International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 04 Issue: 07 | July -2020 ISSN: 2582-3930

EFFECT OF ADDITIVES ON CALIFORNIA BEARING RATIOS OF BLACK COTTON SOIL

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Abstract -Nowadays all over the globe, building of civil infrastructure has attained unbelievable preference towards the globalization. Most of thehuge projects are the symbolic depiction to say whether a particular country is developed or not. All these projects have to be built on the earth or soil mass. Depending upon the local geological conditions and prevailing environment, variety of soil can be seen all over the world. At the same time, we also rendezvous with the arduous soils, which pose expansion/shrinkage, high compressibility and collapse when loaded. There is a colossal demand to establish convenient foundation technique to overcome the difficulties associated with this type of soil. Hence, suitable techniques are to be embraced for alleviating these problems posed by black cotton soil. In the present investigation, soil strength and CBR are important parameters considered in the pavement design. The CBR test results obtained on clayey samples treated with various admixtures like Fly ash and Quarry dust are presented and discussed. Fly ash (FA) and Quarry dust (QD) are used in a proportion 0%, 10%, 20%, 30%, 40% and 50% and 0% 2%, 4%, 6%, 8% and 10%, respectively. For the FA + QD combination, 0%FA + 0%QD, 5%FA + 5%QD, 10%FA + 10%QD, 15%FA + 15%QD, 20%FA + 20%QD and 25%FA + 25%QD proportion is used. The increase in CBR at the 30% of FA content and 30% of QD content is 130% and 375 %, respectively and the increase is about 2.1 to 2.3 and 4.75 times as compared to the untreated soils, respectively. For the combination of 20%FA + 20%QD content, the increase is 3.7 to 3.8 times that of the untreated soils.

Key Words:Black cotton soil, fly ash, Quarry dust, California Bearing Ratio

1.INTRODUCTION

Fly ash is an outgrowth from thermal power plants that utilize coal fuel. The production of fly ash estimated per annum is about 120 tons from all over Indian power plants and occupying many 1000s of hectares of land. Katti et al (1979) mentioned that many measures like application of adequate surcharge load, pre-wetting, wet management, Cohesion Non-Swelling layer technique in dominant the adverse effects posed by the expansive clay soils. Bell (1996) invented the changes in properties of soil–lime mixtures. When lime is added to clayey soils, calcium ions primarily combine or get absorbed by clay minerals. These alterations continue till lime fixation point purpose. This addition of lime helps in the development of soil workability. The effectiveness of lime stabilization is dependent upon the development of reaction products developed from the attack of lime on the minerals on clay deposit. Fly ash disposal inflict severe health and environmental problems. Boominathan (1999) had mentioned that, continuous efforts are created and incentive by the government, merely 5% to 10% of ash is being employed for construction functions like brick creating, cement making, as fill material and stabilization of soil. Mahrt (2000) had said that, the molded wet content increase in the CBR value of soil and also the optimum proportion being 60% of soil with 40% dust. Pandian (2002) had said that, the CBR of black cotton soil that consists of finer particles is contributed by cohesion. The CBR of fly ash that consists of coarser particles is contributed by its frictional component. The addition of fly ash to Black cotton soil increases the CBR of the mix up to the primary optimum level and causes a decrease up to 60% and then up to the second optimum level there is a rise. The present investigation of improvement of CBR values with admixtures like fly ash and stone dust pertaining to black cotton soil.

2. MATERIALS

2.1 Soil

Black cotton soil is collected from Maharashtra at a depth of about 1 m from the ground level after removing all the vegetation matter. The collected soil was air dried and pulverized and kept in airtight bags in the laboratory. The physical properties and the chemical composition of the soil are presented in Table 1 and 2, respectively.

Table -1: Physical Properties of Black Cotton Soil

Property		Value
Specific Gravity		2.72
Atterberg Limits	Liquid Limit (%)	58.00
	Plastic Limit (%)	25.00
	Shrinkage Limit (%)	10.80
Plasticity Index (%)		31.00
Particle Size Distribution	Fine sand size fraction (%)	24.55
	Silt size fraction (%)	30.20
	Clay size fraction (%)	45.25
IS Classification		CH
Compaction Characteristics	Optimum Moisture Content (OMC) (%)	26.65
	Maximum Dry Density (MDD) (g/cc)	1.459
Unconfined Compressive Strength (kN/m^2)		85.73
Difference Free Swell Value (%)		50

Soaked CBR (%)	1.89

Table -2: Chemical composition of Black Cotton Soil

Constituents	% by Weight
SiO_2	51.30
Al_2O_3	19.50
TiO_2	0.85
Fe_2O_3	12.90
MnO	0.40
MgO	0.45
CaO	0.5
K_2O	0.18
Na_2O	0.10
Loss of Ignition	----

2.2 Fly ash

The physical properties and chemical composition of Fly ash are tabulated in Table 3 and 4, respectively as shown below.

