Paramatic Study of Stabilization on Natural Soil Subgrade using Sugarcane Bagasse Ash

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Abstract— The development of any country depends on the transportation facilities and the construction projects. Roads are one of the strongest measures of economic activity and the development of any nation. India has a road network of more than 33 lakh km which is the second largest road connecting system in the world. About 65% of freight and 80% of passenger traffic are carried by the roads. Due to massive growth of infrastructure projects, conventional construction materials are diminishing day by day or found short in supply at various locations in the country. The "Pradhan Mantri Gram Sadak Yojna" (PMGSY) is a nationwide plan in Indiato provide good all-weather road connectivity to unconnected villages. This Centrally Sponsored Schemewas introduced in 2000 by the Prime Minister of India Shri Atal Bihari Vajpayee. It is under the authority of the Ministry of Rural Development, Government of India and began on 25 December 2000. It is fully funded by the Central Government.For executing the transportation facilities, the quality of a pavement depends on the strength of its sub-grade soil. The strength of sub-grade is the major parameter for determining the thickness of pavement. In case of pavement the sub-grade must be uniform in terms of geotechnical properties like shear strength, compressibility etc. Pavement construction may be on natural soil which may be Expansive soil, Black cotton soil, clayey soil, organic soil etc. Natural soils, suffer volume change due to moisture content, which causes heaving, cracking and the break-up of the road pavement. Due to this reason Stabilization of these types of soil is necessary, to suppress swelling and increase the strength of the soil. The growing cost of traditional stabilizing agents and the need for the economical utilization of industrial and agricultural wastes for beneficial engineering purposes has prompted an investigation into the stabilizing potential Sugarcane Bagasse Ash in subgrde soil. These Large Quantities of Waste Materials Sugarcane Bagasse Ash e.g. create negative impact on the environment causing air pollution, water pollution, affecting the local eco-system and hence safe disposal of this waste material is required. Utilizing these waste materials as alternative materials for the construction is no doubt a best solution.The objective of this work is to utilize the effectiveness of Sugarcane Bagasse Ash (SCBA) material to enhance the properties of natural soil used for subgrade material in pavement. The laboratory work involved index properties to classify the soil sample. The preliminary investigation of the soil shows that it belongs to A-6 class of soil in the AASHTO soil classification system. Whereas as per IS classification this class are generally of clay with low compressibility (CL).Atterberg limits, compaction, swelling pressure and CBR tests were used to evaluate properties of stabilized soil. The soil was stabilized with Sugarcane Bagasse Ash in stepped concentration of 5%, 10%, 15%, 20%, 25% and 30% by dry weight of the soil individually. All stabilized soil samples were also cured for 96 hours for CBR test in fully saturated condition. The test results indicate that the addition of SCBA enhances the percentage of grain size distribution, but with addition of SCBA till 20% the LL, PL, PI and swelling pressure decreases, while these parameters further increases in this limit beyond i.e. 20% to 30% of SCBA, Specific Gravity and Maximum Dry Density (MDD) decrease with addition of SCBA, for all percentage values, whereas OMC increases in each material. The CBR value increases with addition of SCBA till 20%, the CBR value increases and it decreases with further addition of SCBA beyond 20% to 30% for both soaked and unsoaked condition.

Key words: Natural Soil, Sugarcane Bagasse Ash, Swelling, OMC, MDD, CBR

I. INTRODUCTION

Today, world faces a serious problem of disposal of large quantities of agricultural and industrial waste like Rice husk ash, Sugarcane bagasse ash etc. The disposal of these wastes without proper attention creates hazardous impact on environmental health. So Rice husk ash and Sugarcane bagasse ash used in this project because these waste materials are also low cost. The scope of this study is that Sugarcane Bagasse Ash (SCBA) is the waste by sugar industries. It's safe disposal and utilization is necessary otherwise these create environment pollution problem. It can be use as an admixture to stabilize the natural soil for the construction of sub grade. SCBA increase the bearing capacity of soil and reduce its swelling. As well as disposal of SCBA is also sort out.

