

Experimental Study on Index Properties of Black Cotton soil Stabilization with Hypo-Sludge

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Abstract—Soil stabilization is the process to improving the geotechnical properties of soil. In various countries like India road network are growing up each year for transportation facilities. In the design of road construction site engineers faces the problem of low strength of soil, due to which settlement and failure of road pavement occurs. For improving the strength of soil pavement Hypo Sludge and Lime and other cementitious materials can be utilized to the soil. Hypo Sludge is mainly waste product from the Paper mill industry. Hypo sludge is incinerated from Waste paper sludge. In this study, Hypo Sludge was used with black cotton soils. The test results such as index properties of soil, grain distribution and DFS on black cotton soil mixed with different proportions of Hypo Sludge were found out. From the results, it is observed that at optimum percentages of 10% Hypo Sludge shows improvement in the compressive strength of the soil.

Index Terms—Expansive Soil, Soil Stabilization, Hypo Sludge, Atterberg limits, DFS

I. INTRODUCTION

Soil stabilization development is a process to increased strength of soil pavement. The simplest method for developing strength of soil to drained out water after compaction of the soil. The other method is adding binder like fly ash, lime, bituminous and cement etc material to the weak soils for improving geotechnical properties of soil. Mechanical and chemical analyses are two major areas for improving soil strengthening properties. In which mechanical process is a physical method like vibration and compaction imparted to soil. In chemical method different percentage of binding material having cementitious properties added to the soil. In present study Hypo Sludge added to the soil and conduct a series of test.

Hypo Sludge is industrial waste material collected from paper mill industries. Hypo Sludge generates continuously throughout the operating year and it behaves like a clayey material consisting of short fiber, ink and other impurities. Due to presence of some hydrated lime (Cao: Calcium hydroxide) with other chemical impurities to the Hypo Sludge is also called Lime Sludge. It is found that high percentage of moisture content is available in the Hypo Sludge after de-inking and re-pulping process in the paper industries. It dried up in the presence of sun before conducting a series of laboratory test for the proposed study.

II. METHODS AND MATERIAL

A. METHODS

a) Particle Size Distribution: The percentage of particle i.e. clay, silt and sand (fine grained or coarse grained) in the soil was found after conducting laboratory experiments as per IS: 2720 (Part V) – 1985.

b) Atterberg Limit: Liquid limit, plastic limit, plasticity index and shrinkage limit was determined as per IS: 2720 (Part IV) – 1985 in the laboratory.

- (i) Liquid Limit (IS:2720- (Part V)-1985)
- (ii) Plastic Limit (IS:2720- (Part V)-1985)
- (iii) Plasticity Index (IS:2720- (Part VII)-1980/87)

c) Specific Gravity: Specific gravity of soil is obtained as per IS: 2720 (Part III) – 1980 with the help of pycnometer method.

d) Differential Free swell Test: Differential Free swell test of soil is obtained as per (IS: 2720(PART 40)-1977)

B. MATERIALS

Soil : Soil is collected from Bilahari, Jabalpur, Madhyapradesh (India)

Hypo Sludge : Hypo Sludge is collected from **Orient Paper & Industries Limited**, Amlai, Shahdol, Madhya Pradesh (India).



Fig. 1 Black Cotton soil



Fig .2 Hypo-sludge

III. MIX PREPRATION

Following mix has been prepared by mixing soil with different percentage of Hypo-sludge.

- 1) Soil+ 0 % Hypo-sludge
- 2) Soil+ 5 % Hypo-sludge
- 3) Soil+ 10 % Hypo-sludge
- 4) Soil+ 15 % Hypo-sludge
- 5) Soil+ 20 % Hypo-sludge

IV. RESULTS AND DISCUSSION

A. Geotechnical Properties of Soil

A series of laboratory test performed to determine the basic engineering properties of soil. The geotechnical parameters of soil are presented in Table1.

Table-1: Geo-technical properties of Soil

S.No.	Geo-technical Properties of soil	
	Parameter	Results
1.	Liquid Limit (%)	64
2.	Plastic Limit (%)	27.63
3.	Shrinkage Limit (%)	10.48
4.	Plasticity index (%)	36.37
5.	Specific Gravity	2.58
6.	Differential Free swell Test	50

Table No. 2 Geo-technical properties of Soil with Hypo Sludge

Soil+Hypo-sludge	Liquid Limit (L.L.)	Plastic limit (P.I.)	Plasticity index (P.I. = L.L. - P.L.)
Soil+ 0 % Hypo-sludge	64	27.63	36.37
Soil+ 5 % Hypo-sludge	68	32.54	35.46
Soil+ 10 % Hypo-sludge	63	35.22	27.78
Soil+ 15 % Hypo-sludge	59	39.47	19.53
Soil+ 20 % Hypo-sludge	54	41.78	12.22

