EFFLORESCENCE:
CAUSES, PREVENTION, REPAIR

Dr. M.A. Hatzinikolas

EFFLORESCENCE: CAUSES, PREVENTION, REPAIR

Efflorescence is a deposit, usually white in colour, that may develop on the surface of masonry or concrete construction. Often it appears just after a structure is completed. Although unattractive and generally harmless, efflorescence deposits can occur within the surface pores of the material, causing expansion that may disrupt the surface.

CAUSES:

A combination of circumstances causes efflorescence. First, there must be soluble salts in the material. Second, there must be moisture to dissolve soluble salts. Third, evaporation of hydrostatic pressure must cause the solution to move toward the surface. And fourth the solution must evaporate to leave salts behind as efflorescence.

All masonry and concrete materials are susceptible to efflorescence. Water-soluble salts that appear in chemical analyses as only a few tenths of a percent are sufficient to cause efflorescence when bleached out and concentrated at the surface. The amount and character of the deposits vary according to the nature of the soluble materials and atmospheric conditions.

Efflorescence is particularly affected by the temperature, humidity, and wind. In the summer even after long rainy periods, moisture evaporates so quickly that comparatively small amounts of salt are brought to the surface. Usually efflorescence is more common in the winter when a slower rate of evaporation allows migration of salts to the surface. With the passage of time, efflorescence becomes lighter and less extensive unless there is an external source of salt. Light-coloured surfaces show the deposit much less than darker surfaces. Efflorescence producing salts are usually carbonates of calcium, potassium, and sodium; sulphates of sodium, potassium, magnesium, calcium, and iron (ferrows); bicarbonate of sodium; or silicate of sodium. However, almost any soluble salt that finds its way into concrete or masonry materials may appear as efflorescence; consequently chlorides, nitrates, and salts of vanadium, chromium, and molybdenum occasionally causes efflorescence. Chloride salts are highly soluble in water, so the first rain often washes them off.

In most cases, slats that cause efflorescence come from beneath the surface, but chemicals in the materials can react with chemicals in the atmosphere to form efflorescence. For example, in concrete, mortar, stucco, or concrete masonry, hydrated portland cement contains some calcium hydroxide as an inevitable product of the reaction between cement or lime and water. Calcium hydroxide brought to the surface by water combines with carbon dioxide in the air to form calcium carbonate, which appears as whitish deposit.

Another source of salts is soil in contact with basement and retaining walls, if the walls are not protected with a good moisture barrier; the salts may migrate a foot or two above grade. Since many factors influence the formation of efflorescence, it is difficult to predict if and when it will appear. However, efflorescence will not occur if:

1. SOLUBLE SALTS ARE ELIMINATED
2. MOISTURE IS ELIMINATED
3. WATER PASAGE THROUGH THE MASS IS PREVENTED

ELIMINATING THE SALTS

In the selection of materials, all ingredients should be considered for their soluble-salt content. To reduce or eliminate efflorescence producing soluble salts:

1. Never use unwashed sand. Use sand that meets the requirements of ASTM C-33 or CSA A23.1 for concrete or ASTM C-114 for mortar.
2. Use low alkali cement.
3. Use dehydrated lime free from calcium sulphate when using lime for mortar or stucco.
4. Use clean mixing water free from harmful amounts acids, alkalies, organic material, minerals, and salts. Do not use drinking water that contains sufficient quantities of dissolved minerals and salts to adversely affect the resulting construction. Do not use seawater.
5. Never use masonry units known to efflorescence while stockpiled. Use only masonry units of established reliability. Use brick passing efflorescence tests in ASTM C-67.
6. Use insulating material free of harmful salts when walls of hollow masonry units are to be insulated by filling the cores.
7. Be certain that mixer, mortar box, mortar boards, and tools are not contaminated or corroded. Never deice this equipment with salt or antifreeze material.
8. Consider using autoclave concrete masonry units.

