Performance and Evaluation of Pavement Design with and without using Geotextiles

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Abstract— Considerable increase in length of roads in India has increased the necessity of rapid, economic and sustainable construction methodologies. Thus at various construction stages of pavement the use of additives has gained significance over the period of time. Geotextile mainly has properties and functions such as providing reinforcement to soil mass, drainage, separation, stabilization of sub grade etc. Geotextiles are mainly available in woven and non woven types. In this project Woven Geotextile from local manufacturer was used. Geotextile was placed at various depths of samples during testing. Improvements in CBR values were recorded. Thus the pavement thickness using Geotextile at various depths was comparatively less than that of without using Geotextile. The results of CBR mould had been found to be much better when Geotextile had been placed in the middle of CBR mould than other depths.

Key words: Soil, Woven Geo Textiles, Depths, Sub Grade, Bearing Capacity, Pavement, Thickness

I. INTRODUCTION

Use of Geo Textile has become one of the most significant practices in pavement design and construction nowadays. It has already proved to be beneficial in almost all conditions except a few. Pavement with each and every variation of traffic volume has to face problems like depression on surface, cracks, unstable sub base, drainage and seepage etc depending upon various factors such as soil properties, sub base properties etc. In this paper Geo textile of woven type has been used at various depths in the CBR mould and thus CBR values have been recorded which varied accordingly.

II. GEOTEXTILE CHARACTERISTICS

Following are the major characteristics of geotextiles considerable to this project:

A. Physical Properties

- Specific Gravity, density, thickness stiffness etc

B. Mechanical Properties

- Tensile strength, flexibility, compatibility, tearing strength, bursting strength, puncturing strength etc

C. Endurance Properties

- Elongation, abrasion resistance, clogging length, and flow etc

III. CLASSIFICATIONS GEOTEXTILE

Geotextiles are fabrics having characteristics which improve certain properties of soil like reinforce, drainage, filtration etc. Generally Geotextiles are made up of mails polypropylene or polyester and other materials. In this paper Geotextile of woven type is used. Certain parameters are available for classification of Geotextiles.

Various classification methods are available as following:

Sr. No	Classification By	Type
1.	Permeability	Permeable Impermeable
2.	Fiber Length	Staple Fiber Filament
3.	Type of Fiber	Natural Chemical
4.	Shape	Planar Tubular Baggy
5.	Method of Production	Knitted Nonwoven Woven

Table 1: Classification of Geotextiles

IV. FUNCTIONS OF GEOTEXTILE IN PAVEMENT CONSTRUCTION AND DESIGN

A. Reinforcement

- Strengthening of soil slopes, RE Wall for bridges approach, Construction on soft soil, Reinforcing pavement layers are some major uses of Geotextile

B. Drainage

- This is an important function of Geotextile by virtue of which the drain off in rainy season becomes easy

C. Separation

- Partitioning between two adjacent layers but of different materials to prevent intermixing.

D. Filtration

- Geotextile is also suitable for the process of filtration which is required for stability of the pavement

V. EXPERIMENTAL PROGRAM

A. Sample Collection

Soil samples were collected from the site of six laining of National Highway (NH_4) Pune to Satara from chainage 830 +00 Km to 833 +00 Km, at 1 km interval each at 1.5 m depth.

B. Geo Textile Details

Geo Textile Details	
Source	Gareware Wall Ropes Ltd, Pune, Maharashtra, India
Type of	Multifilament Woven Geo

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Geotextile	Textile
Pore Size	Less than 75 micron
Bursting Strength	5500KPa
Type of Fiber	Polypropylene
Permeability	31 Lit/m²/sec
Trade Name	GWF (T) 40/210
Weight	210 gm/m²

Table 2: Classification of Geotextiles

C. Testing Procedures:

Some soil tests necessary for pavement construction like Grain Size analysis, Modified Proctors Compaction Test, Atterberg's Limits Etc were carried out. From the results of various tests important soil properties like sieve analysis, liquid limit, plastic limit, plasticity index, Optimum Moisture content etc was founded out.

The soil samples thus collected from site were prepared for California Bearing Ratio (CBR) test. The soil samples were mixed with water content relevant to Optimum Moisture Content obtained from the graphs and the CBR moulds have been filled with sample soil according to the procedure from test manual. An in-between level like 3, 6 and 9 cm of the mould height introduction of single layer Geotextile was done. Soil samples without Geotextiles were also been tested.

