



AWWA C400-65

American Water Works Association

AWWA STANDARD
for
ASBESTOS-CEMENT WATER PIPE

This "Standard for Asbestos-Cement Water Pipe" is based on a consensus of AWWA Committee 8340 D on the minimum practice consistent with good, economical service under normal conditions. It is not designed for unqualified use under all conditions, and its applicability under any circumstances must be reviewed by the responsible engineer. The standard is not intended to preclude the manufacture, marketing, purchase, or use of any product, process, or procedure.

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Change in Designation of C400

With this fourth printing of the Second Edition of AWWA C400, the former designation, "C400-64T," has been changed to "C400-65." The document has been advanced to "Standard" without revision.

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AWWA C400-65

AWWA Standard for

Asbestos-Cement Water Pipe

Foreword

The designated pressure classes, 100, 150, and 200 psi, as used in this standard, are intended to apply only to asbestos-cement pipe.

Sec. 1—Scope

This standard covers three pressure classes of asbestos-cement pipe, 4 in.—36 in. in diameter, intended to be used for the transmission of water under pressure and to be laid underground in public highways or private rights-of-way.

The pressure class designations of Class 100, Class 150, and Class 200 shall mean that the pipe is intended for water service at operating pressures of 100, 150, and 200 psi, respectively, under the conditions of installation and operation encountered in many water distribution systems.*

* The purchaser should determine for himself, from AWWA H2, *Standard Practice for the Selection of Asbestos-Cement Water Pipe*, the proper class of pipe to be used under the installation and operating conditions that will exist on the project on which the pipe is to be used. He should then refer to AWWA C603 (Installation of Asbestos-Cement Water Pipe) for instruction in laying pipe.

Sec. 2—Information to Be Provided by Purchaser

When purchasing pipe to comply with the requirements of this standard, the purchaser shall provide specific information in his supplementary specifications regarding the following:

2.1. Standard used—that is, AWWA C400-65.

2.2. Affidavit of compliance (Sec. 5), if required.

2.3. Specific requirements for each size and class of pipe to be furnished regarding:

a. Nominal inside diameter (Sec. 6.3).

b. Class of pipe (Sec. 6.2).

c. Lineal feet to be furnished in standard and random lengths (Sec. 6.4).

2.3.1. Number, size, class, lengths, and extent of machining of special short lengths (Sec. 6.4.3).

2.4. Whether inspection by the purchaser (Sec. 4) and application of special marking (Sec. 10.4) are required.

2.5. Limit for uncombined calcium hydroxide content, if any, and method of test (Appendix).

Sec. 3—Definitions

Under this standard, the following definitions shall apply:

3.1. *Purchaser*: The person, firm, corporation, or government agency entering into a contract or agreement to purchase pipe according to this standard.

3.2. *Manufacturer*: The person, firm, or corporation that manufactures the pipe.

3.3. *Supplier*: The person, firm, or corporation that enters into a contract or agreement to furnish pipe to the purchaser.

3.4. *Inspector*: The authorized representative of the purchaser, entrusted with the duty of inspecting pipe produced and tests performed under this standard.

3.5. *Inspection*: Inspection of the pipe and the tests by the inspector.

3.6. *Operating pressure*: The maximum hydrostatic pressure to which the pipe will be subjected in normal operation after installation, exclusive of allowance for water hammer.

Sec. 4—Inspection

4.1. *General*. Inspection shall not relieve the manufacturer or supplier of the responsibility to furnish and deliver material conforming in all respects to the requirements of this standard.

4.2. *Notification*. If factory inspection is required by the purchaser, the manufacturer shall notify the purchaser, in advance, of the date, time, and place of inspection and testing of the pipe, in order that the purchaser may be represented at the test.

4.3. *Access*. The inspector shall have free access to those parts of the manufacturer's plant that are involved in work performed under this standard. The manufacturer shall afford the inspector, without charge, all reasonable facilities for determining whether the pipe meets the requirements of this standard.

