A Comparative Study of Stabilization on Sub-Grade Soil by Using Rice Husk Ash in Different Combinations

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Abstract: The objective of this work is to utilize the effectiveness of Rice Husk Ash (RHA) material to enhance the properties of natural soil used for subgrade soil. The standard of a pavement depends on the strength of its soil sub-grade. The soil sub-grade should be uniform in terms of properties like index, compaction and strength properties etc. Materials selection for the construction of soil sub-grade should be of adequate strength and at a similar time it should be economical to be used. If the natural soil is soft and weak, it desires some improvement to be used as soil sub-grade. It is therefore required to stabilize the weak soil to increase its strength and reduced softness. The laboratory work concerned index properties to classify the soil sample. The preliminary investigation of the soil shows that it belongs to SC class of soil in the USCS soil classification system. Whereas as per IS classification this class are generally of clay with low compressibility (CL). Atterberg limits, compaction, and CBR tests were used to evaluate properties of stabilized soil. The soil was stabilized with Rice Husk Ash (RHA) in stepped concentration of 5%, 10%, 15%, 20%, 25% and 30% by dry weight of the soil individually. All stabilized soil samples were cured for 96 hours for CBR test in fully saturated condition.The test results indicate that the addition of RHA enhances the percentage of grain size distribution, but with addition of RHA till 10% the LL, PL and PI decreases, while these parameters further increases in this limit beyond i.e. 10% to 30% of RHA. Specific Gravity and Maximum Dry Density (MDD) decrease with addition of RHA for all percentage values, whereas OMC increases in each material. The CBR value increases with the addition of RHA till 10%, while it decreases beyond the limit 10% to 30% with addition of RHA.

Keywords: Subgrade, Rice Husk Ash (RHA), LL, PL, PI, MDD, OMC, CBR.

I. Introduction

The development of any country depends on the transportation facilities and the construction projects. Roads networks are one of the strongest measures of economic activity and development of any nation. India has a broad road network of over 3300000 kilometer that is the second largest road connecting system within the world. About 65% of freight and 80% of traveler traffic carried by the roads gives large growth of infrastructure of India.

The "Pradhan Mantri Gram Sadak Yojna" (PMGSY) may be a nationwide step in India to produce unrestricted road property to unconnected villages. This centrally sponsored theme was introduced in 2000 by the former Prime Minister of India. It underneath the authority of the Ministry of Rural Development, Government of Asian country and started on twenty five Gregorian calendar month 2000. It is funded by the central government for death penalty, the transportation facilities; the standard of a pavement depends on the strength of its sub-grade soil.

Pavement the sub-grade should be uniform in terms of geotechnical properties like shear strength, bearing strength etc. Pavement construction could also be on natural soil which can be expansive soil, black cotton soil, clayey soil, organic soil etc. Natural Soil suffers volume amendment to wetness content that causes heaving, cracking and therefore the break-up of the road pavement take place. So stabilization of those verities of soils is important, to suppress swelling and increase the strength of the soil The growing price of ancient stabilizing agents and therefore the economical utilization of commercial associate degreed agricultural wastes have prompted an investigation into the stabilizing potential of Rice Husk Ash in subgrade soil. These massive quantities of waste materials rice husk produce negative impact on the pollution; therefore safe disposal of this waste is needed.

II. Related Work

A number of researchers have studies on soil stabilization for the previous couple of years. Some sailent works area unit as follows; A study of Rice husk ash on engineering properties of soil was carried out by **Phanikumar and Sharma (2004)** through an experimental programme. The effect on parameters like free swell index (FSI), swell potential, swelling pressure, plasticity, compaction, strength activity of expansive soil were studied. The ash blended expansive soil with Rice husk ash contents of 0, 5, 10, 15 and 20% on a dry weight basis and they inferred that increase in Rice husk ash content reduces plasticity characteristics and the FSI was reduced about 50% by the addition of 20%.Rice husk ash decreases with an increase in Rice husk ash content. Due to the increase in Rice husk ash content increases in maximum dry unit weight. When the Rice Husk Ash content increases there is a decrease in the optimum moisture content and as a result the maximum dry unit weight increases.

