Soil Permeability Comparison By Laboratory Tests: Baghdad City

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Abstract: Intermediate part of Iraq and symbolizes the first governorate from the eighteen governorates of Iraq in area called of Baghdad City. Permeability in Baghdad city is the meaning property that effects on the construction's constancy, then, the research is focused to evaluate the permeability for (cohesion less soil). Because of the soil morphology of Baghdad city, numerous disturbed samples at different depths were taken indicative of locations covering the region in Baghdad governorate. Four sites of soils in Baghdad city are certain. These sites are categorized consistent with the values of effective diameter to (A, B, C and D). The coefficient of permeability (k) is valued by using the constant head permeability test when the soil samples are arranged in dry national, then distribution the soil within the permeability shape at changed density by using raining soil (at different void ratio), these tests are recurrent at different coefficient of uniformity (CU). The mathematical representation of the coefficient of permeability data are represented by empirical equation. The relapse analysis was performed by using the statistical package and the results of the analysis provide the empirical equation for Baghdad soil. The empirical equation (12) compare with the Poiseuille's equation (11), the results of the empirical equation are conventional as compared to Poiseuille's equation. The results got from the present empirical equation (12) are compared with the field results of the four arbitrary sites which indication a good matching.

Keywords: Keywords: Baghdad city, Coarse Particles, Poiseuille's Theory, Permeability

1. INTRODUCTION

A material property that allows fluids to run through it ,called of Permeability. Any material that contains gaps that are connected to each other continuously allow that substance to pass through the fluids. Soil moisture content has a clear effect on its properties when the water flow through a soil is generated Leakage forces have an impact on the safety of the aquatic plant. As be explained later, shear resistance to the soil have to be partly controlled by the free discharge during stress. The slope of the mud layer depends. (Settlement Consolidation) the amount of water stored and filtered through the earth dam and below is dependent on the permeability of the dam and on the foundations. When a base hole is required in an area below the level of the surface of the groundwater, the amount of water leaching in the hole can be predicted if the adjacent soil permeability is known. The important soil that needs to be solved is solving many engineering problems [Ahuja et. al. (1980] flow is classified according to (flow Laminar) and (flow Turbulent). In the first case, the mass of the fluid starting from a particular point follows a certain path that does not intersect with the paths of the other particles that start from different locations. In the case of turbulent flux, the velocity of the particle changes over time in volume and direction and follows a winding path and intersects the paths of the rest of the particles. This leads to a rate of flow velocity and the sum of the random velocity vehicles on the direction of motion at any moment is equal to zero. The flow in the pipes and the normal speed in the hydraulic engineering is usually disturbed. In most soil types, the gaps are small so that the flow is a process (K, Gumi 2000). It is also necessary when studying Engineering Problems Exposure to water leakage through the soil and what is important to us is to study the combined effect of runoff during all the gaps of the soil. The aim of the research is to change the values of the permeability coefficient from one region to another in Baghdad while simultaneously changing it horizontally or vertically in one region point to point (Empirical equation) (K) for any area in the city of Baghdad at any depth (soil Cohesion less) and using (Statistical-Ms)And based on the results obtained from the laboratory for several samples, and then compare this equation with the theoretical equation that was derived in advance based on the hypotheses and later will verify the reliability of those parameters by field tests. 2-2. MEASUREMENT of PERMEABILITYThe different types of devices used in the determination of soil permeability coefficient are referred to as (Permeameter). There are two types, the head constant method and the method head falling, the first type is tested under constant height (h) and uses soil coarse (Soil cohesion less) while the second type is under variable height and is used for fine soil [Head, K. H. (1982)], Figure (1) shows the permeability of Coefficient, which is used in the current search. The dry soil sample is placed in a vertical cylinder between two porous plates. The density of the dry soil is controlled by changing the fall distance of the soil grains from the vessel.

Figure 1: *The device used in constant head access experiment*

The internal area of the cylinder represents the cross section of the soil sample (I) In the beginning, the soil is saturated by connecting the source of the equipment to the bottom. The water rises up through the sample. All the air in the gaps is pushed upward and the fixed level of the water source is connected at the top of the sample to generate steady flow conditions with a constant rise (h) Water is from top to bottom for flow Water is collected abroad cylinder are included (jar) and calculates the size of the cylinder. (jar in water of volume) and within a specified period of time (t), thus obtaining the amount of

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discharge [q =]when this discharge is equal at any time period, that flow is (flow state Steady), which is the discharge we use in Darcy law to find the permeability coefficient (k). In order to avoid a large error, it is necessary to have the amount of water collected is large The size of the test cell depends on the size of the soil granules examined, To the diameter of the largest granule should be greater than (12) [(2006) 68 - D2434 ASTM].

