

SECTION 04 30 00

STONEMWORK

PART 1 - GENERAL

1.1 SUMMARY

- A. General: Provide Stonework in accordance with requirements of the Contract Documents.
- B. Related Work Specified Elsewhere
 - 1. Steel supports for stone countertops is specified in Section 05 50 00 "Metal Fabrications".
 - 2. Plywood underlayment for stone countertops is specified in Section 06 10 00 "Rough Carpentry".
 - 3. Stone saddles is specified in Section 09 30 00 "Tiling".
 - 4. Section 01 23 00 "Alternates".
 - 5. Section 01 81 13 "Sustainable Design Requirements".
 - 6. Section 01 44 00 "Construction Indoor Air Quality Management"
 - 7. Section 01 74 19 "Construction Waste Management.
 - 8. Section 01 81 15 "Volatile Organic Compound (VOC) Limits For Adhesives, Sealants, Paints & Coatings".

1.2 DEFINITIONS

- A. Dimension Stone Tile: Modular stone units less than 3/4 in. thick.
- B. Module Size: Actual tile size plus joint width.
- C. Polished Finish: Smooth surface that produces sharp, mirror-like reflections. Reflected images of overhead fluorescent tubes have straight lines without visible distortion when viewed at arm's length.
- D. Honed Finish: Smooth, non-reflective surface similar to that produced by grinding with a 400- to 1200-grit abrasive.
- E. Sand-Rubbed Finish: Uniform, fine-textured surface similar to that produced by grinding with a 40-grit abrasive.
- F. Thermal Finish: Uniform, coarse-textured surface produced by thermal shock.
- G. Natural-Cleft Finish: Uneven surface produced by splitting stone along a natural cleavage plane; without visible tool marks.

1.3 REFERENCES

- A. General: Comply with the applicable provisions and recommendations of referenced standards, except as modified by governing codes and by the Contract Documents. Where a recommendation or suggestion occurs in the referenced standards, such recommendation or suggestion shall be considered mandatory. In the event of conflict between referenced standards, this specification or within themselves, the more stringent standard or requirement shall govern.
 - 1. National Building Granite Quarries Association (NBGQA): "Specifications For Building Granite".
 - 2. Indiana Limestone Institute of America (ILI): "Indiana Limestone Institute Handbook".
 - 3. Marble Institute of America (MIA): "Design Manual".
 - 4. Masonry Contractors Association of America (MCAA): "Hot & Cold Weather Masonry Construction".
 - 5. American Society for Testing and Materials (ASTM): ASTM C1242 "Standard Guide for Design, Selection, and Installation of Stone Anchors and Anchoring Systems".
 - 6. United States Green Building Council (USGBC): Leadership in Energy & Environmental Design (LEED®): Green Building Rating System for New Construction & Major Renovations (NC) Version 2.2

1.4 SYSTEM DESCRIPTION

- A. Design Requirements:
 - 1. Exterior Stone Cladding System: An engineered exterior wall covering system consisting of dimension stone panels together with the anchors, fasteners, and sealants used to secure the stone to the building structure and to produce a weather-resistant covering.
 - 2. Detailing: The method of erecting, installing and anchoring of stone indicated on the drawings is diagrammatic only and shall be used for the purposes of bidding. Contractor shall be responsible for design and warranty the structural support, the permanent anchorage and the watertight integrity of stone Work. Alternate methods of detailing, proposed by the Contractor, will be considered provided it complies with aesthetic design shown and performance criteria specified. Design the installation to allow for expansion, contraction and differential deflection of supporting floors of the building structure.
- B. Performance Requirements:
 - 1. Interior Stonework Performance: Design, fabricate and install interior stonework, anchorage and component to withstand lateral loading of 5psf positive and negative pressures.
 - 2. Thermal Movements: Provide stone cladding system that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing displacement of stone, opening of joints, overstressing of components, failure of joint sealants and connections, and other detrimental effects. Base engineering calculations on surface temperatures of materials due to both solar heat gain and nighttime sky heat loss.
 - a. Temperature Change (Range): 120 deg F., ambient; 180 deg F., material surfaces.

3. Seismic Requirements: Design to withstand minimum lateral movements per floor shown and as follows:
 - a. Connections: Design connections for $4/3$ times specified forces. Design bolts, inserts, welds, dowels and similar fasteners to withstand 4 times specified forces.
 - b. Lateral Acceleration: Accommodate minimum seismic design forces of not less than 0.3 times weight of supported element.
 - c. Seismic Requirements: Per Uniform Building Code.
 - d. The deformation capacity of a flexible connection shall be determined as the value of deformation that results in fracture or cracking or otherwise causes a loss of strength on the connector or panel, or is the value of deformation that causes sliding parts to come into contact.
 - e. Under either Earthquake Level, corner units at building corners shall be joined in a way as to permit the out-of-plane deformations on one face occur without impact to panels or panel connections on adjacent perpendicular faces.
 - f. Provide miscellaneous steel framing not shown on drawings which is required to satisfy seismic criteria.
4. Building Movement: Design, fabricate and install exterior wall to withstand building movements including loading deflections, shrinkage, creep, seismic and similar movements.
 - a. Live Load Deflection: Design, fabricate and install the exterior wall to accommodate live load deflection of spandrel beams and floor assemblies. Anticipated mid-span live load deflections of spandrel beams in this installation shall not exceed $3/8$ in.
5. Critical Dimensions: The following critical dimensions shall be utilized without modification.
 - a. Wall Assembly Depth: Provide a complete stone wall cladding system as shown and specified with components and systems located within the area from the exterior face as shown to the face of column, beam or edge of slab shown, without encroachment or displacement of the interior construction and finishes shown.
6. Deflections: Submit engineering calculations to show maximum deflections based on full panel loads, uniformly distributed, building deflections, thermal stresses, and erection tolerances. Glass, sealants and interior finishes shall not be included to contribute to strength, stiffness or lateral stability. Maximum full load deflections, normal to the wall plane, for any wall member or component shall not exceed the following:
 - a. Stone Walls: Design wall support systems holding stonework to limit deflection within the system and within the stone units to values which allow the stone units to sustain imposed loads, for each combination of stone/anchor/support framing configurations and variations, intended for use on the project, within the specified design limits and factors of safety; but not greater than $1/360$ of its clear span or $1/8$ in.; whichever is less. In addition to the above deflections, stone supporting aluminum framing members shall be limited to $1/600$ parallel

and perpendicular to the wall plane, with rotation of continuous member on kerfed stone limited to 1/16 in. maximum.

- b. Windows within Exterior Stone Walls: 1/175 of its clear span between anchorages or 3/4 in., whichever is less.
7. Permanent deformation, weld or fastener failure, component disengagement or breakage shall not occur under loading equal to 1.5 times the design load pressures (positive and negative) specified. Permanent deformation is defined as deflection without recovery exceeding length/1000.
8. Air and Water Control: Design, fabricate and install stone cladding system and components to provide a completely impervious air and vapor barrier. Provide tight joints and effectively seal component parts of stone wall, including their joints with contiguous work, against water leakage and air infiltration. Water leakage is defined as the appearance of uncontrolled water, other than condensation, on any inboard part of exterior wall, either during field water penetration testing or under actual weather conditions. Uncontrolled water is defined as leakage that is not contained and/or drained away in a manner as to cause damage to the exterior wall or adjacent construction or finishes.
 - a. Make provisions to drain water and condensation to exterior face of wall.
 - b. Provide two distinct lines of defense against the intrusion of water into the stone cladding systems.
 - c. Provide a system of gutters and drainage components separately or in conjunction with contiguous work. Collect and drain water from within the stone exterior walls at every story height. Make provisions to drain water and condensation to exterior face of stone wall. Provide flashings and gutters for exterior stone walls and for the connection of contiguous work. Give special attention to the connection of drainage members at columns, spandrel beams and other areas of limited access. The use of carbon steel components for gutter and drainage assemblies is prohibited. Provide stainless steel or aluminum components.
 - 1) Air infiltrations shall not exceed the 0.06 cfm/ft^2 of wall area when tested at 6.24 psf test pressure.
 - d. Continuous Air Space: Provide a continuous air space behind stone facing, except as required at locations of stone anchors. Provide stone anchors with cross sectional profiles orientated to promote water drainage, unless used as part of the drainage system. Provide holes, slots or other drainage outlets for stone anchors wider than 4 in. .
 - e. Give special attention to the connection of drainage members to assure the control of water to gutters and weeps, to prevent the entry of uncontrolled water at the locations of connection between exterior stone walls and contiguous windows.
9. Stone Design Safety Factors: The minimum safety factor to be used in the flexural design of the stone and the design of the stone at the anchorage(s) shall be based on preliminary stone test data as derived. The safety factors shall be made up of two separate components; the Variance Factor (V.F.) and the Durability Factor (D.F.).
 - a. Variance Factor (V.F.): The V.F. is defined as a measure of the natural range of

flexural strength test results. Evaluate the results of the tests performed in accordance with ASTM C880 as specified under Paragraph "Preliminary Tests". Calculate the Coefficient of Variation of results. Use a Variance Factor according to the following table:

ASTM C880 Test, Coefficient of Variation	Variance Factor (V.F.)		
Variation	Granite	Limestone	Marble
0% - 10%	2.5	3.5	3.0
10% - 20%	3.0	4.0	3.5
Above 20%	3.5	4.5	4.0

- b. Durability Factor (D.F.): The D.F. is defined as a measure of the effect of accelerated weathering test results. Evaluate the results of the preliminary stone tests, accelerated weathering aging test, ASTM C666 , Modified as specified. Calculate the percentage of flexural strength (in accordance with ASTM C880) as (average after 300 thermal cycles/average before thermal cycling) x 100%. Use a Durability Factor according to the following table:

ASTM C880 Test % of Initial Flexural Strength	Durability Factor (D.F.)
100% - 75%	1.0
75% - 60%	1.5
Less than 60%	1.8

- c. Stone Flexural Safety Factor (F.S.F.): The minimum safety factor to be used in the flexural design of stone panels shall be calculated as follows:

$$F.S.F. = V.F. \times D.F.$$

- d. Stone Anchorage Safety Factor (A.S.F.): The minimum safety factor to be used in checking stone stresses at anchorage zones shall be calculated as follows:

$$A.S.F. = F.S.F. \times 1.4$$

- e. To establish stone allowable stresses, the Safety Factors calculated, or greater safety factors if deemed appropriate by the engineer responsible for the design of the stone system, shall be applied to the average flexural strength (in accordance with ASTM C880) of tests performed prior to thermal cycling.
- f. The Architect will review the calculations of safety factors and the preliminary test data. The Architect may further modify the safety factor as deemed appropriate.

10. Stone Design Safety Factors: The minimum safety factors to be used in the flexural design of the stone and the design of the stone at the anchorages shall be as specified. The Architect will review the production stone testing data and may further modify the safety factor as deemed appropriate.

- a. Stone Flexural Safety Factor (F.S.F.): The minimum safety factor to be used in the flexural design of stone panels shall be as follows:

Granite: 4.0

Marble: 5.0

- b. Stone Anchorage Safety Factor (A.S.F.): The minimum safety factor to be used in checking stone stresses at anchorage zones shall be calculated as follows:

$$A.S.F. = F.S.F. \times 1.4$$

11. Anchorage: The ultimate strength of anchors, inclusive of the derived or specified safety factor shall be developed completely by the mechanical action of the anchor. Adhesives shall not be allowed to contribute to the structural capacity of the anchor assembly.
12. Control of Corrosion and Staining: Prevent galvanic and other forms of corrosion as well as staining by isolating metals and other materials from direct contact with incompatible materials. Use materials that do not stain exposed surfaces of stone and joint materials.
13. Design exterior stonework to anchor and support the window washing restraint system, for the Government's selected window washing system, including imposed loads created by the system.
14. Stone Flooring and Exterior Paving
 - a. Stone Abrasion Resistance: Minimum abrasive hardness of 10, as determined per ASTM C241.
 - b. Static Coefficient of Friction: Per ASTM C1028:
 - 1) Level Surfaces: Minimum 0.6.
 - 2) Step Treads: Minimum 0.6.
 - 3) Ramp Surfaces: Minimum 0.8.
15. Green Building Performance Criteria
 - a. The manufacturing locations and origin of raw materials for the stonework shall be identified and documented if within 500 miles of the project site.
 - b. The post-industrial and/or post consumer recycled content (by weight) of the major stonework components shall be identified and documented.
 - 1) Recycled Content: Metal products shall strive to achieve a recycled content of 50% to 100%.
 - c. All field-applied adhesives, sealants, primers, paints and coatings used on the interior of the building shall meet the volatile organic compound (VOC) and chemical component limitations as defined in Section 01 81 15 "Volatile Organic Compound Limits", VOC contents shall be identified and documented.
16. Shipping and Handling: The stone and the stone anchorage shall not be compromised to any degree by distress in the assembly which may occur as a result of shipping and handling of the assembly.
17. Design Modifications: Make design modifications of work shown only as may be necessary to meet performance requirements and coordinate the work. Variations in details and materials which do not adversely affect appearance, durability or strength

shall be submitted to the Architect for review. Maintain the general exterior design concept without altering profiles and alignments shown.

1.5 SUBMITTALS

- A. Product Data: Submit, for Architect's action. Submit manufacturer's literature and specifications describing the general properties of each material and accessory to be used in the Work.
- B. Shop and Setting Drawings: Submit for Architect's action. Submit shop and setting drawings for the fabrication and installation of the Work concurrent with calculations. Prepare details at not less than 3 in. = 1 ft. minimum scale. Show in detail profiles, dimensions, the dominant face grain pattern, jointing, bearings, anchors and dowels, exterior building maintenance tiebacks, sizes and locations of cut-outs, drainage/weep systems, relation to work of other trades, and other pertinent data and information. Number each piece on the setting drawings to correspond to the identification number on the back of each stone. Each sheet of each submittal shall be signed and sealed by a licensed Professional Engineer retained by the Contractor who is registered in the State of Colorado.
 - 1. Submit Procedures For The Replacement Of Stones: Submit procedures for the replacement of stones after installation for each type of setting method.
 - 2. Large-Scale Details: Submit large-scale details of decorative surfaces, perforated surfaces.
- C. Samples: Submit the following for Architect's action. Label samples to indicate product, characteristics, and location in the Work. Samples will be reviewed for color and appearance only. Furnish sufficient samples to establish the full range of colors and textures for materials exposed in the finished work. Compliance with other requirements is the responsibility of the Contractor.
 - 1. Stone Samples: Three (3) sets each, containing three (3) 24 in.² x full thickness sample slabs of each type and finish of stone specified, indicative of the entire range of materials and their respective finishes. By submitting these samples, the Contractor certifies that the range of materials represented will be maintained throughout the Work.
 - 2. Stone Paver Samples: Three (3) each, 6 in.² x full thickness sample pavers of type and finish of stone specified, indicative of the entire range of materials and their respective finishes. By submitting these samples, the Contractor certifies that the range of materials represented will be maintained throughout the Work.
 - 3. Sealant Samples: 12 in. by 12 in. sample panels showing sealant materials for Architect's review and selection of jointing materials.
 - 4. Mortar and Grout Samples: Samples of each type and color of mortar or grout for exposed joints, nominal 1/2 in. x 12 in. long.
 - 5. Reinforcement and Anchorage Samples: one of each type.
- D. Calculations: Submit the following for Architect's information.
 - 1. Calculations determining safety factors for stone flexural and anchorage design. The design safety factors to be used shall be calculated as specified and calculations shall be based on preliminary tests specified. Each sheet of calculations shall be signed and sealed by a licensed Professional Engineer retained by the Contractor who is registered in the State of Colorado.

2. Preliminary calculations using historic stone data for each stone specified which require calculations. After testing of actual stone samples has been completed, submit final calculations using documented test results from stone quarried specifically for this Project.
3. Calculations indicating that the proposed exterior stonework system complies with the specified performance criteria. These calculations will not be construed as relieving the Contractor of the responsibility for complying with the specified mock-up and testing requirements.