Sec. 5—Affidavit of Compliance

The purchaser's supplemental specifications may require an affidavit from the manufacturer or supplier, whether factory inspection has been required or not, to the effect that the materials furnished under the purchaser's order comply with all applicable requirements of this standard.

Sec. 6—General Requirements

6.1. *Materials*. Asbestos-cement pipe shall be composed of an intimate mixture of portland cement or portland blast furnace slag cement, and asbestos fiber with or without silica; or portland pozzolana cement and asbestos fiber, with or without the addition of curing agents. It shall be free from organic substances and it shall be formed under pressure and cured.

6.2. *Classes of pipe*. Pipe supplied under this standard shall be made in one or more of the following three classes: Class 100, Class 150, and Class 200, as defined in Sec. 1, above.

6.3. *Pipe diameters*. Pipe shall be made with nominal inside diameters of 4, 6, 8, 10, 12, 14, 16, 18, 20, 24, 30, and 36 in., as specified by the purchaser. The average inside diameter of a standard or random pipe length shall not be less than the nominal diameter by more than 5 per cent for sizes through 16 in. and 1.5 per cent for sizes 18 in. and larger.

6.4. *Pipe lengths.* Pipe shall be supplied in standard, random, and short lengths, as specified below:

6.4.1. The standard length of all pipe 8 in. in diameter and larger shall be 13 ft. Pipe 4 in. and 6 in. in diameter may be supplied in standard lengths of 10 ft or 13 ft. At least 90 per cent of the total footage of pipe of any class and size, excluding special short lengths, shall be furnished in standard lengths with a tolerance of ± 1 in. The remaining 10 per cent may be in random lengths of not less than 7 ft. Coupling areas of all standard lengths shall be machined or otherwise rendered suitable for making a tight joint with the coupling.

6.4.2. All random lengths shall be cut from standard lengths and, if greater than 9.5 ft, shall meet the requirements of Sec. 9.3. Random lengths shorter than 9.5 ft shall not require flexural testing. The coupling area of all random lengths shall be machined or otherwise rendered suitable for making a tight joint with the coupling.

6.4.3. Special short lengths for making connections to valves, fittings, or structures, and for making closures shall be furnished as specified by the purchaser. They shall be properly machined to serve their intended purpose, whether at ends only or over their entire length, as specified by the purchaser.

6.5. *Couplings.* The number, type, and composition of couplings and rubber rings supplied under this standard shall be as specified below:

6.5.1. One coupling of the size and class specified shall be furnished with each length of pipe. Every coupling shall include an asbestos-cement sleeve, of the same composition as the pipe, and two rubber rings. The couplings

shall be machined so as to insure a tight joint with the pipe.

6.5.2. The rubber rings used to seal the joints of the asbestos-cement pipe shall conform to the requirements of the latest revision of ASTM D 1869 (Rubber Rings for Asbestos-Cement Pipe).

Sec. 7—Detail Requirements

7.1. *Wall thickness.* The wall thickness of the *machined portion* of any length of pipe shall not be less than the manufacturer's standard by an amount exceeding 0.08 in. for pipe having a design thickness of 1 in. or less, or by an amount exceeding 0.10 in. for pipe having a design thickness greater than 1 in.

7.2. *Imperfections.* The inside surface of each length of pipe shall be free from bulges, dents, and tears that result in a variation in diameter of more than 0.20 in. from the diameter of adjacent unaffected portions of the surface.

The coupling areas of the barrel of each length of pipe shall be free from dents and gouges that can cause leakage from the joint.

Flaking on the exterior surface and edge of machined ends shall not extend back more than 0.500 in. from the end, have a depth of more than 0.125 in., nor extend around the perimeter more than 0.500 in. at any one location.

Sec. 8—Strength Requirements

8.1. *Minimum bursting strength.* Each length of pipe and each coupling shall have sufficient strength to withstand an internal hydrostatic pressure of four times the rated operating pressure for its class.

