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Designation: C 1324 – 02

Standard Test Method for Examination and Analysis of Hardened Masonry Mortar[1]

This standard is issued under the fixed designation C 1324; 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 covers procedures for petrographic examination and chemical analysis of samples of masonry mortars. Based upon such examination and analysis, proportions of components in masonry mortars can be determined.

NOTE 1—Some historic mortars may contain non-resolvable constituents that may interfere. However, significant information may be obtained by petrographic examinations.

1.2 Interpretations and calculations of chemical results are dependent upon results of the petrographic examination. The use of the chemical results alone is contrary to the requirements of this test method.

1.3 Procedures for sampling, petrographic examination, chemical analysis, and calculations of component proportions are given in the following sections:

	Section
Sampling	7
Petrographic examination	8
Chemical analysis	9
Mortar proportion calculations	10
Report	11

1.4 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

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 determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

C 114 Test Methods for Chemical Analysis of Hydraulic Cement[2]

C 125 Terminology Relating to Concrete and Concrete Aggregates[3]

C 144 Specification for Aggregate for Masonry Mortar[4]

C 270 Specification for Mortar for Unit Masonry[4]

C 295 Guide for Petrographic Examination of Aggregates for Concrete[3]

C 457 Test Method for Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete[3]

C 823 Practice for Examination and Sampling of Hardened Concrete in Constructions[3]

C 856 Practice for Petrographic Examination of Hardened Concrete[3]

C 1084 Test Method for Portland-Cement Content of Hardened Hydraulic-Cement Concrete[3]

D 1193 Specification for Reagent Water[5]

3. Terminology

3.1 Terms used in this test method are defined in Terminology C 125 or the other referenced ASTM standards.

4. Significance and Use

4.1 This test method provides procedures for petrographic examination and chemical analysis of mortar for components of masonry mortar. These components may include portland cement, hydrated calcitic or dolomitic lime, masonry cement, aggregates, and air.

4.2 The test method consists of procedures and subprocedures, each requiring a substantial degree of petrographic and chemical skills and relatively elaborate instrumentation.

4.3 The chemical data considered together with results of petrographic examination of a mortar provide for calculation of component proportions and thus allow a determination of mortar composition as represented by Types M, N, S, and O in Table 1 (Proportion Specification Requirements) of Specification C 270.

4.4 Failure of a mortar to have the composition of any type as defined in Table 1 of Specification C 270 does not necessarily mean that the mortar does not meet the requirements of Specification C 270. The mortar may meet the alternative requirements of Table 2 (Property Specification Requirements) of Specification C 270.

4.5 The maleic acid method of analysis is not applicable for the analysis of mortar because it is greatly influenced by

[1] This test method is under the jurisdiction of ASTM Committee C12 on Mortars for Unit Masonry and is the direct responsibility of Subcommittee C12.02 on Research and Methods of Test.

Current edition approved August 10, 2002. Published October 2002. Originally published as C 1324 – 96. Last previous edition C 1324 – 96.

[2] *Annual Book of ASTM Standards,* Vol 04.01.

[3] *Annual Book of ASTM Standards,* Vol 04.02.

[4] *Annual Book of ASTM Standards,* Vol 04.05.

[5] *Annual Book of ASTM Standards,* Vol 11.01.

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carbonation and does not provide for the determination of calcium.

5. Qualifications of Petrographer and Chemist

5.1 *Petrographer*:

5.1.1 The petrographic examination requires the skill of a petrographer well versed in the petrographic methods of Practice C 856, Test Method C 457, and Guide C 295, and in the evaluations of portland cement-containing materials and of masonry mortars.

5.1.2 The interpretation and evaluation of the petrographic data requires detailed knowledge of the requirements of Specification C 270.[6]

5.2 *Chemist*:

5.2.1 The chemical analysis requires the skills of a chemist well versed in methods of chemical analysis, such as of Test Methods C 114 and Test Method C 1084, and in the analytical procedures of these standards.

5.2.2 The interpretation and evaluation of the results of the chemical analysis requires detailed knowledge of the requirements of Specification C 270.[7]

6. Apparatus, Reagents, and Materials

6.1 Apparatus used for the petrographic examination and preparation of specimens are given in Guide C 295, Test Method C 457, and Practice C 856.

