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Preliminary Soil Properties Analysis of Abha City, Saudi Arabia:A Case Study

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Abstract: **the soil properties are an important parameter for both Architectural as well as structural design of building structures. It is the properties of soil that determine the required strength of the structure and also it determines the design of the building aesthetically. The city of Abha is located in semi-arid cold climate region of the Kingdom of Saudi Arabia. Since it is a famous tourist destination all around the year the development of the city is exponential, leading to a number of structures constructed in last one decade. The present study determines the properties of the soil to provide a base data which can be used for the construction design. The soil properties were analysed in terms of pH, Conductivity, Moisture content, Bulk Density, Dry Density, Silt content etc. the study concluded that the soil properties are better for structural development than Greenification. But still the quality of soil is better than the most area of the Kingdom.**

Index Terms: Soil properties, Structural design, pH, Moisture content, Bulk Density.

I. INTRODUCTION

The development of any region depends on its soil quality. The development in modern world can be classified as structural development and aesthetical development. the structural development deals with all the infrastructure required for the physical needs of the society in form of buildings, transportation, communication etc. all these structures require a foundation, which will be constructed as per the soil quality. The aesthetical development deals with bringing the civilization in harmony in nature by the development of parks, gardens etc. which is again directly influenced by the properties of soil.

II. STUDY AREA

The Abha city is situated at an elevation of 2270 m (7,500 feet) above sea level, it is a mountain retreat and vacation spot for people from across Saudi Arabia and the other Arabian Gulf countries, gives it a relatively moderate climate.

S. No.	Location
1	Andalus
2	Thirah
3	Al Shifa
4	Al Muftaha

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5	Al Faisalyah
6	Al Wardatain
7	Shamasan
8	Al Manhal

III. METHODOLOGY

Overall 8 Locations were identified for sampling in the City of Abha. The properties of samples were determined in accordance with ASTM code. The parameters which were determined are pH, Conductivity, Moisture Content, Bulk Density, Dry Density, specific gravity, Clay Content and Sand content.At each sampling site, we dug two to four pits, each about 60 cm deep. Bulk samples composited from three locations within a 7-by 12-meterplot were taken from the 0- to 7.5-, 7.5-to 15-, 15- to 22.5-, and 22.5-to 30-cm depths.

IV. RESULTS AND DISCUSSION

A. pH

The soil pH reflects whether a soil is *acidic, neutral, basic or alkaline*. The acidity, neutrality or alkalinity of a soil is measured in terms of hydrogen ion activity of the soil water system. The negative logarithm of the H^+ ion activity is called pH and thus pH of a soil is a measure of only the intensity of activity and not the amount of the acid present. The pH range normally found in soils varies from 3 to 9.[1]

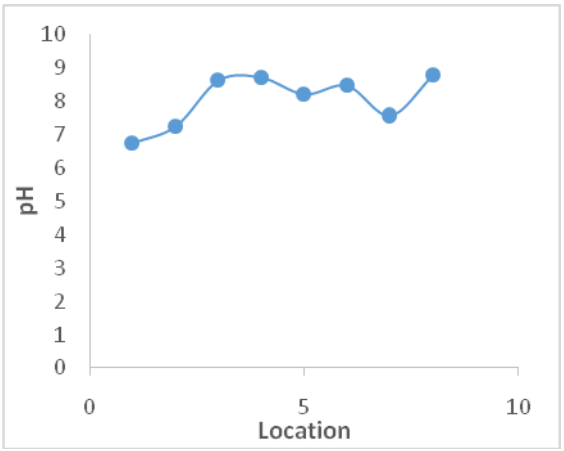

Figure 1 pH of Soil

The graph represents the pH values of the soil samples. The maximum value of pH is 8.78 for Manhal while 6.75 is the minimum pH value obtained for Andalus. The average pH value is 8.04.

