

Colorado Department of Transportation Staff Bridge Bridge Detail Manual	Chapter: Table of Contents Effective: March, 05 2024 Supersedes: October, 11 2023
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COLORADO DEPARTMENT OF TRANSPORTATION STAFF BRIDGE BRIDGE DETAIL MANUAL	Chapter: Introduction Effective: April 12, 2000 Supersedes: March 1, 2000
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.

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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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General Instructions

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.

Sheet Revisions			
	Date:	Comments	Init.
(R-1)	6/3/03	Added expansion joint note	SLW
(FR-1)	6/30/03	Corrected Dimension	BAF
()			
()			

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.

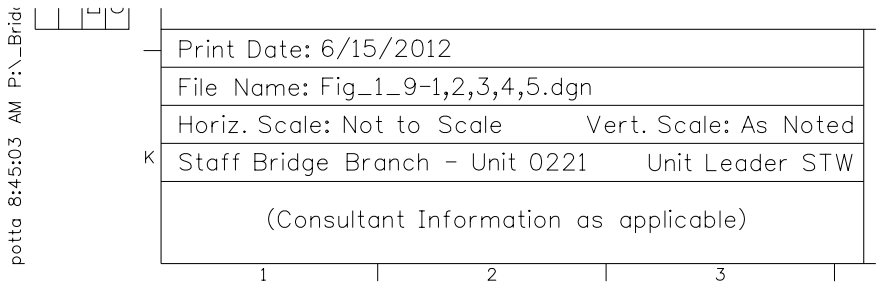


Fig. 1.9-5 Sample of Miscellaneous Information

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

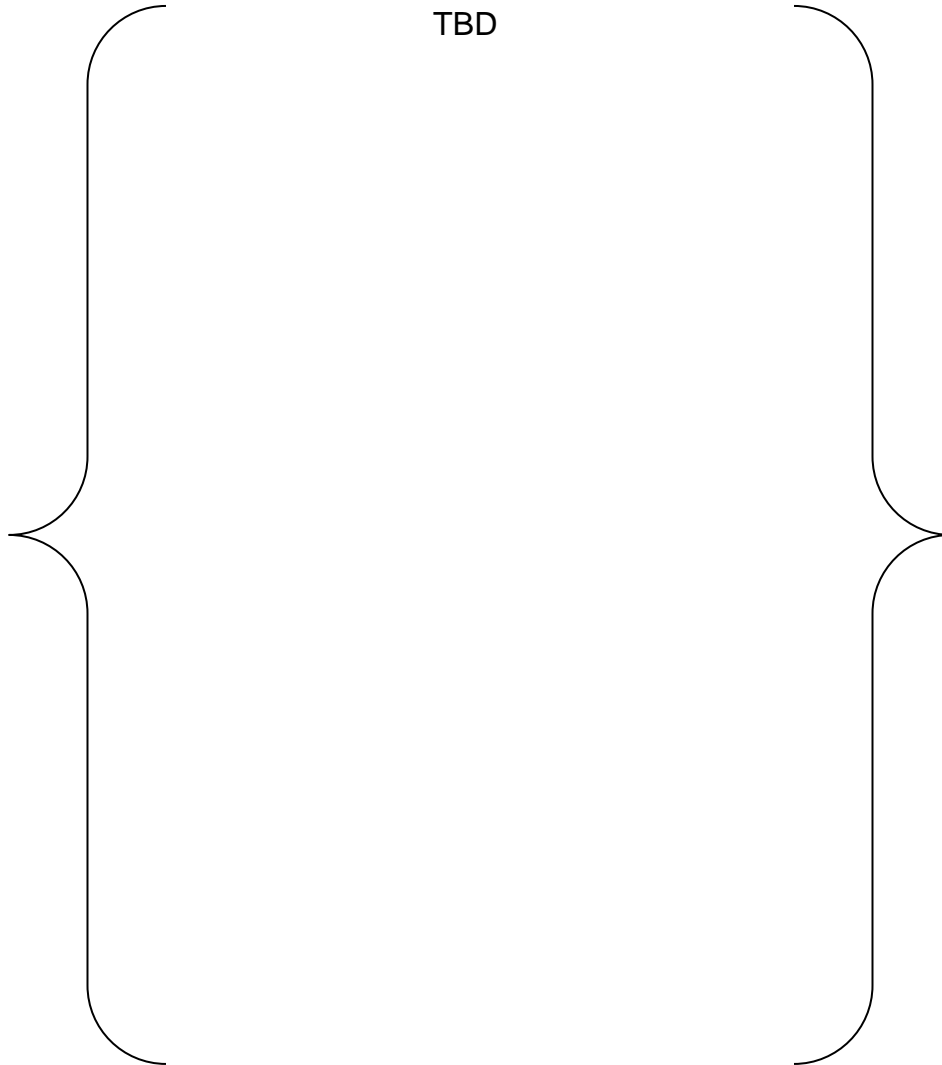


Fig. 1.11-1 Projectwise Directory Structure

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

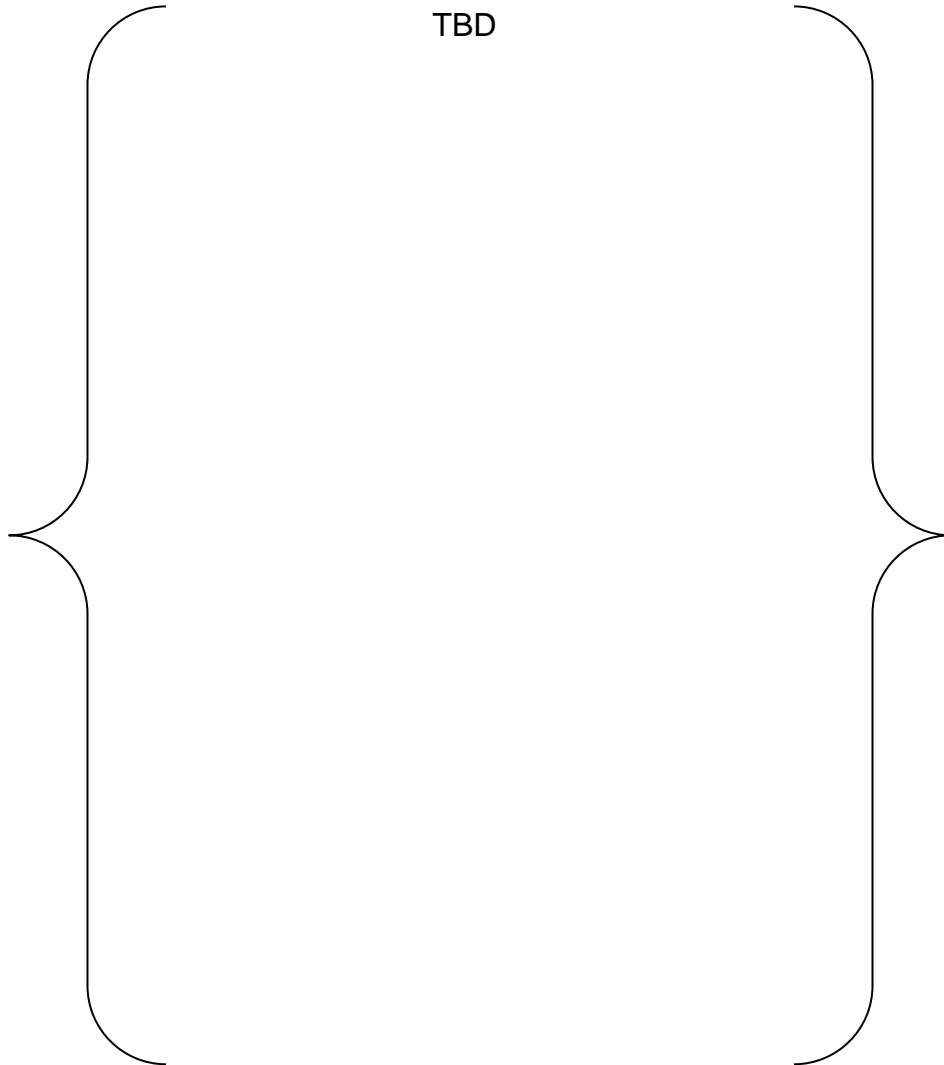


Fig. 1.11-2 Internal Projectwise Directory Structure

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 the letter of the original girder before the original naming convention, e.g. girder 1A will become girder A1A, and girder 1B will become girder B1B, etc. Where two bridges are merged together and widened, the rules stated previously for widenings apply. When adding an additional girder in between the original girders that is not being substituted or sistered, then the labeling should be girder letter to the left with a prime following by the additional girder number (A'1, A'2 or 3A'1, 3A'2 for Span 3) (see figure 1.13-6).

NUMBERING SYSTEM FOR BRIDGE COMPONENTS

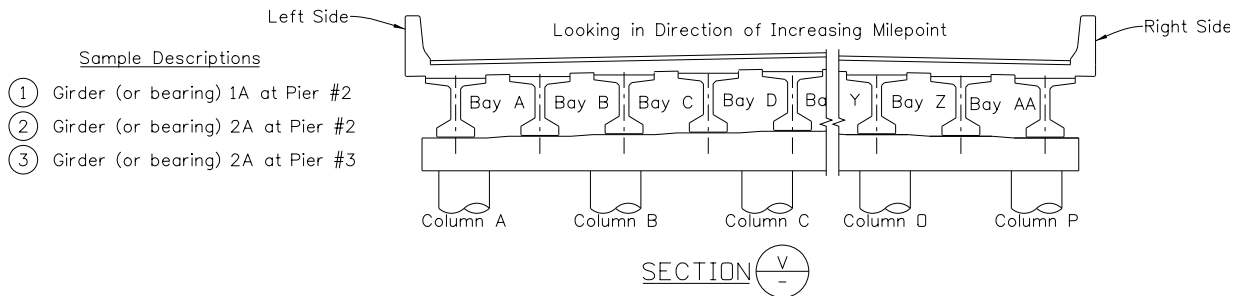
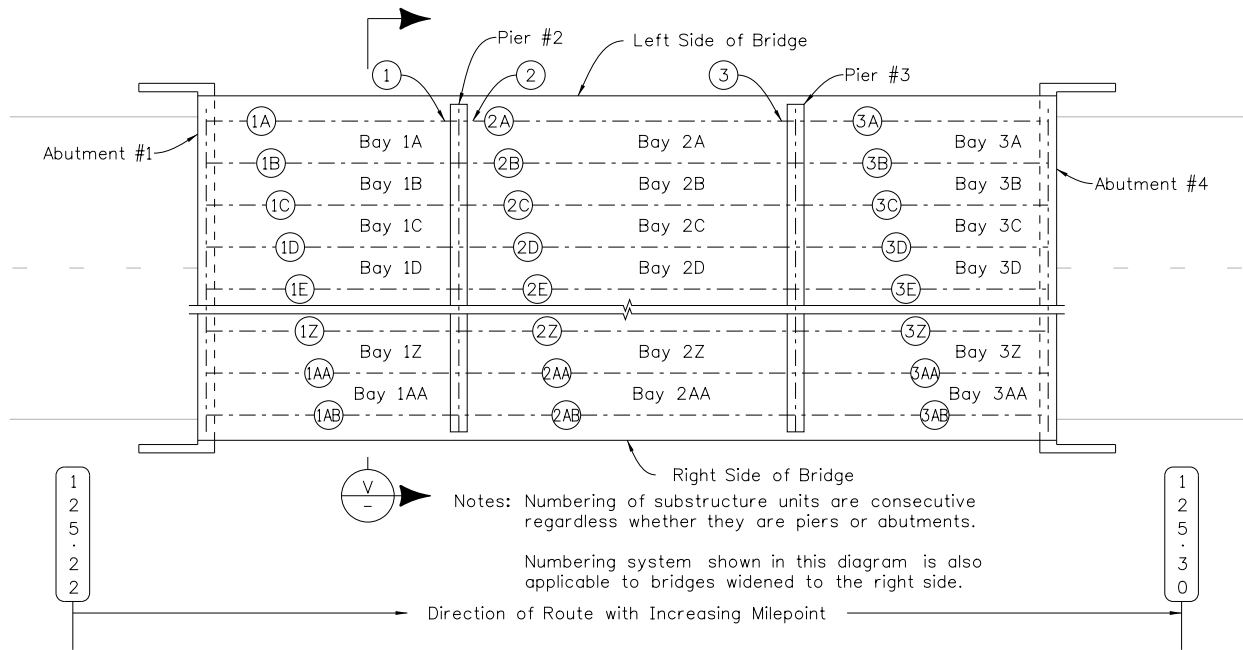


Fig. 1.13-1 Structure Component Naming Convention

NUMBERING SYSTEM FOR LEFT WIDENED BRIDGE COMPONENTS

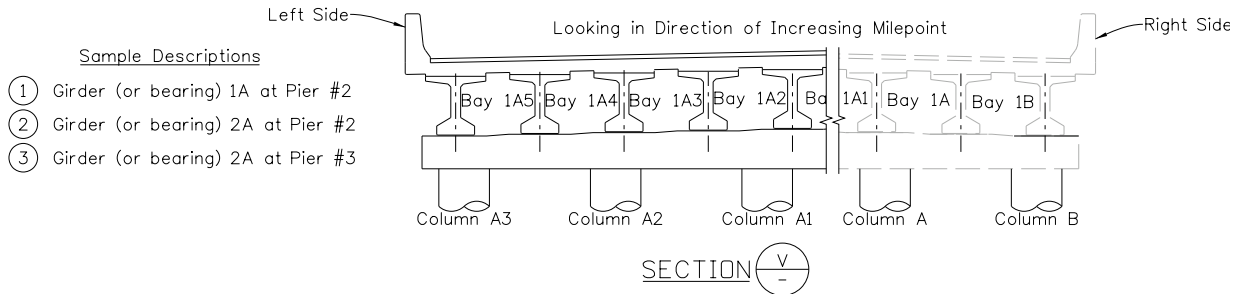
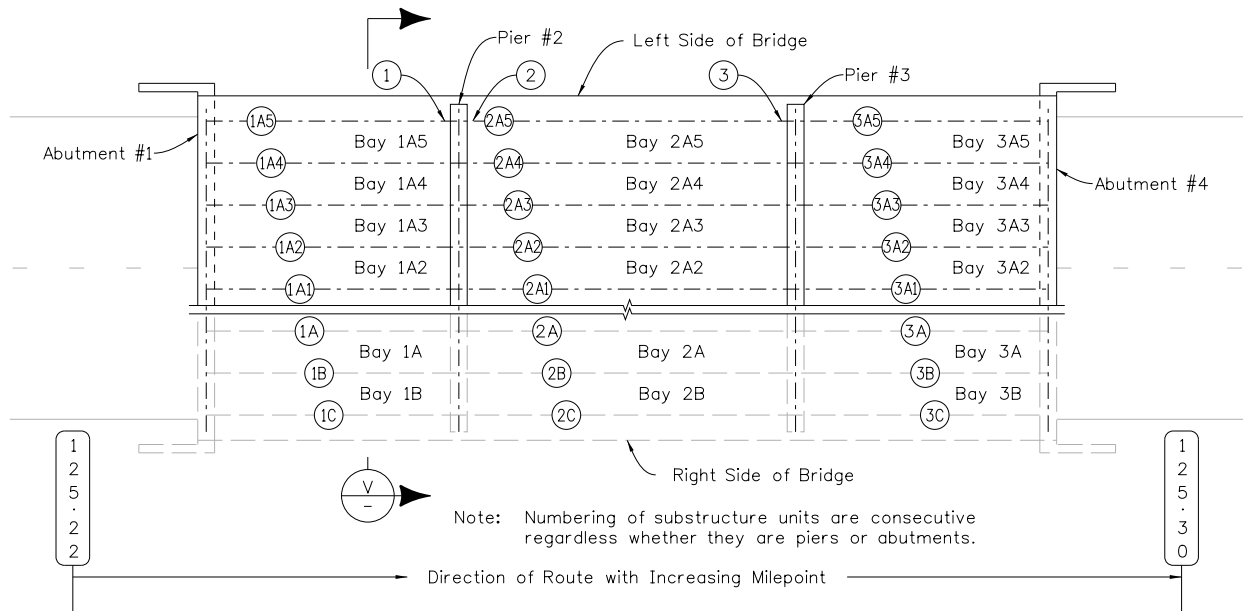


Fig. 1.13-2 Structure Component Naming Convention for Left Widened Bridges

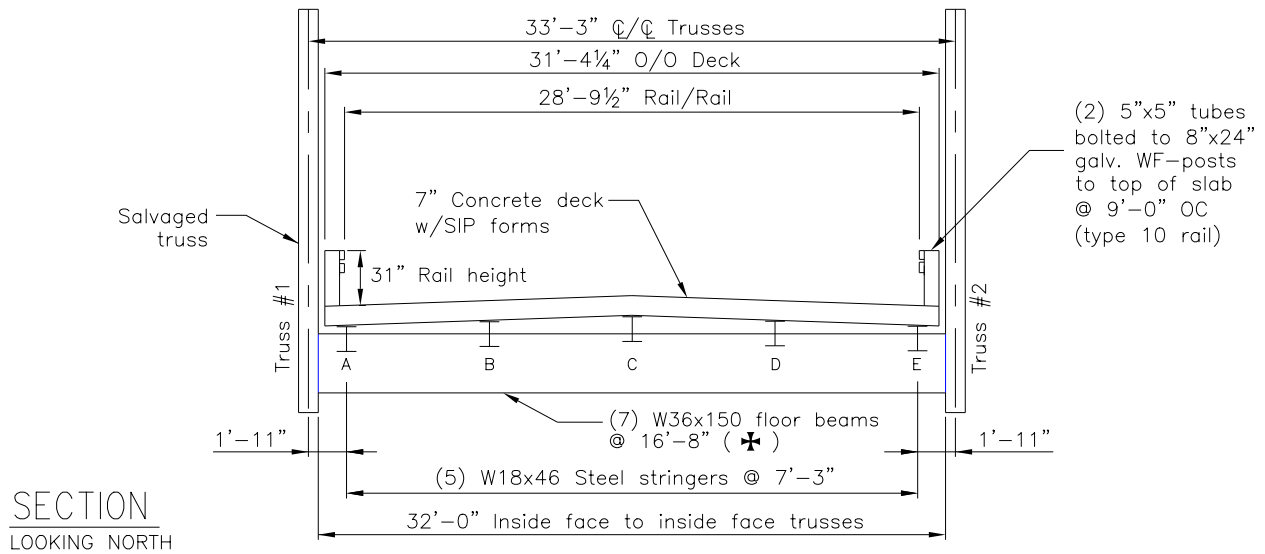
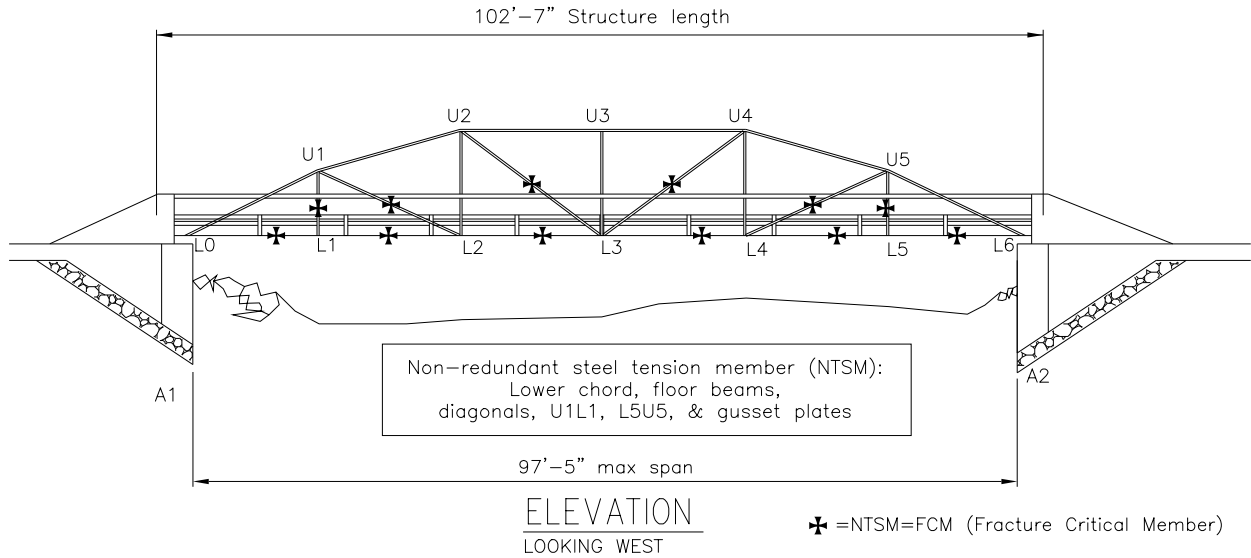
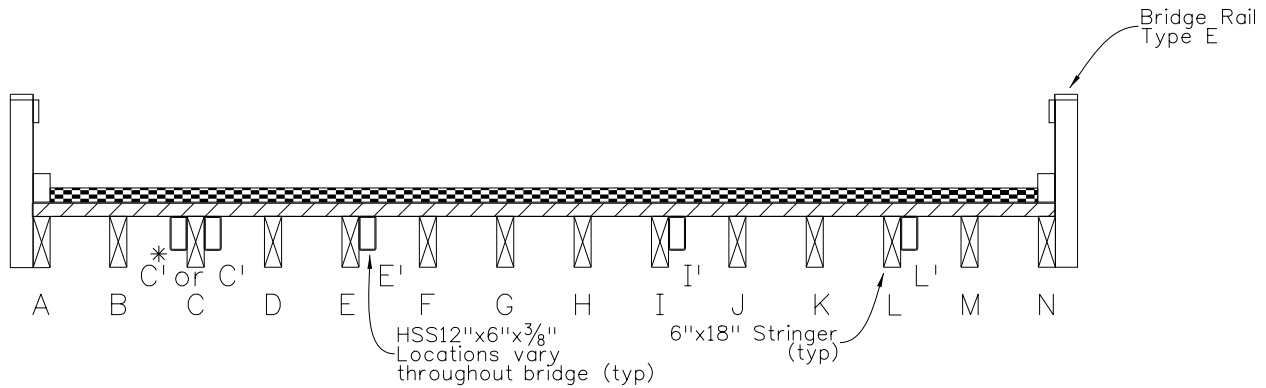


Fig. 1.13-3 Structure Component Naming Convention for Trusses



* The added girder may be on either side depending on the span.

SECTION

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

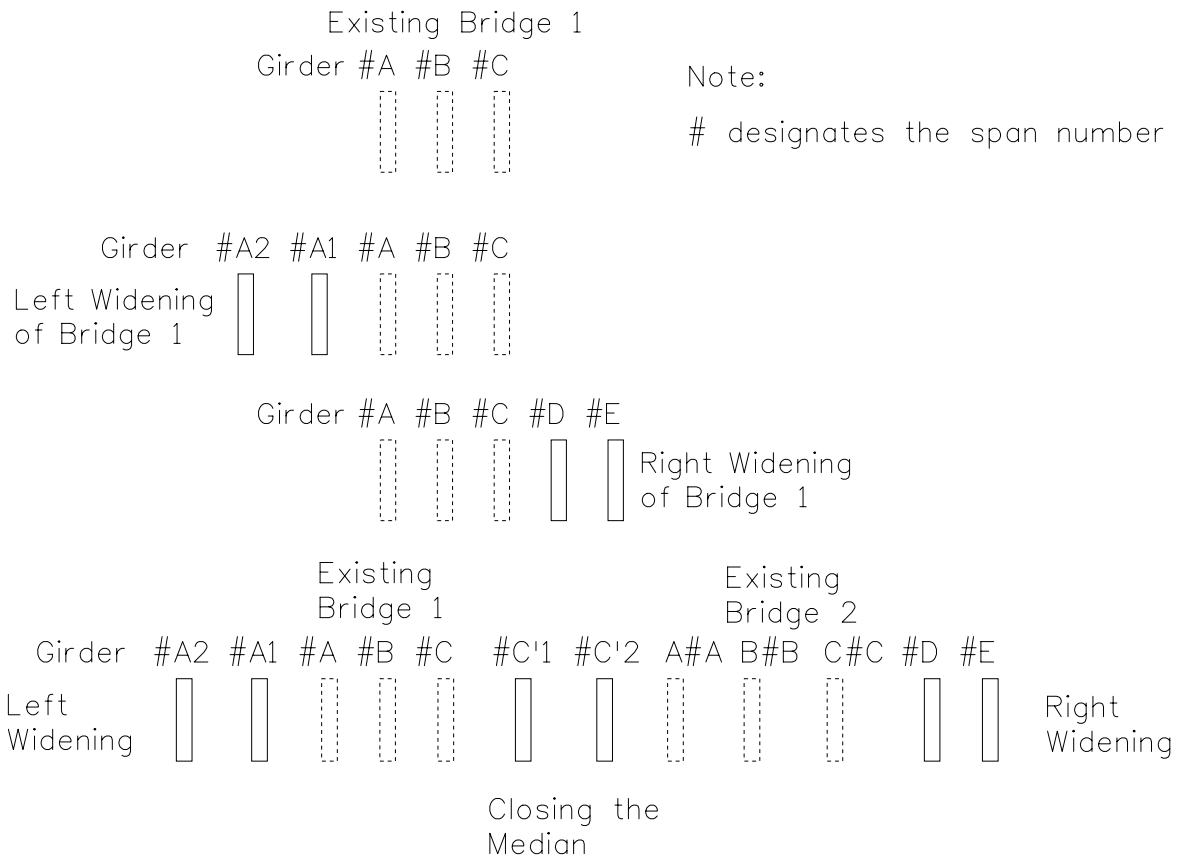
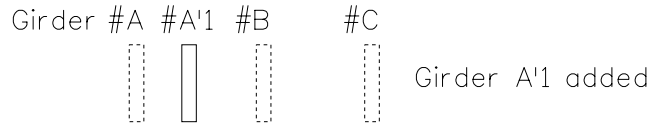
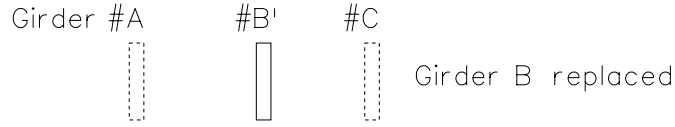


Fig. 1.13-5 Structure Component Naming Convention for Left & Right widening



Note:

designates the span number

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.

<p style="text-align: center;">COLORADO DEPARTMENT OF TRANSPORTATION STAFF BRIDGE BRIDGE DETAIL MANUAL</p>	<p>Chapter: 02 Effective: November 17, 2022 Supersedes: March 19, 2019</p>
<p>DRAFTING STANDARDS AND PROCEDURES</p>	

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.


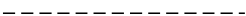

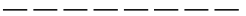









<u>Linetype</u>	<u>Width</u>	<u>Description/Use</u>
	0.012"	Visible Object Line or Profile Line - Used as the Visible Outline of the objects, should be an outstanding feature and consists of a continuous unbroken line
	0.008"	Hidden - Used to indicate hidden or invisible object lines and consists of 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 details 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

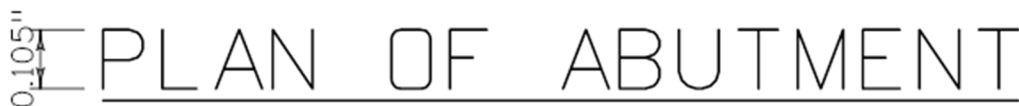


Fig. 2.5-2 Typical Example of Title

2.6 ACCURACY OF DIMENSIONS AND ELEVATIONS

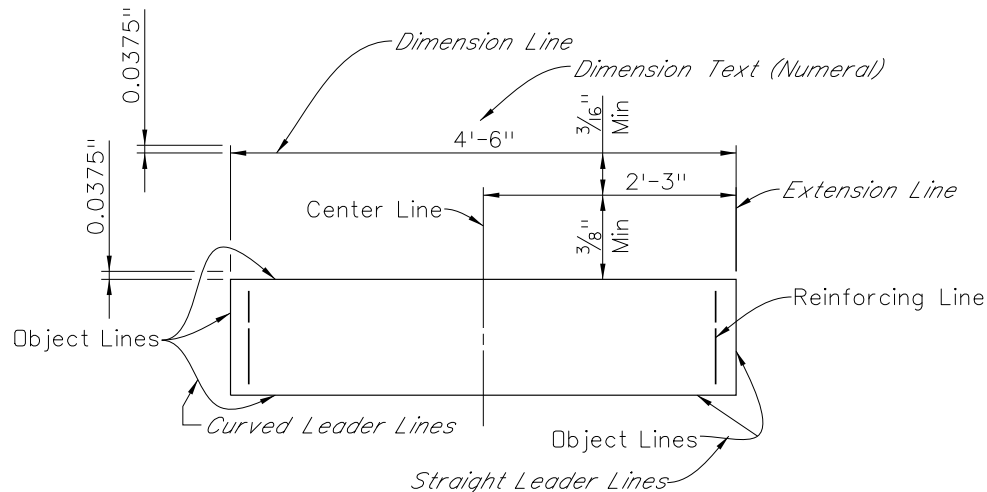
The degree of accuracy used on the drawings shall be as follows:

- 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 caissons 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 caissons 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.

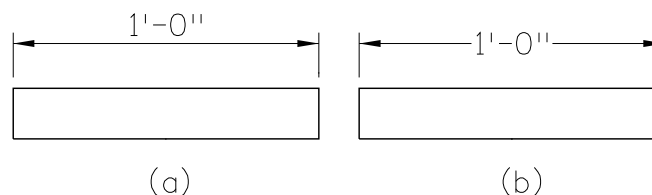


Fig. 2.7-2 Dimensions

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.

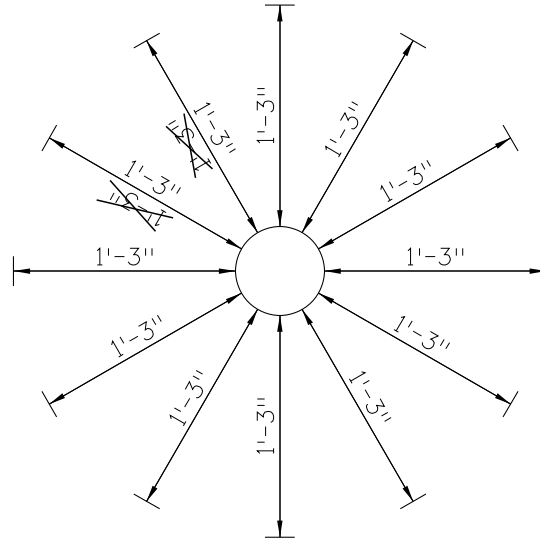


Fig. 2.7-3 Reading Directions for Dimensions

- 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.

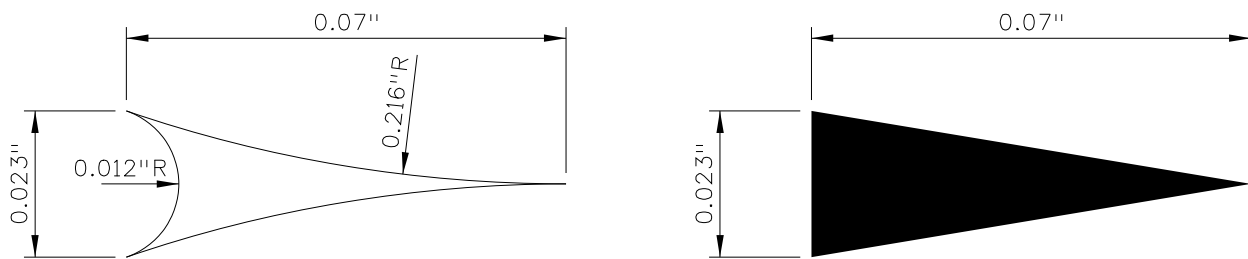


Fig. 2.7-4 Arrowheads

- 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.

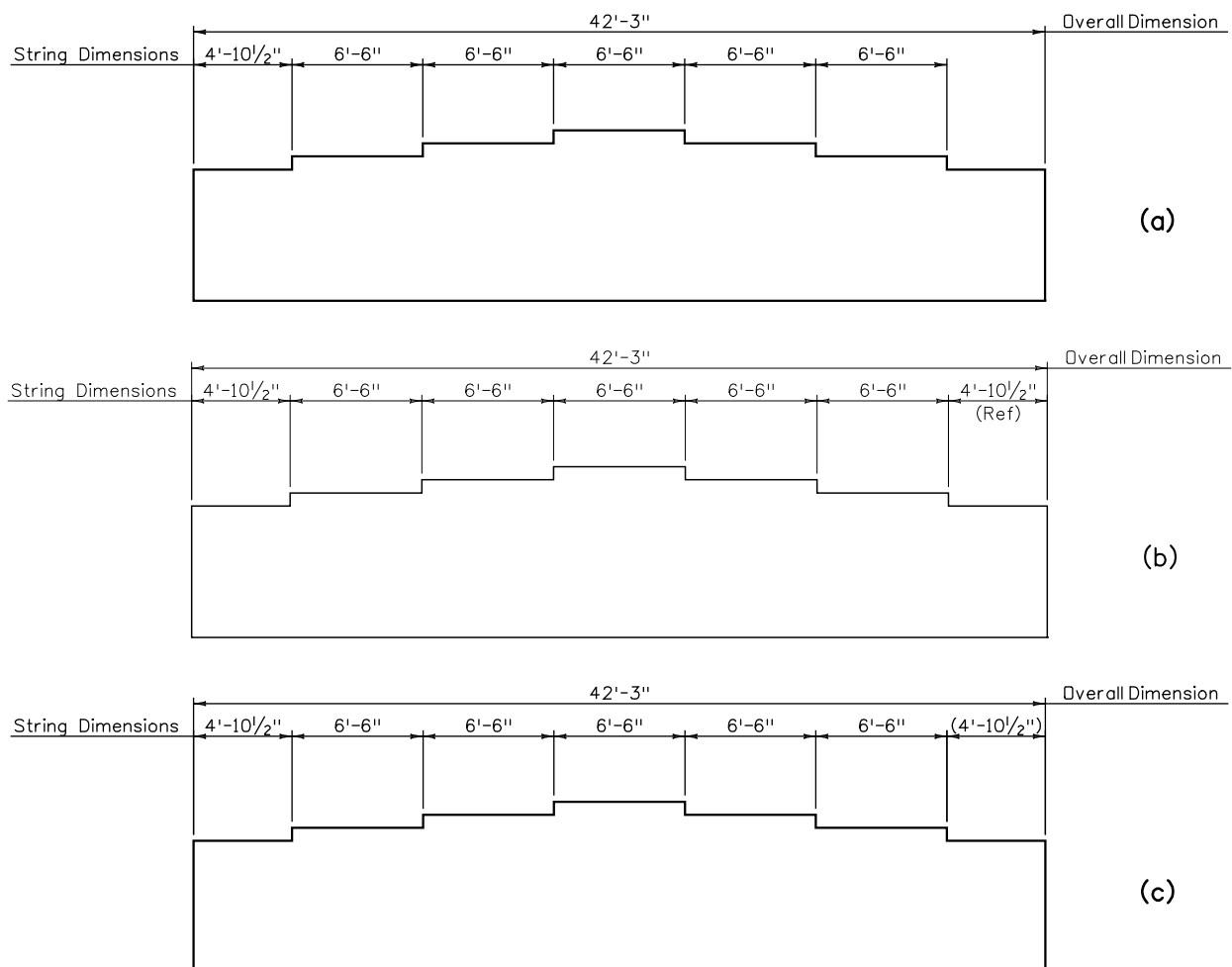


Fig. 2.7-5 String Dimensions

- 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.

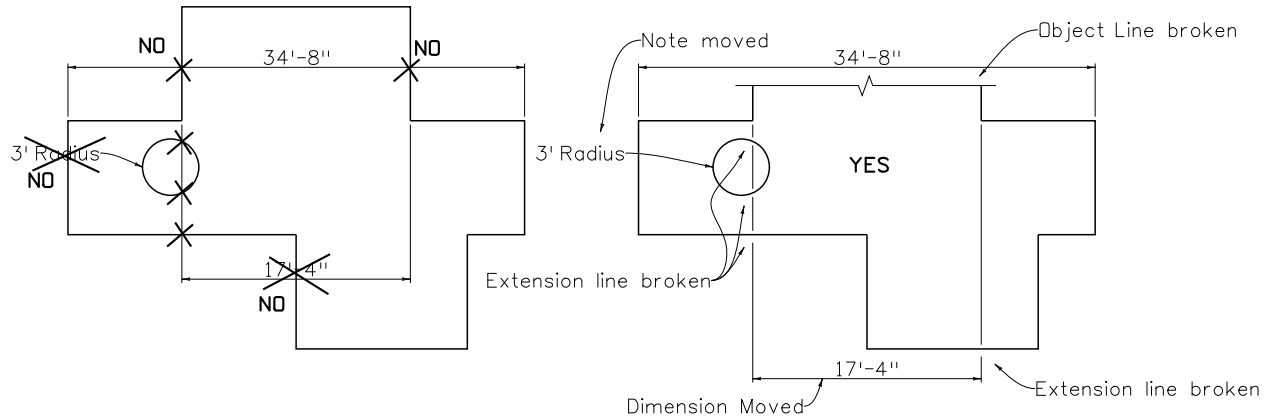


Fig. 2.7-6 Dimension and Object Lines

- 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.

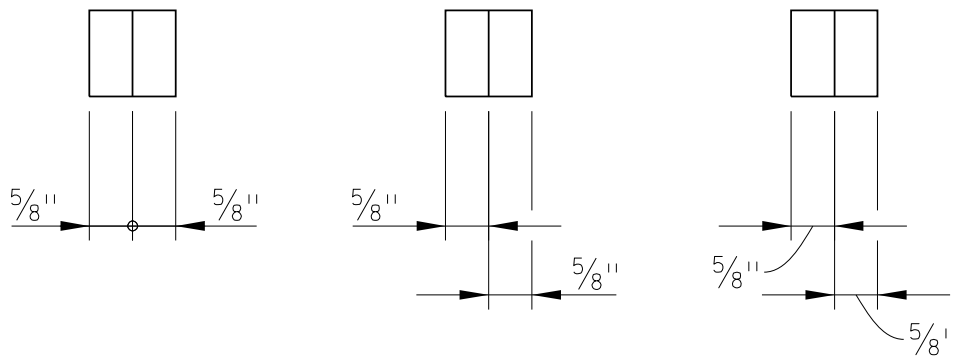


Fig. 2.7-7 Compressed Dimensions

- 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.

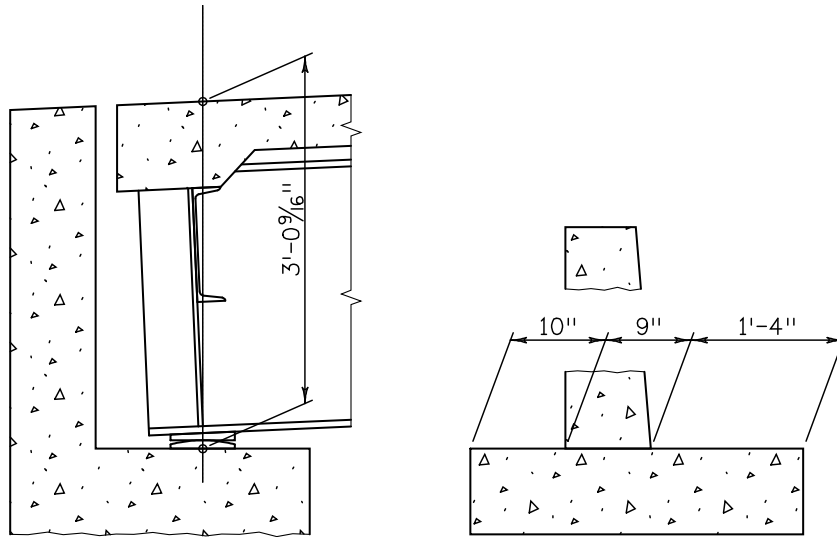


Fig. 2.7-8 Dimensioning to a Point

- 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"

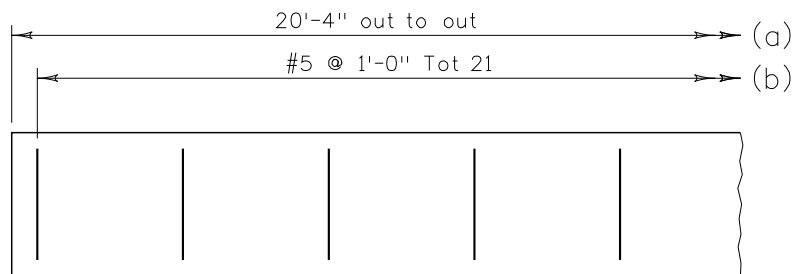


Fig. 2.7-9 Double Arrowheads

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

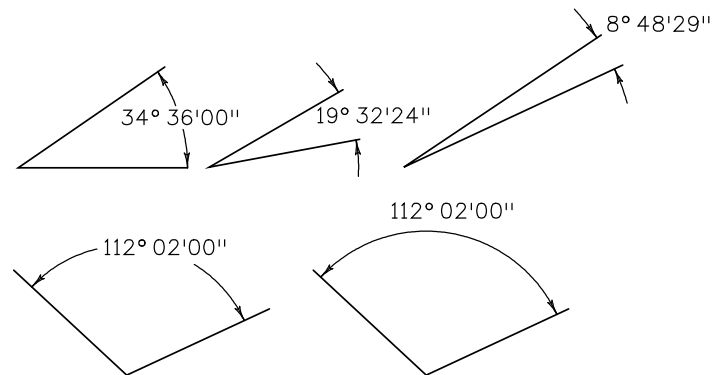


Fig. 2.7-10 Angles

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

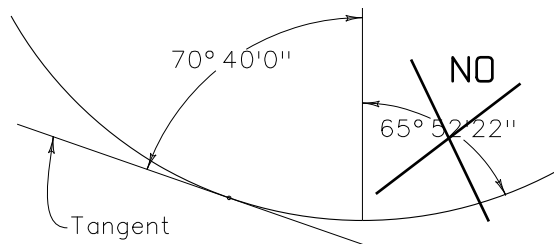


Fig. 2.7-11 Arc Tangents

- 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:

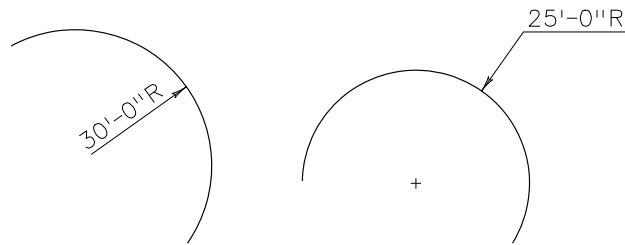


Fig 2.7-12 Radii

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

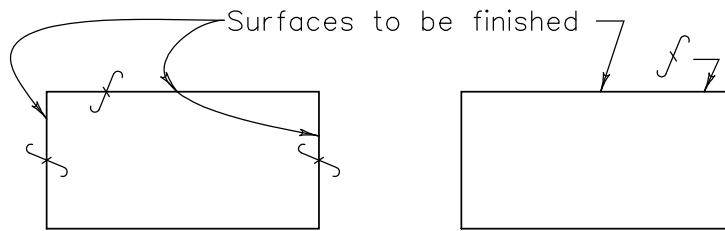


Fig. 2.7-13 Finish Marks

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.

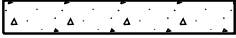

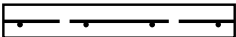
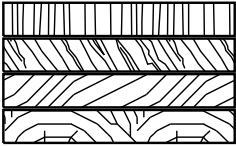






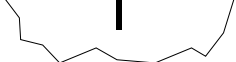




	Concrete
	Structural Steel
	Reinforced Concrete
	Timber
	Bronze
	Earth or Ground
	Fill or Sand
	Rock
	Riprap
	Grouted Riprap/Masonry
	Joint Filler
	Elastomeric Bearing Pad
	Hot Mix Asphalt (Bituminous Pavement)
	Brick
	Brick

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.

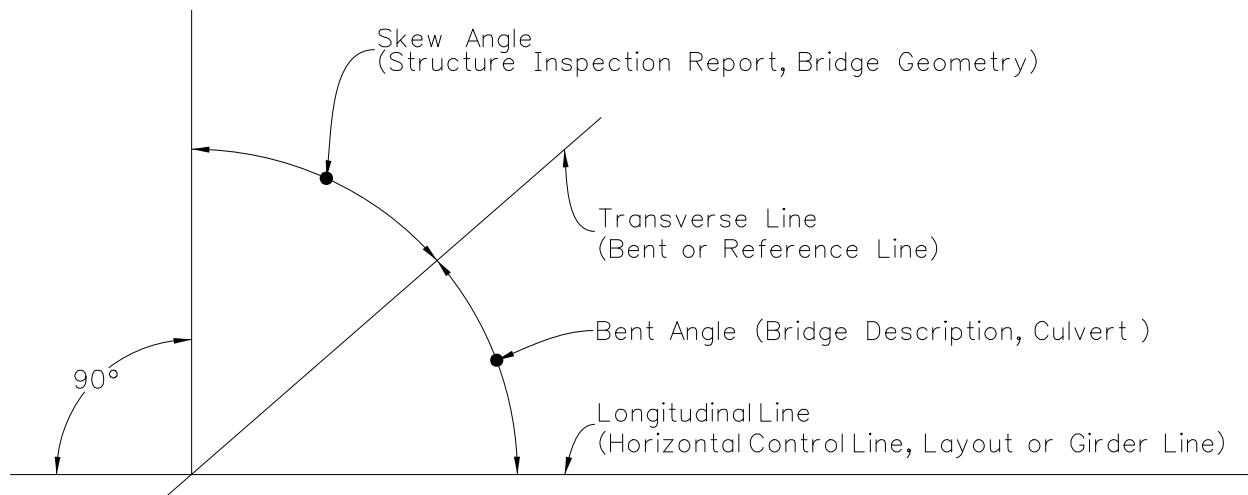


Fig. 2.10-1 Bent and Skew Angle

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.

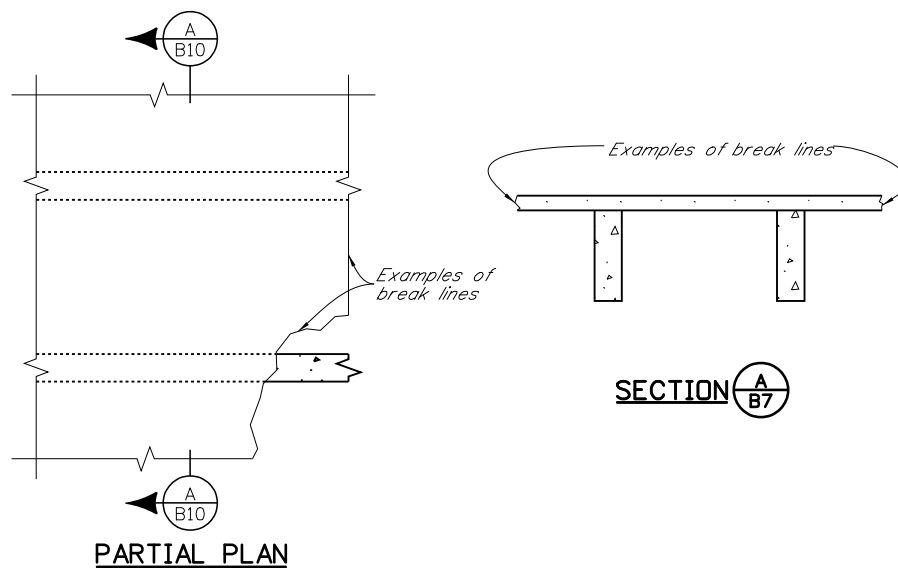


Fig. 2.11-1 Section Cut Example

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

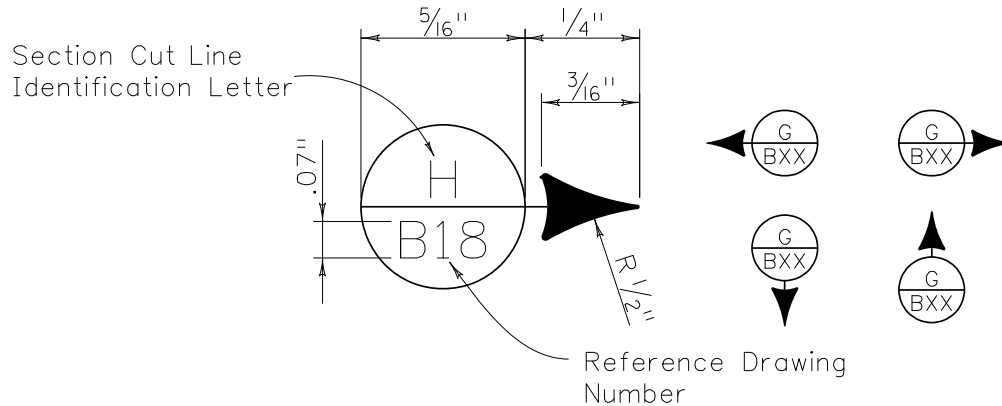


Fig. 2.11-2 Typical Section Arrow and Identification Circle

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.

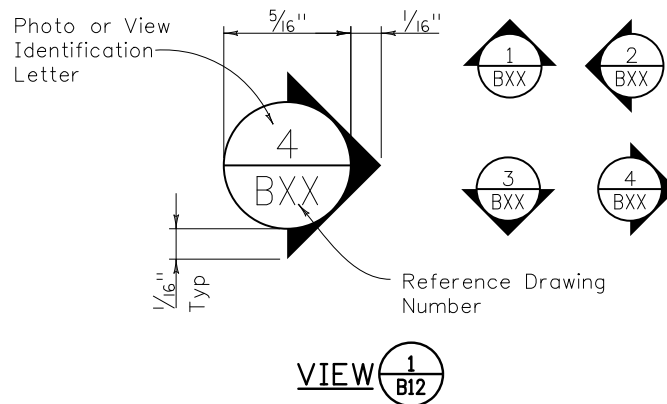


Fig. 2.11-4 Typical View Indicators

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.

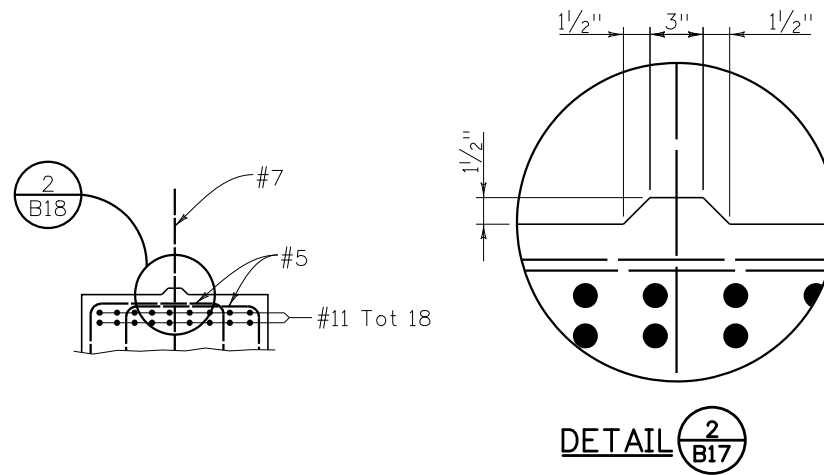


Fig 2.12-1 Enlarged Detail

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.

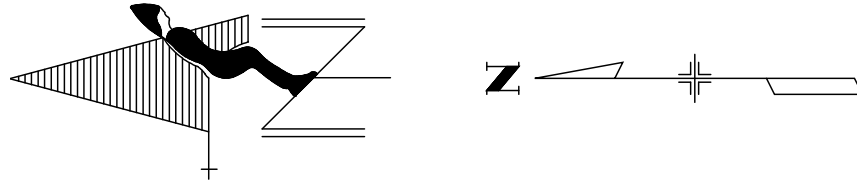


Fig. 2.14-1 Acceptable North Arrows

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.

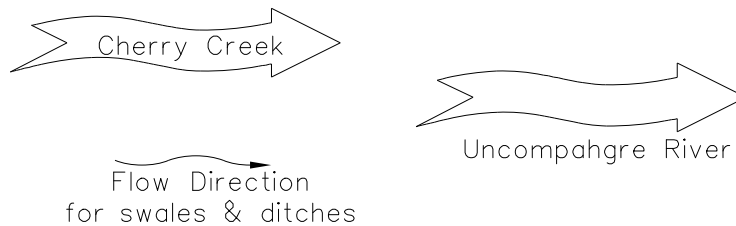
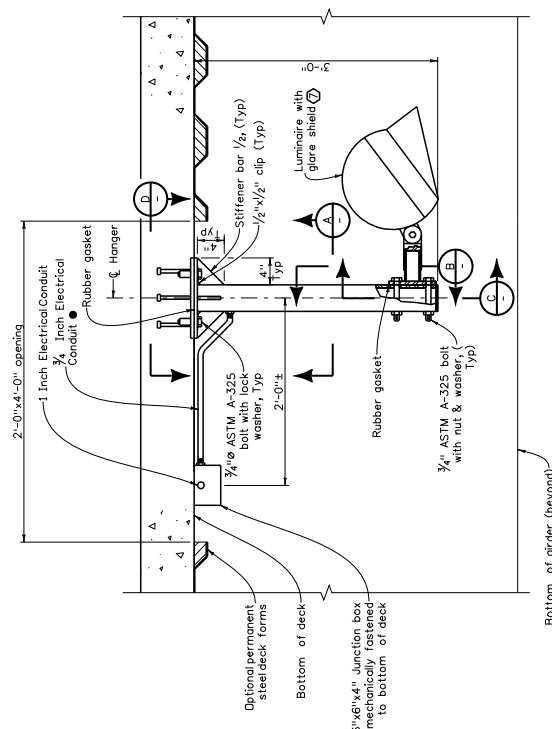
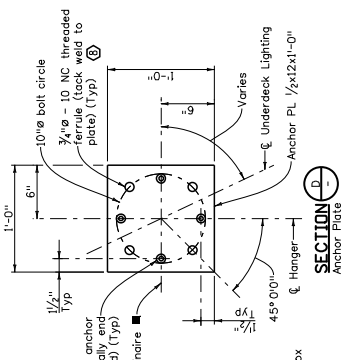
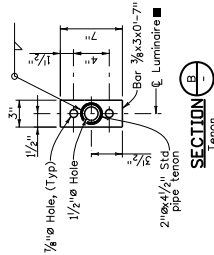
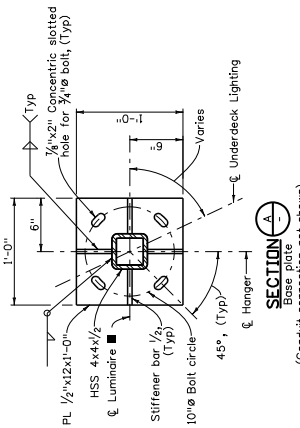
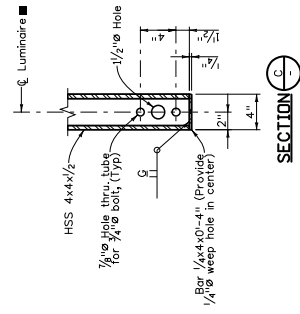


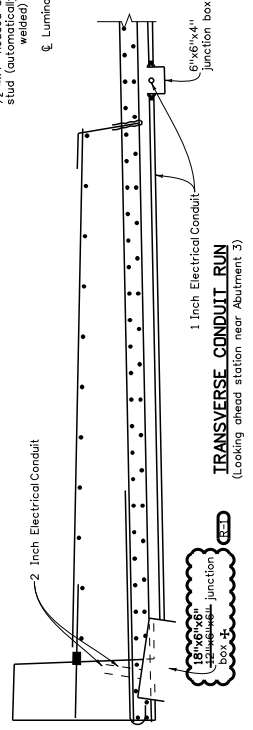
Fig. 2.14-2 Flow Arrows

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.



LUMINAIRE HANGER DETAIL



TRANSVERSE CONDUIT RUN
(Looking ahead station near Abutment 3)

NOTES

1. Cost of providing and installing luminaire hanger shall be included in the cost of the luminaire. See Lighting Plans.
 2. Hanger assembly shall be ASTM A-36.
 3. If permanent steel deck forms are used, provide 2'-0"x4'-0" opening in steel forms and form zone around hanger with removable forms. Center opening to include hanger and junction box.
 4. Following fabrication, all steel components shall be galvanized, in accordance with Section 509.
 5. Use rubber gasket between all steel-to-steel connections.
 6. For underdeck luminaire locations and additional notes, see "Construction Layout" sheet.
- ⑦ Attach luminaire to tenon per Manufacturer's recommendations. For luminaire details, see Lighting Plans.
 - ⑧ Provide 3/8" hole through Anchor Plate at each ferrule location.
 - Provide connection in tube and junction box for 3/4" electrical conduit.
 - Luminaire shall be parallel to G-Grider and shall be approximately centered between griders.
 - + Locate junction box to clear reinforcing. Up to one bottom mat bar in each direction may be cut to clear junction box.

Fig. 2.15-1 Example of Preferred Notes

COLORADO DEPARTMENT OF TRANSPORTATION STAFF BRIDGE BRIDGE DETAIL MANUAL	Chapter: 03 Effective: April 16, 2018 Supersedes: December 19, 2014
CHECKING STANDARDS AND PROCEDURES	

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

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

- 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.
- 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_V8\Standards-Global\Trnsport_Itemelist.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
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

Checker's Totals	% Difference

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:

- 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.

COLORADO DEPARTMENT OF TRANSPORTATION STAFF BRIDGE BRIDGE DETAIL MANUAL	Chapter: 4 Effective: August 18, 2014 Supersedes: November 12, 1999
REINFORCING	

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.

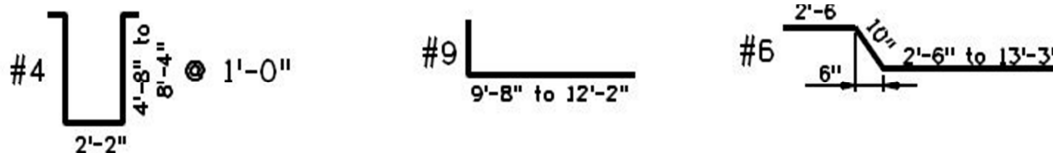
Adequate information shall be shown on each sheet so that the dimensions and shapes of the bars detailed may be readily determined without referring to other detail sheets.

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.

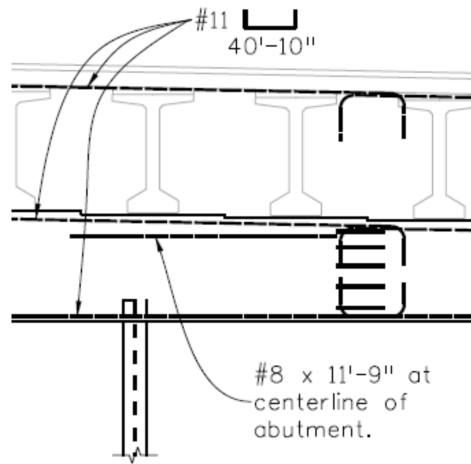


Fig. 4.3-2 Example 1: Rebar not controlled by concrete dimensions

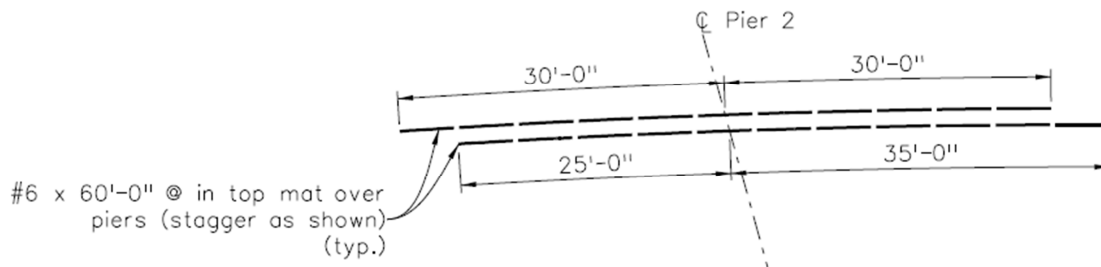


Fig. 4.3-3 Example 2: Rebar not controlled by concrete dimensions

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 **(N)** or an **(E)** next to the reinforcing which has the fewest number of bars. A note "**(N)** denotes non coated reinforcing steel" or "**(E)** 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 1/2 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 \oslash 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.

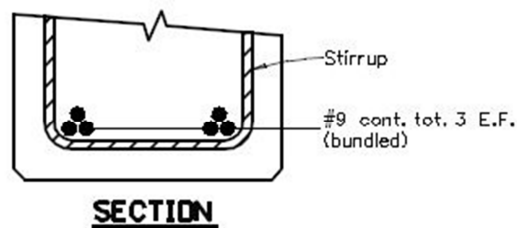


Figure 4.9-2 Bundled Bars in Section

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 $\frac{1}{2}''=1'$. At scales $\frac{1}{2}''=1'$ 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 $\frac{1}{2}''=1'$ 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.

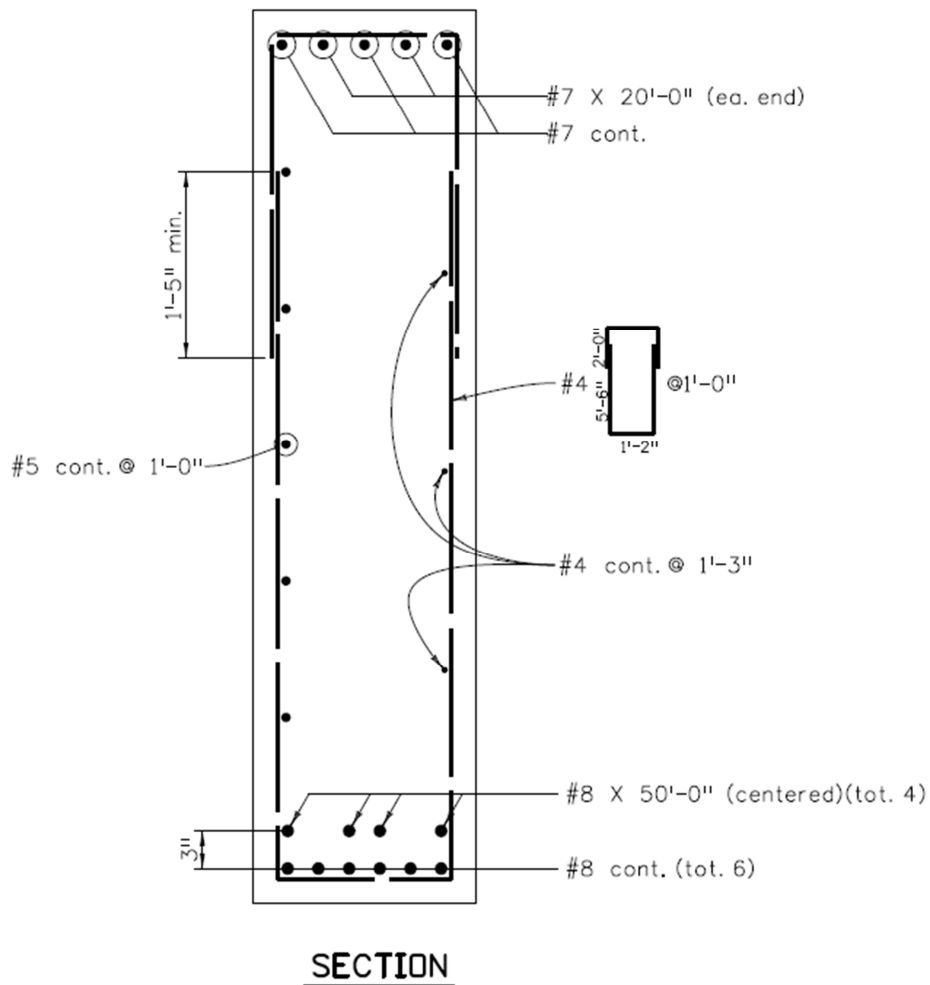


Figure 4.11-1 Bars in Section (Example)

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> .

COLORADO DEPARTMENT OF TRANSPORTATION STAFF BRIDGE BRIDGE DETAIL MANUAL	Chapter: 5 Effective: November 19, 2021 Supersedes: July 29, 2011
GENERAL INFORMATION – SUMMARY OF QUANTITIES	

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:

The diagram shows a table with 9 columns and 10 rows. The columns are labeled: Item No, Description, Unit, Super-structure, Abutment 1, Pier 2, Wall, and Total. The dimensions for the columns are: 3/4", 3 1/2", 1/2", 3/4", 3/4", 3/4", 3/4" (Typ), and 1". The rows are: Row 1 (headers), Row 2 (blank), Row 3 (blank), Row 4 (blank), Row 5 (blank), Row 6 (blank), Row 7 (blank), Row 8 (blank), Row 9 (blank), and Row 10 (blank). The table is broken into three sections by diagonal lines. The first section contains the first three columns, the second section contains the next four columns, and the third section contains the last two columns. The height of the first row is 3/8", and the height of the remaining rows is 3/16".

Item No	Description	Unit	Super-structure	Abutment 1	Pier 2	Wall	Total

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 steels 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 7/8" diameter, high strength, unless otherwise noted.

Leaving ends are ungalvanized bearings. They shall be cut or milled 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 for information only. It is the responsibility of the contractor to determine the location of underground utilities as they may be necessary to avoid damage thereto. The Contractor shall contact the Utility Notification Service at 811 (toll free) at least 7 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 CDDT-R2, Maintenance.



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: 30 lbs per sq. ft. for permanent steel deck forms

Assumes 2 lbs. per sq. ft. for permanent steel deck forms

Reinforced Concrete: Class D Concrete: f_c = 4,500 psi

Precast Prestressed Concrete Girders: f_c = (see details)

Reinforcing Steel: f_s = 270,000 psi

Reinforcing Steel: f_y = 60,000 psi

Structural Steel: f_y = 36,000 psi

AASHTO M270 (ASTM A709) Grade 36 f_y = 50,000 psi

AASHTO M270 (ASTM A709) Grade 50

INDEX OF DRAWINGS

- B01 GENERAL INFORMATION
- B02 SUMMARY OF QUANTITIES
- B03 GENERAL LAYOUT
- B04 BRIDGE GENERAL LAYOUT
- B05 BRIDGE HYDRAULIC INFORMATION
- B06 RIPRAP SITE PLAN AND DETAILS
- B07 CONSTRUCTION LAYOUT AND DETAILS
- B08 ABUTMENT DETAILS (1 OF 2)
- B09 ABUTMENT DETAILS (2 OF 2)
- B10 PRESTRESSED CONCRETE CBT
- B11 PRESTRESSED CONCRETE CBT
- B12 INTERMEDIATE DIAPHRAGM
- B13 DECK DETAILS - SECTION
- B14 PRECAST PANEL DECK FORM (1 OF 2)
- B15 PRECAST PANEL DECK FORM (2 OF 2)
- B16 BRIDGE RAIL TYPE 10MASH
- B17 BRIDGE RAIL TYPE 10MASH
- B18 TRANSITION DETAILS (1 OF 2)
- B19 TRANSITION DETAILS (2 OF 2)
- B20 MECHANICALLY STABILIZED BACKFILL
- B21 BRIDGE DECK ELEVATIONS
- B22 ROADWAY APPROACHES
- B23 BRIDGE DECK ELEVATIONS
- B24-B26 BRIDGE DECK ELEVATIONS
- B27 ROADWAY APPROACHES

SEISMIC DESIGN CRITERIA

Earthquake Design method: Force based (General)

Latitude = 39.0720° N
Longitude = 105.9742° W

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

Period (sec) (g) 0.07 pCa - Site Class D
0.2 0.160 S_s - Site Class D
1.0 0.042 S₁ - Site Class D

Spectral Response Accelerations:
As = F_pg/F_a - Site Class D
F_pg = 1.600, F_a = 1.600, F_v = 2.400

Operational Class: Seismic Zone or Category: A

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

Example 5-1

BRIDGE DESCRIPTION

Simply span (90° skew along both) bridge, concrete prestressed I girder (CPG) (US-85) with 10' wide plate girder. 44'-0" roadway curb to curb. Bent angle 90°. 1'-6" curbs, Type 10MASH bridge rail with BRDM-GR3 transition.

GENERAL INFORMATION

SUMMARY OF QUANTITIES

Item No	Description	Unit	Superstructure		H-13-H		Approach Slabs	Total
			Abut 1	Abut 2	Abut 1	Abut 2		
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 Mx 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
605-01400	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:

- See Roadway plans for additional quantities related to embankment protection at abutments.
- The 4 pullboxes (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.

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 thoroughly cleaned before fresh concrete is placed.
- Backfill shall not begin until 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 $\frac{3}{4}$ inch.
- All dimensions are perpendicular to the centerline of the box.
- All transverse reinforcing shall be normal to the centerline of the structure during construction.
- 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 datum. Verify all dependent dimensions in the field before ordering or fabricating any material.
- All physical and transverse dimensions are measured horizontally and include no correction for grade.
- The information herein on these plans concerning the type and location of construction joints is for informational purposes only. 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 be responsible for obtaining all necessary permits and approvals (1-800-922-1997) at least 3 days (3 days not including the day of notification) prior to any excavation or other earthwork.

Example 5-3

INDEX OF DRAWINGS

- B01 GENERAL INFORMATION, SUMMARY OF QUANTITIES
- B02 GENERAL LAYOUT
- B03 CHANNEL PROTECTION
- B04 BOX CULVERT EXTENSION DETAILS

BRIDGE DESCRIPTION

0246331948BL:
 Replace a 2-span steel girder bridge (H-19-C) with a 2 cell 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°
 0246332060BR:
 18' Extension at outlet of the existing 1 cell 8' x 4' x 56' CBC (built in 1935, 4' extension at inlet in 1969)
 18' Extension at inlet of the existing 1 cell 8' x 4' x 56' CBC (built in 1935, 4' extension at inlet in 1969)
 Angle between CL Roadway and CL CBC = 0°

SUMMARY OF QUANTITIES

Item No	Description	Units	0246331948BL		0246332060BR		Total Project
			CBC & Headwalls	Wingwalls	Channel Protection	Total	
202-0026	Removal of Slope and Ditch Paving	SY		310			310
202-0050	Removal of Wall (CBC Wingwalls)	EA				2	2
202-0040	Removal of Bridge	EA				1	1
206-0000	Structure Excavation	CY	95	75	10	30	255
206-0050	Structure Backfill (Class 2)	CY	270	130		20	440
206-0178	Shoring (Area 1)	L5	1				1
206-0178	Shoring (Area 2)	L5	0.5			0.5	0.5
515-0020	Waterproofing (Membrane)	SY	252				252
601-0300	Concrete Class D (Box Culvert)	CY	224	40	9	16	23
602-0000	Reinforcing Steel	LB	23405	4115	685	3825	4600
602-0020	Reinforcing Steel (Epoxy Coated)	LB	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
 $f_y = 60,000$ psi
- Live Load CBC: HL-93 (design truck or tandem, and design lane load)
- Dead Load CBC: 125 lbs. per cu. ft. for soils
 146.07 lbs. per cu. ft. for asphalt

- Wingwall Loading:
 At-rest earth fluid pressure for concrete stem design = 55 pcf for 2' (min); 1:1 sloped backfill
 Active earth fluid pressure for concrete footing design = 40 pcf for 2' (min); 1:1 sloped backfill
 Minimum resistance for soilbearing = 5.5 ksi
 Soilbearing resistance factor = 0.45



**Know what's below.
Call before you dig.**

Section or Detail Identification



Cross Reference Drawing Number
(If blank or 0000, reference is to same sheet)

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 conditions and may vary slightly from the original 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 materials shall remain property of the Contractor. CDDT 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 of the bridge deck, which falls or is otherwise generated, 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 a thickness 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 (Planning).
- 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. Rebar 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.

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)

DESIGN DATA

- AASHTO LRFD Design Specifications, Eighth Edition.
- Concrete Patching Material: See Special Provision
- Reinforcing Steel: Fy = 60,000 psi

SUMMARY OF QUANTITIES

Item No	Description	Unit	Quantity	As-Built
202-00240	Removal of Asphalt Mat (Planning)	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 and shall be approved 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.

LEGEND



Example 5-4

SUMMARY OF QUANTITIES

ITEM NO	DESCRIPTION	UNIT	SUPERSTRUCTURE	ABUTMENT 1	PIER 2	PIER 3	PIER 4	PIER 5	ABUTMENT 6	APPROACH SLABS	URBAN DESIGN	TOTAL
①	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
	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 SIX) (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 1)	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
	601-03040 CONCRETE CLASS D (BRIDGE)	CY	1,563	152	122	119	117	115	149	287	80	2,704
	601-40005 CURB 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
③	602-00020 REINFORCING STEEL (EPOXY COATED)	LB	357,133	19,419	30,047	30,047	30,047	30,047	19,419	40,716	8,183	585,118
	604-25000 VANE GRADE 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	613-01200 2 INCH ELECTRICAL CONDUIT (PLASTIC)	LF									1,378	1,378
⑤	613-01300 3 INCH ELECTRICAL CONDUIT (PLASTIC)	LF									365	365
⑥	613-01400 4 INCH ELECTRICAL CONDUIT (PLASTIC)	LF									441	441
②	613-13000 LUMINAIRE (LED)	EA						6				6
⑨	613-15200 RECESSED LIGHT (SPECIAL)	EA									44	44
⑪	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

NOTES:

- Riprap, Loosefill and Geotextile quantities are shown in the Drainage Plans.
- For Lighting at Pier 5.
- Includes 7.36 CY for ceiling terminus columns at abutments and 43.28 CY for columns at piers and 43.28 CY for plinths.
- Includes 345 LB for railing terminus columns at abutments and 5,502 LB for columns at piers and 2,176 LB for plinths.
- Irrigation sleeve (PVC Conduit) in median.
- Irrigation sleeve (PVC Conduit) in right edge of deck.
- Two electrical conduits in left edge of deck, one electrical conduit in right edge of deck, and one electrical conduit in right edge of deck.
- One irrigation sleeve in right edge of deck
- Removal of Pedestrian bridge.
- Includes 16 for stone columns and 28 for plinths.
- See Structures Selection Report for Structure Temporary Access Road (Location 1 and 2) for conceptual details.
- To facilitate phase I bridge and landscaping well construction at the east abutment.
- Quantity includes 22 for splices not shown in the plans.

Example 5-5

SUMMARY OF QUANTITIES

COLORADO DEPARTMENT OF TRANSPORTATION STAFF BRIDGE BRIDGE DETAIL MANUAL	Chapter: 6 Effective: November 20, 2018 Supersedes: April 12, 2000
GENERAL LAYOUT	

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 preparing 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 foot 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.

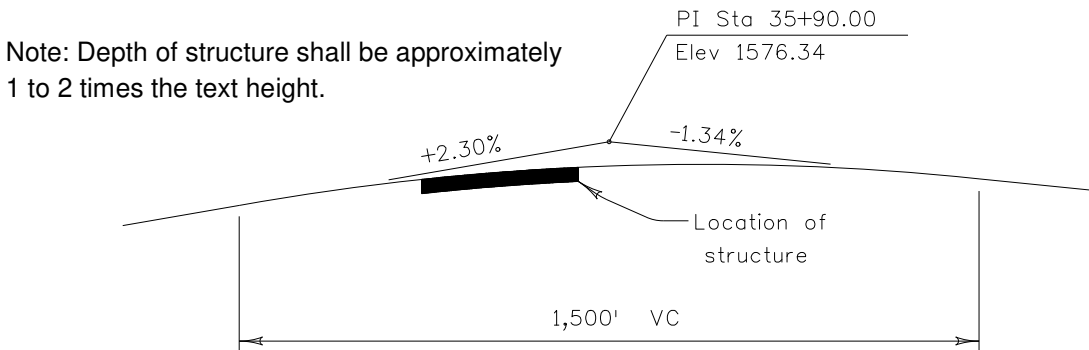


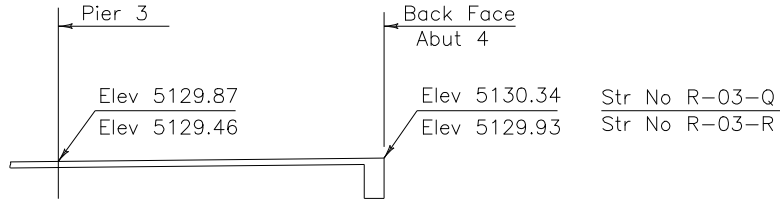
Figure 6.5-1 Typical Profile Grade Diagram

- 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 "SECTION" 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 "ELEVATION".
- R) For parallel structures of the same type, a single longitudinal section will suffice. This section, titled "SECTION" 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 "SECTION STR NO R-03-Q".

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 "TYPICAL SECTION".

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".

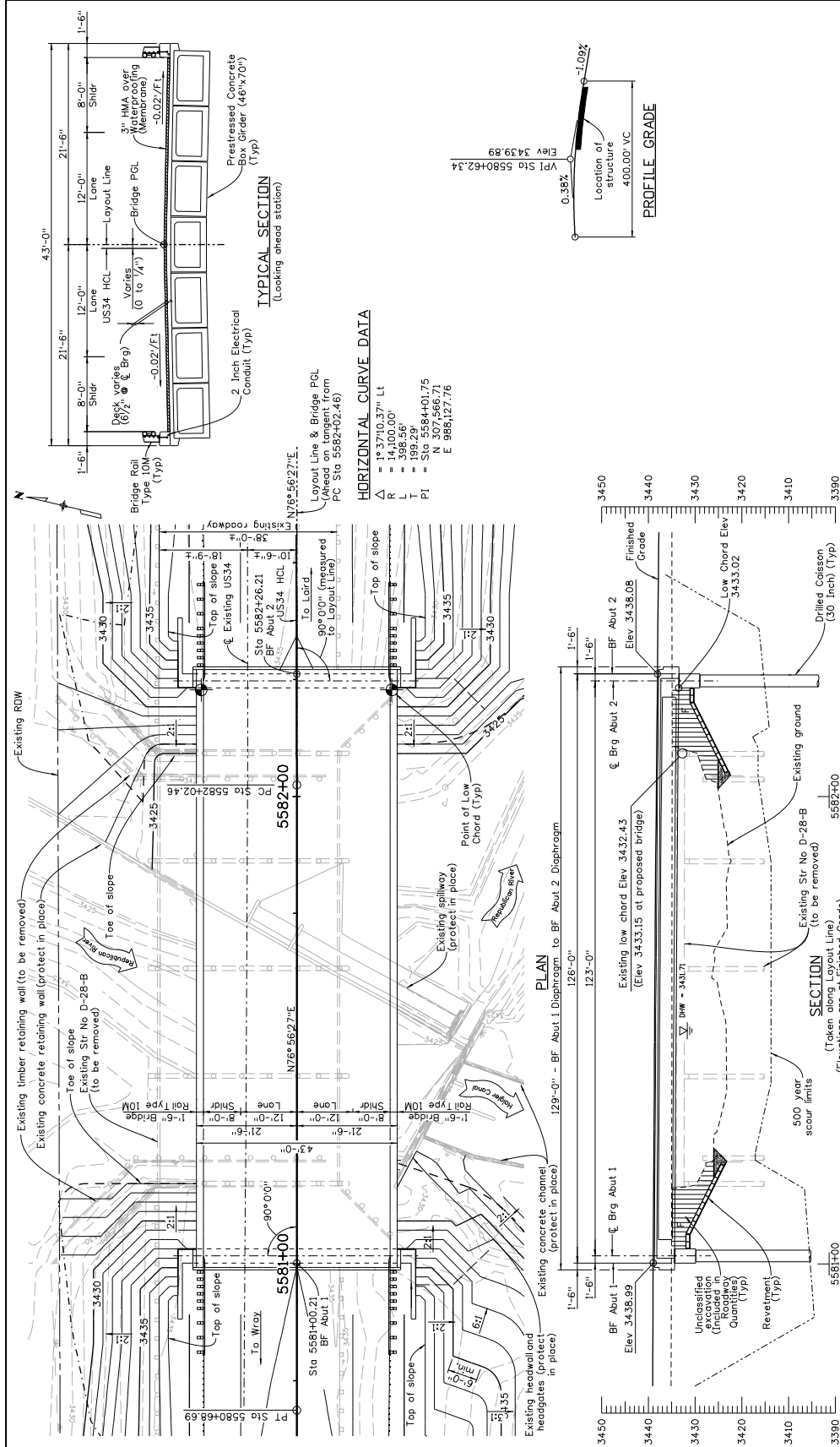


Figure 6-1 Example 1

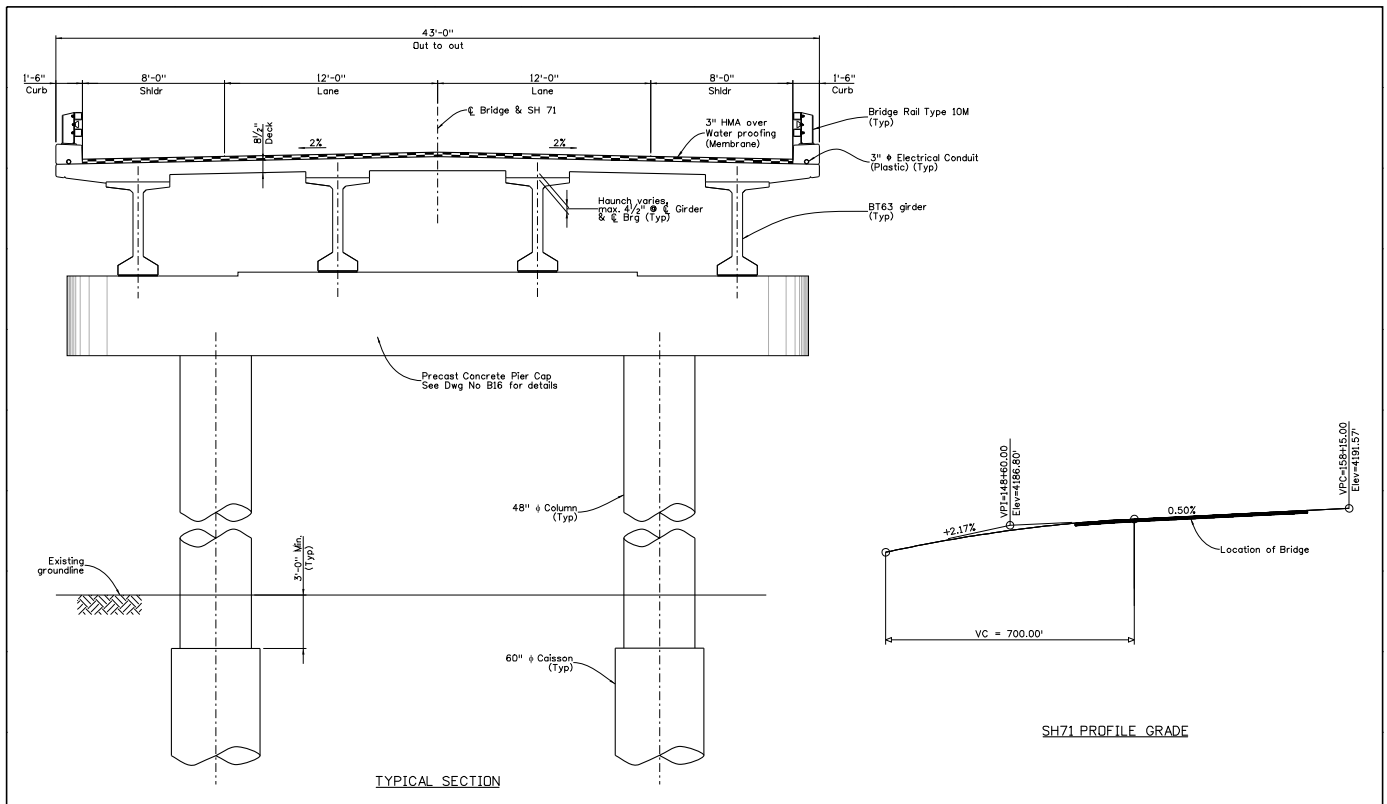
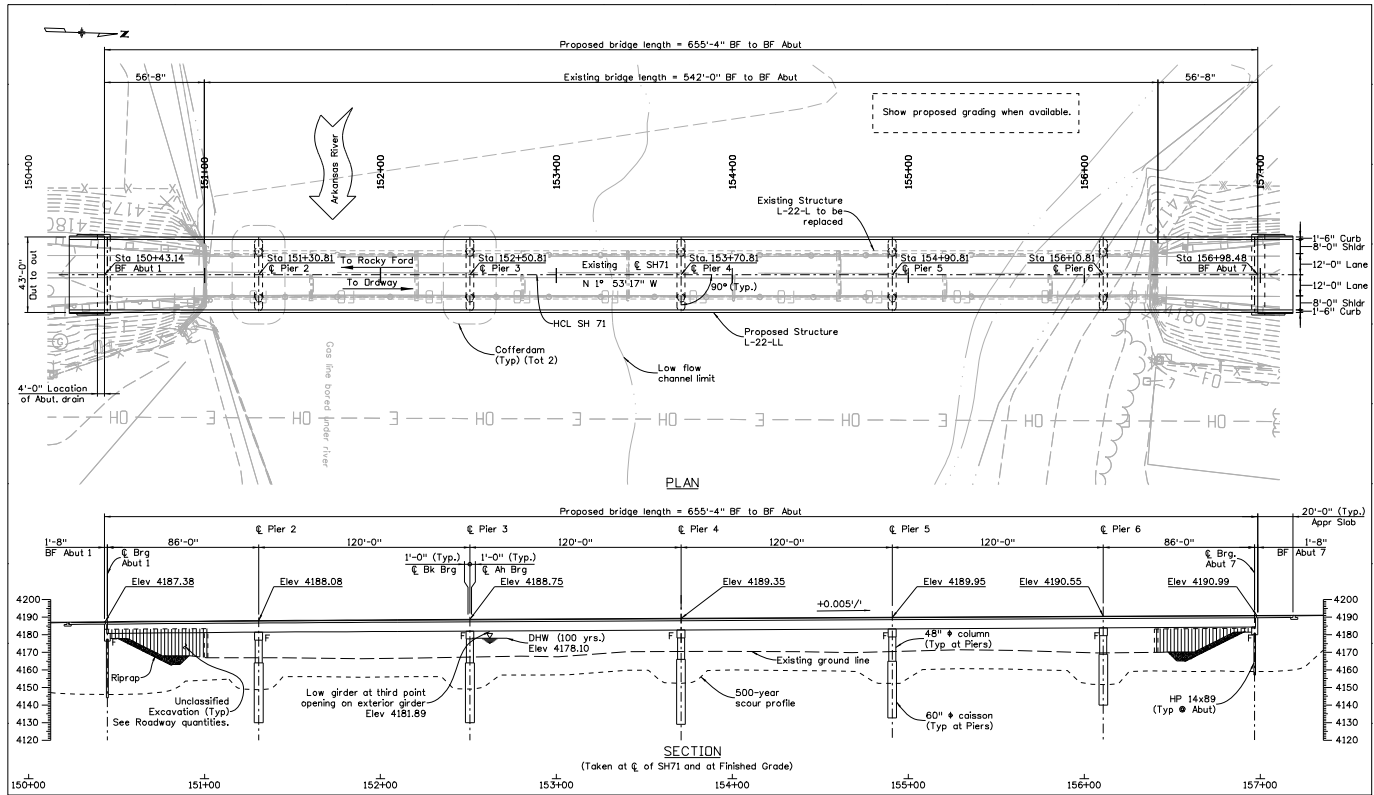


Figure 6-2 Example 2

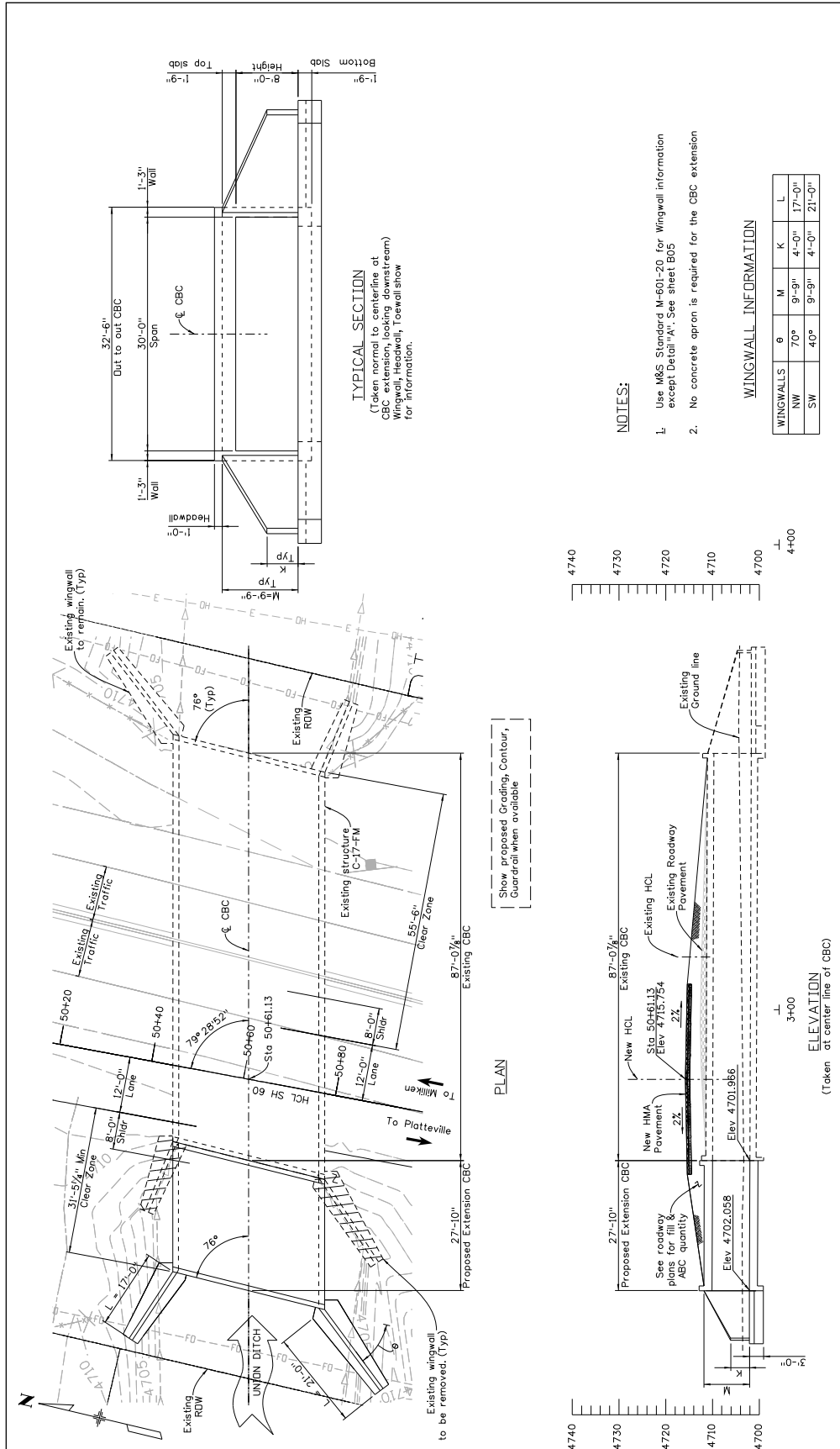
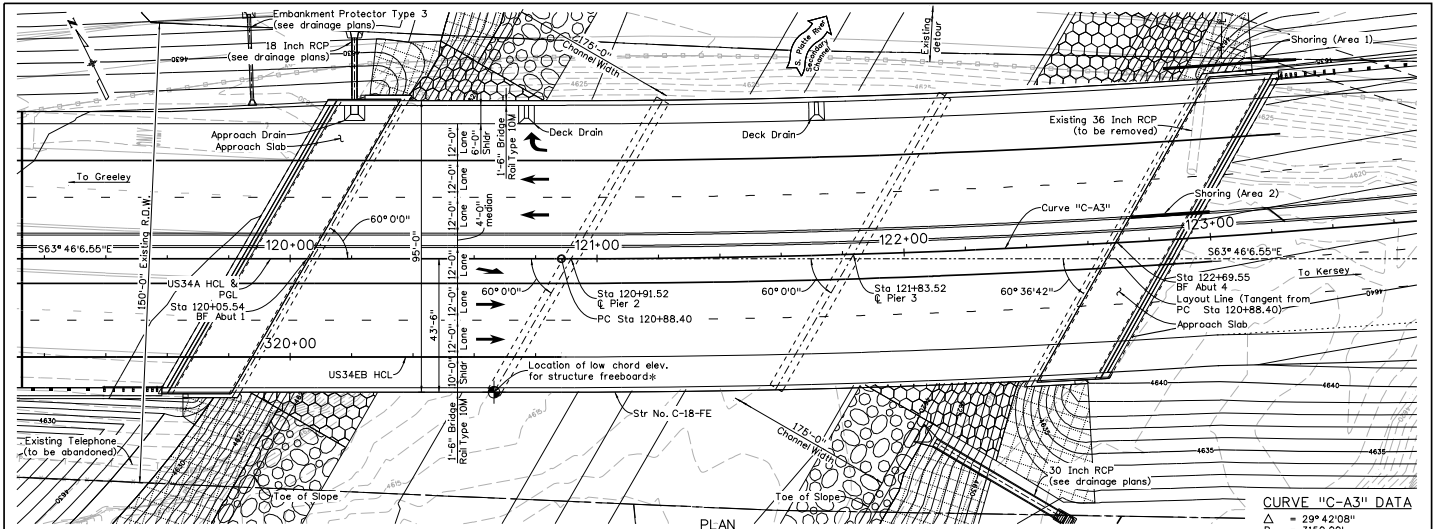
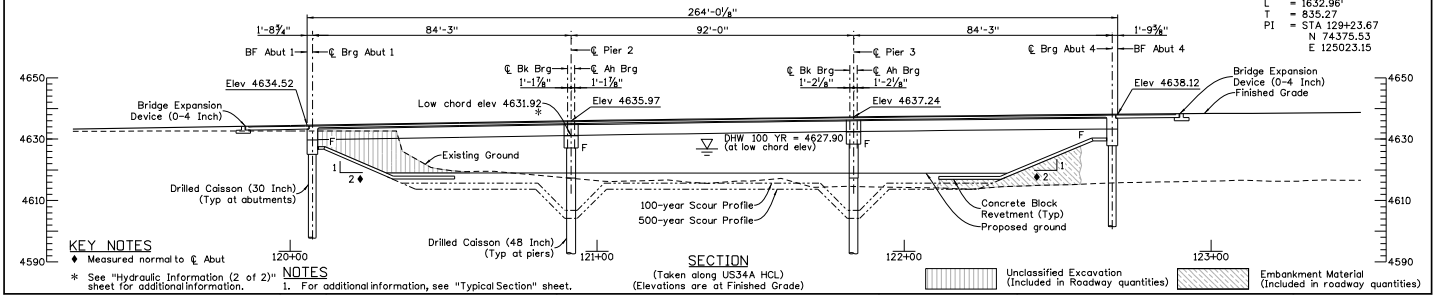


Figure 6-3 Example 3



CURVE "C-A3" DATA

Δ	= 29° 42' 08"
R	= 3150.00'
L	= 1632.96'
T	= 835.27'
PI	= STA 129+23.67
	N 74375.53
	E 125023.15



KEY NOTES

Measured normal to ϵ Abut

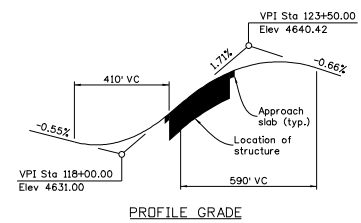
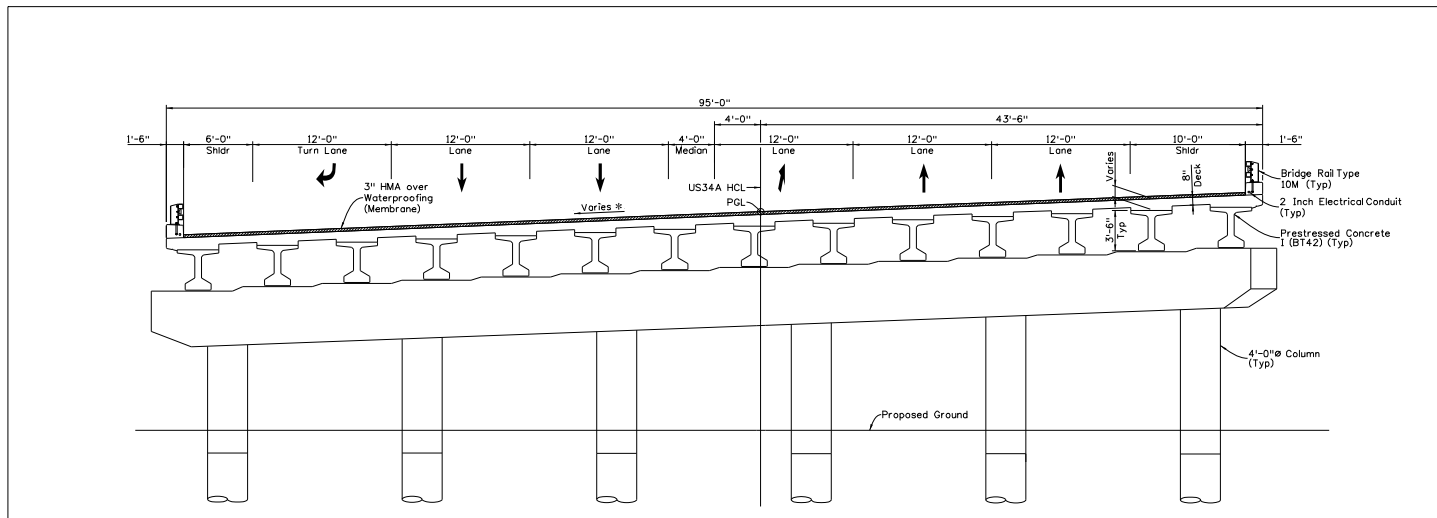
* See "Hydraulic Information (2 of 2)" sheet for additional information.

