

**3601
Riprap Material**

3601.1 SCOPE

This Specification covers stone and filter layer material for use in random, hand-placed, or quarry-run riprap; gabion; and revet mattress (3602) construction.

3601.2 REQUIREMENTS

A Stones

A1 Quality

The Contractor shall furnish only durable, field or quarried, stone of the quality approved by the Department and meeting the following requirements:

- (a) The individual pieces of stone are free of defects such as seams or cracks that will cause rapid or excessive deterioration or degradation during service.
- (b) The riprap is free of soil or other debris before placement.
- (c) The placed riprap contains less than 10 percent of undesirable material by mass. Undesirable material is defined as:
 - (1) Individual pieces of stone with defects that are visually differentiated from acceptable pieces.
 - (2) Stone that is slabby or elongated (having width or thickness less than 30 percent of the length).

To determine suitable quality of any stone, the Department may consider the results of laboratory tests, the behavior of the stone under natural exposure conditions, the behavior of the riprap from the same or similar geological formations or deposits, or other tests or criteria. The Contractor shall not use recycled concrete as riprap unless allowed by the Contract.

A2 Type

A2a Random Riprap..... Table 3601-1

A2b Hand-Placed Riprap

The Contractor shall furnish individual stones with a minimum mass of 22 kg (**50 pounds**). Smaller stones required for chinking do not have a minimum mass.

A2c Quarry-Run Riprap

The Contractor shall furnish quarried stone, including spalls, well graded (full range and even distribution of sizes) from the maximum size shown in the Plans to not more than 15 percent by mass smaller than the 2.00 mm (#10) sieve.

A2d Gabions and Revet Mattresses

The Contractor shall furnish stones for filling the baskets that are well graded, ranging in size from 100 to 200 mm (**4 to 8 inches**) for gabions and 75 to 150 mm (**3 to 6 inches**) for revet mattresses.

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**TABLE 3601-1
RANDOM RIPRAP REQUIREMENTS**

Mass kilogram (pounds)	Size mm (inches) (A)	Approx. % of Total Mass Smaller than Given Mass Class of Riprap				
		I	II	III	IV	V
900 (2000)	750 (30)	--	--	--	--	100
450 (1000)	600 (24)	--	--	--	100	--
300 (650)	525 (21)	--	--	--	--	75
180 (400)	450 (18)	--	--	100	--	--
113 (250)	375 (15)	--	--	--	75	50
55 (120)	300 (12)	--	100	75	50	--
22 (50)	225 (9)	--	75	50	--	--
7 (15)	150 (6)	100	50	--	--	10
2 (5)	100 (4)	--	--	--	10	--
1 (2)	75 (3)	50	--	10	--	--
--	50 (2)	--	10	--	--	--
--	25 (1)	10	--	--	--	--

(A) Mass to approximate size conversion based on a specific gravity of 2.60 and a volume average between a sphere and a cube.

B Filter Material

B1 Granular Filter

Granular filter material shall conform to 3149 and the following gradations.

B1a Under Class I Random Riprap 3149.2G

B1b Under Other Riprap, Gabion, and Revet Mattress
..... Table 3601-2

**TABLE 3601-2
GRANULAR FILTER MATERIAL**

Sieve Size	Percent Passing by Mass
150 mm (6 inches).....	100
75 mm (3 inches).....	75-95
25 mm (1 inches).....	35-75
4.75 mm (#4).....	10-40
2.00 mm (#10).....	5-25
425 µm (#40).....	0-10
75 µm (#200).....	0-5

B2 Geotextile Filter..... 3733

3601.3 SAMPLING AND TESTING

The Department will inspect the material for compliance with the foregoing requirements for quality, mass, and gradation. The Contractor shall obtain the Engineer's approval of the quality of the stone before the stone is delivered to the Project. The Engineer will inspect for compliance to the gradation requirements at the Project.

The Engineer will visually check riprap gradations. In case of disagreement, the Engineer will test gradation based on mass. For random riprap, compliance shall be within 10 percent of the percentages indicated.

When the quantity of riprap for any class exceeds 30 m³ (**40 cubic yards**), the Engineer may require, that size and quality compliance be referenced to a control unit consisting of approximately 3 m³ (**4 cubic yards**) of riprap constructed at the source or construction site. When the Engineer requires and approves a control unit for reference, the control unit shall remain intact during the course of riprap construction until being incorporated as the last stones placed. The Contractor shall use production stone equivalent in all respects to the stone placed in the approved control unit.

