

## Study on the Influence of Grain Composition on Seepage Velocity of Slope Soil

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**Abstract:** Soil infiltration performance is an important study of soil factors, It is a key part of the runoff cycle. It affects soil erosion by changing the relationship between rainfall and runoff, The important physical parameters of the soil are the permeability of the soil. Its value represents the occurrence and development of soil water infiltration capacity and slope soil erosion. This paper studies the soil of unsaturated soil in Chenggong section, Yunnan province, Particle analysis test and combining with ring methods to measure permeability coefficient to study the effect of particle grade distribution of soil infiltration rate, the results show that the soil particles are the important factors that affect soil permeability, in addition, organic matter content, plant roots, animal activities can also affect the soil water infiltration.

### 1. Introduction

In the natural ecological environment, soil is one of the important component of the surface soil, in particular, has a very important role in the hydrologic cycle, rainfall (or irrigation) infiltration, surface runoff, surface evaporation and transpiration, soil moisture dynamic savings and deep leakage, etc., are all through the medium of soil takes place continuously and reciprocal transformation. Soil is composed of solid, liquid and gas phases, among which soil water is an important part of the terrestrial water body and the most active factor in the three phases, which is closely related to people's production and survival[1]. Water flows down into the soil through all or part of the surface, moves and stores in the soil, and the process of forming soil water [2] is soil water infiltration. Soil water infiltration is an important link in the mutual transformation of precipitation, surface water, soil water and groundwater[3]. The study of soil water infiltration can provide scientific basis for the basic theory of soil water infiltration and migration in unsaturated zone and the comprehensive analysis of surface and groundwater resources.

For the study of soil permeability characteristics, from 1852 to 1856, French engineer darcy obtained the famous darcy's law through the penetration test of cohesive soil. That is the infiltration velocity of water flow in soil is directly proportional to the hydraulic gradient[5]. Li Xuezhan et al. believed that soil water potential gradient and hydraulic conductivity determine the size of infiltration. The infiltration capacity of water is affected by the average potential gradient in the humid zone of infiltration flow. The higher the soil moisture content is, the higher the soil water potential is on the infiltration front, and the smaller the average potential gradient is between the infiltration front and the surface. Therefore, the higher the initial soil moisture content, the lower the soil infiltration capacity[6]. Soil structure is affected by soil organic matter, which can change the tough bulk structure of clay and the dispersed unstructured state of sandy soil, improve the permeability and water storage of soil, and accelerate the infiltration rate of water[7]. Shi Deming et al. believed that one of the main factors affecting soil infiltration ability was soil bulk density. They believed that water infiltration weakened with the increase of soil bulk density or strengthened with the decrease of soil bulk density[8]. In fact, soil infiltration capacity is not only affected by organic matter and soil severity, but also mainly affected by soil mechanical composition, soil initial moisture content and water stable aggregate content[4]. Soil is composed of many particles of different sizes, which must

have a great influence on soil infiltration capacity. Therefore, this paper uses stratified sampling and measurement to obtain the soil particle gradation, and uses the ring knife method to measure the permeability coefficient of stratified soil sample, focusing on the study of the effect of granular matching soil water infiltration.

## 2. Geographical Location of the Test Area and Field Sampling

Period of home camp test area is located in the Chenggong new area of Yunnan province, the county is located in the southeast of Kunming north latitude  $24^{\circ} 21' - 24^{\circ} 45'$ , longitude  $102^{\circ} 45'$  between  $59' - 102^{\circ}$ . Mountainous area accounts for 49.5%, hilly area 33.1%, and dam area 17.4%. The selected test site is located at maka mountain, Duan jia ying village, Chenggong, about 1.8km from the south to the north of Yunnan Normal University, Chenggong university town.

Select the representative position, dig 1m x 1.5m rectangular pit, and take 1-1,2-1,3-1,4-1,5-1 five layers of soil samples from top to bottom(0-20cm,20-40cm,40-60cm,60-80cm,80-100cm), The sampler is perpendicular to the ground, and the soil depth and sampling amount are uniform. Put the collected samples into the sample bag, and at the same time, mark the sampling place, date, depth of sampling layer, number and person inside and outside a label, and make a sampling record.

