Designation: A 438 – 80 (Reapproved 1997)

# Standard Test Method for Transverse Testing of Gray Cast Iron[1]

This standard is issued under the fixed designation A 438; 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.

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

## 1. Scope

1.1 This test method covers a procedure for performing transverse bending tests on separately cast cylindrical test bars of gray cast iron.

1.2 *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. Significance and Use

2.1 A transverse bending test on an unmachined test bar of gray cast iron is useful as a rapid and inexpensive means for estimating the approximate strength of the test bar, but is not a dependable substitute for a tension test on a machined specimen (Explanatory Note 1). The test yields easily measured deflection values which are useful for comparing the relative ductilities of different test bars of gray cast iron (Explanatory Note 2). The test can also be used to calculate a modulus of rupture or an apparent modulus of elasticity (Explanatory Note 3).

## 3. Dimensions and Form of Test Bars

3.1 The test bars shall be separate castings of essentially cylindrical shape (Explanatory Note 4), and available in three standard sizes as shown in Fig. 1 (Explanatory Note 5). They may contain a reasonable amount of pattern draft, but the diameter at the middle of the test bar shall be within the tolerances given in Fig. 1.

3.2 Molds for the test bars shall be approximately at room temperature when poured. The test bars shall be cooled in the mold to a temperature less than 900°F (490°C), and then may be cooled in still air to room temperature.

## 4. Procedure

4.1 Perform the transverse test on a bar in the as-cast (unmachined) condition, loading the bar as a simple beam with the load applied midway between the supports as shown in Fig. 1. The supports and the loading fixture shall be designed to give essentially point contact with the test bar. Satisfactory contact is considered to exist when the supports and loading fixture have a cylindrical surface with a diameter of about ¼ to 1 in. (6.4 to 25.4 mm) and when this surface is positioned normal to the length of the test bar.

4.1.1 Round bars are those whose minimum and maximum diameters, at the middle of the length of the bars, differ by less than 0.025 in. (0.64 mm) for test bar *A* and by less than 0.050 in. (1.27 mm) for test bars *B* and *C*. Determine the reported breaking load, in pounds, for round bars by dividing the actual breaking load by a correction factor (Table 1), entering the table with the arithmetic average of the minimum diameters of the bar. The load is to be applied in line with the minimum diameter.

4.1.2 Elliptical bars are those whose minimum and maximum diameters, at the middle of the length of the bar, differ by more than 0.025 in. (0.64 mm) for test bar *A* or 0.050 in. (1.27 mm) for test bars *B* and *C*. For elliptical bars, apply the load in line with the minimum diameter. Determine the reported breaking load, in pounds, by dividing the actual breaking load by a correction factor (Table 1) entering the table with the minimum diameter.

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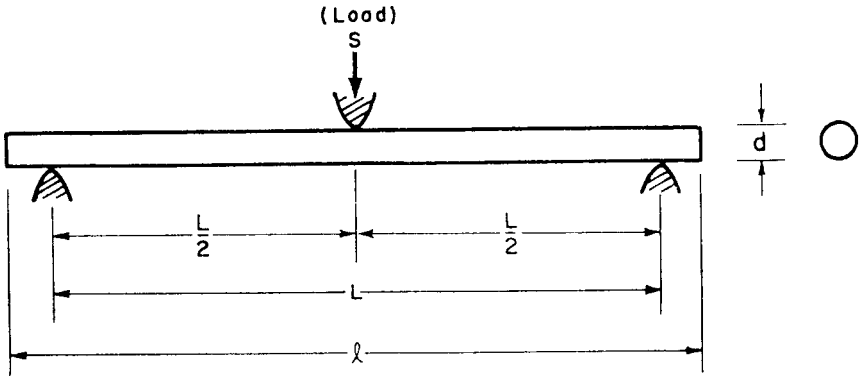
[1] This method is under the jurisdiction of ASTM Committee A04 on Iron Castings and is the direct responsibility of Subcommittee A04.21 on Testing.

