

TROWEL TIPS

Information

Efflorescence

Efflorescence is a crystalline deposit, usually white, that may develop on the surfaces of masonry construction (see Fig. 1). Often it appears just after the structure is completed—when builder, architect, and owner are most concerned with the appearance of the new structure. Although unattractive, efflorescence is generally harmless. However, some forms (alkali carbonates) may be able to saponify paints, leading to failure of the paint-masonry bond. Other deposits can occur within the surface pores of the material, causing expansion that may disrupt the surface. This condition is sometimes termed *cryptoflorescence*.

This information sheet examines the causes, prevention, and removal of efflorescence encountered on masonry surfaces.

Causes

A combination of three common circumstances causes efflorescence:

- soluble compounds in the masonry
- moisture to pick up the compounds and carry them to the surface
- evaporation or hydrostatic pressure that causes the solution to move

If any one of these conditions is eliminated, efflorescence will not occur.

All masonry and concrete materials are susceptible to efflorescence. During the construction process, water used to achieve a workable mortar or flowable grout constitutes an available source of moisture in the masonry system. Additional moisture is often introduced into exposed masonry by rain or snow. Water-soluble salts that appear in chemical analyses as only a few tenths of one percent are sufficient to cause efflorescence when leached out and concentrated at some point on the surface. The amount and character of the deposits vary according to the nature of the soluble materials and the atmospheric conditions.



Figure 1. Efflorescence is often called "new building bloom" because it appears on fresh masonry surfaces. (T0026)

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 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 decreases in severity unless there is recurrent moisture movement through the wall. Deposits from efflorescence are less noticeable on lighter-colored surfaces than on darker-colored surfaces.

In most cases, compounds that cause efflorescence come from beneath the surface; but chemicals in the materials can react with chemicals in the atmosphere to form the efflorescence. For example, in concrete masonry, mortar, or stucco, hydrated portland cement contains a substantial amount of calcium hydroxide as an inevitable product of the reaction between cement or lime and water. Calcium hydroxide brought to the surface by moisture combines with carbon dioxide in the air to form calcium carbonate, which then appears as a whitish deposit. Since calcium hydroxide is much more soluble in water at cold temperatures

Figure 2. Tooling joints compacts the mortar and creates a weather-tight bond. This minimizes water entry into the wall, which reduces the potential for efflorescence. (70027)

than at warm temperatures, such deposits are again more common in winter than summer.

Another source of soluble compounds is the soil in contact with basement and retaining walls. If the walls are not protected with an effective moisture barrier, the compounds may migrate a foot or two above grade.

Other sources of efflorescence may be seawater exposure or previous attempts at cleaning that did not remove contaminants from the surface.

Prevention

Since many factors influence the formation of efflorescence, it is difficult to predict if and when any will appear. There is no accepted standard test method for measuring the efflorescence potential of masonry mortar. Several experimental methods have been proposed, but none has been accepted as effectively predicting the performance of mortar materials in actual use.

ASTM C 67 does include an efflorescence test for clay brick. The test is helpful in indicating whether or not clay units will effloresce by themselves when exposed to moisture. However, it does not address the potential for efflorescence resulting from cement-brick reactions or other external conditions that often occur in service.

Given the characteristics of masonry materials and construction, it is virtually impossible to eliminate all the soluble salts, construct walls containing no free moisture, or completely eliminate paths of moisture migration. However, steps can be taken to minimize the extent of these three contributing factors. Good workmanship is one of the most effective means of limiting the potential for efflorescence.

Most efflorescence can be classified as temporary. Often termed "new building bloom," indicating its link to the exposure conditions and excess moisture that accompany new masonry construction, it is harmless and should not cause undue concern. On the other hand, recurrent efflorescence indicates a chronic moisture problem. Efforts should be taken to correct the moisture problem, thereby preventing and eliminating recurrent efflorescence. The following recommendations are targeted toward that goal:



Provide for good drainage

- Correctly install waterstops, flashing, weepholes, and copings per design details. Maintain clean cavities and unobstructed weepholes during the construction of cavity walls.

Construct good mortar joints

- 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 unit (see Fig. 2) Weeping, raked, and untooled struck joints are not recommended in exposed applications.
- Assure that joints are properly fitted. Deteriorated or defective mortar joints should be repaired to keep moisture out of the wall.

Ensure proper curing

- Assure adequate hydration of cementitious materials by protecting masonry from cold temperatures, premature drying, or improper use of admixtures.

Limit water entry

- Apply paint or other proven protective treatment to the outside surfaces of porous masonry units. Caulk around window and door openings. Seal or otherwise repair cracked joints in walls. Also, use through-wall flashing at ground level to prevent capillary rise of ground moisture.
- Install vapor barriers in exterior walls (interior surfaces of exterior walls) or apply vaporproof paint to interior surfaces and use designs that minimize condensation within masonry.
- Carefully plan the installation of lawn sprinklers or any other water source so that walls are not subjected to unnecessary wetting.
- If feasible, use wide overhanging roofs to protect walls from rainfall.



