



Florida Department of Transportation

RICK SCOTT
GOVERNOR

605 Suwannee Street
Tallahassee, FL 32399-0450

ANANTH PRASAD, P.E.
SECRETARY

December 16, 2014

Khoa Nguyen
Director, Office of Technical Services
Federal Highway Administration
545 John Knox Road, Suite 200
Tallahassee, Florida 32303

Re: State Specifications and Estimates Office
Section **530**
Proposed Specification: **5300000 Riprap and Articulating Concrete Block Retement Systems**

Dear Mr. Nguyen:

We are submitting, for your approval, two copies of the above referenced Supplemental Specification.

This change was proposed by Catherine Earp of the State Roadway Design Office to add Articulating Concrete Block as a rip rap revetment option.

Please review and transmit your comments, if any, within two weeks. Comments should be sent via email to SP965DS or daniel.scheer@dot.state.fl.us.

If you have any questions relating to this specification change, please call me at 414-4130.

Sincerely,

signature on file

Daniel Scheer, P.E.
State Specifications Engineer

DS/ot

Attachment

cc: Florida Transportation Builders' Assoc.
State Construction Engineer

RIPRAP.(REV ~~6-1910-15-27-12-15-14~~)

SECTION 530 is deleted and the following substituted:

SECTION 530**RIPRAP AND ARTICULATING CONCRETE BLOCK REVETMENT SYSTEMS****530-1 Description.**

530-1.1 Riprap: Construct riprap composed of sand-cement or rubble (consisting of broken stone or broken concrete) as shown in the Design Standards and in the Plans. ~~Place Type D-2 geotextile filter fabric, meeting the requirements shown on Design Standards, Index No. 199, and a minimum 1 foot thick layer of bedding stone under all rubble riprap.~~

530-1.2 Articulating Concrete Block (ACB) Revetment Systems: *Furnish and install an ACB revetment system in accordance with this Section and in conformance with the lines, grades, design, and dimensions shown in the Plans. ~~Provide~~ Submit shop drawings for review and approval by the Engineer in accordance with Section 5. Provide signed and sealed calculations of the block and cable sizing design for approval. - Comply with the National Concrete Masonry Association's Design Manual for Articulating Concrete Block Revetment Systems, Second Edition, or the National Highway Institute, Hydraulic Engineering Circular (HEC) No. 23, Publication No. FHWA NHI 09-110. Use a minimum Factor of Safety of 1.5- and a maximum 0.5 inch for the block projection.*

Blocks must be open cell and non-tapered unless otherwise stated in the Plans. Bi-directional revetment cabling must 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~~.

If the ACB revetment system is intended for use as bridge abutment protection, ~~submit~~ include the following drawings with the APL submittal:

- 1. At the corner transition between the front and side slopes.*
- 2. For anchorages, filter fabric, treatment of voids between adjacent blocks, limits on void size between adjacent blocks and other special details required to successfully install the ACB.*

- 3. ~~See Section A-A, B-B, C-C and D-D on the Slope Protection Details in the Structures Details Guide for locations~~ For areas adjacent to bridge abutments, detail mat placement around curves, connections, protection of mat ends and splicing of mat.*

~~Provide signed and sealed calculations of the block and cable sizing design for approval~~ block and cable sizing calculations by the Manufacturer's Engineer for approval by the Engineer of Record. The Engineer of Record will provide hydraulic flow, velocity and slope or channel geometry and wave climate (if applicable) to the Manufacturer's Engineer. For sizing calculations, the Manufacturer's Engineer shall ~~c~~Comply with the National Concrete Masonry Association's Design Manual for Articulating Concrete Block Revetment Systems, Second Edition, or the National Highway Institute, Hydraulic Engineering Circular (HEC) No. 23,

Publication No. FHWA NHI 09-110. Use a minimum Factor of Safety of 1.5 for both methodologies, accounting for and a maximum 0.5 inch for the block projection.

530-2 Materials.

