January 23, 2025

Welcome to Bridge Briefings

We will begin at 11:30 AM

Reminders

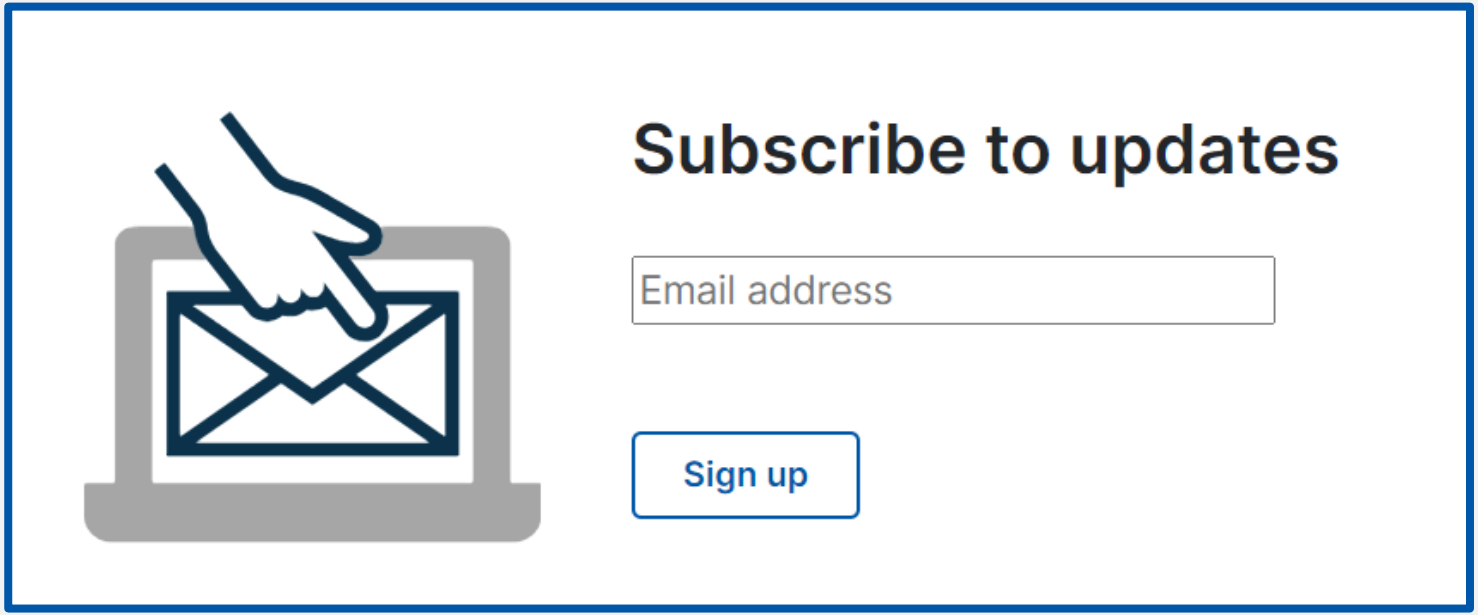
Chat is turned off, please use the Q&A box

Slides will be posted on the Bridge Website

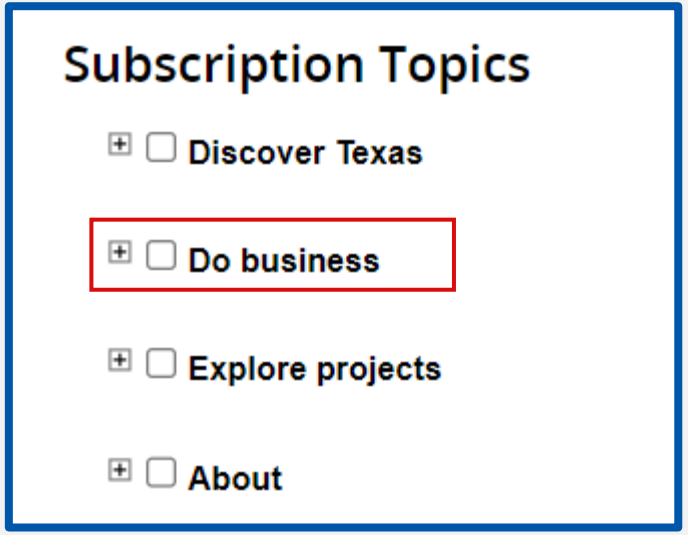
https://www.txdot.gov/business/resources/highway/bridge/webinar-presentations/bridge-briefings.html

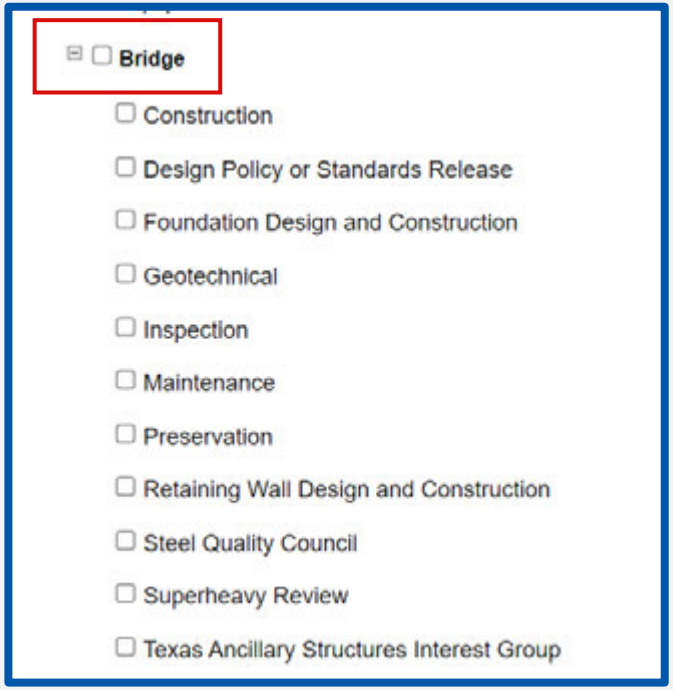
Don’t miss out on other updates!

https://www.txdot.gov/about/divisions/bridge-division.html



Don’t miss out on other updates!





PDH

- Please remember Bridge Division does not provide documentation for TX Board PDH approval. Each engineer should exercise personal judgement when counting webinar topics for their professional development hours. For more info on what qualifies for Continuing Education, please visit https://pels.texas.gov/CEPInfo.htm

2025 Roadway Design and Bridge Conference

- Registration is filling up fast!

https://roadway-design-and-bridge-conference.webflow.io/

January 23, 2025

Slope Stability Considerations

Ryan L. Eaves P.E.

Bridge Division – Geotechnical Branch

Why is Slope Stability Important?

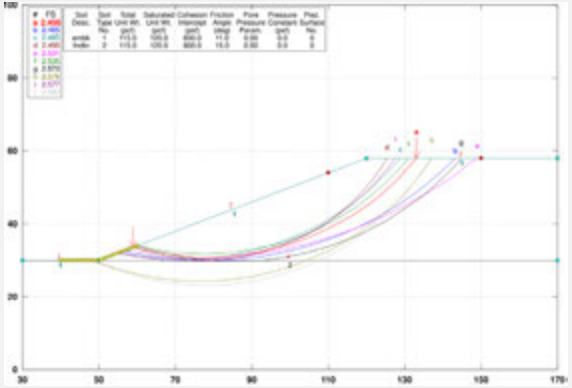
- Damage to Underground
- Maintenance Cost
- Traffic Impacts

Why is Slope Stability Important?

- Roadway/Structure Stability
  - Slopes and Retaining Walls are structural systems.
  - What unique load conditions affect the slope or retaining wall design?

Slope Stability

- Slope is often the first thought to carry roadway approach
- TxDOT Geotechnical Manual slope stability requirement
- Global stability analysis



Evaluate all slopes, whether a cut or a fill and whether in soil or in rock, for global stability for both short-term (undrained) and long-term (drained) conditions. Specific site conditions may require evaluation for additional types of failure, such as bearing capacity, settlement, and undercutting (for rock cuts).

Scoping Challenges

- Wall/Slope Geometry
  - Is there enough footprint to provide a stable slope?
  - What retaining wall type will fit my constraints?
  - What geometric conditions affect the retaining wall or slope design?

Engineering Resources

- TxDOT Geotechnical Manual Requirements
  - Chapter 7

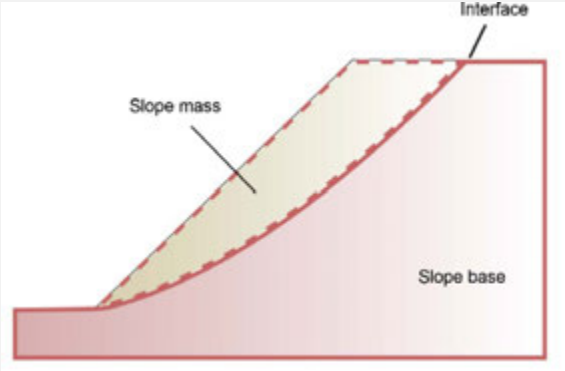
Evaluate all slopes, whether a cut or a fill and whether in soil or in rock, for global (overall) stability. Slopes steeper than 3:1 must have a documented evaluation. When warranted, evaluate for both short-term (undrained) and long-term (drained) conditions under Strength I limit state condition per current edition of AASHTO LRFD Bridge Design Specifications. However, the load factors are not compatible with limit equilibrium analysis and resistance factor is yet to be calibrated & implemented in commercially available software, overall stability analysis still be performed under Allowable Stress Design (ASD) methods.

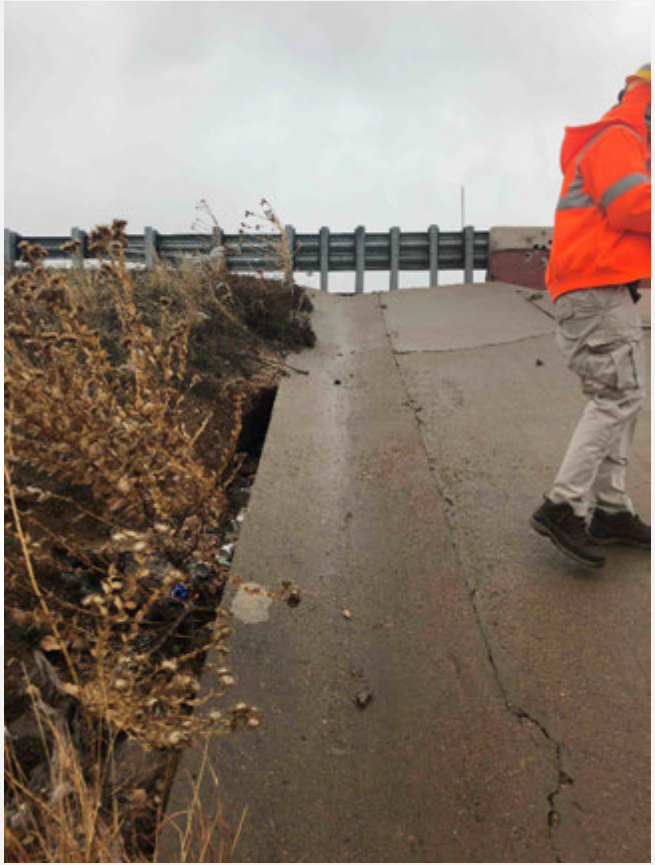
Table 7-1: Plasticity Index Range for Exposed Side Slopes Required for FS =1.3 for the Long Term or Drained Condition

Slope X:1	Plasticity Index (PI) (%)
2.5 to 1	< 5
3.0 to 1	< 20
3.5 to 1	< 35
4.0 to 1	< 55
4.5 to 1	< 85

Design Considerations

- What can we do during design?
  - Geotechnical Stability
    - Material composition
    - Slope angle
    - Surcharge condition





Surface Treatment Limitations – Flexible Revetment

- Not steeper than 3:1 slope recommended

Bridge Briefing – Rail Retrofits

Taya Retterer, P.E.

