Assesement Studies on The Use of Rice Husk Ash And GGBS in Improving Coastal Sandy Soils

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Abstract- *Soil is highly complex, heterogeneous and unpredictable material which has been subjected to vagaries of nature, without any control. The word sandy soil represents a soil which consists of more amount of sand particles and small amount of clay and silt particles. Sandy soil is generally found in western grads, coastal areas. The soil profile in coastal area often consists of sandy soil extended to a depth of 3 to 4 m from the ground level underlies by clay soil of medium consistency. The very low shearing resistance of foundation bed causes local as well as punching shear failure this type of soil profile found coastal area of Coastal Andhra. Sandy soil also consists of low plasticity, low bearing capacity and high moisture content. Hence it is very essential to stabilize the sandy soil. Hence in order to improve the properties of such soils many methods are available like soil stabilization, soil replacement, moisture control, prewetting etc. soil stabilization is a widely accepted technique that process by changing the behavior and properties of soil under certain conditions. Soil stabilization involves changes in properties like strength, density, swelling behavior, etc. Soil stabilization techniques can considerably increase the profiles of the low strength expansive soils to the desired extent. Further, these techniques are very economical and reduce the overall cost of a project. In recent years, soil stabilization by using various industrial wastes was a most common practice. Keeping in view in the present research, experimentation was carried out to investigate the performance of agricultural waste like Rice Husk Ash and industrial waste GGBS. To understand the performance of stabilized soil, its properties like Atterberg's Limits, Compaction Parameters, and Penetration Parameters were studied in the laboratory.*

Keywords- Weak Coastal Sandy Soils, GGBS, POFA, Strength

I. INTRODUCTION

Ground improvement refers to any procedure undertaken to increase the shear strength, decrease the permeability and compressibility, or otherwise render the physical properties of soil more suitable for projected engineering use. The improvement may be accomplished by drainage, compaction, preloading, reinforcement, and grouting, electrical, chemical or thermal methods. Among the various soil stabilization procedures, the most suitable one is selected depending upon the type of soil available, time, cost involved etc. (Kumar, 2010). One of the most dramatic depositional landforms, which occupy large areas all over the world, is coastal sand. Coastal sands in various forms cover large areas of the world. Extensive efforts have been made to understand their origin (Shearzid, 1989) physical and mineralogical properties, environmental impacts. Some studies have also been directed towards coastal sand sand stabilization (Al-Soud, 2000). There is, however, scarcity in the literature concerning the geotechnical characteristics of these soils.

A single coastal sand can be defined as a mound or hill of sand, which rises to a single summit. They are accumulations of windblown sand, which change their position or their shape due to wind action as long as their surface consists of loose granular material of appropriate size.

Apart from the common problems of salinity or acidity, there are location specific problems, viz. sea-water intrusion in unbunded low-lying areas, iron toxicity in Orissa, impeded drainage in coastal Andhra Pradesh and Tamil Nadu along the east coast as well as in parts of Kerala and Gujarat along the west coast, highly permeable sandy soils in parts of Gujarat, and highly leached low-fertility lateritic soils with severe erosion problem along with undulating topography in some parts of Maharashtra, Goa, Karnataka and Kerala. The soils of Lakshadweep Islands are essentially coral sandy, calcareous and alkaline, whereas those of the Andaman and Nicobar group of islands are acidic, as well as low in organic matter and available phosphorus. Nitrogen recovery by the crops is very low due to heavy loss of the nutrient, particularly in saline and alkaline soils (by volatilization) and also in deep waterlogged areas (byleaching and run-off).

The salient factors limiting crop growth in the coastal plains are: (i) Excess accumulation of soluble salts and alkalinity in soil, (ii) predominance of acid sulphate soils, (iii) periodicinundation of soil surface by the tidal water, (iv) accumulation of salts and sediments by the natural calamities like tsunami, cyclone and (v) Shallow saline ground water,

(vi) eutrophication and hypoxia. The major abiotic stresses common to coastal rice soils in Asia.

