

CHAPTER 5 BURIED STRUCTURES

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5.2 Structural Plate Pipe and Pipe Arch

5.2.1 Introduction

These are corrugated metal structures of either steel or aluminum that are used for short-span crossings. Pipes and Pipe arches are the least expensive and most commonly used buried structures.

5.2.2 Prerequisites

You will need the following:

- 1) Final Horizontal and Vertical Alignments
- 2) Skew of structure to CL Construction
- 3) Station where CL of Structure crosses CL Construction
- 4) Final Roadway Design (travel way and shoulder width, superelevation, side slopes, etc.)
- 5) Structure size (rise and span)
- 6) Inlet and Outlet elevations
- 7) End Cut of Structure
- 8) Bedding material type and depth, geotextile usage
- 9) Toe wall geometry
- 10) Riprap blanket size, type and location
- 11) Theoretical streambed elevation
- 12) Notes

5.2.3 Detailing

Structural Plate Pipes and Pipe Arches require a combination of explicit and performance-based detailing. Earthwork and concrete toe walls are detailed explicitly, while the structure itself is drawn diagrammatically. The Fabricator of the structure and the Contractor need to be considered equally when detailing.

5.2.4 Typical Sheet Names and Contents

5.2.4.1 Pipe/Pipe Arch

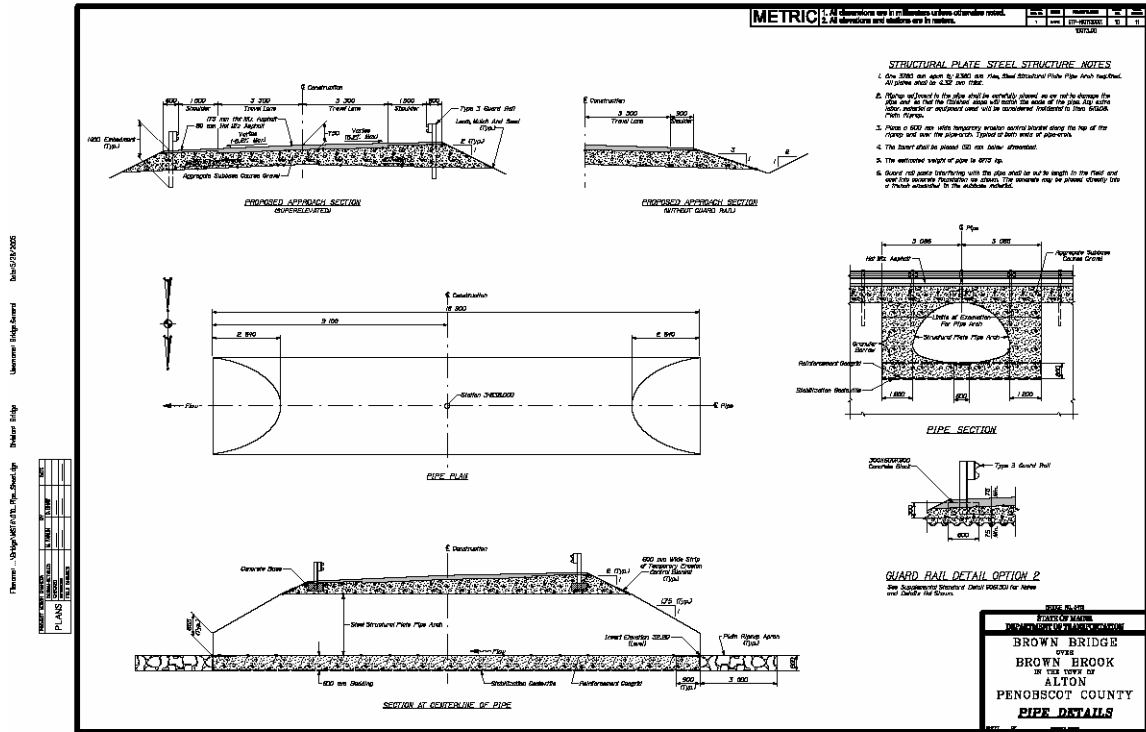


Figure 5-1 Pipe/Pipe Arch Sheet

Will Contain:

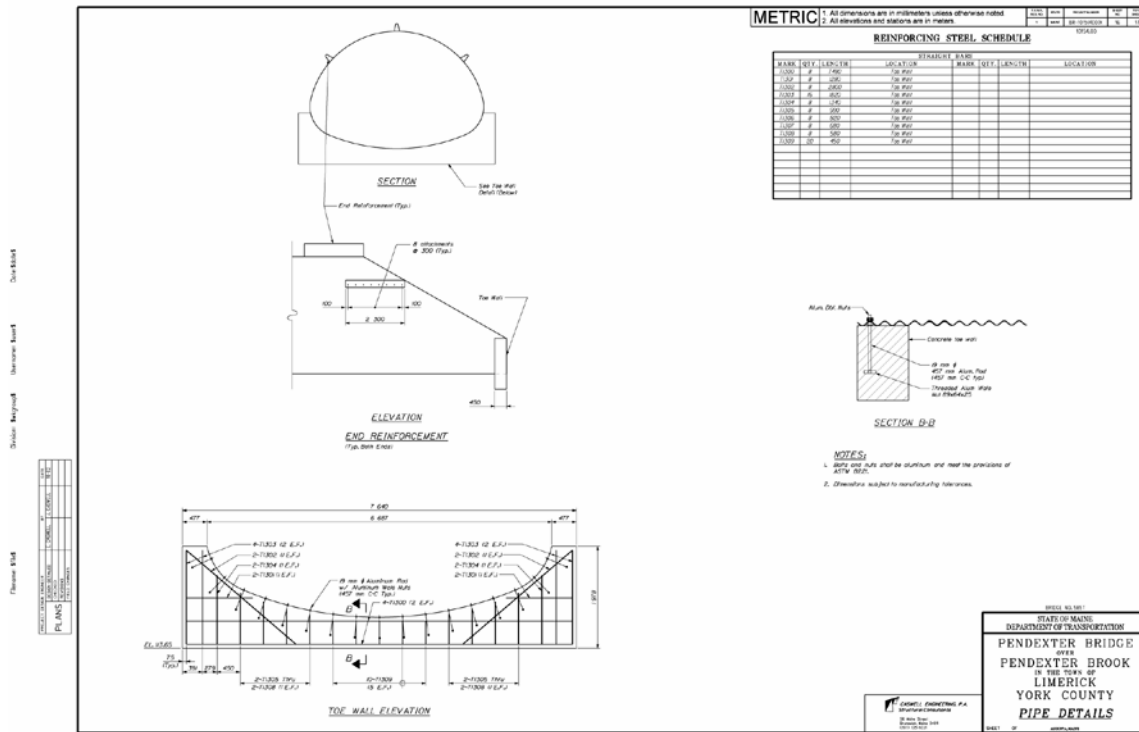
- 1) Pipe Plan
- 2) Typical Pipe Section (Longitudinal)

May Contain:

- 1) Notes
- 2) Other Sections or Details

5.2.4.2 Pipe/Pipe Arch Details

Figure 5-2 Pipe/Pipe Arch Details Sheet



Will Contain:

- 1) Additional Details

May Contain:

- 1) Reinforcing Steel Schedule
- 2) Notes

5.2.5 Standard Notes

5.2.5.1 Structural Plate Structure Notes

- 1) One XX inch diameter Structural Plate Pipe is required. Top plates shall be XX inches thick; bottom (three) plates(s) shall be XX inches thick. The pipe shall be elongated 5% vertically.
- 2) One XX'-XX" span by XX'-XX" rise Structural Plate Pipe Arch required. Top plates shall be XX inches thick; bottom and corner plates shall be XX inches thick.
- 3) Ends shall be cut on a 1:1.75 bevel normal to the end skew shown on the details.

- 4) Riprap adjacent to the pipe shall be carefully placed so as not to damage the pipe (pipe arch) and so that the finished slope will match the ends of the pipe. Any extra labor, material, or equipment used will be considered incidental to Item 610.08, Plain Riprap.
- 5) Place a 2 foot wide temporary erosion control blanket along the top of the riprap and over the pipe (pipe-arch). Typical at both ends of pipe (pipe-arch).

(The following two notes are used for aluminum pipe or pipe arch.)

- 6) End reinforcement devices shall be of aluminum and shall be of sufficient strength to provide a minimum section modulus, about an axis perpendicular to the center of the pipe of 1.10 in 3 /ft of pipe circumference. Maximum spacing of the devices shall be 5'-5". Attachment to the pipe shall be with 3/4" galvanized steel bolts. Section properties and details of the device and the method of attachment shall be submitted to the Resident for approval.
- 7) Payment for end reinforcement devices will be considered incidental to Item 509.XX, Aluminum Alloy Structural Plate (Pipe) Arch.

5.2.6 Checklists

5.2.6.1 Structural Plate Pipe or Pipe Arch Plan

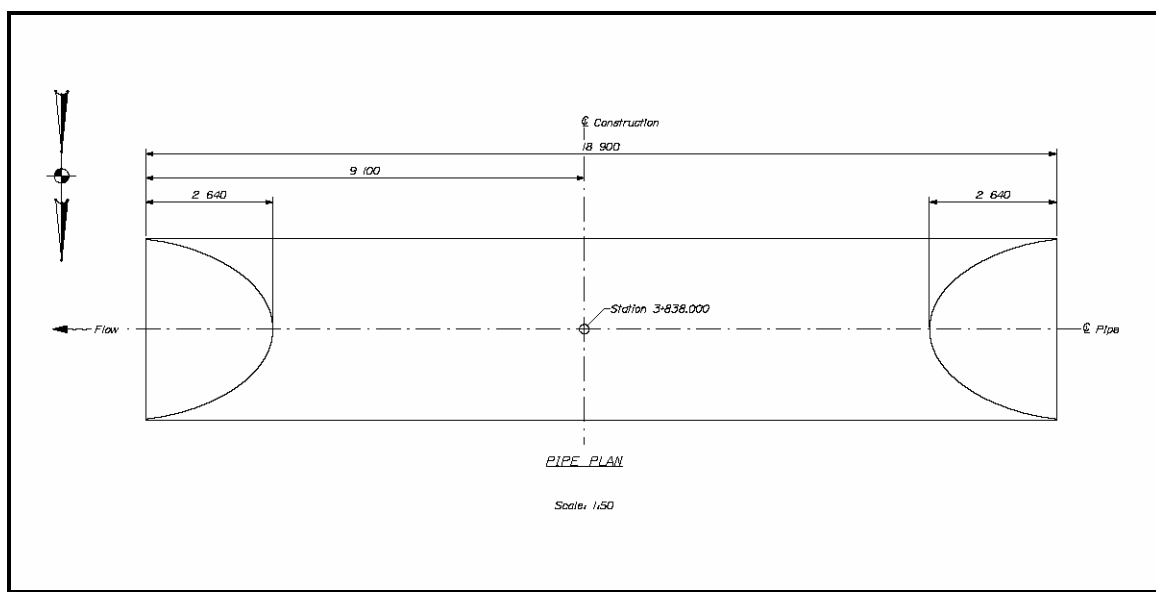


Figure 5-3 Structural Plate Pipe Plan

Intro: Top view of structure, showing the relationship to the working lines.

