



# TEXAS DEPARTMENT OF TRANSPORTATION



## HOW TO USE THE C-RAIL-R GUIDE DRAWING

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Bridge Division  
July 18, 2013



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# Introduction

- Why?
  - Anticipated statewide increase in rail upgrades
  - 31” MBGF implemented
- Provides details for common retrofits
- Can be used for several superstructure types

SHEET 1 OF 4

 *Texas Department of Transportation*  
*Bridge Division*

**RETROFIT GUIDE  
FOR CONCRETE RAILS**  
(T221, C221, T401, T402,  
C402, T551, SSTR, & T552)  
(NOT TO BE USED AS A STANDARD)

**C-RAIL-R**

FILE: r1std022.dgn	DN: TxDOT	CK: TxDOT	DW: JTR	CK: JMH
© TxDOT April 2009	DISTRICT	FEDERAL AID PROJECT		SHEET
REVISIONS				
05-11: 6" CG Slab Rail Retrofit.	COUNTY	CONTROL	SECT	JOB HIGHWAY

# Introduction

Bridge Standards (English)

## RAILING STANDARDS

Rev Date	Std Name	Description	File Name
07-13		Index Sht of Railing Standards	<a href="#">PDF</a> table04e.dgn

### TRAFFIC RAILS

Rev Date	Std Name	Description	File Name
07-12	T1F	Stl Post w/Alum Tube & Opt Drains (33" tall)	<a href="#">PDF</a> rlstd001.dgn
07-12	T1W	Stl Post w/Stl Tube & Opt Drains (32" tall)	<a href="#">PDF</a> rlstd002.dgn
07-12	T221	Concrete Parapet (32" tall)	<a href="#">PDF</a> rlstd004.dgn
07-12	T223	Conc Bm & Post w/6' Openings (32" tall)	<a href="#">PDF</a> rlstd005.dgn
07-12	T401	Concrete Parapet w/Stl Post and Rail (33" tall)	<a href="#">PDF</a> rlstd006.dgn
07-12	T402	Concrete Parapet w/Stl Post and Rail (42" tall)	<a href="#">PDF</a> rlstd007.dgn
07-12	T411	Conc Traf Rail w/Windows(Tx Classic)(32" tall)	<a href="#">PDF</a> rlstd008.dgn
07-12	T551	Concrete Safety F-Shape (32" tall)	<a href="#">PDF</a> rlstd009.dgn
07-12	T552	T551 w/Multiple Drain Slots (32" tall)	<a href="#">PDF</a> rlstd010.dgn
07-12	T66	Conc Bm, Post & Curb w/5.25' Max Open (32" tall)	<a href="#">PDF</a> rlstd012.dgn
07-12	T77	Steel Post w/Two Elliptical Pipes (33" tall)	<a href="#">PDF</a> rlstd013.dgn
07-12	SSTR	Conc Single Slope Traffic Rail (36" tall)	<a href="#">PDF</a> rlstd014.dgn
07-12	T80HT	Conc & Steel Heavy Truck Traffic Rail (50" tall)	<a href="#">PDF</a> rlstd015.dgn
07-12	T80SS	Conc Single Slp Hvy Truck Traff Rail (42" tall)	<a href="#">PDF</a> rlstd016.dgn

### COMBINATION RAILS

Rev Date	Std Name	Description	File Name
07-12	C1W	Steel Post w/Stl Tube & Opt Curb Drain (42" tall)	<a href="#">PDF</a> rlstd017.dgn
07-12	C221	T221 w/Steel Pipe Rail (42" tall)	<a href="#">PDF</a> rlstd018.dgn
07-12	C223	T223 w/Steel Pipe Rail (42" tall)	<a href="#">PDF</a> rlstd019.dgn
07-12	C402	T402 w/Steel Pipe Rail (42" tall)	<a href="#">PDF</a> rlstd020.dgn
07-12	C411	Comb Rail w/windows (Tx Classic) (42" tall)	<a href="#">PDF</a> rlstd021.dgn
07-12	C412	Conc Comb Rail w/Windows (TL-4) (42" tall)	<a href="#">PDF</a> rlstd033.dgn

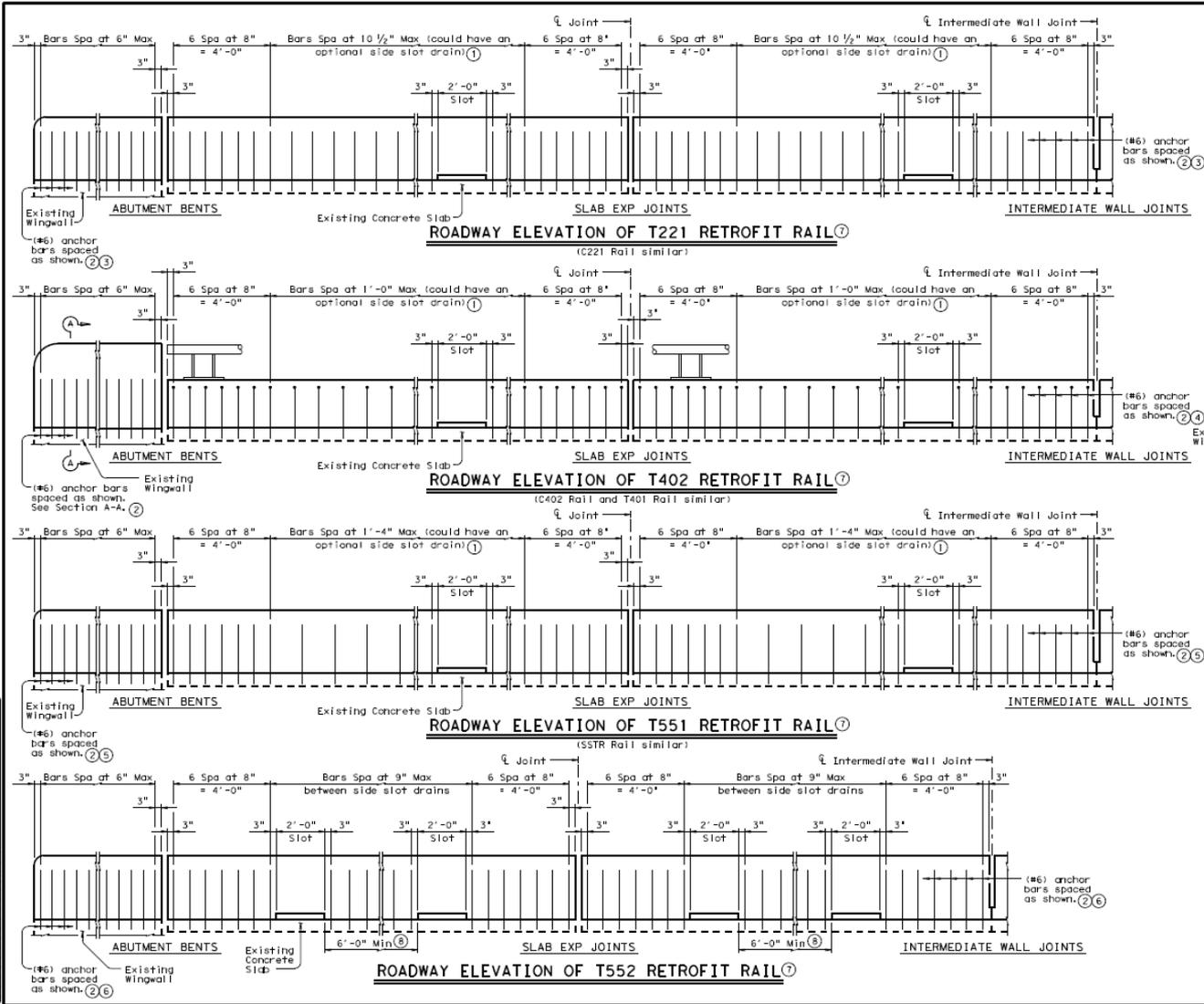
### MISCELLANEOUS RAILS

Rev Date	Std Name	Description	File Name
05-11	C-RAIL-R	Retrofit Guide for Concrete Rails	<a href="#">PDF</a> rlstd022.dgn
11-12	T131RC	Retrofit Guide for Curbed Structures	<a href="#">PDF</a> rlstd034.dgn
04-09	T2/T201TR	Guide for T2/T201(Retrofit Thrie-Beam Transition)	<a href="#">PDF</a> rlstd025.dgn
04-09	T202TR	Guide for T202 (Retrofit Thrie-Beam Transition)	<a href="#">PDF</a> rlstd026.dgn
05-11	TRF	Traffic Rail Foundation	<a href="#">PDF</a> rlstd027.dgn
04-09	PR1	Pedestrian Rail,Steel Pipe (42" tall)	<a href="#">PDF</a> rlstd028.dgn
05-11	PR2	Pedestrian Rail,Steel Pipe on Parapet (42" tall)	<a href="#">PDF</a> rlstd029.dgn
04-09	PR3	Pedestrian Rail,Steel and Conc (43.75" tall)	<a href="#">PDF</a> rlstd030.dgn
04-09	PR3-HD	Handrail Details for PR3 Pedestrian Rail	<a href="#">PDF</a> rlstd031.dgn
04-09	CLF-RO	8 Ft Chain Link Fence for Railroad Overpass	<a href="#">PDF</a> rlstd032.dgn

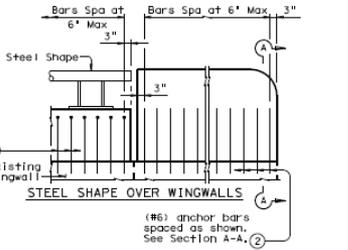
# Introduction

DISCUSS: The use of this standard is governed by the Texas Engineering Practice Act. No warranty of any kind is made by TxDOT for any purpose whatsoever, other than that of correct format and for incorrect results or damages resulting from its use.

