To: ALL BRIDGE DESIGNERS

From: D. Carl Puzey

Subject: Steel Railing, Type IL-OH (Base Sheet series R-40)

Date: October 12, 2021

The 2016 AASHTO Manual for Assessing Safety Hardware (MASH) introduced new crash load criteria and barrier height revisions for Test Levels (TL) 3 and 4. This new criteria equated to an Impact Severity increase of 56% for TL-4 and 13% for TL-3 compared to the same TL’s in the previous standard for railing and barrier safety (NCHRP 350). These increases reflect a changing vehicle fleet with larger trucks and an increased understanding of safety performance.

The Department’s Steel Railing, Type SM (Base sheet series R-34), which is rated NCHRP 350 TL-4, was evaluated and found to be equivalent to MASH TL-2. Therefore, to continue to provide a current MASH TL-4, side mounted steel railing, the Department collaborated with the Ohio Department of Transportation and funded research for a new railing through the Midwest Regional Safety Facility (MwRSF) at the University of Nebraska – Lincoln.

Included are the details and policies of the new IL-OH Steel Side Mounted Railing. This railing was designed and successfully crash tested to satisfy MASH TL-4.

**Highlights of the Type IL-OH Railing**

- The railing height = 39”. This satisfies the minimum required 36” height and accommodates up to a 3” future wearing surface (FWS).

- There are three horizontal railing elements. Two hollow structural sections (HSS’s) 8 X 6 X ¼” and one HSS 12 x 4 x ¼” placed horizontally and mounted on top of the post. These HSS members are common and readily available.

- The railing post is a W 6 x 15 with a maximum post spacing = 8'-0”. The lighter post size and larger post spacing compared to the previous R-34 railing help offset the cost of the new post connection.

- The post connection was designed such that the post will yield before the impact causes anchorage pull out damage to the deck beam or bridge deck. This “yielding post” failure mode minimizes repair costs and road closure time.

- The post spacing from the last bridge post to first driven Traffic Barrier Terminal (TBT) post = 9'-0”. The post spacing from the last bridge post to first post on the approach slab = 8'-0”. These increased transition spaces help span potential wingwall interference and the abutment drainage treatment.

- Shim plates have been specified and detailed for proper railing alignment and plumbness.
The railing splice connection was tested with a bolted connection on both sides of the splice. However, the researchers confirmed based on the new yielding post failure mode, the railing splice does not go into tension. Therefore, it was proposed, and the researchers approved, the detailed splice connection with a simple bolted connection on one side. This will be easier to install initially and to repair after impact damage. The splices are also sized for all possible joint applications.

Multiple detailed railing applications were developed for various wearing surfaces and superstructure types.

There are five applications for the new IL-OH side mounted steel railing detailed on the R-40 Base Sheets in the “Railings” CADD Cell Library.

<table>
<thead>
<tr>
<th>Application</th>
<th>Base Sheet</th>
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</thead>
<tbody>
<tr>
<td>Deck Beam with initial Concrete Wearing Surface</td>
<td>R-40CWS</td>
</tr>
<tr>
<td>Deck Beam with initial Hot Mix Asphalt Wearing Surface</td>
<td>R-40HMAWS</td>
</tr>
<tr>
<td>Deck Beam with initial Hot Mix Asphalt Wearing Surface and Approach Slab</td>
<td>R-40 HMAWS-AS</td>
</tr>
<tr>
<td>Deck Beam with no wearing surface</td>
<td>R-40NWS</td>
</tr>
<tr>
<td>Bridge Deck</td>
<td>R-40BD</td>
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</tbody>
</table>

The Department still maintains the Illinois Steel Railing, Type SM as detailed on the R-34 base sheet series, but this railing is limited to MASH TL-2 applications.

Superstructure Connection

Figures 1, 2 and 3 illustrate the bridge deck geometry and necessary reinforcement required for the IL-OH railing connections. On deck beam structures, the IL-OH railing connection shall always be in the deck beam, regardless of the wearing surface type or thickness. The analysis and crash tests encompassed all the proposed railing applications and the necessary post lengths for each are detailed on the base sheets. The “Beams - Prestressed Deck Beams” CADD Cell Library has been updated with the required reinforcement configurations for the IL-OH railing connections. Additionally, the “Superstructure – Prestressed Deck Beams” CADD Cell Library has been updated.

Transition Details

Traffic Barrier Terminal (TBT), Type 13 (Highway Standard 631061) is required at all ends of the IL-OH railing. This new TBT was successfully crash tested for MASH TL-3. The first and last IL-OH railing post mounted on the bridge deck shall always be at 3'-0" from the end of the bridge deck or deck beam. The two HSS 8 x 6 x 1/4" railing members extend 8'-0" beyond the last bridge post with a unique transition to connect to the TBT. These railing extensions are included in the bridge railing pay item. See the base sheets
and highway standard for further pay limit details. If a bridge approach slab is present, the IL-OH railing shall extend an additional 8'-0" post spacing onto the approach slab and then transition to the TBT. The “Approach Slabs-Bridge Cast in Place” CADD Cell Library has been updated for this application.