NOTES

1. For additional information, see "Typical Section" sheet.

Unclassified Excavation (Included in Roadway quantities)

Embankment Material (Included in roadway quantities)



SUPERELEVATIONS

US34A HCL *

STATION	SUPERELEVATION
118+81.40	0% 0%
122+26.40	-6.00% +6.00%
135+83.36	-6.00% +6.00%

Figure 6-4 Example 4

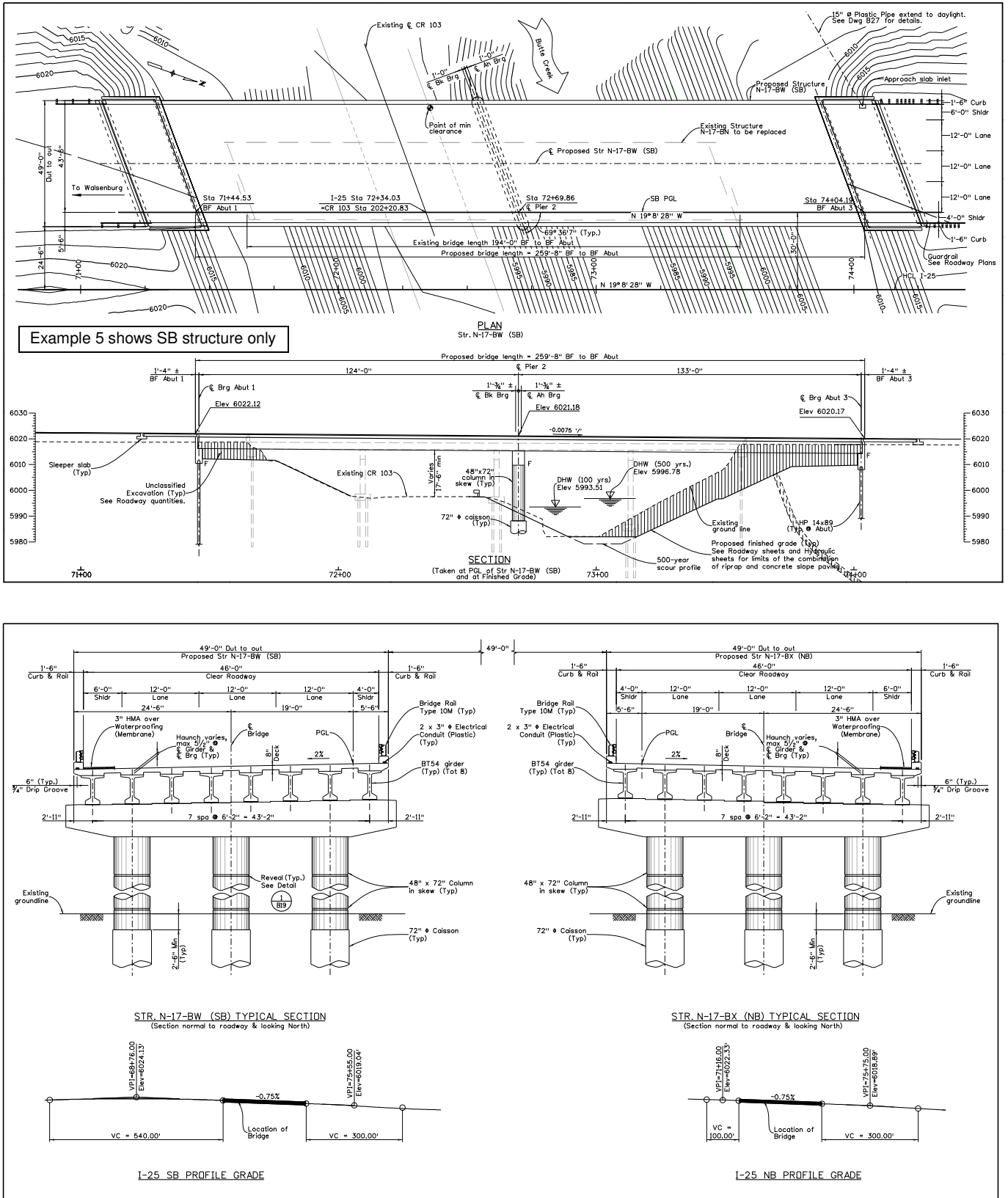


Figure 6-5 Example 5

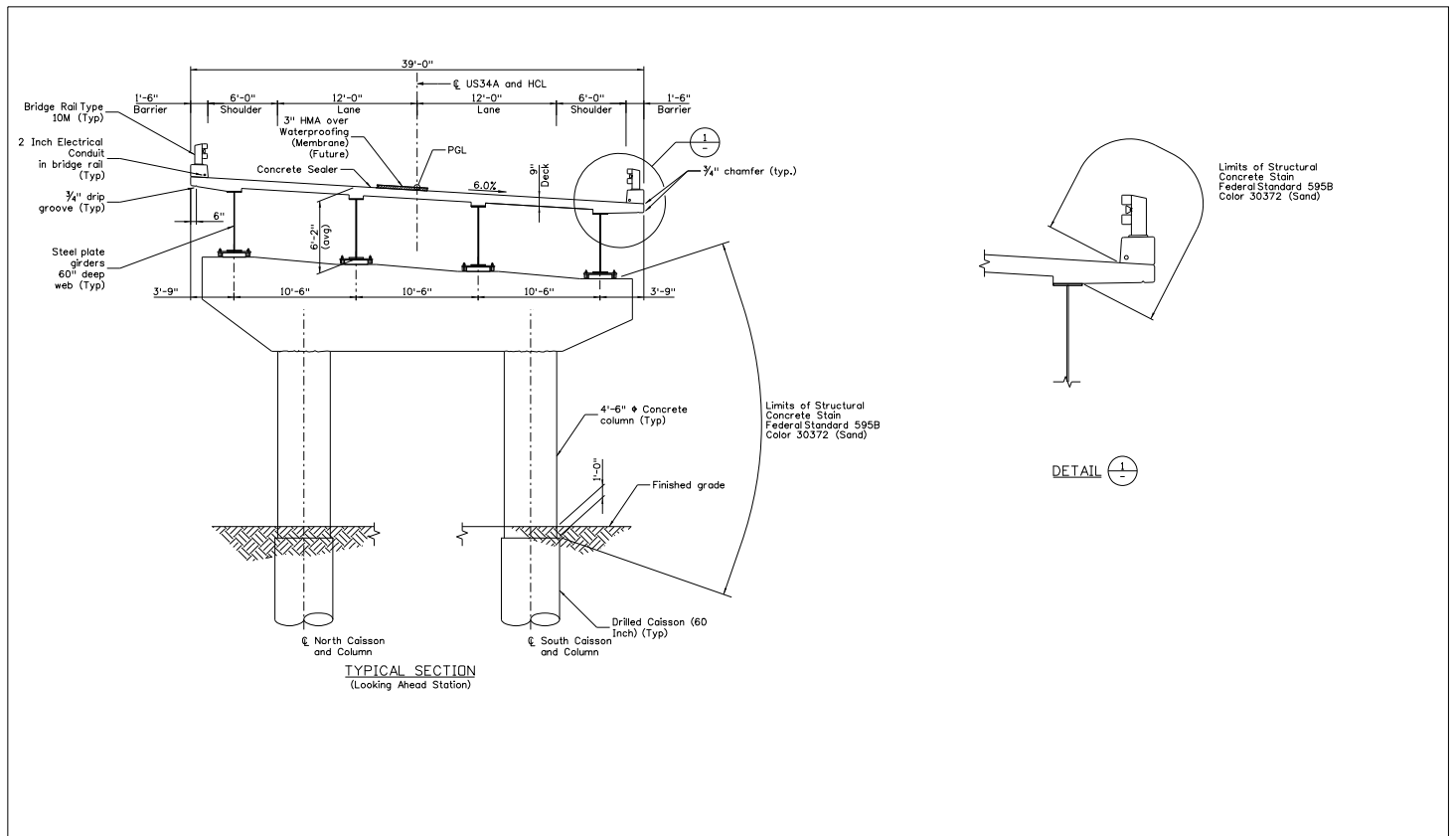
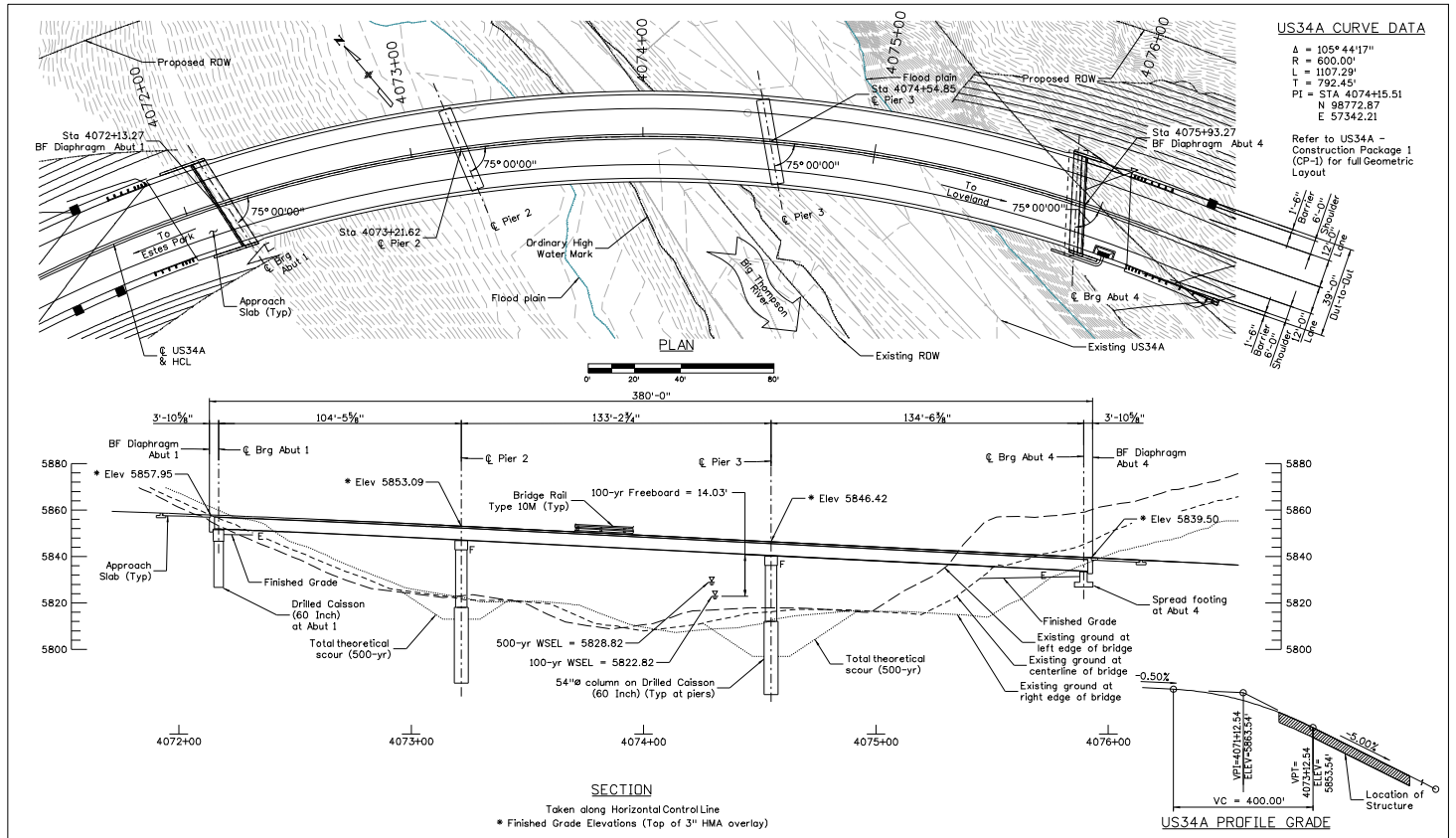


Figure 6-6 Example 6

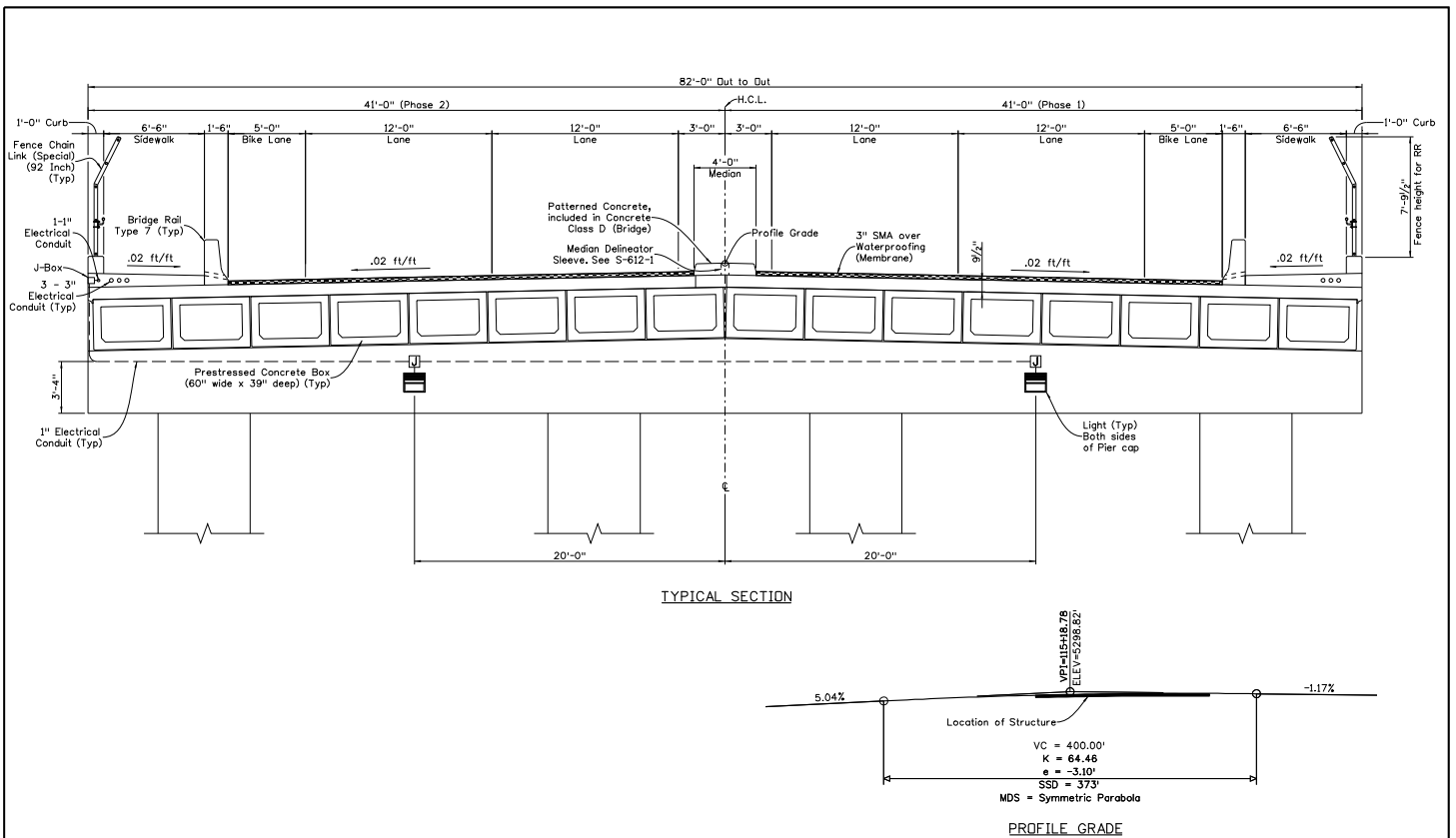
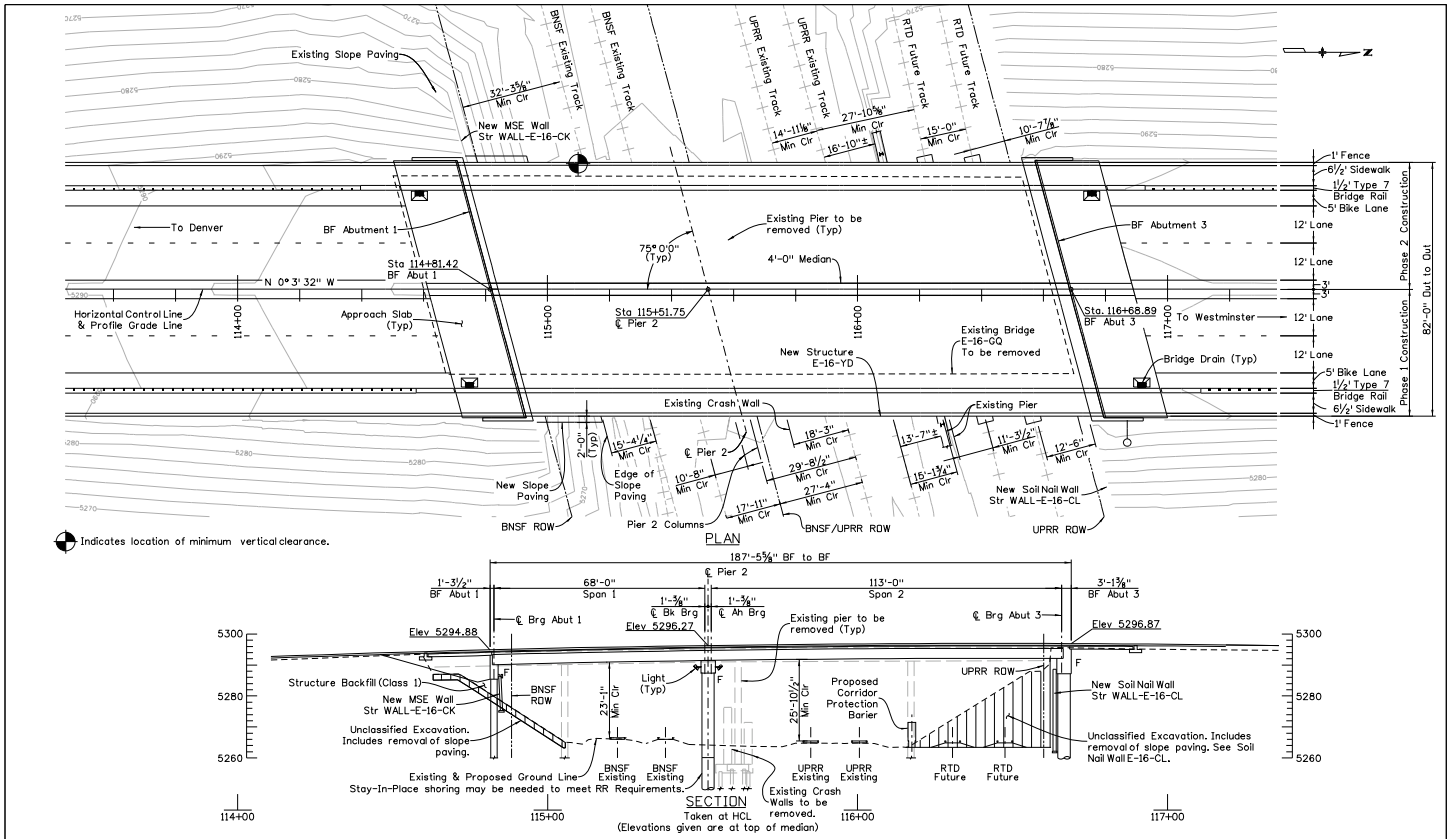


Figure 6-7 Example 7

COLORADO DEPARTMENT OF TRANSPORTATION STAFF BRIDGE BRIDGE DETAIL MANUAL	Chapter: 7 Effective: October 11, 2023 Supersedes: April 12, 2000
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

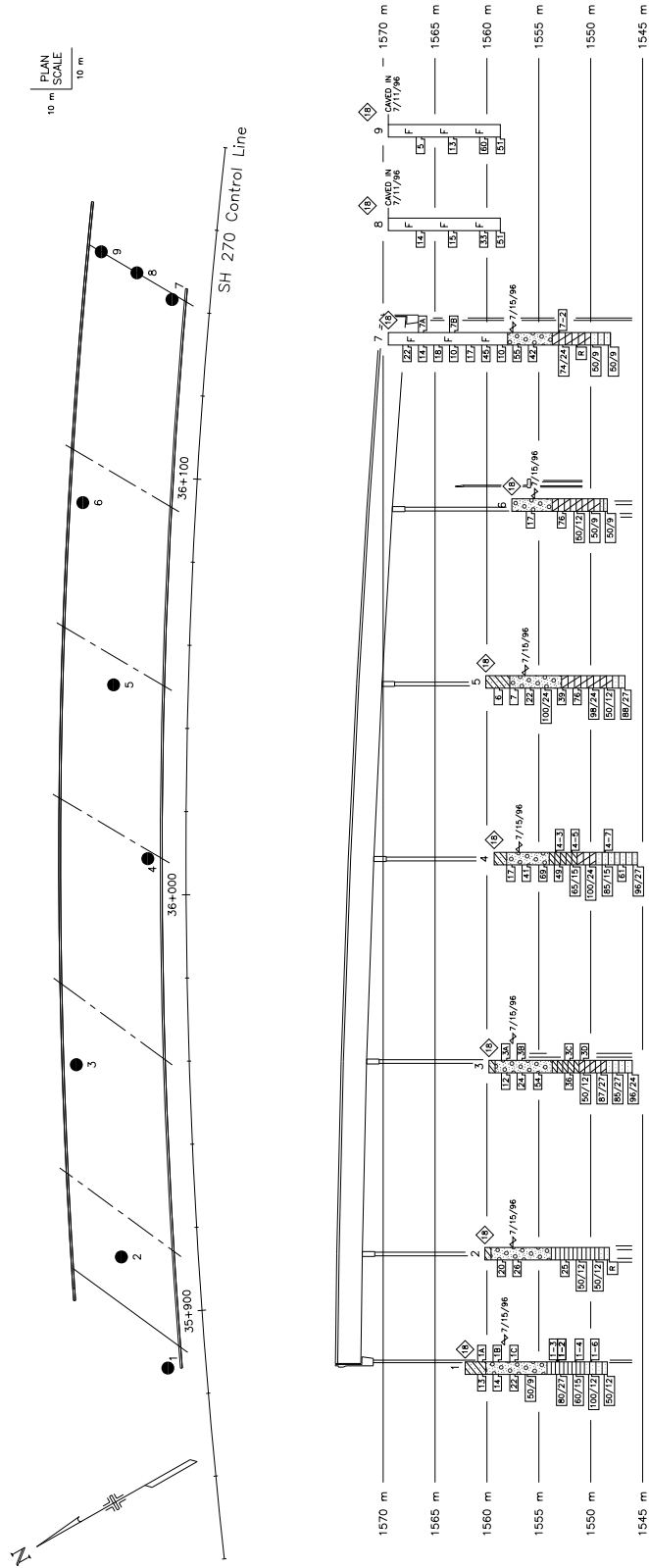
Listed below are items that must be checked to see that they appear on the drawing.

- 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	Sample Depth (Meters)										Number of Tests	Average		
			1	2	3	4	5	6	7	8	9	10				
1A	1.2-1.7	Sandy Clay	4	4	28	14	47	20	27	9.2						
1B	2.7-3.2	Sand	7	33	56	4	NV	NP	NP	1.6						
1C	4.3-4.7	Silty Sand	34	35	18	NV	NP	NP	NP	0.0						
1D	5.3-5.7	Gravelly Sand	24	37	33	6	NV	NP	NP	14.4						
1E	6.3-6.7	Sandy Clay	0	3	21	78	45	23	22	20.1						
1F	7.3-7.8	Sandy Clay	0	3	21	78	45	23	22	20.1						
1G	8.3-8.8	Sandy Clay	0	3	21	78	45	23	22	20.1						
1H	9.3-9.8	Sandy Clay	0	3	21	78	45	23	22	20.1						
1I	10.3-10.8	Sandy Clay	0	3	21	78	45	23	22	20.1						
1J	11.3-11.8	Sandy Clay	0	3	21	78	45	23	22	20.1						
1K	12.3-12.8	Sandy Clay	0	3	21	78	45	23	22	20.1						
1L	13.3-13.8	Sandy Clay	0	3	21	78	45	23	22	20.1						
1M	14.3-14.8	Sandy Clay	0	3	21	78	45	23	22	20.1						
1N	15.3-15.8	Sandy Clay	0	3	21	78	45	23	22	20.1						
1O	16.3-16.8	Sandy Clay	0	3	21	78	45	23	22	20.1						

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

TEST BORING

Blows per 0.30 m (10 in) = $\frac{N}{10}$

50 mm Diameter Bore Point
6.75 m Free Fall
63.5 kg Hammer

Blows Per 0.30 m

LEGEND

● Location of Test Boring
○ Location of Continuous Penetration Test
□ 75 mm Wireline Boring
◇ Rotary Boring
◇ Auger Boring

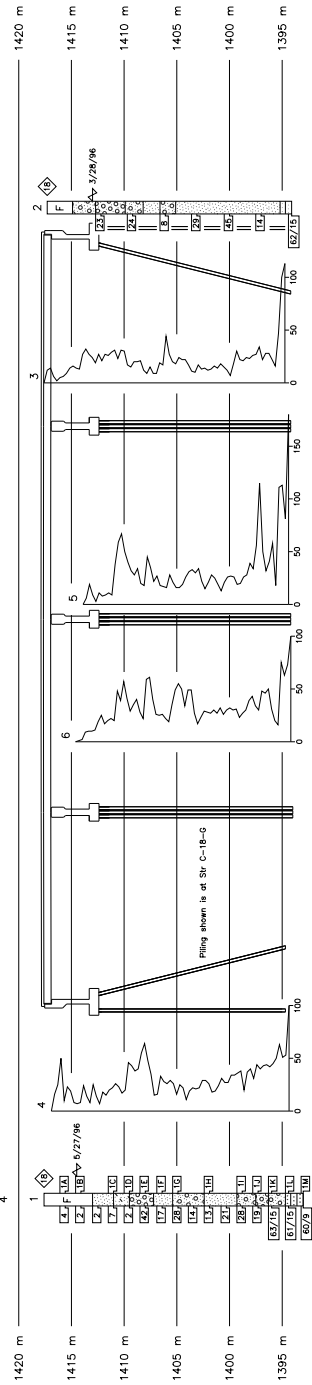
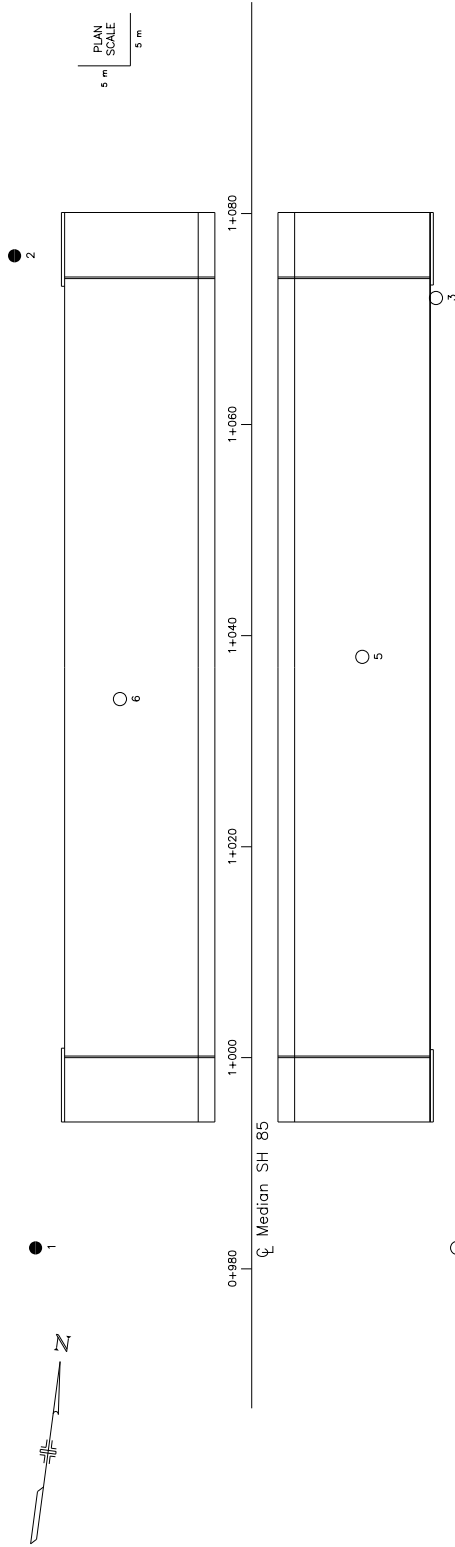
TYPE OF MATERIAL

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

CONTINUOUS PENETRATION TEST

Standard Test (ASTM D 2081-74)

Example 7-1



The boring logs of the above test holes are on file in the Geotechnical Section Office, Staff Materials Branch, (030757-9274)

SUMMARY OF TEST RESULTS		TYPE OF MATERIAL	
Sample Number	Depth (meters)	Classification	Material
1	1.2-2.0	Silty Gravelly Sand	Gravelly Silty Sand
2	2.2-3.5	Gravelly Sand	Levee Material - Gravelly Silty Sand
3	3.7-4.8	Silty Gravel	Cloyey Silty Sand
4	5.1-6.6	Gravelly Sand	Sand
5	7.2-12.7	Gravelly Sand	Gravelly Sand, Silty Gravelly Sand
6	18.2-20.3	Silty Gravelly Sand	Sandy Gravel
7	21.2-23.2	Silty Gravelly Sand	Silty Sandstone
8	24.2-26.8	Clay	Silty Sandstone

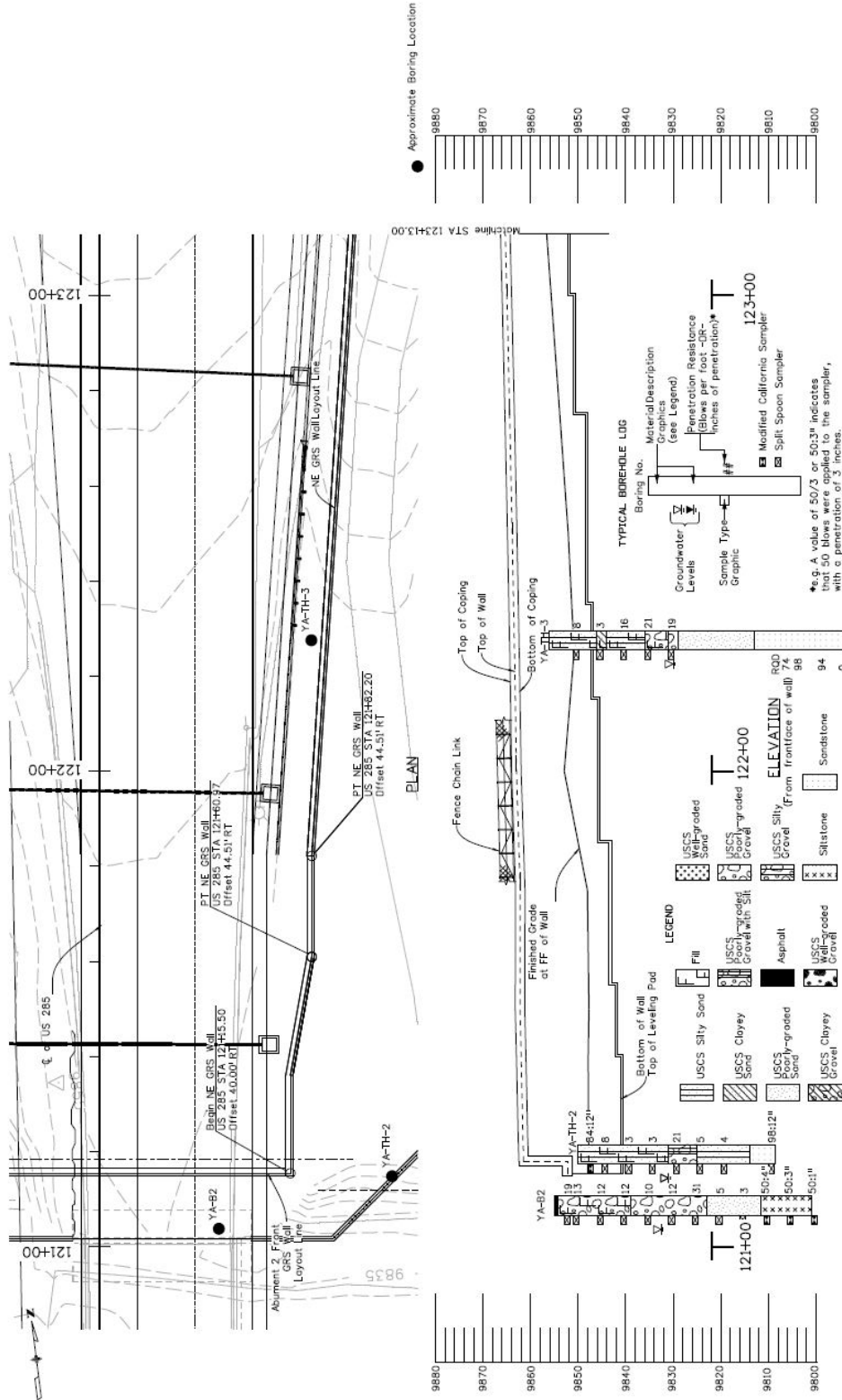
Sample No.	Depth (m)	ASTM			ASTM			ASTM			Notes
		100	200	300	100	200	300	100	200	300	
1	1.2-2.0	100	100	100	100	100	100	100	100	100	100
2	2.2-3.5	100	100	100	100	100	100	100	100	100	100
3	3.7-4.8	100	100	100	100	100	100	100	100	100	100
4	5.1-6.6	100	100	100	100	100	100	100	100	100	100
5	7.2-12.7	100	100	100	100	100	100	100	100	100	100
6	18.2-20.3	100	100	100	100	100	100	100	100	100	100
7	21.2-23.2	100	100	100	100	100	100	100	100	100	100
8	24.2-26.8	100	100	100	100	100	100	100	100	100	100

TEST BORING
 Blows per 0.30 m (1 ft) = Refusal
 R = Refusal
 50 Blows in 2 cm
 Core Recovery R.O.B. (%)

CONTINUOUS PENETRATION TEST
 50 mm Diameter Drive Point
 63.5 kg Hammer
 76 mm Wireline Boring
 Rotary Boring
 Auger Boring

LEGEND
 Location of Test Boring
 Location of Continuous Penetration Test
 76 mm Wireline Boring
 Rotary Boring
 Auger Boring

Example 7-2



Example 7-3

COLORADO DEPARTMENT OF TRANSPORTATION STAFF BRIDGE BRIDGE DETAIL MANUAL	Chapter: 8 Effective: October 11, 2023 Supersedes: May 25, 2000
BRIDGE HYDRAULIC INFORMATION	

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

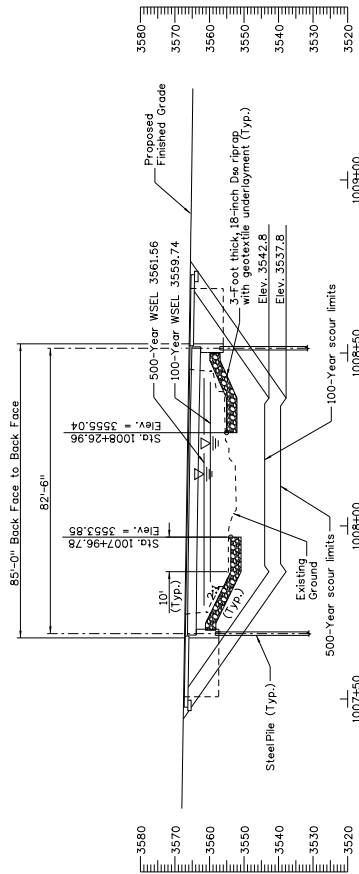
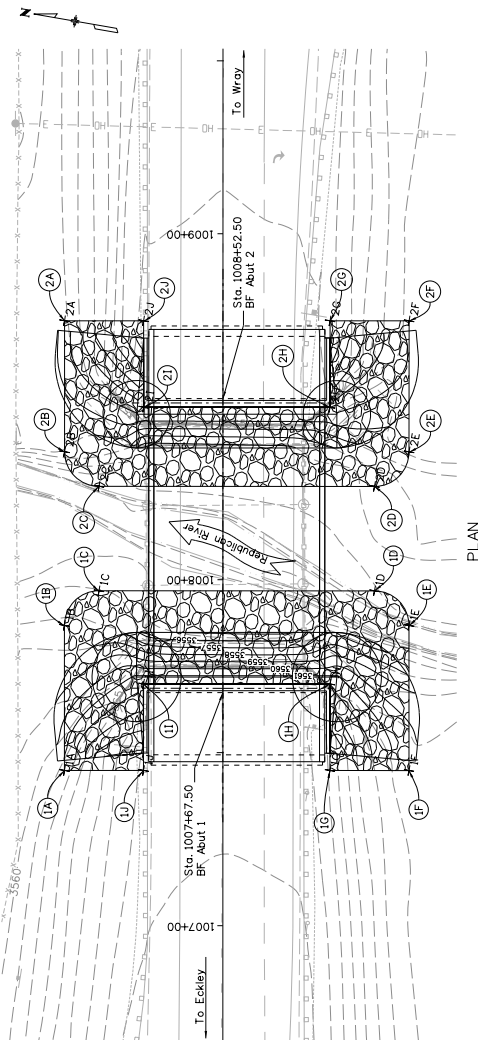
There may be instances when additional details are required, such as bank protection, channel changes, etc. If possible, these details should be shown on this drawing; however, if additional drawings are required, they should directly follow the "BRIDGE HYDRAULIC INFORMATION" drawing.

TABLE OF RIPRAP LOCATIONS

Position Label (X)	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	3905466.255
1I	1287015.190	3905459.121
1J	1287010.967	3905434.488
2A	1287055.523	3905556.723
2B	1287049.115	3905521.403
2C	1287037.567	3905513.239
2D	1286958.949	3905526.738
2E	1286950.785	3905536.286
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

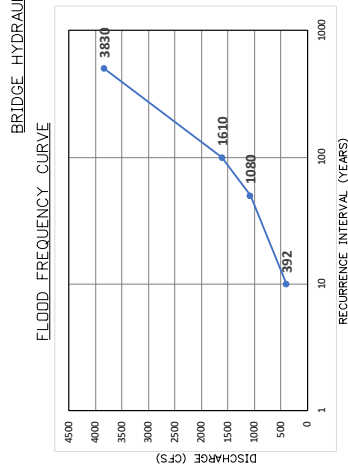
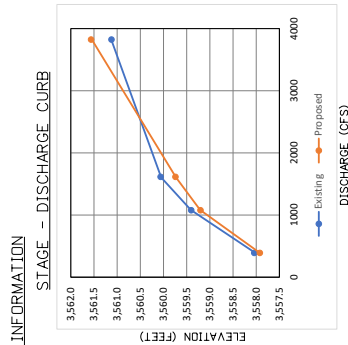
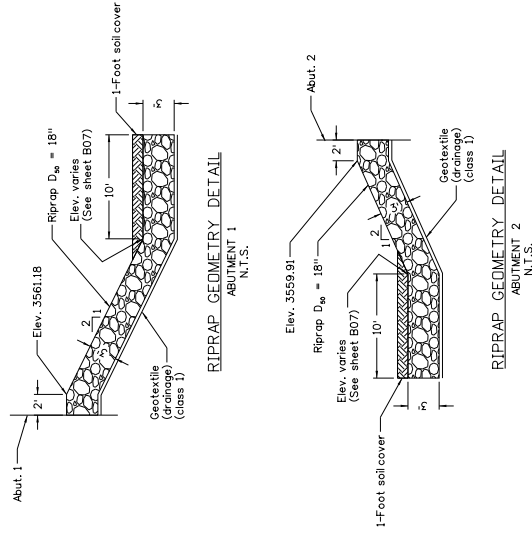
- All riprap slopes are 2:1 (perpendicular to abutment).
- The contractor is responsible for any and all cost associated with the installation of the riprap, including, but not limited to, dewatering. The cost for the dewatering is to be included or paid for separately but included in the cost of riprap.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



ELEVATION

* Elevations shown of finished grade (taken at HCL US 34)

Example 8-1



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

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
NOTE: WSEL FROM LOCATION OF MAXIMUM BACKWATER

SCOUR ANALYSIS RESULTS

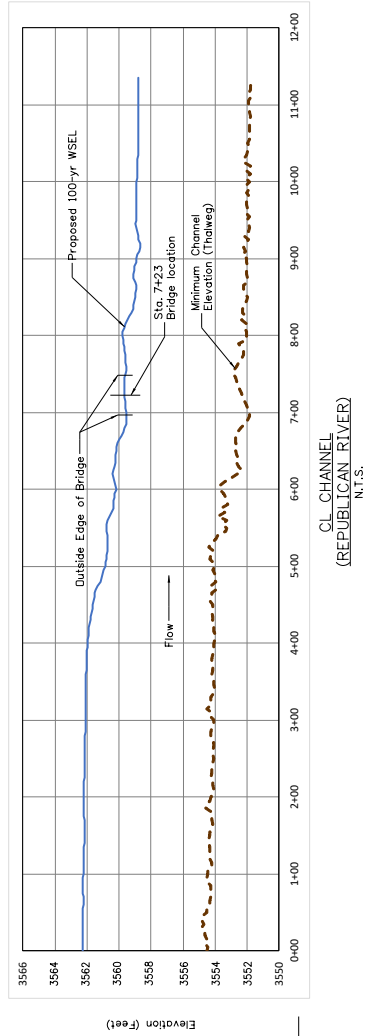
TYPE	DEPTH (FT)	
	100-YEAR	500-YEAR
CONTRACTION SCOUR	7.7	12.3
ABUTMENT SCOUR	8.9	13.9
TOTAL SCOUR	8.9	13.9
SCOUR ELEV. (NAVD-88)	3542.8	3537.8

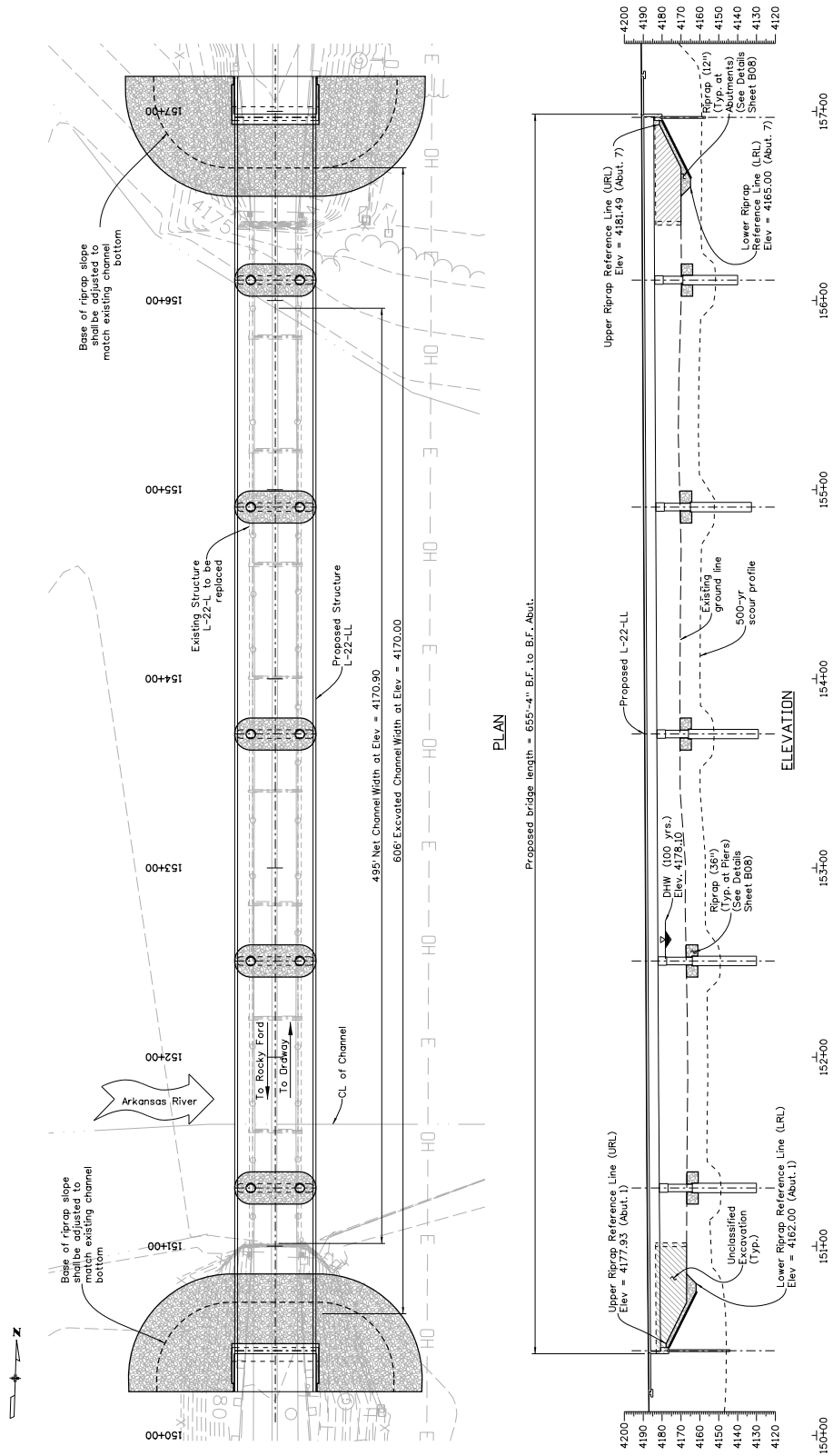
100-YEAR RECURRENCE INTERVAL

FLOW UPSTREAM OF BRIDGE = 1610 CFS
DRAINAGE AREA = 645 Sq Mi

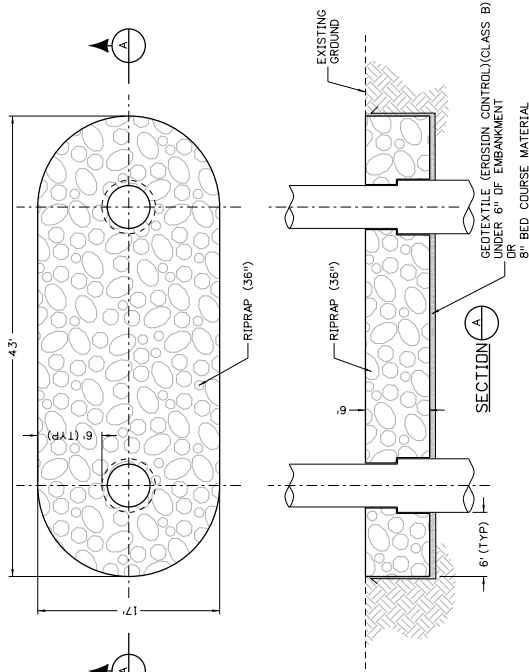
CHANNEL DESCRIPTION

BOTTOM MATERIAL SIZE: = CLAY SILT SAND GRAVEL COBBLES OTHER
 STREAM FORM: = STRAIGHT MEANDERING BRAIDED
 MANNINGS 'n' FOR DESIGN: CHANNEL 0.030 OVBANK 0.035
 DEBRIS POTENTIAL: LOW

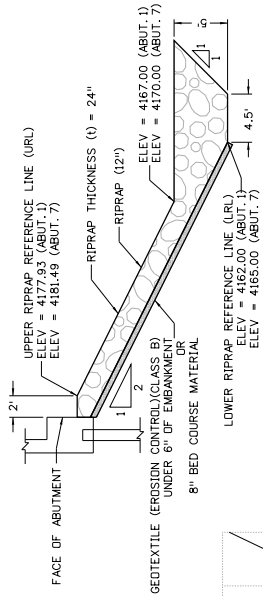




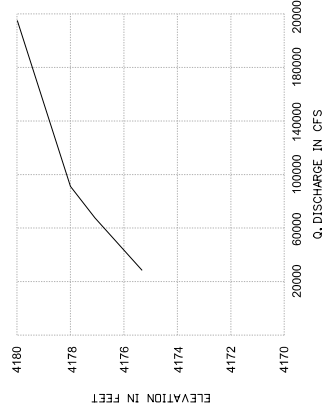
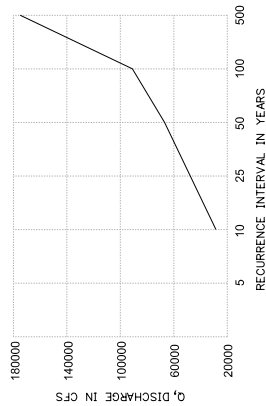
Example 8-3



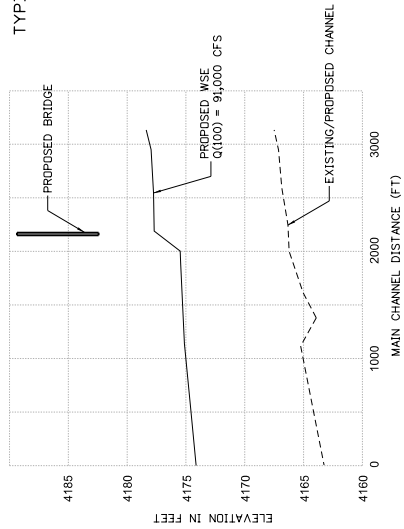
TYPICAL RIPRAP AT PIER DETAIL (NTS)



TYPICAL RIPRAP AT ABUTMENT DETAIL (NTS)



- Drainage Area = 11,500 square miles
- CHANNEL DESCRIPTION
- Bottom Material - Cohesive Non Cohesive
 - Bottom Material Size - Clay Silt Sand Gravel
 - Bottom Material Size - Cobbles Other
 - Debris - Brush Trees/Logs Ice Other



Example 8-4

COLORADO DEPARTMENT OF TRANSPORTATION STAFF BRIDGE BRIDGE DETAIL MANUAL	Chapter: 9 Effective: March 25, 2022 Supersedes: June 18, 2021
CONSTRUCTION LAYOUT	

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 crossslope 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 crossslopes 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's 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 $4\frac{1}{2}$ " 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%.

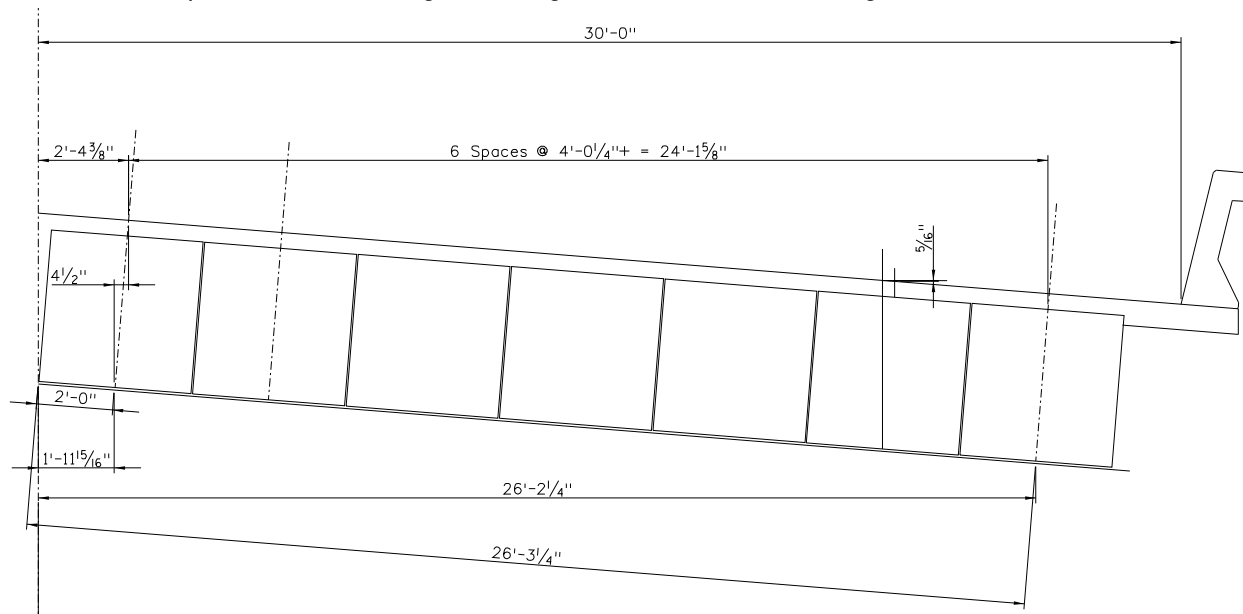


Figure 9.9-1

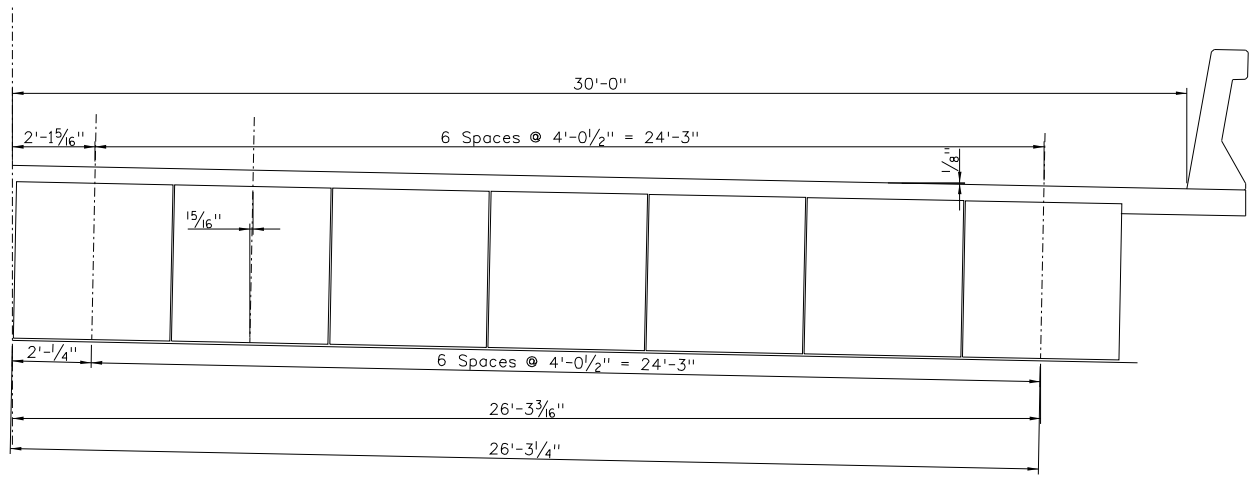


Figure 9.9-2

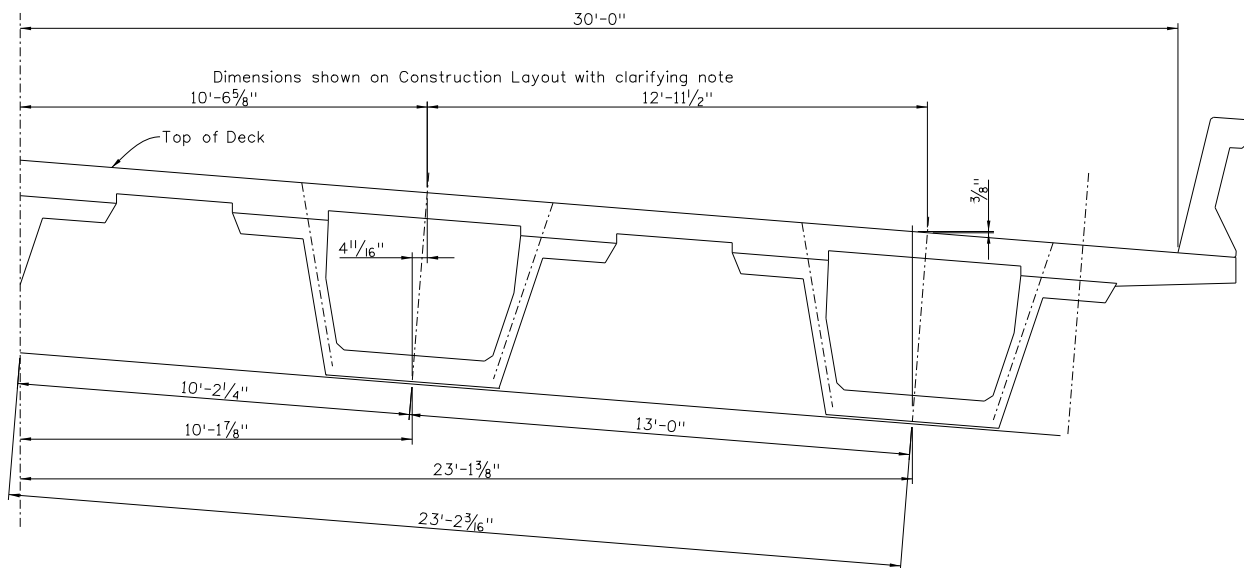


Figure 9.9-3

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
- F) All necessary dimensions
- G) Curb offsets
- H) All required angles
 - I) Electrical conduits & junction boxes
- J) Drains
- K) Title the plan "CONSTRUCTION LAYOUT". For plans with more than one structure, add the structure number to the title.
- L) Label back face of abutments, centerline of bearings and centerline of piers.
- M) Dimension widths of curbs and sidewalks
- N) Project number in proper locations.
- O) Typical notes
- P) Complete title block
- Q) Spacing and location of type 10 rail posts
- R) Spacing and location of fencing
- S) Label girders (see section 1.13 in Chapter 1 for naming convention)
- T) 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:

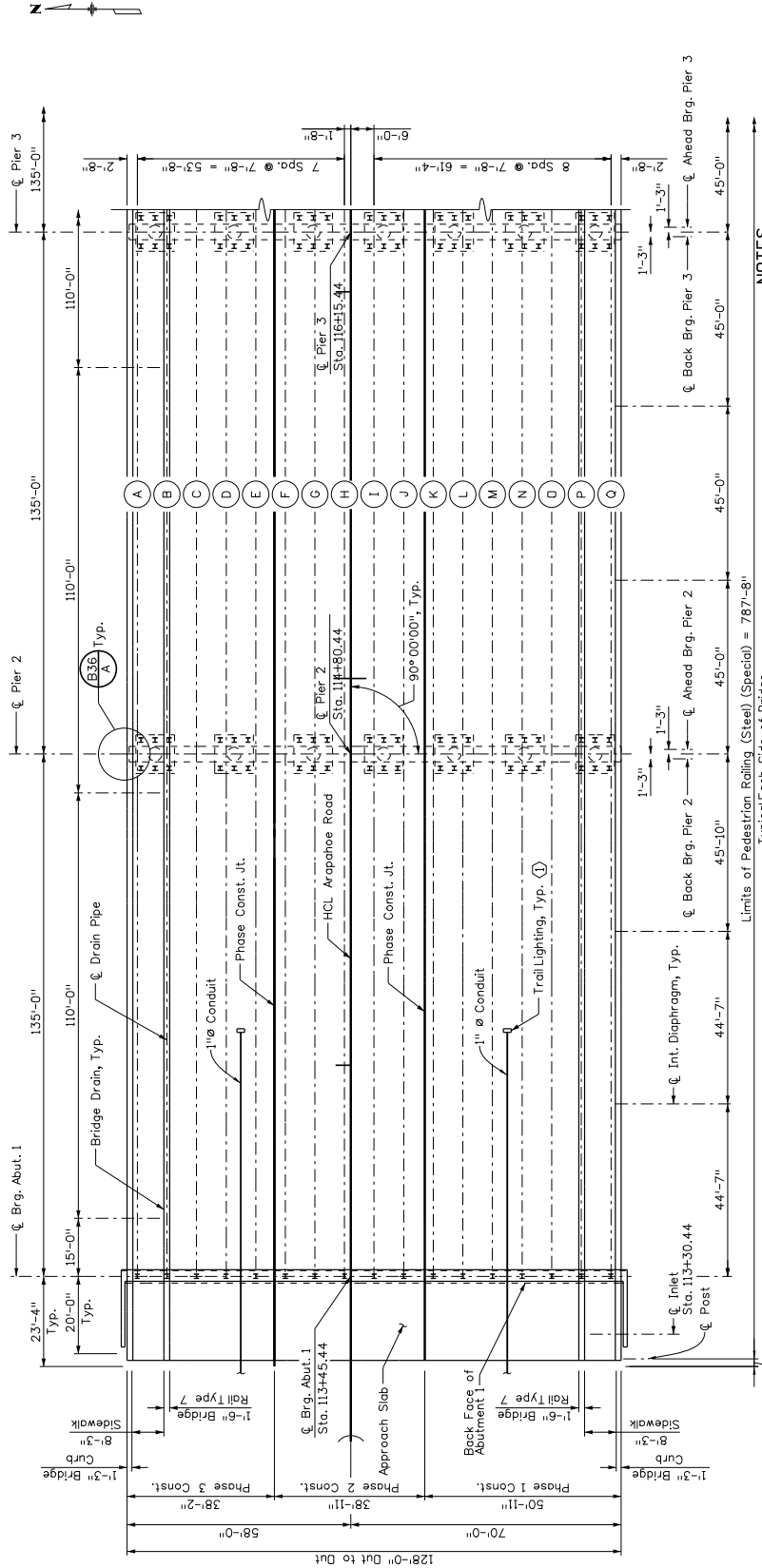
CONSTRUCTION LAYOUT

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.



- 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" Conduit in the interior barriers.
 - 1 - 3" Conduit in the exterior curbs.
 - 1" Conduit for street lights & trail lights
 - 3/4" Conduit for step lights
 6. For other size conduit used see quantity & payment on

KEY NOTES:

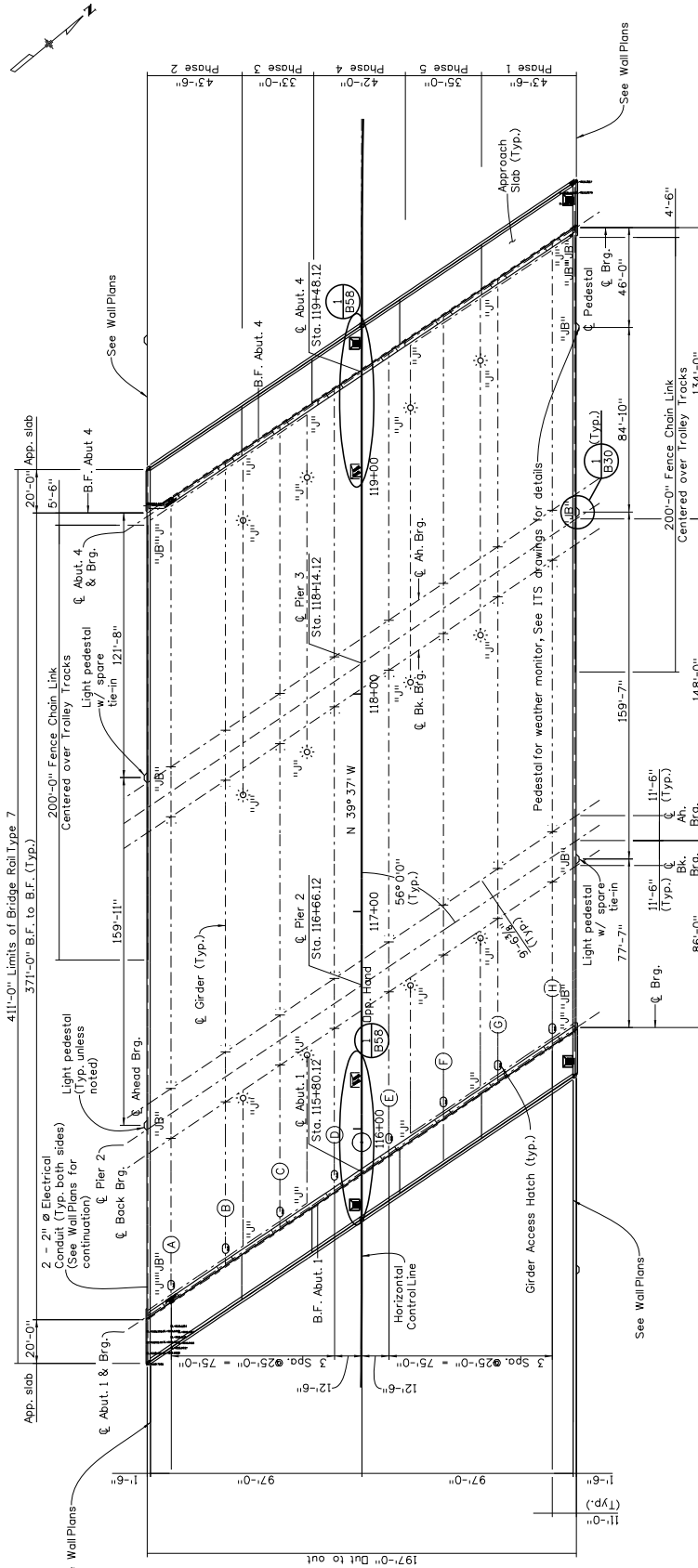
① For Path lighting under bridge deck, Contractor to coordinate lighting designer. For conduit sizes and length, see lighting plans.

SPAN 2

SPAN 1

CONSTRUCTION LAYOUT

Limits of Pedestrian Railing (Steel) (Special) = 787'-8"
Typical Each Side of Bridge

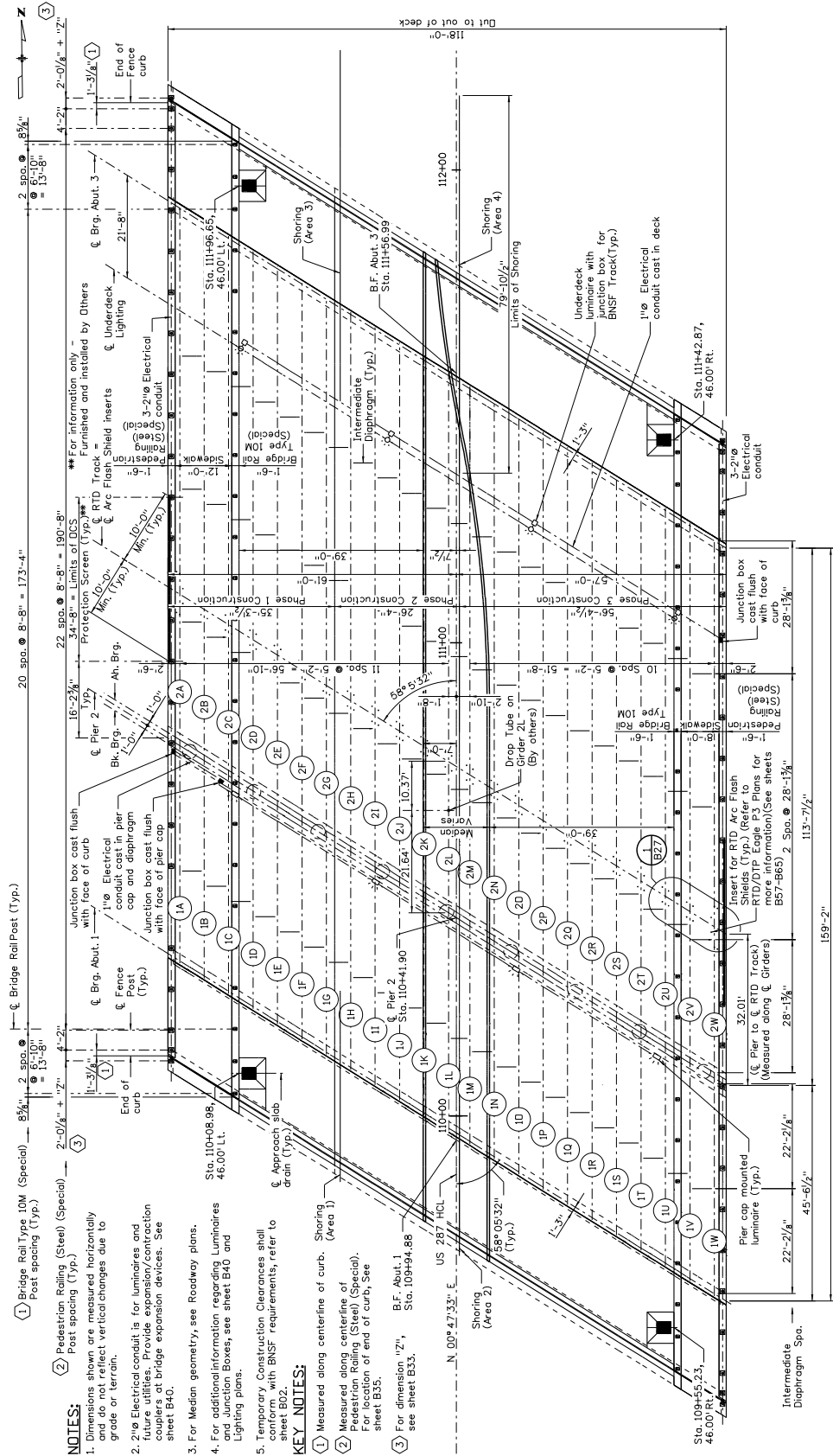


- Notes:**
1. All exposed Electric Conduit shall be Galvanized rigid metal.
 2. Junction box shall be flush to front face of Bridge Rail and provided with a water tight cover. Drain for interior condensation.
 3. For pull box information, see light pedestal drawings No B30 & B31.

CONSTRUCTION LAYOUT

⊙: Hidden Luminaire Location.
 See Lighting Plans for Details
 "J" = 6"x6"x4" Junction Box flush with bottom of slab. Drain for interior condensation.

"UB" = 8"x18"x8/2" Barrier Junction Box



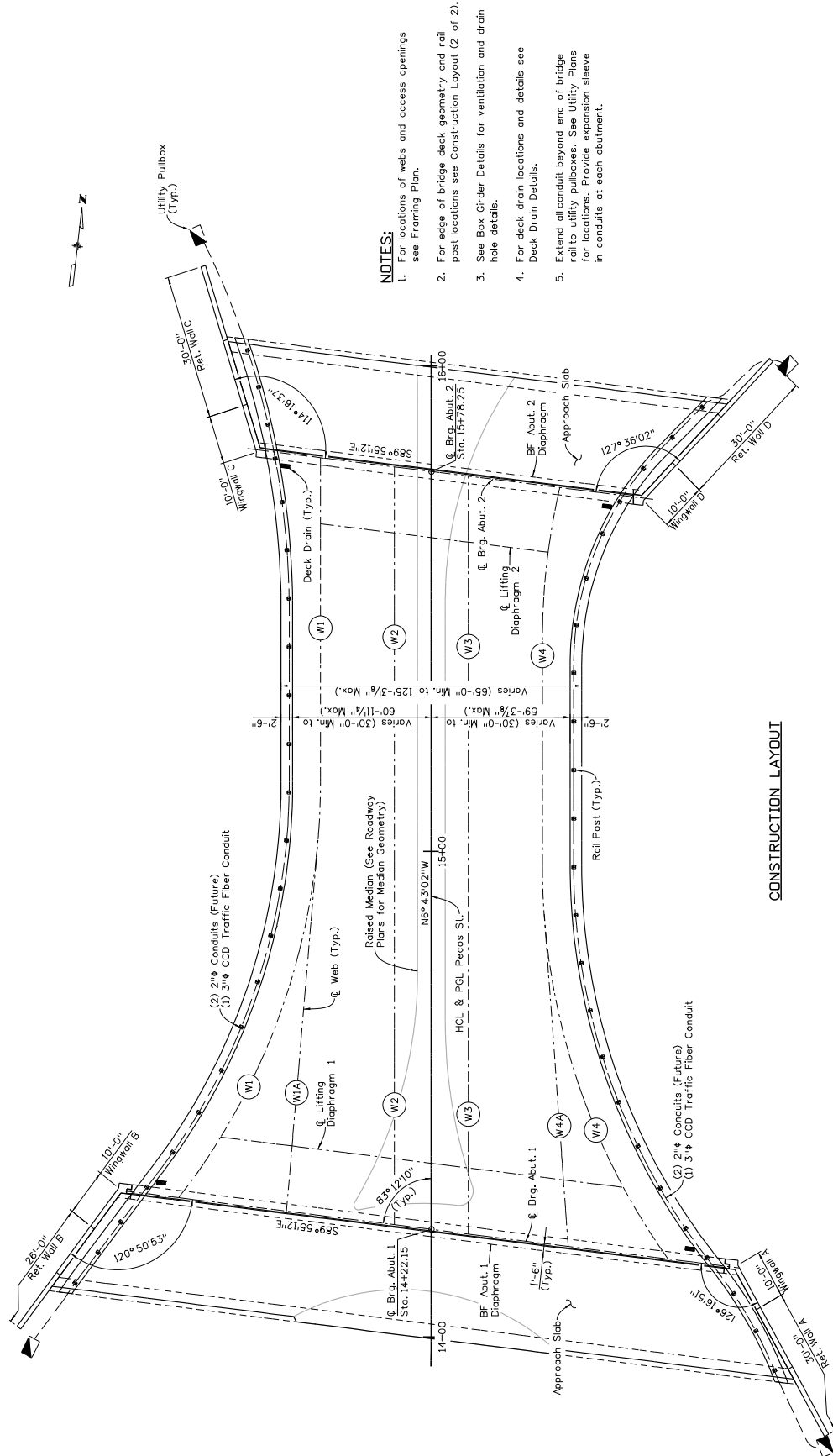
CONSTRUCTION LAYOUT

NOTES:

1. Dimensions shown are measured horizontally and do not reflect vertical changes due to grade or terrain.
2. 2" 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:

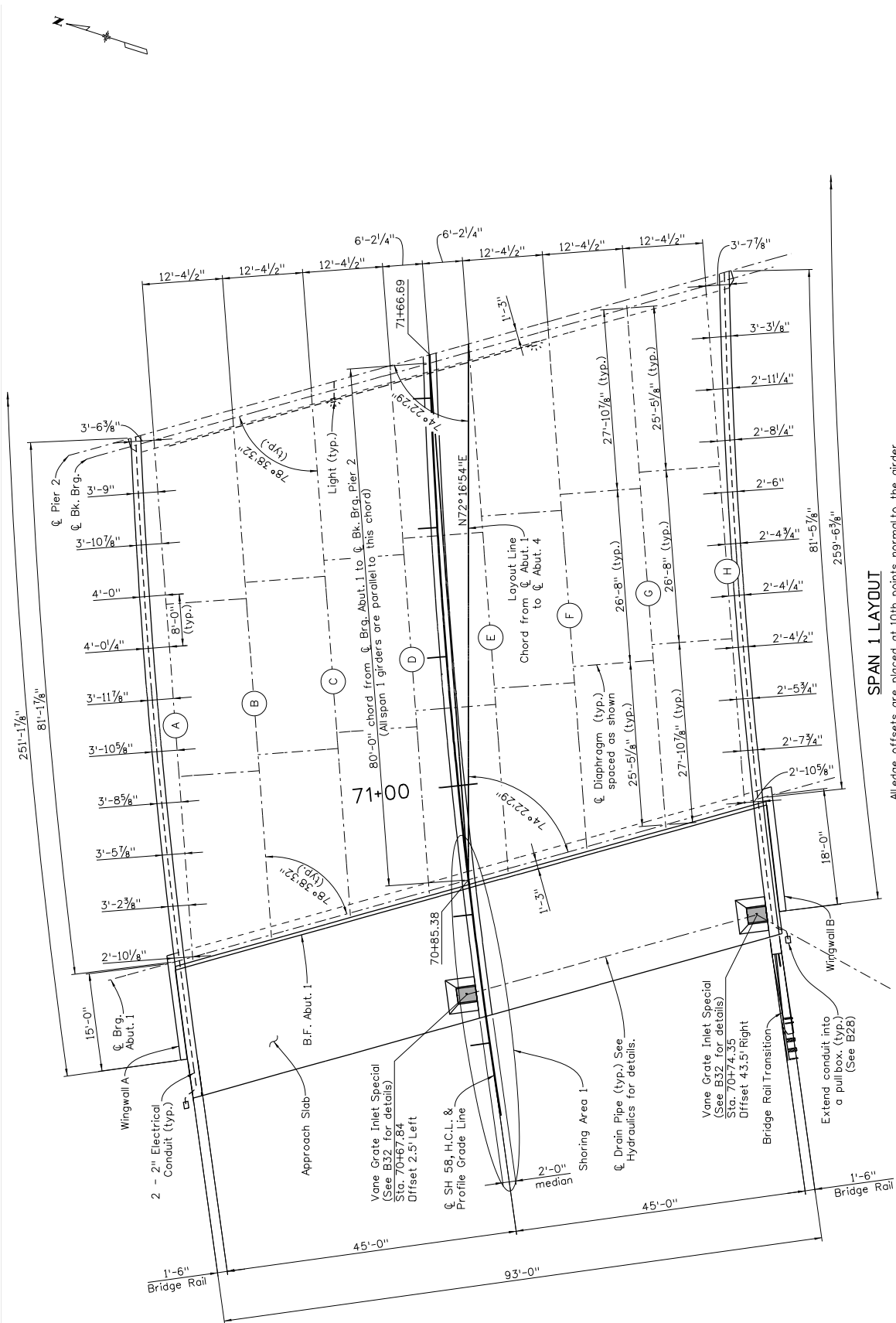
- (1) Measured along centerline of curb. Shoring (Area 1).
- (2) Measured along centerline of Pedestron Railing (Steel) (Special). For location of end of curb, See sheet B35.
- (3) For dimension "Z", B.F. Abut. 1 see sheet B33.



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 pulboxes. 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 C bearings.

COLORADO DEPARTMENT OF TRANSPORTATION STAFF BRIDGE BRIDGE DETAIL MANUAL	Chapter: 10 Effective: May 31, 2023 Supersedes: March 19, 2019
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 00° 00' 00" E. The "layout line" may be chord between two specified points.

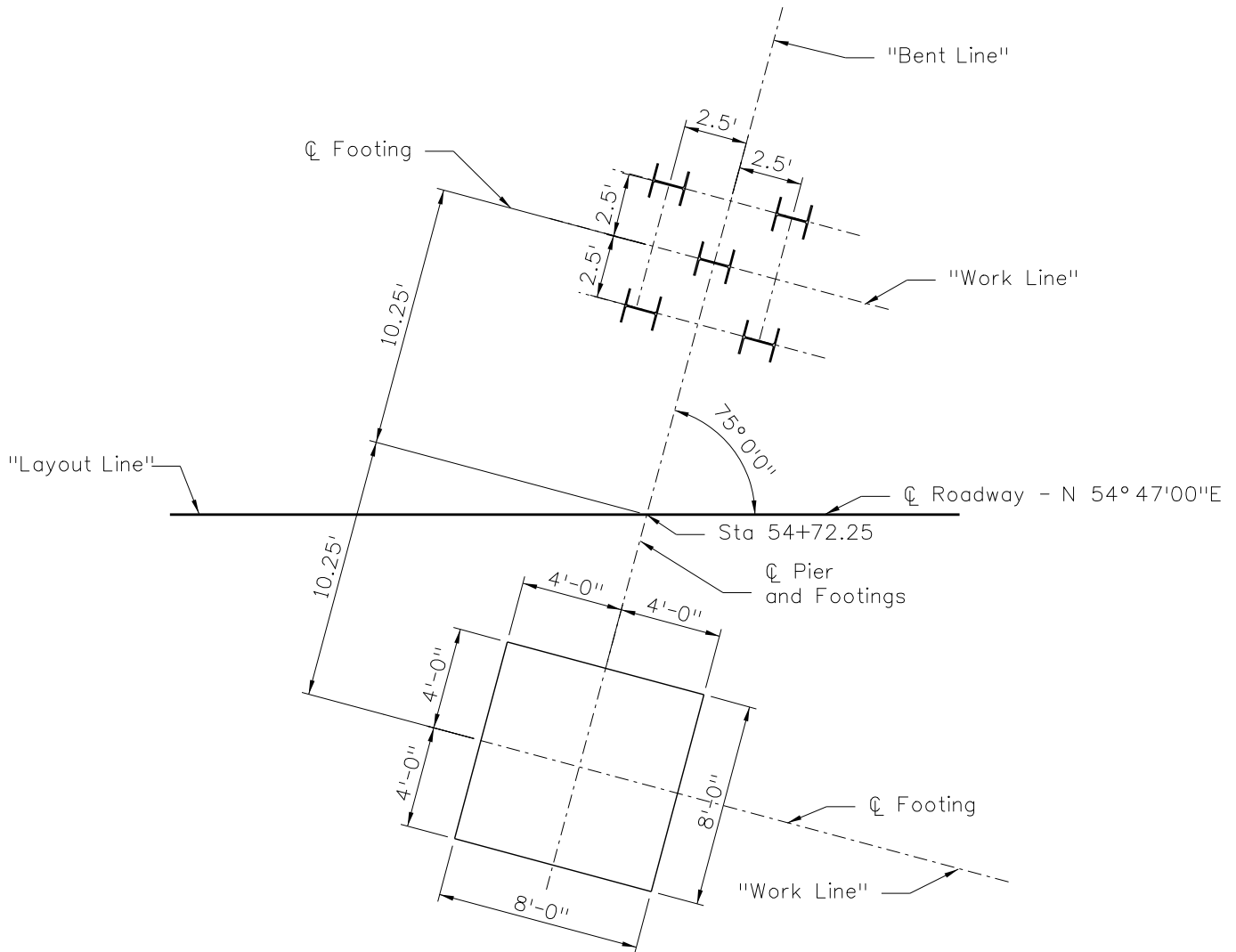


Fig. 10.5-1 Detail of Layout, Bent, and Work Lines

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.

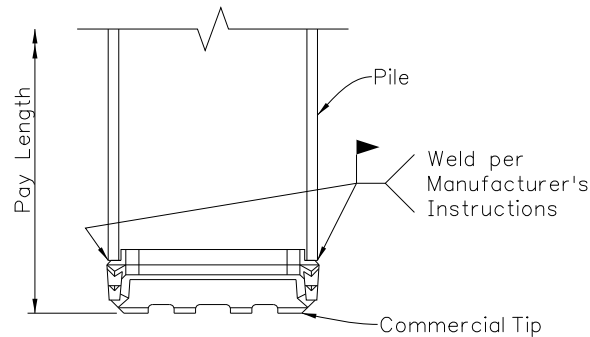
Refer to Figures 10.5-1 and 10-1 through 10-4 for other pertinent dimensions.

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))



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.

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.

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- (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

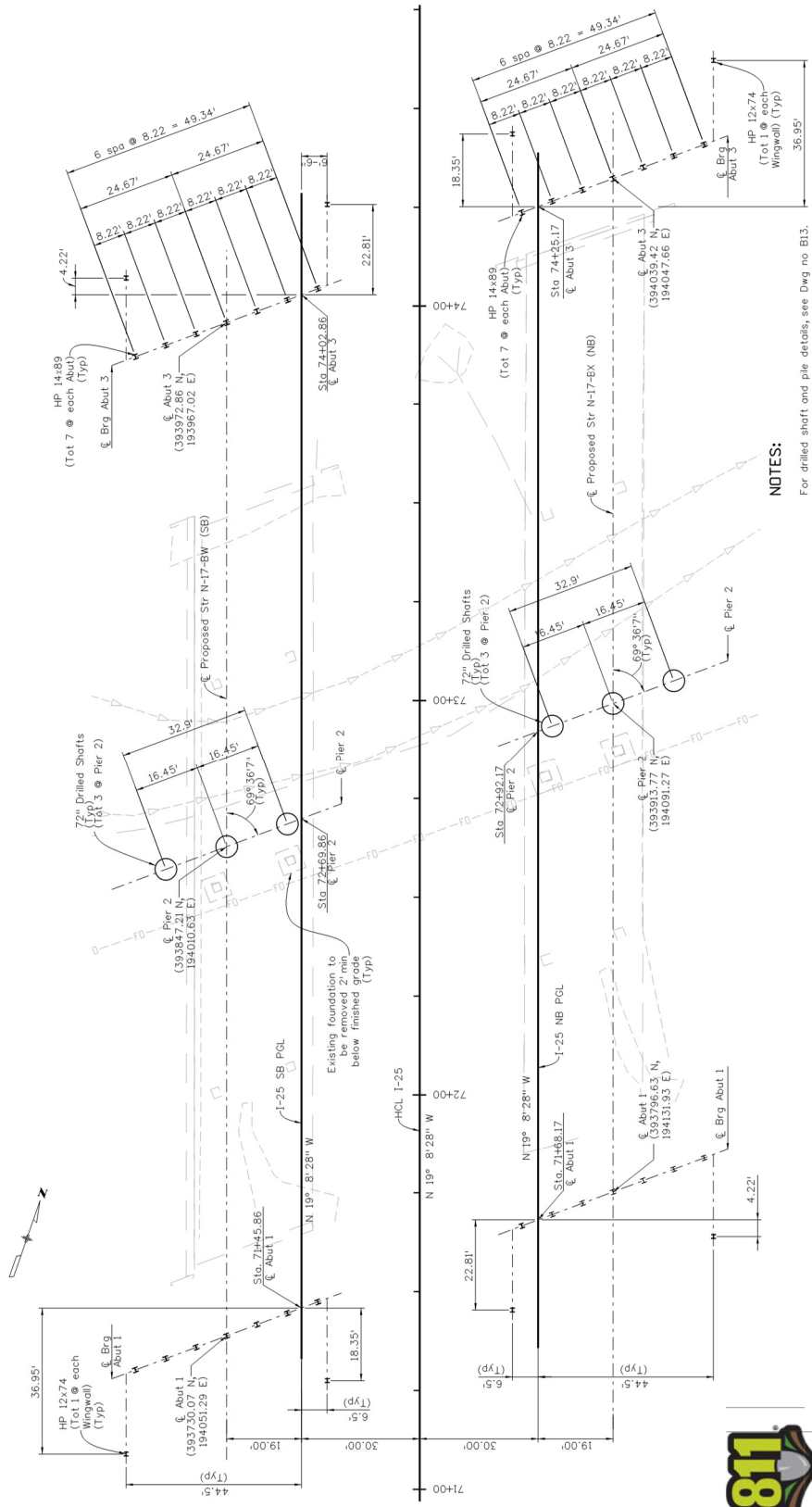
This drawing is titled "FOOTING AND PILING LAYOUT", "FOOTING LAYOUT", "DRILLED SHAFT LAYOUT", "PILING LAYOUT", etc., and shall be so indicated in the title block. If other details are combined on this drawing, they shall be so indicated in the title also. Example: If the "Construction Layout" is placed 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.

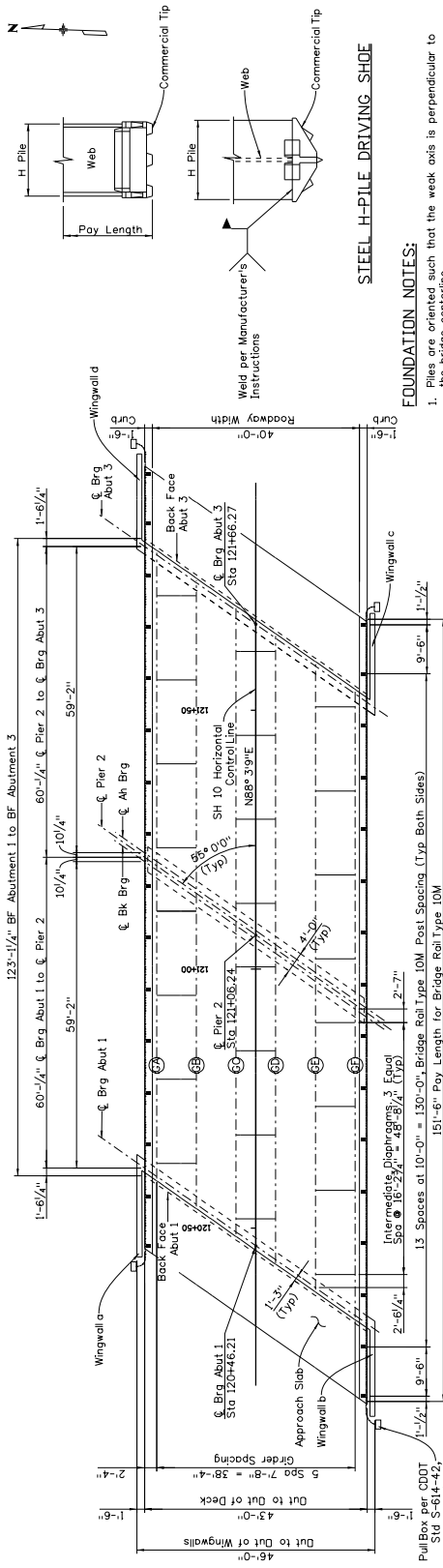


NOTES:
For drilled shaft and pile details, see Dwg no B13.

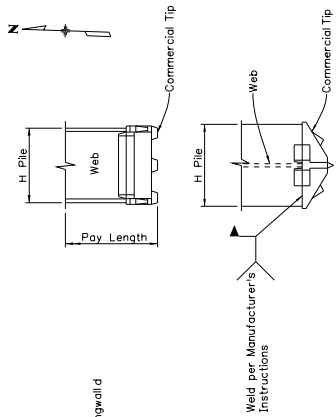
FOUNDATION LAYOUT



Fig. 10-1 Example 1



STEEL H-PILE DRIVING SHOE



FOUNDATION NOTES:

1. Piles are oriented such that the weak axis is perpendicular to the bridge centerline.
2. All welders, welding and weld procedures shall be certified or established per the project specifications.
3. A minimum of one pile dynamic test shall be required per abutment.
4. Only Complete Joint Penetration (CJP) welds shall be used for pile splices

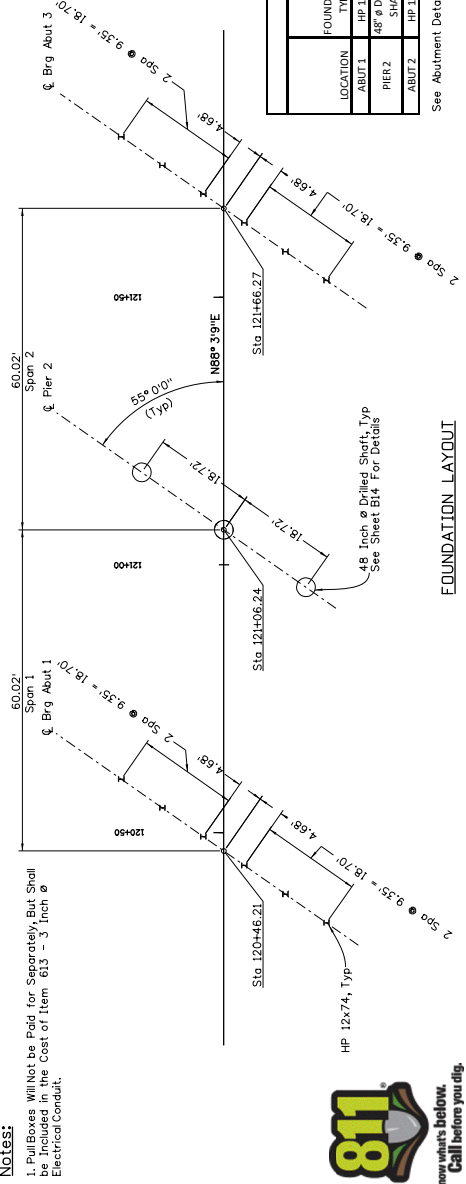
FOUNDATION NOTES:

- Drilled Shafts and Piles are Designed per AASHTO LRFD
- Drilled Shafts:
 Nominal Tip Resistance in Bedrock = 65 ksf
 Nominal Side Resistance in Bedrock = 13.7 ksf
 Resistance Factors for Tip and Side Resistance Are 0.50 and 0.45, Respectively
- Piles:
 Combined Nominal End Bearing and Side Resistance in Bedrock = 35 ksi
 (Grade 50 Steel)
 Resistance Factors for Combined Resistance Is 0.65

DRILLED SHAFT AND PILING DATA						
LOCATION	FOUNDATION TYPE	ELEVATION	PILE CUTOFF ELEVATION	ESTIMATED TOP OF BEDROCK ELEVATION	AVERAGE TIP ELEVATION	MAXIMUM UNFACTORED AXIAL LOAD
ABUT 1	HP 12x74	4101	4113	4093	4072	185 kips
PIER 2	48" Ø DRILLED SHAFT	4101	-	-	4074	602 kips
ABUT 2	HP 12x74	4101	4113	4093	4072	185 kips
						244 kips
						861 kips
						244 kips

See Abutment Details sheet B11 for cut off information.

CONSTRUCTION LAYOUT



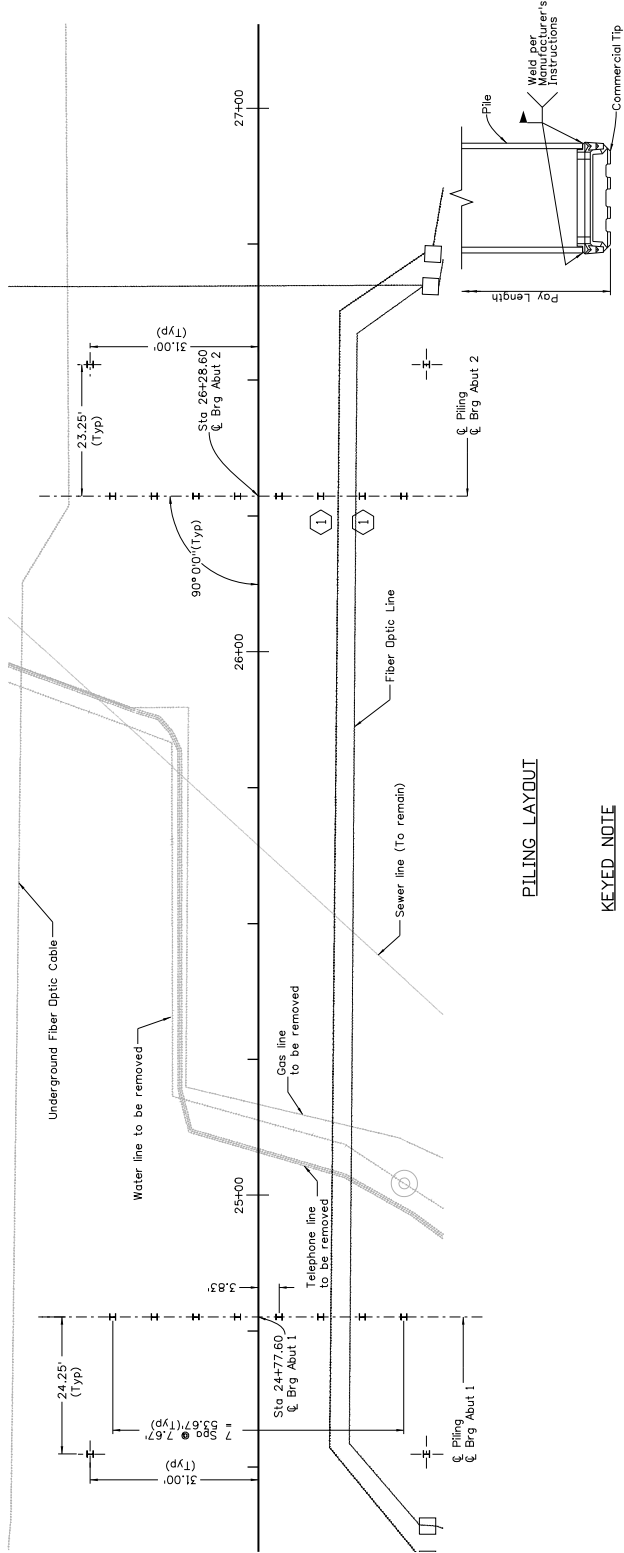
FOUNDATION LAYOUT

Notes:

1. Pull Boxes Will Not be Paid for Separately, But Shall be Included in the Cost of Item 613 - 3 inch Ø Electrical Conduit.



Fig. 10-2 Example 2



PILING LAYOUT

KEYED NOTE

① Pile Cutoff Elevation 7195.416 ft

REINFORCING TIP DETAIL
 Use commercial tip ABF Hard Bite
 77800, 77750, DPF H-776,
 Verso-Steel VS-300, Construction
 Supply HT-3300 or approved alternate.
 (Scale: None)



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:

- Piling shall be placed in 16" drilled holes up to bedrock. Drilled holes are not required for wing wallpiles.
- All steel piles shall be (AASHTO M270, Grade 50) HP 14 X 89 with a protective cast-steel pile cap and a minimum embedment of 16 feet. The protective pile point installation shall be included under pay item 502, "Steel Piling (Install only)".
- On site observation of pile driving to confirm the bearing strata and determine the exact elevation at which the competent bedrock or dense gravel/sands, and to check for pile crimping, buckling and alignment by a representative of the geotechnical engineer will be provided.
- 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 (303-388-6804) a minimum of ten calendar days prior to beginning of any pile driving work.
- The contractor's Field Engineer shall record actual pile tip elevations in the pile data table for as-constructed plans.
- Pile tips are not required for wing wallpiles.

Fig. 10-3 Example 3

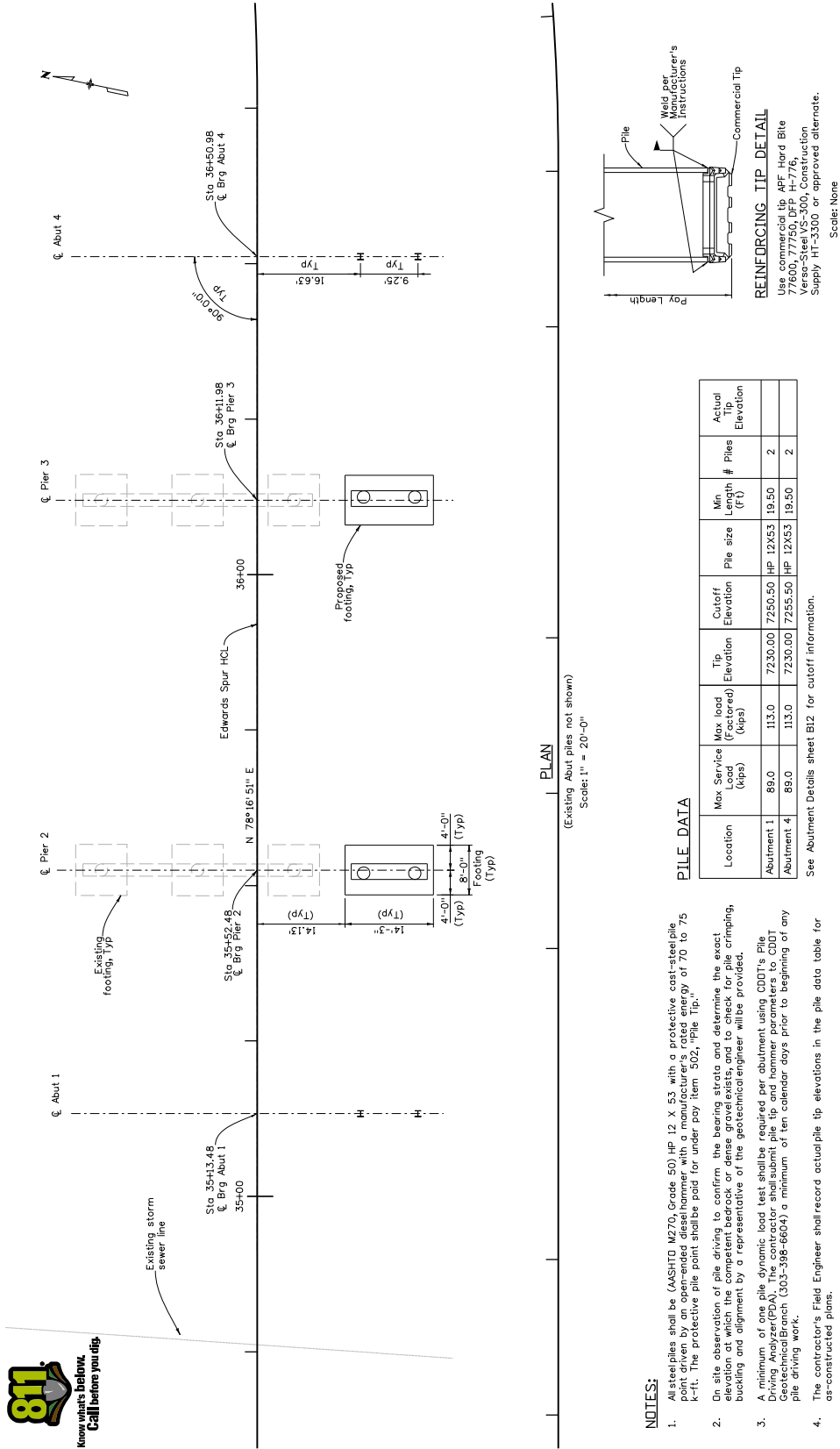


Fig. 10-4 Example 4



COLORADO DEPARTMENT OF TRANSPORTATION STAFF BRIDGE BRIDGE DETAIL MANUAL	Chapter: 11 Effective: November 17, 2022 Supersedes: August 19, 2021
ABUTMENT DETAILS	

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.

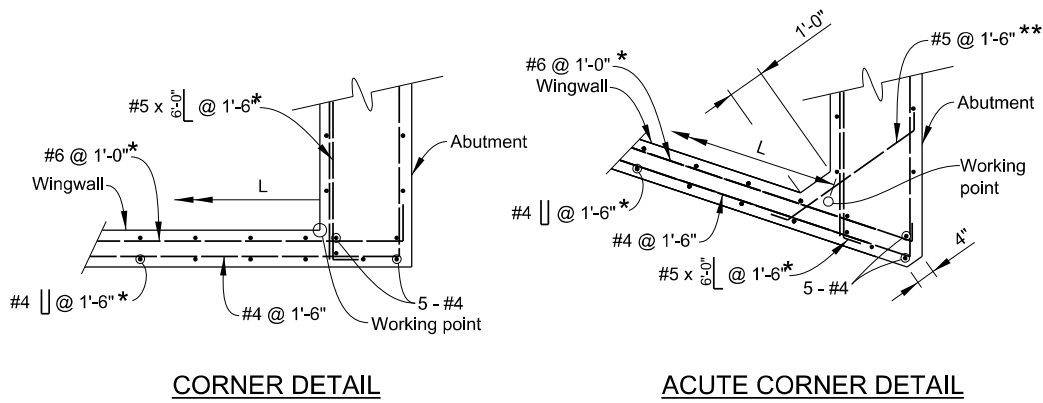
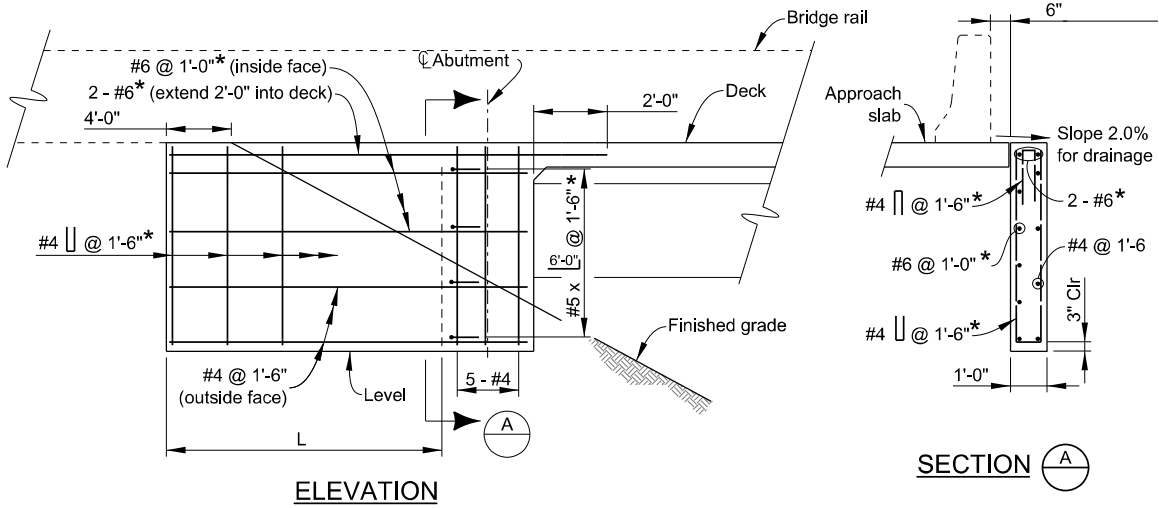
11.5 OPPOSITE HAND DETAILS

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.



- * Reinforcing steel determined by design
- ** Where bar interferes with cast in girders, increase fillet or bend bar to fit.

Fig. 11.6-1 Wingwall Details

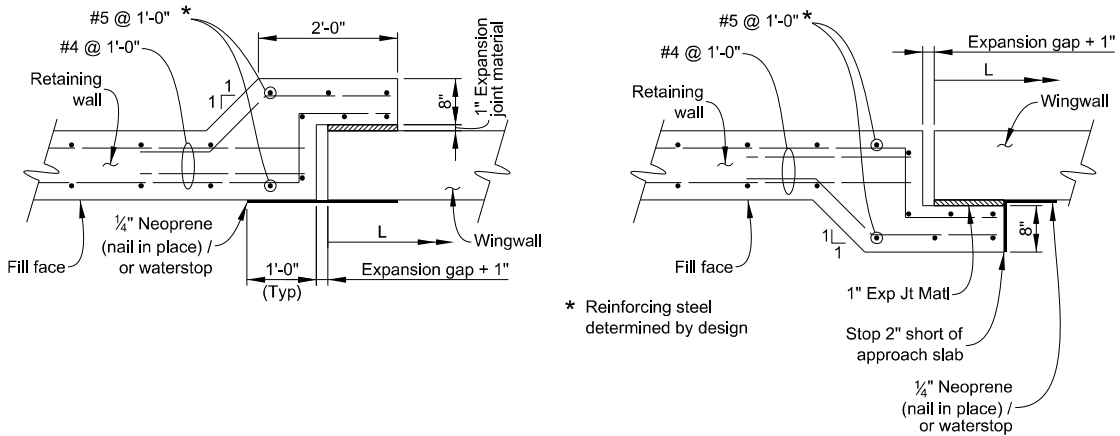


Fig. 11.6-2 Wingwall to Retaining wall Connection Detail

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.

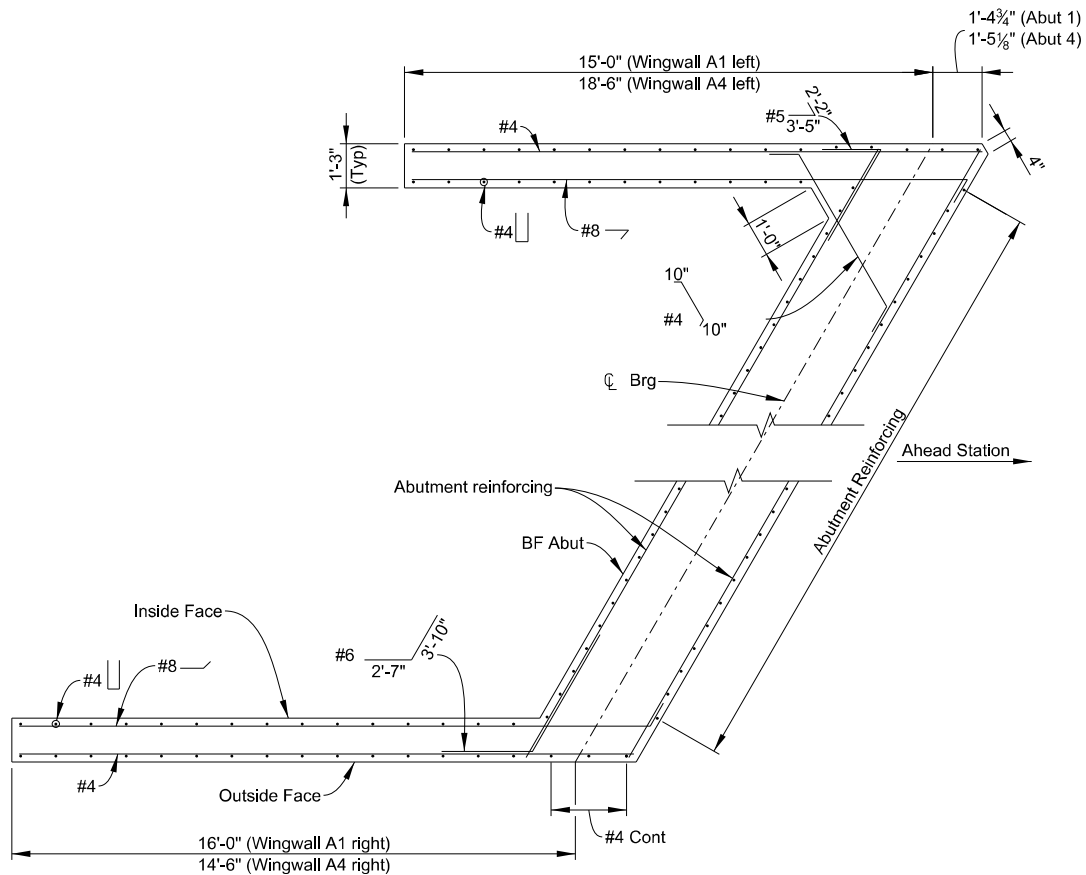


Fig. 11.7-1 Wingwall Designation

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.

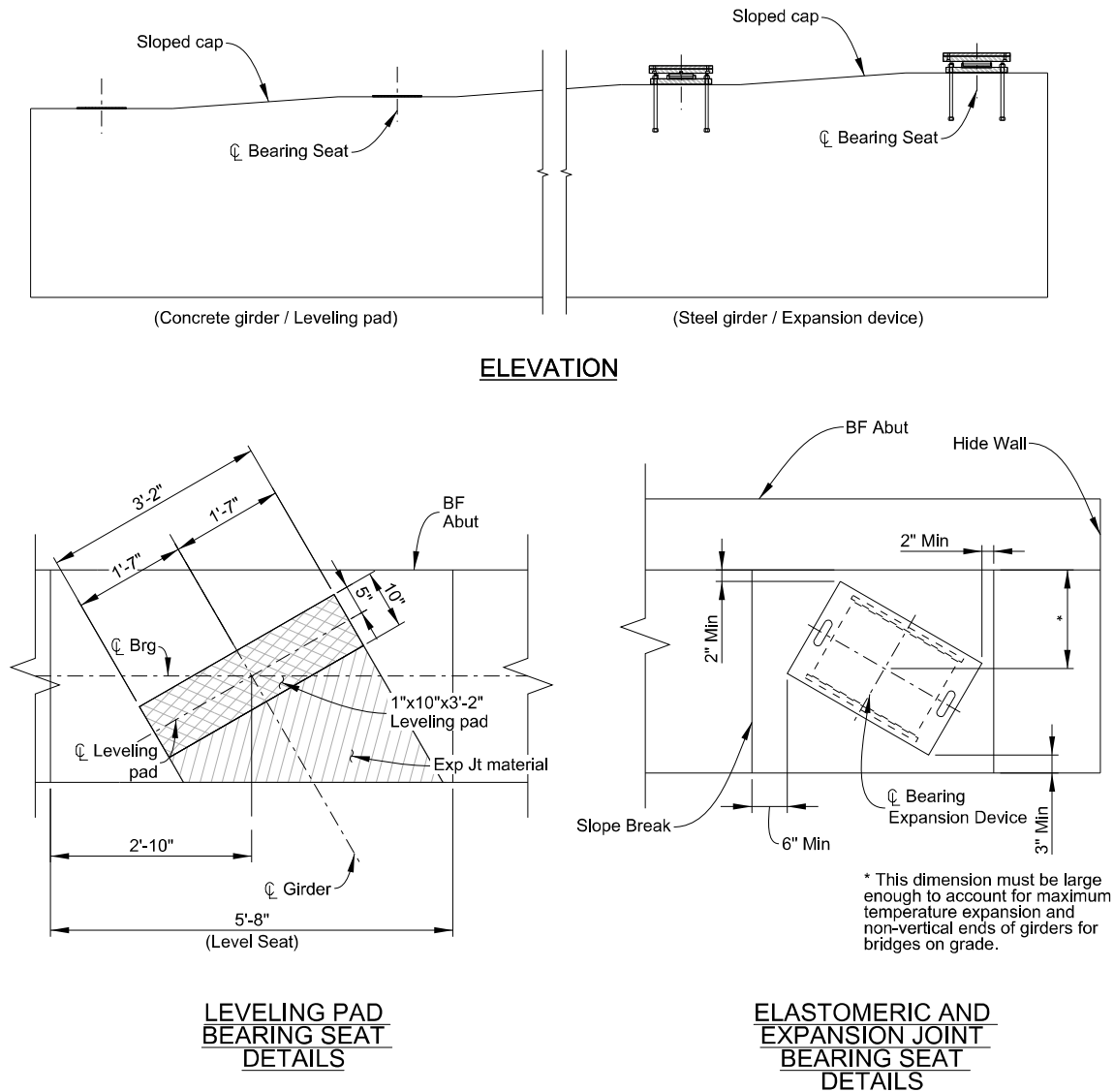


Fig. 11.8-1 Bearing Seat Details

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

- i) Centerline of all girders
- ii) Centerline of bearings
- iii) Centerline of roadway
- iv) Typical centerline of anchor bolts or bearing pads.

