Geotechnical Behaviour of Stabilised Soil Using Iron Ore Mine Tailing"

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Abstract— **The term soil stabilization means to alter and modify one or more properties of soil to improve the engineering characteristics and performance of a soil. Soil stabilization is the oldest and popular method of ground improvement. Stabilization of soil using cement and lime are well known. But very few researchers had tried the Iron ore mine tailing (an industrial waste) for stabilizing the soil. Many problems arise from the industrial development. One of them is the proper and effective disposal of its waste. Generally, industrial waste causes many serious environment problems. Therefore, utilization of industrial waste in construction industry is the best way to dispose it.**

Using industrial waste in construction industry is beneficial in many ways such as disposal of waste, saving bio-diversities, increasing soil properties like strength, reduce permeability, etc., preserve the natural soil and making economic structures.

In the present investigation, industrial by-product Iron ore mine tailing were utilized to enhance the various properties of soil. The evaluation involves the determination of the various properties of soil i.e. Particle size distribution, consistency limits, Optimum moisture content, Maximum dry density and soaked CBR were determined for the samples in its natural state as well as when mixed with varying proportion of IRON ORE mine tailing from 3 to 15% at interval of 3%.

Keywords— **Iron ore mine tailing waste, Particle size distribution, Liquid limit, Plastic limit, Plasticity Index, OMC, MDD and CBR**

I. INTRODUCTION

The soils having low bearing capacity are problematic to the civil engineering structure because if soil having low bearing capacity so it is harmful for the structure. If bearing capacity of the soil is low, then some time the soil shows uneven settlement. Uneven settlement causes severe damages to the structure especially buildings foundation, airport runways, highways, water conveyance canal and lined reservoir unless appropriate measures are taken. In the civil engineering soil stabilization are most effective method for improving the bearing capacity and other properties of soil. In present study we use Iron ore mine tailing to enhance the properties of soil. In India as well as all over the world there are several industrial waste which are being produced in millions of tones as unwanted by-product in the manufacturing industries and thermal power plants. Most of these wastes are left unutilised and are posing bad impact in environmental condition by polluting the soil, water and air. Some of these wastes are Fly ash, Iron ore mine Tailing, Red mud, Silica fumes etc. Soil Stabilization is found one of the effective, quick and popular method to enhance the properties of soil so the Iron ore mine tailing can be effectively used for civil engineering construction to reduce the disposal problem of waste and minimize the environmental hazards.

Components of stabilization: Soil stabilization involves the use of stabilizer (binder materials) in weak soils to improve various properties. The components parts of soil stabilization technology include soils and or soil minerals and stabilizing agent or binders (cementious/pozzolanic material).

II. MATERIALS

The various material used in this study are: -

SOIL: The clay soil used in this research was obtained from Shihora, JABALPUR District, MADHYA PRADESH, INDIA. The soil was collected by open excavation at a depth of 1m below from natural ground level.

IRON ORE MINE TAILING: Tailings consist of ground rock and process effluents that are generated in a mine processing plant. Mechanical and chemical processes are used to extract the desired product from the run of the mine ore and produce a waste stream known as tailings. This process of product extraction is never 100% efficient, nor is it possible to reclaim all reusable and expended processing reagents and chemicals. The unrecoverable and uneconomic metals, minerals, chemicals, organics and process water are discharged, normally as slurry, to a final storage area commonly known as a Tailings Management Facility (TMF) or Tailings Storage Facility (TSF). Not surprisingly, the physical and chemical characteristics of tailings and their methods of handling and storage are of great and growing concern. Tailings are generally stored on the surface either within retaining structures or in the form of piles (dry stacks) but can also be stored underground in mined out voids by a process commonly referred to as backfill. Backfilling can provide ground and wall support, improve ventilation, provide an alternative to surface tailings storage and prevent subsidence.

Mine tailing is a waste material of Iron industries. Iron ore mine tailing was obtained in an open dump from JAIN MINES AND MINERALS INDIA PVT. LTD. HARGARH INDUSTRIAL AREA, JABALPUR District, MADHYA PRADESH, INDIA. After removing the vegetation and other matter on the surface of mine dump, it was air dried, pulverized and passing through 425 micron BIS sieve was used in different proportion from 3% to 15% at the interval or 3% in the present investigation.

