INFLUENCE OF STRONGER OVERLYING LAYER AND REINFORCEMENT ON CBR PROPERTY OF DIFFERENT SOFT SUBGRADE - A LAB STUDY

DIFFERENT SOFT SUBGRADE

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Abstract: Utilization of bulk quantiites of natural soil is a viable technique in pavement constructions. Natural Subgrade supports the pavement loads and hence should have adequate strength. Providing stronger layer above soft layer and reinforcing weaker soils using geo-synthetics like geo-grids are few techniques to improve subgrade performance. Present project work aims to study the influence of stronger aggregate layer over soft soil subgrade with and without reinforcement at the interface over CBR property of different subgrade. Four subgrade types with varying plasticity properties are use for present study. Laboratory and field CBR tests are conducted with varying H_r (H_a / H_s) from 0, 0.1, 0.2, 0.3, 0.4 0.5. Where H_s and H_a are thickness of subgrade and thickness of overlying aggregate respectively. Effect of separator reinforcement (geosynthetic) is also studied on CBR for various H_r.

Index Terms: Plasticity index, CBR value, reinforcement, subgrade, stronger overlying layer, and Geosynthetics

I. INTRODUCTION

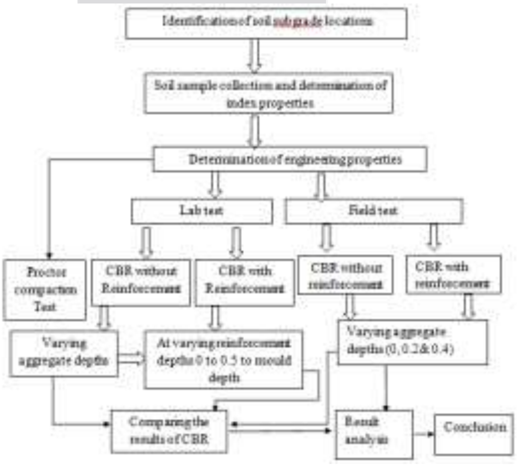
The service-life and performance of roads depend to a large extent on the strength and stiffness characteristics of subgrade. Subgrade characteristics assist road engineers in the selection of materials for sub-base and base courses of pavements. Hence, the evaluation of subgrade strength assumes great importance in pavement design. In geotechnical and foundation engineering, in-situ penetration tests have been widely used for site investigation in design. California Bearing Ratio (CBR) value is very popular among highway engineers as a soil support value for pavement design.

Geosynthetics have been used for subgrade stabilization and base course reinforcement for construction of unpaved structures. Placed between the subgrade and the base course, or within the base course, the Geosynthetic improves the performance of the unpaved roads carrying channelized traffic and unpaved areas subjected to random traffic. Geosynthetics in road structures can have a reinforcement, separation and filtration function. Because of the reinforcement function significant higher shear stresses can be observed at the interface subbase - geosynthetic – subsoil.

Objective

a. To determine the laboratory CBR and engineering properties for a four soil subgrades viz., clayey soil of varying plasticity characteristics.
b. To study the influence of stronger aggregate layer over soft soil subgrade with / without separator reinforcement at the interface over composite CBR property of soil- aggregate subgrade.
c. To study the influence of fines content, plasticity and varied thickness of overlying stiff aggregate layer with and withou N1PM separator reinforcement on CBR value of composite subgrades.

II. METHODOLOGY



III. EXPERIMENTAL STUDIES

Experimental studies for determination of index and engineering properties on different subgrade are carried out. The engineering properties are determined on subgrade samples in both lab and field. Four types of soil subgrade, Geotextile reinforcement and coarse aggregate are used for study.

