



Standard Test Method for Apparent Hoop Tensile Strength of Plastic or Reinforced Plastic Pipe by Split Disk Method¹

This standard is issued under the fixed designation D 2290; 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 (€) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

€¹ NOTE—Keywords editorially added in November 2003.

1. Scope

1.1 This test method covers the determination of the comparative apparent tensile strength of most plastic products utilizing a split disk test fixture, when tested under defined conditions of pretreatment, temperature, humidity, and test machine speed. This test method is applicable to reinforced-thermosetting resin pipe regardless of fabrication method. This test method also is applicable to extruded and molded thermoplastic pipe.

Procedure A is used for reinforced-thermosetting resin pipe; Procedure B is used for thermoplastic pipe of any size; Procedure C is used for thermoplastic pipe with nominal diameter of 4-½ in. and greater.

1.2 The values stated in inch-pound 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:

D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing²

D 1599 Test Method for Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing, and Fittings³

E 4 Practices for Force Verification of Testing Machines⁴

3. Summary of Test Method

3.1 The test specimen is loaded through the suggested self-aligning split disk test fixture (Fig. 1) which applies tensile

stress to the test ring. An apparent tensile strength rather than a true tensile strength is obtained in this test because of a bending moment imposed during test at the split between the split disk test fixture. This moment is induced by the change in contour of the ring between the two disk sections as they separate. The test fixture is designed to minimize the effect of this bending moment.

4. Significance and Use

4.1 Split disk tension tests, properly interpreted, provide reasonably accurate information with regard to the apparent tensile strength of plastic pipe when employed under conditions approximating those under which the tests are made.

4.2 Tension tests may provide data for research and development, engineering design, quality control, acceptance or rejection under specifications, and for special purposes. The test cannot be considered significant for applications differing widely from the load-time scale of the standard test.

NOTE 1—Procedure C has been used on polyethylene and polybutylene pipe to produce results equivalent to Quick Burst results (Test Method D 1599) for 4 in. to 8 in. pipes.

5. Apparatus

5.1 *Micrometers*—Suitable ball-type micrometers, reading to at least 0.001 in., for measuring the width and thickness of the test specimens.

5.2 *Testing Machine*—A universal testing machine of the constant-rate-of-cross-head-movement type and comprising essentially the following:

5.2.1 *Drive Mechanism*—A drive mechanism for imparting to the crosshead a uniform controlled velocity with respect to the base, this velocity to be regulated as specified in Section 9.

5.2.2 *Load Indicator*—A load-indicating mechanism capable of showing the total tensile load carried by the test specimen. This mechanism shall be essentially free from inertia lag at the specified rate of testing and shall indicate the load with an accuracy of ±1 % of the indicated value. The accuracy of the testing machine shall be verified in accordance with Method E 4.

¹ This test method is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.40 on Test Methods.

Current edition approved June 10, 2000. Published September 2000. Originally published as D 2290 – 64 T. Last previous edition D 2290 – 92.

² *Annual Book of ASTM Standards*, Vol 08.01.

³ *Annual Book of ASTM Standards*, Vol 08.04.

⁴ *Annual Book of ASTM Standards*, Vol 03.01.

