PART C

Chapter 6

Cleaning and Maintenance

This chapter provides guidance on the correct methods of cleaning and maintaining concrete masonry to retain attractive finishes.

Contents



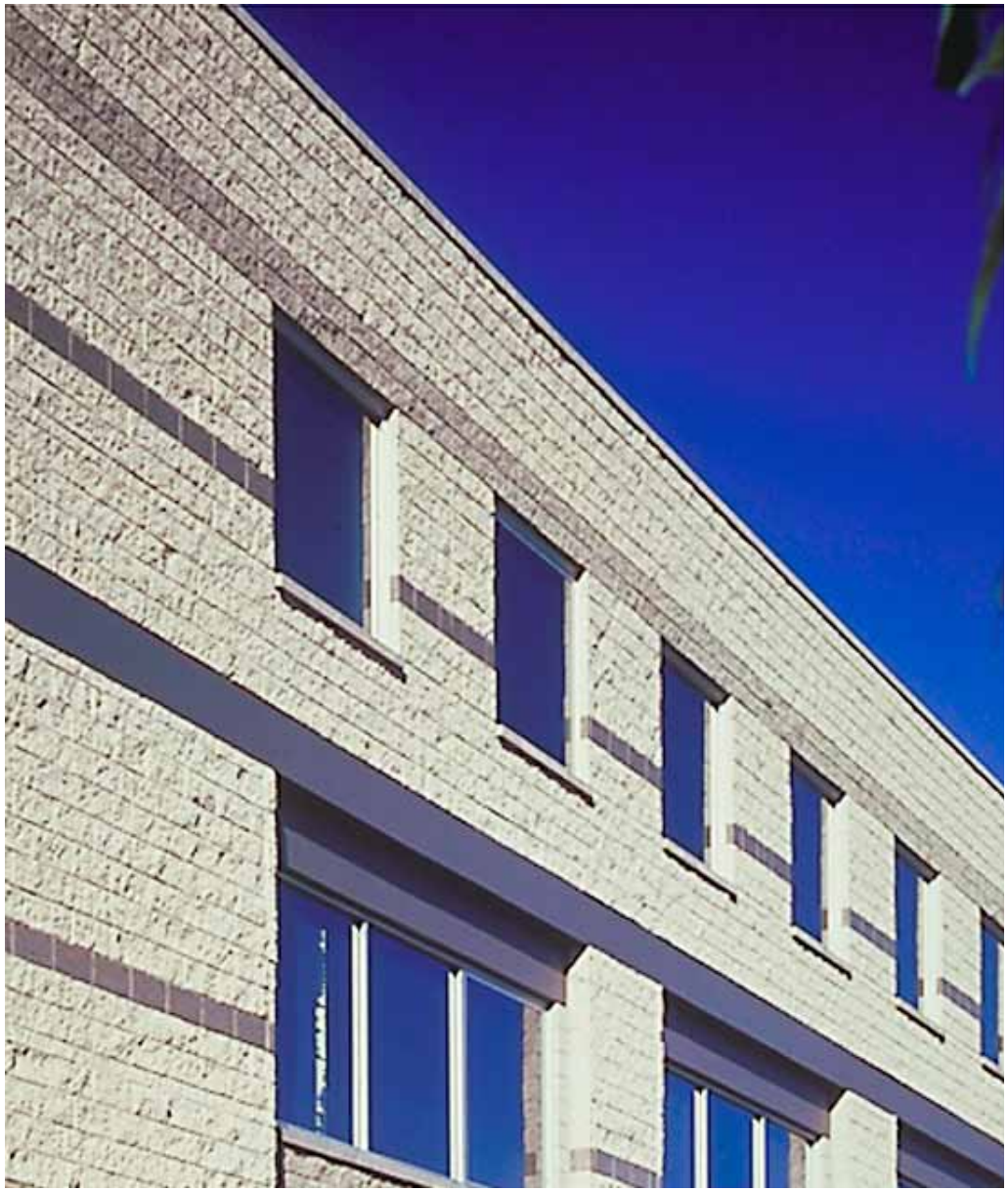





6.1 GENERAL BUILDING MAINTENANCE

Concrete masonry may be generally described as a 'low-maintenance' walling material. However, there are some important simple precautions that should be taken to ensure its long-term attractiveness and its ability to perform the required structural function. These involve:

- Ensuring that the masonry remains weatherproof
- Repairing any cracks or deterioration of control joints
- Cleaning off any efflorescence, staining or mould and, if necessary, sealing the surface.



