

SECTION 32 32 16 PRECAST MODULAR BLOCK RETAINING WALL PART 1 - GENERAL 1.01 SUMMARY A. Section includes furnishing all materials and labor required for the design and construction of a precast concrete modular block (PMB) retaining wall with or without geosynthetic reinforcement. Precast modular block retaining wall blocks under this section shall be cast utilizing a wet-cast concrete mix and exhibit a final handling weight in excess of 1,000 pounds (450 kg) per unit. B. Scope of Work: The work shall consist of furnishing materials, labor, equipment and supervision for the construction of a precast modular block (PMB) retaining wall structure in accordance with the requirements of this section and in acceptable conformity with the lines, grades, design and dimensions shown in the project plans. C. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 31, Division 32 and Division 33 also apply to this Section. 1.02 PRICE AND PAYMENT PROCEDURES A. Allowances: No allowance shall be made in the price of the retaining wall for excavation beyond the limits required for retaining wall construction as shown on the project plans. The cost of excavation for the purposes of site access shall be the responsibility of the General Contractor. Removal of unstable soils and replacement with select fill shall be as directed and approved in writing by the Owner or Owner's representative and shall be paid under separate pay items. B. Unit Prices: In addition to a lump sum price pursuant to completion of the scope of work described in Part 1.01 of this Section, the General Contractor shall provide a unit price per square foot of vertical wall face that shall be the basis of compensation for up to a ten (10) percent increase or reduction in the overall scope of the retaining wall work. C. Measurement and Payment: 1. The unit of measurement for furnishing the precast modular block retaining wall system shall be the vertical area of the wall face surface as measured from the top of the leveling pad to the top of the wall excluding coping. The final measured quantity shall include supply of all material components and the installation of the precast modular block retaining wall system. The final accepted quantities of the precast modular block retaining wall system will be compensated per the vertical face area as described above. The quantities of the precast modular block retaining wall as shown on the plans and as approved by the Owner shall be made per square foot of vertical wall face. 1.03 REFERENCES A. Where the specification and reference documents conflict, the Owner's designated representative will make the final determination of the applicable document. B. Definitions: 1. Precast Modular Block (PMB) Unit - machine-placed, wet cast concrete modular block retaining wall facing unit. 2. Geotextile - a geosynthetic fabric manufactured for use as a separation and filtration medium between dissimilar soil materials. 3. Geogrid - a geosynthetic material comprised of a regular network of tensile elements manufactured in a mesh-like configuration of consistent aperture openings. When connected to the PMB facing units and placed in horizontal layers in compacted fill, the geogrid prevents lateral deformation of the retaining wall and provides effective tensile reinforcement to the contiguous reinforced fill material. 4. Drainage Aggregate - clean, crushed stone placed within and immediately behind the precast modular block units to facilitate drainage and reduce compaction requirements immediately adjacent to and behind the precast modular block units. 5. Drainage Pipe - clean, crushed stone placed within the hollow vertical core of a precast modular block unit. Typically, this stone material used for drainage aggregate as defined above. 6. Foundation Zone - soil zone immediately beneath the leveling pad and the reinforced zone. 7. Retained Zone - soil zone immediately behind the drainage aggregate and wall infill for wall sections designed as modular gravity structures. Alternatively, in the case of wall sections designed with geosynthetic soil reinforcement, the retained zone is the soil zone immediately behind the reinforced zone. 8. Reinforced Zone - structural fill zone within which successive horizontal layers of geogrid soil reinforcement have been placed to provide stability for the retaining wall face. The reinforced zone extends only for retaining wall sections that utilize geosynthetic soil reinforcement for stability. 