

SECTION 02834

SEGMENTAL CONCRETE RETAINING WALL SYSTEM

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. The work includes furnishing and constructing a segmental concrete retaining wall (SRW) system, including leveling pad, soil reinforcement, unit drainage fill, reinforced backfill, and incidental materials required for SRW construction to the lines and grades shown on the construction drawings and specified herein.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices
 - 1. Measurement - The unit of measurement for furnishing and fabricating the SRW shall be the vertical square foot of wall surface from the top of the leveling pad to the top of the wall or wall coping.
 - 2. Payment - The accepted quantities of SRW will be paid at the contract unit price, which shall be full compensation for design, supply, and installation of the SRW including face units, caps, leveling pad, unit drainage fill, soil reinforcement and reinforced backfill.
 - 3. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 Reference Standards

- A. ASTM C1372 Specification for Segmental Retaining Wall Units
- B. ASTM D422 Particle Size Analysis
- C. ASTM D698 Laboratory Compaction Characteristics of Soil -Standard Effort
- D. ASTM D1388 Stiffness of Fabrics
- E. ASTM D2166 Unconfined Compressive Strength of Cohesive Soil
- F. ASTM D3034 Polyvinyl Chloride Pipe (PVC)
- G. ASTM D3080 Direct Shear Test of Soils
- H. ASTM D4218 Carbon Black Content
- I. ASTM D4318 Liquid Limit, Plastic Limit and Plasticity Index of Soils

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- J. ASTM D4475 Horizontal Shear Strength of Pultruded Reinforced Plastic Rods
- K. ASTM D4595 Tensile Properties of Geotextiles - Wide Width Strip
- L. ASTM D5262 Unconfined Tension Creep Behavior of Geosynthetics
- M. ASTM D6638 Connection Strength – Reinforcement/Segmental Units
- N.. ASTM D6916 Shear Strength Between Segmental Concrete Units
- O.. ASTM G51 Measuring pH of Soils
- P. ASTM G57 Measurement of Soil Resistivity
- Q. GRI-GG2 Determination of Geogrid Junction Strength
- R. GRI-GG4 Determination of Long Term Design Strength of Geogrids
- S. GRI-GG5 Determination of Geogrid (soil) Pullout
- T. GRI-GG7 Determination of Carboxyl End Group Content
- U. GRI-GG8 Determination of the Number Average Molecular Weight
- V. NCMA SRWU-1 Test Method for Determining Connection Strength of SRW
- X. NCMA SRWU-2 Test Method for Determining Shear Strength of SRW
- Y. Standard Specifications for Highway Bridges, 17th Edition, 2002
- X. AASHTO M 252 Corrugated Polyethylene Drainage Pipe
- AA. AASHTO M 288-96 Specifications for Geotextiles

1.04 DEFINITIONS

- A. Segmental Concrete Units - a modular concrete facing unit machine made from Portland cement, water and mineral aggregates.
- B. Soil Reinforcement - geosynthetic or steel reinforcement 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 as reinforcement. Soil reinforcement shall be specifically manufactured for soil reinforcement.
- C. Unit Drainage Fill - drainage aggregate that is placed within and behind the segmental concrete units.
- D. Reinforced Backfill - compacted soil that is within the reinforced soil volume as shown on the plans.
- E. Foundation Soil – compacted, imported or in-situ soil beneath entire wall.
- F. Retained Soil – compacted, imported or in-situ soil behind reinforced zone of the retaining wall.

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1.05 SUBMITTALS

- A. A set of detailed SRW design plans sealed by a registered professional engineer licensed in the state of the project. The SRW plans shall include plan and elevation views of each wall, cross sections and all details, dimensions and quantities necessary to construct the SRW.
- B. Product literature indicating specifically which SRW units and soil reinforcement are proposed for use on the project including color, face style and texture.
- C. Documentation for the SRW units and soil reinforcement demonstrating compliance with the requirements of this specification including but not limited to SRW compressive strength and absorption; SRW/soil reinforcement connection and shear; and reinforcement strength.
- D. Manufacturer's certification that the SRW units and soil reinforcement meet the requirements of this specification.

