Case studies on field trial of non-woven natural geo-textiles in reinforced vegetative bank protection

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Abstract: Needle punched non-woven fabric made from natural fibres can be used as a medium for growing of plant seeds. Roots of plants easily trap soil particles thereby preventing erosion. These Geo-fabrics are widely used as these are eco-friendly, economical and attractive nature and have been advantageously used for ideal erosion control of soil due to their biodegradability, nontoxicity, hygroscopicity and drapability. The present investigation is the basis of reports of field trials with Geo-naturals at several places of Indian soil.

1 INTRODUCTION

Today, the use of geosynthetics is increasingly being accepted as building and construction material not only in developed countries but also in the developing countries for soil erosion and other purposes.

Geo-natural non-wovens made of jute, coir, flax, ramie, pineapple, sisal, sunnhemp were used to see the vegetation establishment using grass seeds in the mat. Natural non-wovens have enough void in the fibrous structures. It can absorb water 5 times of its weight.Thus when geotextiles is applied some sort of microclimatic condition is developed in the adjacent areas which are very conducive to biological propagation. The natural materials are suitable for the use of topsoil erosion control.

In the application of geo-natural for erosion control purpose consideration for short term and long term may be taken into account. Short-term protection is given, solely by woven geonatural material to the soil surface, whereas long-term protection is afforded by vegetation. The vegetation covered geo-natural root reinforcing non-wovens can be ensured for long period of time and high velocity overland flow is anticipated. This paper highlights the reports of field trials with Geo-naturals at several places of Indian soil.

2 MATERIALS & METHODS

The Geo-natural non-wovens like, jute, ramie, pineapple, flax, sisal, coir were prepared at geo-textile unit, NIRJAFT. The penetration depth and punching density were kept 13 mm and 200 stitch per sq. cm. respectively.

The thicknesses of fabrics were 3 to 4 mm respectively. The average california bearing ratio with soil, tenacity, and cone bursting strength were measured as 10, 2.5 gm/tex and 33 Kg respectively. The moisture regain and water holding capacity were found to be 14% (at 65% R.H.) and 1.5 – 2 times of its own weight respectively.

The temperature, relative humidity and rainfall were recorded on every day of trial and found to vary as follows :

Tem - 25C – 30C
R.H. - 67 – 98%
Rainfall - 20mm – 25 mm.

3 BENCH SCALE FIELD TRIALS

The field trials were carried out in simulating conditions to investigate the effectiveness of different types of geo-nonwovens like “geo-jute, ramie, coir, sisal, flax” in protecting embankments and similar slopes from soil erosion due to heavy rainfall. The nonwoven samples were placed on each 0.6 m wide and 4 m on plot of a silty soil while all the plots were seeded with commercially available grasses.

The grass commenced to grow within a period of fifteen days. The grass length, number of grasses / sqm were recorded in 15 days intervals for 3 specified dates which were tabulated in Table –1 and observed that the growth and length of plants were higher with geo-natural in comparison with control areas (no fabric).

Effectiveness of jute specimen (plot-1) is observed to be better than using any other specimens for all specified time scale. Based on performances of geo-natural with seedling / sq m and length of grasses in cm, the geo-nonwovens can be ranked in order of increasing sensitivity to create microclimatic conditions for the stimulation to grasses in the following manner :

Jute > Ramie > Pineapple > Flax > Sisal > Coir > Control (no fabric)
(Plot-1 > P-2 > P-3 > P-6 > P-5 > P-4 > P-7)

Jute has been found to have higher moisture regain value in contrast to other fibres. The capacity of root reinforcing into the soil would help to catch the soil quickly thus to prevent erosion.

4 CASE - STUDIES WITH NON-WOVEN GEO-TEXTILES IN HEAVY RAINFALL ZONES OF INDIA

(a) Sobujdeep ghat (Hooghly District of West Bengal):

River bank protection works carried out with jute non-woven geo-textiles has brought success. The project was designed in the optics of making an extensive use of natural geo-textiles to compensate the lack of suitable conventional solution. All the major design decisions were supported by experimental information and or accepted method obtained and formulated of the agro-engineering field trials with natural geo-textiles.The general characteristics of soil obtained from top layer of the river side reveals that soil is grey/silt/silty clay. The consistency

of the sub-soil was very soft and one test sample from Sobujdeep-ghat site tested for the properties which was given in Table-2.

