

SECTION 32 32 24

LIMESTONE WALL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. This work shall consist of furnishing and installing Stone Seat Wall (Dry Stack Wall), Stone Masonry Veneer 4.0" Thick, and Stone Column and for the dry stack wall, stone veneer for retaining walls, stone columns and precast concrete caps at the locations and quantities shown in the Drawings
- B. Related Sections:
 - 1. Section 01 57 13 - Temporary Erosion and Sediment Control.
 - 2. Section 31 23 00 - Excavation and Fill.

1.02 PRICE AND PAYMENT PROCEDURES

- A. Measurement and Payment
 - 1. Stone Masonry Veneer 4.0" Thick- measured and paid for by the square foot (face)
 - 2. Stone Seat Wall (Dry Stack Wall)- measured and paid for by the square foot (face)
 - 3. Stone Column- measured and paid for by each installed
 - 4. Stone Masonry Veneer 4.0" Thick- measured and paid for by the square foot (face)
 - 5. Stone Seat Wall- measured and paid for by square foot (face)Precast Concrete Caps- measured and paid for by the linear foot, which shall be compensation in full for all costs of furnishing and installing Precast Concrete Caps in place as specified
- B. The furnishing and installing of specific items and/or the performance of work under certain circumstances shall not be individually paid. The costs shall be included in the unit price bid for the associated retaining wall items. Such items of work include but are not limited to:
 - 1. Furnishing and installing appropriate sub-drainage, including piping and granular backfill, include in the price bid for retaining wall.
 - 2. Excavation, furnishing and installing granular footing material, and backfilling, include in the price bid for retaining wall.
 - 3. Furnishing and installing any anchoring support necessary, include in the price bid for retaining wall.
 - 4. Furnishing and installing a geosynthetic wall reinforcement system, include in the price bid for retaining wall.
 - 5. Disposal of any excess or unsuitable excavated material, include in the price bid for retaining wall.
 - 6. Protecting existing improvements from damage included in the price bid for retaining wall.
 - 7. Gradation and compaction testing to meet requirements of source and field quality control include in the price bid for retaining wall.
 - 8. Preparation, furnishing, and applying surface sealer as specified herein, include in the price bid for retaining wall.

1.03 REFERENCES

- A. American Society for Testing Materials
- B. Marble Institute of America (MIA)

- C. Building Stone Institute (BSI)
- D. Reference City of Northfield Standard Contract Documents and Technical Specifications.
- E. ACI
 - 1. 301 - Specifications for Structural Concrete for Buildings
 - 2. 305 - Hot Weather Concreting
 - 3. 306 - Cold Weather Concreting
 - 4. 309 - Recommended Practice for Consolidation of Concrete
 - 5. 350 - Environmental Engineering Concrete Structures
- F. ASTM
 - 1. A36 - Carbon Structural Steel
 - 2. A307 - Carbon Steel Bolts and Studs
 - 3. A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
 - 4. C33 - Standard Specification for Concrete Aggregates
 - 5. C94 - Standard Specification for Ready-Mixed Concrete
 - 6. C171 - Standard Specification for Sheet Materials for Curing Concrete
 - 7. C260 - Standard Specification for Air-Entraining Admixtures for Concrete
 - 8. C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections
 - 9. C494 - Standard Specification for Chemical Admixtures for Concrete
 - 10. C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
 - 11. C989 - Standard Specification for Slag Cement for Use in Concrete and Mortars
 - 12. C1240 - Standard Specification for Silica Fume Used in Cementitious Mixtures
 - 13. D1741 - Test Method for Functional Life of Ball Bearing Greases (Withdrawn 1991)
- G. All applicable MnDOT Specifications and Standard Specifications for Construction.

1.04 SUBMITTALS

- A. Shop Drawings
 - 1. Submit cutting and setting drawings indicating sizes, dimensions, sections, elevations and profiles of stone faces; arrangement and provisions for jointing, supporting, anchoring, and bonding stonework; and details showing relationship with, attachment to, and reception of, related work.
- B. Samples
 - 1. Representative samples of stones color and texture (a minimum of 4 in. x 4 in. sq.) shall be submitted for Engineers approval.
- C. Concrete Caps
 - 1. Submit manufacturer's data for concrete admixtures, liquid curing material, floor joint filler, finishing compounds, bonding agents, and adhesive anchoring material.
 - 2. Submit concrete aggregate test reports and concrete mix designs at least 14 days prior to placement of concrete.
 - 3. Submit results of concrete strength tests.
- D. STORAGE AND HANDLING
 - 1. Store and handle stone material to prevent damage due to moisture, contaminants, breakage, chipping or other causes.
 - 2. Do not use pinch or wrecking bars.