Texas Department of Transportation

January 23, 2025

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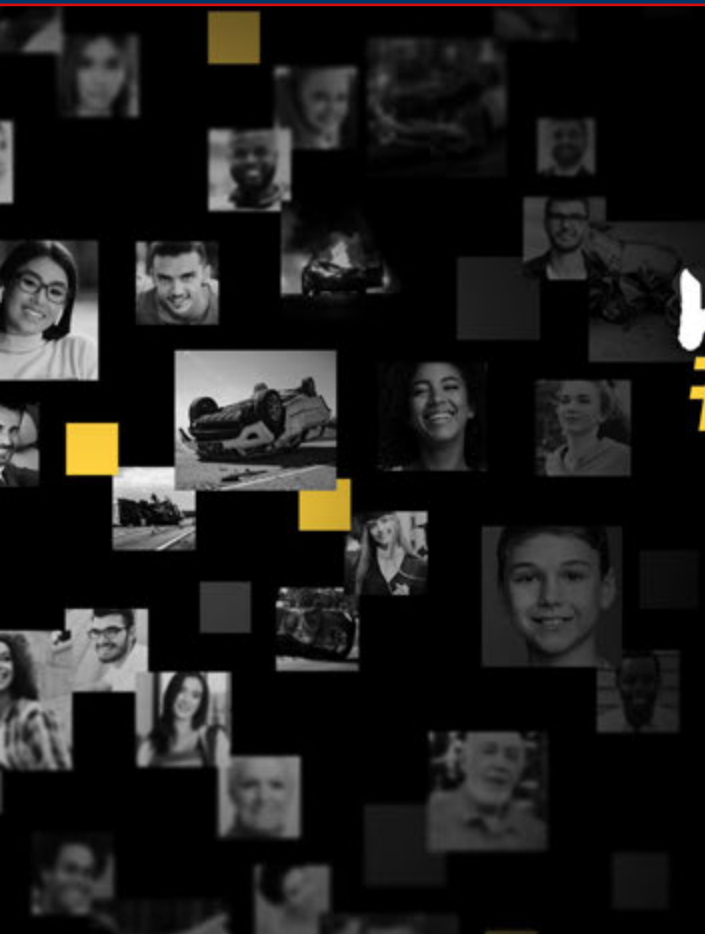


HELP

#EndTheStreakTX

End the streak of daily deaths on Texas roadways.

TxDOT.gov
#EndTheStreakTX Toolkit

Upgrading Bridge Rails

- *Upgrade*, v.
  - To make (something) better by including the most recent information or improvements
  - To get something that is better than what you had originally

- Two ways to upgrade bridge railing
  - Replace
  - Raise height

Upgrading Bridge Rails

- Retrofit ??
  - catch-all phrase, used for both
  - Process (means) by which an upgrade is effected
- Why do we do them?
  - Increase SAFETY

Bridge Railing Manual

https://iapps/apps/OnlineManuals/txdotmanuals/rlg/rlg.pdf

Bridge Railing Manual

- Chapter 2, Section 3 – Texas Policy on Bridge Railing - Overview

  - **New bridges**. Texas bridge railing on new construction must meet FHWA crash-test criteria as specified in MASH 2016.
  - **Existing bridges**. See Chapter 4, "Treatment of Existing Railing" for TxDOT policy on upgrading existing rails

Bridge Railing Manual

- Chapter 2, Section 3 – Texas Policy on Bridge Railing - Approval
  - For a bridge railing type to be considered for approval for use on Texas bridges it must meet one of the following crash worthiness determination:
    - It has been successfully crash tested in accordance with MASH 2016.
    - It has been approved for specific uses by FHWA after evaluation of results from successful crash testing.
    - It has been evaluated by TxDOT and identified as similar in strength and geometry to another rail that has been successfully crash tested in accordance with MASH 2016 criteria.
  - Meeting the above crash worthiness criteria does not guarantee approval of the bridge rail for use on Texas bridges

Bridge Railing Manual

- Chapter 2, Section 3 – Texas Policy on Bridge Railin[illegible]al
  - For a bridge railing type to be considered for a[illegible]bridges it must meet <u>one of</u> the following crash worthiness determinatio[illegible]
    - It has been successfully c[illegible]
    - It has been approved [illegible]esults from successful crash testing.
    - It has been evaluated by [illegible]milar in strength and geometry to another rail that has been successfully crash [illegible]ce with MASH 2016 criteria.
  - Meeting the above crash worthiness [illegible]a does not guarantee approval of the bridge rail for use on Texas bridges

MUST BE APPROVED BY BRG

Bridge Railing Manual

- Chapter 2, Section 3 – Texas Policy on Bridge Railing – **Rail Type Selection**
  - Use the **greater** of the posted speed or design speed...
    - Above 45 mph must be at least TL3
    - 45 and below must be at least TL2
    - When in doubt, go with TL3

https://houston.culturemap.com/news/travel/09-08-12-is-the-new-85-mph-highway-all-about-the-money-why-the-fastest-road-in-america-makes-cents/

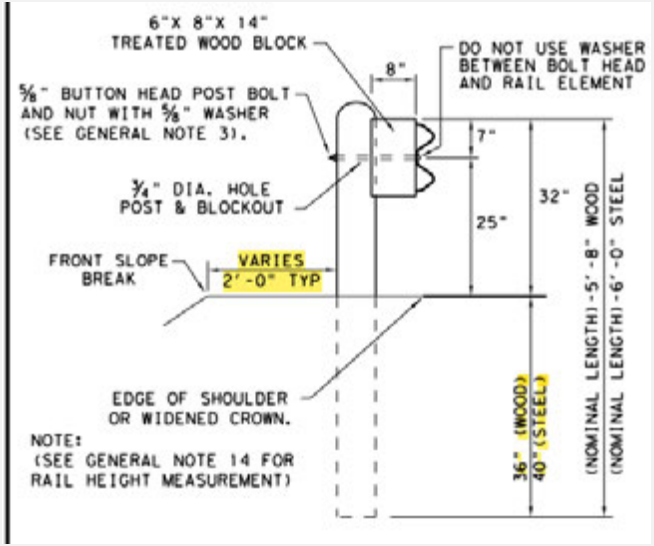
Bridge Railing Manual

- Chapter 2, Section 3 – Texas Policy on Bridge Railing – **Rail Type Selection**
  - Based on this recommendation, **bridge railings rated TL-4 as per MASH 2016 are required for new construction and for bridge railing upgrades of all bridges carrying the main lanes of Interstate highways and divided highways. Bridge railings rated TL-4 are recommended for other routes that carry a mixture of trucks and heavy vehicles**.

https://www.aaroads.com/guides/tx-024/

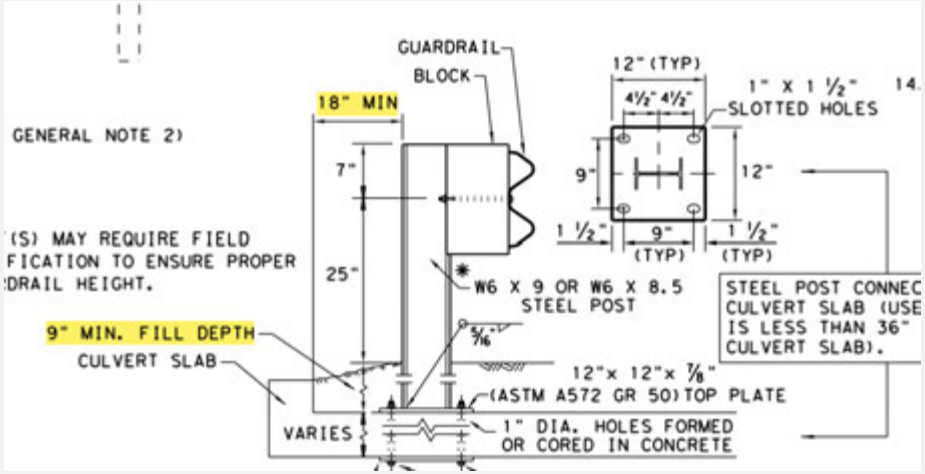
Bridge Railing Manual

- Chapter 2, Section 3 – Texas Policy on Bridge Railing – **Culverts**
  - Metal beam guard fence meets TL-3 requirements and can be provided as an option to bridge railing in the following ways:
    - If there is 36 in./42 in. or more of fill, the posts can be soil-embedded as per standard GF(31)-14.



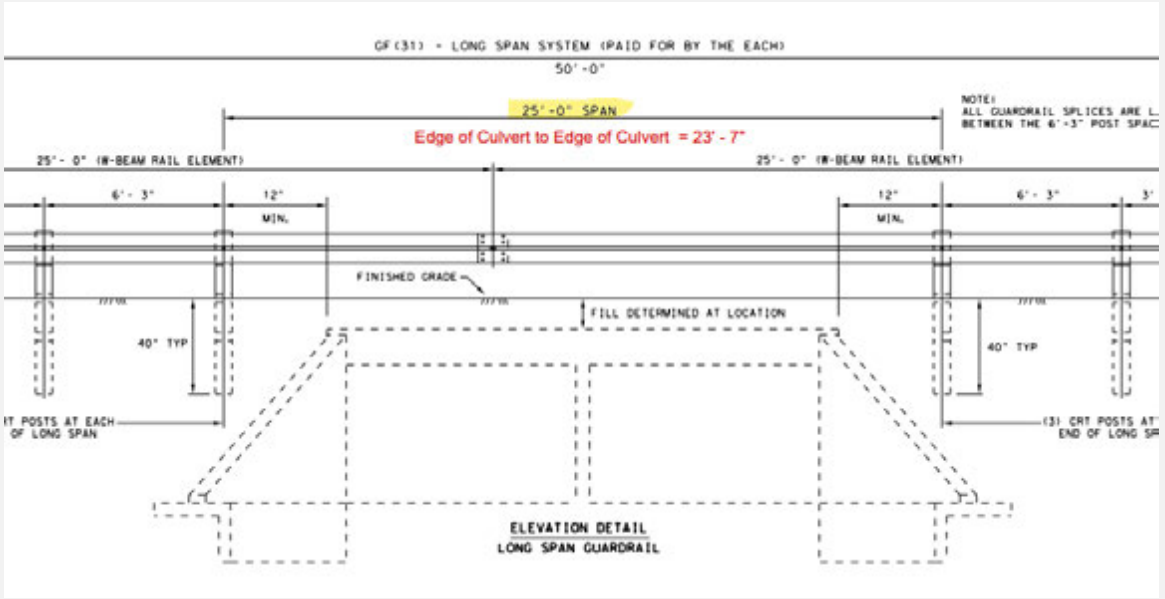
Bridge Railing Manual

- If there is less than 36 in. of fill but at least 9 in., the low fill culvert post detail shown on standard (31)-14 can be used. Requires at least 18 inches between the back of the MBGF and the front of the curb.



Bridge Railing Manual

- Long span guard fence, shown on standard GF(31)LS-14, can be used for shorter bridge-class culverts provided the clearances required by the standard are met

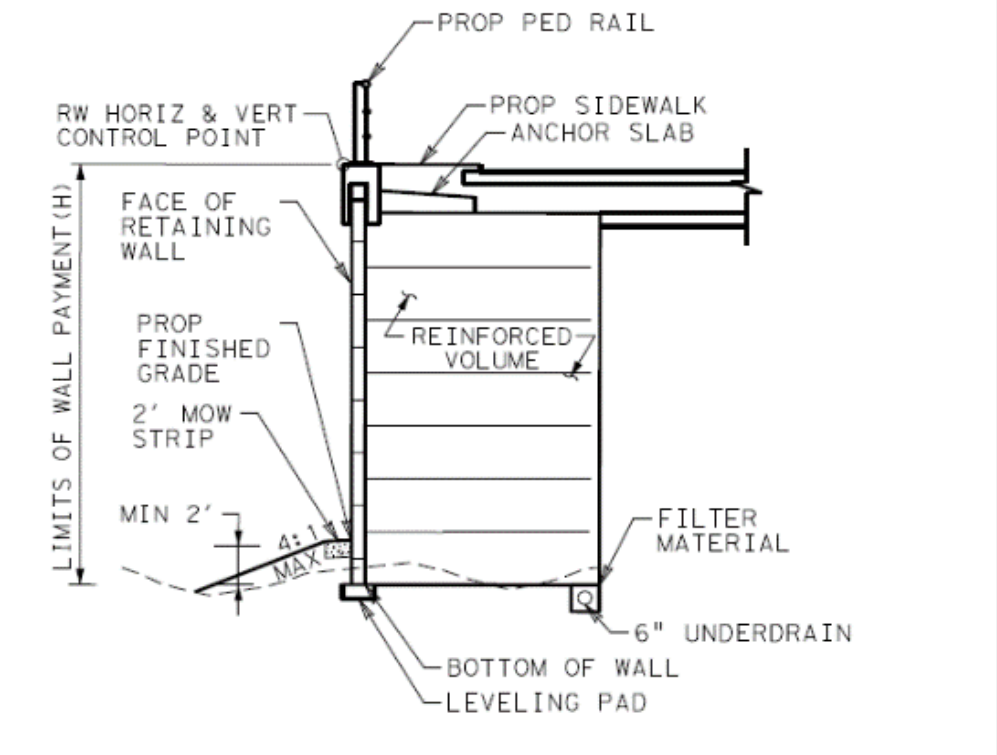


Bridge Railing Manual

- Chapter 2, Section 3 – Texas Policy on Bridge Railing –
  Railing on Roadways Elevated by Retaining Walls
  - Bridge railing placed in-line with the edge of bridge slab or edge of traveled way, extended along the roadway until the retaining wall drop-off terminates.
  - Metal beam guard fence and end treatment attached to bridge railing on the bridge or continuous the full length of the retaining wall and extended along the edge of roadway until the retaining wall dropoff terminates and side slopes are protected in accordance with the Roadway Design Manual.
  - Where raised sidewalks are between the traveled way and the retaining wall, refer to Chapter 3 for requirements

