A REVIEW STUDY ON THE SHEAR STRENGTH PROPERTIES OF SOIL CONTAING COPPER SLAG WHEN ADMIXED WITH LIME

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Abstract: Soil is highly heterogeneous, complex and unpredictable material which has been subjected to vagaries of nature, without any control. The properties of soil change not only from one place to other but also at the place with depth and with a change in the environmental, loading and drainage conditions. The properties of a soil depend not only on its type but also on the conditions under which it exists. In comparison to other construction materials such as concrete or steel, it is not economically feasible to transport the soils from one place to other, because a huge quantity of soil is involved and it is not opened to inspect at greater depth for foundations of different structures. Sometimes, Civil Engineers or Geotechnical engineers are forced to construct a structure on the site selected for reasons other than soil conditions. In this research paper an experiments are performed on the soil properties by using copper slag admixed with lime.

Keywords: Copper slag, Lime, Soil stabilization, unconfined compressive strength.

1.1 INTRODUCTION

The financial development of any nation is depended up on the infrastructural improvement. In each multiyear plan, the lion offer of venture happens for the frameworks explicitly parkways and express ways. India has a broad street system of 3.3 million kms which is the second biggest on the planet. The eleventh multiyear plan additionally contributed more than 3.5 lakh crores in the street division. Consequently specialists are requiring strenuous exertion to plan the quality street asphalts also; it relied upon the quality of the sub-grade. Typically adaptable asphalt will be the adept decision for the development of street. The characteristic soil will be the sub-grade material dependably, yet the list properties and quality of the dirt isn't sufficient. At that point the consistency of the sub-evaluation will be accomplished by adjustment. The admixture, for example, fly cinder, rice husk fiery debris, lake cinder, copper slag and some other mechanical squanders are attempted as a stabilizer to accomplish strength and incompressibility. Soil improvement is the procedure in improving the building properties of soils and along these lines making it progressively steady. It is basic when the dirt available for development isn't appropriate for the foreseen reason. In its broadest sense, adjustment included compaction, reconsolidation, waste and numerous other such procedure .However, the term adjustment is commonly limited to the procedures which modify the dirt material itself for development of its properties a solidifying material or a synthetic is included o a characteristic soil with the end goal of adjustment. Is to

improve the regular soils for the development of establishments, parkways and runways. Soil adjustment is utilized to diminish the penetrability what's more, compressibility of the dirt mass n earth structures and to build its shear quality. Soil adjustment is of wound required to build the bearing limit of establishment soils. In any case, the fundamental utilization of the standards of soils adjustment are utilized for controlling the evaluating of soils and totals in the development of bases and sub-bases of the establishments, expressways and landing strips. A portion of the ongoing endeavors made by couple of scientists has investigated the reasonableness of granulated copper slag, created as waste from broiling of copper, being effectively utilized as interstate development material. It has discovered its appropriateness in different layers of the asphalt, both adaptable and inflexible, in mix with the neighborhood soils or some other waste materials. Be that as it may, mass use of fine copper slag for street development and land filling exercises yet need appropriate examination through conveying different lab and field tests. Waste is straightforwardly connected to human advancement, both innovative and social. The arrangements of various squanders have differed after some time and area, with mechanical advancement and development being legitimately connected to squander materials.

Copper slag, after blending with soil, can be utilized as a viable balancing out operator for the improvement of tricky soils for use in expressway dikes, sub-evaluations and sub-bases. Likewise, by blending it with fly cinder, it winds up appropriate for bank fill material. Slag, when blended with fly fiery remains and lime, creates pozzolanic responses . Fly fiery remains has been generally acknowledged as dike and basic fill material . Copper slag blended with fly cinder and nearby soils (accessible close Delhi) in various extents indicated successful outcomes with the appropriateness in bank, sub base and base of a street asphalt.

1.2 LITERATURE REVEW ON COPPER SLAG AND CEMENT

Dr. K. Suresh et al studied on the use of copper slag and cement in soil. In this study, The Compaction and California Bearing Ratio tests were led dependent on Indian Standard (IS) method to the exploratory program. The impacts of Copper slag, Steel slag on dark cotton soil and furthermore the consolidated impact of Copper slag and Steel slag on dark cotton soil has been contemplated. With increase in the percentage of copper slag, dry density of soil increased to a maximum value 1.69 g/cc at 20%, percentage increase is 15.7%. The percentage of increases in dry density are 3.4%, 8.2%, 12.3%, 15.7% for with increases of copper slag from zero, 5%, 10%, 15% and 20%.

