
Standard Method of Test for Concrete Pipe, Manhole Sections, or Tile

AASHTO Designation: T 280M/T 280-24^{1,2}

Technically Revised: 2024

Technical Subcommittee: 4a, Concrete Drainage Structures

ASTM Designation: C497M-20a and C497-20^{e1}



**American Association of State Highway and Transportation Officials
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Washington, DC 20004**

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1. SCOPE

1.1. These test methods cover testing of concrete pipe, manhole sections, and tile. The test methods described are used in production testing and acceptance testing to evaluate the properties provided for in the specifications.

1.2. The test methods appear in the following order:

	Section
External load crushing strength	4
Flat slab tops	5
Base section test	6
Core strength	7
Absorption	8
Hydrostatic	9
Permeability	10
Manhole step	11
Cylinder strength	12
Gasket lubricant	13
Joint shear	14
Alkalinity	15
Gasket measurement	16
Off-center hydrostatic joint test	17
Hydrostatic external joint test	18
Welded splice pull test	19

1.3. The test specimens shall not have been exposed to a temperature below 4°C [40°F] for the 24 h immediately preceding the test. The thermometer for measuring the temperature of the environment immediately surrounding the specimens shall meet the requirements of M 339M/M 339, with a temperature range of at least 0 to 25°C [32 to 77°F] and an accuracy of ±1°C [±1.8°F], that records the maximum–minimum temperatures (see Note 1).

Note 1—Thermometer types suitable for use include ASTM E1 mercury thermometers; ASTM E230/E230M thermocouple thermometer, Type T standard; IEC 60584 thermocouple thermometer Type T, Class 1 or 2; or ASTM E2877 digital metal stem thermometer.

1.4. If any test specimen fails because of mechanical reasons such as failure of testing equipment or improper specimen preparation, it shall be discarded and another specimen taken.

1.5. Specimens shall be selected in accordance with the specifications for the type of pipe or tile being tested.

- 1.6. The values stated in SI units are to be regarded as the standard. U.S. Customary units follow in brackets.
- 1.7. *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.*
- 1.8. *The quality of the results produced by this standard are dependent on the competence of the personnel performing the procedure and the capability, calibration, and maintenance of the equipment used. Agencies that meet the criteria of R 18 are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard are cautioned that compliance with R 18 alone does not completely assure reliable results. Reliable results depend on many factors; following the suggestions of R 18 or some similar acceptable guideline provides a means of evaluating and controlling some of those factors.*

2. REFERENCED DOCUMENTS

2.1. *AASHTO Standards:*

- M 231, Weighing Devices Used in the Testing of Materials
- M 262, Concrete Pipe and Related Products
- M 339M/M 339, Thermometers Used in the Testing of Construction Materials
- R 18, Establishing and Implementing a Quality Management System for Construction Materials Testing Laboratories
- R 100M/R 100, Making and Curing Concrete Test Specimens in the Field
- T 22M/T 22, Compressive Strength of Cylindrical Concrete Specimens
- T 24M/T 24, Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
- T 231, Capping Cylindrical Concrete Specimens

2.2. *ASTM Standards:*

- A 370, Standard Test Methods and Definitions for Mechanical Testing of Steel Products
- C 670, Standard Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials
- C 1231/C 1231M, Standard Practice for Use of Unbonded Caps in Determination of Compressive Strength of Hardened Cylindrical Concrete Specimens
- D 2240, Standard Test Method for Rubber Property—Durometer Hardness
- E 1, Standard Specification for ASTM Liquid-in-Glass Thermometers
- E 4, Standard Practices for Force Verification of Testing Machines
- E 230/E 230M, Standard Specification for Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples
- E 879, Standard Specification for Thermistor Sensors for General Purpose and Laboratory Temperature Measurements
- E 1137/E 1137M, Standard Specification for Industrial Platinum Resistance Thermometers
- E 2877, Standard Guide for Digital Contact Thermometers