3. Lift with wide belt type slings where possible; do not use wire rope or ropes containing tar or other substances which could cause staining.
4. Store stone on wood skids or pallets, covered with non-staining, waterproof membrane.
5. Protect stored stone from weather with waterproof, non-staining covers or enclosures.

PART 2 PRODUCTS

A. MANUFACTURER

1. Vetter Stone Company, P.O. Box 38, Kasota, MN 56050; (507) 345 - 4568.

B. STONE

1. Stone selection type: Northern Valley Stone, Glacier Buff Minnesota Stone color.
2. Size
 - a. Veneer for stone columns and retaining walls: Stone range to be 3" to 4" high X 6" to 8" long by nominal 4" deep for running bond pattern.
 - b. Dry stack walls: Stone range to be 3 1/4" high X 24" +/- to 16" long X 12" deep.
3. Finish
 - a. Split face
 - b. Honed
 - c. Vein cut (cut vertically against the bed)

C. MORTAR

1. Meeting and exceeding latest ASTM standards.
2. Setting: Type N mortar or mortar consisting of one-part Portland cement, one-part hydrated lime or lime putty and six parts sand by volume.
3. Mix in as stiff a consistency as can be worked into joints.

D. ANCHORS

1. Anchors and Dowels: Stainless steel.

E. DIMENSION STONE FABRICATION

1. General: Fabricate stonework in sizes and shapes required to comply with requirements indicated, including details on drawings and final shop drawings.
2. For Minnesota Stone comply with recommendations of MIA/BSI.
3. Cut and drill sinkages holes in stones for anchors, fasteners, supports and lifting devices as indicated.
4. Cut stones to produce pieces of thickness, size and shape indicated or required and within fabrication tolerances recommended by MIA/BSI.
5. Finish exposed faces and edges of stones to comply with requirements indicated for finish under each type and application of stone required and to match approved samples.

F. ELASTOMERIC JOINT MATERIAL

1. Joint Seals with Elastomeric Sealants: The fabricator shall determine the appropriate joint filler material and elastomeric sealants that will be compatible with the composition of the stone, as well as, the site conditions in which the stone is to be placed. The color of the elastomeric sealant shall match the color of the stone color.

