Designation: E 436 – 91 (Reapproved 1997)

Standard Test Method for Drop-Weight Tear Tests of Ferritic Steels[1]

This standard is issued under the fixed designation E 436; 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.

1. Scope

1.1 This test method covers drop-weight tear tests (DWTT) on ferritic steels with thicknesses between 3.18 and 19.1 mm (0.125 and 0.750 in.).

1.2 The values stated in SI (metric) units are to be regarded as the standard.

1.3 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

E 208 Test Method for Conducting Drop-Weight Test to Determine Nil-Ductility Transition Temperature of Ferritic Steels[2]

3. Significance and Use

3.1 This test method can be used to determine the appearance of propagating fractures in plain carbon or low-alloy pipe steels (yield strengths less than 825 MPa or 120 000 psi) over the temperature range where the fracture mode changes from brittle (cleavage or flat) to ductile (shear or oblique).

3.2 This test method can serve the following purposes:

3.2.1 For research and development, to study the effect of metallurgical variables such as composition or heat treatment, or of fabricating operations such as welding or forming on the mode of fracture propagation.

3.2.2 For evaluation of materials for service to indicate the suitability of a material for specific applications by indicating fracture propagation behavior at the service temperature(s).

3.2.3 For information or specification purposes, to provide a manufacturing quality control only when suitable correlations have been established with service behavior.

4. Apparatus

4.1 The testing machine shall be either a pendulum type or a vertical-dropped-weight (Note 1) type. The machine shall provide sufficient energy to completely fracture a specimen in one impact.

4.1.1 As a guide in the design of the equipment it has been found that up to 2712 J (2000 ft·lbf) of energy may be required to completely fracture specimens of steel up to 12.7 mm (½ in.) in thickness with tensile strengths to 690 MPa (100 000 psi).

NOTE 1—Equipment of the vertical-dropped-weight variety that can be readily modified to conduct the drop-weight tear test is described in Test Method E 208.

4.2 The specimen shall be supported in a suitable manner to prevent sidewise rotation of the specimen.

4.3 The velocity of the hammer (in either type of testing machine) shall be not less than 4.88 m/s (16 ft/s).

5. Test Specimen

5.1 The test specimen shall be a 76.2 by 305-mm (3 by 12-in.) by full-plate-thickness edge-notch bend specimen employing a pressed notch. Fig. 1 presents the dimensions and tolerances of the specimens. The specimens shall be removed from the material under test by sawing, shearing, or flame cutting, with or without machining.

NOTE 2—If the specimen is flame cut it is usually difficult to press in the notch unless the heat-affected zone is removed by machining.

5.2 The notch shall be pressed to the depth shown in Fig. 1 with a sharp tool-steel chisel with an included angle of 45 ± 2°. Machined notches are prohibited.

NOTE 3—The notch radius obtained with a sharp tool-steel chisel is normally between 0.013 to 0.025 mm (0.0005 to 0.001 in.). When many specimens are to be tested, it is helpful to use a jig that will guide the chisel and stop it at the proper depth.

6. Procedure

6.1 In the temperature range from − 73 to 100°C (−100 to + 212°F) employ the procedure described in 6.1.1 and 6.1.2.

6.1.1 Completely immerse the specimens in a bath of suitable liquid at a temperature within ±1°C (±2°F) of the desired test temperature for a minimum time of 15 min prior to

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[1] This method is under the jurisdiction of ASTM Committee E-8 on Fatigue and Fracture and is the direct responsibility of Subcommittee E08.02 on Standards and Terminology.

Current edition approved Aug. 15, 1991. Published October 1991. Originally published as E 436 – 71 T. Last previous edition E 436 – 74(1986).

[2] *Annual Book of ASTM Standards*, Vol 03.01.

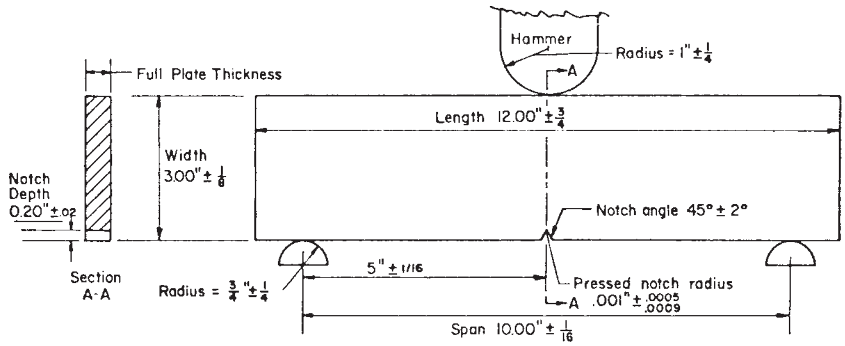

FIG. 1 Drop-Weight Tear Test Specimens and Support Dimensions and Tolerances (for Specimens ⅛ to ¾ in. in Thickness)

testing. Separate the specimens by a distance at least equal to the thickness of the specimen. Make provision for circulation of the bath to assure uniform bath temperature.