Hence in order to improve the properties of such soils many methods are available like soil stabilization, soil replacement, moisture control, prewetting etc. soil stabilization is a widely accepted technique that process by changing the behavior and properties of soil under certain conditions. Soil stabilization involves changes in properties like strength, density, swelling behavior, etc. Soil stabilization techniques can considerably increase the profiles of the low strength soils to the desired extent. Further, these techniques are very economical and reduce the overall cost of a project. In recent years, soil stabilization by using various industrial wastes was a most common practice. Keeping in view in the present research, experimentation was carried out to investigate the performance of agricultural waste like Rice Husk Ash and industrial waste GGBS. To understand the performance of stabilized soil, its properties like Atterberg's Limits, Compaction Parameters, and Penetration Parameters were studied in the laboratory.

1.2 OBJECTIVES OF THE STUDY

The objectives of present experimental study are to develop correlations between engineering characteristics of coastal sandy soils. The study is focused on

- Improvement of locally available soil using some eco-friendly and cheap waste materials.
- Evaluation of strength characteristics of virgin as well as blended soil using different materials like GGBS and Rice husk ash.
- Determination of appropriate GGBS and Rice husk ash content ratio co achieve the maximum gain in strength of soil.

II. LITERATUREREVIEW

2.1Studies on coastal sandy soil

PARIMAL JHA , NISHEET TIWARI (APRIL- MAY 2016) performed a research on black cotton soil & described that Black Cotton Soils exhibit high swelling and shrinking when exposed to changes in moisture content and hence have been found to be most troublesome from engineering considerations. This behaviour is attributed to the presence of a mineral montmorillonit. The wide spread of the black cotton soil has posed challenges and problems to the construction activities. To encounter with it, innovative and non traditional research on waste utilization is gaining importance now a days. Soil improvement using the waste material like Slags, Rice husk ash, Silica fume etc., in geotechnical engineering has been in practice from environmental point of view. The main objective of this study is to evaluate the feasibility of using Rice Husk Ash with lime as soil stabilization material. A series of laboratory experiment has been conducted on 0.5% lime mixed black cotton soil blended with Rice Husk Ash in 10%, 20% and 30% by weight of dry soil.

MANDEEP SINGH , ANUPAM MITTAL (29 MARCH 2014) observed that, solid waste materials such as rice husk ash and waste tyres are used for this intended purpose with or without lime or cement. Disposal of these waste materials is essential as these are causing hazardous effects on the environment. With the same intention literature review is undertaken on utilization of solid waste materials for the stabilization of soils and their performance is discussed. Soil stabilization means alteration of the soils properties to meet the specified engineering requirements. Methods for the stabilization are compaction and use of admixtures. Lime and Cement was commonly used as stabilizer for altering the properties of soils. Earth reinforcement techniques with commonly used with mild steel rods, geo synthetics etc.

TAPASH KUMAR ROY (APRIL 29-MAY4TH 2013) investigated the benefits of using rice husk ash (RHA) with clayey soil as the subgrade material in flexible pavements with addition of small amount of lime. Four ratios of RHA of 5%, 10%, 15% and 20% mixed with the clayey soil by weight of soil sample. Further for getting the better performance, lime hasbeenaddedinthisstudyinthevaryingproportionsfrom 1% to 3% by weight of soil. The compaction characteristics and unconfined compressive strength tests were conducted on these different mixed soils. The test results shows that the rice husk ash can be used advantageously with addition of clayey soil and lime as cost effective mix for construction of subgrade of the roadway pavement.

