



INDIANA DEPARTMENT OF TRANSPORTATION

Driving Indiana's Economic Growth

Design Memorandum No. 19-08

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TO: All Design, Operations, and District Personnel, and Consultants

FROM: /s/ Elizabeth W. Phillips
Elizabeth W. Phillips
Director, Standards and Policy

THRU: Stephanie Wagner
Director, Bridge Design

SUBJECT: Bridge Railing

REVISES: *Indiana Design Manual (IDM) Section 404-4.0 Bridge Railing*

EFFECTIVE: Stage 3 Submittal on or after September 5, 2019

The referenced section of the IDM has been rewritten to include information about the FHWA-AASHTO MASH Implementation agreement, revised test level selection process, test level exceptions, and current bridge railing standards. The information is summarized below and the referenced IDM section is included on the following pages. The revisions will be incorporated into the IDM on-line at a later date.

The Level One checklist has been updated to reflect the new guidance. This memo may be used as the design criteria reference until the IDM on-line is updated. Exceptions must be documented but no longer require a formal design exception.

Questions regarding project-specific bridge railing test level applications should be discussed with the Bridge Design Division Director, Stephanie Wagner at swagner2@indot.in.gov or the Standards and Policy Director, Elizabeth Phillips at ephillips@indot.in.gov.

IDM Revisions

404-4.0 BRIDGE RAILING

All bridges require bridge railing. Bridge-length culverts should have guardrail or bridge railing. Roadways elevated by retaining walls require bridge railing or guardrail for the entire length of the retaining wall. Mechanically stabilized earth (MSE) retaining walls require a moment slab in conjunction with the bridge railing.

404-4.01 Bridge Railing Criteria

MASH Implementation. Per the AASHTO-FHWA Joint Implementation Agreement, all new and replacement installations of bridge railing on the National Highway System (NHS), with contract letting date after December 31, 2019, must be evaluated using the AASHTO *Manual for Assessing Safety Hardware* 2016 (MASH) criteria.

FHWA Policy. All new or replacement bridge railing on the NHS must meet MASH crash-test criteria.

New and Replacement Bridge Railing, INDOT. All new and replacement bridge railing on an INDOT bridge should meet MASH crash test criteria, both on and off the NHS. Exceptions should be rare. Exceptions will be considered on a project-by-project basis at the discretion of the Bridge Design Division off the NHS and in cooperation with FHWA on the NHS.

New and Replacement Bridge Railing, LPA. All new and replacement bridge railing on a local agency bridge should meet MASH crash test criteria, both on and off the NHS. On a locally-owned bridge that is not on the NHS, MASH-compliant railing is encouraged, but not required. NCHRP 350-compliant railing may be used at the bridge owner's discretion. The decision to use an NCHRP 350-compliant railing and supporting documentation should be included in the project file.

Existing Bridge Railing. Upgrading existing bridge railing should be considered on bridge preventative maintenance projects where such work is cost-effective. See Chapter 412. In general, existing NCHRP 350-compliant bridge railing in good condition may remain in place.

404-4.02 Test Level Selection

This section provides guidance on selecting bridge railing test level. The guidance in this section is intended for use on INDOT and LPA bridges. Exceptions are discussed in Section 404-4.02(06).

MASH uses the same six Test Levels established under the previous crash testing criteria, National Cooperative Highway Research Program Report 350 (NCHRP 350) *Recommended Procedures for the Safety Performance Evaluation of Highway Features*.

FHWA Policy. All new or replacement railing on the NHS must meet Test Level 3 (TL-3) crash-test criteria at a minimum.

If ...	And...	The minimum (MASH) test level is	INDOT Bridge Standards	Notes
Bridge carries interstate mainline or system interchange ramp traffic		TL-5	Type FT Type TF-2	Once the minimum test level is determined, use the evaluation criteria listed below to assess if a higher test level is appropriate. A higher test level railing may be used to satisfy lower test level requirements.
The design speed is ≥ 50 mph		TL-3	Type FC Type PF-1 Type PS-1	
The design speed is ≤ 45 mph	The route is on the NHS	TL-3	Type FC Type PF-1 Type PS-1	
The design speed is ≤ 45 mph	The route is not on the NHS	TL-2	Type TX (LPA only)	

Consider the following evaluation criteria **listed below** when selecting the bridge railing test level.

- Highway design speed. Use the greater of posted speed or the design speed to establish the minimum test level. A lower test level may be acceptable for low volume roadways.
- Average annual daily traffic and percent trucks. Higher traffic volumes have inherently higher likelihood of crashes. High truck volumes (truck DDHV is 250 vph) are a consideration for selecting a higher test level.
- Highway geometry (grades and horizontal curvature). Steep grades (sustained longitudinal grades greater than 5%) and sharp curves (horizontal curve radius less than 1,500 ft) are considerations for using a higher test level.

