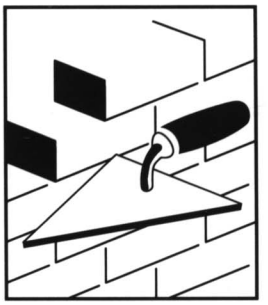
Heritage Notes

Architectural Preservation | Masonry



Number 5

Repointing Historic Masonry

Larry Pearson

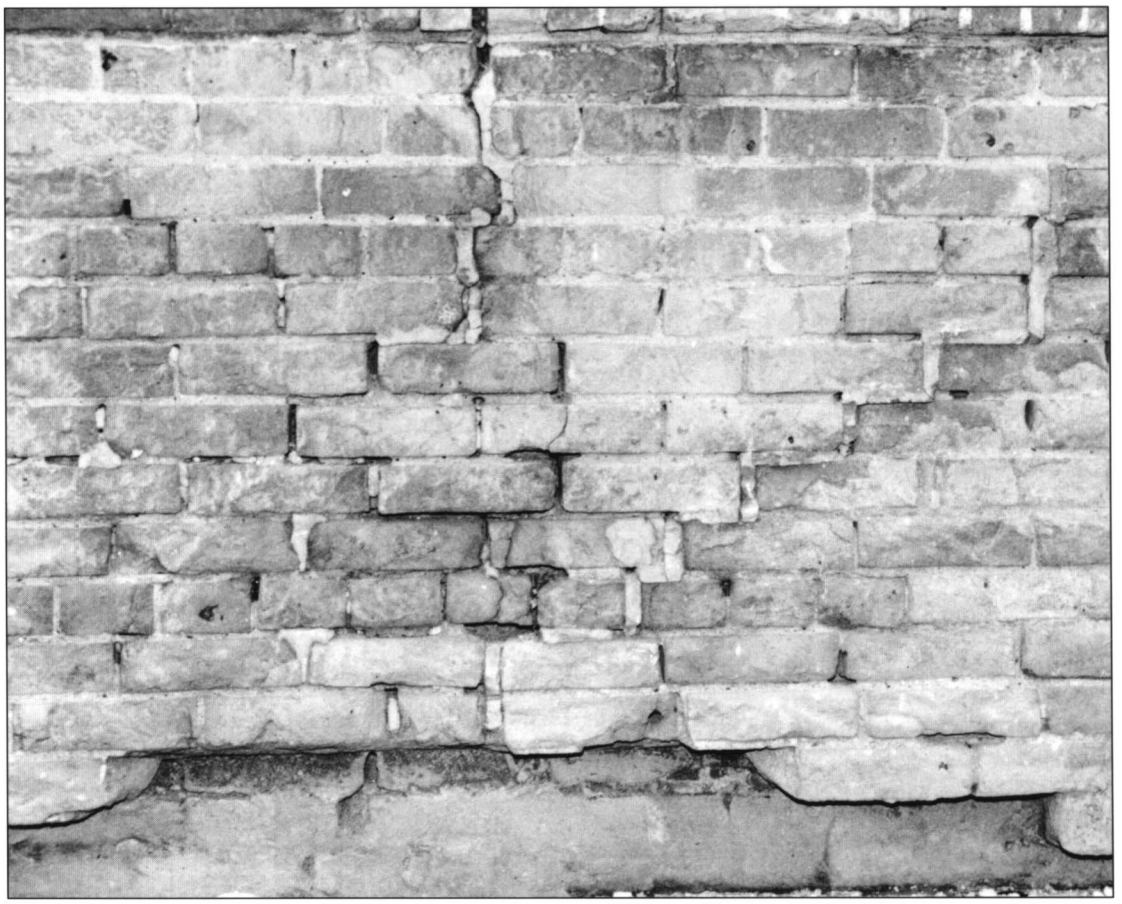


Figure 1: Where mortar is damaged or missing from a masonry wall, the resulting open joints will allow water to enter the structure easily. To prevent further deterioration from water damage or the loss of masonry units, the joints should be repaired through the replacement of the mortar, a process known as repointing.

The purpose of this Heritage Note is to provide owners of heritage buildings and their contractors with a general understanding of the functions of mortar within a historic wall structure, as well as information on treating its deterioration through proper repointing. This Note will outline the basic steps involved in carrying out a successful repointing project, including detailed information on the development of an appropriate repointing mortar. The final section, "Keys to Additional Information" provides a detailed bibliography for those readers wishing to obtain further information on this topic.

The Function of Mortar in a Masonry Wall

In order to understand the need for, and the correct approach to the repair of deteriorated mortar, it is necessary to understand what mortar is and how it functions within a masonry wall system. By definition masonry is an assembly of small building units, such as bricks or building stones, held together by mortar. Mortar is a mixture of aggregates (usually sand) and cementitious materials (such as lime or portland cement), made plastic by the addition of water.

ALBERTA HISTORICAL RESOURCES FOUNDATION

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COMMUNITY DEVELOPMENT

The Minister of Culture and Multiculturalism's ***Guidelines for the Rehabilitation of Designated Historic Resources*** contains the following recommendations on the repointing of historic masonry:

Guideline 11:
Repair masonry walls and other masonry features 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 plasterwork.

Guideline 12:
Remove old mortar by carefully hand-raking the joints to avoid damaging the masonry.

Guideline 13:
Duplicate old mortar in strength, colour, and texture.

Guideline 14:
Duplicate old mortar joints in width and in joint profile.
Guidelines for the Rehabilitation of Designated Historic Resources, (1990) p. 19.

