Bridge Railing Considerations for Preservation Projects

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- Standards Reminders ❤️
- Criteria for upgrading bridge railing as part of bridge preservation
- Railing retrofit details
- LRFD bridge railing design specifications
- Bridge rail and guardrail details to consider with concrete overlays

Communication

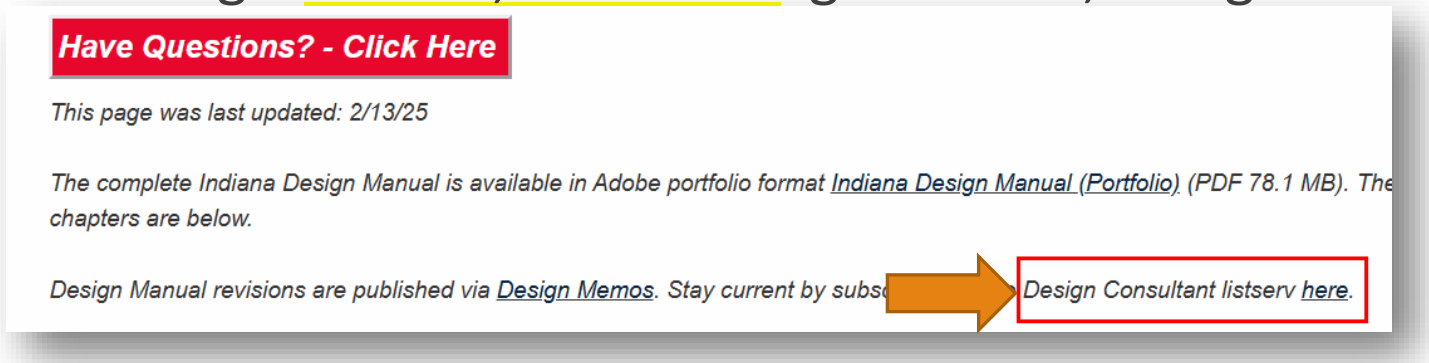
How Do Notify Designers?

What Do We Communicate?

How To Subscribe?

- Email notification via listserv

  ~~Gov Delivery~~ Marketing Cloud – Design Consultant
- Design Memos - changes to design guidance and design procedures, yearly Standard Drawings publication, RSPs that affect designers
- Bridge Design Aids
- Training opportunities, surveys
- Links available from multiple webpages: Indiana Design Manual, Active Design Memos, Designers



Design Memos

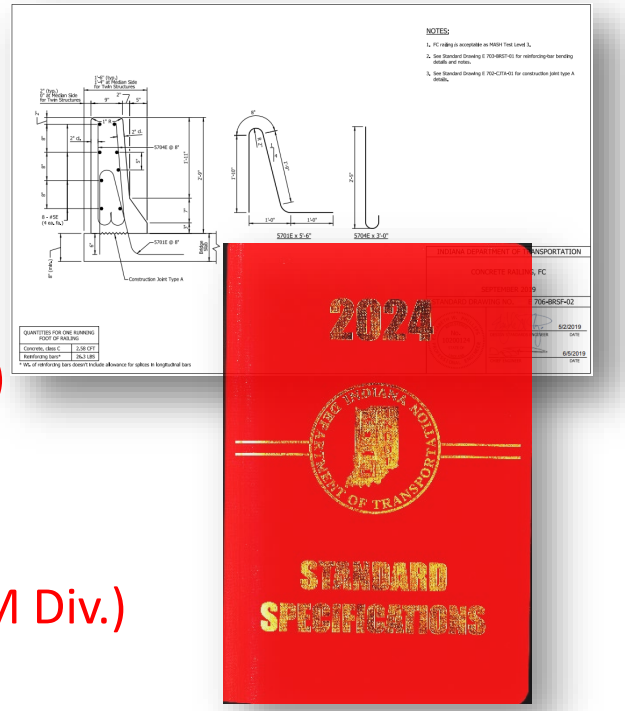
- Published the second week of each month
- Associated revisions to the IDM are incorporated concurrently, unless otherwise stated. Link in memo.
- Memos remain active for year and are then “Archived”
- Superseded memos are archived immediately
- Memos that include guidance that has not been incorporated into the IDM or other INDOT publication may remain active
- Memos that are integral to applying a recurring special provision (RSP) or recurring plan detail (RPD) may remain active

Standards Publication Dates

The Standard Drawing Index can be filtered to show changes from previous year

Revisions from the previous spec book are posted on-line

- **2025** *Standard Drawings*
  - Effective **September 2025**
  - Published every year
- **2026** *Standard Specifications* (CM Div.)
  - Effective **September 2025**
  - Published every other year
- Recurring Special Provisions Menu (CM Div.)
  - Published Feb, May, Aug, Nov
  - Applicable menu is based on contract letting date. Available from the *Recurring Special Provisions and Plan Details* webpage



Menu and Basis for Use	Expected Publication Date	For Lettings
FEB. 2025 MENU	Posted 01/30/25	June, July, and August 2025
NOV. 2024 MENU	Posted 10/31/24	March, April, and May 2025
AUG. 2024 MENU	Posted 8/1/24	December 2024, January, and February 2025

