Texas A&M Transportation Institute

Texas Department of Transportation

PROJECT SUMMARY REPORT

0-7087: Develop Standards for Temporary Concrete Median Barrier in Flood-Prone Areas

Background

Portable concrete barriers are commonly used as temporary positive protection in work zone applications to shield motorists from hazards in the work zone and protect workers from errant vehicles. The barriers are also used in permanent applications as a median barrier to mitigate serious cross-median crashes by preventing penetration of errant vehicles into oncoming traffic. When implemented in flood-prone areas, the solid nature of these portable concrete barriers can act as a dam to floodwaters, as seen in Texas during Hurricane Harvey. This damming effect can raise the height of floodwaters and increase the severity of flooding on highways and surrounding roads and in communities. Floodwaters can also push long lengths of free-standing portable concrete barriers across multiple lanes of a freeway, effectively closing the facility until the barrier can be disconnected and reinstalled or transported off site.

The objective of this project was to develop a hydraulically efficient portable concrete barrier (PCB) that complies with the American Association of State Highway and Transportation Officials *Manual for Assessing Safety Hardware* (*MASH*).

What the Researchers Did

Researchers developed a new PCB with large openings (i.e., drainage scuppers) to help mitigate the effects and consequences of severe flooding on a roadway and the adjacent community. Various design concepts were developed with consideration of current PCB profiles, segment lengths, and connection types used in Texas. The project panel selected a single-slope barrier concept with one large, centrally located drainage scupper in each 30-ft segment for further development and evaluation.

Large-scale hydraulic testing was performed to determine the hydraulic efficiency of the PCB with scupper. A scaled model of a barrier segment was designed and installed in a concrete channel for hydraulic testing. The test results were used to generate a rating curve for the barrier to explain its hydraulic efficiency. Velocity profiles were created to describe the water flow through the scuppers. Strain gages were used to determine the force acting on the barrier at various locations at different flow rates.

Finite element simulations were performed to evaluate the impact behavior of the proposed design options in a predictive manner following *MASH* impact conditions. Finite element models

Research Performed by:
Texas A&M Transportation Institute

Research Supervisor:
Roger Bligh, TTI

Researchers:
Chiara Silvestri-Dobrovolny, TTI
Blair A. Johnson, The University of Texas at Austin (UT)
Michael E. Barrett, UT
James Holyoke, UT
Greg Hendrickson, UT
Aniruddha Zalani, TTI

Project Completed:
10-31-2023

of the single-slope barrier with large drainage scupper were developed for two different segment connection types. Data were extracted from the simulations to evaluate *MASH* criteria, including occupant risk and vehicle stability. Prototypes of the selected 42-inch-tall single-slope PCB with large scupper and X-bolt connections were fabricated for full-scale crash testing. The scupper was 12 inches tall and 18 ft long and was centered within the barrier segment. The ends of the scupper were tapered to reduce vehicle snagging during an impact. Full-scale crash tests were performed in accordance with *MASH* Test Level 4 (TL-4) conditions.

What They Found

Data from the hydraulic testing indicated a significant increase in both upstream water depth and flow rate when the flow transitioned from Type 1 to Type 2. The velocity through the scupper of the hydraulically efficient PCB was much larger than the flow velocity just upstream of the barrier, which means the flow velocity significantly increased when the flow was forced through the scupper opening. The barrier was susceptible to sliding or overturning when the upstream water depth was greater than half of the barrier height.

Predictive finite element simulations indicated that the single-slope profile PCB with a large scupper should satisfy *MASH* TL-4 impact performance criteria. Subsequent full-scale crash testing verified that the new hydraulically efficient PCB is *MASH* TL-4 compliant.

What This Means

A single-slope PCB with large scupper was successfully developed and crash tested following *MASH* TL-4 criteria. The new hydraulically efficient barrier, shown in Figure 1, is designed to mitigate roadway flooding and damming effects that can occur with solid-profile concrete barrier systems. The barrier can be implemented in areas susceptible to flooding to help alleviate the consequences of severe flooding and decrease risk to motorists.

Figure 1. Hydraulically Efficient Single-Slope Portable Concrete Barrier.

For More Information

Project Manager:
Darrin Jensen, TxDOT, (512) 783-5388

Research Supervisor:
Roger Bligh, TTI, (979) 317-2703

Project Monitoring Committee Members:
Ken Mora, Rose Marie Klee, Abderrahmane Maamar-Tayeb, Taya Retterer, John Riley, Adam Jack, and Prassana Chebbi

Research and Technology Implementation Office
Texas Department of Transportation
125 E. 11th Street
Austin, TX 78701-2483

www.txdot.gov
Keyword: Research

Technical reports when published are available at **http://library.ctr.utexas.edu**.