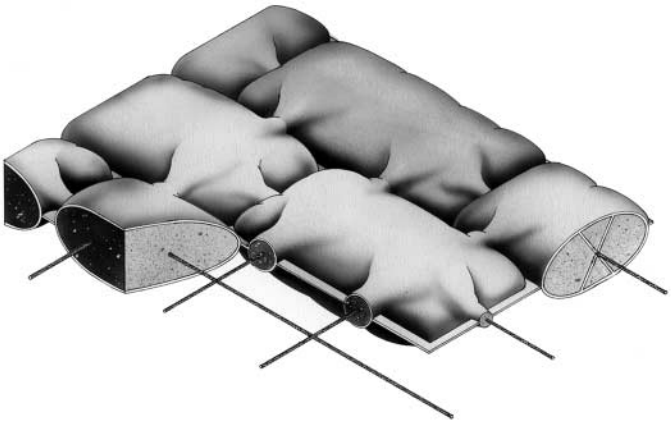

HYDROTEX™

Specification Guideline

Fabric-formed Concrete Erosion Control Systems

Articulating Block Mat

Table 1.0 Typical Dimensions and Weights

Articulating Block	AB400	AB600	AB800	AB1000	AB1200
Average Thickness, in (mm)	4.0 (102)	6.0 (152)	8.0 (203)	10 (254)	12 (305)
Mass Per Unit Area, lb/ft^2 (kg/m^2)	45 (220)	68 (330)	90 (440)	113 (550)	135 (661)
Mass per Block, lb (kg)	88 (39.8)	188 (85.2)	325 (148)	563 (255)	844 (382)
Nominal Block Dimensions, in (mm)	20 x 14 (508 x 356)	20 x 20 (508 x 508)	20 x 26 (508 x 660)	30 x 24 (762 x 610)	30 x 30 (762 x 762)
Concrete Coverage, ft^2/yd^3 (m^2/m^3)	75 (9.1)	50 (6.1)	38 (4.6)	30 (3.6)	25 (3.0)
Shear Resistance, lb/ft^2 (kg/m^2)	26 (127)	39 (190)	52 (254)	65 (317)	78 (381)

Note: Values shown are typical and will vary with weight of concrete and field conditions.

Product Description

Articulating Block Mats form cable-reinforced concrete block mattresses that resist erosive forces. They are often constructed where a revetment is exposed to frontal attack by wave action. AB Mats are typically used to protect coastlines, underwater pipelines, bridge piers, and other marine structures from propeller wash, ship wakes, wind waves, currents, and high velocity flows. They are also used in environmental construction for landfill caps, down chutes, and collector channels.

The AB fabric form consists of a series of compartments, linked by an interwoven perimeter. Ducts interconnect the compartments, and high strength revetment cables are installed between and through the compartments and ducts. Once filled, the AB Mats becomes a mattress of pillow-shaped, rectangular concrete blocks. The interwoven perimeters between the blocks serves as a hinge to permit articulation. The cables remain embedded in the concrete blocks to link the blocks together and facilitate articulation.

Relief of hydrostatic pressure, when required, is accomplished through slits cut between blocks and/or by inserting plastic weep tubes at specified centers prior to filling the form with concrete.

1.0 GENERAL

1.1 Scope of Work: The Contractor shall furnish all labor, materials, equipment, and incidentals required to perform all operations in connection with the installation of the proposed Articulating Block (AB) Lining in accordance with the lines, grades, design, and dimensions shown on the Contract Drawings and as specified herein.

1.2 Description: The work shall consist of installing an unreinforced concrete lining by positioning specially woven, double-layer synthetic forms on the surface to be protected and filling them with a pumpable, fine aggregate concrete (structural grout) in such a way as to form a stable lining of required thickness, weight and configuration.

2.0 MATERIALS REQUIREMENTS

2.1 Fine Aggregate Concrete: Fine aggregate concrete shall consist of a proportioned mixture of Portland cement, fine aggregate (sand) and water. The consistency of the fine aggregate concrete delivered to the concrete pump shall be proportioned and mixed as to have an efflux time of 9-12 seconds when passed through the 0.75 inch (19 mm) orifice of the standard flow cone that is described in ASTM C 939. Pozzolan, fluidifier or pumping aid conforming to this Specification may be used at the option of the Contractor. The mix shall exhibit a compressive strength of 2,000 lb/in^2 (13.8 MPa) at 28 days, when made and tested in accordance with ASTM C 31 and C 39.

2.1.1 Portland cement shall conform to ASTM C 150, Type I or Type II.

2.1.2 Fine aggregate shall conform to ASTM C 33, except as to grading. Aggregate grading shall be reasonably consistent and shall not exceed the maximum size which can be conveniently handled with available pumping equipment.