PART 2 PRODUCTS

2.01 DESIGN METHOD

- A. Design of SRW's using geosynthetic reinforcement shall be in accordance with the NCMA Design Guidelines for Segmental Walls, AASHTO or NCMA utilizing AASHTO earth pressure and stability design criteria. Metallic reinforcement systems shall be designed in accordance with AASHTO Standard Specification for Highway Bridges, Section 5.8, using the Coherent Gravity Method. All designs shall conform to the minimum safety factors in this Specification. Design submittals not meeting this design criteria or technical/administrative criteria specified will be rejected in their entirety until complete compliance is achieved.
- B. Design Parameters - The design of the SRW system shall be based on the following soil parameters provided by a geotechnical report.
- C. Design Requirements - Unless otherwise indicated below, the SRW design shall be performed in strict compliance with this Specification.

Internal Stability	Minimum Factor of Safety
Tension (Peak)	1.5
Pullout (Peak)	1.5
Facing Connection (Peak/serviceability)	1.5/NA
Facing Shear (Peak/serviceability)	1.5/NA
External Stability	Minimum Factor of Safety
Base Sliding (static)	1.5
Overturning	2.0
Bearing	2.0

Global	1.3
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- D. In addition, to further clarify the Owner's intent, the design shall:
1. Address hydrostatic, seismic, surcharge and backslope loading as shown on the plans. Minimum live loads of 100 psf (4.8 kPa) and 250 psf (12 kPa) shall be for all walls and walls supporting areas subject to traffic, respectively.
 2. Provide a minimum reinforcement length of 60% the total height of the wall for each layer or longer as required by calculation.

Provide continuous, 100% geosynthetic coverage at each reinforcement layer (no gaps).

Use a maximum spacing between vertically adjacent reinforcing layers of no more than 2 times the actual (not nominal) SRW unit depth (face to tail).

Only the weight of the mass vertically over the plane of sliding shall be included in the resisting forces for sliding and overturning.

2.02 BASE LEVELING PAD

- A. level compacted gravel or unreinforced concrete pad upon which the first course of segmental concrete facing units is placed.

2.03 SEGMENTAL CONCRETE UNITS

- A. Modular concrete unit face color as shown on the drawings or as determined by the City. Finish (smooth or split face or otherwise will be as shown on the drawings or as determined by the City .
- B. Manufactured in accordance with ASTM C1372 with a minimum 28-day compressive strength of 3000 psi (21 MPa) (4000 psi (28 MPa) for steel reinforced systems) and a maximum moisture absorption of 8% (6% in northern climates).
- C. Provide shear pins or connection devices to provide a mechanical connection between vertically and horizontally adjacent units so as to provide at a 2 psi (13 kPa) normal pressure a minimum inter-unit shear strength of 600 plf (8 kN/m) per ASTM D6916 (NCMA SRWU-2) and a geosynthetic to SRW unit peak connection strength of 500 plf (7 kN/m) per ASTM D6638 (NCMA SRWU-1). Shear devices shall protrude at least 7/8 inch (22 mm) into receiving openings of the SRW units. At least one shear connector is required per linear foot (300 mm) of wall for each course. The shear connector must fit within an aperture of the soil reinforcement and be capable of holding the reinforcement in the proper position during tensioning and backfilling. Connectors shall result in a design wall batter of 1° to 10°.

2.04 SOIL REINFORCEMENT

- A. Furnish earth reinforcements that meet the design requirements. For permanent walls, galvanize or epoxy coat all steel elements in contact with soil. Epoxy coat with a minimum 18-mil coating thickness. Epoxy coat the reinforcing only when shown in the plans or as approved. When using nonmetallic or epoxy coated earth reinforcements, use connection hardware that is likewise nonmetallic or epoxy coated.

2.05 DRAINAGE AGGREGATE

- A. Use drainage aggregate to fill the void within concrete block units and in the zone 1 ft. behind the units. Provide drainage aggregate that is free from organic or otherwise deleterious materials and that conforms to the gradation limits in below as determined by Tex-110-E..

