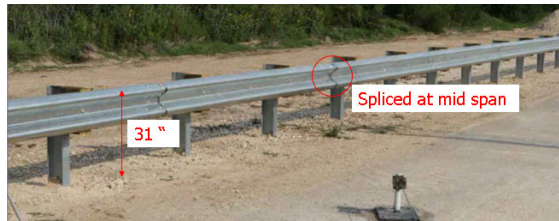


## MASH Implementation of W-Beam Guardrail and Bridge Railing

Elizabeth Phillips &  
Katherine Smutzer  
INDOT Standards and Policy



### What Do We Want you to Get From this Session?

- MGS guardrail systems are different than w-beam guardrail systems. For design guidance on MGS w-beam guardrail refer to Design Memos 17-10 and 17-17. If you have questions, ask.
- If you need to modify a guardrail system, send your recommendation in for review, [DesignManualInquiries@indot.IN.gov](mailto:DesignManualInquiries@indot.IN.gov)
- MASH implementation for bridge railing is coming.

## Sunset Dates NCHRP 350/MASH 2009

### Letting Dates (With Latest Updates)

- December 31, 2017: **Standard W-Beam** Guardrail & Permanent Concrete Barriers
- June 30, 2018: **Single-Sided Tangent** Guardrail End Treatments (End Terminals)
- December 31, 2018: Impact Attenuators, ~~Cable Barriers & Cable Terminals~~
- December 31, 2019: Bridge rails, temporary work zone devices\*, transitions, **Cable Barriers & Cable Terminals**, other longitudinal barriers (**includes Double-Sided (Median) End Treatments, Flared End Treatments, W-Beam Guardrail Transition to Concrete Bridge Rail, W-Beam Guardrail with Reduced Post Spacing**), other terminals, sign supports, and all other breakaway hardware

\* Temporary work zone devices manufactured before 12/31/19 that were successfully crash tested under NCHRP 350 or MASH 2009 may continue to be used throughout their "normal service life." INDOT will determine "normal service life".

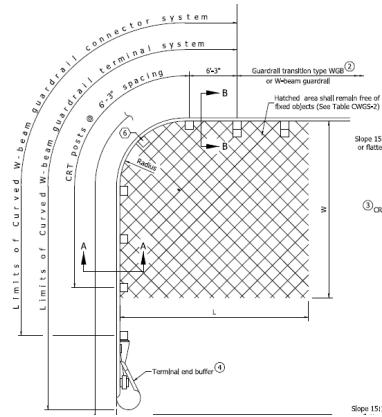
## Sunset Dates For OS End Treatments

### June 30, 2018: **Single-Sided Tangent** Guardrail End Treatments (End Terminals)

- 27 ¾" OS End Treatment is no longer available on the Approved Material List (AML)
  - Don't use 27 ¾" OS End Treatment pay item
- Where a Curved W-Beam Guardrail Connector System requires an OS End Treatment.
  - a MGS Height Transition should be used to allow a 31" OS End Treatment to be placed.
- If site limitations prevent the placement of both a MGS Height Transition and a 31" OS End Treatment, send in an inquiry for your the project. Provide the following with your inquiry:
  - Project Des Number
  - Construction plans
  - Plan details should show the standard guardrail system that will not fit your location and why
  - Approach AADT
  - Crash history at the intersection

### Curved Guardrail System (Std Dwg. 601-CWGS)

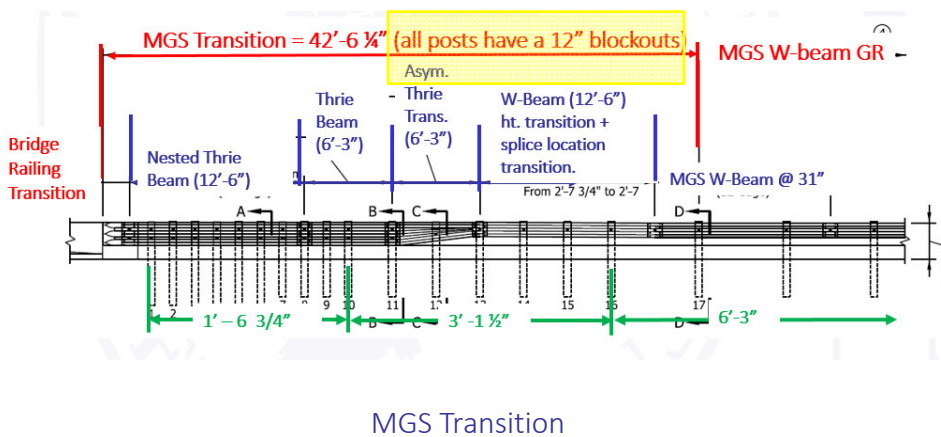
- Curved guardrail consists of W-beam and controlled released terminal (CRT) posts
- Currently no MASH-compliant equivalent
- Design Options
  - Transition MGS to W-beam. Use MGS Height Transition and Curved Guardrail System Standard.
  - Where there is limited space, it may be necessary to install NCHRP 350 compliant devices in a quadrant that requires curved w-beam guardrail. Coordination with Standards and Policy Office is required.



Update: There is currently an active NCHRP Report, NCHRP 15-53, that is working on a curve end treatment with a rail height of 31 inches. The completion date is set for December 2019.

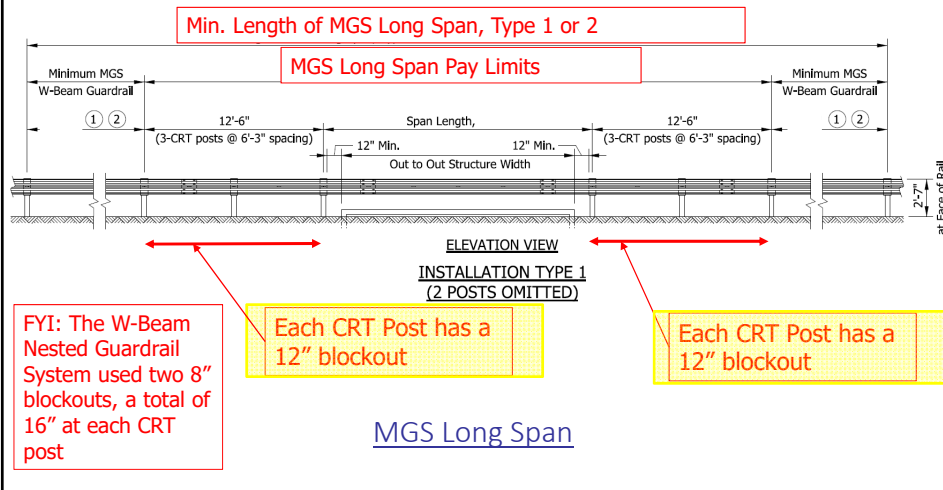
### Midwest Guardrail System (MGS) Reminders

- The MGS Transition and MGS Long Span require the use of 12-in. deep blockouts.



### Midwest Guardrail System (MGS) Reminders

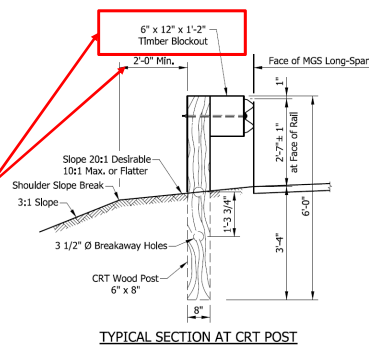
- The MGS Transition and MGS Long Span require the use of 12-in. deep blockouts.



