An Experimental Study on Behaviour of GSB Layer by Utilization of Granulated Sub Base, Crumb Rubber and Pond Ash

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Abstract— Subbase is a layer of aggregate material laid on the subgrade, on which the base course layer is located. Subbase is often the main load-bearing layer of the pavement. Its role is to spread the load evenly over the subgrade. The quality of subbase is very important for the useful life of the road. Subbase is prepared according to the MORTH norms. Red soils denote the second largest soil group available in India. The handling of Red soil is a difficult task for highway engineer to construct the road due to several reasons, so various soil modification techniques are tried to enhance the properties of soil. Granulated blast furnace slag (GBFS) is major by-product of steel plants, which causes the environmental pollution and also Crumb Rubber (CR) is a leftover product of castoff rubber tyres. Both of these waste product's causes the disposal problem. In this study these materials are used as a reinforcing material for subbase layer. This study presents the result of experimental investigation on the influence of Pond ash (PA) on the index properties of Red soil. The aggregates which are used in subbase level can be replaced with varying percentages GBFS and CR separately.

Keywords: California Bearing Ratio (CBR), Granulated Blast Furnace Slag (GBFS), Granular Subbase (GSB), Pond Ash (PA), Crumb Rubber Tyre (CR)

I. INTRODUCTION

The sub-base course is the layer of material beneath the base course and the primary functions are to provide structural support, improve drainage, and reduce the intrusion of fines from the sub-grade in the pavement structure If the base course is open graded, then the sub-base course with more fines can serve as a filler between sub-grade and the base course. The materials used may be either unbound granular, or cement-bound. The quality of subbase is very important for the useful life of the road.

The utilization of waste materials like granulated blast furnace slag, waste rubber tyre pieces, rice husk ash etc. in road construction industries is gradually gaining significant importance by considering the disposal, environmental problems and gradual depletion of natural resources like soil and aggregates. Steel slag is a waste material generated as a by-product during the manufacturing of steel from steel industries. Increase in motor vehicles tends to increase in discarded rubber tyres.

II. LITERATURE REVIEW

Teresa Sunny et, al (2014) studied on the effects of marine clay stabilized with Banana Fibre. The main objective of this study is to investigate the use of waste material such as Banana fibre in geotechnical applications, various tests such as Unconfined Compression (UCC), California Bearing Ratio (CBR), Atterberg limits, Compaction were carried out and the results are analyzed.

Muhanned Qahtan Waheed, (2012) stated that increase in max dry density and the corresponding reduction in Optimum Moisture Content values were observed with the addition of varying percentages of Magnesium Chloride ($MgCl_2$) and Sodium Chloride (NaCl) chemicals. Chemical modification by adding lime has been practiced for the last two decades.

O.O, Ogunniyi et.al (2011) determined the geotechnical properties of lateritic soil modified with sugarcane straw ash with a view to obtaining a cheaper and effective replacement for the conventional soil stabilizers. Preliminary tests were performed on three samples, A, B and C for identification and classification purposes followed by the consistency limit tests. Geotechnical strength tests (compaction, California bearing ratio (CBR), unconfined compression test and triaxial) were also performed on the samples, both at the stabilized and unstabilized states with different varying percentages of sugarcane straw ash. The results showed that sugarcane straw ash improved the geotechnical properties of the soil samples. Optimum moisture content, CBR and unconfined compression strength for the three samples A,B and C has been increased with increase in sugarcane straw ash.

Laxmikant Yadu et. Al (2011) studied the change in the index and strength properties of the BC soil by adding various proportions of FA and RHA. Furthermore, a thorough laboratory investigation has been conducted to determine the optimum amount of stabilizers. Results indicate that addition of FA and RHA reduces the plasticity index (PI) and specific gravity of the soil. The moisture and density curves indicate that addition of RHA results in an increase in optimum moisture content (OMC) and decrease in maximum dry density (MDD), while these values decrease with addition of FA. The addition of stabilizers (i.e., FA and RHA) increases UCS and CBR values, indicating the improvement in the strength properties of the soil.

Basha et. al (2004) his studies report the potential of burnt agricultural by-product, rice husk, as a material for stabilising soil. Investigation includes the evaluation of such properties of the soil as compaction, strength, and X-ray diffraction. Test results show that both cement and rice husk ash reduce the plasticity of soils. In term of compactability, addition of rice husk ash and cement decreases the maximum dry density and increases the optimum moisture content.