2.3. *International Electrotechnical Commission Standards:*

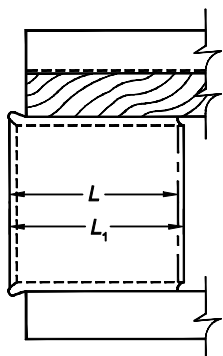
- IEC 60584-1:2013, Thermocouples - Part 1: EMF Specifications and Tolerances
- IEC 60751:2008, Industrial Platinum Resistance Thermometers and Platinum Temperature Sensors

3. TERMINOLOGY

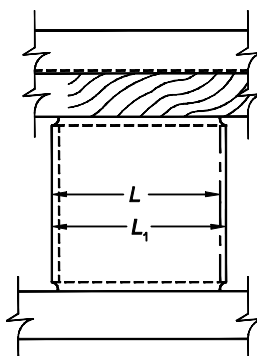
- 3.1. *Definitions*—For definitions of terms relating to concrete pipe, see M 262.

4. EXTERNAL LOAD CRUSHING STRENGTH TEST BY THE THREE-EDGE-BEARING TEST METHOD

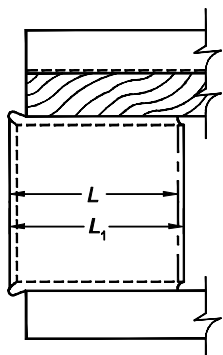
- 4.1. *Summary of Test Method*—The test specimen is tested in a machine designed to apply a crushing force upon the specimen in a plane through the vertical axis extending along the length of the specimen.
- 4.2. *Significance and Use*—The crushing test shall be either a quality-control test performed to establish that the finished, shippable pipe has sufficient strength to withstand the crushing loads stated in the specifications or a proof of design test performed to prove the adequacy of design.
- 4.3. *Apparatus*:
- 4.3.1. The testing machine shall be of any type of sufficient capacity and shall be capable of providing the rate of loading prescribed in Section 4.5.3.
- 4.3.2. The testing machine shall be substantial and rigid throughout, so that the distribution of the load will not be affected appreciably by the deformation or yielding of any part.
- 4.3.3. The three-edge-bearing method of loading shall be used. The test specimen shall be supported on a lower bearing of two parallel longitudinal strips and the load applied through an upper bearing (see Figures 1, 2, 3, and 4). At the option of the manufacturer, either or both the lower bearing and the upper bearing beam shall extend the full length or any portion of the length of the specimen (see Figure 5).