### Midwest Guardrail System (MGS) Reminders

- Provide 2 ft of embankment behind the back of post. Where limitations within the project prevent the 2 ft of embankment from being placed:
  - for Standard MGS W-Beam Guardrail (6'-3\" post spacing) an inquiry is not required, a level two design exception should be filed with the project.
  - for all other MGS W-Beam Guardrail Systems, a project specific inquiry will be required. The approved inquiry should be filed with a level two design exception.

**Example MGS Long Span: Make sure to take into account the 12 inch blockout and 2 ft embankment width behind the post when laying out your typical section**



## Midwest Guardrail System (MGS) Common Mistakes

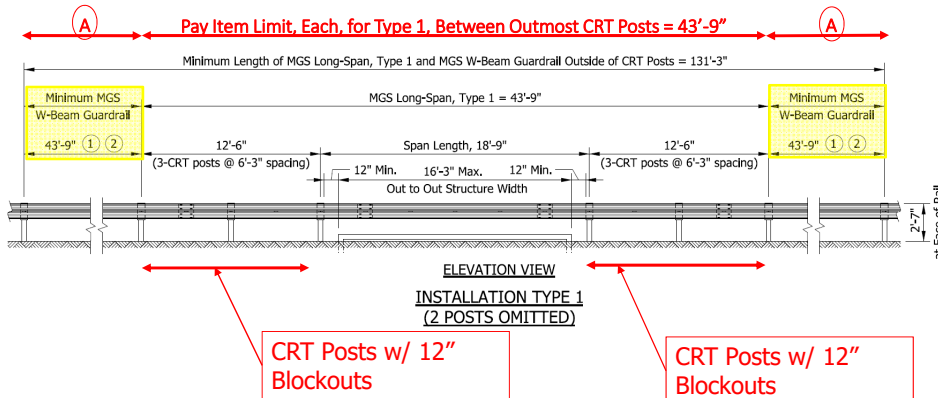
- System Modifications
  - Do not modify the systems, e.g. remove a post, modify a post, reduce the embankment. If you have a project that you feel needs special consideration, send in an inquiry. If an approved modification is recommended, that recommendation should be filed with a level two design exception.
- MGS Long Span Pay Limits
  - The pay limits are from outermost CRT post to outermost CRT post.
  - For the system to preform properly a minimum length of MGS w-beam guardrail should be provided on the approach and departure ends of the outermost CRT posts. The minimum length can include MGS w-beam guardrail, a transition, an OS end treatment, or cable terminal anchor.

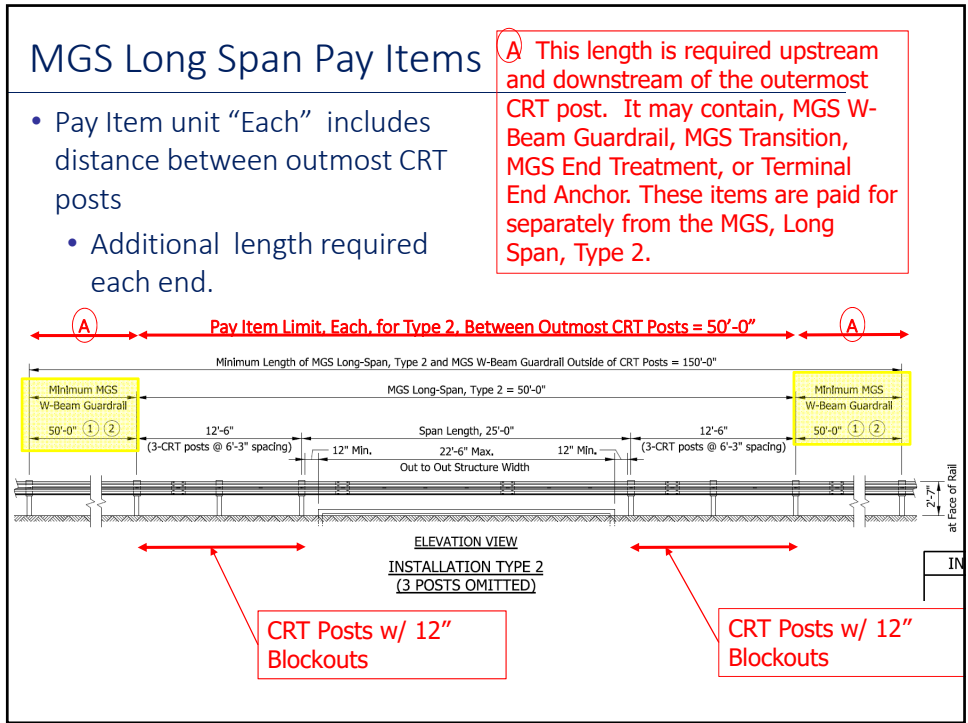
FYI: Do not Flare an OS End Treatment more than 25:1

## MGS Long Span Pay Items

- Pay Item unit “Each” includes distance between outmost CRT posts
  - Additional length required each end.

(A) This length is required on the approach and departure ends of the outermost CRT posts. It may contain, MGS W-Beam Guardrail, Transition, End Treatment, or Cable Terminal Anchor. These items are paid for separately from the MGS, Long Span, Type 1.





### When to Upgrade Guardrail and End Treatments

- Similar to most code changes, the implementation to MASH as the current standard for crash testing roadside hardware does not require that all existing guardrail be replaced immediately.
- In addition to the sunset dates for new installations and full replacements, the FHWA-AASHTO Implementation Plan urged State DOTs to establish a process to replace existing highway hardware. The focus being on systems that have not been successfully tested to NCHRP Report 350 or later criteria.
- INDOT encourages looking for opportunities to upgrade.
  - Instead of asking "do I have to upgrade?" consider "is this the opportunity to upgrade?" or, "is it cost effective?"
  - Again, if you have a question, ask.

## When to Upgrade Guardrail and End Treatments

---

- **Items to review when considering guardrail upgrade include:**
  - **What system is currently in place?** Is the system NCHRP-350 TL-3 Tested, does it match Standard Drawing Series E601-WBGA? If the blockouts are steel, it is not NCHRP-350 TL-3.
  - **Scope of the project.** 4R, 3R, or Preventative Maintenance (PM)?
  - **Time frame of future work.** If your project is a short term bandage and the entire roadway is being reconstructed 5 years from now, the second project is likely the better opportunity for upgrading. If the guardrail only serves to protect the bridge ends, then the concrete overlay project (even though PM) may be the right opportunity to upgrade.
  - **Functional classification of the roadway.** Interstates should have a higher priority for upgrading, regardless of project scope.
  - **Crash history.** Frequent crash locations may benefit (in safety and maintenance) from upgrading.
  - **Traffic Counts.** High traffic volumes are typically associated with higher risk.

