

SECTION 040140.61 – STONE REPAIR

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes repairing stone masonry.
1. Repairing stone/ adjacent brick, including replacing whole units.
 2. Patching stone structures and stone sills.
 3. Removal, salvage and reinstallation of existing stone.
 4. Reset loose, displaced and missing adjacent brick.
 5. Remove paint.
 6. Preliminary cleaning, including removing plant growth.
 7. Cleaning exposed stone surfaces.
 8. Application of water repellent/light consolidator.
- B. Related Sections:
1. Section 040140.62 – Stone Repointing.
- C. Reference and Industry Standards:
1. The following reference standards shall be applicable to this Section:
 - a. The current Enterprise Green Communities (EGC) Criteria, and the current New York City Overlay.
 2. Industry Standards
 - a. ASTM (American Society for Testing and Materials).
- D. The current NYC Overlay of the current Enterprise Green Communities Criteria:
1. Mandatory Requirements: See the NYC Overlay of the EGC reference standard for full specifications.
 - a. All projects must achieve compliance with mandatory criteria measures that are applicable:
 - Criterion 6.4: Healthier Material Selection
 - Criterion 6.10: Construction Waste Management
 2. Optional Project Requirements for Certification Points
 - a. Additionally, rehab projects are required to achieve **55** optional points. Criteria with optional points related to this Specification Section include, but may not be limited to:
 - Criterion 6.1 Ingredient Transparency of Material Health
 - Criterion 6.3 Chemical Hazare Optimization

- Criterion 6.5 Environmentally Responsible Material Selection
- Criterion 6.10: Construction Waste Management

1.2 DEFINITIONS

- A. Rebuilding (Setting) Mortar: Mortar used to set and anchor masonry in a structure, distinct from pointing mortar installed after masonry is set in place.
- B. Very Low-Pressure Spray: under 100 psi; 4 to 6 gpm.
- C. Low-Pressure Spray: 100 to 200 psi; 4 to 6 gpm.

1.3 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on stone units as follows:
 1. Existing Stone: Test each type of existing stone indicated for replacement, according to ASTM C170 for compressive strength, wet and dry, perpendicular and parallel to rift; ASTM C99 for modulus of rupture, wet and dry, perpendicular and parallel to rift; and ASTM C97 for absorption and bulk specific gravity. Carefully remove five (5) existing stones from locations designated by Design-Professional-of-Record. Take testing samples from these stones.
 2. Existing Mortar: Test according to ASTM C295, modified as agreed by testing service and Design-Professional-of-Record for Project requirements, to determine proportional composition of original ingredients, sizes and colors of aggregates, and approximate strength. Use X-ray diffraction, infrared spectroscopy, and differential thermal analysis as necessary to supplement microscopical methods. Carefully remove existing mortar from within joints at five (5) locations designated by Design-Professional-of-Record or testing service.
 3. Existing Mortar of tenement buildings erected before 1929 determine by testing if Portland cement is present. Thermal expansion of Portland cement mortar can damage weaker pre 1929 masonry. Carefully remove existing mortar from within joints at five (5) locations designated by Design-Professional-of-Record or testing service.
 4. Temporary Patch: As directed by Design-Professional-of-Record provide temporary materials at locations from which existing samples were taken.
 5. Replacement Stone: Test each proposed type of replacement stone, according to ASTM C170 for compressive strength, ASTM C99 for modulus of rupture, and ASTM C97 for absorption and bulk specific gravity.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.

B. Shop Drawings:

1. Replacement stone units and their jointing, showing relation of existing to new units.
2. Provisions for expansion joints or other sealant joints.

C. Samples: For each exposed product and for each color and texture specified.

1.6 INFORMATIONAL SUBMITTALS

1. Documentation for compliance with Enterprise Green Communities criteria.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials to site in manufacturer's original unopened containers and packaging, bearing labels as to type and names of products and manufacturers, color numbers and batch numbers.
- B. Protect grout, mortar and other materials from deterioration by moisture and temperature. Store in a dry location or in waterproof containers. Keep containers tightly closed and away from open flames. Protect liquid components from freezing. Comply with manufacturer's recommendations for minimum and maximum temperature requirements for storage.
- C. Comply with the manufacturer's written specifications and recommendations for mixing, application, and curing of grouts and patching materials

1.8 PROTECTION / SITE CONDITIONS

- A. Protect persons, motor vehicles, building site and surrounding buildings from injury resulting from stone repair work.
- B. Cold Weather Requirements: Do not work in temperatures below 40° F, when the substrate is colder than 40° F, or when the temperature is expected to fall below 40° F for 72 hours after installation of repair mortars.
- C. Hot Weather Requirements: Protect repair mortar from direct sunlight and wind. Do not use or prepare mortar when ambient air temperature is above 90° F.
- D. Prevent stone patching materials from staining the face of masonry or other surfaces to be left exposed. Immediately remove all patching materials that come in contact with such surfaces.
- E. Cover partially completed work when work is not in progress.
- F. Protect sills, ledges and projections from droppings.

