

**भारतीय मानक ब्यूरो**

**BUREAU OF INDIAN STANDARDS**

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*भारतीय मानक मसौदा*

**वस्त्रादि — कटाव नियंत्रण अनुप्रयोगों के लिए बिना बुने हुए जटा के सिले मिश्रित  
भू-वस्त्र — विशिष्ट**

*Draft Indian Standard*

**Textiles — Coir Non-woven Stitched Composite Geotextiles for Erosion Control  
Applications — Specification**

ICS 59.080.70

Geosynthetics Sectional Committee, TXD 30

Last date for receipt of comment is  
**19 August 2024**

**FOREWORD**

*(Formal clauses will be added later)*

Coir non-woven stitched composite geotextiles (CNWGT) is natural coir matrix stitched with polypropylene (PP), high-density polyethylene (HDPE) or low-density polyethylene (LDPE) netting on both sides as a homogenized fabric. Acting as a barrier between soil surfaces and rainfall, CNWGT mitigates erosion caused by rainwater and wind on road and railway embankments, mine spoil dumps, and hill slopes. By impeding surface runoff, it prevents the displacement of soil particles containing seeds and nutrients, thus facilitating the growth of vegetation and stabilizing slopes. The selection of CNWGT for a geotechnically stable slope against surface run off, basically depends on type of soil, slope and extreme rain fall in limited time span. The impact of raindrops and surface wind on exposed soil surfaces can trigger surface runoff, carrying away soil particles along with seeds and nutrients, inhibiting natural vegetation growth.

CNWGTs are permeable fabrics made from natural coir fiber with netting on both sides stitched with mono filament or multi filament yarn, controls soil erosion by providing a protective ground cover which is in firm contact with soil and arrests the surface flow of rain water, reducing rain splash erosion and controlling the flow velocity of runoff water.

The village roads where the traffic is less are usually unpaved. The deformation of unpaved road on soft sub grade will be higher due to high axial loads. The sub-grade strength is normally expressed in terms of its California Bearing Ratio (CBR) value. During rainy season in the absence of any bond between different layers of soil particles, the fine soil particles may penetrate from one layer to another. Due to high hydrostatic pressure which leads to formation of large depression or potholes. Also due to poor bearing capacity of the soil foundation the sub-base soil undergoes large deformation. To prevent local shear failure, either increase the thickness of the base layer or improve the sub grade through stabilization. Another effective measure is the application of coir non-woven stitched composite geotextiles, which can improve the characteristics of unpaved roads.

## **1 SCOPE**

**1.1** This standard prescribes the specifications and guidelines for the coir non-woven stitched composite geotextiles made of a layer of bio-degradable coir blanket sandwiched between two layers of polypropylene/high-density polyethylene/low-density polyethylene (PP / HDPE / LDPE) netting used in rainwater or wind erosion control application in slopes of road and railway embankments, mine spoil dumps in hill slopes or earth work and road construction.

**1.2** This standard does not apply to other types of erosion control mats made from natural material such as jute, straw and polymer fibers.

## **2 REFERENCES**

The standards listed in Annex A contain provisions, which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated in Annex A.

## **3 TERMINOLOGY**

For the purpose of this standard, the following definitions shall apply.

**3.1. Coir non-woven stitched composite geotextiles** — Open structure coir non-woven stitched composite geotextiles made out of Coir fibre made in to non-woven matrix with polypropylene/high-density polyethylene/low-density polyethylene (PP/HDPE/LDPE) netting and stitched with mono or multifilament polypropylene/high-density polyethylene/low-density polyethylene yarn together as a homogenized composite geotextile.

**3.2 Mulch** — Mulch refers to any material that would be decomposed fully or partially over a period of time and serving as a nutrient to the vegetation that is being nurtured. The mulch has a short-term role to play and not a long-term role in soil stabilization.

## **4 TYPES**

**4.1** Coir non-woven stitched composite geotextiles shall be of the following types based on the mass:

- a) *Type I*— Having mass 300 g/m<sup>2</sup>;
- b) *Type II*— Having mass 450 g/m<sup>2</sup>; and
- c) *Type II*— Having mass 550 g/m<sup>2</sup>.

In addition to above types, specialized coir non-woven stitched composite geotextiles can also be manufactured as per the agreement between the buyer and seller.

4.2 Table 1 shows the types of coir non-woven stitched composite geotextiles and their respective suitability for different slope conditions.

**Table 1 Slope Suitability of Coir Non-woven Stitched Composite Geotextile for Different Slope Conditions**

(Clause 4.2)

Sl No. (1)	Type of CNWGT (2)	GSM Min (3)	Suitability (4)
i)	I	300	1H:2V slopes
ii)	II	450	1H:2V slopes and low to medium flow channels
iii)	III	550	1H:1V slopes and medium to high flow channels

## 5. MANUFACTURE, WORKMANSHIP AND FINISH

5.1 Coir fibre made in non-woven matrix sandwiched between two polypropylene/high-density polyethylene/low-density polyethylene (PP/HDPE/LDPE) netting and all three (bottom netting, coir fibre and top netting) is stitched together with polypropylene/high-density polyethylene/low-density polyethylene (PP/HDPE/LDPE) monofilament or multi filament yarn in the coir stitch blanket making machine. The coir fiber used for manufacturing the CNWGT shall be homogeneously blended and evenly distributed throughout the mat.

