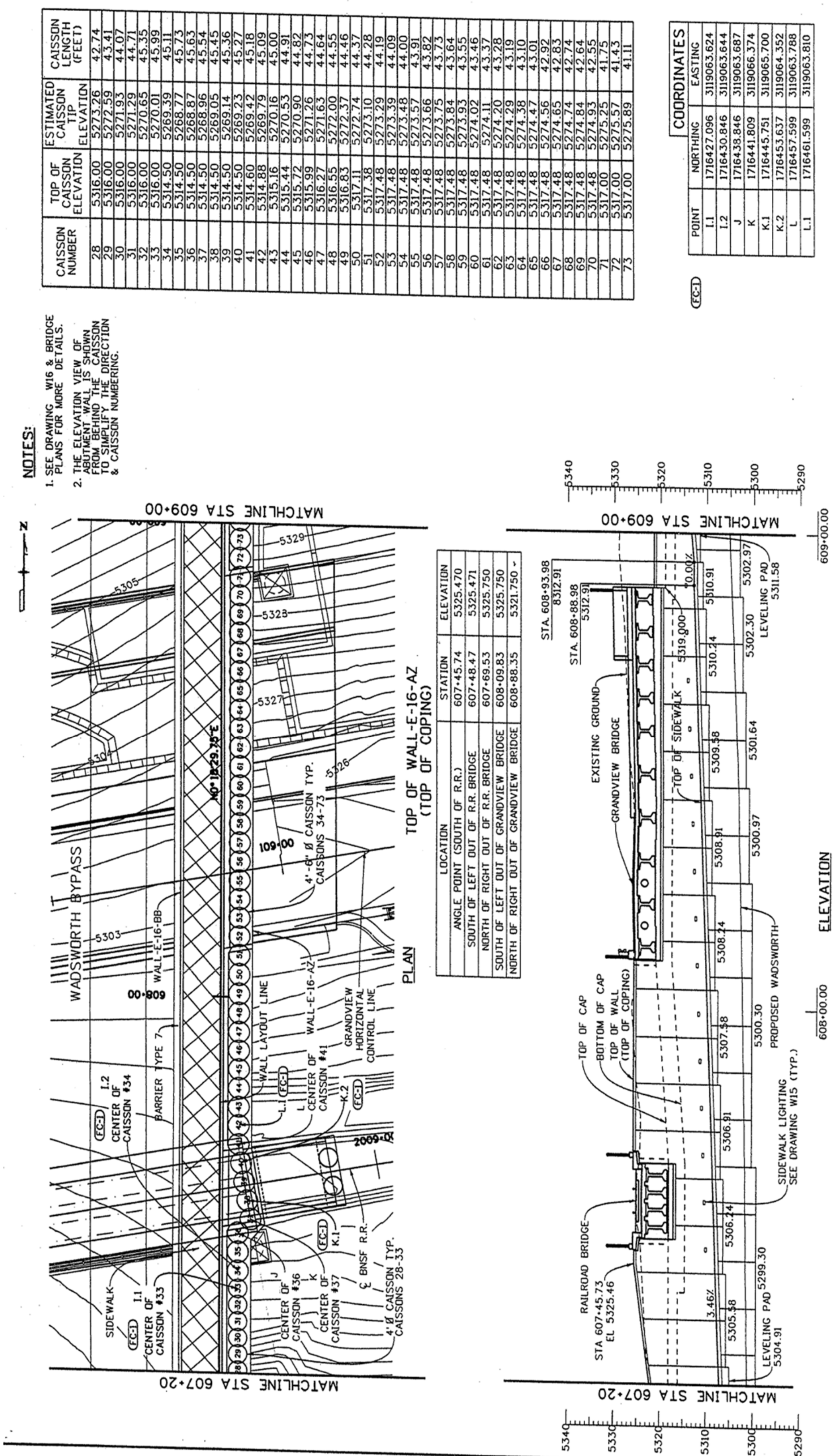


Fig. 15.1.12-3 Secant Caisson Wall Example

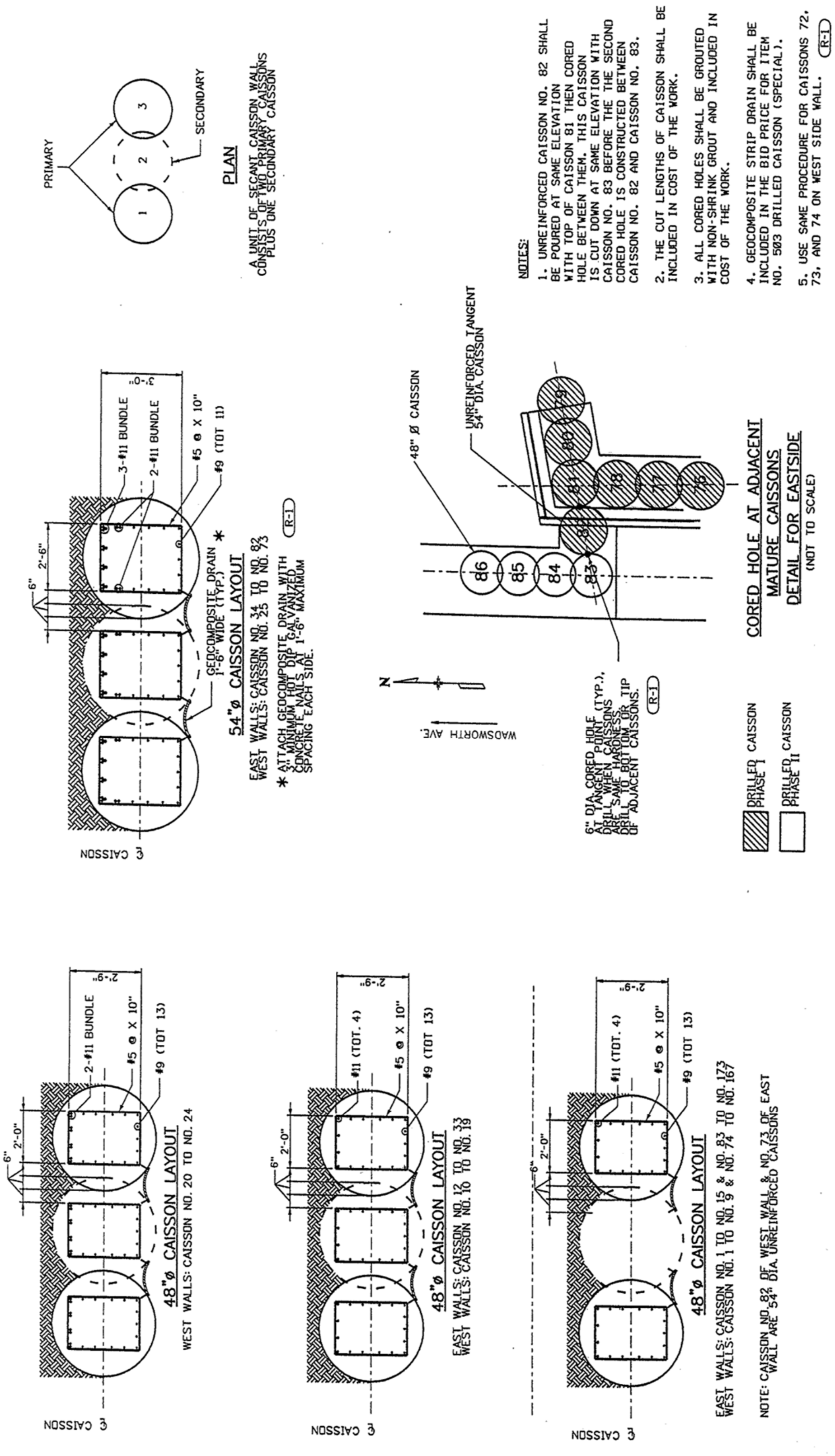


Fig. 15.1.12-4 Secant Caisson Wall Details Example

15.1.13 Sound Barrier Examples & Check Items

Listed below is a summary of items that shall be checked and appear on the drawing in addition to the General Items listed in Section 15.1.8. Additional information may appear as necessary to fully depict required work. The wall examples shown here are a guide only; each wall shall be evaluated for applicability of examples and worksheets on a case by case basis.

CHECK ITEMS

A) Identify wall material.
B) Provide access panel details and locations.
C) Provide caisson/piling spacing details based on wall panel lengths.
D) Provide cornering details as required.
E) Provide noise reduction requirements.
F) Provide height of panel from driving surface.
G) Verify width of supporting barrier for anchor suitability.

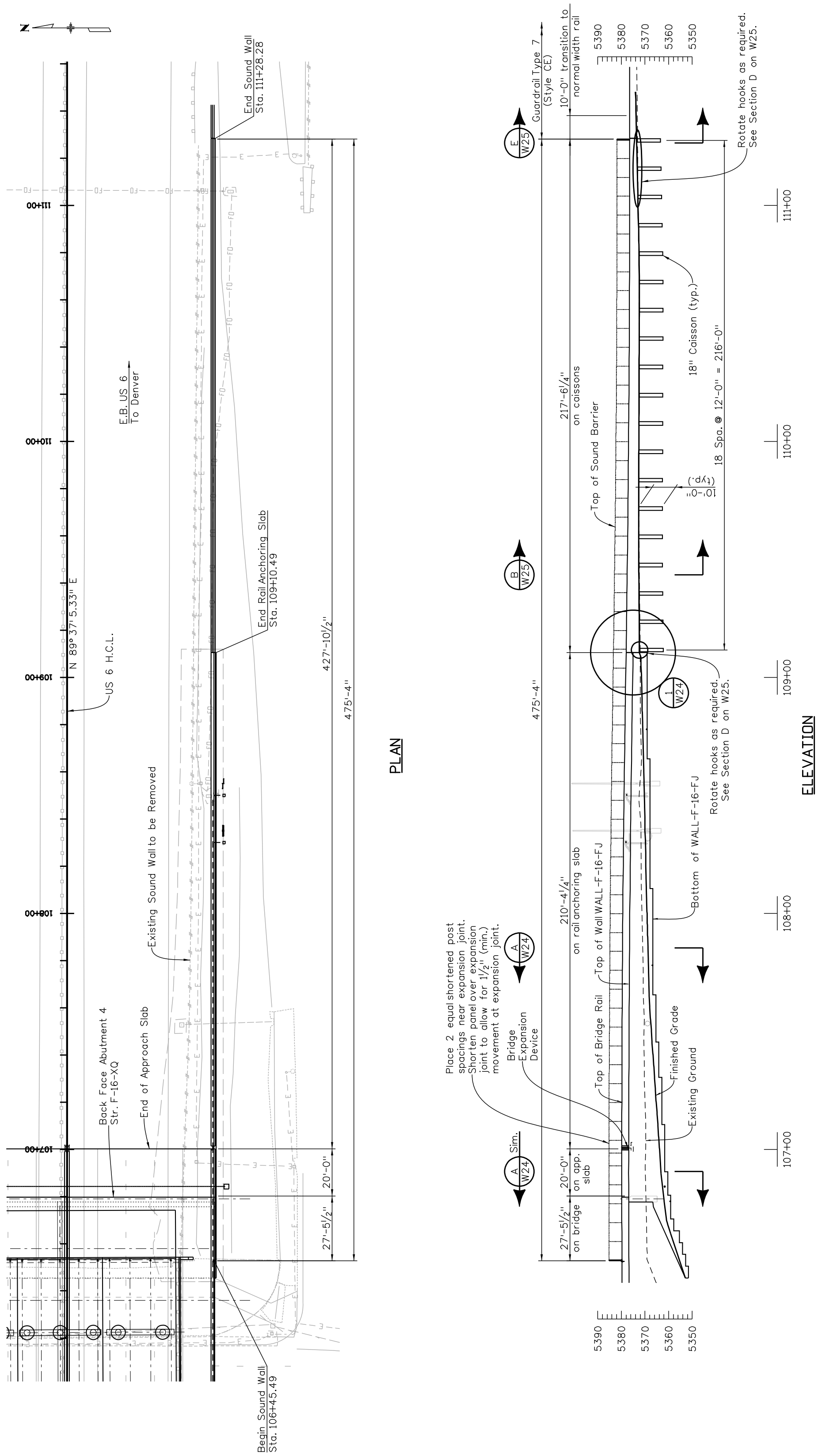


Fig. 15.1.13-1 Sound Barrier Layout Example

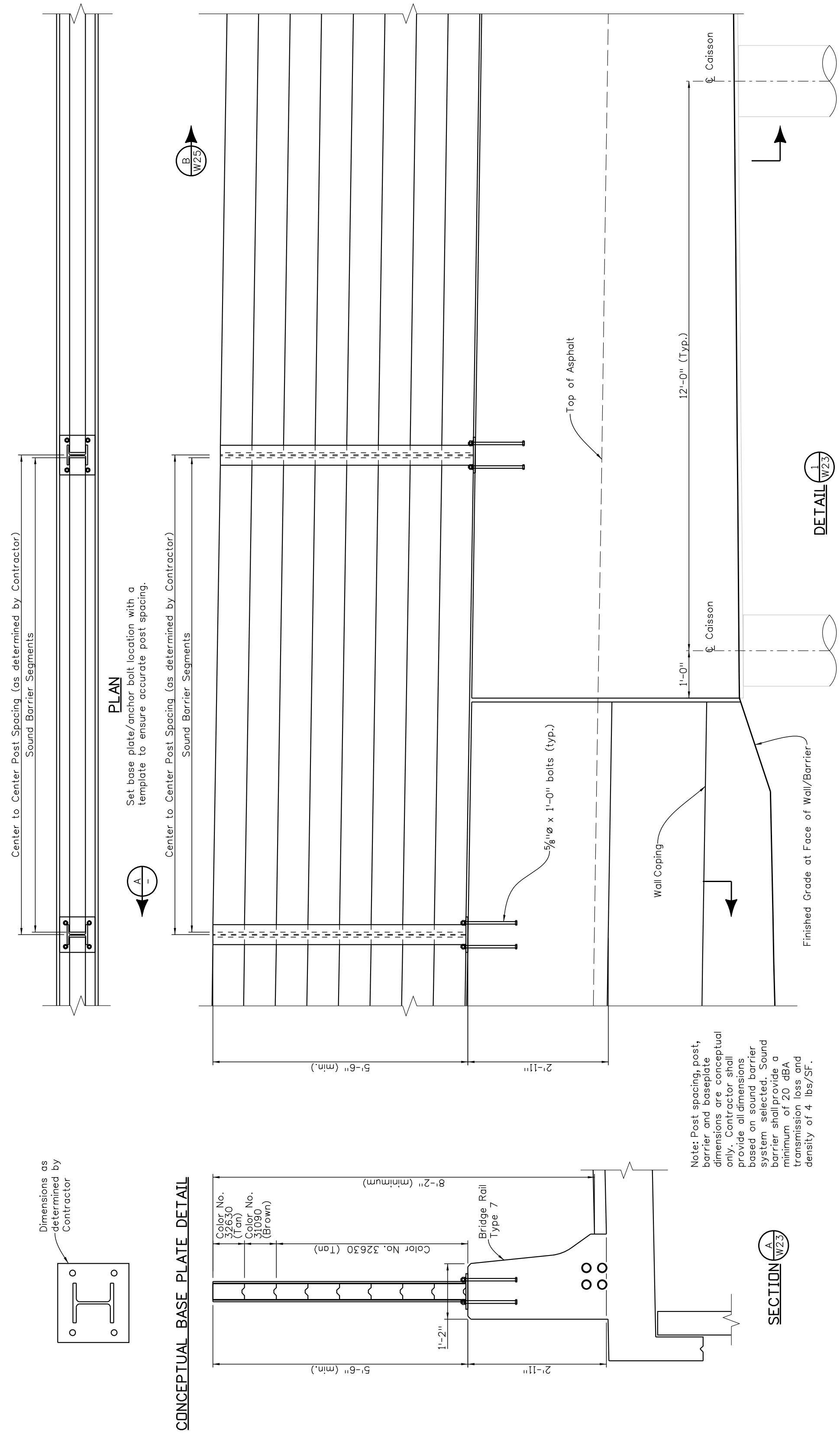


Fig. 15.1.13-2 Sound Barrier on Bridge Example

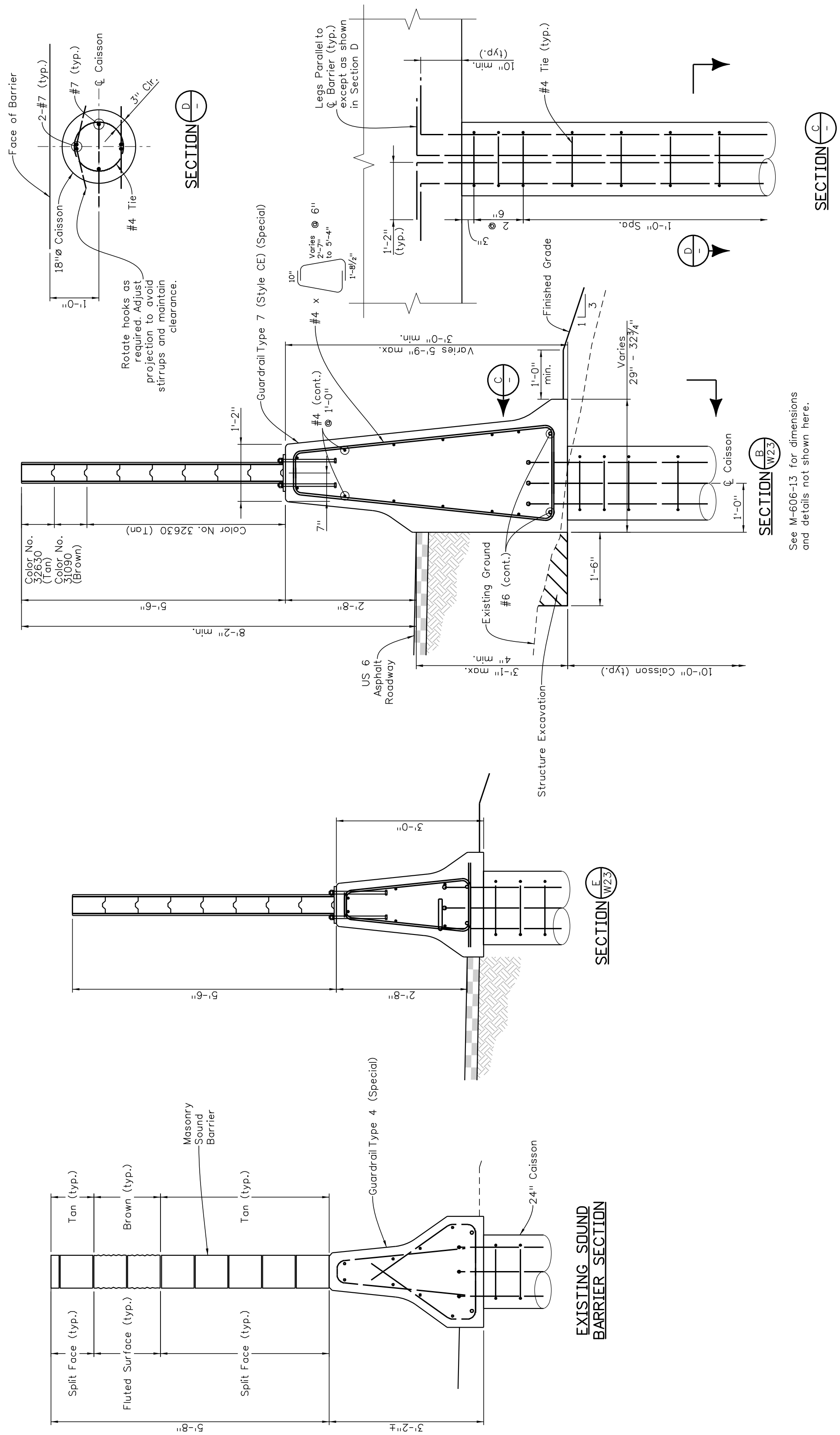


Fig. 15.1.13-3 Standalone Sound Barrier Example

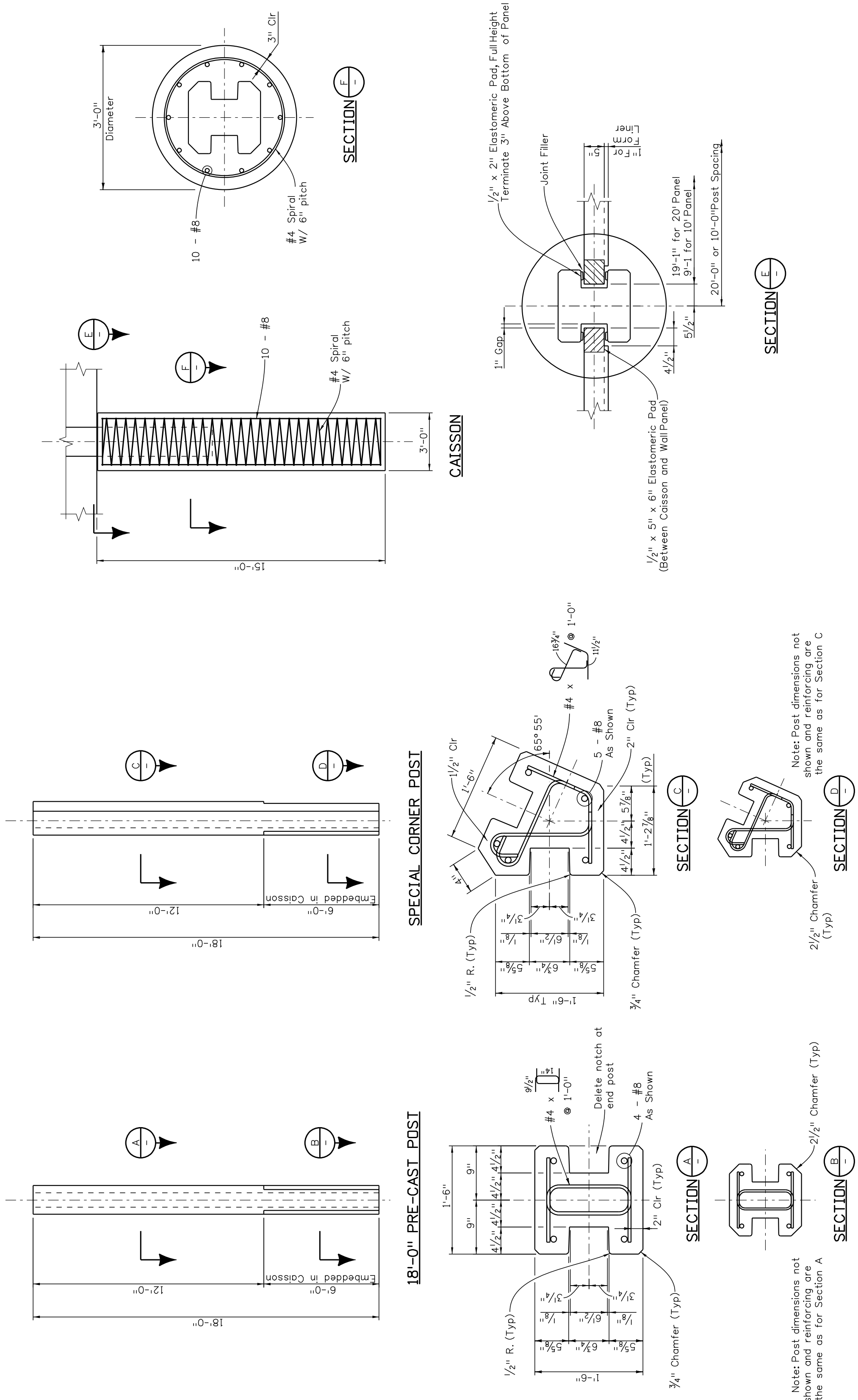


Fig. 15.1.13-4 Corner and Post Details Example

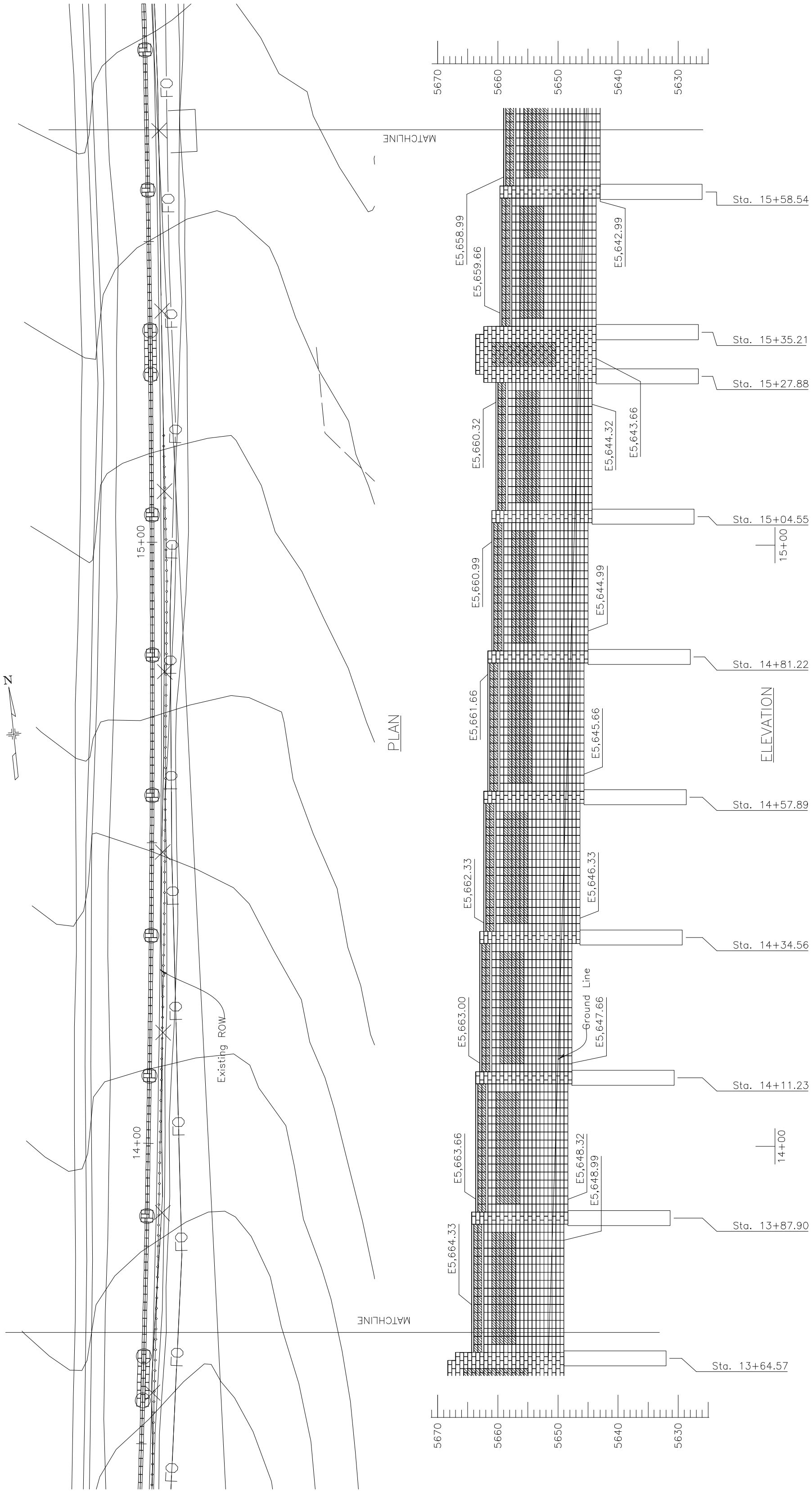


Fig. 15.1.13-5 Masonry Sound Barrier Example

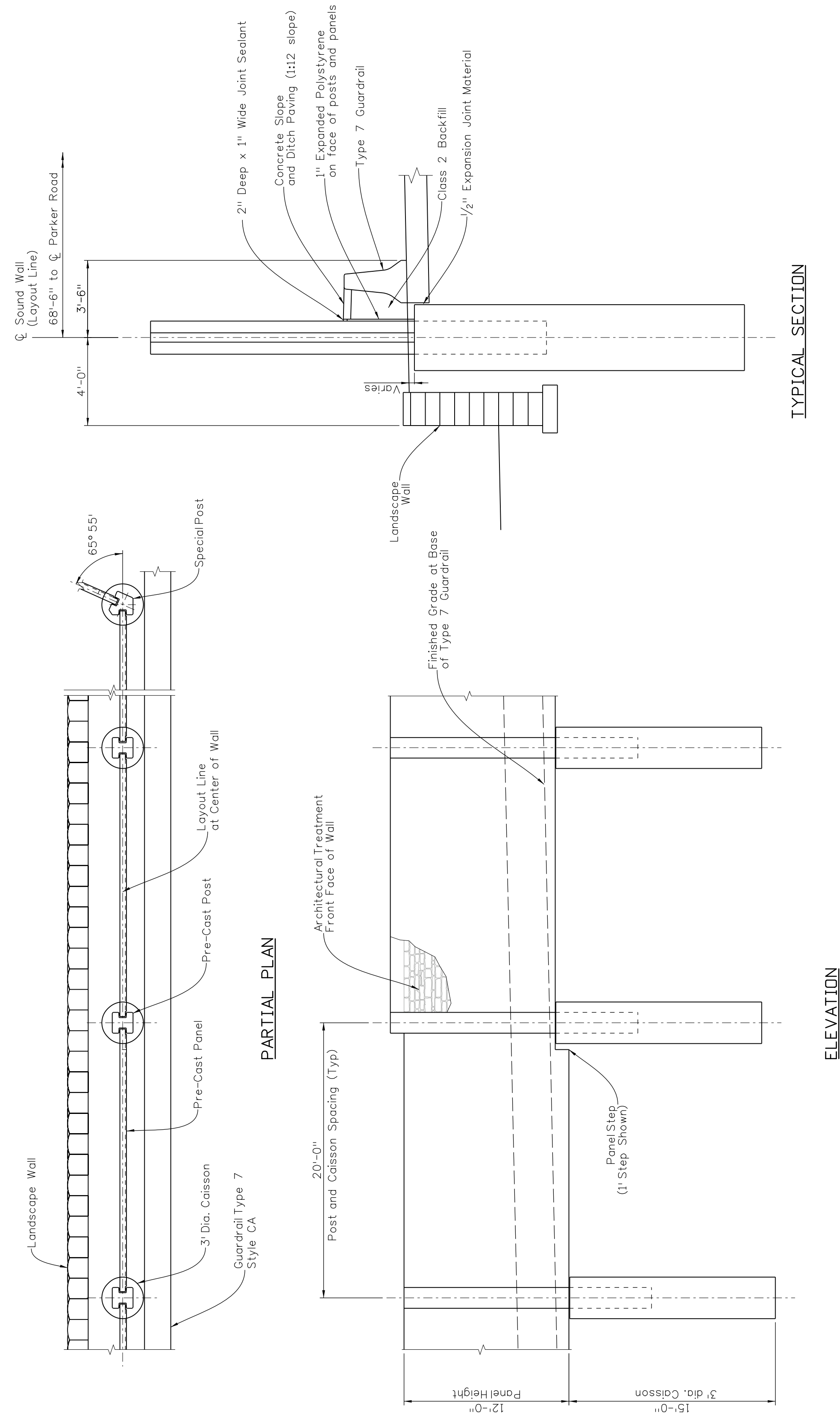


Fig. 15.1.13-6 Precast Panel Sound Barrier Example

Fig. 15.1.13-7 Miscellaneous Sound Barrier Example

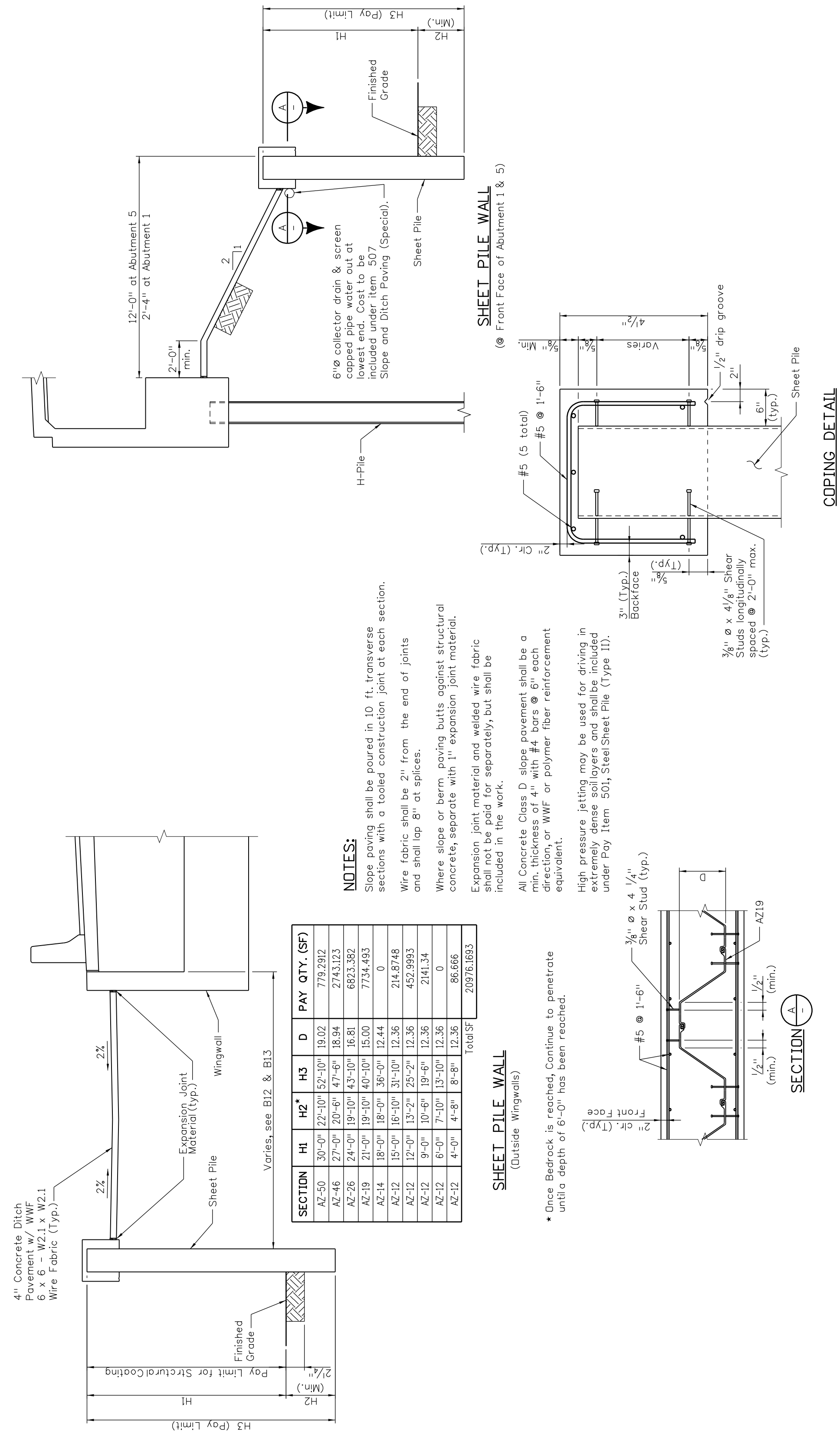
Fig. 15.1.13-8 Miscellaneous Sound Barrier Example 2

15.1.14 Sheet Pile Wall and Miscellaneous Examples & Check Items

Listed below is a summary of items that shall be checked and appear on the drawing in addition to the General Items listed in Section 15.1.8. Additional information shall appear, as required. The wall examples shown here are a guide only; each wall shall be evaluated for applicability of examples and worksheets on a case by case basis

CHECK ITEMS

A) Provide tie back spacing
B) Provide designation or type of sheet pile
C) Provide sheet pile and dead-man connection details
D) Identify soil type (pH and sulfate levels)
E) Provide required minimum pile tip elevation
F) Provide drivability and penetration through soil layers
G) Provide horizontal tolerance and type of coping
H) Provide corrosion countermeasures
I) Provide type of weep hole vs. ground water table
J) Provide driving plumbness criteria
K) Provide lateral deformation (counter batter) and requirement of tie-back anchor or dead-man anchor
L) Note that pre-drill may be required
M) Provide drainage passage at back face of wall
N) Depict end of wall treatment
O) Provide staged excavation in front of wall



SECTION	H1	H2*	H3	D	PAY QTY. (SF)
AZ-50	30'-0"	22'-10"	52'-10"	19.02	779.2912
AZ-46	27'-0"	20'-6"	47'-6"	18.94	2743.123
AZ-26	24'-0"	19'-10"	43'-10"	16.81	6823.382
AZ-19	21'-0"	19'-10"	40'-10"	15.00	7734.493
AZ-14	18'-0"	18'-0"	36'-0"	12.44	0
AZ-12	15'-0"	16'-10"	31'-10"	12.36	214.8748
AZ-12	12'-0"	13'-2"	25'-2"	12.36	452.9993
AZ-12	9'-0"	10'-6"	19'-6"	12.36	2141.34
AZ-12	6'-0"	7'-10"	13'-10"	12.36	0
AZ-12	4'-0"	4'-8"	8'-8"	12.36	86.666
				Total SF	20976.1693

* Once Bedrock is reached, Continue to penetrate until a depth of 6'-0" has been reached.

NOTES:

Slope paving shall be poured in 10 ft. transverse sections with a tooled construction joint at each section.

Wire fabric shall be 2" from the end of joints and shall lap 8" at splices.

Where slope or berm paving butts against structural concrete, separate with 1" expansion joint material.

Expansion joint material and welded wire fabric shall not be paid for separately, but shall be included in the work.

All Concrete Class D slope pavement shall be a min. thickness of 4" with #4 bars @ 6" each direction, or WWF or polymer fiber reinforcement equivalent.

High pressure jetting may be used for driving in extremely dense soil layers and shall be included under Pay Item 501, Steel Sheet Pile (Type II).

Fig. 15.1.14-1 Sheet Pile Wall Example

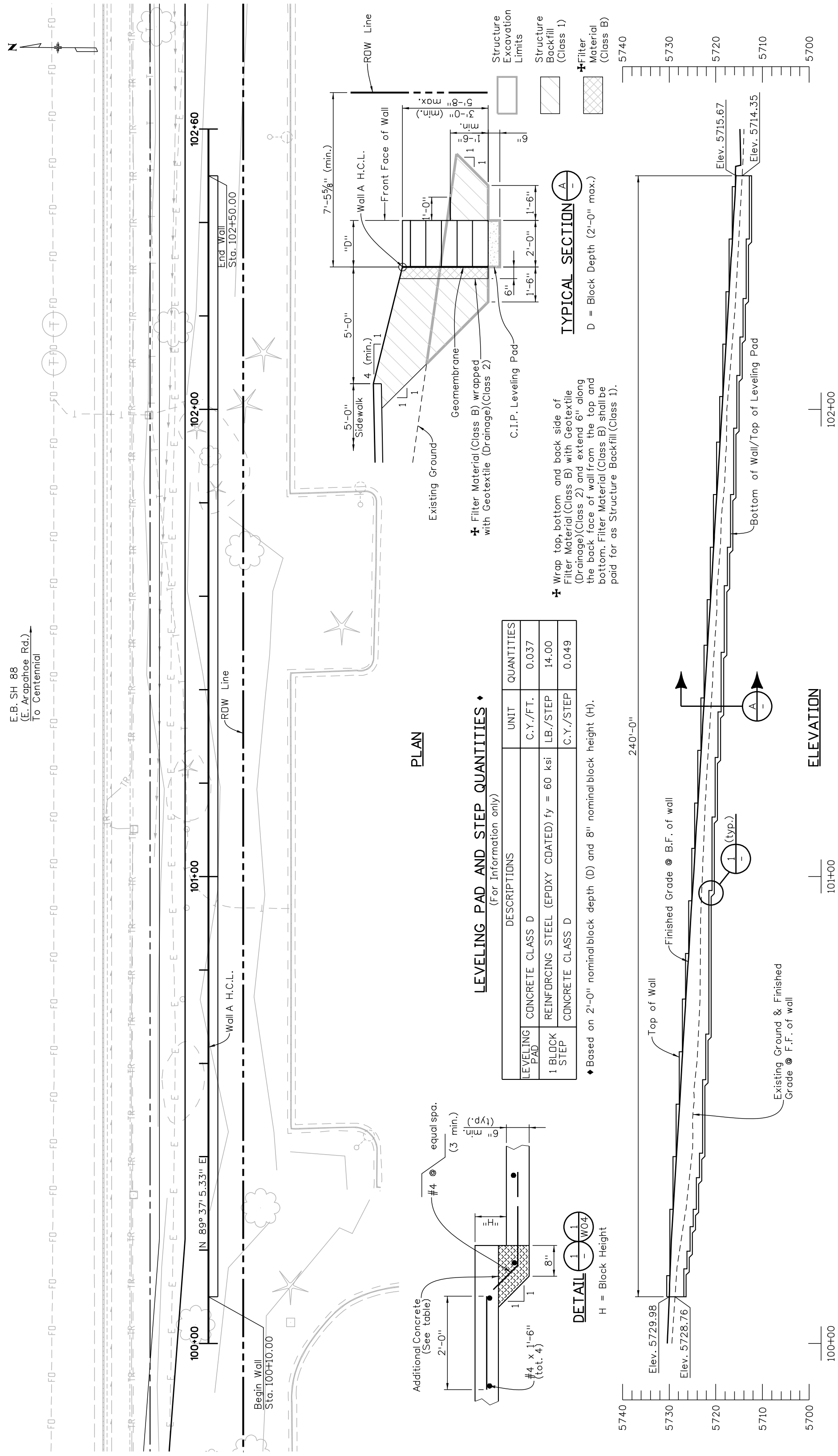


Fig. 15.1.14-2 Gravity Block Wall Example

15.2.1 Purpose

These drawings are to graphically present all pertinent information necessary for the construction of miscellaneous structures as well as depict constructability and ROW issues. Miscellaneous structures are structures within CDOT ROW that cover multiple definitions as defined in the Bridge Design Manual. Examples include culverts, pedestrian/bike structures, non-standard overhead signs, overhead pipes, overhead cables, railroad bridges, private drive structures, overhead conveyor belts, and overhead snow sheds.

15.2.2 Responsibility

The graphical presentation of information on these drawings shall be the responsibility of the individual preparing the drawings in addition to the designer. Close cooperation with Roadway design group is essential for proper layout. Layout lines should be provided by the Roadway Design unit and checked by the Bridge Design Unit. Structure design using standard worksheets should be provided by the Bridge Design Unit and checked by the Roadway Design Unit.

15.2.3 Scales

Standard Architectural and Civil scales shall be used that are suitable to make the details legible on a standard sheet.

15.2.4 Orientation of Details

The PLAN of the structure shall be placed, if possible, at the upper left of the drawing.

The ELEVATION of the structure shall be projected below the PLAN when possible. When possible, the END ELEVATION and/or Sections shall be placed to the right of the PLAN and ELEVATION. If space is limited, the sections or secondary views may be shown on another sheet. Generally, sections should be taken from the PLAN and ELEVATION rather than from secondary views or other sections.

15.2.5 Control

The horizontal control line for the structure shall be identified as well as the profile grade line.

15.2.6 Dimensions

A sufficient number of dimensions shall be shown on the details to provide adequate information necessary in the checking of the plans and the construction and/or design of the structure. Quantities should be able to be verified based on plan dimensions.

15.2.7 Angles

The following angles shall be shown in the PLAN view of the structure when applicable:

A) Bent angle

15.2.8 Worksheets

The use of the Bridge Worksheets is encouraged, but the designer shall verify the dimensions and applicability of the worksheet for the required application.

15.2.9 Check Items for All Structure Types

Listed below is a summary of items that shall be checked and appear on the drawings for all structure types as applicable. See specific structure types in sections 15.2.10 through 15.2.13 for additional information as required. Structure drawings should show sufficient information in order to check any shop or working drawing information provided by the Contractor. Additional information shall be shown as required for the project as well as for the individual structure type.

Check Items

A) Identify Horizontal Control Line. Station and offset information from Roadway horizontal control line is acceptable for structure control. If structure control line is based on roadway information, roadway information shall be provided in the structure plans as a reference, e.g. bearings, horizontal curve date, etc.
B) Identify vertical control information. If vertical control information is based on roadway information, roadway information shall be provided in the structure plans as a reference, e.g. vertical PIs, grades, etc.
C) Provide structure number.
D) Identify concrete coating (color) limits and/or rustications.
E) Identify limits of concrete sealer and/or waterproofing membrane.
F) Delineate approximate construction or excavation limits for structure type shown in plan view.
G) Show weephole/drainhole locations in elevation views.

H) Show surface drainage plan.
I) Locate interferences or special details such as light supports.
J) Depict and show interferences for structure in elevation views such as drains, abutments.
K) Provide isometric views for difficult intersections such as at abutments or angle points.
L) Show all known utilities and utility crossings.
M) Show utility details of conduits entering/exiting structures.
N) Show locations of changes in typical section.
O) Show proposed grade as applicable
P) Show existing grade.
Q) If structure is not associated with a bridge plan set, the name and direction of the nearest town shall be provided at the beginning and end of the structure.
R) Show finished contour lines when they are available.
S) Show standard North Arrow.
T) Show nearby structures, such as pipes, overhead signs, bridges, etc. that affect the design or construction.
U) Show type of slope protection as applicable.
V) Show direction and rate of fill or cut slopes. Show approximate location of toe and top of slopes.
W) Show existing structures (dashed), label with structure number, and note if the existing structure is to be removed.
X) Title the General Layout plan view “PLAN”.
Y) Provide matchlines for structures which extend to multiple sheets. Matchlines should be placed to avoid critical section changes or alignment changes in the structure.
Z) Show ROW limits if available and dimensions to railroad as needed.
AA) Verify accuracy of dimensions and elevations in accordance with Section 1.6 of this manual.
BB) Show allowable long-term settlement.
CC) Provide design information and constraints, e.g. Ground Water levels, allowable bearing capacity, allowable differential settlement, fill material properties

15.2.10 Culvert Examples & Check Items

Listed below is a summary of items that shall be checked and appear on the drawing, when applicable. Additional information may appear as necessary to fully depict required work. The structure examples shown here are a guide only, each structure shall be evaluated for applicability of examples and worksheets on a case by case basis. The items to be shown in the drawings for CBCs are similar to the items identified in Chapter No 6, sections 6.5 through 6.7. If standard box culverts are used on the project and there are no deviations from the M-Standard plans, then the M-Standard sheets may be used and additional details may not be required.

Check Items

A) Identify bent angle of the structure.
B) Identify length.
C) Show wingwall information, e.g. skews, lengths, heights, etc. Tabular information is acceptable.
D) Show material type (concrete, metal, precast, CIP, etc).
E) Delineate construction or excavation limits. (Applicable only if M standards are not used) Note: the pay limits for CBCs are typically 1’-6” from the edge of the CBC but reasonable cut limits should be shown as approximate or conceptual for constructability purposes.
F) Identify clearance envelope if required, e.g. wildlife crossings, bike/pedestrian paths, etc.
G) Include note that height and width vary based on manufacturer (for steel arch structures).
H) Show phasing details.
I) Show shoring locations if required.
J) Show precast/CIP connections.
K) Show lighting details.
L) Identify invert elevations.
M) Show minimum fill height used for design.
N) Show path or channel widths.
O) Provide foundation information (for arch structures, 3 sided box culvert, etc).

