5300000 RIPRAP AND ARTICULATING CONCRETE BLOCK REVETMENT SYSTEMS
COMMENTS FROM INTERNAL/INDUSTRY REVIEW

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Comments: (11-5-14)
Section 530-4.3 Articulating concrete Block (ACB) Revetment System has the following: "The quantity to be paid for will be the plan quantity, in square feet, completed and accepted, subject to the provisions of 9-3.2. No allowance will be made for ACB placed outside the Plan dimensions, unless otherwise ordered by the Engineer"

It makes it sound like (to me) the Engineer is in charge of deciding what to pay, not if added ACB is required and ordered by the Engineer (unforeseen condition) then they get paid.

Change to "unless the additional placement is ordered by the Engineer
Or "unless the Engineer ordered the placement"

Response: Language has been changed to "*No allowance will be made for ACB placed outside the Plan dimensions, unless the additional placement is ordered by the Engineer*"

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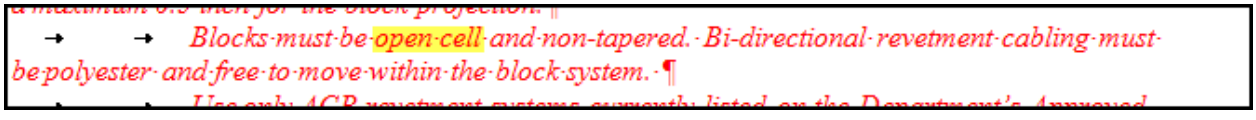
Comments: (12-1-14)
Attached are our comments and suggestions on the ACB portion of the draft of Section 530 provided through FTBA. We have included detailed discussion of each item at the end of the transmittal.

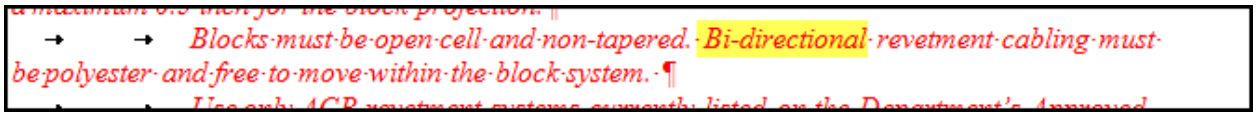
1. 530-1.2 (2nd paragraph): Revise to include close-cell blocks.
Block Type Alternatives - The draft refers to an open-cell block and does not mention a closed-cell block even though both are allowed in ASTM 6684 and used depending on the site-specific design requirements. We encourage the Department to revise the specification to cite the acceptance of closed-cell systems. By allowing closed-cell systems, there will be additional alternatives available to the specifying engineer, which increases their ability to supply the most efficient and cost-effective solution to the Department. A potential benefit of closed-cell solutions is that they present less open area, reduced vegetation growth potential and therefore, results in a solution that requires less maintenance. We suggest citing closed-cell blocks as a design alternative.



Response: Language changed to "Block must be open cell and non-tapered, unless otherwise

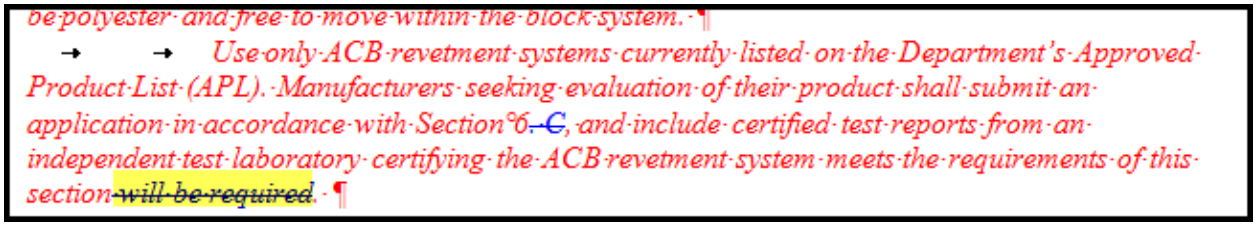
stated in plans." The Department prefers the default ACB option to be open-cell blocks, to allow for the water-quality benefits of infiltration and vegetation growth. However, if project constraints necessitate a closed cell block, and approved by the District Drainage Engineer, closed cell block may be used.

