



# Standard Specification for Non-Asbestos Fiber-Cement Nonpressure Sewer Pipe<sup>1</sup>

This standard is issued under the fixed designation C 1449/C 1449M; 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.

## 1. Scope

1.1 This specification covers requirements relating to non-asbestos fiber-cement non-pressure sewer pipe, joints, and fittings suitable for use with gravity flow, intended for sewerage and drainage applications from point of use to point of treatment or disposal. It defines certain conditions of manufacture, classification, characteristics, and acceptance tests applicable to these products.

1.2 The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exact equivalents; therefore each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the specification.

NOTE 1—Rubber rings suitable for use with this pipe are covered in Specification D 1869.

NOTE 2—This specification is issued for product standardization and purchasing purposes only, and does not include requirements for installation or the relationships between operating conditions and the strength characteristics of the various classifications of pipe. The purchaser is cautioned that he must correlate installation and operating conditions with the specified characteristics of the pipe.

1.3 *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:<sup>2</sup>

C 150 Specification for Portland Cement

C 497 Test Methods for Concrete Pipe, Manhole Sections, or Tile

C 500 Test Methods for Asbestos-Cement Pipe

C 595 Specification for Blended Hydraulic Cements

C 1154 Terminology for Non-Asbestos Fiber-Reinforced Cement Products

D 1869 Specification for Rubber Rings for Asbestos-Cement Pipe

### 2.2 Federal Standard:

No. 123 Marking for Domestic Shipment (Civilian Agencies)<sup>3</sup>

### 2.3 Military Standard:

No. 129 Marking for Shipment and Storage<sup>3</sup>

### 2.4 ISO Standards:

ISO 390:1993 Products in Fibre Reinforced Cement—Sampling and Inspection<sup>4</sup>

ISO 2859-1:1999 Sampling Procedures for Inspection by Attributes Part 1: Sampling Schemes Indexed by Acceptance Quality Limit (AQL) for Lot-by-Lot Inspection<sup>4</sup>

ISO 3951:1989 Sampling Procedures and Charts for Inspection by Variables for Percent Nonconforming<sup>4</sup>

### 2.5 Other Standards:

Uniform Freight Classification Rules<sup>5</sup>

National Motor Freight Classification Rules<sup>6</sup>

## 3. Terminology

3.1 *Definitions*—Refer to Terminology C 1154.

3.1.1 *coupling*—section for joining fiber-cement non-pressure sewer pipe, as defined in 5.3, that when properly installed with the proper accessories, develops an assembled joint, equivalent in serviceability and strength to the pipe sections when tested in accordance with 6.3.

3.1.2 *fitting*—components such as wyes, tees, adaptors, for use in laying fiber-cement pipe, such that, when properly installed, yields develops an assembly fitting equivalent in serviceability and strength to the pipe sections.

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee C17 on Fiber-Cement Products and is the direct responsibility of Subcommittee C17.02 on Non-Asbestos Fiber-Cement Products.

Current edition approved Dec. 15, 2005. Published January 2006. Originally approved in 1999. Last previous edition approved in 2005 as C 1449 – 05.

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>3</sup> Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

<sup>4</sup> Available from International Organization for Standardization (ISO), 1 rue de Varembé, Case postale 56, CH-1211, Geneva 20, Switzerland.

<sup>5</sup> Available from the Uniform Classification Commission, Room 1106, 222 S. Riverside Plaza, Chicago, IL 60606.

<sup>6</sup> Available from National Motor Freight Inc., 1616 P St., NW, Washington, DC 20036.

3.1.3 *pipe*—fiber-cement non-pressure sewer pipe as defined in Sections 1, 3, and 5.

#### 4. Classification

4.1 The types of pipe shall be shown as Type I and Type II corresponding to the chemical requirements given in S3.

NOTE 3—There are no chemical requirements for Type I pipe. Type II pipe is generally accepted as being unaffected by sulfates in groundwater which cause matrix expansion and consequential pipe deterioration.

