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Research on Ecological Ladder Retaining Wall in Lhasa City

Yaping Wang*, Yue Lu, Xinyi Li, Xudong Hu, Xing Zheng

Tibet University, Tibet, Lhasa, 850000, China
**Corresponding author*

Abstract: *With the continuous improvement of the level of economic and social development and the continuous growth of the population, the degree of human exploitation and utilization of resources has deepened, resulting in a series of serious environmental pollution and destruction. It has threatened the normal life and production activities of local residents. In order to maintain the local ecological balance, we must take effective measures to ensure its healthy development, which is an urgent problem to be solved. In view of the special environment of Lhasa, this paper comprehensively analyzes different types of ecological retaining walls by using a variety of literature and field investigations, in order to find an effective way that not only meets the requirements of environmental protection, but also contributes to the sustainable economic development of Lhasa. Through the comparative analysis of several typical retaining wall structural forms common in Lhasa, the ecological stepped retaining wall structure forms suitable for Lhasa City are proposed, and the applicability of the stepped retaining wall is evaluated by qualitative analysis method, and it is concluded that the stepped ecological retaining wall has good adaptability and meets the construction requirements of Lhasa.*

Keywords: *Ecology; Qualitative analysis; Lhasa City; Ecological retaining walls; Stepped retaining walls*

1. Introduction

The topic of this study is mainly based on the actual situation of Lhasa, which has poor climatic conditions, low rainfall, low temperature, low vegetation coverage and damage to the ecological environment, which affects the economic development and social development of Lhasa. The research significance of this study lies in the analysis of the feasibility of building an ecological stepped retaining wall through the study of the ecological environment problems in Lhasa, and the reasonable solution is proposed to provide reference for the improvement of the ecological environment in Lhasa. Scholars at home and abroad have studied the design calculation method, mechanical properties and construction safety of the ecological stepped retaining wall in Lhasa, and conducted in-depth research on the development prospect of the ecological stepped retaining wall in Lhasa. The researchers will study the common retaining wall in Lhasa and compare it with the ecological stepped retaining wall. Secondly, the researchers will analyze the stability theory of the ecological stepped retaining wall. Finally, the economic benefit analysis of the ecological stepped retaining wall is carried out. The results of this study will provide a reference for the construction of retaining walls in Lhasa, so as to better protect the land resources of Lhasa.

2. Studying Geography

Located on the southwest edge of the Qinghai-Tibet Plateau, 3,650 meters above sea level, Lhasa is the first large city in the Tibet Autonomous Region, and its geographical location and historical value are extremely important, not only the political, economic and cultural core of the Tibet Autonomous Region, but also the transportation hub of the Tibet Autonomous Region, providing a solid foundation for local social progress and development.

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3. Eco-stepped retaining walls

3.1 Types of retaining walls in Lhasa

In Lhasa, retaining walls are usually made of gravity, buttresses and bolts. Each form has unique characteristics and has its own unique advantages in actual construction. Gravity retaining wall can effectively resist the side pressure of the soil, its advantages are low cost and easy operation, but due to its own large weight, material consumption is also correspondingly increased, so the bearing capacity of the foundation is also higher; Buttress retaining wall is a kind of concrete structure with superiority, which can not only effectively reduce material consumption, but also meet the requirements of foundation bearing capacity, but it will also consume a large amount of steel and cement, thereby increasing construction costs and extending the construction period. The anchor retaining wall can effectively improve the stability and overturning ability of the retaining wall, but the technology is complex, which requires a lot of capital investment and will increase a certain amount of labor costs. [1] Therefore, in order to better play the role and function of the retaining wall, the appropriate retaining wall type should be selected according to the local situation.

3.2 Eco-stepped retaining walls

Ecological retaining walls can not only protect the environment, but also beautify the landscape, while also preventing soil erosion, it is extremely adaptable and can meet a variety of different needs. The use of stepped ecological retaining walls can effectively reduce land occupation, and at the same time, it can save a lot of building materials. The use of reinforced earth retaining walls can save 10%-15% of the investment, while the use of gravity retaining walls can save 20-30% of the cost. And the stepped retaining wall is more stable and safe than other retaining walls. Ultimately, because every part of the stepped retaining wall can be prefabricated in advance, it can greatly speed up construction and play a significant role in emergency situations. [2]

