



CULVERT WIDENINGS

TxDOT Bridge Presentations Webinar

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Design and Constructability Considerations for Culvert Widenings

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Texas Culvert Facts

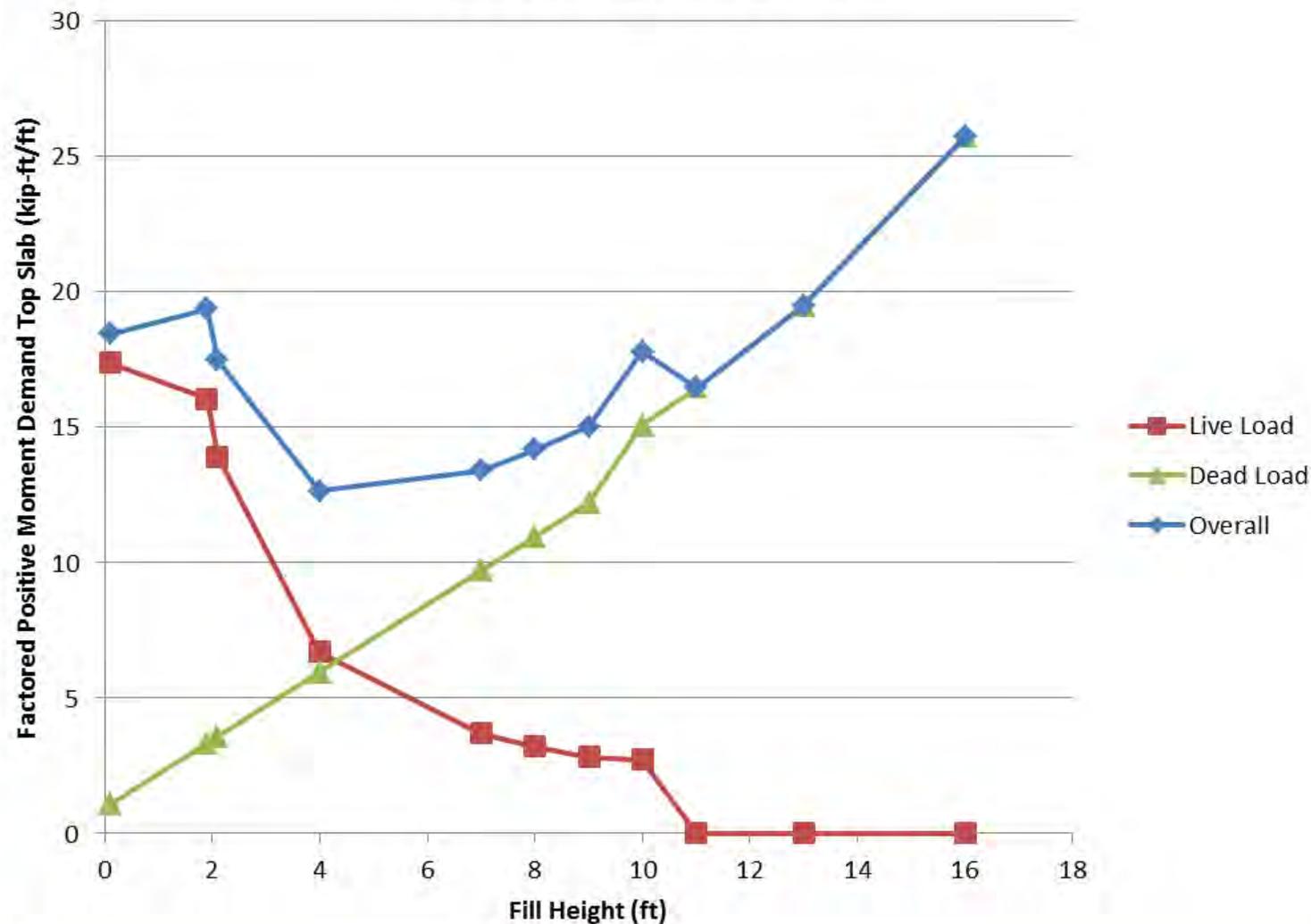
- Nearly 40% of On-System Bridge Structures are Bridge Class Culverts
- Of the 13,564 Bridge Class Culverts:
 - 0.2% are Structurally Deficient
 - 3.6% are Functionally Obsolete
 - 63% have been Widened
- Some of our Oldest Operating Structures are Culverts
 - 1914 Oldest on System Culvert on FM 308 in Waco District
 - 1933 First Culvert Widening on BU 59 in Atlanta District
- Non-Bridge Class Culverts (Total Length < 20 ft.)
 - Not a “tracked” asset
 - Number easily more than 100,000

Determining if a Culvert Can Be Widened

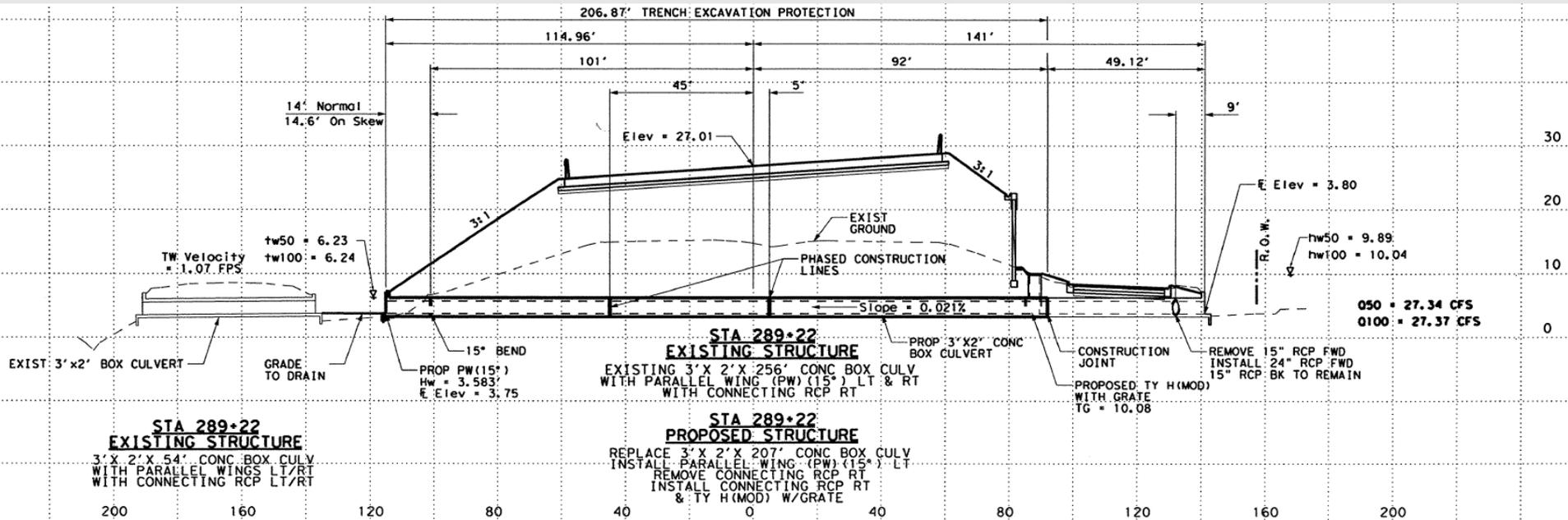
- Evaluate Structural Condition
 - Obtain latest inspection reports from PONTEX
 - Conduct condition survey (maybe)
 - Load rate culvert (maybe)
- Age or Era Considerations
 - Oldest widened = 89 years
 - Pre-1938, 1938, 1946, 1958, 2003 era standard designs
 - Concrete mixes in the 1950's and 1960's not as robust
- Consider Proposed Condition
 - Removing or adding fill?
 - Hydraulics adequate?

Consideration of Revised Fill Height

10 x 6 Single Cell Box

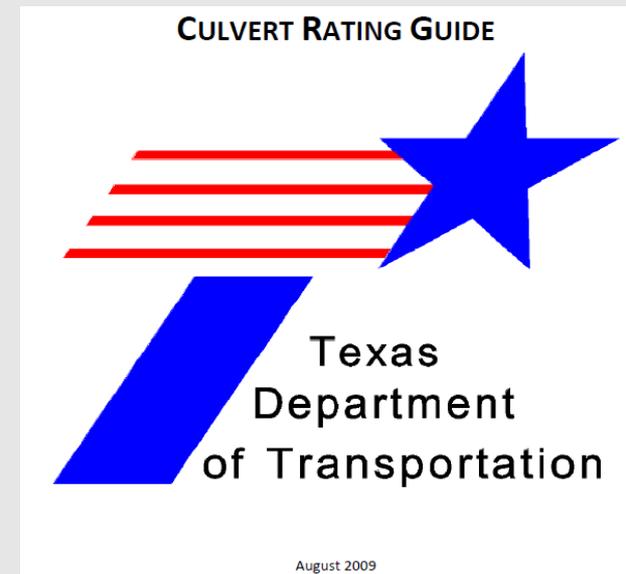
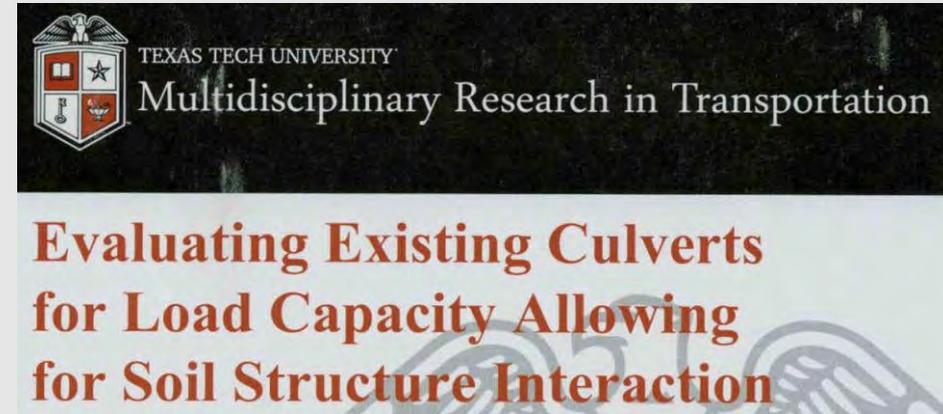


