

# Studying the Physical and Chemical Properties of the Soil of Technical Institute/Kut and its Effect on Foundations of Concrete Structure

**Basima Abbas Jabir Al-humairi**

*Technical Institute of Kut*

Basimaabbas86@yahoo.com

## Abstract

This study has been conducted in the site of the Technical Institute/Kut, which is located (10) Kilometers south of Wassit city. The research work was designed to study soil characteristics and some factors such as soil physical properties which represent moisture content, porosity, density real, bulk density and conductivity of water, soil texture, porous and chemical properties such as sulfate, sodium, chloride and pH, EC.

The main objective of the study is the effect of the physical and chemical characteristics of the soil on foundations of concrete structure, and the study found that the soil of the entrance Institute is the best site have a few percentage from sulfate and chloride salts that effect on foundations of concrete structure.

**Key words** : Soil, Physical properties, Chemical properties, Sulphate content in the soil

## الخلاصة

أجريت هذه الدراسة في موقع المعهد التقني/ كوت التي تقع على مسافة (١٠) كم جنوب مدينة واسط واعتمد منهاج البحث على دراسة خصائص التربة بشكل تفصيلي ودراسة بعض العوامل منها صفات التربة الفيزيائية والتي تمثل المحتوى الرطوبي، المسامية، الكثافة الحقيقية، الكثافة الظاهرية والايصالية المائية المشبعة، المسامية ونسجة التربة وكذلك صفات التربة الكيميائية المتمثلة بالكبريتات، الصوديوم، الكلوريد، المغنيسيوم والبوتاسيوم والايصالية الكهربائية و pH.

يعد الهدف الرئيسي للدراسة هو تأثير خصائص التربة الفيزيائية والكيميائية على اساسات المنشأ الخرساني ومن خلال الدراسة وجد ان تربة مدخل المعهد أفضل موقع يحتوي على نسبة قليلة من املاح الكبريتات والكلوريدات التي تؤثر على اساسات المنشأ الخرساني.

**الكلمات المفتاحية** : التربة، الصفات الفيزيائية، الصفات الكيميائية، محتوى الكبريتات في التربة

## Introduction

Can be divided into the basic characteristics of the soil physical properties and Mechanical properties and other Chemical properties. These characteristics, but differed in the degree of importance of origin to another, and from one region to another, but they are all important and necessary to judge the soil being studied, and testing them in the laboratory is necessary to come out with recommendations regarding the integrated soil and foundations.

The intended physical characteristics of soil, its characteristics related to the nature of the soil as the content of the natural moisture and the limits of liquidity and plasticity as well as the specific gravity, density, voids ratio and degree of saturation.

The mechanical properties of the soil are intended to soil properties and behavior under the influence of loads, resistance soil shear and the strength of cohesion between the particles and angle of internal friction and compressive strength and compaction and Consolidation and others.

The chemical properties of the soil are intended by the content of chemicals that may have a negative effect on the concrete foundations, as the content of sulfates, content of chlorides, organic impurities and total soluble salts and Acidity or alkalinity of environment, which indicates the (pH value), **Sami Ahmed Hijjawi (2003)**. There are a lot of studies on the properties of soils, studied researcher **Ibrahim Kiki (2006)** on improving the properties of the clay soil expansive using



waste lime was reached that the treatment of the soil industrial waste lead to an increase in the moisture content optimization and a decrease in the value of dry density majority of the soil and an increase in compressive strength is trapped in addition to increasing the effective soil shear coefficients. **Farmanullah Khan *et al.* (2013)** Studied effect of slope position on physico-chemical properties of eroded soil in Samarbagh, District Lower Dir, soil samples were collected from top-slope, midslope and bottom slope positions at horizon-A, B and C. Results showed a significant difference among the physicochemical properties of top, mid and bottom slope soils. Bulk density of the top-slope ( $1.51 \text{ gm/cm}^3$ ) was the highest followed by mid ( $1.39 \text{ gm/cm}^3$ ) and bottom slopes ( $1.32 \text{ gm/cm}^3$ ). Conversely, electrical conductivity  $\text{EC}-2.47 \text{ dS m}^{-1}$ , phosphorus ( $3.40 \text{ mg/ kg}$ ), Potassium ( $118.8 \text{ mg/ kg}$ ), Organic matter content ( $1.52 \%$ ), clay content ( $20.39 \%$ ) and silt content ( $49.17\%$ ) were the highest at bottom slope followed by mid and top-slopes. And relating to the chemical properties of the soil with all its recent materials and cause damage to the presence of buried parts of the building or origin contact with the soil, such as forms the foundation, basement walls, concrete pipes and any contact with each other parts with the surrounding soil. The following is a summary of the most important aspects of the process that are related to the chemical characteristics of the soil.

