

Guide for Cementitious Repair Material Data Sheet

Reported by ACI Committee 364



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Guide for Cementitious Repair Material Data Sheet

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The purpose of this document is to provide a guide to the protocol for testing and reporting of data for cementitious repair materials. It does not address all of the issues associated with material selection. It is the responsibility of the user of this document to determine the suitability of the repair material before use.

Keywords: data protocol; material properties; repair material; test methods.

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Reference to this document shall not be made in contract documents. If items found in this document are desired by the Architect/Engineer to be a part of the contract documents, they shall be restated in mandatory language for incorporation by the Architect/Engineer.

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CHAPTER 1—REPAIR MATERIAL DESCRIPTION

The following information should be reported on the material data sheet, including the test methods for the determination of the reported data with the method used listed adjacent to the reported data.

1.1—Recommended use

The information used to describe where the product should be used, any auxiliary or ancillary products, and acceptable service conditions are listed in this section. *Examples: Horizontal, vertical, overhead, traffic wearing surface repairs, cosmetic.*

1.2—Claimed benefits

Any benefits or special properties claimed for the product should be listed in this section. *Examples: Rapid strength development, shrinkage compensated, polymer modified.*

1.3—Stated limitations

Any stipulations or limitations placed upon the storage, mixing, use, application methods, placement, curing, or exposure conditions should be listed in this section. *Examples: Minimum/maximum placement depth with/without aggregate, application temperature range, moisture exposure, thermal coefficient of expansion compared to substrate concrete, contains chlorides if content is high, and special equipment, if any such is needed during application.*

CHAPTER 2—DEFINITIONS

cementitious material—for the purposes of this guide, cementitious material is defined as that fraction of the repair material passing a No. 170 mesh (90 μm) sieve per ASTM E11, and mortar is defined as a material consisting of a

cementitious binder with the only aggregate being fine aggregate, according to ASTM C33/C33M. No recognized method could be found to physically separate the binder from the fine components of the repair material. Therefore an assumption is made that any material passing this size mesh is to be considered as binder or a cementitious component. Some of the following compositional reporting requirements are based on the level of the component compared to the cementitious fraction, which is the purpose for determining the quantity of this size fraction of the repair material.

concrete—concrete is either a repair mortar that has been extended with the addition of coarse aggregate or a concrete mixture that was originally proportioned with coarse aggregate. *Example: This repair mortar is composed of a precise blend of portland cement, microsilica, graded aggregates, redispersible polymer, and fine fibers. Because different tests for mortars and concretes are used for determination of some of the physical properties listed below, this definition clarifies when the different test methods should be used.*

mortar—mortar is a mixture of cement paste and fine aggregate, with or without additives.

CHAPTER 3—COMPOSITION

3.1—Total sulfur trioxide (SO_3) (ASTM C114)

The total SO_3 content should be stated as a percentage by mass of cementitious constituents determined according to ASTM C114. If sulfate levels are above those contributed from portland cement, the material producer should provide data and methods used to establish suitability for the recommended uses stated in Chapter 1.

Gypsum or another calcium sulfate is added to portland cement to prevent flash set. Test method ASTM C563 is generally used by cement manufacturers to determine the optimum SO_3 content based on maximization of the 24-hour compressive strength of a standard mortar mixture. In cement analysis, the convention is to report the chemical constituents at their highest oxidation state, which for sulfur is sulfur trioxide. Additions of sulfates beyond the optimum levels determined by ASTM C563 or even beyond the maximum limits of ASTM C150 are sometimes used to accelerate the strength development or improve the shrinkage compensation of formulated products (Taylor 1990). ASTM C845 defines three types of expansive cements, all of which would indicate elevated levels of sulfate in this analysis. Hewlett (2004) describes the expansive nature of different sulfates in contact with portland cement. Exposure to different sulfate solutions (either from outside environment or leaching from internal additions) can cause what is commonly known as sulfate attack or an uncontrolled destructive expansion. Due to concern for potential over expansion or susceptibility to deterioration in some environments, the total sulfur trioxide is to be reported as percentage by mass of cementitious materials. Elsewhere in this document, sulfate resistance per ASTM C1012 is to be reported.

3.2—Total alkali content (ASTM C114)

The total alkali content should be stated as a percentage by mass of cementitious constituents determined as sodium equivalent alkali according to ASTM C114.

