StoneWall II® MSE Specifications

The following specification is for the construction of StoneWall II® MSE segmental retaining wall (SRWs). Specifications for segmental retaining wall units are provided in Standard Construction Specification Institute (CSI) format.

Section _____

StoneWall II® RETAINING STRUCTURE

PART 1: GENERAL

1.01 Description

A. Work shall consist of furnishing all materials, labor, equipment, and supervision to install the multi piece system in accordance with these specifications and in reasonably close conformity with dimensions shown on the plans or as established by the Owner or Owner's Engineer.

B. Work shall consist of furnishing and installing appurtenant materials required for construction of the retaining wall as shown on the construction drawings.

1.02 Related Work

A. Section _____ - Section - Information Available to Bidders: Geotechnical Report

B. Section _____ - Section - Testing and Inspection Services

C. Section _____ - Section - Site Preparation

D. Section _____ - Section - Earthwork

1.03 Reference Standards

A. Engineering Design

1. NCMA SRW Design Manual for Segmental Retaining Walls 3nd Edition
2. ASTM D 6638 Standard Test Method for Determining the Connection Strength Between Geosynthetics Reinforcement and Segmental Concrete Units
3. ASTM D 6916 Standard Test Method for Determining the Shear Strength Between Segmental Concrete Units

B. Segmental Retaining Wall Units

1. ASTM C140 - Sampling and Testing Concrete Masonry Units
2. ASTM 1262 Standard Test Method for Evaluating the Freeze-Thaw Durability of Manufactured Concrete Masonry Units and Related Concrete Units
3. ASTM C1372 Standard Specification for Dry-Cast Segmental Retaining Wall Units

C. Geosynthetic Reinforcement

1. ASTM D 6706 – Standard Test Method for Measuring Geosynthetic Pullout Resistance in Soil
2. ASTM D6916 Shear Strength Between Segmental Concrete Units

D. Soils

1. ASTM D 422 Standard Test Method for Particle-Size Analysis of Soils

2. ASTM D 698 Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lb/ft3(600 kN-m/m3))

E. Drainage Pipe

1. ASTM F 405 Standard Specification for Perforated Polyethylene (PE) Pipe and Fittings

2. ASTM F 758 Standard Specification for Smooth-Wall Poly(Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage

Where specifications and reference documents conflict, the Architect/Engineer shall make the final determination of applicable document.

1.04 Approved Segmental Retaining Wall Systems

A. Suppliers of segmental retaining wall system material components shall have demonstrated experience in the supply of similar size and types of segmental retaining walls on previous projects, and shall be approved by the Owner's Engineer. Each supplier must be approved two weeks prior to bid opening. Systems currently approved for this work are:

B. Segmental Wall Units

1. Basalite Concrete Products-StoneWall II®

2. _____

C. Geosynthetic Reinforcements

1. Strata Systems

2. T.C. Mirafi

3. _____

D. Submittals

1. Material Submittals – The Contractor shall submit manufacturer's certifications, 30 days prior to the start of work, stating that the SRW units, geosynthetic reinforcement, reinforced backfill, and gravel fill meet the requirements of Part 2.0 of this specification. The Contractor shall provide a list of (put # here) successful projects with references showing that the installer for the segmental retaining wall is qualified and has installed a minimum of (put # here) square feet.

E. Delivery, Storage and Handling

1. The Contractor shall inspect the materials upon delivery to assure that proper type and grade of material has been received.

2. The Contractor shall store and handle materials in accordance with the manufacturer's recommendations and in a manner to prevent deterioration or damage due to moisture, temperature changes, contaminants, corrosion, breaking, chipping or other causes.

3. The Contractor shall protect the materials from damage. Damaged material shall not be incorporated into the segmental retaining wall.

PART 2: MATERIALS

2.01 StoneWall II® Retaining Wall Units

A. StoneWall II® concrete segmental units shall conform to the requirements of ASTM C 1372 and have a minimum net average 28 days compressive strength of 3,000 psi and an absorption of ≤8% (for normal weight) as determined in accordance with ASTM C 140. For areas subject to detrimental freeze-thaw cycles, as determined by the Owner or Owner's Engineer, the concrete shall have adequate freeze/thaw protection and meet the requirements of ASTM C 1372 when tested in accordance with ASTM C1262.