Drainage Aggregate Gradation Limits

Sieve Size	Percent Retained
1 in.	0
3/4 in.	25–50
1/2 in.	50–100
No. 4	75–100

2.06 REINFORCED BACKFILL

- A. Shall consist of soil with less than 35% passing the No. 200 sieve per ASTM D422 with a maximum size of 3/4 inches (19 mm) (4 inch (100 mm) maximum for steel reinforced systems). If site-specific geogrid installation damage testing has been performed to determine RFID, the maximum size may be increased to 2" (50mm);
- B. A plasticity index less than 10 per ASTM D4318;
1. An effective internal angle of friction $\geq 30^\circ$ per ASTM D2166 or D3080 at the compaction standard;
- C. Less than 0.5% organic material;
1. Material can be site-excavated soils where the above requirements can be met. Unsuitable soils for backfill including ML, CL, MH, CH, OH or Pt shall not be used in the backfill or in the reinforced soil mass.
- D. Use of an effective friction angle greater than 30 degrees for design shall be verified by appropriate testing submitted to and approved by the owner's engineer prior to construction.
- C. Backfill reinforced with geosynthetic shall have a pH in the range of 3 to 9 per ASTM G51.

- D. Backfill reinforced with steel reinforcement shall have a pH in the range of 5 to 10 per ASTM G51, minimum resistivity of 3000 ohm-cm at 100% saturation per ASTM G57 and free of sulfates > 200 ppm or chlorides > 100 ppm. If the resistivity is ≥ 5000 ohm-cm, the chloride and sulphate requirements are waived. Subject to approval, the owner's engineer may allow slightly wider ranges of pH for higher resistivities.

2.07 BASE LEVELING PAD

- A. Base leveling pad shall be constructed of dense graded crushed stone or crushed gravel. A concrete leveling pad consisting of lean unreinforced concrete may be used at the wall contractor's option.

2.08 Delivery, Storage and Handling

- A. The contractor shall check all materials upon delivery to assure that the proper type, grade, color and material certification have been received. Contractor shall protect materials from damage due to jobsite conditions and in accordance with the manufacturer's recommendations. Damaged materials shall not be incorporated into the work.

PART 3 EXECUTION

3.01 CONSTRUCTION

- A. General – Construction and construction tolerances shall be in accordance with NCMA Section 6 and 7 or AASHTO Section 7 with the following additions or clarifications.
- B. Place the concrete block facing units in accordance with the approved working drawings. Fill the voids within the units and fill the 1-ft. zone immediately behind the facing with drainage aggregate . Systems tested without unit fill may omit the fill as indicated on the approved drawings. Systems with approved filter fabric details may omit the drainage aggregate in the 1-ft. zone immediately behind the facing
- C. Compact backfill to provide not less than 95% of density determined in accordance with Tex-114-E. Field density determination will be made in accordance with Tex-115-E. Sprinkle backfill as required to ensure adequate uniformly distributed moisture in each lift prior to and during compaction. Place fill in lifts of 8 in. or less (loose measurement). Place fill in a manner that avoids segregation of the fill. Decrease the lift thickness if necessary to obtain the required compaction. Use hand-operated or walk-behind compaction equipment in the 3-ft. wide strip adjacent to the wall panels. Do not displace panels or distort or damage the reinforcement system during compaction. Modify backfill material, placement, and compaction methods as necessary to meet density requirements while maintaining wall tolerances.

- D. For walls using earth reinforcements, place reinforcements and backfill. Pay particular attention to the connection details of the earth reinforcements to the concrete block units.

3.02 Field Quality Control and Assurance

- A. Field Quality Assurance - The Owner shall engage inspection and testing services, including independent laboratories, to provide quality assurance and testing services during construction. As a minimum, quality assurance testing should include foundation soil inspection, inspection for the need for any additional drainage, soil and backfill testing, verification of design parameters, and observation of construction for general compliance with design drawings and specifications. This does not relieve the Contractor from securing the necessary construction quality control testing during construction.
- B. Field Quality Control - The Contractor's quality control testing and construction inspection services shall only be performed by independent, qualified and experienced technicians and engineers. The Contractor's quality control testing, as a minimum, shall include:
 - 1. Field density testing
 - a. Subgrade: one test for every 2500 square feet of subgrade.
 - b. Reinforced Backfill: one test for every 2500 square feet per lift with a minimum of one test for every other lift.
 - c. Retained and Foundation Soil: per Section 02330.

END SECTION