

Chemical admixtures

Chemical admixtures are materials in the form of powder or fluids that are added to the concrete to give it certain characteristics not obtainable with plain concrete mixes. In normal use, admixture dosages are less than 5% by mass of cement and are added to the concrete at the time of batching/mixing.^[11] The common types of admixtures^[12] are as follows.

- Accelerators speed up the hydration (hardening) of the concrete. Typical materials used are CaCl₂, Ca(NO₃)₂ and NaNO₃. However, use of chlorides may cause corrosion in steel reinforcing and is prohibited in some countries, so that nitrates may be favored.
- Retarders slow the hydration of concrete and are used in large or difficult pours where partial setting before the pour is complete is undesirable. Typical polyol retarders are sugar, sucrose, sodium gluconate, glucose, citric acid, and tartaric acid.
- Air entrainments add and entrain tiny air bubbles in the concrete, which will reduce damage during freeze-thaw cycles, thereby increasing the concrete's durability. However, entrained air entails a trade off with strength, as each 1% of air may result in 5% decrease in compressive strength.
- Plasticizers increase the workability of plastic or "fresh" concrete, allowing it be placed more easily, with less consolidating effort. A typical plasticizer is lignosulfonate. Plasticizers can be used to reduce the water content of a concrete while maintaining workability and are sometimes called *water-reducers* due to this use. Such treatment improves its strength and durability characteristics. Superplasticizers (also called *high-range water-reducers*) are a class of plasticizers that have fewer deleterious effects and can be used to increase workability more than is practical with traditional plasticizers. Compounds used as superplasticizers include sulfonated naphthalene formaldehyde condensate, sulfonated melamine formaldehyde condensate, acetone formaldehyde condensate and polycarboxylate ethers.
- Pigments can be used to change the color of concrete, for aesthetics.
- Corrosion inhibitors are used to minimize the corrosion of steel and steel bars in concrete.
- Bonding agents are used to create a bond between old and new concrete (typically a type of polymer) .
- Pumping aids improve pumpability, thicken the paste and reduce separation and bleeding.

Efflorescence is a crystalline deposit on surfaces of masonry, stucco or concrete. It is whitish in appearance, and is sometimes referred to as "whiskers". Efflorescence has been a problem for many years, and is a topic of much controversy. The formation of these salt deposits are not mysteries. They are, for the most part, water-soluble salts that come from many possible sources to mar and detract from an otherwise beautiful and serviceable structure. First of all, there must be water present to dissolve and transport the salts. Groundwater is often a source of efflorescence. For water to carry or move the salts to the surface there must be channels through which to move and migrate. The more dense the material, whether it be brick, stone, stucco or concrete, the more difficult for the water to transport salts to the surface. Conversely, the more porous the material, the greater the ease with which salts are transported and deposited. Salt-bearing water, on reaching the surface of a structure, air evaporates to deposit the salt. When humidity is low, the water may evaporate before reaching the surface of the structure, leaving the salt deposit beneath the surface, and unseen. When the humidity is high, water evaporation is slower allowing more opportunity for whisker growth. Growths which project 1/4 to 1/2 inch below the surface have been reported in some areas of the country.

Since humidity has a definite effect on whether or not the salts appear, it can be assumed that efflorescence is a seasonal problem. The intensity of efflorescence increases after rainy winter seasons, decreases in spring, and by summer has practically disappeared. This cycle may repeat for months or years, but generally the intensity of the efflorescence decreases in all but very extreme cases, and by about the third year it should be practically eliminated.

The mechanics by which efflorescing salts are carried to the surface of structures by moisture and capillary action through porous materials, is understood. The amount and character of the material deposited varies considerable, depending on the nature and source of the soluble materials.

Composition of Efflorescence

The problem of efflorescence, or the deposit of water-soluble salts on the surfaces of masonry, stucco or concrete, is an old one, and one that has been studied and reported on as early as 1877. These reports are all in common agreement that efflorescence originates from more than one source, and may be made up of more than one or two compounds.

In addition, other salts such as chlorides and nitrates, and salts of vanadium, chromium and molybdenum are mentioned without giving specific composition. These last, particularly vanadium, are said to produce green efflorescence on white or buff burned clay units, while other salts produce white or gray deposits. Efflorescence derived from complex vanadium compounds contained in the clay used in brick manufacture is not uncommon in the southwestern part of the United States.

Sources of Efflorescence

There are many sources for water-soluble salts with some salts more soluble than others. The movement of groundwater into building foundations and by capillary action, or wicking, upwards into masonry, stucco or concrete, is very often the cause of efflorescence. In the case

where soil conditions exhibit water soluble sulfates, precautions should be taken to preclude the passage of this sulfate-bearing water to the structure. Low absorption is the best assurance against efflorescence. Properly graded aggregates, low water-cement ratio, good compaction and proper curing practices will produce concrete of maximum density and low water absorption.