- Type of land use below deck. Roadways under are higher risk than waterways under due to the risk of multiple injuries.
- In-service performance. Unsatisfactory in service performance is a consideration for selecting a higher test level.

404-4.02(01) TL-2

The AASHTO *LRFD Bridge Design Specifications* describes TL-2 bridge railing as generally acceptable for most local and collector roadways with favorable site conditions and small numbers of heavy vehicles.

Bridges with speeds of 45 mph and below should have railings that meet TL-2 criteria or higher.

Bridges with low traffic volumes are inherently associated with lower risk. TL-2 railings on low volume roads with design speeds greater than 45 mph will be considered on a project-by-project basis.

Bridges on the NHS must have railings that meet TL-3 criteria or higher, regardless of design speed.

INDOT uses TL-3 railing for these applications. Bridge Railing Type TX may be used for LPA bridges only.

404-4.02(02) TL-3

A TL-3 bridge railing is generally acceptable for applications on typical high-speed high-volume roadways. Bridges with speeds of 50 mph and above should have railings that meet TL-3 criteria or higher.

Bridges with low traffic volumes inherently are associated with lower risk. TL-3 railings on very low volume roads with design speeds greater than 50 mph will be considered on a project-by-project basis.

Bridges on the NHS must have railing that meets TL-3 or higher.

Where any of the conditions listed below exist, a higher test level should be considered.

1. TL-2 criteria are not met;
2. Sustained longitudinal grades greater than 5%;
3. Horizontal curve radius less than 1,500 ft;

4. Truck DDHV is 250 vph or greater; or
5. High hazard environment below the bridge, such as a densely populated area or high-volume roadway.
6. In-service performance history that indicates an existing TL-3 bridge railing is not meeting the site-specific needs.

INDOT uses Bridge Railing Types FC for these applications. Where pedestrian or open railing is desired, INDOT uses Bridge Railing Types PF-1 (deck-mounted) and PS-1 (sidewalk-mounted) for these applications.

404-4.02(03) TL-4

The AASHTO *LRFD Bridge Design Specifications* describes TL-4 as taken to be generally acceptable for the majority of applications on high speed highways, freeways, expressways, and Interstate highways with a mixture of trucks and heavy vehicles. Initial testing of NCHRP 350 compliant TL-4 bridge railing to MASH criteria resulted in a recommendation to increase in the minimum railing height from 32 in. to 36 in.

Considering the minimal increase in cost, the INDOT uses TL-5 for these applications.

404-4.02(04) TL-5

The AASHTO *LRFD Bridge Design Specifications* describes TL-5 as taken to be generally acceptable for the same applications as TL-4 and where large trucks make up a significant portion of the average daily traffic or when unfavorable site conditions justify a higher level of rail resistance.

A TL-5 bridge railing should be used on all interstate bridges carrying mainline interstate routes and system interchange ramps or where the considerations for a higher test level noted in TL-3 exist.

INDOT uses Bridge Railing Types FT and TF-2 for these applications.

404-4.02(05) TL-6

The AASHTO *LRFD Bridge Design Specifications* describes TL-6 taken to be generally acceptable for applications where tanker-type trucks or similar high center of gravity vehicles are anticipated, particularly along with unfavorable site conditions.

INDOT does not have a TL-6 bridge railing standard. The need to use a TL-6 bridge railing should be coordinated with the Bridge Design Division on a project-by-project basis.

404-4.02(06) Test Level Selection Exceptions

INDOT Bridge. Designers should coordinate bridge railing test level exception requests with the Bridge Design Division. A formal design exception is not required on non-NHS routes or on NHS routes where at least a TL-3 railing is provided. The request should include project information, scope of work, and a brief discussion of the factors below.

- Test level required and test level proposed.
- Speed of traffic in the bridge location.
- Resistance to impact of the existing railing. Has the railing been crash tested?
- Whether the bridge ends are intersections protected by stop signs or stop lights.
- Whether the geometry is straight into, along, and out of the bridge.
- Whether traffic on the bridge is one-way or two-way.
- Crash history on the bridge, including damages to and repairs of the railing.
- Whether the bridge crosses a roadway or waterway.
- Whether the required railing will further narrow an already narrow lane width.
- Whether the required will reduce sight distance to an unacceptable level due to increased height.
- Any additional pertinent information.

LPA Bridge. Exceptions are not required for bridge railing test level on a locally-owned, non-NHS bridge as the test level is at the discretion of the bridge owner. Designers should coordinate test level selection with the LPA. Documentation to support the selected test level should be included in the project file.