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Permeability And Retentive Capacity On Soil Sample

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***Abstract:** This research deals basically on the permeability of different soil samples (Sand and Clay) which were obtainedfrom a dredging site at Amassoma Community in Southern Ijaw Local Government Area of Bayelsa State, Nigeria. Both soil samples were heated differently to an evaporating point. The soil samples were then mixed at varying percentage by weight which were later grouped into Sample A (100% sandy soil, 0% clay soil); B (90% sandy soil and 10% clay soil); C (80% sandy soil and 20% clay soil); down to F (50% sandy soil and 50% clay soil). These soil samples were then subjected to a permeability test by allowing 800ml of water to flow through each sample. The time of first drop ofvolume water received, volume of water retained and average flow rate were obtained. The results as indicatedtable 1 to 6, shows that permeability of these soil mixtures (Sand and Clay) appreciate with increase in percentage of sand with a reduction in retentive capacity and depreciate with an increase in percentage of clay and an increase in retentive capacity.*

***Keyword:** soil, percentage, samples, permeability*

I. INTRODUCTION

Soil is the upper layer of the earth in which plants grow. Soil is formed by either physical or chemical processes. It is a medium for plant growth as mentioned earlier, and it is also a means of water storage, supply, and purification. Soils are critical ecosystem service providers for the sustenance of humanity.

Soil is a mixture of organic matter, living organisms, gas and water soil minerals are divided into three size classes namely: sand, silt, and clay. The percentages of particles in these size classes are called “soil texture”. Soil texture has a profound effect on soil properties and this is why it is considered important physical properties of the soil (Braddy and Weil, 2002). Permeability is one the property of a soil which permits the passage or seepage of water through its interconnecting voids. There are a number of factors that affect the permeability of soil such as particle size, void ratio, impurities in water, degree of saturation, entrapped air and organic matter etc. Therefore, percolation mechanism (permeability) of soil water is needed to be understood in order to make a good use of soil water resources.

OBJECTIVE

The objective of this research includes:

- ✓ To determine the permeability of water through the mixture of two different soil sample (sand and clay).
- ✓ To also determine the water retentive capacity for the various percentages of sand and clay.

BASIC THEORIES

- ✓ *POROSITY*

Porosity (η) is the ratio of the volume of voids to the total volume of soil (v) and is expressed as a percentage

$$\eta = \frac{V_v}{V} \times 100$$

✓ *HYDRAULIC CONDUCTIVITY*

Hydraulic conductivity (K) is the ease at which fluid passes through the fracture of soil. It is also known as the coefficient of permeability. It is expressed as

$$K = \frac{VL}{Ath}$$

Where V = flow volume
L = Height of sample
A = Area of sample
t = time taken
h = height of water

✓ *AIR CONTENT*

Air content (a_c) is the ratio of the volume of air (V_a) to the volume of voids

$$a_c = \frac{V_a}{V_v}$$

✓ *VOID RATIO*

Void ratio (e) is the ratio of the volume of voids (V_a) to the volume of soil solids (V_s) and is expressed as a decimal

$$e = \frac{V_v}{V_s}$$

✓ *DISCHARGE VELOCITY AND SEEPAGE VELOCITY*

The true and actual velocity with which water percolates through a soil is called the velocity of percolation or seepage velocity. It is the rate of discharge of percolating water per unit of net sectional area of voids perpendicular to the direction flow.

Thus;

$$V_s = \frac{Q}{A_v}$$

Where V_s = seepage velocity
Q = rate of flow or discharge
A_v = net sectional area of voids.

II. MATERIALS

The materials used in the course of this work include: Beaker, digital weighing balance, retort stand, sieve of 500mic for sand and 106% for clay; source of heat (oven), stop watch, transparent P.V.C pipe, and water.

III. METHODOLOGY

The research was carried out in the Physics Laboratory to investigate the rate at which water flow through the mixture of two soil samples. Two different soil samples (sand and clay) were collected from a sand dredging site at Amassoma Community, Southern Ijaw Local Government Area Bayelsa State, Nigeria. The soil samples were taken to the laboratory and were heated in the oven to a temperature of about 120^{o}C and were allowed to cool to a room temperature of 30^{o}C. The two soil samples were sieved using different sieve sizes (500 mic and 106 υ for sand and clay soil respectively).

Percentage by weight of the soil samples were obtained using the digital weighing balance and were mixed as detailed by the various tables (table 1 to 6) which give rise to six different groups such as (A, B, C, D, E and F). The various grouped soil samples were poured into a transparent PVC pipe with one end close with a sieve. 800ml was measured with a beaker and was poured into the pipe. The time for first drop for each sample was taken. The time for the volume of water received at an interval of 100ml was noted as well, until the water stopped to flow. Another 800ml of water was allowed to flow through each saturated group sample and record was taken for the different time intervals with the correspondent volume of water, until it seized to drop.The data obtained were interpreted by plotting graphs of volume of water (ml) against time (sec).

IV. RESULTS

The results obtained from the various experiment are presented in tabular form and are graphically represented in fig. 1 to 8.

