



Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)¹

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

1. Scope

1.1 This specification covers three grades of packaged dry, hydraulic cement grout (nonshrink) intended for use under applied load (such as to support a structure, a machine, and the like) where a change in height below initial placement height is to be avoided.

1.2 Grouts covered are composed of hydraulic cement, fine aggregate, and other ingredients. They require only the addition of mixing water for use.

1.3 The values stated in SI units are to be regarded as the standard. The inch-pound units in parenthesis are for information only. Values in SI units shall be obtained by measurement in SI units or by appropriate conversion of measurements made in other units, using the Rules of Conversion and Rounding given in IEEE/ASTM SI-10.

1.4 The following safety hazards caveat pertains only to the test method portion of this specification: *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:

C 109/C 109M Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)²

C 125 Terminology Relating to Concrete and Concrete Aggregates³

C 138/C 138M Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete³

C 157/C 157M Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete³

C 185 Test Method for Air Content of Hydraulic Cement Mortar²

C 305 Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency²

C 702 Practice for Reducing Field Samples of Aggregate to Testing Size³

C 827 Test Method for Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures³

C 939 Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)³

C 1090 Test Method for Measuring Change in Height of Cylindrical Specimens for Hydraulic-Cement Grout³

C 1437 Test Method for Flow of Hydraulic Cement Mortar²
IEEE/ASTM SI-10 Standard for Use of the International System of Units (SI): The Modern Metric System⁴

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 Consistency:

3.1.2 *flowable, adj*—a grout consistency having a flow of 125 to 145 by the flow test in accordance with the applicable provisions of Test Method C 1437; the flow after 5 drops of the flow table in 3 s.

3.1.3 *fluid, adj*—a grout consistency having a time of efflux of 10 to 30 s when tested by the flow cone procedure of Test Method C 939.

3.1.4 *plastic, adj*—a grout consistency having a flow of 100 to 125 by the flow test in accordance with the applicable provisions of Test Method C 1437; the flow after 5 drops of the flow table in 3 s.

3.2 Description of Terms Found in Terminology C 125:

3.2.1 *grout (nonshrink), hydraulic-cement, n*—a hydraulic-cement grout that produces a volume that, when hardened under stipulated test conditions, is greater than or equal to the original installed volume; often used as a transfer medium between load-bearing members.

¹ This specification is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.43 on Packaged Dry Combined Materials.

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² *Annual Book of ASTM Standards*, Vol 04.01.

³ *Annual Book of ASTM Standards*, Vol 04.02.

⁴ *Annual Book of ASTM Standards*, Vol 14.04.

4. Classification

4.1 This specification covers three grades of grout, classified in accordance with the volume-control mechanism exhibited by the grout after being mixed with water.

4.1.1 *Grade A Pre-Hardening Volume-Adjusting*—Volume control of grout is caused by expansion before hardening occurs.

4.1.2 *Grade B Post-Hardening Volume-Adjusting*—Volume control of grout is caused by expansion after grout hardens.

4.1.3 *Grade C Combination Volume-Adjusting*—Volume control of grout is caused by a combination of both mechanisms.

5. Ordering Information

5.1 When the purchaser specifies that properties of the packaged, dry grout meet the requirements of this specification (see 15.1), the grade of grout desired shall also be specified and which, if any, of the optional requirements apply.

5.2 When the grout is to be used in contact with stressed tendons or other corrosion-sensitive, load-bearing structural members, the purchaser shall supply this information to the manufacturer and obtain assurances that the material meets relevant chloride, nitrite, nitrate, sulfide, and sulfate requirements, and any other material limitations imposed by the applicable codes and standards (Note 1).

5.3 When the grout is to be used in abnormal or aggressive environments, the purchaser shall supply this information to the manufacturer and obtain assurance that the grout has a successful history of performance in the same or similar exposures.

NOTE 1—Since all conditions of use cannot be anticipated, this specification requires nonshrink grout to exhibit no shrinkage when tested in a laboratory-controlled, moist-cured environment, and requires only the reporting of the observed height change, usually shrinkage, when test specimens are subjected to some degree of drying. It is suggested that users consult with manufacturers on specific applications to determine the applicability of specific test results.

6. Materials

6.1 The materials used as ingredients in packaged, dry, grout include hydraulic cement, fine aggregate, and other ingredients.

7. Performance Requirements

7.1 Specimens shall be made from freshly mixed grout and from grout that has been retained in the mixer for the maximum usable working time allowed by the manufacturer. Specimens from both conditions shall meet the requirements prescribed in Table 1.

