

Repointing Mortars for Older Masonry Buildings— Site Considerations

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This Update presents information critical to the successful application of repointing mortars for the conservation of older masonry buildings.

This Update should be read in conjunction with Update No. 67: Repointing Mortars for Older Masonry Buildings—Design Considerations.

Repointing of older masonry buildings typically involves the use of low-strength mortars and requires more care and attention to detail than modern masonry construction. Many factors come into play both in the selection of suitable mortars and in their application. Design and selection issues were addressed in a previous Update. Here, the focus is on application, including scheduling of the work, qualifications of the workers, preparation of the mortar joint, mixing, application of the mortar, and curing. The specifications for a project should describe in detail what is expected in each of these areas.

Pre-construction Considerations

Before construction begins there are several important aspects to consider, to ensure a successful repair.

Selection of qualified contractors. Selection of contractors experienced in the restoration of older masonry is vital. Accreditation of the contractor gives assurance that the workers executing the job have received appropriate training by a recognized organization. In the case of historic structures a minimum number of years experience in



Figure 1. Repointing is the process of removing the outer (deteriorated) layer of mortar and replacing it with new mortar.

conservation work would be a good starting point. For example, PWGSC has suggested that the mason have over five years of experience in a similar type of work following accreditation, or work under the supervision of someone with such experience. Quality of previous jobs could also be used to assess the qualification of the contractor.

Some colleges and historic masonry conservation organizations offer training courses on masonry restoration. Mortar manufacturers also offer hands-on training for use of their products.

Seasonal considerations. Time of year and weather can be a constraint on a project. Low-strength mortars are sensitive to extreme climate conditions during application and curing. For example, freezing conditions and high temperatures leading to rapid drying will have a detrimental effect on the durability of the mortar. In northern climates the window of opportunity for repointing can be quite short.

Building occupancy issues. It is important to ensure that repointing work does not cause undue disruption for building occupants or visitors. Scaffolding may need to be in place for extended periods and joint preparation can be very noisy and dusty. These conditions can affect the operation of the building and need to be taken into account in the scheduling of the work.

Test panels. The contractor should prepare representative test sections in an out-of-the-way part of the building. This way the contractor can set the benchmark for an acceptable standard of quality as work proceeds. These test panels can be used to assess the mason's skill and confirm the mortar colour, texture and joint finishes that have been selected for the job.

Joint Preparation

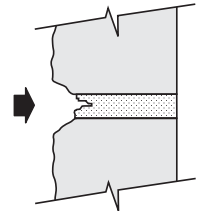
Preparing the joint is the critical first step in the repair work. It must be done carefully so as to enable good compaction of the fresh mortar into the joint and good bonding to both the masonry units and the bedding mortar. Incorrect procedures, improper tools or inadequate skills can result in damage to the edges of masonry units, which not only affects their visual character but can also increase the chance of weather damage.

A clear rectangular space must be raked in the joint for placing the repointing mortar (Figure. 2). In general the depth of the raking should be twice the thickness of the joint. With thin mortar joints, only the deteriorated areas should be raked to avoid damaging the masonry units. Loose material

Incorrect

Mortar not cleaned out to a sufficient, uniform depth

Edges of masonry unit damaged by tool or grinder. Creates a wider joint.



Correct

Mortar cleaned out to a uniform depth

Undamaged edges of masonry unit

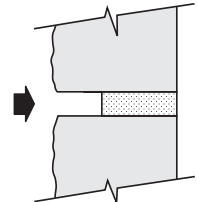


Figure 2. Correct and incorrect ways of raking the joint in preparation for repointing

further inside the joint should also be removed. The deeper the joint, the more difficult it is to compact fresh mortar properly into it. With extensive or deep raking of joints the stability and stresses in the wall should be evaluated before deciding on the area of wall to be repointed at any one time.

Manual tools such as hand chisels or small pneumatic chisels are traditional methods of removing old mortar, as they minimize the risk of damage to the masonry units. Power saws and grinders should not be used on masonry with thin joints, nor on vertical joints, as there is a higher risk of damage to the edges of the masonry units. However, on wide and uniform horizontal joints, careful use of a power grinder or saw in the middle of the joint can help break hard mortar; the raking of the joint is then completed with a hammer and chisel. This may also be necessary with softer stones laid in a harder existing mortar, using the grinder to cut the centre of the joint to facilitate removal of the mortar. Before power tools are used a test should be carried out to confirm the procedure and the operator's experience.

