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High Performance Steel

Purdue ECT Team
Purdue University, ectinfo@ecn.purdue.edu

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HIGH PERFORMANCE STEEL

THE NEED

High strength steels have been available for years, but their use required more welding control and fabrication processes than conventional strength steels. For this reason few bridge owners have been willing to risk potential problems in fabrication, even though the design could be more efficient with higher strength steel.

FIGURE 1 HIGH PERFORMANCE STEEL

THE TECHNOLOGY

A new grade of high performance steel, HPS-485W or HPS-70W, developed by a cooperative program between the Federal Highway Administration, the American Iron and Steel Institute, and the Department of the Navy in August 1994; uses a new chemical composition that provides improved welding and toughness properties. The increase in strength and performance will allow targeted use of HPS that will extend the useful life of steel bridge structures; and even greater savings with the reduction of the total steel weight.

Although this new steel has the same strength levels as the currently available AASHTO N270 Grade 70W steel, its unique chemical and physical properties allow the use of more economical fabrication practices. The main differences between M270 steel and HPS is: Carbon is almost half that of the current steel, and sulfur is 1/10. Toughness value of over 200 Joules are commonly obtained, as compared to values of 30 to 50 Joules for the current steel.

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THE BENEFITS

The benefits related to HPS include enhancements in: weldability, toughness, corrosion resistance, ductility, fatigue and fire resistance, formability, and strength. These factors combined lead to construction elements of higher economic efficiency, ease of maintenance, and longer service life. Because of the low carbon levels, minimum or no preheat would be required which allows increased productivity of fabrication and reduced cost. HPS steel bridges can also be recycled at virtually 100% which offers the greatest advantage when it comes to the environment.

STATUS

The technology won the 1997 CERF Pankow Innovative Applications Award. According to the Civil Engineering Research Foundation (CERF) report on the CONMAT program, there are several steel research projects planned which focus on the production of new HPS, the development of new HPS structural systems, and life-cycle cost analysis for HPS structures.

There are two states that are currently pioneering the use of HPS-70W for bridge structures. Tennessee, with the construction of a bridge located on Route 53, Jackson County. In this bridge the weight of steel was reduced almost 25% compared to the original bridge design using the 50W grade steel. Nebraska, which is applying the HPS in a three phase project: Phase I is a simply supported bridge, designed on 50W steel, but that will be constructed on HPS-70W. This project will resolve questions related to constructability, familiarize contractors with the new technology, and it will be used to update the AASHTO Bridge Design Manual. Phase II will involve optimizing design and construction of a two span continuous steel girder using HPS-70W. Phase III will include the construction of a steel bridge using a new innovative design and HPS.

Twenty new bridges are being designed or fabricated in several states, including Tennessee, Nebraska (2), Pennsylvania (2), North Carolina, Virginia, New York (7), New Jersey, Massachusetts, Washington, West Virginia, Texas and Florida.

The Building and Fire Research Laboratory, sponsored by the National Institute of Standards and Technology, is currently developing design methodologies and specifications for the design of HPS systems.

BARRIERS

- High yield-to-tensile ratios (less ductile behavior such as desirable in earthquakes).
- Cost premium for base material.

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- Currently, the AASHTO Manual for Design of Steel Bridges includes 50W limitations that prevent full utilization of the higher yield strength of HPS (Jamshidi et al., 1997).
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Points of Contact

William Wright, Federal Highway Administration
Tel: (703) 285-2496
Camille George Rubeiz, American Iron and Steel Institute
Tel: (202) 452-7118, Fax: (202) 463-6573
William D. Michalerya, Industry Liaison & Technology Transfer. ATLSS Center
Tel: (703) 285-2496, Email: mailto:mjustason@berminghammer.com
John L. Gross, Building and Fire Research Laboratory
Tel: (301) 975-6068

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REVIEWERS

Peer reviewed as an emerging construction technology

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