



## Specification For CornerStone® Geogrid Reinforced Retaining Wall System

The following specifications provide CornerStone®'s typical requirements and recommendations. At the engineer of record's discretion these specifications may be revised to accommodate site specific design requirements.

### SECTION 1

#### Part 1: General

##### 1.1 Description

The work consists of supplying and installing all aspects of the CornerStone Segmental Retaining Wall (SRW) units as specified in the construction drawings or as established by the Owner, Architect or Engineer.

##### 1.2 Related Work

- A. Section 02100 Site Preparation
- B. Section 02200 Earthwork
- C. Section 02070 Geosynthetic Block Retaining Walls
- D. Section 02832 Interlocking Block Retaining Walls
- E. Section 01270 Unit Prices

##### 1.3 Reference Standards

###### A. Engineering Design

- AASHTO M288 Geotextile Specification for Highway Applications
- AASHTO Standard Specifications for Highway Bridges
- NCMA Design Manual for Segmental Retaining Walls (SRW)
- NCMA SRWU-1 Determination of Connection Strength between Geosynthetics and SRW units
- NCMA SRWU-2 Determination of Shear Strength between Concrete Segmental Retaining Wall (SRW) units

###### B. Segmental Retaining Wall (SRW) units

- ASTM C 140 Sample & Testing Concrete Masonry Units
- ASTM C 1262 Evaluation the Freeze-Thaw Durability of Manufactured Concrete Masonry Units and Related Concrete Units
- ASTM C 1372 Standard Specification for Segmental Retaining Wall (SRW) Units

###### C. Geosynthetic Reinforcement

- ASTM D 4595 Tensile Properties of Geosynthetics by the Wide Width Strip Method
- ASTM D 5262 Evaluating the Unconfined Creep of Geosynthetics
- ASTM D 6638 Grid Connection Strength (NCMA SRWU-1)
- ASTM D 6916 Grid Shear Strength (NCMA SRWU-2)
- GRI GG 1 Single Rib Geogrid Tensile Strength
- GRI GG 4 Determination of Long Term Design Strength of Geogrids
- GRI GG 5 Determination of Geogrid (soil) Pullout
- GRI GG 6 Determination of Geotextile (soil) Pullout



### D. Soils

- ASTM D 698 Test Methods for Laboratory Compaction Characteristics of Soil using Standard Effort
- ASTM D 422 Gradation Analysis of Soil Particles
- ASTM D 4318 Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils
- ASTM D 51 Testing Methods for Measuring pH of Soil
- ASTM D 2487 Standard Classification of Soils (Unified Soil Classification System)

### E. Drainage Pipe

- ASTM D 3034 Specification for Type PSM Polyvinyl Chloride (PVC) pipe
- ASTM D 1248 Corrugated Plastic Pipe

### F. The Owner or Owner's Representative shall determine the final application if the specifications and reference documents conflict.

#### 1.4 Design Submittals

- A. Material installation and description data should be submitted for each product specified
- B. The SRW designs and drawings should include geosynthetic layout, bottom and top of wall elevation, drainage details and any other unique applications.
- C. Design Method and Calculations should be in accordance with the NCMA Design Guidelines or the AASHTO Standard Specifications for Highways. Global stability analysis should be calculated as part of the final design.
- D. Samples of the SRW units, color and texture should be submitted as per design specifications. Geosynthetic sample should also be furnished as per design.
- E. All test reports should be in accordance with ASTM C 140 and performed by an independent laboratory.

#### 1.5 Delivery, Storage and Handling

- A. The Contractor shall inspect all materials delivered to the site to ensure proper type and grade of materials have been received as per the project specifications.
- B. The Contractor shall ensure proper storage, handling and protection from damage of the materials. Damaged materials shall not be used in the construction of the Segmental Retaining Wall.
- C. The Contractor shall prevent excessive mud, wet concrete, and like materials from coming in contact with the wall materials.

