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06.29.2016

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

28 JUN 2016

DEPARTMENT ORDER)
)
NO. 142)
Series of 2016 06.29.16)

SUBJECT: Amendment to DPWH Standard Specification for Item 622 – Coconet Bio-Engineering Solutions

It has been the thrust of the Department to provide effective standard specifications in the implementation of various infrastructure projects. As such, there is a need to set an upgraded standard specification for bio-engineering materials for controlling soil erosion and slope stabilization. The attached amendment to **DPWH Standard Specification for Coconet Bio-Engineering Solutions, Item 622** (*henceforth renamed as "Coconet Bio-Engineering Technology")* is hereby prescribed, for the guidance and compliance of all concerned.

This specification shall form part of the revised 2012 edition of the DPWH Standard Specifications (Volume II – Highways, Bridges and Airports).

This Order shall take effect immediately.

ROGELIO L. SINGSON
Secretary

14.1.2 FET/RPF

Department of Public Works and Highways
Office of the Secretary
WIN6U01331

DPWH STANDARD SPECIFICATION FOR ITEM 622 - COCONET BIO - ENGINEERING TECHNOLOGY

622.1 Description

This item covers installation of coconut bio-engineering materials such as coconets, cocologs, cocotwines and cocopeat for controlling soil erosion caused by surface runoff and stabilizing slope in accordance with the cross section shown on the plans or as directed by the Engineer. This shall include treatment of embankments and cut slopes in roads construction.

622.2 Definition

For the purpose of this item, the following terms shall be defined:

a. Coconut Bio-Engineering Technology – the use of coconut materials to stabilize slopes and minimize soil erosion or restore and maintain the land damaged by erosion in a natural condition by placing the materials in sloping lands and embankments to hold the vulnerable soil and permit vegetation to control surface erosion and conserve the productivity of the soil.

b. Bio-engineering solution – any aspect of bio-engineering technology used in a particular instance such as material, technique, patterns, and others.

c. Coconut Bio–engineering materials - any coconut husk-based materials such as coconets, cocologs, cocopeat, placed in sloping lands and embankments to hold the vulnerable soil and permit vegetative growth to control surface erosion and conserve the productivity of the soil.

d. Coir – fibers from coconut husks.

e. Coconet – mechanically and or manually spun coir fiber twine woven into blankets of different density and size.

f. Cocolog –a tubular structure of coconut coir fiber blankets of different diameter filled with coco coir and cocopeat.

g. Cocotwine – a string made of coir strands mechanically and or manually twisted together.

h. Cocopeat –natural and residual materials or dust from coconut husk which serves as soil conditioner or growing medium.

i. Live plants - refer to woody plants such as trees or shrubs propagated through cuttings such as madre de cacao.

622.3 Material Requirements

622.3.1 Coir

Coir for use in making of coconets and cocologs shall be of Grades CH-3 and/or CH-2 in accordance with PNS/BAFPS 21:2008 ICS 59.060.10.

622.3.2 Coconet and Cocolog

Coconet and Cocolog to be used shall conform with Tables 1 and 2, respectively.

Table 1
Physical Properties of Coconet

PROPERTIES		COCONET 400	COCONET 700	COCONET 900
Minimum thickness, mm		10.0 ± 1.0	10.0 ± 1.0	10.0 ± 1.0
Minimum width, m*		1.0	1.0	1.0
Minimum length, m*		25.0	25.0	25.0
Weight per square meter, g/m^2 at 18-24% MC		400 ± 20	700 ± 35	900 ± 45
Diameter of twine, mm (mechanically or manually spun)		5.0 ± 1.0	5.0 ± 1.0	5.0 ±1.0
No. of twines/m, (min)	Crosswise Direction**	40	40	70
	Lengthwise Direction***	40	70	70
		Woven netting made from high strength 100% coconut fiber twine		
Color		Natural Earth Tone		
Tensile Strength, N/twine, (min)		150	150	150
Elongation, (min)	(Machine Direction), %	26	34	42
	(Cross Machine Direction), %	32	38	32
"C" Factor		0.002	0.002	0.002
Applicability in terms of water velocity (surface run-off), m/s, (min)		2.7	3.35	4.26
Water Absorption, %, (min)		163	146	132
Applicability in terms of slope inclination		Less than or equal to 1:1 (45° and below)	Greater than 1:1 to 1:1.5 (46° to 60°)	Greater than 1:1.5 (61° to 70°)

