Hydraulic Conductivity of Sandy Soil with Varying Grain Size

P. Dayakar, K. Venkat Raman, R.Venkata Krishnaiah

Abstract - A concept of mean particle size and size factor is presented in this paper and an attempt is made to relate the hydraulic conductivity to mean particle size, taking into account the optimum moisture content and maximum dry density. The distribution of particle size has a significant effect on hydraulic conductivity. It is possible to determine the mean particle size and size factor from the gradation curve. For the purpose of experimental analysis, three samples of soils were collected, local river sand available in market, coarse sand1.18mm sieve and quarry dust. For determining the hydraulic conductivity a constant head permeability test is conducted. A few exact conditions to compute water powered conductivity utilizing grain estimate dispersion of unconsolidated spring materials have been assessed in this examination. Evaluating examination of soil tests extricated from the test openings during ground water examination venture was performed to decide their arrangement and molecule measure dispersion attributes, from which pressure driven conductivities were figured. In particular, every single exact equation are to be utilized carefully inside the space of appropriateness.

Key words*: *Hydraulic conductivity, Grain size analysis, Empirical formula.

I. INTRODUCTION

Hydraulic Pressure driven conductivity is one of the most significant normal for water bearing developments. Its extent, design, changeability fundamentally impact ground-water stream design[1],[3],[5]. All in all, pressure driven conductivity speaks to capacity of a permeable medium to transmit water through its interconnected voids. Water powered conductivity of soils is a significant parameter in numerous seaward geotechnical examines, for example, wave-soil cooperation[32],[34]. Darcy's condition holds useful for the laminar progression of water through the void spaces in soil (sand and earth). In view of this examinations it has been reasoned that, for stream of water through fine and medium sand, sediment, and mud, the stream is laminar and Darcy's law is substantial (Muskat, 1937; Mitchell, 1976) [25],[27],[29].

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The index properties of the soil samples namely fine sand, coarse sand and quarry dust used in this project work is furnished in table 1.

Table 1 – Properties Of Soil Samples

Description	Fine Sand (FS)	Coarse Sand (CS)	Quarry Dust (QD)
Specific Gravity	2.67	2.60	2.76
D10	0.099	0.73	0.1
D15	0.18	0.93	0.2
D30	0.24	1.05	0.4
D60	0.36	1.1	1.8
Cc	1.6	1.767	0.88
Cu	3.6	1.833	18
γd max	1.84	1.78	2.26
OMC	14.29	7.95	6.67
e_{max}	0.71	0.69	0.51
e_{min}	0.52	0.54	0.3
e_{avg}	0.615	0.615	0.405
Classification	SW	SP	SP

II. GRAIN SIZE DISTRIBUTION

This arrangements with the technique for the assurance of grain estimate dispersion in soils. An examination of this caring express quantitatively the extents by mass of the different sizes of particles present in the dirt. In a dirt, the rock, sand, residue and mud divisions are perceived as containing particles of diminishing size[2],[4],[6]. The real scope of measurements of the particles are given in IS: 1498-1970. The aftereffects of grain measure examination may likewise be spoken to graphically as a grain estimate conveyance bend in which the aggregate rates better than realized proportionate grain sizes are plotted against these sizes, the last being on a logarithmic scale. The consequences of grain measure investigation are broadly utilized in soil arrangement[7],[9],[11]. The information acquired from grain measure appropriation bends is utilized in the structure of channels for earth dams to decide the reasonableness of soils for street development. In this the standard, grain sizes have been gotten line with IS: 1498-1970.

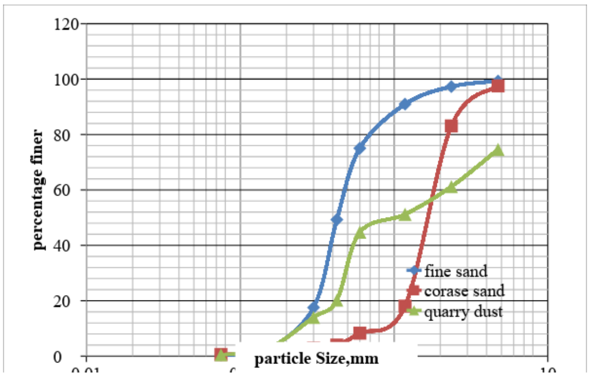

Fig. 1 Particle size distribution of soil samples

III. METHODOLOGY

For preparing hydraulic conductivity of test setup an acrylic cylinder of Diameter 19 cm height 26 cm average flow Q 50 cm³/sec Constant Hydraulic head h, 37.5 cm.

Fig 2 Hydraulic Conductivity typical test setup

The notations followed for various soils in various states for determining the hydraulic conductivity is furnished in table 2.

Table – 2 Notation Followed

Description	Notations
Fine Sand Loose State	FSLS
Fine Sand Medium Dense	FSMD
Fine Sand Dense State	FSDS
Coarse Sand Loose State	CSLS
Coarse Sand Medium Dense	CSMD
Coarse Sand Dense State	CSDS
Quarry Dust Loose State	QDLS
Quarry Dust Medium Dense	QDMD
Quarry Dust Dense State	QDDS

IV. EXPERIMENTAL INVESTIGATION

Though the cohessionless soils have unique hydraulic conductivity, the behavior of the same is different when a combination of layers are formed[8],[10],[12]. To understand this behavior in the first case a combination of coarse sand, quarry dust and fine sand is placed one over the other and hydraulic conductivity is determined. Fig 3.15 shows the test setup of the determination of hydraulic conductivity of combination of quarry dust, c in the medium dense state. To obtain this state of soil the three samples is filled in the acrylic tube in the dense state by compacting for 10cm filled to reduce the void ratio partially[26],[28],[30]

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Fig 3. Hydraulic Conductivity of layered soil coarse sand, quarry dust and fine sand andQuarry Dust, Coarse Sand , Fine Sand - Medium Dense State

A relationship between hydraulic conductivity and time taken to reach a constant value of hydraulic conductivity for the coarse sand, quarry dust and fine sand in the medium dense and state is shown in fig 4[31],[33]. In this case, approximately after 480 seconds a constant value is established, and the quarry dust, coarse sand and fine sand in the medium dense state is in this case, approximately after 1530 seconds a constant value is established[14],[16], [18].