3602

Gabions and Revet Mattresses Materials

3602.1 SCOPE

This Specification covers the material and the construction of baskets for gabions and revet mattresses.

The baskets are rectangular, variable in size, and manufactured either from double-twisted metallic-coated wire mesh or from metallic-coated welded wire fabric.

- A Gabion Rectangular Basket**
- B Revet Mattress Thin Flat Rectangular Basket**

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3602.2 REQUIREMENTS

Gabions and revet mattresses shall conform to ASTM A 974 (welded wire fabric) or ASTM A 975 (double-twisted wire). Unless otherwise specified the double-twisted wire gabions and revet mattresses shall have a Style 1 coating, and the welded wire fabric gabions and revet mattresses shall have a Style 2 coating. The Contractor shall furnish the Engineer a manufacturer’s Certificate of Compliance, in accordance with 1603, that the material conforms to these requirements.

3602.3 SAMPLING AND TESTING

Wire and basket construction for gabions and revet mattresses shall be certified by the manufacturer in accordance with 1603.

3604

Precast Articulated Concrete

3604.1 SCOPE

This specification covers manufactured articulated concrete block and mat revetment systems for protection of embankment slopes, river channels and spillways and vehicle accesses where the soil is susceptible to erosion. The two systems:

A Articulated Block Mat - closed cell or open celled

This system is cabled together blocks into a prefabricated mat placed over a geotextile, meeting the following material specifications.

B Articulated Interlocking Block - closed cell or open celled

This system consists of hand placed blocks onto a geotextile, meeting the following material specifications.

3604.2 REQUIREMENTS

The Articulated Block Mat systems are made up of individual concrete blocks that are strung together with cable. These mats are placed side-by-side and clamped together and anchored to provide one homogeneous erosion protection system. Articulated Interlocking Block is individual concrete blocks interlocked together to form a soil protecting paver system. All systems consist of either all-open cells or all closed cells system. Open cell units shall have a minimum of 10% open area.

A Concrete 2461

Blocks shall be manufactured in a plant having a Mn/DOT-approved quality control plan, shall have a design air content of 6.5%, shall have less than 1.0 % loss in 100 freeze/thaw cycles when tested in accordance with ASTM C1262 using a distilled water solution, and shall have less than 1.0% loss in 50 freeze/thaw cycles when tested in

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accordance with ASTM C67. Concrete shall have a maximum absorption of 7.0% when tested in accordance with ASTM C140.

Wet cast concrete blocks shall have a minimum design strength of 27.6 Mpa (**4000 PSI**) @ 28 days when tested in accordance with ASTM C 140.

Dry cast concrete blocks shall have a minimum design strength of 40.0 Mpa (**5800 PSI**) @ 28 days when tested in accordance with ASTM-C-140.

B Cable

In systems that utilize cables, the cables shall be stainless steel or shall be galvanized with a minimum estimated life span of 50 years.

C Geotextile Filter 3733

Shall be in accordance with the manufacture’s recommendations and be sized appropriately for the soil conditions present.

D Clamps

Sufficient galvanized or stainless steel wire rope clamps/sleeves shall be used to secure loops of adjoining mats.

E Anchors

Anchors used to secure the top and exposed sides of the mattress shall have a pull resistance of 905 kg (**2000 pounds**).

F Fine Filter Aggregate 3149

Bedding sand shall conform to the grading requirements of 3149.2J. Sand shall be spread 25 mm (**1 inches**) thick evenly over the compacted subgrade when requested by the manufacture for placing articulated interlocking block.

3604.3 SAMPLING AND TESTING

A Manufacture’s certification that the revetment system and all of its components meet the requirements of this specification shall be supplied.

3608

Concrete Armor Units

3608.1 SCOPE

This specification covers manufactured concrete armor units for use in streambank, riverbank, and lakeshore stabilization; and soil bioengineering construction.

