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## Study the influence of industrial waste iron sludge on the stabilization of the expansive soil for the road subgrade

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**Abstract:** *The Aim of this paper is to Stabilize Expansive soil of Sub Grade and to improve its California bearing ratio and free swell index and other properties using Industrial Waste materials Iron Sludge. Expansive soil have tremendous strength but it becomes very soft when it getting wet, It expands/swells due to its mineralogical composition during its wet condition, It creates cracks or consolidated when it is dry. Expansive soils can be found on almost all the continents on the Earth. Destructive results caused by this type of soils have been reported in many countries. Frist of all, identify the engineering properties of soil and then add 5, 10... 30 % iron Sludge in natural Soil. And again check the change in engineering properties of soil like plastic limit, plasticity Index, swelling Index of treated soil. By comparing the test results of virgin soil and treated soil we check the feasibility of using Iron Sludge for stabilization of expansive soil.*

**Keywords:** *Expansive Soil, Iron Sludge, Plastic Limit, Liquid Limit, Free Swell Index.*

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### I. INTRODUCTION

Expansive soil is one of major soil deposits of India. Expansive soil exhibit high rate of swelling and shrinkage when exposed to changes in moisture content and hence have been found to be most troublesome from engineering consideration. The cracks in expansive soils are usually more than 50mm wide and several millimeters deep. The Expansive soils have low strength and are susceptible to excessive volume changes, making their use for construction purposes very difficult. Instability of these soils causes more damage to structures than any other natural hazard, including earthquakes and floods, unless proper soil stabilization performed. Expansive nature of this soil negatively affects its bearing capacity. Replacement of expansive soil with a non-expansive material is a common method of reducing shrink-swell risk. In the case when expansive soil or stratum is thin, then the entire layer can be removed. However, often the soil or stratum extends too deep and in that case, this method is not economically efficient.

#### A. Problem Faced in Expansive Soil

- Swelling of soil in the subgrade.
- Shrinkage creates crakes in subgrade in a dry session.
- Consolidation creates uneven pavement in dry session.
- Low CBR value causes the high thickness of layers.
- Low Permeability and low shear strength.

### II. MATERIAL AND METHOD

#### A. Iron Sludge

Iron Sludge is generated by Pharmaceutical Industry. Photo shows the industrial iron sludge generated after some chemical processes. This sludge is in the wet zone.



**Fig. 1 Wet Iron Sludge**

After some periods, it will be dried. For 1 tone of finished product 0.7 tonne Iron Sludge is generated. As from the below photo, we can say that its disposal is very difficult so that companies stored it into the bags and throw it on the ground as a waste.



**Fig. 2 Dry State Iron Sludge**

**B. Properties of Iron Sludge**

**Table 1 Properties of Iron Sludge**

No.	Parameters	Unit	Results
1	Particle Size	Micron	< 75
2	Density	KN/mm2	32.33
3	Colour	PtCo.So.	600.0000
4	Ph	Unit	7.3300
5	Total Acidity as CaCO3	gm/kg	0.6000
6	Total Alkalinity as CaCO3	gm/kg	0.9000
7	Total Inorganic Solids (TIS)	gm/kg	921.2000
8	Bio-Chemical oxygen demand (5 days 20oc)	gm/kg	1.2500
9	Chemical oxygen demand	gm/kg	4.0700
10	Oil & Oil Emulsions	gm/kg	0.1200
11	Iron	gm/kg	447.1000
12	Ammonical Nitrogen	gm/kg	0.0220
13	Chloride	gm/kg	1.8000
14	Sulphate	gm/kg	5.5000
15	Total dissolved Solids	gm/kg	14.6000
16	Calcium	gm/kg	0.1600
17	Magnesium	gm/kg	0.0240
18	Percent Sodium	%Na	94.000

C. Test to be Performed

- Atterberg Limit (IS 2720 Part 5)
- Free Swelling Index (IS 2720 Part 40)

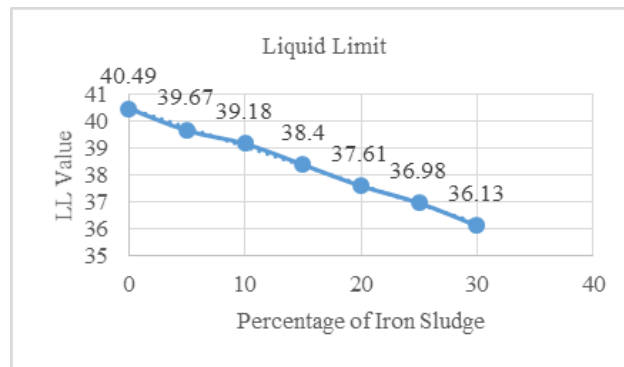
**II. RESULTS AND DISCUSSION**

A. Properties of natural soil

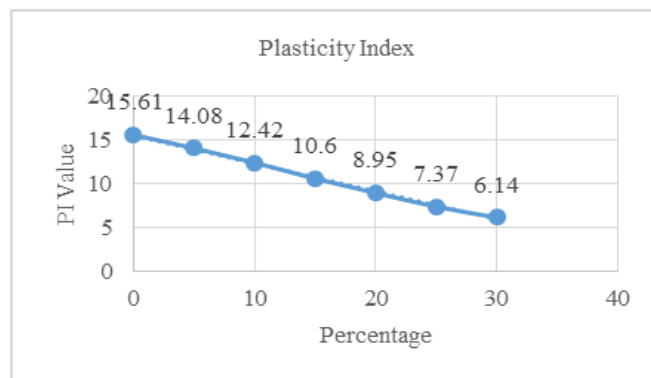
**Table 2**  
Natural soil test results

Organic Silt and Silty Clay	Percentage
Gravel	0.97
sand	7.86
Silt	39.18
Clay	51.99
LL	40.49
PI	15.61
IS Classification	OL

B. Atterberg Limit



**Fig. 3 Liquid Limit Value**



**Fig. 4 Plasticity Index value**

In the above graph, the variation of liquid limit value and plasticity index value is observed. 0 % Iron Sludge means it is the value of natural soil. As the percentage of admixture, Iron Sludge increased the liquid limit and plasticity index value was decreased.

C. Free Swelling Index

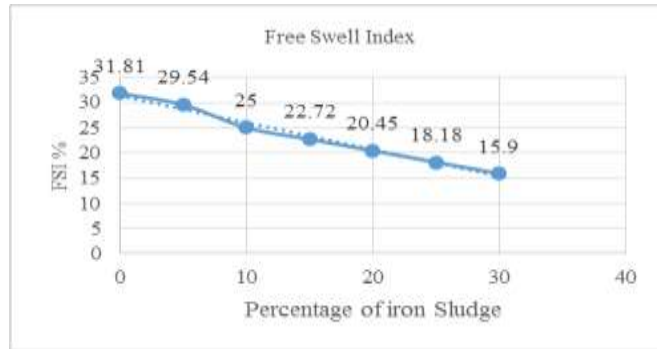


Fig. 5 Free swell Index value

In free swelling Index, the value of swelling is also decreased as the percentage of Iron Sludge Increased.

**CONCLUSION**

After studied the Properties of Iron Sludge and the significant decrease in the Plastic limit, Plasticity Index and Free Swelling Index value resulting with the addition of Iron Sludge, it seems that it can be used for stabilization of Black cotton Soil. Further, from the other geotechnical test of soil, the optimum value of addition of Iron Sludge will find out.

**REFERENCES**

- [1] IS 2720 Part 5
- [2] IS 2720 Part 40