Project Summary

Texas Department of Transportation

0-5706: Impact of Overhang Construction on Girder Design

Background

Economical constraints on the design of bridges usually necessitate the use of as few girders as possible across the bridge width. The girders are typically uniformly spaced transversely with the deck extending past the fascia girders, thereby resulting in an overhang. While designers commonly employ rules of thumb with regard to the geometry of the overhang, these rules of thumb generally lack research justification and the actual girder behavior is not well understood. Problems have arisen on both steel and concrete girder systems. For steel girder systems, the problems that can occur are associated with either the global or local stability of the girders. The problems with local stability arise because the cantilever brackets that support the overhang often react near mid depth of the relatively thin web plates. The global stability problems often are a problem on systems with a relatively large span to width ratio such as the case in applications where the bridge is widened. The steel girders in these cases are susceptible to a system mode of buckling where all the girders buckle in a half sine curve. On concrete girder systems, problems during construction of the bridge deck have consisted of rotations in the fascia girder, and in some cases the girders have been dangerously close to dropping the precast deck panels. The purpose of this study was to identify problematic geometries for both steel and concrete girder systems and to also develop details that can minimize the problems with the overhang.

What the Researchers Did

The research included field monitoring, laboratory testing, and finite element analytical (FEA) studies. The field monitoring was conducted during construction on a prestressed concrete girder bridge as well as two steel girder systems. The concrete bridge was located in Austin and the instrumentation consisted of measuring girder twists and deflections as well as strains in the top bracing bar that is used to restrain the girder from twisting. The first steel bridge that was instrumented was in Lubbock and consisted of a straight girder with a 60 degree support skew. The second steel bridge was a continuous curved steel girder bridge located in Austin. The laboratory tests were conducted on the prestressed concrete girder systems and consisted of experiments on the elastomeric bearings, tipping behavior of a prestressed girder, as well as tests on the bracing systems for the concrete girder system. The laboratory and field tests provided valuable data for validating finite element analytical (FEA) models for both the steel and concrete girder systems. The FEA models were used to carry out parametric analyses on both concrete and steel girder systems so that design methodologies could be developed. In addition, for the concrete girder systems, a design tool was developed that consists of an Excel spreadsheet that can be used to predict geometrical configurations that are at risk for problems during construction.

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What They Found

Results from the field studies on the steel girders along with the parametric FEA studies showed that most steel bridges commonly used in the state of Texas will not experience problems with excessive web deformation from the overhang brackets reacting on the webs. In addition, it is recommended that the transverse layout of the girders in widenings be selected to balance the overhang, which will minimize girder deformations. Expressions for determining the required spacing were developed in the project and are included in research report 0-5706-1.

For concrete girder systems, the girders that are the most at risk for excessive rotation of the fascia girder are smaller prestressed girders that are relatively light. The researchers considered the rotational behavior of both rectangular and circular bearing pads as well as the stiffness of conventional bracing bars that frame into the R-bars that extend from the top of the prestressed concrete girders. A stiffer connection was also developed in the project in which the bracing bar frames into the R-bar closer to the top of the concrete girder. The spreadsheet tool that was developed on the project allows the engineer to input the girder size as well as the basic geometry of the overhang and the program will evaluate the likelihood of whether the girder will have problems during construction. If the girders have a problem the engineer can investigate the use of additional bracing on the girders, or can simply add a girder, which will result in a smaller overhang. The program, UT Lift 1.1, is available on the following website for free download: http://fsel.engr.utexas.edu/software/index.cfm

What This Means

For steel girder systems, the equations for balancing the overhang load will provide the engineer with a simple method of accounting for the unbalanced load from the overhang. With the balanced load, the engineer can then use equations in research report 0-5706-1 for predicting the buckling capacity of the steel girder system in the system mode of buckling. For concrete girder systems, the design methodology that is in the report and has been incorporated into the spreadsheet tool provide the designer with a way to evaluate the performance of the concrete girders during placement of the concrete deck. The use of these equations should improve the safety of both steel and concrete bridge systems during construction.

For More Information:

0-5706-1 Impact of Overhang Construction on Girder Design

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