



**CORNERSTONE**  
WALL SOLUTIONS, INC.

**MagnumStone™ Specifications**  
***Geogrid Reinforced***



# SPECIFICATION FOR MAGNUMSTONE™ GEOGRID REINFORCED Mechanically Stabilized Earth (MSE) SYSTEM

## **PART 1: GENERAL**

### 1.01 Description

The work consists of supplying and installing all aspects of the MagnumStone™ Precast Mechanically Stabilized Earth (MSE) units as specified in the construction drawings or as established by the Owner, Architect or Engineer.

### 1.02 Related Work

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

### 1.03 Reference Standards

- A. Engineering Design
  - AASHTO M288 Geotextile Specification for Highway Applications
  - AASHTO Standard Specifications for Highway Bridges
  - 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 Mechanically Stabilized Earth (MSE) Units
- B. 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 (MSEU-1)
  - ASTM D 6916 Grid Shear Strength (MSEU-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
- C. 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)
- D. Drainage Pipe
  - ASTM D 3034 Specification for Type PSM Polyvinyl Chloride (PVC) pipe

- ASTM D 1248 Corrugated Plastic Pipe
- The Owner or Owner's Representative shall determine the final application if the specifications and reference documents conflict.

1.04

Design Submittals

- A. Material installation and description data should be submitted for each product specified
- B. The MSE 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 AASHTO Standard Specifications for Highways. Global stability analysis should be calculated as part of the final design.
- D. Samples of the MSE 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.
  - a. Delivery, Storage and Handling
- F. 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.
- G. 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 Mechanically Stabilized Earth.
- H. The Contractor shall prevent excessive mud, wet concrete, and like materials from coming in contact with the wall materials.

**PART 2: MATERIALS**

2.01

Concrete Mechanically Stabilized Earth (MSE) units

- A. MSE concrete units shall be MagnumStone™ units as manufactured by licensed \_\_\_\_\_ producer in accordance with NPCA, ASTM or AASHTO standards and conform as per project engineer specifications.
- B. MagnumStone™ units shall have a minimum 28 days compressive of equal to 25 MPA (or greater if specified) and a maximum absorption of 5 pcf (or less if specified) (ASTM C 140). Final compressive strength shall be 40 MPA min average for 3 units. (Suggested air content of 5 +\_ 1 % with slump 50 +- 20 mm)
- C. Color for the MagnumStone™ 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 5% and the height dimensions from front to back plus or minus 1/8<sup>th</sup> of an inch and end to end will not vary more than plus or minus 1/4 of an inch over 4 feet. All other specifications must meet the ASTM C 1372.
- F. The MagnumStone™ 2-4 units shall have a face area of 8 sq ft (.75 sq m) and MagnumStone™ 1-4 units shall have a face area of 4 sq ft (.37.5 sq m)
- G. The MagnumStone™ unit weight shall be approximately +-1400 lbs with a combined unit/gravel infill of +-800 lbs.
- H. The MagnumStone™ 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. MagnumStone™ capping units shall be a regular unit with 8 inches of the back of the unit removed to allow for soil materials placed over the hollow units and up against the back of the front face.
- J. Concrete sample in accordance with AASHTO T-141, Compression test in accordance with AASHTO T-23 and AASHTO T-22, Air content testing in accordance with AASHTO T-152 or AASHTO T-196, Slump test in accordance with AASHTO T-119, 28 day testing in accordance with AASHTO T-23 and AASHTO T-22 or as specified by the project engineer.

- K. Reinforcing Mesh – Reinforcing mesh (if required) shall be shop-fabricated of cold drawn steel wire conforming to the minimum requirements of ASTM A-82 (AASHTO M-32) and shall be welded into the finished mesh fabric in accordance with ASTM A-185 (AASHTO M-55). Galvanization shall be applied after the mesh is fabricated and conform to the minimum requirements of ASTM A-123 (AASHTO M-111). Connector bars shall be fabricated of cold drawn steel wire conforming to the requirements of ASTM A-82 (AASHTO M-32) and galvanized in accordance with ASTM A-123 (AASHTO M-111).
- L. Electrochemical Requirements if applicable will follow the AASHTO specifications.

2.02 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 AASHTO specifications.

2.03 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.

2.04 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.

2.05 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 if specified.
- C. AASHTO specifications will be followed when constructing concrete footing for DOT projects.

2.06 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.

2.07 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.

- 2.08 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.

2.09 AASHTO

When constructing DOT projects all AASHTO and ASTM specifications should be followed unless otherwise specified by the engineer.

