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DETERMINATION OF ORGANIC CONTENT IN DIFFERENT BOREHOLES IN VARIOUS REGIONS IN KHULNA DIVISION

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Abstract

The study was conducted to find out the organic matter in different boreholes in various regions in Khulna division. Organic content influences the engineering properties of soil. Soil sample were collected from Khulna, Jessore, and Bagerhat up to the depth of 50 feet from the existing ground surface. Organic content was determined by loss-on-ignition method. A compression was made between organic content with Standard Penetration Test value (N-value). Graph was plotted organic content vs. depth. Organic content is also very important for top soil of agricultural lands for well growth of plants. Top soil samples were collected from seven sites of Khulna region up to the maximum depth of 30 cm from the ground surface. From the study it could be shown that (1) from engineering point of view, top layers contain more organic content than subsequent bottom layers and amount of organic content of Khulna district was higher than that of Jessore and Bagerhat, (2) from agricultural point of view the agricultural top soil should have at least 5% organic content. But most of the agricultural soils contain less than 5% organic content in Khulna region.

Introduction

Soil organic content is one of the most vital properties that influence other properties of soil either directly or indirectly. Soil organic matter protects the top soil against erosion and supplies cementing substance for desirable aggregate formation. Excessive amounts of organic residues produce different phytotoxins during their decomposition. Generally more than 5% organic content considered as excessive in nature which may sometimes cause difficulties (Reddi and Inyang 2000). Organic substance in soil range from microscopic incompletely decomposed plant to animal residue dark colored humus. Humus include product of decomposed of organic residue, precipitation of dissolve organic compound and organic molecules in solution. Organic substances are composed of mainly carbon, oxygen and hydrogen. However, different organic parent materials various aerobic and anaerobic condition of degradation and different degrees of humification produce organic substances with a wide range of molecular structure and particle morphology. A high peripheries and flexible cellular structure is the most important characteristics of organic coarse particles which are granular. Organic fine substance usually smaller than 100µm consist of irregular shape such as cell fragment and tissue parts, as well as of globular organic precipitation and smaller than 1µm. Organic fine substances are negative charged and display substantial cat-ion exchange capacity, which increase with degree of humification and strongly influenced by the hydrogen ion in the pore water.

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Objective of this study

- To determine the organic content of soil sample in different boreholes in Khulna region
- To compare the results with known engineering parameters, and
- To determine the organic content in the top soil of agricultural lands

Literature review

Many soil properties impact soil quality, but organic matter deserves special attention. It affects several critical soil functions such as soil structure, particle size distribution etc. It is well established that addition of soil organic matter (SOM) can not only reduce bulk density (D_b) and increase water holding capacity, but also effectively increase soil aggregate stability (Jalal 2014).

Generally good soil conditions are associated with dark brown colours near the soil surface, which is associated with relatively high organic matter levels, good soil aggregation and high nutrient levels (Peverill 1999).

The presence of organic matter in soil is often ignored, although it influences some important properties. Organic matter, although relatively small in volumetric production, significantly affects the water absorbing capacity of soils. In terms of mechanical properties of soils, the organic matter is known to reduce the maximum dry unit weight and cohesion of soils (Franklin et al. 1973).

According to Russel (1960), soil organic matter consists of a whole series of productions which ranges from undecayed plant and animals tissues through ephemeral production of decomposition to fairly stable brown to black materials bearing no trace of the anatomical structure from which it was derived (it is latter material that is normally defined as humus)

The term organic matter generally used to represent the organic constituents in the soil excluding undecayed plant and animal tissue and their partially decomposition products and the soil biomass. The end product of organic matter decomposition is humus (Gupta 1999).

Soil organic matter defined as the totality of organic matter in soil also includes the organisms that live in soil, the soil biomass, although they usually account for less than 5% of the soil organic matter (Russel 1960).

Soil deposits of organic origin

Organic deposits are due to the decomposition of organic matters and usually in topsoil and marshy place. A soil deposit of organic origin is said to peat if it is at the higher end of the organic content scale (75% or more according to some authors), organic soil at the low end, and muck in between. Peat soil deposit is usually formed of fossilized plant materials and characterized by fiber content and lower decomposition or humification. However, there are many criteria existed to classify the organic deposits and it remains still as a controversial issues with numerous approaches available for varying purposes of classification. Soil from organic deposit refers to a distinct mode of behave different than traditional soil mechanics in certain respect. A possible approach is beings considered by the American Society for Testing and Materials (ASTM) for classifying soils having organic contents (OC) which may stated as follows (Edil 1997).