E. Ravi et al did the study on the strength properties of soil with copper slag. This paper examines the possibility of using the mechanical result copper slag as a stabilizer in the development soil where swelling qualities are higher and makes serious harm the structure and street asphalt. The investigation has been reached out to distinguish the sufficient level of copper slag added substance in the quality improvement of earth soil. Three various divisions were tested in the present procedure of adjustment viz. 10%, 20% and 30% of copper slag and likewise the consequences of Maximum Dry Density (MDD), Optimum Moisture Content (OMC) and

California Bearing Ratio (CBR) are contrasted and the ASTM and Indian guidelines for the structure necessities of sub-grade for the adaptable asphalt. The outcomes demonstrate that the mix of 70% mud soil and 30% copper slag is the good adjustment proportion which expands all the alluring qualities of sub-grade necessities.

Shubham Raj et al studied on the Suitability of stabilized copper slag and fly ash mix for road construction. The reason for this paper is to research copper slag and fly fiery remains blends with concrete as stabilizer for their legitimate use in street construction. Different preliminary blends of copper slag and fly powder were tried for getting the ideal blend having greatest dry thickness. Round and hollow examples were readied utilizing ideal blend with various extent of bond (3, 6 and 9 percent) and relieved for time of 7, 14 and 28 days in desiccator. A few tests, for example, delegate test, unconfined compressive quality test, part rigidity test and splashed CBR test were conveyed out. After investigating the variety of test results with shifting concrete substance and relieving period, most extreme compressive quality of 10 MPa what's more, greatest rigidity of 1.5 MPa was found for example having 9 percent bond substance restored for a time of 28 days. It was finished up that copper slag and fly fiery debris when blended in ideal extent and balanced out with 6 and 9 percent bond can be viably utilized as granular material in sub base and base layer of street asphalt.

Bambhaniya Mehul Ashok bhai et al did the study on the strength properties of soil with copper slag. The fundamental reason for this task is to examine the utilization of copper slag in geotechnical and transportation applications, also, to order these materials as indicated by pertinent factors, for example, accessibility, application, natural effect, and cost. In particular, it is worried about the utilization of such reused materials to improve the building properties of minor soils, while keeping up conformance with guidelines and practice as far as the ecological, affordable, and down to earth constraints of such use. The task includes a few parts. Initial, a far reaching writing audit was led so as to rather accessibility data, specialized details, and parameter information for copper slag. Data was gathered on the accessibility, cost, and prior execution of the material so as to limit the rundown of potential material which could be actualized to improve minimal soils in roadway development. Information from huge scale field assessments and other case narratives in the writing were additionally aggregated.

R.C. Gupta et al studied on the clayey soil stabilized by copper slag. Industrialization very requests to the elevate of country's economy. Be that as it may, it causes extreme Ecological Pollution because of the created waste materials. As the non-inexhaustible crude materials for modern generation are diminishing step by step, endeavors are to be made for transformation of these undesirable mechanical squanders into utilizable crude materials, which thusly controls natural contamination. in this investigation, without a doubt the most extreme dry thickness was 1.937 gm/cm3 for the mix of half Earth and half Copper slag. The greatest dry thickness was higher than 1.87 gm/cm3 for the mix of 70% Clay with 30% Copper slag to 30% earth with 70% copper slag.

Ayyar, et al. completed tests on coir fiber strengthened earth and found that the discrete strands of little measurement arbitrarily appropriated in soil offer a more prominent protection from swelling than the bigger pieces put comparatively. Mandal what's more, Vishwamohan have completed execution investigations of far reaching mud for three sorts of dirts by leading California bearing proportion test utilized coir fiber and jute fiber as geo-textures set in layers.

