"A STUDY OF EXPANSIVE SOIL USING BETAMCHERLA SLAB POLISH WASTE"

HARISH.P[1], Dr. CH. Sudharani

[1]*Assistant Professor, Department of Civil Engineering in sri kalahastheeshwara institute of technology, sri kalahasthi. Andhra Pradesh.*

[2] *Professor, Department of Civil Engineering in Sri Venkateswara University, Tirupathi, Andhra Pradesh.*

---***---

ABSTRACT - Soils are naturally formed materials due to weathering of rocks of different compositions. The soil that undergo swelling in wet condition and shrink in dry condition are known as expansive soils. Expansive soil causes serious problem to structures due to its Swelling and Shrinking tendency. The problems may develop in many forms such as formation of new cracks or widening of existing cracks, tilting of structures etc. In order to reduce the volumetric changes in expansive soils, mechanical stabilization and chemical stabilization i.e using admixtures in the raw form or liquid form to the expansive soil is desirable. An attempt has been made in this project to use Betamcherla Slab Polish Dust or waste as an additive to the expansive soil selected is studied by conducting experiments on Soil-Betamcherla Slab Polish Dust mixtures. Betamcherla Slab Polish Dust is added to the expansive soil in increments of 5% starting from 0% to 30%. In this study, the potential of Betamcherla Slab Polish Dust (by-product of stone polishing industries) as a stabilizing additive to an expansive soil is evaluated.The stabilization characteristics of Betamcherla Slab Polish Dust are mainly due to its high lime content. In this paper investigation the effect of Soil-Slab Polish Dust on Plasticity characteristics, Compaction, Swelling, CBR, of expansive soil is studied.

Key Words : Betamcherla Slab Polish Dust, Compaction CBR, Expansive Soil, Plasticity, Soil Stabilization, Swelling.

INTRODUCTION

Expansive soils, popularly known as black cotton soils in India, are one of the major regional deposits of India covering an area of about one fifth of the country's land area (about 3 lakhs sq. km). Soils containing the clay mineral Montimorillonite generally exhibit these properties. Expansive soils swell and shrink in a marked way due to gain or loss in moisture content. Therefore, during summer when evaporation from the ground and transpiration due to vegetation exceeds the rainfall, the expansive soil dries up and moisture deficiency develops in the soil, giving rise to soil shrinkage. During the rains, the soil absorbs moisture and swells. Because of their susceptibility to high seasonal volumetric changes, extensive damages have been caused to Structures. Such soils are not peculiar to this country alone. In the United States alone, the expansive soils inflict about $9 billion per year in the form of damages to structures which is more than twice the combined damage from earthquakes, floods, tornados and hurricanes (Jones and Holtz, 1973; Jones and Jones, 1987).In general, expansive soils have high plasticity, and are relatively stiff. The pore water pressure is initially negative and the deposit is generally unsaturated. These soils often have some Montmorillonite clay mineral present. The higher the amount of monovalent cations adsorbed to the clay mineral (e.g. sodium), the more severe the expansive soil problem (Fredlund and Rahardjo, 1993). In this paper study the effect of Soil-Slab Polish Dust on Plasticity characteristics, Compaction, Swelling, CBR, of expansive soil is studied.

REVIEW OF LITERATURE

Ground modification techniques have become a major part of civil engineering practice over the last 30 years (Hausmann, 1990). Improvement of sites with weak or high compressible or high swelling or any other such problematic soils is commonly done by removing the problematic soils and replacing them with more competent ones such as compacted gravel, crushed rock, or lightweight aggregates to increase the load bearing capacity (Kukko, 2000). Although this is considered a good solution, usually has the drawback of high cost due to the cost of the replacement materials. The use of admixtures derived from coal combustion by-products (CCPs) such as fly ash are considered is more cost-effective solution which can result in adequate improved engineering properties of the treated foundation soils.In India, expansive soils are found in regions where the annual rainfall ranges from 300 to 900 mm. SubbaRao et al. 1985 have emphasized that the Montmorillonite content is the predominant clay fraction in these soils. The Cation Exchange Capacity of these soils vary from 80 to 130 m.eq/100 gm and their consistency limits vary from 53% to 100%, 20% to 50% and 7% to 18% for liquid limit, plastic limit and shrinkage limit respectively. The specific gravity varies from 2.7 to 2.9 for black cotton soils. The clay fraction of black cotton soils is very rich in silica (60%) with only 15% iron and 15%

