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Performance and Analysis of Concrete Bridge Railing using Conventional and Composite Reinforcement Materials

INTRODUCTION

Since the 1920s, the American Association of State Highway and Transportation Officials (AASHTO) has provided various specifications to address the design and details of bridge railings. Dramatic changes in bridge railing specifications have been needed to adapt to the changes in the auto industry and the wide variety of vehicles present on the highways. In the 1960s, AASHTO defined the primary purpose of bridge railings as the ability to contain the average vehicle. The application of the 10-kip load was established for the design of such railings, and it remained AASHTO's primary criteria through the 1980s. Throughout the nation, multiple-fatality truck and school bus accidents involving bridge railings focused bridge engineers' attention on how closely the 10-kip load represented the real-life impact loads. The load indicator walls in the crash test sites suggested that the actual loads were in the range of 30 kips to 200 kips. In August 1986, the Federal Highway Administration (FHWA) required the full-scale crash testing of all bridge rails that were to be used on federal aid projects. In 1989, AASHTO adopted a guide specification for bridge railing. This specification was intended to be a basis for the design of prototype bridge railings that were to be crash tested. It was also intended to provide a basis for the design of one-of-a-kind bridge railing where the cost of crash test program may not be justified. The guide specification was based on a multiple performance level theory, which requires a different rail for a different situation.

In 2007, AASHTO reached a consensus that, because of the dramatic change in the traffic vehicle and vehicle geometry and the speed on the highways, the 1994 LRFD specification needed to be revised.

A report published by Texas Department of Transportation (TxDOT) recommended new design forces from different performance levels of bridge barriers. The report assessed the safety of existing barriers and recommended changes to some that failed. Concrete barriers that were assessed in that study covered cast-in-place barriers but not precast barriers. Therefore, those precast barriers should be assessed to ascertain their successful performance under the new recommended lateral, longitudinal, and vertical forces that result from an errant vehicle that collides with the barrier.

OBJECTIVE

The principal objective of this study was to assess the structural adequacy and strength of a precast concrete bridge railing section used by DOTD for the current

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national cooperative highway's (NCHRP Report 350) guidelines and for the recommended changes in the Texas study.

SCOPE

The work was divided into computational and fieldwork: the computational work consisted of assessing the ultimate capacity of the barrier, while the fieldwork dealt with subjecting the barrier to a static load to failure.

METHODOLOGY

To achieve the research objective, the research work included performing a literature search to learn about behavior of precast barriers, casting and instrumenting a barrier, computing the ultimate capacity of the barrier, field testing of the barrier, and comparing the computational and field results.

CONCLUSIONS & RECOMMENDATIONS

The major findings are as follows:

- The measured load-to-failure of the precast barrier agreed with the predicted section capacity of the barrier obtained from the analytical analysis.
- Anchorage of the tested barrier were strong enough that cracks initiated in the wall portion of the barrier and not the slab.
- The barrier test specimen failed in two different subsequent modes: torsion and breakout of anchorage detail.

The barrier failed at the middle region, and as such, testing the end region could not be performed. Based on that and until additional work is done to assess the capacity of the section at the end region, it can be concluded that the precast concrete barriers similar to the one tested in this study are not TL3 compliant and their use should be limited to conditions that qualify for TL2.

This is reserved for work zones and most local and collector roads with favorable site conditions as well as where a small number of heavy vehicles is expected and posted speeds are reduced. Speed limit in work zones is limited to 45 miles per hour.

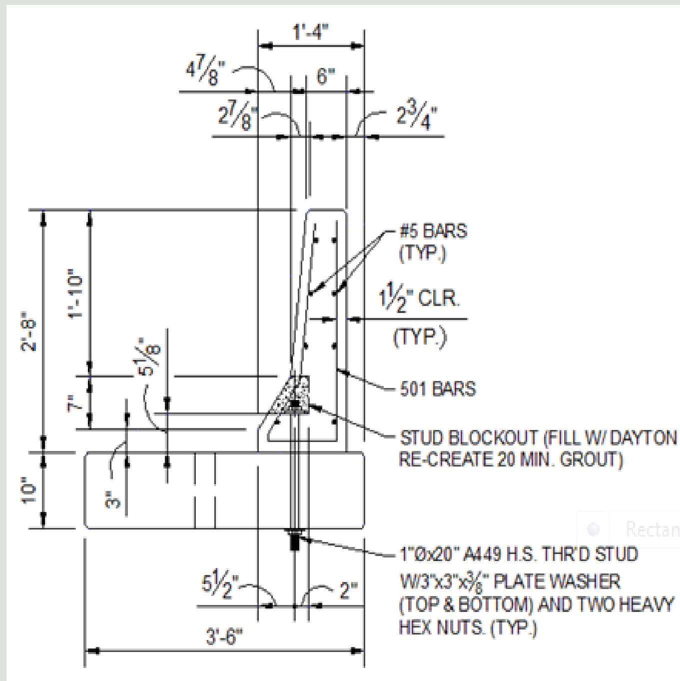

Figure 1
Cross section of tested precast concrete barrier

Figure 2
Barrier after failure