## PART 2: MATERIALS

### 2.1 Concrete Segmental Retaining Wall (SRW) units

- A. SRW concrete units shall be CornerStone units as manufactured by licensed producer in accordance with NCMA, ASTM or AASHTO standards and conform to the NCMA Tek 2-4.
- B. CornerStone units shall have a minimum 28 days compressive of equal than 3000 psi (or greater if specified) and a maximum absorption of 15 pcf (or less if specified) (ASTM C 140).
- C. Color for the CornerStone units shall be
- D. ASTM C 1262 shall be standard for areas subject to many freeze-thaw cycles.
- E. The maximum water absorption shall be less than 7% and the height dimensions from front to back and end to end will not vary more than plus or minus 1/16th of an inch. All other specifications must meet the ASTM C 1372.



- F. The CornerStone 100 & 200 units shall have a face area of 1 sq ft (.093 sq m) for the straight face and .94 sq ft (.09 sq m) for rock face.
- G. The CornerStone 100 unit weight shall be approximately +-77 lbs with a combined unit/gravel infill of +-115 lbs. The CornerStone 200 unit weight shall be approximately +-115 lbs with a combined unit/gravel infill of +-180 lbs.
- H. The CornerStone units shall be sound and free of cracks, chips or other defects that may prevent the contractor from properly installing the wall units or reduce the long term strength of the wall structure.
- I. CornerStone capping units shall be secured by using high strength concrete adhesive.
- J. Units shall be free of dust, dirt and standing water before applying the concrete adhesive.

### 2.2 Geosynthetic Reinforcements

- A. Geosynthetic reinforcements shall be high tensile Geogrid or Geotextile manufactured for soil reinforcement applications.
- B. The construction design and drawings shall show the type, strength and location of the geosynthetics. Manufacturers specifications shall be used for test data and installation procedures.
- C. Geosynthetics shall be evaluated in accordance with the NCMA and or AASHTO specifications.

### 2.3 Foundation Soil

- A. The foundation soils shall be undisturbed native site soils.
- B. The foundation soils shall be inspected and tested by an engineer before installing base leveling gravel.
- C. Disturbed or unsuitable foundation soils shall be properly compacted or replaced with expectable soils as specified by the engineer.

### 2.4 Backfill Soil

- A. Backfill soils shall be free of organic materials and other unsuitable materials.
- B. Soils classified as GP, GW, SP, SW, or SM types and accordance with ASTM D 2487 are suitable. All soils shall be approved by the engineer.
- C. The plasticity of the backfill soils shall have fine fraction of less than 20.

### 2.5 Base Leveling Materials

- A. The base leveling gravel shall be well graded compacted gravel (GW)
- B. Unreinforced concrete base leveling pad can also be used is specified.

### 2.6 Drainage and Unit Infill Aggregate

- A. Drainage Aggregate shall be clean crushed gravel meeting the gradation in accordance with ASTM D 448.
- B. Drainage Aggregates shall be placed in all unit voids and 6" to 12" behind the wall units with uniform particle size less than 1" (25mm) and not more than 5% passing through the No. 200 sieve.

### 2.7 Drainage Pipe

- A. Drainage pipe shall be perforated PVC or corrugated HDPE pipe with a minimum size of 4" in diameter.
- B. Geotextiles wrap around the drainage pipe shall be used as specified by the engineer if required.
- C. Drainage pipe shall be manufactured in accordance with ASTM D 3034 and/or ASTM D 1248.



### 2.8 Geotextile Fabric

- A. The Geotextiles shall be non-woven as specified by the specifications and construction drawings.
- B. The Geotextiles when used as a soil separator shall be permeable allowing water to effectively pass through the fabric openings.

### 2.9 Concrete Adhesive

- A. The adhesive shall be high strength concrete adhesive that will permanently secure the concrete cap units to the CornerStone top units or steps.
- B. Concrete adhesive may be used for other applications as specified by the designer.

