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Analysis Method of Slope Stability Considering Infiltration and Evaporation

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Abstract

In this study, an analytical method is proposed. The parameters of water transport and shear strength in unsaturated soils depend on saturation, and then saturation can be determined experimentally. The distribution of instantaneous shear strength parameters of inclined soils under any specific infiltration and evaporation environment can be solved by numerical calculation. On this basis, the transient slope safety factor can be obtained by the conventional stability analysis method.

Keywords

Unsaturated soil; infiltration; stability analysis of evaporation slope; transient water content distribution; transient safety factor.

1. Introduction

Expansive soils, residual soils and other clay soils are distributed in western, southern and southwestern China. In those areas, landslides often occur in rainy season, and shallow slides are the most common. The mechanism of the landslide is that the shallow soil near the surface is mostly unsaturated cohesive soil, and the change of climate has a great influence on its mechanical properties. Rainwater infiltration will increase the saturation of the soil, decrease the adsorptive force and greatly reduce the cutting strength. Continuous rainfall can lead to the rise of groundwater level or temporary occurrence of groundwater in relative aquifers. Therefore, if the duration and intensity of continuous rainfall exceed a specific limit, the slope of the soil will become unstable. The penetration of cohesive soil is usually affected by weather changes, because the depth of cohesive soil is only a few meters, so the depth of landslides is usually confined to shallow layers[1].

The physical and mechanical properties of shallow soil can change at any time because of weather factors. In previous slope stability analysis methods, because the influence of water infiltration and evaporation cannot be taken into account, the slope stability associated with this shallow slip is adopted. However, shallow landslides have brought huge losses to the national economy and people's lives and property. Because of the sudden occurrence of such landslides, it is difficult to predict and avoid those. Therefore, it is necessary to develop a stable method to analyze the effect of the slope of unsaturated soil on water infiltration and evaporation.

In this paper, the temporary water content distribution in a given infiltration and evaporation environment is solved by using a research method for the movement of unsaturated soil moisture. Based on the assumption that there is a functional relationship between the instantaneous scattering intensity of water molecules and the saturation of unsaturated soils, the instantaneous distribution of water content is transformed into the instantaneous shear strength parameter of inclined soils. According to this result, because the transition safety factor of soil tilt is calculated by stability analysis, it can solve the complex combination problem[2].

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2. Water form in soil

All manuscripts must be in English, also the table and figure texts, otherwise we cannot publish your paper. Please keep a second copy of your manuscript in your office. Soil water is classified according to the shape of water and the nature and size of supporting force. The main forces of water in soil are adsorption, attraction, gross force and gravity. Therefore, the liquid water of soil can be divided into four forms as follows.

2.1 Hygroscopic water

The unit volume of soil is a strong adsorbing force, because the surface area of soil particles is large, which can absorb water vapor molecules from the surrounding environment to the surface. Water bound to the surface of soil particles is called hygroscopic water.

2.2 Film water

The amount of deliquescent water reaches the maximum. Soil particles have strong activity to absorb water vapor molecules in the air, which is not strong enough, but liquid water molecules in the surrounding environment can only absorb. The water absorbed by this force is called membrane water, because the water film outside the absorbed water gradually becomes thicker, forming a continuous water film.

2.3 Capillary water

The fine pores between soil particles can be regarded as capillaries. The water-air interface in the capillary is meniscus. The liquid water under the curved liquid surface is sucked by the surface tension, which is also called capillary force. If the film water in the soil reaches its maximum, the excess water will be called capillary water. Under natural conditions, groundwater rises along the soil pores under capillary force, and the water retained in the capillary pores is called capillary ascending water. If the groundwater level is very deep, the capillary water rises at a distance from the surface. At this time, with the aid of capillary force[3], water is retained in the upper aquifer pores after rainfall, which is called capillary floating water.

2.4 Gravity water

When the diameter of the soil particle is large enough, the capillary phenomenon is very weak. If the water in the soil exceeds the field capacity of the soil, the excess water will not be absorbed by capillary force, thus free movement under gravity. This is called gravity water.

3. Water constant

According to the description above, there are various forms of limit eigenvalues of intermediate water cut-off. These solid values have no basic changes to the specific texture and structure of the soil, so these extremities are called the constant of intermediate water cut-off. There are several normal water content constants[4].

Maximum hygroscopicity: In vapor saturated air, the maximum hygroscopicity of soil can be absorbed. Maximum molecular water holding capacity: Royal Water Content when Thin Film Water reaches its Maximum. Field water holding capacity: Soil moisture when capillary planktonic water reaches its maximum. It has hygroscopicity, very thin film water and capillary suspended water limit. Water content at capillary break: The water content at the beginning of breaking due to the reduction of water content to a certain degree of haste in the continuous state of capillary suspended water. Saturated water content: The water content of all the voids in the soil when filled with water.

4. Rainfall infiltration

4.1 Rainfall elements and performance methods

The main concepts are rainfall, rainfall time, rainfall intensity and rainfall area. In order to reflect the temporal variation of rainfall, the rainfall process line and the cumulative rainfall curve are generally

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used. Rainfall refers to the depth of the water layer formed by falling into a specific location or surface in a specific accounting process without evaporation or skilled leakage loss. Rainfall duration generally refers to the time from one moment to another in the process of rainfall. Rainfall intensity is the amount of rainfall per unit time, also known as rainfall intensity. Rainfall intensity is usually divided into average rainfall intensity and instantaneous rainfall. Rainfall area is the horizontal projection area within the range of rainfall. The change of rainfall intensity is called rainfall process line. Generally speaking, the cylindrical chart of rainfall in good columns of YX shows the grade as coordinate, and the time as transverse coordinate. If the time is very short and the time is zero, the cylindrical curve is a smooth curve, that is, the process of instantaneous rainfall intensity[5].