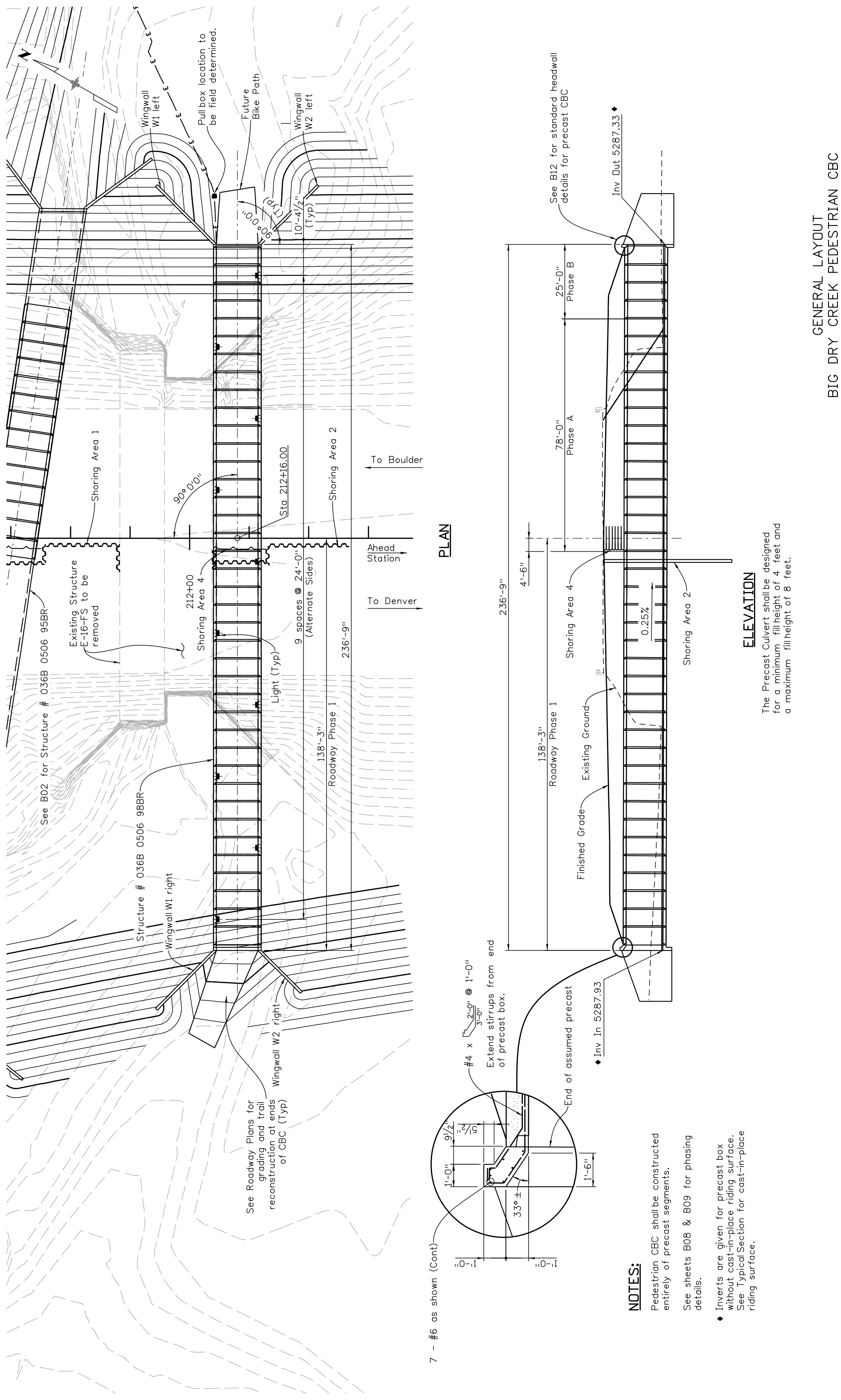


Fig 15.2.10-1 CBC General Layout

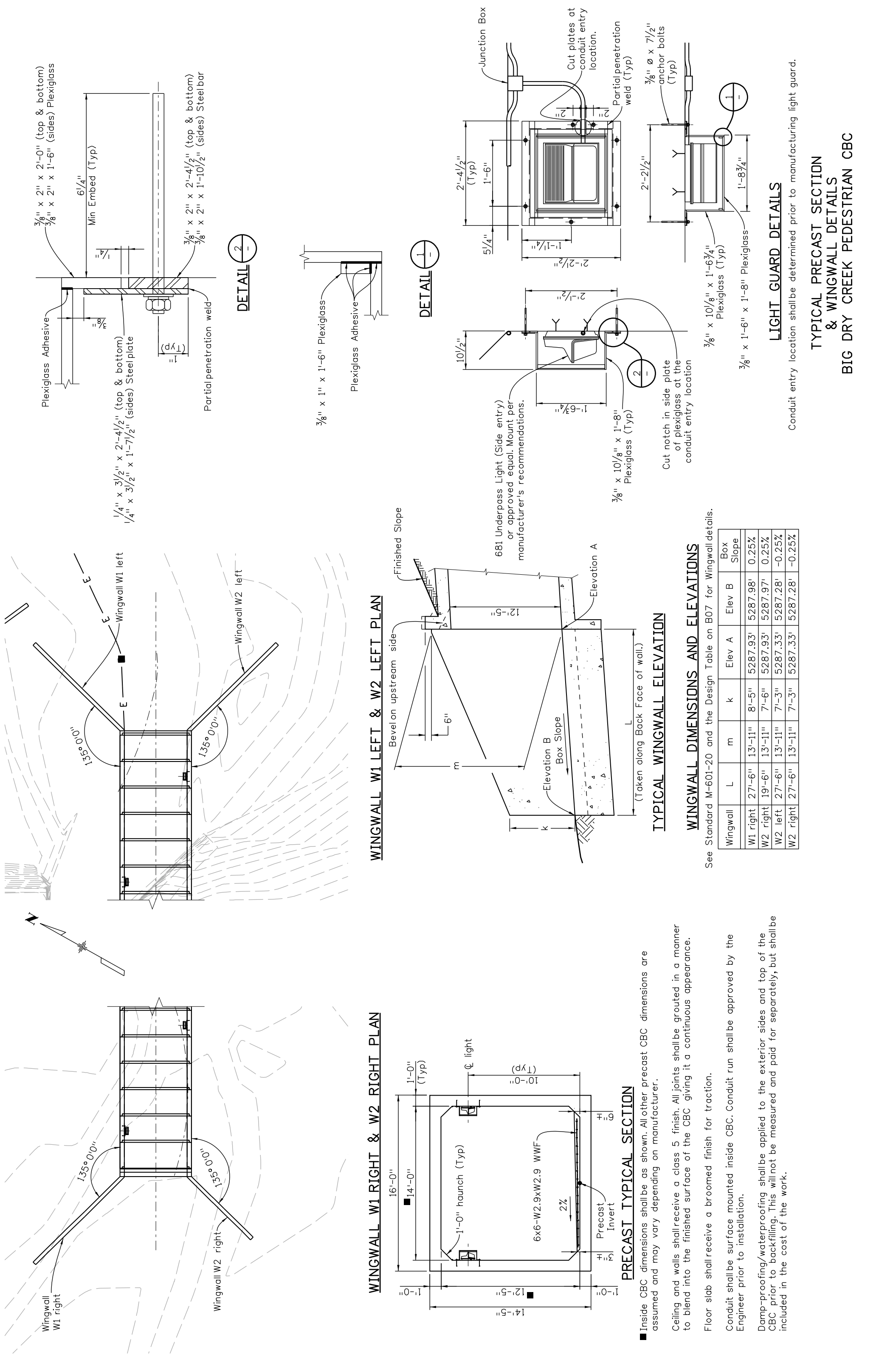


Fig 15.2.10-2 CBC Precast Details

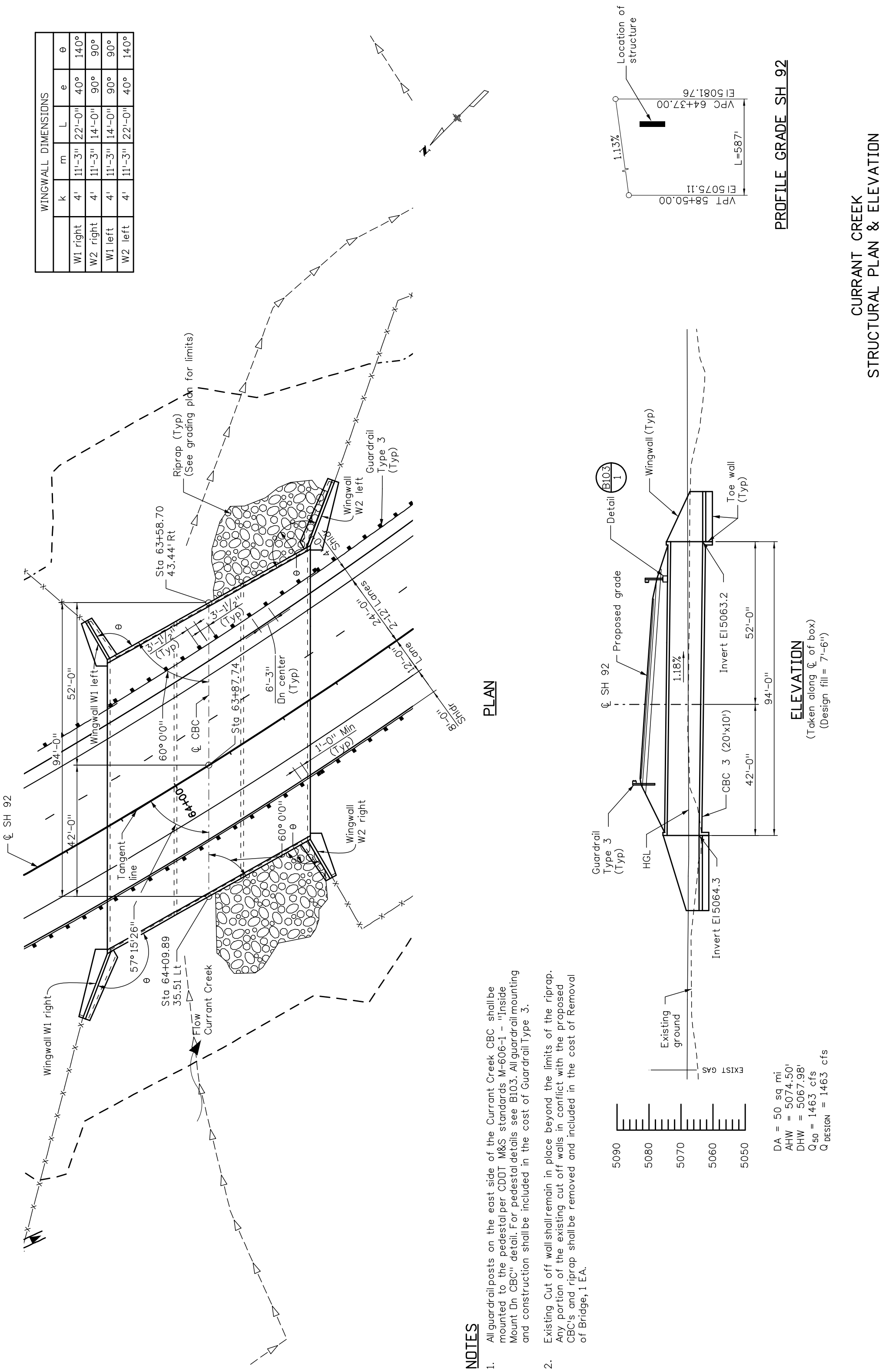


Fig 15.2.10-3 Cast in Place General Layout

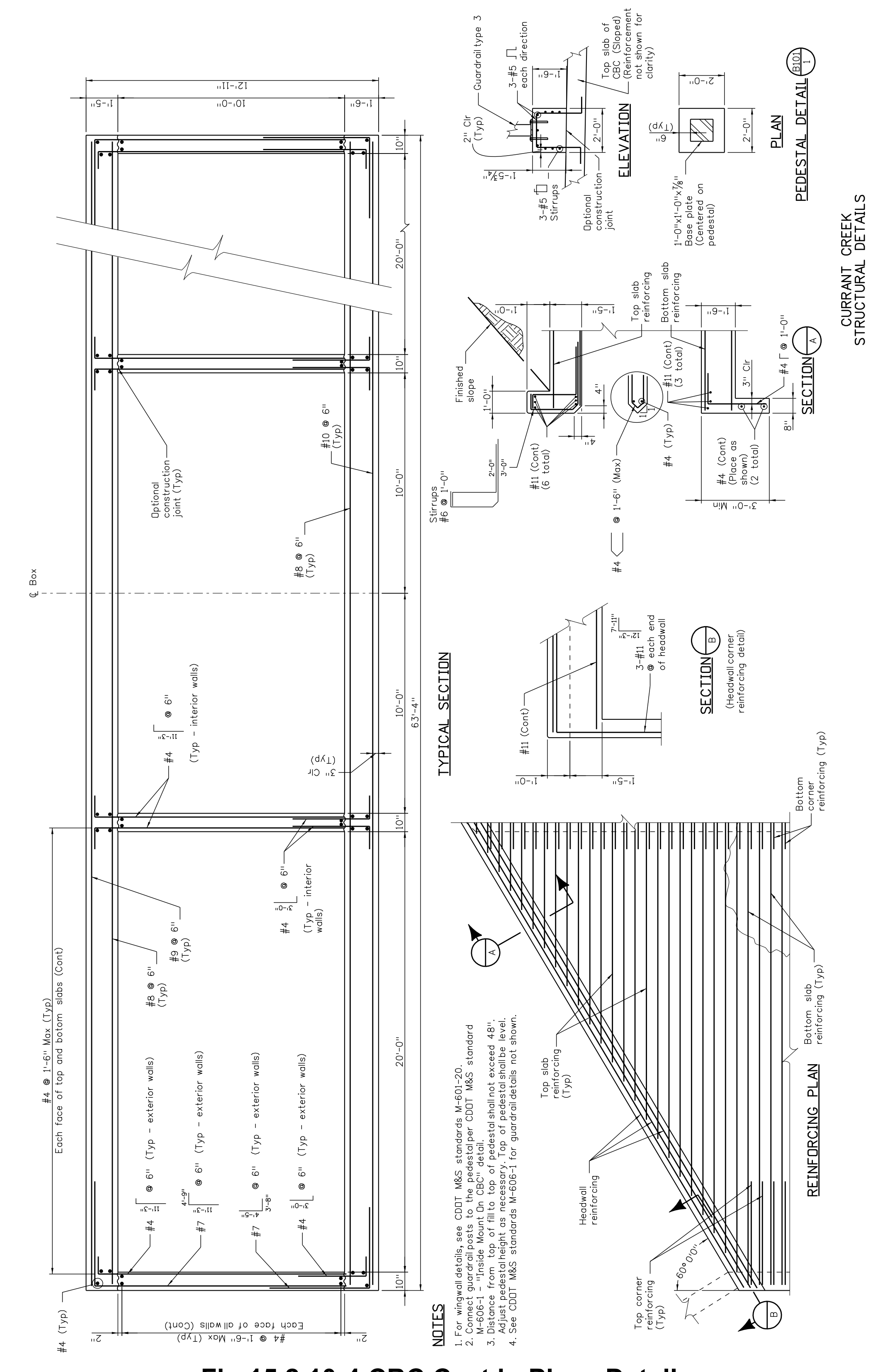


Fig 15.2.10-4 CBC Cast in Place Details

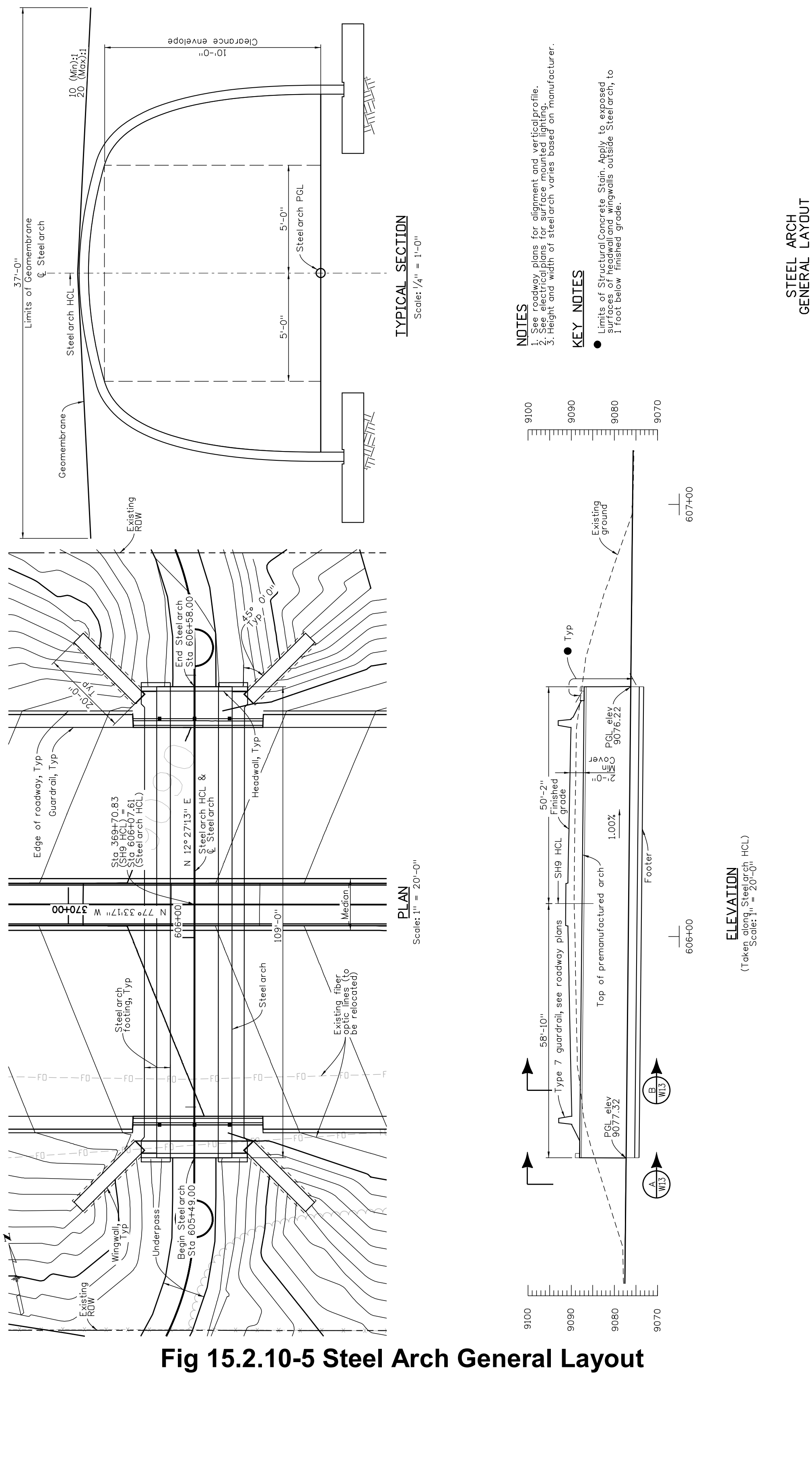


Fig 15.2.10-5 Steel Arch General Layout

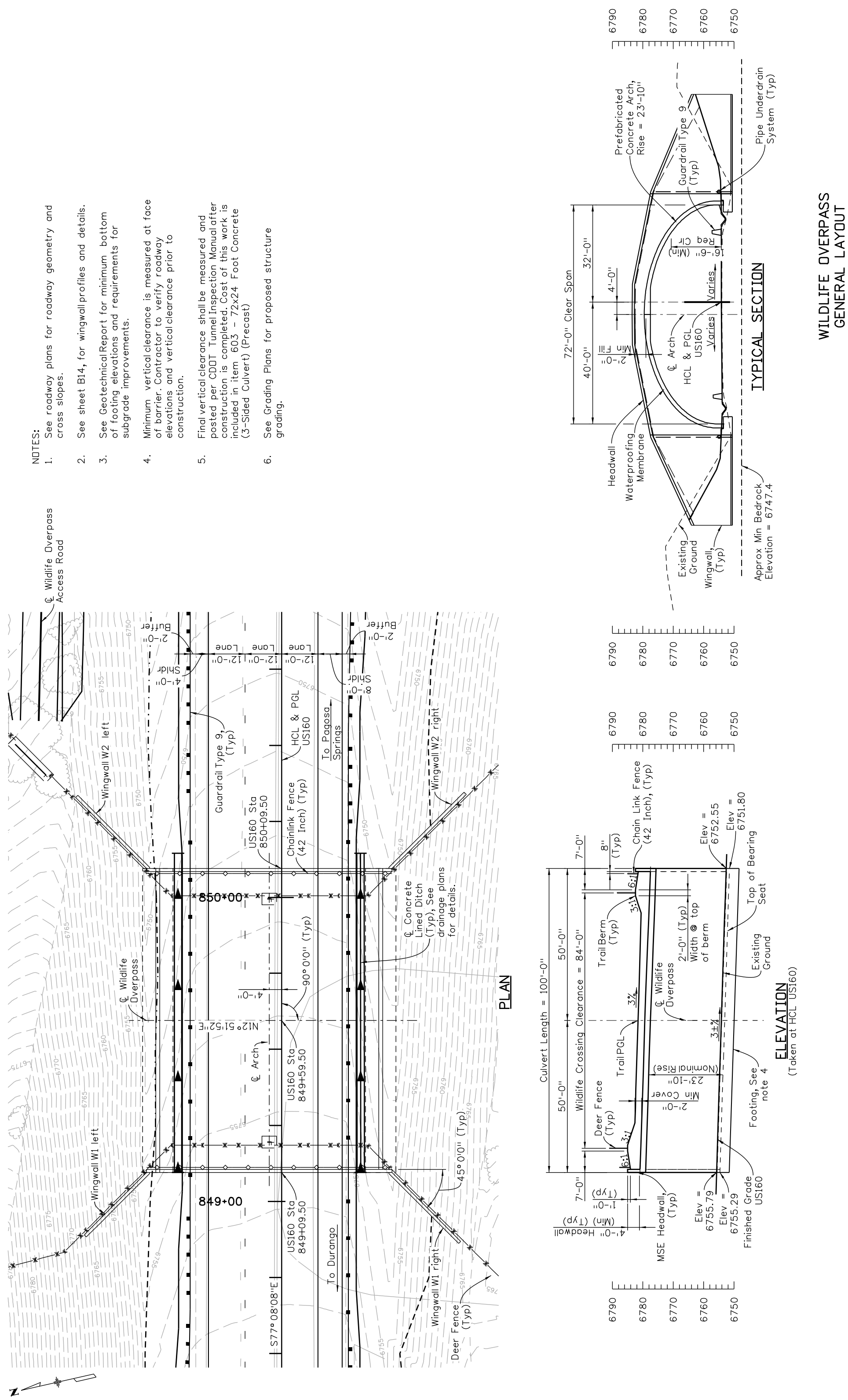


Fig 15.2.10-6 Overpass Arch General Layout

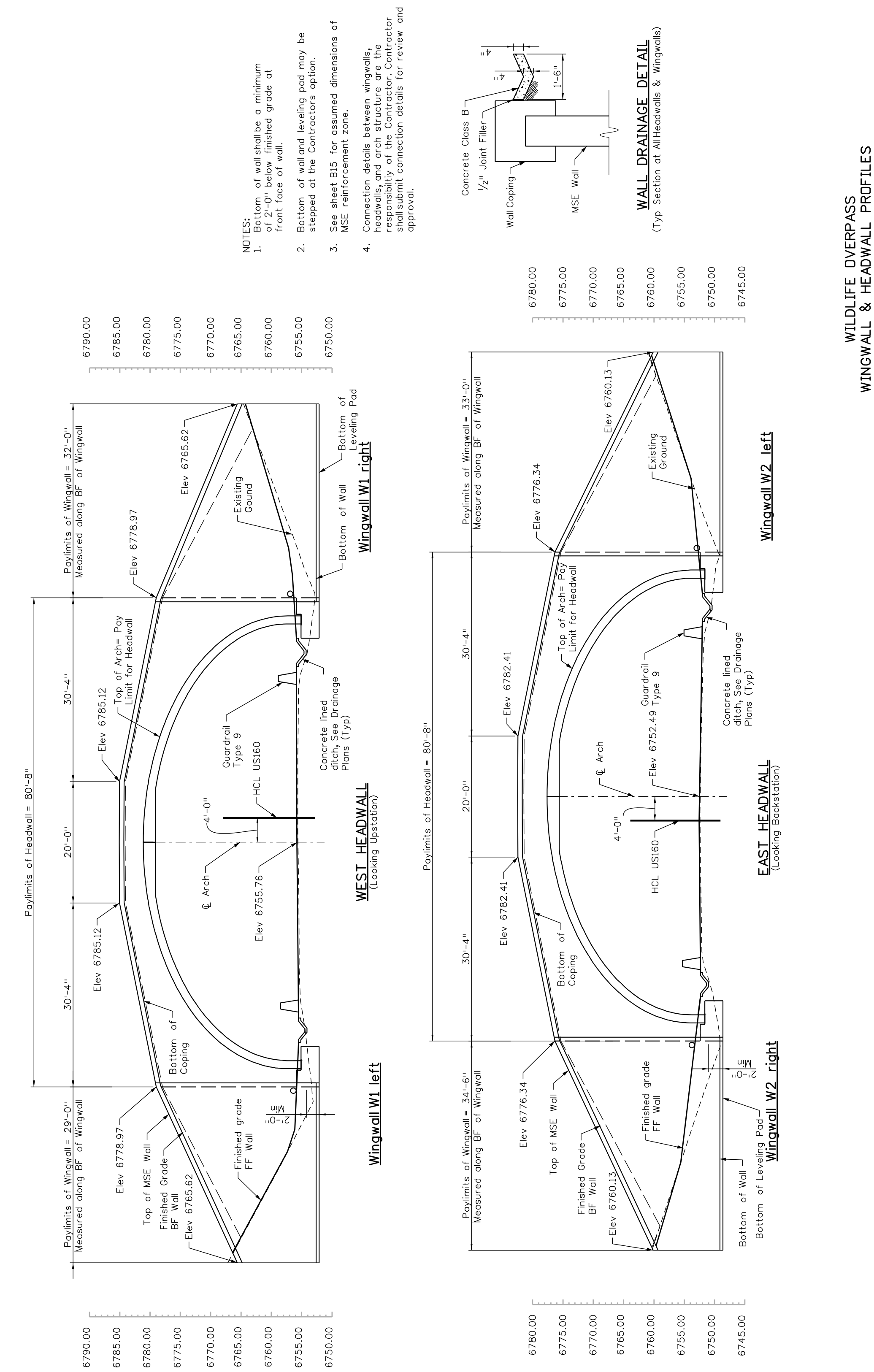


Fig 15.2.10-7 Overpass Wall Layout

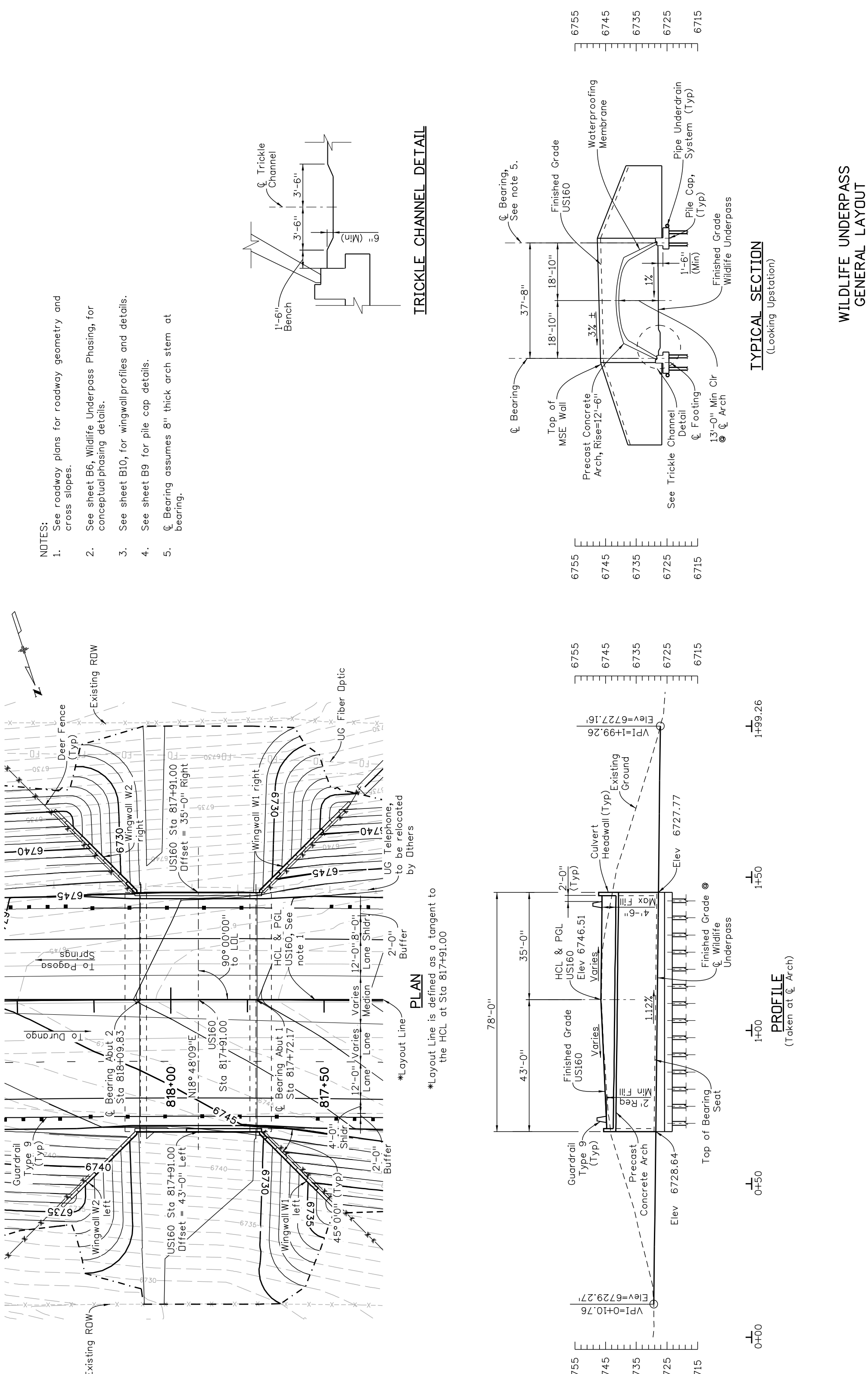


Fig 15.2.10-8 Underpass General Layout

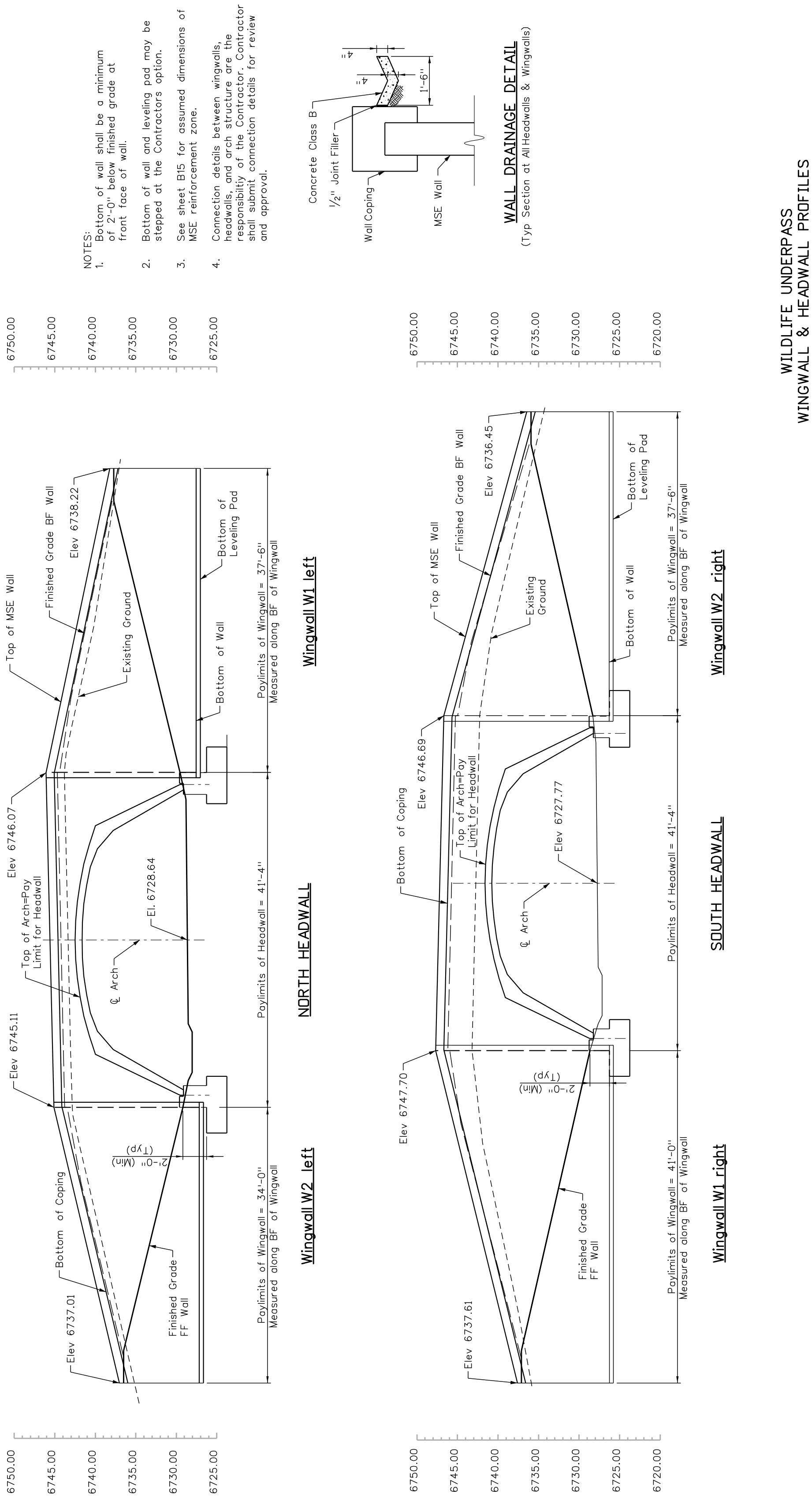


Fig 15.2.10-9 Underpass Wall Layout

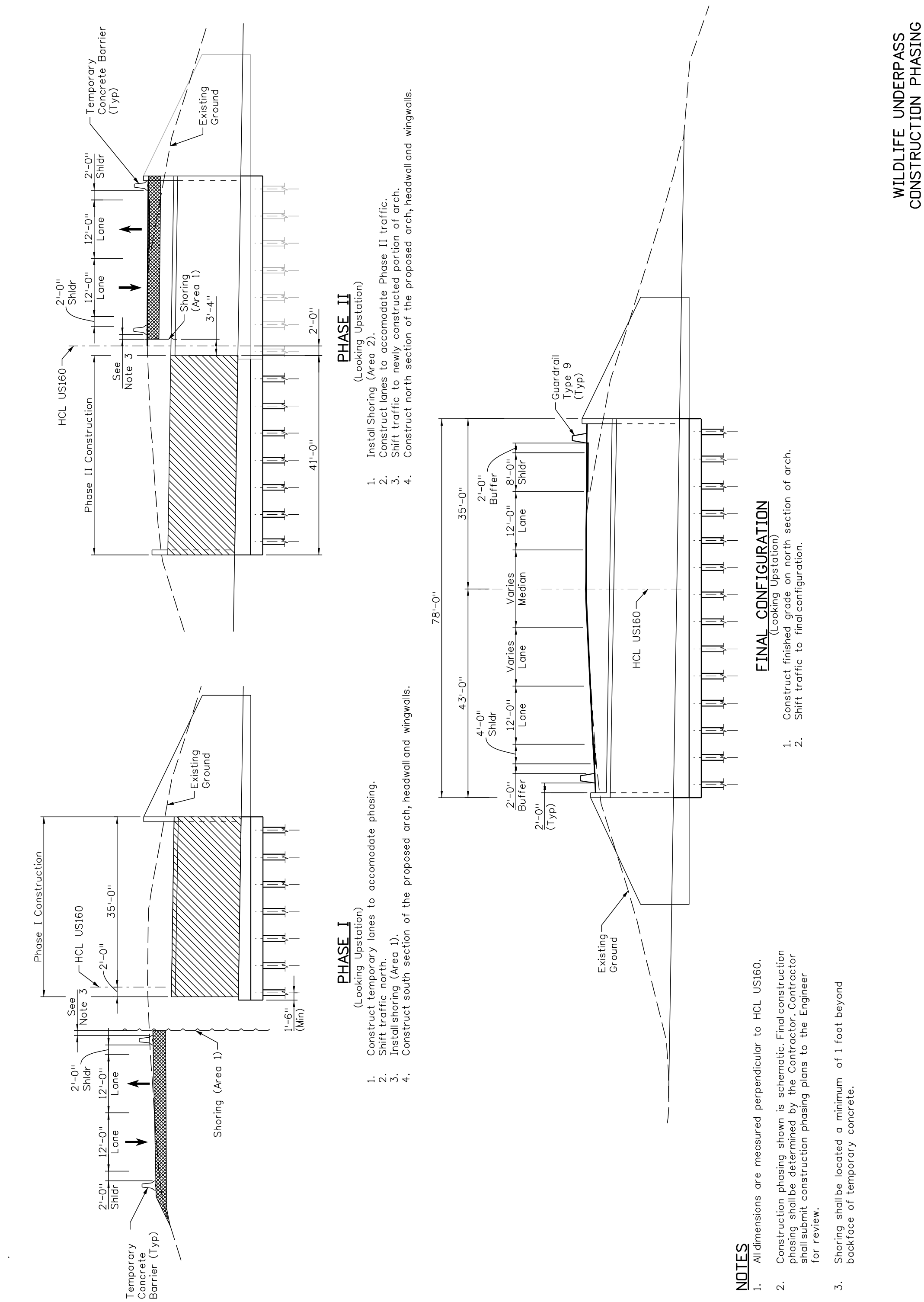


Fig 15.2.10-10 Underpass Construction Phasing

15.2.11 Pedestrian Bridge Examples

Pedestrian bridges will generally follow the detail requirements as a bridge structure already laid out in this manual. Additional information may appear as necessary to fully depict required work, including necessary ramp details to the structure. The structure examples shown here are a guide only, each structure shall be evaluated for applicability of examples and worksheets on a case by case basis. The items to be shown in the drawings for pedestrian bridges are similar to the items identified in the various bridge item chapters.

When a prefabricated pedestrian bridge is used, i.e. designed and supplied by the Contractor's fabricator, design load requirements for the substructure shall be shown. General depiction of requirements for the superstructure shall also be provided as well as what material is field placed and what is shop built.

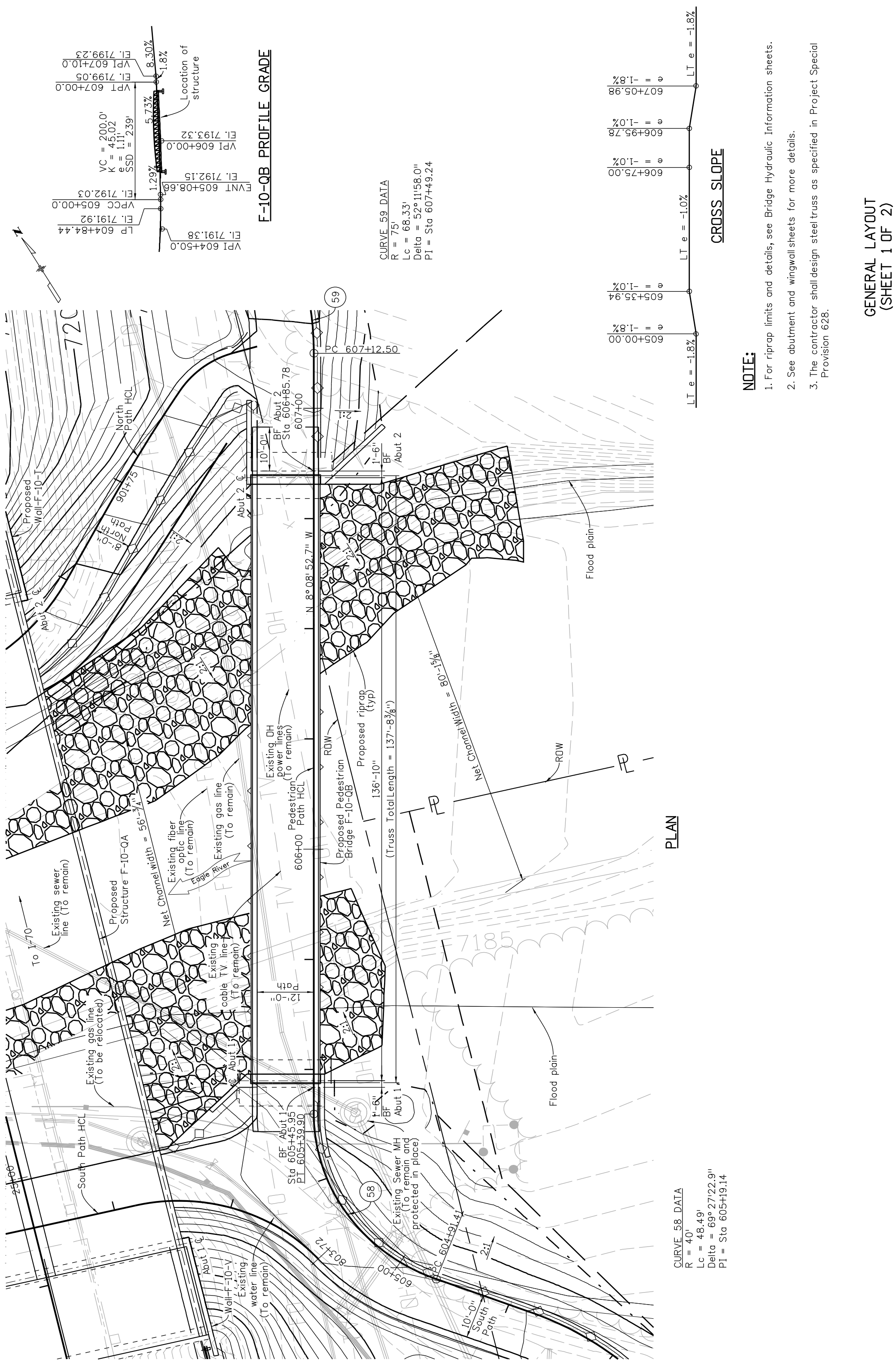


Fig 15.2.11-1 Pedestrian Bridge General Layout

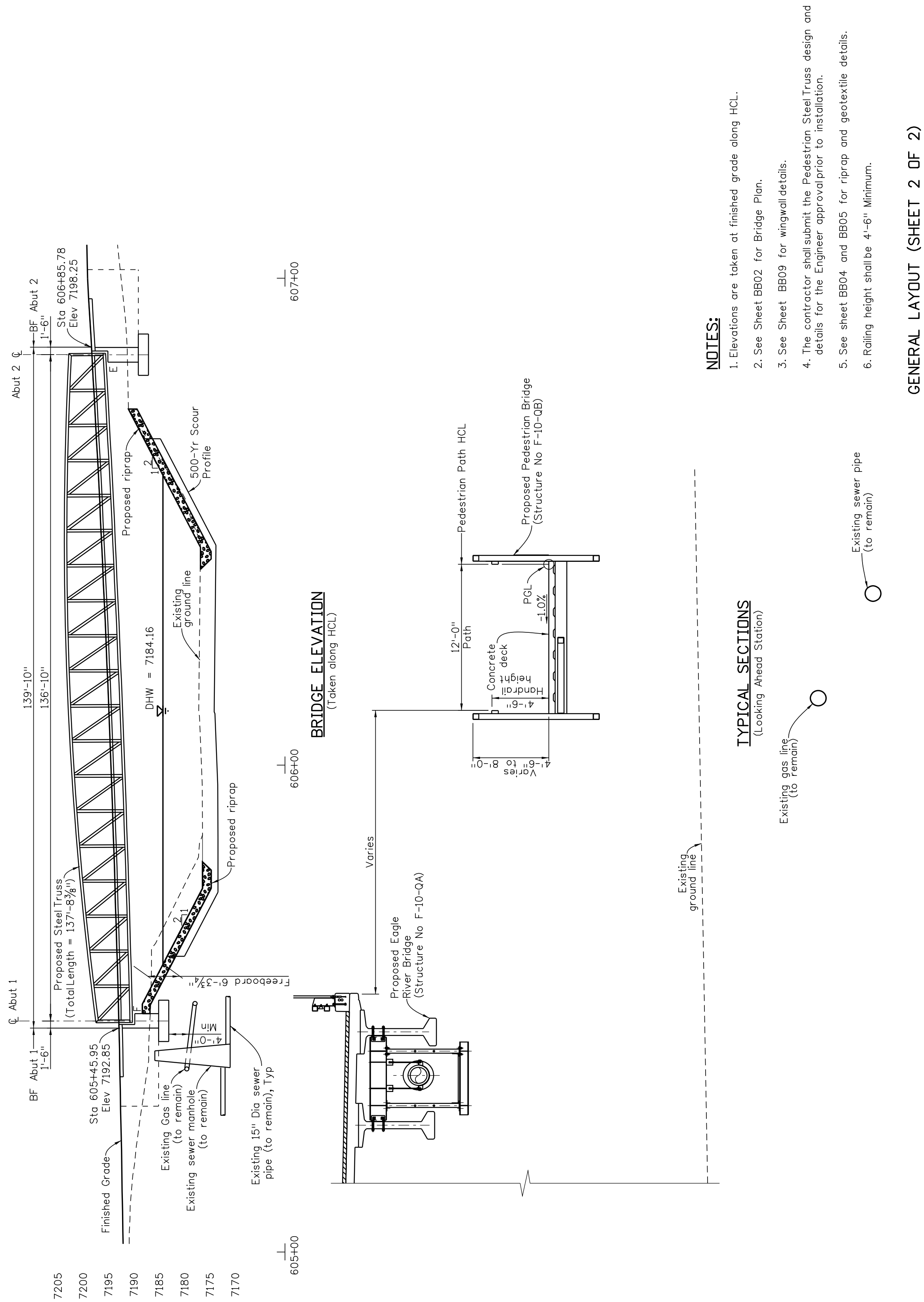


Fig 15.2.11-2 Pedestrian Bridge Layout

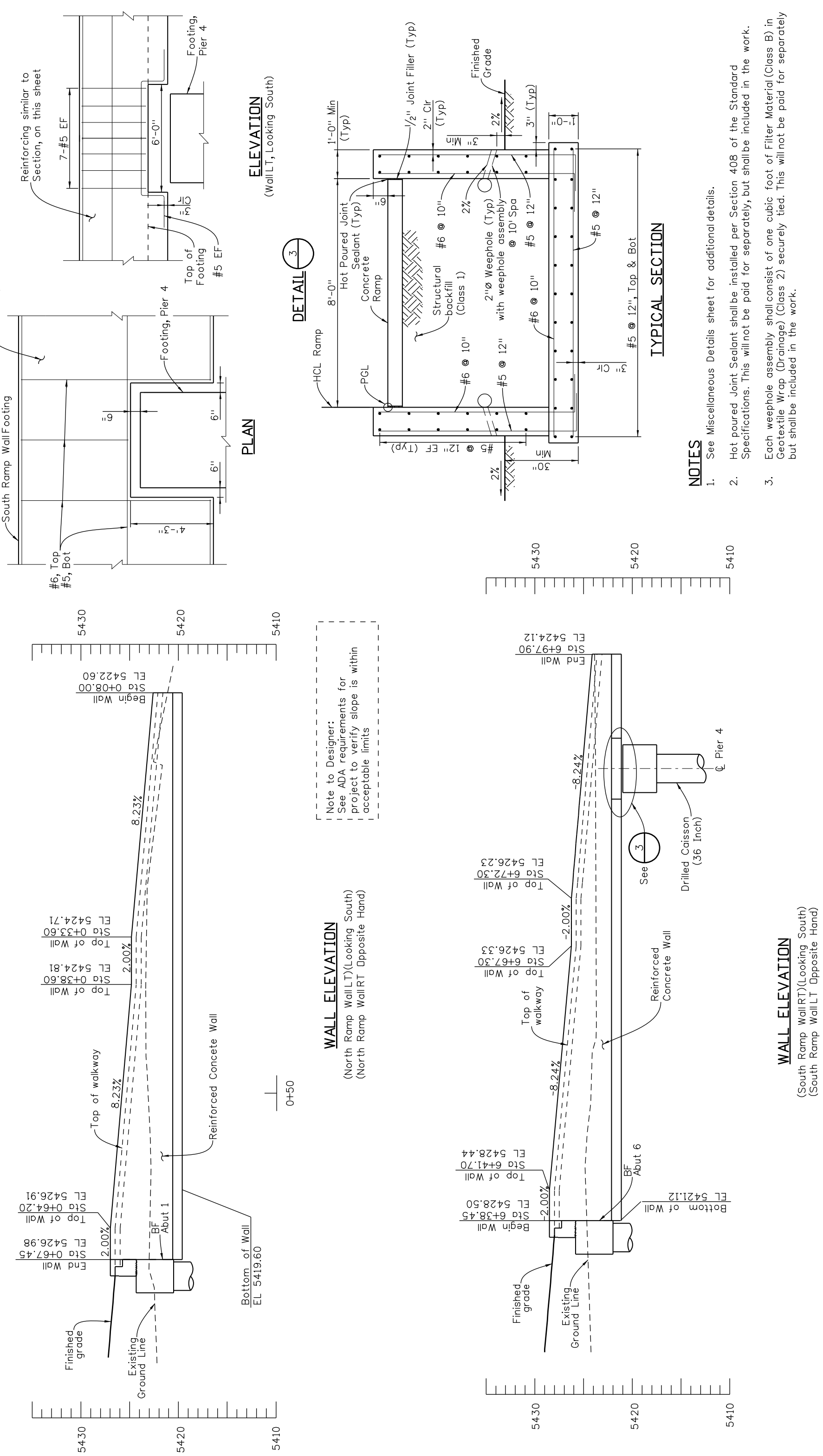


Fig 15.2.11-3 Pedestrian ramp details

15.2.12 Non S-Standard (Special) Sign Structure Examples & Check Items

Listed below is a summary of items that shall be checked and appear on the drawing, when applicable. Additional information shall appear, as required. The structure examples shown here are a guide only, each structure shall be evaluated for applicability of examples and worksheets on a case by case basis. Structure details shall match S-standard details wherever possible.

Check Items

A) Identify Skew Angle.
B) Provide design criteria (design wind speed, gust effect factor, service life, etc).
C) Show connection details.
D) Show clearance requirements.
E) Show tube diameter (if monotube).

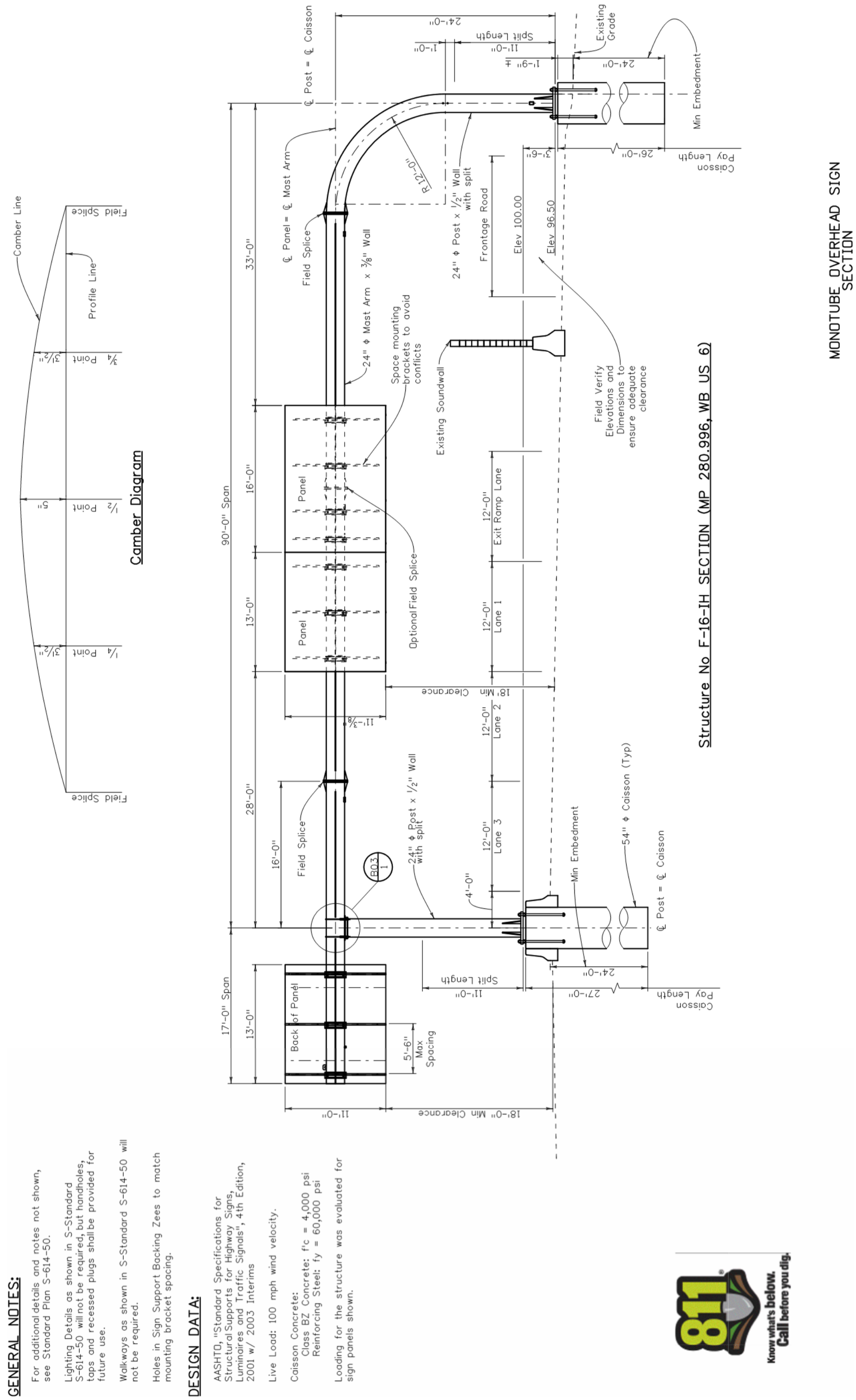


Fig 15.2.12-1 Monotube overhead sign

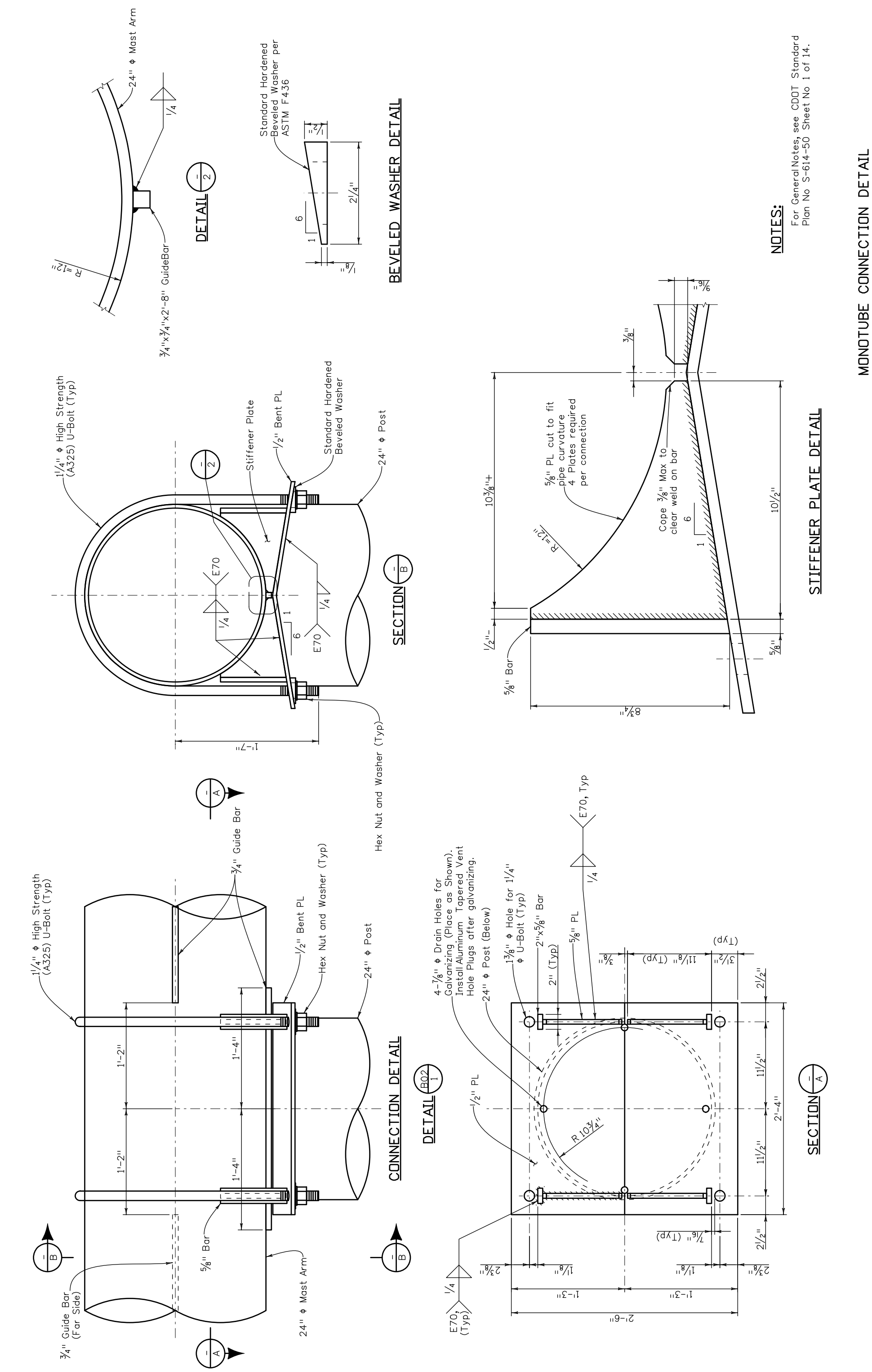


Fig 15.2.12-2 Monotube connection details

16.1 Purpose

Repair drawings graphically present all pertinent information necessary in the field construction of repairs to a structure. Some of these repair types include:

A) Bridgerail Replacement
B) Expansion Joint Replacement
C) Deck Rehabilitation / Overlay
D) Pier Cap and Column Repair
E) Impact Repair
F) Corbel Placement
G) Timber Pile Repair
H) Timber Bridge Girder Repair
I) Falsework
J) Wall Repair
K) Steel Corrosion/Fatigue Repair
L) Culvert Repair
M) Bearing Replacement

More than one kind of repair may be included in a drawing set for a given structure or multiple structures, e.g. deck rehabilitation and expansion joint replacement may share the same general layout. Figure 16.1-1 presents a portion of the general information sheet for a repair project that includes multiple structures. The checklists in this chapter will sometimes contain both design issues and detailing issues. The detailer shall verify any unknown design issues with the designer of the repair. Worksheet B-100-1AR should be used in the repair set.

If time allows, redraw details to show existing conditions. The appropriate portions of the as-built plans into the drawings may be included in the contract plans if the appropriate details cannot be redrawn.

The repair details shall provide all the information required to describe the work and any items that may affect the work. If specifications, calculations or other documentation is required for the work, it should be included per the Design Manual.

16.2 Responsibility

This drawing shall be prepared and checked in the Design Unit. The graphic presentation of information on this drawing shall be the responsibility of the individual preparing the drawing.

16.3 Scales

Standard Architectural and Civil scales should be used that are suitable to fit the details to a standard sheet.

BRIDGE DESCRIPTION (E-17-GL & E-17-GM)

E-17-GL (Westbound) and E-17-GM (Eastbound) are seven span (50'-0" typ.) CSG bridges located on I-76 at MP 7.652. Structures are 30'-0" curb to curb with 2'-0" wide curb on both sides and type 10 rail. The average skew is 68°. The bridges have approximately 4" of asphalt.

WORK DESCRIPTION (E-17-GL & E-17-GM)

Install temporary support as shown in the plans. Remove unsound concrete from surfaces of concrete girder and pier cap and place concrete patching as shown in the drawings and as directed by the Engineer. Install corbels under girders as shown in the drawings.

BRIDGE DESCRIPTION (F-16-FL)

F-16-FL, is a four span (31'-8",50'-0" , 50'-0",31'-8") bridge; concrete on rolled I beam, composite and concrete tee. It is located at the intersection of SH 6 and SH 95 at MP 282.273. Structure is 98'-0" curb to curb with no skew, it has 2'-0" wide curb on both sides. Existing rail type 4.

WORK DESCRIPTION (F-16-FL)

Install pier cap supports as shown in the plans. Install temporary support as shown in the plans. Remove unsound concrete from surfaces of concrete column and pier cap and place concrete patching as shown in the drawings and as directed by the Engineer. Install corbels under girders as shown in the drawings.

BRIDGE DESCRIPTION (E-17-GA & E-17-GB)

E-17-GA (Westbound) and E-17-GB (Eastbound) are three span (31'-0", 66'-6", 31'-0") bridges, Concrete Slab and Girder, Composite. They are located on I-70 at MP 278.49 over SH 35 (Quebec Street). Structures are 48'-0" curb to curb with a 0° skew. They have 2'curbs on both sides with Type 10 Bridgerail.

WORK DESCRIPTION (E-17-GA & E-17-GB)

Remove unsound concrete from surfaces of columns. Sandblast reinforcing steel, place new reinforcing steel as required. Patch concrete removal areas. Apply concrete sealer to pier columns.

INDEX OF DRAWINGS

Dwg. No. B01 GENERAL NOTES AND WORK DESCRIPTION

Dwg. No. B02 SUMMARY OF QUANTITIES

Dwg. No. B03 GENERAL LAYOUT E-17-GL & E-17-GM

Dwg. No. B04 SECTIONS & DETAILS E-17-GL & E-17-GM

Dwg. No. B05 BEARING REPAIR DETAILS E-17-GL & E-17-GM

Dwg. No. B06 TEMPORARY SUPPORT DETAILS E-17-GL & GM

Dwg. No. B07 GENERAL LAYOUT F-16-FL

Dwg. No. B08 COLUMN AND PIER CAP REPAIR F-16-FL

Dwg. No. B09 BEARING REPAIR DETAILS F-16-FL

Dwg. No. B10 TEMPORARY SUPPORT DETAILS F-16-FL

Dwg. No. B11 PIER CAP SUPPORT DETAILS F-16-FL

Dwg. No. B12 GENERAL LAYOUT AND REPAIR DETAILS E-17-GA & E-17-GB

Fig. 16.1-1 Portion of General Notes Sheet for Multiple Structures

16.4 Orientation of Details

The PLAN of the bridge shall be placed, if possible, at the upper left of the drawing. The location of the repairs should be shown in plan view when possible. The ELEVATION of the bridge shall be projected below the PLAN if necessary for clarifying the repair location. When possible, the END ELEVATION and/or Sections shall be placed to the right of the PLAN and ELEVATION. If space is limited, the sections or secondary views may be shown on another sheet. Generally, sections should be taken from the PLAN and ELEVATION rather than from secondary views or other sections.

Bridge specific details should be shown on sequential sheets so a Contractor can pull the sheets for a specific bridge easier. If there are details common to multiple bridges, those details may be put at the end of the plan set to avoid duplication.

16.5 Control

Original Horizontal Control Lines, Stationing, Layout Lines, Profile Grade Lines and Centerlines are not required to complete the work and should not be shown. All locations or control lines should be dimensioned off of the existing structure. Abutments, piers and girders shall be labelled according to the current inspection report. A note should be added on the drawings if this numbering is different from original drawings, (e.g., “Abutment & Pier Numbers match Structure Inspection Reports; Previous As-Built Drawings may differ.”) The display of lane lines and shoulders are helpful for determination of traffic control, but are not required.

16.6 Centerlines

Centerlines shall be identified and shown as discussed in the following subsections:

Location - Centerlines shall be shown on views which help locate the repair, when applicable.