1.9 SEQUENCING / SCHEDULING:

- A. Perform stone repair work in the following sequence:
 1. Remove biological growth.
 2. Remove coatings, stains and foreign material from all stone surfaces.
 3. Rake-out existing mortar from joints of stonework indicated to be repaired.

4. Repair adjacent brick, including replacing existing brick with new brick materials as indicated.
5. Point mortar joints.
6. Inspect for open mortar joints and repair before cleaning to prevent the intrusion of water and other cleaning materials into the wall.
7. Clean stone surfaces.

PART 2 - PRODUCTS

2.1 STONE MATERIALS

- A. Stone Matching Existing: Natural building stone of variety, color, texture, grain, veining, finish, size, and shape that match existing stone.
 1. Physical Properties for [**Granite**] [**Limestone**] [**Marble**] [**Brownstone**]:
 - a. Compressive Strength: According to ASTM C170.
 - b. Modulus of Rupture: According to ASTM C99.
 - c. Absorption: According to ASTM C97.
 - d. Bulk Specific Gravity: According to ASTM C97.
 2. For existing stone that exhibits a range of colors, texture, grain, veining, finishes, sizes, or shapes, provide stone that proportionally matches that range rather than stone that matches an individual color, texture, grain, veining, finish, size, or shape within that range.
- B. Cutting New Stone: Cut each new stone so that, when it is set in final position, the rift or natural bedding planes will match the rift orientation of existing stones.

2.2 MORTAR MATERIALS

- A. Portland Cement: ASTM C150, Type I or Type II, except Type III may be used for cold-weather construction; white [**or gray, or both**] where required for color matching of mortar.
 1. Provide cement containing not more than 0.60 percent total alkali when tested according to ASTM C114.
- B. Hydrated Lime: ASTM C207, Type S.
- C. Masonry Cement: ASTM C91.
- D. Mortar Cement: ASTM C1329.
- E. Mortar Sand: ASTM C144.
 1. Exposed Mortar: Match size, texture, and gradation of existing mortar sand as closely as possible. Blend several sands, if necessary, to achieve suitable match.
 2. Colored Mortar: Natural sand or ground marble, granite, or other sound stone of color necessary to produce required mortar color.

- F. Mortar Pigments: ASTM C979, compounded for use in mortar mixes, and having a record of satisfactory performance in stone mortars.
 - 1. Use formulation that is vapor and water permeable (equal to or more than the stone), exhibits low shrinkage, has lower modulus of elasticity than stone units being repaired, and develops high bond strength to all types of stone.
 - 2. Formulate patching compound in colors, textures, and grain to match stone being patched.
- G. Cementitious Crack Filler: Ultrafine superplasticized grout that can be injected into cracks, is suitable for application to wet or dry cracks, exhibits low shrinkage, and develops high bond strength to all types of stone.
- H. Stone-to-Stone Adhesive: Two-part polyester or epoxy-resin stone adhesive with a 15- to 45-minute cure at 70 deg F, recommended in writing by adhesive manufacturer for type of stone repair indicated, and matching stone color.

2.3 ACCESSORY MATERIALS

- A. Setting Buttons and Shims: Resilient plastic, non-staining to stone, sized to suit joint thicknesses and bed depths of stone units, less the required depth of pointing materials unless removed before pointing.
- B. Other Products: Select materials and methods of use based on the following, subject to approval of a mockup:
 - 1. Previous effectiveness in performing the work involved.
 - 2. Minimal possibility of damaging exposed surfaces.
 - 3. Consistency of each application.
 - 4. Uniformity of the resulting overall appearance.
 - 5. Do not use products or tools that could leave residue on surfaces.

2.4 MORTAR MIXES

- A. Measurement and Mixing: Measure cementitious materials and sand in a dry condition by volume or equivalent weight. Do not measure by shovel; use known measure. Mix materials in a clean, mechanical batch mixer.
- B. Colored Mortar: Produce mortar of color required by using specified ingredients. Do not alter specified proportions without Architect's approval.
 - 1. Mortar Pigments: Where mortar pigments are indicated, do not add pigment exceeding 10 percent by weight of the cementitious or binder materials, except for carbon black which is limited to 2 percent.
- C. Do not use admixtures in mortar unless otherwise indicated.
- D. Mixes: Mix mortar materials in the following proportions:

1. Rebuilding (Setting) Mortar by Type: ASTM C270, Proportion Specification, [**Type N**] unless otherwise indicated, with cementitious material limited to [**Portland cement and lime**] [**masonry cement**] [**or**] [**mortar cement**].
2. Pigmented, Colored Mortar: Add mortar pigments to produce exposed, setting (rebuilding) mortar of colors required.

