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Standard Methods of Testing ASBESTOS-CEMENT PIPE[1]

This Standard is issued under the fixed designation C 500; 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

1. Scope

1.1 These methods cover the testing of asbestos-cement pipe for hydrostatic strength, flexural strength, crushing strength, and uncombined calcium hydroxide, and are for use in connection with the individual specifications for asbestos-cement pipe.

1.2 The test methods appear in the following order:

	Sections
Hydrostatic Proof Test	3 to 5
Flexure Proof Test	6 to 8
Crushing Test	9 to 11
Straightness Test	12 to 13
Uncombined Calcium Hydroxide Test	14 to 18
Environmental Aggressiveness	19 to 25

2. Applicable Documents

2.1 *ASTM Standards:*

E 11 Specification for Wire-Cloth Sieves for Testing Purposes[2]

HYDROSTATIC PROOF TEST

3. Significance

3.1 The hydrostatic proof test is performed to establish the fact that finished, shippable material has strength to withstand the internal bursting pressures stated in the specifications. The strength level required by the specifications assures that a minimum strength is maintained and that the pipe will not leak or weep in service and will accommodate the stresses simultaneously induced by internal pressure, earth loads, and surge pressures.

4. Description of Term

4.1 *Hydrostatic Strength*, as used in this method, refers to the ability of the pipe and coupling sleeve to withstand the forces resulting from internal pressure.

5. Procedure

5.1 Place the pipe, coupling, or pipe and coupling with factory-assembled joint, in a hydrostatic pressure testing machine with gaskets that seal the ends but exert no end pressure. Expel all air and apply the internal water pressure at a uniform rate of not less than 100 psi/s (689 kPa/s) to the specified pressure; maintain the pressure at this level for not less than 5 s. Couplings may instead be tested with a rubber bladder inside of the coupling.

FLEXURE PROOF TEST

6. Significance

6.1 The flexure proof test is a quality control test performed to establish the fact that finished, shippable material has sufficient strength to withstand the minimum applied loads stated in the specifications. These proof test loads provide adequate strengths to resist transverse bending loads normally encountered in field service when good bedding methods are employed by the installer.

7. Description of Term

7.1 *Flexural Strength*, as used in this method, refers to the ability of a standard pipe section to withstand external loads bearing on the pipe transversely to its longitudinal axis that induce bending in the section.

8. Procedure

8.1 Support the pipe in a flexure testing

[1] These methods are under the jurisdiction of ASTM Committee C-17 on Asbestos-Cement Products.

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[2] *Annual Book of ASTM Standards*, Parts 13, 14, 15, 18, 26, 30, and 41.

machine over a clear span of 9 ft (2.74 m). Unless otherwise specified, it shall be optional with pipe lengths in excess of 12½ ft (3.8 m) to test at 75 % of the specified loads on supports 12 ft (3.66 m) apart. Apply the load at a uniform rate of at least 250 lbf/s (1.1 kN/s) until it equals the proof load specified; maintain this load for at least 5 s. Distribute the load equally and apply at the third points of the clear span as indicated in Fig. 1.

8.2 Failure of the flexural proof test shall be considered to have taken place when a break occurs in the pipe as a result of the flexural load being applied to the pipe during the test prior to reaching the minimum flexural load, or while holding at the minimum flexural load, designated in the specification.

CRUSHING TEST

9. Significance

9.1 The crushing test establishes the fact that the pipe has sufficient strength to withstand the crushing loads stated in the specifications. The strength level required by the specifications assures minimum strengths that will satisfactorily withstand the magnitude of loads normally encountered in field service with a reasonable margin of safety.

10. Description of Term

10.1 *Crushing Strength*, as used in this method, refers to the ability of the pipe to withstand external loads that tend to collapse the pipe.

10.2 Failure of the crushing test shall be considered to have taken place when a break occurs in the pipe as a result of the crushing load being applied to the pipe during the test prior to reaching the minimum crushing load designated in the specifications.