Example of Changed Fill Height



Culvert Load Rating

- Basic Guidance
 - TxDOT Bridge Inspection Manual
 - AASHTO Manual for Bridge Evaluation
 - AASHTO Standard Specifications for Bridges (17th Ed. 2002)
- Bridge Division Refining Procedures
 - Research Project 5849 (Completed 2010)
 - Developed Culvert Rating Guide and CULVLR Software
 - 3 Levels of Demand Calculation
 - 1st Level (CULV5 Methodology) Only One Considered Reliable Currently
 - Research Product is Being Addressed by IAC
 - Refine/Validate Higher Level Demand Analysis
 - Load Rate all On-System Culverts



Culvert Widening Considerations

- Overall Geometry
 - Requisite roadway and shoulder width
 - Terrain
- End Geometry
 - ROW Availability
 - Construction Access
 - Side Slope Rate
 - Treatments for Traffic Safety
 - Culvert Size
 - Maintenance Access
 - Drift Conditions
 - Hydraulic Considerations
- Safety Elements
 - Safety End Treatments
 - Need for Bridge Rails or MBGF
 - Clear Zone (Non-Bridge Class)
- Traffic Control During Construction
 - Room for Equipment
 - Temporary Barriers
 - Temporary Shoring
 - Effect of Tie-in Detail

Parallel Wingwall Examples

- Wingwall in line with culvert end
- Effective for water features with trapezoidal cross-section
- Allows extension close to ROW line
- Needs MBGF or bridge rail on bridge class culverts



Flared Wingwall Examples

- Wingwall flares away from culvert ends and tapers to match side slope
- Effective for ill-defined or broad waterway channels
- Allows use of safety end treatment

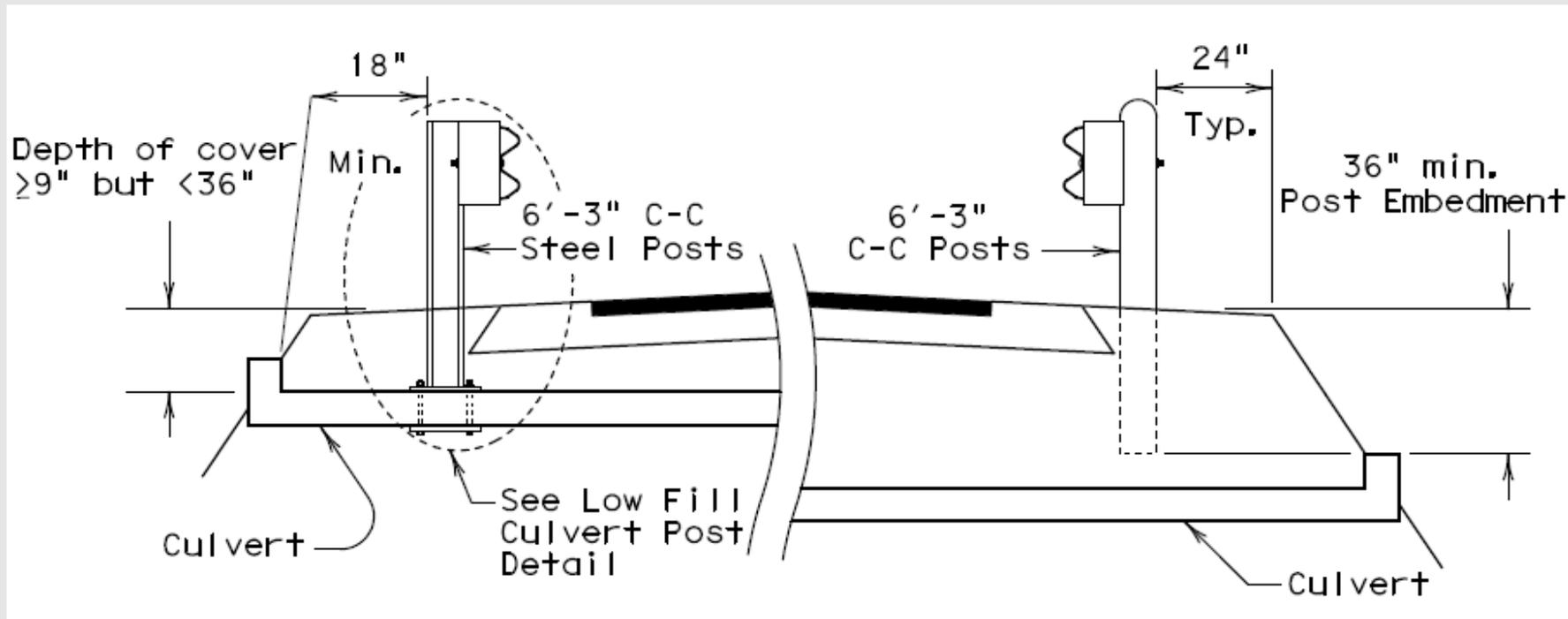


Treatment of Cross Drainage Culvert Ends for Roadside Safety

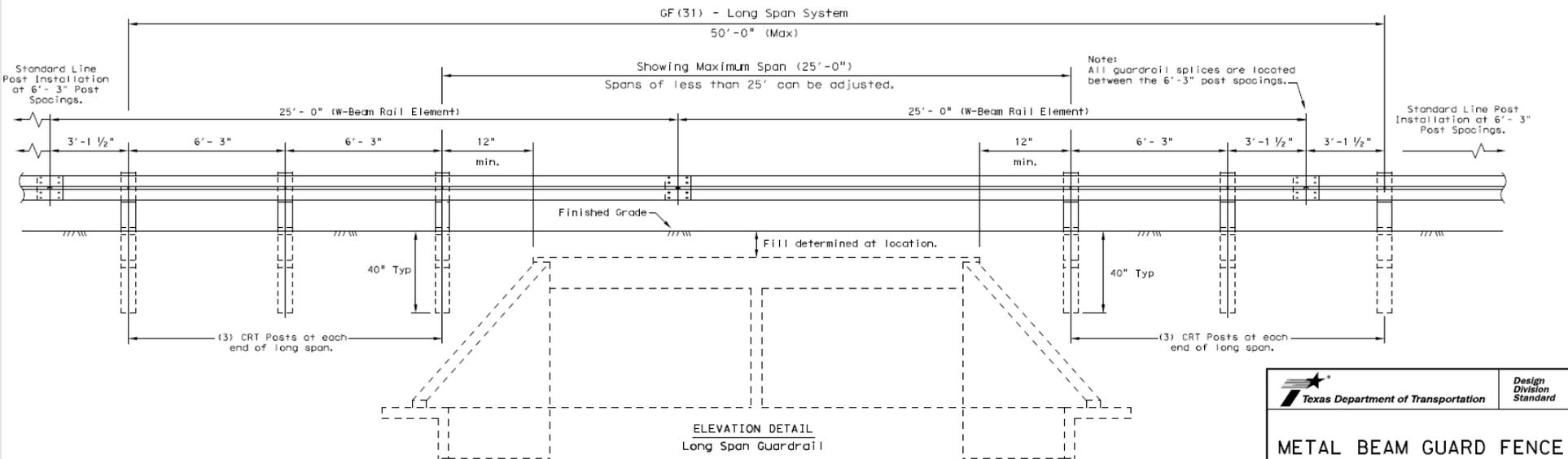
- Guidance
 - Roadway Design Manual, Ch 2 Sec 7 “Drainage Facility Placement”
 - Bridge Railing Manual, Ch 1 Sec 3 “Railing on Bridge-Class Culverts”
- Classification of Cross Drainage Elements
 - Small Pipe Culverts
 - Intermediate Size Single Box and Single/Multiple Pipe Culverts
 - Multiple Box Culverts and Large Single Pipes or Boxes
 - Bridge Class Drainage Culverts*
- Preferred Order of Treatment
 - Sloped Ends with Safety End Treatment
 - Move End Outside Clear Zone*
 - Protection with Barrier

