

3601 RIPRAP MATERIAL

3601.1 SCOPE

Provide stone and filter layer material for use in random or hand-placed riprap, gabion, andrevet mattress construction.

3601.2 REQUIREMENTS

A Stones

A.1 Quality

Provide stone of the quality approved by the Department and meeting the following requirements:

- (1) Free of defects that could cause rapid or excessive deterioration or degradation during service such as cracks or seams,
- (2) Free of soil or other debris before placement,
- (3) Crushed, non-weathered, not smooth or round and
- (4) Contains less than 10 percent of the following by weight:
 - (4.1) Individual pieces of stone with any of the defects listed above in items (1) through (3), or
 - (4.2) Stone with a width or thickness less than 30 percent of the length.

To determine suitable quality of stone, the Department may consider the results of laboratory tests, the performance of the stone under natural exposure conditions, the performance of the riprap from the same or similar geological formations or deposits, or other tests or criteria. Do not use recycled concrete as riprap unless otherwise allowed by the contract.

A.2 Type

A.2.a Random Riprap Table 3601-1

A.2.b Hand-Placed Riprap

Provide individual stones with a weight of at least 50 lb [22 kg]. The Department will not require a minimum weight for smaller stones required for filling in the narrow openings between individual stones (chinking).

A.2.c (Blank)**A.2.d Gabions and Revet Mattresses**

Provide well graded stones for filling the baskets, ranging in size from 4 in to 8 in [100 mm to 200 mm] for gabions and 3 in to 6 in [75 mm to 150 mm] for revet mattresses.

Table 3601-1 Random Riprap Gradation Requirements						
Weight, lb [kg]	Size, in [mm]*	Approximate Percent of Total Weight Smaller than Given Weight				
		Class of Riprap				
		I	II	III	IV	V
2,000 [900]	30 [750]	—	—	—	—	100
1,000 [450]	24 [600]	—	—	—	100	—
650 [300]	21 [525]	—	—	—	—	75
400 [180]	18 [450]	—	—	100	—	—
250 [113]	15 [375]	—	—	—	75	50
120 [55]	12 [300]	—	100	75	50	—
50 [22]	9 [225]	—	75	50	—	—
15 [7]	6 [150]	100	50	—	—	10
5 [2]	4 [100]	—	—	—	10	—
2 [1]	3 [75]	50	—	10	—	—
—	2 [50]	—	10	—	—	—
—	1 [25]	10	—	—	—	—

* Weight to size conversion based on a specific gravity of 2.60 and a volume average between a sphere and cube

B Filter Material**B.1 Granular Filter**

Provide granular filter material in accordance with 3149, "Granular Material," and the following gradations:

B.1.a Under Class I Random Riprap..... 3149.2G

B.1.b Under Other Riprap, Gabion, and Revet Mattress Table 3601-2

Table 3601-2 Granular Filter Material	
Sieve Size	Percent Passing by Weight
6 in [150mm]	100
3 in [75 mm]	75 – 95
1 in [25 mm]	35 – 75
No. 4 [4.75 mm]	10 – 40
No. 10 [2.0 mm]	5 – 25
No. 40 [425 μm]	0 – 10
No. 200 [425 μm]	0 – 5

B.2 Geotextile Filter 3733

3601.3 SAMPLING AND TESTING

The Department will inspect the material for compliance to the requirements of this section. Obtain the Engineer’s approval of the quality of the stone before delivering the stone to the project. The Engineer will inspect the stone for compliance to the gradation requirements after delivery of the stone to the project.

The Engineer will visually check riprap gradations. If the Contractor disagrees with the results of the Engineer’s visual check, the Engineer will test the gradation based on weight. The gradation of random riprap must be within 10 percent of the percentages in Table 3601-1.

If the quantity of riprap for any class is greater than 40 cu. yd [30 cu. m], the Engineer may require construction of a control unit consisting of 4 cu. yd [3 cu. m] of riprap as a reference for size and quality compliance. Construct the control unit at the source or on the project. When the Engineer requires and approves a control unit for reference, maintain the control unit during riprap construction and incorporate the stones from the control unit as the last stones placed in the riprap construction. Use production stone equivalent to the stone placed in the approved control unit.