11. Procedure

11.1 *Three-Edge-Bearing Method:*

11.1.1 *Wooden-Bearing Surfaces*—Test each specimen by the three-edge-bearing method as indicated in Fig. 2.

11.1.1.1 The lower bearing for the specimen consists of two strips with vertical sides, having their interior top corners rounded to a radius of approximately ½ in. (13 mm). The strips shall be of hardwood or metal; if metal, a piece of leather belting 3⁄16 in. (5 mm) in thickness shall be laid over them. They shall be straight and be fastened securely to the bearing block with their vertical interior sides parallel and spaced a distance apart as follows: for sizes up to and including 16 in. (400 mm), the space shall be 1 in. (25 mm); for sizes 18 through 27 in. (450 through 675 mm), the space shall be 2 in. (50 mm); for sizes 30 in. (750 mm) and above, the space shall be 3 in. (75 mm). Tolerances are −0, + ⅛ in. (−0, + 3 mm).

11.1.1.2 The upper bearing shall be a rigid wooden block, straight and true from end to end. The upper and lower bearing shall extend the full length of the outside of the specimen. Place the specimen symmetrically between the two bearings, and so place the center of application of the load that the vertical deformation at the two ends of the specimen will be equal.

11.1.2 *Rubber-Bearing Surfaces*—Test each specimen by the basic three-edge method indicated in Fig. 2 except that the bearing surfaces shall be rubber. The rubber shall be cut or formed from material having a durometer hardness between 45 and 60. The strips shall be of rectangular cross section having a width of 2 in. (50 mm) and a thickness of not less than 1 in. (25 mm) nor more than 1½ in. (38 mm).

11.1.2.1 Use two parallel strips on the bottom bearing spaced a distance apart of approximately 1 in. (25 mm)/ft of pipe diameter, but in no case less than 1 in. Lay the bottom strips on the 2-in. (50-mm) dimension and position on the bearing with wood or metal strips between them and adjacent to their outside edges, provided the thickness of these positioning strips does not exceed one half the thickness of the rubber-bearing strips.

11.1.2.2 Use the top-bearing edge with the 2-in. (50-mm) dimension of rubber in contact with the pipe. Position it on the upper bearing (see 11.1.1.2) by the use of wood or metal strips along its outside edges, provided the thickness of the positioning strips does not exceed one half the thickness of the rubber-bearing edge. The rubber-bearing strips may be attached to the bearings by adhesive, if desired, provided such method of attachment results in the strip remaining firmly fixed in position.

11.1.3 *Wood-Bearing Surfaces with Plas-*

ter-of-Paris Fillets—Test each specimen by the basic three-edge method indicated in Fig. 2. The bearing surfaces shall not have a cross section smaller than 1 in. (25 mm) in either dimension. They shall be straight and securely fastened to the bearing block with their vertical interior sides parallel and spaced a distance apart of approximately 1 in./ft of internal pipe diameter, but in no case less than 1 in.

11.1.3.1 Before the pipe is placed on the bottom bearing, a fillet of plaster of paris thick enough to compensate for the inequalities of the pipe barrel shall be cast on and between the lower-bearing edges. The pipe shall be placed on the fillet while the plaster of paris is still workable, and prior to the time of initial set.

11.1.3.2 The upper-bearing edge shall be the same as that described in 11.1.1.2. A fillet of plaster of paris thick enough to compensate for the inequalities of the pipe barrel shall be cast along the length of the pipe crown. The upper bearing shall be brought in contact with the plaster of Paris while it is still workable and prior to initial set.

11.1.4 *Sand-Bearing Surfaces*—Test each specimen by the basic three-edge method indicated in Fig. 2 except that the wooden surfaces are replaced with sand-bearing surfaces. The sand-bearing edges should be made from heavy canvas duck or woven-cloth hose such as is commonly used for fire hose. They shall have a diameter not less than 2 in. (50 mm) nor more than $2^1/_2$ in. (63 mm) and shall be filled with tightly packed dry sand such as will pass a No. 6 (3.35-mm) sieve conforming to the requirements of Specification E 11. The ends of the bags shall be tightly stitched or fastened to prevent escape of the sand.

