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A Preliminary Experimental Analysis of Infiltration Capacity through Disturbed River Bank Soil Samples

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ABSTRACT
Soil sample analysis is indispensable for knowing the properties of soil through which the water recharge will occur. Experiment using a varies soil samples were conducted on a 10 cm to 50 cm depth soil filled with setup. This research examined a common, problem associated with water supply development, the modifications made to soil structure for filter design and the associated reduced pollutants of water and increased runoff. The experiment is conducted homogeneous soil columns and leads to the conclusion that the reduction of infiltration capacity is not directly related to time but rather to the moisture on the surface. It is important that obtained data to estimate the infiltration rates associated with local development patterns. Soils on residential developments have lower water infiltration rates than the soils replace. This study to measure how soil amendments perform under actual conditions and the practical aspects of using them are being performed. Infiltration tests were conducted in collecting disturbed soil samples and the data was compared. Experiments Results found the hydrologic responses of the different infiltration capacities with different plot configurations.
***Keywords*–**Disturbed soils, filtration rate, infiltration capacity, moisture content, water supplies.

I. Introduction

Infiltration is the movement of water into the soil from the surface. The water is driven into the porous soil by force of gravity and capillary attraction. Infiltration of water in unsaturated soils has long been an interest of study in many branches of science and engineering such as soil science, hydrology, and geotechnical engineering. The identified significant reductions in infiltration rates in disturbed urban soils. Since the early 1990s, a series of laboratory and field tests have been conducted by the writers on soils covering a wide range of soil textures, densities, and stiffness. Infiltration rate usually shows a sharp decline with time from the start of the application of water. The appearance of layered soil is more common than uniform soil in nature with the latter being the exception, vertical infiltration in layered soils has drawn much attention and been studied by many authors. The constant rate approached after a sufficiently large time is referred to as the steady-infiltration rate. The process is described by the equations of Kostiakov (1932) and Horton (1940), which show a decreasing infiltration rate as a function of time. The use of infiltration basins reduces peak flows, water volumes in downstream networks, and limits pollution discharges to surface waters. It may also promote urban development in areas distant from existing networks or natural outlets and enhance urban sites when basins are designed as parks or playgrounds. Other attractive aspects are lower costs and groundwater recharge. Particularly through analytical or numerical methods and through experimental methods. All the studies showed that the transient process of infiltration is complex due to the high nonlinearity of soil water characteristics and soil permeability and various boundary and initial conditions. The complexity is further increased by the hysteretic behavior of soil water interaction.

In the present study laboratory tests of vertical infiltration were the constant infiltration rates of different soils under different soil conditions were calculated by double ring infiltrometer method, and compared with assessment of the suitability of different models for estimation of infiltration rate of particular soil under particular soil condition was carried out with correlation coefficient and standard error as a tool.

II. Objective

One objective of the present experimental study is to observe the sequence of events associated with infiltration interface under different depth loading. A different type of material samples facilitates such observations. For this purpose, particle size and particle distribution may be a major determinate of infiltration rates the pore size distribution is modified by organic matter content, aggregation, tillage, and compaction. Storage capacity depends upon the porosity and changes in pore size distribution in the soil profile, which may be utilized as river bank filter material to remove the pollutants from the water directly by extracting water through pump via natural filters.However, Flow rates depend upon the texture, porosity, pore size distribution, soil stratification, antecedent soil moisture content, salinity, and biotic activity.

III. MATERIALS USED

3.1. Soil type

The soil used in this study consists of alluvial aquifer. The alluvial aquifer is an excellent source of water because of its favorable hydrologic characteristics. Total thickness of the alluvial aquifer in Odisha ranges from about 50 to 150 feet (ft), thus providing a limited but still considerable amount of stored ground water. Throughout much of Odisha, the alluvial aquifer is overlain by a silt and clay unit that is generally 10 to 50 ft deep. The aquifer originated from weathering of fine-grained sedimentary bedrock. The comprising unconsolidated material deposited by water, typically occurring adjacent to rivers. The sites are located adjacent to the river banks in odisha. The soil is classified as inorganic clayey silt. In its natural state, it is porous and it has numerous pinhole pores. The soil material is also brittle and it can be crumbled with finger pressure. It has low moisture content (4.6-6.7%), but no tension cracks are observed in situ.Water from the alluvial aquifer is used for public supply only where an adequate supply of water of better quality is not available from deeper aquifers. Characteristics that limit its usefulness as a public water source are excessive hardness, high concentrations of iron and manganese, and high salinity. In most countries, however, ground water from the alluvial aquifer is very well suited for agricultural supply.

