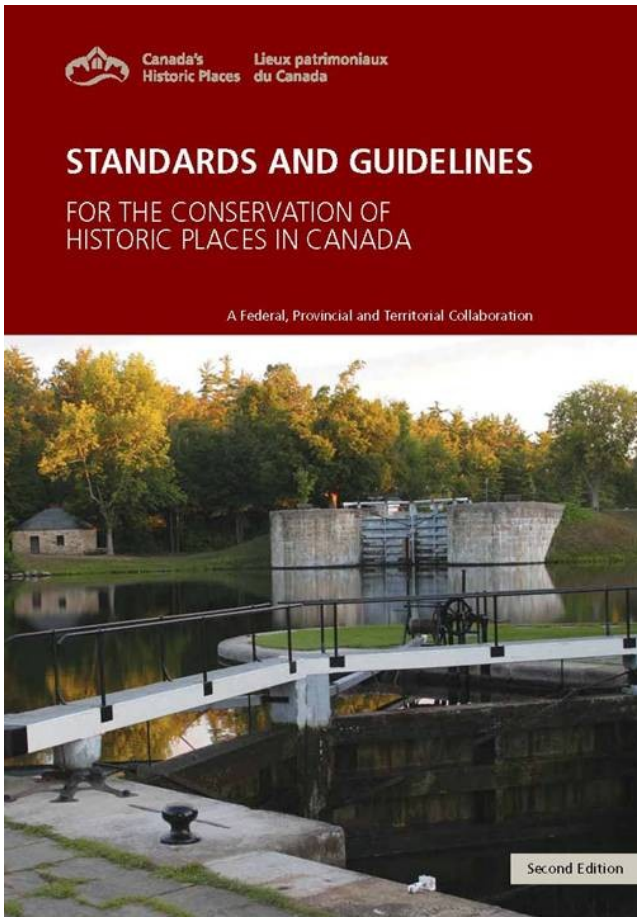
CONSERVATION BULLETIN SERIES

Brick Masonry

Saskatchewan Heritage Foundation



The Saskatchewan Heritage Foundation (SHF) is a Crown Corporation established by provincial legislation in 1991 to support heritage projects at the provincial and community level that seek to conserve, research, interpret, develop and promote Saskatchewan's diverse heritage resources.

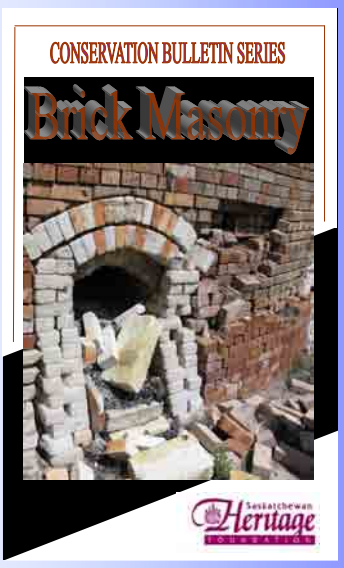
The Heritage Conservation Branch (HCB) of the Ministry of Tourism, Parks, Culture and Sport facilitates the protection and conservation of heritage resources in Saskatchewan under *The Heritage Property Act*.

The Standards and Guidelines for the Conservation of Historic Places in Canada (the "Standards & Guidelines) represents nationally-adopted guidance on how to best conserve Canada's irreplaceable heritage resources. The Standards & Guidelines have been formally adopted by the SHF and the HCB.

Brick Masonry - This Conservation Bulletin is a resource guide for some of the most common issues surrounding brick masonry on Saskatchewan heritage structures. It provides information to anyone considering the repair of historic brick masonry.

Cover Photo - DESTABILIZED EXTERNAL WALL, CLAYBANK BRICK PLANT/ M.G. Miller

CONTENTS



1. INTRODUCTION

Conserving Brick Masonry

One thing is for certain, the construction season for masonry repair in Saskatchewan is relatively short.

This is further challenged by the need for much more advance planning if successful masonry conservation is to stay ahead of Mother Nature; quite possibly more than that which may be required for contemporary masonry buildings. Despite some important efforts, there is evidence throughout Saskatchewan to suggest that masonry deterioration is frequently neglected until significant repair is required.

Even in a relatively harsh climate, a well-constructed masonry wall can stand for more than a hundred years if it is protected from moisture damage and regularly maintained. Consider the former Land Registry Office in Battleford, which was built in 1877-78.

Protecting brick masonry from moisture is one matter; that bricks are naturally porous and subject to penetration by water is yet another. Moisture penetration can occur from a number of sources; including rising damp; rain; and in the form of evaporation followed by the crystallization of soluble salts. In addition to moisture as a building's worst enemy, brick masonry is also subject to settlement; failure of lintels and arches; the corrosion of metal inserts; poor workmanship; penetration of the fabric by vines and the most fatal of all hazards except the bulldozer, neglect. The conservation of brick masonry therefore requires methods to inhibit moisture penetration, whether that includes repointing or the control of effective rain disposal systems; all are very important conservation measures.

Fig. 1—The former Land Registry Office in Battleford was constructed in 1877-78. (Photo: M.G. Miller)

Interventions and the Standards and Guidelines for the Conservation of Historic Places in Canada

The Saskatchewan Heritage Foundation has adopted the *Standards and Guidelines for the Conservation of Historic Places in Canada* (the "Standards & Guidelines") as the benchmark for best-practice in the conservation of historic places. In relation to the conservation of historic brick masonry, a number of interventions may attract specific recommendations that can guide property owners, professionals and skilled trades people prior to undertaking work on historic masonry structures in Saskatchewan. Several common interventions are discussed below. For more detail on the Standards and Guidelines, refer to the Saskatchewan Heritage Foundation's Conservation Bulletin titled *Standards and Guidelines for the Conservation of Historic Places in Canada.*

Characteristics of Brick Masonry

Brick, a modular, man-made building material was used long before Saskatchewan existed as we know it today. It is used for both structural and decorative purposes and has historically been classified as soft-mud, stiff-mud, or pressed brick, with conservation problems most frequently involving soft-mud or pressed brick. The characteristics of masonry may vary somewhat depending on the sub-surface condition of clays and also the firing methods. The causes of deterioration can be similar in any geographic location where environmental conditions are similar; for example, efflorescence will occur when moisture migrates and salts are deposited on the surface of masonry.