P. Rajendra Kumar et al studied on the Black Cotton Soil Blended with Copper Slag and Fly-Ash. Far reaching soil is one of the real soil stores in India they display high swelling and shrinkage when presented to changes in dampness substance and thus have been observed to be most inconvenient from designing contemplations. So there is a need to settle these dirts when they are utilized for development. The fundamental target of the present work is to think about the physical and geotechnical properties of Expansive soils accessible at Pendlimari, Kadapa to think about the quality properties of soil by expansion of Copper Slag, Fly-Ash with water at various rates i.e., 10%, 20%, 30%, 40% and half and Fly-Ash 2%, 4%, 6%, 8%, 10%. In such manner, the far reaching soil properties are discovered. To this dirt, as a first thought, balanced out with copper slag including at an interim of 5% coming to up to 30%. In second thought, fly-fiery remains is chosen as a settling specialist to balance out the broad soil at an interim of 2%, coming to up to 10%. In the last thought, test of sweeping soil with 30% copper slag is taken to be balanced out with fly-fiery debris at an interim of 2%reaching up to 10%. At long last relapse examination for these test outcomes is completed.

Prof. Jinka Chandrasekhar et al talked about that Copper slag is one of the waste materials that are being utilized broadly in the structural designing development industry. Copper creating units in India leave a huge number of huge amounts of copper slag as waste each day. Huge amounts of the gathered slag is dumped and left on exorbitant land, causing wastage of good cultivable land. In view of U.S. natural security office guidelines, overseeing strong waste qualities, copper slag can be named a nonhazardous material. Granulated copper slag is increasingly permeable and, subsequently, has molecule size equivalent to that of coarse sand. In this paper, an audit of the past research studies did by different scientists on usage of copper slag in geotechnical applications is talked about and displayed.

P. Bharath Goud et al studied on the use of Rice husk ash and Copper slag in soil. In this examination, the adjustment of Black Cotton Soils by Copper slag (CS) and Rice husk powder (RHA) were attempted in the past independently. The creators attempted to utilize them two together in adjustment of BC soils. Present examination was attempted to assess the viability of various rates of rice husk powder and copper slag as soil stabilizers. The tests performed on the blended extent of BC soils, Copper Slag and Rice Husk Ash are Vane shear, California Bearing Ratio (CBR), Atterberg's limits, free swell list (FSI), and compaction tests. Restricted examinations have been accounted for the mix of copper slag and rice husk powder in soil adjustment. The ideal blend was observed to be in the extent of 64%BC+30%CS+6%RHA. FSI of soil treated with RHA+CS diminished steeply from 100% to 20.4%. There was a slight change in most extreme dry thickness of the treated

soil. The unsoaked CBR test demonstrates that quality of ideal blend was 12.7%. The settled soil blends have demonstrated acceptable quality attributes and can be utilized for minimal effort developments to construct houses and street infrastructure. Laboratory vane shear tests have been done under undrained conditions to contemplate the shear quality parameters of the balanced out soil.

1.3 PREPARATION OF REINFORCED SOIL SAMPLES

Following Mixes are made for the experimental program::

1. M 1- Soil sample
2. M 2- Soil sample + 6 % Cement
3. M 3- Soil sample + 12 % Cement
4. M 4- Soil sample + 18 % Cement
5. M 5- Soil sample + 12 % Copper Slag
6. M 6- Soil sample + 24 % Copper Slag
7. M 7- Soil sample + 36 % Copper Slag
8. M8- Soil sample + 48 % Copper Slag
9. M 9- Soil sample + 6 % Cement + 12 % Copper Slag.
10. M 10- Soil sample + 6 % Cement + 24 % Copper Slag
11. M 11- Soil sample +6 % Cement + 36 % Copper Slag
12. M 12- Soil sample +6 % Cement + 48 % Copper Slag
13. M 13- Soil sample + 12 % Cement + 12 % Copper Slag
14. M 14- Soil sample + 12 % Cement + 24 % Copper Slag
15. M 15- Soil sample + 12 % Cement + 36 % Copper Slag
16. M 16- Soil sample + 12 % Cement + 48 % Copper Slag
17. M 17- Soil sample + 18 % Cement + 12 % Copper Slag
18. M 18- Soil sample + 18 % Cement + 24 % Copper Slag
19. M 19- Soil sample + 18 % Cement + 36 % Copper Slag
20. M 20- Soil sample + 18 % Cement + 48 % Copper Slag

1.4 UNCONFINED COMPRESSIVE STRENGTH

Shear strength of the soil is one of the most important properties in geotechnical applications. The effect of CS on shear strength was studied by conducting the unconfined compressive strength test on mix of local soil. The UC strength of the mix increases up to 50% when CS is added and there after decreases. The increase in the unconfined compressive strength is because of the high internal friction of the copper slag.