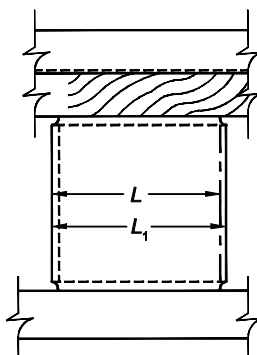
Modified Tongue and Groove Pipe



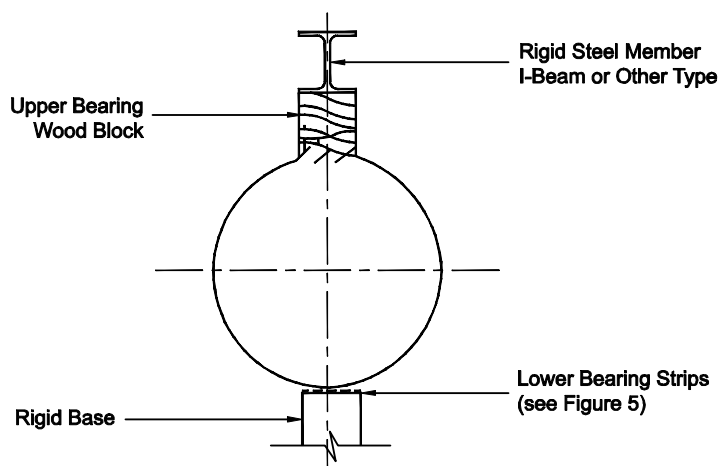
Tongue and Groove Pipe



Bell and Spigot Pipe



Plain End or Cut Pipe

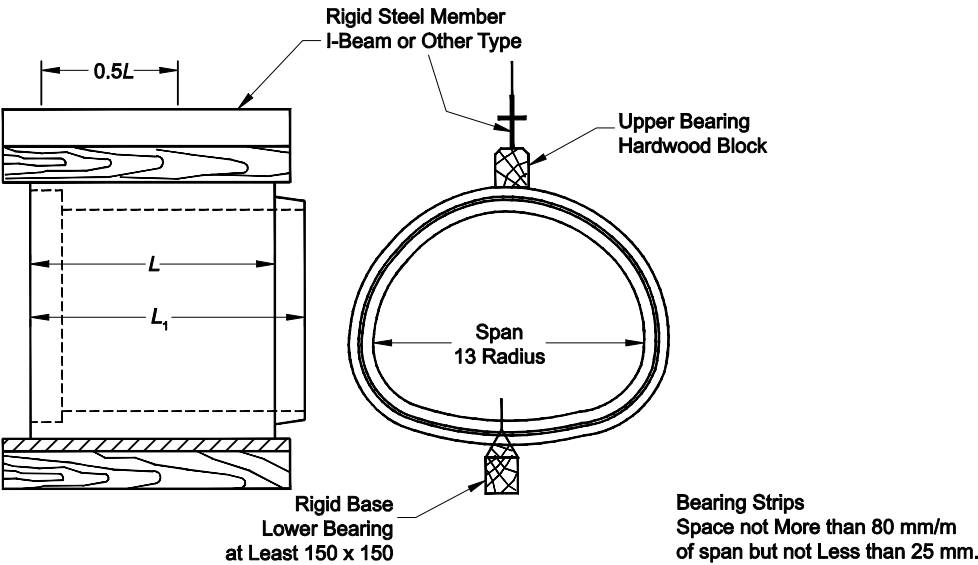


Note: The figures illustrate a method of applying the load to the pipe.

Figure 1—Three-Edge-Bearing Test, Circular Pipe

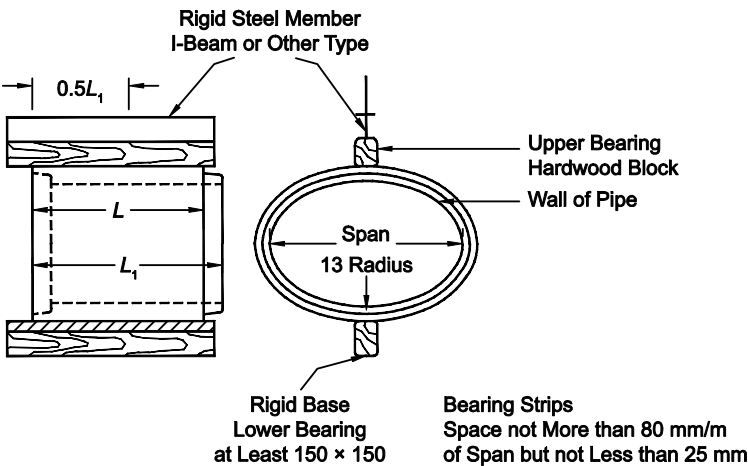
SI Equivalents for Values in Figures 1 through 13

0.3 mm	0.01 in.	80 mm/m	1 in./ft
1.5 mm	$\frac{1}{16}$ in.		
3 mm	$\frac{1}{8}$ in.	0.25 mm/mm	$\frac{1}{4}$ in./in.
13 mm	$\frac{1}{2}$ in.		
25 mm	1 in.	250 mL/min	0.07 gal/min
50 mm	2 in.		
75 mm	3 in.	26.25 kN	1800 lb
100 mm	4 in.	58.33 kN	4000 lb
125 mm	5 in.		
150 mm	6 in.	21°C	70°F
600 mm	2 ft		