***MOVING END OUTSIDE CLEAR ZONE ALONE IS NOT ACCEPTABLE FOR BRIDGE CLASS CULVERTS**

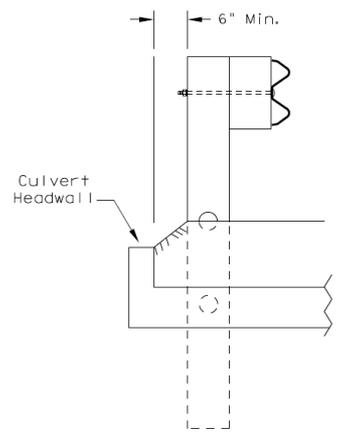
Metal Beam Guard Fence Over Culverts



Metal Beam Guard Fence Spanning Culvert



<p>Texas Department of Transportation</p>	<p>Design Division Standard</p>
<p>METAL BEAM GUARD FENCE (Long Span)</p> <p>GF(31)LS-14</p>	



Lateral Offset Between the Guardrail and the Culvert Headwall

Safety End Treatments

- Preferred Over Flexible or Rigid Barrier
- Require Cross Slopes 3:1 or Flatter
- Require Approaching Cross Slopes That Don't Warp or Flatten
- Straight Wings or Flared Wings Up to 30 deg Skew by Standards
- Custom Designs Possible for Skews over 30 deg
- Not Recommended for Streams with Measurable Drift Potential

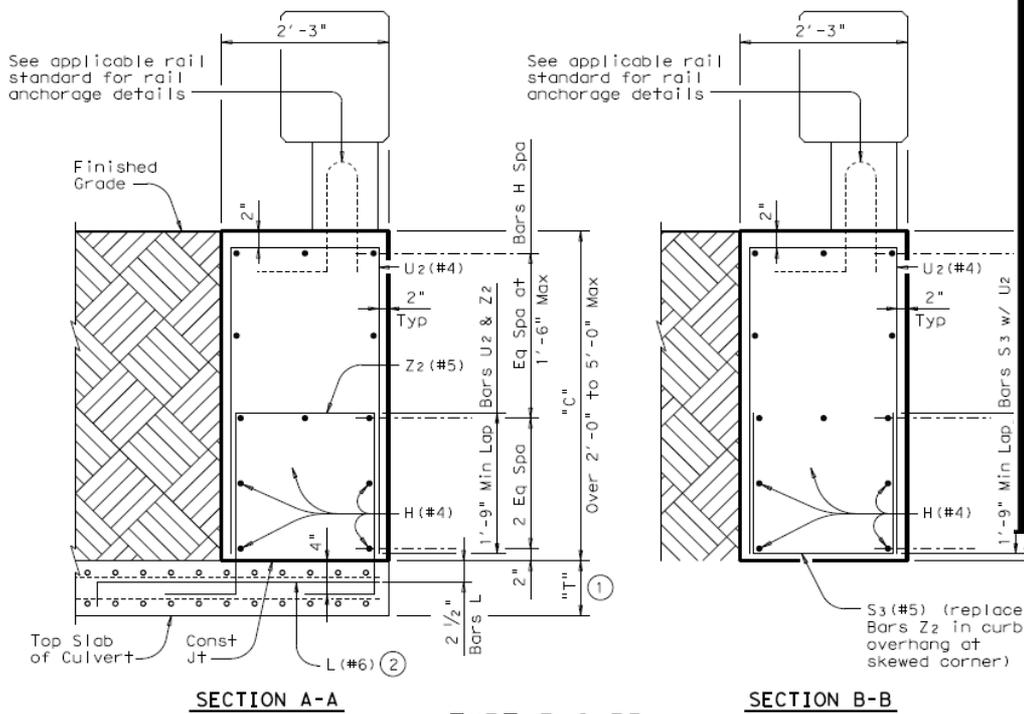


Rigid Bridge Rail

- Least-preferred option, but may be necessary in certain situations



Rail Anchorage Curbs



Used for curbs over 2'-0" to 5'-0" (Showing "C"= 4'-0"). Showing T223 Rail, other rails similar. (Bars L on T223 and C223 Rails are not used for this structure). Bars H, as shown and required on standards T80HT and T80SS are not required.



Bridge Division Standard

RAIL ANCHORAGE CURB

BOX CULVERT

RAIL MOUNTING DETAILS

(CURBS 8" TO 5'-0" TALL ONLY)

RAC

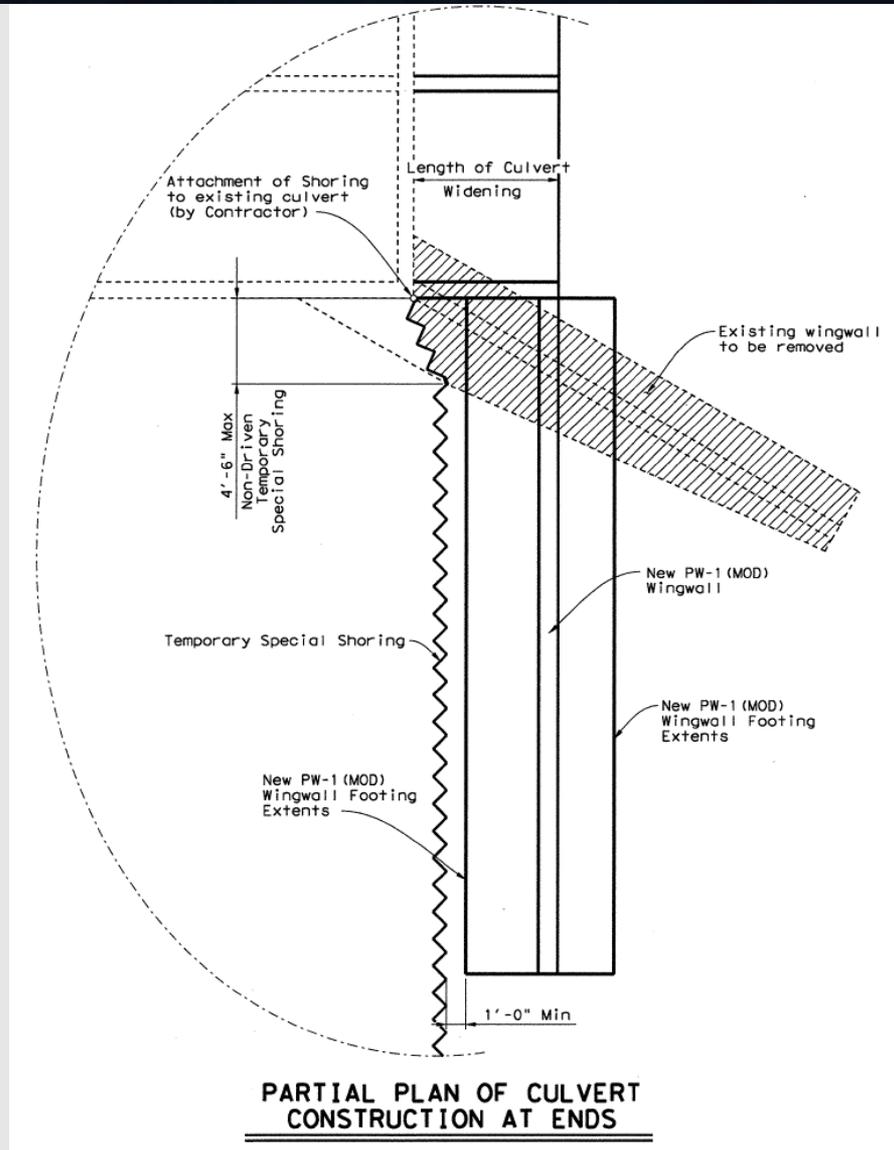
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© TXDOT February 2010	CONT	SECT	JOB	HIGHWAY
REVISIONS				
05-11: Type 3 Curb, Sect B-B, Gen Notes, T101 Anchor PL				
07-12: Width.				
DIST	COUNTY			SHEET NO.

Traffic Control and Shoring

- Need sufficient room for temporary barrier
- Determine need and limits of temporary special shoring, and access for installation
- Consider relationship of proposed and existing structure
- Consider backfill type and placement method
- Will top slab be broken back?