Table 1: Unconfined Compressive strength

Sr. No	Mix	UNCONFINED COMPRESSIVE STRENGTH (KN/m^2)	
		7 Days Curing	28 Days Curing
1	**M 1- Soil sample**	141.98	199.97
2.	**M 2- Soil sample + 6 % Cement**	157.40	231.24
3.	**M 3- Soil sample + 12 % Cement**	168.60	246.03
4.	**M 4- Soil sample + 18 % Cement**	181.91	250.68
5.	**M 5- Soil sample + 12 % Copper Slag**	160.15	242.97
6.	**M 6- Soil sample + 24 % Copper Slag**	178.63	258.18
7.	**M 7- Soil sample + 36 % Copper Slag**	194.08	276.16
8.	**M8- Soil sample + 48 % Copper Slag**	185.97	266.29
9.	**M 9- Soil sample + 6 % Cement + 12 % Copper Slag.**	193.31	265.97
10.	**M 10- Soil sample + 6 % Cement + 24 % Copper Slag**	201.31	290.95
11.	**M 11- Soil sample +6 % Cement + 36 % Copper Slag**	195.61	268.38
12.	**M 12- Soil sample +6 % Cement + 48 % Copper Slag**	179.23	230.65
13.	**M 13- Soil sample + 12 % Cement + 12 % Copper Slag**	190.30	279.75
14.	**M 14- Soil sample + 12 % Cement + 24 % Copper Slag**	203.47	289.98
15.	**M 15- Soil sample +12 % Cement + 36 % Copper Slag**	199.04	276.38
16.	**M 16- Soil sample +12% Cement + 48 % Copper Slag**	170.38	198.62

17.	**M 17- Soil sample +18 % Cement + 12 % Copper Slag**	186.37	278.98
18.	**M 18- Soil sample +18 % Cement + 24 % Copper Slag**	198.06	287.81
19.	**M 19- Soil sample +18 % Cement + 36 % Copper Slag**	203.60	260.11
20.	**M 20- Soil sample +18% Cement + 48 % Copper Slag**	201.34	246.68

1.5 EFFECT ON CBR

CBR test results reviewed from the finding data on cement and copper slag-treated soil showed good increase in the CBR value with an increase in the copper slag content for all mix proportions. The CBR values of mixed soil there is a reduction in swelling characteristics and increase in density results in an increase in the CBR values. Increase in CBR values is essential in poor sub-grade soils and for the application in rigid pavements laid in problematic soils.

Table 2: CBR Variation for both soaked and unsoaked

Sr. No	Mix	Unsoaked	Soaked
1	**M 1- Soil sample**	3.23	7.06
2.	**M 2- Soil sample + 6 % Cement**	5.58	10.17
3.	**M 3- Soil sample + 12 % Cement**	5.91	10.53
4.	**M 4- Soil sample + 18 % Cement**	6.47	10.91
5.	**M 5- Soil sample + 12 % Copper Slag**	6.40	15.49
6.	**M 6- Soil sample + 24 % Copper Slag**	6.68	15.92
7.	**M 7- Soil sample + 36 % Copper Slag**	6.80	16.50
8.	**M8- Soil sample + 48 % Copper Slag**	6.76	16.26

9.	**M 9- Soil sample + 6 % Cement + 12 % Copper Slag.**	7.32	17.14
10.	**M 10- Soil sample + 6 % Cement + 24 % Copper Slag**	7.69	18.05
11.	**M 11- Soil sample +6 % Cement + 36 % Copper Slag**	8.74	12.81
12.	**M 12- Soil sample +6 % Cement + 48 % Copper Slag**	11.08	13.33
13.	**M 13- Soil sample + 12 % Cement + 12 % Copper Slag**	9.24	15.52
14.	**M 14- Soil sample + 12 % Cement + 24 % Copper Slag**	11.01	18.10
15.	**M 15- Soil sample +12 % Cement + 36 % Copper Slag**	11.23	23.09
16.	**M 16- Soil sample +12% Cement + 48 % Copper Slag**	10.32	21.66
17.	**M 17- Soil sample +18 % Cement + 12 % Copper Slag**	9.90	21.26
18.	**M 18- Soil sample +18 % Cement + 24 % Copper Slag**	10.77	24.25
19.	**M 19- Soil sample +18 % Cement + 36 % Copper Slag**	11.25	24.93
20.	**M 20- Soil sample +18% Cement + 48 % Copper Slag**	11.71	26.71

