

Safety Benefits of Bridge Pier Shielding

tech transfer summary

May 2009

RESEARCH PROJECT TITLE

Analysis of Safety Benefits of Shielding of Bridge Piers

SPONSORS

Iowa Department of Transportation
(InTrans Project 08-322)

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Grade separation structures with piers and abutments close to the roadway may present safety concerns for traffic passing underneath.

Objectives

- Determine whether bridge piers, abutments, and other structural support elements at bridges over state-maintained, high-speed, multilane divided roadways in Iowa need to be shielded regardless of their offset from the traveled way
- Determine the benefit-to-cost ratio for the addition of new shielding

Problem Statement

The highway system in Iowa includes many grade separation structures constructed to provide maximum safety and mobility to road users on intersecting roadways. However, these structures can present safety concerns for traffic passing underneath due to the proximity of piers and abutments to the roadway. For exposed bridge elements within the calculated clear zone, shielding for these support structures has been a design consideration for many years, with options that include w-beam guardrails, concrete retaining walls, and high-tension cable rail. However, the benefits of shielding have not always been evident.



Unshielded median bridge pier



W-beam guardrail and concrete retaining wall combination at outside pier

Research Description

After a review of the Iowa Department of Transportation bridge inventory database and the most recent seven years of crash data, the following shielding options for Iowa's grade separation structures were considered:

- Do nothing beyond current shielding
- Shield all unprotected piers on curved roadways
- Shield piers based on offset from the travel lanes
- Shield all median piers, regardless of offset
- Shield all bridge piers, regardless of offset
- Shield all two-span bridge embankments

To determine the best option for Iowa's grade separation structures, a benefit-to-cost ratio was calculated. The costs included the expenses of installing and maintaining the shielding in two speed exposures: 55mph and greater and 65 mph and greater. The benefits included the reduction in societal costs (in dollars) that would result from implementing the shielding option.

Calculating the benefits involved selecting crash reduction factors for each shielding option and the dollar amount of each crash type (as recommended by the Federal Highway Administration), as well as analyzing crash experience at Iowa's grade separation structures.



High-tension cable rail in median

Recommendations

- With few exceptions, the economic analyses did not indicate an urgent need to install shielding at a significant number of currently exposed bridge substructure elements.
- It is recommended that additional shielding only be installed on an individual basis at locations where the need is clearly warranted, perhaps based on a combination of offset, horizontal alignment, side of roadway, traffic volume, and crash history.
- Unshielded grade separation structures with a multiple-crash history at or near the bridge should be

Key Findings

- In general, but not always, benefit-to-cost ratios were slightly higher for higher speed roadways.
- Shielding bridge piers on horizontal curves would yield a benefit-to-cost ratio, for all crashes, of 3.29 (55+ mph) and 3.87 (65+ mph).
- Piers located in the median were most likely to be struck by errant vehicles. Shielding these piers, regardless of offset distance, would yield a benefit-to-cost ratio of 5.58 for fatal crashes and 1.40 for all crashes (55+ mph) and 6.30 for fatal crashes and 1.58 for all crashes (65+ mph).
- Shielding of all exposed bridge substructure elements in both the median and along the outside of divided roadways does not appear feasible: the calculated benefit-to-cost ratios are 1.48 for fatal crashes and 0.44 for all crashes (55+ mph) and 1.88 for fatal crashes and 0.52 for all crashes (65+ mph). When arbitrarily higher crash reduction factors are applied, the resulting benefit-to-cost ratios for all crashes increase to 2.22 (55+ mph) and 2.58 (65+ mph).
- Shielding exposed abutment embankments at two-span bridges would yield a very low benefit-to-cost return, well below 1.00 for all speeds.

analyzed to determine whether the existing shielding design is appropriate.

- Even if fully shielded previously, bridges with a history of crashes should be studied for possible additional safety mitigation, including improved pavement markings, retro-reflectorization of the substructure element, and installation of closely spaced delineators along frequent road departure areas.
- Currently available references for crash reduction factors are inadequate. More research is needed to develop more accurate factors for these applications.