2) Section through Abutment

- i) Centerline of bearings
- ii) Identification – The centerlines shown on the abutment details shall be identified in the following ways:
 - a) 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."
 - b) 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.

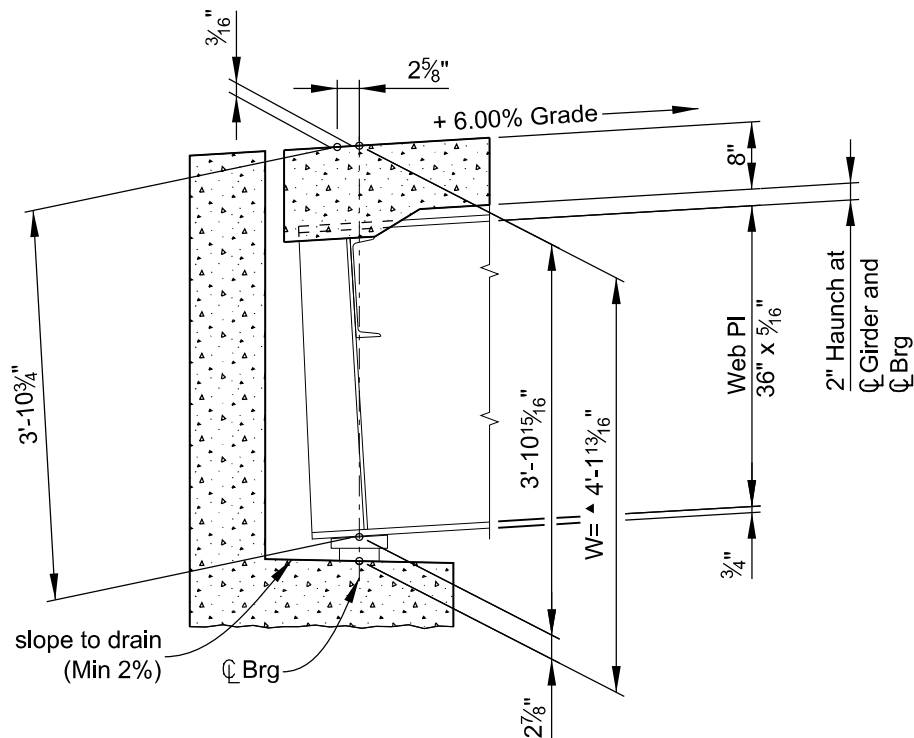
In some instances, the roadway grade may be severe enough to make a difference in the vertical dimension. If this difference is equal to or greater than 1/16 inch, it shall be included in the dimension.

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."



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

(other required details not shown for clarity)

Fig. 11.14-1 Dimensions with bridge on severe grade

- 3) Width and depth of notch for approach slab
- 4) Abutment with constant width
 - i) Back face of abutment to centerline of bearing

- ii) Centerline of bearing to front face of abutment
 - iii) Back face of abutment to front face of abutment
- 5) Abutment with spread footing
- i) Back of footing to back face of abutment
 - ii) Back face of abutment to front face of parapet
 - iii) Front face of parapet to centerline of bearing
 - iv) Centerline of bearing to front face of abutment
 - v) Front face of abutment to front face of footing
 - vi) Footing width
 - vii) 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 70°

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."

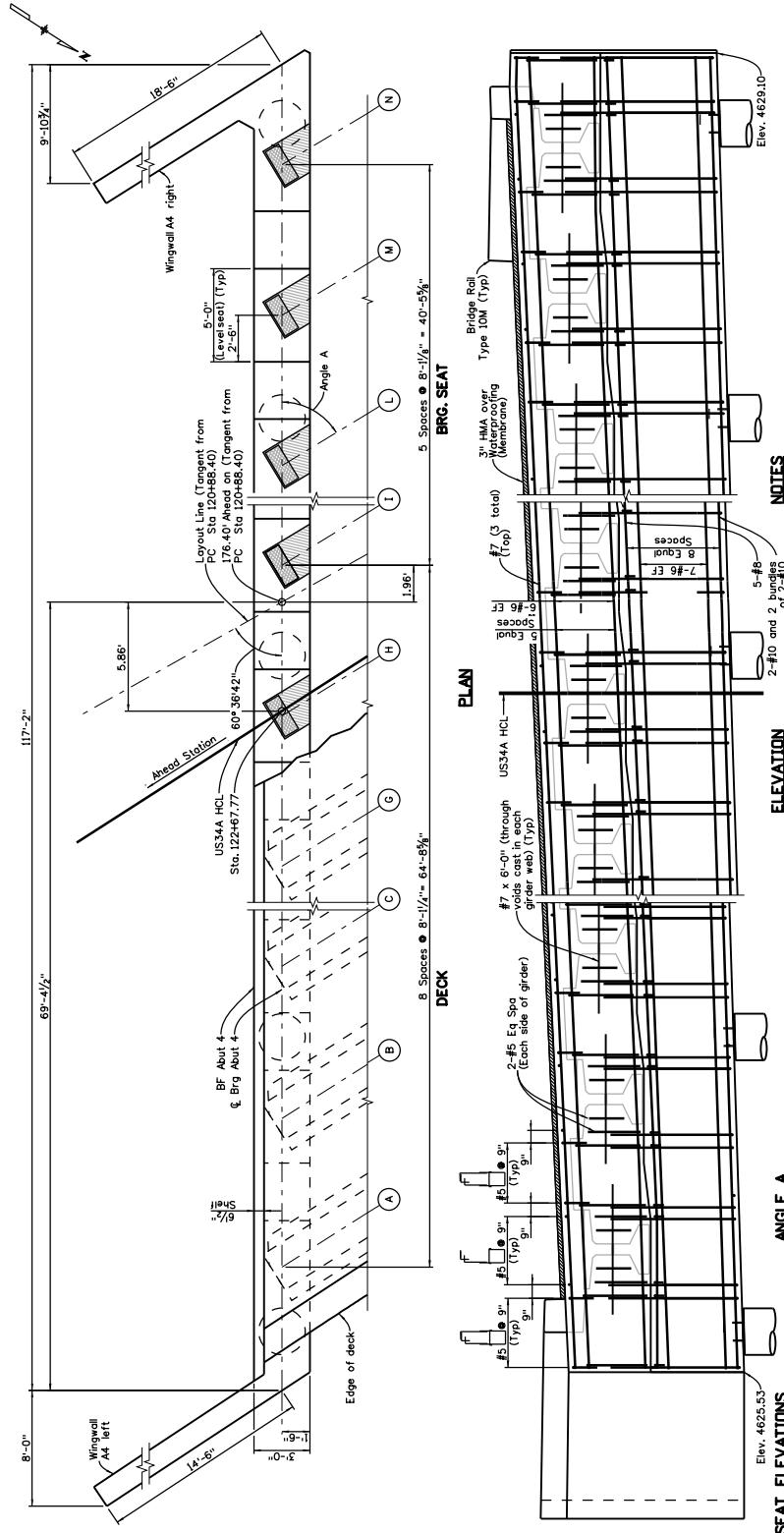
If other details are combined on this drawing, they shall be indicated in the title. Example: If the "Pier Details" are placed on this drawing with the "Abutment Details," the title shall be "ABUTMENT 1 AND 3 DETAILS - PIER 2 DETAIL."

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 _____" \varnothing 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)



SEAT ELEVATIONS

GIRDER	ELEVATION
G1	4630.53
G2	4630.93
G3	4631.84
G4	4632.02
G5	4632.39
G6	4632.76
G7	4633.13
G8	4633.90
G9	4634.24
G10	4634.61
G11	4634.98
G12	4635.35
G13	4635.70
G14	4636.00

ANGLE A

GIRDER	ANGLE
G1	57° 33'00"
G2	57° 40'00"
G3	57° 43'00"
G4	57° 53'00"
G5	58° 00'00"
G6	58° 07'00"
G7	58° 14'00"
G8	58° 20'00"
G9	58° 27'00"
G10	58° 33'00"
G11	58° 41'00"
G12	58° 48'00"
G13	58° 54'00"
G14	59° 01'00"

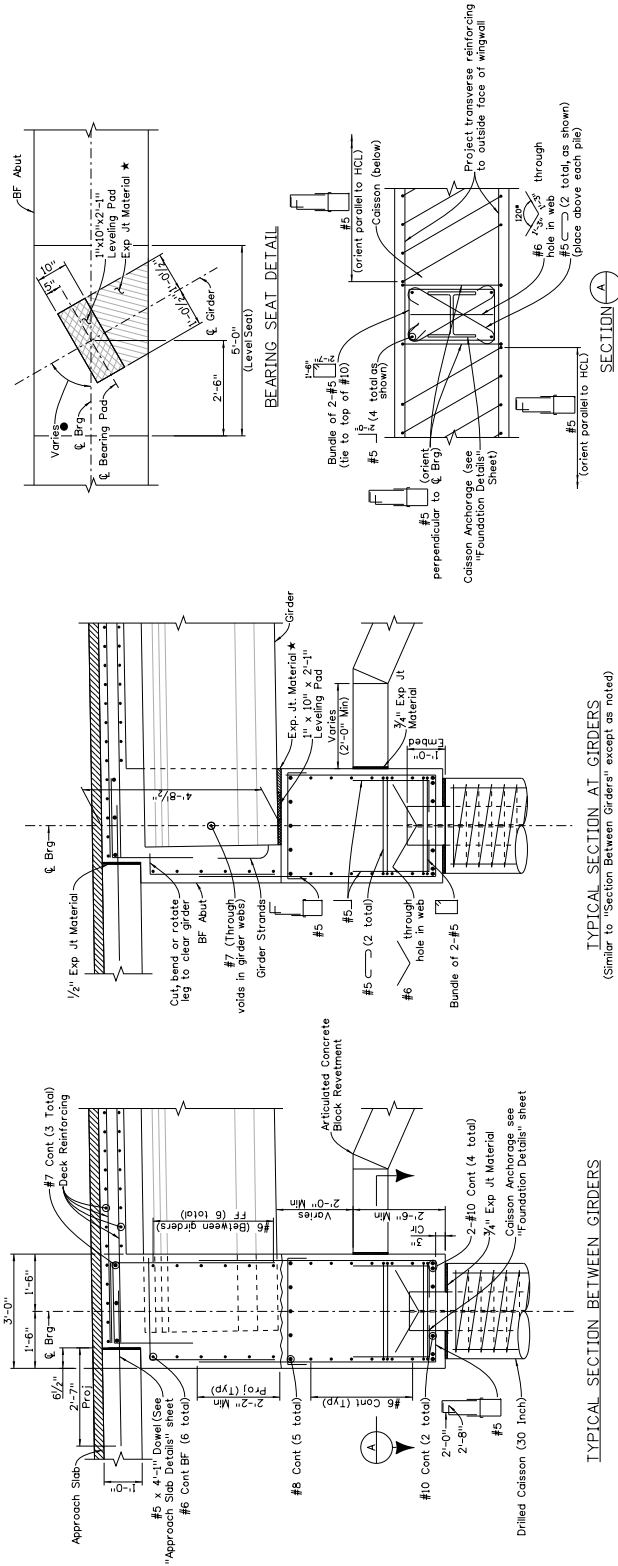
ELEVATION
(Looking ahead station)
(Reinforcing for deck and wingwalls not shown for clarity)

NOTES

1. Abutment cap and diaphragm shall be Concrete Class D (Bridge).
2. Seat elevations are taken at intersection of G, Brg and G, 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.

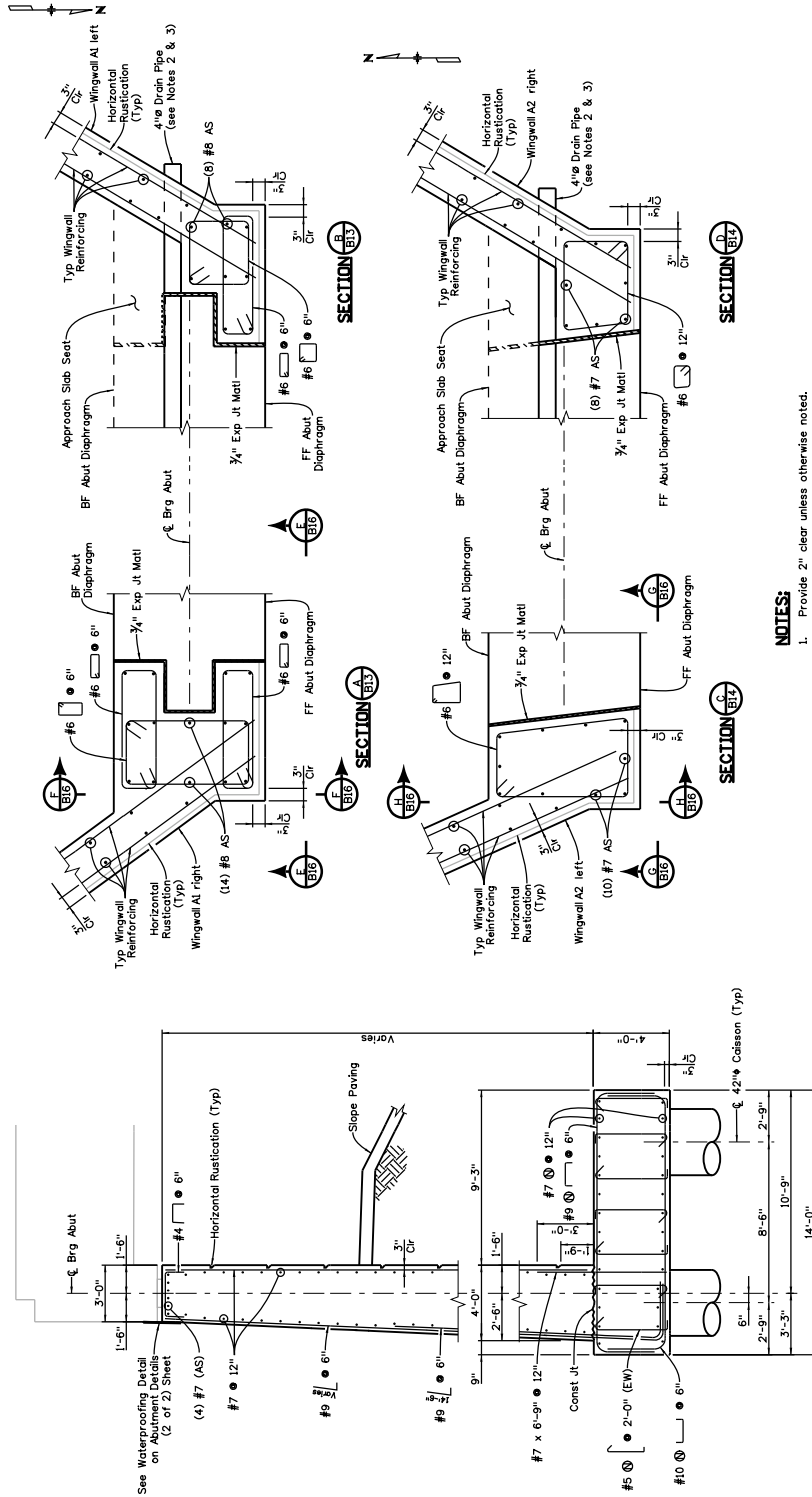
Example 11-1

ABUTMENT 4



- NOTES**
- 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. Expansion joint material shall be placed in the joint 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

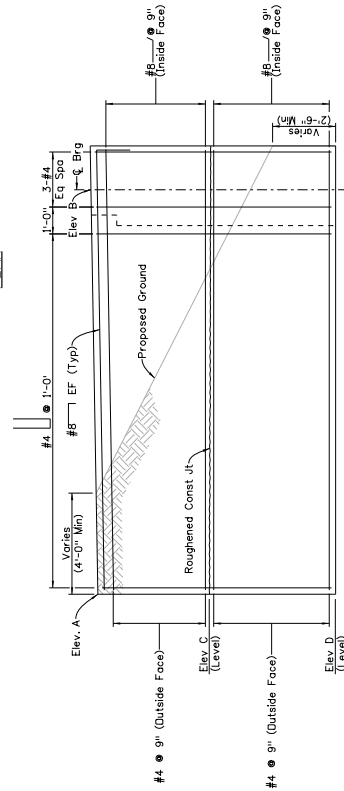
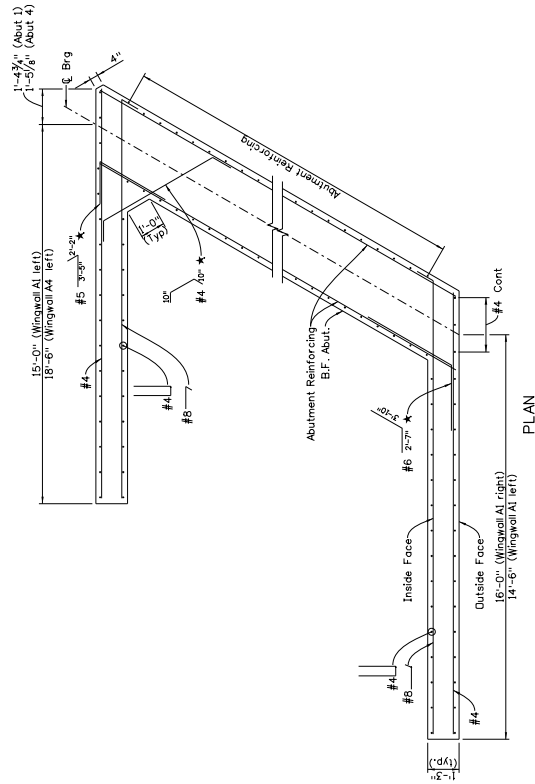
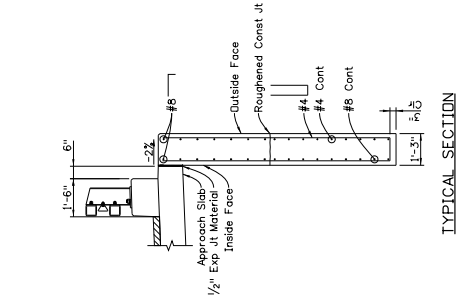


NOTES:

1. Provide 2" clear unless otherwise noted.
2. Cast continuous half circle section of Schedule 60 HDPE pipe into abutment near key for drainage trough. The grade of the trough shall match the roadway crossfall.
3. Extend 4" Trimmed Plastic Pipe through the wingwall and extend 4" (Min) beyond outside face.

ABUTMENT DETAILS (1 OF 2)

Example 11-3

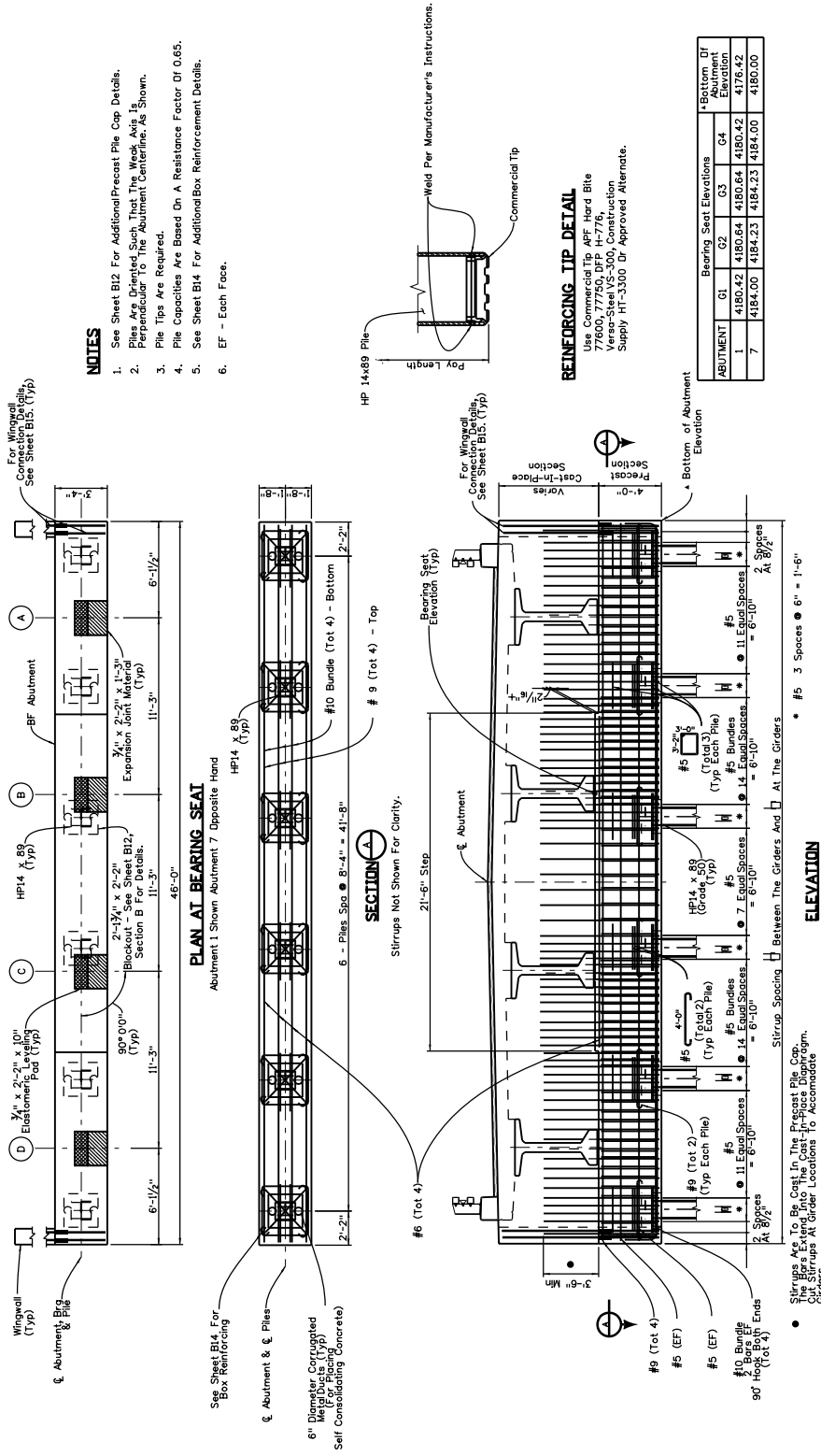


ELEVATION SUMMARY

WINGWALL	ELEV. A	ELEV. B	ELEV. C	ELEV. D
A	4634.57	4634.84	4629.07	4624.07
B	4634.57	4634.84	4629.07	4624.07
C	4635.35	4635.25	4630.53	4625.53
D	4640.59	4640.42	4635.35	4629.10

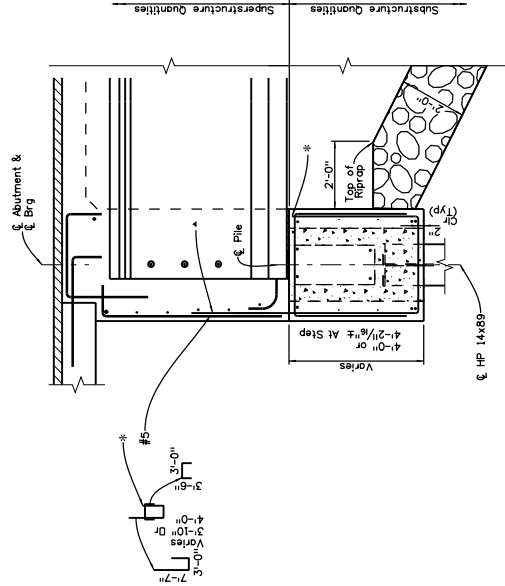
- NOTES**
1. Wingwall elevations are taken at Outside Face.
 2. Concrete shall be Concrete Class D (Bridge).
- KEYED NOTES**
- * Space with abutment reinforcing.

Example 11-4

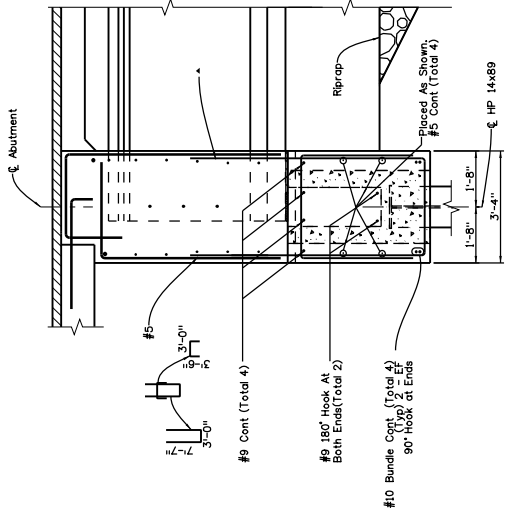


PRECAST ABUTMENT
PLAN & ELEVATION

Example 11-5



TYPICAL SECTION AT GIRDERS
For Diaphragm Reinforcing See Sheets B11 & B12



TYPICAL SECTION
For Diaphragm Reinforcing See Sheets B11 & B12

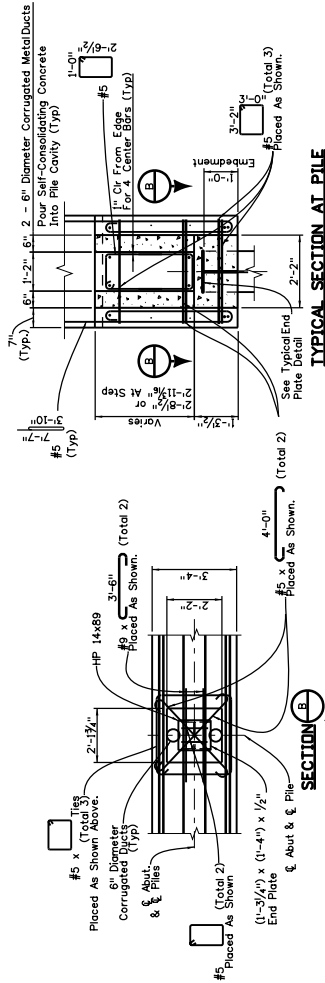
NOTES

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. Welding 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)

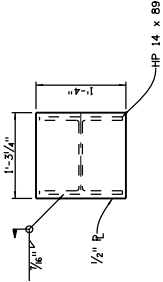
EF - Each Face
FF - Front Face
BF - Back Face
Pile: HP - 14 x 89
Grade 50

PILE TOLERANCE

The driven piles have a lateral installation tolerance of 5" in any transverse direction and 3/8" 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 bucket.

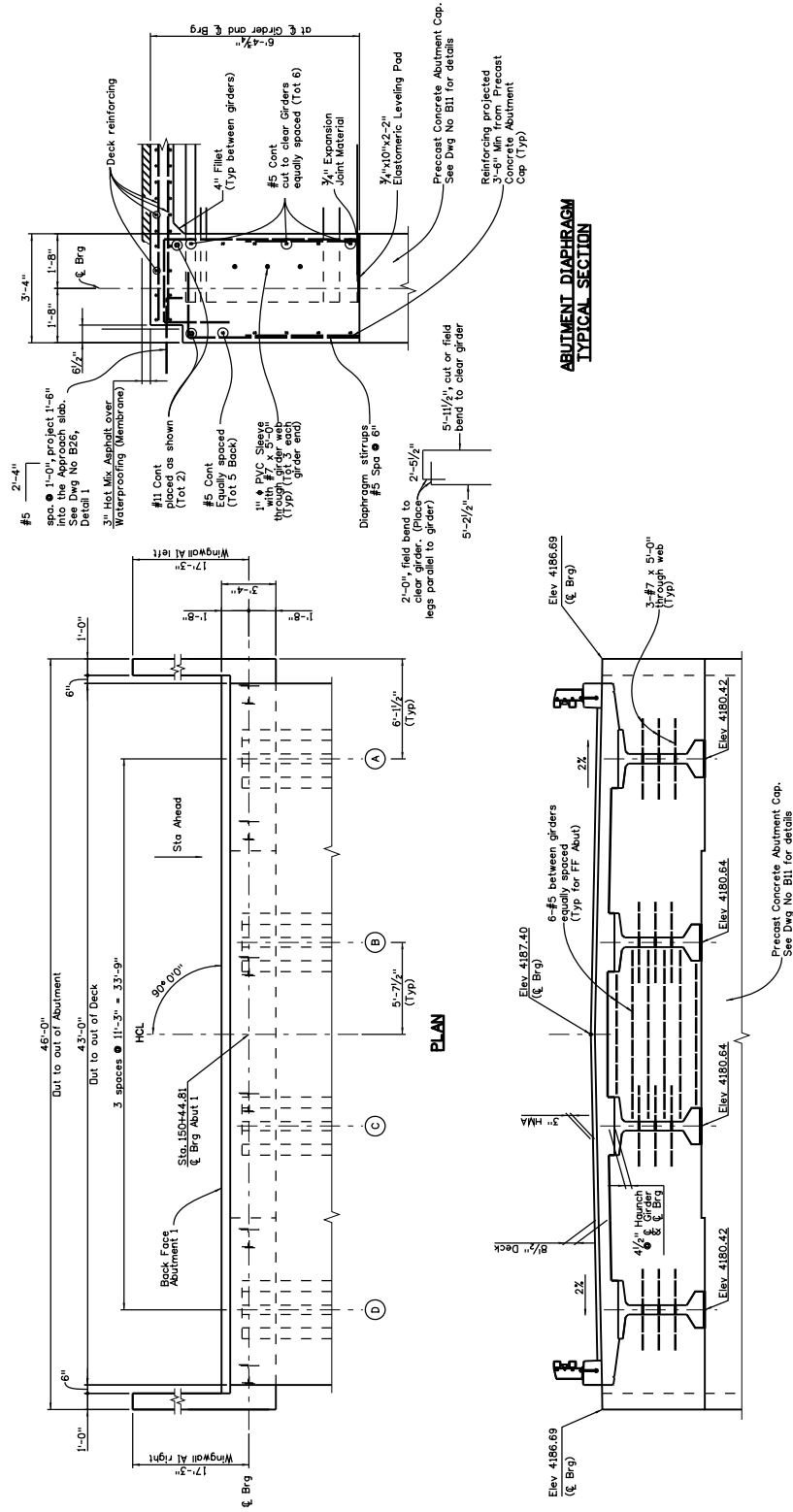


TYPICAL SECTION AT PILE



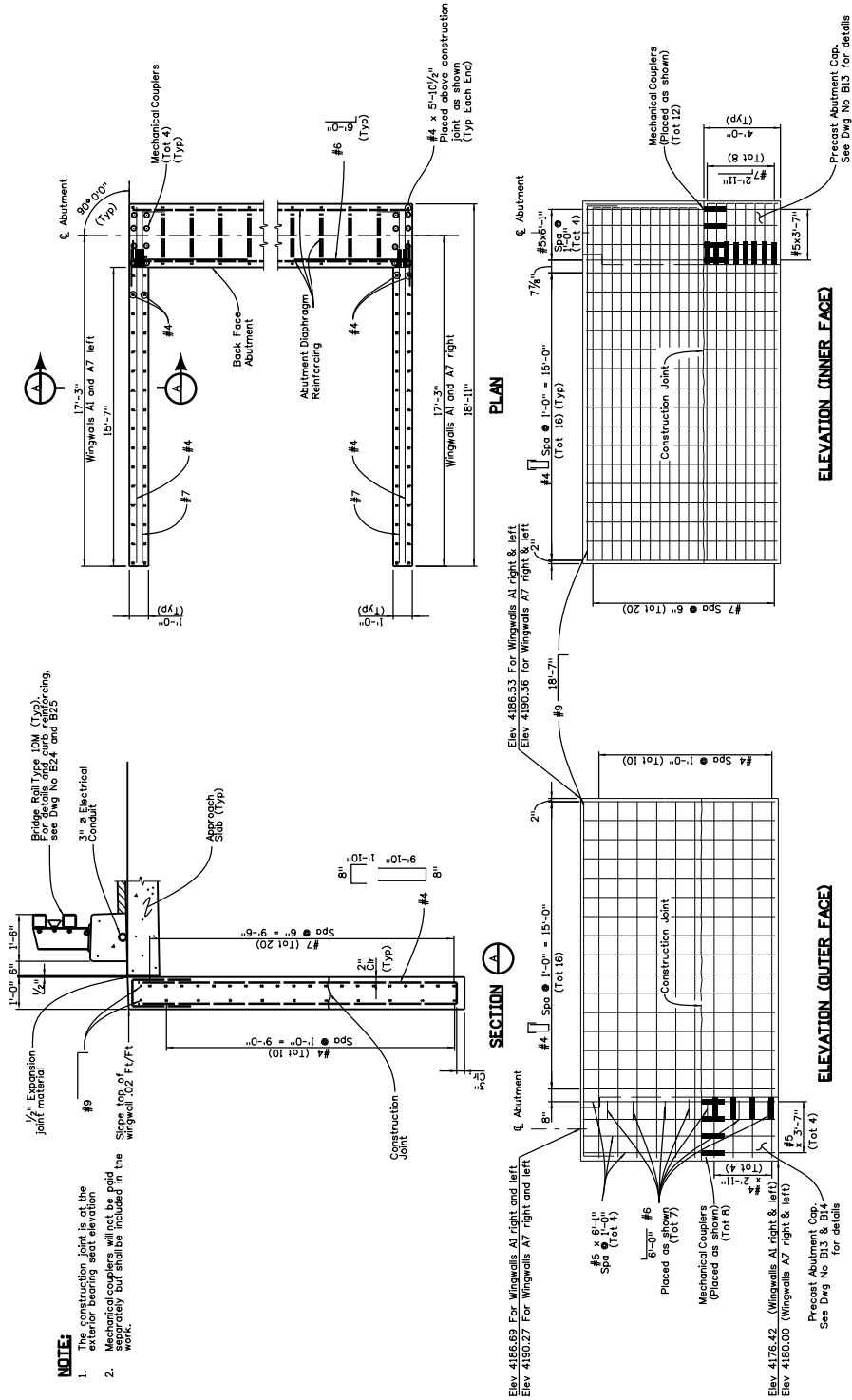
TYPICAL END PLATE DETAIL

PRECAST ABUTMENT DETAILS

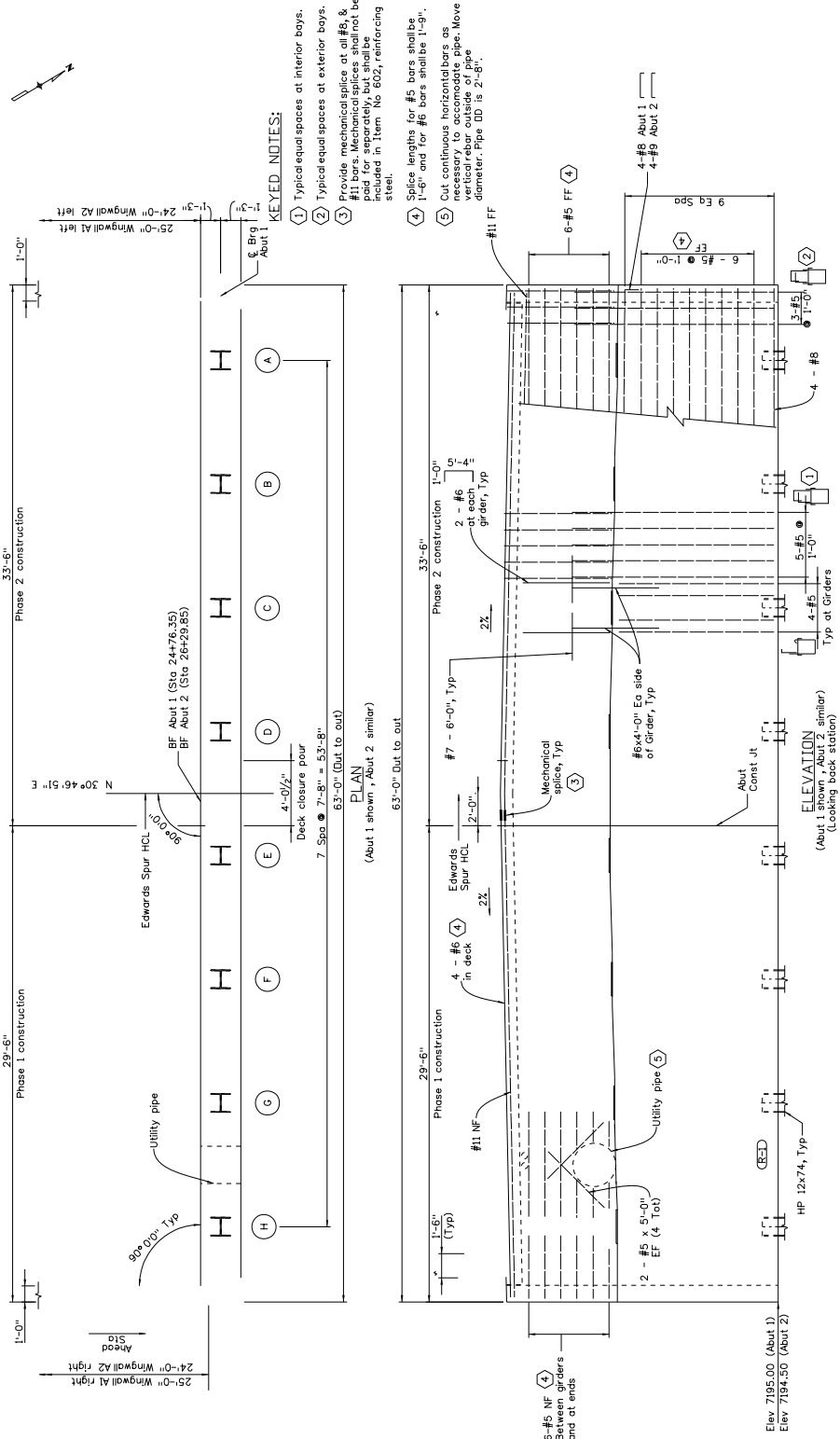


Example 11-7

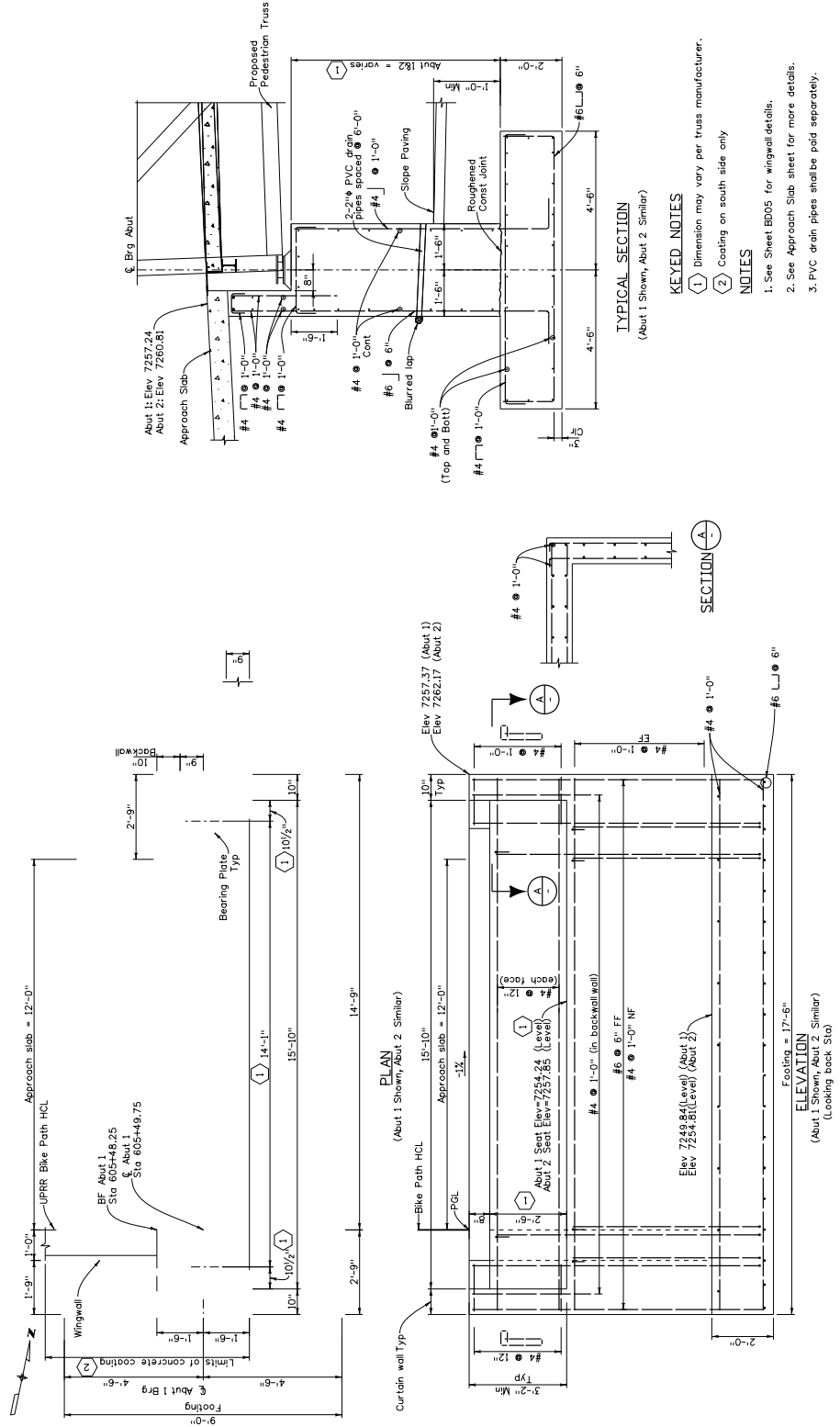
ABUTMENT 1 DIAPHRAGM DETAILS



Example 11-8



Example 11-9



Example 11-10

COLORADO DEPARTMENT OF TRANSPORTATION STAFF BRIDGE BRIDGE DETAIL MANUAL	Chapter: 12 Effective: September 14, 2020 Supersedes: October 8, 1986
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
 - i) Centerline of pier
 - ii) Centerline of all girders
 - iii) Centerline of all bearings
 - iv) Centerline of roadway
 - v) Centerline of columns and footings
 - vi) Typical centerline of anchor bolts or bearing pads.
 - 2) Elevation View
 - i) Centerline of caissons
 - ii) Centerline of columns and footings
 - 3) Section Through Pier
 - i) Centerline of bearings
 - ii) Centerline of caissons
 - iii) 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.
 - i) 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".

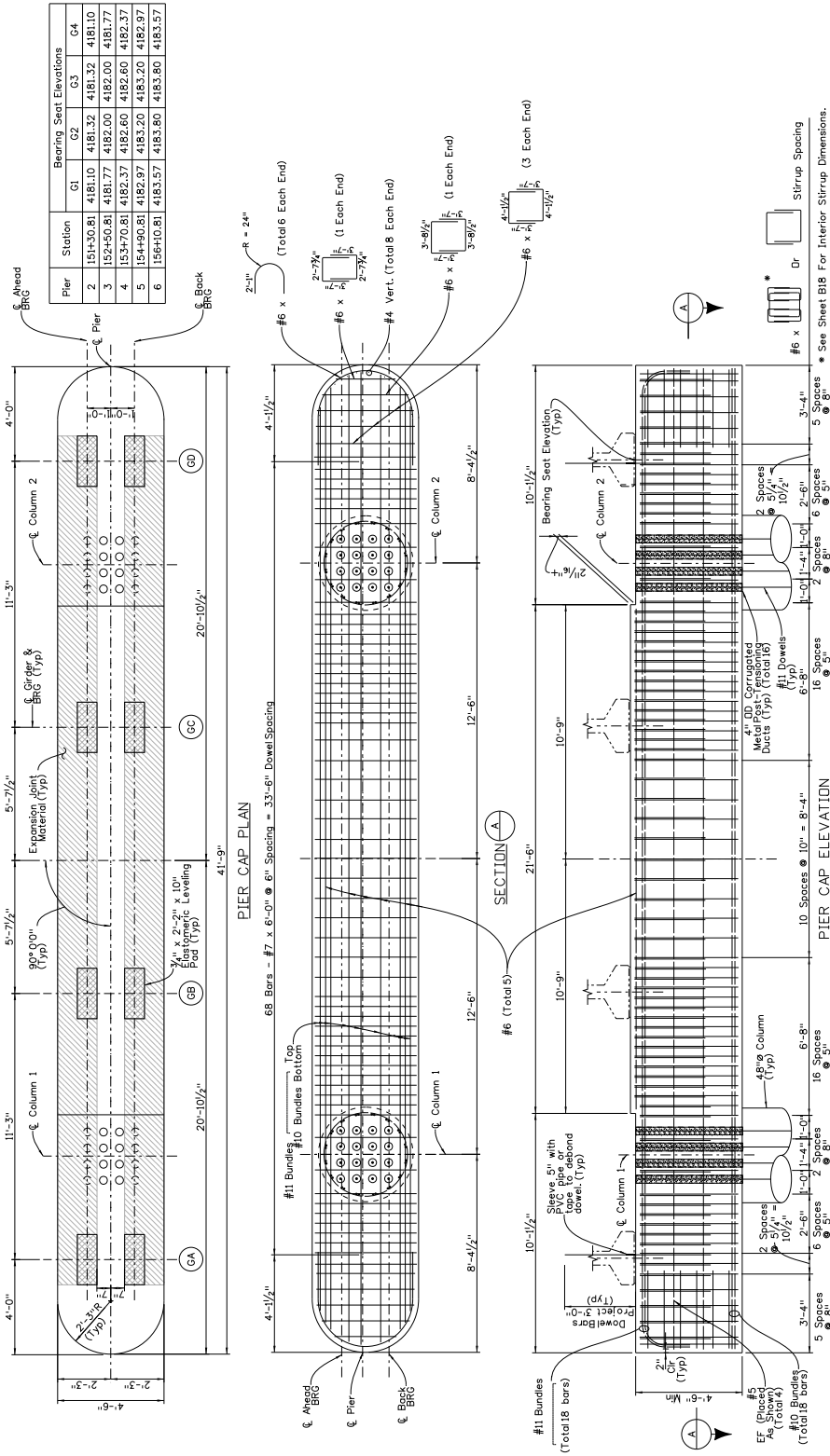
If other details are combined on this drawing, they shall be indicated in the title. Example: If the "Abutment Details" are placed on this drawing with the "Pier Details", the title shall be "ABUTMENT DETAILS - PIER DETAILS".

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

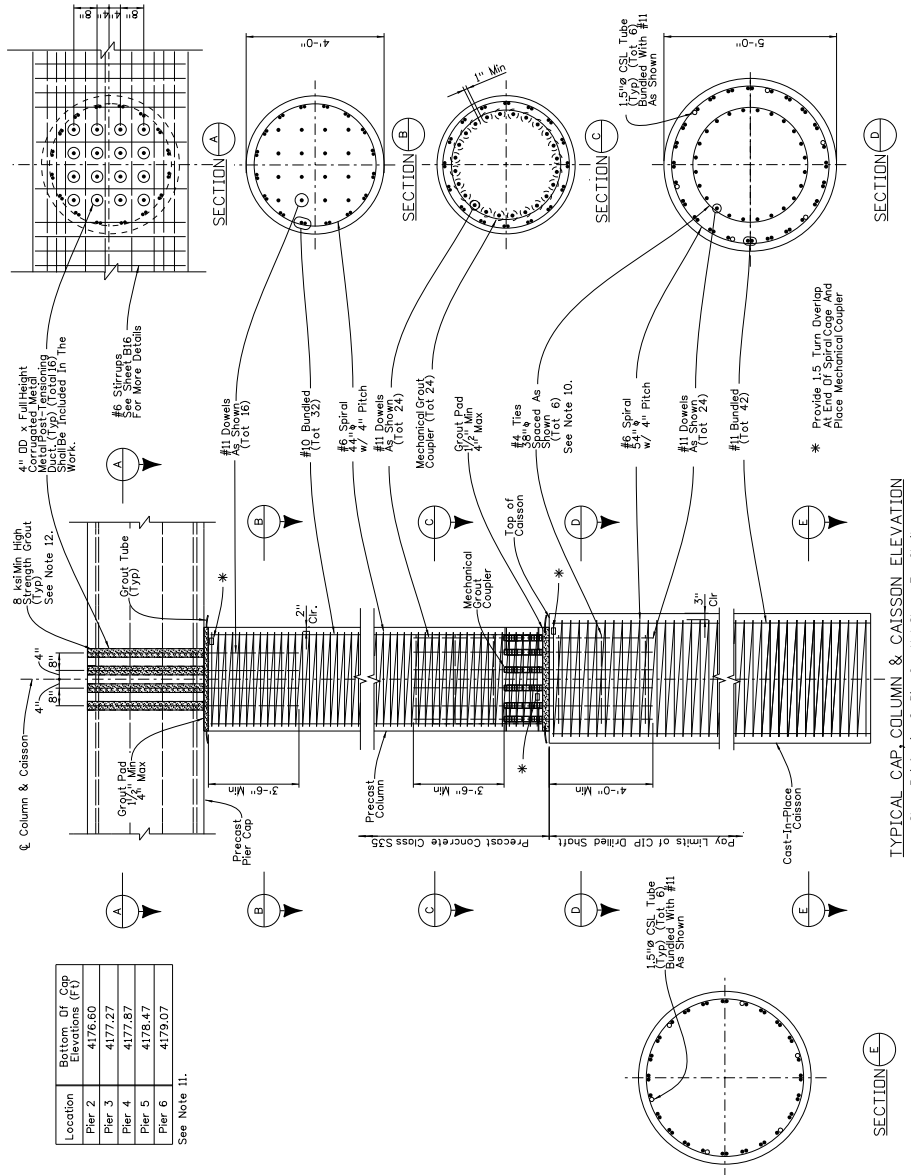
The following notes shall appear on the drawing when applicable:

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



EXAMPLE 12.1

PIER PLAN AND ELEVATION



PIER DETAILS (1 OF 2)

TYPICAL CAP, COLUMN & CAISSON ELEVATION

Shear Reinforcing In Pier Cap Not Shown For Clarity.

NOTES

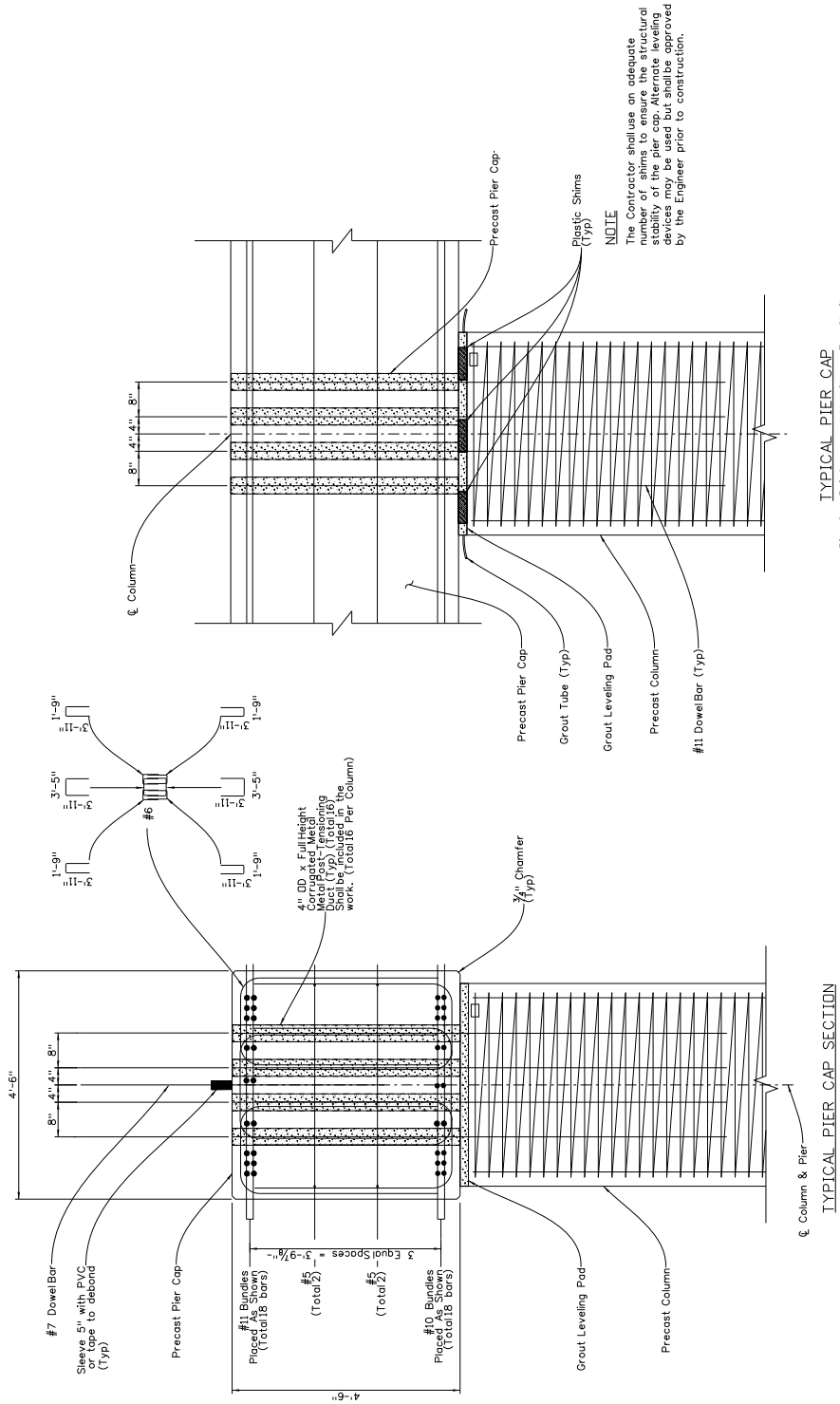
1. Provide 2'-0" Extra Length For Spiral Cage And Vertical Bars At Each End Of The Pier Cap. The Ends Of The Spiral Cage As Shown In The Caisson Details. Continuous Spiral.
2. Spiral Cage Shall Use Mechanical Splices To Form A Continuous Spiral.
3. Steel Casing Shall Be Used. It Shall Be Included In 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 And Formwork Is Necessary To Accommodate Jigs And Templates.
6. The Contractor Shall Verify The Top Of Each Precast Member After Placement. The Tops Of Member Elevations And Orientation Shall Be Verified At Each Phase Of Construction. Any Necessary Adjustments To Elevations Shall Be Made By Adjusting GROUT PAD THICKNESSES. THE USE OF SHIMS OR LEVELING BOLTS IS NOT RECOMMENDED.
7. The Length Of Dowel Bars Protruding From The Top Of Precast Column Shall Be As Recommended In The Manufacturer's Recommendations For Embedment Into The Mechanical GROUT COUPLER. THE CONTRACTOR SHALL DETERMINE THIS LENGTH PRIOR TO POURING THE CAISSON.
8. In Order To Maintain Min. Clearance Between The Caisson And The Mechanical GROUT COUPLER, THE COUPLER DIAMETER (DUA TO DIA) SHOULD BE LIMITED TO 3/2" 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 not intended 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 1/2" minimum grout pad thicknesses at the top and bottom of the columns.
12. As a minimum, the dowel bars into the cap shall extend through the cap and then cut flush with the top of the cap. The use of ultra high performance concrete may be used for the cap. 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 $\pm 1/2"$ In Any Direction From That Shown On The Plans. A 1/2" Column Tolerance Is The Sum Of The Gaps At Top And Bottom Of The Columns, The Gap At The Ends Of The Dowel Bars, The Gap At The Ends Of The Mechanical GROUT COUPLERS, The Gap At The Top Column Is Between The Face Of The Dowel Bars And The Inside Face Of The GROUT DUCT In The Cap.

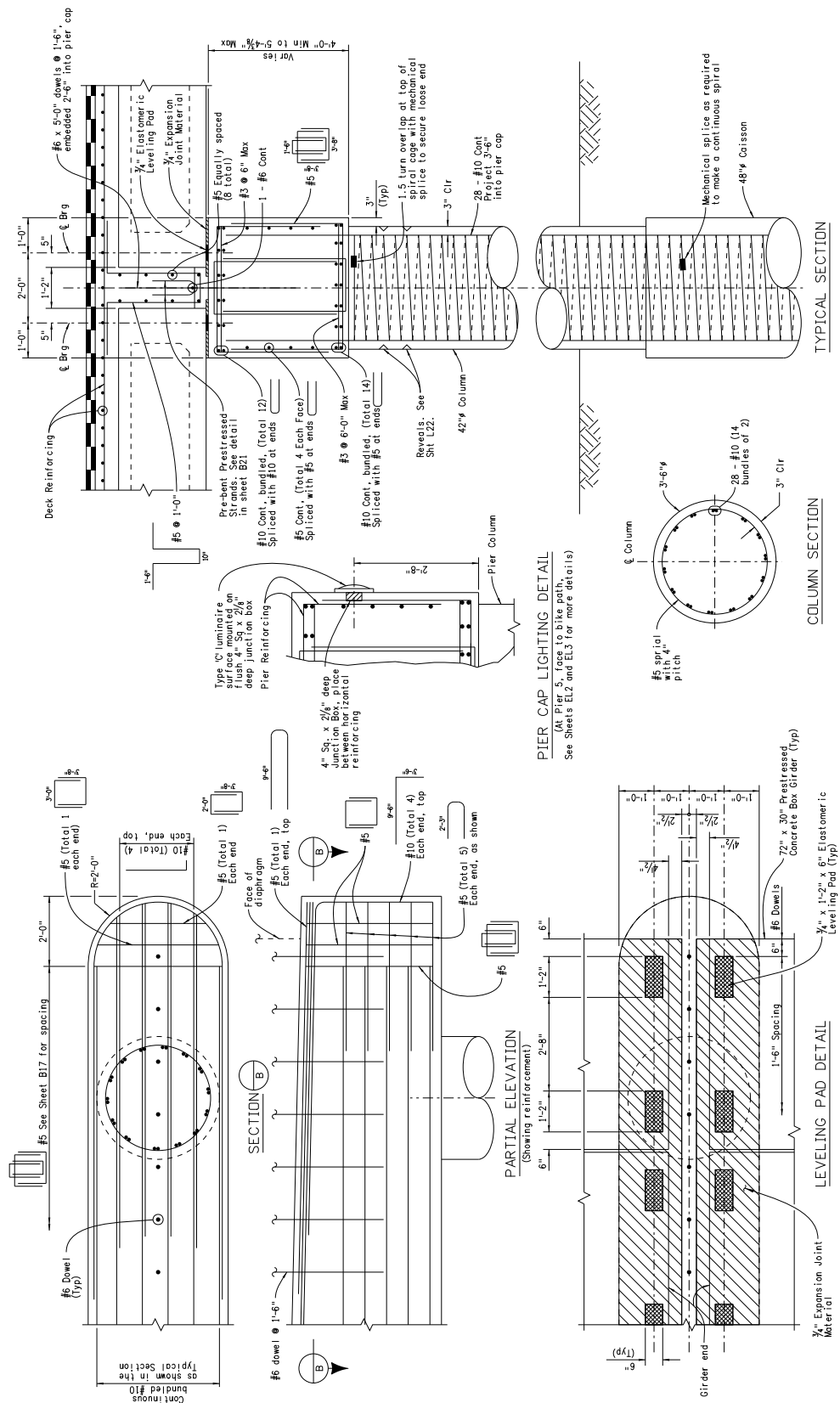
Tolerance At The Top Of The Column Is Based On The Selection Of The Mechanical GROUT COUPLER. THE ASSUMED Tolerance Due To The Mechanical Couplers Is 1/4".

EXAMPLE 12.2



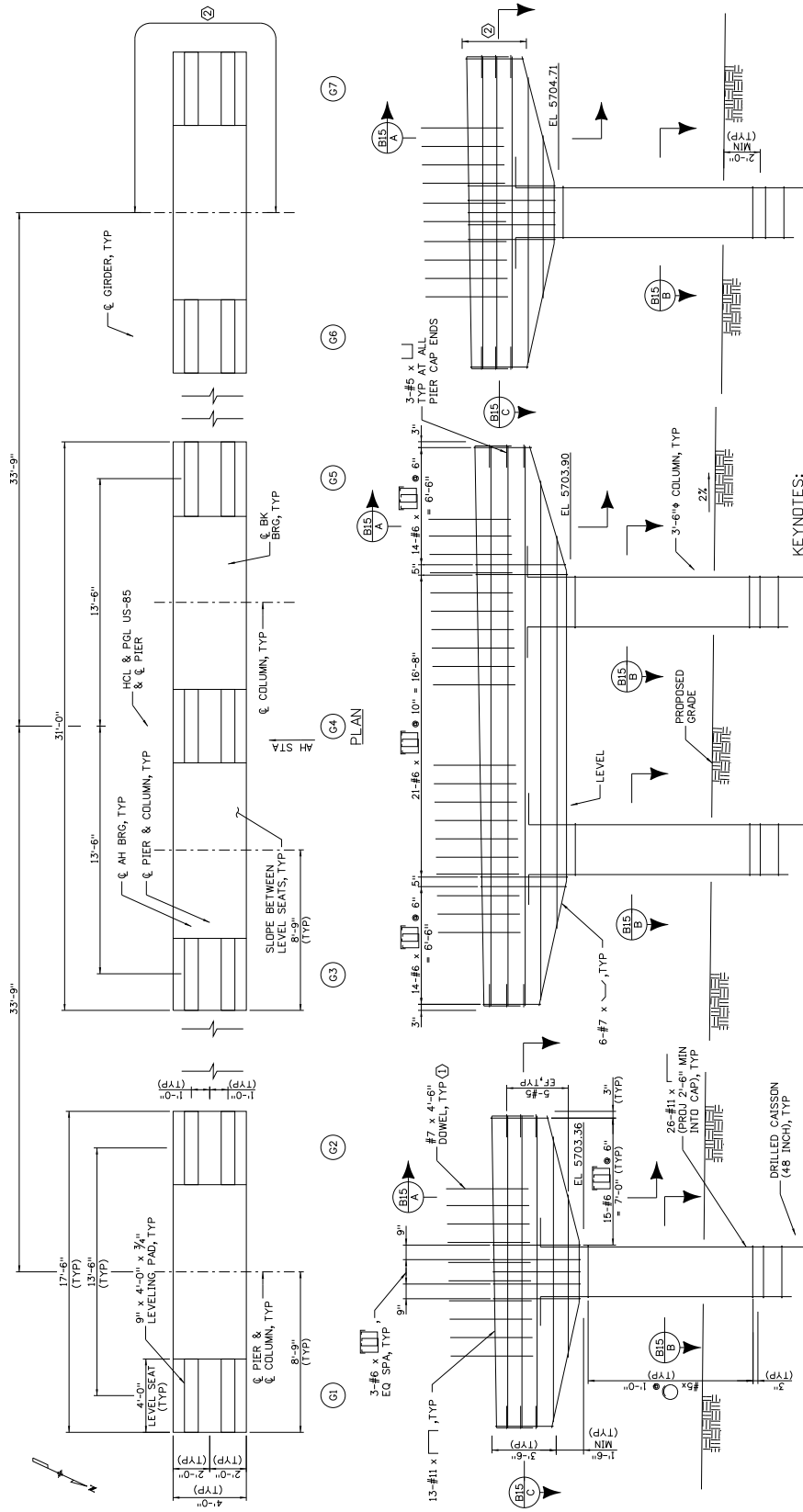
TYPICAL PIER CAP
Pier Cap Reinforcement Not Shown For Clarity

EXAMPLE 12.3



PIER SECTIONS & DETAILS

EXAMPLE 12.5



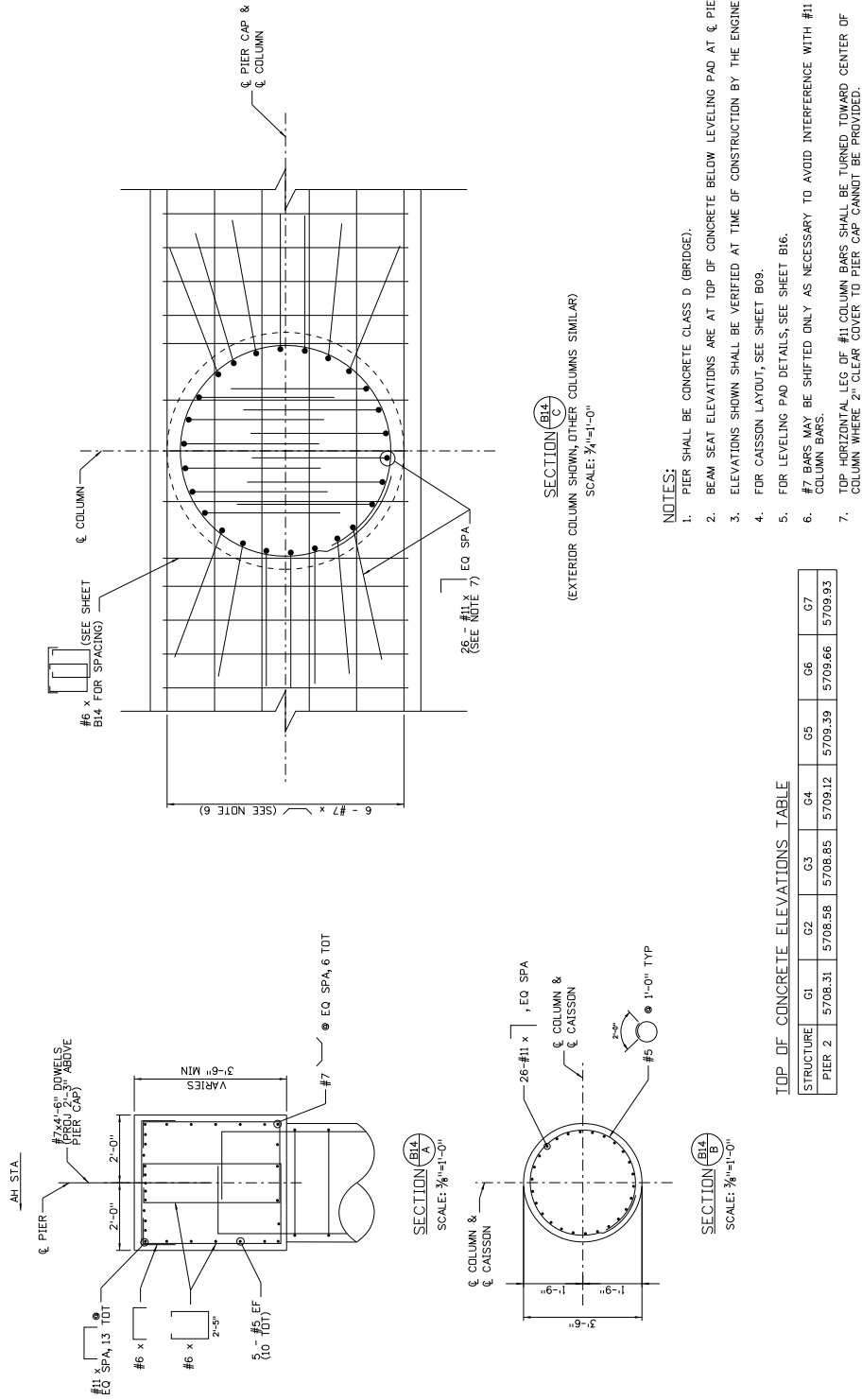
KEYNOTES:

- ① SEE SHEET B16 FOR SPACING.
- ② LIMITS OF SPRAY ON WATERPROOFING MEMBRANE (30 MIL THICK) INCLUDE IN THE CONCRETE (BRIDGE), APPLY UNDER EXTERIOR GIRDERS ONLY.

ELEVATION
(LOOKING AHEAD STATION)
(RIPRAP NOT SHOWN)

US-85 OVER SAND CREEK
PIER 2 (SHEET 1 OF 2)

EXAMPLE 12.6

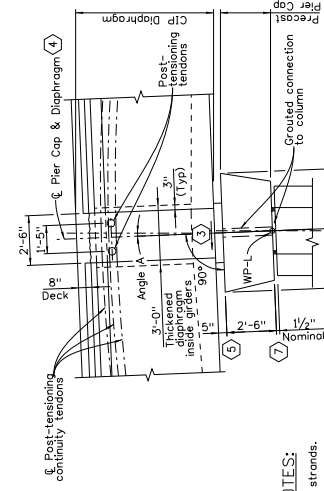


EXAMPLE 12.7

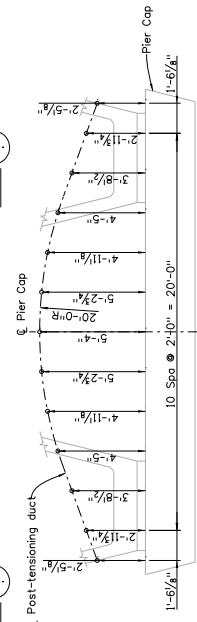
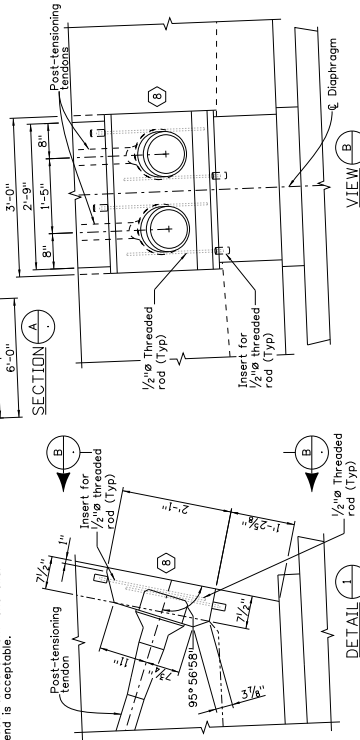
US-85 OVER SAND CREEK
PIER 2 (SHEET 2 OF 2)

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

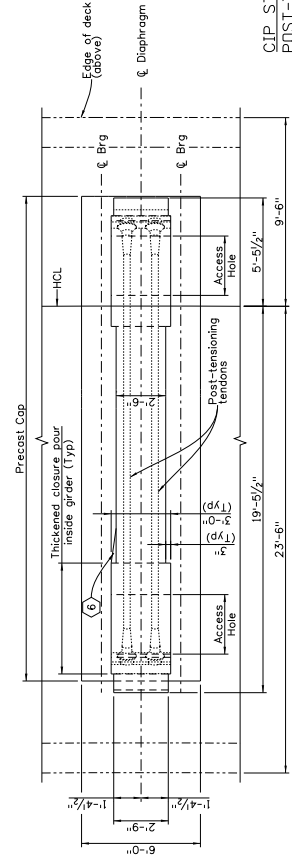
See Angle A
Orientation Key,
Sht No B7g



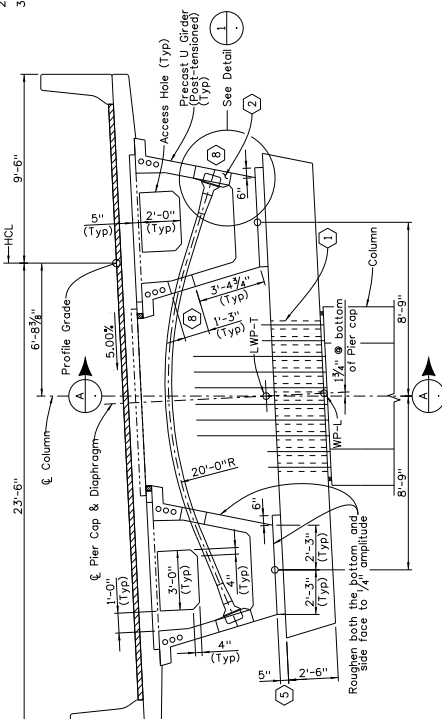
CIP STEM POST-TENSIONING NOTES:
 1. Each tendon has 19 - 0.6" strands.
 2. Peak = 835 kips/tendon
 3. Stress both tendons from one end.
 3. Stress both tendons from one end.
 3. Stress both tendons from one end.



POST-TENSIONING TENDONS GEOMETRY DETAIL
 US85/C470 INTERCHANGE IMPROVEMENTS
 SOUTHBOUND TO EASTBOUND FLYOVER
 PIER 4, 6, 8, 10 DETAILS (1 of 3)



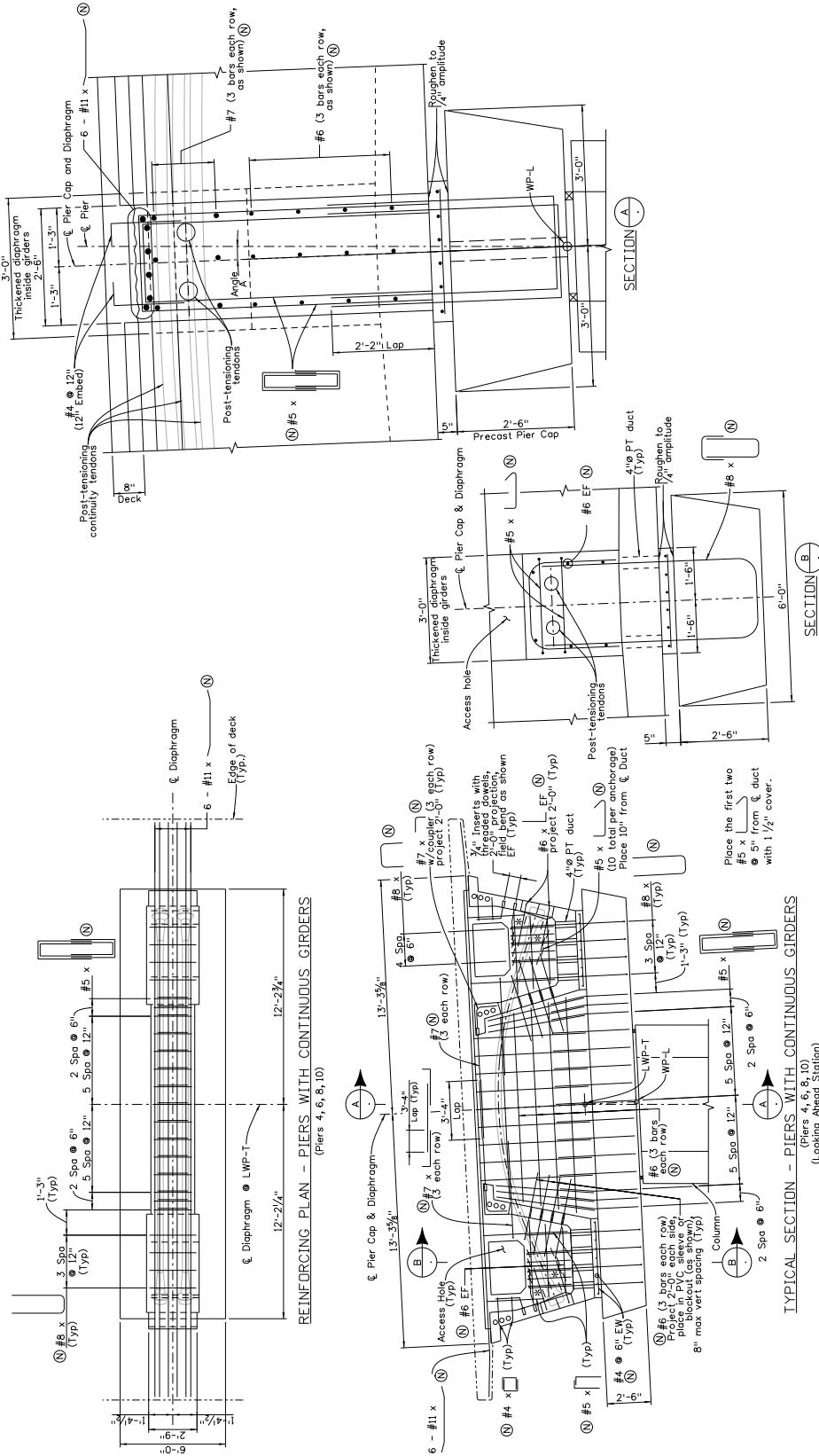
PLAN - PIERS WITH CONTINUOUS GIRDERS
 (Piers 4, 6, 8, 10)



TYPICAL SECTION - PIERS WITH CONTINUOUS GIRDERS
 (Looking Ahead Station)

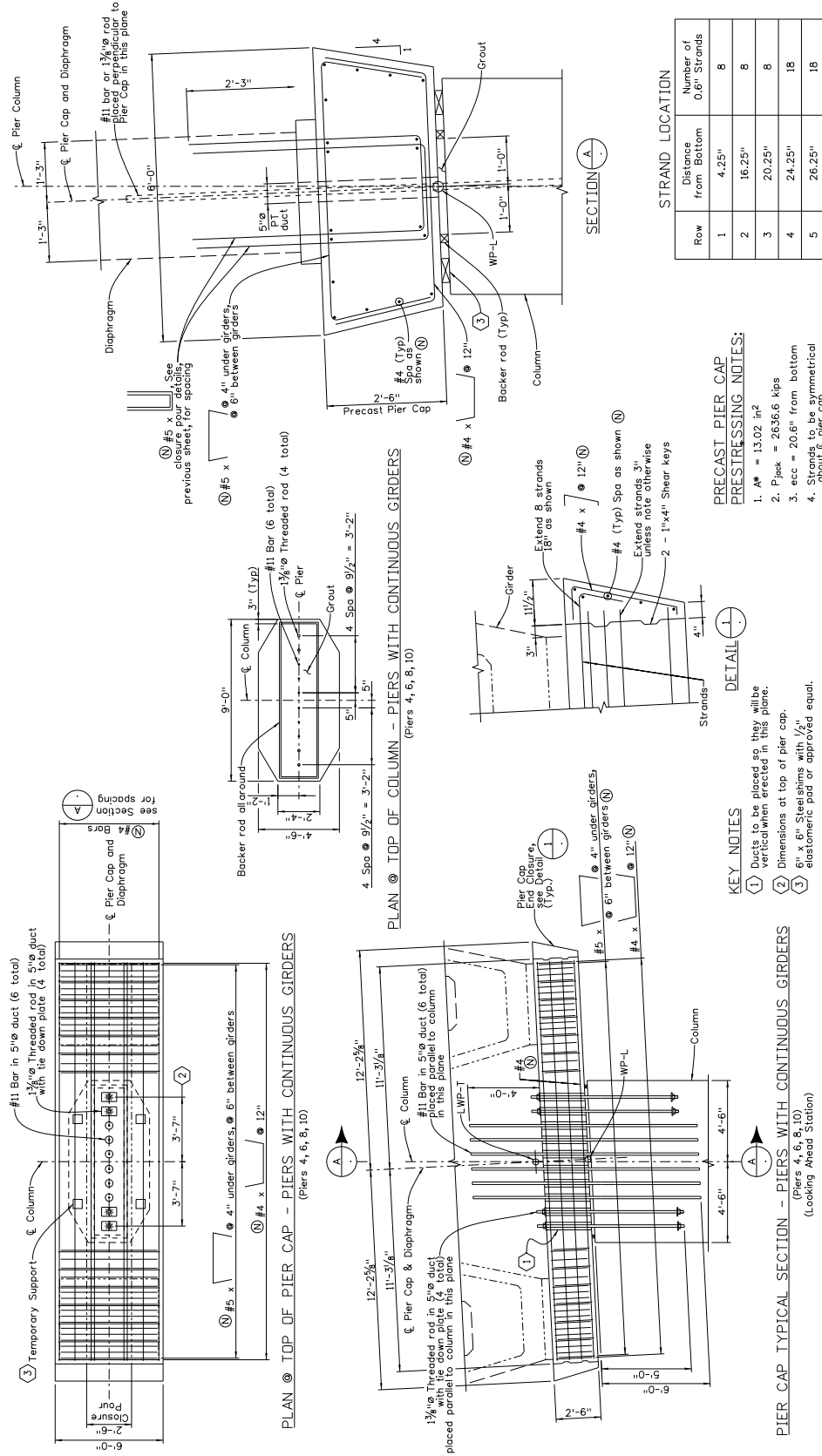
- KEY NOTES**
- 1) Dowels from column to pass through corrugated post-tensioning ducts.
 - 2) Post tensioning access pocket to be filled with Class B Concrete after grouting ducts.
 - 3) Match longitudinal grade.
 - 4) Diaphragm to be placed perpendicular to the pier cap.
 - 5) Concrete shall be placed under the girders and achieve 100% consolidation. Self-consolidating concrete may be used as an alternative.
 - 6) Place dry pack grout to prevent potential for water ponding.
 - 7) Grout thickness set at 1/2" nominally. Allowable thickness 1/4" to 3/4".
 - 8) See Detail 2 for 2' Sides Details sheet for location and dimensions of all voids, blockouts, ducts and sleeves through girder.

EXAMPLE 12.8



EXAMPLE 12.9

US85/C470 INTERCHANGE IMPROVEMENTS
SOUTHBOUND TO EASTBOUND FLYOVER
PIER 4, 6, 8, 10 DETAILS (2 of 3)



US85/C470 INTERCHANGE IMPROVEMENTS
SOUTHBOUND TO EASTBOUND FLYOVER
PIER 4, 6, 8, 10 DETAILS (3 of 3)

EXAMPLE 12.10

COLORADO DEPARTMENT OF TRANSPORTATION STAFF BRIDGE BRIDGE DETAIL MANUAL	Chapter: 13.1 Effective: May 31, 2023 Supersedes: November 19, 2021
CONCRETE SUPERSTRUCTURE DETAILS	

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

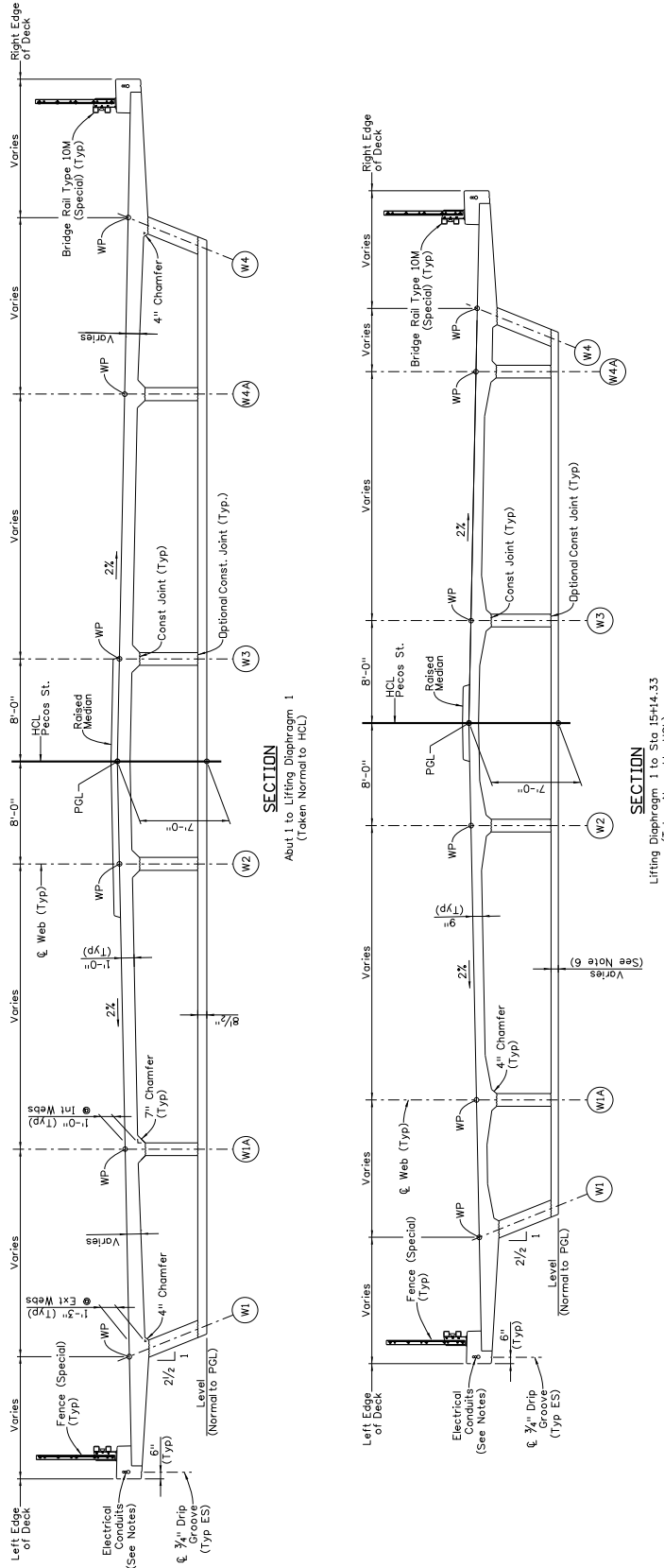
For post-tensioned structures, the following information shall be included:

- 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".



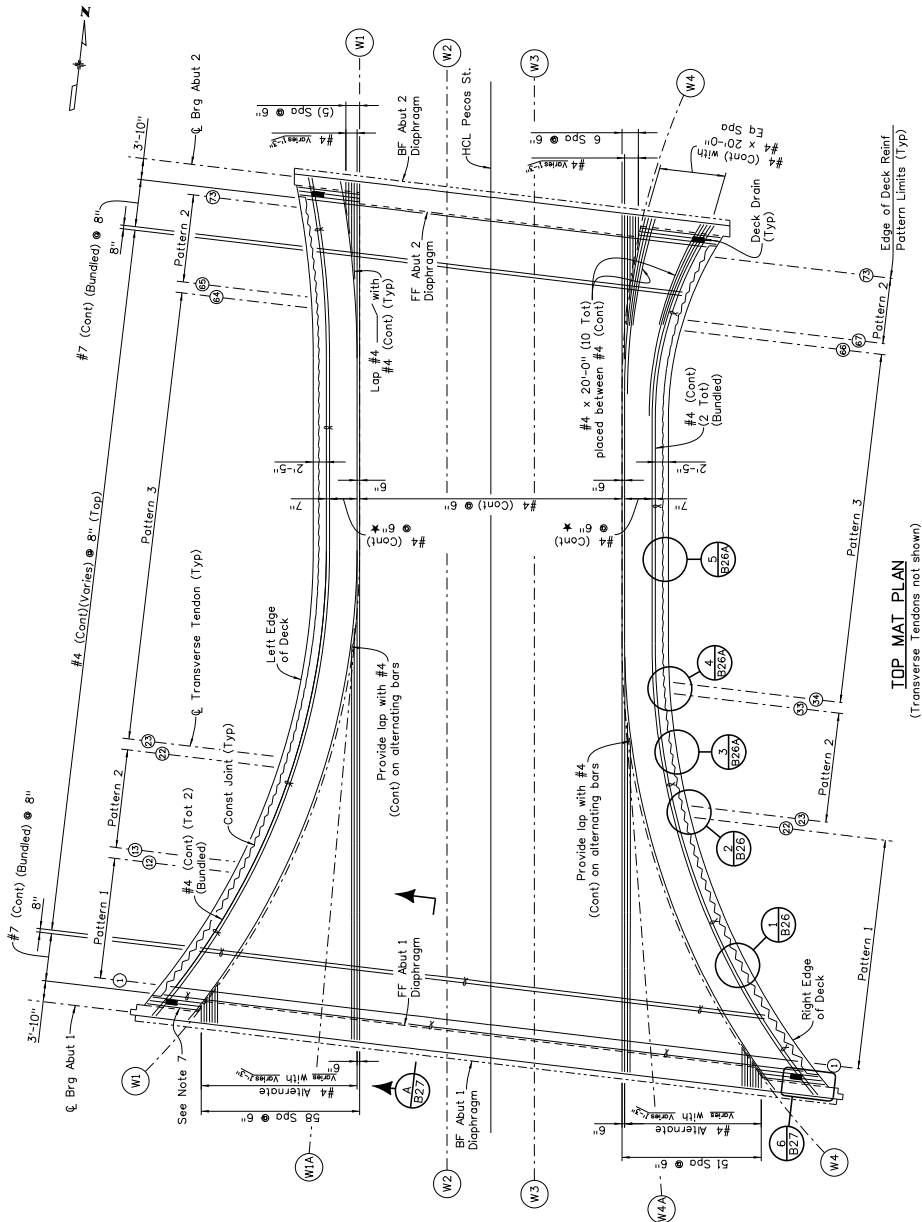
- NOTES:**
1. See Superstructure Details (3 of 3) for additional dimensions.
 2. Work Point (WP) location = ϕ Web at Top of Deck.
 3. All transverse dimensions are taken normal to HCL and are horizontal unless noted otherwise.
 4. See Construction Layout (1 of 2) for required electrical conduits.
 5. See Roadway plans for median geometry.
 6. See Longitudinal/PT Layout (Internal) sheet for bottom slab thickness.

**SUPERSTRUCTURE
DETAILS (1 OF 3)**

Example 13.1-1

NOTES:

1. All reinforcement not shown. See Deck Reinforcing Details for additional reinforcement at edges of deck.
 2. Place all transverse deck reinforcement parallel to \perp Bearing.
 3. Adjust location of transverse bars up to 2" as required to provide 2" minimum clear between transverse deck reinforcement and transverse tendons.
 4. See Deck Drain Details for deck drain locations.
 5. See Transverse Tendon Layout for transverse tendon locations.
 6. See Transverse Tendon Layout and Transverse P1 Details (1 of 3) for Construction Joint details.
 7. See Abutment Diaphragm Details sheets for reinforcement projecting from diaphragm into deck.
 8. For Edge of Deck Reinforcing Patterns, see Deck Reinforcing Details sheets.
- ★ Place bars parallel to edge of deck except as shown in NE corner.



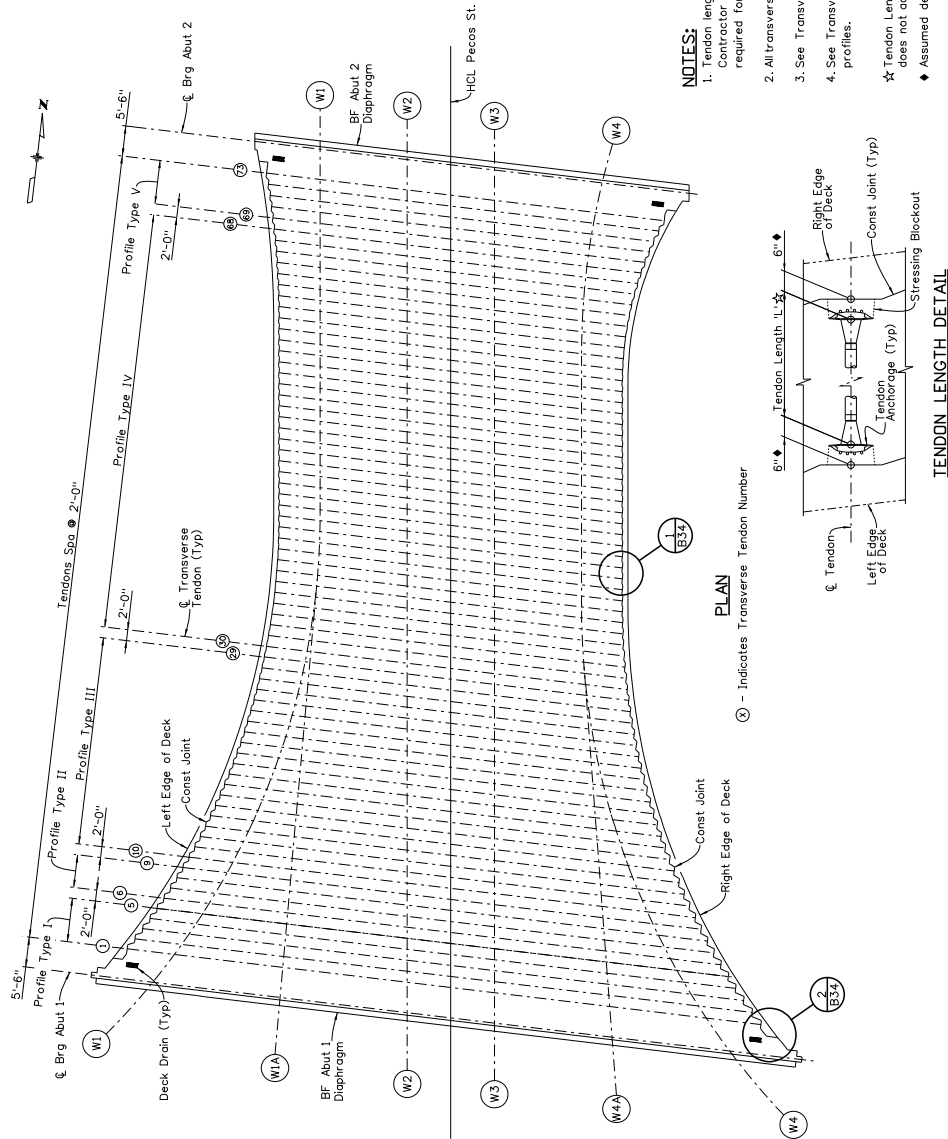
Example 13.1-2

DECK REINFORCING
TOP MAT PLAN

TOP MAT PLAN
(Transverse Tendons not shown)

TRANSVERSE POST-TENSIONING SCHEDULE

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

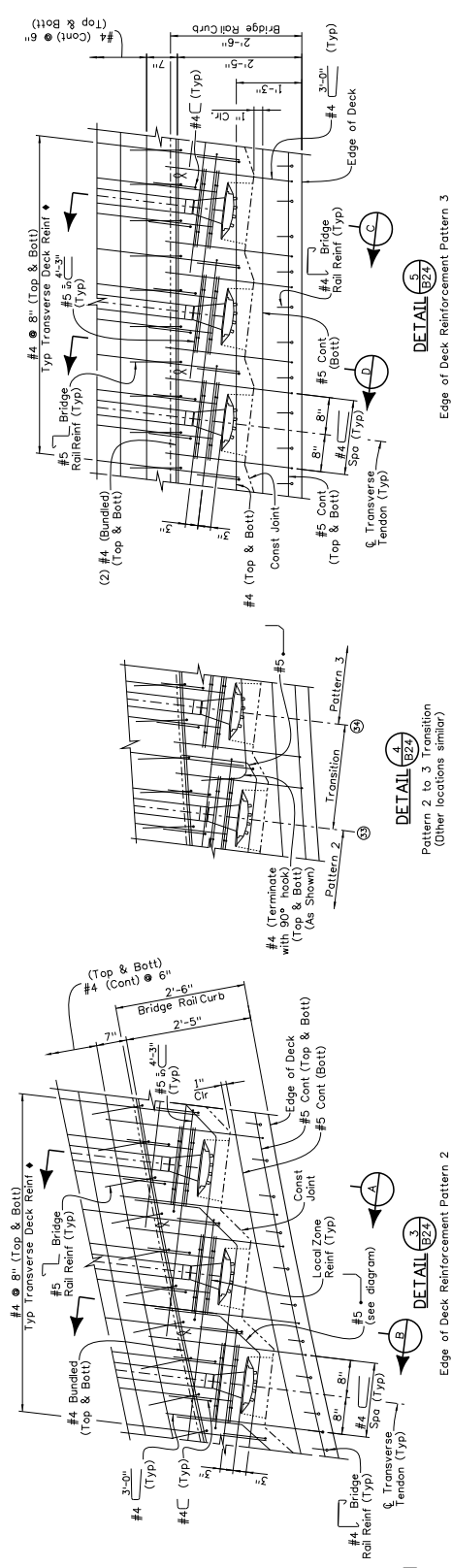


NOTES:

- Tendon lengths provided are for information only. The Contractor is responsible for verifying the tendon lengths required for transverse post-tensioning.
 - All transverse tendons shall be placed parallel to ξ Bearing.
 - See Transverse PT Details (1 of 3) for additional information.
 - See Transverse PT Details (2 of 3) and (3 of 3) for tendon profiles.
- * Tendon Length 'L' is measured in plan along ξ tendon end does not account for additional length due to tendon profile.
- ◆ Assumed depth of pocket former. Actual dimensions may vary.

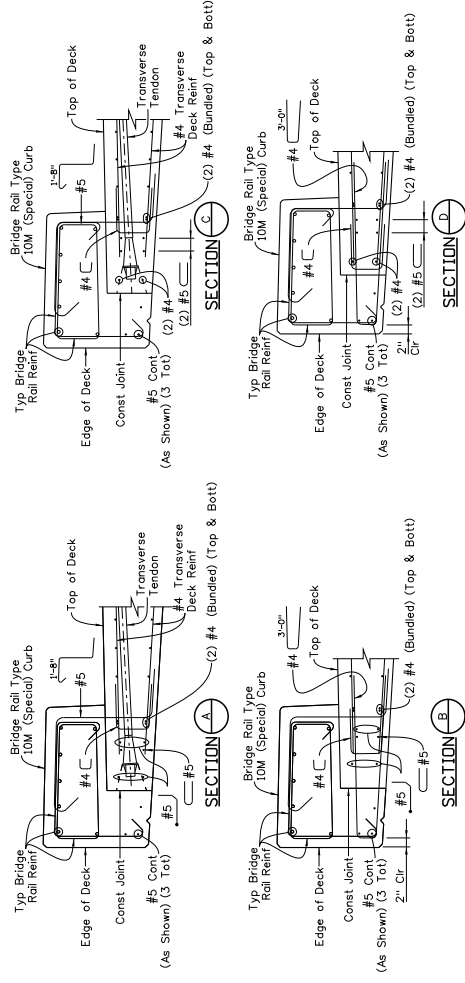
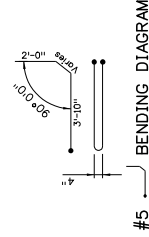
Example 13.1-3

TRANSVERSE
TENDON LAYOUT

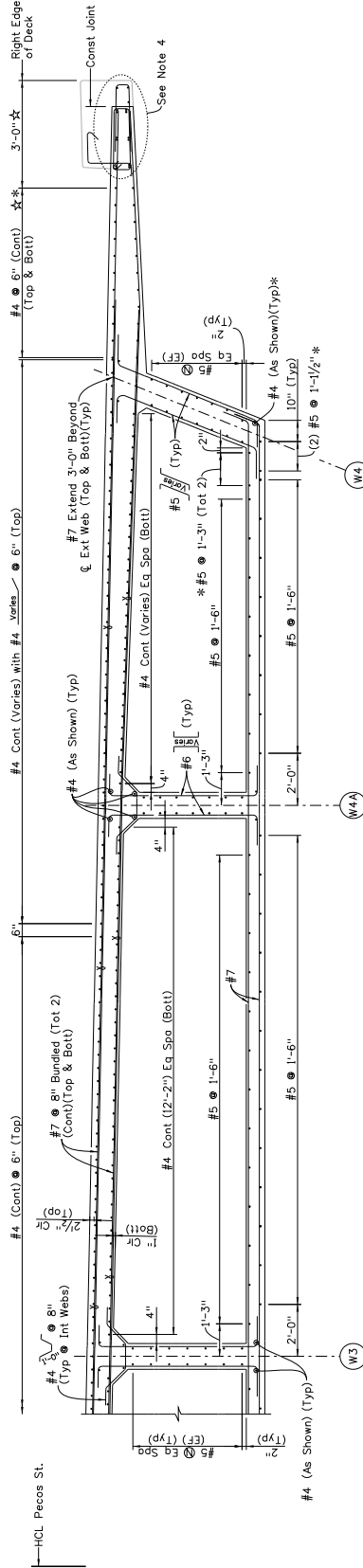


Example 13.1-4

- NOTES:**
1. For local zone reinforcement, see Transverse PT Details (1 of 3).
 2. See Transverse Tendon Layout for transverse tendon locations.
 3. See Bridge Rail Type 10M (Special) sheets for typical bridge rail reinforcement.
- ◆ See Transverse Reinforcement Detail on Deck Reinforcing Details (1 of 3) sheet



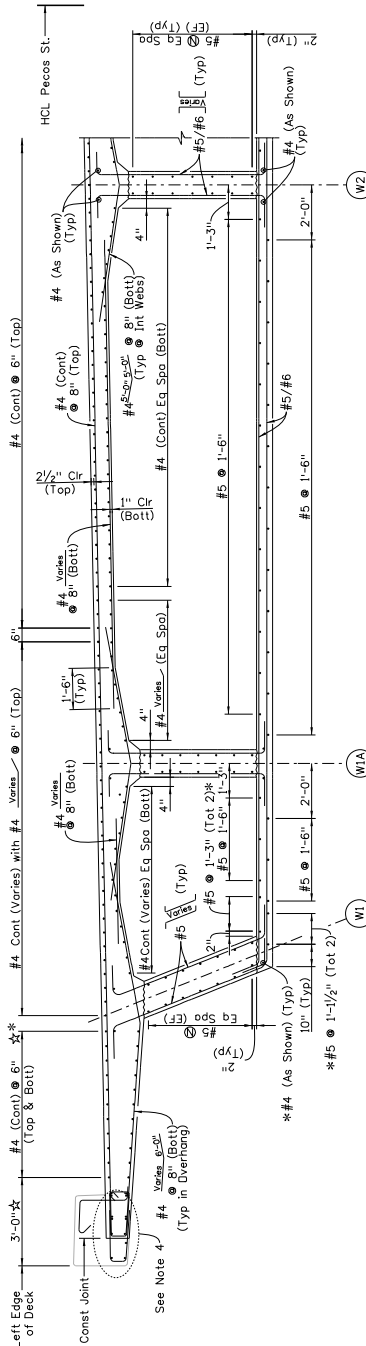
DECK REINFORCING DETAILS
(2 OF 3)



PARTIAL SECTION
Abut 1 to Lifting Diaphragm 1
(Taken Normal to HCL)

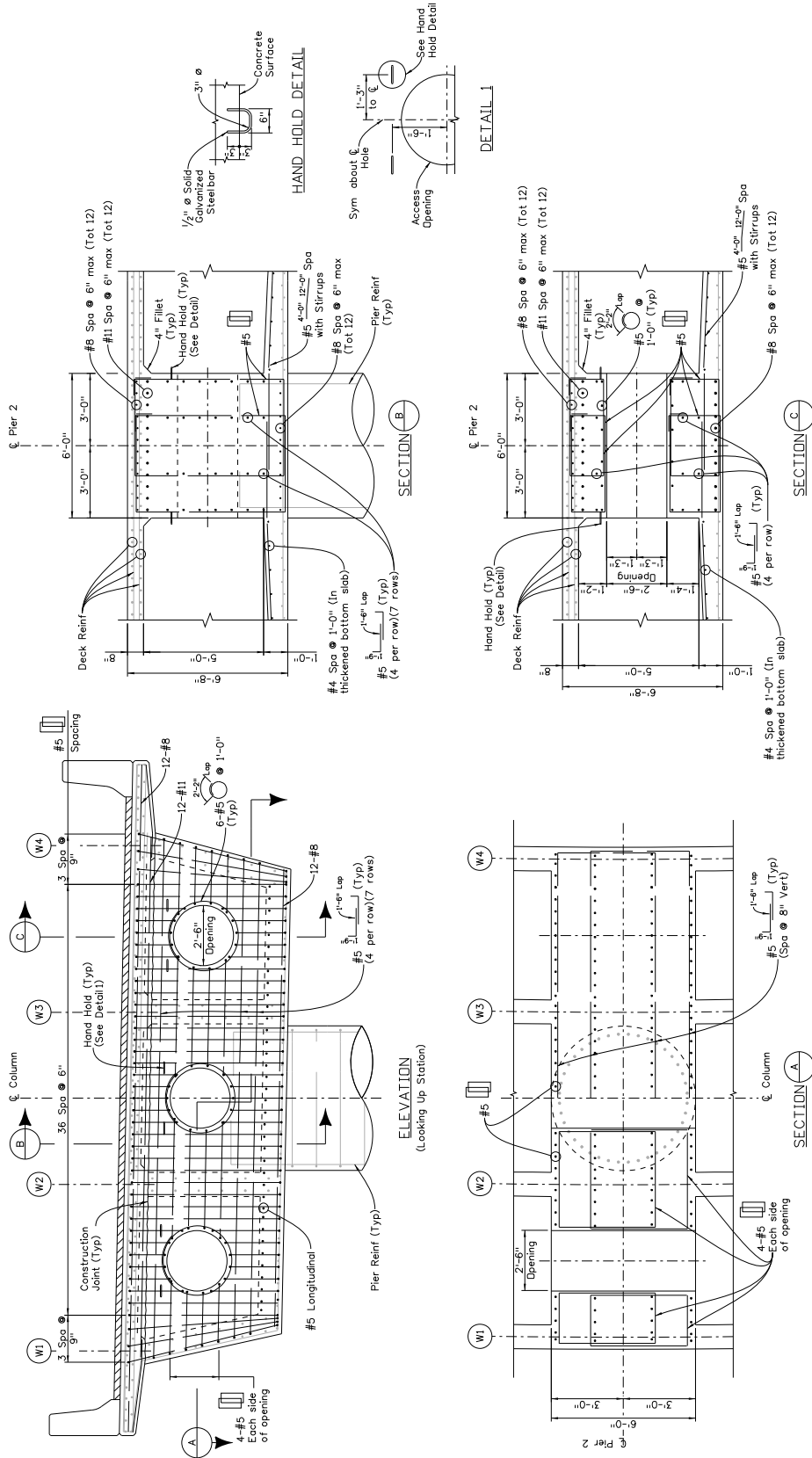
NOTES:

1. Provide 1/2" clear concrete cover unless otherwise noted.
 2. For additional details see Deck and Bottom Slab Reinforcing Plan sheets.
 3. All bottom slab reinforcing is non-coated. All other reinforcing is epoxy coated unless noted otherwise.
 4. See Deck Reinforcing Plan and Details sheets for details of reinforcement at edge of deck.
 5. For web stirrup spacing, See Longitudinal PT Layout - Internal.
 6. Web stirrups extend through the lifting diaphragm.
- * Place along Curve
* Measured normal to Edge of Deck



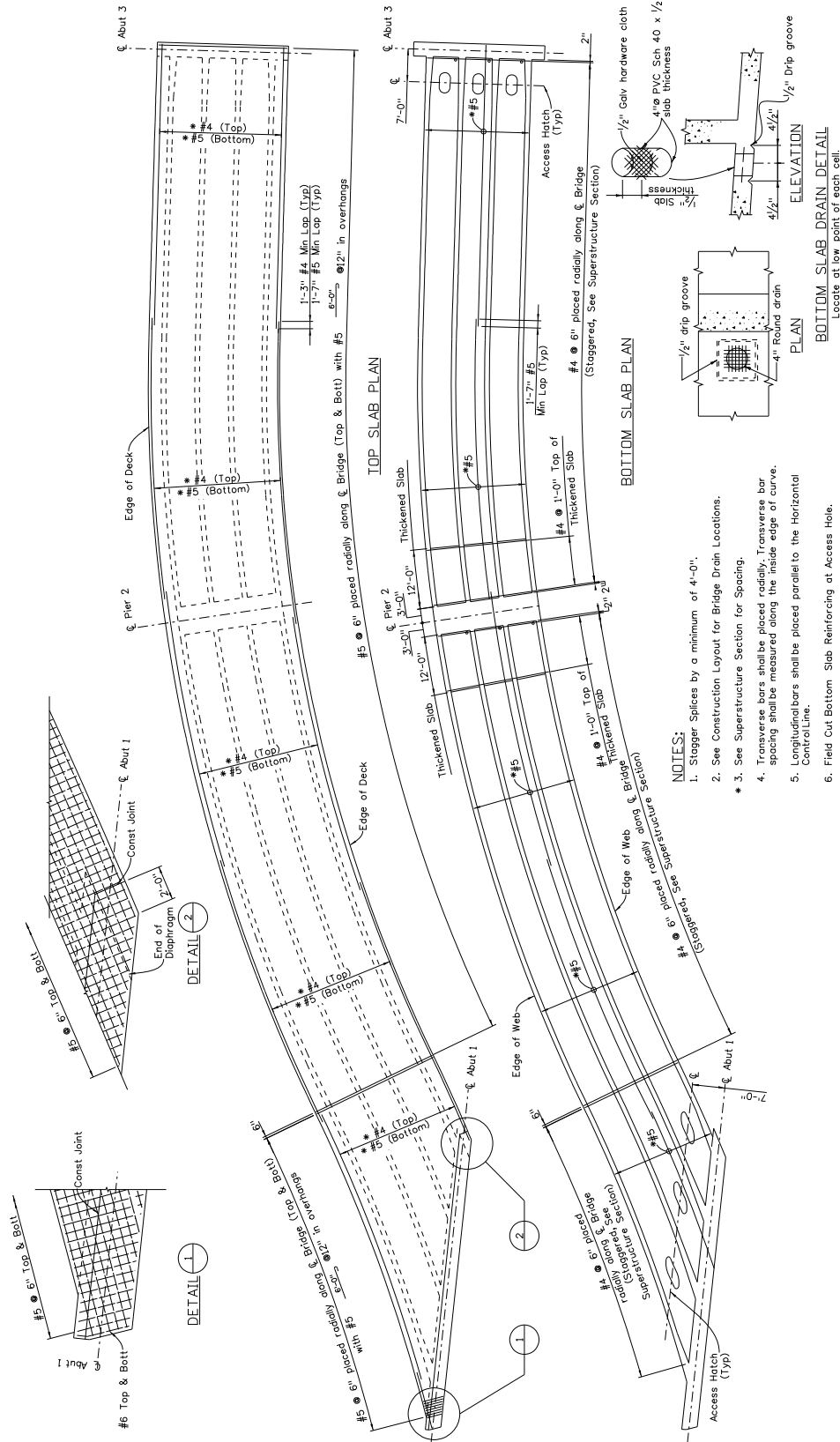
PARTIAL SECTION
Lifting Diaphragm 1 to Sta 15+4.33
(Taken Normal to HCL)

Example 13.1-5



PIER 2 DIAPHRAGM DETAILS

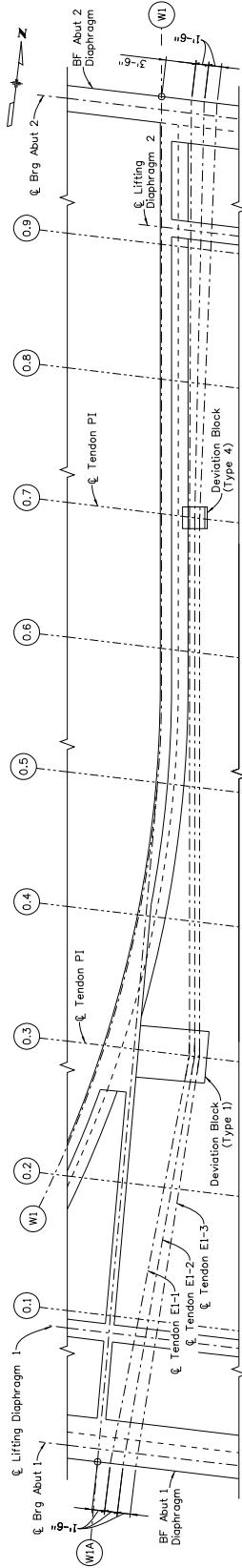
Example 13.1-7



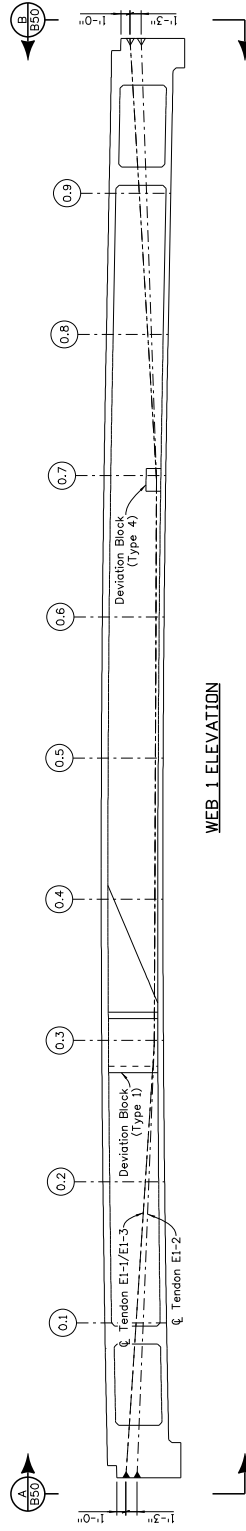
Example 13.1-8

SLAB REINFORCING PLAN

BOTTOM SLAB DRAIN DETAIL
Locate at low point of each cell.



