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FPL-GTR-107

Plans for Crash-Tested Bridge Railings for Longitudinal Wood Decks on Low-Volume Roads

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Abstract

The plans for crashworthy bridge railings for low-volume roads were developed through a cooperative research program involving the USDA Forest Service, Forest Products Laboratory (FPL); the Midwest Roadside Safety Facility, University of Nebraska-Lincoln (MwRSF); and the Forest Service, National Forest System, Engineering. Three railings were developed and successfully tested in accordance with National Cooperative Highway Research Program (NCHRP) Report 350 Test Level-1 requirements. The fourth system was developed for a lower test level based on criteria developed by the Forest Service for single-lane bridges on very low-volume roads. For the convenience of the user, full drawing sets are provided in customary U.S. and S.I. units.

August 1998

Ritter, Michael A.; Faller, Ronald K.; Bunnell, Steve; Lee, Paula D. Hilbrich; Rosson, Barry T. 1998. Plans for crash-tested bridge railings for longitudinal wood decks on low-volume roads. Gen. Tech. Rep. FPL–GTR–107. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 12 p.

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Plans for Crash-Tested Bridge Railings for Longitudinal Wood Decks on Low-Volume Roads

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Introduction

Since 1989, the USDA Forest Service, Forest Products Laboratory (FPL), and the Midwest Roadside Safety Facility, University of Nebraska-Lincoln (MwRSF) have worked in cooperation to develop crash-tested bridge railings for timber bridge decks. This research originally focused on Performance Level 1 (PL-1) and Performance Level 2 (PL-2) railings as outlined in the *AASHTO Guide Specifications for Bridge Railings* (AASHTO 1989), but was expanded as a cooperative effort with the Federal Highway Administration (FHWA) to include Test Level 2 (TL-2) and Test Level 4 (TL-4) railings in accordance with *Recommended Procedures for the Safety Performance Evaluation of Highway Features* (NCHRP Report 350) (Ross and others 1993). Although this research resulted in numerous railing systems for bridges on primary or secondary highways, there were no railings developed specifically for low-volume roads (Ritter and others 1995). Since most timber bridges are located on low-volume roads, the Forest Service, National Forest System, Engineering, identified a need to develop crashworthy timber bridge railings designed specifically for low-volume applications.

These plans reflect the results of a cooperative research project between FPL, MwRSF, and the Forest Service, National Forest System, Engineering, to develop four crashworthy bridge railing designs for low-volume applications. Three of the railings were developed and successfully tested in accordance with NCHRP 350 TL-1 requirements (Ross and others 1993). The fourth system was developed for a lower test level based on criteria developed by the Forest Service for single-lane bridges on very low-volume roads. For the convenience of the user, full drawing sets are provided in customary U.S. and S.I. units.

Acknowledgments

We express sincere appreciation to Brent Prauner, Keith Robertson, and Eric Keller of the Midwest Roadside Safety Facility, University of Nebraska-Lincoln, and the FPL Information Services Team for assistance in preparing this publication.

Specifications

AASHTO. 1989. Guide specifications for bridge railings. Washington, DC: American Association of State Highway and Transportation Officials.

AASHTO. 1995. Standard specifications for transportation materials and methods of sampling and testing. vol. 1: specifications. Washington, DC: American Association of State Highway and Transportation Officials.

- M111 Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- M133 Preservatives and Pressure Treatment Process for Timber
- M168 Wood Products
- M180 Corrugated Sheet Steel Beams for Highway Guardrail
- M232 Zinc Coating (Hot-Dip) on Iron and Steel Hardware

AASHTO-AGC-ARTBA.1995. A guide to standardized highway barrier hardware. Washington, DC: American Association of State Highway and Transportation Officials.

ASTM. 1998. Annual book of ASTM standards. Philadelphia, PA: American Society for Testing and Materials.