Table -3: Physical Properties of Fly ash

Property		Value
Specific Gravity		2.25
Atterberg Limits	Liquid Limit (%)	60.00
	Plastic Limit (%)	Non-plastic
	Shrinkage Limit (%)	----
Plasticity Index (%)		----
Particle Size Distribution	Fine sand size fraction (%)	81.44
	Silt size fraction (%)	17.65
	Clay size fraction (%)	0.91
Compaction Characteristics		
Optimum Moisture Content (OMC) (%)		46.50
Maximum Dry Density (MDD) (g/cc)		0.890

Table -4: Chemical composition of Fly ash

Constituents	% by Weight
SiO_2	60.05
Al_2O_3	24.50
TiO_2	1.34
Fe_2O_3	3.95
MnO	Below detection
MgO	1.10
CaO	11.30
K_2O	0.81
Na_2O	0.19
Loss of Ignition	3.01

2.3Quarry Dust

The physical properties and chemical composition of Quarry dust are tabulated in Table 5 and 6, respectively as shown below.

Table -5: Physical Properties of Quarry dust

Property	Method of Test	Value
Specific Gravity	IS:2386 Part 3-1963	2.58
Bulk Density (kg/m^3)	IS:2386 Part 3-1963	1780
Water absorption (%)	IS:2386 Part 3-1963	1.35
Moisture Content (%)	IS:2386 Part 3-1963	----
Fine Particles less than 0.075mm (%)	IS:2386 Part 3-1963	13.00
Sieve analysis	IS:383-1970	Zone II

Table -6: Chemical composition of Quarry

Constituents	% by Weight
SiO_2	76.76
Al_2O_3	5.42
TiO_2	0.25
Fe_2O_3	3.62
MgO	1.64
CaO	3.81
K_2O	2.15
Na_2O	0.63
Loss of Ignition	0.74

3. METHODOLOGY

The proportions of Fly ash (FA) and Quarry dust (QD) used along with the soil in the study are 0%, 10%, 20%, 30%, 40% and 50% and 0% 2%, 4%, 6%, 8% and 10%, respectively. The tests were conducted on the Black cotton soils samples mixed at different proportions of fly ash and stone dust. The California Bearing Ratio tests were conducted as per IS: 2720 (Part 16) – 1987 and the controlled conditions as per the procedures given in the concerned codes of Indian Standard.

4. RESULTS AND DISCUSSION

Soil strength and C.B.R. are crucial criterion that can be taken into scrutiny in the pavement design. CBR of a particular soil can be estimated reasonably by conducting the CBR test in the laboratory. The CBR test results obtained on clayey samples treated with various admixtures are explained and discussed. The admixtures used are FA, QD, and combinations of mixtures FA + QD. The proportions of FA and QD used in the study are 0%, 10%, 15%, 20%, 25%, 30%, 40% and 50%. For the FA + QD combination, the

proportions used are 0%FA + 0%QD, 5%FA + 5%QD, 10%FA + 10%QD, 15%FA + 15%QD, 20%FA + 20%QD and 25%FA + 25%QD.

The clay samples admixed with FA, QD and FA + QD the CBR samples were prepared at their respective OMC obtained in the heavy compaction test. For admixed clay soils, the CBR samples are prepared at the OMC of the untreated clay soils. For all the samples, soaked CBR tests were conducted. The results obtained are presented in Figures 1-3 and discussed.

4.1 Influence of FA on the soaked CBR of three clay soils

The results explaining the effect of FA on the soaked CBR of clayey soil are presented in Figure1.It presents the load-penetration curves for soil treated with different proportions of FA. From the figure, it can be seen that the load-penetration curves are riding one over the other in the order as FA proportion increases from 0% to 50%. The load penetration curves of FA proportion 30%, 40% and 50% are moving closely. The gap between the curve of untreated soil and the curves related to FA proportion of 30%, 40% and 50% is large. This indicates that as the % FA increases, the mixture is offering resistance against the penetration under a given load. The increase in the CBR observed corresponding to the 30% of FA content is 133%. and this increase can be seen as almost 2.1 to 2.3 times as compared to the untreated soils.