WEB 1 PARTIAL PLAN



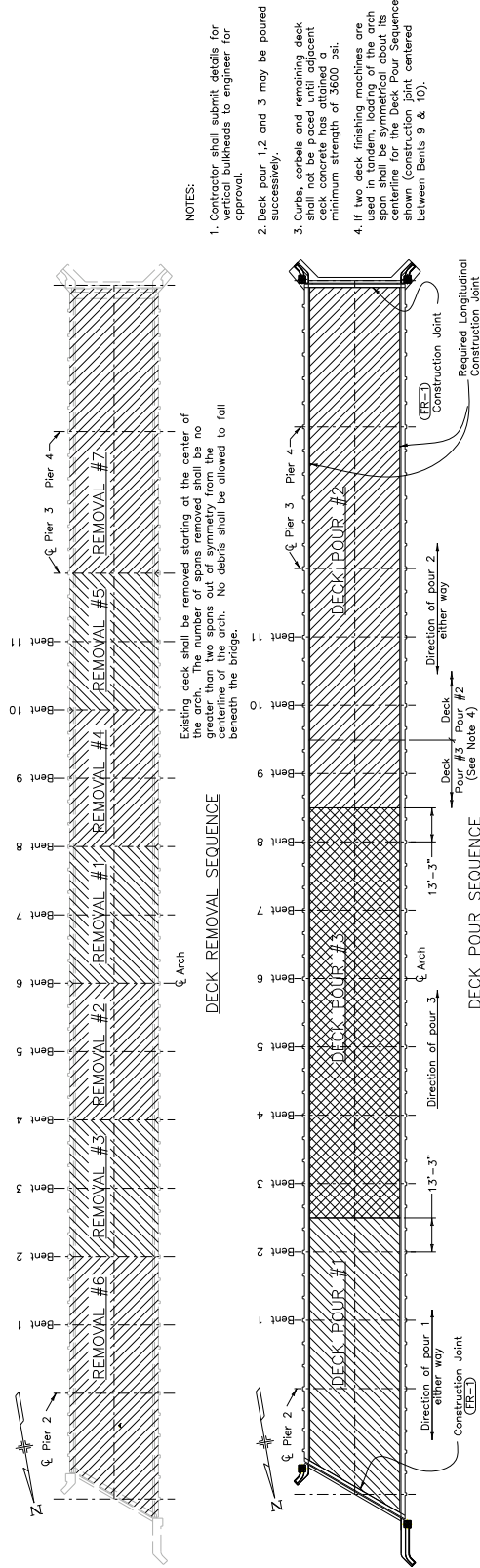
WEB 1 ELEVATION

- LEGEND:**
- ▷ Non-Stressed Anchor
 - ▶ Stressed Anchor
 - E3-2 Tendon Number *
 - Associated Web
 - E - External
 - I - Internal
- 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 0.619" 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.

- STRESSING SEQUENCE:**
- All external longitudinal tendons shall be jacked from Abut. 1 end following abutment diaphragm PT bar stressing operations. No more than 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 1/6 of the total prestressing force be applied eccentrically about the centerline of the structure.
- DESIGN:**
- Design is based on $K=0$ and $\mu=0.25$, $P/(FNA)$ 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_n MINIMUM = 270 sq. inches for each external tendon.
 f_{ps} = 5800 psi at 28 days field compressive strength
 f_{pc} = 4800 psi at stressing
- The Contractor shall submit elongation and jacking calculations based on KL/μ (including anchor set, if any) and initial stress (initial stress ratio times jacking stress before long term losses) at each tenth point.

- LONGITUDINAL PT LAYOUT**
EXTERNAL (1 OF 3)

Example 13.1-9



- NOTES:**
1. Contractor shall submit details for vertical bulkheads to engineer for approval.
 2. Deck pour 1, 2 and 3 may be poured successively.
 3. Curbs, corbels and remaining deck shall not be placed until adjacent spans have reached their design minimum strength of 3600 psi.
 4. If two deck finishing machines are used, the machines shall be spaced such that span shall be symmetrical about its centerline for the Deck Pour Sequence shown (construction joint centered between Bents 9 & 10).

CONSTRUCTION SEQUENCE DETAILS

Example 13.1-10

COLORADO DEPARTMENT OF TRANSPORTATION STAFF BRIDGE BRIDGE DETAIL MANUAL	Chapter: 13.2 Effective: October 8, 1986 Supersedes: New
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. 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 |

13.2.3 Structural Steel (General) (Continued)

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:

13.2.4 Welding (Continued)

- (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:

13.2.5 Welding Symbols (continued)

- (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.

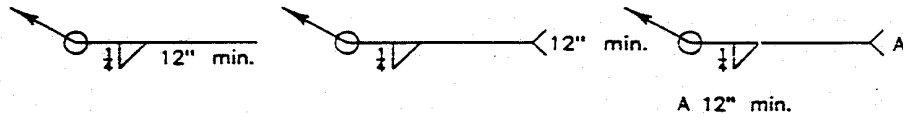
A brief description of the items follows:

- (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 Angel: 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.

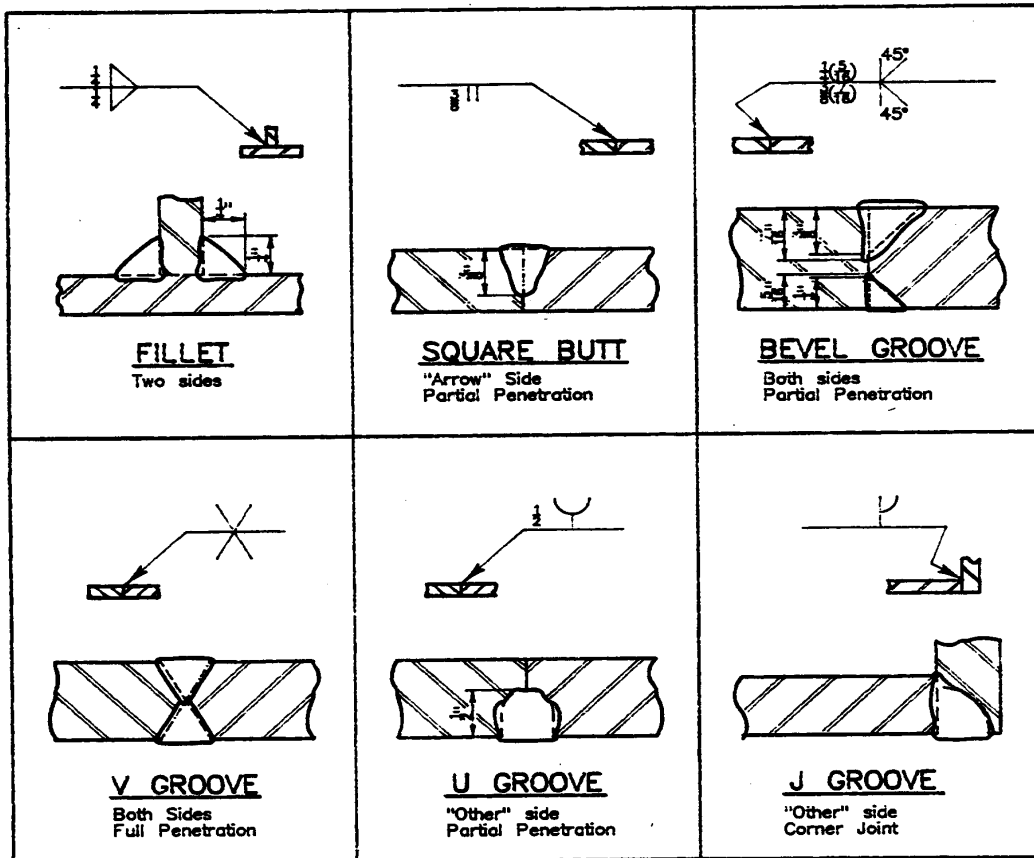
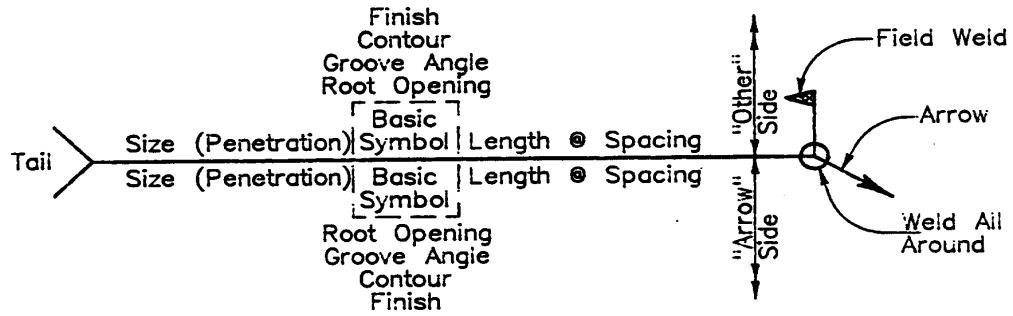
13.2.5 Welding Symbols (continued)

- (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:



10/08/86

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.



13.2.5 Welding Symbols (continued)

- (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.

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.

13.2.6 Fillet Welds (continued)

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.

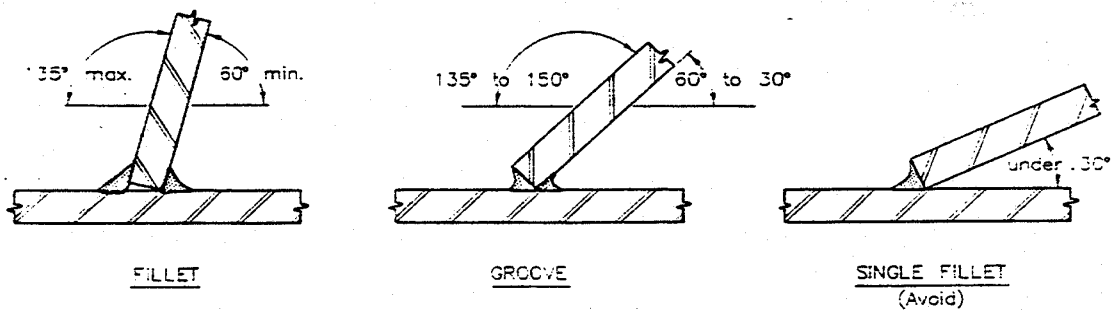


FIG. 13.2-2 T JOINT WELD LIMITS

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.

13.2.8 Bolted Connections (continued)

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 <u>Size</u>	Absolute <u>Minimum</u>	Preferred <u>Minimum</u>
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 FRAMING PLAN 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

13.2.11 Framing Plan (continued)

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

13.2.12 Girder Elevation (continued)

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 H. S. bolts) (1-1/8" X 15/16" for 7/8" Ø H.S. 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:

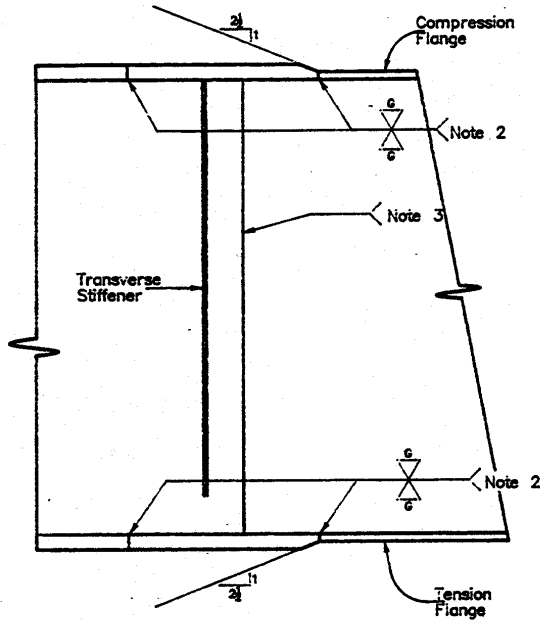
- (a) The stiffeners are ground to bear or full penetration welded against the bottom flange and welded to the top flange at the ends of the girder.
- (b) Where the girder is continuous over a pier, the stiffener shall be ground to bear or full penetration welded against the bottom flange and tight fit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

13.2.16 Lateral Bracing Details

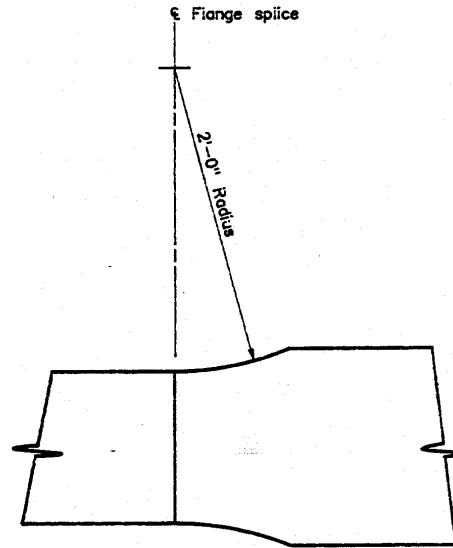
The details for the lateral bracing shall include:

- (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.

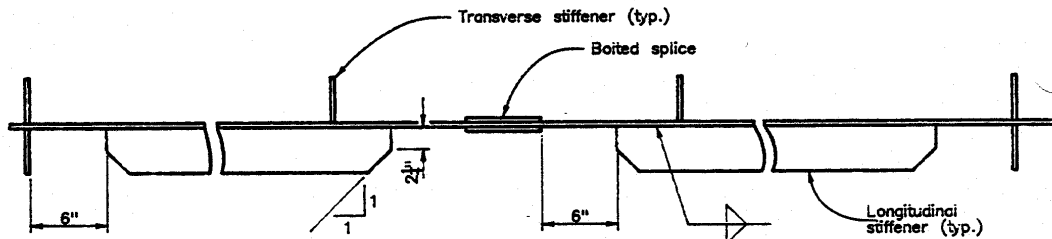
4



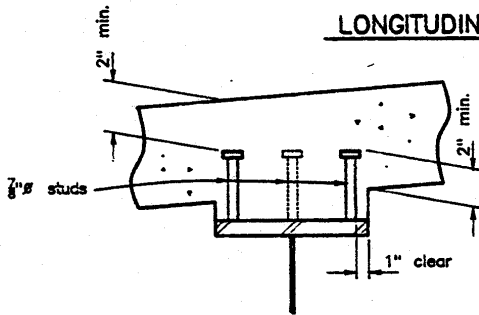
FABRICATION DETAIL



FLANGE WIDTH TRANSITION



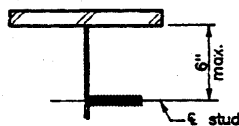
LONGITUDINAL STIFFENER DETAILS



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%.



7/8 inch 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

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.

13.2.20 Slab (continued)

- (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 side of the flange for noncomposite 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."
- (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, "SECTION."

Special attention should be given to the placement of the reinforcing near the expansion device.
- (g) 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

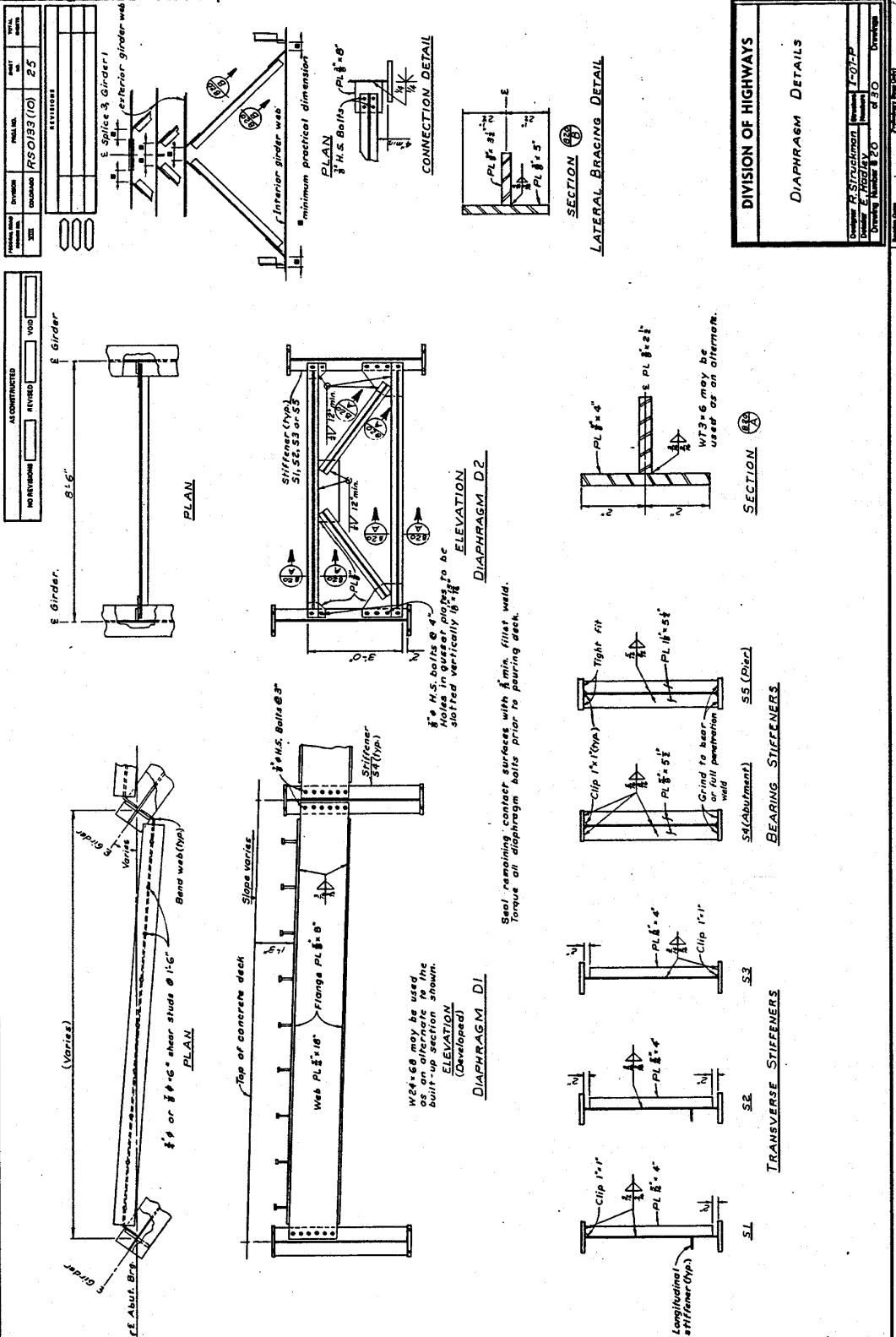
Railing will usually be shown on standard sheets obtained from the Standards Unit. Special details may be required for architectural considerations, unusual requirements, etc.

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.

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Steel Superstructures 13.2



9-15-82

Fig. 13-2-3

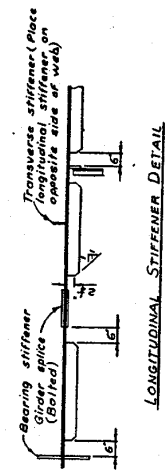
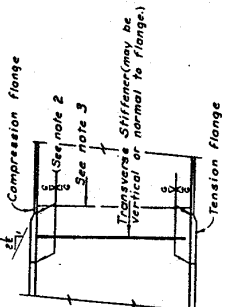
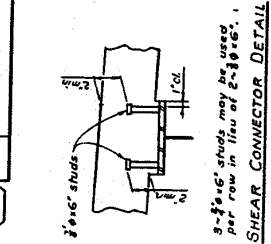
13-20	13-21	13-22	13-23	13-24	13-25	13-26	13-27	13-28	13-29	13-30
13-20	13-21	13-22	13-23	13-24	13-25	13-26	13-27	13-28	13-29	13-30

13.2 Detailing and Checking Procedures

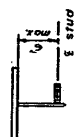
Volume II

PROJECT NO.	SECTION	DATE
RSO133(10)	26	
REVISIONS		

AS CONTRACTED	REVISED

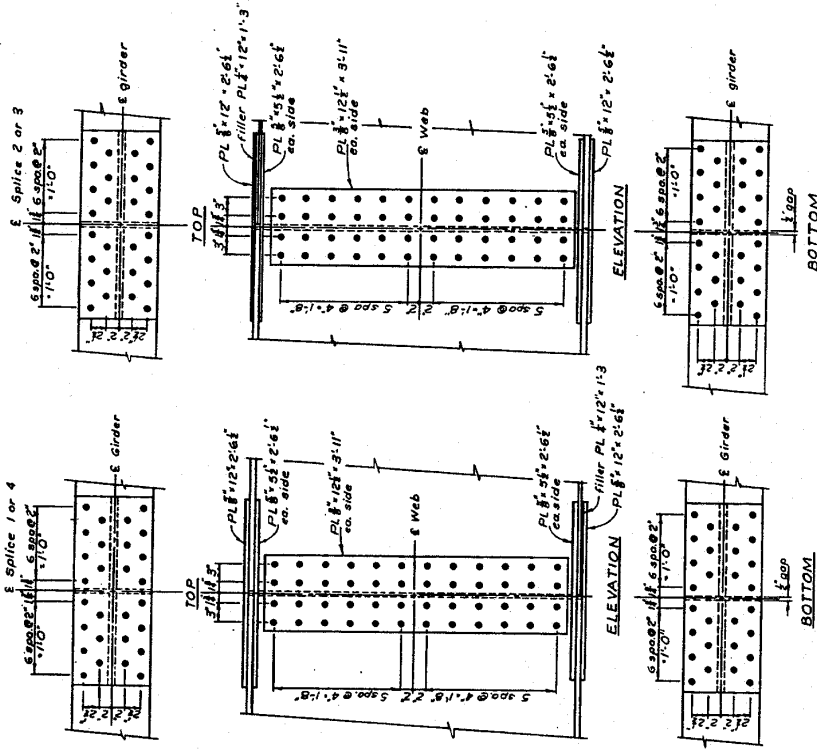


1. ALL WELDS TO BE FULL PENETRATION BUTT JOINTS.
2. WELD ALL FLANGES BUT WEBS.
3. WELDS MUST BE MADE IN ACCORDANCE WITH AISC SPECIFICATION FOR STRUCTURAL STEELWORK. THE WELD METS SHALL BE GRADE F50.
4. STIFFENERS NEAR A FIELD SPICE MAY BE FIELD WELDED.
5. ALL FIELD WELDS AND STIFFENERS SHALL BE VERTICAL EXCEPT WHERE SHOWN OTHERWISE. TO MAKE THE WELDS LESS THAN 2".



USE 3/4 x 6 STUDS AT ALL POINTS OF CONNECTION BETWEEN PLATES AND GIRDER WEBS. SUPPORTS SHALL BE SPECIFIED BY THE CONTRACTOR. ALL WELDS SHALL BE FULL PENETRATION BUTT JOINTS.

SUPPORT FOR FALSEWORK



SPICE 2 OR 3

SPICE 1 OR 4

All splice bolts to be 5/8 H.S.

DIVISION OF HIGHWAYS

SPLICE DETAILS

MISCELLANEOUS STEEL DETAILS

Contract No.	757 (12/1/75)	Revision	1/27: P
Sheet No.	13.2	Drawing Number	13.2
Project Name		of 30 Drawings	

9-15-82

DATE	BY	CHECKED	APPROVED

Fig. 13-2-6

Volume II

Steel Superstructures 13.2

NO REVISIONS	AS CONSTRUCTED	VOID
REVISIONS	REVISED	VOID

REVISIONS

DATE	BY	REVISIONS

SPAN NUMBER 1

CAMBER CUTTING DIMENSIONS FOR A WELDED PLATE GIRDER

SPAN NUMBER 1

SPAN NAME 1

SPAN LENGTH (IN FEET) = 117.000

SPAN NUMBER 2

SPAN NAME 2

SPAN LENGTH (IN FEET) = 117.000

SPAN NUMBER 3

SPAN NAME 3

SPAN LENGTH (IN FEET) = 117.000

SPAN NUMBER 1

SPAN NUMBER 1

SPAN NAME 1

SPAN LENGTH (IN FEET) = 117.000

SPAN NUMBER 2

SPAN NAME 2

SPAN LENGTH (IN FEET) = 117.000

SPAN NUMBER 3

SPAN NAME 3

SPAN LENGTH (IN FEET) = 117.000

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SPAN NAME 3

SPAN LENGTH (IN FEET) = 117.000

DIVISION OF HIGHWAYS

CAMBER AND DEAD LOAD DEFLECTIONS

DESIGNED BY STRUCTURAL DIVISION

DRAWN BY

DATE

PROJECT NO.

DRIVING SURFACE

9-15-82

9-15-82	AS	CONSTRUCTED
9-15-82	AS	CONSTRUCTED
9-15-82	AS	CONSTRUCTED
9-15-82	AS	CONSTRUCTED

Fig. 13-2-7

COLORADO DEPARTMENT OF TRANSPORTATION STAFF BRIDGE BRIDGE DETAIL MANUAL	Chapter: 13.3 Effective: May 31, 2023 Supersedes: March 15, 2021
PRESTRESSED CONCRETE SUPERSTRUCTURE DETAILS	

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

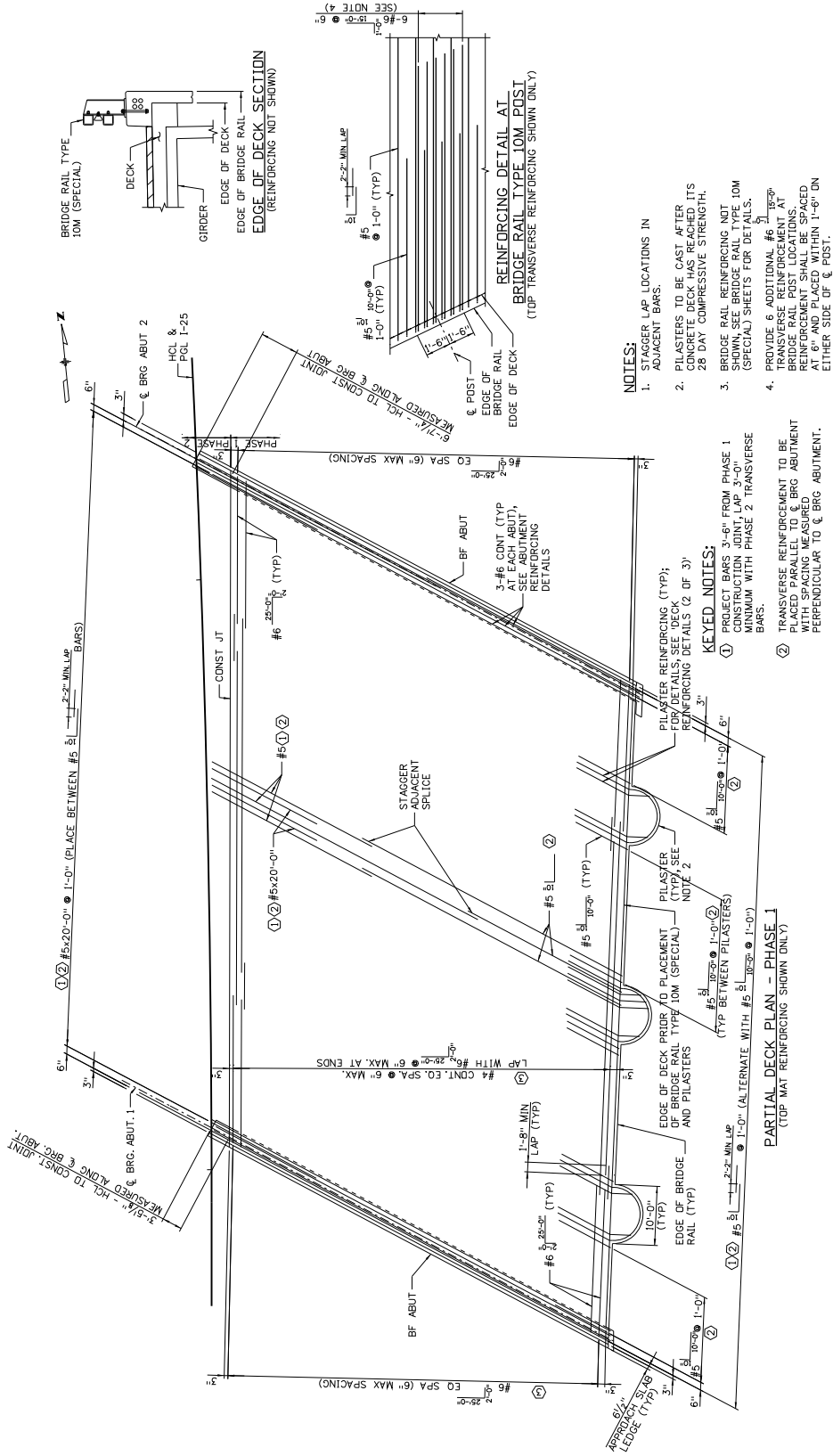
13.3.12 TITLE BLOCK

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

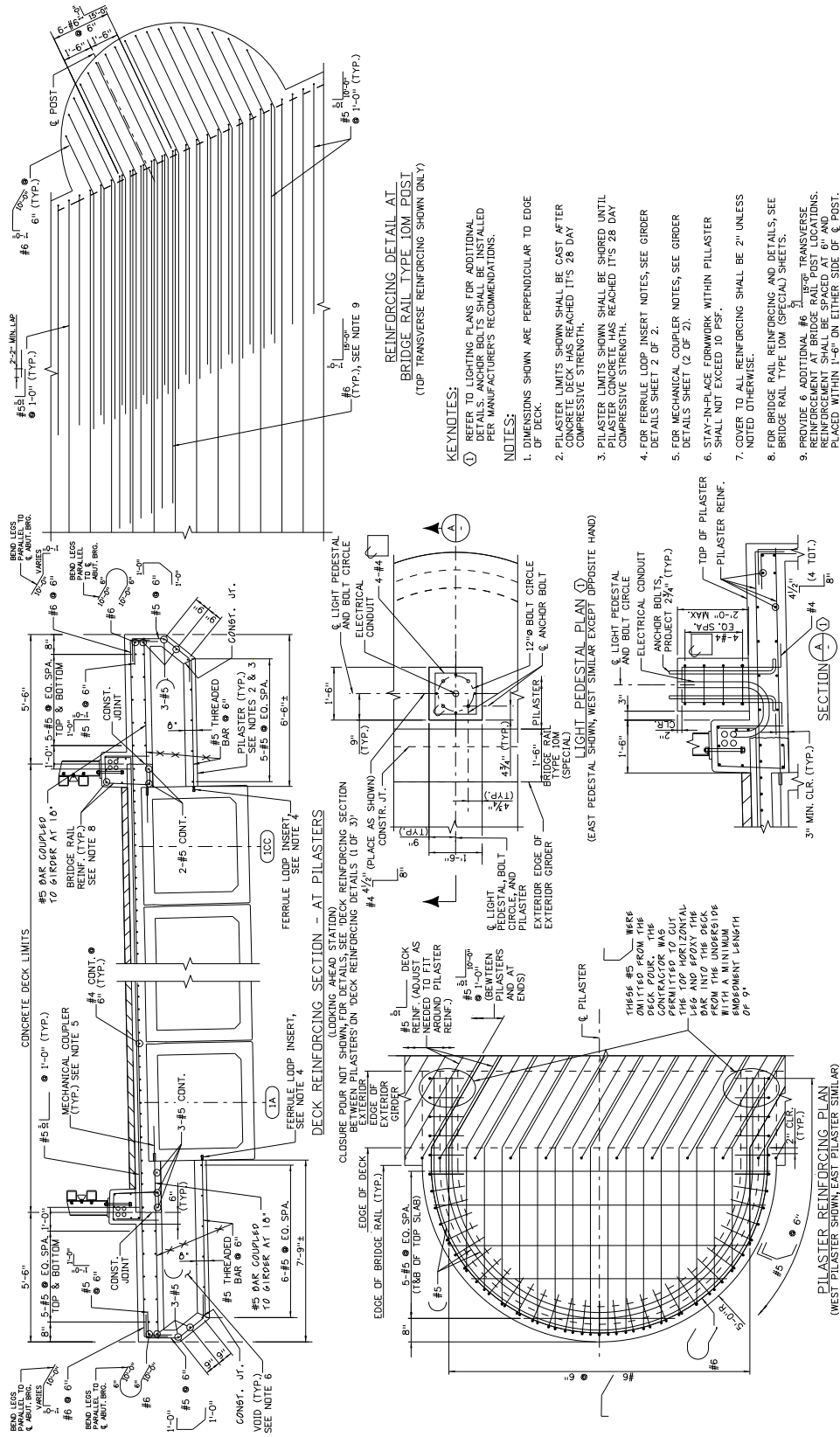
If other details are combined on this drawing, they shall be indicated in the title. Example: If the "Barrier Details" are placed on this drawing with the "Deck Details", the title shall be "DECK DETAILS - BARRIER DETAILS".

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



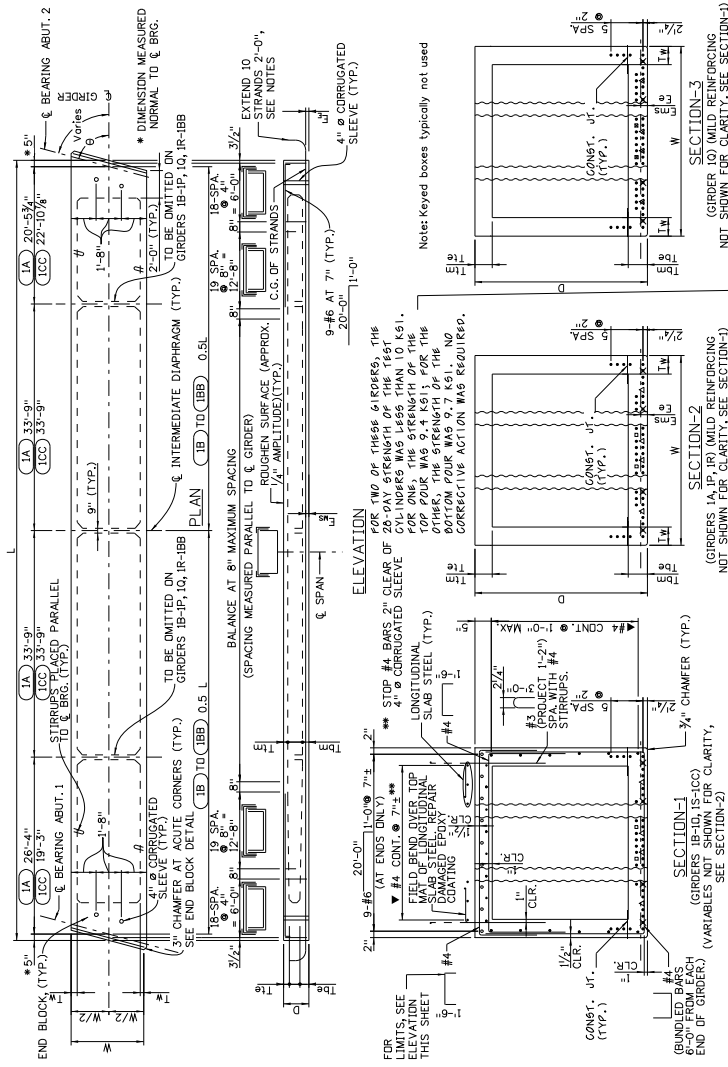
EXAMPLE 13.3.2 –Reinforcing Details

NOTES:
WHEN APPROVED BY THE ENGINEER, A MINIMUM OF TACK WELDING WILL BE PERMITTED ON ASTM A706 UNGRADED REINFORCING STEEL.
REINFORCING PROJECTING FROM THE TOP OF THE GIRDER AND REINFORCING WITHIN 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 EPXY PROTECTANT. EXCEPT AS SHOWN, DO NOT MAKE COSMETIC REPAIRS (DAMAGE LESS THAN 1" DEEP) TO THE PARTS OF THE GIRDER EMBEDDED IN CONCRETE.
USE LOW RELAXATION STRANDS MEETING THE REQUIREMENTS OF ASTM A-416 GRADE 270. THE MINIMUM CLEAR DISTANCE BETWEEN GROUPS OF INDIVIDUAL STRANDS SHALL BE 1" BUT NOT LESS THAN 1/2". THE MINIMUM COVER FOR PRESTRESSING 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" CHAMFER ON ALL CORNERS, EXCEPT AS NOTED.
PREDICTED GIRDER FINAL CAMBER IS THE CAMBER FOR THE GIRDER ALONE AT 90 DAYS AFTER CASTING. THE CAMBER PLUS 1" PRIOR TO THE DECK POUR BY WEIGHTING, SCHEDULING FABRICATING, POST TENSIONING, OR OTHER MEANS AND MUST REPORT TO THE ENGINEER. THE CAMBER SHALL BE APPROVED BY THE ENGINEER. THE APPROVED REMEDIAL MEASURES SHALL BE ADVISORY. THE CONTRACTOR SHALL TAKE ALL NECESSARY MEASURES TO CORRECT THE CONTRASTING WITH ALL REPAIRS AND MEASURES SHALL BE MADE BY THE CONTRACTOR.

SIZE AND TYPE OF REINFORCING SHALL BE AS SHOWN. OVER PROBS OR REPAIRS SHALL BE APPROVED BY THE ENGINEER. THE CAMBER PLUS 1" PRIOR TO MORE THAN 1" BEFORE THE DECK POUR. PRIOR TO PLACING DECK REINFORCING, THE CONTRACTOR SHALL ADJUST THE DIFFERENCE BY PULLING THE RUSH BOXES DOWN AND LOW BOXES UP.
DEPTH (D) TOLERANCE SHALL BE + 1/8" - 1/8".
THE CONTRACTOR IS RESPONSIBLE FOR DETERMINING NECESSARY BRACING, 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 Δ = 6 FEET ρ = 2 FEET
EXTENDER STRAND SHALL NOT BE DEBONDED AND SHOULD BE PLACED ADJACENT TO ANCHOR STRIPS.

A_p = MINIMUM AREA OF TENSILE PRESTRESSING STEEL.
A_s = ULTIMATE STRENGTH OF PRESTRESSING STEEL.
F₁ = JACKING FORCE PER GIRDER.
F₂ = REQUIRED CONCRETE STRENGTH AT RELEASE.
f_{1c} = REQUIRED PRESTRESS FORCE STRENGTH AT 28 DAYS OF AGE.
L = LENGTH OF GIRDER ALONG THE GRADE OF DECK.
Δ = IMMEDIATE DEFLECTION AT CENTERLINE OF SPAN DUE TO CAST-IN-PLACE SLAB.
θ = BRIDGE SKEW ANGLE.
E_m = DISTANCE MEASURED FROM BOTTOM OF GIRDER TO C.G. OF STRAND GROUP AT ENDS.
*A-P = DEBONDED LENGTH. SEE NOTES FOR LIGHTLY TENSIONED STRANDS MAY BE USED AS AN ALTERNATE.

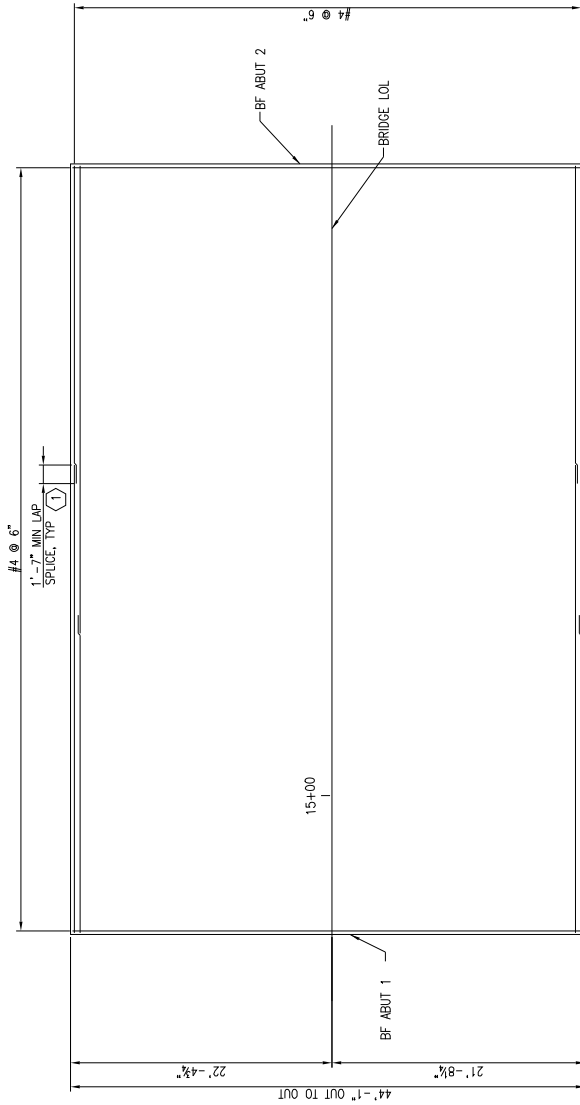


GIRDER SCHEDULE

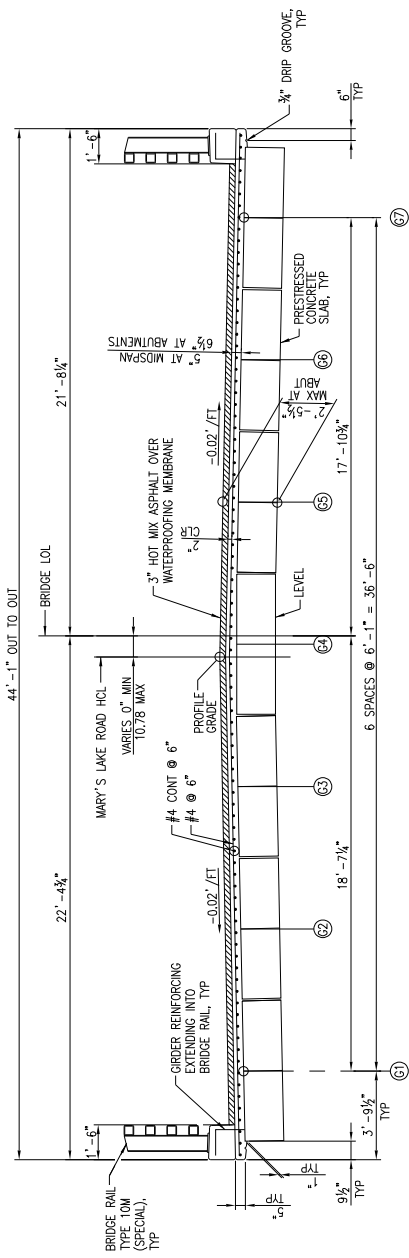
(GIRDERS 1A, 1P, 1R) (MILD REINFORCING NOT SHOWN FOR CLARITY, SEE SECTION-1)
(GIRDERS 1B, 1D, 1S-1CC) (VARIABLES NOT SHOWN FOR CLARITY, SEE SECTION-2)

SPAN GIRDER NO.	L _t (FT)	W (IN)	D (IN)	θ (DEG)	T _w (IN)	T _{tm} (IN)	T _{te} (IN)	T _{be} (IN)	L _t (FT)	A _s * (SQ IN)	E _m (KIPS)	E ₁ (KIPS)	F ₁ (KIPS)	f _{1c} (KIPS)	f _{2c} (KIPS)	Δ _i (IN)	PREDICTED RELEASE CAMBER (IN)	PREDICTED FINAL CAMBER (IN)		
1 1A, 1P	115'-3 1/4"	60"	54"	59°59'58"	6"	6"	5 1/2"	6"	0	9.98	21.7	4.08	4.08	2021	1610	6,000	10,000	1.64	2.27	4.55
1 1B-1D	115'-3 1/4"	60"	54"	59°59'58"	6"	6"	5 1/2"	6"	0	9.11	23.8	4.06	4.06	1845	1496	6,000	10,000	1.02	1.92	3.78
1 1D	112'-10"	60"	54"	62°13'24"	6"	6"	5 1/2"	6"	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'-5 3/4"	60"	54"	64°32'32"	6"	6"	5 1/2"	6"	0	9.11	23.8	4.06	4.06	1845	1498	6,000	10,000	0.79	1.93	3.86
1 1R	110'-5 3/4"	60"	54"	64°32'32"	6"	6"	5 1/2"	6"	0	9.98	21.7	4.08	4.08	2021	1610	6,000	10,000	1.52	2.27	4.61

EXAMPLE 13.3.4 – Prestressed Girder



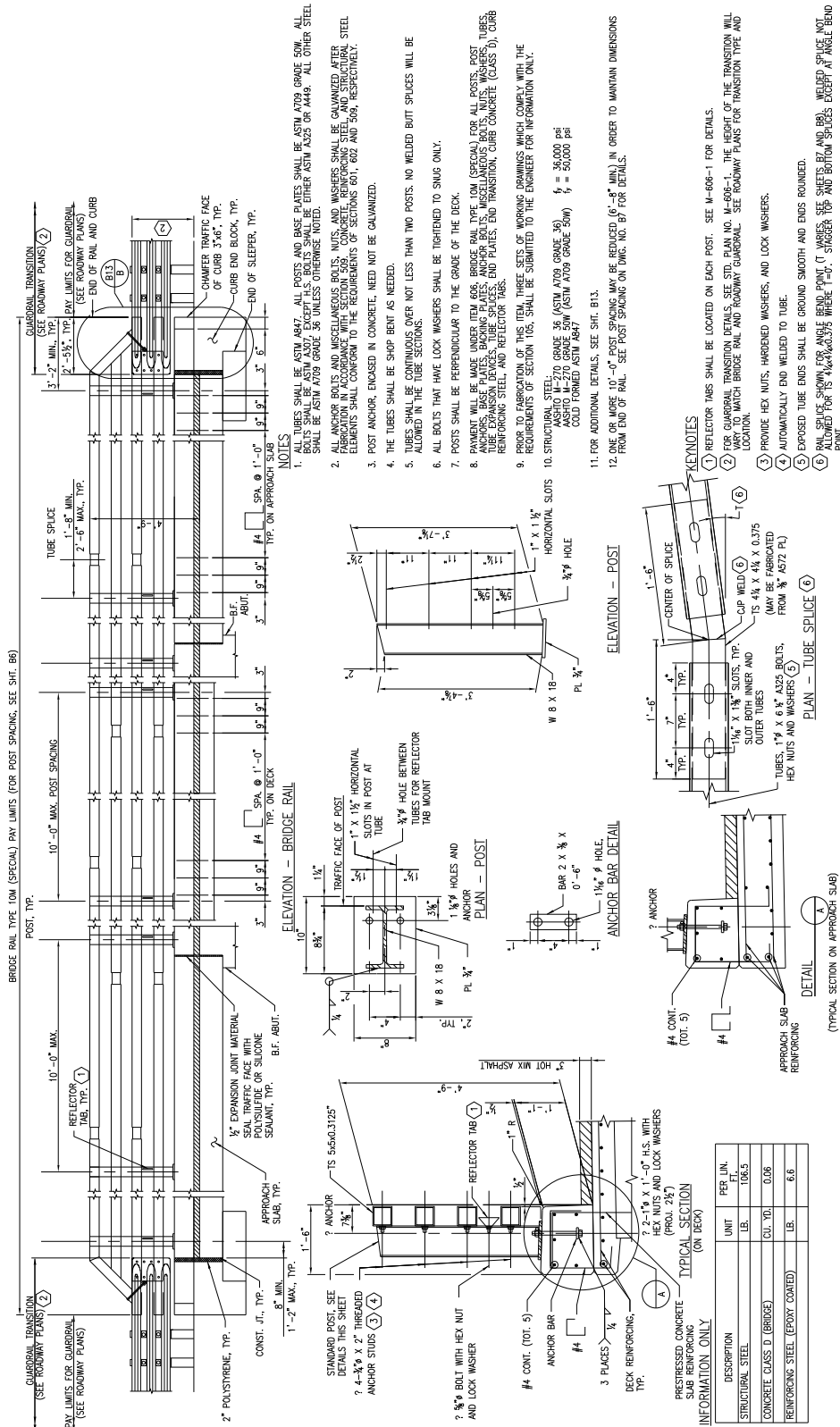
DECK REINFORCING PLAN
SCALE: 3/8" = 1'-0"



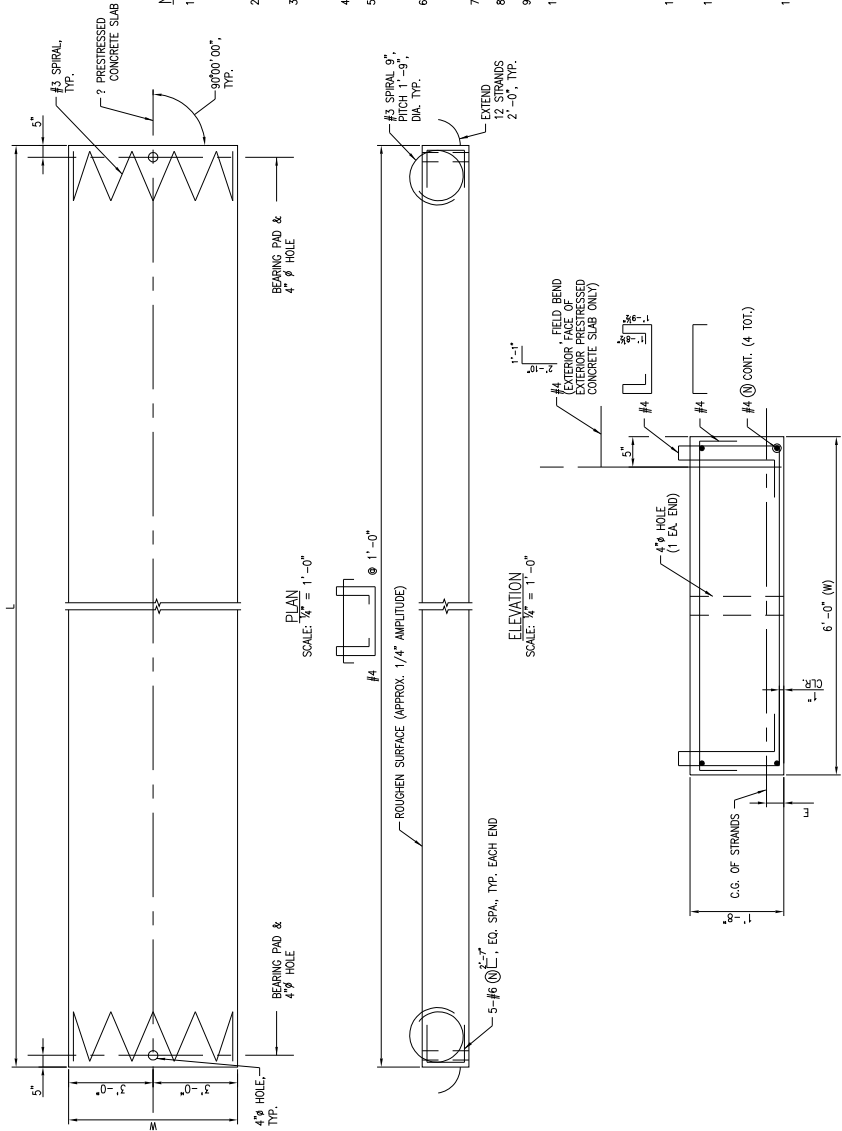
KEYED NOTES
① STAGGER SPICES AS SHOWN.

- NOTES**
1. CONCRETE SHALL BE CONCRETE CLASS S40.
 2. FOR BRIDGE RAIL DETAILS, SEE DWGS B12 AND B13.

EXAMPLE 13.3.5



EXAMPLE 13.3.6



NOTES

1. ALL WORK NECESSARY TO FABRICATE AND INSTALL THE INTEGRAL PARTS OF THE PRESTRESSED CONCRETE SLAB SHALL BE IN ACCORDANCE WITH THE PRESTRESSED CONCRETE SLAB (D-137), WITH A PAY UNIT OF 50 FEET WHICH SHALL BE MEASURED BY DIMENSION LAW.
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 1/2" 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, BUT NOT LESS THAN 1/8". THE MINIMUM COVER FOR PRESTRESSING STEEL IS 1/2".
7. CONCRETE SHALL BE CLASS FS.
8. ENTRAINED AIR IS NOT REQUIRED FOR PRESTRESSED CONCRETE SLAB CONCRETE.
9. USE 1/2" CAMBER 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 WEIGHING, SCHEDULING FABRICATION, POST TENSIONING, OR OTHER MEANS AND MUST REPORT TO THE ENGINEER THE MEASUREMENTS AND RESULTS. THE CONTRACTOR SHALL TAKE ALL NECESSARY 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 TABLE 13.3 SECTION 8.6 SHALL APPLY AS SPECIFICATION TOLERANCE, EXCEPT THAT THE DEPTH TOLERANCE SHALL BE $\pm \frac{1}{8}$, $\pm \frac{1}{4}$.
12. SIDE BY SIDE SLABS PLACED OVER ROADS OR PEDESTRIAN FACILITIES SHALL NOT HAVE CAMBERS OF ADJACENT GRIDDERS 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 GRINDING OR GRADING TO MINIMIZE DIFFERENTIALS, OR BY PULLING THE HIGH BORDS DOWN AND LOW BORDS 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.

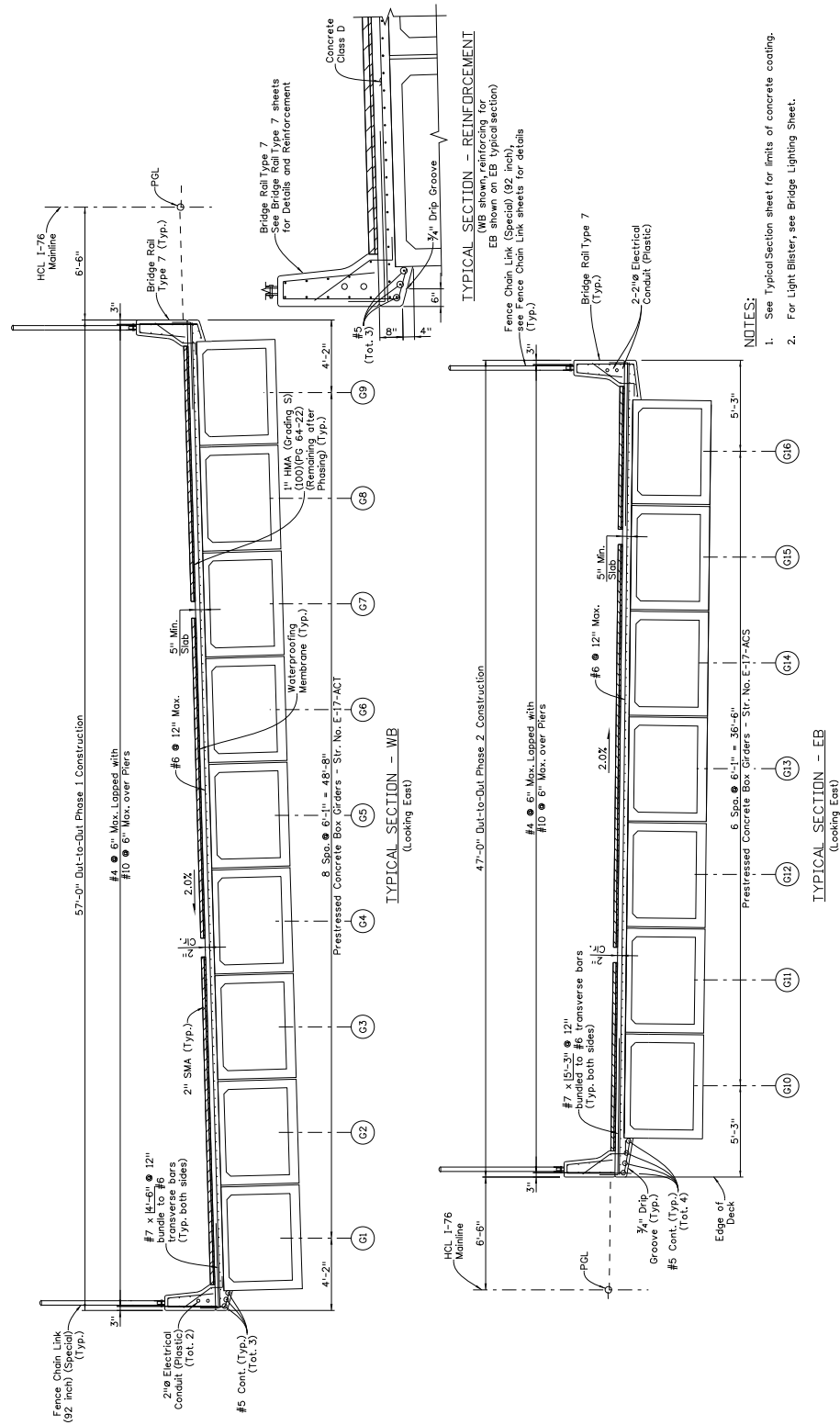
ABBREVIATIONS

- A_s = MINIMUM AREA OF THE PRESTRESSING STEEL
- d_s = NOMINAL STRAND DIAMETER
- F_j = JACKING FORCE PER PRESTRESSED CONCRETE SLAB
- F_i = FINAL FORCE PER PRESTRESSED CONCRETE SLAB AFTER ALL LOSSES
- f_{ps} = REQUIRED CONCRETE STRENGTH AT RELEASE OF PRESTRESS FORCE
- f_{cd} = REQUIRED CONCRETE STRENGTH AT 28 DAYS OF AGE
- L = LENGTH OF PRESTRESSED CONCRETE SLAB ALONG THE GRADE OF THE BRACING
- W = WIDTH OF THE PRESTRESSED CONCRETE SLAB
- Δ = DEFLECTION AT CENTERLINE OF SPAN DUE TO CAST-IN-PLACE SLAB, DIMPHRAGMS, ASPHALT, CURBS, AND RAILS

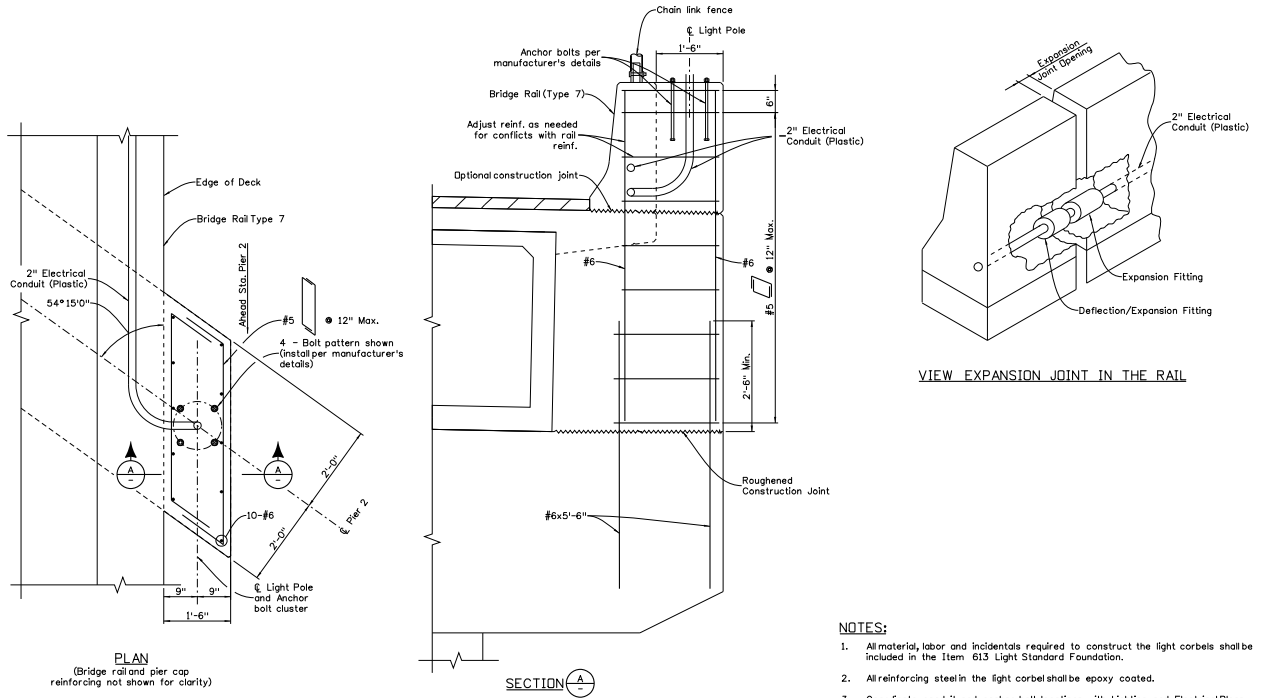
PRESTRESSED CONCRETE SLAB SCHEDULE

GRIDER NO.	L (FEET)	A _s SQUARE (INCH)	E (INCH)	F _i (KIPS)	F _j (KIPS)	CONCRETE STRENGTH (KPSI)	f _{ps} (KSI)	f _{cd} (KSI)	A (INCH)	PREDICTED CAMBER (INCH)	DEBOND STRANDS (%)
⑥ TO ⑥	64.50	10.416	3.92	2109	1796	5.70	6.50	0.80	2.38	25	

EXAMPLE 13.3.7 – Prestressed Concrete Slab



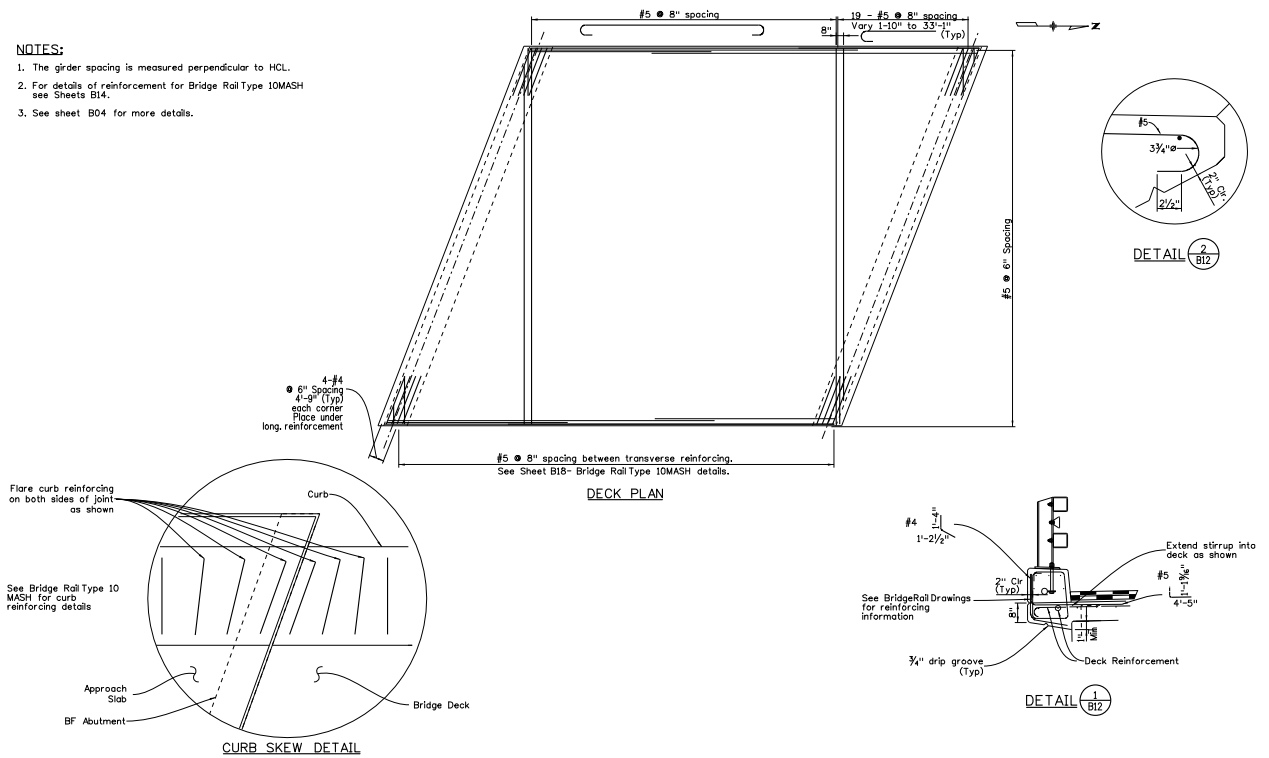
EXAMPLE 13.3.10



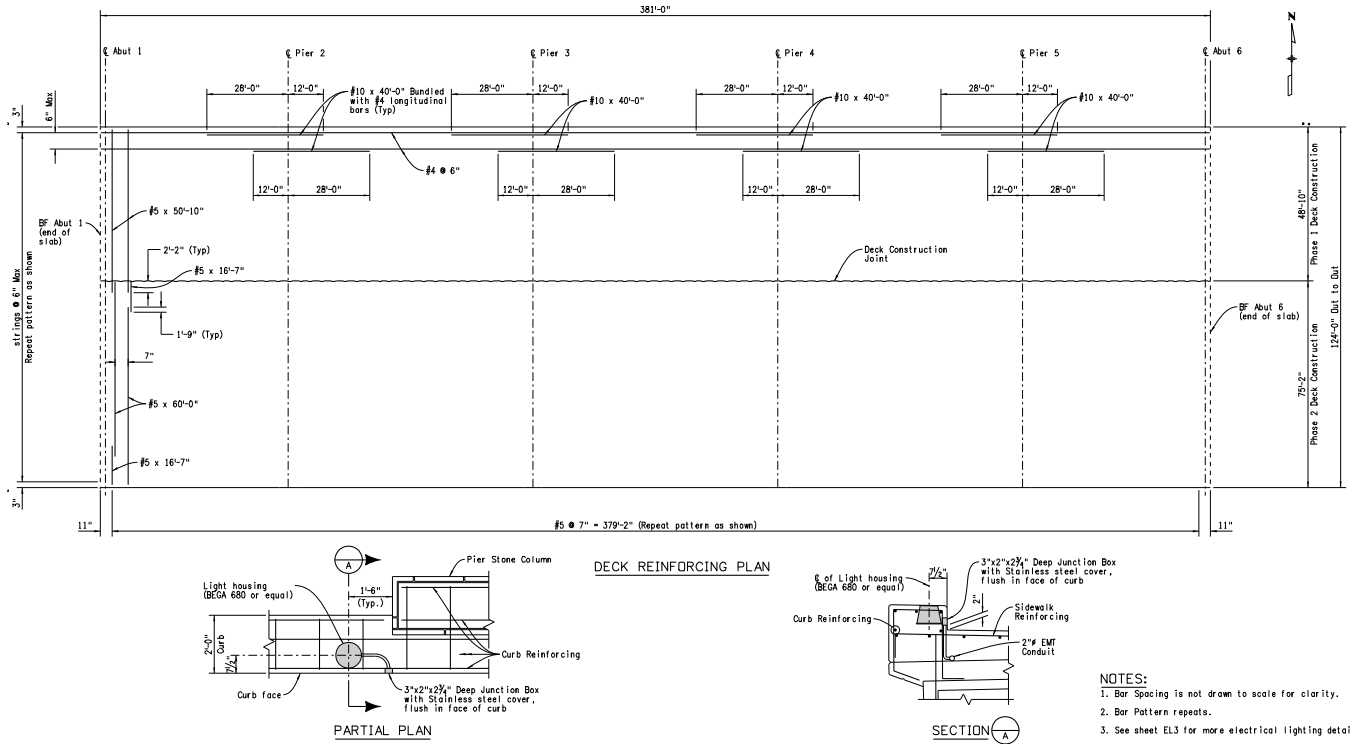
EXAMPLE 13.3.11

NOTES:

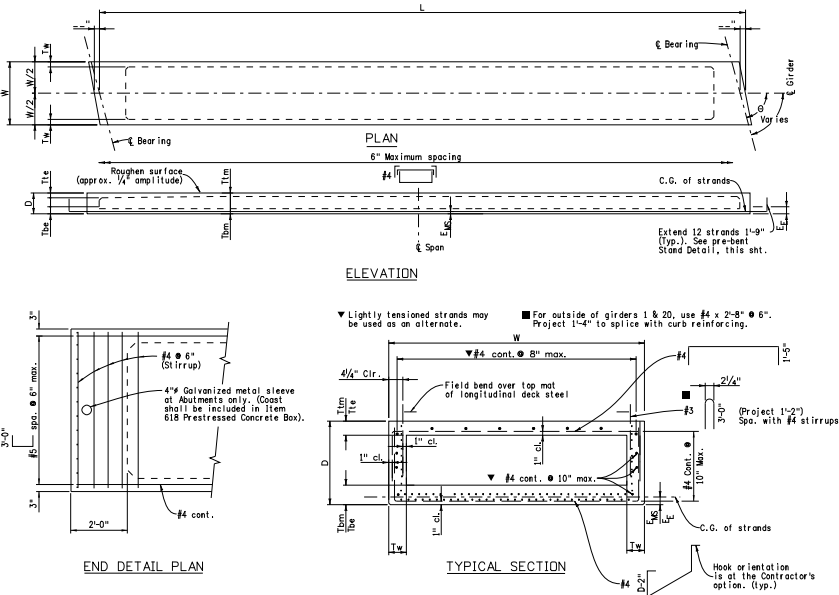
1. The girder spacing is measured perpendicular to HCL.
2. For details of reinforcement for Bridge Rail Type 10MASH see Sheets B14.
3. See sheet B04 for more details.



EXAMPLE 13.3.12

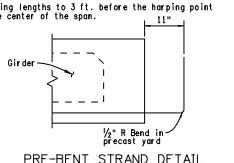


EXAMPLE 13.3.13

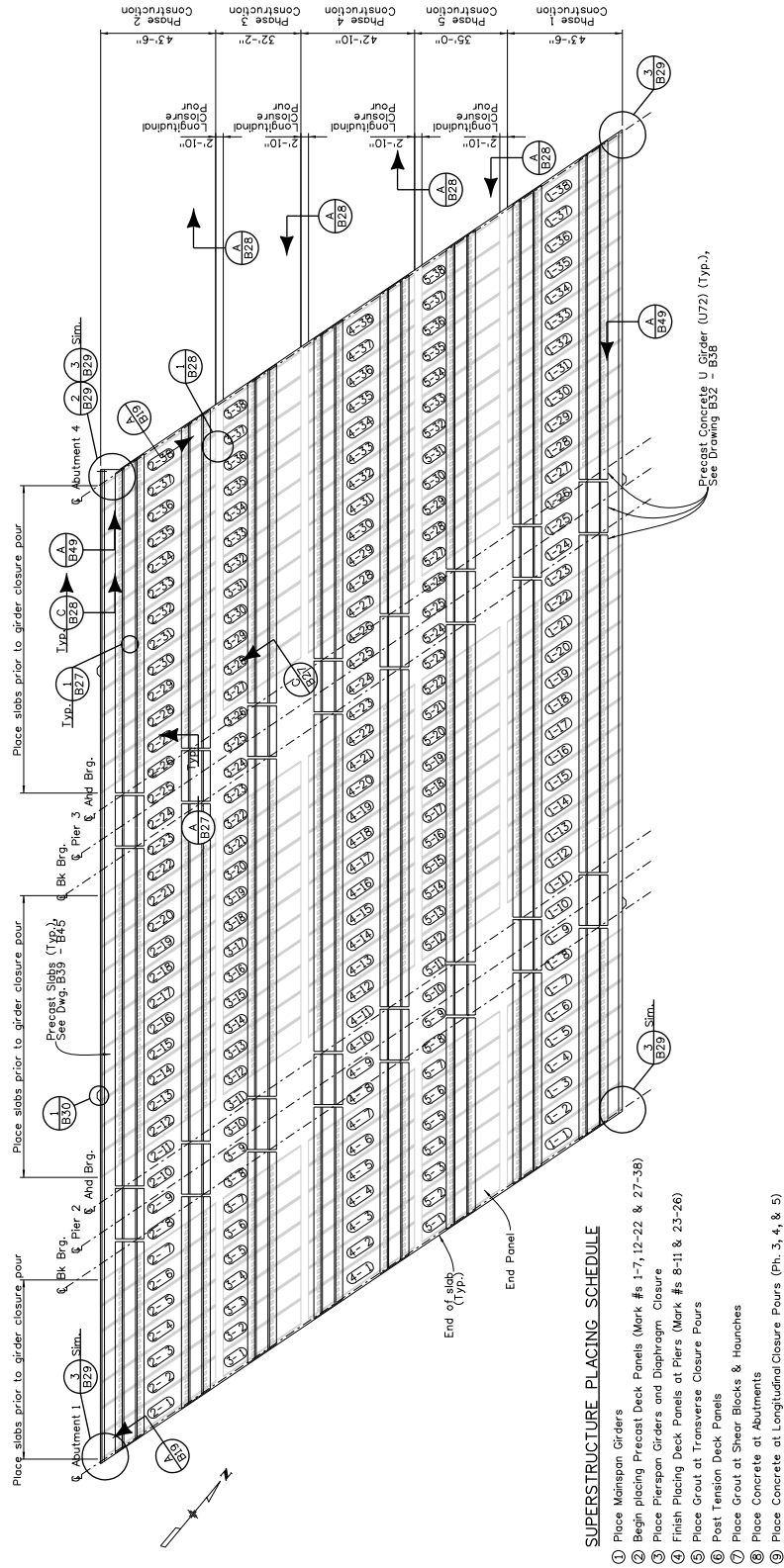


GIRDER SCHEDULE														
Span No.	Girder No.	L (Feet)	W (Inch)	D (Inch)	Θ (Deg.)	T ₁ (Inch)	T ₂ (Inch)	T ₃ (Inch)	T ₄ (Inch)	A _n ² (Square Inch)	Debonded Strands (percent)	E _g (Inch)	F ₁ (KIPS)	
1 & 5	All	62.583	72	30	90	6	6	4	6	5.21	25	3.25	3.25	1054.6
2 - 4	All	82.833	72	30	90	6	6	4	6	7.38	23.5	3.19	3.19	1494
														933.8
														6,500
														8,500
														0.663
														1.163
														2.23

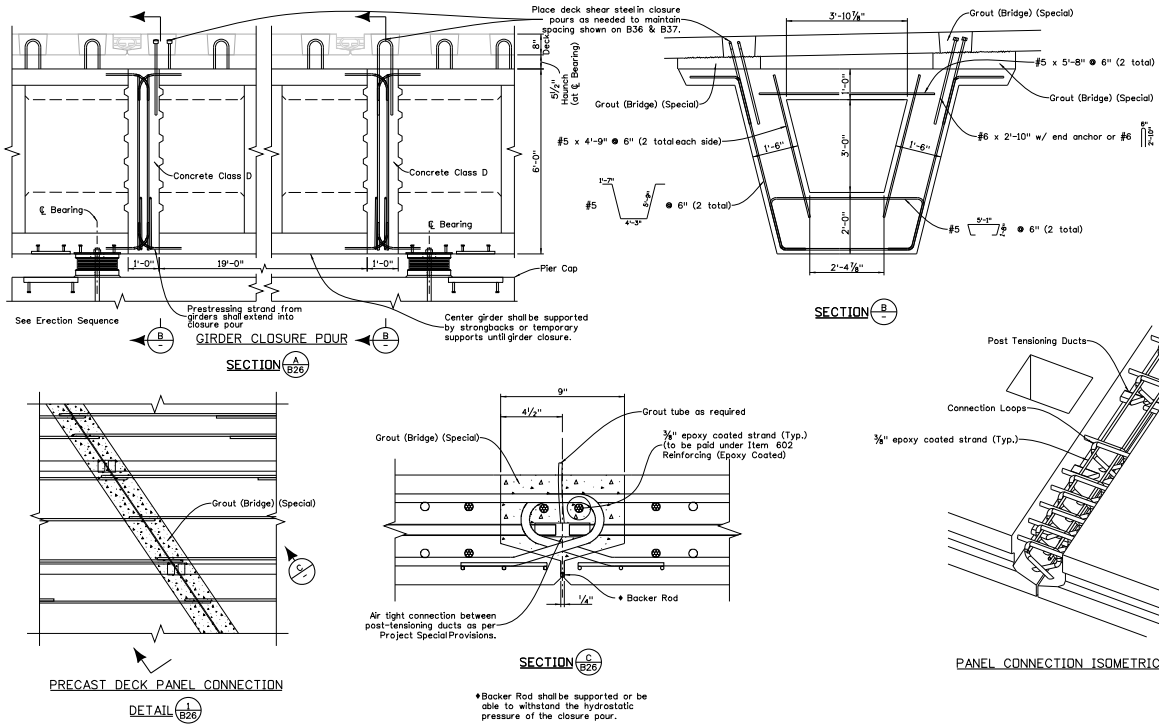
DEBONDING TABLE							
Span No.	Girder No.	Row	Y (Inches)	Total No. 0.6" Strands	No. Debonded Strands Each		
					2 ft	4 ft	6 ft
1 & 5	All	1	2.25	30	2	4	4
1 & 5	All	1	4.25	18	2	4	4
2 - 4	All	1	2.25	34	2	4	4
2 - 4	All	1	4.25	32	2	4	4



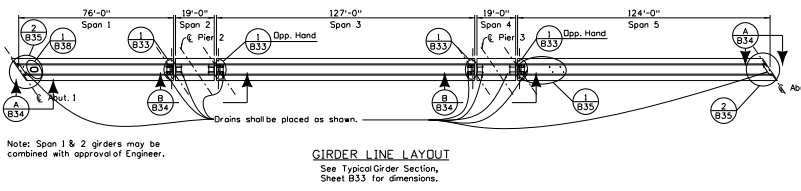
EXAMPLE 13.3.14



EXAMPLE 13.3.15 – Precast Prestressed Concrete Deck Details



EXAMPLE 13.3.16 – Precast Prestressed Deck Details



NOTES:

- All work necessary to fabricate and install the integral parts of the girder (including the interdiaphragms, if any, and leveling pods, as shown on the plans) shall be included in the bid price for Item No. 618, Precast Concrete U Girder (U2) (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 steels 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 1/2" 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) but not less than 1 1/4". The minimum cover for prestressing steels is 1 1/2".
- 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".

PHASE 1, 2 & 4 GIRDER SCHEDULE - GIRDERS A, B, D, E, G & H

Span No.	L (Ft.)	F _w (In.)	D (In.)	θ (Deg.)	T _w (In.)	T _b (In.)	L _b (Ft.)	A _s (In ²)	Debond Strands (percent)	E _s (In.)	E _w (In.)	F _i (KIPS)	F _u (KIPS)	Concrete Strength (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	8750/9000	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	8750/9000	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	8750/9000	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	8750/9000	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	8750/9000	2.13	2.81	4.98

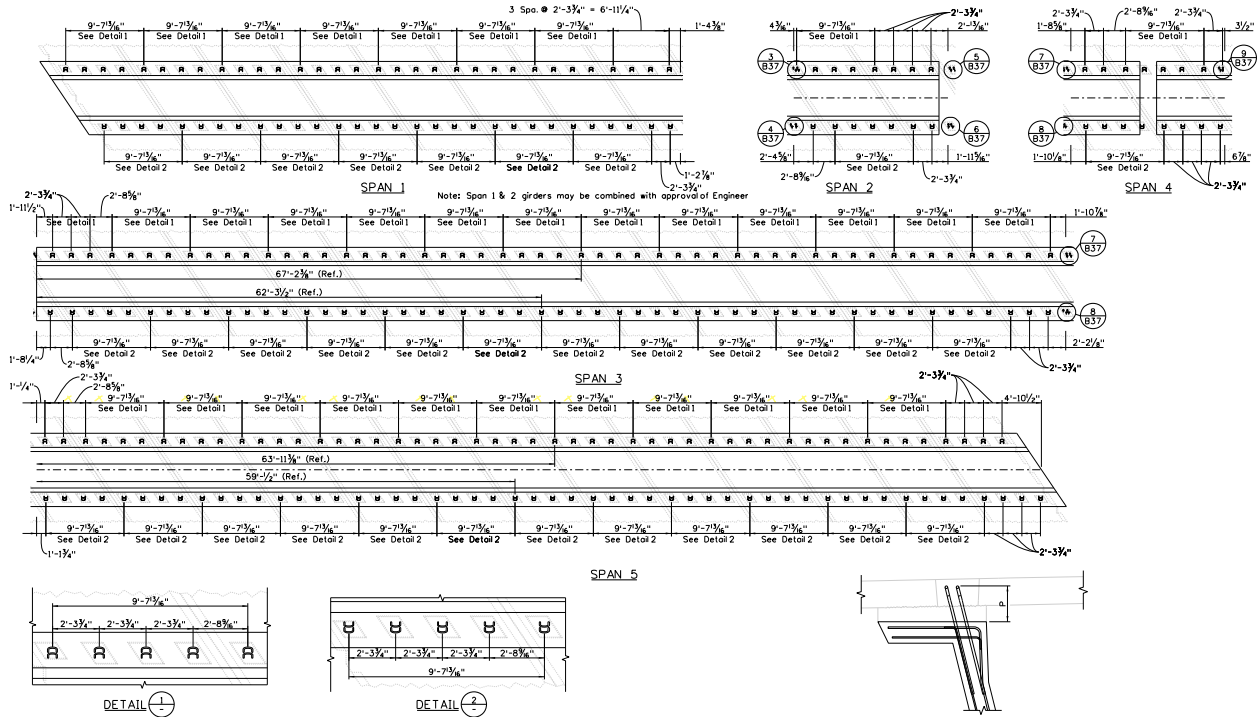
PHASE 3 & 5 GIRDER SCHEDULE - GIRDERS C & F

Span No.	L (Ft.)	F _w (In.)	D (In.)	θ (Deg.)	T _w (In.)	T _b (In.)	L _b (Ft.)	A _s (In ²)	Debond Strands (percent)	E _s (In.)	E _w (In.)	F _i (KIPS)	F _u (KIPS)	Concrete Strength (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	8750/9000	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	8750/9000	0.01	0.0	0.0
3	127	32	72	90	7.5	8.1	19.1	16.662	14.0	13.78	4.79	3779.1	3132.4	8750/9000	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	8750/9000	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	8750/9000	2.55	3.06	5.43

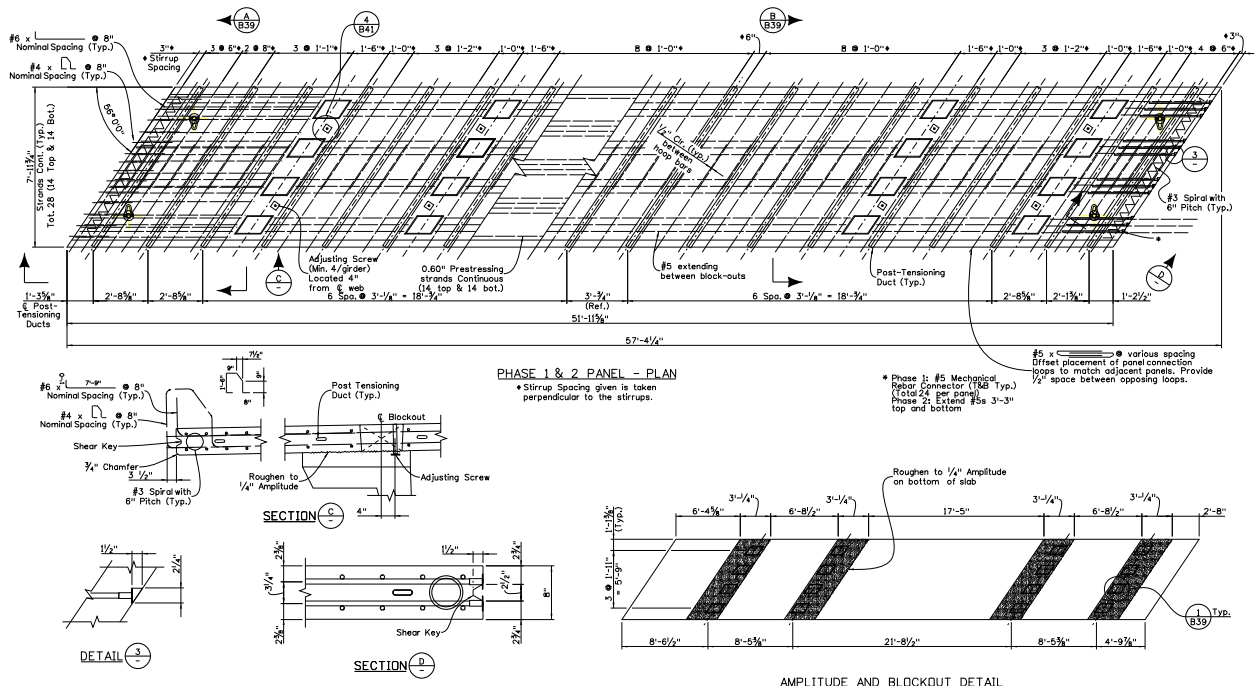
- * In the bottom row, debond 2 strands for 10 feet, 2 strands for 11 feet, 2 strands for 12 feet and 2 strands for 14 feet. In the second row from bottom, debond 2 strands for 10 feet.
- ① Debonded strands shall be area required by access hatch. See Section A on B38.
- * In the third row from bottom, 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. In the third row from bottom, debond 5 strands for 16 feet, 4 strands for 24 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.

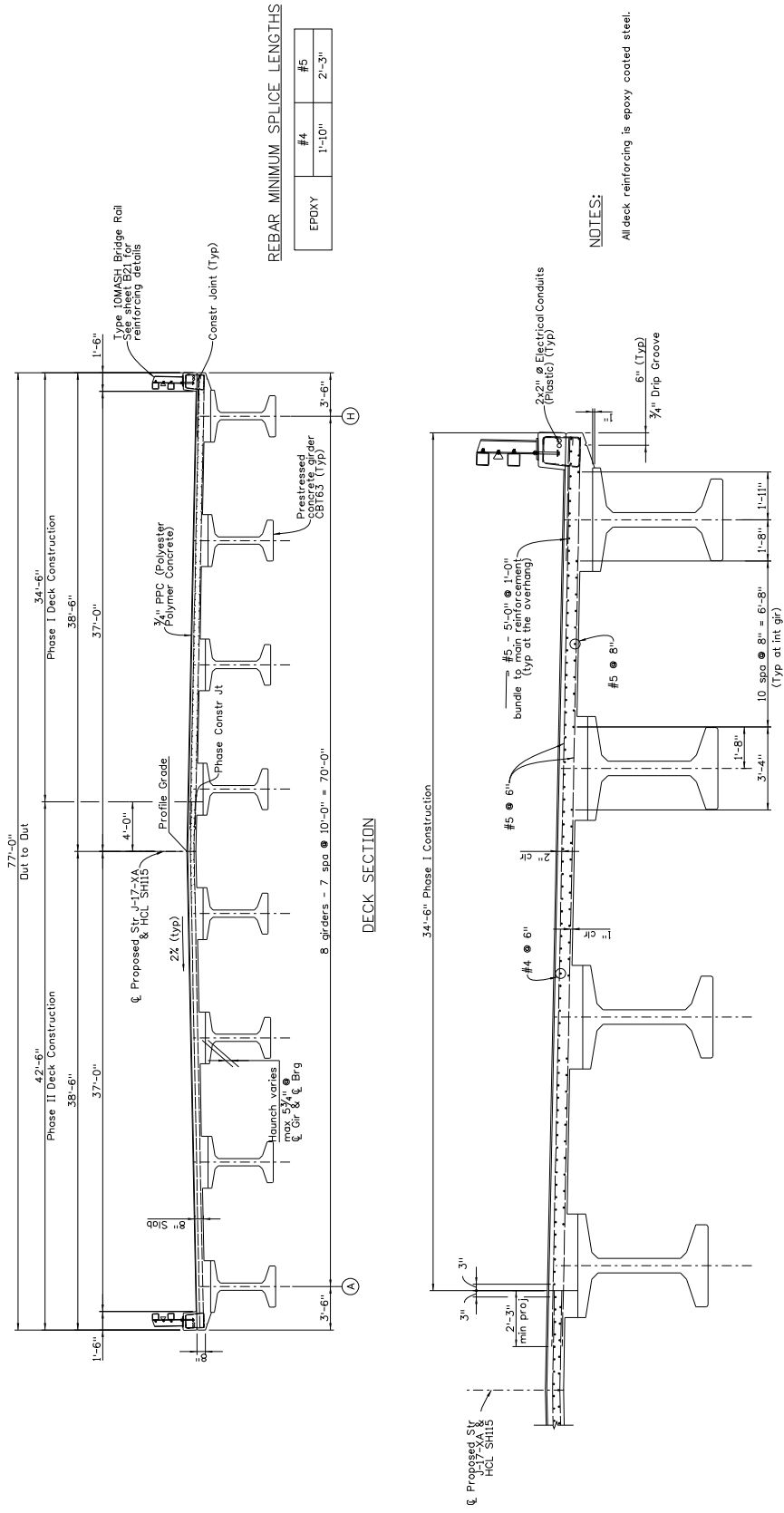
EXAMPLE 13.3.17 – Prestressed Concrete Girder Details



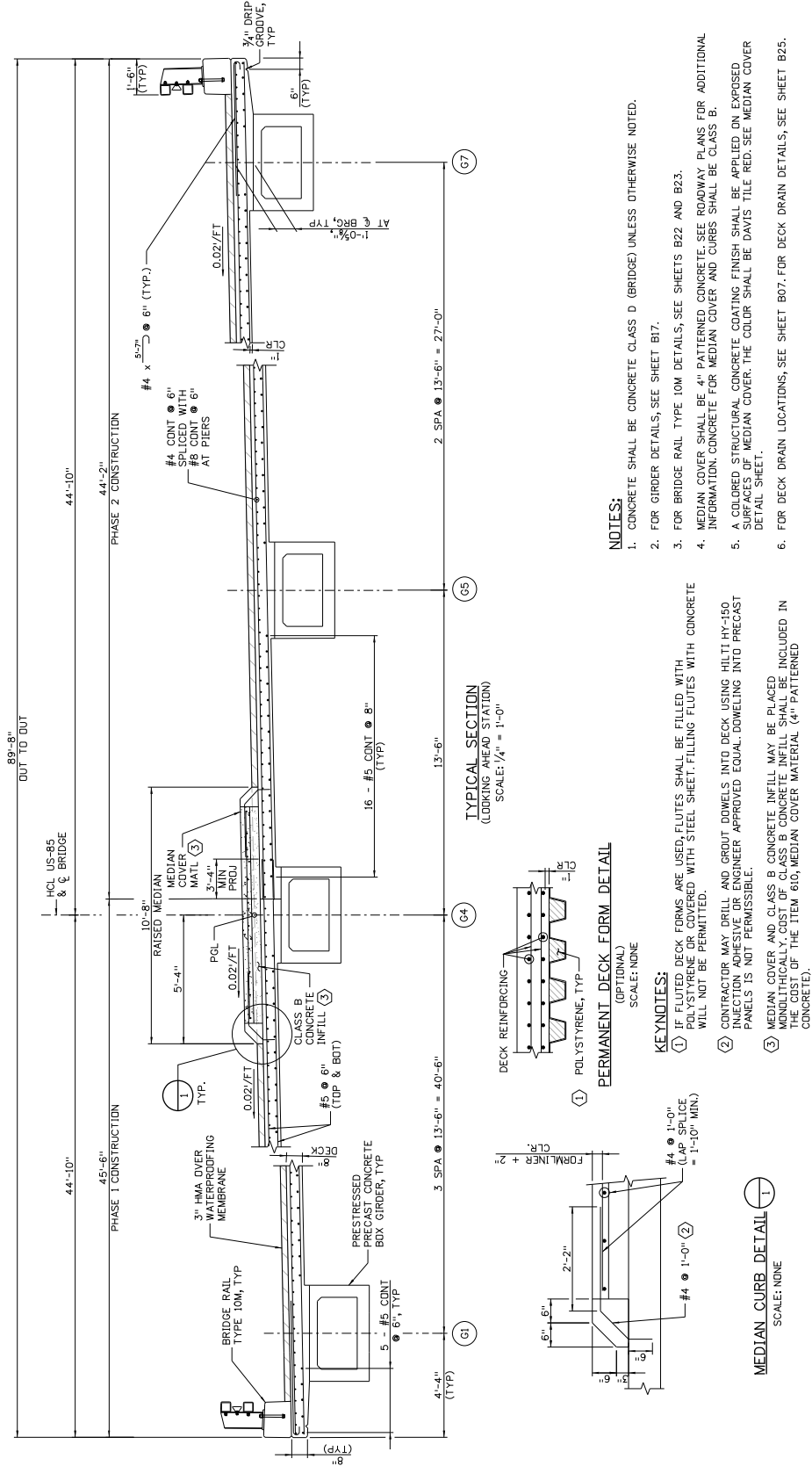
EXAMPLE 13.3.18 – Prestressed Concrete Girder Details



EXAMPLE 13.3.19 – Prestressed Concrete Details



EXAMPLE 13.20 – Prestressed Concrete CBT Girder



EXAMPLE 13.3.21 – Prestressed Concrete Box Girder

COLORADO DEPARTMENT OF TRANSPORTATION STAFF BRIDGE BRIDGE DETAIL MANUAL	Chapter: 14 Effective: March 25, 2022 Supersedes: October 12, 2020
BRIDGE DECK ELEVATIONS SHEETS	

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 Department of Transportation Staff Bridge Design Bridge Geometry Project Coordinate Converter Version 1.00 Run date & time = Sat Jun 01 13:21:38 2013 Input Northing Offset = 142618.800000 Input Easting Offset = 169548.500000 Input Bearing = S 89 55 41.0500 E	DESCRIPTION Units: feet; Project: FBR 0142-055; Subaccount: 18085; Designer: H. Bui; Detailer: L. Waldron; Location: SH 14 over Cache-LaPoudre River; SH 14 Poudre Bridge in Ft. Collins Replaces B-16-D at M.P. 135.88 on SH 14 This is a straight bridge	

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
		170+10.0000	PC 7347.3800		-1.033333
		171+60.0000	PI 7345.7187	7345.8300	
		173+10.0000	PT 7343.8350		
	7333.9930	PC 180+50.0000			-1.330000
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 (ON TANGENT)	SLOPE LEFT	SLOPE RIGHT	VC LENGTH
	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

LAYOUT LINE INTERSECTS REF LINE AT	HCL STA	OFFSET	X	Y
	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.

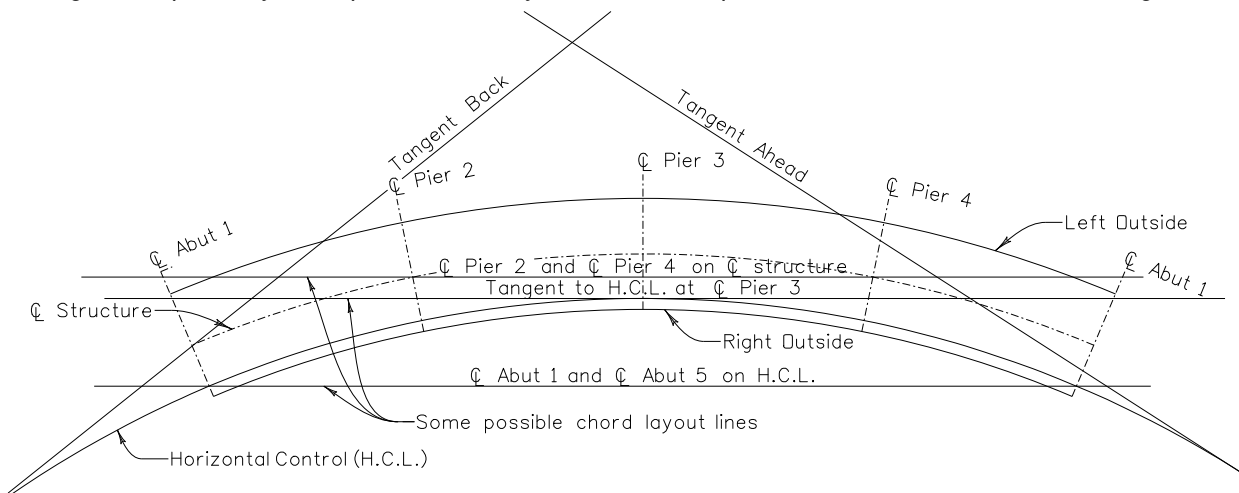


Fig. 14.8.2 Chord Layout Lines - Examples

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													
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						
INCH	0.0000	0.1458	0.2801	0.3873	0.4560	0.4797	0.4560	0.3873	0.2801	0.1458	0.0000	INCH	A4= 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	A3= 0.00000
SLOPE	0.120945										-0.120945	SLOPE	A2= 1.87004
													A1=-1.87004
													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
- F) Edges of the deck
- G) Construction phase lines
- H) Curb line or flowline
- I) 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			FROM LAYOUT LINE OFFSET :	PROJECT COORDINATES		BENT LINE LENGTH FROM	SKEW			GIRDER LINE LENGTH FROM		
:	STATION	OFFSET	ELEVATION	:	NORTHING	EASTING	Y-AXIS	D	M	S	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	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	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.