In all masonry walls, mortar has the principal function of making the wall watertight by filling the spaces between the masonry units. Mortar also has an aesthetic function, as the particular colour and detailing of the mortar-filled joints lend a specific appearance to the wall. The joints in brick walls serve to accommodate the slight dimensional differences in the bricks themselves. For this reason, joints are not necessarily of uniform dimensions. In other respects, the role played by mortar in an older wall differs significantly from that in modern construction. Failure to understand these differences when selecting mortar for repointing can result in serious damage to a masonry wall.

In modern buildings, a strong and rigid mortar joins the individual units together to create a single, monolithic structure. Movements in the wall are minimized by proper foundations or are accommodated by control or expansion joints placed at regular intervals along the wall. Alternatively, modern brickwork may be in the form of non-load-bearing veneer panels. By contrast, the masonry itself was load-bearing in early Alberta buildings and the use of a lime and sand mortar, which is characteristically soft, was almost universal. This softness was needed to allow the mortar to act more as a cushion between the bricks or stones, accommodating movement in the wall caused by the uneven settling of poor foundations or the expansion and contraction of the units as temperatures changed.

Of equal importance was the sacrificial role played by mortar in the control of moisture-related deterioration of the wall. By being softer and more porous than the surrounding units, the mortar served as the principal route for the evaporation of moisture within a wall. As moisture escaped along the joints, any salts trapped within would be deposited in the mortar rather than in the brick or stone. The resulting deterioration to the mortar joints was anticipated by early masons who understood the need to replace damaged mortar at regular intervals by repointing.

Repointing when necessary with the appropriate mortar is critical to the successful maintenance of a historic masonry wall.

Preliminary Analysis

To ensure the success of a repointing project, it is important that both the physical integrity of the wall is maintained and that the aesthetic role played by the joints is respected. It is equally important to understand that joint deterioration does not happen on its own. A successful repointing project will be in vain if the initial cause of mortar deterioration goes unchecked. For this reason, a detailed and careful preliminary inspection must be done, and proper mortar and application techniques chosen. The planning of a repointing project should begin with developing an understanding of the following:

1) the areas where repointing is necessary;

2) the visual characteristics of the historic joints to ensure that their replacements match in colour and tooling;

3) the physical properties of the original mortar so that they may be duplicated in the specifications for the replacement mortar and;

4) the reasons for the failure of the original mortar so that the causes (i.e. rising damp, leaking downspouts) may be corrected in conjunction with the repointing project. If the cause of the deterioration is not readily apparent, it may be necessary to hire a consultant who can determine the reason for the failure and recommend corrective action.

Where and When to Repoint

Repointing will be necessary where damaged mortar allows water to penetrate the wall. If this is the case, the joints are usually visibly open. The condition can also encourage plant growth between stones and if serious, can result in loose or failing masonry. Damp interior wall surfaces may also indicate that water is entering the building through open joints.

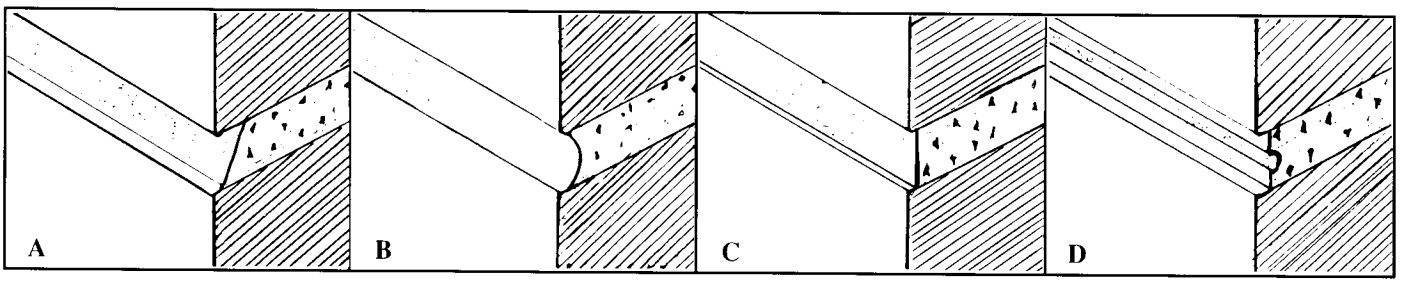


Figure 2:
A-*Struck or Weather Joint*
B-*Tooled or Concave Joint*
C-*Recessed Joint*
D-*Tooled and Scribed or "Grapevine "Joint*

There are a variety of approaches to finishing or "tooling" a joint when the joint-filling stage of repointing has been completed. These are examples of a number of repointing styles used in Alberta. As the style of pointing has a significant impact on the visual character of a masonry wall, care must be taken to match the original style as closely as possible if the areas of repointing are to blend with the surrounding original joints.

To determine which areas are to be repointed, a careful inspection of the wall will be necessary. When carrying out this examination, only "deteriorated" mortar should be considered for replacement. The complete or "blanket" repointing of a structure is not recommended, as sound, historic mortar should remain in service as long as possible.

The following conditions can be used as a guide to judging the need for mortar replacement:

1) there is no mortar present in the joint within 1½ inches of the wall;
2) mortar can be scraped from the joint easily with a screwdriver or poked out with a finger;
3) the mortar is sandlike, crumbles freely, and the original treatment of the joint is unrecognizable;
4) the mortar can be prodded from the joint and disengages from the brick cleanly.