DR.D.KOTESWARA RAO, G.V.V. RAMESWARA RAO , P.R.T. PRANAV (APRIL29-MAY 4TH 2013) reported that The soil found in the ocean bed is classified as marine soil. It can even be located onshore as well. The properties of marine soil depend significantly on its initial conditions. The properties of saturated marine soil differ significantly from moist soil and dry soil. Marine clay is microcrystalline in nature and clay minerals like chlorite, kaolinite and illinite and non-clay minerals like quartz and feldspar are present in the soil. The soils have higher proportion of organic matters that acts as a cementing agent. Clay is an impermeable soil, meaning it holds water, as opposed to permeable soil that allows water to rapidly drain, like a gravel or sand. It is also an expansive soil, such as the marine clay which predominates in almost all countries of the world, which when shrinking or expanding, can damage foundations and structures. The shrink and swell movements are due to changes in soil moisture. Providing uniform soil moisture next to and under your foundation is the only best thing to reduce or minimize the damaging effects of expansive soil. Accumulation of various waste materials is now becoming a major concern to the environmentalists. Rice Husk ash is one such by-product from Timber industries and Wood cutting factories. Rice Husk ash by itself has little cementitious value but in the presence of moisture it reacts chemically and forms cementitious compounds and attributes to the improvement of strength and compressibility characteristics of soils. So in order to achieve both the need of improving the properties of marine clays and also to make use of the industrial wastes, the present experimental study has been taken up. In this paper the effect of Rice Husk ash and Lime on strength properties of marine clay has been studied.

LAXMIKANT YADU AND DR. R KTRIPATHY(2013) studied the effect of Granulated blast furnace slag and fly-ash stabilization on soft soil. The soil was classified as CI- MI as per Indian Standard Classification System. Different amount of GBS (3%, 6%, 9%, and 12%) and fly ash (3%, 6%, 9%, 12%) was mixed to the parent soil and both UCS and CBR are carried out. They found that there was an increase in maximum dry density but decrease in Optimum Moisture Content with increasing GBS content. Addition of GBS increased the UCS value and this increase was maximum up to 9% and then it started falling. In case of both soaked and unsoaked CBR samples, addition of GBS causedsharp increase in CBR value and it is maximum up to 6%. Hence they found out 3% fly ash + 6% GBS mix to be optimum.

AKINMUSURU (1991) put his effort in finding out the effect of mixing of GGBS on the consistency, compaction characteristics and strength of lateritic soil. GGBS content varied from 0% -15% by dry soil weight. He observed a decrease in both the liquid and plastic limits and an increase in plasticity index with increasing GGBS portion. Further, he observed that the compaction, cohesion and CBR increased with increasing the GGBS content up to 10% and then subsequently decreased. The angle of friction was to be decreased with increasing percentage of GGBS.

GUPTA AND SEEHRA (1989) studied the effect of lime-GGBS on the strength of soil. They found that lime- GGBS soil stabilized mixes with and without addition of gypsum, orcontaining partial replacement of GGBS by fly ash produced high UCS and CBR in comparison to plain soil. They also concluded that partial replacement of GGBS withfly ash further increased theUCS

SREERAMA RAO, G. SRIDEVI AND M. RAMA RAO (2009) 25 reported about heave studies on expansive clays with stabilized granulated blast furnace slag cushion. Experiments were also conducted to study the effect of the cement content as well as the cushion thickness on the heave of the black cotton soil bed. The study also aimed at comparing the performances of Granulated Blast Furnace Slag (GBFS) and the ground granulated blast furnace slag (GGBFS) and to study the effect of cushion thickness on the swelling behavior of black cotton soil. It was reported that both the slag cushions, stabilized with cement, are effective in minimizing the swell of black cotton soils. For GGBFS, there is a significant reduction of heave at low cement contents itself but for GBFS, as the cement content is increased, the swell potential decreased steeply. 6% to 8% cement content has been found to be optimum. No such optimum was observed in GGBFS. As the thickness of the cushion increased, there was a corresponding decrease in the swell potential.

2.2 STABILIZATION

Soil stabilization is the process of altering some soil properties by different methods, mechanical or chemical in order to produce an improved soil material which has all the desired engineering properties. Soils are generally stabilized to increase their strength and durability or to prevent erosion and dust formation in soils.. The properties of soil vary a great deal at different places or in certain cases even at one place; the success of soil stabilization depends on soil testing. Various methods are employed to stabilize soil and the method should be verified in the lab with the soil material before applying it on the field.