530-2.1 Riprap:

530-2.1.1 General: Meet the following requirements:

Portland Cement Section 921

Fine Aggregate..... Section 902

Grout..... Section 934

Type D-2 Geotextile Fabric Section 514

530-2.1.2 Sand-Cement Sacks:

~~(1) Portland Cement: Provide cement from an approved source meeting the requirements of Section 921. Certify that cement meets the requirements of the Contract Documents.~~

~~(2) Fine Aggregate: Meet the requirements of 902-3.3.~~

~~(3) Sacks:~~ Provide sacks made of jute, cotton, or scrim reinforced paper capable of holding the sand-cement mixture without leakage. Ensure that sack material is permeable and absorptive enough to permit passage of water to provide for hydration of the cement. Ensure that paper used in sacks is non-asphalt laminated with a polyester fiber scrim reinforcement in a three-way directional pattern, has an embossed finish, and is perforated approximately 3/32 inch in approximate 1 inch centers. Extend perforations continuously through the entire wall.

Provide sacks of uniform size and dimensions, in order to provide uniformity of lines in the completed work. Use sacks that are free from holes and strong enough to withstand handling without ripping or splitting. Use only one type and size of sack at any one structure.

~~(4) Grout: Provide sand from an approved source meeting the requirements of 902-3.3. Provide cement from an approved source meeting the requirements of Section 921.~~

~~(5) Geotextile Fabric: Meet the requirements of Section 514 and Design Standards, Index 199.~~

530-2.1.3 Rubble:

530-2.1.3.1 Rubble (Bank and Shore Protection): Provide sound, hard, durable rubble, free of open or incipient cracks, soft seams, or other structural defects, consisting of broken stone with a bulk specific gravity of at least 2.20. Ensure that stones are rough and angular.

For this application, use broken stone meeting the following gradation and thickness requirements:

| Weight Maximum Pounds | Weight 50% Pounds | Weight Minimum Pounds | Minimum Blanket Thickness in Feet |
|--|----------------------|--------------------------|--------------------------------------|
| 670 | 290 | 60 | 2.5 |
| Ensure that at least 97% of the material by weight is smaller than Weight Maximum pounds]. | | | |
| Ensure that at least 50% of the material by weight is greater than Weight 50% pounds]. | | | |
| Ensure that at least 85% of the material by weight is greater than Weight Minimum pounds]. | | | |

530-2.1.3.2 Rubble (Ditch Lining): Use sound, hard, durable rubble, free of open or incipient cracks, soft seams, or other structural defects, consisting of broken stone

or broken concrete with a bulk specific gravity of at least 1.90. Ensure that stones or broken concrete are rough and angular.

Use broken stone or broken concrete meeting the following gradation and thickness requirements:

| Weight Maximum Pounds | Weight 50% Pounds | Weight Minimum Pounds | Minimum Blanket Thickness in Feet |
|---|-------------------|-----------------------|-----------------------------------|
| 75 | 30 | 4 | 1.5 |
| Ensure that at least 97% of the material by weight is smaller than Weight Maximum pounds. Ensure that at least 50% of the material by weight is greater than Weight 50% pounds]. Ensure that at least 90% of the material by weight is greater than Weight Minimum pounds]. | | | |

530-2.1.23.3 Physical Requirements of Broken Stone and Broken

Concrete: Use broken stone and broken concrete meeting the following physical requirements:

| | |
|---|---|
| Absorption (FM 1-T85) | Maximum 5% |
| Los Angeles Abrasion (FM 1-T096) | Maximum loss 45%* |
| Soundness (Sodium Sulphate) (AASHTO T104) | Maximum loss 12%** (after five cycles) |
| Flat and elongated pieces | Materials with least dimension less than one third of greatest dimension not exceeding 10% by weight. |
| Dirt and Fines | Materials less than 1/2 inch in maximum dimension accumulated from interledge layers, blasting or handling operations not exceeding 5% by weight. |
| Drop Test*** (EM 1110-2-2302) | No new cracks developed, or no existing crack widened additional 0.1 inch, or final largest dimension greater than or equal to 90% original largest dimension of dropped piece. |
| * Ensure that granite does not have a loss greater than 55% and that broken concrete does not have a loss greater than 45%. ** The Engineer may accept rubble exceeding the soundness loss limitation if performance history shows that the material will be acceptable for the intended use. The Engineer will waive the soundness specification for rubble riprap (broken stone and broken concrete) when project documents indicate it will be placed in or adjacent to water or soil with a sulfate content less than 150 parts per million and a pH greater than 5.0. *** The Engineer will waive the Drop Test unless required to ensure structural integrity. Provide all equipment, labor and testing at no expense to the Department. EM refers to the US Army Corps of Engineer's Specification Engineering Method. | |