In each of the above situations repointing is required.[1]

In some instances, the mortar may be in excellent condition, but repointing may still be necessary, for example, where a hard portland cement-based mortar has been used for previous repointing work and the surrounding masonry has been damaged as a result. Here, the need to replace the masonry will necessitate the replacement of the mortar. As outlined below, the use of hard mortar for pointing soft masonry can be shown to lead to serious deterioration of the masonry units. For this reason it is sometimes recommended that such mortar from previous attempts at repointing should be considered defective and removed. As the removal of such mortar can prove very difficult and can itself result in damage to the adjacent masonry, it is generally better to leave such situations alone unless it can be demonstrated that the mortar is in fact contributing to the deterioration of the adjacent masonry units.

An effective way of conveying information on the exact areas to be repointed to a contractor is through the use of photodrawings. By following annotations on actual photographs of the structure, the craftsman carrying out the work is given a very clear indication of the extent of work to be done. Once a scaffold has been placed and repointing begun, similar conditions found elsewhere on the structure by the mason can be brought to the attention of the owner or the consultant.

While carrying out the detailed visual inspection of the wall, care should be taken to note the style of tooling that the joints were given. Figure 2 indicates some of the common treatments for joints found in Alberta. Take note of any differences in how vertical and horizontal joints were struck, and of the order in which they were finished. While the colour of the mortar joints is usually the result of the colour of the mortar or pigments added to it, some masons finished joints after tooling them to change their colour, using a material such as asphalt mastic. Where such treatments are in good condition, they should be duplicated in the final tooling of repointed areas. If the original style of tooling is too badly eroded to be discernable, the best approach is to finish the joint with a slightly recessed concave profile.

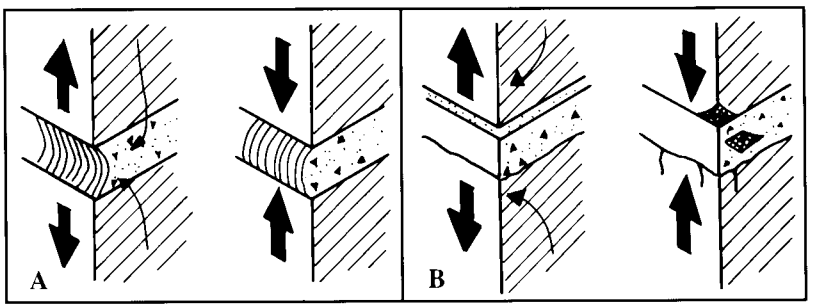


Figure 3: Strength of repointing mortar. A- Joints pointed with soft mortar can absorb stresses developed through movement of the adjacent masonry. B - Wall movements in masonry repointed with hard mortar will produce cracks between mortar and bricks or will cause spalling.

TYPE OF MASONRY BEING REPOINTED	EXPOSURE OF MASONRY BEING REPOINTED		
	Sheltered	Moderate	Extreme
Highly Durable: granite, hard brick	O	N	S
Moderately Durable: Stone, bricks	K	O	N
Poorly Durable: soft brick, friable stone *(such as Paskapoo sandstone)*	*	K	O
MORTAR DESIGNATION (CSA)	MORTAR MIX: Proportion of Portland Cement: lime: aggregate		
Type S Mortar = 1 : 1/2 : 4 - 4 1/2			
Type N Mortar = 1 : 1 : 5 - 6			
Type O Mortar = 1 : 2 : 8 - 9			
Type K Mortar = 1 : 3 : 10 - 12			
Type * Mortar = 0 : 2 : 5 - 6			

Figure 4: Recommended mixes for repointing mortar

Selecting an Appropriate Repointing Mortar

As stated above in the discussion on the function of mortar within a masonry wall, historic masonry relied on the softness and permeability of lime mortars to accommodate the stresses of expansion and contraction, moisture movement and settlement which such a wall would be expected to encounter. In developing an appropriate mix for repointing mortar it is critical that these characteristics be considered and that a suitably soft mortar be employed. Figure 3 illustrates the impact that the use of too hard a repointing mortar may have on older, softer masonry. It is equally important to match the colour and texture of the original mortar closely so that the repaired areas blend with the surrounding wall when work is complete.

This need to match the physical and aesthetic qualities of a historic mortar has led to the development of a number of fairly sophisticated physical and chemical approaches to historic mortar analysis. It is usually unnecessary, however, to know the detailed physical and chemical proportions of the original mortar mix precisely. Often it is sufficient to carry out relatively simple and straightforward visual and chemical tests. An example of such an approach for obtaining a close colour match is discussed on page 5, in "An Approach to Matching Mortar Colour and Texture".

As an aid in developing specific mix formulae, Figure 4 provides a series of suggested mixes. To ensure that the strength of the mix (or more appropriately, its softness) is correct for the surrounding masonry, it should correspond to the strength of the material it is replacing. For example, for most soft brick buildings or those made from the buff-coloured sandstone common in Alberta, a mix equivalent to Type K is preferred. Secondly, the mixes are varied with respect to the severity of the exposure of the area to be repaired. The section on "Material Specifications" contains more detailed information on writing specifications for the mortar mix.

Material Specification for Repointing Mortars

Modern materials should be specified in a manner which conforms to the the specifications of the Canadian Standards Association (CSA).

Lime: the preferred product is lime putty made by slaking quicklime and allowing it to age. This ageing process takes a minimum of two weeks and as a result it is often more convenient (but not as good) to use hydrated lime to produce lime putty. Either Type S or Type N limes may be used, although only Type N lime is readily available in Alberta. Lime putty is made from the lime by adding dry bagged lime to water. The mass is stirred to form a thick cream-like mixture. Where Type N lime is used it should be allowed to stand at least 24 hours prior to use.

