TWO-RAIL STEEL-BACKED TIMBER GUARDRAIL SYSTEM

Crown Point Highway
Multnomah County, Oregon

Construction Report

OREGON EXPERIMENTAL FEATURE PROJECT #OR92-03

by

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DISCLAIMER

Two-Rail Steel-Backed Timber Guardrail System

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1.0 INTRODUCTION

Guardrails in Oregon have traditionally been constructed using a steel W-beam guardrail. Although the steel guardrail has functioned well in the past, it is not aesthetically pleasing. To achieve a more pleasant drive through parks and scenic highways, the Oregon Department of Transportation (ODOT) decided to install a timber guardrail. The Federal Highway Administration (FHWA) has approved the use of a two-rail steel-backed timber guardrail, that was tested by the Texas Transportation Institute [1], for use on federally funded projects. The tests were in accordance with the National Cooperative Highway Research Program (NCHRP) Report 230 [2]. The two-rail steel-backed timber guardrail provides an alternative to the standard guardrail used in Oregon.

The objective of this project is to implement an in-service evaluation for the two-rail steel-backed timber guardrail installed on Crown Point Highway (Highway 125) in Multnomah County, between mile posts 10.23 and 11.05. The evaluation will include monitoring the construction process, construction costs, maintenance costs and performance of the guardrail for a two year period. This report will cover the construction process and construction costs.

2.0 DESIGN

2.1 MATERIALS

The materials for the two-rail steel-backed timber guardrail will be broken down into materials used for the: rail, posts, and the hardware.

The material used for the rail consisted of both wood and steel. The wood used for the railing was a Douglas-fir 4″ × 8″ (nominal) select structural plank (Figure 2.1). To guard against decay by organisms and insects, the wood was pressure treated with ammoniacal copper zinc arsenate (ACZA) to a retention of 0.40 lbs/ft^3. The backing material was fabricated from a ⅜″ thick × 7″ wide galvanized steel plate that ran the length of the Douglas-fir rail.

The posts were also fabricated from ACZA pressure treated Douglas-fir, but were cut from 8″ × 10″s (nominal). Two different lengths of posts were used in the project. When the back slope was relatively flat, a 6′-6″ post was used. If the back slope was steep, an 8′-0″ post was used to give additional resistance.

The purpose of the hardware was to fasten the railing to the posts. The material used for the hardware was galvanized steel. A list of the hardware used, as shown in Figure 2.1, follows:

⅜″ × 7″ × 3′-2″ splice plates used to fasted two rails together end to end.

1″ diameter × 6″ long carriage bolts with hex nut and washer used to connect the rail to the steel backing and splice plate.

⅝″ diameter × 2-½″ long lag screws used to fasten the wood rail to the steel backing.

⅝″ diameter × 10″ long bolt with hex nut and 4″ × 4″ × ¼″ plate washer used to connect the splice plate to the posts.

⅝″ diameter × 14″ long bolt with hex nut and 4″ × 4″ × ¼″ plate washer used to connect the rail and backing to the posts where no splice was present.

