



Designation: C141/C141M – 14 (Reapproved 2022)

# Standard Specification for Hydrated Hydraulic Lime for Structural Purposes<sup>1</sup>

This standard is issued under the fixed designation C141/C141M; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This specification covers hydrated hydraulic lime for structural purposes.

1.2 Hydrated hydraulic lime may be used in the scratch or brown coat of plaster, stucco, mortar, or in portland-cement concrete either as blend, amendment, or admixture.

1.3 The values stated in either SI units or inch-pound units are to be regarded separately as standard. Within the text, the inch-pound units are shown in brackets. 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 following precautionary caveat pertains only to the test method portion, Section 11 of this specification: *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *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:*<sup>2</sup>

C25 Test Methods for Chemical Analysis of Limestone, Quicklime, and Hydrated Lime

C50 Practice for Sampling, Sample Preparation, Packaging, and Marking of Lime and Limestone Products

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee C07 on Lime and Limestone and is the direct responsibility of Subcommittee C07.02 on Specifications and Guidelines

Current edition approved July 1, 2022. Published July 2022. Originally approved in 1938. Last previous edition approved in 2014 as C141/C141M – 14. DOI: 10.1520/C0141\_C0141M-14R22.

<sup>2</sup> 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.

C51 Terminology Relating to Lime and Limestone (as Used by the Industry)

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

C110 Test Methods for Physical Testing of Quicklime, Hydrated Lime, and Limestone

C187 Test Method for Amount of Water Required for Normal Consistency of Hydraulic Cement Paste

C191 Test Methods for Time of Setting of Hydraulic Cement by Vicat Needle

C230/C230M Specification for Flow Table for Use in Tests of Hydraulic Cement

C270 Specification for Mortar for Unit Masonry

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

C778 Specification for Standard Sand

C1271 Test Method for X-ray Spectrometric Analysis of Lime and Limestone

C1301 Test Method for Major and Trace Elements in Limestone and Lime by Inductively Coupled Plasma-Atomic Emission Spectroscopy (ICP) and Atomic Absorption (AA)

## 3. Terminology

3.1 *Definitions*—For definitions of terms related to this specification, see Terminology C51.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *hydrated hydraulic lime, n*—the product resulting from the slaking of hydraulic quicklime generally to a powder, without any addition, and with or without grinding. It has the property of setting and hardening under water and by reaction of carbon dioxide from the air. The hydraulic properties of this material comes only from the composition of the raw materials.

3.2.2 *hydraulic quicklime, n*—a cementitious product obtained by calcining argillaceous or siliceous limestone, or a mixture of similar composition to form sufficient free lime to permit hydration by slaking.

3.2.3 *reworkability, n*—the ability of a material which has setting and hardening properties to be remixed after a given period without significantly compromising the final hardened properties of the material.

3.2.4 *period of reworkability, n*—the length of time a material can be reworked after initial mixing; it shall be expressed in hours.

NOTE 1—Hydrated hydraulic limes have a long working time lasting up to 24 h. The user should seek advice from the producer as to maximum working time.

#### 4. Chemical Composition

4.1 The hydrated hydraulic lime shall conform to the following requirements as to chemical composition, calculated to the LOI-free basis:

	Min	Max
Calcium and magnesium oxides (CaO and MgO calculated to the LOI-free basis), %	50	75
Silica (SiO <sub>2</sub> calculated to the LOI-free basis), %	4	20
Iron and aluminum oxides (Fe <sub>2</sub> O <sub>3</sub> and Al <sub>2</sub> O <sub>3</sub> calculated to the LOI-free basis), %	...	7
Carbon dioxide (CO <sub>2</sub> on an as received basis), %	...	16
Available lime (CaO calculated with Test Methods C25 – 11, Section 28, Available Lime Index), %	16	...

#### 5. Fineness

5.1 The sample shall leave a residue of not more than 0.5 % on a 600 μm (No. 30) sieve, and not more than 10 % on a 75 μm (No. 200) sieve when tested as described in 11.2.

#### 6. Time of Setting

6.1 The neat lime paste mixed to normal consistency shall not develop an initial set in less than 2 h as determined by the Vicat needle method (see 11.4). Final set shall be attained within 48 h at 100 % RH.

