CONCRETE SURFACES

MATPRO

Components of Concrete

Concrete is a mass of sand, gravel, and crushed rock bonded together by a hardened paste of hydraulic cement and water. When these ingredients are properly proportioned and combined, they form workable mixes that can be placed into forms of different desired sizes and shapes. Workable mixes are easily prepared, handled, transported, and placed with vibration without the loss of homogeneity. The water in the mix reacts with the cement in the placed concrete to convert it to a hard and durable product. In addition to structures of poured concrete, there are several other building materials that use cement as the binder to hold them together. These include concrete and cinder block, plaster, stucco, and brick.

Reinforcing Concrete

Steel reinforcing bars (“rebar”) are often used in concrete beams to impart additional tensile strength. Prestressed concrete is formed using steel bars, wires, or ropes running the length of concrete beams. These are tightened against a metal plate on each end of the form before the concrete is poured. This tensioning increases flexural strength of the beams and reduces cracking.

Similar Features of All Cementitious Surfaces

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These include concrete block, plaster, stucco, and brick. They all have the following properties that affect their paintability:

Because these construction materials are porous to a significant extent, it is often necessary to reduce their permeabilities. This need to reduce penetration of moisture varies greatly with different porosities and different environmental and service conditions.

Efflorescence

Because of their porosities, moisture migration in the fully cured cementitious substrates occurs from an area of higher to one of lower moisture content, usually to the surface. The migrating moisture often carries with it soluble alkaline products, mostly lime. These products react with carbon dioxide in the air to deposit fluffy white crystals called efflorescence on the surface of the cementitious material. Efflorescence frequently occurs around doors and windows on masonry block walls where water has entered the wall. It must be removed by dry brushing before painting the concrete.

Laitance

Efflorescence should not be confused with laitance. Laitance is formed during placement of new concrete. It is caused by overworking overly wet concrete to form bleed water. This results in a milky-white surface layer, which is cement-water-rich. Upon fully curing, it is converted into a thin, brittle layer that is poorly bonded. Like mill scale, laitance must be removed mechanically before coating, or its later disbondment will damage the coating.

Because concrete and other cementitious surfaces are alkaline, coatings applied directly to them should be alkali-resistant. Thus, oil-based coatings such as alkyds must never be applied directly to these surfaces. Alkalinity causes drying oils to become saponified (hydrolyzed and converted into fatty acid soaps) and disbonded. If an oil-based coating is desired on a cementitious surface for better scrub resistance or special gloss or color, it can be applied over an emulsion or other alkali-resistant primer.

Cracking

Properly prepared concrete may appear to be a hard, tough construction material with a uniform surface, but microscopic examination reveals thousands of microcracks initiated during the curing process, mostly from shrinkage. These microcracks can propagate with stresses over time to form larger cracks that significantly affect the structural integrity of the concrete. Some of the stresses that may contribute to crack propagation are:

- Excessive loss of water (shrinkage)
- Temperature changes
- Loading
- Corrosion of reinforcing steel

Excessive Loss of Water.

The greater the loss of water, and thus shrinkage, the greater the tendency to propagate cracks. Thus, the W/C ratio should be kept as low as practical.

Temperature Changes.

Expansion and contraction of concrete will cause volume changes and stresses in the concrete. Freezing and thawing will also create volume changes and stresses.

Loading

Heavy loadings can cause dimensional changes and stresses. Minimum deflection is maintained by proper design and observing load limits.

Corrosion of Reinforcing Steel.

Steel reinforcing bars (rebars) in concrete are subject to corrosion. This is especially true at marine locations, because chloride ions that permeate the concrete accelerate this action. The corrosion products formed are much greater in volume (about 6:1) than the original steel and expand with great force to cause concrete to crack and spall.

Control of this corrosion can be achieved by

1 - hot- dip galvanizing the bars or powder coating them with fusion-bonded epoxy

2 - cathodic protection

3 - incorporating polymers such as epoxy into the concrete mix to reduce permeability and increase strength, and/ or

4- pouring a thick (e.g., three-inch [75 mm]) cover of dense concrete over them. Coating the concrete may occasionally help control rebar corrosion. Coating rebar with fusion-bonded epoxy is probably the most frequent- ly used technique for controlling its corrosion. Cathodic protection (both sacrificial anode and impressed current) is used most frequently on concrete bridge decks and waterfront structures subject to salt contamination.

Alkali-Aggregate Reactions.

The alkali-aggregate reaction (AAR) is the chemical reaction occurring in mortar or concrete between alkalies from portland cement and certain constituents in aggregates. Under some circumstances, deleterious expansion of mortar or concrete may cause popouts (breaking away of small portions from localized internal stresses). The alkali-silica reaction (ASR) is the most prevalent form of AAR.