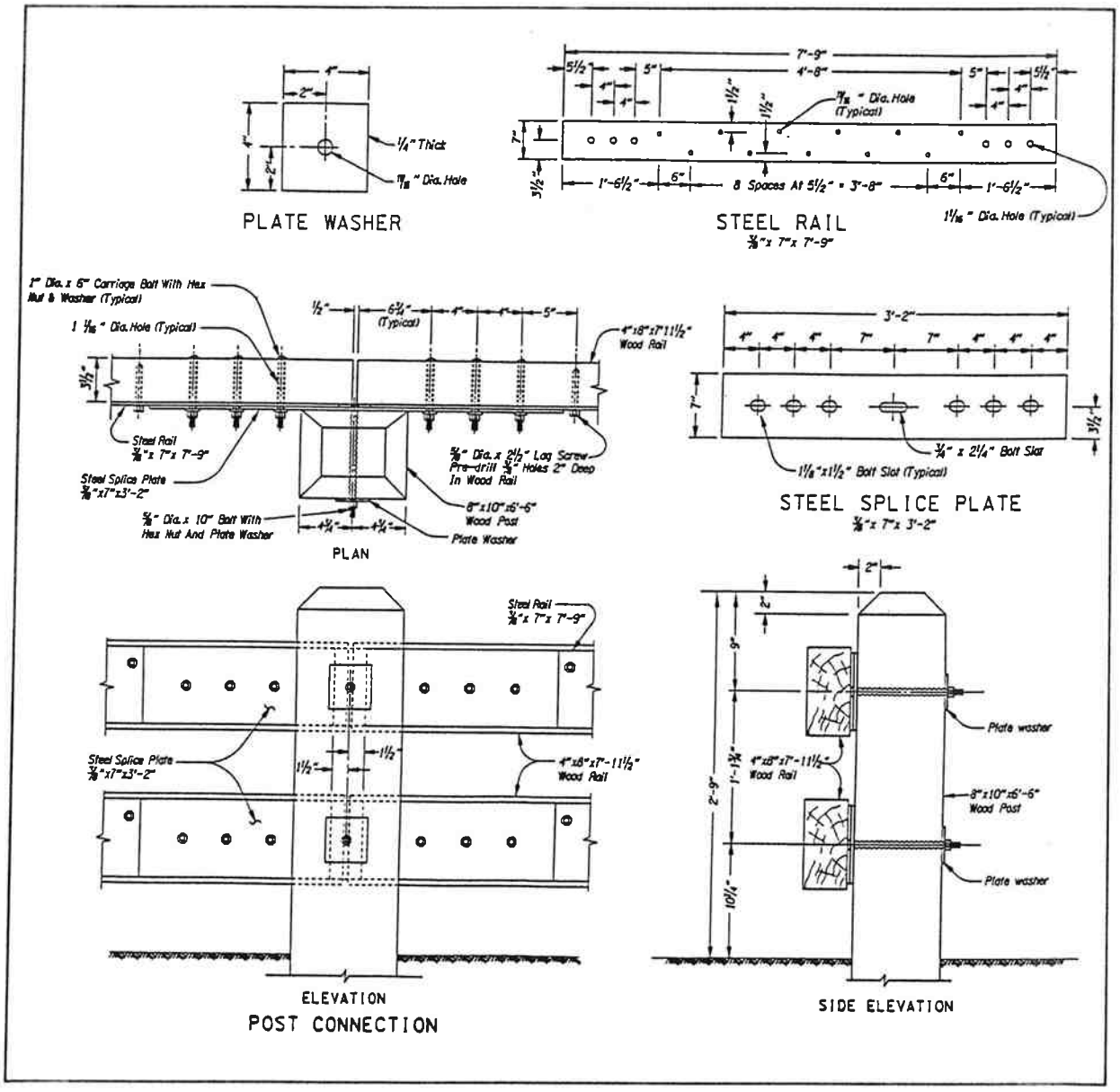

Figure 2.1: Two-Rail Steel-Backed Timber Guardrail Connection

2.2 SPECIFICATIONS

The plans called for the guardrail posts to be spaced at 8-foot intervals on center for the majority of the length. Terminal points required different spacings (Figure 2.2), depending on circumstances. The posts were placed so that a 2′-9″ section was exposed to allow the rails to be fastened (Figure 2.1).

The guardrail design was such that the Douglas-fir rails were reinforced, or backed, with the ⅜″ thick galvanized steel backing. The steel backing was fastened to the wood rail with a series of lag screws along the center section. The end sections of the steel backing were fastened to the wood rail and steel splice plates with the 1″ diameter × 6″ long carriage bolts (Figure 2.1).

