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Standard Practice for Preparing and Testing Specimens from Shotcrete Test Panels¹

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1. Scope

1.1 This practice covers procedures for preparing test panels of dry-mix or wet-mix shotcrete and for testing specimens sawed or cored from the panels.

1.2 The values stated in inch-pound units are to be regarded as the standard.

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:*

¹ This practice is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.46 on Shotcrete.

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- C 42/C 42M Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete²
- C 78 Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)²
- C 138/C 138M Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete²
- C 143/C 143M Test Method for Slump of Hydraulic Cement Concrete²
- C 171 Specification for Sheet Materials For Curing Concrete²
- C 231 Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method²
- C 457 Test Method for Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete²
- C 511 Specification for Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes²
- C 513 Test Method for Obtaining and Testing Specimens of Hardened Lightweight Insulating Concrete for Compressive Strength²
- C 642 Test Method for Density, Absorption, and Voids in Hardened Concrete²
- C 995 Test Method for Time of Flow of Fiber-Reinforced Concrete Through Inverted Slump Cone²
- C 1018 Test Method for Flexural Toughness and First-Crack Strength of Fiber-Reinforced Concrete (Using Beam with Third-Point Loading)²
- C 1399 Test Method for Obtaining Average Residual-Strength of Fiber-Reinforced Concrete²

3. Summary of Practice

3.1 Test panels of shotcrete are fabricated using the personnel, materials, equipment, and shooting positions under investigation. Specimens are core drilled or sawed from these panels for evaluation.

4. Significance and Use

4.1 Specimens obtained in accordance with the procedure section of this practice may be used for preconstruction studies of shotcrete mixtures, to qualify nozzle men and equipment, or for quality control, or compressive or flexural strength testing, during the progress of a project.

5. Test Panels

5.1 Forms for Panels:

5.1.1 The form for receiving the shotcrete shall be either wood or steel construction and sufficiently rigid to prevent dislodging of the shotcrete through vibration or deformation. The form shall have a minimum width and length of 24 in. (610 mm) and a minimum depth of 3½ in. (89 mm) with either square or sloped sides. Larger panels may be desirable for qualifying nozzle men, equipment, or mixture design.

5.1.1.1 *Wood Forms*—Wood forms shall have a back made from plywood at least ¾ in. (19 mm) thick. Side pieces shall be made of lumber with a minimum thickness of 1½ in. (38 mm).

5.1.1.2 *Steel Forms*—Steel forms shall be made using material having a minimum thickness of ⅜ in. (5 mm).

6. Materials

6.1 *Dry-Mix Process*—The test mixture shall be of the same materials and proportions being used or proposed for use in the structure.

6.2 *Wet-Mix Process*—The test mixture shall be of the specified slump and have the specified air content and unit weight, or, when fibers are used, the specified time of flow, air content, and unit weight as the mixture being used or proposed for use in the structure. Determine the air content by Test Method C 231, the unit weight by Test Method C 138/C 138M, slump by Test Method C 143/C 143M and time of flow by Test Method C 995 prior to shooting the panels.

7. Procedure

7.1 *Number of Panels*—A separate panel shall be shot for each mixture representing each admixture type or dosage, fiber type or fiber volume and each shooting position anticipated in the structure (that is, slab, slopes, vertical, and overhead).

7.2 The admixture, if one is used, shall be added in the same manner and dosage as proposed for use or used in the structure.

7.3 Reinforcing bars shall be included in test specimens used for bar encapsulation studies and qualification of personnel, equipment, and application techniques. Reinforcing bars should be excluded from samples prepared for compressive, flexural, and tensile tests. If fibers are added to the shotcrete, they should be included in the respective test samples.

7.4 Shotcreting:

7.4.1 *Equipment*—Shotcrete shall be applied using the equipment, water pressure, and air pressure to be used on the structure.

7.4.2 *Personnel*—The operating personnel (nozzle men and gun operator) shall be those to be used on the structure.