After raking, the joints should be brushed or vacuumed, then washed out with a water jet from the top of the masonry area down, to remove any remaining debris and dust.

Mortar Mixing

Mortar materials should be stored in a dry area. Sand should be protected from contamination from ground materials and from rain. Batching (measuring) mortar ingredients by weight gives much better uniformity between batches of mortar than the common industry practice of batching by volume. Volume batching introduces larger variations because the level of compaction in measuring containers varies with the individual doing it (therefore one person should be responsible for the batching). As well, sand can increase in volume up to 30% when it becomes damp, resulting in variations in mortar strength.

The specified mortar mix may be based on either a dry or “damp” sand (CSA A179 assumes sand in the mix proportions is in a damp state). This specification must be taken into account when batching mortar ingredients on site. It is advisable to check before and during construction to determine how damp the sand actually is and to adjust the mix proportions to allow for changes in the moisture content of the sand. To help obtain a consistent degree of dampness throughout the project, the sand can be protected from direct exposure to the elements (e.g., stored in a box or protected from sun and rain). Bagged pre-mix mortars, which only require the addition of water, offer one solution to the variability of on-site batching.

Mortar ingredients should be mixed into a homogeneous state. Mechanical mixing is preferred, using a standard paddle mortar mixer or a mortar mill (normally used for mortars with lime putty as the main binder). Small amounts of mortar can also be mixed using a hand drill with a whisk attachment used for plaster, or vigorously by hand, mixing no more than needed at one time. Mix procedures should be specified before work begins. A thorough blending of the ingredients is required. The procedures differ depending on the binders used (see manufacturers’ specifications for guidance). Plasticity improves with mixing time, although care must be taken if an air-entraining agent has been added, as too much mixing may introduce excessive air into the mix. Usually a maximum of five minutes wet mixing is recommended.



Figure 3. The Vicat cone is dropped into a cylinder of mortar; the depth of penetration provides an indication of the mortar consistency.

Sometimes the mortar is allowed to stand for a short while after mixing to allow good wetting of the ingredients. This can be especially important if dry sand has been used (e.g., pre-mix mortars). A brief remixing and addition of any extra water occurs after this period.

The total volume of water necessary for a mortar mix will depend on the weather conditions. Often this is left to the judgment of the mason on site; however, there are some points to consider. The amount of water added to mix a repointing mortar is less than the amount added for mixing a bedding mortar for laying masonry units. A drier mortar is cleaner to work with (less risk of staining the units around the joints), can be compacted into the joint better and will be less prone to shrinkage during curing. Conversely, a repointing mortar can be too dry. An excessively dry mortar may not activate air-entraining agents, which are added to the mix to improve frost resistance. The end result will be a mortar that performs poorly. A Vicat cone test (ASTM C780) can be used quickly on site to help ensure consistent workability for a particular mix (Figure 3). Repointing mortars should have a Vicat cone reading of approximately 15-30 mm, depending on the type of mortar and site conditions.

