The Ohio Department of Transportation
Office of Research & Development
Executive Summary Report

Verification of Performance and Design Criteria for Higher Performance Steel Bridges

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Problem

A new grade of high performance steel has recently been developed that can help reduce costs associated with construction and maintenance of highway bridges. This new grade of steel, designated as HPS-70W, was developed through a cooperative research agreement between the FHWA, the United States Navy, and the American Iron and Steel Institute. The steel has a higher yield strength, improved weathering characteristics, and is much tougher than existing grades of steel. One of the most promising applications for the new steel is in the fabrication of bridge girders. The improved material properties enable engineers to span greater distances, eliminate intermediate piers, alleviate clearance problems, and provide increased resistance to fatigue and corrosion. Currently, HPS is available as plate material produced using a Q&T process. Using this process, the length of plate is limited to approximately 50 feet - a length that is significantly shorter than most bridge girders. A new thermo-mechanical-controlled-process (TMCP) has been developed that allows plates to be rolled in much longer lengths. The focus of this study is to determine if design and fabrication procedures used for HPS-70W Q&T steel are appropriate for HPS-70W TMCP.

Objectives

Before HPS-70W TMCP steel can be widely used, fabrication and design guidelines need to be verified and/or modified. The objectives of the proposed research are to:

1. Verify the mechanical properties of HPS-70W TMCP steel by performing coupon testing of plate material

2. Evaluate the performance of punched and drilled bolt holes in thicker HPS-70W steel plates

3. Examine erection stresses on a bridge constructed of HPS-70W TMCP while the concrete deck is cast to provide data for investigating alternative erection schemes.

4. Verify existing performance criteria by performing load testing of a bridge constructed from HPS-70W TMCP steel.

Description

The project consisted of tensile coupon testing and Charpy V-notch toughness testing of numerous specimens fabricated from 7/8" thick and 2" thick HPS-70W TMCP plates, fatigue testing of dog-bone samples with punched, drilled, and sub-punched and reamed holes to investigate the fatigue resistance of HPS-70W TMCP steel for these details, fatigue testing of samples welded by conventional submerged arc welding (SAW) processes and by newer narrow gap improved electro slag welding (NGI-ESW) processes, field monitoring of girder stresses during concrete deck installation, and periodic field monitoring of service stresses due to truck loads.

Conclusions & Recommendations

During the study, the material properties of HPS-70W were found to be adequate, though some of the samples exhibited a roundhousing phenomenon that resulted in a poorly defined yield point and a 0.2% offset yield stress below ASTM minimums. Some questions remain concerning the influence of plate thickness on toughness. The fatigue performance of samples with punched, drilled, and sub-punched and reamed holes was comparable with what would be expected from conventional HSLA steels. Fatigue resistance of samples welded with SAW and NGI-ESW processes was found to be more than adequate. Finally, field test data showed that current design criteria are appropriate for HPS-70W TMCP but that some gains could be made by considering different screed alignments during deck casting.

Implementation Potential

Based on the results of this study, the authors can conclude that HPS-70W TMCP is ready for broad use in bridges within the state of Ohio and across the nation. Other studies have demonstrated that economic gains can be realized by using this product. The current investigation has shown that current design criteria results in adequate performance based on all measures.