BRANZ

ISSUE 593

BULLETIN

EFFLORESCENCE

February 2016

Although efflorescence does not affect the performance of blockwork, brickwork or concrete, it is considered unsightly and spoils the appearance of the wall.

Efflorescence is common on new masonry or concrete walls, but it can be removed and will generally disappear naturally over time.

This bulletin describes how soluble and insoluble efflorescence can be identified and removed. It updates and replaces Bulletin 442 *Efflorescence on masonry*.

1.0 INTRODUCTION

1.0.1 Efflorescence generally appears as a white deposit (although it may also be brown, green or yellow in colour) on the surface of clay and concrete masonry and concrete walls. It occurs when soluble salts in the concrete or mortar dissolve in moisture in the blockwork, brickwork or concrete and are then carried to the surface as the moisture migrates through. When the moisture evaporates, the salts remain as a residue on the surface.

1.0.2 White or grey efflorescence is likely to be a calcium, sodium or potassium salt originating mainly from the cement in mortar, grout or concrete. Calcium hydroxide ($Ca(OH)_2$) is a common cause of efflorescence (Figure 1). Coloured efflorescence indicates vanadium salts and generally occurs on cream or light-coloured bricks.

1.0.3 While efflorescence does not affect the performance of blockwork, brickwork or concrete, it is considered unsightly and spoils the appearance of the wall.

1.0.4 This bulletin describes how soluble and insoluble efflorescence can be identified and removed. It updates and replaces Bulletin 442 *Efflorescence on masonry*.

2.0 WHY DOES EFFLORESCENCE OCCUR?

2.0.1 Efflorescence can occur on new masonry or concrete walls, as soluble salts tend to be present in the blockwork, concrete or mortar. The salts may come from a number of sources including:

- the cement in masonry units, mortar, grout or concrete – cement contains up to 2% soluble salts
- the atmosphere, for example, salt spray in coastal areas or atmospheric pollutants in industrial areas
- water absorbed into masonry or concrete.

2.0.2 Three conditions are required for efflorescence to occur. There must be:

- soluble salts present
- moisture in the wall
- evaporation of moisture.

2.0.3 A number of factors exacerbate the incidence of efflorescence such as:

- masonry units not being protected before laying from rain or groundwater
- masonry veneer walls not being protected from rain during construction and water entering the cavity
- inadequate flashings at the top of walls
- too much water in the mortar mix.

3.0 EFFLORESCENCE PROCESS

3.0.1 Efflorescence may occur as either soluble or insoluble deposits.

3.0.2 Soluble efflorescence occurs initially when the water containing dissolved salts evaporates from the wall leaving the salt to crystallise on the surface. The residue is powdery and generally easily removed by brushing. It may even disappear as a result of wind or rain washing.