#### 7. Reworkability

7.1 Test for reworkability as described in subsection 11.7.1. The average compressive strength value of the second set of cubes (set B) shall not be less than 30 % of the first set (set A).

#### 8. Soundness

8.1 The samples when made, stored, and autoclaved as described in 11.5 shall not have an expansion of more than 1.0 %.

#### 9. Compressive Strength

9.1 The average compressive strength of at least three 50 mm [2-in.] cubes, made, stored, and tested in accordance with 11.6, shall be not less than 1.7 N/mm<sup>2</sup> [250 psi] and no more than 10.3 N/mm<sup>2</sup> [1500 psi] at the age of 28 days.

9.2 The producer shall state the compressive strength, when tested in accordance with 11.6, at the age of 28 days.

9.3 The product shall be reworkable at 24 h as tested in accordance with 11.7.

NOTE 2—For quality control convenience, compressive strengths are tested at 28 days. Hydrated hydraulic limes will gain considerably in strength over time (up to 90 % of final strength being realized at twelve months).

#### 10. Sampling

10.1 Each sample selected for purpose of tests shall weigh at least 2.3 kg [5 lb] and shall represent not more than

22 680 kg [50 000 lb]. If only one sample is taken, it shall weigh at least 4.5 kg [10 lb].

10.2 The sample shall be given a preliminary sieving by being passed through a 850 μm [No. 20] sieve in order to thoroughly mix the sample and break up lumps.

10.3 Samples shall be shipped and stored in airtight, moistureproof containers.

10.4 The sampling, inspection, rejection, retesting, packaging, and marking shall be conducted in accordance with Practice C50.

#### 11. Test Methods:

##### 11.1 *Chemical Analysis:*

11.1.1 Analyses for chemical composition shall be carried out in accordance with Test Methods C25, or, for total elemental analysis, Test Methods C1271 or C1301. The Available Lime Index shall be determined in accordance with Test Methods C25.

##### 11.2 *Fineness:*

11.2.1 Fineness shall be determined by wet sieve analysis or air jet sieving of hydrated lime methods found in Test Methods C110.

##### 11.3 *Normal Consistency:*

11.3.1 Determine normal consistency by the Vicat apparatus in accordance with Test Method C187.

##### 11.4 *Time of Setting:*

11.4.1 Determine time of setting by the Vicat needle method in accordance with Test Method C191. The test will be done on a sample kept at 100 % RH. It will only be removed for measuring.

##### 11.5 *Autoclave Expansion:*

11.5.1 Determine autoclave expansion in accordance with the section on Autoclave Expansion of Hydrated and Hydraulic Lime of Test Methods C110 – 14 (subsection 9.3, Procedure for Expansion Testing), with the following modifications to the procedure:

11.5.1.1 Weigh 25 g ± 0.1 g of HHL. Add 3 mL ± 1 mL of water to the weighed sample and mix by hand until wetted. If the balance allows it, work directly in the specimen mold. If this is not possible, work in an intermediate container and transfer the mixture to the specimen mold in as a complete state as possible. Press to 5.0 N/mm<sup>2</sup> ± 1.5 N/mm<sup>2</sup> [725 psi ± 218 psi] for 10 s and demold specimen and autoclave as described.

##### 11.6 *Compressive Strength:*

###### 11.6.1 *Apparatus:*

11.6.1.1 *Scales and Weights, Sieves, Glass Graduates, Specimen Molds, Tamper, Trowel, and Testing Machine*, in accordance with Test Method C109/C109M.

11.6.1.2 *Flow Table*, conforming to the requirements of Specification C230/C230M.

11.6.1.3 *Mixing Apparatus*, conforming to the requirements of Practice C305.

11.6.2 *Standard Sand*—Use 20–30 sand meeting the requirements of Specification C778.

11.6.3 *Proportions for Standard Mortar*—The mortar shall consist of 1 part of hydrated hydraulic lime to 3 parts of Specification C778 sand, by weight. The quantity of water measured in millilitres shall be such as to produce a flow of 100 % to 115 % as determined by the flow table in 11.6.5.

