

Efflorescence, Can it be Controlled?

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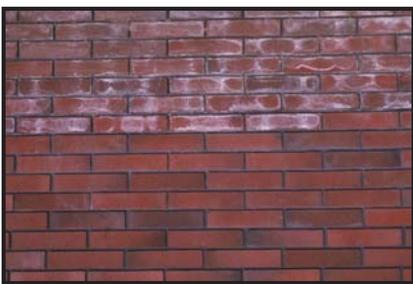
Introduction

The masonry industry has long been plagued with concern and confusion for what has been termed efflorescence.

Although efflorescence is not well understood, the masonry industry is able to generally define what it is, where it comes from, and how to reduce the potential of it occurring.

Definition

Efflorescence is a deposit of soluble salts which usually appears as a fine, white, crystalline powder on the surface of masonry as the internal water evaporates. If the salts are non-soluble (they don't break down in water), they are not considered efflorescing salts.



Efflorescence sometimes appears as a brown, a green, or a yellow stain resulting from the presence of different types of salts.

Causes

Efflorescence is a very complex problem to understand. The

most basic concept of efflorescence occurs when water reacts or mixes with masonry materials to move salts to the surface of the element. In some cases, the water reacts with the masonry components to create free salts.



In other instances, free water dilutes already-free salts in the masonry into solution which can be transported through the masonry element. If the salt deposits are transported to the surface, we refer to them as efflorescence.

If the salts are deposited within the masonry where they form a crystal, we refer to the salt deposit as crytoflorescence. Since these are not visible, their presence is often discovered after the crystal formation creates forces in the masonry sufficient to cause spalling.

In order for efflorescence to occur, a masonry wall must contain soluble salts, water, and a force to move the -dissolved salts to the exterior of the wall.

The absence of any one of these three elements will virtually eliminate efflorescence.

Salts

Water-soluble and non-water-soluble salts may be present in the masonry units, mortar ingredients (cement, lime, sand, admixtures and other constituents), grout ingredients (cement, sand, aggregates, and other admixtures), water, contacting soils, and windborne chemicals and dusts.

Some soluble salts in masonry are created as a result of the reaction between masonry units, mortars, grouts, embedded conduits and reinforcing. It is not until the masonry element is constructed that the salts become soluble.



If the masonry element is exposed to large concentrations of moisture such as rain or snow during construction, but prior to hydration, setting and bonding of the mortar and grout, the salts in the materials are more susceptible to being dissolved.

Cleaning solutions may also react with masonry materials to create soluble salts. Cleaning agents high in acid content are the most notorious for bringing out efflorescence as they are quick to dissolve most salts.

can dissolve salts in the masonry materials. Dissolved salts are carried to the surface by forces of evaporation.

Although clay brick are the only products required to be tested

Regions of high humidity will also be exposed to greater efflorescence potential. In these regions the author recommends conducting a wick test on the entire masonry assembly or prism.

In order to dissolve a salt, there needs to be sufficient solution. Water is the solution. The more water available, the more salt is able to be dissolved.

Masonry Unit

The absorption and porosity of the masonry unit may also have an impact that may not be recognized until after the wall is constructed.

For instance, the author has observed that certain masonry units classified as “not effloresced” according to ASTM C67 effloresce more in the wall than other units designated as “effloresced”. In some cases these “not effloresced” units are darker which make efflorescence stand out more than on light colored units.



Certain water-soluble salts present in the masonry units, mortars, and grouts can be determined prior to installation by testing the components using the wick method outlined in ASTM C67.

In this method, the masonry unit is placed in a tray of distilled water for 7 days. Distilled water is selected because it is salt free and eliminates the water as a potential source of salt. During the test, water is wicked through the masonry element where it

according to ASTM C67, the author recommends testing the other constituents for their contribution to efflorescence. Mortars and grouts can be major contributors to efflorescence and should be tested.

The designer should recognize that specifying “not effloresced” brick is not a sure remedy that efflorescence will not occur on their project, only that the materials are not the contributor.

Moisture

The potential of a masonry element to effloresce is directly related to its exposure to moisture. Masonry construction in coastal and other high annual rainfall regions will be exposed to higher quantities of water both during and after construction.



Some “not effloresced” brick have higher absorptions. The higher absorption brick allow more water to enter the masonry which provides more water to

dissolve and transport free salts in the wall. A prism wick test might bear this out.

Temperature

The exposure of a masonry element to temperature also has an impact on efflorescence. Temperature has two effects on the masonry. The first is speed of water movement in the wall and the second is location of evaporation.

As the temperature of the air and the masonry increases, this increases evaporation.



The rate of evaporation has a significant impact on movement of salts in a wall. This can be understood conceptually by contrasting the Mississippi River with the Colorado River at flood stage. The maximum particle size of transported materials in the Mississippi is limited to fine silts and sands. On the other hand, house sized



boulders are frequently moved in the Colorado.

Efflorescing salts are large particles in a wall and require higher flow rates to get them to move through the wall. Lower temperatures reduce the flow of moisture and consequently have little impact on the salts.

In understanding efflorescence, it is also important to consider that salt formation occurs at the margin between saturation and evaporation. Consider the south face of a building or the top of a paving brick. As the face of the brick gets warm it causes evaporation to occur on the surface. As the surface of the brick begins to dry, it moves the point of saturation deeper into the wall. It is at this location that salts are deposited.