The plans called for the guardrails to be fastened to the posts by passing a ⅝″ diameter × 10″ bolts through the steel splice plate and post. The 4″ × 4″ × ¼″ plate washer would be placed between the nut of the bolt and the wooden post. The rails would be placed at heights of 10-¼″ and 24″ along the length of the guardrail system (Figure 2.1).

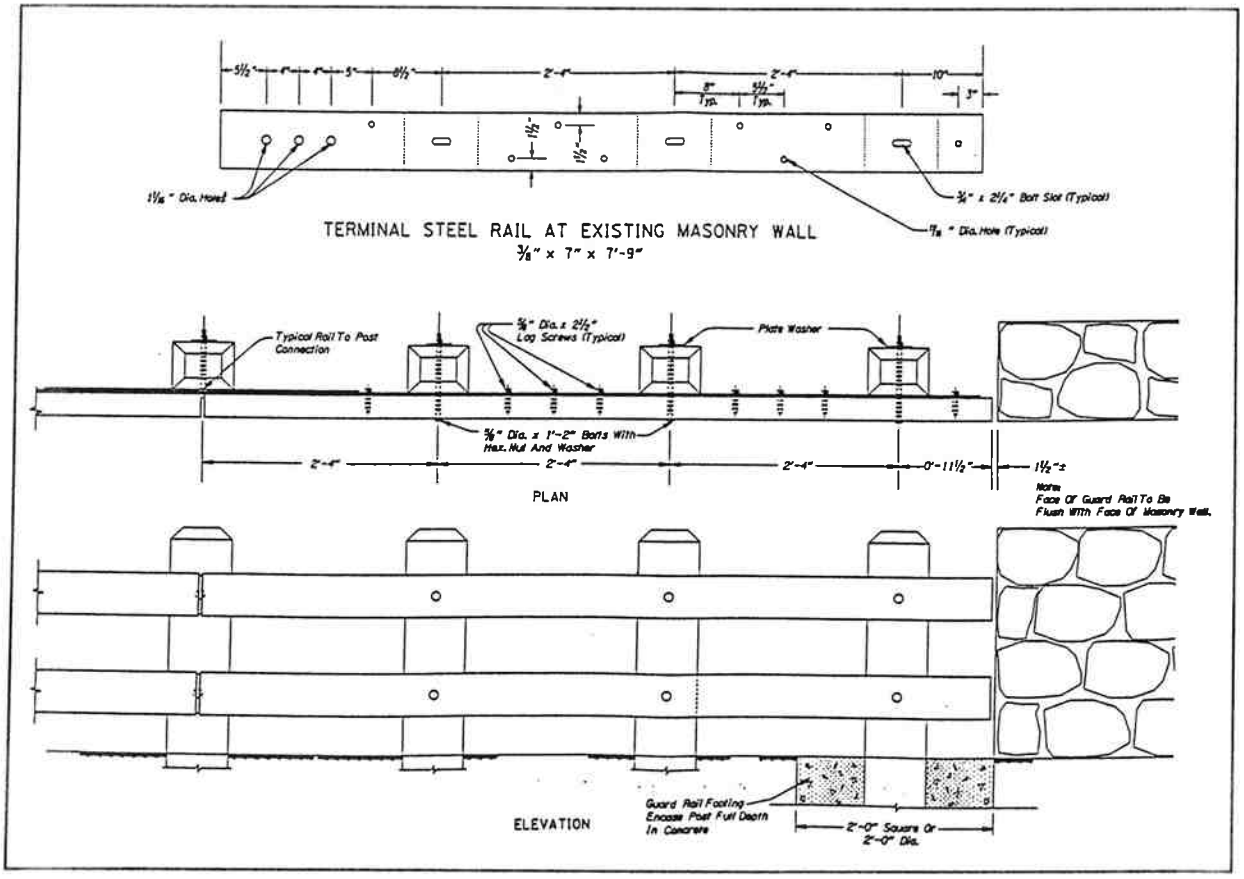

Figure 2.2: Terminal wood rail at existing masonary wall

3.0 CONSTRUCTION

3.1 CONSTRUCTION SUMMARY

Dirt and Aggregate, Inc. removed the old guardrail along the Crown Point Highway from Women's Forum Park to approximately 0.3 mile from the Crown Point Vista House. The contractor then proceeded with the installation of the two-rail steel-backed timber guardrail.

