POST FRACTURE BEHAVIOR OF A FULL-SCALE IN-SITU STEEL TRUSS BRIDGE

by Charles Kieffer III

Abstract:

The classification of steel truss bridge members as Non-Redundant Steel Tension Members has long dictated rigid inspection and management requirements, driven by the assumption that the loss of a single primary tension member will lead to catastrophic structural collapse. This research evaluates these assumptions through one of the first full-scale destructive investigations of an in-service steel truss bridge. By utilizing explosive charges to sever a primary tension member (L4–U5) under a significant static sand load, this study demonstrates that the bridge possesses substantial uncredited system-level redundancy. Experimental data, validated through computer vision-based displacement tracking and traditional instrumentation, reveal that the bridge successfully redistributed internal forces to adjacent members without compromising global geometric stability. Following fracture, the truss transitioned from behaving primarily as a determinate axial system to an indeterminate frame in which secondary flexural behavior at the connections contributed to maintaining equilibrium. A detailed finite element model was benchmarked and calibrated using the experimental live-load, sand loading and the fracture datasets. This validated model was subsequently used to evaluate alternative fracture scenarios and ultimate loading capacities. The results confirm that the bridge's ability to prevent collapse is rooted in its inherent system-level redundancy and the activation of alternative load paths, providing valuable experimental evidence to support more quantitative approaches for evaluating redundancy and classifying or removing the classification of Non-Redundant Steel Tension Members.