Dilip Shrivastava, A K Singhai and R K Yadav (2014), Black Cotton Soils exhibit high swelling and shrinking once exposed to changes in wetness content and thence are found to be most hard from engineering issues. The soil behavior is attributed to the

presence of a mineral montmorillonite. The most objective of this study is to judge the feasibility of exploitation Rice Husk Ash with lime as soil stabilization material. A series of laboratory experiment has been conducted on lime mixed with black cotton soil blended with Rice Husk Ash in 5%, 10%, 15%, and 20% by weight of dry soil. The experimental results indicate an increase in CBR value and UCS strength. From this investigation it has been found that the Rice Husk Ash options as possible to spice up the characteristics of black cotton soil.

Sudipta Adhikary & Koyel Jana (2016), Rice Husk Ash may be a pozzolanic material that might be doubtless utilized in Soil stabilization, although it's moderately created and freely accessible. This paper presents the results of experimental study meted out by mother soil sample was taken aboard the pool of "Jadavpur University"(Jadavpur Campus), Classified as CI(clay of medium plastic) as per AASTHO soil arrangement and was stable with 10%,15% & 20% maximize Rice Husk Ash(RHA) by weight of the dry soil. The testing program conducted on mother soil samples by mixed with different percentages of rice-husk materials, it's embedded Atterberg limits, California Bearing Ratio, Unconfined Compressive Strength, and Standard Proctor test. It was found that a general decrease within the maximum dry density (MDD) and increase in optimum moisture content (OMC) is shown with increase of the % of RHA content and there was conjointly a major improvement shown in CBR and UCS values with the rise in % of RHA.

III. Material Used

The materials utilized in the current investigation were Rice husk ash (RHA) and Natural Soil (NS). The physical properties of these materials are summarized within the following sections.

a) Natural Soil: The Natural soil sample is employed during this study was taken from **Oriental Institute of Science & Technology (OIST), Bhopal (M.P)** from a depth of 1 m from ground level. It contains deleterious substances and of various sizes. The soil was air dried and small-grained manually. This natural soil is gray and black in colour.

b) Rice Husk Ash (RHA): Rice husk ash is largely agricultural waste product obtained from the rice milling. Rice milling generates a byproduct as husk. During milling of paddy regarding 75% of weight is received as rice, broken rice and bran, and rest 25% of the load of paddy is received as husk. This was obtained from native Rice Mill at **Majestic Basmati Rice** in **Mandideep, Bhopal (M.P.)**.

IV. Methodology & Test Program

All the test of soil before and after stabilization with different mixtures of NR Sample was carried out as per the Indian standard. For laboratory tests specimens of soil with or without admixtures were ready by thorough mixture the specified amount of soil and stabilizers in pre-selected proportions in dry state then required amount of water mixed to produce a homogenous and uniform mixture of soil and RHA. There are varies test performed in laboratory as per IS code standards like test Grain size distribution, LL, PL, PI, specific gravity, OMC, MDD and CBR. The samples utilized in the analysis work are Natural Soil, Rice Husk Ash (RHA) and Natural Soil stabilized with varied percentages i.e. (5, 10, 15, 20, 25 & 30%) of RHA one by one for the development of sub grade soil. These samples i.e. Natural soil, Rice husk ash is named as N and R notation severally in additional analysis work. The substitute of combined Samples i.e. NR that are mixture of Natural Soil and Rice Husk Ash, the detail of prepared samples and their notation are mentioned below in Table No.1:

Figure No.1: Liquid Limit Test Performed

Table No. 1: Details and Notation used for Prepared Sample

S. N.	Details of Prepared Samples	Notation used for samples
1	Natural Soil (NS)	N
2	Rice Husk Ash (RHA)	R
3	Natural Soil + 5% RHA	NR-1
4	Natural Soil + 10% RHA	NR-2
5	Natural Soil + 15% RHA	NR-3
6	Natural Soil + 20% RHA	NR-4
7	Natural Soil + 25% RHA	NR-5
8	Natural Soil + 30% RHA	NR-6

V. Laboratory Test Results:

The laboratory test results for different parameters of NR sample are presented in Table No.2.