3602 GABIONS AND REVET MATTRESSES MATERIALS

3602.1 SCOPE

Provide material and construct baskets for gabions and revet mattresses meeting the following characteristics:

- (1) Rectangular,
- (2) Variable in size, and
- (3) Manufactured from double-twisted metallic-coated wire mesh or metallic-coated welded wire fabric.

A Gabion..... Rectangular Basket

B Revet Mattress Thin Flat Rectangular Basket

3602.2 REQUIREMENTS

Provide gabions and revet mattresses meeting the requirements of ASTM A 974, for welded wire fabric, or ASTM A 975 for double-twisted wire. Unless otherwise specified, provide welded wire fabric gabions and revet mattresses with a Style 2 coating, and provide double-twisted wire gabions and revet mattresses with a Style 1 coating as listed in the ASTM A 974 and ASTM A 975 specifications, respectively.

3602.3 SAMPLING AND TESTING

Submit to the Engineer a manufacturer's Certificate of Compliance for the wire and basket materials and the construction of gabions and revet mattresses.

3604 PRECAST ARTICULATED CONCRETE

3604.1 SCOPE

Provide manufactured articulated concrete block and mat revetment systems to protect embankment slopes, river channels, spillways, and vehicle accesses where the soil may erode.

3604.2 REQUIREMENTS

A Revetment Systems

Provide articulated block mat and articulated interlocking block systems meeting the requirements of ASTM D 6684-04 and the following material specifications.

Provide Type A, Type B, Type C, Type D, and Type E articulated block mat in accordance with the following and as specified in Table 3604-1.

Provide Type A, Type B, and Type C articulated interlocking block in accordance with the following and as specified in Type 3604-1.

Table 3604-1 Bed Shear Requirements	
Type	Minimum Bed Shear, <i>lb/sq. ft [Pa]</i>
A	10 [479]
B	15 [718]
C	20 [958]
D	25 [1,197]
E	30 [1,436]

A.1 Articulated Block Mat

Provide closed cell or open cell articulated block mat consisting of blocks cabled together into a prefabricated mat placed on a geotextile fabric. Place the mats side-by-side, and clamp and anchor to provide one homogeneous erosion protection system. Provide blocks for the mats ranging in thickness and weight meeting the bed shear requirements in accordance with Table 3604-1, "Bed Shear Requirements." Determine the type in accordance with Table 3604-1, "Bed Shear Requirements."

A.2 Articulated Interlocking Block

Provide closed cell or open cell articulated interlocking block consisting of hand placed concrete blocks placed on a geotextile fabric and locked together to form a soil protecting paver system. Provide blocks ranging in thickness and weight meeting the bed shear requirements in accordance with Table 3604-1, "Bed Shear Requirements." Determine the type in accordance with Table 3604-1, "Bed Shear Requirements."

Provide open cell units with an open area of at least 20 percent when measured at the bottom of the block in the system. Provide closed cell systems with an open area no greater than 10 percent when measured at the bottom of the block in the system.

B Concrete..... 2461

Provide blocks meeting the following requirements:

- (1) Manufactured in a plant with a Department approved quality control plan,
- (2) Design air content of 6.5 percent for wet cast blocks,
- (3) Less than 1.0 percent loss in 100 freeze/thaw cycles when tested in accordance with ASTM C 1262 using a distilled water solution or less than 1.0 loss in 50 freeze/thaw cycles when tested in accordance with ASTM C 67, and
- (4) Absorption no greater than 7.0 percent when tested in accordance with ASTM C 140.

Provide wet cast concrete blocks with a design strength of at least 4,000 psi [27.6 MPa] when tested at 28 days in accordance with ASTM C 140.

Provide dry cast concrete blocks with a design strength of at least 5,800psi [40.0 MPa] when tested at 28 days in accordance with ASTM C 140.

C Cable

For systems using cables, provide stainless steel or coated high-strength polyester cables compatible with the system and designed to meet a 5:1 factor of safety in accordance with ASTM D 6684. Use stainless steel cable at least $\frac{3}{16}$ in [0.48 cm] thick and use high-strength polyester cable at least $\frac{1}{4}$ in [0.64 cm] thick.