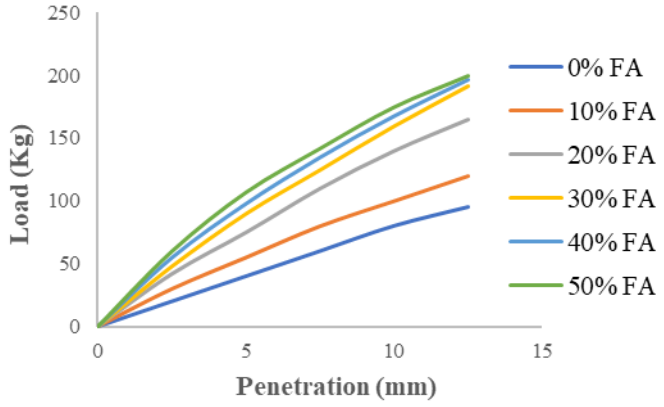

Fig -1:Load-penetration curve for Fly ash (FA) treated soil

4.2 Influence of QD on the soaked CBR of three clay soils

The results explaining the influence of QD on the soaked CBR of the clayey soils are presented in Figure 2. This presents the load-penetration curves for soil addition with different proportions of QD. It can be seen that, the load-penetration curves are riding one over the other in the order as QD proportion increases from 0% to 50%. The load penetration curves of QD proportion 30%, 40% and 50% are almost merged. The gap between the curve of untreated soil and the curves related to QD proportion of 30%, 40% and 50% is large. This indicates that, as the % QD increases, the mixture is offering resistance against the penetration under a given load. From this figure, it can be seen that as the % QD increases from 0 to 50%, the CBR of the clayey soils is increasing and this increase is observed drastic up to the 30% of QD and thereafter no increase in CBR is noticed. The increase in the CBR observed corresponding to the 30% of QD content is 375%. The increase in CBR at 30% QD is almost 4.75 times as compared to the untreated soils.

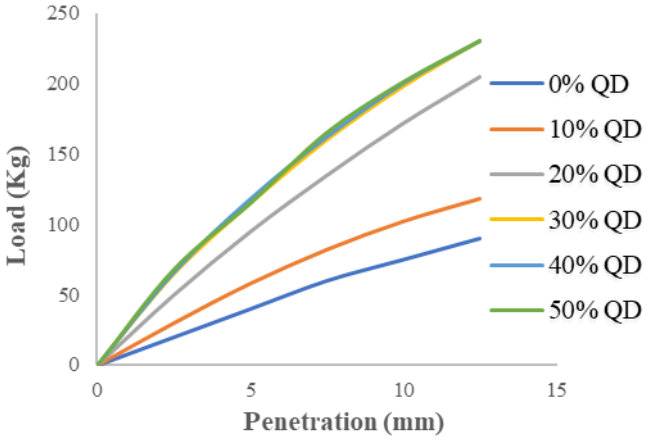

Fig -2:Load-penetration curve for Quarry Dust (QD) treated soil

4.3 Influence of combination of FA + QD on the soaked CBR of the clay soil

The results explaining the role of combination of FA + QD on soaked CBR of the clayey soil are presented in Figure 3 and load-penetration curves for the soil treated with different proportions of FA + QD. From this figure, it can be seen that, the load-penetration curves are riding one over the other in the order as FA + QD proportion increases from 0%+0% to 25%+25%. The load penetration curves of FA + QD proportion 20%+20% and 25%+25% are merging each other whereas, the load penetration curve of FA + QD of 15%+15% is moving closely with the curves of higher admixture proportions. The gap between the curve of untreated soil and the curves related to FA + QD proportion of 15%, 20% and 25% is large after a penetration level of 2.5 mm. This indicates that as the % FA + QD increases, the mixture is offering resistance against the penetration under a given load. Further, it can be noticed that as the % FA + QD increases from 0%+0% to 25%+25%, the CBR of the soil is increasing and this increase is observed drastic up to the 20%+20% of FA + QD and thereafter no increase in CBR is noticed. The increase in the CBR observed corresponding to the 20%+20% of FA + QD content is 283% and this increase in CBR at the 20%+20% of FA + QD can be seen as almost 3.7 to 3.8 times as compared to the untreated soilcontent.

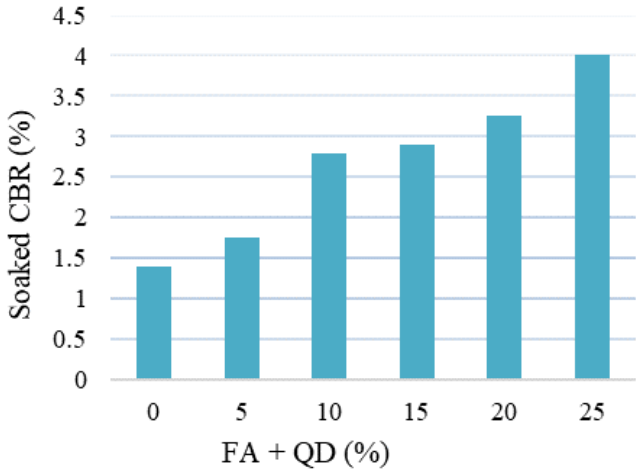

Fig -3:Influence of combination of FA and QD on soaked CBR of soil

5. CONCLUSION

- The increase in CBR at the 30% of FA content is 130% and increase is about 2.1 to 2.3 times as compared to the untreated soils.
- The increase in the CBR observed corresponding to the 30% of QD content is 375% and increase is almost 4.75 times as compared to the untreated soils.
- The enhance in the CBR observed for soils corresponding to the 20%FA + 20%QD content is 3.7 to 3.8 times that of the untreated soils.

ACKNOWLEDGEMENT

We are very much thankful to our colleagues, parents, Professors of civil engineering department and Principal who provided their expertise views that greatly aided the research. We would also like to explicit our obligation to almighty to enabling us to complete this research study.

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BIOGRAPHIES

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