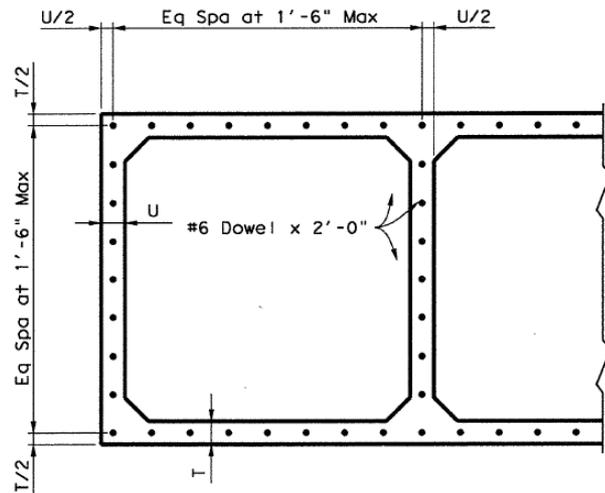


Temporary Shoring and Existing/Proposed Relationship



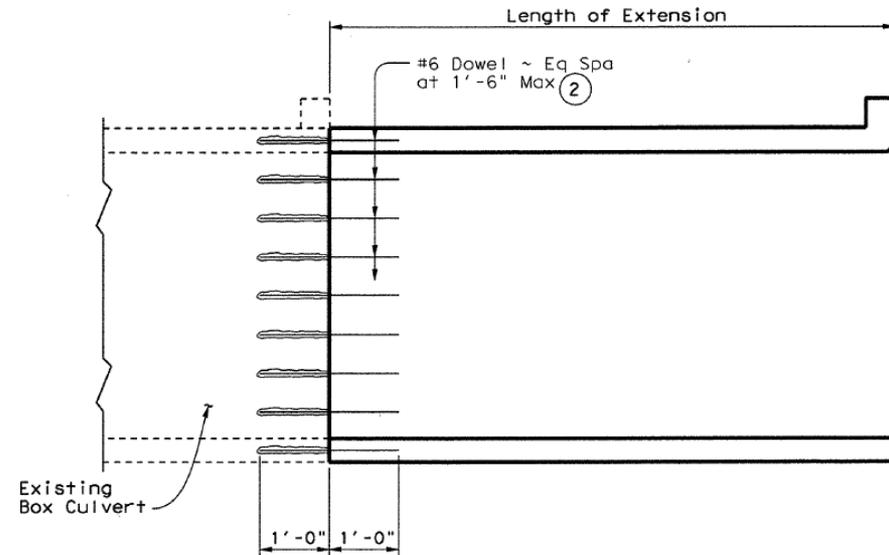
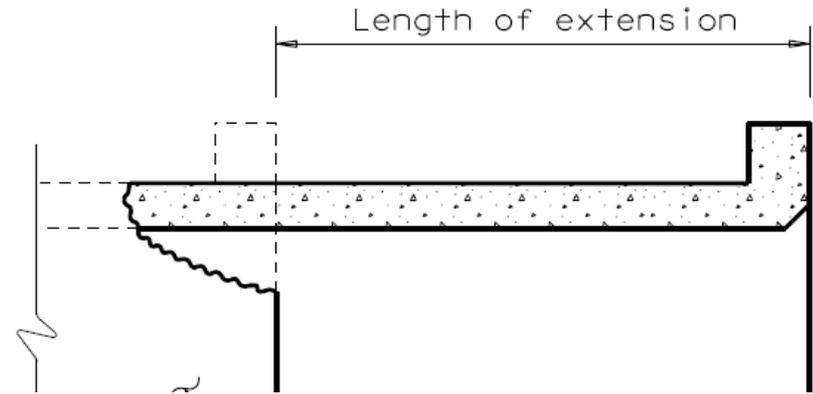
Attachment to Existing

- SCC-MD and MC-MD standards require top slab breakback of approximately 2 ft for direct traffic culverts
- BRG has modified on occasion to allow doweling for select traffic control cases



LENGTHENING DETAIL TYPICAL SECTION ①

① When lengthening existing box culverts with dimensions different than current standard dimensions, horizontal and vertical transitions shall be formed as directed by the Engineer. Bottom slabs shall match to maintain an uninterrupted flow line. Existing and new reinforcing shall be field bent into transition maintaining specified cover requirements



LENGTHENING DETAIL TYPICAL SIDE VIEW ①

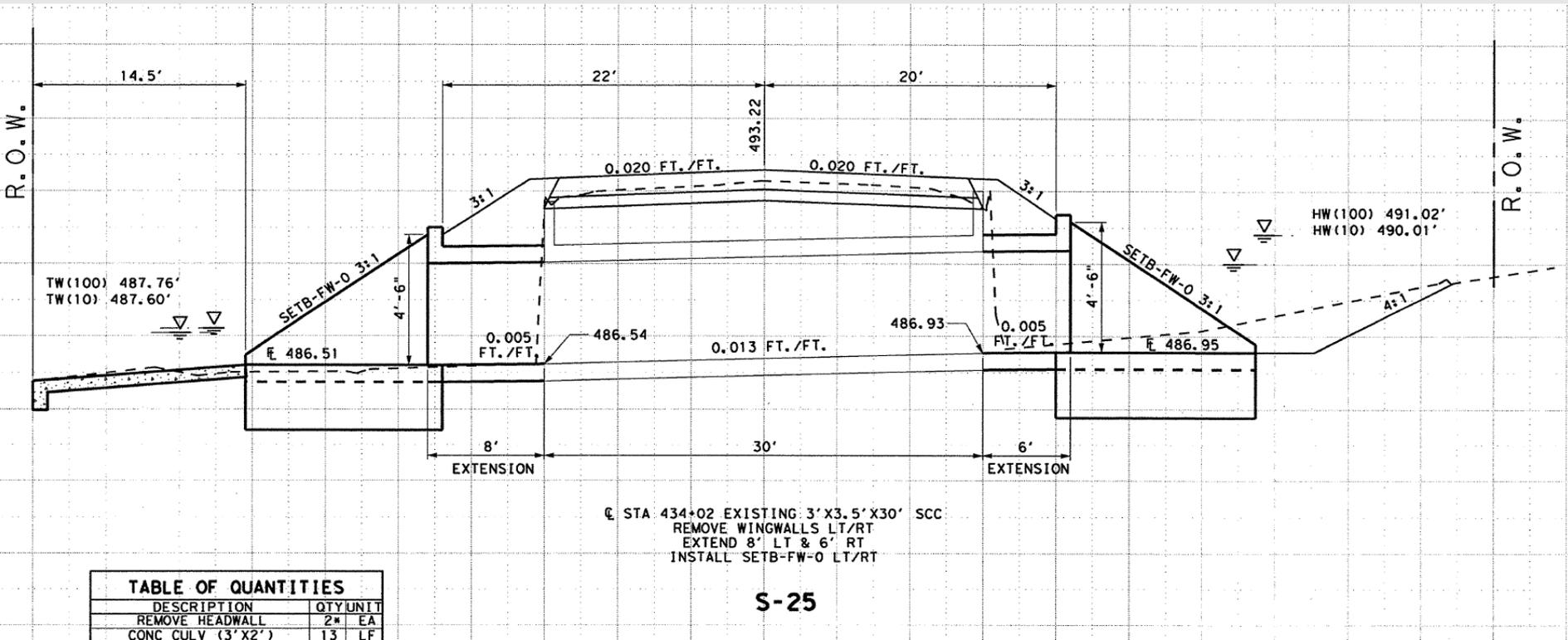
② Drill and grout #6 Dowel 1'-0" into existing structure as shown in accordance with Item 420.4.G.10, "Concrete Structures"

Need Good Construction Quality at Construction Joint



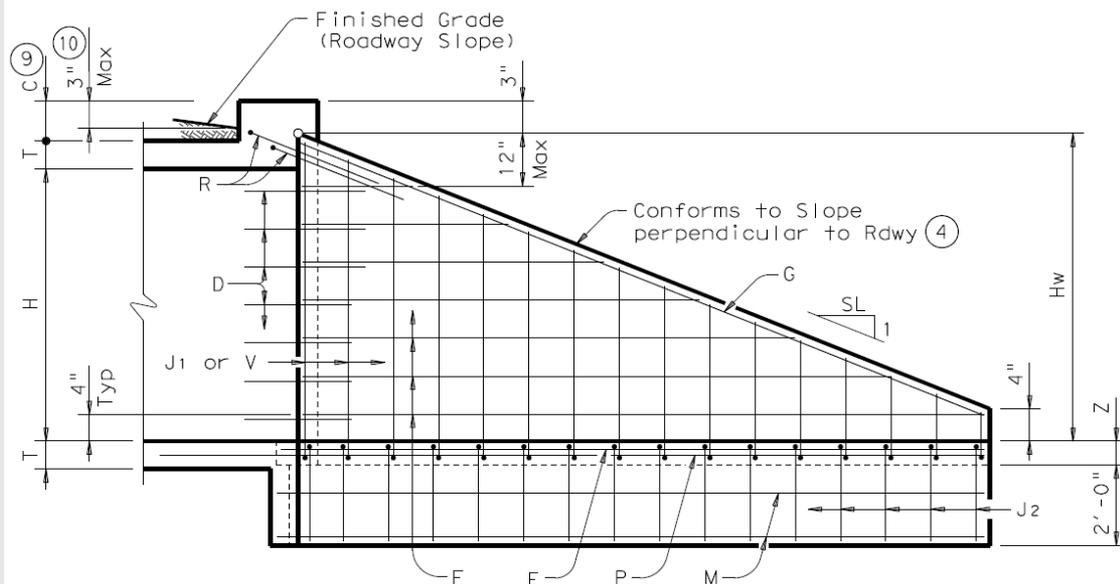
NOTE: Minor cracking, delamination & spalling on top slab & culvert walls along both widening joints - with exposed steel on top slab of north widening joint in Boxes 1, 2 & 4 (from west).

