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

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United States
Department of
Agriculture

Forest Service

Forest
Products
Laboratory

General
Technical
Report
FPL-GTR-107



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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.

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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/in² Tensile Strength
- A325 Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 kips/in² 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.

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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.

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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

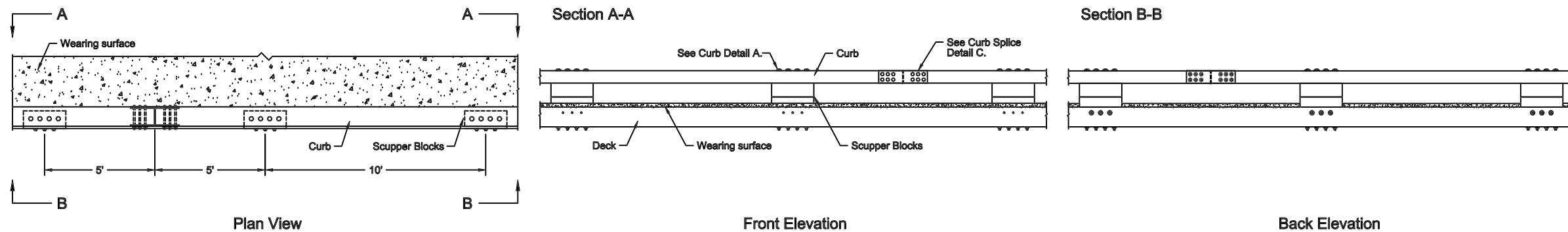
Address comments on these drawings to the Wood Transportation Structures Team, USDA Forest Products Laboratory, One Gifford Pinchot Drive, Madison, WI 53705-2398. <http://www.fpl.fs.fed.us/wit/>

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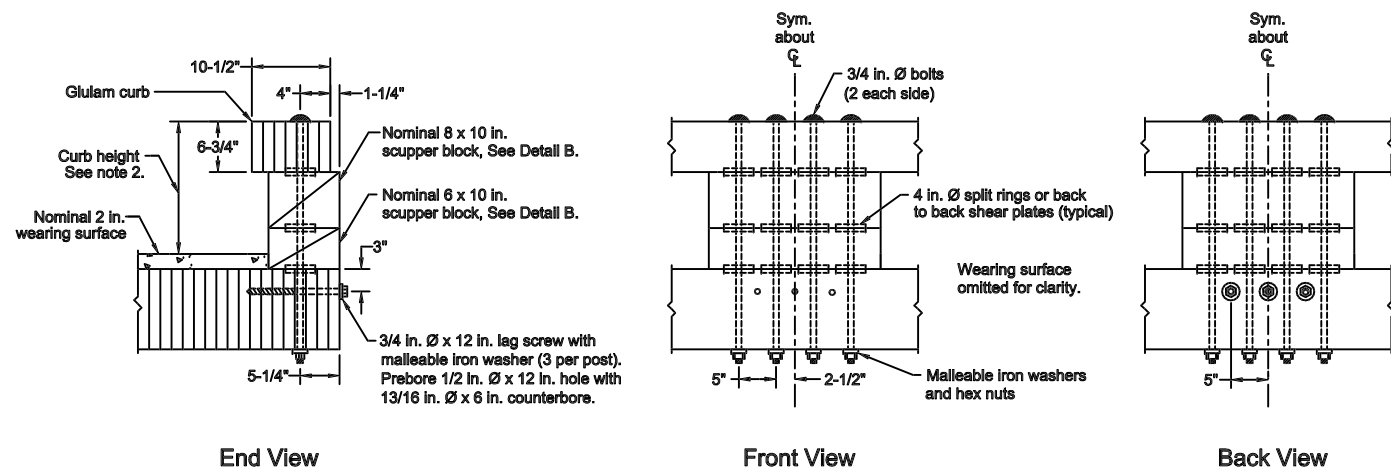
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2 Side-Mounted Breakaway Railing, NCHRP 350 Test Level 1	9
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Rail Drawings in Customary U.S. Units