D Geotextile Filter

Provide geotextile appropriate for the soil conditions in accordance with the manufacture's recommendations and 3733, "Geotextiles." The Engineer will make the final approval of the geotextile type.

E Clamps

Use stainless-steel wire rope clamps and sleeves to secure loops of adjoining mats.

F Anchors

Use anchors with a pull resistance of 4,000 lb [1,815 kg] to secure the top and exposed sides of the mattress.

G Bedding Material

Provide cohesive soil for bedding material meeting the requirements for common borrow in 2105, "Excavation and Embankment," or 3149, "Granular Material."

H Fine Filter Aggregate

Provide fine aggregate bedding sand for bedding in accordance with 3149, "Granular Material," and the grading requirements of 3149.2.J, "Fine Filter Aggregate." Place sand 1 in [25 mm] thick. Spread the sand evenly over the compacted bed, or over geotextile if required by the manufacturer, to place articulated interlocking block or articulated block mat.

3604.3 SAMPLING AND TESTING

Submit to the Engineer a manufacture's Certificate of Compliance for the revetment system and components that meets the requirements of ASTM D 7277 and ASTM D 7276.

3608 CONCRETE ARMOR UNITS

3608.1 SCOPE

Provide manufactured concrete armor units for use in stream bank, riverbank, and lakeshore stabilization, and for soil bioengineering construction.

3608.2 REQUIREMENTS

Use interlocking concrete cross shaped units, each with two individual and symmetrical interlocking halves, to provide concrete armor units. Assemble the units with the two individual halves forming a three dimensional cross with six symmetrical legs. Assemble multiple, identical units into a continuous and flexible interlocking matrix with a 40 percent void space for soil filling and planting.

Use concrete meeting the following requirements to form the armor units:

- (1) In accordance with the requirements for Type 3 in 2461, "Structural Concrete,"
- (2) Compressive strength of at least 4,000 psi [27.6 MPa], and
- (3) Water absorption no greater than 10 lb per cu. ft [160 kg per cu. m].

Ensure each concrete armor unit meets the physical requirements in accordance with the following:

Table 3608-1 Concrete Armor Units Size		
Designation	A-24	A-36
Overall dimension (outside of leg to outside of leg)	24 in [610 mm]	36 in [910 mm]
Thickness of each side of leg	3.6 in [93 mm]	5.5 in [142 mm]
Kerf corner reinforcement	1.8 in [46 mm]	2.7 in [92 mm]
Overall weight of assembled unit	78 lb [35 kg]	265 lb [119 kg]
NOTE: Dimensions are nominal dimensions with a 10 percent tolerance.		

3608.3 SAMPLING AND TESTING — (BLANK)

3612 SEWER BRICK (CLAY)

3612.1 SCOPE

Provide brick made from burned clay or shale for the following:

- (1) Drainage structures that are part of a sewage, industrial waste, or storm water system; and
- (2) Related structures such as manholes and catch basins.

3612.2 REQUIREMENTS

Use sewer bricks meeting the requirements of AASHTO M 91 for the grade shown on the plans. If the plans do not specify a grade, provide Grade MM or higher.

3612.3 SAMPLING AND TESTING

- A Compressive Strength and Absorption.....AASHTO T 32**
- B Freezing and Thawing.....AASHTO T 32**
- C Sample Bricks**

The Engineer will select bricks for testing. Provide test specimens from the manufacturer or seller, at no additional cost to the Department.

3613 BUILDING BRICK (CLAY OR SHALE)

3613.1 SCOPE

Provide clay or shale building brick for use in the construction of transportation facilities.

3613.2 REQUIREMENTS

Provide clay or shale building brick meeting the requirements of AASHTO M 114. Provide grade SW, unless otherwise required by the contract.

3613.3 SAMPLING AND TESTING

Sample and test in accordance with the Schedule of Materials Control.

3614 BUILDING BRICK (SAND-LIME)

3614.1 SCOPE

Provide sand-lime building brick for use in the construction of transportation facilities.

3614.2 REQUIREMENTS

Provide sand-lime building brick meeting the requirements of ASTM C 73. If the contract does not require a specific brick grade, provide grade MW building brick.

3614.3 SAMPLING AND TESTING

Sample and test in accordance with the Schedule of Materials Control.

