5.6 Masonry Technical Guidelines

5.6.1 INTRODUCTION

Masonry is defined as “Stone, brick, or similar elements installed so that the weight of the unit bears on the one below, typically with mortar in the joints between the units.” Types of masonry typically used in north Texas include load-bearing brick walls, brick veneer, concrete block and stonework. Also used are cast stone windowsills, lintels and limited amounts of stone trim and veneer at commercial and residential buildings. These guidelines shall primarily address brick and stone materials.

Refer to ‘Masonry Design Guidelines,’ section 4.6, for design information regarding masonry in historic properties.

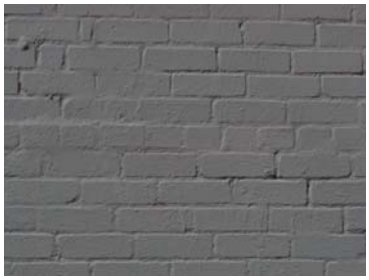
5.6.2 CLEANING OF MASONRY BUILDINGS

The reasons for cleaning any building must be considered carefully before arriving at a decision to clean. Is the cleaning being done to improve the appearance of the building or to make it look new?

The general nature and source of 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 discolored portion of the masonry itself rather than extraneous materials. Removal of part of the masonry thus would be required to obtain a "clean" appearance, leading to loss of detail and gradual erosion of the masonry. Other common cleaning problems include metal stains such as rust or copper stains, and organic matter such as the tendrils left on the masonry after removal of ivy. The source of dirt, such as coal soot, may no longer be a factor in planning for longer term maintenance, or it may be a continuing source of problems. Full evaluation of dirt and its effect on the building may require one or several kinds of expertise: consultants may include building conservators, geologists, chemists, and preservation architects.

Removal of Paint at Masonry: If the proposed cleaning is to remove paint, it is important in each case to learn whether or not exposed brick is historically appropriate. Many buildings were painted at the time of construction or shortly thereafter; retention of the paint, therefore, may be more appropriate historically than exposing the brick, in spite of current attitudes about "natural" brick. Even in cases where unpainted masonry is appropriate, the retention of the paint

may be more practical than removal in terms of long-range preservation of the masonry. In some cases, however, removal of the paint may be desirable. For example, the old paint layers may have built up to such an extent that removal is necessary prior to repainting.



PAINTED BRICK

PAINTED BRICK STOREFRONT

Types Of Cleaning: Cleaning methods generally are divided into three major groups:

- Water
- Chemical
- Mechanical (abrasive).

The potential effect of each proposed method of cleaning on the environment should be evaluated carefully. Chemical cleaners, even though diluted, may damage trees, shrubs, grass, and plants. Animal life, ranging from domestic pets to song birds to earth worms, also may be affected by the runoff. In addition, mechanical methods can produce hazards through the creation of airborne dust.

The proposed cleaning project also may cause property damage. Wind drift, for example, may carry cleaning chemicals onto nearby automobiles, causing etching of the glass or spotting of the paint finish. Similarly, airborne dust can enter surrounding buildings, and excess water can collect in nearby yards and basements. The potential health dangers of each method proposed for the cleaning project must be considered relative to personal safety, and the dangers must be avoided.

Several potentially useful cleaning methods should be tested prior to selecting the one for use on the building. The simplest and least dangerous methods should be included as well as those more complicated. All too often simple methods, such as a low pressure water wash, are not even considered, yet they frequently are effective, safe, and least expensive. It is worth repeating that these methods should be tested prior to considering harsher methods; they are safer for the building, safer for the environment, and less expensive.

Test Patch: Cleaning tests, whether using simple or complex methods, should be applied to an area of sufficient size to give a true indication of effectiveness. The test patch should include at least a square yard, and, in buildings with stone veneer, should include several stones and mortar joints. It should be remembered that a single building may have several types of masonry materials and similar materials may have different surface finishes; each of these differing areas should be tested separately. The results of the tests may well indicate that several methods of cleaning should be used on a single building.

