Engineering Properties of Red Soils In North Coastal Districts Of Andhra Pradesh – Vishakhapatnam Regions

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Abstract: Visakhapatnam region is largely covered by red soils. These are found in warm temperate, moist climate under deciduous conditions and not capable of retaining moisture which are and red in colour due to rich iron contents. These soils have high potential applications as geotechnical material in civil engineering structures. Due to inherent reasons these soils subjected to volume reduction under saturation cause differentiation settlement. To study the volume change behaviour i.e (collapsibility), 30 soils were collected and tested for various geotechnical characteristics. Based on the test results the rate and quality of collapsibility of these soils are characterized with respect to Index and Engineering Properties.

Keywords: Red Soils, Volume Change behaviour, collapsibility, geotechnical Characteristics.

1. INTRODUCTION:

Collapsible behaviour of red soils can be considered as critical issue for construction of infrastructural projects especially road networking. The geotechnical engineers have been frequently encountering the challenges during design, construction and maintenance of structures founded on red soils. The challenges are related to differential settlements, loss of shear strength and volume reduction cause pumping of subgrade material under traffic loading. The above phenomena will reflect on the road surface as rough and bumpy which will demand frequent repair and rehabilitation increases the maintenance cost.

Some of the earlier thinkers worked for understanding of collapsible soils are Mitchell and Soga (2005), Pereira et al (2000), Clemence and finbarr (1981), Jennings and knight (1957), Bell and Bruyn (1997),

In the present analysis 30 red soils from Vishakhapatnam region in north coastal districts of Andhra Pradesh were collected and tested for their geotechnical characterization. Based on these values, their effective utilization in geotechnical applications has been verified.

2. MATERIALS:

To study the geotechnical characterization of red soils in Visakhapatnam region, the soil samples were collected at a depth of 1.0 – 1.5m from the ground level and the collected samples were dried and subjected for geotechnical characteristics such as grain size distribution, plasticity, compaction and strength as per IS 2720.

3. TESTS & RESULTS:

3.1) Grain Size Distribution:

The collected red soil samples were dried and tested for grain size distribution by performing dry sieve analysis (IS 2720-Part 4-1985) wet sieve analysis and the results are shown in table 1.

TABLE 1: GEOTECHNICAL PROPERTIES OF RED SOIL OF VISAKHAPATNAM REGION

Property	Values		
Gradation Properties			
Gravel (%)	0	0	0
Sand (%)	74 – 85	74-84	56-80
Fines (%)	15 – 26	16 – 26	20 - 44
Silt (%)	14 – 21	10-16	12 – 28
Clay (%)	0 – 6	4 – 12	8 – 16
Specific Gravity (G)	2.65 – 2.66	2.65 – 2.66	2.6 – 2.67
Index Properties			
Liquid Limit (%) (W_L)	20 – 23	22 – 26	25 – 34
Plastic Limit (%) (W_P)	17 – 19	17 – 19	18 – 20
Plasticity Index (I_p)	3 – 4	5 – 7	7 – 14
IS Classification	SM	SM – SC	SC
Compaction Characteristics			
Optimum Moisture Content (OMC %)	8.8 – 9.5	9 – 10.4	10 – 12.5
Maximum dry density (MDD g/cc)	1.68 – 1.75	1.75 – 1.80	1.76 – 1.80
Strength Parameters At OMC & MDD			
C (t/m^2)	1.0 -1.4	1.2 – 1.7	1.6 – 3.0
Φ (Degrees)	28-30	26 – 29	22 – 28
Strength Parameters At Saturated Condition			
C_s (t/m^2)	0.4 – 0.8	0.5 – 0.9	0.8-1.8
Φ_s (Degrees)	20-24	20 – 23	16 – 20
CBR%	4.2 – 5.0	5.0 - 5.5	5.3 – 6.2

Grain size distribution analysis shows that red soils are dominated by sand particles (4.75 mm – 0.075mm) of ranging from 56 – 85% and fines (< 0.075 mm) in the range of 15 – 44% out of which silt particles (0.075mm – 0.002mm) are in the range of 10 – 28% and clay particles (< 0.002 mm) are in the range of 4 – 16%.

