Influence of Skew and Nonlinear Deck on Elastic versus Inelastic Distribution Behavior and Ultimate Capacity of Steel Girder Bridges

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Load Distribution Methodologies: skew vs inelastic distribution factors

Purpose

Research Objectives

- Assessment of alternative load distribution methodologies for potential discrepancies that arise when evaluating distribution behavior of skewed steel girder bridges.
- Investigate the influence of skew and material nonlinearities (concrete cracking and steel yielding) on
  - Load distribution behavior (elastic versus inelastic).
  - System capacities (yielding and ultimate).

Results of Sensitivity Study

Bridge Information

Nebraska Laboratory Bridge Test (Kathol et al. 1995)

Huron Bridge Test (Nowak and Eom 2001)

Concluding Remarks

Summary and Conclusions

- Influence of skew was examined on load distribution behavior, and nonlinear system-based capacities (yielding and ultimate) of composite steel girder bridges in presence of full material nonlinearities. In addition, assessment of two general definitions (beam-line and response fraction approaches) for quantifying load distribution behavior was performed for a range of skew variations on a validated in-service bridge model.
- Response-based fractions (such as deflections, strains, curvatures and moments) have limited applicability at higher skewed (≥30°), significantly biasing load effect distribution factors compared to the reference beam-line definition.
- The propagation of concrete cracking results in a substantial increase in distribution factors at higher skew. For 60° skew, an increase up to 36% in distribution factor of girders relative to the uncracked elastic state was observed for the case study in-service bridge.
- Load distribution factors decreased with increasing skew as load progressed from elastic to ultimate states. However, AASHTO LRFD based distribution factors were overly conservative in predicting distribution behavior at all load levels (on average 66% higher at elastic and 90% higher at ultimate for critical girder).
- System-based ultimate capacity increased with skew, but the first yielding initiation load capacity was poorly correlated with skew despite the reduction of moment demands in girders.