Bridge Railing Manual

- No longer allowed
- Improve safety, treat the same as a bridge
- See Appendix B



Bridge Railing Manual

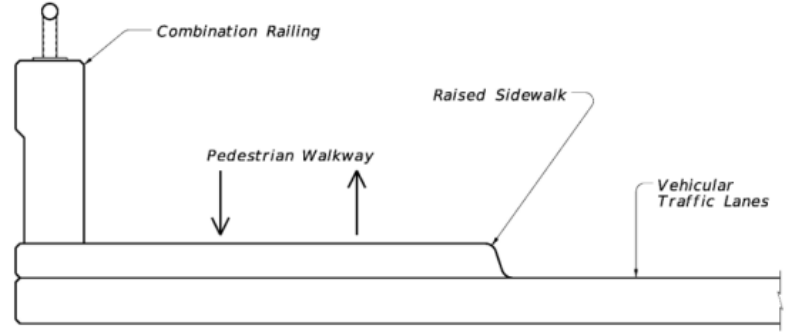


Figure B-2. Bridge railing for vehicular and non-vehicular traffic -- low speed

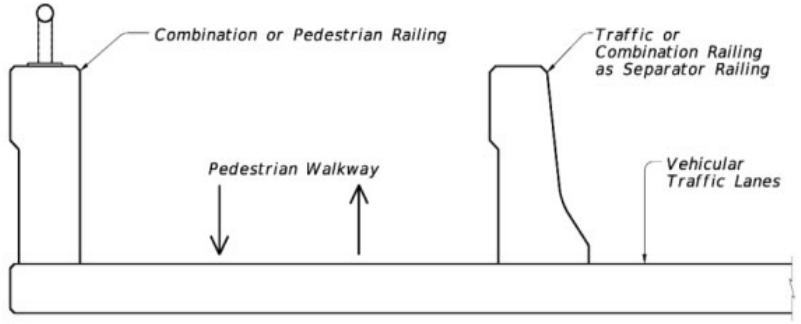
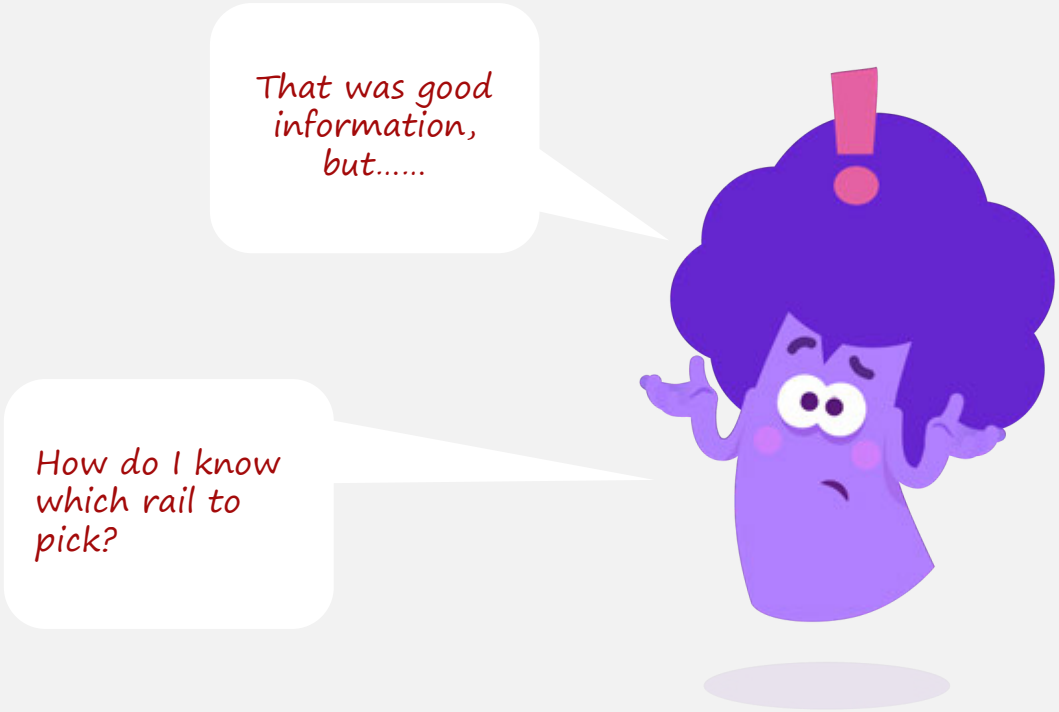


Figure B-3. Bridge railing for vehicular and non-vehicular traffic -- high speed

Bridge Rail Selection



Bridge Rail Selection

- Appendix A – Current Standard Bridge Railings in Texas
  - Introduction
    - T – Vehicular Traffic – designed for vehicles only, NO Pedestrians
    - P – Pedestrian – NOT rated for vehicular traffic
    - C – Combination Pedestrian and Traffic
  - Section 2 – Metal Railing
  - Section 3 – Metal and Concrete Railing
  - Section 4 – Concrete Railing

Bridge Rail Selection

- Appendix A – Current Standard Bridge Railings in Texas
  - Section 5 – **Bridge Rail Type Selection Guidance**
    - Based on Recommended Guidelines for the Selection of Test Levels 2 Through 5 Bridge Rails (NCHRP 22-12(03))
    - Web-Only Document 307 https://www.trb.org/Publications/Blurbs/182548.aspx

Bridge Rail Selection

Bridge Rails by Test Level

Low speed (45 mph or less)	High Speed (above 45 mph)			
TL-2 (car and pickup)	**TL-3 (car and pickup)**	**TL-4 (single unit truck, car, and pickup)**	**TL-5 (tractor-van trailer, car, and pickup)**	**TL-6 (tractor-tank trailer, car, and pickup)**
T631LS	T1F	T2P / C2P	T224	T80TT
T411	T1P	T222	T80HT	
C411	T1W	T402 / C402	T80SS	
	T221 / C221	SSTR	C412	
	T223 / C223	C1W		
	T551 / T552			
	T631			
	T66 / C66			
	T131RC			
	T221P			

Bridge Rail Selection

- Historic Looking

Bridge Rails by Test Level

Low speed (45 mph or less)	High Speed (above 45 mph)			
TL-2 (car and pickup)	TL-3 (car and pickup)	TL-4 (single unit truck, car, and pickup)	TL-5 (tractor-van trailer, car, and pickup)	TL-6 (tractor-tank trailer, car, and pickup)
T631LS	T1F	T2P / C2P	T224	T80TT
T411	T1P	T222	T80HT	
C411	T1W	T402 / C402	T80SS	
	T221 / C221	SSTR	C412	
	T223 / C223	C1W		
	T551 / T552			
	T631			
	T66 / C66			
	T131RC			
	T221P			

Bridge Rail Selection

- Aesthetic

Bridge Rails by Test Level

Low speed (45 mph or less)	High Speed (above 45 mph)			
TL-2 (car and pickup)	TL-3 (car and pickup)	TL-4 (single unit truck, car, and pickup)	TL-5 (tractor-van trailer, car, and pickup)	TL-6 (tractor-tank trailer, car, and pickup)
T631LS	T1F	T2P / C2P	T224	T80TT
T411	T1P	T222	T80HT	
C411	T1W	T402 / C402	T80SS	
	T221 / C221	SSTR	C412	
	T223 / C223	C1W		
	T551 / T552			
	T631			
	T66 / C66			
	T131RC			
	T221P			

Bridge Rail Selection

- Open and Partially Open

Bridge Rails by Test Level

Low speed (45 mph or less)	High Speed (above 45 mph)			
TL-2 (car and pickup)	TL-3 (car and pickup)	TL-4 (single unit truck, car, and pickup)	TL-5 (tractor-van trailer, car, and pickup)	TL-6 (tractor-tank trailer, car, and pickup)
T631LS	T1F	T2P / C2P	T224	T80TT
T411	T1P	T222	T80HT	
C411	T1W	T402 / C402	T80SS	
	T221 / C221	SSTR	C412	
	T223 / C223	C1W		
	T551 / T552			
	T631			
	T66 / C66			
	T131RC			
	T221P			

Bridge Rail Selection

- Other categories covered
  - Drainage
  - Lightest
  - Narrowest
  - Precast or rapid construction

Bridge Rail Selection

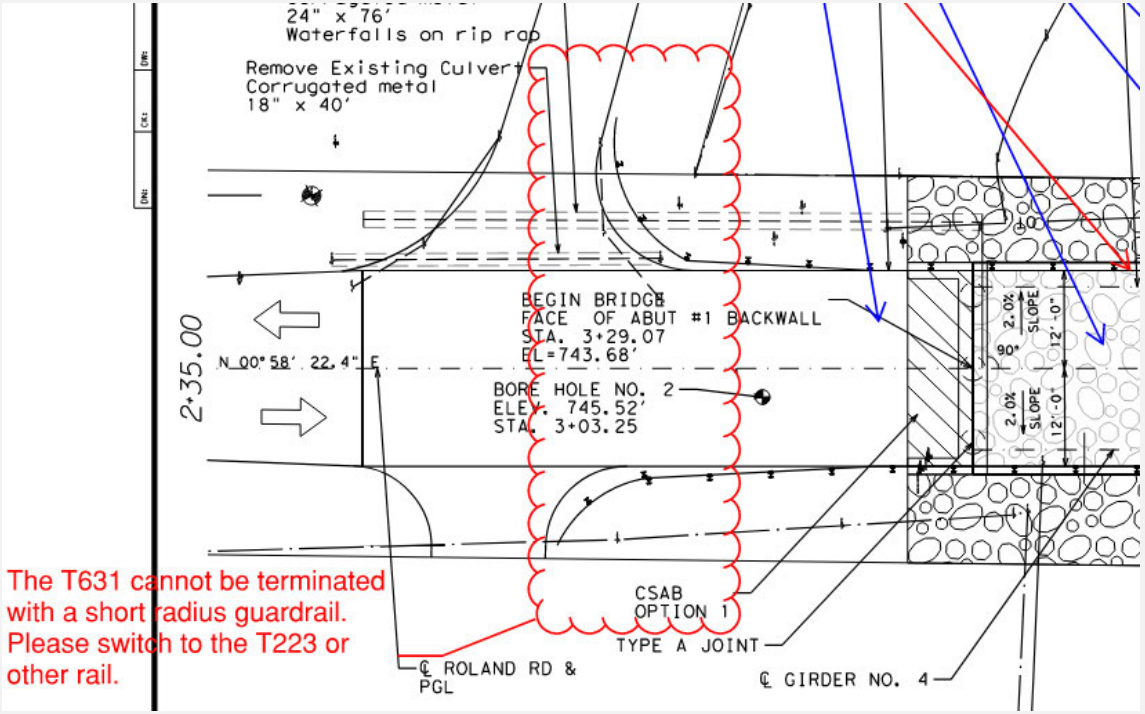
- Considerations
  - ADT / ADTT – higher levels warrant a higher test level (ie, TL4 or TL5)
  - Type of Roadway
  - Traffic Mix
  - What is located under or adjacent to the bridge?
    - T631 and T631S cannot be used over a lower roadway
    - Schools, emergency services, other critical buildings or infrastructure may warrant a higher test level (TL5, rarely TL6)

Bridge Rail Selection

- Considerations
  - Posted speed
  - Approach roadway horizontal and vertical curves
  - Bridge width, shoulder width, horizontal and vertical curves
  - Pedestrians
  - Drainage
  - Maintenance – should NOT be the only consideration

Bridge Rail Selection

- End Treatments
  - Is there space?
  - Do NOT mix a T631 with a short radius MBGF
  - T631 must be anchored with 25’ MBGF plus appropriate end treatment



Policy in the Bridge Railing Manual

Policy in the Bridge Railing Manual

- Chapter 4 – Treatment of Existing Railing
  - Section 2 – Bridge Railing Retrofit Requirements
    - FHWA Policy
    - Texas Policy
    - Existing Railing Meeting Current Standards
    - Measuring Bridge Railing Height
    - Bridge Railing Height in Pavement Overlay
    - Transition Upgrades
    - Recommendations

https://ftp.txdot.gov/pub/txdot-info/library/pubs/bus/bridge/railing.pdf

Policy in the Bridge Railing Manual

- Need to upgrade bridge railing is based on:
  - Project classification
  - Work done in project affecting the rail
- Found in Table 4.2.1

Table 4.2.1: TxDOT Requirements Upgrading Bridge Railing Current Standards

Project Classification		Railing Action
Preventive Maintenance (PM) and 2R		Replacement of traffic railing not complying with MASH or NCHRP Report 350 is recommended but not required as long as the minimum rail height requirement is met. Existing traffic railing complying with MASH, or NCHRP Report 350 may be raised to meet the minimum rail height requirement. Existing rail that does not meet the minimum rail height and does not comply with MASH, or NCHRP Report 350 must be upgraded to comply with MASH.
3R	If the structure is not widened and if no work affecting the existing railing is done as part of the 3R project.	Replacement of traffic railing not complying with MASH or NCHRP Report 350 is recommended but not required as long as the minimum rail height requirement is met. Existing traffic railing complying with MASH, NCHRP Report 350 may be raised to meet the minimum rail height requirement.
3R	If rehabilitation work is scheduled or performed which widens the structure to either side or redecks (full-depth) any complete span of the structure, or if any work affecting the rail is done to the existing structure as part of the 3R project.	All traffic railing on the structure must comply with MASH. Railing adjacent to pedestrian walkways must comply with requirements in Chapter 3. Exceptions by approval of Design Exception or Design Waiver Request. Submit the Design Exception or Design Waiver Requests to the Bridge Division. Exceptions to compliance with MASH: 1. Design Exception approval required if ADT is greater than 1,500 VPD. 2. Design Waiver approval required if ADT is less than 1,500 VPD.
4R		Traffic railing must comply with MASH. Railing adjacent to pedestrian walkways must comply with requirements in Chapter 3. Exceptions by approval of Design Exception Request.
Hazard Elimination Program (HES) Projects		3R or 4R criteria as applicable to the elements affected by the programmed scope of the HES project.
All Project Classifications		When traffic rail is upgraded to MASH, adjacent MBGF and guard fence transitions must also be upgraded.