#### 1 - Sulphate content in the soil

Sulfates are dissolved in water, which are normally present in the soil in the form of Sodium sulphate- $\text{Na}_2\text{SO}_4$  and Magnesium sulphate - $\text{MgSO}_4$ . There is Calcium sulphate - $\text{CaSO}_4$  in the form of Gypsum, but slow water solubility.

And expresses the ratio of sulfates in the soil usually by finding the proportion of Sulphur trioxide -  $\text{SO}_3$  where . The danger of sulfate dissolved in the groundwater in the attack for concrete and other materials containing cement . Being the interaction between the sulfate and Aluminate compounds in the cement, causing the crystallization of these compounds leads to dilation, give rise to additional stresses causing cracks and crumbling . The presence of sulfates in the soil surrounding the buried metal pipes leading to the steel pipe (Corrosion), causes the Leakage. **(Garston, 1975).**

According to determine the proportion of sulfates in the soil in the estimation of the size of the damage that may be caused by, so as to take the necessary Is obligatory precautions, such as the use of Sulphate resisting cement or increase the proportion of cement in the concrete mix.

The presence of salts in soil or groundwater near the level of foundation is a source of the erosion of concrete and where as some salts attack the concrete work on the fragment, such as sulfates, penetrating chloride salts into the concrete until it reaches the reinforcing steel and cause it to corrosion, and dissolved salts when penetrating into the concrete by capillary action increases the concentration in the concrete surface exposed to the atmosphere due to evaporation, which leads to an increase in the size of the gaps close to the surface and is working to rupture and fragmentation of concrete.

#### 2 - Organic matter content:

Diverse organic compounds that may exist in the soil varied greatly depending on the diversity of its sources. The materials in organic soil are formed from remnants of animals and farms . The effect of the presence of these organic materials on the behavior of the soil is negative and can be summed up as follows **(Head, 1982):**



- lead to decrease in the value of the bearing capacity of the soil .
- leads to increase compressibility of soil.
- leads to increase risk of Swelling and Shrinkage due to the change in moisture content .
- The presence of gas in the voids organic soil can lead to an Immediate settlement, as it may affect the accuracy of the derivation of Consolidation coefficients during laboratory testing
- The existence of the gas can also lead to getting false values for shear resistance ,
- The presence of organic material gives (low value of pH), and sometimes the presence of sulfates .
- The presence of organic material in the soil used for the purposes of installation on the roads has a detrimental effect .

### 3 - Chloride content:

Helps to know the chloride content in the groundwater or in the soil to determine whether the groundwater is sea water or the soil has been exposed to sea water .It is noted in the coastal areas in the Middle East that the concentration of salt sodium chloride (NaCl) in groundwater is much higher than the concentration in seawater, and the high concentration of chloride may change in the areas of soil and rocks executed that there are no connection between them and the sea, (AASHTO, 1996).

Nor reacts chloride directly with cement as in the case of sulfate , but its effect is limited to metal parts that may be up for it and most important of steel reinforcement, and this leads to corrosion of these parts, causing damage to the reinforced concrete and the occurrence of cracks in their parts . It should be noted that the chlorides may be present in the basic components of concrete, sand, coarse aggregate and water. And access to the steel reinforcement is not limited to penetrate the soil .

### 4- Acidity or alkalinity - pH value:

Affect basal or acidic groundwater in the soil has a negative impact on the concrete buried in the ground. Vallost acid, was moderately acidic, leading to metal rust which explains the acidic damage to reinforced concrete. There are some kind of correlation between pH and the proportion of sulfates, where necessary measure pH is measured where the proportion of sulfates. It has been proven that if the pH value of less than 4.3 with a high proportion of sulfates, this indicates the presence of sulfuric acid ( $H_2SO_4$ ).

### 5- Calcium content

That the role of calcium in soil is not very clear, it is the chemicals in the interaction with the sulfates are expected to result in a sulfo aluminate calcium in addition to sulfo frit calcium, causing expansion on the other hand, the aluminate iron quadrant calcium be more resistant to the effect of sulfate of compound C3A is due to the composition of the class protective over calcium aluminate Free.

