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PERFORMANCE OF COIR GEOTEXTILE IN REINFORCED FLEXIBLE PAVEMENTS USING DYNAMIC CONE PENETRATION TEST

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Abstract *:* Natural geotextile like jute and coir are gaining importance because of their ecofriendly nature. There are several studies conducted on the application of different materials for improving the bearing capacity of weak soil. Coir is one of the reliable material to be used as a geotextile as it is strong and degrades slowly compared to other natural fibers due to high lignin content.

IndexTerms – Coir Geo textile, bearing capacity,weak soil

1. *INTRODUCTION*

A wide network of road transport plays a major role in connecting different places in India and it is the only reliable transport medium of many rural people. While constructing a pavement, it is designed for a period of 20years. But in actual situation, the service period is always less than the design period. One of the major reasons for the failure of pavement is its weak subgrade. Maintenance treatments of such failures are often ineffective or short lived due to their inability to treat both the cause of the problems and renew the existing pavement condition. Therefore the preferred strategy for long-term pavement performance is to build in safeguards during initial construction.

There are different techniques to stabilize soil subgrade like excavating the soft soil and refilling, chemical stabilization using lime, cement etc, or by using geosynthetics. The application of geosynthetics in pavement construction and maintenance is an effective option in a country like India where the raw materials and labour can be easily made available. The use of geosynthetics in pavements is not novel, it started in late 1970s.

According to ASTM 2000, Geosynthetic is a planar product manufactured from a variety of synthetic polymer materials that are specifically fabricated to be used in geotechnical, geoenvironmental, hydraulic and transportation engineering related materials as an integral part of a man-made project, structure or system. Polyethylene, polyester, polypropylene, nylon etc. are the common polymers used in the manufacturing of geosynthetics. Geotextiles, geogrids and geocomposites are the commonly used geosynthetics in pavements. They perform mainly three major functions: separation, reinforcement and drainage. They also prevent the mixing of subgrade with the base course, provide stiffness and strength to pavement and allow proper drainage of the pavement and thus increasing the life of paved roads.

Natural geotextiles made from coir fibres, jute, sisal etc can be used as an alternative to polymeric geosynthetic materials. The main advantage of natural material is that it enables the use of local materials and the design becomes cost effective and sustainable. Also skilled labour and heavy machineries are not needed. But since the fibres are biodegradable, the strength of the pavement varies with time. In order to study its effect, a long term performance study of coir reinforced pavement has to be done.

In this paper, six flexible pavements reinforced with coir geotextiles in 2021 are taken for study. The performance of pavement is evaluated using Dynamic cone penetrometer and visual evaluation area reported.

2. *LITERATURE REVIEW*

The geotextile acts as a tensioned membrane and reduce the vertical stress acting on the subgrade (Giroud and Noiray, 1981). The placement position of the reinforcement is the major factor affecting the bearing capacity of reinforced granular soil and higher bearing capacity has been observed when the depth of placement of reinforcement is decreased (Sankariah and Narahari, 1988). The presence of reinforcement layer increases lateral restraint or passive resistance of the fill material, increasing the rigidity of the system and reducing the vertical and lateral pavement deformation (Ajitha and Jayadeep, 1997; Cancelli and Montanelli,1999; Perkins,1999; Som and Sahu ,1999) Reinforcement placed high up in the granular layer hinders lateral movement of the aggregate due to frictional interaction and interlocking between the fill material and the reinforcement which raises the apparent load spreading ability of the aggregate and reduces the necessary fill thickness. (Perkins, 1999)

Natural geotextile like jute and coir are gaining importance because of their ecofriendly nature. There are several studies conducted on the application of different materials for improving the bearing capacity of weak soil. Coir is one of the reliable material to be used as a geotextile as it is strong and degrades slowly compared to other natural fibers due to high lignin content.