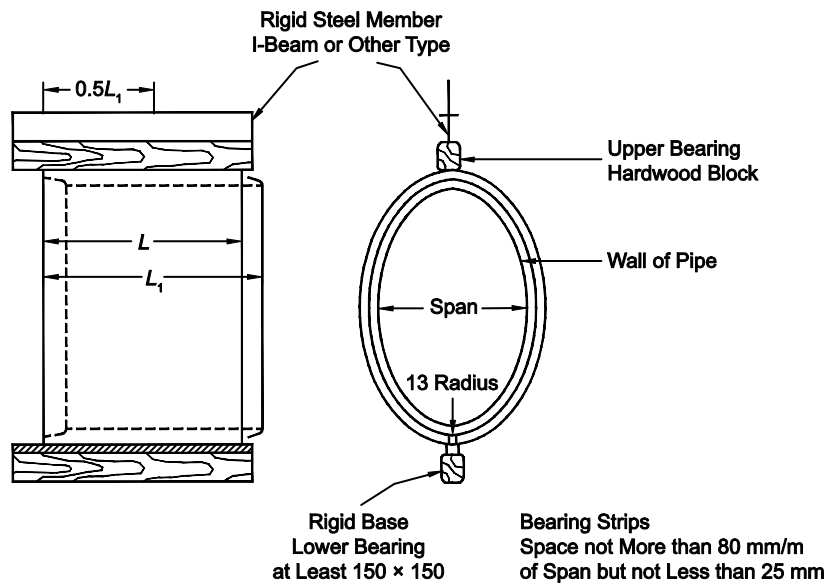
Note: The figures illustrate a method of applying the load to the pipe.

Figure 2—Three-Edge-Bearing Test, Arch Pipe



Note: The figure illustrates a method of applying the load to the pipe.

Figure 3—Three-Edge-Bearing Test, Horizontal Elliptical Pipe



Note: The figure illustrates a method of applying the load to the pipe.

Figure 4—Three-Edge-Bearing Test, Vertical Elliptical Pipe

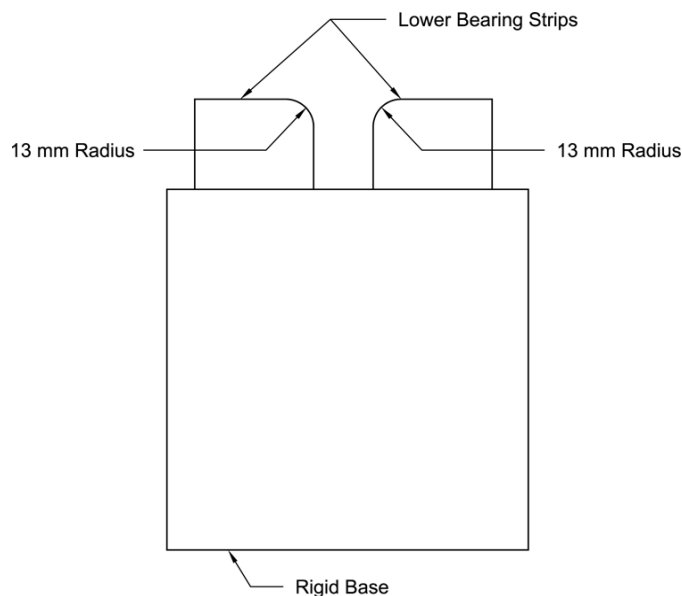


Figure 5—Lower Bearing Strip Detail

- 4.3.4. The lower bearings shall consist of wood or hard rubber strips. Wooden strips shall be straight, have a cross section of not less than 50 mm [2 in.] in width and not less than 25 mm [1 in.] nor more than 38 mm [1½ in.] in height, and shall have the top inside corners rounded to a radius of 13 mm [½ in.]. Hard rubber strips shall have a durometer hardness of not less than 45 nor more than 60. They shall be rectangular in cross section, having a width of not less than 50 mm [2 in.], a thickness of not less than 25 mm [1 in.] nor more than 38 mm [1½ in.], and shall have the top inside corner rounded to a radius of 13 mm [½ in.].