3.2. Soil Sampling

There is no standard procedure for obtaining soil samples for appraising. Usually the details of procedure will depend on the purpose for which the sample is taken. If the objective is to obtain a general evaluation of soil in a given, the many number of samples provides an index for the over-all appraisals. The variation among samples gives an index of the variation in ingredients content that may be encountered in the theater of operations. Soil samples may be retrieved using a variety of methods and equipment, depending on the part of the soil profile required (surface versus subsurface), and the type of sample required (disturbed versus undisturbed) and the soil type. Soil is collected immediately, using Hand auger, a series of extension rods, a “T” handle, and a thin-wall tube sampler. The auger bores a hole to a desired sampling depth and then is removed. The auger tip is then replaced with a tube core sampler, lowered down the borehole, and forced into the ground at the completion depth. The core is then withdrawn and the sample collected. Augers are better for direct sample recovery, are fast, and provide a large volume of sample. First insert the auger into the material to be sampled at a 0^0 to 45^0 angle from vertical. Extraction of samples may require tilting of the sampler. Then augers rotate once or twice to cut a core of material. Withdraw the auger slowly; making sure that the slot is facing upward. An acetate core may be inserted into the auger prior to sampling. By using this technique, an intact core can be extracted. Then the sample transfer into a homogenization container.

3.3. Soil Texture

It is well recognized that the distribution of particle sizes influences the moisture retention and transmission Identification and properties of soils. Particle-size analysis may be made, as a rule; coarse-textured soils have low-moisture retention and high permeability, whereas fine-textured soils have high-moisture retention and generally have lower permeability. However, owing to an eminent degree of aggregation of the particles, there are notable examples of fine-textured soils that are moderately permeable. The presence of a high percentage (50 or more) of silt size particles often causes soils to deliver relatively low permeability. There is also evidence that some silt-size particles, presumably those having a platy shape, are more effective in reducing permeability than others. In general, the physical properties of fine textured soils are affected more adversely rate of infiltration percentage than coarse textured soils.

3.4. Soils and their properties

Four soil Samples were used and referred to as an alluvial aquifer region in the study. Clayey Sand where residual clayey soils of different local formations. The study was part of a research effort of investigating the potential usage of the available local soils for some engineering applications, which included River bank Filtration system, involving distinguishable finer over coarser soils. Preliminary trials have indicated that the soils had very different hydraulic properties than the other one; and trial tests have shown that finer over a coarser layer of these soils were stable with negligible soil particle migration. Therefore, these soils were selected for the infiltration tests involving finer over coarser layered soils. Basic properties of the soils and soil-water characteristic curves which is also known as soil-moisture retention curve, describes the relationship between the volumetric water content of the soil. The test data were best-fit to obtain from the upward infiltration tests on the soil see the section on test results.

IV. Experimental Setup And Measurements

The experimental apparatus is a modification of a previous device was produced built by Lopamudra Priyadarsini (2012) ("manufactured by Department of Civil Engineering, National Institute of Technology, Rourkela Odisha, INDIA"). It consists of a simple cylindrical fiber tube supported at the stand as shown in Fig 1. From the base, a conical portion is extended to collect water with a tap to regulate water. The top of the cylinder was covered with a perpex sheet of 1 inch thickness a hole of 2 cm diameter was made to connect to the inlet pipe is keyed to connect with the source of water tank stored. Continues Depth of water were maintained during these experiments. The infiltration rate was determined directly by measuring the time required for water percolating in to the soil samples inside the cylinder using a stopwatch. The observed flow phenomena were dependent of the sample specimen characteristics. The cylinder axis was levelled using the fluid level inside the stationary cylinder.

