Designation: C94/C94M – 21a

Standard Specification for Ready-Mixed Concrete[1]

This standard is issued under the fixed designation C94/C94M; 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 This specification covers ready-mixed concrete as defined in 3.2.2 (Note 1). Requirements for quality of ready-mixed concrete shall be either as stated in this specification or as ordered by the purchaser. When the purchaser's requirements, as stated in the order, differ from those in this specification, the purchaser's requirements shall govern. This specification does not cover the placement, consolidation, curing, or protection of the concrete after delivery to the purchaser.

NOTE 1—Concrete produced by volumetric batching and continuous mixing is covered in Specification C685/C685M. Fiber-reinforced concrete is covered in Specification C1116/C1116M.

1.2 As used throughout this specification the manufacturer produces ready-mixed concrete. The purchaser buys ready-mixed concrete.

1.3 The values stated in either SI units, shown in brackets, 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.

1.4 The text of this specification 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 specification.

1.5 *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 use.[2])

1.6 *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]

C31/C31M Practice for Making and Curing Concrete Test Specimens in the Field

C33/C33M Specification for Concrete Aggregates

C39/C39M Test Method for Compressive Strength of Cylindrical Concrete Specimens

C125 Terminology Relating to Concrete and Concrete Aggregates

C138/C138M Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete

C143/C143M Test Method for Slump of Hydraulic-Cement Concrete

C150/C150M Specification for Portland Cement

C172/C172M Practice for Sampling Freshly Mixed Concrete

C173/C173M Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method

C231/C231M Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method

C260/C260M Specification for Air-Entraining Admixtures for Concrete

C330/C330M Specification for Lightweight Aggregates for Structural Concrete

[1] This specification is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.40 on Ready-Mixed Concrete.

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[2] See Section on Safety Precautions, Manual of Aggregate and Concrete Testing, *Annual Book of ASTM Standards*, Vol 04.02.

[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.

***A Summary of Changes section appears at the end of this standard**

C494/C494M Specification for Chemical Admixtures for Concrete
C567/C567M Test Method for Determining Density of Structural Lightweight Concrete
C595/C595M Specification for Blended Hydraulic Cements
C618 Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
C637 Specification for Aggregates for Radiation-Shielding Concrete
C685/C685M Specification for Concrete Made by Volumetric Batching and Continuous Mixing
C989/C989M Specification for Slag Cement for Use in Concrete and Mortars
C1017/C1017M Specification for Chemical Admixtures for Use in Producing Flowing Concrete
C1064/C1064M Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
C1077 Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
C1116/C1116M Specification for Fiber-Reinforced Concrete
C1157/C1157M Performance Specification for Hydraulic Cement
C1240 Specification for Silica Fume Used in Cementitious Mixtures
C1602/C1602M Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
C1611/C1611M Test Method for Slump Flow of Self-Consolidating Concrete
C1798/C1798M Specification for Returned Fresh Concrete for Use in a New Batch of Ready-Mixed Concrete

2.2 *ACI Documents:*[4]

ACI 211.1 Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 211.2 Standard Practice for Selecting Proportions for Structural Lightweight Concrete
ACI 301 Standard Specifications for Structural Concrete
ACI 305R Guide to Hot Weather Concreting
ACI 306R Guide to Cold Weather Concreting
ACI 318 Building Code Requirements for Structural Concrete and Commentary

2.3 *Other Documents:*[5]

NIST 105-1 National Institute of Standards and Technology Handbook

3. Terminology

3.1 *Definitions*—The terms used in this specification are defined in Terminology C125.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *concrete, central-mixed, n*—ready-mixed concrete mixed completely in a stationary mixer.

3.2.2 *concrete, ready-mixed, n*—concrete manufactured and delivered to a purchaser in a fresh state.

3.2.3 *concrete, shrink-mixed, n*—ready-mixed concrete partially mixed in a stationary mixer with mixing completed in a truck mixer.

3.2.4 *concrete, truck-mixed, n*—ready-mixed concrete completely mixed in a truck mixer.