## When to Upgrade Guardrail and End Treatments

---

Where to start when considering to upgrade guardrail to MASH-compliant hardware :

- Project Scope
- Roadway Functional Classification
- Test Level of the Existing Guardrail, (IDM Section 49-5.02)
- Percent of Existing Guardrail being Replaced or Reset



## When to Upgrade Guardrail and End Treatments

EXISTING GUARDRAIL ANALYSIS (TREATMENT)					
Work Type (Preventative Maintenance (PM), 3R, or 4R)	Existing Guardrail Compliance	Existing Guardrail Run to be Removed <sup>1</sup>			
		Percent Removed <sup>2</sup>			No proposed Removal <sup>3</sup>
		≥50% of the run <sup>3</sup>	<50% of the run but > 200 ft <sup>3</sup>	≤ 200ft <sup>3</sup>	
Interstate (3R and 4R)	Non NCHRP-350	Full Replacement Required	Full Replacement Required	Full Replacement Required	Full Replacement Required
	NCHRP-350	D:Full Replacement M:Partial Replacement <sup>6</sup>	D:Partial Replacement <sup>6</sup> M:Reset Existing <sup>4</sup>	Reset Existing <sup>4</sup>	Leave In-Place <sup>5</sup>
Interstate (PM)	Non NCHRP-350	Full Replacement Required	D:Full Replacement M:Partial Replacement <sup>7</sup>	D:Full Replacement M:Reset Existing <sup>4</sup>	D:Full Replacement M:Leave In-Place <sup>5</sup>
	NCHRP-350	D:Full Replacement M:Partial Replacement <sup>7</sup>	D:Partial Replacement <sup>7</sup> M:Reset Existing <sup>4</sup>	Reset Existing <sup>4</sup>	Leave In-Place <sup>5</sup>
Non-Interstate (4R)	Non NCHRP-350	Full Replacement Required	Full Replacement Required	Full Replacement Required	Full Replacement Required
	NCHRP-350	Full Replacement Required	D:Partial Replacement <sup>6</sup> M:Reset Existing <sup>4</sup>	Reset Existing <sup>4</sup>	Leave In-Place <sup>5</sup>
Non-Interstate (3R)	Non NCHRP-350	Full Replacement Required	D:Full Replacement M:Partial Replacement <sup>9</sup>	D:Full Replacement M:Reset Existing <sup>5</sup>	D:Full Replacement M:Leave In-Place <sup>5</sup>
	NCHRP-350	D:Full Replacement M:Partial Replacement <sup>7</sup>	D:Partial Replacement <sup>7</sup> M:Reset Existing <sup>4</sup>	Reset Existing <sup>4</sup>	Leave In-Place <sup>5</sup>
Non-Interstate (Functional or Structural)	Non NCHRP-350	See Non-Interstate (3R)			D:Full Replacement M:Leave In-Place <sup>5</sup>
	NCHRP-350				Leave In-Place <sup>5</sup>
Non-Interstate (PM)	Non NCHRP-350	See Non-Interstate (3R)			Leave In-Place <sup>6</sup>
	NCHRP-350				Leave In-Place <sup>5</sup>

Superscript numbers will require the designer to check the existing rail height, coordinate with the District to determine the existing condition, etc.

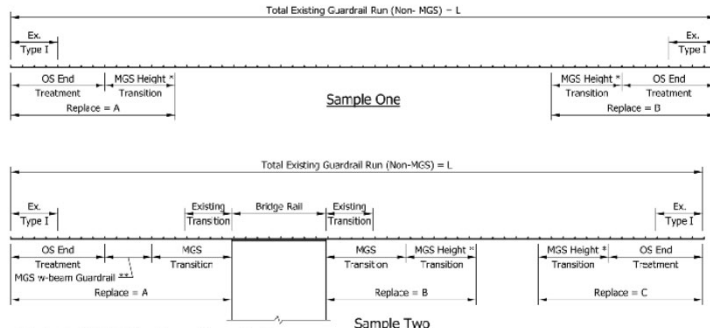
## When to Upgrade Guardrail and End Treatments

EXISTING GUARDRAIL END TREATMENT (TREATMENTS) <sup>4</sup>			
Work Type	Existing End Treatment Test Type		
	Type I End Treatment	NCHRP-350	MASH
Interstate (All Work Type, except PM)	Replacement Required	D : Replacement Recommended <sup>4</sup> M: Leave in-place <sup>2</sup>	Leave in-place <sup>3</sup>
Interstate (PM)	D : Replacement Recommended <sup>4</sup> M: Leave in-place <sup>2</sup>	D : Replacement Recommended <sup>4</sup> M: Leave in-place <sup>2</sup>	Leave in-place <sup>3</sup>
Non-Interstate (4R)	Replacement Required	D : Replacement Recommended <sup>4</sup> M: Leave in-place <sup>2</sup>	Leave in-place <sup>3</sup>
Non-Interstate (3R)	See Non-Interstate (4R)		
Non-Interstate (Functional or Structural)	See Non-Interstate (4R)		
Non-Interstate (PM)	D : Replacement Recommended <sup>4</sup> M: Leave in-place <sup>2</sup>	D : Replacement Recommended <sup>4</sup> M: Leave in-place <sup>2</sup>	Leave in-place <sup>3</sup>

Superscript numbers will require the designer to check the existing guardrail to be replaced, coordinate with the District to determine the existing condition, etc.



## When to Upgrade Guardrail and End Treatments



\* The length of MGS height transition must be considered in the calculation for replacement.

\*\* Standard MGS w/ beam should be placed where the space between to MGS Systems is less than the length of two MGS height transition, (37'-0" each) plus 100 ft of existing rail, 175 ft.

$$(A+B+C)/L < 50\% \text{ Partial Replacement}$$

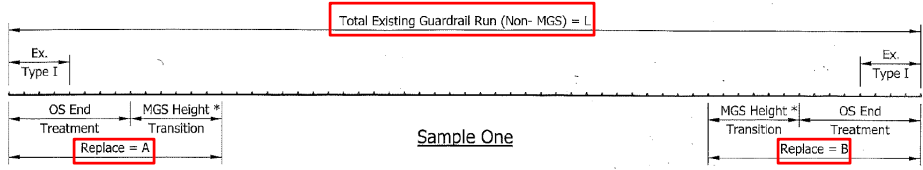
$$(A+B+C)/L \geq 50\% \text{ Full Replacement}$$

Sample Calculation for Proposed Guardrail Removal

Figure XXX-XX

Calculating the percent of existing guardrail being replaced.

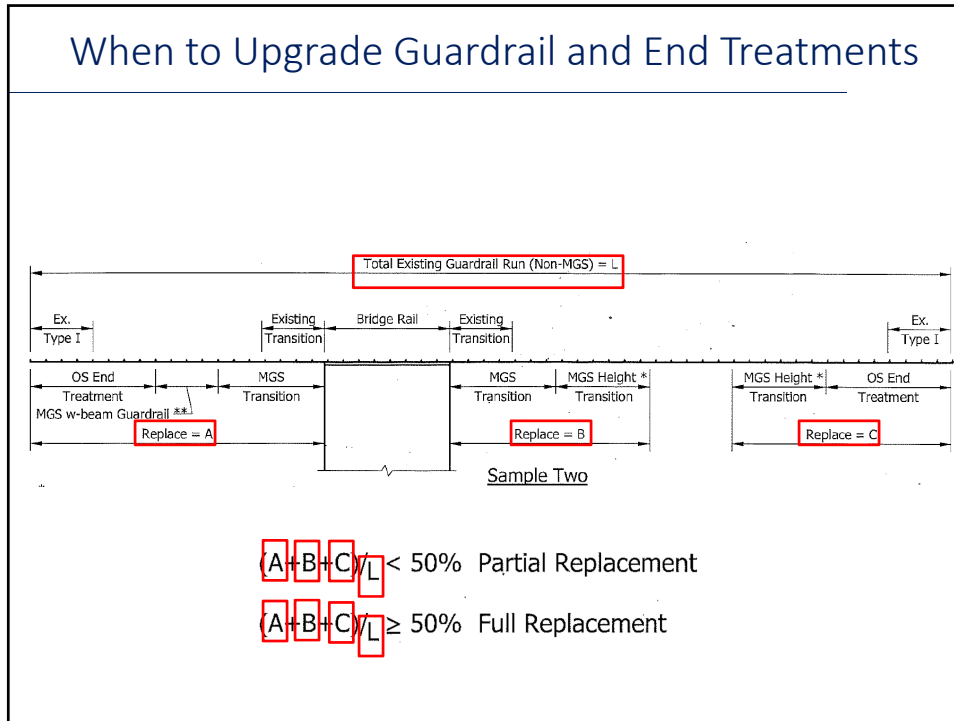
## When to Upgrade Guardrail and End Treatments



$$(A+B+C)/L < 50\% \text{ Partial Replacement}$$

$$(A+B+C)/L \geq 50\% \text{ Full Replacement}$$

C=0 for this Sample.



