

# Study on Stabilization of Black Cotton Soil using Copper Slag for Pavement Subgrade a Review Paper

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## ABSTRACT

- Soil stabilization improves various engineering properties e.g. bearing capacity, compressibility, strength, and various other properties of soil. In this study the impacts of Copper slag to improve the strength of soil.
- Copper slag is a by-product of copper smelting and refining process. As refineries draw metal out of copper ore, they produce a large volume of non-metallic dust, soot, and rock.
- The effect of varying percentage of Copper slag on properties of Expansive Soil.
- To study the variation of Liquid Limit, Plastic Limit, Plasticity Index, Dry density, OMC, CBR (Soaked & Un-soaked) of soil.
- The strength has been compared on the basis of CBR for virgin soil and soil with Copper slag soaked conditions.
- The Unsoaked CBR value of the raw soil is 5.42 % and after mixing of Copper Slag in the soil, there is remarkable change in CBR value from 5.42 to 12.28%. when Copper Slag is increased from 0 to 16% is effective beyond also there is a decrease in CBR of soil from 12.28 to 10.47% when Copper Slag is increased from 16% to 24%.

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## INTRODUCTION

Soil is the basic construction material. It supports the substructure of any structure and in case of pavement structures; sub-grade soil is an essential component as it supports the sub-base/base. soils with significant plasticity may additionally shrink and swell drastically with modifications in moisture conditions. The repeated cycles of swelling or shrinkage of soil, in addition reason deteriorations and distresses at the structures if those are supported in these types of soil, This necessitates the development/stabilization of soil at a site as an imperative pastime, due to rising cost of the land and a big call for infrastructure improvement in developing nations like India. Soil stabilization is a way added with the primary reason to adjust the geotechnical properties of the soils making them capable of assembly the necessities of the unique engineering projects.

- Sweeping soils, which more often than not contain the earth mineral montmorillonite, incorporate sedimentary and remaining soils, clay stones, and shale's. In parched and semiarid atmospheres, they exist in a dampness inadequate,

unsaturated condition. The sweeping idea of soil is most clear close ground surface where the profile is liable to occasional, natural changes (Terzaghi, Peck and Mesri, 1996; Fredlund and Rahardjo, 1993). There are numerous connections that are helpful in distinguishing conceivably extensive soils. It might likewise be conceivable to recognize them outwardly. Damages on the surrounding structures due to expansion of soil



Figure 1: Natural Soil (Black Cotton Soil)

## COPPER SLAG

Copper slag is a by-product of copper smelting and refining process. As refineries draw metal out of

copper ore, they produce a large volume of non-metallic dust, soot, and rock. Copper slag which is an industrial waste obtained from smelting and refining process of copper from industry. Nearly four tons of copper is obtained as waste is disposed to lands cause's environmental impacts. So it can be reused as concreting materials. In refinery plants when copper metal produced by extraction process then copper slag is generated in a large amount in the production of copper metal. About 2-2.5 tons of copper slag produced for each one ton of copper production. Production of concrete has many environmental benefits for example waste recycling and resolve disposal problems. Concrete is wide utilized in the development of superior structures like high rise buildings, long-span bridges etc.

### Literature Survey

This chapter deals with the study of expansive soil, various methods of stabilization of expansive soil, its need and its advantages. In addition to this the research work done by various authors to make the expansive soil stable i.e. to withstand the stresses on the pavement structures, improvement in the CBR value after stabilization by using different stabilizing materials is also reviewed

- Dr. Robert M. Creeks (2009) had learned about the dirt adjustment utilizing fly debris and rice husk debris. He had led tests, for example, Compaction test, UCS, CBR and free swell record. That's what the experimental outcomes presumed, by expanding rice husk debris to the dirt outcomes in increment of CBR esteem, UCS and grows derivation. With expanded fly debris content, there was an expansion in the pressure strain conduct of restricted compressive strength. He presumed that ideal fly debris and rice husk debris content was viewed as 25% and 12% individually. He likewise finished up those dirt can be energetically suggested for reinforcing the sub grade of extensive soil.
- Rathod, R., Suryawanshi, N., and Memade, P. (2010). Designed high embankment the use of red mud primarily based on the laboratory geotechnical research and the stability evaluation the usage of finite element evaluation. To defend the dispersive red dust against external weathering it became advocated to cover it with local soil. The embankment with soil cover was discovered to have greater than required FOS cost. The embankments were additionally analyzed thinking about focused load and the weight with vibration. The FOS is found to lower with static and vibration load.
- Lavanya (2011) had learned about use of copper

slag in geotechnical applications. In this paper, she examined about the Index properties, free swell list, compaction properties, CBR and UCC. She presumed that the halfway substitution of copper slag from 30% to half with dark cotton soils, impressively showed the expansion in properties of the dirt. She likewise presumed that halfway supplanting of copper slag with dark cotton soil brought about use of such soils in sub level, sub base and dike of streets and it was additionally further developed the sub level soil condition.

