

ENGINEERING DIRECTIVE

Patricia A. Leavenworth, P.E. (signature on original)

CHIEF ENGINEER

Updated Standards for Guardrail and Guardrail End Terminals

The primary purpose of this Engineering Directive is to formally issue new Construction Standard Details for W-Beam Guardrail and Guardrail End Terminals that conform to the performance requirements contained in the 2016 edition of the *Manual for Assessing Safety Hardware (MASH)*. In addition, this Directive removes Blocked-Out Thrie Beam as a standard median treatment for semi-rigid barrier for use on highway facilities with design speeds greater than 40 mph, as specified in the *Project Development and Design Guide*.

MASH-compliant w-beam guardrail is uniquely characterized by and may be identified in the field by having the following properties (see standard detail drawings for all design details):

- 31" height measured from top of pavement/riding surface to top of rail
- 8" wood or plastic offset blocks
- Mid-span panel splices

The new standard detail drawings are included in the *October 2017 Construction Standard Details*, which shall be referenced in the plans and contract documents of all projects advertised after October 21, 2017. All of the new and superseded standard detail drawings are listed at the end of this Directive.

This Directive also supersedes the following Engineering Directives:

- E-95-008 – Impact Attenuator Terminals
- E-02-001 – Guardrail End Treatments and Elimination of Back-up Plates
- E-05-002 – New Construction Drawings for Guardrail Buried in Back-Slope

New Construction or Reconstruction

The *October 2017 Construction Standard Details* shall be used for all projects advertised after October 21, 2017 and for all Highway Access Permits issued after October 21, 2017.

Active Construction or Reconstruction

For projects advertised prior to October 22, 2017, contractors may continue to install guardrail and guardrail end terminals in accordance with the relevant contract documents for each contract, unless otherwise directed by MassDOT on a case-by-case basis.

Maintenance and Accident Recovery

MassDOT District personnel shall inspect damaged guardrail end terminals to determine if they can be repaired or if total replacement is required. Typically, minor damage that results from snow plows, mowers or low-speed “nuisance” hits may only require tightening of bolts, re-tensioning of cable(s), replacement of reflective sheeting, etc., in accordance with the manufacturer’s specifications. This work may continue to be performed in order to maximize the useful service life of the end terminal. The District shall keep on file a record of any work performed, including a description of the repairs, the date of service and the names of people performing the work.

Guardrail end terminals that are damaged beyond repair shall be replaced with a MASH-compliant end terminal. In locations where the end terminal is connected to non-compliant w-beam guardrail, a transition that conforms to the *Construction Standard Details* between the MASH-compliant end terminal and the non-MASH-compliant w-beam guardrail is required. Alternatively, if the District determines that a significant portion of the w-beam guardrail is also damaged beyond repair, the entire run may be replaced with MASH-compliant w-beam guardrail and a MASH-compliant end terminal.

Downstream end terminals that serve as a trailing anchorage shall be repaired in kind unless the adjacent guardrail section is upgraded to a MASH-compliant system. In those instances the trailing anchorage shall be replaced with a system that conforms to the *Construction Standard Details*.

Damaged sections of w-beam guardrail and blocked-out thrie beam, when the end terminal is undamaged, may be replaced in kind. However, the District should review cases when a significant percentage of the run is damaged to determine if it is cost effective to replace the whole run with a MASH-compliant system.

In kind repair work shall be completed in accordance with the manufacturer’s instructions and with the applicable *Construction Standard Details* for the affected safety hardware components. These details may be contained in a superseded version of the *Construction Standard Details*.

General Requirements

Guardrail systems to be replaced may include components from existing systems, provided that the components are in serviceable condition and do not require alteration in any way. Cutting posts or panels and punching holes in posts or panels will not be allowed.

With exception of thrie beam panels used as transitions between different barrier types, blocked-out thrie beam guardrail should be replaced with a flexible, semi-rigid, or rigid barrier system that conforms to MASH crash testing standards.