Plan View

Centerline of all girders (if part of the repair)

Elevation View

Centerline of Piers

Centerline of columns and footings

Identification - The centerlines shall be identified in the following ways:

Centerline of Girder - A circle containing the girder letter is placed on each girder centerline, as shown in the PLAN views in the graphic examples. Widened bridges may have a letter / number naming convention. These girder letters shall correspond to those shown in the Inspection Sketch. Span number may be added to the girder label.

Other Centerlines - When it is applicable to identify other centerlines, it should be done by using their particular names. Examples: Centerline Bearing, Centerline Anchor Bolts, Centerline Columns, Centerline Footings, etc.

16.7 Elevations

Elevations are not typically required on repair projects since most of the work is relative to the existing structure. Elevations may be useful in determining scale, clearances, and access issues.

16.8 Dimensions

A sufficient number of dimensions shall be shown on the details to provide adequate information necessary in the checking of the plans and the construction and/or design of the repair. Quantities should be able to be verified based on plan dimensions.

The +/- symbol should only be used to draw the Contractor's attention to items that should be field verified and are critical to design or fabrication. A general note such as “Dimensions are subject to typical construction tolerances” could be used as well.

16.9 Angles

The following angles shall be shown in the PLAN view of the structure, when applicable.

A) Bent angle
A) Angles that the girders generate with the centerline of pier or centerline of bearings, if they are different than the bent angle.

16.10 Temporary Support

Some repairs will require temporary support of the girders in order to complete the required work. At a minimum, a conceptual temporary support detail should be provided. See Section 16.12(I).

16.11 Worksheets

The use of the Bridge Worksheets is encouraged, but the designer shall verify the dimensions and applicability of the worksheet for the required repair.

16.12 Plan Sheet Information

The following paragraphs provide a brief overview of each repair type, a checklist of information that is likely to be required for each repair type, photographs and sample plan sheets. The repair examples shown here are a guide only; each repair shall be evaluated for applicability of examples and worksheets on a case by case basis. See Chapter 1 for border information checking procedures.

A) **Bridgerail Replacement** – Typically these projects involve replacing substandard bridge rails with new standard rails. The option of missing the existing post locations or matching the post locations is typically determined by the region's bridge unit leader but may be required by bridge restrictions as well.

Check Items

The following is a list of information to be shown on the drawings, as applicable. Additional information may be shown as required. A field visit should be made prior to FOR to verify as-built locations, curb heights and conflicts.

1) Distance from last bridge rail posts to end of bridge or approach slab
2) Standard post to post dimensions
3) Details to match existing anchor bolts if required
4) Illustration that standard Guardrail Terminators can be installed without hitting abutment or approach slab
5) Typical section, bridge elevation and pier sections and details to depict access and construction restrictions such as high water level, traffic, etc.
6) Any required bridge rail transitions
7) Work Description
8) Bridge Description

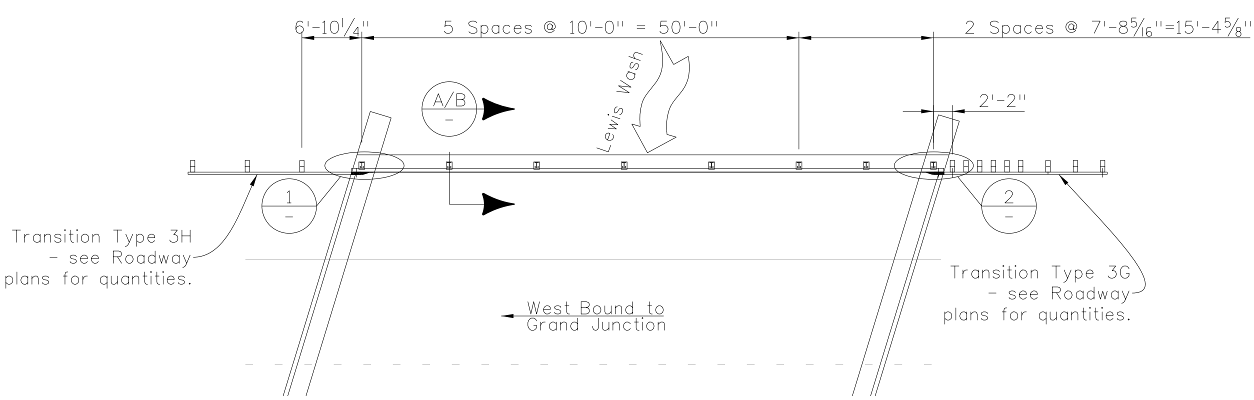
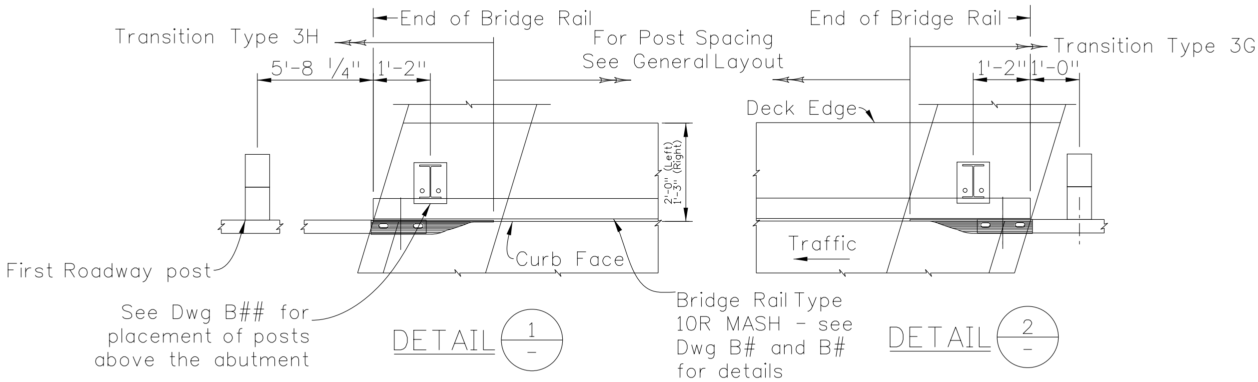


Fig. 16.12(A)-1 Sample Plan showing Bridgerail Post Spacing

N)



O)
P)

Fig. 16.12(A)-2 Sample Detail showing Bridgerail post locations/clearances near Abutment

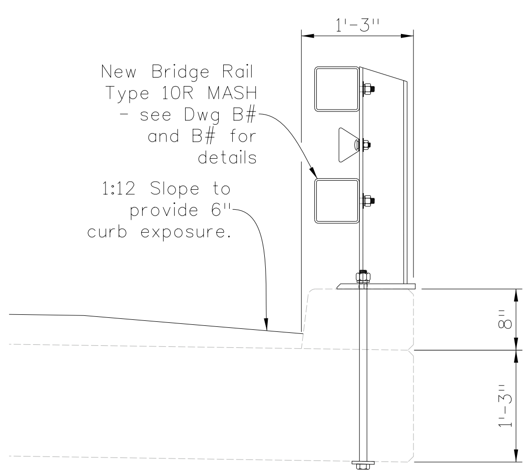


Fig. 16.12(A)-3 Sample Section showing paving detail and Post Connection

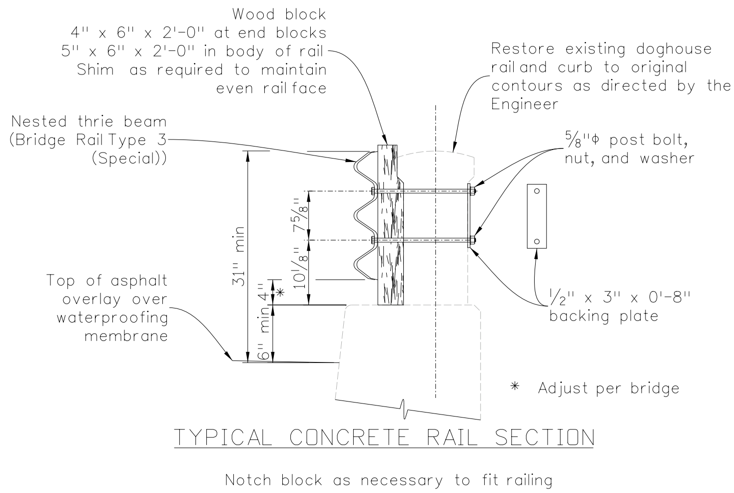
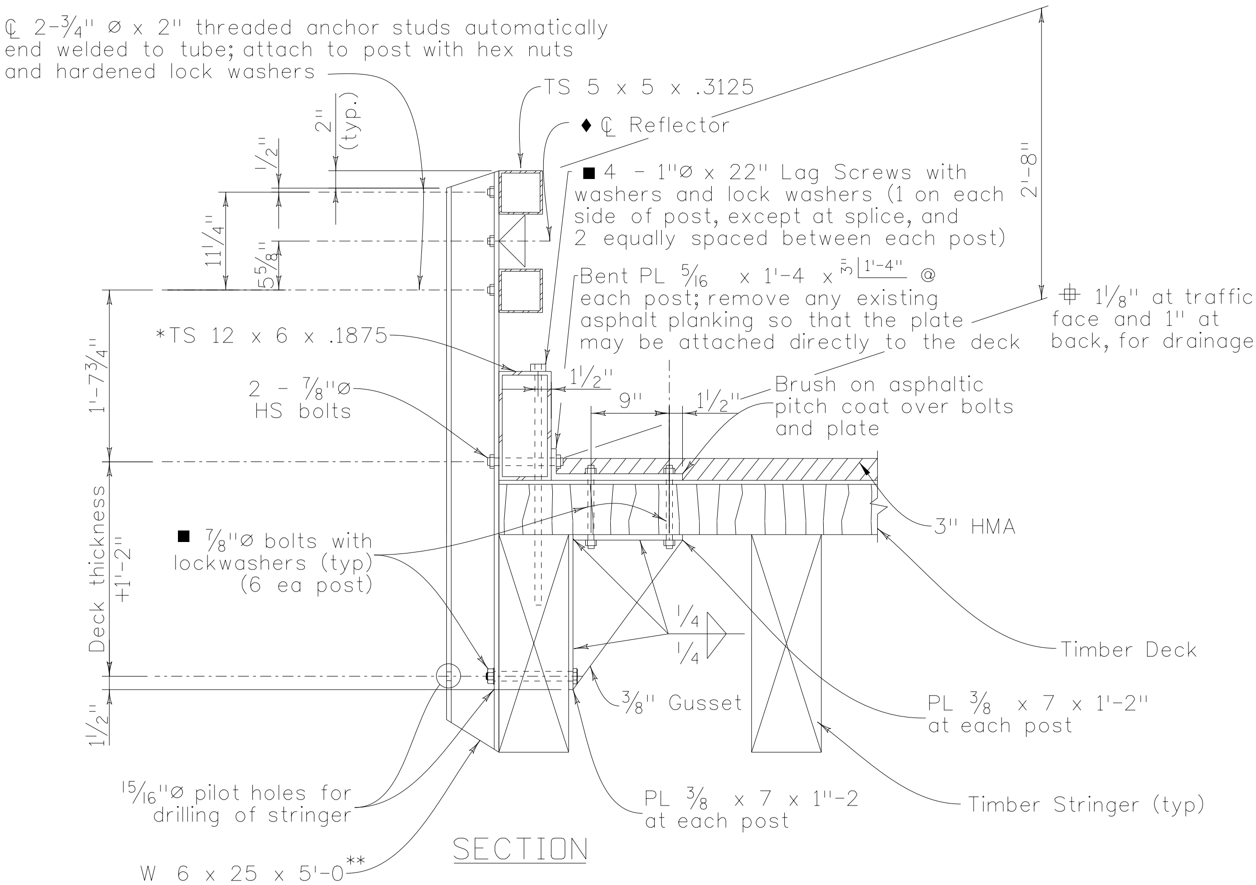


Fig. 16.12(A)-4 Sample Section showing Bridgerail Repair for Doghouse Type Rail

(To be used if replacement is not an option)



♦ See M-606-1 for details - attach to post with 5/8"⌀ bolt with hex nut and lock washer

* Existing timber wheelguard shall be removed

** Post length for 6" deck, 3" HMA

Fig. 16.12(A)-5 Sample Section showing Timber Bridge Rail Replacement

(To be used if replacement is not an option)

B) **Expansion Joint Replacement** – These repairs are typically removal of existing expansion joints and replacement with a new standard expansion joint. Some modular joints can be repaired in place, although the repair longevity is questionable. Expansion Joint Replacement should typically be done with overnight closures if lanes cannot be closed. Provide temporary bridge decking / cover plates if repair area will need to be traversed by daytime traffic.

Check Items:

The following is a list of information to be shown on the drawings, as applicable. Additional information may be shown as required. A field visit should be made prior to FOR to verify as-built locations, curb heights and conflicts.

1) Existing reinforcing and interferences and resolve issues
2) Existing utilities
3) Depth of concrete removal
4) Depth of asphalt (height of header)
5) Bridge rail type
6) Curb plate size
7) Construction phasing and details
8) Opening dimensions
9) Typical section, bridge elevation and pier sections and details to depict access and construction restrictions such as high water level, traffic, etc.
10) Work Description
11) Bridge Description

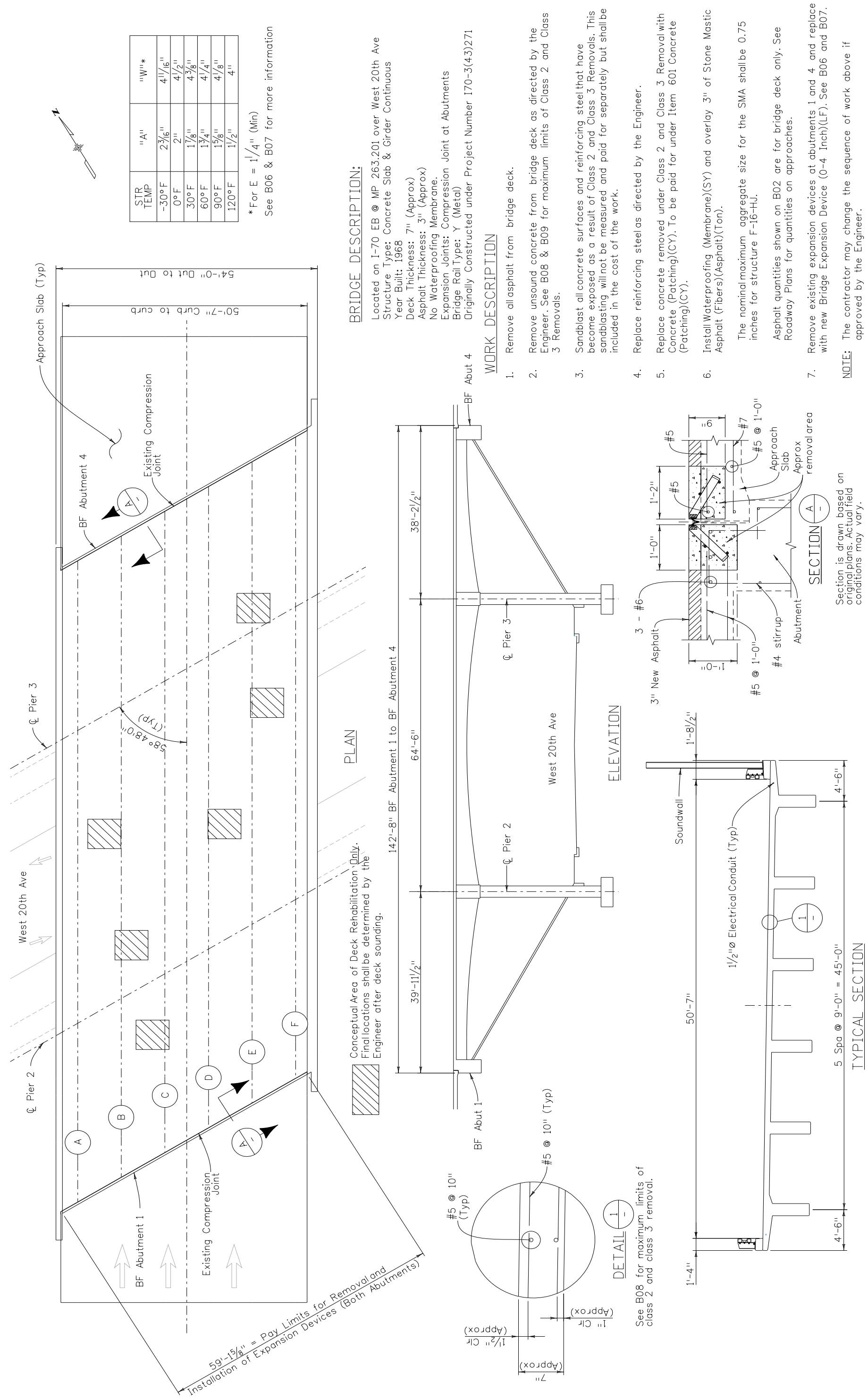


Fig 16.12(B)-1 Sample General Layout for Expansion Joint Replacement

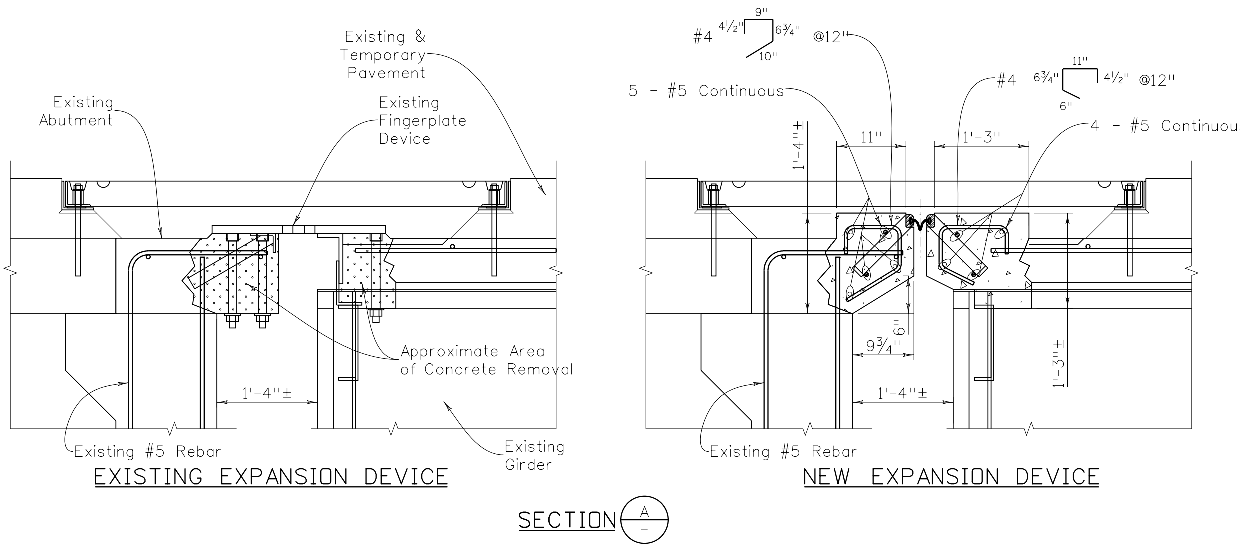


Fig. 16.12(B)-2 Sample Sections showing existing and proposed expansion joint devices

Fig. 16.12(B)-3 Photo of new Expansion device shown in Fig. 16.12(B)-2

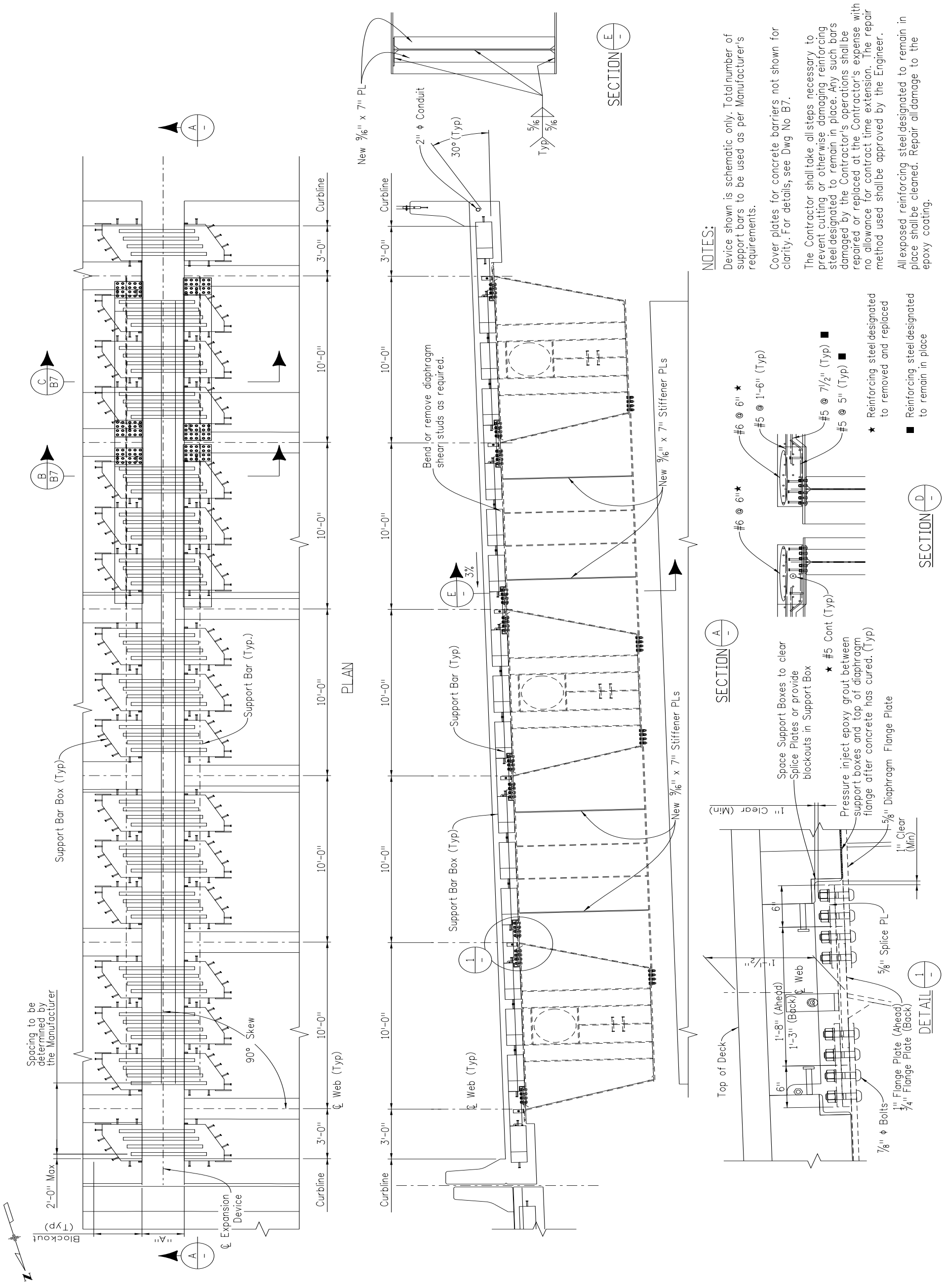


Fig. 16.12(B)-4 Sample of Detail required for a Modular Expansion Device Replacement

C) **Deck Rehabilitation** – Typical requirements for deck rehabilitation include removal of asphalt mat, location of rehabilitation areas, and removal and replacement of concrete. Pay Items for removal vary between regions, e.g.

Region 1 construction prefers using only Class 2 & Class 3 Removals. Rehabilitation areas shown are generally conceptual but may be based on deck sonars or mapping of lower side of the deck & soffit. Waterproofing Membrane should be added to extend the life of the deck. A Typical General Layout Sheet is shown in figure 16.12(C)-4.

Check Items:

The following is a list of information to be shown on the drawings, as applicable. Additional information may be shown as required. A field visit should be made prior to FOR to verify as-built locations and conflicts.

1) Approximate locations of rehab, if locations are only conceptual, label accordingly
2) Length and width of bridge
3) Removal details and pay items
4) Phasing details
   a) For cast-in-place concrete boxes, tee girder bridges and other girder types which rely on the deck for stability, show amount of removal permissible without the requirement of falsework
   b) For steel girders, precast girders and other girder types which do not rely on the deck for stability, show permissible amount of removal similar to Figure 16.12(C)–3
5) Joint details to clarify any interference with rotomilling operations
6) Existing reinforcing, sizes, and spacing
7) Typical section
8) Depth of asphalt for milling/replacement
9) Existing utilities, especially those in the deck
10) Dimension girder spacing
11) Show drain locations and details
12) Typical section, bridge elevation and pier sections and details to depict access and construction restrictions such as high water level, traffic, etc.
13) Work Description
14) Bridge Description
15) Existing concrete strength (if pertinent)

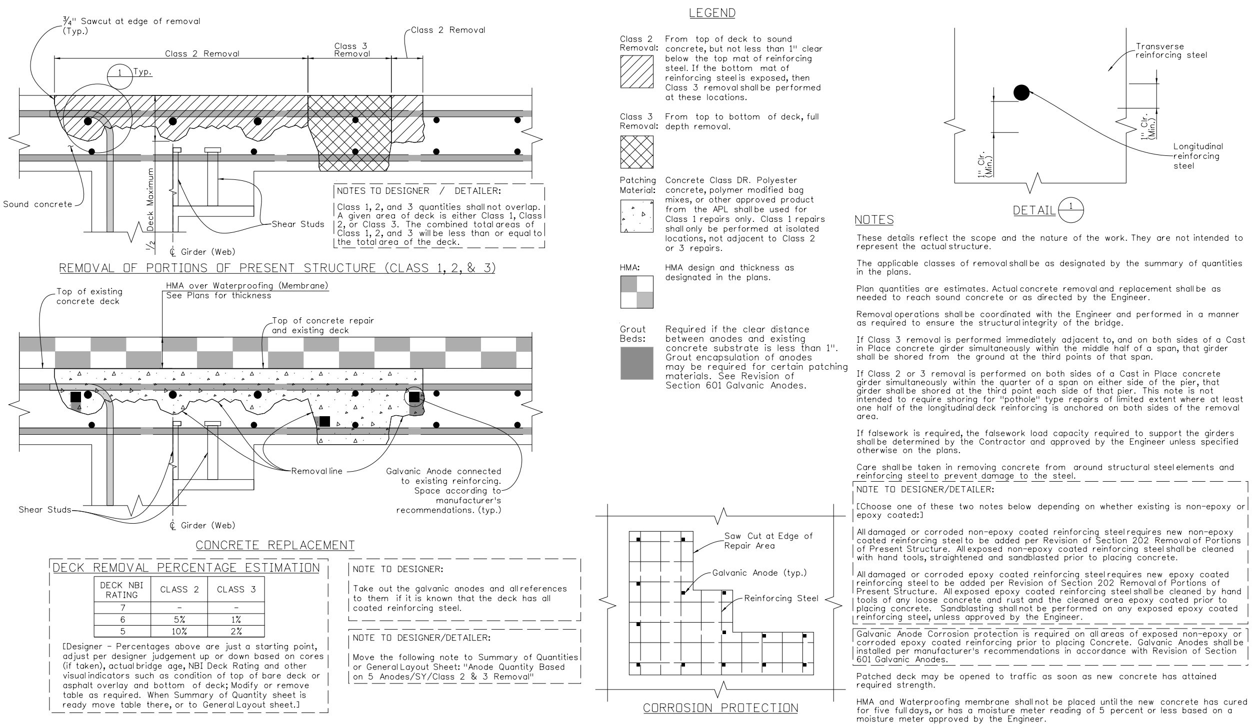


Fig. 16.12(C)-1 Sample of Worksheet for Deck Rehabilitation Removal Details

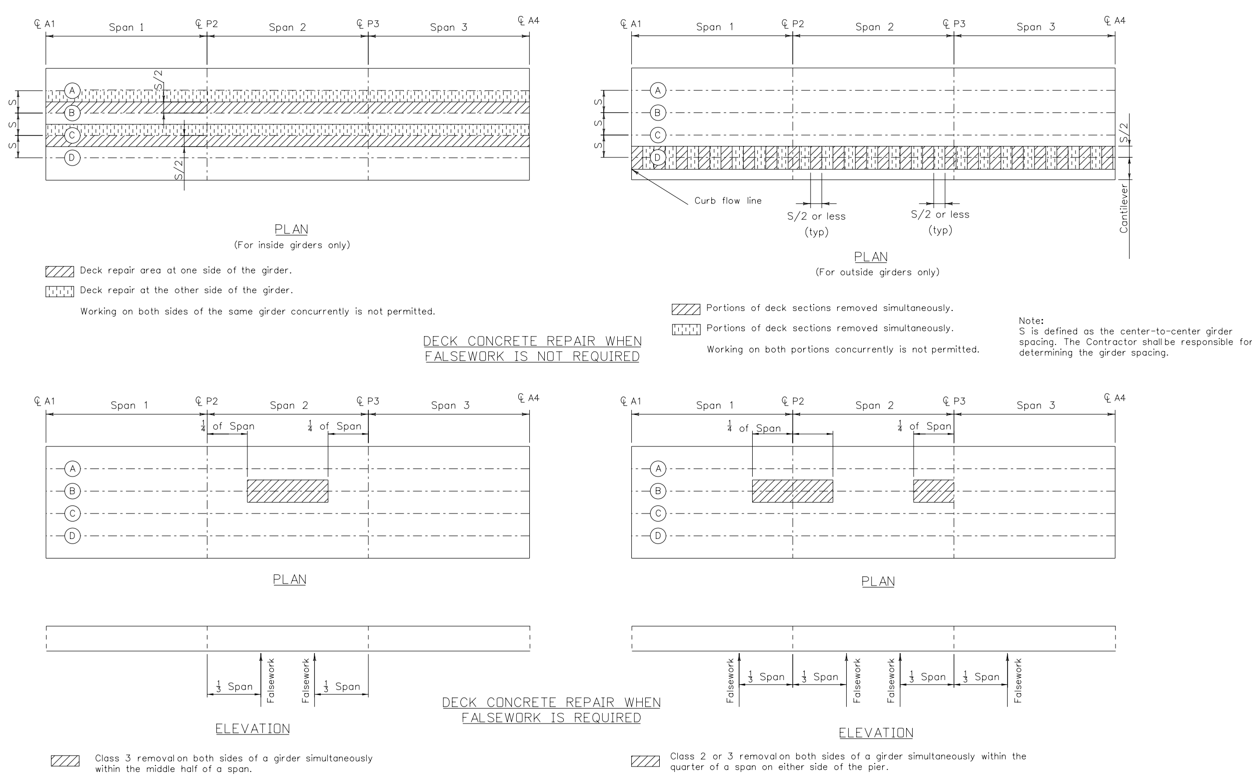


Fig. 16.12(C)-2 Sample Phasing Details for Girders where Falsework may be required

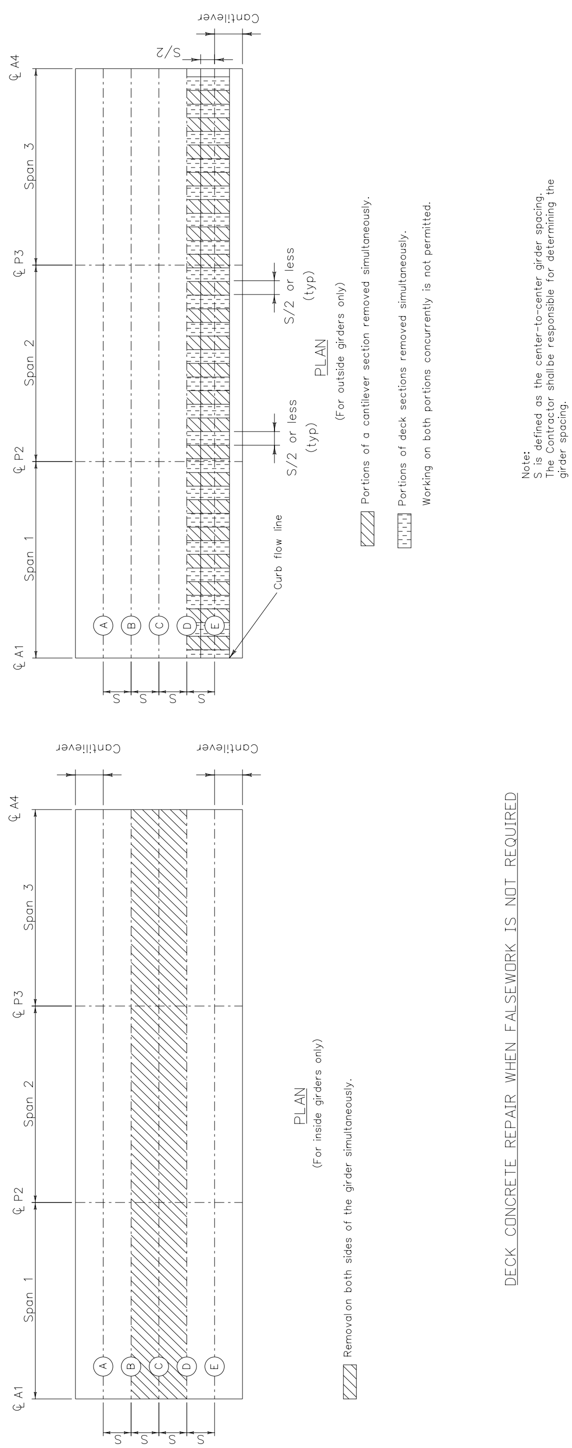


Fig. 16.12(C)-3 Sample Phasing Details for Girders where Falsework is generally not required

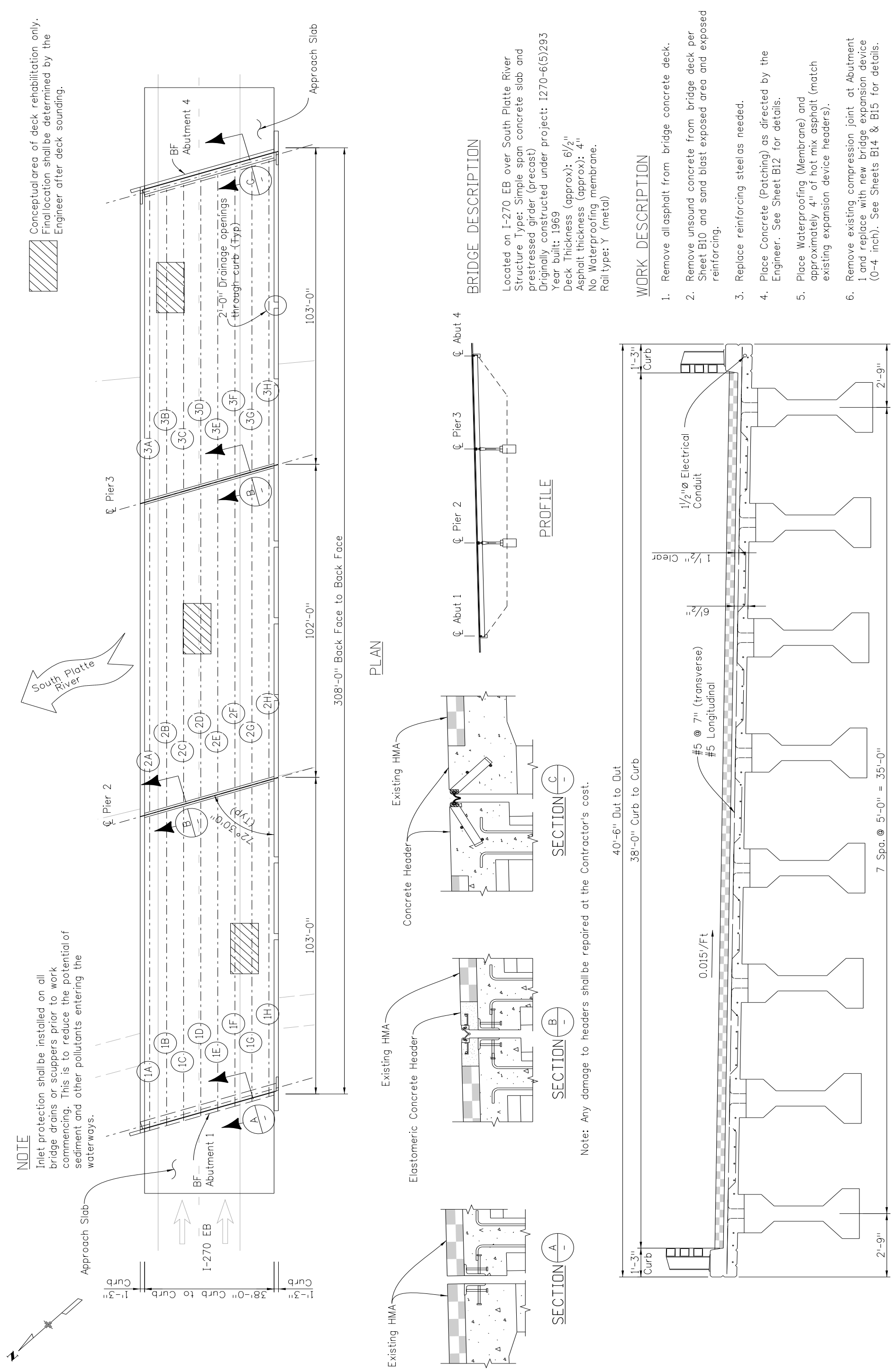


Fig. 16.12(C)-4 Sample Layout and Details for Deck Rehabilitation Project

Fig. 16.12(C)-5 Close-up Photo of Deck Rehabilitation

Fig. 16.12(C)-6   Photo of Deck Rehabilitation (Removals approaching critical levels)

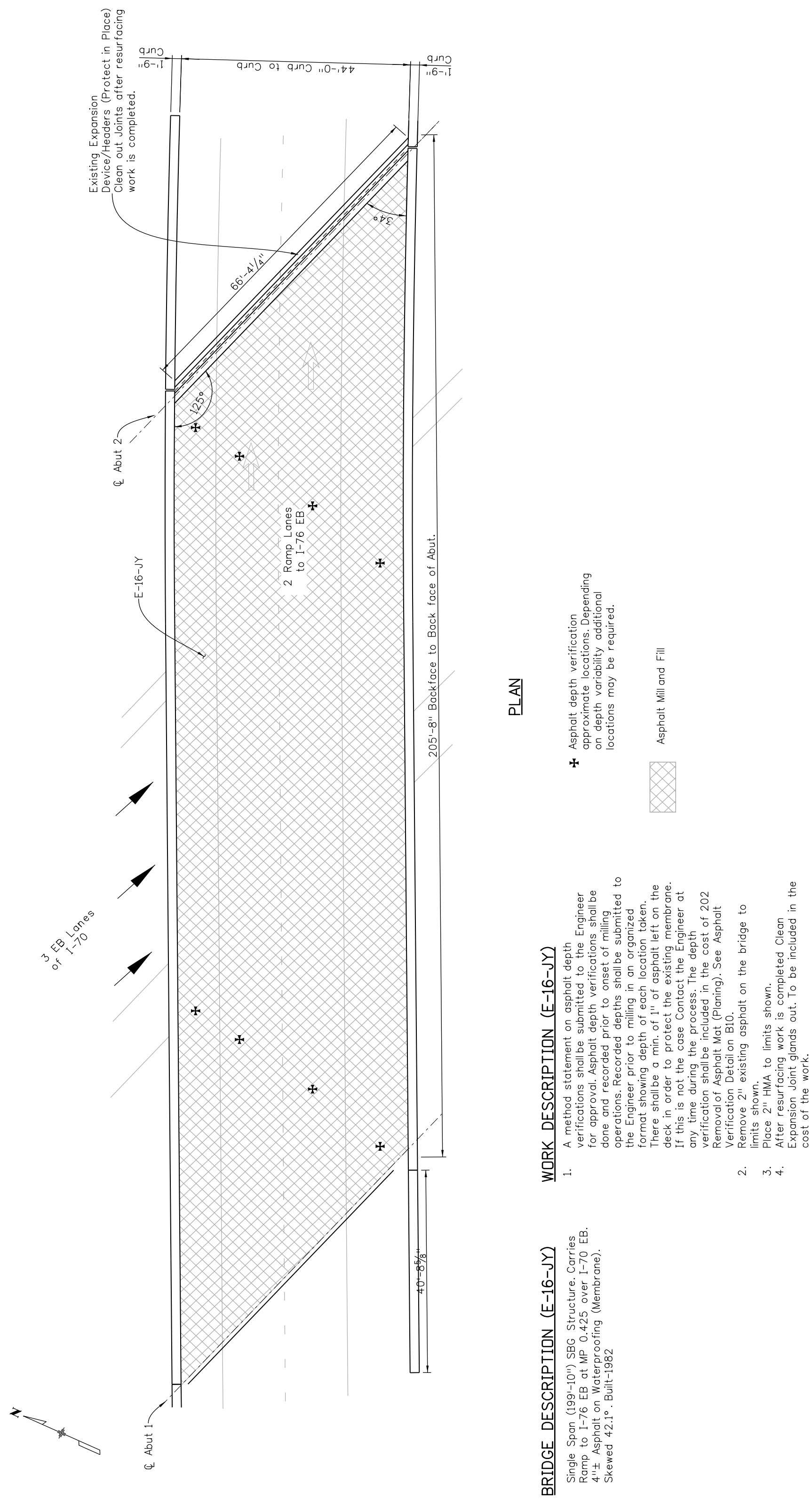


Fig. 16.12(C)-7 Example of asphalt deck coring

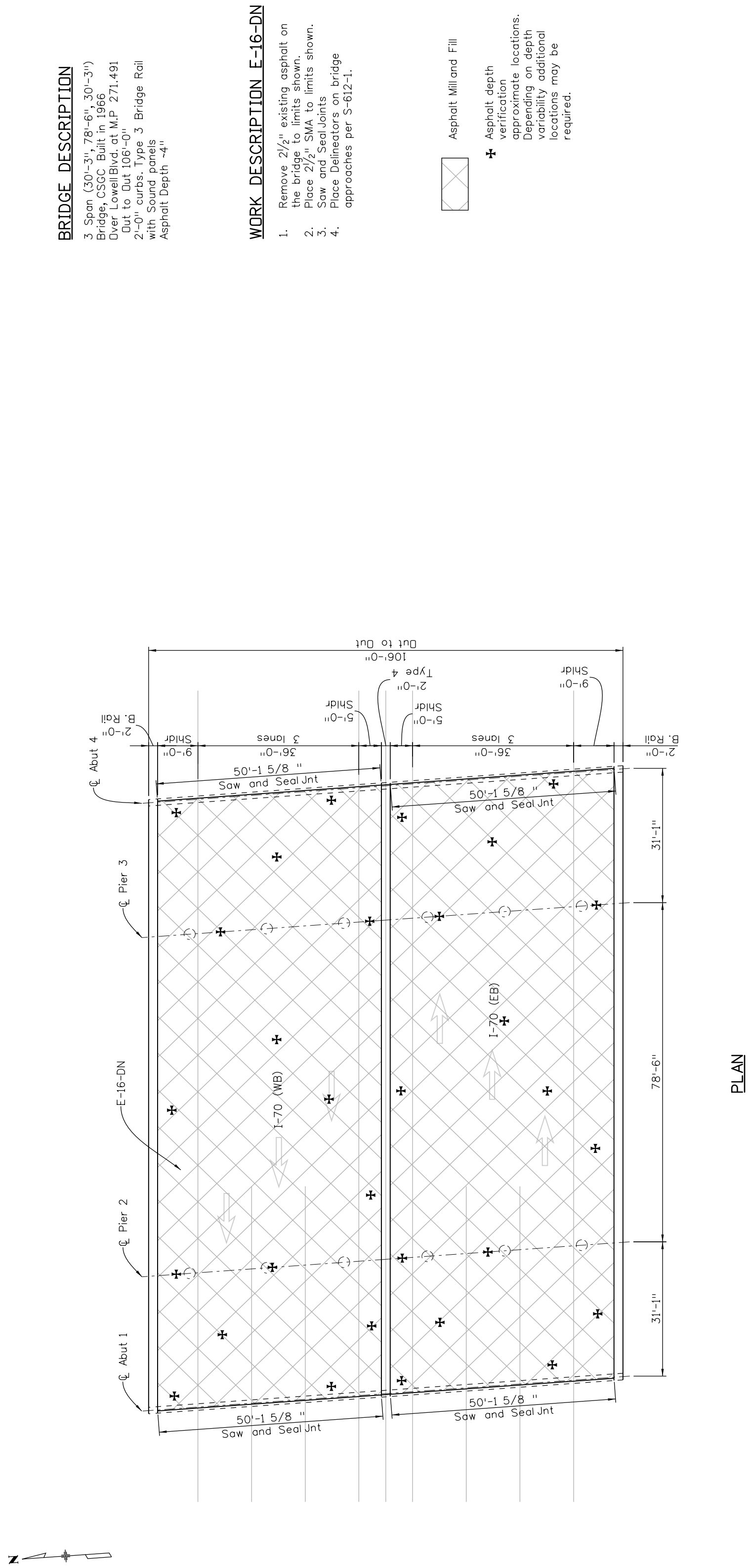


Fig. 16.12(C)-8 Example of asphalt deck coring

D) **Pier Cap and Column Repair** – These repairs are typically rehabilitation of column, abutment & pier damage due to water leakage or corrosive salts. Often they are done in conjunction with the addition of corbels. If possible, the source of leakage should be removed. Waterproofing/Sealing can extend the life of the repair. Sample repair details are shown in Figures 16.12(D)-1 through 6.

Check Items:

The following is a list of information to be shown on the drawings, as applicable. Additional information may be shown as required. A field visit should be made prior to FOR to verify as-built locations and conflicts.

1) Approximate locations of repair
2) Existing reinforcing, sizes and spacing
3) Amount of permissible loss from column prior to contacting Staff Bridge or providing temporary support
4) Splicing details
5) Repair details
6) Rebar replacement details
7) Typical section, bridge elevation and pier sections and details to depict access and construction restrictions such as high water level, traffic, etc.
8) Work Description
9) Bridge Description

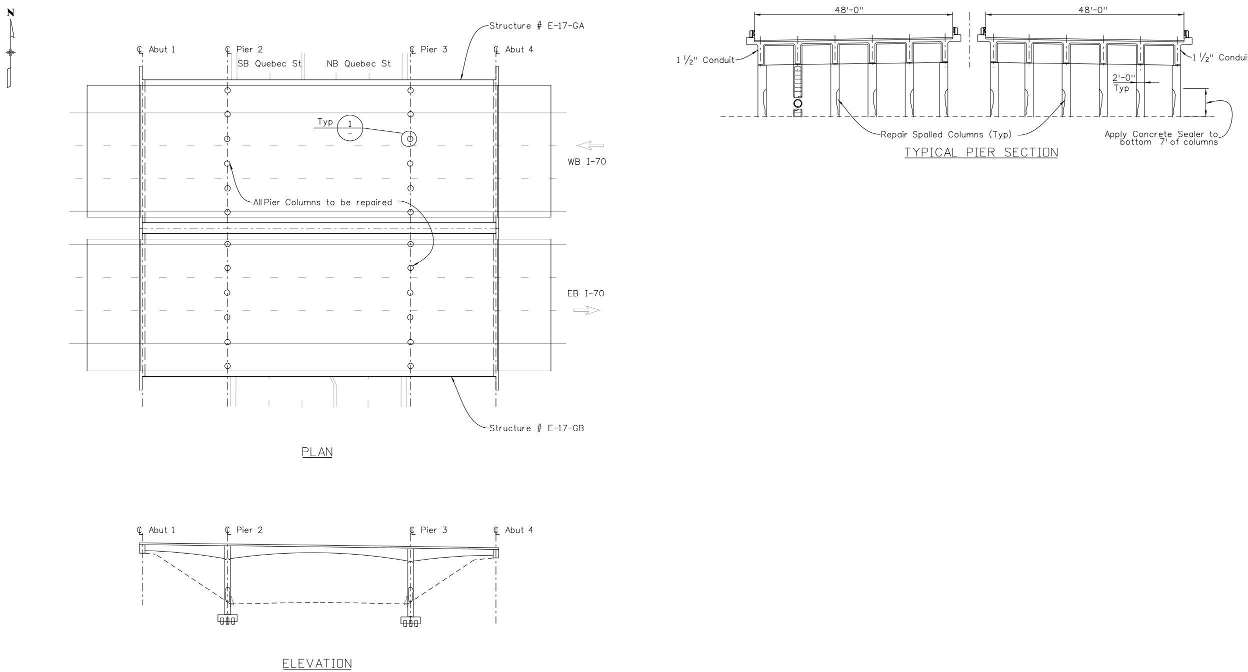


Fig. 16.12(D)-1   Sample General Layout for a Pier Cap/Column Repair

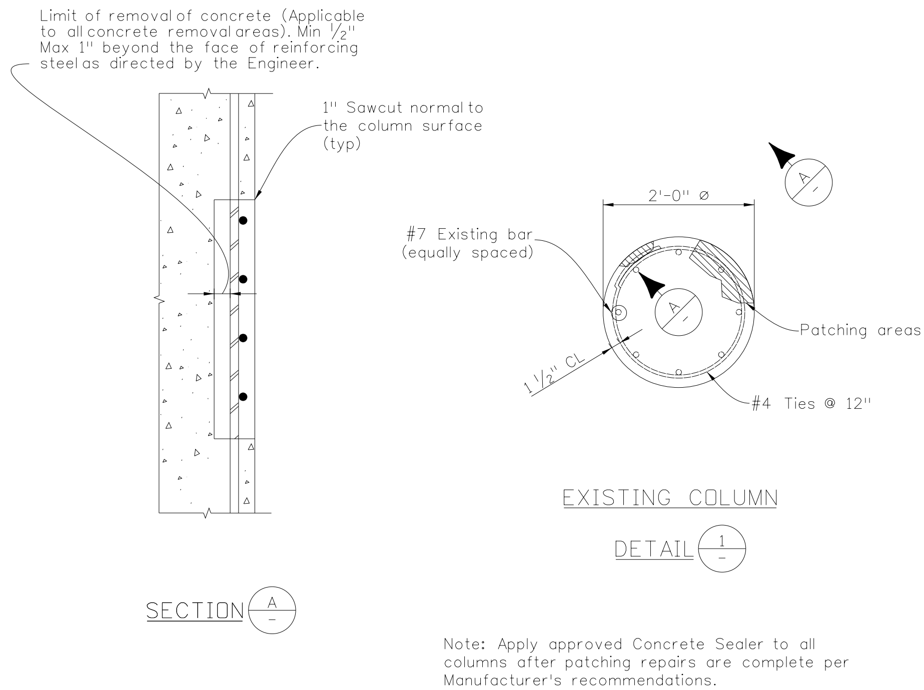


Fig. 16.12(D)-2 Sample Detail showing Removals and Patching

Fig. 16.12(D)-3 Photos showing column damage and repair process

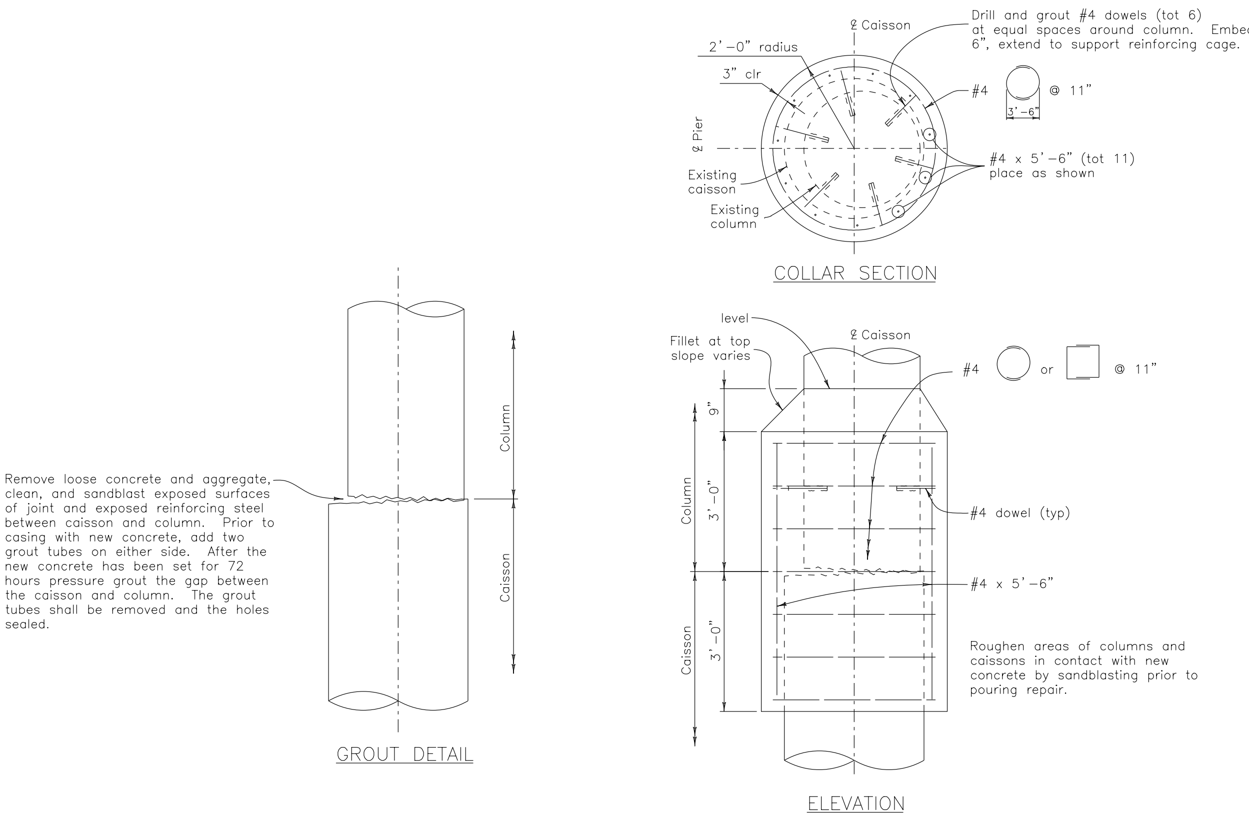


Fig. 16.12(D)-4 Sample of Column Repair

Fig. 16.12(D)-5   Photo of Damage to be repair by (D)-4 details

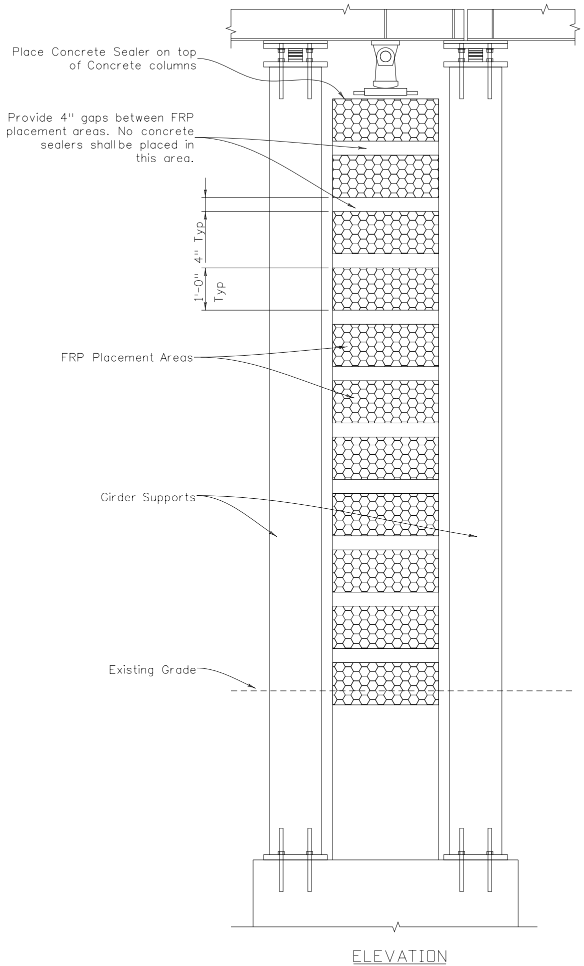


Fig. 16.12(D)-6 Sample of Fiber Wrap Details

Fig. 16.12(D)-7 Photo of Fiber Wrap

Q) **Impact Repair** – These repairs are typically required due to high loads hitting and damaging the bridge girders. If the damage is not too severe for steel girders, flame straightening can often be used to bring the girder back to its original position although lead based paints can be an issue. Lead based paints or coatings should be addressed in the repair details. Provide appropriate specifications for dealing with the lead based coatings prior to the repair. Depending on the amount of damage to the girder, partial or full closure of the bridge may be necessary.