- A36 Standard Specification for Structural Steel
- A47 Standard Specification for Ferritic Malleable Iron Castings
- A307 Standard Specification for Carbon Steel Bolts and Studs, 60,000 lbs/in^2 Tensile Strength
- A325 Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 kips/in^2 Minimum Tensile Strength
- A722 Standard Specification for Uncoated, High-Strength Steel Bar for Prestressing Concrete

SAE. 1985. J429. Mechanical and material requirements for externally threaded fasteners. Warrendale, PA. Society of Automotive Engineers.

SAE. 1989. J412. General characteristics and heat treatment of steels. Warrendale, PA. Society of Automotive Engineers.

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Faller, R.K.; Rosson, B.T. 1997. Development of a flexible bridge railing for longitudinal timber decks. Res. Rep. TRP-03-62-96. Lincoln, NE: University of Nebraska-Lincoln, Midwest Roadside Safety Facility.

Faller, R.K.; Rosson, B.T.; Sicking, D.L.; [and others]. 1995. Design and evaluation of two bridge railings for low-volume roads. In: Proceedings of 6th International conference on low-volume roads; 1995 June 25-29; Minneapolis, MN. Washington, DC: National Academy Press; Vol. 2: 357-372.

Faller, R.K.; Rosson, B.T.; Fowler, M.D.; Ritter, M.A. 1996a. Top-mounted W-beam bridge railing for longitudinal timber decks located on low-volume roads. Res. Rep. TRP-03-61-96. Lincoln, NE: University of Nebraska-Lincoln, Midwest Roadside Safety Facility.

Faller, R.K.; Rosson, B.T.; Ritter, M.A.; [and others]. 1996b. Railing systems for longitudinal timber deck bridges. In: Ritter, M.A.; Duwadi, S.R.; Lee, P.D.H., ed(s). National conference on wood transportation structures; 1996 October 23-25; Madison, WI. Gen. Tech. Rep. FPL-GTR-94. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory: 145-157.

Faller, R.K.; Rosson, B.T.; Soyland, K.; [and others]. 1996c. TL-1 curb-type bridge railing for longitudinal timber decks located on low-volume roads. Res. Rep. TRP-03-54-96. Lincoln, NE: University of Nebraska-Lincoln, Midwest Roadside Safety Facility.

Ritter, M.A.; Faller, R.K.; Sicking, D.L.; Bunnell, S. 1993. Development of low-volume curb-type bridge railings for timber bridge decks. Res. Rep. TRP-03-31-93. Lincoln, NE: University of Nebraska-Lincoln, Midwest Raodside Safety Facility.

Ritter, M.A.; Faller, R.K.; Lee, P.D.H.; [and others]. 1995. Plans for crash-tested bridge railings for longitudinal wood decks. Gen. Tech. Rep. FPL-GTR-87. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 27p.

Ross, H.E., Jr.; Sicking, D.L.; Zimmer, R.A.; Michie, J.D. 1993. Recommended procedures for the safety performance evaluation of highway features, National Cooperative Highway Research Program (NCHRP) Rep. 350. Washington, DC: National Research Council, Transportation Research Board.

Comments

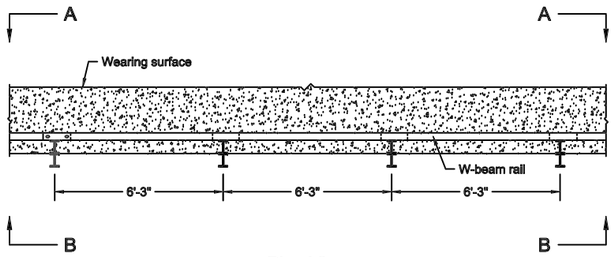
Address comments on these drawings to the Wood Transportation Structures Team, USDA Forest Products Laboratory, One Gifford Pinchot Drive, Madison, WI 53705-2398. http://www.fpl.fs.fed.us/wit/

