Transportation Pooled Fund Program

Study No. 405160-13
November 2009

Roadside Safety Pooled Fund

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

Single Slope Barrier in Front of 1.5H:1V Slope

INTRODUCTION

The objective of this research was to restrict lateral deflection of a concrete barrier when placed adjacent to slopes as steep as 1.5H:1V or on top of Mechanically Stabilized Earth (MSE) walls, without using a concrete moment slab. The final design was required to incorporate 20-ft long single slope barrier segments with grouted rebar grid connection. The design was required to meet Test Level 3 (TL-3) requirements of *MASH*.

DESIGN AND ANALYSIS

The performance of a single slope barrier with grouted rebar-grid connection was not known in a free-standing condition. The researchers first evaluated the performance of the barrier in a free-standing condition using a combination of smaller scale bogie impact test and simulation analysis. It was determined that the free standing single slope barrier with the grouted rebar-grid slot connection cannot provide adequate lateral resistance to allow its use adjacent to 1.5H:1V slopes or on MSE walls. Simulation results indicated that the free-standing barrier is likely to result in a lateral deflection of greater than 30 inches, which was significantly more than the desired deflection for this research.

The researchers then evaluated restraining the single slope barrier by embedding it 10 inches in soil. Another series of bogie tests and simulation analysis was performed and it was determined that the lateral deflection of the barrier was significantly reduced. Based on the results of the analysis, it was recommended that a crash test be performed with the barrier embedded 10 inches in soil.

Single-Slope Barrier in Front of 1.5H:1V Slope

CRASH TESTING

A 100-ft installation of the 42-inch tall single slope barrier was embedded 10 inches in soil as shown above. The effective height of the barrier was thus reduced to 32 inches due to the 10 inch embedment. The barrier was placed at a 2-ft lateral offset from the 1.5H:1V slope break point of the soil embankment. The concrete barrier was comprised of five 20-ft long barrier segments that were connected using the grouted rebar-grid connection. The embedded barrier was crash tested using *MASH* TL-3 criteria.

A 2270P vehicle, traveling at an impact speed of 63.1 mi/h, impacted the single-slope barrier at an angle of 24.2 degrees. The barrier successfully contained and redirected the vehicle. The vehicle did not penetrate, underride, or override the installation.

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

(CONTINUED)

Maximum dynamic and static deflections of the barrier during the test were 5.6 inches and 5.5 inches, respectively. No detached elements, fragments, or other debris were present to penetrate or show potential to penetrate the occupant compartment, or to present undue hazard to others in the area.

Maximum occupant compartment deformation of the vehicle was 5.5 inches. The vehicle remained upright during and after the collision event. Maximum roll angle was 44 degrees. Occupant risk factors were within the limits specified in *MASH*. The vehicle also remained within the exit box.

The embedded single-slope barrier in front of 1.5H:1V slope performed acceptably according to the requirements of *MASH*

The embedded barrier application developed in this research is expected to result in significant cost savings for the user transportation agencies. The benefit of this application comes from the elimination of the use of a moment slab to restrict lateral barrier deflection. The cost of constructing and installing the single slope barrier with a moment slab is typically $375 per linear foot (based on recent bids received by Washington State Department of Transportation). The cost of constructing and installing the embedded single slope barrier on the other hand is approximately $75 per linear foot (based on test article construction in this research). This implies a cost saving of nearly 80%.

While there are certain metal guardrail designs approved for use adjacent to steep slopes, a significant advantage of using the embedded concrete barrier comes from the low maintenance required in the event of a vehicle impact. Due to a small lateral barrier deflection of 5.5 inches, the barrier is expected to require little or no maintenance after most impacts. This can be very advantageous to user agencies with mountainous areas, where steep slopes and narrow shoulder widths make repairs difficult, costly, and increase crew exposure to traffic.

Due to the small lateral deflection upon vehicle impact, the embedded concrete barrier application developed in this research can also be used on top of MSE walls.

Barrier after Test

Test Vehicle after Test

VIDEO ACCESS:

Real-Time Panned View
Real-Time Rear View
High-Speed Digital Down the Gut View
High-Speed Film Down the Gut View
High-Speed Overhead View
High-Speed Film Rear View
High-Speed Digital Rear View

Final Report Access

FOR MORE INFORMATION:

TTI Research Supervisor:
Nauman M. Sheikh
nauman@tamu.edu

Pooled Fund Technical Rep.:
Dave Olson
Washington State
Department of Transportation
Olsonda@wsdot.wa.gov

Roadside Safety Pooled Fund

Visit our website at:
www.roadsidepooledfund.org