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Stabilization of Clayey Soil by using Quarry Dust Particles

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ABSTRACT

The Stabilization of soil is important in construction of foundations and highways as it improves the Engineering properties of soil like Compressibility, Permeability and Shear Strength. In this paper the experimental results obtained in the laboratory on expansive soil treated with low cost material (quarry dust) are presented. A study is carried out to check the improvements in the properties of expansive soil with addition of quarry dust in different percentages. The test results for as Atterberg's limit, compaction characteristics, differential Free Swelling Index, Unconfined Compressive Strength obtained from the tests on expansive clays mixed with different proportions of quarry dust as an admixture are presented and discussed in this paper. It is observed that the stabilized clay has reduced the Swelling and increased the maximum dry density. In present study, the soil samples prepared with addition of ceramic waste by 5%, 10%,15%,20% and 25% Quarry Dust At those OMC, several tests like CBR, UCS, Consolidations tests were conducted. CBR test was carried in both un soaked and soaked conditions variation of ceramic waste has been used to modify their engineering properties and index properties of a black cotton soil.

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INTRODUCTION

For any land-based structure, the foundation is very important and has to be strong to support the entire structure. In order for the foundation to be strong, the soil around it plays a very critical role. So, to work with soils, we need to have proper knowledge about their properties and factors which affect their behaviour. The process of soil stabilization helps to achieve the required properties in a soil needed for the construction work.From the beginning of construction work, the necessity of enhancing soil properties has come to the light. Ancient civilizations of the Chinese, Romans and Incas utilized various methods to improve soil strength etc., some of these methods were so effective that their buildings and roads still exist. In India, the modern era of soil stabilization began in early 1970's, with a general shortage of petroleum and aggregates, it became necessary for the engineers to look at means to improve soil other than replacing the poor soil at the building site. Soil stabilization was used but due to the use of obsolete methods and also due to the absence of proper technique, soil stabilization lost favor. In recent times, with the increase in the demand for infrastructure, raw materials and fuel, soil stabilization has started to take a new shape. With the availability of better research, materials and equipment, it is emerging as a popular and cost-effective method for soil improvement.

MATERIALS AND METHODOLOGY

Black cotton soil:

Black cotton soil are type of expansive soils and they shows high swell shrinkage behaviour owing to fluctuating water content. In India, black cotton soil covers as high as 20% of the total land area and majorly in central and south part of India. These soils have high swelling and shrinkage characteristics and extremely low CBR value and shear strength soil was collected by village near by Vijayawada, Andhra Pradesh and it was collected at a depth of 2-3.0 m from the ground surface. The collected soil was air dried to use it for the further investigations. The soil properties and its classifications are presented in Table 3.1.

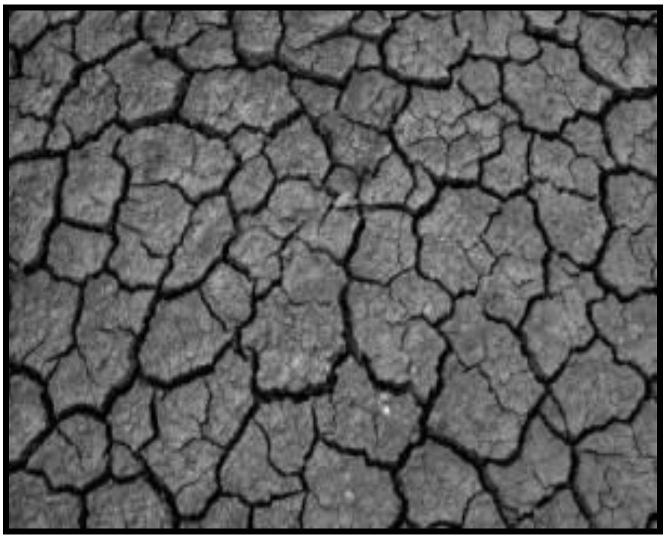


Fig-1 Black cotton soil

Characteristics	Value
Color	Black
Specific Gravity	2.67
Liquid Limit (%)	52
Plastic Limit (%)	25.15
Plasticity Index (%)	26.85
Classification	CH
Optimum Moisture Content (%)	20
Maximum Dry Density (g/cc)	1.5
Unsoaked CBR	2.9
Soaked CBR	2.1
Unconfined Compressive Strength (kg/cm_2)	0.9
Differential Free Swell (%)	50
Coefficient of Compressibility (cm^2/kg)	0.043
Compression Index (cm^2/kg)	0.056
Coefficient of Volume Change (cm^2/kg)	0.029

