



Designation: ~~C94/C94M – 14b~~ C94/C94M – 15

## Standard Specification for Ready-Mixed Concrete<sup>1</sup>

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 reappraisal. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

*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 ~~hereinafter specified~~ stated in this specification or as specified ~~ordered~~ ordered by the purchaser. ~~In any case where the requirements of the purchaser differ from these~~ 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. Fiber-reinforced concrete is covered in Specification C1116.

1.2 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.

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

1.4 The text of this standard references notes and footnotes which provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard.

1.5 *This standard does not purport to address all 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. (Warning—Fresh hydraulic cementitious mixtures are caustic and may cause chemical burns to skin and tissue upon prolonged use.)<sup>2</sup>*

### 2. Referenced Documents

2.1 *ASTM Standards*.<sup>3</sup>

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

C494/C494M Specification for Chemical Admixtures for Concrete

<sup>1</sup> 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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<sup>2</sup> See Section on Safety Precautions, Manual of Aggregate and Concrete Testing, *Annual Book of ASTM Standards*, Vol 04.02.

<sup>3</sup> 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

- [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 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 Specification for Fiber-Reinforced Concrete and Shotcrete](#)  
[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](#)  
 2.2 *ACI Documents:*<sup>4</sup>  
[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 214R Guide to Evaluation of Strength Test Results of 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:*<sup>5</sup>  
[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.

### 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 are the responsibility of the producer.

### 5. Materials

- 5.1 In the absence of designated applicable materials specifications, the following materials 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](#).

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

<sup>5</sup> 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>.

5.3 *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 23).

5.6 *Chemical Admixtures*—Chemical admixtures shall conform to either Specification **C494/C494M** or **C1017/C1017M** as applicable (Note 23).

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.

## 6. Ordering Information

6.1 In the absence of designated applicable general specifications, the purchaser-purchaser's order shall specify 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 ~~When air-entrained concrete is specified, the air content of the samples taken~~ Total air content at the point of discharge from the transportation unit delivery for concrete that will be exposed to cycles of freezing and thawing or anticipated exposure of the concrete (see Section 8 and Table 1 for the total sampling for air content tests and tolerances) (Note 5);

NOTE 5—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 (density, Note 6), and

NOTE 6—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 7—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.

**TABLE 1 Recommended Total Air Content for Air-Entrained Concrete<sup>A</sup> Exposed<sup>B</sup> to Cycles of Freezing and Thawing**

Exposure Condition <sup>C</sup> (See Note 5)		Total Air Content, %					
		Nominal Maximum Sizes of Aggregate, in. [mm]					
		¾ [9.5]	½ [12.5]	¾ [19.0]	1 [25.0]	1½ [37.5]	2 [50.0]
Mild	4.5	4.0	3.5	3.0	2.5	2.0	1.5
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

<sup>A</sup> For air-entrained concrete, when specified.

<sup>B</sup> Unless exposure conditions dictate otherwise, it is permissible to reduce air contents recommended above by up to 1% for concretes with specified compressive strength,  $f'_c$ , of 5000 psi [35 MPa] or above.

<sup>C</sup> For description of exposure conditions, refer to Standard Practice ACI 211.1, Section 6.3.3, with attention to accompanying footnotes.

NOTE 8—An example of a drum revolution limit would be “XXX” revolutions.

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 permitted to use cementitious materials in concrete mixtures that will satisfy the concrete properties and other requirements of the purchaser as ordered.

NOTE 5—In selecting the specified air content, the purchaser should consider the exposure conditions to which the concrete will be subjected. Air contents less than shown in Table 1 may not give the required resistance to freezing and thawing, which is the primary purpose of air-entrained concrete. Air contents higher than the levels shown may reduce strength without contributing any further improvement of durability.

NOTE 6—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.

#### 6.4 Option A:

6.4.1 When the purchaser requires the manufacturer to assume full responsibility for the selection of the proportions for the concrete mixture (Note 79), the purchaser shall also specify the following:

6.4.1.1 Requirements for compressive strength as determined on samples taken from the transportation unit at the point of discharge evaluated in accordance with Section 18. The purchaser shall specify the requirements in terms of the compressive strength of standard specimens cured under standard laboratory conditions for moist curing (see Section 18). Unless otherwise specified the age at test shall be 28 days.