Current edition approved March 28, 1980. Published July 1980. Originally published as A 438 – 60 T. Last previous edition A 438 – 62 (1974).




**Dimensions, in. (mm)**

| Transverse Test Bar | Length of Test Bar, *l* | | Diameter of Test Bar, *d* | | Distance Between, Supports, *L* |
|---|---|---|---|---|---|
| | Nominal | Tolerance | Nominal | Tolerance | |
| *A* | 15 (381) | ±1 (25.4) | 0.88 (22.4) | ±0.03 (0.8) | 12 (305) |
| *B* | 21 (533) | ±1 (25.4) | 1.20 (30.5) | ±0.06 (1.5) | 18 (457) |
| *C* | 27 (686) | ±1 (25.4) | 2.00 (50.8) | ±0.10 (2.5) | 24 (610) |

**FIG. 1 Cast Transverse Test Bars and Illustration of Method of Loading**

**TABLE 1 Correction Factors for Round Transverse Test Bars**

NOTE— In order to correct the standard nominal diameter, the actual breaking load and actual deflection obtained in testing the bar shall be divided by the following correction factors in order to obtain reported breaking load and reported deflection.

| Test Bar *A* 0.88 in. (22.4 mm) in Diameter | | | Test Bar *B* in. (30.5 mm) in Diameter | | | Test Bar *C* 2.00 in. (50.8 mm) in Diameter | | |
|---|---|---|---|---|---|---|---|---|
| Diameter of Test Bars, in. (mm) | Correction Factor | | Diameter of Test Bars, in. (mm) | Correction Factor | | Diameter of Test Bars, in. (mm) | Correction Factor | |
| | Load | Deflection | | Load | Deflection | | Load | Deflection |
| 0.825 (20.96) | 0.824 | 1.067 | 1.10 (27.9) | 0.770 | 1.091 | 1.90 (48.3) | 0.857 | 1.053 |
| 0.830 (21.08) | 0.839 | 1.060 | 1.11 (28.2) | 0.791 | 1.081 | 1.91 (48.5) | 0.871 | 1.047 |
| 0.835 (21.21) | 0.854 | 1.054 | 1.12 (28.4) | 0.813 | 1.071 | 1.92 (48.8) | 0.885 | 1.042 |
| 0.840 (21.34) | 0.870 | 1.048 | 1.13 (28.7) | 0.835 | 1.062 | 1.93 (49.0) | 0.899 | 1.037 |
| 0.845 (21.46) | 0.885 | 1.041 | 1.14 (29.0) | 0.857 | 1.053 | 1.94 (49.3) | 0.913 | 1.032 |
| 0.850 (21.59) | 0.901 | 1.035 | 1.15 (29.2) | 0.880 | 1.043 | 1.95 (49.5) | 0.927 | 1.026 |
| 0.855 (21.72) | 0.917 | 1.029 | 1.16 (29.5) | 0.903 | 1.034 | 1.96 (49.8) | 0.941 | 1.021 |
| 0.860 (21.84) | 0.933 | 1.023 | 1.17 (29.7) | 0.927 | 1.026 | 1.97 (50.0) | 0.955 | 1.015 |
| 0.865 (21.97) | 0.950 | 1.017 | 1.18 (30.0) | 0.951 | 1.017 | 1.98 (50.3) | 0.970 | 1.010 |
| 0.870 (22.10) | 0.966 | 1.011 | 1.19 (30.2) | 0.975 | 1.009 | 1.99 (50.5) | 0.985 | 1.005 |
| 0.875 (22.22) | 0.983 | 1.006 | 1.20 (30.5) | 1.000 | 1.000 | 2.00 (50.8) | 1.000 | 1.000 |
| 0.880 (22.35) | 1.000 | 1.000 | 1.21 (30.7) | 1.025 | 0.992 | 2.01 (51.0) | 1.015 | 0.995 |
| 0.885 (22.48) | 1.017 | 0.994 | 1.22 (31.0) | 1.051 | 0.984 | 2.02 (51.3) | 1.030 | 0.990 |
| 0.890 (22.61) | 1.034 | 0.989 | 1.23 (31.2) | 1.077 | 0.976 | 2.03 (51.6) | 1.046 | 0.985 |
| 0.895 (22.73) | 1.052 | 0.983 | 1.24 (31.5) | 1.103 | 0.968 | 2.04 (51.8) | 1.061 | 0.980 |
| 0.900 (22.86) | 1.070 | 0.978 | 1.25 (31.8) | 1.130 | 0.960 | 2.05 (52.1) | 1.076 | 0.976 |
| 0.905 (22.99) | 1.088 | 0.972 | 1.26 (32.0) | 1.158 | 0.952 | 2.06 (52.3) | 1.092 | 0.972 |
| 0.910 (23.11) | 1.106 | 0.967 | 1.27 (32.3) | 1.185 | 0.945 | 2.07 (52.6) | 1.109 | 0.967 |
| 0.915 (23.24) | 1.124 | 0.962 | 1.28 (32.5) | 1.214 | 0.938 | 2.08 (52.8) | 1.125 | 0.962 |
| 0.920 (23.37) | 1.142 | 0.957 | 1.29 (32.8) | 1.242 | 0.930 | 2.09 (53.1) | 1.141 | 0.957 |
| 0.925 (23.50) | 1.161 | 0.951 | 1.30 (33.0) | 1.271 | 0.923 | 2.10 (53.3) | 1.158 | 0.952 |

