RESEARCH ARTICLE OPEN ACCESS

An Experimental Study on strength behavior of Pavement using jute geo textile

S.Krishna Prashanth[1], V.Sindhuja[2]
Assistant Professor, Department of Civil Engineering, PSNACET, Dindigul, Tamilnadu, India[1]
Assistant Professor, Department of Civil Engineering, SSMIET, Dindigul, Tamilnadu, India[2]

ABSTRACT
This experimental investigation studies the benefits of reinforcing the various sub grade soils in flexible pavement. Three types of soils A, B and C and a particular type of Jute geo textile material were selected for the study. Fundamental properties of soils like specific gravity, liquid limit, plastic limit and optimum moisture content were determined on unreinforced soils; California Bearing Ratio (CBR) test and Unconfined Compression (UCC) Strength test were also conducted on unreinforced and reinforced soils. The optimum quantity of jute geo textile was arrived based on the results from CBR test, other parameters such as modulus of elasticity and failure stress were ascertained from the results of UCC test. Using the optimum geo textile content, the thickness of pavement required over the three types of sub grade soils with and without reinforcement was determined based on the guidelines specified in IRC 37-2001. A comparative analysis was carried out to identify the economy in the material due to the effect of reinforcing the soils with jute geo textile. Subsequently cost benefit analysis of reinforced and unreinforced pavement was also done to ascertain the economic viability of fibre material. From the result analysis it was observed there is a significant material save of about 25% per every km of pavement.
Keywords: failure stress, geo textile, optimum moisture content, sub grade, unreinforced

I. INTRODUCTION

The escalating cost of materials and energy and lack of resources available have motivated highway engineers to explore new alternatives in building new roads and rehabilitating the existing ones. Reinforcing the sub grade soils with jute geo-textile is one such alternative. Recently, synthetic materials like geogrid and fibres have evoked considerable interest among both highway engineers and manufacturers for using these materials as reinforcing materials in flexible pavements. However, absence of well documented design procedure for reinforced flexible pavements has resulted in low confidence in highway engineers while using these materials.

Reinforcing the soil with geo-textile is one such method, which can give technically as well as economically superior solution to improve the engineering performance of sub grade soils. The published literature shows that there is a considerable improvement in the strength characteristics of soils due to jute geo-textile reinforcement in terms of CBR value, the shear strength parameters and failure stress. Reinforcing the sub grade soils with jute geo-textile appears to have the greatest potential for successful application in the design of flexible pavements. These benefits can be realized by extending the service life of the pavement and reduction in sub base or base thickness.

II. OBJECTIVES OF THE STUDY

The following are the objectives of the present study

a) To analyse the general engineering properties of the selected soil samples.
b) to assess the feasibility of jute geo-textile for application in road construction based on the laboratory investigations
c) To assess the influence of jute fibre in CBR, elastic properties, total pavement thickness.

III. REVIEW OF LITERATURE

Satish Chandra et al. (2008) investigated the benefits of polypropylene reinforcement in the sub grade soil and found that for a constant thickness of base and DBM, the thickness of the sub-base was reduced .the pavement resisting on reinforced sub-grade soils is beneficial in reducing the construction materials .actual saving wound depend upon the option exercised by the designer for reducing the thickness of an individual layer.

Tolia et al.(1997): Jute geo-textile appears to be very effective even in weak sub-grade soils in reducing their compressibility and increasing their strength as reflected from the good performance even after a lapse of 7 years.

Rao and Balan.(1996): With time, the subgrade becomes less and less dependent on the fabric for its stability and therefore, the long term durability aspect of jute fabric should not deter its use as a geo-textile for various applications in road construction.
Kabir et al. (1988) : The average CBR value has increased from 3.5% to 6.0% and the sub grade had strengthened by the application of JGT.

IV. MATERIALS AND METHODS

The following are the general properties of jute geo textile material:

a) Polymer composition: Non woven polypropylene.
b) Grade: NW-21-(260 GSM)
c) Colour: White
d) Static puncture resistance: 1600 N
e) Permeability: $115x10^{-3}$ m/s.
f) Tensile strength: 10kN/m (machine direction)
g) Percentage elongation at break: 45%.

Three types of soils A, B and C and a particular type of Jute geo textile material were selected and their fundamental properties viz. specific gravity, liquid limit, plastic limit and optimum moisture content were determined on unreinforced soils.