I. OC<5%; little effect on behavior, considered inorganic soil.
II. OC in between 6-20%; effects properties but behavior is still like mineral soil, organic silts and clays.
III. OC in between 21-74%; organic matter governs properties; traditional soil mechanics may be applicable; silty or clayey organic soils.
IV. OC>75%; Display behavior distinct from traditional soil mechanics especially at low stresses; peat.

Peats have certain characteristics that set them apart from most mineral soils and require special considerations for construction over them. These special characteristics include:

I. High nature moisture content (up to 1500%)
II. High compressibility including significant secondary and even tertiary compression.
III. Low strength in nature condition.

Soil formation

Soils are formed by the disintegration of rock material of the earths relatively deeper crust, which itself is formed by the cooling of volcanic magma. The stability of crystalline structure governs the rock formation. As the temperature falls, new and often mare stable minerals are formed. Most natural soils are composed of the breakdown products of rocks, which have been attack by physical, chemical or biological weathering processes (Reddi and Inyang 2000). The weathered materials have been transported and deposited elsewhere as sediments, or may remain in situ as residual soils. The properties of soil deposition depend on the soil forming factors. In general, five independent variables may be viewed as governing soil formation:

i. Climate,
ii. Organisms present,
iii. Topography,
iv. The nature of the parent material and

v. Time.

It is generally established in the soil science literature that any property of soil is invariably linked to these five fundamental soil forming factors (Jenny 1941).

Phase composition of soils

As the result of the interactions among the parent rocks, atmospheric agencies (primarily water and air), and organisms, during their formation, soils consist of four components or phases such as mineral matter, organic matter, water and air. Nature introduces "fluidity" to the inert weathered rock mass through the water and air phases, and this is where the challenges of predicting the engineering behavior of soils arise. The myriad factors responsible for the co-existence of the four components during soil formation impact a great variety of properties to soils. The need to know the relative proportions of these components of soils property leads us to the soil composition at a scale finer than that of soil profiles. The typical volumetric composition of the four phases of soils is shown in the following Figure 1. Among the four components, organic matter occupies the least amount of volume, and its quality decreases with depth below the ground surface.

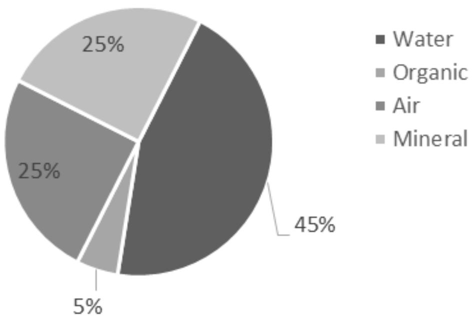

Figure 1. Typical volumetric composition of the four components of soils (Source: Islam 2006)

Significance of organic soils

Any soil containing a sufficient amount of organic matter to influence its engineering properties is called an organic soil. The amount of organic matter is expressed in terms of organic content, which is the ratio between the weight of organic matter and the oven dried weight of sample. The weight of organic matter can be determined by heating the sample to ignite the organic substances (McFarland 1959).

Natural soil deposits may contain a very small percentage of organic matter. Generally a relatively small percentage will contribute sufficient undesirable characteristics (Teng 1997). In some special applications (e.g. soil-cement) only a fraction of one percent may render the soil undesirable.

Organic matters are derived principally from plant life and occasionally from animal organisms. They are found in the following forms:

i. Top soil (loam): the upper layer of ground, usually several inches deep;
ii. Leached stratum: organic matter accumulated on an impervious layer from leaching through upper previous soil; and
iii. Organic deposits: peat, swamp, lignite, coal, etc. In Engineering literatures the term muskeg is sued in Northern United States and Canada to denote a terrain consisting of swamp, bog, or other peat deposits.

Soils containing high organic matter will, evidently, have the following undesirable characteristics:

i. Low shear strength;
ii. High compressibility;
iii. Spongy structure which deteriorates rapidly; hence, results in subsidence without external load; and
iv. Acidity and other injurious characteristics to construction material.

Importance of organic matter on soil properties

The presence of organic matter in soils is often ignored, although it influences some important properties. Organic matter, although relatively small in volumetric proportion, significantly affects the water absorbing capacity of the soils. In terms of mechanical properties of soils, the organic matter is known to reduce the maximum dry unit weight and cohesion of soils (Franklin et al. 1973). The cation-exchange capacity may increase significantly when the organic matter is present in soils. On an average, the cation-exchange capacity of the soil increases by 2mEq/100 g for each 1% of well-humified organic matter (Lyon et al. 1952). Organic matter is also a very good source of nutrients, an important consideration in bioremediation of contaminated sites.