SCALE: 1/4" = 1'-0"  
 PATH  
 C-RAIL-R



- ① A maximum of 2 optional side slot drains per panel are allowed, if needed. 8'-0" Min clear spacing between drain slots.
- ② Embed (#6) anchor bars 5/4" with Hilti HIT RE500 epoxy adhesive. Other Type III Class C epoxy adhesives meeting the requirements of DMS-6100, "Epoxyes and Adhesives", may be used if it can be demonstrated that they meet or exceed the strength of Hilti HIT RE500 with the same embedment depth and anchor bar size and spacing. Follow manufacturer's directions for installing the epoxied anchor bars.
- ③ See T221 or C221 Rail Sections in "Retrofit Rail Section on Wingwalls using Epoxy Anchor Bars" and/or "Retrofit Rail Section on Concrete Slabs using Epoxy Anchor Bars".
- ④ See T402, C402 or T401 Rail Sections in "Retrofit Rail Section on Wingwalls using Epoxy Anchor Bars" and/or "Retrofit Rail Section on Concrete Slabs using Epoxy Anchor Bars".



- ⑤ See T551 or S5TR Rail Sections in "Retrofit Rail Section on Wingwalls using Epoxy Anchor Bars" and/or "Retrofit Rail Section on Concrete Slabs using Epoxy Anchor Bars".
- ⑥ See T552 Rail Sections in "Retrofit Rail Section on Wingwalls using Epoxy Anchor Bars" and/or "Retrofit Rail Section on Concrete Slabs using Epoxy Anchor Bars".
- ⑦ Showing spacing of (#6) anchor bar epoxy anchored in a retrofitted rail condition. Secondary (#4) anchor bar epoxy anchored in retrofitted rail not shown for clarity. Reinforcing steel and terminal connections not shown for clarity. See appropriate rail standard for details and notes not shown.
- ⑧ Place side slot drains as shown. See appropriate rail standard for side slot drains, except as noted.

SHEET 1 OF 4

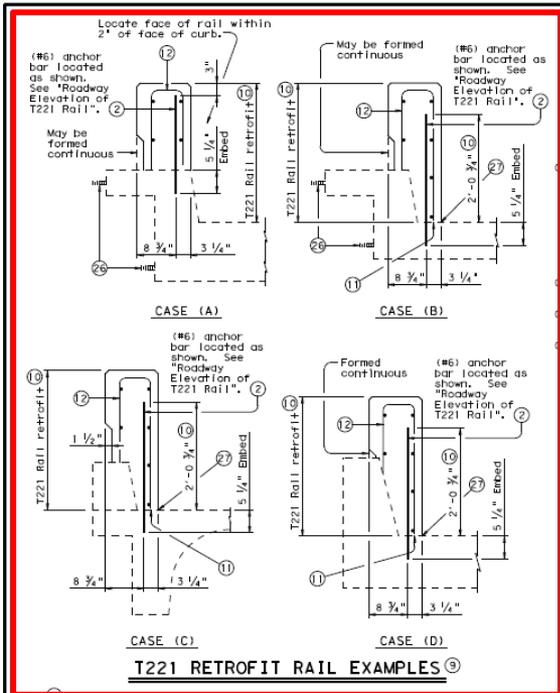
Texas Department of Transportation  
 Bridge Division  
**RETROFIT GUIDE FOR CONCRETE RAILS**  
 (T221, C221, T401, T402, C402, T551, S5TR, & T552)  
 (NOT TO BE USED AS A STANDARD)  
**C-RAIL-R**

FILE#	P164322.dgn	NO	T2007	CS	T2007	CS	ATE	CS	JMH		
DATE	SEP 11 2009	REVISED		FEDERAL AID PROJECT					SHEET		
REVISIONS											
NO-	11	4"	CS	S16	RAIL	REPAIRS	COUNTY	CONTRACT	SECTION	JOB	REMARK





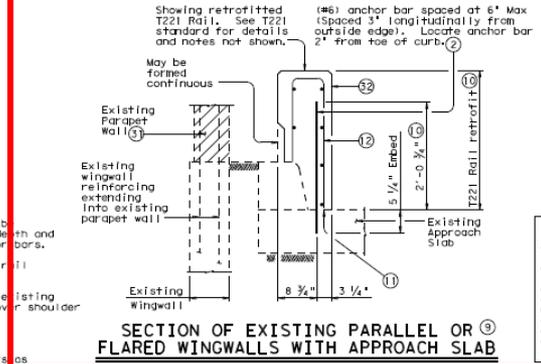
# Introduction



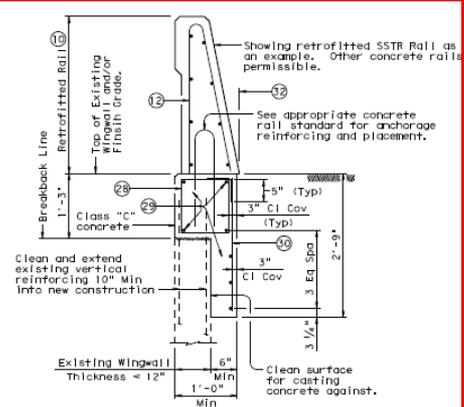
**T221 RETROFIT RAIL EXAMPLES**

1. Embed (#6) anchor bars 5 1/2" with HIT or HIT 100 epoxy adhesive. (Other type III Class C epoxy adhesives meeting the requirements of MS-E100, "Epoxy Resin and Adhesives", may be used if it can be demonstrated that they meet or exceed the strength of HIT or HIT 100 with the same embedment depth and anchor bar size and spacing. Follow manufacturer's directions for installing the epoxied anchor bars.
2. Showing location or locations of anchor bars in a retrofitted rail condition. See appropriate rail standard for details and notes not shown.
3. Increase by amount of existing overlay/seal coat thickness, not to exceed 2". If thickness of existing overlay/seal coat is greater than 2" at toe of rail, taper overlay at a 1:10 or flatter slope over a shoulder width to a thickness of 2" or less at toe of rail.
4. Do not cast rails or parapet walls on top of overlays/seal coats.
5. See appropriate rail standard for reinforcing steel. Modify length of vertical reinforcing bars as required to fit existing structure. Longitudinal reinforcing bars may be removed only if their location puts them in conflict with un-removed portions of existing structure.
6. Remove existing rail, cut and grind anchor bolts flush, and paint ends with two coats of zinc-rich paint conforming to the Item "Galvanizing".
7. Void out area in retrofitted rail to accommodate existing drain holes in deck.
8. Space (#4) stirrups at 8" Max. (Spaced 3 1/4" longitudinally from retrofitted ends of wingwall).
9. 7 - (#5) bars with 3" end cover.
10. Space (#4) bars at 8" Max with 3" end cover, spaced with (#4) stirrups.
11. Remove all concrete and reinforcing steel from existing parapet wall. Existing reinforcing cut off from existing wingwall must be painted with two coats of a zinc-rich paint conforming to the Item "Galvanizing".
12. Face of rail and/or toe of rail. Location or placement of retrofitted rail must match face of rail and/or toe of rail on bridge.

- Case (A): Permitted only with Type T221, C221 and SSTR rails. Do not use unless existing curb is at least 10" wide and the fillet at its base is at least 10.5" high with no strength reduction factor applied.
- Case (B): Locate anchor bar 2" from toe of curb.
- Case (C): Locate anchor bar no closer than 2" from toe of curb.
- Case (D): Do not remove any part of curb unless it has been determined to not be a structural element. Locate anchor bar 2" from toe of curb.



