

## SECTION 02279 - CELLULAR CONCRETE MATTRESSES FOR EROSION CONTROL

### PART 1 - GENERAL

1.1 SCOPE OF WORK. The work covered by this Section consists of furnishing all plant, labor, equipment, and materials, and performing all operations in connection with the installation of cellular concrete mattresses in accordance with the lines, grades, design, and dimensions shown on the drawings and as specified herein.

1.2 REFERENCES. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

American Society for Testing and Materials (ASTM) Publications.

ASTM C 33-93	Concrete Aggregates
ASTM C 140-96B	Sampling and Testing Concrete Masonry Units
ASTM C 476-95	Grout for Masonry
ASTM D 698-78	Moisture Density Relationship of Soils

U.S. Federal Highway Administration (FHWA) and U.S. Bureau of Reclamation (USBR) Report.

FHWA-RD-89-199 Hydraulic Stability of Articulated Concrete Block Revetment Systems During Over-topping Flow.

1.3 DELIVERY, STORAGE, AND HANDLING OF MATERIALS.

1.3.1 Delivery and Storage. Materials delivered to the site shall be inspected for damage, unloaded and stored with the minimum of handling. Materials shall be kept free of dirt and debris.

1.3.2 Handling. Materials shall be handled in such a manner as to ensure delivery to the site in sound, undamaged condition. Synthetic geotextiles that are not to be installed immediately shall be protected from the direct sunlight and in accordance with the applicable portions of the Section entitled GEOTEXTILES USED AS FILTERS.

1.4 SUBMITTALS. The following shall be submitted in accordance with the Section entitled SUBMITTAL PROCEDURES.

1.4.1 Shop Drawings. At least 30 days prior to the start of any installation of the cellular concrete mats, the Contractor shall submit to the owner shop drawings for the layout and details of the cellular concrete mats. The cellular concrete mats layout shall be to the lines and grades shown

on the drawings. The shop drawings shall include layout, layout sequence, anchor details, mat junction details, anchor to mat connection details, and details for grade change.

1.4.2 Representative Samples. The sources from which the Contractor proposes to obtain materials shall be selected well in advance of the time when the materials will be required in the work. Product literature and suitable samples of the cellular concrete mattresses, cable, fittings, anchors and filter fabric shall be submitted to the owner for approval, prior to delivery of any such material to the site of the work. All samples shall be obtained by the Contractor and delivered at his expense to a point designated by the owner at least 10 days in advance of the time when the placing of the concrete mattresses is expected to begin. The contractor shall submit the cellular concrete block revetment system Manufacturer's certification that the revetment system and components meet the requirements of this specification.

1.4.3 Documentation of Testing. The contractor shall provide to the owner test results documenting that the revetment system has been tested under controlled flow conditions for hydraulic performance characteristics in accordance with FHWA-RD-89-199, utilizing a 2:1 slope in the direction of flow.

1.5 MEASUREMENT OF CELLULAR CONCRETE MATTRESSES. The unit of measurement for the cellular concrete mattresses shall be by the square foot of cellular concrete mattresses placed.

1.6 PAYMENT for acceptable cellular concrete mattresses placed will be made at the contract unit price per square foot for "Cellular Concrete Mattresses," which prices shall include all costs for furnishing, hauling, and placing the cellular concrete mattresses as specified herein and as shown on the drawings.

## **PART 2 – MATERIALS**

### **2.1 MATERIALS FOR CELLULAR CONCRETE BLOCKS.**

2.1.1 Concrete shall conform to ACI requirements for normal weight concrete and shall have a minimum compressive strength of 4,000 psi at 28 days when tested in accordance with ASTM C 140-96B.

2.1.2 Aggregate shall meet the requirements of ASTM C 33 except for grading. Aggregate grading shall be reasonably consistent and shall be well graded from the maximum size, which can be conveniently handled with available equipment.

2.2 CELLULAR CONCRETE BLOCKS shall be either wet cast using concrete as specified herein, or formed by a vibratory block forming machine. Cellular concrete blocks shall be interlocking; and penetrations shall be included for revetment cables as necessary to bind the individual blocks into mattresses. Cable penetrations shall prevent any exposure of cables to potential UV degradation within the dimensions of the individual blocks (i.e., cables shall not pass through open areas within the dimensions of individual blocks). The blocks shall be open or closed cell, as shown in the plans, and capable of articulation when formed into mattresses.