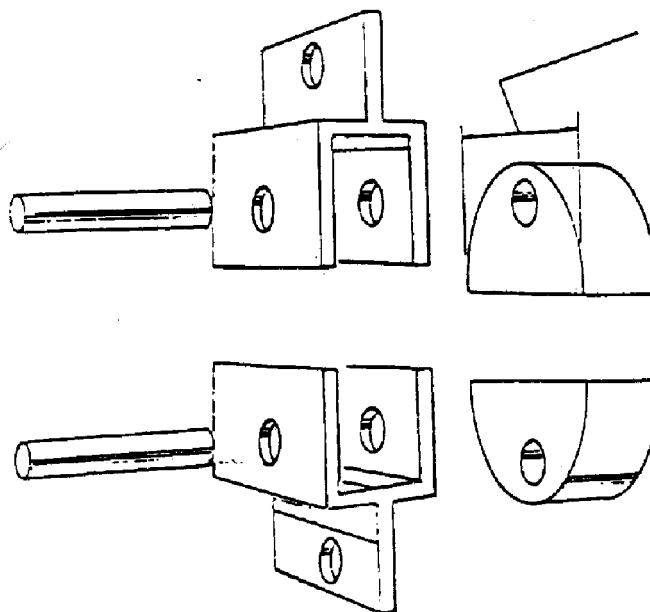


FIG. 1 Test Fixture: Typical

5.3 Test Fixture—The recommended test fixture is shown in Fig. 1. The width of the split disk for Procedure A shall be at least 0.1 in. greater than the width of the specimen. The width of the split disk for Procedure B shall be 0.5 in. \pm 0.05 in. The width of the split disk for Procedure C shall be 2.0 in. \pm 0.1 in. The supports for holding the tension test fixture shall be self-aligning, that is, they shall be attached to the fixed and movable member of the test machine, respectively, in such a manner that they move freely into alignment as soon as any load is applied, so that the direction of the applied pull is directly perpendicular to the split axis of the test fixture.

5.4 Conditioning Apparatus—Apparatus for maintaining the standard laboratory atmospheric temperature of $23 \pm 2^\circ\text{C}$ ($73.4 \pm 3.6^\circ\text{F}$) and $50 \pm 5\%$ relative humidity for conditioning prior to test, as defined in Procedure A of Methods D 618, shall be used, except 24 h will be the minimum time period.

6. Test Specimen

6.1 Test specimen for Procedure A shall be full-diameter, full-wall thickness rings cut from reinforced thermosetting resin pipe by any suitable means. Specimens shall conform to Fig. 2. Specimens shall have a minimum overall width of 0.90 in., and a minimum width in the reduced section(s) of 0.55 in. The number of reduced areas shall be one or two. If two, they must be located 180° apart. Reduced areas must be centered relative to the specimen width to within 0.05 in.

6.2 Test specimens for Procedure B shall be full-diameter, full-thickness rings cut from thermoplastic pipe, by any suitable means, as shown in Fig. 3. The reduced cross sections shall be located at the point of minimum wall thickness and at 180° thereto except when the test is used for specialized purposes (see Note 2). The specimen must be free of machining marks and uniform in cross section.

NOTE 2—The reduced sections for the extruded or molded specimens can be located at any points on the periphery of the specimen provided

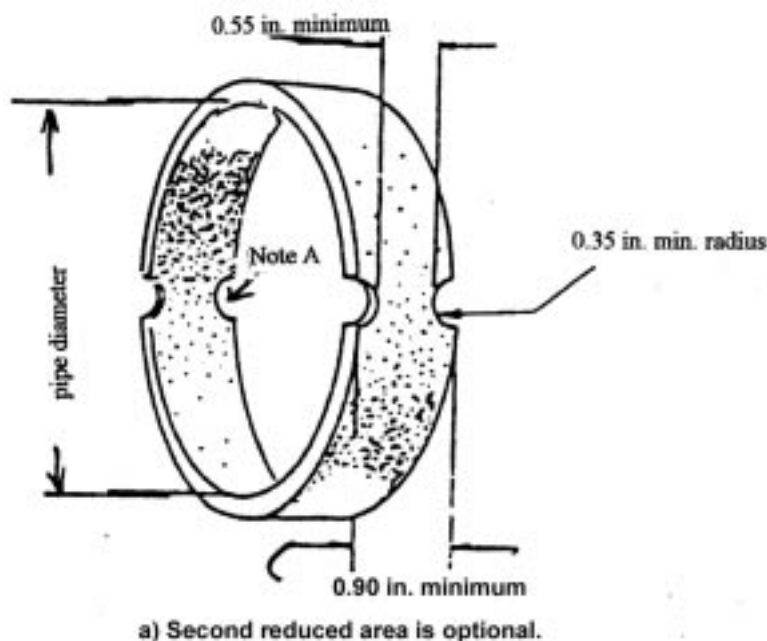


FIG. 2 Reduced-Section Specimens for Procedure A

they are 180° apart, that is, even at the weld or “knot” line of the specimen if the strength of these areas is being investigated.