**SECTION OF EXISTING PARALLEL OR FLARED WINGWALLS WITH APPROACH SLAB**



**SECTION OF EXISTING PARALLEL WINGWALLS LESS THAN 12\"/>**

- CONSTRUCTION NOTES:**  
 1. By adding additional anchorage, welding can be performed at a minimum spacing of 3 ft between cage and additional anchorage. By satisfying additional anchorage requirements, slip forming is allowed, do not weld to the required anchorage.
- MATERIAL NOTES:**  
 1. (#6) and (#4) anchor bars used for the epoxied anchorage system must not be epoxy coated within the required embedment.
- GENERAL NOTES:**  
 1. Use of these retrofit details will result in a rail strength acceptable for Test Level 3 regardless if the higher ratings that may be indicated on the rail standard.  
 2. Rail strength tests have been performed on the epoxied (#6) anchor bar system which have demonstrated that the ultimate strength can be developed in the anchorage system.  
 3. Rail anchorage details shown on this guide may require modification for select structure types. See appropriate details elsewhere in plans for these modifications. Not all possible combinations of existing railing, curbs, parapets, etc., have been shown on this sheet. Other combinations and reinforcement arrangements are permissible if they meet the same strength requirements as indicated on this guide.  
 4. Do not remove any part of a curb until it has been evaluated to not be a load-carrying structural component.  
 5. Payment for a retrofit rail will be as per Item 50, "Railing", by the type of the rail retrofit. Examples are "Ty 551 (Retrofit)", "Ty SSTR Retrofit", etc.

This sheet is to be used as a guide for retrofitting existing structures with rails listed on this sheet. Details with appropriate modifications, such as 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 reinforcement positioning. This sheet may not be used without modification. The details shown may need to be checked if the exact existing condition is not covered. In all cases, details not required must be crossed out or eliminated, if needed, the phrase "Not to be used as a standard" removed, and the sheet sealed and signed.

SHEET 4 OF 4

Texas Department of Transportation  
 Bridge Division

## RETROFIT GUIDE FOR CONCRETE RAILS

(T221, C221, T401, T402, C402, T551, SSTR, & T552)

(NOT TO BE USED AS A STANDARD)

### C-RAIL-R

Project	1144002.dgn	Drawn	TJTOT	Checked	JTR	Date	04/11
Revision	01	Issue	04/11/2009	Revised	FEDERAL AID PROJECT	Sheet	
95-111 6" C-RAIL RETROFIT							
County		Contract		Subcontract		Job	

## ■ 0-4823 Adhesive Anchors for Retrofit/Repair of Bridge Rails

- Tested T501 and T203 on a bridge deck
  - (now T551 & T223)
- Statically test conventional anchorage (CIP)
- Dynamically test conventional anchorage (CIP)
- Develop an adhesive anchorage and dynamically test

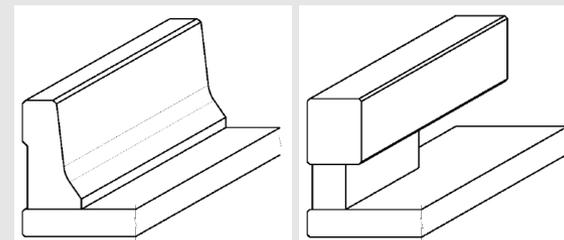


Table 1. Summary of Analytical and Full-Scale Testing.

No.	Case	Calculated Conventional Anchored Strength (kips)	Static Strength Conventional Anchored Design (kips)	Dynamic Strength Conventional Anchored Design 50-ms Avg. (kips)	Retrofit Design Strength (Dynamic) 50-ms Avg. (kips)
1	T501 Mid-span (Avg. 2 Tests)	59.7	70.5	68.0	62.8
2	T501 End/Joint	36.4	41.0	46.0	50*
3	T203 End/Joint	23.2	33.0	N/A	39.5
4	T203 Mid-span (Avg. 2 Tests)	71.0	72.8	71.0	68.3

# Testing



Figure 13. Bogie Vehicle Used in Dynamic Load Testing.

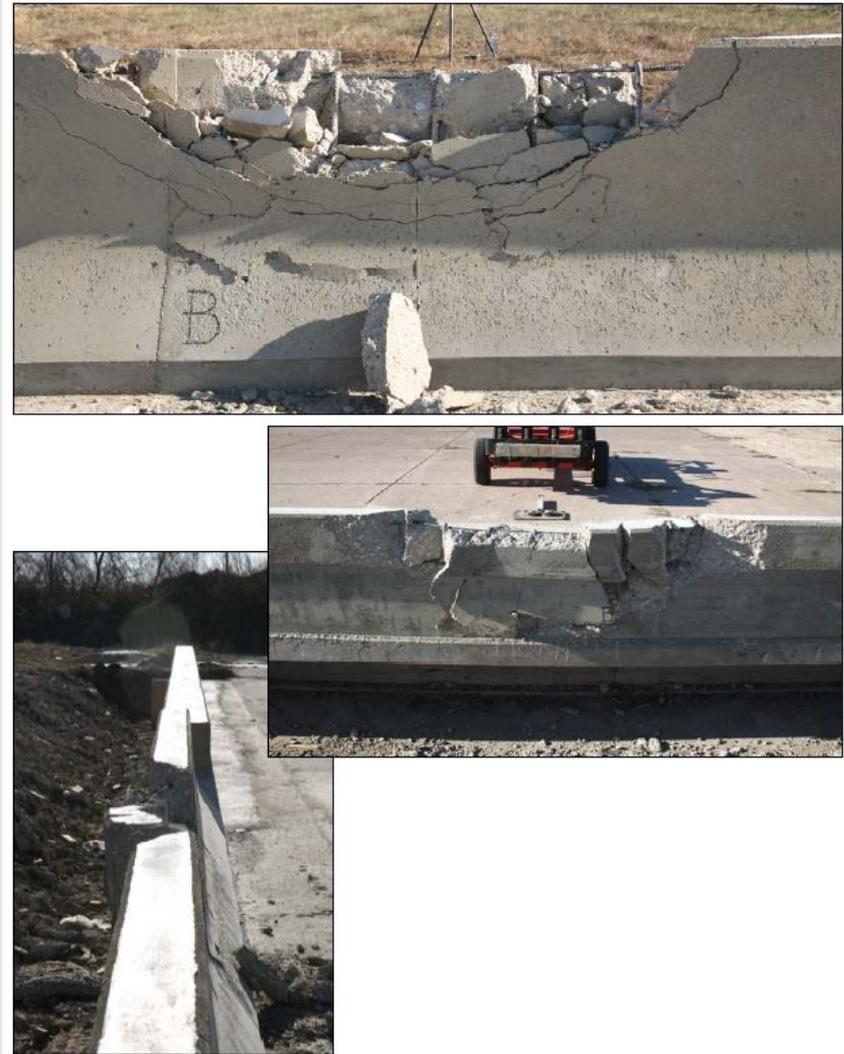


Figure 23. Bridge Rail T501 Retrofit/Repair at Location B after Test B8.

# Testing

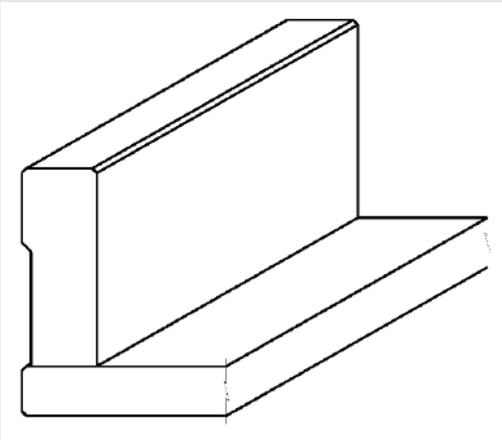
- 9-1002 MASH Test 3-11 of the SSTR on Pan-formed Bridge Deck
  - 6” slab with 21.25” overhang (typical pan form)
  - Pickup truck at 62 mph
  - Test successful
    - No dynamic or permanent deflection seen



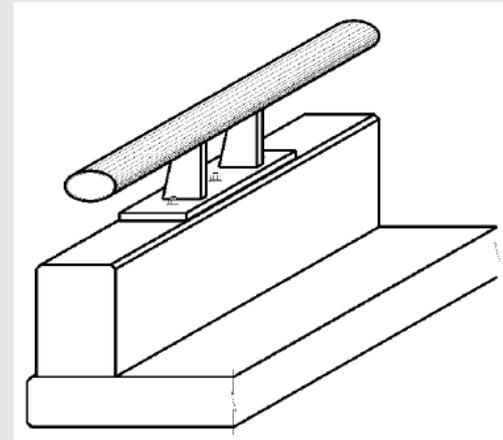
Figure 5.4. Installation after Test No. 420020-3.

