

Research Paper

EFFECT OF LIME AND RICE HUSK ASH ON ENGINEERING PROPERTIES OF BLACK COTTON SOIL

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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 behavior is attributed to the presence of a mineral montmorillonite. The wide spread of the black cotton soil has posed challenges and problems to the construction activities. To encounter with it, innovative and nontraditional 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 5% lime mixed black cotton soil blended with Rice Husk Ash in 5%, 10%, 15% and 20% by weight of dry soil. The experimental results showed a significant increase in CBR and UCS strength. The CBR values increases by 287.62% and UCS improved by 30%. The Differential free swell of the black cotton soil is reduced by 86.92% with increase in Rice Husk Ash content from 0% to 20% respectively. From this investigation it can be concluded that the Rice Husk Ash has a potential to improve the characteristics of black cotton soil.

Keywords: Black cotton soil, Soil Stabilization, Rice husk ash, Engineering Properties

INTRODUCTION

The wide spread of the black cotton soil has posed challenges and difficulties in the construction activities because of its shrink-swell behavior and low strength. The inadequate natural stability of black cotton soil can be reduced using various techniques; one of them is through admixtures. Stabilization techniques can be adopted on large scale when the treatment is low cost and durable. Rice husk ash is one of the major wastes found abundantly. The annual production of paddy is one of the major

wastes found abundantly. In India, the annual production of paddy is about 100 million tones. The burning of rice husk generates about 20% of its weight as ash. Thereby generating more than 4 million tons of rice husk ash. Hence research work is done on utilization of rice husk ash in improvement of geotechnical characteristics of black cotton soil. In the present investigation, an attempt has been made to evaluate the changes in the compaction and strength characteristics of black cotton soils such as optimum moisture content, maximum dry density, CBR and UCS in addition of 5% lime and rice husk ash in different proportions.

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LITERATURE REVIEW

Satyana^rayan et al., 2004 studied the effect of FA and lime on the expansive soil used for construction of road base, sub base (Satyana^rayan et al., 2004). Stabilization of expansive soil using rice husk ash (RHA) as a pozzolanic material along with a binder has been studied by researchers a number of times (N K Bhasin et al., 1988), (A S Muntohar and G Hantoro, 2000), Effect of RHA with cement (E A Basha et al., 2003), (A N Ramakrishna and A V Pradeep Kumar, 2006), effect of RHA with calcium chloride (R S Sharma, 2008), effect of RHA with marble dust (A K Sabat and R P Nanda, 2011), effect of RHA and lime with gypsum (D K Rao et al., 2011) etc. Similarly the mixing of lime sludge along with a pozzolanic material has also been studied. Some are bagasse ash with lime sludge (A K Sabat, 2012), fly ash with lime sludge (R K Srivastava et al., 1997). Chandra et al. had stabilized a non-expansive clayey soil with RHA and lime sludge (S Chandra et al., 2005). RHA added to soil was from 5 to 20% in steps of 5% and lime sludge from 4 to 16% in steps of 4%. Properties of the stabilized soil studied were, Atterberg's limits, maximum dry density (MDD), optimum moisture content (OMC), unconfined compressive strength (UCS) and soaked California bearing ratio (CBR) of soil. Sabat (A K Sabat, 2012) had studied the stabilizing effects of bagasse ash and lime sludge on compaction properties, UCS, CBR and swelling pressure of an expansive soil , Brooks (2009) studied the potential of Rice Husk Ash (RHA)and fly ash (FA) blended soil as a swell reduction layer between the footing of a foundation and subgrade. He recommended 12% and 25%, RHA and FA, respectively, for modifying the expansive subgrade soil. Ali et al. (2004) studied the effect of RHA and lime on characteristics of bentonite. (Ali M and Sreenivasulu V, 2004).

MATERIALS AND METHODS

A series of laboratory tests were conducted on 5%lime mixed BC Soil blended with RSA in various percentages i.e. 0%, 5%, 10%, 15% and

20% by weight of dry soil. The following tests were conducted on 5%lime mixed BC soil and Rice mixes; as per relevant IS Code. The tests are

1. Compaction Test
2. California Bearing Ratio
3. Unconfined Compressive Strength
4. Differential Free Index

BLACK COTTON SOIL

The black cotton soil used in this study was collected from Bilhari area of Jabalpur (M. P.) The physical characteristics of clay sample is given in Table 1.

RICE HUSK ASH

The stabilizer materials used in this study was Rice Husk Ash. Rice Husk Ash used in this study collected from Rice Mill, Shahpura, Dist. Jabalpur (M. P.) The properties of RHA is presented in Table 2.

The black cotton soil was mixed with 5%lime and soaked for four days. After oven drying, the following samples are prepared by mixing different percentage of rice husk ash to it.