4.2 Fiber-cement sewer pipe furnished under this specification shall be designated as Class I, II, III, IV, and V. The corresponding strength requirements are prescribed in **Table 1**. The D load is the saturated crushing test load expressed in pounds-force per linear foot per foot of diameter. [The D1 load is the saturated crushing test load expressed in Newtons per linear metre per millimetre of diameter.] The pipe shall be furnished in 4, 6, 8, 10, 12, 15, 18, 21, 24, 27, 30, 33, 36, 42 and 48-in. [100, 150, 200, 250, 300, 375, 450, 525, 600, 675, 750, 825, 900, 1050 and 1200-mm] sizes.

4.3 When requested by the owner, the manufacturer shall provide the owner the relationship between the short term crush load required to achieve the long-term design loads with supporting estimates of service life using recognized calculation methods.

NOTE 4—To assist the purchaser in choosing the type of pipe most suitable for his use, guidelines for the definitions of aggressiveness of water and of soil environments for selection of the proper type of fiber-cement pipe are covered in the appropriate sections of Test Methods **C 500**.

#### 5. Materials and Manufacture

5.1 Fiber-cement pipes shall be composed of an intimate mixture of an inorganic hydraulic binder (see Specification **C 150**) or a calcium silicate binder (see Specification **C 595**) formed by the chemical reaction of a siliceous material and a calcareous material reinforced by organic fibers, inorganic non-asbestos fibers, or both. Process aids, fillers and pigments which are compatible with fiber-reinforced cement are not prohibited from being added.

5.2 The pipe shall be of laminar construction formed under pressure to a homogeneous structure and cured under natural or accelerated conditions to meet the chemical and physical requirements of this specification.

##### 5.3 Couplings:

5.3.1 Fiber-cement non-pressure sewer couplings shall be made in conformance with **5.1** and **5.2**.

5.3.2 Fiber-cement non-pressure sewer couplings shall be equivalent in serviceability to those couplings defined in **5.3.1** and shall be installed in accordance with the manufacturer's recommendations.

**TABLE 1 Minimum Crushing Load**

Pipe Class	D Load lbf/ft/ft	D1 Load N/m/mm
I	1200	60
II	1500	75
III	2000	100
IV	3000	150
V	3750	175

**TABLE 2 Minimum Quality Sample Size**

Inspection by Variables		Inspection by Attributes	
Inspection Lot Size	Number Samples	Inspection Lot Size	Number Samples
< 280	3	< 150	5
281 - 500	4	151 - 500	8
502 - 1200	5	501 - 3200	13

#### 5.4 Fittings:

5.4.1 Fiber-cement non-pressure sewer fittings shall be made in conformance with **5.1** and **5.2**.

5.4.2 Fiber-cement non-pressure sewer fittings shall be equivalent in serviceability to those fittings defined in **5.4.1** and shall be installed in accordance with the manufacturer's recommendations.

#### 6. Physical Properties

6.1 *Crushing Strength*—Crushing tests shall be conducted before shipment. Test specimens 12 in. [150 mm] cut from an unmachined portion of pipe shall be tested in accordance with the appropriate section of Test Methods **C 497**.

6.2 *Flexural Strength*—Longitudinal bending tests shall be conducted before shipment. Each length of pipe 10 ft [3 m] or longer, for designated sizes 8 in. [200 mm] and less, shall have the minimum proof flexural strength prescribed in **Table 3**, when tested in accordance with the appropriate section of Test Methods **C 500**.

6.3 *Joint Tightness*—The tests outlined in this section are considered to be one-time qualification tests to establish the adequacy of the manufacturer's joint design. Instead of requiring performance of these tests, the purchaser may require the manufacturer to certify that pipes and couplings equivalent in material and design have passed the tests enumerated in this section. At his own expense, however, the purchaser, by designation with his order, shall have the option to require that assembled pipes and couplings pass the following performance tests without leakage.