Table No.2: Laboratory Test Results for Index, Compaction and Strength Properties of NR Artificial Sample

S.N.	Properties of Natural Soil		N	NR-1	NR-2	NR-3	NR-4	NR-5	NR-6	R
1	Grain Size Distribution									
	Gravel (%)		18.50	14.91	15.50	11.38	15.30	11.32	12.53	0.37
	Coarse Sand (%)		7.10	10.54	15.38	17.30	16.00	18.30	17.05	4.43
	Medium Sand (%)		52.60	50.38	45.84	48.30	46.80	46.20	46.15	40.40
	Fine Sand (%)		20.30	22.41	21.08	20.18	18.80	20.82	20.55	46.60
	Silt and Clay (%)		1.50	1.76	2.20	2.85	3.10	3.36	3.72	8.20
2	IS Classification		CL	CL	CL	CL	CL	CL	CL	--
3	USCS Classification		SC	SC	SC	SC	SC	SC	SC	--
4	Liquid Limit (%)		26.00	22.00	19.00	23.00	24.00	26.00	31.00	NP
5	Plastic Limit (%)		17.06	14.90	13.10	15.80	17.70	18.70	21.30	NP
6	Plasticity Index (%)		8.94	7.10	5.90	7.20	6.30	7.30	9.70	--
7	Specific Gravity		2.65	2.59	2.53	2.46	2.41	2.35	2.29	1.65
8	OMC (%)		12.18	13.87	16.54	19.92	21.80	22.80	25.88	66.57
9	MDD (gm/cm3)		1.88	1.79	1.69	1.65	1.57	1.45	1.37	0.76
10	CBR (%)	Unsoaked	7.19	11.80	13.60	11.60	10.05	8.52	6.89	15.02
		Soaked	3.92	6.20	7.10	6.05	5.20	4.43	3.49	12.91

VI. Results and Discussion

The various properties of soil like LL, PL, MDD, OMC and CBR are obtained when tests and totally different modification of those soil properties with addition of RHA combined mix sample are studied as follows. The various properties of NR Sample like LL and PL, MDD and OMC and CBR are obtained after carrying out tests and different change of these Natural soil (N) properties with addition of RHA (R) 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 % of RHA are shown in Table No 2. The character of changes of LL, PL, PI and Specific gravity with the different % of RHA conjointly is showed in Figure No: 1 to 4respectably is given below:

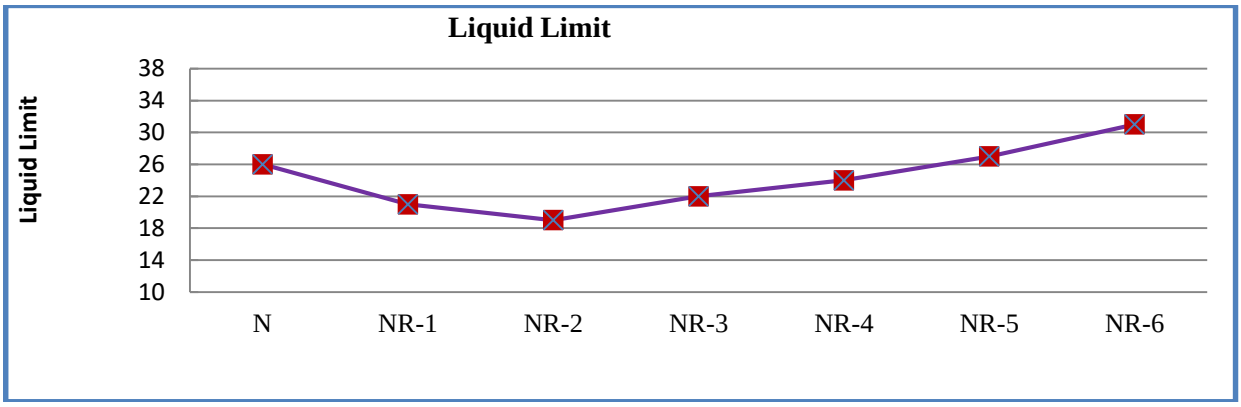

Fig.1 Variation of Liquid Limit with Natural Soil and RHA Combinations

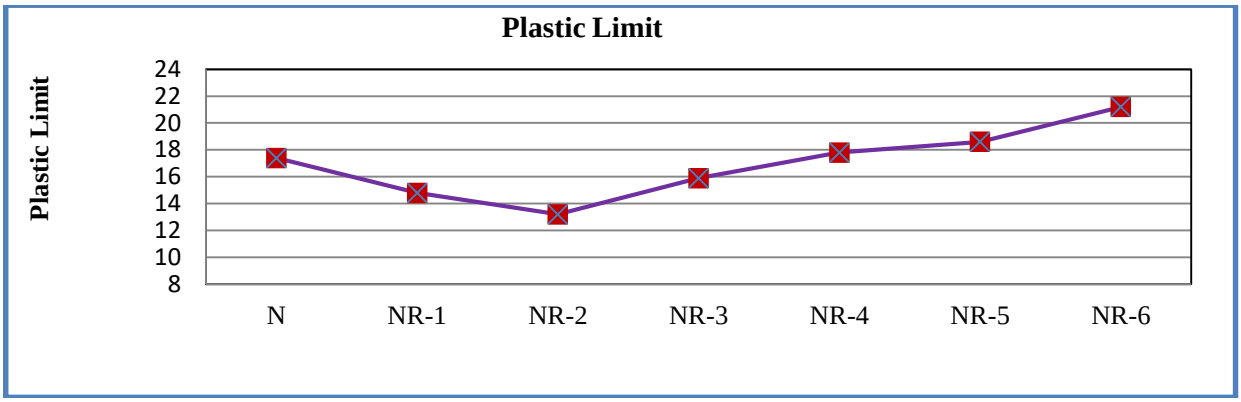

Fig.2 Variation of Plastic Limit with Natural Soil and RHA Combinations

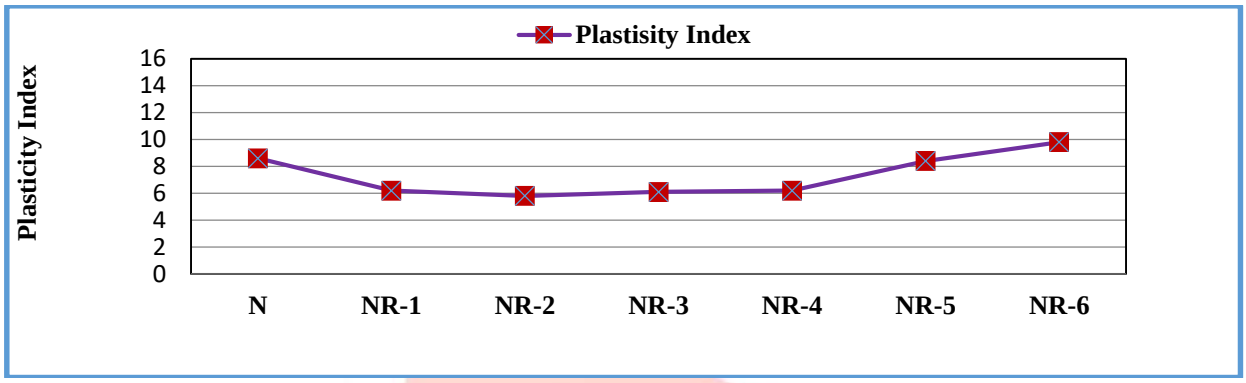

Fig.3: Variation of Plasticity Index with Natural Soil and RHA Combinations