Models reinforced with geotextiles improves the bearing capacity of kaolinite (Rao and Dutta, 2006). The benefits of using reinforcements in flexible pavements depend largely on the quality and thickness of the granular base and location of the geosynthetics within the pavement structure along with other factors such as mechanical properties of reinforcement material, subgrade strength, nature of interaction between soil and geosynthetics and applied load magnitude (Al-Qadi et al, 2007) it is reported that maximum bearing capacity is obtained when woven and non-woven coir geotextile were used at the interface of silty clay subgrade and granular base course of 150mm thickness. It has been found that membrane effect of reinforcement diminishes with increase in the thickness of the road aggregate layer (Babu et al, 2008)

Saikia et al., 2010evaluated the effect of coir geotextile in improving the strength of the pavement and reducing its thickness and reported that he thickness of pavement found to be reduced by 75% after the intrusion of coir mat.

Senthil and Pandiammal (2011) studied the effect of needle punched nonwoven coir and jute geotextiles on CBR strength of soft subgrade and reported that coir geotextiles increases the CBR strength for 2.5mm penetration. The rate of reinforced to unreinforced is 1.5 for coir geotextile and

2.7 for jute geotextiles. Nithin et al., 2019 conducted studies on improving the bearing capacity of lateritic subgrade using coir geotextiles and reported that the load-carrying capacity of lateritic subgrade is improved and percentage reduction in settlement varies between 7% and 57%.

In all these papers researches are confined for a limited period of time and long term evaluation is necessary.

3 *METHODOLOGY*

Five pavements with CBR value less than three are selected for geotextile reinforcement after conducting preliminary soil property studies and the work commenced in 2019. The initial Roadway subgrade preparation typically involves removal of all vegetation, roots, and top soil. Localized soft or otherwise unsuitable subgrade areas are excavated and backfilled with select material. After preparing a subgrade layer of 30cm thickness, the coir geotextile is rolled out and sufficiently anchored to the soil. It is laid in the direction of construction traffic. Geotextile are overlapped both side-to-side and end-to-end, in the direction of aggregate placement. The recommended overlaps range from 1.5 to 3 feet, depending on subgrade strength. Coir geotextiles with 812 GSM (H2M5) are used in these pavements. After placing the geotextile, granular subbase layer of 75mm thickness and two water bound macadam layer of each 75mm are constructed, over which the bitumen layer is laid. The cross section of the pavement is given in figure 1. Photograph of pavement during and after construction are shown in Figure 2 and 3. Details of pavement are presented in Table 1 and 2.

Section of Pavement

Table 2. Subgrade Soil Properties

Sl No	**Soil properties**	**Road 1**	**Road 2**	**Road 3**	**Road 4**	**Road 5**	**Road 6**
1	Liquid limit (%)	42	35	46	41.4	65	61
2	Plastic limit (%)	25	19	26	11.73	39	29
3	Dry density (g/cc)	1.72	1.94	1.65	1.63	1.53	1.63
4	Silt and clay (%)	42.09	26.58	27.06	58.16	53.20	48.08
5	Soaked CBR	1.35	2.84	1.41	1.01	1.52	1.28

Fig:2 Construction of Coir geotextile Reinforced Pavement

Fig:3 Photogaph of the finished Coir Geotextile Reinforced Pavement

The pavement immediately after construction was opened to traffic. and to evaluate the performance of pavement, dynamic cone penetrometer test (DCP) was conducted. A schematic diagram of the DCP is shown in Figure 4.

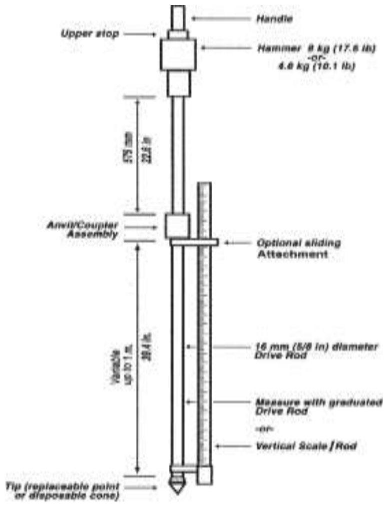

Fig:4 Schematic diagram of DCP

Testing were conducted as per the procedure given in ASTM D6951/D6951M- 09. Using a core cutter or suitable instrument, a hole is made such that its lowest point is a few centimeters above the subgrade layer. Once the layer to be tested has been reached, a reference reading is taken and the thickness of the layers cored through is recorded. This reference reading is the point from which the subsequent penetration is measured.