Table No. 3 Differential Free swell Test

		0 %	5 %	10 %	15 %	20 %
Water	initial	28	27	25	23	22
	Final (V_d)	30	27.5	25	23	22
Kerosene	initial	20	20	21.5	21.5	22
	Final (V_k)	20	20	21.5	21.5	21.5
DFS %		50	37.5	16.28	6.97	2.32

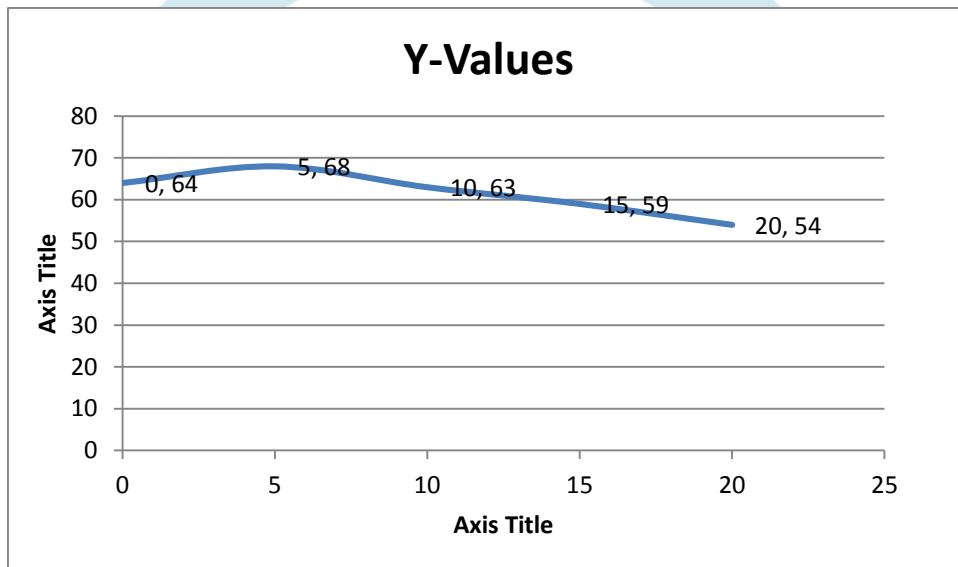


Fig 3. Liquid Limit Decrease in % with Addition of Hypo-sludge in Black cotton Soil

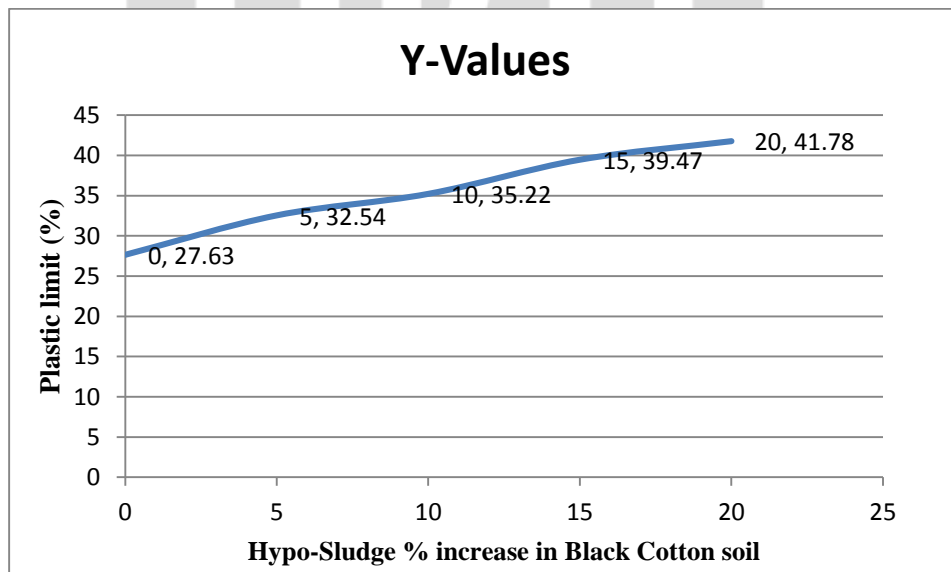


Fig 4. Plastic Limit increase in % with Addition of Hypo-sludge in Black cotton Soil