E. Green Building Submittal Requirements

1. A completed GREEN BUILDING MATERIALS CERTIFICATION FORM (GBMCF), appended to Section 01 81 13: "Sustainable Design Requirements". Information to be supplied for this form shall include:
 - a. Cost breakdowns for the materials included in the Contractor or sub-contractor's work. Cost breakdowns shall include total cost plus itemized material costs for the metal fabrication systems and associated products.
 - b. The manufacturing location and raw material sources of the stonework and associated products.
 - c. The amount of post-consumer and/or post industrial recycled content in the stonework systems.
 - d. The VOC content of all interior and field-applied adhesives, sealants, paints, and coatings.
2. GBMCF Back-Up Documentation: These documents are used to validate the information provided on the GBMCF (except cost data). For each material listed on the GBMCF, provide documentation to certify the material's GREEN BUILDING attributes, as applicable:
 - a. Recycled content: Provide published product literature or letter of certification on the manufacturer's letterhead certifying the amounts of post-consumer and/or post-industrial content.
 - b. Regional manufacturing (within 500 miles): Provide published product literature or letter of certification on the manufacturer's letterhead indicating the city/state where the manufacturing plant is located and the distance in miles from the project site.
 - c. Regional raw materials (within 500 miles): Provide published product literature or letter of certification on the manufacturer's letterhead indicating the city/state from which each of the raw materials in the product were extracted, harvested or recovered, and the distance in miles from the project site. If only some of the raw materials for a particular product or assembly originate within 500 miles of the project site, provide the percentage (by weight) that these materials comprise in the complete product.
 - d. Product cut sheets for materials that meet the GREEN BUILDING Materials Certification Form. Cut sheets shall be submitted with the Contractor or sub-contractor's stamp, as confirmation that the submitted products are the products installed in the Project

- e. Material Safety Data Sheets (MSDS), for applicable products. Applicable products include, but are not limited to field-applied adhesives, sealants, carpets, paints and coatings used on the interior of the building. Material Safety Data Sheets shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC limits, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC limits).
 - 3. The GREEN BUILDING submittal information shall be assembled into one (1) package per Section or trade, and sent to the Consultant of review. Incomplete or inaccurate GREEN BUILDING submittals may be used as the basis for rejecting the submitted products or assemblies.
- F. Quality Control Submittals: Submit the following for Architect's information.
- 1. Testing
 - a. Testing Procedures: A detailed description of testing procedures. Include data on testing equipment to be used, records showing most recent calibrations, drawings of test set-up and loading techniques and outline of loading sequences. Coordinate testing procedures and requirements with the Government's Stone Testing Agency prior to submittal
 - b. Test Reports: Test reports for each stone variety specified including stone related testing as listed in Paragraph "Quality Control". Petrographic analysis testing shall contain testing agencies conclusions as to suitability of stone(s) and long term durability. For metal components, indicate chemical and physical properties of each proposed metal. Base reports on testing done within previous five years.
 - 2. Certificates
 - a. Document Review: Before commencing work, submit a written statement signed by the Contractor and the Applicator certifying that the Contract Documents, shop drawings and product data have been reviewed with material manufacturers' qualified technical representatives and that they agree the selected materials are proper, compatible with contiguous materials and adequate for the application shown.
 - b. General: After review of samples by the Architect and prior to fabrication, certify in writing and submit evidence required indicating that a sufficient quantity of materials within the range of accepted mock-up materials is available from a single quarry to satisfy the total requirements of the Project.
 - c. Map of Quarry: Submit a schematic map of the quarry. Show location and benches intended for use in the production of stone for this Project. Indicate the location where submitted samples were selected from, location that preliminary test samples will be provided from and approximate full extent of area intended for quarrying. The map shall be reviewed and substantiated by the Government's Stone Testing Agency prior to submittal.
 - d. Substrate Acceptability: Prior to commencing erection, submit a certified statement issued by the firm awarded the exterior stone wall Work attesting that areas to receive exterior stone walls have been inspected and found satisfactory for the reception of this Work; and are not in conflict with the "Warranty"

requirements. Application will be construed as acceptance of surfaces.

G. Closeout Submittals: Submit the following for Government's Documentation.

1. Warranties: Special warranties as specified.
2. Maintenance Data: Two copies of an assembled and bound maintenance manual, describing the materials, devices and procedures to be followed in cleaning and maintaining each specified type stone. Provide information for procedures for replacement of stonework for different systems.

1.6 QUALITY ASSURANCE

- A. Basis of Design: When particular manufacturers' materials, products or processes are specified for an item of Work, any one thereof is acceptable for the Contractor to choose. An alternative material, product or process will be considered if the Contractor submits a written substitution request together with such information as may be necessary to assist the Architect in determining whether the proposed substitution is acceptable; the burden of proof rests solely upon the Contractor.
- B. General: The Contractor shall provide and maintain an effective Quality Control program and perform sufficient inspections, surveys and tests of items of Work, including those of other trades, to ensure compliance with the Contract Documents and local authorities having jurisdiction. Furnish appropriate facilities, accurately calibrated instruments and testing devices required to perform the quality control operations and with sufficient trained work forces to cover the construction operations within the actual construction sequences. Coordinate this Work with the quality control requirements of other technical Sections of the Specifications and with requirements of the Government and governing authorities having jurisdiction.
- C. Qualified Installer
 1. Exterior Stonework: Award the stonework to a specialized firm to provide undivided responsibility for the complete stonework system.
 2. Fabricator: The stonework shall be provided by a firm having 5 years experience engineering and fabricating stone units of similar sizes, shapes, materials, and finishes to the units required for this project. The Firm shall have ample production facilities to produce, furnish and supply the units required for installation without delay to the Work.
- D. Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances and regulations of Federal, State and Municipal authorities having jurisdiction. Obtain necessary approvals from authorities having jurisdiction.
- E. Mock-Ups:
 1. Visual: Following acceptance of sample slabs and preliminary tests construct visual mock-ups as follows:
 - a. Wall Facing
 - 1) Provide a mock-up, size as shown or if not shown minimum 50 ft.², under finished Project lighting conditions, of each type of stone wall facing system, complete with the specified components and including typical penetrations such as wall outlets and light switches.
 - 2) Alter or revise mock-up, as directed, to obtain the acceptance of the

Architect.

- 3) The approved mock-ups shall serve as a standard of quality for stone work for the project and may remain as a permanent part of the Work if in same condition as new at time of final acceptance.
 - b. Exterior Paving: Provide as shown, placed on a setting bed to simulate final condition, direction of graining, and including a typical expansion joint with joint filler and sealant specified in Section 07 92 00 "Joint Sealants".
 - c. Interior Flooring: Provide as shown, placed on setting bed to simulate final condition, types of stone, finishes, direction of graining, pointing mortar, grouting and sealant joint of stone flooring system.
2. Alter or revise mock-ups as directed, to the satisfaction of the Architect, at which time they shall remain as the standard of workmanship for the Project. Mock-ups, if approved, may be utilized in the final work. The approval of visual mock-ups does not constitute approval of deviations from the Contract Documents nor does it relieve the Contractor of it's obligation to perform the work in accordance with the Contract Documents.
- F. Prefabrication Conference: Prior to the start of fabrication of the stonework, meet at the fabricator's plant to review methods and sequence of stonework fabrication, special details and conditions, standard of workmanship, testing and quality control requirements, and other pertinent topics related to the fabrication of the stonework.
 - G. Pre-Installation Meeting: Prior to the start of the Work, meet at the Project site to review methods and sequence of stonework, special details and conditions, standard of workmanship, testing and quality control requirements, job organization and other pertinent topics related to the Work.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling and Unloading: Carefully pack and load finished stone for shipment and take necessary precautions against damage in transit. Do not use material for blocking and packing which would cause staining or discoloration and exercise care to prevent staining during the storage period.
- B. Storage and Protection: Deliver packaged setting materials in the original packages and containers of the manufacturer. Keep aggregate dry and free from soiling. Do not use cementitious materials that have become damp.