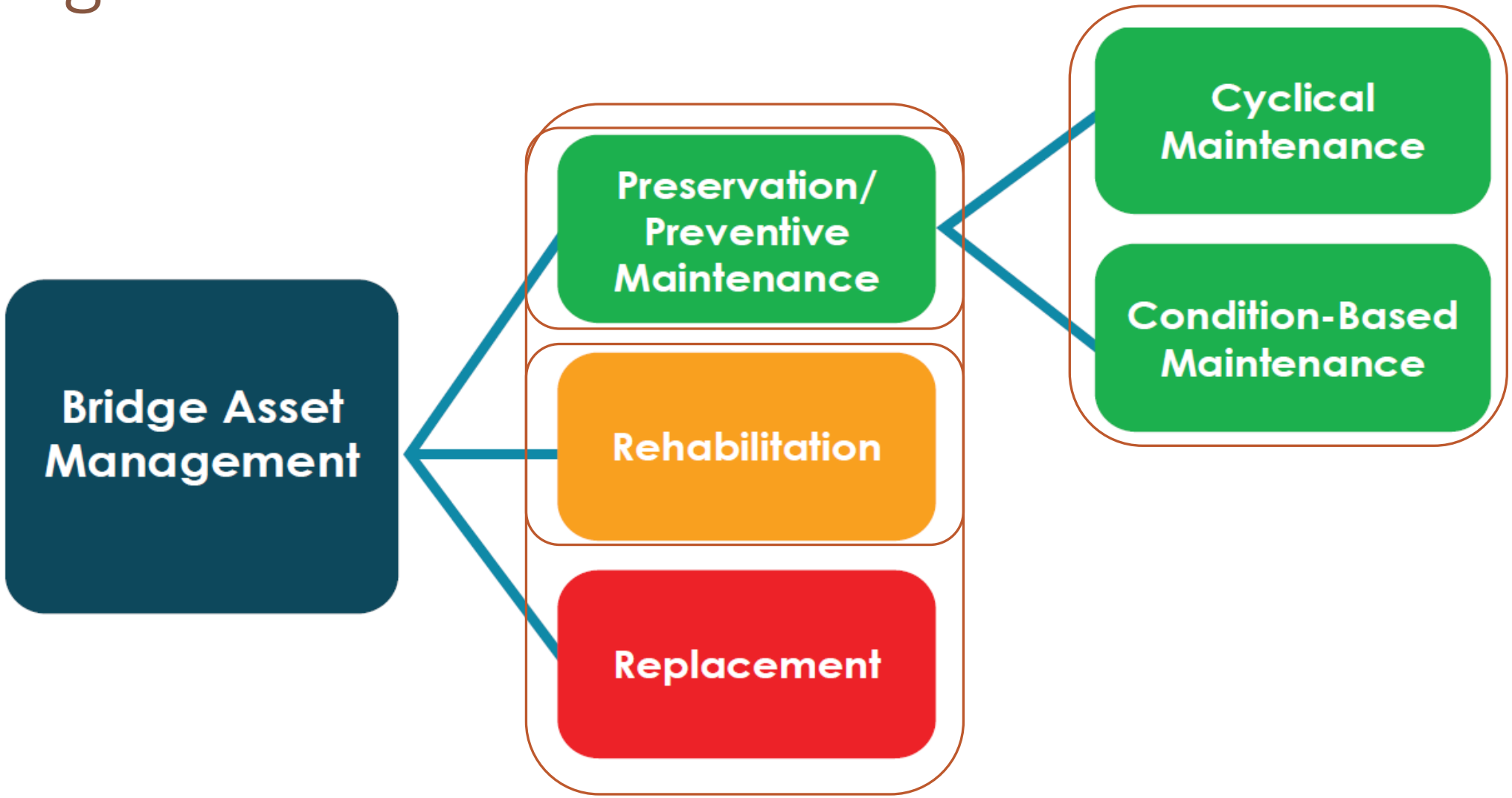
Poll

What is the #1 issue for INDOT Technical Writers?

- Receiving the wrong RSP menu for the contract letting date.

- You may need to resubmit the menu if you turn your Final Tracings in early or the letting date moves.

Bridge Preservation



Source: FHWA *Bridge Preservation Guide*

Criteria for Upgrading Bridge Railing

Treatments Type	Bridge Component (Item Code)	Component Rating	Other Criteria [2]
Railing Repair [1]	Deficiency Noted	N/A	WS/D/SS>4
Relief/Terminal Joint Repair [1]	Deficiency Noted	N/A	WS/D/SS>4
Upgrading End Treatments, Guardrail, Railing, Attenuators [1, 4]	N/A	N/A	WS/D/SS>4
Adding Reinforced Concrete Deck to an Adjacent Box Beam Bridge without a Deck [5]	Superstructure (59) and Substructure (60)	(59) >5 (60) >4	N/A

[1] Items may only be included in a project incorporating other preventive maintenance treatments

[4] When found to be cost-effective *producing good results without costing a lot of money - Brittanica*

CONDITION-DRIVEN PREVENTIVE MAINTENANCE ELIGIBILITY CRITERIA
Figure 412-1A

Cost is a judgment call. Discuss with the district Bridge Asset Engineer

Criteria for Upgrading Bridge Railing

412-3.01(03) Bridge Railing [Rev. Mar. 2021]

1. Preventive Maintenance Project. Existing bridge railing may remain in place as part of a preventive maintenance project if the railing is in good condition and is functioning as originally intended with the following exception. All existing aluminum bridge railing on the NHS should be replaced when the treatments include a rigid overlay. The current standards apply to new bridge railing. The intent to leave substandard railing in place should be clearly stated in the Initial Field Check Minutes and agreed upon by the Bridge Rehabilitation reviewer.

General assessment, not the SNBI rating

Practical considerations to keep on the NHS and to replace off the NHS

Evaluating Bridge Railing

- **Stability** (Height, Shape, and Stiffness)
  - Basic ability to contain vehicle
  - Updates for LRFD Section 13 currently under review by AASHTO COBS
- **Geometrics** (Snag Hazards)
  - Post setback, clear openings between longitudinal rail elements, and available vertical contact surface area.
  - Risk includes increased vehicle deceleration (occupant risk), vehicle damage, and instability.
  - Also consider joints and connections at bridge railing approaches
- **Strength** (Capacity)
  - Ability to withstand impact conditions and effectively contain and redirect a vehicle
  - MASH TL-4 Impact loads will vary with barrier height

(NCHRP Research Report 1109)

Minimum rail heights for MASH

MASH Test Level	Minimum Rail Height (in.)
1	20
2	24
3	30*
4	36
5	42

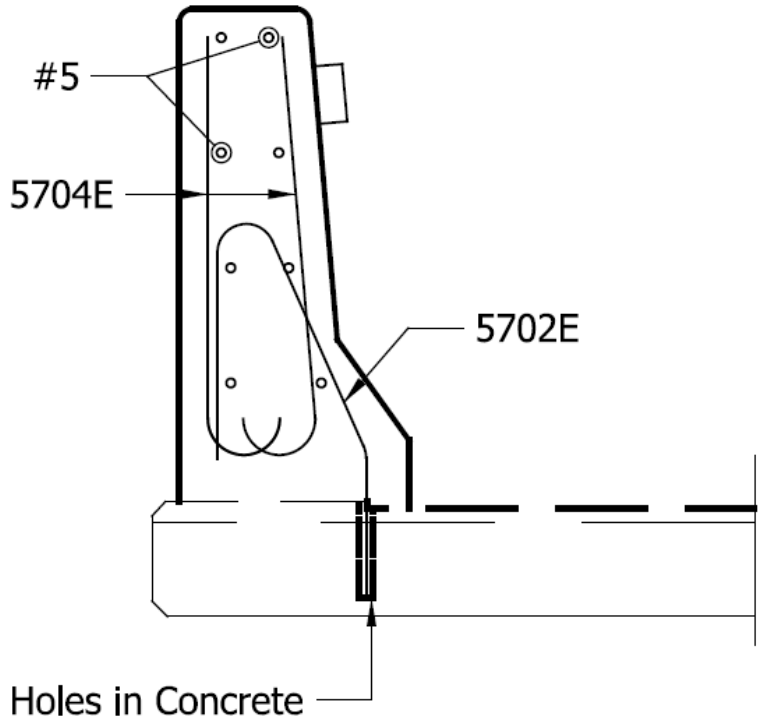
*Simulation results suggest 29 in. may be adequate.

36-in. height – box glides over top of barrier

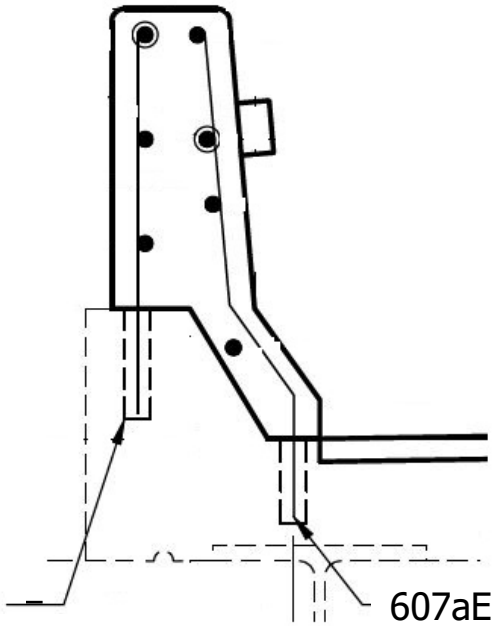
39-in. height – direct box impact

Enter test level and testing criteria on Level One checklist, e.g. TL-4 (NCHRP350)