NOTE 4—Alternatively, other methods of heating and cooling may be used, provided they produce equivalent time at temperature of the specimens.

6.1.2 Remove the specimens from the bath and break as described herein within a time period of 10 s. If the specimens are held out of the bath longer than 10 s return them unbroken to the bath for a minimum of 10 min. Do not handle the specimen in the vicinity of the notch by devices the temperature of which is appreciably different from the test temperature.

6.2 For temperatures outside of the range specified in 6.1 maintain the specimen temperature at the time of impact within ± 2°F of the desired test temperature.

6.3 Insert the specimen in the testing machine so that the notch in the specimen lines up with the centerline of the tup on the hammer within 1.59 mm (1⁄16 in.). Also, center the notch in the specimen between the supports on the anvil.

6.4 Consider tests invalid if the specimen buckles during impact.

NOTE 5—Buckling has been experienced with specimen thicknesses less than 4.75 mm (0.187 in.).

7. Specimen Evaluation

7.1 For the purposes of this method, shear-fracture surfaces shall be considered as those having a dull gray silky appearance which are commonly inclined at an angle to the specimen surface. Cleavage or brittle fractures shall be considered those that are bright and crystalline in appearance and that are perpendicular to the plate surface. The cleavage fractures generally extend from the root of the notch and are surrounded by a region of shear or shear lips on the specimen surface.

7.2 Evaluate the specimens (Note 6) by determining the percent shear area of the fracture surface neglecting the fracture surface for a distance of one specimen thickness from the root of the notch and the fracture surface for a distance of one specimen thickness from the edge struck by the hammer. Fig. 2 illustrates in the cross-hatched area that portion of the fracture surface to be considered in the evaluation of the percent shear area of the fracture surface.

NOTE 6—If the specimens are to be preserved for some length of time after evaluation of the shear area or if a considerable time elapses between testing and evaluation, the fracture surfaces should be treated to keep them from corroding.

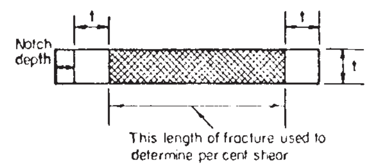

FIG. 2 Fracture Surface Included in Shear-Area Determination

7.3 Occasionally specimens will exhibit the fracture appearance shown in Fig. 3. On specimens of this type the fracture appears to have stopped and started a number of times exhibiting intermittent regions of shear and cleavage in the midthickness portion of the specimen. The shear area included in the rating of specimens of this type shall be that shown in the cross-hatched area of Fig. 3 (neglect the shear areas in the region of intermittent shear and cleavage fracture in rating the specimen).

7.4 For referee method of determining the percent shear area of the fracture surface, measure the cleavage area of the fracture surface with a planimeter on a photograph or optical projection of the fracture surface. Then divide the cleavage area by the net area of the specimen included in the rating, express as percent, and subtract from 100. Alternative methods more adaptable to routine rating are described in 7.4.1-7.4.3.

7.4.1 The percent shear area can be evaluated by comparing the fracture surfaces with a calibrated set of photographs of previously fractured specimens or with actual specimens of calibrated percent shear areas for a specific thickness. Calibrate in accordance with 7.4.

7.4.2 The percent shear area can be evaluated with the procedure described in Annex A1.

7.4.3 The percent shear area can be evaluated with any other procedure that has been demonstrated to produce results equivalent to those obtained in 7.4.

7.5 Fig. 4 shows five DWTT specimens that have been tested over the temperature range from − 17 to 16°C (0 to

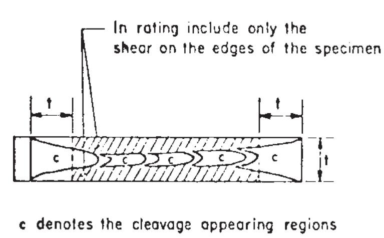

FIG. 3 Alternative Shear-Cleavage Fracture Appearance