1.8 WARRANTY

- A. General: Warranties and guaranties specified in this Article shall not deprive the Government of other rights the Government may have under other provisions of the Contract Documents and are in addition to and run concurrent with other warranties made by the Contractor under requirements of the Contract Documents.
 1. Special Warranty: Submit for Government's documentation. Provide a written warranty, for a 5 year period, against water, leaks, or other defects of materials or workmanship. Upon notification of defects, within the warranty period, make the necessary repairs and replacements, at the convenience of the Government. Warranty shall be signed by the Contractor and the single firm awarded the exterior stone walls work.

1.9 MAINTENANCE

- A. Extra Materials: Furnish to Government, at job site, 100 ft² in selected sizes of each species and

finish of stone type installed. Provide in cartons suitable for storage, along with storage instructions.

PART 2 - PRODUCTS

2.1 STONE MATERIALS

- A. General: Provide stone of soundness (hardness and density), texture, graining, finish, crystal patterning, color and tone matching the sample in the Architect's office (and subject to the Architect's review) and satisfying the performance criteria specified. Stone shall be sound and free from cracks, seams, starts and other defects which will impair strength, durability, finish appearance and is supplied from a single quarry source, with sufficient capacity, to satisfy the total requirements of the project.
 1. Quarry and fabrication plant facilities shall be available for the Government's and Architect's inspection at any time.
 2. The Government shall test stone in accordance with the requirements of Paragraph "Quality Control".
 3. Visual Qualities of Stone: The color, grain and general character of stone provided shall be of a range consistent with the existing conditions for which stone types are to replicate in addition to the samples submitted to the Architect and Contracting Officer. Stone which, in the opinion and judgment of the Architect, fails to comply with this requirement may be rejected by the Architect at any time during the course of the Work. Markings or other defects such as striations, swirl marks, etc., due to machine processing shall be deemed unacceptable. The Contractor shall bear the costs associated with the removal and replacement of rejected stone with acceptable material.
- B. Stone: Comply with ASTM C119, Natural Building Stone, in addition to the other reference standards specified for the respective species.
 1. Granite: ASTM C615, granite building stone. Provide the following or approved equal:
 - a. Stone **(ST01)**: "Rockville Beige"; Rockville MN; thermal finish. To match existing granite in finish, color and texture.
 2. Marble: ASTM C503, marble building stone. Provide the following or approved equal:
 - a. Stone **(ST20)**: "Alabama Marble" (Georgia Marble Company); honed finish
 - b. Stone **(ST22)**: "Alabama Marble" (Georgia Marble Company); honed finish
- C. Stone Pavers: Comply with ASTM C119, Natural Building Stone, in addition to the other reference standards specified for the respective species. 21 in. x 21 in. x 2 in. thick nominal dimensions unless otherwise indicated; complying with the following requirements:
 1. Marble: ASTM C503, marble building stone; Type **(ST22)**. Provide "Pearl Gray" (Polycor); honed finish or approved equal:
 - a. At trench drain locations, provide removable 3 in thick pavers with 5/8 in. diameter perforations as indicated.
 2. Compressive Strength ASTM C140: Greater than 8000 psi.

3. Flexural Strength ASTM C293: Greater than 700 psi
4. Absorption: Less than 5%.
5. Density: 155 lb./ ft.³

2.2 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C150, Type I, or Type II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
 1. Low-Alkali Cement: Portland cement for use with limestone shall contain not more than 0.60% total alkali when tested according to ASTM C114.
- B. Hydrated Lime: ASTM C207, Type S.
- C. Sand: Sand complying with ASTM C144 sieve size or white marble dust except for joints narrower than 1/4 in. and pointing mortar, use aggregate graded with 100 % passing No. 16 sieve.
- D. Shrinkage Reducing Accelerator: "Sika Set" (Sika Corp.), or approved equal.
- E. Mineral Coloring Pigments: Finely ground, synthetic, limeproof, non-fading mineral oxides having purity of 98%; maximum additive of 5% of the mortar cement by weight.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. "SGS Mortar Colors" (Solomon Grind-Chem Service, Inc.)
 - b. "True Tone Mortar Colors" (Davis Colors Sub., Rockwood Industries)
 - c. "Bayferrox Iron Oxide Pigments" (Lanxess subdivision of Bayer Corporation)
 - d. "Custom Colors" (Lafarge Corporation.).
- F. Mortar for Setting Stone Paving, Flooring, Risers and Treads: One part waterproof white Portland cement, four parts sand. Mix as dry as can be worked.
- G. Latex-Modified Portland Cement Setting-Bed Mortar for Paving and Flooring: Factory portioned and mixed Portland cement, aggregate, fillers and latex additive for setting bed to comply with directions of latex additive manufacturer and as necessary to produce stiff mixture with a moist surface at time stone is set. Provide one of the following:
 1. "Custom-Float Bedding Mortar", "Acrylic Mortar Admix" (Custom Building Products).
 2. "Laticrete 226 Thick Bed Mortar", "Laticrete 3701 Admix" (Laticrete International).
 3. "Mapecem 100", "Planicrete PM" additive (MAPEI).
 4. "TA-325 Quik Patch", "TA-861 Primer and Patch Additive" (TEC Incorporated).
- H. Mortar for Setting Other Stone: One part white Portland cement, one part hydrated lime, five parts sand. Provide waterproof admixture for exterior stone.
- I. Wall Pointing Mortar: One part white Portland cement, two parts sand, mineral coloring admixture

as required to match stone. Mixed as dry as can be worked.

- J. Grout for Paving and Flooring Joints: ANSI A118.6, polymer–modified cement grout suitable for use with stone. Factory proportioned cement, sand, polymer additives and alkali resistant non–fading mineral pigments in dry blend to be mixed with water. Grout color as selected by Architect. Use only enough water to produce grout with consistency of thick cream. Do not exceed pigment-to-cement ratio of 1-to-10, by weight. Provide one of the following:
 - 1. “Classic Blend Sanded Tile Grout” (Custom Building Products).
 - 2. “Laticrete Tri-Poly Fortified Grout 1500 Series” (Laticrete International).
 - 3. “Keracolor S” (MAPEI).
 - 4. “TA–650 AccuColor Sanded Grout” (TEC Incorporated).
- K. Spotting Plaster: Stiff mix of molding plaster and water.
- L. Molding Plaster (Plaster of Paris Plaster): ASTM C59 .
- M. Water: Clear and free of deleterious material which would impair the Work.

2.3 ANCHORS, INSERTS AND SUPPORTS

- A. Stone Anchors: Comply with applicable provisions of ASTM C1242; Provide anchors embedded within stone in sizes, configurations and profiles as shown or as required to sustain imposed loads without exceeding allowable design stresses, and install anchorages and supports free from rattle or displacement.
 - 1. Exterior Stone Anchors: ASTM A666, AISI Type 304 stainless steel, 3/16 in. minimum thickness. Provide stone anchors complying with the "Performance Criteria" specified.
 - 2. Interior Stone Tie Wire: No. 8 brass or stainless steel wire.
 - 3. Fasteners and Anchorage Devices: Type, grade, class and style best suited for the respective purpose.
 - a. Fasteners for Steel Subframe Components: ASTM A307, Grade A (ASTM F568, Property Class 4.6), for bolts; ASTM A563, Grade A, for nuts; and ASTM F436 for washers; either hot-dip or mechanically zinc coated.
 - b. Fasteners for Stainless Steel Stone Anchors: Annealed stainless-steel bolts, nuts, and washers of same alloy as anchors. ASTM F593 for bolts and ASTM F594, for nuts.
- B. Anchor Inserts: Provide inserts located in masonry or concrete for the attachment of stone anchors with capability to sustain, without failure, load imposed within factors of safety indicated for connections and in accordance with the following:
 - 1. Wedge Inserts: "Wedge Inserts" (Hohman & Barnard) or equal, hot-dipped galvanized malleable iron with tee-shaped wedge action slots designed for askewed head bolts.
 - 2. Dovetail Slots: Stainless steel, 24 ga. minimum, filled with waterproof filler and with open face sealed.
 - 3. Miscellaneous Inserts: Hot-dipped galvanized or stainless steel. Provide units as shown

or required for intended use.