## PART 3: WALL DESIGN

### 3.1 Design Standard

- A. The wall design engineer and/or geotechnical engineer shall consider the internal, local stability, external stability, bearing capacity and global stability of the soil mass above, behind and below the wall structure.
- B. Geosynthetic reinforcement vertical spacing shall not exceed 2 feet or 3 units.
- C. Geosynthetic reinforcement shall be 100% horizontal coverage parallel to the length of the wall
- D. The CornerStone wall system shall be designed in accordance to the NCMA Design Manual for Segmental Retaining Walls, Second Edition. The minimum factors of safety shall be (greater if specified by engineer)

**External Stability;** Base Sliding = 1.5, Overturning = 2.0, Bearing Capacity = 2.0, Global Stability = 1.3

**Internal Stability;** Tensile Overstress = 1.0, Pullout = 1.5, Internal Sliding = 1.5

**Local Stability;** Facing Shear = 1.5, Connection = 1.5

### 3.2 Soil Standards

- A. The following soil design parameters shall be used (or specified by engineer)
  - Drainage/Unit Fill;** Soil Unit Weight = \_\_\_\_ lb/cub ft (KN/cub m), Friction Angle = \_\_\_\_ degree, Cohesion = \_\_\_\_ lbs/sq ft (o kPa)
  - Reinforced Backfill;** Soil Unit Weight = \_\_\_\_ lb/cub ft (KN/cub m), Friction Angle = \_\_\_\_ degree, Cohesion = \_\_\_\_ lbs/sq ft (o kPa)
  - Base Leveling Pad;** Soil Unit Weight = \_\_\_\_ lb/cub ft (KN/cub m), Friction Angle = \_\_\_\_ degree, Cohesion = \_\_\_\_ lb/sq ft (o kPa)

### 3.3 Project Design

- A. The site grades and information will determine the length, height and overall elevations for the CornerStone retaining wall requirements.
- B. The design height (H) shall be measured from the top of the base leveling pad to the top of the wall cap units.
- C. The above and below slopes of the wall details will be on the site construction drawings.
- D. The minimum embedment depth of the wall shall be no less than one (1) unit (8") or H/10 or as specified by the site construction drawings.
- E. Geosynthetic minimum length shall not be less than 60% of the height of the wall (H/.6).



### PART 4: CONSTRUCTION

#### 4.1 Qualifications

Contractor and site supervisor shall have proven qualified experience to complete the installation of the segmental retaining wall system.

#### 4.2 Excavation

- A. The contractor shall excavate to the lines and grades shown on the project grading plans.
- B. Back excavated cut shall notched benches of 5 feet vertical for every 2 feet horizontal bench or as per the engineers specifications.
- C. Over excavated or filled areas shall be well compacted and inspected by an engineer.
- D. Excavated materials that are used for backfilling reinforcement zone shall be protected from the weather.
- E. All organic or other non gravel materials shall not be used in the backfilled reinforcement zone.

#### 4.3 Foundation Preparation

- A. Foundation trench shall be excavated to the dimensions indicated on the construction drawings.
- B. The reinforced zone and leveling pad foundation soil shall be examined by the on site engineer to ensure proper bearing strength.
- C. Soils not meeting required strength shall be removed and replaced with proper materials.
- D. Foundation materials shall be compacted to a minimum of 95% Standard Proctor dry density or greater, before placing leveling pad. (ASTM D 698)

#### 4.4 Base Leveling Pad

- A. Granular aggregate materials, minimum 6 inches thick and 3 times the width of the wall unit, shall be placed and compacted to a minimum of 95% Standard Proctor dry density or greater. (a un-reinforced concrete pad may be used)
- B. The base leveling pad shall be level horizontally and back to front to ensure the first course of units are level.
- C. Top of base leveling pad elevation and installation of granular materials shall be in accordance of the specifications and construction drawings. The toe of the wall burial depth shall be constructed as shown on the construction drawings.
- D. A concrete reinforced footing should be placed below the frost level and constructed in accordance to the specification and construction drawings.