NOTE 9—The purchaser, in selecting requirements for which he assumes responsibility should give consideration to requirements for workability, placeability, durability, surface texture, and density, in addition to those for structural design. The purchaser is referred to Standard Practice ACI 211.1 and Standard Practice ACI 211.2 for the selection of proportions that will result in concrete suitable for various types of structures and conditions of exposure. The water-cement ratio of most structural lightweight concretes cannot be determined with sufficient accuracy for use as a specification basis.

6.4.2 At the request of the purchaser, the manufacturer shall, prior to the actual delivery of the concrete, furnish a statement to the purchaser, giving the dry masses of cement and saturated surface-dry masses of fine and coarse aggregate and quantities, type, and name of admixtures (if any) and of water per cubic yard or cubic metre of concrete that will be used in the manufacture of each class of concrete ordered by the purchaser. He shall also furnish evidence satisfactory to the purchaser that the materials to be used and proportions selected will produce concrete of the quality specified.

#### 6.5 Option B:

6.5.1 When the purchaser assumes responsibility for the proportioning of the concrete mixture, he shall also specify the following:

6.5.1.1 Cement content in pounds per cubic yard [kilograms per cubic metre] of concrete,

6.5.1.2 Maximum allowable water content in gallons per cubic yard [litres per cubic metre] of concrete, including surface moisture on the aggregates, but excluding water of absorption (Note 79), and

6.5.1.3 If admixtures are required, the type, name, and dosage to be used. The cement content shall not be reduced when admixtures are used under this option without the written approval of the purchaser.

6.5.2 At the request of the purchaser, the manufacturer shall, prior to the actual delivery of the concrete, furnish a statement to the purchaser giving the sources, densities, and sieve analyses of the aggregates and the dry masses of cement and saturated-surface-dry masses of fine and coarse aggregate and quantities, type and name of admixture (if any) and of water per cubic yard or cubic metre of concrete that will be used in the manufacture of each class of concrete ordered by the purchaser.

#### 6.6 Option C:

6.6.1 When the purchaser requires the manufacturer to assume responsibility for the selection of the proportions for the concrete mixture with the minimum allowable cement content specified (Note 810), the purchaser shall also specify the following:

6.6.1.1 Required compressive strength as determined on samples taken from the transportation unit at the point of discharge evaluated in accordance with Section 18. The purchaser shall specify the requirements for strength in terms of tests of standard specimens cured under standard laboratory conditions for moist curing (see Section 18). Unless otherwise specified the age at test shall be 28 days.

6.6.1.2 Minimum cement content in pounds per cubic yard [kilograms per cubic metre] of concrete.

6.6.1.3 If admixtures are required, the type, name, and dosage to be used. The cement content shall not be reduced when admixtures are used.

NOTE 10—Option C can be distinctive and useful only if the designated minimum cement content is at about the same level that would ordinarily be required for the strength, aggregate size, and slump or slump flow specified. At the same time, it must be an amount that will be sufficient to ensure durability under expected service conditions, as well as satisfactory surface texture and density, in the event specified strength is attained with it. For additional information refer to Standard Practice ACI 211.1 and Standard Practice 211.2 referred to in Note 79.

6.6.2 At the request of the purchaser, the manufacturer shall, prior to the actual delivery of the concrete, furnish a statement to the purchaser, giving the dry masses of cement and saturated surface-dry masses of fine and coarse aggregate and quantities, type, and name of admixture (if any) and of water per cubic yard or cubic metre of concrete that will be used in the manufacture of each

class of concrete ordered by the purchaser. He shall also furnish evidence satisfactory to the purchaser that the materials to be used and proportions selected will produce concrete of the quality specified. Whatever strengths are attained the quantity of cement used shall not be less than the minimum specified.

6.7 The proportions arrived at by Options A, B, or C for each class of concrete and approved for use in a project shall be assigned a designation to facilitate identification of each concrete mixture delivered to the project. This is the designation required in 14.1.7 and supplies information on concrete proportions when they are not given separately on each delivery ticket as outlined in 14.2. A certified copy of all proportions as established in Options A, B, or C shall be on file at the batch plant.

6.8 The purchaser shall ensure that the manufacturer is provided copies of all reports of tests performed on concrete samples taken to determine compliance with specification requirements. Reports shall be provided on a timely basis.