Check Items:

The following is a list of information to be shown on the drawings, as applicable. Additional information may be shown as required. A field visit should be made prior to FOR to verify as-built locations and conflicts.

1) Amount of impact deflection in steel girders
2) Approximate area of repair (Pictures may be used to depict the amount of damage but should not be the sole description)
3) Layout, girder spacing & typical section
4) Grade of steel
5) Typical section, bridge elevation and pier sections and details to depict access and construction restrictions such as high water level, traffic, etc.
6) Specifications for Hazardous Coatings
7) Work Description
8) Bridge Description

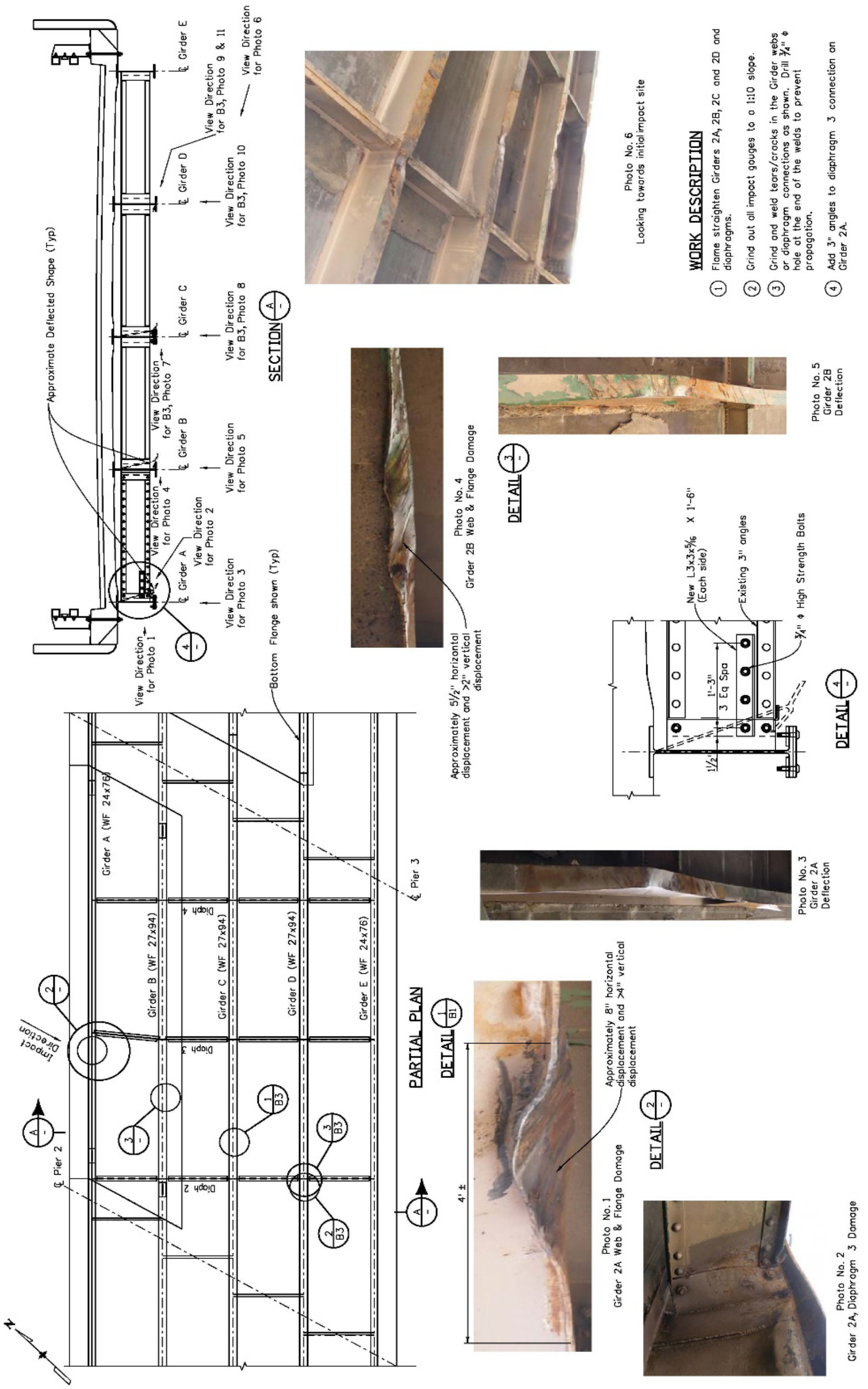


Fig. 16.12(E)-1 Sample of Plan for Steel Repairs

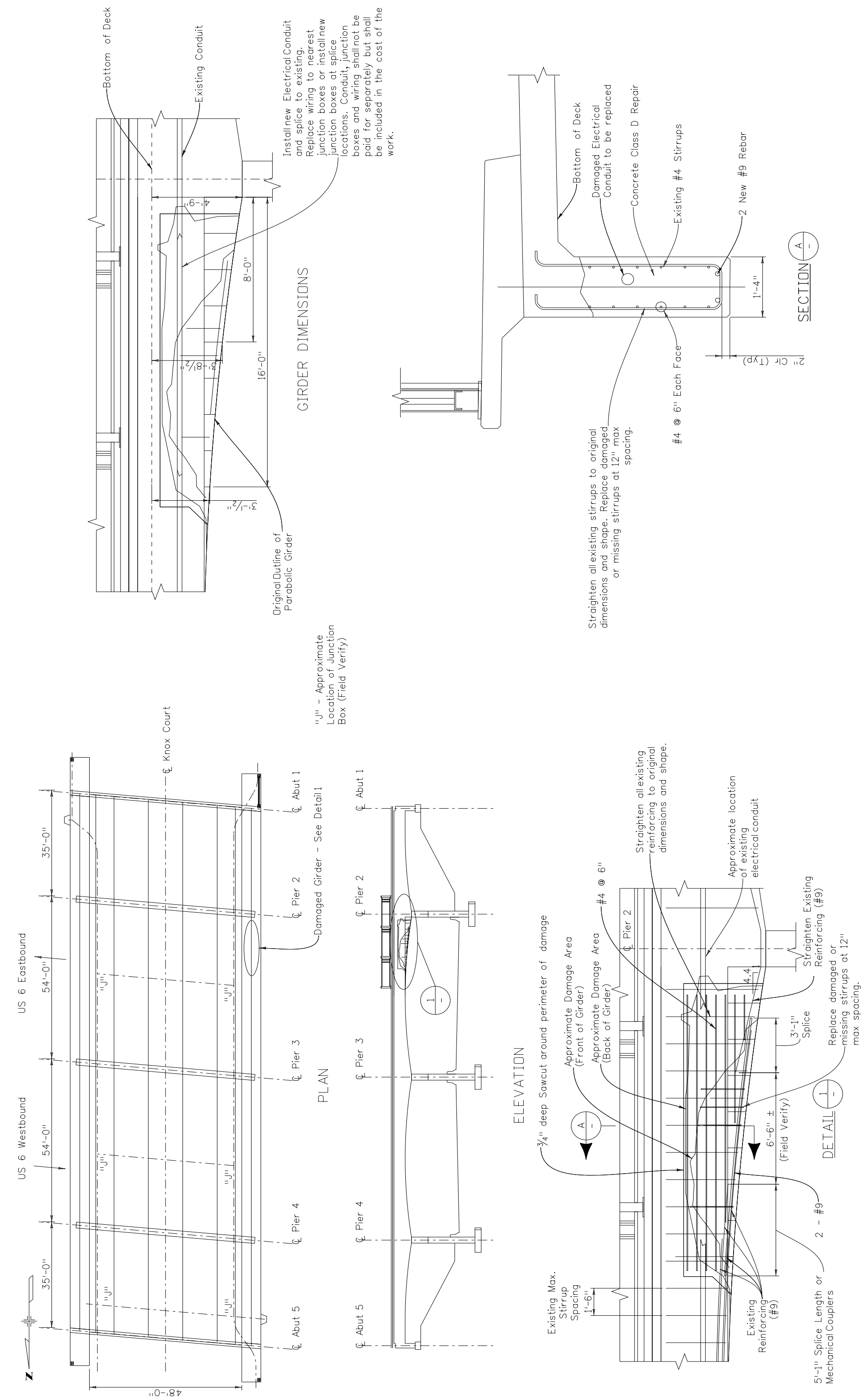


Fig. 16.12(E)-2 Sample Plan of Concrete Tee Girder Repair

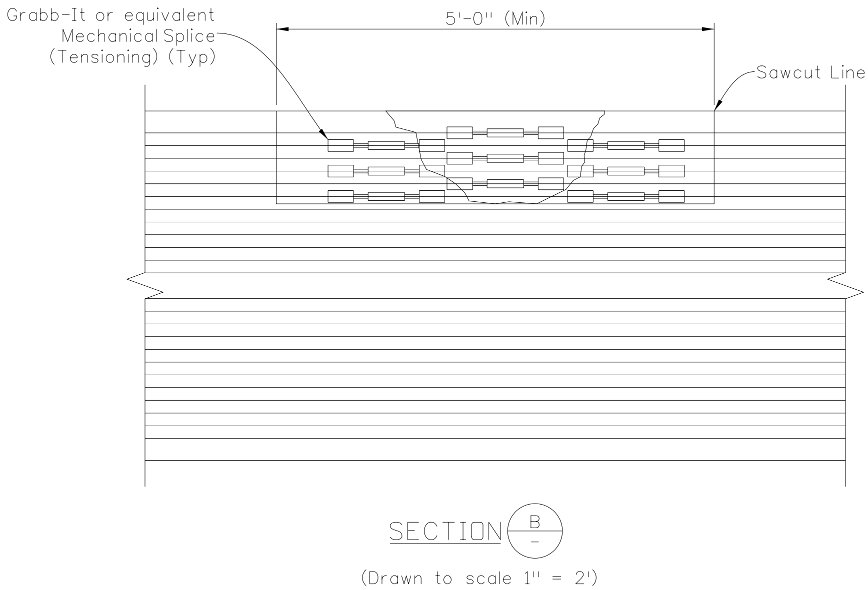


Fig. 16.12(E)-3 Sample Section of Precast Prestressing Repair

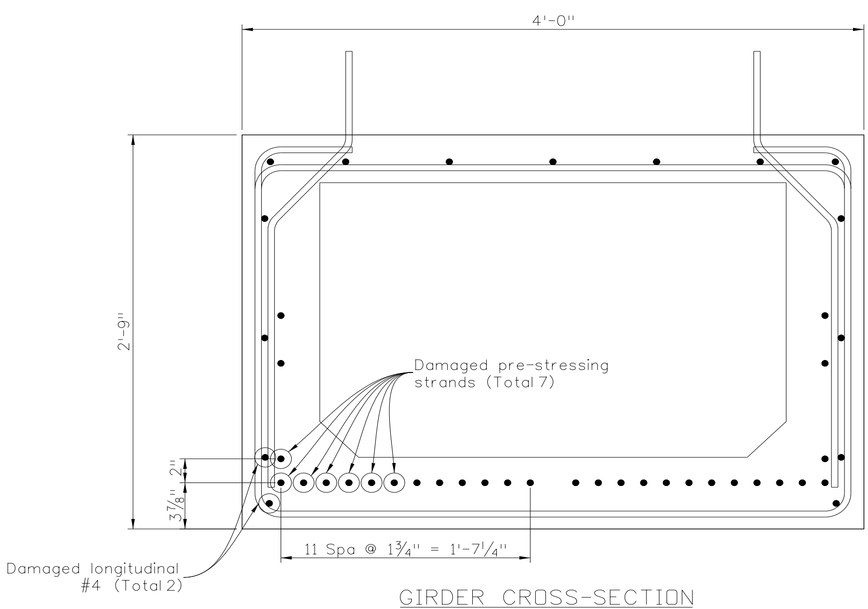


Fig. 16.12(E)-4 Sample Section of Precast Girder Repair

Fig. 16.12(E)-5 Photo of Precast Girder repair in progress

R) **Corbel Placement** – These repairs are typically requested by Bridge Inspection when the amount of girder bearing has been significantly reduced. Corbels could be considered as permanent falsework, but are considered more of a secondary support. If the loss or removal area for the pier or abutment patching is greater than ~33% of the bearing area, temporary supports will probably be required during pier repair and corbel installation. In some cases, the temporary support may be able to be used for a more permanent support, e.g. pier straddle supports. See Section (I) for sample falsework details.

<u>Check Items:</u>

The following is a list of information to be shown on the drawings, as applicable. Additional information may be shown as required. A field visit should be made prior to FOR to verify as-built locations and conflicts. In addition, constructability and “fit” of supports will be checked (see Section I)

1) Conflicts with existing reinforcing and/or resolutions
2) Location of bolt pattern
3) Skew angle and angle of corbel if different than skew
4) Dimension from top of cap to bolt layout
5) Width of Pier Cap
6) Copy of the existing plans or enough details to depict reinforcing & conflicts clearly
7) Temporary support details as required (See Section I)
8) Typical section, bridge elevation and pier sections and details to depict access and construction restrictions such as high water level, traffic, etc.
9) Work Description
10) Bridge Description

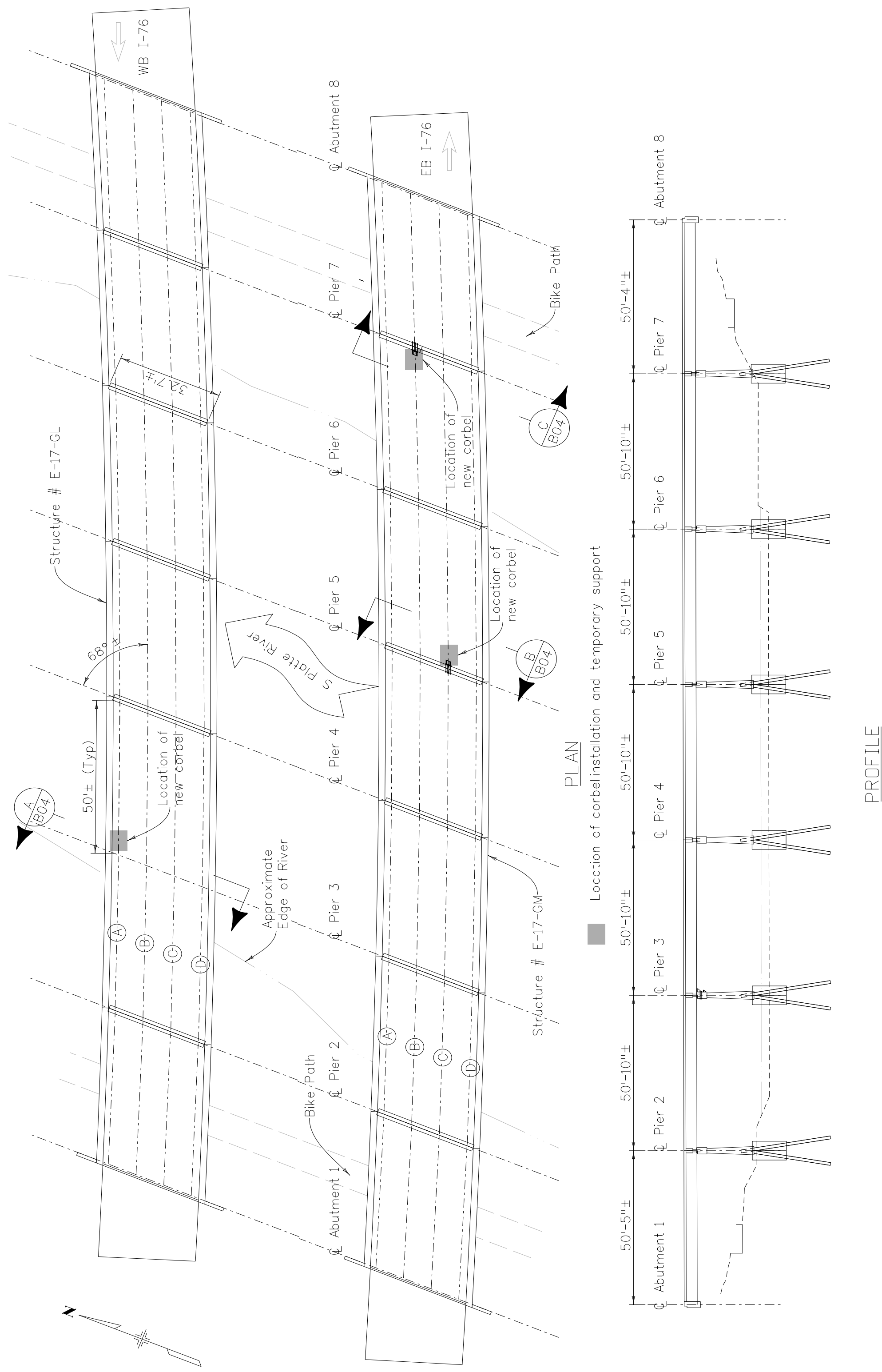


Fig. 16.12(F)-1 Sample Plan for Corbel Placement

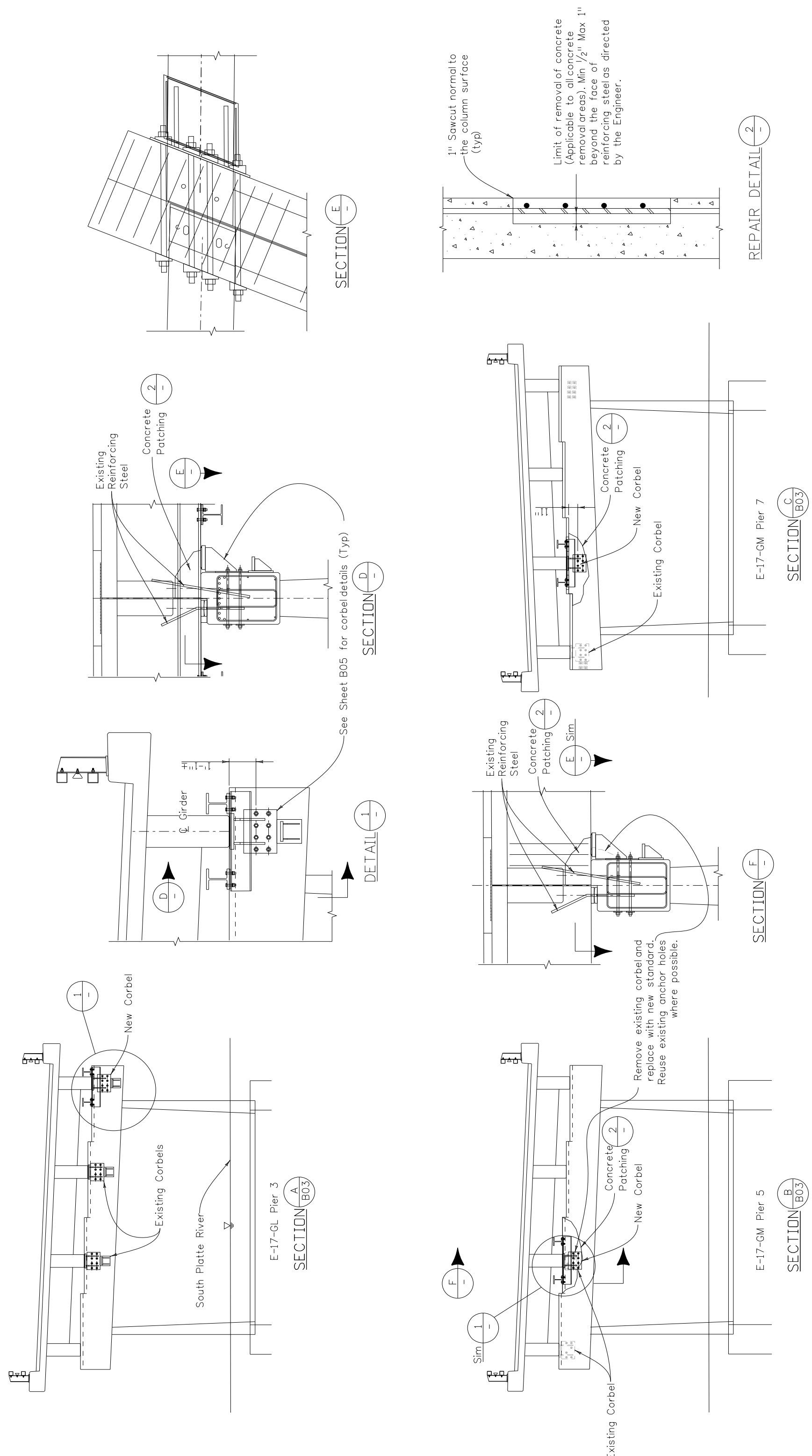
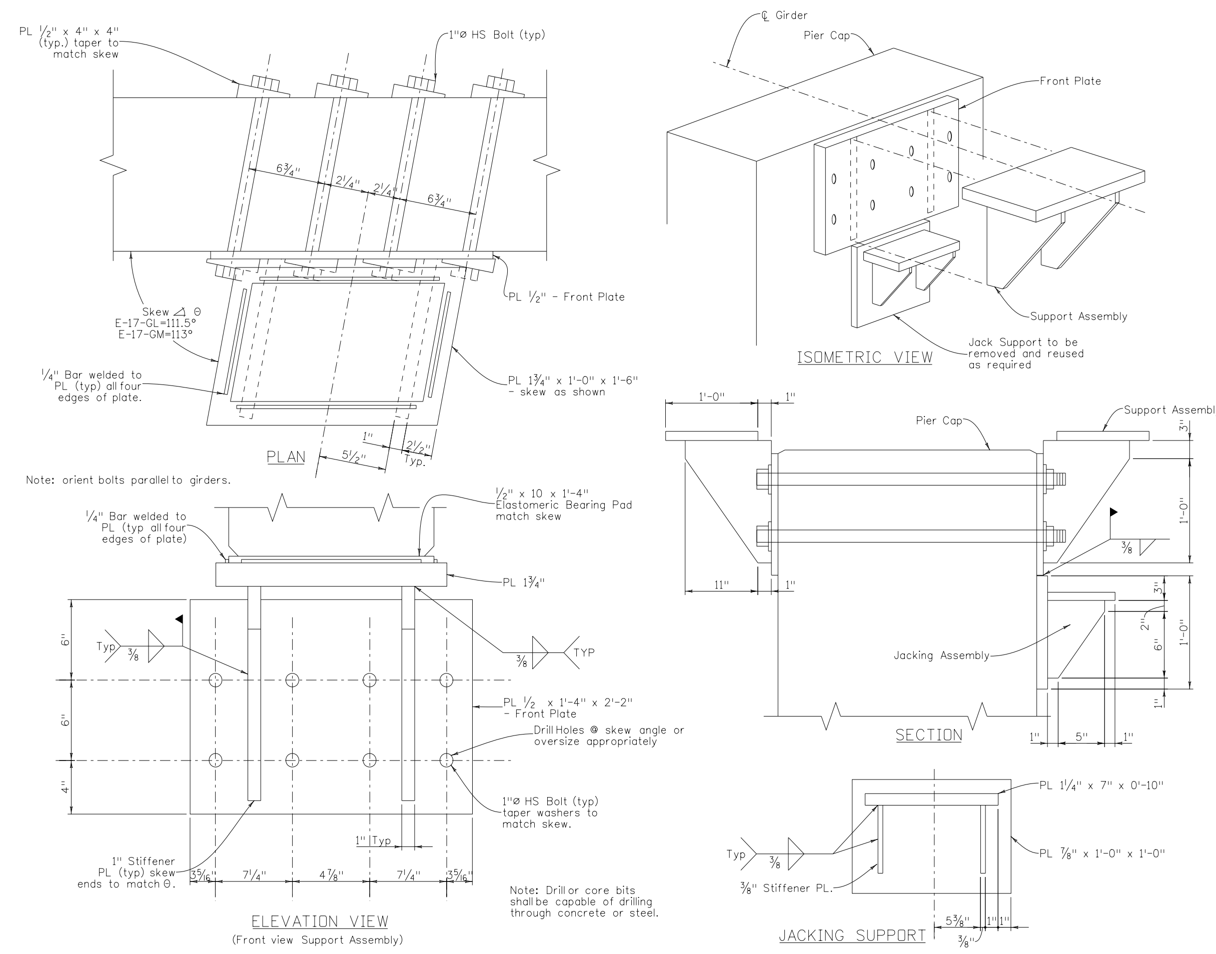


Fig. 16.12(F)-2   Sample Sections and Elevations for Corbel Placement



GENERAL NOTES:

Design lengths below assume a CSG structure type carrying an HS 20-44 loading with an 8" deck and 4" of asphalt.

Note: where repair is required on both sides of a pier cap along a single girder line, place bearing assembly on both sides as shown in the section.

All bolts shall be A449 high strength bolts.

The Contractor shall verify all dimensions prior to ordering materials

SUGGESTED CONSTRUCTION PROCEDURE

1. Locate and mark centerline of the girder on the pier cap.
2. Mark location of bolt holes on pier cap, see elevation view and section.
3. Drill holes in pier cap and place bolts.
4. Cut holes in plywood form to match bolt holes in pier cap.
5. Remove loose concrete and clean reinforcing steel.
6. Bolt the form in place and restore the pier cap to its original section using an approved grout (Duracal, etc.)
7. Allow curing time as recommended by the Manufacturer before removing the form.
8. Using the form for a pattern, cut the bolt holes in the front plate.
9. Attach plates and tighten bolts. (100 lb-ft Torque).
10. Raise the support assembly until the elastomeric pad is compressed 1/16" (200 psi x pad area = jacking force).
11. Field weld the support assembly to the front plate.
12. Paint all steel as directed by the Engineer.

Fig. 16.12(F)-3 Sample Worksheet for Corbel Placement Details

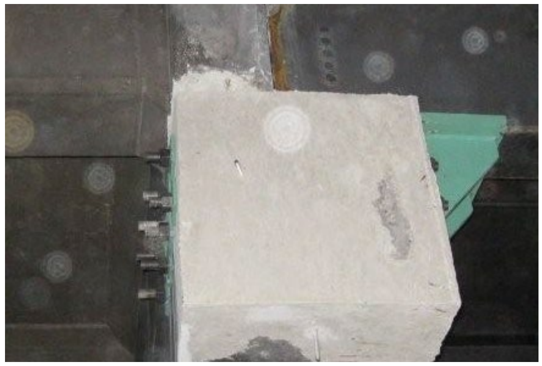


Fig. 16.12(F)-4 Photo of Corbel Placement and Pier Cap repair

Fig. 16.12(F)-5 Front Side of Corbel

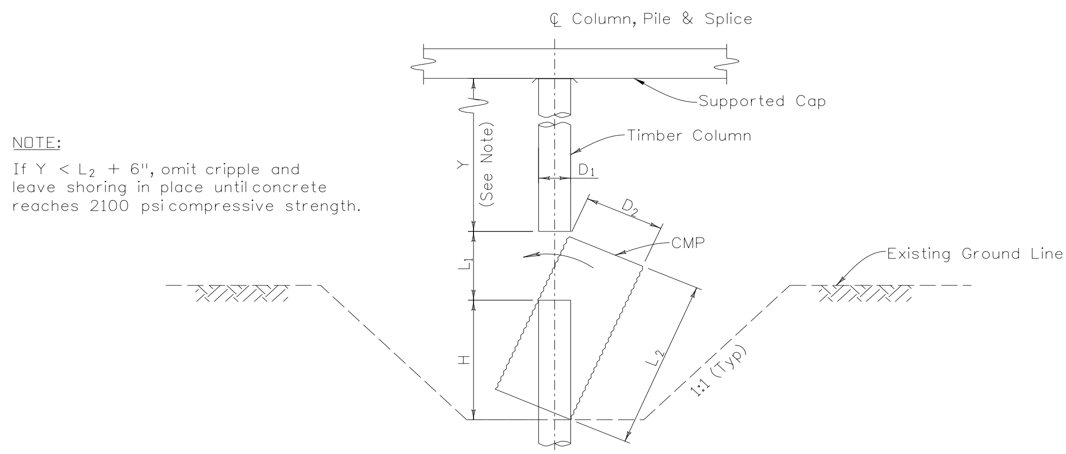
Fig. 16.12(F)-6 Back Side of Single Corbel

S) **Timber Pile Repair** – Typically timber piles need repair due to rotting or insufficient diameter. Repairs include replacing decomposed areas with timber, concrete encasing, or adding supports or bracing.

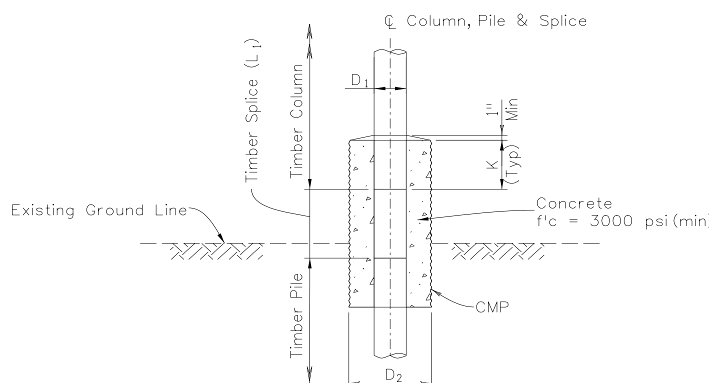
Check Items:

The following is a list of information to be shown on the drawings, as applicable. Additional information may be shown as required. A field visit should be made prior to FOR to verify as-built locations and conflicts and to confirm applicability.

1) Location of damaged column
2) Typical section, bridge elevation and pier sections and details to depict access and construction restrictions such as high water level, traffic, etc.
3) Work Description
4) Bridge Description



SECTION
(CMP Installation)



SECTION
(Completed Splice)

Fig. 16.12(G)-1 Sample Repair Detail for a Timber Pile/Column Repair

Fig. 16.12(G)-2 Photo of Timber Pile/Column Repair in progress

D_2	D_1	A	ℓ	θ
30	10	5	9	37°
	11	5½	9½	40°
	12	6	10	44°
	13	6½	10½	47°
	14	7	11	50°
	15	7½	11½	53°
36	10	5	9	31°
	11	5½	9½	34°
	12	6	10	37°
	13	6½	10½	40°
	14	7	11	43°
	15	7½	11½	45°

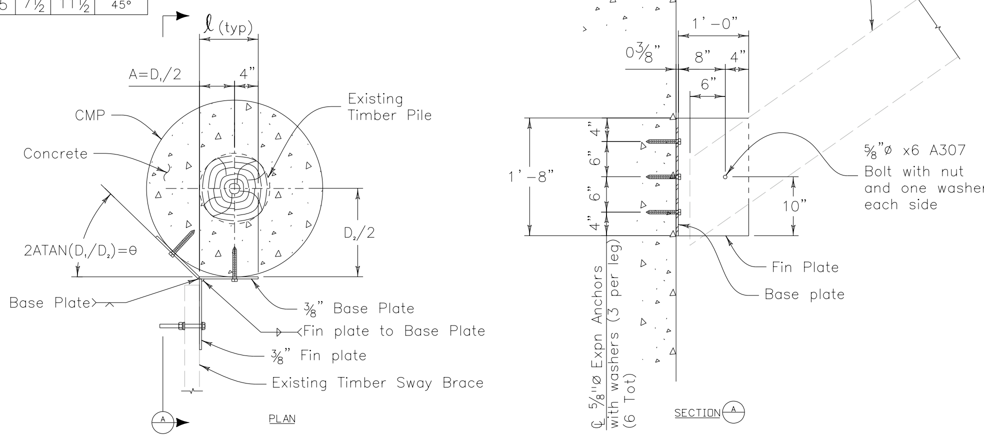


Fig. 16.12(G)-3 Sample Detail of Timber Pile Repair and Bracing

Fig. 16.12(G)-4   Photo of Timber Pile Repair and Bracing Connection

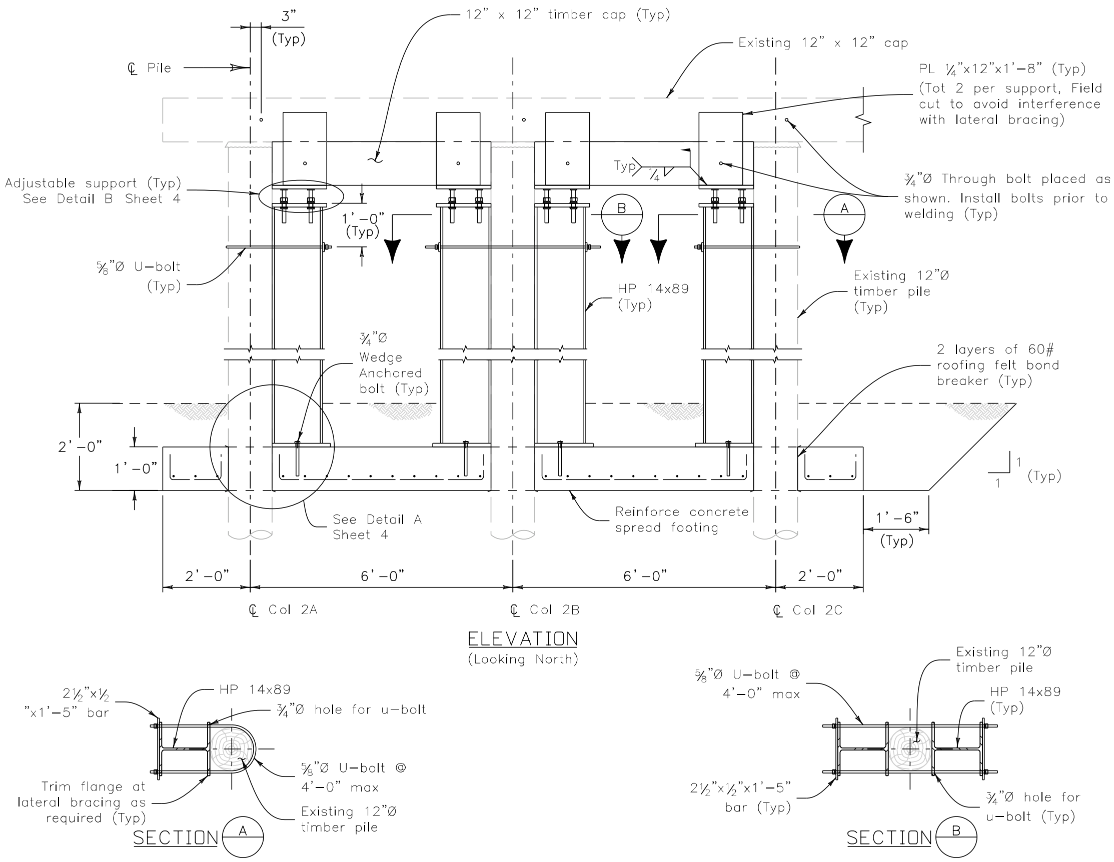


Fig. 16.12(G)-5   Sample of Adding Columns to a Pile

Fig. 16.12(G)-6   Photo of Adding Columns to a Pile

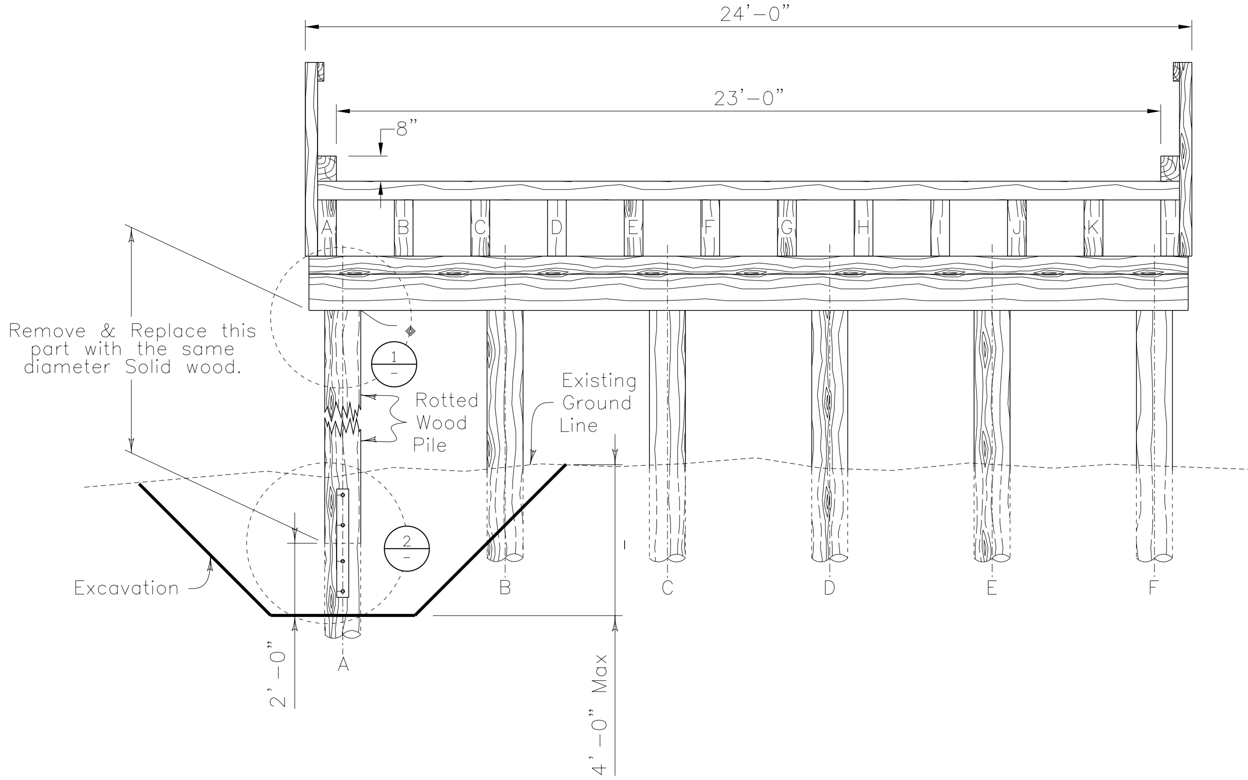


Fig. 16.12(G)-7   Sample Section of Replacing Portion of Timber Pile

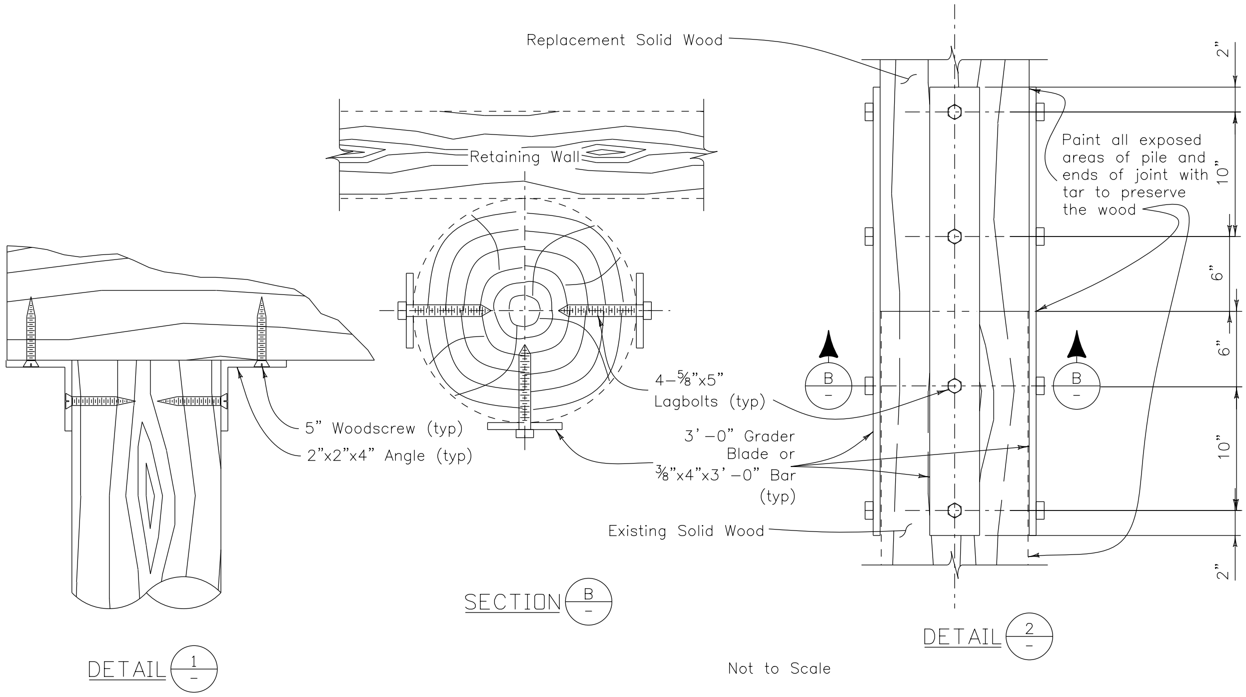


Fig. 16.12(G)-8 Sample Details of Replacing Portion of Timber Pile

H) **Timber Bridge Girder Repair** – Typically Bridge Girder repairs are necessary when girders split or have deficient ratings. Some repairs include bolting split girders (done in the past), adding new bents or adding additional girders. New bents may be of timber construction or steel construction.

Check Items:

The following is a list of information to be shown on the drawings, as applicable. Additional information may be shown as required. A field visit should be made prior to FOR to verify as-built locations and conflicts as well as to confirm applicability.

1) Location of damaged girders
2) Lag bolts in cracked stringer, attachment of snow plow or grader blades, false bents, etc. Lag bolting new damage is not recommended
3) Typical section, bridge elevation and pier sections and details to depict access and construction restrictions such as high water level, traffic, etc.
4) Work Description
5) Bridge Description

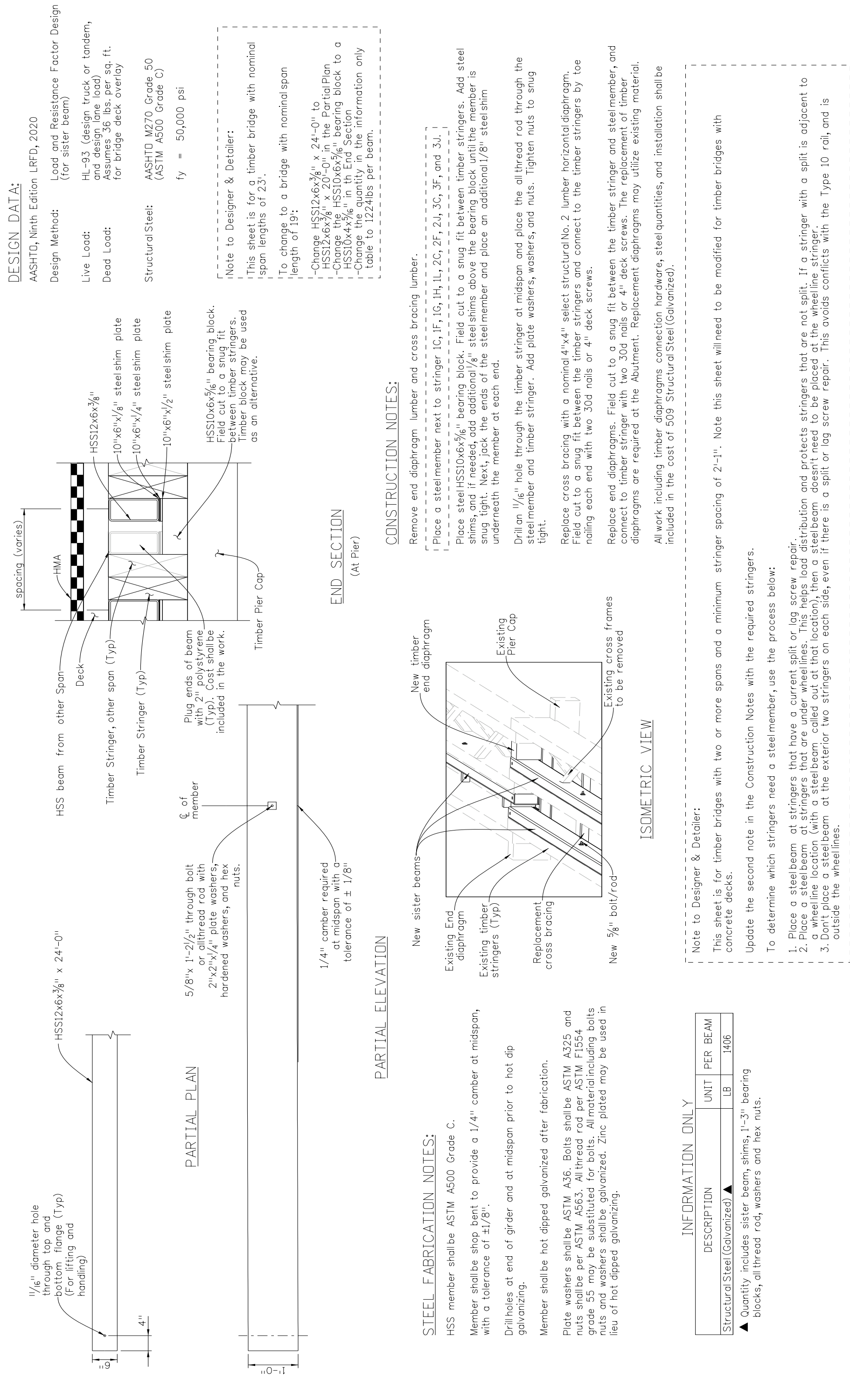
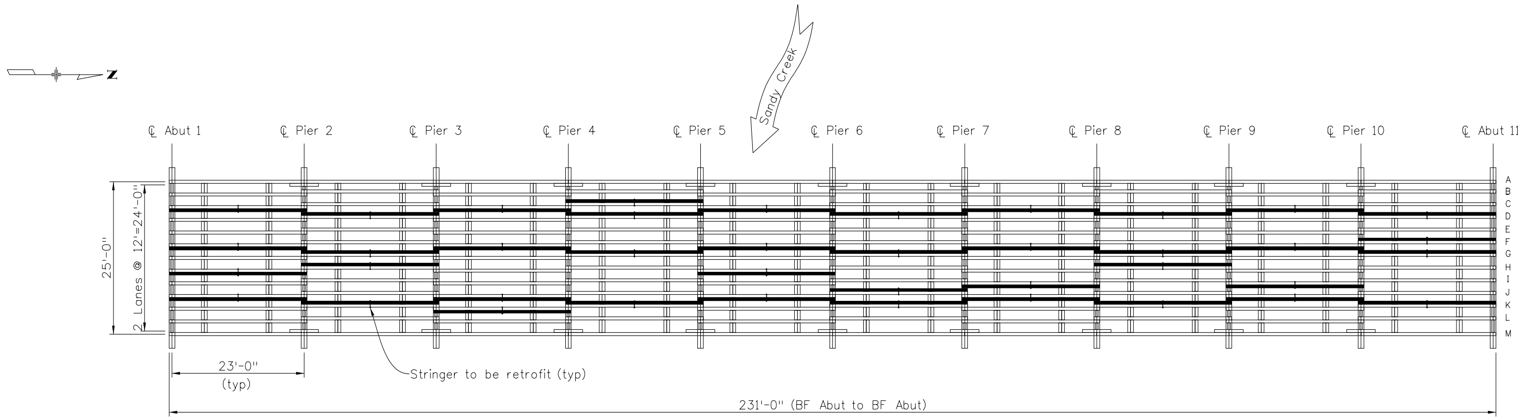


Fig. 16.12(H)-1 Current worksheet for Timber Girder repaired with Steel Sister Beam



PLAN VIEW

GENERAL NOTES:

All work shall be done in accordance with the Colorado Department of Transportation 2019 Standard Specifications for Road and Bridge Construction and the contract documents.

Unless otherwise noted, dimensions contained in these plans are calculated from the "As Constructed Plans." These dimensions may be adjusted to meet the existing structure. The Contractor shall verify all dependent dimensions in the field before ordering or fabricating any material.

All longitudinal and transverse dimensions are measured horizontally and include no correction for grade.

The Contractor shall be responsible for the stability of the structure during construction.

The Contractor is responsible for making his own determination as to the type and location of utilities as may be necessary to avoid damage thereto. The Contractor shall contact the Utility Notification Center of Colorado at 811 (1-800-922-1987) at least three business days (two full business days in advance not including the day of notification) prior to any excavation or other earthwork.

Existing lag bolts to remain in place.

TABLE OF STEEL MEMBERS

Span	1	2	3	4	5	6	7	8	9	10
Girder	C	D	C	C	C	D	C	D	C	D
	F	G	F	D	F	G	F	G	F	F
	H	H	J	G	H	J	I	H	I	G
	J	K	K	K	J	K	J	K	J	K

SUMMARY OF APPROXIMATE QUANTITIES:

	Item No.	Description	Unit	Structure B-26-F	Total
①	509-00001	Structural Steel (Galvanized)	LB	44350	44350

① Pay item 509-00001 Structural Steel (Galvanized) shall include removal and resetting of timber diaphragms. Cost of all thread rod, plate washer, washers, and nuts shall not be paid for separately but included in the cost of the work.

DESCRIPTION OF WORK:

Repair and Strengthen using steel HSS sections, and bolt to existing split timber stringer

Fig. 16.12(H)-2 Example of General Layout for a timber stringer repair project

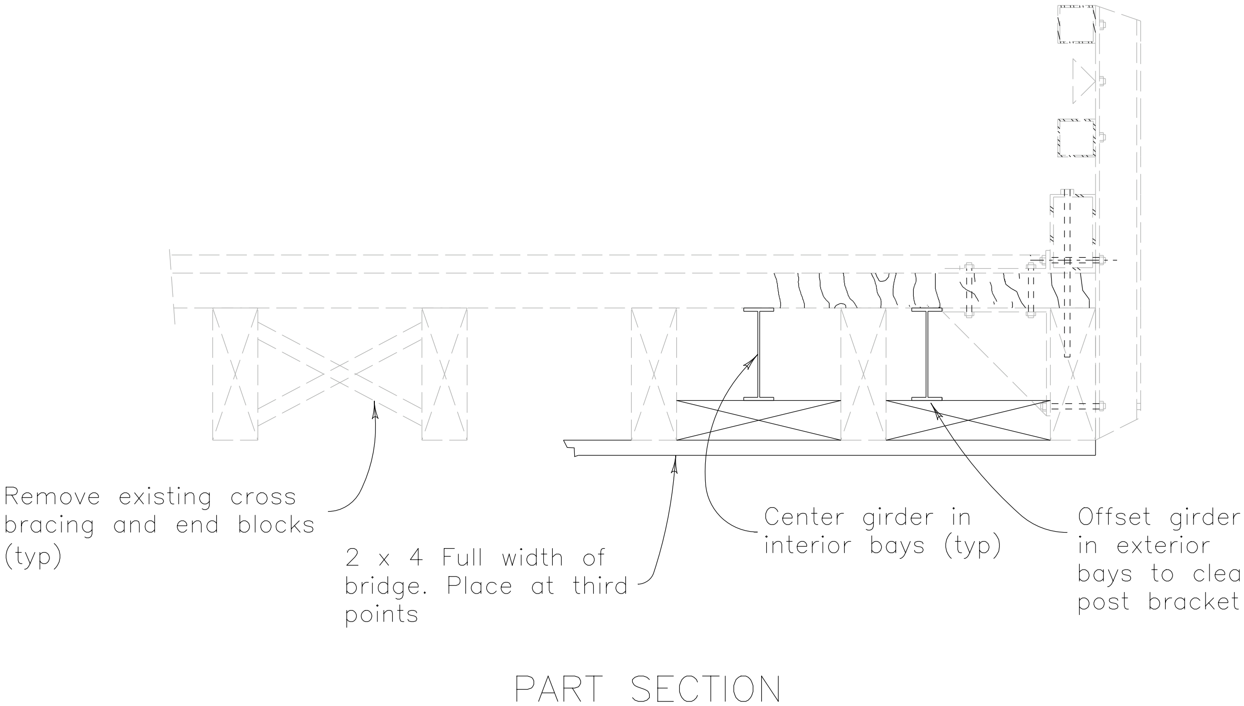


Fig. 16.12(H)-3 Sample Section of adding steel girders to a Timber Bridge

Fig. 16.12(H)-4   Photo of steel girders added to a Timber Bridge

Fig. 16.12(H)-5   Photo of Added Steel Girder and Grader Blade on Timber Girder

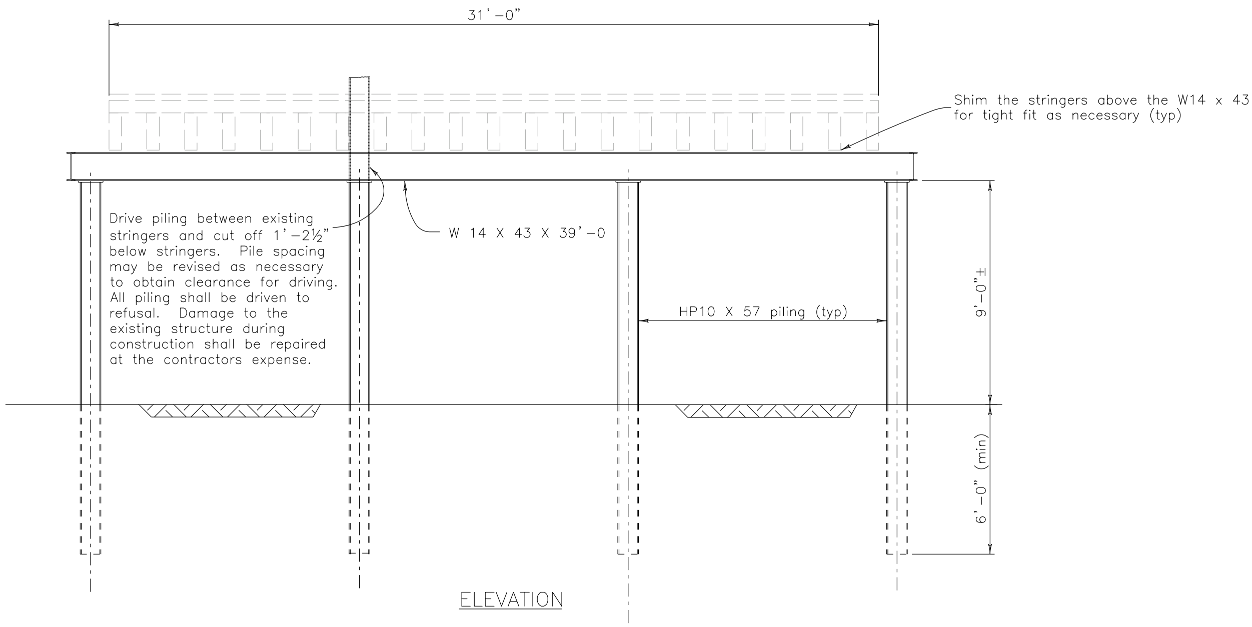


Fig. 16.12(H)-6 Sample Section showing additional Bents

Fig. 16.12(H)-7 Photo of New Support Bent near Abutment

Fig. 16.12(H)-8   Photo of New Support Bent at Midspan

Fig. 16.12(H)-9   Photo of New Timber Bent

I) **Falsework** – Falsework may be required to support a bad deck or may be required to support a girder, etc. during repair work. A conceptual idea should be presented as a minimum.

Check Items:

The following is a list of information to be shown on the drawings, as applicable. Additional information may be shown as required. A field visit should be made prior to FOR to verify as-built locations and conflicts. In addition, constructability and "fit" of supports will be checked.