2.2.1 METHODS OF SOIL STABILIZATION

- Mechanical Stabilization.
- Soil Cement Stabilization.
- Soil Lime Stabilization.
- Soil Bitumen Stabilization.
- Thermal Stabilization.
- Chemical Stabilization.

III. METHODOLOGY

MATERIALS USED AND THEIR PROPERTIES

3.1 Coastal sandy soil

The soil used was a typical Coastal sandy soil collected from ‘kakinada’ in East Godavari District, Andhra Pradesh State, India. The properties of soil are presented in the Table All the tests carried on the soil are as per IS specifications.

TABLE 3.1 Properties of soil

S. No.	Property	Value
1	Specific gravity	2.64
4	Grain Size Distribution	
	i) Gravel Size Particles (%)	5
	ii) Sand Size Particles (%)	86
	iii) Silt & Clay Size Particles (%)	9
6	Compaction Parameters	
	i) Max. Dry Density (g/cc)	1.65
	ii) Optimum Moisture Content (%)	15.4
7	Penetration Parameters	
	i) CBR - Unsoaked (%)	9.7
	ii) CBR - Soaked (%)	3.6
8	Unconfined Compressive Strength (UCS) at OMC & MDD (kPa)	96

3.2 Ground Granulated Blast Furnace Slag (GGBS)

Ground Granulated Blast Furnace Slag (GGBS) is a byproduct of the steel industry. Blast furnace slag is defined as “the non-metallic product consisting essentially of calcium silicates and other bases that is developed in a molten condition simultaneously with iron in a blast furnace.” In the production of iron, blast furnaces are loaded with iron ore, fluxing agents, and coke. When the iron ore, which is made up of iron oxides, silica, and alumina, comes together with the fluxing agents, molten slag and iron are produced. The molten slag then goes through a particular process depending on what type of slag it will become. Air cooled slag has a rough finish and larger surface area when compared to aggregates of that volume which allows it to bind well with portland cements as well as asphalt mixtures. GGBS is produced when molten slag is quenched rapidly using water jets.

3.3 Rice husk ash

Rice husk is a potential material, which is amenable for value addition. The usage of rice husk either in its raw form or in ash form is many. Most of the husk from the milling is either burnt or dumped as waste in open fields and a small amount is used as fuel for boilers, electricity generation, bulking agents for composting of animal Manure, etc. The exterior of rice husk are composed of dentate rectangular elements, which themselves are composed mostly of silica coated with a thick cuticle and surface hairs. The mid region and inner epidermis contain little silica Jauberthie et al., confirmed that the presence of amorphous silica Is concentrated at the surfaces of the rice husk and not within the husk itself. The chemical composition of rice husk is similar to that of many common organic fibers and it contains of cellulose 40-50 percent, lignin 25-30 percent, ash 15-20percent and moisture 8- 15 percent.

After burning, most evaporable components are slowly lost and the silicates are left. No other plant except paddy husk is able to retain such a huge proportion of silica in it. Plants absorb various minerals and silicates from earth into their body.

The rice husk ash is collected from the brick manufacturing unit, East Godavari District, Andhra Pradesh.

IV. LABORATORY EXPERIMENTATION

The soil was initially air dried prior to the testing. The tests were conducted in the laboratory on the marine clay to find the properties of virgin marineclay.

- Grain size distribution
- Specific gravity
- Index properties –liquid limit, plastic limit
- Compaction tests
- Penetration tests-California bearing ratio test.
- Unconfined Compression Test-Triaxial

V. RESULTS AND DISCUSSIONS

In the laboratory, various experiments were conducted by combination of different percentages of GGBS and RHA in the lateritic soil. Compaction, CBR and UCS tests were conducted with a view to determine the optimum combination of GGBS and RHA. CBR and UCS are conducted for curing studies.