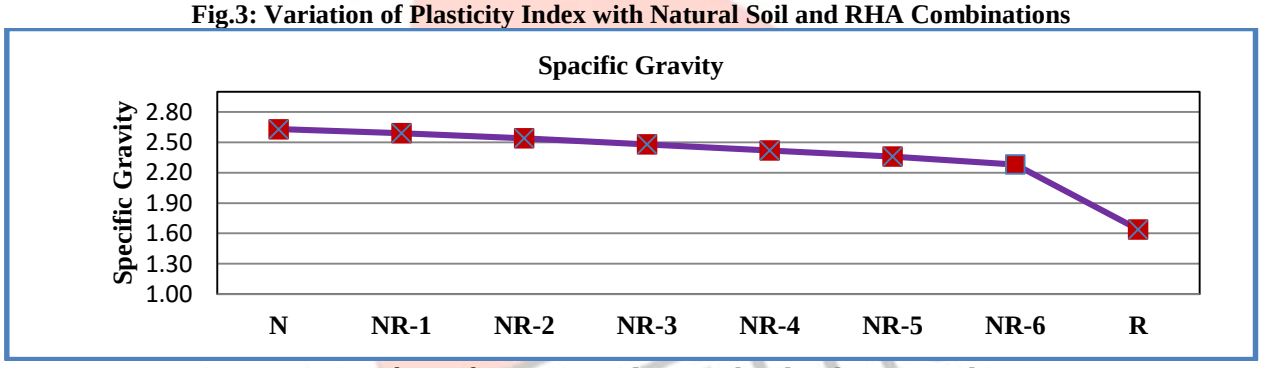

Fig.4: Variation of Specific Gravity with Natural Soil and RHA Combinations

B) Compaction Properties (OMC and MDD)

The variation of OMC and MDD with the different % of RHA combinations as shown in Figure No: 5 and 6 respectively and their details are given in Table No.2.

