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Comparison between Flexible Soil and Geotextile Soil for Pavement Design of Runway.

Dhaval Dalal[1], Prof. Asha Oak[2]

[1]M. TECH CONSTRUCTION MANAGEMENT, MIT – ADT UNIVERSITY, PUNE.
[2]H.O.D. CONSTRUCTION MANAGEMENT, MIT – ADT UNIVERSITY, PUNE.

ABSTRACT - Soil Mechanics and Geo technique is one of the youngest disciplines of improving soil properties. A natural earth is incapable of supporting modern wheel loads. The flexible Pavements are used for heavier loads and can be constructed over relatively poor soil such as black cotton soil.

The focus of this research is to stabilization of black cotton soil by using geotextile material in The Airport runway. Geo textile materials a newly emerging field in the civil engineering .Geo textiles shall be used in pavement which requires less repair and maintenance

In this study, an attempt is made to enhance the performance of the flexible pavement using geo textiles materials between the layers of soft sub grade and base course and comparative analysis of pavement on black cotton soil and geo textile pavement in order to check scope of geo textile material in Airport runway pavement.

Key Words: Geo textile, CBR, Pavement thickness, separation, drainage, reinforcement, stability.

1. INTRODUCTION

The Firstly, the word "SOIL" is coming from Latin word "Solium" which means the upper surface of the earth that can be dug. It is produced by disintegration of rocks. Soil generates or produce the life of plant. Generally in India, The present of black cotton soil are used in construction of pavement. Black cotton soils contract in dry season so it causes the deformation of layers into soil and causes expansion of layer by more rate of montmorillonite so that we have to decide the material consist of more strength and stabilization as compared to these soil i.e. "GEOTEXTILE". The term "GEOTEXTILE" is defined as the word "GEO" means earth and "textile "means fabric material. The first use of textile fabric structure for geotechnical engineering was in 1926 for road construction. Geo textile have been used to enhance tensile strength and mechanical properties of civil engineering.

2. FUNCTIONS OF GEOTEXTILE

1) Separation

2) Filtration

3) Drainage

4) Reinforcement

3. APPLICATION OF GEOTEXTILE

- **Airfield work**: Geotextiles are used below ground layers to reinforce road beds and airport runways.

- **Road work:** The basic principal of incorporating geotextiles into a soil mass are the same as those utilized in design of reinforced concrete by incorporating steel bars.

- **Rail work:** The development of railway networks is being greatly boosted by the present state of economy.

- **Drainage:** Geo textiles protects river banks from erosion due to currents or lapping. For erosion prevention, geo textile used can be either woven or nonwoven.

4. ADVANTAGES OF GEOTEXTILE:

A non-woven geo textiles is ideal for use with roads, roofs, runways, rail ponds, ponds, dams, trenches and landfills.

- 100% propylene staple fibres.
- Needle punched.
- UV resistant.
- Rot resistant.
- Biological degradation Resistant.
- High in strength.
- Chemically inert.
- Increase life of roads.
- Less maintenance cost.
- Lighter in weight.
- Easy to handling and laying on site.
- Transport and labour costs are less in real term.

5. DISADVATAGES OF GEOTEXTILE

- Properly installed matting provides excellent erosion control but so at relatively high cost.

- Geo textile may delay seed germination due to reduction in soil temperature.

- Plastic sheeting is easily vandalized, photodegradable, and must be disposed of at a landfill.

- Plastic results in 100% runoff, which may cause serious erosion problems in the areas receiving the increased flow.

-Installation is critical and required experienced contractors.

- Geo textile may have maximum flow rate limitation.

- Not suitable for areas that have foot traffic

6. LITRETURE REVIEW

i) Dewey w. white jr. stated on geo textiles to improve pavements for general aviation airport.

A total of 104 different reports, magazines, articles, periodicals, books and technical paper were reviewed. Responses were received from 9 of 22 written communications for data. Under the section titled,

A brief summary of some full scale traffic test conducted by Webster is given below: Other items related to geo textile usage that are considered to be important are also discussed a full scale traffic test on geo grid and geo textile reinforced aggregate layers over a sand (SP) subgrade were conducted by Webster . This test were conducted using a truck, tank, and simulated C-130 aircraft tire traffic.

TRUCK	C-130	TANK
Ton of 5 military	Single tire	70 ton
Payload at 20,000 lb.	Load at 35,000 lb.	- -
Gross weight at 41,900 lb.	-	- -
Tires pressure at 70 psi	Tires pressure at 100 psi	- -

Author: Dewey w. white Jr

ii) A study of CBR properties of soil reinforced with jute geo textile with reference to the road construction in Assam.