## Materials and methods of work

### 1 - Collect and create soil samples

This study was conducted at the site of the Technical Institute / Kut shown in figure (1) ,which is located at a distance of 10 kilometers south of the city of Wassit and adopted a research plan to study the soil and the content of some of the elements and compounds, as well as the physical characteristics of the soil, which are the moisture content, texture soil, conductivity of water, real density, bulk density, porosity and chemical characteristics of the soil and of sulfate, sodium, magnesium , potassium, chloride EC, pH.



Five samples are taken from the soil of the site in different locations each sample Institute away from the other at a rate of an estimated distance between (200-520) meters and a depth of between (0-30 cm). Samples were

dried and then milled, aerobically using sieve diameter hole(2) mm for the purpose of Some estimate the physical and chemical characteristics of the soil. These samples are brought in every sample and placed in a bag and the title.

2-Determination of physical characteristics studied:

Volumetric distribution for soil atoms was estimated by Hydrometer method as stated in (Bauder & Gee, 1986) and The bulk density for samples of soil was estimated by unexcited method as stated in ((Blake & Hartge 1986), estimated the conductivity of water-saturated soil using (Falling Head) (Klute & Dirksen,1986). And calculated Porosity by using the following relationship:

$$\text{Porosity \%} = 1 - \left( \frac{\text{Bulk Density}}{\text{real density}} \right) \times 100$$

3 - Chemical analysis:

Was estimated ions dissolved in solution of soil extract paste saturated, with estimated calcium and magnesium ions, calibrated with a solution of EDTA, and sodium ions by a Flame photometer. The chlorides have been appreciated by volumetric way titration with silver nitrate, were measured electrical conductivity using the device (EC-meter) to express the amount of total dissolved salts, and measured the degree of interaction of soil using a device (pH-meter).