6.3 Test specimens for Procedure C shall be cut normal to the pipe axis with parallel sides. The width of the specimen shall be nominally 1.75 in. to 2.00 in. Two areas, one of which includes the minimum pipe wall thickness and the other 180° deg opposite, shall be wet sanded to remove cutting marks; care must be exercised to retain the rectangular cross-section of the prepared areas.

6.4 Number of Test Specimens—The number of test specimens is optional; however, a minimum of five specimens is needed to obtain a reliable average for a sample.

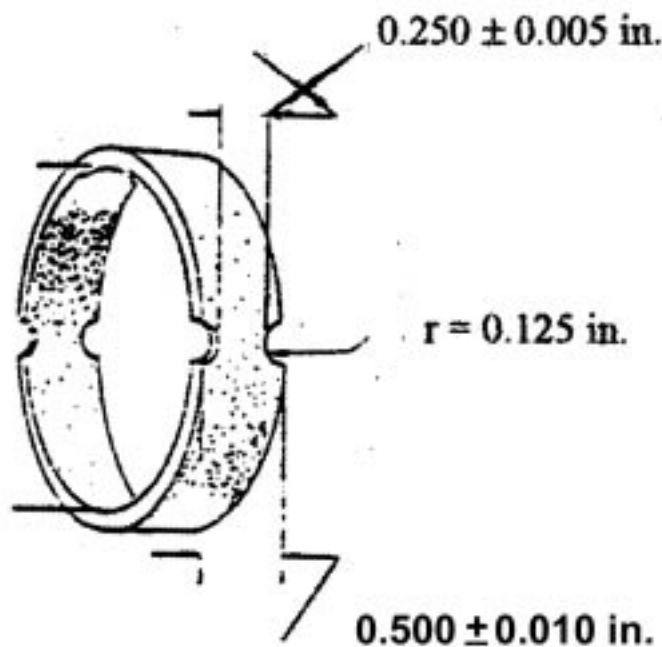


FIG. 3 Reduced Section Specimen for Procedure B

7. Conditioning

7.1 *Conditioning*—Condition the test specimens at $23 \pm 2^\circ\text{C}$ ($73.4 \pm 3.6^\circ\text{F}$) and $50 \pm 5\%$ relative humidity for not less than 24 h prior to test in accordance with Procedure A of Methods D 618 for those tests where conditioning is required. In cases of disagreement, the tolerances shall be $\pm 1^\circ\text{C}$ ($\pm 1.8^\circ\text{F}$) and $\pm 2\%$ relative humidity.

7.2 *Test Conditions*—Conduct tests in the standard laboratory atmosphere of $23 \pm 2^\circ\text{C}$ ($73.4 \pm 3.6^\circ\text{F}$) and $50 \pm 5\%$ relative humidity, unless otherwise specified in the test methods or in this specification. In cases of disagreement, the tolerances shall be $\pm 1^\circ\text{C}$ ($\pm 1.8^\circ\text{F}$) and $\pm 2\%$ relative humidity.

7.3 Special conditioning procedures may be used by agreement between cooperating laboratories.

8. Speed of Testing

8.1 Speed of testing is velocity of separation of the two members of the testing machine when running idle (under no load). Speed of testing shall be 0.1 in./min (ipm) minimum and 0.5 ipm maximum for Procedure A. It shall be 0.5 ipm for Procedures B and C.

9. Procedure

9.1 *Procedure A* (parallel-fiber-reinforced specimens):

9.1.1 Measure the minimum width of the reduced area(s) to the nearest 0.001 in., using a suitable micrometer.

9.1.2 Mount the specimen on the lubricated periphery of the test fixture, with the reduced area(s) centered 2.0 ± 0.2 in. away from the split in the disk.

9.1.3 Run the test at a constant speed between 0.1 and 0.5 ipm.

9.1.4 Record the maximum load carried by the specimen during the test.

9.2 *Procedure B:*

9.2.1 Measure the width and thickness of the reduced sections to the nearest 0.001 in. using a ball-type micrometer or a dial indicator. Record the width and thickness of both cross-sectional areas.

9.2.2 Mount the test specimen on the split disk test fixture with the reduced sections at the split in the fixture. Align the test specimen on the split disk specimen holder so that it is centered on the line joining the points of attachment of the fixture to the test machine.

