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Protection of Gully Slope in Loess Plateau

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Abstract

Rigid protection of traditional engineering slope protection measures can play a certain role in slope protection at the initial stage of the project, but with the passage of time, the slope will be affected by weathering, the stability of the slope will be reduced, in addition, a large area of engineering rock surface exposed will not be coordinated with the surrounding natural vegetation environment, which does not meet the requirements of sustainable development. Therefore, the ecological engineering restoration technology combining engineering measures and biological measures has become the trend and mainstream of slope management and restoration.

Keywords

Slope Protection; Channels; Slope Body; Slope Surface; Plant Protection.

1. Introduction

As one of the main reserve resources of arable land, Loess gully is one of the main grain production bases in Shaanxi Province, and also an important dry farming area in China[1]. This area has great production potential from to the bottom of the gullies. As long as fields are transformed into fields, deserted ditches are leveled, and gullies are damped for water storage and irrigation, there will be a general situation of transformed into granaries and gullies transformed into banks"[2]. However, due to serious soil and water loss, gullies and valleys are dendritic. At the same time, due to the complexity of loess soil and the collapsibility of loess soil, the high slopes on both sides of the gully are prone to geological disasters such as landslides under the action of heavy rainfall, earthquake and other external loads, which seriously affect the smooth implementation of the gully reclamation project [3]. The large-scale excavation and backfilling in the process of ditching and land construction will inevitably break the original mechanical balance system of geological body, change the original topography and cause a series of engineering geological problems. How to carry out engineering treatment is also a very important factor affecting the effect of land consolidation[4,5].

2. Influence of Excavation on Slope Stability

Limited by geographical location, geological environment and natural conditions, most towns and cities on the Loess Plateau are located in loess gullies with little arable land. Due to geographical limitations and lack of housing land, local people have had the habit of chopping slopes and building kilns since ancient times. The slope foot formed by Malan loess and Lishi loess should be excavated when building houses in the hilly area of loess, which makes the soil slope stand steeply and the free surface increase, creating conditions for the occurrence of

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collapse and landslide. At the same time, with the rapid development of economy and the expansion of urban construction scale, in recent years, a high demand has been put forward for the quantity and quality of construction land. In order to obtain more construction land, a large number of loess slopes have been excavated, which has seriously damaged the original balance of geological environment and caused geological disasters such as landslide, collapse and debris flow. According to the statistics of 13 counties and districts in Yan 'an City, there were 249 cases of landslide directly caused by excavation and indirect landslides caused by abandoned soil accumulation after excavation, accounting for 18.44% of the total number of landslides, while 337 unstable slopes caused by engineering excavation, accounting for 77.65% of the total number of unstable slopes. It can be seen that loess landslide induced by manual excavation shows an increasing trend. The stability of artificially excavated loess slope in Yan 'an area is worrying.

2.1. Retaining Wall

Retaining wall is a kind of structure to prevent slope deformation and instability and withstand lateral earth pressure. The traditional retaining wall is made of stone masonry. It relies on its own gravity to balance the earth pressure to maintain the stability of the slope, it is currently a commonly used form of retaining wall, the wall is mostly made of stone masonry, but also concrete or brick. It has the advantages of local materials, simple structure, convenient construction and good economic effect. But compared with anti-slide pile, its anti-slide ability is lower, and the suitable height is 2~8 m. In addition, the excavation amount of retaining wall foundation is large, so in order to avoid the instability of slope easily caused by large-scale excavation, the excavation of section hopping is often used in construction. A retaining wall is usually set up in the lower part of the slope in Loess Plateau to prevent the deformation and failure of the stress concentration at the foot of the slope. It can also be arranged according to the actual needs of the slope at all levels of the platform.

2.2. Flexible Protection Technology

Rigid protection measures for slope in Loess Plateau are generally expensive, and the coordination deformation ability between structure and soil is poor. With the development of engineering technology, flexible protection measures continue to emerge, and the representative types include soil nailing wall and anchor frame beam.

Soil nailing wall is composed of reinforced soil, long and thin metal rods (soil nailing) placed in the reinforced soil, and concrete panels attached to the slope, forming a retaining wall similar to the retaining wall, so as to resist the earth pressure and other forces behind the wall, so as to stabilize the excavation slope. The difference between soil nailing wall and traditional retaining structure is that soil nailing and soil work together. The composite soil is formed which can greatly improve the strength and stiffness of the original soil, change the deformation and failure behavior of the slope, and significantly improve the overall stability of the slope.