8.2. *Flexural strength.* Each length of pipe tested in flexure, as specified in Sec. 9.3., shall, except as otherwise pro-

TABLE 1
Flexural Test Loads

Nominal Diameter in.	Class 100	Class 150	Class 200
	Total Applied Load—lb		
4	1,200	1,460	1,860
6	2,800	3,700	4,900
8	5,330	7,600	10,130

vided in that section, support the load indicated in Table 1.

8.3. Crushing strength. Each length of pipe shall have sufficient strength, when subjected to the crushing test as specified in Sec. 9.4., to support at least the load indicated for its class in Table 2.

Sec. 9—Physical Testing Methods

9.1. Test specimens. All pipe and couplings tested under this standard shall be in a normal, air-dried condition when tested.

9.2. Hydrostatic tests. Hydrostatic tests shall be performed as specified below:

9.2.1. Each standard, random, or short length of pipe, and each coupling sleeve shall be tested under an internal hydrostatic pressure as follows: Class 100, 350 psi; Class 150, 525 psi; Class 200, 700 psi. All air shall be expelled and the water pressure shall be increased to the test pressure at a uniform rate of not less than 100 psi per second. The specified test pressure shall be maintained for at least 5 sec. Any pipe length or sleeve showing leakage, sweating, or other defect shall be rejected.

9.2.2. From each 300 standard lengths of pipe or fraction thereof, of each size and class, one length shall be hydrostatically tested to a pressure

four times the rated operating pressure for that class in the manner specified in Sec. 9.2.1. If inspection by the purchaser has been specified, the inspector shall be permitted to select the length of pipe to be tested. Each length of pipe so tested shall be retested in the manner and at the pressure specified in Sec. 9.2.1.

9.3. Flexure tests. Each standard length of pipe having a nominal diameter of 4, 6, or 8 in. shall be tested in flexure for at least 5 sec. The supports shall be 9 ft apart, except that, at the manufacturer's option, lengths greater than 12.5 ft may be tested on supports 12 ft apart at 75 per cent of the load specified in Table 1. The total load shall be divided equally and applied at the third points of the clear span as shown in Fig. 1. Each pipe so tested shall support, without evidence of cracks or other defects, the applicable total load shown in Table 1. The load shall be applied at a minimum rate of 500 lb per second, and the total load shall be maintained for at least 5 sec.

TABLE 2
Crushing Test Loads

Nominal Diameter in.	Class 100	Class 150	Class 200
	Applied Load per Foot of Length—lb		
4	4,100	5,400	8,700
6	4,000	5,400	9,000
8	4,000	5,500	9,300
10	4,400	7,000	11,000
12	5,200	7,600	11,800
14	5,200	8,600	13,500
16	5,800	9,200	15,400
18	6,500	10,100	17,400
20	7,100	10,900	19,400
24	8,100	12,700	22,600
30	9,700	15,900	28,400
36	11,200	19,600	33,800

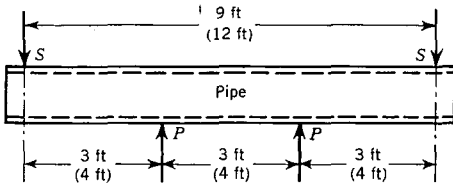


Fig. 1. Flexure Test Assembly

The numbers not in parentheses represent the distances between bearings, S, and pressure points, P, for lengths of pipe shorter than 12.5 ft. The numbers in parentheses indicate the spacing that may be used on lengths of pipe longer than 12.5 ft. One-half the total pressure is applied at each point, P.

9.4. Crushing tests. On lots containing more than 100 lengths of each size and class, one length from each 300 lengths, or fraction thereof, shall be tested for crushing strength. If inspection by the purchaser has been specified, the length of pipe to be tested shall be selected by the inspector. From each selected length, one un-machined section of pipe 1 ft long shall be cut. This section shall be tested by the crushing test method shown in Fig. 2. After 75 per cent of the specified load has been reached, the loading shall be applied at a uniform rate of approximately 2,000 lb per minute. The test section shall not fail until the total load applied exceeds the applicable value shown in Table 2.

