



Standard Test Methods for Asbestos-Cement Pipe¹

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1. Scope

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

1.2 Test methods appear in the following sections:

	Section
Hydrostatic Pressure Test	4
Flexural Test	5
Crushing Test	6
Straightness Test	7
Uncombined Calcium Hydroxide Test	8

1.3 Guidelines for internal and external corrosion included in Section 9 serve as an aid in determining the type of pipe which should be specified to maximize service life for a particular application.

1.4 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.5 *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 1067 Test Methods for Acidity or Alkalinity of Water²
- D 1126 Test Method for Hardness in Water²
- D 2946 Terminology for Asbestos and Asbestos-Cement Products³
- E 11 Specification for Wire-Cloth Sieves for Testing Purposes⁴
- E 50 Practices for Apparatus, Reagents, and Safety Consid-

erations for Chemical Analysis of Metals, Ores, and Related Materials⁵

E 200 Practice for Preparation, Standardization, and Storage of Standard and Reagent Solutions for Chemical Analysis⁶

2.2 BNQ Standard:

BNQ 3807-098 Vulcanized Rubber: Hardness Determination⁷

2.3 Other Standard:

Regulation No. 3, Formula for Completely and Specifically Denatured Alcohol⁸

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *crushing strength*—a property of solid material that indicates its ability to withstand collapse from external compressive loads.

3.1.1.1 *Discussion*—Consider failure of the crushing test to have taken place when, as a result of application of the crushing load to the pipe during the test, a break occurs in the pipe before reaching the minimum crushing load designated in the specification.

3.1.2 *flexural strength*—the ability of a standard pipe longitudinal section to withstand external loads that bear on the pipe transversely to its longitudinal axis and induce bending.

3.1.3 *hydrostatic strength*—the ability of the pipe and coupling sleeve to withstand the forces resulting from internal pressure.

3.1.4 *uncombined calcium hydroxide*—the content of unreacted calcium hydroxide that remains in the sample of cured product when tested.

NOTE 1—See Terminology D 2946 for additional terms.

4. Hydrostatic Pressure Test

4.1 *Significance and Use*—The hydrostatic pressure test establishes the fact that the pipe has sufficient strength to withstand the hydrostatic pressure loads stated in the specifications. The strength level required by the specifications

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² *Annual Book of ASTM Standards*, Vol 11.01.

³ *Annual Book of ASTM Standards*, Vol 04.05.

⁴ *Annual Book of ASTM Standards*, Vol 14.02.

⁵ *Annual Book of ASTM Standards*, Vol 03.05.

⁶ *Annual Book of ASTM Standards*, Vol 15.05.

⁷ Bureau de Normalisation du Québec, Department of Industry and Commerce, 50 St. Joseph St. East, Quebec, QC, Canada G1K 3A5.

⁸ Published by the US Treasury Department, Bureau of Industrial Alcohol, Washington, DC.

