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Determination of Infiltration Parameter Estimation Rates in a Small Region in Andhra Pradesh

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Abstract: Infiltration is the process by which water on the ground surface enters the soil. Infiltration rate in soil science is a measure of the rate at which soil is able to absorb rainfall. The main theme of our project is to find the infiltration rate at "KL University" campus located at Vaddeswaram near Vijayawada. The unit used to calculate the infiltration rate is mm/hour. The calculation of the infiltration rate entering the soil, a double-ring infiltrometer is used for the experiment. Four locations have been selected as the study area which is nearby the laboratory of Civil and lawn area, in front of Civil engineering block and in front of girl's hostel. We conducted experiment in both the soil conditions such as wet state and in dry state. The Apparatus used and the Experiment name is "Double ring Infiltrometer" which consists of outer and inner rings of diameter 60cm and 30cm. The parameters that is responsible for infiltration is studied and observed. By plotting Graph between Time taken and infiltration rate in mm/hr in excel we got the equation in similarity with the general equation f= (fc-fo)ekt. From this we had obtained the infiltration terms such as Fc, Fo, where Fc is called as "Ultimate Infiltration" and Fo is called as "Initial infiltration". And finally we had obtained the different (infiltration parameter "K") values at the stations we conducted .The calculation that is using in this experiment is Horton's Equation. The analysis indicated that the soil for the four selected areas is Black cotton soil with less sand content. The infiltration rate at KL University comparatively uniform.

Keywords: *Double ring infiltrometer, Horton's equation, infiltration capacity, infiltration rate.*

1. Introduction

Infiltration is the process by which water on the ground surface enters the soil. Infiltration rate in soil science and it is a measure of the rate at which soil is able to absorb water from rainfall or any other means. The Infiltration process is governed by two major factors viz. Gravity and Capillarity action. Gravity is a natural phenomenon and Capillary action is the ability of liquid to flow in narrow spaces. Infiltration process is controlled by three mechanism, the initial entry of the water through the soil/plant surface (percolation), movement of the water through the unsaturated zone, and finally, depleting of the soil water storage capacity. Soil is a reservoir that stores water for plant growth and part of this water in soil may be replenished by infiltration. Hence computation of infiltration in any water shed region is important aspect.

Several researchers have been attempting to study about infiltration and reporting their research work. Robert Pit et al (1999) have presented experimental results on distributed urban soils and compost amended soil effects on and reported quality and quantity of runoff in an area. Ellen R. Turner (2006) has reported five equations obtained from experiments in a hilly area and also stated that Horton's equation produces better result. Mohammad Farah Bin Salleh (2006) conducted experiment on infiltration using "Double ring Infiltrometer", and reported infiltration parameters in different locations of KUTKEM (Kolej University Kejuruteraan & Technology Malaysia) area using Horton's equation and classified soils based on ASTM D 2487. Eze Bassey Eze et al (2011) reported infiltration capacity of soils using double ring infiltrometer experiment in local Government area covering wide ranges of soil surfaces across a river in Nigeria. While infiltration of vertically non uniform soils was reported by Keith Beven Infiltration Studies of Different Soils Under Different Soil Conditions and Comparison of Infiltration Models With Field Data was reported by Jagdale Satyawan Dagadu .Derek C. Godwin et al (2012) reported infiltration rates for Low Impact Development Infiltration facilities that include rain gardens, vegetated filter strips, porous pavements, infiltration planters, swales, drywells, and soakage vegetated filter strips, porous pavements, infiltration

planters, swales, drywells, and soakage trenches. Calmer Almer & Greg Le Fevre (2008) reported impacts of Storm water on infiltration on the Groundwater System in an areaS.mohan and Sangeetha had done a research on recharge estimation of infiltration was reported. Infiltration studies for varying land cover conditions thin layer of silts and clay particles at the surface of the soil and vegetation by C. L. Jejurkar and Dr. M. P. Rajurkar. The present study is to develop infiltration equations in K.L. University Campus area situated in Guntur District of Andhra Pradesh, India as shown in Fig—1.The Latitude and Longitude of the study area is 16.441518N and 80.621795E respectively.