The work mainly focuses on the necessity of the use of jute geo textile as a construction material in with reference to Assam and also the behavior of the soil after reinforcing it with jute geo textile. In this study, the soil sample has been collected from an earth quarry near Mirza, a small town in the outskirts of Guwahati, Assam and the untreated jute geo textile from a jute mill in Howrah city in the state of West Bengal. The main problems faced by the engineers in road construction in an area like Assam is the presence of the loose and soft soil, poor drainage conditions and also low CBR value of the sub grade soil. The roads constructed over such loose and soft soil demands higher pavement thickness, increasing the cost of construction of the pavement.

Authors: B.Sarma ,K.Kaushik ,R.Bharali ,B.Sharma

iii) Effect of geo grid reinforcement location in paved road improvement

The geo grids have an elastic-plastic behavior so that they quickly react to applied loads with an increase in the elastic modulus; in the case of short term impact loading, creep phenomenon does not occur, therefore the whole tensile resistance of the geo grid can be mobilized. Although there is a lot of information and experience with geosynthetic reinforcement of sub grade soils, many pavement failures still occur.

Authors: Hossein Moayedi , Dina Kazemian , Arun Prasad , Bujang B.K.Huat

7. METHODS FRO COLLECTION OF SOIL SAMPLE:

There are three methods for collecting a soil:

1) Random sampling
2) Topography sampling
3) Grid sampling

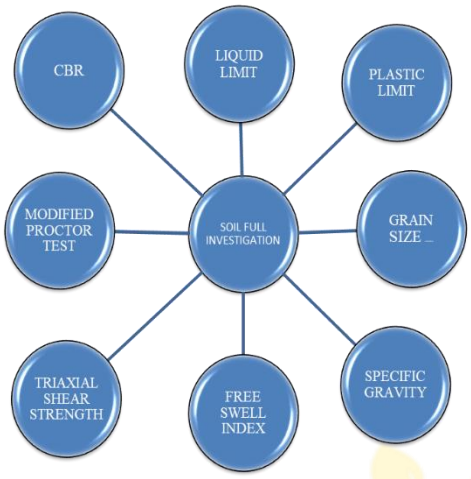

Fig 1 – Soil Investigation

1) Liquid limit: (IS: 2720 Part 5)

Liquid limit states that it is the amount of water which is responsible for this state of consistency of soil. It is the water content at which soil passes from zero strength to an infinitesimal strength. We performed the test by using cone penetrometer.

Result:

Soil Type	Penetration (mm)	Penetration (cm)	Container no.	Container weight (gm)	Weight of Container + wet soil (gm)
	169	16.9	1	122.3	146.9
Black cotton soil	166	16.6	2	243.9	284.4
	190	19	3	169.4	183.5
	178	17.8	4	188.6	212.9
	174	17.4	1	122.3	148.1
	167	16.7	2	243.8	277.7
	183	18.3	3	169.5	188.6
	181	18.1	4	188.5	221.4

Weight of Container + Dry soil (gm)	Weight of Water(gm)	Weight of Dry soil (gm)	Moisture content(%)	**Liquid Limit(%)**
139.2	7.7	16.9	45.56213018	48.17565972
269.6	14.8	25.7	57.59	61.23
178.4	5.1	9	56.67	57.68
204.8	8.1	16.2	50.00	52.00
138.4	9.7	16.1	60.2484472	63.12042662
266.9	10.8	23.1	46.75324675	49.61872831
181.2	7.4	11.7	63.24786325	65.18718191
209	12.4	20.5	60.48780488	62.56819744

Fig 2 – Observation of liquid limit

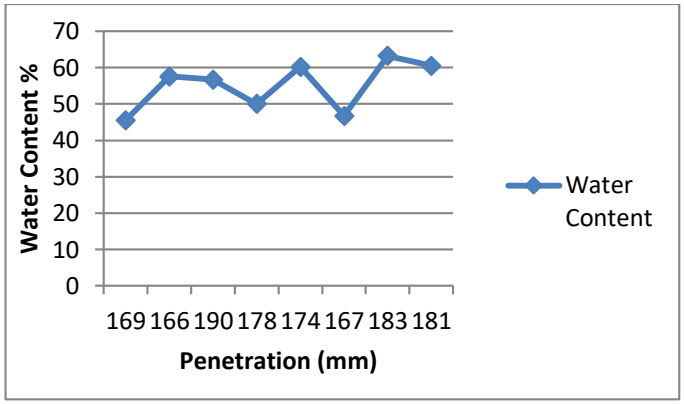

Fig 3- Moisture content of soil samples

2) PLASTIC LIMIT: IS 2720 – 5(1985)

Plastic limit is the water content corresponding to an arbitrary limit between the plastic and the semi –solid state of consistency of a soil.It is defined as the minimum water content at which a soil will just begin to crumble when rolled into a thread apporximately 3 mm in diameter.

