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IMPROVEMENT OF INDEX PROPERTIES OF EXPANSIVE SOIL BY USING COPPER SLAG.

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Abstract. The recent developments and application in the use of advanced composites in the improvement of soil are increasing on the basis of specific requirements and national needs. The need of efficient stabilization and strengthening techniques of existing soil has resulted in research and development of newer materials for improvement. Copper slag is a waste product after undergoing several industrial processes in Sterile Industries. Copper slag is one of the waste materials that are being used extensively in the civil engineering construction industry. Copper producing units in India leave thousands of tonnes of copper slag as waste every day. In this paper, a review of the previous research studies carried out by various researchers on utilization of copper slag in geotechnical applications is discussed and presented.

***Keywords*: Copper Slag, Increase in Strength properties, Effective alternative by-product.**

INTRODUCTION

Copper slag is a by-product and draw metal from copper ore. Its produced during the copper smelting in refineries and in a large volume of non-metallic dust and slag too. Copper slag is widely utilized in construction field and geotechnical application and serves as a form of recycling. Because it is available in the huge quantity 40,000,000 metric tonnes across the world. It is estimated that the production of one tone of blister copper generates 2.2 to3 tonnes of slag (Copper Statistics, U.S. Geological Survey).

Copper slag is currently being used for many purposes like land filling, construction of abrasive tools, roofing granules, cutting tools and rail road ballast material etc. The soil often is weak and has no enough stability in heavy loading. The aim of the study was to review on stabilization of soil using low-cost methods. It poses relatively little threat to the environment and used to build up the earth to support roads, buildings, or other surfaces-copper slag is a waste product and chemical composition. It is ductile and soft material. It is commonly used in electrical, construction and transportation industries. Pure copper is rarely found in nature, but is usually combined with other chemicals in the form of copper ores.

Copper slag is an inorganic waste material and found to have high thermal and electrical conductivity. The process of extracting copper from copper ore varies

according to the type of ore and the desired purity of the final product. Each process consists of several steps in which unwanted materials are physically or chemically removed, and the concentration of copper is progressively increased. Once the waste materials have been physically removed from the ore, the remaining copper concentrate must undergo several chemical reactions to remove the iron and sulphur. This process is called smelting process.

Otherwise, these materials would cause problems to the environment. Based on U.S. environmental protection agency regulations, governing solid waste characteristics, copper slag can be classified as a non-hazardous material Metal industry slag, mine stone and mining waste are generally suitable for recycling or reuse in building, road and geotechnical applications.

Table 1 Chemical Composition of Copper Slag **Property (% wt)**

Iron Oxide	Fe2O3(42 – 48)
Silica	SiO2(26- 30)
Aluminium Oxide	Al2O3 (1 – 3)
Calcium Oxide	CaO(1– 2)
Magnesium Oxide	MgO(0.8– 1.5)

(Ref. Ankleshwar, Gujarat, India)

Table 2 Physical Properties of Copper Slag

Property Analysis	
Hardness	Scale :6 – 7
Specific Gravity	3.51
Plasticity Index	Non-Plastic
Swelling Index	Non-Swelling
Granule Shape	Angular, Sharp edges & Multifaceted
Grain Size Analysis	
Gravel (%)	1.00
Sand (%)	98.90
Silt + Clay (%)	0.05

(Ref. Ankleshwar, Gujarat, India)

II: REVIEW OF RESULTS AND DISCUSSION

Grain Size Distribution

The grain size distribution of Copper Slag is essentially a coarse grained material with around more than 95% sand size particles. And it is classified as poorly graded sand as per the Indian Standard Classification.

Effect of CS on Plasticity Index

Copper slag, when mixed with locally available soil in a proportion of 30% CS and 70% soil, the plasticity index of the soil was reduced by 15%. Copper slag and local soil mixes were found to be non-plastic in nature. Decrease in plasticity index shows that the copper slag when mixed with local soil.

Effect of CS on Free Swell Index

Free swell Index decreases from 115% to 76% for the local soil when mixed with 30% of CS with 70% soil. There is a considerable reduction in the free swell index with copper slag when mixed with local soil. Copper slag can be used in controlling the swelling properties of

Expansive clays.

Effect of CS on Compaction Properties

Maximum dry density of the copper slag was observed to be 1.755gm/cc and 16.50%. The soil mixed with CS showed increased MDD and decreased OMC. An increase in the maximum dry density and a decrease in the optimum moisture content which can give effective results for the sub-grade and sub-base applications.

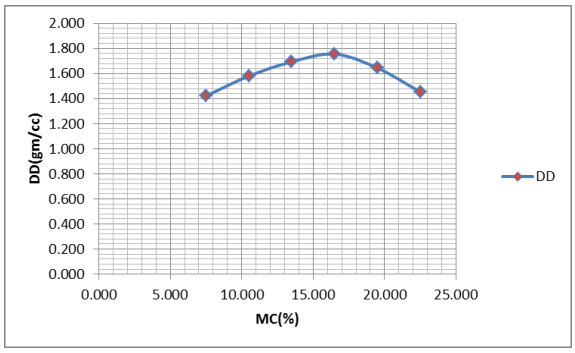

Fig. 1 MDD Vs. OMC Graph shows using soil+ copper slag

III: CONCLUSIONS

From the aforementioned review, the following conclusions are presented:

1. Copper slag has the potential to use as admixture to improve the properties of expansive soils.
2. Copper slag with 30% to 45% can be mixed with expansive soils to improve or modify the soil characteristics.
3. Copper slag can be recommended for sub-grade, subbase, Application.
4. By utilizing and reusing the industrial waste product, namely, copper slag, wastage of good cultivable land can be avoided when large quantities of the accumulated slag is dumped and left on costly land.

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