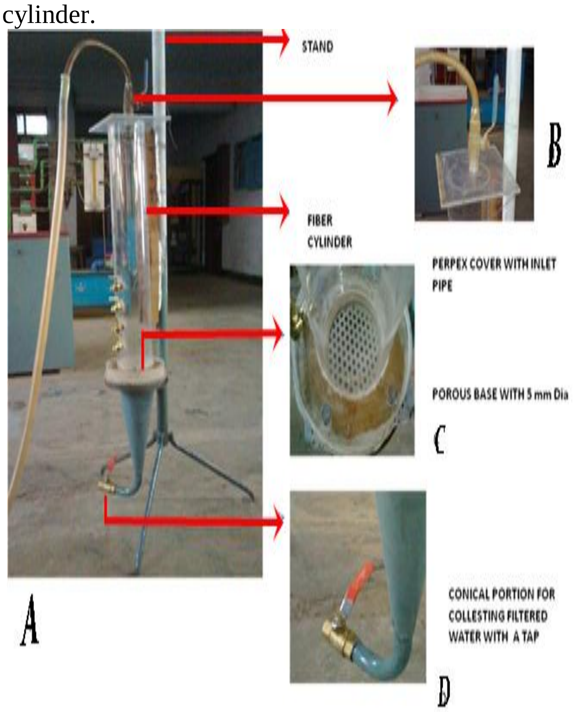

Fig 1: Apparatus Using of Infiltration Rate

V. Factors Affecting Infiltration

The infiltration rate of a soil profile is the result of the interaction of numerous soil, biotic, and hydrologic properties. Porosity and pore size distribution are the main determinations of infiltration. The surface area, size, and shape of soil particles influence pore size, shape and continuity with other pores. Although particle size and particle distribution may be a major determinate of infiltration rates (Table. 1) the pore size distribution is modified by organic matter content, aggregation, tillage, and compaction. Compaction loads as small as a person walking can significantly reduce infiltration rates. Compaction from trucks being driven over a sandy loam just after a rain, reduced infiltration rates from 15 to 0.3 cm /h.

Table 1: Infiltration rates for certain particle-size classes (FAO 1979).

Textural	**Infiltration rate (cm/h)**		
Class	**Minimum**	**Mean**	**Maximum**
Clay	0.01	0.05	0.1
Silty Clay	0.03	0.25	0.50
Clay Loam	0.25	0.8	1.5
Loam	0.8	1.3	2.0
Sandy Loam	1.3	2.5	7.6
Sand	2.5	5.0	25.0

In general any profile discontinuity, such as a change in texture, that affects pore size distribution, will result in differing soil porosity size distribution and thus decreased water movement between horizons. Where a coarse textured material such as sand overlies a finer textured material such as a loam, the infiltration rate will be dependent upon the loam layer and water will accumulate in the sand layer. Where a finer textured material overlies a coarse material the initial infiltration rate will be governed by the surface layer, and then will reduce when the wetting front encounters the larger pores in the coarse layer. Water will not enter the larger pores until it has accumulated in the fine layer to a point where it can overcome the adhesive and cohesive forces of the finer pores in the fine layer and flow can then take place into the larger pores of the underlying coarse layer.

VI. Result And Discussion

In this experimental study, Soil samples from three basins are used for this analysis. Multivariate data analysis is used to reveal systematic information from this large data set that may have been with the soil profile approach. Further, the hydraulic resistance is integrated and eventual correlation with infiltration variables is explored. This method is developed: it is used to identify correlations in large data sets. Linear combinations of the original variables yield a new set of variables. The method describes the largest variance in the data set that describes as flow rate with respective time as possible and so on. Samples and variables are plotted defined by the porous space in the elements. Before performing experiment, the data set is generalized. The procedure is run applying water travel distances as the measure of similar time.

The permeability of soil, in a qualitative sense, refers to the readiness with which the soil conducts or transmits fluids. In a quantitative sense, when permeability is expressed with numbers, it seems desirable that permeability be defined as a property of the porous medium refers to the proportionality factor in the Darcy flow equation. For porous media with fixed structure, such as sandstone or fired ceramic, measurements of intrinsic permeability with air, water, or organic liquids all give very nearly the same numerical value. Gravity, density, and the viscosity of the liquid are taken into account in the flow equation. However, if the intrinsic permeability for a soil as measured with air is markedly greater than the permeability of the same sample as subsequently measured using water, then it may be concluded that the action of water in the soil brings about a change in structure indicated by the change in permeability.

