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Standard Specification for Materials and Manufacture of Articulating Concrete Block (ACB) Revetment Systems[1]

This standard is issued under the fixed designation D6684; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 The purpose of this Standard is to provide specifications for articulating concrete block (ACB) revetment system structural components, material composition and physical properties, manufacturing methods and testing requirements.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory requirements prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C33 Specification for Concrete Aggregates

C39/C39M Test Method for Compressive Strength of Cylindrical Concrete Specimens

C42/C42M Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

C67 Test Methods for Sampling and Testing Brick and Structural Clay Tile

C140 Test Methods for Sampling and Testing Concrete Masonry Units and Related Units

C150 Specification for Portland Cement

C207 Specification for Hydrated Lime for Masonry Purposes

C331 Specification for Lightweight Aggregates for Concrete Masonry Units

C595 Specification for Blended Hydraulic Cements

C618 Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

C666/C666M Test Method for Resistance of Concrete to Rapid Freezing and Thawing

C1262 Test Method for Evaluating the Freeze-Thaw Durability of Dry-Cast Segmental Retaining Wall Units and Related Concrete Units

D4533 Test Method for Trapezoid Tearing Strength of Geotextiles

D4632 Test Method for Grab Breaking Load and Elongation of Geotextiles

D4833 Test Method for Index Puncture Resistance of Geomembranes and Related Products

2.2 *Other Documents:*

American Association of State Highway Transportation Officials (AASHTO), 1995, "Standard Specification for Geotextiles," AASHTO Designation M 288, February.

Koerner, R.M., 1998, "Designing With Geotextiles," 4th Edition, Prentice-Hall Publishers, Englewood Cliffs, N.J. p. 761.

3. Terminology

3.1 *Definitions:*

3.1.1 *articulating concrete block (ACB) revetment system, n*—a matrix of interconnected concrete block units sufficient for erosion protection. Units are connected by geometric interlock and/or cables, geotextiles, or geogrids, and typically include a geotextile underlay for subsoil retention.

4. Significance and Use

4.1 An articulating concrete block system is comprised of a matrix of individual concrete blocks placed together to form an erosion-resistant revetment with specific hydraulic performance characteristics. The system includes a filter layer compatible with the subsoil which allows infiltration and exfiltration to occur while providing particle retention. The filter layer may be comprised of a geotextile, properly graded granular media, or both. The blocks within the matrix shall be dense and durable, and the matrix shall be flexible and porous.

4.2 Articulating concrete block systems are used to provide erosion protection to underlying soil materials from the forces of flowing water. The term "articulating," as used in this Standard, implies the ability of individual blocks of the system to conform to changes in subgrade while remaining interconnected by virtue of geometric interlock and/or additional system components such as cables, ropes, geotextiles, or geogrids.

[1] This specification is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.25 on Erosion and Sediment Control Technology.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

4.3 The definition of articulating concrete block systems does not distinguish between interlocking and non-interlocking block geometries, between cable-tied and non- cable-tied systems, between vegetated and non-vegetated systems or between methods of manufacturing or placement. Furthermore, the definition does not restrict or limit the block size, shape, strength, or longevity; however, guidelines and recommendations regarding these factors are incorporated into this Standard. Block systems are available in either open-cell or closed-cell configurations.

5. Materials and Manufacture

5.1 *Materials Specifications: Cementitious Materials*—Materials shall conform to the following applicable ASTM standards:

Portland Cements	C150
Blended Cements	C595
Hydrated Lime Types	C207
Pozzolans	C618

5.2 Aggregates shall conform to the following ASTM specifications, except that grading requirements shall not necessarily apply:

Normal Weight	C33
Light Weight	C331

5.3 *Physical Properties*—At the time of delivery to the work site, the units shall conform to the physical requirements prescribed in Table 1.

