DRISI

Caltrans Division of Research, Innovation and System Information

Research Results

Time Dependent Deflection of In-Span Hinges of Prestressed Concrete Structures during Construction.

The main goal of the this research was to generate information from detailed field and analytical studies that will aid Caltrans in estimating the deflection of in-span hinges (Hinge Curl) during construction and the life of the bridge.

Geotechnical/ Structures

AUGUST 2015

Project Title:
Time Dependent Deflection of In-Span Hinges of Prestressed Concrete Structures during Construction.

Task Number: 1946

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Task Manager:
Hamid Ikram, Transportation Engineer
hamid_ikram@dot.ca.gov

WHAT WAS THE NEED?

Cast-in-place (CIP) post-tensioned concrete (PS) box girder bridges in California have experienced undesirable in-span hinge deflections that have led to construction and serviceability issues. A rational method to estimate hinge curl was developed by the California Department of Transportation (Caltrans) through Memo to Designers (MTD) No. 11-34 and has been used in design. However, this method does not always lead to results that match those observed in the field. Hence, grinding of the superstructure at the hinge and other remedial measures are often necessary to address elevation mismatch at the hinge. The mismatch between the two sides of the hinge creates a bump on the road and presents a road hazard with safety risk to the travelling public. Furthermore, the remedial work results in extra cost and delay. It is clear that accurate prediction of deflection of superstructure in-span hinges is important to improve road safety.

WHAT WAS OUR GOAL?

The objectives of the study were to evaluate the Caltrans method (MTD 11-34) method based on field measurements and analytical studies, identify the extent and sources of discrepancies between the estimated and actual hinge curls, and propose a new method to more accurately estimate short-term and long-term hinge curl.

WHAT DID WE DO?

Caltrans worked closely with the research team to identify candidate cast-in-place (CIP) prestressed concrete box girder bridges with in-span hinges for monitoring. The research team measured the actual bridge deformation of five bridges in California in the field during construction. The correlation between the measured and estimated hinge curl based on

the current version of the Caltrans document, MTD 11-34, was investigated. Furthermore, the deformation of CIP/PS bridges was studied using computer modelling with construction stage analysis including material time-dependent effects. This was conducted using SAP2000 and ABAQUS computer programs for simple and detailed modeling, respectively. Parametric studies were also conducted to study the effect of skew angle and superstructure curvature on hinge curl. A new method was developed to improve accuracy of hinge curl estimation and was implemented in a proposed new version of the MTD 11-34.

WHAT WAS THE OUTCOME?

The field data showed that the current design method significantly underestimated the deflection of in-span hinges. The primary source of the difference between the estimated and measured hinge curl is the assumption about the boundary condition of the short cantilever. The time-dependent factors in the current method also contributed to the differences between the actual hinge curls and those estimated using the current method. It is recognized that exact prediction of in-span hinge curl is not possible due to uncertainties in material properties of concrete, prestress losses, falsework configuration and falsework settlement, and other factors such as construction tolerances. However, considering proper boundary conditions and other adjustments proposed in this study, leads to reasonably accurate hinge curl estimates.

WHAT IS THE BENEFIT?

A rational method to estimate hinge curl with reasonable accuracy was developed in this study to reduce corrective measures in the field. The study validated the applicability of the proposed method for hinge curl prediction. The new method and other proposed modifications were summarized in addition to a design example in a new proposed document in MTD format to facilitate adoption of the new method by Caltrans. Accurate prediction of hinge curl will help avoid extra construction cost and delay due to hinge curl repair, will minimize maintenance work, and lead to safer and smoother ride for the travelling public.