The DCP device is held in a vertical or plumb position. The 8Kg hammer is raised until it makes only light contact with the handle and then allowed to free-fall through a distance of 575mm and impact the anvil coupler assembly. The number of blows and corresponding penetrations are recorded. The depth of penetration is taken as 300mm.

DCP Test is conducted on geotextile reinforced and unreinforced sections of each pavement. Photograph of testing using DCP apparatus is shown in figure 5.

Fig: 5 Photograph of the DCP Test Setup

3. *RESULTS AND DISCUSSION*

DCP test is conducted on the pavements at an interval of maximum 50m. Depth of penetration is taken as 300mm and the penetration values obtained is plotted with the number of blows and are shown in the figure 6 to figure 11

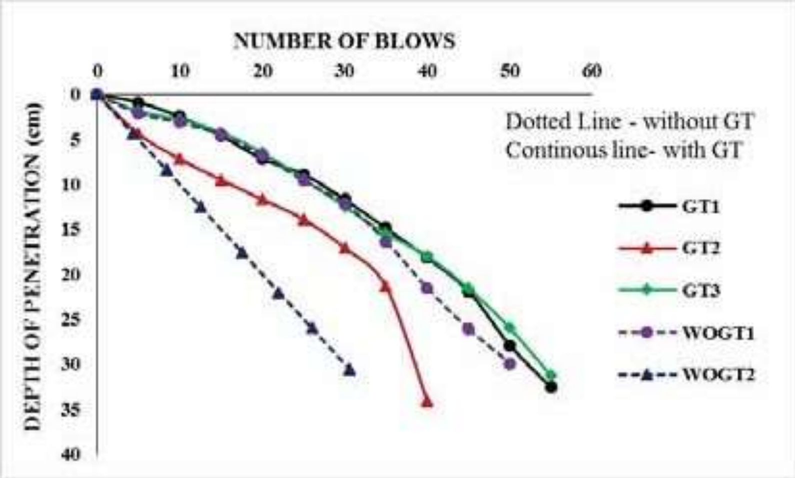

Fig:6 Penetration/blow for road 1

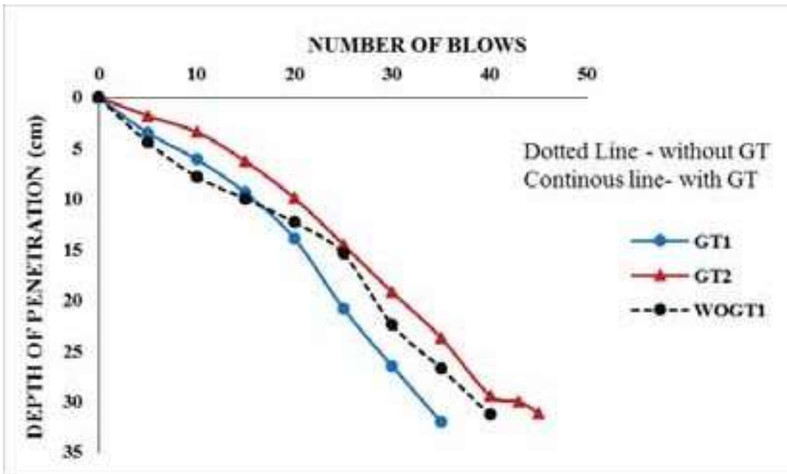

Fig: 7 Penetration/blow for road 2

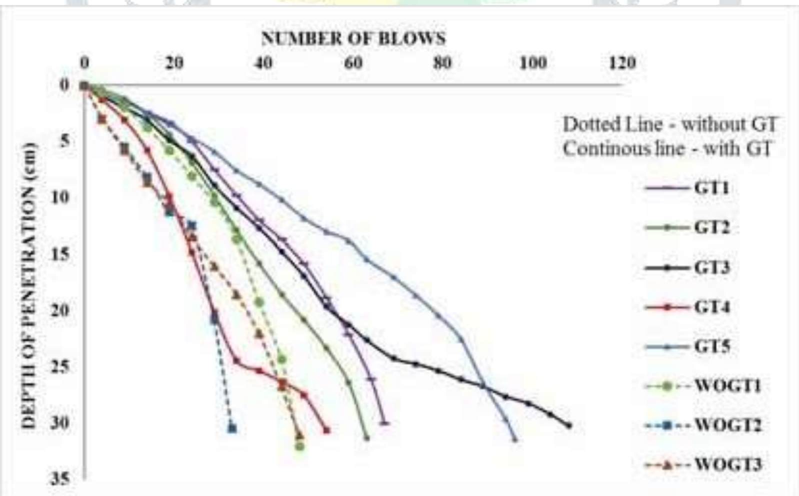

Fig: 8 Penetration/blow for road 3

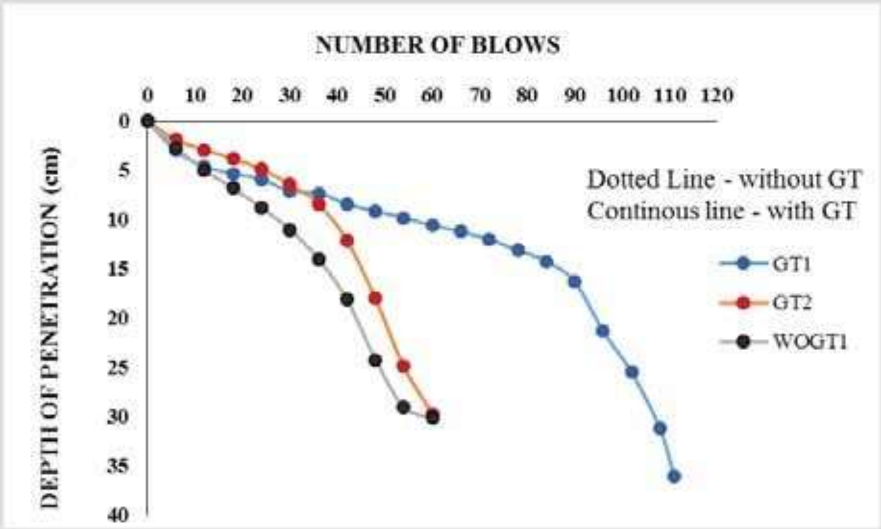

Fig: 9 Penetration/blow of road 4

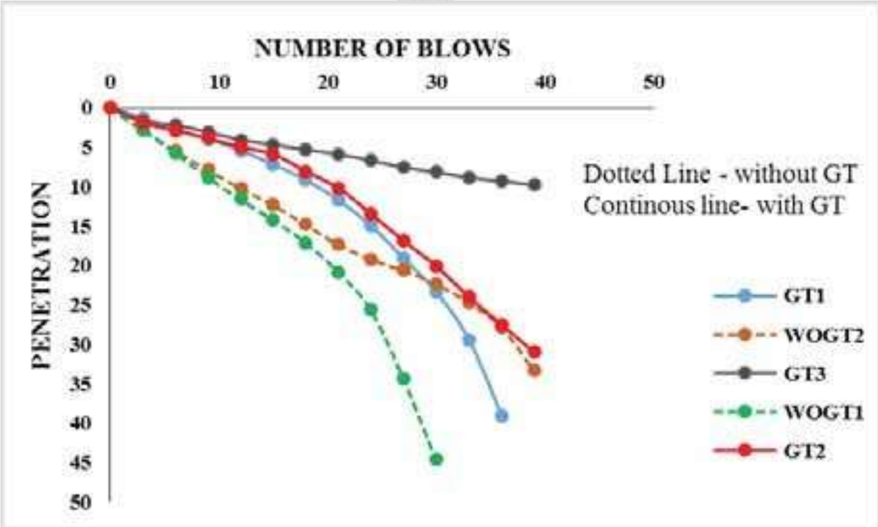

Fig: 10 Penetration/blow of road 5

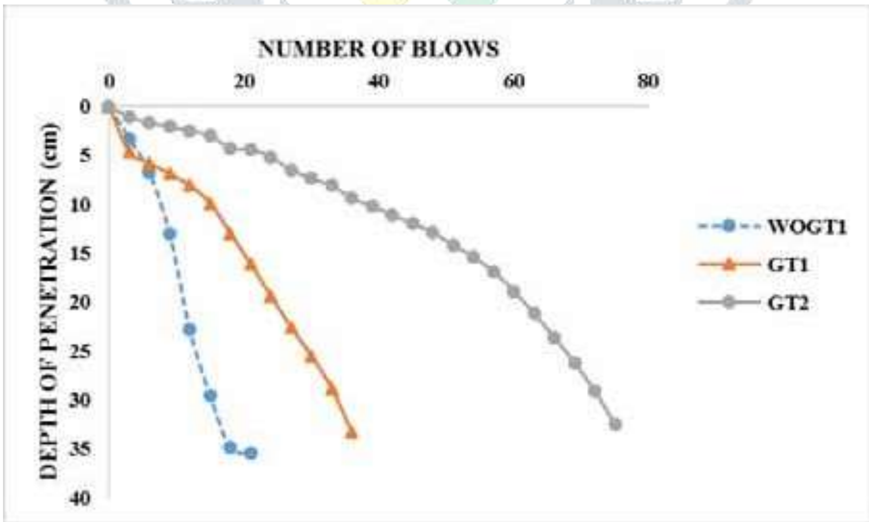

Fig: 11 Penetration/blow of road 5

Penetration index for all the roads are calculated and is taken as the slope of number of blows vs penetration curve. It is given in Table 3

