NATIONAL
CONCRETE MASONRY
ASSOCIATION

TEK 08-03A

CONTROL AND REMOVAL OF EFFLORESCENCE

INTRODUCTION

Efflorescence is a deposit of soluble salts and bases, usually white in color, that sometimes appear on the surfaces of masonry or concrete construction. Although it may be an aesthetic concern, efflorescence will not affect structural performance.

Often efflorescence is apparent just after the structure is completed. If the efflorescence is essentially uniform throughout the exterior facade, it indicates normal water loss from the materials and the building. Some identify this occurrence as “early age” efflorescence or “new building bloom”. If unattended, the salts will eventually be removed by rain water.

If the deposit is heavy and essentially shows as white streaks immediately below mortar joints or covering localized areas of the masonry, it indicates that water has entered or is entering the wall at a higher elevation. These salts are called leachates, referred to “lime spots”, “lime runs” and “lime deposits”; and are sometimes identified as “late age” or recurrent efflorescence. Late age or recurrent efflorescence usually consists of more permanent surface accumulations and indicates a need for corrective measures.

This TEK discusses the various mechanisms which cause efflorescence and presents recommendations for its control and removal.

CAUSES OF EFFLORESCENCE

A combination of circumstances causes efflorescence. First, there must be soluble compounds in the masonry. Second, moisture must be present to pick up the soluble salts and carry them to the surface. Third, some force—evaporation or hydrostatic pressure—must cause the solution to move. If any one of these conditions is eliminated, efflorescence will not occur.

Source of Salts

The individual elements and compounds associated with efflorescence may be present in concrete masonry units, mortar and grout. However, efflorescence of masonry is generally attributed to water soluble sodium, potassium and calcium. These solutions either precipitate as hydroxides or combine with atmospheric carbon dioxide and sulfur trioxide. The compounds produced by the combination of these elements are white or yellow salts, all of which are less water soluble than their former hydroxide counterparts. Chlorides are usually a result of contamination of masonry units and sand by sea water or runoff from alkaline soils. Since chloride salts are highly soluble in water, rain will often wash them off.

The amount and character of the deposits vary according to the nature of the soluble materials and the atmospheric conditions. Efflorescence is particularly affected by temperature, humidity and wind. In the summer, even after long rainy periods, moisture evaporates so quickly that comparatively small amounts of efflorescence are brought to the surface. Thus, efflorescence is more common in the winter when a slower rate of evaporation allows migration of salts to the surface. In spring, condensation frozen within the masonry may be released by warm weather allowing for further solubilizing of compounds and their migration to the surface. With the passage of time, efflorescence becomes lighter and less extensive unless an external source of salts or recurrent water migration is present.

In most cases, compounds that cause efflorescence are water soluble and are left on the surface as the water containing them evaporates. Sometimes, however, chemicals in the construction materials react with chemicals in the atmosphere to form the efflorescence. In the case of concrete masonry or mortar, the hydrated cement contains some calcium hydroxide (soluble) as a product of the reaction between cement or lime and water. When this calcium hydroxide is brought to the surface by water it combines with carbon dioxide in the air to form calcium carbonate (slightly soluble), which then appears as a whitish deposit.

Cements used in the production of mortar and concrete masonry units contain small amounts of water soluble compounds of sodium and potassium. Such water soluble alkalis, present as only a few tenths of one percent, can appear as efflorescence when leached out of the masonry by migrating moisture and concentrated at some point on the surface.

In addition to the masonry materials, building trim such as concrete copings, sills and lintels may also contain considerable amounts of soluble compounds. Some admixtures or ground water may also contribute to efflorescence. Most admixtures are proprietary and their compositions are not disclosed. Accordingly, the efflorescence potential of such admixtures should be determined by experience or laboratory tsts. Dispersing agents used in pigments may increase the potential for efflorescence.)

Sources of Moisture

Water serves as the vehicle by which soluble salts and bases are transported to the surface, where they accumulate as the water evaporates. The primary source of moisture is rain water. Rain water may enter the wall through one or more of the following paths—permeable masonry units, partially filled mortar joints, inadequate flashing and sealing details, and cracks or other openings in the wall.