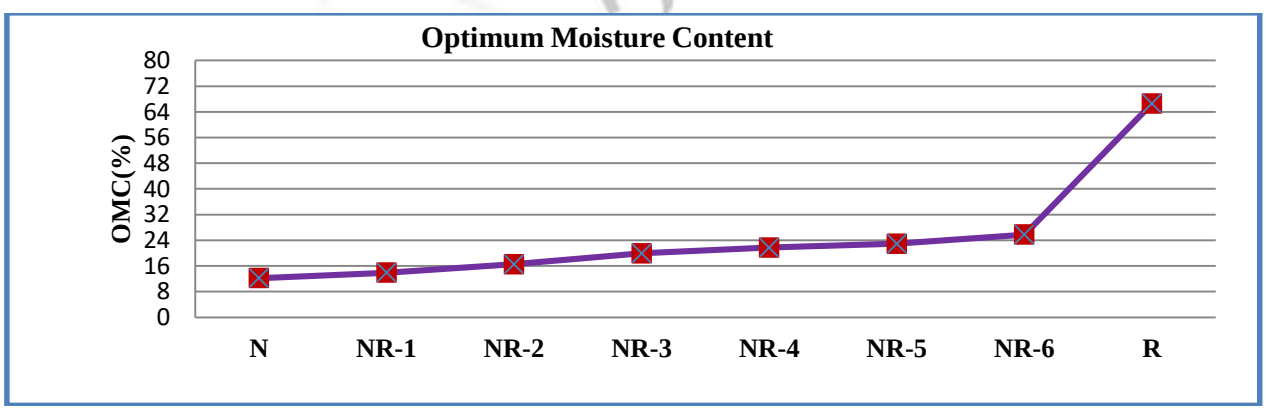

Fig.5: Variation of OMC with Natural Soil and RHA Combinations

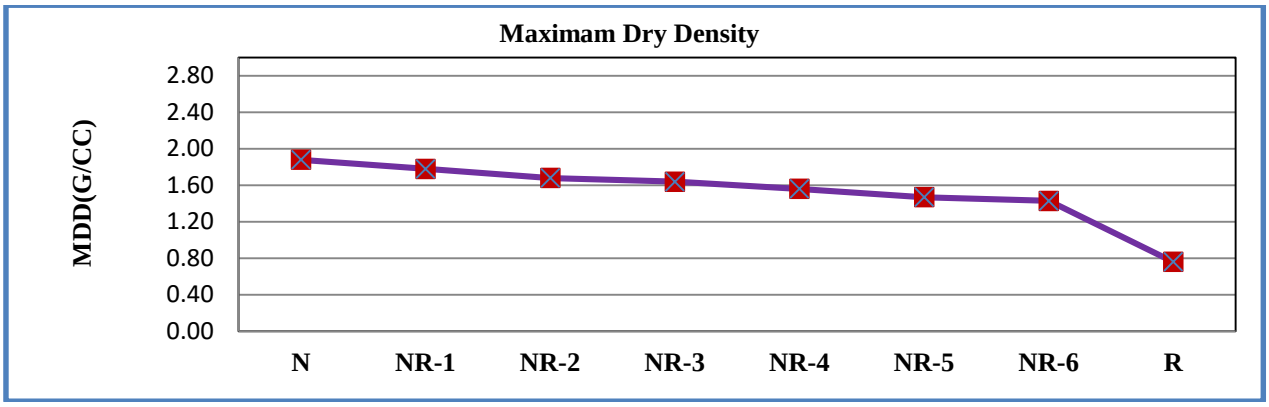

Fig.6: Variation of Maximum Dry Density with Natural Soil and RHA Combinations

C) Strength Properties (CBR)

The results of CBR test take place on the Natural Soil with the various % of RHA in Unsoaked and soaked conditions as shown in Table No:2.The different changes of CBR values with different proportions in Unsoaked and soaked conditions are given in Figure No.7. The comparative result in CBR value of NR Sample towards Natural Soil is additionally given in Figure No: 8.

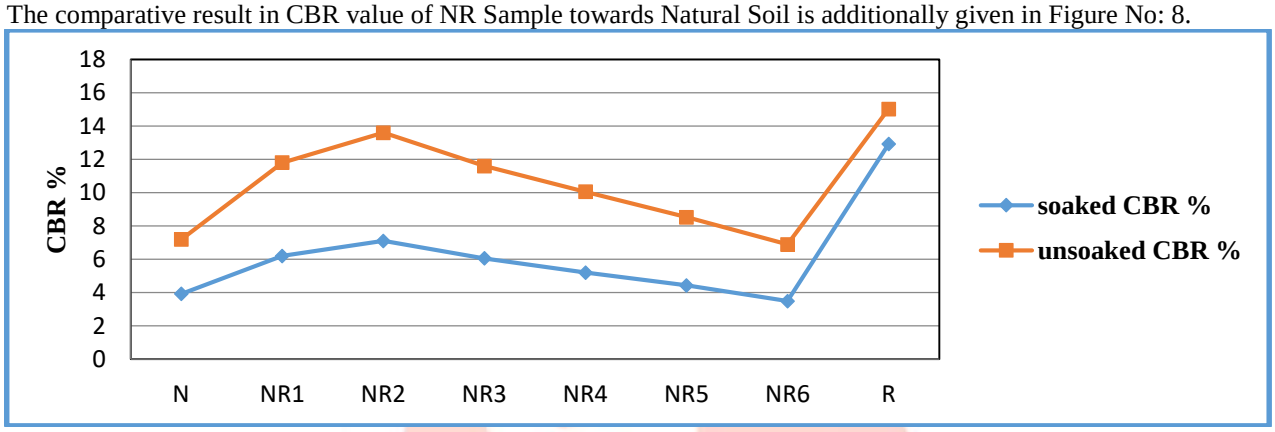

Fig.7: Variation of CBR Value with Natural Soil and RHA Combinations.