This study has been supported by different types of literatures and a series of laboratory experiments. However, the findings of the research are limited to one soil sample considered in this research which is expansive clay. The results are also specific to the type of additives used and test procedures that have been adopted in the experimental work. Therefore, findings should be considered indicative rather than definitive for filed applications. The work is undertaken with the following sub objectives are; to determine the Geotechnical properties of Natural Soil, SCBA individually, for the construction of sub grade soil and to study the suitability of stabilized soil for sub grade soil. In this article Geotechnical properties of Natural soil, Stabilized with different percentages (5, 10, 15, 20, 25 & 30) of SCBA individually, for the construction of sub grade soil. To study the variation of Grain size distribution, Liquid Limit, Plastic Limit, Plasticity Index, Specific Gravity, Optimum Moisture Content, Maximum Dry Density, Swelling Pressure and CBR for both conditions of natural soil with and without SCBA with above percentage.

II. MATERIAL USED IN RESEARCH WORK

A. Natural Soil

The Natural soil sample is used in this project were taken from Lakshmi Narain College of Technology (LNCT) Campus Bhopal (M.P) from depth of 2.5 m from ground level. It contains deleterious substances and of various sizes. The soil was air dried and pulverized manually. This natural soil is grey and black in colour.

B. Sugarcane Bagasse Ash

Sugarcane bagasse ash which is utilized in this project is taken from Shakti Sugar (Mill) Pvt Ltd Kodia, Gadarwara, Narsinghpur (M.P).

The burning of bagasse of sugarcane produces bagasse ash which is a waste material. Presently in sugar factories bagasse is burnt as a fuel so as to run their boilers. This bagasse ash is generally spread over farms and dump in ash pond which causes environmental problems also research states that Workplace exposure to dusts from the processing of bagasse can cause the chronic lung condition pulmonary fibrosis, more specifically referred to as bagassosis. So there is great need for its reuse, also it is found that bagasse ash is high in silica and is found to have pozollinic property so it can be used as substitute to construction material.

C. Water

Throughout the investigation potable water is used in this project, which is supplied in the Lakshmi Narain College of Technology Bhopal (M.P).

III. METHODOLOGY

All the tests of soil before and after stabilization with different mixtures of NS Sample were carried out as per the Indian standard. For laboratory tests specimens of soil with and without admixtures were prepared by thorough mixing the required quantity of soil and stabilizers in pre-selected proportions in dry state and then required quantity of water was added and mixed thoroughly to get a homogeneous and uniform mixture of soil and SCBA. There are various test performed in laboratory as per IS code standards like test Grain size distribution, LL,PL,PI, specific gravity, compaction, OMC, MDD, swelling and California CBR and their result are discusses by graph and tables which are given below. The samples used in the research work are Natural Soil, Sugarcane bagasse Ash (SCBA) and Natural Soil stabilized with varying percentages i.e. (5, 10, 15, 20, 25 & 30%) of SCBA individually for the construction of sub grade soil. These parents samples i.e. Natural soil, Sugarcane Bagasse ash are named as N and S notation respectively in further research work. The artificial Mix Samples i.e. NS which are mix of Natural Soil plus Sugarcane Bagasse Ash, The details of the prepared samples and their notation are discussed below in Table No.1:

IV. DETAILS AND NOTATION USED FOR PREPARED SAMPLES

S. No	Details of Prepared Samples	Notation used for samples
1	Natural Soil (NS)	N
2	Sugarcane Bagasse Ash (SCBA)	S
3	Natural Soil + 5% SCBA	NS-1
4	Natural Soil + 10% SCBA	NS-2
5	Natural Soil + 15% SCBA	NS-3
6	Natural Soil + 20% SCBA	NS-4
7	Natural Soil + 25% SCBA	NS-5
8	Natural Soil + 30% SCBA	NS-6

Table 1: Details and Notation used for Prepared Samples.