7.2 Specimens shall be prepared using materials and equipment at temperatures representing the maximum and minimum usable temperatures specified by the manufacturer for his product. Specimens from both conditions shall meet the requirements prescribed in Table 1, except that the compressive-strength requirements do not have to be met at minimum usable temperature.

7.3 Specimens for testing shall be prepared by combining the use of grout retained in the mixer as in 7.1 with the minimum and maximum as mixed and curing temperatures

TABLE 1 Performance Requirements

Compressive Strength, min	MPa (psi)		
	MPa	(psi)	
1 day ^A	7.0	(1000)	
3 day	17.0	(2500)	
7 day	24.0	(3500)	
28 day	34.0	(5000)	
	-A ^B - Pre-hardening Volume Controlled Type	-B ^C - Post-hardening Volume Controlled Type	-C- Combination Volume Controlled Type
Grade Classification			
Early Age Height Change			
Max % @ Final Set	+ 4.0	NA	+ 4.0
Min % @ Final Set	0.0	NA	0.0
Height Change of Moist Cured Hardened Grout at 1, 3, 14 and 28 Days			
Maximum, %	NA	+ 0.3	+ 0.3
Minimum, %	0.0	0.0	0.0

^A When required, the purchaser must so specify in the purchase contract.

^B If posthardening expansion occurs during evaluation of a Grade A material, then the material shall be evaluated according to Grade C criteria.

^C If prehardening expansion occurs during evaluation of a Grade B material, then the material shall be evaluated according to Grade C criteria.

used in 7.2. Specimens from these combinations of conditions shall meet the requirements of Table 1, except that the compressive-strength requirements do not have to be met at minimum usable temperature.

7.4 All test specimens for performance evaluation shall be prepared using the highest water to solids ratio suggested by the manufacturer for his product.

8. Sampling

8.1 Use whole packages of grout selected at random from the lot of grout to be examined.

8.2 Where lesser quantities of grout will serve the purpose, select 3000 g (7 lb) of dry grout from a whole package in accordance with the mechanical-splitter method in Practice C 702. For high-density grouts, adjust the mass to provide an equivalent volume.

9. Batching

9.1 Grout mixtures shall be produced in the following conditions:

9.1.1 Batch grout mixtures at temperature conditions corresponding to the maximum recommended temperature limit and at a temperature corresponding to the minimum temperature stated by the manufacturer.

9.1.2 For standard temperature testing, maintain the grout mixture and the testing equipment at a temperature of 23 ± 3°C (73 ± 5°F).

9.2 Bring all materials and equipment to be used in preparing test specimens to the specified test temperature, ±3°C (±5°F) prior to use.

9.2.1 When the controlled-environment test room is too small to accommodate large equipment, immediately prior to use, bring the mixer to the desired testing temperature by filling it with water at the appropriate temperature and agitating it by

turning the mixer on. When this water has stabilized at the desired temperature, discard it and start preparing the batch immediately.

9.3 The manufacturer is not prohibited from including, in the package instructions, procedures for adjusting the mixing water temperature to achieve limitations imposed on the grout use temperatures. Use of this technique shall not abrogate the extended mixing time requirement of this specification.

10. Proportioning

10.1 The minimum and maximum amount of water recommended by the manufacturer on the package shall be used to determine conformance with the requirements of this specification. If the manufacturer provides maximum flow (thinnest consistency) information on the package, conduct consistency tests to an accuracy of $\pm 5\%$ to determine the amount of water to be added for testing. In either case, express the weight of water so determined as a ratio of water to dry grout material by weight. If both are given, make tests at whichever involves the larger amount of water by ratio of dry grout mixture.

11. Mixing

11.1 Apparatus:

11.1.1 *Mixer for Preliminary Adjustments*—For smaller quantities of grout, the mortar-mixing apparatus shall be as specified in Practice C 305. However, the mixer shall be provided with a bowl positioner to enable clearance of the largest sized aggregate in the mixture being tested.

11.1.2 *Mixer for Grout Performance Qualifications*—A 90-L (3-ft³) capacity mortar mixer (Note 2) is required. The mixer shall be clean, pre-wetted, and drained and essentially free of hardened mortar and other foreign material that can be removed with a trowel or by reasonably striking with a hammer.

