International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 09 Issue: 02 | Feb 2022 www.irjet.net p-ISSN: 2395-0072

Evaluate Properties of Expansive Soil by the Experimental Study

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Abstract - *In Developing countries like India Civil engineers are frequently challenged to use land with expansive soil, which shows massive volume change against fluctuations of moisture content. Expansive soils, taken into consideration as tricky soils hence, their right identity and characterization turns into an absolute necessity in the attitude of the nowadays geotechnical engineering practice. Expansion and shrinkage of soil can more often than not appear close to the pinnacle surface, Where it's without delay subjected to seasonal and environmental variations. Construction of civil systems on expansive soil is relatively unstable due of seasonal drying and wetting cycle of soil inflicting sizeable deformations. All the time soil motion can harm buildings, roads, and different civil structure, which might be without delay located in this sort of soil. This paper intends to discuss diverse techniques to be had to a subject geotechnical engineer to reap this crucial goal.*

Key Words **: Expansive soil, *Swelling, Shrinkage,* Free swell, SPT, CBR**

1.INTRODUCTION

In India Expansive soil occupies nearly 20% of the available land. Black cotton is one among the expansive soil available in India. Black cotton soil is an expansive soil that generally available within the tropical zones. Their Colour varies from black colour to brown colour. Expansive soil major portion generally found in central part and a some places in south India. Expansive soils known by black cotton soil are available within the Madhya Pradesh, Maharashtra, Gujarat, Andhra Pradesh state and in some parts of Odisha, in India.

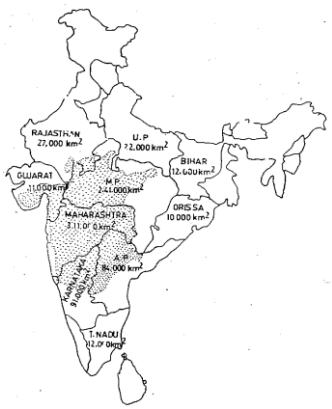

Fig.1.2 Area covered by Expansive Soil in India

This type of soil also available within the valley of river Tapti, Narmada, Godavari and Krishna. The aspect of Deccan plateau and in top part of Krishna and Godavari basin. During this place the black cotton soil intensity is noticeably narrow.

Soils shaped with the aid of using the residual operation of basalt or lure rocks. The preference cause at the back of formation of soils is weathering of igneous rocks, after eruption through the cooling motion of lava. These soil show off excessive plasticity nature.The key clay mineral is montmorillonite. These clays shows more swelling and shrinkage characteristic due to montmorillonite group mineral. The foremost problem with this sort of minerals is instability of earth material. Expansive soils are difficult when they lose water content, and additionally the any other day in the event that they seize water they emerge as tender in nature.

In light weight structure it creates problem, under burden and by changing volumetrically alongside regular dampness variety. Subsequently, In Infrastructure the superstructures generally counter heavily settlement and different developments, bringing about harm to establishment frameworks, basic components and structural elements construction. During a critical number of cases the structure gets to be precarious or dreadful. Notwithstanding when endeavours are made to boost swelling soil, the absence of proper innovation in some cases results volumetric change that are in blame of billion dollars harm each year. It's because of this obsessed. The look was to test the extent of enhancing bearing limit esteem and lessen extensiveness by including added substances. These soils are hard in dry state however lose their load carrying strength when once they're permitted water into the clay structure.so we are able to say that especially expansive soil touchy to changes in environment. These properties have made the soil inadmissible for structural designing purposes or embankment material or foundation material.

Fig.1.2 EXPANSIVE SOIL

2. MATERIALS AND METHODOLOGY

For the present research work, Black cotton soil was collected from Kadana in Mahisagar district Gujarat by method of distributed method of sampling. The air dried will be pulverized using wooden hammer.

The various tests will be conduct in the geotechnical laboratory for engineering properties of black cotton soil. Various important tests are perform in the laboratory as per the relevant IS code:

1. Specific gravity (IS: 2720 PART III/ Sec I) – 1980

2. Liquid limit (IS: 2720 PART-V)-1985.

3. Plastic limit (IS: 2720 PART-V)-1985.

4. Free Swell index test of Soil (IS-2720-PART-40-1970)

5. Standard Proctor Test (IS-2720(Part-7),1965)

6. CBR (California Bearing Ratio) test of soil (IS-2720-PART-16-1979)

3. RESULTS AND DISCUSSIONS

3.1. SPECIFIC GRAVITY TEST

OBSERVATION	SAMPLE	
	1	2
Mass of empty bottle (W_1)gm	663	663
Mass of pycnometer + mass of dry soil (W_2)gm	863	863
Mass of pycnometer + mass of dry soil + water (W_3)gm	1730	1732
Mass of pycnometer + water (W_4)gm	1615	1616
Specific gravity (Gs) = $\frac{(W2-W1)}{((W2-W1)-(W3-W4))}$	2.35	2.38

Table 3.1: Determination of specific gravity of BCS

Result:

Specific gravity of black cotton soil is 2.38.