6.2 WEATHERPROOFING

Buildings should be designed and constructed so as to prevent water from penetrating masonry walls. This can be achieved by the following steps:

- Ensuring that the building is correctly designed and detailed to account for weatherproofing requirements, foundation movement, shrinkage and the efficient removal of rain water.
- All rainwater downpipes and gutters should be regularly inspected and kept clean, free of corrosion, and connected to a correctly-functioning storm water drain.
- Flashings should be secured and the joints sealed with flexible sealant such as silicone. It may be necessary to renew sealants over time if they deteriorate.

6.3 CRACKING, FOOTING MOVEMENT AND CONTROL JOINTS

Unreinforced concrete masonry is a brittle material which will crack if long walls are constructed without a break or if supports move. Cracking may occur in the concrete masonry units themselves or in the cement mortars and cement renders used in conjunction with them.

Footing movement

Footing movement is a major source of cracking in unreinforced masonry. When buildings are constructed on clay or similar soils, moisture movements in the soils lead to expansion and contraction of the soil, causing the building to either cantilever on its footings beyond a shrinking soil mound or to sag between an expanded soil rim. As the supporting soil contracts or expands, any unreinforced masonry may crack, moving sympathetically with the deflected concrete footings supporting the structures.

The main contributing factors to footing movement are:

- Inadequately designed footings with insufficient strength and stiffness which deflect and cause the masonry to crack.
- Clay soils which are prone to expansion and contraction.
- Trees which may suck the moisture out of the soil causing it to shrink.
- Poor or badly maintained drainage systems which allow a build up of moisture in the soil causing it to expand.

A completed building and its surrounding site should be regularly maintained, ensuring that:

- The site stormwater drainage system is removing rainwater
- The plumbing reticulation system is not leaking
- Trees have not grown too close to the footings and other structures.

Control joints

The strategic placement of control joints will limit the position and width of cracks. In a wall exposed to the weather, contraction joints must be weather-proof with a flexible sealant at the surface. Periodically the sealants should be inspected, and if they have deteriorated, they should be removed and replaced.

Expansion joints (for thermal movement) and articulation joints (for footing or support movement) must be kept free of hard material such as mortar droppings and must be free to close under the action of thermal expansion and footing movement.

6.4 EFFLORESCENCE AND STAINING

6.4.1 CAUSES OF EFFLORESCENCE

White calcium carbonate efflorescence is occasionally present on concrete masonry walls. The most common mechanism for its occurrence is:

- Moisture enters the masonry through open-topped walls, sills or poorly constructed mortar joints.
- The moisture dissolves calcium oxide in the cement and lime, forming calcium hydroxide.
- A combination of low external humidity and high humidity in the cavity and cores in the masonry units forces the calcium hydroxide solution to the outer surface of the wall.
- The calcium hydroxide combines with the carbon dioxide in the atmosphere to deposit insoluble white calcium carbonate on the surface.

6.4.2 DETAILING TO AVOID EFFLORESCENCE

The following measures should be taken to minimise the occurrence of efflorescence in masonry walls.

Tops of walls and parapets
Walls and parapets should have protection such as flashings or capping to the top surface. A common source of staining of masonry is water entering walls and cavities at this point via the exposed horizontal surface.

Window sills
Window sills with an inadequate projection provide a source of water entry to the walls and will promote staining. The incorrect installation of window flashings will exacerbate this problem.

Flashings
Flashings should protrude to the outside face of the brickwork. If the flashing is stopped short of the core holes in the external leaf, any moisture entering the wall will be channelled into the units, permeating the mortar, dissolving calcium hydroxide and eventually passing to the outside surface where the calcium hydroxide carbonates.