B. Each of the StoneWall II® SRW units shall match the color, surface finish, and dimension for height, width, depth, and batter as shown on the plans.

C. StoneWall II® units dimensions shall not differ by more than ± 1/8 in., as measured in accordance with ASTM C140. This tolerance does not apply to architectural surfaces, such as split faces.

D. All units shall be sound and free of cracks or other defects that would interfere with the proper placing of the unit or significantly impair the strength or permanence of the construction. Any cracks or chips observed during construction shall fall within the guidelines outlined in ASTM C1372.

E. 3 way alignment plug (3WAP) used by the retaining wall system shall be supplied by the retaining wall supplier and shall be made for the express use with the StoneWall II® units supplied.

F. Cap adhesive shall meet the requirements of the SRW unit manufacturer.

G. The following Segmental Retaining Wall Units have been pre-approved:

1. StoneWall II® units
2. StoneWall II® Universal Cap units
3. _____

H. Each course of StoneWall II® Units shall be positively interlocked to the preceding course with a minimum shear capacity of 450 lb/lf at 2 psi as tested in accordance with ASTM D6916.

I. In climate where freeze thaw durability is a consideration the following recommendation should be considered.

Minimum Required Net Average Compressive Strength, psi (MPa)		**Maximum Water Absorption Requirements lb/ft^3 (kg/m^3)**		
		Weight Classification Oven-Dry Density of Concrete lb/ft^3 (kg/m^3)		
Average of 3 Units	Individual Unit	Lightweight: Less than 105 (1682)	Medium Weight: 105 (1682) to less than 125 (2002)	Normal Weight: 125 (2002) or more
3000 (20.7)	2500 (17.2)	18 (288)	15 (240)	13 (208)

J. StoneWall II® units shall meet the following constructability and geometric requirements:

1. Units shall be capable of attaining concave and convex curves to a minimum radius of 72 inches.

2. Vertical Wall: Units shall be positively engaged to the unit below so as to provide a reverse (- ½ inch), near vertica (0 inch) or setback (½ inch) horizontal setback per vertical foot of wall height.

3. The shapes shall be Trapezoidal, Orthogonal (Transition), Rectangular, used in combination within a wall creating a closed gap wall face on one or both sides and a Corner Unit-the corner unit can be made from the use of one or more Rectangular units.

4. StoneWall II® units shall be erected such that the completed location is within the following tolerances relative to the plan location and project drawing:

   a) Vertical Control: ± 1.25 inches from plan elevation.

   b) Horizontal Control: Straight Walls: ± 1 ½ inches over a horizontal distance of 10 feet.

   c) Wall Batter: ± 2.0 degrees of design height.

2.02 Geosynthetic Reinforcements

K. Geosynthetic Reinforcements shall consist of high tenacity PET geogrids, HDPE geogrids, or geotextiles manufactured for soil reinforcement applications. The type, strength and placement location of the reinforcing geosynthetic shall be as shown on the plans. The design properties of the reinforcement shall be determined according to the procedures outlines in this specification and the NCMA Design Manual for Segmental Retaining Walls (3rd Edition, 2009) Detailed test data shall be submitted to the Owner's Engineer for approval at least 30 days prior to construction and shall include tensile strength (ASTM D 4595 or ASTM D 6637), creep (ASTM D 5262), site damage (ASTM D 5818 durability (FHWA guidance (FHWA NHI-00-043, FHWA NHI-00-044)), pullout (ASTM D 6706 direct shear (ASTM D 5321 and connection (ASTM D 6638) test data.