6.3.1 *Couplings*—The couplings, when assembled on pipe, shall be capable of withstanding simultaneously:

6.3.1.1 The minimum crushing load prescribed in **Table 1**, when tested in accordance with the appropriate section of Test Methods **C 497**, and

6.3.1.2 The hydrostatic pressure tests described in **6.3.1.3** and **6.3.1.4**.

6.3.1.3 *Straight Alignment*—A hydrostatic pressure test shall be made on an assembly of two sections of pipe properly connected with a coupling in accordance with the joint design.

**TABLE 3 Flexural Proof Strength**

Designated Size, in. [mm]	Total Applied Load <sup>A</sup>
4 [100]	550 [2.4]
5 [125]	950 [4.2]
6 [150]	1500 [6.7]
8 [200] <sup>B</sup>	2700 [12.2]

<sup>A</sup> The indicated loads are applied over a clear span of 9 ft [2.7 m]. It shall be optional to test at 75 % of the indicated loads on a clear span of 12 ft [3.7 m].

<sup>B</sup> 8 in. [200 mm] Class V pipe (per **Table 1**) shall be tested to a Total Applied Load of 3000 Lbf [13.3 kN].

An equivalent alternative shall be a single pipe with a coupling on each end. The assembly shall be subjected to an internal hydrostatic pressure of 10 psi [70 kPa] for 10 min. Any visible water leakage shall be considered failure of the test requirements.

6.3.1.4 *Maximum Deflected Position*—Upon completion of the test for pipe in straight alignment in accordance with 6.3.1.3, deflect the test sections 5° [90 mrad] for 12 in. [300 mm] and smaller diameters, 3° [50 mrad] for 14 in. [350 mm] and larger diameters (with one half of the deflection being between each pipe and the coupling). The deflected assembly shall be subjected to an internal hydrostatic pressure of 10 psi [70 kPa] for 10 min. Any visible water leakage shall be considered a failure of the test requirements.

## 7. Dimensions and Tolerances

7.1 Couplings and coupling areas of the pipe shall be machined or otherwise finished to such dimensions as will meet the joint tightness requirements defined in 6.3.

7.2 The permissible variation of the internal diameter shall be in accordance with Table 4.

7.3 The inside diameter shall not vary from a true circle by more than 3 % of its average inside diameter.

7.3.1 The average inside diameter shall be determined by taking any two 90° [1.6-rad] opposing measurements and averaging the readings.

## 8. Workmanship, Finish and Appearance

8.1 Ends of the pipe that receive the coupling shall be free of dents and gouges that will affect the tightness of the joint.

8.2 Each pipe shall be free of bulges, dents, and tears in the inside surface that result in a variation of more than 0.2 in. [5 mm] from that obtained on adjacent unaffected portions of the surface.

8.3 Each length of pipe shall not vary in straightness by more than the following tolerances when the variation is measured in accordance with Section 6 of Test Methods C 500.

Designated Size, in. [mm]	Tolerance, in./ft [mm/m]
4 to 6 [100 to 150]	0.06 [5]
8 to 42 [200 to 1050]	0.05 [4]

## 9. Sampling

9.1 Test all material under this specification after immersion under water at 73 ± 7°F [23 ± 4°C] for a minimum of 24 h for the crushing tests and in a normal air-dried condition in equilibrium with atmospheric humidity for the flexural tests.

9.1.1 Employ sampling procedures providing an average outgoing quality limit (AOQL) of 6.5 %, except where specific sampling is required by particular test procedures. Appendix X2 describes a sampling plan which provides an AOQL of 6.5 %.

9.1.2 The minimum sample size for sampling and acceptance by attributes or variables shall be in Table 2.

9.1.3 Pipes of different sizes or classes but of sequential manufacture in a continuous manufacturing process may be sampled as being in the same inspection lot.