Figures 4, 5 and 6 illustrate the post placement and railing anchorage details for a deck beam structure with no approach slab; a deck beam structure with an approach slab; and an integral abutment structure with an approach slab. A shorter 1'-3" railing anchorage was successfully tested in solid deck beam ends at abutments and ends of bridge decks at abutments and may be used at acute corners for proper fit and anchorage as detailed. See the IL-OH railing base sheets for further details.

The IL-OH railing may also be used at expansion joints. The standard railing splice shown on the base sheets will accommodate the thermal movement required by the joint. The Splice Dimensions table shown on the base sheets provides required splice lengths for various joint types and may be used as-is in contract plans.

The IL-OH railing is required to be anchored into a section similar to deck overhang sections. Thickened sections at the exteriors of approach slabs meet this requirement. Wingwalls parallel to roadway, commonly used with stub abutments, do not meet this requirement, and therefore the IL-OH railing cannot be anchored into wingwalls. While it is possible to mount approach slabs on top of parallel wingwalls and thereby allowing the railing to be anchored into the approach slab and not the wingwall, this results in two-way approach slab behavior that is different than the intended one-way design of the approach slab. Therefore, to utilize IL-OH railings in conjunction with stub abutments while still maintaining the use of typical approach slab standards, the parallel wingwalls normally used with stub abutments should be replaced with perpendicular “dog-ear” wingwalls. The R-40BD and the R-40HMAWS-AS Base Sheets have been developed to accommodate integral, semi-integral, and stub abutments without modification.

**Implementation**

The Steel Railing, Type IL-OH shall be effective for all applicable projects with Type, Size and Location (TSL) plans approved after November 1, 2021 and may also be implemented for projects currently under design as determined by the District. Please direct questions to Mark Shaffer of the Policies, Standards and Specifications Unit by telephone at (217) 785-2914 or email at Mark.Shaffer@illinois.gov.

Attachments

KLR/kktABD21.3-20211112
The maximum overhang is 2'-1" if the intent is to have the interior beam design control over the exterior beam design. There will be cases, especially with the prestressed beams, where overhangs greater than 2'-1" will be required.

Maximum fillet minus minimum fillet plus 1/2". The maximum fillet is determined based on dead load deflection, camber and grade.

Constant determined from maximum value calculated in note 2.

Constant determined from overhang width.

At Minimum Fillet

At Maximum Fillet
#5 b(E) bars equally spaced at 12"± cts.

#6 b1(E) bars over piers equally spaced between b(E) bars

Transverse reinforcement a(E) and a1(E) bars to be designed.

b2(E) bars equally spaced btwn. bms. As of b2(E) bars = 67% of bottom transverse reinforcement

Notes:
All edges shall have 3/4" chamfer.
Reinforcement bars designated (E) shall be epoxy coated.
Place A-#4 a6(E) bars in top evenly spaced. Fan as necessary into corner

**PLAN**

*(showing top reinforcement only)*

<table>
<thead>
<tr>
<th>Skew</th>
<th>A</th>
</tr>
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<tbody>
<tr>
<td>&lt;15°</td>
<td>0</td>
</tr>
<tr>
<td>15°-20°</td>
<td>1</td>
</tr>
<tr>
<td>20°-25°</td>
<td>2</td>
</tr>
<tr>
<td>25°-35°</td>
<td>4</td>
</tr>
<tr>
<td>35°-45°</td>
<td>5</td>
</tr>
</tbody>
</table>

**BAR a6(E)**

**ACUTE CORNER DECK REINFORCEMENT FOR SIDE MOUNTED RAILINGS ON INTEGRAL ABUTMENT BRIDGE DECKS**

Figure 3
* For special cases, where the skew is greater than 35°, increase to miss splitting reinforcement.

R40 POST PLACEMENT AT END OF DECK BEAM BRIDGE WITH NO APPROACH SLAB
**R40 POST PLACEMENT AT END OF DECK BEAM BRIDGE WITH APPROACH SLAB**

*For special cases, where the skew is greater than 35°, increase to miss splitting reinforcement.*

Figure 5
INTEGRAL ABUTMENT BRIDGE
END OF BRIDGE DECK FOR R40 POST PLACEMENT AT

R40 POST PLACEMENT AT END OF BRIDGE DECK FOR INTEGRAL ABUTMENT BRIDGE

Figure 6