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4.3 Ship analysis of permeation process

Water infiltration reflects the general process of infiltration. Coleman and Bodman divide the water content into four regions, namely, saturated zone, transitional zone with obvious decrease of water content, conductive zone with little change of water content[6], and rapid decrease of water content to arbor value, namely, the wet zone. The leading edge of the wetting zone is called the wetting front. It has been generally recognized that there is a skilled wetting zone in the conduction zone. However, there are different opinions on saturation and transition zones. Many researchers believe that this process is difficult to cover the surface of the soil, and the transition phase is not clear. The existence of these two regions may be an abnormal phenomenon of unstable surface soil structure, but in fact it does not exist.

5. Effect of soil evaporation

The main concepts are rainfall, rainfall time, rainfall intensity and rainfall area. In order to reflect the temporal variation of rainfall, the rainfall process line and the cumulative rainfall curve are generally used. Rainfall refers to the depth of the water layer formed by falling into a specific location or surface in a specific accounting process without evaporation or skilled leakage loss. Rainfall duration generally refers to the time from one moment to another in the process of rainfall. Rainfall intensity is the amount of rainfall per unit time, also known as rainfall intensity. Rainfall intensity is usually divided into average rainfall intensity and instantaneous rainfall. Rainfall area is the horizontal projection area within the range of rainfall. The change of rainfall intensity is called rainfall process line. Generally speaking, the cylindrical chart of rainfall in good columns of YX shows the grade as coordinate, and the time as transverse coordinate. If the time is very short and the time is zero, the cylindrical curve is a smooth curve, that is, the process of instantaneous rainfall intensity[5].

Stopping evaporation is a process in which water in the main part rises under the action of water potential gradient and enters the atmosphere skillfully in the surface layer. The formation and intensity of soil evaporation mainly depend on two factors. One is the effect of weather conditions, such as sunlight, humidity, humidity and wind speed. This is the external condition of evaporation. It not only determines the energy supply in the process of water evaporation, but also affects the

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diffusion process of water vapor from soil evaporation surface to atmosphere. Secondly, it is affected by the size and distribution of soil moisture. This is the condition for the soil to carry water upward, that is, when the King's gun is fired, the soil's water supply capacity is sufficient, and the evaporation of the soil is only related to meteorological conditions; when the King's body is unsaturated, the evaporation of the King's body depends on one of the two factors that determine the reduction of evaporation[8].

After the end of rainfall, the water content of topsoil is almost saturated. According to the characteristics and rules of soil evaporation, the evaporation process can be divided into two stages: atmospheric evaporation capacity and soil water supply capacity.

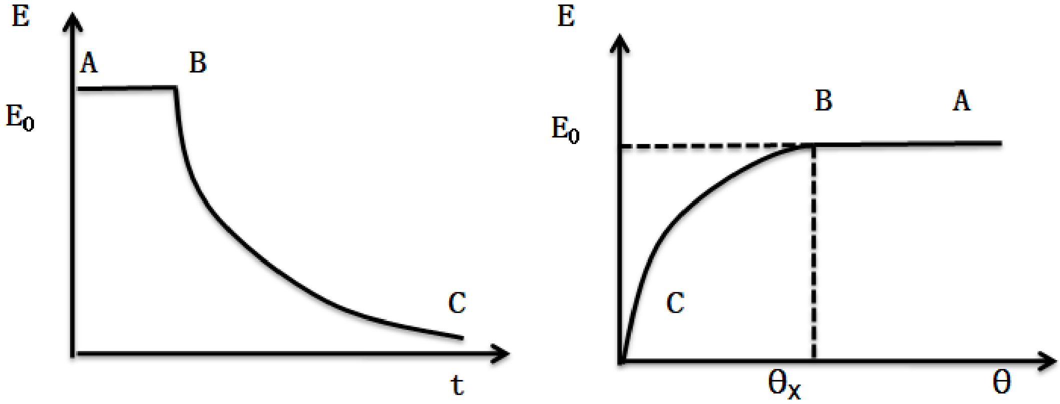

Figure 1. Two stages of soil surface evaporation

6. Conclusion

Evaporation is an indispensable factor in determining the initial state of inclined plane. The relationship between evaporation intensity and soil water content can be obtained by self-organizing evaporation model. If your soil is saturated, you can consider the specific evaporation intensity in the soil as a reference value. If the saturation ratio is low, the evaporation intensity decreases with the decrease of saturation. After rain, water will continue to infiltrate deep soil, and the stability of the slope will be further reduced. When the minimum safety factor is reached, the stability of the gradient will increase gradually. Considering the evaporation after rainfall, the slope stability will continue to decline, and the minimum value will be the same as that without considering evaporation, but evaporation will recover faster. Under the action of evaporation, zero flux surface appears in the shallow layer of slope. That is to say, water will move to the zero flux surface and penetrate under the zero flux surface[9].

Verification and application of evaporation model. The environmental conditions generated by evaporation tests are real simulations, and you have to verify that they are consistent with reality. In fact, temperature, humidity and sunlight are not fixed. The relationship between actual meteorological conditions and evaporation intensity established by evaporation model is also worth studying. The evaporation model has not considered the influence of wind, which is also an aspect that needs to be improved. Because of the rain, the importance of landslide research has increased. Through this study, we know that the occurrence of debris flow is not only related to the total rainfall. The method of establishing the relationship between various factors and landslide is a necessary condition for landslide warning. Practical projects are valuable in exploring implementation strategies to avoid or mitigate the adverse effects of rainfall on slopes. Demonstration and on-site examinations on slopes under rainfall. This paper mainly studies the calculation of rainfall tilt W model, but lacks the support of a physical model. In the future, indoor test mode W and digital simulation can be combined.

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