



Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete¹

This standard is issued under the fixed designation C1602/C1602M; 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 specification covers the compositional and performance requirements for water used as mixing water in hydraulic cement concrete. It defines sources of water and provides requirements and testing frequencies for qualifying individual or combined water sources. In any case where the requirements of the purchaser differ from these in this specification, the purchaser's specification shall govern.

1.2 This specification does not purport to cover methods of storage, transportation, or blending of water, or to address the development and maintenance of quality control programs sponsored or managed by the manufacturer.

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 standard.

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 and health practices and to determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:²

C31/C31M Practice for Making and Curing Concrete Test

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.

Current edition approved Feb. 1, 2012. Published March 2012. Originally approved in 2004. Last previous edition approved in 2006 as C1602/C1602M-06. DOI: 10.1520/C1602_C1602M-12.

² 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.

Specimens in the Field

C33/C33M Specification for Concrete Aggregates

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

C94/C94M Specification for Ready-Mixed Concrete

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

C114 Test Methods for Chemical Analysis of Hydraulic Cement

C125 Terminology Relating to Concrete and Concrete Aggregates

C192/C192M Practice for Making and Curing Concrete Test Specimens in the Laboratory

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

C403/C403M Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance

C494/C494M Specification for Chemical Admixtures for Concrete

C1603 Test Method for Measurement of Solids in Water

2.2 ACI Documents:³

ACI 318 Building Code Requirements for Structural Concrete and Commentary

3. Terminology

3.1 *For definitions of terms used in this specification, refer to Terminology*

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *combined water, n*—a mixture of two or more sources of water blended together, before or during introduction into the mixture, for use as mixing water in the production of concrete.

3.2.2 *hydration stabilizing admixtures, n*—set retarding admixtures, conforming to Specification **C494/C494M** Type B or D, that can predictably reduce the hydration rate of cement for applications requiring the management of time of setting of returned concrete, reducing the hydration rate of cement fines

³ Available from American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333.

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

in water from concrete production, or for applications requiring extended delivery time of ready mixed concrete.

3.2.3 *non-potable, adj*—water sources that are not fit for human consumption, or if it contains quantities of substances that discolor it or make it smell or have objectionable taste but does not contain water from concrete production operations.

3.2.4 *potable water, n*—water suitable for human consumption

3.2.5 *water from concrete production operations, n*—water recovered from processes of hydraulic cement concrete production that includes wash water from mixers or that was a part of a concrete mixture; water collected in a basin as a result of storm water runoff at a concrete production facility; or water that contains quantities of concrete ingredients.

4. Requirements for Use

4.1 Mixing water shall consist of:

4.1.1 Batch water (water weighed or metered through the batch plant),

4.1.2 Ice,

4.1.3 Water added by truck operator,

4.1.4 Free moisture on the aggregates, and

4.1.5 Water introduced in the form of admixtures when this water increases the water-cementitious materials ratio by more than 0.01.

4.2 Potable water is permitted to be used as mixing water in concrete without testing for conformance with the requirements of this specification.

4.3 Mixing water that is wholly or partially composed of sources of water that are non-potable or from concrete production operations are permitted to be used in any proportions to the limits qualified to meet the requirements of **Table 1**. At the option of the purchaser and when appropriate for the construction, any of the optional limits found within **Table 2** shall be specified at the time of concrete ordering according to the section on *Ordering Information* of Specification **C94/C94M**.

4.3.1 Non-potable sources of water shall be qualified for use in accordance with **5.1**. When required by the purchaser, requirements of **5.4** shall also apply. When the non-potable water source is blended with a potable source, the qualification of the mixing water shall be at the highest percentage of the non-potable source in the combined mixing water anticipated during production.

4.3.2 Combined water blended from two or more sources, where one of the sources includes that from concrete production, shall be qualified for use in accordance with **5.2**. When required by the purchaser, requirements of **5.4** shall also apply. The combined water shall be qualified at the highest solids content in the total mixing water anticipated during production. Mixing water containing total solids equal to or less than the level qualified by testing shall be permitted.

5. Testing and Requirements

5.1 For sources of non-potable mixing water (as defined in **3.2.3**) proposed for use as total mixing water or in the combined mixing water (as defined in **3.2.1**), the following shall apply to the total combined mixing water:

5.1.1 Water shall be tested for compliance with **Table 1** before first use and thereafter every three months or more often when there is reason to believe that a change has occurred in the characteristics of the source. Testing is permitted to be at a lower frequency, but not less than annually when results from four consecutive tests indicate compliance with **Table 1**. Testing shall be in accordance with **5.3**.

5.2 For sources of water from concrete production operations (as defined in **3.2.5**) proposed for use as the total mixing water or in the combined mixing water (as defined in **3.2.1**), the following shall apply to the total combined mixing water:

5.2.1 The density of the water from concrete production operations shall be tested at least on a daily basis in accordance with Test Method **C1603** or monitored with a hydrometer that has been verified in accordance with Test Method **C1603**. Manufacturers that use automated devices shall maintain at the production facility documentation on the procedures and calibration of systems, as needed (See **Note 1**).