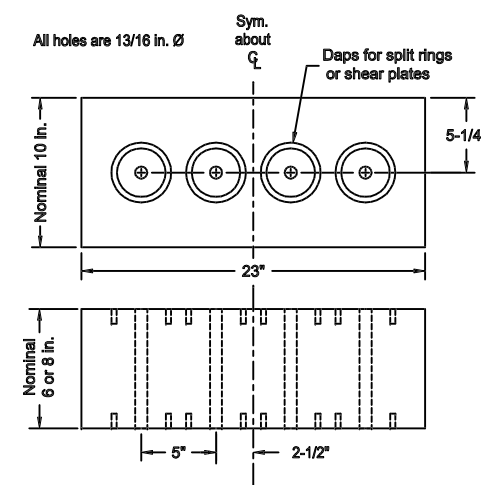
General Configuration



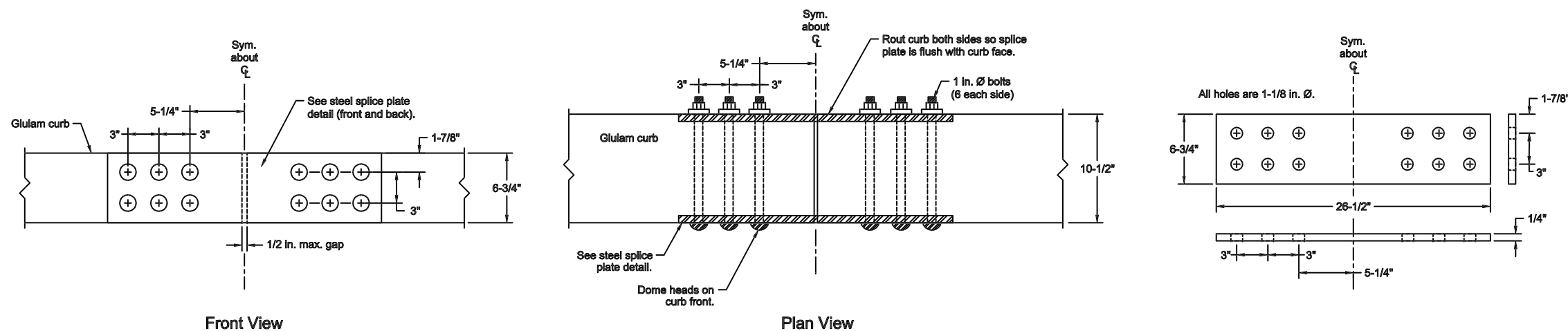
A Curb Details



B Scupper Block Detail



C Curb Splice Details



Design

1. This curb railing was successfully crash tested to the requirements for Test Level 1 (TL-1), as outlined in NCHRP Report 350 (Ross and others 1993). 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 TL-1 Curb-Type Bridge Railing for Longitudinal Timber Decks Located on Low-Volume Roads (Faller and others 1996c).

2. Actual height of the curb railing rail shall be 17-3/4 to 18-3/4 in. above the traveled way (top of wearing surface or top of bridge deck if a wearing surface is omitted), but not greater than 20-3/4 in. above the bridge deck.

3. Dimensions for glulam components are actual dimensions. Dimensions for sawn lumber components are nominal dimensions. Actual sawn lumber dimensions may be up to a maximum of 1/2 in. less than nominal dimensions to permit the use of surfaced or rough-sawn material.

4. Curb railing splices are midway between scuppers and shall be located so that curb is continuous over not less than two scuppers. It is recommended that the glulam curbs be continuous over the length of the bridge.

Materials

5. Sawn lumber and glulam shall comply with the requirements of AASHTO M168 and shall be pressure treated with wood preservative in accordance with AASHTO M133. Glulam shall be manufactured using wet use adhesives to an industrial appearance grade.

6. Curb railing shall be visually graded glulam Western Species Combination No. 2 or Southern Pine Combination No. 48. Other species and grades of glulam may be used, provided the minimum tabulated values are not less than the following:

$$F_b = 1,800 \text{ lb/in}^2$$

$$E = 1,800,000 \text{ lb/in}^2$$

7. Scupper blocks may be sawn lumber or glulam. When sawn lumber is used, material shall be visually graded No. 1 Southern Pine or visually graded No. 1 Douglas Fir-Larch. Glulam and other species and grades of sawn lumber may be used, provided the minimum tabulated values are no less than the following:

$$F_b = 1,350 \text{ lb/in}^2$$

$$E = 1,500,000 \text{ lb/in}^2$$

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

9. Bolts shall comply with the requirements ASTM A307, Grade 2, and should preferably be dome head timber bolts. Bolts on top of the curb rail shall be dome head.