NOTE 2—An electric motor-driven mixer is preferable in the laboratory to avoid noise and exhaust fumes. The horizontal revolving blades are preferred to have rubber tips that contact and wipe the sides of the stationary tub for the most efficient mixing. For greater safety, the mixer should be equipped with a lever-operated clutch. While these comments are selected safety precautions, it is the user's responsibility to see that any equipment in use is not hazardous in a physical or mechanical way to operators and attendant personnel, and that safe work practices are required at all times.

11.2 *Mixing Procedure for Preliminary Adjustment:*

11.2.1 Use a 3000-g (7-lb) sample to determine the consistency classification and to determine the water content of grout tested at a maximum flowability.

11.2.2 For less than whole package amounts, weigh all grout on a balance or on a platform scale to the nearest 0.1 %.

11.2.3 Measure the water by mass or volume to the nearest 0.1 %.

11.2.4 Mix for 3 min, briefly stopping the mixer (not over 15 s) at 1 min to scrape into the batch any grout that may have collected on the side of the bowl. Use other mixing procedures if recommended by the manufacturer (Note 3).

NOTE 3—It is advisable to cover the bowl with a lid while mixing. A metal disc in which a slit has been cut to accommodate the mixer shaft has been found suitable. If excessive splash-over occurs, a larger mixer should be used.

11.3 *Procedure for Grout Performance Qualifications:*

11.3.1 Prepare all performance-qualification specimens from the batch of grout prepared as described herein. Perform tests to verify compliance with performance requirements (see Note 2).

11.3.2 With materials and equipment brought to the testing temperature, use enough whole bags of material to produce a minimum 56 L (2 ft³) of mixed grout. Use this batch for both freshly-mixed and delayed-mixed testing at one specified temperature. Place the total required amount of mixing water in the mixer (Note 4). Use the weighed contents of the packages to determine the amount of water added. Then, with the mixer running, add the grout material in a steady flow, sliding it into the mixer along the side away from the discharge. After mixing for 1 min, stop the mixer for not more than 30 s and scrape down the sides and blades (see Note 2). Mix for 5 min after all the dry grout has been added, unless otherwise recommended by the manufacturer.

NOTE 4—Extensive lumping generally occurs during the procedure for adding grout and water. If it occurs repeatedly, try adding about 80 % of the water, then add all of the grout. Add the remaining water after about 1 min. If lumping persists, contact the grout manufacturer for recommendations.

11.3.3 After completely mixing, discharge a portion of the material through a 9.5-mm ($\frac{3}{8}$ -in.) mesh screen into a clean, pre wet container. If lumps or balls of partially mixed material remain on the screen, reject the entire batch and start over.

11.3.4 Leave the portion of grout to be tested later in the mixer with the mixer running, unless otherwise recommended by the manufacturer, for the period recommended by the manufacturer as the maximum usable working time.

11.3.5 If the manufacturer requires other equipment or a different mixing procedure, or both, when using a particular grout, they shall be used if adequately detailed in the manufacturer's instructions.

12. Test Methods

12.1 *Consistency:*

12.1.1 Determine the consistency of the grout mixture in accordance with Test Method C 827, Preparation of Mixtures, with the exception of temperature. To adjust for consistency, repeat the procedure starting with dry material. Do not add water or dry material to an existing mixture.

12.1.2 Determine the consistency with the required water content, at the temperature extremes allowed by the manufacturer, both with freshly mixed grout and grout mixed to the maximum allowed usable working time. The consistency at the end of the maximum allowed usable working time at each of the allowed temperature extremes shall remain within the specified flow ranges.

12.1.3 Do not adjust the water at extreme conditions unless recommended by the manufacturer. When water adjustment is recommended, perform tests required by this specification to verify that the water-adjusted grout meets the requirements of this specification.

12.2 *Yield*—Determine the yield of the grout using the 400-mL cylindrical measure described in Test Method C 185.

12.2.1 *Calculation*—Calculate the density of the grout in accordance with Test Method C 138 and calculate the yield of freshly mixed grout per package of specified mass as follows:

$$Y = (1 + A) \frac{W_t}{W} \quad (1)$$

where:

Y = Yield of grout, L (ft³) (expressed to nearest 0.5 L [0.01 ft³]),

W = Unit weight of grout, kg/m³ (lb/ft³),

A = Fraction of water added to grout,

$$\frac{\text{Mass of Water}}{\text{Mass of Dry Grout}}$$

W_t = Net weight marked on package, kg (lb).

