

**SECTION 02920**  
**SEGMENTAL CONCRETE BLOCK RETAINING WALL**

**PART 1 GENERAL**

**1.01 - Section Includes**

- A. Segmental Concrete Block Retaining Wall
- B. Geogrid Reinforcement
- C. Subdrain

**1.02 - Description of Work**

- A. Segmental Concrete Block Retaining Wall: includes furnishing and constructing a segmental concrete block retaining wall to the lines and grades shown on the construction drawings and as specified herein.
- B. Geogrid Reinforcement: includes preparing foundation soil, furnishing and installing leveling pad, geogrid reinforcement, unit fill and backfill to the lines and grades shown on the construction drawings.
- C. Subdrain: includes furnishing and installing all related materials required for construction of the retaining wall as shown on the construction drawings.

**1.03 - Reference Standards**

- A. American Society of Testing and Materials (ASTM)
  - 1. ASTM C33 Specification for Concrete Aggregates.
  - 2. ASTM C90 Load Bearing Concrete Masonry Units.
  - 3. ASTM C140 Sampling and Testing Concrete Masonry Units.
  - 4. ASTM C150 Specification for Portland Cement.
  - 5. ASTM D448 Sizes of Aggregate for Road and Bridge Construction.
  - 6. ASTM C1262 Test Method of Freeze-Thaw Durability of Masonry Concrete Units.
  - 7. ASTM C1372 Segmental Concrete Retaining Wall Units.
  - 8. ASTM D698 Laboratory Compaction Characteristics using Standard Effort.
  - 9. ASTM D595 Wide width tensile test for geosynthetics.
  - 10. ASTM D4632 Breaking Load and Elongation of Geotextiles.
  - 11. ASTM D5262 Tension Creep Testing of Geotextiles.
- B. American Association of State Highway Transportation Officials (AASHTO)
  - AASTHO T99-90 Moisture-Density relationships of soils using a 5.5-pound weight rammed in 12-inch drop.
- C. Geosynthetic Research Institute (GRI)
  - 1. GRI GG3 -Creep Behavior and Long Term Design Load of Geogrids.
  - 2. GRI GG5 -Test Method for Geosynthetic Pullout.
  - 3. GRI GT6 -Test Method for Geotextile Pullout.
- D. National Concrete Masonry Association (NCMA)
  - 1. SRWU-1 Test method for Determining Connection Strength for Segmental Retaining Wall Units.
  - 2. Tek 2-4 Specification for Segmental Retaining Wall Units.

**1.04 - Submittals**

- A. The wall supplier selected by the Contractor shall submit complete design calculations and detailed shop plans for the proposed wall system no later than 15 days from the date of notification to proceed with the Project. The detailed Shop Drawings shall be sealed by a licensed professional engineer in the state of Iowa. The detailed Shop plans shall include all details,

dimensions, quantities and cross-sections necessary to construct the wall and shall include but not be limited to the following items:

1. Plan, elevation and cross-section views for each wall showing the following:
  - a. Plan view of the wall indicating the offsets from the construction centerline to the face of the wall at all changes in horizontal alignment. The plan view shall show the limits of geogrid soil reinforcing, if any, and stations where length and/or size changes. The centerline of any drainage structures or pipe behind or passing through/under the structure shall also be shown.
  - b. An elevation view of the wall indicating the elevations of the blocks at the top and bottom of the wall. The elevation view shall show the top of the leveling pad, all steps in the leveling pads and the final ground line. The dimensions of geogrid soil reinforcing, and locations (elevation and distance along the wall) of their connection to the blocks shall be indicated.
  - c. A summary of quantities list shall be provided on the elevation sheet(s).
  - d. Typical cross-sections showing the limits of the geogrids, the reinforced select fill volume, and course aggregate unit-fill behind the units.
  - e. All general notes required for constructing the wall.
  - f. Subdrains or drainable backfill as required.
2. All details for concrete coping or barriers constructed as part of the wall contract. When coping or barriers are not specified, a cap block shall be used to cover the top of the segmental units.
3. All details of the block and geogrid soil reinforcement placement around all appurtenances located behind, on top, or passing through the geogrid reinforcement volume such as traffic barriers, coping, foundations, and utilities, etc. shall be clearly indicated. Any modifications to the design of these appurtenances to accommodate a particular system shall be submitted.
4. All details of architectural block treatment, including color, texture and form liners/casting shall be shown. The exterior face shall be three-plane split "rock texture" pattern, and gray in color unless other wise specified.
5. Details for fence on top of wall, if required.
- B. Detailed calculations for the proposed wall system prepared and sealed by a licensed professional engineer in the state of Iowa. The calculations shall include but not be limited to the following:
  1. External stability of the soil reinforced mass as calculated by Rankine or Coulomb earth pressure theories. Only the weight of the mass vertically over the plane of sliding shall be included in the resisting forces for sliding and overturning.
  2. Internal stability of the soil reinforced mass including:
    - a. Tension loads in geosynthetic layers.
    - b. Pullout capacity of resisting geosynthetic layers from the zone outside of the failure wedge.
    - c. Connection load and capacity of each geosynthetic/unit connection.
    - d. Shear resistance at each geosynthetic/unit interface.
    - e. Bending calculation of the face units between each layer of geosynthetic reinforcing.
    - f. Over-turning stability calculations for the units above the top layer of soil reinforcing.
    - g. Local stability of the face during construction.
    - h. Additional structural analysis when fence is installed on top of wall.
- C. Design methodology shall be in accordance with FHWA publication Demo82 or the NCMA Design manual, 2nd edition with the following additions:
  1. Maximum spacing between vertically adjacent reinforcing layers shall not exceed twice the depth of the concrete unit (as measured from face to tail).

2. Maximum allowable load at the connection shall be the peak connection load as determined in accordance with SRWU-1, reduced by a factor of safety of 1.5.
  3. All layers shall be of equal or greater length to the base layer, shorter intermediate layers shall not be allowed.
  4. All layers shall be designed for 100 percent coverage.
  5. The vertical component of soil friction shall be ignored in calculations of face stability.
  6. The maximum design height as a gravity structure shall be limited to 2.5 times the width of the unit, or a calculated factor of safety of 1.5 on overturning, whichever is less.
  7. Minimum soil reinforcing lengths shall be 0.6 times the design height of the structure or as required to maintain a factor of safety of 1.5 on sliding at the base or on geosynthetic reinforcing layers, which ever is greater.
  8. If designing in accordance with Demo82, the dead load calculated for a sloping fill shall be limited to the area of soil within the theoretical Rankine or Coulomb failure plane.
- D. Detailed hand calculations and verification of any computer programs used for design provided by a licensed professional Engineer.
  - E. Samples of all products used in the Work of this section.
  - F. Manufacturer's specifications (latest edition) for proposed materials, method of installation and list of materials proposed for use.

#### **1.05 - Delivery, Storage and Handling**

- A. Contractor shall check the materials upon delivery to assure that proper materials have been received.
- B. Contractor shall prevent excessive mud, wet cement, epoxy, and similar materials (which may affix themselves) from coming in contact with the materials.
- C. Contractor shall protect the materials from damage. Damaged materials shall not be incorporated into the retaining wall structure.
- D. Geogrids shall be stored above -20° F.
- E. Rolled geogrid material may be laid flat or stood on end for storage.

### **PART 2 PRODUCTS**

#### **2.01 - Definitions**

- A. Segmental Concrete Units - a modular preset concrete facing unit manufactured of Portland cement, water and mineral aggregates.
- B. Geogrid products shall be high-density polyethylene or polypropylene expanded sheet or polyester woven fiber materials, specifically fabricated for use as soil reinforcement.
- C. Structural Geogrid - a structural geogrid formed by a regular network of integrally connected tensile elements with apertures of sufficient size to allow interlocking with surrounding soil, rock, or earth and function primarily as reinforcement.
- D. Unit Fill - drainage aggregate which is placed within a required distance from fill side of the modular concrete units.
- E. Reinforced Backfill - Compacted soil that is within the reinforced soil volume as shown on the plans.