Considerable moisture may also enter a masonry wall as vapor from the interior of a building and accumulate within the wall as it condenses. Excessive accumulation of condensed water vapor may lead to efflorescence.

A third source of moisture that may contribute to the future formation of efflorescence is water that enters the masonry during construction. Improper protection of masonry during and after construction can allow considerable moisture to enter, which can cause efflorescence.

Masonry in contact with soil, such as in basement and retaining walls, may absorb ground water containing soluble salts. Through capillary action, salts present in the soil may rise several feet above the ground, producing an accumulation of salts in the masonry.

CONTROL OF EFFLORESCENCE

Since many factors influence the formation of efflorescence, it is difficult to predict if and when it will appear. However, to reduce the probability of efflorescence occurring in masonry construction, it is necessary to minimize the amount of soluble salts and moisture present in the masonry. Of the two, moisture is the more easily avoided.

Design

The reduction of moisture in concrete masonry will minimize the mechanisms that cause efflorescence. The designer must review each area of the design prior to construction to see if water can enter and where it will flow or accumulate if it does enter.

The selection of wall type—single-wythe, multi-wythe or cavity—should be considered from the standpoint of resistance to rain penetration and the exposures to which it may be subjected. Design details that will prevent the entrance of moisture into the masonry assembly are critical. Details that will direct water collection away from wall tops and horizontal surfaces should be considered. If architecturally feasible, wide overhanging roofs help protect walls from rainfall.

Parapets require special attention because of their exposure. Flashing should be installed in locations where water will tend to accumulate (i.e., parapets, spandrels, lintels, base of wall) within the masonry. The flashing should be installed to direct the water outward through weep holes.

Joints between masonry and door and window openings should be given careful attention during design as well as construction. Backer rods and sealants should be properly selected and installed in the same careful manner as other elements in the structure. **TEK 19-2B** Design for Dry Single-Wythe Concrete Masonry Walls and TEK **19-4A** Flashing Strategies for Concrete Masonry Walls (refs. 4, 7) provide a more complete discussion on the proper use of flashings and details to minimize water entry.

Numerous surface treatments are available for the construction of weathertight concrete masonry walls. Properly applied, coatings can be relied on to give a satisfactory weathertight concrete masonry wall for up to 10 years in most geographic areas. Clear water-repellent surface treatments decrease efflorescence by repelling water from entering the masonry. However, the application of clear coatings to a masonry wall that has the tendency to effloresce, without reducing the mechanisms for the occurrence of that efflorescence, may lead to surface spalling of masonry units or deposits on the interior and/or exterior surface of the surface treatment.

The designer and owner may also want to consider the use of integral water repellents in the masonry. Integral water repellent admixtures have been shown to reduce the tendency to effloresce, since they reduce water migration throughout the wall. For more information on surface treatments and integral water repellents see **TEK 19-1** Water Repellents for Concrete Masonry Walls (ref. 15).

Materials

In the selection of masonry materials, all component parts—masonry units, mortar and grout—should be considered for their soluble salt content.

At present there is no standard test for evaluating the efflorescence potential of concrete masonry units or mortar. However, in light of this absence, Standard Test Methods of Sampling and Testing Brick and Structural Clay Tile, ASTM C67 (ref. 13) which does contain a test method to esitmate efflorescence potential, is occasionally specified to evaluate concrete masonry units for efflorescence potential.

All cement should meet applicable ASTM specifications. Lime should be hydrated lime and should meet the requirements of ASTM C207 (ref. 14). Sand should meet the requirements of ASTM C144 (ref. 1) and clean mixing water should be used.

If walls of hollow masonry units are to be insulated by filling the cores, the insulating material should be free of harmful salts.

Construction

Materials received at the construction project should be properly stored throughout the construction process. Units should be stored on pallets, or otherwise isolated from the ground, and be adequately covered to prevent water absorption.

Materials removed from stockpiles should be handled such that they remain protected from rain and soil. If colored units are involved, the distribution from the stockpile should be such that the color range of the units is known and units with acceptable color variations are uniformly dispersed throughout the field of the masonry.

During construction, the mixer, mortar box and mortar boards should be kept clean. During cold weather construction, this equipment should not be deiced with salt or antifreeze material. Tools should also be clean and free of rust, salts and other harmful material. For example, workers should not use a shovel for salt and then use it for sand without first thoroughly washing the shovel.

