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Influence of Clay and Silt on the Physical Properties of Major Soil Groups of Madurai District (Tamil Nadu)

By

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ABSTRACT

Fortythree profile soil samples from two profiles of each five major soil groups representing alluvial, black, red, laterite and colluvial soils were collected and analysed for mechanical fractions and physical properties. The physical properties like percentage of pore space, moisture equivalent, upper and lower plasticity, maximum water holding capacity and hygroscopic moisture at 99.8 per cent relative humidity were found to be influenced by both clay and silt while volume expansion on wetting and hygroscopic moisture at 50 per cent relative humidity by clay alone.

INTRODUCTION

Four major soil groups namely alluvial, black, red and laterite soils occupy most of the area in South India while colluvial soils occupy small portions near hillocks. The productivity of these soils is mostly influenced by their physical properties which in turn are influenced by the mechanical fractions especially clay and silt. Keen and Raczkowski (1921) observed a positive correlation between the physical properties and the clay content of a soil. In order to account for the variations of properties that are exhibited by various types of soils due to mechanical composition especially clay and silt, a detailed investigation of the major soils of South India with regard to physical properties of the soils was made. The present paper deals with the results of the studies.

MATERIALS AND METHODS

Fortythree soil samples from two typical profiles from each of the five major soil groups of Madurai district of Tamil Nadu *viz.* alluvial, black, red laterite and colluvial were collected and processed for analysis. The processed samples were analysed for mechanical fractions by the international pipette method outlined by Piper (1950). Physical properties by using Keen-Raczknowski brass cup-method and moisture constants as described by Sankaram (1965). With the data obtained simple correlations were worked out and regression equations were set up for significant correlations.

RESULTS AND DISCUSSION

It was observed that black soils had the highest amount of clay

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throughout the profile and that red soils contained lesser amount of finer fractions than other soils. These observations are similar to those made by Menon and Mariakulandai (1957 a, b, c). The above workers also observed laterite soil to contain more than 50 per cent clay which is also in agreement with the results of the present study.

Maximum water holding capacity was high in black soils due to high amount of clay. A high significant correlation was observed between finer fractions and maximum water holding capacity (r=0.69 and 0.66 for clay and silt respectively). That may be due to absorption of more water by finer fractions. Janarthanan Nair *et al.* (1966) found that water holding

TABLE I. Physical Properties of the Soils

Soil Samples Depth in cm	Clay %	Silt %	Hygroscopic Coefficient at 99.8% R. H.	Hygroscopic Coefficient at 50% R. H.	Moisture equivalent %	Lower plasticity number	Upper plasticity number	Maximum water holding capacity %	Pore space %	Volume expansion on wetting %	Apparent density	Absolute specific gravity
Profile 1: Alluvial Soil												
0—30	11.9	2.8	2.2	1.2	6.9	17.7	25.3	31.4	42	8.8	1.39	2.18
30—60	11.9	3.6	2.5	1.5	9.6	21.1	29.4	38.6	40	9.5	1.38	2.33
60—75	8.6	8.9	2.6	1.6	10.6	20.9	33.1	37.2	40	10.3	1.39	1.91
75—115	8.9	3.6	2.3	1.7	10.3	17.8	28.1	32.3	51	8.3	1.57	2.78
115—165	3.6	5.5	6.6	4.1	21.4	26.2	40.5	49.4	61	27.4	1.42	2.78
Profile 2: Alluvial Soil												
0—30	21.5	11.8	5.2	2.6	14.7	22.6	43.2	55.2	44	15.5	1.33	1.84
30—60	23.7	34.0	6.6	5.0	17.1	39.9	60.8	66.9	51	22.0	1.29	1.82
60—90	28.5	25.3	7.9	5.2	26.0	39.5	39.9	66.7	57	26.3	1.22	1.91
90—120	28.8	21.4	8.7	5.4	26.5	36.9	49.5	42.7	63	15.7	1.29	2.33
120—165	10.7	7.0	9.0	5.5	13.9	17.7	48.3	36.0	44	9.6	1.32	2.16
Profile 3: Black Soil												
0—30	47.4	16.0	8.9	6.0	35.5	28.7	62.6	58.8	62	43.3	1.30	2.28
30—60	51.6	11.6	10.0	6.8	35.8	29.7	55.1	56.5	64	53.9	1.41	2.51
60—95	51.1	14.8	10.7	7.0	42.5	34.4	62.2	65.5	69	67.0	1.41	2.71
95—120	57.5	14.9	10.2	7.4	50.3	32.0	74.0	77.8	71	78.4	1.32	2.03
Profile 4: Black Soil												
0—22.5	51.0	9.6	10.5	8.2	34.2	33.6	59.6	58.9	65	50.0	1.29	2.36
22.5—45	57.9	10.0	12.6	9.0	36.1	32.1	71.4	64.4	70	46.8	1.23	2.63
45—85	61.3	7.6	14.0	9.8	40.6	38.6	70.0	63.6	69	49.6	1.21	2.40