- C. Cushions, Setting Buttons and Setting Shims: Clear plastic shims and/or 50 Durometer neoprene pads non-staining, sized to suit joint thicknesses and bed depths of stonework involved without intruding into required depths of mortar joints or joint sealants or causing third-side adhesion between sealant and cushions.
- D. Pedestals: Support ring with integral joint spacers, "Terring 160" and shims "Leveling Plate 160" (Wegu Canada Inc.); capable of supporting an imposed load of 2,650 lbs. per support ring without permanent deformation.
- E. Facade Stonework Support System: Provide a complete system of support members and anchors to secure and support stone cladding capable of sustaining imposed loads. Comply with the related specifications sections specified and Section 08 03 50 "Exterior Wall, General".

2.4 AUXILIARY MATERIALS

- A. Reinforcing Wire Fabric for Paving: Galvanized welded wire fabric, 2 in. by 2 in. - WO.3 by WO.3 16 ASW gauge or 0.0624 in. dia.; comply with ASTM A185 and ASTM A82 except for minimum wire size.
- B. Epoxy Cement: 2 part epoxy resin based adhesive in grade (liquid or knife grade) as recommended by manufacturer formulated specifically for bonding stone to stone, with an initial set time of not more than 2 hours at 70 deg F.. Provide one of the following:
 - 1. "Akepox" (Akemi North America).
 - 2. "Akabond Epoxy" (Axson North America, Inc.).
 - 3. "Touchstone Ratio Pac Clear Gel Epoxy" (Bonstone Materials Corporation).
 - 4. "Duralcrete Gel" (Tamms Industries).
 - 5. "EVA-POX Quick Gel" (E-Poxy Industries).
- C. Joint Filler: Filler as specified in Section 07 92 00 "Joint Sealants". Provide filler of dimensions in width as required to compress firmly into joints, in any case not less than 1/4 in. greater than the width of joints.
- D. Abrasive Insert: "Type WP1" (Wooster Products Inc.) or approved equal; 3/8 in. deep x 3/4 in. wide; 3 per tread; color as selected by Architect.

2.5 FABRICATION

- A. Shapes and Dimensions: Accurately cut, dress, drill, fit and finish stone work to shapes and dimensions shown on Drawings and final shop and setting drawings. Make exposed plane surfaces true in line. Markings or other defects on finished stone panels such as striations, swirl marks, etc., due to machine processing shall be deemed unacceptable.
- B. Cutting of Joints and Edges: Cut external corners with (quirk-miter) (gauged edge) joints where shown; cut other joints and edges square and at right angles to face, and with backs parallel to face. Make arises straight, sharp, true, and continuous at joints.
- C. Cutting and Drilling of Stones: Cut and drill stones in shop as required for supports, anchors, ties,

grab and Lewis bolts, and other inserts. Cut slots, kerfs, holes and other recessed cutouts leaving smooth surfaces and eased intersections between changes of surfaces planes, free from sharp edges and arises, to reduce stresses at anchor locations.

- D. Allowance for Expansion and Contraction: Allow for expansion and contraction within the limits of the joint material when cutting for anchorage devices.
- E. Stone Thickness: Provide greater stone thickness than indicated where thicknesses indicated are insufficient for the sizes or where extent of cutouts shown decreases effective strength of the remaining material, or for proper and sufficient anchorage, suitable and adequate bearing areas or surfaces. The use of liners properly sized and secured to stone facing will be permitted only where shown on Drawings, and final shop drawings.
- F. Inspection of Finished Stone: Carefully inspect finished stones at fabrication plant for compliance with requirements relative to qualities of appearance, material, finishing, and fabrication; replace defective stones with ones that do comply. Grade and mark stones for overall uniform appearance when assembled in place. Natural variations in appearance are acceptable if installed stones match range of colors and other appearance characteristics represented in approved samples and field-constructed mock-ups.
- G. Facade Stonework: Cut facade stonework to sizes shown, with square corners and parallel edges, unless otherwise shown and in accordance with the following tolerances:
- H. Dimensional Tolerances: As follows:
 - 1. Height: +/- 1/16 in..
 - 2. Width: +/- 1/16 in..
 - 3. Thickness: + 1/16 in., - 0.0 in..
 - 4. Out of Square: +/- 1/16 in..
 - 5. Exposed Face Flatness: +/- 1/16 in..
- I. Stone Tiles: Shop-cut stone tiles with edges square and at right angles to face and with backs cut parallel with face. Make edges straight and true with arrises slightly eased. Cut units with face corners at right angles and parallel edges unless otherwise shown. Finish exposed edges of stone tiles to match exposed face.

2.6 SOURCE QUALITY CONTROL

- A. Contractor's Quality Control Responsibilities: Contractor is solely responsible for quality control of the Work.
- B. Contractor's Testing: The Contractor shall have testing performed in an independent certified testing laboratory acceptable to the Government and the Architect. Furnish the laboratory sufficient quantities of specimens to comply with referenced testing standards. Test stonework and furnish test reports for materials specified.
 - 1. Stone Testing: Stone testing shall be performed by the Government as specified. The Contractor shall furnish access to the Work, stonework materials and facilities for the Government's usage.
 - 2. Aggregate Testing: Test aggregate as follows:
 - a. Mortar Aggregate: ASTM C144.

3. Mortar Testing: Test mortar samples in accordance with ASTM C109. Test each mortar type and color each week as follows:
 - a. Compressive Strength: Test nine cube specimens per occurrence for each mortar type and color as follows:
 - 1) Test hardened mortar cubes taken from field mixed mortar for each type and color at least once per week.
 - 2) Mix mortar and test hardened mortar cubes in laboratory from material samples from site. Mix mortar in accordance with ASTM C270.

2.7 GOVERNMENT'S MONITORING ACTIVITIES

- A. Government's Testing Agency: A testing agency, selected by the Government and engaged at the Contractor's expense, will perform the following activities to monitor the Contractor's Quality Control Program. The monitoring activities do not relieve the Contractor of responsibilities under the Contract.
 1. The Government shall select a Quality Control Agent, retained at the Contractor's expense, to perform testing and inspection services for the stonework required for the Project including but not limited to inspection and testing of stone wall at the project site and, if work is performed off site, inspection and testing of stone work in fabrication plants. Comply with Paragraph "Field Quality Control" specified.
 2. Stone Testing, General
 - a. All preliminary testing and submission of the results for review shall be submitted prior to the quarrying of production stone. Stone fabricated prior to review of test data and calculations is subject to rejection.
 - b. Appropriately identify and label samples identifying the layer from which they come by number at the quarry immediately upon cutting. Use this numbering system as the basis for sample identification throughout the cutting, shipping and testing procedure.
 - c. The minimum number of samples to be provided for testing shall be 20% greater than the number of tests specified to allow for breakage.
 - d. Mark the rift (bedding) surface of the stone samples immediately upon cutting complying with the applicable ASTM standards. Samples which have not been marked will not be accepted for testing. Provide a cutting diagram for the Architect's record that describes where and from what layer the samples were cut from the quarry block and substantiating the rift markings by sample number.
 3. Preliminary Testing: Stone samples provided for preliminary tests shall be produced from (3) three different locations within area(s) intended for quarrying during the production phase of the Project and as indicated on the submitted map of the quarry. No more than 20% of the samples required for each specified test shall be taken from any single quarry block. Preliminary tests shall be completed prior to the start of production stone quarrying.
 - a. Exterior Stone Testing: The results of preliminary stone tests for exterior cladding shall be used to establish appropriate design safety factors to be used

in the stone and anchorage design calculations. Calculations will not be reviewed prior to completion of preliminary stone testing. Provide the following tests incorporating the samples required by the tests unless otherwise stated below:

- 1) Petrographic Analysis: ASTM C1721: "Standard Guide for Petrographic Examination of Dimension Stone": 1 test, number of specimens as required.
- 2) Absorption and Density: ASTM C97; "Absorption and Bulk Specific Gravity of Natural Building Stone": 3 tests each; 9 samples total.
- 3) Compressive Strength: ASTM C170; "Compressive Strength of Natural Building Stone": 20 tests total; 5 tests each wet and dry, perpendicular and parallel to rift.
- 4) Modulus of Rupture: ASTM C99; "Modulus of Rupture of Natural Building Stone": 20 tests total; 5 tests each wet and dry, perpendicular and parallel to rift.
- 5) Flexure Strength: ASTM C880; "Flexural Strength of Natural Building Stone": 200 total; 5 samples wet and 5 samples dry per test; 10 tests perpendicular to rift and 10 test parallel to the rift. Samples shall be the thickness of stone proposed for use on the Project. For stone that is to be flame finished on the Project, the samples shall be provided with a flamed finish and the tests shall be run with the flamed finish in tension.
- 6) Accelerated Weathering ASTM C666, Modified: For the selected stone in the specified finish, prepare, cycle and/or condition, and perform tests on specimens in planes both parallel and perpendicular to the rift, in quantities, size and finishes to those provided for ASTM C880 described above, and as follows:
 - a) To evaluate the effect of acid rain and freeze-and-thaw, expose specimens, duplicating and in quantity in all respects specimens tested for Flexural Strength (ASTM C880), to cyclic preconditioning and testing as follows:
 - (1) ASTM C666, Modified: Cyclic testing with Procedure A, except that only the bottom 1/4 in. of the stone, including edges shall be immersed in a slightly acid water acid solution (pH of 4.5 ± 0.5) during cycling. Maintain solution level by refilling the container at a rate of once every 24 hours. Clean and refresh containers with new solution, as specified above, every 50 cycles.
 - (2) Center of specimens shall be subjected to temperature cycles from 130 deg. F to -10 deg. F within a period of six hours.
 - (3) Monitor ambient and center of specimen temperatures. Perform cycling to ensure that at the 130 deg. F and at the -10 deg. F conditions, the maximum temperature difference between the ambient and the center of specimen does not exceed 50 deg. F.

- (4) Prior to cycling and after 25, 50, 150, 200 and 300 thermal cycle intervals, test specimens shall be tested to establish Young's Modulus of Elasticity in accordance with ASTM C215, a nondestructive test method. Young's Dynamic Modulus shall be plotted (Young's modulus versus degradation cycles) to ascertain if the degradation due to accelerated aging has leveled off to a value. Failure to level off to a value at 300 cycles shall be grounds for rejection.
 - (5) Test specimens per ASTM C880 procedure, as specified above. Flexural tests shall be performed with the surface that had been immersed during cycling in tension. Perform tests on samples prepared in both parallel and perpendicular rift plane orientation
 - (6) Report results including changes that are visually observable, loss of weight, Dynamic Modulus of Elasticity for each stage, and the final flexural strengths, and associated variances for specimens tested both wet and dry.
 - b) The maximum Allowable Flexural Strength for each specified type of weathered stone shall be the lowest of the weathered specimens test results.
 - 7) Accelerated Aging Test, Acid Rain: 20 samples identical in size and finish to those provided for ASTM C880. Samples shall have the rift parallel to their primary axis.
 - b. Exterior Stone Paving Testing
 - 1) Petrographic Analysis: ASTM C295: "Petrographic Analysis": 1 test, 3 sample specimens.
 - 2) Absorption and Density: ASTM C97; "Absorption and Bulk Specific Gravity of Natural Building Stone": 3 tests each; 9 samples total, 3 per test specimen.
 - 3) Compressive Strength: ASTM C170; "Compressive Strength of Natural Building Stone": 20 tests total; 5 tests each wet and dry, perpendicular and parallel to rift, 100 sample specimens required total.
 - 4) Modulus of Rupture: ASTM C99; "Modulus of Rupture of Natural Building Stone": 20 tests total; 5 tests each wet and dry, perpendicular and parallel to rift, 100 sample specimens required total.
 - 5) Abrasion Resistance: ASTM C241; "Standard Test Method for Abrasion Resistance of Stone Subjected to Foot Traffic"; test each stone type and surface finish scheduled to be used for foot traffic; 1 test, 3 specimens.
 - 6) Coefficient of Friction: ASTM C1028: "Standard Test Method For Evaluating the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull Method"; test each

stone type and surface finish scheduled to be used for foot traffic; 12 tests in total, 6 tests each wet and dry. Samples shall be finished as proposed for use on the Project.

c. Interior Stone Flooring Testing

- 1) Absorption and Density: ASTM C97; "Absorption and Bulk Specific Gravity of Natural Building Stone": 3 tests each; 9 samples total, 3 per test specimen.
- 2) Compressive Strength: ASTM C170; "Compressive Strength of Natural Building Stone": 20 tests total; 5 tests each wet and dry, perpendicular and parallel to rift, 100 sample specimens required total.
- 3) Abrasion Resistance: ASTM C241; "Standard Test Method for Abrasion Resistance of Stone Subjected to Foot Traffic"; test each stone type and surface finish scheduled to be used for foot traffic; 1 test, 3 specimens.
- 4) Coefficient of Friction: ASTM C1028: "Standard Test Method For Evaluating the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull Method"; test each stone type and surface finish scheduled to be used for foot traffic; 12 tests in total, 6 tests each wet and dry. Samples shall be finished as proposed for use on the Project.

d. Anchor Testing for Exterior Stone Cladding: Perform stone anchor testing in accordance with ASTM C1354 "Standard Test Method for Strength of Individual Stone Anchorages in Dimension Stone" and as modified below:

- 1) Anchor tests shall not be performed until after the Architect has reviewed stone flexural and anchorage calculations. Calculations shall be based on safety factors derived from the preliminary stone test in accordance with the procedure before specified.
- 2) Perform 10 tests of each type of anchor proposed for use on the project, 5 tests in each loading direction simulating positive and negative wind loading. In addition, perform 10 tests, 5 tests in each loading direction with the load applied in each direction the anchor is being tested. Tests shall be performed with the stone in either a wet or dry condition, at the direction of the Architect, after review of the preliminary stone test results. Anchors to be used as gravity plus lateral load on the Project shall have the gravity load simulated in the test. When adhesives are used in conjunction with mechanical anchorage assemblies, testing shall be performed without the benefit of the proposed adhesive component.
- 3) Samples shall be the thickness of stone proposed for use on the Project and shall be as required by the Testing Laboratory. Samples shall be finished as required on the Project. Tool the samples identical to the proposed procedure for the Project. Anchors shall be installed at the Testing Laboratory by the personnel that will be doing this work on the Project.
- 4) The tests shall be performed using the following procedure:

- a) Gradually load the anchor with the gravity load as required simulating the gravity design load of the anchor plus 20%.
- b) Apply the lateral load in 50 lb. increments, holding each increment for 10 seconds, up to three times design load.
- c) Gradually increase the lateral load to failure.
- d) Record the load at failure. Record the type of failure; stone failure, anchor pull/push out, or anchor failure.
- e) If the pressure at failure of single test is less than the F.S.F times the design load or if the average result of tests is less than the A.S.F. times the design load, the Architect may require that the anchorage assembly be modified and re-tested.

e. Production Testing

- 1) Stone samples and panels shall be produced from every fifth block throughout the quarrying operation, unless otherwise noted.
- 2) Stone Tests: Provide the following tests:
 - a) Petrographic Analysis: ASTM C295; "Petrographic Analysis": 1 test, 3 sample specimens.
 - b) Absorption and Density: ASTM C97; "Absorption and Bulk Specific Gravity of Natural Building Stone": 3 tests each, from first block only; 9 samples total, 3 per test specimen.
 - c) Compressive Strength: ASTM C170; "Compressive Strength of Natural Building Stone": 20 tests total; 5 tests each wet and dry, perpendicular and parallel to rift, from first block only; 100 sample specimens required total.
 - d) Modulus of Rupture: ASTM C99; "Modulus of Rupture of Natural Building Stone": 20 tests total; 5 tests each wet and dry, perpendicular and parallel to rift, from first block only; 100 sample specimens required total.
 - e) Flexure Strength: ASTM C880; "Flexural Strength of Natural Building Stone": 200 total; 5 samples wet and 5 samples dry per test; 10 tests perpendicular to rift and 10 test parallel to the rift. Samples shall be the thickness of stone proposed for use on the Project. For stone that is to be flame finished on the Project, the samples shall be provided with a flamed finish and the tests shall be run with the flamed finish in tension.
 - f) Coefficient of Friction: ASTM C1028: "Standard Test Method for Evaluating the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull Method"; 12 tests in total, 6 tests each wet and dry. Samples shall be finished as proposed for use on the Project.

