Improvement of Subgrade CBR Using Geotextile

Gaurav Pandey[1], Faisal Rahman[1], Harshit Jailapia[1], Narad Muni Prasad[2]
[1]UG Student Department of Civil Engineering Delhi Technological University
[2]Professor Department of Civil Engineering Delhi Technological University

---***---

Abstract - The main purpose of our project is to test the improvement in the CALIFORNIA BEARIBG RATIO of SUBGRADE SOIL upon usage of GEOTEXTILE layer in the soil. We planned to test the effect of geotextile under different conditions of placement height, soil characterstics and moisture content. We performed experiments in the laboratory to determine the results and variation of CBR value and plotted it to draw inferences.

Key Words: CBR, Geotextile, Subgrade, Moisture Content, Silty soil, Sandy soil.

1.INTRODUCTION

The construction of civil engineering structures, including dams, bridges, buildings, and roads, necessitates a robust foundation that relies on soil with high bearing capacity. However, weak soils at construction sites must be strengthened to enhance their shear strength and bearing capacity, ensuring safe load-bearing capacity without failure. Chemical stabilizers, admixtures, and physical geosynthetic materials such as geogrids, geocells, and geotextiles are commonly used to stabilize expansive soils. Geotextiles, in particular, are widely used in road construction to improve soil performance. Research on synthetic, artificial, and natural geofabrics/geomaterials is extensively conducted to explore cost-effective methods of reducing the required depth of the soil layer by utilizing various combinations of these materials in road construction.

2. Problem Identification

Unpaved roads have substantial economic and developmental impacts on developing and underdeveloped nations. Soft subgrade soils can cause deformation and failure of flexible pavements. However, challenges in obtaining suitable aggregate material that meets design requirements, due to local availability or high transportation costs, often arise. Therefore, it is crucial to identify techniques that eliminate the reliance on high-quality aggregate or minimize its usage, while still ensuring satisfactory road performance. These techniques need to be further optimized based on local soil conditions to maximize output and minimize costs.[1]

3. METHODOLOGY

Literature review: The research focused on investigating the improvement of subgrade California Bearing Ratio (CBR) using geotextile reinforcement. The experimental approach involved conducting tests on soil samples using molds with layers positioned at different heights, specifically at l/4, l/2, and 3l/4 levels.[2] Additionally, two different types of soil samples were tested to evaluate their performance.[3] Furthermore, the tests were conducted under different conditions, including soaked and unsoaked conditions,[4] to enable a comprehensive comparison of the effects of different heights and soil types on subgrade CBR improvement.

Procurement of soil: The soil was procured from the soil laboratory of Delhi Technological University for both the samples and tested there itself.

Procurement of Geotextile: Geotextile was procured from Shiv Sons, a geotextile supplier in Ajmeri Gate, Delhi. It is a 150 GSM TARCO Brand, permeable geotextile, non-Woven type.

4. Experimental Investigations

Table -1: Preliminary Tests on the samples

Properties	Sample 1	Sample 2
Specific Gravity (G)	2.74	2.56
Liquid Limit (w_l)	44%	29%
Plastic Limit (w_p)	25%	22%
Plasticity Index (I_p)	19%	7%
OMC	6.5%	9.4%
MDD	19.4 KN/m^3	22 KN/m^3
D_{60}	5.3 mm	0.530 mm
D_{30}	2.1 mm	0.327 mm
D_{10}	0.5 mm	0.198 mm
C_u	10.6	2.7
C_c	1.66	1.02

Table -2: CBR Tests on the sample 1 Unsoaked

Penetration (mm)	L/4	L/2	3L/4	No
0.5	120	125	130	135
1	210	220	230	240
1.5	280	290	305	320
2	365	380	395	415
2.5	445	460	485	505
3	490	505	530	555
3.5	540	555	585	610
4	590	610	640	670
4.5	635	655	690	720
5	665	690	720	755
5.5	700	725	760	795
6	730	750	790	825
6.5	755	780	815	855
7	770	800	835	875

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 07 Issue: 04 | April - 2023 Impact Factor: 8.176 ISSN: 2582-3930

7.5	800	825	865	905
8	815	845	885	925
8.5	835	860	905	945
9	845	870	915	955
9.5	855	885	925	970
10	855	885	925	970
CBR 2.5 %	34	35	37	39
CBR 5 %	31	32	33	35

Table -2: CBR Tests on the sample 2 Unsoaked

Penetration (mm)	**L/4**	**L/2**	**3L/4**	**No**
0.5	110	105	95	95
1	195	185	175	170
1.5	265	250	235	230
2	340	320	300	295
2.5	415	395	365	360
3	455	430	405	395
3.5	500	475	445	435
4	555	525	490	480
4.5	595	565	525	515
5	625	590	550	540
5.5	660	625	580	570
6	680	645	600	590
6.5	705	665	625	610
7	720	685	640	625
7.5	750	710	665	650
8	760	720	675	660
8.5	780	740	690	675
9	790	750	700	685
9.5	800	760	710	695
10	800	760	710	695
CBR 2.5 %	32	30	28	28
CBR 5 %	29	27	26	25

Table -2: CBR Tests on the sample 1 Soaked

Penetration (mm)	**L/4**	**L/2**	**3L/4**	**No**
0.5	20	25	25	25
1	45	45	50	50
1.5	65	70	70	75
2	90	90	95	100
2.5	105	110	115	120
3	125	130	135	140
3.5	130	135	145	150
4	145	150	160	165
4.5	155	160	165	175
5	165	170	175	185
5.5	175	180	190	200
6	180	185	195	205
6.5	190	195	205	215
7	200	205	215	225
7.5	210	220	230	240
8	220	230	240	250
8.5	225	235	245	255
9	230	235	250	260
9.5	240	245	260	270
10	240	245	260	270
CBR 2.5 %	8	8.4	8.8	9.2
CBR 5 %	7.7	7.9	8.1	8.6