2. 530-1.2 (2nd paragraph): Revise to remove "Bi-directional" reference.
Cable System Style - The draft specification includes the term "*bi-directional*" when referring to the cable. There are several suppliers of ACB systems in the state of Florida. The blocks offered by these suppliers varying in geometry and cable systems. While most offer single-directional cable systems, there is only one that offers a bi-directional cable system. By including the "*Bi-directional*" reference, the specification effectively restricts the ability to supply ACBs on FDOT project to "*bi-directional*" suppliers only and prohibits the suppliers of a well-established, proven, single-direction systems from participating and thereby increasing the costs to the State. It may be worth noting several large FDOT projects that utilized single-direction cable in the past. These projects include SR 30/US 98 in Franklin County (650,000 sf) and CR 707 in St. Lucie County (1,215,000 sf). ASTM 6684 does not distinguish between bi-and single-direction cable styles, but simply establishes requirements to ensure safe lifting and placing of mattresses under Section 5.5. Therefore, we request that the term "bi-directional" be removed from the specification and that this sentence be revised to read "*Revetment* cabling must…".


→ → *Blocks must be open cell and non-tapered. Bi-directional revetment cabling must be polyester and free to move within the block system.*

Response: The Department prefers the use of bi-directional cabling for added stability and ease of installation.

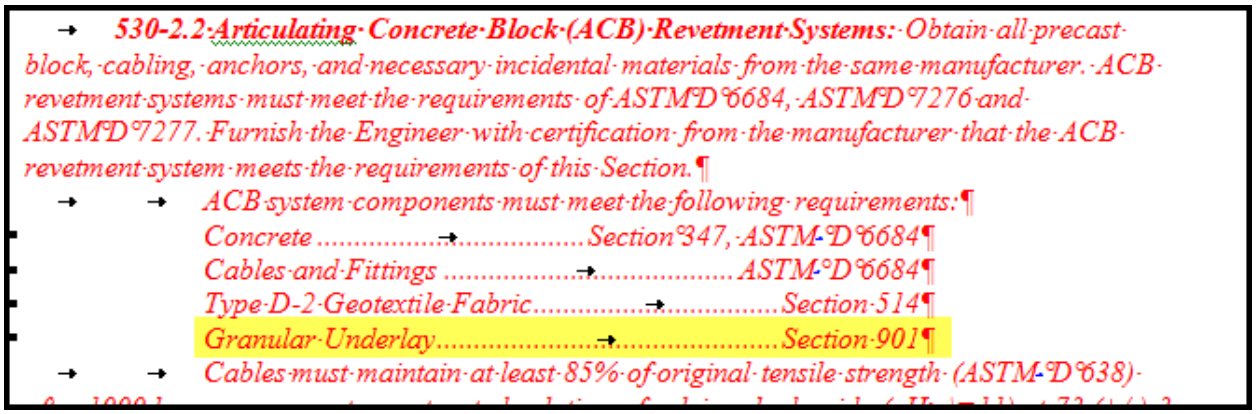
3. 530-1.2 (3rd paragraph): Revise to require installed as tested language.
APL Certified Tests - The draft specification requires that all ACB products be listed on the Department's Approved Products List (APL). This section establishes requirements of the APL including the need to submit hydraulic test reports and certification from an independent test laboratory. The primary components of the design section utilized in the laboratory testing can vary from one manufacturer to another. For example, a drainage layer may have been utilized to facilitate the relief of pore pressure and/or a substantially unique and special, non-standard geotextile may have been used. Considering this, we request that the requirements of the APL be expanded to require the approved block/system be installed in a manner that is consistent with how it was tested.


be polyester and free to move within the block system.
→ → *Use only ACB revetment systems currently listed on the Department's Approved Product List (APL). Manufacturers seeking evaluation of their product shall submit an application in accordance with Section 6. ~~C~~, and include certified test reports from an independent test laboratory certifying the ACB revetment system meets the requirements of this section ~~will be required~~.*

Response: The testing is not intended to replicate the variations of site specific conditions, but

instead the block hydraulic properties. ASTM D 6884 covers installation methods. No change.

4. 530-2.2: Revise to remove “Granular Underlay”.
Granular Underlay - ACBs are typically constructed over subgrade constructed of suitable on-site or fill material. Section 530-2.2 makes reference to a granular underlay and references Section 901 of the FDOT Standard Specifications for Road and Bridge Construction, addresses coarse aggregates and their gradation. Coarse aggregates can be used to construct the subgrade for ACBs, however, their use is generally limited to address special site conditions and in the design section for wave attack applications. The use of coarse aggregates is not considered for most FDOT applications and its inclusion would unnecessarily add costs to FDOT projects. Considering this, we recommend removing the “granular underlay” from the specification and address this material on an as-needed basis.


530-2.2 Articulating Concrete Block (ACB) Revetment Systems: Obtain all precast block, cabling, anchors, and necessary incidental materials from the same manufacturer. ACB revetment systems must meet the requirements of ASTM D 6684, ASTM D 7276 and ASTM D 7277. Furnish the Engineer with certification from the manufacturer that the ACB revetment system meets the requirements of this Section.