V. RESULTS AND DISCUSSION

The laboratory test results for different parameters of NS Sample are presented in Table No.2 below:

S.N.	Properties Natural Soil		N	NS-1	NS-2	NS-3	NS-4	NS-5	NS-6	S
1	**Grain Size Distribution**									
	Gravel (%)		18.4	13.04	13.53	13.40	16.00	15.00	15.70	0.84
	Coarse Sand (%)		7.2	16.30	15.80	16.60	45.00	14.80	15.20	4.20
	Medium Sand (%)		52.6	47.70	47.50	46.70	45.00	43.90	42.80	37.96
	Fine Sand (%)		20.3	20.80	20.70	20.40	21.10	22.40	21.90	47.20
	Silt and Clay (%)		1.5	2.16	2.47	2.90	3.40	3.90	4.40	9.80
2	IS Classification		CL	CL	CL	CL	CL	CL	CL	-
3	AASHTO Classification		A-6	A-6	A-6	A-6	A-6	A-6	A-6	-
4	Liquid Limit (%)		26.00	23.00	21.00	18.00	16.00	19.00	22.00	NP
5	Plastic Limit (%)		17.40	14.80	13.40	11.50	10.70	12.20	14.30	NP
6	Plasticity Index (%)		8.60	8.20	7.60	6.50	5.30	6.80	7.70	--
7	Specific Gravity		2.63	2.61	2.57	2.54	2.49	2.45	2.39	1.87
8	OMC (%)		12.18	14.42	15.80	17.85	18.05	21.00	23.80	47.22
9	MDD (gm/cm3)		1.88	1.74	1.67	1.64	1.58	1.50	1.44	0.98
10	CBR (%)	Unsoaked	14.08	14.98	16.24	17.33	14.08	11.91	7.95	11.19
		Soaked	6.86	7.22	8.84	9.21	7.58	5.78	5.41	6.68
11	Swelling Pressure		2.15	1.10	0.96	0.84	0.67	1.26	1.42	1.95

Table 2: Laboratory Test Results for Index, Compaction and Strength Properties of NS Artificial Sample.

The different properties of soil like Liquid Limit and Plastic Limit, Maximum Dry Density and Optimum

Moisture Content and California Bearing Ratio are obtained after carrying out tests and different change of these soil properties with addition of SCBA Mix are studied as follows. The different properties of NS Sample like Liquid Limit and Plastic Limit, Maximum Dry Density and Optimum Moisture Content and California Bearing Ratio are obtained after carrying out tests and different change of these Natural soil (N) properties with addition of SCBA (S) are studied as follow.

A. Index Properties (Grain Size Distribution, LL, PL, PI And Specific Gravity)

The results of Index Properties tests on the Natural Soil with the different percentage of SCBA are shown inTable.1. The nature of changes of LL, PL, PI and Specific Gravity with the different percentage of SCBA also presented in Figure No: 1 to 4 respectively is given below:

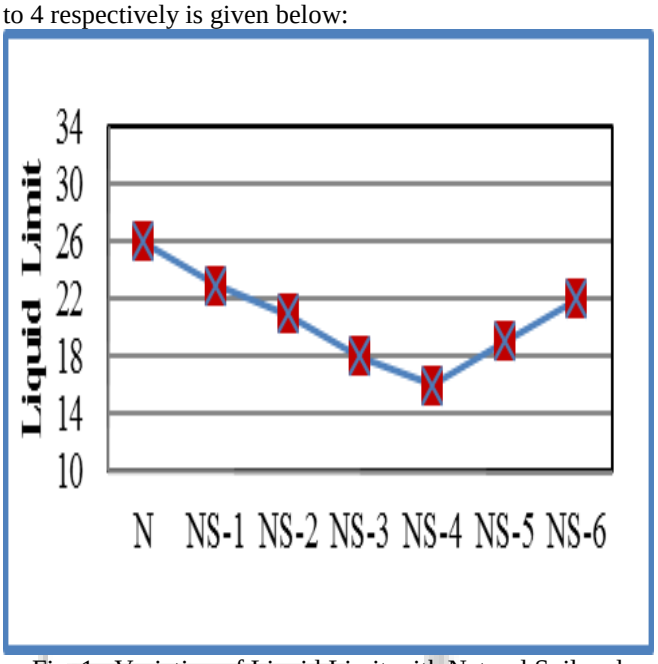

Fig. 1. Variation of Liquid Limit with Natural Soil and SCBA Combinations.