G. SEALANT

1. Graffiti control "Defacer Eraser" by ProSo Co., Inc.
2. Salt resistant.

H. Precast Concrete Caps

1. Concrete Material

- a. Cement: Conform to ASTM C150, Type I.
 - 1) Alkali content less than or equal to 0.6 percent (expressed as Na₂O).
 - 2) Provide cement from one source of supply.
 - b. Aggregate
 - 1) Coarse Aggregate: ASTM C33-5S
 - a) Provide from one source of supply.
 - b) For exterior exposed surfaces.
 - 2) Fine Aggregate: ASTM C33.
 - a) Provide from one source of supply.
 - b) For exterior exposed surfaces.
 - 3) Do not use fine or coarse aggregates containing spalling-causing deleterious substances.
 - 4) Local aggregates not complying with ASTM C33 but which have been shown by special test or actual service to produce concrete of adequate strength and durability may be used when approved by Engineer.
 - 5) Maximum Size
 - a) 1/5 the narrowest dimension of concrete member; nor
 - b) 1/3 the depth of slab; nor
 - c) 3/4 the clear spacing between reinforcement bars; nor
 - d) 1-1/2 inches
 - e) Gradation sizes 467, 57 or 67: ASTM C33, Table 2.
 - c. Water
 - 1) Clean potable and free from deleterious amounts of oil, acid, alkali, or other foreign matter.
2. ADMIXTURES
- a. Air Entraining Admixture: ASTM C260.
 - b. Water Reducing Admixture: ASTM C494, Type A.
 - c. High Range Water-Reducing Admixtures (Superplasticizer): ASTM C494, Type F and contain no
 - d. chlorides.
 - e. Retarding Admixtures: ASTM C494, Types B and D.
 - f. 5. Set-Accelerating Admixtures: ASTM C494, Type C. No chloride containing admixtures will be
 - g. allowed.
 - h. Viscosity Modifying Admixture: Demonstrate compatibility with other admixtures.
 - i. Pozzolans
 - 1) Fly Ash: ASTM C618, Class C or F. Loss on ignition shall be limited to 3 percent maximum.
 - 2) Ground Granulated Blast-Furnace Slag: ASTM C989, Grade 100 or 120.
 - 3) Silica Fume: ASTM C1240, 6 percent maximum.
3. MISCELLANEOUS MATERIAL
- a. Burlap-Polyethylene Sheet: Burlap weighing not less than 10 ounces per linear yard, 40 inches wide impregnated on one side with white opaque polyethylene 0.006 inch thick. Sheeting shall conform to ASTM C171.
 - b. Liquid Curing Compound: ASTM C309, Type 1-D, Class B clear or translucent with fugitive dye. Do not apply to floor slabs.
 - c. Expansion Joint Material: Bituminous fiber type conforming to ASTM D1751 with bituminous or paraffin binder.
 - d. PVC Waterstops
 - 1) Serrated type with centerbulb.
 - 2) Material: Virgin PVC.
 - 3) Minimum Thickness: 3/16-inch.

- 4) Greenstreak Plastic Products Company, specification grade, or approved equal.
 - 5) Install 4-inch width for construction joints located flush with slab or wall.
 - 6) Centerbulb diameter: 3/4-inch minimum.
 - 7) Install 6-inch width for all other construction joints, unless otherwise noted.
 - 8) Centerbulb diameter: 15/16-inch minimum.
 - 9) Water Stop Joints: Manufacturer's standard prefabricated joints at intersection points and corners.
- e. Hydrophyllic Waterstops
 - 1) Rubber Concrete Joint: Volclay Akwastop in accordance with manufacturer's recommendations, or approved equal.
 - 2) Bentonite RX 101: Colloid Environmental Technologies Company, installed per manufacturer's specification with approved bonding agent.
 - f. Interior Joint Filler: 1 part, self-leveling, polymer reinforced joint filler.
 - 1) Everjoint manufactured by L&M Construction Chemicals, Inc., or approved equal.
 - g. Exterior Joint Sealant: 2 parts, self-leveling, polyurethane sealant.
 - 1) Sonolastic SL2 manufactured by Sonneborn, or approved equal.
 - h. Bonding Agent: Acryl 60 manufactured by Thoro System Products, or approved equal.
 - i. Adhesive for anchoring steel reinforcement dowels and threaded rods in concrete: 2 component injected epoxy structural adhesive.
 - 1) Approved Products
 - 2) Hilti RE-500 Adhesive by Hilti Fastening Systems
 - 3) Epoxy-Tie Adhesive by Simpson Strong-Tie
 - 4) Epogel by Sonneborn
 - j. Epoxy Injection: Sika 35, Hi-Mod, LV or equal with Sikadur 31 Paste Epoxy or equal to be installed as manufacturer's recommendations.
 - k. Dovetail Anchor Slot: 18 gauge stainless steel.

PART 3 EXECUTION

3.01 PREPARATION

- A. Contact Engineer a minimum of 5 days prior to starting work so they may be present on site at start of stone masonry work.
- B. Inform the Engineer of any problems and or changes prior to setting the stones.
- C. Work directly with the Engineer with placement and orientation of stone masonry.
- D. Stone must be brushed free of dust and foreign matter.
- E. Wet stone sufficiently to take up surface absorption.

3.02 SETTING DIMENSION STONE

- A. All settings shall be done by competent stone setter, having performed this type of work for at least five years prior, and all work shall be done in strict accordance with approved shop drawings.
- B. Provide all labor, materials, and accessories necessary to erect complete material. Anchor stone securely in correct vertical and horizontal alignment.
- C. Before setting, be sure stone is free from loose debris, ice or frost.