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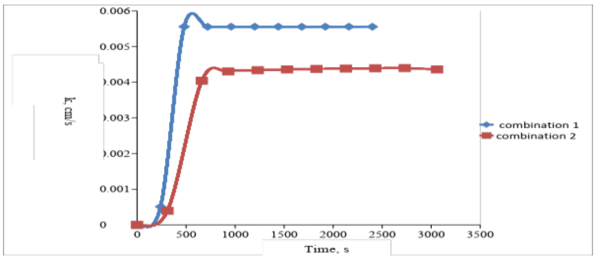

Fig 4. Relationship between Hydraulic Conductivity and Time for Coarse Sand, Quarry Dust and Fine Sand and quarry dust, coarse sand and fine sand - Medium Dense State.

V RESULT AND DISCUSSION

From the experimental investigation of determining hydraulic conductivity for various states of different soil samples, a comparison is made with the available empirical relationship to determine the hydraulic conductivity[19],[21],[23]. Table 3 shows the comparison of hydraulic conductivity determined by empirical relationship namely Allen Hazen's equation and Sherard's equation along with the experimental values.

Table 3. shows the comparison of hydraulic conductivity of three different soil samples in three different states namely loose, medium dense and dense state[13], [15] ,[17]. From the table, it can be understood that for any type of soil loose state gives higher hydraulic conductivity when compare to dense state.

From the investigation, it can be seen that quarry dust in the loose state is more porous then coarse sand and fine sand. A graphical representation of the same is shown in the fig 5. to understand the behavior clearly [20],[22], [24]

Table – 3 Comparision of Empirical Formula and Experimental Value

Soil	State	Experimental value k, cm/s	Allen Hazen's Equation k, cm/s	Sherard's Equation k, cm/s
Equation		k=QL/Aht	k=C(D10)²	k=0.35(D15)²
Fine Sand	Loose	0.1858		
Fine Sand	Medium	0.0776	0.0225	0.011
Fine Sand	Dense	0.0173		
Coarse Sand	Loose	0.1957		
Coarse Sand	Medium	0.1638	0.5329	0.5
Coarse Sand	Dense	0.1101		
Quarry Dust	Loose	0.2755		
Quarry Dust	Medium	0.0024	0.01	0.014
Quarry Dust	Dense	0.0005		
C.S+Q.D+F.S	Medium	0.0045	-	-
Q.D+C.S+F.S	Medium	0.0035	-	-

A comparison is made for the various cases of determination of hydraulic conductivity by plotting the curve in a single graph as shown in fig 5.

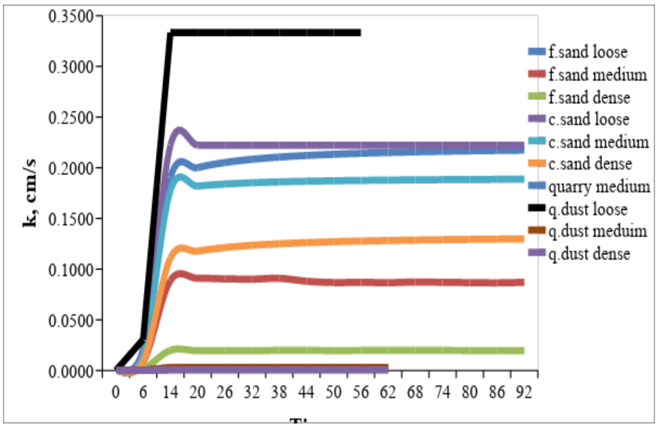

Fig 5. Relationship between HydraulicConductivity and Time for all the three soil samples

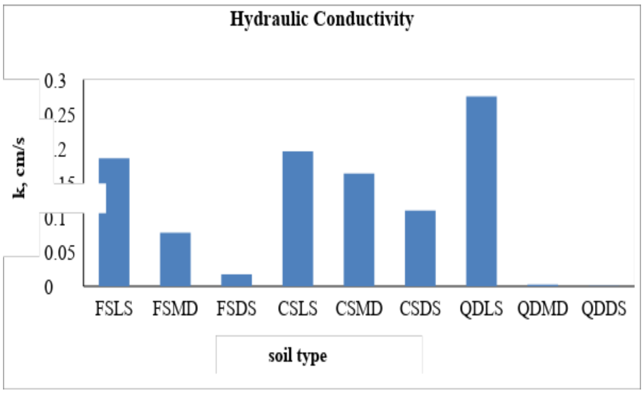

Fig 6 Graphical representation of Hydraulic Conductivity vs soil samples

V. CONCLUSION

In case of fine sand there is a reduction of 90% and 58% hydraulic conductivity when dense state and the medium dense state is compared with loose state respectively .

In case of coarse sand there is a reduction of 43% and 16% hydraulic conductivity when dense state and the medium dense state is compared with loose state respectively .

In case of quarry dust there is a reduction of 99% and 99% hydraulic conductivity when dense state and the medium dense state is compared with loose state respectively.

From the comparison of experimental results with the empirical relationship it may be concluded that only overestimation or underestimation of hydraulic conductivity can be arrived when these empirical relationship are used.

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