B.Conductivity

Soil electrical conductivity (EC) is a measurement that correlates with soil properties that affect crop productivity, including soil texture, cation exchange capacity (CEC), drainage conditions, organic matter level, salinity, and subsoil characteristics. The electrical conductivity of soils varies depending on the amount of moisture held by soil particles. Sands have a low conductivity, silts have a medium conductivity, and clays have a high conductivity. Consequently, EC correlates strongly to soil particle size and texture.[2]

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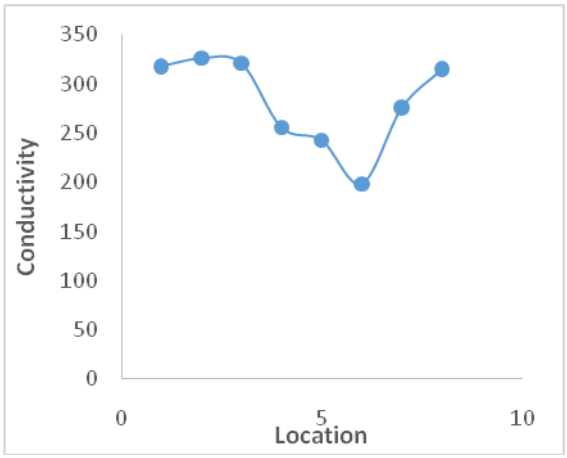

Figure 2 Conductivity of Soil Samples

The graph represent the conductivity of soil samples. The maximum is 376µmhos/cmfor thirah while the minimum conductivity is depicted by the Al wardatain soil sample with the value of 199 µmhos/cm. the average soil conductivity is 281.75 µmhos/cm..

C. Moisture Content

Water contained in soil is called soil moisture. The water is held within the soil pores. Soil water is the major component of the soil in relation to plant growth. If the moisture content of a soil is optimum for plant growth, plants can readily absorb soil water. Not all the water, held in soil, is available to plants. Much of water remains in the soil as a thin film. Soil water dissolves salts and makes up the soil solution, which is important as medium for supply of nutrients to growing plants.

The soils hold water (moisture) due to their colloidal properties and aggregation qualities. The water is held on the surface of the colloids and other particles and in the pores. The forces responsible for retention of water in the soil after the drainage has stopped are due to surface tension and surface attraction and are called surface moisture tension. This refers to the energy concept in moisture retention relationships. The force with which water is held is also termed as suction.[3][4]

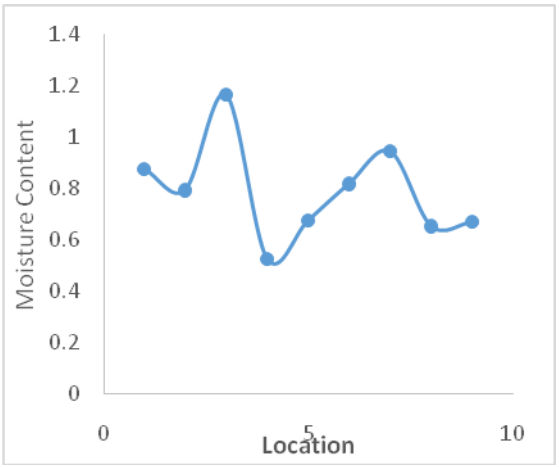

Figure 3 Moisture Content of Soil Sample

The graph represent the results of moisture content value for soil samples tested. The maximum moisture content was found in the soil sample from AL Shifa with 1.2 % of moisture content while the minimum moisture content is represented by the soil sample from Al Muftaha with 0.52 %. The average moisture content value is 0.8%.

D. Bulk Density

Bulk density is an indicator of soil compaction. It is calculated as the dry weight of soil divided by its volume. This volume includes the volume of soil particles and the volume of pores among soil particles. Bulk density is typically expressed in g/cm3. Bulk density reflects the soil's ability to function for structural support, water and solute movement, and soil aeration. Bulk densities above thresholds indicate impaired function. Bulk density is also used to convert between weight and volume of soil. It is used to express soil physical, chemical and biological measurements on a volumetric basis for soil quality assessment and comparisons between management systems.[5]