1) Location, grade, size and spacing of timber or other material as required. Timber is typically used because of weight and availability issues
2) Provide typical section, bridge elevation and pier sections and details to depict access and construction restrictions such as high water level, traffic, etc.
3) Work Description
4) Bridge Description

5) Construction details as required

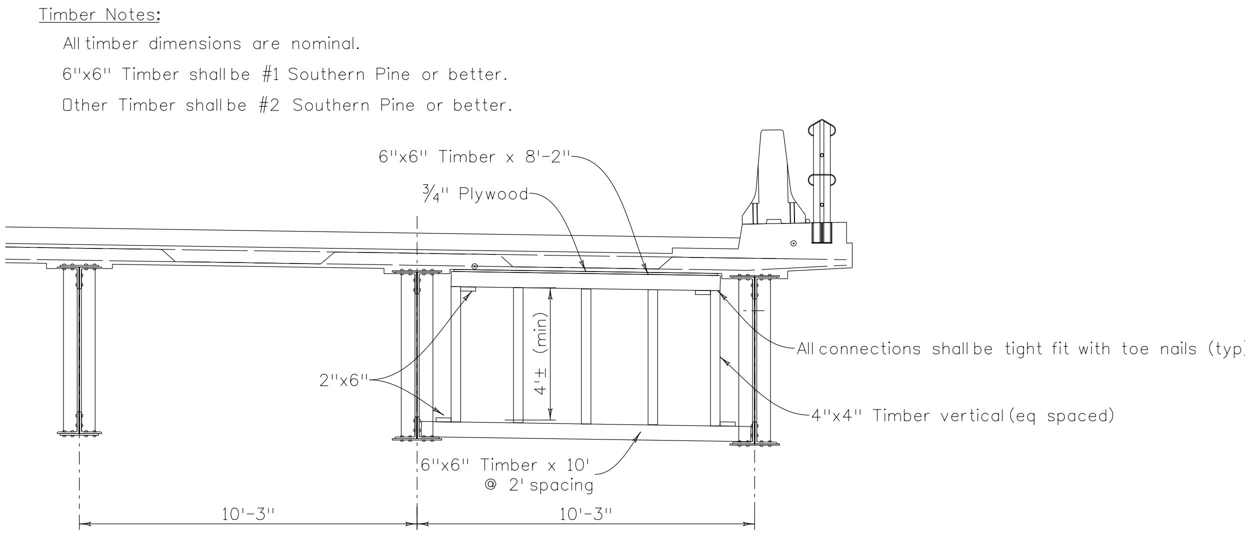


Fig. 16.12(I)-1 Sample Section of Falsework to support a deck

Fig. 16.12(I)-2 Photo of Deck Falsework

Fig. 16.12 (I)-3   Photo of Falsework to support a steel girder

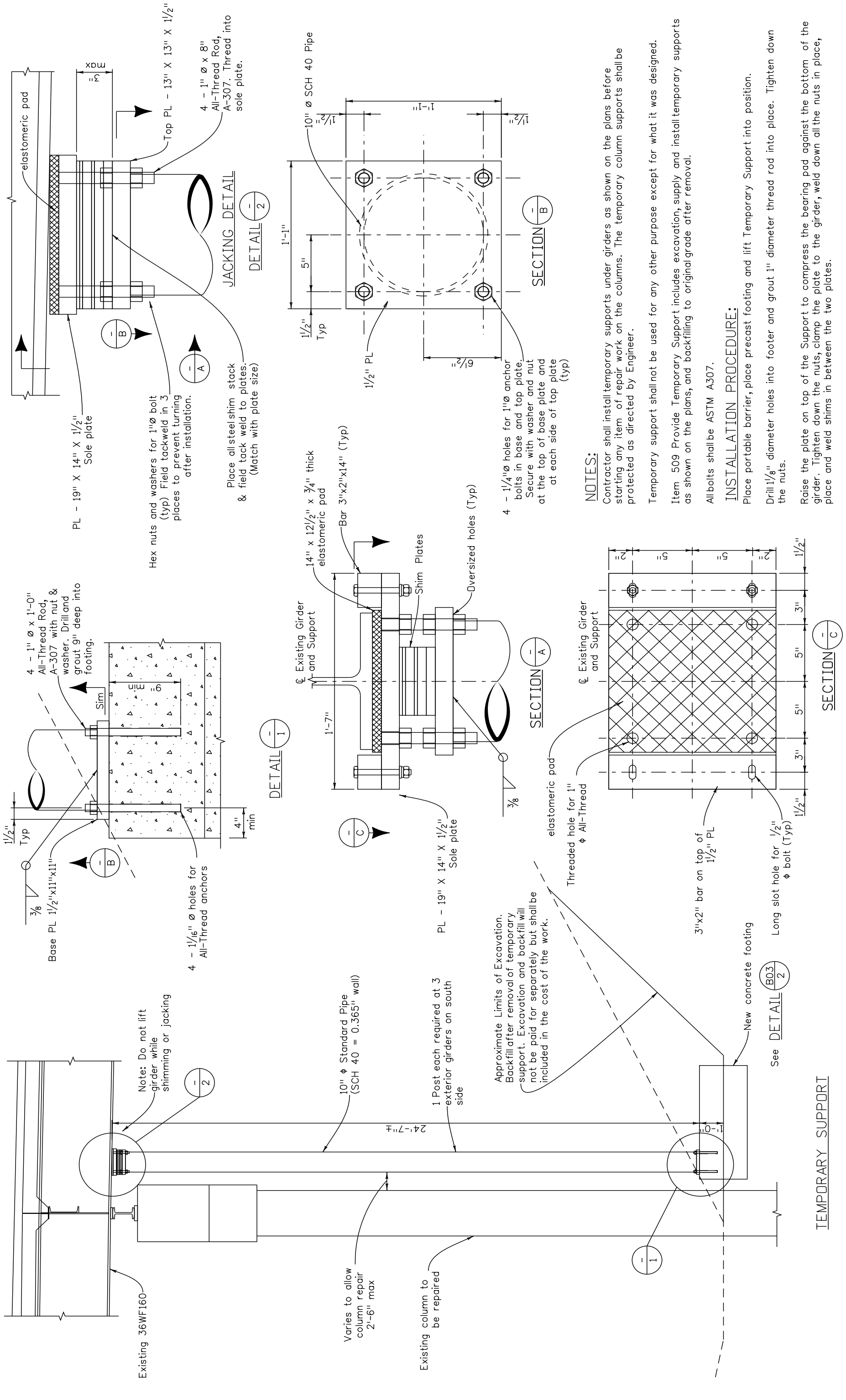


Fig. 16.12(I)-4 Sample Details for Falsework to Support a Steel Girder

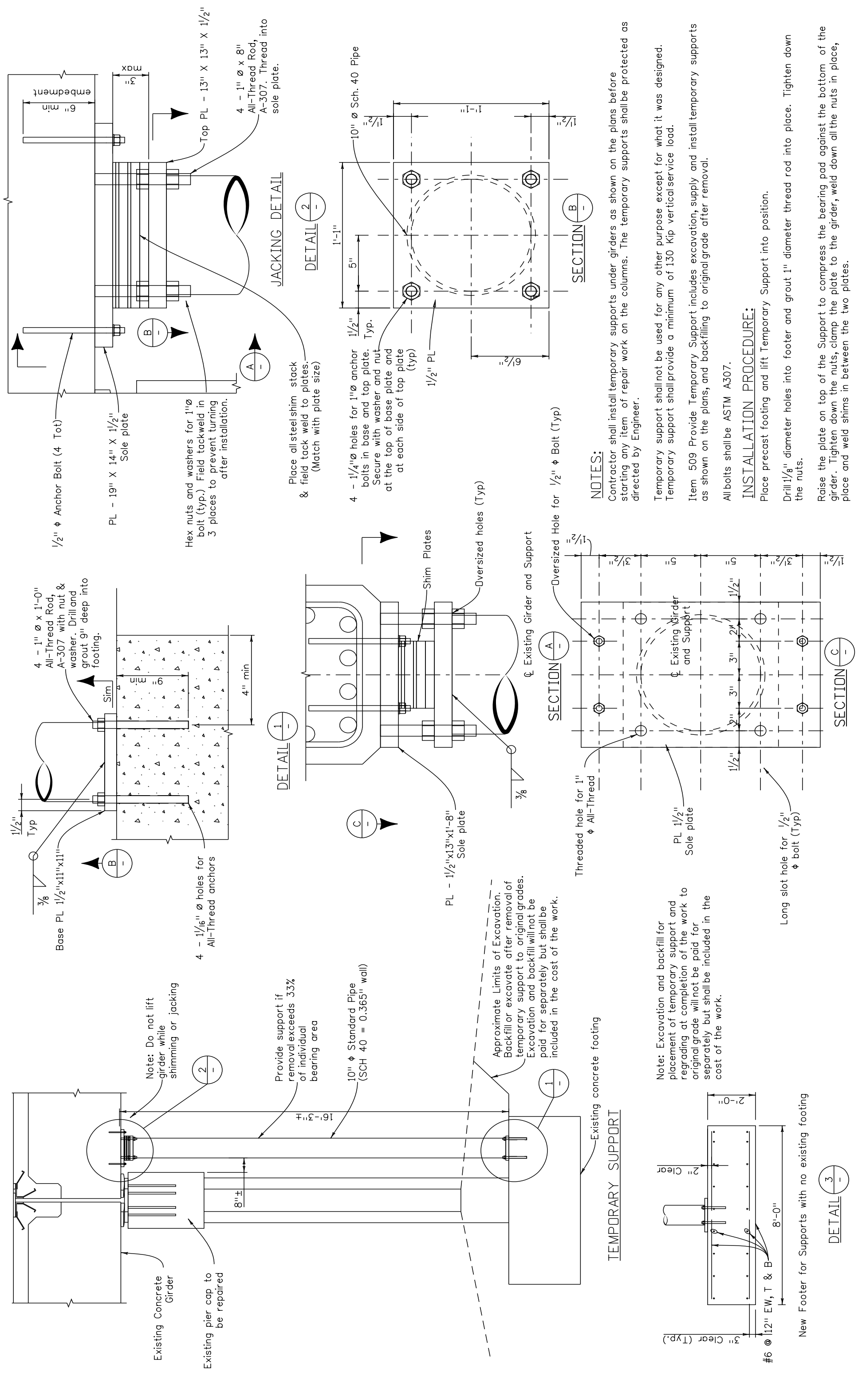


Fig. 16.12(I)-5 Sample Details for Falsework to Support a Concrete Girder

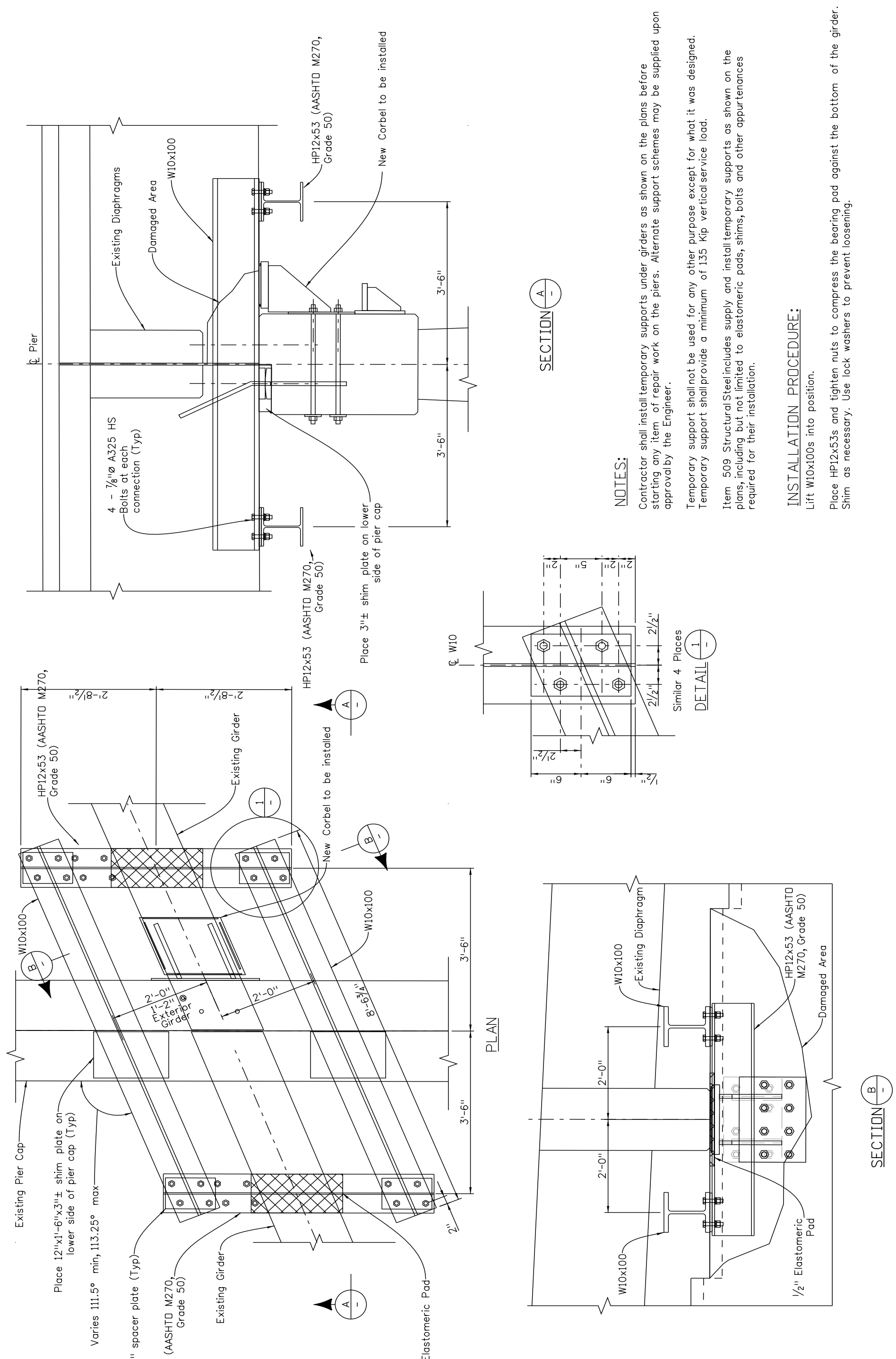


Fig. 16.12(I)-6   Sample Details of Straddle-Type Falsework

J) **Wall Repair –** These repairs typically include the strengthening or repairing of existing walls where replacement is not practical.

Check Items:

The following is a list of information to be shown on the drawings, as applicable. Additional information may be shown as required. A field visit should be made prior to FOR to verify as-built locations and conflicts. If the wall does not have a structure number, one shall be obtained from CDOT Bridge Asset Management.

1) Location and extent of repair
2) Utility conflicts, etc. that will affect the work
3) Phasing as required
4) Typical section, bridge elevation and pier sections and details to depict access and construction restrictions such as high water level, traffic, bridge constraints, etc.
5) Work Description and Construction Sequence
6) Bridge and/or Wall Description

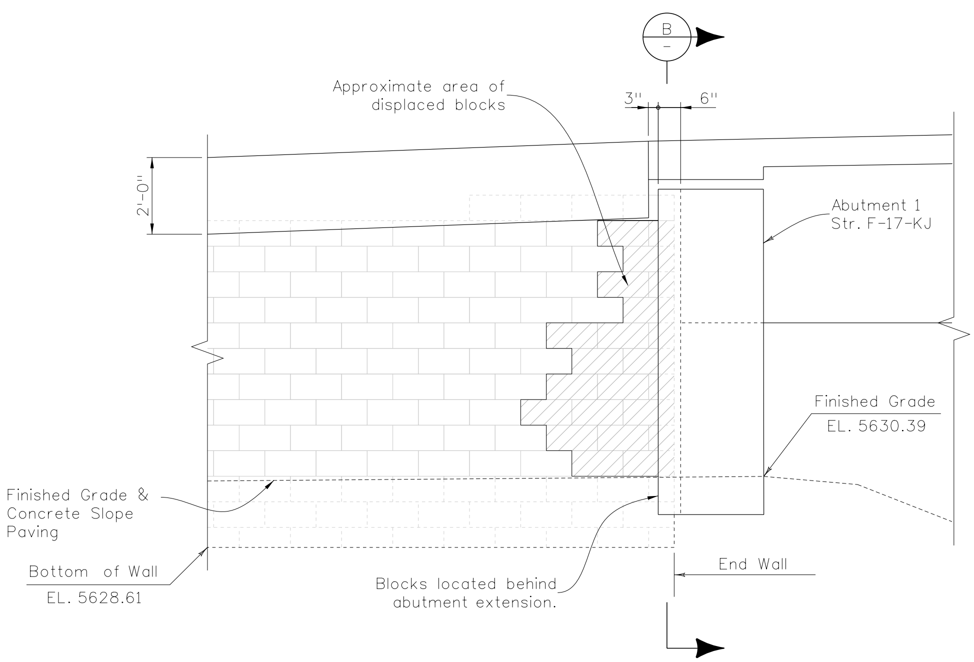


Fig. 16.12(J)-1 Sample Elevation of Area to be repaired on a MSE Wall

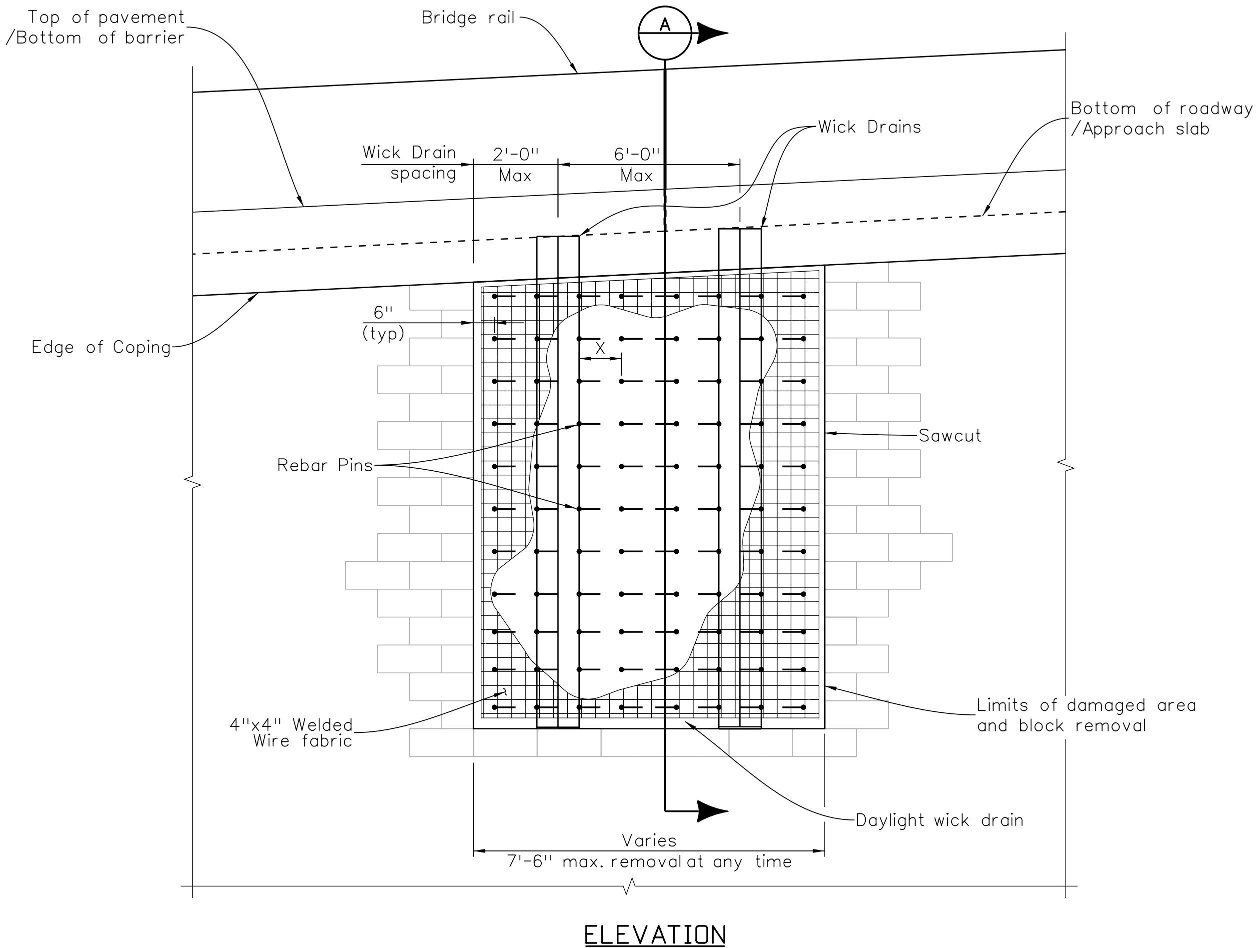


Fig. 16.12(J)-2 Sample Details on Block MSE Repair

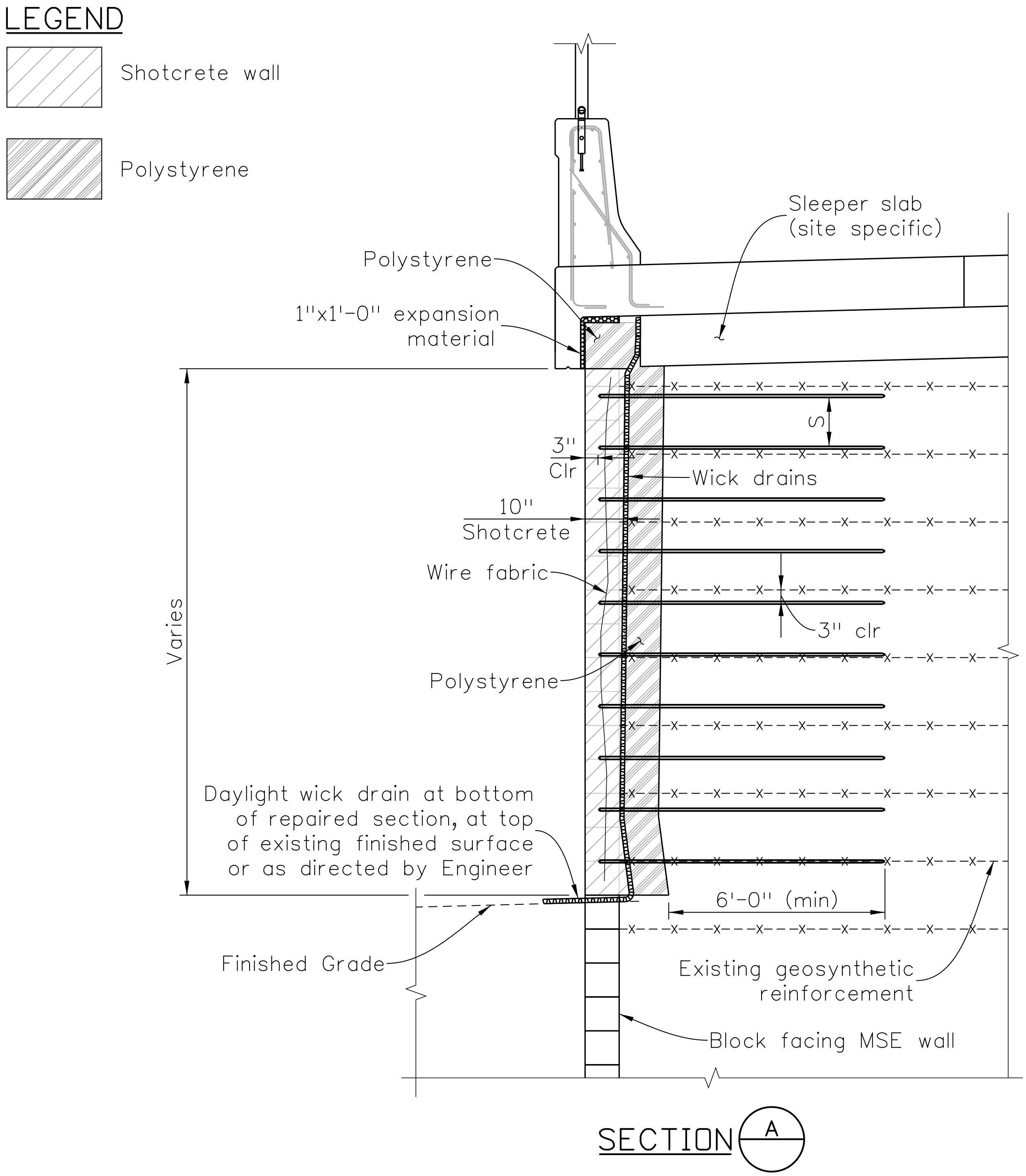


Fig. 16.12(J)-3 Sample Section for block MSE Repair

K) **Steel Corrosion/Fatigue Repair** – These repairs typically include adding additional steel plates or rewelding problem structures. Lead based paints or coatings should be addressed in the repair details. Provide appropriate specifications for dealing with the lead based coatings prior to the repair. Some repairs can be accomplished with a written description or welding procedure.

Check Items:

The following is a list of information to be shown on the drawings, as applicable. Additional information may be shown as required. A field visit should be made prior to FOR to verify as-built locations and conflicts and to confirm applicability.

1) Location and extent of repair
2) Welding design and procedure per AWS D1.5 and/or D1.1
3) Location of damaged areas
4) Typical section, bridge elevation and pier sections and details to depict access and construction restrictions such as high water level, traffic, etc.
5) Specifications for Hazardous Coatings
6) Work Description
7) Bridge Description

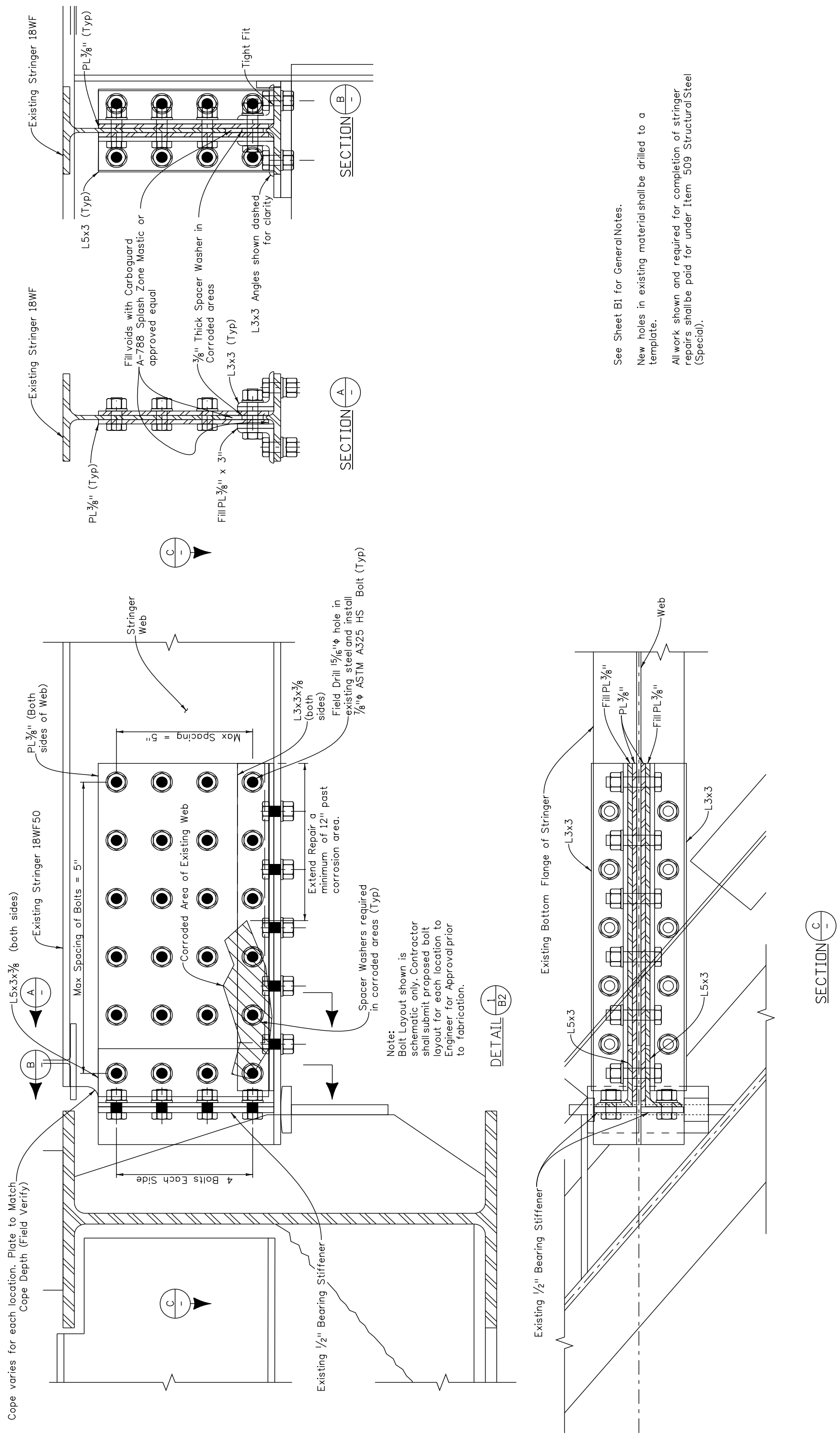
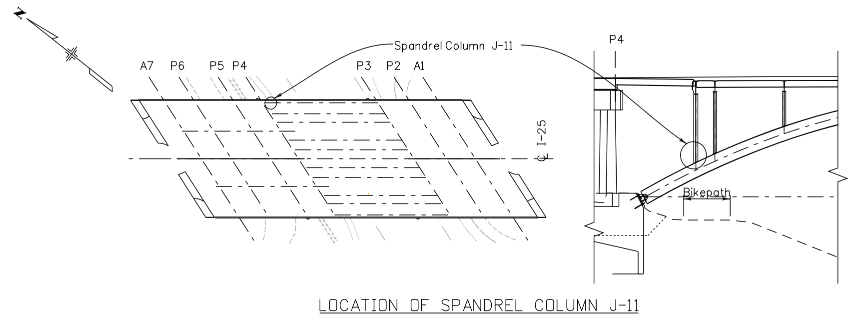
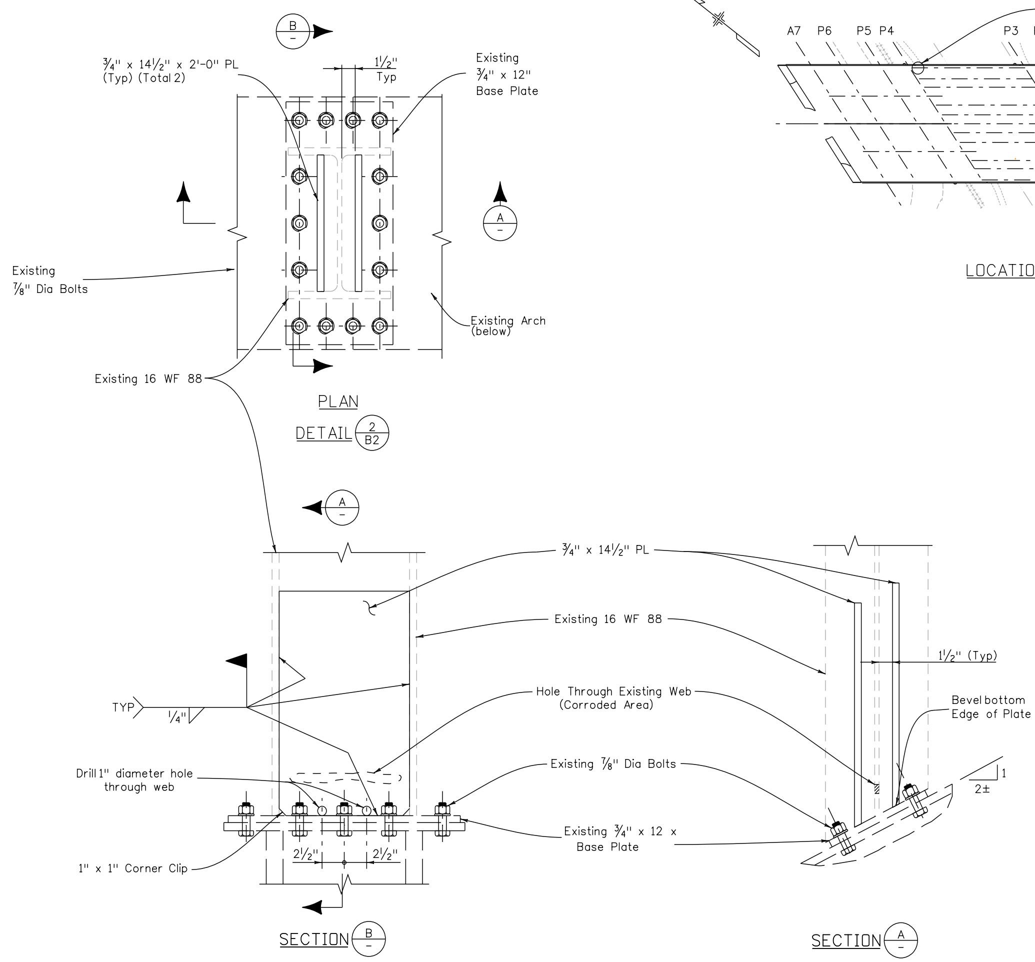


Fig. 16.12(K)-1 Sample Details for Adding Steel Plates to a Corroded Girder





NOTES:

1. The work area shall be prepared by removing all mastic and tar from the base plate and anchor bolts. The lower 2'-6" of the spandrell column and the base plate shall then be cleaned per Note 7.

2. Two 1" diameter holes shall be drilled through the web and new plates, flush with the top of the base plate for drainage.

3. Welding of plates shall conform to the Bridge Welding Code AWS D1.5. Welds shall be made using E70XX electrodes.

4. Prior to welding plates the areas that are to receive welds shall be masked and the web, inside surfaces of flanges, and inside surfaces of plates are to receive a prime coat. After plates are welded into place, remaining surfaces are to be primed and painted in conformance to Section 509 of the Specification. The top coat color shall match the existing paint color.

5. All work associated with the installation of the steel plates as shown on this sheet shall be paid for under Item 210 Rebuild Portions of Present Structure. For informational purposes, amount of structural steel = 148 lbs.

6. The existing structure contains lead based paint. All coatings within a minimum of three inches of repaired areas shall be removed after being neutralized. Cover coating or stripper Ecobond LBP Chemical or approved equal which chemically react with the lead to render it non-leachable and non-hazardous will be an acceptable method of treatment and removal as described in the Project Special Provision - Revision of Section 509. For other removal and disposal environmental requirements, see CDOT Standard Specifications Section 250. Removal and disposal of lead based paint shall be CDOT approved and follow industry prescribed standards. Cost of this removal and disposal shall not be paid for separately, but shall be included in the cost of the work. Contractor shall submit a written methods statement a minimum of two weeks prior to start of the work describing containment and removal procedures for approval.

7. Clean and Sandblast Structural steel in accordance with the requirements of Structural Steel Painting Council (SSPC) - SP11 "Power Tool Cleaning to Bare Metal".

8. Areas affected by the repair work shall be primed and repainted in accordance with Section 509 of the Standard Specifications and as noted herein. The color shall match the existing girder color. A type II, organic zinc-rich primer shall be applied to the prepared steel surfaces before new rust forms. The primer shall be compatible with the surface preparation and profile. All paint shall be applied in accordance with the manufacturer's recommendations. The cost of priming and repainting shall not be paid for separately, but shall be included in the cost of Item 509 Paint Existing Structure (Special).

Fig. 16.12(K)-2 Sample Details for Repairing/Strengthening a Corroded column

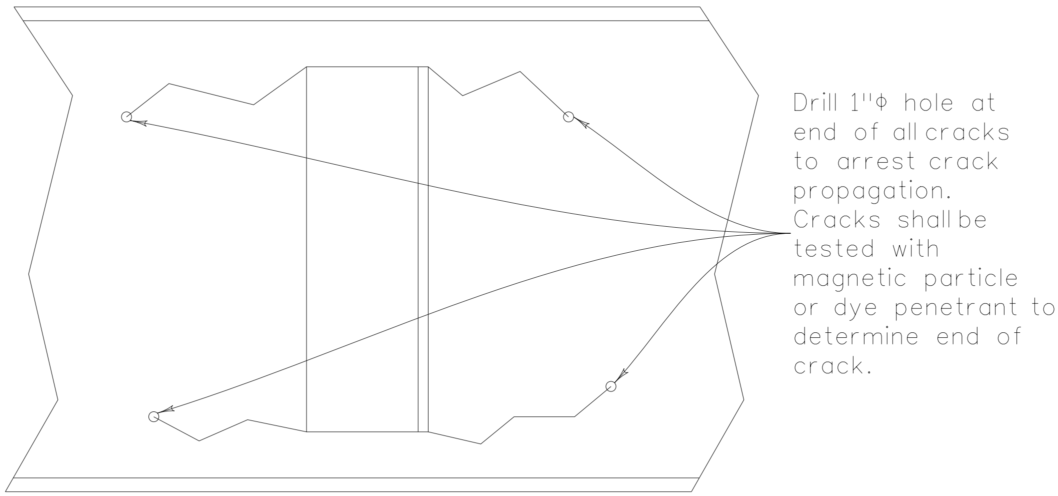


Fig. 16.12(K)-3 Sample Detail of Drilling Holes at the end of Fatigue Cracks

Repair procedure welding, testing, and inspection shall be in accordance with AWS D1.1. Welding shall be performed by a Certified Welder in accordance with AWS D1.1, and inspection performed by an AWS CWI (Certified Welding Inspector). An acceptance report shall be submitted by the CWI upon completion of the work.

Remove the weld cracks at the repair location by grinding. Test the affected area using Magnetic Particle (MT) to determine if any of the crack remains. If part of the crack is still present, excavate and repeal the MT testing until the crack is gone.

1) Prepare the base metal; grind the affected areas to be re-welded to bright sound metal, removing any zinc or paint coating.
2) If the pipe wall is penetrated, provide backing if possible.
3) Grind smooth any rough metal edges to be welded.
4) Preheat the base metal to a minimum of 100 degrees Fahrenheit.
5) The deposited fillet weld shall match the original fillet weld size.
6) Deposit filler metal per the attached W.P.S i7'CDOT 08-03, (Welding Procedure Specification).
7) Allow the repair weld and base metal to cool to ambient temperature.
8) Visually inspect the weld, and MT test.
9) Apply a zinc rich primer paint.

Fig. 16.12(K)-4 Sample Welding Repair Procedure

ANNEX E AWS D1.1/D1.1M:2002

WELDING PROCEDURE SPECIFICATION (WPS) Yes [X]
PREQUALIFIED X QUALIFIED BY TESTING ____
or PROCEDURE QUALIFICATION RECORDS (PQR) Yes [ ]

Identification # CDOT 08-03
Revision N/A Date 12/10/08 By M. STADIG
Company Name C.D.O.T. Authorized by M. STADIG Date 12/10/08
Welding Process(es) SMAW Type—Manual [X] Semi-Automatic [ ]
Supporting PQR No.(s) N/A Machine [ ] Automatic [ ]

JOINT DESIGN USED
Type: CORNER
Single [ ] Double Weld [ ]
Backing: Yes [ ] No [X]
Backing Material:
Root Opening ____ Root Face Dimension ____
Groove Angle: ____ Radius (J–U) ____
Back Gouging: Yes [ ] No [X] Method ____

POSITION
Position of Groove: ____ Fillet: 3F
Vertical Progression: Up [ ] Down [ ]

ELECTRICAL CHARACTERISTICS SMAW
Transfer Mode (GMAW) Short-Circuiting [ ] N/A
Globular [ ] Spray [ ]
Current: AC [ ] DCEP [X] DCEN [ ] Pulsed [ ]
Other ____
Tungsten Electrode (GTAW)
Size: N/A
Type: ____

BASE METALS
Material Spec. ASTM A709-36
Type or Grade 36
Thickness: Groove ____ Fillet 1/2"
Diameter (Pipe) ____

FILLER METALS
AWS Specification A5.1
AWS Classification E7018

TECHNIQUE
Stringer or Weave Bead: STRINGER
Multi-pass or Single Pass (per side) ____
Number of Electrodes 1
Electrode Spacing N/A Longitudinal ____
Lateral ____
Angle ____

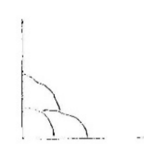
SHIELDING
Flux X Gas ____
Composition ____
Electrode-Flux (Class) ____ Flow Rate ____
Gas Cup Size ____

Contact Tube to Work Distance N/A
Peening ____
Interpass Cleaning: GRINDER, HAMMER, WIRE BRUSH

PREHEAT
Preheat Temp., Min 100° MINIMUM
Interpass Temp., Min 150° Max 400°

POSTWELD HEAT TREATMENT N/A
Temp. ____
Time ____

WELDING PROCEDURE

Pass or Weld Layer(s)	Process	Filler Metals: Class	Filler Metals: Diam.	Current: Type & Polarity	Current: Amps or Wire Feed Speed	Volts	Travel Speed	Joint Details
> 5/16" MULTI-PASS	SMAW	E-7018	1/8"	DC	140-220	20-25	N/A	 1/2" Fill

Form E-1 (Front)

334

Fig. 16.12(K)-5 Sample of Welding Repair Information

L) **Culvert Repair –** These repairs typically include the strengthening or repairing of existing culverts where replacement is not practical.

Check Items:

The following is a list of information to be shown on the drawings, as applicable. Additional information may be shown as required. A field visit should be made prior to FOR to verify as-built locations and conflicts.

1) Location and extent of repair, utility conflicts, etc. that will affect the work
2) Typical section, elevation and pertinent details (flow direction, etc.)
3) Work Description and Construction Sequence
4) Culvert Description

GENERAL NOTES

The work on this sheet repairs the eroded bottom slab of this CBC.

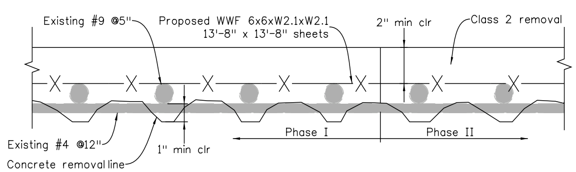
Others will be providing plans to extend this box on both ends to correct the erosion problems.

All longitudinal and transversal dimensions are measured horizontally and include no correction for grade.

Welded wire fabric (WWF) shall conform to ASTM A185 with fy = 65,000 psi. It shall be provided in 13'-8" by 3'-8" sheets and shall be galvanized after being cut to size.

Concrete shall be Class D with f'c = 4,500 psi.

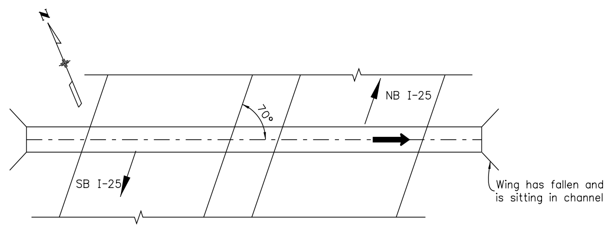
PHOTO 1 - Concrete Class 2 removal and replacement



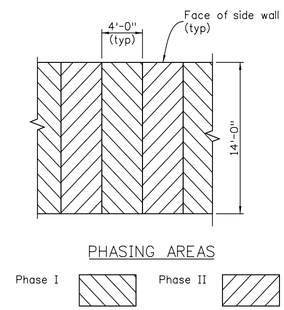
DETAIL 01 - CONCRETE REPLACEMENT

SUMMARY OF QUANTITIES

ITEM NO.	DESCRIPTION	UNITS	025A145120BL Bottom slab
202-00453	Removal of Portions of Present Structure (Class 2)	SY	417
211-03005	Dewatering	LS	1
601-03000	Concrete Class D	CY	104
602-00210	Welded Wire Fabric	SY	373



SCHEMATIC OF THE BOX CULVERT AT MILE MARKER 145.120



PHASING AREAS

INDEX OF DRAWINGS

B01 General Information, Summary of Quantities, Repair Details

BRIDGE DESCRIPTION:

Single Concrete Box Culvert (14'-0" x 12'-0" x 268'-0") built in 1959 with over 10' of fill cover; carries I-25 over unnamed drainage; 186.5' Roadway, 20° skew.

WORK DESCRIPTION:

The bottom slab of the box culvert must be dry and sediment free before work begins. The contractor shall provide sand bags to block the normal flow and a pipe to convey the water through the CBC during the work. The pipe shall be attached to the side wall of the culvert at a sufficient height above the bottom slab to allow the removal and patching work to be done. Pipe and all anchorages shall be removed from the culvert sidewall at the completion of the work. Holes from anchors shall be patched.

Saw cut from wall to wall to a depth of ¾" minimum at a spacing of 4'-0"±. Cut locations may be adjusted to avoid damaging reinforcing steel.

Perform Class 2 Removals on the 4'-0" wide Phase I areas. Removal of Portions of Present Structure (Class 2) shall consist of removing concrete from the bottom slab of the CBC within the limits shown on the plans, or as directed by the Engineer. Class 2 removal shall begin at the surface of the existing concrete and extend to sound concrete, but not less than 1 inch below the top transverse reinforcing steel

Pneumatic hammers heavier than nominal 15 lb. class shall not be used in removing concrete from below and around reinforcing steel. Pneumatic hammers and chipping tools shall not be operated at an angle exceeding 60° relative to the surface of the slab. Such tools may be started in the vertical position but must be immediately tilted to 60° operating angle. Care shall be taken so as not to fracture sound concrete below the top main reinforcing. Hand tools such as hammers and chisels shall be provided for removal of final particles of loose, un-bonded concrete. Only short, one-handed hammers with a maximum head weight of 5 pounds will be allowed. Any bars damaged by the Contractor's operations shall be repaired or replaced at the Contractor's expense. Payment will be made under Removal of Portions of Present Structure (Class 2 Square Yards).

Following the Class 2 concrete removal, all exposed reinforcing steel shall be cleaned to sound steel by sandblasting. Sound steel is defined as free of oil, dirt, concrete fragments, or laitance, loose rust scale, and other coatings of any character that would destroy or inhibit the bond with the new concrete. Concrete shall be poured within seven calendar days or the reinforcing shall be re-sandblasted at the Contractor's expense. Sandblasting reinforcing steel will not be measured and paid for separately, but it shall be included in the cost of the work.

All removed concrete, sandblasting slag, water and any other construction debris shall be collected and disposed of off-site in accordance with all applicable Federal, State and Local Regulations at no additional cost to the project. Under no circumstances shall such material be allowed to enter any natural or man-made waterway or storm drain. The cost of removing debris shall be included in the work.

Form edges of Phase 1 pours. Place galvanized welded wire fabric (WWF) sheets flush with the existing reinforcing steel mat and tie securely in place.

Pour Concrete Class D in Phase 1 areas. Clearance over welded wire fabric shall be 2". Remove forms.

Repeat these steps for Phase 2 areas. Phase 2 areas need not be formed but can use the Phase 1 areas to control edges and finished surface grade.

Fig. 16.12(L)-1 Sample Details for Repairing the concrete bottom slab of a box culvert

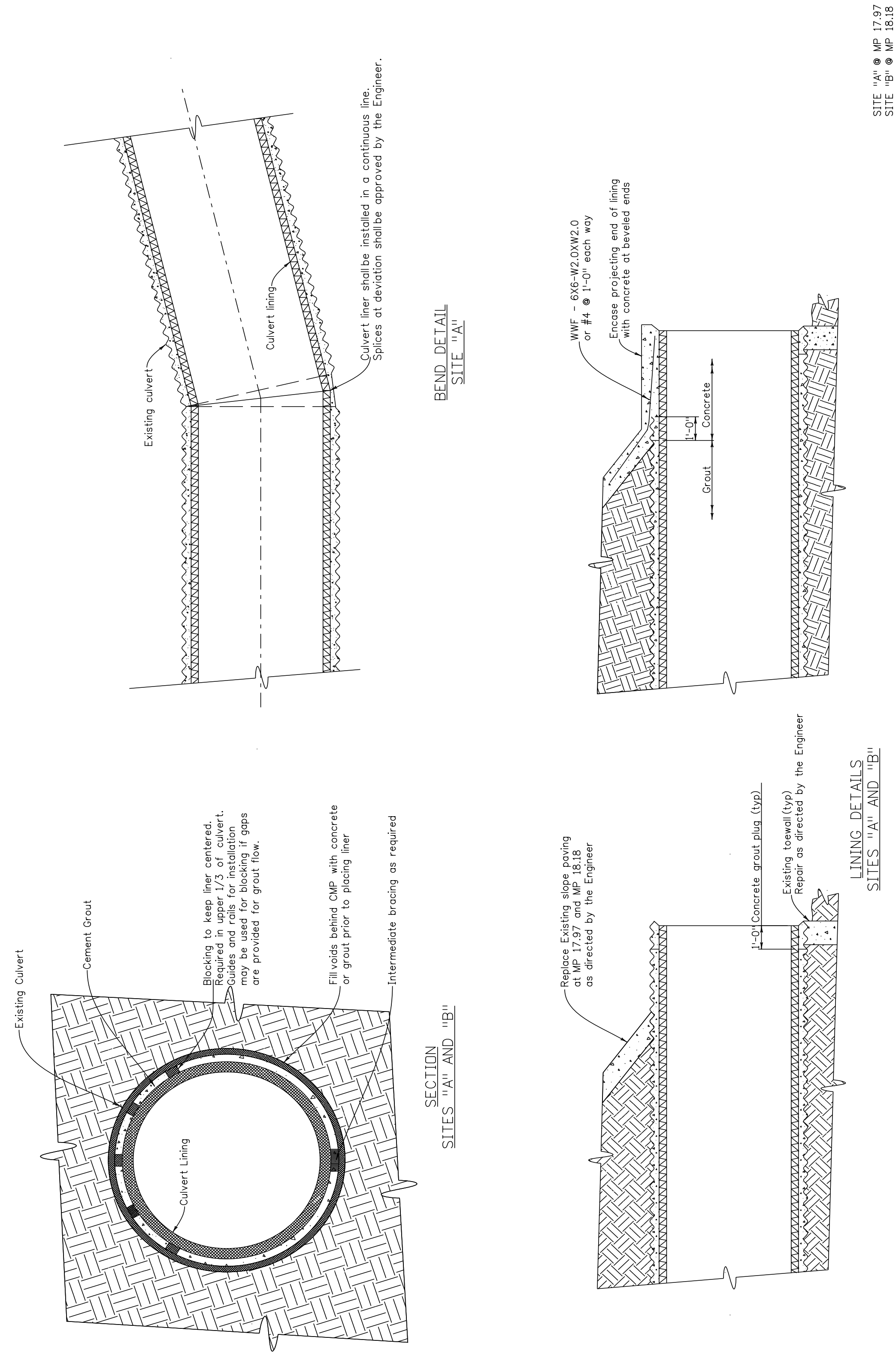


Fig. 16.12(L)-2 Sample Details for Repairing a circular culvert by slip-lining

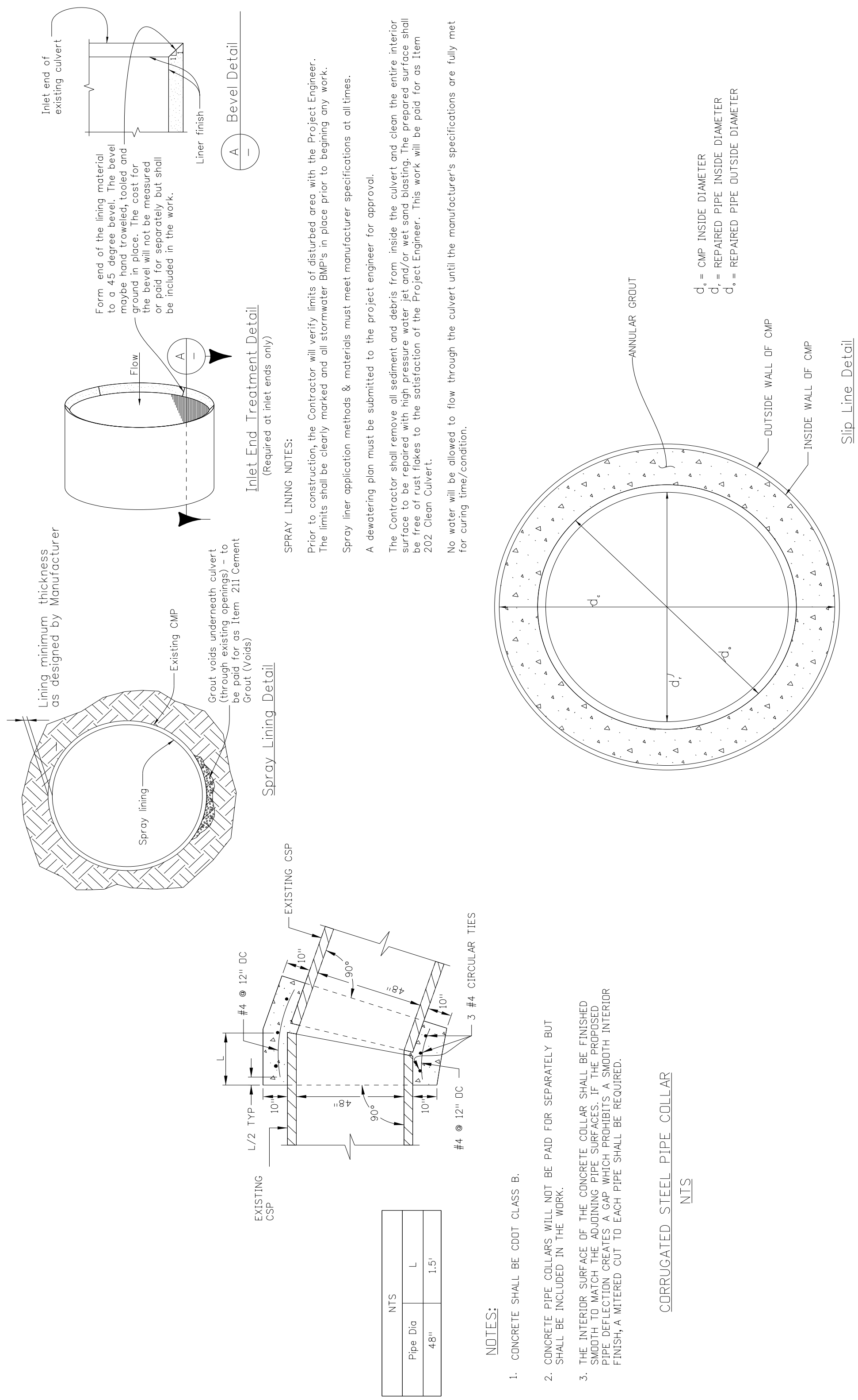


Fig. 16.12(L)-3 Sample Details for Repairing a circular culvert by slip-lining

M) **Bearing Replacement** – These repairs typically include the details required for replacement of pot or other style bearings.

Check Items:

The following is a list of information to be shown on the drawings, as applicable. Additional information may be shown as required. A field visit should be made prior to FOR to verify as-built locations and conflicts.