The compares the infiltration rates of soil groups, classified according to the texture of the soil profiles. In each set of measurements, the infiltration rate of the coarse group was much higher than the medium to fine group. As it is not possible to vary soil texture independently of other characteristics it is not inferred that the infiltration rates are caused by texture. It is more likely due to associated characteristics including the configuration of pores and fissures. Nevertheless it seems that infiltration rates summer are invariably associated with coarse texture whereas values less than on medium to fine soils.

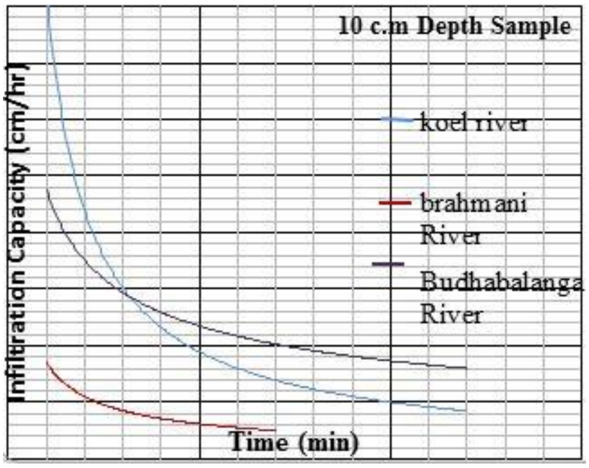

Fig 2: Observed Infiltration rate and calculated infiltration rate verses time for 10 cm depth

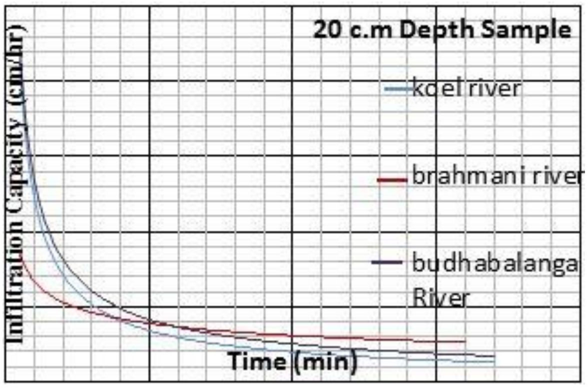

Fig 3: Observed Infiltration rate and calculated infiltration rate verses time for 20 cm depth

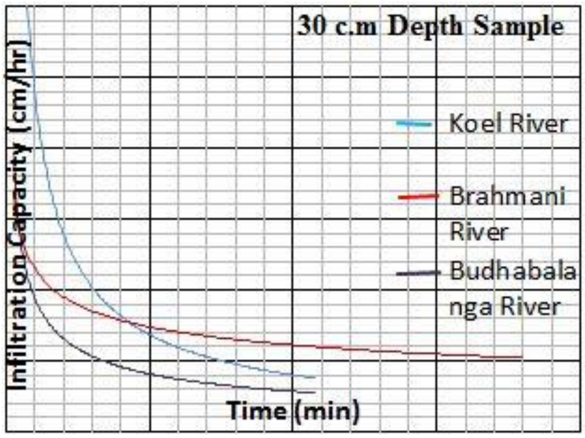

Fig 4: Observed Infiltration rate and calculated infiltration rate verses time for 30 cm depth

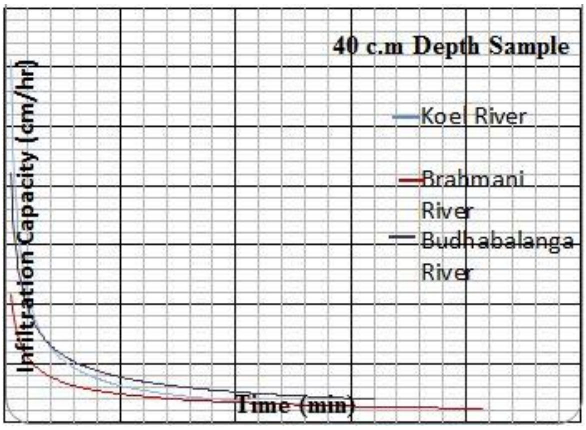

Fig 5: Observed Infiltration rate and calculated infiltration rate verses time for 40 cm depth