- ### When to Upgrade Guardrail and End Treatments
- Bridge Preventative Maintenance Projects (IDM 412-3.01(05))
    - Upgrade existing guardrail when found to be cost effective, e.g. the concrete bridge railing transition is being replaced and the posts for the existing transition need to be removed; it might be the opportunity to replace the guardrail transition with an MGS Transition.
  - Bridge Rehabilitation Projects (IDM 412-3.01(05))
    - All existing roadside safety items, including but not limited to guardrail, transitions, and end treatments should be upgraded to current standards.
- Current Standards: We would consider retaining existing NCHRP-350 compliant guardrail. We would rely on the District to inspect the existing guardrail for remaining service life and current condition. Send in an inquiry.

## When to Upgrade Guardrail and End Treatments

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- Bridge Preventative Maintenance Projects, IDM 412-3.01(05)
  - Roadside safety features should be upgrade to current standard when proved to be cost effective as part of a preventative maintenance project.
    - If the guardrail work is very limited and does not require posts within the 50 ft of the existing end treatment to be removed, it could be an option to retain the existing end treatments.
- Bridge Rehabilitation Projects, IDM 412-3.01(05)
  - All existing roadside safety items including but not limited to guardrail, transitions, and end treatments should be upgraded to current standards.
    - There may be cases that allow a NCHRP-350 TL-3 tested end treatment to remain in place. Ask the question.

Current Standards: We would consider retaining existing NCHRP-350 compliant guardrail. We would reply on the District to inspect the existing end treatment for remaining service life and current condition. Send in an inquiry.

## Guardrail Recommendations Given in 2018

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The following slides will show some guardrail recommendations that our office gave this year. These recommendation were a product of an inquiry.

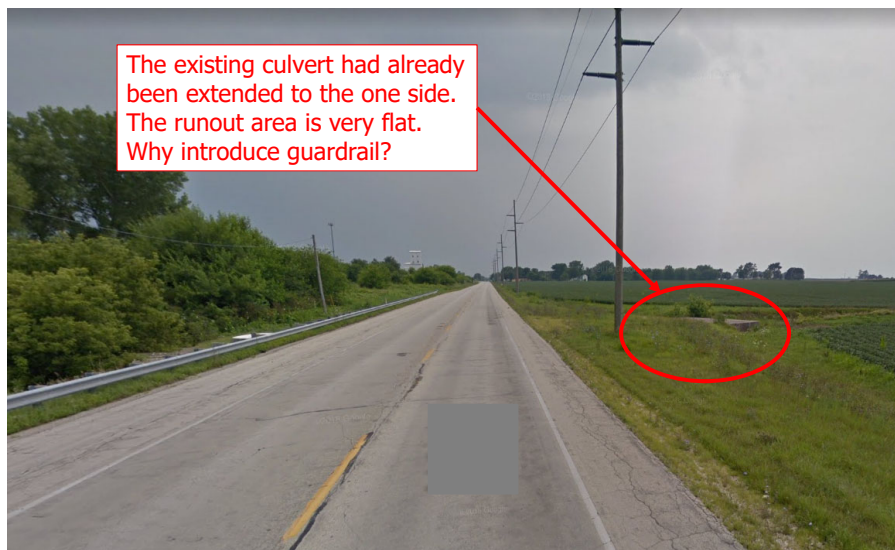
### Example of When Guardrail May Not be Needed

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### Example of When Guardrail May Not be Needed

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## Example of When Guardrail May Not be Needed

Range of Treatments IDM Chapter 46 section 49-3.01(01) for roadside hazards:

- Remove or redesign so that it can be safely traversed
- Relocate outside of the clear zone to a point where it is less likely to be hit
- Make breakaway to reduce impact severity
- Shield with a traffic barrier or impact attenuator ← Placement of a Barrier, #4
- Delineate if the above treatment are not practical

## Example of When Guardrail May Not be Needed

Items to Consider for Maintaining the Extended Structure without Guardrail Protection:

- What needs to be protected on this project? (Concentrate on the side without existing guardrail)
  - The culvert end does not need to be shielded because:
    - The culvert can daylight outside of the Clear Zone
    - The grading prior to, over, and past the culvert are relatively flat (10:1 or less) or the ditch is traversable. The grading provides room for recovery.
    - The crash history does not lead the designer to protect the culvert end outside of the clear zone.

## Example of When Guardrail May Not be Needed

Items to Consider for Maintaining the Extended Structure without Guardrail Protection (Cont’):

- What needs to be protected on this project? (**Concentrate on the side without existing guardrail**)
  - The utility pole is inside the Clear Zone but may not need to be shielded because:
    - The utility pole is in a long line of utility poles that parallel the roadway unshielded by a barrier.
    - The utility pole adjacent the culvert is not closer to the roadway than the other poles paralleling the road.
    - The utility pole does not appear to have been struck in the past.

**Recommendation would be to extend the culvert end out past the clear zone, keeping the approximate existing side slope for recovery, and not place guardrail on that side of the roadway. Adding a run of guardrail may be more of a hazard than the utility pole.**

## Visually Consistent Corridor

If a structure is extended beyond the clear zone or slightly farther, keep a visual consistency to best delineate the roadway.

**The extended aggregate shoulder was viewed as being part of the roadway.**





## Visually Consistent Corridor

If a structure is extended beyond the clear zone or slightly farther, to eliminate guardrail, keep visual consistency. Visual consistency is the best way to delineate the roadway.

Adding the grass and object markers better delineates where the driver should proceed. In addition, not visible in the picture, a rumble strip was added for further delineation.



## Visually Consistent Corridor



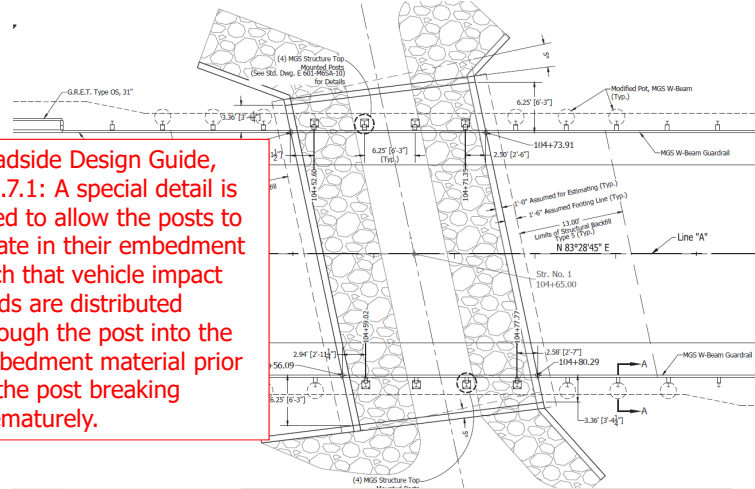
Added grass visually directs the driver toward the roadway.