Contents

Rail Drawings in Customary U.S. Units

University of Nebraska Lincoln

General Configuration



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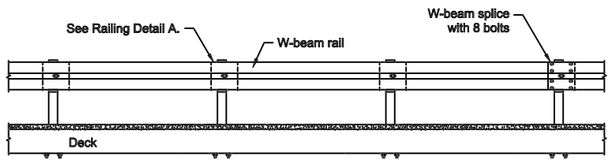

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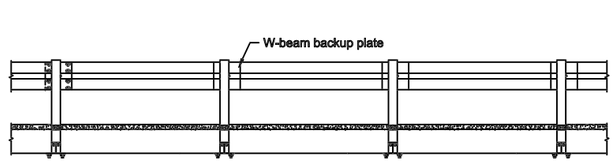
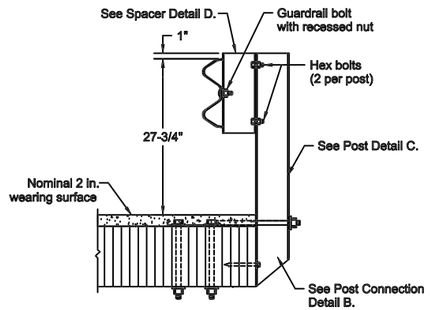
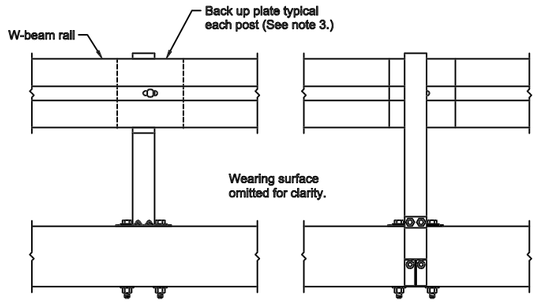