Water Cleaning: Water methods of cleaning soften the dirt and rinse the deposits from the surface, and include: (1) low pressure wash over an extended period, (2) moderate to high pressure wash, and (3) steam. Bristle brushes frequently are used to supplement the water wash. All joints, including mortar and sealants, must be sound in order to minimize water penetration to the interior.

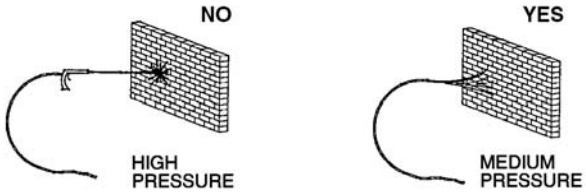
Porous masonry may absorb excess amounts of water during the cleaning process and cause damage within the wall or on interior surfaces. Normally, however, water penetrates only part way through even moderately absorbent masonry materials.

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

efflorescence; in dry climates, the water may evaporate inside the masonry, leaving the salts slightly in back of the surface. Efflorescence usually can be traced to a source other than a single water wash.

Another source of surface disfigurement is chemicals such as iron and copper in the water supply; even "soft" water may contain deleterious amounts of these chemicals. Water methods cannot 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.

In spite of these potential problems, water methods generally are the simplest to carry out, the safest for the building and the environment, and the least expensive.



WATER PRESSURE WHEN CLEANING MASONRY

Chemical cleaning: Chemical cleaners react with the dirt and/or masonry to hasten the removal process; the deposits, reaction products ducts and excess chemicals then are rinsed away with water. Since most chemical cleaners are water based, they have many of the potential problems of plain water. Chemical cleaners have other problems as well. 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 caused by the chemicals, not by removal of dirt; the cleaner also may 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 efflorescences, as mentioned earlier. Historic brick buildings are particularly susceptible to damage from hydrochloric (muriatic) acid, although it is, unfortunately, widely used on these structures.

Mechanical cleaning: Mechanical methods include grit blasting (usually sand blasting), grinders, and sanding discs, which remove the dirt by abrasion and usually are followed by a water rinse. Grit blasters, grinders, and sanding discs all operate by abrading the dirt off the surface of the masonry, rather than reacting with the dirt and masonry as in water and chemical methods. Since the abrasive does not differentiate between the dirt and the masonry, some erosion of the masonry surface is inevitable with mechanical methods, especially blasting. Although a skilled operator can minimize this erosion, some erosion will still take place. Mechanical methods should never be used on brick, soft stone, detailed carvings or polished surfaces and should be used with extreme caution on others.

Grit blasting, unfortunately, still is widely used in spite of these serious effects. In most cases, blasting will leave minute pits on the surface of the masonry. This additional roughness actually increases the surface area on which new dirt can settle and on which pollutants can react.

Mortar joints, especially those with lime mortar, also can be eroded by mechanical cleaning. In some cases, the damage may be visual, such as loss of joint detail or increased joint shadows. Joints constitute a significant portion of the masonry surface (up to 20% in a brick wall) so this change should not be considered insignificant. In other cases, however, the erosion of the mortar joint may permit increased water penetration, leading to the necessity for complete repointing.

5.6.3 WATER REPELLENT AND WATERPROOF COATINGS

Coatings frequently are applied to historic buildings without concern for the cause of any water infiltration or the consequences of the coating. Water penetration to the interior usually is not caused by porous masonry but by deteriorated gutters and down spouts, deteriorated mortar, capillary moisture from the ground (rising damp), or condensation. Coatings will not solve these problems.

Coatings may make existing adverse conditions worse; in the case of rising damp the coatings will allow the water to go even higher because of the retarded rate of evaporation. The claim also is made that coatings keep dirt and pollutants from collecting on the surface of the building thus reducing the requirement for future cleaning. While at times this may be true, at other times the coatings actually retain the dirt more than uncoated masonry. More important, however, is that these coatings can cause greater deterioration of the masonry than that caused by pollution, so the treatment may be worse than the problem one is attempting to solve.

