

Masonry

Introduction

Masonry - stone, brick, architectural terra cotta, cast stone, concrete and concrete block - is often found on heritage buildings. Common masonry applications include complete masonry exteriors, foundations, chimneys, and decorative elements. Masonry is prone to deteriorate over time. To ensure the visual and structural integrity of your building regular maintenance and cleaning is required.

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This guide provides information on repointing and the variety of cleaning methods and materials that are available for use on the exterior of heritage masonry buildings. The information in this guide was largely adopted from the US National Park Service Preservation Brief #1 and #2 related to repointing and cleaning historic masonry, respectively. Although specifically intended for heritage buildings, the information is applicable to all masonry buildings.

Understanding Masonry Types

Masonry is a term used to represent a group of building materials that include: stone, brick, architectural terra cotta, cast stone, concrete and concrete block. These materials can represent structural elements of a building or can be used aesthetically as cladding or decorative elements. The occurrence of historic masonry types will often depend on what was locally available from regional quarries. Some types of masonry are more expensive than others or unavailable in certain geographic areas. Expensive or unavailable materials may have been imitated for cost savings. For this reason, along with the similarity in appearance in some masonry, such as sandstone and limestone, it can be hard to differentiate between different masonry types. As well, materials that appear to be masonry, such as decorative cornices, entablatures and window hoods

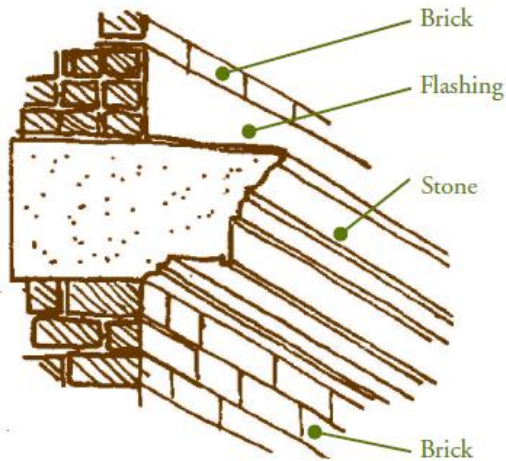


Image: Wall section (Saint John Heritage, 2010)

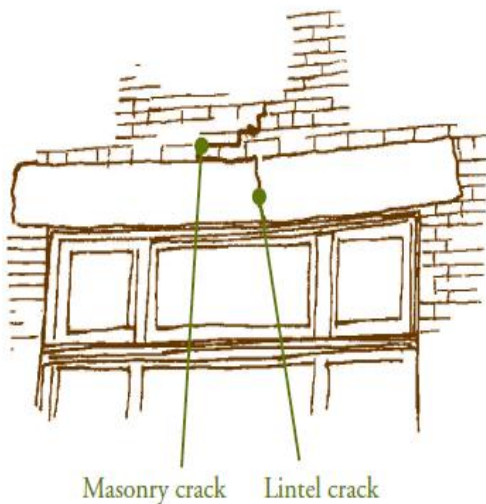


Image: Exterior wall crack (Saint John Heritage, 2010)

may, upon further inspection, prove to be metal and/or wood. The use of stucco, a lime, sand and water mixture, has also commonly been used to imitate masonry. Before beginning any masonry intervention it is important to first properly identify the masonry types you are working with.

Maintenance and Repair

Investigate and document your masonry surfaces before making alterations or repairs. It is important to identify any deterioration caused by exterior or interior moisture and locate the source. Deterioration, most commonly identified by cracks or spalling, is often a result of:

- Water penetration from the interior or exterior
- Expansion and contraction of materials due to repeated wetting and drying
- Freezing and thawing action of water in the masonry
- Stresses caused by the formation of salt crystals beneath the surface, especially common when cement is used as a quick fix to fill a masonry crack
- Material impurities and incompatibility
- Poor craftsmanship during construction
- Structural settlement shifts

All moisture problems should be resolved before trying to repair the masonry. Repairs often include repointing or cleaning. These should not be attempted by untrained professionals and efforts should be made to ensure that every intervention is reversible.