B The following Geosynthetic Reinforcement have been pre-approved:

1. TenCate Mirafi

2. Stratagrid

C. Included with the raw test data shall be a report that shows that the proposed geosynthetic reinforcements have the following minimum properties:

Property	Geosynthetic Reinforcement		
	Type 1	Type 2	Type 3
Long-Term Design Strength LTDS (lb/ft)			
Coefficient of Pullout Interaction - C_i			
Coefficient of Direct Sliding - C_{ds}			

2.03 Drainage Pipe

A. The drainage collection pipe shall be a perforated or slotted PVC or corrugated HDPE pipe. The pipe and gravel fill may be wrapped with a geotextile that will function as a filter.

B. Drainage pipe shall be manufactured in accordance with ASTM F 405 or ASTM F 758.

2.04 Leveling Pad and Unit Fill Material

A. Material for leveling pad shall consist of crushed stone placed a minimum of 6 inches thick.

B. Unit Fill shall consist of free draining gravel or crushed stone.

1. Consolidate Unit Fill by running hand-operated vibrating compaction equipment behind units; do not run mechanical vibrating plate compactors directly on top of bare concrete units. Compact unit fill to a minimum 95% standard proctor density (ASTM D-698) or 92% of modified proctor density (ASTM D-1557).

2.05 Drainage Aggregate

A. Gravel fill shall be a clean crushed stone or granular fill meeting the following gradation as determined in accordance with ASTM D 422:

Sieve Size	Percent Passing
1 in.	100
3/4 in.	75 - 100
No. 4	0 - 60
No. 40	0 - 50
No. 200	0 – 5

B. The vertical drainage layer placed within and behind the SRW unit shall be no less than 12 -inches wide as measured from the back of the SRW units.

2.06 Infill Soil/ Reinforced Backfill

A. A. The reinforced backfill shall be free of debris and consist of one of the following inorganic USCS soil types: GP, GW, SW, SP, or SM type meeting the following gradation as determined in accordance with ASTM D 422.

Sieve Size	Percent Passing
1 in.	100
No. 4	100 - 20
No. 40	0 - 60
No. 200	0 - 35[1]

The maximum size should be limited to 2.0 in. for geosynthetic reinforced soil SRWs unless tests have been performed to evaluate potential strength reduction in the geosynthetic due to installation damage.

[1] Cohesionless, coarse-grained soils, are preferred; finer soils with low-plasticity (i.e., PI of the finer fraction is less than 20) may be used provided the following four additional design criteria are implemented:

a. Proper internal drainage is installed.

b. Only soils with low to moderate frost heave potential are utilized.

c. The internal cohesive shear strength parameter $(c)_c$ is conservatively ignored for stability analysis.

d. The final design for critical walls is checked by a qualified geotechnical engineer to ensure that the use of cohesive soils does not result in unacceptable time-dependent movement of the SRW system.

e. [1] For taller applications the PI may be reduced to PI < 5 to 10.

B. The pH of the backfill material shall be between 3 and 9 when tested in accordance with ASTM G 51.

C Unsuitable Soils are Organics soils or soils classified as CH, OH, MH, OL or PT.

D Impervious Materials: Clayey soil or other similar material which will prevent percolation Into the drainage zone behind the wall.

2.07 Geotextile Filter Fabric

A. When required, Geotextile filter fabric shall be a polypropylene, needle punched non woven fabric or as designated by the design engineer.

PART 3: CONSTRUCTION

3.01 Construction Observation

A. The Owner or Owner's Engineer should verify the materials supplied by the contractor meet all the requirements of the specification. This includes all submittals and proper installation of the system.

B. The Contractor's field construction supervisor shall have demonstrated experience and be qualified to direct all work at the site.

3.02 Excavation

A. Contractor shall excavate to the lines and grades shown on the project grading plans and SRW plan and profile drawing. Contractor shall take precautions to minimize over-excavation. Over-excavation shall be filled with compacted infill material, or as directed by the Architect/Engineer, at the Contractor's expense.

3.03 Foundation Preparation

A. Following excavation for the leveling pad and the reinforced soil zone, foundation soil shall be examined by the Owner's Geotechnical Engineer to assure the actual foundation soil strength meets or exceeds the assumed design bearing strength. Soils not meeting the required strength shall be removed and replaced with soil meeting the design criteria, as directed by the Owner's Geotechnical Engineer.