- 4.3.5. The lower bearing strips shall be fastened to a wooden or steel beam or directly to a concrete base, any of which shall provide sufficient rigidity so that deflection is not greater than $\frac{1}{720}$ of the specimen length when the maximum load is applied. The rigid base shall be at least 150 mm [6 in.] wide. The interior vertical sides of the strips shall be parallel and spaced a distance apart of not more than 80 mm/m [1 in./ft] of specimen diameter, but in no case less than 25 mm [1 in.]. The bearing faces of the lower strips shall not vary from a straight line vertically or horizontally by more than 2.5 mm/m [$\frac{1}{32}$ in./ft] of length under no load.
- 4.3.6. The upper bearing shall be a rigid wood beam with or without an attached hard rubber strip. The wood block shall be sound, free of knots, and straight and true from end to end. It shall be fastened to a steel or wood-faced steel beam of such dimensions that deflections under maximum load will not be greater than $\frac{1}{720}$ of the specimen length. The bearing face of the upper bearing block shall not deviate from a straight line by more than 2.5 mm/m [$\frac{1}{32}$ in./ft] of length. When a hard rubber strip is used on the bearing face, it shall have a durometer hardness of not less than 45 nor more than 60, and shall have a width of not less than 50 mm [2 in.] and a thickness of not less than 25 mm [1 in.] nor more than 38 mm [$1\frac{1}{2}$ in.] and shall be secured to a wood beam meeting the above requirements.
- 4.3.7. If mutually agreed upon by the manufacturer and the owner prior to the test, before the specimen is placed, a fillet of plaster of paris not exceeding 25 mm [1 in.] in thickness shall be cast on the surface of the upper and lower bearings. The width of the fillet cap, upper or lower, shall not be more than 80 mm/m [1 in./ft] of the specimen diameter, but in no case less than 25 mm [1 in.].
- 4.3.8. The equipment shall be so designed that the load will be distributed about the center of the overall length (L_1) of the specimen (Figures 1, 2, 3, and 4). At the option of the manufacturer, the center of the load shall be applied at any point of the overall length (L_1) of the specimen. The load shall be applied either at a single point or at multiple points dependent on the length of the specimen being tested and the rigidity of the test frame.
- Note 2**—The user of these test methods is advised that multiple points of load applications to the upper bearing will permit use of lighter beams without excess deflection.
- 4.4. *Calibration*—The loading device shall be one that shall provide an accuracy of ± 2 percent at the specified test loads. A calibration curve shall be used. The machines used for performing the three-edge-bearing tests shall be verified in accordance with ASTM E4.
- 4.5. *Procedure:*
- 4.5.1. Place the specimen on the two lower bearing strips in such a manner that the pipe or tile rests firmly and with uniform bearing on each strip.
- 4.5.2. Mark the two ends of the specimen at a point midway between the lower bearing strips and then establish the diametrically opposite point on each end. Place the upper bearing so that it is aligned with these marks.
- 4.5.3. For reinforced concrete pipe, any rate of load application up to a maximum of 110 kN/linear m [7500 lbf/linear ft] of pipe per min shall be used up to 75 percent of the specified design strength, at which time the rate of loading shall be reduced to a maximum uniform rate of one third of the specified design strength of the pipe per min. This rate of loading shall be continuous until the specified acceptance design strength is reached. If both the design strength and the ultimate strength are being determined, a specified rate of loading need not be maintained after the acceptance design strength has been reached. For nonreinforced concrete pipe, any rate of load application up to a maximum of 110 kN/linear m [7500 lbf/linear ft] of pipe per min may be used up to 75 percent of the specified ultimate strength, at which time the rate of loading shall be reduced to the maximum uniform rate of 44 kN/linear m [3000 lbf/linear ft] of pipe per min. At

the manufacturer's option, the rates of loading in this paragraph shall be any rates that do not exceed the specified maximums.

