ABSTRACT

Anna Tarasova, Purdue University. Innovative Repair Methods for Corrosion-Damaged Steel Bridges. Advisor: Dr. Jungil Seo

Girder ends of steel bridges can be corrosion damaged due to deicing salts, water, and other contaminants leaking from deck expansion joints. When the corrosion becomes significant, it can decrease the sectional properties of end steel girders and eventually reduce structural resistance against bearing and shear. Conventional methods that are typically used to repair corrosion-damaged girders require a substantial amount of time and resources to complete and often cause public inconvenience due to traffic lane closure. Therefore, there is a need for practical, rapid, and robust repair methods that can be implemented by maintenance personnel of a local Department of Transportation (DOT).

In this study, five innovative repair methods for corroded steel girders were evaluated through a selection process called the House of Quality Matrix, a commonly used tool in the consumer product industry. After completing the evaluation and additional numerical simulations, the "Sandwich Panel" repair method was selected for further investigation. The main concept of the proposed "Sandwich Panel" repair method is the encasement of the corroded region with a filler material reinforced by threaded rods. Two thin steel plates installed on both girder sides serve as stay-in-place formwork, expediting the installation process. This repair method eliminates labor-intensive steps of jacking, welding, and formwork disassembly, making it more cost-effective and less time-consuming.

The structural performance of the method was evaluated experimentally by conducting seven large-scale tests. Various test parameters were considered in the tests, including i) threaded rod layout, ii) filler material, and iii) support condition. The test specimens were corrosion-damaged steel girders from decommissioned highway bridges in Indiana. The experimental results indicate that the method is effective enough to recover their original design strength. The experimental evaluation was followed by a numerical parametric study using finite element models benchmarked using the experimental results. Detailed design guidelines and recommendations were developed based on the experimental and numerical results.