Masonry units
Unless required otherwise, it is a reasonable expectation that concrete masonry units have an efflorescence potential of nil or slight.

Mortar
Mortar should be hard and sound. The recommended mixes are:

Type M3 For general applications (except as listed for M4).

Preferred: 1 part Type GP cement, 5 parts sand plus methyl cellulose water thickener.

Alternative: 1 part Type GP cement, 1 part lime, 6 parts sand.

Type M4 For applications subject to saline wetting and drying, in aggressive soils, in severe marine environments, in saline or contaminated water including tidal splash zones and within 1 km of an industry producing chemical pollutants.

Preferred: 1 part Type GP cement, 4 parts sand plus methyl cellulose water thickener.

Alternative: 1 part Type GP cement, 1/2 part lime, 4 1/2 parts sand.

Methyl cellulose is an agent which holds moisture in the mortar while the cement hydrates. It is quite different from the air-entraining agent commonly used in mortars.

Control joints
Walls should include well-positioned control joints to prevent indiscriminate cracking of the wall that would permit ingress of moisture. Control joints should be correctly sealed.

Weep holes
Cavity walls should include numerous well-positioned weep holes to allow any moisture in the cavity to escape. Cavities should be free of mortar droppings.

Removal of mortar smears
The external face of the masonry should be kept clear of mortar smears.

6.4.3 REMOVAL OF EFFLORESCENCE AND STAINING

Once an efflorescence or staining problem is identified, the following procedure is suggested.

- Engage an expert to identify and report on the source of efflorescence or staining. The report should consider possible contributions by poor detailing (allowing ingress of water and contaminants) and the materials (including masonry units, mortar and grout).
- Since the staining could continue for some time, it is suggested that a building be allowed to stand for, say, six months from when the efflorescence first appears before any remedial action is taken.
- At the end of this time, any unsightly deposits will be visible and the appropriate cleaning strategy can be devised and implemented. Cleaning strategies may include:
  - Dry brushing efflorescence off the surface
  - Washing with low pressure water jet
  - Steam cleaning
  - High pressure water jet blasting
  - Washing efflorescence off the surface using proprietary cleaners and chemicals
  - Wet abrasive (grit) blasting
  - Dry abrasive (grit) blasting.
- Building maintenance should be performed at this time, including:
  - Cracked mortar should be pointed
  - Control joints sealed with a polyurethane flexible sealant
  - Flashings should be repaired
  - Rainwater downpipes should be repaired or installed if not already in place
  - A clear sealant may be applied or renewed to protect the masonry against ingress of rainwater.

6.4.4 CLEANING METHODS

The methods of general cleaning, listed in order of increasing rigour, are:

Dry Brushing
Dry hand brushes from small soft to hard scrubbing brushes can be used to remove soft or loose surface deposits such as dust, salts and weak crusts. However, it is possible that surface deposits of soluble salts will reappear if water enters the surface of permeable masonry and subsequently evaporates from the surface. Repeated dry brushing may eventually arrest the appearance of the salts, but washing will probably be more efficient.

Water Washing
This is one of the gentlest processes available. Use of bucket and brush or garden hose and brush can generally remove most surface dirt. This will remove surface deposits of soluble salts, but will probably fail to remove hardened calcium carbonate or mortar smears.

Soaking with water has been used since Roman times, a slow steady stream of water causes the dirt deposits to swell, loosening their grip on the underlying masonry. Accumulated waters, cascading over the face of the masonry, then wash the loosened dirt away.

Steam Cleaning
This is not often used because it is slow. However, it can sometimes help remove deep-seated soiling, softening oily, greasy or tarry deposits and for killing mould or algae on damp surfaces.

