
Standard Method of Test for

**Portland Cement Content of
Hardened Hydraulic-Cement
Concrete**

AASHTO Designation: T 178-22

Technically Revised: 2022

Technical Subcommittee: 3c, Hardened Concrete

ASTM Designation: C1084-19



**American Association of State Highway and Transportation Officials
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1. SCOPE

- 1.1. This test method covers the determination of portland cement content of a sample of hardened hydraulic-cement concrete.
- 1.2. The values in SI units are to be regarded as the standard. The values given in parentheses are provided for information purposes only.
- 1.3. *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.* Disposal of some or all of the chemicals used in this method may require adherence to EPA or other regulatory guidelines.
- 1.4. *The quality of the results produced by this standard are dependent on the competence of the personnel performing the procedure and the capability, calibration, and maintenance of the equipment used. Agencies that meet the criteria of R 18 are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard are cautioned that compliance with R 18 alone does not completely assure reliable results. Reliable results depend on many factors; following the suggestions of R 18 or some similar acceptable guideline provides a means of evaluating and controlling some of those factors.*

2. REFERENCED DOCUMENTS

- 2.1. *AASHTO Standards:*
 - M 339M/M 339, Thermometers Used in the Testing of Construction Materials
 - R 18, Establishing and Implementing a Quality Management System for Construction Materials Testing Laboratories
 - R 76, Reducing Samples of Aggregate to Testing Size
 - T 24M/T 24, Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
 - T 105, Chemical Analysis of Hydraulic Cement
- 2.2. *ASTM Standards:*
 - C670, Standard Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials
 - C823/C823M, Standard Practice for Examination and Sampling of Hardened Concrete in Constructions

- < C856/C856M, Standard Practice for Petrographic Examination of Hardened Concrete
- < D1193, Standard Specification for Reagent Water
- < E1, Standard Specification for ASTM Liquid-in-Glass Thermometers
- < E11, Standard Specification for Wire-Cloth Sieves for Testing Purposes
- < E230/E230M, Standard Specification for Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples
- < E832, Standard Specification for Laboratory Filter Papers
- < E879, Standard Specification for Thermistor Sensors for General Purpose and Laboratory Temperature Measurements
- < E1137/E1137M, Standard Specification for Industrial Platinum Resistance Thermometers
- < E2877, Standard Guide for Digital Contact Thermometers

2.3. *International Electrotechnical Commission Standards:*

- < IEC 60584-1:2013, Thermocouples - Part 1: EMF Specifications and Tolerances
- < IEC 60751:2008, Industrial Platinum Resistance Thermometers and Platinum Temperature Sensors

3. SIGNIFICANCE AND USE

- 3.1. This test method consists of two independent procedures: an oxide-analysis procedure that consists of two subprocedures and an extraction procedure. Each procedure requires a substantial degree of chemical skill and relatively elaborate chemical instrumentation. Except for the influence of known interference, determined cement contents are normally equal to, or slightly greater than, actual values except for the maleic acid procedure, where results can also be significantly low when the paste is carbonated (Note 1).

Note 1—With certain limitations, the procedure is also applicable for eliminating the combined content of portland cement and pozzolan or slag in concretes made with blended hydraulic cement and blends of portland cement with pozzolans and slags. The results of this test method when applied to concretes made with blended cements or pozzolans depend on the composition of the pozzolan, the age of the concrete, the extent of the reaction of the pozzolan, and the fact that this test method may determine only the portland cement component of a blended cement. The test method should be applied to the determination of the blended cement content or the pozzolanic content only by use of calibration concrete samples or other information. Earlier versions of this test method can provide useful information as detailed by Hime¹ and Minnick.²

4. INTERFERENCES

- 4.1. Many constituents of concrete may interfere with the analysis of the concrete for portland cement content. The following limited lists of materials have been provided as a guide. The rocks, minerals, or mineral admixtures listed will interfere with the cement content determination to the extent of their solubility during the dissolution procedure used. The solubility of rocks, minerals, or mineral admixtures may depend on the fineness of the test sample, the water/cement ratio of the concrete, the extent of hydration, and the age of the concrete (extended exposure of the high pH of the concrete may affect the solubility of some minerals).

4.2. *Substances Affecting Calcium Oxide Subprocedure:*

- 4.2.1. The following are soluble in even the cold dilute hydrochloric acid of this procedure and will contribute a high bias to the cement content calculated from the soluble calcium oxide: limestone, marble, dolomitic limestone, calcareous sandstone, calcareous chert, and caliche-encrusted and calcite- or dolomite-coated rocks.

- 4.2.2. The following may be soluble depending on the age and pH of the concrete; whether the mineral present is glassy or crystalline, or weathered or strained; and the fineness of the minerals present, and, if soluble, will bias the cement content calculated from the soluble calcium oxide high depending on the calcium content of the minerals: weathered or altered plagioclase feldspar, caliche-encrusted rocks, altered volcanic rocks (with calcareous inclusions), and many other calcium containing rocks.
- 4.2.3. Every percent of soluble calcium oxide that is contributed by soluble aggregate or mineral admixtures will bias the cement content high by approximately 1.6 percent.
- 4.2.4. Silica fume may lower the acid solubility of the sample and hence bias the result low.
- 4.3. *Substances Affecting the Soluble Silica Subprocedure:*
- 4.3.1. The following may be soluble depending on the age and pH of the concrete; whether the aggregate is glassy or crystalline, or weathered or strained; and the fineness of the minerals: chert, opal, chalcedony, glassy volcanic rock, strained quartz (highly strained), quartzite, cataclastic rocks (mylonite, phyllonite), gneiss, schist, metagraywacke, and many other soluble silicon-containing rocks and minerals.
- 4.3.2. Every percent of soluble SiO₂ contributed by aggregate or mineral admixtures will bias the reported cement content high by approximately 4.7 percent.
- 4.3.3. Silica fume may lower the acid solubility of the sample and hence bias the result low. If the digestion time or temperature are sufficient to digest all of the portland cement, the silica fume will also be solubilized and bias the calculated cement content high.
- 4.4. *Substances Affecting the Maleic Acid Procedure:*
- 4.4.1. The same substances that are soluble in the soluble calcium or the soluble silica subprocedures may be soluble in the maleic acid procedure. (See Sections 4.2.1, 4.2.2, and 4.3.1.)
- 4.4.2. Every 1 percent of the sample that is aggregate or mineral admixture dissolved by the maleic acid will bias the cement content high by 1 percent.
- 4.4.3. Carbonated cement paste may not be soluble in the maleic acid-methanol dissolution and thus may bias the cement content results low.
- 4.4.4. The unhydrated iron and aluminum phases of the portland cement may not be soluble in the maleic acid and, if not soluble, will bias the cement content low. This may be significant at early ages and less significant at later ages.

5. APPARATUS

- 5.1. *Choose the apparatus from applicable items given in T 105 and from the following:*
- 5.1.1. Chipmunk (jaw ore crusher).
- 5.1.2. Disk pulverizer.
- 5.1.3. Rotary mill (rotating puck).
- 5.1.4. Sieves, 300 µm (No. 50), 1.18 mm (No. 16), and 4.75 mm (No. 4).