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REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
OFFICE OF THE SECRETARY
MANILA

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DEPARTMENT ORDER)	**SUBJECT:** **DPWH Standard Specifications for Erosion Control Mats, Roving, and Cellular Confinement Systems, Item 512**
No. 35)	
Series of 2006 07.26.06)	
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In line with the mandate of the Department in providing effective standard specifications to be used in the implementation of various infrastructure projects and in view of the need of setting standard specifications for erosion control mats, roving, and cellular confinement systems the attached **DPWH Standard Specifications for Erosion Control Mats, Roving, and Cellular Confinement Systems, Item 512**, are hereby prescribed for the guidance and compliance of all concerned.

These specifications shall form part of the revised edition of the DPWH Standard Specifications (Volume II - Highways, Bridges and Airports).

This order shall take effect immediately.

HERMOGENES E. ERDANE, JR.
Acting Secretary

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DPWH STANDARD SPECIFICATIONS FOR

ITEM 512 - EROSION CONTROL MATS, ROVING, AND CELLULAR CONFINEMENT SYSTEMS

512.1 Description

This item shall consist of furnishing and placing erosion control mats, roving, and cellular confinement systems installed at the locations designated for ditch and slope protection, and stabilization, in accordance with this specification and in conformity with the lines, grades, dimensions, and arrangements shown on the plans or as directed by the Engineer.

512.2 Materials Requirements

512.2.1 Erosion Control Mats

Erosion control mats shall conform to the specifications as shown below:

512.2.1.1 Type 1 – Straw mats, burlap fabric, jute mesh, and woven paper or sisal mesh netting

1. *Straw mats* - shall be clean agricultural straw made from oats, wheat, rye, or other grain crops that is free from weeds, mold, or other objectionable material and furnished in an air-dry condition suitable for placing with mulch blower equipment. Straw erosion control mat shall conform to Table 1 as shown below:

Table 1
Straw Erosion Control Mat

Material	Property	Specification
Straw(1)	Moisture Content, g/m^2, min.	240
Netting	Photodegradable netting on one side 5 – 20 mm square mesh(2), kg/100 m^2, min.	1.5

(1) Moisture content shall not exceed 20 percent
(2) Dimensions are approximate and may vary to meet manufacturer's standards.

2. *Burlap fabric* – shall have a standard weave and a mass of 145 ± 20 grams per square meter.

3. *Jute mesh* – shall have a uniform open plain weave fabricated from jute yarn that does not vary in thickness by more than half its normal diameter. Jute mesh shall conform to the following:

Mesh size	25 by 25 mm max.
Mesh mass, ASTM D1776	0.5 kg/m^2 ± 5%

4. *Woven paper or sisal mesh netting* – Mesh netting of woven paper or woven sisal twisted yarn shall conform to the following:

Mesh openings	3 to 6 mm
Shrinkage after wetting	20% max.

512.2.1.2 Type 2 – Straw and coconut mats, excelsior blanket, or mulch blanket

1. *Straw and coconut mats* – a mat consisting of straw and undyed untreated biodegradable jute, coconut coir, and synthetic polypropylene fibers or other approved yarn woven into a plain weave mesh. Straw and coconut mats shall conform to Table 2 as shown below:

Table 2
Straw and Coconut Mat

Material	Property	Specification
Straw(1) 70%	Moisture Content, g/m^2, min.	240
Coconut 30%	Moisture Content, g/m^2, min.	240
Netting	Photodegradable netting on both sides 16 – 25 mm square mesh(2), kg/100 m^2, min.	1.5

(1) Moisture content shall not exceed 20 percent
(2) Dimensions are approximate and may vary to meet manufacturer's standards

2. *Excelsior blanket* – shall be of uniform thickness consisting of curled wood excelsior secured on the top side to a biodegradable, photodegradable extruded plastic mesh and

shall have smolder resistant without the use of chemical additives. Excelsior blanket shall conform to the following:

Excelsior fibers ≥ 200 mm length	80% min.
Mesh size	25mm by 50mm
Blanket mass/area	0.53±0.05 kg/m^2

3. *Mulch blanket* – shall be 3 to 13 mm thick blanket consisting of organic, biodegradable mulch such as straw, curled wood cellulose, coconut coir, or other material evenly distributed on one side of a photodegradable, polypropylene mesh having a minimum mass of 0.27 kg/m^2.