3608.2 REQUIREMENTS

Concrete armor units shall consist of interlocking concrete cross shaped units. Each unit shall consist of 2 individual and symmetrical interlocking halves. When assembled, the two individual halves shall form a three dimensional cross with six symmetrical legs. Each unit shall be identical so that multiple units can be placed into a continuous and flexible interlocking matrix. When interlocked into a matrix, there

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shall be approximately 40 percent void space to allow ample space for soil filling and planting. Concrete used in the units shall meet 2461 Type 3 with a minimum of 27.6 MPa (**4000 psi**) compressive strength and a maximum water absorption of 160 kg/m³ (**10 pound per cubic foot**). Physical requirements shall be as indicated in Table 3608-1:

TABLE 3608-1*

Designation	A-24	A-36
Overall dimension (Outside of leg to outside of leg)	610 mm (24 inches)	910 mm (36 inches)
Thickness of each side of leg	93 mm (3.6 inches)	142 mm (5.5 inches)
Kerf corner reinforcement	46 mm (1.8 inches)	92 mm (2.7 inches)
Overall weight of assembled unit	35 kg (78 pounds)	119 kg (265 pounds)

* Dimensions in Table 3608-1 are nominal dimensions with a 10% tolerance.

3608.3 SAMPLING AND TESTING

Samples for testing shall be of such size and numbers as requested by the Engineer.

**3612
Sewer Brick (Clay)**

3612.1 SCOPE

This Specification covers brick made from clay or shale and burned, and which are to be used in drainage structures for the conveyance of sewage, industrial wastes, or storm water.

3612.2 REQUIREMENTS

Sewer brick shall conform to AASHTO M 91 for the grade specified. If no grade is specified, Grade MM or better shall be furnished.

3612.3 SAMPLING AND TESTING

- A Compressive Strength and Absorption ...AASHTO T 32**
- B Freezing and Thawing.....AASHTO T 32**
- C Bricks for testing shall be selected by the Engineer.**

The manufacturer or seller shall furnish test specimens without charge.

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3613

Building Brick (Clay or Shale)

Building brick (clay or shale) shall conform to AASHTO M 114. Three grades of brick are covered; SW, MW, and NW. The grade required will be specified in the Contract.

3614

Building Brick (Sand-Lime)

Building brick (sand-lime) shall conform to ASTM C 73. Unless otherwise specified the grade required shall be MW.

3615

Building Brick (Concrete)

Building brick (concrete) shall conform to ASTM C 55. Unless otherwise specified the grade required shall be S-II.

3616

Sewer Brick (Concrete)

3616.1 SCOPE

This Specification covers concrete brick for use in the construction of catch basin and manholes.

3616.2 REQUIREMENTS

The units shall conform in quality to ASTM C 139, except that:

- (a) At the time of delivery to the site of the work, the minimum compressive strength requirements shall be 28 Mpa (**4100 psi**) for any individual unit, and 31 MPa (**4500 psi**) for the average of three units.
- (b) The concrete units shall be cured by the steam or water curing methods, unless the use of a sealing membrane or other curing methods are authorized by the Engineer. When steam curing is used, atmospheric temperature in the curing chamber shall not exceed 70°C (**158 °F**). The concrete units shall be protected against freezing until the curing is completed. Curing shall continue for a sufficient length of time so that the concrete will develop the specified compressive strength at 28 days or less.

The dimensions of the brick may be any standard size that will produce the required dimensions in the completed structure.

3616.3 SAMPLING AND TESTINGASTM C 140

The Materials Engineer is the Engineer with authority regarding this Specification. The manufacturer shall notify the Engineer before starting production, in sufficient time to permit the required testing and inspection during manufacturing.

3621

3621
Concrete Masonry Units

3621.1 SCOPE

This Specification covers solid, precast, segmental concrete masonry units for use in the construction of catch basins and manholes.

3621.2 REQUIREMENTS

The units shall conform to 3616.2, except as modified below:

The dimensions of the units shall be such that the catch basins or manholes will have the dimensions shown in the Plans, within a tolerance of 10 mm (**3/8 inch**) in the 200 mm (**8 inches**) wall thickness.

3621.3 SAMPLING AND TESTING 3616

3622

Sectional Concrete Manhole/Catch Basin Units

3622.1 SCOPE

This Specification covers precast, reinforced concrete manhole/catch basin units consisting of riser sections and appurtenances such as grade rings, base slabs, tops and special sections to be used in constructing sewer or water works.

3622.2 REQUIREMENTS

Reinforced concrete manhole/catch basin units furnished under this Specification shall conform to AASHTO M 199 and 3236, together with the additional requirements and modifications set forth herein.

