Designation: C 1218/C 1218M – 99 (Reapproved 2008)

Standard Test Method for Water-Soluble Chloride in Mortar and Concrete[1]

This standard is issued under the fixed designation C 1218/C 1218M; 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 provides procedures for the sampling and analysis of hydraulic-cement mortar or concrete for chloride that is water soluble under the conditions of test.

1.2 The text of this standard references notes and footnotes that provide explanatory information. These notes and footnotes shall not be considered as requirements of this standard.

1.3 The values stated in either SI units or inch-pound units are to be regarded separately as a standard. Within the text, the inch-pound units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system shall be used independently of the other.

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

2. Referenced Documents

2.1 *ASTM Standards:* [2]

C 42/C 42M Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

C 114 Test Methods for Chemical Analysis of Hydraulic Cement

C 670 Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials

C 823 Practice for Examination and Sampling of Hardened Concrete in Constructions

C 1084 Test Method for Portland-Cement Content of Hardened Hydraulic-Cement Concrete

D 1193 Specification for Reagent Water

E 11 Specification for Wire Cloth and Sieves for Testing Purposes

E 832 Specification for Laboratory Filter Papers

3. Significance and Use

3.1 Water-soluble chloride, when present in sufficient amount, is capable of leading to initiation or acceleration of the corrosion of metals, such as steel, embedded in or contacting a cement system such as mortar, grout, or concrete. Thus, its determination shall be required to evaluate the potential of a cement system for undergoing such reactions or to investigate cement systems where such reaction has already occurred. However, it must be recognized that water-soluble chloride determined at some particular time in the life of a cement system is capable of being substantially different than that at another time; for example, the service environment is capable of resulting in a higher water-soluble chloride content due to changes in solubility or a lower one due to leaching.

3.1.1 Test conditions are capable of affecting water-soluble chloride determinations. Take caution when comparing results from this test method with those from other test methods.

3.2 Sulfides are known to interfere with the determination of chloride content. Blast-furnace slag aggregates and cements contain sulfide sulfur in concentrations that are capable of such interference and produce erroneously high test results. Treatment with hydrogen peroxide, as discussed in Test Methods C 114, is used to eliminate such interference.

3.3 There are aggregates that contain chloride that is not available for corrosion. Such chloride will be detected by use of this test method.[3]

4. Apparatus

4.1 *Sampling Equipment*:

4.1.1 The apparatus required for obtaining samples by coring or sawing is described in Test Method C 42/C 42M.

4.1.2 Use the following apparatus for sampling by drilling (pulverization):

4.1.2.1 Rotary impact drill and drill or pulverizing bits.

4.1.2.2 Spoon or other suitable means to collect without contamination pulverized sample material produced by drilling.

[1] This test method is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.69 on Miscellaneous Tests.

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[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.

[3] For more information see "The Determination of the Chloride Content of Concrete," by Brian B. Hope, John A. Page and John S. Poland, *Cement and Concrete Research*, Volume 15, Number 5, Pergamon Press, New York, September 1985, pp. 863–870.

4.1.2.3 Sample containers capable of maintaining samples in an uncontaminated state.

4.2 *Sample Processing Apparatus*—The apparatus required for processing samples shall be chosen for its suitability for the purposes of the investigation, and frequently includes a concrete saw and one or more pulverizers.

4.2.1 Samples more than 25 mm [1 in.] in maximum dimension shall be reduced in size by use of a jaw crusher or broken into smaller pieces by hammering carefully to avoid loss of smaller pieces.

4.2.2 Crush particles less than 25 mm [1 in.] in maximum dimension using a rotating-puck grinding apparatus, or by using a disc pulverizer, or mortar and pestle operated to restrict to negligible levels the loss of fine particles.

4.2.3 The 850-µm [No. 20] sieve shall comply with Specification E 11.

4.3 The apparatus required for the chloride determination step is given as the reference test method for chloride in Test Methods C 114.

4.4 Glazed paper to minimize adherence of fine particles for use as described in 7.1.

5. Reagents

5.1 The reagents required for the chloride determination are given in the reference test method for chloride of Test Methods C 114.

6. Sampling

6.1 Select the sample as required for the purpose of the investigation (Note 1).

NOTE 1—Because of the small nominal maximum size of the aggregate in a mortar, pieces of mortar having a mass of at least 10 g will be more representative of a much larger volume of mortar than would an equivalently sized sample of concrete. Practice C 823 may be used as a guide for sampling.

6.1.1 Take concrete cores in accordance with Test Method C 42/C 42M unless otherwise specified (Note 2):

NOTE 2—Concrete cores taken in accordance with Test Method C 42/C 42M may be cut longitudinally to provide a 12-mm [½-in.] thick section generally representative of the core, or cut laterally into 12-mm [½-in.] thick discs representative of the concrete core at various depths. Experience has shown that the cooling water from core cutting will not dissolve a significant amount of the chloride.