## EXPLANATORY NOTES

NOTE 1—The approximate general relationship between the tensile strength of gray cast iron and the corrected transverse breaking load as determined by this test method is given in Table 2.

NOTE 2—It is recommended that deflections at fracture be measured, corrected, and recorded. Correction for deviation of a test bar from the nominal diameter is made by dividing the observed deflection by the correction factors listed in Table 1 corresponding to the diameter in the direction of the line of the load. The diameter should be measured at the fracture surface. Enter Table 1 with the minimum diameter.

NOTE 3—The modulus of rupture for a round test bar tested in accordance with this test method can be calculated as follows:

$$\text{Modulus of rupture, psi} = 2.55\,SL/D^3 \quad (1)$$

where:

$S$ = breaking load, lbf,
$L$ = distance between supports, in., and
$D$ = actual diameter of round test bar, in.

The apparent modulus of elasticity for a round test bar tested according to this test method can be calculated as follows at loads and deflections prior to fracture:

**TABLE 2 Approximate General Relationship Between Tensile Strength of Gray Cast Iron and Corrected Transverse Breaking Load as Determined by This Method**

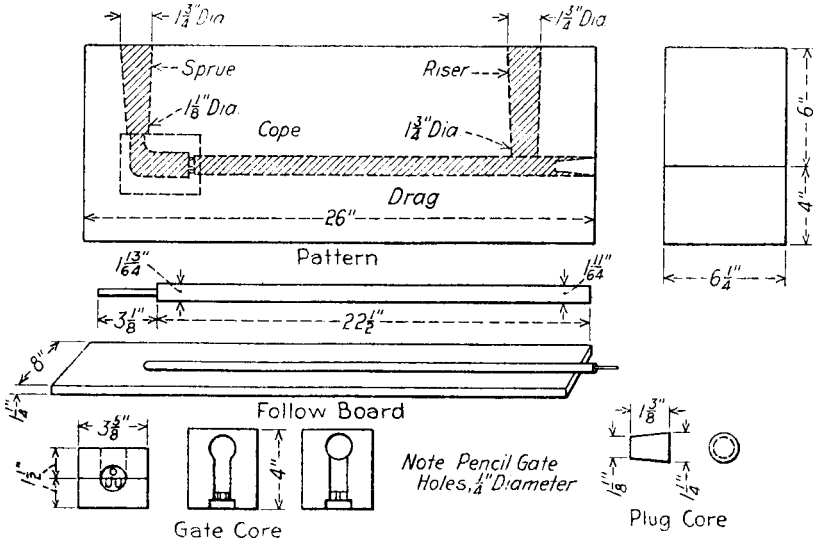
| As-Cast Test Bar . . . | | *A* | | *B* | | *C* | |
|---|---|---|---|---|---|---|---|
| Nominal Diameter of Test Bar, *d*, in. (mm) | | 0.88 (22.4) | | 1.20 (30.5) | | 2.00 (50.8) | |