NOTE 3—This proportion is by weight and differs from Specification C270, which is by volume.

11.6.4 *Preparation of Standard Mortar*—Mix the mortar in accordance with Section 8 of Practice C305 – 14 (Procedure for Mixing Mortars), using 500 g of hydrated hydraulic lime and 1500 g of Specification C778 sand with the necessary water to give the desired flow.

11.6.5 *Determination of Flow*—Determine the flow in accordance with subsection 10.3 of Test Method C109/C109M – 13 (Determination of Flow).

11.6.6 *Molding of Test Specimens:*

11.6.6.1 Prepare molds in accordance with subsection 10.4 of Test Method C109/C109M – 13 (Molding of Test Specimens).

11.6.6.2 The temperature of the air in the vicinity of the mixing slab and of the dry materials, molds, base plates, and mixing bowl, shall be maintained between 20 °C and 27.5 °C [68 °F and 81.5 °F]. The temperature of the mixing water, moist closet or moist room, and water in the storage tank shall not vary from 23 °C [73.4 °F] by more than  $\pm 1.7$  °C [ $\pm 3$  °F]. The moist closet or moist room shall be so constructed as to provide storage facilities for test specimens at a relative humidity of not less than 90 %.

11.6.6.3 Mold test specimens in accordance with subsection 10.4 of Test Method C109/C109M – 13 (Molding of Test Specimens).

11.6.7 *Storage of Test Specimens*—Keep all test specimens, immediately after molding, in the molds on plane plates in a damp closet, maintained at a relative humidity of 90 % or more, for from 48 to 52 h in such a manner that the upper surfaces are exposed to the moist air. Then remove the specimens from the molds and maintain them at a relative humidity of not less than 90 % until the 28-day tests are performed.

11.6.8 *Testing of Specimens:*

11.6.8.1 Test the specimens for 28-day strengths after removal from storage as described in 11.6.7.

11.6.8.2 The remainder of the testing procedure shall be in accordance with Section 9 (Preparation of Specimen Molds) and subsection 10.6 (Determination of Compressive Strength) of Test Method C109/C109M – 13.

11.6.9 *Faulty Specimens*—Specimens that are manifestly faulty or that give strengths differing by more than 15 % from

the average value of all test specimens made from the same sample and tested at the same period, shall not be considered in determining the compressive strength.

11.7 *Reworkability: Testing of Specimen:*

11.7.1 Prepare a mortar mix in accordance with 11.6.4 in sufficient amount to be able to fill two sets of three 2-in. cubes. Cut the mix in half, use first half to prepare a first set of cubes (set A). Store second half in a hermetic container and let rest for 24 ( $\pm 1$ ) h. Once waiting time is achieved, mix the mortar of the second set to achieve required flow as 11.6.5 and prepare a second set of three cubes (set B). Store all cubes as described in 11.6.7. Measure compressive strength of both sets at 28 days of age starting with first mixing time in accordance with 11.6.

## 12. Storage

12.1 The hydrated hydraulic lime shall be stored in such a manner as to permit easy access for proper inspection and identification of each shipment, and in a suitable weathertight building that will protect the hydrated hydraulic lime from damage.

## 13. Inspection

13.1 Every producer shall provide the purchaser with the opportunity to sample and inspect the material either at the place of manufacture or at the destination, as may be specified by the purchaser.

## 14. Rejection

14.1 *Product*—The hydrated hydraulic lime may be rejected if it fails to meet any of the requirements of this specification. At least 31 days shall be allowed for completion of the 28-day test.

14.2 *Packaging*—Packages varying more than 10 % from the weight marked thereon may be rejected, and if the average weight of packages in any shipment, as shown by weighing 50 packages taken at random, is less than the weight marked thereon, the entire shipment may be rejected.

## 15. Packaging and Marking

15.1 The hydrated hydraulic lime shall be delivered in suitable containers with the brand and name of the manufacturer and the net weight plainly marked thereon. All packages shall be in good condition at the time of inspection.

## 16. Keywords

16.1 compressive strength; hydrated hydraulic lime; hydraulic lime; mortar; portland cement concrete; plaster; stucco