## Do Not Place Posts in Structure Backfill Type 5

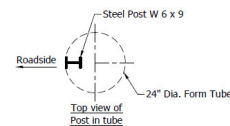
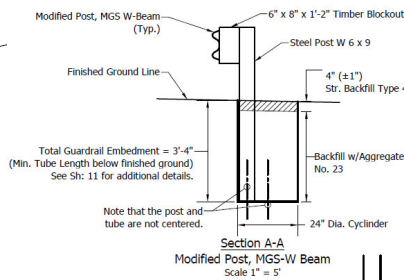
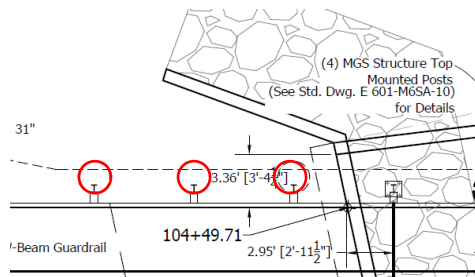
Some times a project may call for structure backfill type 5, if your guardrail posts fall within the limits of the structure backfill type 5 a special detail will be needed. To allow the guardrail posts to rotate.

Roadside Design Guide, 5.6.7.1: A special detail is need to allow the posts to rotate in their embedment such that vehicle impact loads are distributed through the post into the embedment material prior to the post breaking prematurely.



## Do Not Place Posts in Structure Backfill Type 5

- The location of the Modified Posts is shown in the plans
- A detail of the Leave-Out Tubes is detailed in the plans
- A USP is included in the contract to describe the construction requirement



D/N

## Do Not Place Posts in Structure Backfill Type 5

**Draft USP**

**DESCRIPTION**  
A modified post, MGS W-Beam shall be used as shown on the plans. The tubes shall be set a minimum of 1 ft below the bottom of the structure backfill Type 5 and above the finished ground line. The forming tube shall be capped with concrete type A at the bottom and fully braced prior to the aggregate No. 23 being placed within the tube or the structure backfill type 5 being placed. The aggregate No 23 shall be placed prior to the structure backfill type 5. The guardrail post shall be driven to the required embedment depth in the compacted aggregate No. 23 after the structure backfill type 5 has set around the tube. Once the guardrail has been driven into the tube, the tube shall be cut to match the finished ground line and 4 in., +/- 1 in., of structure backfill type 4 having a compressive strength of less than 120 psi placed level to the finished ground line as shown on the plans. Tubes that are placed outside of the neat lines of the approved working drawings for the structure will not be paid.

**Construction Requirements**  
The modified posts shall be placed within tubes as shown on the plans. The tubes shall be placed within the limits of the structure backfill type 5. The tubes shall be set a minimum of 1 ft below the bottom of the structure backfill Type 5 and above the finished ground line. The forming tube shall be capped with concrete type A at the bottom and fully braced prior to the aggregate No. 23 being placed within the tube or the structure backfill type 5 being placed. The aggregate No 23 shall be placed prior to the structure backfill type 5. The guardrail post shall be driven to the required embedment depth in the compacted aggregate No. 23 after the structure backfill type 5 has set around the tube. Once the guardrail has been driven into the tube, the tube shall be cut to match the finished ground line and 4 in., +/- 1 in., of structure backfill type 4 having a compressive strength of less than 120 psi placed level to the finished ground line as shown on the plans. Tubes that are placed outside of the neat lines of the approved working drawings for the structure will not be paid.

The Contractor shall provide working drawings for the bracing of the tubes in accordance with 105.02 for approval by the Engineer prior to installation.

The Contractor shall provide working drawings for the bracing of the tubes in accordance with 105.02 for approval by the Engineer prior to installation.

**Method of Measurement**  
Modified Post, MGS W-Beam, as shown on the plans, will be measured by the number of units installed, complete in place.

**Basis of Payment**  
Modified Post, MGS W-Beam will be paid for at the contract unit price per each, complete in place.

Pay Item	Pay Unit Symbol
Modified Post, MGS W-Beam	.....EACH

The cost of the forming tube, compacted aggregate No. 23, structure backfill type 4, transportation, bracing and placement, working drawings, and all incidentals as shown on the plans to place the tube shall be included in the cost of the pay item.

## Do Not Place Posts in Structure Backfill Type 5

The previous detail was modified from the design recommendation for posts to be placed in rock, see Roadside Design Guide Figure 5-51b.

Therefore where guardrail will be located in a rock area a similar detail will need to be created.

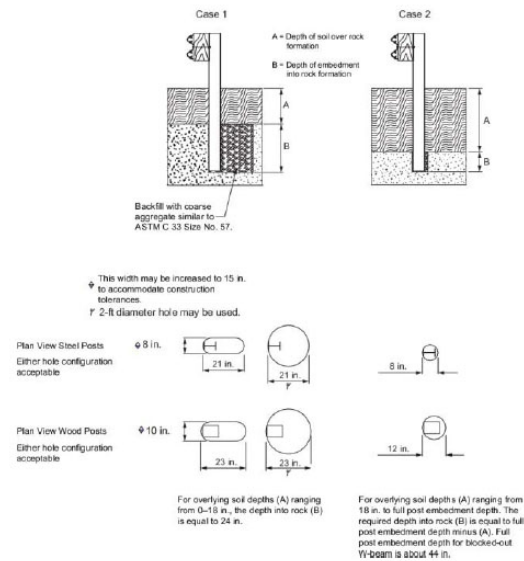
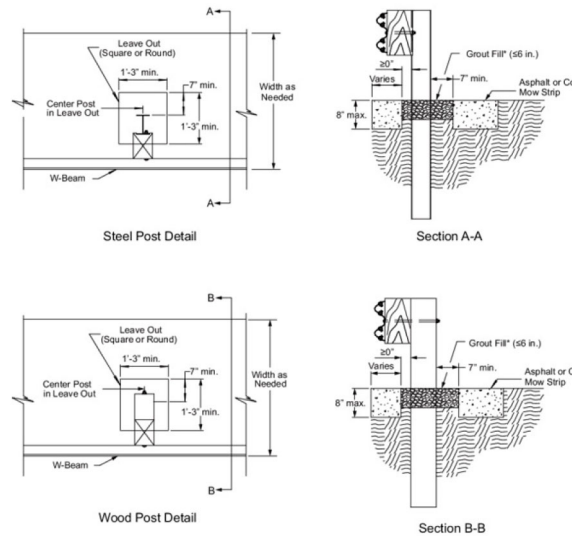


Figure 5-51b. Guardrail Post Details in Rock Formation (U.S. Customary Units)

## Do Not Place Posts in HMA or Concrete

Post should not be encased in HMA or concrete pavement. Similar to required guardrail placement in the area of structure backfill type 5 or rock, a leave-out detail and the leave-out locations should be included in the plans. The leave-out detail for HMA and concrete pavement is not nearly as detailed, it is basically a hole in the HMA or Concrete, backfilled with Structure Backfill Type 4. Structure Backfill Type 4 is removal and has a compressive strength of approximately 120 psi.