Transitions from non-MASH-compliant to MASH-compliant w-beam guardrail shall conform to the *Construction Standard Details*.

Proprietary hardware related to w-beam guardrail and guardrail end terminals shall conform to MASH testing standards and be listed on the Qualified Traffic Control Equipment List.

Any w-beam guardrail that is found to be less than 26.5” high shall be removed and reset to meet the applicable *Construction Standard Details* for the affected system, or shall be replaced with MASH-compliant guardrail. In addition, any w-beam guardrail that is expected to be less than 26.5” high following an overlay or any type of reconstruction work shall be removed and reset to meet the applicable *Construction Standard Details* for the affected system, or shall be replaced with MASH-compliant guardrail as part of the project. The guardrail height is measured from the top of pavement/riding surface at the edge of road to the top of rail.

The Design Engineer is responsible for selecting the appropriate MASH Test Level (TL) criteria for all new and replacement barrier systems. Unless otherwise directed by MassDOT, the Design Engineer is responsible for selecting the barrier type (flexible, semi-rigid, or rigid), location, and length based upon the site conditions and the criteria found in the *Roadside Design Guide*.

End terminals for TL-2 barrier systems shall be TL-2, unless otherwise specified by MassDOT. End terminals for TL-3 and higher barrier systems shall be TL-3.

Non-Conforming Installations

Any proposed installations of guardrail and guardrail end terminals that will not conform to the applicable *Construction Standard Details* must be approved by the Chief Engineer. In those cases, the designer, contractor or other responsible project engineer shall document the deficiency and the proposed solution to justify the non-conforming installation in the form of a written memorandum to the Chief Engineer.

MassDOT will allow non-conforming installations if it can be demonstrated that unique site conditions prohibit the installation of a conforming system and that public safety will not be compromised by the use of the proposed non-conforming system.

Payment Items

The following payment items shall be used for MASH-compliant guardrail items:

- 620.12 Guardrail, TL-2 (Single Faced) Foot
- 620.13 Guardrail, TL-3 (Single Faced) Foot
- 620.32 Guardrail – Curved, TL-2 (Single Faced) Foot
- 620.33 Guardrail – Curved, TL-3 (Single Faced) Foot
- 621.12 Guardrail, TL-2 (Double Faced) Foot
- 621.13 Guardrail, TL-3 (Double Faced) Foot
- 621.32 Guardrail – Curved, TL-2 (Double Faced) Foot
- 621.33 Guardrail – Curved, TL-3 (Double Faced) Foot
- 627.1 Guardrail Trailing Anchorage Each
- 627.72 Guardrail End Treatment, TL-2 (Double Faced) Each
- 627.73 Guardrail End Treatment, TL-3 (Double Faced) Each
- 627.82 Guardrail Tangent End Treatment, TL-2 Each
- 627.83 Guardrail Tangent End Treatment, TL-3 Each
- 627.92 Guardrail Flared End Treatment, TL-2 Each
- 627.93 Guardrail Flared End Treatment, TL-3 Each
- 628.31 Transition to NCHRP 350 Guardrail Each
- 628.32 Transition to Rigid Barrier (Single Faced) Each

- 628.33 Transition to Rigid Barrier (Double Faced) Each
- 628.34 Transition to Bridge Rail Each
- 628.35 Transition to Thrie Beam Each

New Standard Details

- 400.1.0 General Notes
- 400.1.1 Guardrail, TL-3
- 400.1.2 Guardrail, TL-2
- 400.1.3 W-Beam & Thrie Beam Panel Details
- 400.1.4 Post & Offset Block Details
- 400.1.5 Guardrail Mounting Heights and Post Depths
- 400.1.6 Guardrail Sections
- 400.2.1 Approach Geometry: Single Faced
- 400.2.2 Approach Geometry: Adjacent to Curb & Double Faced
- 400.2.3 Layout to Single Faced Rigid Barrier or Bridge Rail
- 400.2.4 Layout to Double Faced Rigid Barrier – Trailing Ends
- 400.3.1 Transition to NCHRP 350 Guardrail
- 400.3.2 Transition to Rigid Barrier (Single Faced)
- 400.3.3 Transition to Rigid Barrier (Double Faced)
- 400.3.4 Transition to Rigid Barrier Details
- 400.3.5 Transition to Bridge Rail (Back of Sidewalk)
- 400.3.6 Transition to Bridge Rail (Face of Curb)
- 400.3.7 Transition to Bridge Rail Details
- 400.4.1 Trailing Anchorage
- 400.4.2 Trailing Anchorage Component Details
- 400.5.1 Special Post Designs