5.2 Coir non-woven stitched composite geotextiles shall be stitched using UV stabilized polyester/polypropylene/high density polyethylene monofilament or multi filament yarn. The stitching thread shall have minimum linear density of 700 denier and a minimum tenacity of 5 gpd. The stitching shall be uniform without any loose thread. The distance between two rows of stitches shall not be more that 60 mm with a minimum stitch density of 2 stitches/dm.

## 6 DIMENSIONS AND TOLERANCE

6.1 The length and width of coir non-woven stitched composite geotextiles shall be as given in Table 2.

**Table 2 Length and Width Requirement for Coir Non-Woven Stitched Composite Geotextiles**  
(Clause 6.1)

SI No.	Characteristics	Requirement	Tolerance Percent
(1)	(2)	(3)	(4)
i)	Length, m	20 to 70 or as agreed	+3
ii)	Width, m	1.2 to 5 or as agreed	-1

## 7 REQUIREMENT

7.1 The coir non-woven stitched composite geotextiles shall meet the requirements as given in Table 3.

**Table 3 Requirements of Coir Non-woven Stitched Composite Geotextiles**  
(Clause 7.1)

SI No	Characteristics	Requirement (s)			Method of test, Ref to
		(3)	(4)	(5)	
(1)	(2)	(3)	(4)	(5)	(6)
		Type I	Type II	Type III	
i)	Thickness, mm, <i>Min</i> (at 2kPa)	4	5	6	IS 13162 (Part 3)
ii)	Mass per unit area, g/m <sup>2</sup> , <i>Min</i>	300	450	550	IS 14716
iii)	Wide width tensile strength (Dry), kN/m, <i>Min</i>				IS 16635
	a) Machine direction	1.5	2.0	2.5	
	b) Cross machine direction	1.0	1.5	2.0	
iv)	Elongation at break (Dry), Percent, <i>Min</i>				IS 16635
	a) Machine direction	20	20	15	
	b) Cross machine direction	15	15	15	
v)	Water absorption, Percent, <i>Min</i>	160	160	160	IS 15868 (Part 4)
vi)	Light Transmittance, Percent, <i>Min</i>	16	7	5	Annex C of IS 16008 (Part 1)

7.2 The netting used for coir non-woven stitched composite geotextiles shall meet the requirements as given in Table 4.

**Table 4 Requirements for Netting**  
(Clause 7.2)

SI No.	Characteristic	Requirement	Method of test, Ref to
(1)	(2)	(3)	(4)
i)	Material	Polypropylene/high density polyethylene/low density polyethylene	IS 667
ii)	Mass per unit area, g/m <sup>2</sup> , <i>Min</i>	8	IS 14716
iii)	Wide width tensile strength, kN/m, <i>Min</i> a) Machine direction b) Cross machine direction	0.8 0.8	IS 16635
iv)	Elongation at break, percent, <i>Min</i> a) Machine direction b) Cross machine direction	14 15	IS 16635
4	Mesh size, mm	10 to 25	—

**7.3** The guidelines for selection and installation of coir non-woven stitched composite geotextiles are given in Annex B. A comprehensive guidance on selecting vegetation species specific to different applications, needs and challenges is given in Annex C. It covers information and recommendations for grasses suitable for soil moisture conservation (SMC) and slope stabilization, species specifically used for nitrogen enrichment in mine areas, and a selection of plant species well-suited for stabilizing overburden dumps and mine pits.

## 8 SAMPLING AND CRITERIA FOR CONFORMITY

### 8.1 Lot

The number of rolls of coir non-woven stitched composite geotextiles of the same size, type and quality delivered to a buyer against one dispatch note shall constitute a lot.

**8.2** The number of rolls of coir non-woven stitched composite geotextiles to be selected at random shall be according to column 2 and column 4 of Table 5. To ensure the randomness of selection, IS 4905 may be followed.

**Table 5 Selection of Rolls for Testing**  
(Clauses 8.2, 8.3 and 8.3.1)

SI No.	Lot Size (No. of Rolls)	Sample Size (No. of Rolls of Coir non woven stitched composite geotextiles)	Permissible Number of Non-conforming Rolls	Sub-Sample Size

i)	(1)	(2)	(3)	(4)
ii)	Up to 50	3	2	0
iii)	51 to 150	5	0	2
iv)	151 to 300	8	1	3
v)	301 to 500	13	2	5
vi)	501 and above	20	3	5

### 8.3 Number of Tests and Criteria for Conformity

**8.3.1** The conformity of a lot to the requirements of the standard, shall be determined on the basis of the tests carried out on the sample selected from the lot as indicated in Table 6.