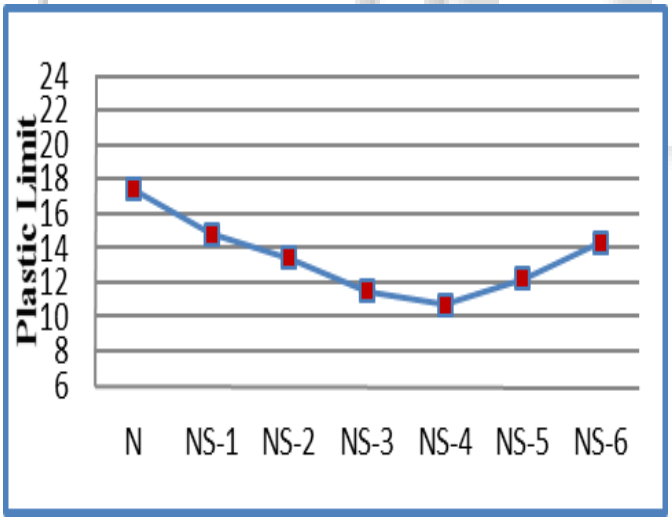

Fig. 2. Variation of Plastic Limit with Natural Soil and SCBA Combinations.

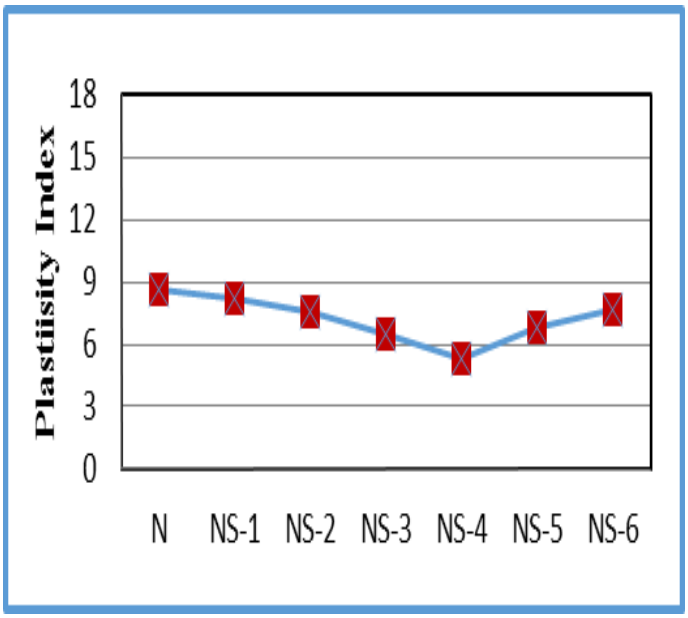

Fig. 3. Variation of Plasticity Index with Natural Soil and SCBA Combinations.

