Development and Effective Applications of Jute Fibre Nonwoven Geotextiles

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ABSTRACT: A variety of nonwoven geo-jute fabrics have been developed based on two main functions of geo-technical end uses i.e. soil erosion and road construction. The different two types of nonwoven jute agri-geo-fabs have been developed which can be used for protection of soil erosion. The various jute:polypropylene (PP) blended nonwoven geo-jute fabrics have also been prepared to see the effect of blends with the treatment of urea-formaldehyde (U.F.) resin and its use for road constructions and to protect road damages.

1 INTRODUCTION

Jute, a natural, biodegradable, environmental friendly fibre has been used for nonwoven geo-textiles. This fibre has distinct advantages over the synthetic and provides cost effective geo-textiles produced for two main applications : (a) The mitigation of soil erosion (Pandey and Majumdar, 1989), (b) For separation, filtration and reinforcement where required life-span is short.

The Jute Technological Research Laboratory (JTRL) has developed nonwoven jute agri-geo-fabs to protect soil erosion and nonwoven jute:pp blended fabrics to reduce road damages with the help of needle loom technology (Gupta, 1988). For preparation of nonwoven jute agri-geo-fabs the plant seeds can be traped at the time of needle bonding for manufacturing the same fabrics. The germination of seeds start only after watering or spraying on the fabrics. This agri-geo-fabs can be laid on mountain/highway road side slopes for plantation and same time for protection of soil from heavy rainfall/winds/strom. It has been reported (Pandey and Majumdar, 1994) that out of five types of nonwoven geo-jute i.e. (a) Needle punched jute geo-textiles, (b) Jute sandwich between pp fabrics, (c) Chemical bonded jute geo-textiles, (d) Jute impregnated by bitumens and (e) Thermically bonded jute geo-textiles, the last one i.e. thermically bonded jute geo-textile has shown better performance than other four types against laboratory model testing for simulation of full scale applications to retard reflective cracking of roads.

The first part of the present work reported here is planned about nonwoven jute agri-geo-fabs and 2nd part of this paper to study the influence of blend ratio and U.F. resin treatment of needle punched geo-jute fabrics against geo-technical laboratory test methods (F.H.W.A., 1985) and to see the performance of same fabrics with a simulation condition of full scale application systems (Puig, Patien and Vecoven, 1990) which can be used to protect road damages.

2 EXPERIMENTAL PROCEDURE

2.1 Agri-geo-fabs to protect soil erosion

Needle punched 100% nonwoven jute agri-geo-fabs have been developed by bonding the cross laid webs, the plant seeds were entraped in the webs. Following three types of nonwoven jute agri-geo-fab were prepared. The details of mechanical and hydraulic properties of nonwoven jute agri-geo-fabs and effect as mulch treatment are given in Table 1.

Fabric (a) 100% jute nonwoven

Fabric (b) 100% jute+jute threads were reinforced at machine direction.

Fabric (c) 100% jute+jute net type of fabric, 6x4-115 g/m², was considered as reinforcing subtitute.

2.2 Nonwoven jute:pp blended fabrics to retard road damages

Table 1 Mechanical and hydraulic properties of needle punched agri-geo-fab(AGF) and effect as mulch treatment.

Test/Types of Fabrics	Fabric A	Fabric B	Fabric C
Area density (Gm/m^2)	100	150	200
Thickness(MM)	2.5	3	3.5
Water permeability ($Litre/m^2/sec$)	80	68	59
Tenacity, narrow width (g/tex)	1.3	1.7	2
C.B.R. value with fabric (without fabric-6)	8	11	14
Soil moisture after 10 days in percentage	25	27	30
Transplantable seedlings per Sq.Metre	400	415	425
Non transplantable seedlings per Sq.Metre	80	100	120
Weight of plant (GM)	15	11	8
Height of plant (GM)	10	8	7.5
Survival rate (%)	90	85	80

2.2.1 Development of untreated nonwoven jute:pp blended geo-jute

The various types of needle punched nonwovens were prepared from jute and pp at different blend ratio computed at Table 2.

2.2.2 Treatment with U.F. resin

The blended fabrics listed at Table 2 (D,E,F, G) were impregnated with U.F. resin (15% w/w) solution (H,I,J,K) and then dried at 80°C, speed 0.5 m/min, pressure - 20 kg/sq.m. (Luncnchloss and Albrecht, 1985).

3 RESULT AND DISCUSSION

3.1 Agri-geo-fabs to protect soil erosion

The mechanical and hydraulic properties of all three agri-geo-fabs have been in Table 1. The area densiy of fabric-c is the highest as it was a combination fabric made of woven and nonwoven. The thickness value of fabric, A is the lowest this fabric was prepared without any reinforcement. The water permeability of fabric-c is the lowest as compactness of this fabric was increased for using jute net fabric as reinforcing material. It has been observed, when the tenacity value has been increased, the C.B.R. value of the fabric also increased.