# Rail Types in Guide Drawing

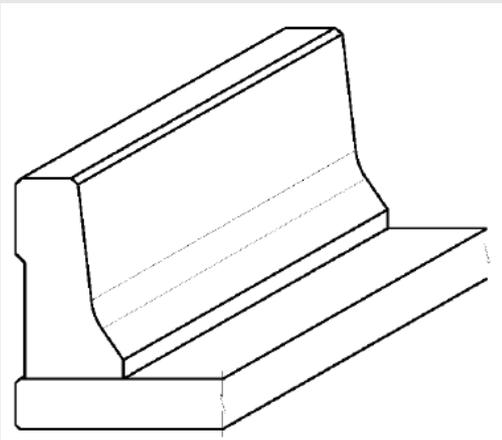
- These rail types are on the Guide drawing



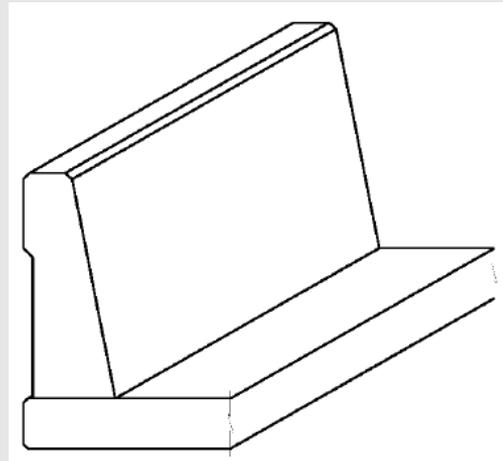
T221,  
C221



T401,  
T402,  
C402



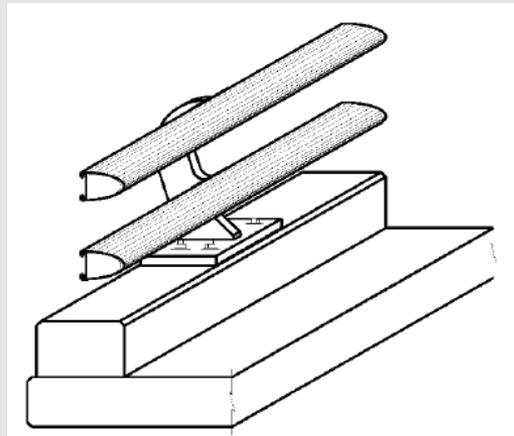
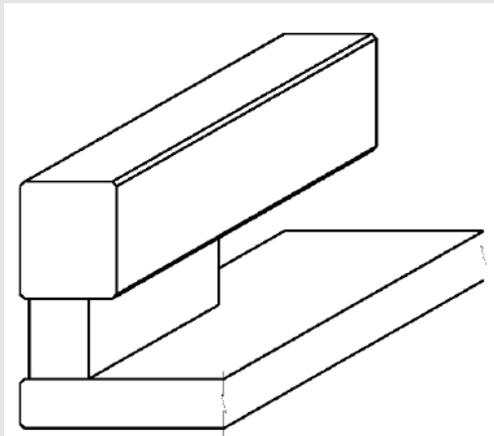
T551,  
T552



SSTR

# Rail Types in Guide Drawing

- What if I want...
  - T223 or T1F, etc?



- Contact BRG – be prepared with
  - Photos (particularly is slab repair also required)
  - Existing plans
  - Form 2488

 **INFORMATION SHEET FOR BRIDGE RAILING UPGRADES, RETROFITS, & REPAIRS** Form 2488  
(Only for work to be performed on existing structures.) (01/13)  
Use a separate form for each structure. Page 1 of 2

Name of Submitter: \_\_\_\_\_ Position (Business Title): \_\_\_\_\_  
Mailing Address: \_\_\_\_\_  
Telephone # (\_\_\_\_) \_\_\_\_\_ - \_\_\_\_\_ Date: \_\_\_\_\_

**Due Dates and Charges:**  
Letting Date: \_\_\_\_\_ Target Date: \_\_\_\_\_ Ready-To-Let (RTL) Date: \_\_\_\_\_  
Charge numbers for Time Sheet: \_\_\_\_\_ (Note that BRG cannot charge to District maintenance and local-let jobs without special permission through District finance.)

NBI Structure #: \_\_\_\_\_ Structure Name: \_\_\_\_\_  
County: \_\_\_\_\_ D/D/O/R: \_\_\_\_\_  
CSJ: \_\_\_\_\_ Project: \_\_\_\_\_

# How to use the details

- First thing first!
  - NOT a standard
  - Must be marked up
  - Label “MOD”
  - Must be sealed & signed by P.E.
- Also must include the rail standard itself
  - C-RAIL-R only provides anchorage details

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, the phrase "(Not to be used as a standard)" removed, and the sheet sealed and signed.

SHEET 4 OF 4



Texas Department of Transportation  
Bridge Division

## RETROFIT GUIDE FOR CONCRETE RAILS

(T221, C221, T401, T402,  
C402, T551, SSTR, & T552)

(NOT TO BE USED AS A STANDARD)

## C-RAIL-R

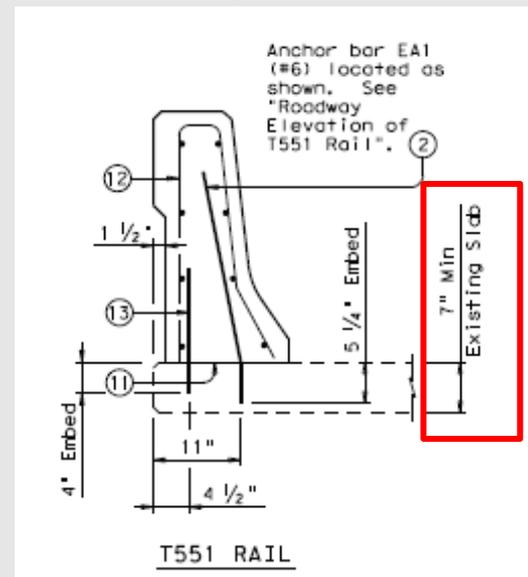
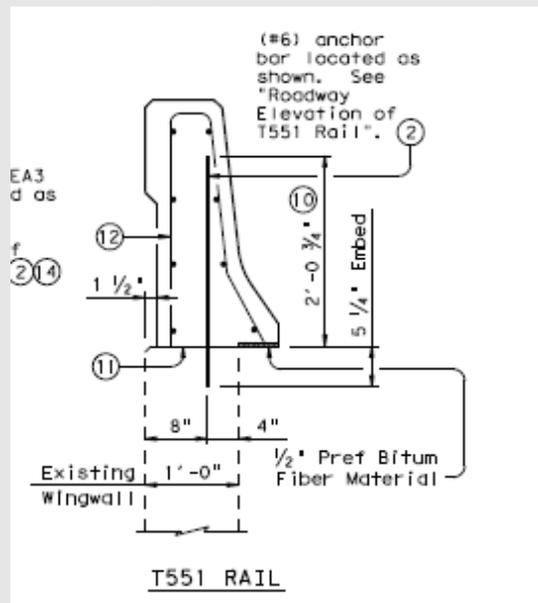
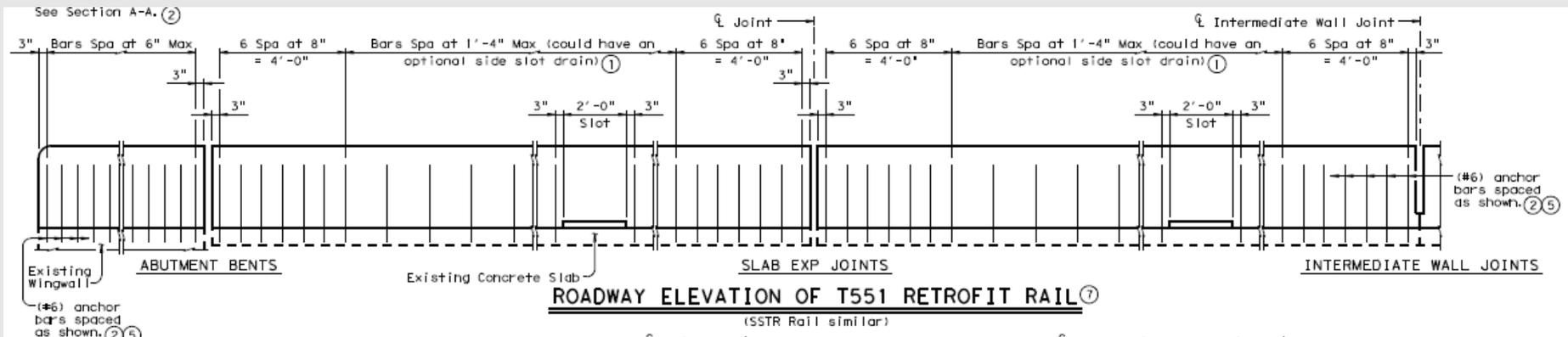
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©	TxDOT	APRIL	2009	DISTRICT	FEDERAL AID PROJECT			SHEET	
REVISIONS									
05-11	6" CC Slab Rail Retrofit	COUNTY		CONTROL	SECT	JOB	HIGHWAY		

