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EXPERIMENTAL INVESTIGATION OF SUB SOIL PROFILE USING GIS

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ABSTRACT

In this paper, GIS technology integrates common database operation such as query and statistical analysis benefits offered by maps. This ability distinguish GIS from other information system and makes it valuable to a wide range of public and private enterprises for explaining events, predicting outcome and planning strategies. The soils at various places of the particular area are collected at the closest distance. QGIS open source software is used for mapping. We have collected samples from four places. From each place 6 KG of soil is collected. The current latitude and longitude position from where the samples are taken are located using GPS and are noted down. The Test was Carried on the Shear strength of the Soil are found by the Direct Shear Test, Bearing capacity of the Soil are found by the CBR(California Bearing Ratio, Permeability of the Soil are found by the Falling Head Flow Method for the Different Location.

Key words: GIS, Direct Shear Test, Bearing Capacity, Permeability.

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1. INTRODUCTION

Geographic Information System (GIS) is a computer tool for mapping and analyzing things that exist. GIS technology is common database operation such as query and statistical analysis benefits offered

by maps. This ability distinguish GIS from other information system and makes it valuable to a wide range of public and private enterprises for explaining events, predicting outcome and planning strategies. Techniques of geostatistics are used to perform traditional statistical analysis and spatial structural analysis with Arc GIS, geostatistical software GS+ and statistical software [1, 2]. Analyse soil nutrient content and the state of applied fertilizers in the northern plain of Henan province, which provides theoretical basis for the proper utilization of soil resources, scientific managing for agricultural production and promoting combined revenues of agricultural production [3]. Some [4, 5] have described characteristics of spatial variation of soil nutrients in the specific areas. Besides, it can also provide decision support [6,7] and some guidance for proper fertilization based on the actual content of soil nutrients and the demand for them. The soils at various places of the particular area are collected at the closest distance. The soil samples are collected from various places manually. QGIS open source software is used for mapping.

1.1. Collection of Samples and Data

The soil samples are collected from various locations of the selected area. Here the selected area is the trichirappalli district. We have collected samples from four places. From each place 6KG of soil is collected. The current latitude and longitude position from where the samples are taken are located using GPS and are noted down. These are the activities that we have carried out in the collection process. The values for samples collected from various places are noted down. Now the values are entered into the open source software by creating separate programs for each test. Thus three separate maps are prepared each indicating a property. Finally the three maps are joined. Thus final map showing the three properties of the soil for a particular selected area is obtained.

2. PROCEDURE OF THE SOIL TEST

2.1. Direct Shear Test for Shear Strength of the Soil

The shear box with bottom grid plate is filled with the soil up to its top level. The calculated quantity of sand needed to obtain the void ratio is kept on the layers into the direct shear mould to the required height of 2cm. Place the grid plate at top perpendicular to the shear loading direction and place the pins in the device. Place the specimen in the loading device and put the loading pad with the initial load of say 4kg on the specimen now apply the load by turning the wheel slowly. When the load dial just starts moving remove the shear pins. Continue to apply the load till the specimen fails, this is the load at which the proving ring does not increase. Take the specimen from the loading device and increase the load take a new specimen with the same soil. Place the specimen in the loading device and increase the loading by 1kg say from 4kg to 5kg apply the load and find the shear failure load. Repeat the process by increasing the weight and note down the shear loads. Table 1 shows the shear strength range for different types of soil.

Table 1 The shear strength range for different types of soil.

Soil Type	Angle of Friction
Sand and gravel mixture	33-36
Well graded sand	32-35
Fine to medium sand	29-32
Silt sand	27-32
Silt (non-plastic)	26-30

2.2. CBR (California Bearing Ratio) Test for Bearing Capacity of the Soil

CBR is defined as the ratio of the load required to penetrate a soil mass with circular plunger of 50mm diameter at the rate of 1.25mm/min to the standard load corresponding to the penetration of the standard material. The standard loads for 2.5mm penetration is 1370kg and for 5mm penetration is 2055kg. Place the mold assembly in the loading machine filled with the standard plunger surcharge weights are placed on the specimen to represent the pavement loading. Fix the proving ring and dial gauge on position set the penetration at the center of the specimen with the smallest possible load. Now apply the load on the piston at the rate of 1.25mm/minute of the piston penetration Record the load readings at the penetration of 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 4.0, 5.0, 7.5, 10 and 12.5mm. Detach the mold from the loading equipment. Draw a smooth curve connecting penetration along x-axis and load along y-axis. If the initial portion of the curve is concave upwards, correction is to be applied by drawing a tangent to the curve at the point of great slope. The values of the load at corrected penetration of 2.5mm and 5.0mm are noted. If these two loads are P1 and P2 respectively The value of CBR = P1/1370 *100 for 2.5mm penetration The value of CBR =P2/2055 *100 for 5mm penetration will be less than 2.5mm take the lower of these two If the CBR value of 5mm penetration is more repeat the test by reversing the specimen. If identical results follow the CBR value of 5mm penetration shall be taken for design.

Table 2 The Bearing Capacity for different types of soil.

