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Experimental Study on Infiltration in Guwahati Using Double Ring Infiltrometer

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ABSTRACT: Infiltration rate of soil is a topic of continued interest. In this paper, an attempt has been made to find the constant infiltration rates of different soils under different soil conditions. Field experiments were carried out at six different sites located within Guwahati. They include DeeporBeel; Assam down town University, Panikhaiti; Eastern Retreat, Panikhaiti; Zoo Road; Bonda and Narengi Housing Colony. The highest infiltration rate obtained was 10.73cm/hr at Eastern Retreat and the lowest was 1.73cm/hr occurred at Bonda. Soil tests have also been done to know the soil type and how the infiltration curve varies for each soil type with respect to time.

KEYWORDS: infiltration, double ring infiltrometer, infiltration rate, cumulative time, infiltration curve.

I. INTRODUCTION

The process through which water enters the soil from the ground surface is known as infiltration. This process is caused by force of gravity and capillary action. Infiltration capacity may be defined as the maximum rate at which a given soil at a given time can absorb water and is expressed in cm/h or mm/h or inches/h. The infiltration capacity is dependent on a large number of factors; some of them are characteristics of the soil, vegetative cover, condition of the soil surface, soil temperature, water content of the soil, rainfall intensity, etc. If the intensity of rainfall exceeds the infiltration rate of a given soil it results in a runoff. Infiltration of water into the soil can be determined by a simple instrument called Double ring infiltrometer. The cylindrical ring made up of stainless steel are partially inserted into the soil and filled with water, after which the speed of infiltration is measured. Two types of cylinders are taken for this experiment of diameter 11cm and 22cm and height 40cm. The double ring limits the lateral spread of water after infiltration. Double ring infiltrometer is better than single ring infiltrometer because in single ring infiltrometer the water will spread both horizontally & vertically, but using double ring infiltrometer the water will penetrate in one direction that is towards the ground water without much wastage of water.

II. LITERATURE REVIEW

A number of literatures and research papers have been studied, which deals with infiltration through different types of soils and related investigations. A few of these findings of these papers have been presented. In ASTM¹(2003) it's mentioned that double ring infiltrometers is a development of the single infiltrometer method in which the error associated with the single ring method can be reduced because the water level in the outer ring forces vertical infiltration of water in the inner ring. Gregory² et al., (2005) Infiltration is the process by which water from the soil surface penetrates the soil and this process affect surface runoff, soil erosion, and groundwater recharge. Dr.Avinash S. Kadam³ (2016) determine the infiltration rate for site selection of artificial water recharge and discuss the various general physical parameters affecting on it. Wu⁴ et al., (1997) stated that numerical modelling has shown that falling head and constant head methods give similar results for fine textured soils, but the falling head method underestimates infiltration rates for coarse textured soils. Tarek Selim⁵ (2011) investigated the effect of land use on soil infiltration rate in heavy clayey soil by using double ring infiltrometer. Maheshwari⁶ (1996) described the advantage of using Double Ring Infiltrometer in estimating infiltration as it is a straight forward procedure and also the instrument is simple. C. L. Jejurkar, Dr. M. P. Rajurkar⁷ (2012) made an attempt to determine infiltration rates of soil under different land cover

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conditions and to compare validity of different infiltration equations viz. Kostiakov, modified Kostiakov, Horton and Philip.

III. MATERIALS

In this study a double ring infiltrometer has been used for measuring infiltration. The instrument essentially consists of:

- Two rings having diameter 11cm and 22 cm.
- Total height of the infiltrometer is 40 cm.
- A steel rod having 4 cm x 4 cm and 70 cm in length.
- A hammer of 2.5 kg weight.
- A spade to collect the remove the sample from site.
- A measuring scale having 30 cm in length.
- Stopwatch and notebook for writing records.
- A sufficient amount of water for reading.