Back Elevation

A Railing Details



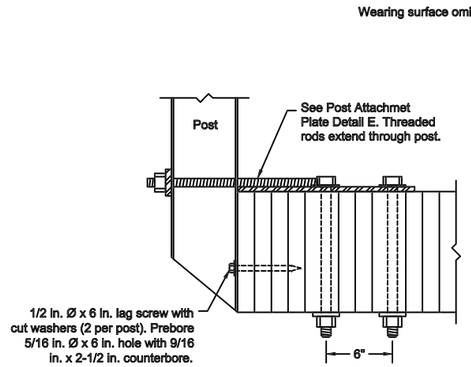
End View



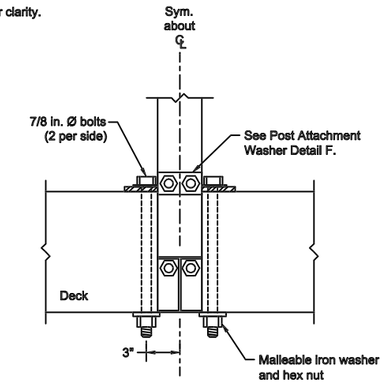
Front View

Back View

B Post Connection

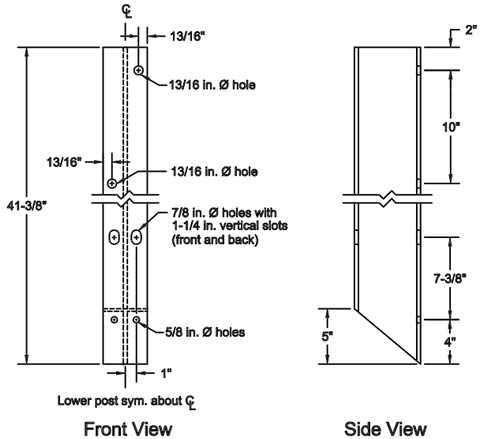


End View



Back View

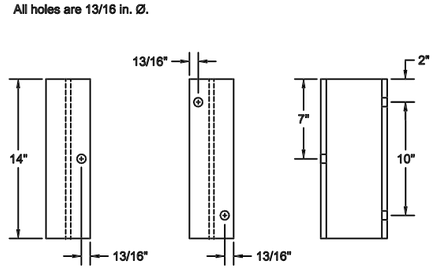
C W6x9 Steel Post



Front View

Side View

D W6x9 Steel Spacer

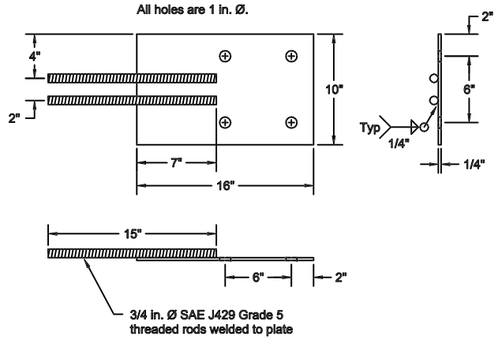


Rail Side

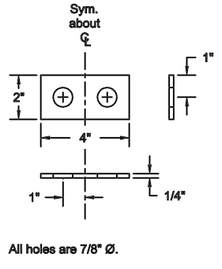
Post Side

Side View

E Post Attachment Plate



F Post Attachment Washer



Design

1. This bridge rail was successfully crash tested to the requirements for Test Level 1 (TL-1), as outlined in NCHRP Report 350. This rail is adaptable to longitudinal stress-laminated, spike-laminated, nail-laminated, and glued-laminated (glulam) timber decks that are 10 in. or greater in actual thickness. For additional information, refer to Top-Mounted W-beam Bridge Railing for Longitudinal Wood Decks Located on Low-Volume Roads (Faller and others 1996a).

2. Height of the bridge rail shall be 27-3/4 in. above the traveled way (top of wearing surface or top of bridge deck if a wearing surface is omitted), but not greater than 29-3/4 in. above the bridge deck.

3. Bridge railing shall be provided with back-up plates (RWB01a) at each post as specified in the AASHTO-AGC- ARTBA (1995) Guide to Standardized Highway Barrier Hardware. Back-up plates are not required where a rail splice occurs.

4. Railing shall include a strong-post W-beam approach guardrail (SGR04a-b) and an appropriate end terminal as outlined in the AASHTO-AGC-ARTBA Guide to Standardized Highway Barrier Hardware.

Materials

5. W-beam rail, rail attachment splice bolts, and spacer bolts shall comply with the requirements of AASHTO (1995) M180. Railing shall be Class A (0.105-in. nominal base metal thickness).

6. Steel plates and shapes shall comply with the requirements of ASTM A36.

7. Unless otherwise noted, bolts and lag screws shall comply with the requirements of ASTM (1998) A307.

8. All steel components and fasteners shall be galvanized in accordance with AASHTO M111 or M232 or shall otherwise be provided with adequate corrosion protection.

Fabrication and Construction

9. To the extent possible, all wood shall be cut, drilled, and completely fabricated prior to pressure treatment with preservatives. When field fabrication of wood is required or if wood is damaged, all cuts, bore holes, and damage shall be immediately treated with wood preservative in accordance with AASHTO M133.

10. Unless noted, malleable iron washers shall be provided under bolt heads and under nuts that are in contact with wood. When the size and strength of the head are sufficient to develop connection strength without wood crushing, washers may be omitted under heads of dome-head timber bolts.

The bridge railings depicted on these drawings were developed and crash tested under a cooperative research agreement between the Midwest Roadside Safety Facility of the University of Nebraska-Lincoln and the USDA Forest Service, Forest Products Laboratory.