7.4.3 *Application of Shotcrete*—Apply the shotcrete to the panel forms in the manner as proposed for use or as is being done in the structure. Dampen wood forms just prior to shotcreting.

² Annual Book of ASTM Standards, Vol 04.02.

8. Curing

8.1 To prevent evaporation of water from the panels, the panels shall be covered and tightly wrapped (as soon after fabrication as is safe to prevent damage) with a sheet of material meeting requirements of Specification C 171 or stored in a moist room meeting the requirements of Specification C 511. Field cured specimens shall be moved to the laboratory just prior to testing.

8.2 Latex admixed shotcrete panels shall be moist-cured for 24 h and then air-dried for the balance of the curing cycle.

9. Obtaining and Testing Specimens

9.1 Specimens shall be obtained from panels by drilling cores or sawing beams in accordance with Test Method C 42/C 42M, or by sawing cubes in accordance with Test Method C 513. Samples to be cored or sawed shall be removed from the central portion of the specimen. Samples shall not be taken from the shotcrete in the space equal to the depth plus 1 in. (25.4 mm) from the outside edges. For 3½ in. (89 mm) deep, 24 × 24 in. (610 × 610 mm) forms, this corresponds to 4½ in. (114 mm) from the inside of the bottom corner formed by the base of the form, resulting in a sample area of 15 × 15 in. (381 × 381 mm). Cores and beams shall be free from corrugations and striations caused by uneven sawing or coring. It is recommended that all flat surfaces be sawed to ensure parallel and smooth surfaces. Cores shall be drilled and tested for compressive strength perpendicular to the surface of the panel. Cubes and beams may be tested either perpendicular or parallel to the surface of the panel. The direction of testing can influence the results and shall be specified. Proper handling of freshly applied specimens requires they be protected from damage due to extremes of temperature and vibrating movements, shaking, or shock during the hydration process. Beams shall be tested in accordance with Test Method C 78 except that beams of fiber-reinforced concrete shall be tested in accordance with Test Method C 1018 or Test Method C 1399.

9.1.1 *Age*—Specimens shall be obtained from panels and tested at designated ages. Unless moisture conditioning is specified, the specimens shall be obtained from panels no more than 2 h before being tested.

9.1.2 *Conditioning*— When moisture conditioning is specified, it shall be in accordance with the provisions of Test Method C 42/C 42M unless otherwise specified by the purchaser.

9.2 The density, absorption, and voids shall be determined in accordance with the provisions of Test Method C 642. Data obtained in flexural tests shall be treated in accordance with Test Methods C 78, C 1018 or C 1399.

NOTE 1—If the purchaser requests it, the air content of the hardened shotcrete may be determined by Test Method C 457.

10. Calculation

10.1 The length to diameter correction factor found in Test Method C 42/C 42M shall be applied to compressive strengths. For sawed cubes, compressive strengths shall be multiplied by a correction factor of 0.85 to obtain equivalent strength of drilled cores.

11. Report

11.1 The report shall include the following data pertinent to the variables or combinations of variables studied in the tests:

11.1.1 Type and proportions of cement and admixture, fine and coarse aggregate including maximum size and grading, free water content, in the case of wet-mix shotcrete, and temperature.

11.1.2 Type and proportion of any fibers used.

11.1.3 Position of panel as shot.

11.1.4 Type of shotcrete, that is, wet or dry.

11.1.5 Name of nozzleman and gun operator.

11.1.6 Specimen size and moisture conditioning.

11.1.7 Direction of testing relative to panel surface.

11.1.8 Unit weight, air content, absorption and voids, slump, and time of flow, if applicable.

11.1.9 Strength and other mechanical properties evaluated and test methods used, and correction factors applied.

12. Precision and Bias

12.1 The precision and bias of tests conducted on specimens prepared according to this practice will be that of the referenced test methods.

13. Keywords

13.1 beams; cores; cubes; shotcrete; test panels

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