- Organic matter is the source of 90-95% of the nitrogen in unfertilized soils.
- Organic matter can be major source of both phosphorus and available sulphur when soil humus is appreciable amounts.
- Organic matter supplies directly or indirectly microbial action the major soil aggregate forming cements particularly the long sugar chain called polysaccharides.
- When left on top of soil as a mulch, organic matter reduce erosion and surface runoff, prevent rapid moisture loss, keeps the soil cooled in hot weather and warm in the winter.
- Aids growth of crops by improving the soils ability to store and transmit air and water as measured by improved porosity.
- Organic matter binds soil particle into structural units called aggregates. These aggregates help to maintain a loose, open granular condition.

Methodology

The holes were made by driving the casings of 10.16 cm (4″) and 7.62 cm (3″) diameter and the drilling was advanced by chopping method. The disturbed samples were collected by driving standard split spoon sampler of 3.49 cm ($1^{3}/_{8}$″) inner diameter with a 63.5 kg (140 lbs) hammer dropping freely a height of 76.2 cm (30″) in an average and the number of blows required to drive the sampler for every 15.24 cm (6″) penetration over 0.61 m (2′) depth was recorded as a measure of standard penetration resistance-N per 0.3 m (1′) depth. All the samples were collected at an interval of 5′depth. The layer to layer organic content was determined by selecting two boreholes spaced between 10 ft to 30 ft from each borehole. Soil samples were collected from different boreholes maximum depth of 50 ft. Those samples were kept in the oven for 24 hours at 105°C to determine the moisture content. After that the dry sample were kept in the muffle furnace at 550°C for 5 hours. Then the organic content was found out.

Estimates of total organic carbon (OC expressed as C) are used to assess the amount of organic matter in soils. The method measures the amount of carbon in plant and animal remains, including soil humus but not charcoal or coal. Levels are commonly highest in Surface soils (Reddi and Inyang 2000) but wide variations from almost zero to above 15% C are possible. This variation occurs due to soil formation and geologic condition of that particular area. During the soil formation, heavy metals moves downward and the organic content moves up due to their light weight.

Sampling sites for soil layers

For this investigation soil samples are collected from different boreholes of different places. The places are Rajbandh, Khulna Medical College, Judge Court in Jessore, Jibon Nagar in Chuadanga, shrimp investigation center in Bagerhat, Sonaganga residential area and KDA in Sonadanga. In these locations the parties or clients requested for soil testing to the CRTS of KUET. The samples are then collected by making boreholes.

Sampling for agricultural top soil

For agricultural top soil, at first sites were selected. The sites are Rupsha, Khulna, University, Teligati, Daulatpur, Maheshwarpasha and KUET campus. The Site selection represents the uniform distribution of Khulna city. Generally root of crops enter 30 cm into the ground. Three bore hole was done at each location, three sample was collected from each bore hole. First sample as collected the surface of ground. Second sample was collected at 15 cm depth. Third sample was collected 30 cm depth. Those three samples were mixed inside. The sample was packed. Then organic content was determined in lab.

Determining organic content

Organic content are determined by the following steps. Those are given below.

- Disturbed sample was collected from different bore holes at various depths.
- Sample was kept in oven at 105ºC to remove water content. Duration of heating is 24 hours.
- Dry hard and large particles are made to fine soil hammer. For uniformly heated the sample.
- Weight of dry sample was taken
- Samples were kept in Muffle furnace.
- Sample was kept in room temperature for cooling.
- Taking the weight again.

Analysis of the results and the interpretation

The study work was concerned with the variation of organic content in different boreholes of different locations of Khulna, Jessore and Bagerhat. The type of variations was obtained with compared to the shape of standard curves which is elaborated in this chapter. Moreover, variations in organic content in horizontal directions are also observed in agricultural top soil at different locations of Khulna region.

Table 1. Organic content and N-value (KMC, Khulna)

Bore Hole 1

Depth (ft)	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50
Organic content (%)	55	21	1.6	15.6	4.8	14.6	6.2	5.7	16.2	14.7
N-value	2	2	3	7	4	7	3	18	8	9

Bore Hole 2

Depth (ft)	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50
Organic content (%)	1.7	21.4	5	21	3.1	6.5	5.6	3.1	11.3	6.1
N-value	5	2	3	8	6	5	3	15	11	23

From the above table, it is observed that, the maximum organic content is 55% at the top layer.

Table 2. Organic content and N-value (Judge court, Jessore)

Bore Hole 1

Depth (ft)	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50
Organic content (%)	5	5.9	5.1	2.6	19.1	13.2	1.9	6.1	5.3	7.4
N-value	4	2	5	4	4	6	12	9	3	4

Bore Hole 2

Depth (ft)	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50
Organic content (%)	7.3	15.4	36.7	6.1	5.3	7.1	9.3	18.1	7.1	9.3
N-value	5	3	2	8	4	4	8	6	5	5

From the above table, the maximum organic content 36.7% lies between 10 to 15 ft layers. The layer to layer variation was very small.