Historical Clay-Product Manufacturers in Saskatchewan

Three major companies produce clay products in Saskatchewan. Clays have been used for structural products since long before Saskatchewan was a province. Early industries such as those at Claybank, Estevan and Bruno manufactured bricks, stoneware and earthenware pottery and fire brick products.

The Moose Jaw Fire Brick and Pottery Company was established in 1904. The Claybank Brick Plant, built in 1912, was called Saskatchewan Clay Products and then, from 1916-1954, the Dominion Fire Brick and Pottery Company. The Dominion Fire Brick and Clay Products Ltd. was a prominent player from 1954-1971; and the A. P. Green Refractories Ltd. from 1971-1989. This company processed refractory clay in the nearby Dirt Hills to produce brick for kilns and steam engine fireboxes, as well as face brick for buildings in Saskatchewan and across Canada, including the Chateau Frontenac in Quebec City, the Gravelbourg Cathedral, and many other public buildings in Saskatchewan.

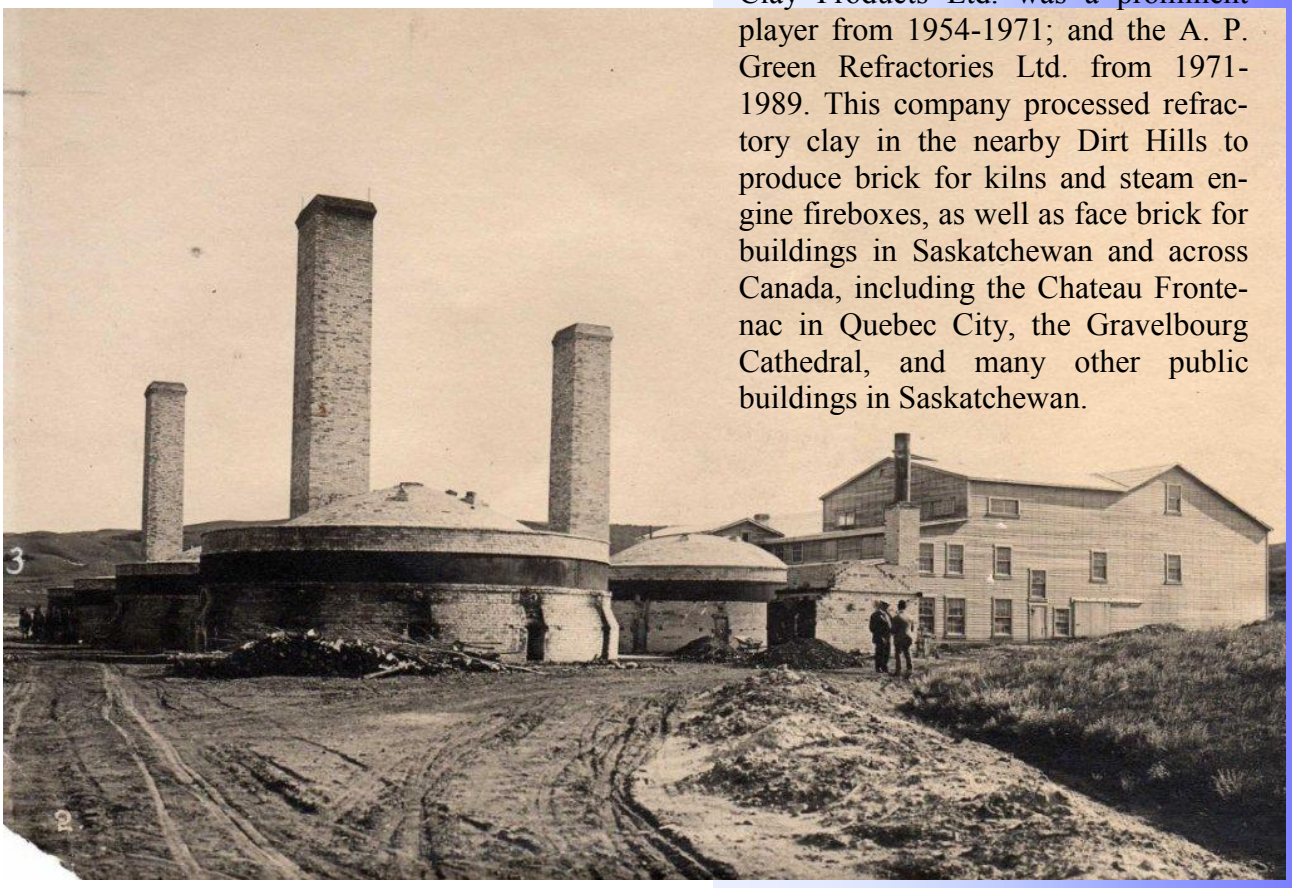


Fig. 2—The Claybank Brick Plant in 1914.

Refractory brick was also used in foundries and smelters across the country. The fire bricks made by the company were also featured in the construction of the launch pads at Cape Canaveral in Florida.

Claybank became Saskatchewan's largest brick producer, employing many local people. It closed in 1989 and became a National Historic Site in 1994.

The Estevan plant was one of the most modern in Canada with 140 different products made from six types of Saskatchewan clay. It sold over ten million bricks annually in Saskatchewan, Alberta, British Columbia, Manitoba, Ontario, Quebec and the United States and was the leading producer of white bricks in Canada.

The Bruno Clayworks was started about 1905 and operated until the 1960s when it closed down due to competition with Saskatchewan Clay Products.

Today, I-XL of Alberta supplies brick products to the western Canadian market. Dealers located in Regina, Saskatoon and Swift Current meet the continued demand for brick and clay products in Saskatchewan.

Brick has been made at the Medicine Hat plant of I-XL since 1886, where Herb Sissons built the original Redcliff plant. By 1913, the company had already switched to the extrusion process and began making wire-cut bricks and hollow building tiles.

I-XL acquired the Medicine Hat plant in 1929, which was established in 1886. This plant remains Alberta's oldest continuously operating industrial site and is one of the top specialty brick manufacturers in North America.

In 2003, the two Alberta operations were consolidated into the Medicine Hat site.

Fig. 4—The Medicine Hat site is Alberta's oldest continuously operating industrial site.

2. BRICK MASONRY DETERIORATION

Common Problems Associated with Brick Masonry

This Conservation Bulletin discusses masonry exteriors and some of the common problems that can arise when agents of deterioration progress ahead of regular and timely maintenance. It addresses interventions in the context of the *Standards and Guidelines for the Conservation of Historic Places in Canada*, the national best-practice approach to the conservation of historic places, adopted by the Province of Saskatchewan in 2004 and recently amended by the Second Edition in February 2011.

