"Laboratory Studies on Geotextile Reinforced Soil for Pavement"

Suyog Gore[1], Amol Patil[2], Dipil Karale[3], Onkar Magdum[4], Reetika Sharan[5]

Dept. of Civil Engineering, Dilkap Research Institute of Engineering & Management Studies, Maharashtra, India

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Abstract - *The economical development of a country is closely related to its road transport infrastructure facilities available. The periodic maintenance of the road is limited due to cost consideration which will disrupt the service and affect the function of the road. To overcome these constraints, Geotextiles shall be used in pavements to extend the service life of the pavement which requires less repair and maintenance and also reduces the total thickness of the pavement system. In this paper, an attempt is made to enhance the performance of the flexible pavement using woven geotextiles between the layers of soft sub grade and base course. The performance of woven geotextiles is better when compared to non-woven geotextiles because of its better puncture resistance when subjected to impact loading. Geotextile layer inserted between soft sub grade and base course overcomes problem of formation of cracks caused due to settlement of subgrade.*

Key Words: Woven Geotextile, Flexible Pavement

1.INTRODUCTION

Many road pavements fail before their design life due to poor quality of construction material improper compaction, improper preparation of sub grade, insufficient drainage, mixing of overlaid pavement layers. To overcome the stresses induced in pavement we should prefer two methods one is to increase thickness of different layers of pavement and other is to increase rigidity of the layers. The performance of highway pavement mainly depends upon strength and stiffness of pavement layer. The cost of highway construction is depends on materials used for construction i.e. Aggregate. Therefore the use of geotextile in road construction improves strength, stiffness of flexible pavement and also achieves economy in construction.

1.1 Woven geotextile

In unreinforced case, the stone aggregates punch into the sub-grade soil under traffic loading. The effective thickness of the pavement will reduce.

The intermixing of stone aggregates and the sub-grade soil can be prevented by introducing a layer of geosynthetic material between the aggregate fill and the sub-grade. Although it will maintain the original aggregate thickness, it will not eliminate the rutting. Woven geotextile is preferred because of its good strength in compression in comparison with non woven geotextile. Geotextile have a high tensile strength so it used in road pavement to increase the load carrying capacity of the pavement. Geotextile are used as reinforcement in pavement which is poor in tension but good in compression. When geotextile is used as reinforcement in pavement it solved many problems arises after construction of pavement therefore geotextile have been used in road pavement. These are laid over the sub base. When the vehicle pass over the road the geotextile deforms and its strength is mobilized.

2. Literature review

NithinS etal.(2015) states that, unpaved road construction in weak sub grades by reinforcing sub grade with natural geotextile is a cost effective. The use of coir & jute geotextile is suitable where there is a low traffic volume flow. Performance improvement of paved and unpaved roads depends on geosythetics used. Functions like drainage, separation, filtration & reinforcement are provided by geosynthetics. Three mechanisms of geosythetics to improve performance of unpaved roads are (a) Tensioned members (b) High bearing capacity (c) lateral resistant. Limiting of shear strain in the base layer is due to modulus of geosynthetic layer. The friction & interlocking between soil & geosynthetic layer completes this mechanism. Geotextile placed in the granular layer prohibits lateral movement of the aggregate due to friction & interlocking between sub grade material & geotextile with increasing load-spreading ability of aggregate layer resulting in reduced necessary filling thickness. In presence of geosynthetic layer alternate failure of surface occurs which increases bearing capacity. Reduced shear stress transferred to the sub grade & vertical confinement around loaded area helps in bearing capacity improvement. Natural geotextiles like coconut fiber, jute fiber, sisal etc. has good mechanical properties which are best alternative for polymeric geosynthetic materials.

Rajagopal etal.(2014) states that many of pavement structures fail before their design life due to improper qualify of construction materials, compaction, and preparation of sub grade over loading. Two methods area available to increase the life of pavement first is increasing the thickness of pavement layer & other by increasing the rigidity of layers & to reduce the stresses transferred to lower layer. This are the most widely used method for increasing life of pavement layer more efficient method is lower the stresses of pavement layer. In the present research work for the improving strength & stiffness of subbase layer the geotextile layer is used for the plate load test by using the geotextile increases the life of movement & reduces economical analysis. In this paper the location of using geotextile pavement road is internal access road at Govid Dairy factory in Phaltan, Maharashtra. There is a black cotton soil and previous road is WBM. While new constructing road the following work procedure is carried out mixes. the lime in soil which by tractor. The geotextile material layer spread over the road section. Settlement observed in the unreinforced section. Uniform surface observed in the geocell section. Before the using of geocell it is tested in lab by using method Plate load test .This test represents the result of field & laboratory test of performance of geosynthetic reinforcement while seen this results concluded that both strength & stiffness of pavement system can be improved by using geosythetic products. The improvement of performance by distributing the load over wide area of subgrade by reducing the stress in sub grade, Geocell gives much higher improvement as compare to geotextile & Geogrids.