Bridge Railing Retrofit



Field Drilled Holes in Concrete
Embed bar 6 in. with approved
Chemical Anchor System

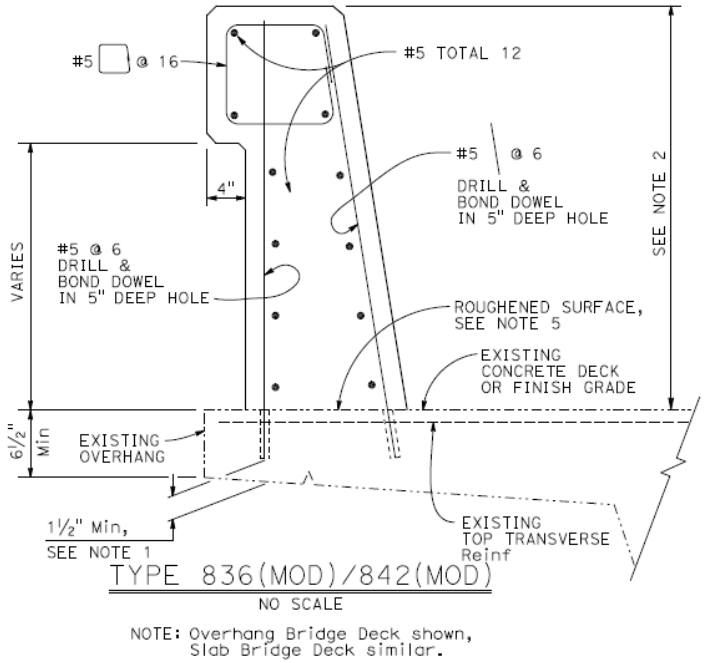


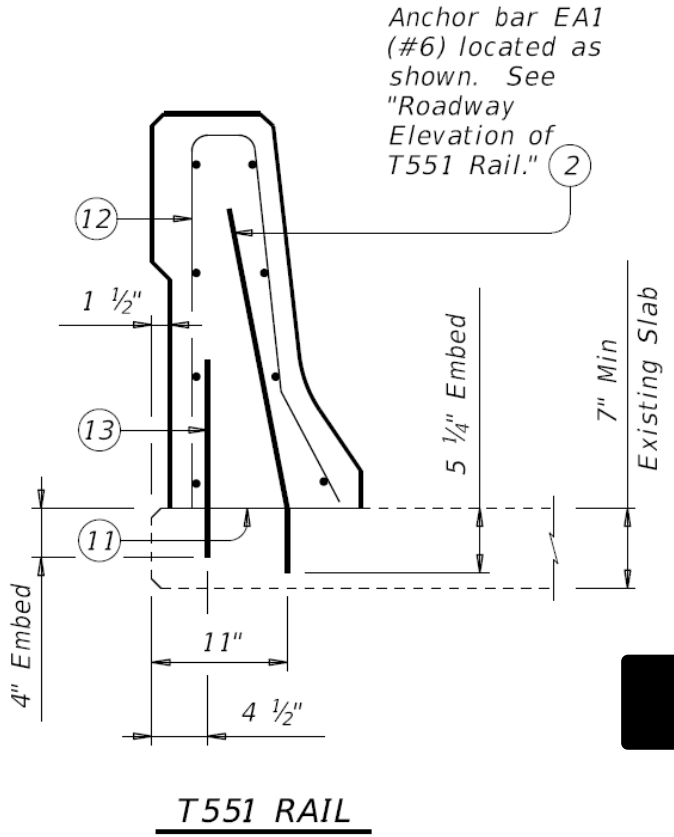
4Ex2'-5" set in
Field Drilled Holes in
Concrete. Embed bar 8 in.
with approved Chemical
Anchor System
(Min. Edge Dist. = 4”

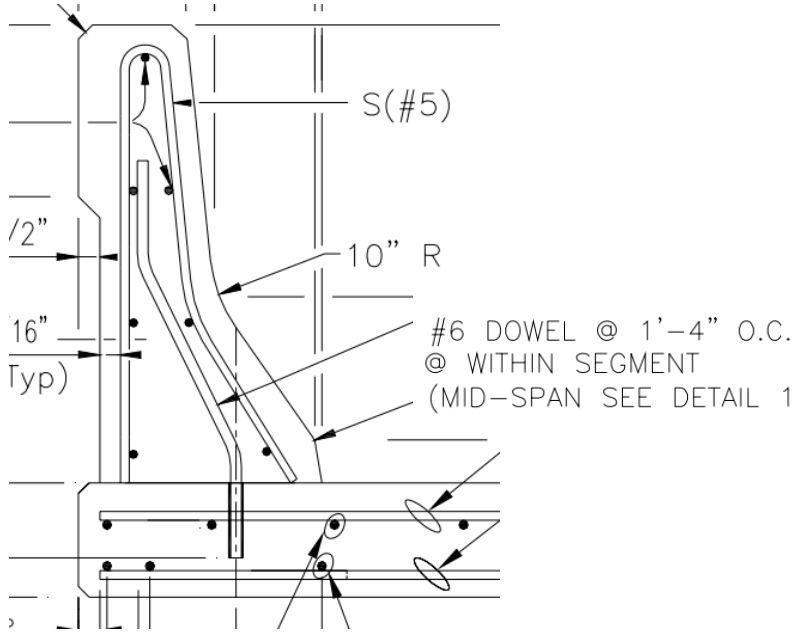
607aE set in
Field Drilled Holes in Concrete
Embed bar 6 in. with approved
Chemical Anchor System

Bridge Railing Retrofit In-service Performance

Bridge Railing Retrofit







Successfully crash tested to NCHRP 350 criteria. Not designed to meet code, instead to resist the actual distribution of force to rail anchorage system.