3.2. LIQUID LIMIT TEST:

Container No.	A	B	C	D	E
No. of blows	12	21	29	36	44
Wt. of bowl (W_0) gm	92	95	91	91	95
Wt. of container + wet soil (W_1) gm	108.3	115	119	120	110
Wt. of container + oven dry soil (W_2) gm	103.3	109	111	112	106
Wt. of water (W_1-W_2) gm	5	6	8	8	4
Wt. of dry soil (W_2-W_0) gm	11.3	14	20	21	11
Water content (%w)	44.25	42.85	40.00	38.1	36.36

Table 3.2: Determination of liquid limit of normal BCS

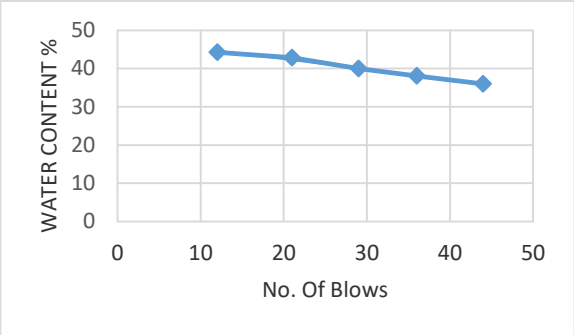

Fig. 3.1 liquid limit of BCS

Result:

Moisture content at 25 blows from the graph and by interpolation of above data Liquid Limit = 41.425%.

3.3. PLASTIC LIMIT TEST:

Container No.	1	2	3
Wt. of container W_0(gm)	95	82	92
Wt. of container + wet soil (W_1)gm	102	92	104
Wt. of container + dry soil (W_2)gm	104	90	101
Wt. of water (W_1-W_2)gm	2	2	3
Wt. of dry soil (W_2-W_0)gm	9	8	9
Water content (%w)	22.22	25	33.33

Table 3.3: Determination of plastic limit of BCS

Result:

Plastic limit $Wp = \frac{(w1+w2+w3)}{3} = \frac{(22.22+25+33.33)}{3}$

= 26.85%

Plasticity index = W_L-W_P

= (41.425-26.85) % = 14.575%

3.4. FREE SWELL INDEX TEST

Vd = 10 mm
Vk = 7.5 mm

% free swell index = $\frac{Vd-Vk}{Vk} * 100$

$= \frac{(10-7.5)}{7.5} * 100$

= 33.33%

Result:

Free swell index of BCS = 33.33%

3.5. STANDARD PROCTOR TEST

OBSERVATION	1	2	3	4	5
Wt. of empty mould (M_1)gm	3661	3361	3661	3661	3661
Wt. of mould + compacted soil (M_2)gm	5419	5454	5555	5589	5577
Wt. of compacted soil (M_2-M_1)gm	1758	1793	1894	1928	1916
Bulk density	1.76	1.79	1.89	1.93	1.92
Water content (%w)	17.2	18.8	23.1	25	25.9
Dry density (gm/cm^3)	1.5	1.51	1.54	1.54	1.52

Table 4.4:determination of MDD & OMC of Expansive soil

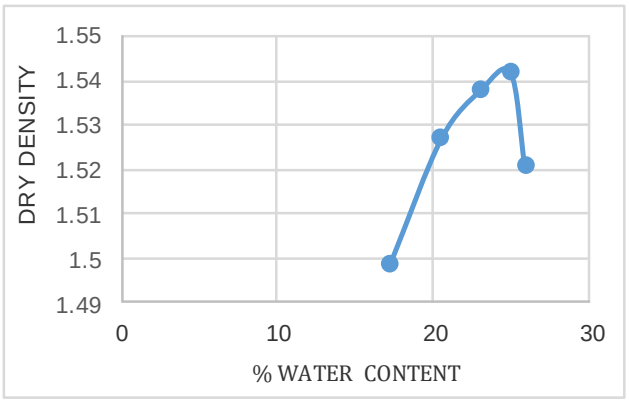

Fig. 3.2 OMC and MDD of Expansive soil

Result: from the graph,

Optimum moisture content (OMC): 24.6%

Maximum dry density (MDD): 1.543 gm/cm^3 =15.13KN/m^3

Penetration (mm)	Proving Ring (div)	Test load (kg)
0.5	3	3.71
1.0	4	4.94
1.5	5	6.18
2.0	6	7.42
2.5	7	8.65
3.0	8	9.89
4.0	9	11.12
5.0	10	12.36
7.5	12	14.83
10.0	14.5	17.92
12.5	16	19.78

Table 4.5. California Bearing Ratio Test

3.6. CALIFORNIA BEARING RATIO (CBR)

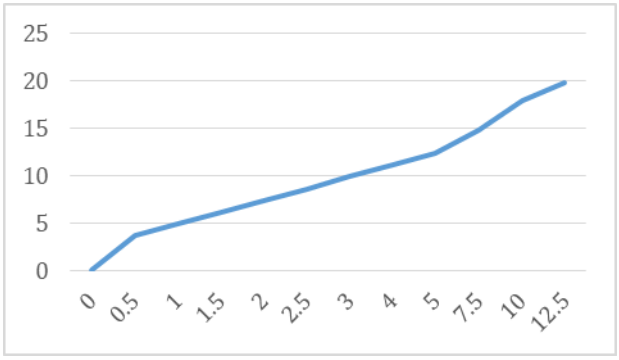

Fig. 3.3 load penetration curve

Result:

Penetration Value

For 2.5mm = (8.64/1370) ×100= 0.63 %

For 5mm = (12.36/2055)×100= 0.60 %

4. CONCLUSIONS

From the evaluation study of Properties Of Expansive Soil it is concluded that the soil testing shold be done first before any construction on expansive soil. Various properties of expansive soil from this study are as below:

Properties	Value
Colour	Black
Specific Gravity	2.38
Liquid Limit(%)	41.42
Plastic Limit(%)	26.85
Plasticity Index(%)	14.57
Free Swell Index	33.33
Maximum Dry Density(kN/M²)	24.6
Optimum Moisture Content(%)	15.13
California Bearing Ratio(%)	0.6

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