10. Split rings shall be manufactured from SAE 1010 hot-rolled carbon steel in accordance with SAE J412 (SAE 1989). Shear plates shall be malleable iron manufactured according to ASTM A47, Grade 32510.

11. 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

12. 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.

13. 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.



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

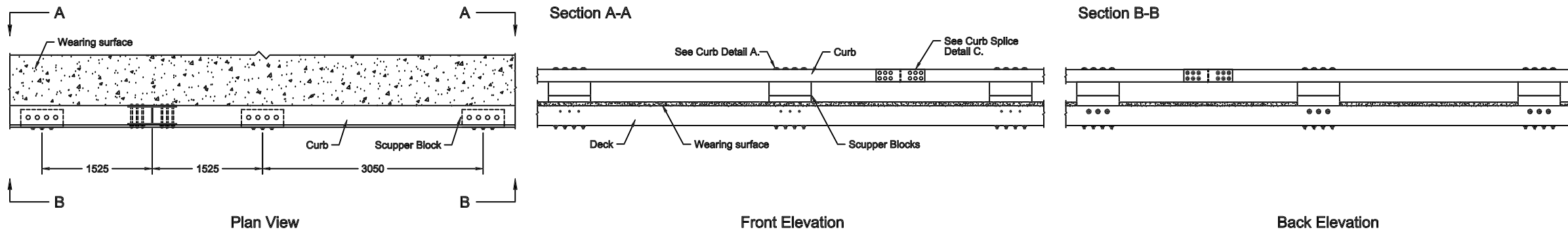
Curb Railing
NCHRP 350 Test Level 1 (TL-1)

August 1998

Sheet 1 of 1

Rail Drawings in S.I. Units

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



Design

1. This curb railing was successfully crash tested to the requirements for Test Level 1 (TL-1), as outlined in NCHRP Report 350 (Ross and others 1993). This railing 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 TL-1 Curb-Type Bridge Railing for Longitudinal Timber Decks Located on Low-Volume Roads (Faller and others 1996c).

2. Actual height of the curb railing rail shall be 451 mm to 476 mm above the traveled way (top of wearing surface or top of bridge deck if a wearing surface is omitted), but not greater than 527 mm above the bridge deck.

3. Dimensions for glulam components are actual dimensions. Dimensions for sawn lumber components are nominal dimensions. Actual sawn lumber dimensions may be up to a maximum of 13 mm less than nominal dimensions to permit the use of surfaced or rough-sawn material.

4. Curb railing splices are midway between scuppers and shall be located so that curb is continuous over not less than two scuppers. It is recommended that the glulam curbs be continuous over the length of the bridge.

Materials

5. Sawn lumber and glulam shall comply with the requirements of AASHTO M168 and shall be pressure treated with wood preservative in accordance with AASHTO M133. Glulam shall be manufactured using wet use adhesives to an industrial appearance grade.

6. Curb railing shall be visually graded glulam Western Species Combination No. 2 or visually graded Southern Pine Combination No. 48. Other species and grades of glulam may be used, provided the minimum tabulated values are not less than the following:

$$F_b = 12.4 \text{ MPa}$$

$$E = 12,410 \text{ MPa}$$

7. Scupper blocks may be sawn lumber or glulam. When sawn lumber is used, material shall be visually graded No. 1 Southern Pine or visually graded No. 1 Douglas Fir-Larch. Glulam and other species and grades of sawn lumber may be used, provided the minimum tabulated values are no less than the following:

$$F_b = 9.3 \text{ MPa}$$

$$E = 10,342 \text{ MPa}$$

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

9. Bolts shall comply with the ASTM A307 requirements, Grade 2, and should preferably be dome head timber bolts. Bolts on top of the curb rail shall be dome head.

10. Split rings shall be manufactured from SAE 1010 hot-rolled carbon steel in accordance with SAE J412 (SAE 1989). Shear plates shall be malleable iron manufactured according to ASTM A47, Grade 32510.

