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CHARACTERISTIC OF GIRNA RIVER SOIL BY USING INFILTRATION ANALYSIS

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Abstract— Infiltration is the unit of hydrological cycle, in which soil allow the water to penetrate inside the ground surface, and include in water table. For analyzing flood in any river, we need to study about the infiltration characteristic of there catchment area soil. So, we study on Girna river flood risk by analyzing of infiltration by considering geological parameter density of soil, this can help for understanding structure of soil, factors which is effect on infiltration rate, and hydrological cycle of various soils which is available on this catchment area. Also, this study is helping farmer of downstream of kantai bhandra at mohadi, Jalgaon by alerting from flood in this river.

Keywords— Infiltration rate, density of soil, Cumulative infiltration curve, Flood risk

1- INTRODUCTION

1.1 General:

Infiltration of soil, which is defined as the percolation of water through soil or 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. Robert E. Horton is best known as the originator of the infiltration excess overland flow concept. For storm water analysis and prediction which in conjunction in unit hydrograph concept, provide foundation for engineering hydrology for several decades. Infiltration equations developed (1933) and the most common empirical equation used to predict infiltration if ponding occurs from [rainfall rate < Ksat all infiltrates - no ponding, soil never becomes saturated]. Horton detailed his theory in a land mark paper published in 1945, only a month before his death, in the bulletin of the geological society of America. Infiltration occurs first by capillary action, then by gravity. During the rain infiltration loss occurs quickly almost exclusively from the water that has reached the ground surface. The water infiltrating into the soil moves downward through larger soil pores under the force of gravity. The smaller surface pores take in water by capillarity. The downward moving water is also sucked in by capillary pores. The gravitational water moves towards the ground water following the path of least resistance. When the capillary pores at the surface are filled and intake capacity reduced infiltration rate decreases. As a trend the rate of infiltration is high in the beginning. It decreases rapidly in the initial stages and then slowly till it approaches a nearly constant rate in about 30 to 90 minutes depending upon the type of soil.

1.2 Objective:

- study the soil characteristic of Girna river catchment by using infiltration analysis.

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- Determination infiltration rate and runoff starting time.
- Determination of cumulative infiltration curve and various parameters.
- Study the flood risk management on hydraulic structure.

Factor Affecting on Infiltration rate:

- Grain Size.
- Condition of land surface.
- Adsorbed Water (Moisture Content).
- Temperature.
- Flow.
- Influences.
- Shape and structure of particle.
- Texture and structure of soil particle.
- Types of soil
- Structural arrangement of soil particles
- Rainfall intensity

2- AREA OF STUDY

The study area is a part of Girna River from Kantai barrage downstream to the confluence Point of Girna River and Tapi River. We are select agriculture land which is along with river and it's depending on the various type of soil like clay soil, silty clay, and clay loam/ black cotton soil. We cover 9.4 km distance of river by infiltration test. Accordance to infiltration data of the soil we understand how much water is collected in Girna river basin.

