PCI Plant Quality Talk
Quality Enhancement Committee

NPCA NATIONAL PRECAST CONCRETE ASSOCIATION
PCI Precast/Prestressed Concrete Institute

SERIES 4, ISSUE 1 - EFFLORESCENCE BASICS

What Is Efflorescence?

Efflorescence is a whitish, powdery residue on the surface of concrete. It occurs due to the presence of soluble salts, such as calcium hydroxide, in the materials used to make concrete.

In concrete at early ages, the hydrated cement contains a substantial amount of calcium hydroxide as a normal product of the hydration reaction between cement and water. Some of the calcium hydroxide that has dissolved in the mixing water migrates to the surface of the fresh concrete, where it reacts with carbon dioxide in the air to form the whitish deposit.

After stripping, efflorescence may appear within a few days. It sometimes does not appear until weeks, months, or (in rare cases) years have passed. Although efflorescence is generally harmless from a structural viewpoint, its initial appearance can be extremely detrimental to the appearance of a finished structure.

What Causes Efflorescence?

A combination of circumstances causes efflorescence.

- First, soluble substances must be in one or more of the materials. An abundance of calcium hydroxide is always present in concrete, but the quantity of soluble alkalis that contribute to efflorescence will vary depending on the cement source.
- Second, moisture must be present to dissolve the substances.
- Third, evaporation or hydrostatic or capillary pressure must cause the solution containing the dissolved substances to move toward the surface of the concrete. There must be a pathway through the pores or cracks in the concrete for the solution to move. Frequent wetting of the concrete surface helps facilitate this path.
- Fourth, the solution must evaporate once it reaches the surface of the concrete, leaving these soluble substances behind as efflorescence.

If any one of these conditions is eliminated, efflorescence will not occur. In most good-quality concrete, the efflorescence tendency will decrease with increasing age, and this decrease is assisted by rapid drying and carbonation of the surfaces. However, concrete that is constantly or frequently saturated with water can continue to develop efflorescence for years.

Minimizing Efflorescence

- Use a low-alkali cement, or a cementitious materials combination low in alkalis.
- Use sand that meets the requirements of ASTM C33/C33M, ASTM C144, or CSA A23.1. Never use unwashed sand containing soluble alkali sulfates or sand contaminated from soil runoff, plant life, or decomposed organic compounds.
- Use clean mixing water that is free from harmful amounts of acids, alkalis, organic material, minerals, and salts.
- Consider using additives and/or surface sealers.
- Use ingredients and methods to reduce concrete permeability and produce a concrete with a low water absorption (5% to 6% by weight or 12% to 14% by volume). Concrete permeability and water absorption are the key factors that the producer can influence to minimize efflorescence. It is therefore important to ensure the following:
  - Properly graded aggregates
  - A minimum cement content for stripping and service strength requirements
  - A low water-cementitious material ratio
  - Good consolidation techniques
  - Thorough curing

Pigment Considerations

- Coloring pigments usually have no positive or negative effect on efflorescence. Synthetic pigments are water insoluble and do not contain noticeable amounts of water-soluble salts.
- Pigments may appear to aggravate an efflorescence problem by making efflorescence more visible.
- Efflorescence deposited on the surface may mask the true color of the concrete, so that the pigment seems to be fading, even though the pigment itself has not changed.

Other Resources
Additional information on efflorescence can be found in PCI Technical Note TN-3, *Efflorescence on Precast Concrete*.

Note: Please complete this form and return to the Quality Control Manager. All crew members should be observant and report to their foreman anything out of the ordinary on a project. See something, say something.

NOTES	ATTENDEE SIGNATURES
DATE PRESENTER	