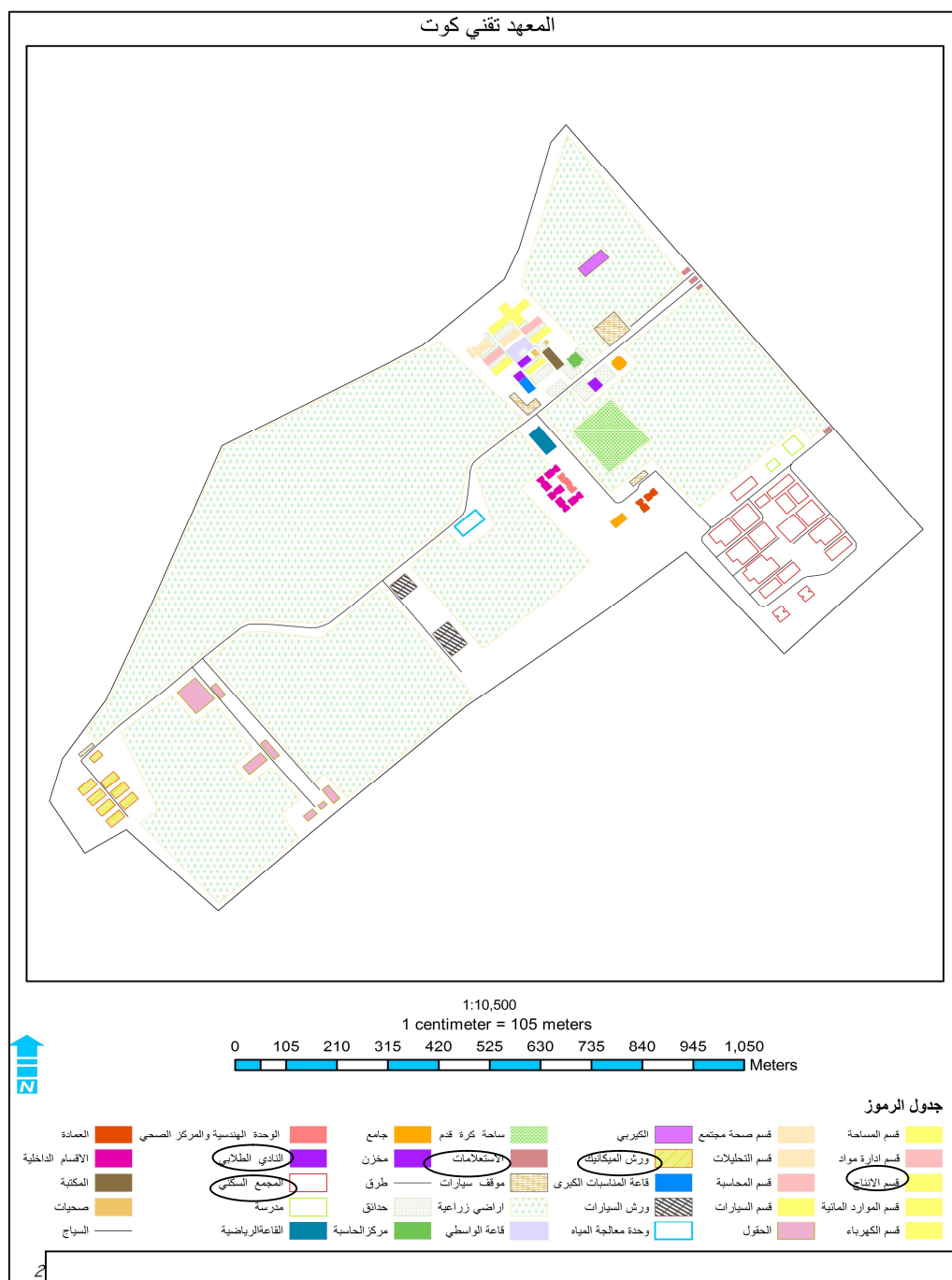


Fig 1: Map of Technical Institute –Kut

### Results and Discussion

It was found through physical tests for moisture content ranges from 3.2% to 18.2% as when increasing the moisture content in the soil which the soil is saturated with water to be unfit for the establishment of any concrete structure, because the presence of water unless address these soils such as the withdrawal of water and compact of soil, bulk density ranging from (0.04552-0.04779) gm/cm<sup>3</sup>. The soil was to be between sandy clay and the clay. the Porosity of soils ranges between (97.07-9.74) % The water conductivity was ranging (0.1797 -0.6847) cm/ sec as shown in Table (1) and all the physical tests effect a little on the concrete structure, only the



effect of moisture content when over the limit, while chemical tests have been studying sulfate, chloride, sodium, calcium, and magnesium were measured pH and EC as well as the examination of the presence of organic materials and through the study of chemical tests as shown in Table (2) was the proportion of sulfates ranging from (0.03087-0.770)% the effect of sulfates within the allowable limit, which is equal to 2 % either Chloride ions are furiously attacking the reinforcing steel and leading to eat and shredding with the passage of time and the percentages were obtained ranging between (20-80) (meq/L), where the allowable ratio either pH values ranging between (7.28-7.9), which came to an appropriate extent with selected species because pH ratios ranging between (12-14) cause corrosion in concrete and reinforcing steel, the values of electrical conductivity range between (0.01604-0.664056) mmhos/cm, where this ratio is very suitable and through study found entrance Institute is the best site have a few percentage from sulfate and chloride salts that effect on foundations of concrete structure, because these two elements have very strong effect if more than the allowable ratio. Figure(2) shows sulphate ratio with location of sample and figure (3) shows chloride ratio with location of sample. Conclusion from this that the sulfate attack concrete and cracks appear and grow and even cause fragmentation of these cracks lead to increase permeability of concrete and reinforcing steel by following exposure to corrosion due to chlorides and salts and water, which affect the reinforcing steel.

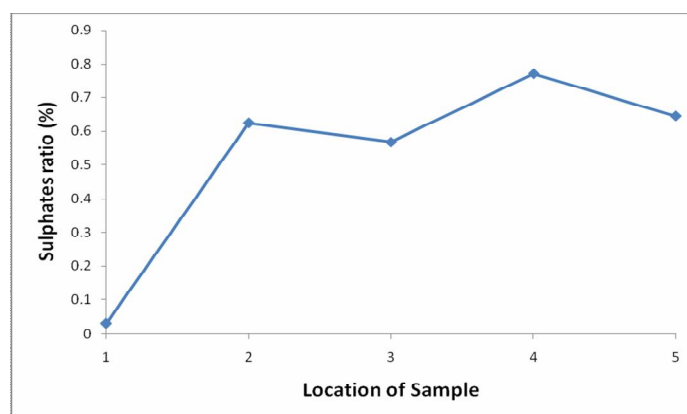
**Table (1) The Results of Physical Tests**