D. Soil Properties

The soil sample has collected from interval on National Highway (NH_4). The soil properties of three different samples are showed in Table 3, Table 4, and Table 5 respectively

Sample 1 : Soil Properties		
Sr. No	**Experiment**	**Results**
1	Liquid Limit	25.0 %
2	Plastic Limit	20.80 %
3	Plasticity Index	4.20 %
4	O.M.C	9.4 %

Table 3: Properties of Soil

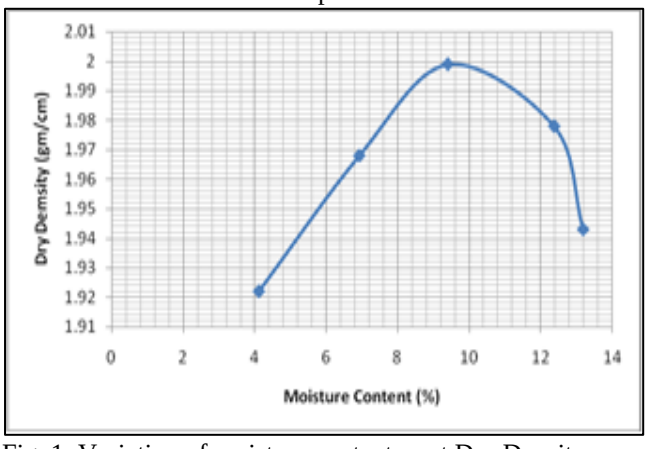

Fig. 1: Variation of moisture content w.r.t Dry Density

Sample 2 : Soil Properties		
Sr. No	**Experiment**	**Results**
1	Liquid Limit	25.20 %
2	Plastic Limit	19.31 %
3	Plasticity Index	5.89 %
4	O.M.C	9.75 %

Table 4: Properties of Soil

Sample 3 : Soil Properties		
Sr. No	**Experiment**	**Results**
1	Liquid Limit	24.80 %
2	Plastic Limit	21.05 %
3	Plasticity Index	3.75 %
4	O.M.C	9.96 %

Table 5: Properties of Soil

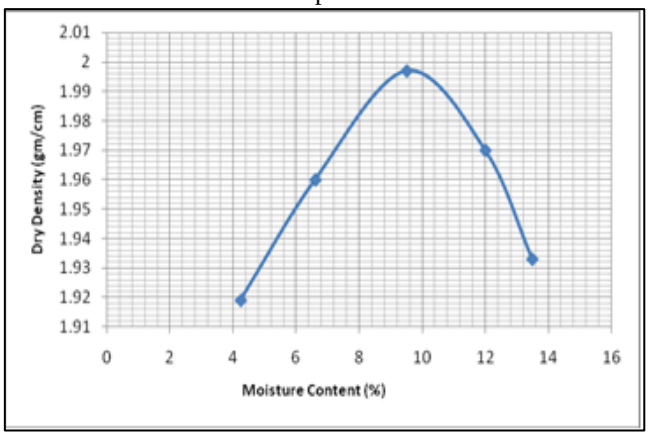

Fig. 2: Variation of moisture content w.r.t Dry Density

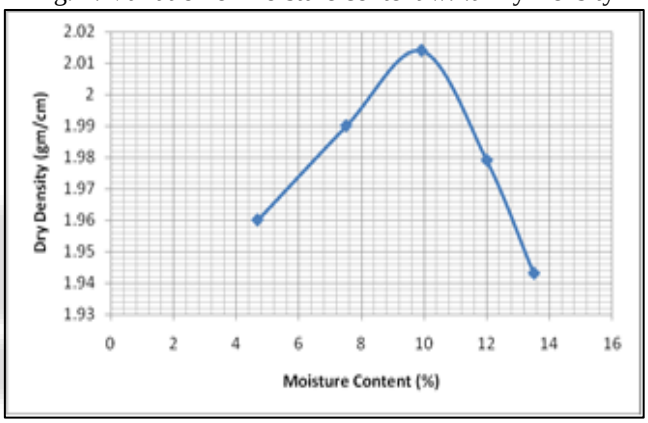

Fig. 3: Variation of moisture content w.r.t Dry Density

Fig 1, Fig2, Fig3 shows the variation of moisture content v/s dry density as moisture content increases dry density also increases and maximum variations of dry density are observed at 9.40%, 9.75%and 9.96% respectively which is also termed as Optimum Moisture Content (O.M.C)