11.1.4.1 Use two parallel bags on the bottom bearing spaced a distance of approximately 1 in. (25 mm)/ft of pipe diameter, but in no case less than 1 in. Determine the spacing by measuring between the points of closest approach of the bags before loading. Use a positioning strip between the bags to secure alignment and spacing, provided it is withdrawn before the pipe is tested.

11.1.4.2 Place the top-bearing bag on the crown of the pipe so that its longitudinal center line parallels as nearly as possible the longitudinal axis of the specimen, and bring the top bearing into contact with it.

11.1.5 For all four test methods apply the load at a uniform rate of 2000 ± 500 lbf/min · linear ft (29.2 ± 7.3 kN/min · linear m).

NOTE 1—When the ultimate load exceeds 6000 lbf/linear ft (87.6 kN/linear m), the load may be applied at a rapid rate until 75 % of ultimate is reached. From then on apply the load at the rate of 2000 ± 500 lbf/min · linear ft (29.2 ± 7.3 kN/min · linear m).

11.1.6 Record the load.

11.2 *Sand-Bearing Method:*

11.2.1 When the sand-bearing method is used, carefully bed the specimen for its full length in sand, above and below, for one fourth of the circumference of the pipe measured on the middle line of the barrel. To facilitate placing of the specimen accurately in the sand, mark each end accurately into quarters of the circumference. The depth of the bedding above and below the pipe at the shallowest points shall be one half the mean radius of the barrel.

11.2.1.1 The sand shall be clean natural sand, or crushed hard rock, that will all pass a No. 4 (4.76-mm) sieve conforming to the requirements of Specifications E 11. The sand shall have a moisture content of not less than 5 percent at the time of test. The sand in the lower bearing shall be loose and uncompacted when a specimen is placed on it.

11.2.1.2 The frames of the bearings shall be made of timbers heavy enough to avoid appreciable bending from the side pressure of the sand. The interior surfaces of the frames shall be dressed. No part of the frames shall come in contact with the pipe during the test. A rigid top plate shall be made heavy enough to avoid appreciable bending. Attach a strip of cloth between the frame and the test specimen. Place the frame on the specimen and carefully bed the specimen for its full length in the cloth covered sand for one fourth of the circumference of the pipe. Level the upper surface of the sand in the top bearing with a straightedge and cover the entire frame with the rigid top plate. Apply the rigid top bearing plate used for the three-edge-bearing method to the top of that plate. Apply the load to the top-bearing plate at the center preferably through a spherical head

11.2.1.3 Apply the load at a uniform rate of 2000 ± 500 lbf/min·linear ft (29.2 ± 7.3 kN)/min·linear m) (Note 1).

11.3 *V-Shaped Bearing Method:*

11.3.1 Test each specimen by the V-shaped bearing method as indicated in Fig. 3.

11.3.2 The lower press-block consists of a V-shaped support having an included angle of 150 deg, made of metal or hardwood. Interpose strips of rubber of suitable width and length between the press-block and the test piece. The rubber strips shall be 0.6 in. (15 mm) thick and a hardness of 60 ± 5 Shore A durometer.

11.3.3 The flat upper press-block, made of the same material shall have a width of 8 in. (200 mm). Interpose a strip of rubber of suitable width and length between the press-block and the test piece. The rubber strip shall be 0.6 in. (15 mm) thick and a hardness of 60 ± 5 Shore A durometer.

11.3.4 Apply the load at a uniform rate so that failure will occur not less than 15 s and not more than 30 s.

STRAIGHTNESS TEST

12. Significance

12.1 The straightness test covers the measurement of the maximum deviation from straightness of a length of asbestos-cement pipe.