Since the early 1980's, the conservation of masonry has become recognized as a specialized discipline requiring particular knowledge and skill. This knowledge and skill is especially important when dealing with Saskatchewan's heritage resources.

Deterioration and damage of masonry often begins early in its life with poor detailing and/or inadequate drainage at the roof and/or foundation, which can also be accelerated by inappropriate restoration materials and/or construction practices.

With the recent opening of the Saskatchewan Centre for Masonry Design (SCMD) an opportunity exists to advance the knowledge of the characteristics of historic masonry and how research, information and awareness regarding the specification and use of new materials is disseminated throughout the industry.

> "*Masonry is one of the oldest engineering trades and yet is considered one of the least understood from those in the industry*."
>
> Mark Ferguson, University Communications, University of Saskatchewan

Fig. 5—The Soo Line Historical Museum, Weyburn, underwent masonry repointing in phases.

What causes brick masonry to deteriorate?

Brick masonry is subject to a wide variety of complex forces and sources of deterioration. Among these are:

- Expansion and contraction due to freeze/thaw cycles.
- Efflorescence (expansion of soluble salts).
- Thermal expansion (movement, which occurs across a long or tall brick wall when that wall is heated by sun exposure) and contraction.
- Expansion of rusting metal contiguous to the masonry units.
- Moisture trapped behind painted masonry unable to escape.
- Spalling (the breaking away of brick surface when soft and porous brick absorb water and are exposed to the freeze-thaw cycle) and dusting
- Cracking caused by settlement
- Masonry "sealed" with an inappropriate sealer.
- Effects of acid rain.
- Failure to properly repair mortar joints (repointing) soon after initial mortar failure.
- Using an incorrectly formulated repair mortar for repointing.
- Failure to repoint.
- Incompatible materials with differing physical characteristics from each other.
- Imperfections in the masonry units resulting from the manufacturing process.
- Incorrectly installed masonry units.
- Poor detailing, design, and specifications.
- Wind erosion.
- Biological growth (plant life).
- Rising damp (the migration of water through masonry by way of capillary action).
- Splash back (water falling from the roof line and back-splashing).
- Being hit by vehicles, lawn mowers, etc.

Several of these forces often work simultaneously on the masonry. Only after the cause of deterioration has been determined can the most appropriate and enduring intervention method be recommended.

The destabilization of older walls due to the deterioration of the inner core rubble - between the exterior and interior withes (walls) of masonry - can be a major concern, and the remedy is often to grout hidden voids within the loosely bound rubble.

Fig. 6—Masonry damage at a common point of failure at the Khedive Recreation Centre, Khedive.

Water Infiltration

Water infiltration and frost action often cause serious deterioration of mortar and stone in exposed landings and stairs. In addition, sodium chloride from deicing salts may be found on foundations and steps.

Copings, which cap the walls rising above the roof, are difficult to inspect and maintain. Water will seep through open coping joints, leading to upper wall deterioration.

Fig. 7—Canada Sound Stage, Regina

Leakage

Leakage from downspouts and built-in gutters frequently causes leaching of mortar on corners where downspouts are mounted.

Snow or ice that collects against a chimney or parapet can also cause leakage. Recurrent flashing problems may require the construction of a cricket to deflect water away from a chimney for example. With this in mind, you should ensure that regular annual inspections of chimney and parapet flashings are undertaken to stay ahead of potential areas of deterioration.

Fig. 8—E. A. Davies Building, Saskatoon

Fig. 9—The Veteran's Memorial Hall, Earl Grey

Inappropriate Cleaning

The inappropriate cleaning and waterproofing of masonry buildings is a major cause of deterioration of Saskatchewan's historic resources. While both treatments may be appropriate under specific circumstances they may also cause serious deterioration of the masonry.

Fig. 10—E. A. Davies Building, Saskatoon

Salts

Salts or other snow removal chemicals used near the building may have dissolved and been absorbed into the masonry, causing potentially serious problems of spalling or efflorescence. Techniques for overcoming each of these problems should be considered prior to the selection of a cleaning method.

Fig. 11—Yvette Moore Art Gallery, Moose Jaw

Nitrates

Nitrates often appear where pigeon roosting has been a problem.

Phosphates

Phosphates can also be introduced in masonry by fertilizer of plantings near the foundation.

Power Tools

Irreversible damage can occur with the use of power tools. Saws with carbide blades or impact hammers used for the removal of mortar almost always results in damage to the bricks by breaking the edges and by overcutting on the head, or vertical, joints. Damage to the bricks not only affects their visual character, but can also lead to accelerated weather damage.

Fig. 12—Residence in Maple Creek showing trees close to the foundation.

What can happen when brick masonry deteriorates?

Cracking

It may seem obvious that a crack in a masonry wall indicates a problem that requires immediate correction. Yet cracking may reflect previous settlement or shifting that is now stable and requires no action other than grouting or repointing to keep moisture out. [Note: This type of "non-action" is based on an understanding of the problem, which is very different from the type of non-action that is characteristic of "neglect".] Frequently, cracking can be caused by deterioration of structural steel or steel reinforcement that is embedded in the masonry. Cracking of brick at the heads of windows, for instance, is often caused by deterioration of steel window lintels and requires replacement of the lintel with galvanized steel.

Bulging

Slight bulging or shifting out of plane in a portion of a masonry wall often indicates that the brick or stone masonry surface veneer is separating from the rest of the wall. This may be because water is entering at a crack or joint, dissolving mortar, rusting ties, or freezing and moving brick or stone outward.

Spalling

Spalling of brick often reflects elevated levels of moisture in masonry but may also be caused by defects in the original masonry unit. An under-fired brick may spall while an adjacent brick remains sound under the same moisture conditions. In a typical Saskatchewan winter, high moisture content in masonry may lead to frost *spalling* or *jacking*, the fracturing of brick due to the freezing of water in porous masonry.

Why should I repair my deteriorated masonry?

Once masonry begins to deteriorate, the rate of deterioration grows exponentially. Repairing masonry as soon as possible costs much less in the long run and protects you from much greater damage and expense in the future.

Fig. 13—A masonry wall shifts out of plane at the Veteran's Memorial Hall in Earl Grey.

