Research on stability analysis of slope engineering

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Abstract

This paper combined with the development of the domestic and international slope engineering technology in recent years, the main factors of slope stability and protection measures were summarized and refined. Slopes may be natural or man-made. The factors affecting slope stability are soil type, soil stratification, seepage, slope geometry, etc. Sometimes, slope failures may occur due to soil erosion, rainfall, external loading and construction near toe. The most important forces causing instability of a slope are gravity and seepage. At the same time, combined with the development of slope engineering in recent years, it discusses the applicability of the pile anchor support, strut form, slope structure, evaluation of slope stability, groundwater control and so on.

Keywords

Slope engineering, slope stability, factors, slope supporting.

1. Introduction

Slopes may be natural or man-made. According to the classification of slope causes can be divided into artificial slope and natural slope, according to the classification of lithology can be divided into soil slope and rock slope. By age classification can be divided into permanent and temporary slope. On the slope stability evaluation, first of all, it is clear that the failure mechanism and evaluation factors, reasonably determine the primary and secondary factors of these evaluation is the key to the stability evaluation of the slope. Factors that affect the stability of the slope can be divided into two aspects of internal and external factors[1]. The internal factors include composition of slope rock soil type and nature, the slope geological structure, slope shape, groundwater. External factors including vibration, climatic conditions, weathering role, the slope's vegetation and human engineering activities etc.. The diversity of the factors and the complexity of the failure mechanism make the analysis and evaluation of the slope stability become one of the difficult problems in the research of geotechnical engineering.

Due to many factors, it is necessary to evaluate the stability of the slope. Through consulting the literature, we can know that there are qualitative analysis and quantitative analysis method of slope stability analysis. By using these methods, the stability of the slope is evaluated. In view of various factors affecting the stability of slope, taking various measures to deal with, the development of slope support engineering is very important to the safety and stability of the slope. This paper mainly introduces three kinds of protective measures, including slope plant protection technology, engineering protection, flexible support.

2. Factors of the Stability of Slope Engineering

From Doug Stead[2], we can summarize that the engineering properties are related to slope stability and shear strength. There are many factors that affect the stability of slope engineering, and it is divided into internal and external factors[3]. These factors can be summarized as the following points:

2.1 Climatic Factors

Climatic factors mainly refers to the temperature and humidity, wind direction and intensity, the most serious degree of frozen soil, etc.. In the large area exposed soil and weathered rock slope, because the diurnal temperature difference on the surface of the role, and landed the erosion of rain, it is prone to weathering phenomenon, resulting in large areas of soil and water loss in, slope cracking, shallow soil surface side slip.

2.2 Hydrological Factors and Hydrogeological Factors

Hydrological factors including ground water overflowing, river flood water level, water level, riparian sediment status, is there any surface water accumulation and accumulation of long. Hydrogeology elements contain groundwater depth the dynamic law of the groundwater, whether there exist the spring water, interlayer water and pore water, etc..

2.3 Geological Factors

Along the route geological factors include rock types, cause, degree of weathering, cracking condition, joints and rock angle, bedding, strike, inclination, thickness, is there any interlayer or the mixture of water and reduced intensity after dissection, and fault zone or other bad geological conditions. In manual excavation of rock and soil slope, although the rock itself is very strong, rock texture extension, for a long time to accept the sun shine, rain erosion, appeared on the surface of a particularly bad weather conditions often occurs slope due to spalling and the fall of stones crushed residue. If it is cutting work surface properties of rock strength is very weak shale, and the texture development of weathering serious, or is a clayey soil and water storage of the gravel layer by layer storage, especially the texture state of the slope layer cutting surface of the rock of bias, it is easy to make cutting landslide occurred.

2.4 Soil Factors

Soil is the main material for the construction of subgrade and slope, and the different soil has different characteristics. The strength of sand and gravel soil is mainly based on the internal friction force, the stronger the intensity, the less affected by the water. Cohesion is the main strength of cohesive soil, increases with the enhance of density, and decreases with the increase of moisture content. The capillary condition of silty soil is very obvious, its strength and load capacity decrease due to the increase of capillary water and humidity. Because of the low permeability and high moisture content of the loess, the water content of the soil can be reached to the full extent, and it is easy to cause the slope to slide. If the material of the roadbed is not up to the standard, and there is no soil reinforcement, there will be damage to the slope structure.

2.5 Artificial factors

(1)Lack of accuracy of geological prospecting. Such as soil slope under the water level survey are not accurate, there is no survey to the water level of the bedrock surface, causing the slope appear side slip, survey of soil cohesion, load capacity, density, cohesion and other numerical values are not accurate, resulting in design errors and landslide phenomenon.

(2)The design of the slope is not reasonable. While designed, in order to reduce upfront investment, the long term effects of climate and geological factors are ignored. In the area of climate drought and less rain, the cut of the rock layer has no protective measures, which causes the weathering phenomenon of the soil on the slope surface. Lack of understanding of all kinds of soil water stability, selection of slope protection facilities is not appropriate, or no design of drainage facilities, resulting in a great impact on the slope of the flow of water. Slope design selection of steep slope, beyond the rock itself can maintain the angle of repose, each step height is not consistent with the natural rock properties, the design calculation of the stability characteristic of the slope is not accurate, resulting in part of the soil under the action of gravity along the slope of a the sliding surface and slip.

(3)The construction method is not scientific. In the process of construction, the slope excavation is not fully based on the design documents, and the cohesive soil layer covered on the rock and soil is not

cleared, or not strictly in accordance with the building regulations construction of subgrade, the order of the construction is not reasonable, compacting and insufficient, etc..

