

Hydrogen Embrittlement Testing of Ultra High Strength Steels and Stampings by Acid Immersion

RATIONALE

Aggressive mass reduction targets for ground vehicles have led to the development of a new generation of high strength steels. Very high tensile strength as well as the presence of retained austenite as a major microstructural constituent make these steels susceptible to hydrogen embrittlement.

1. SCOPE

This standard describes a test method for evaluating the susceptibility of uncoated cold rolled and hot rolled Ultra High Strength Steels (UHSS) to hydrogen embrittlement. The thickness range of materials that can be evaluated is limited by the ability to bend and strain the material to the specified stress level in this specification.

Hydrogen embrittlement can occur with any steel with a tensile strength greater than or equal to 980 MPa. Some steel microstructures, especially those with retained austenite, may be susceptible at lower tensile strengths under certain conditions. The presence of available hydrogen, combined with high stress levels in a part manufactured from high strength steel, are necessary precursors for hydrogen embrittlement.

Due to the specific conditions that need to be present for hydrogen embrittlement to occur, cracking in this test does not indicate that parts made from that material would crack in an automotive environment. Results from this test should be considered in conjunction with the strain state of the material and the operating environment of the part when selecting any UHSS. Since this test method is comparative, the most information can be gained if a control sample of known performance is evaluated along with the material being studied.

NOTE: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Material Description

This specification is intended for evaluating dual phase, multi-phase and martensitic steels for their susceptibility to hydrogen embrittlement.

1.2 Typical Applications

Steels that are intended for this test method generally include, but are not limited to, those that are manufactured into parts that are used in body structure, closure, hardware and chassis applications.

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For more information on this standard, visit
https://www.sae.org/standards/content/J3215_202303/

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J2745 Categorization and Properties of Advanced High Strength Automotive Sheet Steels

SAE J2947 Categorization and Properties of Steel Sheet for Automotive Cold Forming Applications

2.1.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM E8M Standard Test Methods of Tension of Metallic Materials

ASTM G39 Standard Practice for Preparation and use of Bent-Beam Stress-Corrosion Test Specimens

2.1.3 Other Publications

GMW 17508 Hydrogen Embrittlement Testing of Ultra High Strength Steels and Stampings by Acid Immersion

3. REQUIREMENTS

3.1 Evaluation of Flat Rolled Steel Samples

3.1.1 Test Samples

Possible test sample configurations are described below. Once the test samples are cut, they are strained according to the procedure described in 3.3.

3.1.2 Edge Condition

Samples are prepared by either shearing coupons to the required dimensions and testing in the as-sheared condition or milling to final dimensions. The condition of the tested edge shall be specified and included in the test report. Punch dies for shearing samples shall have a 15% die clearance with a tolerance of $\pm 1\%$.

3.1.3 Test Sample Configuration A

The test coupon is 180 x 30 mm oriented transverse to the rolling direction such that when being bent, the bend is parallel to the rolling direction. The dimensions of the test coupon are shown in Figure 1.

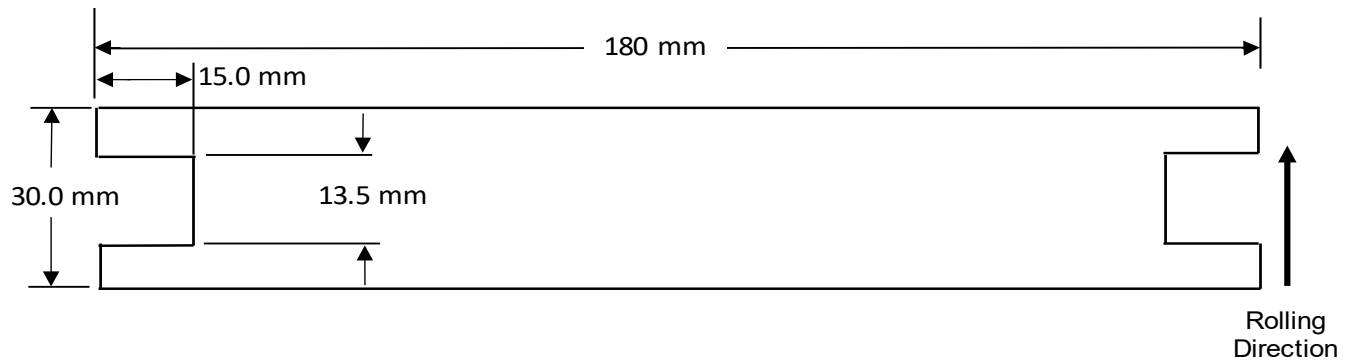


Figure 1 - Test sample dimensions for Configuration A

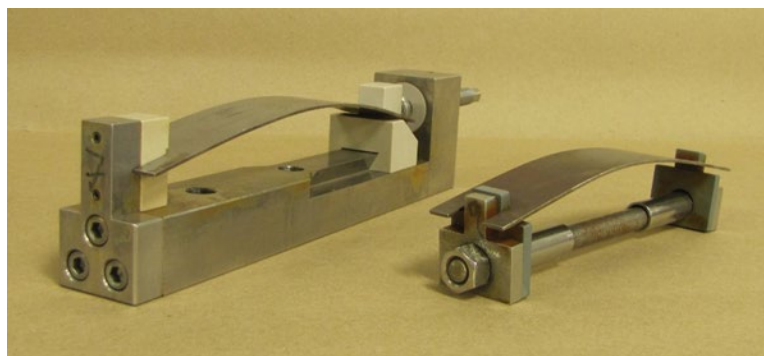


Figure 2 - Examples of fixtures for stressing single test specimen for Configuration A

3.1.4 Test Sample Configuration B

The specimen for this configuration will typically be a rectangle, 130 x 30 mm as shown in Figure 3. The test fixture shown in Figure 4 below is beneficial in loading samples of thick and/or of sufficiently high strength materials that are difficult to be loaded in the normal fixture. This fixture is described in ASTM G39-99 (2021) Figure 4.

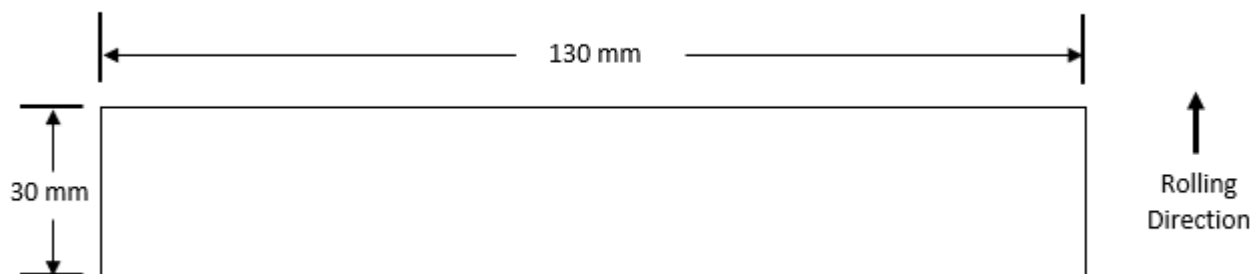


Figure 3 - Test sample dimensions for Configuration B