The manufacturer shall notify the Engineer prior to starting production, in sufficient time to permit the required testing and inspection during manufacturing.

A Calcium Chloride 3911

Calcium chloride may be added to the mixture to accelerate hardening, at the rate of not more than 1.0 kg (**2.2 pounds**.) of Type 1 (flakes) or 0.8 kg (**1.8 pounds**.) of Type 2 (pellets) per 50 kg (**110 pounds**.) of cement. Admixtures other than calcium chloride and air-entraining agents shall not be used without approval of the Engineer.

B Physical Properties

Dimensions, shape, wall thickness, and the type and quantity of reinforcement shall be in conformance with the Plans.

Manufacturers may produce the alternative spigot-up joint. Manufacturers may also produce the alternative offset joint. This type of offset joint is to be used with the profile or pre-lubricated pipe seal system.

The concrete shall develop a compressive strength of not less than 21 Mpa (**3100 psi**) at 14 days. Cores taken from the finished units shall have a compressive strength of not less than 28 MPa (**4200 psi**) at 28 days. However, all manhole sections including Structural Manhole

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Covers, Standard Plate 4020, shall attain full design strength prior to shipment.

C Manufacture

The units shall be true to shape and their surfaces shall be smooth, dense and uniform in appearance. Minor surface cavities or irregularities that do not impair the service value of the unit and that can be corrected without marring the appearance shall be filled with mortar as soon as the forms are removed. Forms shall remain in place until they can be removed without damage to the unit.

When the manufacturer provides blockouts or cuts holes in manhole units, additional steel shall be provided in the remaining unit to prevent cracking. If the unit is cracked, the cracked portion shall be removed and replaced with mortar.

3622.3 INSPECTION AND ACCEPTANCE 3236

3630

Precast Concrete Median Barriers

3630.1 SCOPE

This Specification covers the construction of precast concrete median barriers at a precasting plant that has been granted "plant pre-approval for acceptance of precast concrete products" by the Materials Engineer.

3630.2 REQUIREMENTS 3238

A Materials

- A1 Concrete 2461
- A2 Mix Designation 2533
- A3 Reinforcement Bars 3301

B Concrete Finish

When required by the Plans or Special Provisions, the Fabricator shall sandblast the precast barrier units and fill the surface imperfections with a grout containing an approved bonding agent as described in 2401.3, Finish of Concrete. The sandblasting and grouting operations shall commence as soon as possible after the forms are stripped, while the concrete barriers are still warm.

3630.3 INSPECTION AND ACCEPTANCE 3236

3661

Reinforced Concrete Cribbing

3661.1 SCOPE

This Specification covers precast reinforced concrete units for use in the construction of cribwalls.

3661.2

3661.2 REQUIREMENTS

The manufacturer shall notify the Engineer prior to starting production, in sufficient time to permit the required testing and inspection during manufacturing.

A Materials

A1 Coarse Aggregate 3137

The class and gradation of the coarse aggregate shall be optional with the manufacturer.

A2 Fine Aggregate 3126

A3 Portland Cement 3101

A4 Calcium Chloride 3911

A5 Reinforcement 3301

B Concrete Production

The reinforced concrete shall consist of a mixture of Portland cement, mineral aggregates, and water, in which steel has been embedded in such a manner that the steel and concrete act together.

The aggregates shall be so sized and so graded and proportioned and thoroughly mixed in a batch mixer with such proportions of cement and water as will produce a homogeneous concrete mixture of such quality that standard test cylinders will develop a compressive strength of not less than 21 Mpa (**3100 psi**) at 14 days. In no case, however, shall the quantity of cement be less than 330 kg/m³ (**556 pounds per cubic yard**) of concrete.

The concrete shall be air-entrained by using either an air-entraining Portland cement or by using standard Portland cement plus an approved air-entraining admixture. The air content of the concrete shall be maintained within the approximate range of 5 to 8 percent.

Calcium chloride may be added to the mixture to accelerate hardening, at the rate of not more than 1.0 kg (**2.2 pounds**) of Type 1 (flakes) or 0.8 kg (**1.8 pounds**) of Type 2 (pellets) per 50 kg (**110 pounds**) of cement. Admixtures other than calcium chloride and air-entraining agents shall not be used without approval of the Engineer.