Fig 1 Natural soil

Fig 2 Iron ore mine tailing

III. METHODOLOGY

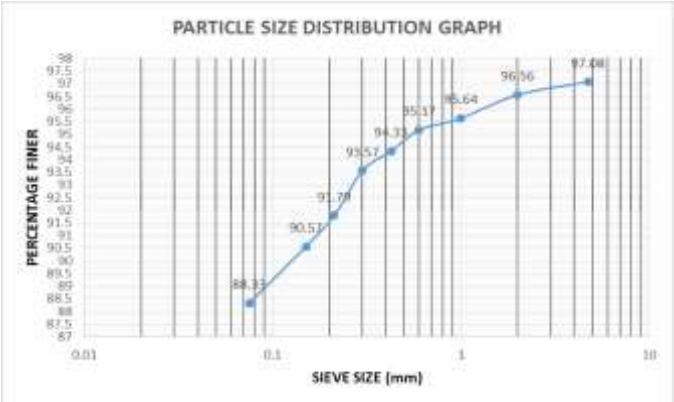
The main aim of present study is to examine the changes in the properties of soil when we add different amount of Iron ore mine tailing in them. The soil sample were collected and all test performed on original soil sample, then the IRON ORE TAILING was added to the prepared sample from 0% to 15% at an interval of 3% (by weight). Firstly, all the materials viz. soil, Iron Ore Waste were oven dried at 105^{o}C for 24 hours. Before mixing soil and stabilizing agent the stabilizing agent were sieved through 425-micron sieve. For the preparation of each specimen, all the materials were mixed thoroughly by trowel and passing the mixture by the sieve which is specify for the particular experiment.

Fig 3 Iron ore mine tailing dump

IV. RESULT

TABLE I
SOIL SAMPPLE SIEVE ANALYSIS

Sr. No.	Sieve Size in mm	Mass Retained in gms (R)	Percentage Mass Retained (N)	Cumulative Percentage Retained (C)	Percentage Finer
1.	4.75	29.18	2.92	2.92	97.08
2.	2.00	5.18	0.52	3.44	96.56
3.	1.00	9.22	0.92	4.36	95.64
4.	.600	4.47	0.47	4.83	95.17
5.	.425	8.44	0.84	5.67	94.33
6.	.300	7.62	0.76	6.43	93.57
7.	.212	17.8	1.78	8.21	91.79
8.	.150	12.22	1.22	9.43	90.57
9.	.075	22.39	2.24	11.67	88.33
10	PAN	883.21	-	-	-



Graph 1: Particle Size Distribution

TABLE III
PROPERTIES OF NATURAL SOIL SAMPLE

Sr. NO.	Characteristics	Unit	Value
1.	Natural Moisture Content	%	15.36
2.	Liquid Limit	%	46.84
3.	Plastic Limit	%	24.68
4.	Plasticity Index	%	22.16
5.	Optimum Moisture Content	%	23.5
6.	Maximum Dry Density	gm/cc	1.66
7.	California Bearing Ratio	%	1.23

Where, % indicates the value of particular characteristic in percentage.

TABLE IIIII
NOMENCLATURE

S No.	Soil Sample	Nomenclature
1.	Simple Soil	S1
2.	Soil + 3% Mine Tailing	S2
3.	Soil + 6% Mine Tailing	S3
4.	Soil + 9% Mine Tailing	S4
5.	Soil + 12% Mine Tailing	S5
6.	Soil + 15% Mine Tailing	S6

TABLE IVV
INDEX PROPERTIES OF SOIL

Sample Nomenclature	Mine Tailing %	L.L.	P.L.	P.I.
S1	0	46.84	24.68	22.16
S2	3	46.75	24.64	22.11
S3	6	45.10	24.56	20.54
S4	9	42.89	24.42	18.47
S5	12	40.45	23.71	16.74
S6	15	38.12	22.35	15.77