Effect of combination percentages of GGBS + RHA in improving the compaction properties of Coastal Sandy Soils:-

Density is an important parameter because it determines the load, which a structural fill will apply to itself and to its foundation, and because it influences the permeability, stiffness and strength of fill, thus affecting the settlement and ultimate stability.. To assess the amount of compaction and water content required in the field, compaction tests are conducted. In the present study Standard Proctor Compaction test as per IS: 2720 (Part VII), 1980 was conducted on soil. The test is conducted on soil alone, soil with combination of GGBS and RHA. The optimum moisture content (OMC) and the maximum dry density (MDD) of the Coastal Sandy Soils was determined using the Standard compaction test. The values of OMC and MDD obtained are 15.4% and 1.65 g/cc respectively for untreated Coastal Sandy

Soils and 11.8% and 1.97 g/cc respectively for combination of 9% GGBS and 15% RHA. The optimum moisture content and maximum dry density of Coastal Sandy Soils treated with % combination of GGBS and RHA are presented in figures 1, 2, 3 and 4.

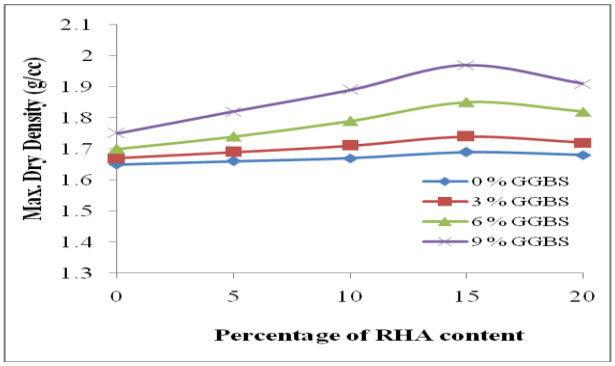

Fig1 shows the Variation in maximum dry density with percentage of RHA content

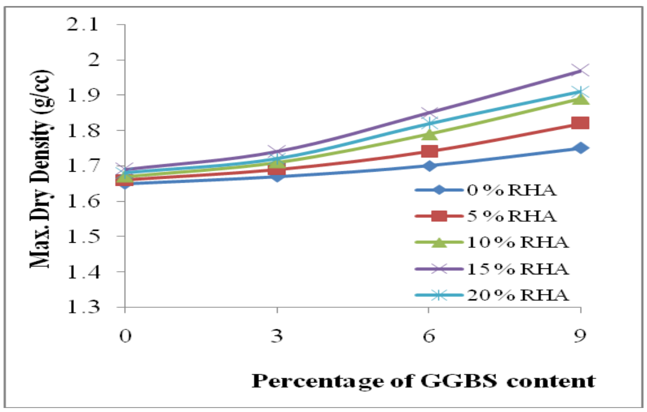

Fig2 shows the Variation in maximum dry density with percentage of GGBS content

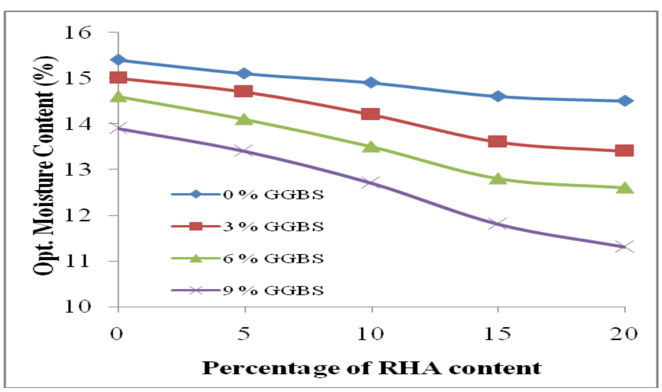

Fig3 shows the Variation in optimum moisture content with percentage of RHA content