## 3. Laboratory Sample Processing and Testing

Bring samples back to the lab, tray to put the sample in clean first, and then put into the oven, water drying, the drying time of 24 h, take out the samples with sieve machine full screen analysis, 15 - 30 min after shaking sieve, starting with the largest aperture sieve, according to the order will take off, the screen will stay on the screen of the soil weighing respectively, accurate to 0.01 g. Particle gradation curve is a curve drawn according to the screening test results. The abscissa represents the particle size, and the ordinate represents the soil weight (cumulative percentage) content less than (or greater than) a certain particle size[9][10]. According to the steepness and slowness of the particle gradation curve, the uniformity or good gradation of soil can be roughly judged by using the logarithmic coordinate. Fig.1 shows the grain gradation curve of soil samples in Chenggong Maca mountain.

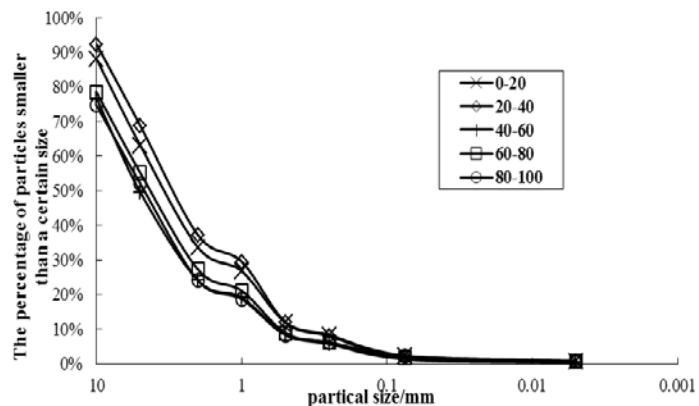


Figure. 1 soil particle gradation curve of Maka mountain Chenggong

Take the soil taken from the test area back to the laboratory, remove the top cover and the bottom cover of the ring cutter, place the bottom end with mesh and the bottom cover with filter paper, immerse the end in water, and the water surface shall not exceed the top edge of the ring cutter. In general, clay was soaked for 24h, loam for 8-12h, and sand for 4-6h. Take out the ring knife at a predetermined time, set a clean empty ring knife with the same specifications as the ring knife to take out the upper end of the ring knife, the place where the interface is sealed with transparent tape first, tape attached to the ring knife should avoid air circulation as far as possible, then use wax to bond, and then check whether the joint is leaking. Then the two combined ring knives are placed on the funnel that has been combined with the funnel frame, and a beaker is placed under the funnel. Record

time interval after soil immersion. Add water into the empty ring cutter above, and the water layer height is 5cm. The first drop of water from the funnel is counted when it is added to the specified water level. After that, every 1,2,3,5,10, .....ti.....tn min, Quickly change the beaker under the funnel each time so that you can measure the amount of water dripping out .And then we measure the amount of infiltration Q1, Q2, Q3, Q5...Qn and record it.Each time the beaker is changed, the water level in the ring cutter above should be increased to the original height.The test time was about 1h, and the seepage began to stabilize; otherwise, it was necessary to continue to observe until the seepage amount was equal in unit time.

#### 4. Test Results and Analysis

As can be seen from the grain gradation curve in figure 1, the soil grain gradation curve first drops sharply and then becomes gentle. The 1-1 and 2-1 gradation curves are located above 3-1, 4-1 and 5-1, reflecting that the grain gradation ratios of 3-1, 4-1 and 5-1 are good.According to the USDA - SCS soil classification standards, clay (< 0.05 mm), powder (0.075 0.05 mm), sand (0.075 mm - 2 mm), gravel particles (> 2 mm), and to statistics of particle size at all levels, the results are shown in table 1, the table 1 shows that the study area marca mountain soil particles of the particle size of section, but the basic above 0.075 mm, with gravel and sand soil particle size in the study area is given priority to, both the sum is more than 90%, followed by silt, clay content, at least only 0.5%.Moreover, there are more gravel grains in the bottom layer than in the upper layer, which are mostly basalt broken gravel with close texture.