Fig. 14—Spalled masonry unit at Khedive Recreation Centre, Khedive.

3. CLEANING

***The reasons** for cleaning any masonry building must be carefully considered before arriving at a decision to clean.*

Cleaning is often the first “improvement” specified for a masonry wall and usually the least important requirement for proper maintenance. Generally, cleaning is an aesthetic concern rather than a maintenance requirement, although it can be important in cases where significant contamination with sulfates or other salts is causing recurrent damage. Some experts claim that if masonry cleaning cannot be undertaken without strong justification it should not take place at all.

STANDARDS & GUIDELINES-RECOMMENDED

Carrying out masonry surface cleaning tests after it has been determined that such cleaning is appropriate. If acceptable, carrying out cleaning tests which should be observed over a sufficient period of time so that both the immediate and the long-range effects are known, the gentlest method possible is selected and appropriate level of cleanliness achieved.

The general nature and source of harmful accumulations (possibly “dirt”) on a building must be determined in order to remove it in the most effective, yet least harmful, manner. Soot and smoke, for example, may require a different method of cleaning than oil stains or bird droppings. The "dirt" also may be a weathered or discoloured portion of the masonry itself rather than extraneous materials. This is commonly known as “patina” and should not be removed unless there is clear evidence that it is contributing to accelerated deterioration. Removal of part of the masonry would therefore be required to obtain a "clean" appearance and this type of intervention would lead to loss of detail and gradual erosion of the masonry.

The construction of the building must be considered in developing a cleaning program because inappropriate cleaning can have a corrosive effect on both the masonry and the other building materials since incorrectly chosen cleaning products can cause damaging chemical reactions with the masonry itself.

Fig. 15— Soiling and efflorescence at The Stoop, Rouleau

Cleaning Methods

Cleaning methods are generally divided into three major groups: water, chemical, and mechanical (abrasive). Water methods soften the dirt and rinse the deposits from the surface. Chemical cleaners react with the dirt and/or masonry to hasten the removal process; the deposits, reaction products and excess chemicals then are rinsed away with water. Mechanical methods may include grit blasting, grinders, and sanding discs, which remove the dirt by abrasion and usually are followed by a water rinse. There are potentially serious problems related to each of these cleaning methods which require careful investigation prior to considering their use.

Simple cleaning methods, such as a low pressure water wash, are often not considered enough, yet they are frequently more effective, safe, and not as expensive as the other methods.

In addition to the "reason" for cleaning, the level of cleanliness desired should also be determined prior to selection of a cleaning method. If the intention behind any cleaning is to remove most of the dirt to achieve a "new" appearance, such an intervention may be inappropriate for a historic building, and achieving such a look may require an overly harsh cleaning method.

When feasible, test areas should be allowed to weather for an extended period prior to evaluation. A waiting period of a full year is not unreasonable in order to expose the masonry to a full range of seasons. For any building which is considered historically important, the delay is insignificant compared to the potential damage and disfigurement which may arise from use of an incompletely tested method.

STANDARDS & GUIDELINES-RECOMMENDED

Cleaning masonry using recognized preservation methods and only when necessary to halt deterioration or remove heavy soiling or graffiti.

The type of soiling that may be found at cornices such as that depicted below, need not be removed—this is called patina . Except for those situations where patina is causing moisture damage or reducing the structural integrity of historic fabric, it should be retained.

Fig. 16—Encrusted patina on the stone cornice at the former Land Titles Office in Moose Jaw.

Potential Problems of Cleaning

Water Wash

Porous masonry may absorb excess amounts of water during the cleaning process and cause damage within the wall or on interior surfaces.

Excess water also can bring soluble salts from within the masonry to the surface, forming efflorescence.

Efflorescence on the inside of the foundation walls indicates that exterior foundation surfaces are inadequately protected against water infiltration. Whatever the salt, efflorescence is a certain sign that moisture is entering a wall.

Once the source of the moisture has been removed and if the natural cycle of rain does not remove the residue salts, it is recommended that localized low-pressure water from a garden hose be used in conjunction with a soft bristle brush. A mild detergent may be used for more aggressive stains.

In Saskatchewan, it is particularly important to acknowledge that water-cleaning methods should not be used during periods of cold weather because water within the masonry can freeze, causing spalling and cracking. Since a wall may take over a week to dry after cleaning, no water cleaning should be permitted for several days prior to the first average frost date, or even earlier if local forecasts predict cold weather. The exception to this general rule might apply to controlled heated environments.