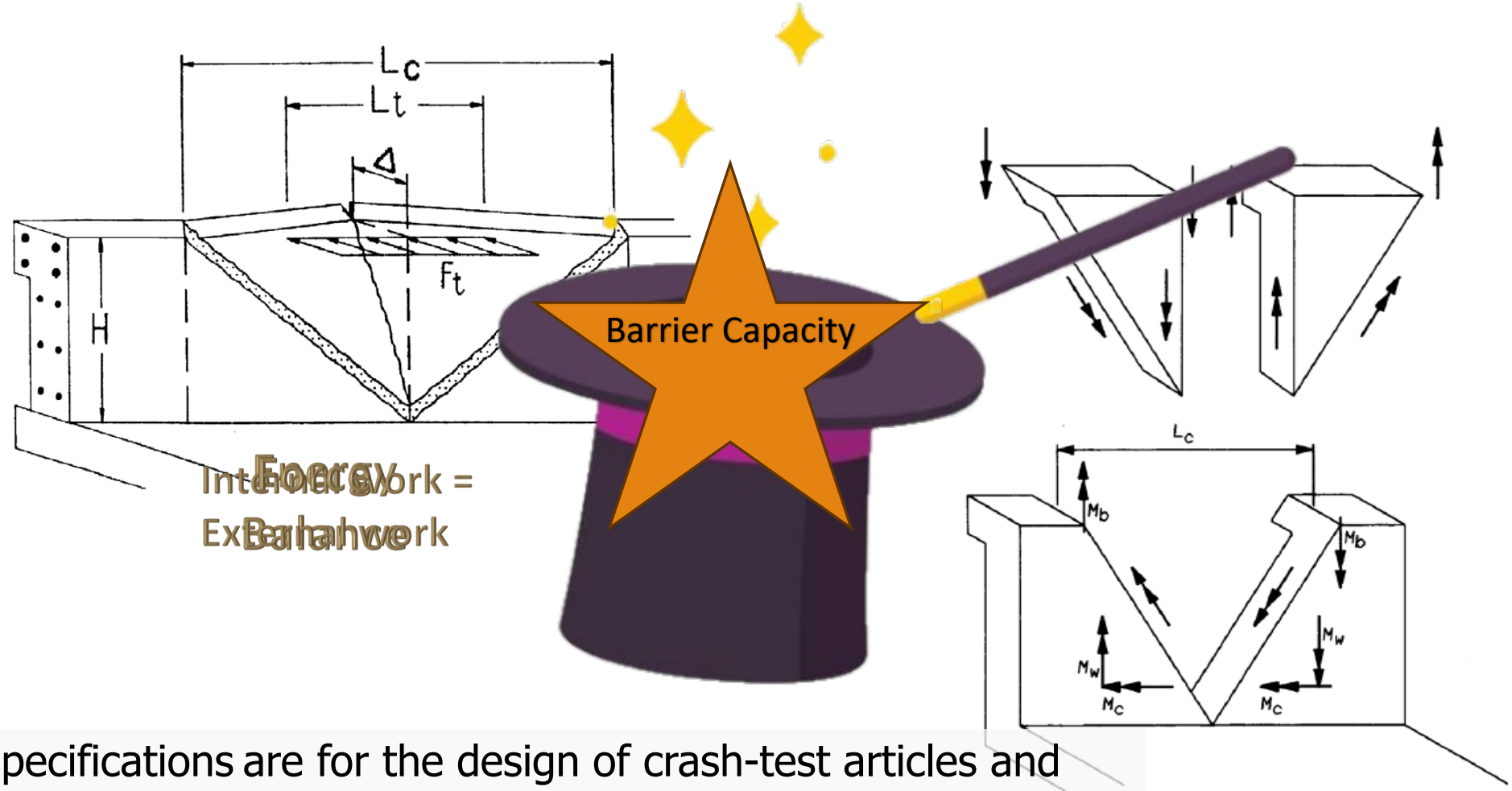
Sources (L – R): California Department of Transportation,
Texas Department of Transportation
Texas Department of Transportation, FHWA/TX-06/0-4823-T1-1 Repair/Retrofit Anchorage Designs for Bridge Rails

LRFD and Crashworthy Railing

13.7.3.1.1—Application of Previously Tested Systems

A crashworthy railing system may be used without further analysis and/or testing, provided that the proposed installation does not have features that are absent in the tested configuration and that might detract from the performance of the tested railing system.

LRFD Railing Design – Yield Line Analysis

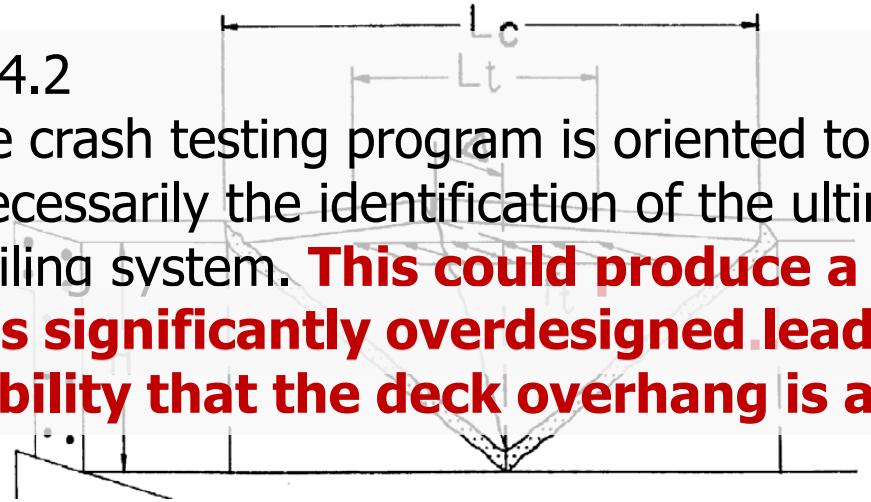


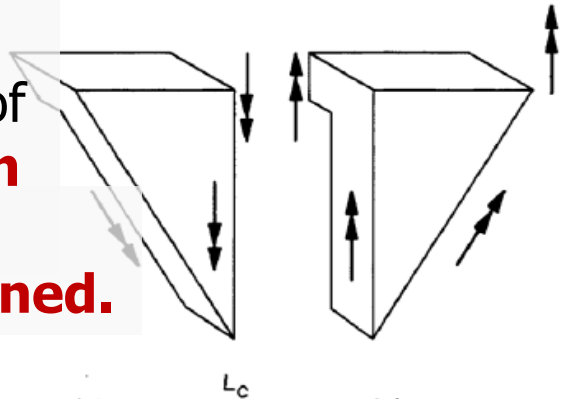
LRFD specifications are for the design of crash-test articles and are not intended to be applied directly for the design of rails or overhangs for in-service use.

LRFD Railing Design – Yield Line Analysis

CA13.4.2

... The crash testing program is oriented toward survival, not necessarily the identification of the ultimate strength of the railing system. **This could produce a railing system that is significantly overdesigned leading to the possibility that the deck overhang is also overdesigned.**



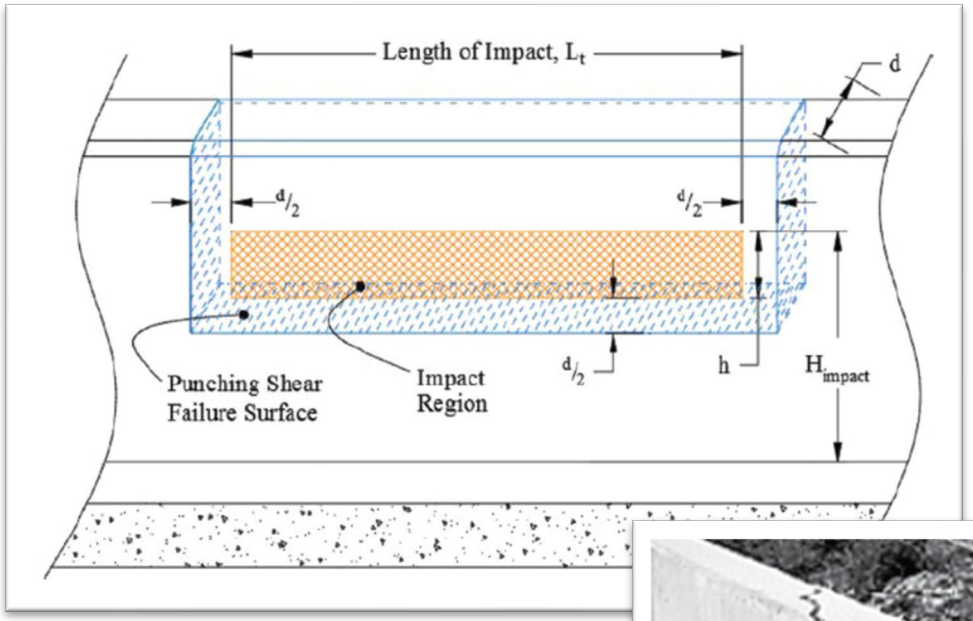


- Bridge decks should be designed such that their capacity is sufficient to support the impact loads exerted on the barrier