Quarry Dust:

Property	Soil		
	Clay	Sand	Rock quarry
Specific gravity	2.61	2.65	2.81
C_c	-	1.08	1.08
C_u	-	2.83	2.83
Liquid limit (%)	42.4	-	-
Plastic limit (%)	20.2	-	-
Plasticity index (%)	22.4	-	-
IS classification	CI	SP	SP
Coarse sand fraction (4.75 –2 mm)	2.8	9.55	17.53
Medium sand fraction (2–4.25 mm)	5.45	60.7	28.67
Fine sand fraction (4.25–0.75 mm)	4.25	29.15	40.2

Fig-2 Quarry dust

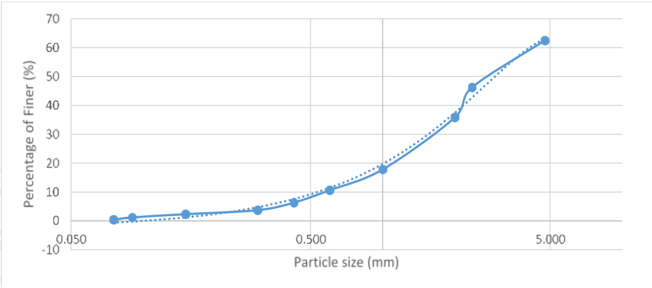
LABORATORY EXPERIMENTAL STUDY

Table 1 Standard specific Gravity

S.no	Type of Soil	Specific Gravity
1	Sand	2.63 – 2.67
2	Silt	2.65 – 2.7
3	Clay and Silty Clay	2.67 – 2.9
4	Organic Clay	< 2.0

Sieve Analysis:

IS Sieve	Weight Retained (g)	Percentage Retained (%)	Cumulative Percentage (%)	Percentage of Finer (%)
4.750	375	37.5	37.50	62.5
2.360	163	16.3	53.80	46.2
2.000	104	10.4	64.20	35.8
1.000	180	18	82.20	17.8
0.600	72	7.2	89.40	10.6
0.425	43	4.3	93.70	6.3
0.300	26	2.6	96.30	3.7
0.150	14	1.4	97.70	2.3
0.090	11	1.1	98.80	1.2
0.075	8	0.8	99.60	0.4
PAN	4	0.4	100.00	0



Graph 1: Slive Analysis Graph

Table 2 observation for specific Gravity

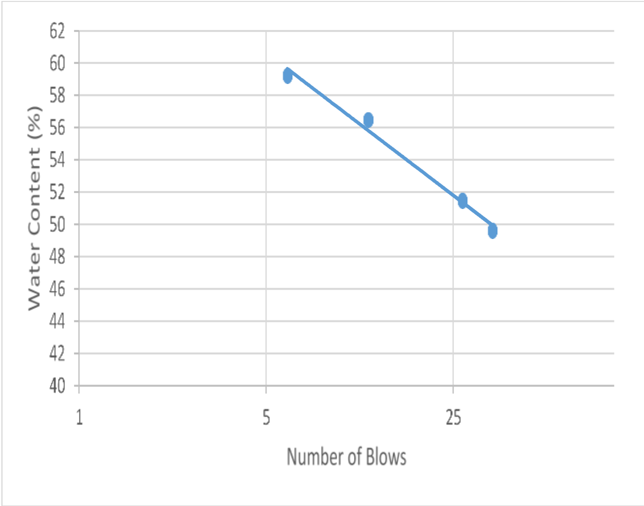
Specific Gravity:

Table.5.2.2: Observation table for Specific Gravity:

S.No	Observation	Weight (g)
1	Weight of the empty Container (W1)	630
2	Weight of Container + Dry Soil (W2)	1245
3	Weight of Container + Dry Soil + Water (W3)	1832
4	Weight of the Container + Water (W4)	1447