# How to use the details

- Need to know:
  - Type of superstructure/culvert
  - Slab thickness ← most important variable
  - Is there an existing curb
  - Photos!!!!
- Scenario 1
- You have a slab thickness 7” or more
  - Lucky – easiest to retrofit
  - Want to use T551
  - Rebar doweled and epoxied into slab
  - Use sheets 1 & 2



# How to use the details

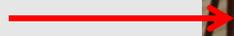




# How to use the details



Anchor bolt

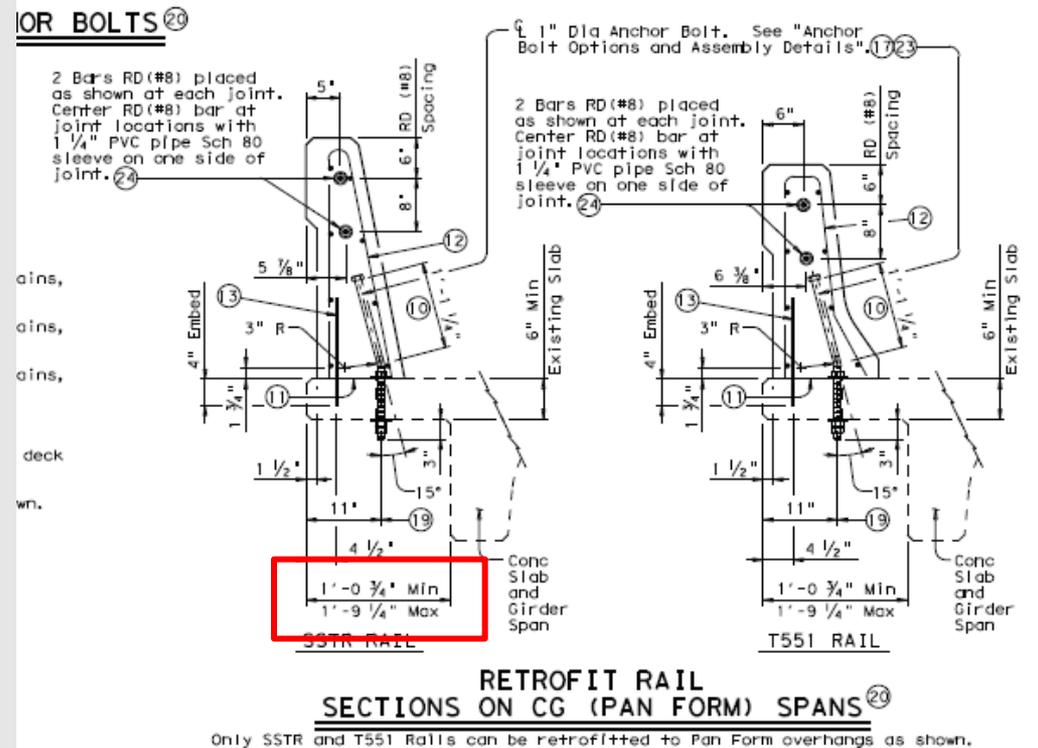
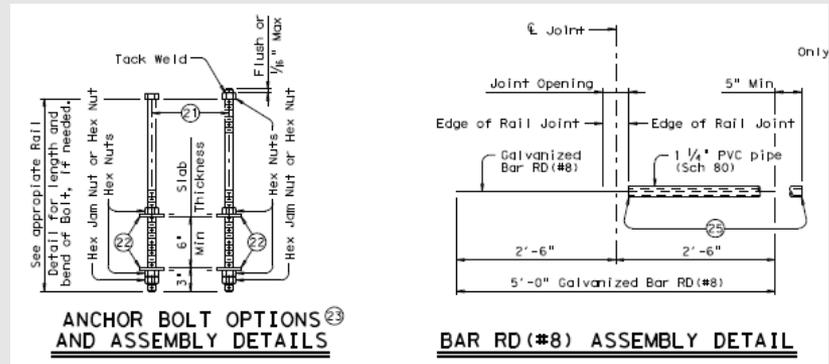


Secondary epoxy anchor



# How to use details

- Scenario 3
- You have a pan-form with overhang
  - Must use the bolt-thru option on sheet 3
  - Spacing of anchors in note 17 (not from sheet 1)
  - Wingwall still uses epoxy bars
  - Only available rails are T551 and SSTR
  - Based on crash testing
  - Has overhang limits



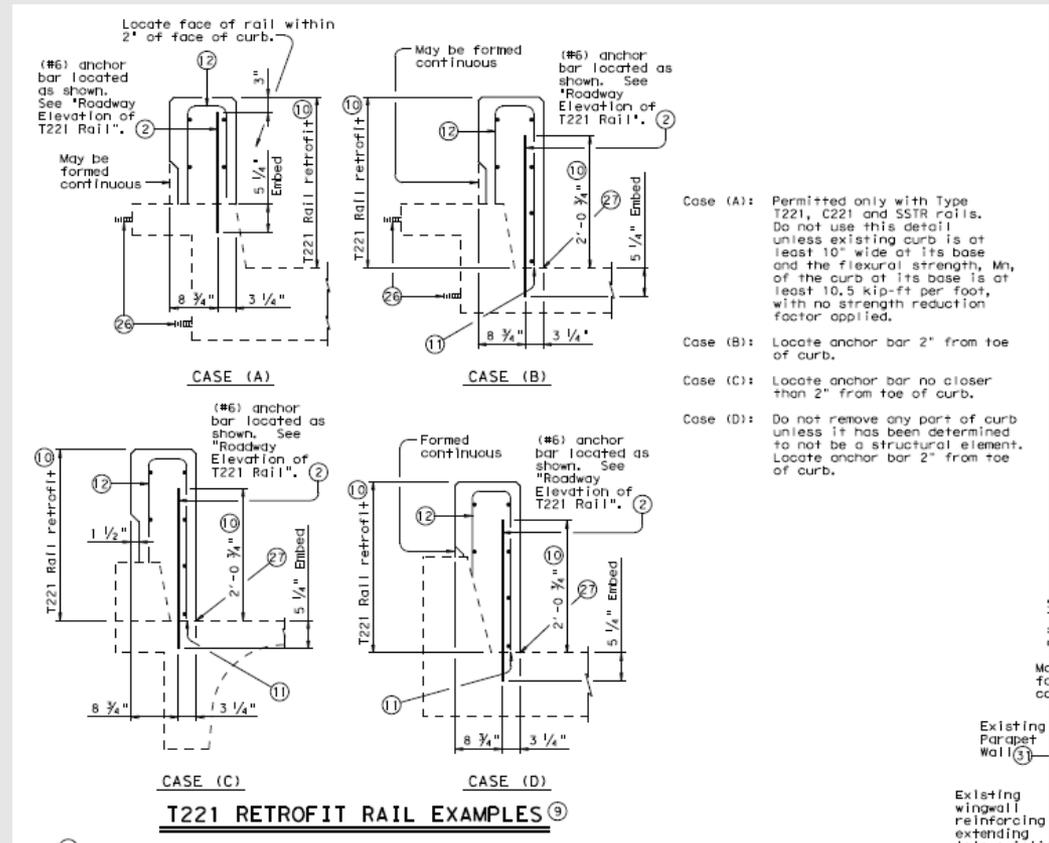
# How to use the details

## ■ Scenario 4

### ■ You have a curb

- DO NOT REMOVE THE CURB
- Use details from sheet 4
- There are restrictions for use of these details
  - Rail type
  - Minimum curb size
- Use same elevation (Sheet 1) for spacing of anchors
- Wingwall still uses epoxy bars

( Also consider T131RC for retrofit on curb )