**Table 6 Number of Tests and Criteria for Conformity**

(Clause 8.3.1)

SI No.	Characteristics	Number of Samples	Criteria for Conformity
i)	Length, width, mesh opening, thickness, mass per unit area	According to col 2 of Table 5	All the test pieces shall meet the requirement.
ii)	Breaking strength, material, water absorption, light transmittance	According to col 4 of Table 5	Number of non-conforming pieces shall not exceed the corresponding number given in column 3 of Table 5

## 9 MARKING AND LABELLING

The rolls of coir non-woven stitched composite geotextiles shall be marked with the following by attaching the printed labels:

- i) Manufacturer's name, initials or trademark;
- ii) Batch /lot number;
- iii) Name of the material with type of the coir non-woven stitched composite geotextiles, that is Type I/Type II/Type III;
- iv) Type of netting used for manufacture of coir non-woven stitched composite geotextiles;
- v) Month and year of manufacture;
- vi) Dimensions (length and width) of coir non-woven stitched composite geotextiles;
- vii) The country of origin; and
- viii) Any other information/instruction provided by the manufacturer/required under law.

## **10 PACKING**

The coir non-woven stitched composite geotextiles shall be supplied in roll form and each roll shall be packed securely so as to allow normal handling and transport without tearing and exposing the contents. The rolls shall be labeled or tagged to provide product identification sufficient for field identification as well as inventory and quality control purpose. Details of the packing shall be as agreed to between the buyer and the seller.

## **11 BIS Certification Marking**

The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act, 2016* and the Rules and Regulations framed thereunder, and the product(s) may be marked with the Standard Mark.

## **12 STORAGE AND HANDLING**

**12.1** During storage, rolls of coir non-woven stitched composite geotextiles shall be elevated off the ground and adequately protected against the following:

- a) Site construction damage;
- b) Excessive precipitation;
- c) Extended exposure to sunlight;
- d) Aggressive chemicals;
- e) Flames or temperatures in excess of 71° C;
- f) Excessive mud, wet concrete, epoxy, or other deleterious materials coming in contact with and affixing to the material;
- g) Any other environmental condition that may damage the physical properties.

**12.2** The coir non-woven stitched composite geotextiles shall be stored at temperatures above -5° C and below 50° C

**12.3** Coir non-woven stitched composite geotextiles shall be stored in a manner which protects them from adverse impact of weather. If stored outdoors, they shall be elevated and protected with an appropriate cover.

**12.4** The coir non-woven stitched composite geotextiles rolls shall be laid flat.

**ANNEX A**  
(Clause 2)

**LIST OF REFERRED STANDARDS**

<i>IS No.</i>	<i>Title</i>
667 : 1981	Methods for identification of textile fibres ( <i>first revision</i> )
4905 : 2015	Random sampling and randomization procedures ( <i>first revision</i> )
13162 (Part 3) : 2021	Geosynthetics — Determination of thickness at specified pressure (part 3) single layers ( <i>first revision</i> )
14716 : 2021	Geosynthetics — Test method for the determination of mass per unit area of geotextiles and geotextile-related products ( <i>first revision</i> )
15868 (Part 1 to 6) : 2008	Natural fibre geotextiles (jute geotextile and coir bhoovastra) — Methods of test
16008 : (Part 1) : 2016	Agrotextiles — Shade nets for agriculture and horticulture purposes — Specification (Part 1): shade nets made from tape yarns ( <i>first revision</i> )
16635 : 2017	Geosynthetics — Wide-width tensile test



**ANNEX B**  
(Clause 7.3)

**B-1 GUIDELINES FOR SELECTION AND INSTALLATION OF COIR NON-WOVEN STITCHED COMPOSITE GEOTEXTILES**

**B-1.1 SELECTION OF COIR NON-WOVEN STITCHED COMPOSITE GEOTEXTILES**

The choices of coir non-woven stitched composite geotextiles basically depend on the type of soil to be protected. It requires to be ensured primarily that the slope to be protected from rainwater erosion is geo-technically stable. It also required considering the extreme rainfall in a limited time span at that location as the intensity of rainfall is more important than the average annual rain fall. It is recommended that the choice of coir non-woven stitched composite geotextiles should be limited to Type I coir non-woven stitched composite geotextiles, where intensity of rainfall and surface wind are mild irrespective of type soil and slope is <1:1.

**B-2 INSTALLATION METHOD OF COIR NON-WOVEN STITCHED COMPOSITE GEOTEXTILES IN SURFACE EROSION CONTROL IN ROAD AND RAILWAY EMBANKMENTS AND HILL SLOPES.**

**B- 2.1** The stages of laying of woven coir non-woven stitched composite geotextiles on slopes for rain water or surface wind erosion control are as under.

**B-2.1.1** The slope should be made free from undulations, soil slurry, mud and sharp projections and compacted with additional earth where necessary.

