Epoxy-Based Compounds used with Concrete

Epoxy compounds are often used with concrete because of their excellent adhesive properties, being able to bond most construction materials to concrete. Epoxies have versatile performances pertaining to strength, moisture resistance, shrinkage, hardening rates, and chemical resistance against acids, oils, alkalis, and solvents. They are generally formulated in two or more parts, and can be used with concrete in various applications including:

1- Bonding fresh concrete to existing concrete
2- Injection works during structural grouting and repair applications
3- Grouting for the installation of handrails, architectural metals and precast concrete panels, or for bonding bolts and dowels to hardened concrete,
4- Coating industrial and commercial surfaces. Fine sand or quartz aggregates may be dispersed over the seal coat to achieve skid-resistant surfaces,
5- Protecting concrete surfaces by thin films of 0.05 to 0.08 mm or high build coating overlays. This is particularly recommended for floors of car-washing areas and parking decks that must withstand attack from abrasive and corrosive cleaning materials
6- Patching of spalled and deteriorated concrete areas
7- Fixing steel bars to restore the integrity of concrete structures
8- General adhesive works

Epoxy compounds must be applied on clean surfaces. Contaminants, loose and unsound materials, oil and grease and any previous coating must be removed prior to the application of epoxy coatings. This is normally achieved for concrete surfaces by sand blasting, steel shot blasting, high pressure water blasting or flame blasting. ASTM C1583 is often used as a reference to assess the adequacy of surface preparation prior to the repair or overlay material being applied. It is also used to assess the repair or overlay material bond and tensile strengths. All surfaces must be dry prior to epoxy application, as if still moist, an epoxy formulation insensitive to moisture must be used. The removal of unsound concrete laitance can be carried out with mechanical devices. The epoxy resin, hardener and any other component provided must be mixed together in the specified ratios to produce a uniform homogenous mix, thus ensuring the reaction is complete.

Epoxies undergo exothermic chemical reactions during the curing process, which cannot be reversed. The resulting temperature increases depend on the mass product and formulation used. The higher the aggregate or filler content, the lower the temperature rise. Epoxy formulations normally include flexibility enhancers, extenders, diluents, and fillers to meet specific application requirements. Different test methods may be performed to determine relevant properties of epoxy-based compounds. These include consistency, gel time, filler content, epoxy equivalent, viscosity, absorption, bond strength, thermal compatibility, heat deflection temperature, linear coefficient of shrinkage, compressive yield strength and modulus, tensile strength and elongation at break, and contact strength.

As epoxies bond very quickly to concrete, shrinkage strains may appear in bonding. Steel and concrete have very similar thermal expansions. Failure in the top 5 mm concrete interface is often caused by a difference in the thermal coefficients of the epoxy and

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concrete. To reduce such difference, flexible epoxies are recommended and often mixed with silica to further increase their modulus of elasticity. In hot temperature climates, pre-cooling of the components may be necessary by storing the epoxies in the shade or in a refrigerator or immersing their containers in cold water. Conversely, in low temperature markets, heating of the components by ensuring storage indoors or immersing the container in a hot water bath may be required. Excessive pre-heating may shorten the open time and render proper application difficult to achieve. Excessive pre-cooling can increase viscosity and prevent the epoxy compound from wetting the surface appropriately.

ASTM C881 classifies epoxy-resin bonding systems according to the type, grade, and class as follows:

Type I - For use in non-load bearing application for bonding hardened concrete to hardened concrete and other materials, and as a binder in epoxy mortars or epoxy concretes.

Type II - For use in non-load bearing applications for bonding freshly mixed concrete to hardened concrete.

Type III - For use in bonding skid-resistant materials to hardened concrete and as a binder in epoxy mortars or epoxy among the few materials to which these systems will not adhere.

Type IV - For use in load bearing applications for bonding hardened concrete to hardened concrete and other materials and as a binder for epoxy mortars and concretes.

Type V - For use in load bearing applications for bonding freshly mixed concrete to hardened concrete.

Type VI - For bonding and sealing segmental precast elements with internal tendons and for span-by-span erection when temporary post tensioning is applied.

Type VII - For use as a non-stress carrying sealer for segmental precast elements when temporary post tensioning is not applied as in span-by-span erection.

The Grade 1 and Grade 2 refer respectively to low viscosity and medium viscosity epoxy compounds whereas Grade 3 refers to products possessing a non-sagging consistency. As the temperature of the hardened concrete surface on which the bonding system is applied may be different from the ambient temperature, ASTM C881 provides the following classification to differentiate between products:

Types I through V:
  o Class A: For use below 4 °C
  o Class B: For use between 4 °C and 15 °C
  o Class C: For use above 15 °C
Types VI and VII:
- Class D: For use between 4.5 °C and 18 °C
- Class E: For use between 15.5 °C and 26.5 °C
- Class F: For use between 24 °C and 32 °C

It is to be noted that epoxy resin systems are normally un-pigmented, but they can be colored or darkened, if required.

The following is a brief selection of Batimix epoxy-based products designed for the construction industry:

**Batimix Epoxy 100**, a solvent-free, two-component product used in non-loading applications for bonding hardened concrete to hardened concrete or other materials, and as a binder in epoxy mortars or epoxy concrete. It complies with ASTM C881, Type I, Grade 1 requirements. The product properties are slightly sensitive to the temperature of the substrate, thus making it suitable for use within Class A, B, or C.

**Batimix Epoxy 110**, a product complying with ASTM C881, Type I, Grade 2 (Class A, B, or C) requirements.

**Batimix Epoxy 120**, a product complying with ASTM C881, Type I, Grade 3 (Class A, B, or C) requirements.

**Batimix Epoxy 200**, a solvent-free, two-component product used in non-loading applications for bonding freshly mixed concrete to hardened concrete or other materials. It complies with ASTM C881, Type II, Grade 1 requirements. The product properties are slightly sensitive to the temperature substrate, thus making it suitable for use within Class A, B, or C.

**Batimix Epoxy 210**, a product complying with ASTM C881, Type II, Grade 2 (Class A, B, or C) requirements.

**Batimix Epoxy 220**, a product complying with ASTM C881, Type II, Grade 3 (Class A, B, or C) requirements.

**Batimix Epoxy Putty 140**, a two-component epoxy paste used for fair-faced surfaces, traffic bearing substrates, or for bonding skid-resistant materials to hardened concrete. It complies with ASTM C881, Type III, Grade 2 (Class A, B, or C) requirements.

**Batimix Epoxy Primer 150**, a solvent-free, medium viscosity epoxy primer used to seal and prime concrete and other substrates prior to the application of liquid resin systems. It complies with ASTM C881, Type IV, Grade 2 (Class A, B, or C) requirements.

**Batimix Epoxy Coating 200**, a solvent-based, medium viscosity epoxy floor coating. It exhibits good self-leveling properties and excellent resistance to abrasion. It complies with ASTM C881, Type IV, Grade 2 (Class A, B, or C) requirements.

**Batimix Epoxy Coating 250**, a solvent-free, medium viscosity epoxy coating for concrete, grano, and mild steel. It has excellent abrasion and chemical resistance. It complies with ASTM C881, Type IV and V, Grade 2 (Class A, B, and C) requirements.
Batimix Epoxy Coating 260, a solvent-free, high-build, heavy-duty floor coating epoxy designed to withstand high impact loads from cars, trucks, fork-lifts and heavy duty mobile equipment. It complies with ASTM C881, Type IV and V, Grade 2 (Class A, B, and C) requirements.

References:
ASTM C1583 / C1583M - 04e1 Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method), Vol. 4, No. 2, ASTM International, West Conshohocken, USA.


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