



Designation: C1898 – 20

Standard Test Methods for Determining the Chemical Resistance of Concrete Products to Acid Attack¹

This standard is issued under the fixed designation C1898; 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 These test methods are intended to evaluate the chemical resistance of cement paste, mortar and concrete materials. This method is loosely based on Test Methods C267, however the solution is more rigorously defined and flexural strength is used. These test methods provide for the determination of changes in the following properties of the test specimens and test medium after exposure of the specimens to the medium:

- 1.1.1 Mass of specimen,
- 1.1.2 Appearance of specimen,
- 1.1.3 Appearance of test medium, and
- 1.1.4 Strength of specimens.

1.2 Guide C1894 provides a standard guide for Microbially Induced Corrosion of Concrete (MICC) products. This standard is used for assessing the chemical resistance of cementitious products to acid attack caused by MICC; however as described in the guideline document for MICC products the current document only applies for Stage III of corrosion. This document is not intended to be a guideline document for the complete evaluation of MICC or for assessing the efficacy of antimicrobial additives used to reduce MICC.

1.3 This standard supplements Test Methods C267 to improve the consistency of reported results for acids generated by MICC or other sources.

1.4 This standard does not cover tests in which acidification is achieved by bacterial activity. Testing protocols for bacterial activity are described in Guide C1894.

1.5 The values stated in SI units are to be regarded as standard. The values given in parentheses are mathematical conversions to alternative units (typically inch-pound units) that are provided for information only and are not considered standard.

1.6 *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 appro-*

priate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.

1.7 *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:

- C14 Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe
- C78/C78M Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
- C125 Terminology Relating to Concrete and Concrete Aggregates
- C192/C192M Practice for Making and Curing Concrete Test Specimens in the Laboratory
- C267 Test Methods for Chemical Resistance of Mortars, Grouts, and Monolithic Surfacing and Polymer Concretes
- C822 Terminology Relating to Concrete Pipe and Related Products
- C904 Terminology Relating to Chemical-Resistant Nonmetallic Materials
- C1768/C1768M Practice for Accelerated Curing of Concrete Cylinders
- C1894 Guide for Microbially Induced Corrosion of Concrete Products
- E4 Practices for Force Verification of Testing Machines

3. Terminology

3.1 Definitions:

- 3.1.1 For definitions of terms used in this standard, refer to Terminology standards C125 and C822.

4. Significance and Use

4.1 As described in Guide C1894, the MICC is considered to be a three-stage process with the reduction in pH (Stage I) (for example, $12.5 > \text{pH} > 9-10$), the establishment of biofilms which further lowers the pH (Stage II) (for example, $9-10 > \text{pH} > 4-6$) and eventual deterioration due to biogenic acid exposure

¹ This test method is under the jurisdiction of ASTM Committee C13 on Concrete Pipe and is the direct responsibility of Subcommittee C13.03 on Determining the Effects of Biogenic Sulfuric Acid on Concrete Pipe and Structures.

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(Stage III) (for example, $< \sim 4$ pH). This document provides standard test methods to assess the effects of acid in Stage 3 for concrete.

4.2 As described in Guide C1894, acid immersion testing should be used with great caution in specifying concrete as this is a final stage of deterioration and the concrete may not be exposed to the conditions of this test.

4.3 The results obtained by these test methods should serve as a guide in, but not as the sole basis for, selection of a chemical-resistant material for a particular application. No attempt has been made to incorporate into this test method all the various factors that may affect the performance of a material when subjected to actual service.

5. Apparatus

5.1 *Equipment*, capable of weighing materials or specimens to ± 0.3 % accuracy.

5.2 *Equipment for Mixing*, consisting of a container of suitable size, preferably made of corrosion-resistant metal, or a porcelain pan, and a strong, sturdy spatula or trowel.

5.3 *Specimen Molds: Equipment*—Molds to manufacture concrete prisms with dimensions 50 by 50 by 200 mm (± 3 mm) for acid immersion testing.

