SPECIAL SPECIFICATION

4542

Articulating Concrete Blocks with Cables

1. Description. Furnish and install dry cast interlocking or non-interlocking concrete blocks with cables and geotextile fabric underlayment to provide an erosion control matrix.

2. Definition. Articulating Concrete Blocks are a matrix of interconnected concrete block units for erosion protection. Units are connected by geometric interlock, cables, ropes, geotextiles, geogrids, or a combination thereof, and typically include a geotextile underlayment for subsoil retention.

   A. Articulating Concrete Blocks with Cables. Use Articulating Concrete Blocks (ACB) that expand and contract.

   Provide individual grid blocks consisting of a homogeneous mass of consolidated concrete. Ensure they are machine-made by a vibration and compression process and are composed of approved aggregates with a no-slump concrete mix. Use mix water that is clean, fresh, and free from oil, acids, soluble salts, and organic impurities. Use cements conforming to ASTM C150. Use test procedures conforming to ASTM C140. Use aggregates conforming to ASTM C33. When potentially reactive aggregates are used, replace 25% to 35% of the cement with a Class F fly ash meeting the requirements of Departmental Material Specification DMS-8900, “Fly Ash” or replace 50% of the cement with Grade 100 or Grade 120 Ground Granular Blast Furnace (GGBF) slag meeting the requirements of ASTM C989. Use Type II cement in sulfate or salt-water environments.

   Ensure the manufacturer of the ACB with cables furnishes the system’s Hydraulic Stability Test Report that complies with the test procedures under Federal Highway Guideline Report FHWA-RD-89-199 to determine the system’s critical shear stress value. Ensure the manufacturer provides test data derived from the ACB specified in this Item concerning weight per square foot and the use of cables. Extrapolation of test data derived from testing smaller blocks or other methods is not allowed. Install the anchoring devices such as helix anchors, duckbill anchors, shear pins, cables, etc., used in the hydraulic stability test procedure in the field, in the same manner in which they were used during the hydraulic stability testing.

   Provide ACB that meet or exceed the type stated in the plans.

   Where placing partial units, fill the void areas with grout.
Provide an ACB Revetment System that exhibits a capacity to withstand the specified hydraulic data and physical application dimensions shown on the plans, with a factor of safety of not less than 1.5. Perform the Factor of Safety calculations in accordance with Hydraulic Engineering Circular 23, FHWA HI-97-030 HEC 23, Bridge Scour and Stream Instability Countermeasures.

Provide ACB meeting the physical requirements shown in Table 1.

### Table 1

<table>
<thead>
<tr>
<th>Property</th>
<th>Physical Requirements of ACB</th>
<th>Test Method</th>
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</thead>
<tbody>
<tr>
<td>Compressive Strength (min)</td>
<td>4000 lbs/sq. in. @ 28 days</td>
<td>ASTM C140</td>
</tr>
<tr>
<td>Water Absorption (ma)</td>
<td>7%</td>
<td>ASTM C140</td>
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<tr>
<td>Specific Weight (min)</td>
<td>130 lbs./cu. ft.</td>
<td>ASTM C140</td>
</tr>
<tr>
<td>Minimum Critical Shear Stress</td>
<td>4 lbs./sq. ft. or as shown on the plans</td>
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**B. Revetment Cable.** Supply pre-manufactured ACB with cables as an assembly of concrete blocks connected into mattresses by the use of revetment cables. Extend the revetment cable through 2 or more tunnels in each block in a manner that provides for binding of the mattresses in both the longitudinal and lateral directions. Use a cable conforming to ASTM D 4268-93. Fabricate the ACB mats at the manufacturer’s plant or another approved location, into mattresses with a width of up to 8 ft. and a length of up to 20 ft.

Construct polyester revetment cable of high tenacity, low elongating continuous filament polyester fibers. Provide cable consisting of a core construction comprised of parallel fibers contained within an outer jacket or cover. Ensure the weight of the parallel core is within 65% to 70% of the total weight of the cable. Provide revetment cable with the following minimum characteristics: nominal 1/4 in. diameter cable, 3,700 lbs. approximate average strength, and the elongation requirements shown in Table 2.

### Table 2

<table>
<thead>
<tr>
<th>Elongation Requirement (based upon stabilized new, dry cable)</th>
<th>% Breaking Strength</th>
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<tbody>
<tr>
<td></td>
<td>10%</td>
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<tr>
<td>Permanent Elongation (while working)</td>
<td>0.7</td>
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<tr>
<td>Elastic Elongation</td>
<td>0.6</td>
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<tr>
<td>Total Stretch</td>
<td>1.3</td>
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</table>

Use revetment cable exhibiting good to excellent resistance to most concentrated acids, alkalis, and solvents. Also, use cable impervious to rot, mildew, and degradation associated with marine organisms. Ensure the materials used in the construction of the cable are not affected by continuous immersion in fresh or salt water.

Select cables and fittings made in a manner that ensures a safe design factor for mattresses being lifted from both ends, thereby forming a catenary. Consider the bending of the cables around hooks or pins during lifting. Select revetment cable splicing fittings so that the resultant splice provides a minimum of 75% of the minimum rated cable strength. Provide fittings such as sleeves, stops, and washers in accordance with the manufacturer’s recommendations unless otherwise shown.
C. **Filter Fabric Underlayment.** Use Type 2 filter fabric as defined by DMS-6200, “Filter Fabric,” or of the type and properties as specified in the plans or approved equivalent.