No.	Location of sample	Texture of soil	Moisture content%	Bulk density gm/cm <sup>3</sup>	Real density gm/cm <sup>3</sup>	Porosity%	Conductivity of water cm/sec
1	Entrance Institute	Clay sandy	3.2	0.04779	1.63	97.07	0.5629
2	Sport Club	Clay	8.9	0.06560	2.27	97.11	0.272
3	Residential district	Clay	14.6	0.04552	2.4	99.68	0.1797
4	Production Department	Clay sandy	18.2	0.04658	1.47	99.74	0.6847
5	Mechanical workshops	Clay	10.8	0.04773	2.08	97.7	0.4859

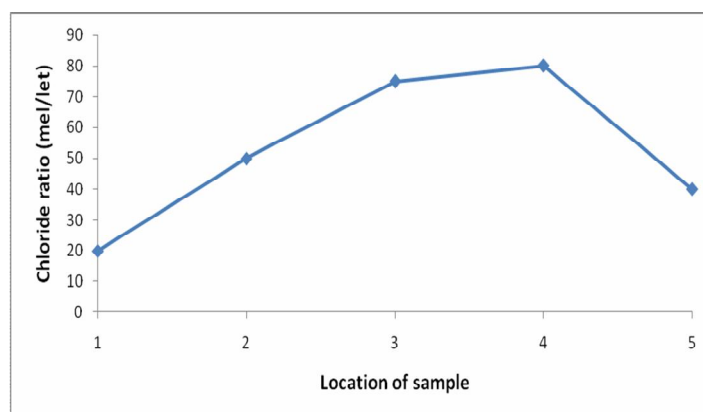
**Table (2) The Results of Chemical Tests**

No.	Location of sample	Sulphates %	chloride (meq/L)	Sodium (meq/L)	Magnesium (meq/L)	calcium (meq/L)	EC mmhos/cm	PH	organic materials
1	Entrance Institute	0.03087	20	80.56	10.6	14.4	0.0164	7.26	NO Found organic materials
2	Sport Club	0.623	50	351.65	8.76	115	0.1361	7.82	No Found organic materials
3	Residential district	0.568	75	131.21	16.8	89.8	0.1313	7.21	Found organic materials
4	Production Department	0.770	80	133.30	39.2	66.8	0.6640	7.27	Found organic materials
5	Mechanical workshops	0.644	40	227.95	9.6	74.6	0.0576	7.90	No Found organic materials





**Fig. (2): Show sulphate ratio with location of sample**



**Fig.( 3): Show chloride ratio with location of sample**

## References

- Blake, G.R. & Hartge , K. H. 1986. Bulk density, In method of soil analysis.Part 1, Physical and mineralogical method , 2<sup>nd</sup> ed . Edited by A. Klute. 363 – 375 .
- Farmanullah Khan, Zubair Hayat, Waqar Ahmad, Muhammad Ramzan, Zahir Shah, Muhammad Sharif, Ishaq Ahmad Mian, and Muhammad Hanif ,2013, “studied Effect of slope position on physico-chemical properties of eroded soil” Soil Environ.32(1):22-28.
- Garston, Watford,1975. Building Research Establishment(BRE).Digest No.174 Concrete in Sulphate – bearing Soils and Groundwater".
- Ibrahim Ahmed Mahmoud Kiki, 2006, (to improve the properties of expansive clay soil using lime waste) Tikrit Journal of Engineering Science Volume 13, Issue 3
- Head. K.,1982,Soil Laboratory Testing.Volume-1:Soil Classification and Compaction Tests. Pentech Press Ltd,.
- Klute, A. and Dirksen ,C. 1986.Hydraulic conductivity and diffusivity laboratory method. In method of soil analysis. Part 1,Physical and mineralogical method,2<sup>nd</sup> ed. Edited by A. Klute. P:637-732 .
- Page, A. I., Miller, R.H. and Kenney, D. R.1982.Methods of soil analysis. Part 2. Agronomy 9 .Madison W.I.
- Sami Ahmed Hijjawi,2003,“Tests the soil for construction purposes” Nablus Standard Specifications for Transportation Materials and Methods of Sampling and Testing.Part II.Methods of Sampling and Testing. AASHTO,1996.