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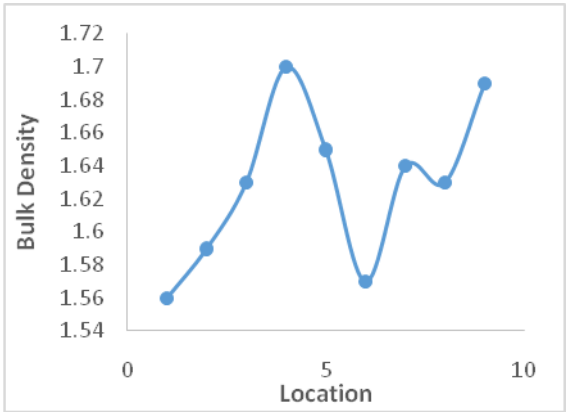

Figure 4 Bulk Density of Soil Samples

The graph depicts the Bulk Density of soil samples. The maximum Bulk Density is 1.7g/cm^3 for Al Muftaha sample while the minimum value is obtained from Andalus with 1.56g.cm^3. the average bulk density value is 1.62g/cm^3.

E. Dry Density

To assess the degree of compaction, it is necessary to use the dry unit weight, which is an indicator of compactness of solid soil particles in a given volume. The laboratory testing is meant to establish the maximum dry density that can be attained for a given soil with a standard amount of compactive effort. The dry density of most soils varies within the range of 1.1-1.6 g/cm^3. In sandy soils, dry density can be as high as 1.6 g/cm^3; in clayey soils and aggregated loams, it can be as low as 1.1 g/cm^3. Because of its high degree of aggregation (i.e., small total porosity), concrete has, in general, a higher dry density than soil. Dry density depends on the structure of the soil matrix (or its degree of compaction or looseness) and on the soil matrix's swelling/shrinkage characteristics.[6]

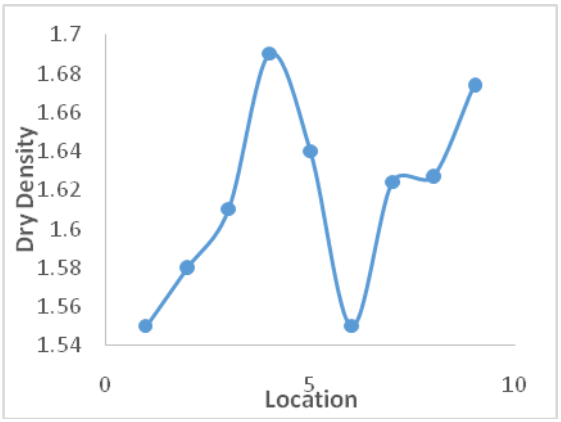

Figure 5 Dry Density of Soil samples

The graph shows the Dry Density results for the soil samples. The maximum dry density is depicted by the sample from Muftaha with a value of 1.69 g/cm^3 while the minimum dry density was 1.55 g/cm^3 from Andalus. The average Dry Density value is 1.60g/cm^3.

F. Specific Gravity

The specific gravity of a substance, designated as Gs, is defined as the ratio of the density of that substance to the density of distilled water at a specified temperature. Since it is a ratio, the value of Gs does not depend on the system of units used and is a numerical value having no units.[7]

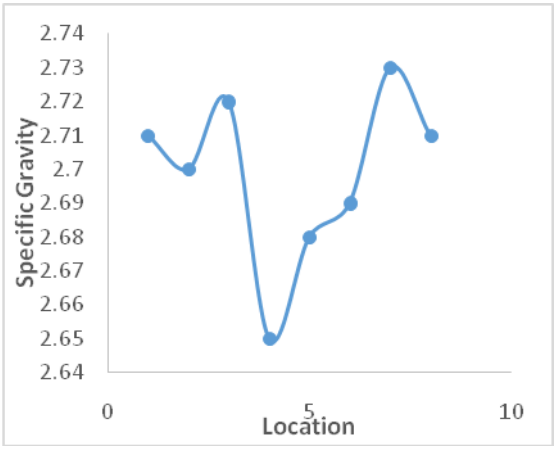

Figure 6 Specific Gravity of Soil samples

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The graph represents the specific gravity of soil samples. The maximum value is obtained from the shamasaan with the value of 2.77 while the minimum value is 2.65 from muftaha. The average value of city soil sample is 2.69.