3.04 Leveling Pad Construction

A. A minimum 6 in. thick layer of compacted granular material shall be placed for use as a leveling pad up to the grades and locations as shown on the construction drawings. The granular base shall be compacted to provide a firm, level bearing pad on which to place the first course of concrete segmental retaining wall units. The leveling pad should extend a minimum of 6 in. from the front and rear of the SRW unit.

3.05 Unit Installation

A. The first course of units shall be placed on the leveling pad at the appropriate line and grade. Alignment and level shall be checked in all directions and insure that the blocks are in full contact with the leveling pad and properly seated.

B. Place the 3WAP into the receiving channel.

C. Install 4 inch drainage pipe.

E. Place and compact drainage fill within the unit channels and behind the wall units. Place and compact the backfill material behind the drainage fill. Sweep the units clean of gravel or other debris.

D. Install next course of units maintaining a "running bond" alignment.

F. Maximum stacked vertical height of wall units, prior to unit drainage fill and backfill placement, shall not exceed two courses.

3.06 SRW and Geosynthetic Reinforcement Placement

A. All materials shall be installed at the proper elevation and orientation as shown in the wall details on the construction plans or as directed by the Owner's Engineer. The concrete segmental wall units and geosynthetic reinforcement shall be installed in general accordance with the manufacturer's recommendations. The drawings shall govern in any conflict between the two requirements.

B. Overlap or splice connections 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 consist of one continuous piece of material. Adjacent sections of geosynthetic shall be placed in a manner to assure that the horizontal coverage shown on the plans is provided.

C. Geosynthetic reinforcement should be installed under tension. A nominal tension shall be applied to the reinforcement and maintained by staples, stakes, or hand tensioning until the reinforcement has been covered by at least 6 inches of soil fill.

D. Broken, chipped, stained or otherwise damaged units shall not be placed in the wall unless they are repaired, and the repair method and results are approved by the SRW Design Engineer.

3.07 Contractor Quality Control

A. The contractor/inspector will perform quality control activities on their work. As a minimum, the contractor/inspector shall prepare a daily report of the quality control activities undertaken that day, summarizing all test data, measurements and observations gathered as part of that effort.

B. The contractor shall provide the Architect/Engineer/Owner with a copy of each quality control daily report.

3.08 Gravel Fill and Drainage Placement

A. Gravel fill shall be placed to the minimum finished thickness and widths shown on the construction plans.

B. Drainage collection pipes shall be installed to maintain gravity flow of water outside of the reinforced soil zone. The drainage collection pipe should daylight into a storm sewer manhole or along a slope at an elevation lower than the lowest point of the pipe within the aggregate drain.

C. The main collection drain pipe, just behind the block facing, shall be a minimum of 4 in. in diameter. The secondary collection drain pipes should be sloped a minimum of two percent to provide gravity flow into the main collection drain pipe. Drainage laterals shall be spaced at maximum 50 ft spacing along the wall face.

3.09 Cap Block Placement

A. The cap block and/or top SRW unit shall be bonded to the SRW units below using cap adhesive described in Part 2. The block shall be dry and swept clean prior to adhesive placement.

PART 4: MEASUREMENT AND PAYMENT

4.01 Measurement

A. The unit of measurement for furnishing the segmental retaining wall system shall be the square foot of wall surface from the top of the leveling pad to the top of the wall, running the length of the complete wall including coping or cap. The quantity to be paid shall include supply and installation of the segmental retaining wall system. Excavation of unsuitable materials and replacement with select fill, as directed and approved in writing by the Owner or Owner's Engineer shall be paid for under separate pay items.

4.02 Payment

A. A. The accepted quantities of segmental retaining wall system will be paid for per square foot in place as measured from the top of the leveling pad to the top of wall, running the length of the complete wall including coping or cap. The quantities of the segmental retaining wall system as shown on plans or as approved by the Owner or Owner's Engineer shall be used to determine the area supplied. Payment will be made under:

Pay Item	Pay Unit
Geosynthetic Reinforced SRW	SQ. FT.

PART 1: END OF SECTION