9. Reinforced Fill - structural fill placed within the reinforced zone. 10. Leveling Pad - hard, flat surface upon which the bottom course of precast modular blocks are placed. The leveling pad may be constructed with crushed stone or cast-in-place concrete. A leveling pad is not a structural footing. 11. Wall Infill - the fill material placed and compacted between the drainage aggregate and the excavated soil face in retaining wall sections designed as modular gravity structures. C. Reference Standards 1. Design a. AASHTO LRFD Bridge Design Specifications, 7th Edition, 2014. b. Minimum Design Loads for Buildings and Other Structures - ASCE/SEI 7-10. c. International Building Code, 2012 Edition. d. FHWA-NHI-10-024 Volume 1 and GEC 11 Design of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes. e. FHWA-NHI-10-025 Volume II and GEC 11 Design of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes. 2. Precast Modular Block Units a. ASTM C94 - Standard Specification for Ready-Mixed Concrete. b. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates. c. ASTM C143 - Standard Test Method for Slump of Hydraulic-Cement Concrete. d. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete. e. ASTM C494 - Standard Specification for Chemical Adhesives for Concrete. f. ASTM C666 - Standard Test Method for Concrete Resistance to Rapid Freezing and Thawing. g. ASTM C920 - Standard Specification for Elastomeric Joint Sealants. h. ASTM C1116 - Standard Specification for Fiber-Reinforced Concrete. i. ASTM C1811 - Standard Test Method for Slump Flow of Self-Consolidating Concrete. j. ASTM D638 - Standard Test Method for Determining Connection Strength Between Geosynthetic Reinforcement and Segmental Concrete Units (Modular Concrete Blocks). k. ASTM D6916 - Standard Test Method for Determining Shear Strength Between Segmental Concrete Units (Modular Concrete Blocks). 3. Geosynthetics a. ASTM M 280 - Geotextile Specification for Highway Applications. b. ASTM D7786 - Standard Test Method for Bursting Strength of Textile Fabrics Diaphragm Bursting Strength Test Method. c. ASTM D4354 - Standard Practice for Sampling of Geosynthetics for Testing. d. ASTM D4355 - Standard Test Method for Deterioration of Geotextiles. e. ASTM D4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity. f. ASTM D4533 - Standard Test Method for Trapezoidal Tearing Strength of Geotextiles. g. ASTM D4596 - Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method. h. ASTM D4832 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles. i. ASTM D4715 - Standard Test Method for Determining Apparent Opening Size of a Geotextile. j. ASTM D4769 - Standard Practice for Determining Specimen Conformance of Geosynthetics. k. ASTM D4833 - Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products. 4. Soil Properties and Properties of the Retaining Wall System a. ASTM D4873 - Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples. m. ASTM D5022 - Standard Test Method for Evaluating the Unconfined Tension Creep and Creep Rupture Behavior of Geosynthetics. n. ASTM D5321 - Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic Friction by the Direct Shear Method. o. ASTM D5818 - Standard Practice for Exposure and Retrieval of Samples to Evaluate Installation Damage of Geosynthetics. p. ASTM D6241 - Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe. q. ASTM D6637 - Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Ro Tensile Method. r. ASTM D6706 - Standard Test Method for Measuring Geosynthetic Pullout Resistance in Soil. s. ASTM D6992 - Standard Test Method for Accelerated Tensile Creep and Creep-Rupture of Geosynthetic Materials Based on Time-Temperature Superposition Using the Stepped Isothermal Method. 4. Soils a. AASHTO M 145 - AASHTO Soil Classification System. b. AASHTO T 104 - Standard Method of Test for Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate. c. AASHTO T 267 - Standard Method of Test for Determination of Organic Content in Soils by Loss of Ignition. d. ASTM C33 - Standard Specification for Concrete Aggregates. e. ASTM D422 - Standard Test Method for Particle-Size Analysis of Soils. f. ASTM D448 - Standard Classification for Sizes of Aggregates for Road and Bridge Construction. g. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort. (12,400 ft-lbf/2,700 kN-m). h. ASTM D1291 - Standard Specification for Materials for Soil-Aggregate Subbase, Base and Surface Courses. i. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method. j. ASTM D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort. (66,000 ft-lbf/2,700 kN-m). k. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System). l. ASTM D2488 - Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). m. ASTM D3080 - Standard Test Method for Direct Shear Test of Soils Under Consolidated Drained Conditions. n. ASTM D4254 - Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density. o. ASTM D4255 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils. p. ASTM D4767 - Test Method for Consolidated-Un drained Triaxial Compression Test for Cohesive Soils. q. ASTM D4872 - Standard Test Method for pH of Soils. r. ASTM D6839 - Standard Test Method for In-Place Density and Water Content of Soil and Aggregate by Nuclear Methods (Shallow Depth). s. ASTM G61 - Standard Test Method for Measuring pH of Soil for Use in Corrosion Testing. t. ASTM G57 - Standard Test Method for Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method. 1.04 ADMINISTRATIVE REQUIREMENTS A. Preconstruction Meeting: As directed by the Owner, the General Contractor shall schedule a preconstruction meeting at the project site prior to commencement of retaining wall construction. Participation in the preconstruction meeting shall be required of the General Contractor, Retaining Wall Design Engineer, Retaining Wall Installation Contractor, Grading Contractor and Inspection Engineer. The General Contractor shall provide notification to all parties at least 10 calendar days prior to the meeting. 1.05 SUBMITTALS A. Product Data: At least 14 days prior to construction, the General Contractor shall submit a minimum of six (6) copies of the retaining wall product submittal package to the Owner's representative for review and approval. The submittal package shall include technical specifications and product data from the manufacturer for the following: 1. Precast Modular Block System brochure. 2. Precast Modular Block concrete test results specified in paragraph 2.01, subparagraph B of this section as follows: a. 28-day compressive strength b. Air content c. Slump or Slump Flow (as applicable) d. Drainage Pipe 3. Geotextile 4. Geosynthetic Soil Reinforcement (if required by the retaining wall design). The contractor shall provide certified manufacturer test reports for the geosynthetic soil reinforcement materials in the manufactured roll with specified. The test report shall list the individual roll numbers for which the certified materials properties are valid. B. Installer Qualification Data: At least 14 days prior to construction, the General Contractor shall submit the qualifications of the business entity responsible for installation of the retaining wall, the Retaining Wall Installation Contractor, per paragraph 1.07, subparagraph A of this section. C. The Owner reserves the right to reject the design services of any engineer or engineering firm who, in the sole opinion of the Owner, does not possess the required experience or qualifications. 1.06 QUALITY CONTROL A. The Owner's Representative shall review all submittals for materials, design, Retaining Wall Design Engineer qualifications and the Retaining Wall Installation Contractor qualifications. B. The General Contractor shall retain the services of an Inspection Engineer who is experienced with the construction of precast modular block retaining wall structures to perform inspection and testing. The cost of inspection shall be the responsibility of the General Contractor. Inspection shall be continuous throughout the construction of the retaining walls. C. The Inspection Engineer shall perform the following duties: 1. Inspect the construction of the precast modular block structure for conformance with construction shop drawings and the requirements of this specification. 2. Verify that soil or aggregate fill placed and compacted in the reinforced, retained and foundation zones of the retaining wall conforms with paragraphs 2.04 and 2.05 of this section and exhibits the shear strength parameters specified by the Retaining Wall Design Engineer. 3. Verify that the shear strength of the in-situ soil assumed by the Retaining Wall Design Engineer is appropriate. 4. Inspect and document soil compaction in accordance with these specifications: a. Required dry unit weight b. Actual dry unit weight c. Allowable moisture content d. Actual moisture content e. Pass/fail assessment f. Test location - wall station number g. Test elevation h. Distance of test location behind the wall face 5. Verify that all excavated spaces in the vicinity of the retaining wall are backfilled, as directed by the project Geotechnical Engineer. 6. Notify the Retaining Wall Installation Contractor of any deficiencies in the retaining wall construction and provide the Retaining Wall Installation Contractor a reasonable opportunity to correct the deficiency. 