Note: ** In cases where the needed width or length are below the minimum, cutting is allowed either crosswise or lengthwise provided that the ends of every two succeeding cut twines are securely locked by tying together.*
*** weft-the crosswise twines on a loom over and under which other twines are passed;*
**** warp-the lengthwise twines on a loom over and under which the weft are passed;*
"C" Factor - Safety factor

Table 2
Physical Properties of Cocolog

Type of Cocolog	Diameter (mm)	Weight (min.) (Kg/m)	Maximum Water Velocity (Surface runoff) Resistability, m/sec
Cocolog 100	100	2.0	1.5
Cocolog 200	200	4.5	2.0
Cocolog 300	300	10	3.0
Cocolog 400	400	20	4.0
Cocolog 500	500	30	Above 4.0

Note: All cocologs must be made of 100% coir fiber netting with at least 2.5 cm eye and filled with 60% Grade E cocopeat covered with 40% Grade CH-W coir.

622.3 .3 Backfill

Backfill shall be in accordance with the approved Plan and shall conform to the requirements of Item 104 – Embankment.

622.3.4 Bamboo Stakes

Bamboo stakes shall be matured with head measuring at least 60 mm wide and 30 mm long; notch, at least 20 mm; and body, at least 40 mm wide and 300 mm long tapered and sharpened at the end. The head shall coincide with the bamboo nodes to ensure strength. Stakes shall be embedded on ground so that only the notch sticks out from the top of the coconets to hold the coconets in place. For cocologs, stakes length equivalent to 1.5 times the diameter shall be added.

622.3.5 Live Plant Stakes (Live Kakawate "madre de cacao" or Ipil-Ipil or Equivalent Species)

Live plant stakes shall be kept moist and planted within the day when prepared and shall be 20 mm to 40 mm in diameter and 300 to 500 in length for cut slope and 500 mm to 1,000 mm in length for embankments.

622.4 Construction Requirements

622.4.1 Quality Control

The geonets manufacturer shall be responsible for establishing and maintaining a quality control program to assure compliance with the requirements of this Specification.

622.4.2 Equipment

Equipment and tools necessary for handling materials and performing all parts of the works shall be approved by the Engineer as to design, capacity and mechanical condition. The equipment shall be at the jobsite sufficiently ahead of the start of construction operations.

622.4.3 Site Measurement

The area to be installed with coconets and cocologs shall be measured based on approved Plans to determine the appropriate dimensions of coconets (in square meter) and cocologs (in linear meter) to be installed.

622.4.4 Site Preparation

Site for coconet installation shall be graded and sloped to the approved design then flattened, compacted, and smoothened and any run-off control such as diversions, dikes and berms shall be completed prior to installation. All depressions/gullies and eroded portions shall be backfilled and compacted for the coconets to snugly come in contact with the soil surface. Likewise, the face of the slope shall be flattened, compacted and smoothened. Rocks, clods, vegetation (deemed detrimental to the erosion control system to be installed), and other obstructions shall be removed from tip to toe of the slope to ensure complete contact of the coconets with the soil. Existing vegetations that are considered not detrimental shall be retained, but shall be trimmed down to facilitate the installation of the coconets.

The Contractor shall be responsible to ensure appropriate site preparation. To ensure that the area is appropriately prepared for coconet installation, the Engineer shall issue Notice to Proceed for bio-engineering solution activity.

622.4.5 Anchoring

All anchoring materials shall be installed at right angles (perpendicular to the ground surface) based on the approved Plan or as directed by the Engineer. Live plant (cutting) and bamboo stakes shall be used. The bamboo stakes shall serve as temporary anchor while vegetation is growing. Stakes shall fix the corners of the area to be covered. The stakes shall be planted in such a way that only 100 mm stick out from the top of either the coconets or cocologs installed in order to minimize any disturbance thus facilitate faster growth. In addition, stakes used for cocologs shall be embedded at least 150 mm on the ground which means that the standard length of stakes for cocologs is equivalent to 250 mm plus the diameter of the cocologs.