5.3.1 In addition to Table 1, when freeze-thaw durability testing is required, such testing shall be performed in accordance with Test Methods C67, C666/C666M, or C1262, at the direction of the Owner. The number of freeze-thaw cycles and the corresponding weight loss criterion for pass-fail determination shall be specified by the Owner along with the test method.

5.3.2 Overall dimensions for width, height, and length shall differ by not more than ± 1/8 in. (3.2 mm) from the specified standard dimensions.

5.4 *Geotextile Filter*—The geotextile filter shall be in compliance with the project specifications, in consideration of its compatibility with the underlying soil subgrade. Minimum strength requirements are provided in Table 2.

5.4.1 *Geotextile*—Subsoil compatibility assessment shall include functional requirements for permeability, particle retention, and resistance to clogging. Physical property requirements for permittivity, aperture size, percent open area, and UV stability should be based on site-specific soil characteristics, site conditions, and construction techniques. Applicable references for conducting compatibility assessments include:

Koerner, R.M., 1998, "Designing With Geotextiles," 4th Edition, Prentice-Hall Publishers, Englewood Cliffs, N.J. p. 761.

5.5 *Revetment Cable and Fittings:*

5.5.1 For cabled systems, the revetment cable or rope and fittings shall be designed to provide adequate strength and durability characteristics to facilitate lifting and placing of large mattresses.

5.5.2 Fittings such as sleeves, clamps and stops shall be as required by the manufacturer. Selection of cable or rope and fittings shall be made in a manner that insures a safe design factor for mats being lifted from one or both ends. Consideration shall be taken for the bending of the cables or ropes around hooks or pins during lifting. Revetment cable or rope, splice fittings, sleeves and stops shall be selected so that the cable or rope and all connections result in a minimum factor-of-safety of 5.0 with respect to lifting.

5.5.3 For those systems performance tested with, and that rely on cables, ropes, or other non-concrete components to maintain the block-to-block interconnection, the cables, ropes, and/or non-concrete components shall also meet the design life of the project.

5.6 *Block Production:*

5.6.1 Articulating concrete blocks may be produced at a block plant or onsite using either wet-cast or dry-cast production techniques, provided that the composition and physical characteristics of the furnished units meet the requirements of 5.1-5.3.

5.7 *Matrix Assembly:*

5.7.1 *Non-Cabled System*—Non-cabled articulating concrete block systems are typically palletized, cured, and shipped to the job site. Non-cabled systems may also be assembled on, and/or glued to, a high-strength geotextile fabric which is used to carry the articulated block mattress.

5.7.2 *Cabled System*—Cabled articulating concrete block revetment systems can be assembled into mattresses, typically up to 480 square feet (45 square meters). Whole mat production can occur at the block plant or at the project. The individual blocks are typically placed in their respective matrix positions on a work surface, and the cables or ropes are inserted through the core holes in the block. Once the blocks have been assembled into a mattress, the ends of the cable or rope are secured as necessary based on the characteristics of the system. Wetcast mattresses can be poured with the cables or ropes integral to the blocks both laterally and longitudinally at the time of production. With this method, cable-end sleeves are not necessary.

6. Sampling and Testing

6.1 Manufacturer shall provide test data showing that concrete products manufactured within the previous 24 months of anticipated ACB placement have met the requirements of this Standard.

TABLE 1 Physical Requirements

Minimum Compressive Strength, lb/in^2		Maximum Water Absorption, lb/ft^3		Minimum Density (in air), lb/ft^3	
Average of 3 units	Individual Unit	Average of 3 units	Individual Unit	Average of 3 units	Individual Unit
4,000	3,500	9.1	11.7	130	125

NOTE 1—For units produced by a wet-cast method, tests shall be conducted in accordance with Test Methods C39/C39M and C42/C42M. For units produced by a dry-cast method, tests shall be conducted in accordance with Test Methods C140.