- Ravi (2016) had learned about the qualities of dirt soil by utilizing copper slag adjustment. In this paper, he tried the CBR and Max thickness, OMD relationship. He noticed higher CBR values in 30% substitution of copper slag and this was additionally filled in as great congruity for the adaptable asphalt with synchronous decrease in the sub base course thickness. He at long last inferred that the expansion of 30% copper slag with 70% BC soil was the appropriate adjustment proportion which expanded all qualities of sub grade prerequisites.
- Amrutha Mathew et al (2016) The expansion of sisal fiber, bagasse debris and glass powder squander in different extents with dark cotton soil and mix on the above portion of substances is contemplated. To accomplish this point exploratory examination had been conveyed in two stage. In the primary segment, the substantial places of soil comprehensive of molecule size conveyance, explicit gravity, Atterberg's cutoff points, expanding strain have been determined. In second segment, various checks have been finished on dark cotton soil utilizing remarkable level of sisal fiber, bagasse debris, glass powder squander and from the most upsides of solidarity check a blend of zero. Nine% sisal fibre, 7% bagasse debris and 14% glass powder squander was moreover done. The outcomes showed that with expansion of sisal fiber, bagasse debris and glass powder squander the dry thickness extended and extreme dampness content material was found to lower. The unconfined compressive energy and California bearing proportion values improved with expansion of surest level of sisal fiber, bagasse debris and glass powder waste to the combination of dark cotton soil. The excellent outcome become gotten for blend of dark cotton soil and most valuable measurements of 0. Nine% of sisal fiber, 7% bagasse debris and 14% glass powder squander
- Nitin Mane, et al. (2017) In especially, creation exercises on dark cotton soil carries troublesome

obligations to him to deal with. At the point when the common frameworks are needed to gather over the dirt, which may not be able to offer the ideal homes to common designs for the development in such cases adjustment is the best way to deal with get the leaned toward properties of soil. By investigating the homes of dark cotton soil, that's what it's miles found, its solidarity homes comprising of UCS and CBR are exceptionally low. To gather any premise at the equivalent soil, we need to balance out the dark cotton soil. Dark cotton soil become settled with red mud through fluctuating the % of mix from 10% to 40% with 2% c program language period sodium silicate is similarly utilized inside the blends so you can give better restricting among the particles. It is seen that outcomes got at the mix extents 10% to 30% is developing. Ideal of 30% of pink residue substitute gives improved results. Alongside this 6% of sodium silicate elective offers improved results. The sodium silicate content material expanded CBR values got stretched out up to eight% of sodium silicate. CBR values got diminished.

- Kuldeep Sharma 2019 Many nations see a quick development in the development business, which includes the utilization of regular assets for the improvement of framework. This improvement poses a danger to regular assets that are advertised. Copper Slag is a modern waste material and it tends to be utilized as the substitution of fine totals and concrete in the development of cement. The chance of subbing normal fine totals with modern side-effects, for example, copper slag offers specialized, financial and ecological benefits which are vital in the current setting of manageability in the development area. The Copper ventures units in India leave great many lots of copper slag as waste consistently. These Large amounts of the collected copper slag are straightforwardly unloaded and left on expensive land, causing wastage of good cultivable land. Copper slag can be delegated a non-dangerous material by U.S. natural insurance organization guidelines in light of the strong waste attributes. Numerous scientists have concentrated on the physical and compound properties of copper slag. Analysts have considered the geotechnical conduct of copper slag blended in with various extents of soil, lime, flyash and concrete. Review have been brought out through unconfined compressive strength tests, direct shear tests and CBR tests notwithstanding fundamental tests like strainer examination and consistency limits, and so forth. In this paper the

result of past examination concentrates on has been thought about, results summed up and holes in the review have been featured regarding geotechnical applications.

