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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~~ Scope*

1.1 The purpose of this ~~Standard~~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 *Units*—The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard. Reporting or use of units other than inch-pound shall not be regarded as non-conformance with this standard.

1.2.1 The gravitational system of inch-pound units is used when dealing with inch-pound units. In the system, the pound (lbf) represents a unit of force (weight), while the units for mass is slugs. The slug unit is not given, unless dynamic (F = ma) calculations are involved.

1.2.2 The SI units presented for apparatus are substitutions of the inch-pound units, other similar SI units should be acceptable providing they meet the technical requirements established by the inch-pound apparatus.

1.2.3 It is common practice in the engineering/construction profession to concurrently use pounds to represent both a unit of mass (lbm) and of force (lbf). This practice implicitly combines two separate systems of units; the absolute and the gravitational systems. It is scientifically undesirable to combine the use of two separate sets of inch-pound units within a single standard. As stated, this standard includes the gravitational system of inch-pound units and does not use/present the slug unit of mass. However, the use of balances and scales recording pounds of mass (lbm) or recording density in lbm/ft^3 shall not be regarded as nonconformance with this standard.

1.2.4 The terms density and unit weight are often used interchangeably. Density is mass per unit volume, whereas unit weight is force per unit volume. In this standard, density is given only in SI units. After the density has been determined, the unit weight is calculated in SI or inch-pound units, or both.

1.2.5 Calculations are done using only one set of units; either SI or gravitational inch-pound. Other units are permissible provided appropriate conversion factors are used to maintain consistency of units throughout the calculations, and similar significant digits or resolution, or both are maintained.

1.3 *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~~ safety, health, and ~~health~~environmental practices and determine the applicability of regulatory ~~requirements~~limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

~~C33~~C33/C33M 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~~C67/C67M Test Methods for Sampling and Testing Brick and Structural Clay Tile

[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.

***A Summary of Changes section appears at the end of this standard**

C140C140/C140M Test Methods for Sampling and Testing Concrete Masonry Units and Related Units
C150C150/C150M Specification for Portland Cement
C207 Specification for Hydrated Lime for Masonry Purposes
C331C331/C331M Specification for Lightweight Aggregates for Concrete Masonry Units
C595C595/C595M 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
C1262C1262/C1262M Test Method for Evaluating the Freeze-Thaw Durability of Dry-Cast Segmental Retaining Wall Units and Related Concrete Units
D653 Terminology Relating to Soil, Rock, and Contained Fluids
D4533D4533/D4533M Test Method for Trapezoid Tearing Strength of Geotextiles
D4632D4632/D4632M Test Method for Grab Breaking Load and Elongation of Geotextiles
D4833D4833/D4833M 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.AASHTO M 288 American Association of State Highway Transportation Officials (AASHTO), 2017, "Standard Specification for Geotextiles," , February.

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

3. Terminology

3.1 For definitions of common technical terms in this standard, refer to Terminology D653.

3.2 *Definitions:Definitions of Terms Specific to This Standard:*

3.2.1 *articulating concrete block (ACB) revetment system, n*—a matrix of interconnected concrete block units sufficient for erosion protection. Unitsprotection, which 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 revetmentsystem with specific hydraulic performance characteristics. These systems in practice are commonly referred to as ACB revetment systems. 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.

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:

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Portland Cements	C150/C150M
Blended Cements	C595/C595M
Hydrated Lime Types	C207
Pozzolans	C618
Portland Cements	C150
Blended Cements	C595
Hydrated Lime Types	C207
Pozzolans	C618

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

Normal Weight	C33/C33M
Light Weight	C331/C331M

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~~Normal Weight~~	~~C33~~
~~Light Weight~~	~~C331~~

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

5.2.1 In addition to Table 1, when freeze-thaw durability testing is required, such testing shall be performed in accordance with Test Methods ~~C67~~C67/C67M, C666/C666M, or ~~C1262~~C1262/C1262M, 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.

5.2.2 Overall dimensions for width, height, and length shall differ by not more than ±⅛ ~~1/8~~ in. (3.2 mm) from the specified standard dimensions.

5.3 *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.

NOTE 1—Strength values appearing in Table 2 taken from AASHTO M288 2017. These values were deemed acceptable by the D18.25.04 subcommittee on Block Revetments for use in this standard.

5.3.1 *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:~~include Koerner[3]:

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

5.4 ~~*Revetment*~~ *Cable and Fittings:*

5.4.1 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.

5.4.2 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~~ 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.

5.4.3 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.

5.5 *Block Production:*

5.5.1 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~~5.2.

5.6 *Matrix Assembly:*

5.6.1 *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.

5.6.2 *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.

TABLE 1 Physical Requirements

Minimum Compressive Strength, lb/in^2		Maximum Water Absorption, lb/ft^3		Minimum ~~Density~~ Unit Weight (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 (27.5 MPa)	3,500 (24.1 MPa)	9.1 (145 kg/m^3)	11.7 (190 kg/m^3)	130 (2080 kg/m^3)	125 (2000 kg/m^3)

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