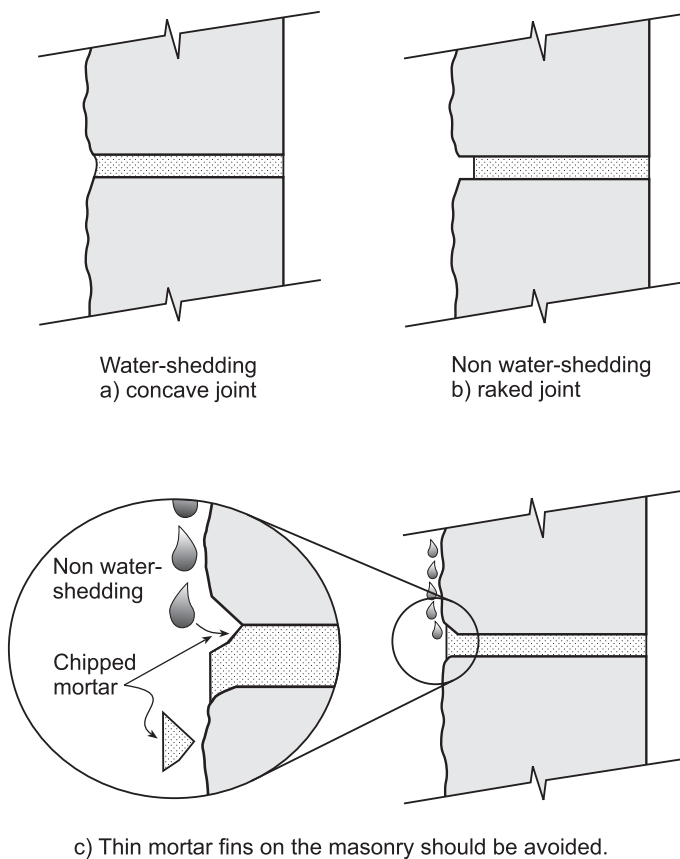


Figure 4. Different types of joint tooling

In warm weather, the mortar container should be covered with a damp cloth to prevent drying (the Vicat cone can be used to assess any reduction in workability). When air temperatures are likely to exceed 27°C, repointing should be postponed.

Mortar Application

Repointing should be done from the top of the façade down, in the shade, away from strong sunlight. Shade can be provided by modifying the scaffolding. The joint should first be wetted to minimize the loss of water from the fresh mortar into the masonry by capillary action. Pre-wetting also keeps the joint damp longer, allowing better curing of the mortar while reducing the risk of staining during application. The extent of pre-wetting will depend on the water absorption capacity of the masonry and the temperature. When repointing is started there should be no surface water on the joint.

The quality of compaction of the fresh mortar into the joint will affect its bond with the substrates (as well as its freeze-thaw resistance). A short pointing iron allows more pressure to be exerted. For joints less than 25 mm deep, successive layers can be repointed without interruption. For deep repointing (backpointing), one should point the first layer only, leaving a rough surface texture, then wait a day. The next step is to rewet the joint and continue with the repointing. Care should be taken not to smear mortar onto the masonry units. Thin joints may require protective tape to avoid staining of the units.

Portland cement-lime mortar mixes should be used within two hours of adding water to the mix when the air temperature is less than 25°C (1½ hours for higher temperatures). Mixes containing hydraulic lime can be used over longer periods (up to 24 hours depending on hydraulicity), and lime-sand mortars can be kept indefinitely provided they remain damp. Re-tempering (remixing with a small addition of water) may be required if the mortar becomes too dry. Portland cement-lime mortar mixes should only be retempered once. Mortars that contain a colouring additive should not be retempered as it can affect the final colour of the mortar.

The final finish (tooling) of the mortar joint affects its water-shedding ability (Figure 4). The mortar should not extend onto the surface of the masonry units. Thin fins of mortar extending onto the face of the masonry unit easily spall and collect water; they also make the mortar joint look thicker than it actually is (see Figure 4c). Standard finishes range from concave (4a—best compaction and weather tightness) to raked (4b—worst). If the masonry units have worn rounded edges, it is best to slightly recess the mortar away from the face. Texture can also be adjusted by using a stiff brush to tap the mortar after its initial set (thumb print hard). For historic masonry and for aesthetic effect, alternative finishes can be used and special tools may be needed.

Natural bristle or nylon brushes can be used to remove small pieces of mortar at the edge of the repointed joint after the mortar has become thumb print hard. If the work was carefully executed, there is no need for any other cleaning. Washing the masonry can lead to leaching of the lime out of the mortar and staining of the masonry.

Mortar Curing and Protection

Rapid drying of the mortar should be avoided because it can lead to shrinkage cracks. Fresh mortar joints should be protected from rain, wind and sun and kept damp for three to seven days. Mixes with slower-hardening hydraulic binders such as hydraulic lime should preferably be damp-cured for a minimum of seven days. Three to four days can be sufficient for Portland cement mixes. Damp curing can be achieved by installing a wet burlap fabric (covered by a plastic sheet) onto the masonry with regular re-wetting of the burlap before it dries (it should be kept a short distance away from the masonry to avoid mortar staining). Regular misting of the masonry alone is an unreliable method as evaporation from the masonry surface can occur quite quickly in warm, dry and windy weather. If misting is used, water should not run off the joints, as staining may result from lime leaching out of the joint.