Liquid Limit calculation:

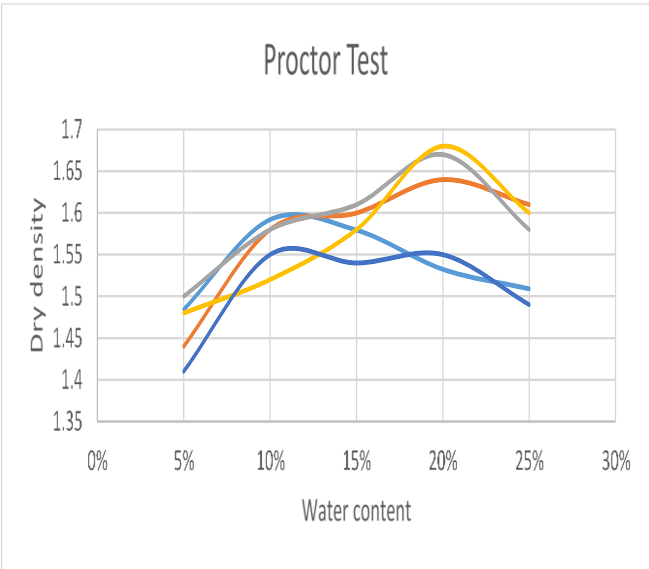
S.no	Observations & Calculations	Test 1	Test 2	Test 3	Test 4
1	Number of Blows	35	27	12	6
2	Mass of Empty Container (M_1)g	24	32	28	21
3	Mass of Container + Wet Soil (M_2)g	62	78	69	72
4	Mass of Container + Dry Soil (M_3)g	45	41	34	37
5	Water Content $W = (M_w/M_d)x100$ %	49.62	54.17	56.50	59.23



Graph 1: Liquid Limit Detremination Graph

Black Cotton Soil with (QD 20%)

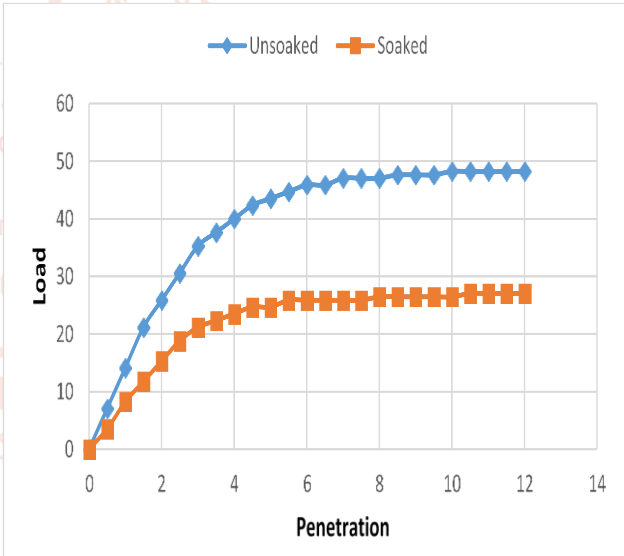
content	% of water				
	5%	10%	15%	20%	25%
Empty Weight of mould , a (g)	4980	4980	4980	4980	4980
Weight of mould + compacted soil ,b (g)	9096	8939	9321	9340	9331
Weight of compacted soil, b-a(g)	4116	3959	4341	4360	4351
Weight of cup	36	36	36	36	36
Weight of cup + wet soil	43	52	57	35	59
Weight of cup + dry soil	42	50	53	52	55
Weight of soil	6	14	17	16	19
mass of water	1	2	4	3	4
water content , W	16.7	14.2	23.5	19	21
Bulk density	1.83	1.76	1.93	1.938	1.93
dry density	1.52	1.58	1.64	1.72	1.68