512.2.1.3 Type 3 – Coconut mat

Coconut mat – shall consist of undyed untreated biodegradable jute, coconut coir, and synthetic polypropylene fibers or other approved yarn woven into a plain weave mesh with approximately 16 to 25 mm^2 openings. Coconut mat shall conform to Table 3 as shown below:

Table 3
Coconut Mat

Material	Property	Specification
Coconut(1) 100%	Moisture Content, g/m^2, min.	240
Netting	Photodegradable netting on one side 16 – 25 mm square mesh(2), kg/100 m^2, min.	1.5

(1) Moisture content shall not exceed 20 percent
(2) Dimensions are approximate and may vary to meet manufacturer's standards.

512.2.1.4 Type 4 – Synthetic erosion control mats and meshes

1. *Synthetic mat* – A flexible mat produced by machine, consisting of polyolefin monofilament fibers positioned between 2 biaxially oriented nets. Mechanically bind the nets together by parallel stitching with polyolefin thread to form a 3-dimensional web-like weave, highly resistant to environmental and chemical deterioration. Synthetic mat shall conform to Table 4 as shown below:

Table 4
Synthetic Erosion Control Mat

Property	Specifications	Test Method
Color	Green	Visual
Thickness, mm, min.	6	ASTM D1777
Strength (1), N/m min.	1590 x 525	ASTM D5035
Elongation (1), %, max.	50	ASTM D5035
Porosity (2), %, min.	85	Calculated
Resiliency (3), %, min.	80	ASTM D1777
Ultraviolet stability(4), %	80	ASTM D4355

(1) Values for both machine and cross-machine directions under dry or saturated conditions. Machine direction specimen for 50 mm strip test includes one machine direction polyolefin stitch line centered within its width and extending the full width length of the specimen.
(2) Calculation based upon mass, thickness, and specific gravity.
(3) The percentage of original thickness retained after 3 cycles of a 690 kilopascal load for 60 seconds followed by 60 seconds without load. Thickness measured 30 minutes after load removed.
(4) Tensile strength retained after 1000 hours in a Xenon ARC weatherometer.

2. *Synthetic polypropylene mesh* – A flexible woven geotextile mesh fabricated from polypropylene fibers that were spun in one direction. Synthetic polypropylene mesh shall conform to Table 5 as shown below:

Table 5
Synthetic Polypropylene Mesh

Property	Specifications	Test Methods
Color	Beige	Visual
Mass, g/m^2, min.	59	ASTM D5261
Tensile Strength, N/m, min.	6700 x 3700	ASTM D5035
Elongation at break, %, max.	40	ASTM D5035
Mullen burst strength, kPa, min.	515	ASTM D3786

3. *Synthetic mulch control netting* – A uniformly extruded, rectangular, plastic mesh netting with 50 by 50 mm nominal mesh openings and weighing at least 8 grams per square meter.

4. *Organic mulch control netting* – A leno weave mesh netting fabricated from 12.7 kg biodegradable cellulose fiber yarn having 5 twists per 25 mm. Make the size of the mesh grid 13 to 25 mm^2. Finish the selvedge to prevent raveling or fraying.

