



Designation: C 979 – 99

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

This standard is issued under the fixed designation C 979; 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 approval. 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 3.7.

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 3.7, 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 SI units are to be regarded as the standard. The inch-pound units in parentheses are for information purposes only.

### 2. Referenced Documents

#### 2.1 ASTM Standards:

- C 33 Specification for Concrete Aggregates<sup>2</sup>
- C 39 Test Method for Compressive Strength of Cylindrical Concrete Specimens<sup>2</sup>
- C 143/C 143M Test Method for Slump of Hydraulic Cement Concrete<sup>2</sup>

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee C-9 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.23 on Chemical Admixtures.

Current edition approved June 10, 1999. Published July 1999. Originally published as C 979–82. Last previous edition C 979–82 (1993).

<sup>2</sup> Annual Book of ASTM Standards, Vol 04.02.

- C 150 Specification for Portland Cement<sup>2</sup>
  - C 173 Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method<sup>2</sup>
  - C 192/C 192M Practice for Making and Curing Concrete Test Specimens in the Laboratory<sup>2</sup>
  - C 231 Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method<sup>2</sup>
  - C 260 Specification for Air-Entraining Admixtures for Concrete<sup>2</sup>
  - C 403/C 403M Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance<sup>2</sup>
  - D 50 Test Methods for Chemical Analysis of Yellow, Orange, Red, and Brown Pigments Containing Iron and Manganese<sup>3</sup>
  - D 1208 Test Methods for Common Properties of Certain Pigments<sup>3</sup>
  - D 1535 Practice for Specifying Color by the Munsell System<sup>4</sup>
  - G 23 Practice for Operating Light-Exposure Apparatus (Carbon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials<sup>5</sup>
- 2.2 *ACI Standards:*
- 211.1 Recommended Practice for Selecting Proportions for Normal and Heavyweight Concrete<sup>6</sup>

### 3. General Requirements

3.1 *Water Wettability*—The pigment shall be water wettable when tested in accordance with 7.1.

3.2 *Alkali Resistance*—The pigment treated with sodium hydroxide shall not show any significant (Note 1) change of color when tested in accordance with 7.2.

3.3 *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 7.3.

3.4 *Water Solubility*—The total matter soluble in water shall not exceed 2.0 mass % of the original pigment sample when tested in accordance with 7.4.

3.5 *Atmospheric Curing Stability*—The magnitude of color differences between pigmented concrete specimens cured in

<sup>3</sup> Annual Book of ASTM Standards, Vol 06.03.

<sup>4</sup> Annual Book of ASTM Standards, Vol 06.01.

<sup>5</sup> Annual Book of ASTM Standards, Vol 14.02.

<sup>6</sup> Available from American Concrete Institute, 38800 Country Club Drive, Farmington Hills, MI 48331.

dry air and those cured at high relative humidity when tested in accordance with 7.5 shall not be greater than the magnitude of the color difference between two unpigmented specimens cured under the same conditions.

3.6 *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 7.6. 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. Lighting and viewing conditions as described in Method D 1535, 6.1, may be used.

### 3.7 *Effects on Concrete:*

3.7.1 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 7.7 (Note 2).

3.7.2 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 7.7 (Note 2).

3.7.3 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 7.7.

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 7.7.

3.8 *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 7.8. 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.

## 4. Rejection

4.1 A pigment may be rejected if it fails to meet any of the applicable requirements of these specifications.

4.2 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.

## 5. Packaging

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

5.2 The package or container shall not be added to the concrete with the pigment.

## 6. Materials for Tests

6.1 *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 C 150 or the cement proposed for specific work.

6.2 *Aggregates*—The aggregates used in all tests shall conform to Specification C 33 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.

6.3 *Admixtures*—If any of the test mixtures contain any admixtures in addition to pigment other than an air-entraining admixture complying with Specification C 260, the pigment shall be considered to comply with this specification only when used in conjunction with such other admixture(s).

## 7. Test Methods

7.1 *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.

7.2 *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  $110 \pm 3^\circ\text{C}$  ( $230 \pm 5^\circ\text{F}$ ) 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.

7.3 *Percentage of SO<sub>3</sub>*—Perform the sulfates soluble in hydrochloric acid test and determine the percentage in accordance with Methods D 50.

7.4 *Water Solubility*—Perform the matter soluble in water test in accordance with Test Methods D 1208.

7.5 *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