Table 1: Properties of Black Cotton Soil

S.N.	Particulars	Test Value
1.	Specific Gravity	2.56
2.	Liquid Limit %	48.5%
3.	Plastic Limit %	22.7%
4.	Plasticity Index %	25.8%
5.	Shrinkage Limit %	8.61%
6.	Grain Size distribution %	89.783%

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|-------|-----------------------------|
| BCS | - Black cotton soil |
| SAM0 | - Black cotton soil+5% lime |
| SAM5 | - SAM0 +5% Rice husk ash |
| SAM10 | - SAM0+10% Rice husk ash |
| SAM15 | - SAM0+15% Rice husk ash |
| SAM20 | - SAM0+20% Rice husk ash |

Table 2: Properties of Rice Husk Ash

S.N.	Parameters	Test Value
I) Chemical Properties		
	Silica	85.14%
	Lime	3.08%
	Alumina	2.07%
	Iron Oxide	1.43%
	Magnesia	4.03%
	Loss on Ignition % w/w	5.08%
II) Physical Properties		
	Specific Gravity	1.81 gm/cc
	Particle Size	13.2%

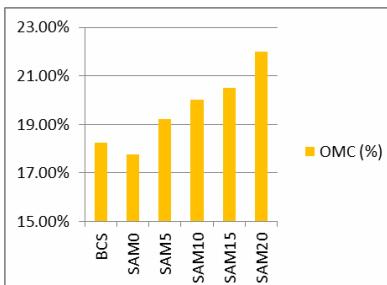
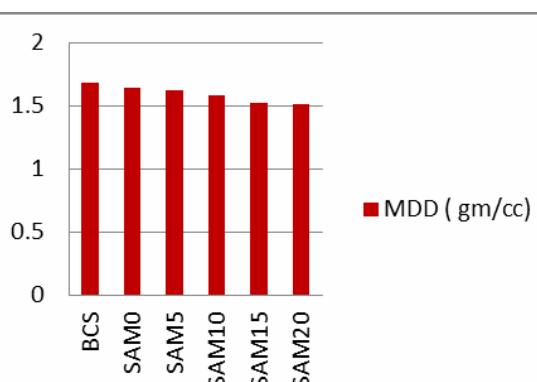
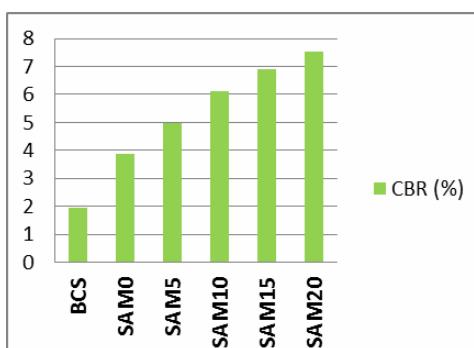
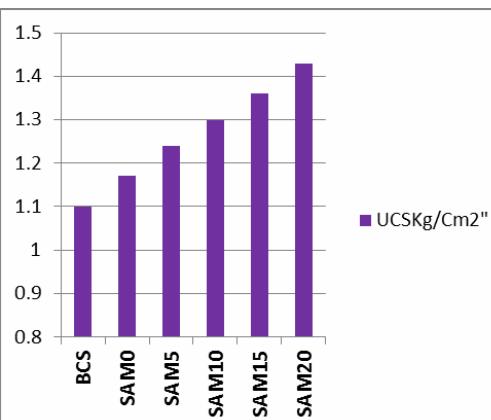
RESULTS AND DISCUSSION

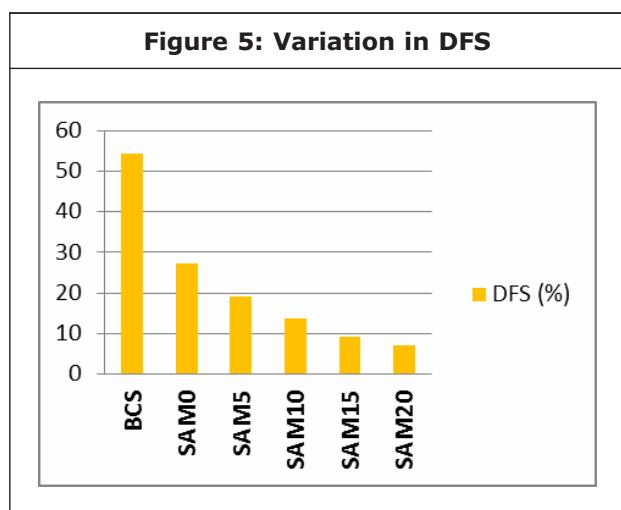
The tests results are summarized in Table 3. The variation in the Optimum moisture contents, Maximum dry density, California bearing ratio, Unconfined compressive strength and Differential free index are shown in Figures 1 to 5.