- Paladi Rajendra Kumar 2020 Expansive soil is one of the significant soil stores in India they display high enlarging and shrinkage when presented to changes in dampness content and subsequently have been viewed as generally irksome from designing contemplations. So there is a need to balance out these dirt when they are utilized for development. In such manner, the sweeping soil properties are found out. To this dirt, as a first thought, settled with copper slag adding at a time span coming to up to 30%. In second thought, fly-debris is chosen as a balancing out specialist to settle the broad soil at a time period, coming to up to 10%. In the last thought, test of sweeping soil with 30% copper slag is taken to be settled with fly-debris at a time period up to 10%. At last relapse examination for these experimental outcomes is completed.
- Bharath Goud 2020 Stabilization of Black Cotton (BC) soils have been in as of late draw in ash (RHA) were tried in the past separately. The authors tried to use both of them together in the stabilization of BC soils. The present study was undertaken to evaluate the effectiveness of different percentages of rice husk ash and copper slag as soil stabilizers. The tests performed on the mixed proportion of BC soils, Copper Slag and Rice Husk Ash are Vane shear, California Bearing Ratio (CBR), Atterberg limits, free swell index (FSI), and compaction tests. Limited studies have been reported for the combination of copper slag and rice husk ash in soil stabilization. The optimum mix was found to be in the proportion of 64%BC+30%CS+6%RHA. FSI of soil treated with RHA+CS decreased steeply from 100% to 20.4%. There was a slight change in maximum dry density of the treated soil. The unsoaked CBR test shows that the strength of the optimum mix was 12.7%. The stabilized soil mixtures have shown satisfactory strength characteristics and can be used for low-cost constructions to build houses and road infrastructure. Laboratory vane shear tests have been carried out under undrained conditions to study the shear strength parameters of the stabilized soil.
- S. Indhumathi 2021 Stabilization of black cotton soil becomes mandatory to reduce the degree of swelling and shrinkage and makes the soil productive for the construction of structures and pavement subgrades. To make use of the surplus

solid waste materials and to mitigate its harmful environmental effects, the solid waste acts as a better alternative for stabilizing agents. The present research focuses on the incorporation of solid waste material such as copper slag (CS) and sawdust ash (SA) for the stabilization of black cotton soil. The experimental investigations are carried out with a partial replacement of copper slag (CS) at 10%, 20%, 30%, 40%, and sawdust ash (SA) at 2%, 4% and 6%, respectively. The properties such as specific gravity, wet sieve analysis, liquid limit, plastic limit, moisture content and free swell index are determined. Unconfined compression (UCC) and California bearing ratio (CBR) tests are performed to determine soil strength with different percentages of copper slag and sawdust ash, and the results are compared to unexplored soil. From the observations, replacement of 30% copper slag and 4% sawdust ash is exposed as an optimum percentage of replacement. The unconfined compressive strength is found to be 92 kN/m<sup>2</sup>, and CBR values are 4.71 and 4.581 at 2.5 mm and 5 mm penetration, respectively. From the experimental investigation, it is apparent that the optimum replacement of solid waste materials like copper slag and sawdust ash in the black cotton soil productively enhances the soil stabilization and upgrades its application in structure and pavement constructions.

- Samuthirakani. V 2021 The design of pavement mainly depends on the strength of sub grade of the soil. The thickness of each layers of a flexible pavement is correlated with the property of the sub grade soil, especially the CBR value of the sub soil. Hence for an economic design of a flexible pavement the sub grade may be stabilized by adding suitable admixtures. The economical and effective admixture is found to be copper slag, which is obtained as a byproduct in smelting of copper, and is abundantly dumped in copper manufacturing plant as a waste material. In this paper various literatures regarding the stabilization of sub grade using copper slag has been compiled and the outcome of each article is compared for optimum utilization. It is concluded that 30% to 40% of copper slag mixed with problematic soil will give optimum results in sub grade strength.
- Paladi Rajendra Kumar et al. (2022) Expansive soil is one of the major soil deposits in India they exhibit high swelling and shrinkage when exposed to changes in moisture content and hence have been found to be most troublesome from

engineering considerations. So there is a need to stabilize these soils when they are used for construction. In this regard, the expansive soil properties are found out. To this soil, as a first consideration, stabilized with copper slag adding at an interval of 5% reaching up to 30%. In second consideration, fly-ash is selected as a stabilizing agent to stabilize the expansive soil at an interval of 2%, reaching up to 10%. In the last consideration, sample of expansive soil with 30% copper slag is taken to be stabilized with fly-ash at an interval of 2% reaching up to 10%. Finally regression analysis for these test results is carried out.

### Objectives

- To study effect of altered percentage of Copper Slag on properties of B.C Soil.

### CONCLUSION

In above study, B.C soil was used and favorable quantity of Copper Slag for achieving maximum soaked CBR.

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