PART 3 - EXECUTION

3.1 PROTECTION

- A. Remove [**gutters and**] downspouts and associated hardware adjacent to stone and store during stone repair. Reinstall when repairs are complete.
 1. Provide temporary rain drainage during work to direct water away from building.

3.2 STONE REMOVAL AND REPLACEMENT

- A. At locations indicated, remove stone that has deteriorated or is damaged beyond repair [**or is to be reused**]. Carefully remove entire units from joint to joint, without damaging surrounding stone, in a manner that permits replacement with full-size units.
- B. Support and protect remaining stonework that surrounds removal area.
- C. Maintain flashing, reinforcement, lintels, and adjoining construction in an undamaged condition.
- D. Notify Design-Professional-of-Record and HPD of unforeseen detrimental conditions including voids, cracks, bulges, and loose units in existing stone or unit masonry backup, rotted wood, rusted metal, and other deteriorated items.
- E. Remove in an undamaged condition as many whole stone units as possible.
 1. Remove mortar, loose particles, and soil from stone by cleaning with hand chisels, brushes, and water.
 2. Remove sealants by cutting close to stone with utility knife and cleaning with solvents.
- F. Clean stone surrounding removal areas by removing mortar, dust, and loose particles in preparation for stone replacement.
- G. Replace removed damaged stone with other removed stone in good condition, where possible, matching existing stone, including direction of rift or natural bedding planes. Do not use broken units unless they can be cut to usable size.
- H. Install replacement stone into bonding and coursing pattern of existing stone. If cutting is required, use a motor-driven saw designed to cut stone with clean, sharp, unchipped edges. Finish edges to blend with appearance of edges of existing stone.
 1. Maintain joint width for replacement stone to match existing joints.
 2. Use setting buttons or shims to set stone accurately spaced with uniform joints.

- I. Set replacement stone with rebuilding (setting) mortar and with completely filled bed, head, and collar joints. Butter vertical joints for full width before setting, and set units in full bed of mortar unless otherwise indicated. Replace existing anchors with new anchors [**of size and type indicated**] [**matching existing configuration**].
 1. Tool exposed mortar joints in repaired areas to match joints of surrounding existing stonework.
 2. Rake out mortar used for laying stone before mortar sets according to *Section 040140.62 "Stone Repointing."* Point at same time as repointing of surrounding area.
 3. When mortar is hard enough to support units, remove shims and other devices interfering with pointing of joints.
- J. Curing: Cure mortar by maintaining in thoroughly damp condition for at least 72 consecutive hours, including weekends and holidays.
 1. Hairline cracking within the mortar or mortar separation at edge of a joint is unacceptable. Completely remove such mortar and repoint.

3.3 PARTIAL STONE REPLACEMENT

- A. Remove defective portion of existing stone unit (backing stone). Carefully remove defective portion of stone by making vertical and horizontal saw cuts at face of backing stone and removing defective material to depth required for fitting partial replacement (dutchman).
 1. Make edges of backing stone at cuts smooth and square to each other and to finished surface; essentially rectangular. Make back of removal area flat and parallel to stone face.
 2. Do not overcut at corners and intersections. Hand trim to produce clean sharp corners with no rounding and no damage to existing work to remain.
 3. If backing stone becomes damaged further, remove damaged area and enlarge partial replacement as required.
- B. Remove mortar from joints that abut area of stone removal to same depth as stone was removed. Remove loose mortar particles and other debris from surfaces to be bonded and surfaces of adjacent stone units that will receive mortar by cleaning with stiff-fiber brush.
- C. Cut and trim partial replacement to accurately fit area where material was removed from backing stone. Fabricate to size required to produce joints between partial replacement and backing stone of no more than 1/16 inch in width, and joints between partial replacement and other stones that match existing joints between stones.
- D. Exposed Pinning: Before applying adhesive, prepare for mechanical anchorage consisting of 1/4-inch- diameter, [**plain**] [**threaded**] stainless-steel pins set into 1/4-inch- diameter holes drilled at a 45-degree downward angle through face of partial replacement and into backing stone.
- E. Concealed Pinning: Before applying adhesive, prepare for concealed mechanical anchorage consisting of 1/4-inch- diameter, [**plain**] [**threaded**] stainless-steel pins set into 1/4-inch-diameter holes drilled into backing stone and into, but not through, the partial replacement.
- F. Apply stone-to-stone adhesive according to adhesive manufacturer's written instructions. Coat bonding surfaces of backing stone and partial replacement, completely filling all crevices and voids.

- G. Apply partial replacement while adhesive is still tacky and hold securely in place until adhesive has cured. Use temporary shims, clamps, wedges, or other devices as necessary to align face of partial replacement with face of backing stone.