512.2.1.5 Type 5 – Turf reinforcement mats

Turf reinforcement mats – A web of mechanically or melt bonded polymer netting, monofilaments, or fibers that are entangled to form a strong and dimensionally stable mat. Bonding methods include polymer welding, thermal or polymer fusion, or the placement of fibers between 2 high-strength, biaxially oriented nets mechanically bound together by parallel stitching with polyolefin thread and is resistant to biological, chemical, and ultraviolet degradation. Turf reinforcement mats shall conform to Table 6 as shown below:

Table 6
Synthetic Polypropylene Erosion Control Mat

Property	Specification	Test Method
Color	Black	Visual
Thickness, mm , min.	13	ASTM D1777
Tensile Strength [(1)], N/m, max.	1370 x 790	ASTM D5035
Elongation [(1)], %, max.	50	ASTM D5035
Porosity [(2)], %, max.	90	Calculated
Resiliency [(3)], %, min.	80	ASTM D1777
Ultraviolet stability[(4)], %, min.	80	ASTM D4355
Functional Longevity	5 years	Observed

(1) Values for both machine and cross-machine directions under dry or saturated conditions using 50 mm strip method.
(2) Calculation based upon mass, thickness, and specific gravity.
(3) The percentage of original thickness retained after 3 cycles of a 690 kilopascal load for 60 seconds followed by 60 seconds without load. Thickness measured 30 minutes after load removed.

(4) Tensile strength retained after 1000 hours in a Xenon ARC weatherometer.

512.2.2 Emulsified Asphalt

Emulsified asphalt shall conform to the applicable requirements of Item 304, Bituminous Surface Treatment.

512.2.3 Cellular Confinement Systems

A flexible honeycomb 3-dimensional structure fabricated from polyethylene that has been properly stabilized with carbon black and/or hindered amine light stabilizers.

512.2.4 Roving

Types of Roving

1. *Fiber glass roving* – Fiber glass roving shall be formed from continuous fibers drawn from molten glass, coated with a chrome-complex sizing compound, collected into strands and lightly bound together into roving without the use of clay, starch, or like deleterious substances. Roving shall be wind into a cylindrical package approximately 300 mm high so it can be continuously fed from the center of the package through an ejector driven by compressed air and expanded into a mat of glass fibers on the soil surface. Roving containing petroleum solvents or other agents known to be toxic to plant or animal life shall not be used. Fiber glass roving shall conform to the following:

Strands/rove, end count	56 to 64
Fibers/strand, end count	184 to 234
Fiber diameter (trade designation G), ASTM D578	0.009 to 0.013 mm
m/kg of rove, ASTM D578	340 to 600 m/kg
km/kg of strand, ASTM D578	26.2 to 2.82
Organic content, ASTM D578	1.65% max.

2. *Polypropylene roving* – Polypropylene roving shall be formed from continuous strands of fibrillated polypropylene yarn. Roving shall be winded into a cylindrical package so that it can be continuously fed from the outside of the package through an ejector driven by compressed air and expanded into a mat of polypropylene strands. The material shall not contain agents that are toxic to plant or animal life. Polypropylene roving shall conform to the following:

Tensile strength, ASTM D2256	15.6 N
Elongation at break, ASTM D2256	15.5%
Mass of strand, ASTM D1907	360 denier

Strands per rove, measured	24
UV stability, ASTM D4355	50% retained after 200 hours

512.2.5 Topsoil

Topsoil shall conform to the requirements of Item 608, Topsoil, of the DPWH Standard Specifications, Volume II.

512.2.6 Turf Establishment

1. *Agricultural limestone*

Agricultural limestone shall conform to the requirements of Item 609, Subsection 609.2.3, Ground Limestone, of the DPWH Standard Specifications, Volume II.

2. *Fertilizers*

Fertilizers shall conform to the requirements of Item 609, Subsection 609.2.2, Fertilizers, of the DPWH Standard Specifications, Volume II.

3. *Mulch*

Straw – shall be made from oats, wheat, rye, or other grain crops that is free from weeds, mold, or other objectionable material and in an air-dry condition suitable for placing with mulch blower equipment.

Hay – shall be made from herbaceous mowing, free from weeds, mold, or other objectionable material. Furnish hay in an air-dry condition suitable for placing with mulch blower equipment.

