Utilization of Ceramic Waste and Solid Waste for Improving Soil Properties Highway Pavement Construction

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Abstract— Utilization of ceramic waste and solid waste for improving soil properties for highway pavement construction.to find properties of soil we performed different types of test like, specific gravity test, liquid limit test, plastic limit test, CBR test, proctor compaction test, free swell and swelling potential, Unconfined compression test. We are also going to take CBR value of normal soil and then we are going try to improve the soil properties by adding with different proportion of admixtures like ceramic waste & solid waste. We perform CBR test on soil by adding only ceramic waste by 2% of soil weight , then in repeating test we are going to add partially agricultural solid waste(coconut fiber) in it by 0.5-1% varying and keep ceramic waste portion constant and vice versa.

Key words: Ceramic Waste, Black cotton soil, fiber, solid waste

I. INTRODUCTION

In developing countries like India, the biggest problem to provide a complete network of road system is the limited finances available to build roads. Use of local materials, including loc1al soils, can considerably lower down the construction cost. If the stability of local soil is not enough for supporting wheel loads, the properties are improved by soil stabilization techniques. The stabilization of soil for use in sub-grade for pavement is an economic. Substitute of costly paving materials. There are many techniques for soil stabilization either mechanical or chemical, but all of them require skilled manpower and equipment to ensure enough performance. Randomly distributed ceramic, when used an addition in highway sub-grade, can produce a high performance in the stabilization of weak roads. Many investigators have used various types of under different test conditions.

The most important findings of the previous research work is that the use of ceramic dust in road construction can significantly increase pavement resistant to rutting as compared to the resistance of non-stabilized pavement over a weak sub-grade. Permanent deformation in each layer is the indicator of rut formation at the road surface. Consequently this is used as a criterion of pavement performance. However, it is difficult to comprehensively include permanent deformation. There are problems in assessing the contribution made by each individual layer to the total rut depth visible at the pavement surface. Hence, the deformation that appears at the surface of a pavement is the sum of deformation of each of the pavement layers, together with that in the sub-grade.

II. MATERIAL & METHODOLOGY

A. Black Cotton Soil:

Black cotton soils are problematic for Civil Engineers, because of their unconventional behaviour. These soils show large volume changes with respect to variation of seasonal moisture content. These soils when subject ted vehicular traffic, road pavement gets heaved and cracked due to swelling and shrinkage. Hence, these soils are to be stabilized before constructing the roads in order to have efficient and long lasting roads. Considerable research has been taken place using different stabilizing materials such as lime, fly ash cement, rice husk ash, industrial wastes and geo-synthetics etc. And proved to be useful in stabilization of black cotton soils.

Fig. 1: black cotton soil

B. Ceramic Waste:

The principle waste coming into the ceramic industry is the ceramic powder, specifically in the powder forms. Ceramic wastes are generated as a waste during the process of dressing and polishing. It is estimated that 15 to 30% waste are produced of total raw material used, and although a portion of this waste may be utilized on-site, such as for excavation pit refill, The disposals of these waste materials acquire large land areas and remain scattered all around, spoiling the aesthetic of the entire region. It is very difficult to find a use of ceramic waste produced. Ceramic waste can be used in concrete to improve its strength and other durability factors.

Fig. 2: Ceramic dust

C. Coconut (Coir) Fiber:

The outer covering of fibrous material of a matured coconut, termed coconut husk, is the reject of coconut fruit. The fibres are normally 50–350 mm long and consist mainly of lignin, tannin, cellulose, pectin and other water soluble substances. However, due to its high lignin content, coir degradation takes place much more slowly than in other natural fibres. So, the fiber is also very long lasting, with infield service life of 4–10 years. The water absorption of that is about 130–180% and diameter is about 0.1–0.6 mm .Coir retains much of its tensile strength when wet. It has low tenacity but the elongation is much higher. The degradation of coir depends on the medium of embedment, the climatic conditions and is found to retain 80% of its tensile strength after 6 months of embedment in clay.