#### 4.5 Units Installation

- A. The first course of CornerStone units shall be carefully placed on a well graded gravel or concrete leveling pad.
- B. The first row of units shall be level form unit to unit and from back to front.
- C. A string line can be used to align a straight wall or PVC flex pipes can be used to establish smooth convex or concave curved walls.
- D. Use the smooth back of the units for alignment and measuring to ensure smooth curves and straight walls.
- E. The second course of units shall have the concrete connecting lugs in the units voids of the first course below and pulled forward resting the lugs against the front edge of the units voids.



- F. All units shall be laid snugly together and parallel to the straight or curved lines.
- G. The CornerStone units shall be swept clean of all dirt or rocks.
- H. After laying each course, perform a visual or string line straightness check.

#### 4.6 Drainage Gravel

- A. CornerStone unit voids and the drainage chimney 12 inches behind the wall shall be filled with a freedraining granular material, such as 3/4" clear rock (clean gravel).
- B. Clear gravel (clean gravel) shall be placed into the unit voids and behind the wall one or two courses.
- C. Clear gravel (clean gravel) does not need any mechanical compaction.

#### 4.7 Backfill

- A. The reinforced backfill materials shall be placed in maximum lifts of 12" and shall be compacted to a minimum 95% Standard Proctor density or greater, in accordance with ASTM D 698
- B. Only hand-operated compaction equipment shall be used within 2 feet of the back of the wall.
- C. Soil density testing shall not be taken within the 2 foot area.
- D. The backfill shall be smooth and level with no dips or bumps.
- E. The toe of the wall shall be filled and compacted as the wall is being constructed.

#### 4.8 Cap Installation

- A. The CornerStone straight or reversible caps shall be secured with an all-weather high strength concrete adhesive.
- B. Units can be placed with an over hang or flush with the wall units.
- C. Soil density testing shall not be taken within the 2 foot area.
- D. Caps and wall units shall be clear of all dirt, dust and standing water before placing the concrete adhesive.
- E. String lines or flex pipes shall be used to align capping units for straight or curved walls.

### PART 5: CONSTRUCTION QUALITY CONTROL AND ASSURANCE

#### 5.1 Construction Quality Control

- A. The wall project installer is responsible to ensure that all installation and materials meet the quality specified in the construction drawings.
- B. A qualified independent party will be responsible to verify that installation procedures have been installed in accordance with the specifications and construction drawings.
- C. All site construction tolerances for vertical alignment, horizontal locations for elevations, corner and radius locations, wall batter and minimum bulging will be with in NCMA specifications.

#### 5.2 Quality Assurance

- A. The owner is responsible to engage testing and inspection services to provide independent quality construction assurance.
- B. Compaction testing of the reinforcement backfill soils shall be performed every 2 vertical feet of material installation.



- C. The tests shall be done a minimum of every 50 lineal feet along the wall at each level of testing.
- D. Testing shall not be closer than 3 feet from the back of the wall and done at a variety of locations to cover the entire reinforced soil zone.
- E. Independent inspection professionals shall ensure all parameters and construction specifications have been followed in accordance to the design drawings and specifications.

### **PART 6: PAYMENT**

- 6.1 Payment for the installation of the CornerStone wall shall be based on the unit price per square face foot (square face meter) of wall product installed. The shipping and delivery slips shall be verified by both Contractor and Owner or Owner representative at the time of product delivery to the site and this will be the bases of the final count or product used.

## Geosynthetic Soil Reinforcement

### **PART 1: GENERAL**

#### **1.1 Description**

The work consists of supplying and installing geosynthetic reinforcements and the reinforcement backfill zone as specified in the construction drawings or as established by the Owner, Architect or Engineer.