In other word, it is the moisture content at which soil can be deformed plastically.

Soil Type	Container no.	Container weight (gm)	Weight of Container + wet soil (gm)	Weight of Container + Dry soil (gm)
Black cotton soil	1	122	132	131
	2	71	83	81
	3	84	90	89
	4	78	84	83
	1	122	135	132
	2	71	84	83
	3	84	93	91
	4	78	85	84

Weight of Water (gm)	Weight Dry soil (gm)	**PLASTIC LIMIT(%)**	**LIQUID LIMIT(%)**	**PLASTICITY INDEX (PI)**
1	9	11.11	48.18	37.07
2	10	20.00	61.23	41.23
1	5	20	57.68	37.68
1	5	20	52	32
3	10	30	63.12	33.12
1	12	8.33333333	49.618	41.28466667
2	7	28.5714286	65.187	36.61557143
1	6	16.6666667	62.568	45.90133333

Fig 4 – Observation of Plastic Limit

- Here, the average value of Plasticity index is 38.11 %.
- The Range of plasticity index of black coptton soil is between 20 to 60%.
- Plasticity index is the differnece between liuid limit and plastic limit.

3) TRIAXIAL SHEAR STRENGTH (IS 2720-11)

The tri axial shear test is most versatile of all the test testing methods for getting shear strength of soil i.e. Cohesion and angle of internal friction, Though it is bit complicated. This test can measure the total as well as effective stress parameters both.

Fig 5 – Triaxial Shear Test

SAMPLE	1	2	3	4	5	6	7	8
Cohesion ©(kg/cm^2	0.97	0.59	0.79	0.83	0.93	0.89	0.71	0.69
Angle of friction(ϕ)degree	25	15	25	22	24	23	18	16

Fig 6 - Observation of Triaxial Shear Test

4) MODIFIED PROCTOR TEST: (HEAVY COMPACTION): (IS 2720-8)

The object of the experiment is to determine the relationship between water content and dry density of soil using standard proctor test or modified proctor test and then to determine the optimum water content and the corresponding maximum dry density for a soil. The test also covers determination of relationship between penetration resistance and water content for the compacted soil.

Sample	1	2	3	4	5	6	7	8
MOISTURE CONTENT(%)	13.8	13.95	15.85	16.78	15.84	15.96	17.07	16.93
DRY DENSITY(gm/cc)	1.88	1.77	1.83	1.79	1.71	1.82	1.75	1.73
Average	15.7725							
	1.785							

Fig 7 - Observation of Modified Proctor Test

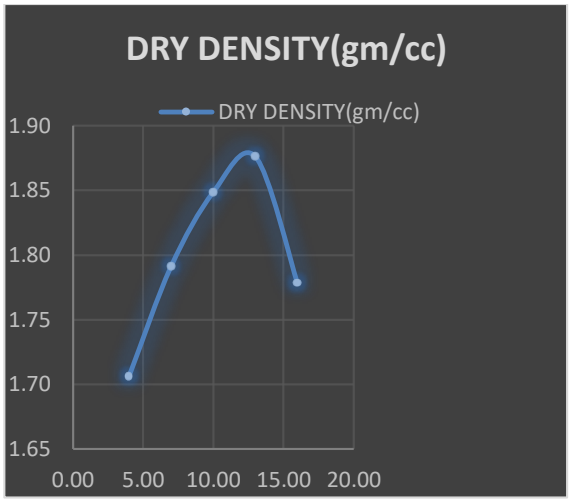

Fig 8 - OMC VS.MDD

Here, this graph shows the optimum moisture content 13.8% and maximum dry density1.88 gm/cc of one of the soil sample.

8. COMPARISON BETWEEN FLEXIBLE SOIL AND GEOTEXTILE SOIL

CBR (Geo textile with soil):

Geo textile provides the strength in pavement surface to carries heavy load on it. The material should attach in the soil with two layers like bottom layer and middle layer. Mostly used in bottom layer can produce the max strength so it's used.