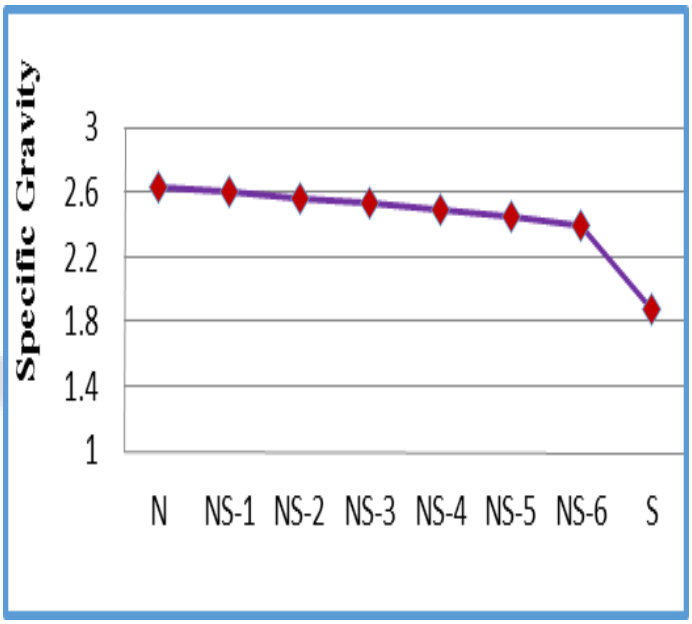

Fig. 4. Variation of Specific Gravity with Natural Soil and SCBA Combinations.

B. Compaction Properties (OMC And MDD)

The variation of OMC and MDD with the different percentages of SCBA combinations as shown in Figure No: 5 and 6 respectively shown by below and their details are given in Table No.1.

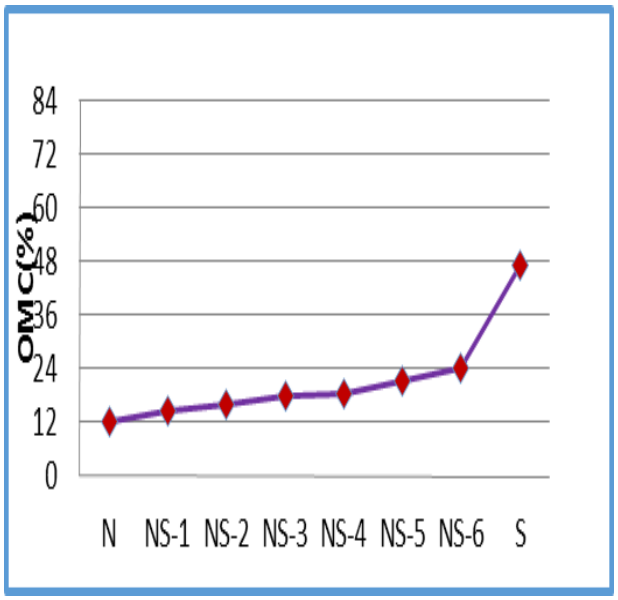

Fig. 5. Variation of Optimum Moisture Content with Natural Soil and SCBA Combinations.