**B-2.1.2** Anchoring trenches should be excavated at the top and toe of the slope (300 mm x 300 mm). The top trench should be sufficiently away from the edge of the slope considering the stability of the slope.

**B-2.1.3** The selected coir non-woven stitched composite geotextiles should be unrolled across the top trench and along the slope downward, caring to see that it touches the soil surface at all points.

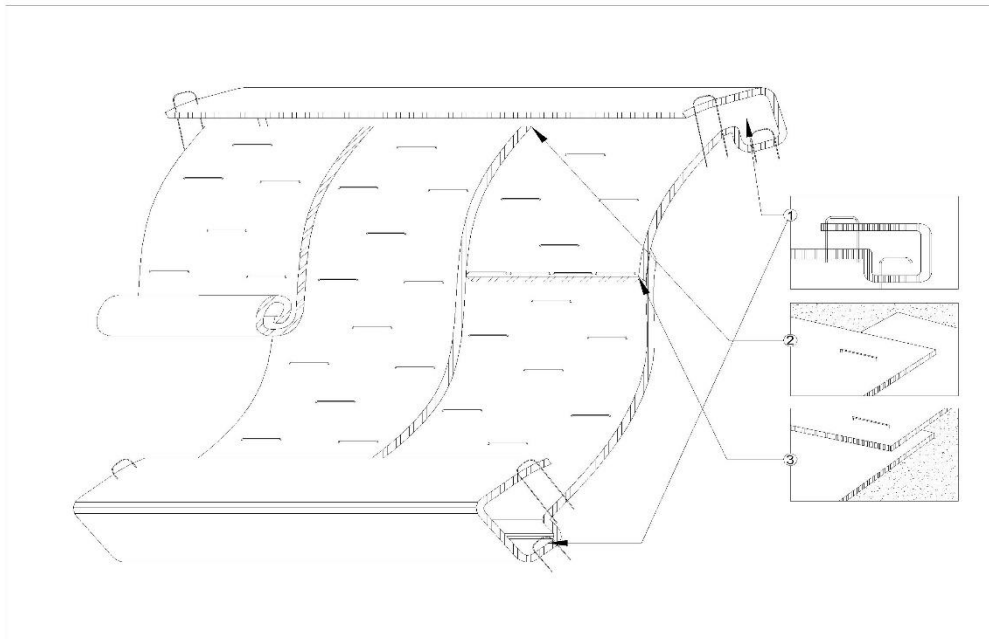


FIG. 1 LAYING METHOD FOR COIR NON-WOVEN STITCHED COMPOSITE GEOTEXTILES AND PIN POSITION

**B-2.1.4** Overlaps should be minimum 300 mm at sides and ends (*see* Fig. 1). The coir non-woven stitched composite geotextiles at the higher level on the slope should be placed over level. Side overlaps of a coir non-woven stitched composite geotextiles piece should be placed over its next piece on one side and under the next piece on the other.

**B-2.1.5** The coir non-woven stitched composite geotextiles should be fixed in position by steel staples (usually of 11 gauge diameter, and minimum 300 mm of length of penetration) as shown in the Fig. 2 or by spilt bamboo pegs. Stapling should be done normally at an interval of 1000 mm both in longitudinal and transverse directions. Special care should be taken to staple the coir non-woven stitched composite geotextiles within the anchoring trenches both at the bottom and at the sides (*see* Fig 1 and Fig.2)

**B-2.1.6** The anchoring trenches should be filled up with brick-bats/soil for preventing displacement of the coir non-woven stitched composite geotextiles. Care should be taken that the overlaps are not displaced during installation.