Waterproof coatings seal the surface from liquid water and from water vapor; they usually are opaque, such as bituminous coatings and some paints. These coatings usually do not cause problems as long as they exclude all water from the masonry. However, if water does enter the wall 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. In addition, the water eventually will get out by the path of least resistance. If this path is toward the interior, damage to interior finishes can result; if it is toward exterior cracks in the coating, it can lead to damage from the buildup of salts as described below.

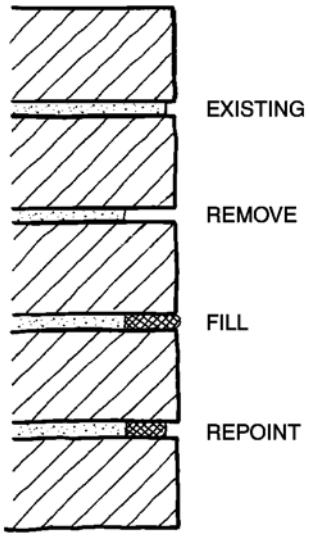
Water repellents keep liquid water from penetrating the surface but allow water vapor to enter and leave through the "pores" of the masonry. They usually are transparent, such as the silicone coatings, although they may change the reflective property of the masonry, thus changing the appearance. Water repellent coatings can also cause serious damage; as they 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, as explained earlier.

This is not to suggest that there is never a use for water repellents or waterproofings. Sandblasted brick, for example, 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. Consideration should be given to treating limited areas of a building 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.

5.6.4 REPOINTING MORTAR JOINTS

A good mortar joint on a masonry wall is meant to last at least 30 years, and preferably 50- 100 years; re-pointing of these joints should be considered as a regular maintenance item for any masonry on a building. The mortar joint in a historic masonry building has often been called a wall's "first line of defense."

Repointing, also known simply as "pointing" or - somewhat inaccurately - "tuck pointing", 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 detracts from the appearance of the building, but may also cause physical damage to the masonry units themselves.



MASONRY REPOINTING

The need to repoint is most often related to some obvious sign of deterioration, such as disintegrating mortar, cracks in mortar joints, loose bricks or stones, damp walls, or damaged plasterwork. However, the root cause of the deterioration - leaking roofs or gutters, differential settlement of the building, capillary action causing rising damp, or extreme weather exposure - should be dealt with prior to beginning work. Without appropriate repairs to eliminate the source of the problem, mortar deterioration will continue and any repointing will have been a waste of time and money.

Repointing is both expensive and time consuming due to the extent of handwork and special materials required. It is preferable to repoint only those areas that require work rather than an entire wall, as is often specified. But, if 25 to 50 per cent or more of a wall needs to be repointed, repointing the entire wall may be more cost effective than spot repointing. Total repointing may also be more sensible when access is difficult, requiring the erection of expensive scaffolding (unless the majority of the mortar is sound and unlikely to require replacement in the foreseeable future). Each project requires judgment based on a variety of factors.

Finding an Appropriate Mortar Match: Preliminary research is necessary to ensure that the proposed repointing work is both physically and visually appropriate to the building. Analysis of unweathered portions of the historic mortar to which the new mortar will be matched can suggest appropriate mixes for the repointing mortar so that it will not damage the building because it is excessively strong or vapor impermeable.

Although not crucial to a successful repointing project, for projects involving properties of special historic significance, a mortar analysis by a qualified laboratory can be useful by providing information on the original ingredients. Analysis requires interpretation, and there are important factors which affect the condition and performance of the mortar that cannot be established through laboratory analysis; these may include: the original water content, rate of curing, weather conditions during original construction, the method of mixing and placing the mortar, and the cleanliness and condition of the sand. The most useful information that can come out of laboratory analysis is the identification of sand by gradation and color. This allows the color and the texture of the mortar to be matched with some accuracy because sand is the largest ingredient by volume.