13. Procedure

13.1 Measure the maximum ordinate from the exterior surface of the pipe by placing a straightedge that exceeds the pipe length against the exterior surface and measuring the maximum distance from the exterior pipe surface to the straightedge.

UNCOMBINED CALCIUM HYDROXIDE TEST

14. Significance

14.1 This method covers the measurement of the amount of uncombined calcium hydroxide in asbestos-cement pipe to establish the fact that the pipe has the required chemical resistance. Criteria for suitability to environmental aggressiveness is given in Section 19.

15. Description of Term

15.1 *Uncombined Calcium Hydroxide*—The chemical resistance of the pipe is related to the uncombined calcium hydroxide determined when using this method.

16. Reagents

16.1 *Ammonium Acetate, Standard Solution (1 ml $= 0.0066$ g $Ca(OH)_2$)*—Dissolve 16.0 g dry crystalline ammonium acetate in 1 litre of absolute or anhydrous ethanol (Note 2). Standardize the solution against calcium oxide (CaO) in accordance with 17.3 and 17.4.

16.1.1 Calculate the calcium hydroxide ($Ca(OH)_2$) equivalent, in grams per millilitre, as follows:

$$Ca(OH)_2 \text{ equivalent, g/ml} = (A \times 1.32)/B$$

where:

A = grams of CaO used, and

B = millilitres of ammonium acetate required for the titration.

NOTE 2—Specially denatured alcohol conforming to Formula No. 30, 3a, or 2b of the U. S. Bureau of Internal Revenue, or alcohol consisting of 95 percent specially denatured alcohol conforming to Formula No. 3a plus 5 percent isopropanol may be substituted.

16.2 *Phenolphthalein Indicator Solution*—Dissolve 1.0 g of phenolphthalein in 100 ml of absolute ethanol (Note 2).

16.3 *Glycerol-Ethanol Solvent (1 + 2)*—Mix 1 volume of glycerol with 2 volumes anhydrous or absolute ethanol (Note 2). To each litre of this solution, add 2.0 ml of phenolphthalein indicator solution. Adjust the solvent to slightly basic with either dilute sodium hydroxide (NaOH) in absolute ethanol (Note 2) or standard ammonium acetate solution, depending on the original pH.

16.4 *Strontium Nitrate* ($Sr(NO_3)_2$).

17. Procedure

17.1 Prepare representative samples of pipe or sleeves and immediately sieve them through a No. 20 (850-μm) sieve. Place the material passing the sieve immediately into a weighing bottle and cover with its ground-glass top.

17.2 Place the bottle, with top removed, in a drying oven at 105 C (220 F) for 2 h, and then cool in a desiccator to room temperature.

17.3 Weigh out 1 ± 0.010 g of the dried sample from a pipe or sleeve to the nearest 0.001 g and place it in a dry 250-ml Erlenmeyer flask. Add a TFE-fluorocarbon encapsulated stirring bar, 60 ml of the glycerol ethanol solvent, and 2.0 g of $Sr(NO_3)_2$. At-

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tach the flask to a water-cooled condenser (with a standard-taper 24/40 glass joint) and place on a hot plate with a magnetic stirrer.

17.4 Boil the solution gently for 30 min with mild stirring. Then remove the flask and filter the mixture on a Büchner funnel under vacuum. Bring the filtrate to a boil and titrate with ammonium acetate solution to a colorless end point. Observe the end point by comparison with a similar mixture containing no phenolphthalein indicator.

18. Calculations

18.1 Calculate the percentage of uncombined $Ca(OH)_2$ in the sample as follows:

$$Ca(OH)_2, \text{ percent} = (AB/C) \times 100$$

where:

A = $Ca(OH)_2$ equivalent of ammonium acetate solution, in grams per millilitre,
B = millilitres of ammonium acetate required for titration of the solution, and
C = grams of sample used.

ENVIRONMENTAL AGGRESSIVENESS

19. Significance

19.1 The maximum limits of uncombined calcium hydroxide permitted by the specifications assure that the pipe will withstand the chemical action encountered in service.