Natural three dimensional blanket matrix provides a pad of surface movements of run off with minimum disturbances. It moderates soil temperature, conserves moisture in the soil to nurture vegetable cover. It stimulates rapid root-development, soil erosion and flora establishment. On laying with geo-natural, grass started growing within the time frame while the area was under water at twenty feet deep during rainy season. After recession of water, the erosion was fully controlled along with effective silted layers of soils (about 4" to 10") deposited on the jute non-woven surface to that with no use of fabric.

(b) At Chor-Krishnabati (5 Km away from case a):

In one of the subprojects in continuation tp justify Sobujdeep project for consolidation at Ganga river side protection, the use of jute non-woven geo-textile to avail of the opportunity through vegetation for root reinforcing technique to catch soil particle, was foreseen for different functions and more precisely soil reinforcement to build reinforced slopes. Erosion control to protect the slopes affected by erosive phenomena separation & filtration for the construction of side drainage trenches using 400 g/m jute non-woven geo-textiles with following performance values at Table-3.

Soil is almost similar to Sabojdeep-ghat as distance between to experimental spot is only 5 Km. The sliding failure is observed over the entire slop area. After geo-jute non-woven laying in the same manner to that in case (a) the control of erosion was protected with better vegetation.

(c) Water conservation on Hilly slopes in Andaman Islands : The water retention capacity of soils being low and the moisture available for crops quickly deplete after cessation of rain, the hilly topography along with heavy rainfall (3100 mm per annum) induces soil erosion of high amount. In this project, an attempt has been made to study the effect of application of different eco-friendly materials as soil cover on the extent of soil erosion and residual moisture content in the hilly slopes of Andaman Islands. A sloppy land with average slope configuration of 30-40% was utilised with soil conservation materials like geo-jute, jute-sack, coir-rope netting, control. The geo-jute was effective in reducing soil-loss and enhancing in situ conservation of rain-water compared to other treatments.

Table 1. Field trial reports with Geo-natural Nonwoven

Geo-nonwovens Date recording	Control Fabric P-7	Pineapple P-3	Ramie P-2	Jute P-1	Flax P-6	Sisal P-5	Coir P-4
15.7.96 Seedling per Sq. m(Av)	160	200	215	250	190	173	150
Length of grass ,cm	15	24	28	30	21	19	19
30.7.96 Seedling per Sq. m(Av)	115	220	230	330	200	195	180
Length of grass ,cm	18	28	30	40	25	23	24
15.8.96 Seedling per Sq. m(Av)	140	250	270	350	240	210	200
Length of grass ,cm	25	40	45	60	34	30	32
Geo-nonwoven properties: Avg GSM – 400, Stitch density – 200 per sq.cm., Cone brusting strength 45-50 Kg, Penetration – 13 mm, Thickness – 3-4 mm, Tenacity – 2.2–2.4 g/tex.							

Table 2. Properties of Soil of Sabujdeep / Chorkrisnabati

Natural Moisture content	36%
Bulk Density	1.7 ton/m^2
Plasticity Index	22
Clay Fraction	38%
Apparent Cohesion Intercept(Kpa)	350
Effective angle of internal friction	$30^0 – 32^0$
From the grading curve of the top soil A.O.S numbers	D_{15} = 0.001 mm, D_{50} = 0.003 mm, D_{85} = 0.05 mm

Table 3. Performances of jute non-woven against geo-technical properties

1	Strength	2.5 gm/tex
2	Thickness	3.5 mm
3	CBR Value	0.5 –1.0 KN
4	Failure strength	25 %
5	Coefficient of permeability	10^{-3} - 10^{-2}
6	‘’ Transmitivity	10^{-4} - 10^{-3}
7	Bond-strength	0.65 gm/tex

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Photo 1. Observing growth of grass through the fabric 15 days later after layout (sabujdeep Project)

Photo 2. Geo-Jute nonwoven to control erosion (Charkrishnabati)

Photo 3. Application of geomat in progress (Andaman)