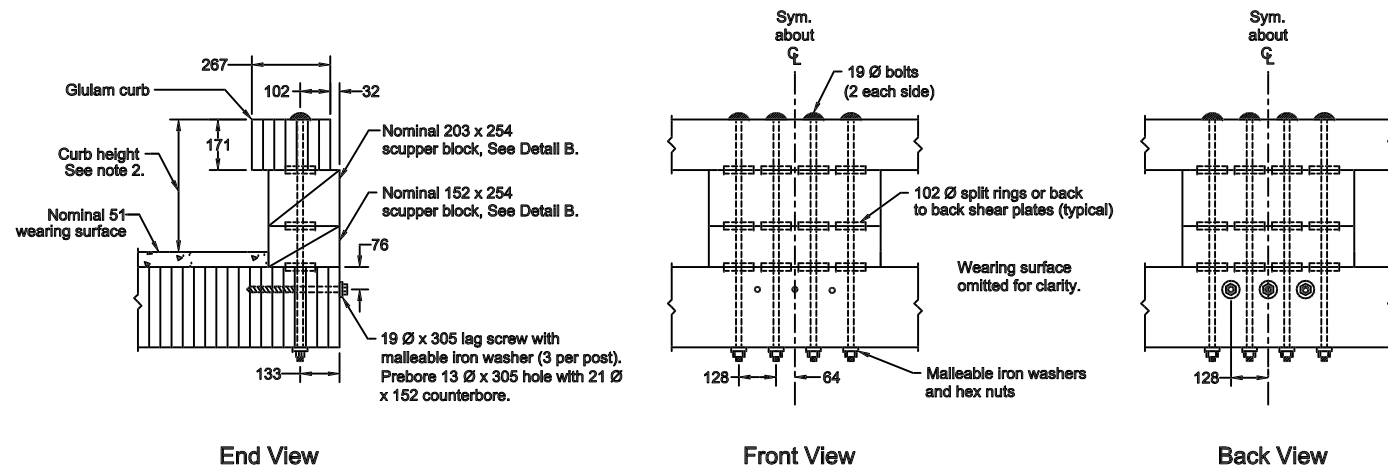
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Fabrication and Construction

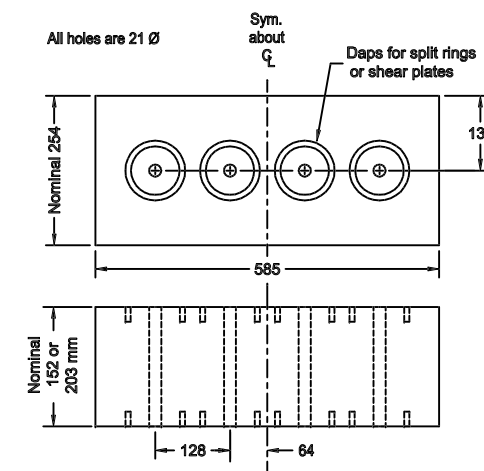
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13. Unless noted, malleable iron washers shall be provided under bolt heads and under nuts that are in contact with wood. When the size and strength of the head are sufficient to develop connection strength without wood crushing, washers may be omitted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

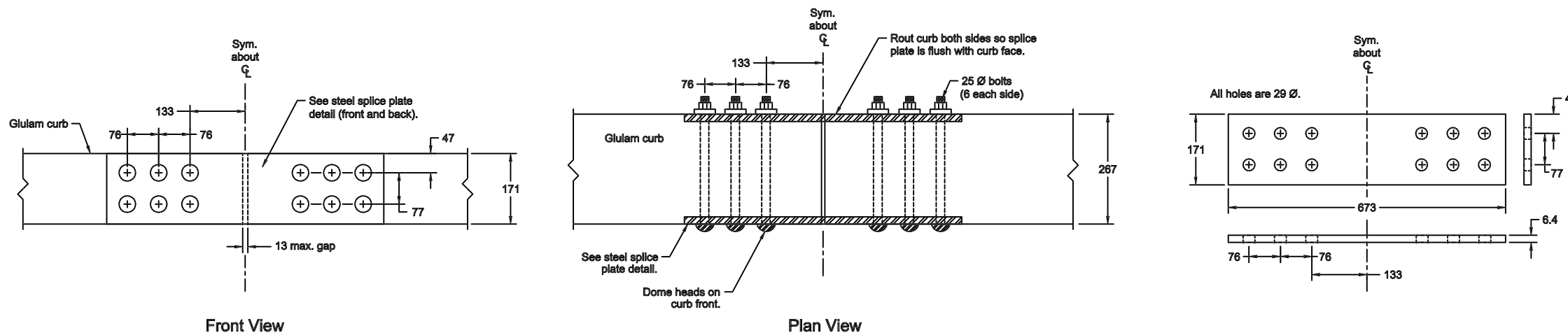
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Curb Railing
NCHRP 350 Test Level 1 (TL-1)

August 1998

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