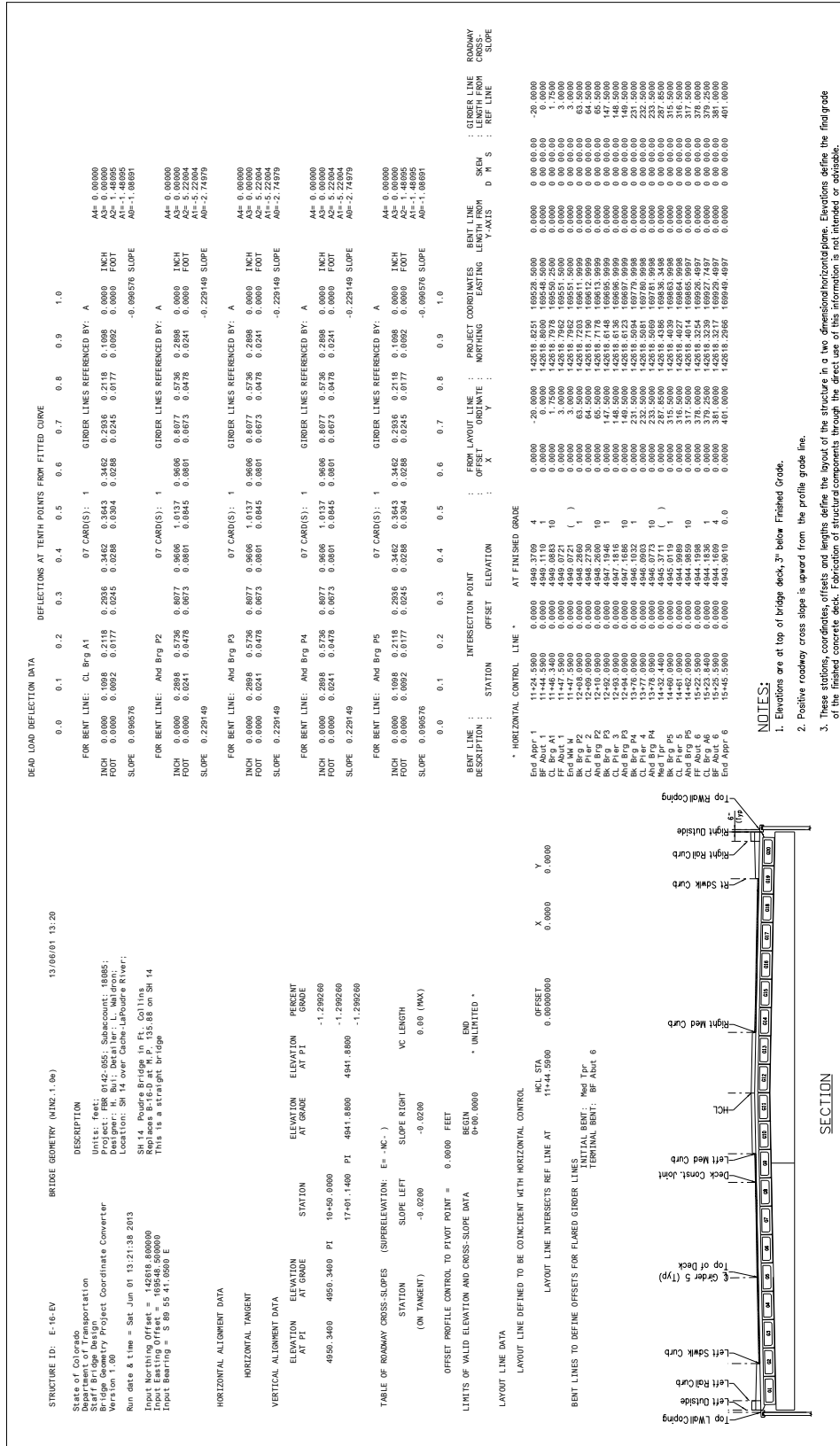
* ROADWAY APPROACHES *			
STATION	OFFSET	ELEVATION	CROSS-SLOPE
1770+50	-18.0000	3407.2221	-0.020000
1770+60	-18.0000	3407.2721	-0.020000
1770+70	-18.0000	3407.3221	-0.020000
1770+80	-18.0000	3407.3721	-0.020000
1770+90	-18.0000	3407.4221	-0.020000
1771+00	-18.0000	3407.4721	-0.020000
1771+10	-18.0000	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.



Example 14-1

Version 1.00
Run date & time = Thu Sep 24 15:34:13 2015
Project: FR 9894-027- Substructure, 2146;
Location: SPOON, WESTFERT, N., WISCONSIN;
Description: SPAN WITH GIRDER CONCRETE SLAB;
OVER SOUTH PLATE RIVER
7 SPAN WITH GIRDER CONCRETE SLAB

Units: feet;
Project: FR 9894-027- Substructure, 2146;
Location: SPOON, WESTFERT, N., WISCONSIN;
Description: SPAN WITH GIRDER CONCRETE SLAB;
OVER SOUTH PLATE RIVER
7 SPAN WITH GIRDER CONCRETE SLAB

STRUCTURE ID: C-17-41
BRIDGE GEOMETRY (INTR. 1.00)
15/09/24 14:53
PAGE 1

DEAD LOAD REFLECTION DATA
LAYOUT LINE REFERRED TO BE COINCIDENT WITH HORIZONTAL CONTROL
OFFSET = 0.0000
H.L. STA. = 39+16.7600
Y = 0.0000
X = 0.0000

DEFLECTIONS AT TERN POINTS FROM FITTED CURVE
LAYOUT LINE INTERSECTS REF LINE AT
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0

FOR BEAT LINE: CL A1
07 CURB(S): 1
GIRDER LINES REFERENCED BY: A
INCH 0.0000 0.1458 0.2811 0.3773 0.4589 0.4797 0.4589 0.3773 0.2811 0.1458 0.0000 INCH
FOOT 0.0000 0.0121 0.0233 0.0303 0.0338 0.0490 0.0303 0.0233 0.0121 0.0000 FOOT
SLOPE 0.120945 -0.120945 SLOPE

FOR BEAT LINE: CL P2
07 CURB(S): 1
GIRDER LINES REFERENCED BY: A
INCH 0.0000 0.7861 1.3452 1.8953 2.5650 2.7738 2.6472 2.1683 1.5116 0.8275 0.0000 INCH
FOOT 0.0000 0.0650 0.1121 0.1533 0.2098 0.2272 0.2206 0.1808 0.1269 0.0690 0.0000 FOOT
SLOPE 0.955906 -0.955906 SLOPE

DEAD LOAD REFLECTION DATA (CONT)
DEFLECTIONS AT TERN POINTS FROM FITTED CURVE
LAYOUT LINE INTERSECTS REF LINE AT
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0

FOR BEAT LINE: CL P3
07 CURB(S): 1
GIRDER LINES REFERENCED BY: A
INCH 0.0000 0.0009 1.5493 2.1510 2.5389 2.6727 2.5389 2.1510 1.5493 0.0009 0.0000 INCH
FOOT 0.0000 0.0097 0.1291 0.1793 0.2116 0.2227 0.2116 0.1793 0.1291 0.0097 0.0000 FOOT
SLOPE 0.075933 -0.075933 SLOPE

FOR BEAT LINE: CL P4
07 CURB(S): 1
GIRDER LINES REFERENCED BY: A
INCH 0.0000 0.0000 0.0000 1.5539 2.1650 2.5444 2.6700 2.5444 2.1650 0.0000 0.0000 INCH
FOOT 0.0000 0.0000 0.0000 0.1295 0.1797 0.2120 0.2232 0.2120 0.1797 0.0000 0.0000 FOOT
SLOPE 0.688848 -0.688848 SLOPE

FOR BEAT LINE: CL P5
07 CURB(S): 1
GIRDER LINES REFERENCED BY: A
INCH 0.0000 0.0040 1.5544 2.1575 2.5461 2.6801 2.5461 2.1575 1.5544 0.0040 0.0000 INCH
FOOT 0.0000 0.0033 0.1295 0.1799 0.2122 0.2233 0.2122 0.1799 0.1295 0.0033 0.0000 FOOT
SLOPE 0.688838 -0.688838 SLOPE

TABLE OF IRREGULAR CROSS-SLOPES (SUPERELEVATION: E=-N=)
VC LENGTH 75.00 (MAX)
SLOPE LEFT -0.0200 SLOPE RIGHT -0.0200
STATION (ON TANGENT) 38+12.5100 PC 421.5000
40+12.5100 PT 472.5000
42+12.5100 PT 473.5000

OFFSET PROFILE CONTROL TO PIVOT POINT = 0.0000 FEET
LIMITS OF VALID ELEVATION AND CROSS-SLOPE DATA
BEGIN UNLIMITED
END UNLIMITED

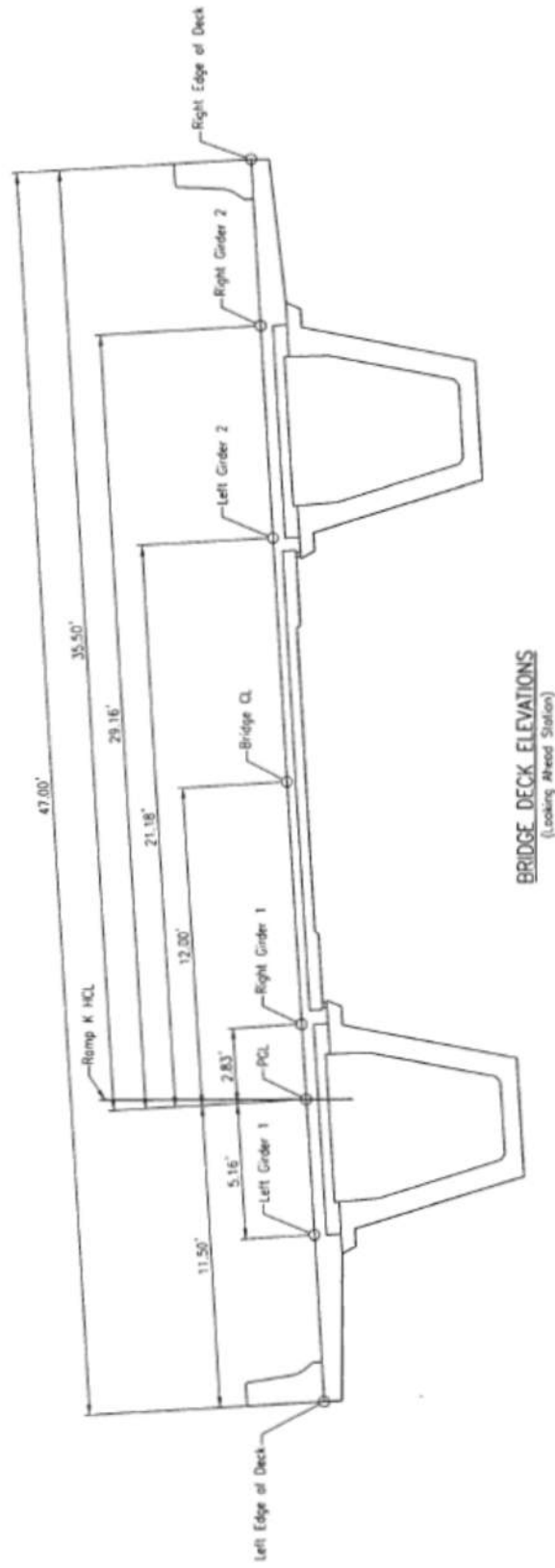
LAYOUT LINE DATA

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



LID SLAB ELEVATIONS
(Looking Ahead Station)



BRIDGE DECK ELEVATIONS
(Looking Ahead Station)

Example 14-6

COLORADO DEPARTMENT OF TRANSPORTATION STAFF BRIDGE BRIDGE DETAIL MANUAL	Chapter: 15.1 Effective: July 23, 2013 Supersedes: New
WALL DETAILS	

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.

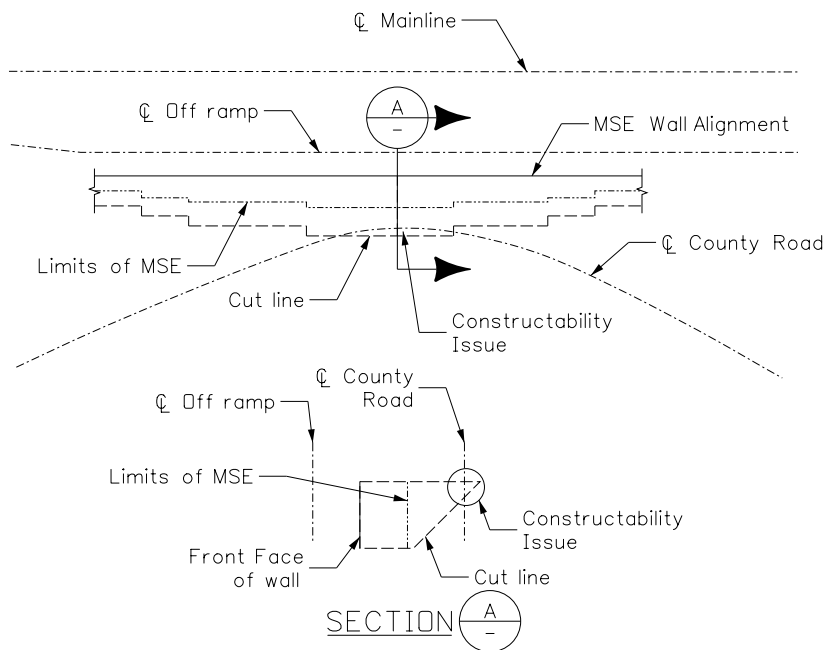


Fig. 15.1.1-1 Wall Conflict Example

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.

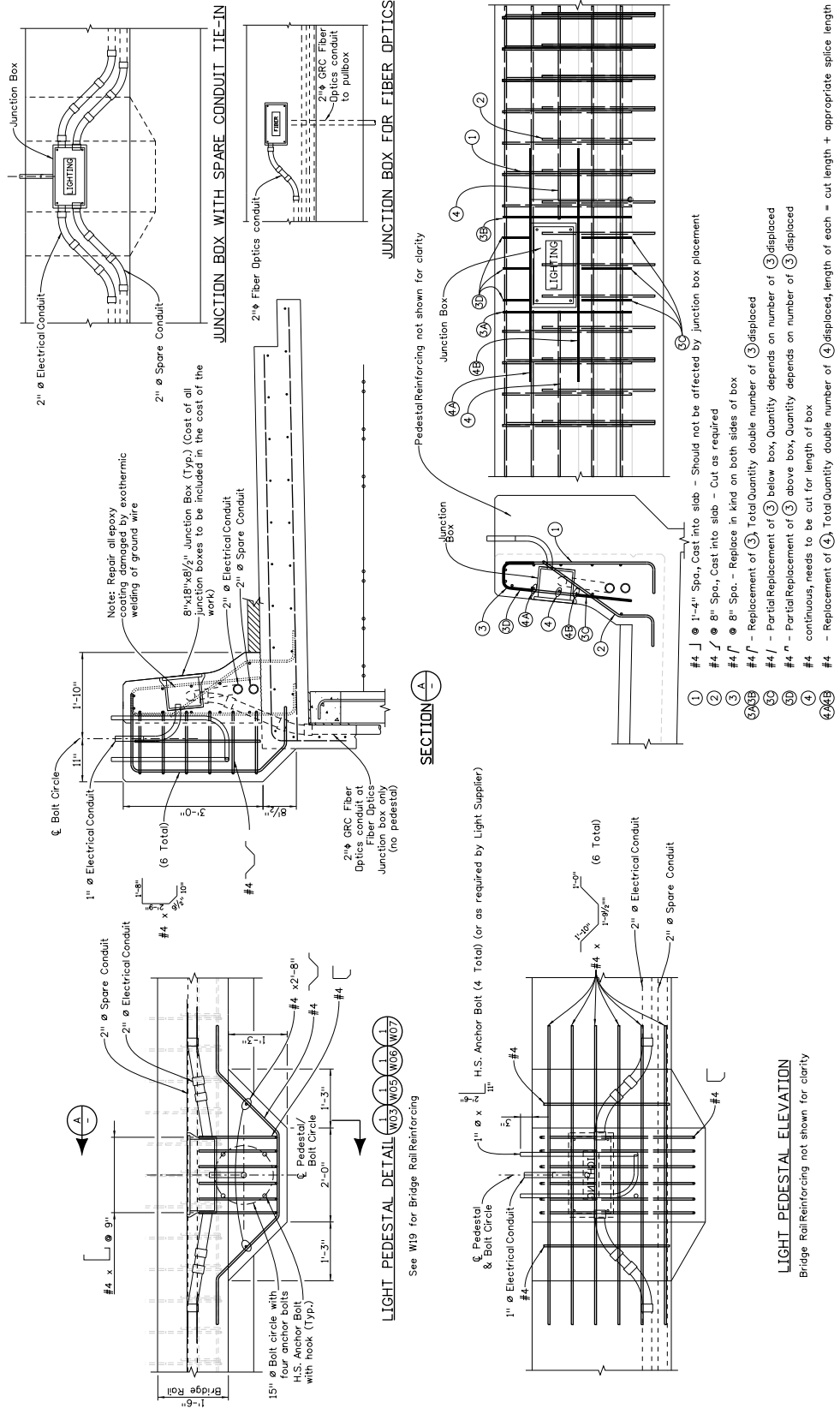


Fig. 15.1.8-1 Light Pedestal Example

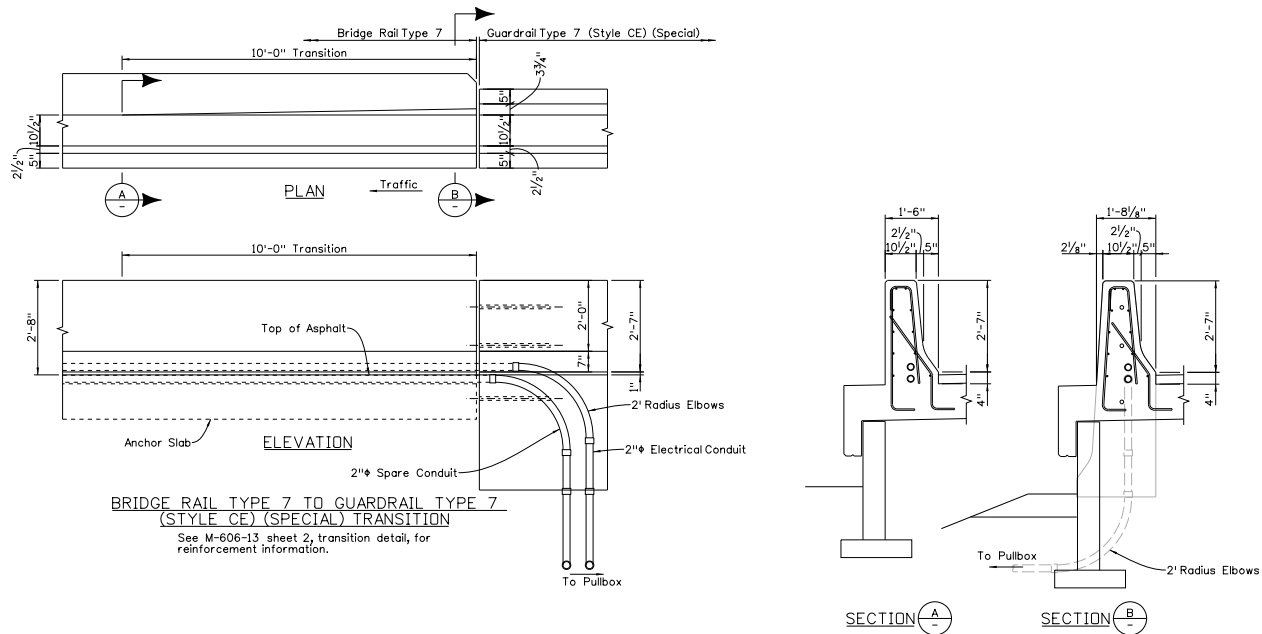


Fig. 15.1.8-2 Conduit Detail Example

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.

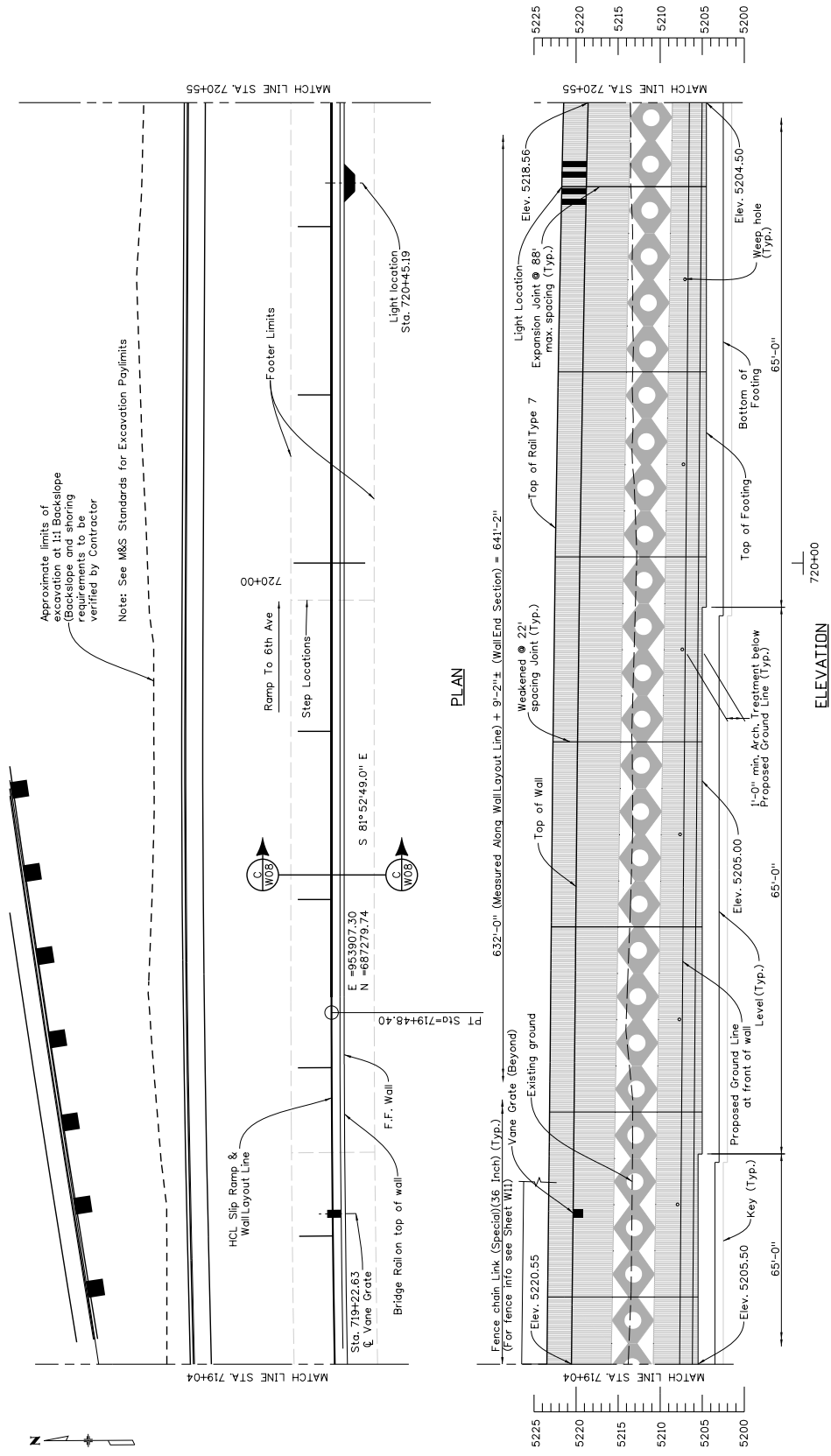


Fig. 15.1.9-1 Cast In Place Example

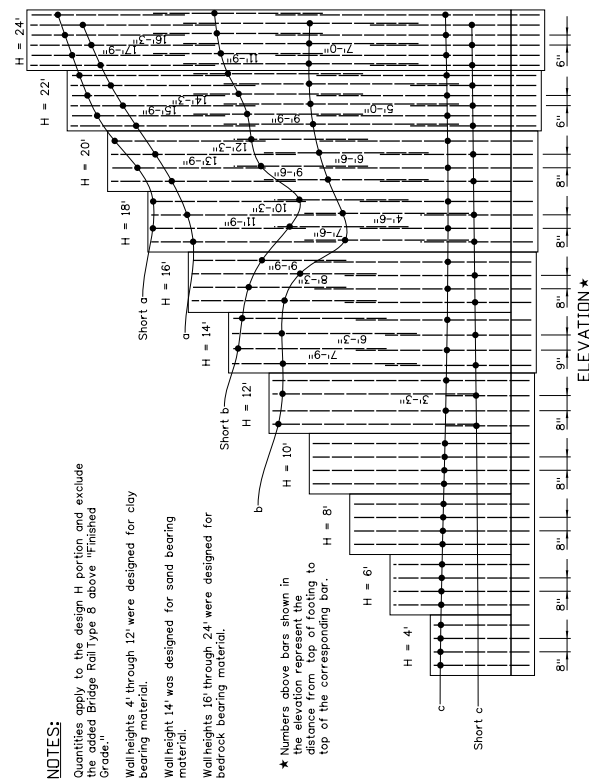
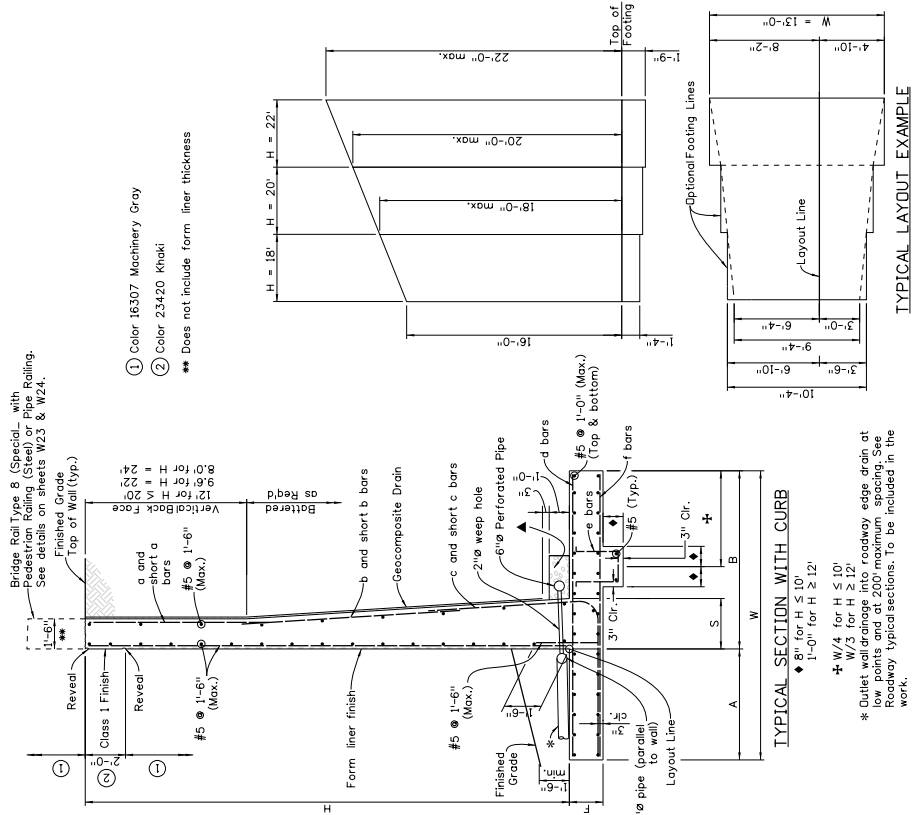


TABLE OF REINFORCING STEEL DIMENSIONS AND DATA

H	4'	6'	8'	10'	12'	14'	16'	18'	20'	22'	24'
W	3'-9"	5'-9"	8'-0"	11'-6"	14'-3"	17'-0"	19'-6"	22'-0"	24'-0"	26'-0"	28'-0"
A	1'-0"	1'-3"	1'-6"	2'-0"	2'-6"	3'-0"	3'-6"	4'-0"	4'-6"	5'-0"	5'-6"
B	2'-9"	4'-0"	5'-0"	6'-6"	8'-0"	9'-6"	11'-0"	12'-6"	14'-0"	15'-6"	17'-0"
F	1'-0"	1'-0"	1'-2"	1'-2"	1'-4"	1'-4"	1'-4"	1'-4"	1'-4"	1'-4"	1'-4"
S	1'-6"	1'-6"	1'-6"	1'-6"	1'-6"	1'-6"	1'-6"	1'-6"	1'-6"	1'-6"	1'-6"
Batter	-	-	-	-	-	-	-	-	-	-	-
a bars	-	-	-	-	-	-	-	-	-	-	-
b bars	#5 @ 8"	#5 @ 8"	#5 @ 8"	#5 @ 8"	#5 @ 8"	#5 @ 8"	#5 @ 8"	#5 @ 8"	#5 @ 8"	#5 @ 8"	#5 @ 8"
c bars	#5 @ 8"	#5 @ 8"	#5 @ 8"	#5 @ 8"	#5 @ 8"	#5 @ 8"	#5 @ 8"	#5 @ 8"	#5 @ 8"	#5 @ 8"	#5 @ 8"
d bars	#5 @ 8"	#5 @ 8"	#5 @ 8"	#5 @ 8"	#5 @ 8"	#5 @ 8"	#5 @ 8"	#5 @ 8"	#5 @ 8"	#5 @ 8"	#5 @ 8"
f bars	#5 @ 8"	#5 @ 8"	#5 @ 8"	#5 @ 8"	#5 @ 8"	#5 @ 8"	#5 @ 8"	#5 @ 8"	#5 @ 8"	#5 @ 8"	#5 @ 8"
Stem Bars	8	10	14	16	18	22	24	26	30	30	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
Steel/Wt	41.3	55.1	75.68	104.65	121.13	161.28	203.00	265.12	365.28	409.42	465.12
Conc. CV/ft	.394	.579	1.086	1.403	1.312	1.436	1.612	1.925	2.292	2.765	3.238

Fig. 15.1.9-2 Cast In Place Example

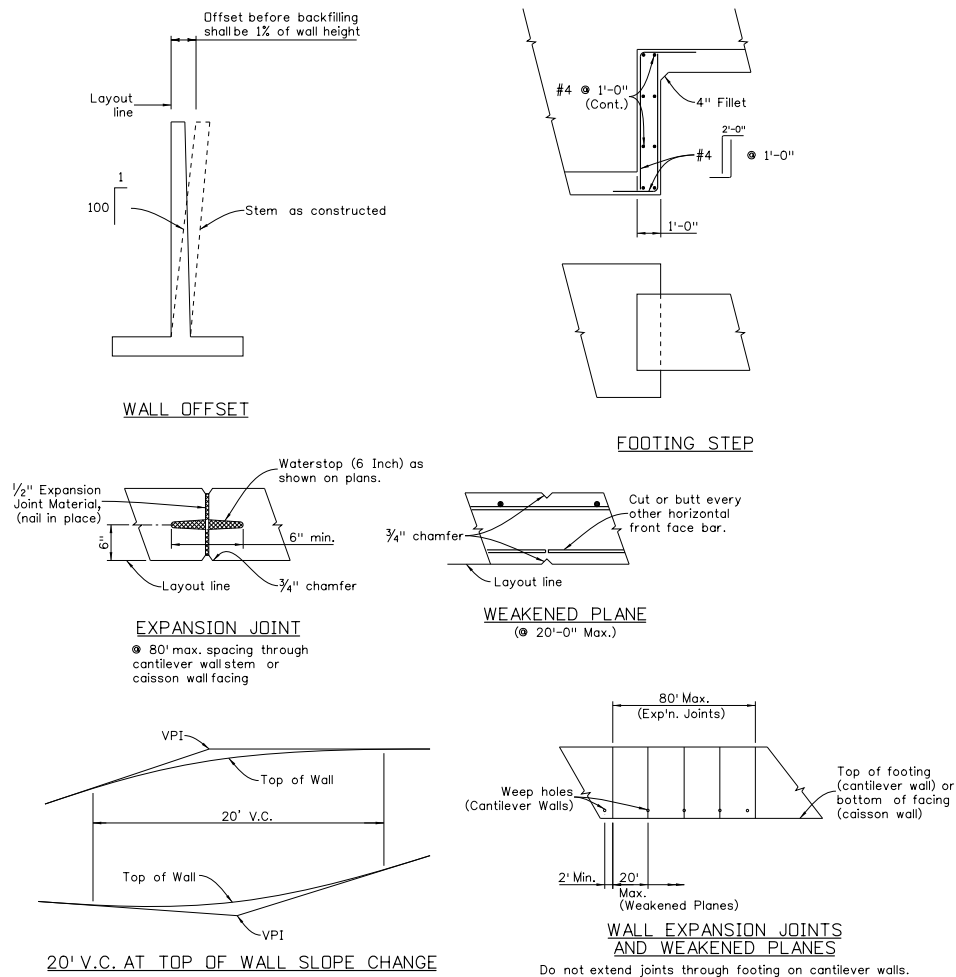


Fig. 15.1.9-3 Cast In Place Details

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.

Check Items

- 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.

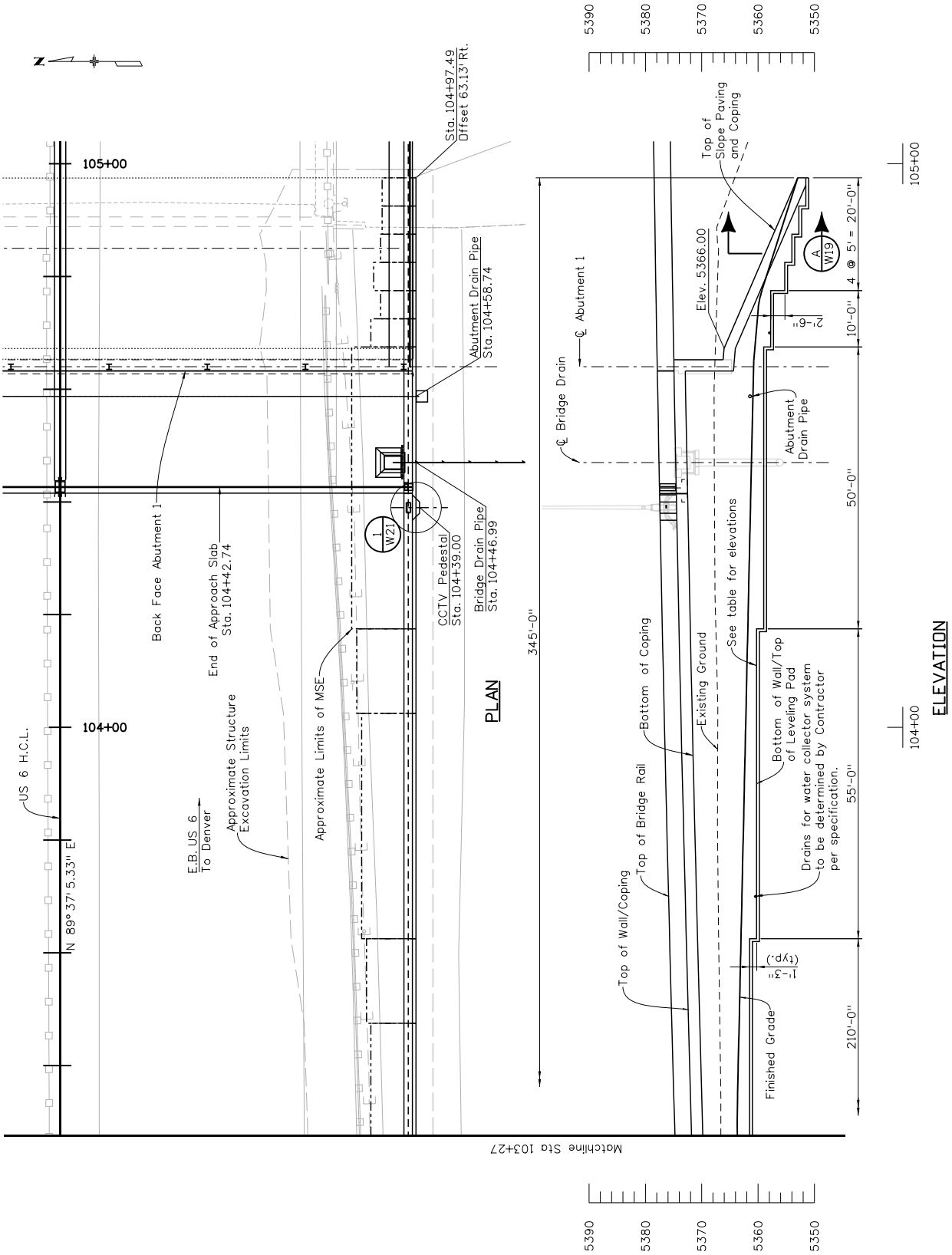
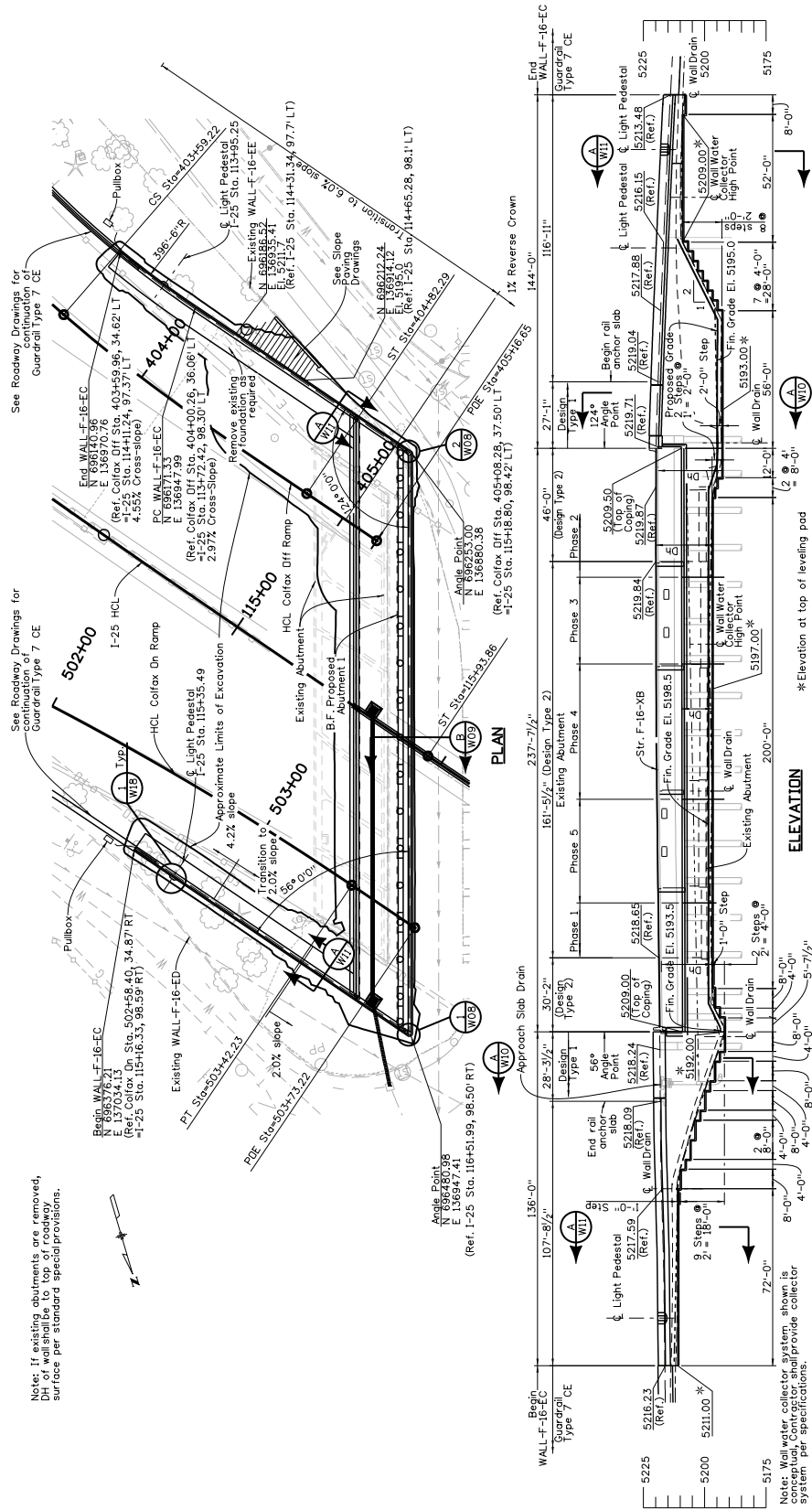


Fig. 15.1.10-1 MSE Wall Example 1



Notes: If existing abutments are removed, DH of wall shall be to top of roadway surface per standard special provisions.

Fig. 15.1.10-2 MSE Wall Example 2

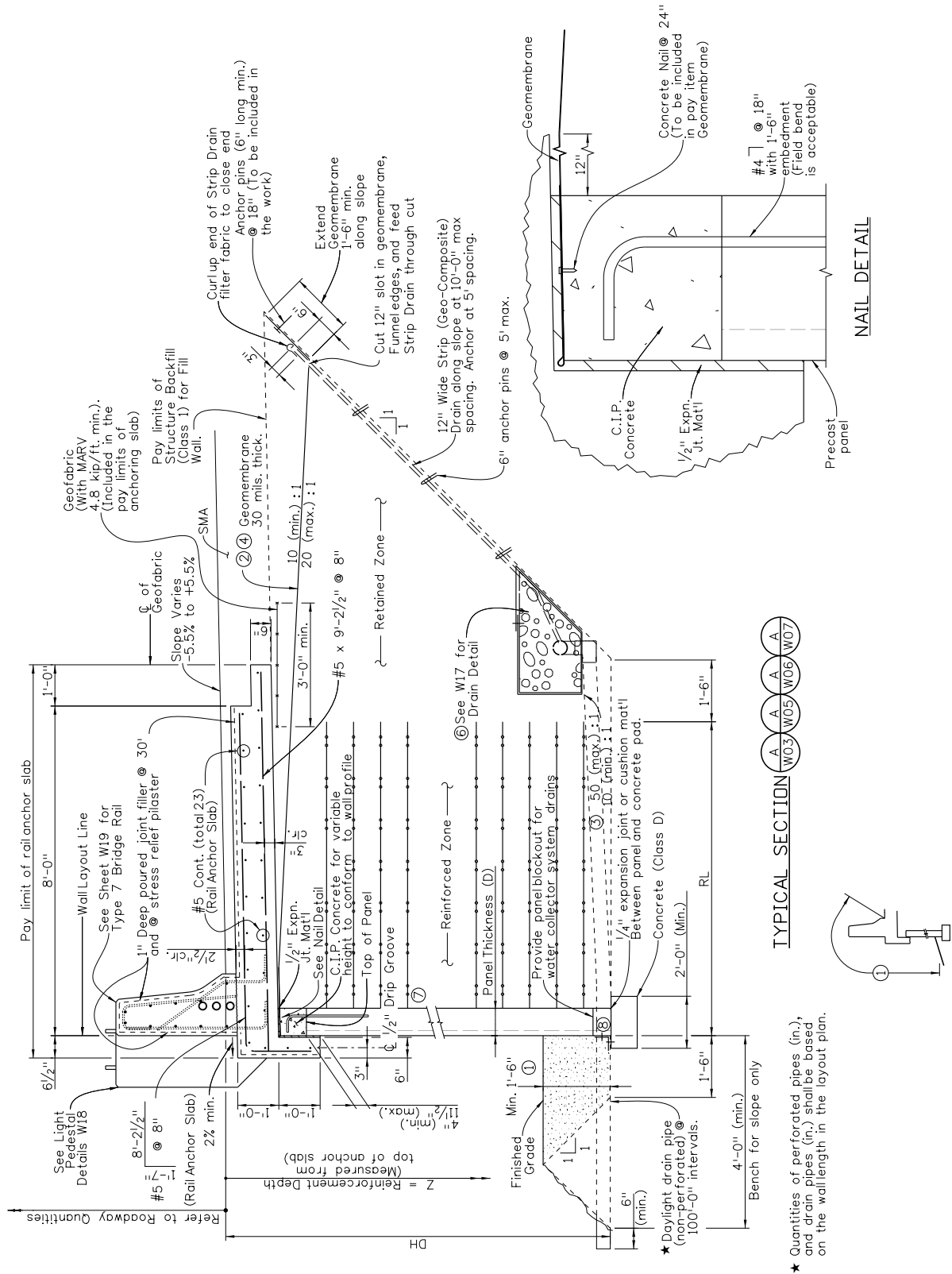
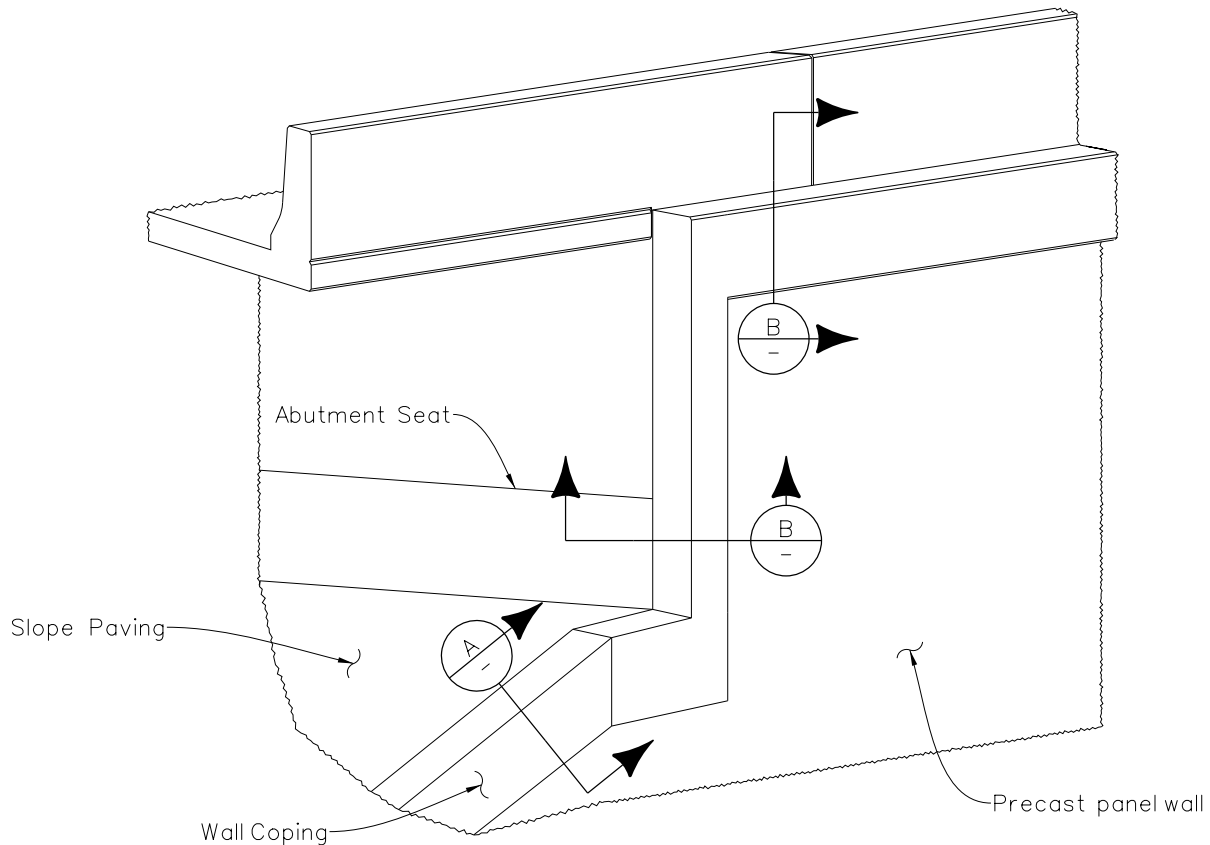


Fig. 15.1.10-3 MSE Wall Section Example



ISOMETRIC DETAIL AT CORNERS
Northeast Corner shown, other corners similar

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.

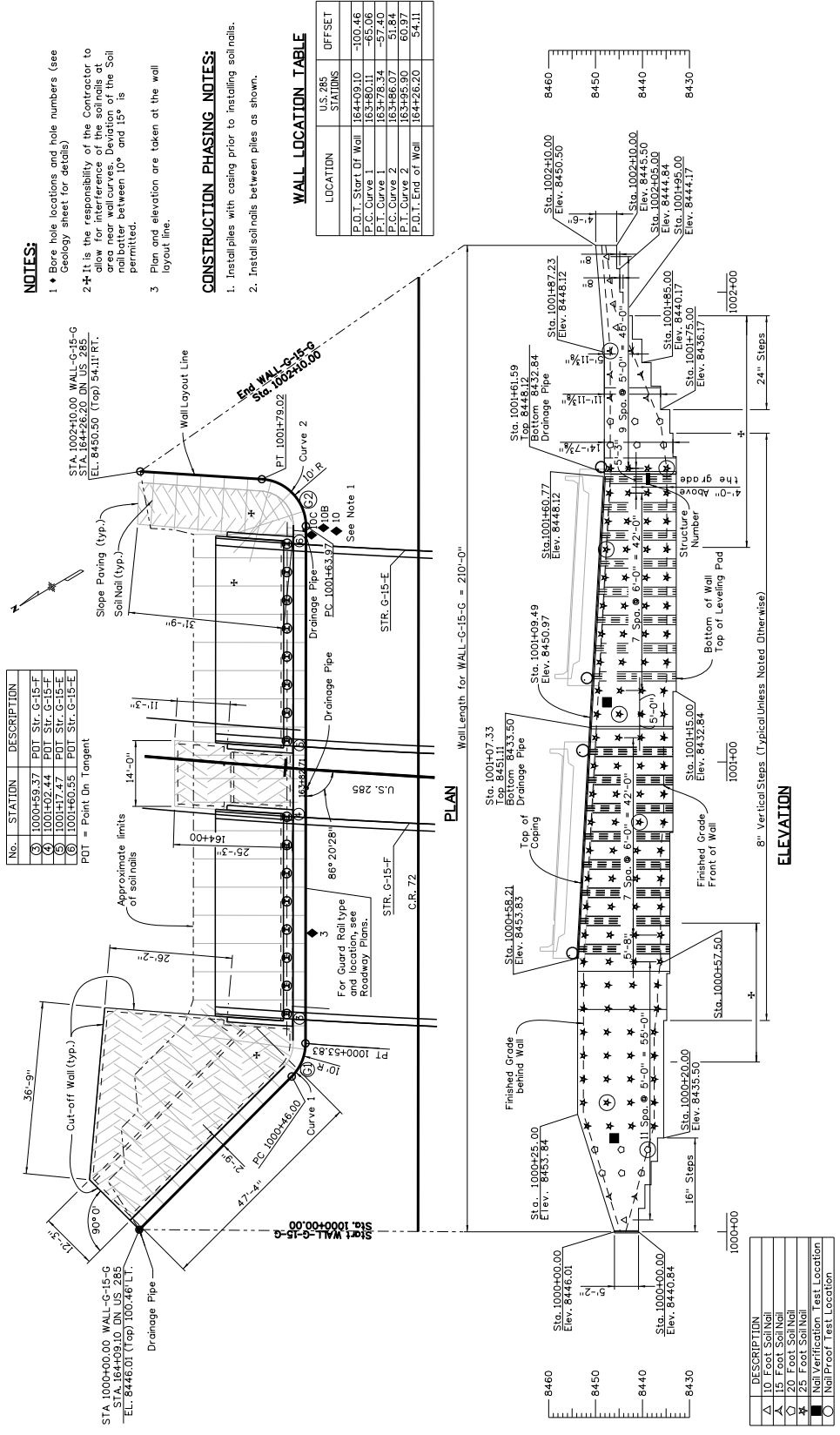


Fig. 15.1.11-1 Soil Nail Wall Example

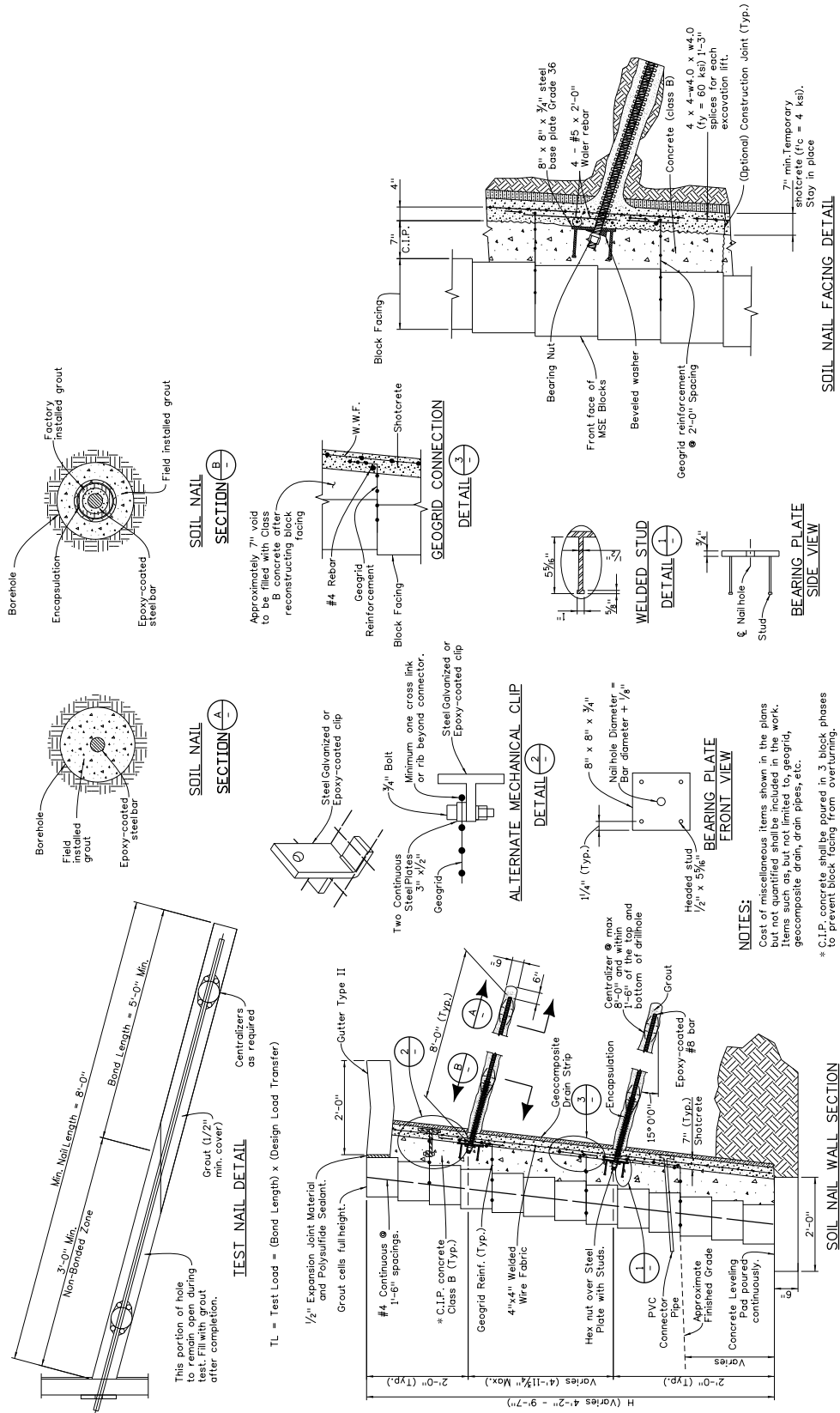


Fig. 15.1.11-2 Soil Nail Details Example

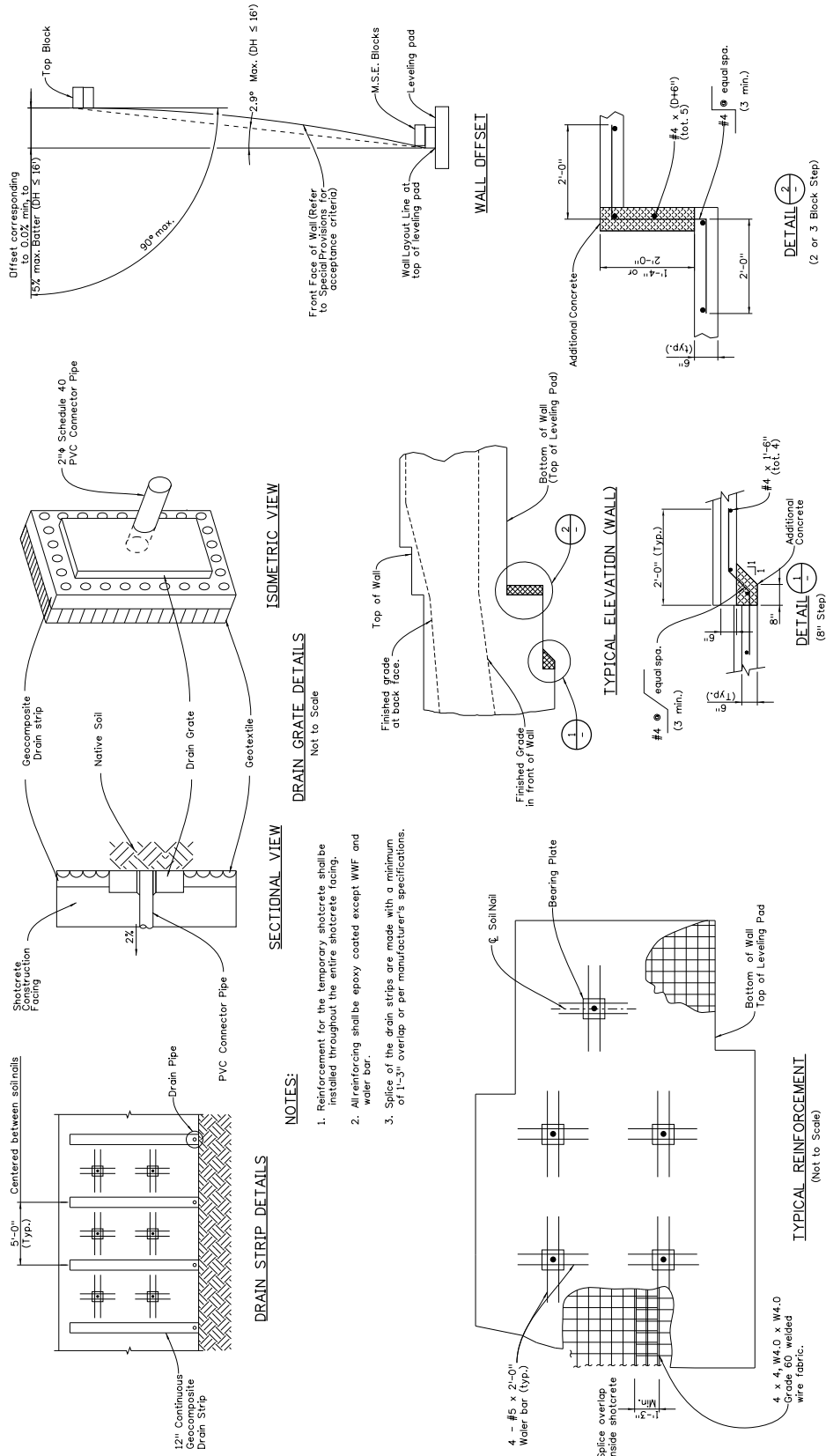


Fig. 15.1.11-3 Soil Nail Details Example 2

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.

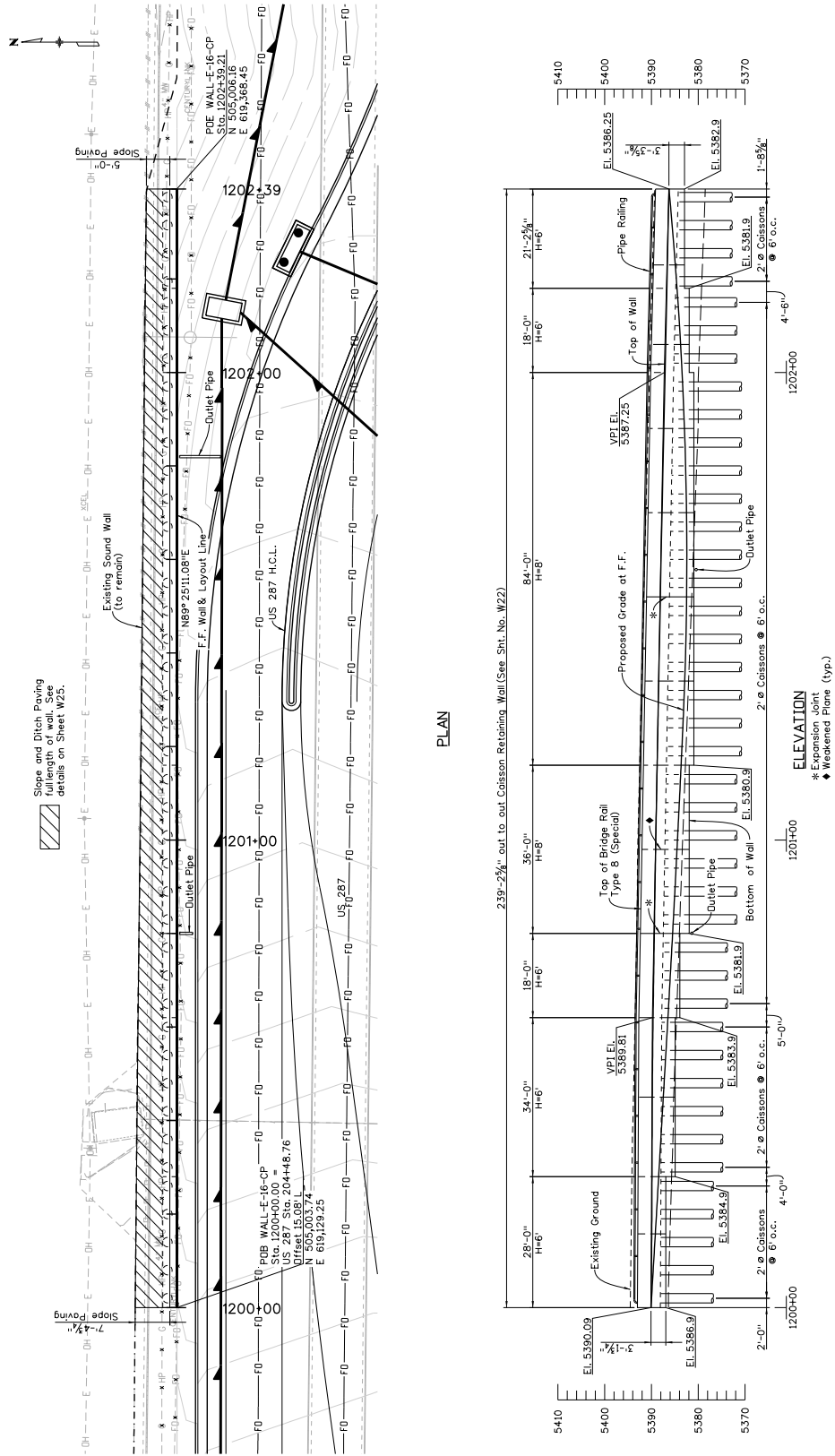


Fig. 15.1.12-1 Caisson Wall Layout Example

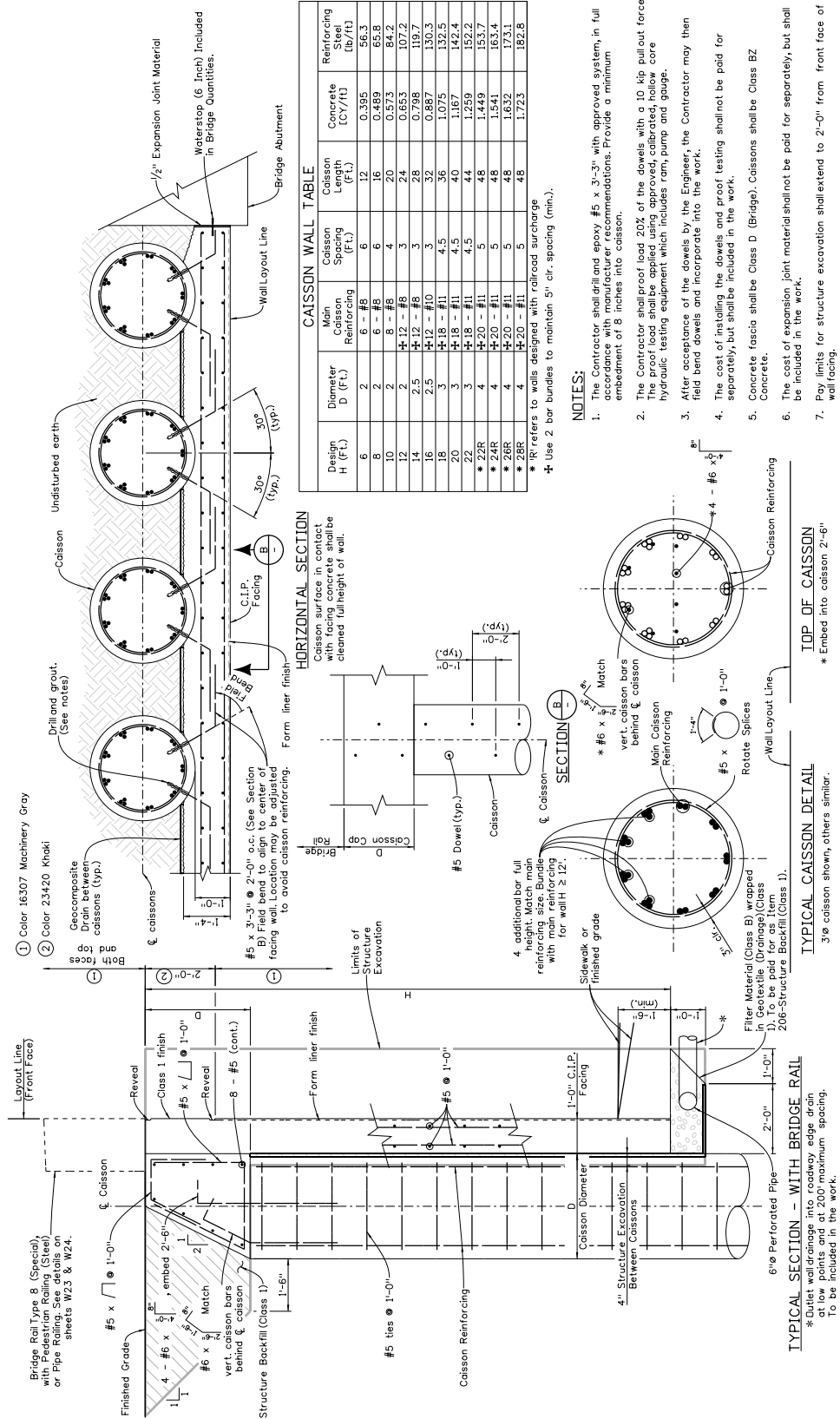


Fig.15.1.12-2 Caisson Wall Section Example

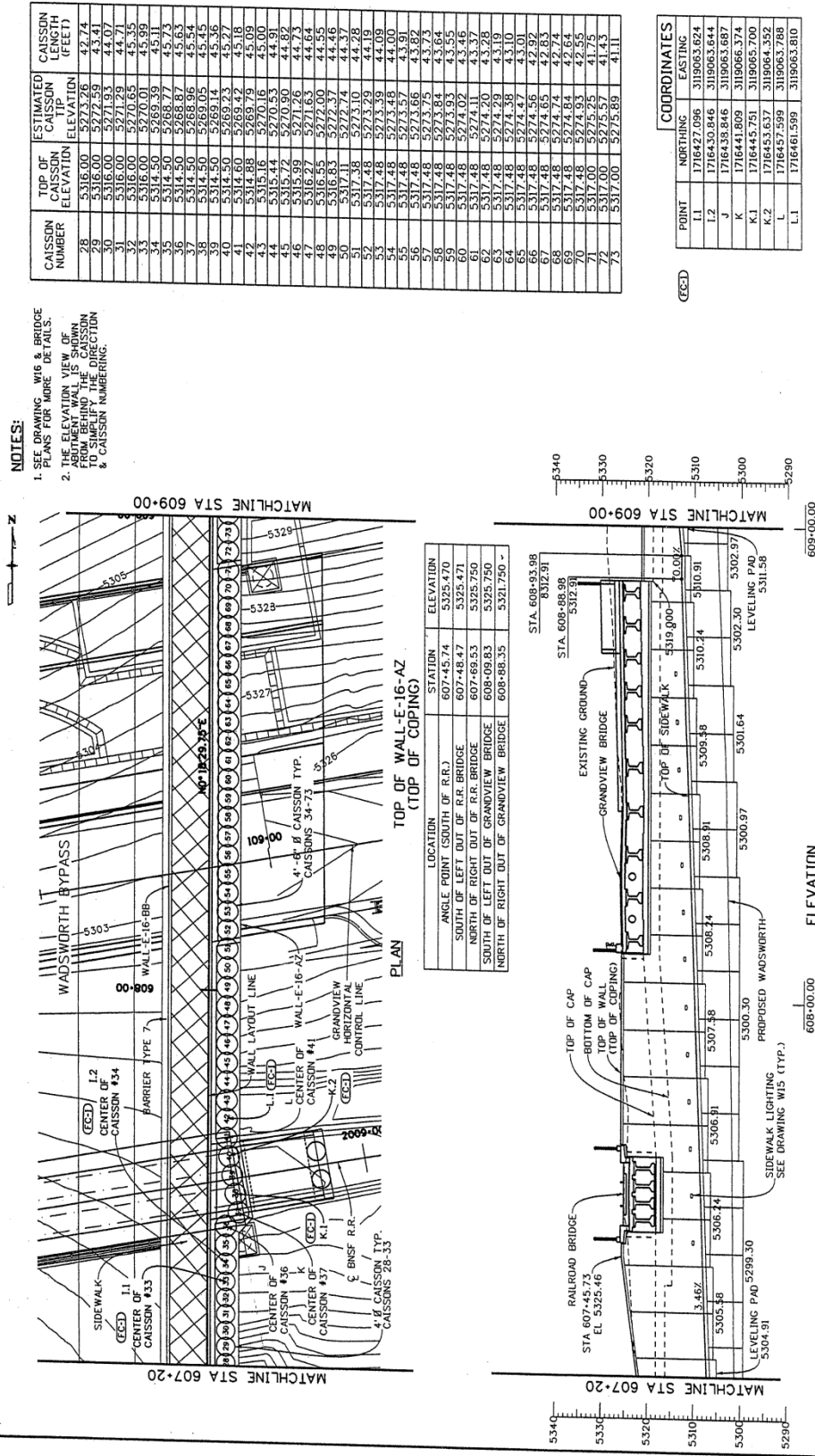


Fig. 15.1.12-3 Secant Caisson Wall Example

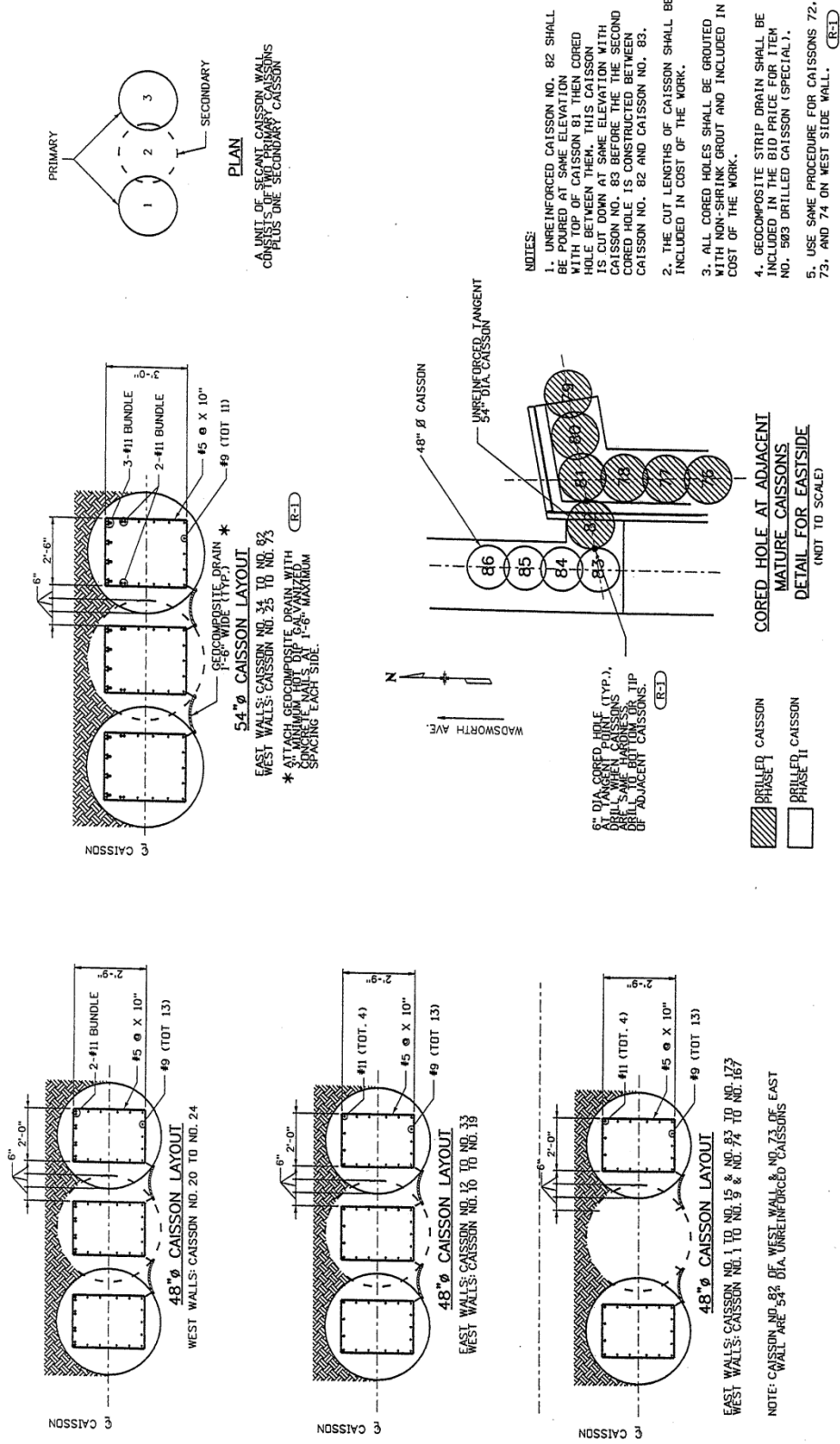


Fig. 15.1.12-4 Secant Caisson Wall Details Example

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.

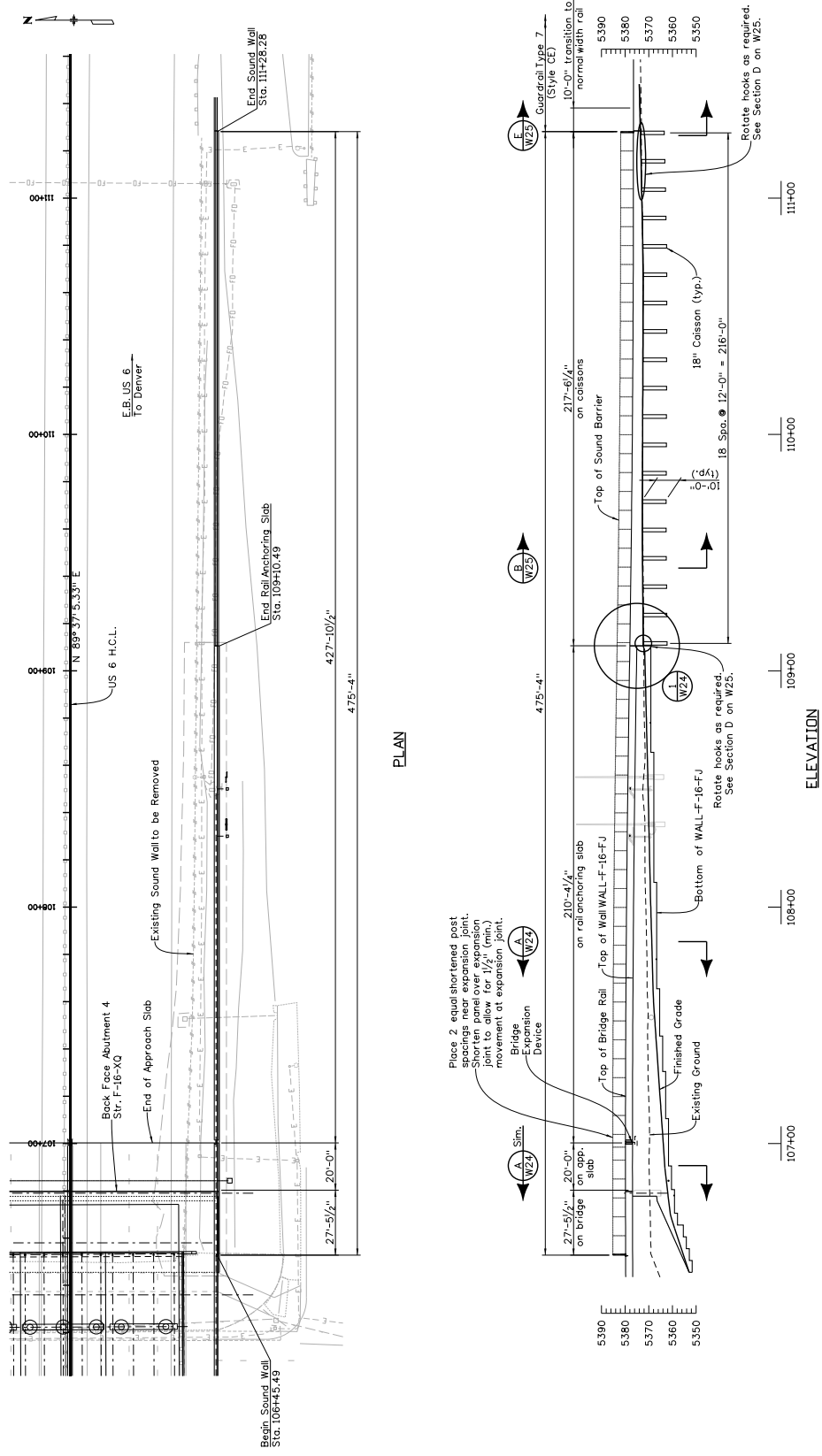


Fig. 15.1.13-1 Sound Barrier Layout Example

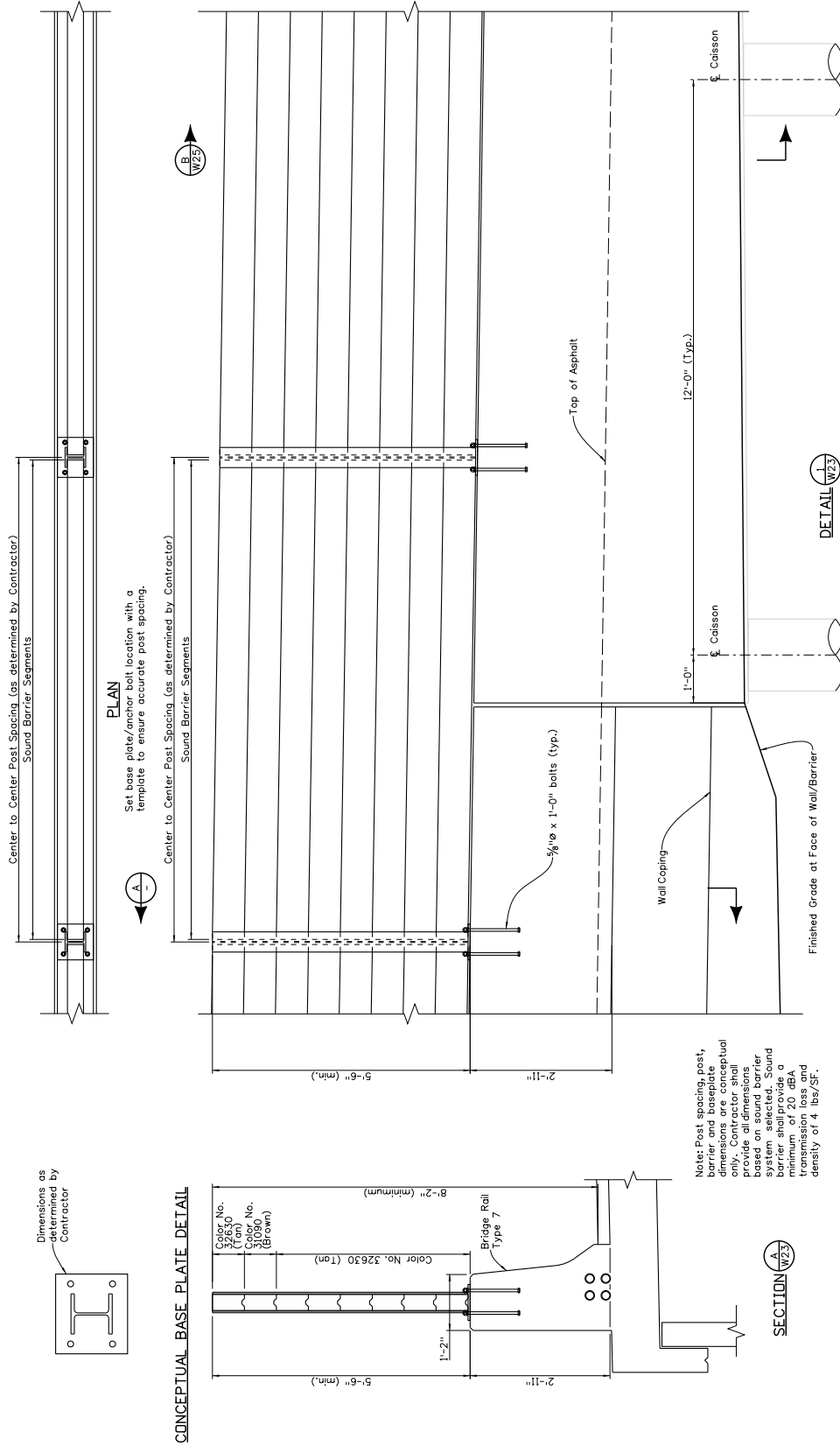


Fig. 15.1.13-2 Sound Barrier on Bridge Example

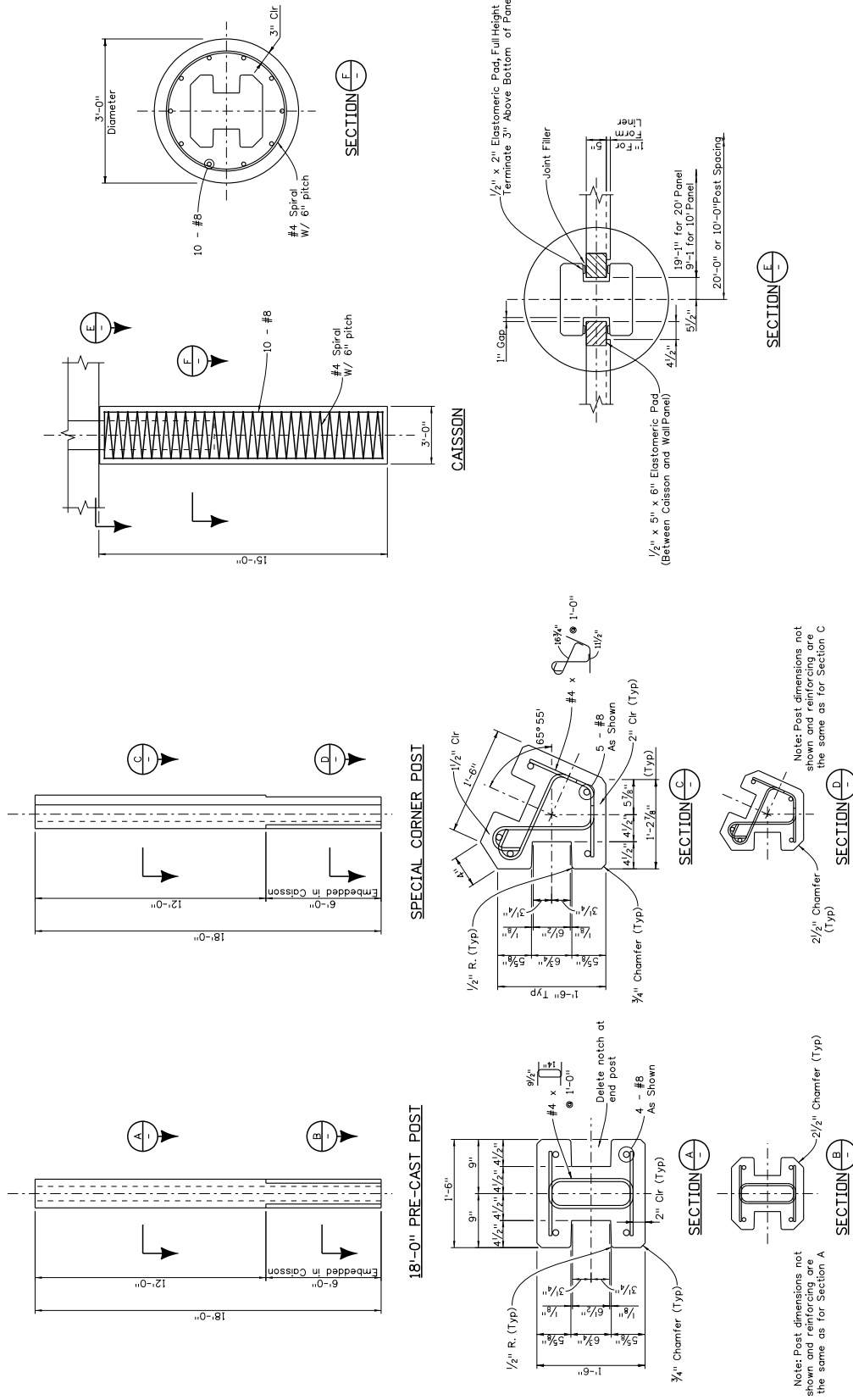


Fig. 15.1.13-4 Corner and Post Details Example

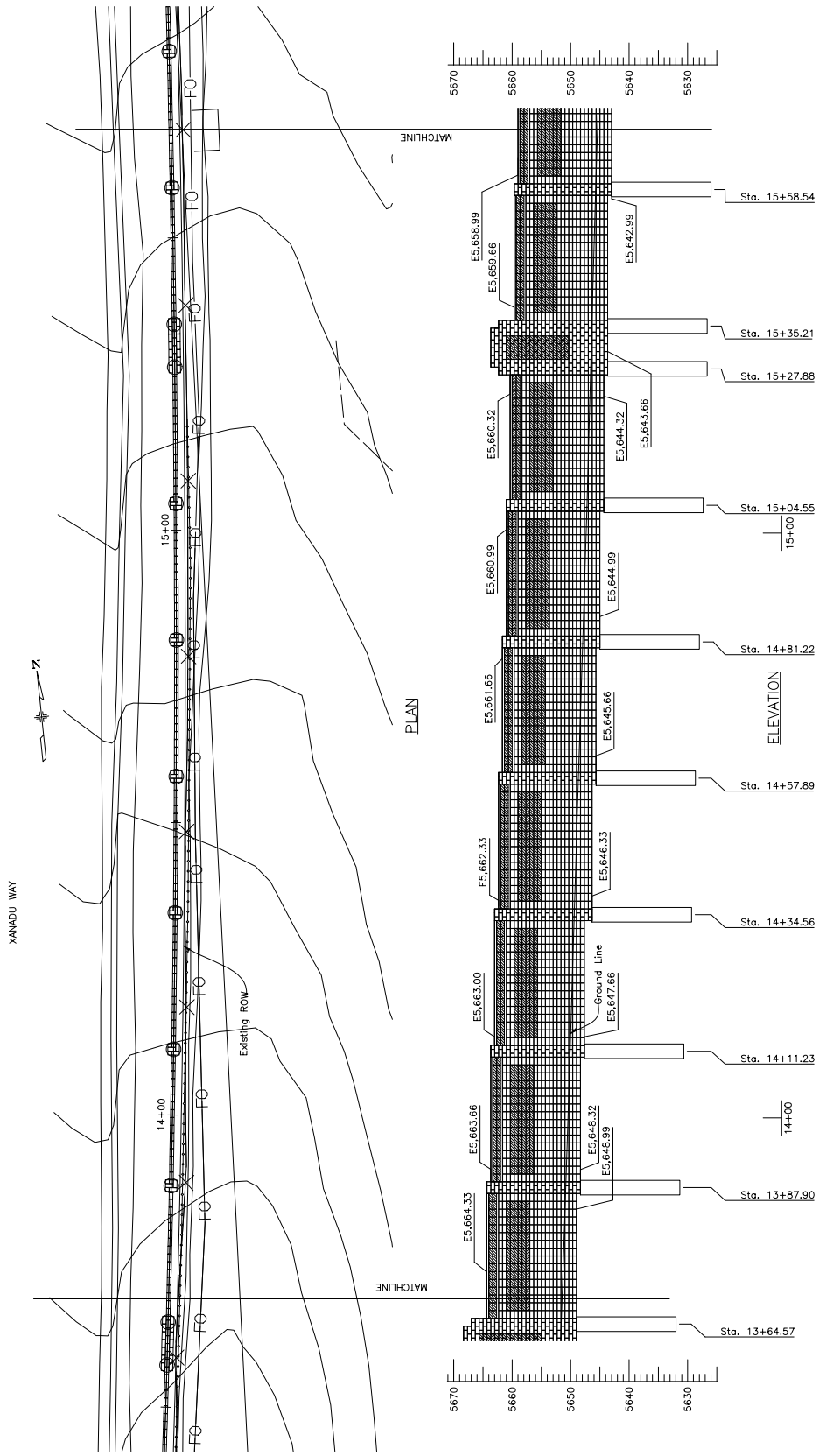


Fig. 15.1.13-5 Masonry Sound Barrier Example

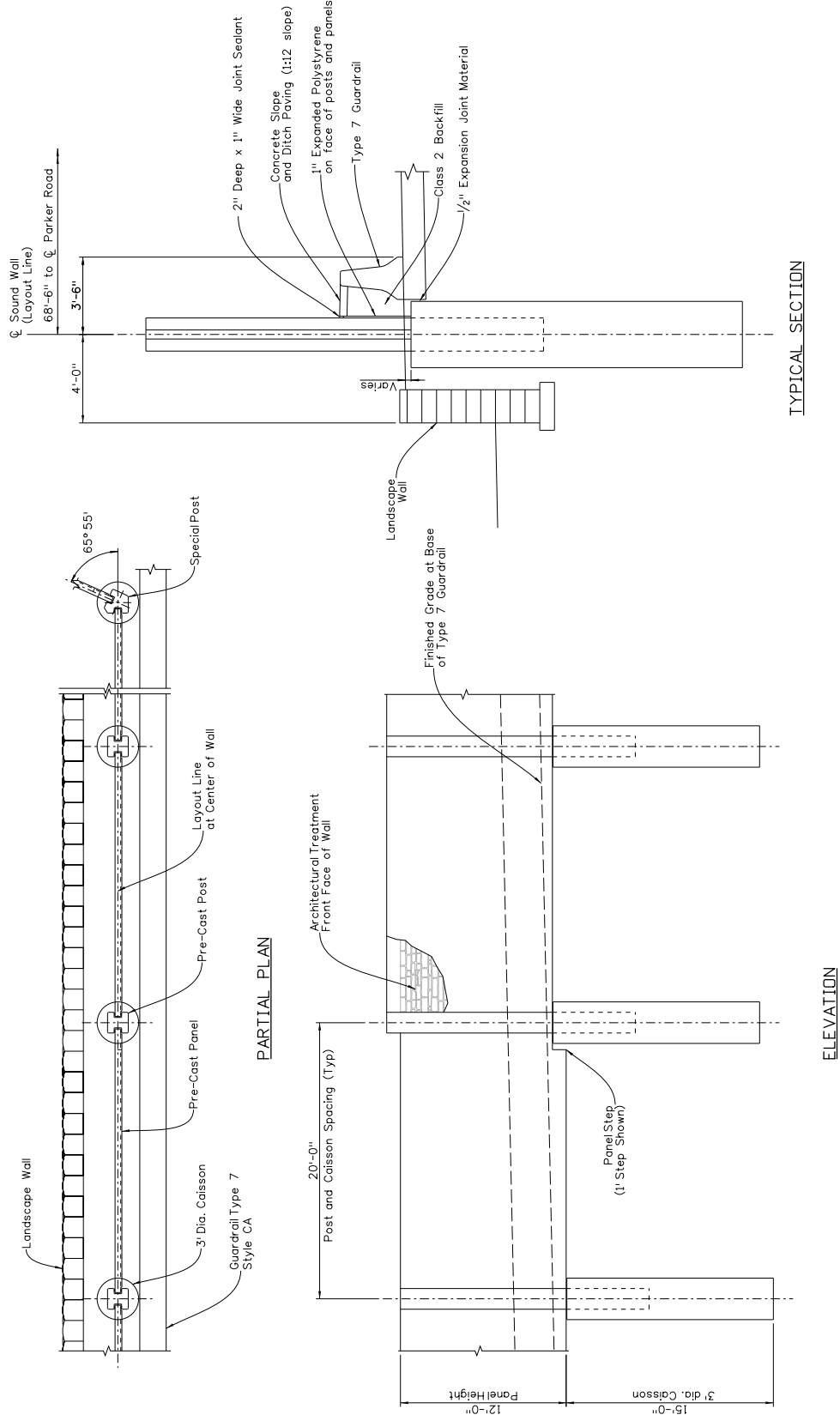


Fig. 15.1.13-6 Precast Panel Sound Barrier Example



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

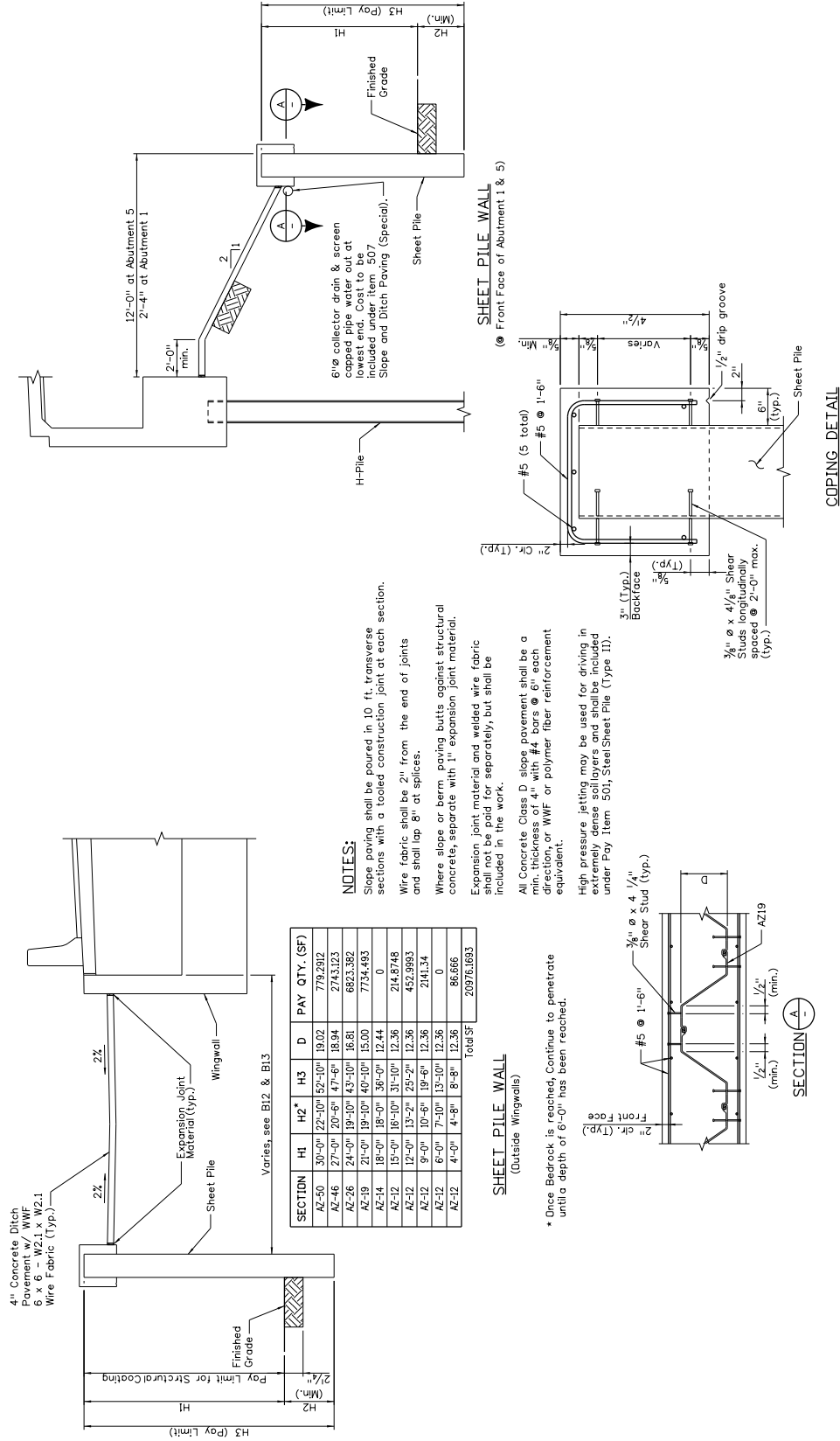


Fig. 15.1.14-1 Sheet Pile Wall Example

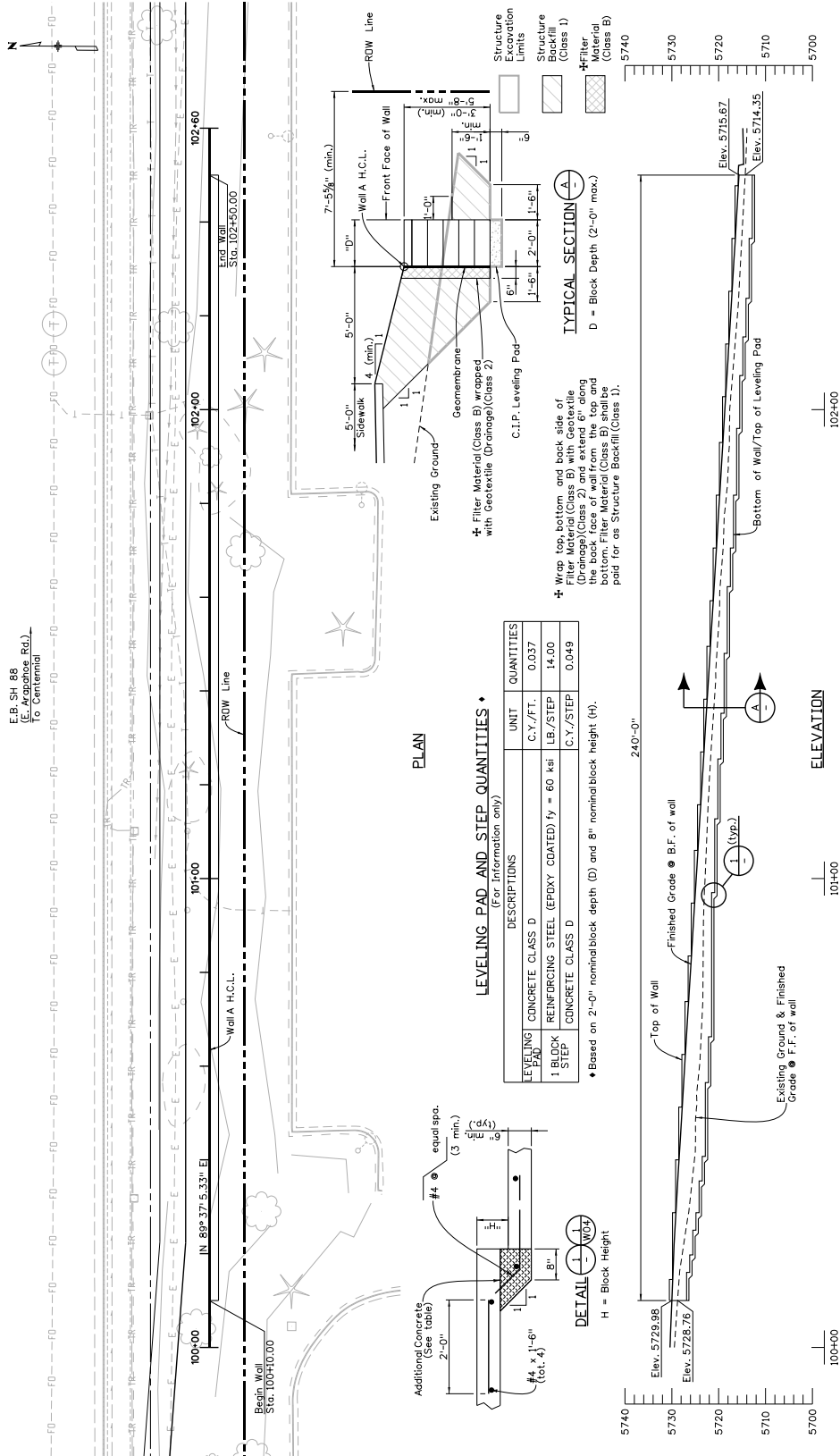


Fig. 15.1.14-2 Gravity Block Wall Example

COLORADO DEPARTMENT OF TRANSPORTATION STAFF BRIDGE BRIDGE DETAIL MANUAL	Chapter: 15.2 Effective: January 16, 2020 Supersedes: New
MISCELLANEOUS STRUCTURES	

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 data, 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".

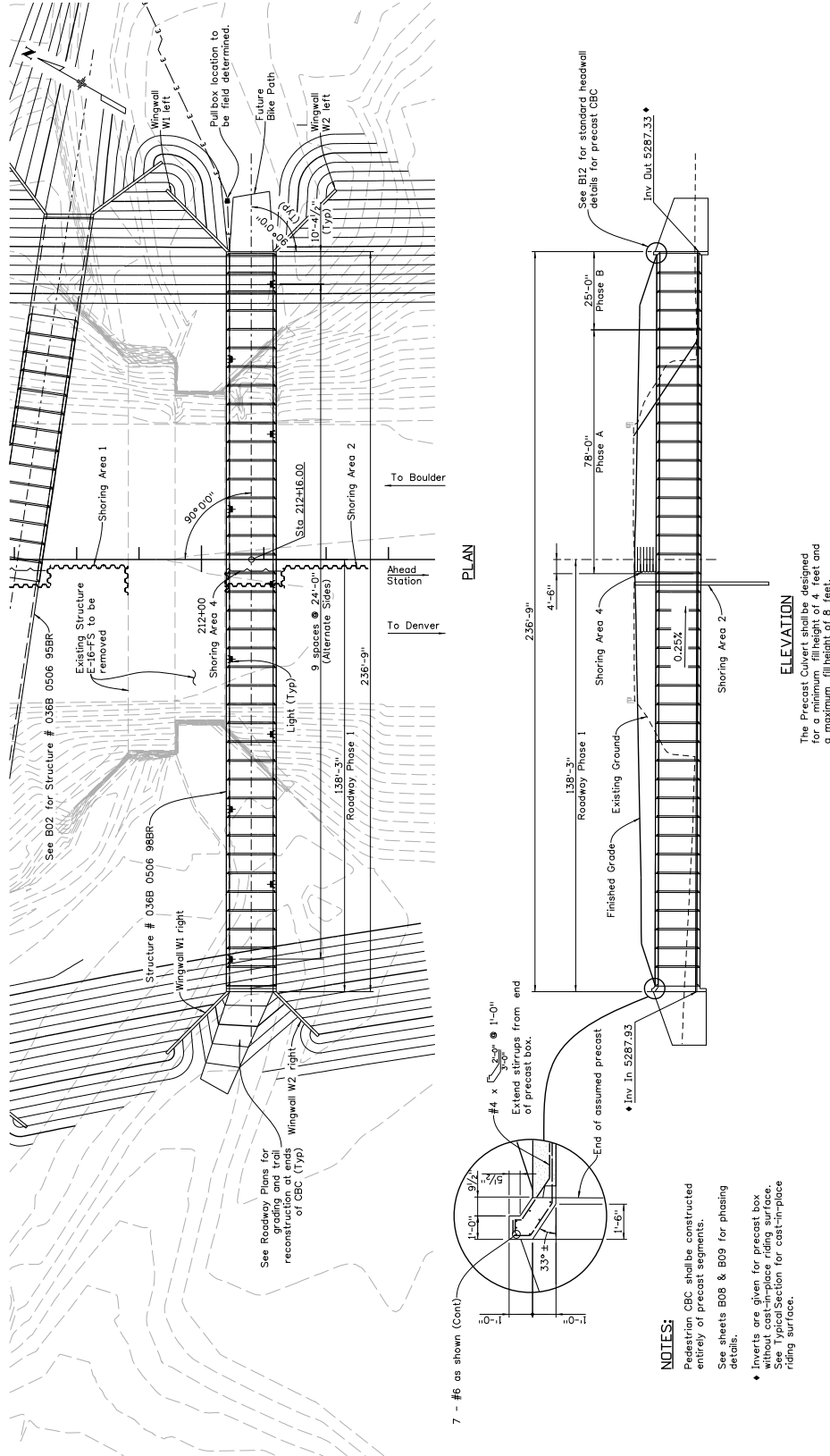
- Y) Provide matchlines for structures which extend to multiple sheets. Matchlines should be placed to avoid critical section changes or alignment changes in the structure.
- Z) Show ROW limits if available and dimensions to railroad as needed.
- AA) Verify accuracy of dimensions and elevations in accordance 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

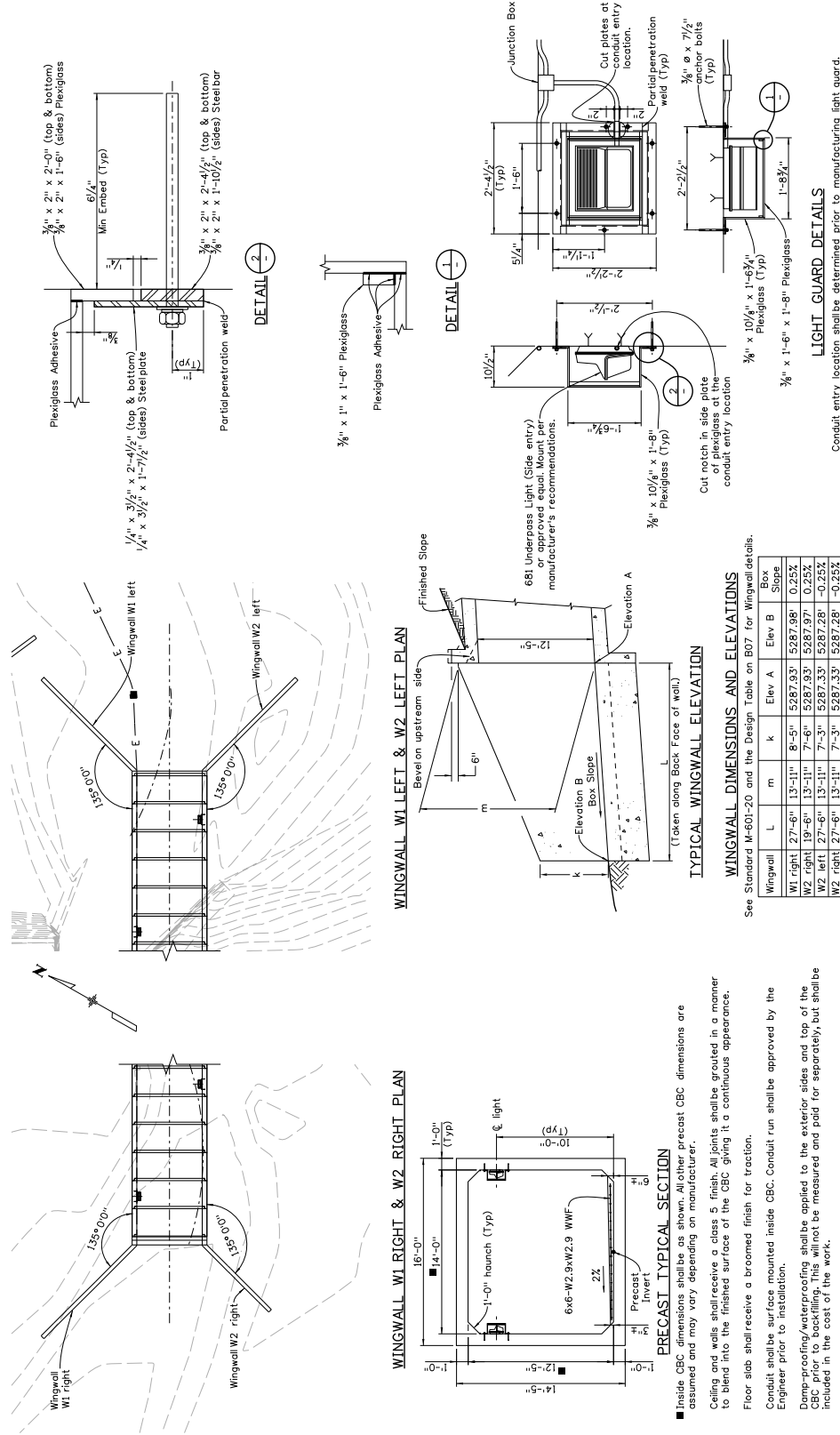
- A) Identify bent angle of the structure.
- B) Identify length.
- C) Show wingwall information, e.g. skews, lengths, heights, etc. Tabular information is acceptable.
- D) Show material type (concrete, metal, precast, CIP, etc).
- E) Delineate construction or excavation limits. (Applicable only if M 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).