Sheet up: Belongs in the upper left of the pipe/pipe arch sheet, directly above the longitudinal section, with the centerlines aligned.

Scale: 1/4". (Check sheet up before proceeding. If plan and longitudinal section won't fit above and below at 1/4", try 3/16" scale.)

Draw:

- 1) Limits of structure (pipe or pipe arch)

- 2) Centerline of Construction/Working Line
- 3) Centerline of Structure
- 4) Beveled end cut
- 5) Construction joint, if required for stage construction
- 6) Toe wall, if required

Dimension:

- 1) Limits of structure:
 - a) The bottom centerline length from the working point to the upstream and downstream ends.
 - b) The top centerline length and end cut length for mitered to slope structures.
 - c) Width of structure.
- 2) Skew angle between CL Structure and line normal to CL Construction/Working Line.
- 3) Skew angle between end of barrel and line normal to CL Structure, if required.
- 4) Construction joint

Label:

- 1) Detail Name
- 2) CL Construction/Working Line
- 3) CL Structure
- 4) North Arrow
- 5) Flow Arrow
- 6) Bevel end cut slope, if end cut is skewed
- 7) Station at intersection of CL Construction/Working Line and CL Structure
- 8) Construction joint

5.2.6.2 Structural Plate Pipe or Pipe Arch Transverse Section

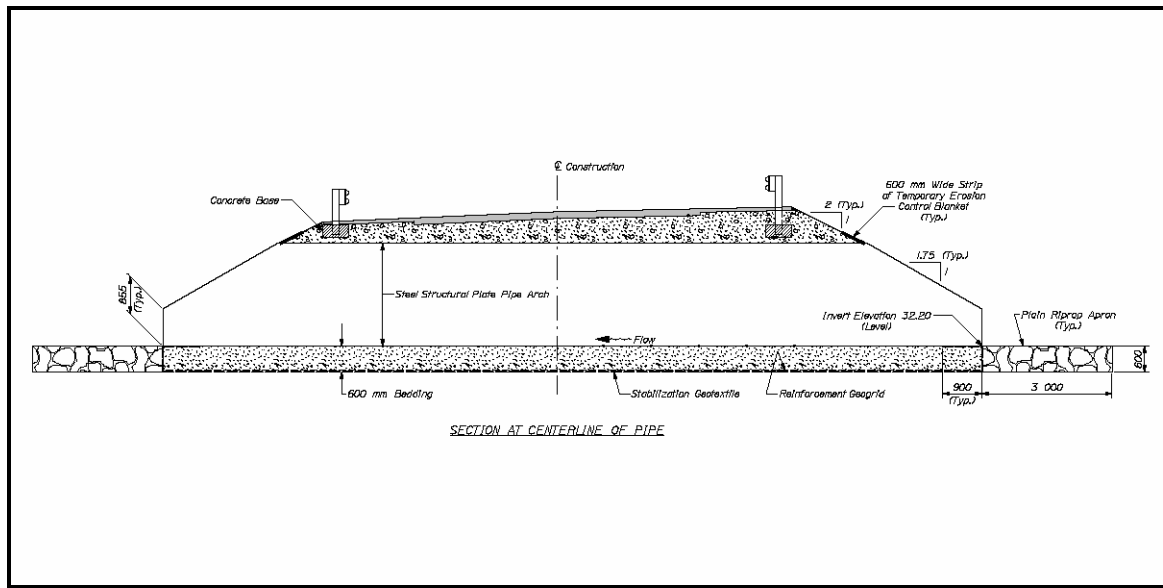


Figure 5-4 Structural Plate Pipe Transverse Section

Intro: Section cut along the CL of Structure, showing the invert elevations and end cut configurations. View is normal to CL of Structure.

Sheet up: Belongs on the Pipe/Pipe Arch Sheet directly below the Plan, with the centerlines aligned.

Scale: Same size as the plan, typically 1/4 ".

Draw:

- 1) Limits of structure
- 2) Centerline of Construction/Working Line
- 3) Roadway, guardrail and side slopes.
- 4) Concrete base for guardrail anchorage, if required.
- 5) Granular borrow cover over structure
- 6) Bedding material
- 7) Riprap blanket
- 8) Riprap side slopes, if required
- 9) Existing ground
- 10) Construction joint, if required for stage construction
- 11) Toe walls, if required
- 12) Concrete collar, if required

Dimension:

- 1) Bottom step cut
- 2) Width of riprap blanket
- 3) Roadway widths can be shown here if there is no typical roadway section, and the pipe is not skewed.

Label:

- 1) Detail Name
- 2) Invert elevations
- 3) End bevel slopes.
- 4) Roadway side slopes, if different from end bevel.
- 5) Guardrail in concrete base
- 6) Bedding material
- 7) Granular borrow cover
- 8) Riprap blanket

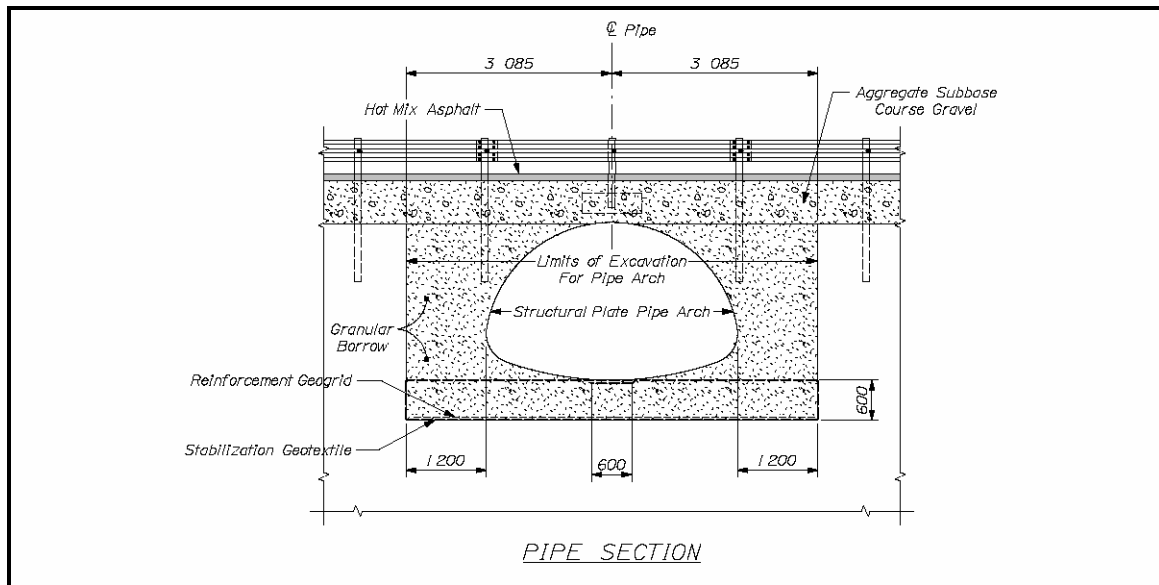


Figure 5-5 Structural Plate Pipe Arch Typical Section

5.2.6.3 Structural Plate Pipe or Pipe Arch Typical Section

Intro: Cross section through pipe or pipe arch showing limits of granular borrow and bedding requirements.

Sheet up: Belongs on Pipe/Pipe Arch Sheet, to the right of the longitudinal section

Scale: Same size as the plan, typically 1/4 " or larger if there is room.

Draw:

- 1) Limits of pipe or pipe arch
- 2) Limits of granular borrow and bedding materials

Dimension:

- 1) Limits of granular borrow and bedding materials

Label:

- 1) Detail Name
- 2) Granular borrow and bedding materials
- 3) Granular borrow and structural earth excavation limits

5.2.6.4 Structural Plate Pipe or Pipe Arch End Reinforcing

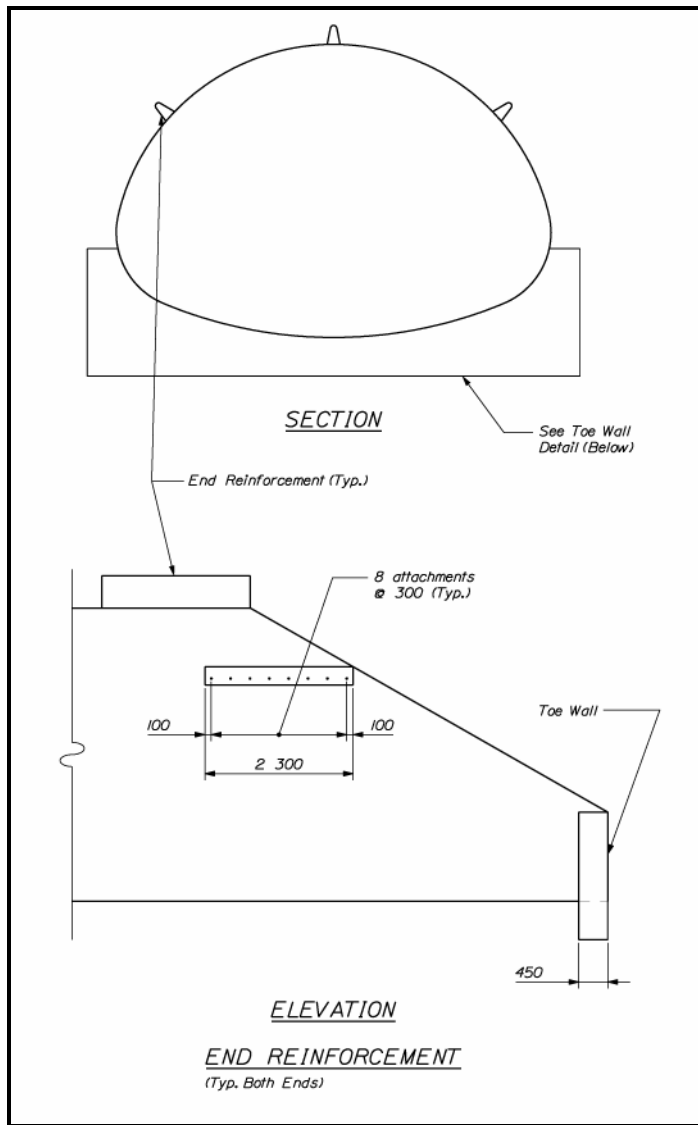


Figure 5-6 Structural Plate Pipe Arch End Reinforcing

Intro: Section and elevation of end reinforcement for aluminum structures, if required.

Sheet up: Belongs on Pipe/Pipe Arch Details sheet.

Scale: Same size as the plan, typically 1/4" or larger if there is room.

Draw:

- 1) Section View – cross-section of pipe or pipe arch and end reinforcement. Toe wall, if required.
- 2) Elevation View – end elevation of pip or pipe arch and end reinforcement. Toe wall, if required.