NOTE 1—Blending proportions of water sources can be determined in accordance with Appendix A1 of Test Method **C1603** for achieving a target solids content.

5.2.2 Combined water shall be tested for compliance with the requirements of **Table 1**, in accordance with **5.3**, at the highest solids content anticipated to be used during production in accordance with the following testing frequencies:

5.2.2.1 When the density of the combined water is less than 1.01 g/mL, the water shall be tested before first use and thereafter once every six months. Testing frequency is permitted to be reduced to once every 12 months when the results of two consecutive tests indicate compliance with the requirements of **Table 1** (See **Note 2**).

NOTE 2—This condition is intended to cover the use of clarified wash water that has been passed through a settling pond system.

5.2.2.2 When the density of the combined water is between 1.01 and 1.03, the water shall be tested before first use and thereafter monthly. Testing frequency is permitted to be reduced to once every three months when the results of 4 consecutive tests indicate compliance with the requirements of **Table 1** (See **Note 3**).

NOTE 3—Water density of 1.03 approximately represents a total solids content of 50,000 ppm.

5.2.2.3 When the density of the combined water exceeds 1.03, the water shall be tested weekly or more often when there

TABLE 1 Performance Requirements for Mixing Water

	Limits
Compressive strength, min % control at 7 days ^A	90
Time of setting, deviation from control, h: min ^A	From 1:00 earlier to 1:30 later

^AComparisons shall be based on fixed proportions for concrete or mortar mixtures. The control mixture shall be made with 100 % potable or distilled water. The test mixture shall be made with the mixing water that is being evaluated. (See **Annex A1**).

TABLE 2 Optional Chemical Limits for Combined Mixing Water^A

	Limits	Test Method
Maximum concentration in combined mixing water, ppm ^B		
A. Chloride as Cl ⁻ , ppm		
1 in prestressed concrete, bridge decks, or otherwise designated	500 ^C	C114 ^D
2 other reinforced concrete in moist environments or containing aluminum embedments or dissimilar metals or with stay-in-place galvanized metal forms	1000 ^C	C114 ^D
B. Sulfate as SO ₄ , ppm	3000	C114 ^D
C. Alkalies as (Na ₂ O + 0.658 K ₂ O), ppm	600	C114 ^D
D. Total solids by mass, ppm	50 000	C1603

^ASpecification limits from this table are not prohibited from being specified as individual items or as a whole in accordance with the section on Ordering Information of Specification C94/C94M.

^Bppm is the abbreviation for parts per million

^CThe requirements for concrete in ACI 318 shall govern when the manufacturer can demonstrate that these limits for mixing water can be exceeded. For conditions allowing the use of calcium chloride (CaCl₂) accelerator as an admixture, the chloride limitation is permitted to be waived by the purchaser.

^DTest Methods C114 includes reference and alternative test methods to measure the concentration of chlorides, sulfates, and alkalis in solutions prepared from dissolving cementitious materials. Use the applicable test methods in Test Methods C114 to measure these constituents. The laboratory performing these tests is not required to conform to the method qualification requirements of Test Methods C114. Alternative instrumental and wet chemistry methods not listed in Test Methods C114 that measure the concentration of these chemical species in solution are permitted. When alternative methods are used, the test method used shall be included in the report.

is reason to believe that there is a change in the water characteristics for compliance with the requirements of Table 1. Testing frequency is permitted to be reduced to once every month when the results of two months of consecutive tests indicate compliance with the requirements of Table 1.

5.2.2.4 Testing for water with density exceeding 1.05 shall be the same as that of 5.2.2.3 whether the water includes or does not include a hydration stabilizing admixture (See Note 4).

NOTE 4—Water density exceeding approximately 1.05, where the solids are essentially composed of cementitious materials, may require the use of hydration stabilizing admixtures to maintain compliance with the requirements of Table 1. The producer should have a documented process in place to verify the effectiveness of the admixtures and dosages employed.

5.3 Testing to verify compliance with the requirements of Table 1 shall be conducted in accordance with Annex A1. A test batch with the mixing water to be qualified shall be compared with a control batch prepared with potable water (See Note 5). One of options 5.3.1, 5.3.2 or 5.3.3 shall be used:

5.3.1 Using Samples from Production Batches:

5.3.1.1 Concrete specimens from production batches for strength tests shall be cast and standard cured in accordance with Practice C31/C31M. Compressive strength test results for each batch shall be the average of at least two standard specimens made from a composite sample.

5.3.2 Using Laboratory Concrete batches:

5.3.2.1 Laboratory concrete batches shall be prepared in accordance with Practice C192/C192M. Specimens for compressive strength shall be prepared and cured in accordance with Practice C192/C192M. Compressive strength test results for each batch shall be the average of at least two standard specimens.

5.3.3 Using Laboratory Mortar Batches:

5.3.3.1 For mortar batches use concrete sand complying with Specification C33/C33M. Mortars shall be prepared in accordance with Practice C305 with one part portland cement and 2.25 parts sand by mass and a w/cm of 0.50 ± 0.02 . Batch

size shall be at least 20 % greater than the quantity required for strength test specimens and time of setting tests.