1) Location and extent of repair
2) Utility conflicts, etc. that will affect the work
3) Typical section, bridge elevation and pier sections and details to depict access and construction restrictions such as high water level, traffic, bridge constraints, etc.
4) Work description and construction sequence
5) Jacking requirements and restrictions
6) Limiting dimensions for new bearing (individual existing dimensions may not need to be matched, provide minimum dimensions available as needed to meet the design requirements). These should be field verified by Designer or Contractor.
7) Information required for the replacement of the existing bearing, such as: existing bearing rotation/position, movement, sole plate slope (if any), if the existing anchor rods / grout pad / sole plate will be replaced

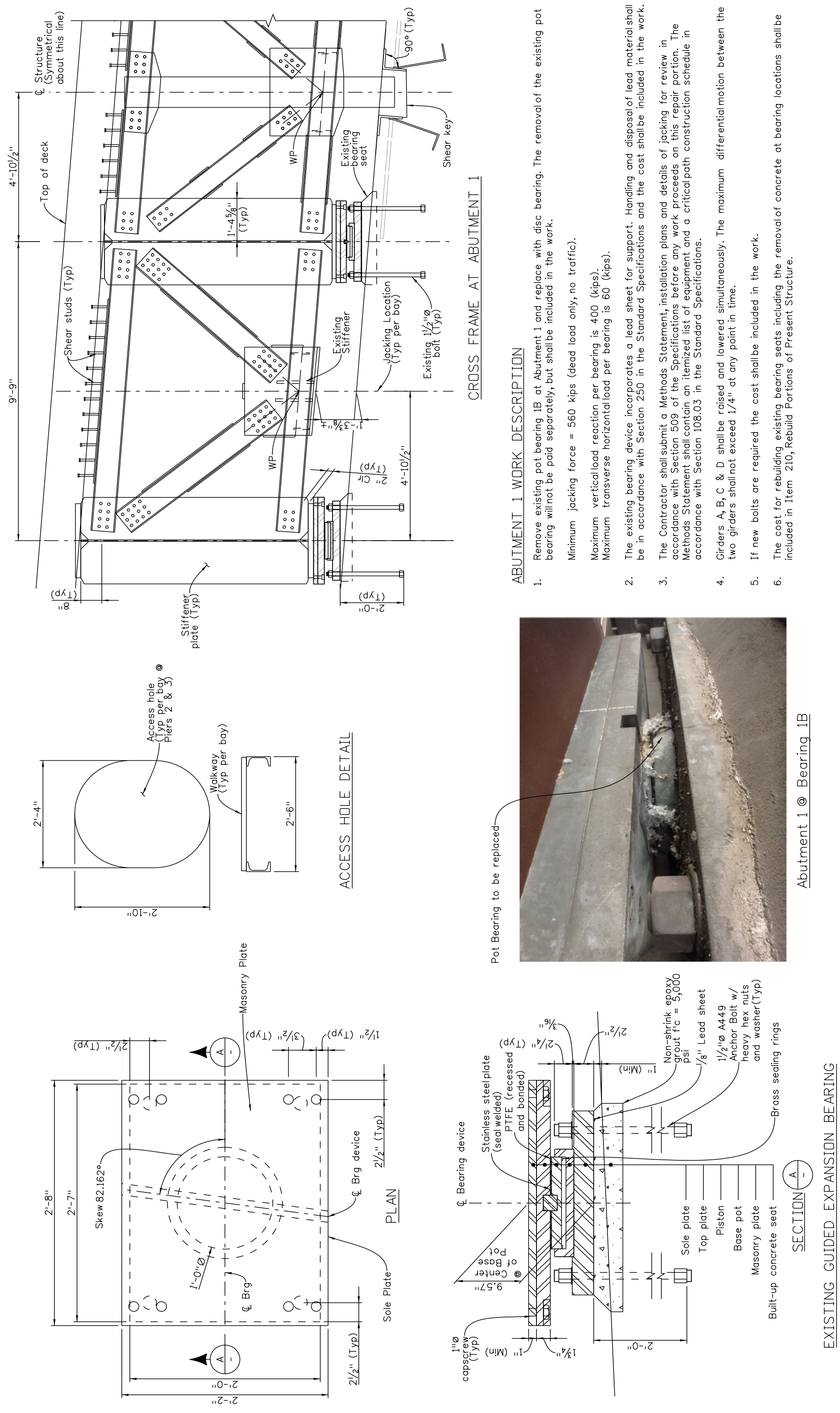


Fig. 16.12(M)-1 Sample Details for Pot Bearing replacement

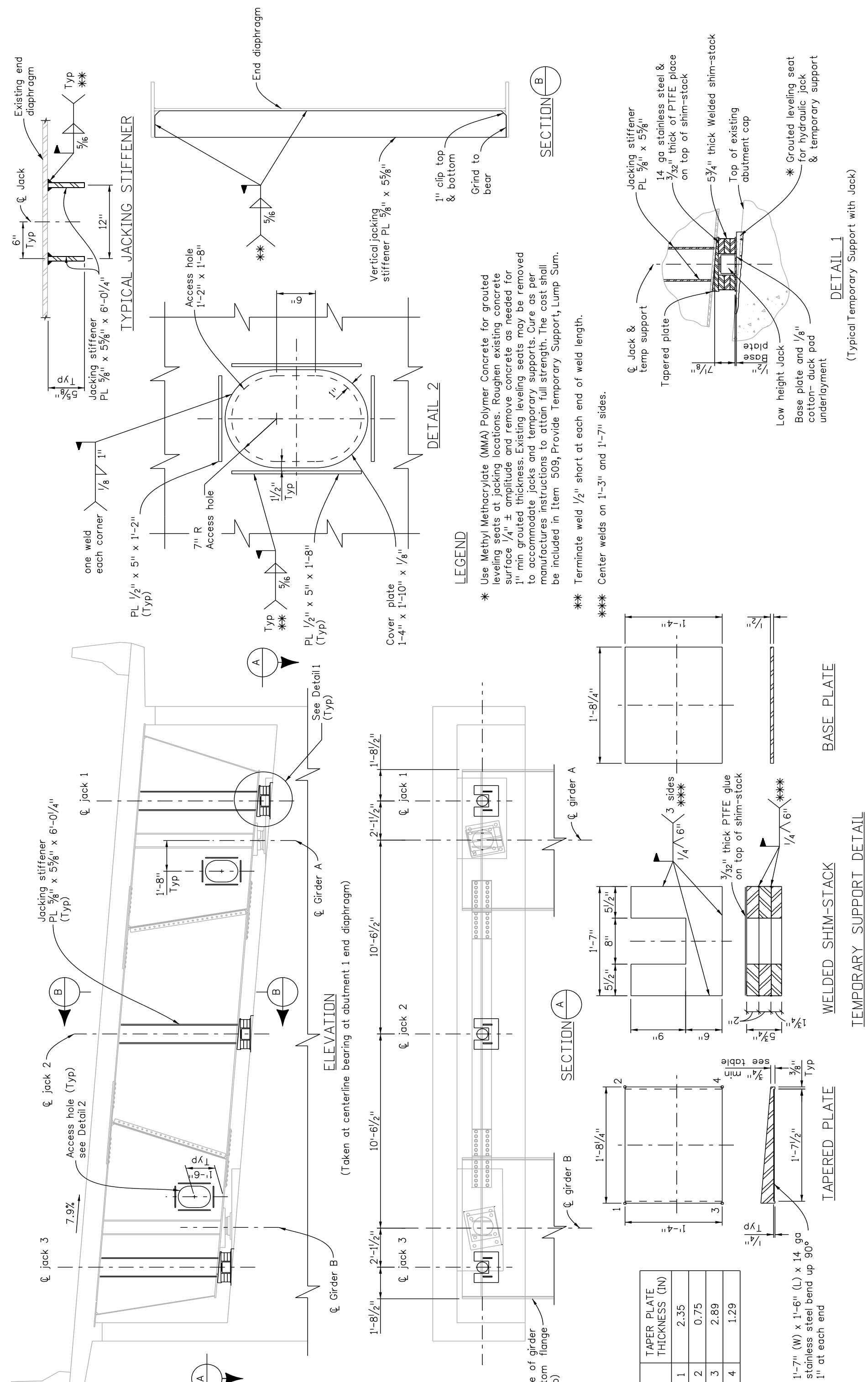


Fig. 16.12(M)-2 Sample Temporary Support Details for Bearing replacement

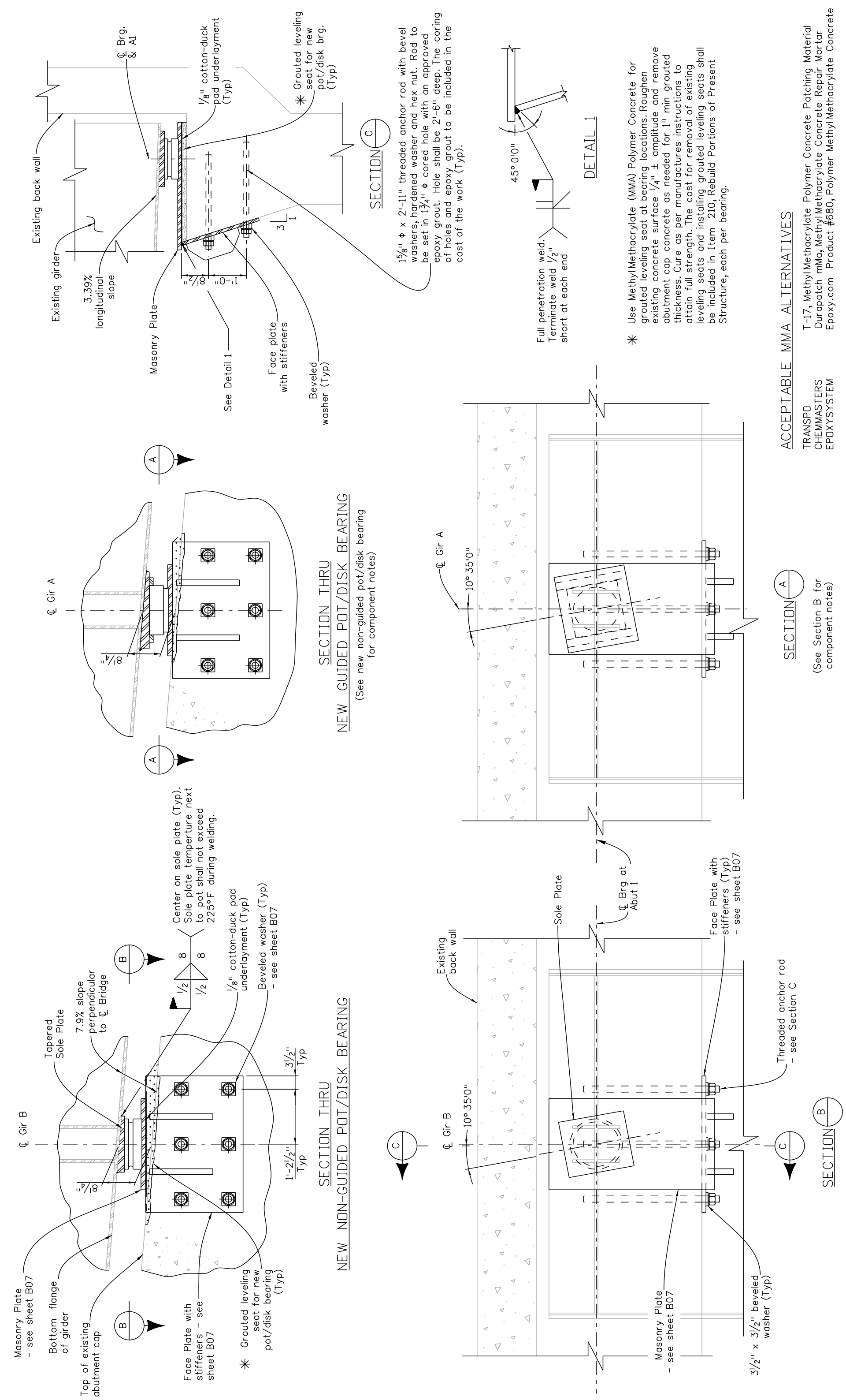


Fig. 16.12(M)-3 Sample Details for Bearing type III replacement

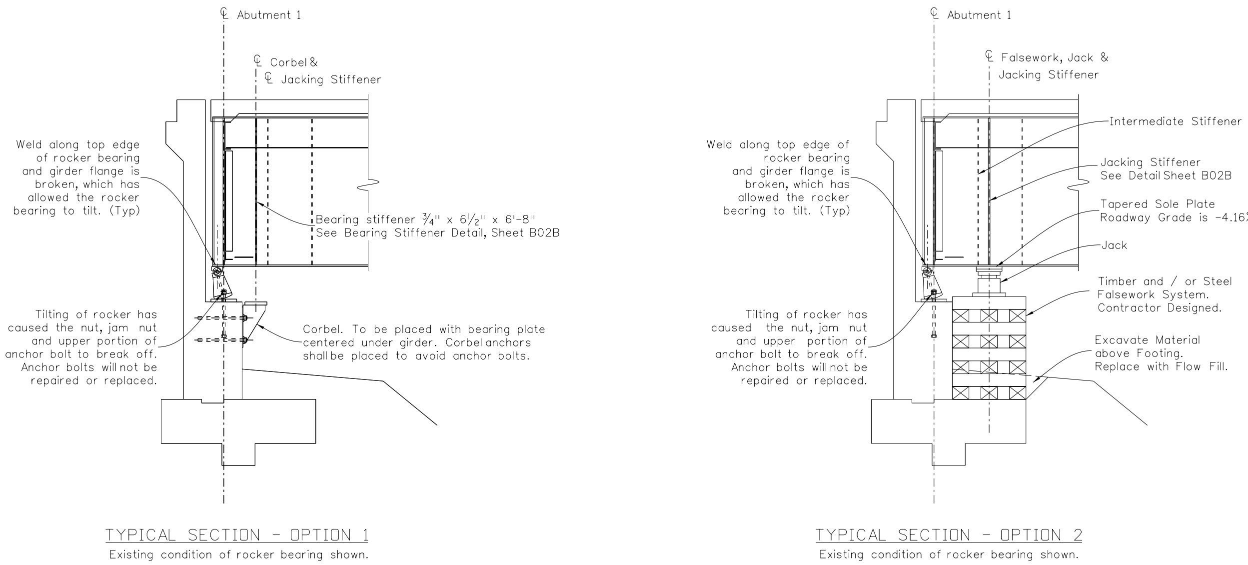


Fig. 16.12(M)-4 Sample Details for Jacking and Bearing Resetting

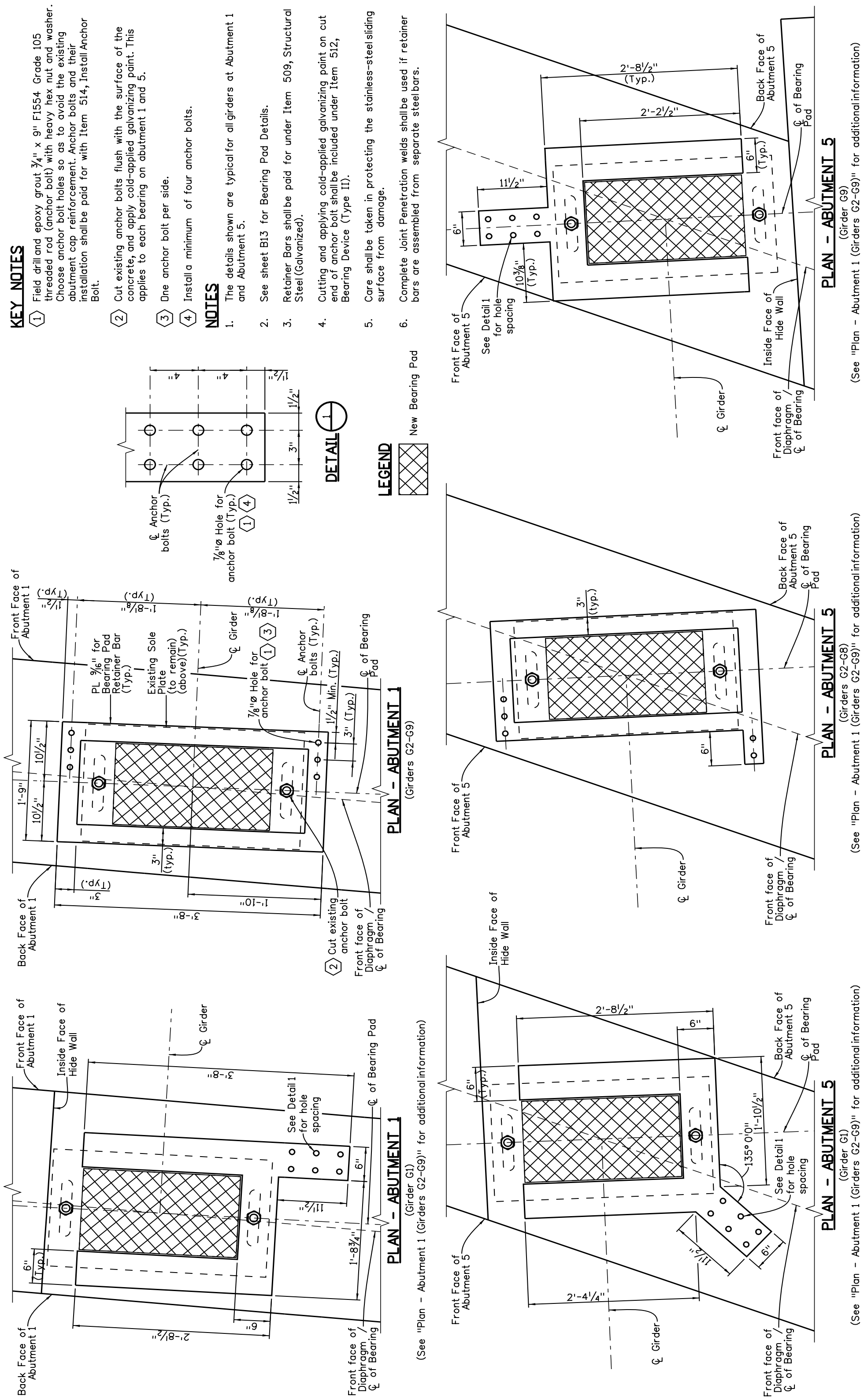


Fig. 16.12(M)-5 Sample Details for Bearing Keeper

17.1 Purpose

The purpose of this drawing is to provide structure information (plan, section, elevation) for field use by inspectors to validate the Specifications for the National Bridge Inventory (SNBI) / National Bridge Inspection Standards (NBIS), Structure Inventory and Appraisal (SI&A) items, and element quantities. In addition, the inspection sketch linework models should be set up in order to be used to maintain linework for the structure for future repair and overlay work. Typically, inspectors will take a hard copy of the sketch to indicate any changes, damage areas, additional field notes, etc. The purpose of this chapter is to establish uniform procedure for presenting information on inspection sketches.

17.2 Responsibility

This sketch/drawing should be prepared and checked after all the structure plans are final and shall be submitted for archiving with the final plans. Since this is a working document, the pdf need not be ISO compliant.

As-built information, as well as subsequent repairs and maintenance will need to be reflected in this inspection sketch. For metal arch and precast arch culverts the inspection sketch shall be based on shop drawings and other as-built information. The Designer of the repairs is responsible for the updates to the inspection sketches.

The graphic presentation of information on this drawing shall be the responsibility of the individual preparing the drawing.

17.3 Requirements

Separate inspection sketches/drawings are required for all major structures (i.e. bridge, culvert), all minor structures and for tunnels. They shall be delivered in both the original CAD and pdf format.

Major modifications during construction that affect the structure's dimensions, add additional inspection elements, or lane changes that revise vertical clearances shall require an updated inspection sketch prior to project closeout.

Structures shall be drawn true size and include the basic outline, bridge rail, curbs, edge of deck, sidewalks, approach slabs, and medians.

The CAD file name shall be the structure number with descriptor (e.g., F-16-XQ Sketch.dgn). This file should have a minimum of 2 models, one for the bridge linework and one for the border. Include any other linework models that are available for roadway, utilities, ROW, and survey information that would show in a general layout type of drawing. The other models in the file shall be referenced and scaled to fit the border. Additional models may be used for the typical section and profile if deemed necessary. The linework model shall either use the project coordinate system with associated geographic coordinate system (GCS) from the survey group or state plane system GCS (central, north, south) based on available aerial imagery. The CAD file shall not reference any external files. The model shall contain all available linework information for the bridge. Control lines, piles, centerlines, girder labels, construction lines, etc. are not shown in the sketch border sheet. Rolled girders shall utilize properly named cells, e.g. W11x24. Welded plate girders shall use rectangles for the plate members.

The structure shall be laid out with increasing mile point (MP) from left to right. This may be contrary to stationing or layout of the construction plans.

17.3.1 Size and Scale

The border model shall be 2D at a 1”=1’ scale.

Maximum scale for referenced plan views shall be 1”= 50’. If the scale is too large, a larger border (8.5”x14”) or multiple sheets may be necessary.

Typically, sketches should fit on an 8.5”x11” sheet with readable dimensions and text (size .07). Girder labels shall use .10” Text. Generally, the structures are shown with the Plan view on top, the Elevation below it and then the Section view on the bottom.

Very long structures, such as viaducts, shall be shown in segments with match lines and stacked on the same page along with the elevation view.

Dimensions shall be shown to the nearest inch.

The border around the sheet has a simple title block at the bottom (see examples included).

Borders for inspection sketches are available in MicroStation as cells: SHEET_InspectionSketch (8.5”x11”) and SHEET_InspectionSketch-Long (8.5”x14”).

17.3.2 Plan View

The Plan View for all structure types shall include:

- North Arrow
- Name of Waterway and approximate edges, and Direction-of-flow arrow

- Highways, paths and railroads that the bridge crosses
- Direction arrow for One-Directional traffic
- Skew angle (see Chapter 2 for definition) shown to the nearest second
- Width, span length, span number

The plan view is used to draw in deficiencies such as patches and damage.

Plan views for bridges over roads shall also include:

- X indicators at vertical clearance points
- Vertical clearance information table (mark minimum and maximum)

17.3.3 Elevation View

The Elevation View for all structure types should be shown at the same scale as the plan view. Vertical scale may be exaggerated.

The Elevation view shall include:

- The labeling of the substructure units (as per Chapter 1 Section 1.13 of this Manual)
- Front face to front face bridge length (NBIS bridge length)
- Back face to back face bridge length (total bridge length)
- Centerline of bearing to centerline of bearing length
- Maximum span length (if multiple, only one needs to be labeled)
- Minimum span length (if multiple, only one needs to be labeled)
- Existing grade line underneath the bridge
- Channel location
- Roads, highways, railroads, and other permanent features, including curbs and barrier
- Pier and Abutment foundations (piles and caissons may be displayed shortened with break lines, although the model shows the true length)
- Vertical dimension from bottom girder to bottom footing/piles
- Dimensions for minimum vertical and lateral underclearances for roadways underneath the bridge. The dimensions shall be left blank, to be completed by the Inspector in the field, since they can change after an overlay or road reconstruction. Vertical dimensions shall be shown at each lane line. Each lane line shall be labeled (YS – yellow stripe, WS – white stripe, ST – stripe, skip or solid). If insufficient space is available, a larger scale detail shall be added on another sheet
- Label of upper and lower nodes and typical panel length for truss bridges

Depict fracture critical members in red using DRAFT_Miscellaneous-Red level (Open Roads Designer (ORD)).

The vertical clearance is measured from the road surface to the lowest point of the structure crossing overhead.

The “underpass” horizontal clearance should be measured between the most restrictive features: concrete barriers, substructure unit, oncoming traffic lanes, toe of slope steeper than 1 to 3 (see SNBI for additional information). The purpose of the horizontal clearance measurement is to give the largest available clearance for the movement of wide loads.

Inspection sketches depict the CDOT numbering system relative to the direction of inventory of the highway; Abutment 1 would be at the lower mile point. Span 1 follows Abutment 1, Span 2 follows Pier 2, and so on.

17.3.4 Section View for Bridges

The Section view shall be drawn looking in the inventory direction (up MP). It denotes the full width of the bridge (typical section) and is used to show:

- Raised medians
- Restricted width
- The rail style and height, and curb height above bare deck
- Type of girder
- Girder spacing
- Girder label
- Vertical dimension between top of rail and bottom of girder
- Lanes and shoulders

Depict fracture critical members in red using DRAFT_Miscellaneous-Red level (ORD).

Do not show the pier cap or concrete diaphragm in section view.

17.4 Culvert Representation

In addition to the requirements of Section 17.3, the following information shall be shown:

17.4.1 Plan View for Culverts

- The out to out length along the culvert
- The length to the far edges of the culvert perpendicular to the roadway
- The skew angle
- If the culvert section is variable, section cuts may be added to clarify sections

17.4.2 Elevation View for Culverts

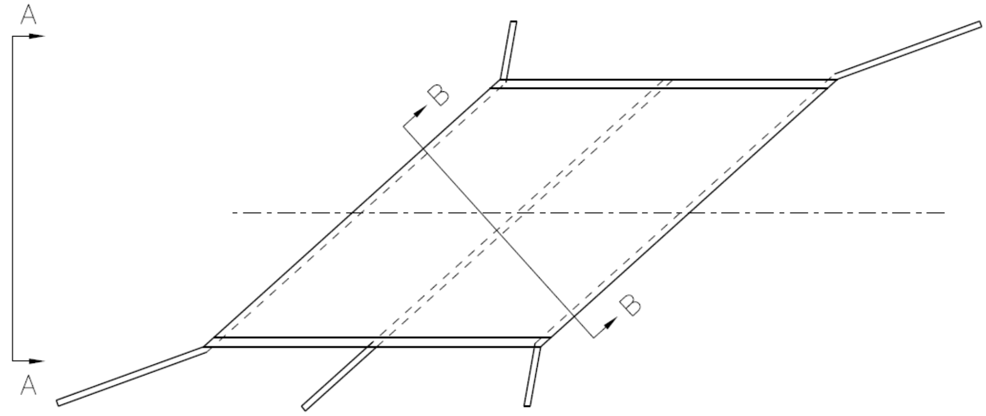
- Fill under all roadway pavements shall be dimensioned

The Elevation is a view of the culvert cut perpendicular to the roadway centerline (see section A Fig. 17.4-1).

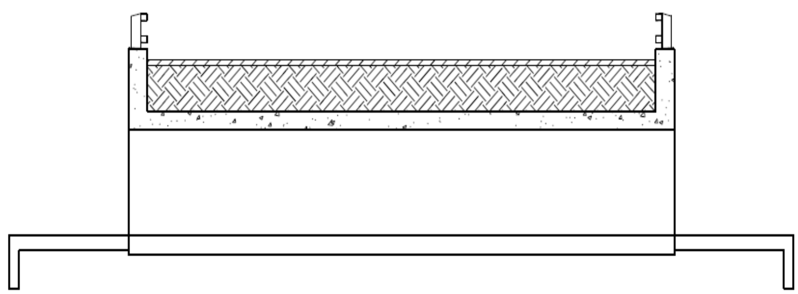
17.4.3 Section View for Culverts

- The distance between inside faces of walls
- The interior cell dimensions

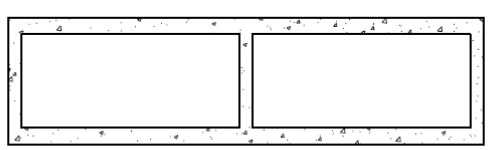
The Section view depicts the section perpendicular to the centerline of the culvert (see section B Fig. 17.4-1).



PLAN



ELEVATION A-A



SECTION B-B

Fig. 17.4-1 Culvert Elevation and Section View

17.5 Tunnel Representation

In addition to the requirements of Section 17.3, the following information shall be shown:

17.5.1 Plan View for Tunnels

- Dimensions for the total length and blank dimensions for tunnel width, sidewalks, access ways and barrier

17.5.2 Elevation View for Tunnels

- The high point and/or direction of slope

17.5.3 Section View for Tunnels

- Ventilation areas, lighting, fire suppression items and barriers
- Additional sections may be required to depict changing tunnel information
- Vertical clearance dimensions shall be shown at each lane line, mark the minimum

