The Study on Stability of Bedding Rock Slope under Rainfall Infiltration

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Abstract: Rainfall is an important factor affecting the stability of bedding rock slopes. In this paper, the factors affecting the stability of bedding rock slope are listed. Then, according to the division of soil bedding rock slope and rock bedding rock slope, the rainfall is in the stability of bedding rock slope. The influence and effect of the process are finally fully explained in the common water control measures in the bedding rock slope engineering.

1. Introduction

With the continuous development and utilization of natural resources and the continuous development of social civilization, especially the population growth and the concentration of cities and the rapid development of urbanization, the world garbage in the world is almost three times faster than its economic growth. At present, domestic and international urban domestic waste technology can be divided into: composting disposal method, incineration disposal method, sanitary landfill method, paralysis method and trampoline method [1]. Compared with other methods, sanitary landfill is a very effective treatment method for treating garbage, which has the lowest cost and is the main way of garbage disposal in China at this stage. If the landfill site selection argument is sufficient, the design and construction are correct, and the management is proper, the purpose of garbage disposal and resource utilization can be achieved. Therefore, this method has been widely adopted by most countries and regions in the world.

Rainfall is one of the important conditions for the instability of bedding rock slopes. The occurrence and development of bedding rock slopes such as collapse, landslide and debris are mostly controlled by rainfall and other factors. According to the relevant statistics, most of the bedding rock slope instability in China is related to rainfall [1]. Whether it is the rain-stricken northwest region or the rainy south China region, from south to north, from east to west, most of the collapse, landslides, and mudslides occur during the rainy season. Especially after heavy rain, a large number of landslides, collapses and other bedding rock slope instability phenomena often occur, and the losses are heavy.

2. Main factors affecting the stability of bedding rock slope

The factors affecting the stability of bedding rock slope are various. After summing up the research results for many years, the basic influencing factors can be divided into two categories: the first type is the internal factor of bedding rock slope, i.e., bedding rock. The structural factors of the slope are represented by litho logy and its combination and structural plane; the other is the external factors of the bedding rock slope, namely environmental factors, groundwater (including atmospheric precipitation) and ground stress (especially the structure thereof) Stress, earthquakes, and human activities are representative [1]. The change of environmental factors often has a decisive influence on the stability of bedding rock slopes. That is to say, the characteristics of the rock and soil of the bedding rock slope are the most basic, and the external factors such as the environment must act through the internal factors. The stability state of the bedding rock slope is determined by the combination of the above two factors. Each factor constitutes an interconnected and interacting whole. Any change in one of the factors will also cause other factors to change, thus integrating affects the stability state of bedding rock slopes.

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2.1 Internal factors.

Internal factors are structural properties. The rock and soil in nature is generally composed of three parts: mineral particles in the soil, water in the soil, and gas in the soil [1]. The mineral particles in the soil are the most basic material components of the soil particles, which directly affect the size and shape of the soil particles and the strength of the weathering resistance, thus affecting the permeability and mechanical properties of the soil. These basic parts, their relative numbers, are constantly changing as the environment changes and time continues [2]. Among them, the absolute amount of solid mineral particles has the lowest rate of change, although under the action of weathering and flowing water (surface and underground) and other dynamics, the solid particles are destroyed, transported or remnant and the amount of increase and decrease and qualitative changes occur. However, these effects must either have certain conditions or take a long time to occur or produce significant effects. However, the water and air in the soil are completely different. The change in their quantity is very sensitive to the influence of the environment, and the change in the amount of water plays a more dominant role [2]. Because of this, the stability of the bedding rock slope is also very sensitive to the environment.

In summary, the internal factors are divided into the following three aspects:

1) Slope shape: The presence of a slope allows the sliding surface to emerge at the leading edge of the slope. This is a prerequisite for landslides. At the same time, the different heights, slopes, shapes and other elements of the slope can cause the internal force state of the slope to change, thereby causing the slope to be unstable.

2) Litho logy: Landslides mainly occur in soils that are easily hydrophilic and softened and in some soft rocks. For example, clay soil, loess, hillside accumulation, weathered rock and soil layer that is easy to expand and soften when exposed to water. Soft rocks include shale, mudstone and marl, phyllis and weathered tuff.

3) Structural structure: Some soft layers such as joints, joints, faults, and morphologies in the slope are close to the slope, and the rock mass of this slope is easy to be unstable and become a landslide. These weak structural planes combine to form a sliding surface.

2.2 External factors.

The external factors are environmental factors, and the external influence factors are played by internal factors. The summaries mainly include groundwater (including atmospheric precipitation), ground stress (especially the tectonic stress), earthquakes, human activities, etc. [3].

1) When the loose ground fill is impervious to the bedrock surface, the large amount of groundwater moves along the bedrock surface, which reduces the strength of the soil, which is an important reason for the widespread distribution of the accumulated landslide.