- D. Where setting buttons are used, care needs to be taken to hold these spacers far enough from the finished face to allow proper joint depths.
- E. Execute dimension stone work by skilled mechanics, and employ skilled stone fitters at site to do necessary field cutting as stones are set.
- F. Set stones to comply with requirements indicated on drawings and final shop drawings, install anchors, supports, fasteners, and other attachments indicated or necessary to secure stonework in place. Shim and adjust as necessary.
- G. Beds and joints shall be full cut and square for the full thickness of the stone with various shapes as detailed. Joints shall generally be 1/4" in width unless otherwise indicated. The backs of stones shall be sawn to approximate true planes parallel to the face.
- H. Stone coming in contact with structural shapes shall be back checked as indicated on drawings. Stone resting on structural members shall have beds shaped to fit the supports.
- I. Cut/drill holes in stone for all anchors, cramps, dowels, etc.
- J. Finished face shall be slightly blunted to remove sharp edge and reduce chipping.
- K. Incidental repair/patching of stone panels which are chipped, stained or otherwise damaged will be permissible provided the method and results of the repair do not detract from the structural integrity or appearance of the panel.

3.03 SETTING SPLIT FACE STONE

- A. Lay stone in accordance with manufacturer's instructions.
- B. Execute split face stone work by skilled mechanics and employ skilled stone fitters at site to do necessary field cutting as stones are set.
- C. Stone is to be anchored to backup with approved non-corrosive metal anchor ties (heavy duty) spaced approximately 16" on center.
- D. Stone is to be selected so colors are evenly distributed throughout the project

3.04 JOINT SEALS WITH ELASTOMERIC SEALANTS

- A. All stone joints for vertical facing shall be caulked in accordance with sealant specifications.
- B. Application: The sealant shall come in direct contact with the substrate, the sealant shall wet the surface of the substrate, and the substrate be strong enough to provide a firm anchor for the sealant. The sealant should be installed in such a manner as to completely fill the recess provided in the joint.
- C. Joint Preparation
 - 1. Joints to receive sealant should be cleaned out and raked to full width and depth required for installation of joint seal materials. Thoroughly clean all joints, removing all foreign matter such as dust, paint (unless it is a permanent protective coating), oil, grease, waterproofing or water-repellent treatments, water, surface dirt, and frost. Clean porous materials such as concrete, masonry, and unglazed surfaces of ceramic tile by brushing, grinding, blast cleaning,

- mechanical abrading, acid washing, or a combination of these methods to provide a clean, sound substrate for optimum sealant adhesion.
2. Remove laitance from concrete by acid washing, grinding, or mechanical abrading and remove form oils from concrete by blast cleaning. Remove loose particles originally present or resulting from grinding, abrading, or blast cleaning by blowing-out joints with oil-free compressed air (or vacuuming) prior to application of primer or sealant.
 3. Clean nonporous surfaces, such as metal, glass, porcelain enamel, and glazed surfaces of ceramic tile chemically or by other means that are not harmful to the substrate and are acceptable to the substrate manufacturer.
 4. Remove temporary protective coatings on metallic surfaces by a solvent that leaves no residue. Apply the solvent with clean oil-free cloths or lint-less paper towels. Do not dip cleaning cloths into solvent. Always pour the solvent on the cloth to eliminate the possibility of contaminating the solvent. Do not allow the solvent to air-dry without wiping. Wipe dry with a clean dry cloth or lint-less paper towels. Permanent coatings that are to remain must not be removed or damaged.
 5. Masking Tape: Install masking tape at joint edges when necessary to avoid undesirable sealant smears on exposed visible surfaces. Use a non-staining, nonabsorbent, compatible type.
 6. Primer and Joint Filler: Install primer when and as recommended by the sealant manufacturer for optimum adhesion. Install compatible joint filler uniformly to proper depth without twisting and braiding.
 7. Sealants: Install sealant in strict accordance with the manufacturer's recommendations and precautions. Completely fill the recess provided in the joint. Sealants are more safely applied at temperatures above 40 degrees F. Joints must be dry.
 8. Tooling: Tooling non-sagging sealants is essential to force the sealant into the joint and eliminate air pockets and should be done as soon as possible after application and before skinning or curing begins. Tooling also ensures contact of the sealant to the sides of a joint to the side of a joint.
 - a. Plastic or metal tools may be used and surface-treated to prevent adhesion to the sealant and shaped to produce the desired joint profile. Dipping tools in certain liquids decreases adhesion of the sealant to the tool. All liquids should first be tested and accepted for use by the manufacturer. In using tooling liquids, care should be taken to ensure that the liquid does not contact joint surfaces prior to the sealant contacting the joint surface. If the sealant overlaps the area contaminated with the liquid, the sealant bond may be adversely affected.
 - b. Tool sealant to force it into the joint, eliminating air pocket and ensuring contact of the sealant with the sides of the joint. Use appropriate tool to provide a concave, flush, or recessed joint as required.
 - c. Immediately after tooling the joint, remove masking tape carefully, if used, without disturbing the sealant.
 10. Field Testing: In cases where the building joints are ready to receive sealant and the question of adhesion of the sealant to novel or untried surfaces arises, install the sealant in a 1.5-m (5 ft) length of joint as a test. Following instructions of the sealant manufacturer and using primer as and when recommended, install the sealant in the joint and examine for adhesion after cure to determine whether proper adhesion has been obtained. Reference: ASTM C-962 "Standard Guide for Use of Elastomeric Joint Sealants."