Culvert Cross Sections



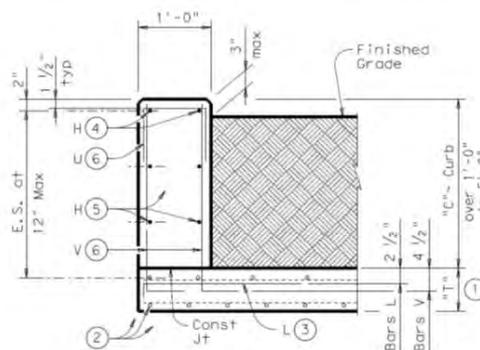
Height Limits of Present Standards

- Wingwall Height for Box Culverts Limited to 16 ft on Parallel Wing and Flared Wing Standards
- ECD Standard Limits Curb Height to 5 ft
 - Likely Safely Modified to Be Taller in Case of No Traffic Rail (eg. shallow culverts with tall wingwalls)
- $H_w > 16$ ft Requires a Custom Retaining Wall Solution



INSIDE ELEVATION

(Showing reinforcing. Culvert and Culvert Toewall reinforcing not shown for clarity.)



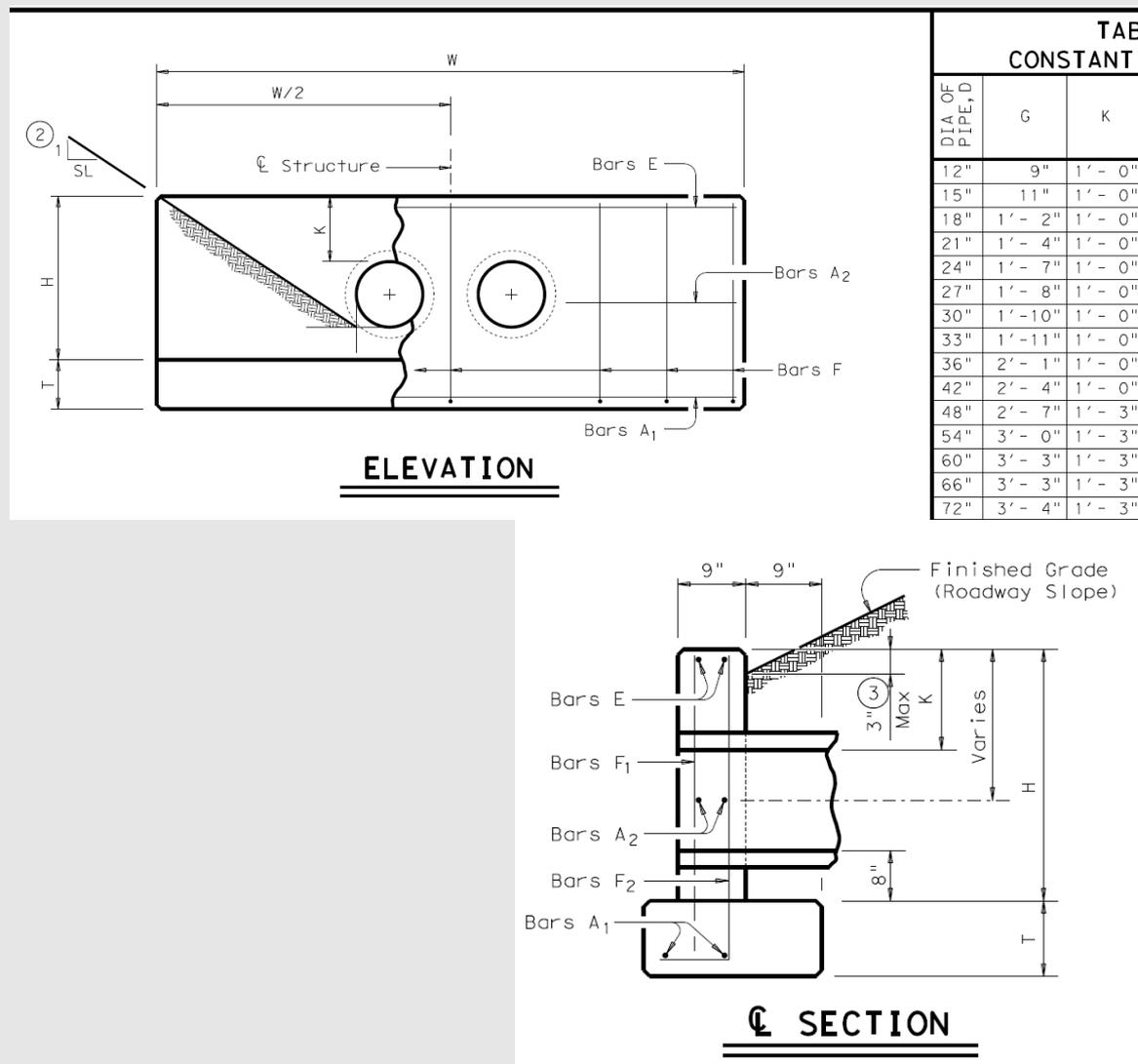
TYPICAL SECTION

Used For Curbs over 1'-0" to 5'-0"

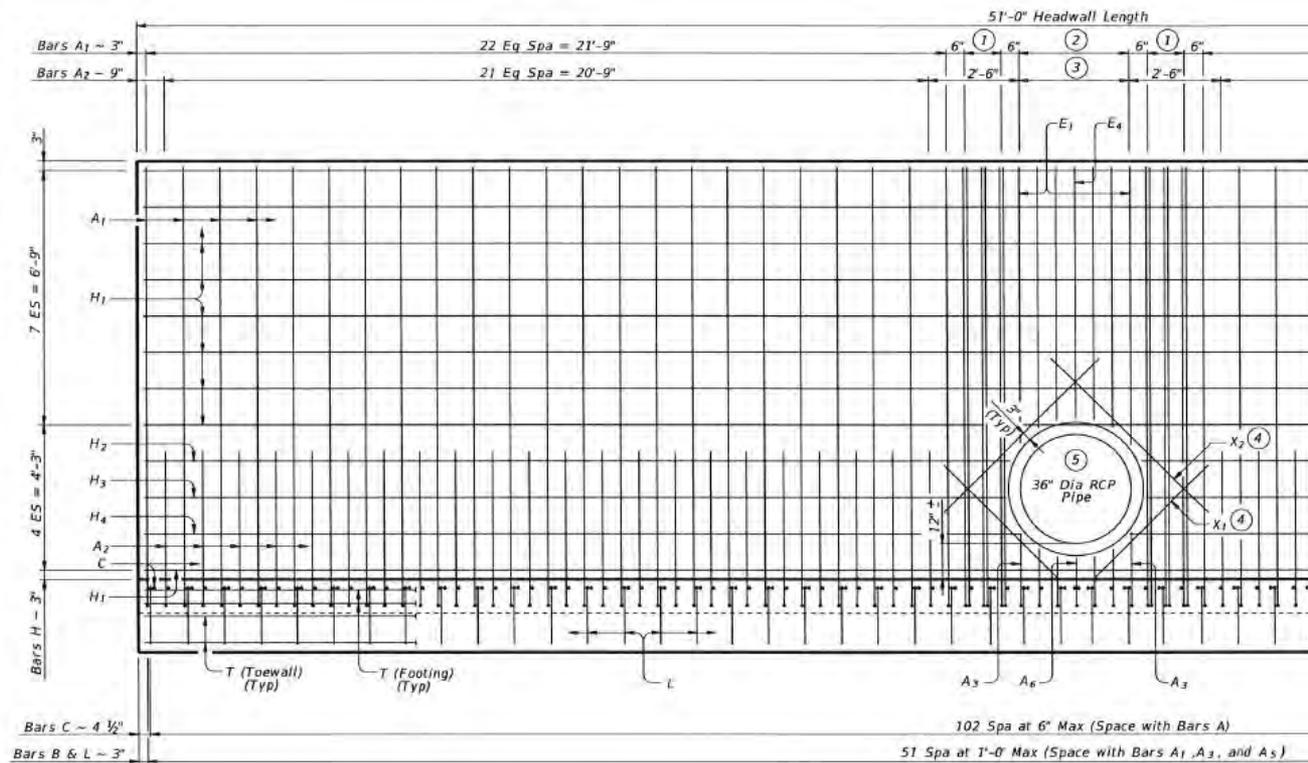
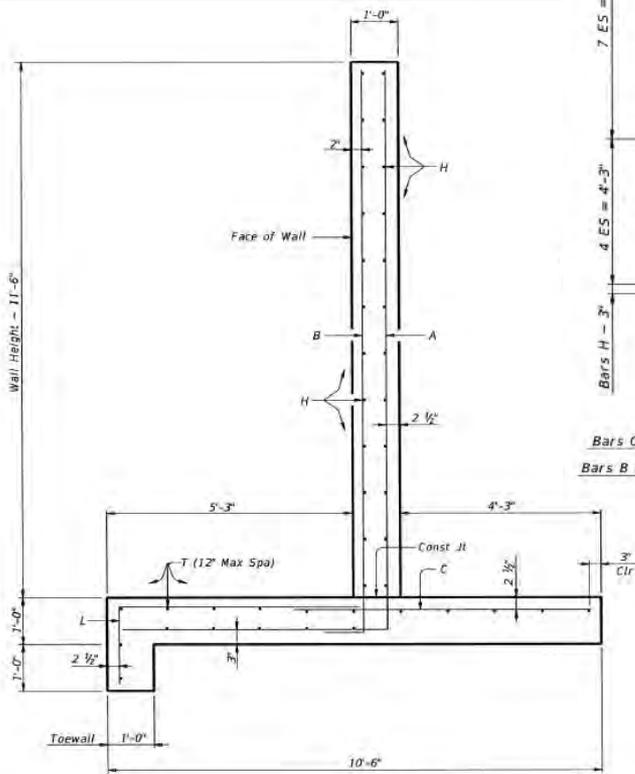
		Bridge Division Standard	
EXTENDED CURB DETAILS FOR BOX CULVERTS WITH CURBS OVER 1'-0" TO 5'-0" TALL			
ECD			
FILE: ecdstd1.dgn	DW: GAF	CK: []	DW: TxDOT CK: GAF
©TxDOT February 2010	CONT	SECT	JOB HIGHWAY
REVISIONS			
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Pipe Headwalls