3.2) Plasticity Characterization:

To know the plasticity characteristics, liquid limit by casagrande's method (I.S 2720-Part-5-1985).Plastic limit (IS 2720-Part-5-1985) were performed and plasticity indices were calculated for all the red soils and the results are shown in table 1 and shown in fig 1-2.

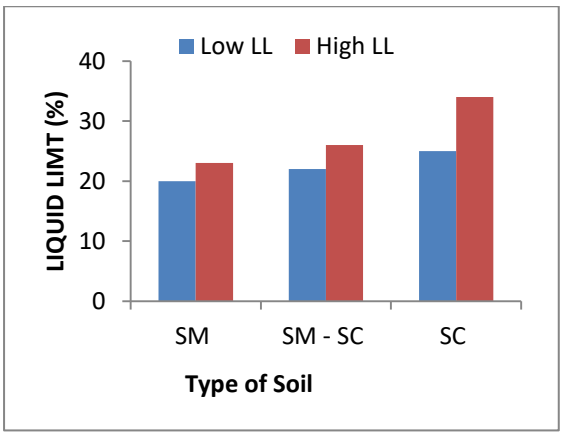

Fig: 1. Variation of Liquid Limit (%)

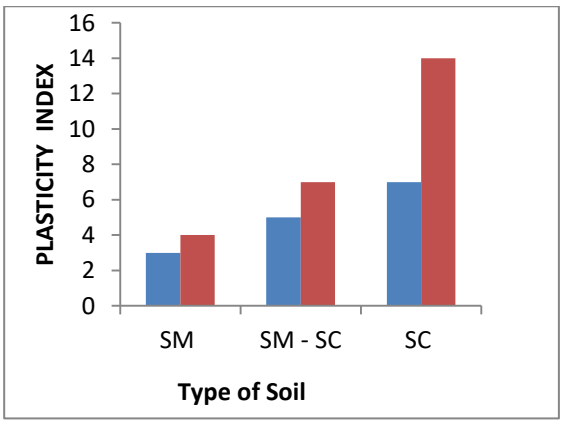

Fig: 2. Variation of Plasticity Index (%)

From the test results of Index Properties it is identified that liquid limit is in the range of 20-34%, and Plasticity Index is in the range of 3-14.

3.3) Compaction Characteristics:

To know the compaction characteristics of red soils modified proctor test (IS-2720-Part-7-1980) was performed compacting by the red soil to 5 layers, each is subjected by 25 numbers of blows with a rammer of 4.89 kg weight and height of fall of 45 cm and the results are Shown in table 1&Fig.3-4.

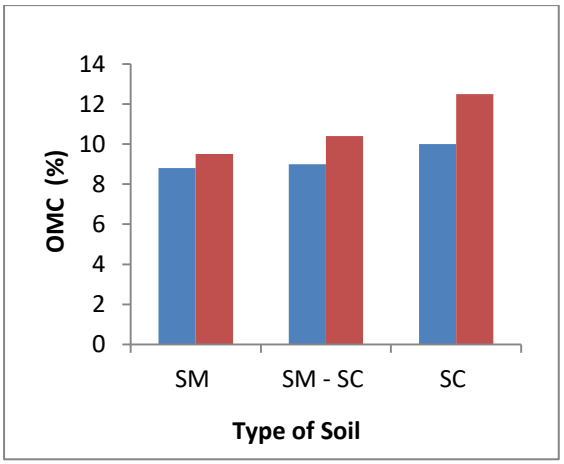

Fig: 3. Variation of OMC (%)

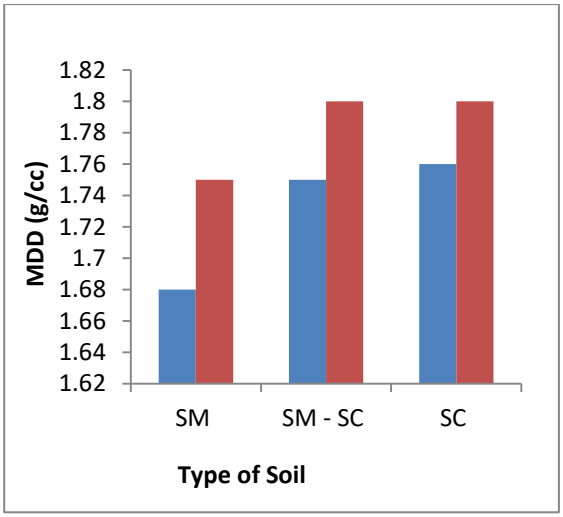

Fig: 4. Variation of MDD (g/cc)

From the test results it is identified that the maximum dry densities are in the range of 1.68 g/cc – 1.80 g/cc where as OMC values are in the range of 8.8% - 12.5%.