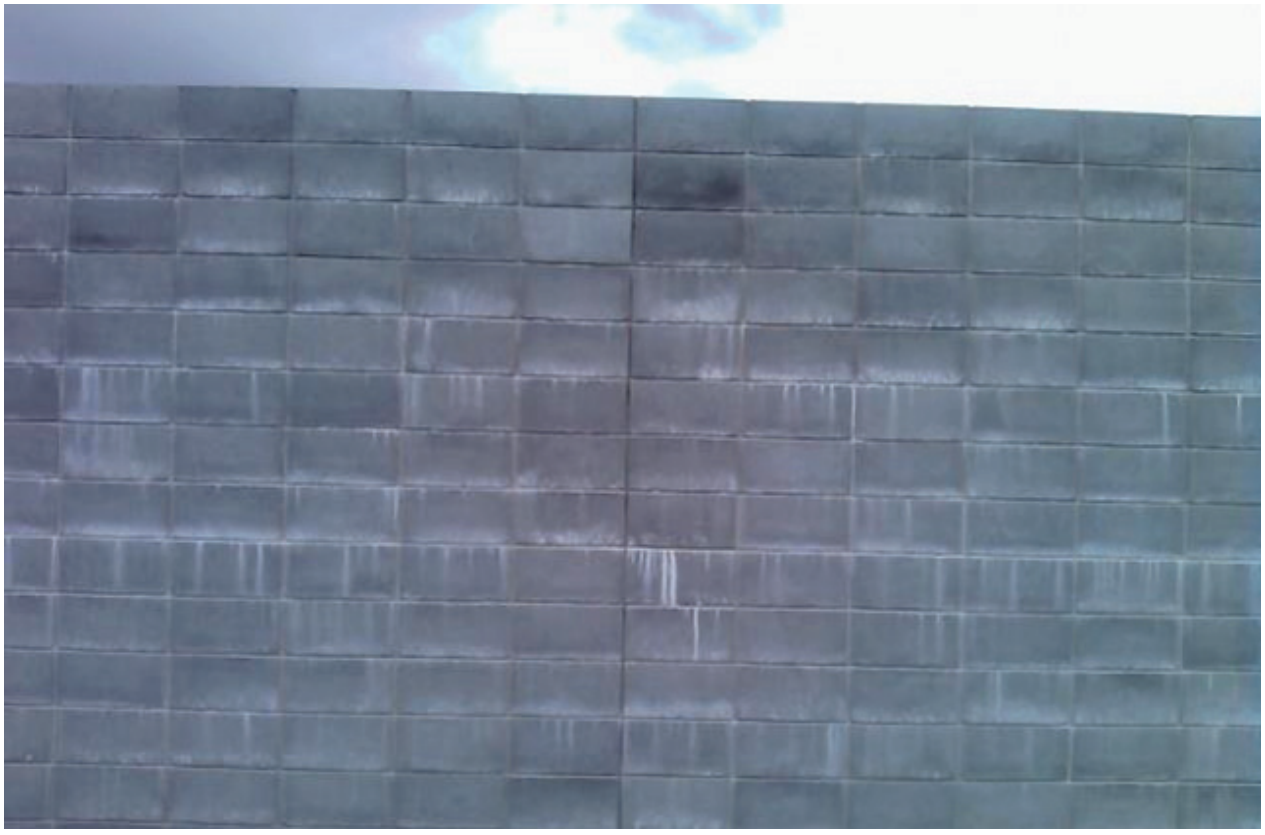

Figure 1. Typical efflorescence pattern on exterior concrete wall.

3.0.3 Insoluble efflorescence occurs over time. Soluble calcium hydroxide ($Ca(OH)_2$) on the masonry or concrete surface will react with carbon dioxide (CO_2) in the air (in a process called carbonation) to form calcium carbonate ($CaCO_3$), which is insoluble. Soluble calcium hydroxide is a byproduct of the hardening of cement. The carbonation process begins as soon as the salt comes into contact with the air, i.e. as soon as the water evaporates. Efflorescence should therefore be removed as soon as possible after it appears. The longer it is left, the harder it is to remove.

3.0.4 Insoluble efflorescence normally occurs just above horizontal mortar joints in masonry because any significant moisture that is absorbed flushes and concentrates the salts at that point.

4.0 CONTROLLING EFFLORESCENCE

4.0.1 If a masonry or concrete wall is completely dry, the salts cannot be dissolved and brought to the surface. Totally eliminating water from masonry or concrete construction is not feasible. Nevertheless, by taking precautions, efflorescence can be controlled. Measures include the following:

- Ensure that bricks or blocks remain dry from time of delivery until completion of the works.
- Ensure that any water that may run down the back face of a brick veneer wall is able to escape at the bottom and is not retained in the cavity.
- Ensure that joints are tooled and compacted to reduce porosity of the mortar.
- Ensure that there is a damp-proof course in the lowest mortar course of masonry veneer above ground level.
- Design walls to minimise water penetration – for example, with eaves and flashings.
- Cure mortar properly to ensure the adequate hydration of cementitious materials. Protect masonry from cold temperatures, premature drying or improper use of admixtures. Curing of concrete masonry and concrete must start as soon as practicable following laying or casting. Covering with polythene is not recommended if aesthetics are important. After curing, concrete masonry should be exposed to good ventilation on all faces. At lower temperatures, more calcium hydroxide may be brought to the surface, increasing visible efflorescence. Windy conditions causing rapid drying will also promote soluble salts to the surface.
- Protect the completed wall from moisture absorption until any coatings are applied.
- Apply a clear sealer (acrylic emulsion) or a water repellent (silane, siloxane or silicone) when the wall is dry.

4.0.2 Most modern clay brick manufacturing processes convert soluble salts in the clay into insoluble salts during the firing process, chemically immobilising them so they cannot occur as efflorescence. However, dissolved salts in the mortar will appear as efflorescence if there is water in the bricks. If the bricks are laid dry, the water from the mortar is unable to migrate through the bricks, so efflorescence will not occur.

4.0.3 Evidence of efflorescence in concrete masonry sometimes follows the line of the mortar joints but is 25 mm or so away (Figure 2). This is likely to be caused by water from the mortar migrating across the face of the blocks and depositing the salts before evaporating.