NOTE 1—The material from which the mold is constructed must be chemically inert and have antistick properties. Polyethylene, polypropylene, polytetrafluoroethylene, and metal forms having either a sintered coating of tetrafluoroethylene or a suitable release agent compatible with the material being tested are satisfactory.

5.4 *Massing Equipment*, of adequate capacity, suitable for accurate weighing to 0.001 g.

5.5 *Micrometer*, suitable for accurate measurement to 0.03 mm (0.001 in.).

5.6 Containers:

5.6.1 *Wide-Mouth Glass Jars*, of sufficient capacity, fitted with plastic or plastic-lined metal screw caps for low-temperature tests involving media of low volatility.

5.6.2 *Erlenmeyer Flasks*, of sufficient capacity, each fitted with standard-taper joints and a reflux condenser attachment for use with volatile media.

5.6.3 *Containers*, as described in 5.6.1 and 5.6.2 having an inert coating on their inner surfaces, or containers of a suitable inert material for use with media which attack glass.

5.7 *Testing Machine*—May be of any type of sufficient capacity which will meet the requirements of Test Method C78/C78M.

5.8 *Equipment*—A benchtop pH meter with an accuracy of ± 0.01 .

6. Test Media

6.1 Two test media shall be used: a sulfuric acid concentration resulting in a pH of 2.00 and a pH of 0.50 (Note 2).

6.2 pH of the test Media shall be prepared to ± 0.03 .

NOTE 2—The pH of the solution can be modified to better simulate anticipated service life conditions however this must be noted and reported.

7. Test Specimens

7.1 The number of specimens required is dependent upon the number of test media to be employed, the number of different temperatures at which testing is performed, and the frequency of test intervals. The test specimens shall consist of sets of a minimum of three prisms for one medium at a single temperature and for each test interval. In addition, one set of at least three specimens shall be available for test immediately following the conditioning period, and other sets of at least three, equivalent to the number of test temperatures, for the total test period. Calculate the total number of specimens required as follows:

7.2 Make all specimens for a single determination from a single mix.

7.3 The specimens will be prisms (with dimensions 50 by 50 by 200 mm (± 3 mm)).

8. Preparation of Specimens

8.1 *Specimen Preparation*—Specimens shall be made in accordance with Practice C192/C192M.

9. Conditioning

9.1 Cure the specimens in the mold in a moist cabinet maintained at a temperature of $23 \pm 2^\circ\text{C}$, ($73 \pm 4^\circ\text{F}$) and a relative humidity of not less than 98 % or under wet mats, for 28 days, with the specimens being removed from the molds at the age of 24 h.

10. Test Conditions

10.1 The testing temperature shall be $23 \pm 2^\circ\text{C}$ ($73 \pm 4^\circ\text{F}$) (Note 3).

NOTE 3—The testing temperature can be modified to better simulate anticipated service life conditions however this must be noted and reported.

10.2 Test medium as described in Section 6.

10.2.1 A solution-to-sample volume ratio of 4.2:1 shall be used.

10.2.2 The samples were elevated from the bottom of the containers to prevent uneven exposure.

10.2.3 The pH of the solution shall be measured every 7 days and replaced with newly prepared solution.

10.2.4 The solutions are not agitated or stirred during each 7 day immersion cycle.

11. Procedure

11.1 *Measurement of Specimens:*

11.1.1 Immediately following the conditioning period, measure the cross-sectional dimensions of all test specimens to the nearest 250 μm (0.01 in.) using a micrometer. Take two measurements for each dimension at mid-height and perpendicular to the load axis and average them.

11.2 *Exposure, Weighing, and Visual Inspection of Test Specimens*—Following the conditioning period, record the mass of all the specimens to the nearest 0.001 g on an analytical balance and record the values. Prior to immersion, record a brief description of the color and surface appearance