3.2.5 *water, target batch, n*—quantity of water to be added to the batch through the water measuring system after compensating for the quantity of ice, if used, surface moisture on the aggregates and water in the admixtures, when applicable, and by subtracting a quantity of water that is anticipated to be added at the job site or in transit to adjust slump or slump flow of the concrete batch.

4. Basis of Purchase

4.1 The basis of purchase shall be a cubic yard or cubic metre of fresh concrete as discharged from the transportation unit.

4.2 The volume of fresh concrete in a given batch shall be determined from the total mass of the batch divided by the density of the concrete. The total mass of the batch shall be determined as the net mass of the concrete in the batch as delivered, including the total mixing water as defined in 9.3. The density shall be determined in accordance with Test Method C138/C138M. The yield shall be determined as the average of at least three measurements, one from each of three different transportation units sampled in accordance with Practice C172/C172M.

NOTE 2—It should be understood that the volume of hardened concrete may be, or appear to be, less than expected due to waste and spillage, over-excavation, spreading forms, some loss of entrained air, or settlement of wet mixtures, none of which is the responsibility of the producer.

5. Materials

5.1 In the absence of designated applicable material specifications, the following material specifications shall be used:

5.2 *Cementitious Materials:*

5.2.1 *Hydraulic Cement*—Hydraulic cement shall conform to Specification C150/C150M, Specification C595/C595M, or Specification C1157/C1157M.

5.2.2 *Supplementary Cementitious Materials*—Coal fly ash or natural pozzolans shall conform to Specification C618. Slag cement shall conform to Specification C989/C989M. Silica fume shall conform to Specification C1240.

5.3 *Aggregates*—Normal weight aggregates shall conform to Specification C33/C33M. Lightweight aggregates shall conform to Specification C330/C330M and heavyweight aggregates shall conform to Specification C637.

5.4 *Water*—Water shall conform to Specification C1602/C1602M.

5.5 *Air-Entraining Admixtures*—Air-entraining admixtures shall conform to Specification C260/C260M (Note 3).

[4] Available from American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333-9094, http://www.concrete.org.

[5] NIST Handbook 105-1 (revised 1990), "Specifications and Tolerances for Reference Standards and Field Standard Weights and Measures-1. Specifications and Tolerances for Field Standard Weights (NIST Class F)," National Institute of Standards and Technology., U.S. Dept. of Commerce, http://www.nist.gov/pml/wmd/upload/105-1.pdf.

5.6 *Chemical Admixtures*—Chemical admixtures shall conform to Specification C494/C494M or C1017/C1017M as applicable (Note 3).

NOTE 3—In any given instance, the required dosage of air-entraining, accelerating, and retarding admixtures may vary. Therefore, a range of dosages should be allowed, which will permit obtaining the desired effect.

NOTE 4—Interchanging kinds, characteristics, types, classes, or grades of the materials permitted in ready-mixed concrete may produce concrete of different properties.

5.7 *Returned Fresh Concrete*—Returned fresh concrete, when permitted by the purchaser, shall conform to Specification C1798/C1798M.

NOTE 5—Specification C1798/C1798M provides requirements for using, measuring, and reporting returned fresh concrete. These requirements are in addition to those stated herein. The purchaser may further clarify which concrete within an order, such as specific mixtures or applications, may incorporate returned fresh concrete.

6. Ordering Information

6.1 In the absence of designated applicable general specifications, the purchaser's order shall include the following:

6.1.1 Designated size, or sizes, of coarse aggregate,

6.1.2 Slump, or slumps, desired at the point of delivery (see Section 7 for acceptable tolerances),

6.1.3 Slump flow, or flows, desired at the point of delivery (see Section 7 for acceptable tolerances),

6.1.4 Total air content at the point of delivery for concrete that will be exposed to cycles of freezing and thawing or anticipated exposure of the concrete (see Section 8 for sampling for air content tests and tolerances).

NOTE 6—Table 1 provides total air contents for concrete that vary by exposure condition and aggregate size. Total air contents less than those shown in Table 1 may be specified or used for concrete that is not subject to freezing and thawing. This may be done to improve workability and cohesiveness, reduce the rate of bleeding, reduce the water content for a given consistency, or achieve required lightweight concrete density. Specified total air contents higher than those shown in Table 1 may reduce strength without any further improvement of durability.