9.2 For crushing tests sample the required number of full lengths of pipe according to the inspection lot size. Cut one test specimen no shorter than 6 in. [150 mm] long from the unmachined end of each of the selected pipe lengths. (**Warning**—In addition to other precautions, when cutting fiber-cement products minimize the dust that results. Prolonged breathing or frequent breathing of significant airborne concentrations of silica is hazardous. When such dust is generated, effective measures shall be taken to prevent inhalation.)

NOTE 5—When sampling from continuous production, these tests may be conducted on dry, equilibrium, or saturated specimens, provided a relationship can be established between this testing and the specified values.

NOTE 6—A manufacturer’s process with an AOQL of 6.5 % indicates that better than 93.5 % of the inspected production exceeds the specifications for marginally accepted product. This type of specification provides the protection and confidence of a clearly defined lower boundary. This would not be true if acceptance were based solely on the average value of the measured property. Examples of sampling schemes which may be used can be found in documents such as ISO 390. Other sampling schemes may be used which maintain equally rigorous quality levels. Inspection by attributes consists of determining, for every item of a sample, the presence or absence of a certain qualitative characteristic (attribute) with respect to the applicable specification. It is, in essence, a pass-fail inspection which determines the number of items in a sample that do or do not conform to the specification. An attribute could be a dimensional measurement, or a flexural strength value, or others that are described in these test methods. Inspection by variable consists of measuring a quantitative characteristic for each item in a sample. Conformance with the applicable specification is determined from the mean values of the measured properties and the statistical variations of these values above and below the mean. Appendix X2 details sampling plans to suit all common sampling situations, and specifies the number of specimens to be taken from each batch and the acceptance/rejection criteria. The specified inspection levels have been selected to suit fiber-cement products, to balance the cost of assessment against confidence in results commensurate with this industry.

9.3 Each length of pipe 10 ft [3 m] or longer in designated sizes 8 in. [200 mm] or less shall be tested in flexure by the manufacturer prior to shipment in accordance with Section 4 of Test Methods C 500.

**TABLE 4 Permissible Variation in Internal Diameter of Pipe**

Designated Size, in. [mm]	Average Internal Diameter	
	min in. [mm]	max in. [mm]
4 [100]	3.75 [95]	4.25 [110]
5 [125]	4.75 [120]	5.25 [135]
6 [150]	5.75 [145]	6.25 [160]
8 [200]	7.75 [195]	8.25 [210]
10 [250]	9.75 [245]	10.25 [260]
12 [300]	11.75 [295]	12.25 [315]
14 [350]	13.75 [345]	14.25 [365]
15 [375]	14.75 [370]	15.25 [390]
16 [400]	15.75 [400]	16.25 [415]
18 [450]	17.73 [450]	18.27 [465]
20 [500]	19.70 [500]	20.30 [520]
21 [525]	20.69 [525]	21.31 [545]
24 [600]	23.64 [600]	24.36 [620]
27 [675]	26.6 [675]	27.40 [700]
30 [750]	29.55 [750]	30.45 [775]
33 [825]	32.51 [825]	33.40 [850]
36 [900]	35.46 [900]	36.54 [930]
39 [975]	38.42 [975]	39.80 [1010]
42 [1050]	41.37 [1050]	42.63 [1085]

## 10. Inspection

10.1 All material furnished under this specification shall conform to the requirements stated herein and shall be subjected to the factory inspection and tests prescribed in this specification. When requested by the purchaser on his order, the manufacturer shall notify the purchaser of the time that the inspection and testing will take place so that the purchaser may arrange for witnessing such tests and inspections at his own expense. Instead of inspection, when requested, the manufacturer shall certify that his product conforms to the requirements of this standard.

10.2 Pipe and coupling shall be inspected by the manufacturer, before shipment, for compliance with the standards for dimensions, tolerances, and workmanship and finish (see Section 8).

10.3 The manufacturer shall maintain a Quality Manual which includes organizational responsibilities in the manufacturing process, the specification of all raw materials, the specification of key process variables, the specification of test methods to be used for testing material in process, and a Process Quality Assurance Inspection and Test Plan which establishes those parts of the process which are subject to regular quality assurance inspection and test.