| Span Between Supports, in. (mm) | | 12 (305) | | 18 (457) | | 24 (610) | |
| Approximate Tensile Strength | | Approximate Corrected Transverse Breaking Load | | | | | |
| ksi | MPa | lbf | kN | lbf | kN | lbf | kN |
| 20 | 138 | 900 | 4.00 | 1800 | 8.01 | 6 000 | 26.69 |
| 25 | 172 | 1025 | 4.56 | 2000 | 8.90 | 6 800 | 30.25 |
| 30 | 207 | 1150 | 5.12 | 2200 | 9.79 | 7 600 | 33.81 |
| 35 | 241 | 1275 | 5.67 | 2400 | 10.68 | 8 300 | 36.92 |
| 40 | 276 | 1400 | 6.23 | 2600 | 11.57 | 9 100 | 40.48 |
| 45 | 310 | 1540 | 6.85 | 2800 | 12.46 | 9 700 | 43.15 |
| 50 | 345 | 1675 | 7.45 | 3000 | 13.34 | 10 800 | 48.04 |
| 60 | 414 | 1925 | 8.56 | 3400 | 15.12 | 12 500 | 55.60 |

$$\text{Apparent modulus of elasticity, psi} = 0.424\,(SL^3/yD^4) \qquad (2)$$

where:
$S$ = load, lbf,
$y$ = deflection with load $S$ applied, in.,
$L$ = distance between supports, in., and
$D$ = actual diameter of round test bar, in.

NOTE 4—Test bars should be sound, straight, reasonably smooth, and round. Several methods of making transverse test bars are shown in Fig. 2, Fig. 3, and Fig. 4. Each of these methods has been used with satisfactory results.

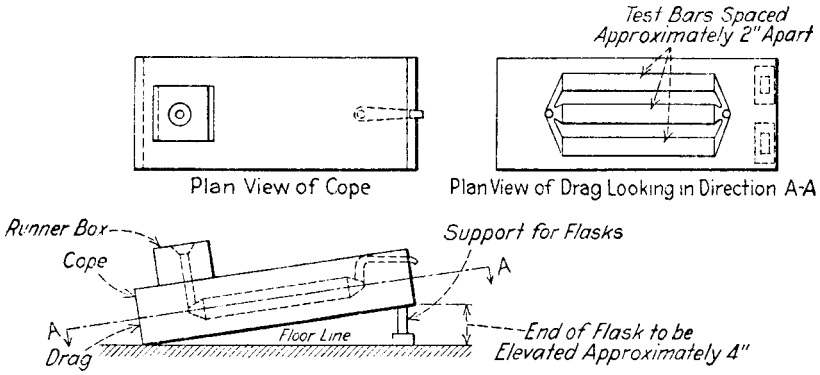
NOTE 5—The nominal diameters of the standard test bars areselected on the basis of an approximate relationship existing between the tensile strength of separately cast test bars and the tensile strength of the same iron in the walls of iron castings. The nature of this general relationship is shown in Table 3.




