Designation: C301 – 13

Standard Test Methods for Vitrified Clay Pipe[1]

This standard is issued under the fixed designation C301; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 These test methods cover the equipment for, and the techniques of, testing vitrified clay pipe prior to installation. Tests using whole pipe determines the resistance to crushing and hydrostatic forces. Tests using pipe fragments measure the amount of water absorption of the pipe body and the quantity of acid-soluble material that may be extracted from it.

NOTE 1—The following standards also apply to clay pipe and can be referenced for further information: Practice C12 and Test Method C828; Specifications C425 and C700.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 *This standard does not purport to address 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:*[2]

C12 Practice for Installing Vitrified Clay Pipe Lines

C425 Specification for Compression Joints for Vitrified Clay Pipe and Fittings

C700 Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated

C828 Test Method for Low-Pressure Air Test of Vitrified Clay Pipe Lines

C896 Terminology Relating to Clay Products

E6 Terminology Relating to Methods of Mechanical Testing

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms used in these test methods, refer to Terminology E6 and Terminology C896.

4. Significance and Use

4.1 *Meaning and Suitability*—The tests called for herein, from their results, indicate the suitability and acceptability of vitrified clay pipe for specifications acceptance, design purposes, regulatory statutes, manufacturing control, and research.

5. Bearing Strength

5.1 *Test Specimens:*

5.1.1 The test specimens shall be sound, full-size pipe and shall be selected by the purchaser, or his representative, at points he designates when placing the order.

5.1.2 The number of specimens to be tested shall not exceed 0.5 % of the number of pipe of each size furnished, except that no less than two specimens shall be tested.

5.2 *Measurement and Inspection of Specimens:*

5.2.1 The specimens shall be free of all visible moisture and frost. These specimens shall be inspected and measured for conformance with the applicable specifications. The results of these observations shall be recorded.

5.2.2 Specimens that are observed to have defects in excess of the limits permitted in the applicable specifications shall be discarded and replaced with additional specimens from the lot to be tested.

5.3 *Loading Apparatus* (see Fig. 1):

5.3.1 *Testing Machine:*

5.3.1.1 The loading apparatus shall consist of a testing machine capable of applying loads, with upper and lower bearings capable of transmitting these loads to the pipe. The bearings shall be bearing beams and contact edges.

5.3.1.2 Any motor driven testing machine that is capable of applying a load at a uniform rate of 2000 ± 500 lbf/min·linear ft (29.2 ± 7.3 kN/min·linear m) of pipe length, shall be used for making the test.

5.3.1.3 The load may be applied at a rapid rate until 50 % of the required bearing strength is reached. Subsequently, the load shall be applied to the pipe at a uniform rate of 2000 ± 500

[1] These test methods are under the jurisdiction of ASTM Committee C04 on Vitrified Clay Pipe and is the direct responsibility of Subcommittee C04.20 on Methods of Test and Specifications.

Current edition approved Jan. 1, 2013. Published February 2013. Originally approved in 1952. Last previous edition approved in 2009 as C301 – 04 (2009). DOI: 10.1520/C0301-13.

[2] 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.