alumina. During monsoon, these soils especially near the surface, imbibe water, under-go heave, loose density and become slushy when more water is available. Conversely, during summer, the soils desiccate, shrink, gain density and become very hard. The decreasing dry density and the loss of strength on monsoon and the gain thereof in summer tend to decrease with depth (Katti, 1978). During summer, polygonal shrinkage cracks appear at the surface which may extend to a depth of about 2m to 3.5m, indicating the active zone in which the volume changes occur.

Materials Used

Soil

The soil used for this investigation is obtained from tirchanoor near Tirupati. The soil is taken by digging a trail pit. The top soil up to 1m is discarded since it contains loose material and some vegetation. Disturbed and Undisturbed soil samples are collected at 2m depth where moisture variations are minimum. The soil sample is dried and pulverized. The soil material passing through I.S.4.75 mm sieve is taken for this investigation.

TABLE 3.1:CHEMICAL COMPOSITION OF SLAB DUST:

SI.No.	Property	Value
1.	Grain size distribution	
	(a)Gravel (%)	9
	(b)Sand (%)	51
	(c)Silt & Clay (%)	40
2.	Atterberg Limits	
	(a) Liquid Limit (%)	66
	(b)Plastic Limit (%)	23.25
	(c) Plasticity Index (%)	43
3.	Free Swell Index (%)	180
4.	Swelling Pressure (kN/m^2)	80
5.	Specific Gravity	2.67
6.	pH value	9.2
7.	Compaction characteristics	
	(a) Maximum Dry Unit Weight (kN/m^3)	19.3
	(b)Optimum Moisture Content (%)	10.84
8.	California Bearing Ratio Value (%)	
	(a) at 2.5 mm penetration	9.142
	(b) at 5.0mm penetration	8.685
9.	Unconfined Compression Strength (kN/m^2)	197
10.	Chlorides(%)	0.34
11.	Sulphates(%)	4.425

Betamcherla waste

The waste material is obtained from the slab polishing industries at Betamcherla of Kurnool Dist. in A.P. The specific gravity of waste material is 2.2 and also confirming to the size less than 90 microns. The properties of Betamcherla waste are presented in Table 3.1.

Table: 3.2: PROPERTIES OF THE SOIL SAMPLE TESTED

S.No.	Parameter	Value
1.	Color	black
2.	pH	8.12
3.	SiO_2	0.61%
4.	Al_2O_3	0.19%
5.	Fe_2O_3	0.25%
6.	MgO	0.94%
7.	CaO	56.36%
8.	Na_2O	0.02%
9.	K_2O	0.04%
10.	*LOI*	41.50%
11.	*TOT/C*	13.91%
12.	*TOT/S*	0.11%

TESTS CONDUCTED

The following tests are conducted in order to meet the objectives of the present investigation. Liquid Limit, Plastic Limit, Compaction , CBR.

RESULTS AND DISCUSSIONLIQUID LIMIT

The results of liquid limit tests conducted at different percentages of slab polish dust mixed with selected soil are presented in Fig.4.1. From this figure, it is found that the liquid limit value of the soil mixture at 0% is 66% and is decreasing with the increase in percentage of slab polish dust up to 25%, where as Liquid Limit is 36% and at 30% replacement of soil with slab polish dust the Liquid Limit value slightly increased to 40%. Table 4.1 shows the absolute values of liquid limit and Table 4.2 shows the percent decrease in liquid limit for different percentages of slab polish dust. From this table, it is observed that liquid limit at 25% of slab polish dust is 36% which is lower when compared to other percentages. The maximum decrease in Liquid limit is about 45% which occurs at 25% of slab polish dust addition.