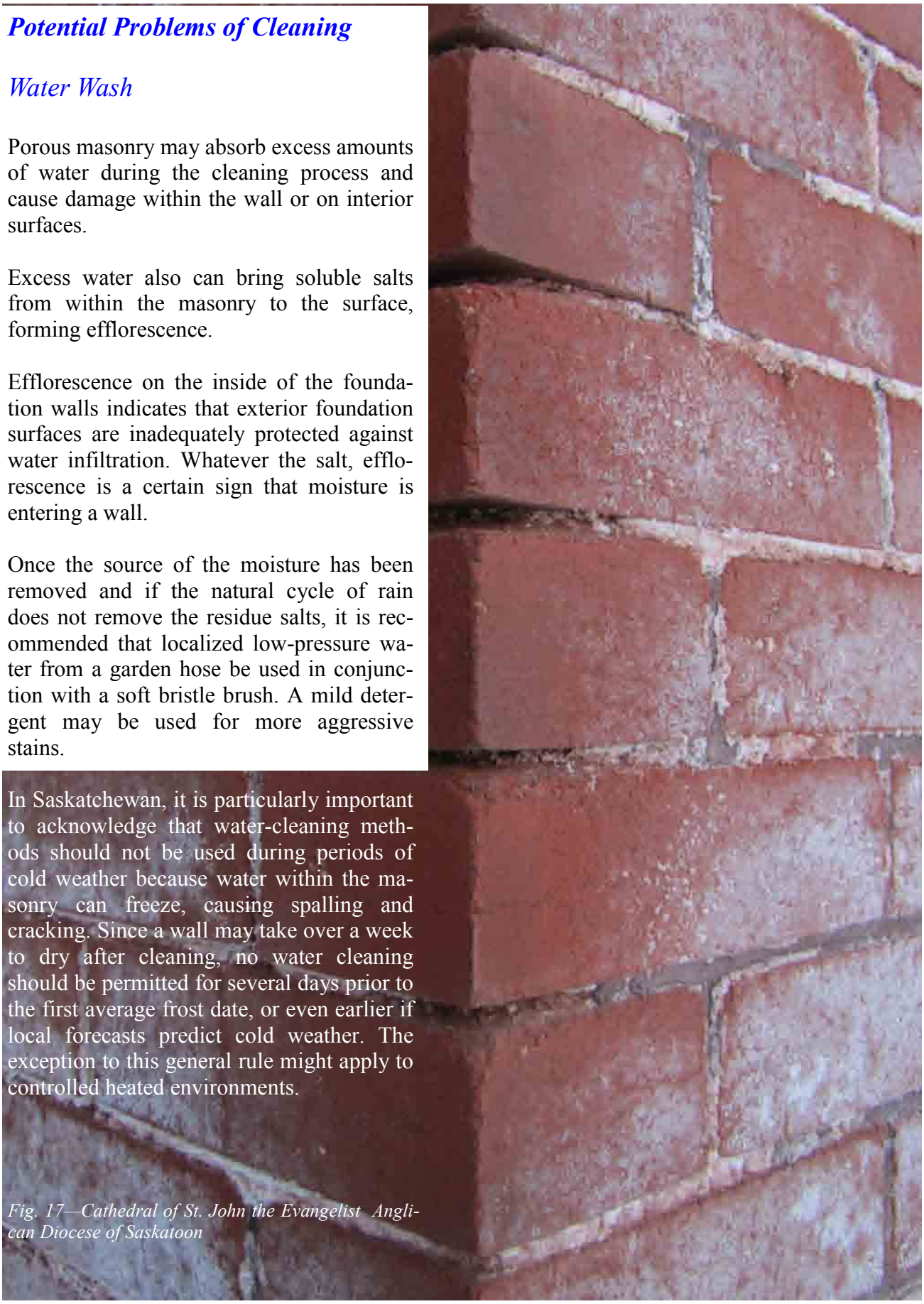


Fig. 17—Cathedral of St. John the Evangelist Anglican Diocese of Saskatoon

Chemical Cleaning

Some types of masonry are subject to direct attack by cleaning chemicals. Marble and limestone, for example, are dissolved easily by acidic cleaners, even in dilute forms. Another problem may be a change in the color of the masonry, which can be caused by the chemicals themselves. Chemical cleaners might also leave a hazy residue in spite of heavy rinsing. In addition, chemicals can react with components of mortar, stone, or brick to create soluble salts which can form efflorescence. Historic brick buildings are particularly susceptible to damage from hydrochloric (muriatic) acid, which is apparently used on historic masonry structures.

Mechanical Cleaning

Grit blasters, grinders, and sanding discs all operate by abrading the dirt off the surface of masonry, rather than reacting with any dirt residue as in water and chemical methods. Since the abrasives do not differentiate between the dirt and the masonry unit to be cleaned, some erosion of the masonry surface is inevitable with mechanical methods, especially blasting. Keep in mind that brick, a fired product, is hardest on the outside where the temperatures were highest; the loss of this protective "skin" of the brick exposes the softer inner portion to more rapid environmental deterioration. Mechanical methods, therefore, should not be used on these surfaces and should be used with extreme caution on others. Mortar joints, especially those with lime mortar, can also be eroded by mechanical cleaning.

STANDARDS & GUIDELINES
RECOMMENDED

Removing deteriorated or inappropriate mortar by carefully raking the joints using hand tools or appropriate mechanical means to avoid damaging the masonry.

STANDARDS & GUIDELINES
RECOMMENDED

Cleaning masonry surfaces using the gentlest method possible, such as low-pressure water and detergents, using natural bristle brushes.

Fig. 18—Previous masonry repairs at a kiln at the Claybank Brickplant, National Historic Site.

4. HISTORIC MORTAR

***When working with** a historic mortar one must identify the type of mortar used.*

If the mortar is a cement, lime and sand mixture, one must know the correct ratio of each material in order to establish the same strength and to ensure a compatible match in color and texture.

Another mortar, such as lime putty, may have been used. Identifying which mortar was used is important, since taking a "one-mortar-fits-all" approach will almost certainly result in damage to the historic fabric of the structure. Of even greater importance is ensuring that any new mortar used on historic buildings is compatible with the historic mortar as well as with the masonry that it bonds.

Five mortar types, each with a corresponding recommended mix, have been established to distinguish high strength mortar from soft flexible mortars. Designated in decreasing order of approximate general strength as:

Type M (2,500 psi),
Type S (1,800 psi),
Type N (750 psi),
Type O (350 psi) and
Type K (75 psi).

(The letters identifying the types are from the words MASON WORK using every other letter.) Type K has the highest lime content of the mixes.

The strength of a mortar can vary. If mixed with higher amounts of Portland cement, a harder mortar is obtained. The more lime that is added, the softer and more plastic the mortar becomes, increasing its workability.

A mortar strong in compressive strength might be desirable for a hard stone (such as granite or for a pier holding up a bridge deck) whereas a softer, more permeable lime mortar is preferable for a historic wall of soft brick. Caution is therefore warranted if a harder and presumed “superior” mortar mix is proposed for use on historic masonry.

Mortars for repointing projects, especially those involving historic buildings, typically are custom mixed in order to ensure the proper physical and visual qualities. These materials can be combined in varying proportions to create a mortar with the desired performance and durability. The actual specification of a particular mortar type should take into consideration all of the factors affecting the life of the building including: current site conditions, present condition of the masonry, function of the new mortar, degree of weather exposure, and skill of the mason. Thus, no two repointing projects are necessarily identical.

Fig. 19—Mortar joints at the Veteran’s Memorial Hall in Earl Grey.

***Masonry** deterioration caused by salt deposition results when the mortar is less permeable than the masonry unit.*

A strong mortar is still more permeable (the rate at which water moves through porous materials) than hard, dense stone. However, in a wall constructed of soft bricks where the masonry unit itself has a relatively high permeability, a soft, high-lime mortar is necessary to retain sufficient permeability.

In severe cases of water infiltration, mortar may become *spent*, and lose all strength and cohesion, allowing masonry to be easily disassembled by hand.

What should mortar matching include?