All these three geo-fabrics, were transported to a village horticulture nursery for conducting field trials to subject the fabrics to soil for comparison and effect as mulch treatments. Results of these activities have been given in Table 1. The soil moisture percentage after ten days has been recorded. The fabric-c shows highest moisture control as the area density and compactness of this fabric are better than the other two fabrics. The fabric has also shown better performances in the case of item-7 and 8 (Table 1) than the other two fabrics, i.e. no. of transplantable seedling per sq. metre and no. of non-transplantable seedling per sq. metre by this geo-fabric was higher than other two fabrics. In the other way, as because area density of fabric-A was less comparable to other two, it has shown better performance in items 9, 10 and 11 of Table 1, i.e. weight of plant (gm), height of plant (cm) and survival rate (%).

3.2 Mechanical and hydraulic properties of nonwoven U.F. resin treated and untreated jute:pp blended geo-jute to protect road damages

The analytical values of area density (g/m^2), thickness (mm) C.B.R. value, water permeability ($litre/m^2/sec$), ball bursting strength (kg), cone bursting strength (kg), (60°), pore size (μ)+, have been given in Table 2 for eight geo-jute fabrics. The area density of untreated samples D,E,F,G, are 310 g/m^2 in average but while the treated samples (H,I,J, K) with U.F. resin, showed increased value of area density i.e. average 350 g/m^2 when pp percentage have been increased in the blend ratio, thickness value also simultaneously increased as pp fibre helped to increase the bulkness character of the fabrics. The thickness value of the all treated samples have been reduced as all nonwoven geo-jute pressed at the time of impregnation. For the case of C.B.R. value, cyclic loading, cone (60°) bursting strength, ball bursting strength tests, it has been observed from Table 3, that all treated samples and with increase of higher percentage of pp showed better performance than untreated samples. It is observed that pore size (μ)+ values increased with increase in pp in the blends. The reason for this are :

i) when jute fibre comes in contact with water it swells and occupies the open area causing the decrease of porosity value.

ii) in the blend, pp is more finer than jute causing the increase of porosity value.

Further it is seen that U.F. resin treated nonwoven geo-jute with lower pore size value than untreated fabrics as resin occupied more open areas of the same samples. For this reason, water permeability constants are low in case of treated non-woven geo-jute samples.

Table 2 Mechanical and hydraulic properties of nonwoven geo-jute to protect road damages

Geo-jute nonwoven fabrics developed, blend ratio, jute:pp nedle punched, stich density 100 per sq.cm. penetration-10 mm

Tests/ Fabric No. with Blend ratio	Untreated D (100:0)	E (60:40)	F (40:60)	G (0:100)
1 Area density Gm/m²)	310	311	310.5	312
2 Thickness (MM)	6	6.5	7	7.5
3 Deformation	5	6	8	9
4 C.B.R. value with fabric (without fabric = 6.0)	10	12	13.5	15
5 Water permeability(Litre/ m²/sec)	89	90	94	95
6 Ball bursting strength(kg)	120	123	125	130
7 Cone bursting strength(kg) (60°)	32	35	36	40
8 Pore size(M)+	110	111	113	114

Table 2 to be continued

Tests/ Fabric No. with Blend ratio	Treated with urea-formaldehyde H (100:0)	I (60:40)	J (40:60)	K (0:100)
1.	350	350.6	351	352
2.	4	4.2	4.4	4.5
3.	7	8	10	12
4.	13	14.2	15.7	17
5.	50	45	42	40
6.	212	218	225	230
7.	55	57	60	63
8.	60	63	65	69

Total eight types of nonwoven geo-jute samples (Table 3) were subjected to soil burial test for the different periods of soil incubation. The samples were collected from soil at the intervals of 6, 12 and 18 months. All U.F. treated samples showed better strength and durability abrasion resistance and anti-microbial and water repellency properties compared to untreated samples.

3.2.1 Laboratory testing for simulation of full scale application

The speed of propagation of cracks were monitored within a test set up consisting of untreated and U.F. resin treated samples and a concreate wearing course for comparison of effectiveness (appearing of cracks, speed of propagation, time of total rupture) of the different system tested. The test results were compared with a reference test carried out in the same test set up represented by two types.

(a) one layer only of asphalt concrete

(b) combination of two centimetres bituminous sand plus one layer of asphalt concrete.

All eight non-woven jute:pp blended untreated and U.F. resin treated geo-jute sample according to Table 2 were tested. The comparison therefore focussed at figure 1, on the basis of their performances.

