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An Experimental Study on Stabilization of Expansive Soil using Admixture

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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. Particularly for the black cotton soils which have high swelling and shrinkage tendencies, demands great deal of attention for stabilization. Modification of black cotton soils by admixtures is a common method for stabilizing the swell-shrink tendency of expansive soils. Advantages of chemical stabilization are that they reduce the swell shrink tendency of the expansive soils and render the soils less plastic. As a further step towards the innovative materials to be used for the stabilization, this study endeavor to use waste material (copper slag) for the soil improvement. Copper slag, which is produced during production of copper from copper ore, contains minerals like iron, alumina, calcium oxide, silica, etc. For every tonne of metal production about 2.2 tonne of slag is generated. By using the admixture described above, Copper slag the index properties of soil has been improved. The various tests like Plasticity index, Standard Proctor and Swell index were performed and the result we got show much improvement. Soil has been collected from Umrakh region near SNPIT & RC College and the Admixture from SWIL (JhagadiaCopper Limited), Gujarat.

KEYWORDS: *Expantion, Copper Slag, Stabilization*

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INTRODUCTION

Soil is an important part of our life is so we can't avoided it covered 29% of earth surface with soil the major construction are caused over soil the various structure are constructed on soil like residential, commercial & industrial buildings the small storey residential building & commercial building can be constructed easily on soil but the heavy one, like tall structure & skyscrapers need a stable soil properties. If the soil below this type of structure or not stable it will adversely affect damage on foundation and super structure. The word 'soil' is obtained from "sodium" which means upper layer of soil (earth)that can be dugged or plowed specially the loose surface material of earth in which plant grow soil is a mixture of organic matter most of which do not expand in presence of moisture. The term soil 'soil engineering' is defined as unconsolited (uncemented) material, accumulated of various soil particle generated by disintegration of rocks.Soil are composed of a variety of materials contain no of clay minerals which are expensive in nature these

includes;

- Smectite
- Bentonite
- Chloride
- Bernie elite
- Vermialite
- Montmorillonite

Special expensive soil covered approximately 17% (1/5 of total area) of land covered in India .In states like Gujarat, Maharashtra, Andhra Pradesh, Madhya Pradesh, Uttar Pradesh, Tamil Nadu etc. Black cotton soil created more damage to the structure like light building& pavement than other natural hazards like earthquake and flood. Difficult problems experienced while working on expansive soil its field compaction and its generally experienced volumetric change due to change in its water content the volumetric properties are shrinking and swelling shrinkage mainly seen in dry season due to evaporation of water and soil because hard due to its increased density and so that cracks are generated which may cause failure of construction. The swelling properties mainly occur in wet seasons due to its density reduced and soil because like a sludge which cause settlement of structure and soil actually gave poor strength. Large civil engineering projects are being carried out all over the country in order to develop the infrastructure of Nation. It is reep for engineer to know the degree by which soil properties are improved that can be used for construction of an intended structure at demand (required) development and stipulated site. Our research work is regarding stabilization of expansive soil, various admixture (copper slag) used with expansive soil at different proportions (10 %, 20 %, 30 %) and modifying its property.

EASE OF USE

Details of Admixture-Copper Slag

A slag is the waste material obtaining from refineries of metals. Copper slag is obtained during pyrometallurgical production of copper from copper ores. For every tone of metal production about 2.2 tone slag is obtained.

Pure copper is rarely found in nature, but is usually combined with other chemicals in the form of copper ores. There are about 15 copper ores mines commercially in 40 countries around the world. The most common are known as sulfide ores in which the copper is chemically bonded with sulfur. Others are known as oxide ores, carbonate ores, or mixed ores depending on the chemicals present. Many copper ores also contain significant quantities of gold, silver, nickel, and other valuable metals, as well as large quantities of commercially useless material.

In addition to the ores themselves, several other chemicals are often used to process and refine copper. These include sulfuric acid, oxygen, iron, silica, and various organic compounds, depending on the process used. 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. Some of these steps are conducted at the mine site itself, while others may be conducted at separate facilities. The initial process of copper extracting is started by crushing the raw material in the crusher. The procedure is as mention in the following paragraph.

Most sulfide ores are taken from huge open pit mines by drilling and blasting with explosives. In this type of mining, the material located above the ore, called the overburden, is first removed to expose the buried ore deposit. This produces an open pit that may grow to be a mile or more across. A road to allow access for equipment spirals down the interior slopes of the pit.