Wood fiber – shall *be* processed from wood chips that is as follows:

a. Colored with a green dye non-injurious to plant growth
b. Readily dispersible in water
c. Nontoxic to seed or other plant material
d. Free of growth or germination inhibiting substances
e. Free of weed seed
f. Air dried to an equilibrium moisture content of 12±3 percent
g. Packaged in new labeled containers
h. Packaged in a condition appropriate for mixing in a homogeneous slurry suitable for application with power spray equipment

Grass straw cellulose fiber – shall be processed from grass straw fiber, as follows:

a. Colored with a green dye non-injurious to plant growth
b. Readily dispersible in water
c. Nontoxic to seed or other plant material
d. Free of growth or germination inhibiting substances
e. Free of weed seed
f. Air dried to a moisture content of 10±0.2 percent
g. Air dried to a uniform mass of 15 percent
h. Packaged in new containers labeled with the manufacturer's name and air-dry mass
i. Packaged in a condition appropriate for mixing in a homogeneous slurry suitable for application with power spray equipment

Peat moss – shall be a granulated sphagnum peat moss conforming to the following:

Sticks, stones, and mineral matter	0%
Partially decomposed stems and leaves of sphagnum	75% min.
Color	brown
Textured from porous fibrous to spongy fibrous	
pH	3.5 to 7.5
Air-dried	

Mature compost – shall be a partially decomposed organic material, such as leaves, grass, shrubs, and yard trimmings, cured for 4 to 8 weeks. Maturity is indicated by temperature stability and soil-like odor. *Also shall be* friable, dark brown, weed-free, and pathogen-free mature compost conforming to the following:

Carbon/nitrogen ratio	25/1 to 35/1
Carbon/phosphorus ratio	120/1 to 240/1
pH	6.0 to 7.8
Water content	40% max.
Particle size	
Seeding and sodding	12 mm max.
Erosion control	25 mm max.
Organic material	50% min.
Man-made inserts (plastic, glass, metal)	2% max.

Straw for hydroseeding – shall be clean agricultural straw milled to 25 mm or less in length. Dry the fibers to 10% moisture for compaction. Bale in heat-sealed plastic bags.

Bonded fiber matrix hydromulch – shall be a mixture of long-wood fibers and bonding agent which when hydraulically applied and dried produce a matrix conforming to the following:

a. Does not dissolve or disperse when wetted.

b. Holds at least 1000 grams of water per 100 grams of dry matrix.
c. Has no germination or growth inhibiting factors.
d. Forms no water insensitive crust.
e. Contains material that is 100 percent biodegradable.

512.3 Construction Requirements

512.3.1 Erosion Control Mats (Type 1, 2, 3, 4, and 5)

Install erosion control mats according to the manufacturer's recommendations.

Install erosion control mats to soil surfaces which are at final grade, stable, firm, and free of rocks or other obstructions. Spread erosion control mats evenly and smoothly, without stretching, to ensure direct contact with the soil at all points. Unroll erosion control mats parallel to the drainage flow direction. Lap edges as recommended by the manufacturer. Place the upslope end in a 150 mm vertical slot. Backfill the slot and compact.

For swale or ditch installations, place up the side slopes to extend above anticipated flow line and construct intermediated 150 mm vertical check slots at 8 m intervals. Construct check slots perpendicular to flow direction. Staple erosion control mats as recommended by manufacturer. Drive all staples flush with the soil surface.

Repair damaged areas immediately. Restore the soil in damaged areas to finished grade, refertilize, and reseed.

Synthetic erosion control mats and meshes (Type 4) shall be installed after turf establishment is in place.

Turf establishment mats (Type 5) shall be installed before turf establishment is in place. After seeding, lightly brush or rake 15±5 mm of topsoil into the mat voids to fill the mat thickness.

512.3.2 Roving

Furnish a pneumatic ejector capable of applying roving at a rate of 0.9 kilograms per minute. Furnish an air compressor capable of supplying 1.1 cubic meters per minute at 620±70 kilopascals, complete with air hoses necessary for supplying air to areas not accessible to the compressor. Furnish an asphalt distributor with necessary hoses and a hand spray bar for slopes and other areas not accessible to the distributor.