E. Results

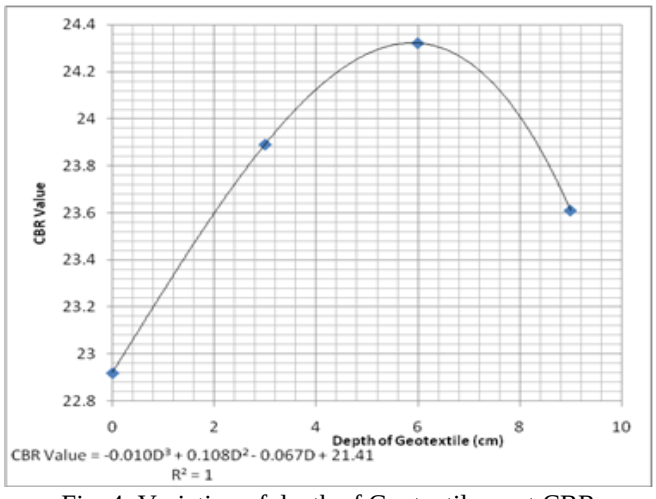

Fig. 4: Variation of depth of Geotextile w.r.t CBR
D=Depth of Geotextile

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Sample 1			
Sr. No	**Position of Geo Textile**	**Reported CBR Value (%)**	**Pavement Thickness (cm)**
1	Without GT	22.92	56.54
2	GT at 3 cm	23.89	55.29
3	**GT at 6 cm**	**24.32**	**54.4**
4	GT at 9 cm	23.61	55.65

Table 6: CBR TEST RESULT

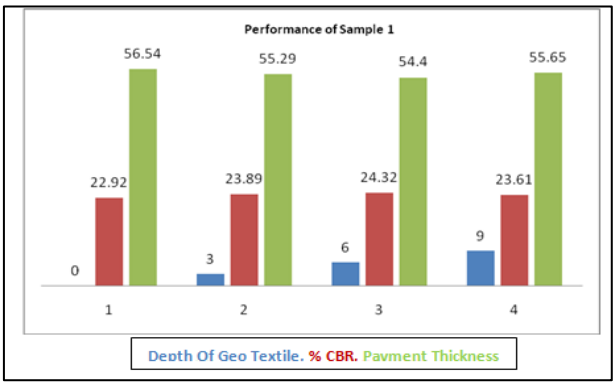

Fig. 5: Variation of depth of Geotextile w.r.t CBR and Pavement thickness

Sample 2			
Sr No	**Position of Geo Textile**	**Reported CBR Value (%)**	**Pavement Thickness(cm)**
1	Without GT	24.32	54.77
2	GT at 3 cm	24.92	54.05
3	**GT at 6 cm**	**25.69**	**53.17**
4	GT at 9 cm	24.98	53.98