530-2.1.23.4 Source Approval and Project Control:

The Engineer will approve mineral aggregate sources in accordance with 6-2.3 as amended by the following:

(1) The Engineer may perform Independent Verification tests on all materials placed on the project.

(2) The Engineer will check the gradation of the riprap by visual inspection at the project site. Resolve any difference of opinion with the Engineer in accordance with the method provided in FM 5-538. Provide all equipment, labor, and the sorting site at no expense to the Department.

(3) The Engineer may test components in a blend of rubble processed from different geologic formations, members, groups, units, layers or seams. The Engineer may select components based on like color, surface texture, porosity, or hardness. The Engineer will reject any blend if a component that makes up at least five percent by volume of the blend does not meet these specifications.

530-2.3-1.4 Bedding Stone: Use Bedding Stone of either a durable quality limestone or other quarry run stone, with a bulk specific gravity of not less than 1.90 and that is reasonably free from thin, flat and elongated pieces. Ensure that the bedding stone is also reasonably free from organic matter and soft, friable particles. Meet the following gradation limits:

| Standard Sieve Sizes - Inches | Individual Percentage by Weight Passing |
|-------------------------------|---|
| 12 inches | 100 |
| 10 inches | 70 to 100 |
| 6 inches | 60 to 80 |
| 3 inches | 30 to 50 |
| 1 inch | 0 to 15 |

The Engineer will conduct source approval and project control of bedding stone as specified in 530-2.2.4. In lieu of limestone or other quarry run stone, the Contractor may substitute non-reinforced concrete from existing pavement that is to be removed and which meets the above requirements for commercial bedding stone.

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 FabricSection 514

Granular UnderlaySection 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 ($pH \geq 11$) 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 aluminum or stainless steel Type 304 or 316 stainless steel.

~~530-2.4 Geotextile Fabric: Meet the requirements of Section 514 and Design Standards, Index 199.~~

530-3 Construction and Installation Methods.

530-3.1 Sand-Cement:

530-3.1.1 Mixing Materials: Proportion sand and cement in the ratio of 5 cubic feet of sand to 94 lbs.pounds (1 bag) of cement. If proportioning the materials by mass, use a

density of 85 ~~lbs/ft³~~ *pounds per cubic foot* (loose volume) for sand. The Contractor may batch sand at the moisture content occurring in the stockpile.

Mix the sand and cement until the mixture is of uniform color.

530-3.1.2 Filling Sacks: Accurately measure the mixed material into each sack, taking care to place the same amount of material in each sack; keep at least the top 6 inches of the sacks unfilled to allow for proper tying or folding and to ensure against breaking of the sack during placing.

530-3.1.3 Placing: Place the filled sacks with their tied or folded ends all in the same direction. Lay the sacks with broken joints, in a regular pattern. Ram or pack the sacks against each other so as to form a close and molded contact after the sand and cement mixture has set up. Remove and replace sacks ripped or torn in placing with sound, unbroken sacks. Then, thoroughly saturate all sacks with water.

530-3.1.4 Grouting: Immediately after watering, fill all openings between sacks with dry grout composed of one part Portland cement and five parts sand.

530-3.1.5 Toe Walls: The Contractor may construct toe walls of riprap for fill slopes of poured in place concrete in lieu of sand cement in sacks. Meet the concrete requirements as specified in Section 347. If using sand cement in sacks for the toe walls, fill the entire trench excavated for the toe walls with sand cement in sacks.