Repointing should be done well before or well after freezing weather. If work has been unavoidably delayed to the cold season, additional measures to protect the fresh mortar from possible freezing conditions should be taken (e.g., the construction of a temporary heated enclosure). For 1:2:8 Portland cement/lime and stronger mortars the recommended curing would be as follows:

- For the first 3 days, the masonry should be maintained at a temperature above 10°C while the damp curing (using a damp burlap covered with a plastic membrane) takes place. This should extend for 7 days in the case of weaker mortars.
- For the next 4 days, the masonry should be protected against wind and rain while keeping the temperature above 0°C

(the damp burlap and plastic should be removed at this point). This will allow the mortar to partially dry before exposure to frost. However, excessive drying of the mortar (heating cold air has the effect of lowering its relative humidity) should be avoided; a high relative humidity level should be maintained within the heated enclosure. For very-low-strength mortars a longer period of protection from precipitation may be needed.

Quality Control

The conservation consultant in charge of supervision and quality control should visit the site more regularly than in the case of modern masonry projects. Quality workmanship is much more important with low-strength mortars to ensure good performance. Inspections after the joints have been raked out, cleaned and squared off, after any deep (>25 mm) backpointing has been done and after the joints have been repointed will help ensure a high-quality job.

Quality control includes tests for compressive strength of mortar cubes, bulking of sand (change in volume due to moisture content of the sand), air content of the fresh mortar, binder/sand ratio, and mortar consistency. The Vicat cone test can be used to immediately check the consistency of the mortar mix and to monitor water loss during hot weather.

Maintenance

After completion of the work, a maintenance manual should be produced to assist the building owner. The manual should document the evaluation of the masonry carried out before the work started, the materials used for the repointing and the application practices. Recommendations on regular visual inspection for signs of deterioration should be provided, ideally in a checklist format, as well as a schedule and mortar recipes for future maintenance. Space should be left to record this maintenance when it occurs. If de-icing salt must be used around the building, more frequent inspections should be undertaken.

Summary

The repointing of older masonry buildings differs from new construction and extra care is required to ensure a successful project. The following are important elements to consider:

- Only contractors, masons and professionals experienced in conservation work should undertake historical restoration projects.
- Special consideration must be given to site conditions such as the scheduling of the work, the preparation of the joint, the mixing of the mortar, the application procedures, and curing.
- Protection should be provided as necessary against freezing conditions.
- Careful quality control must be exercised as low-strength mortars are less forgiving of mistakes.
- Regular maintenance should be undertaken in order to avoid problems that will shorten the service life of the structure.

Complementary Reading

Maurenbrecher, A.H.P., Trischuk, K., Rousseau, M.Z., Subercaseaux, M.I., Repointing Mortars for Older Masonry Buildings—Design Considerations, Construction Technology Update No. 67, Institute for Research in Construction, National Research Council of Canada, March 2008.

Maurenbrecher, A.H.P., Trischuk, K., Rousseau, M.Z., Subercaseaux, M.I., Key Considerations for Repointing Mortars for Conservation of Older Masonry, Research Report No. 225. Ottawa, 2007. Institute for Research in Construction, National Research Council of Canada, Jan. 2007. <http://irc.nrc-cnrc.gc.ca/pubs/rr/rr225/index.php?lang=e>

ASTM C780. *Standard test method for pre-construction and construction evaluation of mortars for plain and reinforced unit masonry*, American Society for Testing and Materials. West Conshohocken, PA.

CSA A179-04. *Mortar & Grout for Unit Masonry*. Canadian Standards Association, 2004.

Maurenbrecher, A.H.P., Trischuk, K., Subercaseaux, M.I., and Suter, G., *Cold Weather Protection Requirements for a Low Strength Repointing Mortar*, Proceedings 10th Canadian Masonry Symposium, Banff, AB, June 2005. <http://irc.nrc-cnrc.gc.ca/pubs/fulltext/nrcc47719/>

The masonry Web site of the NRC Institute for Research in Construction provides further information about repointing mortars and links to other Web sites: http://irc.nrc-cnrc.gc.ca/bes/hmpe/masonry/index_e.html

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