For this test, the two lower bearings shall consist of two straight wooden strips with vertical sides, each strip having its interior top edge rounded to a radius of approximately 0.5 in. The strips shall be securely fastened to a rigid block, with the interior vertical faces parallel and a distance apart of not less than 0.5 in. nor more than 1 in. per foot of diameter of the pipe. The upper bearing shall be a rigid wooden block, straight and true from end to

end. The upper and lower bearings shall extend the full length of the test section.

9.5. Machines for testing. The machine used for the hydrostatic test shall have gaskets that seal the ends of the pipe without materially counteracting the hydrostatic test pressure. The machines used for the flexure and crushing tests shall be substantial and rigid throughout, so that the distribution of the load will not be appreciably affected by the deformation or yielding of any part of the machine.

9.6. Retests and rejection. The failure of any specimen tested for crushing strength to support 75 per cent of the crushing load listed as required in Table 2, Sec. 8.3. shall be cause for rejection of the entire lot of that size and class manufactured during the same shift as the test specimen.

If any specimen tested for crushing strength supports more than 75 per cent but less than 100 per cent of the

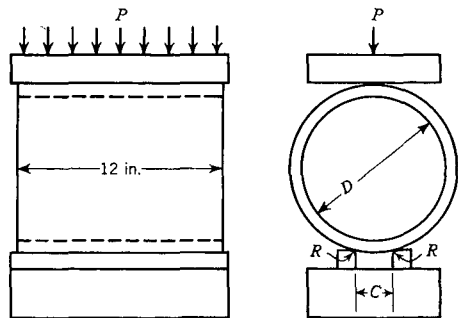


Fig. 2. Crushing Test Assembly

The diagram at the left shows a side view of the test assembly; that at the right, an end view. P represents load; R, approximately 0.5 in.—the radius of the bearings; D, the nominal diameter of the pipe; and C, the clear space between wooden supports. C should be 0.5 in. for diameters of 12 in. and under, 1 in. for 14–24 in. inclusive, and 2 in. for 30 in. and over.

crushing load, two additional pipe sections of the same size and class, manufactured during the same shift, shall be subjected to the crushing test. The additional lengths shall be selected by the inspector, if inspection has been specified. The failure of one of these additional specimens to meet the crushing strength requirements specified in Sec. 8.3 shall be cause for rejection of the entire lot of that size and class manufactured during the same shift as the test specimen.

If any pipe subjected to the hydrostatic tests specified in Sec. 9.2.2 fails to withstand the specified pressure, two additional lengths of the same size and class, manufactured during the same shift, shall be subjected to the same hydrostatic test. The additional lengths shall be selected by the inspector, if inspection has been specified. The failure of one of these additional lengths to withstand the specified pressure shall be cause for rejection of the entire lot of that size and class manufactured during the same shift as the test lengths.

Sec. 10—Test Records

The results of all crushing tests shall be recorded and retained for one year and shall be available to the purchaser at the place of manufacture.

Sec. 11—Marking

11.1. *Standard and random lengths.* Each standard or random length of pipe shall be clearly marked on the outside surface with the trade name, nominal inside diameter, class, hydrostatic test pressure, and date and shift of manufacture.

11.2. *Special short lengths.* Each short length of pipe shall be clearly marked on the outside surface with the nominal inside diameter, the class, and the letter "T" to indicate that it has been hydrostatically tested.

11.3. *Couplings.* All component parts of each coupling shall be clearly marked for use with the pipe for which they are intended. Each coupling sleeve shall also be marked with the letter "T" to indicate that it has been hydrostatically tested.

11.4. *Special markings.* If factory inspection is made by the purchaser or his authorized inspector, each pipe and each coupling sleeve shall receive an additional special marking of no more than three letters, as required by the purchaser.

Sec. 12—Preparation for Shipment

All pipe and couplings shall, unless otherwise specified, be prepared for standard commercial shipment.

APPENDIX

Test for Uncombined Calcium Hydroxide

This test procedure is provided for use in those instances in which purchasers specify a limit for uncombined calcium hydroxide in asbestos-cement water pipe manufactured in accordance with AWWA C400.