Policy in the Bridge Railing Manual

- PM and 2R
  - Preventative maintenance projects
  - Resurfacing and restoration projects
  - Usually work does not affect the bridge
- Upgrade?
  - Recommended, not required
  - Must meet minimum rail height

Preventive Maintenance (PM) and 2R	Replacement of traffic railing not complying with MASH or NCHRP Report 350 is recommended but not required as long as the minimum rail height requirement is met. Existing traffic railing complying with MASH, or NCHRP Report 350 may be raised to meet the minimum rail height requirement. Existing rail that does not meet the minimum rail height and does not comply with MASH, or NCHRP Report 350 must be upgraded to comply with MASH.

Policy in the Bridge Railing Manual

- 3R
  - Rehabilitation projects
  - Often can affect the rail
- Upgrade?
  - Depends on the work done

3R	If the structure is not widened and if no work affecting the existing railing is done as part of the 3R project.	Replacement of traffic railing not complying with MASH or NCHRP Report 350 is recommended but not required as long as the minimum rail height requirement is met. Existing traffic railing complying with MASH, NCHRP Report 350 may be raised to meet the minimum rail height requirement.
3R	If rehabilitation work is scheduled or performed which widens the structure to either side or redecks (full-depth) any complete span of the structure, or if any work affecting the rail is done to the existing structure as part of the 3R project.	All traffic railing on the structure must comply with MASH. Railing adjacent to pedestrian walkways must comply with requirements in Chapter 3. Exceptions by approval of Design Exception or Design Waiver Request. Submit the Design Exception or Design Waiver Requests to the Bridge Division. Exceptions to compliance with MASH: 1. Design Exception approval required if ADT is greater than 1,500 VPD. 2. Design Waiver approval required if ADT is less than 1,500 VPD.

Policy in the Bridge Railing Manual

- 3R no work affecting rail
- Upgrade?
  - Recommended, not required
  - Must meet minimum rail height
- 3R work affecting rail
  - widening
  - re-decking
  - other
- Upgrade?
  - Required

Policy in the Bridge Railing Manual

4R	Traffic railing must comply with MASH. Railing adjacent to pedestrian walkways must comply with requirements in Chapter 3. Exceptions by approval of Design Exception Request.
Hazard Elimination Program (HES) Projects	3R or 4R criteria as applicable to the elements affected by the programmed scope of the HES project.
All Project Classifications	When traffic rail is upgraded to MASH, adjacent MBGF and guard fence transitions must also be upgraded.

NOTE: For project classifications and work that does not require the bridge rail to be upgraded, MBGF and MBGF transitions may be upgraded without upgrading the bridge railing provided no work is done to the bridge railing other than the connection of the bridge railing to the transitions or guard fence.

Existing Railing Meeting Current Standards

- Chapter 4 – Treatment of Existing Railing
  - Section 2 – Bridge Railing Retrofit Requirements
    - FHWA Policy
    - Texas Policy
    - Existing Railing Meeting Current Standards
    - Measuring Bridge Railing Height
    - Bridge Railing Height in Pavement Overlay
    - Transition Upgrades
    - Recommendations

Policy in the Bridge Railing Manual

- Rails posted on BRG Standards Webpage
  - https://www.dot.state.tx.us/insdtdot/orgchart/cmd/cserve/standard/bridge-e.htm#BRIDGERAILINGSTANDARDS
- All traffic/combination rails are compliant and meet MASH

TRAFFIC RAILS

Rev Date	Std Name	Description	File Name
09-19	T1F	Steel Post w/Alum Tube & Opt Curb Drain Slots (TL-3) (33" tall)	RL-T1F-19.dgn
09-19	T1W	Steel Rail w/Curb & Opt Curb Drain Slots (TL-3) (32" tall)	RL-T1W-19.dgn
09-19	T2P	Steel Rail w/Curb & Opt Curb Drain Slots (TL-4) (42" tall)	RL-T2P-19.dgn
09-19	T221	Concrete Vertical Parapet (TL-3)(32"tall)	RL-T221-19.dgn
09-19	T222	Concrete Vertical Parapet (TL-4)(36"tall)	RL-T222-19.dgn
09-19	T223	Concrete Beam & Post w/6' Openings (TL-3)(32" tall)	RL-T223-19.dgn
09-19	T224	Concrete Beam & Post w/10' Openings (TL-5)(42" tall)	RL-T224-19.dgn
09-19	T402	Concrete Parapet w/Steel Posts & Rail (TL-4)(42" tall)	RL-T402-19.dgn
07-20	T411	Concrete Traffic Rail w/Windows (Tx Classic)(TL-2)(32" tall)	RL-T411-20.dgn
09-19	T551	Concrete Safety F-Shape (TL-3)(32" tall)	RL-T551-19.dgn
09-19	T552	T551 w/Multiple Drain Slots (TL-3)(32" tall)	RL-T552-19.dgn
03-23	T631	Steel Rail w/ W-Beam (TL-3) (31" tall)	RL-T631-23.dgn
03-23	T631LS	Steel Rail w/ W-Beam (TL-2) (31" tall)	RL-T631LS-23.dgn
09-19	T66	Concr Bm, Post & Curb w/5.25' Max Openings (TL-3) (32" tall)	RL-T66-19.dgn
09-19	SSTR	Concrete Single Slope Traffic Rail (TL-4)(36" tall)	RL-SSTR-19.dgn
09-19	T80HT	Concrete & Steel Heavy Truck Traffic Rail (TL-5)(50" tall)	RL-T80HT-19.dgn
09-19	T80SS	Concrete Single Slope Heavy Truck Traffic Rail (TL-5) (42" tall)	RL-T80SS-19.dgn

COMBINATION RAILS

Rev Date	Std Name	Description	File Name
09-19	C1W	Steel Rail w/Curb & Opt Curb Drain Slots (TL-4)(42" tall)	RL-C1W-19.dgn
09-19	C2P	Steel Rail w/Picket Panels & Opt Curb Drain Slots (TL-4) (42"tall)	RL-C2P-19.dgn
09-19	C221	T221 w/Steel Pipe Rail (TL-3)(42" tall)	RL-C221-19.dgn
09-19	C223	T223 w/Steel Pipe Rail (TL-3)(42" tall)	RL-C223-19.dgn
09-19	C402	T402 w/Steel Pipe Rail (TL-4)(42" tall)	RL-C402-19.dgn
07-20	C411	Conc Combination Rail w/windows (TL-2)(Tx Classic) (42" tall)	RL-C411-20.dgn
09-19	C412	Concrete Combination Rail w/Windows (TL-5)(42" tall)	RL-C412-19.dgn
09-19	C66	T66 w/Steel Pipe Rail (TL-3)(42" tall)	RL-C66-19.dgn

Policy in the Bridge Railing Manual

- In Chapter 4, Table 4.2.2
  - All traffic/combination rails are compliant for NCHRP Report 350
  - But are no longer used for new construction
  - These rails do NOT need to be upgraded
  - Check the approval level (TL) stated in the table
  - Some of these rails can be raised to meet minimum height

Policy in the Bridge Railing Manual

Table 4.2.2: Acceptable Railing No Longer Used for New Construction

Railing Type	NCHRP Report 350 Approval Level	Nominal Height	Minimum Height	Description
T101RC	TL-3	27 in.	27 in.	A version of T101 rail for retrofitting on bridges with curbs. Superseded by T131RC.
T2	TL-3	27 in.	27 in.	Vertical faced concrete parapet with W-beam fascia; designed for vehicular traffic. Superseded by T201.
C2	TL-2	39 in. from sidewalk	39 in. from sidewalk	Vertical faced concrete parapet with W-beam fascia and steel pipe rail; designed for vehicular and pedestrian traffic. Superseded by C201.
T201	TL-3	27 in.	27 in.	Vertical faced concrete parapet; designed for vehicular traffic. Superseded by T221.
C201	TL-2	42 in.	42 in.	Vertical faced concrete parapet with steel pipe rail; designed for both vehicular and pedestrian traffic. Superseded by C221.
B201	Not applicable*	63 in.	63 in.	Vertical faced concrete parapet with chain-link fence; designed for bicycle and pedestrian use. Superseded by B221. *The presence of chain-link fence makes this railing only approved for speeds of 45 mph and below.
T202	TL-2	27 in.	27 in.	Concrete posts with concrete beam rail; designed for vehicular traffic. Superseded by T203.
C202	TL-2	42 in.	42 in.	Concrete posts with concrete beam rail; designed for vehicular traffic. Superseded by C203.
T203	TL-3	27 in.	27 in.	Concrete posts with concrete beam rail; designed for vehicular traffic. Superseded by T223.
C203	TL-2	42 in.	42 in.	Concrete posts with a steel pipe rail between each post, a concrete beam rail and a steel pipe rail; designed for both vehicular and pedestrian traffic. Superseded by C223.
B221	Not applicable*	68 in.	68 in.	Vertical faced concrete parapet with chain-link fence; designed for bicycle and pedestrian traffic. *The presence of chain-link fence makes this railing only approved for speeds of 45 mph and below.
C4 (A)	TL-2	42 in.	42 in.	Concrete parapet with aluminum railing; designed for vehicular and pedestrian traffic. Superseded by C402. There are two heights of C4 rail 39 inches and 42 inches. The 39 inch tall version is acceptable for traffic only.
C4 and C4 (S)	TL-3	42 in.	42 in.	Concrete parapet with steel railing; designed for both vehicular and pedestrian traffic. Superseded by C402. There are two heights of C4 rail 39 inches and 42 inches. The 39 inch tall version is acceptable for traffic only.
T401	TL-3	33 in.	31 in.	18-inch concrete parapet and a steel ellipse or rectangular HSS 15 inches above the concrete. It has twin steel posts spaced a maximum of 10 ft. apart. It features a bolt anchorage system for the steel rail posts that may be drilled and epoxy-anchored, allowing slip-forming of the concrete parapet. Its parapet is thicker than that of the T4(S) railing, from which its design is derived. Superseded by C402.
T421	TL-2	32 in.	30 in.	Slanted steel posts with large round tubular rails; designed for vehicular traffic.
T5	TL-4	32 in.	29 in.	Concrete safety shaped parapet; designed for vehicular traffic. Superseded by T501. Needs a 3 foot long vertical taper at toe of rail on upstream rail end to meet NCHRP Report 350 criteria.
T501	TL-4	32 in.	29 in.	Concrete safety shaped parapet; designed for vehicular traffic. Superseded by T551.
C501	TL-2	42 in.	42 in.	Concrete safety shaped parapet with steel pipe railing; designed for both vehicular and pedestrian traffic.
T502	TL-4	32 in.	29 in.	Concrete safety shaped parapet with multiple drain slots; designed for vehicular traffic. Superseded by T552.
C502	TL-2	42 in.	42 in.	Concrete safety shaped parapet with multiple drain slots and with steel pipe railing; designed for both vehicular and pedestrian traffic.
T503	TL-4	32 in.	29 in.	Precast concrete safety-shaped parapet bolted to slab; designed for vehicular traffic.
T504	TL-4	32 in.	29 in.	Precast concrete safety-shaped parapet bolted to slab and designed for box-beam and slab-beam structures; designed for vehicular traffic.
T77	TL-3	33 in.	31 in.	Concrete curb with steel posts and two steel tube rails, designed for vehicular traffic.
HT	TL-5	50 in.	47 in.	Modified concrete safety-shaped parapet with steel railing; designed for heavy truck traffic. Superseded by T80HT.
TT	TL-6	90 in.	90 in.	Modified concrete safety-shaped parapet with concrete posts and concrete railing; designed for heavy tank truck traffic. Never issued as a standard rail type. Superseded by T80TT.
T501SW	TL-4	Not applicable	Not applicable	8-foot reinforced concrete safety-shaped parapet and vertical wall; designed for use on bridges and on pavement. Never issued as a standard rail type. May also be referred to as T501NB and in heights other than 8-feet.
TW3	TL-3	29 in.	27 in.	Concrete curb with steel posts and two steel tube rails, designed for vehicular traffic. Never issued as a standard rail type. Superseded by T1W.
CW2	TL-2	42 in.	42 in.	Concrete curb with steel posts and four steel tube rails, designed for vehicular and pedestrian traffic. Never issued as s standard rail type. Superseded by C1W.
T412	TL-4	42 in.	42 in.	Concrete with 6-inch windows; designed for vehicular traffic. Never issued as a standard rail type. Superseded by C412.
T414	TL-4	42 in.	42 in.	Concrete with 6-inch windows; designed for vehicular traffic. Never issued as a standard rail type. Superseded by C412.
Low-Profile	TL-2	20 in.	20 in.	Concrete rail, designed for vehicular traffic. Never issued as a standard rail type. This rail cannot be transitioned with an MBGF, so requires special details for the transition.
PR1	Not applicable	42 in.	42 in.	Steel posts with steel rails, designed for pedestrian traffic.
PR2	Not applicable	42 in.	42 in.	Concrete parapet with steel posts and steel rails, designed for pedestrian traffic.

