Designation: G49 − 85 (Reapproved 2023)$^{\varepsilon 1}$

Standard Practice for Preparation and Use of Direct Tension Stress-Corrosion Test Specimens[1]

This standard is issued under the fixed designation G49; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

ε[1] NOTE—Editorially updated units in November 2023.

1. Scope

1.1 This practice covers procedures for designing, preparing, and using ASTM standard tension test specimens for investigating susceptibility to stress-corrosion cracking. Axially loaded specimens may be stressed quantitatively with equipment for application of either a constant load, constant strain, or with a continuously increasing strain.

1.2 Tension test specimens are adaptable for testing a wide variety of product forms as well as parts joined by welding, riveting, or various other methods.

1.3 The exposure of specimens in a corrosive environment is treated only briefly because other standards are being prepared to deal with this aspect. Meanwhile, the investigator is referred to Practices G35, G36, G37, and G44, and to ASTM Special Technical Publication 425 (**1**).[2]

1.4 The values stated in SI units are to be regarded as standard. The values given in parentheses after SI units are provided for information only and are not considered standard.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[3]

E8/E8M Test Methods for Tension Testing of Metallic Materials

G35 Practice for Determining the Susceptibility of Stainless Steels and Related Nickel-Chromium-Iron Alloys to Stress-Corrosion Cracking in Polythionic Acids

G36 Practice for Evaluating Stress-Corrosion-Cracking Resistance of Metals and Alloys in a Boiling Magnesium Chloride Solution

G37 Practice for Use of Mattsson's Solution of pH 7.2 to Evaluate the Stress-Corrosion Cracking Susceptibility of Copper-Zinc Alloys

G44 Practice for Exposure of Metals and Alloys by Alternate Immersion in Neutral 3.5 % Sodium Chloride Solution

3. Summary of Practice

3.1 This practice covers the use of axially loaded, quantitatively stressed ASTM standard tension test specimens for investigating the resistance to stress-corrosion cracking of metallic materials in all types of product forms. Consideration is given to important factors in the selection of appropriate specimens, the design of loading equipment, and the effects of these factors on the state of stress in the specimen as corrosion occurs.

4. Significance and Use

4.1 Axially loaded tension specimens provide one of the most versatile methods of performing a stress-corrosion test because of the flexibility permitted in the choice of type and size of test specimen, stressing procedures, and range of stress levels.

4.2 The uniaxial stress system is simple; hence, this test method is often used for studies of stress-corrosion mechanisms. This type of test is amenable to the simultaneous

[1] This practice is under the jurisdiction of ASTM Committee G01 on Corrosion of Metals and is the direct responsibility of Subcommittee G01.06 on Environmentally Assisted Cracking.

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[2] The boldface numbers in parentheses refer to a list of references at the end of this standard.

[3] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

exposure of unstressed specimens (no applied load) with stressed specimens and subsequent tension testing to distinguish between the effects of true stress corrosion and mechanical overload (**2**). Additional considerations in regard to the significance of the test results and their interpretation are given in Sections 6 and 10.

4.3 Wide variations in test results may be obtained for a given material and specimen orientation with different specimen sizes and stressing procedures. This consideration is significant especially in the standardization of a test procedure for interlaboratory comparisons or quality control.

5. Test Specimens

5.1 Whenever possible, tension test specimens used in evaluating susceptibility to stress-corrosion cracking should conform to the dimensions of standard tension test specimens specified in Test Methods E8/E8M, which contain details for specimens machined from various product forms.

5.2 A wide range of sizes for tension test specimens is possible, depending primarily upon the dimensions of the product to be tested. Because the stress-corrosion test results can be markedly influenced by the cross section of the test specimen, this factor should be given careful consideration with regard to the object of the investigation. Although larger specimens may be more representative of most actual structures, they often cannot be machined from product forms to be evaluated; and they present more difficulties in stressing and handling in the laboratory. Also, larger specimens of some materials may require longer exposure periods than smaller specimens.

5.3 Smaller cross-section specimens are widely used because they (*1*) have a greater sensitivity to the initiation of stress-corrosion cracking, (*2*) usually give test results more quickly, and (*3*) permit greater convenience in testing. On the other hand, the smaller specimens are more difficult to machine, and their performance is more likely to be influenced by extraneous stress concentrations resulting from non-axial loading, corrosion pits, etc. Therefore, specimens less than about 10 mm (0.4 in.) in gauge length or 3.0 mm (0.12 in.) in diameter are not recommended for general use.

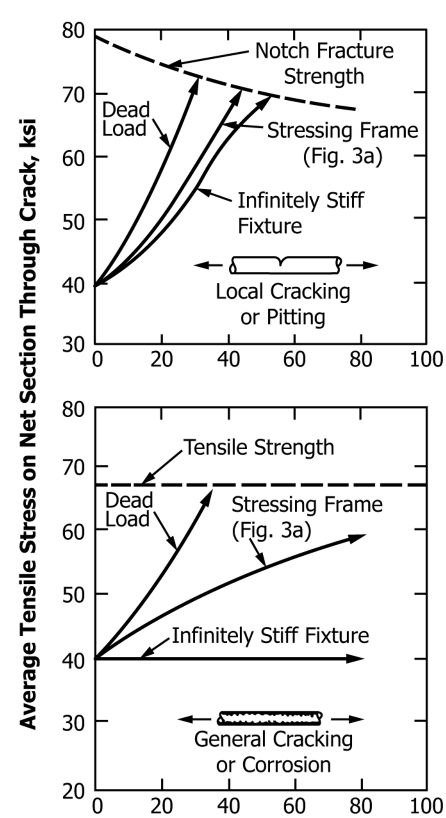
5.4 Tension specimens containing machined notches have been used in studies of stress-corrosion cracking and hydrogen embrittlement (**3**). The presence of a notch induces a triaxial stress state at the root of the notch wherein the actual stress will be greater by a concentration factor dependent on the notch geometry. Advantages of such specimens include the probable localization of cracking to the notch region and acceleration of failure. However, unless directly related to practical conditions of usage, spurious results may ensue.

5.5 Tension specimens containing a machined notch in which a mechanical precrack (for example, a fatigue or tension crack) has been started will be the subject of another ASTM standard. Various types of precracked specimens are discussed in other publications (**2, 4**).

6. Stress Considerations

6.1 There are several factors that may introduce bending moments on specimens, such as a longitudinal curvature, misalignment of threads on threaded-end round specimens, and the corners of sheet-type specimens. The significance of these factors is greater for specimens with smaller cross sections. Even though eccentricity in loading can be minimized to equal the same standards accepted for tension testing machines, inevitably, there is some variation in the tensile stress around the circumference of the test specimen which can be of such magnitude that it will introduce considerable error in the desired stress. Tests should be made on specimens with strain gauges affixed to the specimen surface (around the circumference in 90° or 120° intervals) to verify strain and stress uniformity and determine if machining practices and stressing jigs are of adequate tolerance and quality.

6.2 Another consideration is the possible increase in net section stress that will occur when corrosion develops during the environmental exposure (**1, 5**). As shown schematically in Fig. 1, there are two limiting curves: one for zero stiffness (dead weight) and the other for infinite stiffness (ideal constant strain). In actual testing with various types of stressing frames, such as those shown in Figs. 2-4, the increase in net section stress will be somewhere in between. When the net section stress becomes greater than the nominal gross section stress and increases to the point of fracture, either of two events can



NOTE 1—The behavior shown is generally representative, but the curves will vary with specific alloys and tempers.

FIG. 1 Effect of Loading Method and Extent of Cracking or Corrosion Pattern on Average Net Section Stress