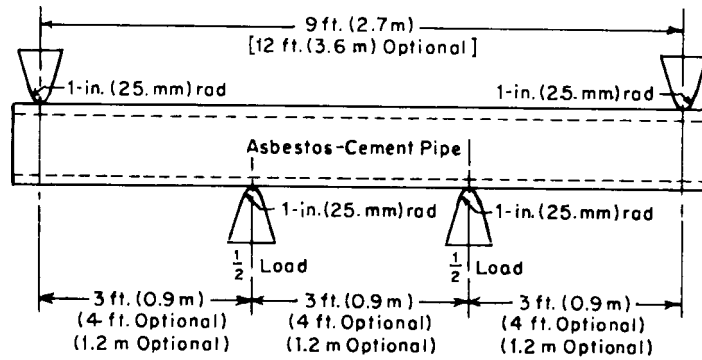


FIG. 1 Assembly for Flexural Strength Test

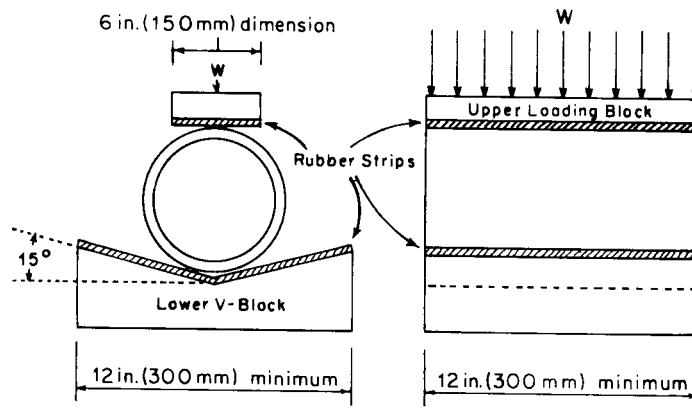


FIG. 2 Assembly for V-Shaped Crushing Strength Test

assures, with a reasonable or designed margin of safety, minimum strengths that will satisfactorily withstand the magnitude of internal operating and surge pressures that are normally encountered in field service.

4.2 Procedure:

4.2.1 Place the pipe, coupling, or pipe and coupling with a 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 690 kPa/s (100 psi/s) nor more than 10 MPa/s (1500 psi/s) to the specified pressure; maintain the pressure.

4.2.1.1 Couplings may be tested separately with a rubber bladder inside of the coupling.

4.2.2 Consider failure of the hydrostatic pressure test to have taken place when the pipe or coupling fails to sustain the test pressure for the 5-s period.

5. Flexural Test

5.1 *Significance and Use*—The flexural test establishes the fact that the pipe has sufficient strength to withstand the flexural bending loads stated in the specifications. Provided that proper bedding methods are employed by the installer, the strength level required by the specifications assures minimum strengths that will satisfactorily withstand the magnitude of transverse bending loads normally encountered in field service.

5.2 Procedure:

5.2.1 Support the pipe in a flexural testing machine over a clear span of 2.75 m (9 ft). Distribute the load equally, and

apply the load at the third points of the clear span as indicated in Fig. 1. Unless otherwise specified, it shall be optional with pipe lengths in excess of 3.8 m (12.5 ft) to test at 75 % of the specified loads on supports 3.65 m (12 ft) apart. Apply the load at a uniform rate between 1.1 and 10 kN/s (250 and 2300 lbf/s) until it equals the proof load specified; maintain this load for at least 5 s.

5.2.2 Consider failure of the flexural proof test to have taken place when, as a result of application of the flexural load to the pipe during the test, a break occurs in the pipe either before reaching the minimum flexural load that is designated in the specification or while holding at that minimum flexural load.

6. Crushing Test

6.1 *Significance and Use*—The crushing test establishes the fact that the pipe has sufficient strength to withstand the crushing loads stated in the specifications. Provided that proper bedding methods are employed by the installer, the strength level required by the specifications ensures minimum strengths that will, with a reasonable margin of safety, satisfactorily withstand the magnitude of external crushing loads normally encountered in field service.

6.2 Procedure:

6.2.1 V-Shaped Three Edge Bearing Method:

6.2.1.1 Test each specimen by the V-shaped bearing method as indicated in Fig. 2.

6.2.1.2 The lower press-block consists of a V-shaped support that has an included angle of 2.6 rad (150°) and is made of metal or hardwood. Interpose strips of rubber of the thickness

and width specified in 6.2.1.3 between the press-block and the test piece.

6.2.1.3 The rubber strips shall be 16 ± 3 mm (0.625 ± 0.125 in.) thick and have a hardness between 50 and 68 DIDC (45 and 65 Shore A durometer)⁹ as specified in BNQ 3807-098.

6.2.1.4 The flat upper press-block, made of the same material as the lower press-block, shall have a minimum width of 15 cm (6 in.). Interpose a strip of rubber of the thickness and hardness specified in 6.2.1.3 between the press-block and the test piece.

7. Straightness Test

7.1 *Significance and Use*—The straightness test covers the measurement of the maximum deviation from straightness of a standard length of asbestos-cement pipe.

7.2 *Procedure*—Determine the outer diameter of each pipe at both ends and in the middle (the middle diameter is generally greater). Calculate the differences in outer diameter between each end and the middle. Either with a rigid straightedge that exceeds the pipe length and is placed in contact with one end of the pipe, or, on a plane surface upon which the pipe is rolled, measure the maximum ordinate between the exterior surface of the pipe and the reference plane. Correct this measurement for the differences in outer diameter determined between the middle and each end of the pipe to obtain a deviation from straightness. Perform the straightness determination over the entire perimeter of the pipe, and note the maximum deviation from straightness determined.