20. Summary of Method

20.1 These sections intend to establish guidelines for the definition of aggressive water and soil environments for the selection of the proper type of asbestos-cement pipe. The aggressive environments caused by internal and external waters, external soil conditions, and (nonacid) soluble sulfate contents of waters and soils should be considered separately even though they may exist in combination.

21. Aggressiveness of Water Transported Through Asbestos-Cement Pipes

21.1 Aggressiveness of water is classified as follows:

Highly aggressive	$pH + \log(AH) < 10.0$
Moderately aggressive	$pH + \log(AH) = 10.0$ to 11.9
Nonaggressive	$pH + \log(AH) > 12.0$

where,

pH = index of acidity (or alkalinity) of the water, standard pH units,
A = total alkalinity, ppm as $CaCO_3$, and
H = calcium hardness, ppm as $CaCO_3$.

21.2 *Type of Asbestos-Cement Pipe for Use with Aggressive Waters*—The following table shows the type of pipe to be used with aggressive waters as described in 21.1:

Water	Pipe Recommended
Highly aggressive	[A]
Moderately aggressive	Type II
Nonaggressive	Types I and II

[A] The serviceability of pipe for such applications should be established by the purchaser in conjunction with the manufacturer

NOTE 3—ASTM Type I and II asbestos-cement pipe may be used where the amount of uncombined calcium hydroxide is unspecified, but generally considered to exceed 1 %. ASTM Type II asbestos-cement pipe should be used where the amount of uncombined calcium hydroxide does not exceed 1.0 %.

22. Aggressiveness of Water External to Asbestos-Cement Pipe

22.1 The following table establishes guidelines for the use of asbestos-cement pipe in nonsulfate acidic soils based upon minimum pH factors alone. Asbestos-cement pipe may or may not perform satisfactorily in acid soil environments having pH values below those listed in this table. To determine the suitability of asbestos-cement pipe in soils having lower pH values, evaluate each situation individually, taking into consideration all aspects of the soil environment that affect its corrosiveness to asbestos-cement pipe:

Water Conditions Within Soil Environment	pH of Acidic Soils When Using Asbestos-Cement Pipe min	
	Type I	Type II
Essentially quiescent	5.0	4.0
Mildly fluctuating	5.5	5.0
Rapidly moving or grossly cyclic	6.3	5.5

23. Aggressiveness of Nonacidic ($pH \geq 7.0$) Soluble Sulfate in Water and Soils

23.1 The following table rates aggressiveness of nonacidic ($pH \geq 7.0$) soluble sulfates in water and soils to asbestos-cement pipe

Sulfate Aggressiveness	SO_4 in Water ppm	SO_4 in Soil ppm
Nonaggressive	150 and less	1000 and less
Mildly aggressive	150 to 1500	1000 to 2000
Moderately aggressive	1500 to 10 000	2000 to 20 000
Highly aggressive	10 000 and above	20 000 and above

23.2 The chemical resistance of asbestos-cement pipe to nonacidic acid ($pH \geq 7.0$) soluble sulfates in water and soils is as follows

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Type I pipe	will be attacked to various degrees by all but the nonaggressive levels of sulfate concentrations in waters and soils (see Note 3)[3]
Type II pipe	resistant to all levels of soluble sulfates

24. Aggressiveness of Acid (pH < 7.0) Soluble Sulfate Waters and Soils to Asbestos-Cement Pipe

24.1 Acid-sulfate soils and waters, whether the acid is inorganic or organic, must be evaluated independently of the criteria and guidelines set forth in Sections 22 and 23, taking into consideration soil permeability and other factors. For guidance, consult the manufacturer.

NOTE 4—This same criteria can be applied to appraise the corrosion resistance of other types of asbestos-cement products.

25. Limitations and References

25.1 Special consideration is recommended for services outside these guidelines.

25.2 These guidelines are based on exposures within the temperature range from 40 to 80°F (4 to 27°C). For pipe exposures to temperatures beyond these limits, consult the manufacturer.