#### **2.02 - Concrete Units**

- A. Modular wall units manufactured by in accordance with ASTM C-1372 with the following revisions:
  1. Concrete wall units shall have a minimum 28-day compressive strength of 3,000 psi.
  2. Standard weight concrete shall have adequate freeze/thaw protection maximum moisture absorption rate of 7 percent.
  3. Dimensional tolerances shall be in +/- 1/8 inch, except for height, which is  $\pm 1/16$  inch.

- B. Modular units shall provide an in-place weight of 120 pcf. including the unit fill that is contained within the nominal dimension of the unit.
- C. Units shall have angled sides capable of concave and convex alignment curves with a minimum radius of 3.5 feet (Where applicable, for straight walls, use non-angled straight side cap units.)
- D. Unit dimensions shall not differ more than  $\pm 1/8$ -inch from manufacturer's published dimensions, except at rough textured face.

### **2.03 - Connection Pins/Devices**

- A. All segmental units shall have shear pins or integral connection devices capable of providing shear connection between vertically and horizontally adjacent units. Shear devices shall protrude a minimum of 1 inch into receiving openings in the concrete units and provide both lateral and longitudinal shear resistance.
- B. Connection devices shall be rounded to minimize damage or cuffing to geosynthetic reinforcement materials.
- C. Connecting pins shall be  $1/2$ -inch rods with a minimum short beam shear strength of 5,000 psi as supplied by the unit manufacturer.

### **2.04 - Construction Adhesive**

Material shall be supplied by the unit supplier for use on all cap units.

### **2.05 - Geogrid**

- A. Geogrid shall be by the following manufacturers and comply with ASTM D4595. Model number shall be as specified in the Special Provisions, Section 01000.
  - 1. Nicolon Mirafi (Mira Grid), 3500 Parkway Lane, Suite 500, Norcross, GA 30092. Phone: (800) 234-0484
  - 2. Tensar Earth Technologies, 5775-B Glenridge Dr., Lakeside Center, Suite 450, Atlanta, GA 30328. Phone: (404) 250-1290

### **2.06 - Base Leveling and Pad Material**

Material shall consist of aggregate gradation conforming to unit manufacturers recommendations. Pea gravel or any other poorly graded stone shall not be permitted.

### **2.07 - Subdrain**

PVC or HDPE material shall conform to Specification Section 02400.

### **2.08 - Unit Fill**

- A. Fill for units shall be fractured stone or gravel, with gradation according to unit manufacturers recommendations. The Engineer shall approve gradation of the fill. "Pea gravel" shall not be used.
- B. Filter fabric shall not be allowed as an alternate to granular drain rock within 2 feet of the face of the units.

### **2.09 - Backfill**

- A. Material may be site-excavated soils when approved by the Engineer or otherwise specified in the design drawings. Unsuitable soils for backfill (high plastic clays or organic soils) shall not be used in the backfill or in the reinforced soil mass.
- B. Where borrow or imported fill is required, Contractor shall submit samples and material specifications to the Engineer for approval.

## **PART 3 EXECUTION**

### **3.01 - Excavation**

Contractor shall excavate to the lines and grades shown on the construction drawings. Contractor shall be careful not to disturb embankment and foundation materials beyond lines shown.

### **3.02 - Foundation Soil Preparation**

- A. Foundation soil shall be excavated as required for leveling pad dimensions shown on the construction drawings, or as required by the Engineer.
- B. Foundation soil shall be subject to prior approval by the Engineer to confirm that the actual foundation soil conditions meet or exceed assumed design conditions.
- C. Unsuitable soils shall be removed and replaced with acceptable material.
- D. Over-excavated areas shall be back-filled with approved compacted backfill material.
- E. Foundation soil shall be proof rolled prior to fill and geogrid placement.

### **3.03 - Base Leveling Pad**

- A. Leveling pad materials shall be placed upon an approved foundation as shown on the construction drawings to a minimum thickness of 6 inches and extend at least 6 inches in width beyond the width of the wall.
- B. Aggregate material shall be compacted to provide a dense, level surface on which to place the first course of modular units. Compaction shall be to 95 percent of Standard Proctor Density as determined in accordance with ASTM D698. For crushed rock, material shall be densely compacted as determined by visual observation.
- C. Leveling pad shall be prepared and leveled to ensure complete contact of retaining wall unit with base.