TABLE 2 Geotextile Strength Requirements (AASHTO M-288)

Property	ASTM Test Methods	Units	Class 1		Class 2		Class 3	
			Elongation <50%[A]	Elongation >50%[A]	Elongation <50%[A]	Elongation >50%[A]	Elongation <50%[A]	Elongation >50%[A]
Grab Strength	D4632	lb	315	200	250	160	180	110
Sewn Seam Strength[B]	D4632	lb	270	180	220	140	160	100
Tear Strength	D4533	lb	110	80	90[C]	55	70	40
Puncture Strength	D4833	lb	110	80	90	55	70	40

[A] As measured in accordance with Test Method D4632.
[B] When seams are required.
[C] The required Minimum Average Roll Value (MARV) tear strength for woven monofilament geotextiles is 55 lb.

NOTE 1—Required geotextile class for permanent erosion control design is designated below for the indicated application. The severity of installation conditions generally dictates the required geotextile class.

Class 1 is recommended for harsh or severe installation conditions where there is a greater potential for geotextile damage, including irregular sections where repeated mattress lifting, realignment, and replacing is expected, or when vehicular traffic on the installation is anticipated.

Class 2 is recommended for installation conditions where mattress placement in regular, even reaches is expected and little or no vehicular traffic on the installation will occur, or when hand-placing on a graded surface of native soils.

Class 3 is specified for the least severe installation environments, typically hand-placed systems (zero drop height) on a bedding layer of graded sand, road base aggregate, or other select imported material.

6.2 Manufacturer shall provide access to lots ready for delivery to the purchaser or his authorized representative for sampling and testing in accordance with the procedures specified in this Standard prior to the commencement of ACB placement.

6.3 For the compressive strength, water absorption, and unit weight (density) determinations, three samples shall be taken from each lot of 50,000 units (i.e., individual blocks) or fraction thereof. Additional samples may be taken at the discretion of the purchaser.

6.4 For the compressive strength, water absorption, and unit weight (density) determinations, specimens shall be obtained from the samples and tested in accordance with Test Methods C39/C39M and C42/C42M for blocks produced by a wet cast method or in accordance with Test Methods C140 for blocks produced by a dry-cast method.

6.5 Samples for compressive strength testing.

6.5.1 For blocks produced by wet-cast methods, sample cylinders, cores or coupons shall use a height to thickness ratio of not less than 1:1 nor greater than 2:1 for purposes of compressive strength testing. The minimum thickness (or diameter) shall be 1.5 in. (38 mm). Care shall be taken to achieve square-cut ends and to ensure proper capping prior to testing.

6.5.2 For blocks produced by dry-cast methods, sample coupons shall have a height to thickness ratio of 2:1 and a length to thickness ratio of 4:1 for purposes of compressive strength testing. The minimum thickness shall be 1.5 in. (38 mm). The coupon shall be cut from the unit such that the coupon height dimension is the same direction as the unit height dimension.

6.6 Samples shall be 100 % solid and shall not contain cable holes or other voids.

6.7 The compressive strength of the sample shall be considered to be the net area compressive strength of the full size unit.

7. Compliance

7.1 In the event that a sample fails to conform to the specified requirements, the manufacturer may sort the shipment and test new units, selected at random by the purchaser from the retained lot. If the second set of tests also fails to conform to the specified requirements, the entire lot may be rejected.

NOTE 1—Unless otherwise specified in the purchase order, the cost of tests is typically borne as follows: (*1*) if the results of the tests show that the units do not conform to the requirements of this Standard, the cost is typically borne by the seller; (*2*) if the results of the tests show that the units conform to the requirements of this Standard, the cost is typically borne by the purchaser.

8. Quality Assurance

8.1 All units shall be sound and free of defects that would interfere with proper placement or that would impair the strength or longevity of the installation.

8.2 Minor cracks incidental to the usual method of manufacture, or chipping that results from customary methods of handling in shipping, delivery and placement shall not be deemed grounds for rejection provided the requirements of 8.1 are met.

9. Keywords

9.1 articulating concrete block (ACB) revetment systems; channel; channel stability; erosion; erosion control; open-channel flow; revetments