7. Notify the General Contractor, Owner and Retaining Wall Design Engineer of any construction deficiencies that have not been corrected timely. 8. Document all inspection results. 9. Test compacted density and moisture content of the retained backfill with the following frequency: a. At least once every 1,000 square feet (90 square meters) (in plan) per 9-inch (230 mm) vertical lift. b. At least once per every 18 inches (460 mm) of vertical wall construction. 1.07 QUALITY ASSURANCE A. Retaining Wall Installation Contractor Qualifications: In order to demonstrate basic competence in the construction of precast modular block walls, the Retaining Wall Installation Contractor shall document compliance with the following: 1. Experience. a. Construction experience with a minimum of 30,000 square feet (2,800 square meters) of the proposed precast modular block retaining wall system. b. Construction of at least ten (10) precast modular block (large block) retaining wall structures within the past three (3) years. c. Construction of at least 50,000 square feet (4,650 square meters) of precast modular block (large block) retaining walls within the past three (3) years. 2. Retaining Wall Installation Contractor experience documentation for each qualifying project shall include: a. Project name and location b. Date (month and year) of construction completion c. Contact information of Owner or General Contractor d. Type (trade name) of precast modular block system built e. Maximum height of the wall constructed f. Face area of the wall constructed 3. In lieu of the requirements set forth in items 1 and 2 above, the Retaining Wall Installation Contractor shall be a certified Precast Modular Block Retaining Wall Installation Contractor as demonstrated by satisfactory completion of a certified precast modular block retaining wall installation training program administered by the precast modular block manufacturer. B. Concrete used in the production of the precast modular block units shall be first-pour, fresh concrete. It shall not consist of returned, reconstituted, surplus, or waste concrete. It shall be an original production mix meeting the requirements of ASTM C94 and exhibit the following: 1. Minimum 28-day compressive strength of 4,000 psi (27.6 MPa). 2. Shall be free of water soluble chlorides and chloride based accelerator admixtures. 3. 6% +/- 15% air-entrainment in conformance ASTM C94. 4. Maximum slump of 5 inches +/- 1 1/2 inches (125 mm +/- 40 mm) per ASTM C143 for conventional concrete mix designs. 5. Slump Flow for Self-Consolidating Concrete (SCC) mix designs shall be between 18 inches and 32 inches (450 mm and 800 mm) as tested in accordance with ASTM C1611. C. Each concrete block shall be cast in a single continuous pour without cold joints. With the exception of half-block units, corner units and other special application units, the precast modular block units shall conform to the nominal dimensions listed in the table below and be produced to the dimensional tolerances shown. D. The Owner reserves the right to reject the design services of any engineer or engineering firm who, in the sole opinion of the Owner, does not possess the required experience or qualifications. 1.08 QUALITY CONTROL A. The Owner's Representative shall review all submittals for materials, design, Retaining Wall Design Engineer qualifications and the Retaining Wall Installation Contractor qualifications. B. The General Contractor shall retain the services of an Inspection Engineer who is experienced with the construction of precast modular block retaining wall structures to perform inspection and testing. The cost of inspection shall be the responsibility of the General Contractor. Inspection shall be continuous throughout the construction of the retaining walls. C. The Inspection Engineer shall perform the following duties: 1. Inspect the construction of the precast modular block structure for conformance with construction shop drawings and the requirements of this specification. 2. Verify that soil or aggregate fill placed and compacted in the reinforced, retained and foundation zones of the retaining wall conforms with paragraphs 2.04 and 2.05 of this section and exhibits the shear strength parameters specified by the Retaining Wall Design Engineer. 3. Verify that the shear strength of the in-situ soil assumed by the Retaining Wall Design Engineer is appropriate. 4. Inspect and document soil compaction in accordance with these specifications: a. Required dry unit weight b. Actual dry unit weight c. Allowable moisture content d. Actual moisture content e. Pass/fail assessment f. Test location - wall station number g. Test elevation h. Distance of test location behind the wall face 5. Verify that all excavated spaces in the vicinity of the retaining wall are backfilled, as directed by the project Geotechnical Engineer. 