Low-Pressure Water Jet
A pump unit projects a low-pressure water jet against the surface to dislodge loosely held material. Often used as a follow up to a loosening process, eg chemical or brushing. Cleaning should begin at the top of the masonry so water will run down and pre-soften the dirt below

High-Pressure Water Jet (Blasting)
This incorporates hot water and a 15° fan nozzle at an appropriate distance (at least 150 mm) from the surface and appropriate pressure. The general procedure is:

- allow at least 7 days for mortar to harden;
- remove large mortar dags with hammer and chisel or scutch hammer;
- mask or protect adjacent areas;
- thoroughly wet the wall until suction of masonry unit is complete;
- apply selected cleaning solution starting at the top of the wall;
- let the cleaning solution stay on the wall for 1 to 5 minutes, or as directed by the manufacturer; and
- wash the wall with high pressure starting at the top (do not direct jet onto mortar joints).

In general, the higher the water pressure, the more effective the cleaning and the greater the potential damage to the surface (see **Table 6.1**).

Table 6.1 *Water Jet Cleaning*

General pressure	Pressure (kPa)	Damage	Cleaning ability
Mains	300	Low	Low
Low	Up to 1500	Low	Moderate
Medium	1500 – 3000	Damage to smooth-face masonry	Moderate to high
High	3000 – 5000	Damage to polished-face masonry	High
Very high	5000 – 50 000	Damage to split-face masonry	High

Acid should not be used through the jet equipment because:

- It pushes the chemical deep into the substrate making it difficult to remove
- Chemical does not remain on wall long enough to work, thus operator tends to use higher strengths to compensate
- Can cause harm to operator and surrounding environment.

Chemical Cleaning

Many chemicals can be applied to concrete masonry without appreciable injury to the surface, but strong acids or chemicals with a strong acid reaction should definitely be avoided. Even weak acid should be used only as a last resort as it dissolves the cement matrix of the masonry, beginning at the surface. This leaves the face more porous so that it absorbs more water and exposes more aggregate, thereby changing the colour and texture of the masonry.

The general procedure is to thoroughly wet the masonry surface, spray or brush a minimum amount of chemical, allow it to act for 1 to 5 minutes and then scrub. Wash it off using one of the methods described above.

Precautions are necessary to protect the operator. Occupational health and safety requirements and common sense should prevail.

Organic solvents are generally used on small areas of greasy substances by using a bandage or poultice. This can be expensive since they tend to evaporate or be absorbed. The more commonly used solvents are white spirit, carbon tetrachloride, methy and ethyl alcohols, proprietary paint stripper or dry-cleaning agents. They also tend to leave a visible residue or stain on the masonry.

Detergents are surfactants (surface active agents) and promote wetting of the soiled surface by water. Small quantities of detergent are often used when washing with water, usually at low pressure. Detergents are by no means harmless, with many being chemically-aggressive. They are most effective and can be used in the removal of earth stains.

Acid cleaners should be used only after considerable thought is given to the consequences, such as effect on the masonry, operator and the environment. There is common well-founded resistance to the use of acids on concrete masonry.

Hydrochloric acid (muriatic acid or spirits of salts) is widely used on clay bricks to remove mortar stains since it dissolves portland cement. However, for this reason, it can have serious effects on the surface of concrete masonry if used incorrectly. Generally, a solution of 1 part acid to 20 parts water (maximum strength 1 part hydrochloric acid to 10 parts water) is recommended, while an area of less than 6 m^2 should be treated at a time.

SAFETY WARNING: *Never* add water to acid, *always* add acid to the water. Hydrochloric acid will not remove salts, and will most likely make removal more difficult.

Phosphoric acid is used for the removal of iron-bearing deposits (rusty stains). A maximum strength of 1 part acid to 10 parts water should be used. Phosphoric acid should not generally be used on coloured concrete masonry as bleaching of the iron oxide pigments will result.

Oxalic acid is used for the removal of hardwood timber stains. 120 grams of oxalic acid with 4 litres of warm water is the recommended mix. Bleaching solutions such as sodium hypochlorite (pool chlorine) have also been found to be very effective and a readily-available chemical for use on hardwood timber stains.