17.6 Examples

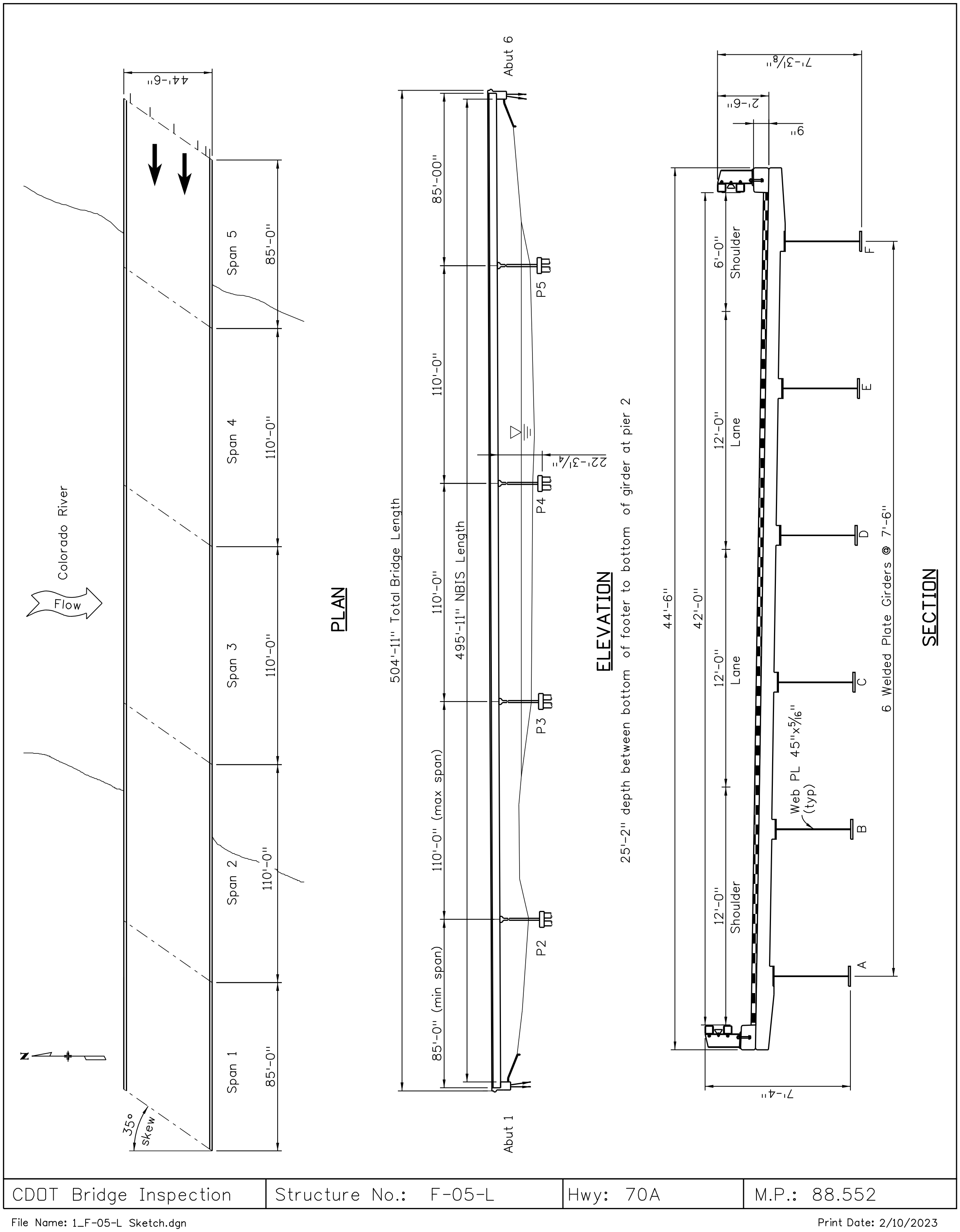


Fig. 17.6-1 Bridge Inspection Sketch – Example 1

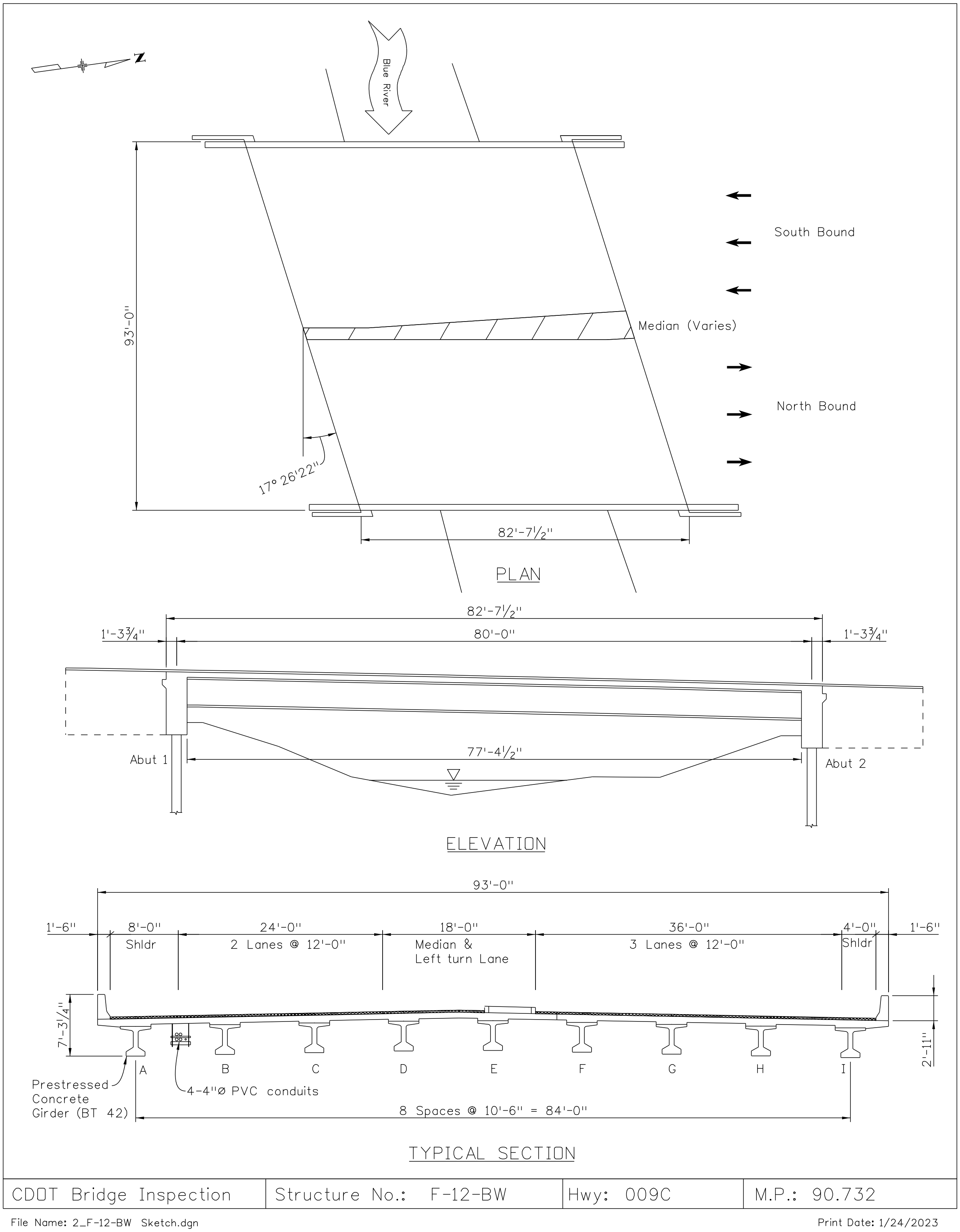


Fig. 17.6-2 Bridge Inspection Sketch – Example 2

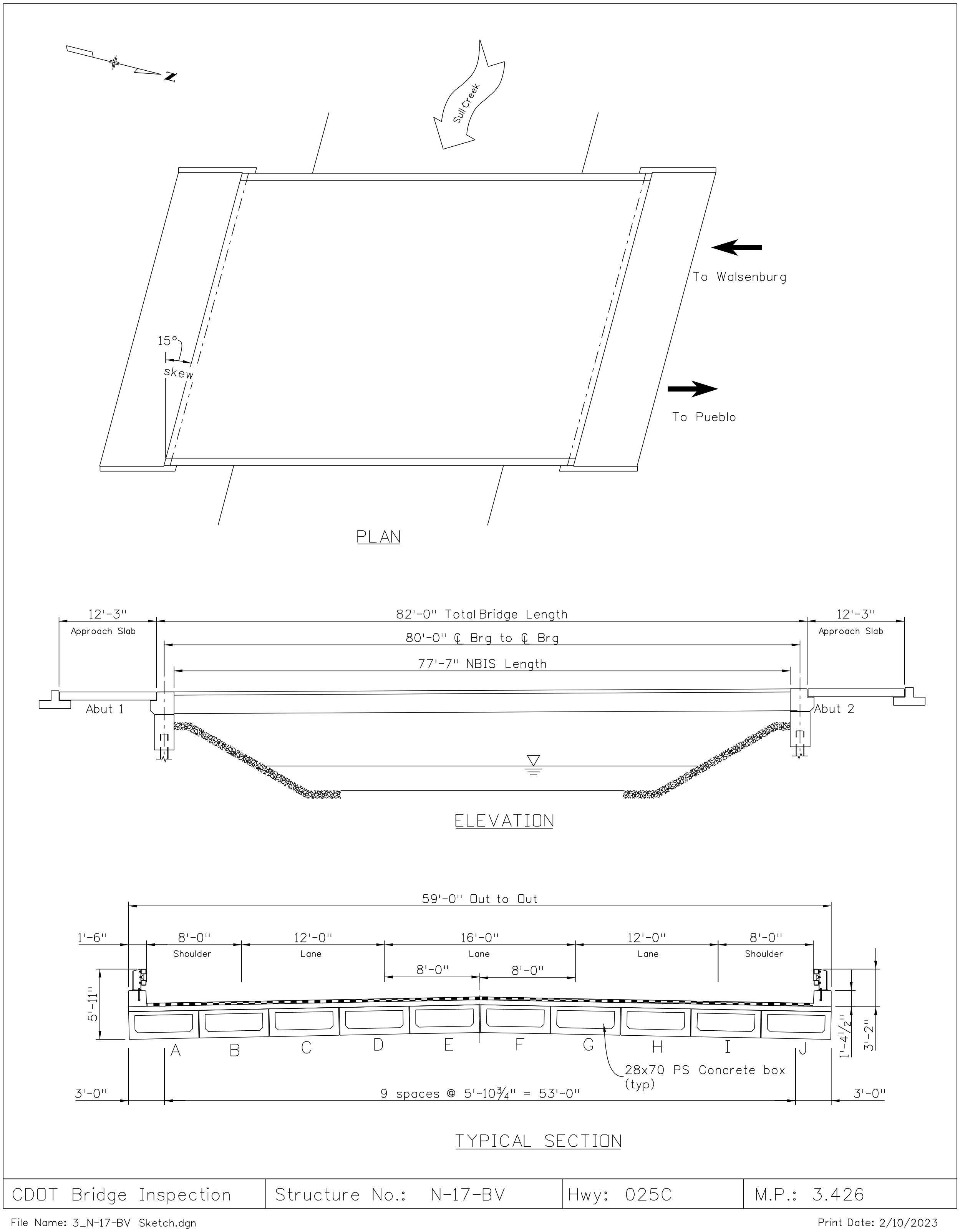


Fig. 17.6-3 Bridge Inspection Sketch – Example 3

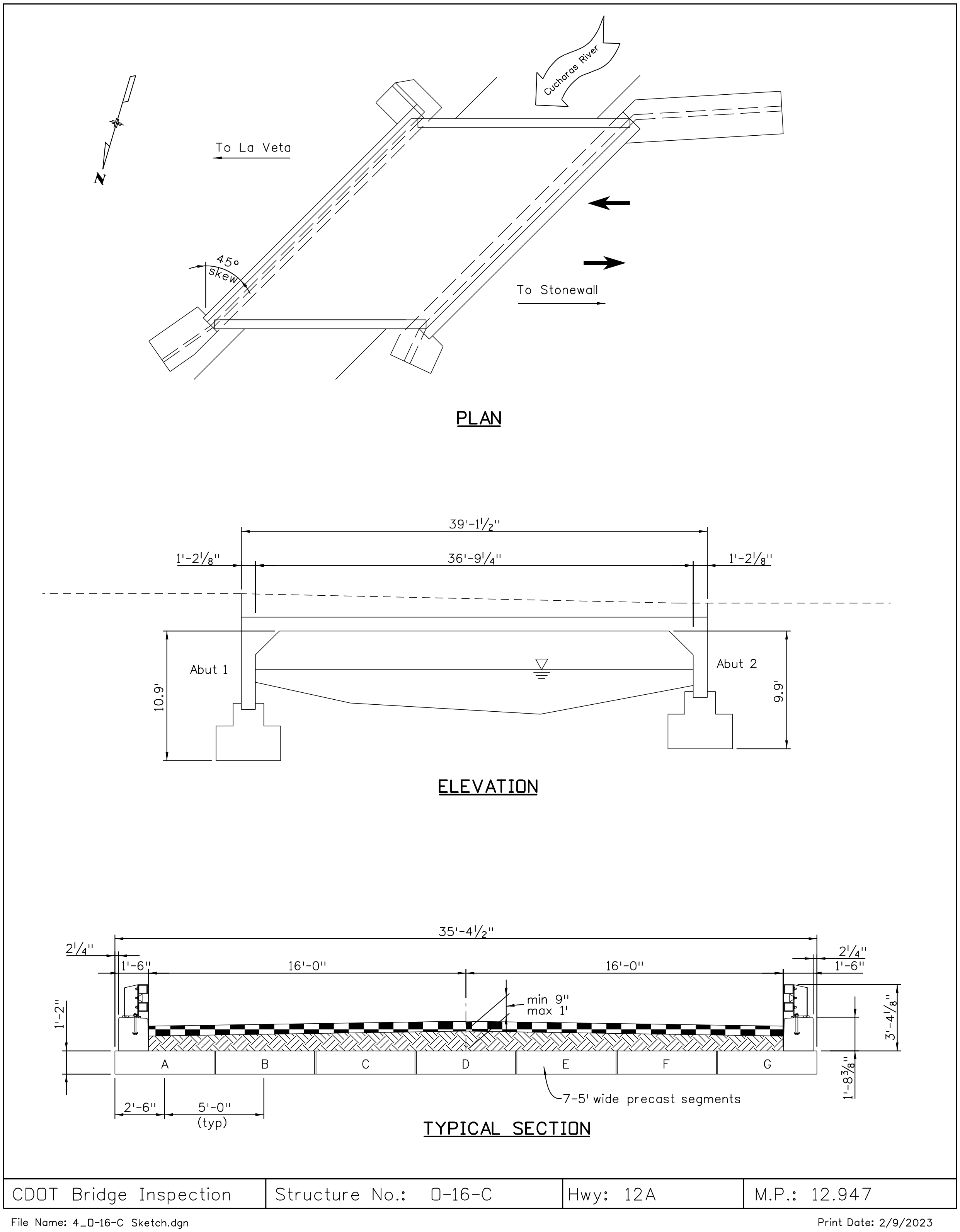


Fig. 17.6-4 Bridge Inspection Sketch – Example 4

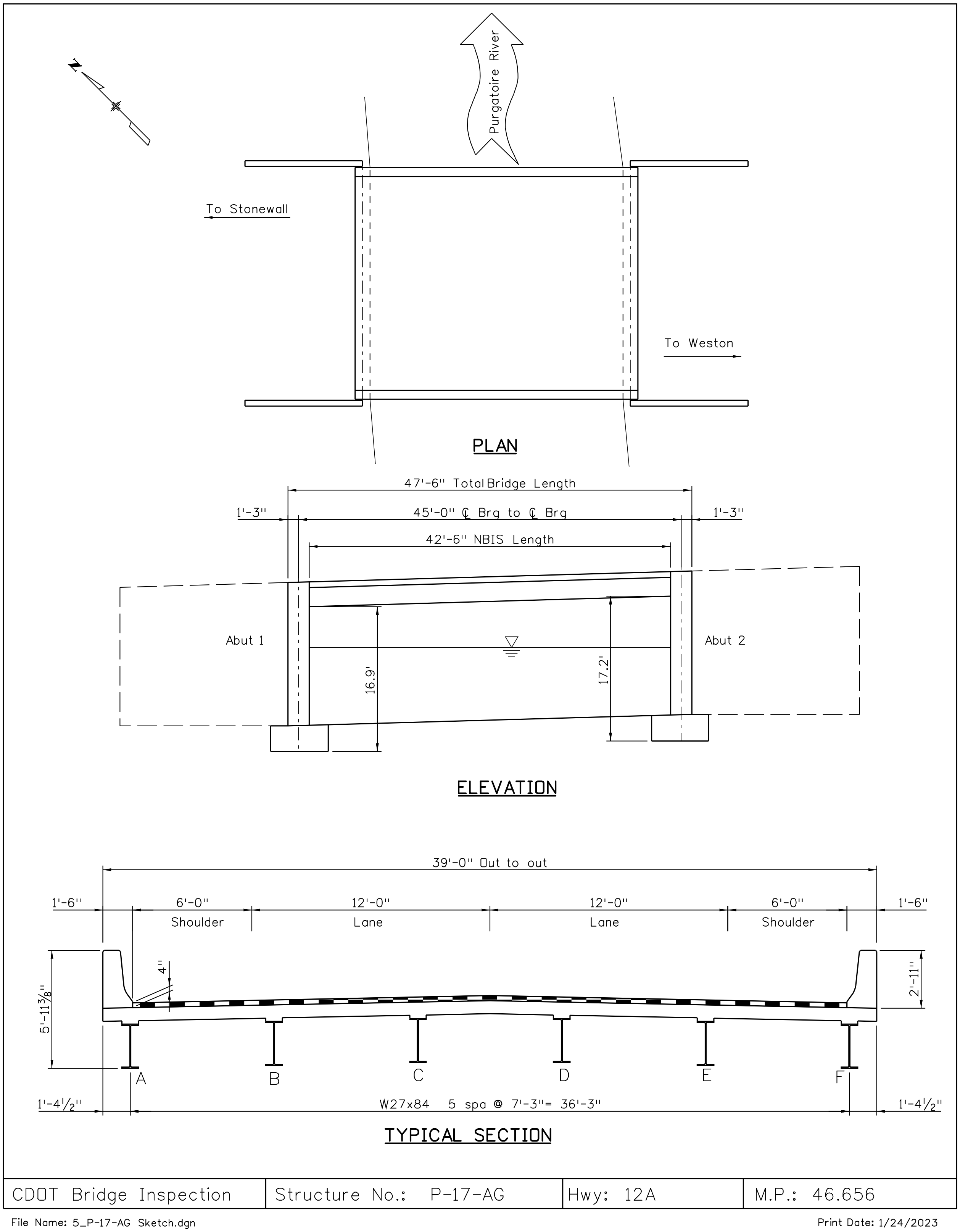


Fig. 17.6-5 Bridge Inspection Sketch – Example 5

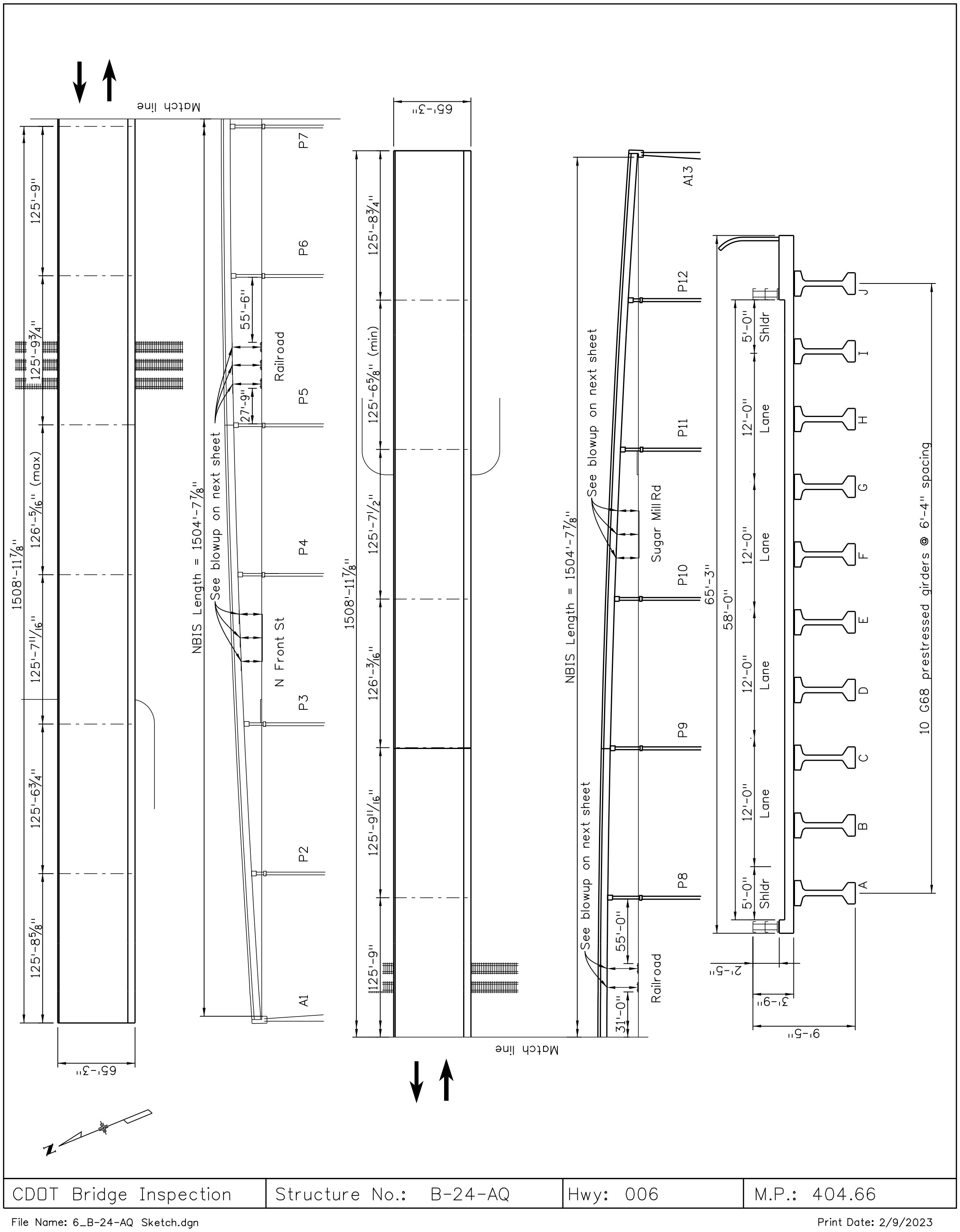


Fig. 17.6-6 Bridge Inspection Sketch – Example 6

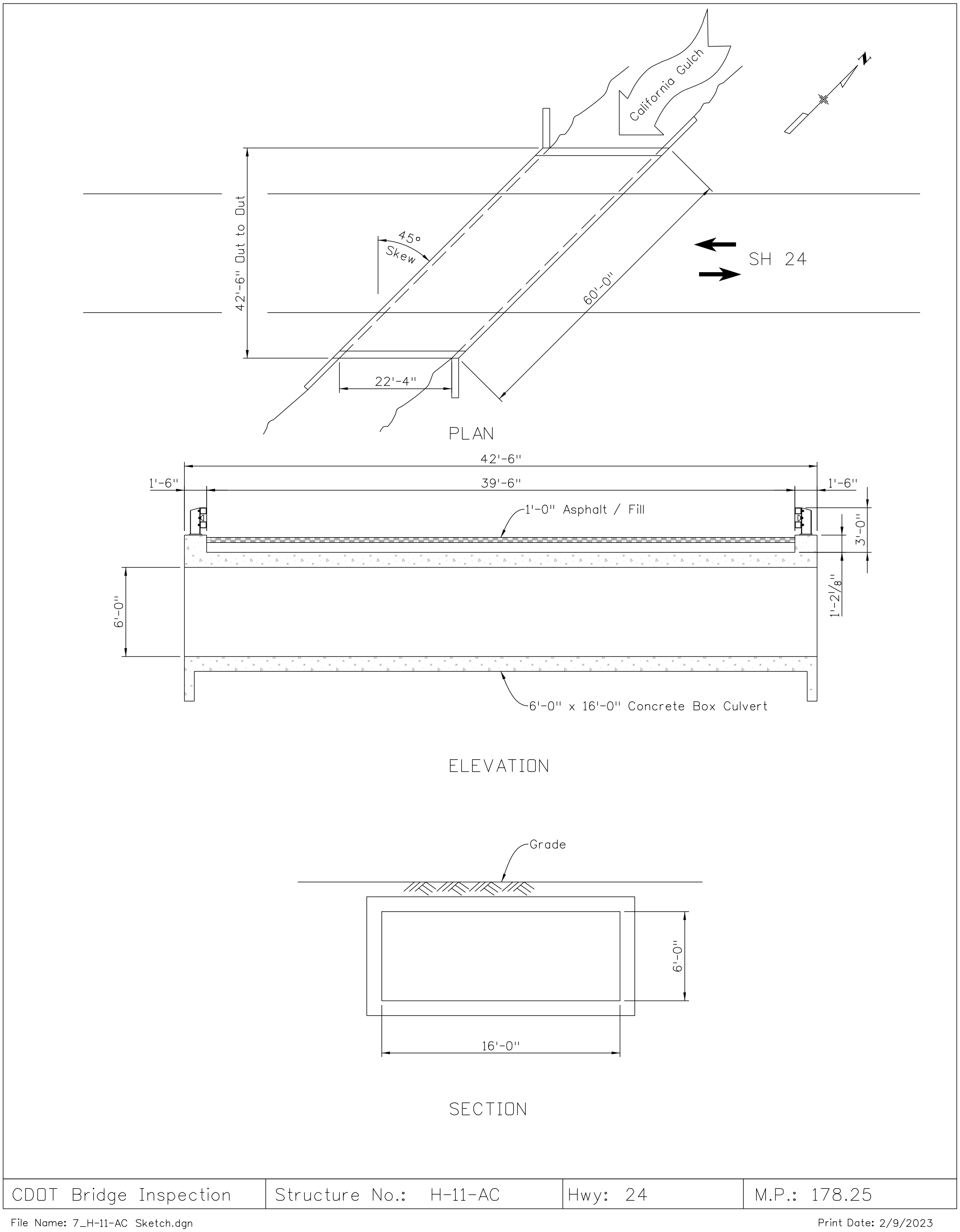


Fig. 17.6-7 Culvert Inspection Sketch – Example 7

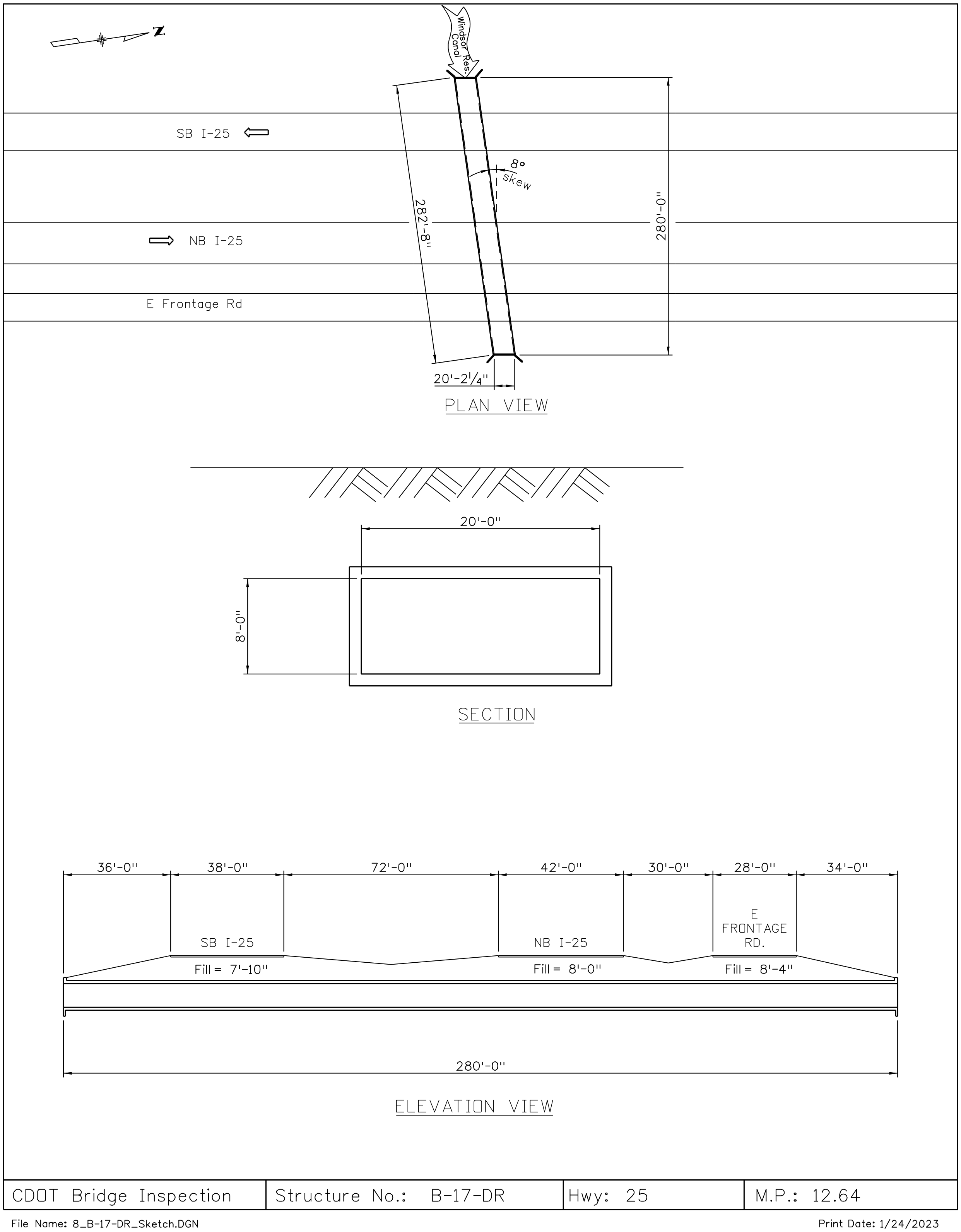


Fig. 17.6-8 Culvert Inspection Sketch – Example 8

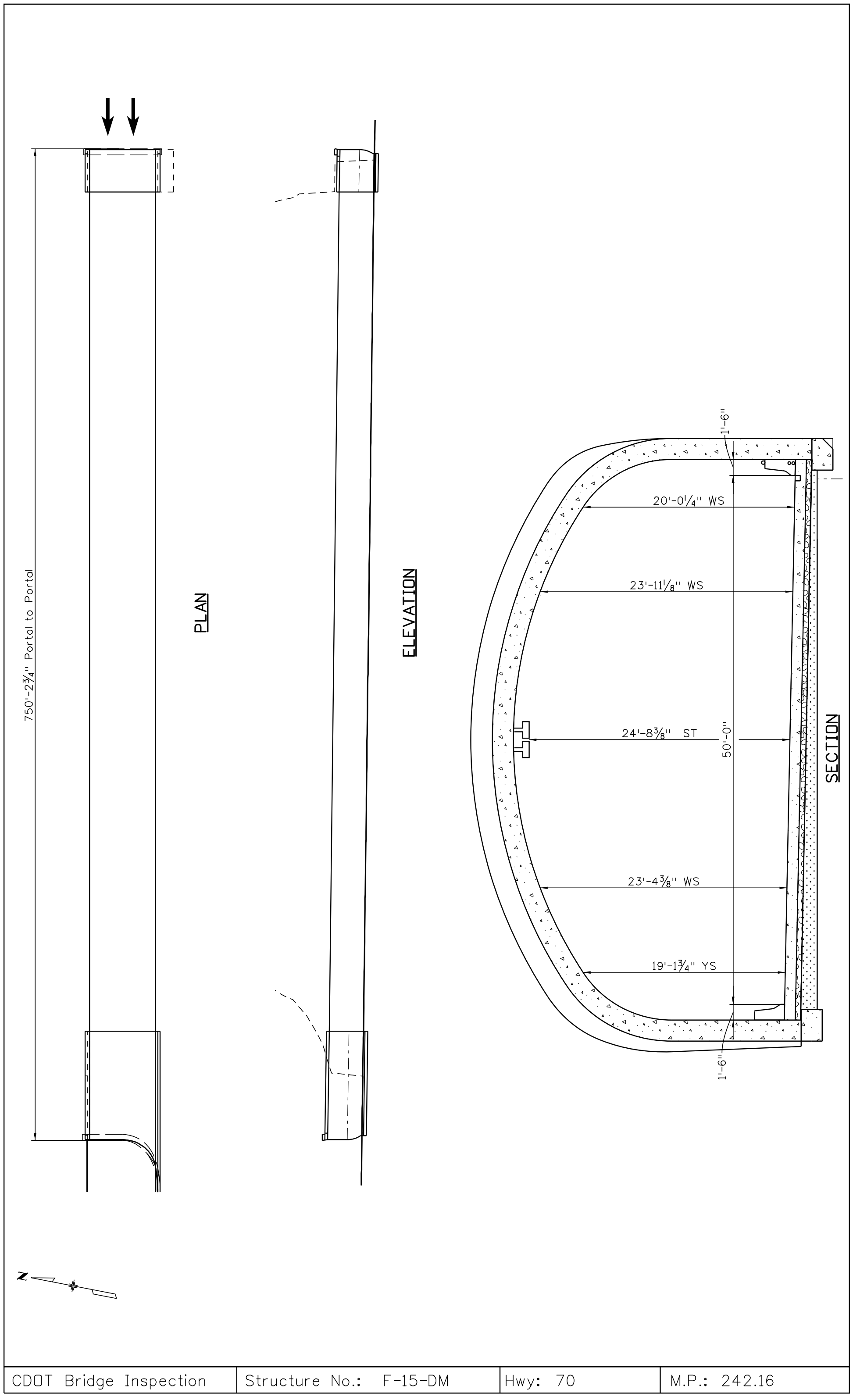
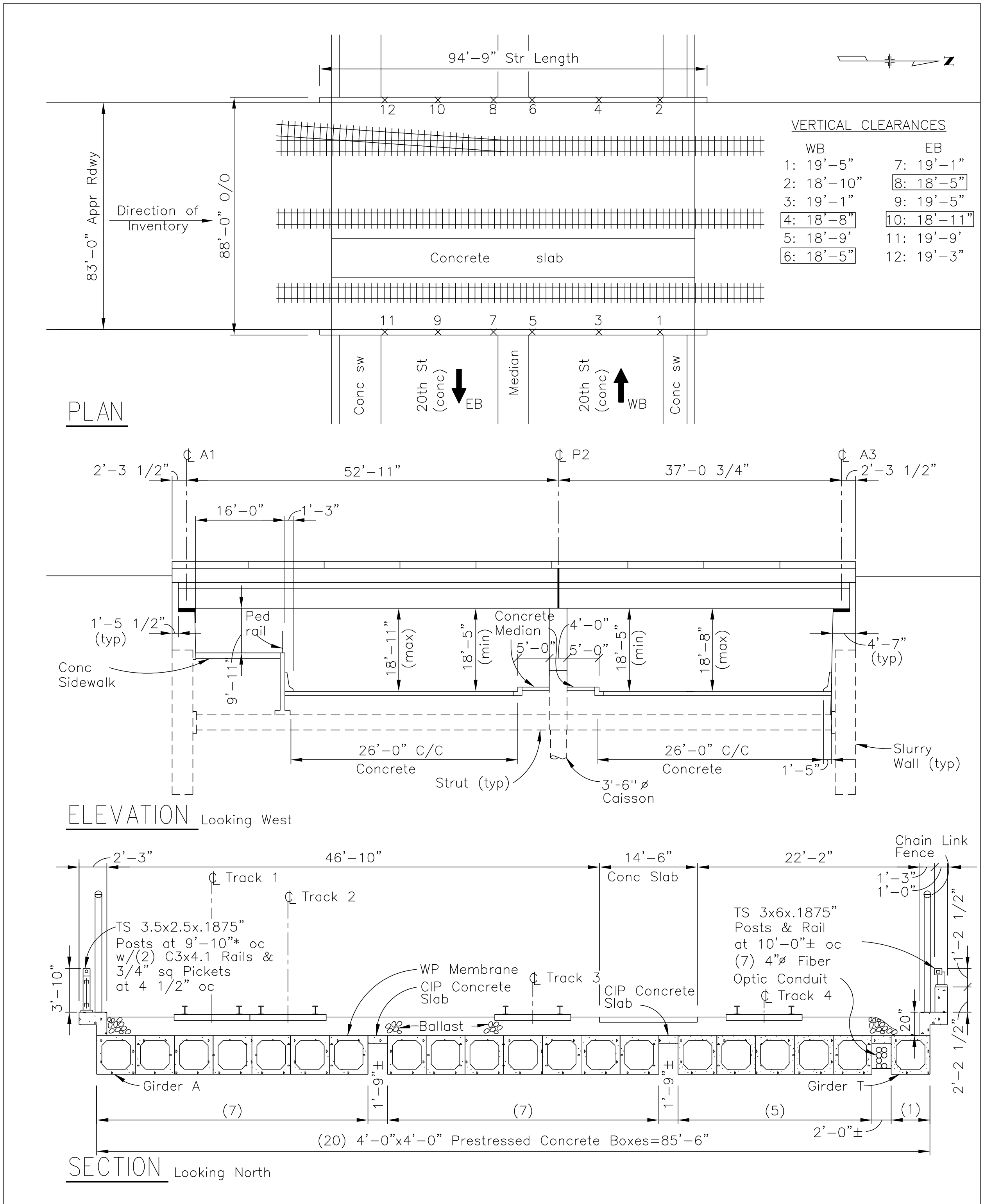


Fig. 17.6-9 Tunnel Inspection Sketch – Example 9



CDOT Bridge Inspection	Structure No.: D-05-RRBR-096	Hwy: 10	M.P.: 125.35

File Name: 10_D-05-RRBR-096_Sketch.DGN

Print Date: 2/9/2023

Fig. 17.6-10 Bridge Inspection Sketch – Example 10

Appendix A – Abbreviations & Acronyms

A.1 Abbreviations & Acronyms

The use of abbreviations and acronyms is generally discouraged unless required due to time or space limitations. If more than one abbreviation is shown in this appendix, the first abbreviation is required although the others have been used in the past. Italicized items in this list are for information only based on historic plans and are not acceptable for current use. This list may not be inclusive. Where special abbreviations are used, a descriptive tabulation may be necessary and is allowed in the plan drawings. Please refer to M Standard M-100-2 for current requirements

Abbreviation or Acronym **Symbols**	**Meaning**
@	at
&	and
[	channel (steel)
ɸ , ∅	Diameter
° ′ ″	Degrees, Minutes, Seconds
′ ″	Feet, inches
#	pound or number
3R	Resurfacing, Restoration, Rehabilitation
8UN	8 thread series (screw thread)
Ⓔ	Epoxy Coated Rebar
Ⓝ	Non-Epoxy Coated Rebar
XX	Girder Label
≤	Less than or Equal to
≥	Greater than or Equal to
⌷	Square
±,+/-	Denotes an approximate or unknown variance/tolerance/ uncertainty usually with a dimension. The last digit written down in a measurement is the 1st digit with some uncertainty
A	
AAC	Aluminum Arch Culvert
AADT	Annual Average Daily Traffic
AAN	American Association of Nurserymen
AAR	Association of American Railroads (functions of the Communications and Signal Division merged into AREMA)
AASHO	American Association of State Highway Officials (defunct 1973, now known as AASHTO)
AASHTO	American Association of State Highway and Transportation Officials

Abbreviation or Acronym **Symbols**	**Meaning**
ABS	Acrylonitrite-Butadiene-Styrene Pipe
Abt, *Abt.*	About
Abut, *Abut.*	Abutment
ACI	American Concrete Institute
ACM	Asbestos Containing Materials
ADA	Americans with Disabilities Act
Adj, *ADJ.*	Adjust
ADT	Average Daily Traffic
AE	Architect-Engineer, Architecture, Engineering
AEC	Architecture, Engineering and Construction
AESC	American Engineering Standards Committee (defunct, now known as ANSI)
AGA	American Gas Association
AGC	Associated General Contractors of America
AQCM	Air Quality Congestion Mitigation
AH, *A.H., Ah.*	Ahead
AI	Asphalt Institute
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
Alt, *Alt.*	Alternate
AMPP	Association for Materials Protection and Performance
ANSI	American National Standards Institute, Inc. (formerly USASI, ASA and AESC)
APCA	American Portland Cement Alliance
API	American Petroleum Institute
APL	Approved Products List
Approx, *Approx.*	Approximate
APWA	American Public Works Association
AQCC	Air Quality Control Commission
ARA	American Railway Association (merged into Association of American Railroads)
ARBBA	American Railway Bridge and Building Association (merged into AREMA)
ARE	Additional Requested Element (Design/Build Terminology)
AREA	American Railway Engineering Association (merged into AREMA)
AREMA	American Railway Engineering & Maintenance-of-Way Association
ARTBA	American Road and Transportation Builders Association

Abbreviation or Acronym Symbols	**Meaning**
AS, *A.S.*	Ahead Station
ASA	American Standards Association (defunct, now known as ANSI)
ASBI	American Segmental Bridge Institute
ASCE	American Society of Civil Engineers
ASD	Allowable Stress Design
ASLA	American Society of Landscape Architects
ASME	American Society of Mechanical Engineers
ASNT	American Society for Non-Destructive Testing
ASOP	American Society of Photogrammetry
ASSE	American Society of Sanitary Engineering, American Society of Safety Engineers
Asst, *Asst.*	Assistant
ASTM	American Society for Testing and Materials
ATSSA	American Traffic Safety Services Association
AUTS	Actual Ultimate Tensile Strength
Ave, *Ave.*	Avenue
AWG	American Wire Gauge
AWPA	American Wood Protection Association, formerly American Wood Preservers' Association
AWS	American Welding Society
AWWA	American Water Works Association

Abbreviation or Acronym Symbols	**Meaning**
B	
Bk to Bk	Back to Back
BEI, *B.E.I.*	By Equal Increments
BM, *B.M.*	Bench mark
BPF, *B.P.F.*	Blows Per Foot
B/	Bottom of
BAFO	Best and Final Offer
Bbl, *Bbl.*	Barrels
BC, *B.C.*	Bolt Circle
Beg.	Begin
BF, *B.F.*	Backface
BFBW, *B.F.B.W.*	Backface of Backwall
Bk, *B.K., Bk.*	Back
Bldg, *Bldg.*	Building
BLM	Bureau of Land Management

Abbreviation or Acronym **Symbols**	**Meaning**
Blvd, *Blvd.*	Boulevard
BM_1	Quantities of Structure Backfill (Class 1) without Shoring
BM_2	Quantities of Structure Backfill (Class 1) with Shoring
BMP	Best Management Practice
Bms, *Bms.*	Beams
BNSF	Burlington Northern & Santa Fe Railroad
Bott, *Bott., Bot.*	Bottom
BP	Maximum Required Allowable Bearing Pressure
BPO	Business Programs Office (CDOT)
BR, *Br.*	Bridge On-System Program, Bridge
Brg, *Brg.*	Bearing
BRO	Bridge Off-System Program
BS, *B.S.*	Back Station
BT, *B.T.*	Beginning of Transition
Btm, *Btm.*	Bottom
Btwn, *Btwn.*	Between
C	
C&G	Curb and Gutter
CRS, *C.R.S.*	Colorado Revised Statutes, as amended. "43-1-225, C.R.S." means "§ 225, Article 1 of Title 43, C.R.S., as amended."
CA	Concrete Arch
CAC	Concrete Arch Culvert
CAD	Computer Aided Design or Computer Aided Drafting
CADD	Computer Aided Design and Drafting
CatEx	Categorical Exclusion
CBC	Concrete Box Culvert
CBG	Concrete Box Girder
CBGC	Concrete Box Girder Continuous
CBGCP	Concrete Box Girder Continuous Prestressed
CBGP	Concrete Box Girder Prestressed
CBGS	Concrete Box Girder Segmented
CCA	Colorado Contractors Association
CCI	Construction Cost Index
CCR	Code of Colorado Regulations, as amended
CDOT	Colorado Department of Transportation
CDPHE	Colorado Department of Public Health and Environment
CDTPG	Concrete Double-Tee Prestressed Girder
CE	Construction Engineering
CF, *Cu. Ft.*	Cubic Feet
CFR	Code of Federal Regulations

Abbreviation or Acronym **Symbols**	**Meaning**
CFS, *C.F.S.*	Cubic Feet Per Second
CG, *CG.*	Center of Gravity
CHP	Colorado Highway Patrol
CI, *CI.*	Cast Iron, Concrete on Rolled I-Beam
CIC	Concrete on Rolled I-Beam Continuous
CICK	Concrete on Rolled I-Beam Continuous & Composite
CICKP	Concrete on Rolled I-Beam Continuous & Composite Prestressed
CIK	Concrete on Rolled I-Beam Composite
CIKP	Concrete on Rolled I-Beam Composite Prestressed
CIOG, *C.I.O.G.*	Cast Iron Ogee (Washer)
CIP, *C.I.P.*	Cast-in-Place, *Cost in Place*
Clr, *CL., Clr.*	Clear
cm, *cm.*	Centimeters
CM, *CM.*	Corrugated Metal
CMAQ	Congestion Mitigation Air Quality
CMO	Contract Modification Order
CMP, *C.M.P.*	Corrugated Metal Pipe
CMS	Changeable Message Sign
CMU	Concrete Masonry Unit
COFRS	Colorado Financial Reporting System
Col, *Col.*	Column
Comp, *Comp.*	Composite
Conn, Con, *Conn.*, *Con.*	Connection
Conc, *Conc.*	Concrete
Const, *Const.*	Construction
Cont, *Cont.*	Continuous
Corr, *Corr.*	Corrugated
Cov, *Cov.*	Cover
CP	Colorado Procedure
CPE	Corrugated Polyethylene Pipe
CPG	Concrete Prestressed Girder (Precast)
CPGC	Concrete Prestressed Girder Continuous (Precast)
CP-L	Colorado Procedure – Laboratory
CPM	Critical Path Method
CPPA	Corrugated Plastic Pipe Association
CPT	Corrugated Polyethylene Tubing
CR	County Road
CRF	Concrete Rigid Frame
CRS	Colorado Revised Statutes, 1973, as amended
CRSI	Concrete Reinforcing Steel Institute

Abbreviation or Acronym **Symbols**	**Meaning**
CS, *C.S.*	Curve to Spiral, Commercial Standard, Concrete Slab
CSC	Concrete Slab Continuous
CSG	Concrete Slab & Girder (Poured in Place)
CSGC	Concrete Slab & Girder Continuous (Poured in Place)
CSGCP	Concrete Slab & Girder Continuous Prestressed (Poured in Place)
CSGP	Concrete Slab & Girder Prestressed (Poured in Place)
Csk, *Csk.*	Countersunk
CSL	Cross Sonic Log
CSP	Corrugated Steel Pipe, Concrete Slab Prestressed
CSPC	Concrete Slab Prestressed Continuous
CTR	Certified Test Reports
Ctr, *Ctr.*	Center
CY, *Cu. Yd., c.y.*	Cubic Yards
D	
D	Degree of Curvature, Depth, Density, Distance, Diameter
DB, D/B	Design Build
DAS, *D.A.S.*	Deformed Anchor Stud
dB	decibels
DBA	Deformed Bar Anchor
DBE	Disadvantaged Business Enterprise
Dbl, *Dbl.*	Double
Deg, *Deg.*, °	Degrees (Angular)
Deg, °F, °C, *Deg., °F., °C.*	Degrees (Thermal) – Degrees Fahrenheit, Degrees Celsius
DEIS	Draft Environmental Impact Statement
Dept, *Dept.*	Department
Dgn, *DGN, Dgn.*	Design, Microstation Drawing, Design
DH	Design Height (or, Avg. height for qty. calculations)
DHV	Design Hour Volume
DHW	Design High Water
DI, *D.I.*	Ductile Iron
Dia, *Dia.*, ϕ, ∅, Φ, &	Diameter
Dist, *Dist.*	District
Div, *Div.*	Division
DMS	Dynamic Message Sign
DNR	Department of Natural Resources
DOR	Design Office Review
DOW	Division of Wildlife (Colorado)
DPA	Department of Personnel & Administration
DRCOG	Denver Regional Council of Governments

Abbreviation or Acronym **Symbols**	**Meaning**
DS, *D.S.*	Down Station
DSR	Design Scoping Review
DTD	Division of Transportation Development (CDOT)
DTM	Digital Terrain Model
Dwg, *Dwg.*	AutoCAD Drawing, Sheet
E	
E to E	End to End
e.g.	Exempli Gratia (For Example)
E/A	Engineer and/or Architect
EA	Environmental Assessment
Ea, *Ea., EA*	Each
EB, *E.B.*	Eastbound
ECR	Epoxy Coated Rebar
EEO	Equal Employment Opportunity
EF, *E.F.*	Each Face
EIA	Electronic Industries Alliance (formerly Electronic Industries Association)
EIS	Environmental Impact Statement
El, *El., EL, Elev.*	Elevation
Elast, *Elast.*	Elastomeric
Elect Cond, *Elect. Cond.*	Electrical Conduit
EM_1	Quantity of Structure Excavation without Shoring
EM_2	Quantity of Structure Excavation with Shoring
Engr, *Engr.*	Engineer
EPA	Environmental Protection Agency
EPDM	Eethylene Propylene Ddiene Monomer-class rubber
Eq, *Eq.*	Equal
ESAL	Equivalent Single Axle Load
ESB	Emerging Small Business
Est, *Est.*	Estimate
ET, *E.T.*	Ending of Transition
EVT	Event Point (InRoads Terminology)
EW, *E.W.*	Each Way
E, *Ex*	Expansion Bearing
Ex, *Ex.*	Example, Except
Exc, *Exc., Excav.*	Excavation
Exist, *Exist.*	Existing
Exp	Non-guided (free floating) expansion bearing
Exp Jt, *Exp. Jt.*	Expansion Joint
Expn, *Expn.*	Expansion

Abbreviation or Acronym **Symbols**	**Meaning**
Ext, *Ext.*	Exterior
F	
F to F	Face to Face
FAP, *F.A.P.*	Federal Aid Project
FL, *F.L.*	Flow Line
FAA	Federal Aviation Administration
FAPG	Federal Aid Policy Guide
FCM	Fracture Critical Member
Fdn, *Fdn.*	Foundation
Fed, *Fed.*	Federal
FEMA	Federal Emergency Management Agency
FES	Flared End Section
FF, *F.F.*	Far Face, Front Face
FFBW, *F.F.B.W.*	Front Face of Backwall
FHWA	Federal Highway Administration
Fig, *Fig.*	Figure
Fin, *Fin.*	Finished
FIPI	Finding-in-the-Public-Interest
FIR	Field Inspection Review
Fl, *Fl.*	Floor
Flg, *Flg.*	Flange
FM	Factory Mutual
FMV	Fair Market Value
FO	Fiber Optic
FONSI	Finding of No Significant Impact
FOR	Final Office Review
fpm, *F.P.M.*	Feet Per Minute
Fps, *F.P.S., FPS*	Feet Per Second
FRA	Federal Railroad Administration
Freq, *Freq.*	Frequency
FRP	Fiber Reinforced Polymer
FS, *F.S.*	Planned Finish Surface
FSS	Federal Specifications and Standards
Ft, *FT, Ft., ft*	Feet
Ft Kip, *Ft. Kip.*	Foot Kips
Ft Lb, *FT LB, Ft. Lb.*	Foot Pounds
FTA	Federal Transit Administration
Ftg, *Ftg.*	Footing
FTP	File Transfer Protocol
Fut, *Fut.*	Future
F, *Fx*	Fixed Bearing

<u>Abbreviation or Acronym</u> **Symbols**	**<u>Meaning</u>**
G	
Ga, *Ga.*	Gage, Gauge
Gal, *Gal.*	Gallons
Galv, *Galv.*	Galvanized
Gd	Guided expansion bearing
GEIA	Government Electronics and Information Technology Group (ITAA)
GIP	Galvanized Iron Pipe
Gir, G, *Gird, Gird., Gir., Grd, Gr*	Girder
GIS	Geographical Information System
GL	Girt Line
GPM	Gallons Per Minute
GPS	Global Positioning System
GRI	Geosynthetic Research Institute
GRS	Geosynthetic Reinforced Soil
GSI	Geosynthetic Institute
GUTS	Guaranteed Ultimate Tensile Strength (replaced by AUTS & MUTS)
H	
H	Depth of Excavation at Wall Layout Line
HAS, *H.A.S.*	Headed Anchor Stud
HAZMAT	Hazardous Materials
HBP	Hot Bituminous Pavement
HC	Horizontal Clearance
HCL, *H.C.L.*	Horizontal Control Line
HCM	Highway Capacity Manual
Hd, *HD, Hd.*	Head
HDPE	High Density Polyethylene
HDPP	High Density Polypropylene
HEEP	Highway Engineering Exchange Program
HES	Hazard Elimination System
Hex Hd, *Hex. Hd.*	Hexagonal Head
HID	High Intensity Discharge (Lamps)
HLMR	Highload Multi-Rotational
HMA	Hot Mix Asphalt
Horiz, *Horz., Horiz., Hor.*	Horizontal
HOV	High-Occupancy Vehicle
HP	H pile, horsepower
HSHP	High StrengthHorsepower
HPC	High Performance Concrete

Abbreviation or Acronym Symbols	**Meaning**
HS Bolt, *H.S. Bolt*	High Strength Bolt
HS, *H.S.*	High Strength
HSC, *H.S.C.*	High Strength Concrete
Ht, *Ht.*	Height
HTF	Highway Trust Fund (Federal)
HUTF	Highway Users Tax Fund (State)
HW, *H.W.*	High Water
Hwy, *Hwy.*	Highway
Hyd, *Hyd.*	Hydraulic
I	
I	I beam or Wide Flange section (steel), Interstate
ICEA	Insulated Cable Engineers Association, formerly IPCEA
ID, *I.D.*	Inside Diameter
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society
IGA	Inter-Governmental Agreement
IMP	Incident Management Plan
IMSA	International Municipal Signal Association
In. Kips	Inch Kips
In. Lb.	Inch Pounds
In., *IN*	Inches
Incl, *Incl., Inc.*	Included
Insp, *Insp.*	Inspector
Int, *Int.*	Interior
Inv, *Inv.*	Invert
IP	Iron Pipe
IPCEA	Insulated Power Cable Engineers Association (defunct, currently known as ICEA)
IRI	International Roughness Index
IRIS	Inventory Road Information System
ISA	Initial Site Assessment
ISO	International Organization for Standards
ISP	Information or Internet Service Provider
ISTEA	Intermodal Surface Transportation Efficiency Act
ITAA	Information Technology Association of America
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation System
IVHS	Intelligent Vehicle Highway System
J	
JB, *J*	Junction Box
JBC	Joint Budget Committee

Abbreviation or Acronym **Symbols**	**Meaning**
Jct, *Jct.*	Junction
Jt, *Jt., jt.*	Joint
K	
Kip, kips	Kilo Pounds, Thousand Pounds
KSF, ksf	kips per square foot
KSI, ksi	Kips per square inch
KW	Kilowatt
L	
L, L	Length, Angle(steel)
LA	Local Agency
Lac, *Lac.*	Lacing
LAN	Local Area Network
Lb, *Lb., LB, lb*	Pounds
Lb/Ft, *lb./ft.*	pound per foot
Lb/SY, *Lb/sy*	Pounds per square yard
Lb-Ft, *lb-ft.*	pound foot
LED	Light Emitting Diode
LEED	Leadership in Energy and Environmental Design
LF, *Lin. Ft.*	Linear Feet
LFD	Load Factor Design
LLDPE	Linear Low-Density Polyethylene
LRFD	Load and Resistance Factor Design
LS, *L.S.*	Lump Sum, Length of Spiral
Lt, *Lt.*	Left
LTDS	Required Long Term Design Strength
Lum, *Lum.*	Luminaire
M	
m	Meters
MPH	Miles Per Hour
M	Mass
Maint, *Maint.*	Maintenance
MARV	Minimum Average Roll Value
Matl, *Matl.*	Material
Max, *Max., max.*	Maximum
MBTA	Migratory Bird Treaty Act
MCR	Minor Contract Revision
MD	Machine Direction
MFBM, *M.F.B.M.*	Thousand Foot Board Measure
Mfg, *Mfg.*	Manufactured, Manufacturer
MHT	Method of Handling Traffic
Mi, *Mi.*	Mile

Abbreviation or Acronym **Symbols**	**Meaning**
MIL	Military Specification
Min, *Min., min.*	Minimum
Misc, *Misc.*	Miscellaneous
mm	Millimeters
MMIS	Maintenance Management Information System
MMP	Materials Management Plan
MMS	Maintenance Management System
MOA	Memorandum of Agreement
Mobl, *Mobl.*	Mobilization
MOSS	Modeling of Surfaces and Strings
MOT	Maintenance of Traffic
MOU	Memorandum of Understanding
MP, *M.P.*	Milepost
MPH, *M.P.H.*	Miles Per Hour
MPO	Metropolitan Planning Organization
MRS	Quantity of Mechanical Reinforcement for prescribed Soil zone
MSE	Mechanically Stabilized Earth
MSEW	Mechanically Stabilized Earth Wall
MSS	Manufacturers Standardization Society of the Valve and Fitting Industry
MTIP	Materials Testing and Inspection Plan
MUTCD	Manual on Uniform Traffic Control Devices
MUTS	Minimum Ultimate Tensile Strength
N	
NA, N/A, *N.A.*	Not Applicable
NACE	National Association of Corrosion Engineers
NAD	North American Datum
NAVD	North American Vertical Datum
NB, *N.B.*	Northbound, Total Number of Blocks
NBIS	National Bridge Inspection Standards
NBS	National Bureau of Standards
NC	Uniform National Coarse (screw thread)
NCHRP	National Cooperative Highway Research Program
NCR	Nonconformance Report
NDT	Non Destructive Testing
NEC	National Electrical Code
NECA	National Electrical Contractors Association
NEMA	National Electrical Manufacturers Association
NEPA	National Environmental Policy Act
NESC	National Electric Safety Code

Abbreviation or Acronym **Symbols**	**Meaning**
NF, *N.F.*	Near Face, Uniform National Fine (screw thread)
NFPA	National Fire Protection Association
NFRT&AQPC	North Front Range Transportation & Air Quality Planning Council
NGS	National Geodetic Survey
NGVD	National Geodetic Vertical Datum of 1929
NHI	National Highway Institute
NHS	National Highway System
NIC, *N.I.C.*	Not in Contract
NIP, *N.I.P.*	Nail in Place
NIST	National Institute of Standards and Technology
No, *No.*	Number
NOAA	National Oceanic and Atmospheric Administration
Nom, *Nom.*	Nominal
NPCA	National Precast Concrete Association
NPDES	National Pollutant Discharge Elimination System
NPT	National Pipe Thread
NS, *N.S.*	Near Side
NSC	Normal Strength Concrete
NSF	NSF International, formerly National Sanitation Foundation
NTCIP	National Transportation Communications for ITS Protocol
NTP	Notice to Proceed
NTS, *N.T.S.*	Not to Scale
NWN	Nonconforming Work Notice
O	
OC, *O.C.*	On Center
OD, *O.D.*	Outside Diameter
OFMB	Office of Financial Management and Budget
OG, *O.G.*	Original Ground
OHW	Ordinary High Water
OJT	On-the-Job Trainee or On-the-Job Training
OP	Overhead Pipe
Opp Hand, *Opp. Hand*	Opposite Hand
OSHA	Occupational Health and Safety Administration
oz, *Oz.*	Ounces
P	
PACOG	Pueblo Area Council of Governments
PC, *P.C.*	Point of Curve
PCA	Portland Cement Association
PCBC	Concrete Box Culvert Precast
PCC, *P.C.C.*	Point of Compound Curve

Abbreviation or Acronym Symbols	**Meaning**
PCCP	Portland Concrete Cement Pavement
PCI	Precast/Prestressed Concrete Institute
PCO	Potential Change Order
PCP	Product Control Plan
PD	Procedural or Policy Directive
PDA	Pile Driving Analyzer
PE	Preliminary Engineering, Professional Engineer, Permanent Easement
PEL	Planning & Environmental Linkage
PEP	Plain Elastomeric Pad
PG	Profile Grade, Performance Grade
PGL, *P.G.L.*	Profile Grade Line
PI, *P.I.*	Point of Intersection
PICS	Project Item Coding System (replaced by Inroads Survey)
PIP	Public Information Plan
PL, Pl, *PL., Pl.*	Plate
PLS	Professional Land Surveyor
PM	Project Manager
POC, *P.O.C.*	Point on Curve
POSS, *P.O.S.S.*	Point of Slope Selection
POT, *P.O.T.*	Point on Tangent
PPACG	Pikes Peak Area Council of Governments
PPE	Personal Protective Equipment
PPI	Plastics Pipe Institute
PPPP	Project Priority Programming Process
PS&E, *P.S. & E.*	Plans, Specification and Estimate
PS, *P.S.*	Planned Subgrade
Prin, *Prin.*	Principle
Proj, *Proj.*	Project, Projection
ProMIS	Project Management Information System
Prov, *Prov.*	Provisions
PSC	Prestressed Concrete
PS&E	Plans, Specifications and Estimate
psf	pounds per square foot
PSI	Preliminary Site Investigation
psi, *P.S.I.*	Pounds per square inch
PSIG	Pounds Per Square Inch Gauge
PT, *P.T.*	Point of Tangent
PTFE	Polytetrafluoroethylene
PTI	Post-Tensioning Institute
PUC	Public Utilities Commission

Abbreviation or Acronym **Symbols**	**Meaning**
PVC	Poly Vinyl Chloride (pipe), Point of Vertical Curve
PVI	Point of Vertical Intersection
Pvmt, *Pvmt.*	Pavement
PVT	Point of Vertical Tangency
Q	
Q	Peak Discharge or Flow Volume
QA	Quality Assurance
QC	Quality Control
QMP	Quality Management Plan (Design/Build Terminology)
R	
R, *R., Rad.*	Radius
RA	Rubble Arch
RAC	Rubble Arch Culvert
rad	radians
RC, *R.C.*	Reinforced Concrete, Reverse Crown
RCO	Request for Change Order
RCP, *R.C.P.*	Reinforced Concrete Pipe, Request for Change Proposal
RCPC	Reinforced Concrete Pipe Culvert
RCRA	Resource Conservation and Recovery Act
Rdwy, *Rdwy.*	Roadway
RE	Resident Engineer, Railroad Easement, Reinforced Earth
Ref, *Ref.*	Reference
Reinf, *Reinf.*	Reinforcing
Rem, *Rem.*	Remove, Removal
Repl, *Repl.*	Replace
Req, *Reg., Req'd, Reqd.*	Required
Rev, *Rev.*	Revised, Revision
RFC	Released for Construction
RFP	Request for Proposals
RFQ	Request for Qualifications
RG	Riveted Plate Girder
RGC	Riveted Plate Girder Continuous
RHM	Recognized Hazardous Materials
RL	Reinforcement Length
RME	Region Materials Engineer
RMWA	Roadmasters and Maintenance of Way Association (merged into AREMA)
ROD	Record of Decision
ROW, *R.O.W., R/W,RW*	Right of Way
RPC	Region Planning Commission

Abbreviation or Acronym Symbols	**Meaning**
rpm, *RPM*	Revolutions Per Minute
RSC	Rigid Steel Conduit
RSS	Reinforced Soil Slope
Rt, *Rt.*	Right
RTD	Region Transportation Director
RWIS	Road Weather Information System
S	
S	Tributary reinforcement spacing for MSE walls, Girder Spacing
SAC	Steel Arch Culvert
SAE	Society of Automotive Engineers
San, *San.*	Sanitary
SAP	Sample Analysis Plan
SB, *S.B.*	Southbound
SBA	Small Business Administration
SBG	Steel Box Girder
SBGC	Steel Box Girder Continuous
SC, *S.C.*	Spiral to Curve
Sch, *Sch.*	Schedule
SCS	Spiral Curve Spiral
SDG	Steel Deck Girder
SDGC	Steel Deck Girder with Floor Beam System
SDGCK	Steel Deck Girder Continuous & Composite
SDI	Steel Decks Institute or Steel Door Institute
SDT	Steel Deck Truss
Sect, *Sec., Sect.*	Section
SF, *Sq. Ft., Sq ft*	Square Feet
SH	State Highway
Shldr, *Shldr.*	Shoulder
SHPO	State Historic Preservation Office
Sht, *Sht.*	Sheet
SIA, SI&A	Structural Inventory & Appraisal
SIC	Standard Industrial Code
SIGN	Overhead Sign
SIGNB	Overhead Sign-Butterfly
SIGNC	Overhead Sign-Cantilever
SIGND	Overhead Sign + Cantilever
Sim, *Sim.*	Similar
SIP, *S.I.P.*	Stay in Place
SJI	Steel Joists Institute
SLT	Steel Low Truss

Abbreviation or Acronym **Symbols**	**Meaning**
Sdwk, *SLWK.*	Sidewalk
SMA	Stone Matrix Asphalt
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association
SME	Subject Matter Expert
SMP	Safety Management Plan
SMSE	Shored Mechanically Stabilized Earth
SOQ	Statement of Qualification, Summary of Quantities
Spa, *Spa.*	Spaces or Spaced
Specs, *Specs.*	Specifications
Spl, *Spl.*	Splice
Sq In, *Sq. In.*	Square Inches
Sq Mi, *Sq. Mi.*	Square Miles
Sq, *Sq., Sqr.*	Square
SRW	Segmental Retaining Walls
SSE	Steel Stringer-Earth Filled
SSM	Steel Stringer-Metal Plank Deck
SSMC	Steel Stringer-Metal Plank Deck Continuous
SSPC	Society for Protective Coatings, formerly Steel Structures Painting Council
SSS	Steel Stringer-Timber Deck
SSSC	Steel Stringer-Timber Deck Continuous
ST, *S.T.*	Spiral to Tangent
St, *St.*	Straight, Street
Sta, *STA, Sta.*	Station
STAC	Statewide Transportation Advisory Committee
Std, *Std.*	Standard
STG	Steel Thru Girder
STIP	Statewide Transportation Improvement Program
STP	Surface Transportation Program
Str, *Str.*	Structure, Structural
STT	Steel Thru Truss
SUSP	Suspension Bridge
SWMP	Stormwater Management Plan
SY, *Sq. Yd., Sq Yd*	Square Yards
Sym, *Symm.*	Symmetrical
T	
T&B	Top and Bottom
T&E	Threatened & Endangered Species
T, *T.*	Tons
TAS, *T.A.S.*	Threaded Anchor Stud

Abbreviation or Acronym Symbols	**Meaning**
TBC	Timber Box Culvert
TC, *T.C.*	Tangent to Curve
TCC	Traffic Communications Center
TCP	Traffic Control Plan
TD	Timber Stringer (Untreated) Concrete Deck
TDH	Total Dynamic Head
TE	Transportation Enhancement funding
TEA-21	Transportation Efficiency Act for the 21st Century
Temp, *Temp.*	Temporary, Temperature
Thd, *Thd.*	Thread
THHN	Thermoplastic High Heat-resistant Nylon coated (Insulation designation for wire)
THWN	Thermoplastic High Water-resistant Nylon coated (Insulation designation for wire)
TIG	Tungsten Inert Gas (Welding)
TIP	Transportation Improvement Program
TLA	Timber Laminated Arch (Gluelam)
TLS	Timber Laminated Stringer(Gluelam)
TLT	Timber Low Truss
TM	Timber Stringer (Untreated) Metal Deck
TMOSS	Terrain Modeling Survey System
TOC	Traffic Operations Center
Tot, *Tot.*	Total
TPI	Threads per Inch
TPR	Transportation Planning Region
TRB	Transportation Research Board
TS, *T.S.*	Tangent to Spiral, Timber Stringer (Untreated) Timber Deck
TSF	Tons/square foot
TSLAB	Timber Slab
TTC	Timber Culvert
TTD	Timber Stringer-Concrete Deck
TTM	Timber Stringer- Metal Deck
TTS	Timber Stringer- Timber Deck
TTT	Timber Thru Truss
TUNC	Tunnel-Concrete Lined
TUNR	Tunnel-Thru Rock-No Lining
Typ, *Typ.*	Typical

Abbreviation or Acronym Symbols	**Meaning**
U	
UDBE	Underutilized Disadvantaged Business Enterprises
UG	Underground
UL	Underwriters Laboratories, Inc.
UMTA	Urban Mass Transportation Administration
UNC	Uniform National Coarse (screw thread)
UNCC	Utility Notification Center of Colorado
8UN	8 thread series (screw thread)
UNF	Uniform National Fine (screw thread)
UNO	Unless Noted Otherwise
UON	Unless Otherwise Noted
UPRR	Union Pacific Railroad
UPS	Uninterruptible Power Supply
US, *U.S.*	Upstation, United States
USACE	United States Army Corp of Engineers
USASI	United States of America Standards Institute (defunct, now known as ANSI)
USC	United States Code
USCS	Unified Soil Classification System
USDA	U.S.S Department of Agriculture
USDOT	U.S.S Department of Transportation
USFWS	U. S.S Fish and Wildlife Service
USGBC	United States Green Building Council
USGS	US Geological Survey
Util, *Util.*	Utility, Utilities
UV	Ultraviolet
V	
VC, *V.C.*	Vertical Curve
VCP	Vitrified Clay Pipe
VE	Value Engineering
VECP	Value Engineering Change Proposal
Veh, *Veh.*	Vehicle
Vert, *Vert.*	Vertical
VMS	Variable Message Sign (also known as DMS)
VMT	Vehicle Miles Traveled○
Vol, *Vol.*	Volume
VPC	Vertical Point of Curvature
VPI	Vertical Point of Tengency
VPT	Vertical Point of Intersection
W	
W/C	Water-Cement Ratio

Abbreviation or Acronym Symbols	**Meaning**
WALL	Retaining Wall
Wash, *Wash.*	Washer
WASHTO	Washington Association of State Highway and Transportation Officials
WB, *W.B.*	Westbound
WBS	Work Breakdown Structure
WF	Wide Flange (Steel section)
WG	Welded Girder
WGC	Welded Girder Continuous
WGCK	Welded Girder Continuous & Composite
WGCKP	Welded Girder Continuous, Composite Prestressed
WGK	Welded Girder Composite
WGKP	Welded Girder Composite Prestressed
WP, *W.P.*	Work Point
WPA	Works Projects Administration (formerly Works Progress Administration, (defunct as of 1943)
WQCD	Water Quality Control Division (Colorado Department of Public Health and Environment)
WRI	Wire Reinforcement Institute
WS, *W.S.*	Water Surface
Wt, *Wt.*	Weight
WWF	Welded Wire Fabric, typically referred to very light gauge wire for crack control
WWR	Welded Wire Reinforcement
X	
Y	
Yd, *Yd.*	Yard

B.1 Configuration

Training materials, manuals, workflows, video tutorials and other resources can be accessed online at:

https://www.codot.gov/business/designsupport/cadd/

The training videos cover assorted subjects. There are also a number of CDOT workflows in pdf format for the MicroStation user that address specific drafting issues such as Print Organizer, Linking Word / Excel Documents to MicroStation, Useful MicroStation Key-ins, Raster Manager, etc. and several InRoads related workflows.

The Bridge Detailer should become familiar with all the available information posted online at the above mentioned web locations. In addition, this information is available through MicroStation Help and CDOT Help links available on the MicroStation menu bar.

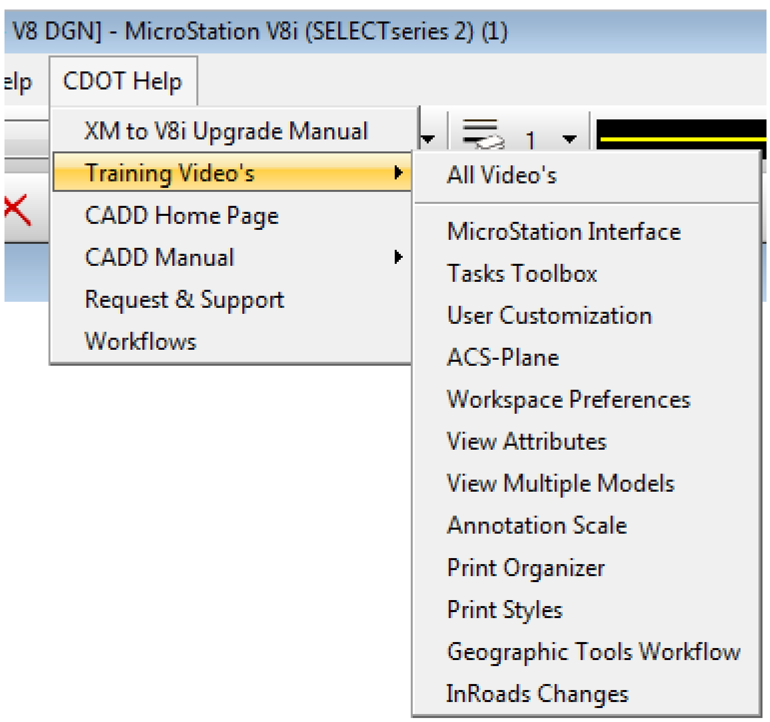


Fig. B.1-1 Help and CDOT Help

B.2 Seed Files

When working in MicroStation, the Bridge Detailer has the option of opening an existing drawing or starting a new one based on the existing bridge templates. Drawing templates used in MicroStation are called “seed files” and are included in the configuration files.

Two seed files are available for the preparation of bridge drawings. They are named *Bridge-3D-Seed_CDOT.dgn* and *Bridge-2D-Seed_CDOT.dgn*.

These seed files are located on *C:\Workspace\Workspace-CDOT_V8i\Standards-Global\MicroStation\Seed*.

The bridge 2D seed file contains two models named Linework and Border.

In the Linework model the detailer will create all line work for details at full scale (1:1). Linework model is the default model that cannot be deleted.

By default, the Border model contains the cell SHEET_Design-Sheet representing the CDOT border (ANSI-B size 11”x17”). The insertion point for the cell is at coordinates (0,0). This is a non-ProjectWise border.

In order to avoid display depth, global origin and other 3D issues, it is recommended that the 2D seed file be used for all drawings that do not require 3D presentation.

It is also recommended that a 2D model be used for the Border.

The Border model will contain the information from the Linework model referenced at the appropriate scale to be displayed in a readable manner on the plan sheet.

There are 3 model types available in MicroStation: design models, drawing models, and sheet models (see MicroStation Help for definition). By default, in the bridge seed files both Linework model and Border model are design models. The border model is set up so the detailer can switch to sheet type if so preferred. One of the benefits of sheet models is they can be selected specifically by the Print Organizer utility.

You can open the Model Properties dialog box by selecting File > Models and then click on the Edit Model properties icon. (see Fig. B.2-1)

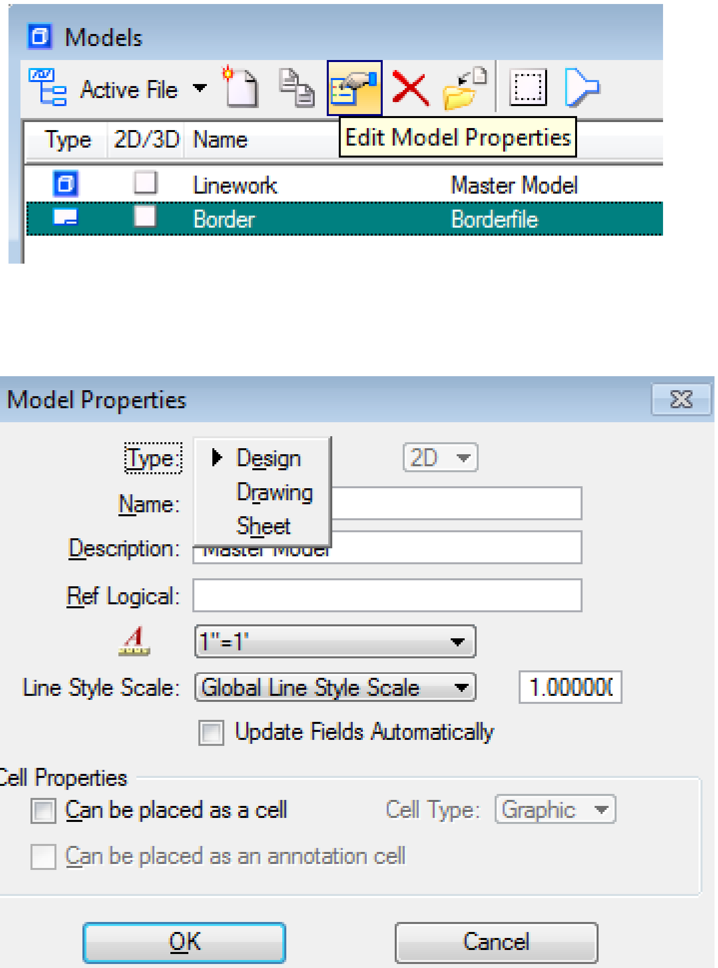


Fig. B.2-1 Models and Model Properties Dialog

B.3 Borders

There are two types of plan sheet border: ProjectWise and non ProjectWise. For ProjectWise border functionality, refer to the documentation available online at http://www.coloradodot.info/business/designsupport/cadd. Both border types are available in the CDOT Menu.

The CDOT border is typically plotted on 11” x 17” paper at scale 1”=1’ and it is a cell named SHEET_Design-Sheet located in General.cel library file. It can be inserted into the Border model from the CDOT Menu, under Drafting.

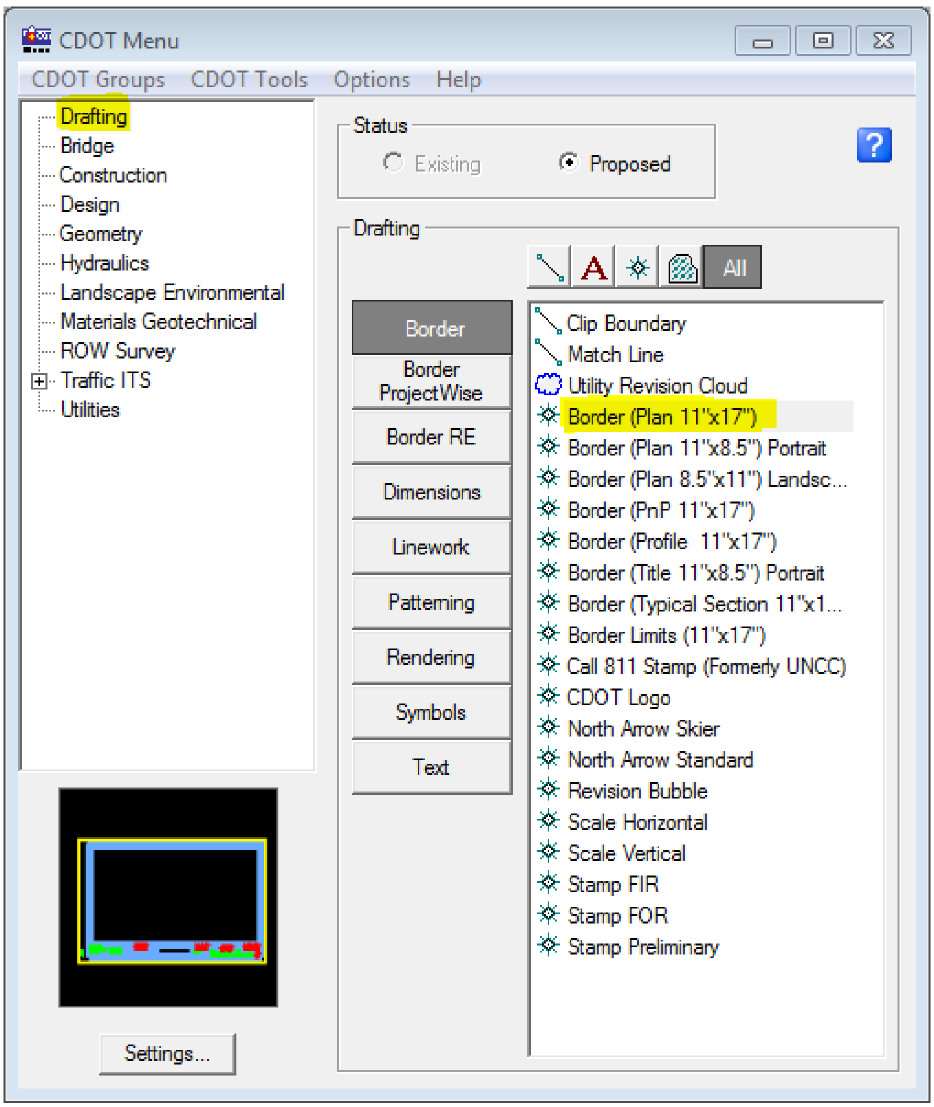


Fig. B.3-1 Border Selection from Drafting Group

The ProjectWise border is available from the CDOT Menu, as shown below.

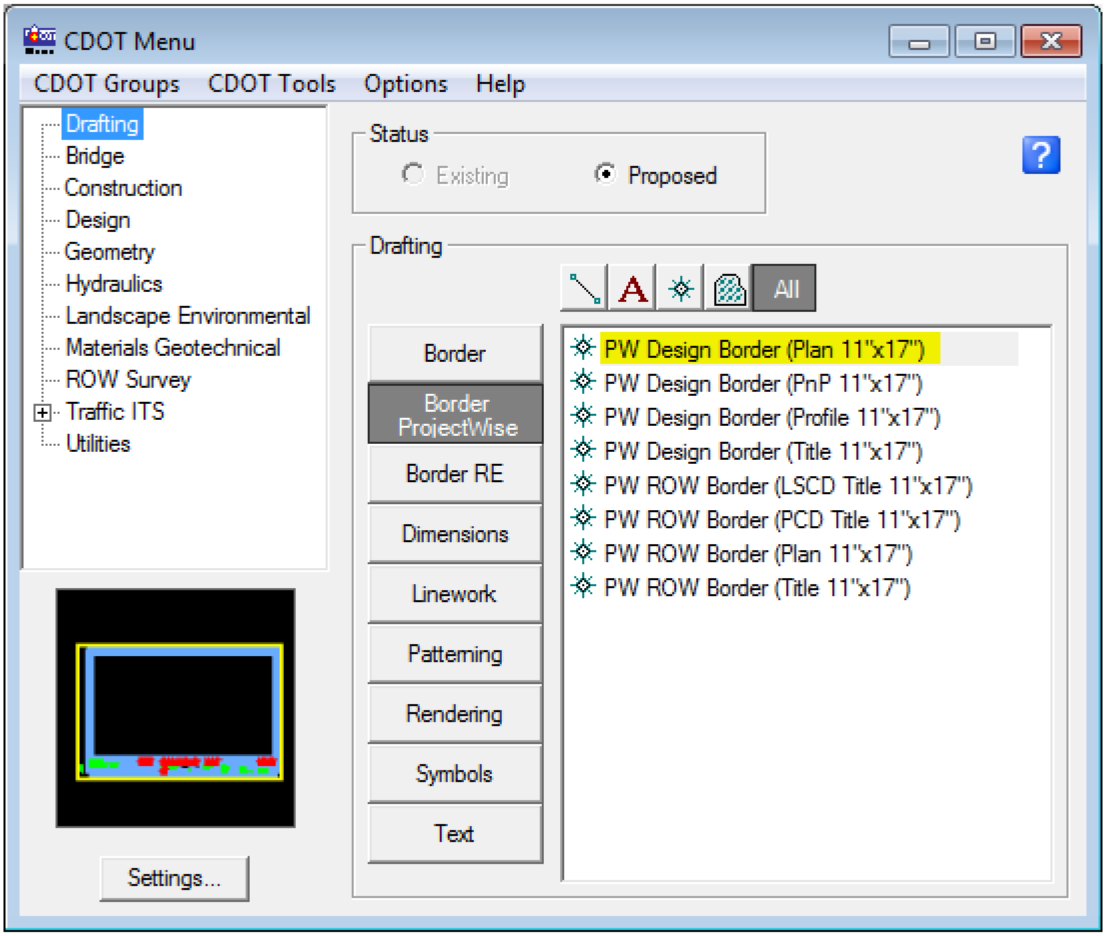


Fig. B.3-2 - ProjectWise Border

The middle part of the border requires the insertion of a cell for the Resident Engineer/Bridge Unit information. This can be inserted from CDOT Menu > Drafting > Border RE or CDOT Menu > Bridge > Border.