D. TOLERANCES

1. All parts of the work, when finished, shall be within the following tolerances:
 - a. Variation in Dimension of Large Stone Blocks & Benches: Plus minus 6 inches in length 3 inches in height and 6 inches in width.
 - b. Deviation from plumb, level or diminished angle must not exceed 1/8" per 12 feet of length or 1/4" in any total run.

- c. Deviation from theoretical position in plan or elevation, including deviation from plumb or level, must not exceed 1/4" total at any location.
- d. Change in deviation must not exceed 1/8" for any 12 foot run in any direction.
- e. Maximum offset from true alignment between two consecutive members or units placed end to end must not exceed 1/16".

3.05 SETTING DRY STACK WALLS (STONE SEAT WALLS)

A. MATERIALS

1. BASE MATERIAL: Aggregate Base (MnDOT 2211). Material used as a driving and/or parking surface shall be Class 5, 100% crushed, meeting the requirements of MnDOT 3138. The specified density method shall be used. No control strips are required; however, field densities, optimum moisture, and maximum moisture will be determined and/or established by an independent testing company retained by the owner.
2. BACKFILL MATERIALS: 3/4" clean sharp gravel, basalt or granite.
3. WALL CAP: Same as wall materials; cut to fit wall.
4. ADHESIVE: Adhesive for affixing top cap course to one course below the cap; use high strength construct adhesive such as PL-400, as deem suitable by the Engineer for exterior use in these conditions. Submit manufacturer's data sheets to Engineer for approval.
5. GEOTEXTILE: 6 oz. non-woven fabric.

B. EXECUTION

1. EXAMINATION: Examine the areas and conditions under which retaining wall is to be constructed and notify Engineer of conditions detrimental to the proper and timely completion of the work. Starting the work shall constitute acceptance of the existing conditions
2. PREPARATION: Foundation soil shall be excavated as required for base and footing dimension shown in the Plans. Foundation soil shall be examined by the Contractor to ensure that the actual foundation soil strength meets or exceeds assumed designed strength. Soil not meeting the required strength shall be removed and replaced with acceptable materials.
 - a. Place a minimum of 6" aggregate base to 98% modified Proctor density under the length of the wall according to the plans. Place aggregate in total prior to setting the first course of wall. Top of aggregate base is to be level end to end and a minimum of 12" below final grade at the base of the wall.
3. INSTALLATION: Install stones according to uniform height, tightly abutting each other and no joint wider than 1/8 inch. Keep level and at repose indicated on the plan. Keep stone flat face to wall face. On curved surface, maximum ledge exposure is to be 0.5" and maximum length is to be 18". Compact backfill at each lift with a mechanical compactor to 98% of modified Proctor. Install limestone caps by use of adhesive to underlying stone keeping top of wall level and joints tight.
4. CLEAN UP AND PROTECTION: Clean wall face and cap of extraneous soil and materials and protect from damage from subsequent construction. Remove all unused or damaged units as well as construction and delivery materials from the site.