C Design Details..... 3238

The finished units shall conform to the dimensions shown in the Plans, to such a degree that they can be assembled in the field without chipping or using mortar.

D Manufacture

The units shall be cast in horizontal position in mortar-tight forms. The concrete in each unit shall be placed without interruption, and shall be consolidated with a vibrator, supplemented by hand tamping, as may be necessary to force the concrete into the corners of the form and prevent the formation of stone pockets or cleavage planes.

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The forms shall remain in place until they can be removed without damage to the units.

The units shall be cured for a sufficient length of time as will develop the specified compressive strength. The units shall be protected from freezing, after being cast and until curing is completed.

The units shall be cured by the steam or water curing methods, as described in AASHTO M 199, unless the use of a sealing membrane or other effective methods are specifically approved by the Engineer. When steam curing is used, atmospheric temperature in the curing chamber shall not exceed 70°C (158 °F)

E Workmanship and Finish

The finished units shall be true to shape and their surfaces shall be smooth, dense and uniform in appearance. All surfaces that will be exposed to view in the completed structure shall have a finish equivalent to that obtained by rubbing with a carborundum brick. Minor surface cavities or irregularities that do not impair the service value of the unit and that can be corrected without marring the appearance may be pointed with mortar as soon as the forms are removed.

F Identification Marks

Each unit shall bear the name or trademark of the manufacturer and the date it was cast, stenciled or otherwise placed thereon in a manner as to remain in evidence for at least 1 year.

Units containing special reinforcement shall be marked as specified in the Plans.

G Physical Tests

Sampling and testing of materials shall be in accordance with the methods and requirements prescribed in the Specifications listed for the individual materials.

Compression tests for satisfying the minimum concrete strength requirement may be made on either standard rodded cylinders cast in accordance with AASHTO T 23 or on cylinders cast and cured in a like manner as the cribbing units.

Three cylinders shall be cast in the presence of and under the supervision of the Engineer for each 100 units, or major fraction thereof, manufactured, but in no case shall the number of test cylinders required under a given contract be less than five.

Compression tests will be made on the cylinders in accordance with AASHTO T 22. The average compression strength of all cylinders tested shall be equal to or greater than the specified strength of the concrete. At least 90 percent of the cylinders tested shall meet the specified strength, and in no case shall any cylinder tested fall below 80 percent of the specified strength.

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3661.3 INSPECTION AND ACCEPTANCE 3238

3667

Precast Concrete Monuments

3667.1 SCOPE

This Specification covers precast concrete units for use as bench marks, right of way markers, section corners, and elsewhere where a permanent monument is required.

3667.2 REQUIREMENTS

A Materials

A1 Concrete

Concrete shall be produced as provided in 2461 subject to the specific requirements and limitations as follows:

- (a) The maximum size of the aggregate (Light Weight Aggregate) shall be 25 mm (**1 inch**).
- (b) The minimum cement content shall be 335 kg/m³ (**565 pounds per cubic yard**) of concrete.
- (c) The concrete shall develop a compressive strength of not less than 21 Mpa (**3100 psi**) in 28 days.
- (d) The air content of the concrete shall be between the limits of 5.5 to 10 percent.
- (e) Maximum density of the concrete shall be 1840 kg/m³ (**115 pounds per cubic foot**).
- (f) Calcium chloride may be added to the mixture to accelerate hardening, at the rate of not more than 1.0 kg (**2.2 pounds**) maximum of commercial product per 50 kg (**110 pounds**) of cement.

A2 Reinforcement

The reinforcement may be bars conforming to 3301, held in place by wire hoops, or it may be steel fabric conforming to 3303 and providing the same strength as the specified number of bars.

B Manufacture

The units shall be cast to the dimensions shown on the Standard Plate to which reference is made in the Contract.

Any metal disks or caps that are required will be furnished to the manufacturer by the Department, in such quantities as may be required from time to time.

The concrete shall be thoroughly consolidated by hand-tamping or by vibrating.

Curing shall be in accordance with 3661.2D.

3667.3 SAMPLING AND TESTING

The Materials Engineer is the Engineer with authority regarding this Specification.

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A Compressive Strength Tests

Three standard cylinders, for use in testing the compressive strength of the concrete, shall be cast in the presence of and under the supervision of the Engineer in accordance with AASHTO T 23 and tested in accordance with AASHTO T 22 for each 100 monuments or fraction thereof in any one order.