Sand and gravel, in their natural state, may or may not have been associated with salt bearing water or soil. If they have, and these salts are not removed by washing, this can be a possible source for efflorescence. Most rock, sand and gravel plants, however, are conscientious in washing material so that any contribution made to efflorescence from this source is negligible.

When mixing-water used for mortar, stucco or concrete is obtained from a natural source which has been in contact with a sulfate-bearing soil, the resulting structure may exhibit efflorescence. The adherence, again, to a good concreting practice of low water-cement ratio, will help reduce the appearance of salts from this source.

Another potential source of soluble salts are clay products, such as building brick and face brick. Generally, in the present day manufacture of these products, the highly soluble salts are washed from the clay, and a barium salt such as barium carbonate is added to the product, to react with the calcium sulfate which may be present. In this reaction, the product is two fairly insoluble compounds-barium sulfate and calcium carbonate. When produced in this manner, clay products exhibit little tendency to efflorescence.

Building brick must be stored in a dry place off the ground to prevent absorption of moisture or dampness from possible salt bearing soil. A standard test may be made to show the capacity of brick to contribute to efflorescence through soluble salt content. A brick is placed on end in a pan of distilled water for seven days, in which time water is drawn upward and through the brick and then evaporated from the surface. Soluble salts are taken into solution by the water and deposited on the surface.

It has also been noted that the occurrence of efflorescence bears a relationship to the type of mortar used. With a particular type of brick and a certain mortar no efflorescence may occur, whereas, the same brick with different mortar may produce a wall heavily coated with salt deposits. The appearances of sodium and potassium salts (as sulfates) usually suggest Portland cement mortar as the origin. The use of low alkali cement in mortar and grout will minimize efflorescence, at least from this source.

Since, for the most part, concrete masonry is somewhat porous, evaporation of the salt bearing water usually takes place before reaching the surface when exposed to a drying atmosphere. The hydroxides are converted by reaction with the carbon dioxide of the air to alkali and calcium carbonates. Efflorescence in the form of alkali chlorides and sulfates is formed when the structure is surrounded, exposed, or in contact with salt-bearing water or soil and appears as columnar or whisker-like crystals.

Some of the sources of water-soluble salts have been covered. These may be deposited on stucco, masonry or concrete walls as efflorescence. Practically any building materials in direct contact with the earth are potential sources for water-soluble salts. This fact has been recognized

by the various producers of building materials, and steps have been taken to reduce their presence to a great degree.

Removal of Efflorescence

Several methods are suggested. One is to use water under pressure or one of a number of products available from stone dealers; another is muriatic acid with subsequent flushing with water. Acid applied to brick masonry, without previous wetting, may cause "burning" or discoloration of the brick and may also eat into the mortar. The Handbook on Reinforced Grouted Brick Masonry Construction suggests the use of light sandblasting for removal of stubborn efflorescence (after many months). Allowing the surface to dry thoroughly and then using a stiff brush, prior to washing with water, has helped prevent re-penetration of the surface by the salt.

Various methods have been used in attempts to remove efflorescence from masonry structures. It has been found that when efflorescence is caused by soluble alkali salts, the salts will dissolve in water applied to the structure and migrate back into it. These salts would then reappear on the surface as the structure redried. It was learned accordingly, that the best way to remove these soluble salts was to brush the surface thoroughly with a stiff brush. Water, however, has been satisfactory for removing efflorescence from the face of concrete structures, since concrete is fairly well saturated with water. In fact, efflorescence in the form of alkali salts will be washed from the surface of concrete structures, if exposed to rain, over some period of time. If the coating is largely calcium carbonate or calcium sulfate, it adheres rather strongly and is difficult to remove by brushing. The practice developed in this case for masonry surfaces, has been to saturate the structure as thoroughly as possible with water, and then wash with diluted muriatic acid, followed immediately with an alkaline wash, then washed with water. The acid recommended is five (5) parts hydrochloric to one hundred (100) parts water, or twenty (20) parts vinegar to one hundred (100) parts water. The alkaline wash recommended is diluted household ammonia.

Much care must be taken in applying acid to Portland cement products. The acid will attack, not only the calcium carbonate and calcium sulfate efflorescence, but also other calcium compounds to produce calcium salts such as calcium chloride. It is, therefore, very important to neutralize the acid before it can attack other compounds.

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Rust Stain Removal

Rust is one of the most difficult stains to remove from marble, granite and other stone surfaces. Many of the rust removers available in stores can damage stone. You may want to give the following suggestion a try:

There is a product called "Iron Out" that is available from most home centers and hardware stores. This product is a white powder that is designed for removing iron from water softeners, but also works great for removing iron and other metal stains from stone. To remove iron stains

mix 1 part "Iron Out" to 2 parts poultice powder (diatomaceous earth). Add water until you get a soupy consistency. Apply this mixture to the iron stain, cover with plastic and let it sit for 24 hours. After 24 hours remove the poultice and reapply if necessary.

As with any stone treatment it is always good practice to try this out on a small section of stone that is not visible to make sure it will not do any damage

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