Cement: low-alkali cement (not more than 0.60% alkali nor more than 0.15% water soluble alkali) should be used, where cement is required, to prevent efflorescence. The choice of cement colour will depend on the final colour of the mortar being matched. The use of white portland cement makes the mortar much lighter in colour than an identical mortar made from grey portland cement.

Sand: the aggregate should be well-graded, washed sand matching the texture and range of sizes found in the mortar to be matched. The most appropriate sand should contain a full range of sizes. Asphalt sand is often best from this perspective.

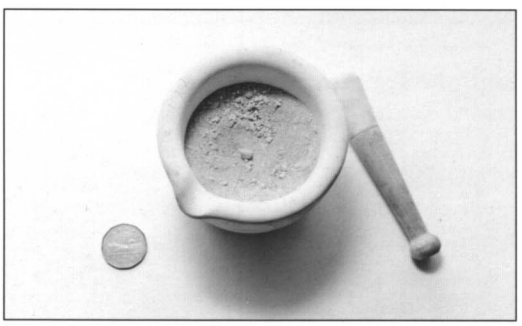
Pigments: where needed, pigments should be dry, powdered, inorganic compounds.

Water: should be potable and free from contamination.

An Approach to Matching Mortar Colour and Texture[2]

For aesthetic reasons, the texture and colour of the mortar should be matched if the areas of replacement are to blend with the sound original mortar adjacent. As the texture and colour of mortar is principally a result of the type of sand used, providing a close match to this ingredient is generally the most effective way to blend with the old. Often a fairly straight-forward visual examination can provide clues to the sand's size, shape and colouring. This can be done by examining an unweathered sample, obtained by removing a fairly large piece of mortar and breaking it open. By crushing the sample, the larger elements, such as sand or impurities, can be separated from the finer lime powder which is easily blown away. (See Figures A and B.)

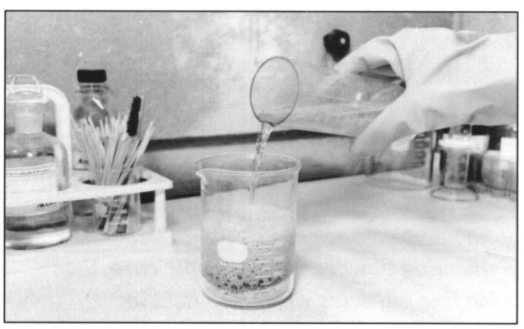
An alternate approach to analyzing mortar is to break a sample down chemically in hydrochloric acid. A large piece of mortar (about 2 cm) is crushed and then placed in a 250 ml jar. A solution of one part HCl to three parts water is then poured over the mortar. Care must be taken, as a fairly vigorous reaction can take place. As the Calcium Carbonate ($CaCO_3$) or lime in the mortar decomposes, a vigorous reaction will result as Carbon Dioxide ($C0_2$) is released (Figure C). Insoluble sand and clay or cement residues can then be separated by allowing the sand to settle to the bottom of the glass container enabling the liquid above to be easily poured off. If the liquid above is cloudy, it indicates the presence of fine particles of clay, cement residue or pigmenting powders. If this is the case, then these fine particles which are held in



A. and B. Samples of mortar removed from the wall are crushed to a fine powder, using a mortar and pestle.

suspension in the liquid can be removed by filtering the liquid (Figure D).

This type of analysis will result in the separation of the mortar's constituent elements, by dissolving the lime binder. The resulting sample of sand left on the bottom of the glass can be washed with water, dried and then examined in detail, providing clear evidence of its size, shape and colour range (Figures E and F). When dried, the colour of the finer residues, or the insoluble components of the binder, can indicate whether an artificial pigment was used to colour the mortar. However, this is usually readily apparent simply by looking at the joints themselves.



C. The powdered mortar is placed in a beaker or jar (500 ml used here). The HCl is then added slowly. Care is need as the effervescence from the reaction can be vigorous and overflow the container easily.

The following procedure for matching the colour of historic mortar through the addition of pigments (based on one developed by Morgan Phillips when he was architectural conservator for the Society for the Protection of New England Antiquities) is both simple and relatively quick. It has the advantage of being usable in a shop or lab setting and can easily provide a mix for testing at the job site.

Using the required proportions of sand (closely matching the sample obtained above) and lime, or lime and cement of the selected mortar type (as selected with reference to Figure 4), a dry mixture is created sufficient to fill a one litre container. This dry mortar is thoroughly mixed to provide a stock of unpigmented material.

Taking about 150 ml of the dry mix, a small amount of pigment is added and the material vigorously shaken. If the original mortar is pigmented, then the selection of the added pigment will be based on the colour of the fine material obtained by filtration above. One or two tablespoons of this mix is then removed and mixed with water to make a mortar of normal consistency. This is then dried. To speed this process the drying can be done on a hot plate set to about 93 -120 degrees C. The small dried sample is then broken open and compared to an unweathered sample of the original mortar. This process is continued until the test sample matches the original. As the pigments are in very small quantities they are not measured, which speeds up the process. The results of this stage will identify the ingredients which will produce the colour of the final repointing mortar.

To arrive at the correct proportions of the pigments return to the unpigmented parent batch of mortar in the litre container and add the different pigments in small measured amounts until the dry appearance of this mixture matches that of the smaller batch arrived at above. This will give the correct proportions of the pigments to be used, but not their final quantities. This final step is carried out at the job site.