2.1.3 Water for mixing shall be clean and free from injurious amounts of oil, acid, salt, alkali, organic matter or other deleterious substances.

PROPERTY REQUIREMENTS - ARTICULATING BLOCK FABRIC[1, 2]				
Property		**Test Method**	**Units**	**Values**
Physical:				
Composition of Yarns				Nylon or polyester
Mass Per Unit Area (double-layer)		ASTM D 5261	oz/yd^2 (g/m^2)	12 (403)
Thickness		ASTM D 5199	mils (mm)	25 (0.6)
Mill Width			in (m)	76 (1.92)
Mechanical:				
Wide-Width Strip Tensile Strength	- Machine	ASTM D 4595	lbf/in (kN/m)	140 (24.5)
	- Cross		lbf/in (kN/m)	110 (19.3)
Elongation at Break	- Machine	ASTM D 4595	%	20
	- Cross		%	30
Trapezoidal Tear Strength	- Machine	ASTM D 4533	lbf (N)	150 (665)
	- Cross		lbf (N)	100 (445)
Hydraulic:				
Apparent Opening Size (AOS)		ASTM D 4751	U.S. Standard Sieve (mm)	40 (0.425)
Flow Rate		ASTM D 4491	gal/min/ft^2 (l/min/m^2)	90 (3665)

Notes:

1. *Conformance of fabric to specification property requirements shall be based on ASTM D 4759, "Practice for Determining the Specification Conformance of Geotextiles."*
2. *All numerical values represent minimum average roll values (i.e., average of test results from any sample roll in a lot shall meet or exceed the minimum values). Lots shall be sampled according to ASTM D 4354, "Practice for Sampling of Geosynthetics for Testing."*

2.1.4 Pozzolan, if used, shall conform to ASTM C 618, Class C, F or N.

2.1.5 Plasticizing and air entraining admixtures, if used, shall conform to ASTM C 494 and ASTM C 260, respectively.

2.2 Fabric Forms: The fabric forms shall be as specified, HYDROTEX™ Articulating Block (see Note A) forms as manufactured by Geostar Corporation; 74 Perimeter Center East, Suite 7420; Atlanta, Georgia 30346-1803, Tel: 800.253.0561 (770.399.5051); or approved equal. The fabric forms shall be composed of synthetic yarns formed into a woven fabric. Yarns used in the manufacture of the fabric shall be composed of nylon and/or polyester. Forms shall be woven with a minimum of 50% textured yarns (by weight) to improve adhesion to fine aggregate concrete and to improve filtration. Partially-oriented (POY), draw-textured, and/or staple yarns shall not be used in the manufacture of the fabric. Each layer of fabric shall conform to the physical, mechanical and hydraulic requirements referenced herein. The fabric forms shall be free of defects or flaws which significantly affect their physical, mechanical, or hydraulic properties.

Note A: The engineer shall indicate the Articulating Block Mat size required (see Table 1.0). Example: AB400.

2.2.1 Fabric forms shall consist of double-layer woven fabric joined together by narrow perimeters of interwoven fabric into a matrix of rectangular compartments that form a concrete articulating block mat with finished nominal block dimensions of ___ inches (mm) x ___ inches (mm) *(see Table 1.0)*, a finished average thickness of *(see Table 1.0)* inches (mm) and a nominal mass per unit area of *(see Table 1.0)* lb/ft^2 (kg/m^2). Cords shall connect the two layers of fabric at the center of each compartment. The cords shall be interwoven in two sets of four cords each, one set for the upper layer and one set for the bottom layer. Each cord shall have a minimum breaking strength of 160 lbf (710 N) when tested in accordance with ASTM D 2256. Fabric form compartments shall be offset one half a compartment length, in the mill width direction, to form a bonded concrete block pattern.

2.2.2 Fabric form compartments shall each have six ducts, two on each of the long sides and one on each of the short sides to allow passage of the fine aggregate concrete between adjacent compartments. The fine aggregate concrete filled, cross-sectional area of each duct shall be no more than 10 percent of the maximum filled cross sectional area of the block transverse to the duct.

2.2.3 Mill widths of fabric shall be a minimum of 76 inches (1.92 m). Each selvage edge of the top and bottom layers of fabric shall be reinforced for a width of not less than 1.35 inches (35 mm) by adding a minimum of 6 warp yarns to each selvage construction. Mill width rolls shall be cut to the length required, and the double-layer fabric separately joined, bottom layer to bottom layer and top layer to top layer, by means of sewing thread, to form multiple mill width panels with sewn seams on not less than 72 inch (182 cm) centers.