### **3.04 - Unit Installation**

- A. The first course of concrete modular wall units shall be carefully placed on the base-leveling pad. Each unit shall be checked for level and alignment.
- B. Ensure that all units are in full contact with base and properly seated.
- C. Units are placed side by side for full length of wall alignment. Alignment may be done by means of a string line or offset from a base line.
- D. Install shear/connecting devices and fill all voids in and around the modular units with unit fill material. Tamp or rod unit fills to insure that all voids are completely filled.
- E. Sweep excess material from top of units and install the next course. Ensure that each course is completely unit filled, back-filled and compacted prior to proceeding to next course.
- F. Place each subsequent course ensuring that connection devices protrude into adjoining courses a minimum of 1 inch. Pull each unit forward, away from the fill zone, locking against the connectors in the previous course and backfill as the course is completed. Repeat procedure to the extent of wall height.
- G. As appropriate where the wall changes elevation, units can be stepped with the grade or turned into the embankment with a convex return end. Provide appropriate buried units on compacted leveling pad in area of convex return end.
- H. The completed wall erection shall be within  $\pm 1.25$  inches, measured over a 10-foot distance, in either a horizontal or vertical direction compared to design line and grade

### **3.05 - Fill Placement**

- A. Follow wall erection and unit fill placement closely with any other backfilling required. Placement of back-fill soils shall be in maximum uncompacted lift thickness of 8 inches and Compacted to 95 percent of Standard Proctor as determined in accordance with ASTM D698 Density. The top 8 inches of the structure fill shall be a low permeability soil to minimize surface water runoff from directly entering the unit fill or reinforced soil zones. The in-place moisture content shall not

exceed the optimum moisture content as determined in accordance with ASTM D698 and be no lower than 2 percentage points below optimum moisture content.

- B. A minimum one foot depth of drainable backfill shall be placed at the bottom of the wall.
- C. Backfill shall be placed, spread and compacted in such a manner that minimizes the development of slack or loss of pretension of the geogrid.
- D. Only hand-operated compaction equipment shall be allowed within 3 feet of the face of the units.
- E. Backfill shall be placed from the wall back towards the embankment to ensure that the geogrid remains taut.
- F. Tracked construction equipment shall not be operated directly on the geogrid. A minimum backfill thickness of 6 inches is required prior to operation of tracked vehicles over the geogrid. Turning of tracked vehicles should be kept to a minimum to prevent tracks from displacing the fill and damaging the geogrid.
- G. Rubber-tired equipment may pass over the geogrid reinforcement at slow speeds, less than 10 mph. Avoid sudden braking and sharp turning.

### **3.06 - Subdrain**

Installation shall conform to Specification Section 02400.

### **3.07 - Geogrid Installation**

- A. Geogrid shall be laid at the proper elevations and orientation as shown on the construction drawings or as directed by the Engineer.
- B. The Contractor shall verify correct orientation (roll direction) of the geogrid.
- C. The geogrid soil reinforcement shall be connected to the modular wall units by placing the geogrid over the connection pins/devices and laying the grid back to the fill side.
- D. The geogrid shall be pulled taut (approximately 50 lbs/ft) to eliminate loose folds and pretension the reinforcement. Stake or secure back edge of geogrid prior to and during backfill and compaction.
- E. Overlap of the geosynthetic in the design strength direction shall not be permitted. The design strength direction is that length of geosynthetic reinforcement perpendicular to the wall face and shall be one continuous piece of material. Adjacent sections of geogrid shall be butted in a manner to assure 100 percent coverage after placement.
- F. Geogrid placement shall be 100 percent coverage in plan on any layer. No space greater than 3 inches shall be allowed between adjacent pieces.
- G. Trim excess geogrid protruding from wall face.

### **3.08 - Cap Installation**

- A. Place Cap units over projecting pins from units below. Pull forward to setback position. Backfill and compact to finished grade with low-permeable soil.
- B. As required, provide permanent mechanical connection to wall units with approved construction adhesive. Apply adhesive to top surface of unit below and place cap unit into position.

**END OF SECTION 02920**