3.4 STONE PLUG REPAIR

- A. Remove cylindrical piece of damaged stone by core-drilling perpendicular to stone surface.
- B. Prepare a replacement plug by core-drilling replacement stone. Use a drill sized to produce a core that will fit into hole drilled in damaged stone with only minimum gap necessary for adhesive.
- C. Apply stone-to-stone adhesive according to adhesive manufacturer's written instructions. Coat bonding surfaces of existing stone and plug, completely filling all crevices and voids.
- D. Apply plug while adhesive is still tacky and hold securely in place until adhesive has cured.
- E. Clean adhesive residue from exposed surfaces.

3.5 STONE-FRAGMENT REPAIR

- A. Carefully remove cracked or fallen stone fragment indicated to be repaired. Reuse only stone fragment that is in sound condition.
- B. Remove soil, loose particles, mortar, and other debris or foreign material from fragment surfaces to be bonded and from parent stone where fragment had broken off, by cleaning with stiff-fiber brush.
- C. Pinning: Before applying adhesive, prepare for mechanical anchorage consisting of 1/4-inch-diameter, **[plain]** **[threaded]** stainless-steel pins set into 1/4-inch-diameter holes drilled at a 45-degree downward angle through face of fragment and into parent stone.
- D. Concealed Pinning: Before applying adhesive, prepare for concealed mechanical anchorage consisting of 1/4-inch-diameter, **[plain]** **[threaded]** stainless-steel pins set into 1/4-inch-diameter holes drilled into parent stone and into, but not through, the fragment.
- E. Apply stone-to-stone adhesive according to adhesive manufacturer's written instructions. Coat bonding surfaces of fragment and parent stone, completely filling all crevices and voids.
- F. Fit stone fragment onto parent stone while adhesive is still tacky and hold fragment securely in place until adhesive has cured. Use shims, clamps, wedges, or other devices as necessary to align face of fragment with face of parent stone.

3.6 CRACK INJECTION

- A. General: Comply with cementitious crack-filler manufacturer's written instructions.
- B. Drill 1/4-inch-diameter injection holes as follows:
 - 1. Transverse Cracks Less Than 3/8-inch Wide: Drill holes through center of crack at 12 to 18 inches on-center.

2. Transverse Cracks More Than 3/8-inch Wide: Drill holes through center of crack at 18 to 36 inches on-center
 3. Delaminations: Drill holes at approximately 18 inches on-center both vertically and horizontally.
 4. Drill holes 2 inches deep.
- C. Clean out drill holes and cracks with compressed air and water. Remove dirt and organic matter, loose material, sealants, and failed crack repair materials.
- D. Place plastic injection ports in drilled holes and seal face of cracks between injection ports with clay or other non-staining, removable plugging material. Leave openings at upper ends of cracks for air release.
- E. Inject cementitious crack filler through ports sequentially, beginning at one end of area and working to opposite end; where possible, begin at lower end of injection area and work upward. Inject filler until it extrudes from adjacent ports. After port has been injected, plug with clay or other suitable material and begin injecting filler at adjacent port, repeating process until all ports have been injected.
- F. Clean cementitious crack filler from face of stone before it sets by scrubbing with water.

3.7 STONE PATCHING

- A. Remove deteriorated material and remove adjacent material that has begun to deteriorate. Carefully remove additional material so patch does not have feathered edges but has square or slightly undercut edges on area to be patched and is at least 1/4 inch thick, but not less than recommended in writing by patching compound manufacturer.
- B. Mask adjacent mortar joint or rake out for repointing if patch will extend to edge of stone unit.
- C. Mix patching compound in individual batches to match each stone unit being patched. Combine one or more colors of patching compound, as needed, to produce exact match.
- D. Brush-coat stone surfaces with slurry coat of patching compound according to manufacturer's written instructions.
- E. Place patching compound in layers as recommended in writing by patching compound manufacturer, but not less than 1/4 inch or more than 2 inches thick. Roughen surface of each layer to provide a key for next layer.
1. Simple Details: Trowel, scrape, or carve surface of patch to match texture and surrounding surface plane or contour of the stone. Shape and finish surface before or after curing, as determined by testing, to best match existing stone.
 2. Carved Details: Build patch up 1/4 inch above surrounding stone, and carve surface to match adjoining stone after patching compound has hardened.
- F. Keep each layer damp for 72 hours or until patching compound has set.
- G. Remove and replace patches with hairline cracks or that show separation from stone at edges, and those that do not match adjoining stone in color or texture.

3.8 FINAL CLEANING

- A. After mortar has fully hardened, thoroughly clean exposed stone surfaces of excess mortar and foreign matter; use wood scrapers, stiff-nylon or -fiber brushes, and clean water, applied by low-pressure spray.
 - 1. Do not use metal scrapers or brushes.
 - 2. Do not use acidic or alkaline cleaners.

END OF SECTION 040140.61