Efflorescence - Removal and Prevention

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The crystallization of soluble salts in Historic masonry causes severe deterioration of the substrate. This crystallization is called subflorescence. These salts are derived from several sources, including salts within the substrate, pollution, deicing salts and improper cleaning chemicals.Problems associated with subflorescence can be diagnosed and identified by visual clues, such as spalling and rising damp.Accurate diagnosis of subflorescence can be confirmed with laboratory testing. Once the salts are detected there are several methods which can remove these salts. Water washing, surface rendering and poulticing are a few of the methods used.If these salts are successfully removed it is important to prevent reoccurrence. Preventative applications might include installation of dampproof barriers, chemical injection and coating the masonry with a sealer or impregnator.

Subflorescence

The deposit of water soluble salts in the pores of Historic masonry is the major cause for deterioration of these surfaces.These salts originate from several sources.Gauri, Holdren and Vaughan (1986) report that these salts are inherent in brick, concrete and natural stone. Boyer(1986) contributes polluted

rain water, roof salts, deicing salts and adjacent materials as the source of salt deposition.Ashurst(1994) reports that careless cleaning using improper chemicals can deposit salts causing deterioration.Regardless of the source all agree that water soluble salt deposition contributes significantly to the rapid deterioration of historic masonry.

Grimmer (1984) defines Subflorescence as follows:

Subflorescence is a potentially harmful accumulation, or build-up of soluble salts deposited under or just beneath the masonry surface as moisture in the wall evaporates.Particularly during the freeze-thaw cycle, the moisture and salts in the wall freeze and expand, building up pressure within the masonry, which if sufficient, may cause parts of the outer surface to spall off or delaminate. (P. 22)

In other words, Subflorescence is the deposit of salt crystals beneath the surface of the masonry.

Subflorescence and Efflorescence

Subflorescence should not be confused with efflorescence.Efflorescence is a deposit of soluble salts on the surface of masonry. Efflorescence can be identified by a whitish haze on the surface of the masonry.Efflorescence can be a precursor to subflorescence since itsindicates the presents of salts.Efflorescence is common and often harmless on newly constructed buildings, but if it appears on historic masonry, it should serve as a warning that moisture has found a way into the masonry.

Diagnosing and Identifying Subflorescence

Subflorescence should be suspect when the following conditions are observed on a masonry surface:

1.Spalling- Spalling of masonry surfaces can be identified by the breaking off of the surface layer. Small pieces of the outer layer will flake off in both small and large portions. Often the surface is very brittle and can easily be removed by prying with a knife. Spalling can also be called delamination when referring to manmade masonry.The term delamination is general used for stone masonry.

2.Rising Damp- Along the base of most masonry buildings, a wet, darken outline can be detected. This darkened area usually extends from the ground to several feet above the ground.This darken is the result of water being carried through capillary action into the porous masonry. This condition is known as rising damp.Rising damp can lead to efflorescence and ultimately subflorescence since salts can be dissolved and carried by the water.Rising damp is a concern in Northern climates where deicing salts are used.If the moisture remains during freezing months, the water will freeze, expand and cause spalling of the masonry surface.

3.Post Cleaning Operations- Frequently masonry surfaces will develop efflorescence within several days after cleaning. The masonry surface should be checked carefully, since efflorescence can be a precursor to subflorescence.This is especially troublesome if the cleaning operation used copious amounts of water.Excessive use of water can saturate the masonry, dissolved salts within the masonr, causing spalling.

4. Chemical Cleaning Operations- Certain chemicals can deposit soluble salts within the pores of the masonry if not rinsed throughly.Alkaline cleaning chemicals contain alkaline salts which can crystallize causing spalling of the masonry surface.If spalling occurs shortly after cleaning check the type of cleaners used.

Testing for Soluble Salts

If soluble salts are suspected, a simple field test can be used to determine if salts are present. To determine the type of salts, thus leading to a possible

source, laboratory tests must be conducted. The following describes these tests.

Field Testing- London (1988) describes a simple qualitative test for determining the presents of soluble salts using a protimeter.The test uses the principle that dissolved salts have a higher capacity to conduct an electrical current.A filter paper is saturated with distilled water, placed on a rubber block and a reading taken with the protimeter.A second filter paper is saturated with distilled water, placed on the suspect masonry and a reading taken.If the reading on the masonry is higher than the reading on the control, then soluble salts may be present. This test does have a margin of error and can be misleading. It is advised to verify with laboratory testing.