III. EXPERIMENTAL PROCEDURE

Experimental studies for determination of index and engineering properties on different Granular subbase mix proportions stipulated as per the MORTH has been carried out. The engineering properties are determined on GSB samples in lab. Two types of waste materials are used for the aggregate replacement in GSB mix and one waste material is used to increase the plasticity properties of soil which is used as a filler material in GSB layer.

IV. MATERIALS USED

In this present work, the materials such as Red soil, Pond ash, Aggregates, GBFS and CR were used.

The soil sample used for this study is collected near jonnada village, Vizianagaram, Vizianagaram district. The index properties of the soil is determined by Atterberg's limit test.

Pond Ash (PA) used for this study is collected from Asokha Buidcon – Andhra Pradesh.

Aggregates of size passing 20mm IS sieve were procured from local quary a place nearer to Bobbili town located in Vizianagaram District – Andhra Pradesh.

Granulated Blast Furnace Slag was produced from Balaji Enterprises, Vizag- Andhra Pradesh.

Crumb Rubber was produced from Tyre Rebuttoning shop in vizag Andhra Pradesh.

V. RESULTS

Average Chemical Analysis (%)	
Feo	0.48
Cao	37.55
Mgo	7.50
Sio_2	34.39
Al_2o_3	17.19
Mno	0.10

Table 1: Chemical properties of GBFS

Atterberg Limits	Unmodified Red soil	Red soil+4% PA
Liquid Limit (%)	28	25
Plastic Limit (%)	18.13	21.05
Plasticity Index (%)	9.87	3.95

Table 2: Atterberg Limits for Red soil with Admixture PA

Blend sample type	MDD (kN/m^3)	OMC(%)
S0-4F	24.11	2.04
GS10-5F	23.27	2.70
GS20-5F	22.86	3.67
GS30-3F	22.78	4.00
GS40-2F	21.23	4.05

Table 3: Optimum Moisture Content (OMC) and Maximum Dry Density (MDD) for various blended mixes with GBFS

Blend sample type	MDD (kN/m^3)	OMC(%)
S0-4F	24.11	2.04
SW2-2F	22.4	3.84
SW4-4F	22.16	4.15
SW6-4F	21.36	3.35
SW8-4F	20.81	4.8

Table 4: Optimum Moisture Content (OMC) and Maximum Dry Density (MDD) for various blended mixes with CR

Blend Sample Type	CBR (%)	
	Unsoaked	Soaked
S0-4F	74.20	66.90
GS10-5F	81.96	71.77
GS20-5F	104.46	98.08
GS30-3F	95.49	89.41
GS40-2F	82.87	68.12

Table 5: CBR values for Aggregate replaced with varying percentages of GBFS

Blend Sample Type	CBR (%)	
	Unsoaked	Soaked
S0-4F	73.6	65.8
SW2-2F	76.67	72.07
SW4-4F	66.66	61.64
SW6-4F	43.63	37.86
SW8-4F	27.64	26.42

Table 6: CBR values for Aggregate replaced with varying percentages of CR

VI. CONCLUSION

Based on the various studies carried out in unit 4 the following conclusions were drawn:

1) Red soil being in abundant quantity can be used as filler for pavements. However due to the limitation in its plasticity properties, can be used in combination with Rice Husk ash. The combined soil has exhibited reduction in plasticity and is satisfying the MORTH standards. An optimum content of 4% rice husk ash has given the desired plasticity required as per MORTH.
2) The influence of Granulated blast furnace slag and waste rubber tyre chips is marginal on MDD and high for OMC. The OMC is found to increase by 1.9 times with GBFS and 2.3 times with CR as compared with unmodified aggregate. An optimum filler content of 5% with GBFS and 2% with CR is recommended for best results.
3) Studies on CR modified aggregates showed considerable improvement in impact, abrasion and crushing. The modified aggregate exhibited 1.3 times resistance to that of unmodified. Hence the modified aggregate can be recommended as GSB layer for pavements.
4) It is concluded that the efficacy of GBFS is higher to that of CR. At optimum conditions CBR increase with GBFS from 40.78% and 46.60% at 20% GBFS content is very high to that with CR i.e from 4.71% to 7.7% at 2%.

From the results on mix proportions, considering economical aspects and preparation of mix, it is concluded that mix of 1:0.4:0.3 &1:0.5:0.5 with GBFS and 1:0.4:0.04 with CR will be suitable and adoptable as per MORTH specifications for pavements

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