Dimension:

- 1) Elevation View – length of end reinforcement and spacing of connectors

Label:

- 1) Detail Name
- 2) End reinforcement
- 3) Toe wall

5.2.6.5 Structural Plate Pipe or Pipe Arch Toe Wall Elevation

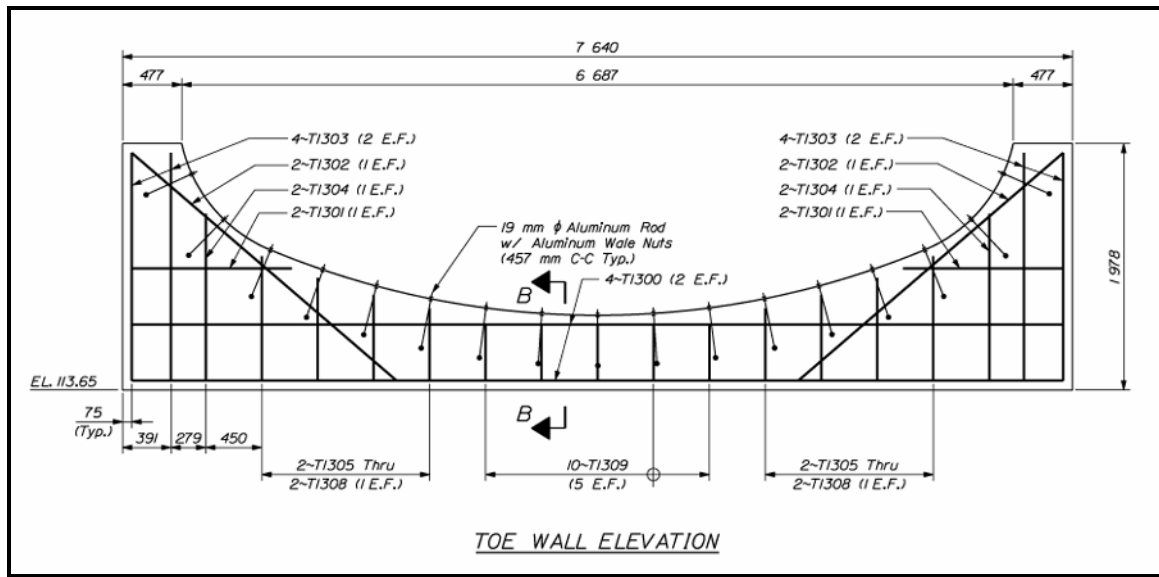


Figure 5-7 Structural Plate Pipe Toe Wall Elevation

Intro: Elevation of reinforced concrete toe wall for aluminum structures, if required.

Sheet up: Belongs on the Pipe/Pipe Arch Details Sheet.

Scale: 1/2" but could be larger or smaller depending on the size of the pipe or pipe arch

Draw:

- 1) Limits of concrete
- 2) CL Structure
- 3) Reinforcing steel
- 4) Aluminum anchor bolts

Dimension:

- 1) Limits of concrete toe wall
- 2) Reinforcing steel location

Label:

- 1) Detail Name

- 2) Section/Detail Cuts
- 3) Reinforcing bars
- 4) Toe wall elevation

5.2.6.6 Structural Plate Pipe or Pipe Arch Toe Wall Section

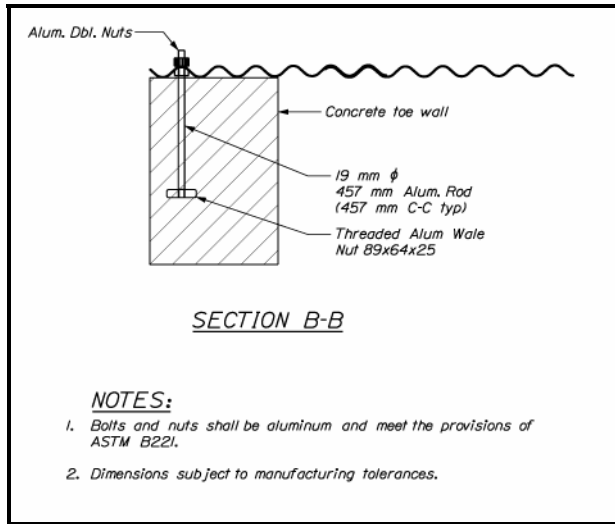


Figure 5-8 Structural Plate Pipe Toe Wall Section

Intro: Cross section through concrete toe wall for aluminum structures, if required.

Sheet up: Belongs on the Pipe/Pipe Arch Details Sheet.

Scale: 1"

Draw:

- 1) Limits of concrete toe wall (hatch concrete)
- 2) Corrugated bottom of pipe or pipe arch
- 3) Anchor bolts

Label:

- 1) Concrete toe wall
- 2) Aluminum anchor bolts and nuts

5.2.6.7 Structural Plate Pipe or Pipe Arch Toe Wall Reinforcing Steel Schedule

REINFORCING STEEL SCHEDULE							
STRAIGHT BARS							
MARK	QTY.	LENGTH	LOCATION	MARK	QTY.	LENGTH	LOCATION
T1300	8	7480	Toe Wall				
T1301	8	1280	Toe Wall				
T1302	8	2800	Toe Wall				
T1303	16	1820	Toe Wall				
T1304	8	1340	Toe Wall				
T1305	8	990	Toe Wall				
T1306	8	820	Toe Wall				
T1307	8	680	Toe Wall				
T1308	8	580	Toe Wall				
T1309	20	450	Toe Wall				

Figure 5-9 Structural Plate Pipe Reinforcing Steel Schedule

Intro: The reinforcing schedule for concrete toe wall.

Sheet up: Belongs in the upper right of the Pipe/Pipe Arch Details Sheet.

Scale: Not to scale, try 1/4". Feel free to draw bars out of scale to help fit them in the schedule.

5.3 Structural Plate Box Culvert

5.3.1 Introduction

These are corrugated metal structures of either steel or aluminum that are used for short-span crossings. Box culverts are used instead of plate pipes and pipe arches when headroom constraints require them.

5.3.2 Prerequisites

You will need the following:

- 1) Final Horizontal and Vertical Alignments
- 2) Skew of structure to CL Construction
- 3) Station where CL of Structure crosses CL Construction
- 4) Final Roadway Design (travel way and shoulder width, superelevation, side slopes, etc.)
- 5) Structure size (rise and span)
- 6) Inlet and Outlet elevations
- 7) Headwall and wingwall geometry
- 8) Bedding material type and depth, geotextile usage
- 9) Toe wall geometry
- 10) Riprap blanket size, type and location
- 11) Theoretical streambed elevation
- 12) Notes

5.3.3 Detailing

Structural Plate Box Culverts require a combination of explicit and performance-based detailing. Earthwork and concrete toe walls are detailed explicitly, while the structure itself is drawn diagrammatically. The Fabricator of the structure and the Contractor need to be considered equally when detailing.

5.3.4 Typical Sheet Names and Contents

5.3.4.1 Steel Box Culvert

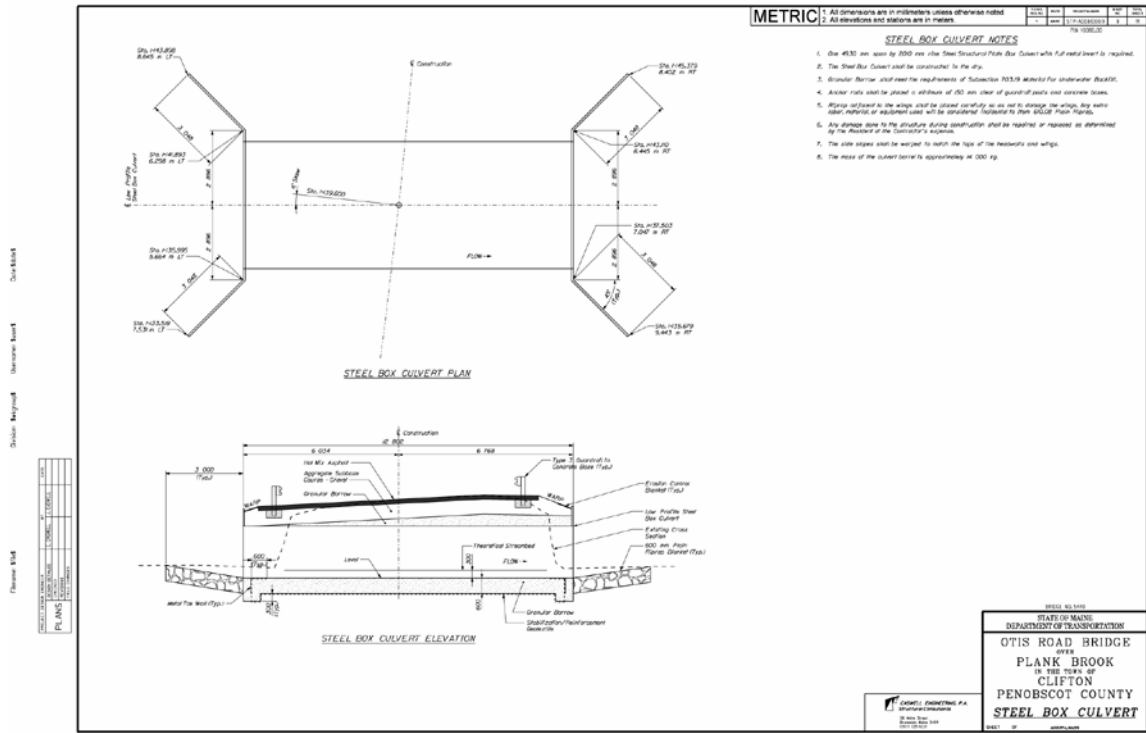


Figure 5-10 Steel Box Culvert Sheet

Will Contain:

- 1) Steel Box Culvert Plan
- 2) Steel Box Culvert Elevation
- 3) Steel Box Culvert Notes

May Contain:

- 1) Additional Details
- 2) Additional Notes

5.3.4.2 Steel Box Culvert Details

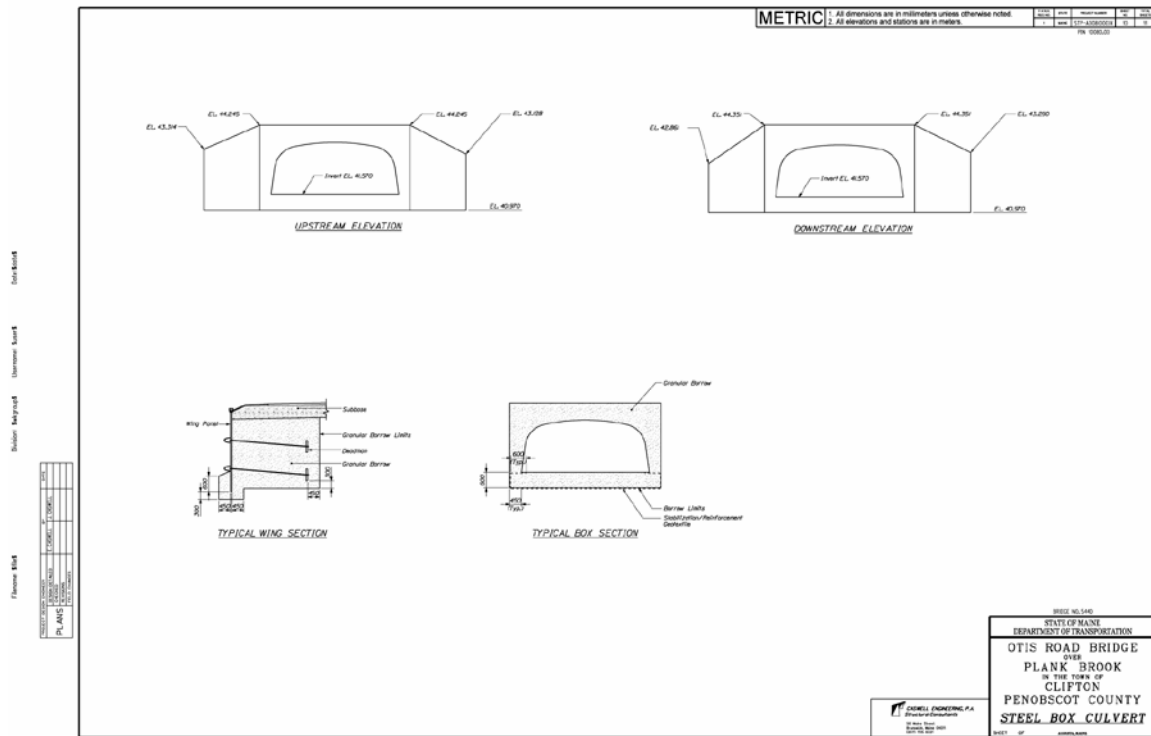


Figure 5-11 Steel Box Culvert Details Sheet

May Contain:

- 1) Upstream and Downstream Elevations
- 2) Typical Wall Section
- 3) Typical Box Culvert Section

5.3.5 Checklists

5.3.5.1 Structural Plate Box Culvert Plan

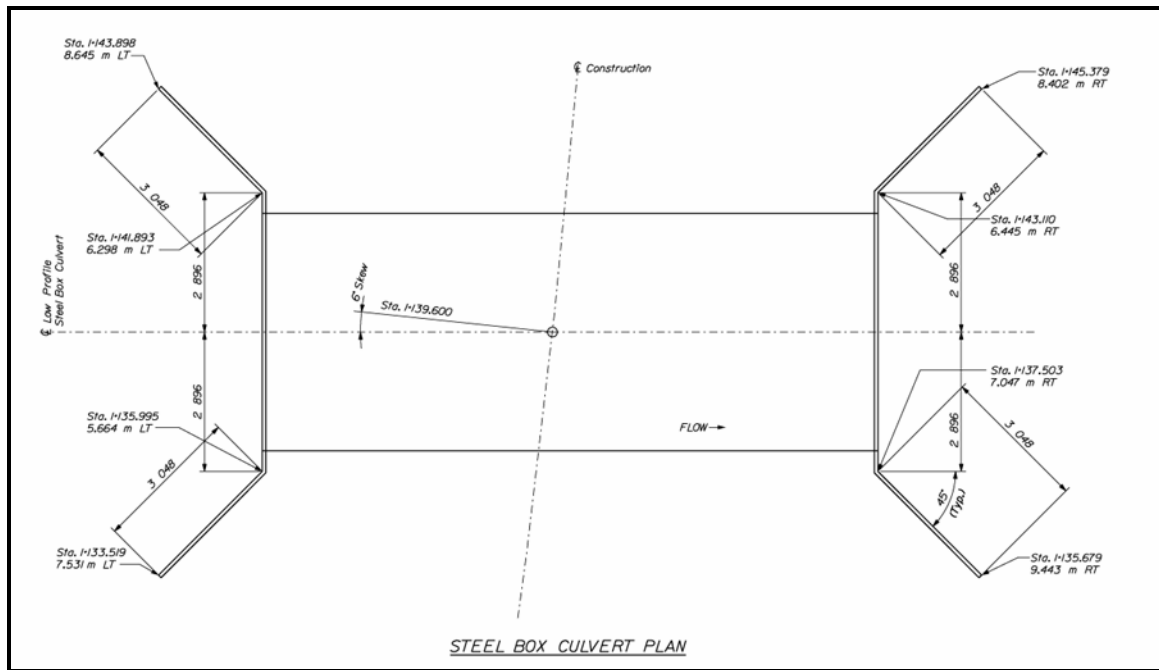


Figure 5-12 Structural Plate Box Culvert Plan

Intro: Top view of box culvert, showing the relationship to the working lines.

Sheet up: Belongs in the upper left of the box culvert sheet, directly above the longitudinal section, with the centerlines aligned.

Scale: 1/4". (Check sheet up before proceeding. If plan and longitudinal section won't fit above and below at 1/4", try 3/16" scale.)

Draw:

- 1) Limits of box culvert
- 2) Head walls
- 3) Wing walls
- 4) Centerline of Construction/Working Line
- 5) Centerline of Structure
- 6) Construction joint, if required for stage construction

Dimension:

- 1) Limits of box culvert, headwalls and wings.
- 2) Centerline length from the working point to the upstream and downstream ends.
- 3) Skew angle between CL Structure and line normal to CL Construction/Working Line.

- 4) Construction joints

Label:

- 1) Detail Name
- 2) CL Construction/Working Line
- 3) CL Structure
- 4) Station at intersection of CL Construction/Working Line and CL Structure
- 5) Station and offset at beginning and end of each wing wall.
- 6) North Arrow
- 7) Flow Arrow
- 8) Construction joint

5.3.5.2 Structural Plate Box Culvert Longitudinal Section

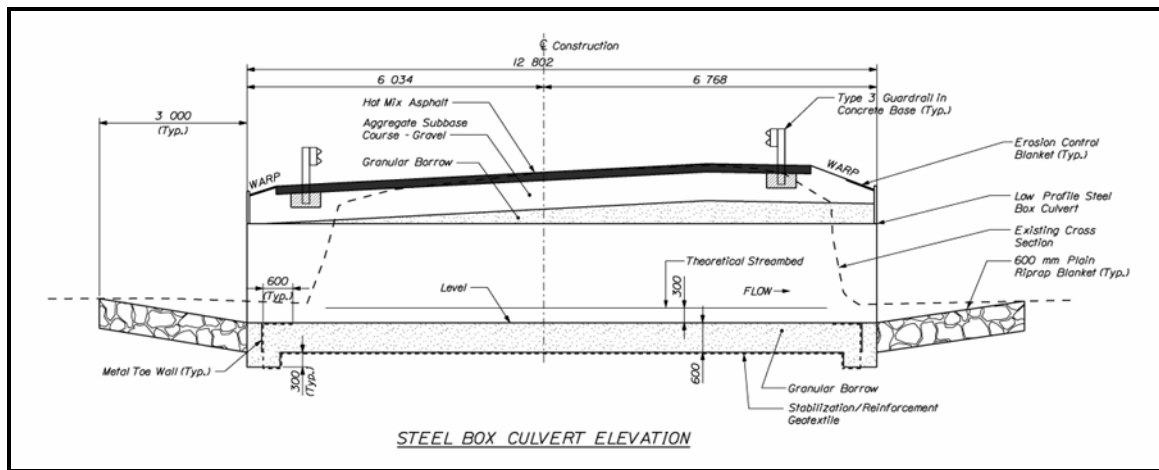


Figure 5-13 Structural Plate Box Culvert Longitudinal Section

Intro: Section cut along the CL of Structure, showing the invert elevations and headwall configurations. View is normal to CL of Structure.

Sheet up: Belongs directly below the Plan, with the centerlines aligned.

Scale: Same size as the plan, typically 1/4".

Draw:

- 1) Limits of structure
- 2) Centerline of Construction/Working Line
- 3) Roadway, guardrail and side slopes.
- 4) Concrete base for guardrail anchorage, if required.
- 5) Granular borrow cover over structure
- 6) Bedding material

- 7) Riprap blanket
- 8) Riprap side slopes, if required
- 9) Construction joint, if required for stage construction
- 10) Toe walls
- 11) Existing ground
- 12) Erosion control blanket, if required on side slopes

Dimension:

- 1) Width of riprap blanket
- 2) Step in bedding materials at toe wall

Label:

- 1) Detail Name (Section A-A)
- 2) Invert elevations
- 3) Roadway side slopes
- 4) Guardrail in concrete base
- 5) Granular borrow cover
- 6) Bedding material
- 7) Riprap blanket
- 8) Toe walls

5.3.5.3 Structural Plate Box Culvert Typical Section

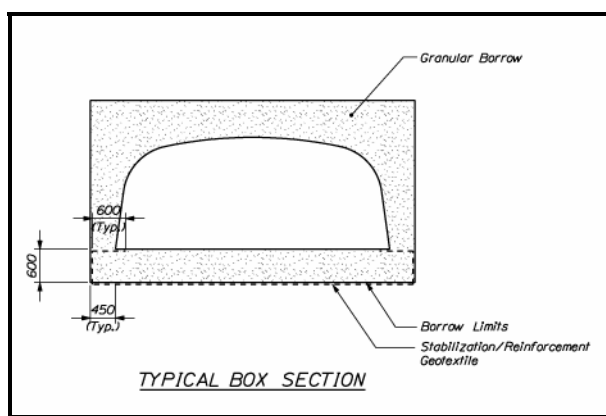


Figure 5-14 Structural Plate Box Culvert Typical Section

Intro: Cross section through box culvert showing limits of granular borrow and bedding requirements.

Sheet up: Belongs to the right of the longitudinal section

Scale: Same size as the plan, typically 1/4" or larger if there is room.

Draw:

- 1) Limits of box culvert
- 2) Limits of granular borrow and bedding materials

Dimension:

- 1) Limits of granular borrow and bedding materials

Label:

- 1) Detail Name (Section B-B)
- 2) Granular borrow and bedding materials
- 3) Granular borrow and structural earth excavation limits

5.3.5.4 Structural Plate Box Culvert Headwall and Wing Elevations

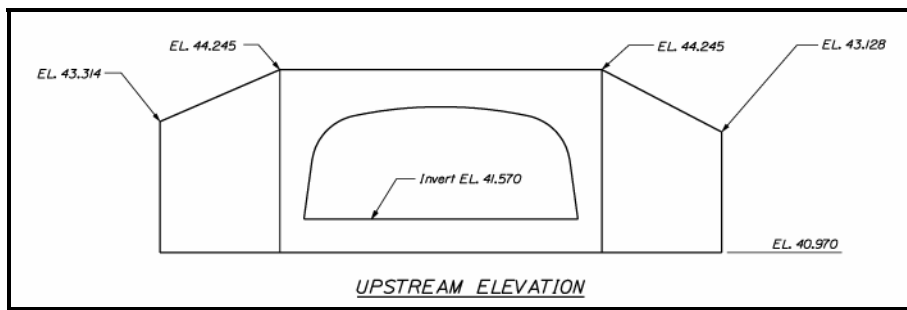


Figure 5-15 Structural Plate Box Culvert Headwall and Wing Elevation

Intro: Separate upstream and downstream elevations showing limits of headwalls and wing walls.

Sheet up: Elevations belong in the upper left of the box culvert details sheet.

Scale: Same size as the plan, typically 1/4" or larger if there is room.