3. Slope Reinforcement Project

The supporting measure is the basic measure in slope protection technology. It is a reliable protection method to use retaining structure (retaining wall, anti-slide pile) to support unstable rock and soil mass of slope. Its advantage is that it can fundamentally solve the problem of slope stability and achieve the purpose of radical cure.

3.1. Anti-slide Pile

The anti-slide pile is a structure which is embedded in the stable rock mass to a certain depth and transmits the soil pressure or sliding force to the stable rock mass by relying on the pile body. Since the anti-slide piles mainly bear lateral forces, reinforced concrete is used as the pile

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material, and the soil arch effect is formed by friction resistance between the piles to stabilize the slope. It has the advantages of strong anti-sliding ability, reliable performance and small construction difficulty, and has been widely used in all kinds of landslide control and slope protection projects. In slope protection in the Loess Plateau, the slope with large scale and weak structural plane may produce large-scale slip deformation, so the anti-slide pile is often used to stabilize the slope.

3.2. Anchor Cable Anti-slide Pile

The calculation of restressed anchor cable anti-slide pile includes the design of ordinary anti-slide pile and the design of restressed anchor cable. Its main task is to determine the tension of anchor cable and calculate the interaction between pile and surrounding soil under the tension of anchor cable. At present, there is no mature theoretical method for the calculation of restressed anchor pile. There are usually two methods, namely general anti-slide pile method and finite difference method.

4. Slope Protection Works

In view of erosion and denudation damage of the side slopes of the Loess Plateau, engineering or plant measures are taken to protect the slope from large-scale instability and farmland destruction caused by the gradual development of slope damage. Slope protection technology can be divided into two categories: engineering measures and plant measures. Engineering measures mainly include wall protection, skeleton slope protection, hanging net spraying, etc. Plant measures mainly refer to grass planting and tree planting on slope and platform.

4.1. Protective Wall

Slurry masonry shard wall is a type of protection made of shard masonry through mortar. This kind of measures is one of the most commonly used types of slope protection in loess Plateau. It has the advantages of local materials, simple structure and convenient construction. Generally used for slope rate 1:0.5~1:1 slope, single stage height is not more than 10 m, wall top width 40~60 cm. Set 1 to 2 ear walls in the wall of more than 4 m to ensure the stability of the wall, the setting of the wall can effectively prevent precipitation infiltration along the slope and reduce the erosion of the slope.

4.2. Skeleton Slope Protection

Skeleton slope protection is the use of masonry into an arch or rhomboid skeleton, the skeleton planting grass greening, the skeleton can be set up water border stone, so as to prevent erosion and erosion of the slope. Generally used for slow 1:1 soil slope, in the formation of new loess slope is more commonly use. As the skeleton slope protection is a combination of engineering measures and plant measures, on the one hand, it avoids the slope closure effect of the solid bowl wall, on the other hand, it greatly improves the road volume landscape, and the effect is good.

4.3. Hang the Net Spray

Screen shotcrete protection is a kind of slope protection measure to prevent slope weathering and spalling or falling, which is mostly used in bedrock slope. However, in the protection of loess slope in recent years, such measures are also adopted for loose soil and low rainfall in the region. Net shotcrete effectively prevents slope erosion and has a good reinforcement effect, but from the perspective of visual sense, especially the emphasis on ecological and environmental protection, its effect is poor.

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4.4. Vegetation Protection

Vegetation protection measures mainly include sod slope protection, planting belt slope protection, hydraulic spray planting grass slope protection, vetiver hedge slope protection, three-dimensional plant mesh slope protection, geoglyph room planting grass slope protection, slurry stone skeleton planting grass slope protection, vine plant protection, planting woody plant slope protection.

5. Conclusion

Planting shrubs, small trees and other woody plants is a common slope protection method. In particular, it should be pointed out that in all slope protection methods, woody plants can be planted and grass irrigation can be combined under appropriate conditions to give full play to the role of both, so as to promote the rapid formation of diverse and stable slope plant communities and play the function of slope ecological protection.

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