In creating a repointing mortar that is compatible with the masonry units, the objective is to match the historic mortar as closely as possible, so that the new material can coexist with the old in a sympathetic, supportive and, if necessary, sacrificial capacity. The exact physical and chemical properties of the historic mortar are not of major significance as long as the new mortar conforms to the following criteria:

- The new mortar must match the historic mortar in color, texture and tooling.
- The sand must match the sand in the historic mortar.
- The new mortar must have greater vapor permeability and be softer (measured in compressive strength) than the masonry units.
- The new mortar must be as vapor permeable and as soft or softer (measured in compressive strength) than the historic mortar.

Components of Mortar:

Sand is the largest component of mortar and the material that gives mortar its distinctive color, texture and cohesiveness. The three key characteristics of sand are: particle shape, gradation and void ratios.

For repointing mortar, rounded or natural sand is preferred for two reasons. It is usually similar to the sand in the historic mortar and provides a better visual match. It also has better working qualities or plasticity and can thus be forced into the joint more easily, forming a good contact with the remaining historic mortar and the surface of the adjacent masonry units. Although manufactured sand is frequently more readily available, it is usually possible to locate a supply of rounded sand.

ORNATE MASONRY DETAILS REQUIRE GREAT CARE IN REPOINTING

Mortar formulations prior to the late-19th century used lime as the primary binding material. Lime is derived from heating limestone at high temperatures which burns off the carbon dioxide, and turns the limestone into quicklime. There are three types of limestone - calcium, magnesium, and dolomitic - differentiated by the different levels of magnesium carbonate they contain which impart specific qualities to mortar. Lime mortar is soft, porous, and changes little in volume during temperature fluctuations thus making it a good choice for historic buildings.

Because some of the kinds of lime, as well as other components of mortar, that were used historically are no longer readily available, even when a conscious effort is made to replicate a "historic" mix, this may not be achievable due to the differences between modern and historic materials.

More recent, 20th-century mortar has used portland cement as a primary binding material. A straight portland cement and sand mortar is extremely hard, resists the movement of water, shrinks upon setting, and undergoes relatively large thermal movements. When mixed with water, portland cement forms a harsh, stiff paste that is quite unworkable, becoming hard very quickly. It may be appropriate to add some portland cement to an essentially lime-based mortar even when repointing relatively soft 19th century brick under some circumstances when a slightly harder mortar is required. The more portland cement that is added to a mortar formulation the harder it becomes - and the faster the initial set.

White, non- staining portland cement may provide a better color match for some historic mortars than the more commonly available grey portland cement. But, it should not be assumed, however, that white portland cement is always appropriate for all historic buildings, since the original mortar may have been mixed with grey cement.

Masonry cement is a preblended mortar mix commonly found at hardware and home repair stores. It may contain hydrated lime, but it always contains a large amount of portland cement, as well as ground limestone and other workability agents, including air-entraining agents. Because masonry cements are not required to contain hydrated lime, and generally do not contain lime, they produce high strength mortars that can damage historic masonry. For this reason, they generally are not recommended for use on historic masonry buildings.

Hydrated lime mortars, and pre-blended lime putty mortars with or without a matched sand are commercially available. Custom mortars are also available with color. In most instances, pre-blended lime mortars containing sand may not provide an exact match; however, if the project calls for total repointing, a pre-blended lime mortar may be worth considering as long as the mortar is compatible in strength with the masonry. If the project involves only selected, "spot" repointing, then it may be better to carry out a mortar analysis which can provide a custom pre-blended lime mortar with a matching sand.

Water should be potable - clean and free from acids, alkalis, or other dissolved organic materials.

Other Components: In addition to the color of the sand, the texture of the mortar is of critical importance in duplicating historic mortar. Most mortars dating from the mid-19th century on, with some exceptions, have a fairly homogeneous texture and color. The visual characteristics of these mortars can be duplicated through the use of similar materials in the repointing mortar.