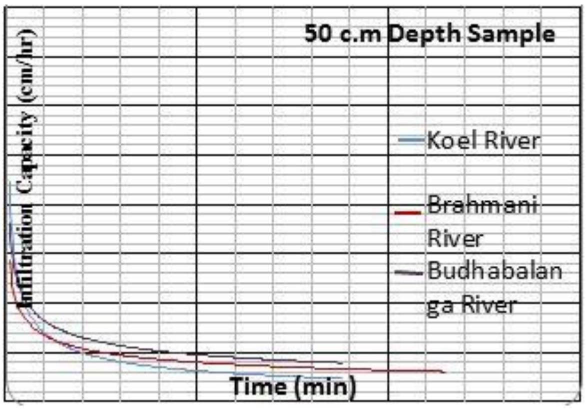

Fig 6: Observed Infiltration rate and calculated infiltration rate verses time for 50 cm depth

The length of time the tests should be conducted and the depth of water to be applied depend upon the purpose of the test and the kind of information that is sought. If it is a matter of appraising an irrigation problem, the depth corresponding to one irrigation may be sufficient; but, if information on infiltration for planning a leaching operation is needed, it may be desirable to apply the full depth of leaching water to a test plot. It often happens that subsurface drainage is sufficiently restricted to cause the infiltration rate to decrease considerably with time independent of the fluid used in its measurement. The term "hydraulic conductivity," on the other hand, is used to Some progress is being made toward evaluating the physical condition of soil in terms of physical properties, i.e., intrinsic qualities of soil that can be expressed in standard units and that have values which are substantially independent of the method of measurement. Infiltration rate, permeability, bulk density, pore-size distribution, aggregation, and modulus of rupture appear to be such properties. Experience shows that the physical condition of any given soil is not stable. There is a range of variation of physical status that is related to productivity, and this is reflected in corresponding ranges in the values of pertinent physical properties. The concept of use, there is a range of physical states for any given soil may have to the improvement filtration of soils.

VII. Conclusion

Infiltration capacity was reasonably stable over an eight year period and accordingly infiltration tests can have a role in assessing the long-term risk of overland flow and the associated pollution hazard. Substantial variation occurred within sites and the variation was greater in winter than in summer. In general, for 50 percent precision, eight measurements are required in summer, and fourteen in winter, on sites composed of a single soil series or phase. A correspondingly greater number will be required on land areas composed of a number of soils. Infiltration tests performed in summer are preferable, as tests performed in winter are unlikely to reflect stable soil characteristics. To assess the risk of overland flow over the whole year, additional information will be required on the duration and degree of wetness. Although the mean difference between day 1 and day 2 was not statistically significant, the two-day test is desirable to reduce the risk of overestimates at individual sites.

There was a pronounced seasonal effect, which was attributed to the influence of antecedent soil water content on the measured infiltration capacities. In summer, infiltration capacity was on average 3.5times the winter rate. Except on an impermeable Gley, the infiltration capacity in summer equalled or exceeded the hourly rainfall expected once in five years. This implies that the risk of overland flow is likely to be very small in summer on freely drained soils that have not been compacted by animals or machines. Irrigation rates of 5 mm hahr-1 or 2.5 mm hrhr-1, permitted by the Code of Good Agricultural Practice, exceed the infiltration capacity of some soils, including free draining soils, in winter. This implies that there may be a significant risk of overland flow in winter.

Experience indicates that the infiltration rate of a given soil can be high or low, depending on physical status and management history. Infiltration rate is often critically influenced by surface soil conditions, but subsurface layers also are sometimes limiting. Water distribution in the profile and depth of water applied are modifying factors. The infiltration rate can be undesirably high or undesirably low. It is the low end of the range that may be a critical limiting factor in the agricultural use of alkali soils.

From the research work it is found that the soil condition affects the infiltration rate. From the graphs of infiltration rates against time it is found that initially infiltration rates were high and decreased with time up to constant infiltration rate.

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