Table 1 Properties of soil A, B and C

Property	Soil A	Soil B	Soil C
Typical name	Black cotton	Clay	Red
Dry density	16.23	14.42	13.14
(kN/m³)			
Optimum	14.68	12.44	10.58
moisture content (%)			
Liquid limit (%)	32.4	28.6	26.8
Plastic limit	21.6	18.2	16.4
(%)			
Plasticity index (Ip)	11.6	9.4	9.8
With Jute fibre	8.24	8.12	9.18
CBR (%)			
	7.22	5.68	7.40
Without Jute fibre			

The optimum quantity of jute geo textile was arrived based on the results from CBR test, and other factors such as modulus of elasticity and failure stress were ascertained from the results of UCC test.
Using the optimum geo textile content, the thickness of pavement required over the three types of sub grade soils with and without reinforcement was determined based on the guidelines specified in IRC 37-2001.

V. RESULTS AND DISCUSSION

After the study of properties of different soil samples, CBR was conducted on unreinforced and reinforced soils with varying water content.

Based on the obtained values, a comparison of CBR values for the reinforced and unreinforced soil samples was made.

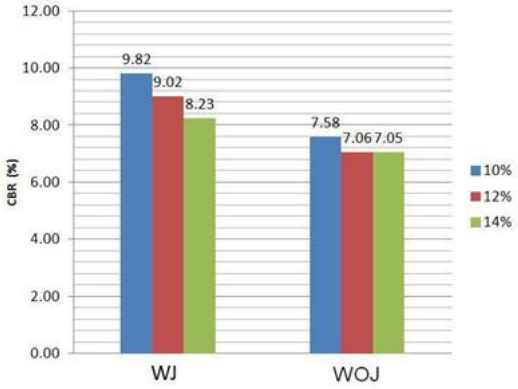

Fig. 1. Comparison of CBR values for black cotton soil

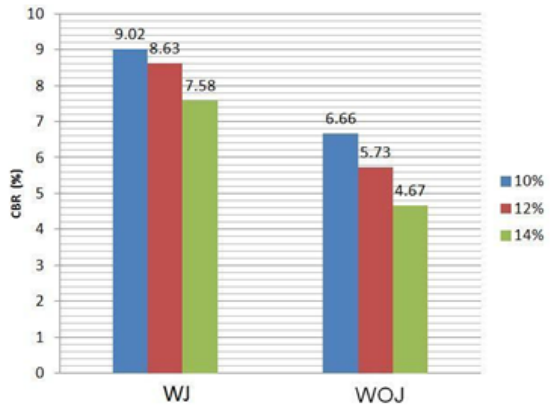

Fig.2. Comparison of CBR values for clay soil

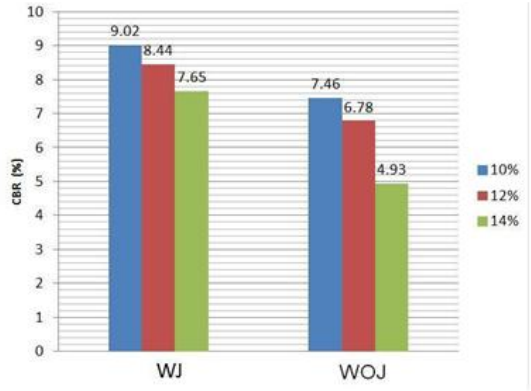

Fig.3. Comparison of CBR values for red soil

UCC tests were conducted on reinforced and un-reinforced soils with varying fibre content and aspect ratio. Stress strain graph was drawn and unconfined compressive strength (qu) was obtained from peak portion of stress-strain curve.

The values of failure stress, failure strain and unconfined compressive strength of reinforced and unreinforced soils at different water content was observed.