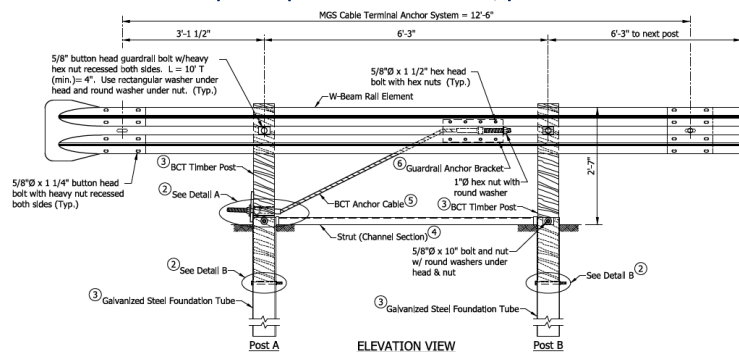


\*Grout fill material has a 28-day compressive strength of 120 psi or less.

Roadside Design Guide, 5.6.7.2 and Figure 5-52b

## When to Use a Cable Terminal Anchor System

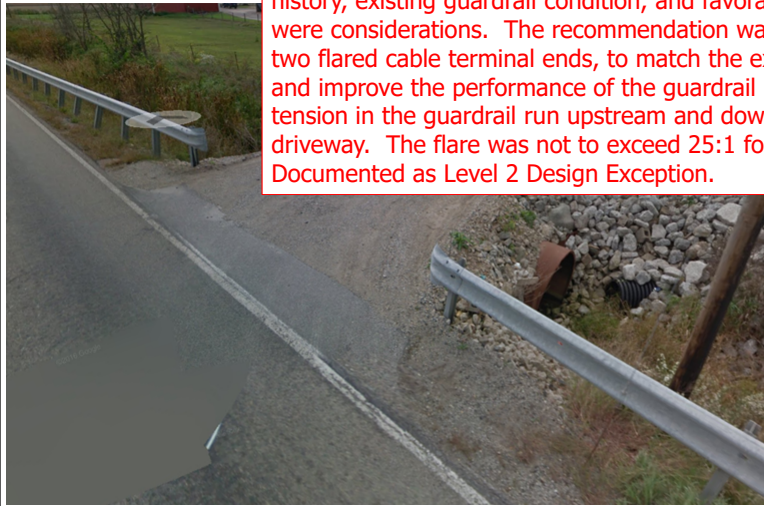
- A cable terminal anchor system is meant to be used on the outgoing end along a divided highway (a guardrail end that is not exposed to oncoming traffic)
- A cable terminal anchor system may not be substituted with 25 ft of W-Beam or MGS W-Beam guardrail
- Where cable terminal anchors are placed, consider flaring the rail at 25:1 away from the roadway
- If you have a location that requires special consideration, you should submit an inquiry



## When to Use a Cable Terminal Anchor System

- Example of a location that required special consideration

This was a resurface project, no right-of-way acquisition, and existing right-of-way was not much past the EOP. The crash history, existing guardrail condition, and favorable geometrics were considerations. The recommendation was to provide two flared cable terminal ends, to match the existing condition and improve the performance of the guardrail by adding tension in the guardrail run upstream and downstream of the driveway. The flare was not to exceed 25:1 for this situation. Documented as Level 2 Design Exception.

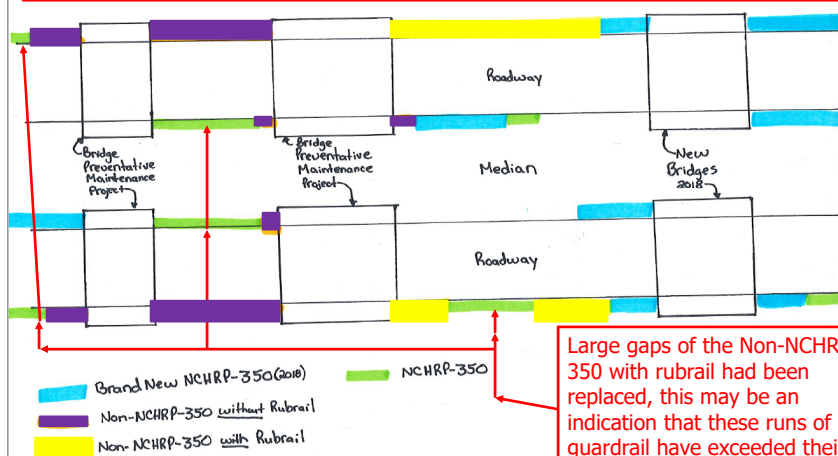


## Evaluate the Existing Guardrail Types

- Example of a location that contains multiple types of guardrail

~3 miles Existing Guardrail

Ex. guardrail, 4 different types, mixture of really old and brand new. Mosaic of Color!



Large gaps of the Non-NCHRP-350 with rubrail had been replaced, this may be an indication that these runs of guardrail have exceeded their service life.

## Evaluate the Existing Guardrail Types

- Example of a location that contains multiple types of guardrail



Project Information: Bridge Preventative Maintenance Project (overlay and replacing the bridge approaches)

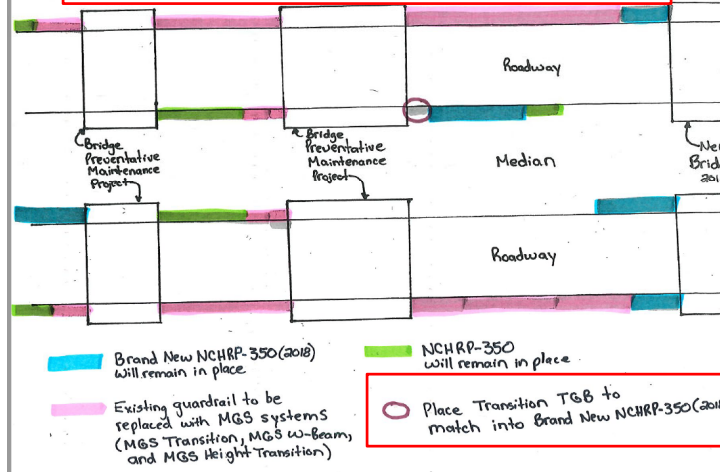
- Interstate
- Speed Limit 70 mph
- Route is NHS
- Next work to be completed on these bridges may be preventative maintenance.
- There are four different types of W-Beam Guardrail within close proximity of the bridges in this preventative maintenance project.

## Evaluate the Existing Guardrail Types

- Example of a location that contains multiple types of guardrail

Guardrail Recommendation for Existing Guardrail to Remain in place and Existing Guardrail to be Replaced

These types of projects can be reviewed on a case-by-case bases. Do not make assumptions, ask the question.



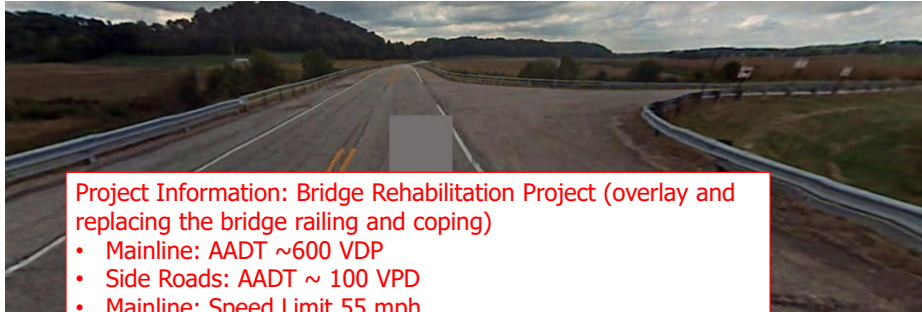
Recommendation:

- All the Brand New 350 (blue) and older 350 (green) guardrail to remain in place.
- Replace all the steel blockout with and without rubrail (yellow and orange) with MGS systems adjacent the bridges in the project.