A very important conclusion can be drawn from the above test that these all nonwoven geo-jute samples can be easily applied on a wide range of pavements with different wearing courses and climates.

All treated samples have shown better performance (Fig 1) than untreated fabrics, even after complete propagation of cracks.

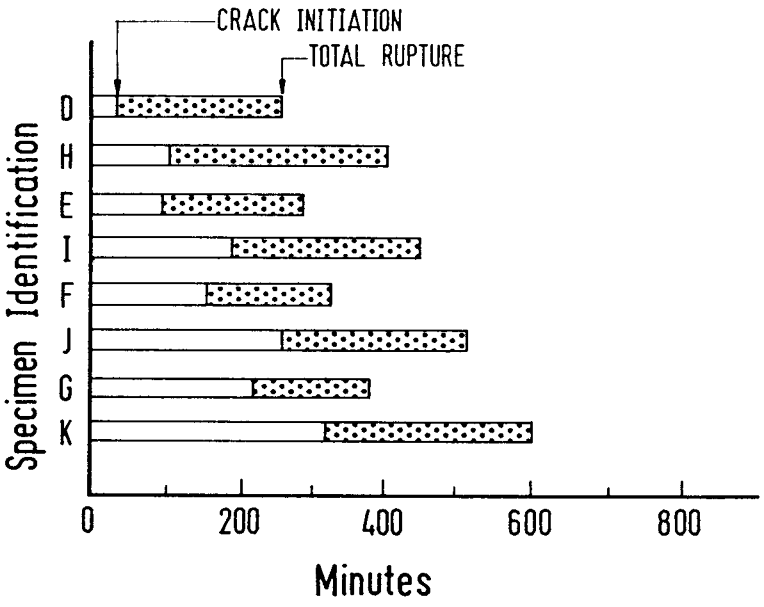

Fig 1. Laboratory Performance of Jute:PP blended fabrics with (F,J,G,K) and without (D,H,E,I) U.F. resin treatment

Table 3 Tenacity test (g/tex) untreated and treated jute nonwoven before and after soil burial test and abrasion test (fibre loss in MGM)

Sample No/ Blend ratio Jute:PP	0 Month	6 Month	12 Month	18 Month	Abrasion resistance loss in MGM
	Untreated				
D(100:0)	0.92	0.78	0.63	0.52	75
E(60:40)	1.30	1.22	1.09	0.99	50
F(40:60)	1.98	1.80	1.73	1.64	46
G(0:100)	2.30	2.26	2.20	2.17	40
	Treated with Urea formaldehyde resin (15%)				
H(100:0)	1.50	1.45	1.38	1.30	32
I(60:40)	1.90	1.80	1.78	1.61	29
J(40:60)	2.59	2.40	2.30	2.20	26
K(0:100)	2.93	2.90	2.88	2.83	20

This greatly minimises penetration of surface water into the underlying support layers.

4 CONCLUSION

It can be concluded that nonwoven jute agri-geo-fabs can be used for agriculture to protect soil erosion at the same time beautificationof hill slopes. It has several advantages such as it is annual crop, bio-degradable, environmental friendly and does not cause pollutions.

The both untreated and U.F. resin treated jute:pp blended nonwoven geo-jute fabrics can be used for construction of roads to protect the reflective cracking of road damages.

REFERENCES

Lunenchloss, J. and Albrecht, W. (1985) Non-woven bonded fabrics, Ellis Horwood Limited, Chichesten, P.328.

F.H.W.A. (1985), Geo-textile Engineering Manual, Federal Highway Administration, Washington, D.C.

Gupta, V.P. (1988), High-Tech Needle Loom for Geo-textiles, Proc. International Conference on reinforced soil and Geo-textiles 88, IIT, Bombay, India, P. F 9.

Pandey, S.N. and Majumdar, .K. (1989), Application of jute as geo-textiles in erosion control, Proc. of International Workshop on geo-textiles, Bangalore, India, Vol.I, P. 247-250.

Puig, J., Patier, M. and Vecover (1990), Results after five years of use of a system of asphat overlay fabric with bitumen to retard reflective cracking in pavements, Proc. 4th International Conference on Geo-textiles, Geo-membranes and Related Products, Vol.2, The Hague, Netherland, P. 872.

Pandey, S.N. and Majumdar, A.K. (1994), Geo-jute nonwovens to retard reflective cracking of roads, Proc. of 2nd International Workshop on geo-textiles, New Delhi, India, P. 103.

Pandey, S.N. and Majumdar, A.K. (1994), A study on jute geo-textiles, Proc. of 2nd International Workshop on Geo-textiles, New Delhi, India, P. 92.