Water repellent surface treatments such as silicones decrease surface efflorescence by causing the dissolved salts to be deposited beneath the treated surface.
However, localized accumulation of salts and their crystallization beneath the treated surface may cause surface spalling flaking. When there are larger amounts of salt in the construction material, use of a surface treatment may cause problems.

ELIMINATING MOISTURE AND WATER PASSAGE

Low absorption of moisture is the best assurance against efflorescence. Cast-in-place concrete will have maximum water tightness when made with properly graded

aggregates, an adequate cement content, a low water-cement ratio, and thorough curing.

When masonry walls are constructed in accordance with recommendations in available literature, it is unlikely that water penetration will be a problem. Research shows that composite walls of brick and block are capable or resisting water infiltration regardless of the type and composition of the mortar used in laying up the walls. For this type of masonry wall, design and workmanship affect water permeance far more than materials do.

To eliminate moisture or moisture passage through the structure, these steps are recommended:

1. Prevent inadequate hydration of cementitious materials caused by cold temperatures, premature drying, or improper use of admixtures.
2. Prevent entry of water by giving proper attention to design details for correct installation of waterstops, flashings, and copings.
3. Cover the top course of masonry at the completion of each day's work, particularly when rain is expected.
4. Cure or dry concrete masonry units the presence of carbon dioxide gas. This appears to be beneficial in changing calcium hydroxide to calcium carbonate, which seems to form in the pores at or just below the surface. The pores are thus partially filled, reducing the passage of water.
5. Install vapour barriers in exterior walls or apply vapour proof paint to interior surfaces.
6. Apply paint or other proven protective treatment to the outside surfaces of porous masonry units.
7. Tool all mortar joints with a V or concave-shaped jointer to compact the mortar at the exposed surface and create a tight bond between mortar and masonry units. Weeping, raked, and untooled stuck joints ate not recommended except in dry climates. Deteriorated mortar joints should be tuck pointed to keep moisture on the wall.
8. Carefully plan the installation of lawn sprinklers or any other water source so that walls are not subjected to unnecessary wetting.
9. If architecturally feasible, use wide overhanging roofs to protect walls from rainfall.

HOW TO REMOVE EFFLORESCENCE

Where there is efflorescence, the source of moisture should be determined and corrective measures taken to keep water out of the structure. Most efflorescence can be removed by dry brushing, water rising with brushing, light waterblasting, or light sandblasting following by flushing with clean water. If this is not satisfactory, it may be necessary to wash the surface with a dilute solution of muriatic acid (1to 10 percent). For integrally coloured concrete, only a 1 to 2 percent solution should be used to prevent surface etching that may reveal the aggregate and hence change colour and texture.

Before applying an acid solution, always dampen the wall surface with clean water to prevent the acid from being absorbed deeply into the wall where damage may occur. Application should be to small areas of not more than 4 sq. ft. (0.4^2) at a time, with a delay of about 5 minutes before scouring off the sale deposit with a stiff bristle brush.

After this treatment, the surface should be immediately and thoroughly flushed with clean water to remove all traces of acid. If the surface is to be painted, it should be thoroughly flushed with water and allowed to dry.

If is often helpful to determine the type of salt in the efflorescence so that a cleaning solution can be found that readily dissolves the efflorescence without adversely affecting the masonry or concrete. Before any treatment is used on any masonry or concrete wall, the method should be tested on a small inconspicuous area to be certain there is not adverse effect.

Since acid and other treatments may slightly change the appearance, the entire wall should be treated to avoid discoloration or mottled effects.

*CAUTION - RUBBER GLOVES, GLASSES AND OTHER PROTECTIVE CLOTHING SHOULD BE WORN BY WORKMEN USING . AND ACID SOLUTION. ALL PRECAUTIONS ON LABELS SHOULD BE OBSERVED BECAUSE MURIATIC ACID CAN AFFECT EYES, SKIN AND BREATHING.

PUBLICATIONS BY THE PRAIRIE MASONRY RESEARCH INSTITUTE