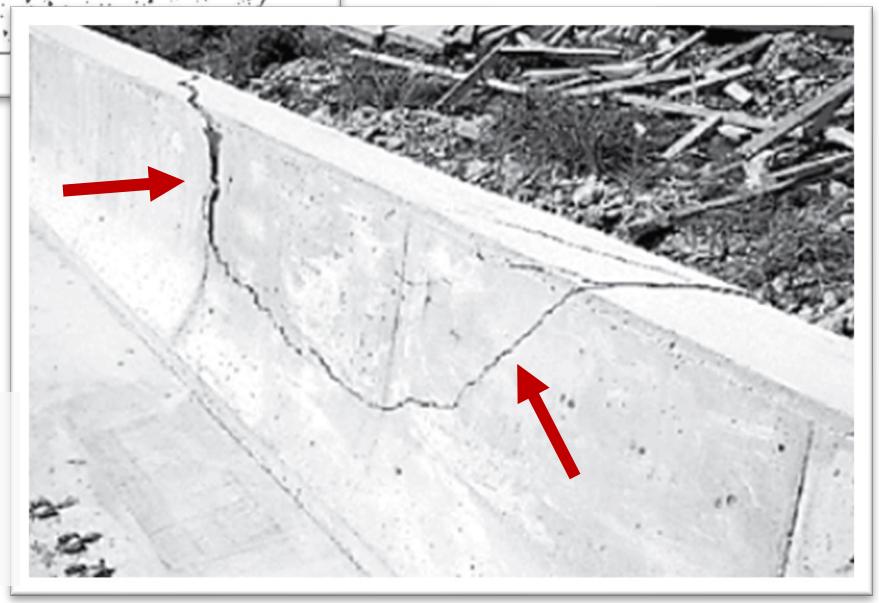
- Many State DOTs have developed alternative overhang design methods
  - Overhang demands determined from lateral impact load, lateral barrier resistance or both rather than assuming the overhang must withstand the full bending capacity of the barrier.

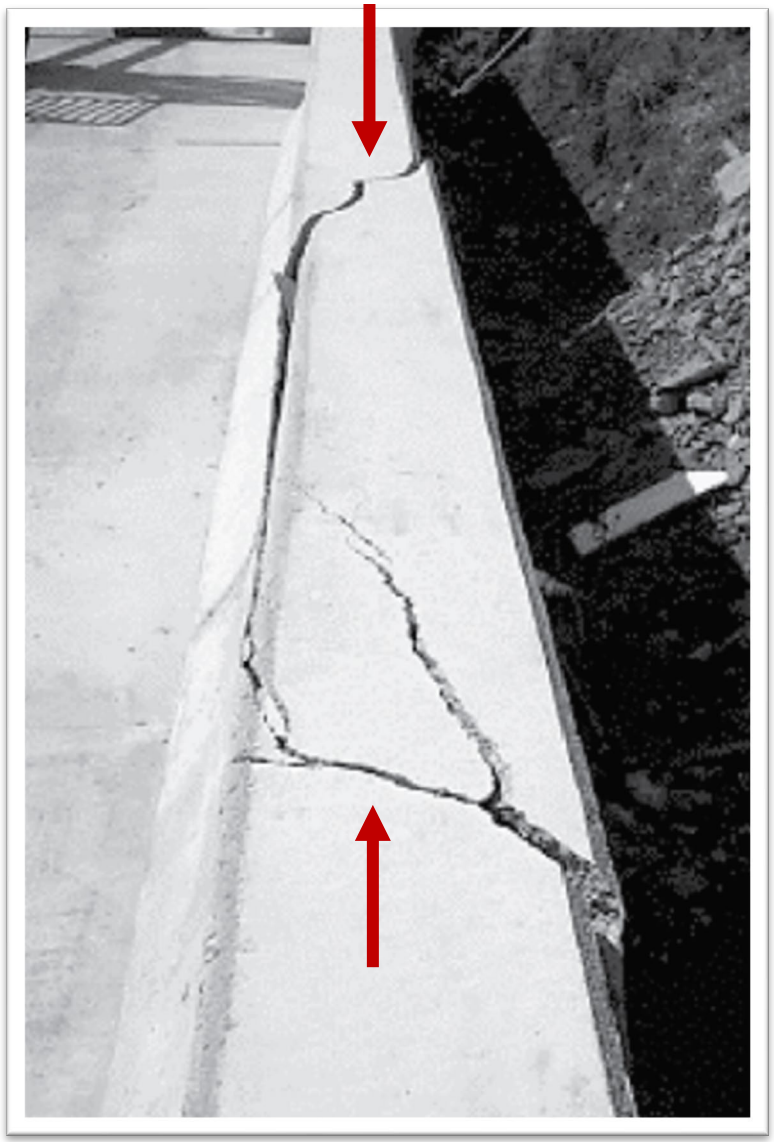
Image Source: AASHTO LRFD Bridge Design Specifications, 9th Ed.

Punching Shear in Concrete Barriers



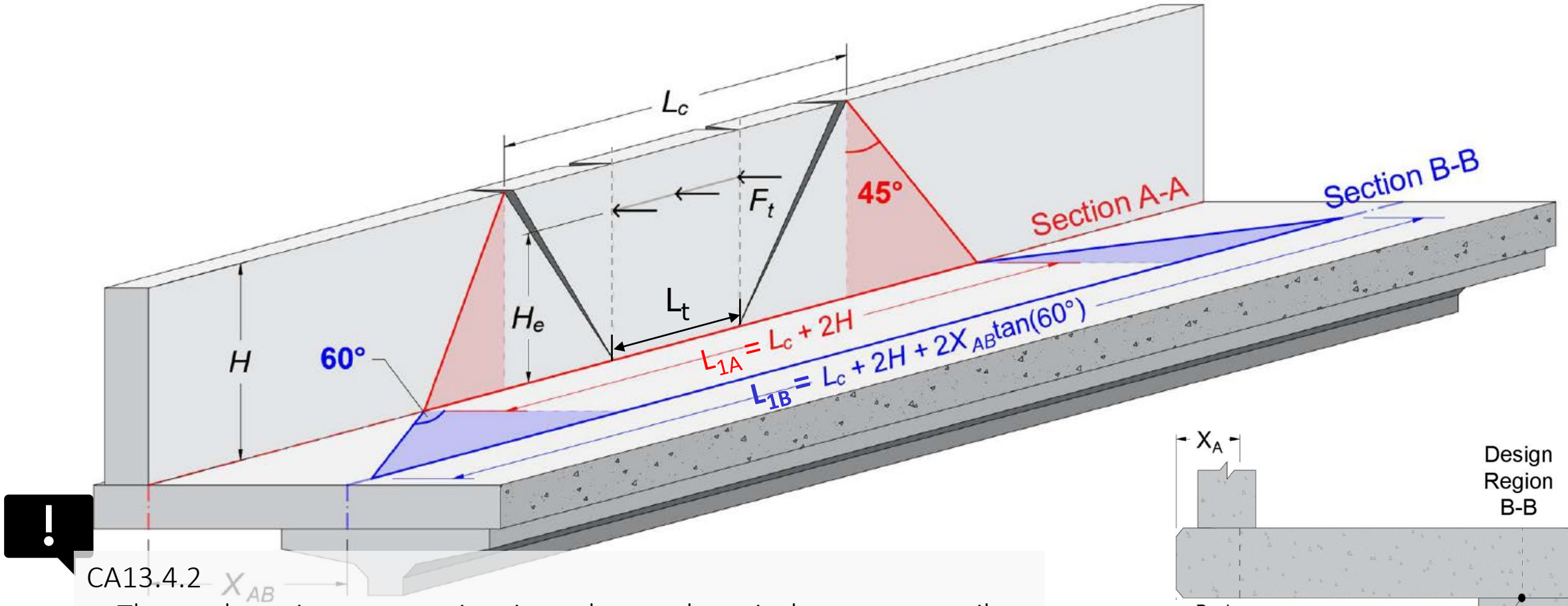
Punching shear behavior is significant and likely controls the strength of solid concrete barriers