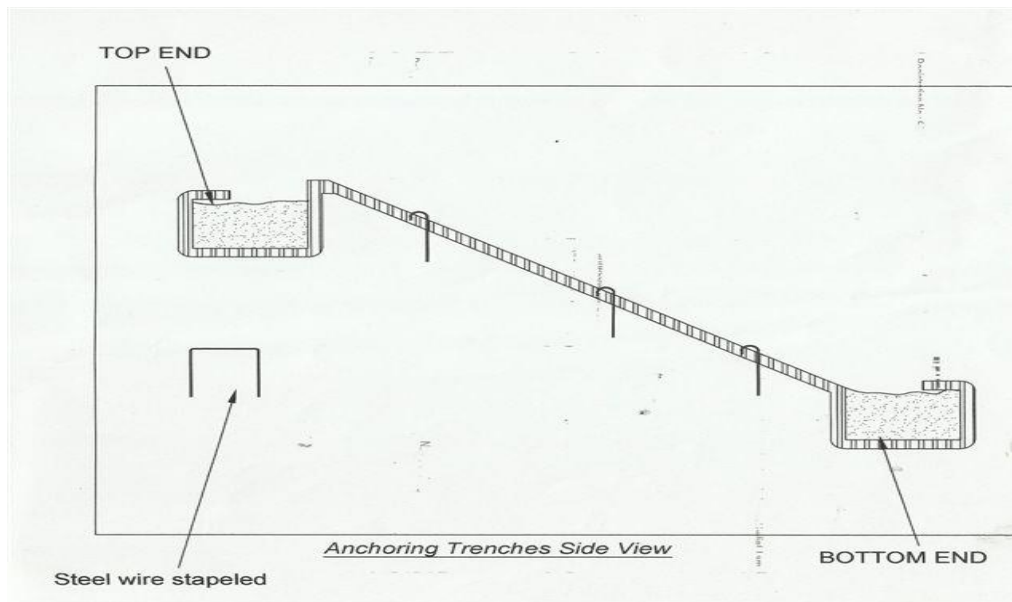


FIG.2 STAPLING OR PEG INSERTION

**B-2.1.7** Care should be taken to ensure that the coir non-woven stitched composite geotextiles are not damaged due to puncture, tear and other operational stresses.

**B-2.1.8** Seeds of vegetation (grass, legumes etc., of appropriate variety, preferably local vegetation) should then be spread (refer to Annex B for guidance in selecting the species of vegetation and refer to Annex C for recommended grasses, plants and trees). If seeds are not available, saplings of the appropriate plant species may be planted at suitable intervals through the opening of the coir non-woven stitched composite geotextiles. Hydro seeding with seeds can also be adopted.

**B-2.1.9** In special circumstances, a second dose of seeds may be spread with dibbling of locally available grass.

**B-2.1.10** Installation should be completed preferably before the monsoon to take advantage of the rains for quick germination of seeds.

### **B-3 INSTALLATION METHOD OF COIR NON-WOVEN STITCHED COMPOSITE GEOTEXTILES IN SURFACE EROSION CONTROL IN MINE SPOIL DUMPS**

**B-3.1** The stages of laying of coir non-woven stitched composite geotextiles in water/surface wind erosion control in mine spoil dumps are as under

**B-3.1.1** The slope should be made free from undulations, soil slurry, mud and sharp projections and compacted with additional earth where necessary.

**B-3.1.2** Anchoring trenches should be excavated at the top and toe of the slope (of size minimum 300 mm<sup>2</sup>). The top trench should be minimum 2 meter away from the edge of the slope.

**B-3.1.3** The selected coir non-woven stitched composite geotextiles should be unrolled across the top trench and along the slope downward, caring to see that it touches the soil surface at all points.

**B-3.1.4** Overlaps should be minimum 300 mm at sides and ends (*see* Fig 3). The coir non-woven stitched composite geotextiles at the higher level on the slope should be placed over level. Side overlaps of a coir non-woven stitched composite geotextiles piece should be placed over its next piece on one side and under the next piece on the other.

**B-3.1.5** The coir non-woven stitched composite geotextiles should be fixed in position by steel staples as shown in the Fig.2 (usually of 11 gauge diameter and minimum 300 mm penetration) or by spilt bamboo pegs. Stapling should be done normally at an interval of 1000 mm both in longitudinal and transverse directions. Special care should be taken to staple the coir non-woven stitched composite geotextiles both at the bottom and at the sides (*see* Fig 3).

**B-3.1.6** The anchoring trenches should be filled up with brick-bats/soil for preventing displacement of the coir non-woven stitched composite geotextiles. Care should be taken that the overlaps are not displaced during installation.

**B-3.1.7** Care should be taken to ensure that the coir non-woven stitched composite geotextiles are not damaged due to puncture, tear and other operational stresses.

**B-3.1.8** Seeds of vegetation (grass, legumes, etc. of appropriate variety, preferably locally available) should then be spread (refer to Annex B for guidance in selecting the species of vegetation and refer to Annex C, D and E for recommended grasses, plants and trees). If seeds are not available, saplings of the appropriate plant species may be planted at suitable intervals through the opening of the coir non-woven stitched composite geotextiles.

**B-3.1.9** In special circumstances, a second dose of seeds may be spread with dibbling of locally available grass.

**B-3.1.10** Proper wetting has to be done for the germination of the seeds or saplings.

## **B-4 MONITORING**

**B-4.1** Close monitoring should be done for at least one season cycle.

**B-4.2** The treated area should be kept out of bounds for cattle and other grazing animals till the time of maturity of vegetation.