- 4.5.4. As defined in M 262, the design strength is the maximum load, expressed as a D-load, supported by the pipe before a crack having a width of 0.3 mm [0.01 in.] occurs throughout a continuous length of 300 mm [1 ft] or more measured parallel to the longitudinal axis of the pipe barrel. The crack is 0.3 mm [0.01 in.] in width when the point of the measuring gauge will, without forcing, penetrate 1.5 mm [$\frac{1}{16}$ in.] at close intervals throughout the specified distance of 300 mm [1 ft]. Measure the width of the crack by means of a gauge made from a leaf 0.3 mm [0.01 in.] in thickness (as in a set of standard machinist gauges), ground to a point of 1.5 mm [$\frac{1}{16}$ in.] in width with corners rounded and with a taper of 0.25 mm/mm [$\frac{1}{4}$ in./in.] as shown in Figure 6.

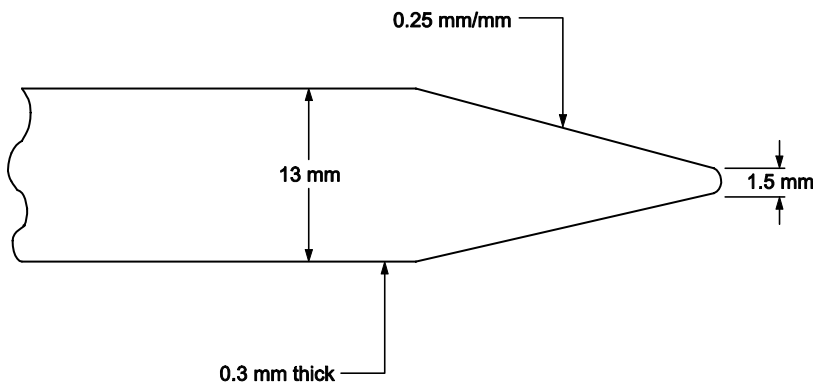


Figure 6—Gauge Leaf for Measuring Cracks

Note 3—As used in this specification, the 0.3-mm [0.01-in.] crack is a test criterion for pipe under load in three-edge-bearing tests and is not intended as an indication of overstressed or failed pipe under installed conditions.

- 4.5.5. As defined in M 262, the ultimate strength is the maximum load supported by the pipe.

Note 4—Ultimate strength of concrete pipe in the buried condition is dependent on varying soil bedding factors and varying failure modes and shall have no relationship to the ultimate strength as defined under three-edge-bearing conditions.

- 4.6. *Conditioning*—The moisture requirements of Section 1.3 are not required, at the option of the manufacturer.

- 4.7. *Calculations:*

- 4.7.1. Strength test results shall be calculated in terms of newtons per linear meter [pounds per linear foot]. The length used in calculating the strength values shall be that indicated by L in Figures 1, 2, 3, and 4. For pipe with a bell, the manufactured length (L) is the length from the spigot/tongue end face to the bell/groove inside shoulder. For straight wall pipe, no bell, the manufactured length (L) is the same as for pipe with a bell or the alternate of the length from the spigot/tongue outside shoulder to the socket/groove end face. For plain end or cut pipe, no bell or spigot, the length L is the same as the overall length. For pipe having a spigot on one end with the opposite end being plain, the manufactured length (L) shall be the distance from the plain end to the bell inside shoulder. See M 262 for definitions of manufactured length (L) and overall length (L_1).

- 4.7.2. The ultimate strength in kilonewtons per linear meter [pounds per linear foot] shall be calculated by dividing the maximum test load applied to the pipe by the laying length L .