

Overview of Ecological Slope Protection Technology

Ge Qi^{1, a}

¹School of Shandong University of Science and Technology, Qingdao, China.

^a734265702@qq.com

Abstract

Ecological slope protection technology has been widely applied and developed at home and abroad. By reviewing the previous ecological slope protection technology applied and improved in slope greening projects, the scope of application of the ecological slope protection technology is introduced, and the existing technology is also proposed some of the shortcomings provide suggestions for engineering applications.

Keywords

Ecological slope; Ecological slope protection technology; Slope greening.

1. INTRODUCTION

Many road slopes will be formed during the highway construction excavation. Slope protection is often used for slope protection. A large amount of cement, stone, sand and other materials are used during construction, which not only disrupts the original ecological balance of the local area, but also causes considerable The large energy consumption is inconsistent with the concept of "green development". Therefore, when slopes are protected, they have begun to adopt green slope protection technology. From the initial dry-laying, mortar block slope protection, concrete shotcrete slope protection, prestressed anchor cable reinforcement slope protection, the development of reinforced concrete frame beam method, Vegetation roll cover method, guest soil plant bag method, fiber greening method, ecological porous concrete greening method, thick layer substrate greening method and other technologies. These technologies have largely repaired the ecological balance of the slope and protected the environment while ensuring the stability of the slope.

2. DEVELOPMENT STATUS OF ECOLOGICAL SLOPE PROTECTION TECHNOLOGY

Ecological slope engineering [1] refers to the use of a combination of plant engineering and civil engineering to repair, reconstruct, and destroy damaged ecological balance systems after necessary excavation and filling of rock and soil. Geomechanical equilibrium of rock and soil is a project to reinforce the mechanical equilibrium of the ecosystem and geomechanics. Among them, plant engineering, also known as ecological slope protection technology, sprays a layer of guest soil substrate for plant seeds to grow on the original slope. Protecting and strengthening the surface of the slope, and the root-soil interaction are also beneficial to the stability of the slope.

Domestic scholars have designed a series of ecological slope protection technologies according to the geological conditions of the slope and the environmental climate of the area.

2.1. Early Ecological Slope Protection Technology

After people realized the ecological environment of the slope, it was just simple to plant grass on the slope or transplant turf elsewhere to the slope. These measures did not take into account the greening effects in the middle and late stages, and only focused on the meaning of greenery expressions without combining with slope protection. The early ecological slope protection technology mainly has the following two types:

(1) Artificial grass slope protection

Artificial grass protection and slope protection is one of the earliest ecological slope protection technologies. It is a traditional vegetation slope protection measure by simply spreading grass seeds on the slope. Because there is no assistance in geotechnical protection, it is only suitable for gentle slopes.



Figure 1. Artificial grass slope protection

This technique is simple in construction and low in cost. The disadvantages are that the artificial seeding of grass seeds is uneven, and the surface seepage protection after rain and rain is low. It is easy to form slope gullies and shallow soil erosion after the rain. Repair work made the technology gradually phased out.

(2) Turf slope protection method

The turf slope protection method is a traditional vegetation slope protection method in which natural turf is manually laid on the slope surface, and the turf grown in different places is transported and spread on the slope required for slope protection.



Figure 2. Turf slope protection method

Turf slope protection is an improved method of artificial grass slope protection, which solves the problem of uneven sowing of artificial grass seeds. The construction is simple, the construction cost is low, and the speed of greening is fast. Quality slope.

Because the turf is transferred off-site, the early maintenance work is heavy, and the vitality of the new turf is weak. It is very vulnerable to various natural disasters. It is not a long-term slope protection technology.

2.2. Improved Ecological Slope Protection Technology

The early ecological slope protection technology gradually failed to meet the requirements of ecological slope protection, and gradually developed a new type of ecological slope protection technology combined with geotechnical structure and flexible protection. Such as lattice reinforcement technology, Three-dimensional vegetation net slope protection method, TBS vegetation slope protection technology and ASE Eco-slope technology and so on.

(1) Lattice beam method

Lattice reinforcement technology [2] is a kind of slope reinforcement technology that uses mortar block stones, cast-in-situ reinforced concrete or pre-stressed concrete to protect the slope slope, and uses anchor rods or anchor cables to fix the slope. At the same time of protecting the slope of the sash, plants can be planted in the sash, which has the function of greening the slope.



Figure 3. Lattice reinforcement technology

Lattice reinforcement technology is relatively weak in the protection of rainfall. The big reason is that the grid is not "rooted" on the slope. Under the wash of rainwater, the topsoil under the sash will be washed away, forming a partial slip, and even the entire top surface soil slides and destroys the sash.

