Concrete Technology in Focus
Efflorescence Guidelines

Introduction

This technical report, primary and secondary efflorescence in concrete are defined and evaluated in detail. Many factors contribute to efflorescence, including cement content, mix water, water-cement ratio, permeability, admixtures, and curing practices. Adjustments to one or more of these factors has an effect on the tendency towards efflorescence. Although efflorescence cannot be prevented completely, it can be controlled using recommended practices and MasterHill® water-repellent admixtures. Guidelines are discussed that provide the most advanced efflorescence-control methods available for concrete masonry.

About Master Builders Solutions

Master Builders Solutions is a leading global supplier of concrete admixtures, as well as other sustainable solutions for the concrete industry. Master Builders Solutions is a masterbrand of Master Builders Solutions US, LLC, a member of the Master Builders Solutions Group (a wholly-owned subsidiary of Master Builders Solutions N.V.), supporting our customers in mastering their building challenges.

What is Efflorescence?

Efflorescence is defined in ACI Concrete Terminology as "a deposit of salts, usually white, formed on a surface; the substance having emerged in solution from within the concrete by reaction, such as carbonation, or evaporation." Although efflorescence does not damage the integrity of the concrete, it does affect the aesthetic quality of the product and is a costly problem to the concrete industry.

Primary vs. Secondary Efflorescence

An arbitrary distinction is often made between primary and secondary efflorescence. Primary efflorescence generally occurs at the point of concrete masonry product manufacture. Secondary efflorescence may occur after the product is placed on the building site. A common practice in the construction industry when efflorescence is observed is to retreat the concrete with an acid wash or to use a stain inhibiting concrete sealer. However, these practices are ineffective in controlling efflorescence, and they are not recommended as primary treatments.

Efflorescence is the result of leached-out materials on the surface of concrete. The primary cause of efflorescence is the migration of water-soluble components from the interior of the concrete to the surface. The migration of these components is influenced by a number of factors, including the water-cement ratio, the curing conditions, and the age of the concrete.

Principles

The principles of efflorescence control are based on the following points:

1. Minimize the amount of water-soluble materials in the concrete. This can be achieved by using admixtures, such as plasticizers, to reduce the water-cement ratio.
2. Control the curing conditions. High temperatures and high humidity can accelerate the movement of water-soluble materials to the surface.
3. Use water-repellent admixtures to reduce the movement of water-soluble materials to the surface.
4. Use a water-repellent coating to reduce the movement of water-soluble materials to the surface.

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Overview

This report provides an overview of the guidelines that will help to minimize efflorescence in concrete masonry. The guidelines are based on the principles discussed in the previous sections and are designed to help concrete masons and concrete producers prevent efflorescence.
Factors That Influence Efflorescence
Efflorescence is affected by several factors including cement content, water/cement ratio, admixtures, curing conditions, and environmental conditions.

Cement Content
The main source of salt, and particularly Ca(OH)₂, is the cement. So, increasing cement content tends to increase efflorescence. The control of efflorescence through the use of high-calcium cement that is held constant at 0.25, while increasing cement content.

Efflorescence Control
Be aware of your salt content, and consider using a weak acid or abrasion. Calcium carbonate is slightly soluble in water, which is formed. The increased availability of carbon dioxide will lead to precipitation of calcium carbonate instead of efflorescence.

Primary efflorescence occurs during production and initial curing of concrete masonry products, when excess water of manufacture can drain to the surface. The alkali value reported on most mill sheets is total alkali. However, since efflorescence is the result of soluble salt content, the correlation is excellent.

Secondary efflorescence occurs when water from an outside source is introduced primarily by the cement, but also may originate from the environmental conditions. For example, concrete may be exposed to an artificial laboratory weathering chamber, which simulates environmental conditions.

Evaluating Efflorescence
The water content of the mix should be avoided in wet or poorly drained areas, as it can lead to efflorescence. Efflorescence can be evaluated by several methods, including the use of a color photometer to measure the color of a sample in the CIELab system. The two rows of pavers in Figure 4 are duplicates with the top row using a dry mix and the bottom row using a wet mix. The increase in efflorescence with the wet mix is shown in Figure 5.

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