The formation of salt crystals in a masonry element is referred to as crytoflorescence. If the salt concentrations beneath the surface of the brick create forces in the clay that exceed the material tensile strength, one might observe spalling. It is the author's belief that it is the formation of these crystals in pavers that causes spalling more often than water freezing.

It is for this reason that south and west facing walls are less prone to efflorescence. These walls receive more exposure to the sun and become hotter. As these walls become warmer, the location of evaporation moves further into the wall.

The north and east facing walls are normally cooler; consequently, water within the wall is allowed to move to the surface before it evaporates. On these faces, the salts would be transported to the surface and would exhibit more efflorescence.

Removal

If efflorescence does appear, the safest approach is to assume that the salts are water soluble. If this is the case, the salts can easily be removed using a dry brush, rinsing with water, or through natural weathering processes.



If the salts are not water soluble, attempt to identify the type of salts present. Consult the masonry manufacture for assistance in identifying free salts. Vanadium and Manganese are salts inherent in many buff and brown and black colored brick. These and other salts may require special cleaning agents to remove them.

Other salts dissolved from the masonry react with the air once they reach the surface. These salts combine to form non-soluble salts and are difficult to remove with standard cleaning

methods. Some of these salts require sandblasting or staining to remove or mask the salts. Common sources of these types of salts come from soils and sprinkler type irrigation.

Prevention

All masonry elements are susceptible to efflorescence since all masonry contains free salts and are exposed to moisture.



High vapor transmission rate (VTR) water repellents have been known to help in reducing efflorescence by reducing the amount of water that gets into a wall thereby reducing the amount of solution available to dissolve the salt. Water repellents also help in reducing the rate of evaporation which slows down the flow of water in the wall which reduces the transportation of larger particles.

High VTR water repellents allow the salts to migrate to the surface. Stay away from non

breathable water proofing materials. These act as a barrier to large particles and may increase cryoflorescence and spalling.

Material Selection

Masonry materials should be selected which have the least source of salts. Select cementitious materials which pass ASTM specifications.

Where available, use low alkali cements. High alkali cement are known source of efflorescing salts. Avoid sands that have not been washed or which have been exposed to contaminants. Avoid masonry units that are known to effloresce in the stockpile. Use clean, potable water free of acids, alkalis and salts.

Test masonry assemblages for efflorescence and select combinations low in efflorescence.



Much could be learned to minimize efflorescence by constructing masonry prisms

from the actual job site units, mortars and grouts and then subjecting them to the ASTM C67, wick test.

Stockpile masonry materials on pallets above the ground. Wicking of salts from the ground is a common problem.

Detailing

The architect should select details which are less susceptible to effloresce. Avoid horizontal masonry copings in wet climates. Specify mortars with proven resistance to efflorescence. Call out mortar joints as tooled concave or V-joint in climates exposed to high rain or freezing. This will help to reduce the water permeance of the mortar.

Select caulking and sealant materials compatible with the masonry and other adjoining materials. Provide flashings and weeps in masonry walls at locations where water can accumulate. Provide weep holes and air vents wherever possible. Vents allow for evaporation to occur on the inside of a wall which helps to keep the salts suspended in the wall. The author does not recommend cotton wicks because of their inability to move water.

Use wide overhangs and rain gutters where architecturally feasible. A continuous damp proofing membrane should be applied at the base of the wall above the soil line to prohibit

salts in the soil from rising into the masonry.

Masonry used to contain soil such as in planters and retaining walls allow wicking of salts from the soil through the masonry onto the face of the masonry wall. Since these salts are normally not water soluble, damp proofing should be placed between the masonry and the soil to stop salt migration.

Landscape, sprinkling systems, and downspouts should be properly placed to avoid splash back. Consider the use of water repellents carefully and their effect on durability.

Masonry used as a paving unit should be designed with adequate drainage and isolated from soil where possible to minimize contact with salts in the soil. Avoid applying de-icing salts to paving areas. De-icing salts will cause efflorescence and may cause spalling.

Construction

Proper construction is critical in establishing a moisture resistant wall and a wall less susceptible to efflorescence.

Protect partially completed masonry from moisture during construction. Moisture allowed into a masonry element during construction can be the greatest source of efflorescence. Open cells containing water should not be grouted.

Follow recommended construction practices in hot and cold weather climate. Cleaning masonry requires the masonry units to be saturated before applying masonry cleaners. This is to prevent cleaning solvents from being absorbed into the brick where they can breakdown efflorescing salts.

Water repellents should be applied to masonry during warm weather so that they can be absorbed more deeply into the brick.

Conclusion

Almost all masonry components contain soluble salts and additional salts may be formed as the masonry components are combined.

When sufficient water is added to the masonry element prior to, during, or after construction, the salts dissolve and go into solution form. When these move to the surface, the result is efflorescence. To reduce efflorescence, the selection of materials with the least potential for efflorescence should be considered.

One way to evaluate the masonry assembly's efflorescence potential is by conducting a wick test. Careful attention should also be made to prescribe details and construction practices that will reduce the elements exposure to moisture.

A thoughtful approach to the selection, design and

construction of a masonry element will reduce efflorescence.

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