IV. METHODOLOGY

Certain places of Guwahati like DeeporBeel, ADTU Panikhati, Eastern Retreat Panikhaiti, Zoo Road, Bonda and Narengi Housing Colony was selected to conduct the test by using double ring infiltrometer. Area of 2m by 4m was taken in all the places. The two cylinders are digged inside the soil but the measurement is taken in the inner cylinder only; the outer cylinder helps the water from the inner cylinder to flow vertically downwards and not laterally. The cylinders are of height 40cm which are been digged up to a height of 20cm inside the soil with the help of steel rod and hammer. Figure 1 shows the infiltrometer that has been used in this experiment with inner diameter 11cm and outer diameter 22cm.



Fig 1: Double ring infiltrometer

Cylinders are kept back 20cm above the ground surface in which the water was poured and the measurement of the decreasing water level was taken. Water is supplied uniformly inside the ring without any disturbance of soil surface. A measuring scale of 30cm is placed in the inner cylinder and the initial water level of the inner cylinder is noted down. The measurement was continued until and unless a constant value of infiltration rate was achieved. A time interval of two minutes and later four minutes and a total of 90 minutes were taken and the decrease in the water level was measured. The water level in the outer cylinder is kept at the same level as the water level in the inner cylinder.

V. STUDY AREA

Guwahati is the largest city of Assam and North-eastern India. Guwahati is the second-largest metropolitan region in eastern India after Kolkata with an area of 1,528 square kilometres (590 sq mi). Guwahati has a humid subtropical

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climate. The average annual temperature is 24.2 °C with extremes ranging from 40.6 °C recorded on 24 April 2014 to 30 °C recorded in January 1964. Guwahati is a city where the topography, climate, humidity, temperature, altitude, soil behaviour, etc varies from place to place. The six study areas have different location and altitude and as the experiments are conducted in different days so the temperature, humidity and pressure also varied. Table 1 shows the details of the climate profile of our study area.

Table 1: Table showing the location, altitude, temperature, humidity and pressure of the study areas.

Study Area	Location	Altitude (m)	Temperature (°C)	Humidity (%)	Pressure (Psi)
Deepor Beel	26.1177° N 91.6494° E	53	27°	62	14.62
ADTU	26°12'04.07"N 91°51'36.75"E	82	31°	57	14.68
Eastern Retreat	26°13'09.10"N 91°52'12.83"E	66	29.2°	82	14.50
Zoo Road	26°10'00.83"N 91°46'57.49"E	45	29°	48	14.65
Narengi Housing Colony	26°10'46.67"N 91°49'55.00"E	53	28°	54	14.67
Bonda	26°11'06.56"N 91°50'42.57"E	88	31.5°	75	14.48

Figure 2 below shows the complete visual process of carrying out the infiltration experiment in the field. Figure 2(a) shows measuring the drop in water level, Figure 2(b) shows measuring whether the infiltrometer is levelled, Figure 2(c) shows noting down the readings, Figure 2(d) shows filling the cylinders with water and Figure 2(e) shows the digging of cylinders into the soil. These pictures also show the different sites where the experiments have been carried out and with different soil cover.

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Fig 2: Some photographs while carrying out the experiment on sites (a) Measuring the drop in water level (b) Measuring whether the infiltrometer is levelled (c) Noting down the readings (d) Filling the cylinders with water (e) Digging the cylinders into the soil

VI. RESULTS AND DISCUSSION

Figure 3 shows the infiltration curves for the different sites. We can see that Eastern Retreat, Panikhaiti has the highest rate of infiltration than the other five study areas and Bonda has the lowest infiltration rate. In Eastern Retreat, the infiltration rate at the beginning was high and decreased to reach the steady (constant) value of 10.73 cm/hr where else, Bonda has lowest infiltration rate of 1.73cm/hr.

