Stabilization of soil by using solid waste – A Review

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***Abstract* - Black cotton soil which is one of the major soil deposits in India becomes highly problematic because of its property of higher degree of swelling and shrinkage. These soils are used in subgrade of pavement and also in construction of structures. Hence in order to improve the properties of such soils many methods are available like soil stabilization, soil replacement, moisture control, prewetting etc. In recent years, soil stabilization by using various minerals like quarry dust, saw dust, copper dust and fly ash were most commonly used. These solid wastes are day by day increasing in India, which is not environmental friendly hence they have to be recycled. Thus, a review is presented to make use of those wastes in soil stabilization. In this paper, the study mainly focusses on stabilization of soil using solid waste. To understand the performance of stabilized soil, its properties like Atterberg limits, compaction characteristics, swelling, shear strength, CBR value and other Index & Engineering properties were discussed.**

Keywords: Soil stabilization, Solid waste, CBR, Index & Engineering properties.

I. INTRODUCTION

Black cotton soils are inorganic clay of medium to high compressibility and form a major soil group of India. The black colour in black cotton soil is due to the presence of Titanium oxide in small concentration. The Black cotton soil has a percentage of clay which is predominantly montmorillonite structures and black or blackish grey in colour. They are characterized by high shrinkage, low bearing capacity and swelling properties. Because of these properties, the Black cotton soil has been challenge to the high way engineers. Black cotton soils are very hard when it dry but loses its strength completely when it wet condition. Soft clays, expensive soils, weak soils, sand and organic deposits are unsuitable for all construction work due to bare engineering properties.

Soil stabilization improves the engineering properties of soils and thus making it more stable. It is essential when the soil accessible for construction is not suitable for the anticipated purpose. The term stabilization is generally restricted to the process which alter the soil material itself for improvement of is properties a solid wastes or chemicals are added to a natural soil for the purpose of stabilization.

The use of by-product materials to improve the soil properties varies with economic, environmental and technical points. In this study, the solid wastes such as fly ash, copper slag, saw dust ash, paper sludge, quarry dust, stone dust, steel slag and brick dust are utilized as cementitious material to stabilization the Black cotton soil.

II. REVIEW OF LITERATURE

Prof. Ranjendra kumar (2017) [1] had studied about the Black cotton soil blended with copper slag and fly-ash which are added in different percentages. The soil properties like liquid limit, plastic limit, plasticity index, free swell, compaction test and CBR (unsoaked) were determined. The results indicated that the dry density, CBR values were improved and swelling was reduced due to addition of copper slag 30% and fly ash 10% (% by weight of soil) in the soil.

Prof. Ramesh babu (2017) [2] had investigated about the behaviour of black cotton soil with addition of copper slag and steel slag. The soil samples are tested by compaction test, unconfined compression test and CBR. It is concluded that CBR, optimum moisture content, maximum dry density and shear strength are increased when the soil is added with 20% of copper slag and steel slag.

Prof. Wajid Ali Butt (2016) [3] had investigated about the Strength Behaviour of Clayey soil stabilized with sawdust ash. The soil properties were determined by computing the Liquid limit, plastic limit, plasticity index, specific gravity, UCC and CBR. He observed that the property of soil showed an acceptable value up to 4% replacement of sawdust ash. He had discovered that sawdust ash acceptably act as a cheap stabilizing material for road pavement.

Prof. Tiza Michael (2016) [4] had reviewed about the stabilization using industrial solid wastes. In this paper, he studied about the replacement of different materials such as Red mud, copper slag, brick dust, polyvinyl waste, ceramic dust, sawdust and fly ash. The soil samples were tested by Atterberg limits, CBR and compaction test. He had concluded that almost all the industrial wastes have the ability to improve the expansive soil with less cost compared to conventional soil.