Furnish filter fabric that is inert to chemicals commonly encountered in natural water and soil conditions.

During periods of shipment and storage, protect the filter fabric from direct sunlight, ultraviolet rays, and temperatures greater than 140 °F. Keep the filter fabric in its protective covering. If the filter fabric protective covering is damaged or removed, immediately cover the filter fabric with an opaque tarp or move the filter fabric to an indoor storage facility.

Filter fabric will be rejected at the time of installation, as determined by the Engineer, if removed from its protective cover for over 72 hours, or has defects, tears, punctures or shows deterioration or damage incurred during manufacture, transportation, or storage.

4. **Construction.**

A. **Earthwork.** Construct the areas where placing the filter fabric and ACB with cables to the lines and grades as shown on the plans. Where such areas are below the allowable grade, place and compact these areas to grade in layers of maximum 8 in. thickness of the selected material. Use the depth of layers and amount of compaction necessary to obtain a density equal to the adjoining undisturbed soil. Remove obstructions such as, but not limited to, roots, lumps, and projecting stones larger than 1 inch. Remove soft or low-density pockets of material and fill the resulting void with select, compacted material. Use a compaction of 90% or greater of the optimum value as determined by Test Method Tex-114-E.

Construct the finished subgrade to exhibit a raked, rolled, or otherwise smooth planer profile within 0 in. to 0.5 in. tolerance within a 10 ft. straightedge from established subgrade shown on the plans or as approved by the Engineer.

Immediately before placing the filter fabric and ACB with cables, the Engineer will inspect the prepared area. Do not place filter fabric or blocks until the Engineer approves that area. Before placing the blocks, perform any necessary repairs to the finished grade at no expense to the Department.

B. **Placing Filter Fabric.** Place the filter fabric directly on the prepared area. Overlap the longitudinal and transverse joints a minimum of 2 ft. The filter fabric shall be free of field seams.

Insert the securing staples, as needed, through both strips of overlapped fabric along one line through the midpoint of the overlap to temporarily hold the filter fabric panels in place until the ACB with cables can be placed. Place a maximum of 200 ft. of filter fabric before covering it with the ACB with cables. If the filter fabric is installed and not covered with the ACB for more than two days, lift the filter fabric and inspect the ground for defects. Lift uncovered filter fabric after a heavy rainfall and inspect the ground for slope damage.
Place the fabric smoothly on the subgrade minimizing tension, stress, folds, and wrinkles.

After placing, do not unnecessarily walk on or disturb the filter fabric unless required to preserve contact with the subgrade. Do not allow equipment on unprotected filter fabric. Protect the fabric from binding, clogging, tears, and other damage while installing.

Place the filter fabric strips from downstream to upstream. Overlap successive filter fabric sheets such that the upstream sheet is placed over the downstream sheet or the upslope sheet is placed over the downslope sheet. Overlap adjoining fabric sections a minimum of 2 ft.

Replace or repair, at no additional cost, fabric damaged while placing the blocks, as directed. Repair any torn, punctured, or otherwise damaged areas by placing a fabric patch of the same material over the area and extending it a minimum of 3 ft. beyond the perimeter of the tear or damage. Orient the patch material so that its fibers are aligned with the damaged filter fabric fibers.

C. Placing ACBs with Cables. Place the ACB with cables on the filter fabric in prefabricated mattresses or by individual concrete blocks.

Place prefabricated mattresses with mats attached to a spreader bar or other approved device to aid in lifting and placing the mats in their proper position by the use of a crane or other approved equipment. Place the mats side by side or end to end, so that the mats have a totally positive interlock with each other. The maximum allowable space or gap between mattresses is 2 in., except that local wider gaps may be accepted if approved by the Engineer. No overlapping of mats will be accepted and no blocks may project more than 1 in. beyond the adjacent blocks. Place the mats in accordance with the manufacturer’s recommendations and the plan details. As adjacent mats are placed, secure them to each other by connecting the protruding cables together with sleeves. Do not allow ties to protrude beyond the mat surface. Fasten with approved sleeves.

Place individual concrete blocks subject to the spacing and level parameters as specified in prefabricated mattresses. Thread revetment cables into the blocks as the placement proceeds and fasten them with approved sleeves, fittings, or fasteners per the manufacturer’s recommendations.

Install ACB with cables to the specified lines and grades shown on the plans. The Engineer will make final acceptance and approval of the installation.

If shown on the plans, backfill the voids of the cabled ACB using seeded and fertilized topsoil. Before placing topsoil, inspect the concrete blocks for damage. Replace and grout individual concrete blocks which are cracked and which are reduced in individual block weight by one-third, or more, before placing the topsoil.

Excavate and prepare foundations for the ACB with cables anchor trenches, toe trenches and aprons, top trenches, upstream termination trenches, and downstream termination trenches as shown on the plans.
5. **Measurement.** This Item will be measured by the square foot as shown on the plans, complete in place.

6. **Payment.** The work performed and materials furnished in accordance with this Item and measured as provided for under “Measurement,” will be paid for at the unit price bid for “ACB with Cables,” of the size specified. This price is full compensation for furnishing the tools, equipment, labor, and incidentals necessary to complete the work.

Furnishing and placing topsoil, fertilizer, and seeding will be measured and paid for by the pertinent bid items.