Exposure conditions for freezing and thawing environments in Table 1 correspond to the following:

Moderate Exposure—Concrete exposed to freeze-thaw cycles but not in contact with the ground or with limited exposure to water, limiting the ability to cause saturation of a portion of the concrete prior to freezing. The concrete shall not receive deicing salts or other aggressive chemicals. Examples include: exterior beams, columns, walls, girders, footings below the frost line, or elevated slabs where application of deicing salt is not anticipated. The air content requirements for this exposure are consistent with those for Exposure Class F1 of ACI 318.

Severe Exposure—Concrete exposed to freeze-thaw cycles while in contact with the ground or with frequent exposure to water, potentially causing saturation of a portion of the concrete prior to freezing. The concrete may receive deicing chemicals or other aggressive chemicals. Examples include: pavements, bridge decks, curbs, gutters, sidewalks, canal linings, or exterior water tanks or sumps. The air content requirements for this exposure are consistent with those for Exposure Classes F2 and F3 of ACI 318.

6.1.5 Which of Options A, B, or C shall be used as a basis for determining the proportions of the concrete to produce the required quality,

6.1.6 When lightweight concrete is specified, the equilibrium density,

NOTE 7—The density of fresh concrete is the only measurable density of lightweight concrete at the time of delivery. The density of fresh concrete is always higher than the equilibrium or oven-dry density. Therefore, for acceptance of lightweight concrete based on density at the time of delivery, a relationship between the equilibrium density and density of fresh concrete needs to be established. Definitions of, and methods for determining or calculating equilibrium and oven-dry density, are covered by Test Method C567/C567M.

6.1.7 When high-density or heavyweight concrete is specified, the density of fresh concrete, and

NOTE 8—High-density or heavyweight concrete typically contains aggregate with a relative density of 3.3 or greater conforming to Specification C637. This concrete is used for radiation shielding or other applications where higher density is required by design. For acceptance of density at the time of delivery, a relationship between the fresh density and the density of hardened concrete required by design should be established.

6.1.8 If desired, any of the optional requirements of Table 2 in Specification C1602/C1602M.

6.1.9 Purchaser shall state any drum revolution limit as to when the concrete discharge must begin. If no drum revolution limit is stated by purchaser, the manufacturer shall determine and communicate the limit to the purchaser prior to delivery.

6.1.10 Purchaser shall state a time limit from the start of mixing defined in 12.3 or 12.5 to when the concrete discharge must be completed. If no time limit is stated by purchaser, the manufacturer shall establish and communicate the limit to the purchaser prior to delivery. The time limit to complete discharge shall be stated on the delivery ticket in accordance with 14.1.14.

NOTE 9—This specification previously included a 1 ½ h time limit to end of discharge since its original publication in 1935. There are many options available to the manufacturer to provide the required quality of concrete with end of discharge limits beyond 1 ½ h or less than 1 ½ h. The purchaser should consult with the manufacturer for available options to establish a time limit to end of discharge prior to or at the time concrete is ordered. Selection of a time limit to end of discharge should consider ambient conditions, types of cementitious materials and admixtures used, placement procedures, and projected transportation time between the batch plant and the point of delivery.

6.2 If a project specification applies, the order shall include applicable requirements for the concrete to be produced in compliance with the specification.

6.3 If the type, kind, or class of cementitious materials in 5.2.1 and 5.2.2 are not designated by the purchaser, it is

TABLE 1 Total Air Content for Air-Entrained Concrete Exposed to Cycles of Freezing and Thawing

Exposure Condition (See Note 6)	Total Air Content, % — Nominal Maximum Sizes of Aggregate, mm [in.]						
	9.5 [⅜]	12.5 [½]	19.0 [¾]	25.0 [1]	37.5 [1½]	50.0 [2]	75.0 [3]
Moderate	6.0	5.5	5.0	4.5	4.5	4.0	3.5
Severe	7.5	7.0	6.0	6.0	5.5	5.0	4.5