Correctly matching mortar extends well-beyond just matching color. In order to confirm the degree of compatibility between any new mortar and the historic mortar and/or masonry units that it bonds, the following characteristics should also be tested/examined and matched:

- Texture
- Physical Properties
- Hardness
- Water Vapor Permeability
- Tooling (Shape of the Mortar Joint)

It is important that repair mortar be matched so that it is compatible with both the surrounding masonry units as well as the contiguous mortar.

STANDARDS & GUIDELINES RECOMMENDED

Using mortars that will ensure the long-term preservation of the masonry assembly. Mortar should be compatible in strength, porosity, absorption and vapor permeability with the existing masonry units. Bedding and pointing mortars should be less durable than the masonry units.

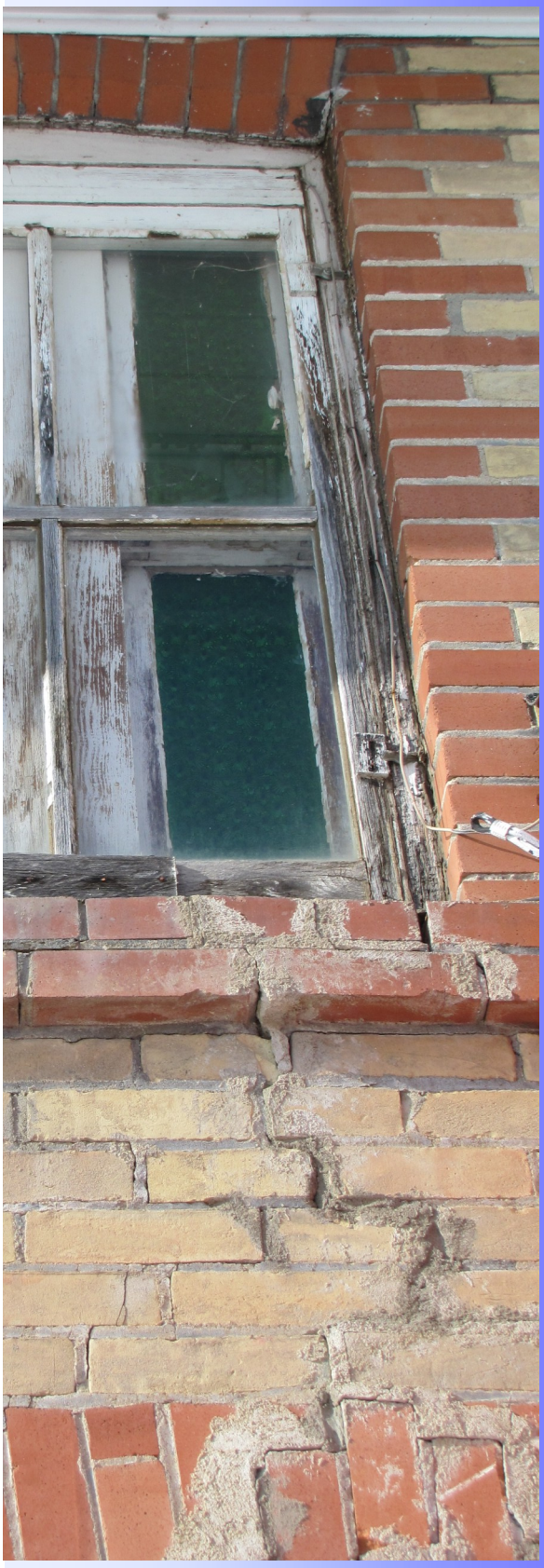


Fig. 20—Lammle Residence, Drinkwater

5. CHARACTERISTICS OF MORTAR

Why is matching the mortar on my historic building important?

If it is not matched, it must certainly be "compatible" with the masonry units that it surrounds. If this is not confirmed, you run the risk that the new repair mortar may contribute to the deterioration of the wall instead of protecting it; or, that the visual impact may be unacceptable if the colour, texture or tooling does not match the historic mortar or is not compatible with the historic masonry units.

The decision to repoint is most often related to some obvious sign of deterioration such as disintegrating mortar, cracks in mortar joints, loose bricks, damp walls, or damaged plasterwork. It is, however, erroneous to assume that repointing masonry will solve all these problems. Therefore, the true cause of the deterioration should be determined before beginning any repointing work. Leaking roofs or gutters, differential settlement of the building, capillary action causing rising damp, or mortar that is exposed to extreme weather conditions should all be dealt with as a high priority.

Analysis of Existing Mortar and/or Brick

All repointing work on historic masonry buildings should be preceded by an analysis of the mortar and by an examination of the bricks and the techniques used in the original construction of the wall. Except for pure conservation work, the exact physical and chemical properties of the historic mortar are not of major significance as long as the new mortar:

- matches the historic mortar in color, texture, and detailing

- is softer (measured in compressive strength) than the brick; and

- is as soft, or softer (measure in compressive strength) than the historic mortar

Fig. 21—The analysis of the historic mortar mix at the Co-Cathredral in Gravelbourg led to the selection of Type K mortar for its repointing.

New Mortar Sacrificial to Historic Masonry

The key characteristic of repointing is "compatibility". Compatibility can also be achieved by understanding the qualities of the masonry which is to be bonded by the new mortar. The key qualities that need to be tested are the masonry's compressive strength and porosity. The results can then be compared to any proposed recipe. The important factor is to ensure that the proposed mortar mix is weaker than the masonry units; and that through the normal process of weathering and movement, it will fail before the masonry. If the mortar is too hard or not sufficiently porous, it will enable movement and absorption to occur through the masonry rather than the mortar. If this process is allowed, then the masonry will fail before the mortar. It is much easier to repair failed mortar than failed masonry units, thus any new mortar mix should always be sympathetic, supportive and if necessary, sacrificial to (i.e. weaker than) the historic masonry.

ON THE IMPORTANCE OF MORTAR COMPATIBILITY

"We are amazed by how many well-intended people are using inappropriate mortars in historic masonry work.

More and more construction defects underscores the need to understand the importance of the compatibility of mortar with the historic masonry units. As an expert witness in numerous litigation cases, we are seeing this all over the country.

If the whole issue of compatibility was explained in the context of the potential construction liability, people would perhaps understand."

John Lambert, Founder and President of Abstract Masonry Restoration

Fig. 22—Mortar failure before the masonry units at the Khedive Recreation Centre, Khedive.

