



Standard Test Methods for Compressive Creep of Chemical-Resistant Polymer Machinery Grouts¹

This standard is issued under the fixed designation C 1181; 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 These test methods cover a quantitative, comparative test for compressive creep of chemical-resistant grouting materials under a sustained load at a test temperature. Constant load is maintained using a bolt and spring washers. Measurements are made at laboratory temperature after exposure periods at the selected test temperature.

1.2 Test Method A outlines the molding techniques for an unbonded test specimen. Test Method B covers the molding techniques for a bonded test specimen.

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.*

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

2. Referenced Documents

2.1 ASTM Standards:

C 904 Terminology Relating to Chemical-Resistant Non-metallic Materials²

E 4 Practices for Force Verification of Testing Machines³

3. Terminology

3.1 *Definitions*—For definitions of terms used in these test methods, see Terminology C 904.

4. Significance and Use

4.1 These test methods provide a means of measuring the total compressive deflection of chemical-resistant, machinery-grout materials under a sustained load at the test temperature. Test stress and temperature can be selected to simulate anticipated use conditions. For the purposes of these tests, creep is

considered to be the compressive deflection in inches per inch, which occurs after the initial loading of the specimen at laboratory temperature. *The results do not necessarily correlate for different specimen thicknesses.* No correlation has been established to actual-use conditions.

5. Apparatus

5.1 *Steel Loading Plates*—Steel plates, as described, are used for loading the grout during the test. They may, also, be part of the mold used to cast the grout specimen.

5.1.1 Two steel plates are required for each test specimen. The plates shall be 4¼ to 5 in. (11 to 13 cm) square by 1 in. (25 mm) thick. A 1⅛-in. (30-mm) diameter hole shall be drilled in the center of the plates. The edges of the plates and holes shall be deburred.

5.1.2 One of the steel plates shall have four ¼-in. (6-mm) measuring holes (one in each corner) with the center ½ in. (13 mm) in from each edge.

5.2 *Bolt Assembly*—A 1-in. (24-mm) diameter by 7.5 in. (19 cm) long, high-strength steel bolt, and nut, flat washers, and spring washers are used to maintain the test load.

5.3 *Belleville Spring Washers*—Four washers are required for each test. These shall be high carbon steel with dimensions of 1⅛ by 2¼ in. (5.7 by 6.0 cm) outside diameter by 0.159-in. (4.0-mm) thickness, with 0.039-in. (1.0-mm) dish. These washers will have an approximate spring rate of 153 000 lb/in. (27 300 kg/cm) and a rated load of 5793 lb (2630 kg) when flattened.

5.4 *Grout Mold*, suitable to cast the 4-in. (10-cm) diameter by 2 in. \pm 0.1 in. (5 cm) thick grout specimen with a 1⅛-in. diameter center hole as shown in Fig. 1. The faces must be parallel to within 0.030 in. (0.75 mm) over the 4-in. diameter specimen contact area (see 5.3). The mold may utilize the steel loading plates.

5.4.1 For the bonded method, the plates are used as mold end plates.

5.5 *Compression Machine or Apparatus*, capable of applying the test load to within \pm 2.0 %.

5.6 *Depth Micrometer*, readable to 0.0001 in. (2.5 μ) with adjustable shaft length capable of reading approximately 3-in. (7.6-cm) depth.

5.7 *Indicating Caliper*, readable to 0.001 in. (25 μ).

¹ These test methods are under the jurisdiction of ASTM Committee C03 on Chemical-Resistant Nonmetallic Materials and are the direct responsibility of Subcommittee C03.01 on Test Methods.

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² *Annual Book of ASTM Standards*, Vol 04.05.

³ *Annual Book of ASTM Standards*, Vol 03.01.

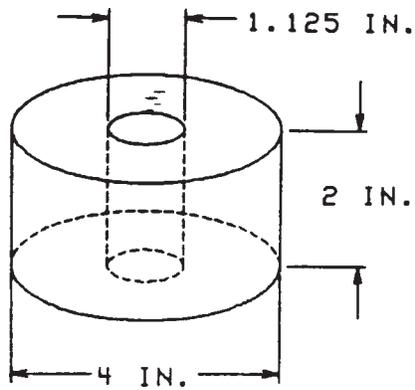


FIG. 1 Test Specimen

5.8 *Constant Temperature Oven*, capable of maintaining the desired temperature $\pm 4^{\circ}\text{F}$ ($\pm 2^{\circ}\text{C}$).

5.9 *Suitable Support Stand*, capable of supporting the test assembly when placed under compressive load.

6. Specimen Preparation

6.1 *Temperature*—Condition all grout components and molds at $73 \pm 4^{\circ}\text{F}$ ($23 \pm 2^{\circ}\text{C}$), for at least 24 h prior to use.