Inadequate hydration of cementitious materials caused by cold temperatures, premature drying or improper use of admixtures should be prevented.

At the end of the work day and after completing one segment of masonry, the top surface of the masonry should be protected to prevent water penetration. Uncovered masonry walls are vulnerable to large quantities of water entering the wall.

Close cooperation between the masonry contractor and designer is necessary to ensure good design and detailing are correctly carried through the construction. Workmanship greatly influences the weathertightness of concrete masonry walls. Concave or vee-shaped mortar joints should be used where the masonry will be subjected to rain or freeze-thaw exposure. Tooling of the joints should be delayed until the mortar is “thumbprint hard”. This partial setting of the mortar provides resistance to the tooling action and forces the mortar tightly against the face shell of the unit to form a good weathertight seal. Joints that do not provide compression of the mortar during the tooling process such as raked, flush, and cut joints are not recommended for exterior applications. They not only do not provide the necessary compressing action against the unit, but by their very nature, leave a ledge for water to accumulate and slowly soak into the masonry.

Head joints are more vulnerable to leakage and poor workmanship as the force of gravity is not working to compress the mortar against the unit to provide a good seal. Head joints must be properly filled to the full thickness of the face shell and compacted by shoving the unit being placed against the previously laid unit. Then of course, the joint must be properly tooled.

The use of water to remove surface accumulations, including efflorescence, will cause additional water to enter the wall particularly if it is applied under high pressure. This water may promote further efflorescence.

REMOVAL OF EFFLORESCENCE

Before any effort to remove the efflorescence is undertaken, the reason for the efflorescence should be established. If it is “early age efflorescence,” moist construction materials may be the cause. If “late age efflorescence” is observed, the possibility of water leakage should be investigated. If the efflorescence is near ground level, ground water may be the cause. In any case, the problem should be repaired prior to removing the efflorescence. Generally, if efflorescence is the main concern regarding masonry surface discoloration, the masonry walls should be allowed to cure and then the salts should be removed.

Compared to other stains, the removal of most types of efflorescence is relatively easy. As stated previously, most efflorescing salts are water soluble and many will disappear with normal weathering unless there is some external source of salts.

In general, most efflorescence can be removed by dry-brushing followed by flushing with clean water. If brushing is not satisfactory, it may be necessary to use a very light (brush) sandblasting to remove the deposits. Brush sandblasting is sandblasting which is light enough that coarse aggregate is not exposed by the sand blasting (ref. 8). Sand blasting needs to be done with care, as it can alter the appearance of masonry by roughening the surface or exposing aggregate. There also are a variety of commercial cleaners available which may be effective for efflorescence removal. Consult manufacturer’s information for applicability.

As a last resort, a dilute solution of muriatic acid (5 to 10 percent) is sometimes used to clean the wall. For integrally colored masonry, a more dilute solution (2 percent) may be necessary to prevent surface etching that may alter colors and textures. Before an acid treatment is used on any masonry wall, the solution should be tested on a small, inconspicuous portion to be sure there is no adverse effect.

Before applying an acid solution, always wet 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 ft^2 (0.37 m^2) at a time, with a delay of about 5 minutes before scouring the salt deposit with a stiff bristle brush. Use a special acid cleaning brush. Do not use a wire brush as the filings of wire left behind could result in further staining as the steel corrodes. After this treatment, the surface should be immediately and thoroughly flushed with clean water to remove all acid. If the surface is to be painted, it should be thoroughly flushed with water and allowed to weather for at least one month.

Since an acid treatment may slightly change the appearance, the entire wall should be treated to avoid uneven discoloration or mottled effects. Windows, doors, or surrounding materials may need to be protected during application.

Calcium carbonate efflorescence is extremely difficult to remove. It appears usually as a flat white deposit and in the worst cases forms a hard white crust. Any effective methods of removal can alter the texture of the block to such an extent that it is necessary to treat the entire wall area and not merely the affected regions. One method of removal reported to be effective is the use of high pressure water jet, sometimes augmented with the addition of fine sand to the water.

References

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Keywords

cleaning | efflorescence | maintenance | stain removal