Draw:

- 1) Limits of box culvert, headwall and wing walls

Label:

- 1) Detail Names: Upstream Elevation and Downstream Elevation
- 2) Top of wing and headwall elevations
- 3) Bottom of wing and headwall elevation
- 4) Invert elevation

5.3.5.5 Structural Plate Box Culvert Typical Wing Section

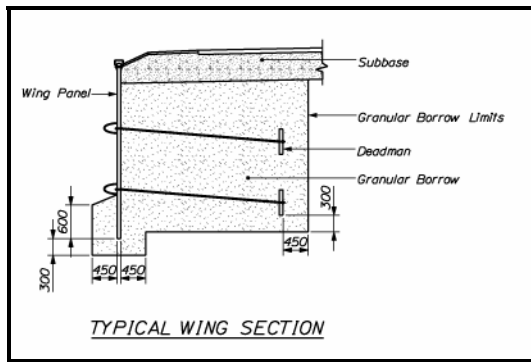


Figure 5-16 Structural Plate Box Culvert Typical Wing Section

Intro: Cross section through structural plate wing showing tie backs and limits of granular borrow.

Sheet up: Belongs in the lower left of the box culvert details sheet.

Scale: Same size as the elevations, typically $\frac{1}{4}$ " or larger if there is room.

Draw:

- 1) Limits of wing wall panel
- 2) Wall tie backs and deadmen
- 3) Limits of granular borrow
- 4) Roadway berm and side slope

Dimension:

- 1) Limits of granular borrow with respect to wall panel and deadman anchors

Label:

- 1) Detail Name
- 2) Wing panel
- 3) Granular borrow
- 4) Granular borrow limits
- 5) Deadman
- 6) Roadway subbase

5.4 Structural Plate Arch on CIP Footings

5.4.1 Introduction

These are corrugated metal structures of either steel or aluminum that are used for short-span crossings. Plate Arches are used instead of other metal structures when ledge is present.

5.4.2 Prerequisites

You will need the following:

- 1) Final Horizontal and Vertical Alignments
- 2) Skew of structure to CL Construction
- 3) Station where CL of Structure crosses CL Construction
- 4) Final Roadway Design (travel way and shoulder width, superelevation, side slopes, etc.)
- 5) Structure size (rise and span)
- 6) End Cut of Structure
- 7) Footing Geometry (width, depth, batter, top elevation)
- 8) Approximate ledge profile at each footing
- 9) Theoretical streambed elevation
- 10) Reinforcing Steel for CIP Footing
- 11) Notes

5.4.3 Detailing

Structural Plate Arches on CIP Footings require a combination of explicit and performance-based detailing. Earthwork and footings are detailed explicitly, while the structure itself is drawn diagrammatically. The Fabricator of the structure and the Contractor need to be considered equally when detailing.

5.4.4 Typical Sheet Names and Contents

5.4.4.1 ARCH DETAILS

Will Contain:

- 1) Plan
- 2) Elevation

May Contain:

- 1) Notes
- 2) Section

- 3) Other Details

5.4.5 Checklists

5.4.5.1 Structural Plate Arch Plan

Intro: Top view of arch, showing the relationship to the working lines.

Sheet up: Belongs in the upper left of the arch sheet, directly above the longitudinal section, with the centerlines aligned.

Scale: 1/4". (Check sheet up before proceeding. If plan and longitudinal section won't fit above and below at 1/4", try 3/16" scale.)

Draw:

- 1) Limits of arch
- 2) Limits of cast-in-place concrete footings/stub abutments
- 3) Centerline of Construction/Working Line
- 4) Centerline of Structure
- 5) Beveled end cut
- 6) Construction joint, if required for stage construction

Dimension:

- 1) Limits of arch. The centerline length from the working point to the upstream and downstream ends. The end cut length measured along the top centerline. Width of opening measured from CL of Structure.
- 2) Limits of cast-in-place concrete footings/stub abutments. The length of each footing from the working point to the upstream and downstream ends.
- 3) Skew angle between CL Structure and line normal to CL Construction/Working Line.
- 4) Skew angle between end of barrel and line normal to CL Structure, if required.
- 5) Construction joint

Label:

- 1) Detail Name
- 2) CL Construction/Working Line
- 3) CL Structure
- 4) Station at intersection of CL Construction/Working Line and CL Structure
- 5) Bevel end cut slope, if end cut is skewed.
- 6) North Arrow
- 7) Flow Arrow
- 8) Construction joint

5.4.5.2 Structural Plate Arch Longitudinal Section

Intro: Section cut along the CL of Structure, showing the springline elevation(s) and end cut configurations. View is normal to CL of Structure.

Sheet up: Belongs directly below the Plan, with the centerlines aligned.

Scale: Same size as the plan, typically 1/4".

Draw:

- 1) Limits of structure
- 2) Centerline of Construction/Working Line
- 3) Roadway, guardrail and side slopes.
- 4) Concrete base for guardrail anchorage, if required.
- 5) Granular borrow cover over structure
- 6) Construction joint, if required for stage construction
- 7) Existing ground

Dimension:

- 1) Overall length of structure only if it can't be shown in plan view.

Label:

- 1) Detail Name (Section A-A)
- 2) Guardrail in concrete base
- 3) Granular borrow cover
- 4) Springline elevation(s)
- 5) Construction joint

5.4.5.3 Structural Plate Arch Typical Section

Intro: Cross section through arch showing limits of granular borrow and cast-in-place concrete footing/stub abutment.

Sheet up: Belongs to the right of the longitudinal section

Scale: Same size as the plan, typically 1/4" or larger if there is room.

Draw:

- 1) Limits of arch
- 2) Limits of cast-in-place concrete footings/stub abutments
- 3) Limits of granular borrow and structural earth excavation
- 4) Existing streambed
- 5) Footing scour protection

Dimension:

- 1) Limits of granular borrow

Label:

- 1) Detail Name (Section B-B)
- 2) Springline
- 3) Granular borrow
- 4) Granular borrow and structural earth excavation limits

5.5 Precast Concrete Box Culvert

5.5.1 Introduction

These are pre-engineered concrete structures that are used for short-span crossings. Concrete Box culverts are used instead of metal structures in corrosive environments or when cover requirements for metal structures can't be met.

5.5.2 Prerequisites

You will need the following:

- 1) Final Horizontal and Vertical Alignments
- 2) Skew of structure to CL Construction
- 3) Station where CL of Structure crosses CL Construction
- 4) Final Roadway Design (travel way and shoulder width, superelevation, side slopes, etc.)
- 5) Structure size (rise and span)
- 6) Inlet and Outlet elevations
- 7) Mitre to slope or headwall/wingwall geometry
- 8) Construction joint location for staged construction
- 9) Guardrail/curb geometry (elevation of top of curb if curb to be placed on box)
- 10) Bedding material type and depth, geotextile usage
- 11) Toe wall geometry
- 12) Riprap blanket size, type and location
- 13) Theoretical streambed elevation
- 14) If there are CIP Curbs: Reinforcing steel design
- 15) Notes

5.5.3 Detailing

Concrete Box Culverts require a combination of explicit and performance-based detailing. Earthwork and curbs are detailed explicitly, while the structure itself is drawn diagrammatically. The Fabricator of the structure and the Contractor need to be considered equally when detailing.

5.5.4 Typical Sheet Names and Contents

5.5.4.1 BOX CULVERT DETAILS

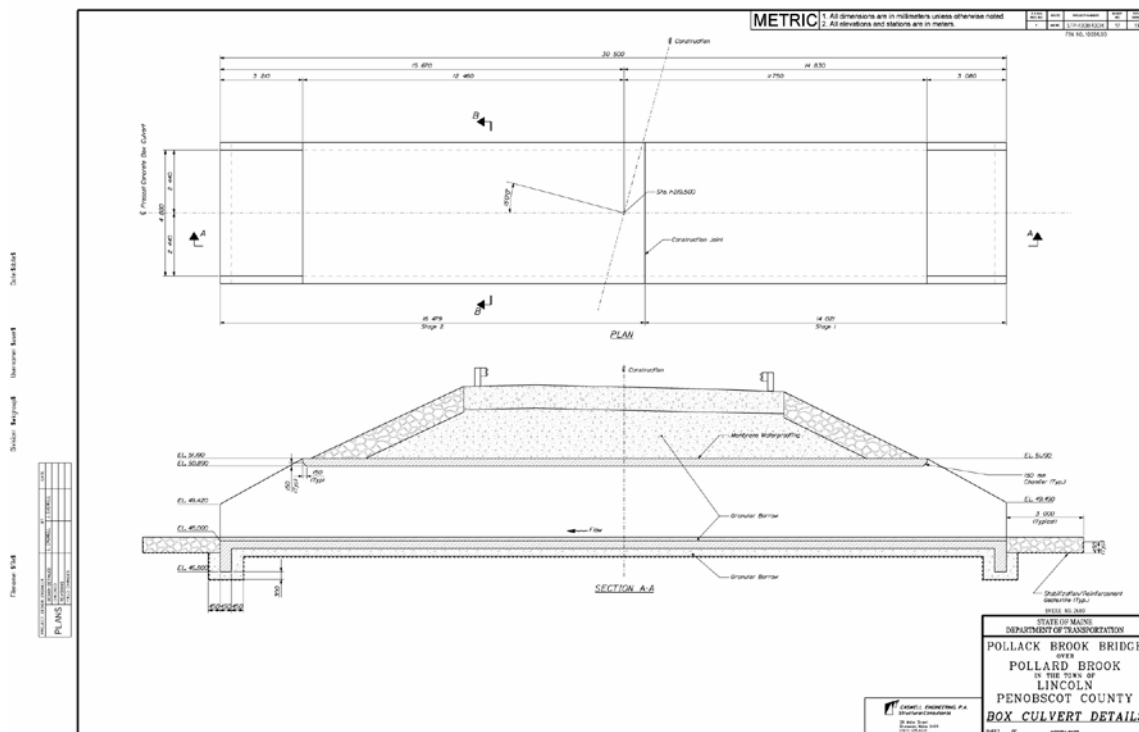


Figure 5-17 Box Culvert Details

Will Contain:

- 1) Plan
- 2) Elevation

May Contain:

- 1) Notes
- 2) Other Details

5.5.5 Standard Notes

5.5.5.1 Precast Concrete Box Notes

(The following note is used if applicable.)

- 1) The precast units shall be designed to carry construction loadings with a minimum fill cover of 1'-6" on top of the units.
- 2) The construction, handling, and assembly of the precast units shall be in accordance with Special Provision Section 534 Precast Structural Concrete, and with the Manufacturer's Specifications as applicable.

- 3) Install membrane waterproofing over the top and to 1 foot down the exterior sides of the precast units.

5.5.6 Checklists

5.5.6.1 Precast Concrete Box Culvert Plan

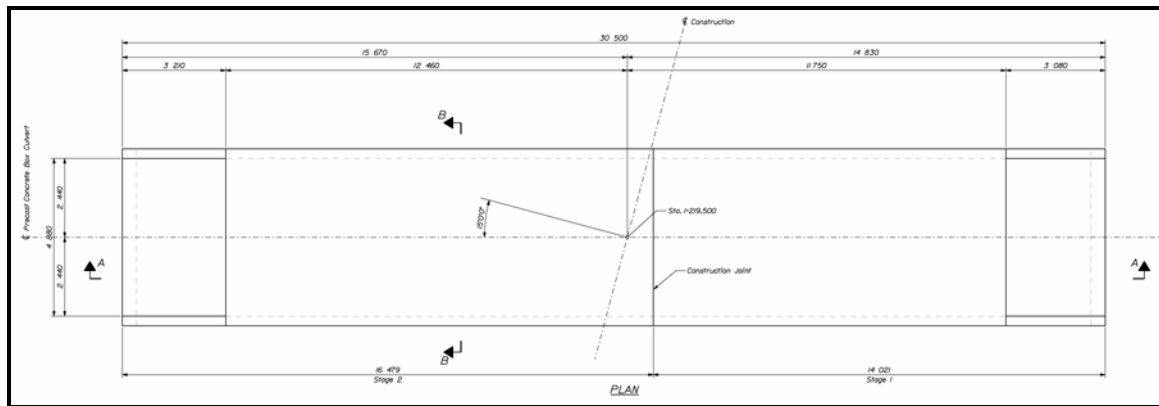


Figure 5-18 Precast Concrete Box Culvert Plan

Intro: Top view of box culvert, showing the relationship to the working lines.