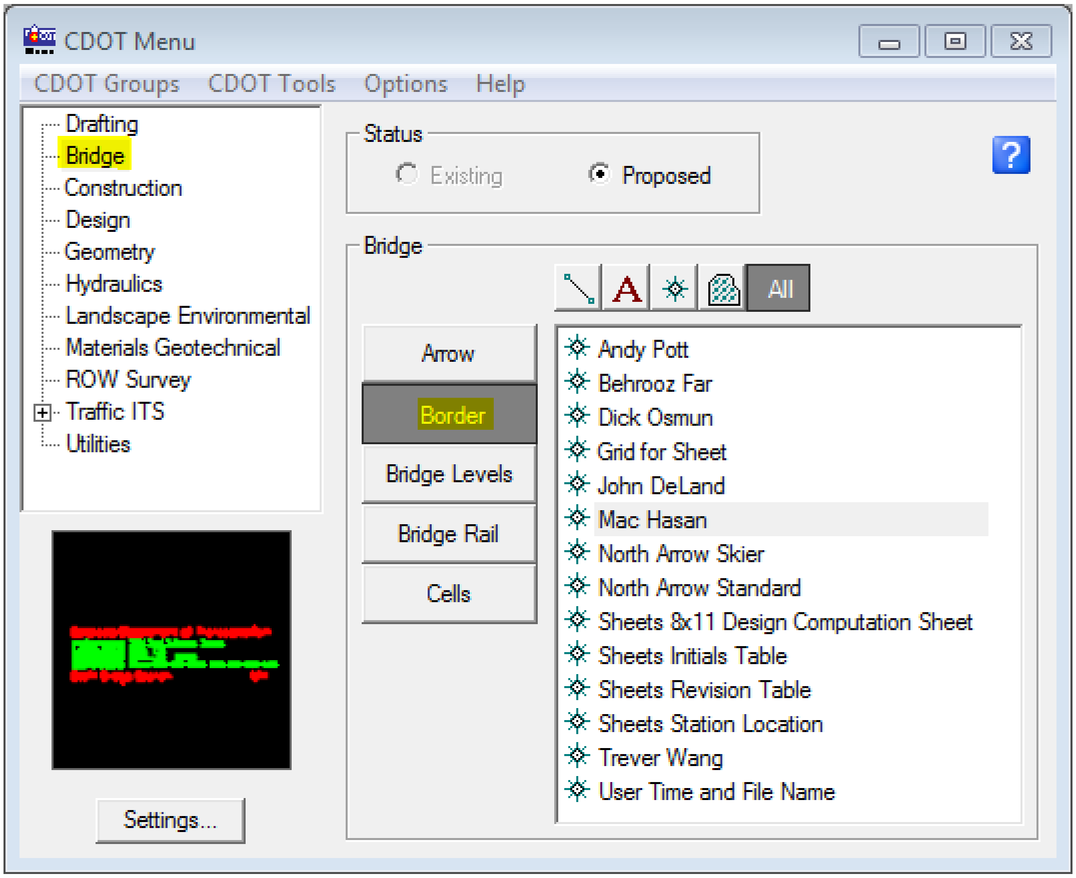


Fig. B.3-3 Border Selection from Bridge Group

B.4 Reference Files

A Reference is a model that is attached to and displayed with the active model for printing or construction purposes. You can reference/attach a model from a different dgn file or a model from the same dgn file (like attaching Linework model into the Border Model of the same dgn file). For that, go to File > References and then select Tools > Attach… and browse for the dgn file that you want to reference.

In order for the objects in a reference to be printed with the appropriate line weights, make sure to check the Line Weights box in the Reference Presentation dialog box (References > Settings > Presentation). Check the Use View Flags box, click on Line Weights, then de-select the View Flags check box and select OK.

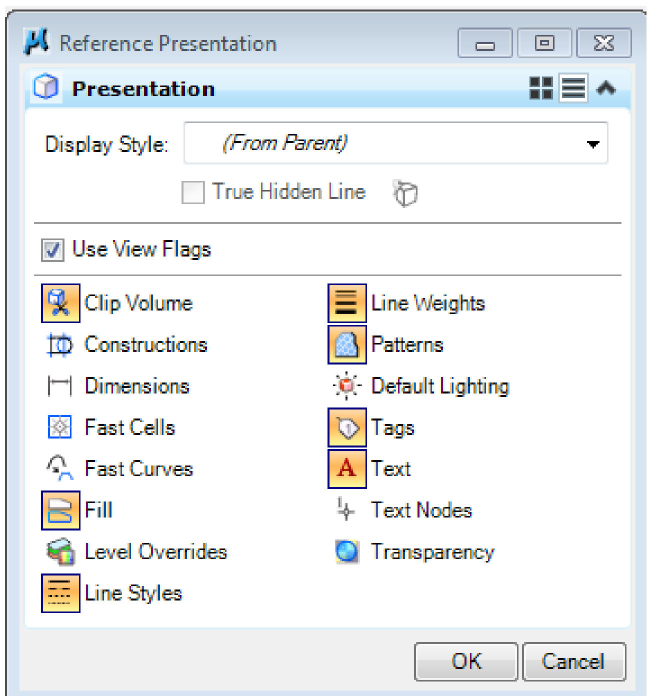


Fig. B.4-1 Reference Presentation Dialog Box

B.5 Levels

Levels in MicroStation are defined in the CDOT configuration by Color, Style, and Weight.

Currently, there are 13 general bridge levels (see table below) and over 150 specific bridge levels defined in the CDOT configuration.

The specific bridge levels mimic the general bridge levels, that is, all Outline levels print the same as the general Outline level, having the same line style and lineweight, but a different color. The purpose for the additional levels is to help in turning the levels off/on in different views and provide additional information for the detailer when developing linework.

The following table indicates the MicroStation general levels to be used to comply with the requirements described in Chapter 2 of the Bridge Detail Manual:

Level Name	Color	Linetype	Lineweight	How it looks in MicroStation
BRDG_BREAK	7	0	0	
BRDG_CENTER	7	4	0	
BRDG_CONSTRUCT	4	0	1	
BRDG_CONTROL	3	0	3	
BRDG_DASHED	2	3	1	
BRDG_DIMENSION	2	0	1	
BRDG_FROZEN	2	0	0	
BRDG_HIDDEN	5	5	1	
BRDG_OUTLINE	3	0	2	
BRDG_PATTERN	6	0	1	
BRDG_REBAR	1	BRDG_Rebar	3	
BRDG_TEXT	4	0	1	
BRDG_TITLE	1	0	3	

The addition or modification of bridge levels requires concurrence within the BUG (Bridge Users Group) committee at CDOT. The detailer is advised to use the levels defined in the configuration.

There are various ways to view and select an active level, as follows:

1. Select the level from the Attributes tool box, as shown in Fig. B.5-1.

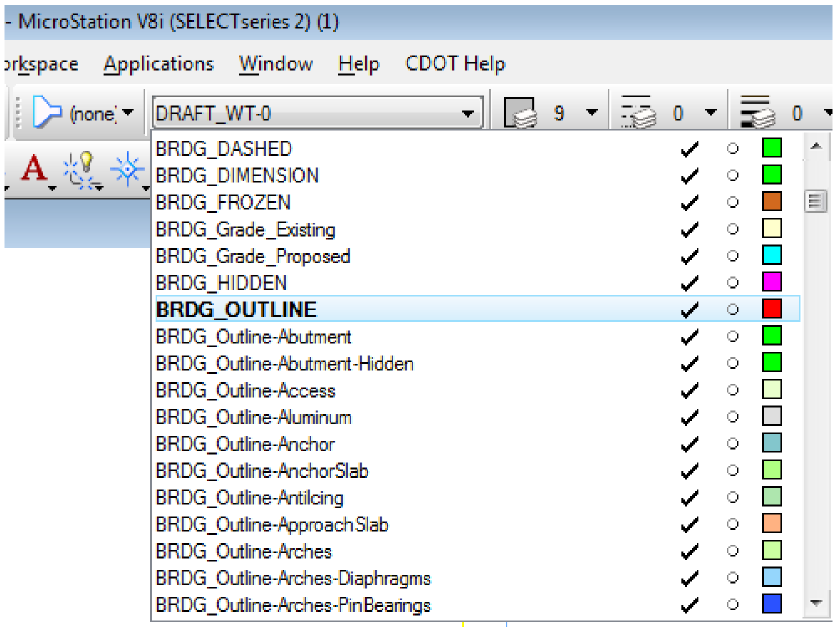


Fig. B.5-1 Active Level Selection

2. Use the CDOT menu by selecting the “Bridge” CDOT group> Bridge Levels> and using the pulldown “Type” menu to narrow the search. (Fig. B.5-2)

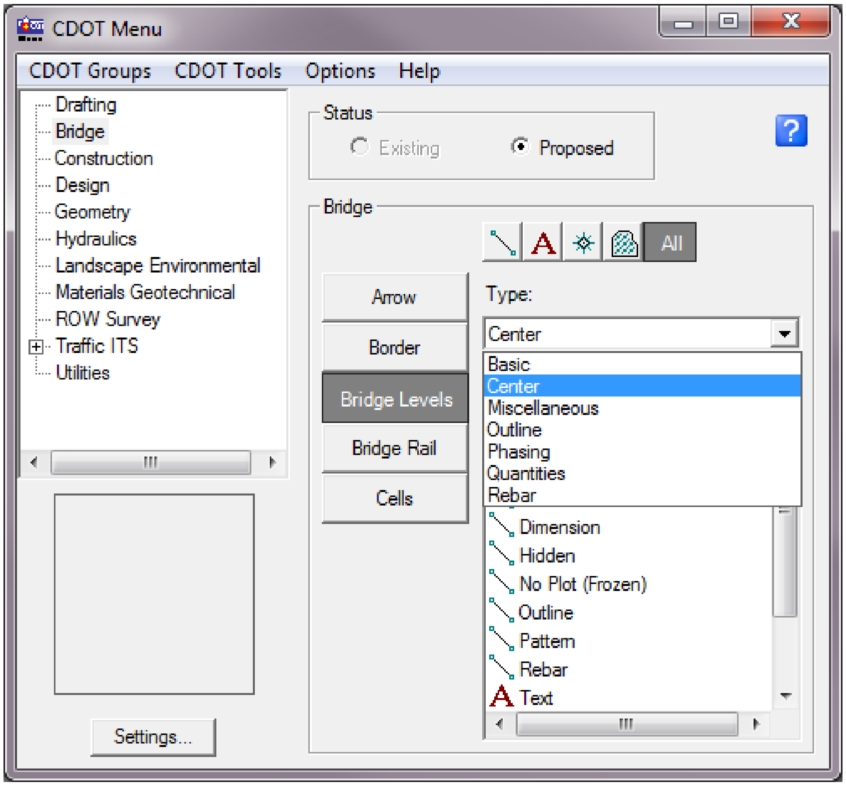


Fig. B.5-2- Bridge Level Selection from CDOT Menu

3. Double click on a level in the level display window. (Fig. B.5-3)

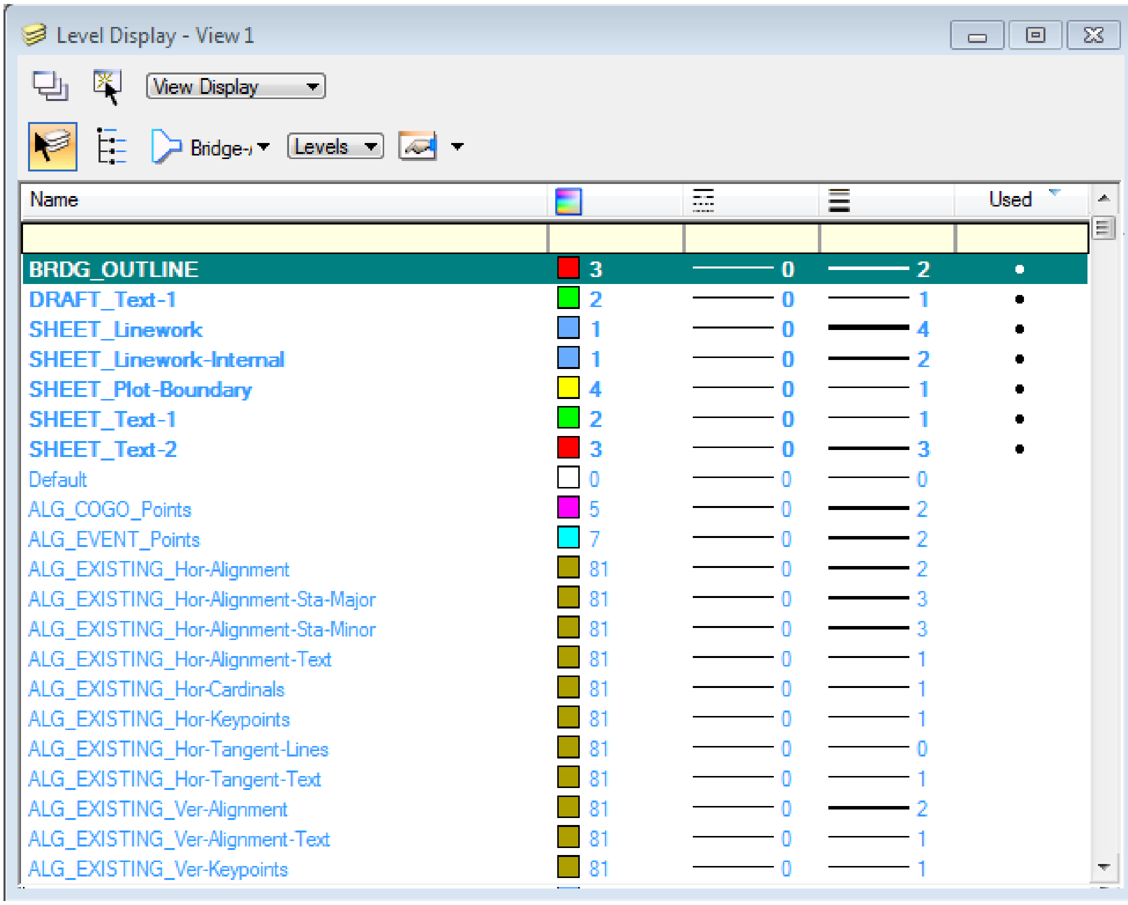


Fig. B.5-3 - Bridge Level Selection from the Level Display

Level filters are a useful way to group associated levels for the purposes of viewing or removing unneeded levels from view. Filters can be used in both the Attributes tool box and the Level Display window. There are several predefined filters available that cannot be modified by the user. (see Fig. B.5-4)

“On the fly” filters can be created in the Level Display window. To do that, first click on the Level Display icon on the Primary Tools tool box, then click the List Filter icon and select Untitled, then enter the desired filter criteria in the appropriate categories (Name, Color, Line Style etc.) in the top row. The example in Fig. B.5-5 shows a filter created “on the fly” with “brdg” in the name, a line style value of “0” and a line weight value of “3”. This filter can be toggled on/off by clicking the List Filter icon and selecting None. The filter remains until you exit MicroStation.

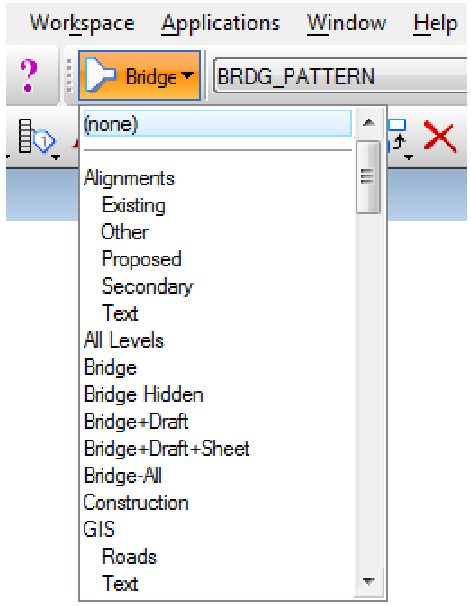


Fig. B.5-4 – Some of the CDOT Predefined filters

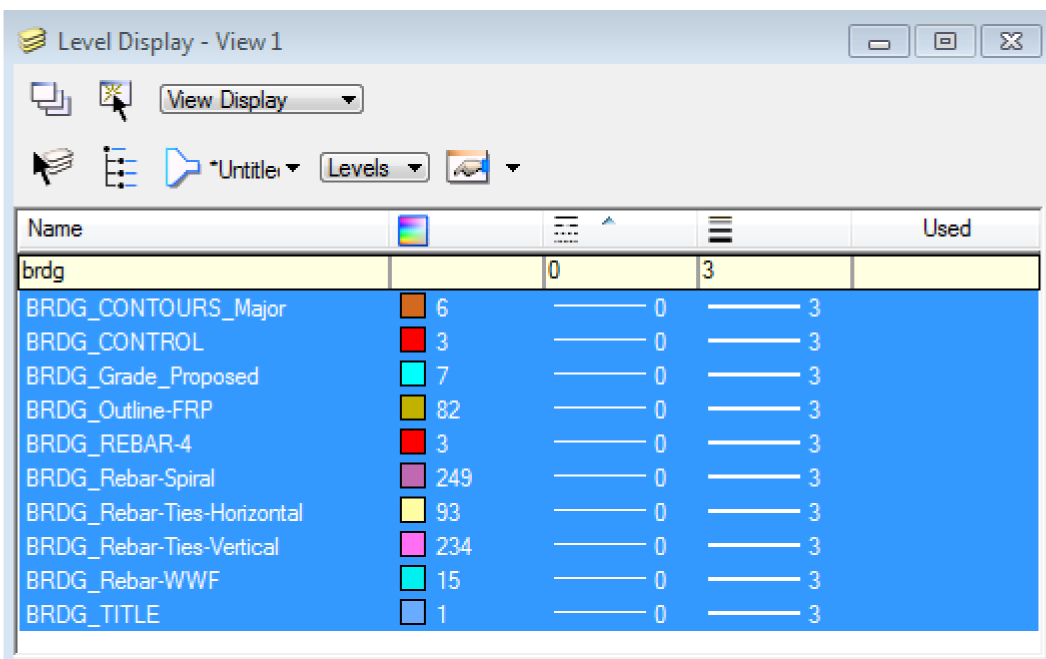


Fig. B.5-5 – Example of filters “on the fly”

All the configuration levels have an assigned color associated with the level. Although the color number of the level can't be changed, its appearance to individual user can. The user can personalize the color table without affecting the plot styles: Settings > Color Table…> Select the color you want to change, click on Change, pick the color you want to replace with and click OK, then select Attach.

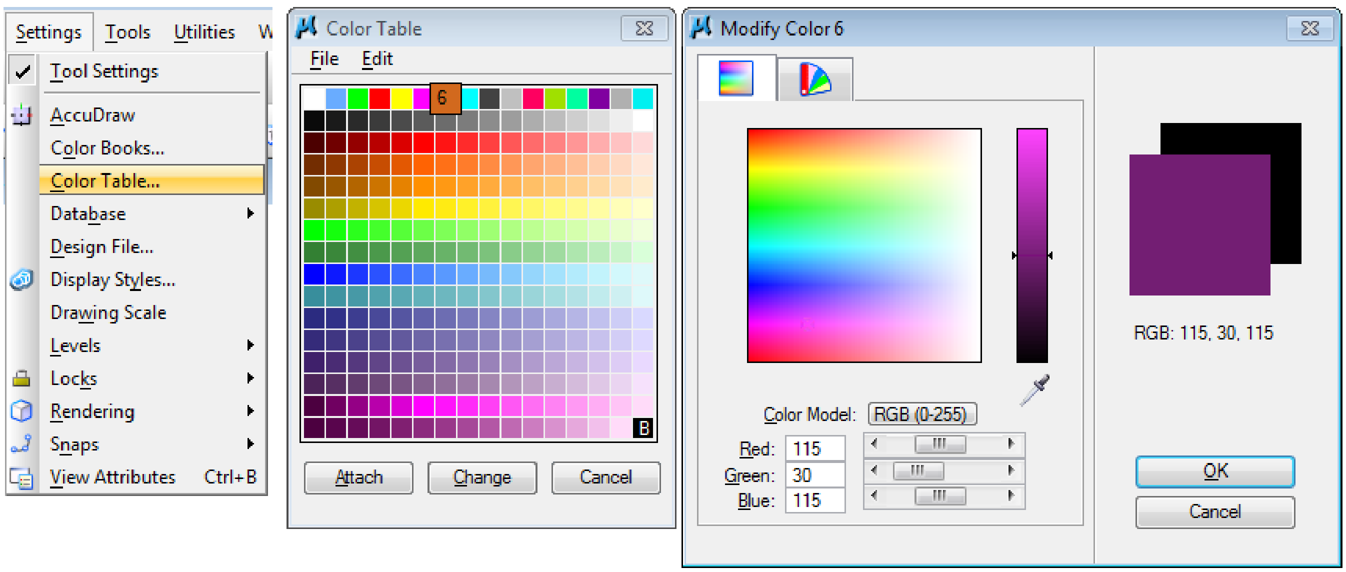


Fig. B.5-6 - Personalizing the Color Table

B.6 Cell Libraries

Cell libraries are ordinary MicroStation design files that have a .cel extension, with multiple models, one for each cell.

Staff Bridge has created cell libraries containing useful details for use in detailing CDOT bridge projects. Those library files are named Bridge.cel, Bridge_Repair.cel and BridgePiping.cel. There are also local developmental cell libraries for testing new cells prior to incorporating them into the configuration.

To view all cells contained in a library, open the Cell Library dialog box by selecting Element > Cells and then File > Attach File. As an alternative, the CDOT Menu can be used by selecting >Bridge > Cells and then selecting the appropriate cell type.

MicroStation provides other methods of accessing the cell libraries, including customized toolboxes, cell selector tools, etc.

The detailer may choose to create his or her own cells and cell libraries. It is important to place the cell origin in a useful location and to place each element of the cell in the appropriate level. The cell can then be saved in one of the existing developmental libraries (located on \\public\Bridge Common\MicroStation\CELLS) so everyone has access to it.

For more information on how to create a cell library and cells, see the MicroStation Help.

B.7 Annotation / Text Styles

The following table describes the text styles used on bridge drawings:

Text Style	Use
07_ENG-100	General notes and detailing text
07_ENG-80	Reduced width font for use in conserving space on plan sheet
10_ENG-100	Title Text
05_ENG-100	Rebar dimensioning normal
05_ENG-80	Rebar dimensioning – conserving space

Unfortunately, outdated text styles that should no longer be used can still be found in archived drawings and they should be replaced with the new styles from the table. For that, the methodology is: *Element* > *Text Styles* > Select style to change and right click > *Remap Elements…*> Pick the new style in the Destination box, then click *OK*. Once replaced, the old text styles can and should be purged (deleted). A note of caution: remapping might cause unwanted changes in the text appearance that need to be addressed.

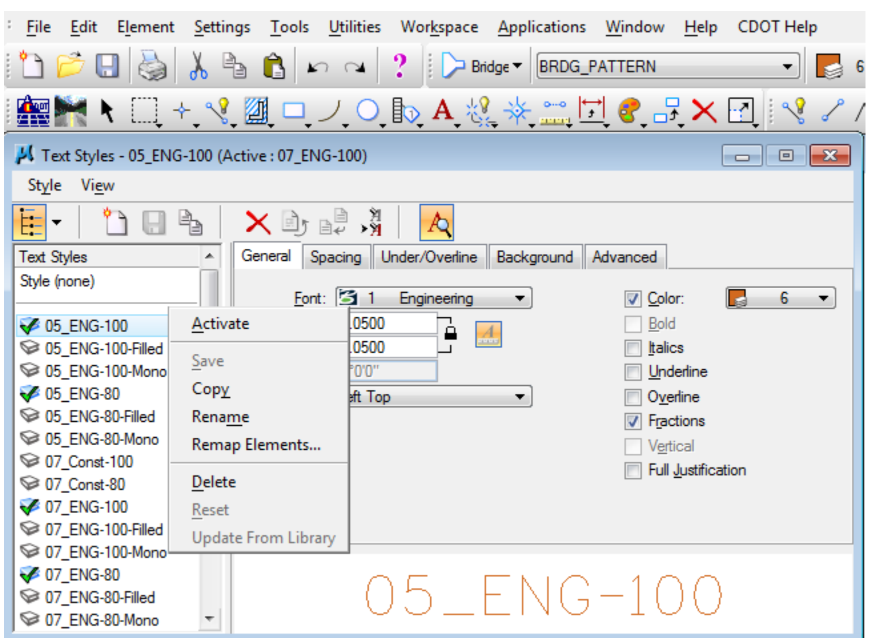


Fig. B.7-1 - Replacing old text styles

Text notes are controlled by the dimension styles and they should be put in the level Text.

B.8 Dimension Styles

The MicroStation Dimension Style for most details should be CDOT 3. This style is a normal architectural style (feet and inches).

Dimension style CDOT 5 should be used for the footing & piling layout plan. It shows dimensions in decimal feet, which is more appropriate for the surveying required to locate the piles and footings.

The dimension style dialog box can be accessed from Element – Dimension Styles.

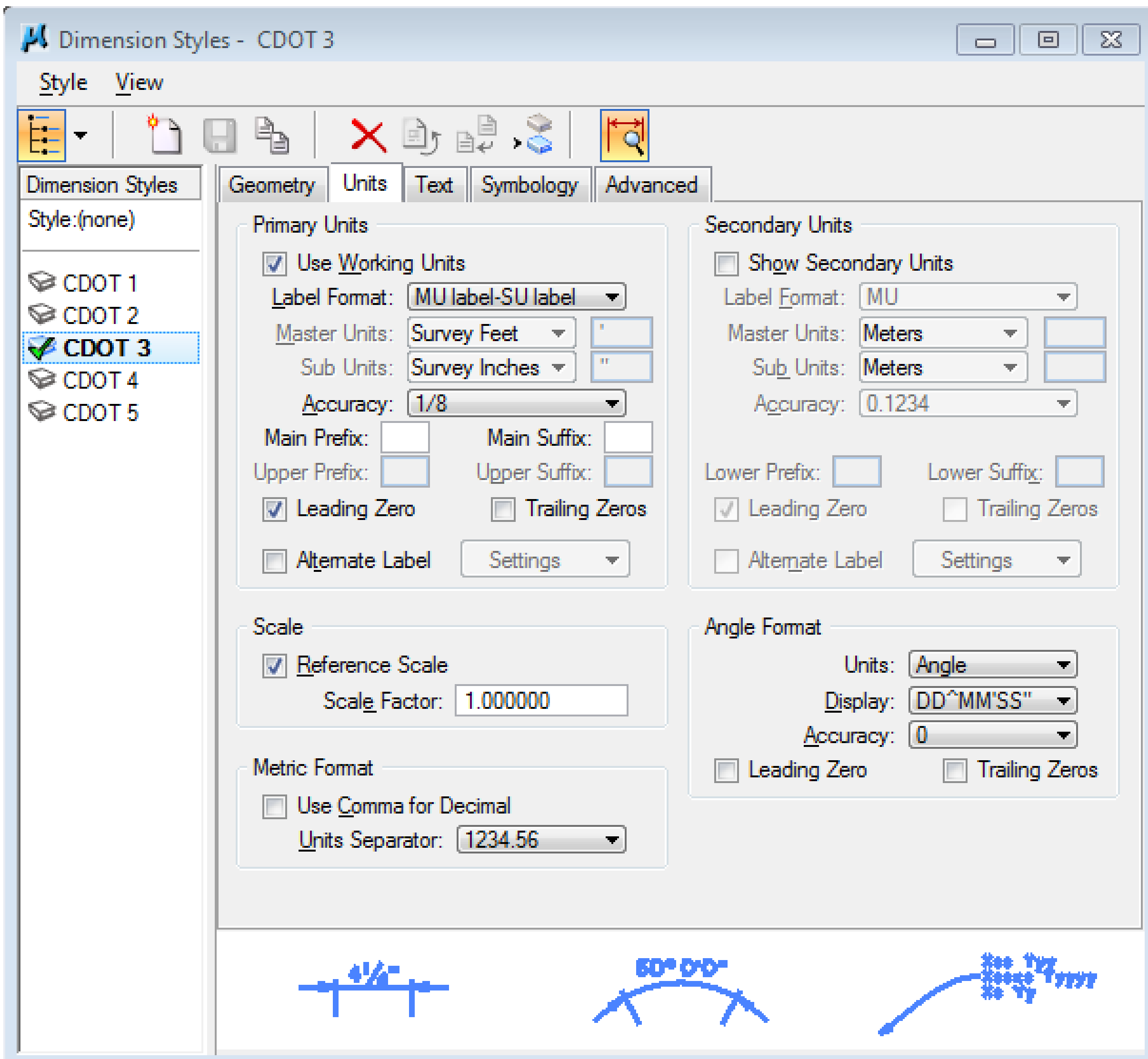


Fig. B.8-1 Dimension Style Dialog Box - Units

The orientation of the dimension text can be modified from Dimension Styles settings – Text – Orientation – Horizontal/Aligned.

Changes can be made to the dimension style as the need arises during detailing, i.e., when using angular dimensioning, angle format can be changed from units “Angle” to units “Length” to show arc size length in feet and inches instead of the angle value in degrees/ minutes/ seconds.

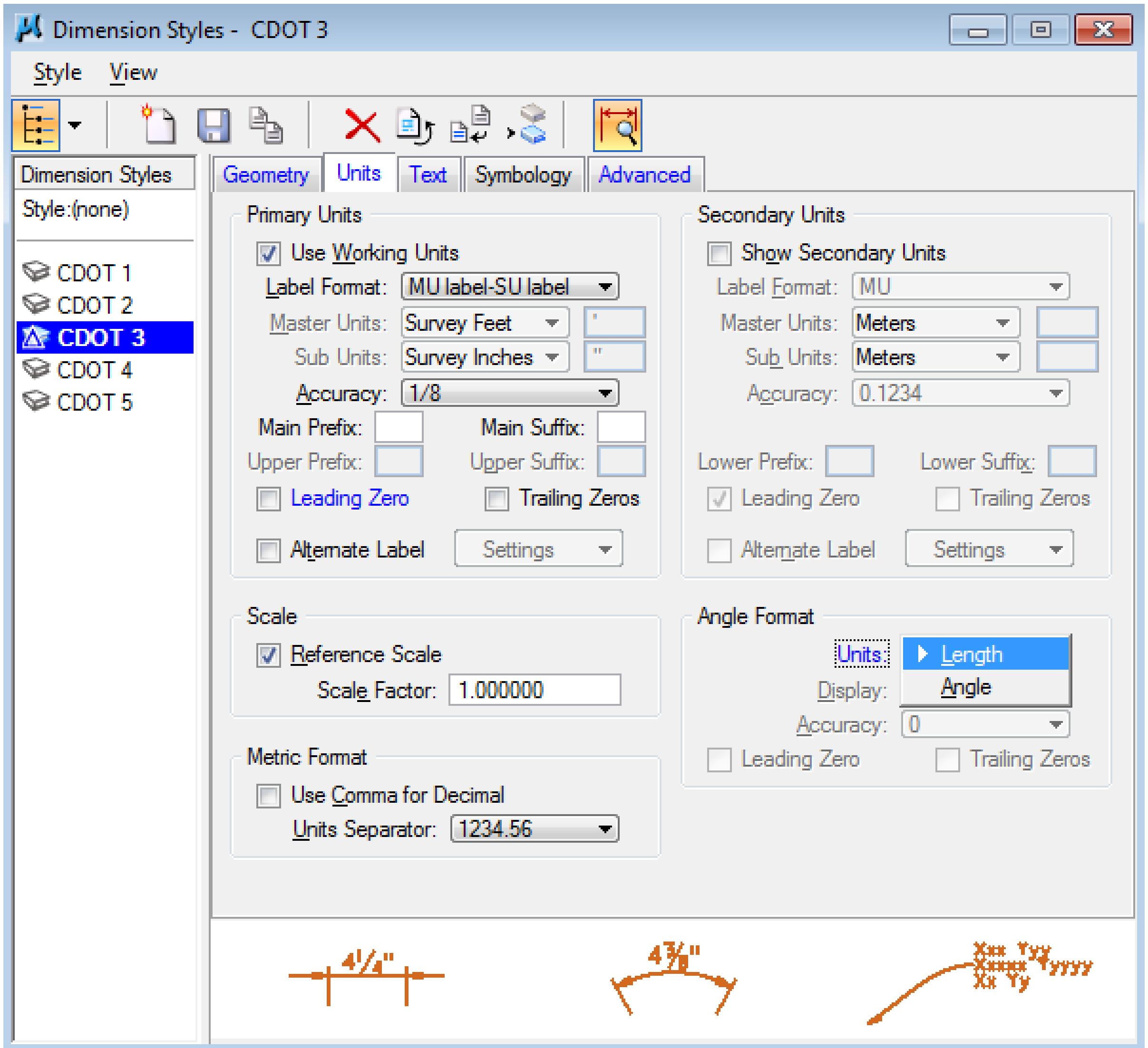


Fig. B.8-2 Dimension Style Dialog Box – Changing Angle Format

Text notes are drawn by default with just an arrow. You can change the terminator by selecting a cell or symbol (Element > Dimension Styles > Geometry > Terminators > Symbols > Note: select Cell or Symbol). The symbols are not set up currently. The default cell is set up to be the 

integral arrow cell that looks like this (see Fig. B.8-3).

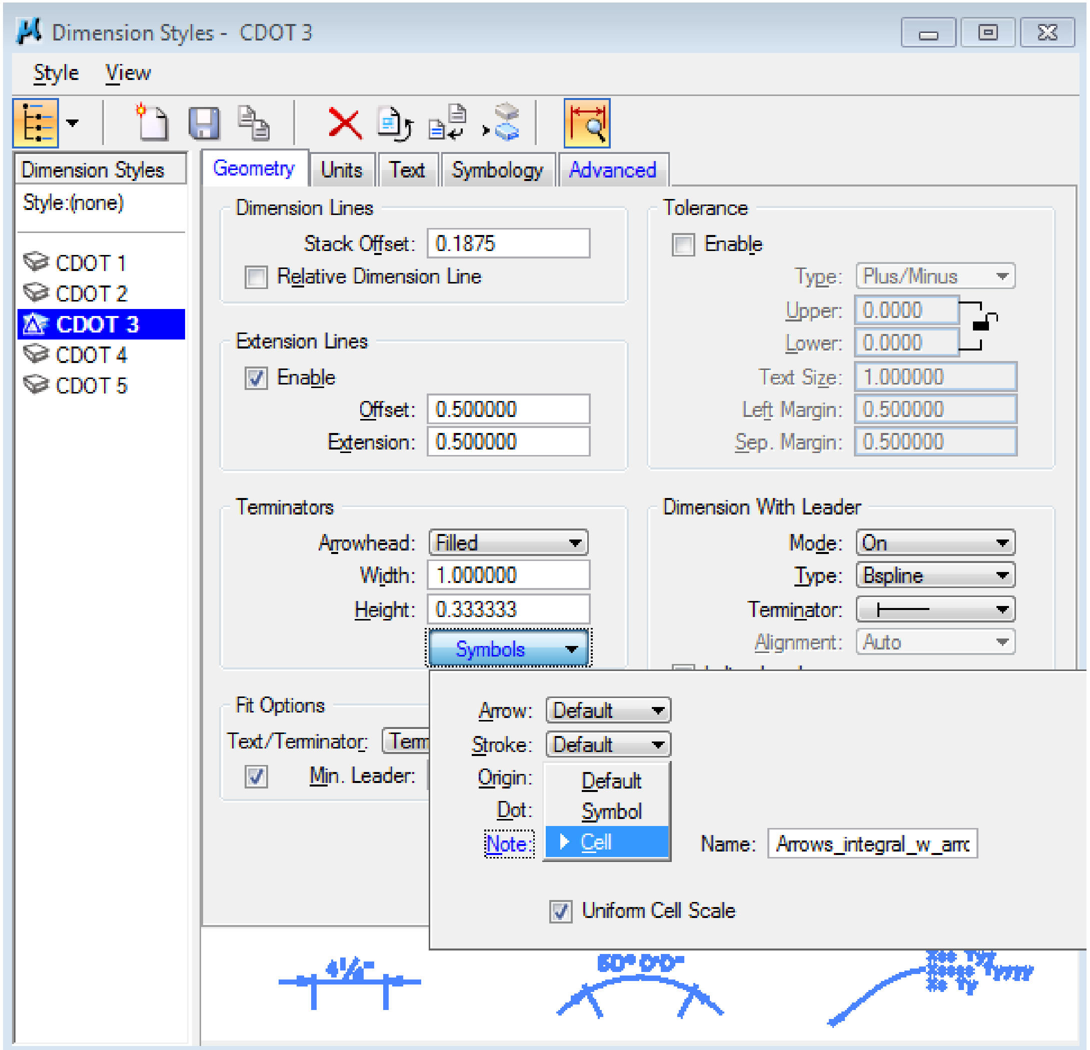


Fig. B.8-3 Dimension Style Dialog Box - Geometry

B.9 Printing

Before printing the drawing it is important to apply the print style, whether it is a hard print or a pdf print. In order to do that, from the Print menu > Settings > Apply Print Style select the printer/plotter desired. By default, the CDOT Default Printer is the one that is used for the hard print.

CDOT PDF (Draft Quality) is of sufficient quality for creating the majority of drawings. CDOT PDF (High Quality) may be required for some rendering.

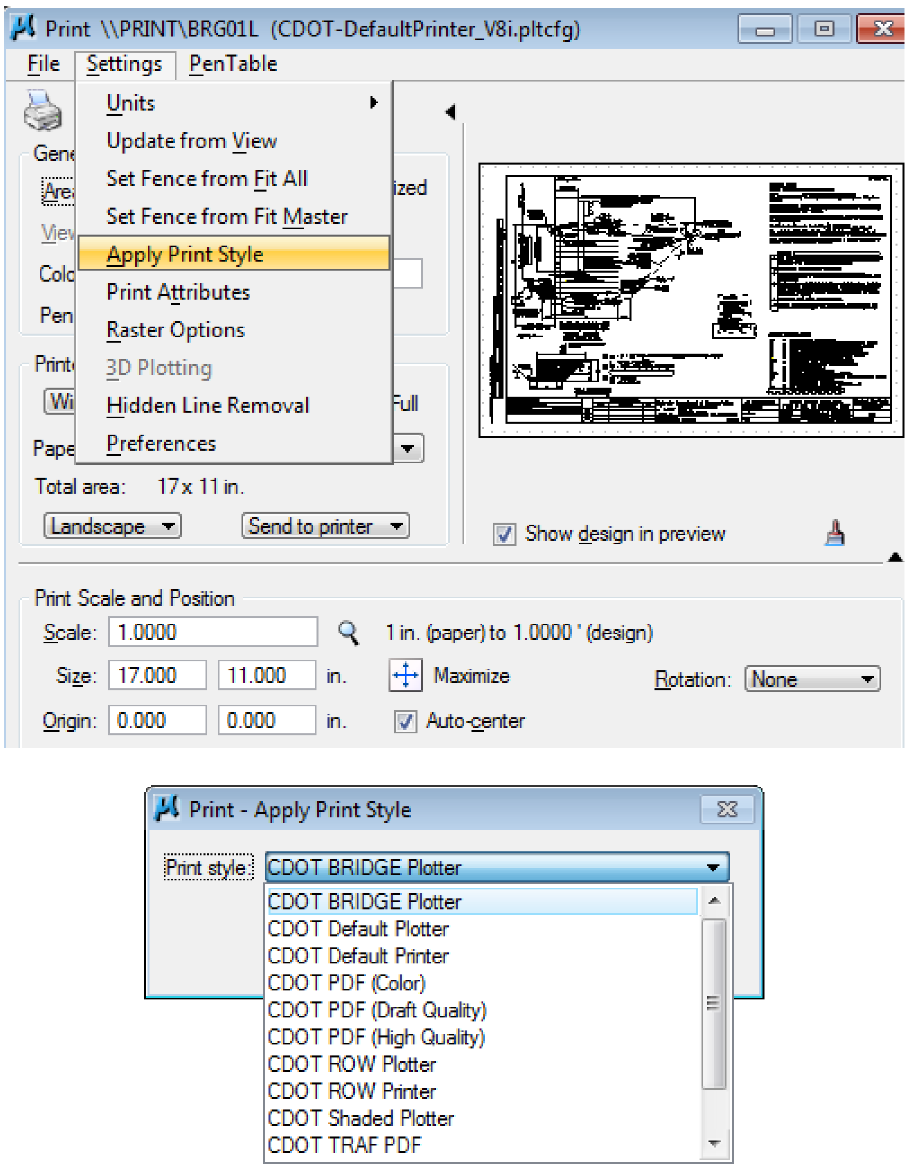


Fig. B.9-1 Print Style Selection

Currently, there are several CDOT printer drivers available. The printer drivers control plotting devices, plot sizes, pen tables etc. The standard plot size for all bridge drawings is 11x17. The default pen table (CDOT-PenTable.tbl) prints all bridge levels in black/white. If a color print is desired, the detailer will go to Print > PenTable > Attach and select one of the color pen tables available. (see Fig. B.9-2)

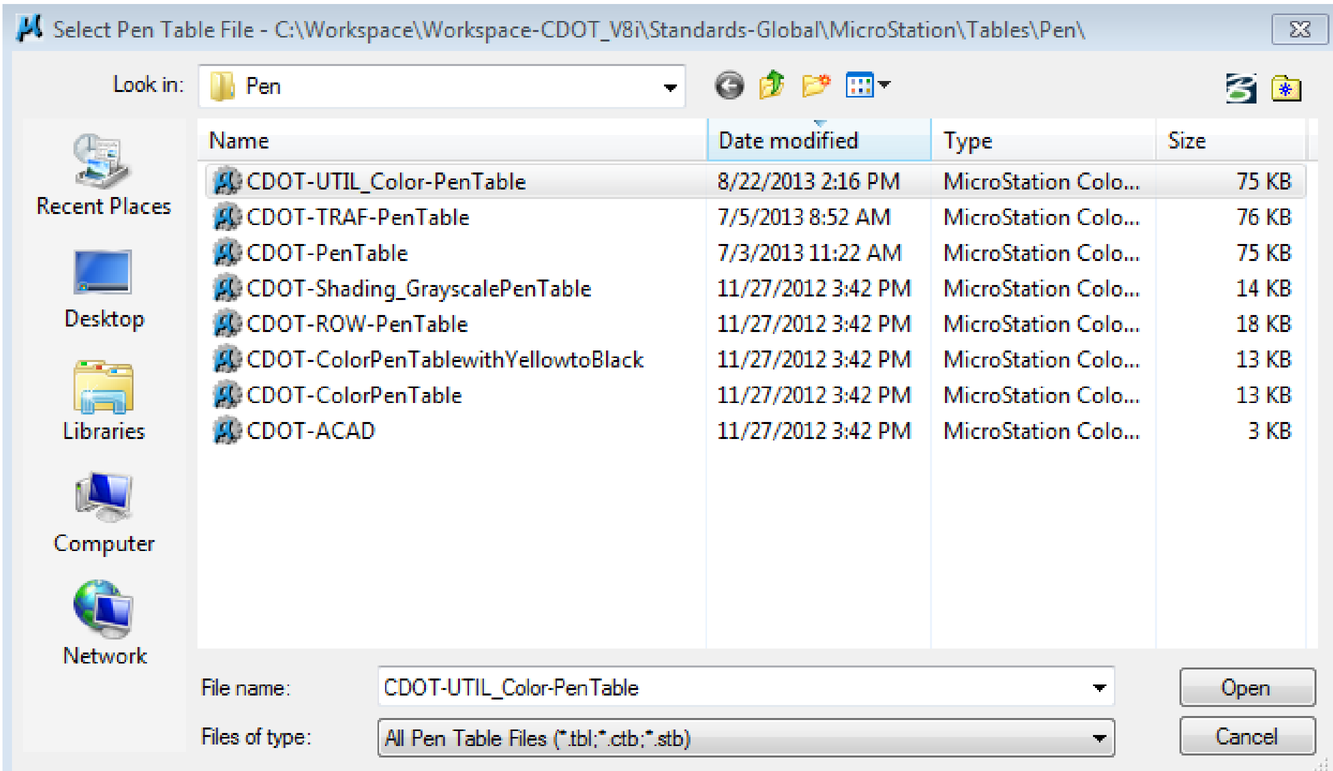


Fig. B.9-2 Pen Table Selection

B.10 Minimum Electronic Standards for Microstation Drawings

1) Final view for plotting hardcopy shall be View 1, a Top View. This view shall be located in the “Border” model.

2) Unless creating 3D elements at elevation, all linework should be at elevation zero.

3) Default symbology should be used for configuration levels.

4) Linework should be drawn at full scale.

5) Sheet models should generally use 1” = 1’.

B.11 Microstation Things that are Good to Know

1) A practice that seems to work well for copying from one file to another: Reference in the item to be copied, select and copy the element of interest. You can detach the reference when you're finished with it.

2) The drawing border should be placed at 0,0,0. A trick for finding this location is to take the following steps:

    - select the "Place SmartLine" tool,
    - data on the beginning point,
    - type p,
    - type "0,0,0" (zero, zero, zero, including commas), click enter,
    - data end point.

    You will have created an arrow (of sorts) that points to the 0,0,0 coordinate. Consistently placing line work at this location will help preclude the loss of drawings in the vast expanses of MicroStation.

3) When adding dimensions it is helpful to open the Dimension Styles window (Element\Dimension Styles) so that you can make changes on the fly in placement and symbols.

4) Draw line work in "default" model and change the model name to "linework". The default model is the Master model, that can't be deleted by mistake. If the Bridge seed file is used, the linework model is already set up as the default.

5) If menus/windows disappear off your screen or are halfway off, making them unusable, change your screen resolution to a different setting, reposition the menu/window and then go back to default screen resolution. To get to the screen resolution, right-click the mouse in your desktop screen.

6) When the Sheet Border is created using 1" = 1', and the Annotation Scale is locked ON and is 1"=1', life is good and text is always the right size for the drawing.

Appendix C – AutoCAD

The purpose of this appendix is to document historical issues with AutoCAD for help in opening archived drawings. The primary issue is font usage and special characters. When opening old AutoCAD files, the text and dimensions may not appear correctly due to this issue. The special characters used by Staff Bridge were contained in Specl13.shx which is a bigfont.

The easiest way to be able to accurately view and print AutoCAD drawings is to put Specl13.shx in the same directory as the AutoCAD drawing. This way it should be in the search path AutoCAD uses to find supporting files.

Bigfonts are two-character structures, in which you must type 2 characters to get the intended single character. For instance, if you were looking for a center-line character, you would want to see an upper-case “L” in the middle of a lower-case “c”. If you look through the chart in Figure C-2, you will find “~E” and “~C” as options for this character. ~E creates a centerline symbol with a slant to the “L”. ~C is a centerline character with a vertical “L”. Note in the table headings the labels “PC” and “TC”. These are the two characters required in the definition of the character. PC = Protect Character; TC = Target Character. Note: Alphabetic characters are case sensitive.

In examining the text of drawings using bigfonts, if you see strange character combinations, it probably belongs to the big font, and there was an unsuccessful link of the bigfont with the font used in the text style. For instance, if within a curve table you saw _D = 28°13’, you would find the intended character to be Greek capital Delta. This would make sense for a curve table. Generally, there aren’t large numbers of these bigfont characters on any sheet, the most common being the centerline characters, and probably the Greek Phi , used to indicate diameter.

In MicroStation, these special characters are either handled by the MicroStation fonts or by using cells. See the Appendix B for MicroStation details.

SPECL/SPECL13 — bigfont

✯ (Partial) Greek Character Set

<NOTE: PC = underline key, unless otherwise indicated>

PC	TC	CHR	CH. NAME	PC	TC	CHR	CH. NAME	PC	TC	CHR	CH. NAME
_	a	α	alpha	_	f	φ	phi	_	m	μ	mu
_	b	β	beta	_	g	γ	gamma	_	n	ν	nu
_	d	δ	delta	_	h	η	eta	_	p	π	pi
_	e	ε	epsilon	_	i	ι	iota	_	q	ϑ	theta
_	c	$\in$		_	k	κ	kappa	_	r	ρ	rho
_	_	_	underline	_	l	λ	lambda	_	s	σ	sigma
_	t	τ	tau	_	D	Δ	DELTA	_	Q	Θ	THETA
_	u	υ	upsilon	~	D	Δ		~	0	θ	
_	w	ω	omega	_	F	Φ	PHI	_	S	Σ	SIGMA
_	x	ξ	xi	~	O	$\emptyset$		_	W	Ω	OMEGA
_	y	ψ	psi	_	G	Γ	GAMMA	_	Y	Ψ	PSI
_	z	ζ	zeta	_	L	Λ	LAMBDA				

Fig. C-1 Greek Characters

SPECIAL CHARACTERS

PC	TC	EXAMPLE
DIAMONDS		
~	a	◇ footnote
~	A	◆ footnote
INVERTED TRIANGLES		
~	t	▽ footnote
~	T	▼ footnote
CIRCLE LORRAINE CROSS		
~	·	◉ footnote
~	p	‡ footnote
STARS		
~	F	✯ footnote
~	f	☆ footnote

PC	TC	EXAMPLE
LESS/GREATER THAN DEGREE SYMBOL		
~	L	L ≦ 1.5'
~	G	5 ≧ 4.99
~	o	14°37'24"
CENTERLINES		
~	E	℄ Pier2
~	C	℄ Pier2
RADICAL SQUARES		
~	V	$\sqrt{2X+4}$
~	s	□ footnote
~	S	▦ footnote

PC	TC	EXAMPLE
CIRCLED CHARACTERS		
~	1	N note
~	2	23 note
~	3	xyz note
TILDE DOUBLE TILDE		
~	~	~ Note
~	y	.5 ≈ .51
GAMMA INFINITY / SHIFTED INF.		
~	g	γ
~	i	∞ footnote
~	I	∞ footnote

Fig. C-2 Special Characters

FRACTIONS

LONG FORMS

SAMPLE INPUT									RESULTS	EXAMPLE	DESCRIPTION
^	0	3	|	–	1	6	^	1	3⁄16	12'-3 5⁄16"	SLASH fraction
^	4	3	|	2	1	6	^	5	$\frac{3}{16}$	12'-3 $\frac{5}{16}$ "	MIDline fraction
^	2	3	|	2	1	6	^	3	$\frac{3}{16?}$	12'-3 $\frac{5}{16?}$"	BASEline fraction
f	^	6	c	^	7				f_c	f_c = 1,200 psi	SUBSCRIPT
3	^	8	4	.	2	^	9		$3^{4.2}$	$V = e^3$	SUPERSCRIPT
X	^	^	2	^	|	a	^	7	X^2_a	f'_c = 3,000 psi	SUPER–SUBscript
~	c	P	~	C	L				℄	℄ El. 8745.3'	Combine 2 letters
~	c	P	~	L					PL	PL ½"x¾"x1'-6"	Combine with L

PC = Protect Character (or, escape code, per AutoCAD manual)
TC = Target Character (or, special character, per AutoCAD manual)

Fig. C-3 Fractions Long Forms

SHORT FORMS

<table>
<tr><th colspan="9">EIGHTHS</th></tr>
<tr><th colspan="3">SLASH</th><th colspan="3">MID–LINE</th><th colspan="3">BASE–LINE</th></tr>
<tr><th>PC</th><th>TC</th><th>EXAMPLE</th><th>PC</th><th>TC</th><th>EXAMPLE</th><th>PC</th><th>TC</th><th>EXAMPLE</th></tr>
<tr><td>|</td><td>A</td><td>$123\,^{1}/_{8}$</td><td>|</td><td>I</td><td>$123\,\frac{1}{8}$</td><td>|</td><td>Q</td><td>$123\,\frac{1}{8}$</td></tr>
<tr><td>|</td><td>B</td><td>$123\,^{1}/_{4}$</td><td>|</td><td>J</td><td>$123\,\frac{1}{4}$</td><td>|</td><td>R</td><td>$123\,\frac{1}{4}$</td></tr>
<tr><td>|</td><td>C</td><td>$123\,^{3}/_{8}$</td><td>|</td><td>K</td><td>$123\,\frac{3}{8}$</td><td>|</td><td>S</td><td>$123\,\frac{3}{8}$</td></tr>
<tr><td>|</td><td>D</td><td>$123\,^{1}/_{2}$</td><td>|</td><td>L</td><td>$123\,\frac{1}{2}$</td><td>|</td><td>T</td><td>$123\,\frac{1}{2}$</td></tr>
<tr><td>|</td><td>E</td><td>$123\,^{5}/_{8}$</td><td>|</td><td>M</td><td>$123\,\frac{5}{8}$</td><td>|</td><td>U</td><td>$123\,\frac{5}{8}$</td></tr>
<tr><td>|</td><td>F</td><td>$123\,^{3}/_{4}$</td><td>|</td><td>N</td><td>$123\,\frac{3}{4}$</td><td>|</td><td>V</td><td>$123\,\frac{3}{4}$</td></tr>
<tr><td>|</td><td>G</td><td>$123\,^{7}/_{8}$</td><td>|</td><td>O</td><td>$123\,\frac{7}{8}$</td><td>|</td><td>W</td><td>$123\,\frac{7}{8}$</td></tr>
<tr><th colspan="9">THIRTY SECONDS</th></tr>
<tr><td>|</td><td>H</td><td>$123\,^{3}/_{32}$</td><td>|</td><td>P</td><td>$123\,\frac{3}{32}$</td><td>|</td><td>X</td><td>$123\,\frac{3}{32}$</td></tr>
<tr><th colspan="9">SIXTEENTHS</th></tr>
<tr><th>PC</th><th>TC</th><th>EXAMPLE</th><th>PC</th><th>TC</th><th>EXAMPLE</th><th>PC</th><th>TC</th><th>EXAMPLE</th></tr>
<tr><td>|</td><td>a</td><td>$123\,^{1}/_{16}$</td><td>|</td><td>i</td><td>$123\,\frac{1}{16}$</td><td>|</td><td>q</td><td>$123\,\frac{1}{16}$</td></tr>
<tr><td>|</td><td>b</td><td>$123\,^{3}/_{16}$</td><td>|</td><td>j</td><td>$123\,\frac{3}{16}$</td><td>|</td><td>r</td><td>$123\,\frac{3}{16}$</td></tr>
<tr><td>|</td><td>c</td><td>$123\,^{5}/_{16}$</td><td>|</td><td>k</td><td>$123\,\frac{5}{16}$</td><td>|</td><td>s</td><td>$123\,\frac{5}{16}$</td></tr>
<tr><td>|</td><td>d</td><td>$123\,^{7}/_{16}$</td><td>|</td><td>l</td><td>$123\,\frac{7}{16}$</td><td>|</td><td>t</td><td>$123\,\frac{7}{16}$</td></tr>
<tr><td>|</td><td>e</td><td>$123\,^{9}/_{16}$</td><td>|</td><td>m</td><td>$123\,\frac{9}{16}$</td><td>|</td><td>u</td><td>$123\,\frac{9}{16}$</td></tr>
<tr><td>|</td><td>f</td><td>$123\,^{11}/_{16}$</td><td>|</td><td>n</td><td>$123\,\frac{11}{16}$</td><td>|</td><td>v</td><td>$123\,\frac{11}{16}$</td></tr>
<tr><td>|</td><td>g</td><td>$123\,^{13}/_{16}$</td><td>|</td><td>o</td><td>$123\,\frac{13}{16}$</td><td>|</td><td>w</td><td>$123\,\frac{13}{16}$</td></tr>
<tr><td>|</td><td>h</td><td>$123\,^{15}/_{16}$</td><td>|</td><td>p</td><td>$123\,\frac{15}{16}$</td><td>|</td><td>x</td><td>$123\,\frac{15}{16}$</td></tr>
<tr><td>|</td><td>,</td><td>0.020⁄.</td><td colspan="6">Ft. / ft. symbol</td></tr>
</table>

The Greek characters were selected / omitted based on the double criteria of 1. prospective usage, and 2. whether or not the Greek character exists in ROMANS.

Some characters have two forms. This is due to two factors: Existing characters, and again the preferences of potential users.

Fig. C-4 Fractions Short Forms