Darcy's' law

q = k. i. A But. q = $1\frac{V}{t}$ & $i\frac{h}{L}$

K= $\frac{V.L}{A.h.t}$ – – – – – – – – – – – – – – (1)

Where:

L: soil length, h: constant head, A: cross sectional area, q = Discharge at steady state

The temperature is recorded during each test. This degree is relative to the value of (k) measured by experiment and often at (20 ° C).

3. HYDRAULIC of LAMINAR FLOW

Derive Poiseuille [G., B, Look, 2007] flow Laminar in the pipe and this equation is known as equation Poiseuilles' (spring). On the assumption that the flow of liquid is through a tube of radius (R) and length (L.) Assuming that the pressure inside. At one end is (P) and the pressure at the other end is (∆P + P) and as shown in Figure (2)

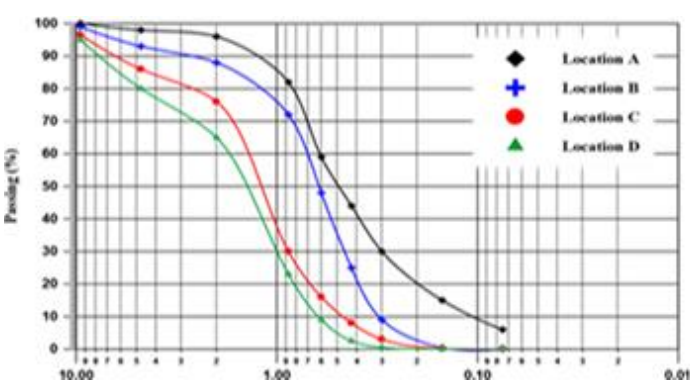


***Figure (2)**: laminar flow in tube ([(G., B, Look (2007)*

It is assumed that the net force of the flow (S) is equal to L.

S= π r2 Δp --------------------(2)

Viscousresis tance= − μ $1\frac{dv}{dr}$ 2π rL .rL--------------(3)

V= $1\frac{\gamma^{w}.i}{4\mu}(R2 \mp r2)$ ------------------------------(4)

Where i is the water gradient.

The amount of runoff is equal to [G., B, Look,2007]

Q= $1\frac{\gamma w.i.\pi.R4}{8\mu}$ ----------------------------(5)

Q=½m²-------------------------(6)

Where:1

a=area of section, m=mean radius of water

Q=Cs.m² $\frac{\gamma w}{\mu}$ i.a-----------------------------(7)

Q =C .m² $\frac{\gamma}{\mu}$ n i.A---------------------------(8)

Equation (8) is similarly modeled for the law of the flow = Q (A. i k) (Law s'Darcy) to clarify. The factors that form the Darcy coefficient of permeability.

Where:

m= $=\frac{\pi.d^3}{6\pi.◻^2}=\frac{1}{6}e.d$ ------------------------------(9)

Equation compensation (8)&(9) Where :n= obtained on

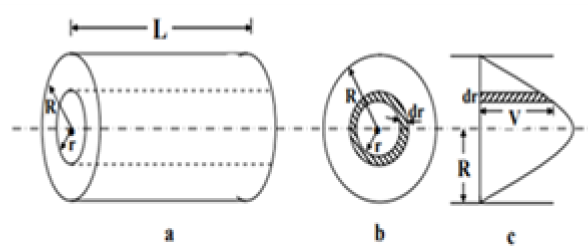
K=Cd². $\frac{\gamma w}{\mu}.\frac{e^3}{1+◻}$ ----------------(10)

Where: C=constant

Equation (9) Which is the theoretical equation to find the permeability coefficient.

4.LABORATORY WORK

The soil used in this research was brought from different areas of Baghdad city. There were differences in the soil from one area to another. Four areas were selected to cover Baghdad governorate. When taking approximately 28 samples from each region. So, through the Sieve analysis carried out on the samples taken, these areas could be divided into four main regions are (A, B, C and D) depended on Effective diameter (D10= 0.0135, 0.0505, 0.0298and 0,059cm) As shown in Figure (3), each granular distribution curve is shown in fig (3).



***Figure;(3)** Analysis of soil samples taken from Baghdad city of soil*

Then, dry density from Equation (11)

γd= ---------------------(11)
γd= 15.629 kN/m^3 , γd= 16.55 kN/m^3 , γd= 18.025 kN/m^3 and γd= 14.995 kN/m^3 Respectively.
In the previous form, the average score for twenty-eight samples taken from several places (different depths) and horizontal.
For each of the four regions, soil models were found to have a specific weight (Gravity Specific) is equal to (64.2). It is also found that for each region the gap ratio values range from (3.51) to (10.8) The values of the uniformity coefficient for each region are variable. Represented of densities are sandy soils from the sand loose to (sand dense), the values of dry densities extracted above were converted in terms of the values of gap ratios ,e = 0.50, e = 0.585, e = 0.32, and e = 0.48 Respectively shown in table (1).