2.2.1 Design Requirements. The weight of the block shall have the following minimum requirements:

LOCATION ~ NOMINAL THICKNESS ~ BLOCK WEIGHT – PSF ~ % OPEN AREA

2.3 CELLULAR CONCRETE MATTRESSES shall be SHOREBLOCK® SD or approved equal. SHOREBLOCK® SD can be obtained from SHORETEC, L.L.C. from \_\_\_\_\_ or \_\_\_\_\_. Cellular concrete mattresses shall be pre-manufactured as an assembly of concrete blocks when connected into mattresses by the use of revetment cables. The assembled mattresses shall be open or closed cell as shown in the drawings. Proposed equals must be approved by the engineer a minimum of thirty (30) days prior to bid date. The owner or his engineer reserves the right to accept or reject any proposed equal cellular concrete mattress system for reasons including but not limited to previous performance record, appropriate and applicable testing, hydraulic performance characteristics, and qualified technical support. The following information must be included in the submittal to be considered for approval:

1. Test results documenting that the revetment system has been tested under controlled flow conditions for hydraulic performance characteristics in accordance with FHWA-RD-89-199, utilizing a 2:1 slope in the direction of flow.
2. Manufacturer's certification that the revetment system design and components meet all of the requirements of this specification.

2.3.1 Size of Cellular Concrete Mattresses. The Cellular concrete blocks and cables and fittings shall be fabricated at the manufacturer's plant or another approved location into mattresses with a width of up to 8 feet and a length that is capable of being transported without special permitting.

2.4 REVETMENT CABLE. The concrete blocks shall be bound into mats by the use of polyester revetment cable and fittings.

2.4.1 Polyester Revetment Cable shall be constructed of high tenacity, low elongating, and continuous filament polyester fibers. Cable shall consist of a core construction comprised of parallel fibers contained within an outer jacket or cover. The weight of the parallel core shall be between 65 to 70 percent of the total weight of the cable. Longitudinal cables shall be sized to provide a minimum cable strength to mat weight ratio of 5:1 for safe material lifting/handling. Additionally, all revetment cable shall have the following minimum physical characteristics:

DIRECTION	NOMINAL CABLE DIAMETER	APPROXIMATE AVG. STRENGTH LB.	WEIGHT/100 FT. (LB.)
Longitudinal & Transverse	¼"	3,700	2.47

2.4.2 Elongation Requirements specified below are based upon stabilized new, dry cable. Stabilization refers to a process in which the cable is cycled fifty (50) times between a load corresponding to 200D<sup>2</sup> and a load equal to 10, 20, or 30 percent of the cable's approximate average breaking strength. Relevant elongation values are as shown on the table below. The tolerance of these values is ± 5 percent.

	% BREAKING STRENGTH		
	10%	20%	30%
Permanent Elongation (while working)	0.7	1.8	2.6
Elastic Elongation	0.6	1.4	2.2
Total Stretch	1.3	3.2	4.8

2.4.3 Revetment Cable shall exhibit good to excellent resistance to most concentrated acids, alkalis and solvents. Cable shall be impervious to rot, mildew and degradation associated with marine organisms. The materials used in the construction of the cable shall not be affected by continuous immersion in fresh or salt water.

2.4.4 Cable and Fittings. Selection of cable and fittings shall be made in a manner that ensures a minimum of 5:1 design safety factor for mattresses being lifted from both ends, thereby forming a catenary. Fittings such as sleeves, stops, and washers shall be in accordance with the manufacturer's recommendations unless otherwise shown on the plans.

2.5 EARTH ANCHORS. Cellular concrete mattresses shall be anchored at the top and at the exposed sides of the ends of the revetment system by fastening the exposed revetment cables to the anchors driven into the anchor trench as shown on the plans. Anchors shall have a minimum pull resistance of 2,000 pounds and shall be attached to the cellular concrete block revetment system in a manner that will achieve little or no slack in the revetment cable. Anchors shall be of the helical or

flexible type and shall be installed at intervals as shown in the plans. Material options for the cellular concrete mattress anchors shall be cast-aluminum, galvanized steel or galvanized ductile cast-iron.

2.6 STRUCTURAL GROUTING shall be required where gaps in the concrete mats occur. Any surface where the clear span between mats is 3 inches or greater shall be grouted. All cable ties and anchoring shall be completed prior to placing grout. The grout shall be coarse and proportioned in accordance with ASTM C 476. The quantity of the mixing water shall be the minimum necessary to obtain a uniform mixture and to permit placing. Grout shall be thoroughly compacted in place and struck off to adjacent surface.

2.7 FILTER FABRIC for the cellular concrete mattresses shall be in accordance with the SECTION entitled GEOTEXTILES USED AS FILTERS.