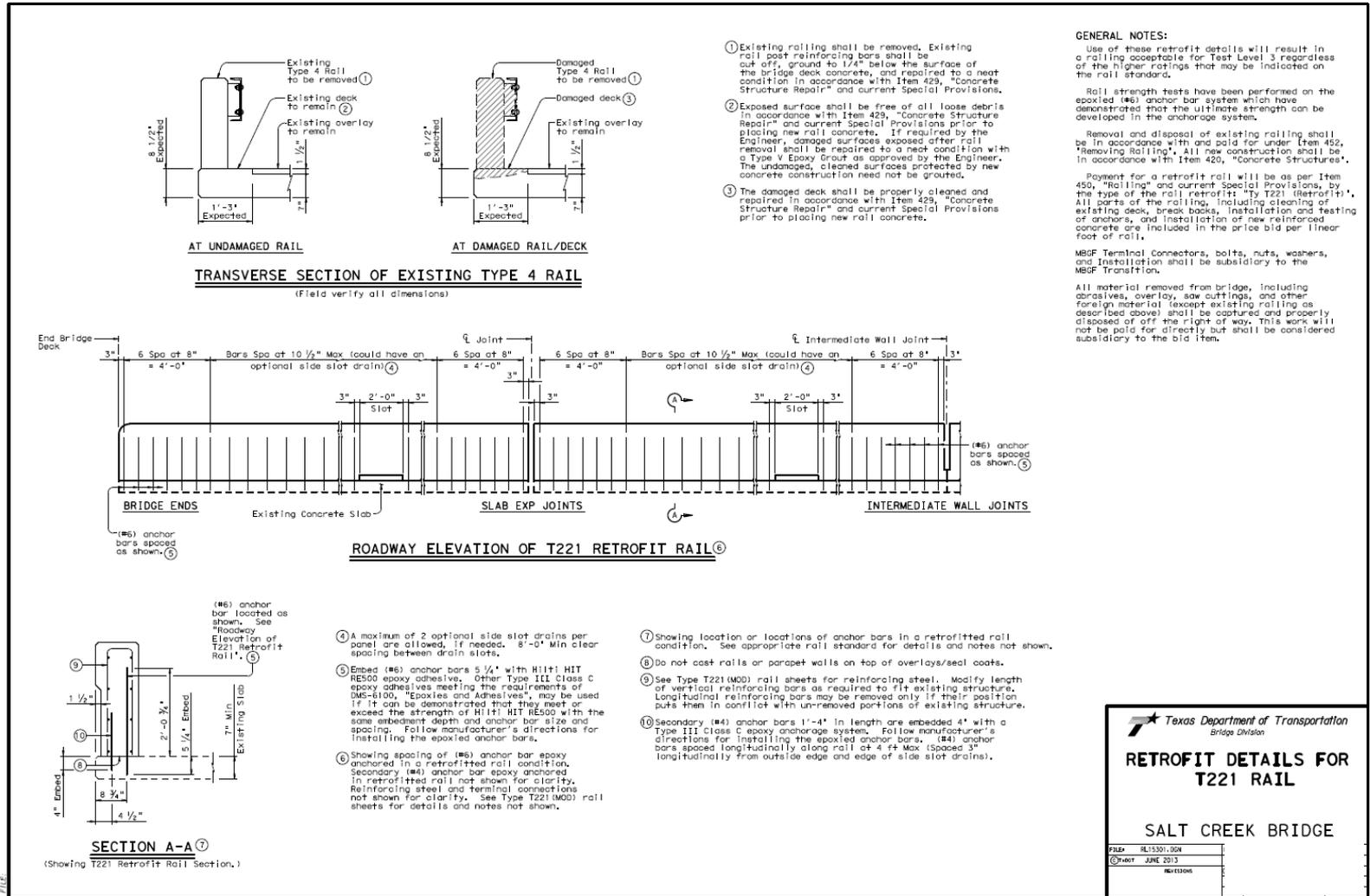


# How to use the details

- Notes, notes, notes
  - Carefully review which notes go with which details
  - Best to strikeout or remove non-applicable notes
  - Epoxy anchors require a particular epoxy – pay attention
  
- General Notes
  - Retrofit details provide a TL-3 rail, regardless of higher rating shown on the individual rail standard
  - Payment Item 450 “Ty xxx (Retrofit)”
  - (will be Item 451 in 2014 Spec book)
  
- Your bridge doesn’t match anything on the C-RAIL-R?
  - Contact BRG

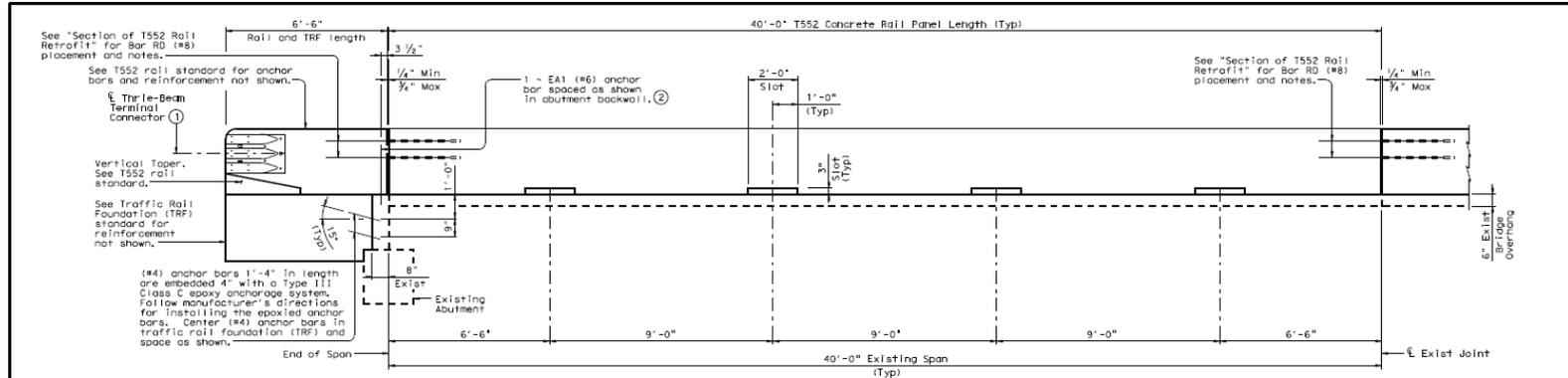
# Example retrofit 1

## ■ T221 on 8.5" slab with epoxy anchors



# Example retrofit 2

## T552 on pan-form with overhang



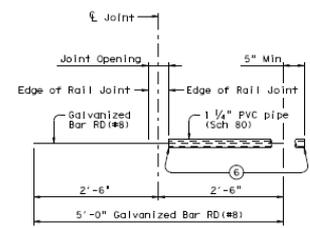
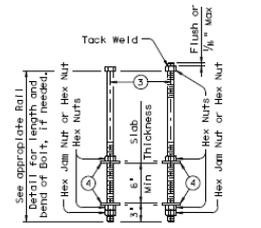
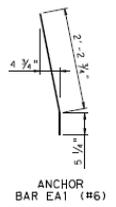
**ROADWAY ELEVATION OF T552 RAIL RETROFIT**  
1" Dia Anchor Bolts not shown for clarity.

- ① Terminal Connectors and associated hardware are to be paid for under the Item "Metal Beam Guard Fence Transition (Thrie-Beam)". Metal Beam Guard Fence Transitions must be attached to the bridge rail and extended along the embankment unless otherwise shown in the plans.
- ② Embed (#6) anchor bar 5 1/2" with Hi111 HIT RE500 epoxy adhesive. Other Type III Class C epoxy adhesives meeting the requirements of DMS-6100, "Epoxyes and Adhesives" may be used if it can be demonstrated that they meet or exceed the strength of Hi111 HIT RE500 with the same embedment depth and anchor bar size and spacing. The contractor is responsible for any cost associated with this demonstration. Follow manufacturer's directions for installing the epoxied anchor bars.
- ③ Use 1" Dia ASTM-F1554 Grade 55 Anchor Bolt or Threaded Rod.
- ④ Plate Washer 3/8" x 3 x 3 ASTM-A36 with 1 1/8" Dia Hole centered.
- ⑤ Galvanize anchor bolts, nuts and plate washers.
- ⑥ Ends of 1 1/4" PVC pipe Sch 80 must be tapered off to prevent concrete or mortar from seeping in.

**CONSTRUCTION NOTES:**  
By satisfying additional anchorage requirements slip forming is allowed. By adding additional anchorage at a minimum spacing of 3 ft, welding between the cage and additional anchorage can be performed. Do not weld to the required anchorage system detailed on this sheet.

**MATERIAL NOTES:**  
(#6) and (#4) anchor bars used for the epoxied anchorage system must not be epoxy coated within the required embedment.

**GENERAL NOTES:**  
Use of these retrofit details will result in a railing acceptable for Test Level 3 regardless of the higher ratings that may be indicated on the rail standard.  
See Traffic Rail T552 standard for details and notes not shown.  
See Traffic Rail Foundation (TRF) standard for details and notes not shown.  
All material removed from bridge must be properly disposed of off the right of way. All material needed and work performed will not be paid for directly but must be considered subsidiary to the bid item.  
Payment for a retrofit rail will be as per Item 450, "Railing", by the type of the rail retrofit, "Ty T552 (Retrofit)".