2) If the groundwater in the slope rock and soil has stable water storage structure (such as fault fracture water), it is easy to produce landslide.

3) The lower part of the hillside is piled up. If there is an ancient trench of buried bedrock that collects groundwater, large-scale accumulation landslides are likely to occur.

4) When the local surface water seeps into the sloped rock and soil body, it tends to produce a bedding landslide when flowing along the lower impervious soft rock layer.

5) The sand and pebble layers in the loess layer are usually rich in groundwater, and the upper loess body often slides along this layer.

6) The water level of rivers, lakes and reservoirs is rising and falling, and it is easy to form bank landslides due to changes in hydrodynamic pressure.

7) The surface water in the upper part of the slope body is infiltrated into a large amount, and the water flow of the slope foot is washed, so that the stress state of the slope body changes, which is easy to cause landslide.

8) Stacking spoil or building houses in the upper middle part of the slope, increasing loads and promoting landslides.

9) Cut the slope in the lower part of the bedding rock slope to weaken the support and easily form a landslide.

10) Destroy the surface cover and vegetation of the hillside, accelerate the weathering of the rock and soil, and make a large amount of surface seepage under water, which may cause landslide.

11) Artificial ditches, urban sewage discharge, rice field leakage and large amount of domestic water discharge may cause landslides.

12) Artificial large blasting and mechanical vibration may cause landslides.

During the earthquake, the strength of the bedding rock slope decreased due to the strong movement of the earth's crust. At the same time, due to the effect of horizontal seismic forces, the stability of bedding rock slopes will be greatly reduced, resulting in the destruction of bedding rock slopes. The initial in-situ stress at any point on the earth's crust today includes gravity and structural residual stress [3]. In any case, gravity is always present, sometimes large, sometimes small, and sometimes negligible. The influence of ground stress on the deformation and stability of some large bedding rock slopes is attracting more and more attention.

3. Effect of rainfall on bedding rock slope

Among the external factors, namely environmental factors, rainfall plays an important role in the deformation and failure of bedding rock slopes. According to the information available, about 90% of the bedding rock slopes (landslides) occur during the rainy season (this is what people often say about the ten slips and nine waters), especially the continuous heavy rain or the participation of groundwater. This fully demonstrates that rainfall is an important factor affecting the deformation, failure and stability of bedding rock slopes [4]. According to the different types of bedding rock slopes, the effects of rainfall on bedding rock slopes are divided into two categories: rainfall on soil bedding rock slopes, rock bedding rock slopes.

Hydrostatic pressure and hydrostatic pressure.

When groundwater is present in the rock mass fissure, the water creates hydrostatic pressure on both walls of the fissure. The fracture hydrostatic pressure is one of the important static loads generated by groundwater on the bedding rock slope. The direction of the hydrostatic pressure of the fissure is perpendicular to the bearing surface, and its value is determined by the head. The higher the head, the greater the pressure and the more serious the influences are the stability of the rock mass of the bedding rock slope [4]. In some cases, this force can reduce the anti-sliding force by about 20% to 40%. It can be seen from Fig. 1 that the large hydrostatic pressure generated by the groundwater due to the existence of large-scale structural faults has a great influence on the stability of the rock mass of the bedding rock slope.

When the rock mass of the bedding rock slope is relatively broken, the groundwater penetrates uniformly in the rock mass to form a unified diving surface, and the water flows out from the foot of the slope, and the hydrostatic pressure is zero.

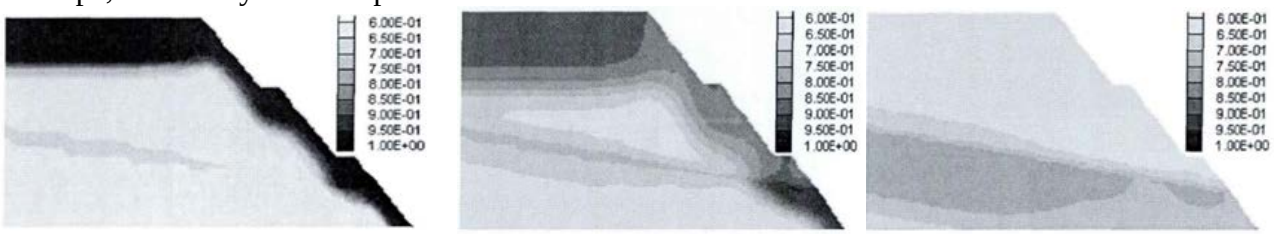

Fig. 1 Analysis of fissure water pressure

When groundwater flows in a fracture in a soil, the pressure applied to the soil particles flowing through it is called hydrodynamic pressure or permeation (osmotic pressure). This is because when groundwater flows in soil or broken rock, it is resisted by soil particles or rock fragments. When water flows, it has to exert force on soil particles or rock fragments to overcome their resistance to water. Thus, hydrodynamic pressure or penetration force is formed [5]. The magnitude of the hydrodynamic pressure is equal to the resistance of the soil particles or rock fragments received by the permeate flow. The magnitude of the hydrodynamic pressure is related to the volume and hydraulic gradient of the flowing water body and can be estimated by:

$$w_D = \frac{e}{1+e}\gamma_w I V_w$$

Where w_D is the hydrodynamic pressure; e is the void ratio; I is the hydraulic gradient; V_w is the volume of the seepage portion of the soil [5]. The dynamic pressure acts on the rock mass of the seepage portion, and its direction coincides with the tangential direction of the flow line passing through the point. In the rocky bedding rock slope, the filling of the structural surface is reduced by the buoyancy of water, and when the hydrodynamic pressure is slightly larger, the filler particles in the structural surface are taken away, and the hollow rock mass is eroded [4]. The filling between the two; at the same time, the moving water will smooth the rough rock surface, make it smooth, reduce the friction coefficient of the rock, reduce the anti-sliding force of the rock mass, and reduce the bedding rock slope. In the soil bedding rock slope, the hydrodynamic force can induce quicksand and piping under certain conditions.

4. Influence of rainfall on the stability of bedding rock slope

For rock bedding rock slopes, the adverse effects of rainfall are mainly reflected in four aspects: reducing rock mass strength, raising groundwater level and increasing pore pressure in bedding rock slope.

4.1 Reduce rock mass strength.

For the stability of rock bedding rock slope, the controlling effect is the strength of the rock mass structural surface. The rock mass structure surface is divided into a hard structural surface and a weak structural surface. The introduction of water has no effect on the strength of the hard structural surface, and the weak structural surface is softened after the surface of the weak structural surface encounters water, especially when the water content of the original filling medium is small, and the rainfall is significantly increased after the rain. The shear strength is significantly reduced [6]. For example, the Tiger Hillside of Y.X. Long in the Three Gorges of the Yangtze River, before the bottom whole discharge, due to the annual rainfall in the area, the mountain is in a dry state. Under the long-term action of the discharge rain and fog, the water content is greatly increased, resulting in a significant decrease in the strength of the rock mass, which leads to the instability of the bedding rock slope. In the areas of strong weathering and soft rock formations, severe landslides often occur.

4.2 Raise the water table.

The extent to which the rainfall increases the groundwater level of the mountain is closely related to the hydro geological conditions. Under certain conditions, the groundwater level can rise significantly, while in other conditions, the water level rise can be extremely limited. Generally speaking, when the rock mass is not particularly strong, the slope is slow and the groundwater level is above the weakly weathered layer, the water content increases and the water level rise requires more water supply, and the water level rises less under the same rainfall conditions. At the same time, due to the development of cracks, the rock has a large fracture and permeability coefficient, and the water is easily drained after the water level rises [6]. This is one of the reasons why the flood level in many mountains is not large.

4.3 The pore pressure in the bedding rock slope increases.

According to the seepage theory, the rock mass is a dual medium composed of a fracture network and a rock mass of a porous medium. The permeability coefficient of the rock block is related to the rock type. The dense rock, such as micro-new granite, has a permeability coefficient of the order of 10-10 cm/s. The crack width is 0.01 cm. According to the hydraulics of the gap, the water permeability coefficient, that is, the permeability coefficient is about 10-4 cm/s. After rainfall infiltration, the velocity of water in the fissure is much greater than the velocity of movement within the pores of the rock mass. In the micro-new rock mass, due to the closure of the fracture, the gap of the fracture is very small, accounting for only 0.01%--0.001% of the volume of the rock mass, while

the volume of the pores of the rock mass is much larger [7].

4.4 The role of water and rock forces.

Under the action of rainfall, the rocky bedding rock slope does not produce large surface erosive erosion like the soil bedding rock slope. However, if the weathering of the rock is serious and the rainfall intensity is high, the weathering layer of the rock will be affected, and it will be peeled off from the bedrock. Under the flow of surface water, the stripped cuttings will be taken away, so that the fresh bedrock will be exposed to the surface and weathered [7]. The long-term reciprocating alternating action will make the rock mass thinner, the strength will decrease, and the weathering crack will deepen, resulting in a vicious circle [7]. When the local surface water is blocked in the rock slope, it will increase the weight of the rock mass and increase the sliding force of the slope.

5. Summary

Rainfall plays an important role in the formation and development of landslides. Therefore, in the treatment of bedding rock slope engineering, the distribution of surface water on the slope and the seepage of groundwater should be mastered as much as possible, and the drainage system of surface water and groundwater should be comprehensively set to make the water on the bedding rock slope. The impact is minimized to ensure that the bedding rock slope is stable.

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