Repointing

Re-pointing consists of removing old and damaged mortar from masonry joints and replacing it with new. If the mortar has eroded as deep as the mortar joint is wide, or water is penetrating, then repointing is necessary. Re-pointing is only necessary where mortar has failed. If these issues are not observed over the majority of the brickwork then no intervention is necessary. A building will seldom need to be completely re-pointed. However, if appropriate repairs are not undertaken to halt the source of the problem, mortar deterioration will continue and repointing will have been a waste of time and money. Heritage conservationists recommend that repointing be undertaken by a trained professional.

Physical Examination

A non-technical evaluation of the masonry units and mortar by an experienced and knowledgeable craftsman can provide information about their strength and permeability. This information is vital when selecting an appropriate repointing mortar. As well, a visual analysis of the historic mortar can provide the clues necessary to choose the new mortar mix and application techniques. The objective in selecting a repointing mortar that is compatible with the masonry units is to mix one that matches the historic mortar as closely as possible. If this is achieved, the new mortar can coexist with the old in a sympathetic and, if necessary, sacrificial way. It is much easier to replace mortar than damaged masonry units.

The strength of a mortar will vary based on its composition. If the mix has a high ratio of Portland cement, a harder mortar will result. The more lime added, the softer, more plastic and workable the mortar becomes. Mortars for repointing projects, especially those involving heritage buildings, are custom mixed, in varying proportions, to ensure they contain the proper physical and visual qualities and can create a mortar with ideal performance and durability. The composition of a particular mortar type should take into consideration all of the factors affecting a specific building, such as: site conditions, current condition of the masonry, function of the new mortar, amount of weather exposure, and skill of the mason.

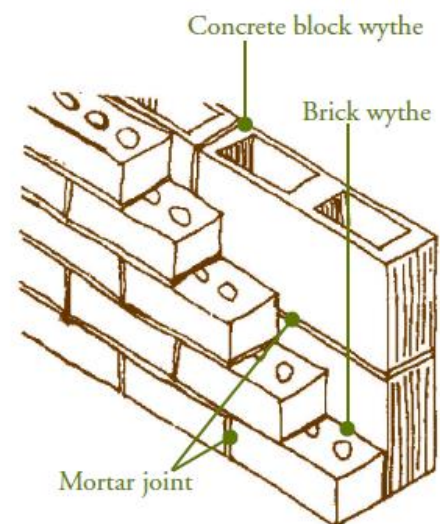


Image: Masonry wall section (Saint John Heritage, 2010)

To prevent damage to the masonry units, **repointing mortars should be softer or more permeable than the masonry units**. It is a common mistake to assume that high strength and hardness is desirable, especially for lime-based historic mortars. Stresses and movements in the walls should be braced by the entire structure, not transferred to individual masonry units through hard mortars. The units' inability to freely move with the structure will result in damage, such as cracks and spalling mortar. Also, the use of mortars with high cement content can trap salt within the masonry envelope, resulting in efflorescence and further deterioration.

New mortar should meet the following criteria:

- Must match the historic mortar in colour, texture and tooling
- Sand must match the sand in the historic mortar (colour and texture of the new mortar will usually be replicated if the sand is well matched)
- Must have greater vapour permeability and be softer (measured in compressive strength) than the masonry units
- Must be as vapour permeable and as soft or softer (measured in compressive strength) than the historic mortar

The mortar application technique and type of mortar joint should be the same as the previously applied mortar and discourage water infiltration.

Mortar Components

Sand

Sand is the highest proportion ingredient in mortar and the material that gives it its distinctive color, texture and cohesiveness. Sand must be free of impurities, such as salts or clay.

Lime

Before the late-19th-century lime was used as the primary binding material in mortar. At that time, limes and other components of mortar varied significantly as they were natural. This is different from modern lime that is manufactured and standardized. Some kinds of lime and other components of mortar that were used historically are no longer readily available, making it difficult to replicate a "historic" mix.

Lime mortar is slightly water soluble and is able to re-seal any hairline cracks that may develop over time. It is a good choice for heritage buildings as it is soft, porous, and changes little in volume during temperature fluctuations. Due to these qualities, high calcium lime mortar could be considered for many repointing projects, not just those involving heritage buildings.