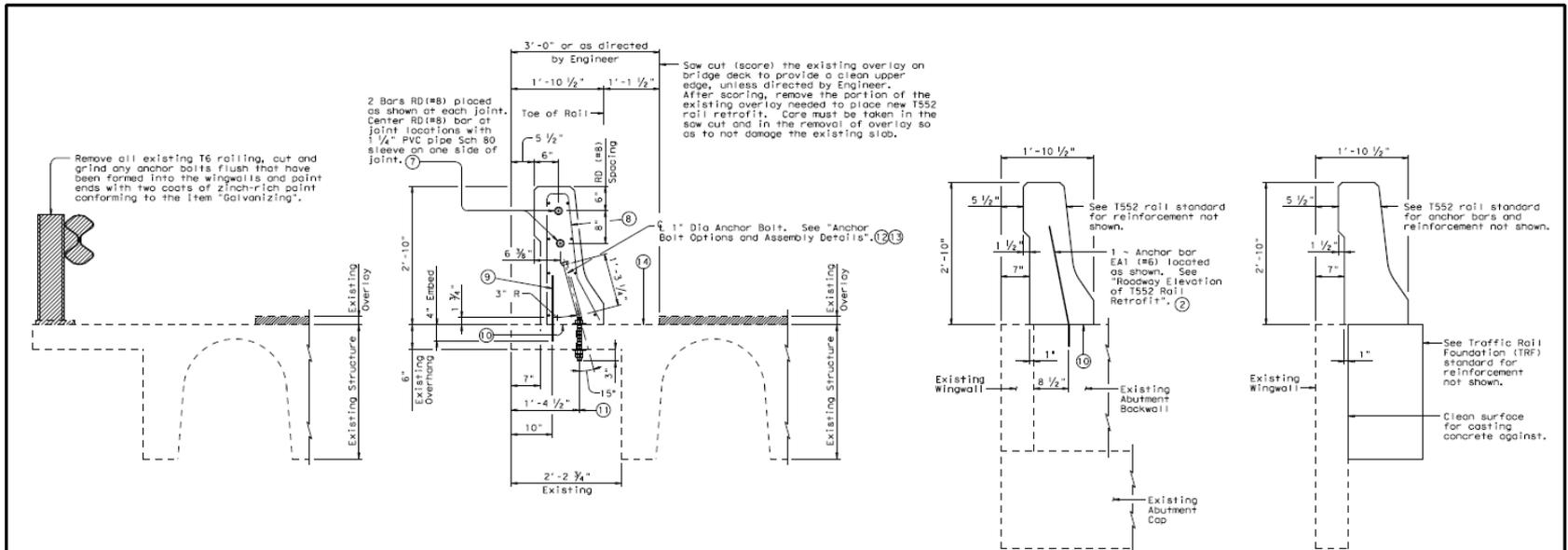


SHEET 1 OF 2

**T552 RAIL RETROFIT**  
**LONG CANYON CREEK BRIDGE**

FILED: \_\_\_\_\_  
DATE: February 2013  
BY: [Signature]

# Example retrofit 2



**SECTION OF EXISTING T6 RAILING TO BE REMOVED**

**SECTION OF T552 RAIL RETROFIT**

**SECTION OF T552 RAIL RETROFIT**

**SECTION OF T552 RAIL RETROFIT**

Showing T552 Rail Retrofit on abutment backwall. 2 Bars RD(#8) not shown for clarity.

Showing T552 Rail Retrofit on TRF.

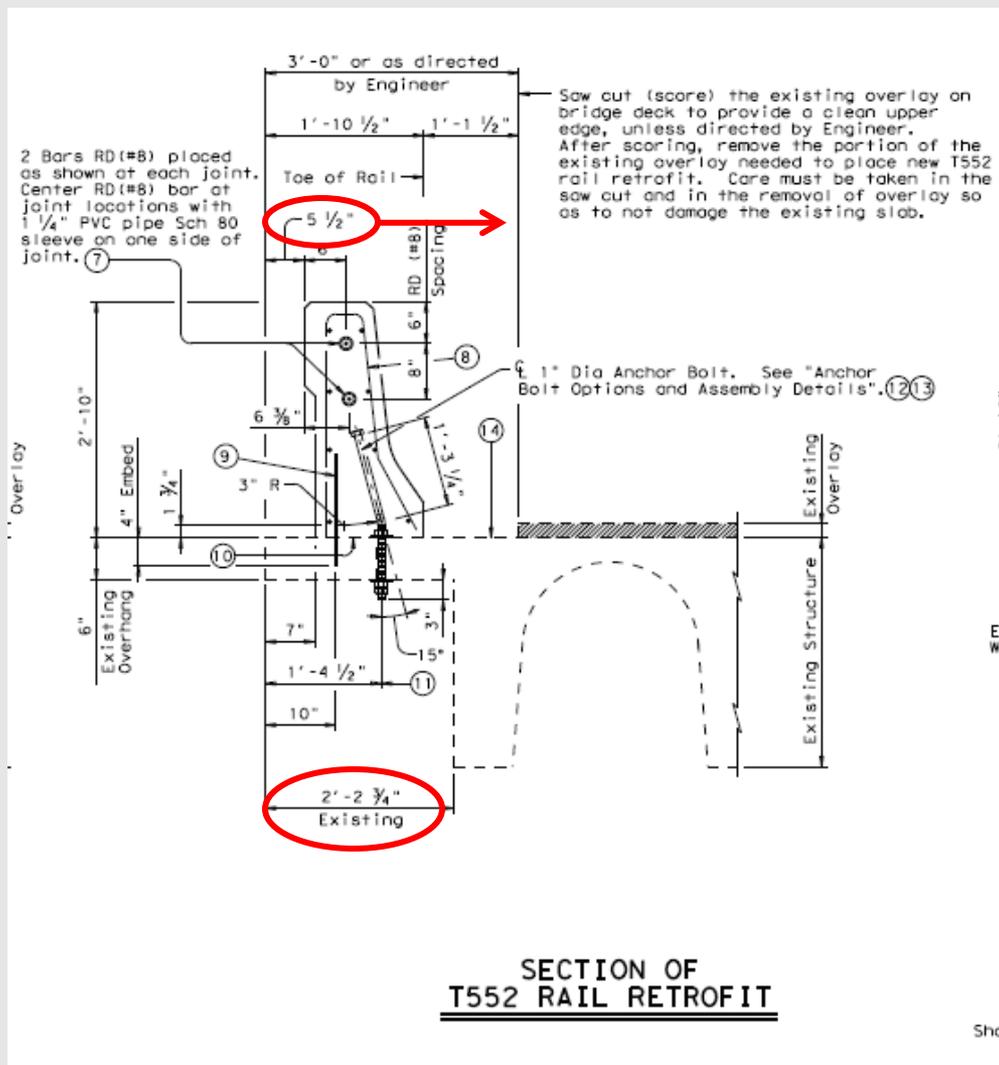
- 2 Embed (#6) anchor bar 5 1/4" with Hilti HIT RE500 epoxy adhesive. Other Type III Class C epoxy adhesives meeting the requirements of DMS-6100, "Epoxyes and Adhesives", may be used if it can be demonstrated that they meet or exceed the strength of Hilti HIT RE500 with the same embedment depth and anchor bar size and spacing. The contractor is responsible for any cost associated with this demonstration. Follow manufacturer's directions for installing the epoxied anchor bars.
- 7 See "Bar RD(#8) Assembly Detail".
- 8 See T552 rail standard for reinforcing steel. Modify length of vertical reinforcing bars as required to fit existing structure. Longitudinal reinforcing bars may be removed only if their position puts them in conflict with un-removed portions of existing structure.
- 9 Secondary (#4) anchor bars 1'-4" in length are embedded 4" with a Type III Class C epoxy anchorage system. Follow manufacturer's directions for installing the epoxied anchor bars. (#4) anchor bars spaced longitudinally along rail at 4 ft Max (Spaced 3' longitudinally from outside edge and edge of side slot drains).
- 10 Do not cast rails or parapet walls on top of overlays/seal coats.
- 11 1 1/2" to 1 1/4" Dia holes. Core drill holes through existing deck (percussion drilling not permitted). Concrete spalls in the bottom of the deck exceeding 1/2" from edge of holes will be patched in accordance with Item 429, "Concrete Structure Repair" at the contractor's expense.
- 12 1" Dia Anchor Bolt Spaced longitudinally along rail at 24" Max (Spaced 6" longitudinally from outside edge and edge of optional side slot drains, if required).
- 13 Galvanize anchor bolts, nuts and plate washers.
- 14 After construction of rail retrofit replace overlay 2" or less as needed to establish a uniform slope from toe rail that is 1:10 or flatter over the shoulder.