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Crash-Tested Bridge Rails for Longitudinal Wood Decks on Low-Volume Roads

Top Mounted Railing NCHRP 350 Test Level 1 (TL-1)	August 1998	Sheet 1 of 1

Rail Drawings in S.I. Units

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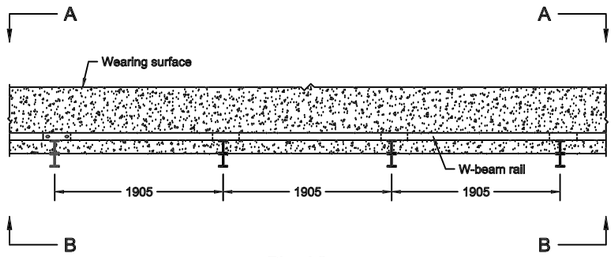
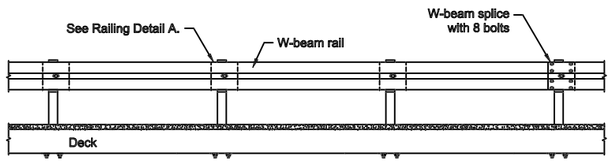
General Configuration

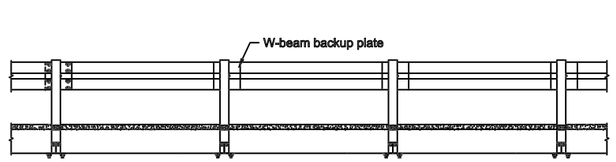
All units are in millimeters based on a soft conversion from customary U.S. units.



Plan View

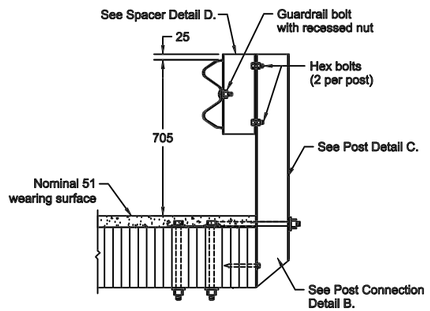


Front Elevation

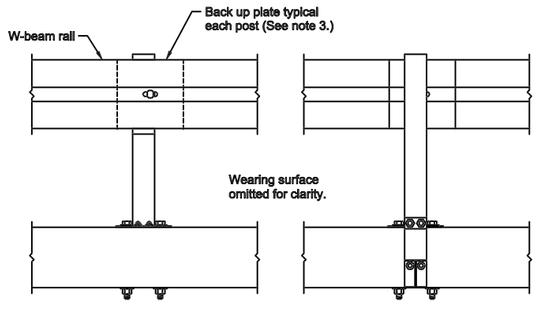


Back Elevation

A Railing Details



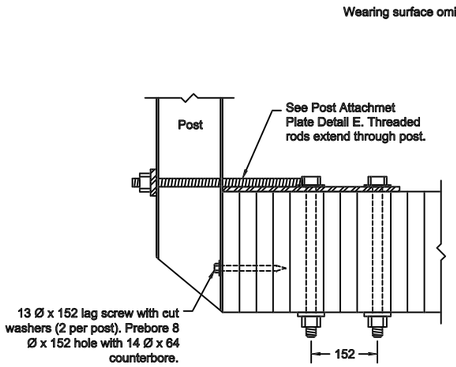
End View



Front View

Back View

B Post Connection



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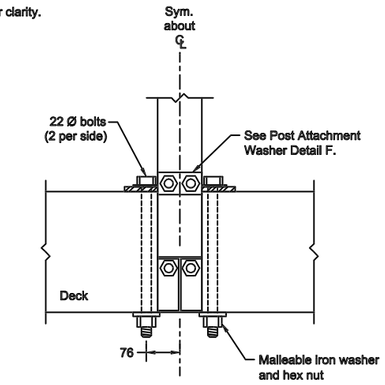
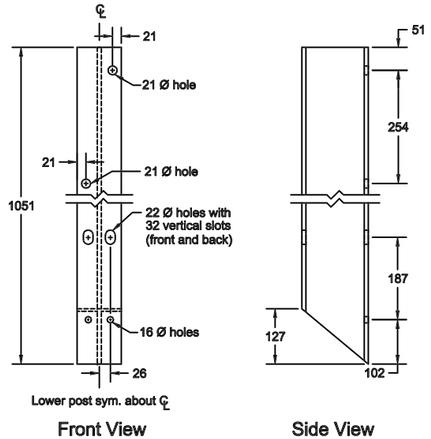