8. Uncombined Calcium Hydroxide Test

8.1 *Significance and Use*—The uncombined calcium hydroxide test method covers the measurement of the amount of uncombined calcium hydroxide in asbestos-cement pipe in order to establish the fact that the pipe has the required chemical resistance. Guidelines for resistance to internal and external corrosion are given in Section 9.

8.2 *Reagents (Analytical Grade Reagents):*

8.2.1 Use reagents specified in Practice E 50.

8.2.2 Follow directions in Practice E 200.

8.2.3 *Solution No. 1*—For each sample prepare approximately 500 cm³ of solution containing 150 cm³ of acetoacetic ester and 350 cm³ of absolute ethyl alcohol. (See 2.3.)

8.2.4 *Solution No. 2*—For each sample prepare approximately 100 cm³ of solution containing 1 g of NaOH and 100 cm³ of absolute ethyl alcohol.

8.2.5 *Solvent for Extraction of Free Lime*—For each sample prepare around 500 cm³ of solvent containing approximately 500 cm³ of solution No. 1 and 1 cm³ of solution No. 2.

8.2.6 *Rinsing Solvent*—Some 250 cm³ of isobutyl alcohol are required per sample.

8.2.7 *Titration Agent:*

8.2.7.1 For each sample, prepare approximately 250 cm³ of titrating agent containing 4.1 cm³ of 72 % perchloric acid or 6.823 g of solid perchloric acid (HClO₄·2H₂O) in 200 cm³ of isobutyl alcohol, and make up the volume to 250 cm by adding isobutyl alcohol.

8.2.7.2 Standardize the titrating agent by titration against standardized potassium biphthalate such as potassium hydrogen phthalate primary standard (such as Fisher P243) COOKHOCOC₆H₄ after having lightly ground the latter and dried it at 120°C for 2 h. Refer to Practice E 200.

8.2.8 *Indicator:*

8.2.8.1 Use a mixture of equal parts of methylene blue solution C₁₆H₁₈ClN₃S·3H₂O (such as Fisher A-766), with thymol blue or (α)-hydroxy-(α), bis(5 hydroxycarvacryl)æptoluenesulfonic acid (such as Fisher T-416), or C₆H₄SO₂OC [C₆H₂-2-CH₃-4-OH-5CH(CH₃)₂]₂.

8.2.8.2 Prepare the methylene blue solution by dissolving 0.05 % of the reagent in the ethanol.

8.2.8.3 Prepare the thymol blue solution by dissolving 0.1 g of the reagent in 10.75 cm³ of 0.02 NaOH and diluting to 250 cm³ by adding water.

8.2.8.4 Prepare the indicator by adding 1 cm³ of the methylene blue solution to 4 cm³ of the thymol blue solution.

8.3 *Procedure:*

8.3.1 Prepare representative samples of pipe or sleeves, and immediately screen them through a 149-µm (No. 100) sieve as described in Specification E 11. The specimen must be ground sufficiently so that all of it will pass through the sieve. However, avoid excessive grinding since this may change the state of carbonation and the rate of reaction of the specimen and lead to erroneous results. Optimum grinding is achieved if at least 5 % of the specimen is retained on a 125-µm (No. 120) sieve described in Specification E 11. Immediately place the material passing the sieve into a weighing bottle, and cover with its ground-glass top. (**Warning**—In addition to other precautions, when handling finely ground asbestos-cement, avoid creating dust, or use an efficient respiratory protector (mask). Prolonged or frequent breathing of significant airborne concentrations of silica or asbestos dust is hazardous.)

8.3.2 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.

8.3.3 Weigh out four specimens of 1 ± 0.010 g of the dried sample from a pipe or sleeve to the nearest 0.001 g.

8.3.4 Place each specimen in an evaporation flask fitted with a condenser and a TFE-fluorocarbon encapsulated stirring bar, add 100 cm³ of the solvent described in 8.2.5 to each flask and heat the evaporators for the following time periods: First specimen—30 min; second specimen—60 min; third specimen—90 min; and fourth specimen—120 min. After the extraction of each specimen cool the flask and filter the contents rapidly on a fritted glass funnel.

8.3.5 Wash each filter cake with 50 cm³ of isobutyl alcohol.

8.3.6 Titrate the filtrate with the titrating agent described in 8.2.7 and the indicator described in 8.2.8.4 until the color changes from light green to dark blue.