Policy in the Bridge Railing Manual

- Chapter 4 – Treatment of Existing Railing
  - Section 2 – Bridge Railing Retrofit Requirements
    - FHWA Policy
    - Texas Policy
    - Existing Railing Meeting Current Standards
    - Measuring Bridge Railing Height
    - Bridge Railing Height in Pavement Overlay
    - Transition Upgrades
    - Recommendations

Policy in the Bridge Railing Manual

- Minimum heights for most bridge railing types are documented in Appendix A, "Current Standard Bridge Railings in Texas" and Table 4-2.
- If the railing is not shown in this Manual, the minimum allowable height is as follows:
  - Traffic Railing
    - Low speed (less than 45 mph) – 27 inches
    - High speed, TL-3 - 29 inches
    - High speed, TL-4 - 36 inches
    - High speed, TL-5 - 42 inches
  - Combination and pedestrian railing – 42 inches.

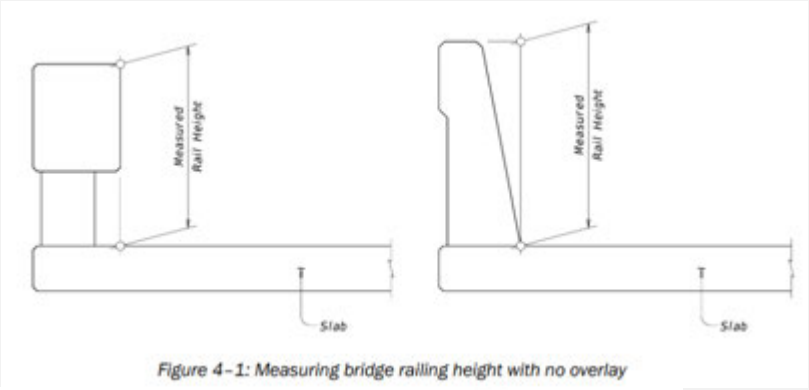


Figure 4-1: Measuring bridge railing height with no overlay

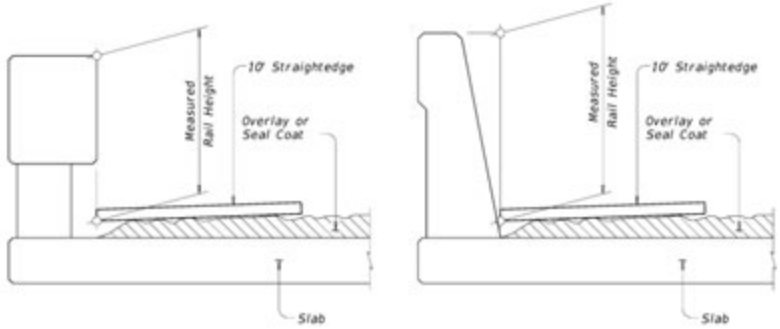


Figure 4-2. Measuring bridge railing height with overlay or seal coat

Policy in the Bridge Railing Manual

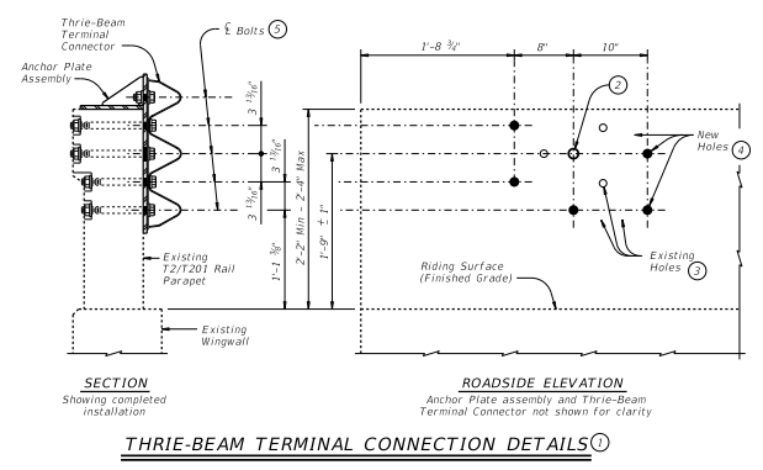
- Chapter 4 – Treatment of Existing Railing
  - Section 2 – Bridge Railing Retrofit Requirements
    - FHWA Policy
    - Texas Policy
    - Existing Railing Meeting Current Standards
    - Measuring Bridge Railing Height
    - Bridge Railing Height in Pavement Overlay
    - Transition Upgrades
    - Recommendations

Policy in the Bridge Railing Manual

- If approach MBGF is upgrade
  - Bridge rail does NOT have to be upgraded
  - Will probably need a transition retrofit
  - Several retrofit guides are available
- If bridge rail is upgraded
  - MBGF has to be upgraded

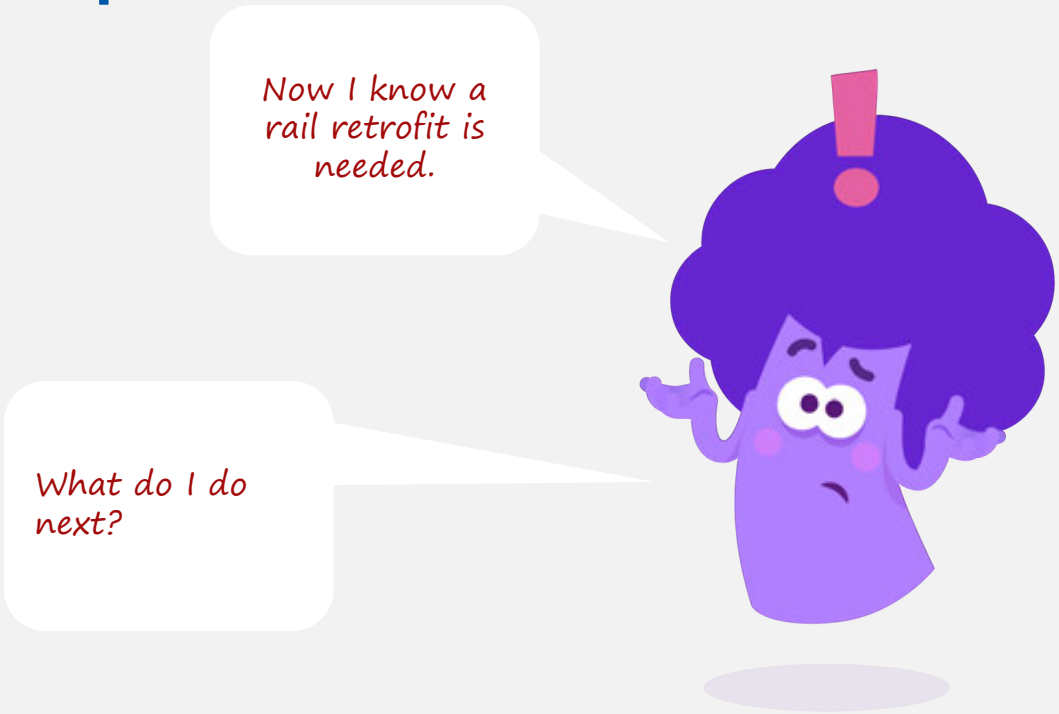
Policy in the Bridge Railing Manual

- Retrofit guides
  - Bridge Standards
    - T2/T201TR
    - T202TR
    - T5/T501/T502TR
  - Roadway Standards
    - GF(31)T101-19
    - GF(31)T6-19



Rail must meet MINIMUM HEIGHT

Rail Retrofit Steps



Rail Retrofit Steps

- Step 1 - Funding - Multiple sources
  - District Maintenance
  - District Construction
  - Highway Safety Improvement Program (administered by Traffic)
  - Rail Replacement Program (administered by Bridge)
    - On system
    - Minimum height 27 inches to remain compliant.
    - RRP pays for maximum of 400 LF of approach rail per structure.
    - RRP does not pay for milling and overlaying a structure even if needed to be compliant for height.

Rail Retrofit Steps

- Step 2 – Gather Information
  - Form 2488
  - Pictures
  - Bridge Inspection Report
  - Existing plans
  - Existing load rating
  - Accident history
  - Traffic mix
  - Review everything completely.
  - Ask questions.
  - If close, go look at it.

Rail Retrofit Steps

- Step 3 – Rail Selection
  - Many of the same considerations as for a new rail, except
    - Structure type
      - Box beam, no slab – Must use a solid concrete rail (SSTR, T551)
      - Curb (structural or not) – cannot removed structural curb
        - Structural – T131RC or solid concrete per sheet 4 of C-RAIL-R
      - T631 must be at level with the adjacent grade, curb must be 12” wide or more

Bridge Rail Selection

- Structural capacity of the bridge (load rate)
  - Lightest rail – T631
  - Under 200 lb/ft – T1F, T1W, T2P
- Roadway width (narrow)
  - Narrow rails – T631, T221, T222 (12 inches wide)

Rail Retrofit Steps

- Step 4 – Draw it to scale
  - Take into account any previous widenings, retrofits, or repairs.
  - Does it all line up – old wingwalls do weird things
    - Transversely?, Longitudinally?, Vertically?
  - How will the retro-fit modify the existing?
    - Wingwalls?, Traffic Rail Foundation?, Roadway Width?
  - Any drop drains, inlets, utilities, driveways causing conflicts?
  - Conflicts with anchor bolts or reinforcing

Rail Retrofit Steps

- Step 4 – Draw it to
  - Tal
  - D
    -
  - Hov
    - \
  - Any d
  - Conflict

VERY IMPORTANT STEP
Many change orders are due to end conditions that are missed.

Rail Retrofit Steps

- Step 5 – Develop Details

PRECAST AND RETROFIT GUIDES

Rev Date	Std Name	Description	File Name
09-19	T221P	Guide for Precast T221 Rail (TL-3)(32.75" tall)	RL-T221P-19.dgn
06-24	CC-RAIL-R	Retrofit Guide for Curb Concrete Rails	RL-CC-RAIL-R-24.dgn
07-20	C-RAIL-R	Retrofit Guide for Concrete Rails	RL-C-RAIL-R-20.dgn
06-24	TC411-R	Retrofit Guide for Texas Classic Rail	RL-TC411-R-24.dgn
06-24	HSS-R	Retrofit Guide for Adding HSS	RL-HSS-R-24.dgn
09-19	T131RC	Retrofit Guide for Curbed Structures	RL-T131RC-19.dgn
09-19	T2/T201TR	Guide for T2/T201 (Retrofit Thrie-Beam Transition)	RL-T2T201TR-19.dgn
09-19	T202TR	Guide for T202 (Retrofit Thrie-Beam Transition)	RL-T202TR-19.dgn
09-19	T5/T501/T502TR	Guide for T5/T501/T502 (Retrofit Thrie-Beam Transition)	RL-T5T501T502TR-19.dgn
02-20	RAC-R	Retrofit Guide for BC w/Curbs 2' & less	CD-RAC-R-20.dgn

Rail Retrofit Steps

This sheet is to be used as a guide for retrofitting existing structures with rails listed on this sheet. Details with appropriate notes from this guide should be prepared for the specific application. Dimensions of existing slab thickness, curb widths, heights, etc., should be shown. Particular care should be taken in identifying the bridge abutment wingwall conditions and providing for proper reinforcement anchorage and approach guard fence post positioning. This sheet may not be used without modification. The details shown may need to be amended if the exact existing condition is not covered. In all cases, details and notes not required must be crossed out or eliminated, "(MOD)" added, this note and the phrase "(Not to be used as a standard)" removed, and the sheet sealed and signed.

