ABSTRACT

Hebdon, Matthew H. Ph.D., Purdue University, August 2015. Member-level Redundancy of Built-up Steel Girders. Major Professor: Robert Connor.

There is a large number of bridges in the inventory having built-up steel construction. The majority of these bridges were constructed prior to the 1960s. This means that most of these bridges are approaching, or have surpassed, their original design life. It is widely accepted in the engineering community that built-up members possess internal member-level redundancy due to the number of different load paths created by the fastening of multiple components together with rivets or high-strength bolts. However, there is very little experimental research which addresses the capacity of built-up girders after a component failure.

The purpose of this research was to describe the behavior of mechanically fastened built-up girders in a partially failed condition. This was achieved by testing large-scale riveted and high-strength bolted built-up specimens to determine their fracture resilience at low temperatures and their fatigue capacity after a single component was failed. Additionally, a finite element parametric study was performed to understand the behavior of built-up girders and to better describe the load distribution that occurs locally in the region adjacent to a failed component.

The results of this research program indicate that the redundant load paths within mechanically fastened girders allows the girders to resist catastrophic fracture of an entire member in the event that a single component fractured. Additionally, it is illustrated that a

conservative lower bounding of the fatigue data is represented by the AASHTO Category D fatigue curve. Finally, the results of the parametric study are used to determine factors affecting the calculated stresses which can be used to determine the remaining fatigue life of built-up girders with a component failure.