530-3.2 Rubble: Dump rubble in place forming a compact layer conforming to the neat lines and thickness specified in the Plans. Ensure that rubble does not segregate so that smaller pieces evenly fill the voids between the larger pieces.

530-3.3 Bedding Stone: Place *a minimum 1 foot thick layer of bedding stone under all rubble riprap* without puncturing or tearing the geotextile fabric. *The Engineer will allow an in place thickness tolerance of plus or minus 1 inch.*

Remove and replace geotextile fabric damaged as a result of operations at no expense to the Department.

~~The Engineer will allow an in place thickness tolerance of plus or minus 1 inch.~~

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~~ plane 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 ASTM D 6884. ~~120-10.2.~~

~~Perform soil testing to determine the appropriate anchor and wire tendon material to resist corrosion. 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 approved by the Engineer-and tested. If mats are wider than eight feet, place intermediate anchors so that spacing Anchor spacing cannot exceed is no greater than eightfour feet.-~~

~~Immediately prior to placing the geotextile fabric and ACB system, inspect the prepared subgrade to ensure it is free of loose material and the surface is smoothly compacted. The Engineer will check subgrade by visual inspection at the project site. Place the geotextile fabric directly on the prepared area, in intimate contact with the subgrade and free of folds or wrinkles. Do not glue or physically bond the geotextile fabric to the ACB mat. For coastal applications subject to wave climates, install a 6 inch thick layer of bedding stone under the geotextile fabric, when called for in the Plans.-~~

~~When installing ACB systems around curves, the mats shall be matched up to the greatest extent possible. Gaps greater than one block size shall be filled with a block and grouted the depth of the block with non-structural grout.~~

~~Do not install blocks with chips that result in any block weighing less than 95% of the fabricated manufacture specified weight.~~

530-4 Method of Measurement.

530-4.1 Sand-Cement: The quantity to be paid for will be the volume, in cubic yards, of sand actually used in the sand cement mixture and grout, satisfactorily placed and accepted.

If sand cement is proportioned by volume, the sand will be measured loose in an approved measure prior to mixing with cement. If sand cement is proportioned by weight, approved scales will be used for this purpose and the volume will be calculated using a standard conversion factor for sand of 85 ~~lbs/ft³~~ *pound per cubic foot*. No adjustment of batch weights to allow for varying moisture content of the sand will be made.

For toe walls, the quantity to be paid for will include only the volume of sand cement in sacks or concrete placed within the neat lines shown in the Plans for the toe walls.

530-4.2 Rubble and Bedding Stone: The quantities to be paid for will be the weight, in tons, in surface dry natural state, by railroad scales, truck scales, or barge displacement. The Contractor shall determine the weights as follows:

(1) Railroad Weights: The Contractor shall weigh railroad cars on railroad scales, before and after loading or before and after unloading. If weighed by other than the Engineer, a certified statement of weights will be required. Certificates of weight, furnished by the railroad company, will be acceptable without further certification.

(2) Truck Weights: The Contractor shall weigh trucks on certified scales, loaded and empty, as prescribed above for railroad weights. The Contractor shall weigh trucks in the presence of the Engineer, or furnish certificates of weights.

(3) Barge Displacement: The Engineer will measure each barge. The Contractor shall fit each barge with gauges graduated in ~~tenths of a 0.10~~ foot increments. The Contractor shall locate a gauge at each corner of the barge near the lower end of the rake. The Contractor shall furnish additional gauges amidships if the Engineer deems necessary. The Engineer will compute all weights.

530-4.3 Articulating Concrete Block (ACB) Revetment System: *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 the additional placement is ordered by the Engineer.*

530-5 Basis of Payment.

530-5.1 Sand-Cement: Price and payment will be full compensation for all work specified in this Section, including all materials, labor, hauling, excavation, and backfill.