Portland cement

Portland cement has been commonly used in 20th-century mortar as a primary binding material. A Portland cement and sand mortar is very hard, resists the movement of water, shrinks upon setting, and expands and contracts as the temperature fluctuates. The more Portland cement added to a mortar mix the harder it becomes and the faster the initial set.

Undertaking the Work

Test Panels

Test panels are often prepared by the contractor using the same techniques that will be used on the rest of the structure. Several test panels may be necessary to cover all types of masonry, mortar colour and joint styles (see the image on the following page illustrating various brick mortar joints). These are ideally located at inconspicuous locations. The panels can be used as a benchmark to evaluate subsequent work on the building.

Joint Preparation

To prepare a masonry wall for repointing, the old mortar needs to be removed to a minimum depth of 2-2.5 times the width of the joint. This ensures the new mortar can bond well and will prevent mortar "popouts." The use of hand chisels and mash hammers is the traditional way to remove mortar. These tools are labour-intensive but they are less likely to damage the historic masonry units, while producing a quality result.

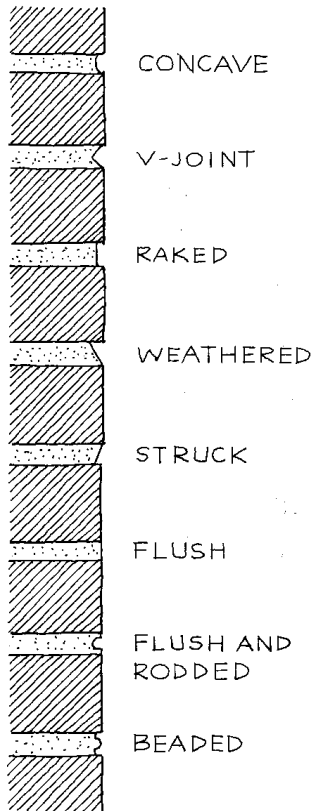


Image: Brick mortar joints
(Betty Anderson, 1983, p. 101)

However, the use of power saws and grinders is the most common method for mortar removal. The use of these tools by unskilled masons can destroy heritage masonry, especially soft brick. Small pneumatically-powered chisels, however, can generally be used safely and effectively to remove mortar on heritage buildings if a mason uses the equipment appropriately.

Foundations and Structural Brick

Foundation repairs should be undertaken before permanent work on walls as most cracks in masonry walls, especially those that run horizontally, are based on problems with the foundation. It is also important not to treat structural brick as brick cladding. Care should be taken not to break or disrupt brick tie courses as this may impact the structural integrity of the wall.

Chimneys

Many heritage buildings have a masonry chimney and their continual exposure to the elements makes them more susceptible to damage and deterioration. To avoid leaks or the danger of fire, chimneys deserve special attention and professional guidance should be sought when considering repairs. Chimney masonry deterioration may include cracks, the breakdown of mortar, or the slanting of a chimney shaft.

Consultant and Contractor Selection

It may be helpful to retain a consultant, such as a historic architect or masonry expert, to analyze your building for causes of deterioration. They will determine the most appropriate solutions to problems and can prepare specifications that reflect the requirements of each job and can provide oversight of the work as it progresses.

Prior to selection, qualified contractors can also provide lists of other repointing projects you can inspect to assess the quality of their work. Ideally, only choose masons that have a minimum of five years experience repointing heritage masonry buildings.

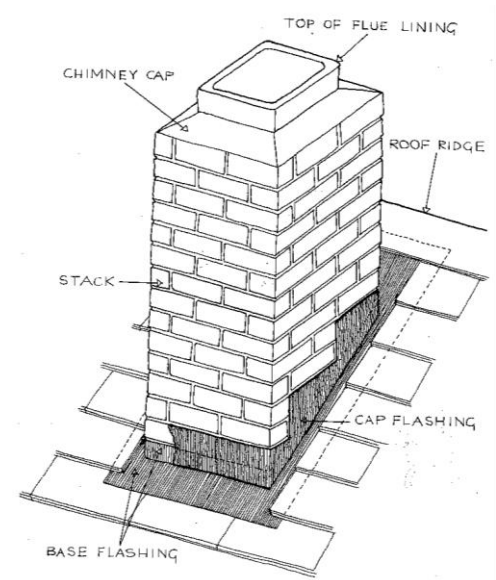


Image: Parts of a masonry chimney (Hanson & Hubby, 1983, p. 70)

Budgeting and Scheduling

Repointing is often expensive and time consuming due to the extent of handwork and special materials required. It is recommended that only the deteriorated mortar be repointed rather than an entire wall. However, if 25-50% or more of a wall needs to be repointed, repairing the entire wall may be more cost effective than spot repointing. Each project requires judgment based on a variety of factors and recognizing this at the outset will help to prevent many projects from becoming prohibitively expensive.

