Midwest States Pooled Fund Program Consulting Quarterly Summary

Midwest Roadside Safety Facility

04-01-2005 to 07-01-2005

Type F Barrier Height Transitions

Question

State: MO
Date: 04-13-2005

There has been a question raised about the concrete height transitions that are connected to the temporary type F barriers. MoDOT is using and has used a 20-foot long concrete height transition for at least 6-8 years. Located on page 3 of 6 at the attached email address
http://www.modot.org/business/standards_and_specs/documents/61720b.pdf

We use the transition for road ways where the posted speeds are less than 35 mph. Other states use a 12.5-foot long concrete height transition. There are two questions:
1. Are there any concerns between the two different transition lengths of 12.5 and 20 feet?
2. Has the height transitions been crash tested at the lower speeds and how did they perform? If not, are there any approved crashed tested concrete height transitions?

Response

Date: 04-21-2005
Question #1:
Although the full-scale vehicle crash testing program was conducted on the approximately 20-ft long sloped segments, HVOSM computer simulation modeling was also performed on the conventional sloped end treatment. Several small car simulation results were provided based on impact angle, impact speed, and impact location.
For end on impacts, the simulation results showed that vehicle overturn was likely at the 30, 37, and 45 mph speeds for taper lengths of 10 and 15 ft. For 20 and 25 ft length, vehicle rollover was only predicted at 45 mph and with the 20 ft long sloped end.
For oblique impacts (15 degrees), vehicle rollover was not predicted for the 20 and 25 ft section lengths and at any of the three speeds.
For oblique impacts (30 degrees), vehicle rollover was predicted for the 10, 15, 20, and 25 ft section lengths and at all three speeds.
The TTI researchers recommended the use of 20 ft sloped sections over 25 ft sloped sections due to the insignificant benefit observed with using 25% longer section. The longer lengths were also noted to provide measurable improvement over the shorter segment lengths.
Question #2:

Six full-scale vehicle crash tests were conducted to evaluate two sloped end treatment configurations, as report in NCHRP Report No. 358. A conventional sloped end treatment and the New York sloped end treatment were evaluated. The CSET was 20 ft long while the NYSET was 19-ft 11 1/2-in. long. The sloped end treatments were anchored along their length during the test program.

The CSET was evaluated with three tests:

(a) small car impacting end at 45 mph and 0 degrees with left wheels aligned on barrier centerline - marginal stability observed - overturn possibly adverted by steel guide flag attached to front wheel assembly [test 8]

(b) small car impacting 2 ft from end at 45 mph and 30 degrees with left wheel contacting side slope - vehicle overturn - failure [test 9]

(c) small car impacting 2 ft from end at 30 mph and 30 degrees with left wheel contacting side slope - vehicle overturn - failure [test11]

The NYSET was evaluated with three tests:

(a) small car impacting end at 45 mph and 0 degrees with left wheels aligned on barrier centerline - marginal stability observed - overturn possibly adverted by steel guide flag attached to front wheel assembly [test 5]

(b) small car impacting 2 ft from end at 45 mph and 30 degrees with left wheel contacting side slope - vehicle overturn - failure [test 6]

(c) small car impacting 2 ft from end at 30 mph and 30 degrees with left wheel contacting side slope - vehicle overturn - failure [test12]

As shown above, crash tests have been performed on 20-ft long, anchored sloped end treatments with small cars. At 45 mph. end-on impacts were mariginal. For oblique impacts at 30 and 45 mph, test results were unsuccessful with vehicle rollover observed.

No crash testing on concrete sloped end treatments has been performed to date in accordance with the NCHRP Report No. 350 requirements. However, the end-on impact would likely qualify as one of the TL-2 test conditions.

Concrete Barrier Orientation

Question

State: OH
Date: 05-10-2005

A question came up already this morning about the orientation of concrete barriers on superelevated roadsides. One thought is that they are installed vertical with respect to a flat surface, while the other thought is they should be rotated so that the vertical axis is perpendicular to the slope of the roadway.

A 1997 NHI course "Design and Construction of Highway Safety Features and Appurtenances" (section 4.1.7) states that "...when CSS barriers are installed on superelevated curves, the preferred orientation is for barrier on the high side f the curve to be installed with its axis perpendicular to the roadway, and on the low side of the curve with the axis vertical."

I say this recommendation still applies, and it also applies to the single slope design. But, I've been requested to ask you whether or not this recommendation still applies, and more specifically, if it also applies to the single slope barrier shape. What are your opinions on this?

Response

Date: 05-10-2005
In the early 1980's, Maurice Bronstad, et al, formerly of Southwest Research Institute, conducted a series of full-scale vehicle crash tests on three curved bridge railing configurations using three different test vehicles. The report references are as follows:
(1)Bronstad, M.E. and Kimball, C.E., Jr.,*Bridge Rail Retrofit for Curved Structures - Volume I: Executive Summary*, Report No. FHWA/RD-85/040, Final Report Prepared for the Offices of Research and Development, Federal Highway Administration, Washington, D.C., September 1986.
(2)Bronstad, M.E. and Kimball, C.E., Jr.,*Bridge Rail Retrofit for Curved Structures - Volume 2: Technical Report*, Report No. FHWA/RD-81/, Final Report Prepared for the Offices of Research and Development, Federal Highway Administration, Washington, D.C., June 1981.
The three test vehicles included an 1,800-lb mini-compact car, a 2,250-lb subcompact car, and a 20,000-lb school bus. All crash tests were performed at the target impact conditions of 40 mph and 15 degrees.
The three bridge railing configurations included:
(1) aNew Jersey concrete safety shape bridge installed**vertical** to a super-elevated bridge deck surface,
(2) aNew Jersey concrete safety shape bridge installed**perpendicular** to a super-elevated bridge deck surface, and
(3) a tubular thrie beam/collapsing tube retrofit bridge railing installed **perpendicular** to a super-elevated bridge deck surface.
The results and conclusions are as follows:
All three barrier systems contained and redirected the full range of test vehicles. In terms of stability and acceleration, the tubular thrie beam retrofit with a more vertical front face was superior but installed perpendicular to the superelevated deck.

For the safety shape testing, there was not a dramatic difference in performance for the two safety shape orientations. The preferred orientation, as determined from a 1976 concrete median barrier research program and from the later research results noted above, was to place the barrier perpendicular to the superelevation when the vehicle approach is up the superelevation. It was noted that vehicle climb was reduced by this preferred orientation in the car tests although only in the bus test was this significant. The authors stated that the school bus test was noticeably less severe in terms of vehicle redirection with the preferred perpendicular orientation. It was also observed that the small car was at the threshold of riding on top of the barrier for the barrier placed vertical to the earth and not perpendicular to the superelevated deck.

Finally, for barriers placed on the downside of the superelevation, I agree with the FHWA that those barriers are preferred to be placed vertical or perpendicular with respect to the earth and not with the superelevated deck.

FHWA Response:

This topic was discussed in the 1977 AASHTO Barrier Guide where it was concluded that the "optimum" orientation was vertical on the low side and perpendicular to the roadway surface on the high side. However, that Guide also indicated the best "compromise" (or practical) orientation was vertical at both locations. A vertical wall (not NJ, F-, or single slope shape) would limit vehicular climb better than any shaped design. No significant difference in crash performance between a NJ and a constant slope shape.