Joshi etal.(2015) studied the improvements of road by using geotextile mainly in case of economy of Road construction for qualify this improvement they used two design methods. Life cycle cost analysis is used to find initial & future cost of 25 low volume roads. A 50 year analysis cycle is used to find cost effectiveness. Ration when geotextile is used for road construction on the base of FHWA statement, they stated that LCCA is useful tool for the cost effectiveness of geotextile application in pavement. In the LCCA procedure various economic indicators due to each of them have its own benefits are used. Present worth method, equivalent uniform annual cost, internal rate of return and the benefits cost ratio. In LCCA they show the relationship between performance and cost of road in which geotextile is use. In using this method engineer will find or predict equivalent single axle loads for the first year and annual are rates, by using this method cost of construction of new highway work and maintenance of highway is understood easily.

Huang etal.(2007) states that the geotextile is in the form of tube & bags. This is used in environmental protection facilities, Such as underwater, breakwater, river dyke improvement. Geosynthetic used for seashore & stream bank for the protection. In the circular flow chamber the flow velocity & particle concentration in the test duration. The speed of motor car is controlled by the steel rod with four steel blades. In a conventional test the high capacity can be generated with the help of water tank & capacity pump. It is difficult to control the turbid flow in a convention plume because of the suspended particle can by damage the pumping system. It is very easy to control this damaging to create a turbid flow by adding the some aggregate in circular flow chamber to help in the flow chamber. If the flow velocity & particle concentration of turbid flow condition in the circular flow chamber, the result of circular chamber test is high degree of abrasion damage. The geotextile may be induced in relatively short test duration under the typical flow velocity.

3. Methodology

CBR method of design of flexible pavement (Without Geotextile) & Design of flexible pavement (With geotextile) by using design charts presented by Prof. J. N. Mandal, Department of Civil Engineering, IIT Bombay.

3.1 Test on sub grade soil

Core cutter test – Dry Density of sub grade = 0.952 gm/cc
Standard proctor test – OMC of sub grade soil = 28.50 %
CBR value at 2.5 mm penetration =

(Load corresponding to 2.5 mm penetration)/ (standard load at 2.5 mm penetration) ×100

= (112.5/1370)×100 = 8.21 %

CBR value at 5 mm penetration =

(Load corresponding to 5 mm penetration)/ (standard load at 5 mm penetration) ×100

= (150/2055) ×100 = 7.29 %

Hence we accept higher value of CBR (i.e. corresponding to 2.5 mm penetration i.e. 8%)

3.2 Traffic Survey – Neral Karjat Road SH-79

Hence Maximum Traffic is on **Saturday**
Passenger car unit: **2441 for 11 Hrs**
Total 24 hr: 1.8 × 2441 = **4394**
Note: For design above **3 tonne** weighing vehicles are considered.

Determination of EWLF & CSA:

Sr. No.	Types of vehicle	No. of vehicles
1	3 Tonne truck	36
2	10 Tonne truck	20
3	20 Tonne	27
4	25 Tonne	27
5	30 Tonne	11
6	>40 Tonne	9

Sr. No.	Type of vehicle	No. of vehicles	Weight of vehicle (tonne)
1	LCV	20	7.5
2	MCV	11	25
3	HCV	36	49

1. for LCV
N = 20
Growth Rate = (R_1) = 5.0 % From Census 2016 of Raigad district
Growth Period = (m + n) = 3+15 =18 (Assumed)
Average Load = 7500 kg

EWLF = 0.07
CSA = (365 {N1×F1× [1+r1] ^ ((m+n))-1})/r1

= (365 {20×0.07× [1+0.05] ^ ((18))-1})/0.05

= 0.018 msa

2. for MCV
N = 11
Growth Rate = (R_1) = 5.0 % From Census 2016 of Raigad district
Growth Period = (m + n) = 3+15 =18 (Assumed)
Average Load = 25000 kg
EWLF = 8
CSA = (365 {N1×F1× [1+r1] ^ ((m+n))-1})/r1

= (365 {11×8× [1+0.05] ^ ((18))-1})/0.05

= 1.54 msa

3. for HCV
N = 36
Growth Rate = (R_1) = 5.0 % From Census 2016 of Raigad district
Growth Period = (m + n) = 3+15 =18 (Assumed)
Average Load = 49000 kg
EWLF = 32
CSA = (365 {N1×F1× [1+r1] ^ ((m+n))-1})/r1