[3] Guidelines for sulfate resistance of portland cement products were taken from the *Concrete Manual*, 8th Ed., Bureau of Reclamation, 1975. Sulfate resistance here applies to all soluble sulfates, regardless of the cation.

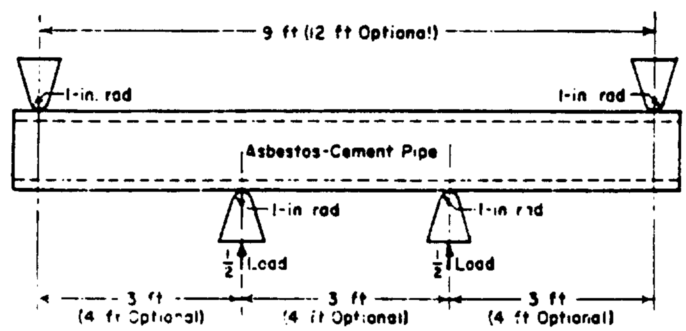

FIG. 1 Assembly for Flexure Strength Test.

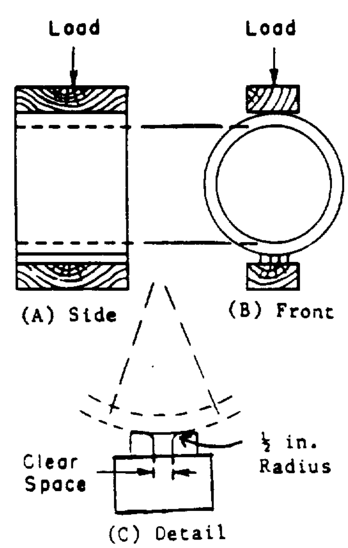

FIG. 2 Assembly for Crushing Strength Test.

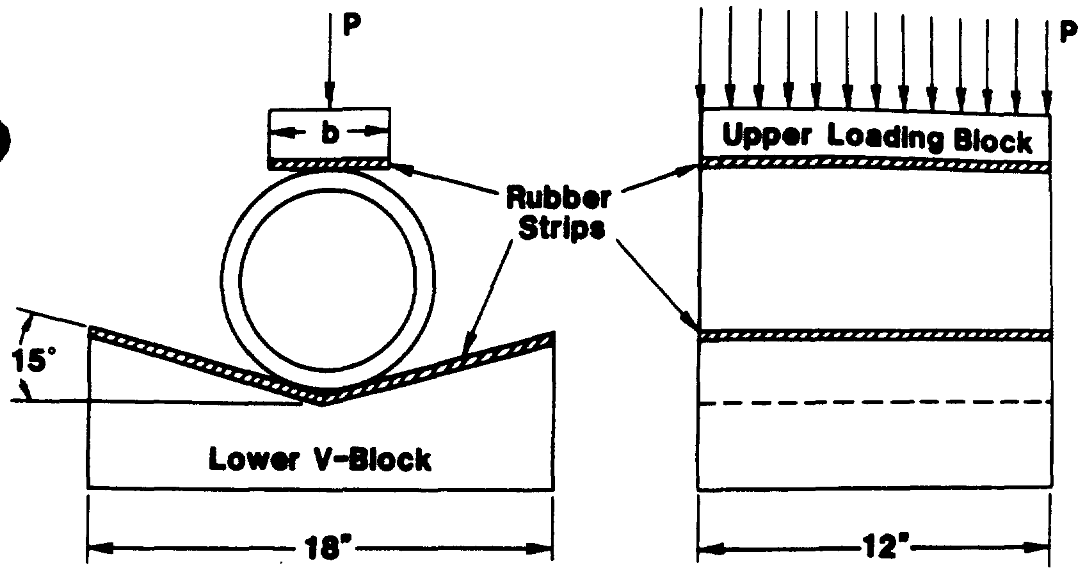

FIG. 3 Assembly for V-Shaped Crushing Strength Test

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