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16. Abstract

Bridges have traditionally relied on a system of expansion joints and flexible bearings to accommodate movements due to temperature, creep, and shrinkage loading. Joints and elements in their vicinity experience a high amount of degradation; thus modern design approaches are advocating their removal, with movement accommodated through flexible piles and abutment walls. While jointless bridges have been performing well, many of them suffer from widespread early-age transverse deck cracking. Restrained concrete shrinkage was identified as the most dominant source for the noted damage based on a literature review and a field investigation. Deck cracking is caused by the build-up of tensile forces resulting from the increased rigidity in jointless bridges. Experimentally calibrated finite-element models were used to predict deck cracking in two bridge systems under shrinkage-induced loading and a parametric study was conducted to investigate the influence of design parameters on restrained shrinkage cracking. Simulation results confirmed that the increase of system restraint increases the tendency for cracking. Models for steel and concrete beam bridges showed that both systems were equally susceptible to deck cracking due to restrained concrete shrinkage. The lowest amount of cracking was predicted for bridges with non-integral abutments, higher shear connector spacing, and a low-shrinkage concrete mix. Changing the deck reinforcement configuration had little effect on the predicted damage patterns. Use of a low-shrinkage concrete mix had the greatest impact on minimizing deck cracking. Overall, the computational simulations indicated that restrained shrinkage cracking in the decks of jointless bridges is unavoidable, but that modifying design details and improving concrete mixture designs can help reduce its extent.

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