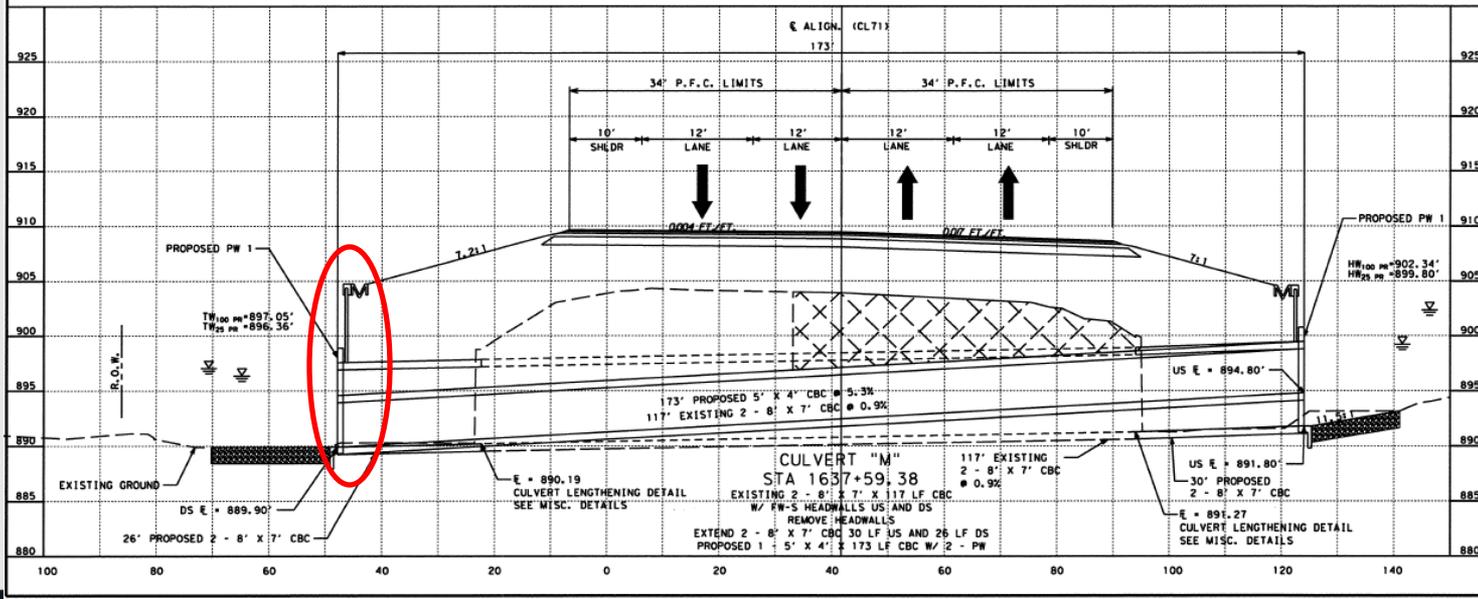
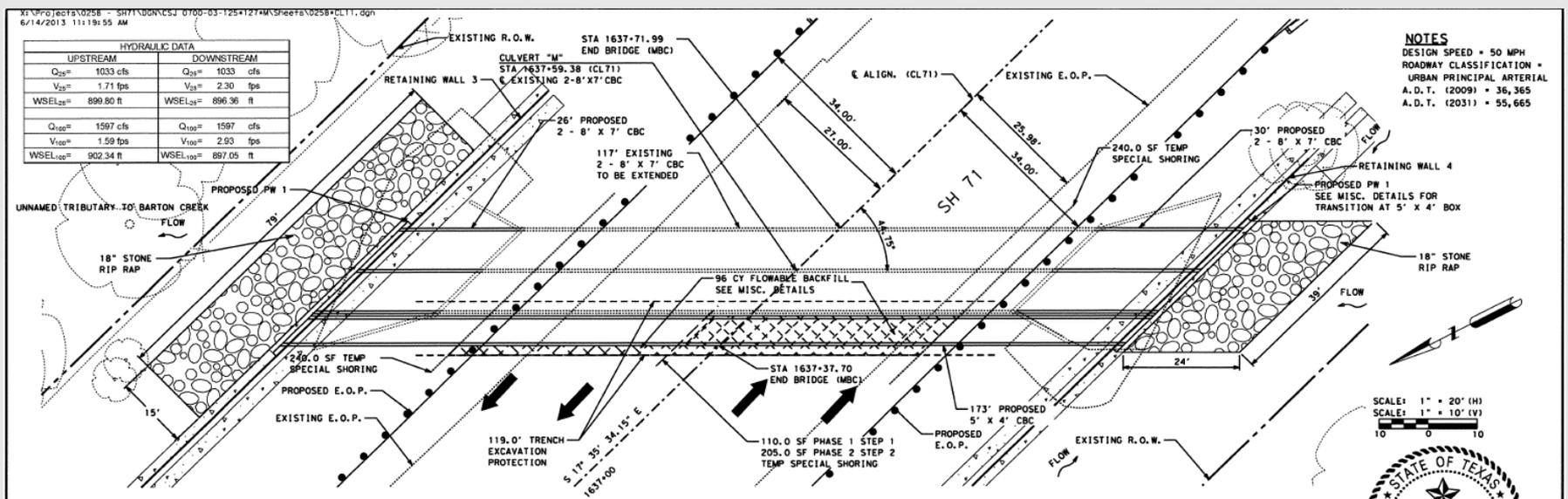
- Pipe Headwall Standard is Only Geared Toward Small Vertical Projection Above Pipe
- Modification without Proper Structural and Geotechnical Evaluation not Recommended
- $H >$ Limits Shown Requires a Custom Solution



Example Custom Pipe Headwall



Retaining Walls at Culvert Ends: MSE Wall



NO. DATE REVISION APPROV.

BROWN & GAY Brown & Gay Engineers, Inc.
 Houston • Austin • Dallas • Fort Worth • Frisco
 TBPE Registration No. F-1046