Table 3 DCP Indices (Penetrations per blow) of 6 Pavements

Average penetration in mm/blow											
Road 1		Road 2		Road 3		Road 4		Road 5		Road 6	
GT	WOGT	GT	WOGT	GT	WOGT	GT	WOGT	GT	WOGT	GT	WOGT
0.63	0.75	0.69	0.76	0.42	0.67	0.33	0.52	0.69	0.95	0.62	1.92

It can be seen that all geotextile reinforced sections required higher number of blows for penetrating of 30cm depth of subgrade than that of unreinforced section. Therefore it can be concluded that there is an increase in the strength of pavement in the geotextile reinforced section even after five years of continuous use.

Visual Evaluation

The performances were studied based on visual examinations by noting Alligator Cracking, Block Cracking, Potholes, ravelling, stripping, and edge breaking. It can also be seen that the performance is better for coir reinforced pavements. Visual examination shows that the reinforced road is subjected to less deformations and distresses than unreinforced road.

4. CONCLUSION

In this paper, findings of condition survey are evaluated and the results of DCP test of six geotextile reinforced pavement sections are compared with unreinforced sections. It can be seen that the pavement remained functionally stable even after five years of service without any visible distresses compared to unreinforced sections. Coir Geotextiles remain in ground even after five years.

5. References

[1] Al-Qadi, I.L., Dessouky, S.H., Kwon, J., Tutumluer, E., (2007). *Accelerated full-scale testing of geogrid-reinfroced Àexible pavements.* Transportation Research Board, 86th Annual Meeting, Washington, DC, USA, CD-ROM, 27 p

[2] Cancelli A. and Montanelli F. (1999). In ground test for geosynthetic reinforced flexible paved roads, *Proc. Of Geosynthetics*, IFAI, Boston.

[3] Farshad A., (2003) "*Potential applications of dynamic and static Cone penetrometers in mdot pavement design and Construction*"unpublished thesis, Jackson State University

[4] Giroud J., Noiray L. (1981).Geotextile reinforced unpaved road design.*ASCE Journal of Geotechnical Engineering*, Vol. 107, 1233-1254.

[5] Koerner, R.M., "*Designing With Geosynthetics*." Fifth Edition,Prentice-Hall Inc., Englewood Cliffs, NJ.,2005

[6] Nithin, S., Sayida, M, K.andSheela Evangeline, Y., "Experimental Investigation on Coir Geotextile Reinforced Subgrade", *Proceedings of Indian Geotechnical Conference*, Delhi, 2012.

[7] Perkins, S.W., (1999) *Geosynthetic Reinforcement of Flexible Pavements: Laboratory Based Pavement Test Sections*. Publication FHWA/MT-99/8106-1, Montana Department of Transportation

[8] Roy, T.K. , (2010), "Application of jute geotextile in the moorum sand mixed layer as granularsubbase of flexible pavement", *Traffic and Transportation Studies*