10.4 When requested by the purchaser for the purposes of quality assurance, and to ensure product conformity, a copy of the Process Quality Assurance Inspection and Test plan shall be supplied by the manufacturer.

## 11. Rejection and Rehearing

11.1 Failure of an inspection lot to comply with the minimum crushing loads of **Table 1** using a sampling plan with an AOQL of 6.5 % shall be cause for rejection of that lot.

11.2 Material that fails to conform to the requirements of this specification constitutes grounds for rejection. Rejection shall be reported to the producer or supplier promptly in writing. In case of disagreement with the results of the test, either the producer or supplier is able to make claim for a rehearing.

## 12. Marking and Shipping

12.1 Each length of pipe, 10 ft [3 m] or longer for designated sizes 8 in. [200 mm] or larger, 5 ft [1.5 m] or longer for designated sizes 4 through 6 in. [100 through 150 mm] shall be marked by the manufacturer with the trade name, designated size, class, type, and the date of manufacture in alkali resistant ink or indelible paint. Each coupling sleeve shall be marked by the manufacturer with the designated size, class, and type for the pipe with which it shall be used.

12.2 Pipe and couplings shall be prepared for commercial shipment to ensure acceptance by common or other carriers.

## 13. Keywords

13.1 drainage; fiber-cement; nonpressure; pipe; sewer

## SUPPLEMENTARY REQUIREMENTS

The following supplementary requirements S1 and S2 shall apply when material is supplied under this specification for U.S. Government procurement:

### S1. Packaging

S1.1 Unless otherwise specified in the contract, the material shall be packaged in accordance with the producer's standard practice which will be acceptable to the carrier at lowest rates. Containers and packing shall comply with **Uniform Freight Classification Rules** or **National Motor Freight Classification Rules**. Marking for shipment of such material shall be in accordance with Fed. Std. **No. 123** for civil agencies and MIL-STD-129 for military agencies.

### S2. Responsibility for Inspection

S2.1 Unless otherwise specified in the contract or purchase order, the producer is responsible for the testing of all material to ensure compliance with the requirements specified herein. Except as otherwise specified in the contract or order, the producer will use suitable facilities for the performance of the inspection and test requirements specified herein, unless disapproved by the purchaser. The purchaser shall have the right to perform any of the inspections and tests set forth in this

specification where such inspections are deemed necessary to ensure that material conforms to prescribed requirements.

### S3. Type II Pipes

S3.1 Supplementary requirements for Type II pipes shall consist of a once only supplementary test series for uncombined calcium hydroxide, with the manufacturer's statement of results provided upon purchaser's request. Fundamental changes in formulation or methods of curing, or curing cycles shall require the subsequent retesting of the supplementary test for uncombined calcium hydroxide. This supplementary type test shall be conducted at least once per year.

S3.1.1 The uncombined calcium hydroxide for Type II pipes shall be less than 1 % when tested in accordance with Test Methods **C 500**.

S3.1.2 The uncombined calcium hydroxide test shall be carried out on a minimum of 5 specimens sampled at random and compliance with the specification of S3.1.1 for Type II pipe shall be achieved within an AOQL of 6.5 %.



**APPENDIXES**
**X1. ADDITIONAL ORDERING INFORMATION**

X1.1 It is suggested that information shall be included in the agreement for purchase of pipe, couplings, and fittings as follows:

X1.1.1 Any tests, in addition to those prescribed by this specification, as the special circumstances shall require,

X1.1.2 The place or places where any additional tests are to be made,

X1.1.3 Description of the additional testing facilities,

X1.1.4 Who shall bear the expense of such additional tests,

X1.1.5 Whether such additional tests shall be made by any sound sampling process or other method approved by the parties, and

X1.1.6 Whether fiber-cement nonpressure sewer couplings and fittings shall be provided.