6.2 The following apparatus for the chemical analysis shall be chosen from applicable items given in Test Methods C 114 and C 1084 and from the following:

6.2.1 Crushers and pulverizers,[8]

6.2.2 Disk pulverizer,

6.2.3 Rotary mill (rotating puck),

6.2.4 Sieve, 300 µm (No. 50),

6.2.5 Ice bath or electric cooling apparatus,

6.2.6 Hot plate,

6.2.7 Buchner porcelain funnel,

6.2.8 Filter paper,

6.2.9 Beakers, 250-mL and 400-mL,

6.2.10 Platinum crucibles, and

6.2.11 Porcelain crucibles.

6.3 *Reagents and Materials*:

6.3.1 *Soluble silica sub-procedure*:

6.3.1.1 Hydrochloric acid, reagent grade, density 1.19 mg/m^3(1 + 3),

6.3.1.2 Sodium hydroxide, (10 g/L).

6.3.2 *Calcium Oxide Sub-procedure*—Use reagents as required in Test Methods C 114.

6.3.3 *Insoluble Residue Procedure*—Hydrochloric acid, reagent grade, density 1.19 mg/m ^{3}(1 + 4).

6.3.4 *Water*—All references to water shall be understood to mean reagent water Type I through IV of Specification D 1193.

7. Sampling

7.1 The mortar sample should include intact pieces for petrographic analysis. A 10-g sample is usually sufficient for each composite petrographic examination and chemical analysis. The sampling should provide for differentiating between pointing and other mortars from the original mortar. For certain purposes, sampling may be done using procedures in Practice C 823.

8. Petrographic Examination

8.1 *General*:

8.1.1 Petrographic examination refers to methods in Practice C 856 and principally to light microscopy and to use of a petrographic microscope and a stereoscopic low power microscope. Ancillary techniques include X-ray diffractometry and scanning electron microscopy.

8.1.2 X-ray diffraction analysis can be used to identify phases present in mortar. This information, in conjunction with the petrographic microscopy information, is a basis for determining, for the chemical analysis, which calcium oxide or magnesium oxide sub-procedure is necessary.

8.1.3 The petrographic and X-ray diffraction information is necessary for interpretations in calculating mortar composition.

8.2 *Mortar*:

8.2.1 Observe the mortar as appropriate, focusing attention on overall mortar appearance, characteristics of tooled surfaces, fracture surfaces and surfaces contacting masonry units, and secondary substances (efflorescence and internal secondary products). Describe and report the observations.

8.2.2 If X-ray diffraction methods are used, analyze for crystalline components in accordance with individual XRD equipment techniques.

8.3 *Aggregate*:

8.3.1 Examine the aggregate component of the mortar for rock and mineral composition using methods of Guide C 295 and Practice C 856.

8.3.2 If components of the aggregate are acid-insoluble, gently break the mortar, and dissolve the paste matrix using dilute hydrochloric acid, and thoroughly wash and filter the residue. Dry the aggregate residue, and examine it microscopically. The residue may also be sorted into particle sizes using the sieving method of Specification C 144. Aggregate particles broken during the mortar breakdown will skew the gradation analysis results.

8.4 *Paste*—Examine the paste fraction of the mortar using methods of Practice C 856. Components of the paste can include residual (partially hydrated portland cement particles), hydration products of the portland cement and their carbonated equivalents, hydrated lime (both calcitic and dolomitic) and carbonated hydrated lime, and finely ground mineral components such as limestone, dolomite, slag, fly ash, clay, and pigments.

8.5 *Air*:

8.5.1 Examine the mortar for air voids and their configurations and distribution. Characterize the air voids as entrained or entrapped as defined in Terminology C 125 and Test Method C 457, or both. Characterize air voids by locations, disposition, and relative size.

[6] Erlin, Bernard and Hime, William G., "Evaluating Mortar Deterioration," Association for Preservation Technology, 1987.

[7] Hime, William G., and Erlin, Bernard, "Methods for Analyzing Mortar," Proceedings of the Third North American Masonry Conference, Masonry Society, 1985.

[8] Crushers and pulverizers may be obtained from many laboratory supply houses, and include chipmunk type jaw crushers, disc pulverizers, and rotating puck devices.

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