The required proportions of sand, lime mortar and cement (if included) for a job-sized batch are accurately measured and mixed. The pigments are then added, again in accurately measured amounts using the proportions established above. The job batch is mixed and a dry sample compared to the dry colour of the sample from the shop. A number of "additions" of pigments in their correct proportions may be needed before these dry samples achieve a match. The result of these attempts is to arrive at a knowledge of the exact amounts of pigments in proportion to the quantities of other ingredients needed to make a job-sized batch. This should of course be tested on the "test panel" and allowed to dry naturally. It should, however, provide a fairly close match for which only fine tuning is required.

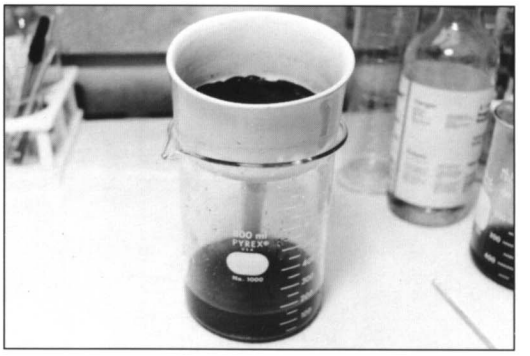
Once approved, these amounts can be "standardized" by cutting down coffee cans or plastic containers to give the correct amounts and proportions for a batch. Thus the mason can easily, but accurately, measure out the required ingredients (Figure G).

The advantage of this procedure is the speed with which a correct match can be achieved. By involving the mason in its final stage it has the added benefit of reinforcing the need for care in measuring and execution with the crew employed by the contractor.

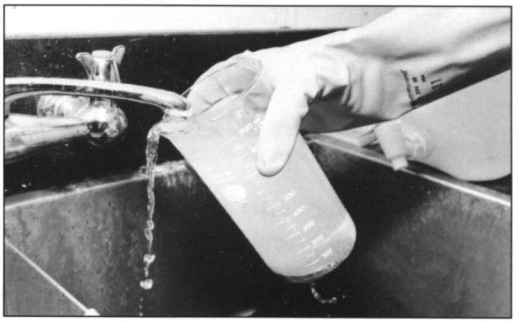
Carrying Out the Work

Test Panels

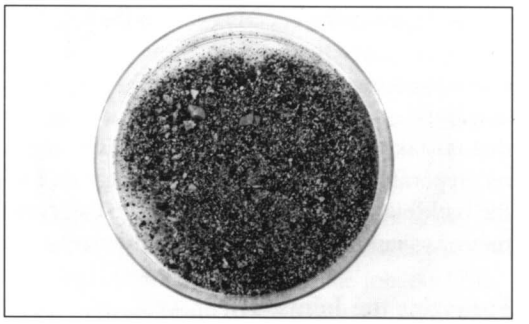
Once an appropriate mortar mix has been selected it is recommended that the selected contractor be asked to prepare a test panel following the procedures specified for the job. The test panel should be prepared under the supervision of the owner or the consultant so that the contractor understands the required procedure fully. Its completion, then, will give the contractor a clear indication of the nature of the job and the standards set by the building owner or consultants. It will allow problem areas or conditions to be identified, discussed



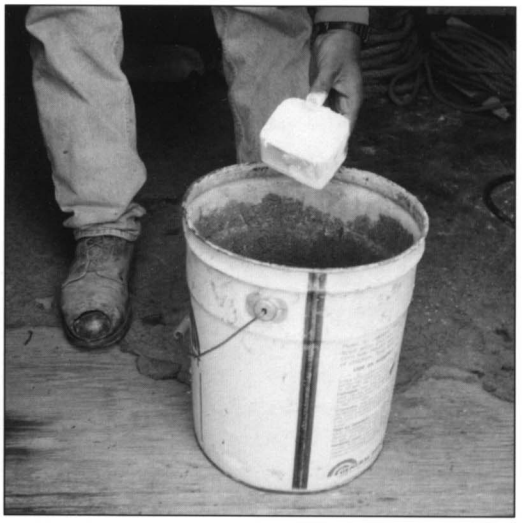
D. The reaction between the acid and the crushed mortar will produce a cloudy liquid above a sandy residue which will settle to the bottom of the beaker. The liquid often contains fine clay powders from cements or pigments. These can be filtered and dried for later examination.



E. The sand from the bottom of the beaker can be washed to remove the acid by placing it in a tall container and slowly running water over it, taking care not to allow the sand to wash out. The clean sand can then be dried and used as a basis for finding an appropriate sand for the repointing mix.



F. When dry, the sand sample can be examined and matched more easily.



G. Here a plastic container has been cut to size to speed mortar preparation. In this case, a single batch of mortar consisted of 3 units of lime to 9 units of sand. To match the colour of the original mortar, 2 teaspoons of pigment were added, mixed with water first to aid in dispersion.

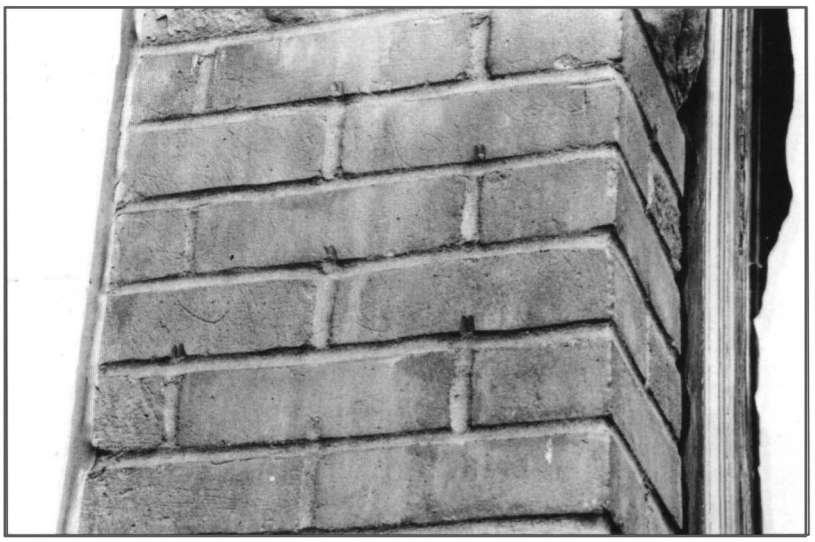


Figure 5: Damage caused to brickwork by a circular saw used to remove mortar from the vertical joints.