3. Evaluation Method of Slope Stability

Due to the influence of internal and external factors, the stability of the slope after the operation is worrying. Slope failure accident occurred, resulting in casualties and economic loss is self-evident, so it is necessary to evaluate the stability of the high slope. Commonly used methods[4]of slope stability analysis are divided into two categories: qualitative analysis, quantitative analysis. Commonly used qualitative analysis mainly stereographic projection method (graphical method), historical origin cause of formation analysis method, engineering database and so on. The most commonly used quantitative analysis method is the limit equilibrium method, the numerical analysis method, and reliable evaluation method, fuzzy evaluation method and so on.

Rock mass classification systems are widely used tools for assessing the stability of rock slopes[5]. This paper mainly discusses the main practical issues affecting the application of Slope Mass Rating (SMR) for the characterization of rock slopes from 3D point clouds.

This paper mentioned that geological discontinuities play an important role in the evaluation of rock slope stability. Rome's Slope Mass Rating (SMR) system[6] provides a methodology to quantify rock slope stability. Employing Bieniawski's Rock Mass Rating (RMR) to classify the rock mass of an investigated slope, SMR enables an objective determination of the rating adjustment values based on discontinuity orientation-slope orientation, respective dips angles and slope excavation methods.

4. Side Slope Support Engineering

4.1 Development Status of Soil Slope Support Engineering

At present, the soil slope support engineering is mostly used in reinforced concrete and masonry retaining wall, part of the steel sheet pile or reinforced concrete pile retaining wall[7]. The setting of the retaining wall is mainly focused on ensuring the stability of the engineering structure, and not too much consideration for the ecological environmental protection. This makes the construction of the project is difficult to effectively integrated with the natural environment. From the perspective of long-term use of the project construction, does not meet the ultimate goal of sustainable development. Specifically, the application of masonry retaining wall and reinforced concrete retaining wall in engineering is not necessary to set up the necessary ecological holes. But it is only an individual to make an independent storage component on the surface of the project, which makes the project completely isolated from the soil after the front wall of the wall. For the water and air in the soil of the connectivity, make it difficult to guarantee the ecological engineering. In addition, due to the large volume of masonry retaining wall and reinforced concrete retaining wall, making it difficult to carry out afforestation construction. If the projection is built in the center of the city, it will greatly affect the beauty of the construction of urbanization.

4.2 Protection Measures of Slope Support

Gu Shouyu, Gao Qi[8] Mainly introduces the main influencing factors of water slope stability, the rapid decrease of water level, rainfall, seepage. Proposed many can play a good role in slope protection, but also improves the engineering environment and reflect the beauty of the natural environment of plant slope protection technology, with the traditional slope protection engineering measures together form the plant protection system of slope engineering.

According to the different conditions of slope soil, the different construction methods and construction technology of the slope plant protection technology is divided into: artificial grass slope, tile turf, hydraulic seeding grass, geonet grassing slope protection, OH liquid grass protection, row planting of vetiver grass slope, honeycomb mesh grass protection, soil plant slope protection plant, spraying mixed vegetation slope protection plant. The commonly used form of engineering protection is retaining wall,

spray and spray concrete protection, retaining wall, anti slide pile, prestressed anchor beam, spray anchor protection.

Prevention and control measures[3] can be summarized as the following:

1)Prevention first, prevention and cure combination

In the road slope design and construction process, must according to the actual situation of the road (soil, slope, catchment area, height, etc.), ahead of the design of drainage ditch, seepage drainage ditches, ditches, drainage ditches and other facilities, in rock and soil is loose and broken place should be Scientific protection.

2) Classification of closure, vertical and horizontal integration

Steep slope and rock slope stability of the drainage system should adopt drainage grading method of closure, vertical and horizontal integration of drainage. The top surface water by intercepting ditch exclusion, slope classification did not set up an order cut ditch drainage, drainage ditch slope setting. Steep slope topography and slope should refer to size, reasonable spacing interval setting vertical drains, let the water drain away as quickly as possible.

3) Exterior and interior drainage, comprehensive management

In slope design, be sure to will affect the stability of surface water block, row to the slope around the outside, to prevent appear overflow and seepage. In order to ensure the stability of the roadbed side slope, the ground surface and ground water are discharged into the slope, and the surface and ground water are discharged into the slope.

4) Slope protection, both supporting and blocking

To fundamentally governance disease, in addition to attention to drainage, should also be built some slope protection project (such as wall, grass, arch type revetment), to ensure the safety and stability of slope. Sometimes, at the foot of the slope but also increase the number of retaining structures, used to increase the ability of anti water damage.

5. Conclusion

In recent years, with the development of civil engineering construction in our country, slope engineering construction of original ideas have been unable to fully meet the current social development needs, on the basis of traditional design, construction and monitoring technology, establish a number of new supporting structure, design methods and design ideas, to promote the rapid development of slope engineering technology. It can be predicted that in the future for a long period of time, slope engineering technology is still an important part of foundation engineering and geotechnical engineering, there are a lot of problems to be further studied and improved. These are the main problems:

1) Strengthen the comprehensive application of various supporting methods in slope engineering and optimize the combination, to further expand the application prospects of a variety of supporting measures or the combination of optimization.

2) Strengthen the new materials, new technology and new method development and application, and to continue to play a greater role in the slope engineering design, construction and detection.

3) Further development in slope engineering theory, founded a new slope engineering support system, the engineering safety stability and protect the ecological environment, saving resources organically combined, strive for the realization of engineering and natural harmony and unity.

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