3.06 PRECAST CONCRETE CAPS

A. CONCRETE PRODUCTION

1. Ready-mixed concrete: Comply with ASTM C94.
 - a. Air Temperature between 85 degrees F (30 degrees C) and 90 degrees F (32 degrees C):
 - 1) Reduce mixing and delivery time to 75 minutes.
 - 2) Air Temperature above 90 degrees F (32 degrees C): Reduce mixing and delivery time to 60 minutes.

- 3) Batch Ticket: Provide for each batch discharged and used in work, indicating project identification name and number date, mix type, mix time, quantity and amount of water introduced and available.
 2. Mix concrete only in quantities for immediate use. Concrete which has set shall be discarded and shall not be re-tempered.
 3. Do not add water at the Site without the approval of Engineer.
 4. Add superplasticizer and mix concrete in accordance with manufacturer's specification.
- B. PLACING WATERSTOP
1. Place waterstop material at all construction joints, unless shown otherwise and confirmed by Engineer.
 2. Center waterstop in the joint and between each layer of reinforcing steel with each half embedded in concrete. Secure waterstop by hog-tying waterstop to protection bar (refer to Drawings) at 12 inches on center prior to placing concrete.
 3. Thoroughly and systematically vibrate concrete around the waterstop to ensure positive contact between concrete and waterstop. When concrete is being placed, take care not to deflect waterstop out of proper position.
 4. Use prefabricated waterstop fittings or follow proper field splicing procedures for all connections and splices
 - a. Miter all intersecting connections at 45 degrees.
 - b. Use a thermostatically controlled heating iron to heat both ends of waterstop to be connected, then butt splice pieces to be joined with full contact.
 5. Follow manufacture's recommendations for proper preparation and installation of waterstop materials.
- C. EMBEDDED ITEMS
1. Place all sleeves, inserts, anchors, and embedded items required for adjoining work or for its support prior to placing concrete.
 2. Position all embedded items accurately and supported against displacement.
 3. Temporarily fill voids in sleeves, inserts, and anchor slots with readily removable material to prevent the entry of concrete into the voids.
- D. PREPARATION BEFORE PLACING
1. Complete formwork and secure all reinforcement and embedded items in place.
 2. Remove all snow, ice, and mud prior to placing concrete.
 3. Do not place concrete on frozen ground.
 4. Do not place concrete on ground with standing water or when upper 2 inches of ground is saturated.
 5. Do not place concrete during rain, sleet, or snow.
- E. CONCRETE CONVEYING
1. Deliver concrete from the mixer to the place of final deposit as rapidly as practical by methods, which will prevent segregation or loss of ingredients.
- F. CONCRETE DEPOSITING
1. Deposit concrete continuously or in layers of such thickness that no concrete will be deposited on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within the section.
 2. Place concrete at such a rate that the concrete which is being integrated with fresh concrete is still plastic.
 3. Do not deposit concrete which has partially hardened or has been contaminated by hardened materials.
 4. Remove rejected concrete from the Site.

5. Deposit concrete as nearly as practicable in its final position to avoid segregation due to handling or flowing.
6. Free fall of concrete shall not exceed 4 feet. Use chutes equipped with hopper heads for placing where a drop of more than 4 feet is required.

G. COLD WEATHER PLACING

1. Do not place concrete when the air temperature is less than 40 degrees F. without the specific approval of Engineer.
2. Cold Weather Concrete Work: ACI 306.1, except as modified by the requirements of these Contract Documents.
3. Do not place concrete against any frozen substrate, including subgrade soils and surfaces of formwork.
4. Do not place concrete around any embedment, including reinforcing steel that is at a temperature below freezing.
5. The temperature of the concrete delivered at the site shall conform to the following limitations.

Minimum Concrete Temperature

Air Temperature	< 12 Inches Thick	12-36 Inches Thick
Above 30° F	60° F	F 55° F
0° to 30° F	65° F	60° F
Below 0° F	70° F	65° F

6. If water or aggregate is heated above 100 degrees F., combine water with the aggregate in the mixer before cement is added. Do not mix cement with water or with mixtures of water and aggregate having a temperature greater than 100 degrees F.
7. When the mean daily temperature is less than 40 degrees F., maintain the temperature of the concrete between 50 and 70 degrees F. for the required curing period.
8. Arrangements for Heating, Covering, Insulation, or housing the Concrete Work:
 - a. Made in advance of placement.
 - b. Adequate to maintain the required temperature without injury due to concentration of cold or heat.
 - c. Keep protection in place for a minimum of 3 days.
9. Do not use combustion heaters during the first 24 hours, unless precautions are taken to prevent exposure of the concrete to exhaust gases.
10. Once the cold weather concrete protection is removed, continue concrete curing for the remainder of the 10 day curing period.