GENERAL LAYOUT
BIG DRY CREEK PEDESTRIAN CBC
(036B 0506 98BR)

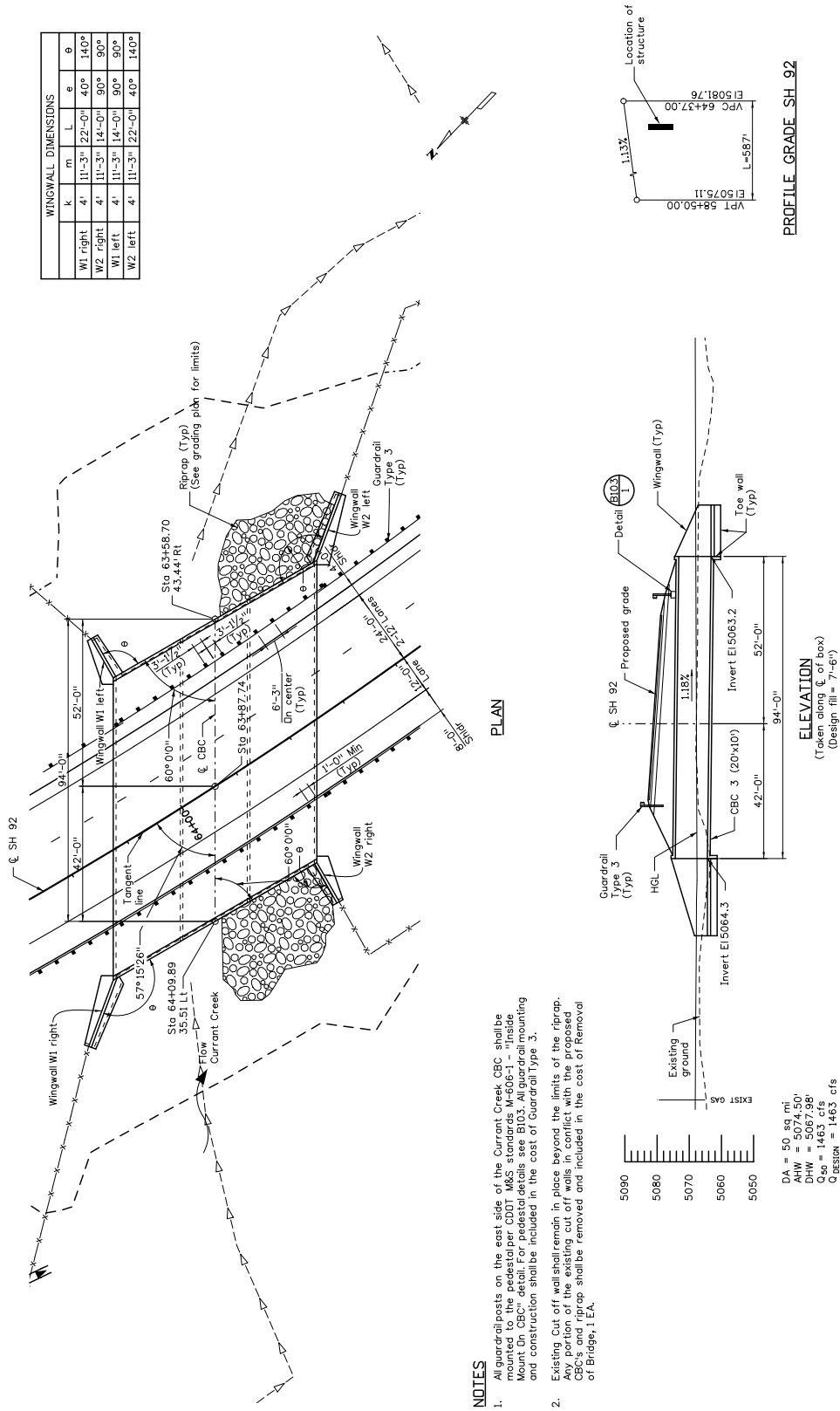
Fig 15.2.10-1 CBC General Layout

- NOTES:**
- Pedestrian CBC shall be constructed entirely of precast segments.
 - See sheets B08 & B09 for phasing details.
 - Inverts are given for precast box without cast-in-place riding surface. See Typical Section for cast-in-place riding surface.



LIGHT GUARD DETAILS
 TYPICAL PRECAST SECTION & WINGWALL DETAILS
 BIG DRY CREEK PEDESTRIAN CBC

Fig 15.2.10-2 CBC Precast Details

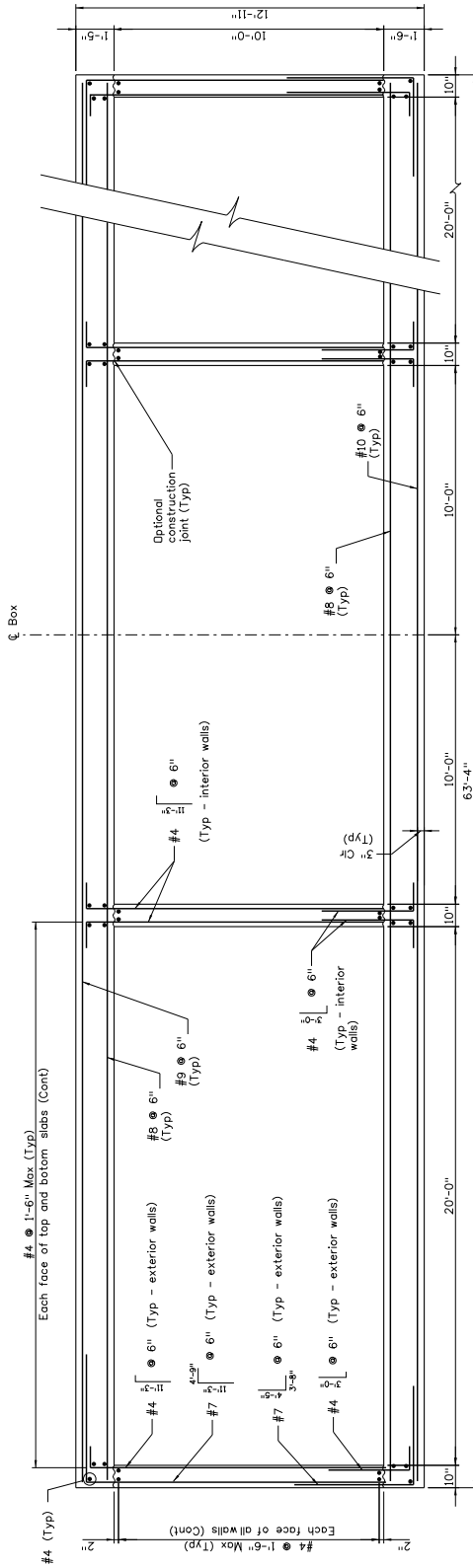


NOTES

1. All guardrail posts on the east side of the Currant Creek CBC shall be mounted to the pedestal per CDOT M&S standards M-606-1 - "Inside Mount On CBC" detail. For pedestal details see BIO3. All guardrail mounting and construction shall be included in the cost of Guardrail Type 3.
2. Existing cut off walls shall remain in place beyond the limits of the riprap. Any portion of the existing cut off walls in conflict with the proposed CBC's and riprap shall be removed and included in the cost of Removal of Bridge, I.E.A.

Fig 15.2.10-3 Cast in Place General Layout

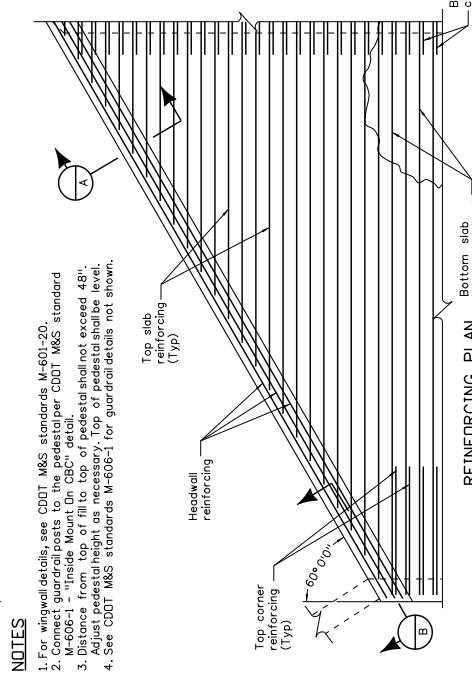
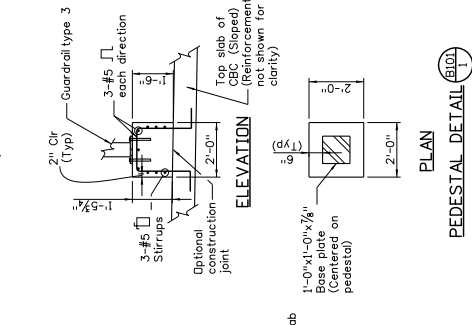
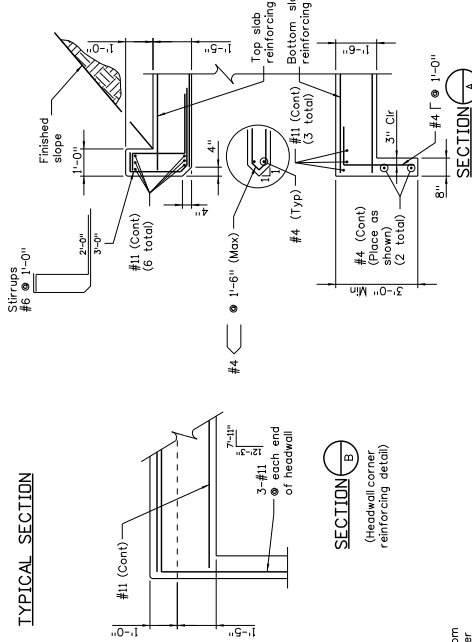
**CURRENT CREEK
STRUCTURAL PLAN & ELEVATION**



NOTES

1. For window details see CDDT M&S standards M-601-20.
2. Connect guardrail posts to the pedestal per CDDT M&S standard M-606-1 - "Inside Mount Dn CBC" detail.
3. Distance from top of fill to top of pedestal shall not exceed 48".
4. Adjust pedestal height as necessary, top of pedestal shall be level.
5. See CDDT M&S standards M-606-1 for guardrail details not shown.

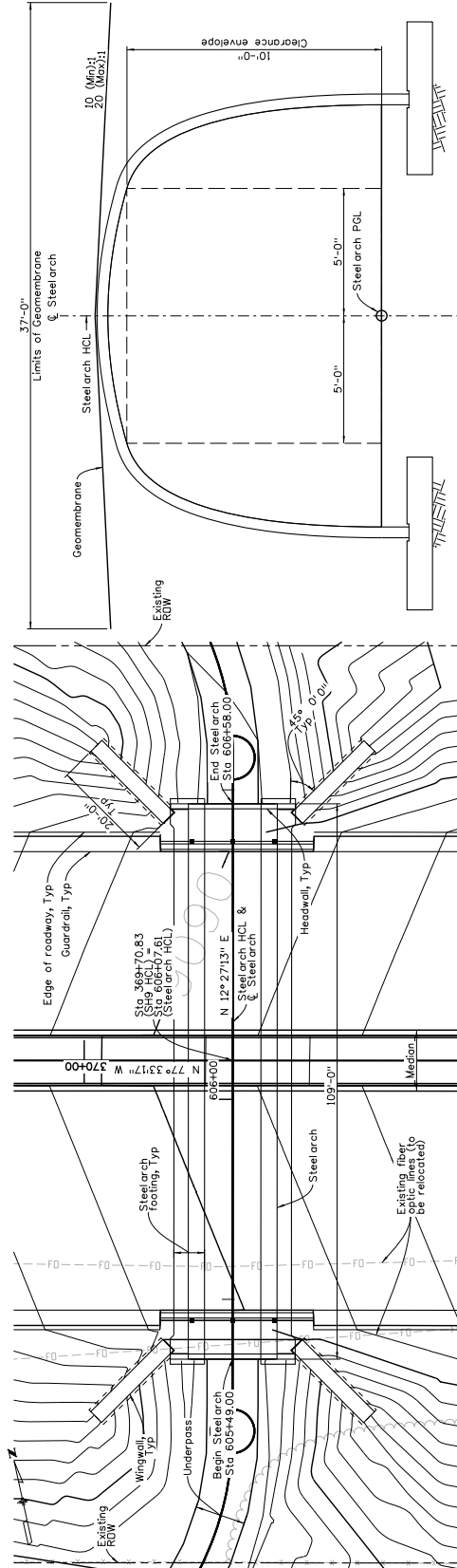
TYPICAL SECTION



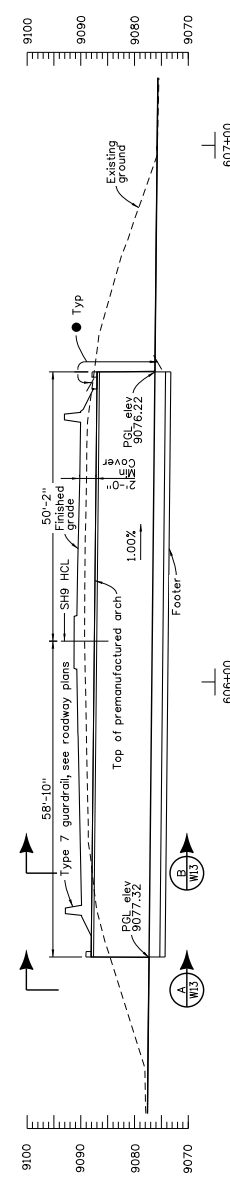
REINFORCING PLAN

PEDESTAL DETAIL

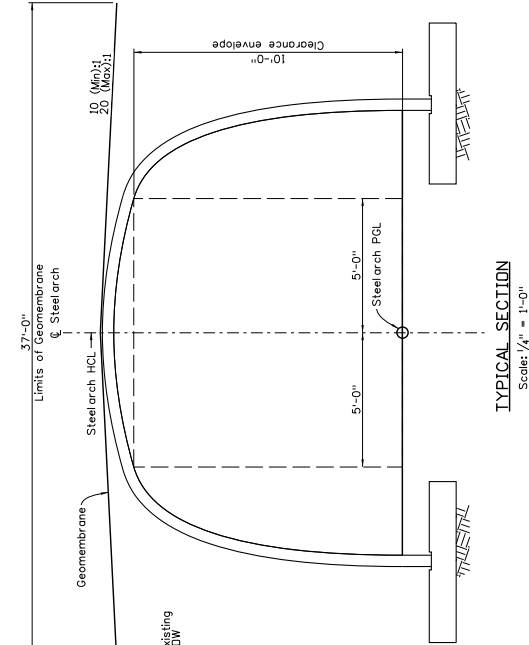
CURRENT CREEK
STRUCTURAL DETAILS



PLAN
Scale: 1" = 20'-0"



ELEVATION
(Taken along Steel arch HCL)
Scale: 1" = 20'-0"



TYPICAL SECTION
Scale: 1/4" = 1'-0"

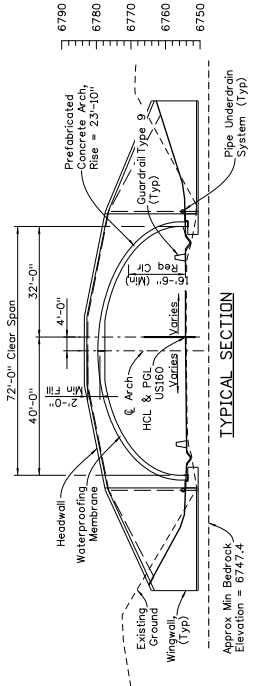
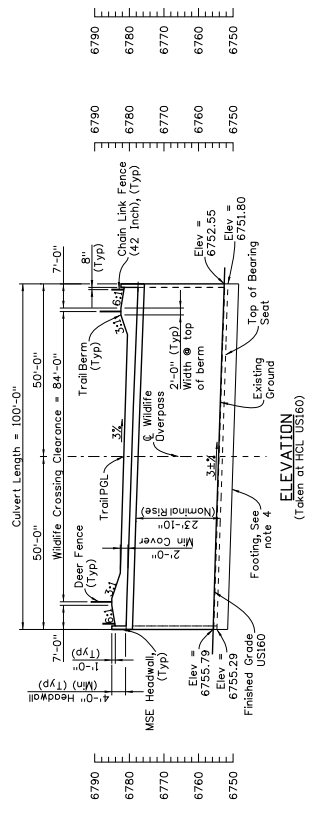
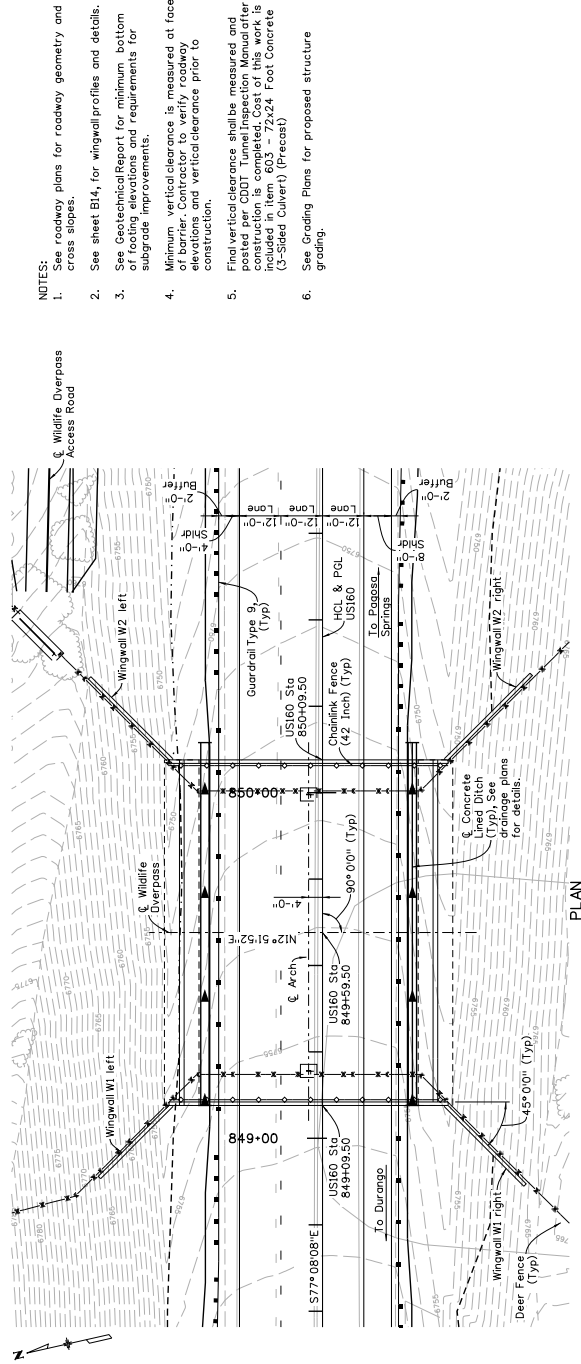
NOTES
1. See roadway plans for alignment and vertical profile.
2. Height and width of steel arch varies based on manufacturer.
3. Height and width of steel arch varies based on manufacturer.

KEY NOTES

- Limits of Structural Concrete Stain. Apply to exposed steel arch and footings outside Steel arch, to 1 foot below finished grade.

STEEL ARCH GENERAL LAYOUT

Fig 15.2.10-5 Steel Arch General Layout



- NOTES:**
1. See roadway plans for roadway geometry and cross slopes.
 2. See sheet B14, for wingwall profiles and details.
 3. See Geotechnical Report for minimum bottom of footing elevations and requirements for saggrate improvements.
 4. Minimum vertical clearance is measured at face of barrier. Contractor to verify roadway geometry and vertical clearance prior to construction.
 5. Final vertical clearance shall be measured and posted after completion of construction. Final posted clearance shall be included in item 603 - 72x24 Foot Concrete (3-Sided Culvert) (Precast)
 6. See Grading Plans for proposed structure grading.

WILDLIFE OVERPASS GENERAL LAYOUT

Fig 15.2.10-6 Overpass Arch General Layout

- NOTES:**
1. Bottom of wall shall be a minimum of 2'-0" below finished grade at front face of wall.
 2. Bottom of walland leveling pad may be stepped at the Contractor's option.
 3. See sheet B15 for assumed dimensions of MSE reinforcement zone.
 4. Connection details between wingwalls, arch and MSE wall shall be the responsibility of the Contractor. Contractor shall submit connection details for review and approval.

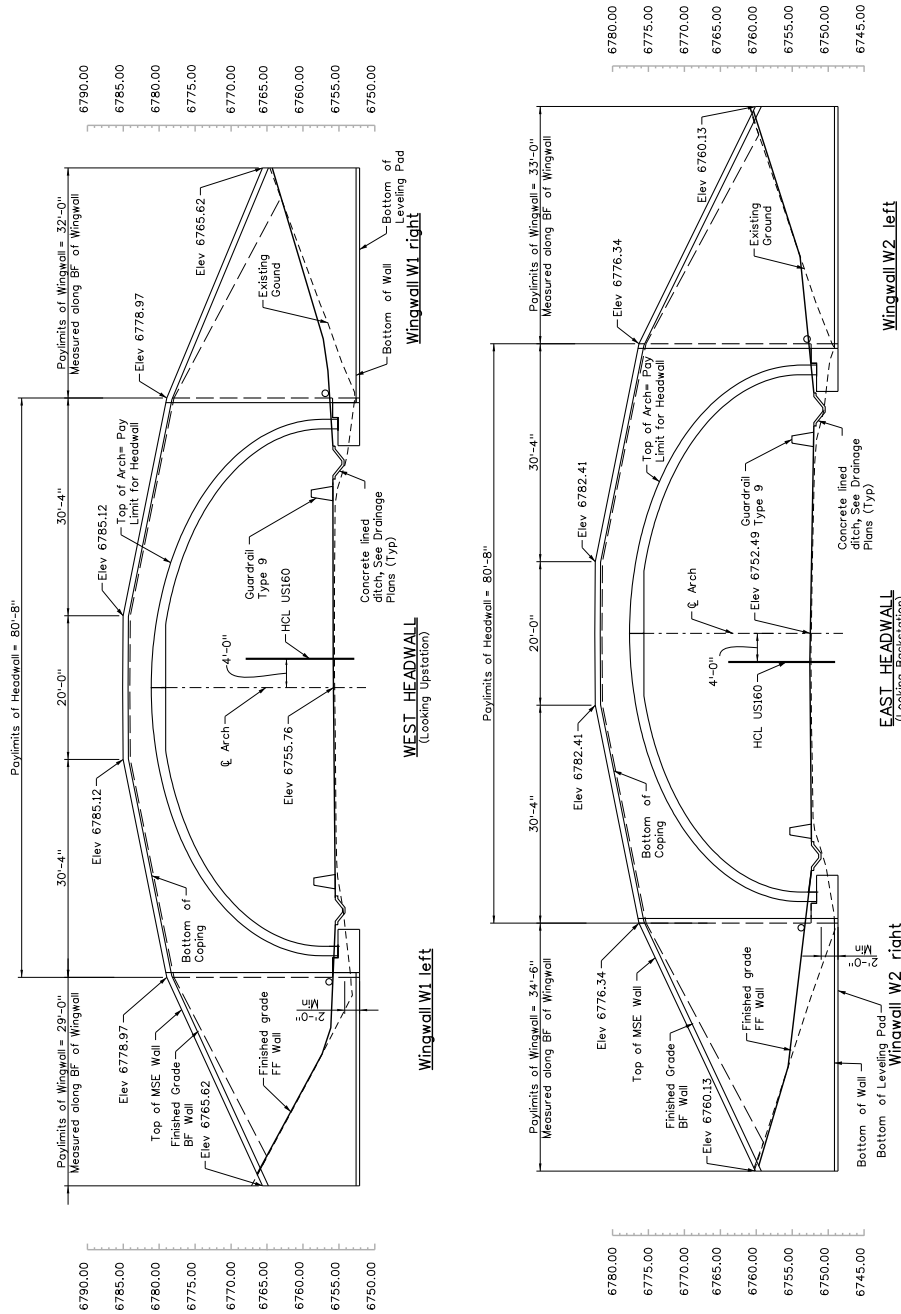


Fig 15.2.10-7 Overpass Wall Layout

WILDLIFE OVERPASS
WINGWALL & HEADWALL PROFILES

- NOTES:**
1. See roadway plans for roadway geometry and cross slopes.
 2. See sheet B6, Wildlife Underpass Phasing, for conceptual phasing details.
 3. See sheet B10, for wingwall profiles and details.
 4. See sheet B9 for pile cap details.
 5. \varnothing Bearing assumes 8" thick arch stem at bearing.

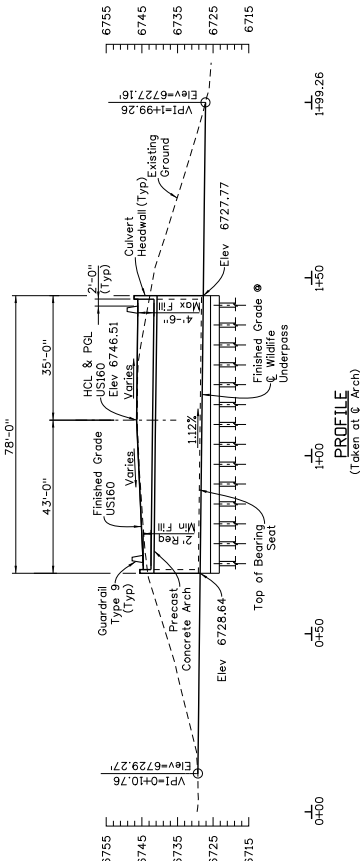
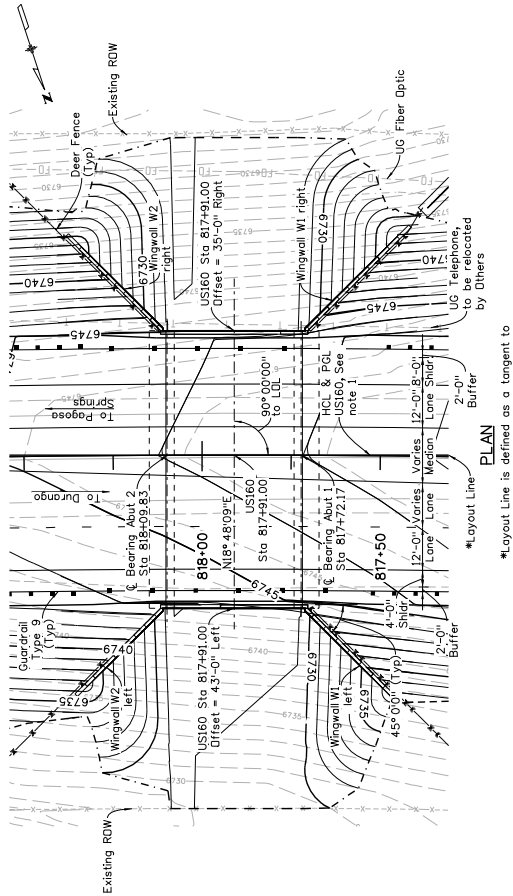
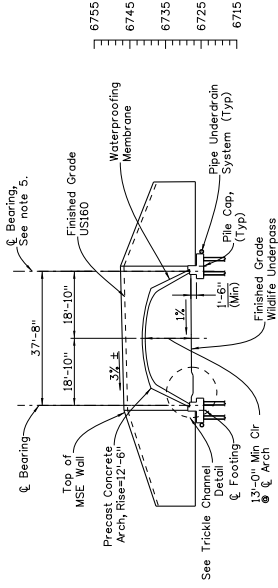
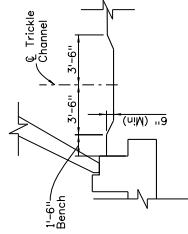
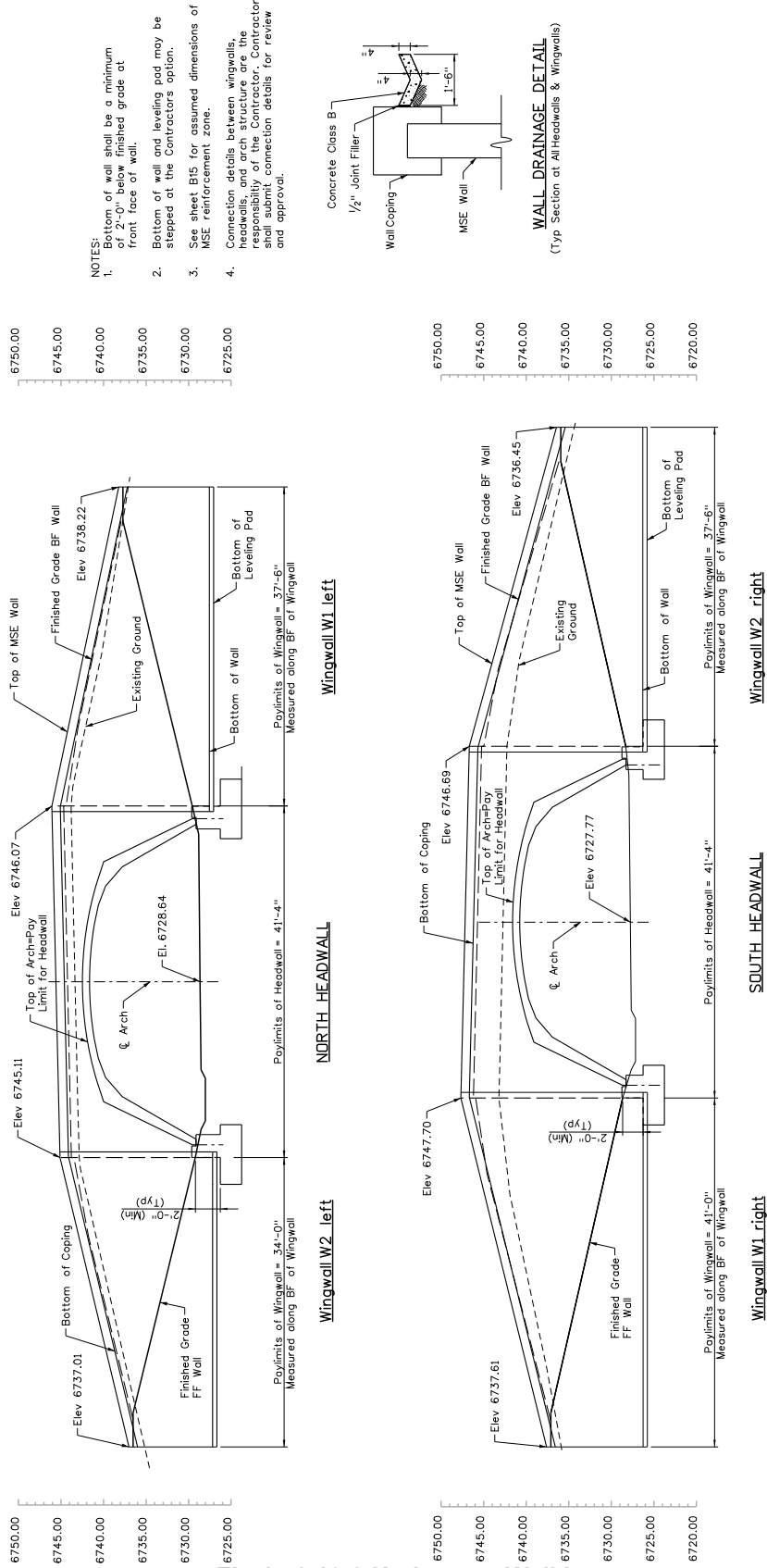


Fig 15.2.10-8 Underpass General Layout

WILDLIFE UNDERPASS
GENERAL LAYOUT



WILDLIFE UNDERPASS
WINGWALL & HEADWALL PROFILES

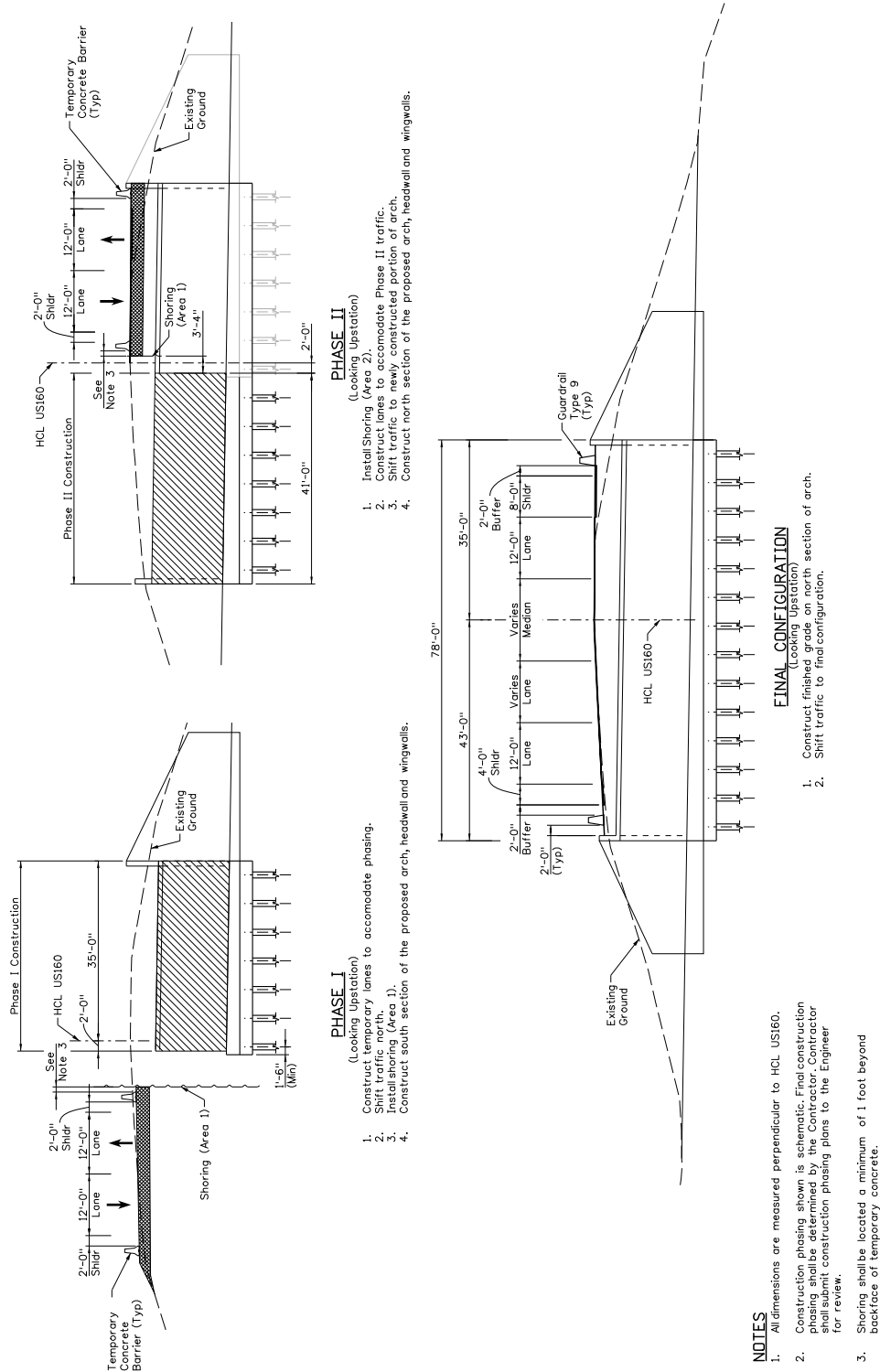


Fig 15.2.10-10 Underpass Construction Phasing

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.

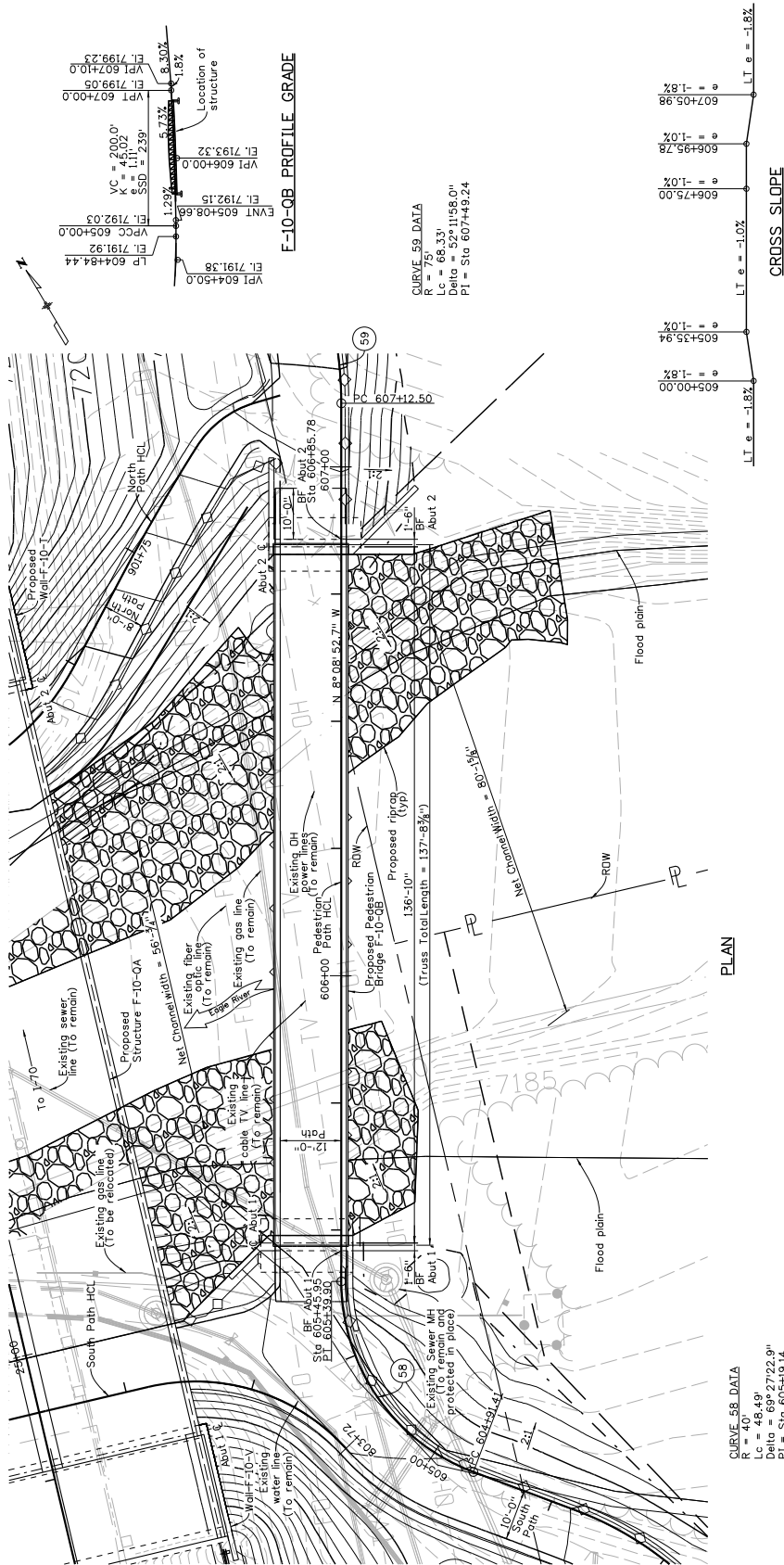


Fig 15.2.11-1 Pedestrian Bridge General Layout

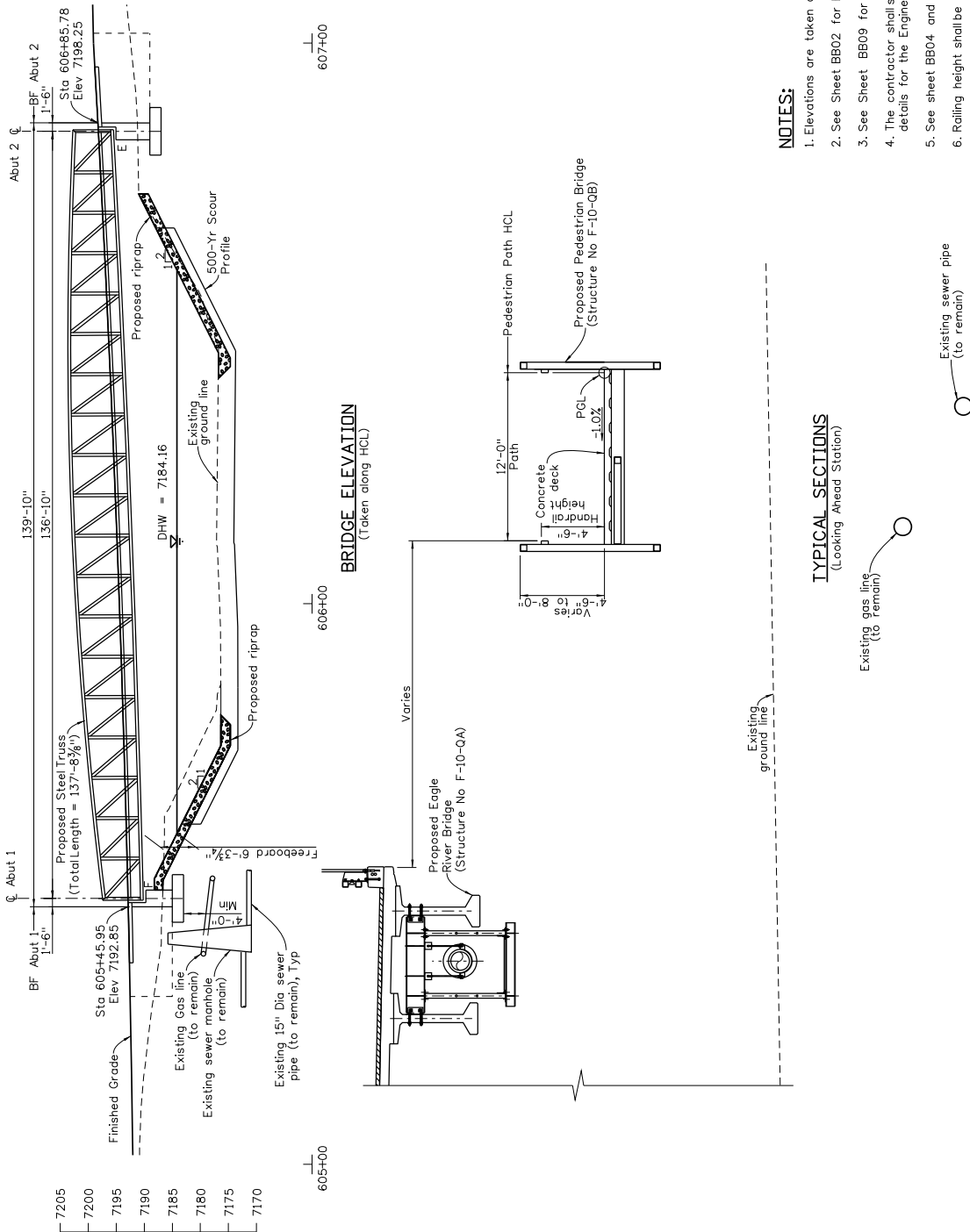
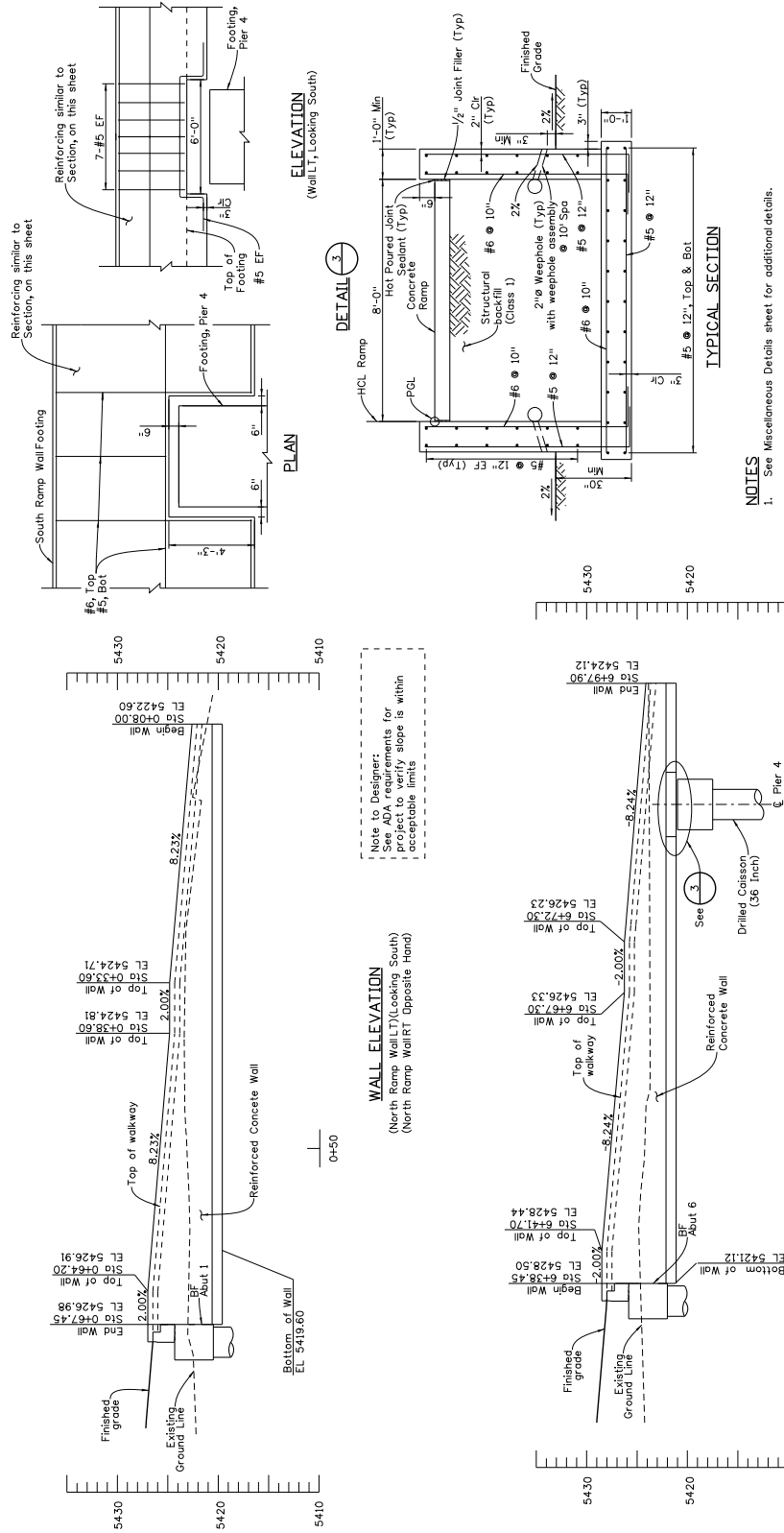


Fig 15.2.11-2 Pedestrian Bridge Layout



- NOTES**
1. See Miscellaneous Details sheet for additional details.
 2. Hot poured Joint Sealant shall be installed per Section 408 of the Standard Specifications. This will not be paid for separately, but shall be included in the work.
 3. Each weephole assembly shall consist of one cubic foot of Filter Material (Class B) in Section 408 (Drainage) (Class 2) securely tied. This will not be paid for separately but shall be included in the work.

REINFORCED CONCRETE WALL LAYOUT

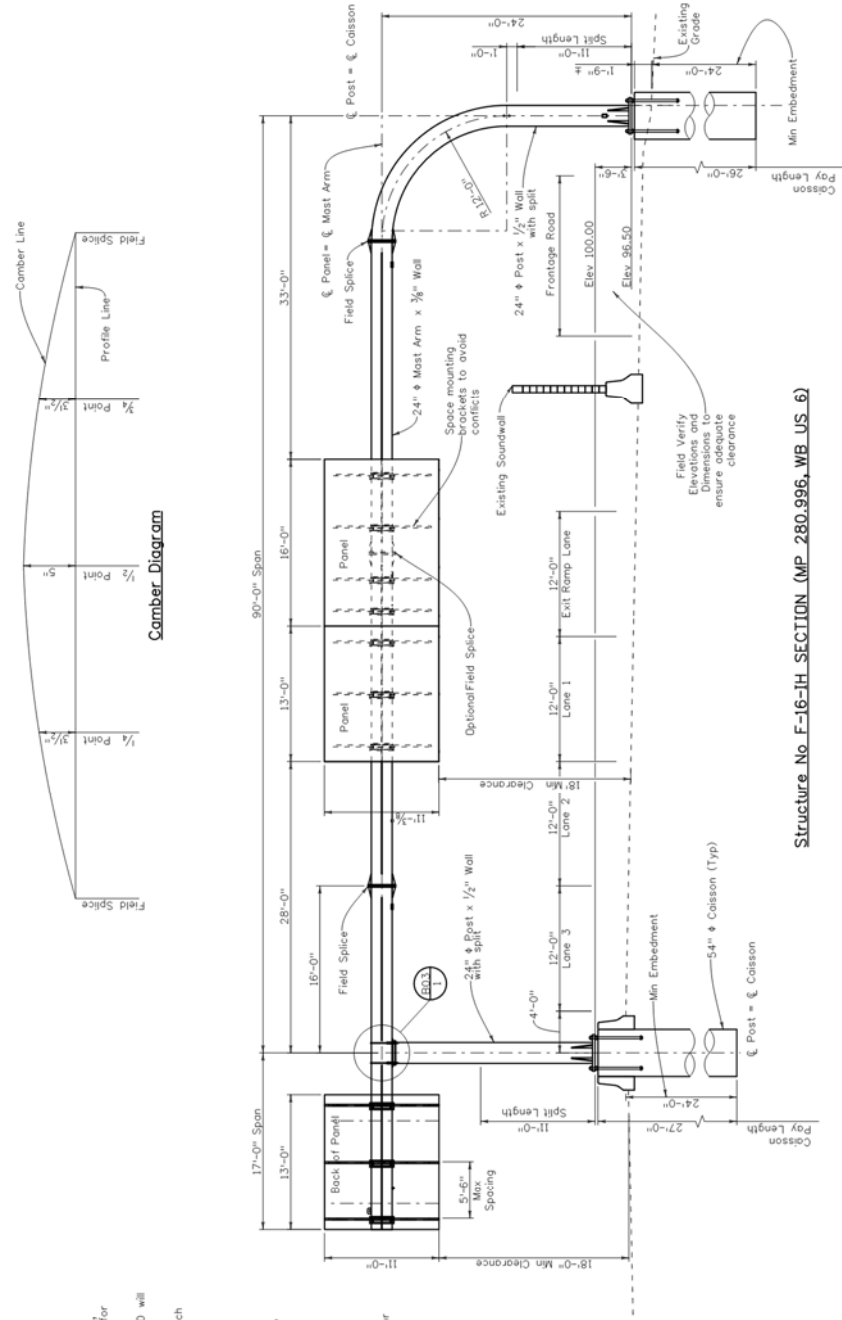
Fig 15.2.11-3 Pedestrian ramp details

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).



Structure No. F-16-1H SECTION (MP 280.996, WB US 6)

MONOTUBE OVERHEAD SIGN SECTION

GENERAL NOTES:

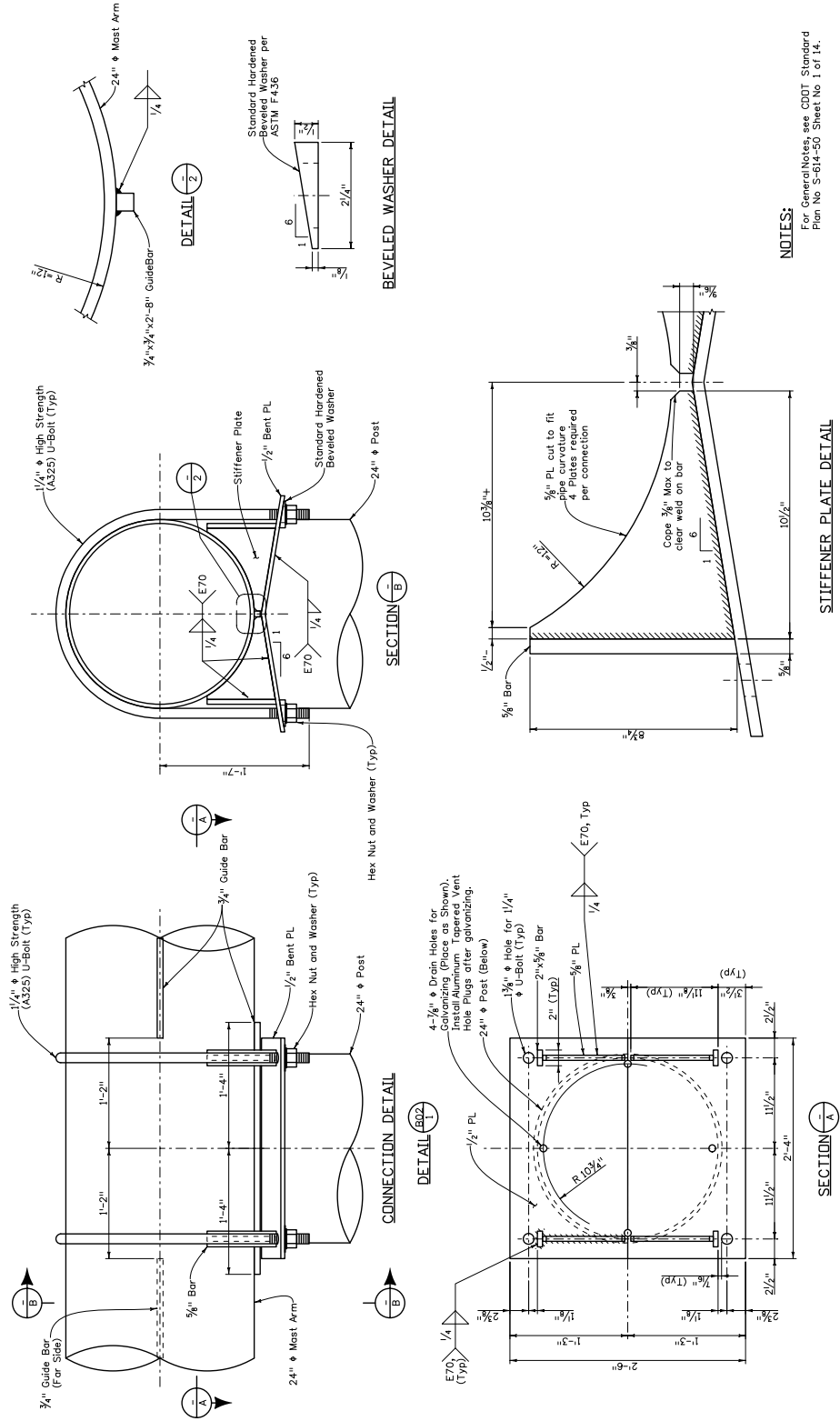
- For additional details and notes not shown, see Standard Plan S-614-50.
- Lighting Details as shown in S-Standard 5-614-50. All lighting fixtures, ballasts, and recessed plugs shall be provided for future use.
- Walkways as shown in S-Standard S-614-50 will not be required.
- Holes in Sign Support Backing Zees to match mounting bracket spacing.

DESIGN DATA:

- AASHTO, "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals", 4th Edition, 2001 w/ 2003 Interims
- Live Load: 100 mph wind velocity.
- Coisson Concrete:
 - Reinforcing Steel: $f_c = 4,000$ psi
 - Reinforcing Steel: $f_y = 60,000$ psi
- Loading for the structure was evaluated for sign panels shown.



Fig 15.2.12-1 Monotube overhead sign



NOTES:
 For General Notes, see CDDT Standard
 Plan No S-614-50 Sheet No 1 of 14.

MONOTUBE CONNECTION DETAIL

Fig 15.2.12-2 Monotube connection details

COLORADO DEPARTMENT OF TRANSPORTATION STAFF BRIDGE BRIDGE DETAIL MANUAL	Chapter: 16 Effective: August 31, 2022 Supersedes: December 15, 2010
REPAIR 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 unbound 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 unbound 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 unbound concrete from surfaces of columns. Sandblast reinforcing steel, place new reinforcing steelas 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
- B) 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(l).

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

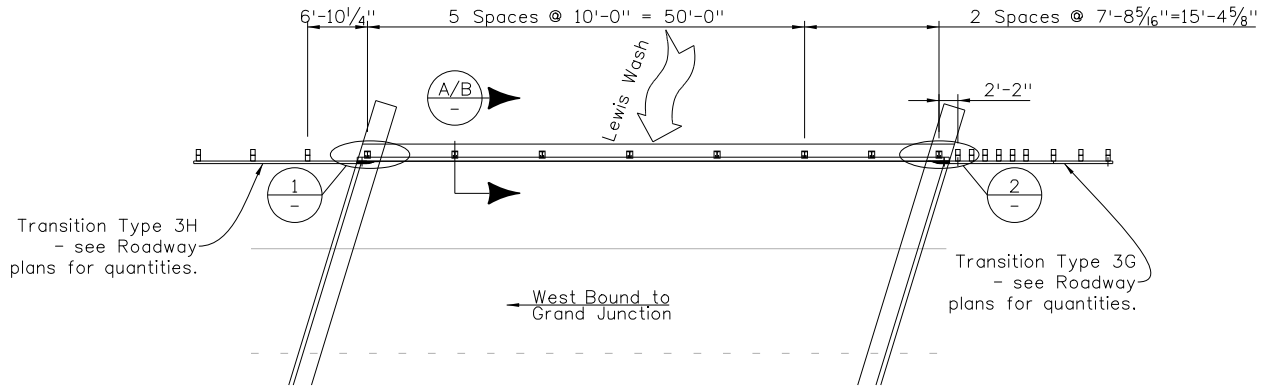


Fig. 16.12(A)-1 Sample Plan showing Bridgerail Post Spacing

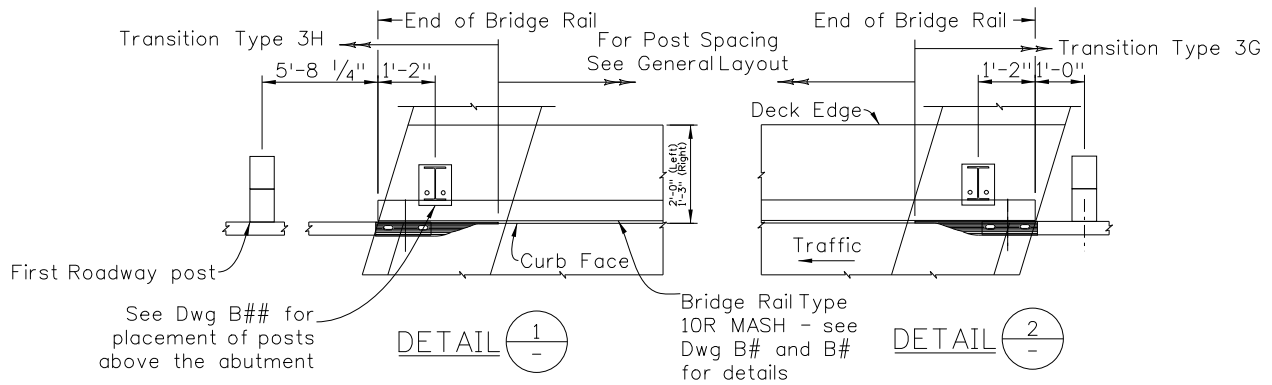


Fig. 16.12(A)-2 Sample Detail showing Bridgerail post locations/clearances near Abutment

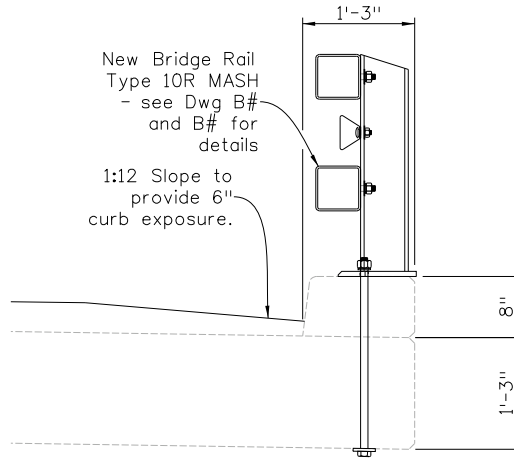
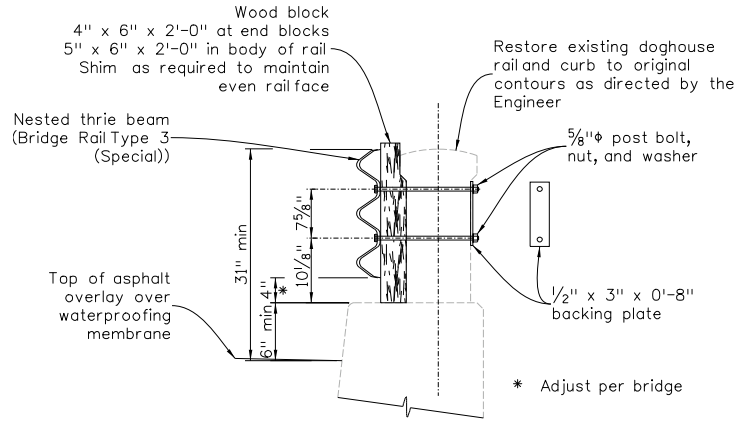


Fig. 16.12(A)-3 Sample Section showing paving detail and Post Connection



TYPICAL CONCRETE RAIL SECTION

Notch block as necessary to fit railing

Fig. 16.12(A)-4 Sample Section showing Bridgerail Repair for Doghouse Type Rail (To be used if replacement is not an option)

- 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

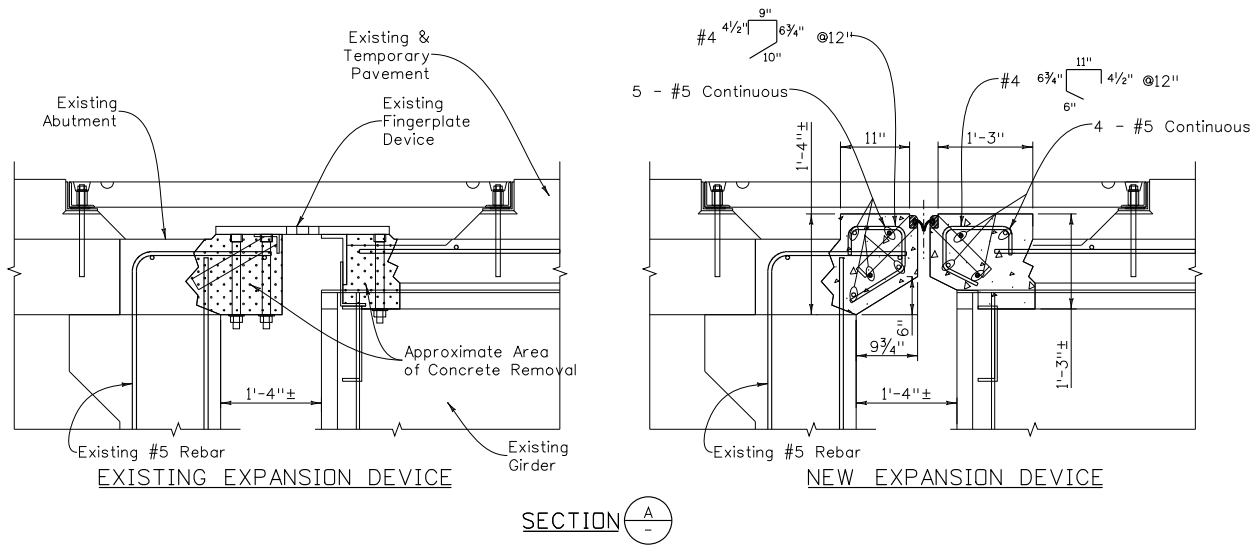


Fig. 16.12(B)-2 Sample Sections showing existing and proposed expansion joint devices



Fig. 16.12(B)-3 Photo of new Expansion device shown in Fig. 16.12(B)-2

- 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
 - i) 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
 - ii) 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)

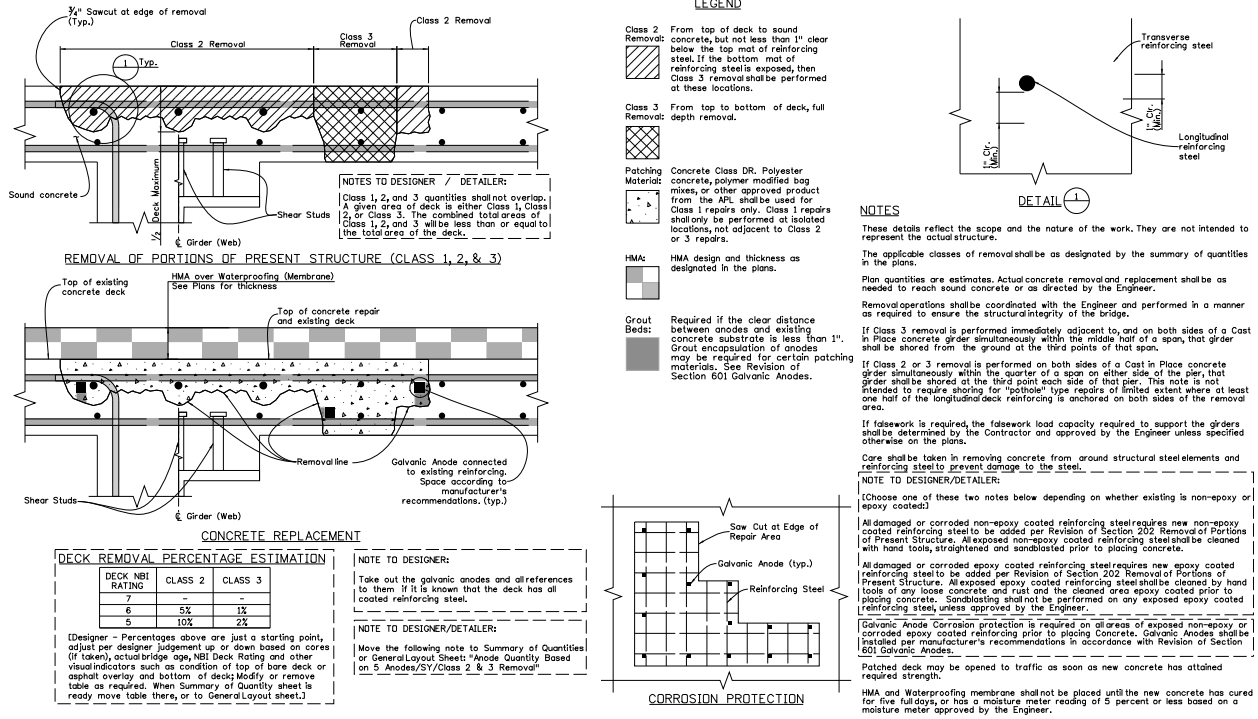


Fig. 16.12(C)-1 Sample of Worksheet for Deck Rehabilitation Removal Details

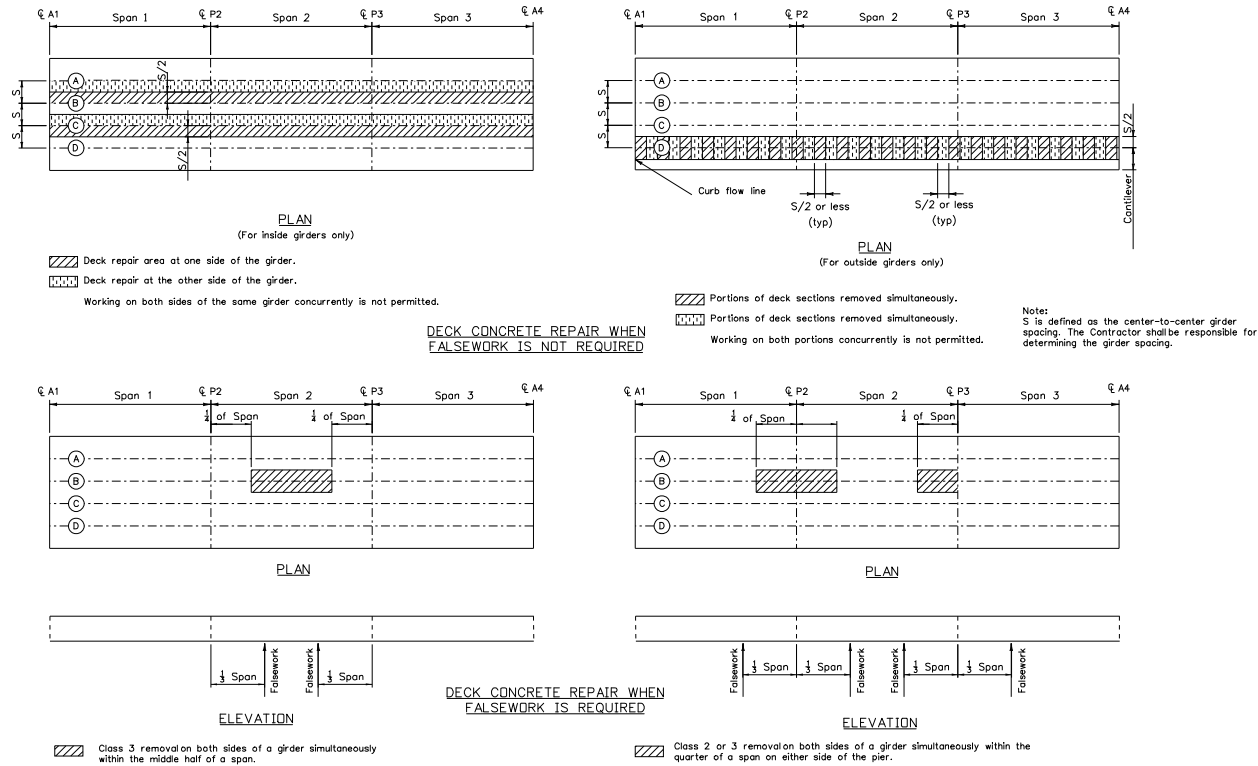


Fig. 16.12(C)-2 Sample Phasing Details for Girders where Falsework may be required

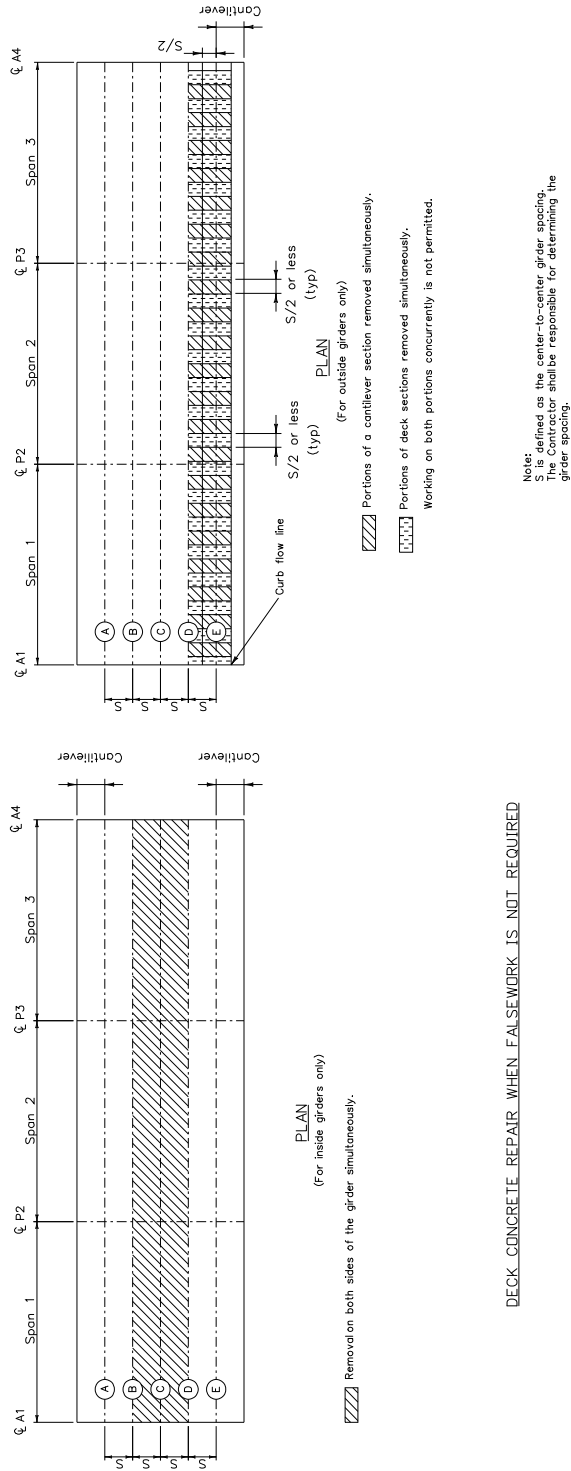


Fig. 16.12(C)-3 Sample Phasing Details for Girders where Falsework is generally not required



Fig. 16.12(C)-5 Close-up Photo of Deck Rehabilitation



Fig. 16.12(C)-6 Photo of Deck Rehabilitation (Removals approaching critical levels)

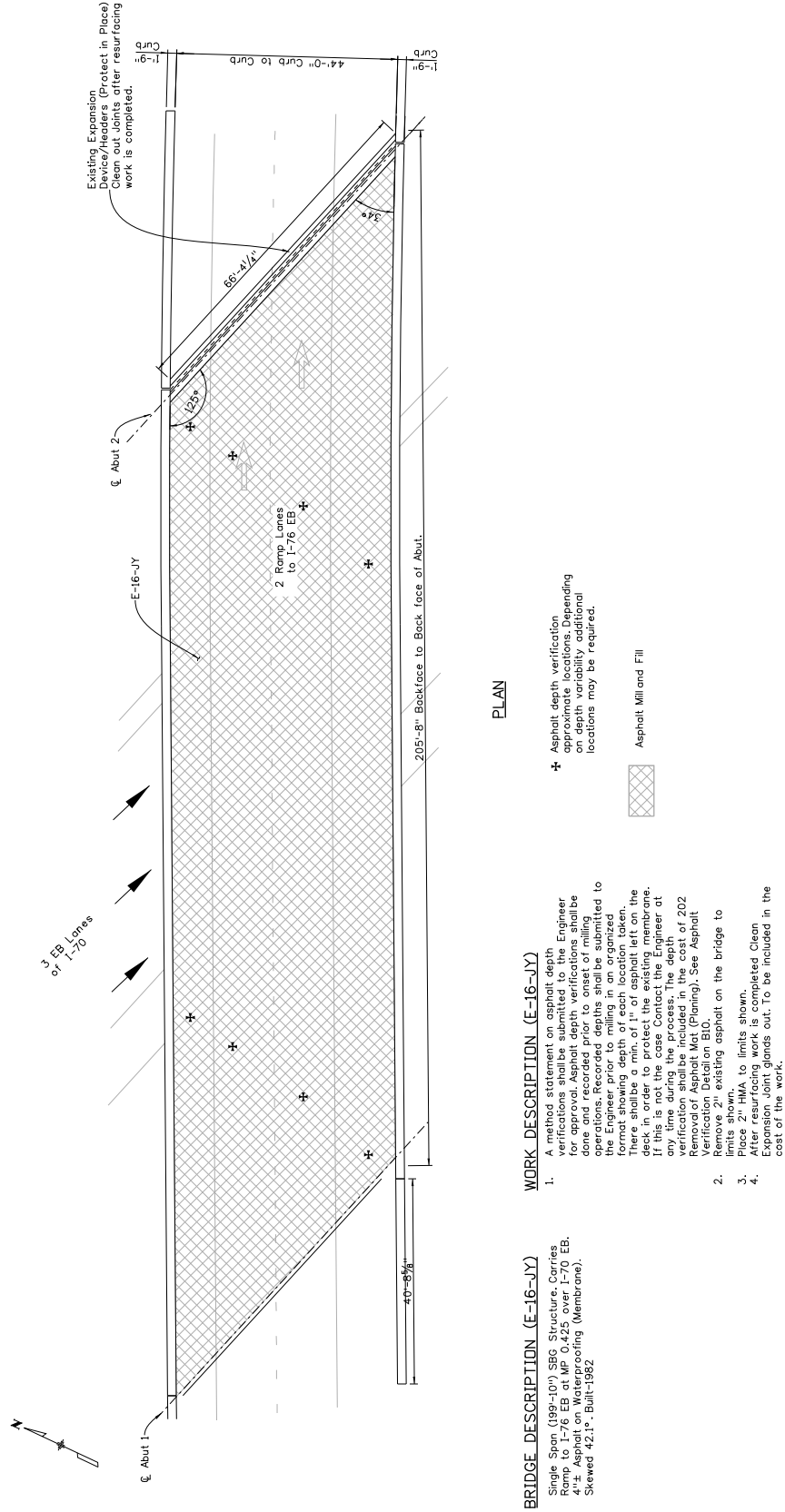


Fig. 16.12(C)-7 Example of asphalt deck coring

BRIDGE DESCRIPTION

- 1. Span (30'-3", 78'-6", 30'-3")
- 2. Bridge, CS&C Built in 1966
- 3. Over Lowell Blvd. at M.P. 271.491
- 4. Out to Out 106'-0"
- 5. Deck Course - Type 3 Bridge Roll
- 6. Asphalt Sealant
- 7. Asphalt Depth - 4"

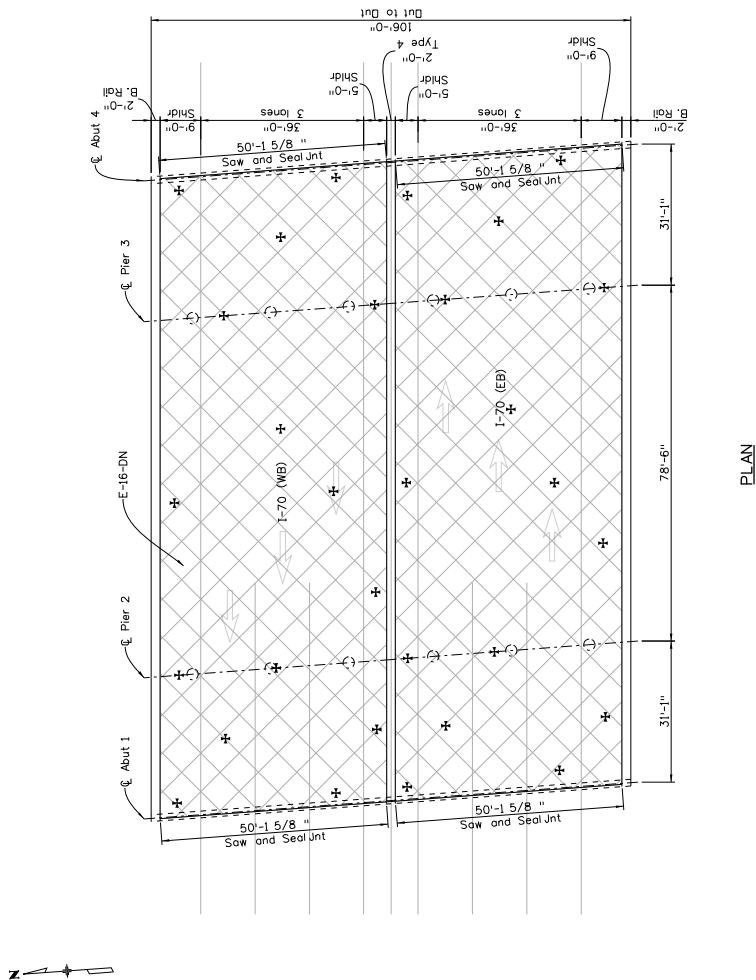
WORK DESCRIPTION E-16-DN

- 1. Remove 2 1/2" existing asphalt on bridge deck.
- 2. Place 2 1/2" SMA in limits shown.
- 3. Saw and Seal Joints.
- 4. Place Delineators on bridge approaches per S-612-1.



Asphalt Mill and Fill

- + Asphalt depth verification locations. Depending on depth variability additional locations may be required.



- 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

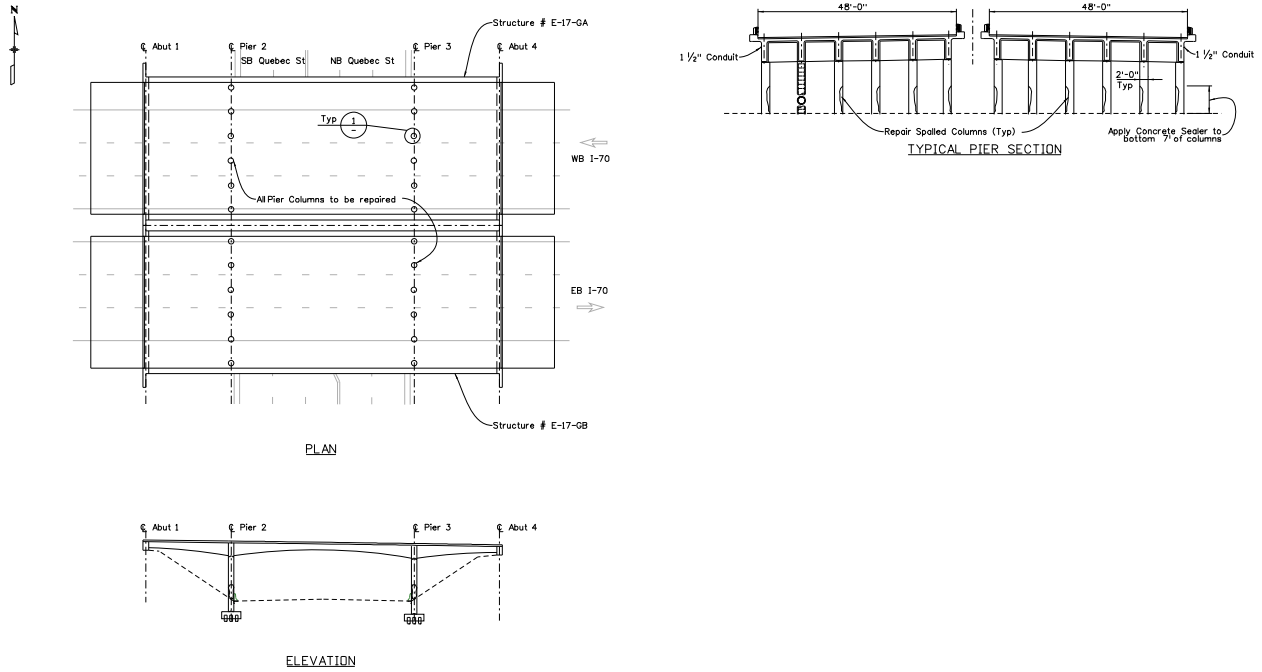
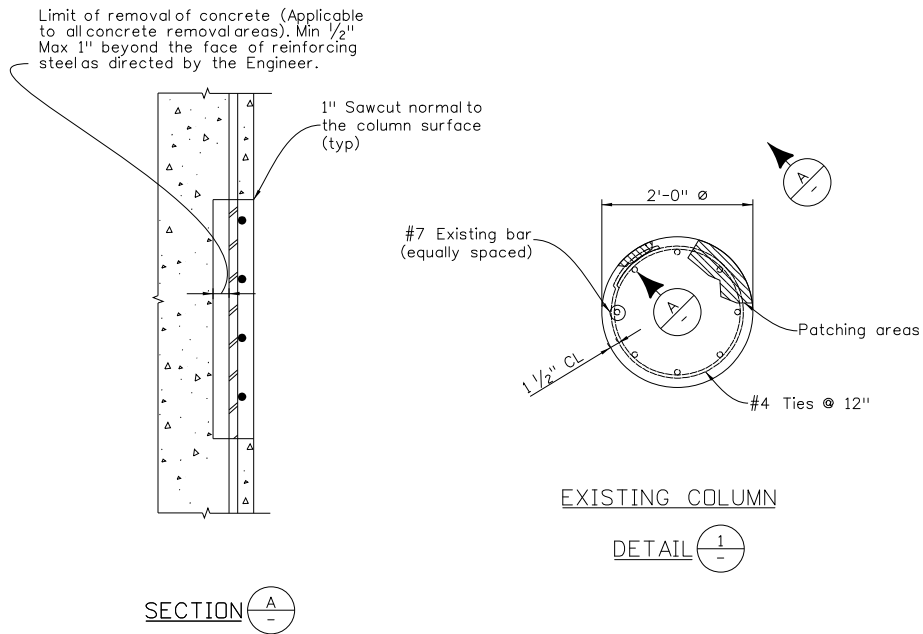


Fig. 16.12(D)-1 Sample General Layout for a Pier Cap/Column Repair



Note: Apply approved Concrete Sealer to all columns after patching repairs are complete per Manufacturer's recommendations.

Fig. 16.12(D)-2 Sample Detail showing Removals and Patching



Fig. 16.12(D)-3 Photos showing column damage and repair process

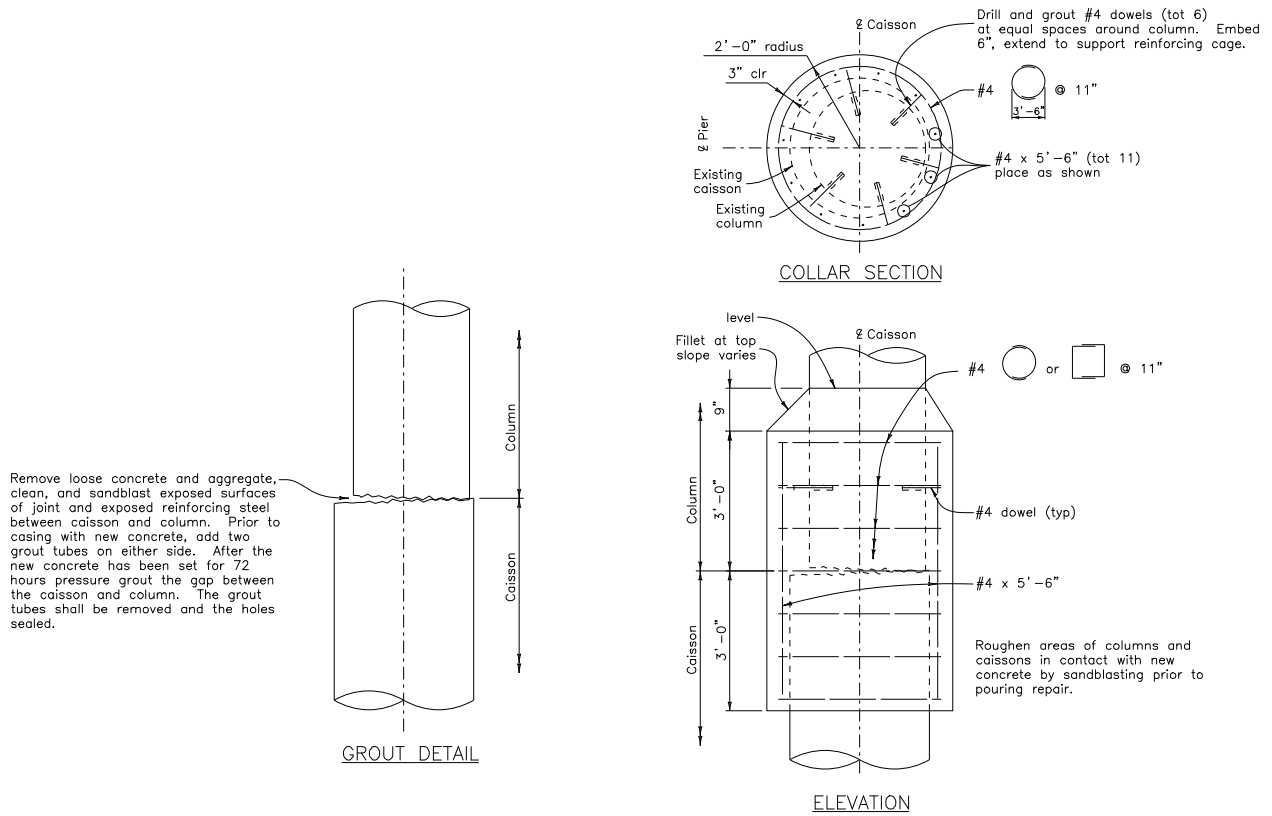


Fig. 16.12(D)-4 Sample of Column Repair



Fig. 16.12(D)-5 Photo of Damage to be repair by (D)-4 details

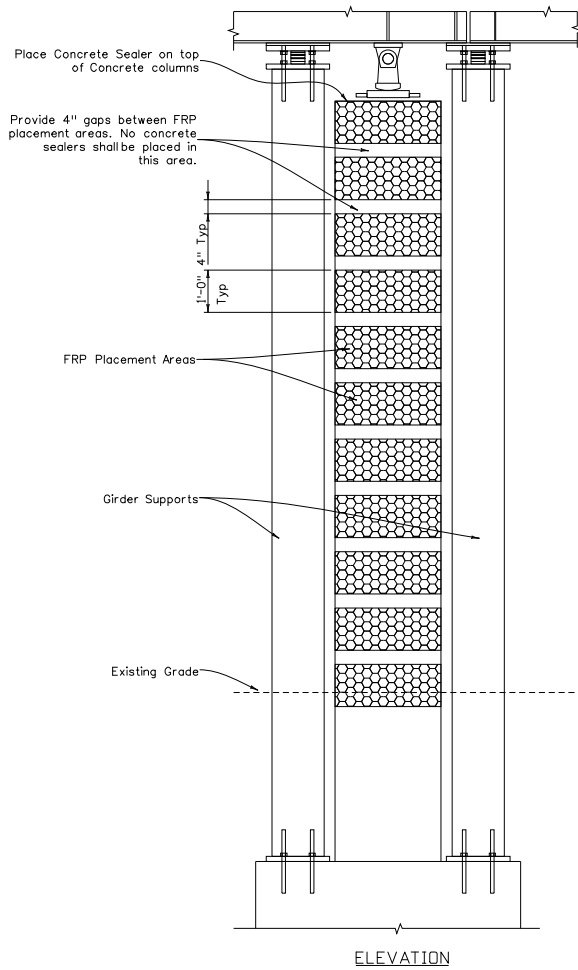


Fig. 16.12(D)-6 Sample of Fiber Wrap Details



Fig. 16.12(D)-7 Photo of Fiber Wrap

- E) **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

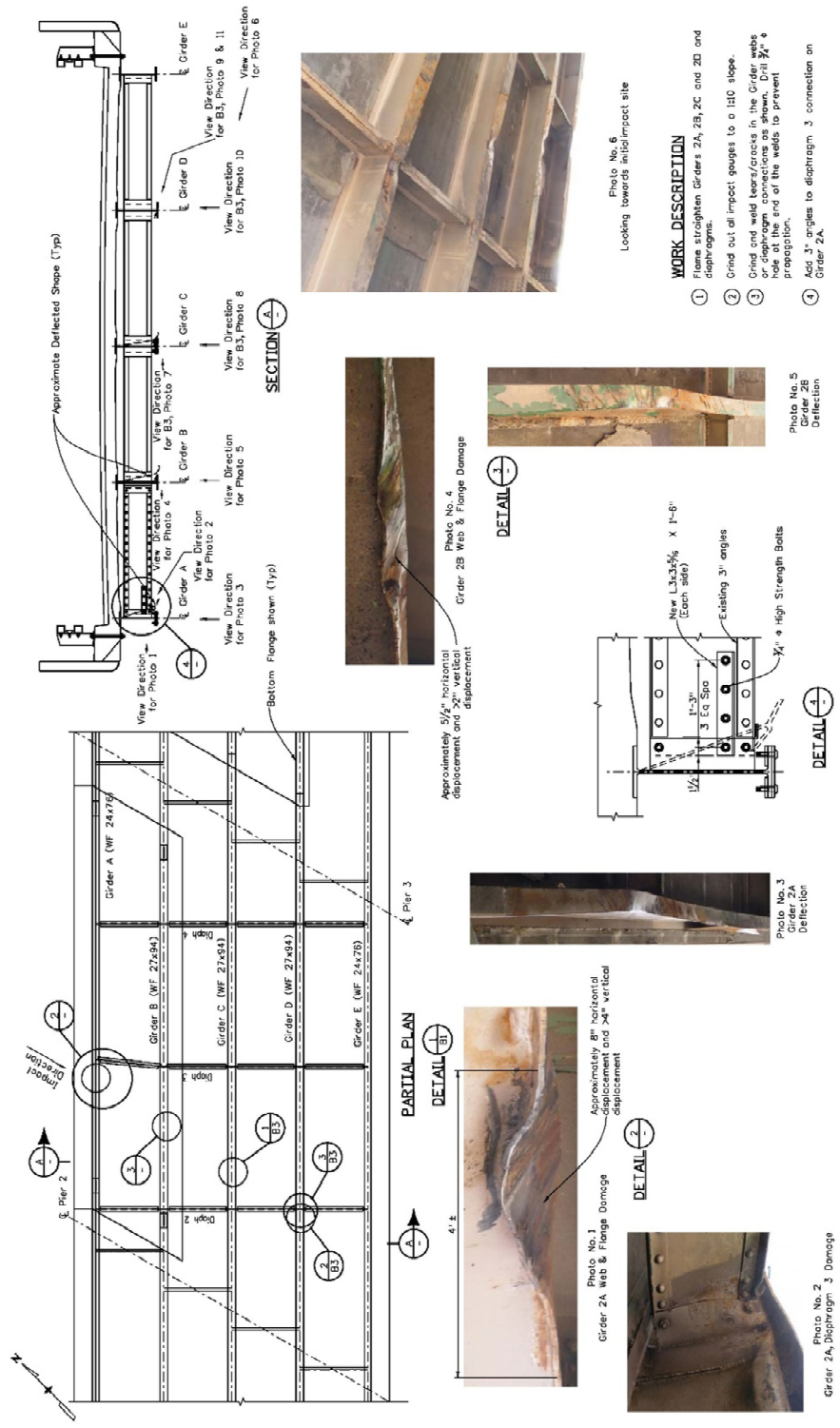


Fig. 16.12(E)-1 Sample of Plan for Steel Repairs

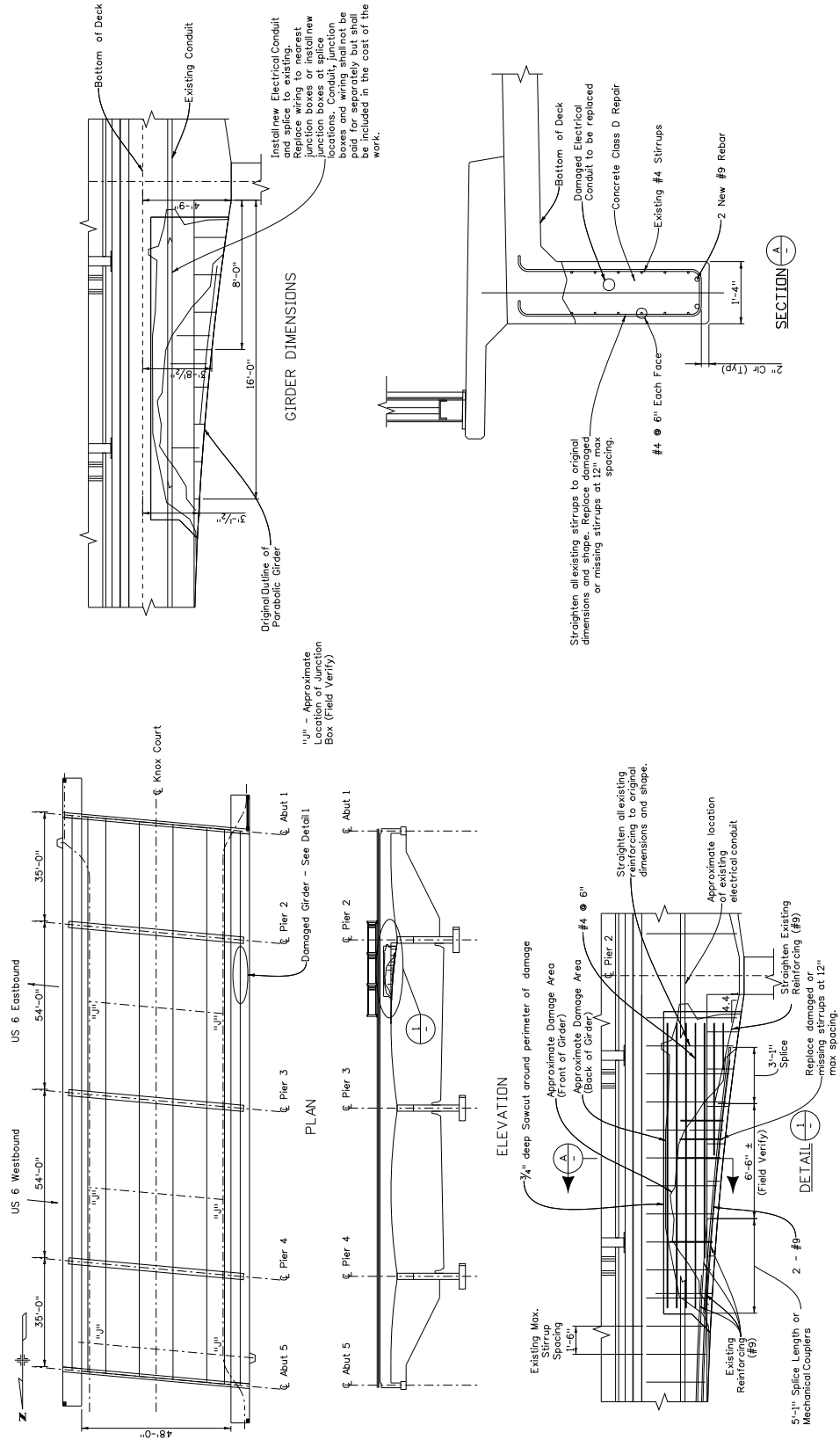


Fig. 16.12(E)-2 Sample Plan of Concrete Tee Girder Repair

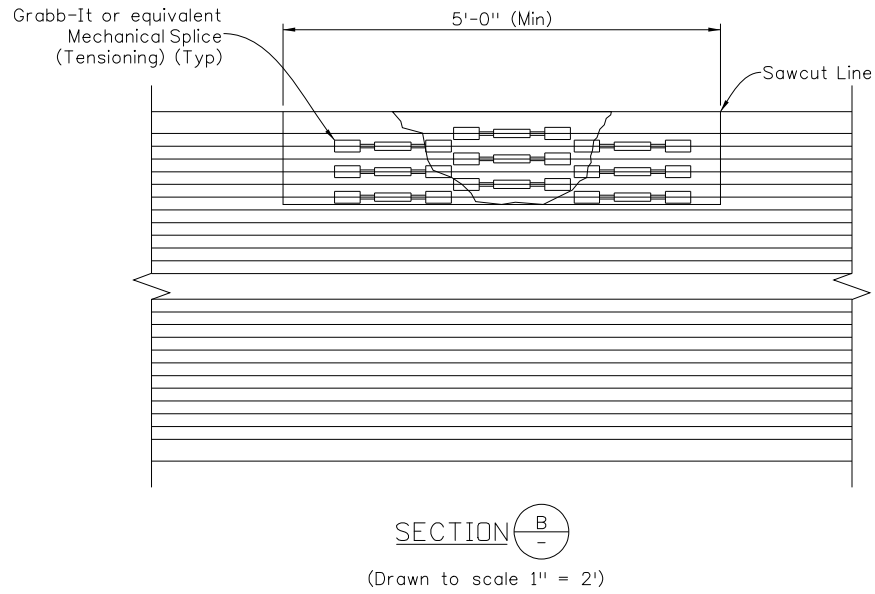


Fig. 16.12(E)-3 Sample Section of Precast Prestressing Repair

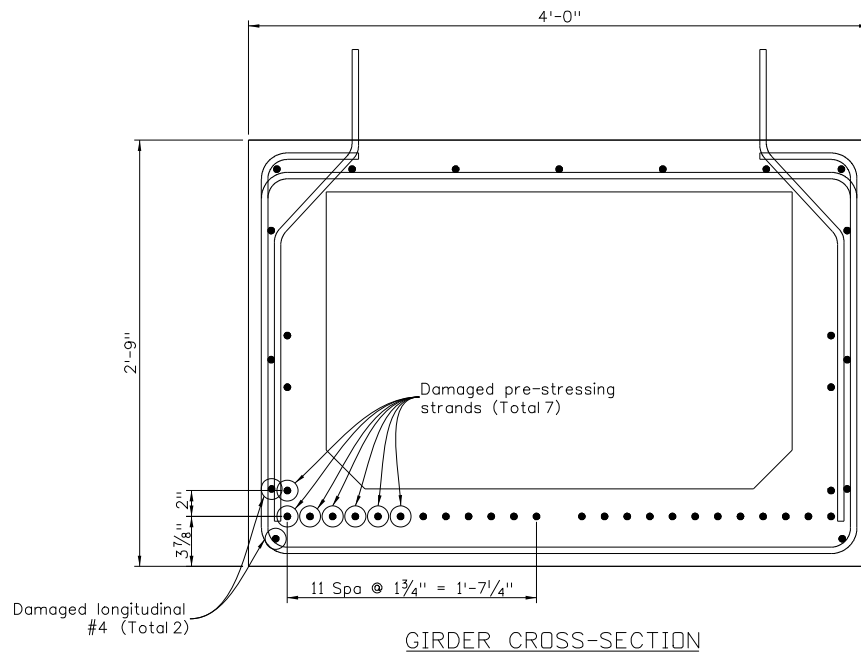


Fig. 16.12(E)-4 Sample Section of Precast Girder Repair



Fig. 16.12(E)-5 Photo of Precast Girder repair in progress

- F) **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.