Dry		Wet	
Volume (ml)	**Time (sec)**	**Volume (ml)**	**Time (sec)**
0	5	100	7
100	9	200	12
200	12	300	15
300	15	400	20
400	20	500	25
500	24	600	29
600	28	700	40
700	48	800	79
750	125	820	155

Table 1: Sample A (100% Sand and 0% Clay)

Dry		Wet	
Volume (ml)	**Time (sec)**	**Volume (ml)**	**Time (sec)**
0	22	100	13
100	62	200	32
200	102	300	57
300	136	400	71
400	153	500	103
500	210	600	163
600	280	700	202
700	340		

Table 2: Sample B (90% Sand and 10% Clay)

Dry		Wet	
Volume (ml)	**Time (sec)**	**Volume (ml)**	**Time (sec)**
0	55	100	34
100	111	200	65
200	146	300	99
300	177	400	150
400	214	500	190
500	263	600	233
600	370	700	280
700	601	800	344

Table 3: Sample C (80% Sand and 20% Clay)

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Dry		Wet	
Volume (ml)	Time (sec)	Volume (ml)	Time (sec)
0	92	100	51
100	141	200	101
200	168	300	148
300	190	400	220
400	221	500	282
500	250	600	356
600	279	700	435
700	476	800	530

Table 4: Sample D (70% Sand and 30% Clay)

Dry		Wet	
Volume (ml)	Time (sec)	Volume (ml)	Time (sec)
0	110	100	92
100	128	200	118
200	152	300	138
300	169	400	189
400	200	500	314
500	227	600	391
600	319	700	499
700	531	800	694

Table 5: Sample E (60% Sand and 40% Clay)

Dry		Wet	
Volume (ml)	Time (sec)	Volume (ml)	Time (sec)
0	170	100	159
100	192	200	186
200	211	300	199
300	230	400	211
400	260	500	250
500	292	600	280
600	418	700	399
700	681	800	650

Table 6: Sample F (50% Sand and 50% Clay)

Sample	Time(sec)
A	5
B	22
C	55
D	92
E	110
F	170

Table 7: Time of First drop

Sample	Volume (ml)
A	14
B	8
C	2.5
D	2
E	1.75
F	1.33

Table 8: Average flow rate

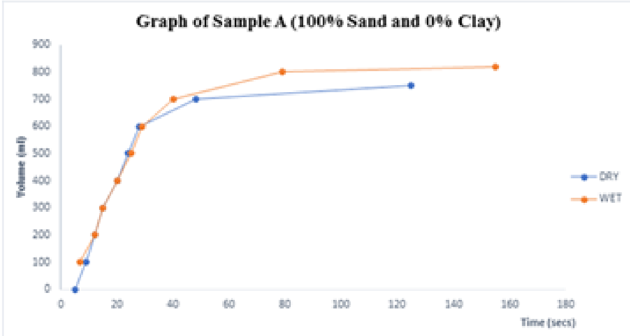

Figure 1: Graph of Sample A (100% Sand and 0% Clay)

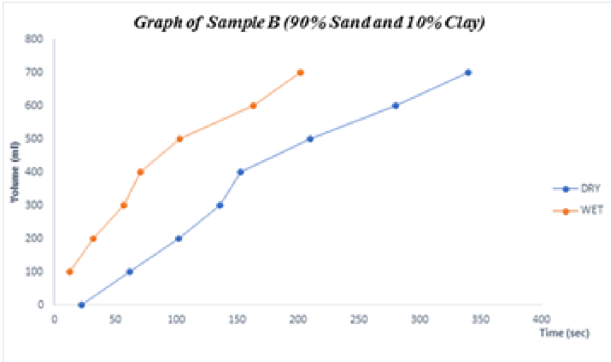

Figure 2: Graph of Sample B (90% Sand and 10% Clay)

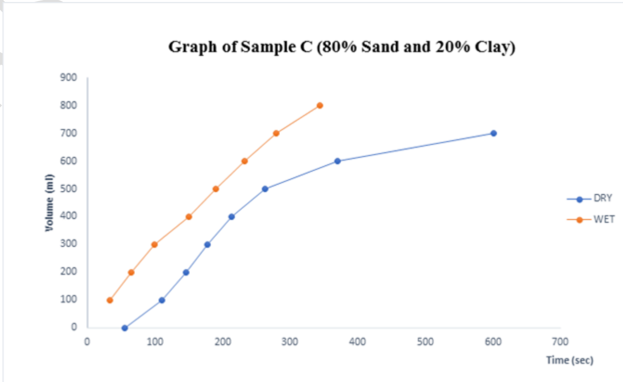

Figure 3: Graph of Sample C (80% Sand and 20% Clay)

