



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

This standard is issued under the fixed designation C 141; 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 specification covers hydraulic hydrated lime for structural purposes.

1.2 Hydraulic hydrated 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 inch-pound units are to be regarded as the standard.

1.4 The following precautionary caveat pertains only to the test method portion, Section 10 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 and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

### 2.1 ASTM Standards:

C 25 Test Methods for Chemical Analysis of Limestone, Quicklime, and Hydrated Lime<sup>2</sup>

C 109 Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-mm Cube Specimens)<sup>2</sup>

C 150 Specification for Portland Cement<sup>2</sup>

C 151 Test Method for Autoclave Expansion of Portland Cement<sup>2</sup>

C 184 Test Method for Fineness of Hydraulic Cement by the 150-μm (No. 100) and 75-μm (No. 200) Sieves<sup>2</sup>

C 187 Test Method for Normal Consistency of Hydraulic Cement<sup>2</sup>

C 230 Specification for Flow Table for Use in Tests of Hydraulic Cement<sup>2</sup>

C 266 Test Method for Time of Setting of Hydraulic-Cement Paste by Gillmore Needles<sup>2</sup>

C 305 Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency<sup>2</sup>

C 778 Specification for Standard Sand<sup>2</sup>

E 11 Specification for Wire-Cloth Sieves for Testing Purposes<sup>3</sup>

## 3. Terminology

### 3.1 Definitions:

3.1.1 *hydraulic hydrated lime*—the hydrated dry cementitious product obtained by calcining a limestone containing

silica and alumina, or a synthetic mixture of similar composition, to a temperature short of incipient fusion so as to form sufficient free lime (CaO) to permit hydration and at the same time leaving unhydrated sufficient calcium silicates to give the dry powder, meeting the requirements herein prescribed, its hydraulic properties.

NOTE 1—The purchaser may increase the hydraulicity by the addition of pulverized portland cement clinker, or a pulverized pozzolan, either natural or artificial.

3.1.1.1 *high calcium hydraulic hydrated lime*—a lime that contains not more than 5 % magnesium oxide (of the nonvolatile portion).

3.1.1.2 *magnesium hydraulic hydrated lime*—a lime containing more than 5 % magnesium oxide (of the nonvolatile portion).

## 4. Chemical Composition

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

	Min	Max
Calcium and magnesium oxides (CaO and MgO calculated to the nonvolatile basis), %	65	75
Silica (SiO <sub>2</sub> calculated to the nonvolatile basis), %	16	26
Iron and aluminum oxides (Fe <sub>2</sub> O <sub>3</sub> and Al <sub>2</sub> O <sub>3</sub> calculated to the nonvolatile basis), %	...	12
Carbon dioxide (CO <sub>2</sub> on an as received basis), %	...	8

## 5. Fineness

5.1 The sample shall leave a residue of not more than 0.5 % on a No. 30 (600-μm) sieve and not more than 10 % on a No. 200 (75-μm) sieve when tested as described in 10.2.

## 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 Gillmore needle method (see 10.4). Final set shall be attained within 24 h.

## 7. Soundness

7.1 The neat bars when made, stored, and autoclaved as described in 10.5 shall not have an expansion of more than 1.0 %.

## 8. Compressive Strength

8.1 The average compressive strength of not less than three 2-in. (50-mm) cubes, made, stored, and tested in accordance with 10.6, shall be not less than 250 psi (1.7 MPa) at the age of 7 days. The average strength attained at 28 days shall be not less than 500 psi (3.4 MPa).

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<sup>2</sup> Annual Book of ASTM Standards, Vol 04.01.

<sup>3</sup> Annual Book of ASTM Standards, Vol 14.02.

## 9. Sampling

9.1 Each sample selected for purpose of tests shall weigh at least 5 lb (2.3 kg) and shall represent not more than 50 000 lb (22 680 kg). If only one sample is taken it shall weigh at least 10 lb (4.5 kg).

9.2 The sample shall be given a preliminary sieving by being passed through a No. 20 (850- $\mu$ m) sieve in order to thoroughly mix the sample, break up lumps, and remove foreign materials.

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

## 10. Test Methods:

### 10.1 Chemical Analysis:

10.1.1 Analyses for chemical composition shall be carried out in accordance with Test Methods C 25.

### 10.2 Fineness:

10.2.1 *Apparatus*—The No. 30 (600- $\mu$ m) and No. 200 (75- $\mu$ m) sieves shall conform to Specification E 11.

10.2.2 *Procedure*—Place a 100-g sample of the material as received on a No. 30 (600- $\mu$ m) sieve nested above a No. 200 (75- $\mu$ m) sieve. Wash the material by means of a stream of water from a faucet (Note 2). Continue the washing until the water coming through the sieve is clear, but in no case shall the washing be continued for more than 15 min (Note 3). Dry the residue on both sieves to constant weight at a temperature between 212 and 248°F (100 and 120°C). Calculate the weights of material retained as a percentage of the original sample, the weight of the material retained on the No. 30 sieve being added to the weight of the material retained on the No. 200 sieve to obtain the correct weight of the material retained on the No. 200 sieve. For additional information, also see Test Method C 184.