TABLE V
ENGINEERINNG PROPERTIES OF SOIL

Sample Nomenclature	Mine Tailing %	MODIFIED PROCTOR		CBR	
		OMC	MDD	CBR VALUE	% CBR IMPROVED
S1	0	23.5	1.66	1.23	-
S2	3	23.2	1.68	1.55	26.02
S3	6	22.56	1.69	1.96	59.35
S4	9	21.77	1.71	2.23	82.11
S5	12	20.86	1.74	2.79	126.83
S6	15	18.21	1.79	2.99	143.09

Where,

Mine Tailing (%) = Iron ore mine tailing

L.L. = Liquid Limit

P.L. = Plastic Limit

P.I. = Plasticity Index

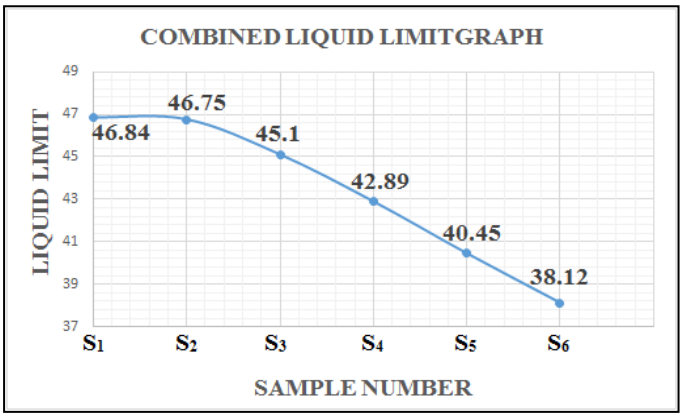
OMC = Optimum Moisture Content

MDD = Maximum Dry Density

CBR = California Bearing Ratio

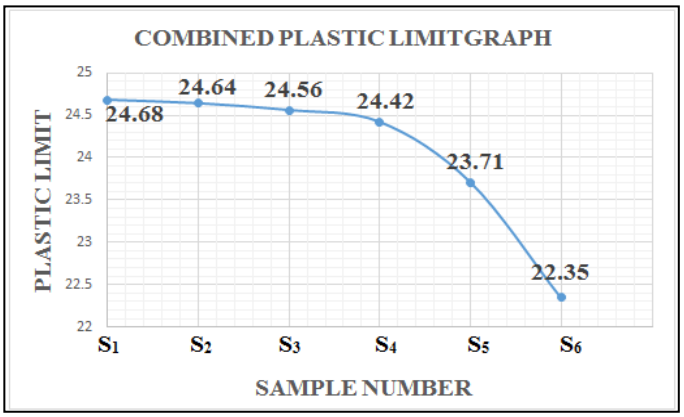
V GRAPHICAL REPRESENTATION

LIQUID LIMIT GRAPH



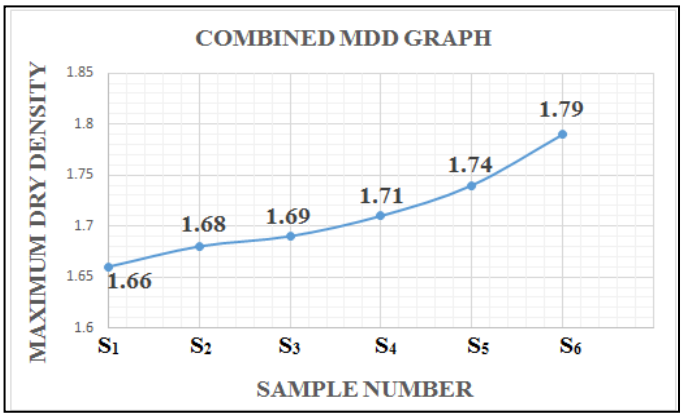
Graph 2: Variation in Liquid Limit

PLASTIC LIMIT



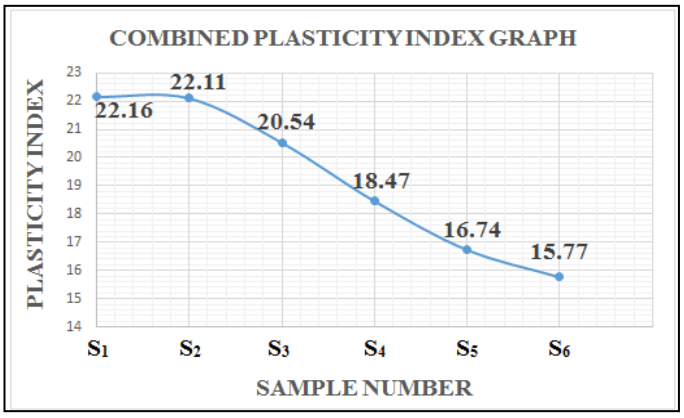
Graph 3: Variation in Plastic Limit

MAXIMUM DRY DENSITY



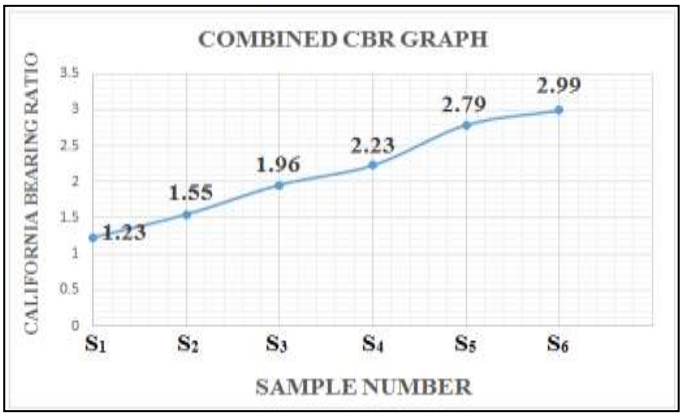
Graph 6: Variation in MDD

PLASTICITY INDEX



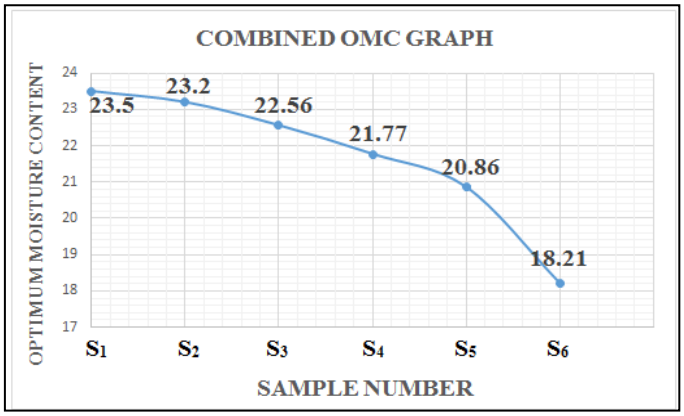
Graph 4: Variation in Plasticity Index

CALIFORNIA BEARING RATIO



Graph 7: Variation in CBR Value

OPTIMUM MOISTURE CONTENT



Graph 5: Variation in OMC

VI CONCLUSION

The soft soil is identified as intermediate compressibility clay of medium plasticity (CI) according to IS Soil Classification System (ISSCS) as per IS: 1498-1970. Stabilizing the soil by applying Iron Ore Mine Tailing is successfully improving the properties of existing poor sub grade soil. Iron Ore Mine Tailing is free of cost and available locally, hence it is economical and also it is used as waste disposal. In present investigation, we show that the soil effectively stabilised with the different proportion of mine tailing. With the increase of Iron ore mine tailing percentage the Liquid limit, Plastic limit, Plasticity Index were decrease. The other properties also change with the admixture. OMC of the soil decreases with increase in the percentage of Iron ore mine tailing. The other two properties MDD and CBR were improved by Iron ore mine tailing stabiliser.

With the adding of Mine Tailing at different proportion i.e. 3% to 15% at interval of 3% the percentage

increase in soaked CBR of soil is 26.02%, 59.35%, 82.11%, 126.83 and 143.09% respectively.

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