Rail Retrofit Steps

Texas Department of Transportation | Bridge Division Standard

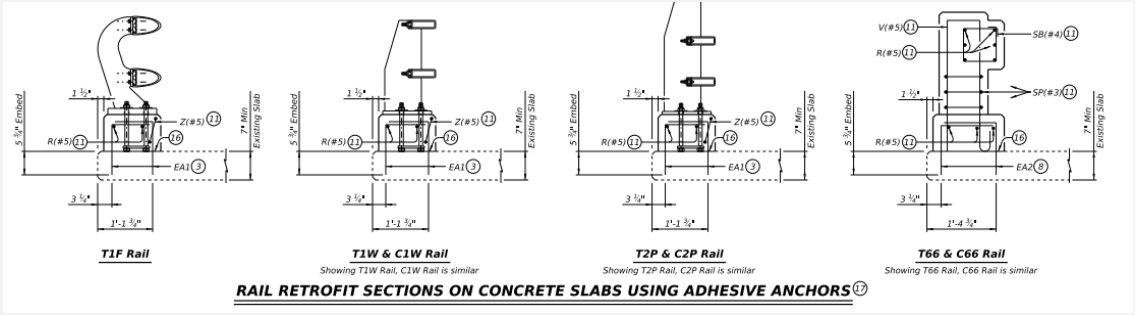
RETROFIT GUIDE FOR CONCRETE CURB RAILS

(T1F, T1W, C1W, T2P, C2P, T66 & C66)

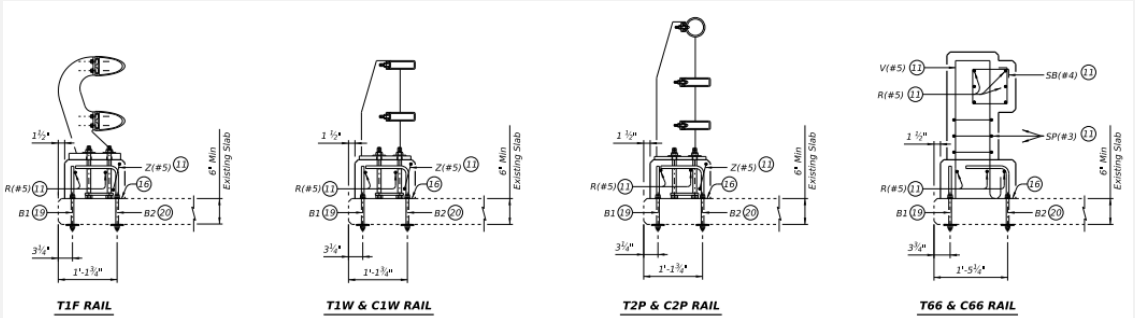
(Not to be used as a standard)

CC-RAIL-R

FILE: RL-CC-RAIL-R-24.dgn	DW: TxDOT	CK: TAR	DW: JTR	CK: TAR
©TxDOT April 2024	CONT	SECT	JOB	HIGHWAY
REVISIONS				
06/2024: Added bolt through option.	DIST	COUNTY		SHEET NO.



RAIL RETROFIT SECTIONS ON CONCRETE SLABS USING ADHESIVE ANCHORS (17)



RAIL RETROFIT SECTIONS ON CONCRETE SLABS USING ANCHOR BOLTS (18)

Rail Retrofit Steps

Texas Department of Transportation | Bridge Division Standard

RETROFIT GUIDE FOR TEXAS CLASSIC RAILS

(TYPE T411 AND TYPE C411 RAILS)

(Not to be used as a standard)

TC411-R

FILE: RL-TC411-R-24.dgn	DW: TxDOT	CK: TAR	DW: SFS	CK: TAR
©TxDOT June 2024	CONT	SECT	JOB	HIGHWAY
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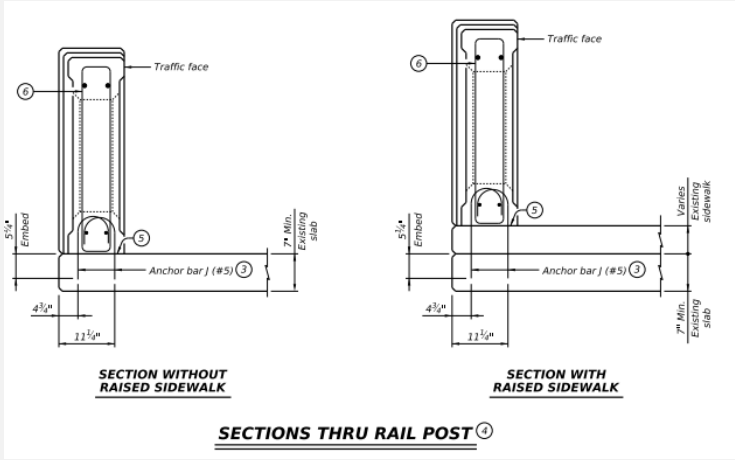

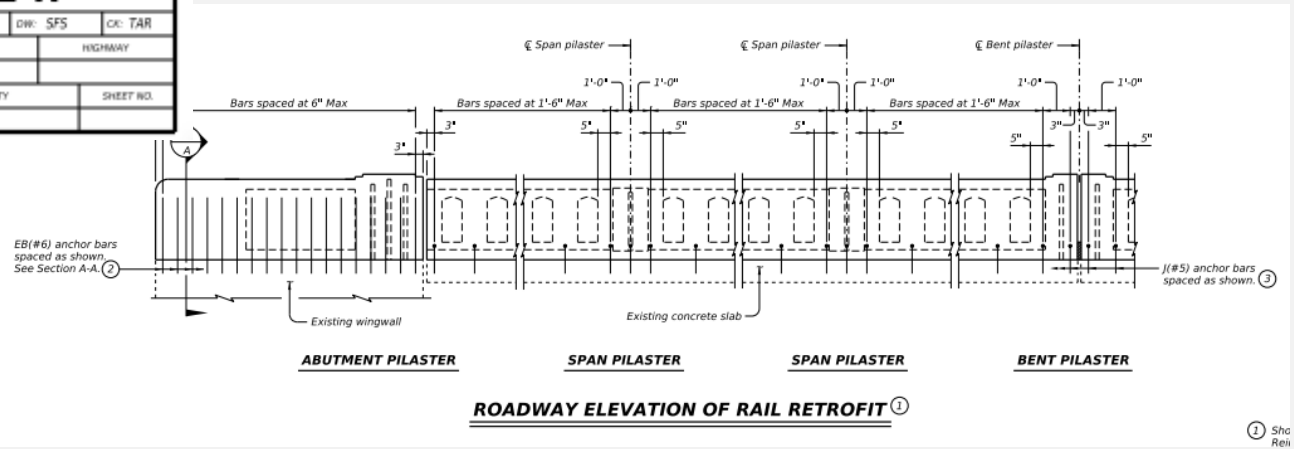

Rail Retrofit Steps

Texas Department of Transportation | Bridge Division Standard

RETROFIT GUIDE FOR ADDING HSS
(TYPE T2, T201-T203, T5 AND T501 RAILS)

(Not to be used as a standard)

HSS-R

FILE: RL-HSS-R-24.dgn	DW: TxDOT	CK: TAR	DW: SFS	CK: TAR
©TxDOT June 2024	CONT	SECT	JOB	HIGHWAY
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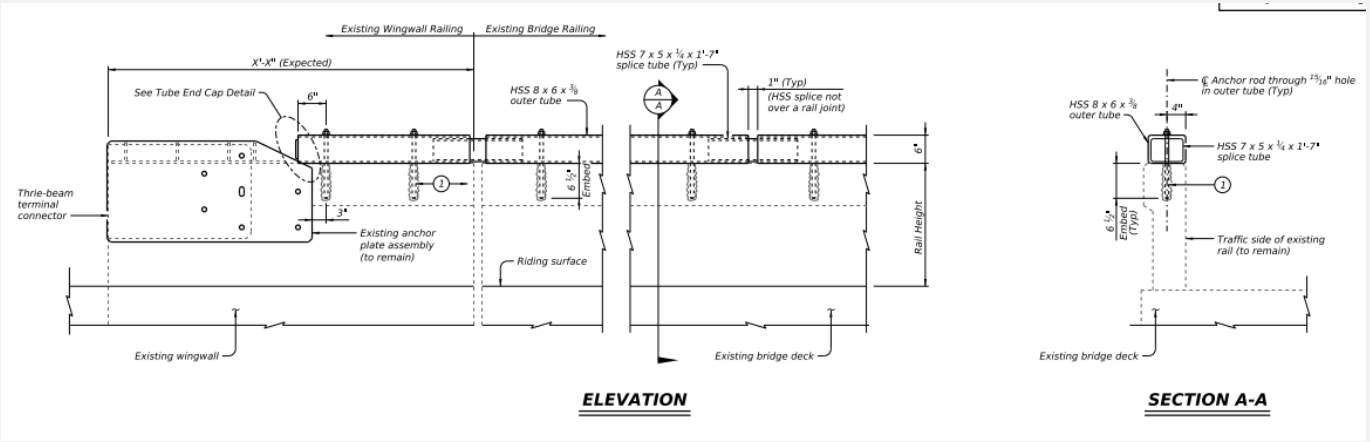

Rail Retrofit Steps

Texas Department of Transportation | Bridge Division Standard

RETROFIT GUIDE FOR CONCRETE RAILS
(T221, T222, C221, T402, C402, T551, SSTR & T552)
(Not to be used as a standard)
C-RAIL-R

FILE: RL-C-RAIL-R-20.dgn	DN: TxDOT	CK: TxDOT	DW: JTR	CK: JMH
©TxDOT September 2019	CONT	SECT	JOB	HIGHWAY
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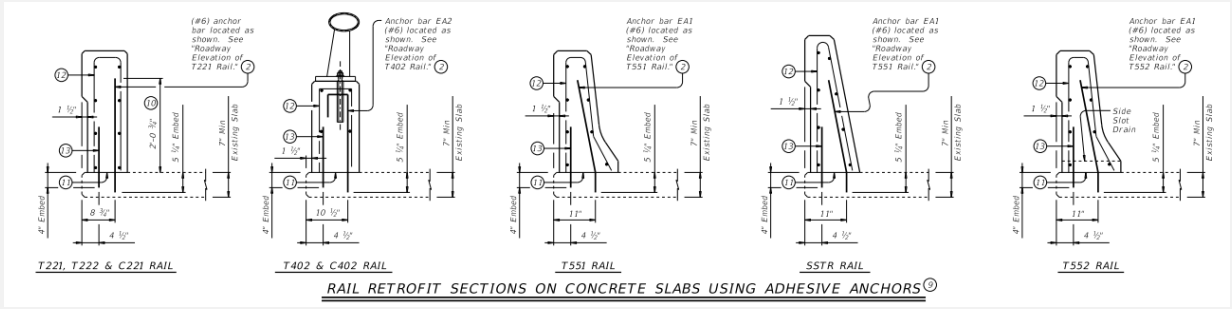
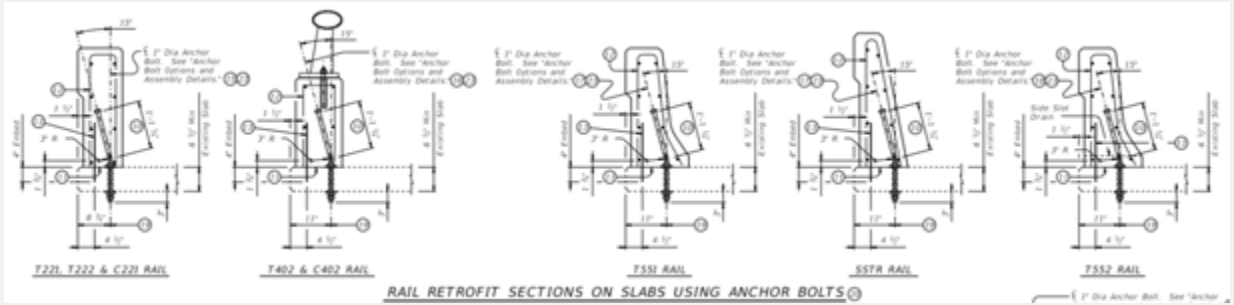
07-20: Text change from epoxy to adhesive and changed MASH Test Level note.				