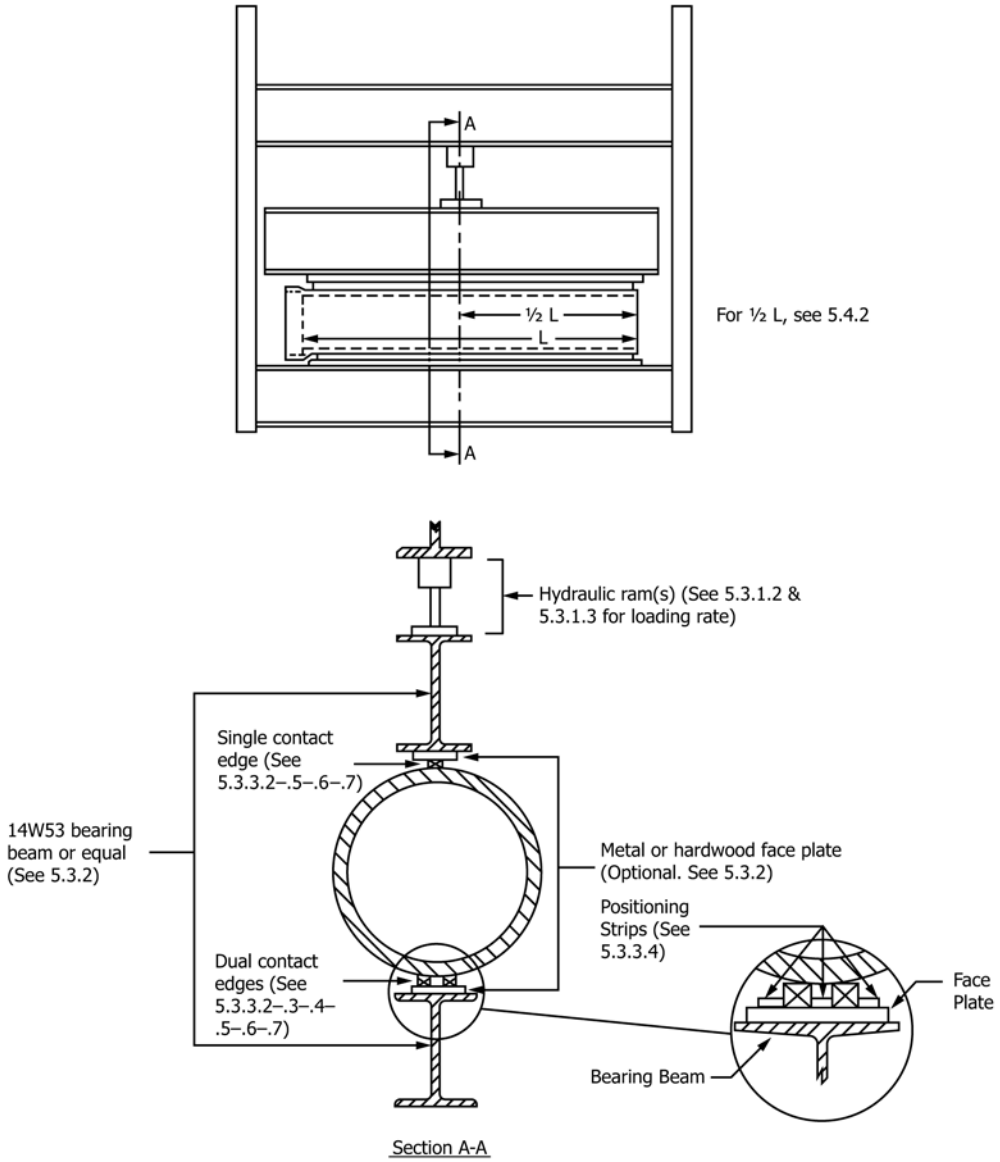

FIG. 1 Three-Edge Bearing Testing (see 5.3.4 for Segmented Testing)

lbf/min·linear ft (29.2 ± 7.3 kN/min·linear m) of pipe length without vibration or shock.

5.3.1.4 The testing machine shall be sufficiently rigid so that the load distribution will not be appreciably affected by the deformation or yielding of any part. The machine and bearings shall be constructed to transmit the load in a vertical plane through the longitudinal axes of the bearings and pipe. The bearings shall be attached to the machine so as to receive and uniformly transmit the loads required in the tests, without vibration or shock. The upper bearing shall be free to rotate in a vertical plane through the longitudinal axis of the bearing and the pipe.

5.3.2 *Bearing Beams*—Bearing beams shall not deflect more than a 14 by 8-in. (355 by 205-mm), 53-lb/linear ft (73-kg/linear m), wide flange beam as specified by the American Institute of Steel Construction. Under no circumstances shall the deflection in inches or millimetres under maximum load exceed that given by the ratio $L/720$ in which L is the beam length in inches or millimetres. The length of the bearing beams shall be no less than the full length of the outside barrel of the pipe. Built-up bearing beams may be used, provided their deflection does not exceed that specified. In order for the bell or socket of the pipe to clear the bearing beams, it is recommended that the bearing beams be faced with a metal or hardwood member for affixing the contact edges.

5.3.3 *Three-Edge Bearings:*

5.3.3.1 Three-edge bearings shall consist of an upper member, comprised of a bearing beam on which one contact edge is located so that it lies in the vertical plane passing through the longitudinal axis of the pipe; and a lower member comprised of a bearing beam on which two contact edges are symmetrically located parallel to that vertical plane.

5.3.3.2 The contact edges shall consist of rubber strips. Contact edges shall uniformly contact the outside barrel of the pipe.