**X2. SAMPLING AND INSPECTION PLANS WITH 6.5 % AOQL**
**X2.1 Inspection by Variables**
*X2.1.1 Inspection by Variables Sample Size:*

X2.1.1.1 The sample size for batch inspection may be drawn in accordance with **ISO 3951:1989** single sampling plan for normal inspection sampled at an inspection level S3. Under a sampling scheme by variables at an inspection level S3 the following Code Letters and sample sizes apply:

Lot Size	Sample Code	Number Samples
< 280	B	3
281 - 500	C	4
501 - 1200	D	5

X2.1.1.2 Specimens in excess of those tabled may be used to determine compliance of the lot with the specification.

X2.1.1.3 Where the inspection sampling is from continuous production it is permissible to assess different sizes and classes of pipe of sequential manufacture as being part of the same lot provided a criteria independent of size and class is used to determine compliance with the specification. (For example, a strength index may be used which is the actual pipe strength observed divided by the minimum strength permitted by the specification.)

X2.1.1.4 Where the inspection sampling is from continuous production it is recommended that the time period between sequential samples does not exceed 6 hours.

*X2.1.2 Inspection by Variables Acceptance:*

X2.1.2.1 The measured values resulting from destructive tests or other observations  $X_1, X_2, \dots, X_n$  are recorded and the mean value ( $\bar{X}$ ) and standard deviation ( $s$ ) of the observations are calculated according to:

$$\bar{X} = \frac{\sum X_i}{n} \quad (X2.1)$$

$$s = \sqrt{\frac{\sum (X_i - \bar{X})^2}{(n - 1)}}$$

X2.1.2.2 The minimum allowable mean value ( $X_s$ ) is calculated according to:

$$X_s = L + ks \quad (X2.2)$$

where:

$L$  = specification limit, and

$k$  = tabled value according to the sample size ( $n$ ).

$n$	3	4	5	6	7	10	15
$k$	1.225	1.161	1.138	1.129	1.126	1.132	1.152
AOQL	6.5%	6.5%	6.5%	6.5%	6.5%	6.5%	6.5%
AQL 90%	1.1%	2.1%	2.8%	3.4%	3.9%	4.8%	5.7%

X2.1.2.3 The inspection lot is accepted if the sample mean value ( $\bar{X}$ ) is equal to or greater than the minimum allowable mean value ( $X_s$ ).

**X2.2 Inspection by Attributes**
*X2.2.1 Inspection by Attributes Sample Size:*

X2.2.1.1 The sample size for batch inspection may be drawn in accordance with **ISO 2859-1:1999** single sampling plan for normal inspection sampled at an inspection level S3. Under a sampling scheme by attributes at an inspection level S3 the following Code Letters and sample sizes apply:

Lot Size	Sample Code	Number Samples
< 150	C	5
151 - 500	D	8
501 - 3200	E	13

X2.2.1.2 Specimens in excess of those tabled may be used to determine compliance of the lot with the specification.

X2.2.1.3 Where the inspection sampling is from continuous production it is permissible to assess different sizes and classes of pipe of sequential manufacture as being part of the same lot.

X2.2.1.4 Where the inspection sampling is from continuous production it is recommended that the time period between sequential samples does not exceed 6 hours.

*X2.2.2 Inspection by Attributes Acceptance:*

X2.2.2.1 The lot is accepted if the number of non complying specimens assessed for a given attribute is equal to or less than the acceptance number ( $A_c$ ). The lot is rejected if the number of non complying specimens for a given attribute is equal to or greater than the rejection number ( $R_e$ ).

X2.2.2.2 The values for  $A_c$  and  $R_e$  are obtained from the following table:

Number Samples	5	8	13	20
$A_c$	0	0	1	2
$R_e$	1	1	2	3
AOQL	6.7%	4.3%	6.3%	6.8%
AQL 90%	2.1%	1.3%	4.2%	5.6%

 **C 1449/C 1449M – 05a**

*ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.*

*This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.*

*This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or [service@astm.org](mailto:service@astm.org) (e-mail); or through the ASTM website ([www.astm.org](http://www.astm.org)).*