Preparation of aggregate-geotextile-soil specimen and conduct of labCalifornia Bearing Ratio(CBR) Test:

Lab CBR test is carried out on soil-aggregate composite layer of thickness, H by placing aggregate layer of thickness, H_a over soil layer of thickness, H_s in CBR mould. Initially soil layer is compacted in the mould to maintain H_s , aggregate of thickness H_a is later filled in the mould above soil. The testing is carried out by varying H_r (a ratio of H_a to H_s). The same tests are carried out by placing a separator geotextile at the interface of soil-aggregate. The thickness of sample H and the densities of soil and aggregate is maintained throughout all the tests. For creating void of height H_a spacer disks of thickness 0.5,1cm, 2cm etc. are used for preparing soil specimen with the desired void space (later filled by coarse aggregate) above soil after compaction in CBR mould. A schematic diagram of lab CBR sample specimen is given in fig.3.2. The samples are compacted at maximum dry density condition for performing CBR test and H_r is varied from 0 to 0.5 in the increments of 0.1. Test setup for sample without and with separator geotextile.

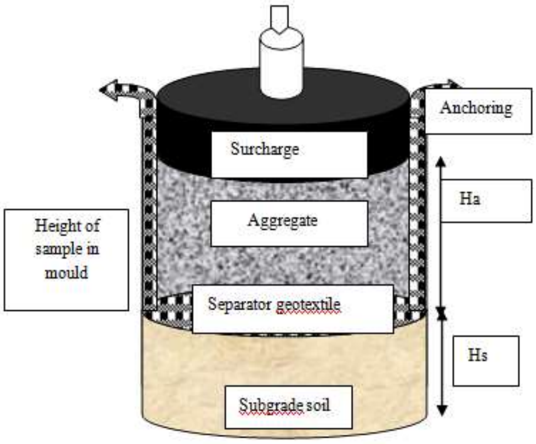


Fig-1: Schematic diagram of soil- aggregate- separator geotextile layers for lab CBR test

Preparation of aggregate-geotextile-soil specimen and conduct of fieldCalifornia Bearing Ratio(CBR) Test:

Field CBR is test conducted at subgrade from where sample-4 is collected. The test is conducted at a depth of 0.6m below ground. Initially a pit of size 1.5m x 1.0m is made. CBRtest is conducted at different locations in the pit by varying H_r. For simplicity zone of influence of soil is taken to be same as thickness in lab. Accordingly H_r is computed and maintained in all the tests. The test set up is shown in figure-2.

Table 3: Engineering properties of Soil subgrade

Sample No.	w_{max} (%)	γ_d (kN/m^3)	CBR (%)
1	17.07	16.90	2.07
2	18.97	16.18	1.66
3	21.04	15.94	1.20
4	15.40	18.14	2.76

Table 4: Lab and field density of subgrade-4

Lab Density(kN/m^3)	Field Density(kN/m^3)
18.14	18.75

Table 5: CBR Ratios R_c and R_c* obtained for soil subgrades#

ParameterH_r	R_{c1}	R_{c1}*	R_{c2}	R_{c2} *	R_{c3}	R_{c3}*	R_{c4}	R_{c4}*
0	1	1.304	1	1.5	1	1.841	1	1.23
0.1	1.277	1.603	1.162	1.807	1.383	2.25	1.33	1.47
0.2	1.594	1.835	1.331	2.162	1.608	2.766	1.49	1.68
0.3	1.69	2.004	1.746	2.334	2.075	2.991	1.68	1.9
0.4	2.004	2.14	2.334	2.5	2.916	3.23	1.9	1.98
0.5	1.872	2.27	2.1	2.668	2.775	3.458	1.79	2.12

subscript 1, 2,3,4 in table 5 indicates subgrade sample number.

Table 6 CBR Ratios F_c ,F_c* and F_c^{**} obtained for soil subgrade

H_r	Lab CBR value		Field CBR value		Fc	Fc *	Fc **
	C_{WS}	C_s	FC_{ws}	FC_s			
0	2.47	3.045	3.01	3.89	0.82	1.01	1.29
0.2	3.7	4.15	4.76	6.01	1.22	1.37	1.99
0.4	4.7	4.9	6.2	7.06	1.56	1.62	2.34

Variation of CBR results with H_r : effect of separator

The variation in CBR values with H_r of separator and without separator soil is shown in figure 4.65 it is observed that the CBR value is increasing with H_r. Using the separator is causing in increase of CBR value. Due to overlaying aggregate, the bearing resistance is increased. With increased H_r due to increased bearing resistance CBR value for all the three soils has increased considerably. With increase in value of H_r from 0 to 0.5 for three different samples, the corresponding CBR value has increased from 2.09 to 3.59; 1.66 to 3.5, and 1.2 to 3.3 for H_r ranging from 0 to 0.5 for without separator soil. There is also decrease in CBR value in spite of increasing the H_r value after a certain threshold level. This is due to lack of interlocking with the increase in air voids the resistance is affected. Similarly the CBR value has increased from 2.7 to 4.7; 2.49 to 4.43 and 2.21 to 4.15 for Hr ranging from 0 to 0.5 for separator soil. Here, the penetration of the aggregate is avoided by using separator.