In this study, particle gradation curve was used to calculate d10(effective particle size), d30(median particle size), d60(limited particle size), as well as Cu (non-uniformity coefficient) and Cc (curvature coefficient), so as to evaluate soil particle gradation. The calculation formulas of Cu and Cc are respectively:

$$Cu = d60/d30; Cc = d30^2/d10 \times d60$$

d10, d30 and d60 respectively express 10%, 30%, 60% in corresponding particle size value of cumulative distribution curve of soil accumulation. Cu reflect the degree of a uniform soil particles, the greater of Cu means fraction distribution is wider, Cu > 10 soil grading is good, but Cu is too big, said may lack the middle size, belongs to the discontinuous gradation, so you also need to use at the same time characterization whether the missing Cc to evaluate some grain group. Cu and Cc values in soil sample 1-1 were 13.2 and 1.48 respectively, indicating that the soil gradation in this area was generally good. The Cu and Cc values in soil sample 2-1 were 10.65 and 0.58 respectively, indicating that the soil gradation in this area was generally good. Cu and Cc values in soil sample 3-1 were 11.81 and 0.86 respectively, indicating that the soil gradation in this area was good. The values of Cu and Cc in soil sample 4-1 were 10.19 and 1.29 respectively, indicating that the soil gradation in this area was good. The values of Cu and Cc in soil sample 5-1 are 11.24 and 2.1 respectively, indicating that the soil gradation in this area is good. Generally speaking, the soil inhomogeneity coefficient in this region is between 10 and 15, the curvature coefficient is between 0.5 and 2, and the particle gradation is relatively good.

Table 1 lists the results of permeability coefficient of soil samples measured by ring knife method in each layer. The average permeability coefficient of 1-1 is about 8.97. The average permeability coefficient of 2-1 is about 0.73, the average permeability coefficient of 3-1 is about 0.27, the average permeability coefficient of 4-1 is about 0.05, and the average permeability coefficient of 5-1 is about 0.09. With the increase of soil depth, the soil permeability coefficient gradually decreases. As can be seen from the table, the percentage of grain distribution at different depths differs within 20%, with little fluctuation. Compared with agricultural soil, slope soil with vegetation development is mainly characterized by more gravel particles and more sand particles, less clay particles and less powder particles. With the increase of depth, the content of gravel tends to increase, which promotes the formation of large pores between gravel and soil. According to the sampling observation, the slope profile of the test site is from the top to the bottom of 3-10cm thick dead branches and deciduous layer

and humus layer, 20-30cm thick soil layer -- root belt, emeishan basalt humus rock, the bedrock is emeishan basalt. The humus layer on the surface often contains a large number of basalt blocks, forming the structure of soil intercalation in the range of 50-100cm, and the underlying emeishan basalt bedrock boundary is clear, the soil infiltration is hindered, is the soil infiltration rate slowed down. In the soil mass, the surface root belt is relatively developed, mainly concentrated between 0 and 50cm, and a large number of aggregates with a thickness of less than 3 cm are netted between the roots, forming a relatively loose structure system, which is conducive to water infiltration. Therefore, the soil permeability coefficient of 1-1 and 2-1 is greater than that of 3-1, 4-1 and 5-1.

Table 1 Characteristics of soil particle gradation and corresponding permeability coefficient

samples	proportion of particle sizes at all levels(%)				Cu	Cc	permeability coefficient
	gravel particles	sand	silt	clay			
1-1	36.92	54.80	7.69	0.59	13.2	1.48	8.97
2-1	31.25	60.77	7.44	0.54	10.65	0.58	0.73
3-1	50.48	43.80	5.40	0.33	11.81	0.86	0.27
4-1	44.87	49.00	5.54	0.58	10.19	1.29	0.05
5-1	47.99	45.78	5.47	0.75	11.24	2.1	0.09

## 5. Conclusion

In this paper, the granule gradation of soil was obtained through the granule gradation experiment of soil, and the infiltration experiment of each soil sample was studied by ring knife method, and the data of the permeability experiment were sorted out and analyzed, and the variation law and conclusion of groundwater permeability in makashan area were obtained.

(1) Generally speaking, the soil particles in the test area are well graded, and there are various particle size sections, most of which are gravel and sand grains, accounting for about 90%.The size of soil particle pair permeability coefficient has great influence.In soil with good grain gradation, small particles fill the pores between large particles, and with the increase of soil depth, basalt debris contained in the soil layer gradually increases, so that the permeability coefficient of the soil gradually decreases.

(2) Although the soil of 1-1 and 2-1 is well graded, the infiltration coefficient of the upper soil is larger than that of 3-1, 4-1 and 5-1 because the upper soil is also affected by a large number of plant roots, soil organisms and organic matter contents.

In the study of soil permeability, the evaluation index is not only the influence of soil particle gradation, but also the influence of organic matter content, plant root system and animal activity on soil water infiltration.

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