513.3.2.1 Fiber Glass Roving

Spread fiber glass roving uniformly at the rate of 0.16±0.03 kg/m^2 to form a random mat of continuous glass fibers.

513.3.2.2 Polypropylene Roving

Spread polypropylene roving uniformly at the rate of 0.08±0.03 kg/m^2 to form a random mat of continuous polypropylene fibers.

Anchor the roving to the ground with a slow setting emulsified asphalt applied uniformly at a rate of 1.5±0.2 liters per square meter over the roving. Bury upslope end of the roving 300 mm deep.

512.3.3 Cellular Confinement Systems

Excavate to the depth of the cellular confinement systems, and smooth and compact the slope. Install the top of the system flush or lower than the adjacent slope. Expand the cellular confinement systems down the slope. Connect adjacent cellular confinement systems sections with hog rings or staples every other cell.

Anchor the system with stakes across the top at every other cell. Repeat the anchoring pattern in every tenth row and in the bottom row.

Backfill the system with topsoil. Hand-compact the topsoil within each cell. Apply permanent turf establishment.

512.4 Acceptance Requirements

512.4.1 Certification

The manufacturer shall file with the purchaser a certificate stating the name of the manufacturer, the chemical composition of the filaments or yarns, and other pertinent information so as to fully describe material (including mats, roving and other cellular confinement systems) for erosion control, ditch and slope protection, and stabilization. The manufacturer shall include in the certificate a guarantee stating that the material that is furnished meets the requirements of the specification. The certificate shall be attested to by a person having legal authority to bind the company. Either mismarking or misinterpretation by the manufacturer shall be reason to discontinue acceptance under these specifications. Notice sent to the manufacturer by the purchaser regarding the discontinuance of acceptance will be considered to be notice to all wholesalers, jobbers, distributors, agents and other intermediaries handling the manufacturer's product.

512.4.2 The Engineer shall evaluate acceptance for the material for topsoil through visual inspection and comply with the requirements of Item 608, Topsoil.

512.4.3 The Engineer shall evaluate acceptance for turf establishment work through visual inspection and certification as prescribed in Subsection 512.4.1, Certification.

512.5 Quality Control

The manufacturer of the material is responsible for establishing and maintaining a quality control program so as to assure compliance with the requirements of this specification.

512.6 Shipment and Storage

512.6.1 During periods of shipment and storage, the material shall be protected from direct sunlight, ultraviolet rays, temperatures greater than 60°C (140°F), mud, dust, and debris. To the extent possible, the material shall be maintained wrapped in a heavy-duty protective covering. Each shipping document shall include a notation certifying that the material is in accordance with the manufacturer's certificate and guarantee previously filed with the purchaser.

512.6.2 Product Marking

Label the material and its container with the manufacturer's name, material's type or trade name, lot number and quantity.

512.7 Method of Measurement

512.5.1 Erosion control mats, roving, and cellular confinement systems shall be measured by the number of square meters excluding overlaps.

512.5.2 Topsoil will be measured and paid for as provided in Item 608, Topsoil.

512.5.3 Turf establishment will be measured on the following applicable methods:

512.5.3.1 Seeding and mulching will be measured by the number of square meters.

512.5.3.2 Fertilizer, dry method will be measured by the metric ton.

512.8 Basis of Payment

The quantities determined as provided above shall be paid for at the contract price per unit of measurement, respectively, for each pay item listed below.

Payment shall be made under:

Pay Item Number	Description	Unit of Measurement
512 (1)	Erosion Control Mat Type ___	Square Meter
512 (2)	Roving	Square Meter
512 (3)	Cellular Confinement Systems	Square Meter

References

1. **DPWH Standard Specification** (Volume II) Highways, Bridges and Airport
2. **Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects** 1996
3. **ASTM**
4. **AASHTO**

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