## Evaluate the Ex. Guardrail Types, Condition, LON

- Example of a location that may required a review of the condition of the existing guardrail and the length of need (LON).

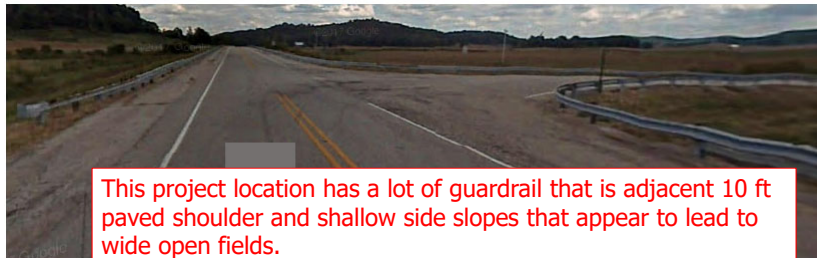


Project Information: Bridge Rehabilitation Project (overlay and replacing the bridge railing and coping)

- Mainline: AADT ~600 VDP
- Side Roads: AADT ~ 100 VPD
- Mainline: Speed Limit 55 mph
- Side Roads: Stop Condition
- Route in Non-NHS
- W-Beam Guardrail Placed in 1977
- Mainline Shoulder Width 10 ft
- Mainline Side Slopes 6:1 off Shoulder with in Clear Zone, even behind Guardrail.

## Guardrail Condition and LON Need to be Reviewed

- Example of a location that may required a review of the condition of the existing guardrail and the length of need (LON).



This project location has a lot of guardrail that is adjacent 10 ft paved shoulder and shallow side slopes that appear to lead to wide open fields.



Radius of the mainline curve is 1400 ft.

## Guardrail Condition and LON Need to be Reviewed

### Guardrail Recommendation:

#### Minimum:

- The district must determine that the existing w-beam guardrail and existing cable terminal anchors are in good condition and can remain in place.
  - Check the crash history
  - Check the maintenance history
- All the existing aluminum guardrail must be removed and replaced with MGS transition and MGS w-beam guardrail (as needed), and MGS height transition.
- The designer should coordinate with the county to determine the need for replacement and review of the guardrail along the county side roads.

#### Desirable:

- Check all the LON calculations along the mainline to see if the guardrail lengths can be reduced.
- Upgrade all the guardrail and end treatments along the mainline to current standards (in accordance with the new LON calculations).
- All the lines of sight should be checked through the project, intersection sight distance, passing sight distance, and stopping sight distance. It appears that through the project area the mainline is marked as a no passing zone. Again changes to the guardrail along the county side roads should be coordinated with the county.

## Guardrail Condition and LON Need to be Reviewed

### Guardrail Recommendation:

#### Minimum:

Some of the reasons that could be noted in the file for retaining the existing w-beam guardrail and existing end treatments could include, but are not limited to:

- Upon a site visit, the district determined that the existing w-beam guardrail and existing cable terminal anchors are in good condition. (This should be confirmed by district maintenance or other district office that reviews guardrail conditions)
- The existing w-beam guardrail along the mainline does have rubrail, as this does not increase the test level it can reduce wheel snag on the posts.
- The accident history in the area of the project is low. (This should be confirmed by the designer or project manager)
- The wide shoulders along the mainline, 10 ft, provides recovery room for an errant driver.
- The existing cable terminal anchors are flared away from the roadway. This may prevent a head on collision with the anchor.

**Side note:** Cable terminal anchors are not designed for a head on collision.

Don't jump to a conclusion based on the AADT alone.



## Guardrail Condition and LON Need to be Reviewed

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### Guardrail Recommendation:

#### Desirable:

Some of the reasons that could be noted in the file for replacing all the guardrail:

- Reducing the length of guardrail may be eliminating a roadside hazard.
- The existing guardrail has been found to be deficient per the districts review.
- The next work to be completed on at this bridge is an overlay, this is preventative maintenance and will not required guardrail replacement. This means the existing guardrail may remain for another 20 to 30 years.
- The existing guardrail end treatments are not crashworthy.

## Example of When Guardrail May Remain In Place

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Bridge project that falls within the limits of a road project

### General rule of thumb:

- Use the project that calls for the more stringent guardrail replacement.
  - Examples
    - If the bridge work is preventative maintenance and falls within a road reconstruction project (3R), the guardrail along the roadway and on the bridge approaches should be upgraded to current standards.
    - If the bridge work is rehabilitation or replacement and falls within a road preventative maintenance resurface project, the guardrail on the bridge approaches should be upgraded to current standards. If there is any other guardrail along the roadway being resurfaced (that is not on the bridge approach) that guardrail should be evaluated as described for a road preventative maintenance resurface project, i.e. check the top rail height, asked the district to inspect the existing guardrail, etc.
- **However like all rules of thumb there is normally a, "However"**

## Example of When Guardrail May Remain In Place

We had a guardrail inquiry for a bridge rehabilitation project that all the existing guardrail and end treatments had been upgraded to NCHRP 350 between 2010 and 2012.



## Example of When Guardrail May Remain In Place

After further review we recommended that the existing guardrail and end treatments remain in place with the following conditions and for the following reasons.

### Conditions:

- The District had to approve the recommendation
- The District had to field verify the guardrail rail height was a minimum of 27 ¾"
- A District certified inspector had to inspect the end treatments to determine they were still in good condition

### Reasons:

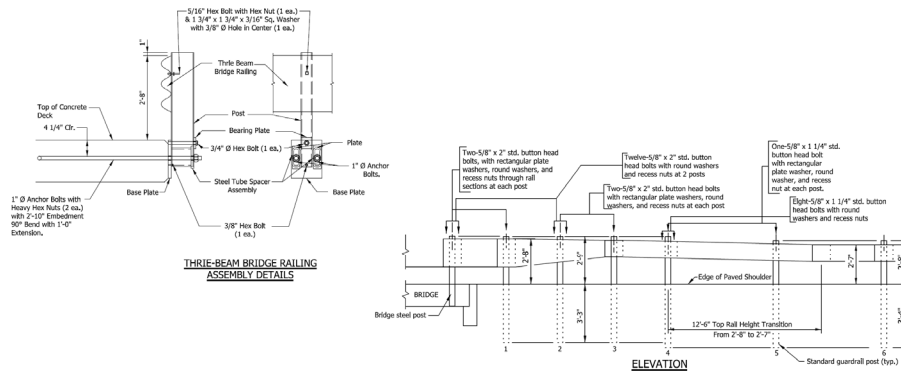
- The existing guardrail is NCHRP-350 TL-3 tested. The w-beam system, with steel posts and wood/composite blockouts, marginally passed MASH TL-3 criteria
- The existing guardrail and existing end treatments are only 6 to 8 years old, they should be left to complete their service life, similar to other existing NCHRP-350 systems.

Moral of the story, if you think it may be able to stay, ask the question. The worst that can happen is we say, no.