H. HOT WEATHER PLACING

1. Comply with ACI 305 when hot weather conditions exist.
2. Maintain concrete temperature at time of placement below 90 degrees F.
3. When the temperature of the steel is greater than 120 degrees F., spray steel forms and reinforcement with water prior to placing concrete.
4. Keep all surfaces protected from rapid drying. Provide windbreaks, shading, fog spraying, sprinkling, ponding, or wet covering in advance of placement.

I. CONSOLIDATION

1. Consolidate all concrete in accordance with provisions of ACI 309.
2. Consolidate each layer of concrete immediately after placing by use of internal concrete vibrators. Maintain a frequency of not less than 8,000 vibrations per minute for each internal vibrator.
3. Provide adequate number of units and power source at all times. Use a minimum of 2 vibrators for all work and maintain spare units to ensure adequacy.
4. Insert the vibrator so as to penetrate the lift immediately below the one being placed. Do not insert the vibrator into lower courses which have begun to set.

5. Limit spacing between insertions of the vibrator to 12-18 inches and do not exceed twice the radius of action as shown in ACI 309 or 18 inches.
6. Do not use vibrators to transport concrete inside the forms.
7. Vibrate concrete to minimize entrapped air and surface voids on formed surfaces.

J. FINISHING FORMED SURFACES

1. Provide a smooth formed surface to all formed surfaces not exposed to view. Smooth formed finish shall consist of the following:
 - a. Patch all tie holes and defects larger than 1/8-inch in diameter and/or 1/8-inch deep.
 - b. Remove all fins, seams and concrete "buttons" protruding more than 1/16-inch.
2. Provide a special form finish to all formed surfaces exposed to view:
 - a. Prepare 3 test samples of various textures for approval by Engineer. Each sample shall be approximately 6 feet by 6 feet in size and located on an unexposed wall surface as directed by Engineer.
 - b. Perform all Concrete Crack Repairs in accordance with Article 3.14.B.
 - c. Remove all form release agents, curing compounds, hardeners, salts, efflorescence, laitance, loose material, unsound concrete, and other foreign materials by sandblasting, shot blasting, mechanical scarification, or other suitable methods.
 - d. Surface Preparation
 - 1) Expose, but not undercut or loosen, aggregate.
 - 2) Expose all bugholes, cracks and subsurface voids.
 - 3) Provide a clean, sound substrate with sufficient surface profile.
 - e. Filling of deep voids, bugholes, etc., exceeding 1/8-inch depth:
 - 1) Dampen surface with clean water to obtain saturated surface-dry (SSD) with no standing water.
 - 2) Brush-apply a small quantity of mixed patching material as a scrub coat to prepare substrate. Thoroughly key-in and work material throughout cavity to promote bond.
 - a) If sc
 - b) and compact thorough scrub coat dries out before wet mortar can be placed, remove scrub coat similar to laitance removal.
 - 3) Place repair mortar onto wet scrub coat using brush with firm trowel pressure.
 - a) Completely fill voids.
 - b) Key in gently to secure bond.
 - c) Apply patching material in lifts of 1/4-inch (8mm) to 2-inches (51mm) and trowel to desired finish promptly after placing material.
 - d) For successive lifts, thoroughly score each lift and allow reaching initial set before next layer is applied.
 - e) Perform wet curing of patched areas for the following conditions:
 - (1) If temperature exceed 85 degrees F (29 degrees C).
 - (2) If relative humidity is below 30 percent.
 - (3) If wind speed exceeds 15 mph.
 - (4) If patches are exposed to direct sunlight for 72 hours after placement.
 - f) Special curing compounds are allowed with approval of Engineer. Do not use solvent-based curing compound.
 - f. Dampen surface with clean water just prior to application of finishing compound.
 - g. Mix 1 part bonding agent to 3 parts clean water for mixing liquid.
 - h. Mix concrete finishing compound with mixing liquid as specified by the manufacturer.
 - i. Apply 2 coats using a stiff fiber brush or textured spray equipment. Spray application of the first coat requires back brushing to properly fill voids, bugholes and nonmoving cracks.
 - 1) First coat: Apply at 2 pounds per sq. yd. and allow to cure a minimum 24 hours.
 - 2) Second coat: Apply at 2 pounds per sq. yd., allow to set and then float to a uniform finish.
 - 3) Perform damp curing to applied product.