2.2.4 All factory-sewn seams shall be downward facing as shown on the Contract Drawings. All seams sewn in the factory shall be not less than 90 lbf/in (15.7 kN/m) when tested in accordance with ASTM D 4884. All sewn seams and zipper attachments shall be made using a double line of U.S. Federal Standard Type 401 stitch. All stitches shall be sewn simultaneously and be parallel to each other, spaced between 0.25 inches (6 mm) to 0.75 inches (19 mm) apart. Each row of stitching shall consist of 4 to 7 stitches per inch (per 25.4 mm). Thread used for seaming shall be nylon and/or polyester.

2.2.5 Baffles shall be installed at predetermined mill width intervals to regulate the distance of lateral flow of fine aggregate concrete. The baffle material shall be nonwoven filter fabric. The grab tensile strength of the filter fabric shall be not less than 90 lbf/in (400 N) when tested in accordance with ASTM D 4632.

2.2.6 Fabric Form Shipment and Storage: The fabric forms shall be kept dry and wrapped such that they are protected from the elements during shipping and storage. If stored outdoors, they shall be elevated and protected with a waterproof cover that is opaque to ultraviolet light. The fabric forms shall be labeled as per ASTM D 4873, "Guide for Identification, Storage and Handling of Geosynthetic Rolls."

2.2.7 Cables shall be installed in the longitudinal direction between the two layers of fabric. A minimum of two longitudinal cables shall pass through each compartment in a manner which provides for the longitudinal and lateral binding of the finished articulating block mat. The cables shall enter and exit the compartments through opposing ducts. The longitudinal cables shall be on approximately 10 inch (25 cm) centers, when measured along the finished mat. All cables within each filled concrete block shall be completely embedded in the fine aggregate concrete.

2.2.8 Cables shall be constructed of high tenacity, low elongation, continuous filament polyester fibers. Cables shall be nominally ____ inches (mm) in diameter and their rated breaking strength shall be not less than ___ lbf (N).

2.2.9 Cable fittings shall be selected so that the resultant cable splice shall provide a minimum of 80 percent of the rated breaking strength of the cable. All cable splices shall have a minimum cable overlap of 6 inches (15.3 cm) and be made with aluminum compression fittings.

2.2.10 The Contractor shall submit a manufacturer's certificate that the supplied fabric forms meet the criteria of these Specifications, as measured in full accordance with the test methods and standards referenced herein. The certificates shall include the following information about each fabric form delivered:

Manufacturer's name and current address;
full product name;
style and product code number;
form number(s);
composition of yarns; and
manufacturer's certification statement.

2.3 Filter Fabrics: The filter fabrics shall be composed of synthetic fibers or yarns formed into a nonwoven or woven fabric. Fibers and yarns used in the manufacture of filter fabrics shall be composed of at least 85% by weight of polypropylene, polyester or polyethylene. They shall be formed into a network such that the filaments or yarns retain dimensional stability relative to each other, including selvages. These materials shall conform to the physical requirements shown below. The filter fabric shall be free of defects or flaws which significantly affect its mechanical or hydraulic properties.

PROPERTY REQUIREMENTS - FILTER FABRIC [1, 2]

Property	Test Method	Units	Values
Grab Tensile Strength	ASTM D 4632	lbf (N)	90 (400)
Elongation at Break	ASTM D 4632	%	15
Trapezoidal Tear Strength	ASTM D 4533	lbf (N)	30 (130)
Permittivity	ASTM D 4491	sec^{-1}	0.5

Notes:

1. *Conformance of filter fabrics to specification property requirements shall be based on ASTM D 4759, "Practice for Determining the Specification Conformance of Geotextiles."*
2. *All numerical values represent minimum average roll values (i.e., average of test results from any sample roll in a lot shall meet or exceed the minimum values). Lots shall be sampled according to ASTM D 4354, "Practice for Sampling of Geosynthetics for Testing."*

3.0 DESIGN REQUIREMENTS

Note B: Select the appropriate pair of paragraphs for the final specification based upon the type of hydraulic application.

The average thickness, mass per unit area and hydraulic resistance of each concrete lining shall withstand the hydraulic loadings (velocity, depth, duration, shear stress, pressure, and frequency of immersion) for the design discharges along the structure(s). The stability analysis for each concrete lining shall be accomplished using a factor-of-safety methodology. A minimum factor of safety of 1.5 shall be required.

The Contractor shall provide to the Engineer calculations and design details, provided by the manufacturer or a professional engineer, attesting to the suitability of each fabric formed concrete lining for the purpose contemplated. Each concrete lining shall be accepted only when accompanied by the documented hydraulic performance characteristics derived from tests performed under controlled flow conditions. Test conditions shall conform to test protocol as documented in "Hydraulic Stability of Fabric Formed Concrete Lining and Mat Systems During Overtopping Flow."

or

The average thickness, mass per unit area and hydraulic resistance of each concrete lining shall withstand the hydraulic loadings (depth, duration, type of wave, wave height and period, and pressure distribution) for the design wave. The stability analysis for the concrete lining shall be accomplished using the factor-of-safety methodology. A minimum factor of safety of 1.5 shall be required.