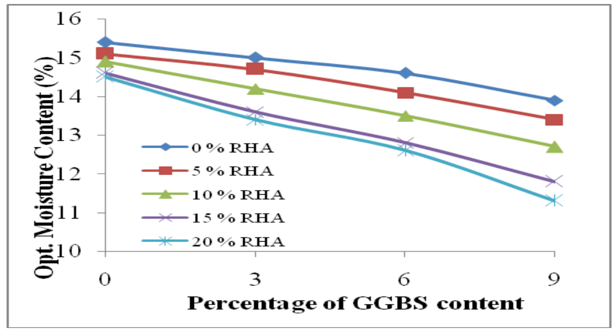

Fig4 shows the Variation in optimum moisture content with percentage of GGBS content

Effect of combination percentages of GGBS and RHA in improving the penetration characteristics of Coastal Sandy Soils

CBR value for untreated soil remained constant for most of the time. When soil treated with GGBS and RHA as the combination dosage was increased CBR values also increased for all curing periods. The test is conducted on soil alone, soil with combination of GGBS and RHA. The test results of CBR test with soil alone, soil with combination of GGBS and RHA dosages were shown in the graphs in fig 5 and 6.

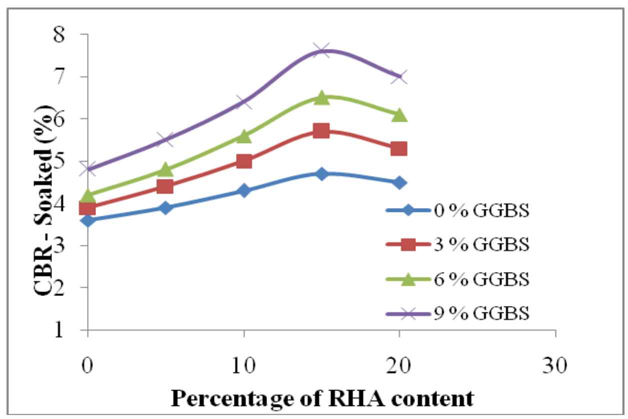

Fig5 shows the Variation in CBR Values with percentage of RHA content

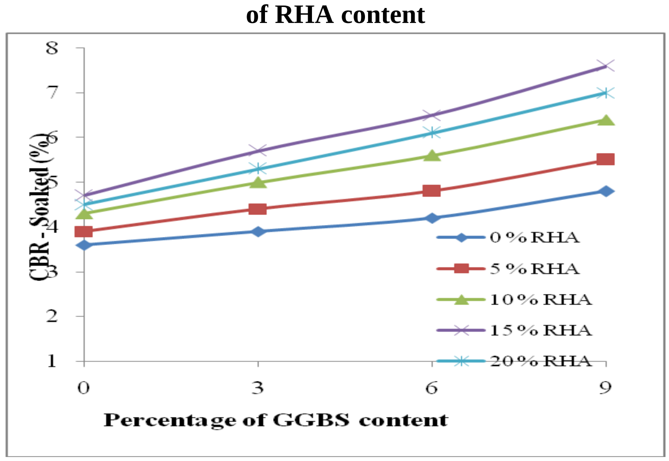

Fig6 shows the Variation in CBR Values with percentage of GGBS content

Effect of combination percentages of GGBS + RHA in improving the unconfined compressive strength of Coastal Sandy Soils

Essentially, the unconfined compression test is a special case of the triaxial compression test of soils where the compression and shear strengths of a soil prism, or cylinder, are measured under zero lateral stress. The unconfined compression test is the simplest and quickest test for determining unconfined compressive strength of the cohesive soils. The shear strength of cohesive soils (cohesion) is taken as equal to half the compressive strength. The load readings were plotted against deformation and the point of failure was identified. Figure 7 and 8 shows the change of unconfined compressive strength with different percentage of combination of GGBS and RHA (RHA). It is found that the unconfined compressive strength increases as we add on GGBS and RHA in combination and decreases after a particular percentage combination addition of GGBS and RHA.