The molten slag is discharged from the furnace at 1000.1300 °C. When liquid slag is cooled slowly, it forms a dense, hard crystalline product where as quick solidification by pouring molten slag into water gives amorphous granulated slag. The copper slag that is usually found is an impure iron silicate glass with small inclusions of copper and copper sulphide. The chemical composition of slag varies with the types of furnace or process of treatment. Typical chemical compositions of copper slag generated from various Indian copper industries are address in the Table.

The cooling rate has a strong influence on the mineralogy and, consequently, the physical and cementitious properties of the nonferrous slags. Granulated slags, which are produced by rapid quenching of the molten slag, are more vitreous and more reactive than similar air-cooled slags. Granulated slag's solidify to relatively small, uniform particles whereas air-cooled slags solidify in a large mass

Name of the plant	Hindustan Copper Limited ICC, Ghatsila	Hindustan Copper Limited ICC, Rajasthan	Sterlite Industries India Limited, Tuticorin	Birla Copper, Gujarat	SWIL, Gujarat
Fe (%)	47	44	36.89	47.80	37.90
SiO2 (%)	-	28	30.91	29.90	25.30
CaO (%)	-	-	-	-	3.90
MgO (%)	-	-	-	-	-
Al2O3 (%)	-	-	2.22	-	-
S (%)	-	-		-	-
Cu (%)	0.68	0.60	0.23	0.70	0.44
Ni (%)	0.05	0.06	0.37	-	-
Co (%)	0.22	0.13	2.3	-	-
Mn (%)	0.03	-	-	-	-
Zn (%)	0.05	-	-	--	1.6

Copper slag generated in India

Name of the plant	Copper slag generation / annum in million tonne
Hindustan Copper Limited ICC, Ghatsila	0.07
Hindustan Copper Limited ICC, Rajasthan	0.07
Sterlite Industries India Limited, Tuticorin	0.22
Birla Copper, Gujarat	0.22
SWIL(JhagadiaCopper Limited), Gujarat	0.11

Chemical/Physical Properties of Copper slag

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

Property Analysis	
Hardness Scale	6-7
Specific Gravity	3.51
Plasticity Index	Non-Plastic
Swelling Index	Non-Swelling
Granule Shape	Angular, Sharp Edges
Grain Size Analysis:	
Gravel (%)	1.00
Sand (%)	98.90
Silt + Clay (%)	0.05
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Hardness Scale	6-7
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Application of Copper Slag

A. The fine material of copper slag can be used for stabilization of soil.
B. In surface blast cleaning mainly the copper slag issued.
C. It can be used as abrasive grit.
D. It is used to form a block as a building material.

Advantages of Copper Slag

A. Copper slag has the potential to enhance the properties of problematic soils.
B. Copper slag can be recommended for sub-grade, sub base, bitumen mixes.
C. Copper slag is similar to medium sand and it can be used as a construction.
D. Due to the high strength weight ratio, it can be used as alternative to sand.
E. Improvement of index properties.

RESULTS

Type	Plasticity Index (%)	Standard Proctor Test		Swell Index (%)
		OMC (%)	MDD gm/cc	
Soil	38.95	38.95	1.49	67
Copper slag (10%)	27	19.45	1.56	48
Copper slag (20%)	21	16.50	1.750	34
Copper slag(30%)	18	15.60	1.81	18

CONCLUSION

1. The plasticity index of soil was 38.95 % and free swell index also decreased from 67 % which show the high plasticity nature of soil.
2. The maximum dry density of soil was 1.49 gm/cc and optimum moisture content was 25%

By Adding 10% copper slag in given soil samples. The results are obtained after adding the copper slag are as follows;

- The plasticity index of soil decreased to 27% and free swell index also decreased from 48%
- The maximum dry density of soil increased to 1.56 gm/cc and optimum moisture content decreased to 19.45%.

By Adding 20% copper slag in given soil samples. The results are obtained after adding the copper slag are as follows;

- The plasticity index of soil decreased to 21 % and free swell index also decreased to 34%.
- The maximum dry density of soil increased to 1.75 gm/cc and optimum moisture content decreased 16.5%.

By Adding 30% copper slag in given soil samples. The results are obtained after adding the copper slag are as follows;

- The plasticity index of soil decreased to 18% and free swell index also decreased from to 18 %.
- The maximum dry density of soil increased to 1.81 gm/cc and optimum moisture content decreased to 15.60%.

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