Source: FHWA/TX-05/9-8132-3 *Testing And Evaluation of the Florida F Shape Bridge Rail with Reduce Deck Thickness Report*

Proposed Revisions to Yield Line Analysis



CA13.4.2

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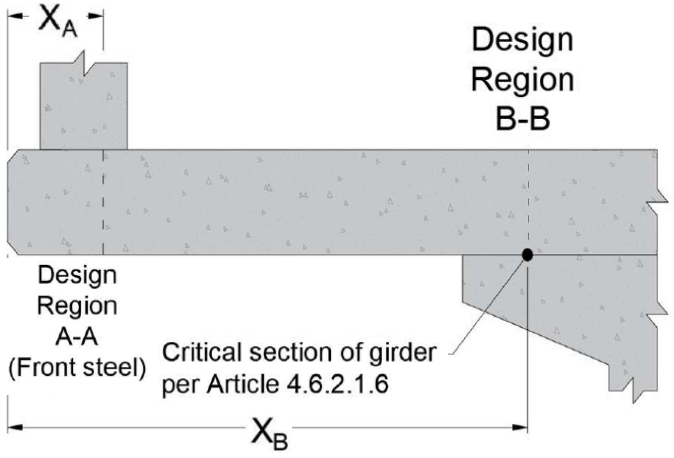
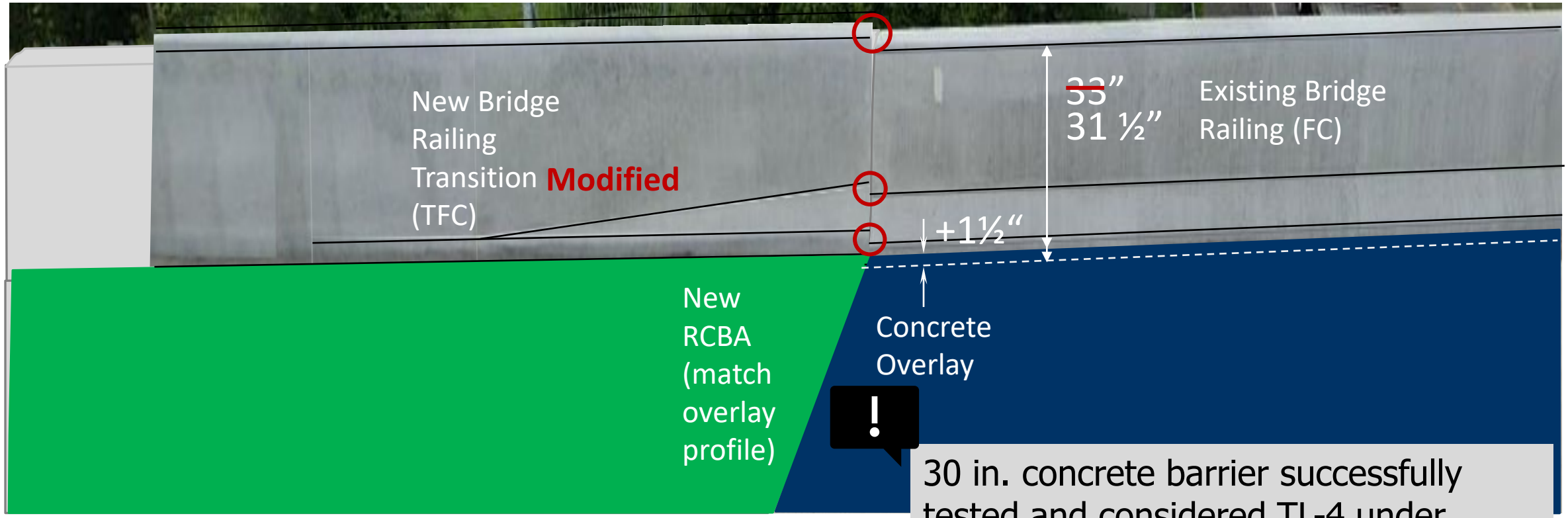


Source: NCHRP Research Report 1109, *Bridge Railing Design Requirements*

Considerations for Concrete Overlay with RCBA Replacement



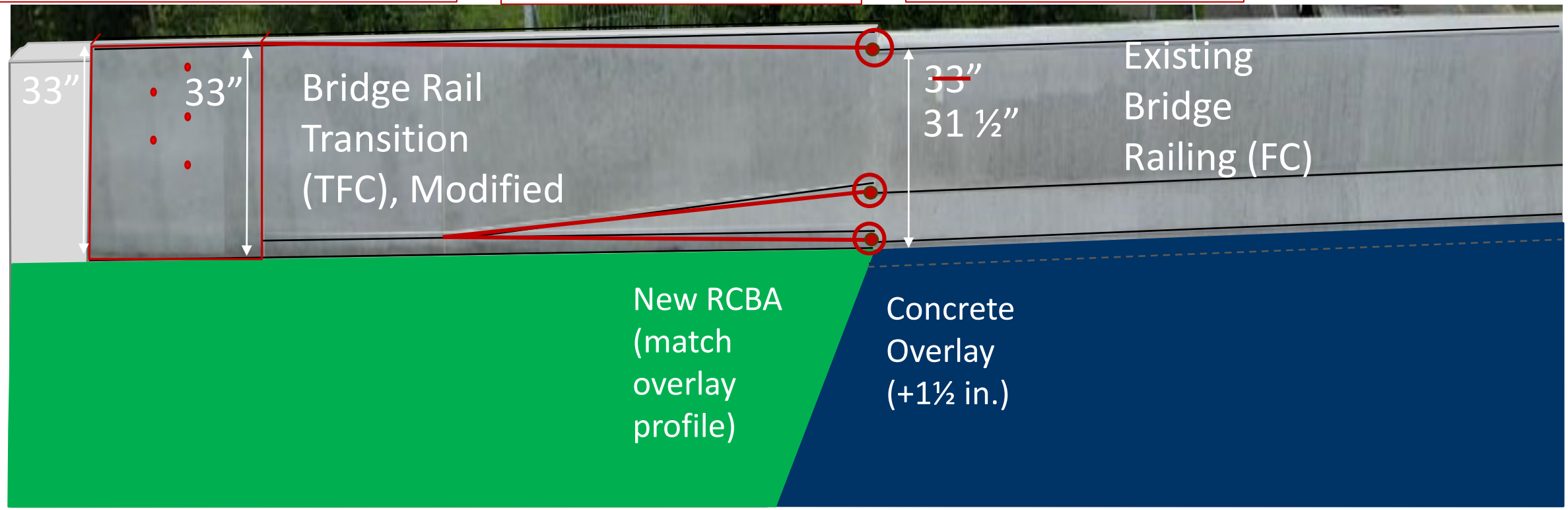
30 in. concrete barrier successfully tested and considered TL-4 under NCHRP 350. A 30 in. height meets TL-3 under MASH