Include the cost of dressing and shaping the existing fills (or subgrade) for placing riprap in the Contract unit price for riprap (sand-cement).

530-5.2 Rubble: Price and payment will be full compensation for all work specified in this Section, including all materials, hauling, excavation, and backfill.

Include the cost of dressing and shaping the existing fills (or subgrade) for placing riprap in the Contract unit price for riprap (rubble).

As an exception to the above, concrete that is shown to be removed from an existing structure and subsequently disposed of by being used in the embankment as riprap will not be paid for under this Section. Include the cost of such work under removal of existing structures.

530-5.3 Bedding Stone: Price and payment will be full compensation for all work specified in this Section, including all materials and hauling.

Include the cost of dressing and shaping the existing fills (or subgrade) for placing bedding stone in the Contract unit price for riprap (rubble).

530-5.4 Geotextile Fabric: Include the cost of materials and installation of the geotextile fabric in the contract unit price for riprap *or ACB revetment system*.

530-5.5 Articulating Concrete Block (ACB) Revetment System: *Price and payment will be full compensation for all work specified in this Section, including all materials, labor, hauling, excavation and backfill.*

530-5.5-6 Payment Items. Payment will be made under:

Item No. 530- 1- Riprap (Sand-Cement) - per cubic yard.

Item No. 530- 3- Riprap (Rubble) - per ton.

Item No. 530- 74- Bedding Stone - per ton.

Item No. 530- ~~X4~~ Articulating Concrete Block (~~ACB~~)-Revetment System - per square ~~foot~~ yard.

RIPRAP.
(REV 12-15-14)

SECTION 530 is deleted and the following substituted:

SECTION 530
RIPRAP AND ARTICULATING CONCRETE BLOCK REVETMENT SYSTEMS

530-1 Description.

530-1.1 Riprap: Construct riprap composed of sand-cement or rubble (consisting of broken stone or broken concrete) as shown in the Design Standards and in the Plans..

530-1.2 Articulating Concrete Block (ACB) Revetment Systems: Furnish and install an ACB revetment system in accordance with this Section and in conformance with the lines, grades, design, and dimensions shown in the Plans. Submit shop drawings for review and approval by the Engineer in accordance with Section 5. Provide signed and sealed calculations of the block and cable sizing design for approval. Comply with the National Concrete Masonry Association's Design Manual for Articulating Concrete Block Revetment Systems, Second Edition, or the National Highway Institute, Hydraulic Engineering Circular (HEC) No. 23, Publication No. FHWA NHI 09-110. Use a minimum Factor of Safety of 1.5 and a maximum 0.5 inch for the block projection.

Blocks must be open cell and non-tapered unless otherwise stated in the Plans. Bi-directional revetment cabling must 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, and include certified test reports from an independent test laboratory certifying the ACB revetment system meets the requirements of this section.

If the ACB revetment system is intended for use as bridge abutment protection, include the following drawings with the APL submittal:

1. At the corner transition between the front and side slopes.
2. For anchorages, filter fabric, treatment of voids between adjacent blocks, limits on void size between adjacent blocks and other special details required to successfully install the ACB.
3. For areas adjacent to bridge abutments, detail mat placement around curves, connections, protection of mat ends and splicing of mat.

530-2 Materials.

530-2.1 Riprap:

530-2.1.1 General: Meet the following requirements:

Portland Cement.....Section 921

Fine Aggregate.....Section 902

GroutSection 934

Type D-2 Geotextile FabricSection 514

530-2.1.2 Sacks: Provide sacks made of jute, cotton, or scrim reinforced paper capable of holding the sand-cement mixture without leakage. Ensure that sack material is permeable and absorptive enough to permit passage of water to provide for hydration of the

cement. Ensure that paper used in sacks is non-asphalt laminated with a polyester fiber scrim reinforcement in a three-way directional pattern, has an embossed finish, and is perforated approximately 3/32 inch in approximate 1 inch centers. Extend perforations continuously through the entire wall.