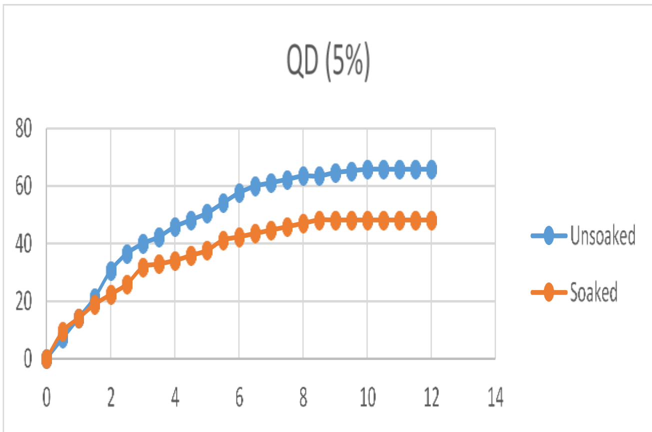
Graph 3 Compaction Curves for Soil Samples with QD

OMC and MDD Values of BC + QD%

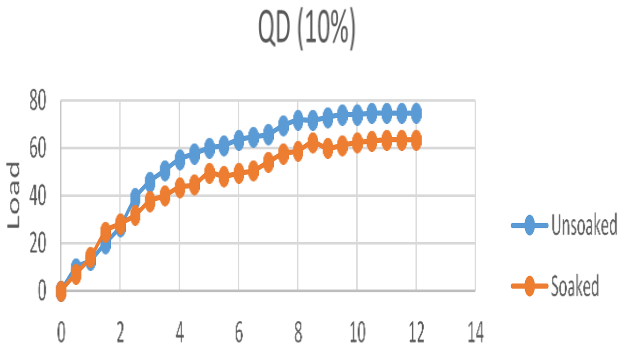
S.no	Sample	OMC (%)	MDD (g/cc)
1	Black Cotton Soil	20	1.59
2	BC+ (QD 5%)	20	1.6
3	BC +TZ (QD 10%)	20	1.64
4	BC + (QD 15%)	20	1.72
5	BC +(QD 20%)	20	1.64



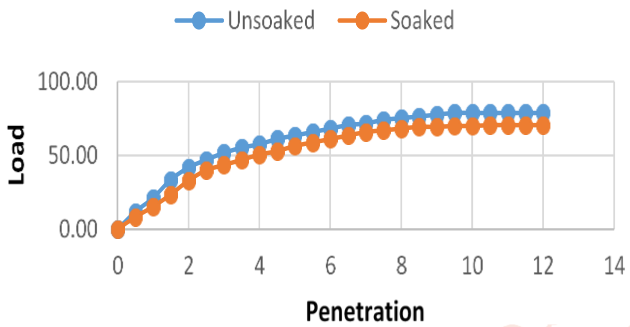
Load Vs Penetration graph for Black Cotton Soil (Unsoaked& Soaked)



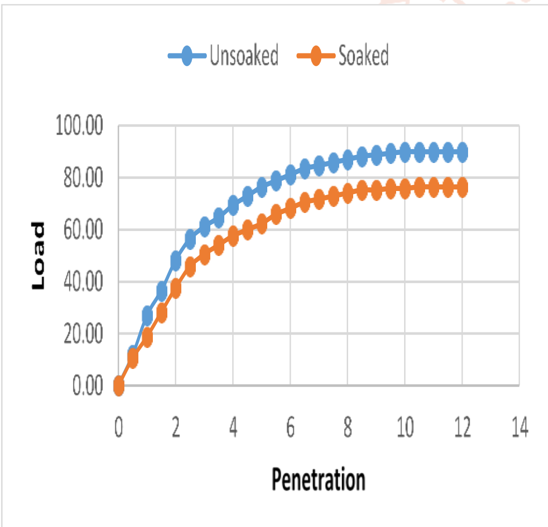
Load Vs Penetration graph for Black Cotton Soil+QD (5%) (Unsoaked& Soaked)