## When and Where to Upgrade Guardrail

### Extra Notes:

- RSP 706-B-140d, TS-1 Bridge Railing with TGS-1 Transition, may ONLY be used on non-NHS LPA collector or local roadways.
  - Current RSP details a TGS-1 Transition that connects into w-beam guardrail.
  - Coming soon, the RSP details will be updated to include a TGS-1 Transition that connects into MGS w-beam guardrail.



## When and Where to Upgrade Guardrail

### Extra Notes:

- Where existing guardrail is being replaced, **be consistent. If one side of the roadway is 50% or greater and the other is only 40%; Replace all the guardrail with MASH-Compliant MGS W-Beam on both sides of the roadway.**
- Where standard guardrail will not fit your specific guardrail location, send the following information to [DesignManualInquiries@indot.IN.gov](mailto:DesignManualInquiries@indot.IN.gov) for an alternate guardrail recommendation:
  - Project Des Number
  - Construction plans
  - Plan details should show the standard guardrail system that will not fit your location
  - Plan detail should show a proposed solution, if the designer can not propose a solution, state so in the request
  - Snap shot of project location

## MGS Weak Post Bridge Rail TL-2 or TL-3

<https://mwrsf.unl.edu/researchhub/files/Report53/mgsbr1aos3.wmv>

<https://mwrsf.unl.edu/researchhub/files/Report53/mgsbr1aos4.wmv>

<https://mwrsf.unl.edu/researchhub/files/Report53/mgsbr1jvc1.wmv>



These are links to the crash test videos for Crash Test TRP-03-226-10 performed by Midwest Roadside Safety Facility. INDOT will review these rail types for incorporation into the standards.

## MGS Weak Post Bridge Rail TL-2 or TL-3



MGS Weak Post Bridge Rail TL-2 or TL-3



MGS Weak Post Bridge Rail TL-2 or TL-3





### INDOT Standard Bridge Railing - 2019

STATE ROUTES			
Railing Designation	MASH Test Level	Nominal Height	Description
FT	TL-5	45"	Concrete F-shape
TF-2	TL-5	50"	2 steel tubes with steel posts on concrete parapet
FC	TL-3	33"	Concrete F-shape
PS-1**	TL-4*	42"	2 steel tubes with steel posts on 24" concrete parapet, sidewalk mounted
PF-1**	TL-4*	42"	2 steel tubes with steel posts on 24" concrete parapet, deck mounted

\* INDOT will designate as a TL-3 railing

\*\* Modification to steel tubes

## INDOT Standard Bridge Railing - 2019

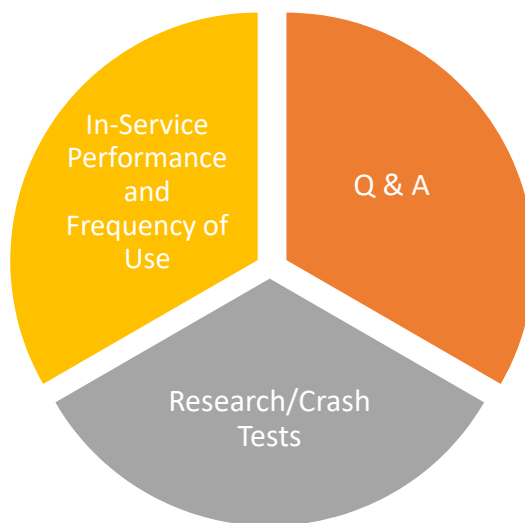
- Local agencies are encouraged to install MASH-compliant bridge railing.
- LPA bridges on non-NHS routes may continue to install NCHRP 350-compliant bridge railing at their discretion.

### LOCAL AGENCY, NON-NHS ROUTES ONLY

Railing Designation	NCHRP 350 Test Level	Nominal Height	Description
TX	TL-2	42"	Vertical concrete parapet with windowed openings
TS-1	TL-2	33"	Side-mounted thrie beam guardrail.



## Bridge Railing Evaluation Criteria





## Bridge Railing – Evaluation Criteria

### Strength Impact forces based on test level

- All factors of the barrier that prevent the vehicle from penetrating the barrier

### Stability Tall enough?

- All characteristics of the barrier, such as height, shape, and stiffness, that affect vehicle stability
- **TL-3 27in. ⇒ 29 in., TL-4 32 in. ⇒ 36 in., TL-5 42 in. ⇒ 42 in. (unchanged)**

### Geometry Will it snag?

- All geometric features that affect occupant risk, such as post setback, clear opening between longitudinal rail elements, and available vertical contact surface area.
- Post setback criteria – LRFD Appendix A
- Asperity Depth and Width guidance – NCHRP Rpt 554 Aesthetic Concrete Barrier Design

## Test Level Selection

### TL-2

- Bridges with speeds of 45 mph and below must have railings that meet TL-2 criteria or greater.
- Bridges on the NHS must have railings that meet TL-3 or greater, regardless of design speed.

### TL-3

- Bridges with speeds of 50 mph and above must have railings that meet TL-3 criteria or greater.
  - A TL-5 or greater railing should be considered if any of the following criteria are met
    - Sustained longitudinal grade greater than 5%
    - Horizontal curve radius less than 1,500 ft.
    - High hazard environment below the bridge, such as a densely populated area.
  - In-service performance of existing TL-3 rail inadequate

### TL-5

- Bridges carrying mainline Interstate routes or system interchange ramps

### Test Level Selection

**TL-2**

- Bridges with speeds of 45 mph and below must have railings that meet TL-2 criteria or greater.
- Bridges on the NHS must have railings that meet TL-3 or greater, regardless of design speed.

**TL-3**

*Until the Test Level guidance is published, this information will be applied on a project-by-project basis through the Standards and Policy Office.*

- Bridge meet T
- A TL-5 or greater railing should be considered if any of the following criteria are met
  - Sustained longitudinal grade greater than 5%
  - Horizontal curve radius less than 1,500 ft.
  - High hazard environment below the bridge, such as a densely populated area.
  - In-service performance of existing TL-3 rail inadequate

**TL-5**

- Bridges carrying mainline Interstate routes or system interchange ramps

### Bridge Railing – Evaluation Criteria for Modifications

- Modifications for traditional installations are discouraged
- Modification for historic bridges and other special cases will require documentation and supporting calculations

<b>Strength</b>	Impact forces based on test level
<b>Stability</b>	Tall enough?
<b>Geometry</b>	Will it snag?
<b>In-Service Performance</b>	Known performance issues?

### Bridge Railing – MASH Updates Summary

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- Lettings on or after Dec. 31, 2019 (Bridge Railing)
- MASH updates + Q&A via AASHTO Committee on Design
  - <https://design.transportation.org/mash-implementation/>
- FHWA will discontinue issuing eligibility letters December 2019
- Each State DOT will develop a process for determining the crashworthiness of roadside safety hardware used on the NHS
- NCHRP Web Only 157 Evaluation of Existing Roadside Safety Hardware
- NCHRP 20-07(395) MASH Equivalency of NCHRP Report 350-Approved Bridge Railings

### What You Should Remember?

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- MGS guardrail systems are different than w-beam guardrail systems. For design guidance on MGS w-beam guardrail refer to Design Memos 17-10 and 17-17.
- If you need to modify an MGS guardrail system, send your recommendation in for review, [DesignManualInquiries@indot.IN.gov](mailto:DesignManualInquiries@indot.IN.gov)
- MASH implementation for bridge railing is coming.

## QUESTIONS

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and Policy



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