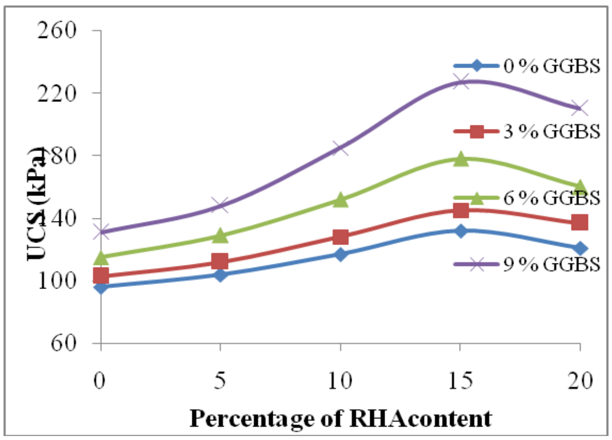

Fig7 shows the Variation in UCS Values with percentage of RHA content

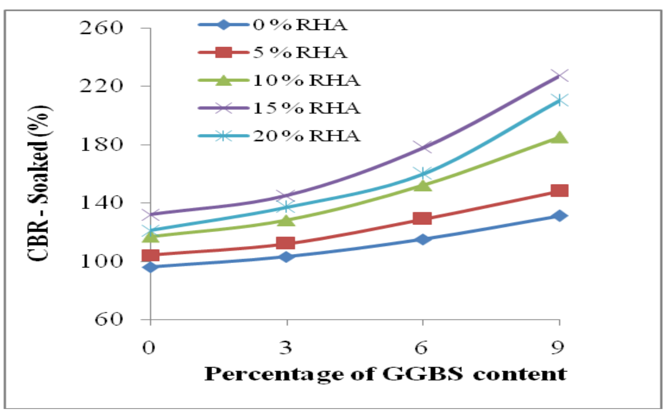

Fig8 shows the Variation in UCS Values with percentage of GGBScontent

From the above discussion on the results obtain from the laboratory experimentation done on combined percentages of GGBS and RHA yielded the significant improvement in the characteristics of Coastal Sandy Soils. The results clearly showed that the Coastal Sandy Soils with 9% GGBS + 15% RHA was the optimum. But the CBR achieved with this optimum is 5% which is not sufficient as the minimum required CBR as per IRC 37-2012 is 8%. Curing study was done on samples prepared with 9% GGBS + 15% RHA treated Weak Coastal Sandy Soils in order to achieve the required CBR value as per IRC 37-2012 which is Soaked CBR of 8%.

Effect of curing on samples prepared with 9% GGBS + 15% RHA

Figure 9 and 10 shows the variation of penetration and shear characteristics for different curing periods. From the figure 9 we can conclude that Coastal Sandy Soils when cured with 28 days had shown more pronounced improvement about 38.15% for CBR. Increase in curing periods had increased the CBR value for all the curing periods up to 28 days. Even at 7 days of curing, the minimum required CBR of 8% as per IRC 37-2012 was achieved.

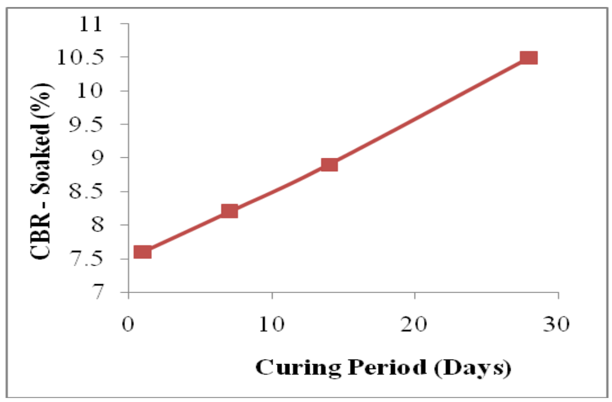

Fig9 shows the Variation in CBR Values with different curing periods

The variation of the unconfined compressive strength test with optimum content of 9 % GGBS + 15% RHA content for different curing periods has been shown in the Fig 10. From the figure it can be seen that the unconfined compressive strength (UCS) of Coastal Sandy Soils increases with the addition of 9% GGBS + 15% RHA. From figure 10 we can conclude that Coastal Sandy Soils when cured with 28 days had shown more pronounced improvement about 87.22% for unconfined compressive strength.