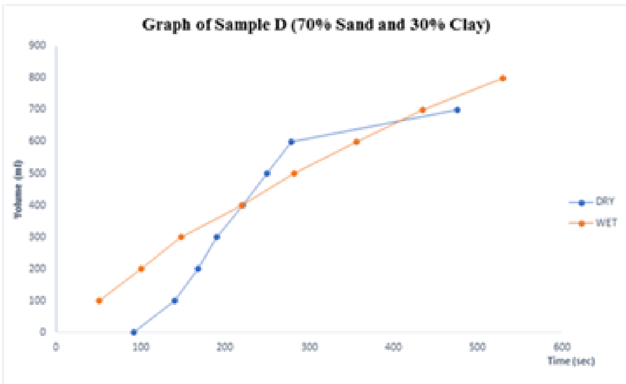

Figure 4: Graph of Sample D (70% Sand and 30% Clay)

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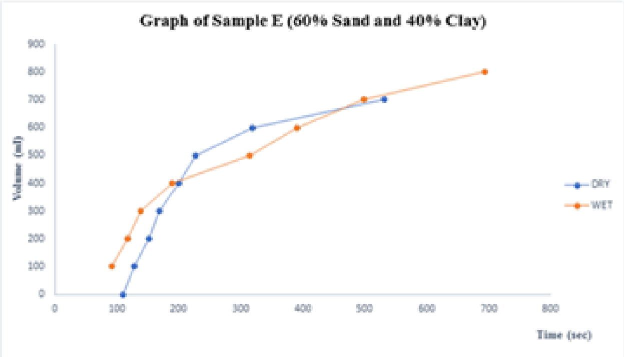

Figure 5: Graph of Sample E (60% Sand and 40% Clay)

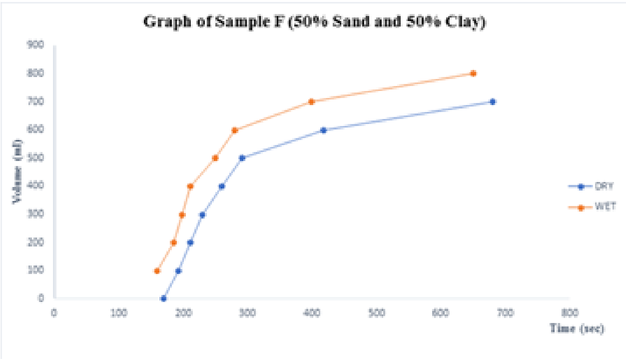

Figure 6: Graph of Sample F (50% Sand and 50% Clay)

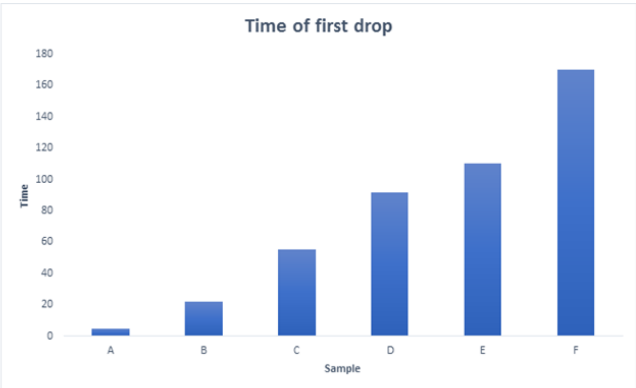

Figure 7: time of first drop

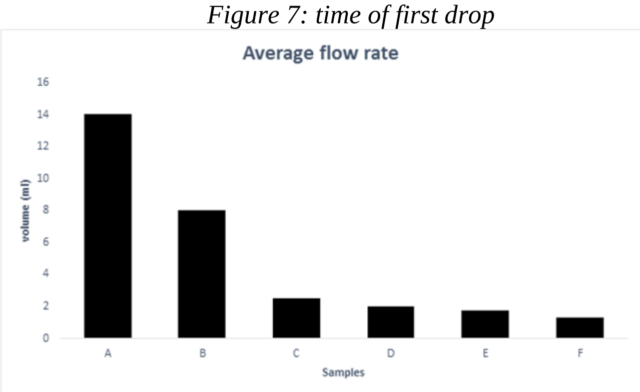

Figure 8: Average flow rate

V. DISCUSSION

From all indication (fig 1 to fig 6) shows that water percolate through the soil samples at different rates. Water percolation decreases gradually from sample A (100% sand and 0% clay) down to sample F (50% sand and 50% clay) due to percentage increase in clay soil. Fig 8 (a graph showing the average flow rate) indicates that there is a marginal difference between the flow rate in the dry and wet sample which suggest that there is a large degree of compaction in the different mixtures.

Consequently, the time of first drop varies for the dry samples (fig 7) while that of the wet samples was at zero all through. Also, the volume of the water received and the water retained varies for the dry and wet samples. This is as result of differences in grain size and particles arrangement. The packing arrangement reduces the voids because clay soil with relatively small size tends to occupy the void spaces between the sand, thereby reducing the number and as well as affecting the possible connectivity between voids. This bring about the reduction of the average flow rate as the percentage of clay soil increase in the sample mixtures.

VI. CONCLUSION

This study has shown the significant effect of clay on physical properties of soil mixture. Fig 1 to fig 6 shows that the flow rate for the wet sample is greater than that if the dry sample. Why, because of the compaction of soil particle which influences permeability, porosity, and hydraulic conductivity of soil.

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