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Research Notes

Evaluating the Shear Strength of End Panels in Steel Bridge Girders

Conduct full-scale testing of 8 steel girders. The parameters include composite slab effect, end panel aspect ratio, web depth-thickness ratio, and steel grade.

Geotechnical/ Structures

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Project Title:
Improve Design Details for Steel Plate Girders

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WHAT IS THE NEED?

In California, many existing steel bridges were designed based on the previous editions of the AASHTO specifications by considering the postbuckling tension-field action for the end web panel of I-section girders. Regular legal vehicles and even heavy permit vehicles have been traveling on these bridges for many years. The current AASHTO LRFD (2009) and LRFR (2008) specifications exclude the postbuckling tension-field action for the end web panel. There are many steel girder bridges, where the end shear controls the overall bridge rating and the rating factor falls below 1.0. A rating factor less than 1.0 means that Caltrans either needs to strengthen the bridge or restrict the vehicular loading on the bridge. Either option would be very costly and would have a huge impact on the public, particularly the extra-legal weight permit industry.

The Commentary of the AASHTO specifications also recognizes that the current shear design strength for end panels is conservative. Among others, the composite action provided by the concrete slab is ignored in evaluating the shear strength. Based on finite element analysis, some researchers also recently questioned the basic assumption that postbuckling tension-field action cannot develop in the end panels. There is an urgent need to evaluate the actual shear strength of end panels in I-section steel girders.

WHAT ARE WE DOING?

It is proposed in this research that full-scale testing of 8 steel girders be conducted. The parameters to be investigated include composite slab effect, end panel aspect ratio, web depth-thickness ratio, and steel grade. Together with the associated finite element simulation, improved shear strength design equations will be proposed. More specifically this work includes a Literature review and analytical study. The Literature review will

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be conducted on the development of tension-field action theory, implementation in design codes, composite slab effect, and the slab effective width issues. The next two tasks will consist of the experimental test program which will investigate the capacity of these girders for two groups of girders based on the web depth-thickness ratio (D/tw, where tw = web thickness). The first group will investigate a lower ratio of 140, whereas the second group will investigate ratios that exceed 200. The final task of this project will draft proposed guidelines to incorporate into the design specifications.

WHAT IS OUR GOAL?

There is an urgent need to develop realistic and practical shear design provisions for the end web panel including the tension-field action for steel girder bridge design and evaluation to avoid costly strengthening of girder webs or restriction of extra-legal permit traffic. The main objective of this research is to develop realistic and practical shear design and load rating provisions for the end web panel of steel girder bridges for California.

WHAT IS THE PRODUCT OF RESEARCH?

Revisions to California Amendments to AASHTO LRFD and LRFR Specifications.

WHAT IS THE BENEFIT?

AASHTO does not provide any provisions about how the end web panel can be designed for tension-field action. As a result, many steel bridge girders need to be retrofitted because the rating factor falls below 1.0 in the end panels.

The objective of this research is to develop realistic and practical shear design and load rating provisions for the end web panel of steel girder bridges for California, to be recommended for adoption in the California Amendments to AASHTO LRFD and LRFR specifications. It is anticipated that the new shear design equations will eliminate the need to either strengthen many existing steel bridge girders or restrict the vehicular loads.

WHAT IS THE PROGRESS TO DATE?

The next step is to modify MTD 20-7 to reflect new design guidance based on this research.

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