### **PART 3 - EXECUTION**

#### **3.1 FOUNDATION PREPARATION.**

3.1.1 Construction Methods. Areas on which filter fabric and cellular concrete mattresses are to be placed shall be constructed to the lines and grades shown on the drawings. The subgrade for the cellular concrete mats shall be free of voids, pits, or depressions and shall be proof-rolled to a minimum of 90% of the ASTM D 698 density. Voids, pits or depressions shall be brought to grade by backfilling in accordance with the applicable portions of the project specifications. All obstructions, such as roots and projecting stones larger than 1 inch remaining on the surface, shall be removed and all of the soft or low density pockets of material removed must be filled with selected material and compacted to a minimum of 90% of the ASTM D 698 density. Special consideration for buried obstructions (i.e. stumps, debris, etc.) will be as shown on the drawings.

3.1.2 Excavation and Preparation for anchor trenches, side trenches, and toe trenches or aprons shall be done in accordance to the lines, grades and dimensions shown on the drawings.

3.1.3 Inspection and Approval. Immediately prior to placing the filter fabric and cellular concrete mattresses, the prepared area shall be inspected by the owner's representative and approval obtained before any fabric or mattresses are placed thereon.

#### **3.2 INSTALLATION OF CELLULAR CONCRETE MATTRESSES.**

3.2.1 General. Cellular Concrete Mattresses shall be placed within the limits shown on the drawings. The cellular concrete mats or blocks shall be placed on the filter fabric in such a manner as to produce a relatively planar surface. No more than 200 linear feet of filter fabric shall be laid before being covered with concrete mattresses, and any fabric installed more than 2 days shall be lifted and the surface of the slope inspected for any slope defects. The owner may require any uncovered fabric to be lifted after heavy rainfall to inspect for slope damage. Final acceptance and

approval of the installation will be made by the owner. The Contractor shall hold the owner harmless from liability of any kind arising from the use of any patented or non-patented invention used in the performance of this work.

3.2.2 Placement of Prefabricated Mattresses shall be done with mats attached to a spreader bar or other approved device to aid in the lifting and placing of the mats in their proper position by the use of a crane or other approved equipment. The mats shall be placed side-by-side and/or end-to-end so that the mats abut each other. The maximum space or gap between mattresses shall be 3 inches, except that local wider gaps may be accepted if the length of the gap is less than 3 feet and the entire gap is grouted. No overlapping of mats will be accepted and no blocks shall project vertically more than 1 inch beyond the adjacent blocks. All placements of mats shall be in accordance with the manufacturer's recommendations and the Contractor's approved shop drawings.

3.2.3 Individual Concrete Blocks that are hand placed shall be subject to the spacing and level parameters specified in Subparagraph: Placement of Prefabricated Mattresses above. Revetment cables shall be threaded into the blocks as the placement proceeds and fastened with approved sleeves, fittings or fasteners.

3.2.4 Prior to installation of earth anchors, as shown on the plans, the geotextile filter fabric shall be cut to allow for the penetration of the anchor.

3.2.5 Filter Fabric for the cellular concrete mattresses shall be installed in accordance with the Section entitled GEOTEXTILES USED AS FILTERS. Adjacent layers of filter fabric shall have a minimum of two feet of overlap. Fabric shall be secured with 6" x 1" x 6" steel pins prior to placement of cellular concrete mattresses.

### 3.3 FINISHING.

3.3.1 Surface Treatment. If required on the plans, the voids of the cellular concrete mats for the limits shown on the drawings shall be filled with topsoil. The soil should then be seeded in accordance with the Section entitled TURF.

3.3.2 Inspection and Approval. Immediately prior to the placement of any required surface treatment per section 3.3.1, the owner shall inspect the installed cellular concrete mattresses for defects and/or damage. Individual blocks which are cracked and the weight reduced below 1/3 of the original individual block weight shall be replaced or grouted per section 2.6 prior to the placement of any required surface treatment.

### 3.4 CONTRACTOR QUALITY CONTROL.

3.4.1 The Contractor shall inspect for compliance with contract requirements and record the inspection of all operations including but not limited to the following, as applicable:

1. Preparation of surface to receive cellular concrete mattresses.
2. Individual concrete blocks and filter fabric soundness and free of defects.
3. Cables and fittings - breaking strength.
4. Assembly of cellular concrete blocks bound by cables to form cellular concrete mattresses.
5. Placement of mattresses and filter fabric on the prepared subgrade.
6. Embedment of cables in the anchor trenches, side trenches, and toe trenches.

SHOREBLOCK® SD Series Spec  
Last Revised February 18, 2008

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