Table -2: CBR Tests on the sample 2 Soaked

Penetration (mm)	**L/4**	**L/2**	**3L/4**	**No**
0.5	25	20	20	20
1	45	45	40	40
1.5	65	60	55	55
2	85	80	75	75
2.5	105	100	90	90
3	120	115	105	105
3.5	135	125	115	115
4	145	135	130	125
4.5	150	140	135	130
5	160	155	145	140
5.5	175	165	155	150
6	180	170	160	155
6.5	185	175	165	160
7	195	185	175	170
7.5	210	195	185	180
8	220	210	195	190
8.5	225	215	200	195
9	225	215	200	195
9.5	235	225	210	205
10	235	225	210	205
CBR 2.5 %	8	7.7	6.9	6.9
CBR 5 %	7.4	7.2	6.7	6.5

3. OBSERVATIONS

i. The findings of the research indicated that unsoaked Sample 1 exhibited a higher load carrying capacity at the same penetration compared to unsoaked Sample 2. Similarly, soaked Sample 1 demonstrated a higher load carrying capacity compared to soaked Sample 2.

ii. The findings of the research indicated that unsoaked Sample 1 exhibited a higher load carrying capacity at the same penetration compared to unsoaked Sample 2. Similarly, soaked Sample 1 demonstrated a higher load carrying capacity compared to soaked Sample 2.

iii. In the case of unsoaked Sample, the top placement of the geotextile layer showed the least load carrying capacity at the same penetration. The middle placement exhibited a slightly higher load carrying capacity compared to the top placement, while the bottom placement demonstrated even higher load carrying capacity. Notably, the mold with no geotextile layer exhibited the highest load carrying capacity among all the placements tested.

iv. In the case of unsoaked Sample 2, the top placement of the geotextile layer showed the highest load carrying capacity at the same penetration, followed by the middle placement with slightly lower load carrying capacity, and the bottom placement with even lower load carrying capacity. Notably, the mold with no geotextile layer exhibited the lowest load carrying capacity among all the placements tested.

v. The load carrying capacity was observed to be higher in unsoaked soil compared to soaked soil for both Sample 1 and Sample 2.

4. CONCLUSIONS

i. Geotextile has been found to be effective in improving the California Bearing Ratio (CBR) of soil in certain cases, as it can reinforce the soil structure and enhance its overall stability.

ii. Coarse Sand has more load carrying capacity than Fine Sand without any geotextile. Coarse Sand particles are larger and have a higher degree of interlocking compared to Fine Sand particles, which makes them more resistant to deformation under load. Fine Sand particles are much smaller and have a lower degree of interlocking, which makes them more prone to deformation under load.

iii. Geotextile is more effective when placed near the top as placing the geotextile near the top can help to distribute stresses more evenly.

iv. Geotextile improves the load carrying capacity for Fine Sand but not for Coarse Sand. Geotextile can improve the load carrying capacity of Fine Sand by increasing its shear strength and reducing its compressibility. This is because geotextile can provide a barrier between the soil particles, which can help to distribute the load more evenly and prevent the soil from being compressed. But geotextile can decrease the load carrying capacity of Coarse Sand by reducing its interlocking and increasing its compressibility. This is because the geotextile can act as a slip surface between the Coarse Sand particles, which can reduce the friction and interlocking between the particles.

v. Soil at OMC shows more load carrying capacity than soaked soil as at OMC, the soil particles are in their most compact state, which can increase their resistance to deformation and improve their ability to support loads. Whereas, when a soil is soaked, the excess moisture can cause the soil particles to separate and become less tightly packed, which can reduce the soil's load carrying capacity. The excess water can also act as a lubricant between the soil particles, reducing their friction and interlocking, which can cause the soil to collapse or settle under heavy loads.

ACKNOWLEDGEMENT

We would like to express our profound thanks to **Professor Narad Muni Prasad**, of **Delhi Technological University** for his constant support and guidance throughout the project.
We would like to thank **Professor T. Vijay Kumar** for giving us the opportunity to undergo this project.
We would like to thank **Professor A. K. Gupta** for providing us the soil laboratory to perform the project experiments.
We would like to thank **Professor B.R.G. Robert** for providing us the soil laboratory to perform the project experiments.
We would also like to thank **Shiv Sons** (No.5214, Main Market, G.B. Road, Ajmeri Gate, Delhi) for providing the required geotextile.
Lastly, we would like to extend our hearty thanks to the Lab Assistants of Transportation, Soil and Concrete lab for their constant guidance and assistance with the Experiments and Apparatus.

REFERENCES

1. R. Ramasamy, "Effect of geotextile on CBR strength of unpaved road with soft subgrade," Electronic Journal of Geotechnical Engineering, vol. 17, no. 6, pp. 2161-2171, 2012.[1]
2. R. Kanapuram, "An experimental study on CBR of expansive soil subgrades using geotextiles," International Journal of Emerging Trends in Engineering and Development, vol. 4, no. 6, pp. 154-160, 2019.[2]
3. M. B. Vikram, "Effect of geotextiles on CBR values," International Journal of Emerging Trends in Engineering and Development, vol. 5, no. 3, pp. 34-40, 2018.[3]
4. K. A. Shah and E. Ahmad, "A study on alluvial soil stabilization using bitumen emulsion," in Proceedings of the International Conference on Civil, Architecture and Environmental Engineering (ICCAEE 2020), 2020, pp. 246-253