G. Silt Content

Silty soil is usually more fertile than other types of soil, meaning it is good for growing crops. Silt promotes water retention and air circulation. Too much clay can make soil too stiff for plants to thrive.[8]

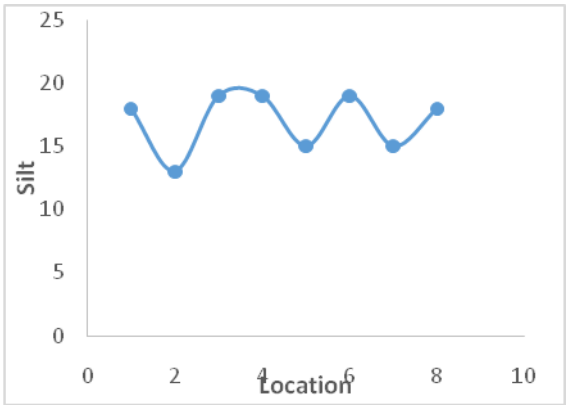

Figure 7 Silt Content of Soil Samples

The graph represents the silt content of the soil samples. The maximum silt content 19% is obtained from three locations while the minimum silt content is 13 from thirrah. The average silt content is 17%.

H. Clay

Because clay particles are so small, pure clay has at least 1000 times more external surface area than coarse sand. Because clays have a large surface area and negative charges, they can attract and hold positively charged ions. This characteristic is important because many positively charged ions are plant nutrients, such as calcium, magnesium and potassium.A soil's ability to hold and store positively charged ions is known as cation exchange capacity (CEC). Soil with high CEC holds more nutrients and loses fewer of them when rainfall leaches through the soil. [9]

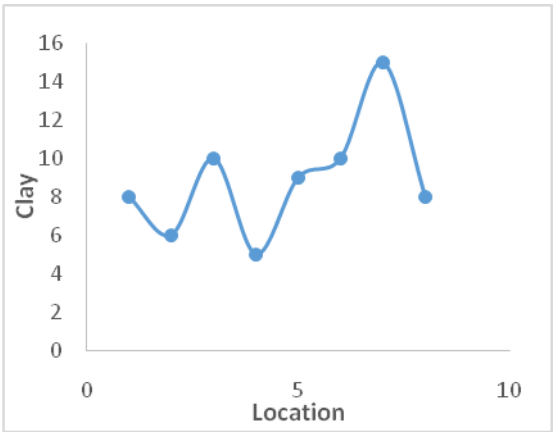

Figure 8 Clay Content of Soil Samples

The graph represents the percentage of clay in the soil samples. The maximum percentage of clay is 10% in Andalus while the minimum is 5 % in Muftaha soil sample. The average clay percentage is 8.5.

V. CONCLUSION

The soil samples results shows that the soil all over the city is alkaline with only the soil of Andalus being slightly acidic with 6.75 value of pH.

The conductivity results of soil samples are relevant to each other but the conductivity vlue is low due to the lower percentage of clay and silt in the soil sample.

The moisture content is very low in all the soil sample making it good for construction but poor for vegetation growth.

The Bulk density and Dry density of soil suggest the soil to be of good quality for structural purpose.

The lower silt and clay content results in very low water holding capacity which results in very low

vegetative growth or growth for a very short period of time. Also swelling properties of soil is educed as the water holding capacity of soil is reduced.

The Soil of Abha city in given condition is very poor for the development of vegetation hence making the development of parks and gardens at a higher cost. Although the soil in the city is better than than most of the Kingdoms land to support the vegetation growth. As per USCS classification the soil can be classified as sandy loam. Which results in better construction soil as the moisture content is low and the sandy soil will not result in bulking owing to the frequent rainfalls experienced by the city. Hence the study concludes that the present soil condition supports the structural development of the city better than the aesthetical development of city.

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