3.4) Strength Characteristics:

To know the shear strength parameters such c & φ, the samples were prepared at their OMC & MDD and these were subjected for loading undrained condition in direct shear apparatus. High shear strength value in terms cohesion (c) as 3.0 t/m^2 and angle of shearing resistance (φ) as 30^o. Similarly at saturated condition, Cohesion (c_s) as 1.8t/m^2 and (φ_s) as 24^o respectively are shown in table 1 & fig: 5&6.

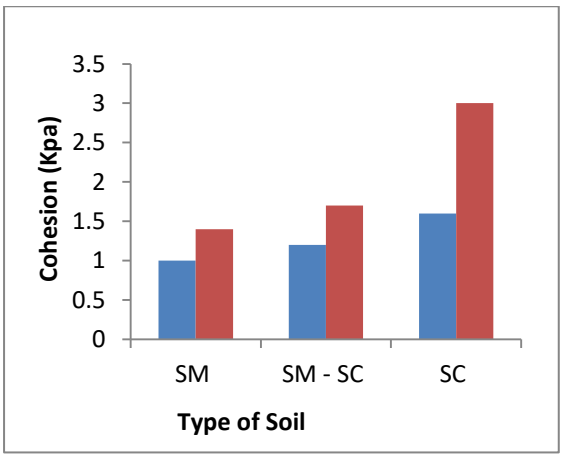

Fig: 5. Variation of Cohesion (t/m^2)

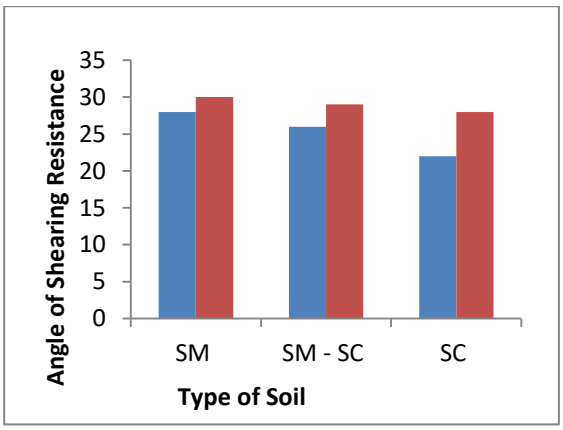

Fig: 6. Variation of Shearing Resistance

3.5) Cbr Characteristics:

To know the CBR values of soil samples, CBR tests (IS: 2720-Part-16-1986) was conducted on samples compacted at their OMC & MDD and the results are shown in table 1 & fig: 7.

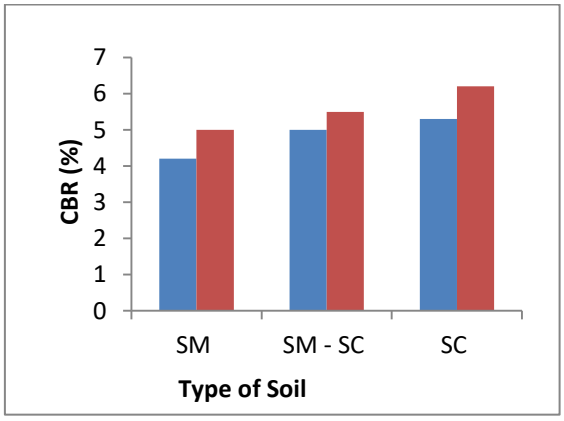

Fig: 8. Variation of CBR (%)

3.6) Affect of grain size composition on plasticity, Compaction and Strength characteristics of red soil:

Based on the test results of red soil samples collected from Visakhapatnam region of north coastal districts of Andhra Pradesh the following identifications are made:

- ✓ Based on the percentage of fines, plasticity index these 30 soils are classified into SM, SM-SC and SC Soils as per IS: 1498-1970.
- ✓ Increasing the percentage of fines increases liquid limit, and plasticity index values i.e., in SM-SC and SC soils where as increasing the percentage of sand decreases liquid limit and plasticity index values. i.e in SM soils.
- ✓ Increasing the percentage of fines increases OMC and MDD values i.e., fines helps in filling up of voids to achieve cohesive and dense matrix.
- ✓ Similarly the same trend is also observed in CBR values.
- ✓ High shear strength values are obtained when the samples are compacted at their maximum dry density and optimum moisture content. Shear strength parameters Cohesion (C) is high for SC soils and angle of shearing resistance (φ) is high for SM soils. Due to increase in the percentage of fines and sand particles respectively.
- ✓ In saturation condition abnormal decrease in cohesion (C_s) and angle of shearing resistance (φ_s) are observed which are in the range of 0.4 – 1.8 t/m^2 and 16^o-24^o range.

- ✓ By observing the engineering properties of red soils low maximum dry densities (less than 2 g/cc) were obtained compared to coarse grained like gravel, sandy gravel, gravely sands etc., and angle of shearing resistance less than 36^0 compared to the above.
- ✓ The decrease in strength values at saturated condition is due to loss of adhesion (bond) between sand particles by leaching of salts, breaking of buttress and loss of friction between sand particles this phenomenon leads to sudden decrease of strength causes volume decrease.

4.0 APPLICATIONS:

- ✓ Dry densities in the range of 1.6-1.8g/cc and plasticity index IP ≤ 7 can be used as fill and embankment shoulder materials.
- ✓ CBR values in between 4-6 can be effectively used as Subgrade for low traffic intensity roads, rural roads, highways.

5. CONCLUSION:

Based on the present experimental results, here we concluded that:

When the red soils are well compacted they can attain high density and bearing values i.e., CBR, c & φ can be effectively used in civil Engineering constructions with less distress and less maintenance cost.

REFERENCES:

[1]. Clemence, S. P,. And Finbarr, A. O. (1981). "Design Considerations for collapsible soils." Journal of the Geotechnical Engineering Division, Vol.107 (No, GT3), 305-31.

[2]. Jennings, J.E and Knight, K. (1975): "A guide to construction on or with materials exhibiting additional settlement due to collapse of grain structure." Proceedings, 6th regional Conference for Africa on Soil Mechanics and Foundation Engineering, Durban, South Africa, Vol.1, pp.99-105.

[3]. Krishnamacharyulu, K.Sarma, V.B. Suryanarayana and V.Viswanadham (1975). "A brief survey of the red soils of waltair uplands" Seminar on foundation problems of coastal district of A.P.

[4]. Mitchell, J. K., and Soga, K. (2005). Fundamentals of soil behaviour, John Wiley& Sons Hoboken, N.J.

[5]. Pradeep Muley, Jain P.K (2010), "Experimental studies on utilization of morrum as hard shoulder material", International Journal of engineering Science and technology. Vol. 2(9), 2010, p. no. 4896-4901.

[6]. Pereira, J.H. F., and Fredlund, D. G. (2000). "Volume change behaviour of collapsible compacted gneiss soil." Journal of Geotechnical and Geoenvironmental Engineering, 126(10), 907-916

[7]. 7. IS 2720: Part 13:1986 Methods of Test for Soils – Part 13 Direct shear test.

[8]. IS 2720: Part 16:1986 Methods of Test for Soils – Part 16 Laboratory Determination of CBR.

[9]. IS 2720: Part 4:1985 Methods of Test for Soils – Part 4 Grain Size Analysis.10

[10]. IS 2720: Part 8:1986 Methods of Test for Soils – Part 8 Laboratory Determination of Water Content – Dry Density relation using Heavy Compaction.

[11]. TarhReema, Ajanta Kalita, "Strength characteristics of red soils blended with fly ash and lime", International Journal of Innovative Research in Science, Engineering and Technology, Vol. 4(3), March 2014.