Modern admixtures are used to create specific characteristics in mortar, and whether they should be used will depend upon the individual project. Air entraining agents, for example, help the mortar to resist freeze-thaw damage in northern climates. Accelerators are used to reduce mortar freezing prior to setting while retarders help to extend the mortar life in hot climates. Selection of admixtures should be carefully considered by the owner or the architect as part of the specifications, not something routinely added by the masons.

Generally, modern chemical additives are unnecessary and may, in fact, have detrimental effects in historic masonry projects. The use of antifreeze compounds is not recommended in north Texas. These are not very effective with high lime mortars and may introduce salts, which may cause efflorescence later. A better practice is to warm the sand and water, and to protect the completed work from freezing. Bonding agents are not a substitute for proper joint preparation, and they should generally be avoided. If the joint is properly prepared, there will be a good bond between the new mortar and the adjacent surfaces. In addition, a bonding agent is difficult to remove if smeared on a masonry surface.

Mortar Type and Mix: Mortars for repointing projects, especially those involving historic buildings, typically are custom mixed in order to ensure the proper physical and visual qualities. 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 exactly the same.

Test Panels are recommended for re-pointing; these should be prepared prior to the beginning of the repointing work. The same techniques planned for use on the remainder of the project should be utilized, and should include all types of masonry, joint styles, mortar colors, and other problems likely to be encountered on the job. Usually a 3 foot by 3 foot area is sufficient for brickwork, while a somewhat larger area may be required for stonework. These panels establish an acceptable standard of work and serve as a benchmark for evaluating and accepting subsequent work on the building.

Joint Preparation: Old mortar should be removed to a minimum depth of 2 to 2-1/2 times the width of the joint to ensure an adequate bond and to prevent mortar "popouts." For most brick joints, this will require removal of the mortar to a depth of approximately ½ to 1 inch. Any loose or disintegrated mortar beyond this minimum depth also should be removed.

Mortar should be removed cleanly from the masonry units, leaving square corners at the back of the cut. Before filling, the joints should be rinsed with a jet of water to remove all loose particles and dust. At the time of filling, the joints should be damp, but with no standing water present. For masonry walls that are extremely absorbent (limestone, sandstone and common brick) it is recommended that a continual mist of water be applied for a few hours before repointing begins.

Mortar components should be measured and mixed carefully to assure the uniformity of visual and physical characteristics. Repointing mortar is typically pre-hydrated by adding water so it will just hold together, thus allowing it to stand for a period of time before the final water is added. It is important to keep the water to a minimum for two reasons: first, a drier mortar is cleaner to work with, and it can be compacted tightly into the joints; second, with no excess water to evaporate, the mortar cures without shrinkage cracks. Mortar should be used within approximately 30 minutes of final mixing, and "retempering," or adding more water, should not be permitted.

Filling the Joint: Where existing mortar has been removed to a depth of greater than 1 inch, these deeper areas should be filled first, compacting the new mortar in several layers. The back of the entire joint should be filled successively by applying approximately 1/4 inch of mortar, packing it well into the back corners. This application may extend along the wall for several feet. As soon as the mortar has reached thumb-print hardness, another 1/4 inch layer of mortar - approximately the same thickness - may

be applied. Several layers will be needed to fill the joint flush with the outer surface of the masonry. It is important to allow each layer time to harden before the next layer is applied; most of the mortar shrinkage occurs during the hardening process and layering thus minimizes overall shrinkage.

When the final layer of mortar is thumb-print hard, the joint should be tooled to match the historic joint. Proper timing of the tooling is important for uniform color and appearance. If tooled when too soft, the color will be lighter than expected, and hairline cracks may occur; if tooled when too hard, there may be dark streaks called "tool burning," and good closure of the mortar against the masonry units will not be achieved.

If the old bricks or stones have worn, rounded edges, it is best to recess the final mortar slightly from the face of the masonry. This treatment will help avoid a joint which is visually wider than the actual joint; it also will avoid creation of a large, thin featheredge which is easily damaged, thus admitting water. After tooling, excess mortar can be removed from the edge of the joint by brushing with a natural bristle or nylon brush. Metal bristle brushes should never be used on historic masonry.