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 (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

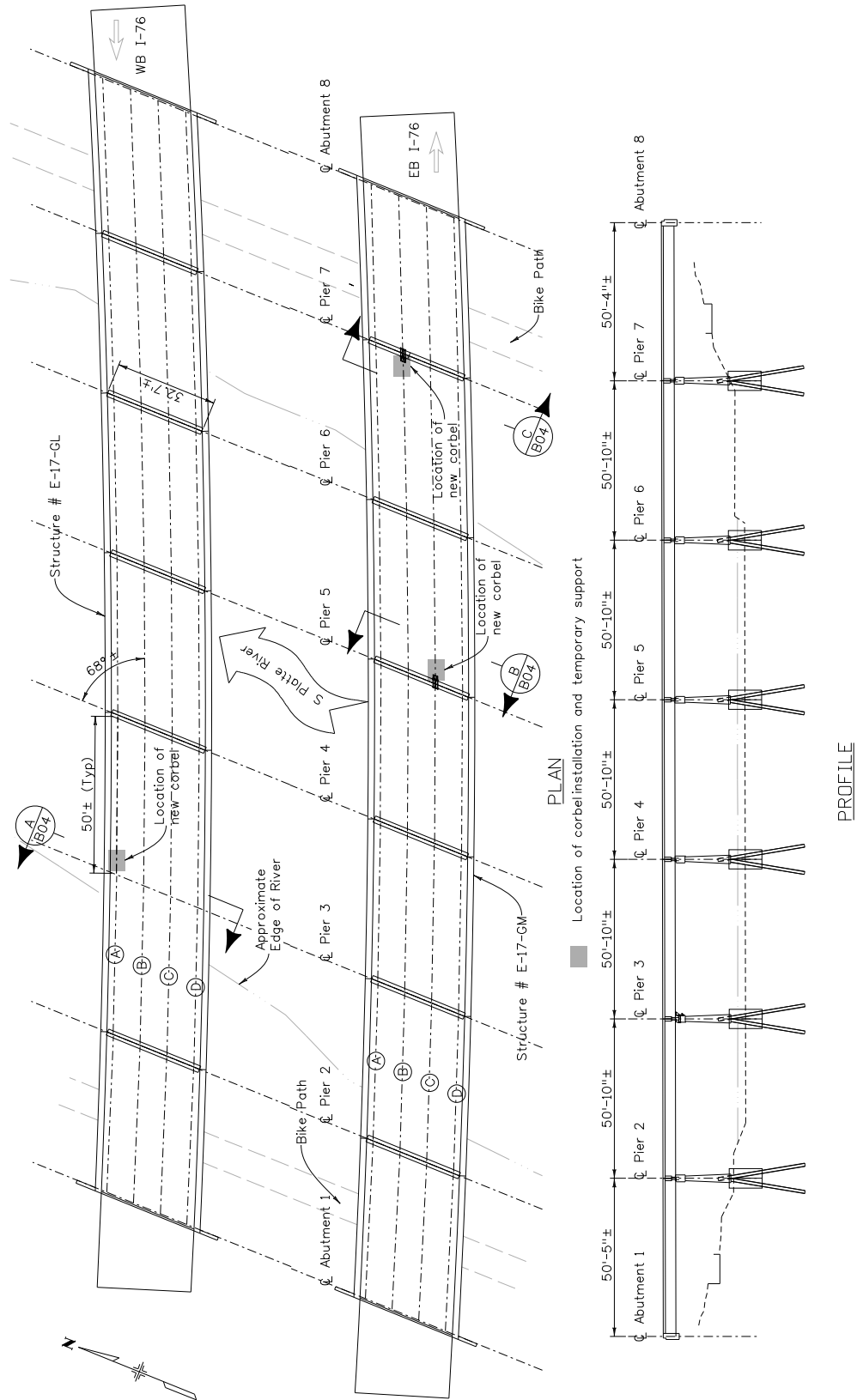


Fig. 16.12(F)-1 Sample Plan for Corbel Placement

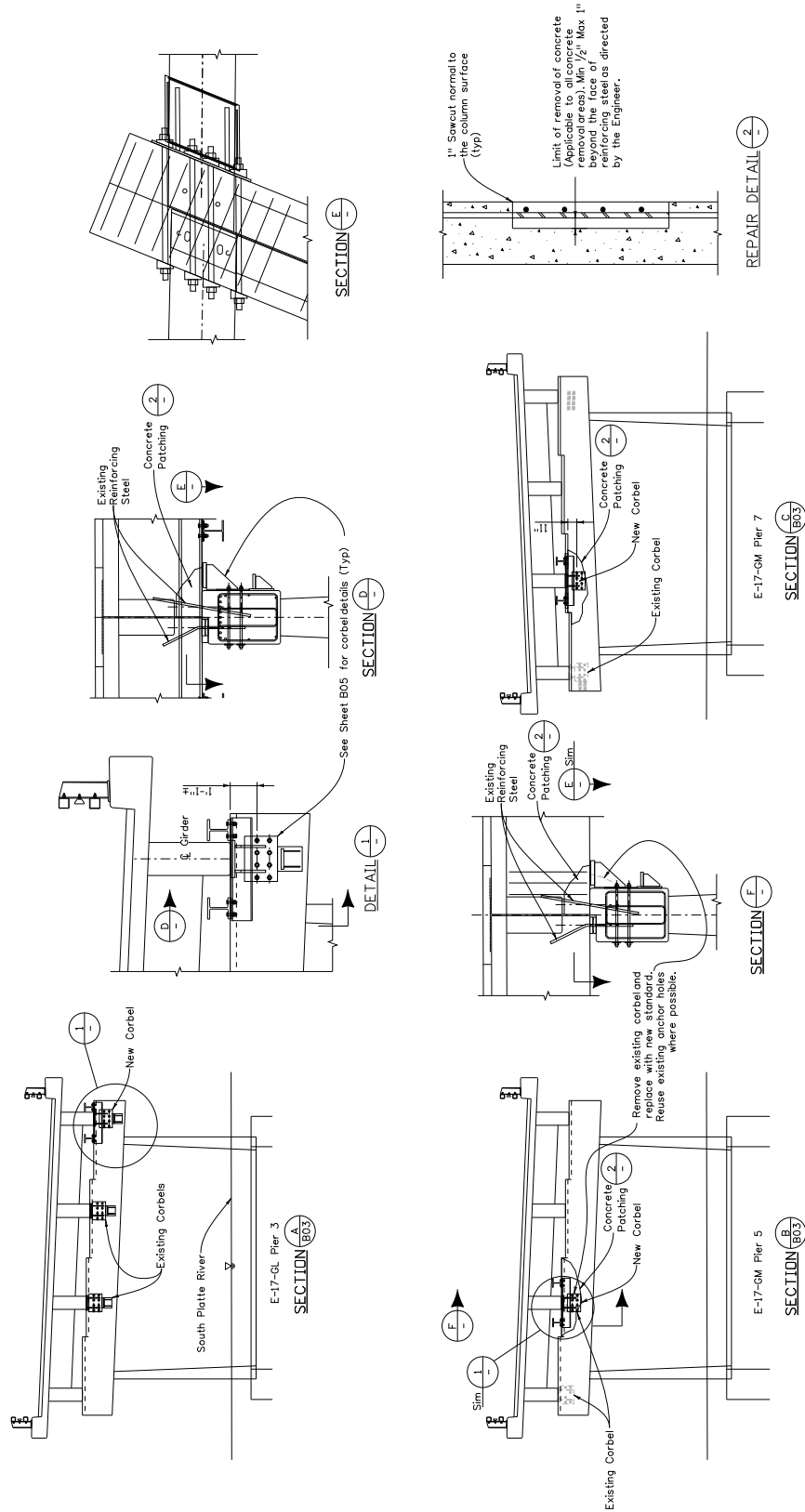


Fig. 16.12(F)-2 Sample Sections and Elevations for Corbel Placement

GENERAL NOTES:
Design lengths below assume a CSG structure with a 44' loading with an 8" deck and 4" of asphalt.
Notes where applicable are required on both sides of 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 as 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 $\frac{1}{8}$ " (200 psi x pad area = jacking force).
11. Field weld the support assembly to the front plate.
12. Point all steel as directed by the Engineer.

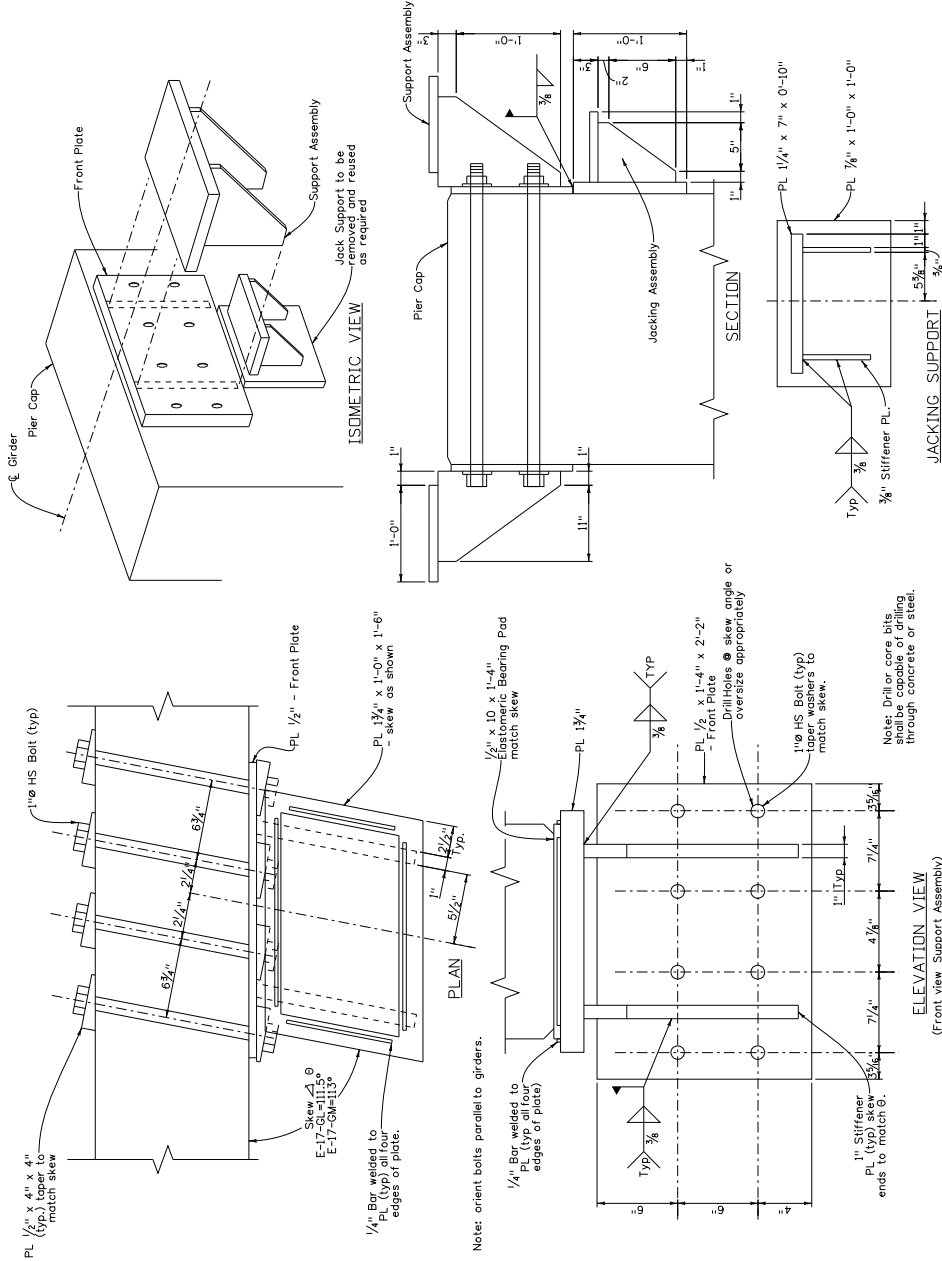


Fig. 16.12(F)-3 Sample Worksheet for Corbel Placement Details



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

G) **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.

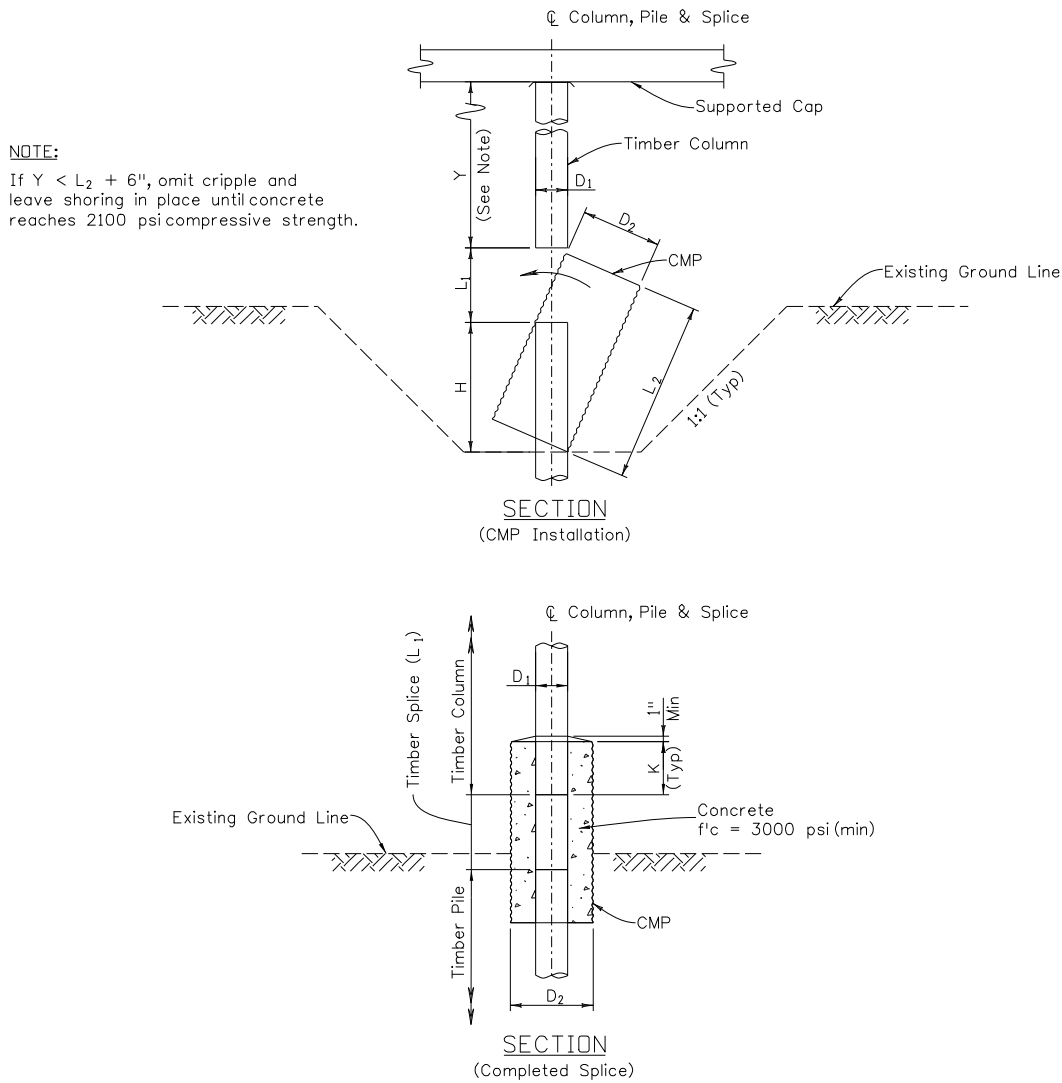


Fig. 16.12(G)-1 Sample Repair Detail for a Timber Pile/Column Repair



Fig. 16.12(G)-2 Photo of Timber Pile/Column Repair in progress

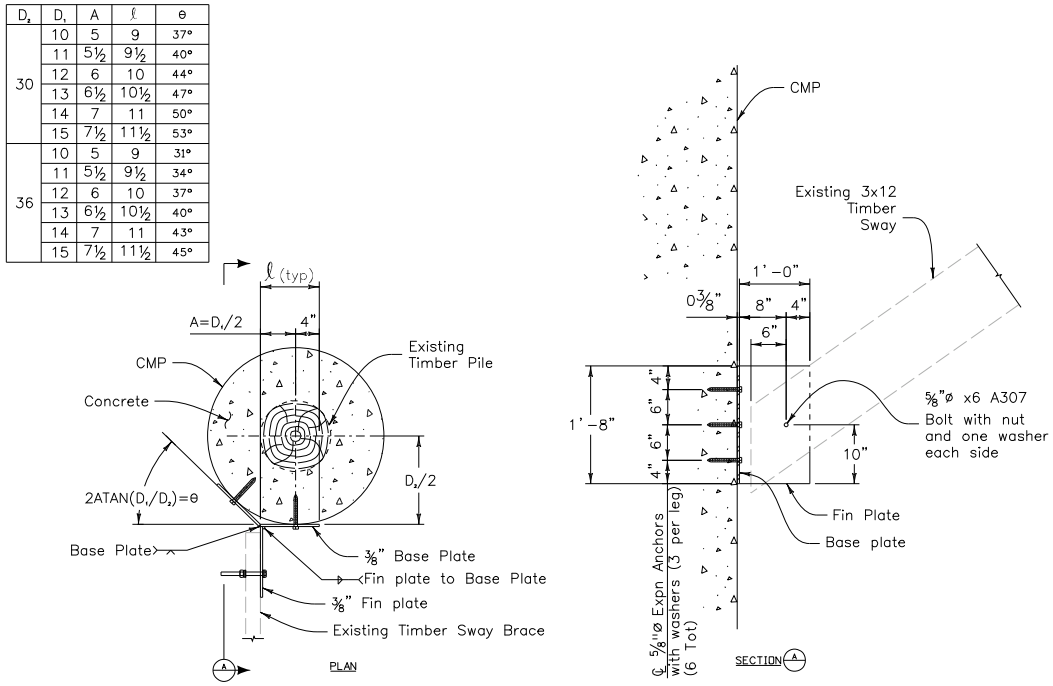


Fig. 16.12(G)-3 Sample Detail of Timber Pile Repair and Bracing



Fig. 16.12(G)-4 Photo of Timber Pile Repair and Bracing Connection

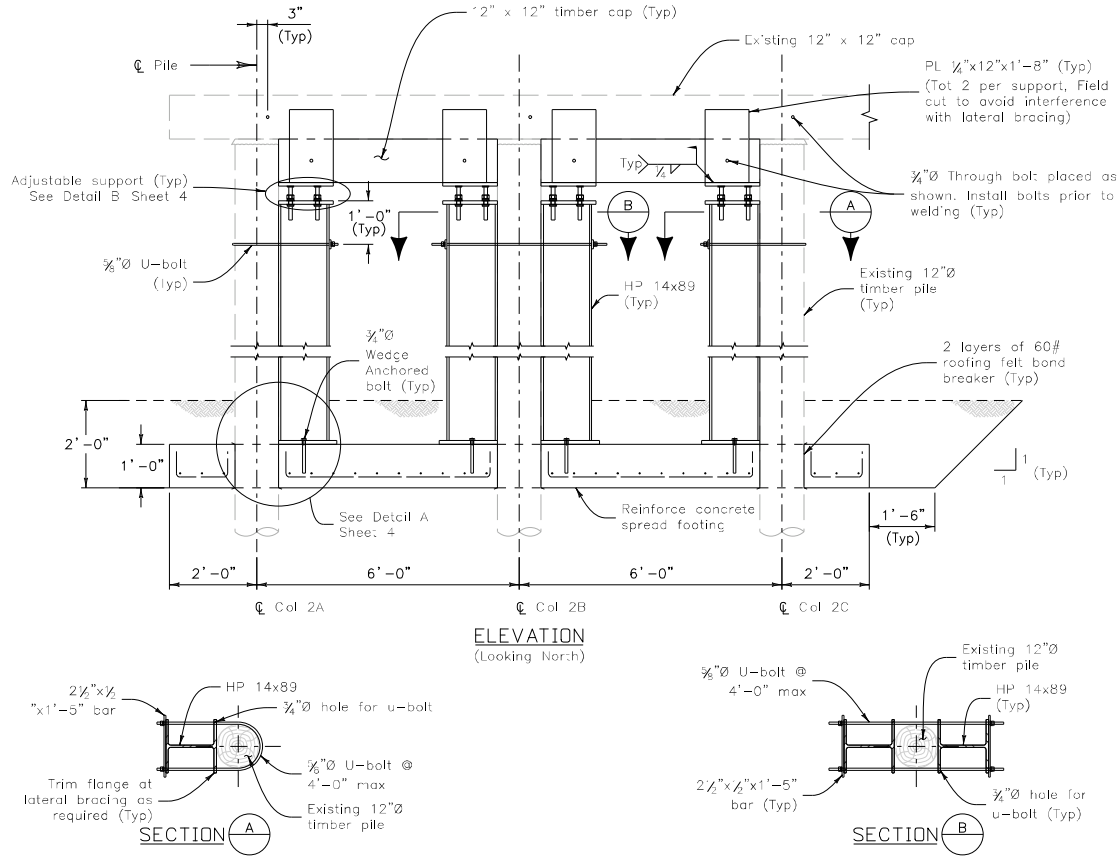


Fig. 16.12(G)-5 Sample of Adding Columns to a Pile



Fig. 16.12(G)-6 Photo of Adding Columns to a Pile

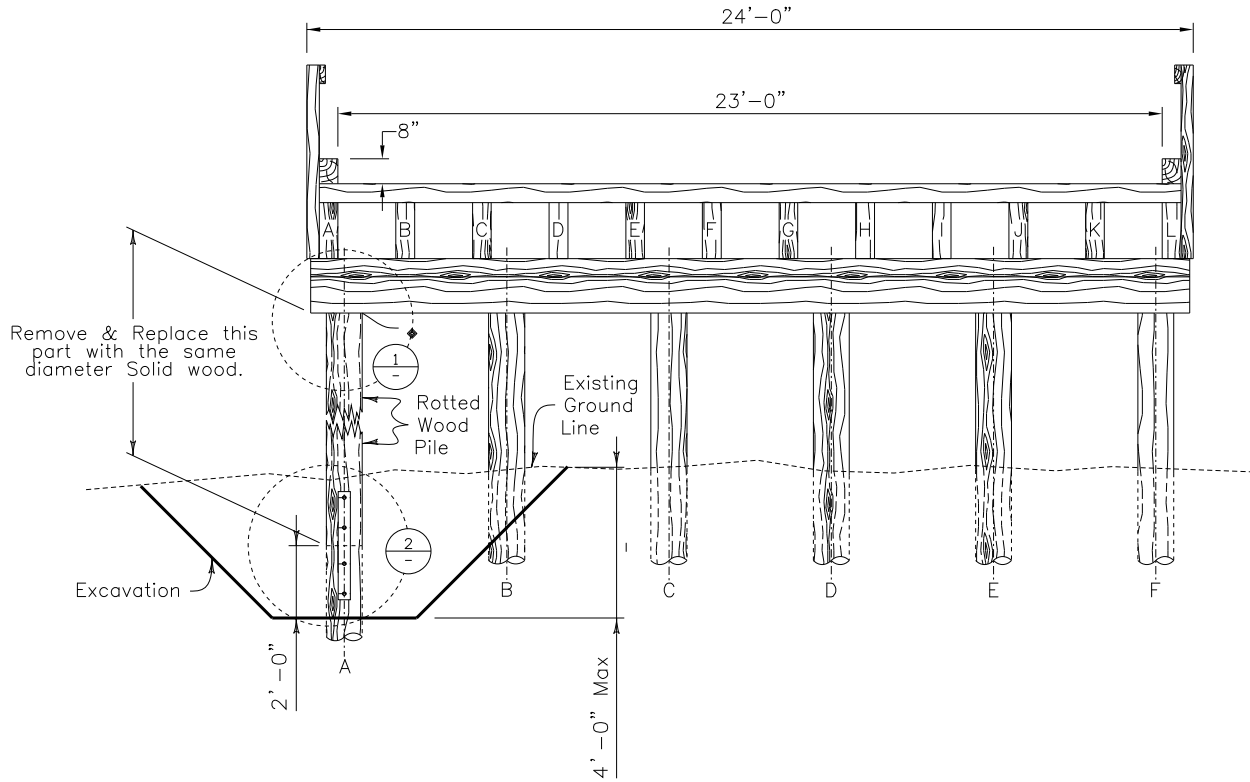


Fig. 16.12(G)-7 Sample Section of Replacing Portion of Timber Pile

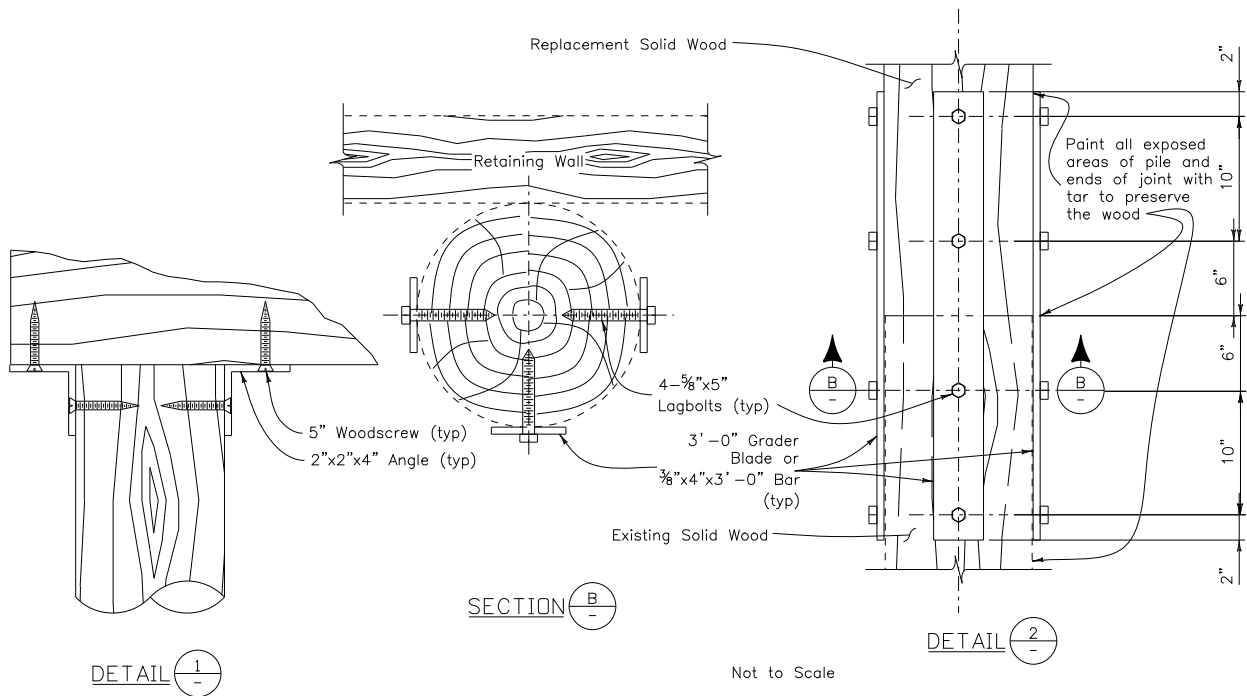


Fig. 16.12(G)-8 Sample Details of Replacing Portion of Timber Pile

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.

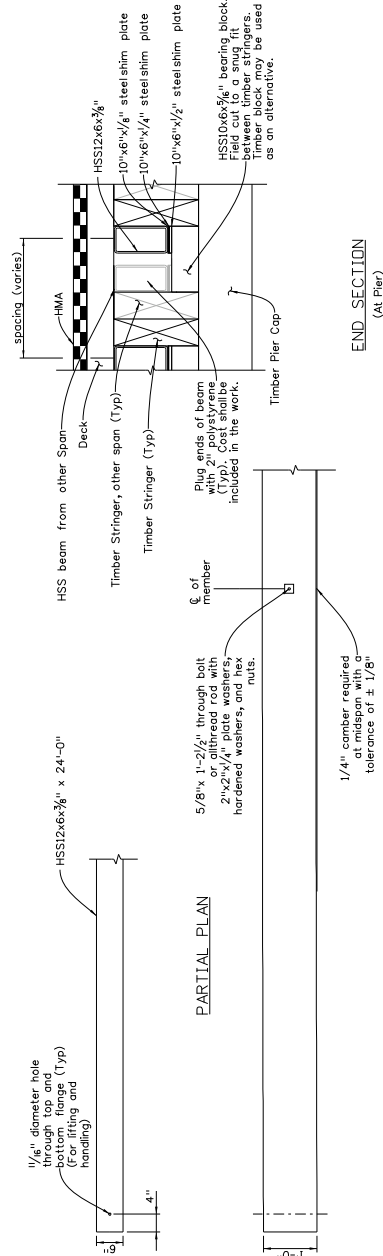
Check Items:

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

DESIGN DATA:
 AASHTO, Ninth Edition LRFD, 2020
 Design Method: Load and Resistance Factor Design (for sister beam)
 Live Load: HL-93 (design truck or tandem, and design lane load)
 Dead Load: Assumes 35 lbs. per sq. ft. for bridge deck overlay
 Structural Steel: AASHTO M570 Grade 50 (ASTM A500 Grade C)
 $f_y = 50,000$ psi

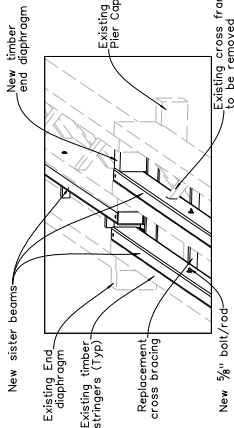
(Note to Designer & Detailer:
 This sheet is for a timber bridge with nominal span lengths of 23'.
 To change to a bridge with nominal span length of 19':
 -Change HSS12x6 $\frac{3}{8}$ " x 24'-0" to HSS10x4 $\frac{1}{2}$ " x 24'-0"
 -Change the HSS10x4 $\frac{1}{2}$ " bearing block to a HSS10x4 $\frac{1}{2}$ " in the End Section
 Change quantities for the information only to 112,24lbs. per beam.



CONSTRUCTION NOTES:

- Remove end diaphragm, lumber and cross bracing lumber.
- Place a steel member next to stringer 1C, 1F, 1G, 1H, 1L, 2C, 2F, 2J, 3C, 3F, and 3J.
- Place steel HSS10x4 $\frac{1}{2}$ " bearing block. Field cut to a snug fit between timber stringers. Add steel shims, and if needed, add additional 1/4" steel shims above the bearing block until the member is snug tight. Next, jack the ends of the steel member and place an additional 1/8" steel shim underneath the member at each end.
- Drill on 1/4" hole through the timber stringer at midspan and place the allthread rod through the steel member and timber stringer. Add plate washers, washers, and nuts. Tighten nuts to snug tight.
- Replace cross bracing with a nominal 4"x4" select structural No. 2 lumber horizontal diaphragm. Field cut to a snug fit between the timber stringers and connect to the timber stringers by toe nailing each end with two 30d nails or 4" deck screws.
- Replace end diaphragms. Field cut to a snug fit between the timber stringer and steel member, and connect to timber stringer with two 30d nails or 4" deck screws. The replacement of timber diaphragms are required at the Abutment. Replacement diaphragms may utilize existing material.

ISOMETRIC VIEW



(All Pier)

(Note to Designer & Detailer:
 This sheet is for timber bridges with two or more spans and a minimum stringer spacing of 2'-0". Note this sheet will need to be modified for timber bridges with concrete decks.
 To determine which stringers need a steel member, use the process below:
 1. Place a steel beam at stringers that have a current split or log screw repair.
 2. Place a steel beam at stringers that have a current split or log screw repair.
 3. Don't place a steel beam at the exterior two stringers on each side, even if there is a split or log screw repair. This avoids conflicts with the Type 10 roll, and is outside the wheel lines.

STEEL FABRICATION NOTES:

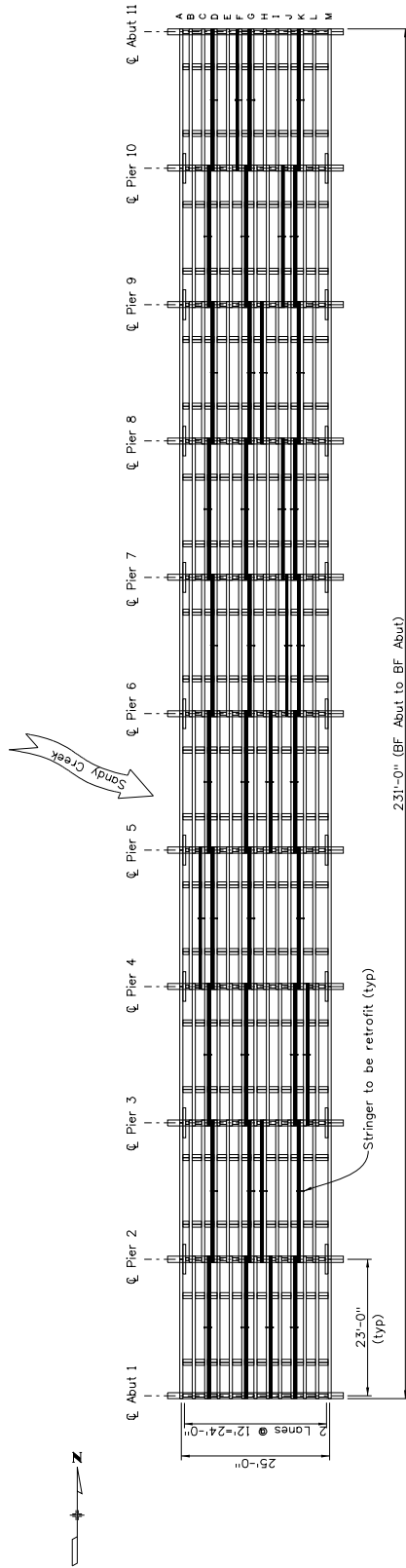
- HSS member shall be ASTM A500 Grade C.
- Member shall be shop bent to provide a 1/4" camber at midspan, with a tolerance of $\pm 1/8$ ".
- Drill holes at end of girder and at midspan prior to hot dip galvanizing.
- Member shall be hot dipped galvanized after fabrication.
- Plate washers shall be ASTM A36. Bolts shall be ASTM A325 and nuts shall be per ASTM A563. All threaded rod per ASTM F1554 grade 55 may be substituted for bolts. All material including bolts and nuts and washers shall be galvanized. Zinc plated may be used in lieu of hot dipped galvanizing.

INFORMATION ONLY

DESCRIPTION	UNIT	PER BEAM
Structural Steel (Galvanized)	LB	1408

▲ Quantity includes sister beam, shims, 1"-3" bearing blocks, allthread rod, washers and hex nuts.

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 log 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	G
	H	H	J	G	H	J	H	J	H	J
	J	K	K	K	J	K	J	K	J	K

SUMMARY OF APPROXIMATE QUANTITIES:

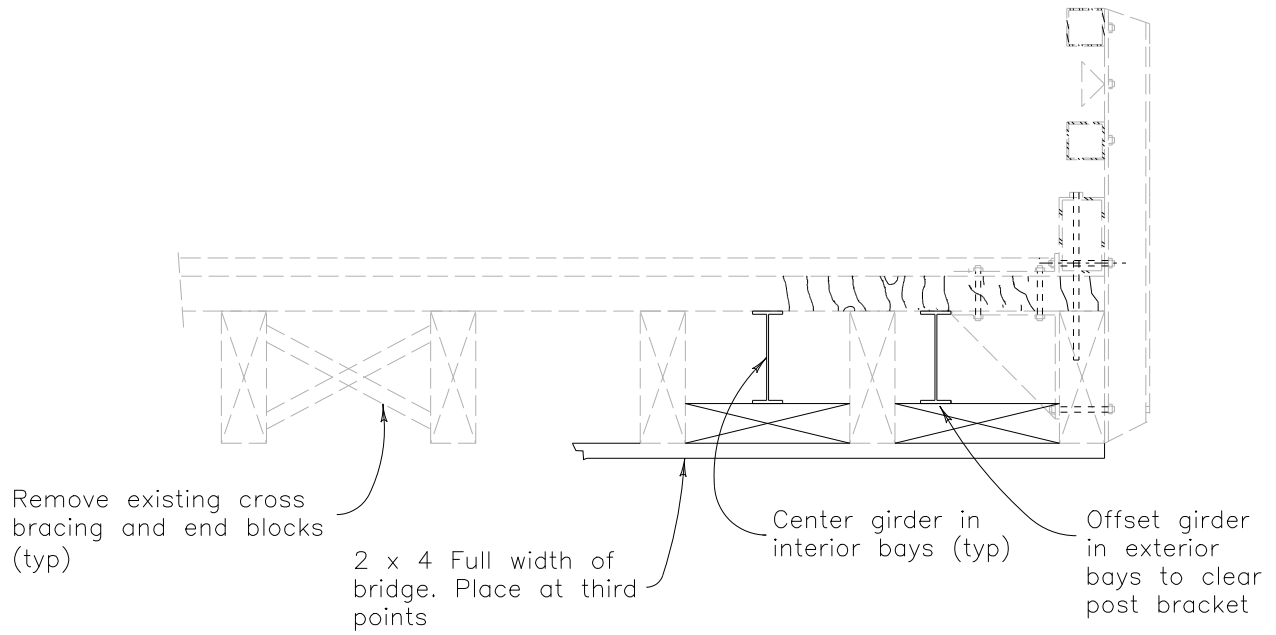
Item No.	Description	Unit	Structure B-26-F	Total
① 509-00001	Structural Steel (Galvanized)	LB	44350	44350

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 steelHSS sections, and bolt to existing split timber stringer

Fig. 16.12(H)-2 Example of General Layout for a timber stringer repair project



PART SECTION

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

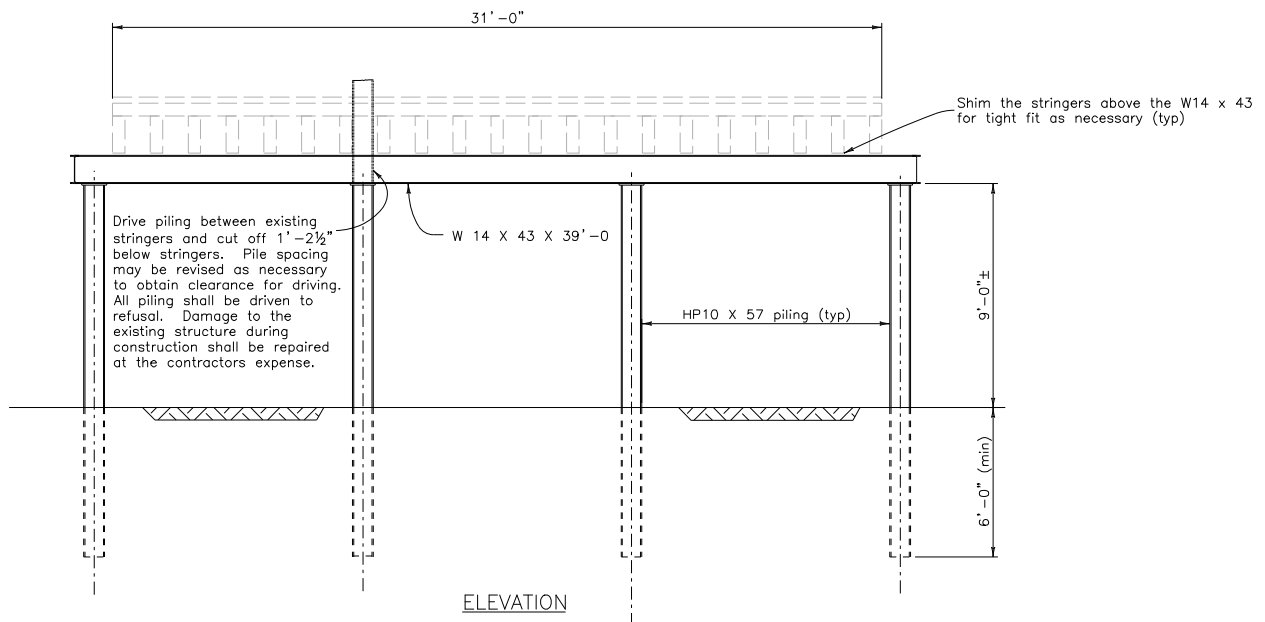


Fig. 16.12(H)-6 Sample Section showing additional Bents



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

- l) **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

Timber Notes:

All timber dimensions are nominal.

6"x6" Timber shall be #1 Southern Pine or better.

Other Timber shall be #2 Southern Pine or better.

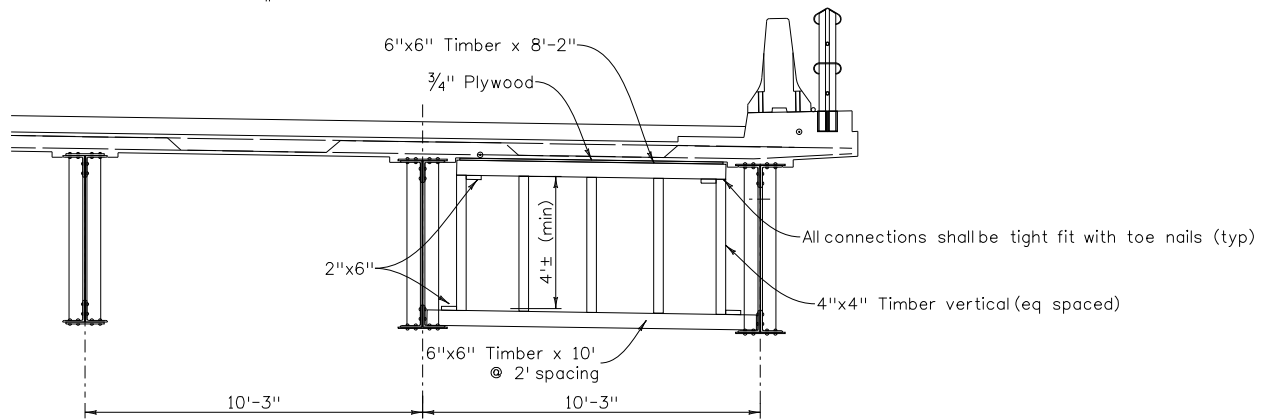


Fig. 16.12(I)-1 Sample Section of Falsework to support a deck



Fig. 16.12(I)-2 Photo of Deck Falsework



Fig. 16.12 (I)-3 Photo of Falsework to support a steel girder

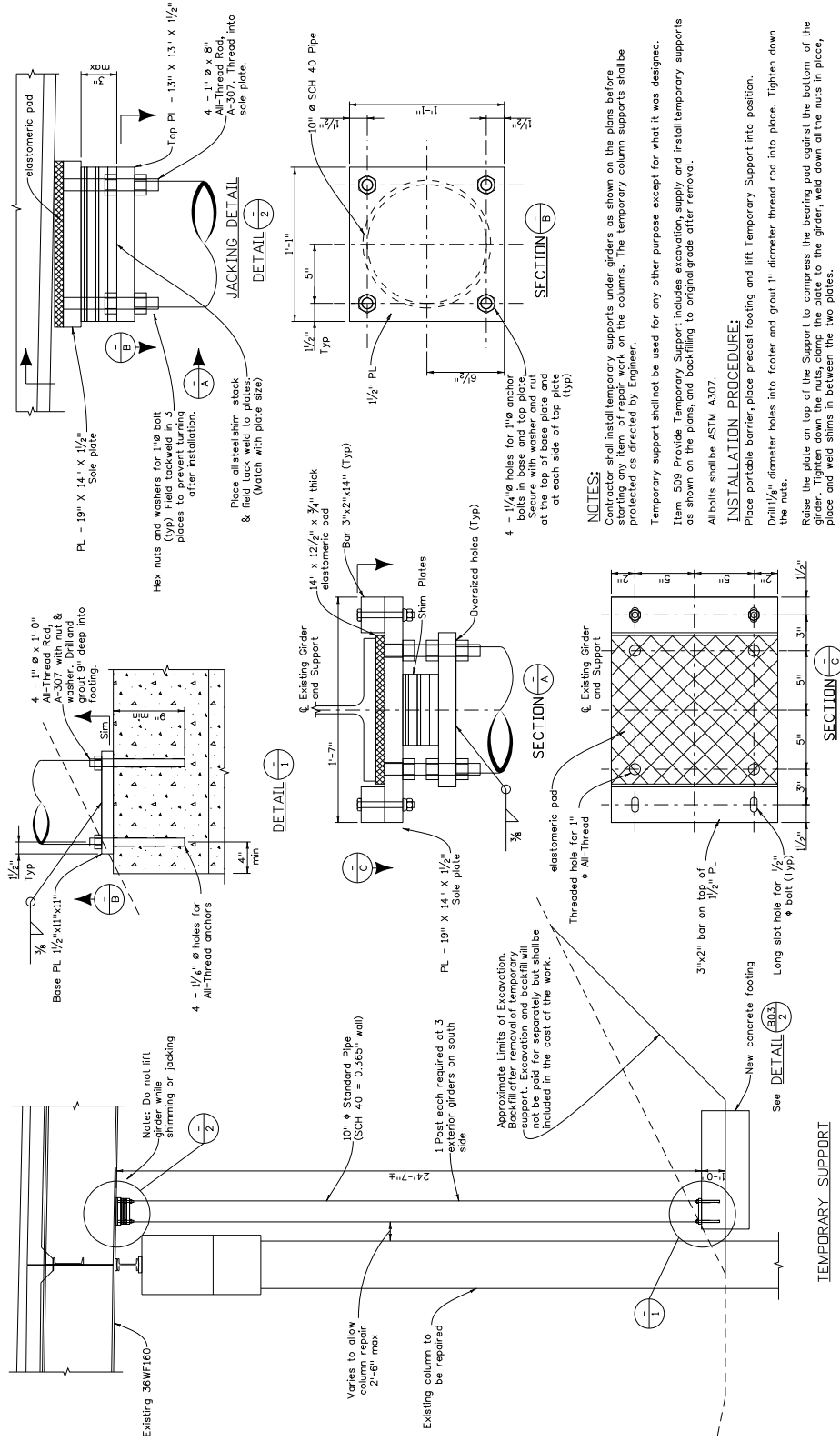


Fig. 16.12(I)-4 Sample Details for Falsework to Support a Steel Girder

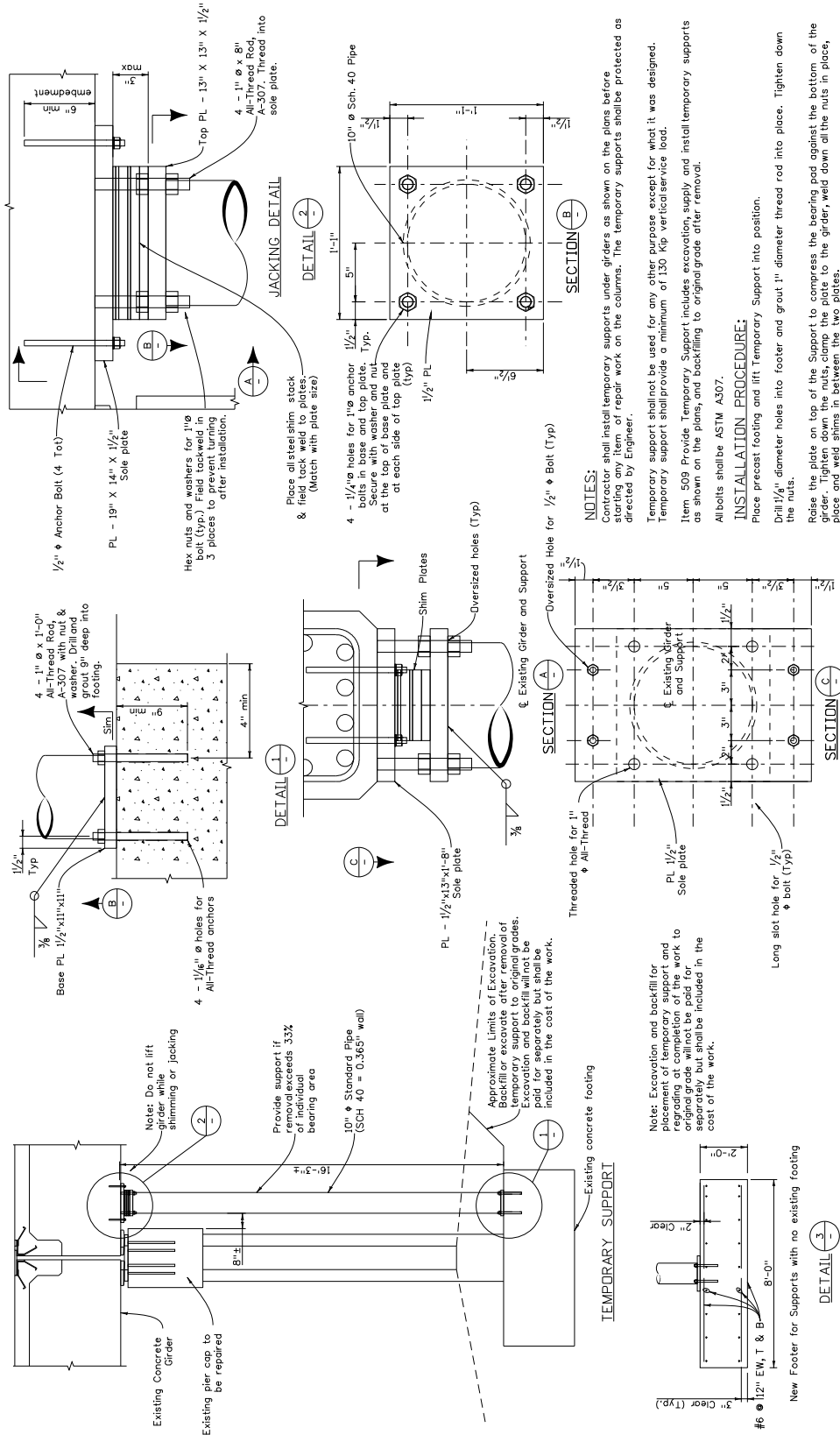


Fig. 16.12(I)-5 Sample Details for Falsework to Support a Concrete Girder

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

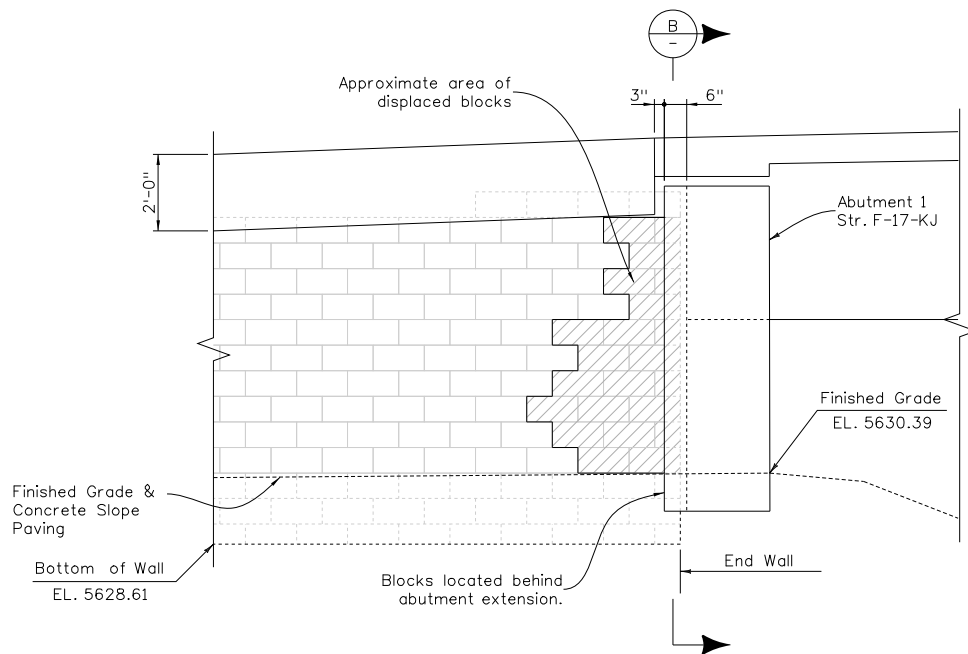


Fig. 16.12(J)-1 Sample Elevation of Area to be repaired on a MSE Wall

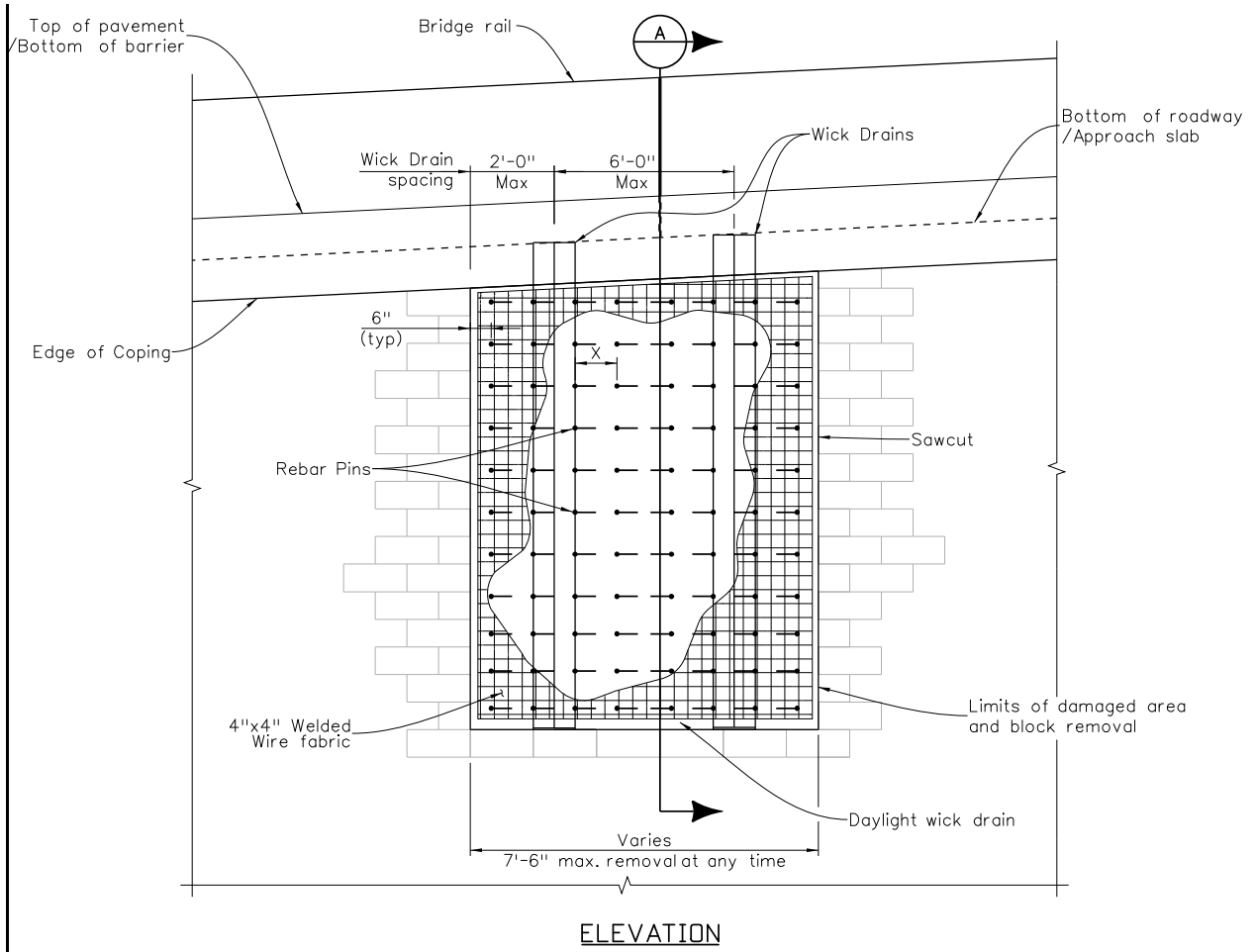




Fig. 16.12(J)-2 Sample Details on Block MSE Repair

LEGEND

-  Shotcrete wall
-  Polystyrene

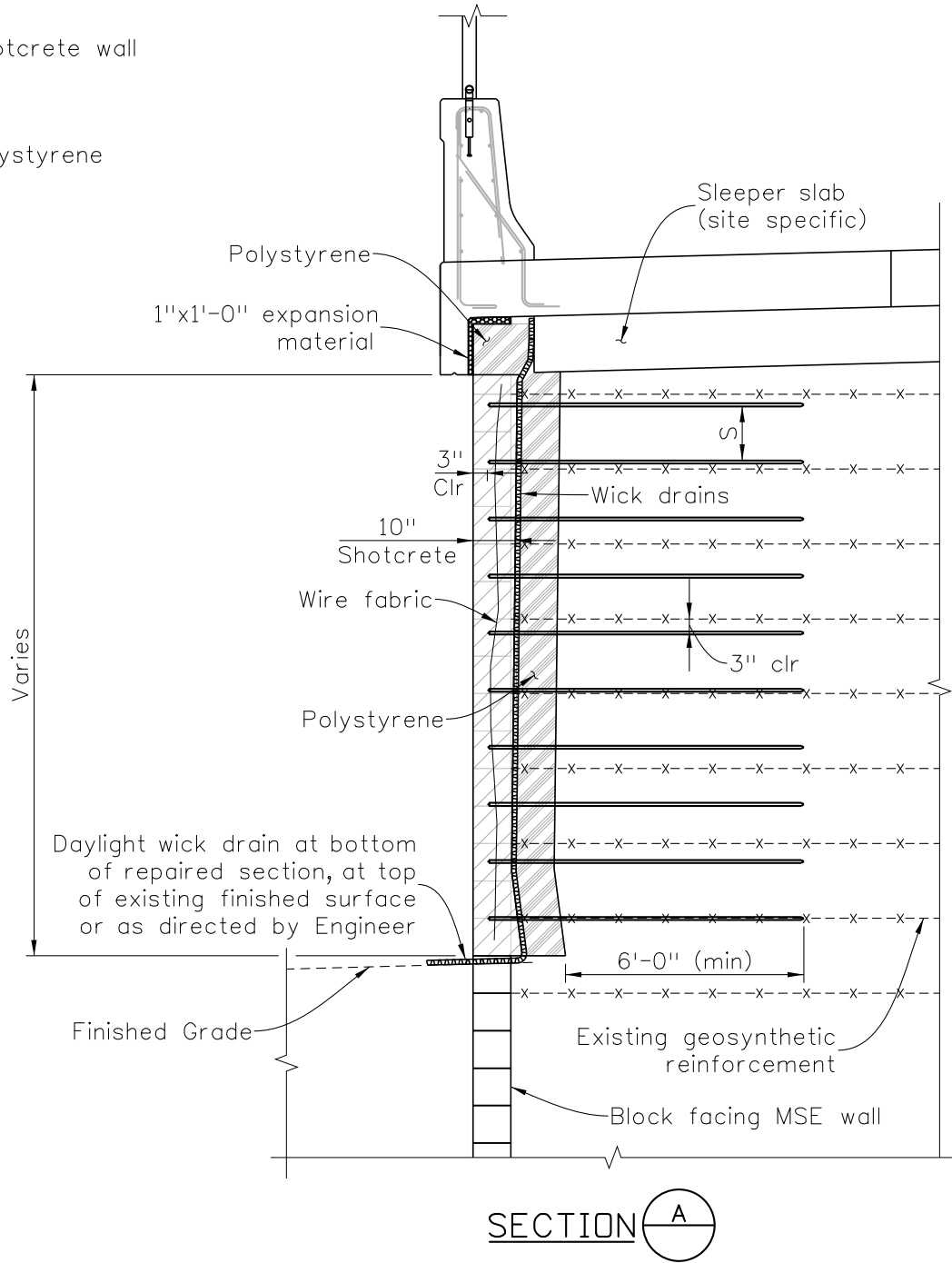


Fig. 16.12(J)-3 Sample Section for block MSE Repair

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

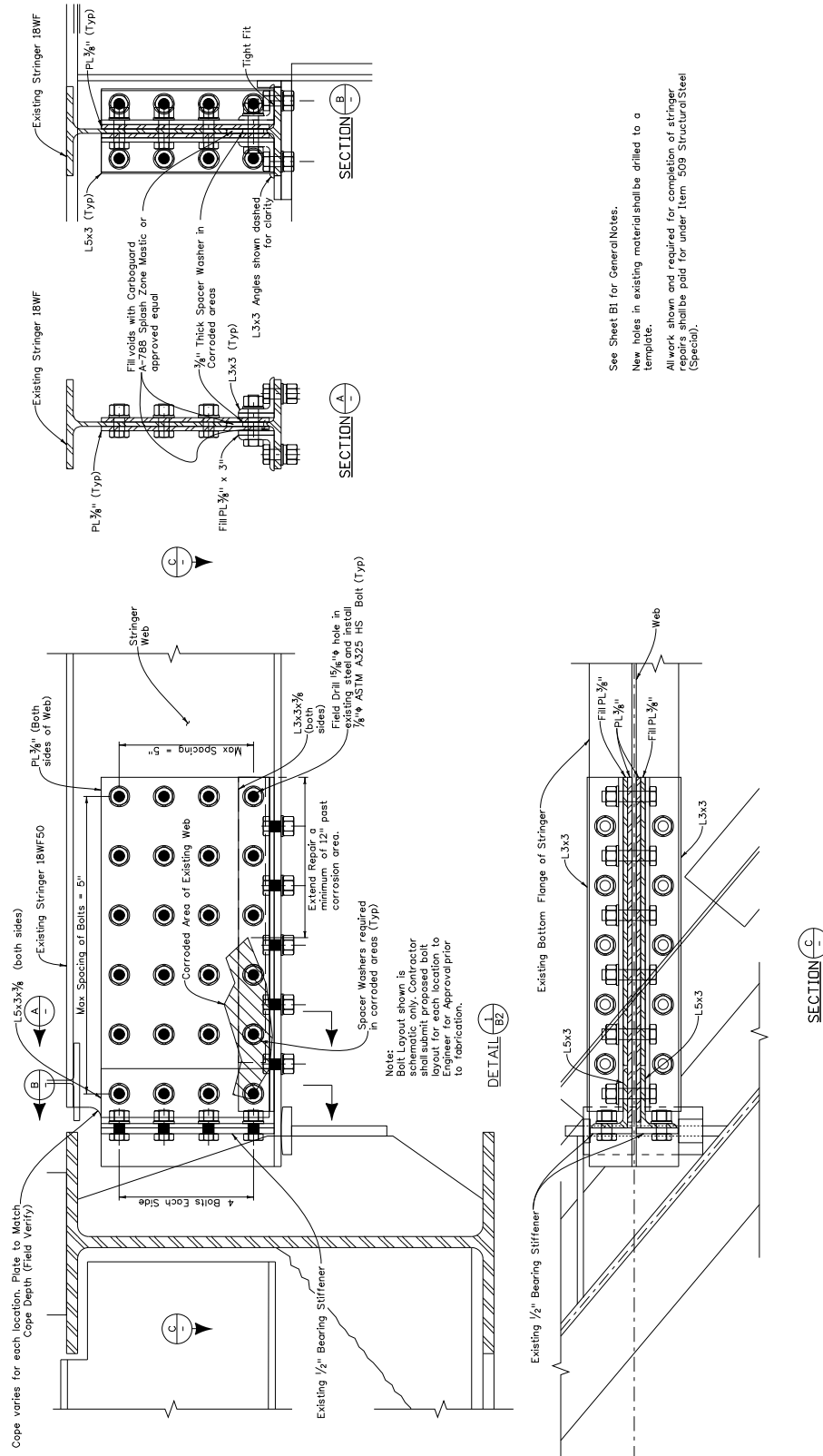


Fig. 16.12(K)-1 Sample Details for Adding Steel Plates to a Corroded Girder

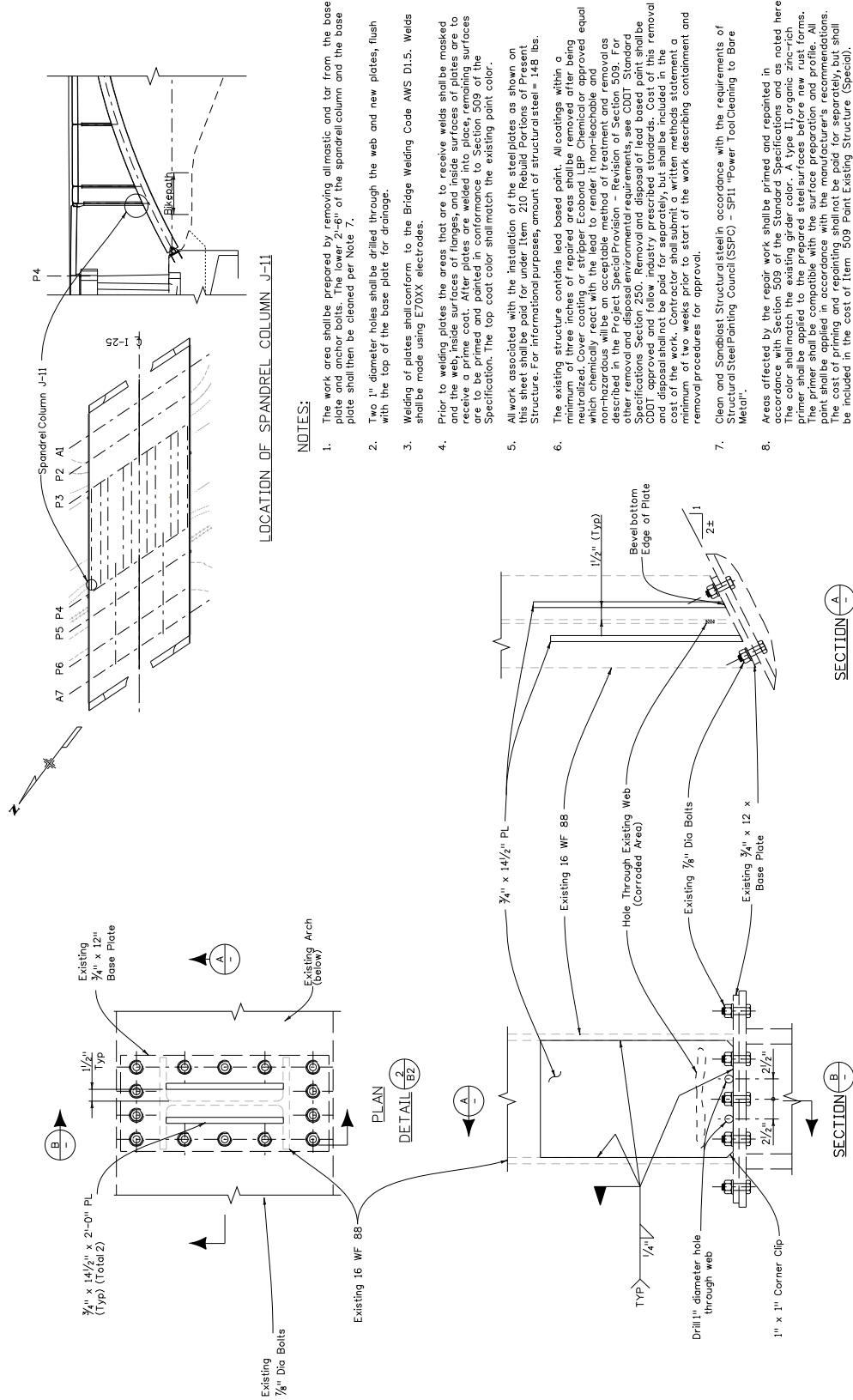


Fig. 16.12(K)-2 Sample Details for Repairing/Strengthening a Corroded column

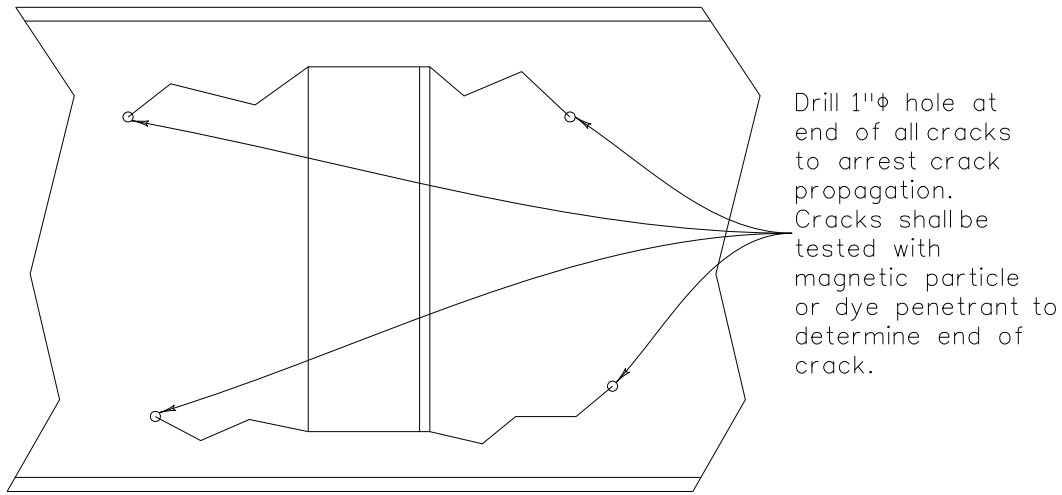


Fig. 16.12(K)-3 Sample Detail of Drilling Holes at the end of Fatigue Cracks

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 repeat 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
PREQUALIFIED QUALIFIED BY TESTING _____
or PROCEDURE QUALIFICATION RECORDS (PQR) Yes

Identification # CDOT 08-03
 Revision N/A Date 12/10/08 By M. STADIG
 Authorized by M. STADIG Date 12/10/08
 Type—Manual Semi-Automatic
 Machine Automatic

Company Name C.D.O.T.
 Welding Process(es) SMAW
 Supporting PQR No.(s) N/A

JOINT DESIGN USED
 Type: CORNER
 Single Double Weld
 Backing: Yes No
 Backing Material: _____
 Root Opening _____ Root Face Dimension _____
 Groove Angle: _____ Radius (J-U) _____
 Back Gouging: Yes No Method _____

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

SHIELDING
 Flux Gas _____
 Composition _____
 Electrode-Flux (Class) _____ Flow Rate _____
 Gas Cup Size _____

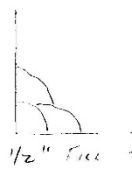
PREHEAT
 Preheat Temp., Min 100° MINIMUM
 Interpass Temp., Min 150° Max 460°

POSITION
 Position of Groove: _____ Fillet: 3F
 Vertical Progression: Up Down

ELECTRICAL CHARACTERISTICS
 Transfer Mode (GMAW) SMAW Short-Circuiting N/A
 Globular Spray
 Current: AC DCEP DCEN Pulsed
 Other _____
 Tungsten Electrode (GTAW) _____
 Size: N/A
 Type: _____

TECHNIQUE
 Stringer or Weave Bead: STRINGER
 Multi-pass or Single Pass (per side) _____
 Number of Electrodes 1
 Electrode Spacing N/A Longitudinal _____
 Lateral _____
 Angle _____
 Contact Tube to Work Distance N/A
 Peening _____
 Interpass Cleaning: GRINDER, HAMMER, WIRE BRUSH
 POSTWELD HEAT TREATMENT N/A
 Temp. _____
 Time _____

WELDING PROCEDURE

Pass or Weld Layer(s)	Process	Filler Metals		Current		Volts	Travel Speed	Joint Details
		Class	Diam.	Type & Polarity	Amps or Wire Feed Speed			
<u>> 5/16"</u> <u>MULTI-PASS</u>	<u>SMAW</u>	<u>E7018</u>	<u>1/8"</u>	<u>DC</u>	<u>140-220</u>	<u>20-25</u>	<u>N/A</u>	

Form E-1 (Front)

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

INDEX OF DRAWINGS

B01. General Information, Summary of Quantities, Repair Details

SUMMARY OF QUANTITIES

ITEM NO.	DESCRIPTION	UNITS	Q25A145120BL 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

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 $f_y = 65,000$ psi. It shall be provided in 13'-6" by 3'-8" sheets and shall be galvanized after being cut to size.
- Concrete shall be Class D with $f_c = 4,500$ psi.

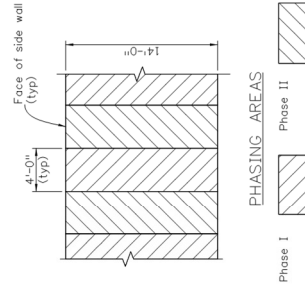
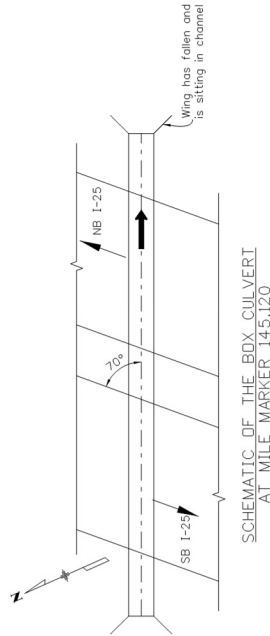
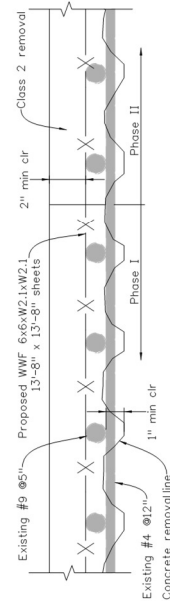


PHOTO 1 - Concrete Class 2 removal and replacement



DETAIL 01 - CONCRETE REPLACEMENT

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 culvert during the work. The pipe shall be placed in the culvert from the upstream side. The bottom slab shall be removed to allow the removal and patching work to be done. Pipe and all anchors 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 3/4" minimum at a spacing of 4'-0". Cut locations may be adjusted to avoid damaging reinforcing steel.

Perform Class 2 Removal on the 4'-0" wide Phase 1 areas. Removal of Portions of Present Structure (Class 2) shall consist of removing concrete from the top slab and the bottom slab. The concrete shall be removed and 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 the bottom slab. Pneumatic chipping tools shall not be used on 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 un-banded 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 shall be made under Removal of Portions of Present Structure (Class 2, Square Yards).

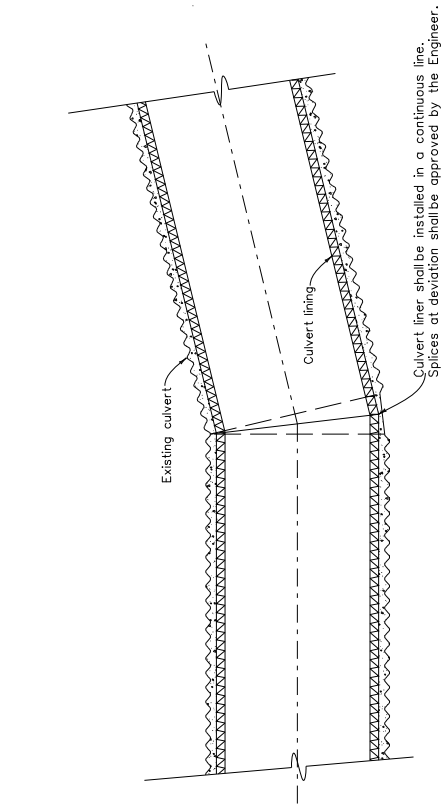
Following the Class 2 concrete removal, all exposed reinforcing steel shall be cleaned to sound steel by sandblasting. Sound steel is defined as free of oil, dirt, concrete fragments, or laitance, loose rust scale, and other coatings of any character that would destroy or inhibit the bond with the new concrete. Concrete shall be 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 sludge, 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 materials 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 pour. Place galvanized welded wire fabric (WWF) sheets flush with the existing reinforcing steelmat 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

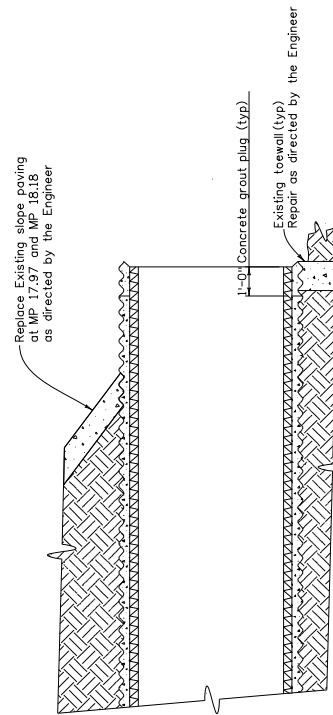


Blocking to keep liner centered. Guides and rails for installation may be used for blocking if gaps are provided for grout flow.

Fill voids behind CMP with concrete or grout prior to placing liner

Intermediate bracing as required

SECTION
SITES "A" AND "B"

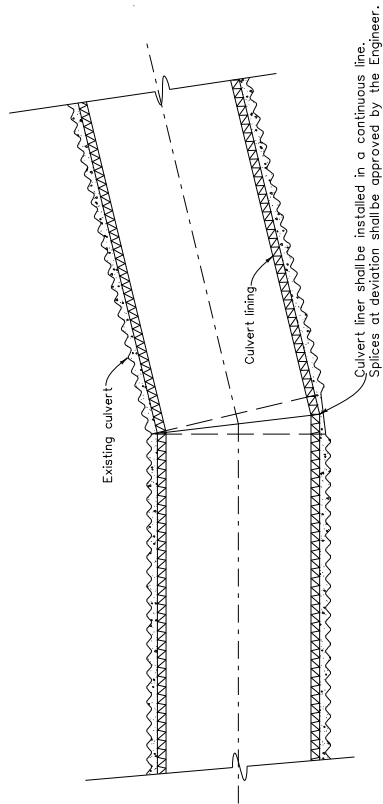


Replice Existing along CMP 1.0' and CMP 5.0' as directed by the Engineer

Existing toewall (typ) Repair as directed by the Engineer

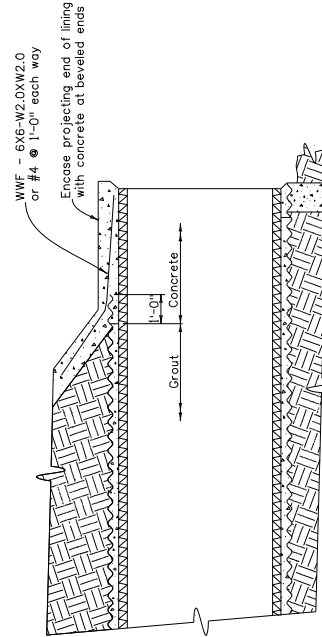
1-0' Concrete grout plug (typ)

SECTION
SITES "A" AND "B"



Culvert liner shall be installed in a continuous line. Splices at deviation shall be approved by the Engineer.

BEND DETAIL
SITE "A"



WWF - 6X6-W2.0XW2.0 or #4 @ 1'-0" each way

Encase projecting end of lining with concrete at beveled ends

Grout

Concrete

1-0'

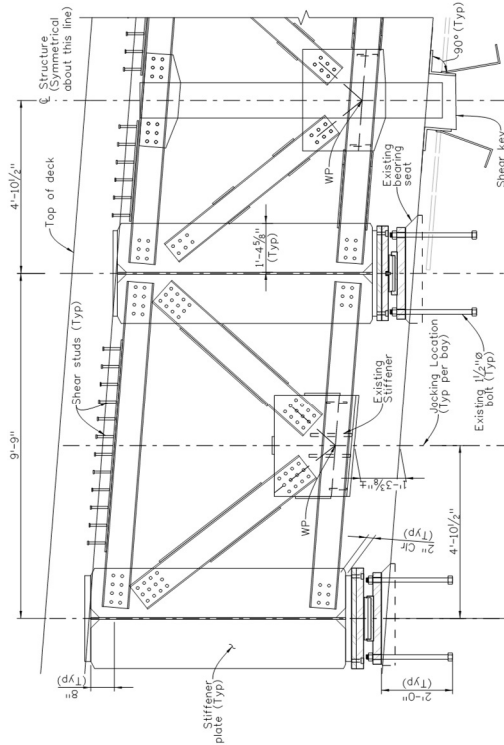
Fig. 16.12(L)-2 Sample Details for Repairing a circular culvert by slip-lining

M) **Bearing Replacement** – These repairs typically include the details required for replacement of pot or other style bearings.

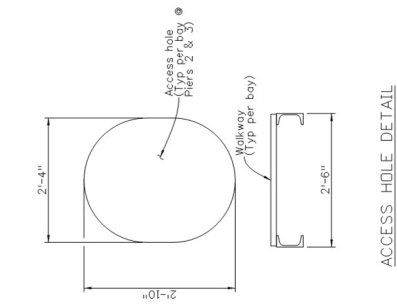
Check Items:

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.

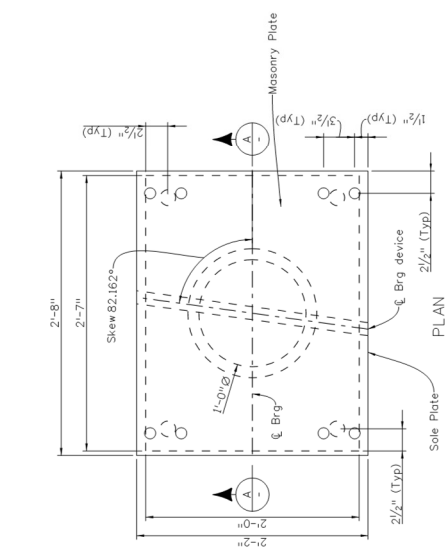
- 1) Location and extent of repair
- 2) Utility conflicts, etc. that will affect the work
- 3) Typical section, bridge elevation and pier sections and details to depict access and construction restrictions such as high water level, traffic, bridge constraints, etc.
- 4) Work description and construction 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



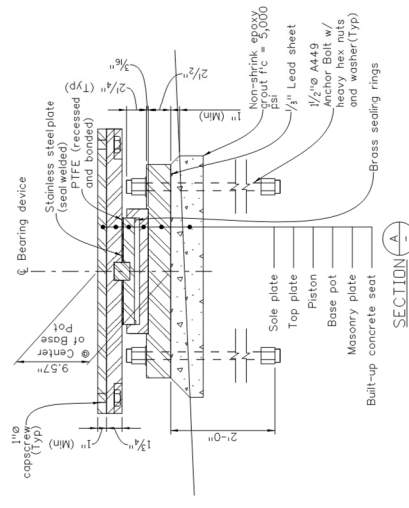
CROSS FRAME AT ABUTMENT 1



ACCESS HOLE DETAIL



PLAN



SECTION A-A

EXISTING GUIDED EXPANSION BEARING



Pot Bearing to be replaced

Abutment 1 @ Bearing 1B

ABUTMENT 1 WORK DESCRIPTION

1. Remove existing pot bearing 1B at Abutment 1 and replace with disc bearing. The removal of the existing pot bearing will not be paid separately, but shall be included in the work.
Minimum jacking force = 560 kips (dead load only, no traffic).
Maximum vertical load reaction per bearing is 400 (kips).
Maximum transverse horizontal load per bearing is 60 (kips).
2. The existing bearing device incorporates a lead sheet for support. Handling and disposal of lead material shall be in accordance with Section 250 in the Standard Specifications and the cost shall be included in the work.
3. The Contractor shall submit a Methods Statement, installation plans and details of jacking for review in accordance with Section 509 of the Specifications before any work proceeds on this repair portion. The Methods Statement shall contain an itemized list of equipment and a critical path construction schedule in accordance with Section 108.03 in the Standard Specifications.
4. Girders A, B, C & D shall be raised and lowered simultaneously. The maximum differential motion between the two girders shall not exceed 1/4" at any point in time.
5. If new bolts are required the cost shall be included in the work.
6. The cost for rebuilding existing bearing seats including the removal of concrete at bearing locations shall be included in Item 210, Rebuild Portions of Present Structure.

Fig. 16.12(M)-1 Sample Details for Pot Bearing replacement

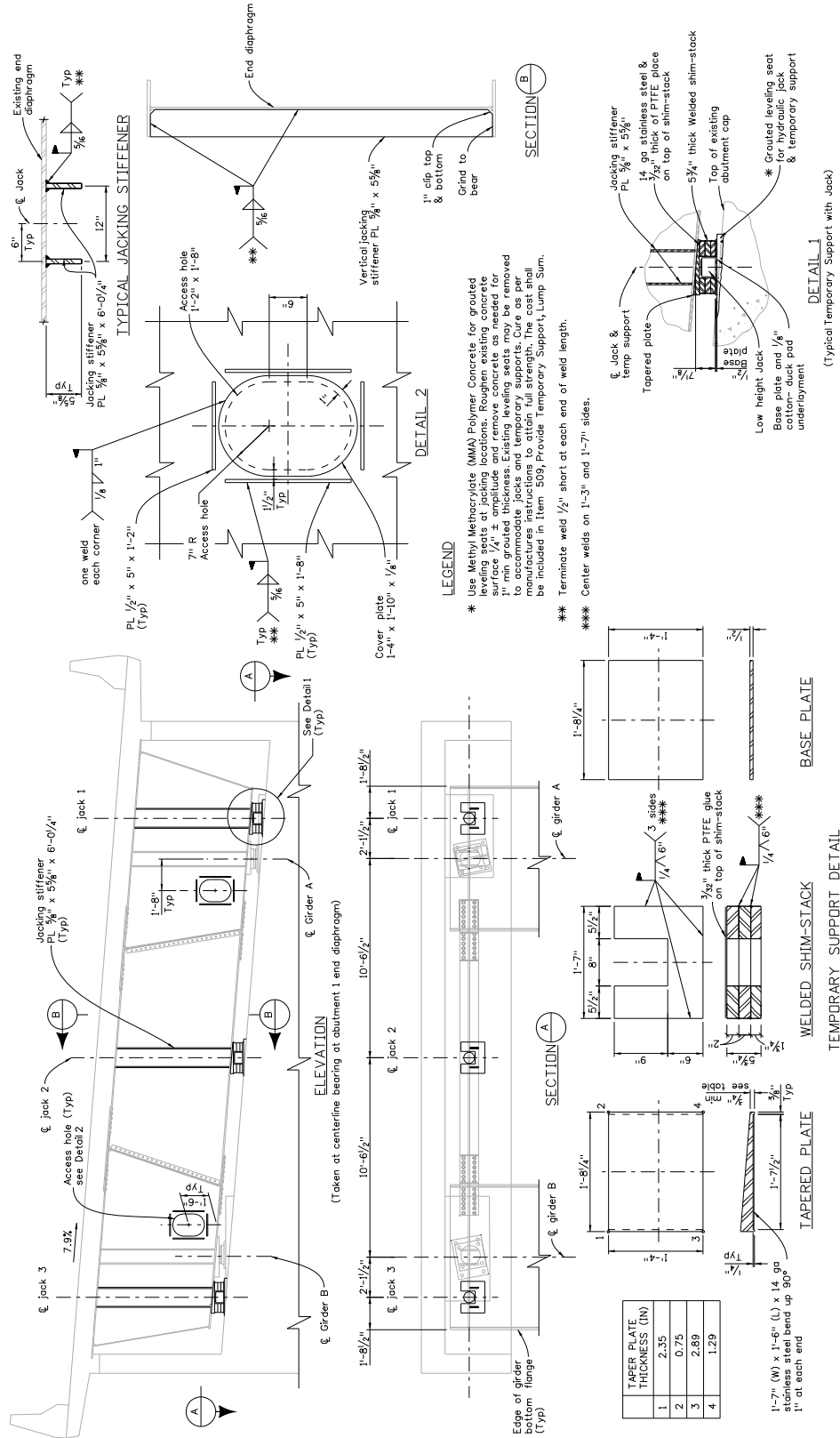
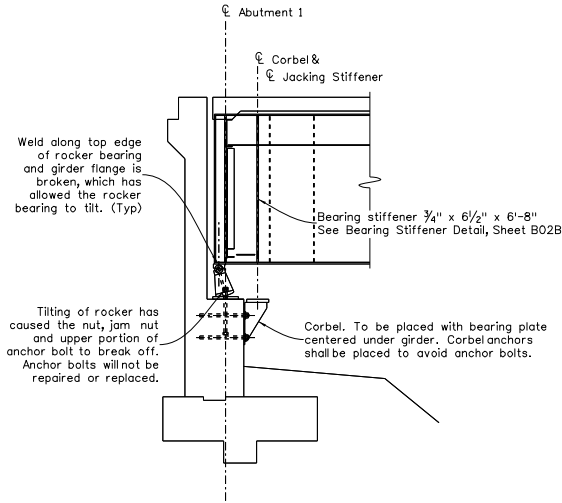
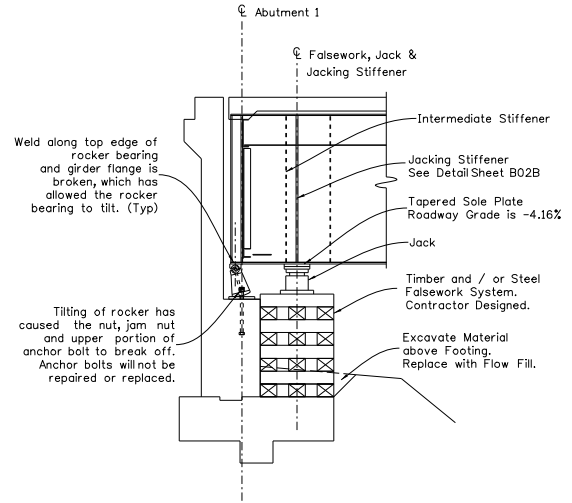


Fig. 16.12(M)-2 Sample Temporary Support Details for Bearing replacement



TYPICAL SECTION - OPTION 1
Existing condition of rocker bearing shown.



TYPICAL SECTION - OPTION 2
Existing condition of rocker bearing shown.

Fig. 16.12(M)-4 Sample Details for Jacking and Bearing Resetting

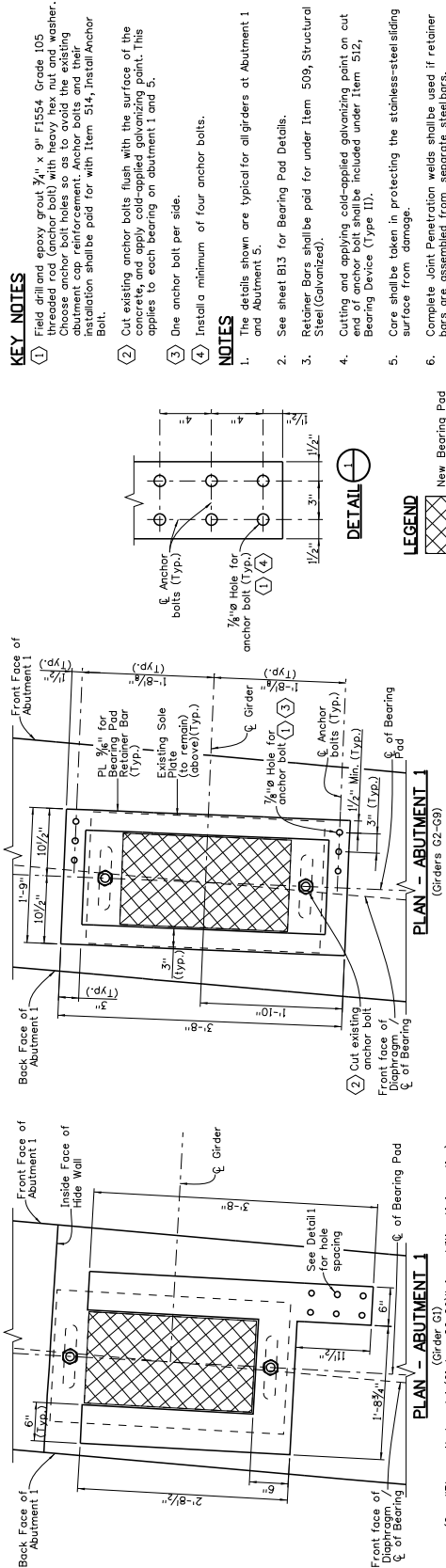
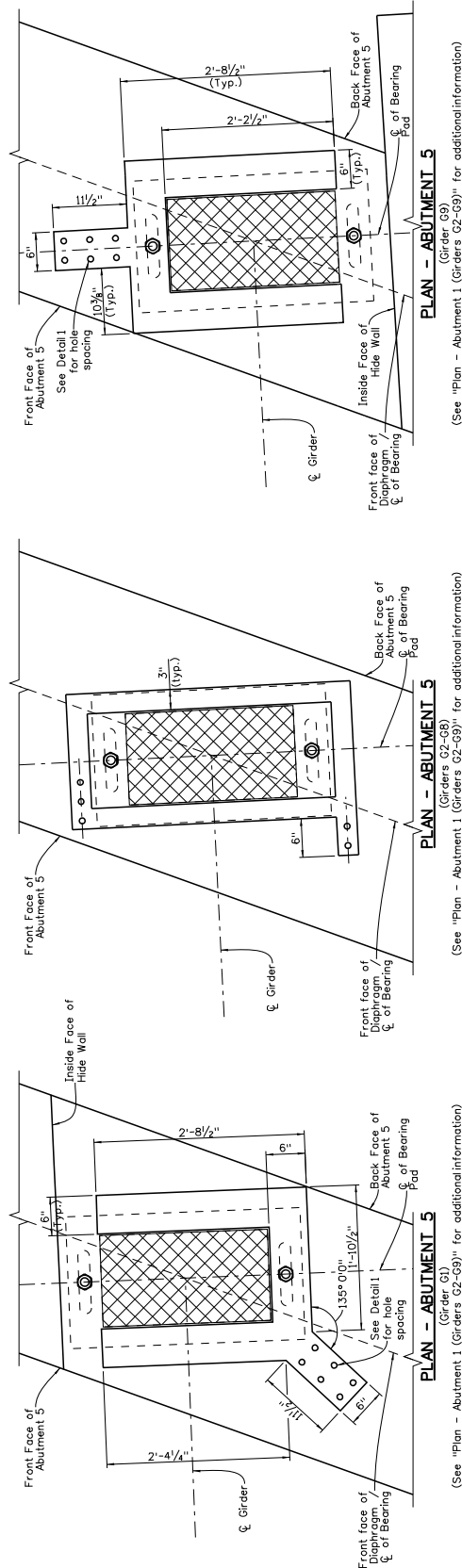


Fig. 16.12(M)-5 Sample Details for Bearing Keeper



<p style="text-align: center;">COLORADO DEPARTMENT OF TRANSPORTATION STAFF BRIDGE BRIDGE DETAIL MANUAL</p>	<p>Chapter: 17 Effective: February 10, 2023 Supersedes: April 16, 2018</p>
<p>INSPECTION SKETCHES</p>	

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).

