



Designation: ~~C979/C979M~~ – 10 ~~C979/C979M~~ – 16

## Standard Specification for Pigments for Integrally Colored Concrete<sup>1</sup>

This standard is issued under the fixed designation C979/C979M; 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 the basic requirement for colored and white pigments in powder form to be used as admixtures in concrete for the purpose of producing integrally colored concrete. Where the pigments are a constituent of a multicomponent admixture, this specification applies to the pigment constituent of the admixture. This specification is not intended to establish compatibility of pigments with any other concrete admixtures unless they are tested in combination in accordance with 4.7.

1.2 This specification does not include the determination of pigment stability when elevated temperature using low-pressure (atmospheric) or high-pressure (autoclave) steam is used to accelerate the curing process.

1.3 In addition to tests defining the pigments themselves, a limited number of tests on concrete are included to define the effects on setting times, air content, and compressive strength. If more extensive information is required for a particular job, additional testing criteria and procedures should be agreed upon between the seller and user.

1.4 The maximum prescribed dosage rate of a pigment, established in accordance with 4.7, shall be equal to or less than 10 mass % of cement. When a combination of pigments is used to produce the desired color and color intensity, the total dosage rate of all pigments combined shall not exceed any of the individual maximum dosage rates of the component pigments.

1.5 The values stated in either SI units or inch-pound units are to be regarded separately as standard. 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. Some values have only SI units because inch-pound equivalents are not used in practice.

### 2. Referenced Documents

#### 2.1 ASTM Standards:<sup>2</sup>

~~C33~~~~C33/C33M~~ Specification for Concrete Aggregates

~~C39~~~~C39M~~ Test Method for Compressive Strength of Cylindrical Concrete Specimens

~~C125~~ Terminology Relating to Concrete and Concrete Aggregates

~~C143~~~~C143M~~ Test Method for Slump of Hydraulic-Cement Concrete

~~C150~~~~C150M~~ Specification for Portland Cement

~~C173~~~~C173M~~ Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method

~~C192~~~~C192M~~ Practice for Making and Curing Concrete Test Specimens in the Laboratory

~~C231~~~~C231M~~ Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method

~~C260~~~~C260M~~ Specification for Air-Entraining Admixtures for Concrete

~~C403~~~~C403M~~ Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance

~~D50~~ Test Methods for Chemical Analysis of Yellow, Orange, Red, and Brown Pigments Containing Iron and Manganese

~~D1208~~ Test Methods for Common Properties of Certain Pigments

~~D1535~~ Practice for Specifying Color by the Munsell System

~~G23~~ Practice for Operating Light-Exposure Apparatus (Carbon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials (Withdrawn 2000)<sup>3</sup>

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.23 on Chemical Admixtures.

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<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.

<sup>3</sup> The last approved version of this historical standard is referenced on www.astm.org.

2.2 *ACI Standards*:<sup>4</sup>

~~211.1-91~~ **211.1-91 (Reapproved 2009)** Recommended Standard Practice for Selecting Proportions for Normal, Heavyweight, and Heavyweight Mass Concrete

### 3. Terminology

3.1 *Definitions*:

3.2 For definitions of terms used in this specification, refer to Terminology **C125**.

### 4. General Requirements

4.1 *Water Wettability*—The pigment shall be water wettable when tested in accordance with **8.1**.

4.2 *Alkali Resistance*—The pigment treated with sodium hydroxide shall not show any significant (**Note 1**) change of color when tested in accordance with **8.2**.

4.3 *Total Sulfates*—Calculated as SO<sub>3</sub>, the sulfates shall not exceed 5.0 mass % of the original pigment sample when tested in accordance with **8.3**.

4.4 *Water Solubility*—The total matter soluble in water shall not exceed 2.0 mass % of the original pigment sample when tested in accordance with **8.4**.

4.5 *Atmospheric Curing Stability*—The magnitude of color differences between pigmented concrete specimens cured in dry air and those cured at high relative humidity when tested in accordance with **8.5** shall not be greater than the magnitude of the color difference between two unpigmented specimens cured under the same conditions.