Table 3: Summary of Results

Mix	OMC %	MDD gm/Cm ³	CBR %	UCS Kg/cm ²	DFS %
BCS	18.25	1.68	1.94	1.10	54.30
SAM0	17.75	1.65	3.87	1.17	27.30
SAM5	19.20	1.62	4.99	1.24	19.04
SAM10	20.00	1.58	6.10	1.30	13.70
SAM15	20.50	1.54	6.92	1.36	9.09
SAM20	22.00	1.51	7.52	1.43	7.10

1. OMC- Optimum moisture contents, 2. MDD - Maximum dry density, 3. CBR-California bearing ratio, 4. UCS - Unconfined compressive strength, 5. DFS-Differential free index.

Figure 1: Variation in OMC**Figure 2: Variation in MDD****Figure 3: Variation in CBR****Figure 4: Variation in UCS**



CONCLUSION

From the results of the investigation carried out within the scope of the study the following conclusion can be drawn

- With the increase in Rice husk ash percentage the Optimum moisture content increases from 18.25% to 22.00%
- Maximum dry density decreases from 1.68gm/cm³ to 1.51 gm/cm³.
- There is significant increase in the values of California bearing ratio and Unconfined Compressive Strength. California bearing ratio increases from 1.94% to 7.52% and Unconfined strength increases from 1.10 Kg/cm² to 1.43Kg/cm².

REFERENCES

- Proceedings of National conference Civil Engineering meeting the challenges of tomorrow, pp. 215-220.
- A K Sabat (2012), "Utilization of Bagasse Ash and Lime Sludge for Construction of Flexible Pavements in Expansive Soil Areas", *Electronic Journal of Geo-technical Engineering*, Vol.17, Bund.H, pp.1037-1046.
 - A K Sabat and R P Nanda (2011), "Effect of Marble Dust on Strength and Durability of Rice Husk Ash Stabilized Expansive Soil", *International journal of Civil and Structural Engineering*, Vol. 1, No. 4, pp. 939-948.
 - A N Ramakrishna and A V Pradeep Kumar (2006), "Stabilization of Black Cotton Soil Using Rice Husk Ash and Cement", in 4. A S Muntohar and G Hantoro (2000), "Influence of Rice Husk Ash and Lime on Engineering Properties of a Clayey Subgrade", *Electronic Journal of Geotechnical Engineering*, Vol. 5.
 - Ali M, Sreenivasulu V (2004). "An Experimental Study on the Influence of Rice Husk Ash and Lime on Properties of Bentonite". *Proceedings of Indian Geotechnical Conference, Warangal (India)*. pp. 468- 471.
 - C S Gourley, D Newill and H D Shreiner (1993), "Expansive Soils: TRL's Research Strategy", in *Proc. of first int. symposium on engineering characteristics of Arid soils*.
 - D K Rao, P R T Pranav and M Anusha (2011), "Stabilization of Expansive Soil with Rice Husk Ash", *lime and gypsum- an experimental study*, *International journal of Engineering Science* 5. Differential Free Index decreases from 54.3% to 7.1% and Technology, Vol. 3, No. 11, pp. 8076-8085.
 - E A Basha, R Hashim and A S Muntohar (2003), "Effect of the Cement Rice Husk Ash on the Plasticity and Compaction of Soil", *Electronic Journal of Geotechnical Engineering*, Vol. 8.
 - IRC: 37-2001, Guidelines for the design of flexible pavements.
 - N K Bhasin, N K Goswami, P Oli, N Krishan and N B Lal (1988), "A Laboratory Study on Utilization of Waste Materials for the Construction of Roads in Black Cotton Soil Areas", *High way research bulle-tin*, No. 36, pp. 1-11.
 - R K Srivastava, D K Joshi, K Srivastava, J Singh, R P Tiwari and N K Shukla (1997), "SEM Analysis and Geotechnical Characterization of Industrial Waste Expansive Soil Interaction Behaviour", in *Proc. of Indian Geotechnical Conference, IGC*- pp. 409-410.
 - R S Sharma, B R Phani Kumar, and B V

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- Rao (2008), "Engineering behaviour of a Remolded Expansive Clay Blended with Lime, Calcium Chloride and Rice Husk Ash", *Journal of Materials in Civil Engineering*, ASCE, Vol. 20, No. 8, pp. 509-515.
13. S Chandra, S Kumar and R K Anand (2005), "Soil Stabilization with Rice Husk Ash and Lime Sludge". *Indian Highways*, Vol. 33, No. 5, pp. 87-98.
14. Satyanarayana P V V, Rama Rao R and Krishna Rao C V (2004), "Utilization of Lime Fly Ash Stabilized Expansive Soil in Roads and Embankments". *Proceedings of Indian Geotechnical Conference, Warangal (India)*. 465-467.



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