5.3.3.2 Prepare at least three 50-mm [2-in.] mortar cubes for each batch. Strength test specimens shall be standard cured in accordance with Test Method C109/C109M.

5.3.4 Strength of concrete cylindrical specimens shall be determined at 7 days in accordance with Test Method C39/C39M.

5.3.5 Strength of mortar cubes shall be determined at 7 days in accordance with Test Method C109/C109M.

5.3.6 Time of setting shall be measured in accordance with Test Method C403/C403M.

5.4 For the optional requirements in Table 2, the manufacturer shall maintain documentation of the chemical concentrations of chlorides, sulfates and alkalis in the sources of non-potable water or water from concrete production operations. These tests shall be conducted before first use and thereafter once every 6 months, or more often when there is reason to believe that a change has occurred in the characteristics of the source. Unless otherwise specified and when required by the purchaser, the requirements of Table 2 shall apply to the combined water as per 4.3.1 and 4.3.2. This information shall be provided to the purchaser on request (See Note 5).

NOTE 5—The sampling of total combined water in its final form from either the batch plant or transportation unit is impractical. Therefore, for the purposes of testing for compliance to the requirements of Table 1 and Table 2, it is acceptable to sample, proportion, and combine the individual sources of water to produce a test sample that is representative of the actual combined mixing water used in production. For concentrations of chlorides, sulfates, and alkalis, it is acceptable to perform measurements on the non-potable water source or on water from concrete production and to calculate the concentration in the combined water.

6. Keywords

6.1 combined water; density; hydration stabilizing admixture; mixing water; recycled water



ANNEX

(Mandatory Information)

A1. COMPARISON BETWEEN TWO CONCRETE OR MORTAR MIXTURES FOR DETERMINING COMPLIANCE WITH

Table 1

INTRODUCTION

To comply with the performance requirements in Table 1, comparison between two concrete or mortar mixtures is required: one as a control batch using a potable water source, and a second as a test batch using the water source(s) proposed for use. The following shall apply:

A1.1 The composition of the water for the test batch that is being qualified for use shall be in accordance with 4.3.1 or 4.3.2.

A1.2 The age of water for the test batch that is being qualified for use shall be as close as possible to the actual age of water used during actual production. The age of water represents the period of time that the water from concrete production operations contained cement fines.

A1.3 Air entraining and water reducing admixtures are permitted in test and control batches. The air-entraining admixture shall be adjusted to produce the target air content with a tolerance of $\pm 1.5\%$. The dosage of water reducing admixture shall be the same in both batches.

A1.4 Hydration stabilizing admixtures are permitted for use in the mixing water for the test batch. No other set controlling admixtures are permitted.

A1.5 Mixing water content of the test batch shall not be less than the mixing water content of the control batch.

A1.6 Mixture proportions for the test and control batches shall be retained and made available upon request.

A1.7 The temperature of samples of control and test batches of concrete or mortar that are being compared shall be within $\pm 3\text{ }^{\circ}\text{C}$ [$5\text{ }^{\circ}\text{F}$] at the time of sampling and shall be subjected to the same curing conditions for strength test specimens and maintained at the same temperature for the duration of the time of setting tests.

APPENDIX

(Nonmandatory Information)

X1. GUIDE FOR TESTING FREQUENCY AS RELATED TO WATER SOURCE USED IN MIXING WATER.

Water Sources	Combined Water Density (g/mL)	Testing Frequency		
		Density, C1603	Table 1	Table 2
Potable	N/A	N/A	N/A	N/A
Non-Potable ^A	N/A	N/A	3 months; after 4 tests annually (5.1.1)	6 months
Concrete	<1.01	Daily (5.2.1)	6 months; annually after 2 tests (5.2.2.1)	6 months
Production ^A	1.01 – 1.03		Monthly; 3 months after 4 tests (5.2.2.2)	
	> 1.03		Weekly; monthly after 8 tests (5.2.2.3)	

^ATesting frequencies apply to the combined mixing water when it is wholly or partially composed of the listed source as defined in Section 3.

SUMMARY OF CHANGES

Committee C09 has identified the location of selected changes to this specification since the last issue, C1602/C1602M–06, that may impact the use of this specification. (Approved February 1, 2012)

- | | |
|--|---|
| <p>(1) Revised definition of hydration stabilizing admixtures (HSA). Revised 5.2.2.4 for consistency in terminology.</p> <p>(2) Deleted 5.1.2 and 5.2.3 and addressed requirements in new section 5.4. Revised Note 5.</p> <p>(3) Revised Footnote A and added new Footnote D in Table 2.</p> <p>(4) Revised 5.3 to address details of the testing requirements for strength and setting time in conformance with requirements</p> | <p>in Table 1 and to include the option of performing this evaluation with mortars.</p> <p>(5) Revised Annex A1.1, A1.2, and A1.7.</p> <p>(6) Eliminated references to standards in Table 1 with details in 5.3. Revised footnotes in Table 1.</p> |
|--|---|

ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.

This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org). Permission rights to photocopy the standard may also be secured from the ASTM website (www.astm.org/COPYRIGHT/).