9.2.3 Set the speed control at 0.50 in./min and start the test machine.

9.2.4 Record the yield and ultimate loads carried by the specimen during the test.

9.3 *Procedure C:*

9.3.1 Measure the width and thickness of the prepared areas to the nearest 0.001 in. using a ball anvil type micrometer. Record the width and thickness of both prepared cross-sectional areas.

9.3.2 Mount the test specimen on the outside of the split disk fixture with the prepared and measured areas located at the split in the fixture. Align the test specimen on the test fixture so that it is centered on the line joining the points of attachment to the test machine.

9.3.3 Set the speed control at 0.50 in./min and start the machine.

9.3.4 Record the yield point and maximum load carried by the specimen during the test.

9.3.5 Record the crosshead separation required to rupture the test specimen.

10. Calculation

10.1 Calculate the apparent tensile strength (at yield or rupture, or both) of the specimen using the appropriate equation and report to three significant figures.

$$\sigma_a = P_b / 2A_m \text{ (Procedure A)} \quad (1)$$

$$\text{or: } P_b / (d_1 b_1 + d_2 b_2) \text{ (Procedure B or C)} \quad (2)$$

where:

σ_a = apparent yield or ultimate tensile stress of the specimen, MPa (or psi),

P_b = maximum or breaking load, or both, N (or lbf),

A_m = minimum cross-sectional area of the two measurements, $d \times b$, in.²,

d = thickness at minimum area, in.,

d_1, d_2 = thickness at reduced or test sections, in.,

b = width at minimum area, in., and

b_1, b_2 = width of reduced or test sections, in.

10.2 For each series of tests, calculate the arithmetic mean of all values obtained to three significant figures and report as the “average value” for the particular property in question.