NOTE 2—A piece of rubber tubing attached to a water faucet may be used for the washing. The velocity of the water, which may be increased by pinching the tubing, shall not be sufficient to cause any splashing of the sample over the sides of the sieve.

NOTE 3—Care shall be taken not to let water accumulate on the No. 200 (75- $\mu$ m) sieve, because the openings will become clogged and the operation cannot be completed in 15 min.

### 10.3. Normal Consistency:

10.3.1 Determine normal consistency by the Vicat apparatus in accordance with Test Method C 187.

### 10.4 Time of Setting:

10.4.1 Determine time of setting by the Gillmore needle method in accordance with Test Method C 266.

### 10.5 Autoclave Expansion:

10.5.1 Determine autoclave expansion in accordance with Test Method C 151, with the following modifications:

10.5.1.1 The material used in preparing the test specimens shall be a blend of 75 weight % of the hydraulic lime to be tested with 25 weight % of a portland cement conforming to Type I of Specification C 150.

10.5.1.2 Dry-mix the hydraulic lime and portland cement before water is added, and prepare the paste in accordance with Test Method C 151.

10.5.1.3 Remove the bars from the mold when they are 48  $\pm$  2 h old, measure, and return them to the moist closet. When 7 days old, 5 days after removing from the mold, autoclave them in the usual manner. For the purpose of this test, consider the difference in length of the test specimens at

the 48-h period and after autoclaving as the autoclave expansion.

### 10.6 Compressive Strength:

#### 10.6.1 Apparatus:

10.6.1.1 *Scales and Weights, Sieves, Glass Graduates, Specimen Molds, Tamper, Trowel, and Testing Machine*, in accordance with Test Method C 109.

10.6.1.2 *Flow Table*, conforming to the requirements of Specification C 230.

10.6.1.3 *Mixing Apparatus*, conforming to the requirements of Practice C 305.

10.6.2 *Standard Sand*—Use 20–30 sand meeting the requirements of Specification C 778.

10.6.3 *Proportions for Standard Mortar*—The mortar shall consist of 1 part of hydraulic hydrated lime to 3 parts of standard Ottawa 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.

10.6.4 *Preparation of Standard Mortar*—Mix the mortar in accordance with Section 6 of Practice C 305, using 500 g of hydraulic lime and 1500 g of standard Ottawa sand with the necessary water to give the desired flow.

10.6.5 *Determination of Flow*—Determine the flow in accordance with Section 8.3 of Test Method C 109.

#### 10.6.6 Molding of Test Specimens:

10.6.6.1 Prepare molds in accordance with Section 7 of Test Method C 109.

10.6.6.2 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 68 and 81.5°F (20 and 27.5°C). The temperature of the mixing water, moist closet or moist room, and water in the storage tank shall not vary from 73.4°F (23°C) by more than  $\pm 3^\circ\text{F}$  ( $\pm 1.7^\circ\text{C}$ ). 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 %.

10.6.6.3 Mold test specimens in accordance with 8.4 of Test Method C 109.

10.6.7 *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 place in the air of the laboratory for 5 days in such a manner as to allow free circulation of air around at least 5 faces of the specimens. At the age of 7 days immerse the specimens for the 28-day tests in saturated lime water in storage tanks of noncorrodible materials.

#### 10.6.8 Testing of Specimens:

10.6.8.1 Test the specimens for 7-day and 28-day strengths after removal from storage as described in 10.6.7.

10.6.8.2 The remainder of the testing procedure shall be in accordance with 8.6 and Section 9 of Test Method C 109.

10.6.9 *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. Storage

11.1 The hydraulic hydrated 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 hydraulic hydrated lime from damage.

## 12. Inspection

12.1 Every facility shall be provided the purchaser for sampling and inspection either at the place of manufacture or at the destination, as may be specified by the purchaser.

## 13. Rejection

13.1 *Product*—The hydraulic hydrated lime may be rejected if it fails to meet any of the requirements of this specification. However, hydraulic hydrated lime failing to meet the 7-day requirements may be held awaiting the result of the 28-day tests before rejection. At least 10 days from the time of sampling shall be allowed for completion of the 7-day

test, and at least 31 days shall be allowed for completion of the 28-day test.

13.2 *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.

## 14. Packaging and Marking

14.1 The hydraulic hydrated 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.

## 15. Keywords

15.1 compressive strength; high calcium hydraulic lime; hydraulic hydrated lime; hydraulic lime; magnesium hydraulic lime; mortar; portland cement concrete; plaster; stucco

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