Wet Abrasive (Grit) Blasting

The objective is not to dissolve and wash away the stain but to remove the outer portion of the masonry on which the stain has deposited. Water and grit (usually sand) are directed onto the surface under pressure. Water cushions the abrasiveness of the grit and therefore is less destructive than dry sandblasting. It is generally acceptable only on concrete masonry units that are intended to have their aggregates exposed, eg split-face, shot-blasted.

Dry Abrasive (Grit) Blasting

This is commonly referred to as sand blasting. It is seldom used as it opens the surface of the masonry thus making it more susceptible to pollutants and staining.

6.4.5 GUIDELINES FOR DETERMINING APPROPRIATE CLEANING METHODS

The appropriate cleaning method depends on the purpose of the cleaning and on the extent of the work to be done. A guide to assist in the selection is shown in **Table 6.2**, the principle of which was developed in a document published by the National Trust[Ref 1]. The table uses four variables:

I_R degree of resistance of the masonry to damage

I_T tenacity or degree of difficulty of removal of the soiling

I_S severity or potential of the method for damaging the masonry

I_C cleaning ability of the method.

When selecting a cleaning method, it must be recognised that the removal of stains may alter the physical condition and appearance of the masonry. The task is to select the method that achieves the desired degree of cleaning while resulting in the least damaging alteration to the masonry.

Table 6.2 can be used as a general guide in the following way.

- Identify the masonry material (I_R) and the tenacity of the soiling (I_T)
- Select a number of provisional cleaning methods such that the cleaning method (I_C) must be as high as the tenacity of the soiling (I_T)
- Select a method with a severity (I_S) that does not exceed the masonry degree of resistance (I_R).

As an example, consider the removal of soft urban grime ($I_T = 3$) from smooth, coloured masonry units ($I_R = 3$). Cleaning methods which have $I_C = 3$ or 4 are considered and low-pressure water jetting is selected ($I_C = 3$). This has an I_S of 2 to 3 and therefore should not damage smooth, coloured masonry with an I_R of 3.

The method should then be tested. If not successful, a method with higher I_C should then be considered. However, if high-pressure water jetting with acid were selected ($I_C = 6$) then this has an I_S of 7 and would probably damage masonry with an I_R of 3.

Table 6.2 *Guide to Selection of Cleaning Methods for Concrete Masonry Surfaces*

MASONRY UNIT TYPE **Index of resistance to damage, I_R** ▼	**SOILING** **Index of tenacity, I_T** ▼	**CLEANING METHOD** **Index of severity, I_S (I_S should not exceed I_R)** ▼	**CLEANING METHOD** **Index of cleaning ability, I_C (I_C to be as high as I_T)** ▼
0	**0**	**0**	**0**
Lime mortar Lime mortar, hard Cement render, old	Loose dust Climbing plants ,moss Fungi, algae Loose flaking paint Powder efflorescence	Dry brushing Water misting Very-low-pressure water washing Organic solvents Steam cleaning	Dry brushing Very-low-pressure water washing
2	**2**	**2**	**2**
Lightweight units Composition mortar Smooth, coloured units	Deposited efflorescence Oil, grease Soils Soft urban grime	Hand brushing Hand brushing with detergent Low-pressure water jetting Mechanical scrubbing Chemical Bleach	Steam Cleaning Organic solvents Low-pressure water washing Hand brushing
4	**4**	**4**	**4**
Standard units Fire-rated units	Bird droppings Plaster Tar Old hard paint Soft mortar smears Timber stains Iron and welding splatter	Medium-pressure water jetting	Medium-pressure water jetting Mechanical scrubbing with detergent Chemical (acids) High-pressure water jetting
6	**6**	**6**	**6**
Honed units Polished units	Moderate urban grime Hardened mortar smears	Manual abrasive removal High-pressure water jetting Very-high-pressure water blasting Wet sand blasting	Very-high-pressure water blasting
8	**8**	**8**	**8**
Shot-blasted units Split-face units	Modern plastic paints Hard urban grime	Dry sand blasting Mechanical grinding	Wet sand blasting Dry sand blasting
10	**10**	**10**	**10**

6.5 REFERENCES AND BIBLIOGRAPHY

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