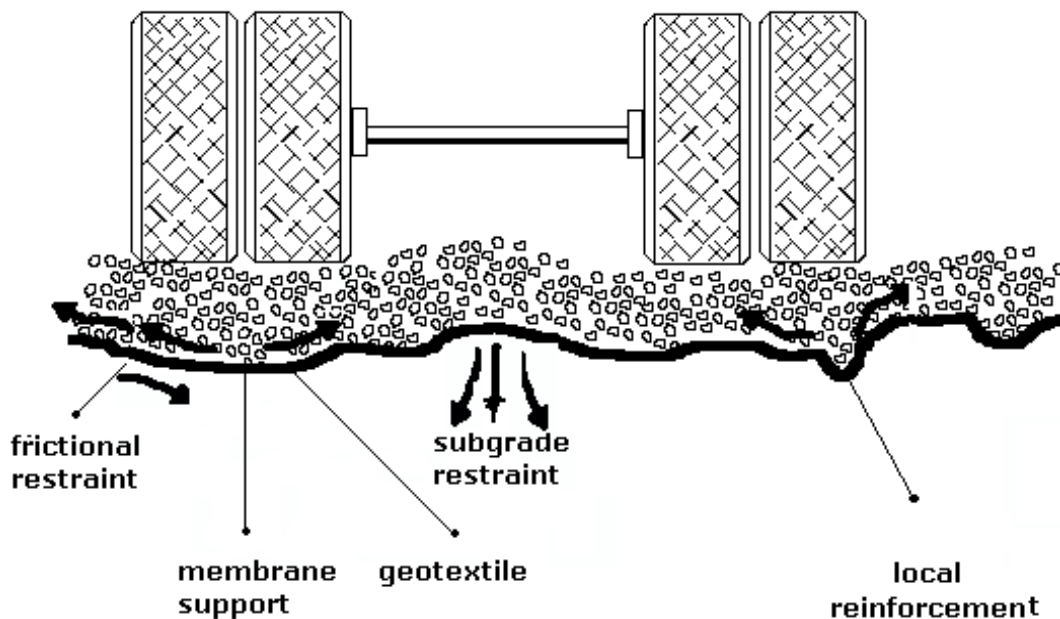
**B-4.3** The damage and displacement of coir non-woven stitched composite geotextiles should be noted for corrective action. Torn portions of the coir non-woven stitched composite geotextiles should be covered with new pieces of coir non-woven stitched composite geotextiles of identical specification duly stapled at all sides.

**B-4.4** Watering/maintenance of identical specifications duly stapled at all sides.

**B-4.5** Advice should be sought from specialist to find out cause of unsatisfactory growth of vegetation. The advice should be implemented. Withered plants should be replaced. Species of vegetation needs to be selected carefully considering the local soil and climatic conditions.

## B-5 INSTALLATION METHOD OF COIR NON-WOVEN STITCHED COMPOSITE GEOTEXTILES IN EARTH WORK AND ROAD CONSTRUCTION

**B-5.1** Unpaved roads are used as a temporary or permanent access depending upon conditions. Coir non-woven stitched composite geotextiles will be an ideal geotextile for the unpaved roads. In order for a coir non-woven stitched composite geotextile to perform beneficially in road stabilization applications the fabric must not only be properly designed it must be properly installed, must be cleared of sharp objects, which could puncture the geotextiles. Nonwoven stitched composite geotextile damaged during placement, or installed in a highly wrinkled condition will not perform. Nonwoven stitched composite geotextile maintain integrity during the course of its life. The aggregate overlay must be placed to its full design depth, and it must apply in a manner that will not cause damage to nonwoven stitched composite geotextile from movement of construction equipment. The main functions of the coir nonwoven stitched composite geotextile in unpaved road application are separation, filtration/drainage and reinforcement



### B-5.2 INSTALLATION

**B-5.2.1** The area over which the coir non-woven stitched composite geotextiles is to be placed must be cleared sharp objects, tree stumps or large stones that could puncture coir non woven stitched composite geotextiles. The area should be excavated, stripping away soft soil or unsuitable base materials, then compacted to design grade.

**B-5.2.2** The coir non-woven stitched composite geotextile is unrolled on to the prepared subgrade in the direction that aggregate will be placed. The coir non-woven stitched composite geotextiles sections must be overlapped side-to-side and end-to-end around 450mm. The edges of coir non-woven stitched composite geotextiles should slope towards drainage ditches or other drain systems that parallel the roadway. Granular material can now be back dumped

on to the coir non-woven stitched composite geotextiles beginning on firm ground just in front of the coir non-woven stitched composite geotextiles.

**B-5.2.3** The aggregate is then spread to a thickness sufficient to allow subsequent compaction. Initial compaction can be accomplished and then fully compacted. Ruts must not be graded down; rather, they should be filled with additional aggregate and compacted.

### **B-6.3 SELECTION OF COIR NON-WOVEN STITCHED COMPOSITE GEOTEXTILES**

**B-6.3.1** The choices of coir non-woven stitched composite geotextiles basically depend on the type of pavement to be protected. It is recommended that the choice coir non-woven stitched composite geotextiles should be limited to Type II.