The typical means by which the alkali content has been controlled with concrete mixtures in the U.S. has been to establish a maximum limit only on the portland cement. Cement with an alkali content of less than 0.6%, expressed as equivalent Na_2O , is referred to as low-alkali cement (ASTM C150). This provision proved satisfactory for concrete. The disadvantage of establishing an alkali limit based on the alkali of the portland cement alone for repair materials is that many proprietary repair materials contain blends of different cements, additives, admixtures, and other constituents that contain alkali. It is the sum of the alkalis from all sources that is pertinent to the potential reaction with a reactive aggregate.

Past research conducted in Germany and Canada led to the conclusion that when the alkali in a mixture is kept below a maximum of 5.0 lb/yd^3 (3.0 kg/m^3), there will be no alkali-silica reaction (ASR) (Gress 1997).

3.3—Chloride content

The total water-soluble (ASTM C1218/C1218M) and acid-soluble (ASTM C1152/C1152M) chloride contents should be stated as a percentage by mass of the mortar or concrete, consistent with ASTM standards. The considerations of chloride-ion content discussed in ACI 222R should be considered and may require a cautionary statement on the packaging if an oxidizable metal such as iron, steel, zinc, or aluminum is allowed to be embedded in proximity of a chloride containing concrete repair material.

BS 8110-1: 1997 and European Standard ENV 206-1:2004 (CEN/TC 104), limit the total chloride ion content in reinforced concrete to 0.40% by mass of cementitious component. ACI 318 considers water-soluble chloride ions only and sets a recommended limit of 0.15% by mass of cement(itious) component. The interaction of chloride levels with pH of the mortar and oxygen availability in moist environments is responsible for many of the issues with reinforcing steel corrosion.

3.4—pH

Report the pH of the fresh and hardened repair material determined according to the following:

Crush a hardened sample of the cementitious repair material to pass a No. 170 ($90 \mu\text{m}$) mesh sieve, stir 10 g of the crushed material into 90 g distilled or deionized water for 1 minute and, after settling, use pH paper or suitable pH meter per the recommendations of the supplier of the pH equipment.

Reporting of the pH of the freshly mixed material is useful information for the applicator of the product. The pH of the hardened material is one indication of the degree of passivation that is imparted to embedded reinforcing steel.

3.5—Characteristics of aggregate (ASTM C33/C33M)

Report the characteristics listed below according to ASTM C33/C33M and the following requirements:

For prepackaged products, use the +170 mesh fraction obtained by wet sieving according to ASTM C117 for reporting the results of the tests specified in the section titled, "Methods of Sampling and Testing" of ASTM C33/C33M.

- Fine aggregate
 - General characteristics
 - Grading
 - Deleterious substances
 - Soundness
- Coarse aggregate
 - General characteristics
 - Grading
 - Deleterious substances

Reporting the amount of fine and coarse aggregate, and the gradations of these components, provides useful information to the applicator regarding selection of mixing and pumping equipment. In addition, it provides guidance concerning requirements for additional aggregate used for extension. The committee that develops and maintains ASTM C33/C33M has determined that the listed characteristics are the minimum requirements needed for assurance of suitability for use in concrete and mortar materials.

CHAPTER 4—PHYSICAL PROPERTIES

4.1—Material unit weight

Report the mixed material density (unit weight) in agreement with the following test methods:

- Mortar: ASTM C185; and
- Concrete: ASTM C138/C138M.

Reporting of the wet density or unit weight of a repair material provides useful information to the applicator for load increase of the applied material when incorporated into the structure. This parameter is also relatively easy to determine in the field and can be one indicator of contamination or improper mixing.

4.2—Time of setting

The initial and final times of setting at minimum and maximum application temperatures should be reported, including the test method used:

- Either ASTM C266 or C191.

The time of setting of hydraulic cement paste provides an indication of the relative working time and strength development of a repair material. Either the Vicat or Gillmore device may be used, but the type of equipment should be reported.

4.3—Air content

Report the mixed material air content determined according to the following test methods:

- Mortar: ASTM C185; and
- Concrete: ASTM C231.

The air content can indicate if air entrainment has been used to provide resistance to cycles of freezing and thawing. While actual testing for the durability is the best indication (see ASTM C666/C666M in Section 5.11), the air content may be influenced by mixing time and speed, as well as other factors.

4.4—Yield

Report the mixed material yield determined according to the following test methods:

- Mortar: ASTM C185; and
- Concrete: ASTM C138/C138M.