ACB system components must meet the following requirements:

Concrete	Section 347, ASTM D 6684
Cables and Fittings	ASTM D 6684
Type D-2 Geotextile Fabric	Section 514
Granular Underlay	Section 901

Cables must maintain at least 85% of original tensile strength (ASTM D 638)

Response: The Department is requiring a 6-inch granular underlay in coastal applications. The following language was added for clarity “Install a 6 inch thick layer of bedding stone under the geotextile fabric, when called for in the plans.”

5. 530-2.2: Revise to cite “Aluminum Sleeves”.
Sleeves - The ACB industry has found stainless steel sleeves to be difficult to crimp effectively and generally, result in a less confident connection. Therefore, we encourage design engineers considering their use to evaluate other materials. The draft specification is written to require polyester cable and for this cable type, the industry uses aluminum sleeves. The aluminum material provides a confident connection, addresses durability concerns and therefore, satisfies the requirements of ASTM 6684, Section 5.5. Considering this, we recommend the specification be revised to cite Aluminum sleeves.

→ ***530-2.2 Articulating Concrete Block (ACB) Revetment Systems:*** *Obtain all precast block, cabling, anchors, and necessary incidental materials from the same manufacturer. ACB revetment systems must meet the requirements of ASTM D 6684, ASTM D 7276 and ASTM D 7277. Furnish the Engineer with certification from the manufacturer that the ACB revetment system meets the requirements of this Section.* ¶

→ → *ACB system components must meet the following requirements:* ¶

Concrete	*Section 347, ASTM D 6684* ¶
Cables and Fittings	*ASTM D 6684* ¶
Type D-2 Geotextile Fabric	*Section 514* ¶
Granular Underlay	*Section 901* ¶

→ → *Cables must maintain at least 85% of original tensile strength (ASTM D 638) after 1000 hours exposure to a saturated solution of calcium hydroxide (pH>\=11) at 73 (+/-) 3 degrees Fahrenheit. Cables must not exceed a maximum of 0.5% moisture absorption at seven days, per ASTM D 570. Cable crimps must be stainless steel Type 304 or 316 ~~stainless steel~~.* ¶

Response: The Department has revised the language to include stainless steel or aluminum sleeves.

6. 530-3.4 (2nd paragraph): Revise to defer to ASTM 6884 for unspecified compaction densities.

Compaction Requirements - In the 1st paragraph, Section 530-3.4 cites that the revetment systems shall be installed in accordance with ASTM D 6884, which includes subgrade preparation and minimum compaction requirements. In the 2nd paragraph, the draft specification references Section 120-10.2 to address instances where the design engineer has not specifically cited a compaction density. Note that Section 120-10.2 cites a minimum quality control density of 100% standard proctor maximum density per AASHTO T-99, Method C, which conflicts with the compaction requirements cited in ASTM D 6884 (90% maximum standard proctor density). Considering this, we recommend the specification be revised to default to the requirements of ASTM D 6884 for subgrade preparation for instances when the design engineer has not directed otherwise.

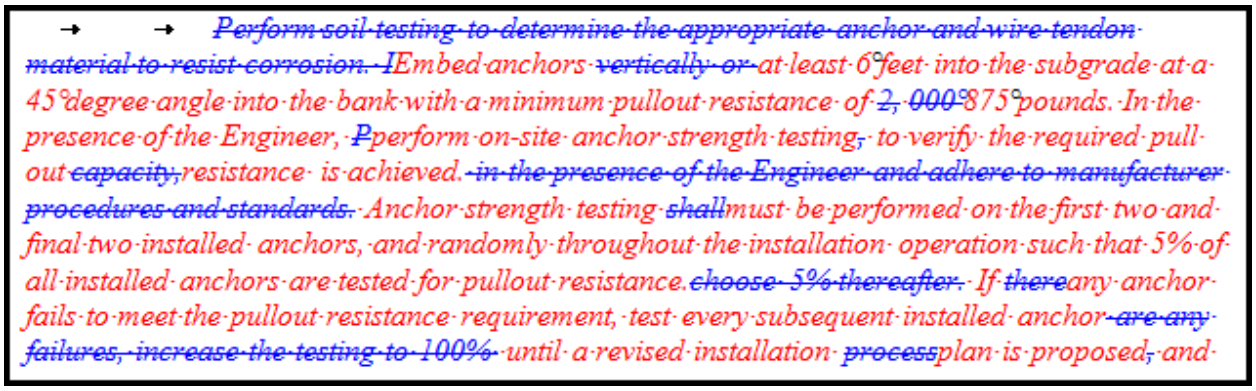
→ ***530-3.4 Articulating Concrete Block (ACB) Revetment System:*** *Install the ACB revetment system in accordance with ASTM D 6884 and the manufacturer's recommendations, unless directed otherwise by the Engineer.* ¶