Figure 3. By placing masonry units on pallets and covering them with tarps, it is possible to keep them dry while stored at the job site. (20480-C)

Limit moisture driving forces

- Provide for pressure equalization between the outside and the void within the masonry wall by appropriate venting of cavities.

Clearly, coordinating design and construction activities is key to producing weather-resistant masonry and eliminating recurrent efflorescence. For a more complete discussion on preventing water penetration of masonry construction see PCA publication IS220, *Building Weather-Resistant Masonry Walls*.

To reduce the potential for efflorescence associated with new construction, the following steps may be taken to limit the moisture introduced into the wall during construction and reduce the level of efflorescing salts.

- Keep masonry units stored at job site covered and on pallets placed in well drained locations (see Fig. 3).
- Cover the top course of masonry at the completion of each day's work, particularly when rain (or snow) is expected (see Fig. 4).
- Use washed ASTM C 144 sand.
- Don't use units known to effloresce while stockpiled. Use brick that pass the ASTM C 67 efflorescence test.
- Use clean mixing water free from harmful amounts of acids, alkalis, organic material, minerals, and salts. Do not use seawater or brackish water for mixing mortar.
- Use insulating material free of salts when walls of hollow masonry units are to be insulated by filling the cores.
- Be certain that mixer, mortar box, mortarboards, and tools are not contaminated or corroded. Never deice this equipment with salt or antifreeze material.
- Use mortar materials of lower alkali content.

Note that "reducing moisture content of masonry" does not mean arbitrarily reducing the water content of mortar or allowing walls

to prematurely dry out. Both of these measures will contribute to increased permeability of the masonry construction and thus increased potential for recurrent efflorescence.

Removal

Since efflorescence often occurs during or right after construction, the first impulse is to immediately wash it off with water or a masonry cleaning solution. This is not advisable, particularly in cool or cold damp weather, when the primary result of such action will be to introduce more water into the masonry wall. Given time, efflorescence will often disappear by itself or at most may require mild cleaning measures such as dry brushing or rinsing and brushing with a stiff brush. If this does not produce satisfactory results, it may be necessary to wash the surface with a proprietary masonry cleaning solution or a very dilute solution of muriatic acid (1% to 10%). In any case, prior to removing efflorescence from a surface, the surest way to establish an appropriate cleaning procedure is to chemically identify the deposit (see table on next page). Following cleaning, the wall should be thoroughly rinsed with clean water to remove all traces of the cleaner (see Fig. 5).

Prior to using a proprietary cleaner or muriatic acid solution, the cleaning agent's compatibility with the masonry units should be verified with the manufacturer of the units. Where integrally colored concrete masonry units or mortars are involved, use only a 1% to 2% acid solution or a proprietary cleaner specifically recommended for that application.



Figure 4. The top of masonry walls should be protected with a tarp whenever rain or snow is expected. It is good practice to cover work at the end of each day to help keep excessive water out and aid curing. (70028)

Figure 5. If efflorescence must be removed chemically, walls should be thoroughly rinsed to remove all traces of the cleaner. (70028)

In any event, care should be taken to assure that the cleaning solution and technique do not etch the surface of masonry units or mortar joints. Improper cleaning can significantly change the appearance of the masonry, damage mortar joints and units, and contribute to additional efflorescence or staining.

It is often helpful to determine the chemical makeup of the efflorescence so that a cleaning solution can be found that readily dissolves the efflorescence without adversely affecting the masonry. Before any treatment is used on any masonry wall, the method should be tested on a small, inconspicuous area to be certain there is no adverse effect. In cases involving recurrent efflorescence, the source of moisture should be determined and corrective measures taken to keep water out of the structure prior to attempted removal of the efflorescence.



Removing Some Forms of Efflorescence

Common compound	Recommended cleaning method
Alkali sulfate	Stiff brush. If necessary, brush with water.
Calcium sulfate	Stiff brush. If chronic, add water washing.
Calcium carbonate	Stiff brush. If not adherent. If adherent, apply dilute acid or proprietary cleaning solution to dissolve efflorescence.

5420 Old Orchard Road
Skokie, Illinois 60077-1083
Voice: 847.966.6200
Fax: 847.966.9781
Internet: <http://www.portcement.org>

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Warning: Contact with wet (unhardened) concrete, mortar, cement, or cement mixtures can cause SKIN IRRITATION, SEVERE CHEMICAL BURNS (THIRD-DEGREE), or SERIOUS EYE DAMAGE. Frequent exposure may be associated with irritant and/or allergic contact dermatitis. Wear waterproof gloves, a long-sleeved shirt, full-length trousers, and proper eye protection when working with these materials. If you have to stand in wet concrete, use waterproof boots that are high enough to keep concrete from flowing into them. Wash wet concrete, mortar, cement, or cement mixtures from your skin immediately. Flush eyes with clean water immediately after contact. Indirect contact through clothing can be as serious as direct contact, so promptly rinse out wet concrete, mortar, cement, or cement mixtures from clothing. Seek immediate medical attention if you have persistent or severe discomfort.

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