3615 BUILDING BRICK (CONCRETE)

3615.1 SCOPE

Provide concrete building brick for construction.

3615.2 REQUIREMENTS

Provide concrete building brick meeting the requirements of ASTM C 55.

3615.3 SAMPLING AND TESTING

Sample and test in accordance with the Schedule of Materials Control.

3616 SEWER BRICK (CONCRETE)

3616.1 SCOPE

Provide concrete brick to construct catch basins and manholes.

3616.2 REQUIREMENTS

Provide concrete brick meeting the requirements of ASTM C 139, as modified by the following:

- (1) Provide concrete brick with a compressive strength of at least 4,100 psi [28 MPa] for any individual unit and an average compressive strength of 4,500 psi [31 MPa] for three units, when delivered to the project, and
- (2) Use steam or water curing methods to cure the concrete, unless the Materials Engineer approves the use of a sealing membrane or other curing methods. If steam curing, maintain an atmospheric temperature in the curing chamber no greater than 158 °F [70 °C]. Protect the concrete from freezing until the completion of curing. Continue curing until the concrete develops the compressive strength shown above in item (1) within 28 days.

Use any standard size brick capable of producing the dimensions in the completed structure as shown on the plans.

3616.3 SAMPLING AND TESTING ASTM C 140

Sample in accordance with the Schedule of Materials Control.

3621 CONCRETE MASONRY UNITS

3621.1 SCOPE

Provide solid, precast, segmental concrete masonry units to construct catch basins and manholes.

3621.2 REQUIREMENTS

Provide concrete masonry units in accordance with 3616.2, "Sewer Brick (Concrete), Requirements," modified to provide units with dimensions as shown on the plans and with wall thicknesses of 8 in $\pm \frac{3}{8}$ in [200 mm \pm 10 mm].

3621.3 SAMPLING AND TESTING 3616

3622 SECTIONAL CONCRETE MANHOLE AND CATCH BASIN UNITS

3622.1 SCOPE

Provide precast, reinforced concrete manhole/catch basin units consisting of riser sections and appurtenances such as grade rings, base slabs, tops, and special sections to construct sewer or water works.

3622.2 REQUIREMENTS

Provide reinforced concrete manhole/catch basin units meeting the requirements of AASHTO M 199, 3236, "Reinforced Concrete Pipe," and the following.

Notify the Engineer, in conjunction with the Materials Engineer, 2 weeks before the manufacturer starts production, to allow the Engineer and Materials Engineer to arrange for inspection during production.

A Physical Properties

Provide sectional concrete manhole/catch basin units in the dimensions, shape, wall thickness, type, and quantity of reinforcement as shown on the plans.

The Contractor may use alternative spigot-up joint or alternative offset joint. Use the profile or pre-lubricated pipe seal system with the alternative offset joint.

Ensure test results show a compressive strength of at least 4,200 psi [28 MPa] at 28 calendar days and before shipping the product to the project site.

B Manufacture

Provide units true to shape and with smooth, dense surfaces uniform in appearance. As soon as the forms are removed, use mortar to fill minor surface cavities or irregularities not impairing the service value of the unit and capable of being corrected without marring the appearance. Remove forms without damaging the unit.

When the manufacturer provides manholes with block outs or holes, provide additional steel in the remaining unit to prevent cracking. If the unit is cracked, remove the cracked portion and repair with mortar.

3622.3 SAMPLING AND TESTING 3236

3630 PRECAST CONCRETE MEDIAN BARRIERS

3630.1 SCOPE

Provide precast concrete median barriers for use in construction work zones.

3630.2 REQUIREMENTS 3238

Provide precast concrete median barriers manufactured at a precasting plant approved by the Materials Engineer.

A Materials

A.1 Concrete..... 2461
A.2 Mix Designation 2533
A.3 Reinforcement Bars 3301

B Concrete Finish

If shown on the plans or required by the special provisions, sandblast the precast barrier units and fill the surface imperfections with a grout-containing bonding agent in accordance with 2401.3.F.2.a, "Ordinary Surface Finish." Begin sandblasting and grouting operations after stripping the forms and while the concrete barriers are still warm.

3630.3 SAMPLING AND TESTING 3236