Field Verification of Construction Procedures for Skewed Steel Bridges Through Monitoring of a HPS Bridge, Research in Progress

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Introduction

Ohio's first high performance steel (HPS) bridge is being constructed near Columbus. The bridge is a four span overpass structure built over a new bypass west of Lancaster, Ohio and it has a 39° skew angle to match the alignment of the underlying roadway. Up to this point, calculations to account for torsional stresses generated during construction and while in service in skewed bridges have been predominantly based on simplified numerical analyses, approximate hand calculation techniques, or their effects have been ignored entirely. With the increased strength of high performance steel, though, section moduli are reduced which may make construction stresses more critical than with conventional steel structures. Therefore, an accurate measure of skew effects on performance is becoming increasingly important so that these structures can be properly designed to resist the loads and deformations that can occur during construction.

Previous Research

Research into the behavior of skewed steel bridges has been limited, and studies during construction have been practically nonexistent. The majority of studies involving field-testing examined the effects of skew angle on distribution factors and stresses in the deck (Bishara et al., 1993; Ghali et al, 1969; Kennedy, 1983; Miller et al., 1994). Further research must be completed to better understand the influence of skew on member response to avoid costly errors or delays during construction, especially when HPS is used for the superstructure.

Test Procedure

The bridge, shown in Figure 1, is a five-girder configuration with spans of 78.5' (23 m), 131' (40 m), 127' (39 m) and 82' (25 m) and integral abutments. It is 39.5' (12 m) wide and is designed to carry a two lane secondary road over a new four-lane bypass highway around Lancaster. The erection sequence has consisted of setting the girders, installing the cross frames, pouring the integral abutments, pouring the deck, and, finally, pouring the parapets. Strain transducers were installed onto the steel superstructure in the north (82') span after placing the integral abutments but prior to pouring the deck. Strains in exterior girders and adjacent cross frames will be recorded during the deck pour, which involves placing the concrete perpendicular to the girders rather than parallel to the bridge skew. Progression of the deck pour across the superstructure will be monitored by recording the location of the concrete paving machine relative to the cross frames to provide benchmarks that will be correlated to the recorded data. Data will be taken at set increments throughout the pour, which will take an entire day.

Figure 1. Bridge Elevation.

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Results
Results from this test will be compared against data collected from tests of other skewed and curved structures and to predictions from numerical models. Specific parameters related to construction issues for skewed bridges manufactured using HPS will be studied, such as: (a) the effects of orientation of the paving machine (either perpendicular to the girders or parallel to the skew) on response; (b) the influence of pouring sequence (moving from one end to the other vs. pouring end spans first followed by interior spans) on stress levels in the girders and cross frames; (c) the effects that torsional and flexural restraint at the integral abutments has on girder behavior; and (d) the effects of reduced HPS section sizes on the constructability of skewed bridge structures.

In addition to the comprehensive construction studies that are planned, controlled tests of the completed structure under known truck loads are scheduled once it is opened to traffic. These tests are being completed to continue the field study skewed steel bridge structures and to develop specific information on the effects of skew angle on girder live load stress levels, which will be amplified for the smaller and lighter HPS girders being used for this structure. In addition, information on the effects of the reduced HPS superstructure stiffness on stress levels in the concrete deck will also be obtained so that data on the correlation between reduced superstructure stiffness and deck deterioration can be generated.

Summary and Conclusions

This paper summarizes an ongoing study of the behavior of a HPS skewed bridge being constructed near Columbus, Ohio. Field testing of the structure both during construction and while in-service is being performed so that information related to the effects of construction sequencing on skewed bridge behavior along with the effects of using HPS bridge superstructures on response can be generated. This information will be useful with developing improved skewed steel bridge construction criteria and with improving design and construction criteria for HPS bridges.

References

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