## 7. Tolerances in Slump or Slump Flow

7.1 Unless other tolerances are indicated by the purchaser, the following shall apply.

7.1.1 When slump is stated as a “maximum” or “not to exceed” requirement:

Tolerances for “Maximum” or “Not to Exceed” Slumps

For Slump of:	Tolerance
3 in. [75 mm] or less	+0 and $-1\frac{1}{2}$ [40 mm]
More than 3 in. [75 mm]	+0 and $-2\frac{1}{2}$ [40 mm]

7.1.2 When slump is stated as a target or nominal slump:

Tolerances for Target or Nominal Slumps

For Slump of:	Tolerance
2 in. [50 mm] and less	$\pm\frac{1}{2}$ in. [15 mm]
More than 2 through 4 in. [50 to 100 mm]	$\pm 1$ in. [25 mm]
More than 4 in. [100 mm]	$\pm 1\frac{1}{2}$ in. [40 mm]

NOTE 11—This option applies when slump is stated as a target slump or nominal slump. For other ways of stating slump, the tolerances should be indicated by the purchaser.

7.1.3 When the purchaser states a slump flow requirement for self-consolidating concrete:

Tolerances for Slump Flow

For Slump Flow	Tolerance
Less than or equal to 22 in. [550 mm]	$\pm 1\frac{1}{2}$ in. [40 mm]
More than 22 in [550 mm]	$\pm 2\frac{1}{2}$ in. [65 mm]

7.1.4 The slump tolerances are applicable when water addition in accordance with 12.7 is permitted.

7.2 Concrete shall be available within the permissible range of slump or slump flow for a period of 30 min starting either on arrival at the job site or after the initial slump adjustment permitted in 12.7, whichever is later. The first and last  $\frac{1}{4}$  yd<sup>3</sup> [ $\frac{1}{4}$  m<sup>3</sup>] discharged are exempt from this requirement. If the user is unprepared for discharge of the concrete from the vehicle, the producer shall not be responsible for the limitation of minimum slump or slump flow after 30 min have elapsed starting either on arrival of the vehicle at the prescribed destination or at the requested delivery time, whichever is later.

## 8. Air-Entrained Concrete

8.1 ~~When~~ Unless otherwise specified, for air-entrained concrete is desired the purchaser the total air contents in Table 1 shall specify the apply based on the exposure condition stated in the purchase order. It is permitted to reduce the total air content of values in Table 1 the concrete. See by one percentage point for concretes with a specified compressive strength greater than or equal to 35 MPa [5000 psi]. Total air content that differs from the values in Table 1 for recommended total air contents is permitted for concrete not exposed to cycles of freezing and thawing (Note 25).

8.2 The air content of air-entrained concrete when sampled from the transportation unit at the point of discharge shall be within a tolerance of  $\pm 1.5$  of the specified value.

8.3 When a preliminary sample taken within the time limits of 12.7 and prior to discharge for placement shows an air content below the specified level by more than the allowable tolerance in accordance with 8.2, the manufacturer may use additional air entraining admixture to achieve the desired air content level, followed by a minimum of 30 revolutions at mixing speed, so long as the revolution limit of 12.76.1.9 is not exceeded (see Note 1012).

NOTE 12—Acceptance sampling and testing in accordance with Practice C172/C172M is not obviated by this provision.

## 9. Measuring Materials

9.1 Except as otherwise specifically permitted, cementitious materials shall be measured by mass. When supplementary cementitious materials are used in the concrete mixtures, the cumulative mass is permitted to be measured with hydraulic cement,

but in a batch hopper and on a scale which is separate and distinct from those used for other materials. The mass of the hydraulic cement shall be measured before supplementary cementitious materials. When the quantity of cementitious material exceeds 30 % of the full capacity of the scale, the measured quantity of the hydraulic cement shall be within  $\pm 1$  % of the required mass, and the cumulative measured quantity of hydraulic cement plus supplementary cementitious materials shall also be within  $\pm 1$  % of the required cumulative mass at each intermediate weighing. For smaller batches to a minimum of 1 yd<sup>3</sup> [1 m<sup>3</sup>], the measured quantity of the hydraulic cement and the measured cumulative quantity of hydraulic cement plus supplementary cementitious materials used shall be not less than the required amount nor more than 4 % in excess. When the purchaser requires alternate methods of measuring cementitious materials, measurement methods and reporting shall be stated in the order (see [Note H13](#)).