SHEET 2 OF 2

<p>Texas Department of Transportation</p>	<p>Bridge Division</p>
<h2>T552 RAIL RETROFIT</h2> <h3>LONG CANYON CREEK BRIDGE</h3>	
<p>FILE: _____</p> <p>© 1407 February 2013</p> <p>REVISIONS _____</p>	

DATE: \_\_\_\_\_ FILE: \_\_\_\_\_

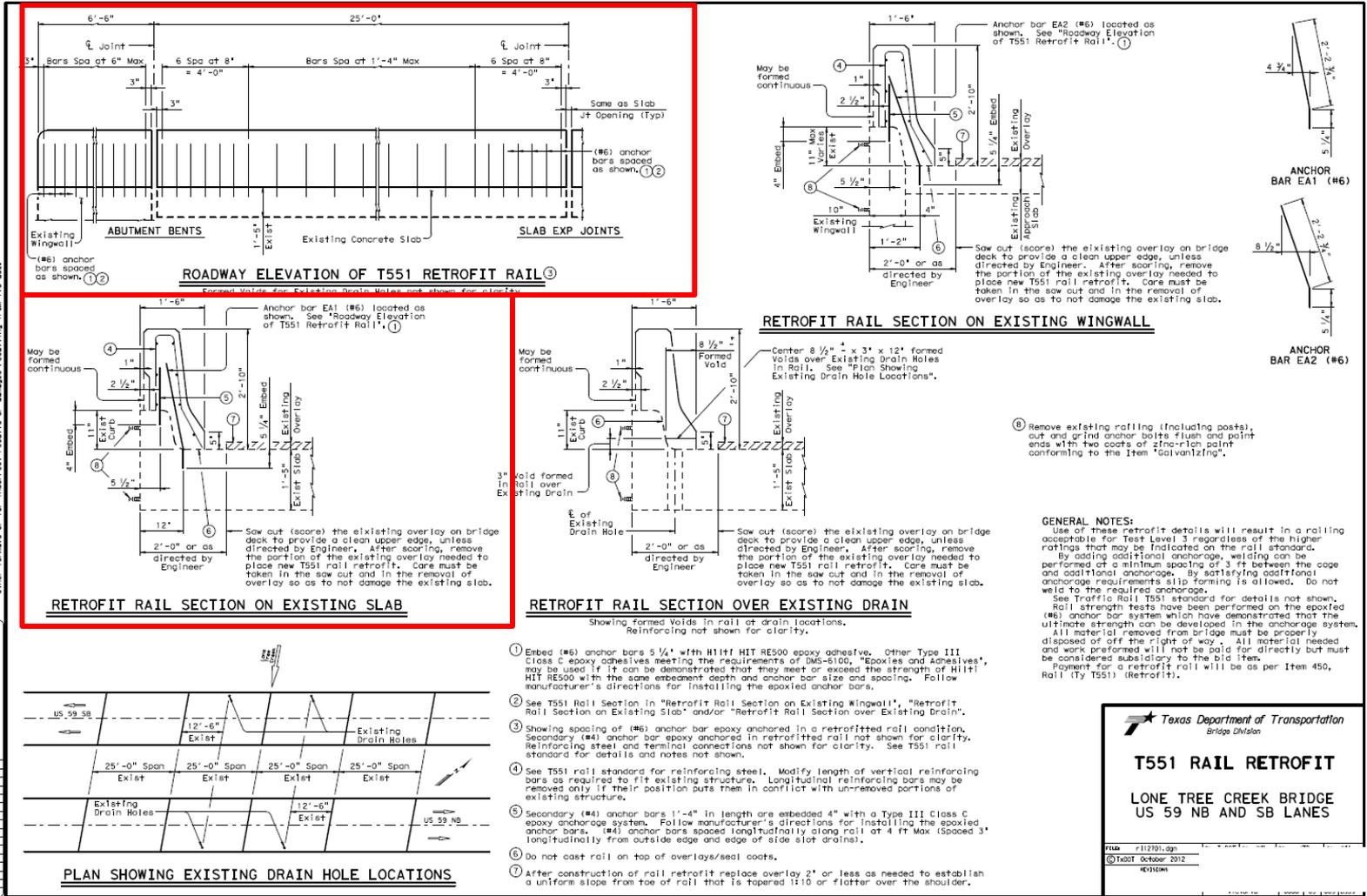
# Example retrofit 2



- Pan-form bridge
- Notice overhang is 2'-2.75"
  - Larger than the 1'-9.25" max on Guide
- Move rail 5.5" from edge to satisfy overhang limit

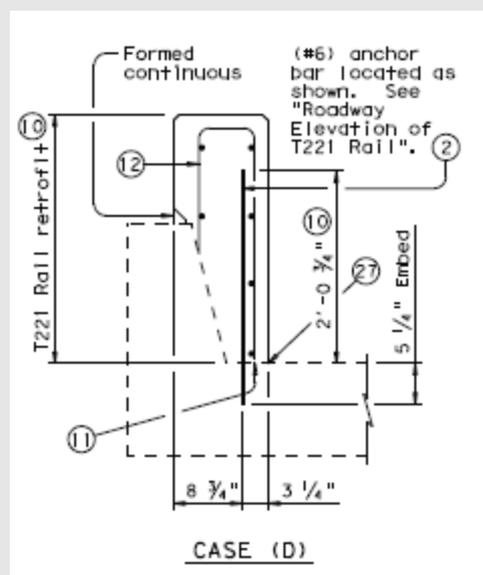
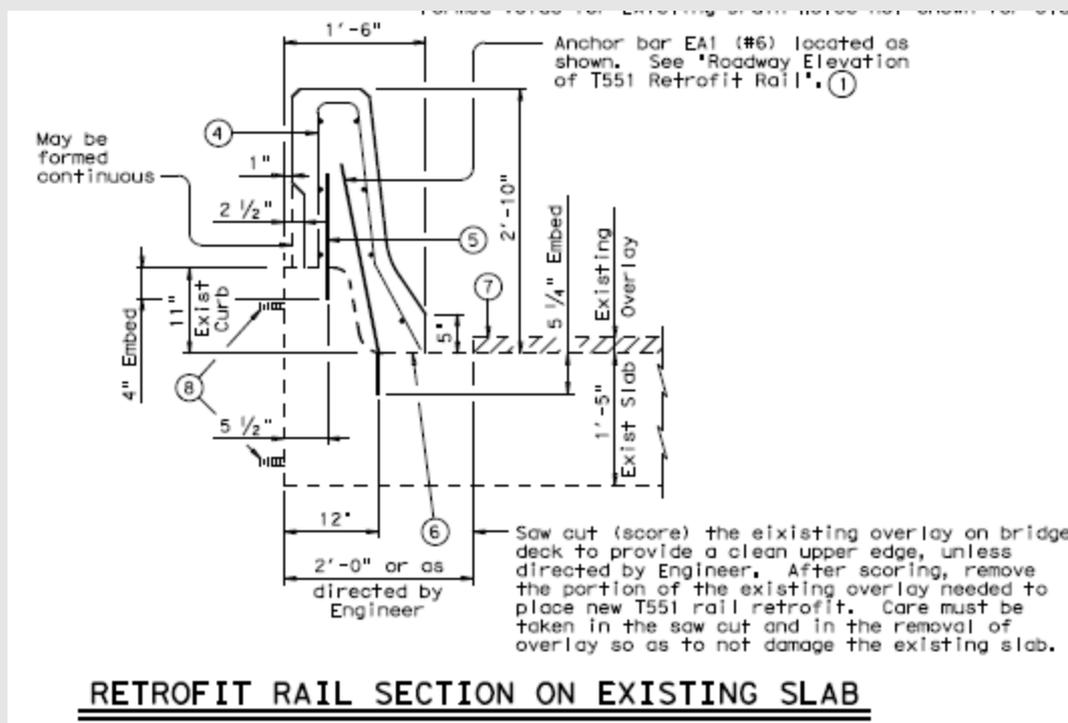
# Example retrofit 3

## T551 with epoxy anchors on slab with curb



# Example retrofit 3

- Compare to Case (D)



from C-RAIL-R

# Summary

	T221	T401	T551	SSTR
	\$/lf	\$/lf	\$/lf	\$/lf
Conventional	54	80	39	34
Retrofit	170	167	106	110

- Retrofit is 2-3x price of conventional install

# Summary

- C-RAIL-R has easy retrofits for:
  - Slabs 6.5”+ thick
  - Most pan-form bridges
  - Slabs with curbs
- Details will provide a TL-3 rail (50mph)
- Must be MOD and sealed/signed
- Other situations can be handled
  - BRG needs to evaluate structure for best rail type and anchorage
  
- Questions?
  - Amy Smith 512/416-2261
  - Jon Ries 512/416-2191