Rail Retrofit Steps

Texas Department of Transportation | Bridge Division Standard

RETROFIT GUIDE FOR T131RC RAIL ON CURBS

(Not to be used as a standard)

TYPE T131RC

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©TxDOT September 2019	CONT	SECT	JOB	HIGHWAY
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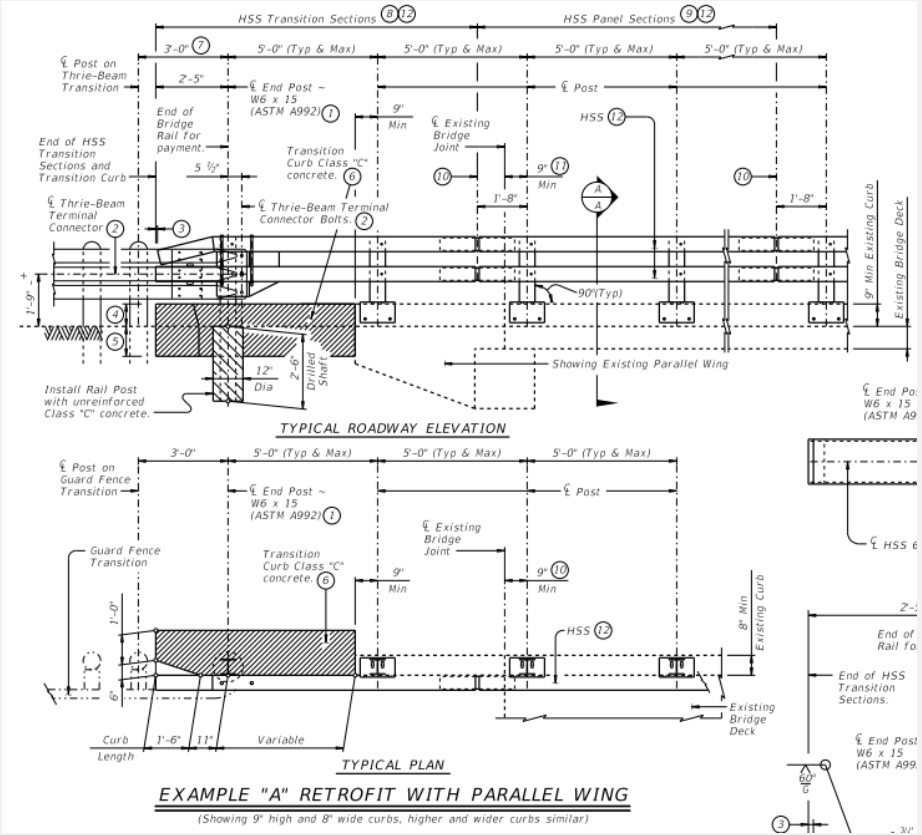
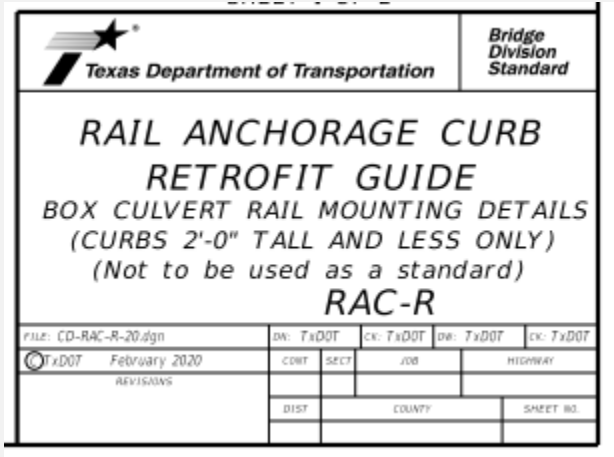


Rail Retrofit Steps



Texas Department of Transportation | Bridge Division Standard

RAIL ANCHORAGE CURB RETROFIT GUIDE

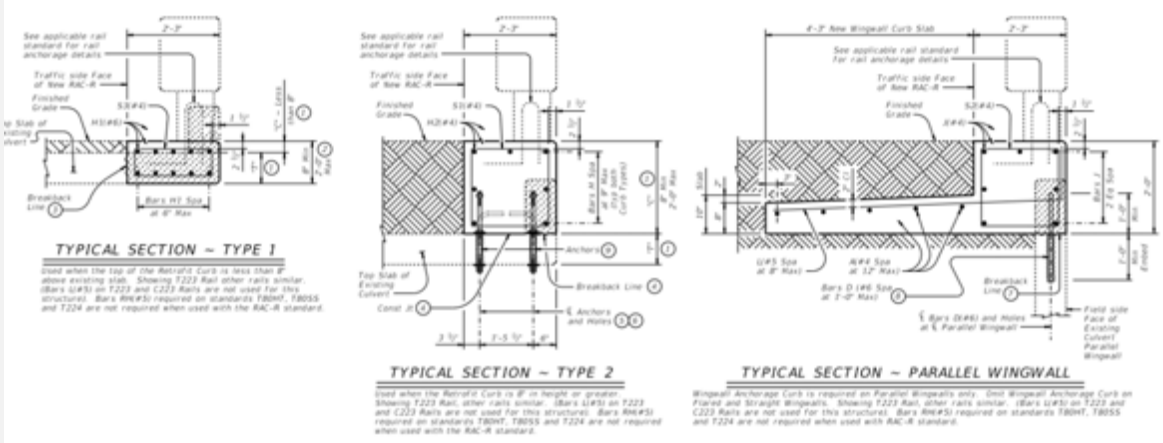
BOX CULVERT RAIL MOUNTING DETAILS
(CURBS 2'-0" TALL AND LESS ONLY)
(Not to be used as a standard)

RAC-R

FILE: CD-RAC-R-20.dgn | DN: TxDOT | CK: TxDOT | DW: TxDOT | CK: TxDOT

©TxDOT February 2020 | CONT | SECT | JOB | HIGHWAY

REVISIONS | DIST | COUNTY | SHEET NO.



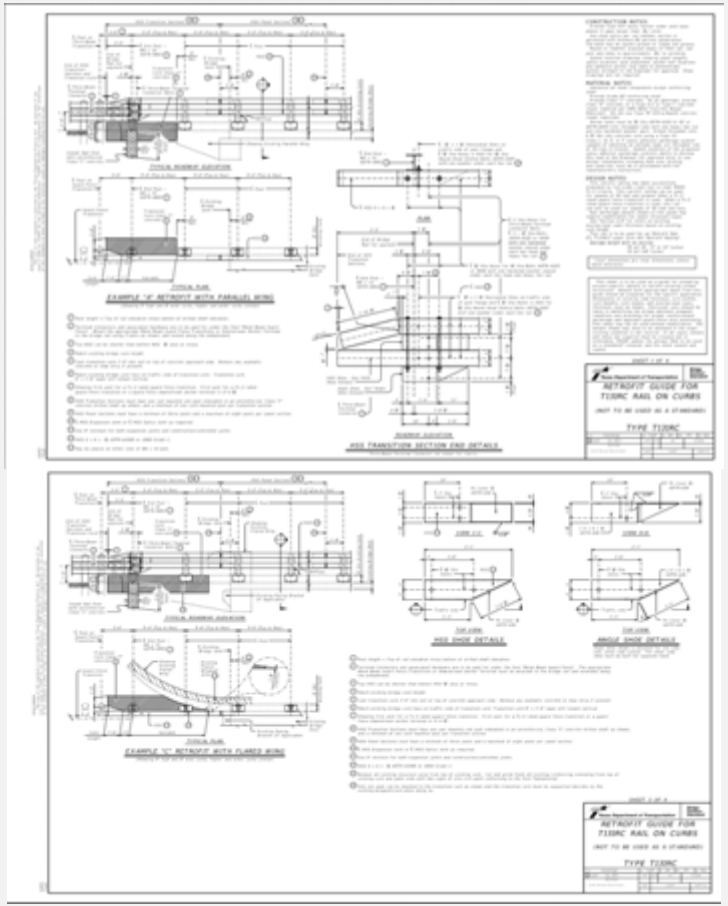
TYPICAL SECTION – TYPE 1

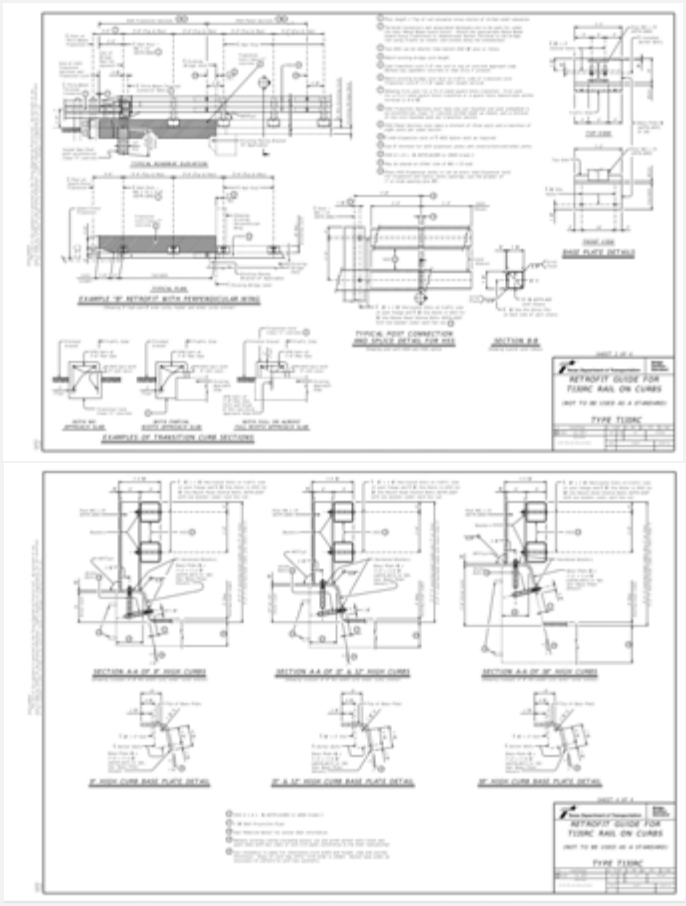
TYPICAL SECTION – TYPE 2

TYPICAL SECTION – PARALLEL WINGWALL

Rail Retrofit Steps

- Think outside the box.
- TRF and TRF80 can be used to replace wingwalls or extend the rail past the bridge
  - Minimum length on these are based on free standing segments.
  - Can be reduced if anchored to bridge or culvert (adhesive anchors)
- Draw to scale – add the rail to Step 4 – Does everything line up?
- Only include the details relevant to your project.


RETROFIT GUIDE FOR
TXDRC RAIL ON CURBS
TYPE TXDRC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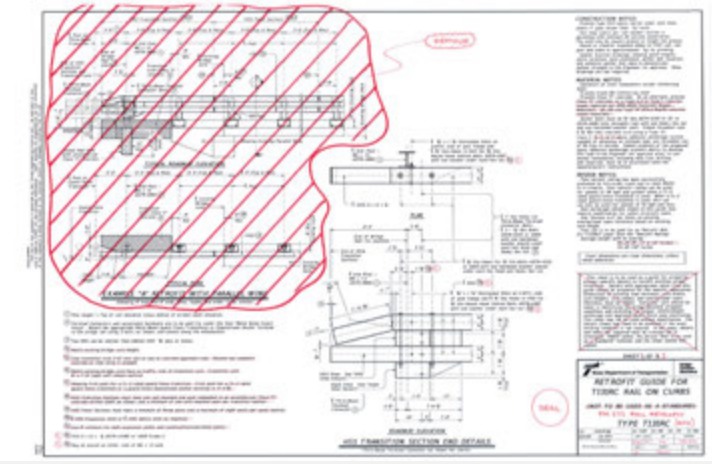
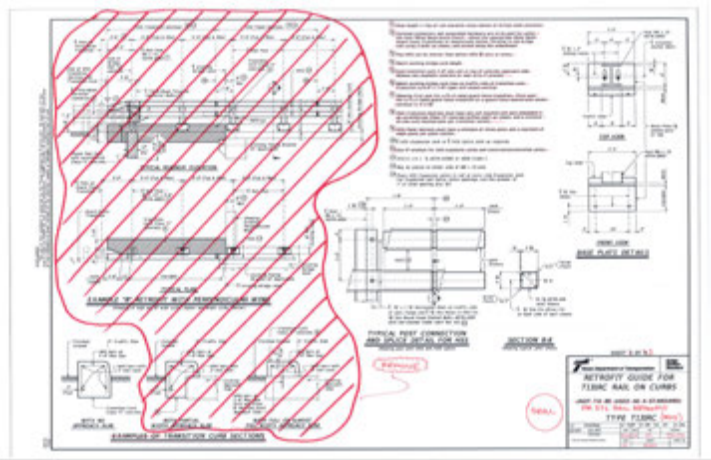
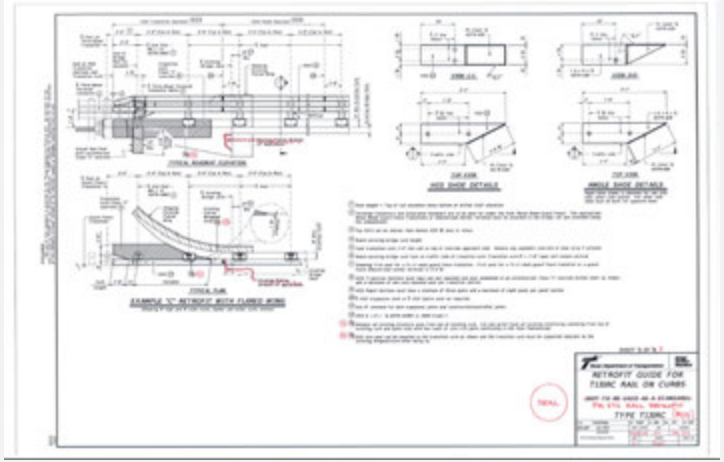
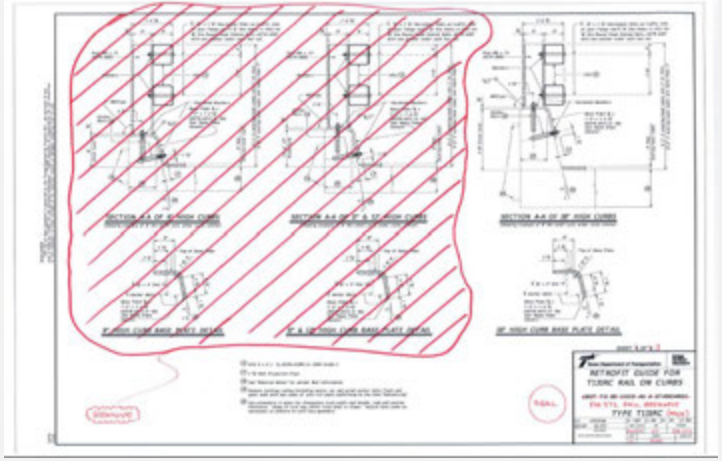
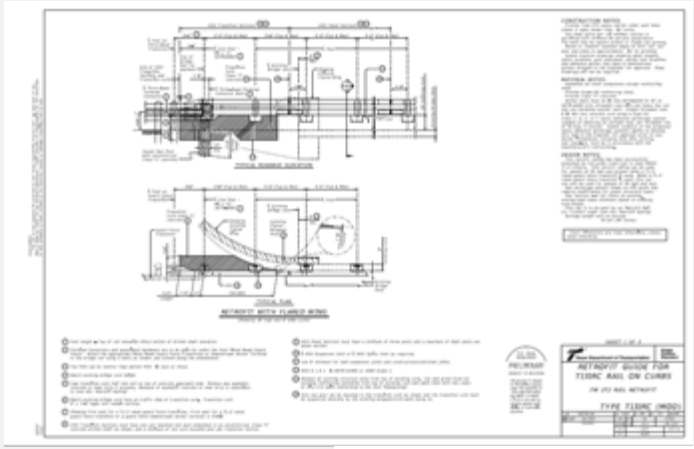
TXDRC RAIL ON CURBS
TYPE TXDRC