Soil Type	Allowable Bearing Capacity
Rock	3240
Soft Rock	440
Course Sand	440
Medium Sand	245
Fine Sand	440
Stiff Sand	100
Soft Clay	100
Very Soft Clay	50

2.3. Falling Head Flow Method Test for the Permeability of the Soil

Permeability is defined as the rate of flow of water under laminar conditions through a unit cross sectional area perpendicular to the direction of flow through a porous medium under unit hydraulic gradient. According to

Darcy's law, $Q = kiA$ (1)

K is coefficient of permeability, I is hydraulic gradient and A is area if cross section of soil normal to the direction of flow. Take some quantity of the given soil and add water content raised to the optimum moisture content. Fill the soil in the mould assembly. Place the porous paper at the bottom and fix the gaskets and connect the specimen in the testing glass stand pipe and outlet pipe. Fill the water in the stand pipe say a height of H_1 and allow the water to pass through the soil sample up to the height of H_2 and note down the time for the water level to cross from H_1 to H_2. Again allow water to pass through the soil sample up to the height and note down the time head drop. Repeat the procedure for different H_1 and H_2 and note down the time. Compute the area of cross section of the stand pipe as well as the mould specimen. Calculate the coefficient of permeability form, the table 3 shows the permeability range for the different type of soil and table 4 shows the location of sample site.

$$K = (q / A) * (L / t) * \log (H_1 / H_2) \quad (2)$$

Table 3 The Permeability Range for different types of soil.

Permeability	Water %	Classification
High	f<15%	G1-G3, S1-S3
Medium	15%f<f<65%	G4 G5 S4
Low	f>65%	F5 F6 F7

Table 4 The Location of Sample Site

No	Location	Latitude	Longitude
1	Ponmalai	10.788	78.707
2	Airport	10.763	78.704
3	Mannarpuram	10.781	76.687

3. RESULTS AND DISCUSSION

3.1. Determination of California Bearing Ratio

Proving ring constant 1division is 11.6kg.

Dial gauge lease count 1division is 0.01mm.

The table 5 shows the California Bearing Ratio Result for three locations and the CBR value is calculated for the three different areas.

Table 5 California Bearing Ratio Result for Sample

No	Dial Reading	Proving Ring	Penetration	Load(kg)	Penetration	Load(kg)	Penetration	Load(kg)
			Ponmalai		Airport		Mannarpuram	
1	0	0	0	0	0	0	0	0
2	100	1	42	130.46	47	153.27	46	149.48
3	200	2	62	194.81	65	204.25	64	214.45
4	300	3	71	241.18	89	260.60	86	251.05
5	400	4	88	284.97	106	294.56	99	293.91
6	500	5	105	322.36	105	322.36	120	314.13
7	600	6	132	376.18	132	376.18	134	351.55

Based on 2.5mm penetration is $(P_1/1370)*100$ is 16.058

Based on 5mm Penetration is (P2/2045)*100 is 15.686

Maximum CBR value of the soil is 16.058% located in Ponmalai and Airport.

Based on 2.5mm penetration is $(P_1/1370)*100$ is 17.09.

Based on 5mm Penetration is (P2/2055)*100 is 15.28.

Maximum CBR value of the soil is 17.09%located in Mannarpuram.

3.2. Determination of Falling Head Permeability Test

The Table 6 shows the falling Head Permeability Test Result for Sample and the Co-efficient of permeability of the soil is calculated using the equation (1) and (2).

Area or sample is 44.18cm^2

Table 6 Falling Head Permeability Test Result for Sample

No	Initial Head	Final Head	Time	Permeability	Initial Head	Final Head	Time	Permeability	Initial Head	Final Head	Time	Permeability
	Ponmalai				Airport				Mannarpuram			
1	154.8	149.7	40.78	3.248*	154.46	142.04	17.34	8.324*	142.14	139.45	39.45	2.725*
2	142.7	138.2	68.87	1.990*	135.43	128.42	67.65	2.070*	134.84	129.84	50.58	1.735*
3	135.6	128.7	84.84	1.648*	124.02	117.38	82.48	1.700*	126.18	125.5	79.45	1.679*
4	120.4	114.4	111.81	1.249*	115.45	102.85	115.6	1.294*	114.15	109.15	112.15	1.237*

Co-efficient of permeability of the soil is 2.033*cm/sec located in Ponmalai.

Co-efficient of permeability of the soil is 3.347*cm/sec located in Airport.

Co-efficient of permeability of the soil is 1.844*cm/sec located in Mannarpuram.

3.3. Determination of direct shear test.

Table 7 Direct Shear Test Result for Sample

No	Normal load	Normal stress	Proving ring reading	Shear load I division= 0.8	Shear stress	Proving ring reading	Shear load I division= 0.8	Shear stress	Proving ring reading	Shear load I division= 0.8	Shear stress
			Ponmalai			Airport			Mannarpuram		
1	4	0.11	11	2.1	0.05	11	1.25	0.03	11	1.44	0.04
2	5	0.13	18	3.1	0.08	18	2.05	0.05	21	3.48	0.09
3	6	0.16	25	3.7	0.1	24	3.52	0.09	27	4.17	0.11
4	7	0.19	32	5.2	0.14	36	4.45	0.12	40	5.44	0.15

Area of shear box is 6cm*6cm is36cm^2

Normal stress is 6/36 is 0.16kg/m^2

Shear parameters of the soil is Cohesion[c] = 0 and Angle of internal friction[ϕ] for the Ponmalai is 33.99, for the Airport is 26.40 and for the Manarpuram 32.70.

4. CONCLUSION

This paper presents subsurface geotechnical information of ponmalai city in the form of GIS based maps in order to provide the database for preliminary assessment of subsoil of various cities. Design of an airport, the shear parameters and depth of penetration are found out as per GIS based maps for various cities with the data based on latitude and longitude given by the GIS map information. N-Value Contour map and average shear parameter have been developed. Though this GIS based maps have many inherent shortcomings, Yet it can be used for preliminary foundation design and foundation design of low cost structures for which detailed subsoil investigations are evaluated.

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