LEARN MORE

http://wolfweb.unr.edu/homepage/saiidi/caltrans/HingeCurl/PDFs/CCEER%2015-03_7-10-15.pdf

IMAGES

Image 1: Bridge falsework (Del Paso Park Overhead, Sacramento)

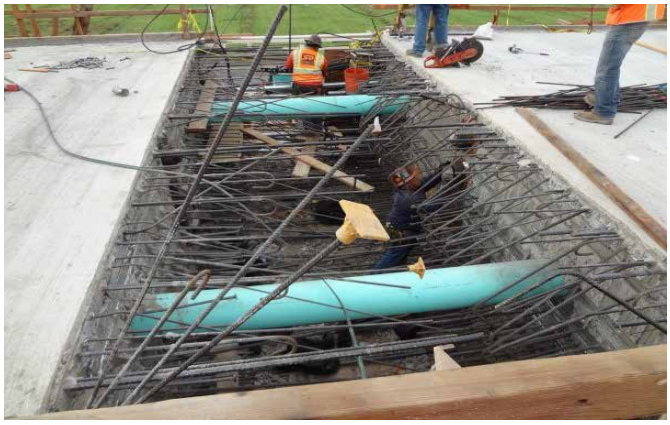

Image 2: Construction of an in-span hinge (Del Paso Park Overhead, Sacramento)

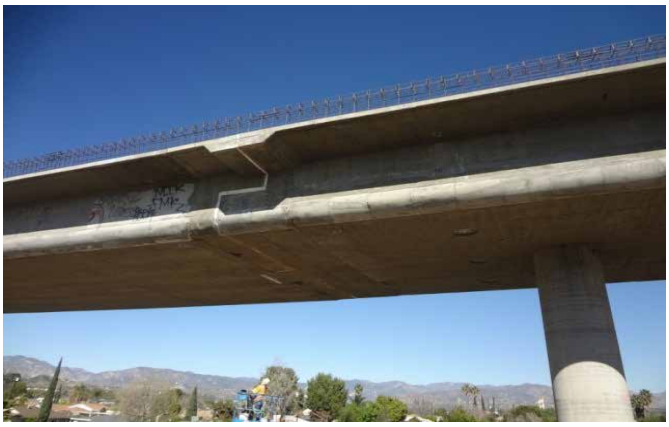

Image 3: In-span hinge of CIP/PS box girder bridge (N170-N5 Connector, Los Angeles)

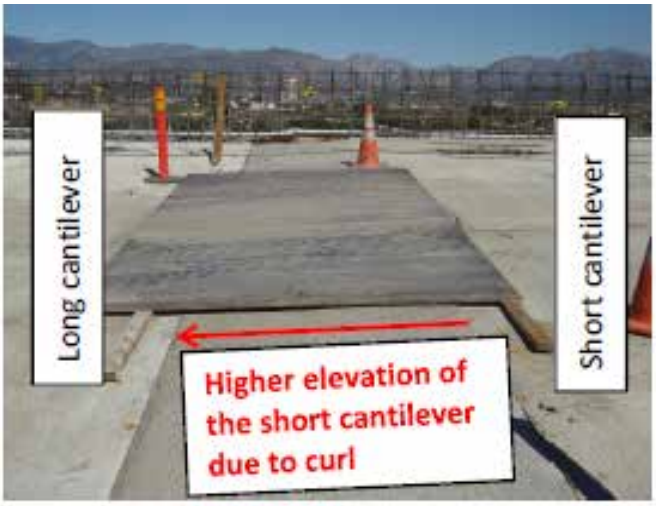

Image 4: Hinge curl during construction

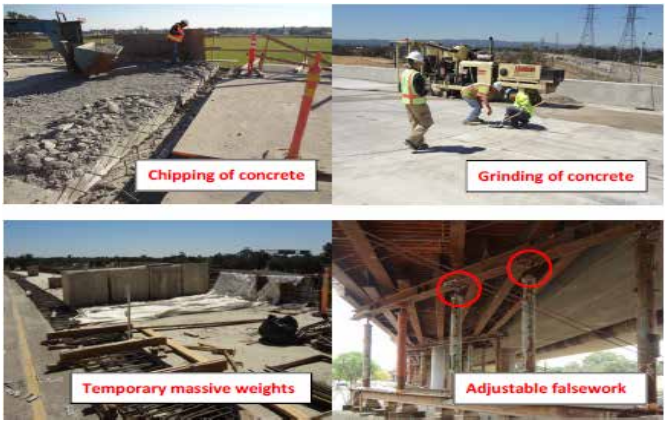

Image 5: Hinge curl remedial measures