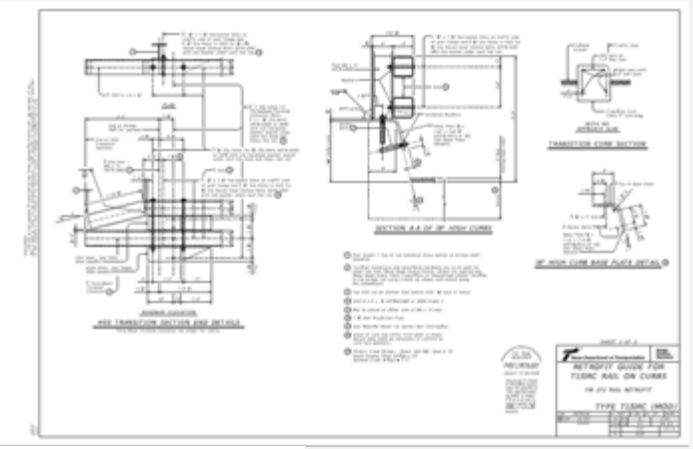









RETROFIT GUIDE FOR
T101RC RAIL ON CURBS
TYPE T101RC (MOD)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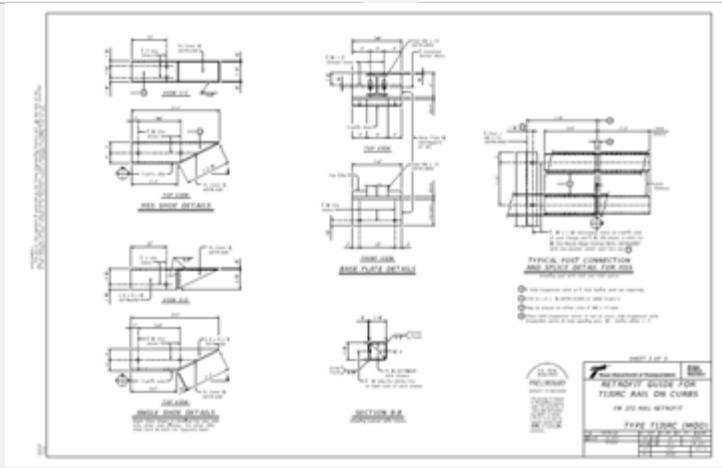
T101RC RAIL ON CURBS
TYPE T101RC (MOD)

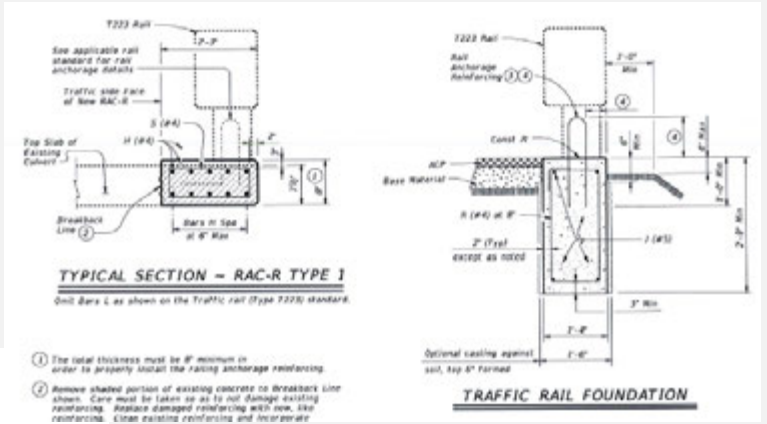

RETROFIT GUIDE FOR
T101RC RAIL ON CURBS
TYPE T101RC (MOD)

Rail Retrofit Steps

- If multiple rail retrofits in one project, consider
  - Grouping
    - Do they all have the same needs?
      - Use a set of standards
    - Are they all unique?
      - Consider, each structure having it’s own sheet.
    - Are some the same and some unique?
      - Use a combination.

Rail Retrofit Steps

- Example with TRF



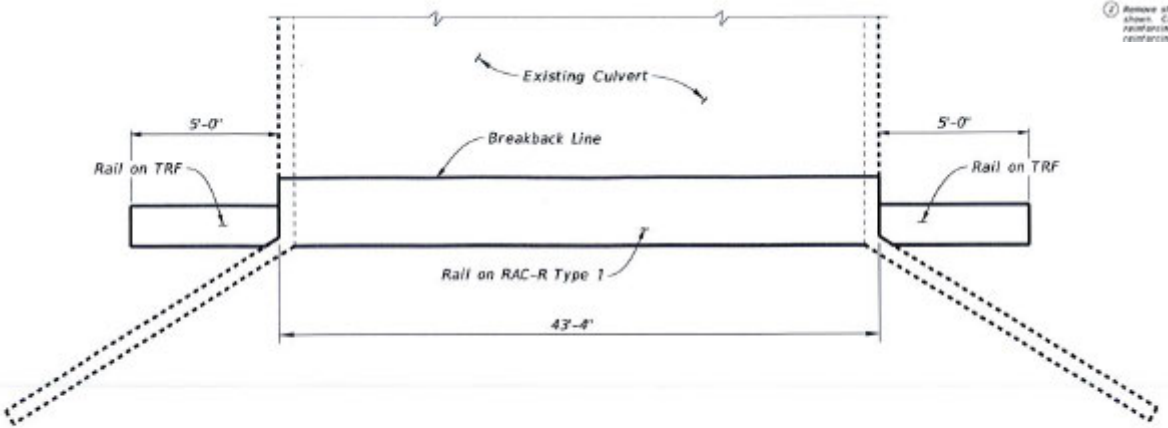
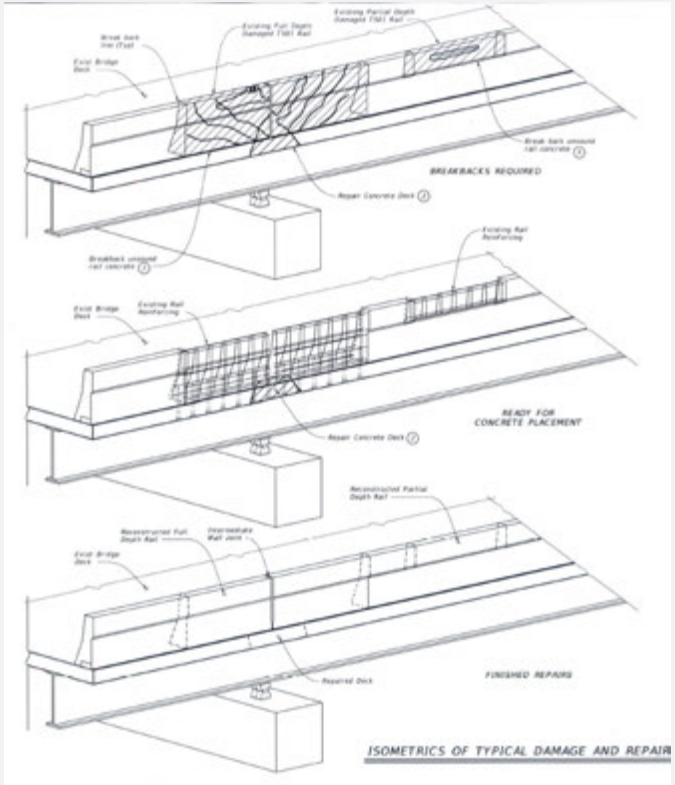


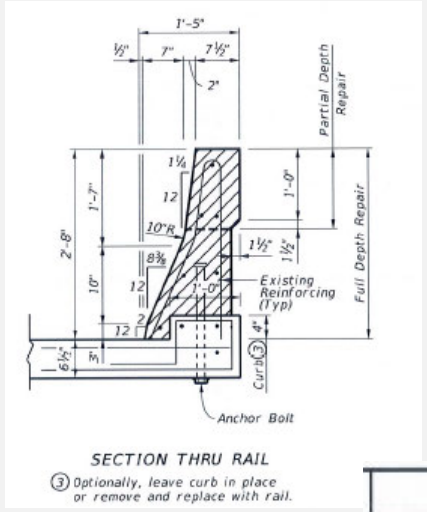
TABLE OF ESTIMATED QUANTITIES			
0420-6066	CL C CONC (RAIL FOUNDATION)	CY	2.7
0420-6136	CL C CONC (RAC-R)	CY	4.8
0451-6007	RETROFIT RAIL (TY T223)	LF	106.7

Bonus – Rail Repairs

Bonus – Rail Repairs



ISOMETRICS OF TYPICAL DAMAGE AND REPAIR



SECTION THRU RAIL

(3) Optionally, leave curb in place or remove and replace with rail.

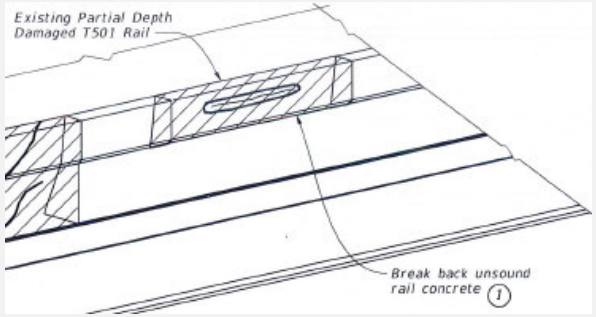


TABLE OF ESTIMATED QUANTITIES

Item	Description	Unit	QTY
0429-6005	CONC STR REPAIR (DECK REP (FULL DEPTH))	SF	4
0778-6011	CONCRETE RAIL REPAIR (TYPE 501)	LF	22

Bonus – Rail Repairs

Bonus – Rail Repairs

- Do NOT reuse damage components


Section Loss


Damaged Anchor Bolt


Galvanized Steel


Corrosion / Pull out

Bonus – Rail Repairs

- Epoxy installed anchors

TOO MUCH

NOT ENOUGH

Bonus – Rail Repairs

OK…maybe

Concrete Repair Manual

March 2021

https://iapps/apps/OnlineManuals/txdotmanuals/crm/crm.pdf

Bid Codes

- KEEP IT SIMPLE
- Use the right one.
  - Item 451, “Retrofit Railing” – Includes removal and replacement of the old rail.
  - Item 420-6136, CL C CONC (RAC-R) or
    Item 420-6137, CL C CONC (RAC-R)(HPC)
  - Item 420-6066, CL C CONC (RAIL FOUNDATION)
  - Item 429, “Concrete Structure Repair”
  - Item 778, “Concrete Rail Repair”
  - Item 776, “Metal Rail Repair”

Resources

- Bridge Railing Manual https://iapps/apps/OnlineManuals/txdotmanuals/rlg/rlg.pdf
- Bridge Railing Standards https://www.dot.state.tx.us/insdtdot/orgchart/cmd/cserve/standard/bridge-e.htm#BRIDGERAILINGSTANDARDS
- Webinar presentations https://www.txdot.gov/business/resources/highway/bridge/webinar-presentations.html
    - For C-Rail-R Guide Drawing https://ftp.txdot.gov/pub/txdot-info/brg/071813-webinar/smith.pdf

Questions

- Reach out to

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