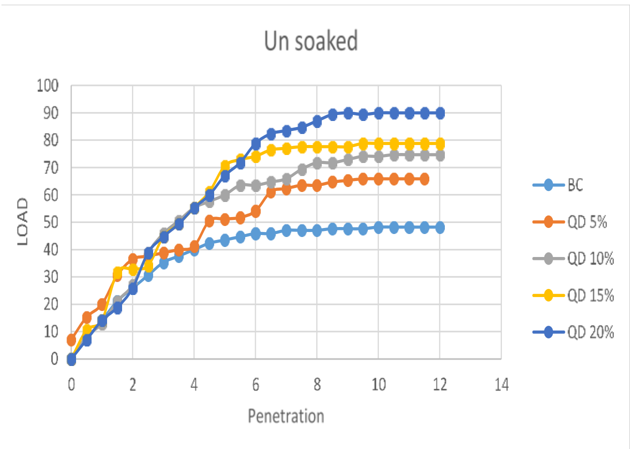
Load Vs Penetration graph for BC+QD (10%) (Unsoaked& Soaked)



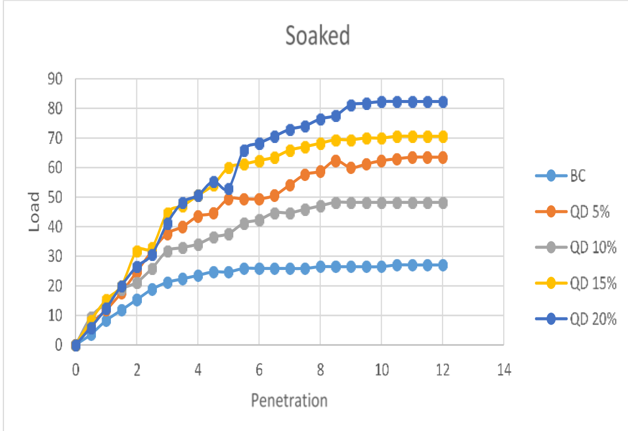
Load Vs Penetration graph for BC+QD (15%) (Unsoaked& Soaked)



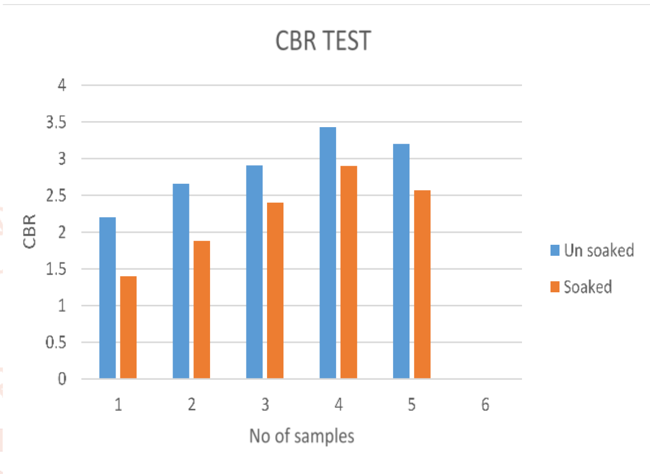
Load Vs Penetration graph for BC+QD (20%) (Unsoaked& Soaked)



Load Vs Penetration graphs of Unsoaked CBR at different percentages of QD



Load Vs Penetration graphs of Soaked CBR at different percentages of TZ



Unsoaked and Soaked CBR values at different percentages of QD

CONCLUSIONS

In this study, the major properties studied are OMC, MDD, CBR, UCS, and Consolidation. Based on the all investigations on all samples and when compared with normal soil, following conclusions were made:

Performance of Quarry dust stabilized soil has been investigated in this work. Based on the tests conducted in the laboratory, the following conclusions were drawn:

- Amount of clay content plays a major role in the variation of consistency limits. It is found that liquid limit decreases from 55% to 48% while the plastic limit reduces from 26% to 24% at the Quarry dust 20%
- Changes are marginal for MDD of quarry dust treated soil which is from 1.486 gm/cm3 to1.78 gm/cm3 whereas decrease in OMC is observed to be 24 to 25%. The decrease is due to effective cat ion exchange process which generally takes longer period in the absence of such stabilizers.
- The UCS value increases from 1.12 KN/m2 to 5.54 KN/m2 This is due to the reaction of enzyme with clay which results in cementation effect.
- It is observed that the treated soaked CBR values are increased as the curing period's increase which is because soil treated with Quarry dust renders improved density values by reducing the void ratios. Initially for the local soil the soaked CBR value was 1.19% but with stabilization after 4weeks of curing the soaked CBR value was 3%

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