5.3.3.3 The two contact edges on the lower member shall be spaced apart approximately 1 in./ft (83 mm/m) of pipe diameter, but in no case less than 1 in. (25 mm).

5.3.3.4 Positioning strips may be used to align the upper contact edge and to align and space the lower contact edges. In the case of rubber contact edges, positioning strips shall not exceed one half of the thickness of the contact edge and may remain in place.

5.3.3.5 If rubber strips are used as contact edges, they shall be cut or formed from material having a Shore A, instantaneous, durometer hardness between 45 and 60. The strips shall be of rectangular cross section, having a 2-in. (51-mm) width, and a thickness not less than 1 in. (25 mm) nor more than 1½ in. (38 mm). The contact edges shall be used with the 2-in. (51-mm) dimension in contact with the bearing beam. Rubber contact edges may be attached to the bearing beam by an adhesive, provided the contact edge remains firmly fixed in position.

5.3.4 *Segmented Bearings (Alternative to Three-Edge Bearing)*—This apparatus shall consist of segmented upper and lower bearing members with the segments of each member connected to a common hydraulic manifold to provide uniform load along the length of the barrel. The segmented bearings shall be of uniform length with the number of segments equal to the nominal length of the test pipe measured in feet. They shall be adjustable to accommodate the length variation allowed in the pipe specification. In no instance shall the length of the segmented bearing be greater than the external length of the barrel of the pipe. Rubber contact edges conforming to 5.3.3.5 shall be attached to the bearing segments.

5.4 *Bearing Tests* (see Fig. 1):

5.4.1 Test pipe for bearing strength in accordance with the three-edge bearing or segmented method. Use either of the specified bearing methods on retests as provided in the applicable specifications.

5.4.2 For tests using rigid bearing beams, multiple loading rams may be used. Each ram must have the same load range, connected by a common hydraulic system, and spaced above the top bearing beam to deliver a uniformly distributed load.

5.4.2.1 Using a straight edge, locate the most uniform bearing surface for testing. Using this location, place the pipe bearing surfaces to achieve uniform loading.

5.4.2.2 The resultant load from the hydraulic cylinder or cylinders shall be applied equidistant from each end as measured inside the barrel of the pipe as shown in Fig. 1.

5.4.3 The loading of the pipe shall be a continuous operation. Do not allow the pipe to stand under load longer than is required to apply the load and record the observations.

5.4.4 The loading shall be stopped after the required strength has been met.

5.4.5 For further evaluation or quality assurance, the loading may be continued to the point of pipe failure.

5.4.6 Record the maximum load sustained by the specimen.

5.5 *Calculation and Report:*

5.5.1 Calculate the bearing strength by dividing the applied load by the inside length of the barrel. The length shall be the average of two measurements taken at points 180° (3.1 rad) apart. Report the individual results of the tests of pipe of each size or lot.

6. Absorption

6.1 *Test Specimens:*

6.1.1 Absorption specimens shall be sound pieces of the full thickness of the barrel of the pipe, with all edges broken. Each specimen shall be as nearly square as possible, with the area on one barrel surface not less than twelve times the wall thickness, expressed as square units. They shall be free of observable cracks or shattered edges and shall not contain laminations and fissures more than is typical of the pipe from which the specimens were taken.

6.1.2 Each specimen shall be marked so that it may be identified with the lot of pipe from which it was taken. The markings shall be applied so that the pigment used shall cover not more than 1 % of the area of the specimen.

6.1.3 Test at least one specimen from each size of pipe.

6.2 *Weighing Apparatus*—The balance used shall be sensitive to 0.5 g when loaded with 1 kg, and weighings shall be made to at least the nearest 1 g. If other than metric weights are used, the same degree of accuracy shall be observed.

6.3 *Procedure:*

6.3.1 Dry the specimen at least 8 h in a ventilated oven at a temperature between 230 and 248°F (110 and 120°C), and make successive weighings at intervals of not less than 3 h until the loss at any weighing is not greater than 0.1 % of the original weight of the specimen.

6.3.2 Suspend the dried specimens in distilled, rain, or tap water that is known to have no effect on test results; heat to boiling; boil for 5 h, and then cool in the water to ambient temperature. Take care that no fragments are broken from the specimens by physical disturbance during the test. When cool, remove the specimens from the water, and drain for not more than 1 min. Then remove the superficial moisture by a damp cloth and weigh the specimens immediately.