6.2 *Test Method A, Unbonded*—To prevent bonding, treat all surfaces of the mold with a suitable release agent, which will contact the material during casting.

6.3 *Test Method B, Bonded*:

6.3.1 Prior to assembly, clean to remove foreign matter such as rust, dirt, or scale from the grout contact surfaces of the two base plates.

6.3.2 To prevent bonding, treat all other surfaces of the mold which will contact the material during casting.

6.4 Mix the grout according to manufacturer's recommendations and pour, or otherwise place, through the fill hole in the mold. The grout may be consolidated with a rounded-end rod.

7. Conditioning

7.1 The specimen shall remain in the mold at least 16 h at $73 \pm 4^{\circ}\text{F}$ ($23 \pm 2^{\circ}\text{C}$).

7.2 Following the initial conditioning period, disassemble the mold (including the end plates if using Test Method A). Maintain the specimens at $73 \pm 4^{\circ}\text{F}$ for a total of seven days, including the time in the mold.

8. Test Procedure

8.1 *Specimen Measurement*:

8.1.1 Immediately following the conditioning period, measure the outside diameter of the test specimen to the nearest 0.001 in. (25 μ) using an indicating caliper. Make two measurements at right angles to one another at mid-height. Record the diameter as the average of the two measurements.

8.1.2 *Test Method A*—Using an indicating caliper, measure the thickness of the specimen in four places around the circumference to the nearest 0.001 in. Record the average of the measurements as the specimen thickness. The variation in the four measurements shall not exceed 0.060 in. (1.5 mm).

8.1.3 *Test Method B*—Using an indicating caliper, measure the distance between the two plates at four places around the circumference to the nearest 0.001 in. Record the average of

the measurements as the specimen thickness. The variation in the four measurements shall not exceed 0.060 in. (1.5 mm).

8.2 Assemble the testing apparatus as follows:

8.2.1 Pass the bolt through the assembly consisting of a flat washer, two nested spring washers, a second flat washer, two more nested spring washers, a third flat washer, the bottom plate, the grout specimen, the top plate, a fourth flat washer, and a nut.

8.3 Calculate the load required to produce the test stress on the specimen using the following formula:

$$L = S \left(\frac{\pi D^2}{4} - A_B \right) \quad (1)$$

where:

L = total force required on a specimen, lb (n),

S = desired stress, psi (MPa),

D = diameter of the grout cylinder, in. (mm), and

A_B = area of the formed bolt hole (may be taken as 1 in.² (640 mm²)).

8.4 Place the assembly on the support stand in the compression machine or apparatus such that the load is applied directly to the bolt head and the opposite plate, leaving the nut accessible for tightening (see Fig. 2).

8.4.1 Apply and maintain the test load.

8.4.2 Tighten the nut hand-tight.

8.4.3 Release the load and remove the test fixture from the compression machine.

8.5 Immediately after removing the test apparatus from the compression machine, measure the distance between the top faces of the plates. Make the measurements to 0.0001 in. through the four corner holes, using the depth micrometer. Record the individual readings and the average of all four.

8.6 Place the specimen in the controlled temperature oven at selected temperature for the designated exposure period, then remove and allow to cool at $73 \pm 4^{\circ}\text{F}$ ($23 \pm 2^{\circ}\text{C}$) for at least 24 h. Reload the specimen as in 8.4; take new readings to 0.0001 in. and record, and then place specimen in the oven for the next exposure period.

8.7 Total exposure periods are shown in Table 1.

8.8 Suggested schedule for a five-day work week is presented in Table 2.

9. Report

9.1 Report the following information:

9.1.1 Manufacturer's product trade name or designation of the material, or both, and type and batch, or lot number, if available,

9.1.2 Conditioning procedure including temperature and time,

9.1.3 Test temperature,

9.1.4 Load and stress applied to the grout specimen,

9.1.5 Individual data including the initial micrometer readings along with all the individual exposed readings and averages with time and date of readings, and