The installation of the guardrail went smoothly and was completed with few delays.

The posts and railings for the guardrail were treated with ACZA and air dried for a period of 30 days prior to use. The white paint (Acrilite Latex 7000 from Miller Paint) used for the guardrail was pre-approved and found to be compatible with the type of preservative used. The contractor applied a prime coat of paint to the wood prior to installation. After the guardrail was installed, a second coat of paint was applied.

3.2 CONSTRUCTION OUTLINE

Work Started: 3-3-92
Work Ended: 3-12-92
Contractor: Dirt and Aggregate Interchange, Inc.
Project Manager: Robert Heard
Inspector: Raydel Killgore

Construction Problems and Solutions:

Problem: The contractor used an auger to drill a hole between two sections of a mason wall to install a guardrail post. The mason wall separated near the hole and the end piece started to fall down the hill (Figure 3.1).

Solution: The contractor wrapped a chain around the fallen section to hold it in place. While it was secured, a mason placed concrete underneath it to act as a footing.

Problem: The ACZA was leaching out of the Douglas-fir, and the posts and rails turned a blue-green color (Figure 3.2).

Solution: To try and cover the discoloration, a second coat of paint was applied to the entire guardrail system, and a third coat was applied to approximately 2000′ of the guardrail. This, however, did not solve the problem. The guardrail still has a discoloration problem.

Figure 3.1: Repaired mason wall with new concrete footings

Figure 3.2: Discoloration of the painted wood as a result of the ACZA leaching out

4.0 EVALUATION

4.1 COSTS

The two-rail steel-backed timber guardrail had a cost $41.00/linear foot for 2906 feet, for a total bid price of $119,146. If a Type 2A guardrail was installed instead, the cost would have been approximately $11.00/linear foot, for a total of about $32,000. The timber guardrail was therefore over 3-½ times more expensive than the traditional guardrail.

Much of the added costs arise from the additional labor required to install the timber guardrail. The posts sizes are larger for the timber guardrail (8″ × 10″ nominal) than the Type 2A guardrail (6″ × 8″ nominal). The current equipment used to drive in guardrail posts are not set up to handle the size of the two-rail steel-backed timber guardrail posts. Therefore, each post must be installed in a previously augured hole and filled.

There are also added costs from the labor and materials used to attach the guardrail to the posts. Each rail must be attached to the steel-backing with eleven lag screws; then attached to the splice plate with three bolts, washers and nuts at each end; and finally attached to the posts with a bolt, plate washer and nut. This is a time consuming process which adds extra costs.

4.2 INSTALLATION

Even though more time was required to install the two-rail steel-backed timber guardrail, there were few complications. It appears to be well designed and went together nicely.

4.3 SITE VISIT

The site was visited on August 11, 1992, five months after installation was completed. In addition to the discoloration that occurred from the preservative leaching out, there was a problem with hardware corrosion and paint peeling.

Figure 4.1 shows corrosion of the hardware that was typical throughout the length of the guardrail. One of the sections of the guardrail has 58 guardrail posts, of which 37 (64%) had visible signs of the galvanized steel corroding. This appeared to be a good representation of the entire guardrail. I believe this is a direct result of the leaching preservative attacking the galvanized steel hardware.