Example Bridge Railing Transition Modification

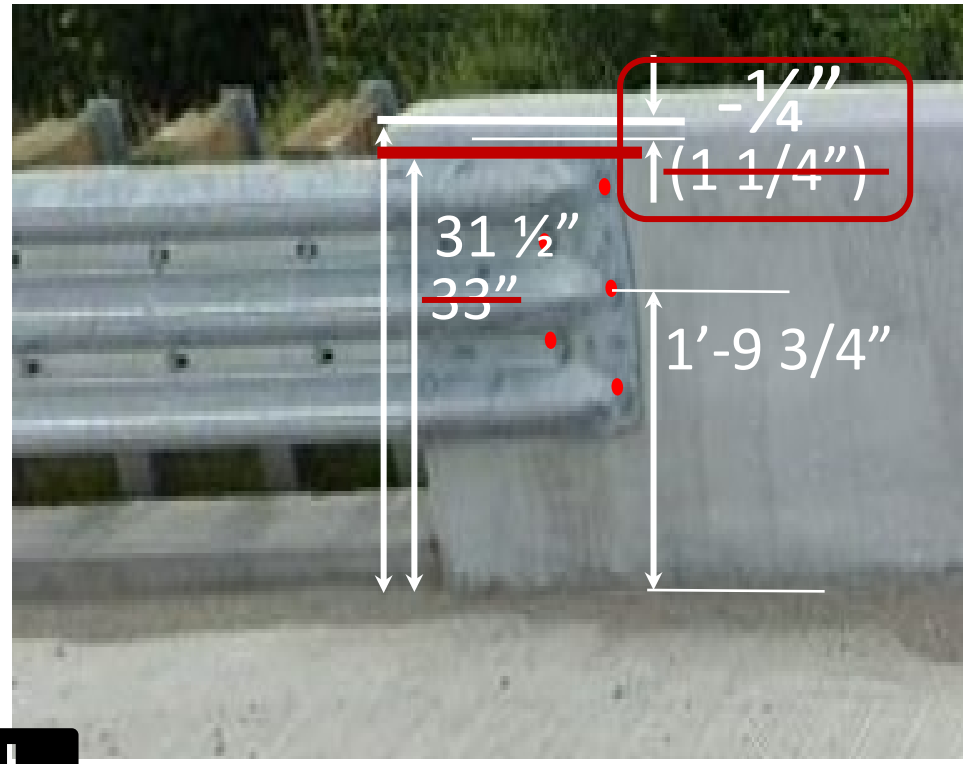
Taper top of rail to standard height at rectangular section

Taper bottom points over standard length

Align top of rail and angular breaks



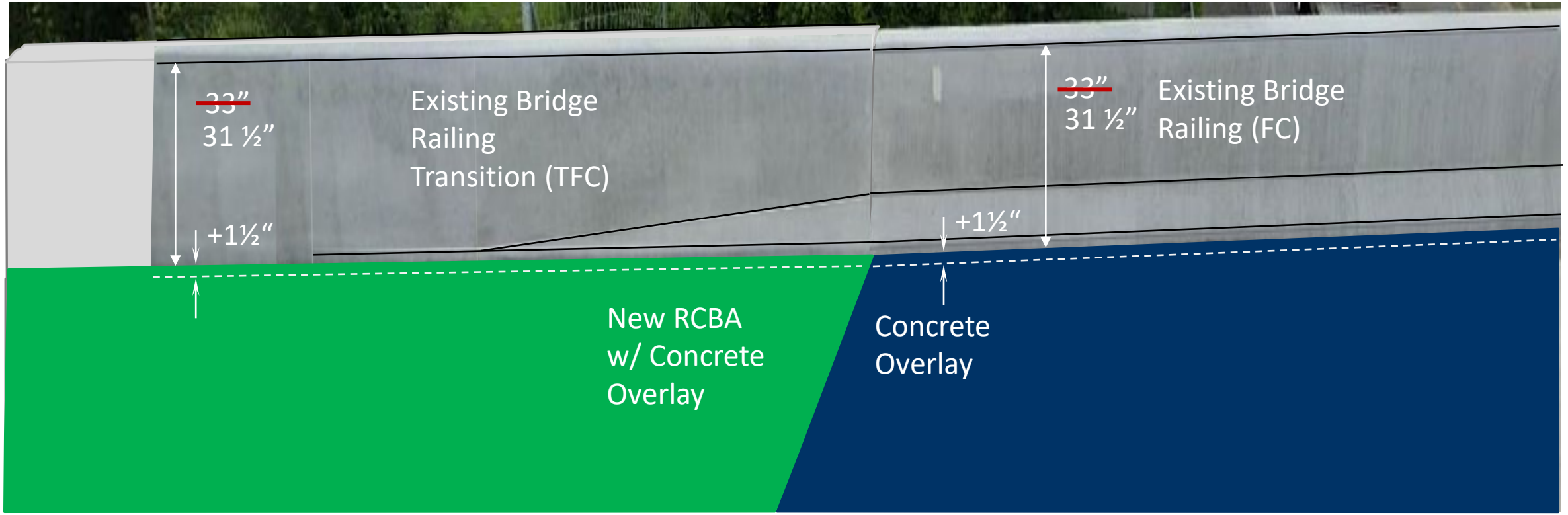
Considerations for Guardrail Transitions



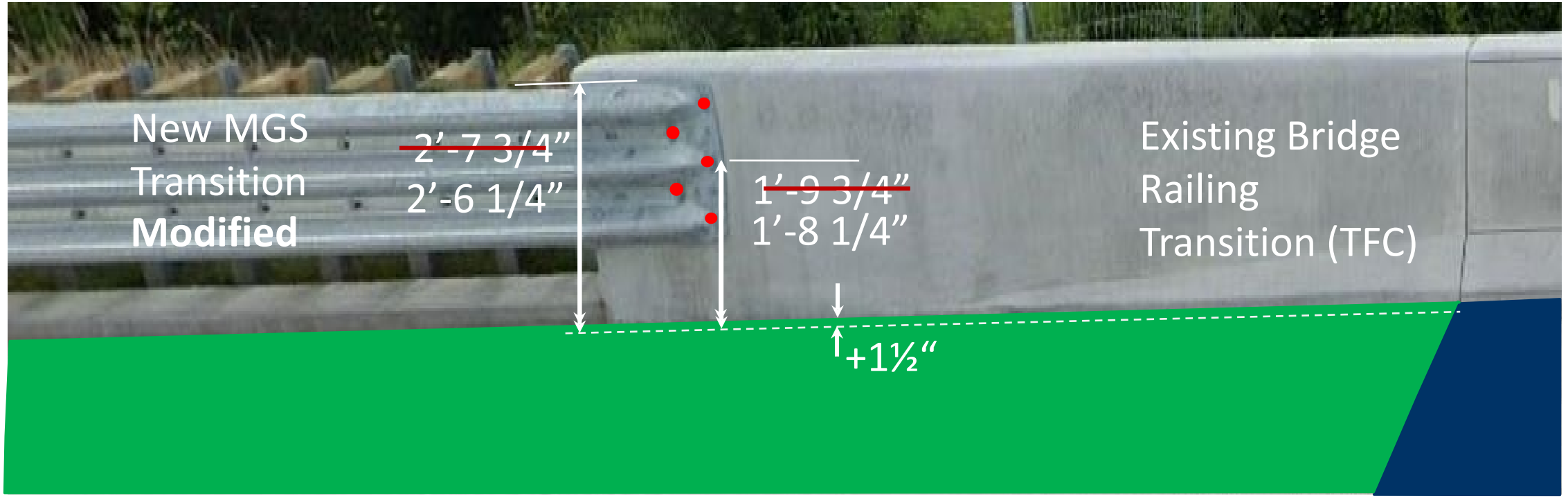
Maintaining the standard height at the rectangular end facilitates proper bolt locations for the guardrail transition.