Table 3. Organic content and N-value (Bagerhat)

Bore Hole 1

Depth (ft)	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50
Organic Content (%)	4.3	9.0	6.4	5.1	5.5	4.2	3.8	2.8	2.4	2.1
N-value	3	3	2	2	2	2	3	4	4	4

Bore Hole 2

Depth (ft)	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50
Organic Content (%)	12.0	7.5	3.1	3.1	3.3	5.5	4.1	2.2	4.1	2.1
N-value	3	2	3	2	2	2	2	3	3	4

From the above table, it was shown that, the maximum organic content exist on the top layer. In both boreholes the idealized variation was seen.

Table 4. Organic content and N-value (Sonadanga, Khulna)

Bore Hole-1

Depth (ft)	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50
Organic Content (%)	60	17	9.4	8.1	3.6	16.1	1.2	3.2	4.2	9.3
N-value	4	3	5	5	4	2	3	32	16	9

Bore Hole-2

Depth (ft)	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50
Organic Content (%)	35.2	11.4	12.3	5.8	6.9	13.4	5.6	7.1	5.7	7.2
N-value	4	2	3	7	3	3	4	27	21	21

At site Sonadanga, the maximum organic content (60%) was found in the top layer, which is excessive for both structural and agricultural point of view. The graph also show idealized diagram.

Table 5. Organic content and N-value (Jibonnagar, Chuadanga)

Bore Hole 1

Depth (ft)	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50
Organic Content (%)	1.5	3.5	2.6	8.6	10.8	2.7	4.4	27.7	5.6	5.9
N-value	4	3	4	5	5	4	11	4	4	6

Bore Hole 2

Depth (ft)	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50
Organic Content (%)	2.64	1.9	1.5	4.8	8.5	6.2	3.6	3.0	3.3	4.8
N-value	5	5	4	5	4	11	6	4	4	6

The maximum organic content 27% lies and idealized variation was not seen.

Table 6. Organic content and N-value (Rajbandh)

Bore Hole 1

Depth (ft)	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50
Organic Content (%)	11.7	23.4	44.6	26.66	15.6	18.6	9.2	13.0	5.6	8.3
N-value	4	5	5	4	4	3	2	3	2	2

Bore Hole 2

Depth (ft)	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50
Organic Content (%)	6.8	13.3	26.8	5.8	5.1	6.9	5.8	6.1	3.8	4.1
N-value	3	4	5	4	4	3	5	5	4	3

The maximum organic content was found in the top layer. The graph also showed idealized diagram.

Table 7. Organic content of agricultural top soil in Khulna region

Site name	NO. of boreholes	Organic Content (%)	Average of Organic Content (%)
Dighulia	01 02 03	2.40 1.70 2.10	2.06
Rupsha	01 02 03	3.04 2.52 2.81	2.70
Khulna University	01 02 03	2.89 4.70 4.16	3.70
Teligati	01 02 03	3.43 5.20 2.10	3.57
KUET	01 02 03	1.70 3.24 2.65	3.80
M. Pasha	01 02 03	2.10 1.78 1.22	1.70
Daulatpur	01 02 03	4.75 5.02 2.99	4.02

Discussion

From our data and observation one type of graph can be established which represents the idealized shape. The results obtained in agricultural top soil is less than the ideal one should be increased.

According to Reddi and Inyang (2000), organic content of soil decreases with the increases of depth. In our observation, the data shows the similar type of result which represents the idealized variation at Jibon Nagar in Chuadanga, there is some variation from the idealized condition. It may be occurred due to the formation of soil and other factors such as temperature, climate etc. Khulna and Bagerhat is situated near the Mangrove forest. This may be one reason for having higher organic content in those regions. For agricultural topsoil, seven sites have been analyzed. All these sites contain less than 5% organic content which should be increased to an extent for the natural growth of plants.

Conclusion

Engineering point of view

From the study, we can found the following information based on our data and observations.

- Amount of organic content in Khulna region is higher than that of Jessore and Bagerhat.
- There is no linear relationship between organic content and depth.
- Generally the top layers contain more organic content than subsequent bottom layers.
- Each layer has at least some amount of organic content. Because Khulna is situated in the southern part of Bangladesh where Mangrove Forest is close at hand. In the soil formation, these regions have some impacts.
- The amount of organic content ranges from 5% to 10% in the most of the soil layers.

Agricultural point of view

The agricultural top soil should have at least 5% organic content. Most of the agricultural soils contain less than 5% in Khulna region. The organic content ranges from 1.70 to 4.02. In a consideration of the maintenance of soil organic content in top layer, the amount of crop residues that must be returned to maintain a certain organic content in soil.

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