8.3.7 Carry out a blank extraction without any specimen, add 50 cm³ of isobutyl alcohol and titrate as described in 8.3.4 to 8.3.6 to determine the correction applicable to take into account the addition of the NaOH in solution No. 2.

8.3.8 Calculate the number of equivalents of Ca(OH)₂ for each specimen and the percentage of Ca(OH)₂ initially present in each specimen.

⁹ DIDC Means Degré International de Dureté des Caoutchoucs (International Degrees for Hardness of Rubbers).

8.4 Calculation:

8.4.1 Plot the values of $\text{Ca}(\text{OH})_2$ calculated for each sample as a function of extraction duration (30, 60, 90 or 120 min) and extrapolate the graph to zero time.

8.4.2 Report the content of $\text{Ca}(\text{OH})_2$ indicated by the graph at zero time as the average content of free lime in the sample.

9. Guidelines for Internal and External Corrosion

9.1 *Scope*—This test method establishes guidelines for the definition and classification of aggressive water and soil environments. The guidelines are based on exposure within the temperature range of 4 to 27°C (40 to 80°F). For pipe exposures to temperatures beyond these limits, consult the manufacturer.

9.2 *Summary of Test Method*—The factors that cause aggressive environments, internal and external waters, external soil conditions, and soluble sulfate contents of waters and soils, are considered separately even though they may exist in combination.

9.3 *Significance and Use*—Guidelines for internal and external corrosion of asbestos-cement pipe are included in this specification solely for the purpose of helping users evaluate the useful service life of asbestos-cement pipe under various soil and water conditions. If either water or soil corrosion guidelines are not adhered to, some decrease in useful service life can be expected; when the guidelines are followed, experience has shown that a satisfactory life can be expected for the pipe.

9.4 *Corrosion Guidelines for Water Transported Through Asbestos-Cement Pipe*:

9.4.1 *Aggressivity Index* —A measure of the corrosivity of water towards asbestos-cement, defined as follows:

$$\text{pH} + \log (AH) \quad (1)$$

where:

- pH = negative of the logarithm of the hydronium molarity, (index of acidity of the water), pH units,
 A = total alkalinity, ppm as CaCO_3 as determined by Test Methods D 1067 and
 H = calcium hardness, ppm as CaCO_3 as determined by Test Method D 1126.

NOTE 2—The aggressiveness of water towards asbestos-cement is classified as follows:

Highly aggressive	Aggressivity index < 10.0
Moderately aggressive	Aggressivity index = 10.0 to 11.9
Nonaggressive	Aggressivity index \geq 12.0

9.4.2 *Type of Asbestos-Cement Pipe for Use with Aggressive Waters*—The following table shows the type of asbestos-cement pipe to be used with aggressive waters as classified in Note 2:

Water	Pipe Recommended
Highly Aggressive	^A
Moderately Aggressive	Type II
Nonaggressive	Type I and II

^A The serviceability of asbestos-cement pipe for such applications should be established by the purchaser in conjunction with the manufacturer.

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

9.5 *Corrosion Guidelines for Acidic Soils External to Asbestos-Cement Pipe*—The following table establishes guidelines, based upon minimum pH factors alone, for the use of asbestos-cement pipe in acidic soils. Asbestos-cement pipe may or may not perform satisfactorily in acidic soil environments that have pH values below those listed in the table. To determine the suitability of asbestos-cement pipe in soils that have 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

9.6 *Corrosion Guidelines for Soluble Sulfate in Water and Soils*:

9.6.1 The following table classifies aggressiveness to asbestos-cement pipe of soluble sulfates found in water and soils.

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

9.6.2 The chemical resistance of asbestos-cement pipe to soluble sulfates found in water and soils is as follows: Type I pipe will be attacked to various degrees by all but the nonaggressive levels of sulfate concentrations in waters and soils.¹⁰ Type II pipe resistant to all levels of soluble sulfates

10. Keywords

10.1 asbestos; asbestos-cement; asbestos-cement pipe; pipe

¹⁰ Guidelines for sulfate resistance of portland cement products were taken from the *Concrete Manual*, Bureau of Reclamation, 8th ed., 1975. Sulfate resistance here applies to all soluble sulfates, regardless of cation.

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