Table 7: CBR Test Result

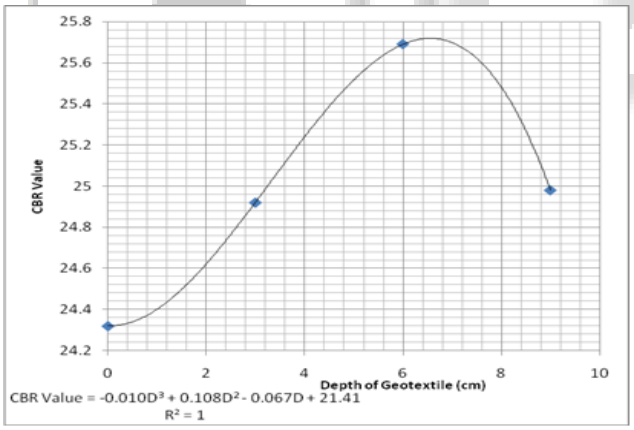

Fig. 6: Variation of moisture content w.r.t Dry Density
D=Depth of Geotextile

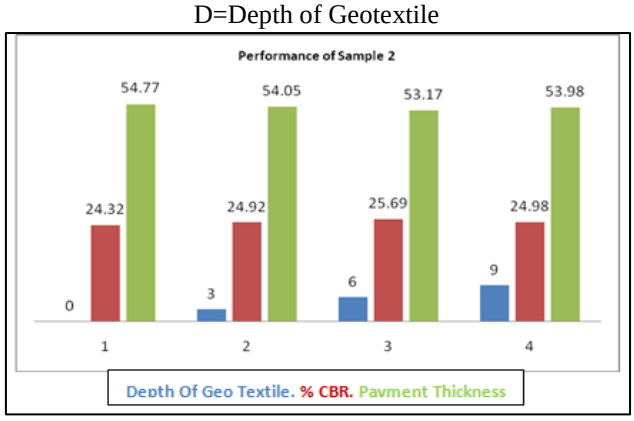

Fig. 7: Variation of depth of Geotextile w.r.t CBR and Pavement thickness

Sample 3			
Sr No	**Position of Geo Textile**	**Reported CBR Value (%)**	**Pavement Thickness(cm)**
1	Without GT	21.41	58.64
2	GT at 3 cm	21.89	57.95
3	**GT at 6 cm**	**22.57**	**57.01**
4	GT at 9 cm	21.70	58.22

Table 8: CBR Test Result

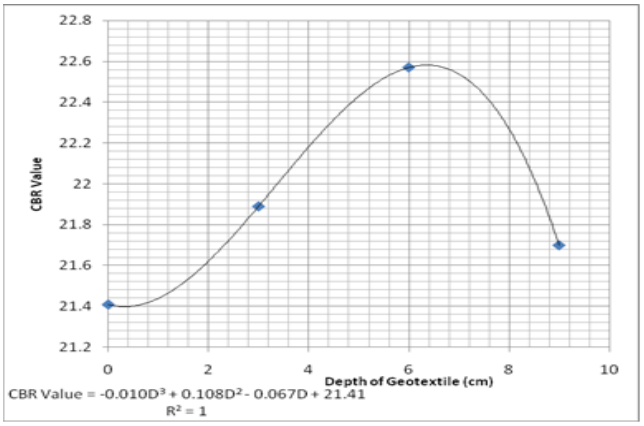

Fig.8. Variation of CBR value (%) w.r.t. Depth of Geotextile
D=Depth of Geotextile

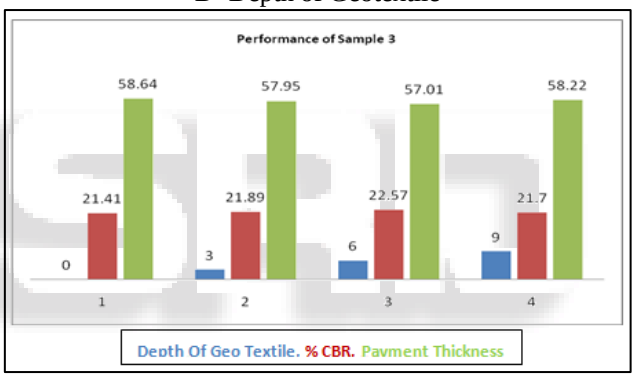

Fig. 9: Variation of depth of Geotextile w.r.t CBR and Pavement thickness

Table6, Table7, Table 8 illustrates the position of Geotextile in the CBR mould, the obtained CBR value and thus the Pavement Thickness according to the formula given by California State Highway Department

Fig4, Fig 6, Fig 8 represents the curve obtained by plotting the CBR value and Depth of geotextile in CBR mould.

Fig 5, Fig 7, Fig 9 illustrates all the parameters viz. depth og geotextile, recorded CBR value and obtained pavement thickness. From the figure it is clear that placement of geotextile in CBR mould causes variation in CBR and thus Pavement Thickness.