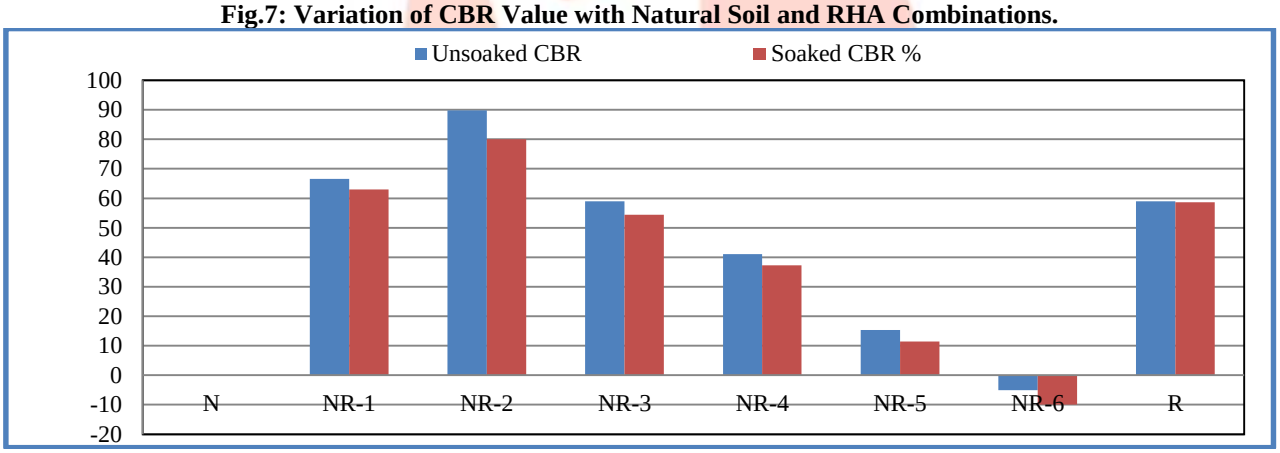

Fig.8: Variation of % Increase in CBR with Natural Soil and RHA Combinations

VII. CONCLUSION

The following conclusions are drawn from the investigation on the basis of the laboratory results of RHA stabilized with the Natural Soil:

- In Grain Size Distribution, major part of the soil belong to sand, it has been determined that increasing proportions of RHA decreases the gravel content and will increase the silt and clay content in soil mixture. Investigation conjointly shows that each soil mixture belongs to **CL** category with IS classification and **SC** category from **USCS** classification.
- The results of Liquid Limit tests on CL soil goes on decreasing from **26 to 19%,** when RHA Sample is increased from **0 to 10%,**and increase from **19% to 31%** when RHA Sample is increased from **10 to 30%** and further increase of value for 100% RHA is sample shows non plastic behavior.
- The results of Plastic Limit tests on CL soil goes on decreasing from **17.06 to 13.10%**, when RHA Sample is increased from 0 to 10%and increase from **13.10 to 21.30%**when RHA Sample is increased from 10% to 30%.
- The results of Plasticity Index tests on CL soil goes on decreasing from **8.94 to 5.90 %**, when RHA Sample is increased from 0 to 10% and is increases from **5.90 to 9.70%** when RHA Sample is increased from 10% to 30%.
- The results of Specific Gravity tests on CL soil goes on decreasing from **2.65 to 2.29**with increase in percentage of RHA from 0 to 30% and **1.65** for 100% RHA.

- The results of OMC of CL Soil continuously increases from **12.18 to 25.88**% from 0 to 30% of RHA and for 100% RHA its value is **66.57%** and MDD decreases from **1.88 g/cc to 1.37 g/cc** from 0 to 30% of RHA and **0.76** for 100% RHA.
- The results of Unsoaked CBR of **CL** Soil goes on increasing from **7.19 to 13.60%** when RHA is increased from 0 to 10% and is decreases from **13.60 to 6.89%** when RHA waste is increased from 10% to 30% and for 100% RHA is **15.02%** and in Soaked CBR of soil goes on increasing from **3.92% to 7.10%** when RHA is increased from 0 to 10% is and is decreases from **7.10% to 3.49%** when RHA Sample is increased from 10% to 30% and for 100% RHA is **12.91%.** In Soaked and Unsoaked CBR test on soil sample it has been observed that Natural Soil with 10% RHA mix gives maximum value of CBR in both Soaked and Unsoaked condition.
- The results of percentage increment in Unsoaked CBR goes on increasing from **64.12 to 89.15%** with respect to Natural Soil when RHA is increased from **0 to 10%** and is decreases from **89.15%to -4.17%** when RHA Sample is increased from 10% to 30%**.** However in Soaked CBR it increases from **58.16 to 81.12%** when RHA is increased from 0 to 10% and is decreases from **81.12 to -10.97%** when RHA Sample is increased from 10% to 30%**.**

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