4.6 *Light Resistance*—The exposed portions of the specimens shall show no significant differences (**Note 1**) in color from the unexposed portions when tested in accordance with **8.6**. While a pigment that fails this test shall not be considered light resistant, a pigment that passes this test may still be subject to fading when exposed to natural weathering conditions.

**NOTE 1**—A significant difference is defined as one that is readily perceptible by visual observation without close examination. ~~The section on Lighting and viewing conditions as described in Practice D1535, 6.1, may be used.~~ Viewing Conditions in Practice **D1535, 6.1**, may be used.

4.7 *Effects on Concrete*:

4.7.1 When compared with the control mixture, the concrete that is pigmented at the maximum prescribed dosage rate shall have a 28-day compressive strength of not less than 90 % and a water-cement ratio of not greater than 110 % of that of the control mixture when prepared and tested in accordance with **8.7 (Note 2)**.

4.7.2 The pigment, when added to a concrete mixture at the maximum prescribed dosage rate, shall neither accelerate the initial or final set by more than 1 h nor retard the initial or final set by more than 1½ h, as compared to the uncolored concrete control mixture when tested in accordance with **8.7 (Note 2)**.

4.7.3 Using the same quantity of air-entraining admixture, the pigments, when added to a concrete mixture at the maximum prescribed dosage rate, shall not change the air content by more than 1.0 %, as compared to the uncolored control mixture when tested in accordance with **8.7**.

**NOTE 2**—These values include allowance for normal variations in test results. The object of the 90 % compressive-strength requirement is to require a level of performance of the pigmented concrete comparable to that of the reference concrete when tested in accordance with **8.7**.

4.8 *Color Match of Shipment*—The color produced by the shipment of pigment shall not be significantly different (**Note 1**) from the color produced by the standard supplied by the pigment manufacturer when samples of both the shipment and the standard are tested in accordance with **8.8**. New concrete specimens containing the standard sample of the particular pigment must be prepared whenever a new shipment is evaluated. This is necessary to eliminate color variations caused by any of the other mortar ingredients, specimen preparation, or curing.

### 5. Rejection

5.1 The purchaser has the right to reject material that does not conform to the requirements of this specification. Rejection shall be reported to the producer or supplier in writing.

5.2 Individual packages or containers varying more than 5 % from the stated mass may be rejected. If the average weight of 50 packages taken at random is less than that stated, the entire shipment may be rejected.

### 6. Packaging

6.1 Packages or containers shall be clearly marked as to color designation and the net mass.

6.2 The package or container for the pigment, only when so designated by the manufacturer, shall be added to the concrete batch, provided that it is composed of disintegrating paper or soluble material which, when tested as a unit (pigment and packaging), conforms to all requirements of this specification.

<sup>4</sup> Available from American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333-9094, <http://www.concrete.org>.



## 7. Materials for Tests

7.1 *Cement*—For the atmospheric curing stability and the light resistance tests, using white cement is suggested. The cement used in all other tests shall be either a Type I or Type II cement conforming to Specification ~~C150~~C150/C150M or the cement proposed for specific work.

7.2 *Aggregates*—The aggregates used in all tests shall conform to Specification ~~C33~~C33/C33M or shall be the aggregates proposed for specific work. For the atmospheric curing stability and the light resistance tests, clean silica sand shall be used. For both the reference and the pigmented mixtures, the aggregate grading shall be controlled by determining the mass of separate fractions.

7.3 *Admixtures*—If any of the test mixtures contain any admixtures in addition to pigment other than an air-entraining admixture complying with Specification ~~C260~~C260/C260M, the pigment shall be considered to comply with this specification only when used in conjunction with such other admixture(s).

## 8. Test Methods

8.1 *Water Wettability*—Add 10.0 g of the pigment to 150 mL of deionized water in a 250-mL beaker. If the pigment does not readily mix with the water when stirred with a spatula, but instead a substantial portion of the pigment floats on the surface of the water, the pigment is repellent and not water wettable.