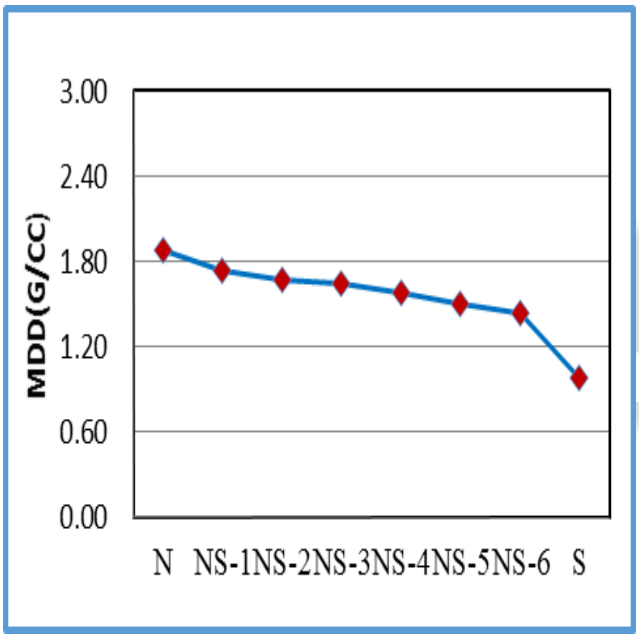

Fig. 6. Variation of Maximum Dry Density with Natural Soil and SCBA Combinations

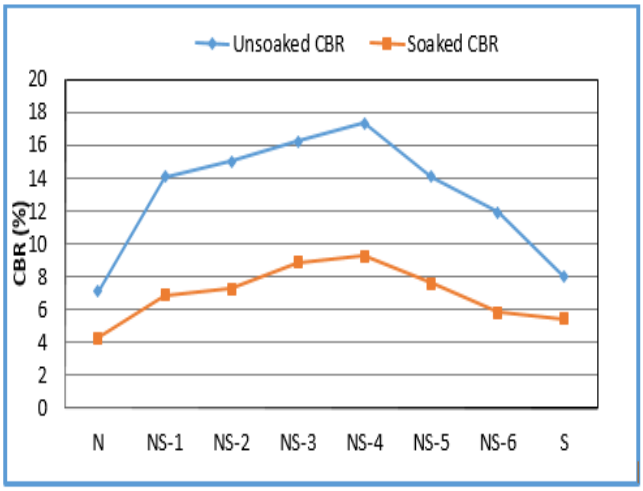

Fig.7: Variation of CBR Value with Natural Soil and SCBA Combinations

C. Strength Properties (CBR and Swelling Pressure)

The results of California Bearing Ratio tests on the Natural Soil with the various mix proportions of SCBA in Unsoaked and soaked conditions as shown in Table No: 2. The different changes of CBR values with different mix proportions in Unsoaked and soaked conditions are also presented in fig.7 and fig.8. The comparative Effect in CBR value of NS Sample towards Natural Soil are also presented in fig. 9.

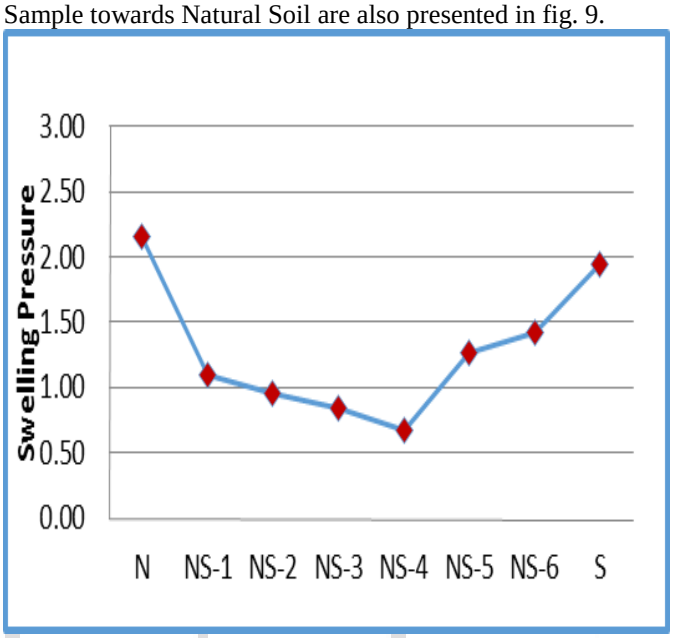

Fig. 8. Variation of Swelling Pressure with Natural Soil SCBA Combinations.

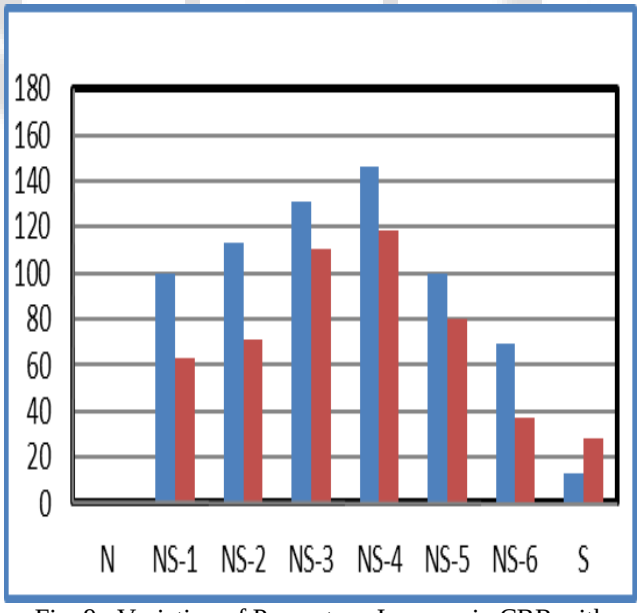

Fig. 9. Variation of Percentage Increase in CBR with Natural Soil and SCBA Combinations.