Sheet up: Belongs in the upper left of the box culvert sheet, directly above the longitudinal section, with the centerlines aligned.

Scale: $\frac{1}{4}''$. (Check sheet up before proceeding. If plan and longitudinal section won't fit above and below at $\frac{1}{4}''$, try $\frac{3}{16}''$ scale.)

Draw:

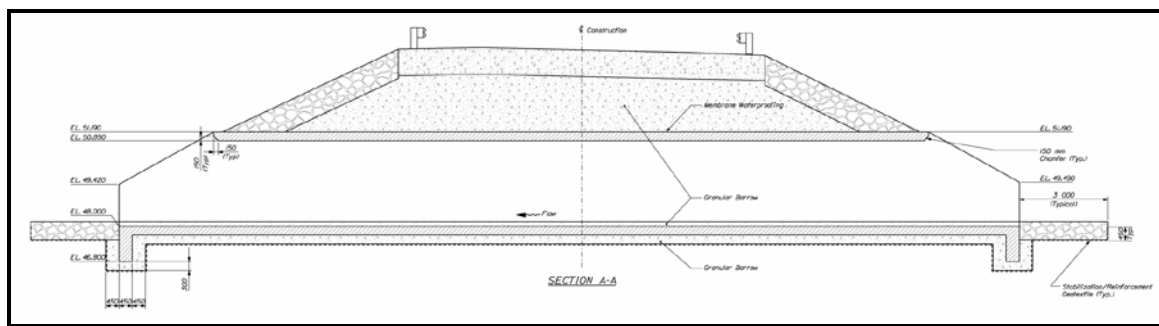
- 1) Limits of box culvert
- 2) Centerline of Construction/Working Line
- 3) Centerline of Structure
- 4) Beveled end cut
- 5) Construction joint, if required for stage construction
- 6) Toe wall, if required

Dimension:

- 1) Limits of box culvert. The bottom centerline length from the working point to the upstream and downstream ends. The top centerline length and end cut length for mitered to slope structures. Width of box culvert.
- 2) Skew angle between CL Structure and line normal to CL Construction/Working Line.
- 3) Skew angle between end of barrel and line normal to CL Structure, if required.
- 4) Construction joint

Label:

- 1) Detail Name
- 2) CL Construction/Working Line
- 3) CL Structure
- 4) Station at intersection of CL Construction/Working Line and CL Structure
- 5) North Arrow
- 6) Flow Arrow
- 7) Construction joint

5.5.6.2 Precast Concrete Box Culvert Longitudinal Section**Figure 5-19 Precast Concrete Box Culvert Longitudinal Section**

Intro: Section cut along the CL of Structure, showing the invert elevations and end cut configurations. View is normal to CL of Structure.

Sheet up: Belongs directly below the Plan, with the centerlines aligned.

Scale: Same size as the plan, typically 1/4".

Draw:

- 1) Limits of box culvert
- 2) Centerline of Construction/Working Line
- 3) Roadway, guardrail and side slopes.
- 4) Concrete base for guardrail anchorage, if required.
- 5) Granular borrow cover over structure
- 6) Membrane Waterproofing
- 7) Bedding material
- 8) Riprap blanket
- 9) Riprap side slopes, if required
- 10) Existing ground
- 11) Construction joint, if required for stage construction

12) Toe walls

Dimension:

- 1) Bottom step cut
- 2) Width of riprap blanket
- 3) Step in bedding materials at toe wall
- 4) Toe wall
- 5) Headwall chamfer

Label:

- 1) Detail Name (Section A-A)
- 2) Invert elevations
- 3) End bevel slopes.
- 4) Guardrail in concrete base, if required
- 5) Bedding materials
- 6) Granular borrow cover
- 7) Riprap blanket
- 8) Membrane waterproofing
- 9) Toe walls
- 10) Headwall chamfer

5.5.6.3 Precast Concrete Box Culvert Typical Section

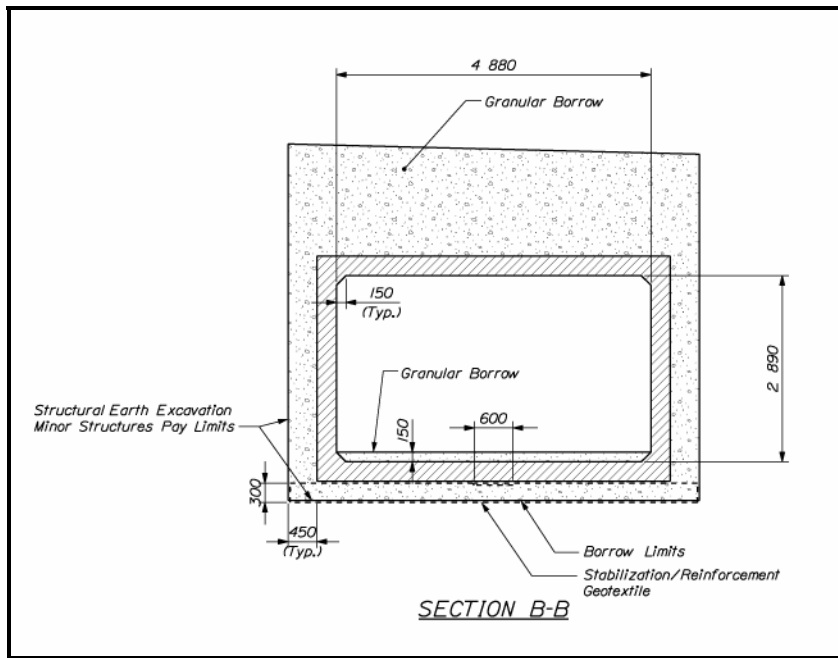


Figure 5-20 Precast Concrete Box Culvert Typical Section

Intro: Cross section through box culvert showing limits of granular borrow and bedding requirements.

Sheet up: If it fits place it to the right of the longitudinal section. on box culvert details sheet.

Scale: Same size as the plan, typically 1/4" or larger if there is room.

Draw:

- 1) Limits of box culvert
- 2) Limits of granular borrow, structural earth excavation and bedding materials

Dimension:

- 1) Limits of granular borrow and bedding materials
- 2) Upper corner haunches

Label:

- 1) Detail Name (Section B-B)
- 2) Granular borrow and bedding materials
- 3) Granular borrow and structural earth excavation limits

5.5.6.4 Precast Concrete Box Culvert Wing Elevations

Intro: Use when the box culvert has headwalls and wings instead of mitered to slope end cut. Separate upstream and downstream elevations showing limits of headwalls and wing walls.

Sheet up: Elevations belong in the upper left of the box culvert details sheet.

Scale: Same size as the plan, typically 1/4" or larger if there is room.

Draw:

- 1) Limits of box culvert, headwall and wing walls

Label:

- 1) Detail Names: Upstream Elevation and Downstream Elevation
- 2) Top of wing and headwall elevations
- 3) Bottom of wing and headwall elevation
- 4) Invert elevation

5.5.6.5 Precast Concrete Box Culvert Typical Wing Section

Intro: Use when the box culvert has headwalls and wings instead of mitered to slope end cut. Cross section through precast wing showing limits of granular borrow.

Sheet up: Belongs in the lower left of the box culvert details sheet.

Scale: Same size as the elevations, typically 1/4 " or larger if there is room.

Draw:

- 1) Limits of precast wing wall panel
- 2) Limits of granular borrow
- 3) Roadway berm and side slope

Dimension:

- 1) Limits of granular borrow with respect to wall panel

Label:

- 1) Detail Name
- 2) Wing wall panel
- 3) Granular borrow
- 4) Granular borrow limits
- 5) Roadway subbase

5.6 Precast Concrete Arch or Rigid Frame on CIP Footing

5.6.1 Introduction

These are pre-engineered concrete structures that are used for short-span crossings. Concrete Arches or Rigid Frames are used instead of other buried structures in corrosive environments where ledge is present.

5.6.2 Prerequisites

You will need the following:

- 1) Final Horizontal and Vertical Alignments
- 2) Skew of structure to CL Construction
- 3) Station where CL of Structure crosses CL Construction
- 4) Final Roadway Design (travel way and shoulder width, superelevation, side slopes, etc.)
- 5) Structure size (rise and span)
- 6) Headwall/Wingwall Geometry
- 7) Footing Geometry (width, depth, batter, top elevation)
- 8) Guardrail/curb geometry (elevation of top of curb if curb to be placed on structure)
- 9) Approximate ledge profile at each footing
- 10) Theoretical streambed elevation
- 11) Reinforcing Steel Design for CIP Footings
- 12) If there are CIP Curbs: Reinforcing steel design
- 13) Springing Line Elevation
- 14) Notes

5.6.3 Detailing

Precast Arches on CIP Footings require a combination of explicit and performance-based detailing. Earthwork and footings are detailed explicitly, while the structure itself is drawn diagrammatically. The Fabricator of the structure and the Contractor need to be considered equally when detailing.