Curing Conditions: The preliminary hardening of high-lime content mortars takes place fairly rapidly as water in the mix is lost to the porous surface of the masonry and through evaporation. Periodic wetting of the repointed area after the mortar joints are thumb-print hard and have been finish tooled may significantly accelerate the carbonation process. When feasible, misting using a hand sprayer with a fine nozzle can be simple to do for a day or two after repointing. Local conditions will dictate the frequency of wetting, but initially it may be as often as every hour and gradually reduced to every three or four hours.

Cleaning the Repointed Masonry: If repointing work is carefully executed, there will be little need for cleaning other than to remove the small amount of mortar from the edge of the joint following tooling. This can be done with a stiff natural bristle or nylon brush after the mortar has dried, but before it is initially set (1-2 hours). Mortar that has hardened can usually be removed with a wooden paddle or, if necessary, a chisel.

Further cleaning is best accomplished with plain water and natural bristle or nylon brushes. If chemicals must be used, they should be selected with extreme caution. Improper cleaning can lead to deterioration of the masonry units, deterioration of the mortar, mortar smear, and efflorescence. New mortar joints are especially susceptible to damage because they do not become fully cured for several months.

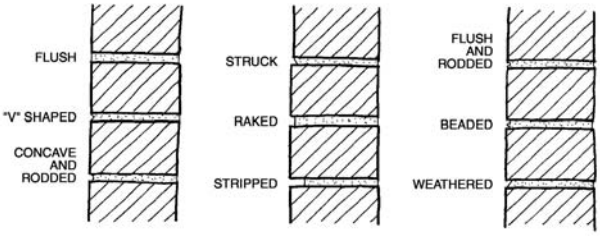
New construction "bloom" or efflorescence occasionally appears within the first few months of repointing and usually disappears through the normal process of weathering. If the efflorescence is not removed by natural processes, the safest way to remove it is by dry brushing with stiff natural or nylon bristle brushes followed by wet brushing. Hydrochloric (muriatic) acid is generally ineffective, and it should not be used to remove efflorescence. It may liberate additional salts, which, in turn, can lead to more efflorescence.

Surface Grouting is sometimes suggested as an alternative to repointing brick buildings, in particular. This process involves the application of a thin coat of cement-based grout to the mortar joints and the mortar/brick interface. The change in the joint appearance can alter the historic character of the structure to an unacceptable degree. Surface grouting cannot substitute for the more extensive work of repointing, and it is <u>not</u> a recommended treatment for historic masonry.

Masonry Joints or Style: There are a wide variety of masonry joints used in historic buildings – flush, V shaped, concave and rodded, struck, raked, stripped, flushed and rodded, beaded and weathered.

Close examination of the historic masonry wall and the techniques used in the original construction will assist in maintaining the visual qualities of the building. Pointing styles and the methods of producing them should be examined. It is important to look at both the horizontal and

the vertical joints to determine the order in which they were tooled and whether they were the same style. Some late-19th and early-20th century buildings, for example, have horizontal joints that were raked back while the vertical joints were finished flush and stained to match the bricks, thus creating the illusion of horizontal bands. Pointing styles may also differ from one facade to another; front walls often received greater attention to mortar detailing than side and rear walls.



MASONRY JOINTS

5.6.5 MASONRY REPAIRS

Masonry, as with any other exterior material, is subject to damage and deterioration from the elements and abuse and accidents from property owners, users and others. When masonry is damaged, it should be repaired in a timely manner to avoid further damage due to lack of protection from the elements.

BRICK PILASTER IN NEED OF REPAIR

Brick details and ornamentation should be retained and repaired when damaged; these are part of the historic character of a historic building or neighborhood and should be retained. Good masonry contractors with experience in working with older buildings can repair historic masonry, and replicate details and ornamentation.