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ASSESSMENTOF FACTORS INFLUENCING INFILTRATION CAPACITY OF SOIL

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Abstract:

The infiltration process is an important factor in the hydrological cycle, the phenomena deserves special attention in watershed management plan. The present study has been carried out to investigate the impact of soil surface characteristics and slope angle on infiltration rate. The factors influencing infiltration rate was studied using rainfall simulator for an experimental plot of 1980 sq.cm., the duration of rainfall has been selected as 5, 10 and 15 minutes respectively for the entire analysis. The infiltration was calculated from the values obtained from calibration run and test run. Infiltration capacity decreased in compacted soil and vegetative cover when compared to the loosely filled soil. Slope angle ranged from 50 to 150 was used to study the effect of infiltration capacity. Infiltration rate decreases with increase in slope angle. Further, it was observed that if intensity of rainfall is high surface runoff depth increases and infiltration rate decreases. Results strongly suggests that, for soil characteristics and slope angles as used here, adequate watershed protections may be developed in order to recharge the groundwater.

Key Words: Infiltration, Groundwater, Precipitation & Runoff

1. Introduction:

Water is vital for all known forms of life that is the main constituent of earth's streams, lakes, oceans and fluids of most living organisms .Water covers 71% of earth surface on that 96.5% of the planet's crust water found in seas and oceans, 1.7% in ground water, 1.7% in glaciers. Only 2.5% of water is fresh water, 98.8% of water is in ice caps and ground water. Water in crises and world fresh water resources. Water on earth moves continually through water cycle of evaporation, transpiration, condensation, precipitation, run off usually rich in sea. Evaporation and transpiration contribute to precipitation over land. Water is key source for agriculture in India agriculture is the cultivation and breeding of animals and plants used to sustain and enhance human life. For the past 30 years nearly 12456 lakes, 27000 ponds, 7rivers and 1, 67,512 Hectares of agriculture land has been vanished in our country. India is witnessed a decline in gravity flow Irrigation and the rise of booming 'Water Scavenging' Irrigation economy. The continuous moment of water on, above and below the surface of earth deals with water cycle. The water cycle involves the physical process such as evaporation, condensation, precipitation, infiltration, subsurface runoff and surface runoff. Evaporation is the transformation of liquid to gaseous form. Condensation is the transformation of water vapour to liquid water droplets in the air, creating clouds and fogs. Precipitation is the condensed water vapour that falls to the earth surface in the form of sleet, glaciers, hail, snow, ice needle. 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. Runoff is the flow of water that moves across the land. Runoff can be of surface and subsurface. Ground water recharge or deep drainage or deep percolation is a hydrologic process where water moves downward from surface water to groundwater. Recharge is the primary method through which water enters an aquifer. This process occurs in plant roots and is expressed as a flux to the water table surface. Recharge occurs both naturally and through anthropogenic processes where rainwater and or reclaimed water is routed to the subsurface. In the last 150–200 years considerable changes have taken place in the gas composition of the atmosphere due to natural processes and human activities, such as increasing energy consumption, industrialization, intensive agriculture, urban and rural development. This may lead to a rise in global temperature and high spatial and temporal variability. Infiltration is the important factor that governs the ground water recharge which is also responsible for the Integrated Sustainable Water Resource management. By considering the above facts, assessment of factors influencing the infiltration capacity of the soil has been taken for study purpose. Therefore the project study deals with following objectives

- ✓ To develop the rainfall simulator model.
- ✓ To determine the infiltration capacity of soil under different conditions.
- ✓ To determine the effect of slope on infiltration capacity.

2. Experimental Setup:

Infiltration is the governing factor for groundwater recharge. This experiment is carried out to setup a rainfall simulator to measure the precipitation and runoff so, that the difference between precipitation and runoff is noted as infiltration. A portable precipitation simulator is equipped with a drip pipeline and nozzles to calculate the infiltration. The experiment is done on soil characteristics and different slope condition. Rainfall Simulator is a device used for rainfall runoff studies, erosion plot studies, and infiltration that applies water in the form and at a rate comparable with natural rainfall. The rainfall simulator is also called sprinkler infiltrometer. This study mainly deals with Rainfall Simulator which consist of a following equipment

- ✓ Tank
- ✓ Open valve

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- ✓ Pipeline
- ✓ Drip system
- ✓ Nozzle
- ✓ Tray of size 1980sq.cm
- ✓ Tray to collect the runoff water and
- ✓ Tank to collect the excess water.

Initially water is discharged from the tank for 5 minutes then water flows through the drip system and sprinkles in the soil which is placed in the tray. After discharging some amount of water is infiltrated whereas remaining water is collected in the tray which will be said as runoff. The experiment is repeated for 10 minutes and 15 minutes respectively in different soil conditions such as loose soil, dense soil, sloping ground and vegetative cover.

Figure 1.1: Rainfall simulator setup

3. Soil Characteristics:

Soil Characteristics: Soil is a mixture of minerals, organic matter, gases, liquids, and countless organisms that together support their life.