CONCLUSION

In this dissertation work, strength characteristics of clayey soil with steel slag have been studied. The following conclusions are derived from the test results of the experimental studies:

With increase in the percentage of copper slag, dry density of soil increased to a

1. With increase in the percentage of copper slag, dry density of soil increased to a maximum value 1.95 g/cc at 6 % Cement and 24 % Copper slag.
2. The maximum CBT Ratio is achieved in Mix 20 having 18 % cement and 48 % Copper slag.
3. The maximum unconfined compressive strength is achieved in Mix 10 having 6 % cement and 24 % copper slag.

4. The optimum moisture content of soil increases by using cement and copper slag.
5. The liquid limit of the soil increases by using cement and copper slag.
6. The Plastic limit of the soil increases by using cement and copper slag.
7. Due to non cohesive and non plastic characteristics of copper slag, care shall be taken during the construction of such mix.
8. The bulk utilization of copper slag in the road construction solves the disposal problems of the industries.
9. On the basis of this research study copper slag can be recommended as effective stabilizing agents for improvement of soils for highway embankments, sub grade and sub base.
10. The use of copper slag as stabilizing agents can b economically attractive in regions near to the areas where these waste by-products are obtained.

REFERENCES

1. Dr. K. Suresh, "Efficacy of CBR on Copper and Steel Slag In Expansive Soils", World Journal of Engineering Research and Technology, 2018, Vol. 4, Issue 5, 187-199.
2. Ravi Ekkabaram, "Enhancing the Clay Soil Characteristics using Copper Slag Stabilization", Volume 12 Number 26, Journal of Advances in chemistry.
3. Shubham Raj, "Suitability of stabilized copper slag and fly ash mix for road construction", World Journal of Engineering.
4. Bambhaniya Mehul Ashokbhai, "Utilization Of Copper Slag To Improve Geotechnical Properties Of Soil", International Research Journal of Engineering and Technology, Volume: 05 Issue: 07, July-2018.
5. R C Gupta, "An Experimental Study of Clayey Soil Stabilized By Copper Slag", Int. J. Struct. & Civil Engg. Res. 2012, Vol. 1, No. 1, November 2012.
6. P.Rajendra Kumar, "Laboratory Study of Black Cotton Soil Blended With Copper Slag and Fly-Ash", International Journal of Innovative Research in Science, Engineering and Technology, Vol. 6, Issue 2, February 2017.
7. P. Bharath Goud, "Stabilization of Black Cotton Soil with Copper Slag and Rice Husk Ash – An Environmental Approach", International Journal of Science and Research, Volume 7 Issue 5, May 2018.
8. Jaber Shahiri, "Utilization of Soil Stabilization with Cement and Copper Slag as Subgrade Materials in Road Embankment Construction", International Journal of Transportation Engineering, Vol.5/ No.1/ summer 2017.
9. M. Kavisri, "Experimental Study on Effects of Stabilization of Clayey Soil Using Copper Slag and GGBS", Rasayan J. Chem, Vol. 11 ,No. 1 ,111-117 ,January - March 2018.
10. Sivapriya S.V, "Utilization of Copper Slag as A Reinforcing Material", International Journal of Science Technology & Engineering, Volume 2 , Issue 12 ,June 2016.

11. G. R. Ashwin kumar, "Stabilization of Marine Clay by Using Copper Slag", International Journal of Engineering Research & Technology, Volume 3, Issue 11.
12. Parvathy S, "A Study on the Effect of Copper Slag on Lime Stabilized Clay", International Journal of Engineering Research & Technology, Vol. 5 Issue 09, September-2016.
13. C.Lavanya, "Study on Coefficient of Permeability of Copper slag when admixed with Lime and Cement", IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 7, Issue 6.
14. Amruta Lage, "A Review Paper on Expansive soil stabilization By Using Bagasseash and Risehuskash", International Journal of advance research in science and engineering, Volume 7, Issue 4, 2018.
15. Tushal Baraskar, "Study on California Bearing Ratio of Black Cotton Soil Use Waste Copper Slag", International journal of engineering sciences & management, Vol. 4, Issue 3: July- Sep: 2014.