and resolved at the outset and will help the contractor to judge his time and cost estimates. The test panel can be used as a reference point throughout the project. To be effective, a test panel should include the range of joint types and problems to be encountered on the job. It should be easily accessible for review as a reference during the remainder of the job but should be in a fairly inconspicuous location so that mistakes or problems which may occur in its preparation will not affect the appearance of the building significantly. Usually a panel two metres square will meet these requirements.

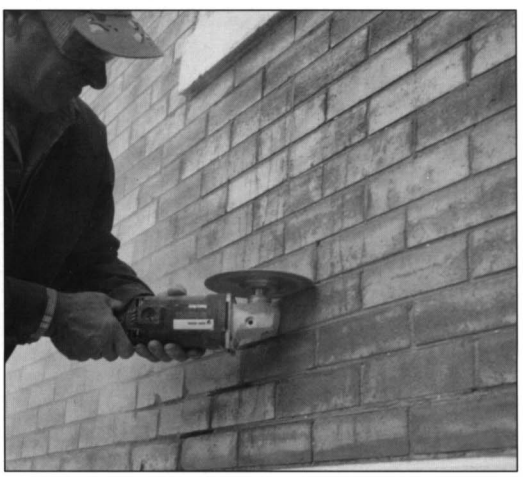
Preparing the Joints

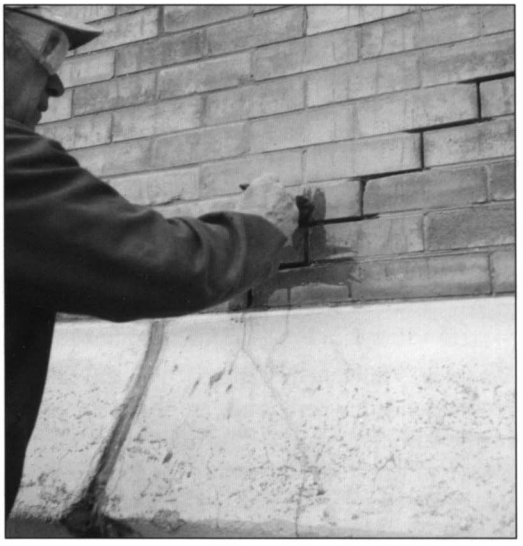
All loose and damaged mortar should be removed, including areas of the wall where the mortar is crumbling, powdery or cracked. Areas which have been previously "repointed" with inappropriate materials such as portland cement or even caulking, should be treated as damaged joints and repointed. *Sound joints should be left alone.*

As a general rule mortar removal is done to a depth of 2 to 2½ times the width of the joint. In brick buildings this will usually mean removal to a minimum depth of 25mm. When the joint is extremely narrow (3mm) the mortar should be removed to a minimum depth of 10mm. This will ensure that the new mortar can be adequately keyed to the wall. In any case, all loose or damaged mortar should be removed, regardless of the subsequent depth to be filled. Mortar should be cleanly removed from both the top and bottom faces of a joint, and the joint should be left as square as possible at the back.

A great deal of damage can be done to historic masonry when mortar is being removed as a prelude to repointing. For this reason only experienced masons should carry out this task so that care is taken not to damage the surrounding brick or stonework. Hand tools are recommended to avoid the chipping and cutting which inevitably accompanies the use of rotary saws and power chisels. Where the masonry is exceptionally soft, "chisels" made from hardwood can be used. However, the presence of portland cement mortar may make the use of power tools necessary. In this instance, it may be helpful to cut a narrow groove down the

Figures 6 & 7: In the hands of a skilled mason, a circular saw may be an effective tool for mortar removal. In this repointing project at a Provincial Historic Resource, mortar replacement was necessary to repair a series of cracks which had opened as a result of nearby construction. As the mortar itself was relatively hard and sound, use of the power tool was allowed, but restricted to the horizontal joints. Mortar from the vertical joints was removed using a chisel. [Charlie Wildermann of Pockar Masonry (Northern) Ltd., working on Old St. Stephen's College, Edmonton.]





Figures 8 & 9: The final step in joint preparation is to ensure that all loose mortar has been removed. Here the joint is first brushed out and then rinsed with water.

middle of the joint. This provides a point of weakness, allowing actual removal to be accomplished by chisel.

Often a mason will argue that the use of power tools will result in a quicker and therefore less expensive job. When the cost in time and materials for replacing the invariably damaged masonry units is taken into account, however, the overall costs are usually equal.

Although it has been demonstrated that, in the hands of experienced masons, power tools can be effectively and safely used, and that even hand tools in the hands of inexperienced persons can cause damage, the selection of the final approach to mortar removal is one of common sense. When supported by concern on the part of the mason for the sensitivity of this aspect of the repointing process, and by on-going monitoring of the work in progress so that methods can be altered where necessary, the most effective approach to mortar removal will be achieved. (See Figures 6 & 7.)

The final stage in joint preparation is to rinse them thoroughly to remove any fine particles which may remain, normally one day before repointing. The joint should still be damp to prevent rapid water loss from the new mortar. However, to reduce the possibility of voids in the mortar caused by water drops, it must not be overly wet. (See Figures 8 & 9.)