Provide sacks of uniform size and dimensions, in order to provide uniformity of lines in the completed work. Use sacks that are free from holes and strong enough to withstand handling without ripping or splitting. Use only one type and size of sack at any one structure.

530-2.1.3 Rubble:

530-2.1.3.1 Rubble (Bank and Shore Protection): Provide sound, hard, durable rubble, free of open or incipient cracks, soft seams, or other structural defects, consisting of broken stone with a bulk specific gravity of at least 2.20. Ensure that stones are rough and angular.

For this application, use broken stone meeting the following gradation and thickness requirements:

| Weight Maximum Pounds | Weight 50% Pounds | Weight Minimum Pounds | Minimum Blanket Thickness in Feet |
|--|-------------------|-----------------------|-----------------------------------|
| 670 | 290 | 60 | 2.5 |
| Ensure that at least 97% of the material by weight is smaller than Weight Maximum pounds]. Ensure that at least 50% of the material by weight is greater than Weight 50% pounds]. Ensure that at least 85% of the material by weight is greater than Weight Minimum pounds]. | | | |

530-2.1.3.2 Rubble (Ditch Lining): Use sound, hard, durable rubble, free of open or incipient cracks, soft seams, or other structural defects, consisting of broken stone or broken concrete with a bulk specific gravity of at least 1.90. Ensure that stones or broken concrete are rough and angular.

Use broken stone or broken concrete meeting the following gradation and thickness requirements:

| Weight Maximum Pounds | Weight 50% Pounds | Weight Minimum Pounds | Minimum Blanket Thickness in Feet |
|--|-------------------|-----------------------|-----------------------------------|
| 75 | 30 | 4 | 1.5 |
| Ensure that at least 97% of the material by weight is smaller than Weight Maximum pounds]. Ensure that at least 50% of the material by weight is greater than Weight 50% pounds]. Ensure that at least 90% of the material by weight is greater than Weight Minimum pounds]. | | | |

530-2.1.3.3 Physical Requirements of Broken Stone and Broken

Concrete: Use broken stone and broken concrete meeting the following physical requirements:

| | |
|---|--|
| Absorption (FM 1-T85) | Maximum 5% |
| Los Angeles Abrasion (FM 1-T096) | Maximum loss 45%* |
| Soundness (Sodium Sulphate) (AASHTO T104) | Maximum loss 12%** (after five cycles) |

| | |
|--|---|
| Flat and elongated pieces | Materials with least dimension less than one third of greatest dimension not exceeding 10% by weight. |
| Dirt and Fines | Materials less than 1/2 inch in maximum dimension accumulated from interledge layers, blasting or handling operations not exceeding 5% by weight. |
| Drop Test***(EM 1110-2-2302) | No new cracks developed, or no existing crack widened additional 0.1 inch, or final largest dimension greater than or equal to 90% original largest dimension of dropped piece. |
| <p>* Ensure that granite does not have a loss greater than 55% and that broken concrete does not have a loss greater than 45%. ** The Engineer may accept rubble exceeding the soundness loss limitation if performance history shows that the material will be acceptable for the intended use. The Engineer will waive the soundness specification for rubble riprap (broken stone and broken concrete) when project documents indicate it will be placed in or adjacent to water or soil with a sulfate content less than 150 parts per million and a pH greater than 5.0. *** The Engineer will waive the Drop Test unless required to ensure structural integrity. Provide all equipment, labor and testing at no expense to the Department. EM refers to the US Army Corps of Engineer's Specification Engineering Method.</p> | |

530-2.1.3.4 Source Approval and Project Control: The Engineer will approve mineral aggregate sources in accordance with 6-2.3 as amended by the following:

(1) The Engineer may perform Independent Verification tests on all materials placed on the project.

(2) The Engineer will check the gradation of the riprap by visual inspection at the project site. Resolve any difference of opinion with the Engineer in accordance with the method provided in FM 5-538. Provide all equipment, labor, and the sorting site at no expense to the Department.