Back View

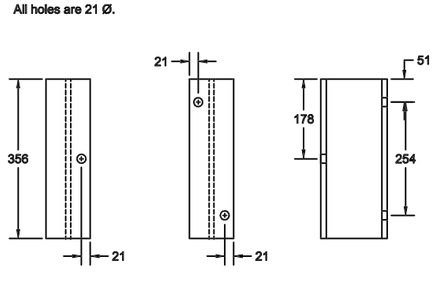
C W6x9 Steel Post



Front View

Side View

D W6x9 Steel Spacer

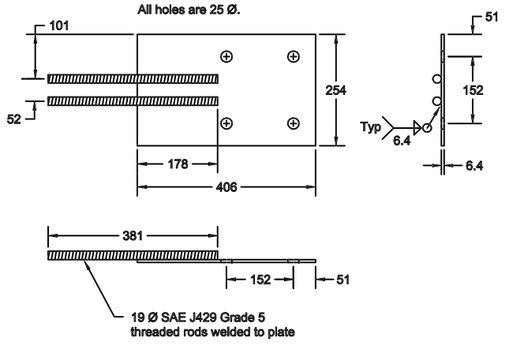


Rail Side

Post Side

Side View

E Post Attachment Plate



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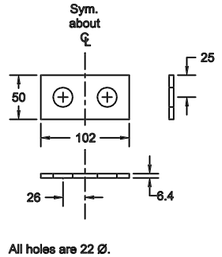

Design

1. This bridge rail was successfully crash tested to the requirements for Test Level 1 (TL-1), as outlined in NCHRP Report 350. This rail is adaptable to longitudinal stress-laminated, spike-laminated, nail-laminated, and glued-laminated (glulam) timber decks that are 254 mm or greater in actual thickness. For additional information, refer to Top-Mounted W-beam Bridge Railing for Longitudinal Wood Decks Located on Low-Volume Roads (Faller and others 1996a).

2. Height of the bridge rail shall be 705 mm above the traveled way (top of wearing surface or top of bridge deck if a wearing surface is omitted), but not greater than 756-mm above the bridge deck.

3. Bridge railing shall be provided with back-up plates (RWB01a) at each post as specified in the AASHTO-AGC- ARTBA (1995) Guide to Standardized Highway Barrier Hardware. Back-up plates are not required where a rail splice occurs.

4. Railing shall include a strong-post W-beam approach guardrail (SGR04a-b) and an appropriate end terminal as outlined in the AASHTO-AGC-ARTBA Guide to Standardized Highway Barrier Hardware.

Materials

5. W-beam rail, rail attachment splice bolts, and spacer bolts shall comply with the requirements of AASHTO (1995) M180. Railing shall be Class A (3-mm nominal base metal thickness).

6. Steel plates and shapes shall comply with the requirements of ASTM A36.

7. Unless otherwise noted, bolts and lag screws shall comply with the requirements of ASTM (1998) A307.

8. All steel components and fasteners shall be galvanized in accordance with AASHTO M111 or M232 or shall otherwise be provided with adequate corrosion protection.

Fabrication and Construction

9. To the extent possible, all wood shall be cut, drilled, and completely fabricated prior to pressure treatment with preservatives. When field fabrication of wood is required or if wood is damaged, all cuts, bore holes, and damage shall be immediately treated with wood preservative in accordance with AASHTO M133.

10. Unless noted, malleable iron washers shall be provided under bolt heads and under nuts that are in contact with wood. When the size and strength of the head are sufficient to develop connection strength without wood crushing, washers may be omitted under heads of dome-head timber bolts.

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Crash-Tested Bridge Rails for Longitudinal Wood Decks on Low-Volume Roads

Top Mounted Railing NCHRP 350 Test Level 1 (TL-1)	August 1998	Sheet 1 of 1