The Contractor shall provide to the Engineer calculations and design details, provided by the manufacturer or a professional engineer, attesting to the suitability of each fabric formed concrete lining for the purpose contemplated. Each concrete lining shall be accepted only when accompanied by hydraulic stability calculations derived from mathematical models developed specifically for fabric formed concrete linings and for this purpose.

4.0 CONSTRUCTION AND INSTALLATION REQUIREMENTS

4.1 Site Preparation

4.1.1 Areas on which fabric forms are to be placed shall be constructed to the lines, grades, contours, and dimensions shown on the Contract Drawings. All obstructions such as roots and projecting stones shall be removed. Where such areas are below the allowable grades, they shall be brought to grade by placing compacted layers of select material. The thickness of layers and the amount of compaction shall be as specified by the Engineer. Where required by the Contract Specifications, soft and otherwise unsuitable subgrade soils shall be identified, excavated and replaced with select materials in accordance with the Contract Specifications.

4.1.2 Excavation and preparation of aprons as well as anchor, terminal or toe trenches shall be done in accordance with the lines, grades, contours, and dimensions shown on the Contract Drawings.

4.1.3 Immediately prior to placing the fabric forms, the prepared area shall be inspected by the Engineer, and no forms shall be placed thereon until the area has been approved.

4.2 Fabric Form Placement

4.2.1 A filter fabric shall be placed on the graded surface

approved by the Engineer.

4.2.2 Fabric forms shall be placed over the filter fabric and within the limits shown on the Contract Drawings. Anchoring of the fabric forms shall be accomplished through the use of anchor, terminal and toe trenches.

4.2.3 Adjacent fabric form panels shall be joined before filling with fine aggregate concrete by field sewing or zippering the two bottom layers of fabric together and the two top layers of fabric together. All field seams shall be made using two lines of U.S. Federal Standard Type 101 stitches. All sewn seams shall be downward facing, and zipper seams shall be fastened as shown on the Contract Drawings, except with the approved of the Engineer.

4.2.4 When conventional joining of fabric forms is impractical or where called for in the Contract Drawings, adjacent forms may be overlapped a minimum of three feet (one meter) to form a lap joint, pending approval by the Engineer. Based on the predominant flow direction, the downstream edge of the form shall overlap the upstream edge of the next form. In no case shall simple butt joints between forms be permitted.

4.2.5 Expansion joints shall be provided as shown on the Contract Drawings, or as specified by the Engineer.

4.2.6 Immediately prior to filling with fine aggregate concrete, the assembled fabric forms shall be inspected by the Engineer, and no fine aggregate concrete shall be pumped therein until the fabric seams have been approved. At no time shall the unfilled fabric forms be exposed to ultraviolet light (including direct sunlight) for a period exceeding five days.

4.3 Fine Aggregate Concrete Placement

4.3.1 Following the placement of the fabric forms, small slits shall be cut in the top layer of the fabric form to allow the insertion of the filling pipe at the end of the fine aggregate concrete pump hose. These slits shall be of the minimum length to allow proper insertion of the filling pipe. Fine aggregate concrete shall be pumped between the top and bottom layers of fabric, filling the forms to the recommended thickness and configuration.

4.3.2 Fine aggregate concrete shall be pumped in such a way that excessive pressure on the fabric forms and cold joints are avoided. A cold joint is defined as one in which the pumping of the fine aggregate concrete into a given form is discontinued or interrupted for an interval of forty-five or more minutes.

4.3.3 Holes in the fabric forms left by the removal of the filling pipe shall be temporarily closed by inserting a piece of nonwoven fabric or similar material. The nonwoven fabric shall be removed when the concrete is no longer fluid and the concrete surface at the hole shall be cleaned and smoothed by hand. Foot traffic on the filled form shall be restricted to an absolute minimum for one hour after filling.

4.3.4 After the fine aggregate concrete has set, all anchor, terminal and toe trenches shall be backfilled and compacted, as specified by the Engineer.

4.3.5 The Articulating Block Mat shall be measured by the number of square feet (square meters) computed from the payment lines shown on the Contract Drawings or from payment lines established in writing by the Engineer. This includes Articulating Block fabric forms, fine aggregate concrete, and filter fabric used in the aprons, overlaps, and anchor, terminal, or toe trenches. Slope preparation, excavation and backfilling, and bedding are separate pay items.

Spec: AB
Revised December 2001

Call or write for your complete set of HYDROTEX™ and HYDROCAST™ Specification Guidelines. Available as printed specifications, in Adobe® Acrobat® (pdf) format, or in an editable text format. PDF specifications are available for download from our web site at www.geostarcorporation.com.

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