Prof. Ravi (2016) [5] had studied about the characteristics of clay soil by using copper slag stabilization. In this paper, he tested the CBR and Max density, OMD relationship. He observed higher CBR values in 30% replacement of copper slag and this was also served as good conformity for the flexible pavement with simultaneous reduction in the sub base course thickness. He finally concluded that the addition of 30% copper slag with 70% BC soil was the suitable stabilization ratio which increased all characteristics of sub grade requirements.

Prof. Paliwal (2016) [6] had experimentally studied about the stabilization of sub grade soil by using foundry sand waste. In this paper he tested various properties like liquid limit, plastic limit, plasticity index, Standard proctor test, CBR and Direct shear test. He concluded that the CBR value and angle of internal friction of soil was improved with addition of 20% foundry dust. He also concluded that OMC shows a lower value for 10% replacement of foundry waste.

Prof. Summaya (2016) [7] had studied about the soil stabilization using tile waste. In this paper, tests were conducted on UCC, CBR, liquid limit, plastic limit, compaction test and shrinkage limit. She concluded that there was reduction in value of liquid limit, plastic limit and OMC and increase in the value of shrinkage limit, MDD, UCC, CBR on addition of tile waste up to 30%.

Prof. Mohammed (2015) [8] had investigated about the improvement in soil properties of Expansive soil by using copper slag. The soil properties like Grain size analysis, liquid limit, plastic limit, plasticity index, compaction test, direct shear test and CBR were determined. He concluded that copper slag 40% and Black cotton soil 60% was optimum and it showed the increase in value of specific gravity and CBR. He finally concluded that such soil can be effectively used in road embankment sub base and sub grade.

Prof. Ravi Shanker Mishra (2015) [9] had studied about the stabilization of black cotton soil by use of Fly ash, Ferric chloride and Stone dust. The soil samples were tested for liquid limit, plastic limit, OMC with Maximum dry density and CBR. He concluded that the liquid limit, plastic limit, Maximum dry density and CBR values are increased due to the adding of Ferric chloride 2.5%, fly ash 15% and stone dust 25%. The results indicated the improvement in soil properties and reduction in pavement thickness on road construction.

Prof. Jinka chandrshekher (2015) [10] had reviewed utilization of waste material "copper slag" in geotechnical applications The soil sample was tested for specific gravity, grain size distribution, free swell index, compaction factor and CBR. The results were observed for 60% copper slag and 40% black cotton and it was concluded that the sub grade, sub base and engineering behaviour of soil was improved. And also the embankment construction, land reclamation of soil conditions was increased.

Prof. Jayapal (2014) [11] had discussed about the comparison of different admixtures using weak soil stabilization. In this paper, admixtures such as quarry dust, fly ash and lime were compared. The tests such as liquid limit, plastic limit, modified proctor compaction, sieve analysis, differential free swell and CBR were conducted. He concluded that the addition of quarry dust, lime and fly ash had not prevented the swelling nature. He also concluded that there was increase in the CBR value with the partial replacement of 20% quarry dust which in turn reduced the pavement thickness of road construction.

Prof. George Rowland Otoko (2014) [12] had investigated about the stabilization of Nigerian Deltaic Laterites with saw dust ash. The soil properties were identified by conducting tests of liquid limit, plastic limit, shrinkage limit, free swell index, plasticity index, MDD with OMC, UCC and CBR. He finally concluded that physical properties and engineering characteristics of Nigerian deltaic laterites were improved with addition of 4% of saw dust ash, and there was also increase in 14% of CBR and UCC values. He also concluded that there was reduction in cost of construction because of the use of solid waste.

Prof. Tushal Baraskar (2014) [13] had studied about california bearing ratio of Black cotton soil. He partially replaced the soil with waste copper slag in various percentages. He conducted various tests such as grain sieve analysis, compaction characteristics and CBR. He concluded that the maximum CBR value is obtained in black cotton soil with 28% replacement of copper slag. He also concluded that such soils can be effectively used as the sub base layer of road pavement.