f. Panel Testing for Exterior Cladding

- 1) Provide 3 full size panel test samples from different blocks.
- 2) Perform a minimum of 3 tests for each anchor type. Panels and anchors to be tested shall be representative of the maximum panel sizes and shapes proposed for the Project and shall be acceptable to the Architect.
- 3) Panel and anchor assemblies shall be accurately configured for testing to simulate Project conditions and details. The perimeter chamber seal shall be detailed such that it does not support the stone panel. When adhesives are used in conjunction with mechanical anchorage assemblies, testing shall be performed without the benefit of the proposed adhesive component.
- 4) Each assembly shall be tested under alternating positive and negative pressures in ± 20 psf increments to F.S.F. times design load. Test the assembly to failure. Record the test pressure at failure and the type of failure.
- 5) If the pressure at failure of single test is less than the V.F. times the design load, or the average result of tests is less than the F.S.F. times the design load, the Architect may require that the anchorage assembly be modified.

PART 3 – EXECUTION

3.1 GENERAL

- A. Manufacturer's Instructions: Prepare substrates and install the work of this Section, including components, and accessories in accordance with the manufacturer's instructions, except where more stringent requirements are shown or specified, and where project conditions require extra precautions or provisions to ensure satisfactory performance of the Work.

3.2 EXAMINATION

- A. Verification of Conditions: Examine the areas to receive the Work and the conditions under which the Work would be performed. Remedy conditions detrimental to the proper and timely completion of the Work. Do not proceed until unsatisfactory conditions have been corrected, including moisture protection, structural supports, provisions for expansion, or other condition which might affect the finished work in appearance, water tightness or integrity of the completed installation.

3.3 PREPARATION

- A. Substrate Acceptability: Commencement of installation shall constitute acceptance of substrate conditions by the Installer.
- B. Verify measurements and dimensions, coordinate the installation of inserts for this work and coordinate and schedule this work with the work of other trades. Give particular attention to the location and size of cutouts required to accommodate mechanical, electrical, and other work or adjoining construction, in accordance with the reviewed shop drawings for such trade.
- C. Review and approve shop drawings of items or assemblies related to the support or anchorage

of stone work, including requirements for clearances for proper installation.

3.4 MORTAR MIX REQUIREMENTS

- A. Mortar for Stone: Comply with ASTM C 270, Property Specification.
 - 1. Mortar for Setting and Pointing Stone: Type N
- B. Comply with ASTM C270 for measuring and mixing of mortar materials and for retempering of mixed mortar. Use accurate measuring devices to mix materials by volume. The use of shovels for measurement is prohibited. Mix colored mortars separately to prevent contamination from each other mortar. Mix only sufficient mortar as required at a given time. Retemper stiffened mortar as required, except discard mortar not utilized within 2 hrs. of initial mixing.
- C. Pointing Mortar:
 - 1. Initially mix mortar ingredients dry to a uniform color. Add only sufficient water to produce a damp, unworkable mix which will retain its form when pressed into a ball. Select and proportion pigments with other ingredients to produce color required.
 - 2. Allow mixed mortar to stand for not less than one (1) hr. and not more than one and one-half (1-1/2) hrs. for pre-hydration.
 - 3. Add sufficient water to the pre-hydrated mortar mix to achieve a stiff working consistency. Re-temper mixed mortar to replace evaporated water as required.
 - 4. Discard mixed mortar not used within two and one-half (2-1/2) hrs. after initial mixing.

3.5 INSTALLATION

- A. Furnishing of Items Requiring Building In to Work and Location Drawings: Furnish dovetail anchor slots, wedge type inserts, and other items requiring building in to concrete or masonry work, along with location drawings, in sufficient time so as not to delay job progress.
- B. Setting, Anchoring and Pointing of Stone: Set, anchor and point stone in accordance with applicable requirements and specifications of the trade association referenced in Paragraph "References" unless otherwise shown or specified.
- C. Setting of Stone According to Final Setting Drawings: Set stone in accordance with final setting drawings, level, plumb, square, and true with uniform joints, accurately aligned with grain running in the direction shown.
- D. Field Cutting Quality: The quality of field cutting shall be the same as for shop cutting. Dry cutting of stone will not be permitted.
- E. Instructions for Anchorage and Installation: Provide dowels, anchors and wire ties in sufficient quantity to eliminate "rattle" or loose pieces and to ensure a rigid installation. Extent of anchorage and installation details shown are intended to indicate minimum requirements. In general, a minimum of one anchor per 2 ft² of area is required, with additional anchorage provided where necessitated by size, thickness, setting or shape (unless calculations and testing indicate fewer anchors are required). Adhesives, when utilized shall not be allowed to contribute to the structural capacity of the anchor assembly.
- F. Erection Tolerances:
 - 1. Variation from Plumb: +/- 1/8 in. in 10 ft, 1/4 in. in story height,

noncumulative

2. Variation from level for lintels, sills, parapets, copings and other horizontal lines: +/- 1/8 in. in any bay or 20 ft., noncumulative

G. Match finished work to visual mock-ups in all respects.

H. Joint Widths: Make joint widths, unless otherwise shown, as follows:

1. Exterior facing and copings: 1/4 in. +/- 1/16 in..
2. Exterior paving: 1/4 in..
3. Interior facing: 1/16 in. maximum.
4. Interior flooring: 1/16 in. maximum, except 1/4 in. at Sealant joints
5. Facade stonework: As shown on drawings.

I. Exterior Facing and Copings:

1. Set relieving angles as required for proper support of stone. Before setting, clean stones and backing. Before setting in mortar saturate with water. Keep cavities behind facing free of mortar or other foreign material.
2. Setting for Sealant Joints: Set stone with two cushions per stone in every horizontal joint, extending full depth of stone and to within the dimension from the face as required to permit installation of compressible backer rod and sealant. Alternate the installation of cushions using plastic in one horizontal course and neoprene in the next joint. Secure with anchors, dowels, cramps, etc., as required for rigid and secure installation. Fill anchorage holes with accelerated setting mortar. Rigidly secure strap anchors to the backing.
3. Repair dampproofing and flashing materials to their original condition where they have been punctured by anchorage or damaged during setting.
4. Flashing: Install flashing in stone construction as indicated and as specified in Section 07 62 00, "Sheet Metal Flashing And Trim" and Section 07 65 00 "Elastomeric Flashing". Protect flashing from damage during construction.
5. Lintels and Miscellaneous Items: Install structural steel lintels and supports for stone as indicated and in compliance with Section 05 50 00 "Metal Fabrications". Build sleeves, insulation, frames, or other miscellaneous items into stone construction as Work progresses.
6. Weep Holes: Provide for exterior stone wall cladding in the vertical joints located immediately above the flashing, support angles, lintels and other structural elements supporting the stone at floor lines or openings. Space weep holes at 24 in. o.c. Install the tubular weeps in the joints, extended from outside face to inside face of the stone. Keep tubing free from obstructions.

J. Interior Facing: Set wall stones before finish floors are installed. Keep free from backing surfaces by spotting with white plaster of Paris mixture, spaced not more than 18 in. apart in each direction over back of unit, but no less than 1 spot per 2 ft², unless otherwise indicated. Secure

with anchors, dowels and cramps as required for rigid installation, cemented in place with material used for spotting. Butter joints fully as each panel is set, using spotting material with mineral color added to match stone. Use plastic cushions and spacers where required to maintain uniform joints. After setting, tool joints flush and smooth. Use Portland Cement mortar for setting spots where stone is applied to inside face of exterior walls and at other locations where stone or cavity will be exposed to moisture.