VI. CONCLUSIONS

In this study Sugarcane Bagasse Ash (SCBA) is used as admixture to with varying their percentages are used to stabilized of Natural Soil (CL) and to evaluate its properties like Grain Size Distribution, LL, PL, PI, OMC, MDD, CBR and Swelling Pressure. Based on the investigation, following conclusions are drawn:

- In Grain Size Distribution, major part of the soil belong to sand, it has been observed that increasing percentage of SCBA decreases the gravel content and increases the silt and clay content in soil mixture. Investigation also shows that all soil mixture belongs to CL class according to IS classification and A-6 Class under AASHTO classification.
- The results of Liquid Limit tests on CL soil goes on decreasing from 26 to 19%, in Sugarcane Bagasse Ash (SCBA) the LL of CL soil goes on decreasing from 26 to 16%, when SCBA Sample is increased from 0 to 20% and increases from 16% to 22% when SCBA Sample is increased from 20 to 30% and further the value for 100% SCBA and the sample shows non plastic behavior.
- The results of Plastic Limit tests on CL soil goes on decreasing from 17.4 to 13.20%, in SCBA it goes on decreasing from 17.40% to 10.70%, when SCBA Sample is increased from 0 to 20%, is increases from 10.70 to 14.30% when SCBA Sample is increased from 20% to 30%.
- The results of Plasticity Index tests on CL soil goes on decreasing from 8.60 to 5.80 %, in SCBA it goes on decreasing from 8.60% to 5.30%, when SCBA Sample is increased from 0 to 20 % and is increases from 5.30 to 7.70% when SCBA Sample is increased from 20% to 30%.
- The results of Specific Gravity tests on CL soil goes on decreasing from 2.63 to 2.28, in SCBA, The Specific Gravity decreases from 2.63 to 2.39 with increase in percentage of SCBA from 0 to 30% and 1.87 for 100% SCBA.
- The results of OMC of CL Soil continuously increases from 12.18 to 25.78 in SCBA Samples, its continuously increases from 12.18 to 23.80% and for 100% SCBA, value of OMC is 47.22% and MDD decreases from 1.88 g/cc to 1.44 g/cc from 0 to 30% of SCBA and the value are 0.98 g/cc for 100% SCBA.
- The results of Unsoaked CBR of CL Soil goes on increasing from 7.04 to 17.33% when SCBA is increased from 0 to 20% and is decreases from 17.33 to 11.91% when SCBA Sample is increased from 20% to 30% and for 100% SCBA is 7.95% andthe Soaked CBR of soil goes on increasing from 4.21 to 9.21% when SCBA is increased from 0 to 20% and is decreases from 9.21 to 5.78% when SCBA Sample is increased from 20% to 30% and for 100% SCBA is 5.41%. In Soaked and Unsoaked CBR test on soil sample it has been observed that Natural Soil with 20% SCBA mix gives maximum value of CBR in both soaked and unsoaked condition.
- The results of Swelling Pressure on CL Soil goes on decreasing from 2.15 to 1.40, in SCBA the Swelling Pressure of soil goes on decreasing from 2.15 to 0.67 when SCBA is increased from 0 to 20% and is increases in Swelling Pressure of soil from 0.67 to 1.42 when SCBA Sample is increased from 20% to 30% and for 100% SCBA is 1.95.
- The results of percentage increment in Unsoaked CBR goes on increasing from 100 to 146.16% with respect to Natural Soil when SCBA is increased from 0 to 10% and is decreases from 146.16 to 69.18% when SCBA Sample is increased from 10% to 30% and for 100% SCBA is 12.93%. However in Soaked CBR it increases from 62.95 to 118.76% when SCBA is increased from 0 to 10% and is decreases from 118.76 to 37.29% when SCBA Sample is increased from 10% to 30% and for 100% SCBA is 28.50%.

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