(3) The Engineer may test components in a blend of rubble processed from different geologic formations, members, groups, units, layers or seams. The Engineer may select components based on like color, surface texture, porosity, or hardness. The Engineer will reject any blend if a component that makes up at least five percent by volume of the blend does not meet these specifications.

530-2.1.4 Bedding Stone: Use Bedding Stone of either a durable quality limestone or other quarry run stone, with a bulk specific gravity of not less than 1.90 and that is reasonably free from thin, flat and elongated pieces. Ensure that the bedding stone is also reasonably free from organic matter and soft, friable particles. Meet the following gradation limits:

| Standard Sieve Sizes -Inches | Individual Percentage by Weight Passing |
|------------------------------|---|
| 12 inches | 100 |
| 10 inches | 70 to 100 |
| 6 inches | 60 to 80 |
| 3 inches | 30 to 50 |
| 1 inch | 0 to 15 |

The Engineer will conduct source approval and project control of bedding stone as specified in 530-2.2.4. In lieu of limestone or other quarry run stone, the Contractor may

substitute non-reinforced concrete from existing pavement that is to be removed and which meets the above requirements for commercial bedding stone.

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:

ConcreteSection 347, ASTM D 6684

Cables and Fittings.....ASTM D 6684

Type D-2 Geotextile FabricSection 514

Granular UnderlaySection 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 ($\text{pH} \geq 11$) 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 aluminum or stainless steel Type 304 or 316.

530-3 Construction and Installation.

530-3.1 Sand-Cement:

530-3.1.1 Mixing Materials: Proportion sand and cement in the ratio of 5 cubic feet of sand to 94 pounds (1 bag) of cement. If proportioning the materials by mass, use a density of 85 pounds per cubic foot (loose volume) for sand. The Contractor may batch sand at the moisture content occurring in the stockpile.

Mix the sand and cement until the mixture is of uniform color.

530-3.1.2 Filling Sacks: Accurately measure the mixed material into each sack, taking care to place the same amount of material in each sack; keep at least the top 6 inches of the sacks unfilled to allow for proper tying or folding and to ensure against breaking of the sack during placing.

530-3.1.3 Placing: Place the filled sacks with their tied or folded ends all in the same direction. Lay the sacks with broken joints, in a regular pattern. Ram or pack the sacks against each other so as to form a close and molded contact after the sand and cement mixture has set up. Remove and replace sacks ripped or torn in placing with sound, unbroken sacks. Then, thoroughly saturate all sacks with water.

530-3.1.4 Grouting: Immediately after watering, fill all openings between sacks with dry grout composed of one part Portland cement and five parts sand.

530-3.1.5 Toe Walls: The Contractor may construct toe walls of riprap for fill slopes of poured in place concrete in lieu of sand cement in sacks. Meet the concrete requirements as specified in Section 347. If using sand cement in sacks for the toe walls, fill the entire trench excavated for the toe walls with sand cement in sacks.

530-3.2 Rubble: Dump rubble in place forming a compact layer conforming to the neat lines and thickness specified in the Plans. Ensure that rubble does not segregate so that smaller pieces evenly fill the voids between the larger pieces.

530-3.3 Bedding Stone: Place a minimum 1 foot thick layer of bedding stone under all rubble riprap without puncturing or tearing the geotextile fabric. The Engineer will allow an in place thickness tolerance of plus or minus 1 inch.

Remove and replace geotextile fabric damaged as a result of operations at no expense to the Department.

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 plane 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 ASTM D 6884.

Embed anchors at least 6 feet into the subgrade at a 45 degree angle into the bank with a minimum pullout resistance of 875 pounds. In the presence of the Engineer, perform on-site anchor strength testing to verify the required pull out resistance is achieved. Anchor strength testing 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. If any anchor fails to meet the pullout resistance requirement, test every subsequent installed anchor until a revised installation plan is proposed and approved by the Engineer. Anchor spacing cannot exceed four feet.

