Tech Brief

October 2017

Shielding Roadside Bridge Substructure

CATEGORY: Design

ISSUE: Because bridge piers or columns are oftentimes the most significant fixed object along a particular section of roadway, it is usually necessary to shield them with appropriate traffic barriers. However, a one-design-fits-all is not practical because the actual type of pier, its lateral offset from the traffic lanes, and site topography are not a constant. The question that DOTs must answer: What is the most cost-effective way to shield these features?

OBJECTIVE: To provide DOTs with general guidelines for procedures they can adopt for optimal shielding of bridge piers at any site condition.

METHODOLOGY: Use information from the 2011 Edition of the AASHTO Roadside Design Guide (RDG) to identify, discuss, and illustrate design parameters to effectively shield the piers/columns.

GENERAL: As with all barrier installations, the first question a DOT must ask is whether shielding is required. Some agencies do not use barriers when the piers or columns are beyond the design clear zone for the highway —most often for high-speed roadways, most typically 30 feet. In photograph A, the piers are well beyond that distance and the flat median slope provides an adequate recovery area. In photograph B, the piers are much closer to the roadway and the median has a shallow V-shape cross section, which makes it more likely that an encroaching vehicle may reach them —even though the piers may be beyond the 30 ft clear zone. The roadway in photograph C has far less traffic than the Interstate facilities, but the proximity of the piers to the travelled way would generally require shielding—to protect the motorists and the structure itself. In photograph D, the guardrail is installed ineffectively in relation to the bridge piers and may not even be required since the piers are located on a cut slope and appear well beyond the clear zone.

A

B

C

D

U.S. Department of Transportation
Federal Highway Administration

ARTBA American Road & Transportation Builders Association

KLS Engineering

Safe Roads for a Safer Future
Investment in roadway safety saves lives

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EXPECTED RESULTS:

Provide safety design engineers with general guidance for effectively shielding bridge piers from various classes of highway vehicles

If a traffic barrier is warranted, then the DOT has numerous options available, depending on the pier design and location. Regardless of which type of shielding is selected, an effective design must satisfy three primary criteria: length of need (LON), placement on a slope, and design deflection.

The guardrail in photograph E probably satisfies the length determined by the LON procedure, but it may not be long enough to intercept a vehicle approaching up the swale at high speed. A better solution could be the guardrail envelope shown in photograph F, which effectively shields the median piers for all approaches (ignore the cable barrier). In photograph G, the guardrail is too close to the concrete piers to prevent pocketing/snagging in a high-speed, high-angle impact.

E

F

G

The barriers shown above are designed for and intended to shield motorists in passenger-type vehicles. If there is a concern for trucks and buses, then a metal-beam barrier is generally inadequate to shield a bridge pier effectively and most DOTs use a concrete barrier, as photograph H shows. DOTs most often specify rigid concrete barriers for this application (i.e., New Jersey Shape, F-Shape, Single/ Constant Slope, and vertical wall barriers). A major consideration with all of these concrete barriers is not that a truck will necessarily penetrate upon impact, but that the resultant roll angle would allow the truck cab or its cargo bed to extend beyond the face of the barrier where it could then strike the bridge piers. The 2011 AASHTO RDG Section 5.5.2, "Barrier Deflection Characteristics," currently provides information on this zone of intrusion (ZOI), which generally extends 24 inches beyond the traffic barrier face of most TL-3 barriers, but as much as 34 or 80 inches for the cab and cargo box, respectively, for a TL-4 barrier up to 42 inches tall. If a barrier must be placed directly in front of a pier (photograph I), then the designer may select a vertical wall to limit the roll; in this case the vertical wall is at a height of 54 inches. The RDG repeats the AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications recommendations for barrier height/offset combinations. These guidelines call for a 42-inch high structural barrier if offset more than 10 feet from the pier or a 54-inch high structural barrier if offset 10 feet or less from the pier. The LRFD, however, does not address how far the increased height should extend upstream from the pier. Until further guidance is developed, states should develop their own standards for pier protection; photographs J and K provide two examples of state-specific designs. In addition, some states suggest the same criteria be applied at overhead sign structures as well. An ongoing research project (NCHRP 12-90: Protection of Bridge Piers http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3170) is intended to develop risk-based guidelines that quantify when bridge piers should be designed for collision forces (as per the AASHTO LRFD Bridge Design Specifications) or shielded with a longitudinal barrier.

H

I

J

K