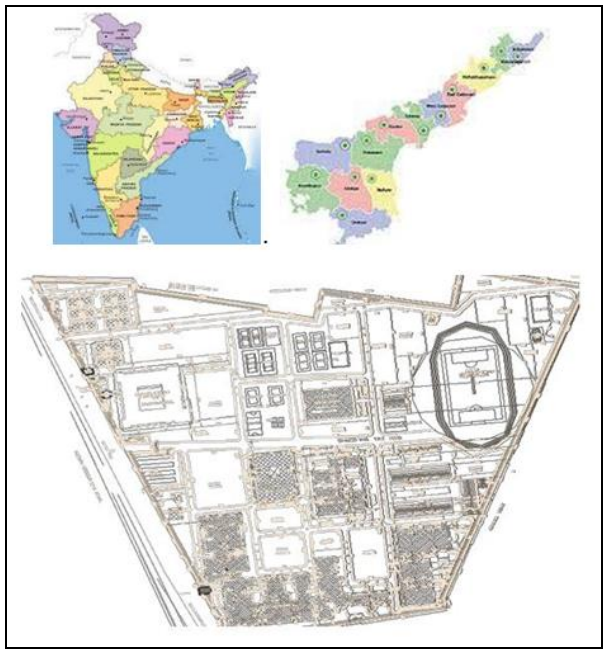

Fig 1: *Study area (K L University)*

2. Methodology

Double ring infiltrometer has been fabricated which comprises of two rings with bevel edge at bottom to allow easily into the ground surface. The outer ring consists of 600 mm dia. and inner ring is of 300 mm diameter with a height of 600 mm. The fabricated device is shown in Fig–2. Before commencement of experiment the ground cover has been removed without disturbing the soil surface. The rings have been set in position and inserted into the ground to about 10mm, or until the rings can be set firmly in the ground as shown in Fig–2. The outer ring was filled with water and inner ring was also filled with water. Observations were taken at regular intervals by observing the infiltration of water into the soil. It was ensured that outer ring contains water of sufficient quantity throughout the phase of experiment to ensure saturation condition in the vicinity. The experiment has been continued until a constant volume added to that of time was achieved and all the observation like time duration and volume of water added has been recorded. The rate of infiltration measured at eight locations with dry and wet conditions in the campus.

3. Results and Discussions

The results obtained from the experiments conducted are Initial rate of infiltration F0 and steady state infiltration rate Fc and infiltration parameter constant index 'k' has been computed by adopting Horton's infiltration equation. The results were tabulated and are shown in Table – 1. The developed infiltration equations based on Horton's model for the campus area were shown for the dry and wet conditions from equation 1 to 8. The general soil class is clay and gravel and at certain locations there are combination soils with gravel as well in the study area.

Fig 2: *Doublering infiltrometer*

Table – 1: *Values of Infiltration at Study area*

S. No.	Soil Observed	Condition of Soil During Experiment	F0 (mm/Hour)	Fc (mm/Hour)
1	Black cotton	Dry	362.45	16.98
2	Laterite	Dry	353.79	15.28
3	Black+ laterite	Dry	370.96	13.58
4	Black+ laterite	Dry	258.58	13.50
5	Black cotton	Wet	312.01	11.88
6	Laterite	Wet	283.86	13.50
7	Black+ laterite	Wet	287.91	5.09
8	Black+ laterite	Wet	375.43	8.49

$$F = 345.47\, e^{-1.916\, t} \quad (1)$$

$$F = 338.51\, e^{-1.453\, t} \quad (2)$$

$$F = 245.08\, e^{-2.524\, t} \quad (3)$$

$$F = 270.36\, e^{-2.45\, t} \quad (4)$$

$$F = 300.13e^{-1.921\,t} \quad (5)$$

$$F = 357.38\,e^{-1.869\,t} \quad (6)$$

$$F = 282.82\,e^{-2.11\,t} \quad (7)$$

$$F = 366.94\,e^{-1.426\,t} \quad (8)$$

The variation of infiltration with time at some of the locations of campus for Dry and Wet conditions of soil when modeled using Horton's equations obtained from the curve is shown in Figures 3and 4 which shows exponential variation.

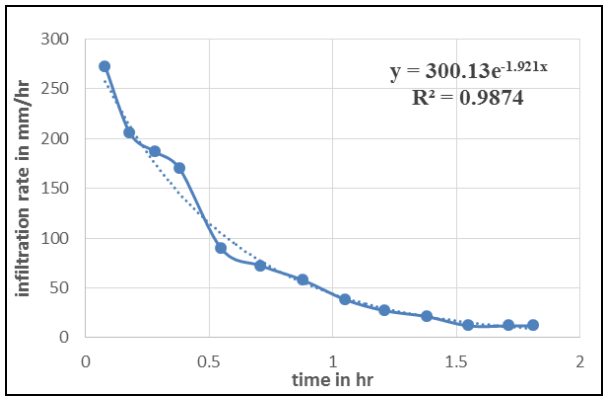

Fig 3: *Infiltration curve (Dry condition)*

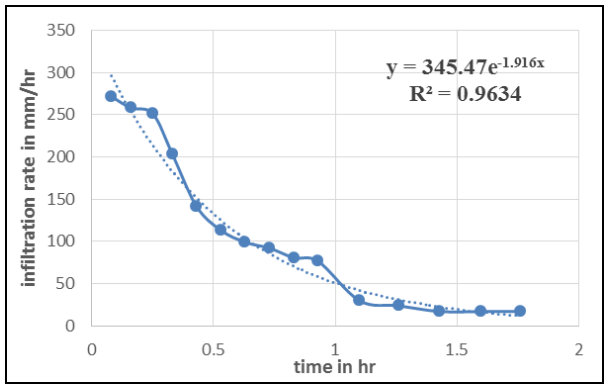

Fig 4: *Infiltration curve (Wet condition)*

4. Conclusions

From the research work carried out it was found that the infiltration rate of soil in the study area was varying from 13mm/hr and 16mm/hr in dry condition. For black cotton with laterite soil as observed it is 13.58mm/hr in dry condition black cotton soil in wet condition was found that 11.8mm/hr, laterite soils the infiltration rate was 15.28mm/hr, and 13.50mm/hr in dry and wet conditions respectively in the selected region. The correlation coefficient and standard error calculations obtained it was found that for all types of soils and their conditions Horton's model is fitting well with correlation coefficient and minimum standard error obtained. The infiltration parameter K lies between 1.4 to 2.5, which is closer to the standard 'K' value for black cotton and laterite soils.

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