PLASTIC LIMIT

Plastic limit values of soil-slab polish dust mixtures with varying percentages of slab dust are presented in Fig 4.1. The plastic limit value of the soil alone is 23.25%. From this figure, it is found that plastic limit value of soil-slab

polish dust mixtures decreases with increase in percentage of slab polish dust at 25% Plastic Limit is 8% and slightly increased for 30% replacement of soil with slab polish dust which is 13%.
Table 4.1 shows the absolute values of plastic limit for different percentages of slab polish dust. The percent decrease in plastic limit values for each of these percentages of slab polish dust are also shown in Table 4.2. The maximum decrease in plastic limit occurs at 25% of slab polish dust and is 64% and slightly increased at 30% is 43%.

FIG 4.1: VARIATION OF LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX WITH PERCENTAGE OF SLAB POLISH DUST ::

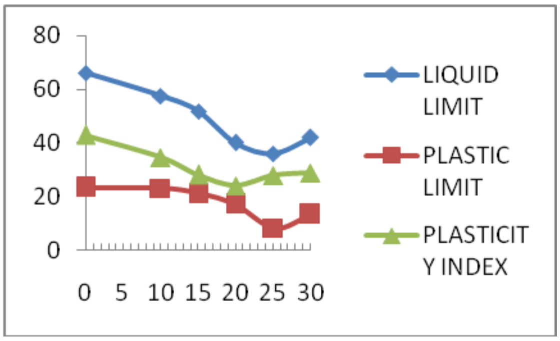


TABLE 4.1: PLASTICITY CHARACTERISTICS OF REPLACED SOIL:

SLAB POLISH DUST MIXTURES (SPD) (%)	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)
100% SOIL + 0% SPD	66	23	43
90% SOIL + 10% SPD	57	23	34
85% SOIL + 15% SPD	51	21	28
80% SOIL + 20% SPD	40	17	24
75% SOIL + 25% SPD	36	8	27
70% SOIL + 30% SPD	42	13	28

COMPACTIONOPTIMUM MOISTURE CONTENT

The results of the Standard Proctor's compaction tests, conducted on Soil-Slab Polish Dust Mixtures with different percentages of Slab Polish Dust are reported in Fig 5.1. The Top most curve corresponds to 15 % of Slab Polish Dust followed by 20 %, 25 %, 30 %, 10 % and 0% respectively. From these curves, it is observed that the peak points are shifted towards right with percent decrease of Soil-Slab polish Dust. The relationship between the Optimum Moisture Content and different percentages of slab polish dust is shown in Fig 5.2. It is observed that the Optimum Moisture Content at 10 % replacement is increased to 14% and at 15%, 20% and 25% replacements it is decreased to 12.5% with percent increase in slab polish dust and at 30% replacement, OMC is again increased slightly to 13.5%. The percent decrease in Optimum Moisture Content for 15 % of slab polish dust is 12.5 %. Table 5.2 shows the absolute values of Optimum Moisture Content for 0%, 10 %, 15%, 20 %, 25 %, and 30 % of addition of slab polish dust . The percentage decrease in Optimum Moisture Content for various percentages of slab polish dust is also given in the same table for comparison. In order to compare the percentages decrease in Optimum Moisture Content of soil alone, the Optimum Moisture Content of soil alone is taken as the reference optimum moisture content. It can be observed from the table that the decrease in the Optimum Moisture Content of soil-slab polish dust mixtures is ranging from 14.0 % to 12.5 %.