K FRIESE & ASSOCIATES, INC.
 FIRM # 6535

Texas Department of Transportation
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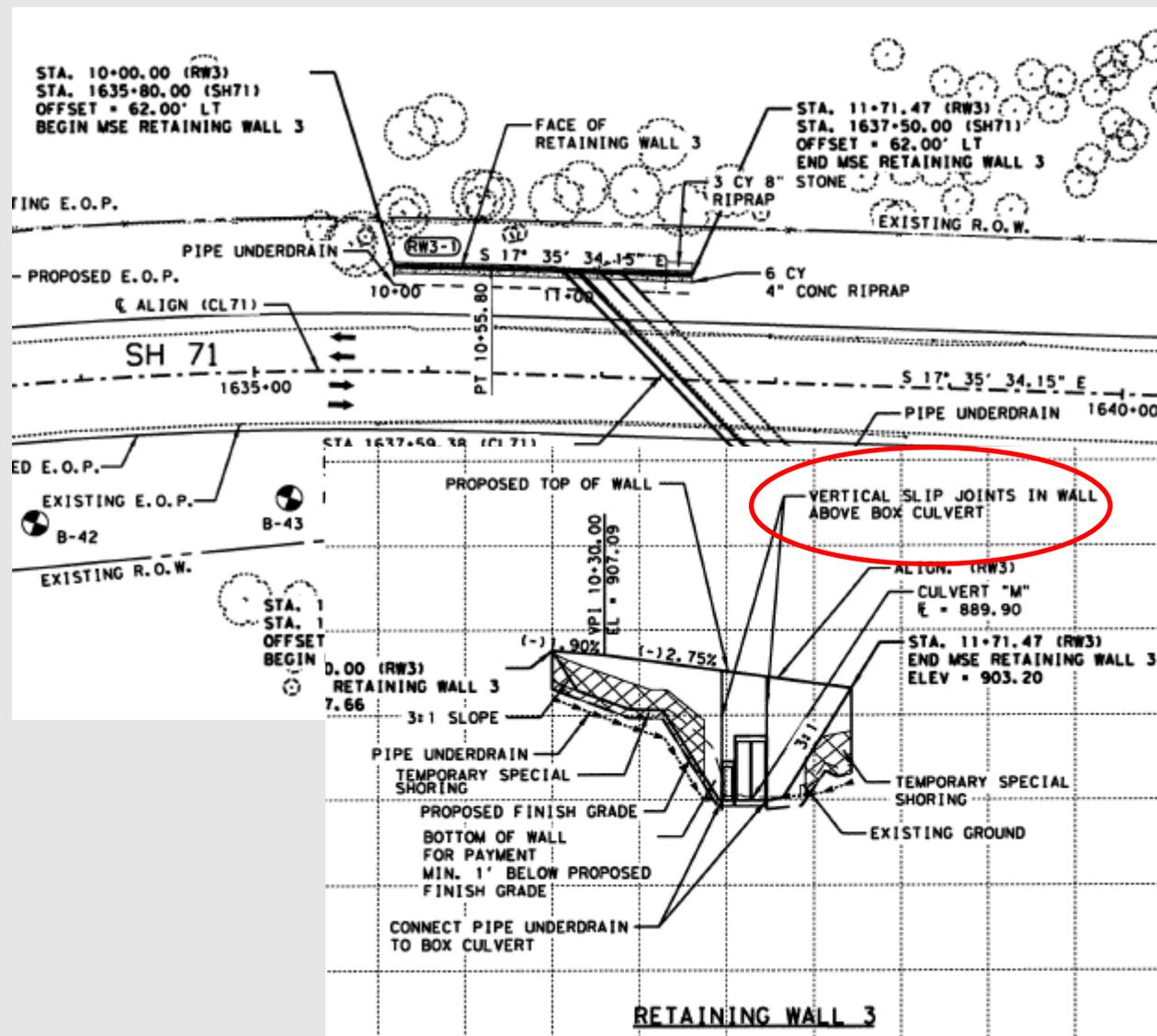
SH 71
 CULVERT LAYOUT
 CULVERT "M"
 STA 1637+59.38
 NBI#14-227-0-0700-03-038

SHEET 1 OF 1

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5		209
STATE	DIST.	COUNTY
TEXAS	AUS	TRAVIS
CONT.	SECT.	JOB
0700	03	125, etc.
		HIGHWAY NO.
		SH 71

Retaining Walls at Culvert Ends: MSE Wall

- Vertical Slip Joints for Differential Support Stiffness
- Inset Wall Panels Nested Behind Curb and Short (~2 ft) PW
- Strap Length Demand Will Require More Installation Room Behind Wall Compared to CIP Cantilever Wall
 - beware in skews
- MSE More Economical than CIP on Larger Scale (~\$35/SF)



Retaining Wall at Culvert Ends: CIP Cantilever Wall

- Essentially Similar to PW Standard
 - Larger Scale Heel/Toe Dimensions
- Can use Spread Footing Retaining Wall Standards as Guide
 - Bar Framing and Load Path Details Considering Culvert Opening
- Requires Less Room than MSE
- More Expensive at \$50/SF, but More Appropriate on Small Scale Projects

Other Structural Considerations

- Some Old Culvert Sizes are Non-Standard Now
 - Custom design using CULV5 and design spreadsheets
- Stone Riprap or Gabions Preferred to Concrete Riprap
 - Need toewalls to prevent undermining



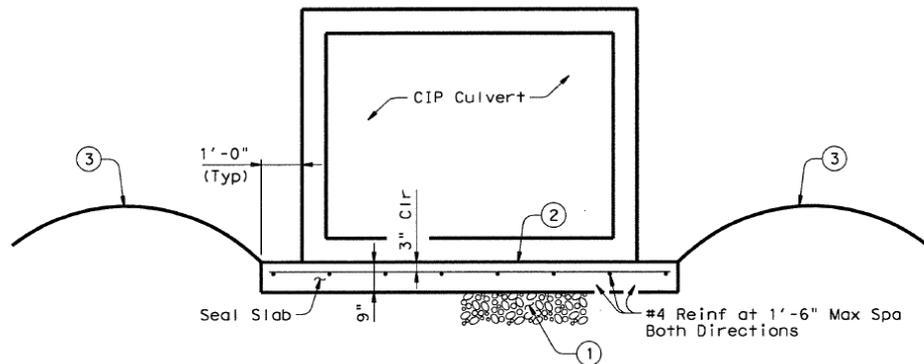
Speed of Construction: Sheet Pile Wings and PC Culverts YKM

- Fast construction using prefabricated sheet piling compared to CIP wingwalls
- No shoring required
- Requires suitable soil conditions and soil borings
- Precast single cell box culverts



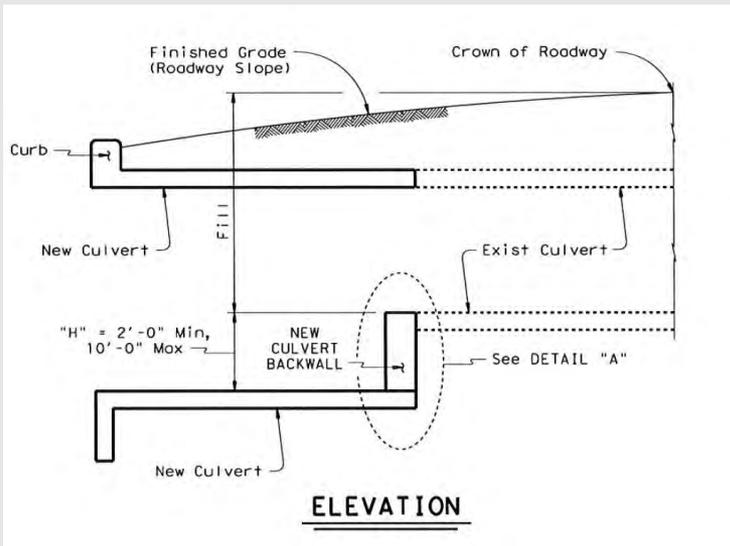
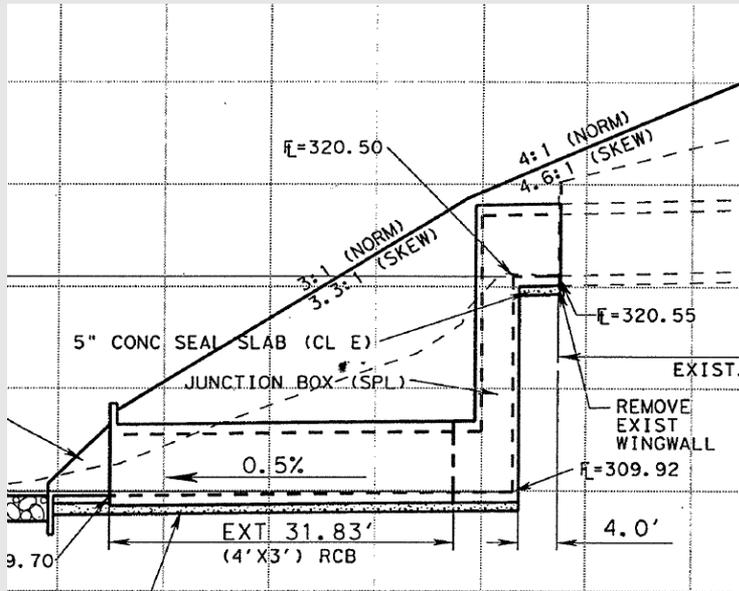
Construction in Standing Water