Loose Soil: Loose soil allows water to drain freely into the ground, preventing waterlogged soil, while supplying the air and nutrients plant roots to thrive. It allows roots to penetrate the water to soil easily and to reach for moisture, nutrients and build a strong support system for the plant. Loose soil has more percentage of void content and porous unconfined.

Dense Soil: Dense soil is tight, heavy with less air voids. This soil makes difficult for plant growth, roots cannot penetrate the soil to obtain the nutrients, water and structural support the required for survival.. Drainage is a major problem in this soil. The soil which have less number of voids.

Vegetative Growth: Vegetation is assemblages of plants species that spread along the surface. Living soil organism includes microorganisms, smaller animals and roots of crops and weeds. Plants extract nutrients and moisture from the soil at different rates depending upon the soil profile.

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Slope conditions:

Slope of 5^o: An inclined plane is a flat supporting surface tilted at an angle, with one end higher than the other, used as an aid for raising or lowering a load. Generally for 5^0 gradient it is calculated that for a length of 11.43m have a rise of 1m. In this experiment we have raised 3.32 cm for 5^o gradient.

Slope of 10^o: An inclined plane is a flat supporting surface tilted at an angle, with one end higher than the other, used as an aid for raising or lowering a load. Generally for 10^0 gradient it is calculated that for a length of 5.67m have a rise of 1m. In this experiment we have raised 6.70 cm for 10^o gradient.

Slope of 15^o: An inclined plane is a flat supporting surface tilted at an angle, with one end higher than the other, used as an aid for raising or lowering a load. Generally for 15^0 gradient it is calculated that for a length of 3.732 m have a rise of 1m. In this experiment we have raised 10.18 cm for 15^o gradient.

4. Test results and Discussion:

Time	Total rainfall	Infiltration rate		
		Loose soil	Dense soil	Vegetative soil
min	Mm	mm/min	mm/mi n	mm/m in
5	55.55	9.29	3.84	5.97
10	111.11	5.16	3.44	4.40
15	166.67	3.57	2.90	3.37

Table 1: Infiltration rate on soil characteristics

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The experiment result for each test are presented in this chapter. The results are given in the form of table. As soil characteristics and slope condition are taken into study and their results are described. From the above results it has been observed that the loose soil has a greater infiltration rate. In 5 minutes the infiltration rate in soil is 9.29mm/min as loose soil have more voids and it is loosely packed the infiltration rate is higher.

Next to loose soil, vegetative growth have a major infiltration rate. Plants in 5 minutes absorb 5.97 mm/min of water that is 65% infiltration rate of loose soil. Finally dense soil has a very less infiltration. As it infiltrates 3.84mm/minute in 5 minutes duration of precipitation. It infiltrates 38% of water that is absorbed in the loose soil. From the above results we can conclude that the infiltration rate is high in loose soil and low in dense soil. From the above results it has been observed that the 5^o has a greater infiltration rate. In 5 minutes the infiltration rate in soil is 5.95mm/min as inclination is the important factor that governs in runoff. Thus, infiltration rate is higher. Next to 5^o, 10^o have a major infiltration rate. Plants in 5 minutes absorb 5.88 mm/min of water that is 98% infiltration rate when compared with 5 degree. Finally 15^o has a very less infiltration. As it infiltrates 4.33mm/minute in 5 minutes duration of precipitation. It infiltrates 72% of water that is absorbed in the 5^o sloping ground. From the above results we can conclude that the infiltration rate decreases with increase in gradient of soil.

Time	Total Rainfall	Infiltration rate (Gradient)		
		5^o	10^o	15^o
min	mm	mm/min	mm/min	mm/mi n
5	55.55	5.95	5.88	4.33
10	111.11	4.39	4.19	3.18
15	166.67	3.71	3.33	2.25

Table 2: Infiltration rate on slope condition

6. Conclusion:

In future our country will face a major problem for water. As there is major demand to be prevailed for the availability of fresh water, groundwater, and lack of rainfall, Irrigation and climatic changes leads to Global warming. As the result of Global Warming the surface becomes heat and the ice glaciers along Himalaya's region start melting. Some Part of our country will face a severe drought where on the other hand some part will suffered by Flood. The best solution chosen for this problem is Watershed management. Watershed management will helps to meet the demand of water during summer season, that helps the agriculture which is the backbone of our country through irrigation and to recharge the groundwater. By recharging the groundwater the infiltration rate in the soil can be increased. This experiment deals with the factors influencing the Infiltration rate. The infiltration is calculated from values obtained from calibration run and test run. Infiltration capacity decreased in compacted and vegetative cover when compared with loosely filled soil. Slope angle ranging from 5, 10 and 15 degrees are studied to know about the effect of infiltration and runoff. The result shows that by increasing the slope angle the infiltration rate decreases and if the intensity of rainfall is high then runoff will be maximum, whereas the infiltration is minimum. Thus in future adequate watershed management has to be developed in order to meet the requirements and demands of fresh water and ground water. We Indians all should take steps to increase the watersheds and recharge the ground water.

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