Pavement Thickness obtained by the CBR value of sample in which the Geotextile was placed at the depth of 6 cm (middle)

Sr no	Result	Thickness
1	Average Maximum Pavement Thickness	56.65
2	Average Minimum Pavement Thickness	54.89
3	Difference	1.76

Table 9: Difference between maximum and minimum value for pavement thickness

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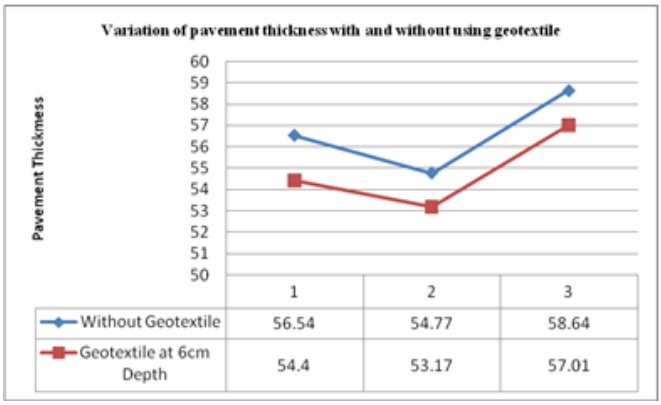
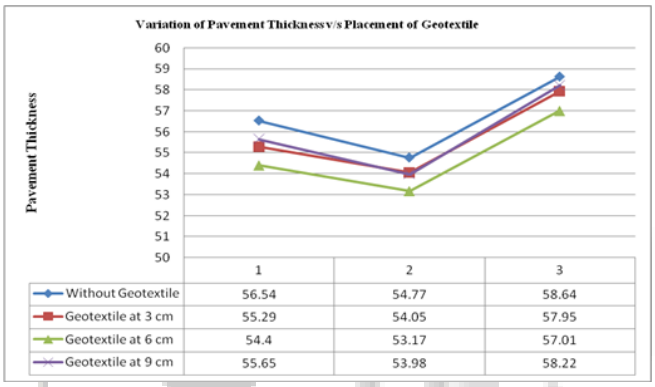


	1	2	3
Without Geotextile	56.54	54.77	58.64
Geotextile at 6cm Depth	54.4	53.17	57.01

Fig. 10: Variation of pavement thickness without and with using geotextile

Fig 10 illustrates the variation of Pavement thickness according to the placement of geotextlie which is most efficient as compared to others. From above Tables 6, Tables 7 and Tables 8 it is clear that the placement of geotextile at 6 cm (middle) of CBR mould is responsible for less Pavement Thickness.



	1	2	3
Without Geotextile	56.54	54.77	58.64
Geotextile at 3 cm	55.29	54.05	57.95
Geotextile at 6 cm	54.4	53.17	57.01
Geotextile at 9 cm	55.65	53.98	58.22

Fig. 11: Variation of pavement thickness without and with using geotextile

Fig11 illustrates the variation of pavement thickness according to placement of Geotextile in CBR mould. From the chart is clearly seen that the pavement thickness is minimum when the Geotextile is placed at 6 cm (middle) of mould with comparison to other depths i.e. 3 cm and 9 cm and with no use of Geotextile

F. Sample Calculations

1) Pavement Thickness:

California State Highway Department (CSHD) gives following recommendations for calculating Thickness of Pavement of State Highways:

Load (P)	4500 Kg
Tire Pressure (p)	6 Kg/cm²
Thickness of Pavement	$\{P[(1.75/CBR)-(1/p\pi)]\}^{0.5}$

Table 10: Values for Constants

2) Sample Calculation:

(Sample 3: Sr no 3)

$\{P[(1.75/CBR)-(1/p\pi)]\}^{0.5}$

$= \{4500[(1.75/CBR)-(1-/6x\pi)]\}^{0.5}$

$= \{4500[(1.75/2.257)-(1-/6x\pi)]\}^{0.5}$

= 57.01 cm

= Thickness of Pavement

VI. CONCLUSIONS

The CBR values thus reported with Geo textiles at various depths of soil samples gives varied results.

1) The CBR value is comparatively least for sample in which Geotextile is not used and thus pavement thickness is higher.
2) The CBR value recorded for sample in which Geotextile used is higher than of in which Geotextile is not used and thus pavement thickness is less
3) The CBR value is maximum for sample where Geotextile is places at depth of 6cm (middle) of CBR mould and thus Pavement thickness is minimum
4) The use of Geotextile thus reduces the pavement thickness.
5) Thus use of Geotextile improves and stabilizes the sub base properties

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