10.3 Calculate the standard deviation as follows and report to two significant figures:

$$s = \sqrt{\frac{\sum X^2 - n\bar{X}^2}{n - 1}} \quad (3)$$

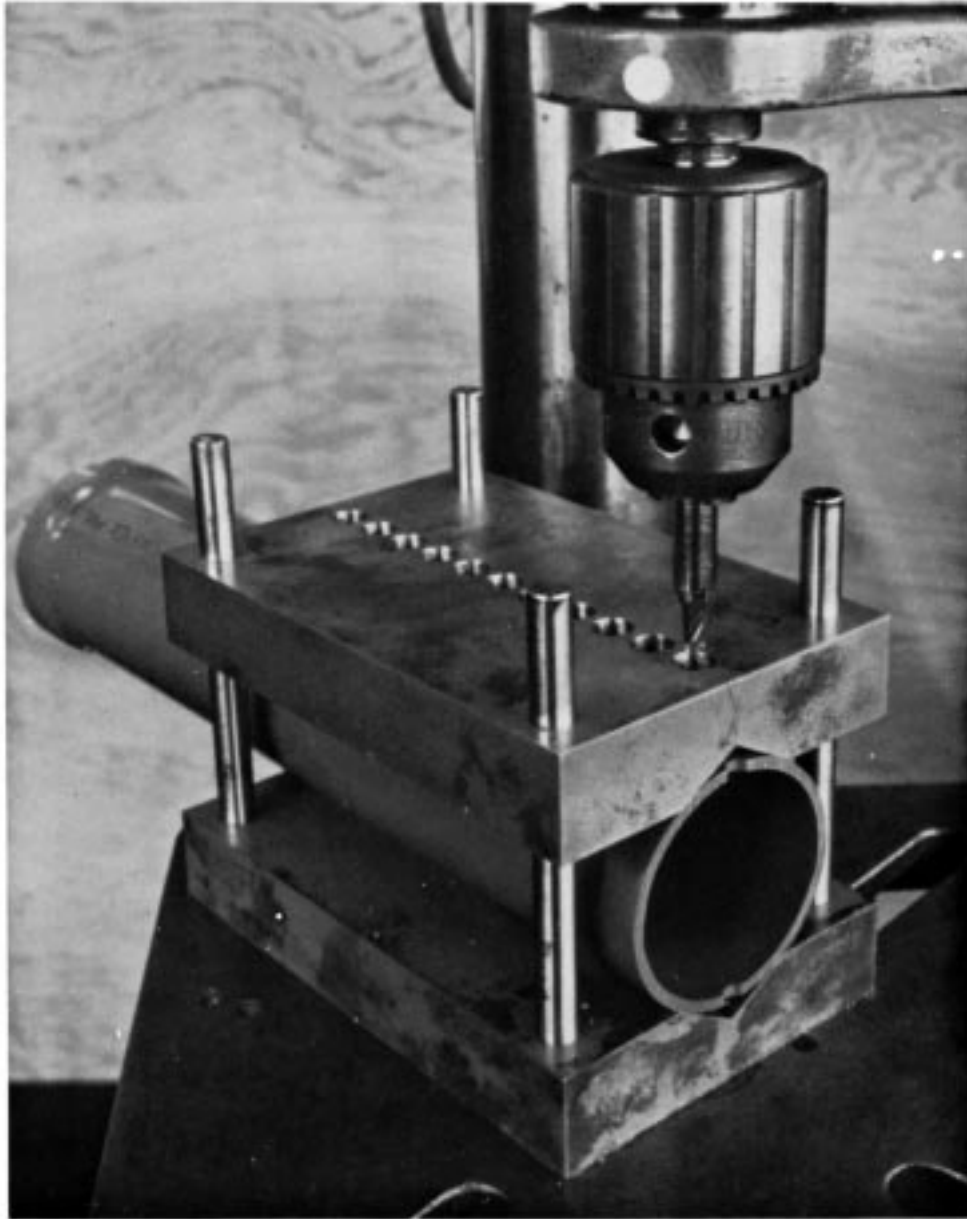


FIG. 4 Fixture for Preparation of Reduced-Section Ring Tensile Specimens

where:

- s = estimated standard deviation,
- X = value of single observation,
- n = number of observations, and
- \bar{X} = arithmetic mean of the set of observations.

11. Report

11.1 The report shall include the following:

- 11.1.1 Complete identification of the material tested, including type, source, manufacturer's code number, form, principal dimensions, and previous history.
- 11.1.2 Fabrication procedure,
- 11.1.3 Type specimen used,

- 11.1.4 Thickness and width of test cross-sectional area,
- 11.1.5 Conditioning procedure used,
- 11.1.6 Atmospheric conditions in test room,
- 11.1.7 Number of specimens tested,
- 11.1.8 Rate of crosshead motion,
- 11.1.9 Apparent composite tensile strength of each specimen, and average calculated and reported to three significant figures,
- 11.1.10 Standard deviation (estimated) of the sample calculated and reported to two significant figures,
- 11.1.11 Average resin content weight percent of specimens when applicable, and
- 11.1.12 Date of test.

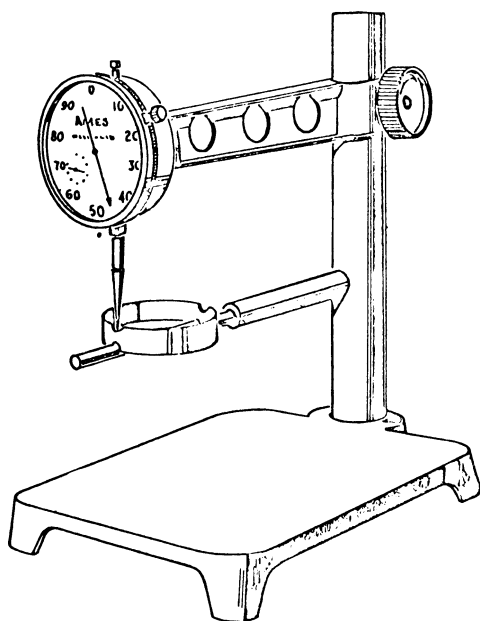


FIG. 5 Instrument for Measuring Ring Tensile Specimens

12. Precision and Bias

12.1 Because of the nature of the materials and a lack of a wide data base on a variety of applicable composites, no definitive statement can be made at this time concerning precision and bias of this test method.

13. Keywords

13.1 apparent tensile strength; hoop tensile strength; plastic pipe; split-disk method

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