Prof. Karthick (2014) [14] had studied about the soil stabilization by partially replacing red soil with Fly Ash. He conducted various tests such as CBR, specific gravity, MDD with OMC, UCC, liquid limit and plastic limit. He finally concluded that 9% partial replacement of fly ash in the soil results in improved properties and he also said that those soils showed good bearing capacity.

Prof. Brajesh Mishra (2014) [15] had investigated about the engineering behaviour of black cotton soil and its stabilization by use of lime. The tests were conducted for properties like atterberg limit, CBR value, free swell index and compaction factor. He finally concluded that 5% partial replacement of soil with lime is optimum to stabilize the black cotton soil. He concluded that 5% partial replacement of fly-ash resulted in reduced liquid limit (15.27%) and swelling and it also increased the CBR values.

Prof. Dr. Gundaliya (2013) [16] had studied about the black cotton soil characteristics with partial replacement of cement waste dust and lime. He computed the behaviour of those soils with various tests such as liquid limit, plastic limits and UCC. The results concluded that cement dust acted as a good stabilizing agent for Black cotton soil. He also concluded that compressive strength was improved with partial replacement of cement with soil. He finally concluded that partial replacement with cement dust only shows improved performance compared to lime and cement dust + lime.

Prof. Monica Malhotra (2013) [17] had investigated about stabilization of expansive soils by using low cost materials. In this paper fly-ash and lime were added as stabilizing agents with varying percentages. He had conducted various tests like liquid limit, free swell index and standard proctor test. He finally concluded that partial replacement of soil with both lime and fly-ash showed a considerable increase in properties like unequal settlement. He also concluded that shrinkage and swelling characteristics of the soil was reduced.

Prof. Lavanya (2011) [18] had studied about utilization of copper slag in geotechnical applications. In this paper, she investigated about the Index properties, free swell index, compaction properties, CBR and UCC. She concluded that the partial replacement of copper slag from 30% to 50% with black cotton soils, considerably showed the increase in properties of the soil. She also concluded that partial replacement of copper slag with black cotton soil resulted in utilization of such soils in sub grade, sub base and embankment of roads and it was also improved the sub grade soil condition.

Prof. Arpita V Patel (2011) [19] had investigated about the geotechnical properties of black cotton soil which are contaminated by castor oil and stabilized by saw dust. Several Tests were conducted like specific gravity, Atterberg limits, MDD with OMC, CBR (soaked and unsoaked) and UCC. He discussed about the index and engineering properties of contaminated

black cotton soil. Then he discussed, that the results were increased with 7.5% partial replacement of saw dust in contaminated black cotton soil. He finally concluded that though soils were contaminated using castor oil, its properties were improved when sawdust was added upto 10% to the soil.

Prof. Dr.Robert M. Brooks (2009) [20] had studied about the soil stabilization using fly ash and rice husk ash. He had conducted tests such as Compaction test, UCS, CBR and free swell index. The test results concluded that, by increasing rice husk ash to the soil results in increase of CBR value, UCS and swell deduction. With increased fly ash content, there was an increase in the stress strain behaviour of confined compressive strength. He concluded that optimum fly ash and rice husk ash content was found to be 25% and 12% respectively. He also concluded those soils can be highly recommended for strengthening the sub grade of expansive soil.

III. CONCLUSION

Stabilization of soil had become the most unavoidable one because it simultaneous possessed two advantages, first it increased the properties of the soil and also it reduced the industrial wastes dumped into the cultivable land. The advantage of soil stabilization using industrial waste was become desirable all over the world. Twenty review papers on the stabilization of soil using industrial waste products were discussed. From the review it was concluded that industrial wastes can be effectively used as replacement material in the stabilization of soil. It also clearly showed that each industrial waste exhibited their own characteristics and modified the index and engineering properties of the soil. These modifications of properties make the stabilized soil as efficient material in the construction of structures.