5.6.4 Typical Sheet Names and Contents

5.6.4.1 ARCH / RIGID FRAME DETAILS

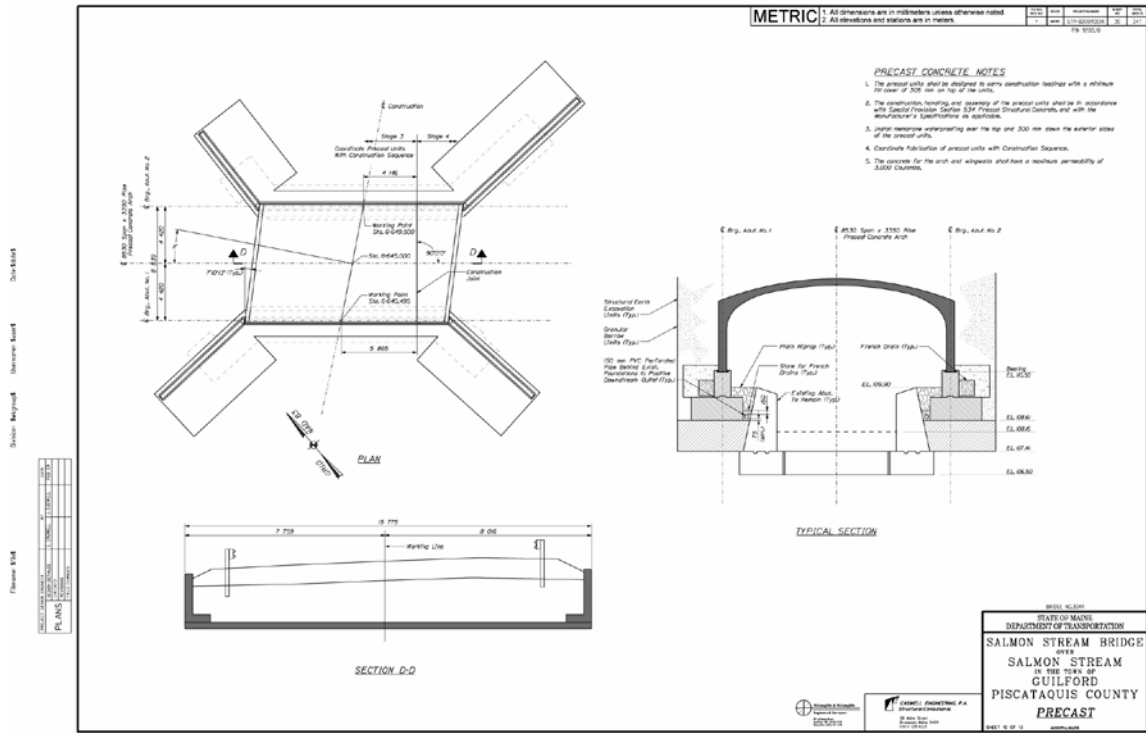


Figure 5-21 Arch / Rigid Frame Details

Will Contain:

- 1) Plan
- 2) Elevation

May Contain:

- 1) Section
- 2) Notes
- 3) Other Details

5.6.4.2 ARCH / RIGID FRAME ELEVATIONS

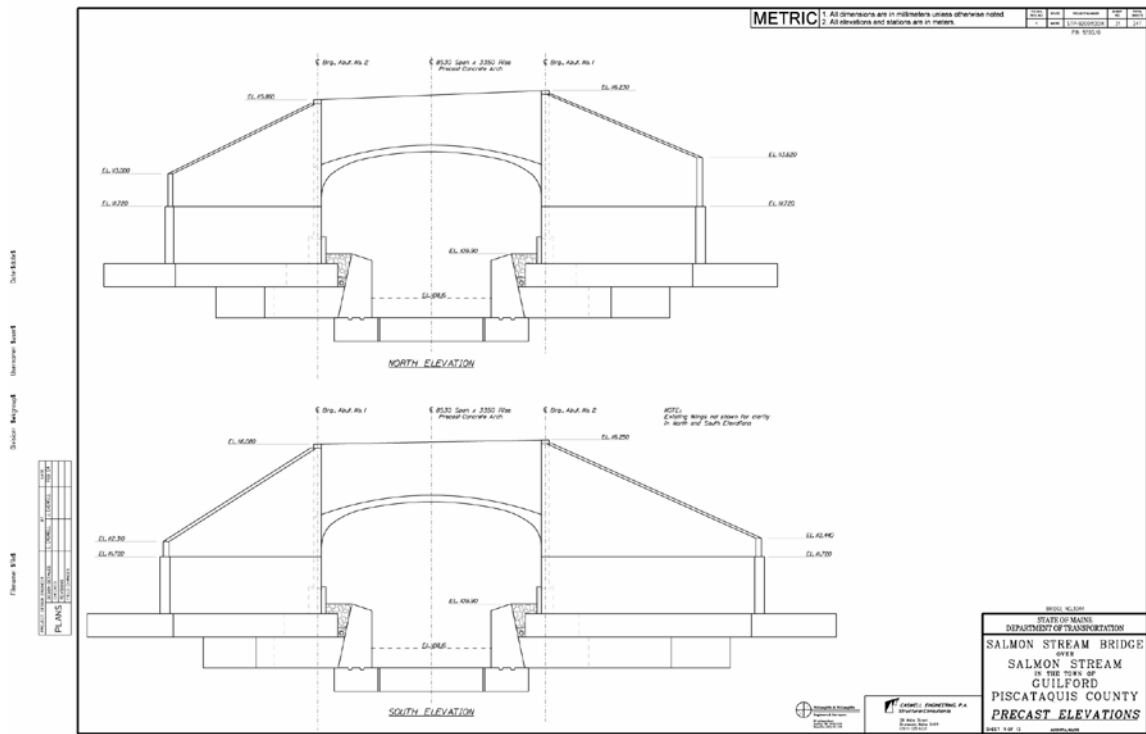


Figure 5-22 Arch / Rigid Frame Elevations

Will Contain:

- 1) Upstream Elevation
- 2) Downstream Elevation

May Contain:

- 1) Notes
- 2) Other Details

5.6.4.3 WING DETAILS

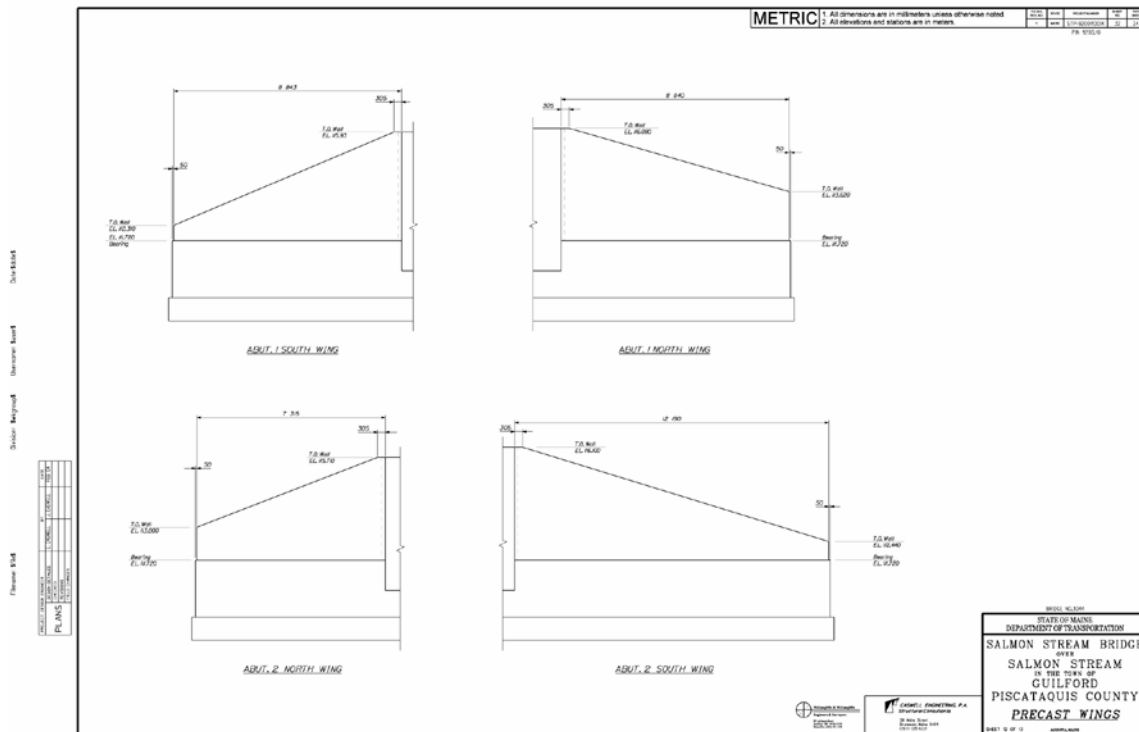


Figure 5-23 Wing Details

Will Contain:

- 1) Wing Elevations

May Contain:

- 1) Wing Plans
- 2) Notes
- 3) Other Details

5.6.5 Standard Notes

1.1.1.1 Precast Concrete Arch Notes

(The following note is used if applicable.)

- 1) The precast units shall be designed to carry construction loadings with a minimum fill cover of 1'-6" on top of the units.
- 2) The construction, handling, and assembly of the precast units shall be in accordance with Special Provision Section 534 Precast Structural Concrete, and with the Manufacturer's Specifications as applicable.

Install membrane waterproofing over the top and to 1 foot down the exterior sides of the precast units.

5.6.6 Checklists

5.6.6.1 Precast Concrete Arch or Rigid Frame Plan

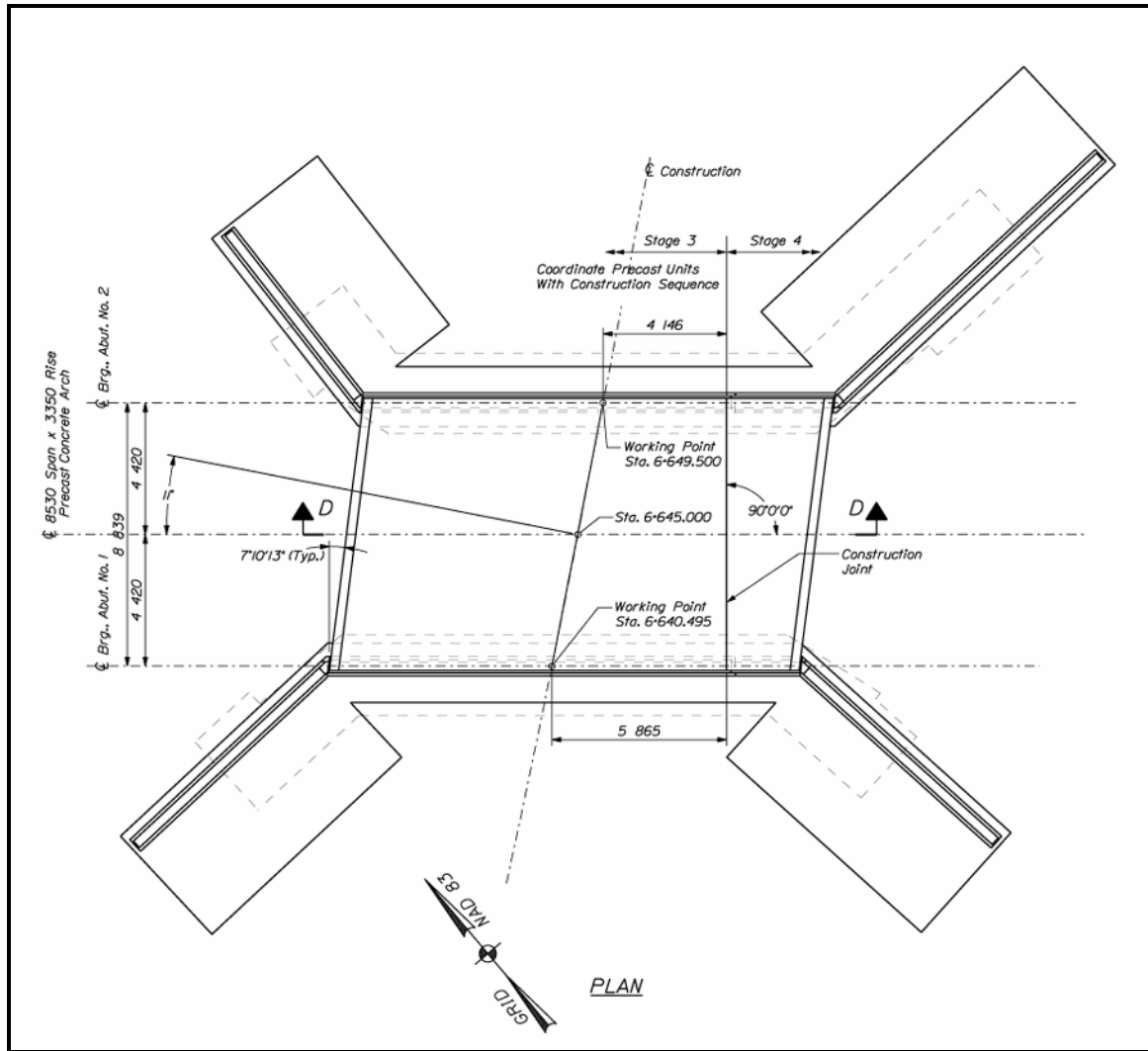


Figure 5-24 Precast Concrete Arch Plan

Intro: Top view of arch or rigid frame, showing the relationship to the working lines.