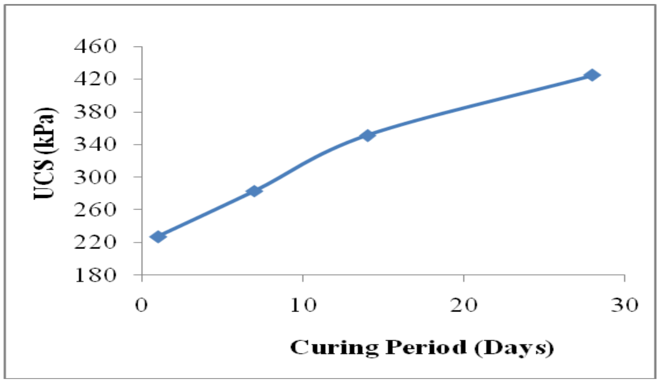

Fig10 shows the Variation in UCS Values with different curing periods

From the above results the outcome revealed that the potentiality of treated Coastal Sandy Soils was established as a sub-grade soil with a combined optimum dosage of 9% GGBS and 15% RHA.

Finally from the above discussions, it is clear that there is improvement in the properties of Coastal Sandy Soils stabilized with GGBS + RHA. It is evident that the addition of GGBS and RHA to the M showed an improvement in plasticity, compaction and strength properties. It can be summarized that the materials GGBS and RHA had shown promising influence on the properties of Coastal Sandy Soils, thereby giving a two-fold advantage in improving problematic Coastal Sandy Soils and also solving a problem of waste disposal.

VI. CONCLUSIONS

The results of this experimental investigation have shown that beneficial effects are obtained by treating Coastal Sandy Soils with Ground granulated blast furnace slag and RHA. Therefore, the resulted geotechnical properties of treated soil have led to the following conclusions:

- From the studies, it is observed that the Coastal Sandy Soils was a problematic soil.
- The treatment of the samples with Ground granulated blast furnace slag and RHA changed the optimum moisture and maximum dry density.
- It was observed that the CBR is increases with increase in combined percentages of Ground granulated blast furnace slag and RHA.
- The unconfined compressive strength of treated soil specimen with Ground granulated blast furnace slag and RHA was affected mostly by the amount mixed in soil mixtures. The unconfined compressive strength increased in association with increasing in combined percentages of GGBS and RHA.
- It was observed that the soil with a combined optimum dosage of 9% GGBS and 15% RHA has improved the properties of Coastal Sandy Soils.
- The optimum moisture content decreased and maximum dry density increased with increasing in combined percentages of GGBS and RHA contents. It can be inferred from the graphs, that there is a gradual improvement in the maximum dry density by an amount of 19.39%.
- The CBR increased for an optimum dosage of 9% GGBS and 15% RHA but not achieved the minimum required CBR as per IRC 37-2012 is 8%.
- The UCS increased about 136.45% for an optimum dosage of 9% GGBS and 15% RHA.
- Curing studies were done on samples prepared with 9% GGBS + 15% RHA treated Weak Coastal Sandy Soils in order to achieve the required CBR value.
- From the curing studies it can be concluded increase in curing periods had increased the CBR values up to 28 days. Even at 7 days of curing, the minimum required CBR of 8% as per IRC 37-2012 was achieved. It is observed that the Coastal Sandy Soils when cured with 28 days had shown more pronounced improvement about 38.15% for CBR and 87.22 for unconfined compressive strength.

Finally it can be summarized that the materials GGBS and RHA had shown promising influence on the properties of Coastal Sandy Soils, thereby giving a two-fold advantage in improving problematic Coastal Sandy Soils and also solving a problem of waste disposal.

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