622.4.5.1 Anchoring the Coconets

622.4.5.1.1 Leading Coconet Edges at the Topmost Berm

The leading edges of the coconets at the top of the slope shall be fixed and secured to the ground by using five (5) bamboo stakes per lineal meter.

622.4.5.1.2 Coconets in Downslopes

The coconets placed downslope shall be fixed and secured to the ground by bamboo and live stakes to ensure direct and even contact of coconets to the ground surface.

a. Common Soil

Bamboo stakes to be used shall be fixed alternately at an interval of 50 cm across and 30 cm down the slope starting at the uppermost corner where the coconets shall be rolled down. Live plant cuttings shall be planted at 3 stakes per square meter, fixed at about 10 cm to either left or right of the bamboo stakes or as per approved Plan or as directed by the Engineer.

Longer stakes shall be used in loose soils to have sufficient ground anchorage and prevent pullout.

b. Compacted Soil

A combination of bamboo stakes and at least 6 mm U-shaped wire staples shall be used for compacted, hard to penetrate soil. An average of 3 stakes /staples per square meter shall be used to ensure uniform contact of coconet to the ground surface.

c. Hard Rock

The coconets shall be anchored to solid rock surfaces using at least 5 stakes per square meter of U-metal stake pins with a minimum diameter of 6.0 mm and length of 200 mm to 300 mm.

622.4.5.1.3. Ending Coconets in Slope Toes and Sides

The last stakes across the slope shall be fixed at a distance which is a fraction of 50 cm from the preceding stakes while the last stakes down the slope shall be fixed at a distance which is a fraction of 30 cm from the preceding stakes. Spacing and interval of stakes should be in accordance with the approved Plans or as per instruction or directed by the Engineer.

622.4.5.2 Anchoring the Cocologs

Cocologs shall be firmly secured to the ground using bamboo and live stakes fixed at the center crosswise and at the sides lengthwise. The center stakes shall be installed starting at a point 50 cm from the edge of the first cocolog and at an interval of one (1) meter thereafter. Side stakes shall be installed in pairs starting at the edge of the cocologs at an interval of 30 cm thereafter. The last of either center or side stakes are installed 10 cm from the edge of the last cocolog in a row, the distance from the preceding stakes being a fraction of the prescribed interval. The pairs of side stakes shall be tied with cocotwine looped at least 5 times and locked closely through knots. Bamboo stakes are also placed beside the live stakes at 50 mm distance along the cocologs.

The last cocolog shall be cut to the desired area dimensions. In this case, it is necessary to tie and lock with knots opposite twines at the cut portion.

622.4.6 Installation / Placing of Coconets

The coconets shall be used on critical cut slopes, embankments and disturbed soils generally steeper than 3:1, where water velocities (surface runoff) are likely to wash out soils and new vegetation. Coconets shall be placed and anchored on the graded surface of the slope to maximize net contact with the slope surface and laid on a 30 cm by 50 cm trench which shall be covered with soil after the nets are laid and anchored.

Installation shall begin at a distance 50 cm from the top edge of the slope with the leading edge of the coconets laid across a 1.1 m trench (30 cm each side and 50 cm width) and folded back. The leading edge shall be anchored according to Subsection 622.4.5.1, Anchoring the Coconets covered with soil, and then unrolled towards the edge of the slope downwards, thereby making an overlap of 1.1 m.

The bottom edge should extend about 30 cm from the last stakes then folded underneath at 10 cm from the edge and embedded or covered with approximately 25 cm soil to prevent dislodging and eventual hanging. Likewise, the edge of the coconets across the slope shall be folded to about 10 cm to prevent twines to loose especially if the coconuts are cut. In case the coconets are cut to the desired width, the twines shall be locked by tying the pair of consecutive twines with knot.

Adjacent coconets shall be installed side-by-side and shall be sewn together every 50 mm using cocotwine only. The coconet shall then be fastened and secured firmly to the ground in accordance to Subsection 622.4.5, Anchoring. The coconets shall not be stretched.

622.4.7 Installation / Placing of Cocologs

When necessary, cocologs shall be used in conjunction with coconets installation to reduce long slopes and as major stopper of downward movement of soil as rainwater carries them downslope.