K. Flooring and Paving (Mortar Set):

1. Saturate concrete with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.
2. Apply cement-paste slush coat over surface of concrete about 15 minutes before placing setting bed. Limit area of slush coat to avoid its drying out before placing setting bed. Do not exceed 1/16 in. thickness for cement-paste slush coat.
3. Apply mortar setting bed over cement-paste slush coat immediately after slush coat has been applied. Spread and screed setting bed to uniform thickness at subgrade elevations required for accurate setting of stone to finished grades indicated. Mix and place only as much mortar setting bed as can be covered with stone before initial set. Cut back, bevel edge, remove, and discard setting-bed material that has reached initial set before placing stone.
4. Place reinforcing wire fabric, lapped at joints by at least one full mesh and supported so mesh becomes embedded in middle of setting bed. Do not butt edges against vertical surfaces.
5. Place stone before initial set of cement occurs. Immediately before placing stone on setting bed, apply uniform 1/16 in. thick, slurry bond coat to bed or to back of each stone unit with a flat trowel. Tamp stone into setting bed with mallet until firmly bedded to the proper level. Set each unit in a single operation before initial set of mortar; do not return to areas already set and disturb stone for purposes of realigning finished surfaces or adjusting joints.
6. Where grinding is required to completely align and level joints, permit a minimum of six days of setting time to elapse before commencing. Perform grinding by wet abrasion, in a manner as to retain the finish, to match the balance of stone paving, and so as to be free of depressions and grind marks. Exercise care to avoid damage or soiling of adjacent work.
7. Grout joints as soon as possible after initial set of setting bed. Force grout into joints, taking care not to smear grout on adjoining stone and other surfaces. After initial set of grout, finish joints by tooling to produce a slightly concave polished joint, free from drying cracks. Do not use sanded grout for polished stone. Cure grout by maintaining in a damp condition for 7 days, except as otherwise recommended by latex additive manufacturer.
8. Installation Tolerances
 - a. Variation in Line: For position shown in plan and continuous joint lines, do not exceed 1/8 in. in 8 ft., 1/4 in. in 20 ft., or 3/8 in. maximum.
 - b. Variation in Surface Plane of Flooring: Do not exceed 1/8 in. in 10 ft., 1/4 in. in 20 ft., or 3/8 in. maximum from level or slope indicated.
 - c. Variation in Joint Width: Do not vary joint thickness more than 1/16 in. or one-fourth of the nominal joint width, whichever is less.

- d. Variation in Plane between Adjacent Units (Lipping): Do not exceed 1/32 in. difference between planes of adjacent units.
- L. Paving (Pedestal Set): Set pavers on pedestals, with open joints, as shown. Shim as required so that top surfaces are at required level or slope, and so that joints are in complete alignment.
- M. Countertops: Install countertops over plywood substrate with full spread of water-cleanable epoxy adhesive. Do not cut stone in field, unless otherwise indicated. If stone countertops or splashes require additional fabrication not specified to be performed at Project site, return to fabrication shop for adjustment. Set stone to comply with requirements indicated on final shop drawings. Shim and adjust stone to locations indicated, with uniform joints of widths indicated and with edges and faces aligned according to established relationships and indicated tolerances.

3.6 FIELD QUALITY CONTROL

- A. Contractor's Quality Control Responsibilities: Contractor is solely responsible for quality control of the Work.
- B. Water Penetration Test: See Section 08 03 50 "Exterior Wall, General" for requirements for water penetration test. Correct deficiencies observed as a result of this test.

3.7 GOVERNMENT'S MONITORING ACTIVITIES

- A. Government's Testing Agency: An independent testing agency selected by the Government, engaged at the Contractor's expense, will perform the following activities to monitor the Contractor's Quality Control Program. The monitoring activities do not relieve the Contractor of responsibilities under the Contract.
- B. Government's Testing and Inspection Program: Testing and inspection will be performed by an independent testing agency(s) selected by the Government and retained at the Contractor's expense. Furnish materials and access to the Work as required by the Government's Testing Agency.
 - 1. The Governments shall retain a Quality Control Agent to perform field testing and inspection services for the exterior wall work required for the Project including but not limited to inspection and testing of exterior stone wall work at the project site and, if work is performed off site, inspection and testing of exterior stone wall work in fabrication plants.
 - 2. The Governments Quality Control Agent shall perform full-time inspection and testing of the exterior stone wall work during construction at timely occurrences to satisfy governing authority having jurisdiction and the quality control established for the Project by the Contract Documents..
 - 3. The Government's independent testing agency work includes but is not limited to the following:
 - a. Weld Testing: Non-destructive testing of exterior stone wall supports and anchor welds, utilizing one of the following test methods which best suits the types of welds to be tested.
 - 1) Liquid penetrant test.
 - 2) Magnetic particle test.

- 3) Radiographic test.
- 4) Ultrasonic test.
- b. Paint Testing: Perform tests to determine the total dry film thickness of coatings applied to painted ferrous metal support and anchorage members. Shop and Site test units at random throughout construction.
- c. Inspection Compliance: Verification of the compliance of; or the deficiencies of the following:
 - 1) Building Superstructure: Examination surveys of the superstructure substrates and supports to receive the exterior stone wall and applicable corrective work performed, if any. Verification that the supporting structure is properly aligned and within the designed tolerances and without missing or mislocated inserts.
 - 2) Exterior Stone Wall Framing Components: Verification that the framing components are properly sized and aligned, are without missing or mislocated anchoring provisions and are without structural defects. Verification that primed and painted components are provided with the specified materials.
 - 3) Connections and Anchors: Verification that anchors are properly placed, welded or bolted. Verification that correct anchoring and/or materials are used in lieu of others where there are field changes. Inspection of welding and bolting where connections are stressed to 50% or more of allowable values. Verification of the calibration of wrenches, review of bolting procedures and inspection of joint surfaces prior to bolting for bolted connections related to the exterior stone wall. Verification of welder's license, qualifications and welding procedures for welds related to the exterior stone wall. Verification of proper welding or bolting of reset connections.
 - 4) Joints and Sealants: Verification that horizontal and vertical movement joints have been provided, and verification that joints are free from obstructions. Confirmation that accepted sealant materials are provided. Verification that sealant joints are properly sealed, and that materials are of sufficient elongation for movement anticipated. The recording of unanticipated movement or displacement beyond performance criteria.
 - 5) Flashings and Drainage: Verification that flashings are the proper materials, are properly installed and that end dams are sealed. Verification that weeps and tubes are installed and are functional.
 - 6) Firebarrier and Safing: Verification of the continuity of firebarrier, insulation and fire safing installation. Verification that the firebarrier and safing is properly sealed at joints and penetrations to maintain the continuity of the barrier at the exterior stone wall.
 - 7) Exterior Stone Wall Insulation: Verification that insulation is continuous and properly sealed at joints and penetrations to maintain the continuity of the vapor barrier.

- d. Observation Compliance of Exterior Stone Wall Subcontractor's Testing Program
 - 1) Field Tests: Observation, as the Government's representative, of field testing of exterior stone wall assembly, for the required Field Water Test: AAMA 501.2 as specified below.
- C. Water Penetration Test: After completion of the installation and nominal curing of sealant and glazing compounds, test for water leaks in accordance with "Specifications for Field Check of Metal Curtain Walls for Water Leakage", AAMA Standard 501.2. Conduct tests in the presence of the Government, the Government's Independent Testing Agency, the Contracting Officer and the Architect. Correct deficiencies observed as a result of this test.

3.8 **ADJUSTING**

- A. The completed installation shall have the acceptance of the Architect. Installed units which are chipped, cracked, or otherwise damaged or which, in the opinion of the Architect, do not conform to the Specification requirements shall be removed and replaced.

3.9 **CLEANING**

- A. Cleaning of Stone: Immediately prior to completion of the Work clean stone by washing with water and bristle brushes; removing stains, dirt and other discolorations. Do not use acids, cleaning compounds or wire brushes.
- B. Removal of Temporary Protection: On completion of construction, remove temporary protection.

3.10 **PROTECTION**

- A. Non-Staining Temporary Wood Guards: After initial cleaning, provide non-staining temporary wood guards at corners and other surfaces subject to damage.
- B. Rope Off of Paving and Flooring: Rope off paving and flooring to permit curing of setting bed.
- C. Protection of Work from Damage: Protect work from damage due to subsequent building operations.

END OF SECTION