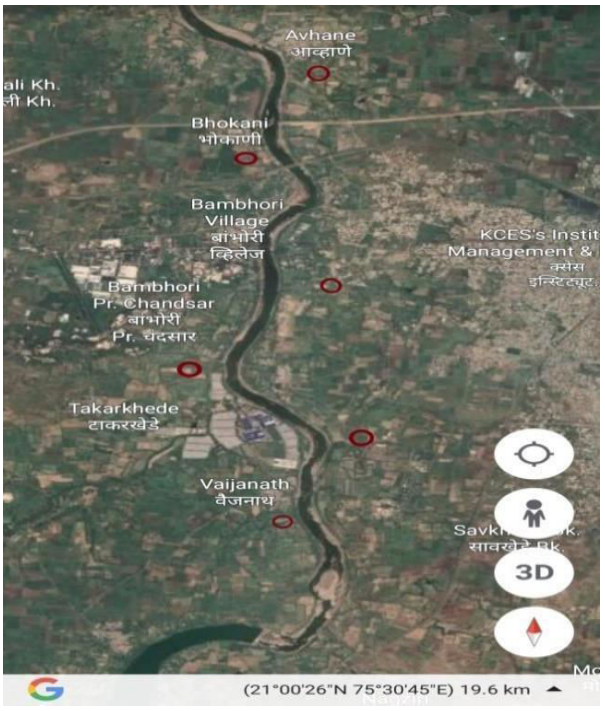

Fig 1.Girna River region at Bambhori, Jalgaon

3- Methodology

3.1 Double Ring Infiltrometer test:

The double ring infiltrometer method consists of driving two open cylinders inner ring and outer ring, measuring rod, hammer, driving plate, Liquid container, watch, thermometer and recording material. Select the free from obstruction and horizontal surface area as per suitability of the site. Place inner ring shrap edge on the ground surface, put driving plate on the top of ring hence insert ring into ground surface by hammering up to 10cm deep. Establish center point of inner ring and insert outer ring into ground surface at equal interval from circumference of inner ring, and same level. Fill the water into the ring up to 15cm high from ground surface. After the 15min interval note the reading of water infiltration into the soil, and add the volume of water similar to infiltrated water. Note the reading in table 3.2 when infiltration rate are get in constant rate.

Calculation:

The infiltration rate (k) is obtained from the relation, For Inner Ring:

where:

$VIR = \Delta VIR / (AIR \cdot \Delta t)$

Fig 2.Setup infiltrometer on site

VIR = inner ring incremental infiltration velocity, cm/h,

ΔVIR = volume of liquid used during time interval to maintain constant head in the inner ring, cm3,

AIR = internal area of inner ring, cm2

Δt = time interval, For Annular Space:

$VA = \Delta VA/(AA \cdot \Delta t)$

VA = annular space incremental infiltration velocity, cm/h.

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ΔVA = volume of liquid used during time interval to maintain constant head in the annular space between the rings, cm 3.

AA = area of annular space between the rings, cm2.

Fig 3.Taking Readings of infiltration rate in (cm)

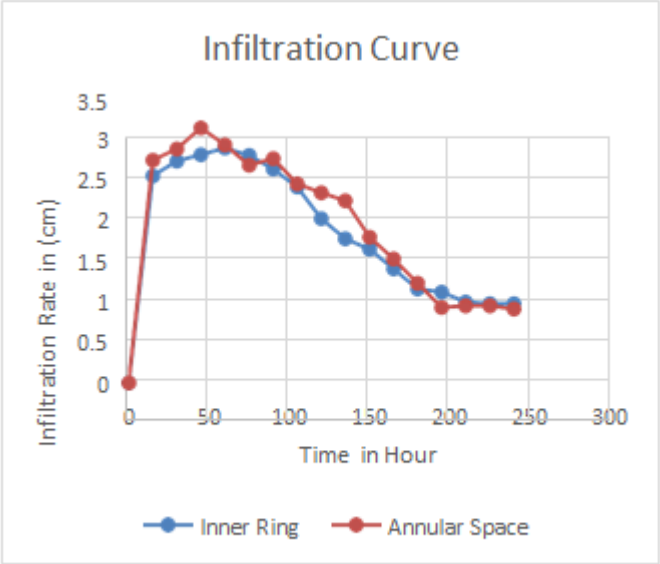

Fig 4. Inflation Curve

Table 3.1

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Project Test No.	1
Type of soil	Clay soil
Date	08 Feb 2022
Height of Ring (h) cm	27
Diameter of Inner Ring (D1) cm	30
Area of inner Ring (A1) = cm2	706.5
Diameter of Outer Ring (D2) cm	60
Area of Annular Space (A2)	2119.5

Table 3.2 Calculation of infiltration rate:

Time min	Time Interval ΔT (hr)	Cumulative Vol.of water (V)(cm^3)		Cumulative infiltration H(cm)		Incremental Infiltration (ΔH)		Infiltration rate(cm/hr) ft=ΔH/ΔT	
		Inenr Ring	Anular Space	Inenr Ring	Anular Space	Inenr Ring	Anular Space	Inenr Ring	Anular Space
08:00	0.00	00	00	00	00	00	00	00	00
08:15	0.25	452.16	1441.26	0.64	0.68	0.64	0.68	2.56	2.75
08:30	0.25	932.58	2967.3	1.32	1.40	0.68	0.72	2.74	2.89
08:45	0.25	1427.13	4620.51	2.02	2.18	0.70	0.78	2.82	3.15
09:00	0.25	1935.81	6167.74	2.74	2.91	0.72	0.73	2.90	2.94
09:15	0.25	2430.36	7587.81	3.44	3.58	0.70	0.67	2.81	2.69
09:30	0.25	2896.65	9050.26	4.10	4.27	0.66	0.69	2.64	2.77
09:45	0.25	3320.55	10343.16	4.70	4.88	0.60	0.61	2.42	2.46
10:00	0.25	3680.86	11572.47	5.21	5.46	0.51	0.58	2.03	2.35
10:15	0.25	3991.72	12759.39	5.65	6.02	0.44	0.56	1.78	2.25
10:30	0.25	4281.39	13713.16	6.06	6.47	0.41	0.45	1.65	1.80
10:45	0.25	4528.66	14518.57	6.41	6.85	0.35	0.38	1.41	1.53
11:00	0.25	4733.55	15133.23	6.70	7.14	0.29	0.29	1.16	1.23
11:15	0.25	4931.37	15599.52	6.98	7.36	0.28	0.22	1.12	0.93
11:30	0.25	5107.99	16087.00	7.23	7.59	0.25	0.23	1.00	0.95
11:45	0.25	5277.55	16574.49	7.47	7.82	0.24	0.23	0.98	0.95
12:00	0.25	5447.11	17040.78	7.71	8.04	0.24	0.22	0.98	0.91

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3.2. Core Cutter Method:

The core cutter method is a method used to determine the dry density of soil and 130 mm long and 100mm diameter cylindrical core cutters are used for testing the in-situ compaction of cohesive and clay soils. Bulk density of the soil can be quickly calculated by using the core cutter method and dry density of the fill can be calculated by determining the moisture content of the soil and also the percentage of voids.

Select the suitable site like horizontal surface and free from route and obstruction. Take the empty weight of core cutter (M1) Place the core cutter cylinder on the ground surface. Put the dolly on the top of core cutter and hence insert the core cutter with dolly by rammer and stop pressing when 15mm of the dolly protrudes above the soil surface. Remove the soil surrounding the core cutter, and take out the core cutter. Remove the dolley. Trim the top and bottom surface of the core cutter carefully using a straight edge. and take the weight (M2). Determine the bulk density of the of soil by using following formula.

Bulk Density (γ b) = (M2 – M1) / V

After the finding bulk density, we determine moisture content of the soil by using oven dry method. take the 3 containers for each soil sample and determine empty weight of container W1. Fill the container by soil sample and determine weight W2. Hence put the container into oven by 105^{o}C temperature. After the 24-hour take- out soil sample from oven and take a weight of container with dry soil. W3. Determine the moisture content by using following formula.

Moisture Content (w) = $\frac{(W2-W1)-(W2-W3)}{(W3-W1)} *100$

Calculate the Dry Density of Soil:

Dry Density (γ d) = γ b / (1 + w)

Dry density (unit gm/cm^3) of the soil is calculated.

Fig 5 Setup of core cutter on site

Fig 6 Soil Sample

Table 3.3 Calculation Density of Soil:

Sr no	Description	Reading		
1	Diameter of core cutter(cm)	10		
2	Height of core cutter(cm)	13		
3	Volume of core cutter(cm^3)	1020.5		
4	Mass of empty core cutter (kg)	869.7		
5	Mass of core cutter with soil	2629.7		
6	Mass of soil in core cutter	1760		
7	Bulk dencity of soil	1.72		
8	Can number	1	2	3
9	Mass of can with lid	55.9	53.5	56.2
10	Mass of can with lid and soil sample	155.9	153.5	156.2
11	Mass of can with lid and oven dry soil sample	150.96	146.15	150.20
12	Mass of water	4.94	7.35	6.00
13	Mass of dry soil	95.06	92.65	94.00
14	Water content	5.19	7.93	6.38
15	Average water content	6.5		
16	Dry density	1.615		

Fig 7 Sample For Moisture Content

4- Conclusion

Case study conclusion: In this study we observe in Girna river region silty clay and black cotton soil are available in most quantity which have infiltration rate is 1.64 to 2.01 and 3.05 to 3.16 respectively. After the 3 to 4 hours this rate becomes constant. Due to this result we say after 3-to-4-hour runoff is started continuously. **Future scope:** Approximately water of 1200 Km2Catchment area are included in Girna river basin and this water are causes of flood during rainy season so to avoid of this risk by this infiltration data we should construct hydraulic structure on Girna river near at Avhana village, Jalagon. This data also may be help for farmer of this region by water management for irrigation.

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