6.4 *Calculation and Report:*

6.4.1 Calculate the absorption of each specimen as percentage of the initial dry weight as follows:

$$\text{Absorption, \%} = [(SW - DW)/DW] \times 100 \quad (1)$$

where:

DW = initial dry weight of specimen, and
SW = weight of specimen after boiling 5 h.

6.4.2 Report the result for each specimen, together with the averages for the pipe of each size and shipment.

7. Hydrostatic Pressure Test

7.1 When the pipe is subjected to an internal hydrostatic pressure of 10 psi (69 kPa) for the elapsed time shown in the following table, there shall be no leakage on the exterior of the pipe. At the option of the manufacturer, water within approximately 5°F (3°C) of the ambient air temperature may be introduced into the pipe for control of condensation. Moisture appearing on the surface of the pipe in the form of beads adhering to the surface shall not be considered leakage.

However, moisture which starts to run on the pipe shall be construed as leakage regardless of quantity.

Testing Time for Pipes

Thickness of Barrel, in. (mm)	Test Time, min
Up to and including 1 (25)	7
Over 1 (25) and including 1½ (38)	9
Over 1½ (38) and including 2 (51)	12
Over 2 (51) and including 2½ (64)	15
Over 2½ (64) and including 3 (76)	18
Over 3 (76)	21

8. Acid Resistance

8.1 Determine the acid resistance of clay pipe by the extraction of acid-soluble matter.

8.2 *Reagent*—When testing with sulfuric (H_2SO_4), hydrochloric (HCl), nitric (HNO_3), or acetic acid (CH_3COOH), as specified by the purchaser, a 1 *N* acid solution shall be used.

NOTE 2—These 1 *N* solutions should contain, respectively, 49, 36.5, 63, and 60 g of the acid per litre of solution. For the purpose of these tests the solutions can be prepared by taking the following volumes of acid and diluting to 1 L; H_2SO_4 (sp gr 1.84), 28.5 mL; HCl (sp gr 1.19), 88.9 mL; HNO_3 (sp gr 1.42), 65 mL; and glacial acetic acid (sp gr 1.05), 57.7 mL.

8.3 *Test Specimens:*

8.3.1 The specimens for acid resistance tests shall be about 2 in. (51 mm) square, and weigh not more than 200 g. They shall be sound pieces with all edges freshly broken, free of cracks or shattered edges, and shall be thoroughly cleaned.

8.3.2 Test at least one specimen from each size of pipe.

8.4 *Weighing Apparatus*—The balance used in weighing the specimens shall be sensitive to 0.01 g when loaded with 200 g.

8.5 *Procedure:*

8.5.1 Dry the specimens to constant weight at a temperature not less than 230°F (110°C).

8.5.2 Suspend the dried specimens in the acid at a temperature between 70 and 90°F (21 and 32°C) for a period of 48 h, then remove them from the solution and thoroughly wash with hot water, allowing the washings to run into the solution in which the specimen was immersed. Filter the solution and wash the filter with hot water, adding the washings to the filtrate. Add 5 mL of H_2SO_4 (sp gr 1.84) to the filtrate. Then evaporate the solution (avoid loss by spattering) to about 5 mL, transfer to a porcelain crucible (previously ignited to constant weight), and heat cautiously to dryness. Then ignite the residue to constant weight.

8.6 *Calculation and Report:*

8.6.1 Calculate the percentage of acid-soluble matter as follows:

$$\text{Acid} - \text{soluble matter, } \% = (R/W) \times 100 \quad (2)$$

where:

R = weight of residue, and
W = initial weight of the specimen.

8.6.2 Report the results for each specimen.

9. Visual Inspection

9.1 The specification for vitrified clay pipe requires visual inspection; reference should be made to Specification C700.

10. Precision and Bias

10.1 No statements are made on the precision or bias of these test methods for measuring (*1*) bearing strength, (*2*) absorption, (*3*) acid resistance, or (*4*) moisture transmitted through the pipe wall in the hydrostatic pressure test, since conformance to specific criteria is the only measure for success specified in these test methods.

11. Keywords

11.1 absorption; acid resistance; bearing strength; clay pipe; corrosion; corrosion resistance; hydrostatic; inspection; loading; pipe; segmented bearing; testing procedure; tests; three-edge bearing; vitrified clay pipe