Lowering the height of the transition without also adjusting the bolt locations can create issues, especially if bolt holes are field-drilled.

Considerations for Concrete Overlay with RCBA Replacement & Overlay

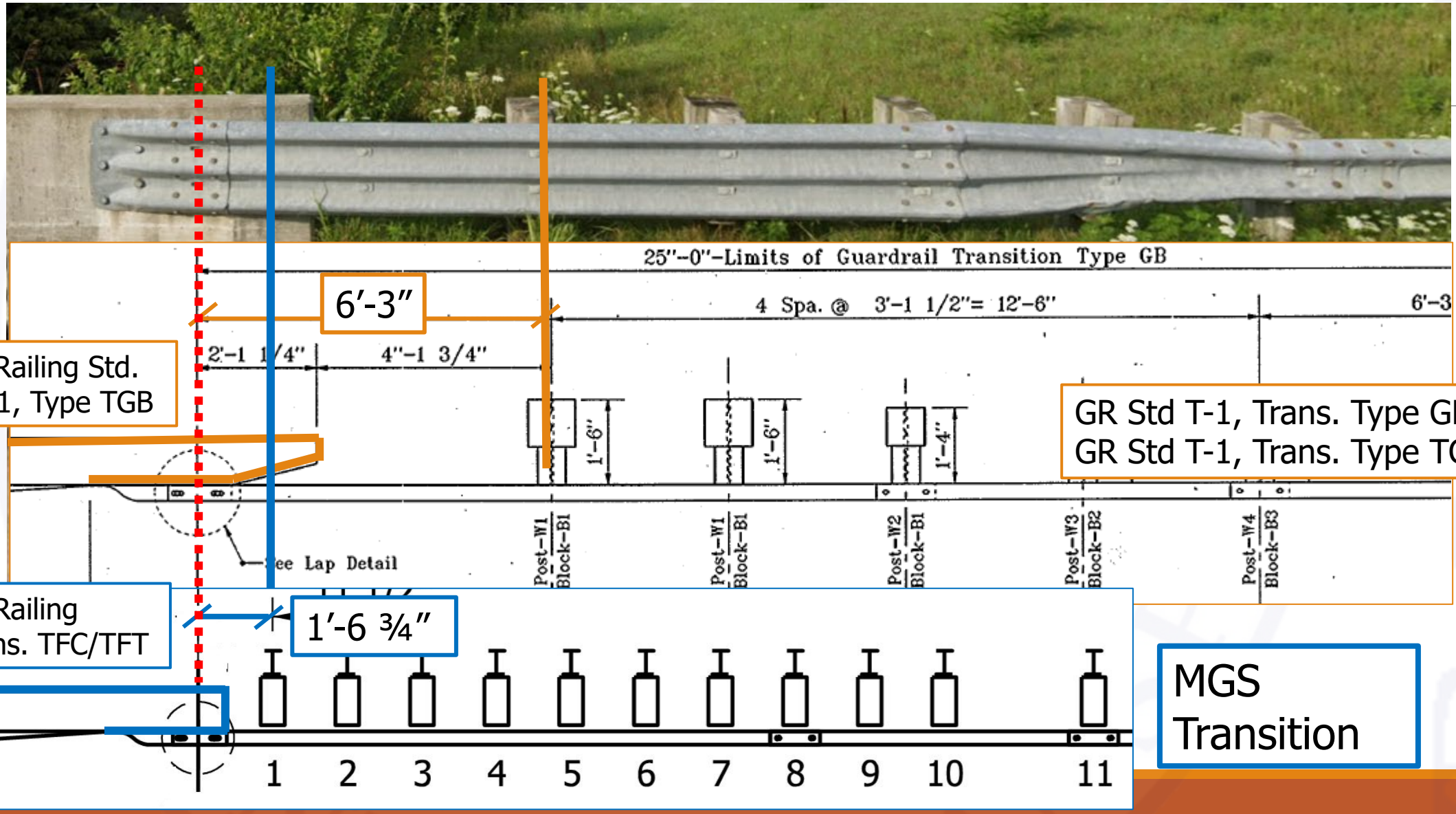


Considerations for Guardrail Transitions



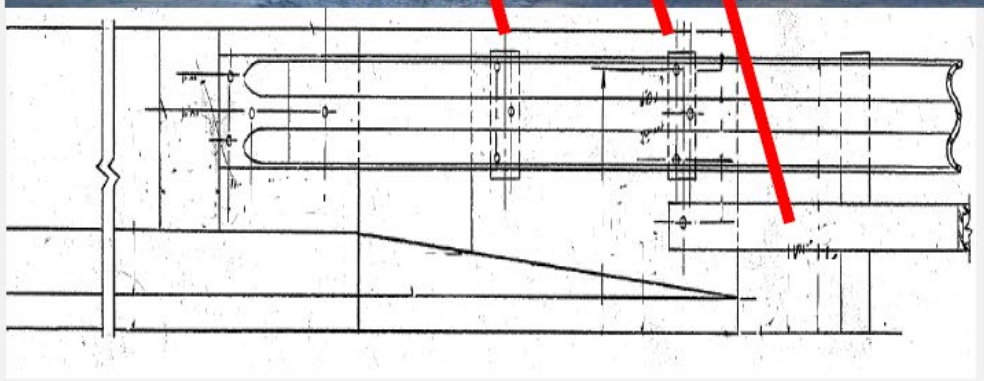
Installation at a non-standard height is a modification and should be identified on the plans and as a pay item supplemental description.

More Considerations for Guardrail Transitions



TRANSITIONS

- Old standards for concrete and guardrail transitions were a pair
  - Designed specifically to be used together and not interchangeable with other transitions
  - Attaching "current standard" guardrail transition does not make the connection MASH compliant. Update the bridge railing transition accordingly



Bridge Standard BR5 Railing Connection

Remember This (TLDR)

- ✓ Ensure the RSP menu is correct for the letting date
- ✓ Bridge railing *can be* included in a bridge preventive maintenance contract, but it is not a requirement.
- ✓ Bridge railing retrofit details have great in-service performance. INDOT is confident that they will perform acceptably. Use them where appropriate. Submit as a railing modification.
- ✓ LRFD bridge railing specifications for solid concrete railing are
  - Not for evaluating in-service bridge railing
  - Conservative. Punching shear is failure mechanism for solid concrete railings
  - AASHTO reviewing proposed modifications to the yield-line analysis procedures
- ✓ Bridge railing transitions and guardrail transitions may need to be modified in conjunction with bridge deck concrete overlays

Bridge Questions?

BridgeDesignOffice@indot.in.gov

General Questions?

DesignManualInquiries@indot.in.gov

INDOT BRIDGE DESIGN CONFERENCE 2025

BRIDGE RAILING CONSIDERATIONS FOR PRESERVATION PROJECTS