622.4.7.1 At Topmost Berm

The cocologs shall be installed at least 50 cm from the edge of the slope, above the coconets. At least 1/2 the diameter of the cocologs shall be embedded.

622.4.7.2 Along the Slope

It shall be placed across and at the middle of the slope on contour and shall be pegged to the ground with bamboo and live kakawate stakes. For slopes with loose soil, the cocologs shall be installed on trenches. The trench shall be deep enough to accommodate embedment of at least 1/2 the diameter of the cocologs in order to effectively dissipate runoff energy. Contour interval shall be a maximum of 7 m depending on the steepness of the slope and the erodibility of the soil. The last cocolog shall be cut to the desired area dimensions. The loose and opposite twines of the cut cocolog shall be tied and locked with knots.

622.4.8 Placing of the Cocopeat as Soil Conditioner or Growing Medium and CH-W Grade Coir as Cover.

Prior to the installation of coconets, cocopeat shall be spread evenly on the slope to at least 10 mm thickness then raked and thumped. Thereafter, CH-W grade coir as classified in PNS/BAFPS 74:2009 ICS 65.080 shall be spread evenly at least 5 mm to cover the coco peat applied. The use of cocopeat shall ensure appropriate soil moisture and nutrient supply to stabilize the root system of the vegetation while the CH-Wcoir cover holds the cocopeat in place or prevent cocopeat to be dislodged. This is called the "triple armor" method of bio-engineering which is most appropriate for an effective slope stabilization and erosion control.

622.4.9 Vegetation

Vegetation is necessary to stabilize slopes where applicable:

1. Slopes with common and compacted soil

Vetiver grass (Vetiveriazizanoides) shall be planted on the slopes of common and compacted soil at a minimum of 6 slips per square meter combined with peanut grass (Arachispentoi) at 8 cuttings per square meter.

2. Slopes with Hard Rock

Leguminous/cover crops such as kudzu (Puerariasp), calopogonium (Calopogoniummucunoides) and centrosema (Centrosemapubescens) shall be planted on rocky/hard soil in combination with vetiver grass planted on the coco logs at a minimum of 3 slips per linear meter.

622.4.10 Performance Monitoring

Post project monitoring shall include checking on any breaks of the installed coconets especially at the point of junctions, the growth of grasses and the manifestation of any failure of germination of plants and the sudden outburst of rain that might have inflicted damaged to some sections. Repair works shall be done on damaged sections of the slope and replacement of all plants shall be done in case of mortality within the warranty period.

Watering, weeding and fertilization may be done subject to the discretion of the Contractor's bio-engineer or plant specialist. Maintenance activities shall be terminated upon the recommendation and certification of the bio-engineer and the approval of the DPWH after the warranty period.

622.5 Certification

The manufacturer shall file with the purchaser a certificate stating the name of the manufacturer, the composition of the coconet as bio-engineering materials and other pertinent information so as to fully describe the coir materials. The manufacturer shall include in the certificate a guarantee stating that the bio-engineering materials that are furnished meet the required Specifications. The certificate shall be attested by a person having legal authority to bind the company. Either mismarking or misinterpretation by the manufacturer shall be a reason to discontinue acceptance under these Specifications. The

discontinuance of acceptance will be considered to be notice to all wholesalers, jobbers, distributors, agents and other intermediates handling the manufacturer's product.

622.6 Method of Measurement

The area to be paid for under this Item shall be the number of square meter (m^2) of coconet, linear meter for cocolog, square meter (m^2) of live vetiver grass hedgerow and square meter (m^2) of effective vegetative growth for grass cover, installed / placed and accepted into the completed project.

622.7 Basis of Payment

The accepted quantity, measured as prescribed in Section 622.6, Method of Measurement shall be paid based on the contract unit price for bio-engineering technology. Such price and payment shall consist of the full compensation for the site preparation, supply of all materials installed, all installation, labor, maintenance of vegetation, equipment, tools and incidental costs necessary to complete the Item.

Payment will be under:

Pay Item Number	Description	Unit of Measurement
622(1)	Coconets***	Square meter
622(2)	Cocologs	Linear meter
622(3)	Vegetation	Square Meter

****Coconet includes cocopeat and CH-W coir.*