K. CURING

1. Immediately after placement, damp cure all concrete for a minimum of 7 days.
2. Cover all slabs and topping with approved burlap-polyethylene film and keep in place throughout the curing period.
3. Cover walls, beams, columns and other formed surfaces with burlap-polyethylene film or spray with an approved curing compound.
4. Anchor all burlap-polyethylene film at the edges to prevent moisture loss.
5. Re-wet all slab surfaces at least once a day during the curing period.

L. PATCHING

1. Repair honeycomb and other defective areas, fill surface voids, and fill form tie holes and similar defects in accordance with ACI 301.
2. Inject concrete cracks as observed during construction and leak testing operations with epoxy to manufacturer's recommendations. Confirm procedures with Engineer prior to installation.
3. Reinforce or replace deficient work as directed by Engineer and at no additional cost to Owner

M. CLEAN UP AND DISPOSAL

1. Upon completion of the walls and prior to any painting, thoroughly clean all exposed or painted concrete surfaces of all concrete spatters, form oil, or other foreign material detrimental to appearance or painting.
2. Remove all excess concrete debris remaining after completion of placement and form removal from the Site and dispose of in a proper and legal manner.

N. ANCHORING DOWELS

1. Drill hole in concrete to the size and depth recommended by the adhesive supplier and as approved by the Engineer.
2. Clean hole with a nylon brush and use compressed air to blow out hole.
3. Fill hole with anchoring adhesive in accordance with manufacturer's recommendations.

O. FIELD QUALITY CONTROL

1. Concrete Strength Tests
 - a. Mold and cure four specimens from each sample in accordance with ASTM C31. Record any deviations from the requirements of ASTM C31 in the test report.
 - b. Test specimens in accordance with ASTM C39. Test two specimens at 28 days for acceptance and one at 7 days for information. Test one specimen at 56 days if desired by Engineer.
 - c. Conduct at least one strength test for each 100 cu. yds. or fraction thereof for each mixture design placed in any one day.
 - d. Furnish a copy of the test results to Engineer as soon as available.
 - e. Costs of concrete cylinder testing will be paid by Owner.
 - f. Mold and field cure specimens as required in ASTM C31.
 - g. Acceptance test results shall be the average strengths of the two specimens tested at 28 days.
 - h. Conduct load test on test cores of concrete that fail to meet the specified strength, in accordance with ASTM C42.
 - i. Failure to meet strength requirements of the cores, shall be a cause for rejection the Engineer.
 - j. The cost of remedial measures required due to test failures shall be paid for by Contractor.
2. Engineer may request adjustment to concrete mixes when characteristics of materials, job conditions, weather, test results, other circumstances warrant.
3. Concrete Slump Tests
 - a. Engineer will determine slump of concrete from each truck in accordance with ASTM C143.
 - b. If slump exceeds maximum allowed, remove batch from work and dispose of off-site.

- c. Test slump at end of conveying system.
- d. All costs of slump testing will be paid by Engineer.
- 4. Concrete Air Content Tests
 - a. Engineer will determine air content of concrete from each truck in accordance with ASTM C231.
 - b. Air content shall be tested at end of conveying system.
 - c. All costs of air content testing will be paid by Owner.
- 5. Concrete Temperature
 - a. Engineer will determine temperature of concrete from each truck in accordance with ASTM C31
 - b. Test temperature at end of conveying system.
 - c. All costs of temperature testing will be paid by Owner.

3.07 CLEANING

- A. Keep stonework as clean as possible as work progresses. Upon completion clean stone thoroughly with water or soap and water and fiber brushes. Thoroughly rinse when complete. Do not use acids or wire brushes.

3.08 GRAFFITI SEALANT

- A. Apply graffiti control sealer in accordance with manufacturer's specifications.

END OF SECTION