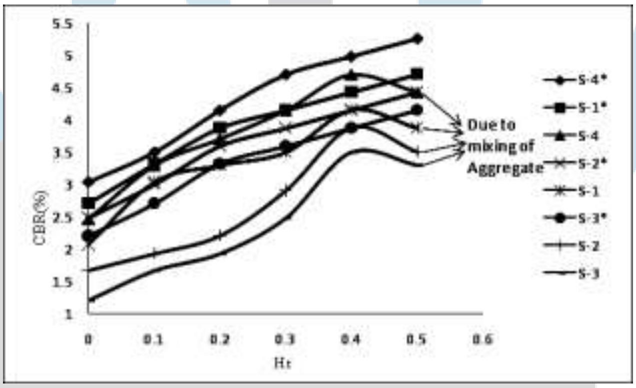


Fig 1: Variation of CBR with respect to H_r

Presentation of variation of CBR Ratio R_c & R_c^* with H_r:

The factored CBR values R_c and R_c^* and their variation with H_r is presented in Fig. 4.69. As expected and it can be seen that a significant contribution is achieved in CBR values due to aggregate and separator geotextile. Hence the problem due to low CBR of natural subgrade can be overcome by providing either overlying aggregate layer or separator or both. However the combination is to be chosen for best results. As observed from the graph for sample-3 R_c^* has increased from 2.25 to peak value of 3.5 for H_r from 0 to 0.5, but R_c has increased only from 1.2 to a peak value of 2.75 for H_r from 0 to 0.4.and later decreased. The same trend is seen for other soil samples also.

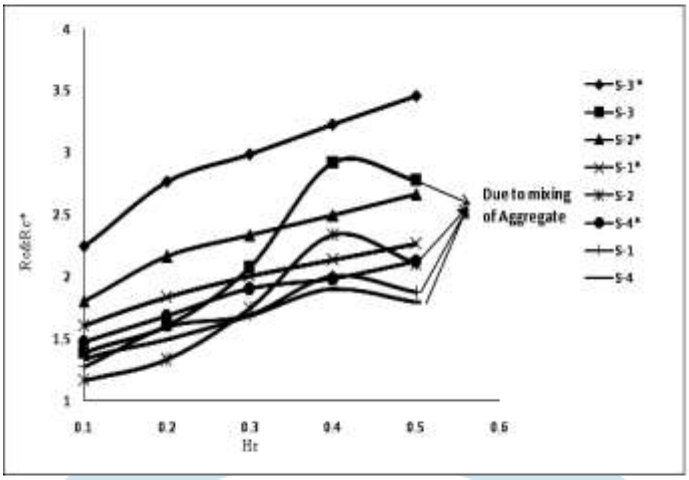


Fig 2: variation R_c &R_c*with H_r

IV. Conclusions

- Fines (%) and PI has an influence on CBR and it is observed that the CBR value decreased by 12% with respect to Fines (%) and by 11.72% with respect to PI.
- It is observed that the CBR value of composite soil (soil+ aggregate) is 33% more than that of soil alone.
- CBR of composite soil with separator soil (H_r=0.1 to 0.5) are 23.47% and 50% higher than thatof CBR values of the soil without separato**r.**
- The effect of separator is insignificant at higher H_r value say 0.4 irrespectively of plasticity. The improvement is significant at low H_r of 0.2 over H_r 0.4.
- Given a soil of plasticity index, the factored CBR, has provided a guideline for choosing optimum combination of aggregate and separator geotextile for a desired improvement by avoiding mixing.
- It is observed that the influence of separator reinforcement and aggregate is more in lab that of field.

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