NO.	A	B	C	D
Void Ratio (e)	0.48	0.32	0.585	0.5
Uniformity Coefficient (CU)	10.8	4.1	6.1	3.51
Effective Diameter (D_{10}) mm	0.0135	0.0505	0.0298	0.059

Table (1): Physical properties of the four sites

5.DISCUSSION

The values of the permeability coefficient (k) for the four sites obtained from the constant elevation experiment were drawn in Figs (4) to (7).

Uniformity coefficient, CU

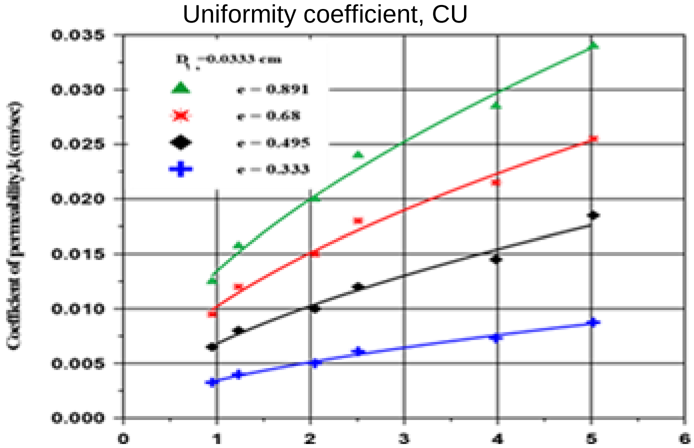


Figure 4: *relationship between (K),(CU)and(e) for site (A)*

Uniformity coefficient, CU

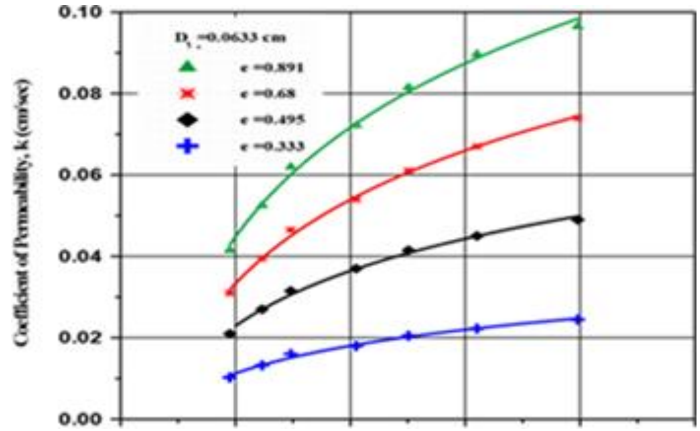


Figure 5: *relationship between (K),(CU)and(e) for site (B)*

Uniformity coefficient, CU

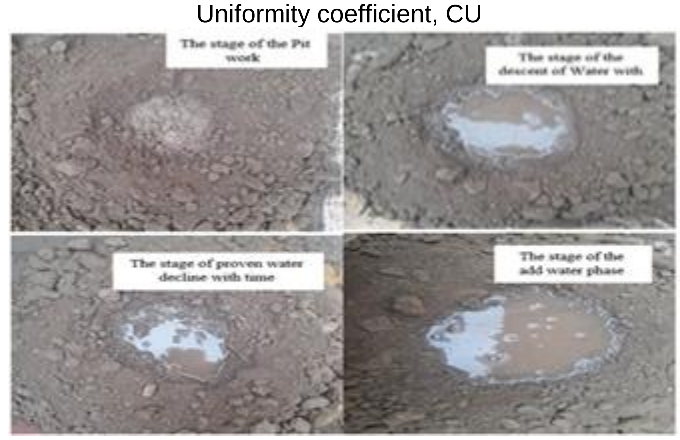


Figure 6: *relationship between (K),(CU)and(e) for site (C)*

Uniformity coefficient, CU

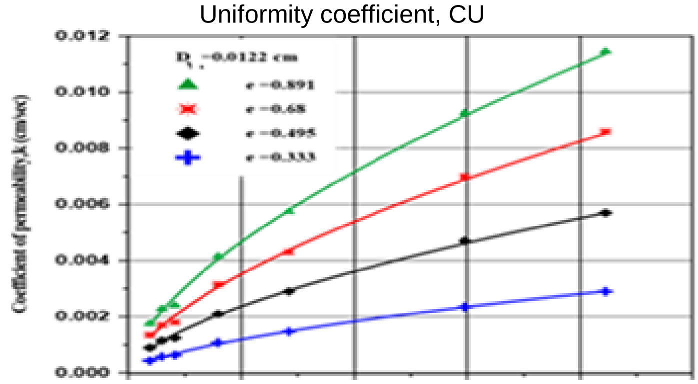


Figure 7: *relationship between (K),(CU)and(e) for site (D)*

These previous figures show that the more values Coefficient of Permeability(k) This is because the more granular the shape of the granule is, the greater the non-interference of soil grains and the formation of large gaps through which the water passes through, thus increasing the permeability coefficient (k). The shapes also showed that the relationship while the permeability factor and soil density values (e) is a positive relationship. At constant value of the coefficient of permeability, the permeability decreases with the decrease of the gap ratio. Laboratory data were introduced for the permeability coefficients, which were found in the previous forms with a statistical program (Ms-statistically) and the positional equation (12) was found, through which the permeability coefficient of any point can be estimated. Any location and at any depth of the city of Baghdad, know the value of the coefficient of regularity (CU) and the effective diameter (D10) and percentage and holes (e). (Empirical equation) have an accuracy (R^2=0.971).

$$K=63.32\left(\frac{e^3}{1+e}\right)CU^{0.5353}\ D10^{1.911} \quad \text{----------------(12)}$$

These (empirical equation) comparisons were compared with laboratory tests. Equation (11) is theoretically derived by (Poiseuille) for (flow laminar) in capillary tubes. The equation is found to be similar to the reasoning derived from the fifth paragraph. The method used in this examination is Inversed auger-hole method (Way and McKee ,1983). In order to apply this field method, random sites were chosen with a water level of 2 to 3 meters below the natural level [Hoorn ,1978)], The results are as follows; When applying the physical characteristics of the four existing sites and random schedule (1) into the equation the posture (12), extracted permeability coefficient values compared with the values of the permeability coefficient was found at the site of the equation (13) and found that there is a big match in those values for all locations in Fig (8) .