When scheduling repointing, seasonal temperatures are a significant factor to consider as they will affect the amount of time it takes for the mortar to settle and the lime to cure. As a rule, repointing should not be done when the temperature is below 5°C. Work undertaken around 20°C is best to prevent freezing or excessive evaporation of the water in the mortar, which will cause the material to expand or contract and inhibit the proper settling of the masonry units. Ideally, repointing should be done in the shade, away from strong sunlight to slow the drying process, especially during hot weather.

Keep in Mind

It is important to keep in mind, as the owner of a heritage building, that repointing is likely to be a lengthy, expensive process. The tendency to rush the work or cut corners should be avoided if the heritage building is to retain its structural and visual integrity. To avoid unanticipated problems, schedules for repointing and other associated projects will require planned coordination. Time should be dedicated to evaluating the building's condition and investigating the cause of problems. The work itself is precise, time-consuming and noisy, and scaffolding may temporarily cover portions of the building

Cleaning

An important aspect of masonry conservation is choosing the appropriate method for cleaning masonry components. The purpose of this guide is to provide information on the variety of cleaning methods and materials that are available for use on the exterior of heritage masonry buildings, and to provide guidance in selecting the most appropriate method or combination of methods. Masonry cleaning is a perceived improvement but may not always be recommended. Unless these procedures are carried out under the guidance and supervision of a trained professional, they may result in irreparable damage to the heritage structure.

Reasons for Cleaning

It is important to first determine if cleaning your masonry is necessary. Reasons for cleaning a heritage masonry building include:

- Improving the appearance of the building by removing dirt, soiling materials, or non-historic paint from the masonry
- Preventing deterioration by removing soiling materials that may damage the masonry
- Providing a clean surface to accurately match repointing mortars or patching compounds, or to conduct a condition survey of the masonry

Historic Appearance

Before removing paint from a masonry building, you should first determine if unpainted masonry is historically appropriate and why the building was painted initially. Structures may have been painted purposefully as a fashionable treatment of the time, to cover bad repointing, unmatched repairs, or to protect soft brick or hide deteriorating stone.

If a building was painted upon its construction or shortly after, the paint should be retained as it may be considered historically important and character defining. Refer to the [Practical Guide: Paint & Colour](#) for more information on paint retention, cleaning and appropriate removal methods.

Choosing the Appropriate Cleaner

When developing a cleaning program, the construction of your building should be considered. Poorly suited cleaning methods can have a negative effect on the masonry and other building materials. To begin, identify the type of masonry. You should always test the chosen cleaning method on a small inconspicuous surface, as choosing the wrong cleaning agents can permanently damage historic masonry. For example, acidic cleaners can be damaging to acid-sensitive stones, like limestone and marble, and will result in etching and dissolution. A firm understanding of the physical and chemical properties of masonry, coupled with testing, will help avoid accidental damage by cleaning.

It is important to keep in mind that other building materials, such as paint and glass, may be affected by the application of cleaning agents on your structure. Some building elements that may not be visible, such as iron cramps or ties, can suffer corrosion from the use of chemicals, even water. Studying your building's unique construction in detail is the best way to evaluate potential cleaning methods and prevent problems from arising.

Cleaning Methods

There are four major groups of masonry cleaning methods: water, chemical, poulticing and abrasion. Regardless of the method selected, masonry cleaning projects should begin at the bottom of the structure and work to the top, always keeping all surfaces wet below the area being cleaned. This is advised based on the assumption that dirty water or cleaning solvents dripping from the area being cleaned above will leave streaks on a dirty surface but will not streak a clean surface if it is frequently rinsed.

Water Cleaning

Water cleaning methods are the gentlest means possible and can be used safely to remove dirt from most types of historic masonry. However, it should be noted that the use of water cleaning on some badly deteriorated masonry, or on gypsum, which is very soluble in water, may be detrimental.