Immediately prior to placing the geotextile fabric and ACB system, inspect the prepared subgrade to ensure it is free of loose material and the surface is smoothly compacted.. Place the geotextile fabric directly on the prepared area, in intimate contact with the subgrade and free of folds or wrinkles. Do not glue or physically bond the geotextile fabric to the ACB mat. Install a 6 inch thick layer of bedding stone under the geotextile fabric, when called for in the Plans.

When installing ACB systems around curves, the mats shall be matched up to the greatest extent possible. Gaps greater than one block size shall be filled with a block and grouted the depth of the block with non-structural grout.

Do not install blocks with chips that result in any block weighing less than 95% of the manufacture specified weight.

530-4 Method of Measurement.

530-4.1 Sand-Cement: The quantity to be paid for will be the volume, in cubic yards, of sand actually used in the sand cement mixture and grout, satisfactorily placed and accepted.

If sand cement is proportioned by volume, the sand will be measured loose in an approved measure prior to mixing with cement. If sand cement is proportioned by weight, approved scales will be used for this purpose and the volume will be calculated using a standard conversion factor for sand of 85 pound per cubic foot. No adjustment of batch weights to allow for varying moisture content of the sand will be made.

For toe walls, the quantity to be paid for will include only the volume of sand cement in sacks or concrete placed within the neat lines shown in the Plans for the toe walls.

530-4.2 Rubble and Bedding Stone: The quantities to be paid for will be the weight, in tons, in surface dry natural state, by railroad scales, truck scales, or barge displacement. The Contractor shall determine the weights as follows:

(1) **Railroad Weights:** The Contractor shall weigh railroad cars on railroad scales, before and after loading or before and after unloading. If weighed by other than the Engineer, a certified statement of weights will be required. Certificates of weight, furnished by the railroad company, will be acceptable without further certification.

(2) **Truck Weights:** The Contractor shall weigh trucks on certified scales, loaded and empty, as prescribed above for railroad weights. The Contractor shall weigh trucks in the presence of the Engineer, or furnish certificates of weights.

(3) **Barge Displacement:** The Engineer will measure each barge. The Contractor shall fit each barge with gauges graduated in 0.10 foot increments. The Contractor shall locate a gauge at each corner of the barge near the lower end of the rake. The Contractor shall furnish additional gauges amidships if the Engineer deems necessary. The Engineer will compute all weights.

530-4.3 Articulating Concrete Block (ACB) Revetment System: 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 the additional placement is ordered by the Engineer.

530-5 Basis of Payment.

530-5.1 Sand-Cement: Price and payment will be full compensation for all work specified in this Section, including all materials, labor, hauling, excavation, and backfill.

Include the cost of dressing and shaping the existing fills (or subgrade) for placing riprap in the Contract unit price for riprap (sand-cement).

530-5.2 Rubble: Price and payment will be full compensation for all work specified in this Section, including all materials, hauling, excavation, and backfill.

Include the cost of dressing and shaping the existing fills (or subgrade) for placing riprap in the Contract unit price for riprap (rubble).

As an exception to the above, concrete that is shown to be removed from an existing structure and subsequently disposed of by being used in the embankment as riprap will not be paid for under this Section. Include the cost of such work under removal of existing structures.

530-5.3 Bedding Stone: Price and payment will be full compensation for all work specified in this Section, including all materials and hauling.

Include the cost of dressing and shaping the existing fills (or subgrade) for placing bedding stone in the Contract unit price for riprap (rubble).

530-5.4 Geotextile Fabric: Include the cost of materials and installation of the geotextile fabric in the contract unit price for riprap or ACB revetment system.

530-5.5 Articulating Concrete Block (ACB) Revetment System: Price and payment will be full compensation for all work specified in this Section, including all materials, labor, hauling, excavation and backfill.

530-5.6 Payment Items. Payment will be made under:

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|----------|----------|---|
| Item No. | 530- 1- | Riprap (Sand-Cement) - per cubic yard. |
| Item No. | 530- 3- | Riprap (Rubble) - per ton. |
| Item No. | 530- 74- | Bedding Stone - per ton. |
| Item No. | 530- 4- | Articulating Concrete Block Revetment System - per square yard. |