Designation: C1928/C1928M – 23

Standard Test Method for Compressive Strength of Alkali Activated Cementitious Material Mortars (Using 2-in. [50 mm] Cube Specimens)[1]

This standard is issued under the fixed designation C1928/C1928M; 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 test method covers determination of the compressive strength of alkali activated cementitious material mortars, using 2-in. [50 mm] cube specimens.

1.2 This test method references notes and footnotes that provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the test method.

1.3 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard. If required results obtained from another standard are not reported in the same system of units as used by this standard, it is permitted to convert those results using the conversion factors found in the SI Quick Reference Guide.

1.4 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* (**Warning—***Fresh hydraulic cementitious mixtures are caustic and may cause chemical burns to skin and tissue upon prolonged exposure.*[2])

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[3]

C109/C109M Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50 mm] Cube Specimens)

C183/C183M Practice for Sampling and the Amount of Testing of Hydraulic Cement

C219 Terminology Relating to Hydraulic and Other Inorganic Cements

C230/C230M Specification for Flow Table for Use in Tests of Hydraulic Cement

C305 Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency

C511 Specification for Mixing Rooms, Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes

C778 Specification for Standard Sand

C1005 Specification for Reference Masses and Devices for Determining Mass and Volume for Use in Physical Testing of Hydraulic Cements

C1433 Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers

C1437 Test Method for Flow of Hydraulic Cement Mortar

2.2 *IEEE/ASTM:*[4]

SI 10 American National Standard for Metric Practice

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms used in this test method, refer to Terminology C219.

3.2 *Definitions of Terms Specific to This Standard:*

[1] This test method is under the jurisdiction of ASTM Committee C01 on Cement and is the direct responsibility of Subcommittee C01.14 on Non-hydraulic Cements.

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[2] See the section on Safety, Manual of Cement Testing, Annual Book of ASTM Standards, Vol 04.01.

[3] 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.

[4] Available from Institute of Electrical and Electronics Engineers, Inc. (IEEE), 445 Hoes Ln., Piscataway, NJ 08854-4141, http://www.ieee.org.

3.2.1 *AACM precursor, n*—substance consisting of one or more finely divided solids as the major constituent containing both alumina and silica that will react and harden when mixed with an alkali activator.

3.2.2 *alkali activator, n*—source of cations of sodium or potassium or both and, in some cases, magnesium or calcium or a combination thereof, as major constituents that, when incorporated in aqueous or solid form, induces reaction, setting, and hardening of an AACM.

3.2.2.1 *Discussion*—Common examples of alkali activators include hydroxides, silicates, aluminates, and sulfates of sodium or potassium.

3.2.3 *alkali-activated cementitious material (AACM), n*—substance consisting of an inorganic precursor or blend of such precursors that, when combined with an alkali activator, and with water as the reaction medium, reacts to produce a hardened monolithic material.

3.2.3.1 *Discussion*—An alkali-activated cementitious material may also be known as an alkali-activated cementitious binder. Some AACMs are also known as geopolymer cements.

3.2.4 *binder solids, n*—part of an AACM consisting of all solids and dissolved solids.

3.2.4.1 *Discussion*—Calculated by subtraction of the water content from the overall mass of the AACM.

3.2.5 *major constituent, n*—powder, usually aluminosilicate, which is present in an AACM in a proportion exceeding 5 % by mass of the total material, and which is not the alkali activator.

3.2.5.1 *Discussion*—An AACM may contain more than one major constituent.

3.2.6 *manufacturer, n*—the producer that assembles the AACM from a range of raw ingredients.

3.2.7 *mixing protocol, n*—process for combining the AACM precursor, alkali activator, aggregate, admixture and water as defined by the manufacturer.

3.2.8 *mixing water, n*—amount of water added during the mixing of AACM.

3.2.8.1 *Discussion*—Mixing water does not include water which is provided as part of the alkaline activator or as part of an admixture, if these are added as aqueous solutions.

3.2.9 *total water content, n*—amount of added mixing water plus water in the liquid activators and as admixtures.

4. Summary of Test Method

4.1 The mortar consists of AACM precursor material, AACM alkali activator, sand, and water. The ratio of binder solids to sand is 1 to 2.75 proportioned by mass. The mixing protocol shall be applied according to the recommendations of the manufacturer of the AACM. Water content is that sufficient to obtain a flow of 110 % ± 5 % in 25 drops of the flow table. 2-in. [50 mm] test cubes are compacted by tamping in two layers. The cubes are cured according to the guidance of the manufacturer either at 23.0 °C ± 2 °C or at 60 °C ± 2 °C until tested. In the case of fast setting mortars, sufficient dose of a retarding admixture, as recommended by the manufacturer, may be added to obtain a set time of 90 min ± 30 min.

5. Significance and Use

5.1 This test method provides a means of determining the compressive strength of alkali-activated cementitious material mortars and results may be used to determine compliance with specifications.

6. Apparatus

6.1 Weights and weighing devices shall meet the requirements of Specification C1005. The weighing device shall be evaluated for precision and bias at a total load of 2000 g.

6.2 *Glass Graduates,* shall conform to the requirements of Test Method C109/C109M.

6.3 *Specimen Molds,* shall meet the requirements and conform to the tolerances stated in Test Method C109/C109M.

6.4 *Mixer, Bowl and Paddle,* with planetary and revolving motion shall conform to the requirements stated in Practice C305.

6.5 *Flow Table and Flow Mold,* shall conform to Specification C230/C230M.

6.6 *Tamper and Trowel,* conforming to Test Method C109/C109M.

6.7 *Testing Machine,* shall meet the requirements and conform to the tolerances of Test Method C109/C109M.

6.8 *Oven,* of sufficient size, capable of maintaining a uniform temperature of 140 °F ± 5 °F [60 °C ± 2 °C].

6.9 *Moist Cabinet or Room,* conforming to the requirements of Specification C511.

7. Materials

7.1 AACM Precursor.

7.2 Alkali activator.

7.3 Graded Standard Sand:

7.3.1 The sand used for making test specimens shall be natural silica sand conforming to the requirements for graded standard sand in Specification C778.

NOTE 1—*Segregation of Graded Sand*—The graded standard sand should be handled in such a manner as to prevent segregation, since variations in the grading of the sand cause variations in the consistency of the mortar. In emptying bins or sacks, care should be exercised to prevent the formation of mounds of sand or craters in the sand, down the slopes of which the coarser particles will roll. Bins should be of sufficient size to permit these precautions. Devices for drawing the sand from bins by gravity should not be used.

8. Temperature and Humidity

8.1 *Temperature*—The temperature of the air in the vicinity of the mixing slab, the dry materials, molds, base plates, and mixing bowl, shall be maintained between 73.5 °F ± 5.5 °F [23.0 °C ± 3.0 °C]. The temperature of the mixing water, moist closet or moist room, and water in the storage tank shall be set at 73.5 °F ± 3.5 °F [23 °C ± 2 °C].

8.2 *Humidity*—The relative humidity of the laboratory shall be not less than 50 %. The moist closet or moist room shall conform to the requirements of Specification C511.