- Seal slab may be needed

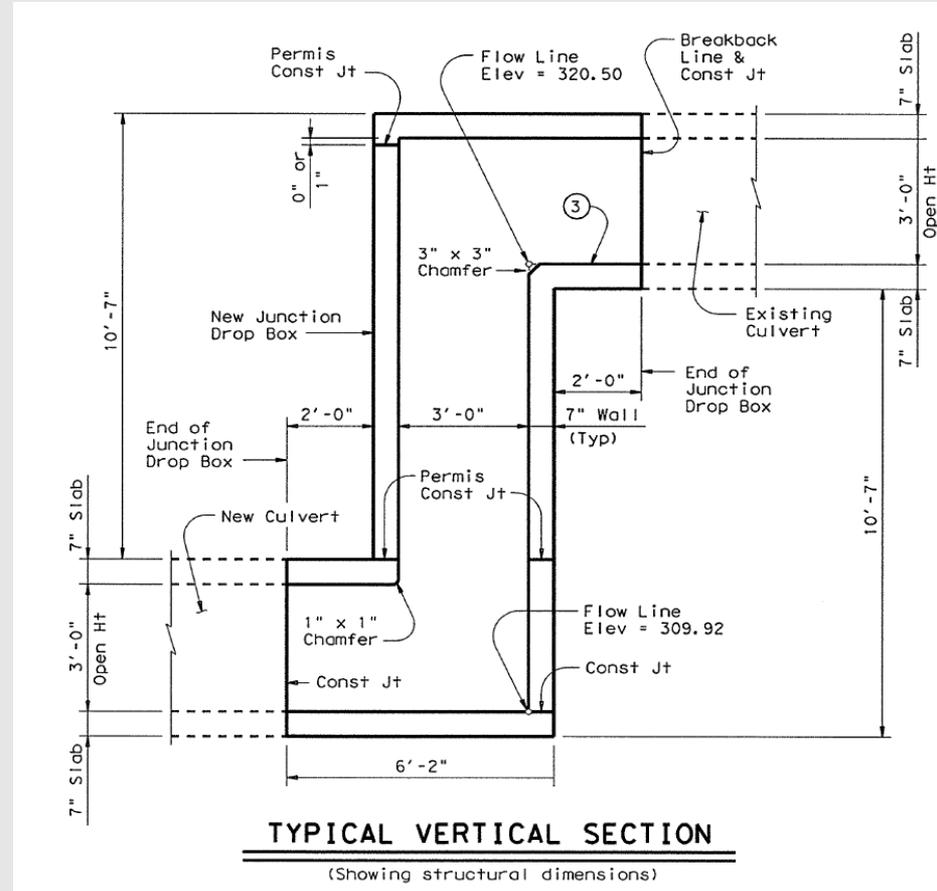


- ① Use proof rolling to identify any loose, soft, or unsuitable materials below the level of the seal slab or below the culvert if the seal slab is not used. Proof roll in accordance with Item 216 with a maximum rut depth of 1" per pass of pneumatic tired roller. If this rut depth criteria cannot be achieved, continue to proof roll and/or remove/replace or modify supporting material as necessary to achieve this criteria.
- ② Grade seal slab to provide culvert flow line specified on culvert layouts.
- ③ Provide perimeter treatment such as sandbags, shoring or other approved method to prevent water from entering area of construction

Unique Situations : Elevation Drop



ELEVATION

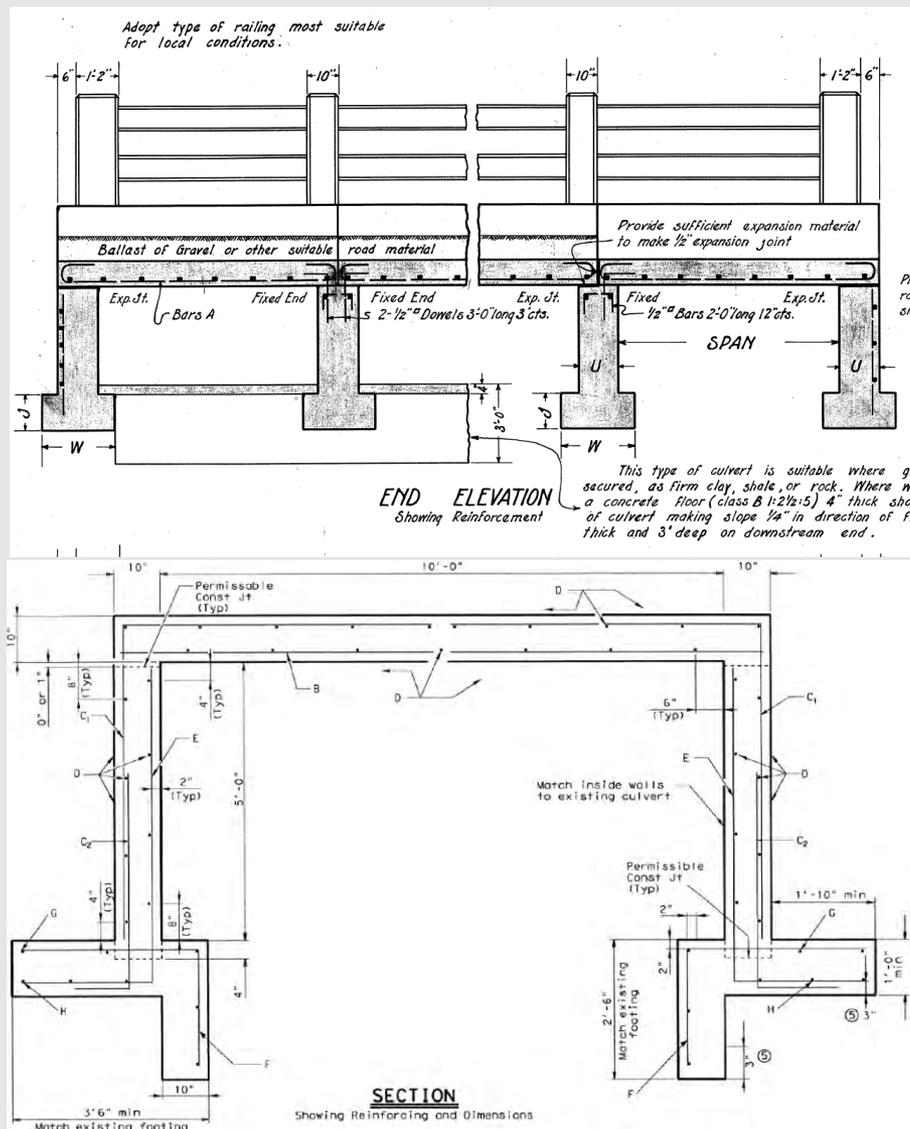


TYPICAL VERTICAL SECTION

(Showing structural dimensions)

Unique Situations: Three-Sided Culverts

- Designs from the 1920's
- Founded on Strip Footings
- Needs Condition Survey

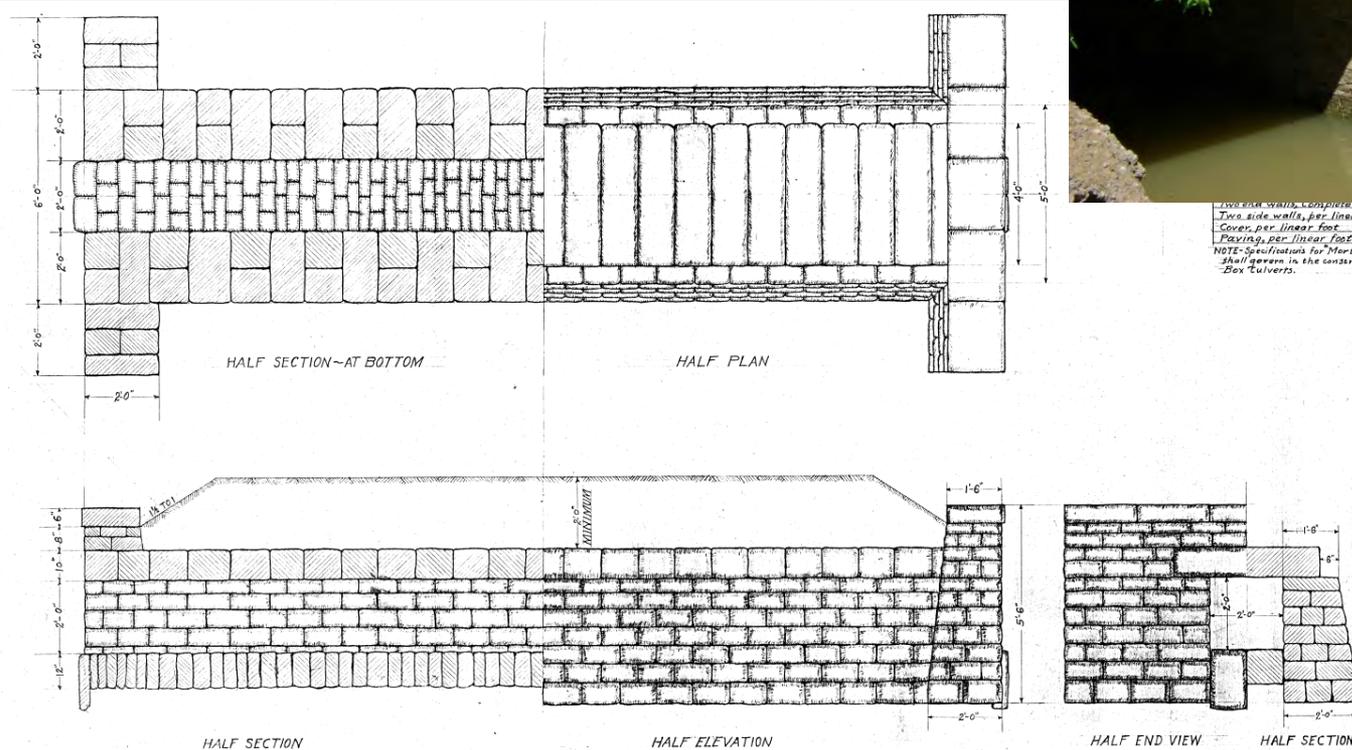


Unique Situations: Masonry Culverts

- THC Might Consider Historic
- Structurally Problematic
- Need Condition Survey



Two end walls, complete
Two side walls, per linear foot
Covers, per linear foot
Paving, per linear foot
NOTE: Specifications for Mortar R
shall govern in the construction
of Box Culverts.



Questions?

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Happy Retirement, Mark Steves!

Culverts Taste Better

When Built Out of Cake