There are four kinds of water-based methods:

1. Soaking

Soaking involves prolonged spraying or misting with water and is a useful method for removing heavy accumulations of soot, sulfate or gypsum crusts that usually form on portions of a building protected from the rain. Water washing with gentle scrubbing is frequently used in combination with soaking and is followed by a final water rinse. This is a very slow, gentle method, taking several days or a week.

2. Pressure water washing

Pressure water washing is a common method for removing dirt or other soiling from historic masonry. It is recommended to begin by using low-pressure water (100 psi or below), even a garden hose, and then progressing to medium-pressure water as needed (no higher than 300-400 psi). To clean areas of the masonry that are especially dirty, scrubbing with natural bristle or synthetic bristle brushes can help. Avoid the use of metal brushes. They can erode the masonry surface and/or imbed metal particles that may stain the masonry.

3. Water washing with detergents

The use of non-ionic detergents, which are synthetic organic compounds and different from household soaps, are used effectively to remove oily soil, especially when added to a low or medium-pressure water wash. Unlike household detergents, non-ionic detergent does not leave a visible residue on masonry. Cleaning textured or intricately carved masonry can be achieved by scrubbing non-ionic detergent with a natural or synthetic bristle brush. Scrubbing should be followed with a final water rinse.

4. Steam cleaning

Steam cleaning is equivalent to a low-pressure hot water washing as the steam condenses upon leaving the hose. It is a gentle method ideal for:

- Cleaning stone, especially acid-sensitive stones
- Removing built-up soil deposits and dried plant materials
- Cleaning carved stone details

Steam cleaning does not generate a lot of water runoff and may also be appropriate for cleaning interior masonry. Paint and graffiti can be removed using the DOFF system, a steam based stone cleaning apparatus that uses super heated steam. Before removing graffiti, refer to the Region of Waterloo's Practical Guide: Paint & Colour for further information.

Potential hazards of water cleaning

Although water-based methods are the gentlest method for cleaning your historic masonry, they still present an opportunity for damage if not well thought out.

It is important to keep in mind that "power washing" at too high a pressure is very abrasive and can easily wear away brick and other soft stones, like marble. As well, the type of nozzle used and the distance it is placed from the masonry surface, coupled with the gallons per minute (gpm), are important variables to consider when water cleaning. Visible grains of stone or sand in the water or solvent runoff is a good indication that the water pressure is too high. Without careful consideration of these factors damage may be done to the heritage masonry. For this reason it is important to take time to work through the process carefully and monitor the results.

To avoid the spalling and cracking of masonry units, do not use cleaning methods that involve water if there is the threat of frost. Moisture trapped in masonry will cause the unit to expand and become damaged. After cleaning, a masonry wall may take over a week to dry. Therefore, water cleaning should not be permitted for several days prior to the first forecasted frost date.

Chemical Cleaning

Chemical cleaners work on historic masonry by reacting with dirt, soiling material or paint, including graffiti. After the reaction, the runoff is rinsed from the masonry surface with water. Chemical cleaners used to remove dirt and stains include acids, alkalis and organic compounds. Paint removers are alkaline, based on organic solvents or other chemicals (please see [Practical Guide: Paint & Colour](#) for information on paint removal).

There are two types of chemical cleaners used to remove dirt:

- 1. Acidic Cleaners**

Acid-based cleaning products should only be used on non-acid-sensitive masonry, including: granite, most sandstone, slate, unglazed brick, unglazed architectural terra cotta, cast stone and concrete. Hydrofluoric acid is the main ingredient in most commercial acidic cleaners. The process involves applying acid cleaners to the pre-wet masonry that should then be kept wet while the acid is cleaning. When the process is complete the acid should be removed with a water wash.

- 2. Alkaline Cleaners**

Alkaline cleaners should only be used on acid-sensitive masonry, including: limestone, polished and unpolished marble, calcareous sandstone, glazed brick, glazed architectural terra cotta, and polished granite. Two ingredients primarily compose alkaline cleaning products: a non-ionic detergent or surfactant, and an alkali such as potassium hydroxide or ammonium hydroxide.