Filling the Joints

The joint filling aspect of repointing work should be carried out when the temperature is between 5 and 25 degrees C to avoid either the possibility of frost or too-rapid drying of the mortar. To avoid the possibility of frost damage, it is often recommended that repointing not be carried out within a week of the earliest or latest recorded frost dates for the locale.

When preparing the mortar, care should be taken to mix the components thoroughly to ensure uniformity throughout the job. As lime-based mortars begin to set within half an hour, each mason should prepare only enough to last this period of time. Keeping mortar workable by "retempering" or adding water will weaken the mortar. To ensure a well-compacted and waterproof joint, the mortar must be applied in successive stages. First, all areas which have been cut deeply should be filled level with new mortar. The joint can then be filled in three successive steps, with the first and second filling roughly 2/5 of the joint each, and the final step the remaining fifth. Each layer should be carefully compacted and allowed to dry thumbnail hard prior to continuing. This "three layer" application will produce greater compaction. By using successive layers, the cracks which may have formed in the previous one will be filled, ensuring a watertight joint (Figure 10).

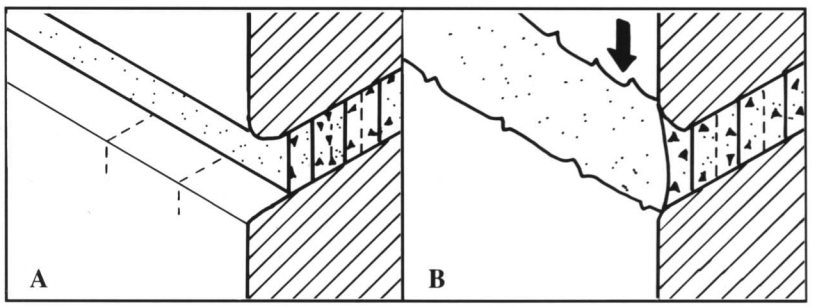


Figure 10: Joint filling and tooling during repointing

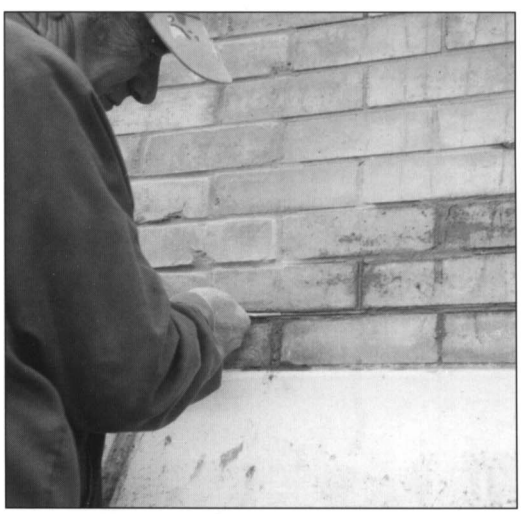
Prior to repointing, joints should be cleaned of all loose or damaged mortar, taking care to remove mortar completely from the top and bottom of the joint, and to leave the face of the remaining mortar square. The joint is then filled in successive stages. The first two should each fill 2/5 of the depth of the cleaned joint while the final stage should fill the remaining fifth.

Where rubble work is being repointed, or where bricks have lost their crisp arrises, the finished joint should be left slightly recessed (A). Mortar should never be spread or buttered over the rounded edges of adjacent masonry (B). The resulting "feathered edge" will easily crack, allowing water to penetrate into the joint. (Source: R.C. Mack, J.S. Askins, "An Introduction to Repointing", p.59.)

While the "three layer" approach is generally recommended, where joints are thin there may not be sufficient mortar mass to allow the mason to work the mortar into the joint. Where this is the case repointing as a single operation may be necessary.

Final Tooling

Once the final layer has been filled and allowed to dry thumbnail hard, it should be tooled to match the original joints. Generally, head or vertical joints were tooled first, but the original method should be followed. Excessive tooling will bring the finer components of mortar to the surface, producing a lighter colour than anticipated. Tooling when the mortar is still too soft will give the same result, in addition to "tool burning", which shows as dark streaks along the joint. Where the masonry has lost its crisp arris or edge, the mortar should be left recessed (Figure 10). This avoids the cracking, spalling, and subsequent water penetration at the joint which can result from a "feather edge" (Figures 11 & 12).



Figures 11 & 12: Mortar is pushed into the prepared joint using a thin pointing tool. When the final layer of mortar has dried thumbnail hard, it is given the appropriate tooled finish, in this case a "beaded" finish.

Aging Mortar Joints

When the repointing job is completed, the new joints may not initially match the old. This is because they have been matched to the unweathered appearance of the old. They will usually be darker and will lack the variegated colour which results from the presence of more sand grains closer to the surface. As the new joints weather, exposing more of the sand, this difference will diminish. Where such concerns are noticed during the test panel stage, it may be possible to rub the joints gently with burlap or other rough fabric, or to stipple them with a brush, to bring out the sand. A similar result can be achieved by spraying the joints with a fine mist of water after the final tooling. Such approaches should be carefully tested before any general use.

Curing and Clean-up

Lime mortars harden over a long period of time, although their initial set may be achieved fairly quickly. In fact setting and hardening are two separate processes. Setting occurs as the mortar dries and some of the hydrated lime crystalizes. Hardening takes place over a long period of time through carbonation, as carbon dioxide combines with the hydrated lime to form calcium carbonate. To ensure proper hardening, mortar should not be allowed to dry

out too quickly. This is accomplished by "curing" the mortar, or keeping it damp for a few days following the repointing. Curing can be achieved by draping the masonry with plastic sheets to prevent evaporation or by covering with burlap and keeping this gently moistened. When weather is dry and hot, extra care should be taken.