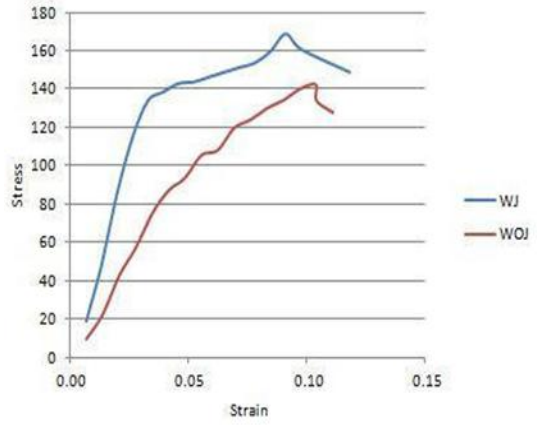

Fig.4. Stress-Strain curve for black cotton soil at 10% water content

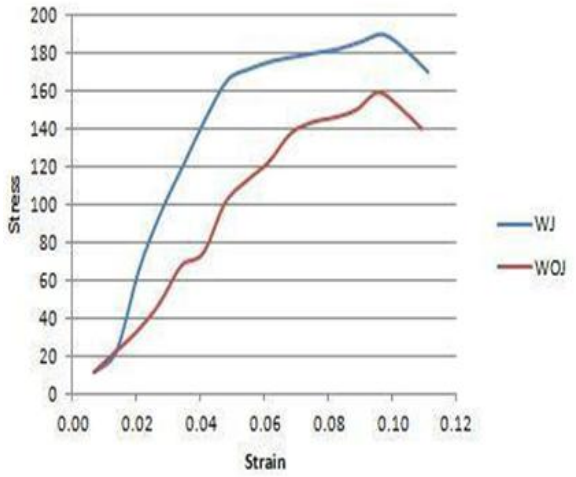

Fig.5. Stress-Strain curve for black cotton soil at 10% water content

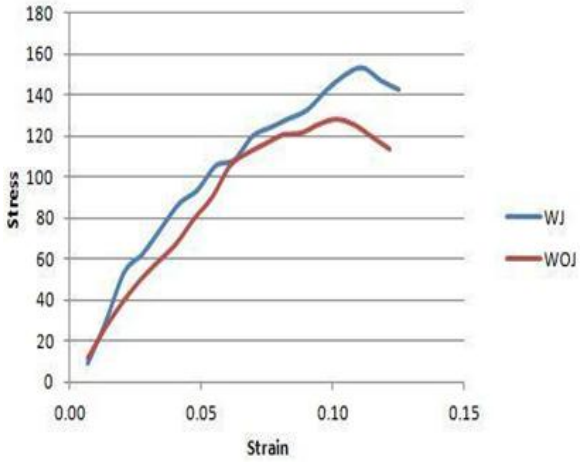

Fig.6. Stress-Strain curve for red soil at 10% water content.

The following data were assumed for the design of pavement thickness:

a) 2 lane single carriage way.
b) Initial traffic in the year of completion of construction (A) = 400 CV per day.
c) Traffic growth per annum (r) =7.5%
d) Design life (n) = 15 years.
e) Vehicle damage factor = 2.5
f) Lane distribution factor = 0.75

The total pavement thickness required is determined as per IRC 37-2001 design charts and is tabulated.

Table 2 Total Pavement thickness of soils

Type of soil	Water content (%)	Total pavement thickness(mm) (WOJ)	(WJ)
	10	562	528
Black cotton soil	12	571	532
	14	576	550
	10	612	540
Clay soil	12	648	546
	14	682	558
	10	558	540
Red soil	12	602	546
	14	686	562

From the above table it was observed that there is considerable reduction in the pavement thickness due to addition of jute fibre.

V. CONCLUSION

From the detailed analysis of results of various soils, it is evidently observed that there is an average increase of 25%, 48%, 32% CBR value in soil A,B, C at different water contents using jute fibre and the maximum percentage increase in CBR value occurred at 10%,14%, 14% moisture content respectively. Failure stress for soils A, B and C were 128.07, 140.10 and 102.18 kN/mm² respectively. These increased to 148.8, 170.20 and 150.36 kN/mm² respectively due to reinforcement of jute fibre. Failure strain (%) for the soils A, B and C were 11.81, 13.70 and 14.58 kN/mm² respectively .These increased to 12.89, 14.38 and 15.28 kN/mm² respectively due to reinforcement of jute fibre.

UCC (qu) for the soils A, B and C were 142.70, 159.40 and 127.84 kN/mm² respectively .These increased to 168.89, 189.97 and 171.80 kN/mm² respectively due to reinforcement of jute fibre. Thus the fibre reinforced soil samples exhibited high ductile behaviour.

The average reduction in pavement thickness was quiet considerable and found to be about 6%, 15% and 10% respectively for reinforcing the soil samples with jute fibre. From the analysis of results it was found that there is a significant increase in CBR due to jute fabric which implies that there will be considerable reduction in pavement thickness making the road construction economical.

REFERENCES

[1]. Ranganathan,S.R.(1995),"Development and potential of jute geo-textile",International Jute Organisation,Bangladesh.
[2]. Praveen Kumar, H.C.Mchnidratta, G.R.Toshniwal,"Effect of jute textile in various layers of pavement",ASCE (2001)
[3]. Bhattacharya, A."Performance evaluation of jute geo-textile", Jute manufactures development council, Kolkata (2007)
[4] IRC 37-2001,"Guidelines for the pavement design of flexible pavements", Indian Road Congress, New Delhi.
[5] Punmia.B.C. (2008),"Soil Mechanics and Foundations", Laxmi, New Delhi.
[6] Khanna.S.K. (2010),"Highway engineering", Nem chand, Roorkee.