→ → *Prior to installation, construct the area to be stabilized to an elevation such that, upon completion of stabilizing operations, the completed stabilized subgrade will conform to the lines, grades and cross sections shown in the Plans. Bring the subgrade surface to a plane approximately parallel to the place of the proposed finished surface, such that, upon placement of the mat, no individual block within the ACB mat will protrude more than one-half inch from any adjacent block. Uniformly compact each subgrade layer to achieve the density required in the Plans. If the Plans do not provide for stabilizing, compact the subgrade in both cuts and fills, to the density specified in 120-10.2.* ¶

→ → ~~*Perform soil testing to determine the appropriate anchor and wire tendon*~~

Response: Specification has been revised to allow 90% maximum standard proctor density, per ASTM D 6884.

7. 530-3.4 (3rd paragraph): Revise this to address anchors as needed.
Special Anchor Requirements - The draft specification addresses anchors under Section 530-3.4. As currently written, the specification appears to suggest that anchors are required for all ACB installations. In actuality, anchors are only required to address project specific design considerations, such as, a steep slope and are required on a fairly small percentage of installations. Considering this, we recommend the paragraph be revised to clarify this point. Often, the paragraph that address anchors in a specification will begin with *"Where permanent anchoring is required, e.g. hanging mats on steep slopes without toe construction, …"*. This clarifies that anchors are required only as specifically detailed in the plans by the design engineer.


→ → ~~Perform soil testing to determine the appropriate anchor and wire tendon material to resist corrosion. I~~Embed anchors ~~vertically or~~ at least 6 feet into the subgrade at a 45 degree angle into the bank with a minimum pullout resistance of ~~2,000~~ 875 pounds. In the presence of the Engineer, ~~P~~perform on-site anchor strength testing~~,~~ to verify the required pull-out ~~capacity,~~ resistance is achieved. ~~in the presence of the Engineer and adhere to manufacturer procedures and standards.~~ Anchor strength testing ~~shall~~must be performed on the first two and final two installed anchors, and randomly throughout the installation operation such that 5% of all installed anchors are tested for pullout resistance ~~choose 5% thereafter.~~ If ~~there~~any anchor fails to meet the pullout resistance requirement, test every subsequent installed anchor ~~are any failures, increase the testing to 100%~~ until a revised installation ~~process~~plan is proposed~~,~~ and

Response: No change to the specification. The Department prefers anchors on all ACB installations, however to accommodate flat applications (which are relatively rare), design guidance will be added to Drainage Manual.

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Comments: (12-1-14)
The ACB has maintenance issues due to following. The blocks are interconnected and tied through cables as stipulated in section 530-2.2. When there is settlement of the sloping surface due to erosion/oozing out of materials, repair/refilling the embankment material can be done only by removing the ACB. This is possible only if the interconnecting cable is cut and removed. Please see the attached photo taken during March 2014 at the South side bridge approach/quadrant of Evan's Crary Bridge on A1A in Martin County. This bridge was constructed, may be 9 years ago. Further the possibility of interconnecting cables deteriorating under Florida weather may be evaluated. Hence the suitability of ACB used for FDOT projects need to be reevaluated. A suggestion to this would be to provide flatter slope like 1:3 minimum and provide ACB without the interconnecting cables. Please see one of the manufacturing units link http://www.shoretec.com/shoreblock-sd.php

Response: The ACB cabling is required for additional stability and ease of installation. Without

cabling, installing individual blocks by hand would be extremely cost prohibitive. The specification change does not promote the use of ACBs or other types of revetment, but instead provides construction guidance for applications where the Department deems it is the preferred option.

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Comments: (12-1-14)
530-3.4 – second paragraph states: “Bring the subgrade surface to a plane approximately parallel to the place of the proposed finished surface…” Recommend replacing “place” with “plane”.

Response: This change will be implemented.

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Comments: (12-2-14)
Can other materials be used in lieu of geotextiles for the underlying soil stabilization? Given that the soils vary from site to site, can granular filters be used when the insitu soils properties will provide adequate strength to both the riprap and articulating block systems? Is it possible to adjust the language in 530-5.4 to allow for other options, especially for underwater installations?

Response: Granular filters may be included at the discretion of the District Drainage Engineer and can be helpful in coastal applications where large waves are expected. Recognize these filters are mare challenging to design install properly than filter fabric.

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