PROCEDURE:

-Take 5 kg soil sample and mixed it with moisture content of proctor test.
- The mould can attach with collar.
- The mould can filled first layer with soil sample at 55 blows with light rammer of 2.5 kg.
- The soil can compacted at specified manner.

Then the geo textile material firstly cut at some space of mould and it put on the bottom layer.

-Then the soil can compacted again in 4 layers with specified manner.
- The first reading can recorded.
-Then second time the material can dug in middle layer and the readings can be recorded.

RESULT:

Sample	RUNWAY	Unsoaked CBR
1	500 m	21.44
2	1000 m	20.95
3	1500 m	21.45
4	2000 m	20.56
5	2500 m	20.61
6	3000 m	22.67
7	3500 m	21.85
8	4000 m	21.44

Fig 9 – CBR of soil sample without GEOTEXTILE

Sample	RUNWAY	UNSOAKED CBR	
		Bottom layer	Middle Layer
1	500 m	34.33	30.22
2	1000 m	35.47	31.21
3	1500 m	36.88	30.66
4	2000 m	34.37	29.88
5	2500 m	33.29	28.57
6	3000 m	33.99	30.56
7	3500 m	35.67	31.48
8	4000 m	34.28	29.47

Fig 9 – CBR of soil sample without GEOTEXTILE at bottom and middle layer

9. PAVEMENT DESIGN FOR RUNWAY WITH GEOTEXTILE

The provision of geo textile in this flexible pavement eliminates surface cracks formed due to settlement of sub grade and increase its service life. As it increase service life, prior maintenance will not be required in consequent years.

Geo textile placed in the granular layer prohibits lateral movement of the aggregate due to friction and interlocking between sub grade material and geo textile with increasing load-spreading ability of aggregate layer resulting in reduced necessary filling thickness.

In presence of geo textile layer alternate failure of surface occurs which increases bearing capacity. Reduced shear stress transferred to the sub grade and vertical confinement around loaded area helps in bearing capacity improvement.

Calculation:

Pavement Thickness California State Highway Department (CSHB) Gives the Following recommendation for calculating thickness of pavement for state highway.

LOAD (P) = 80,000 kg

TYRE PRESSURE (p) = 14.17 kg / cm2

Thickness of Pavement = {P*[(1.75/CBR)-(1/p*3.14)]}*(1/2)

The pavement thickness was calculated by using above formula for various CBR method.

Results:

Sample	Runway	CBR value	Pavement thickness
1	500	21.44	2365.924
2	1000	20.95	2442.287
3	1500	21.45	2364.402
4	2000	20.56	2505.668
5	2500	20.61	2497.408
6	3000	22.67	2188.78
7	3500	21.85	2304.66
8	4000	21.44	2365.924

Fig – 10 Pavement thickness of soil without geo textile

Sample	Runway	Geotextile in bottom layer	
		CBR value	Pavement thickness
1	500	34.33	1140.031
2	1000	35.47	1074.497
3	1500	36.88	999.0461
4	2000	34.37	1137.658
5	2500	33.29	1203.732
6	3000	33.99	1160.428
7	3500	35.67	1063.432
8	4000	34.28	1143.005

Fig 11 - Pavement thickness of soil with geo textile at bottom layer

Sample	Runway	Geotextile in middle layer	
		CBR value	Pavement thickness
1	500	30.22	1417.345
2	1000	31.21	1343.869
3	1500	30.66	1384.103
4	2000	29.88	1443.702
5	2500	28.57	1551.121
6	3000	30.56	1391.574
7	3500	31.48	1324.632
8	4000	29.47	1476.295

Fig 12 - Pavement thickness of soil with geo textile in middle layer

This results shows the pavement thickness around which the layer should be prefer to apply the material for reducing the thickness. The data shows that the bottom layer should be prefer for geo textile material have less thickness of pavement. Pavement thickness is minimum when placed geo textile material at bottom layer.

Graphs:

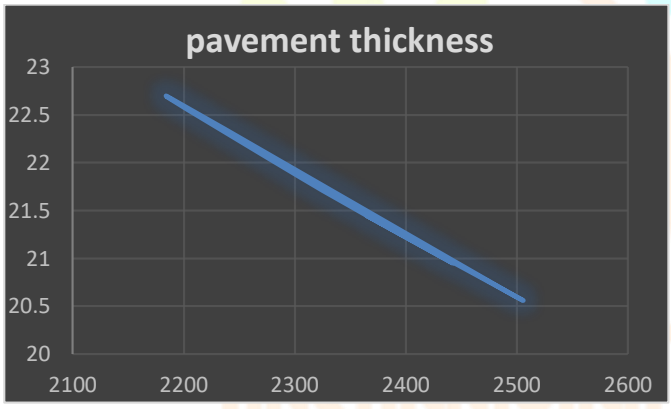

Fig – 13 Pavement thickness of soil without geo textile

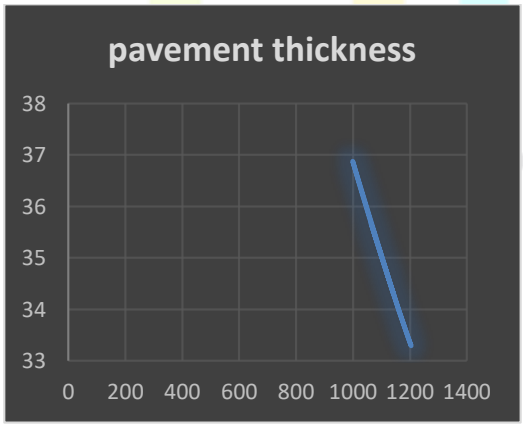

Fig 14 - Pavement thickness of soil with geo textile at bottom layer

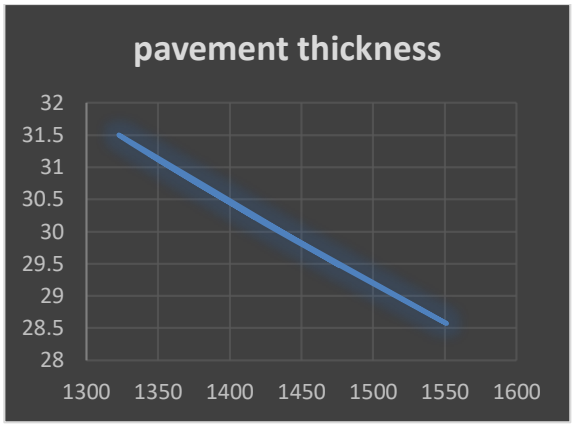

Fig 15 - Pavement thickness of soil with geo textile in middle layer

10. CONCLUSION

We observed that the cost of runway with geo textile is initially high but along the life period it is economic as maintenance cost reduces.

It was also concluded that labour work and machine work are less as weight of the geo textile is less and its installation also required less machinery work.

From the study, we concluded that CBR value increases by using geo textile as it increase the soil property and the load carrying capacity of runway also increases.

As we use of geo textile, prevent mixing of soil layer into one another. This separation results in minimizing of cracks.

The results shows the pavement thickness around which the layer should be prefer to apply the material for reducing the thickness. It shows that the bottom layer should be preferred for geo textile material have less thickness of pavement.

11. REFERENCES

Annu, Maiyanka Verma Presents " Use of Geotextile Pavement in Road Construction In India: IOSR Journal of Engineering (IOSRJEN) www.iosrjen.orgISSN (e): 2250-3021, ISSN (p): 2278-8719Vol. 08, Issue 9 (September. 2018), ||V (III) || PP 01-05

Sayali V Paygude1, Priyanka S Dhumal2 presents, "REVIEW ON GEOTEXTILES IN ROAD CONSTRUCTION" JOURNAL OF INFORMATION, KNOWLEDGE AND RESEARCH IN CIVIL ENGINEERING Borakanvar, M. (2018). Capacity estimation of NH-50. world journal of technology,engineering and research ISSN: 0975 – 6744| NOV 16 TO OCT 17 | Volume 4, Issue 2.

Bhavesh Joshi,M. Tech Scholar, CE, CTAE, Udaipur, India presents, "PAVEMENT DESIGN BY USING GEOTEXTILE"International Journal of Civil Engineering and Technology (IJCIET),Volume 6, Issue

11, Nov 2015, pp. 39-44, Article ID: IJCIET_06_11_005 Available onlinath.

Dr. S. K. Chaudhary, Assistant Engineer, Road Construction Department, Road Subdivision, Sakri, Darbhanga, Bihar represented Geotextiles in Road Construction,Maintenance and Erosion Control.

Dheemu Lavanya Kumari1, Ummenthala Veda Vyas2, represented. EXPERIMENTAL INVESTIGATION OF FUNCTIONS OF GEOTEXTILES IN ROAD CONSTRUCTION L.R.KADIYALI. (2008).

Aneesha Aseez1, Firdousul Hakh CT2, presents. STRENGTHENING OF SUB-GRADE SOIL USING GEOSYNTHETICS", International Research Journal of Engineering and Technology (IRJET), e-ISSN: 2395-0056, Volume: 05 Issue: 03

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