9.1.6 A graph showing the total creep in in./in. as a function of time in the oven.

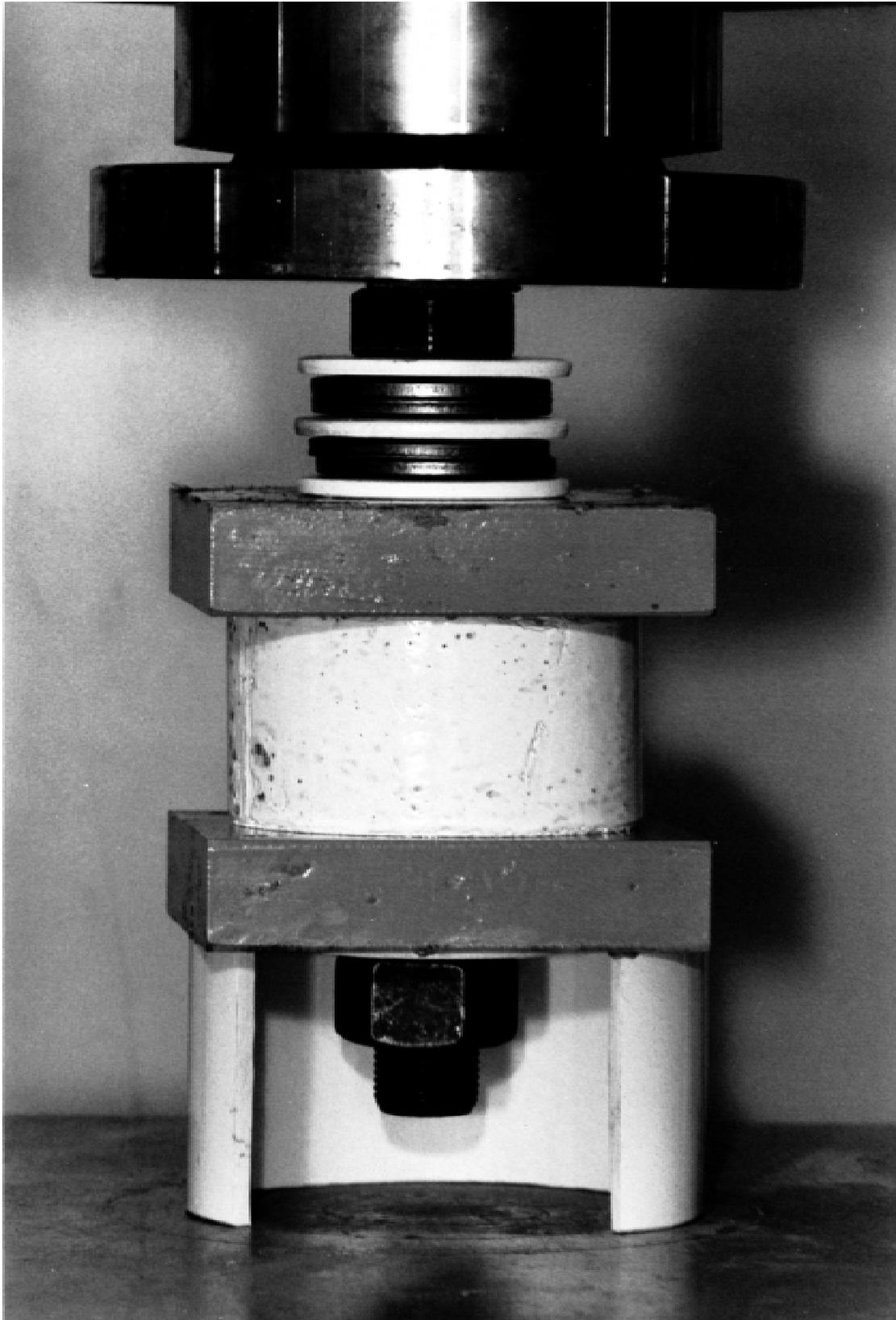


FIG. 2 Typical Arrangement to Apply the Compression Load and Hand Tighten the Nut

TABLE 1 Total Exposure Periods

Total Oven Exposure	Cycle No.	Cooling, min	
		Time in Oven	Time at 73 ± 4°F
24 ± 2 h	1	24 h	24 h
48 ± 4 h	2	24 h	24 h
120 ± 6 h	3	72 h	24 h
7 d ± 6 h	4	48 h	24 h
14 d ± 6 h	5	7 days	24 h
28 d ± 12 h	6	14 days	24 h

TABLE 2 Suggested Schedule, Five-day Work Week

Cycle	Place in Oven	Remove from Oven	Measure and Reload
1	Monday (1) ^A	Tuesday (2)	Wednesday (3)
2	Wednesday (3)	Thursday (4)	Friday (5)
3	Friday (5)	Monday (8)	Tuesday (9)
4	Tuesday (9)	Thursday (11)	Friday (12)
5	Friday (12)	Friday (19)	Monday (22)
6	Monday (22)	Monday (36)	Tuesday (37)

^A Denotes calendar days from start of the test.

10. Precision and Bias

10.1 Precision and bias have not been established for these test methods. It is suggested that duplicate tests be run to verify reproducibility of test results.

11. Keywords

11.1 chemical-resistant; compressive creep; compressive deflection; creep; polymer machinery grouts; stress

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