UNIVERSITY TRANSPORTATION RESEARCH CENTER **RESEARCH BRIEF**

Project Title: Analysis of Curved Weathering Steel Box Girder Bridges in Fire

Principal Investigator: Reeves Whitney

This study examined the performance of curved weathering steel bridges in fire. Bridge fires can present a severe hazard to the transportation infrastructure system. In fact, a nationwide survey by the New York State Department of Transportation (NYSDOT) has shown that fires have collapsed approximately three times as many bridges as earthquakes. Bridge fires are often intense as they may be fueled by gasoline from vehicles that have crashed in the vicinity of the bridge. Large fuel loads and a lack of code requirements for fire protection of bridges have left bridges quite vulnerable to fire, particularly unprotected steel bridges.

Box girder bridges (Figure 1) were studied using both straight and curved plan alignments. The box girder's cross-section makes it attractive for use in both simple and continuous spans. Our research considered a three-span continuous support configuration. Weathering steel, which is commonly used in bridge construction, was used in lieu of traditional steel. Weathering steel performs differently than traditional steels at elevated temperatures, such as a greater reduction in yield strength (Figure 2).

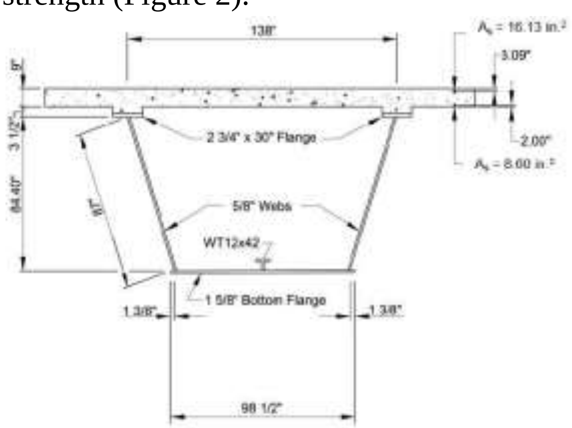

Figure 1. Box Girder Cross-Section

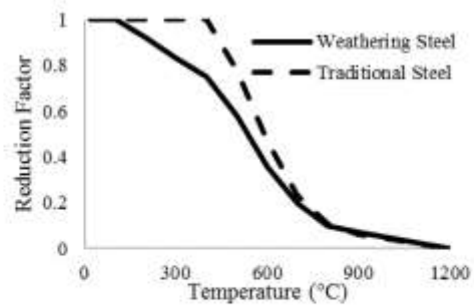

Figure 2. Yield Strength Reduction vs. Temperature

Our analysis was performed considering bridge fires occurring at two locations: at the middle of the center span, and adjacent to the first interior bridge pier. We found that the fire location at the middle of the center span was more critical, with failure in as little as 10 minutes. The fire adjacent to the first interior bridge pier initiated failure in about 18 minutes. The results were similar for both the curved and straight bridge alignments.

This work relied on complex numerical finite element modeling (FEM) using Abaqus software. We also present results for a simplified method which uses the strength equations from the AASHTO design standard. The equations were modified to account for the reduction in material properties, such as yield strength and elastic modulus, due to the elevated temperatures. It was found that the simplified method gave reasonable results for predicting the time to failure.

This work has illustrated that the infrastructure risk due to fires at box girder bridges is significant. The short failure times, similar to those seen in plate girder bridges, may not be adequate for response by fire personnel. Improving the fire performance of critical steel bridges seems warranted.

Sponsors:

Completion Date:

University: **Manhattan College**