9934 Development of Appropriate Resistance Spot Welding Practice for Transformation-Hardened Steels

Benefits

- Development of tempering diagrams and post-processing maps for effective resistance spot welding of transformation-hardened steels
- Facilitation of widespread use of new high-strength steels with existing manufacturing technology
- Improved use of input resources

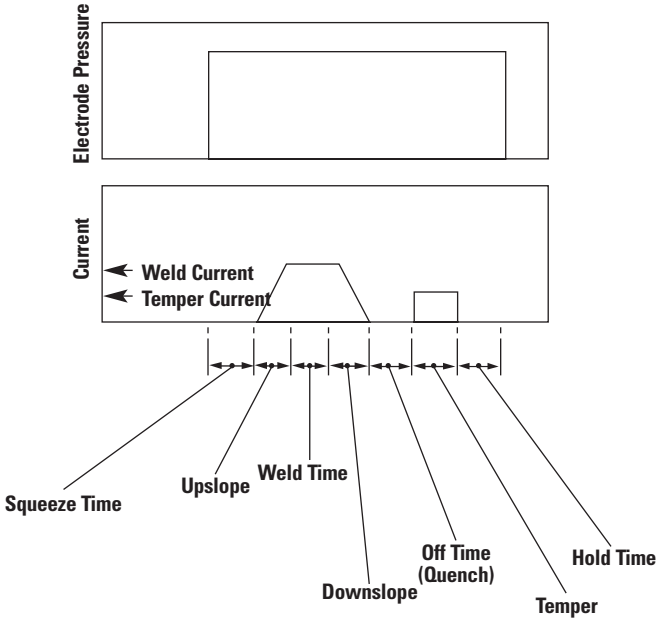
Applications

Potential results of this project will allow users of transformation-hardened steels to select process set-ups based on material strength and gauge directly, facilitating the use of these materials in newer designs of vehicles.

Appropriate resistance spot welding practice will minimize hold-time sensitivity for higher carbon/manganese content steels

Transformation-hardened steels are those that use varying levels of carbon and manganese to achieve desired levels of strength. The specific strengthening mechanisms vary, but such steels are covered under classifications such as dual phase steels. Considerable work over the years has demonstrated that higher carbon/manganese grades of steels are susceptible to hold-time sensitivity during resistance spot welding. A hold-time sensitive steel is defined as one which exhibits a full button failure mode when short hold-times are used. Recent work has demonstrated that such hold-time sensitivity on carbon/manganese steels is directly related to weld hardness, and particularly cleavage of weld metal grains.

At the Edison Welding Institute (EWI) in Columbus, Ohio, a program has been organized to investigate the development of new processing schemes for reducing hold-time sensitivity behavior in transformation-hardened steels. It has been previously demonstrated that the use of post weld/in process tempers are one effective way of reducing hold-time sensitivity behavior. In addition, reduction of cooling rates in the resistance spot welding process using down-slopes and post-heats also offers potential for reducing hold-time sensitivity.



Schematic of a typical spot weld cycle and temper pulse.

This project has been initiated under the American Iron and Steel Institute (AISI) Technology Roadmap Program. For a range of steel types and thicknesses, maps defining appropriate post welding processing will be established. Best practices resulting from these maps will undergo additional mechanical properties testing. As a result of this program, users of transformation-hardened steels will be able to select process set-ups based on material strength and gauge directly, facilitating the use of these materials in many applications.

Project Description
Goal: To utilize standard metallographic techniques and mechanical testing to develop temper diagrams and optimized post-cooling rates for a number of candidate transformation-hardened steels.

This project is divided into two phases. In Phase I, the quench and temper requirements for a number of candidate transformation-hardened steels will be developed. The candidate materials will include a range of chemistries and gauges. In Phase II, two different methods of reducing the post-cooling rate will be evaluated. These methods include the use of down-slope and post-heat techniques. Throughout both phases of work, verification will be established through standard metallographic techniques, destructive testing, and mechanical test evaluation.

Progress and Milestones
- This two-year project started in March 2000.

Phase I: Development of the Quench and Temper Requirements for Transformation Hardened Steels -- Completion in 11 Months from Project Start Date.
- Task 1: Selection and Collection of Candidate Steels.
- Task 2: Development of Temper Diagrams for Each Candidate Steel.
- Task 3: Metallographic Examinations and Destructive Testing.
- Task 4: Quantification of Representative Mechanical Properties.
- Task 5: Report on Phase I.
- Project Review Held at Technology Roadmap Meeting in May 2000.

Phase II: Evaluation of Post Weld Cooling Rate Techniques -- Completion in 11 Months from End of Phase I.
- Task 1: Prediction of Critical Cooling Rates for Candidate Steels.
- Task 2: Comparison of the Down-Slope and Post Heat Methods for Reducing Cooling Rates.
- Task 3: Development of Post Processing Maps.
- Task 4: Metallographic Examinations and Destructive Testing.
- Task 5: Quantification of Representative Mechanical Properties.
- Task 6: Report on Phase II.
- Task 7: Final Report by Spring 2002.

Total Project Cost/Duration
$190,000/two years.

Research Organization
Edison Welding Institute (EWI)
Columbus, OH

Industry Participants
AK Steel Corporation
Middletown, OH

Dofasco, Incorporated
Ontario, Canada

Ispat Inland Incorporated
East Chicago, IN

National Steel Corporation
Mishawaka, IN

For additional information,

Edison Welding Institute (EWI)
Wayne Chuko
wayne_chuko@ewi.org

American Iron and Steel Institute
Joe Vehec
aisiap@aol.com