Laboratory Testing- Laboratory testing can determine quantitative as well as the exact identification of the salts.It is important to know which type of salts are present in order to determine the origin.Most all salts in historic masonry can be classified as follows:

Chlorides- Chloride salts are found in deicing salts. Ashurst (1988) also reports that chlorides can be hygroscopic, taking moisture directly from the atmosphere. Chlorides can also be found in high concentrations in environments near oceans and salt marshes. Chlorides can also be present in the make up of the masonry itself.

Nitrates- If nitrate salts are detected, ground water should be suspected. Nitrates are commonly found in fertilizers and in soils.

Carbonates- Carbonates are found in high concentrations in masonry mortars continuing lime. Carbonates are also present in pointing mortar and will usually present a problem when a building is repointed.

Sulfates- Sulfates are found in air pollution from vehicle exhaust, industrial pollutants etc. Sulfates are an increasing problem in areas where pollution is high.

Alkaline and Acid Salts- Alkaline and acid salts are deposited into historic masonry when cleaners are used and not rinsed probably. If efflorescence and/or subflorescence occurs shortly after cleaning, these salts should be suspect.Hydrofluoric acid is commonly used to clean historic masonry since it is one of the few chemicals that do not deposit soluble salts(Ashurst, 1988).

Subflorescence

Removal of Soluble Salts

Before any attempt is made to treat historic masonry and to remove both efflorescence and/or subflorescence it is necessary to find the origin of the salts. If this is not found, further damage may result.Once the origin is found the first step in salt removal is to eliminate the source.

There are several methods for desalination of historic masonry. The following methods have proved successful but are not fool proof. It is vital that these procedures be performed by trained and experienced individuals.

Ashurst (1988) describes two possible procedures for removal of soluble salts, poulticing and sacrificial rendering.Poulticing uses an absorbent clay mixed with distilled water into a paste.This past is applied to the masonry, which has been saturated with water. As the clay dries it will absorb the moisture from the masonry carrying the salts with it.Poulticing can be an effective treatment for removing soluble salts but caution must be exercised since salts can be drawn to the surface and crystallization may occur. Sacrificial Rendering uses an application of a thin coat of a lime and sand mixture.This mixture is trowel on the wall as if applying stucco. The principle is that the rendering will absorb moisture and transfer the soluble salts to it.Gauri et al (1986) describes two suction techniques for removal of soluble salts.The suction method uses a vacuum pump attached to a funnel. The masonry is saturated with water and the vacuum pump pulls the moisture out with the soluble salts.This method

can be time consuming on larger surfaces but industrial equipment is available that can process several hundred square feet per day. Grimmer (1984) suggests the use of water washing to remove efflorescence.The water washing method employs the use of water sprayed on the surface of the masonry. The water can be applied with

high pressure, low pressure, intermittent with an endless number of spray patterns. Water washing is the most common method employed for cleaning historic masonry but does have its shortcomings. Chemical cleaning is often used in an attempt to remove soluble salts with little to no result. Hydrofluoric acid is the most often used chemical on masonry surfaces.The acid works by dissolving the salts which are rinsed away after a timed dwell period. Hydrofluoric acid also is damaging to the masonry itself since it dissolved the substrate.

Which ever method is used it is important to perform a test on the masonry and monitor it closely for any harmful effects.

Preventing Subflorescence

Damaging salts are carried into historic masonry by moisture. To prevent salt deposition it is necessary to eliminate the moisture. Grimmer (1984) suggests using a dampproof course. This dampproof course consists of placing a material such as plastic, horizontally in a masonry wall to prevent moisture from rising into the substrate.Injecting chemical plastics into the masonry have also been used to eliminate moisture as well as the application of sealers and impregnators.

Whichever preventive treatment is used it is important to remove the existing salts. This can be accomplished by the methods mentioned above or the masonry should be left alone and the salts allowed to migrate out. This is especially important with chemicals treatments. Sealers,

consolidants and impregnators should not be applied to masonry containing

salts.The application of these sealers, etc will prevent moisture from escaping, accelerating the chance of deterioration.

Conclusions

The deterioration of Historic masonry through the crystallization of soluble salts is a growing problem in the preservation community. Improper cleaning techniques and air pollution both contribute to the build up of these salts.It is important that the proper diagnosis be formulated so that further damage is not caused.Desalination practices and procedure must be tested and performed by experience individuals.

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