### PART 3 WALL DESIGN

3.01 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 4 feet or 2 units.
- C. Geosynthetic reinforcement shall be 100% horizontal coverage parallel to the length of the wall unless specified by the engineer.
- D. The MagnumStone™ wall system shall be designed in accordance to the Design Manual for Mechanically Stabilized Earths, in accordance to AASHTO. The minimum factors of safety shall be (or 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

3.02 Soil Standards

- A. The following soil design parameters shall be used (or specified by engineer)
- B. **Drainage/Unit Fill;** Soil Unit Weight = \_\_\_\_\_ lb/cub ft (KN/cub m), Friction Angle = \_\_\_\_\_ degree, Cohesion = \_\_\_\_\_ lbs/sq ft (0 kPa)
- C. **Reinforced Backfill;** Soil Unit Weight = \_\_\_\_\_ lb/cub ft (KN/cub m), Friction Angle = \_\_\_\_\_ degree, Cohesion = \_\_\_\_\_ lbs/sq ft (0 kPa)
- D. **Base Leveling Pad;** Soil Unit Weight = \_\_\_\_\_ lb/cub ft (KN/cub m), Friction Angle = \_\_\_\_\_ degree, Cohesion = \_\_\_\_\_ lb/sq ft (0 kPa)

3.03 Project Design

- A. The site grades and information will determine the length, height and overall elevations for the MagnumStone™ 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 1/2 unit (12”) 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

4.01 Qualifications

Contractor and site supervisor shall have proven qualified experience to complete the installation of the Mechanically Stabilized Earth system.

#### 4.02 Excavation

- A. The contractor shall excavate to the lines and grades shown on the project grading plans.
- B. Back excavated cut shall be 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.

#### 4.03 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)

#### 4.04 Base Leveling Pad

- A. Granular aggregate materials, minimum 6 inches thick and 2 (48") 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.

#### 4.05 Units Installation

- A. The first course of MagnumStone™ 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 unit voids of the first course below and pulled forward resting the lugs against the front edge of the 2 lower unit voids.
- F. All units shall be laid snugly together and parallel to the straight or curved lines.
- G. The MagnumStone™ units shall be swept clean of all dirt or rocks before installing the next layer of units or placing the geosynthetics.
- H. After laying each course, perform a visual or string line straightness check.

Drainage Gravel



- A. MagnumStone™ unit voids and the drainage chimney 6 to 12 inches behind the wall shall be filled with a free-draining granular material, such as ¾" clear rock (clean gravel).
- B. Clear gravel (clean gravel) shall be placed into the unit voids and behind the wall each course before placing the geosynthetic reinforcement layer.
- C. Clear gravel (clean gravel) does not need any mechanical compaction.

#### 4.06 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 so that the geosynthetic lays flat with no dips or bumps.
- E. The toe of the wall shall be filled and compacted as the wall is being constructed.

#### 4.07 Cap Installation

- A. The MagnumStone™ full size cap units should be placed in the same installation procedures as the regular MagnumStone™ units.
- B. Geotextiles should be used as a soil separator between the final layer of backfill and drainage materials and the top soil materials to prevent fines from migrating into the drainage gravel or through the wall face.
- C. A special MagnumStone™ 6" high cap can be used to complete the top of the wall. Concrete adhesive should be used to glue the cap units to the regular units.

### **PART 5 CONSTRUCTION QUALITY CONTROL AND ASSURANCE**

#### 5.01 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 AASHTO specifications.

#### 5.02 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**

**6.01** Payment for the installation of the MagnumStone™ 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**

#### 1.01 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.

#### 1.02 Related Work

- A. Section 02832 Mechanically Stabilized Earth Retaining Wall
- B. Section 02200 Site Preparation
- D. Section 02300 Earthwork
- E. Section 02070 Geosynthetic Reinforcement Walls

#### 1.03 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

#### 1.04 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

#### 1.05 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**

#### 2.01 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 MagnumStone™ specification and approved testing.
- E. All products shall be approved by the site Engineer.

### **PART 3 CONSTRUCTION**

3.01 Qualification

Refer to Section 02832 Mechanically Stabilized Earth Wall

3.02 Excavation

Refer to Section 02832 Mechanically Stabilized Earth Wall

3.03 Foundation Preparation

Refer to Section 02832 Mechanically Stabilized Earth Wall

3.04 Leveling Pad

Refer to Section 02832 Mechanically Stabilized Earth Wall

3.05 Unit Installation

Refer to Section 02832 Mechanically Stabilized Earth Wall

3.06 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 MagnumStone™ 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 MagnumStone™ 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 MagnumStone™ 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.

3.07 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 MagnumStone™ units forward and reduce the set back of the wall while compacting the backfill materials.
- D. Once the MagnumStone™ 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 and up the back side of the wall up to the cap unit. The fabric will prevent the planting soil fines from migrating into the drainage gravel and from staining the wall face.

3.08 Cap Installation

Refer to Section 02832 Mechanically Stabilized Earth Wall



## **PART 4 PAYMENT**

4.01 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.