Sheet up: Belongs in the upper left of the arch or rigid frame sheet, directly above the longitudinal section, with the centerlines aligned.

Scale: 1/4". (Check sheet up before proceeding. If plan and longitudinal section won't fit above and below at 1/4", try 3/16" scale.)

Draw:

- 1) Limits of arch or rigid frame
- 2) Limits of wing walls
- 3) Limits of cast-in-place footings/stub abutments

- 4) Centerline of Construction/Working Line
- 5) Centerline of Structure
- 6) Construction joint, if required for stage construction

Dimension:

- 1) Limits of arch or rigid frame. The centerline length from the working point to the upstream and downstream ends. Width of opening measured from CL of Structure.
- 2) Skew angle between CL Structure and line normal to CL Construction/Working Line.
- 3) Skew angle between end of barrel and line normal to CL Structure, if required.
- 4) Construction joint

Label:

- 1) Detail Name
- 2) CL Construction/Working Line
- 3) CL Structure
- 4) Station at intersection of CL Construction/Working Line and CL Structure
- 5) North Arrow
- 6) Flow Arrow
- 7) Construction joint

5.6.6.2 Precast Concrete Arch or Rigid Frame Section

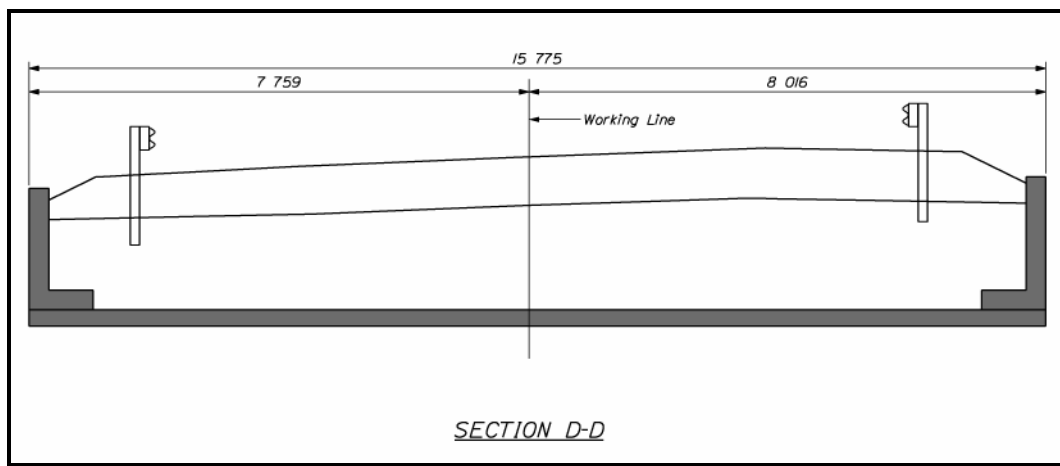


Figure 5-25 Precast Concrete Arch Section

Intro: Section cut along the CL of Structure, showing the springline elevation(s) and headwall configurations. View is normal to CL of Structure.

Sheet up: Belongs directly below the Plan, with the centerlines aligned.

Scale: Same size as the plan, typically 1/4 “.

Draw:

- 1) Limits of structure
- 2) Centerline of Construction/Working Line
- 3) Roadway, guardrail and side slopes.
- 4) Concrete base for guardrail anchorage, if required.
- 5) Granular borrow cover over structure
- 6) Construction joint, if required for stage construction
- 7) Existing ground
- 8) Erosion control blanket, if required on side slopes.

Dimension:

- 1) Overall length of structure only if it can't be shown in plan view.

Label:

- 1) Detail Name (Section A-A)
- 2) Guardrail in concrete base
- 3) Granular borrow cover
- 4) Springline elevation(s)
- 5) Construction joint

5.6.6.3 Precast Concrete Arch or Rigid Frame Typical Section

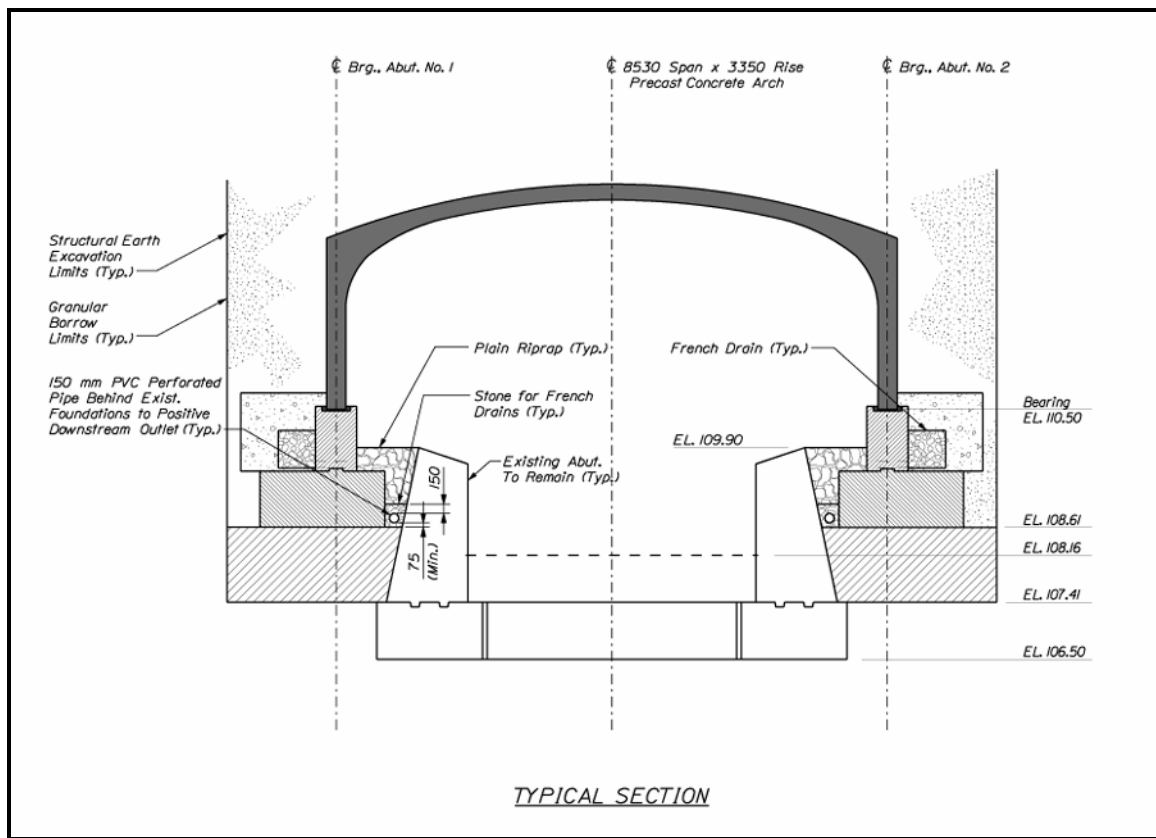


Figure 5-26 Precast Concrete Arch Typical Section

Intro: Cross section through precast arch or rigid frame showing limits of granular borrow and cast-in-place concrete footing/stub abutment.

Sheet up: Belongs to the right of the longitudinal section

Scale: Same size as the plan, typically 1/4 " or larger if there is room.

Draw:

- 1) Limits of precast arch or rigid frame
- 2) Limits of cast-in-place concrete footings/stub abutments
- 3) Limits of granular borrow and structural earth excavation
- 4) French drain
- 5) Existing streambed
- 6) Footing scour protection

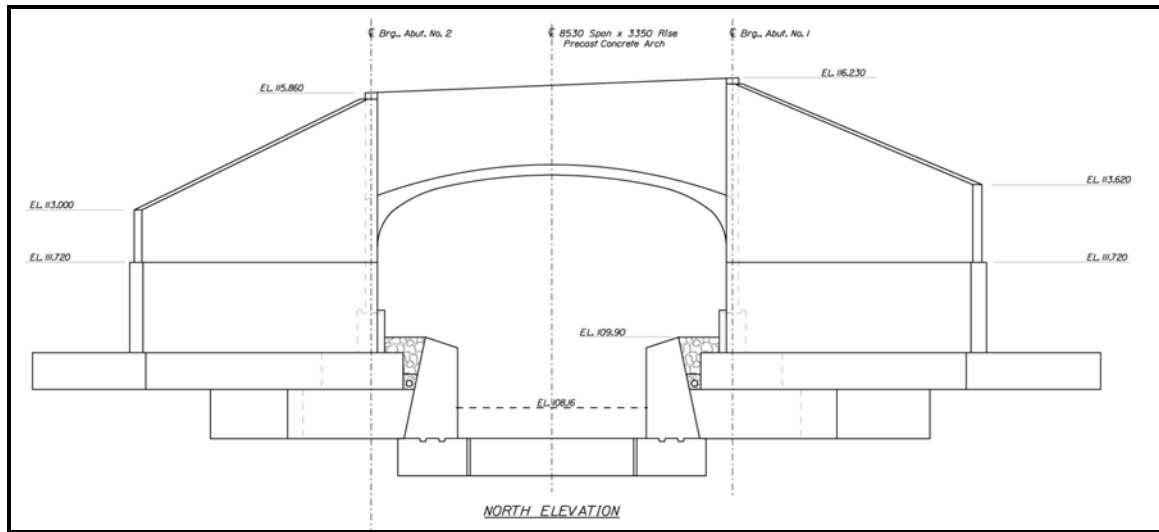
Dimension:

- 1) Limits of granular borrow

Label:

- 1) Detail Name (Section B-B)
- 2) Precast arch or rigid frame bearing elevation
- 3) Granular borrow
- 4) Granular borrow and structural earth excavation limits

5.6.6.4 Precast Concrete Arch or Rigid Frame Headwall and Wing Elevations

**Figure 5-27 Precast Concrete Arch End Elevation**

Intro: Separate upstream and downstream elevations showing limits of headwalls and wing walls. Separate elevations of each wing wall may be necessary to provide all wing dimensions.

Sheet up: Elevations belong in the upper left of the arch or rigid frame details sheet.

Scale: Same size as the plan, typically 1/4" or larger if there is room.

Draw:

- 1) Limits of arch or rigid frame, headwall and wing walls
- 2) Limit of cast-in-place concrete footings/stub abutments

Label:

- 1) Detail Names: Upstream Elevation and Downstream Elevation
- 2) Top of wing and headwall elevations
- 3) Bottom of precast wing elevation