12.3 *Early Age Height Change*—Determine the early-age height change of grout in accordance with the applicable portions of Test Method C 827.

12.4 *Height Change of Hardened Grout:*

12.4.1 Determine height change of hardened grout at 1, 3, 14, and 28 days in accordance with Test Method C 1090 and report.

12.4.2 At 28 days age, leave specimens in the apparatus and expose to 50 % relative humidity air, in accordance with Test Method C 157, until 56 days age. Determine the net change in specimen height after 28 days of moist curing followed by 28 days of storage in 50 % relative humidity air at 23 ± 2°C (73 ± 5°F).

12.5 *Compressive Strength*—Determine compressive strength in accordance with the applicable portions of Test Method C 109/C 109M except as modified in this section.

12.5.1 For fluid or flowable grouts, fill each mold in the set halfway. Puddle each with a gloved finger five times to consolidate. Fill the mold and puddle again. When filling the mold, use sufficient material so that after the final consolidation the mold is slightly overfilled. Bring the excess grout to the center and finish the surface by cutting off the excess with the straight edge of a trowel held vertically and drawn across the top of the mold with a sawing motion. Plastic grouts shall be consolidated as described in Test Method C 109/C 109M.

12.5.2 Clamp a cover plate over the cube molds using two C-clamps, taking care that the grout does not prevent seating of the plate. The cover plate shall be rigid, nonreactive and not less than 6 mm (¼ in.) thick. The cover plate shall overlap the cube mold by not less than 6 mm (¼ in.). Immediately place test specimens in moist room.

12.5.3 For 1 day compressive strength specimen, strip molds at 24 ± ½ h after molding. Strip remaining molds at 72 ± 1 h after molding and place specimens in moist cabinet or moist room protected from dripping water. Three cubes shall be tested at each age—1, 3, 7, and 28 days.

13. Report

13.1 Report the following information:

13.1.1 Source and identification of grout tested,

13.1.2 Details of any variations and options practiced by the tester that are recommended or allowed by the manufacturer or others. Also, designate by whom exceptions are allowed or recommended,

13.1.3 Number and size of each grade of grout specimen and the date molded,

13.1.4 Consistency at the time the specimens were molded and the water to dry solids ratio,

13.1.5 Mixing temperature and curing temperature,

13.1.6 Identify the grade, usable working time, and temperature range within which the grout specimens were prepared, placed, cured, and tested,

13.1.7 Height change from placement to time of final setting, %,

13.1.8 Height change of hardened, moist-cured grout at specimen age of 1, 3, 14, and 28 days, %,

13.1.9 Height change of hardened grout at 56 days of age when exposed to air drying for 28 days after 28 days of moist-curing, %,

13.1.10 Compressive strength of cubes at 1, 3, 7, and 28 days, and

13.1.11 Yield, determined in 12.2.

14. Inspection and Rejection

14.1 Inspection of the dry grout material shall be agreed upon between the purchaser and the manufacturer as part of the purchase contract.

14.2 Any material that fails to conform to any of the requirements for the applicable grade of grout in this specification shall be designated as nonconforming material. The purchaser has the right to reject any nonconforming material. Rejection shall be reported to the producer or supplier in writing.

15. Certification

15.1 The manufacturer shall, at the time of purchase, provide the purchaser, on request, a certification under terms of the purchase contract, that the product meets the requirements of this standard.

16. Product Marking

16.1 All packages shall show at least the following information in clearly legible form:

16.1.1 Brand name, grade, usable working time for high and low temperatures within which the grout will meet the grade requirements of this specification, net weight,

16.1.2 Date of manufacture and the recommended use expiration date, and

16.1.3 Lot identification number.

16.2 The following additional information shall be either marked on package or attached to it:

16.2.1 Surface preparation, mixing, placing, and curing instructions,

16.2.2 Maximum amount of mixing water to be used, or maximum recommended consistency,

16.2.3 Yield at maximum mixing water content, or maximum consistency. The yield claimed shall not be greater than that measured in 12.2,

16.2.4 Recommended maximum usable working time, “pot-life,” and approximate consistency at end of that time. Usable working time shall not exceed the time after initial mixing that grout retains properties required in this specification, and

16.2.5 High and low temperatures during preparation and placement within which the grout will meet the requirements of this specification.

17. Keywords

17.1 dry hydraulic cement grout; grout; nonshrink hydraulic cement grout; packaged dry grout; shrinkage compensated grout

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