

Guide for the Application of Epoxy and Latex Adhesives for Bonding Freshly Mixed and Hardened Concretes

Reported by ACI Committee 503

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The objective of this guide is to provide information, requirements and procedures necessary to achieve a bond between freshly mixed and hardened concretes by use of either epoxy or latex adhesives.

Keywords: acrylics; adhesives; bonding; concrete evaluation; concrete preparation; epoxy resins; latexes; styrene-butadiene; vinyl acetate polymers and copolymers.

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ACI 503.6R-97 became effective September 24, 1997.
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CHAPTER 1—SCOPE

The objective of this guide is to provide (primarily to contractors) information, requirements and procedures necessary to achieve a bond between freshly mixed and hardened concretes by use of either epoxy or latex adhesives. The requirements and procedures of this guide consist of:

- Evaluation of the hardened concrete to determine the proper preparation and surface conditioning prior to application of adhesives,
- Selection of the most suitable epoxy or latex adhesive depending on the expected performance and environmental conditions (ACI 503.3R), and
- Application method.

CHAPTER 2—HARDENED CONCRETE EVALUATION

Contaminated and deteriorated concrete can be detected by visual inspection; however, in many cases, visual determination of the soundness of the concrete is not sufficient to select the repair and preparation methods. It is necessary to determine the extent of the deterioration, its cause, and whether that cause is still active. Guidance on surveys for these determinations may be obtained from ACI 201.1R, ACI 364.1R, ACI 546.1R and ASTM C 823.

Common methods for evaluating and determining concrete condition include sounding with a hammer or chain drag, ultrasonic pulse velocity, petrographic analysis, infrared thermography, radar detection, core evaluation, measurement of chloride ion content, and bond tests such as that described in ACI 228.1R and Appendix A of ACI 503R.

Proper preparation, as in Chapter 4, of any concrete to receive an adhesive is of primary importance. Bond failure at the adhesive interface is likely if preparation is inadequate.

Certain surface conditions are required with different types of adhesive and are described in later sections.

CHAPTER 3—REMOVAL OF UNSOUND CONCRETE

The removal of the unsound or damaged concrete is a necessary part of rehabilitation work on structures involving the use of an adhesive prior to placement of the freshly mixed concrete. Such removal should be accomplished by well-controlled means.

The first step involves saw cutting the periphery of the required removal area to a minimum of $\frac{1}{4}$ in. (6 mm) in depth, consistent with the type of repair. This saw cutting delineates the repair area and serves to reduce edge spalling and weakness possibly introduced by outlining the area using other methods. Also, it serves to give a shoulder against which the repair materials can be placed and finished. It also results in a neater appearance. The saw-cut line should be located at least 4 in. (100 mm) outside of the determined limits of the defect to ensure that all defective concrete is removed and that the fresh material is bonded to sound concrete.

Several types of systems are available to remove unsound concrete (ACI 503R):

- a. Scabblers or bush hammers, that are tools with several points that remove concrete by pulverizing or fracturing the surface,

- b. Scarifiers, that have wheels with several points that are tipped with carbide, tungsten or diamonds. This equipment removes concrete by scraping or impacting the surface,

- c. Water blasting (hydrodemolition), which removes concrete by projecting jets of potable water,

- d. Jackhammers, which remove concrete by impacting the surface.

Upon completion of removal of the concrete by one or more of the above methods (Department of the Army, 1995), except for water blasting, all newly exposed surfaces should be abrasive blasted and thoroughly washed down with a water jet with a minimum pressure of 1500 psi (10 MPa). The surface is then blown off with dry, oil-free compressed air or vacuumed to remove any residual debris.

It is recommended that the concrete is tested for pull-off strength in accordance with the procedure described in Appendix A of ACI 503R. If 250 psi (1.7 MPa) is achieved, then the surface preparation and concrete quality is adequate. If the pullout value is less than 250 psi (1.7 MPa) and 90 percent failure occurs in the concrete at depth of $\frac{1}{4}$ in. (6 mm) or greater, then the surface preparation is adequate, but the concrete quality may not be adequate for the application. In this case, an additional evaluation in accordance with Chapter 2 may be necessary.

CHAPTER 4—SURFACE PREPARATION

Those surfaces or parts of surfaces, which do not require removal of concrete, must be cleaned to remove all surface contaminants detrimental to the bond of the adhesive. Such contaminants include, but are not limited to laitance, curing membranes, surface coatings and treatments, oil, grease, rust stains, and dust.

The following methods commonly used to remove such contaminants are:

- a. Shot blasting, which projects metal balls of varying size at high velocity to impact and abrade the surface,

- b. Abrasive blasting, which projects particles of varying size to impact and abrade the surface. The particles may be carried by air or water,

- c. Scabbling using bush hammers,

- d. Scarification,

- e. Water blasting.

One or more of these methods, alone or in combination, may be required for proper preparation. Guidance can be obtained from ASTM D 4258 and D 4259.

Regardless of surface preparation method, the results should be such that the surface is abraded to expose the aggregate in the surface with a maximum profile of $\frac{1}{2}$ in. (13 mm), that is the depth between the lowest and highest points of the surface. It is recommended that the concrete is tested for pull-off strength in accordance with the procedure described in Appendix A of ACI 503R. If 250 psi (1.7 MPa) is achieved, then the surface preparation and concrete quality is adequate. If the pullout value is less than 250 psi (1.7 MPa) and 90 percent failure occurs in the concrete at depth of $\frac{1}{4}$ in. (6 mm) or greater, then the surface preparation is adequate, but the concrete quality may not be adequate for the application. In some applications the design engineer may increase the required pullout value.