REFERENCES

[1] E. Ravi, R. Udhayasakthi, T. Senthil Vadivel, "Enhancing the Clay Soil Characteristics using Copper slag Stabiliation",Journal of Advances in Chemistry, Vol.12, Issue No. 26, December 2016.
[2] Monica Malhotra, Sanjeev Naval, "Stabilization of Expansive Soils Using Low Cost Materials" International Journal of Engineering and Innovative Technology, , Vol. 02, Issue No. 11, May 2013.
[3] Mohammed A. Qureshi, Hevin M. Mistry, Vikas D. Patel,"Improvement in Soil Properties of Expansive Soil by Using Copper Slag", International journal of Advance Research in Engineering in Science and Technology, Vol.2, Issue No.07, July 2015.
[4] Brajesh Mishra, ravi Shanker Mishra, "A Study on Stabilization of Black Cotton Soil Use of Fly Ash, ferric Chloride and Stone Dust", International Journal of Engineering and Science, Vol.5, Issue No. 10, PP- 20-25, October 2015.
[5] Jink chandrshekhar, Timir A Chokshi, "A Review on Utilization of Waste Material Copper Slag in Geotechnical Applications", International Journal for Innovative Research in Science and Technology, Vol. 1, Issue No.12, May 2015.
[6] Jayapal, S.Boobathiraja, M.Samuel Thanaraj, K.Priyadharshini, "Weak soil stabilization using different admixtures A comparative study", International Journal of engineering research and technology, Vol 3, Issue No.10, October 2014.
[7] George Rowland otoko, Braide K. Honest, "Stabilization of Nigerian deltaic laterites with saw dust ash", International Journal of scientific research and management, Vol 2, Issue No.8, August 2014.
[8] Tushal baraskar, S.K Ahirwar, "Study on California bearing ratio of black cotton soil use waste copper slag', International Journal of structural and civil engineering research", Vol.3, Issue no.4, November 2014.
[9] Karthik.S, Ashok Kumar. E, Gwtham. P, Elango. G, Gokul. D, Thangaraj. S, "Soil Stabilization by Using Fly Ash", IOSR Journal of Mechanical and Civil Engineering, Vol. 10, Issue No.6, Jan 2014, PP 20-24
[10] K.P. Summaya, Mohammed Refeequedheen. K, Sameer V.T, Firoz, Khais .P.T, Jithin. K, "Stabilization of expansive soil Treated with Tile Waste", International Journal of Civil Engineering, Vol. 3, Issue No. 03, March 2016.
[11] P. Rajendra Kumar, P. Suresh Praveen Kumar, G. Maheswari, "Laboratory Study of Black Cotton Soil Blended with Copper Slag and Fly Ash", International Journal of Innovative Research in Science, Issue No.2, February 2017.
[12] Monica Malhotra, Sanjeev Naval, "Stabilization of Expansive Soils Using Low Cost Materials" International Journal of Engineering and Innovative Technology, Vol. 02, Issue No. 11, May 2013.
[13] Dr. Ronert M. Brooks, "Soil Stabilization with Fly Ash and Rice Husk Ash", International Journal of Research and Reviews in Applied Science, Vol. 01, Issue No. 3, December 2009.
[14] A. Mohan chand, V Ramesh babu, B. Ramesh babu, K. Niveditha, "Behaviour of Black Cotton Soil with Addition of Copper Slag and Steel Slag", International Research Journal of Engineering and Technology, Issue No. 01, Jan-2017.
[15] Wajid Ali Butt, Karan Gupta, J.N Jha, "Strength behaviour of Clayey soil Stabilized with Saw Dust Ash", International Journal of Geo-Engineering, Issue No. 21 October – 2016
[16] Prashant Kumar, M.C. Paliwal, A.K. Jain,"Stabilization of Sub Grade Soil by using Foundry Sand Waste", International Journal of Engineering Science and Research Technology, September 2016.