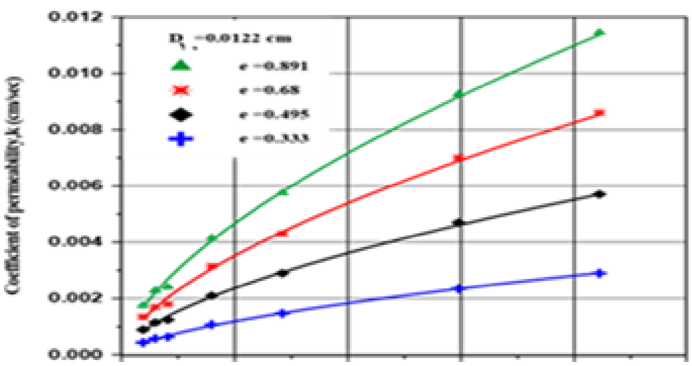


Figure 7; *The stages of water descent over time*

Therefore, can use empirical equation (12) find soil permeability when any site of Baghdad at any point whether its horizontally or vertically (at any depth required) rather than using farm methods with high cost and that takes a long time and had summarized that comparison in Table (6) as; below:

NO.	A	B	C	D
Void Ratio (e)	0.48	0.32	0.585	0.5
Uniformity Coefficient (CU)	10.8	4.1	6.1	3.51
Effective Diameter (D_{10}) mm	0.0135	0.0505	0.0298	0.059

Table 6*: comparison of permeability coefficient (Empirical Equation) with field values*

6.CONCLUSIONS

There is a significant correlation between the values of the permeability coefficient extracted from the positional equation (12) with the values of the measured field permeability coefficient and the four sites randomly selected in Baghdad City. The empirical equation (12), which was extracted based on the laboratory values, is a general equation for finding the permeability of any area (for any point) in the city of Najaf and at the required depth once the physical properties of that point have been found . The empirical equation is very similar to the general theoretical equation (11), which was derived from the hypothesis that the soil pores are like the connected pipe and the difference between the equations is the introduction of the soil granularity coefficient in the positional equation. The permeability coefficient (k) is directly proportional to the coefficient of regularity (CU) of the soil granule. In other words, the granular surface is more uniform. The larger the gaps between the granules and thus the larger flow and the higher permeability parameters. The permeability coefficient increases with increasing the effective diameter value (D10). For the future world, using the empirical equation (12) to find the permeability coefficient (k) for any incoherent soil with characteristics similar to the soil of Baghdad instead of being extracted from laboratory or field. Finding a position equation to find values (k) for cohesive soils with the introduction of physical parameters for this type of soils. Guess the permeability of a mixture of clay and sandy soil.

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