8.2 *Alkali Resistance*—Add two 10.0 g-portions of the pigment to separate 250-mL beakers, each containing 150 mL of deionized water. Stir until thoroughly mixed. Add 10 mL of 10 mass % sodium hydroxide solution to one beaker, and stir thoroughly once more. Let the slurries stand 1 h, then remix and filter on separate Buchner funnels. Wash the filter cake with three replacement washes of hot deionized water. Dry the cake on the filter paper in an oven at  $110 \pm 3$  °C [ $230 \pm 5$  °F] for  $4 \pm 0.5$  h. Remove from the oven, cool, and crush the pigment into a fine powder in a mortar. Make two small adjacent piles of the pigment powders and press them flat with a spatula. Compare the color of the control and treated pigment powders.

8.3 *Percentage of SO<sub>3</sub>*—Perform the sulfates soluble in hydrochloric acid test and determine the percentage in accordance with Test Methods ~~D50~~.

8.4 *Water Solubility*—Perform the matter soluble in water test in accordance with Test Methods ~~D1208~~.

8.5 *Atmospheric Curing Stability*—The composition and method of preparation of the test specimens shall be in accordance with ~~Annex A1~~. Pigments shall be tested at both ½ % and 6 % levels (based on the cement mass). Two sets of specimens (designated as control specimens and test specimens) shall be prepared at the same time under identical conditions except for curing. Each set shall consist of two pigmented mortar specimens, one at each of the two levels of pigmentation, and one unpigmented specimen. If, for a particular pigment being tested, the specimens that contain the pigment at a dosage rate of ½ % of the cement mass do not provide a significant difference (~~Note 1~~) in color when compared to the corresponding unpigmented specimen, the pigment dosage rate shall be increased until but not beyond the rate at which the difference in color becomes significant. In addition, tests using the higher dosage rate of 6 % of the cement mass shall continue to be performed as specified. Compare for color the specimens that were cured under different conditions. For evaluating the color stability of the pigment tested, also compare the uncolored mortar specimens for color variations. Differences in the curing conditions or efflorescence, or both, can affect the color shade of any finished mortar or concrete, either colored or uncolored.

8.6 *Light Resistance*—The test shall be conducted in a Type E or EH exposure apparatus as described in Practice ~~G23~~. Type EH apparatus shall be operated without automatic humidity control. The exposure apparatus shall be operated in accordance with Practice ~~G23~~, except that no water spray or dark cycles shall be employed. The black panel temperature shall be  $54 \pm 3$  °C [ $130 \pm 5$  °F]. The composition and method of preparation of the test specimens shall be in accordance with Annex I. Pigments shall be tested at both ½ % (~~8.5~~) and 6 % levels (based on the cement mass). Half of each specimen shall be masked from light exposure by an aluminum foil covering. The other half of each specimen shall be exposed to light for 500 h after which time its color shall be compared to the unexposed half (~~4.6~~).

### 8.7 *Effects on Concrete:*

8.7.1 *Preparation of Mixtures*—Prepare concrete mixtures both with and without the pigment under test. Refer herein to the concrete mixture without the pigment as the reference or control mixture. The control mixture and the pigmented mixture shall be of the same composition and batched in the same proportions except that the pigmented mixture shall include the pigment addition at the maximum prescribed dosage rate (~~1.4~~), and the water content of each mixture shall be adjusted to produce a slump of  $100 \pm 13$  mm [ $4 \pm \frac{1}{2}$  in.], as determined by Test Method ~~C143~~C143M. Add the pigment to the first increment of coarse aggregate and water. The mixture shall be proportioned using ACI Practice ~~211.1~~Practice 211.1 (~~Note 4~~). The cement content shall be either the cement content for specific work or  $307 \pm 3$  kg/m<sup>3</sup> [ $517 \pm 5$  lb/yd<sup>3</sup>]. If an air-entraining admixture complying with Specification ~~C260~~C260/C260M is used, its dosage rate shall be the same for both the pigmented and the control mixtures.

8.7.2 *Making and Curing*—Specimens made from concrete with and without the pigment under test shall be molded and cured in accordance with Method ~~C192~~C192M. Three or more compression specimens shall be prepared for each mixture.