Figure 4.1: Corroded hardware in contact with ACZA

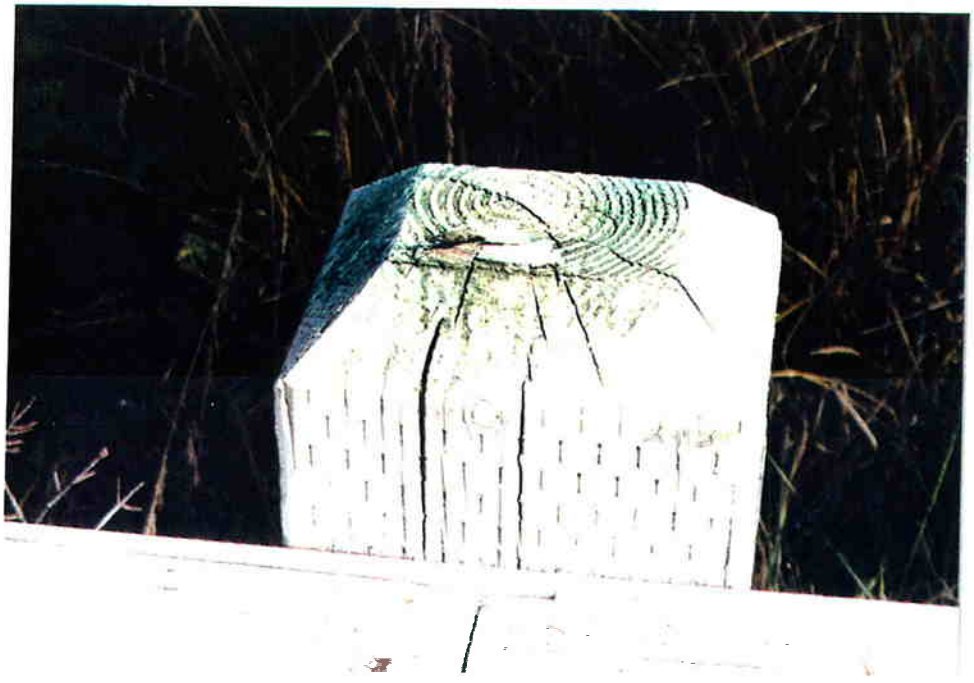

Figure 4.2: End grain of a typical post showing paint flaking and peeling off

Figure 4.2 shows the end grain section of a guardrail post. The photo shows the prominent discoloration and the flaking and peeling of the paint, which occurred mainly on the tops of the posts, where the preservative did the majority of leaching.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

- The two-rail steel-backed timber guardrail was installed on Crown Point Highway (Highway 125) with few delays.

- The intent of the project to install an aesthetically pleasing alternative to the standard steel guardrail system was not met. The guardrail system has the wood preservative ACZA leaching out and discoloring and peeling the paint.

- Although the fabrication of the two-rail steel-backed timber guardrail is more time consuming than the standard steel guardrail, it was assembled with few delays.

- The two-rail steel-backed timber guardrail was more expensive to install than a comparable Type 2A guardrail.

5.2 RECOMMENDATIONS

- To achieve a more aesthetic look, the wood should be left unpainted. The pressure treatment alone should be sufficient to avoid decay from microorganisms and attack from insects. This will solve the problem of the preservative leaching out through the paint, and give the guardrail a natural wood look that would better suit the surrounding environment.

- The leaching of the preservative should still be corrected to stop the corrosive reactions with the galvanized steel, and environmental concerns. The wood should be kiln dried rather than air dried after it is removed from the pressure treatment vessel.

- To help reduce installation costs, standard post sizes should be considered. Reducing the spacing between posts and using a 6″ × 8″ (nominal) will allow the contractor to use available equipment to drive the posts. This would be more efficient than auguring a hole, placing the post, and filling in around the post. For safety considerations, this should be crash tested before implementation.

6.0 REFERENCES

1. Bligh, R.P. and Bullard, L. **Analysis and Testing of Oregon DOT Steel-Backed Timber Guardrail, Report RF 7161-1F.** Texas Transportation Institute. The Texas A&M Univ. System, College Station, TX. March, 1991.

2. Michie, J.D. "Recommended Procedure for the Safety Performance Evaluation of Highway Appurtenances", National Cooperative Highway Research Program, Report 230. Transportation Research Board. Washington, D.C., March 1981.