6. CONSTITUENTS OF MORTAR

Sand

Sand is the largest constituent of mortar and the material that gives mortar its characteristic color and texture. When viewed under a magnifying glass or low-power binocular microscope, particles of sand generally have either rounded edges, such as found in beach or river sand, or sharp, angular edges, found in crushed or manufactured sand. For repointing mortar, rounded or natural sand is preferred for two reasons. First, it is usually similar to the sand in the historic mortar, thus providing a better visual match. Second, it has better 'working' qualities or plasticity and can thus be forced into the joint more easily, forming a good contact with the historic mortar and the surface of the bricks. Although the manufactured sand is frequently the only type readily available, it is worth the search to locate a sufficient quantity of rounded or natural salt-free sand for repointing.

Lime or Portland Cement

The two commonly used binders for mortar are lime and Portland cement. Of the two, lime produces a mortar that meets nearly all the requirements for a compatible mortar for historic buildings. High lime mortar is soft, porous, and changes little in volume during temperature fluctuations. In addition, lime mortar is slightly water soluble and thus is able to re-seal any hairline cracks that may develop during the life of the mortar.

Portland cement, on the other hand, can be extremely hard, is resistant to movement of water, shrinks upon setting, and undergoes relatively large thermal movements.

One can get away with using cement in mortar on modern masonry because it is typically built on solid concrete foundations and has expansion joints every so often.

As lime mortar is intrinsically soft it is easier for the inexperienced to condemn old mortar as being 'powdery' when there is nothing particularly wrong with it; such critics may be confusing it with cement and expecting it to be as hard as the mortar in a modern wall.

Cement-rich mortars are harder and just as important as, but less permeable to water than lime mortars. Impermeable mortars force moisture in the wall to evaporate through the brick rather than through mortar joints. The use of cement-rich mortars to repoint early brickwork can in this way cause brick to deteriorate through spalling at the edges or by subflorescence (salt crystallization inside masonry units, which can cause damage to the units' internal structure) in the brick.

It is important, therefore, that repointing mortar be mixed from individual components and that premixed bagged mortars not be used on historic buildings.

7. SEALERS AND COATINGS

***The practice** of applying sealers and coatings to masonry has not been widely acclaimed by many experts.*

In addition, past treatments have often caused more problems than they have resolved. The natural tendency of bricks is for uninhibited ability to breath; to prevent moisture from entering the wall while allowing water vapour to escape.

Is Waterproofing Necessary?

Coatings are frequently applied to historic buildings without concern for the requirement or the consequences of the coating. Most historic buildings have survived for years without coatings, so why are they needed now? Water penetration to the interior usually is not caused by porous masonry but by deteriorated gutters and downspouts, capillary action or condensation. Coatings will not solve these problems.

Types of Coatings

There are two types of masonry coatings: waterproof coatings and water repellent coatings. Waterproof coatings seal the surface from liquid water and from water vapor; they are usually opaque, such as bituminous coatings and some paints. Water repellents keep liquid water from penetrating the surface but allow water vapor to enter and leave through the "pores" of the masonry. They are usually transparent, such as the silicone coatings, although they may change the reflective property of the masonry, thus changing the appearance.

Fig. 23—Knox United Church, Saskatoon

Waterproof coatings

These coatings usually do not cause problems as long as they exclude all water from the masonry. If water does enter the wall, however, the coating can intensify the damage because the water will not be able to escape. During cold weather this water in the wall can freeze, causing serious mechanical disruption, such as spalling.

Beware of the promise of quick fixes! For consistency, they can be grouped with the same promise as “maintenance free” products! There are no wonder products that can be brushed or sprayed on that will substitute for the recommended treatments in this conservation bulletin. “Waterproofing” applications are almost always unnecessary if other repairs are properly carried out in a timely manner.

Water repellent coatings

Water repellant coatings can also cause serious damage to brick masonry, but in a different way. Since water repellent coatings do not seal the surface to water vapor, it can enter the wall as well as leave the wall. Once inside the wall, the vapor can condense at cold spots, producing liquid water. Water within the wall, whether from condensation, leaking gutters, or other sources, can do damage, especially in environments such as that present in Saskatchewan, where the freeze-thaw cycle can be quite aggressive.

The presence of a water repellent coating, however, prevents the water and dissolved salts from coming completely to the surface. The salts then are deposited slightly behind the surface of the masonry as the water evaporates through the pores. Over time, the salt crystals will grow and will develop substantial pressures which will spall the masonry, detaching it at the depth of crystal growth. This build-up may take several years to notice.

This is not to suggest that there is never a use for water repellents or waterproofing. In the unfortunate circumstance where brick has been sand-blasted for example, the bricks may have become so porous that paint or some type of coating is essential. In other cases, the damage being caused by local pollution may be greater than the potential damage from the coatings. Generally, coatings are not necessary, however, unless there is a specific problem which they will help to solve. If the problem occurs on only a portion of the masonry, it is best to treat only the problem area rather than the entire building. Extreme exposures such as parapets, for example, or portions of the building subject to driving rains can be treated more effectively and less expensively than the entire building.

STANDARDS & GUIDELINES
RECOMMENDED

Applying new or non-historic surface treatments such as proven water-repellent coatings to masonry only after repointing and only if masonry repairs, alternative design solutions or flashings have failed to arrest water penetration problems.

8. BRICK MASONRY REPAIRS

***Buildings** are seemingly inanimate objects.*

However they do move above their foundations - with the degree of movement dependant on such factors as shrinkage, temperature gradients, the degree of restraint from foundations, geometry, etc., as well as loading conditions from wind and snow.

Repair Solutions

Common solutions for historic projects involve pointing the building, individual brick replacement and, at times, wall rebuilding if severe damage has occurred.

Regular Maintenance

It is also often thought that old brick buildings will remain solid and sturdy forever, requiring little or no maintenance. However, the life expectancy for most mortars is up to 75 years. This does not mean that one does not have to do any maintenance for 75 years. Regular annual inspections of the masonry and carrying out maintenance activities will certainly be required to prevent the type of moisture and water infiltration that can create damage to the interior of the building.

Repointing

History has shown that the incorrect selection of materials and techniques for repointing has the potential to accelerate the deterioration of masonry structures more than any other process - apart from perhaps incorrect cleaning practices.

Repointing is the process of removing deteriorated mortar from the joints of a masonry wall and replacing it with new mortar. Properly done, repointing restores the visual and physical integrity of the masonry. Improperly done, repointing not only has the potential of detracting from the appearance of the building, but it may cause irreversible physical damage to the masonry units themselves.