Fig. 3: Coconut fiber

III. RESULT ANALYSIS

Specific gravity test of soil	2.5%
Liquid limit test of soil	45%
Plastic limit test of soil	25%
MDD of soil	1.75 kn/m²
OMC of soil	15%
Free swell index of soil	80%
UCT test of soil	3.14kg/cm²
CBR value of soil	8.9%

Table 1: Basic Properties of Soil

Sr. No.	CBR Specimen	CBR Value in %		Increment in CBR value (in %)	
		2.5 mm	5mm	2.5 mm	5mm
1	Normal BC Soil	9.70%	11.20 %	0%	0%
2	BC Soil+2% ceramic dust	11.75 %	12.93 %	2.05%	1.73%
3	BC Soil+4% ceramic dust	12.10 %	13.33 %	2.4 %	2.13%
4	BC Soil+6% ceramic dust	9.54%	11.02 %	-0.16%	-0.18%
5	BC Soil+4% ceramic dust+0.5% coconut fiber	11.98 %	12.30 %	2.28%	1.10%
6	BC Soil+4% ceramic dust+1.5% coconut fiber	12.23 %	13.46 %	2.53%	2.26%
7	BC Soil+4% ceramic dust+ 1.5% coconut fiber	12.40 %	13.80 %	2.70%	2.60%
8	BC Soil+4% ceramic dust+ 2.0% coconut fiber	13.82	14.10	4.12%	2.90%
9	BC Soil+4% ceramic dust+ 2.5% coconut fiber	11.40	12.20	1.70%	1.0 %

Table 2: CBR test result of ceramic and solid waste mix

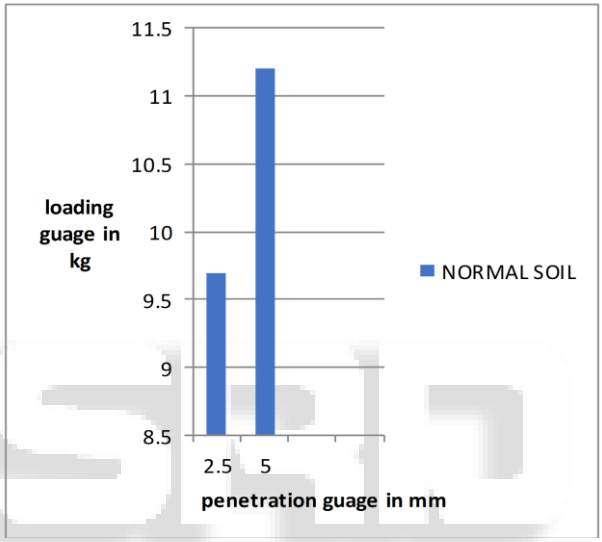

Fig. 4: Loading vs penetration graph(normal soil (BCS))