#### **1.2 Related Work**

- A. Section 02832 Modular Block Retaining Wall
- B. Section 02200 Site Preparation
- C. Section 02300 Earthwork
- D. Section 02070 Geosynthetic Reinforcement Walls

#### **1.3 Reference Standard Geosynthetic Reinforcement**

- A. ASTM D 4595 Tensile Properties of Geosynthetics
- B. ASTM D 5262 Evaluating the Unconfined Creep of the Geosynthetics
- C. GGI GG -1 Single Rib Geosynthetic Tensile Strength
- D. GGI GG -5 Geogrid Pullout
- E. GGI GG -6 Geotextile Pullout

#### **1.4 Reference Standards for Soils**

- A. ASTM D 698 Moisture Density Relationship for Soils
- B. ASTM D 422 Gradation of Soils
- C. ASTM D 424 Atterberg limits of Soils
- D. ASTM D G51 Soil Ph

#### **1.5 Delivery, Storage and Handling**

- A. The Contractor shall inspect all geosynthetic products delivered to the site to ensure for the proper type and strength.
- B. Geosynthetics shall be stored in accordance with the manufactures specifications.
- C. Geosynthetics shall be protected from the weather and any other conditions that could damage the material.



### PART 2: MATERIALS

#### 2.1 Geosynthetic Products

- A. Geogrid products specifically produced for the use of soil reinforcement and consisting of high-density polyethylene or polypropylene.
- B. Geotextiles are woven fabrics produced for the use of soil reinforcement.
- C. The manufactured specifications shall be used for test data and installation procedures.
- D. Approved Geosynthetics as per CornerStone specification and approved testing.
- E. All products shall be approved by the site Engineer.

### PART 3: CONSTRUCTION

#### 3.1 Qualification

Refer to Section 02832 Modular Block Retaining Wall

#### 3.2 Excavation

Refer to Section 02832 Modular Block Retaining Wall

#### 3.3 Foundation Preparation

Refer to Section 02832 Modular Block Retaining Wall

#### 3.4 Leveling Pad

Refer to Section 02832 Modular Block Retaining Wall

#### 3.5 Unit Installation

Refer to Section 02832 Modular Block Retaining Wall

#### 3.6 Installation of Geosynthetics Reinforcement

- A. The construction plans shall show the type, strength and location of the geosynthetics.
- B. Manufacturer's specifications shall be used for test data and installation procedures.
- C. The geosynthetics shall be cut to the correct length and laid in the orientation as specified by the manufacturer.
- D. The CornerStone unit voids, drainage chimney and backfill zone are filled, compacted and leveled correctly before placing the geosynthetics.
- E. Ensure that the drainage materials directly behind the wall units are flush or slightly higher than the top of the units so that the geosynthetics will not be sheared on the back of the unit's sharp edge.
- F. The units shall be swept clean of all dirt or rocks before placing the geosynthetics.
- G. Shimming of units shall not be allowed on the geosynthetic layers.
- H. The geosynthetics shall be placed as far forward on the CornerStone units as possible without revealing materials on the face of the wall.
- I. Loosely lay geosynthetics toward the back of the compacted backfill zone.
- J. Gently pull the geosynthetics toward the back of the compacted backfill zone after placing the next row of CornerStone units on top of the geosynthetics and on top of the lower units.
- K. Use stakes or gravel materials to maintain tension on the geosynthetics. Excessive tension may alter the alignment of the wall units.





### 3.7 Backfill

- A. Contractor shall not drive equipment directly on the exposed geosynthetics.
- B. Backfill the reinforced zone by placing materials from the back of the wall towards the end of the geosynthetics in order to maintain tension on the reinforcement.
- C. Contractor shall leave 12" trench between the back of the wall and backfill materials to allow for drainage clean gravel drainage materials. This process will prevent undue soil pressures that could rotate the CornerStone units forward and reduce the set back of the wall while compacting the backfill materials.
- D. Once the CornerStone units, geosynthetics and backfill materials have been placed, fill the unit voids and the drainage chimney with clear rock.
- E. Continue the construction of the wall based on the previously outlined steps placing and compacting soils as specified.
- F. When completing the final layer of backfill materials and drainage gravel, and before placing the planting soil, place a layer of geosynthetic soil separation fabric. The fabric shall be placed no less than 4 feet behind the wall

### 3.8 Cap Installation

Refer to Section 02832 Modular Block Retaining Wall

### PART 4: PAYMENT

- 4.1 Payment for the placement of the geosynthetics shall be based on the unit price per square yard (square meter) installed or as per contract agreement.