6.1.2 Powdered concrete obtained by use of a rotary impact drill is frequently useful in determining chloride concentration with depth in bridge decks and pavements. When the nominal maximum coarse aggregate size is 25 mm [1 in.] or more such samples are unrepresentative. The data must be used with care or several samples combined. Procedures for this method of sampling are as follows:

6.1.2.1 Using the rotary impact drill, drill perpendicular to the concrete surface or parallel to the axis of a cored specimen to a specified depth or a depth sufficient to obtain a representative sample of at least 20 g of powdered material. To prevent sample contamination, avoid contact of sample with hands and other sources of perspiration. Clean all sampling tools prior to each sampling operation (Note 3). Do not use lubricants during drilling.

NOTE 3—Sampling tools may be cleaned with a brush, cloth, ethyl alcohol rinse, water rinse, or other method that will not contaminate the sample.

6.1.2.2 Transfer powdered sample into the sample container using a spoon or other suitable means.

7. Sample Preparation

7.1 Pulverize the sample so that all the material will pass a 850-µm [No. 20] sieve. Thoroughly blend the material by transferring it from one glazed paper to another at least ten times.

8. Procedure

8.1 Select a sample having a mass of approximately 10 g. Weigh the sample to the nearest 0.01 g and place it into a 250-mL beaker. Add 50 ± 1 mL of reagent water meeting Specification D 1193, cover with a watch glass, bring to a boil and boil for 5 min. Allow to stand 24 h. Filter by gravity or suction through a fine-texture, Type II, Class G filter paper of Specification E 832. Transfer the filtrate to a 250-mL beaker. Add 3 ± 0.1 mL of (1:1) nitric acid and add 3 ± 0.1 mL of hydrogen peroxide (30 % solution) to the filtrate. Cover the beaker with a watch glass and allow to stand for 1 to 2 min. Heat the covered beaker rapidly to boiling. Do not allow to boil for more than a few seconds. Remove from hot plate (Note 4). Proceed in accordance with the reference test method for chloride of Test Methods C 114, starting with the procedure that follows removal of the sample from the hot plate in Test Methods C 114.

NOTE 4—It is important to keep the beaker covered during heating and digestion to prevent the loss of chloride by volatilization.

9. Calculation

9.1 Calculate percent chloride by mass of mortar or concrete, by the reference test method for chloride given in Test Methods C 114.

9.2 Other useful measures of chloride concentration can be obtained as follows:

9.2.1 For calculating kilograms of chloride per cubic meter [pounds of chloride per cubic yard] of concrete, multiply percent chloride by $D_1/100$ or $D_2/100$,

where:

D_1 = oven-dry density as determined in the section on Concrete Density in Test Method C 1084, kg/m^3[lb/yd^3].

D_2 = saturated-surface-dry density as determined in the section on Concrete Density in Test Method C 1084, kg/m^3[lb/yd^3].

The report must state which density is used in the calculation.

9.2.2 For calculating percent chloride by mass of cement, multiply percent chloride by $100/P$,

where:

P = percent cement by mass in the mortar or concrete, as known or determined in accordance with Test Method C 1084.

10. Precision and Bias

10.1 *Precision*[4]—This precision statement is based on samples passing a 600-µm [No. 30] sieve instead of an 850-µm [No. 20] sieve and on a 1 min boil instead of a 5 min boil.

NOTE 5—It is the opinion of the committee that this difference in procedure should not significantly influence the precision beyond what is presented here.

10.1.1 The single-laboratory standard deviation has been found to be 0.0013 % chloride by mass of mortar or concrete.[5] Therefore, results of two properly conducted tests in the same laboratory on the same material are not expected to differ by more than 0.0037 %.

10.1.2 The multilaboratory standard deviation has been found to be 0.0037 % chloride by mass of mortar or concrete.[5] Therefore, results of two properly conducted tests from two different laboratories on samples of the same material are not expected to differ by more than 0.0106 %.[5] (Note 6).

NOTE 6—This precision statement applies to tests of samples prepared and ground by a single laboratory. Test results of concrete construction will vary depending upon the method of obtaining the sample and the size of the sample before it is crushed and reduced to pass the 850-µm [No. 20] sieve or pulverized.

10.2 *Bias*—The procedure in this test method has no bias because the value of water-soluble chloride is defined by the procedure.

11. Keywords

11.1 chloride; chloride content; concrete; mortar; water-soluble chloride

[4] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR: C09-1003.

[5] These numbers represent, respectively, the (1s) and (d2s) limits as described in Practice C 670.