Little clean-up should be required following a repointing job if the work has been properly carried out. Where spills of mortar do occur, they should be left to dry, and then removed with a nylon brush. Should efflorescence occur following repointing, it will likely weather away naturally. If it persists, it can usually be removed by brushing.

Conclusion

Repointing can be both an expensive and time consuming process. For this reason a repointing project should be carefully scheduled and carried out. Normally, repointing work is done after all stone replacement and cleaning has been completed, with the final pointing of repaired areas done last. To make maximum use of scaffolding, all work which will require it should be scheduled to coincide with or precede repointing. If properly carried out, the process adds decades to the life span of the repointed masonry walls.

Keys to Further Information

This **Heritage Note** was prepared from a variety of sources and from information gained through projects carried out by the Historic Sites and Archives Service of Alberta Culture and Multiculturalism. The following documents which were used in its development are located in the library and technical files of the Service:

Cliver, E. Blaine. "Tests for the Analysis of Mortar Samples." *The Bulletin of the Association for Preservation Technology*, Vol. VI, No. 1, 1974, pp. 68-73.

Davidson, J. I. "Masonry Mortar, CBD No. 163." *Canadian Building Digest*, Ottawa: National Research Council of Canada,1974.

Ferro, Max, and Russack, Tom, "Assessing the Condition of Masonry." *The Old House Journal 1987 Yearbook*, Brooklyn, N.Y.: The Old House Journal Corp., 1988, p. 28.

Herman, Frederick. "Masonry Repointing." *The Old House Journal*, Vol. VII, No. 6, June 1979, pp. 61, 66-68.

Jedrzejewska, H. "Old Mortars of Poland, A New Method of Investigation." *Studies in Conservation*, Vol. 5, No. 4,1960, pp.132-138.

Mack, R. C.; Tiller, de Teel Patterson; and Askins, J. S, "Repointing Mortar Joints in Historic Buildings." *Preservation Briefs: 2* Washington, D.C.: Heritage Conservation and Recreation Service, U.S.Department of the Interior, 1980.

Mack, R. C., and Askins, J. S. "An Introduction to Repointing." *The Bulletin of the Association for Preservation Technology*, Vol. XI, No. 3, 1979, pp. 44-60.

McKee, Harley. *Introduction to Early American Masonry: Stone, Brick, Mortar and Plaster.*

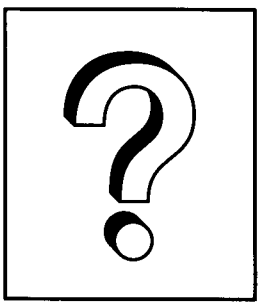
Phillips, Morgan, ed. "SPNEA-APT Conference on Mortar, 1973." *The Bulletin of the Association for Preservation Technology*, Vol. VI, No. 1, 1974.

_____. "Brief Notes on the Subjects of Analyzing Paints and Mortars and the Recording of Moulding Profiles." *The Bulletin of the Association for Preservation Technology*, Vol. X, No. 2, 1978, pp. 79-85.

Weaver, Martin. "Keeping it Together: Mortars in Old Buildings". *Canadian Heritage*, August 1982, pp. 43-46.

Williams, Gilbert. *Repointing Stone and Brick Walling*. London: The Society for the Protection of Ancient Buildings, 1979.

Woroch, G. S. "How to Repoint." *The Old House Journal 1987 Yearbook*. Brooklyn, N.Y.: The Old House Journal Corp., 1988, pp. 13-17.



Footnotes

1) This system for evaluating the condition of mortar is based on one devised by restoration architect Max Ferro and masonry conservator Tom Russack which was presented together with a similar procedure for brick evaluation in the following article: "Assessing the Condition of Masonry", *The Old House Journal*, Jan/Feb. 1987, p. 28.

2) The question of the need for mortar analysis has been raised by many practitioners and a number of detailed methods for the analysis of mortar have been developed. Three of these can be found in the following publications:

   American Society for Testing Materials. "Standard Method of Test for Cement Content of Hardened Portland Cement Concrete, Designation C85-66." 1971 *Annual Book of ASTM Standards, Part 10*, 1971, Philadelphia, pp. 42-45.

   Cliver, E. B. "Tests for the Analysis of Mortar Samples." *The Bulletin of the Association for Preservation Technology*, Vol. VI, No 1.,1974 pp. 68-73.

   Jedrzejewska, H. "Old Mortars of Poland: A New Method of Investigation." *Studies in Conservation*, Vol 5, No. 4,1960, pp.132-138.

These three articles are compared by John Stewart and James Moore in "Chemical Techniques of Historic Masonry Mortar Analysis" in the *Bulletin of the Association for Preservation Technology*, Vol. XIV, No. 1, 1982, pp. 11-16. The authors of this article point out that none of these tests correctly analyzed all of a series of eight standard samples they tested, although they believed the system presented by Jedrzejewska to be the most accurate.

Morgan W. Phillips, in "Brief Notes on the Subjects of Analyzing Paints and Mortars and the Recording of Moulding Profiles" (*Bulletin of the Association for Preservation Technology*, Vol. X, No. 2, 1977, pp 77-85) argues that given the difficulties in accurately determining the exact constituents of historic mortars, analysis should be limited to fairly simple and straightforward assessments of an older mortar's strength alone. He also presents a system for matching mortar colours, given above.

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