TABLE I. Physical Properties of the Soils — *(Contd.)*

Soil Samples Depth in cms.	Clay %	Silt %	Hygroscopic Coefficient at 99.8% R. H.	Hygroscopic Coefficient at 50% R. H.	Moisture equivalent %	Lower plasticity number	Upper plasticity number	Maximum water holding capacity %	Pore space %	Volume expansion on wetting %	Apparent density	Absolute specific gravity
Profile 5: Red Soil												
0—20	21.9	5.7	3.6	1.4	10.2	14.9	25.1	30.5	48	13.2	1.53	2.57
20—40	26.0	3.1	3.8	1.6	12.0	14.7	21.5	31.7	48	11.9	1.47	2.51
40—100	39.5	3.3	4.7	2.0	13.9	16.5	35.5	36.4	51	16.9	1.40	2.36
Profile 6: Red Soil												
0—45	14.9	4.4	3.1	2.0	8.7	14.5	23.9	29.3	47	12.2	1.43	2.19
45—80	29.0	9.5	5.5	3.7	19.0	20.4	37.0	37.0	49	20.1	1.37	2.26
80—115	23.5	10.9	6.1	3.7	17.2	20.5	28.4	36.6	47	23.0	1.37	2.09
115—150	22.2	5.4	6.4	4.2	13.8	20.4	32.2	34.6	46	19.7	1.36	2.07
Profile 7: Laterite Soil												
0—45	24.2	17.7	11.1	8.4	19.9	37.0	53.0	46.3	57	13.8	1.29	2.18
45—90	22.0	12.0	4.9	2.9	19.8	31.4	42.5	39.6	49	8.7	1.18	2.09
90—135	37.4	20.0	7.2	3.4	30.9	44.0	65.8	48.0	52	9.8	1.14	2.01
135—192.5	29.2	18.0	6.5	3.3	28.8	42.2	58.0	55.4	55	14.2	1.19	2.10
192.5—222.5	19.1	10.3	5.3	3.0	19.2	33.9	48.2	46.3	40	7.8	1.17	2.04
222.5—272.5	16.9	11.5	5.3	2.3	23.7	37.7	58.8	50.9	60	12.4	2.19	2.65
Profile 8: Laterite Soil												
0—30	39.9	10.9	6.2	2.7	26.6	29.8	54.1	46.9	58	5.1	1.23	2.73
30—75	50.3	11.5	7.6	3.2	30.3	35.5	54.0	52.2	46	11.2	1.25	2.16
75—112.5	45.0	19.6	7.2	3.1	24.4	35.4	57.6	51.7	48	10.3	1.20	2.03
112.5—180	31.2	24.0	4.5	2.4	23.3	37.9	52.5	55.2	52	12.3	1.26	2.17
180—225	22.0	22.5	3.0	2.1	22.7	34.3	46.1	49.5	56	10.6	1.17	2.44
Profile 9: Colluvial Soil												
0—25	32.2	5.4	5.4	3.1	15.8	18.6	20.9	32.3	42	18.5	1.34	1.97
25—50	37.7	5.0	6.2	3.7	20.5	19.5	38.4	36.4	48	26.3	1.42	2.17
50—75	37.8	4.4	6.7	3.8	21.4	20.4	32.8	34.4	47	25.3	1.45	2.17
75—107.5	36.8	5.4	6.8	5.3	19.9	21.4	34.6	37.7	48	32.0	1.46	2.17
Profile 10: Colluvial Soil												
0—25	5.8	5.3	1.6	0.9	6.9	16.8	28.8	28.4	40	3.0	1.33	2.13
25—50	6.6	5.3	1.8	0.8	8.0	14.0	26.6	27.5	40	5.0	1.39	2.19
50—75	8.1	4.6	1.9	0.9	8.8	20.9	30.4	29.6	43	4.3	1.39	2.32
75—105	7.9	6.1	2.9	0.8	7.7	18.5	25.5	22.8	35	10.4	1.51	2.12