MAXIMUM DRY UNIT WEIGHT: The variation of Maximum Dry Unit Weight with percentage of Slab Polish Dust for Soil-Slab Polish Dust Mixtures shown in Fig.5.3 from the figure, it is seen that the maximum dry unit weight decreases with the increase in percentage of slab polish dust. The percentage decrease in maximum dry unit weight at 10 % of slab polish dust is about 18.71 %.Table – 5.3 shows both the absolute values and percent decrease in maximum dry unit weight for 0 %, 10 %, 15 %, 20 %, 25 % and 30 % of slab polish dust. The percentage decrease in dry unit weight of soil mixture is computed based on maximum dry unit weight of soil alone. It ranges from 0.25 % to 3.05 %.From the aforementioned discussion, it is clear that the optimum moisture content decrease whereas the maximum dry unit weight increase slightly with increase in percentage of slab polish dust.

Table 5.1: Compaction Characteristics of Soil-Slab Polish Dust Mixtures

Water content (%)	Dry unit weght(kn/m³)					
	Slab Polish Dust (%)					
	0	10	15	20	25	30
6	16.5	17.38	18.07	18.07	18.21	17.19
8	16.9	18.25	19.07	19.07	18.79	17.54
10	17.7	18.59	19.44	19.35	19.13	18.88
12	18.2	18.71	19.28	19.28	19.06	19.06
14	17.9	18.64	18.82	18.77	18.6	18.5
16	17.28	18.24	18.2	18.2	18.03	17.91

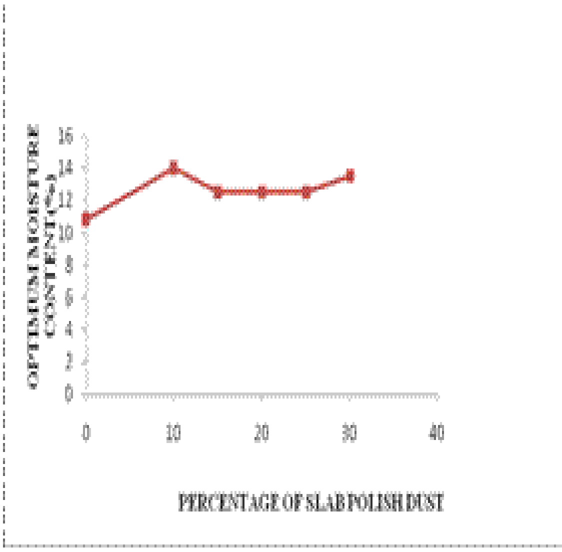


Fig 5.2 Variation of Optimum Moisture Content With Percentage of Slab Polish Dust

CALIFORNIA BEARING RATIO:

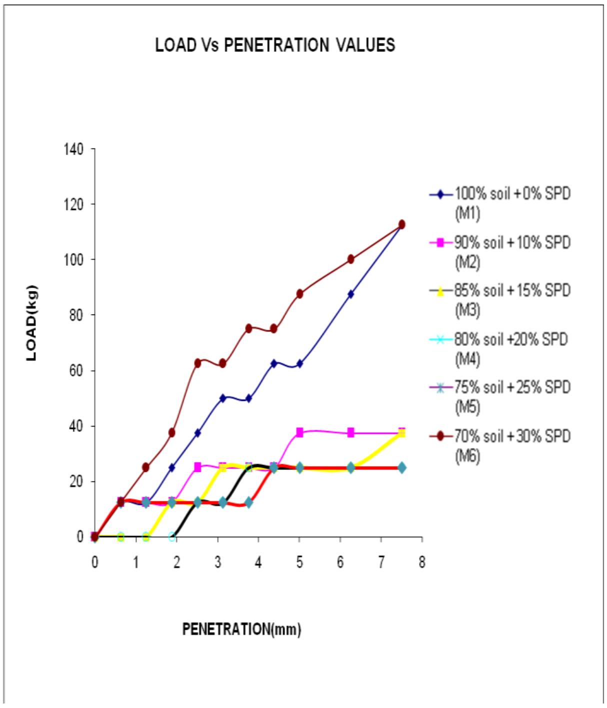
The load-penetration curves of soil mixtures obtained from California Bearing Ratio tests at different percentages of Slab Polish Dust are shown in Fig 6.1. The load-penetration curve of soil alone obtained from the results of California Bearing Ratio test is also shown in Fig 6.1. The load versus penetration values with different percentages of slab polish dust are given in Table 6.1. The Soaked CBR values calculated corresponding to 2.5 mm and 5.0 mm penetrations of the soil alone are 2.55% and 3.55% respectively. The variation of California Bearing Ratio values with addition of different percentages of Slab Polish Dust to the soil at 2.5 mm penetration is plotted in Fig 6.2. From the figure, it is observed that the CBR value of the soil mixtures decreases with percent increase of the Slab Polish Dust. Similarly the variation of California Bearing Ratio values with different percentages of Slab Polish Dust at 5 mm penetration is plotted in Fig 6.3. The same trend is observed in this case too. The CBR values of soil mixed with different percentage of Slab Polish Dust computed at 2.5 mm penetration are tabulated in Table 6.2. In a similar manner the CBR values calculated at 5.0 mm penetration are given in Table 6.3. The percent decrease in CBR values corresponding to 2.5 mm and 5.0 mm penetrations are also shown in these tables. It is observed from Table 6.2 and 6.3 that the CBR values of soil mixtures corresponding to 2.5 mm as well as 5.0 mm penetrations are lower than that of the soil alone. The Un soaked CBR values corresponding to 2.5mm penetration of the soil are 9.142% and 8.68% respectively. The variation of CBR values with addition of different percentages of Slab Polish Dust at 2.5 mm penetration is plotted in Fig 6.4. From the Figure it is observed that the Un Soaked CBR value of the soil mixtures decreases with

percentage increase of the Slab Polish Dust. Similarly the variation of CBR values with addition of different percentages of Slab Polish Dust at 5 mm penetration is plotted in Fig 6.5.

Table 6.1 Load vs Penetration Data for Soaked Condition

Penetration (mm)	Load (kn)					
	Slab polish dust (%)					
	0	10	15	20	25	30
0	0	0	0	0	0	0
0.625	12.51	12.51	0	0	12.51	12.51
1.25	12.51	12.51	0	0	12.51	25.02
1.875	25.02	12.51	12.51	0	12.51	37.53
2.5	37.53	25.02	12.51	12.51	12.51	62.55
3.125	50.04	25.02	25.02	12.51	12.51	62.55
3.75	50.04	25.02	25.02	25.02	12.51	75.06
4.375	62.55	25.02	25.02	25.02	25.02	75.06
5	62.55	37.53	25.02	25.02	25.02	87.57
6.25	87.57	37.53	25.02	25.02	25.02	100.08
7.5	112.59	37.53	37.53	25.02	25.02	112.59

Fig 6.1 Load vs Penetration Curves of Soil – Slab Polish Dust Mixtures for Soaked Condition



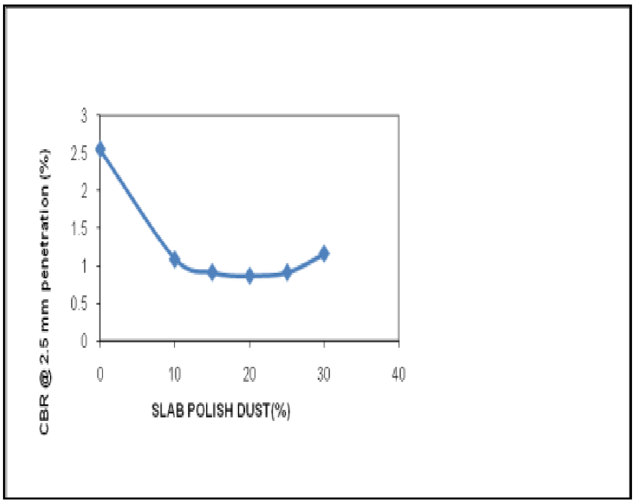


Fig 6.2 Variation of Soaked CBR Values for Soil-Slab Polish Dust Mixtures at 2.5mm Penetration

