Kansas Department of Transportation

TECHNICAL SUMMARY

# Skewed Steel Bridges: Effect of Cross-Frame Layout on Lateral Flange Bending Stresses

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## Introduction

Lateral flange bending stresses can arise from a number of sources, such as wind loading or eccentric concrete placement, but of particular interest are lateral flange bending stresses, $f_l$, that occur due to skew. Lateral flange bending stresses that occur in skewed bridge systems tend to develop due to lateral forces transferred through cross frames which may connect adjacent girders at different span points. In lieu of a refined analysis, the AASHTO (2010) *LRFD Bridge Design Specifications* currently permit engineers examining bridges skewed more than 20° to use a minimum value of $f_l$ = 10 ksi for an interior girder and $f_l$ = 7.5 ksi for an exterior girder. The estimates for $f_l$ provided within the *AASHTO LRFD Bridge Design Specifications* are based on a limited data set for skewed bridges. Additionally, since the *AASHTO LRFD Bridge Design Specifications* state that cross frames or diaphragms should be placed in a staggered configuration when a bridge is skewed more than 20°, the approximate values provided for $f_l$ should not be expected to be indicative of the lateral flange bending stresses experienced when cross frames are instead carried parallel to the skew in bridges skewed beyond 20°.

## Project Description

The authors have performed a study to investigate the effects of cross frame orientation and skew angle upon lateral flange bending stresses, by examining lateral flange bending stresses in a suite of detailed 3D solid finite element analyses of skewed bridge systems, in which cross frame layout, spacing, and skew angle were varied. Skewed bridge systems with cross-frames placed parallel to the skew angle as well as systems with cross-frames arranged in a staggered configuration were considered. The models included both material and geometric nonlinearities to assess the lateral flange bending stresses in the different bridge systems.

## Project Results

The findings of this study showed that cross frames placed parallel to the angle of skew produced significantly lower values for $f_l$ than cases in which cross-frames were placed perpendicular to the girder line and staggered. Both reducing the skew angle and decreasing cross frame spacing were found to reduce lateral flange bending stresses. The values of lateral flange bending stress for all configurations were greater than the bounds of the approximate values suggested by AASHTO. Moreover, the minimum values for $f_l$ provided in the *AASHTO LRFD Bridge Design Specifications* were found to be significantly lower than the results obtained from this study.

## Project Information

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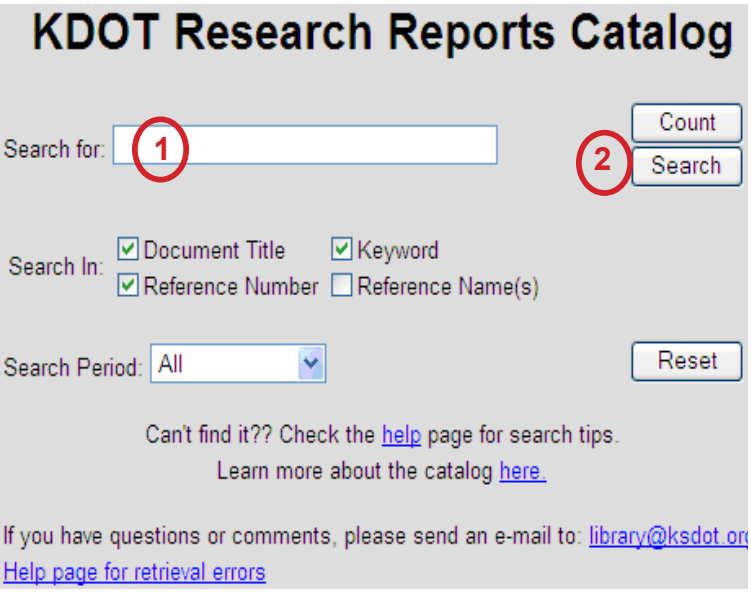


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