TABLE II. Correlation Studies

Relationship between X	Y	Correlation Coefficient "r"	Regression equation	Number of pairs (N)
Clay	Hygroscopic Coefficient at 99.8% R. H.	0.827**	Y=0.15+ 1.8	43
Clay	Hygroscopic Coefficient at 50% R. H.	0.730**	Y=0.11+ 0.6	43
Clay	Moisture equivalent	0.810**	Y=0.13+17.3	43
Clay	Lower plasticity number	0.480**	Y=0.28+18.7	43
Clay	Upper plasticity number	0.694**	Y=0.67+24.2	43
Clay	Maximum water holding capacity	0.693**	Y=0.58+28.0	43
Clay	Percentage of pore space	0.733**	Y=0.43+39.2	43
Clay	Percentage of expansion on wetting	0.714**	Y=0.06+19.5	43
Silt	Hygroscopic Coefficient at 99.8% R. H.	0.323*	Y=0.14+ 4.7	43
Silt	Moisture equivalent	0.433**	Y=0.63+14.2	43
Silt	Lower plasticity number	0.800**	Y=1.0 +16.0	43
Silt	Upper plasticity number	0.596**	Y=1.2 +30.7	43
Silt	Maximum water holding capacity	0.661**	Y=1.21+31.0	43
Silt	Percentage of pore space	0.359**	Y=0.46+46.3	43

capacity to be a function of finer fraction. Percentage of pore space was observed to be mainly decided by the clay content of the soil. High significant correlation was observed between pore space and clay (r=0.73) which is in agreement with the work of Thomas D' Souza (1962) and Velayutham (1964). Correlation between pore space and silt was not highly significant (r=0.36) as was expected. A significant correlation (r=0.71) was observed between volume expansion on wetting and clay content.

A high significant correlation was observed between finer fractions and hygroscopic moisture at 99.8 per cent relative humidity (r=0.81 and 0.32 for clay and silt respectively). Higher the finer fractions more is the hygroscopic moisture. This finding is in close agreement with the work of Alway and Rost (1916) and Kandasamy (1961). Significant correlation (r=0.73) was observed between hygroscopic moisture at 50 per cent relative humidity and clay. Moisture equivalent was found to be closely associated with finer fraction (r=0.88 and 0.43 for clay and silt respectively).

Lower plasticity number was found to be closely correlated with the lower plasticity number but among the finer fraction silt was highly associated with the finer fraction. More the finer fraction, higher is the plasticity number. A significant correlation was obtained between plasticity number and finer fraction (r=0.48 and 0.80 for clay and silt respectively). Similar relationship between upper plasticity number and finer fraction (r = 0.69 and 0.60 for clay and silt respectively) was also observed.

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