**Metric Equivalents**

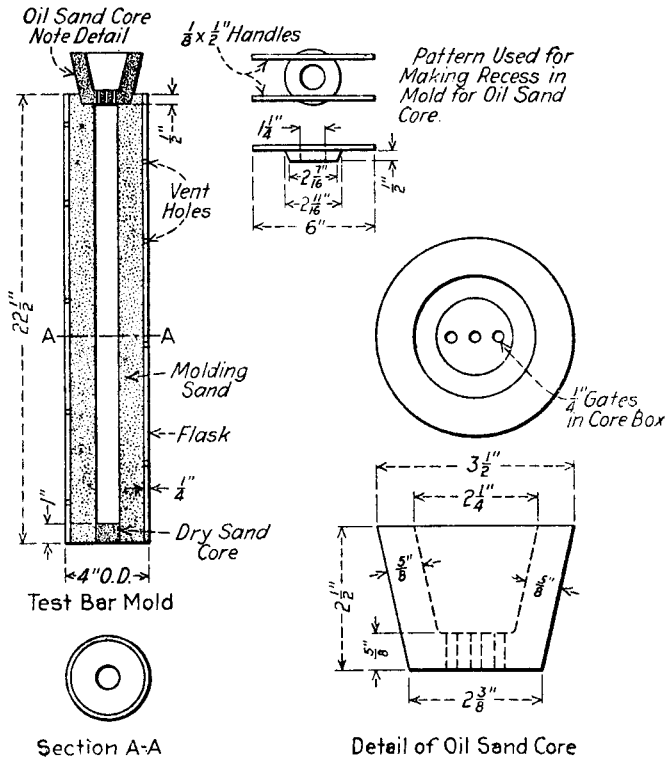
| in. | mm | in. | mm | in. | mm |
|---|---|---|---|---|---|
| 1 1/8 | 28.6 | 1 1/2 | 38.1 | 6 | 152.4 |
| 1 11/64 | 29.8 | 1 3/4 | 44.4 | 6 1/4 | 158.8 |
| 1 13/64 | 31.4 | 3 1/8 | 79.4 | 8 | 203.2 |
| 1 1/4 | 31.8 | 3 5/8 | 92.1 | 22 1/2 | 572 |
| 1 3/8 | 34.9 | 4 | 101.6 | 26 | 660 |

**FIG. 2 Transverse or Flexure Test Bar, 1.20-in. (30.5-mm) Diameter, Cast Horizontally**




Arrangement of Flasks for Casting Test Bars.

**FIG. 3 Test Bar Cast on Incline**




**Metric Equivalents**

| in. | mm | in. | mm | in. | mm |
|---|---|---|---|---|---|
| 1 / 8 | 3.2 | 1 1 / 4 | 31.8 | 2 11 / 16 | 68.3 |
| 1 / 4 | 6.4 | 2 1 / 4 | 57.2 | 3 1 / 2 | 88.9 |
| 1 / 2 | 12.7 | 2 3 / 8 | 60.3 | 4 | 101.6 |
| 5 / 8 | 15.9 | 2 7 / 16 | 61.9 | 6 | 152.4 |
| 1 | 25.4 | 2 1 / 2 | 63.5 | 22 1 / 2 | 572 |

**FIG. 4 Transverse or Flexure Test Bar Cast Vertically**

**TABLE 3 Nature of General and Approximate Relationship Between Tensile Strength in Separately Cast Cylindrical Bars and in the Walls of Castings of Gray Cast Iron**

| Transverse Test Bar | Dimensions Which Sometimes Yield Similar Tensile Strengths, in. (mm) | |
|---|---|---|
| | Nominal Diameter of Test Bar, *d* | Nominal Thickness of Walls of Casting |
| *A* | 0.88 (22.4) | 0.25 to 0.50 (6.4 to 12.7) |
| *B* | 1.20 (30.5) | 0.51 to 1.00 (13.0 to 25.4) |
| *C* | 2.00 (50.8) | 1.01 to 2.00 (25.7 to 50.8) |