NOTE 13—Cementitious materials in bags may be used when requested by the purchaser.

9.2 Aggregate shall be measured by mass. Batch mass measurements shall be based on dry materials and shall be the required mass of dry materials plus the total mass of moisture (both absorbed and surface) contained in the aggregate.

9.2.1 For aggregates measured in individual or cumulative weigh batchers, when the required intermediate or final mass is less than 30 % of the scale capacity the aggregate mass shall be within  $\pm 0.3$  % of scale capacity or within  $\pm 3$  % of the required mass, whichever is less.

9.2.2 When aggregates are measured in an individual weigh batcher and the required mass of aggregate is equal to or greater than 30 % of the scale capacity, the quantity of aggregate shall be within  $\pm 2$  % of the required mass. When aggregates are measured in a cumulative aggregate weigh batcher, and the required intermediate and final cumulative mass of aggregate components is equal to or greater than 30 % of the scale capacity, the quantity of aggregate at each successive weighing shall be within  $\pm 1$  % of the required mass.

NOTE 14—The batching accuracy limit of 0.3 % of scale capacity establishes a reasonable minimum weighing tolerance limit that is independent of the quantity of material being weighed. It generally governs for smaller batch quantities weighed in weigh batchers (scales).

9.3 Mixing water shall consist of water added to the batch, ice added to the batch, water occurring as surface moisture on the aggregates, and water introduced in the form of admixtures. The added water shall be measured by mass or volume to an accuracy of 1 % of the required total mixing water. Added ice shall be measured by mass. In the case of truck mixers, any wash water retained in the drum for use in the next batch of concrete shall be accurately measured; if this proves impractical or impossible the wash water shall be discharged prior to loading the next batch of concrete. Total water (including any wash water) shall be measured or weighed to an accuracy of  $\pm 3$  % of the specified total amount.

9.4 Chemical admixtures in powdered form shall be measured by mass. Liquid chemical admixtures shall be batched by mass or volume. Admixtures measured by either mass or volume, shall be batched with an accuracy of  $\pm 3$  % of the total amount required or plus or minus the amount or dosage required for 100 lb [50 kg] of hydraulic cement, whichever is greater.

NOTE 15—Admixture dispensers of the mechanical type capable of adjustment for variation of dosage, and of simple calibration, are recommended.

## 10. Batching Plant

10.1 Bins with adequate separate compartments shall be provided in the batching plant for fine and for each required size of coarse aggregate. Each bin compartment shall be designed and operated so as to discharge efficiently and freely, with minimum segregation, into the weighing hopper. Means of control shall be provided so that, as the quantity desired in the weighing hopper is approached, the material shall be shut off with precision. Weighing hoppers shall be constructed so as to eliminate accumulations of tare materials and to discharge fully.

10.2 Indicating devices shall be in full view and near enough to be read accurately by the operator while charging the hopper. The operator shall have convenient access to all controls.

10.3 Scales shall be considered accurate if their accuracy is verified through the normally used capacity in accordance with [Table 2](#) and load indicated relative to applied test load is within  $\pm 0.15$  % of the total capacity of the scale or 0.4 % of the net applied load, whichever is greater. The minimum quantity and sequence of applied test loads used to verify material scales shall conform to [Table 2](#) and its notes.

10.4 All exposed fulcrums, clevises, and similar working parts of scales shall be kept clean. Beam scales shall be equipped with a balance indicator sensitive enough to show movement when a weight equal to 0.1 % of the nominal capacity of the scale is placed in the batch hopper. Pointer travel shall be a minimum of 5 % of the net-rated capacity of the largest weigh beam for underweight and 4 % for overweight.

10.5 The device for the measurement of the added water shall be capable of delivering to the batch the quantity required within the accuracy required in [9.3](#). The device shall be so arranged that the measurements will not be affected by variable pressures in the water supply line. Measuring tanks shall be equipped with outside taps and valves to provide for checking their calibration unless other means are provided for readily and accurately determining the amount of water in the tank.

NOTE 16—The scale accuracy limitations of the National Ready Mixed Concrete Association Plant Certification meet the requirements of this specification.