Often, overall repointing is neither necessary nor sufficient to halt water infiltration and is undertaken needlessly.

Repairing Root Cause

Repairing the symptom (i.e., pointing, caulking selective brick replacement) where embedded steel corrosion is occurring without taking care of the root cause of corrosion will not optimize the long-term performance of the wall but may be a decision related to the owner's intended length of possession of the building. Such areas should be repaired with a long-term solution in mind, including, where appropriate, stripping the façade sufficiently to expose the imbedded steel, treating the corrosion and rebuilding the wall.

STANDARDS & GUIDELINES
RECOMMENDED

Retaining *sound exterior masonry or deteriorated exterior masonry that can be repaired.*

Fig. 24—Repointing the smoke stacks at Claybank Brick Plant NHS.

Selective Replacement

Deterioration caused by spalling and dusting can only be remedied by replacing any unsound brick. There are no effective treatments to arrest disintegration of soft brick once it has started. Efforts aimed at sealing the brick attract a host of other long-term challenges that may not be readily apparent when immediate stabilization is the short-term objective.

Structural Intervention

The failure of lintels or other structural deficiencies may be corrected following normal building practices such as underpinning, replacement or resetting of lintels and arches and the replacement of cracked brick. For large structures, this can be a substantial intervention; hence the importance of regular annual inspections of masonry buildings cannot be over-stated.

Minimum Intervention

If adjacent masonry is not threatened with damage due to water infiltration, it is often preferable to leave a slightly damaged brick in place. [Note: This type of "non-action" is based on an understanding of the problem, which is very different from the type of non-action that is characteristic of "neglect".]

STANDARDS & GUIDELINES RECOMMENDED

Repairing *masonry walls and other masonry elements by repointing the mortar joints where there is evidence of deterioration such as disintegrating mortar, cracks in mortar joints, loose bricks, damp walls or damaged plaster work.*

9. WORKMANSHIP

Even if appropriate mortar is used, *considerable damage can be done by careless raking or removal of mortar from the joints.*

The use of hand-held circular grinders to open joints can cause extensive damage, especially when fine joints are widened or when the cutting of vertical joints damages the brick above and below the joint. It is much safer to use hand tools or if necessary, fine pneumatic chisels that have been adapted from the stone-carving industry.

10. CHIMNEYS

Why should I be concerned about maintaining/repairing my chimney?

A chimney or firebox left unrepaired can:

- Release dangerous, toxic, and unhealthy gases into your building.
- Allow flames and sparks to escape and come in contact with potentially combustible materials in your building. It is a real fire hazard.
- Allow loose masonry materials to fall and potentially cause damage to property or people.

What are the main things I can do to prevent my chimney from deteriorating?

Make sure your chimney crown (the 'roof' of your chimney) is constructed of the correct materials and is designed to function correctly. If it is cracked or deteriorated, make sure the correct decision is made to repair it or where repair is not practical, remove and replace it with a new crown, in kind.

Chimneys are among those features that require the most frequent maintenance, but they are usually neglected because of their location.

Fig. 25—Claybank Brick Plant NHS

Fig. 26—Claybank Brick Plant NHS

Fig. 27—E. A. Davies Building, Saskatoon

Fig. 28—Loose masonry at the Assumption Catholic Church in Holdfast.

11. ADVICE

On projects where consultants have been retained, the architect/consultant should assist the owner in planning for any research and construction investigations that may be required to substantiate any proposed interventions. The consultant should also realize that older buildings have special circumstances usually not encountered with modern building materials or techniques of construction. Therefore, extra research may be required, and nonstandard materials and procedures may need to be used in evaluating the work of potential contractors to ensure that they are qualified to work on projects of the type anticipated. The consultant may also wish to thoroughly consider the scope of any proposed work in order to determine whether they should be prepared to spend more time than is customary in modern construction in the planning, development and/or construction stages.

Remember that the work you specify and/or commission to be undertaken by others may be in place for a hundred years. Take the time to plan it carefully!

12. REFERENCES

Abstract Masonry Restoration www.masonry-restoration.com

Claxton, Bevis (2008), *Maintaining and Repairing Old Houses*, A Guide to Conservation, Sustainability and Economy, Copyright Bevis Claxton/Old House Info Ltd.

Ferguson, Mark (September 10, 2011), OCN *On Campus News,* Masonry research designed to benefit industry

Howell, Mark K. and Adrienne DeRan (1998), Structural Preservation Systems, *Maintaining Masonry – Repair Beyond Caulk*

I-XL, The Brick People, http://www.ixlbrick.com

MacKenzie, Janet (March 2003), Saskatchewan's Clay Resources

Pieper, Richard (1998), Caring for Your Historic House, *Exterior Masonry*, Heritage Preservation and National Park Service, Copyright 1998 Heritage Preservation

Preservation and Conservation: Principles and Practices, *Masonry and Masonry Products: Brick, Adobe, Stone and Architectural Ceramics*, Proceedings of the North American International Regional Conference conducted under the auspices of the International Centre for Conservation, Rome, Italy and the International Centre Committee of the Advisory Council on Historic Preservation, Copyright 1976 National Trust for Historic Preservation

Preservation Briefs: 1 *The Cleaning and Waterproof Coating of Masonry Buildings*, Robert C. Mack, National Park Service (1998)

Preservation Briefs: 1 *Repointing Mortar Joints in Historic Brick Buildings*, Robert C. Mack, National Park Service (1998)

University of Saskatchewan News Release (October 1, 2010), University of Saskatchewan launches centre for the study of masonry design

Fig. 29— Dislodged masonry at the 1886 McNaughton Stores in Moosomin.

The Saskatchewan Heritage Foundation is an agency that provides financial support and conservation advice to owners of Municipal or Provincial Heritage Property in Saskatchewan.

Grant assistance of up to ***50%*** *of "eligible" project costs may be offered by the SHF for the conservation of your heritage property, depending on the demand for and the availability of funds.*

Visit our website for details:
www.tpcs.gov.sk.ca/SHF

Activities such as masonry repair may be eligible for grant assistance. Retroactive funding may be considered provided that the full scope of conservation work has been discussed with the SHF and the applicant has received its approval-in-principle for agreed eligible works.

Saskatchewan Heritage Foundation

(306) 787-2105

9th Floor
1919 Saskatchewan Drive
Regina, Saskatchewan
S4P 4H2