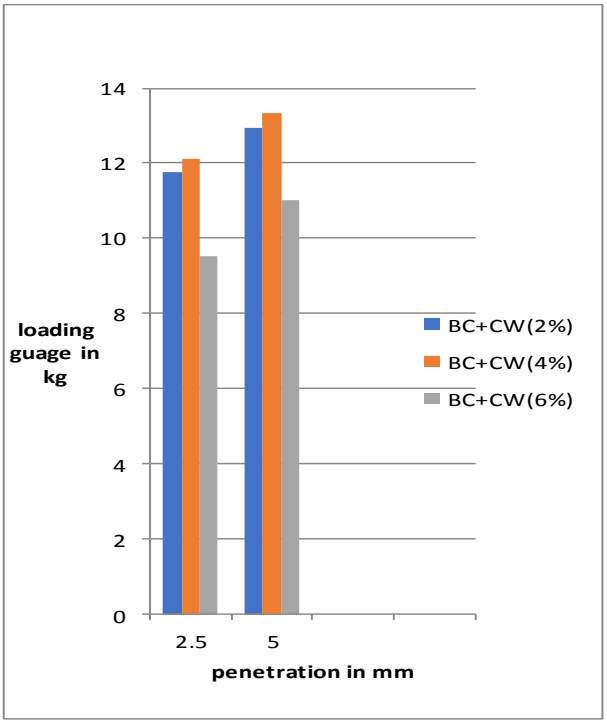

Fig. 5: BC+CW

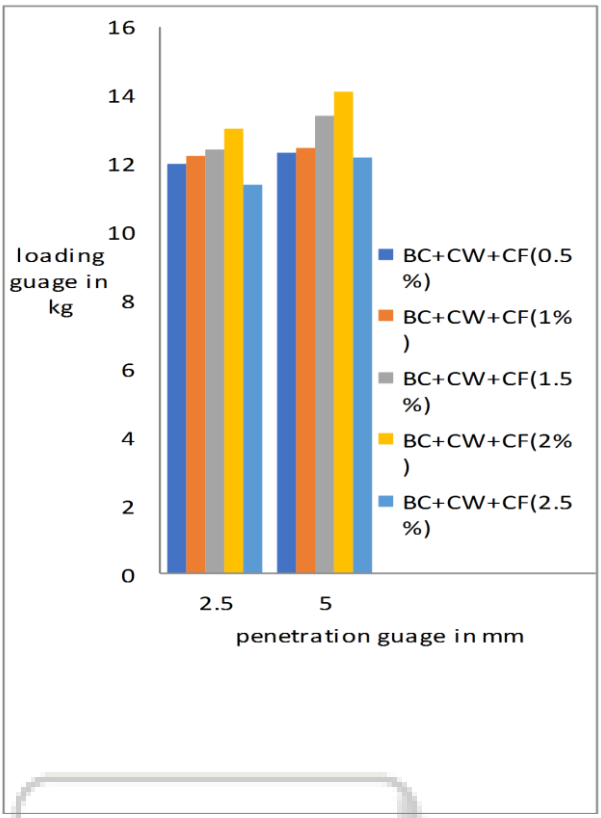

Fig. 7: BC+CW+CF

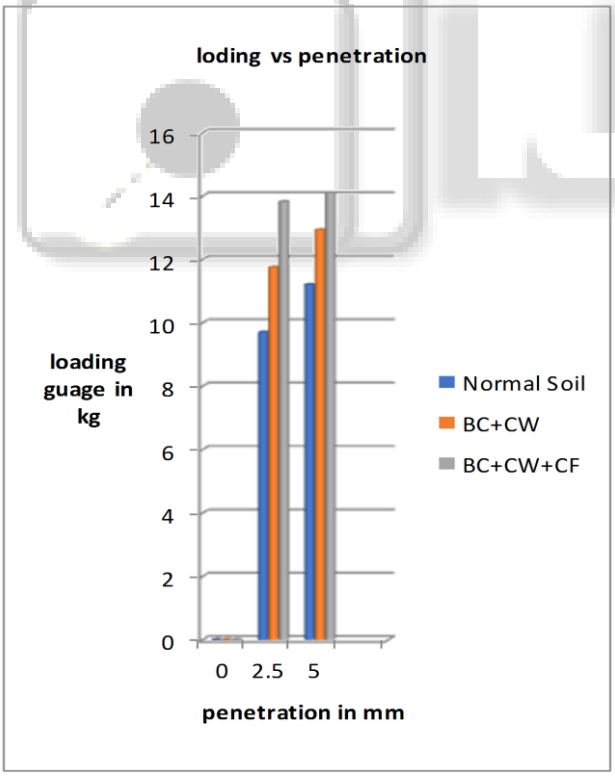

Fig. 8: loading vs penetration graph

IV. Conclusion

After studying the result of CBR test of various proportion of ceramic dust and coconut fibres in black cotton soil, the CBR value of soil is increases 2%-4%. But after adding more proportion of ceramic dust the CBR value is decreases because of the soil and ceramic dust did not perform the strong bond like lime and soil.

The ceramic dust we used is a totally waste of ceramic industry and did not useful in any other way, so we can use this waste as a dumping material in sub grade soil to improve its strength. E.g. Fly Ash

1) The coconut fibres are also a one type of waste material of agricultural industries which is used in fertilizers in small amount, so we also can add it into small proportion in soil sub grade to improve strength of soil for highway pavement construction.
2) We used 0.5%-1.5% coconut fibbers weight per weight of total soil mass, after adding this coconut fibbers with ceramic dust the OMC decreases and the CBR value is increases.
3) By using this type of waste materials we can reuse it, and pollution level decreases and the strength of soil is increases in 2%-4% so we can re-use this materials as a dumping materials is sub grade for highway pavement construction.

References

[1] Basha, E. A., Hashim, R., Mahmud, H. B. and Muntohar, A. S. (2005). Stabilization of residual soil with rice husk ash and cement Stabilization of residual soil with rice husk ash and cement. Construction and Building Materials, Vol. 19, 448 453.
[2] Gosavi, M., Patil, K.A" Mittal, S. and Saran, S (2004). "Improvements ofproperties of black cotton soil subgrade through synthetic reinforcement." Joumal of Institution of Engineers (India), 84,257-262.
[3] Improvement in CBR of the expansive soil sub grades with a single reinforcement layer by A.K. Choudhary, K.S. Gill, J.N. Jha, S.K. Shukla .(2012)
[4] IS: 2720(Part 2), 1973 Methods of Test for Soils, Determination of water content.
[5] IS: 2720(Part 2), 1973 Methods of Test for Soi
[6] IS:2720(III/SEC-I): 1980 Methods of Test for Soils, Determination of specific gravity
[7] IS:2720(VII):1980 Methods of Test for Soils, Determination of water content dry density relation using light compaction.
[8] IS:2720(IV):1985 Methods of Test for Soils, determination of grain size analysis.