In the beginning the infiltration rate is high as the soil is in the dry state and slowly as the soil saturates it decreases and finally gets a constant value. This may be attributed to the fact that infiltration rate depends on soil characteristics. After performing soil tests, we found Eastern Retreat is surrounded by sandy soil and Bonda has loamy soil. Moreover, it is found that for loamy soil the type of infiltration is slow-moderate, for sandy loam soil the type of infiltration is moderate whereas, for sandy soil we got moderate-rapid rate of infiltration. Again, except DeeporBeel we found that all the five study areas have Poorly Graded Sand whereas DeeporBeel has Well Graded Sand.

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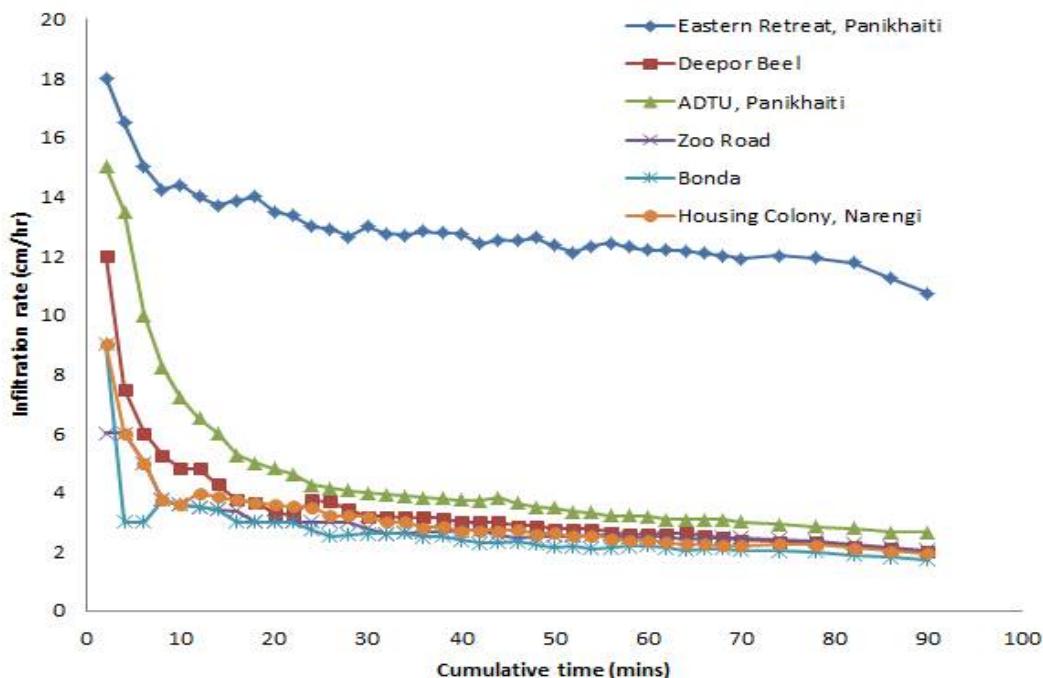


Fig 3: Infiltration curve of the six study areas of Guwahati

VII. CONCLUSION

From research work it was found that soil conditions effects infiltration rate. From the graphs of infiltration rates against time it is found that initial infiltration rates were high and decreased with time up to constant infiltration rate. From the graph plotted, it is seen that Eastern Retreat, Panikhaiti has the highest infiltration capacity while Bonda has the lowest infiltration capacity. The application of infiltration method in the study area indicated that DeeporBeel, Bonda and Narengi Housing Colony are characterised by slow-moderate rate of infiltration. ADTU, Panikhaiti and Zoo Road is characterized by moderate rate of infiltration whereas, Eastern Retreat, Panikhaiti is characterized by moderate-rapid rate of infiltration. It is found that for loamy soil the type of infiltration is slow-moderate, for sandy loam soil the type of infiltration is moderate whereas, for sandy soil we got moderate-rapid rate of infiltration. The Atterberg limits (liquid limit and plastic limit) indicated that generally the sediments are with low to medium plasticity index. From the sieve size analysis test, we found that the soil the study area is generally covered by poorly graded sand.

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