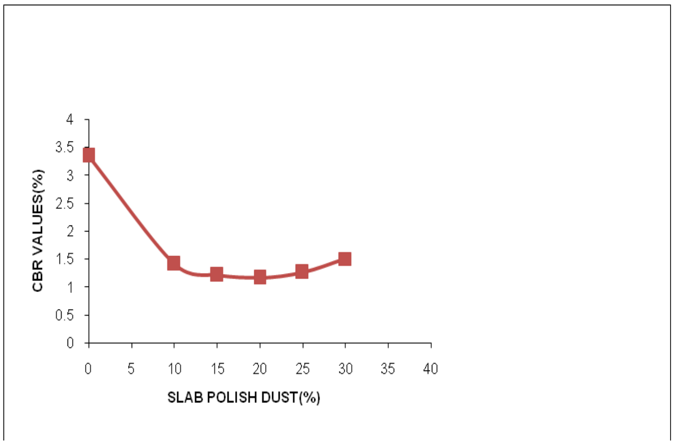


Fig 6.3 Variation of Soaked CBR Values for Soil-Slab Polish Dust Mixtures at 5.0 mm Penetration

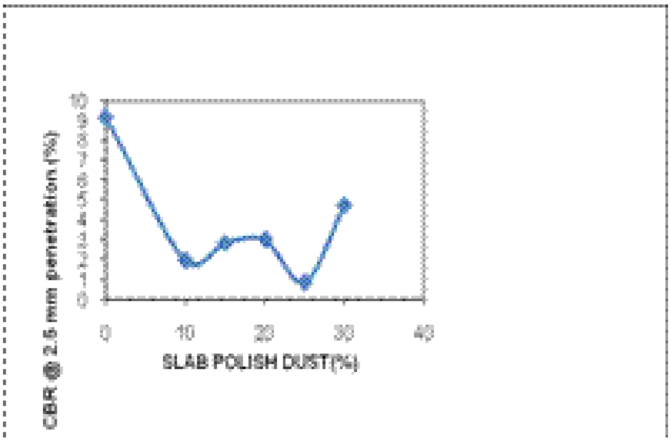


Fig 6.4 Variation of UnSoaked CBR Values for Soil-Slab Polish Dust Mixtures at 2.5mm Penetration

CONCLUSIONS:

- Both the Liquid Limit and Plastic Limit values of the mixed Soil-Slab Polish Dust Mixtures decreases with increase in percentage of Slab Polish Dust.
- The Plasticity index values of Soil-Slab Polish Dust mixtures are less than that of the soil alone.
- The OMC increases slightly with increase in percentage of Slab Polish Dust.
- Maximum Dry Unit Weight decreases with percentage increase of Slab Polish Dust.
- The Soaked CBR values with addition of different percentages of Slab Polish Dust to the soil at 2.5 mm and 5.0 mm penetrations decreases with percentage increase of Slab Polish Dust.
- The UnSoaked CBR values also decreases with addition of different percentages of Slab Polish Dust to the soil at 2.5 mm and 5.0 mm penetrations

REFERENCES

1. Baser, O., 2009, “Stabilization of expansive soils using waste marble dust”,
Master of Science thesis submitted to Civil Engineering Department, Middle East ,Technical University
2 . Chen, F. H., 1988, “Foundations on expansive soils”, Chen & Associates,
Elsevier Publications, U.S.A.
3. Gourley, C. S., Newill, D., and Shreiner, H. D., 1993, Expansive soils: TRL’s research strategy. Proc., 1st Int. Symp. on Engineering Characteristics of arid soil

Author’s Biography:

HARISH P received M Tech degree from Sri Venkateswara University and presently working as Assistant Professor in SKIT College.

Dr.CH.Sudha Rani received Ph.D from Sri Venkateswara University and presently working as professor in the department of Civil Engineering in Sri Venkateswara University.