## **ANNEX C** (Clause 7.3)

### **GUIDANCE IN SELECTING THE SPECIES OF VEGETATION**

The vegetation species for their use in different soil types, specific site conditions are listed in the following table:

<i>Sl No.</i>	<i>Name of the species</i>	<i>Suited for</i>
1	Chrysopogon zizanioides (khus - khus)	All type of soil
2	Avicennia officinalis	Shrub suitable for marshy places
3	Rhizophora Mucrunata	Shrub suitable for marshy places
4	Cyperus Exaltatus	Grass suitable for highway slopes
5	Acrostichum Aureum	Shrub suitable for dam sites
6	Adiantum spices	Shrub suitable for dam sites
7	Cyanodon dactylon	For light sandy soils
8	Cenehurs ciliaris	For most types of soil
9	Eragrostis curuvla	For protecting terraces and channels
10	Dianthus annulatum	For light soil
11	Pennisetum pedicellatum	Sandy loam soil
12	Both rochola glabra	For red semi arid soil
13	Stylosanthis gracilis	For light soils with low moisture
14	Stylosamthis gusineusis	For light and medium soil with low moisture
15	Pucraria hirsute	Cover crop suited to alluvial soil and For hills in humid climate
16	Pennisetum purpureum	For hill slopes
17	Peuraria hirsta	Cover crop suited to alluvial soil

**GRASSES RECOMMENDED FOR SOIL MOISTURE CONSERVATION (SMC)  
AND SLOPE STABILIZATION**

The grass species recommended for their use and effectiveness in soil moisture conservation (SMC) and slope stabilization are listed in the following table:

<i>Sl No.</i>	<i>Species</i>	<i>Propagation method</i>
1	<i>Bambusa arundinacea</i>	Rhizome/Seeds
2	<i>Bothriochloa pertusa</i>	Seeds
3	<i>Chrysopogon fulvus</i>	Slips
4	<i>Cymbopogon citratus</i>	Slips/Seeds
5	<i>Cymbopogon flexuosus</i>	Slips
6	<i>Cymbopogon martini</i>	Slips
7	<i>Cymbopogon nardus</i>	Slips
8	<i>Chrysopogon zizanioides</i> (khus - khus)	Slips
9	<i>Cynodon dactylon</i>	Rhizome/Seeds
10	<i>Dendrocalamus strictus</i>	Rhizome
11	<i>Dichanthium annulatum</i>	Seeds
12	<i>Eleusine indica</i>	Slips/Seeds
13	<i>Heteropogon contortus</i>	Slips/Seeds
14	<i>Pennisetum pedicellatum</i>	Seeds
15	<i>Saccharum spontaneum</i>	Slips

**SPECIES RECOMMENDED FOR NITROGEN ENRICHMENT OF MINE AREAS**

The vegetation species which are recommended for nitrogen enrichment of mine areas based on their ability to improve soil fertility and promote ecological restoration in these challenging environments are listed in the following table:

<i>Sl No.</i>	<i>Species</i>	<i>Family</i>	<i>Habit</i>
1	<i>Cassia auriculata</i>	Caesalpinaceae	Shrub
2	<i>Cassia hirsuta</i>	Caesalpinaceae	Shrub
3	<i>Cassia mimosoides</i>	Caesalpinaceae	Herb
4	<i>Cassia occidentalis</i>	Caesalpinaceae	Herb
5	<i>Cassia tora</i>	Caesalpinaceae	Herb
6	<i>Crotalaria albida</i>	Fabaceae	Herb
7	<i>Crotalaria juncea</i>	Fabaceae	Herb
8	<i>Crotalaria retusa</i>	Fabaceae	Herb
9	<i>Crotalaria verrucosa</i>	Fabaceae	Herb
10	<i>Indigofera cassioides</i>	Fabaceae	Shrub
11	<i>Mimosa pudica</i>	Mimosaceae	Herb
12	<i>Stylosanthes fruticosa</i>	Fabaceae	Herb
13	<i>Tephrosia purpurea</i>	Fabaceae	Herb
14	<i>Tephrosia villosa</i>	Fabaceae	Herb

**PLANT SPECIES SUITABLE FOR OVER BURDEN DUMP AND MINE PIT  
STABILIZATION**

Plant species suitable for overburden dump and mine pit stabilization, prevent erosion and restore ecological balance in disturbed mining areas. The list of such species is given in the following table:

<i>Sl No.</i>	<i>Plant species</i>	<i>Family</i>	<i>Habit</i>
1	<i>Acacia catechu</i>	Mimosaceae	Tree
2	<i>Acacia chundra</i>	Mimosaceae	Tree
3	<i>Acacia nilotica</i>	Mimosaceae	Tree
4	<i>Aegle marmelos</i>	Rutaceae	Tree
5	<i>Agave Americana</i>	Agavaceae	Shrub
6	<i>Agave sisalana</i>	Agavaceae	Shrub
7	<i>Albizia lebbeck</i>	Mimosaceae	Tree
8	<i>Albizia odoratissima</i>	Mimosaceae	Tree
9	<i>Albizia procera</i>	Mimosaceae	Tree
10	<i>Annona squamosa</i>	Annonaceae	Tree
11	<i>Anogeissus latifolia</i>	Combretaceae	Tree
12	<i>Azadirachta indica</i>	Meliaceae	Tree
13	<i>Bauhinia racemosa</i>	Caesalpiniaceae	Tree
14	<i>Boswellia serrata</i>	Burseraceae	tree
15	<i>Bothriochloa pertusa</i>	Poaceae	Herb
16	<i>Calotropis gigantean</i>	Asclepiadaceae	Shrub
17	<i>Calotropis procera</i>	Asclepiadaceae	Shrub
18	<i>Cassia auriculata</i>	Caesalpiniaceae	Shrub
19	<i>Cassia fistula</i>	Caesalpiniaceae	Tree
20	<i>Chloroxylon swietenia</i>	Flindersiaceae	Tree
21	<i>Chrysopogon fulvus</i>	Poaceae	Herb
22	<i>Cymbopogon flexuosus</i>	Poaceae	Herb
23	<i>Cymbopogon martini</i>	Poaceae	Herb
24	<i>Cymbopogon nardus</i>	Poaceae	Herb
25	<i>Dalbergia latifolia</i>	Fabaceae	Tree
26	<i>Dalbergia sissoo</i>	Fabaceae	Tree
27	<i>Dendrocalamus strictus</i>	Poaceae	Shrub
28	<i>Dichanthium annulatum</i>	Poaceae	Herb
29	<i>Diospyros melanoxylon</i>	Ebenaceae	Tree
30	<i>Dodonaea viscosa</i>	Sapindaceae	Shrub
31	<i>Dolichandrone atrovirens</i>	Bignoniaceae	Tree
32	<i>Eleusine indica</i>	Poaceae	Herb
33	<i>Ficus racemosa</i>	Moraceae	Tree
34	<i>Ficus religiosa</i>	Moraceae	Tree
35	<i>Garuga pinnata</i>	Burseraceae	Tree



36	<i>Givotia rottleriformis</i>	Euphorbiaceae	Tree
37	<i>Gmelina arborea</i>	Verbenaceae	Tree
38	<i>Grewia tiliifolia</i>	Tiliaceae	Tree
39	<i>Haldina cordifolia</i>	Rubiaceae	Tree
40	<i>Hardwickia binata</i>	Caesalpiniaceae	Tree
41	<i>Heteropogon contortus</i>	Poaceae	Herb
42	<i>Holoptelea integrifolia</i>	Ulmaceae	Tree
43	<i>Lagerstroemia parviflora</i>	Lythraceae	Tree
44	<i>Limonia acidissima</i>	Rutaceae	Tree
45	<i>Madhuca longifolia var latifolia</i>	Sapotaceae	Tree
46	<i>Melia dubia</i>	Meliaceae	Tree
47	<i>Mitragyna parvifolia</i>	Rubiaceae	Tree
48	<i>Morinda pubescens</i>	Rubiaceae	Tree
49	<i>Pennisetum pedicellatum</i>	Poaceae	Herb
50	<i>Phyllanthus emblica</i>	Euphorbiaceae	Tree
51	<i>Pithecelobium dulce</i>	Mimosaceae	Tree
52	<i>Pongamia pinnata</i>	Fabaceae	Tree
53	<i>Pterocarpus marsupium</i>	Fabaceae	Tree
54	<i>Saccharum spontaneum</i>	Poaceae	Herb
55	<i>Santalum album</i>	Santalaceae	Tree
56	<i>Sehima nervosum</i>	Poaceae	Herb
57	<i>Soyimida febrifuga</i>	Meliaceae	Tree
58	<i>Stereospermum personatum</i>	Bignoniaceae	Tree
59	<i>Stylosanthes hamata</i>	Fabaceae	Herb
60	<i>Tamarindus indica</i>	Caesalpiniaceae	Tree
61	<i>Tecoma stans</i>	Bignoniaceae	Tree
62	<i>Terminalia bellirica</i>	Combretaceae	Tree
63	<i>Terminalia chebula</i>	Combretaceae	Tree
64	<i>Vitex negundo</i>	Verbenaceae	Shrub
65	<i>Wrightia tinctoria</i>	Rubiaceae	Tree
66	<i>Ziziphus mauritiana</i>	Rhamnaceae	Tree

## FORMAT FOR SENDING COMMENTS ON BIS DOCUMENT

(Please use A4 size sheet of paper only and type within fields indicated. Comments on each clause/sub-clause/table/fig. Etc. be stated on a fresh box. Information in Column 2 should include reasons for the comments and suggestions for modified wording of the clauses which the existing text is found not acceptable. Adherence to this format facilitates Secretariat's work)

NAME OF THE COMMENTATOR/ORGANIZATION .....

DOCUMENT NO : [Doc :TXD 30 (25914)]

<b>Item, Clause Sub- Clause No. Commented upon (Use Separate Box afresh)</b>	<b>Comments</b>	<b>Specific Proposal (Draft clause to be add/amended)</b>	<b>Remarks</b>	<b>Technical References on which (2), (3), (4) are based</b>
(1)	(2)	(3)	(4)	(5)