(2) Three-dimensional vegetation net slope protection method

The three-dimensional vegetation net slope protection method, also known as the three-dimensional geonet mat spraying grass slope protection technology, is a relatively mature slope greening technology, which belongs to the guest soil spraying technology [3]. This technology uses geosynthetics to combine plants and spray. After sowing, the geotechnical three-dimensional network is covered, and the shallow layer of the slope is reinforced by the root system of the plant. Domestic scholars [4] have conducted a comprehensive and in-depth study of the three-dimensional vegetation network one after another. Influence of soil body under net protection slope.



Figure 4. Three-dimensional vegetation net slope protection method

The three-dimensional vegetation slope protection method is ecologically friendly, convenient to construct, and low in cost. Moreover, the three-dimensional geonet mat can be transplanted into a grass blanket for off-site transplantation [5]. It can solve the engineering needs that require rapid protection.

Although the three-dimensional vegetation network can maintain the stability of the slope surface to a certain extent, it does not contribute much to the overall stability of the slope. Therefore, it is mainly used for rock slopes with slow slopes or good self-stability.

(3) TBS vegetation slope protection technology

TBS (Thick-layer Base Material Spraying) vegetation protection technology [6] is a green protection technology that uses an improved concrete sprayer to spray a uniform and thick layer of substrate mixture on the rock slope surface according to the designed thickness. The basic structure is composed of anchors or anchor rods, composite material nets, and thick substrates. Among them, the thick layer substrate is the key to this technology, which serves as the substrate for seed growth to provide developmental nutrients for the seeds.



Figure 5. TBS vegetation slope protection technology

The main advantage of TBS vegetation slope protection technology lies in the aspect of greening. With thick substrates, multiple combinations of vegetation can be planted, which has evolved into a reasonable vegetation community to form a good ecosystem to adapt to differences in different regions and climates. Especially in the later stage of the evolution of the vegetation community, it has good self-regulation ability in combination with the surrounding environment. In addition, TBS vegetation slope protection technology has significant advantages in economic effects, environmental effects, and construction period compared to traditional slope protection technologies such as mortar block stones.

(4) ASE Eco-slope technology

ASE ecological slope protection technology is a new ecological protection technology developed this year. It combines the two problems of slope protection and greening, and applies the earth grid, GFRP anchor and other environmental materials, which is a new technology with a large market [7].



Figure 6. ASE Eco-slope technology

ASE ecological slope protection technology is a new technology integrating protection and greening. In terms of protection, the ASE ecological slope protection technology can solve the problem of stability of the high and steep slope by adding a layer of reinforcement material structure to the outside of the guest soil and the secondary anchorage of the anchor rod. In terms of greening, the ASE ecological slope protection technology ensures the growth and development of plants through the soil rich in organic matter, laying a good foundation for greening.

(5) Ecological bags and vegetative bags

The two new methods of greening the ecological bag and the vegetation bag on the slope are made of new special materials such as polyethylene or polypropylene, polyester fiber, etc., which have the advantages of non-toxic and harmless, good environmental protection, water-permeable solid soil, It is suitable for slopes with insufficient soil fertility or soil without soil and unsuitable for plant growth.



Figure 7. Ecological bags and vegetative bags

In the construction process, only the planting soil needs to be filled into the bag, the difference is that the green bag is planted after the ecological bag is built, and the plant bag is a non-woven

fabric with seed embedded in a nylon bag, which saves the later stage the process of sowing greenery.

In addition to the simple and fast construction method of ecological bag and green bag slope protection, the method of filling soil is more than that of other slope greening methods, especially the special stacking method. Played a significant role in the construction of terraces [8].

(6) Ecological porous concrete greening method

Porous cement concrete, also known as water-permeable cement concrete, is a kind of porous lightweight concrete made by mixing aggregate, cement, water and additives. Porous concrete has the characteristics of strong water absorption, high strength, and porosity [9], which creates conditions for plant root growth and water absorption.



Figure 8. Ecological porous concrete greening method

Similar to the method of dividing the entire greening unit into small units of ecological porous concrete, the existing soil is directly mixed with a variety of materials through a certain proportion of the guest soil, and the water is added, molded and dried to form a fixed shape and strength. Guest soil blocks can be used for garden landscape and indoor greening as well as greening of building exterior walls.

3. PROSPECTS

From the continuous progress of ecological slope protection technology, it can be seen that ecological slope protection technology has changed from the initial focus on slope protection with geotechnical structure, followed by greening solid soil, to the view that slope protection with plant solid soil and geotechnical structure complement each other, and is developing towards a more ecological and sustainable direction.

In some accepted ecological slope engineering, the phenomenon of shallow soil landslide occurs after rainfall, especially in the southeast coastal areas of China, strong rainfall often produces landslide, so the shallow soil further reinforcement of ecological slope is a hot spot.

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