The treatment process is similar to that of acidic cleaners, with the addition of two steps. The alkaline cleaner is applied to pre-wet masonry, allowed to settle and then rinsed off with water. Next, the masonry is neutralized with a slightly acidic wash, often with acetic acid, and then rinsed with water again. Alkaline cleaners may need to set longer than acidic cleaners.

Removing stains effectively depends on matching the right remover to the stain. Stains may be: industrial (smoke, soot, grease, tar), metallic (iron, copper), or biological (plant, fungal). The successful removal of stains from historic masonry may require a process of elimination until the right remover is found.

Stripping layers of paint from historic masonry is done by applying the remover with a brush, roller or spray, followed by a water wash. There are three types of chemical cleaners used to remove stains, paint and graffiti:

1. Alkaline paint removers

Alkaline paint removers are often similar in composition to alkaline cleaners. They can effectively remove multiple layers of paint, specifically oil, latex and acrylic paints, and may also remove some acrylic water-repellent coatings. Similar to other alkaline cleaners, an acidic neutralizing wash and final water rinse are recommended following their use.

2. Organic solvent paint removers

Organic solvent paint removers may include a combination of solvents, including methylene chloride, methanol, acetone, xylene and toluene.

3. Other paint removers and cleaners

Paint removers based on N-methyl-2-pyrrolidone (NMP), or on petroleum-based compounds can also be used to remove paint and some graffiti from heritage masonry.

Potential hazards of chemical cleaning

As most chemical cleaning methods involve water, they are susceptible to the same hazards as mentioned in the water cleaning section above. As well, many chemical cleaners do not work in cold temperatures, so their use should be avoided in months with the potential for frost. It is important to keep in mind that acidic and alkaline cleaners can be dangerous to those using them. Precautions should be taken to limit environmental contamination and plan for the safe disposal of chemicals associated with masonry cleaning.

Chemical cleaners have the potential to react adversely with many types of masonry if not chosen appropriately. Unfortunately, the composition of masonry materials is not always known and for this reason testing the cleaner on an inconspicuous spot on the building's masonry is advisable.

Poulticing

The use of a poultice is often the most effective way to remove graffiti and stains that have penetrated masonry. A poultice is a paste that can be applied to a stain. It is composed of an absorbent material or clay powder (such as kaolin or fuller's earth, or even shredded paper or paper towels), mixed with a liquid (a solvent or other remover). The moist poultice should remain on the stain as long as it takes to dry and draw the stain out of the masonry surface. The masonry must be thoroughly rinsed once the stain has been removed.

Abrasive and Mechanical Cleaning

As a general rule, the use of abrasive cleaning methods is not recommended on heritage buildings as they operate by wearing down dirt or paint from a masonry surface. These methods include grit blasters, grinders and sanding discs, all of which mechanically remove dirt, soiling material or paint, and possibly some of the masonry surface. Blasting with abrasive grit or another rough material is the most commonly used abrasive technique. Brick, architectural terra cotta, soft stone, detailed carvings, and polished surfaces are most at risk of physical and aesthetic damage by abrasive methods. Mortar joints, especially those with lime mortar, also can be eroded by abrasive or mechanical cleaning, leading to water penetration and ultimately to the need to repoint.

Summary

Well-planned masonry repointing and cleaning efforts are essential to the preservation, restoration or rehabilitation of historic masonry. Adhering to the guidelines discussed in this practical guide can enhance the aesthetics and structural stability of a masonry heritage building. A sound repointing job can last at least 30 years and as long as 100 years; guaranteeing the long life of the mortar joint, the wall, and ultimately the historic structure. As such, the mortar joint in a heritage masonry building has been called a wall's "first line of defense." It is important to remember that mortar joints are intended to be sacrificial and will probably require repointing in the future.

If undertaken by qualified individuals, removing years of accumulated dirt, pollutants, stains, graffiti and paint can extend the life of a heritage structure. Cleaning masonry should be done using the gentlest means possible to avoid damage. Using the wrong cleaning method or using the right method incorrectly can result in serious damage, both physically and aesthetically. You should always pause before undertaking work to evaluate and determine if the intervention is really necessary and in the best interest of the overall structure. Do not hesitate to seek guidance from masonry experts before undertaking any work to your heritage structure.

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