6. Notify the Retaining Wall Installation Contractor of any deficiencies in the retaining wall construction and provide the Retaining Wall Installation Contractor a reasonable opportunity to correct the deficiency. 7. Notify the General Contractor, Owner and Retaining Wall Design Engineer of any construction deficiencies that have not been corrected timely. 8. Document all inspection results. 9. Test compacted density and moisture content of the retained backfill with the following frequency: a. At least once every 1,000 square feet (90 square meters) (in plan) per 9-inch (230 mm) vertical lift. b. At least once per every 18 inches (460 mm) of vertical wall construction. 2.01 PRECAST MODULAR BLOCK RETAINING WALL UNITS A. All units for the project shall be obtained from the same manufacturer. The manufacturer shall be licensed and authorized to produce the retaining wall units by the precast modular block system patent holder/endorser and shall document compliance with the published quality control standards of the proprietary precast modular block system licensor for the previous three (3) years or the total time the manufacturer has been licensed, whichever is less. B. Concrete used in the production of the precast modular block units shall be first-pour, fresh concrete. It shall not consist of returned, reconstituted, surplus, or waste concrete. It shall be an original production mix meeting the requirements of ASTM C94 and exhibit the following: 1. Minimum 28-day compressive strength of 4,000 psi (27.6 MPa). 2. Shall be free of water soluble chlorides and chloride based accelerator admixtures. 3. 6% +/- 15% air-entrainment in conformance ASTM C94. 4. Maximum slump of 5 inches +/- 1 1/2 inches (125 mm +/- 40 mm) per ASTM C143 for conventional concrete mix designs. 5. Slump Flow for Self-Consolidating Concrete (SCC) mix designs shall be between 18 inches and 32 inches (450 mm and 800 mm) as tested in accordance with ASTM C1611. C. Each concrete block shall be cast in a single continuous pour without cold joints. With the exception of half-block units, corner units and other special application units, the precast modular block units shall conform to the nominal dimensions listed in the table below and be produced to the dimensional tolerances shown. D. The Owner reserves the right to reject the design services of any engineer or engineering firm who, in the sole opinion of the Owner, does not possess the required experience or qualifications. 2.02 GEOTEXTILE A. Nonwoven geotextile fabric shall be placed as indicated on the retaining wall construction shop drawings. Additionally, the nonwoven geotextile fabric shall be placed in the shaped joint between adjacent block units on the same course. The nonwoven geotextile fabric shall meet the requirements Class 3 construction survivability in accordance with AASHTO M 288. B. Preapproved Nonwoven Geotextile Products 1. Mafrol 1400 2. Protop Geotex 412 3. Shaps GT-142 4. Triace-Linq 140EX 5. Carthage Mills FX-40HS 6. Stratex ST 142 C. Substitutions: No substitutions of geogrid reinforcement products shall be allowed. D. Drainage Aggregate and Wall Infill A. Drainage aggregate (and wall infill for retaining walls designed as modular gravity structures) shall be a durable crushed stone conforming to No. 57 size per ASTM C33 with the following particle-size distribution requirements per ASTM D422. U.S. Standard Sieve Size (75 mm) 100% (100 mm) 100% (125 mm) 95-100 (150 mm) 25-100 (190 mm) 0-10 (230 mm) 0-0 (250 mm) 0-0 (300 mm) 0-0 (375 mm) 0-0 (425 mm) 0-0 (475 mm) 0-0 (530 mm) 0-0 (595 mm) 0-0 (660 mm) 0-0 (725 mm) 0-0 (787 mm) 0-0 (850 mm) 0-0 (915 mm) 0-0 (985 mm) 0-0 (1065 mm) 0-0 (1145 mm) 0-0 (1225 mm) 0-0 (1305 mm) 0-0 (1385 mm) 0-0 (1465 mm) 0-0 (1545 mm) 0-0 (1625 mm) 0-0 (1705 mm) 0-0 (1785 mm) 0-0 (1865 mm) 0-0 (1945 mm) 0-0 (2025 mm) 0-0 (2105 mm) 0-0 (2185 mm) 0-0 (2265 mm) 0-0 (2345 mm) 0-0 (2425 mm) 0-0 (2505 mm) 0-0 (2585 mm) 0-0 (2665 mm) 0-0 (2745 mm) 0-0 (2825 mm) 0-0 (2905 mm) 0-0 (2985 mm) 0-0 (3065 mm) 0-0 (3145 mm) 0-0 (3225 mm) 0-0 (3305 mm) 0-0 (3385 mm) 0-0 (3465 mm) 0-0 (3545 mm) 0-0 (3625 mm) 0-0 (3705 mm) 0-0 (3785 mm) 0-0 (3865 mm) 0-0 (3945 mm) 0-0 (4025 mm) 0-0 (4105 mm) 0-0 (4185 mm) 0-0 (4265 mm) 0-0 (4345 mm) 0-0 (4425 mm) 0-0 (4505 mm) 0-0 (4585 mm) 0-0 (4665 mm) 0-0 (4745 mm) 0-0 (4825 mm) 0-0 (4905 mm) 0-0 (4985 mm) 0-0 (5065 mm) 0-0 (5145 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