= (365 {20×32× [1+0.05] ^ ((18))-1})/0.05

= 11.24 msa

TOTAL CSA = 0.018 + 1.54 + 11.24 = 12.80 msa

3.3 CBR method of design of flexible pavement

CBR value of sub grade soil = 8%
CSA of Existing Road SH-69 = 12.80 msa

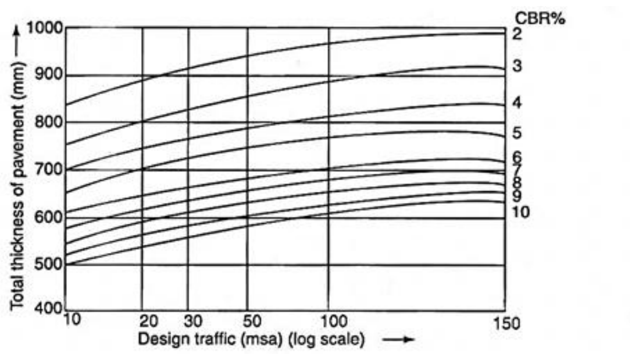


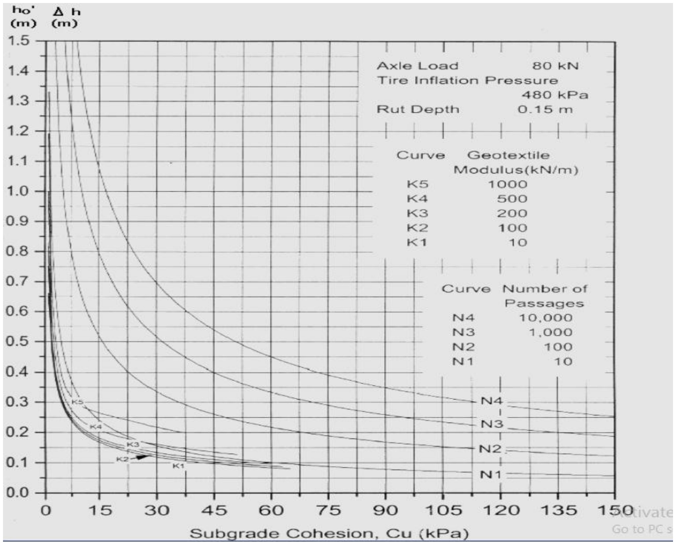
FIG. 7.9 *Pavement thickness design chart for traffic 10 to 150 msa (IRC: 37-2001)*

From above graph,

Total pavement thickness	575 mm
Granular sub base	200 mm
Granular base	250 mm
Dense bituminous macadam binder course	85 mm
Bituminous surface course	40 mm

3.4 Design of geotextile reinforced pavement

By using design charts presented by Prof. J. N. Mandal, Department of Civil Engineering, IIT Bombay.



Undrained shear strength	s_u (kPa)
Hard soil	$s_u > 150$ kPa
Stiff soil	$s_u = 75 \sim 150$ kPa
Firm soil	$s_u = 40 \sim 75$ kPa
Soft soil	$s_u = 20 \sim 40$kPa
Very soft soil	$s_u < 20$ kPa

Subgrade Cohesion = Cu = 75 kPa
Modulus of geotextile = E = k = 100 kN/m
No. of passes = N = 1000

Solution:
From the design charts,
ho = 0.45 for cu = 75 kPa, and N = 1000
Δh = 0.125 for cu = 75 kPa, and E = K = 100 kN/m
The required thickness of pavement using geotextile,
= ho - Δ h = 0.45 – 0.125 = 0.325 m

Layers of Pavement	Thickness with Geotextile	Thickness without Geotextile

Bituminous surface course	48 mm	40 mm
Dense bituminous macadam binder course	—	85 mm
Granular base	125 mm	250 mm
Granular sub base	150 mm	200 mm
Geotextile	2 mm	—
Total pavement thickness	325 mm.	575 mm

4. CONCLUSION

Here we conclude that the total effective thickness of the pavement will be reduced due to this innovative concept of in reinforced pavement in place like Neral which carries heavy traffic load is effective. On Neral – Karjat road (SH–79) traffic is more due tourist attraction named Matheran Hill station & also faster growth rate. Karjat taluka belongs to konkan where heavy rainfall affects the roads causing potholes, which leads to periodic repairs. & these potholes are main reason for accidents if not repaired. The provision of geotextile in this flexible pavement eliminates surface cracks formed due to settlement of subgrade & increases its service life. As it increases service life, prior maintenances will not be required in consequent years. This directly saves treasury of PWD.

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