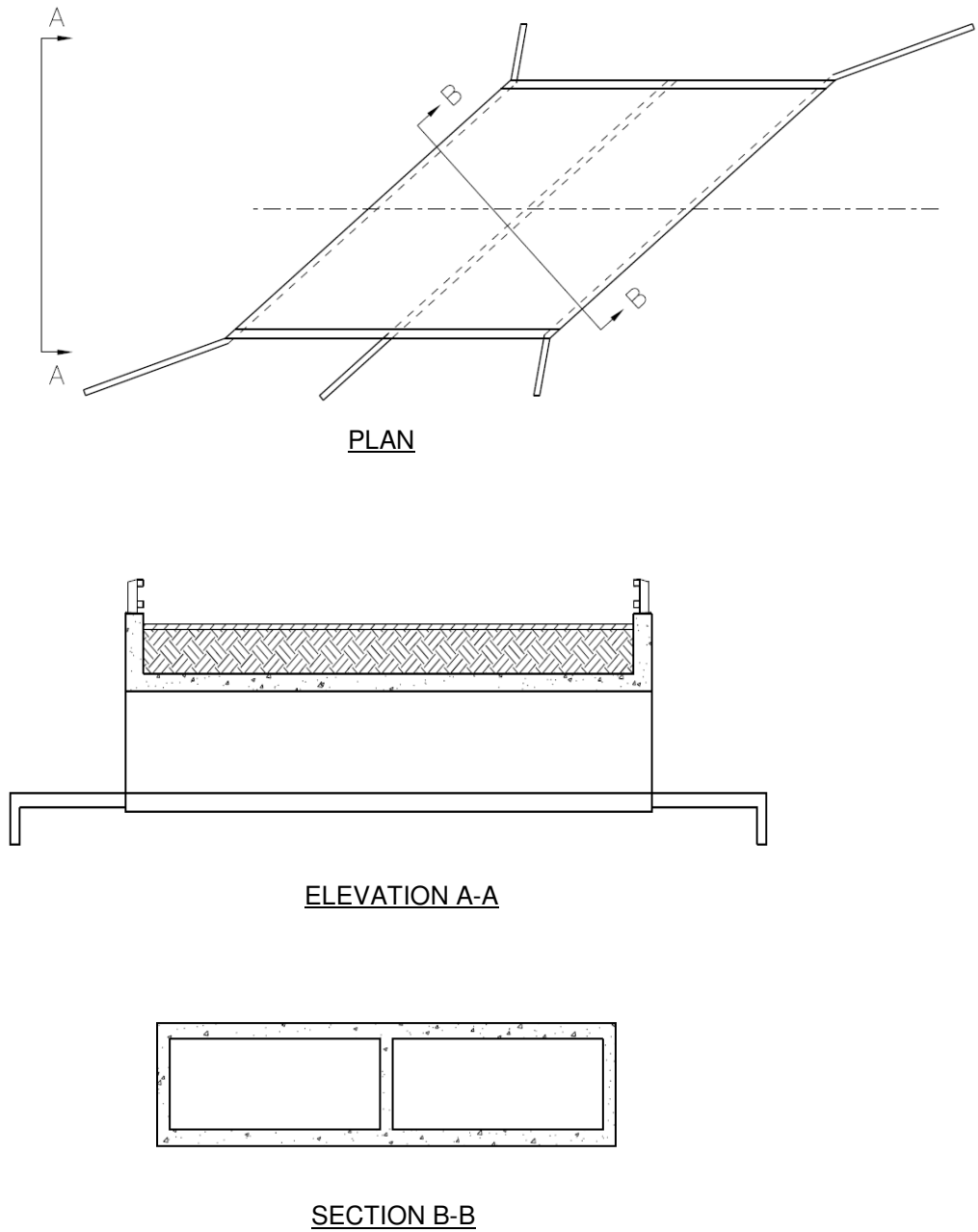


Fig. 17.4-1 Culvert Elevation and Section View

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

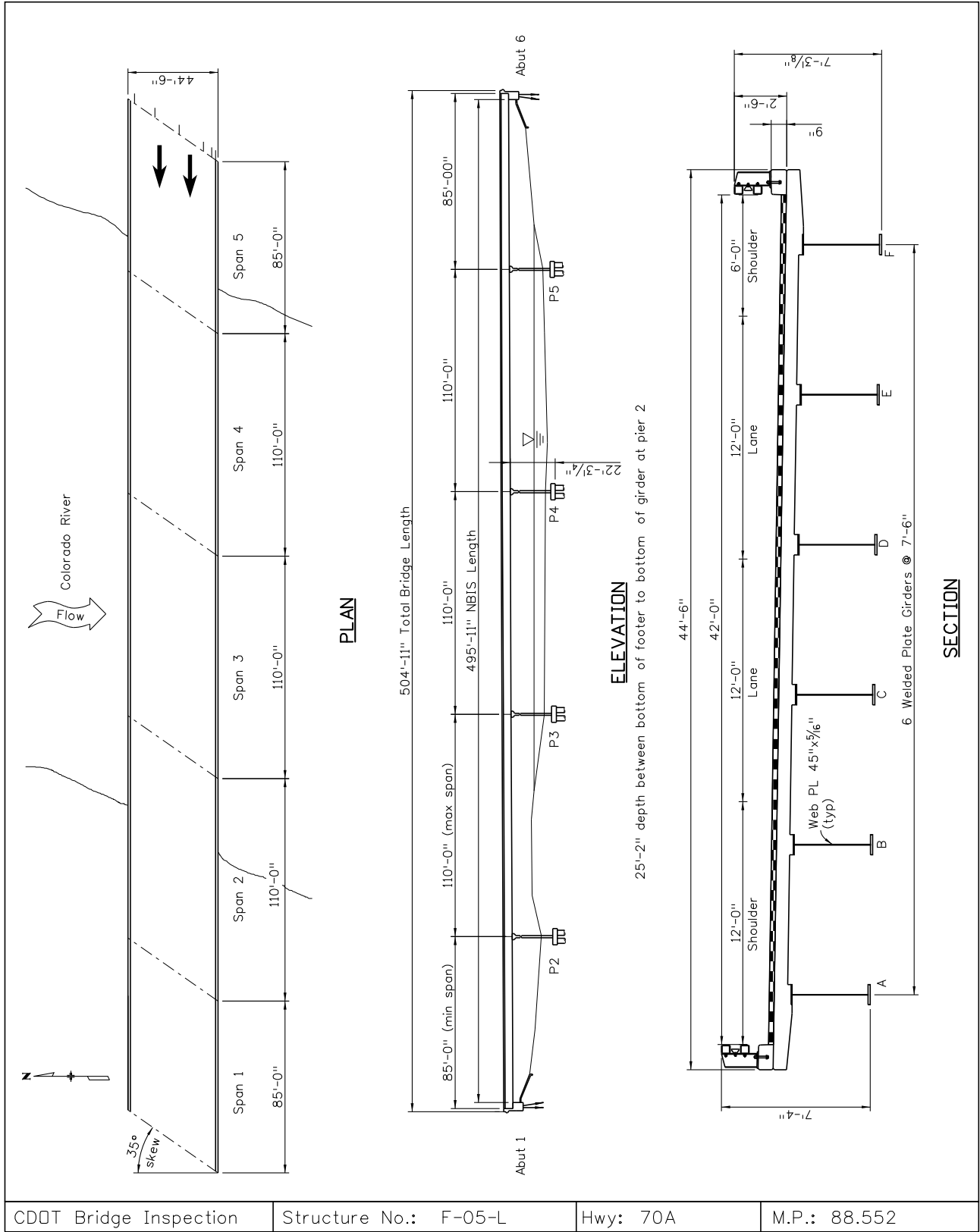
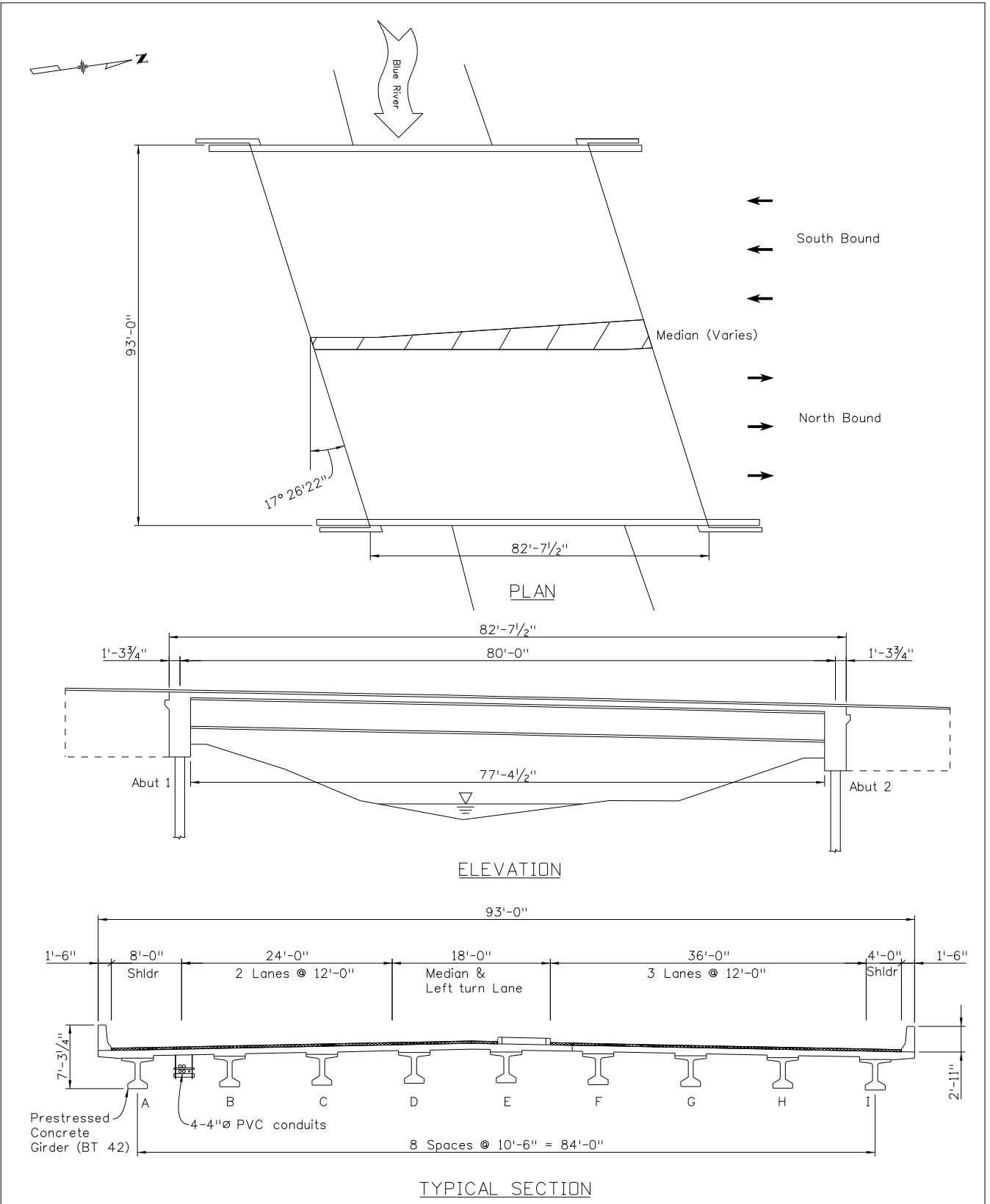


Fig. 17.6-1 Bridge Inspection Sketch – Example 1



CDOT Bridge Inspection

Structure No.: F-12-BW

Hwy: 009C

M.P.: 90.732

File Name: 2_F-12-BW Sketch.dgn

Print Date: 1/24/2023

Fig. 17.6-2 Bridge Inspection Sketch – Example 2

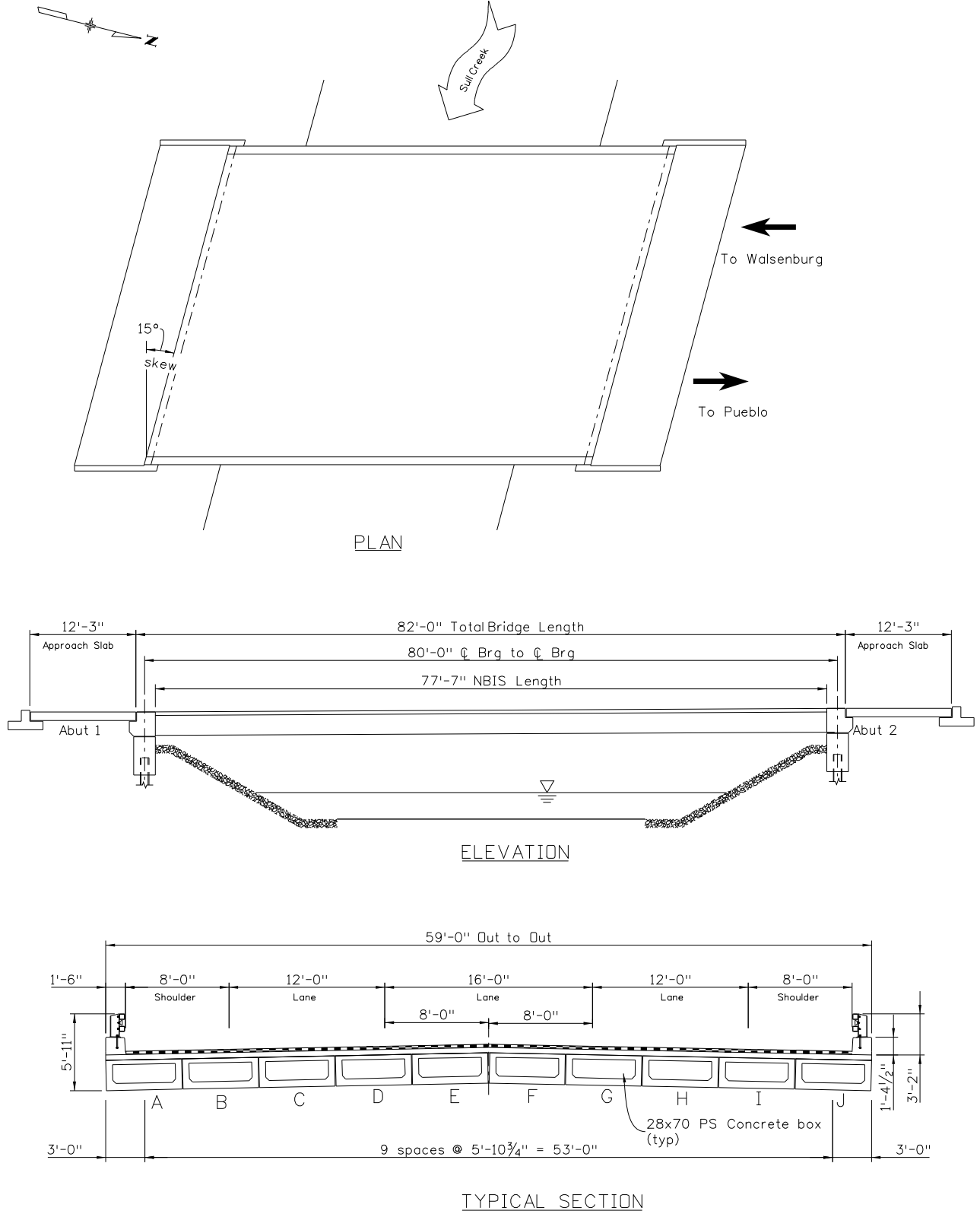
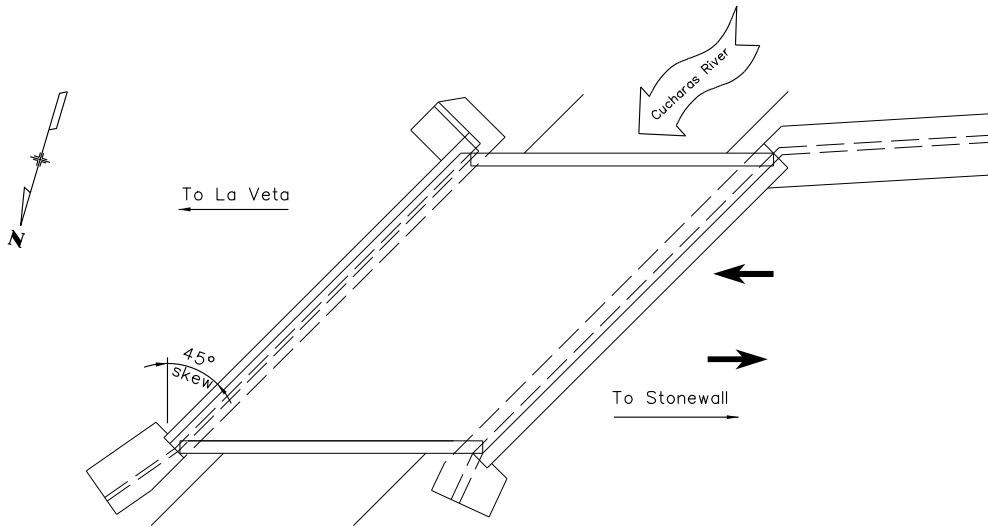
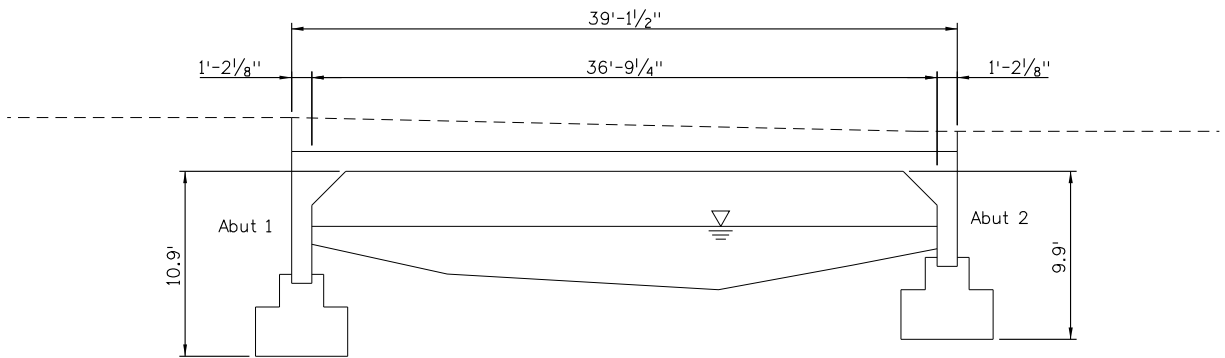


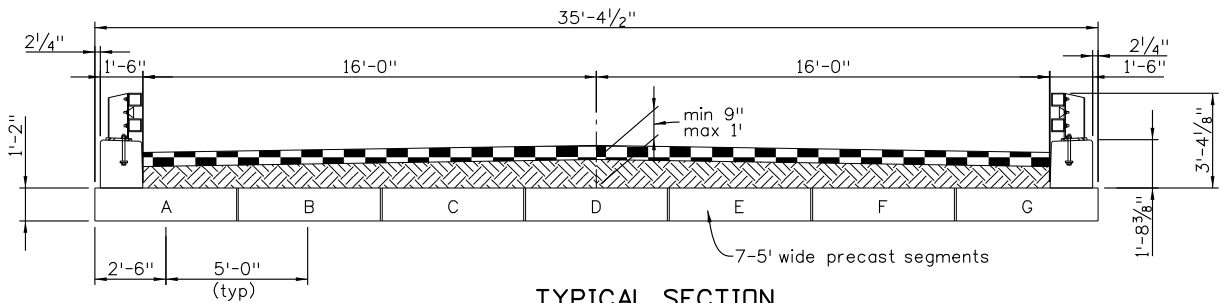
Fig. 17.6-3 Bridge Inspection Sketch – Example 3



PLAN

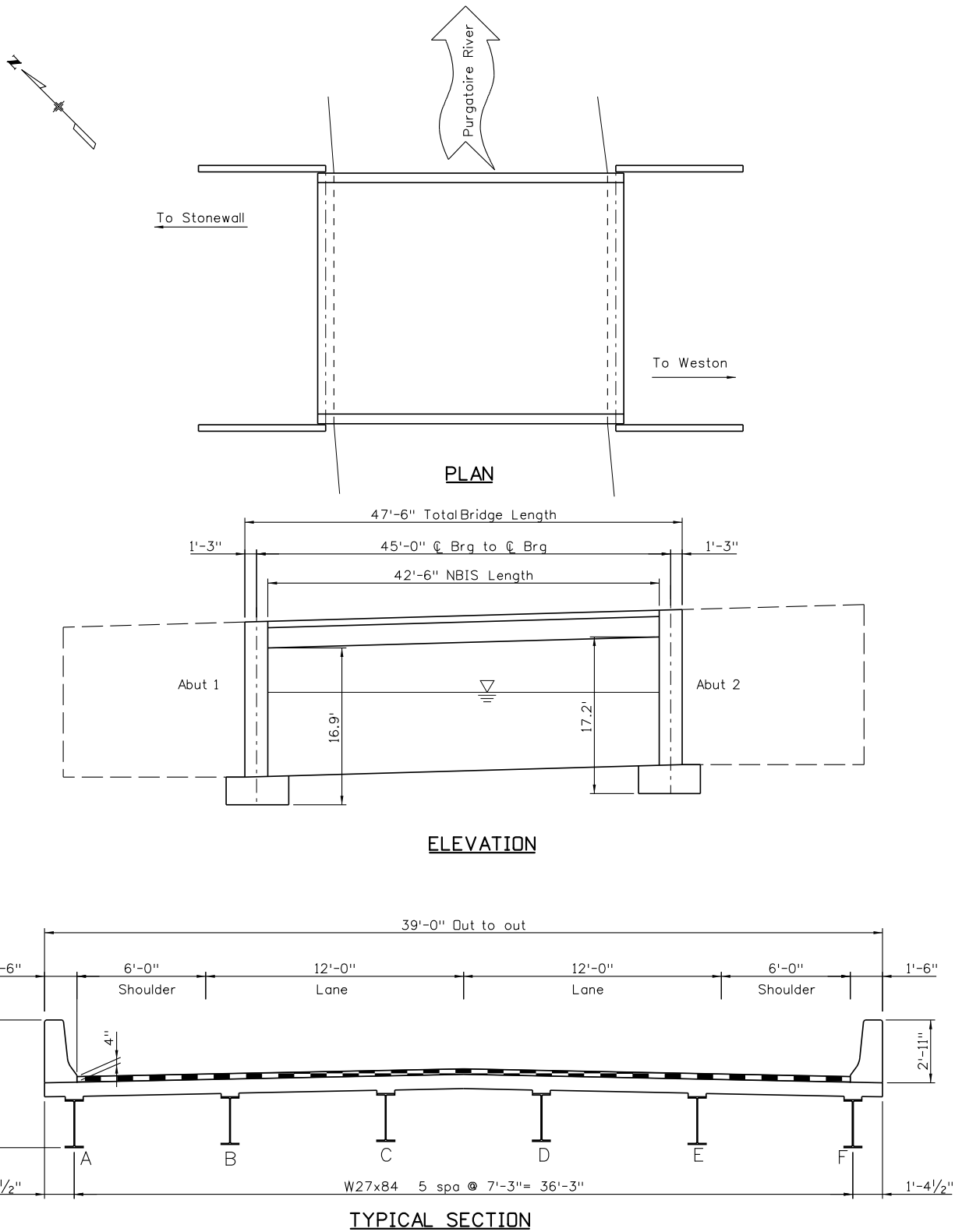


ELEVATION



TYPICAL SECTION

Fig. 17.6-4 Bridge Inspection Sketch – Example 4



CDOT Bridge Inspection

Structure No.: P-17-AG

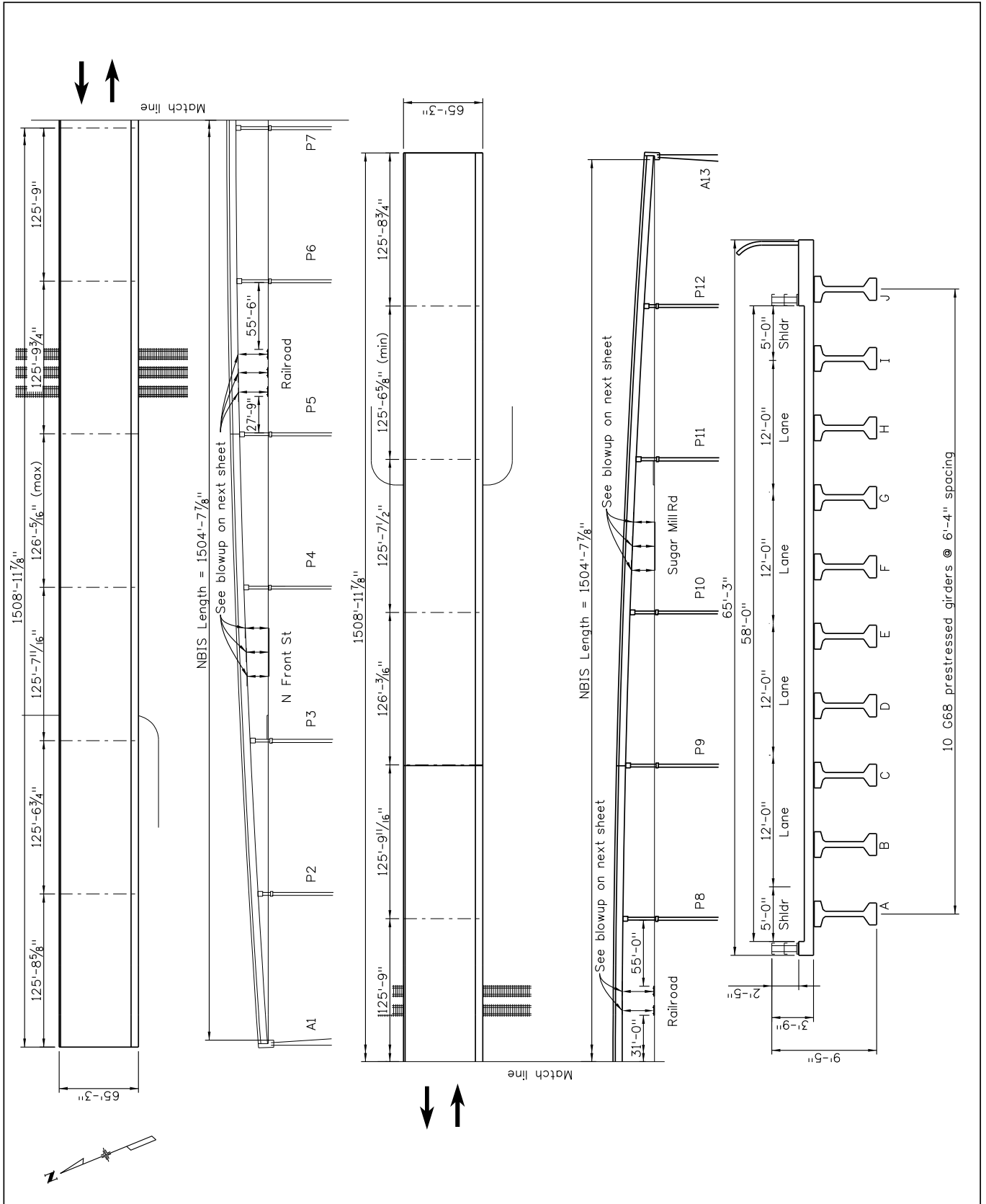
Hwy: 12A

M.P.: 46.656

File Name: 5_P-17-AG Sketch.dgn

Print Date: 1/24/2023

Fig. 17.6-5 Bridge Inspection Sketch – Example 5



CDOT Bridge Inspection

Structure No.: B-24-AQ

Hwy: 006

M.P.: 404.66

File Name: 6_B-24-AQ Sketch.dgn

Print Date: 2/9/2023

Fig. 17.6-6 Bridge Inspection Sketch – Example 6

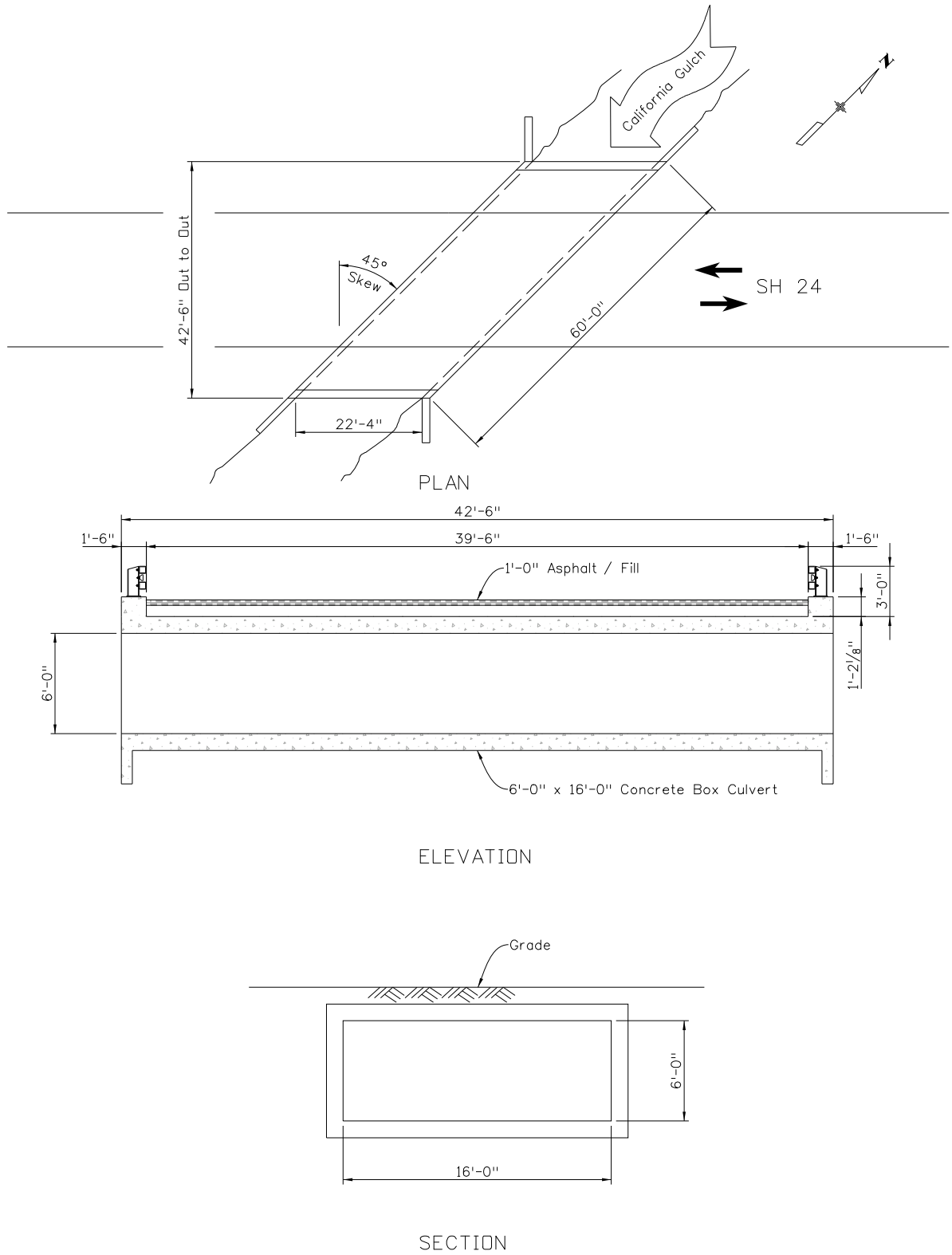
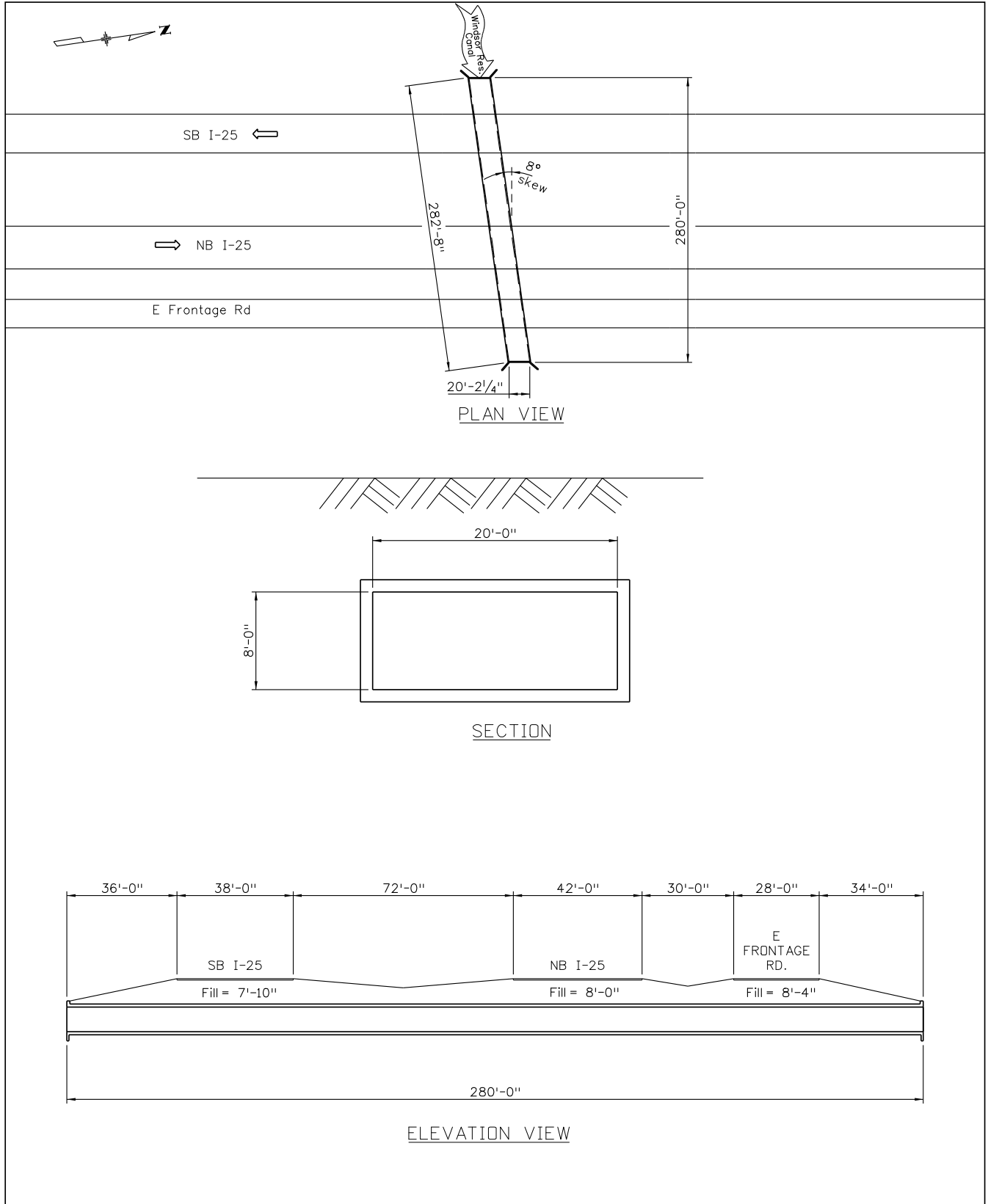


Fig. 17.6-7 Culvert Inspection Sketch – Example 7



CDOT Bridge Inspection

Structure No.: B-17-DR

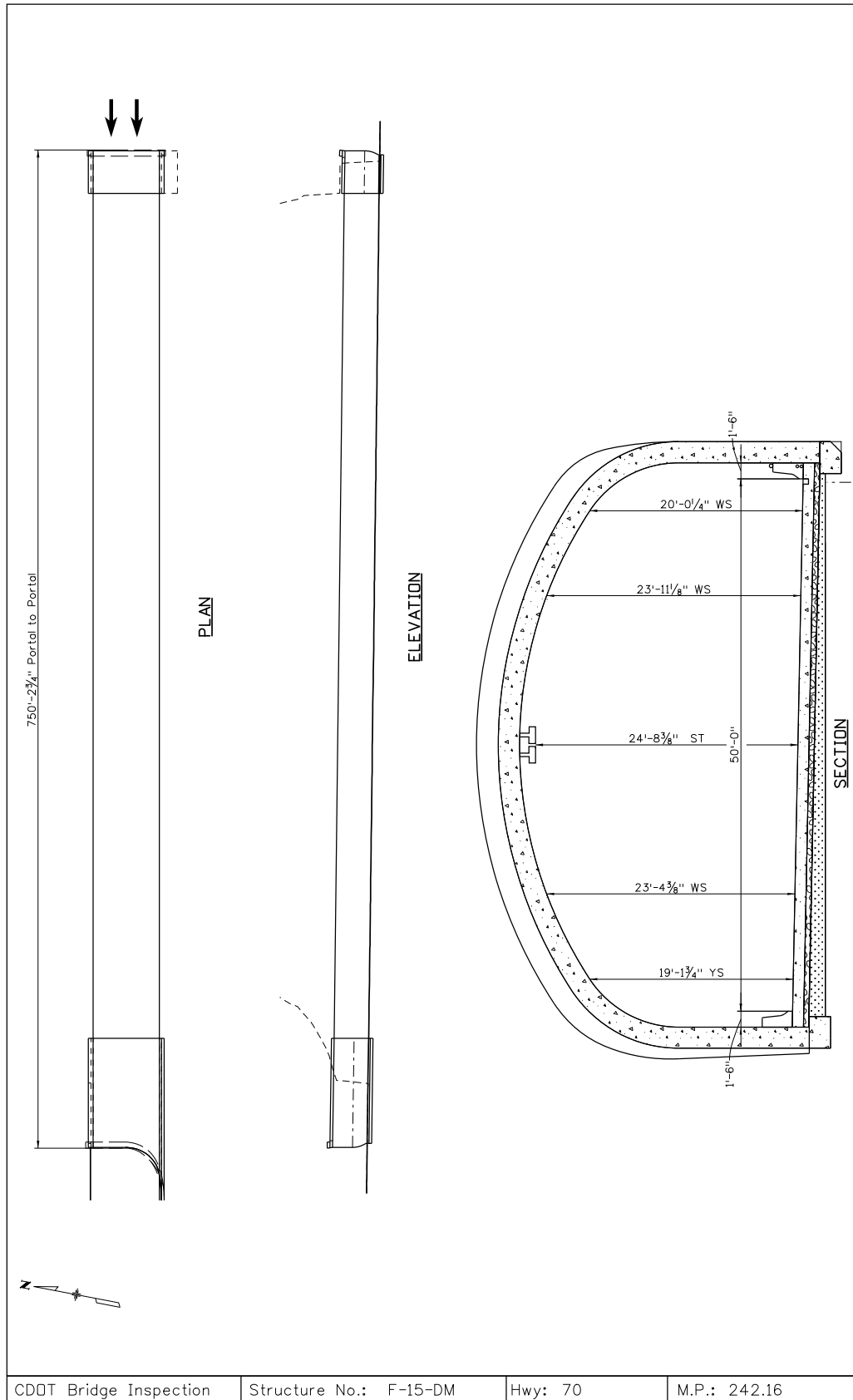
Hwy: 25

M.P.: 12.64

File Name: 8_B-17-DR_Sketch.DGN

Print Date: 1/24/2023

Fig. 17.6-8 Culvert Inspection Sketch – Example 8



CDOT Bridge Inspection

Structure No.: F-15-DM

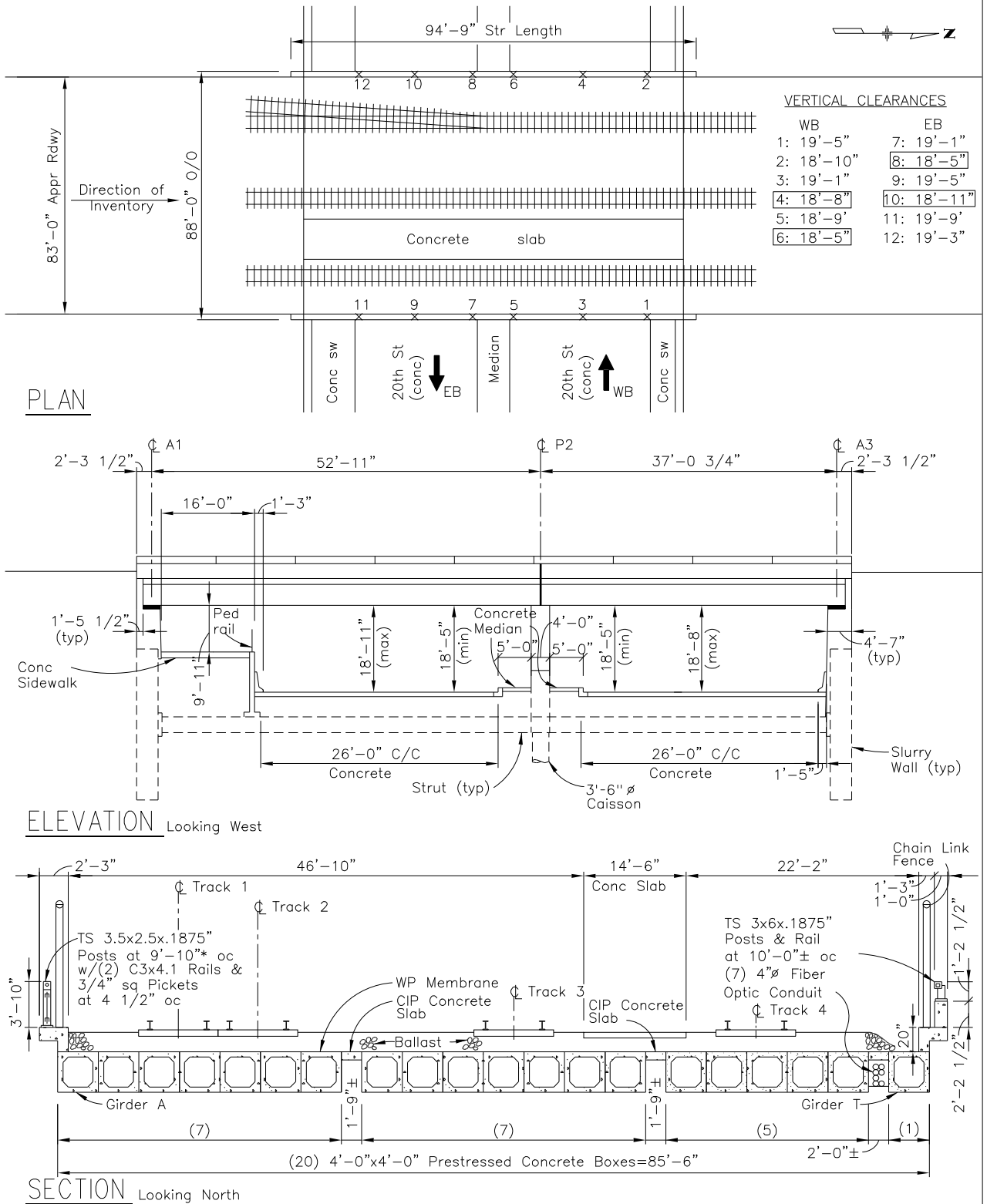
Hwy: 70

M.P.: 242.16

File Name: 9_F-15-DM Sketch.dgn

Print Date: 2/9/2023

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

COLORADO DEPARTMENT OF TRANSPORTATION STAFF BRIDGE BRIDGE DETAIL MANUAL	Chapter: Effective: Supersedes:	Appendix A June 18, 2021 January 2, 2009
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

<u>Abbreviation or Acronym Symbols</u>	<u>Meaning</u>
@	at
&	and
[channel (steel)
ϕ , \varnothing	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
ⓧⓧ	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 1 st 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
ABS	Acrylonitrile-Butadiene-Styrene Pipe
Abt, <i>Abt.</i>	About
Abut, <i>Abut.</i>	Abutment
ACI	American Concrete Institute
ACM	Asbestos Containing Materials
ADA	Americans with Disabilities Act
Adj, <i>ADJ.</i>	Adjust
ADT	Average Daily Traffic
AE	Architect-Engineer, Architecture, Engineering
AEC	Architecture, Engineering and Construction

<u>Abbreviation or Acronym Symbols</u>	<u>Meaning</u>
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, <i>Alt.</i>	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, <i>Approx.</i>	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
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, <i>Asst.</i>	Assistant
ASTM	American Society for Testing and Materials
ATSSA	American Traffic Safety Services Association
AUTS	Actual Ultimate Tensile Strength
Ave, <i>Ave.</i>	Avenue
AWG	American Wire Gauge
AWPA	American Wood Protection Association, formerly American Wood Preservers' Association
AWS	American Welding Society
AWWA	American Water Works Association

<u>Abbreviation or Acronym Symbols</u>	<u>Meaning</u>
B	
Bk to Bk	Back to Back
BEI, <i>B.E.I.</i>	By Equal Increments
BM, <i>B.M.</i>	Bench mark
BPF, <i>B.P.F.</i>	Blows Per Foot
B/	Bottom of
BAFO	Best and Final Offer
Bbl, <i>Bbl.</i>	Barrels
BC, <i>B.C.</i>	Bolt Circle
Beg.	Begin
BF, <i>B.F.</i>	Backface
BFBW, <i>B.F.B.W.</i>	Backface of Backwall
Bk, <i>B.K., Bk.</i>	Back
Bldg, <i>Bldg.</i>	Building
BLM	Bureau of Land Management
Blvd, <i>Blvd.</i>	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, <i>Bms.</i>	Beams
BNSF	Burlington Northern & Santa Fe Railroad
Bott, <i>Bott., Bot.</i>	Bottom
BP	Maximum Required Allowable Bearing Pressure
BPO	Business Programs Office (CDOT)
BR, <i>Br.</i>	Bridge On-System Program, Bridge
Brg, <i>Brg.</i>	Bearing
BRO	Bridge Off-System Program
BS, <i>B.S.</i>	Back Station
BT, <i>B.T.</i>	Beginning of Transition
Btm, <i>Btm.</i>	Bottom
Btwn, <i>Btwn.</i>	Between
C	
C&G	Curb and Gutter
CRS, <i>C.R.S.</i>	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

Abbreviation or Acronym Symbols	Meaning
CDTPG	Concrete Double-Tee Prestressed Girder
CE	Construction Engineering
CF, <i>Cu. Ft.</i>	Cubic Feet
CFR	Code of Federal Regulations
CFS, <i>C.F.S.</i>	Cubic Feet Per Second
CG, <i>CG.</i>	Center of Gravity
CHP	Colorado Highway Patrol
CI, <i>CI.</i>	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, <i>C.I.O.G.</i>	Cast Iron Ogee (Washer)
CIP, <i>C.I.P.</i>	Cast-in-Place, <i>Cost in Place</i>
Clr, <i>CL., Clr.</i>	Clear
cm, <i>cm.</i>	Centimeters
CM, <i>CM.</i>	Corrugated Metal
CMAQ	Congestion Mitigation Air Quality
CMO	Contract Modification Order
CMP, <i>C.M.P.</i>	Corrugated Metal Pipe
CMS	Changeable Message Sign
CMU	Concrete Masonry Unit
COFRS	Colorado Financial Reporting System
Col, <i>Col.</i>	Column
Comp, <i>Comp.</i>	Composite
Conn, Con, <i>Conn., Con.</i>	Connection
Conc, <i>Conc.</i>	Concrete
Const, <i>Const.</i>	Construction
Cont, <i>Cont.</i>	Continuous
Corr, <i>Corr.</i>	Corrugated
Cov, <i>Cov.</i>	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
CS, <i>C.S.</i>	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, <i>Csk.</i>	Countersunk

Abbreviation or Acronym Symbols	Meaning
CSL	Cross Sonic Log
CSP	Corrugated Steel Pipe, Concrete Slab Prestressed
CSPC	Concrete Slab Prestressed Continuous
CTR	Certified Test Reports
Ctr, <i>Ctr.</i>	Center
CY, <i>Cu. Yd., c.y.</i>	Cubic Yards
D	
D	Degree of Curvature, Depth, Density, Distance, Diameter
DB, D/B	Design Build
DAS, <i>D.A.S.</i>	Deformed Anchor Stud
dB	decibels
DBA	Deformed Bar Anchor
DBE	Disadvantaged Business Enterprise
Dbl, <i>Dbl.</i>	Double
Deg, <i>Deg., °</i>	Degrees (Angular)
Deg, °F, °C, <i>Deg., °F., °C.</i>	Degrees (Thermal) – Degrees Fahrenheit, Degrees Celsius
DEIS	Draft Environmental Impact Statement
Dept, <i>Dept.</i>	Department
Dgn, <i>DGN, Dgn.</i>	Design, Microstation Drawing, Design
DH	Design Height (or, Avg. height for qty. calculations)
DHV	Design Hour Volume
DHW	Design High Water
DI, <i>D.I.</i>	Ductile Iron
Dia, <i>Dia., ∅, Ø, Φ, &</i>	Diameter
Dist, <i>Dist.</i>	District
Div, <i>Div.</i>	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
DS, <i>D.S.</i>	Down Station
DSR	Design Scoping Review
DTD	Division of Transportation Development (CDOT)
DTM	Digital Terrain Model
Dwg, <i>Dwg.</i>	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, <i>Ea., EA</i>	Each
EB, <i>E.B.</i>	Eastbound
ECR	Epoxy Coated Rebar
EEO	Equal Employment Opportunity
EF, <i>E.F.</i>	Each Face
EIA	Electronic Industries Alliance (formerly Electronic Industries Association)
EIS	Environmental Impact Statement
EI, <i>EI., EL, Elev.</i>	Elevation

Abbreviation or Acronym Symbols	Meaning
Elast, <i>Elast.</i>	Elastomeric
Elect Cond, <i>Elect. Cond.</i>	Electrical Conduit
EM ₁	Quantity of Structure Excavation without Shoring
EM ₂	Quantity of Structure Excavation with Shoring
Engr, <i>Engr.</i>	Engineer
EPA	Environmental Protection Agency
EPDM	Eethylene Propylene Ddiene Monomer-class rubber
Eq, <i>Eq.</i>	Equal
ESAL	Equivalent Single Axle Load
ESB	Emerging Small Business
Est, <i>Est.</i>	Estimate
ET, <i>E.T.</i>	Ending of Transition
EVT	Event Point (InRoads Terminology)
EW, <i>E.W.</i>	Each Way
E, <i>Ex</i>	Expansion Bearing
Ex, <i>Ex.</i>	Example, Except
Exc, <i>Exc., Excav.</i>	Excavation
Exist, <i>Exist.</i>	Existing
Exp	Non-guided (free floating) expansion bearing
Exp Jt, <i>Exp. Jt.</i>	Expansion Joint
Expn, <i>Expn.</i>	Expansion
Ext, <i>Ext.</i>	Exterior
F	
F to F	Face to Face
FAP, <i>F.A.P.</i>	Federal Aid Project
FL, <i>F.L.</i>	Flow Line
FAA	Federal Aviation Administration
FAPG	Federal Aid Policy Guide
FCM	Fracture Critical Member
Fdn, <i>Fdn.</i>	Foundation
Fed, <i>Fed.</i>	Federal
FEMA	Federal Emergency Management Agency
FES	Flared End Section
FF, <i>F.F.</i>	Far Face, Front Face
FFBW, <i>F.F.B.W.</i>	Front Face of Backwall
FHWA	Federal Highway Administration
Fig, <i>Fig.</i>	Figure
Fin, <i>Fin.</i>	Finished
FIPI	Finding-in-the-Public-Interest
FIR	Field Inspection Review
Fl, <i>Fl.</i>	Floor
Flg, <i>Flg.</i>	Flange
FM	Factory Mutual
FMV	Fair Market Value
FO	Fiber Optic
FONSI	Finding of No Significant Impact
FOR	Final Office Review
fpm, <i>F.P.M.</i>	Feet Per Minute
Fps, <i>F.P.S., FPS</i>	Feet Per Second
FRA	Federal Railroad Administration
Freq, <i>Freq.</i>	Frequency

Abbreviation or Acronym Symbols	Meaning
FRP	Fiber Reinforced Polymer
FS, <i>F.S.</i>	Planned Finish Surface
FSS	Federal Specifications and Standards
Ft, <i>FT, Ft., ft</i>	Feet
Ft Kip, <i>Ft. Kip.</i>	Foot Kips
Ft Lb, <i>FT LB, Ft. Lb.</i>	Foot Pounds
FTA	Federal Transit Administration
Ftg, <i>Ftg.</i>	Footing
FTP	File Transfer Protocol
Fut, <i>Fut.</i>	Future
F, <i>Fx</i>	Fixed Bearing
G	
Ga, <i>Ga.</i>	Gage, Gauge
Gal, <i>Gal.</i>	Gallons
Galv, <i>Galv.</i>	Galvanized
Gd	Guided expansion bearing
GEIA	Government Electronics and Information Technology Group (ITAA)
GIP	Galvanized Iron Pipe
Gir, <i>G, Gird, Gird., Gir., Grd, Gr</i>	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, <i>H.A.S.</i>	Headed Anchor Stud
HAZMAT	Hazardous Materials
HBP	Hot Bituminous Pavement
HC	Horizontal Clearance
HCL, <i>H.C.L.</i>	Horizontal Control Line
HCM	Highway Capacity Manual
Hd, <i>HD, Hd.</i>	Head
HDPE	High Density Polyethylene
HDPP	High Density Polypropylene
HEEP	Highway Engineering Exchange Program
HES	Hazard Elimination System
Hex Hd, <i>Hex. Hd.</i>	Hexagonal Head
HID	High Intensity Discharge (Lamps)
HLMR	Highload Multi-Rotational
HMA	Hot Mix Asphalt
Horiz, <i>Horz., Horiz., Hor.</i>	Horizontal
HOV	High-Occupancy Vehicle
HP	H pile, horsepower
HSHP	High StrengthHorsepower
HPC	High Performance Concrete
HS Bolt, <i>H.S. Bolt</i>	High Strength Bolt

<u>Abbreviation or Acronym Symbols</u>	<u>Meaning</u>
HS, <i>H.S.</i>	High Strength
HSC, <i>H.S.C.</i>	High Strength Concrete
Ht, <i>Ht.</i>	Height
HTF	Highway Trust Fund (Federal)
HUTF	Highway Users Tax Fund (State)
HW, <i>H.W.</i>	High Water
Hwy, <i>Hwy.</i>	Highway
Hyd, <i>Hyd.</i>	Hydraulic
I	
I	I beam or Wide Flange section (steel), Interstate
ICEA	Insulated Cable Engineers Association, formerly IPCEA
ID, <i>I.D.</i>	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., <i>IN</i>	Inches
Incl, <i>Incl., Inc.</i>	Included
Insp, <i>Insp.</i>	Inspector
Int, <i>Int.</i>	Interior
Inv, <i>Inv.</i>	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, <i>J</i>	Junction Box
JBC	Joint Budget Committee
Jct, <i>Jct.</i>	Junction
Jt, <i>Jt., jt.</i>	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, <i>Lac.</i>	Lacing

<u>Abbreviation or Acronym Symbols</u>	<u>Meaning</u>
LAN	Local Area Network
Lb, <i>Lb.</i> , <i>LB</i> , <i>lb</i>	Pounds
Lb/Ft, <i>lb./ft.</i>	pound per foot
Lb/SY, <i>Lb/sy</i>	Pounds per square yard
Lb-Ft, <i>lb-ft.</i>	pound foot
LED	Light Emitting Diode
LEED	Leadership in Energy and Environmental Design
LF, <i>Lin. Ft.</i>	Linear Feet
LFD	Load Factor Design
LLDPE	Linear Low-Density Polyethylene
LRFD	Load and Resistance Factor Design
LS, <i>L.S.</i>	Lump Sum, Length of Spiral
Lt, <i>Lt.</i>	Left
LTDS	Required Long Term Design Strength
Lum, <i>Lum.</i>	Luminaire
M	
m	Meters
MPH	Miles Per Hour
M	Mass
Maint, <i>Maint.</i>	Maintenance
MARV	Minimum Average Roll Value
Matl, <i>Matl.</i>	Material
Max, <i>Max.</i> , <i>max.</i>	Maximum
MBTA	Migratory Bird Treaty Act
MCR	Minor Contract Revision
MD	Machine Direction
MFBM, <i>M.F.B.M.</i>	Thousand Foot Board Measure
Mfg, <i>Mfg.</i>	Manufactured, Manufacturer
MHT	Method of Handling Traffic
Mi, <i>Mi.</i>	Mile
MIL	Military Specification
Min, <i>Min.</i> , <i>min.</i>	Minimum
Misc, <i>Misc.</i>	Miscellaneous
mm	Millimeters
MMIS	Maintenance Management Information System
MMP	Materials Management Plan
MMS	Maintenance Management System
MOA	Memorandum of Agreement
Mobl, <i>Mobl.</i>	Mobilization
MOSS	Modeling of Surfaces and Strings
MOT	Maintenance of Traffic
MOU	Memorandum of Understanding
MP, <i>M.P.</i>	Milepost
MPH, <i>M.P.H.</i>	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

<u>Abbreviation or Acronym Symbols</u>	<u>Meaning</u>
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
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

<u>Abbreviation or Acronym Symbols</u>	<u>Meaning</u>
oz, Oz.	Ounces
P	
PACOG	Pueblo Area Council of Governments
PC, <i>P.C.</i>	Point of Curve
PCA	Portland Cement Association
PCBC	Concrete Box Culvert Precast
PCC, <i>P.C.C.</i>	Point of Compound Curve
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, <i>P.G.L.</i>	Profile Grade Line
PI, <i>P.I.</i>	Point of Intersection
PICS	Project Item Coding System (replaced by Inroads Survey)
PIP	Public Information Plan
PL, PI, <i>PL., PI.</i>	Plate
PLS	Professional Land Surveyor
PM	Project Manager
POC, <i>P.O.C.</i>	Point on Curve
POSS, <i>P.O.S.S.</i>	Point of Slope Selection
POT, <i>P.O.T.</i>	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, <i>P.S. & E.</i>	Plans, Specification and Estimate
PS, <i>P.S.</i>	Planned Subgrade
Prin, <i>Prin.</i>	Principle
Proj, <i>Proj.</i>	Project, Projection
ProMIS	Project Management Information System
Prov, <i>Prov.</i>	Provisions
PSC	Prestressed Concrete
PS&E	Plans, Specifications and Estimate
psf	pounds per square foot
PSI	Preliminary Site Investigation
psi, <i>P.S.I.</i>	Pounds per square inch
PSIG	Pounds Per Square Inch Gauge
PT, <i>P.T.</i>	Point of Tangent
PTFE	Polytetrafluoroethylene
PTI	Post-Tensioning Institute
PUC	Public Utilities Commission
PVC	Poly Vinyl Chloride (pipe), Point of Vertical Curve
PVI	Point of Vertical Intersection
Pvmt, <i>Pvmt.</i>	Pavement
PVT	Point of Vertical Tangency

Abbreviation or Acronym Symbols	Meaning
Q	
Q	Peak Discharge or Flow Volume
QA	Quality Assurance
QC	Quality Control
QMP	Quality Management Plan (Design/Build Terminology)
R	
R, <i>R.</i> , <i>Rad.</i>	Radius
RA	Rubble Arch
RAC	Rubble Arch Culvert
rad	radians
RC, <i>R.C.</i>	Reinforced Concrete, Reverse Crown
RCO	Request for Change Order
RCP, <i>R.C.P.</i>	Reinforced Concrete Pipe, Request for Change Proposal
RCPC	Reinforced Concrete Pipe Culvert
RCRA	Resource Conservation and Recovery Act
Rdwy, <i>Rdwy.</i>	Roadway
RE	Resident Engineer, Railroad Easement, Reinforced Earth
Ref, <i>Ref.</i>	Reference
Reinf, <i>Reinf.</i>	Reinforcing
Rem, <i>Rem.</i>	Remove, Removal
Repl, <i>Repl.</i>	Replace
Req, <i>Req.</i> , <i>Req'd</i> , <i>Reqd.</i>	Required
Rev, <i>Rev.</i>	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, <i>R.O.W.</i> , <i>R/W</i> , <i>RW</i>	Right of Way
RPC	Region Planning Commission
rpm, <i>RPM</i>	Revolutions Per Minute
RSC	Rigid Steel Conduit
RSS	Reinforced Soil Slope
Rt, <i>Rt.</i>	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, <i>San.</i>	Sanitary
SAP	Sample Analysis Plan
SB, <i>S.B.</i>	Southbound
SBA	Small Business Administration
SBG	Steel Box Girder

<u>Abbreviation or Acronym Symbols</u>	<u>Meaning</u>
SBGC	Steel Box Girder Continuous
SC, <i>S.C.</i>	Spiral to Curve
Sch, <i>Sch.</i>	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, <i>Sec., Sect.</i>	Section
SF, <i>Sq. Ft., Sq ft</i>	Square Feet
SH	State Highway
Shldr, <i>Shldr.</i>	Shoulder
SHPO	State Historic Preservation Office
Sht, <i>Sht.</i>	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, <i>Sim.</i>	Similar
SIP, <i>S.I.P.</i>	Stay in Place
SJI	Steel Joists Institute
SLT	Steel Low Truss
Sdwk, <i>SLWK.</i>	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, <i>Spa.</i>	Spaces or Spaced
Specs, <i>Specs.</i>	Specifications
Spl, <i>Spl.</i>	Splice
Sq In, <i>Sq. In.</i>	Square Inches
Sq Mi, <i>Sq. Mi.</i>	Square Miles
Sq, <i>Sq., Sqr.</i>	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, <i>S.T.</i>	Spiral to Tangent
St, <i>St.</i>	Straight, Street
Sta, <i>STA, Sta.</i>	Station
STAC	Statewide Transportation Advisory Committee
Std, <i>Std.</i>	Standard
STG	Steel Thru Girder

<u>Abbreviation or Acronym Symbols</u>	<u>Meaning</u>
STIP	Statewide Transportation Improvement Program
STP	Surface Transportation Program
Str, <i>Str.</i>	Structure, Structural
STT	Steel Thru Truss
SUSP	Suspension Bridge
SWMP	Stormwater Management Plan
SY, <i>Sq. Yd., Sq Yd</i>	Square Yards
Sym, <i>Symm.</i>	Symmetrical
T	
T&B	Top and Bottom
T&E	Threatened & Endangered Species
T, <i>T.</i>	Tons
TAS, <i>T.A.S.</i>	Threaded Anchor Stud
TBC	Timber Box Culvert
TC, <i>T.C.</i>	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, <i>Temp.</i>	Temporary, Temperature
Thd, <i>Thd.</i>	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, <i>Tot.</i>	Total
TPI	Threads per Inch
TPR	Transportation Planning Region
TRB	Transportation Research Board
TS, <i>T.S.</i>	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, <i>Typ.</i>	Typical

<u>Abbreviation or Acronym Symbols</u>	<u>Meaning</u>
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, <i>U.S.</i>	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, <i>Util.</i>	Utility, Utilities
UV	Ultraviolet
V	
VC, <i>V.C.</i>	Vertical Curve
VCP	Vitrified Clay Pipe
VE	Value Engineering
VECP	Value Engineering Change Proposal
Veh, <i>Veh.</i>	Vehicle
Vert, <i>Vert.</i>	Vertical
VMS	Variable Message Sign (also known as DMS)
VMT	Vehicle Miles Traveled
Vol, <i>Vol.</i>	Volume
VPC	Vertical Point of Curvature
VPI	Vertical Point of Tangency
VPT	Vertical Point of Intersection
W	
W/C	Water-Cement Ratio
WALL	Retaining Wall
Wash, <i>Wash.</i>	Washer
WASHTO	Washington Association of State Highway and Transportation Officials
WB, <i>W.B.</i>	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

<u>Abbreviation or Acronym Symbols</u>	<u>Meaning</u>
WGK	Welded Girder Composite
WGKP	Welded Girder Composite Prestressed
WP, <i>W.P.</i>	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, <i>W.S.</i>	Water Surface
Wt, <i>Wt.</i>	Weight
WWF	Welded Wire Fabric, typically referred to very light gauge wire for crack control
WWR	Welded Wire Reinforcement
X	
Y	
Yd, <i>Yd.</i>	Yard

COLORADO DEPARTMENT OF TRANSPORTATION STAFF BRIDGE BRIDGE DETAIL MANUAL	Chapter: Appendix B Effective: January 31, 2013 Supersedes: New
APPENDIX B - Microstation Configuration Details	

First time users of Microstation should read “Chapter 2 - Getting Started in MicroStation” available online at:

<http://www.coloradodot.info/business/designsupport/cadd/manuals-training-resources/v8i-ss2-training-materials/microstation/microstation-v8i-ss2-guide/chapter2/view>

B.1 CONFIGURATION

Training materials, manuals, workflows, video tutorials and other resources can be accessed online at:

<http://www.coloradodot.info/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.

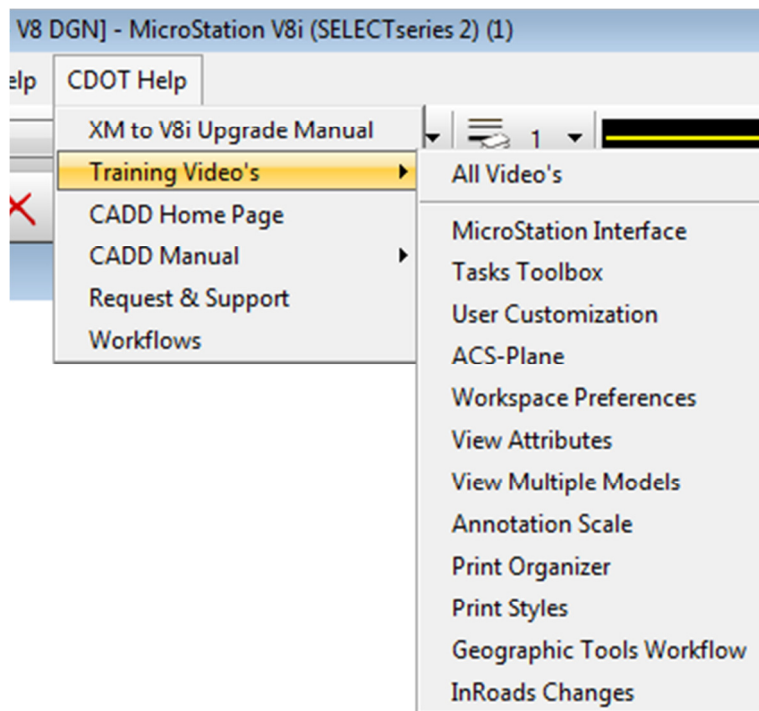


Fig. B.1-1 Help and CDOT Help

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)

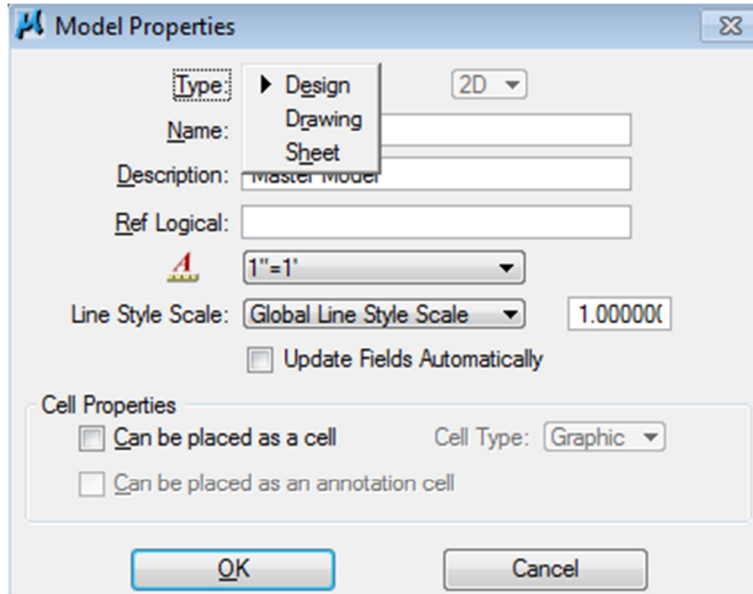
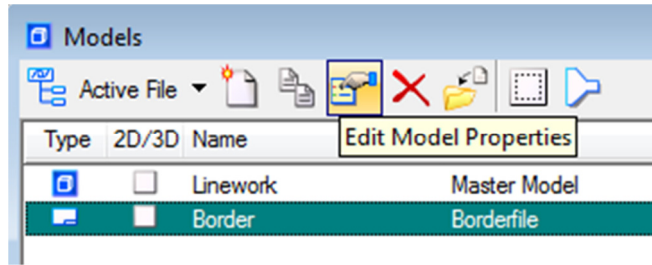


Fig. B.2-1 Models and Model Properties Dialog

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.

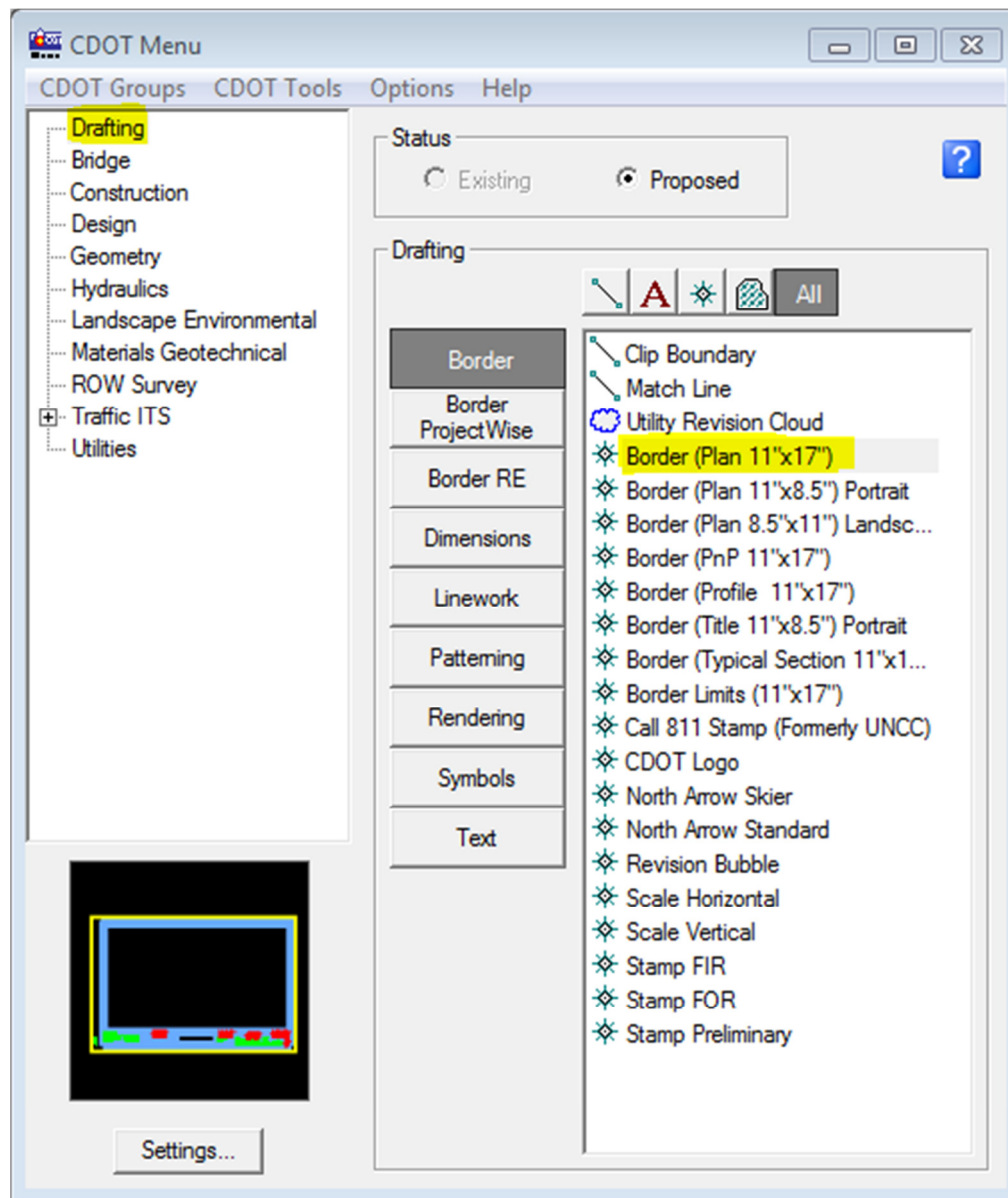


Fig. B.3-1 Border Selection from Drafting Group

The ProjectWise border is available from the CDOT Menu, as shown below.

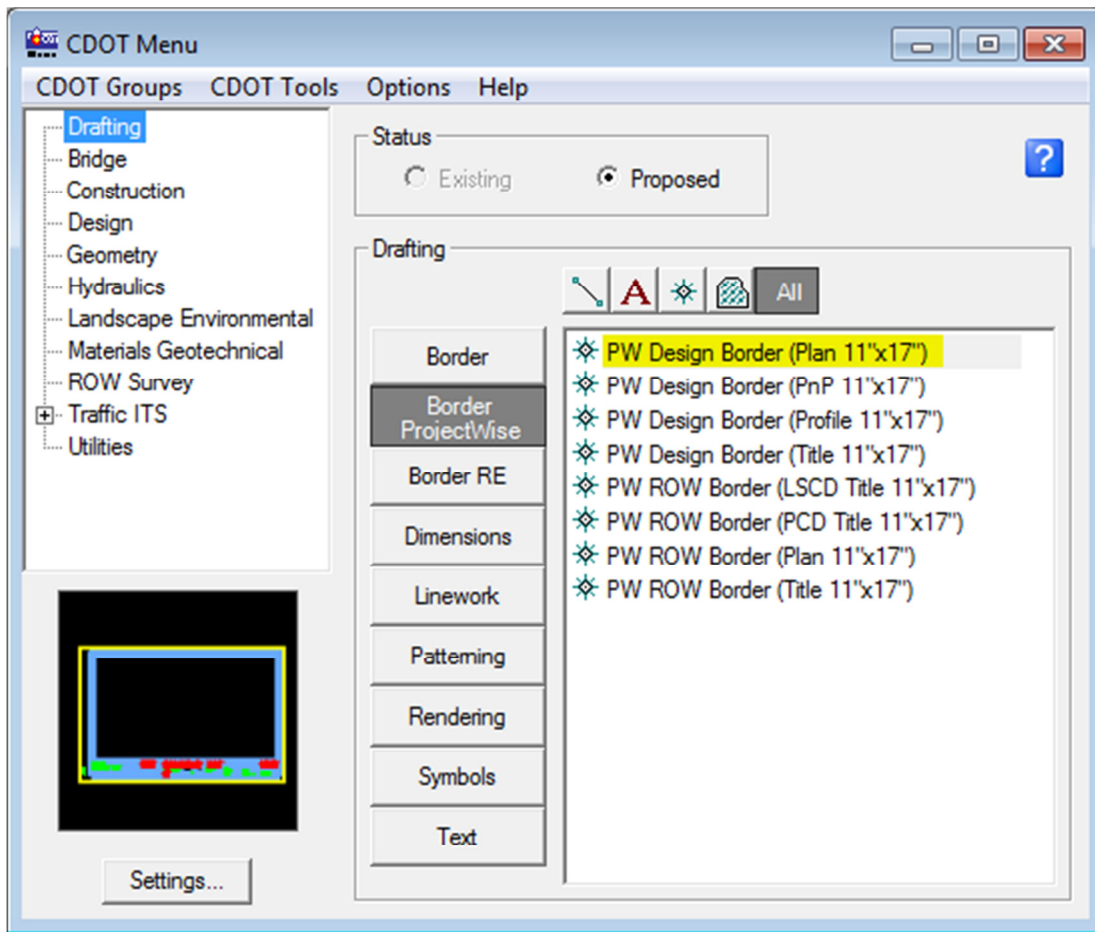


Fig. B.3-2 - ProjectWise Border

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.

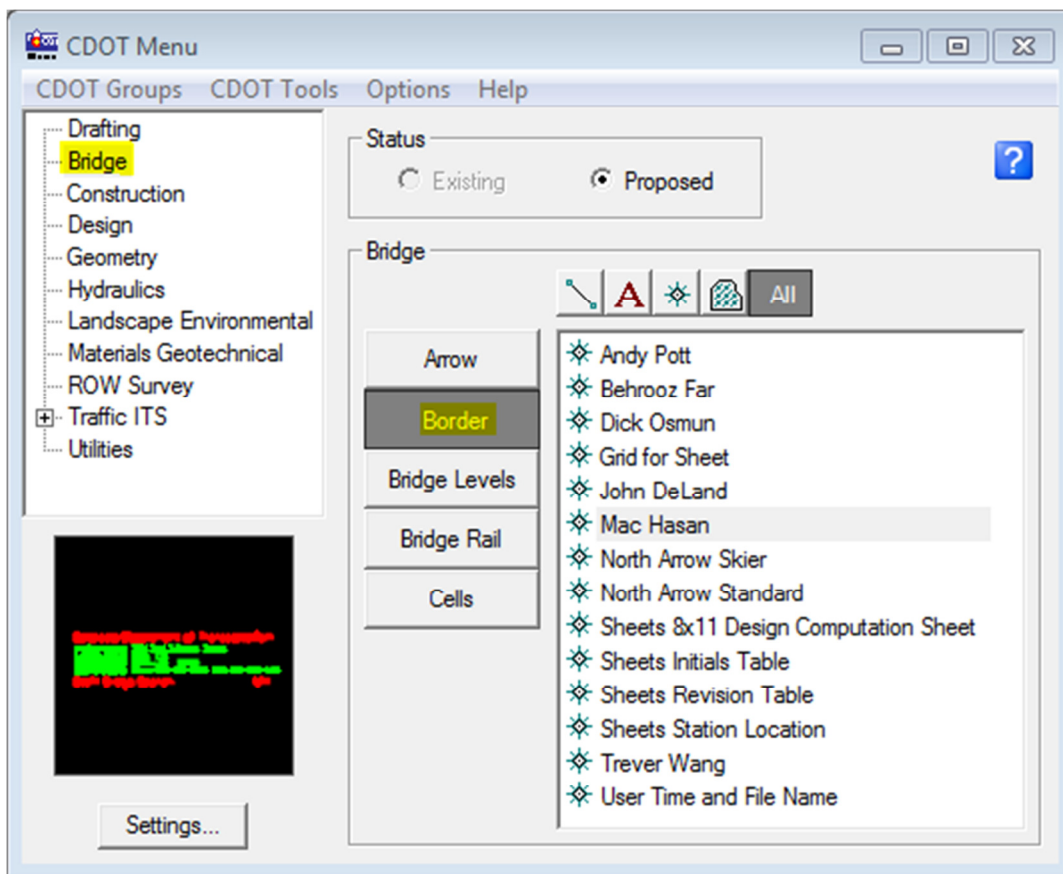


Fig. B.3-3 Border Selection from Bridge Group

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.

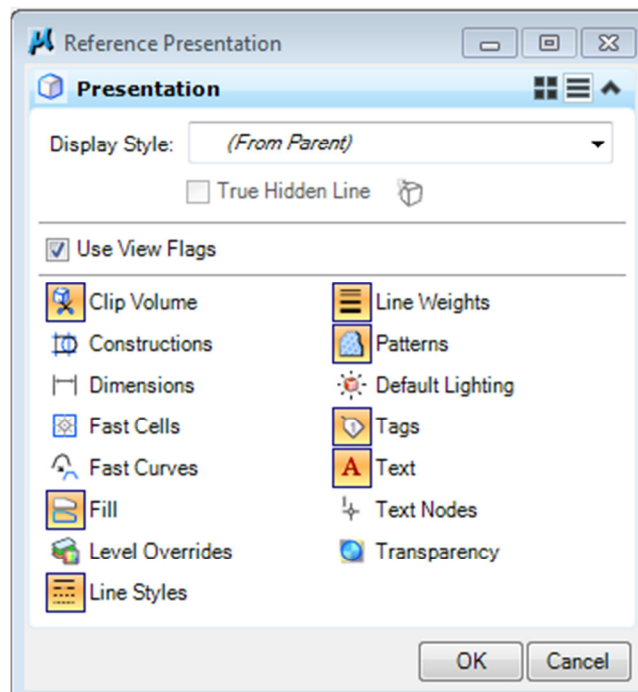


Fig. B.4-1 Reference Presentation Dialog Box














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.

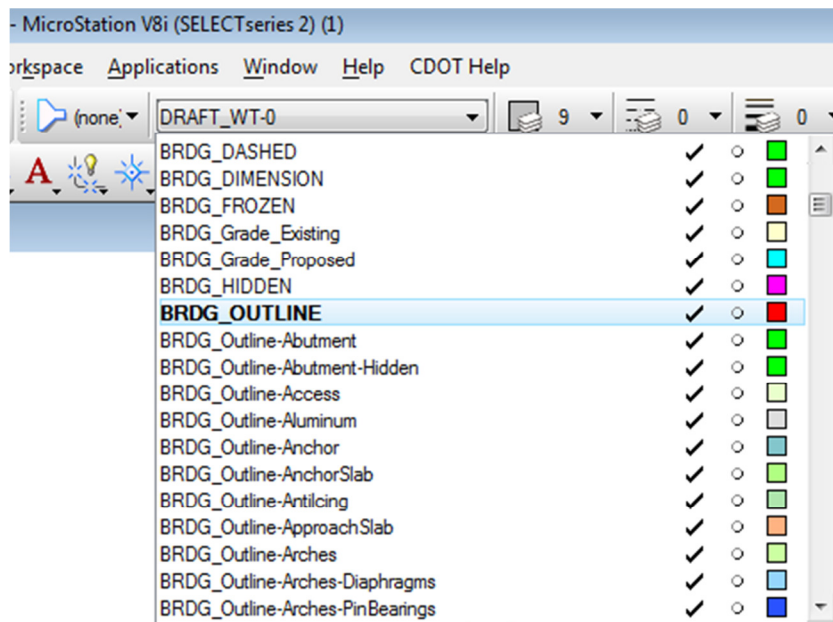


Fig. B.5-1 Active Level Selection

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)

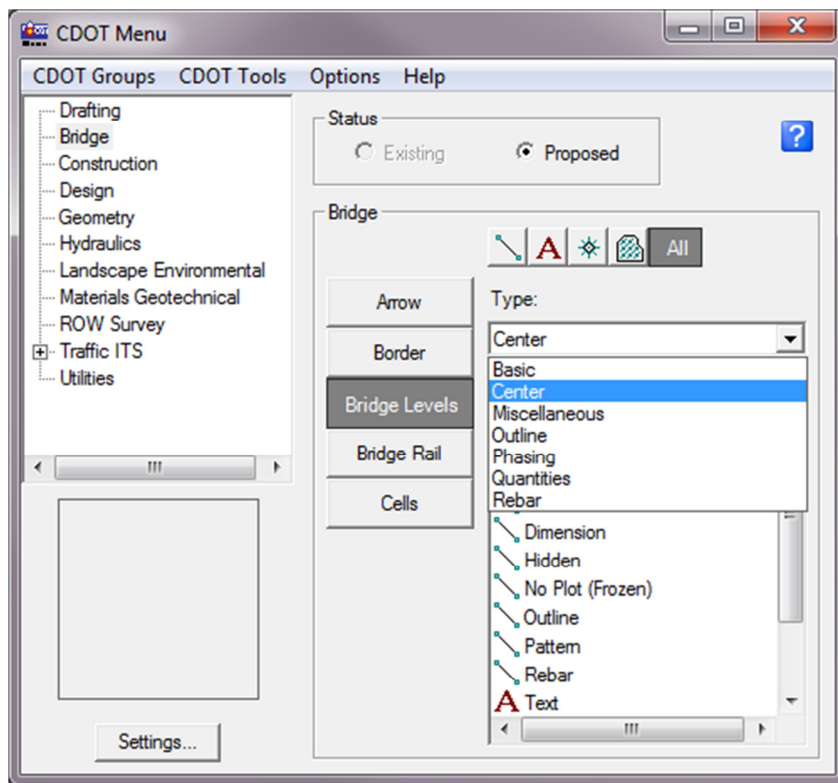


Fig. B.5-2- Bridge Level Selection from CDOT Menu

3. Double click on a level in the level display window. (Fig. B.5-3)

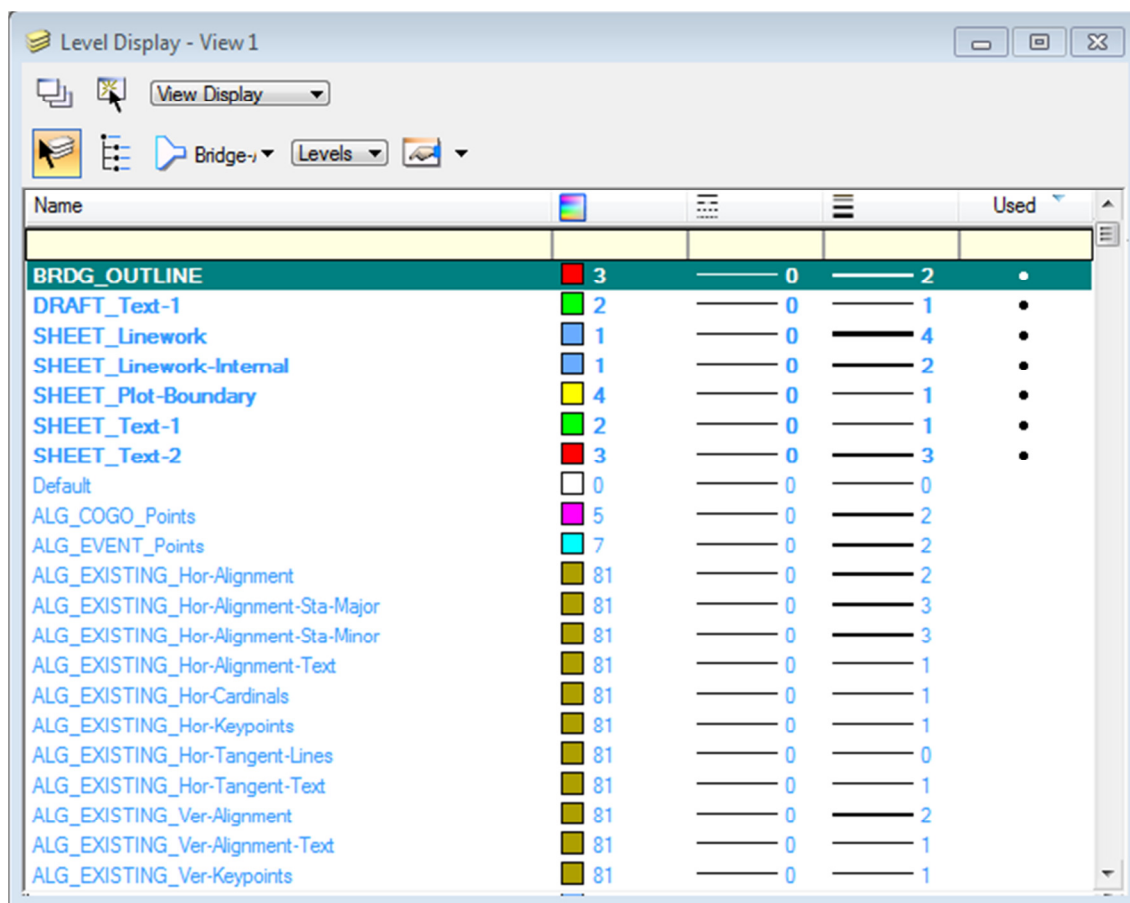


Fig. B.5-3 - Bridge Level Selection from the Level Display

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.

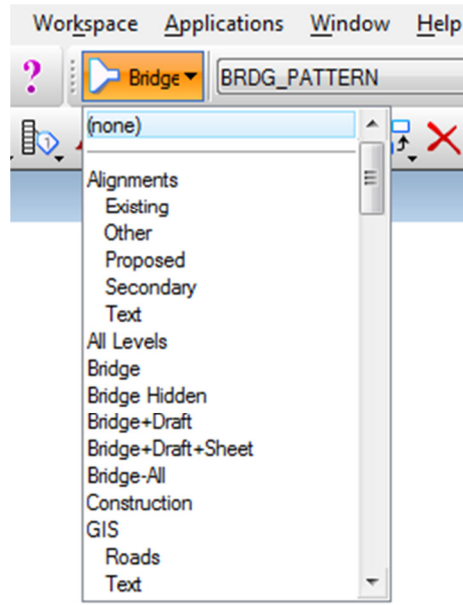


Fig. B.5-4 - Some of the CDOT Predefined filters

Level Display - View 1

View Display

*Untitled Levels

Name	Color	Count	0	3	Used
brdg			0	3	
BRDG_CONTOURS_Major	Orange	6	0	3	
BRDG_CONTROL	Red	3	0	3	
BRDG_Grade_Proposed	Cyan	7	0	3	
BRDG_Outline-FRP	Yellow	82	0	3	
BRDG_REBAR-4	Red	3	0	3	
BRDG_Rebar-Spiral	Purple	249	0	3	
BRDG_Rebar-Ties-Horizontal	Yellow	93	0	3	
BRDG_Rebar-Ties-Vertical	Pink	234	0	3	
BRDG_Rebar-WWF	Cyan	15	0	3	
BRDG_TITLE	Blue	1	0	3	

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.

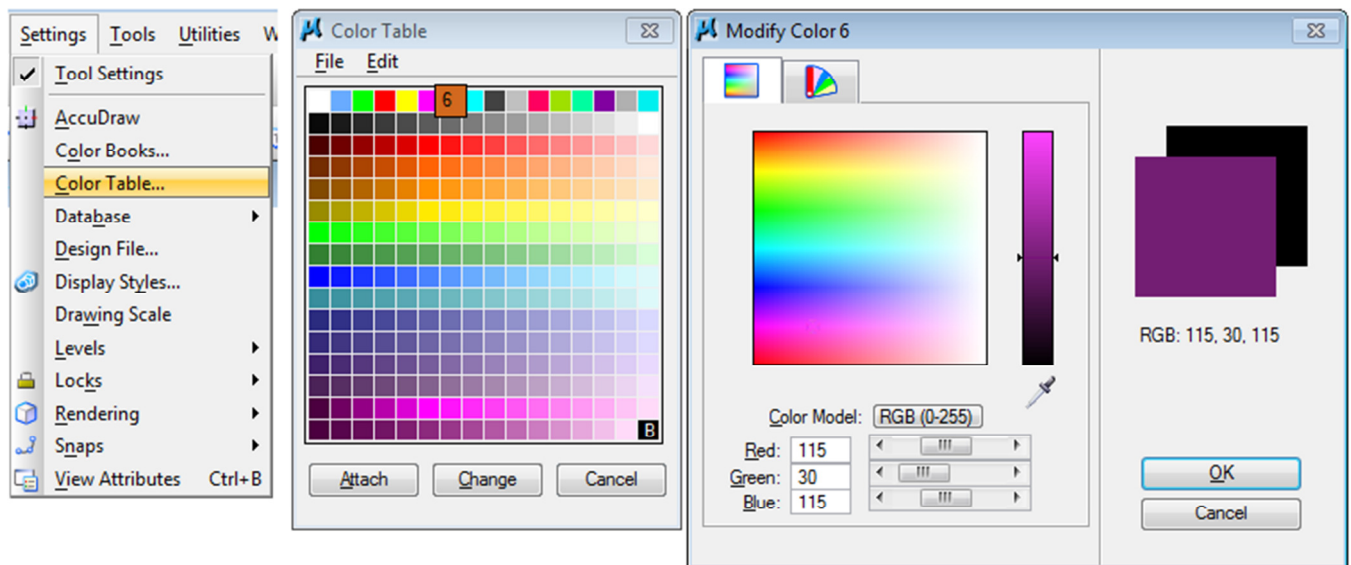


Fig. B.5-6 - Personalizing the Color Table

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.

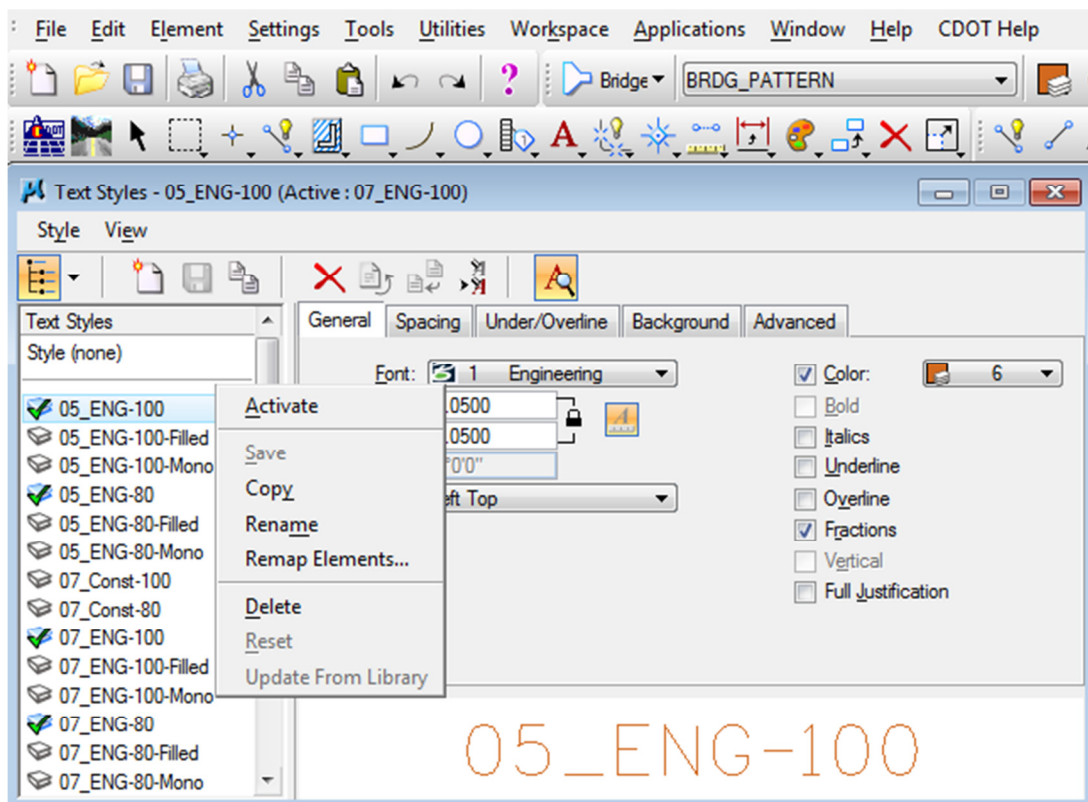


Fig. B.7-1 - Replacing old text styles

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.

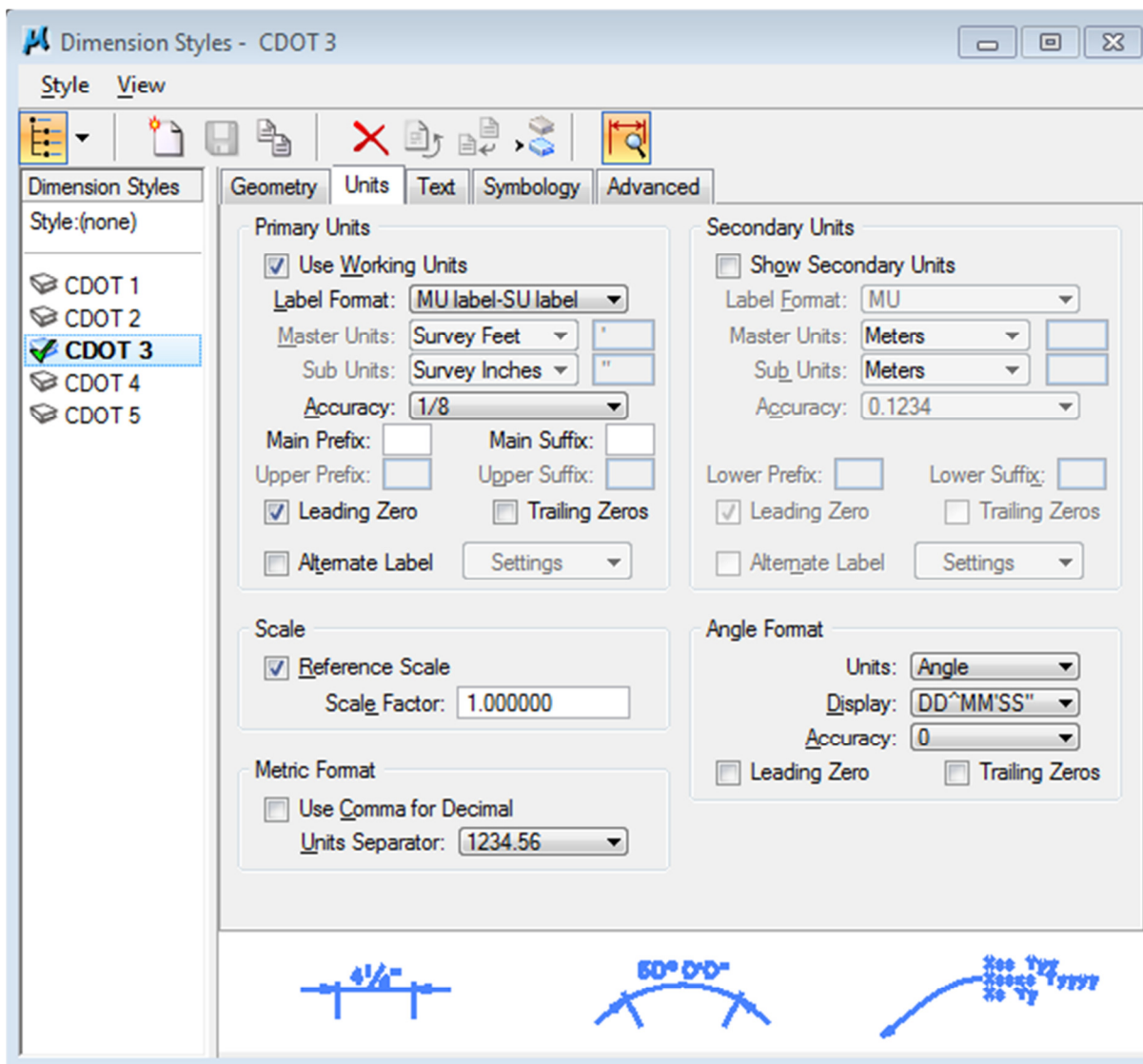


Fig. B.8-1 Dimension Style Dialog Box - Units

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.

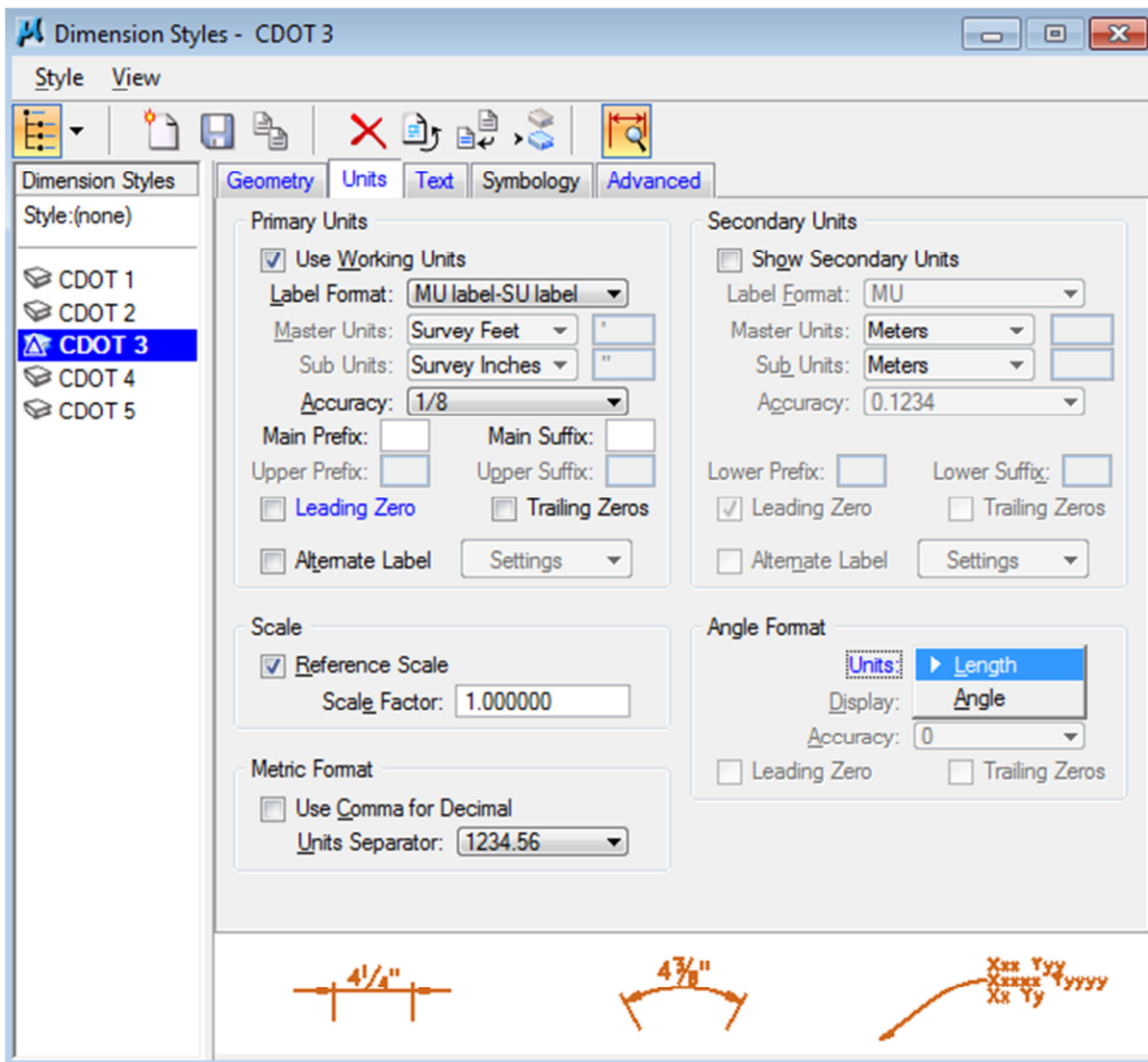


Fig. B.8-2 Dimension Style Dialog Box - Changing Angle Format

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 ← Place Note (see Fig. B.8-3).

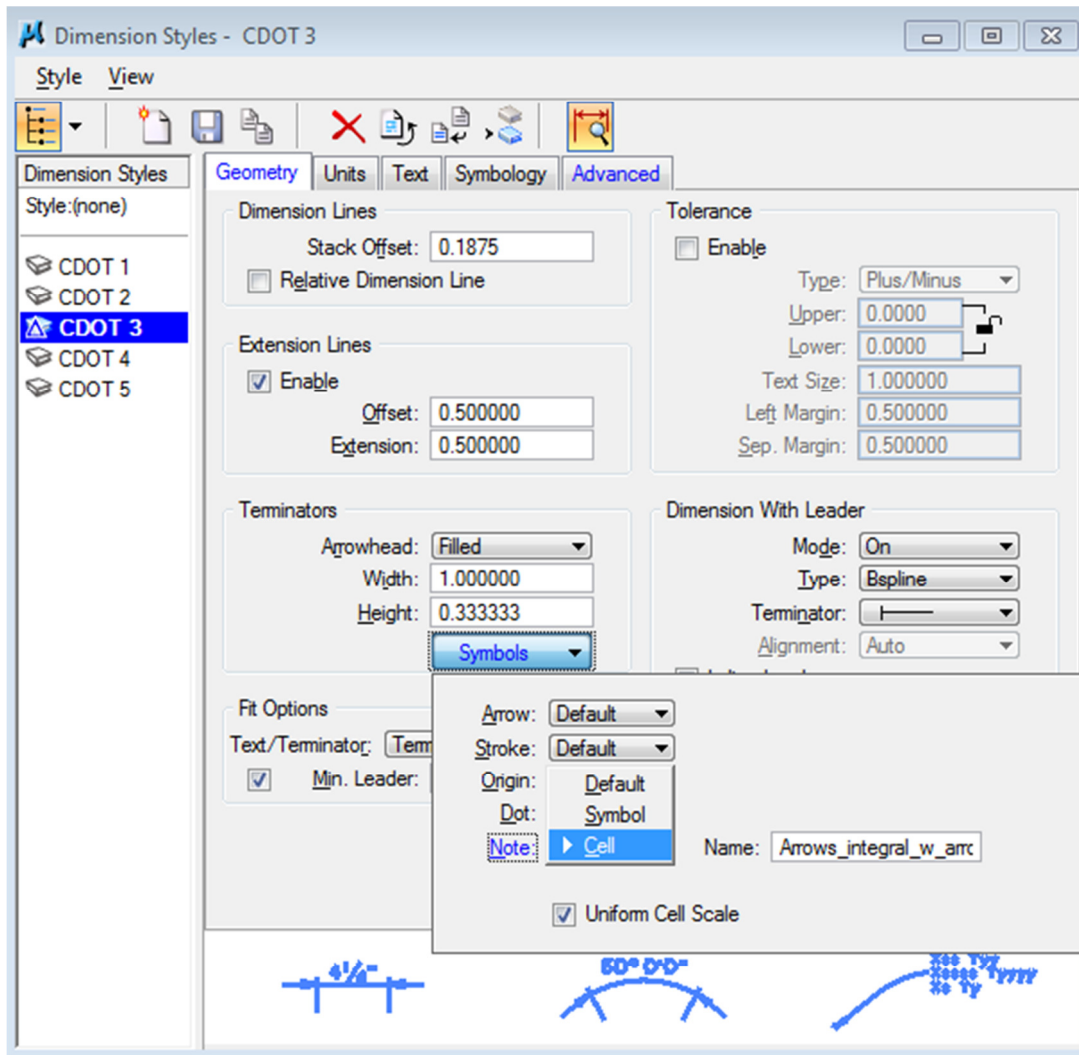


Fig. B.8-3 Dimension Style Dialog Box - Geometry

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.

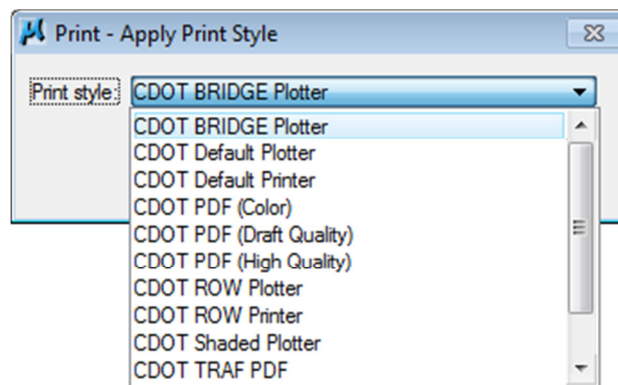
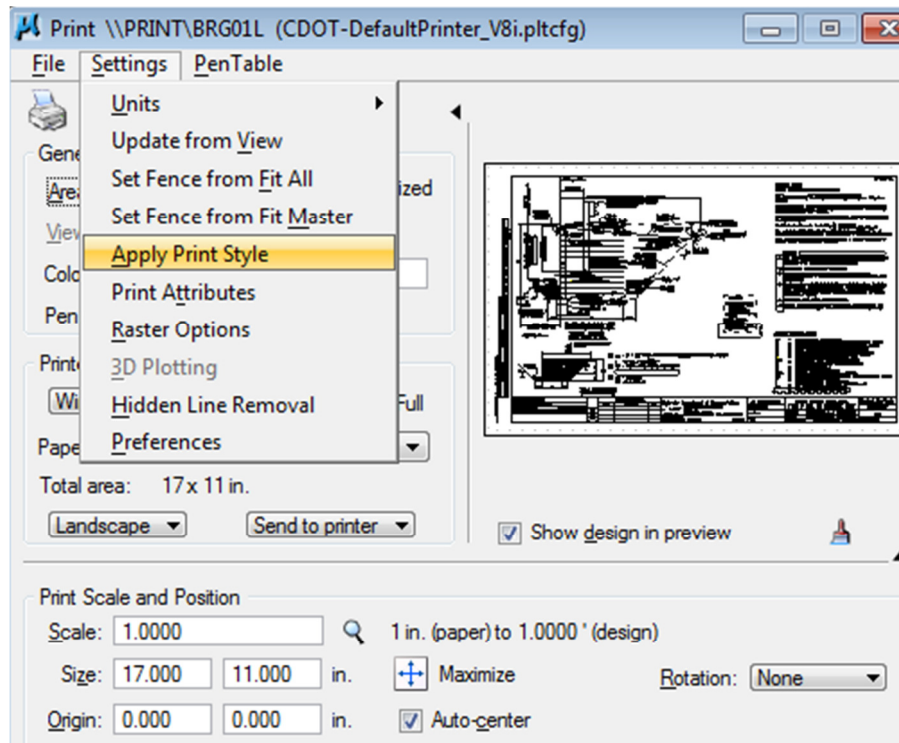


Fig. B.9-1 Print Style Selection

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)

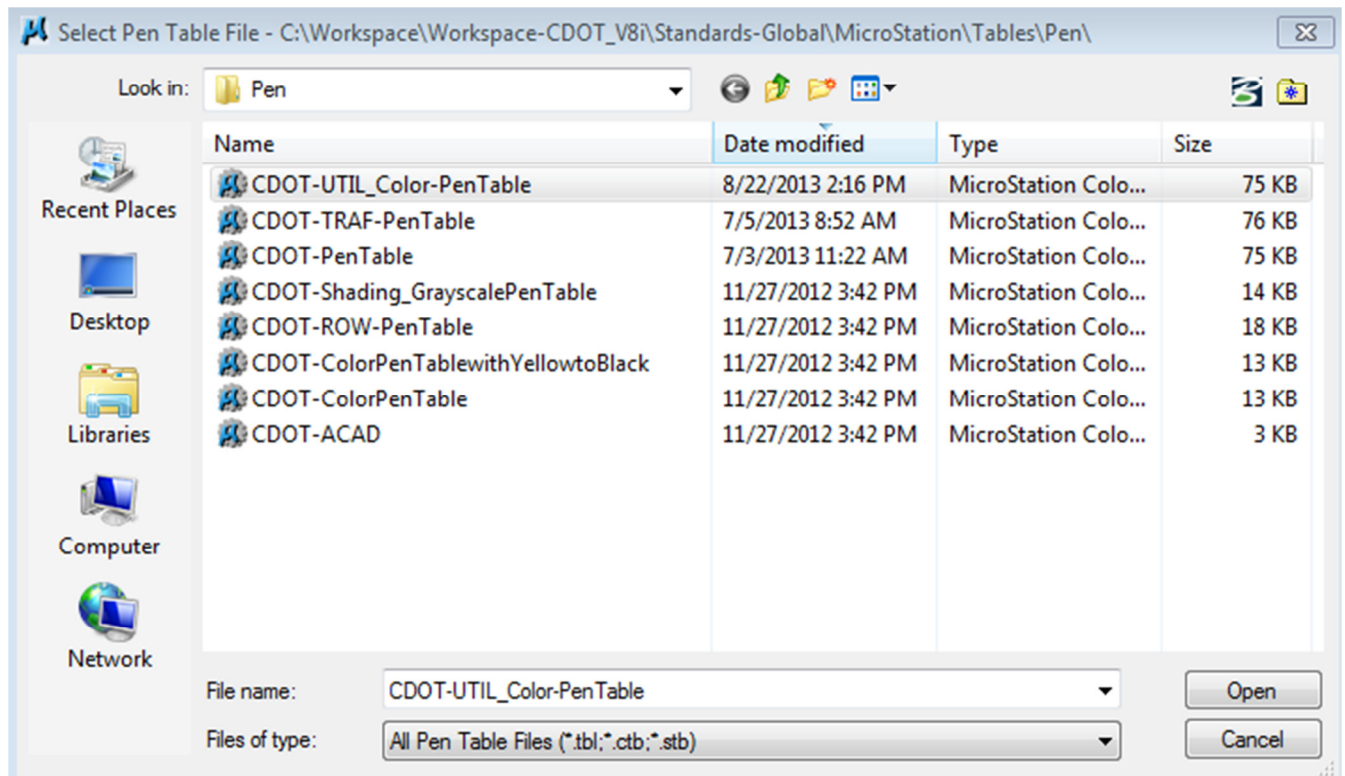


Fig. B.9-2 Pen Table Selection

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:
 - o select the "Place SmartLine" tool,
 - o data on the beginning point,
 - o type p,
 - o type "0,0,0" (zero, zero, zero, including commas), click enter,
 - o 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.

COLORADO DEPARTMENT OF TRANSPORTATION STAFF BRIDGE BRIDGE DETAIL MANUAL	Chapter: Appendix C Effective: July 29, 2011 Supersedes: NEW
APPENDIX C - AutoCAD	

C(1) 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 $_D = 28^{\circ}13'$, 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	€		_	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	∅		_	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	PC	TC	EXAMPLE	PC	TC	EXAMPLE
		DIAMONDS			LESS/GREATER THAN DEGREE SYMBOL			CIRCLED CHARACTERS
~	a	◇ footnote	~	L	$L \leq 1.5'$	~	1	Ⓝ note
~	A	◆ footnote	~	G	$5 \geq 4.99$	~	2	Ⓣ note
		INVERTED TRIANGLES	~	o	14°37'24"	~	3	Ⓧ note
~	t	▽ footnote			CENTERLINES			TILDE DOUBLE TILDE
~	T	▼ footnote	~	E	£ Pier2	~	~	~ Note
		CIRCLE LORRAINE CROSS	~	C	£ Pier2	~	y	.5 ≈ .51
~	.	⊙ footnote			RADICAL SQUARES			GAMMA INFINITY / SHIFTED INF.
~	p	‡ footnote	~	V	$\sqrt{2X+4}$	~	g	γ
		STARS	~	s	□ footnote	~	i	∞ footnote
			~	S	■ footnote	~	l	∞ footnote
~	F	★ footnote						
~	f	☆ footnote						

Fig. C-2 Special Characters

FRACTIONS

LONG FORMS	SAMPLE INPUT							RESULTS	EXAMPLE	DESCRIPTION				
	^	0	3		-	1	6	^	1	$\frac{3}{16}$	12'-3 $\frac{5}{16}$ "	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 $\frac{2}{0}$	f' _c = 3,000 psi	SUPER-SUBscript
	^	c	P	^	c	L					ℓ	ℓ El. 8745.3'	Combine 2 letters	
	^	c	P	^	L						ℓ	ℓ 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

EIGHTHS

SHORT FORMS	SLASH			MID-LINE			BASE-LINE		
	PC	TC	EXAMPLE	PC	TC	EXAMPLE	PC	TC	EXAMPLE
		A	123 $\frac{1}{8}$		I	123 $\frac{1}{8}$		Q	123 $\frac{1}{8}$
		B	123 $\frac{1}{4}$		J	123 $\frac{1}{4}$		R	123 $\frac{1}{4}$
		C	123 $\frac{3}{8}$		K	123 $\frac{3}{8}$		S	123 $\frac{3}{8}$
		D	123 $\frac{1}{2}$		L	123 $\frac{1}{2}$		T	123 $\frac{1}{2}$
		E	123 $\frac{5}{8}$		M	123 $\frac{5}{8}$		U	123 $\frac{5}{8}$
		F	123 $\frac{3}{4}$		N	123 $\frac{3}{4}$		V	123 $\frac{3}{4}$
		G	123 $\frac{7}{8}$		O	123 $\frac{7}{8}$		W	123 $\frac{7}{8}$
	THIRTY SECONDS								
	H	123 $\frac{3}{32}$		P	123 $\frac{3}{32}$		X	123 $\frac{3}{32}$	
SIXTEENTHS									
PC	TC	EXAMPLE	PC	TC	EXAMPLE	PC	TC	EXAMPLE	
	a	123 $\frac{1}{16}$		i	123 $\frac{1}{16}$		q	123 $\frac{1}{16}$	
	b	123 $\frac{3}{16}$		j	123 $\frac{3}{16}$		r	123 $\frac{3}{16}$	
	c	123 $\frac{5}{16}$		k	123 $\frac{5}{16}$		s	123 $\frac{5}{16}$	
	d	123 $\frac{7}{16}$		l	123 $\frac{7}{16}$		t	123 $\frac{7}{16}$	
	e	123 $\frac{9}{16}$		m	123 $\frac{9}{16}$		u	123 $\frac{9}{16}$	
	f	123 $\frac{11}{16}$		n	123 $\frac{11}{16}$		v	123 $\frac{11}{16}$	
	g	123 $\frac{13}{16}$		o	123 $\frac{13}{16}$		w	123 $\frac{13}{16}$	
	h	123 $\frac{15}{16}$		p	123 $\frac{15}{16}$		x	123 $\frac{15}{16}$	
	.	0.020 $\frac{1}{4}$	Ft. / ft. symbol						

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