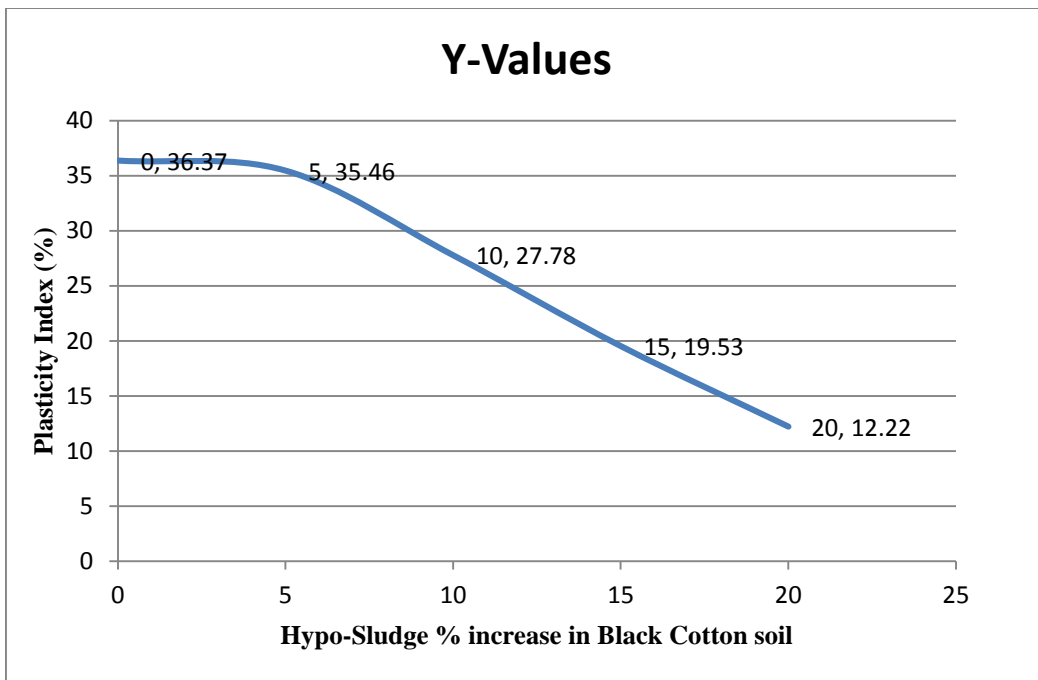


Fig 5. Plasticity Index in % with Addition of Hypo-sludge in Black cotton Soil

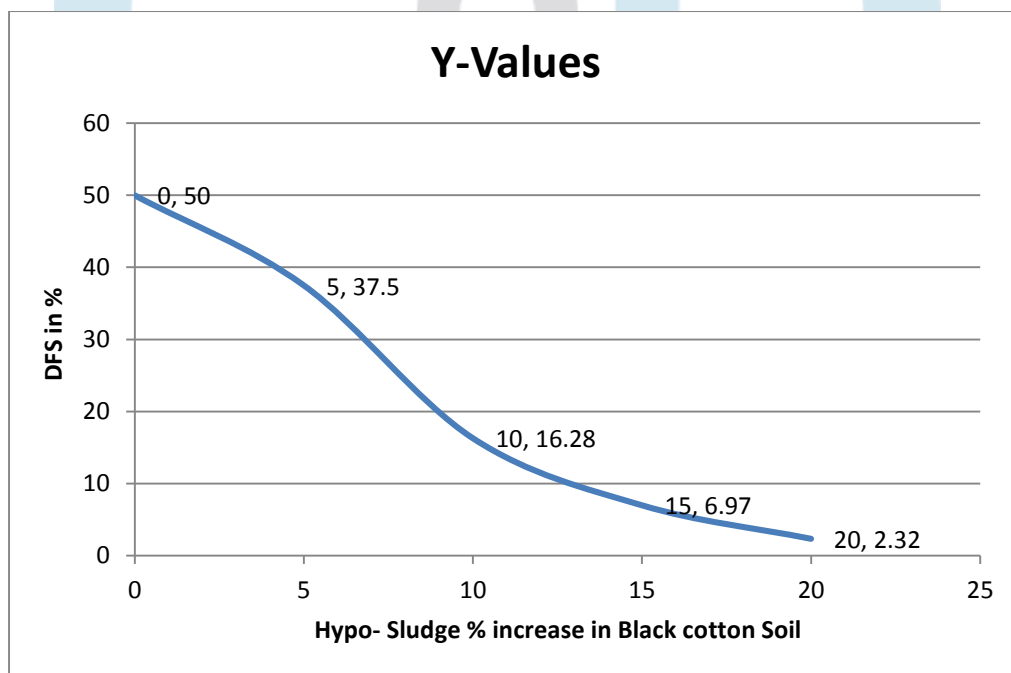


Fig 6. DFS % with Addition of Hypo-sludge in Black cotton Soil

V. CONCLUSIONS

From the results of investigation following conclusions can be drawn.

1. Liquid limit of soil decreases from 64% to 54% with increase in Hypo-sludge (%) .
2. Plasticity index of soil decreases from 36 % to 12.22% with increases in Hypo-sludge content up to 20%. There after slight increase in Plasticity Index is found with addition of Hypo-sludge.
3. Differential Free swell test of soil is obtained as per (IS: 2720(PART 40)-1977) and the swelling properties of black cotton soil is decrease with increase of Hypo-sludge percentage.

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