Transportation Pooled Fund Program

Study No. 405160-12
September 2010

Roadside Safety Pooled Fund

TPF-5(114)
Roadside Safety
Research Program
Pooled Fund Study

Steel Posts over Underground Structures

INTRODUCTION

For guardrail installations across low-fill culverts, small structures, or underground obstructions where proper post embedment cannot be achieved, either long span guardrail or steel post over underground structures similar to the details shown in Figure 1 are desirable.

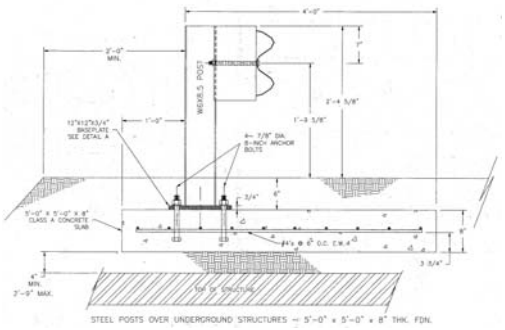
If deflection tolerance is limited due to existing tight lateral restrictions, the steel post over underground structures detail can be specified. However, there has been no physical crash testing of this system according to National Cooperative Highway Research Program (NCHRP) *Report 350* Test Level 3 requirements. Moment slabs can become an expensive alternative to most local municipalities that might use a detail such as the one shown above. Therefore, there is a need for a more cost effective design for this situation.

The objective of this study is to develop a steel post design utilizing a shallow moment slab for Type 2 strong post guardrail that can be placed over low-fill culverts or other buried structures where low deflection limits apply. This system would be crash tested and meet the minimum requirements for *NCHRP Report 350* requirements, Test Level 3. It would be a viable alternative for supporting a guardrail post where shallow underground obstruction(s) exist. It would save cost compared to a larger moment slab supporting several guardrail posts.

RESEARCH METHODOLOGY

Engineering analyses have been performed on several design options. These options have been submitted to the state technical representative for review and approval. The state technical representative has sent these options to the supporting state members in the pooled fund for review and approval.

Several design options were analyzed. One option utilizing a 5 ft x 5 ft square footing was recommended for full scale testing. Details of this design are presented as follows. Depending on the performance of this design, a 4 ft x 4 ft square footing is a testing option.



5 ft x 5 ft Footing Cross Section

TEST ARTICLE

Two W6x8.5 guardrail posts were anchored to two simulated concrete footings of different sizes. One footing measured 4 ft x 4 ft in plan and the second footing measured 5 ft x 5 ft in plan. Both footings were 8 inches thick. Both footings were reinforced with a single layer of reinforcing steel spaced on 6 inch centers in both the transverse and longitudinal directions. A 6 inch layer of compacted soil was placed on top of the footings. The W6x8.5 posts were welded to 12 inch x 12 inch x 3/4-inch thick base plates and anchored to the 8-inch thick concrete footings with four 7/8-inch diameter A325 bolts cast within the footings. These anchor bolts were 8-1/2 inches in length and were embedded a minimum of 6 inches into the footings. Concrete compressive strengths tests performed on samples of the footing concrete on the day the tests were performed yielded an average compressive strength of 3669 psi.

PARTICIPATING PARTNERS:

Alaska Department of Transportation & Public Facilities

California Department of Transportation

Louisiana Department of Transportation and Development

Minnesota Department of Transportation

Pennsylvania Department of Transportation

Tennessee Department of Transportation

Texas Department of Transportation

Washington State Department of Transportation

Federal Highway Administration

Texas Transportation Institute

CONTACT INFORMATION:

Dave Olson, Chair
Washington DOT
Policy, Standards and Safety Res.
P.O. Box 47372
Olympia, WA 98504-7372
(360) 705-7952
Olsonda@wsdot.wa.gov

D. Lance, Bullard, Jr., P.E.
Roadside Safety & Physical Security Division
Texas Transportation Institute
TAMU 3135
College Station, TX 77843-3135
(979) 845-6153
l-bullard@tamu.edu

Roadside Safety Pooled Fund

www.roadsidepooledfund.org

Steel Post before Test P1

Steel Post after Test P1

Steel Post before Test P2

Steel Post after Test P2

CONCLUSIONS

Full-scale pendulum tests were performed on the two footing designs. The 5 ft x 5 ft footing rotated approximately 6 degrees resulting in a dynamic rotation of the post of approximately 30 degrees from the impact. The 4 ft x 4 ft footing rotated approximately 15 degrees from the pendulum impact. The dynamic rotation of the posts for the 5 ft x 5 ft footing was in excess of 30 degrees. These tests were performed in the strong axis direction of the posts. Plastic failure occurred in the W6x8.5 steel posts for both designs tested. No distress was observed in the anchor bolts or concrete for both tests.

Full scale crash testing was performed on a w-beam guardrail system using W6x9 anchored posts to a simulated concrete box culvert for the Washington State Pooled Fund Project 405160-5. For this project, 9 inches of fill was used atop the simulated box culvert slab. Based on the results from the full-scale crash test, the pickup was contained and redirected. The test met the requirements of *NCHRP Report 350* requirements for Test Designation 3-11. A comparison was made to the performance of the W6x9 anchored post attached to the top of the simulated box culvert and the W6x8.5 posts tested for this project. The maximum angle of rotation in the strong axis direction of the posts in the immediate impact areas was approximately 24 degrees. This matches closely to what was observed in Test P1. However, the W6x8.5 posts anchored to the simulated box culvert in the crash test were subjected to weak axis bending thus making it difficult to compare with the two posts tested for this project.

Considering the comparison in performance between the W6x9 posts in the box culvert guardrail crash test and the W6x8.5 post anchored to the 5 ft x 5 ft footing, the 5 ft x 5 ft footing design tested herein with anchored W6x8.5 steel post appears to be suitable for use in instances where single posts are located over underground structures. A full scale crash test should be performed to validate the use of the shallow footing for cases where multiple posts are supported on shallow footings due to underground structures/obstructions.

FOR MORE INFORMATION:

TTI Research Supervisor:
William F. Williams
w-williams@tamu.edu

Pooled Fund Technical Rep.
William Longstreet
Pennsylvania
Department of Transportation
will.longstreet@dot.gov

Technical Memo

Roadside Safety Pooled Fund

Visit our website at:
www.roadsidepooledfund.org