Superseded Standard Details

- E 401.1.0 Steel W Beam Highway Guard
- E 401.1.1 Steel W Beam Highway Guard Sections
- E 401.2.0 Installation for Steel W Beam Highway Guard for Sign Protection
- E 401.2.1a Steel W Beam Highway Guard Buried in Back-Slope Plan View
- E 401.2.1b Steel W Beam Highway Guard Buried in Back-Slope Post Location
- E 401.2.1c Steel W Beam Highway Guard Buried in Back-Slope Post Location
- E 401.2.1d Steel W Beam Highway Guard Buried in Back-Slope Anchorage Details
- E 401.2.1e Steel W Beam Highway Guard Buried in Back-Slope End Anchorage Details for Posts 1, 2, and 3
- E 401.3.0 Table of Offsets for Highway Guard Flared Ends
- E 401.5.0 Steel Thrie Beam Highway Guard Rail Details
- E 401.5.1 Bridge Rail to Highway Guard Transition
- E 401.5.2 Bridge Rail to Highway Guard Transition – Details
- E 401.5.3 Steel Thrie Beam Highway Terminal Connector
- E 401.5.4 Bridge Rail to Highway Guard Collapsing Tube
- E 401.5.5 Bridge Rail to Highway Guard Transition at Sidewalk
- E 401.5.6 Bridge Rail to Highway Guard Transition at Sidewalk – Sections

- E 401.6.0 Steel Thrie Beam Highway Guard Details
- E 401.6.1 Steel Highway Guard Transition Beam
- E 401.7.0 Steel W Beam Highway Guard Rail Details
- E 401.8.0 Steel W Beam Highway Guard Posts and Terminal Section Details
- E 401.10.0 Steel Beam Highway Guard with Wood Post
- E 401.11.0 Special Base Anchor for Highway Guard Installation on Concrete
- E 401.12.0 Modified Highway Guard Post Installation Where Standard Embedment is Not Feasible
- E 401.16.0 Steel Thrie Beam Highway Guard Median – Barrier
- E401.20.0 Offset Blocks for Steel W Beam Highway Guard
- E 401.21.0 Offset Blocks for Steel Thrie Beam Highway Guard
- E 402.2.0 Steel W Beam Highway Guard Terminal Connections on Existing Bridge W-Rail Leading End at Abutments and End Posts
- E 402.3.0 Installation of Steel W Beam Highway Guard (Trailing End) at Existing Bridge Abutments and End Posts (W-Rail)
- E 402.4.0 Masonry Bracket for Steel W Beam Highway Guard on Abutments and End Posts (Trailing End)
- E 402.5.0 Masonry Bracket for Steel W Beam Highway Guard on Abutments and End Posts (Trailing End)
- E 402.7.0 Steel Thrie Beam Highway Guard Terminal Connectors on an Existing Bridge Leading End at Abutment and End Post
- E 402.8.0 Steel Thrie Beam Highway Guard (Trailing End) at Existing Bridge Abutments and End Posts
- E 402.9.0 Masonry Bracket for Steel Thrie Beam Highway Guard on Abutments and End Posts (Trailing End)
- E 402.9.1 Guardrail Retrofit on Bridges (Plan View)
- E 402.9.2 Guardrail Retrofit on Bridges (Details)
- E 402.9.3 Guardrail Retrofit on Bridges (Notes)