The frequency of such tests by the manufacturer or supplier should be determined by mutual agreement between the manufacturer or supplier and the purchaser and specified in the contract agreement. The date and results of the tests shall be available to the purchaser on request.

Reagents

Phenolphthalein indicator. Dissolve 1.0 g of phenolphthalein in 100.0 ml of absolute ethanol.*

Glycerol-ethanol solvent. Prepare a solution consisting of glycerol and anhydrous or absolute ethanol,* 1:2 by volume. To each liter of this solution add 2.0 ml phenolphthalein indicator. Adjust the solvent to slightly basic with either dilute NaOH in absolute ethanol* or standard ammonium acetate, depending on the original pH.

Standard ammonium acetate solution. Dissolve 16.0 g dry crystalline ammonium acetate in 1 liter absolute or anhydrous ethanol.* Standardize the solution by the analytical procedure described in Step 3, below.

* Specially denatured alcohol No. 30, 3a, or 2b, or alcohol consisting of 95 per cent specially denatured alcohol No. 3a plus 5 per cent isopropanol, may be substituted.

Procedure

Step 1. Brush representative samples of the pipe free of dust and drill with a clean, sharp 0.25 in. carbide tipped drill inward from the outer surface until the drill point emerges from the inside wall. Drill on a clean sheet of glazed paper at a rate of penetration of approximately 1 ipm. Use a soft brush to collect all drillings. Screen through a 20-mesh screen immediately, and place in a weighing bottle.

Step 2. Place the bottle with top removed, in a drying oven at 105°C for 2 hr, and then cool to room temperature in a desiccator.

Step 3. Weigh out 1 ± 0.010 g of the dried sample to the nearest 0.001 g and place it in a dry 250-ml erlenmeyer flask, to which a teflon-encapsulated stirring bar, 60 ml of the glycerol-ethanol solvent and 2.0 g $\text{Sr}(\text{NO}_3)_2$ have been added. Attach the flask to a water-cooled condenser (with a standard 24/40 glass joint) and place on a hot plate with a magnetic stirrer. Boil the solution gently for 30 min, stirring it slowly. Then remove the flask and filter the mixture, under vacuum, through a Buchner funnel. Bring the filtrate to a boil and titrate to a colorless endpoint with the standardized ammonium acetate reagent. Determine the endpoint by comparison with a similar mixture containing no phenolphthalein indicator. Do not add

excess ammonium acetate at any time, because an excess may react with calcium silicates and aluminates.

Standardize the ammonium acetate solution by titrating against pure CaO that has been freshly prepared by calcining pure calcium carbonate or calcium oxalate to constant weight in a platinum crucible at 900 to 1000°C. When the calcined CaO has cooled in a desiccator, perform the following operations in rapid succession: Grind it in an agate mortar. Then weigh out 0.05 to 0.06 gram CaO into a dry 250 ml erlenmeyer flask and add 60 ml of the glycerol-ethanol solvent and 2.0 grams of anhydrous strontium nitrate to the flask. Place a Teflon encapsulated magnetic stirring bar into the flask and attach a reflux condenser. Adjust the heating rate and stirring speed to obtain a vigorous boiling and complete agitation. Titrate the hot solution with ammonium acetate solution every 5 min. The endpoint is reached when no further color appears in the solution after 10 min of boiling. Titration is to be carried out only on

a hot solution. Good titration procedure is evidenced by a change to pink color on cooling.

Calculations

Standardization of ammonium acetate solution. Standardize the ammonium acetate solution by the formula:

$$E = \frac{WC_aO \times 1.32}{V_a}$$

in which E is the weight of $\text{Ca}(\text{OH})_2$ in grams per milliliter of ammonium acetate solution; WC_aO is the weight of CaO in grams; and V_a is the volume, in milliliters, of ammonium acetate used in titration.

Percentage of uncombined calcium hydroxide. Determine uncombined calcium hydroxide from the formula:

$$\text{Percentage Ca}(\text{OH})_2 = \frac{EV}{W} \times 100$$

in which V is the volume of ammonium acetate solution required by sample, in milliliters; and W is the weight of the sample in grams.