5.0 REMOVING SOLUBLE EFFLORESCENCE

5.0.1 Remove soluble efflorescence as soon as it appears. If there are both soluble and insoluble salts in the efflorescence, the soluble salts should be removed first. The treatment for insoluble efflorescence involves the use of dilute acid, which will not remove soluble salts and may make their removal more difficult.

5.0.2 Remove soluble efflorescence by brushing with a stiff, dry bristle brush. Collect the removed salt residue with a brush and pan or by vacuuming.

5.0.3 Another option is to wipe down the surface using a damp absorbent cloth such as a chamois. Take care to use as little water as possible in the cloth, and rinse the cloth regularly in clean water to remove the salts.

5.0.4 For heavy deposits of soluble salts from masonry or mortar, apply a poultice of paper pulp and water to the affected area after removing the surface efflorescence. The poultice will draw out any efflorescing salts. It should be removed when dry and the process repeated several times.

5.0.5 Do not wash efflorescence off with water as this will dissolve the salts on the surface and possibly wash them back into the masonry or concrete. As the water evaporates again, the efflorescence will reappear.

5.0.6 Do not sandblast to remove efflorescence as the abrasive action of the sand will erode the surface of the masonry or concrete. This is likely to increase the porosity of the masonry and damage the integrity of the tooled mortar joints.

5.0.7 Efflorescence will recur if the wall has not completely dried or water has been absorbed. Soluble efflorescence on the internal face of a single-skin wall can be an indication that water is being absorbed into the wall from inside and/or outside.

5.0.8 Most efflorescence will naturally disappear over time. If efflorescence persists, however, it is an indication that water is continuing to get into the masonry or concrete, perhaps though inadequate flashing or damp-proof course.

5.0.9 Cleaning efflorescence off masonry or concrete walls does not cure the problem. It only removes the symptoms.

Figure 2. Salt deposits resulting from water in the wall exiting above each horizontal mortar joint.

6.0 REMOVING INSOLUBLE EFFLORESCENCE

6.0.1 Once carbonation has occurred and the $Ca(OH)_2$ has been converted to $CaCO_3$, the efflorescence is no longer soluble and is more difficult to remove. It appears as a white deposit that disappears (i.e. becomes invisible) when wet.

6.0.2 Wire brush the insoluble efflorescence. If done at an early stage, it can be effective. If brushing does not remove it, an acid wash or a proprietary chemical cleaning agent must be applied. Wire brushing and acid washing are likely to affect the surface of the masonry or concrete so must be carried out carefully.

6.0.3 Before using an acid wash or proprietary cleaning agent, test on a small area of wall where it is not too visible, such as behind a downpipe. The test area must be completely dry to fully assess the effectiveness of the cleaning.

6.0.4 Acid washes suitable for removing efflorescence include the following:

- Hydrochloric acid diluted to 1 part acid to between 9 and 19 parts water. (Hydrochloric acid **must not** be used on clay bricks. It can only be used on concrete and concrete masonry.)
- Phosphoric acid diluted to 1 part acid to 9 parts water.
- 1 part phosphoric acid plus 1 part acetic acid diluted at a rate of 1 part acid to 19 parts water.

6.0.5 Proprietary chemical cleaning agents are also available to avoid having to dilute acids. These must be used according to the manufacturer's directions.

6.0.6 When applying an acid wash or a proprietary product, the wall must be thoroughly saturated with water and kept wet during the efflorescence removal process. Failure to keep the wall wet is likely to result in further staining, as the solution with some mortar dissolved in it will be drawn into the dry masonry or concrete. The salts in the mortar will be deposited as a residue on the surface as the acid/water solution evaporates.

6.0.7 Leave the acid wash on the masonry or concrete for a maximum of 3–6 minutes. Leave the proprietary solution on for the length of time recommended by the manufacturer. Thoroughly rinse the wall to remove all traces of the solution.

6.0.8 Treat only a section of the wall at any one time, typically an area of no more than 2–6 m^2. **Do not** allow the acid or proprietary solution to dry on the bricks.

7.0 SAFETY PRECAUTIONS

7.0.1 Safety precautions when using acid or proprietary chemical cleaning agents:

- Wear eye protection, gloves and protective clothing.

- Pour acid into water, not the other way around, as this avoids splashing.
- If acid or cleaning agent contacts the skin, rinse immediately with water or, if possible, swab with a bicarbonate soda solution to neutralise the acid.

8.0 FURTHER INFORMATION

CCANZ Information Bulletin IB44 *Efflorescence in concrete*

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ISSN 1170-8395