3.3 Ecological retaining wall plant test

Lhasa is located at the extreme extreme of southwest China, on the southern edge of the Qinghai-Tibet Plateau, and belongs to the plateau continental climate. The climatic characteristics of the city of Lhasa influenced the plant species in the area, as well as the construction of retaining walls. Summer is hot, the highest temperature can reach 37 ℃, there is precipitation in summer, the average monthly precipitation is 100~200mm, under this condition plant growth is rapid, which provides good environmental conditions for the growth of plants in the ecological retaining wall. The winter in Lhasa city is mild, with no precipitation, low humidity, and little snowfall, resulting in slow plant growth and is not conducive to plant growth. There are fewer plants that can survive in ecological concrete, and we need to choose plants that can grow well in Lhasa's special environment. In this experiment, we selected ecological concrete and tall fescue seeds with 25% porosity for growing greenery. In general, the survival of plants is inseparable from good soil, sufficient water, warm environment and sufficient sunlight, which are necessary conditions for plant survival. When carrying out ecological porous concrete planting experiments in Lhasa, the local soil, fertilizer, grass ash and water are first mixed in a certain proportion, filled into the ecological concrete voids, and then placed on a shaker with lower power and vibrated for about 10 seconds to make the soil evenly accumulate in the porous concrete voids to achieve the purpose of plant growth. A 1cm thick porous concrete surface is covered to provide the nutrients the plants need, and it is protected from damage to the seeds from wind and animal trampling. After planting, the germination and growth of seeds is very important. Therefore, we should put them in an environment suitable for temperature and humidity, and take care of them carefully; During the growing season, we should water plants frequently and fertilize them regularly to ensure that they receive adequate water, sunlight and nutrients. Before planting, pay attention to watering and avoid high temperature exposure. When watering, avoid large water flow spraying, but use a watering can to spray with fine water to prevent plant sprouts from being washed away; In order to ensure the healthy growth of plants, nutrient supply should be moderate, scientific and reasonable fertilization, to avoid excessive fertilization leading to plant shrinkage or even death. Pests and diseases are essential for the health and growth of plants, and as long as the environmental conditions are right, they can invade the plant and cause serious damage to the plant. In order to avoid the spread of the disease, regular check-ups and measures should be taken to protect health. If disease develops, it should be controlled immediately with antibiotics or pesticides to prevent the spread of the disease.

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According to research, Astragalus, fescue and dwarf dog grass seeds have good ability to adapt to the climate of Lhasa, among which, the growth of dwarf dog grass seeds is even more amazing, within a week, they can germinate, the germination rate is very high, the growth rate is also very fast, its vitality is strong, within 15 days, the height of the plant can reach 8 cm, within 60 days, its height can be increased to 32 cm. Therefore, the ecological retaining wall is implementable in Lhasa.

4. Stability Analysis of Eco-Step Retaining Walls

4.1 Forms of destruction of retaining walls

The form of destruction of the retaining wall refers to the tilted, collapsed and fractured state of the retaining wall. Therefore, it is very important to study the stability of the ecological stepped retaining wall to avoid the damage state of the retaining wall such as tilt, collapse and fracture to ensure the stability of the retaining wall. The inclined state refers to the tilt state of the retaining wall itself due to geological conditions and external forces. When the geological environment and external forces facing the retaining wall change, the stability of the retaining wall will be affected, resulting in the inclined state of the retaining wall. The collapse state refers to the collapse state of the retaining wall due to the influence of geological conditions and external forces. As the geological environment and external factors change, the stability of the retaining wall may be compromised and may even collapse. The fracture state refers to the fracture state of the retaining wall due to the influence of geological conditions and external forces. When the geological environment and external forces facing the retaining wall change, the stability of the retaining wall will be affected, resulting in the fracture state of the retaining wall. Therefore, the stability analysis of the ecological stepped retaining wall in Lhasa is very important, in order to avoid the damage state of the retaining wall such as tilt, collapse and fracture, a comprehensive stability analysis of the retaining wall must be carried out to ensure the stability of the retaining wall.

4.2 Active earth pressure calculation

K_α-It is a key parameter to measure the quality of foundation pit support design. Its accuracy determines the success of the support project, and also determines the economic benefits of the project. According to Rankine earth pressure theory and Coulomb earth pressure theory, we can calculate the coefficient in the active earth pressure formula-K_α. This physical quantity is determined by the internal friction angle of the fill behind the wallφ、Inclination angle of wallα、The slope of the ground-βAnd friction angle between wall and fill-δDetermined.

Calculation formula of active earth pressure：

$$E_\alpha = \frac{1}{2}\gamma H^2 = \frac{cos^2(\varphi-\alpha)}{cos^2\alpha cos(\alpha+\delta)\left[1+\sqrt{\frac{sin(\delta+\varphi)sin(\varphi-\beta)}{cos(\delta+\varphi)cos(\varphi-\beta)}}\right]^2} = \frac{1}{2}\gamma H^2 K_\alpha \qquad (1)$$

Active earth pressure coefficient calculation formula：

$$K_\alpha = \frac{cos^2(\varphi-\alpha)}{cos^2\alpha cos(a+d)\left[\frac{sin(\delta+\varphi)sin(\varphi-\beta)}{cos(\delta+\varphi)cos(\varphi-\beta)}\right]^2} \qquad (2)$$

In order to improve the performance of the eco-stepped retaining wall, we need to improve its impact resistance. First of all, its impact resistance should be proportional to the surface smoothness of the wall, that is, its impact resistance should be proportional to the surface smoothness of the wall. Secondly, its impact resistance should be proportional to the surface smoothness of the wall, that is, its impact resistance should be proportional to the surface smoothness of the wall. Finally, in order to improve the impact resistance, we should repair its surface without planting the plant to make it stronger and more durable.

The retaining wall before optimization is calculated,K_α=0.645, E_α=93.23（KN）.

The calculation results of the optimized retaining wall show that K_α value for K_α=0.553, and E_α value for E_α=85.42（KN）.

When total earth pressure E_α. When lowered, the retaining walls are also subjected to less earth pressure, making the retaining walls more stable.

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4.3 Stability analysis of retaining walls

In the stability analysis of the retaining wall, we first adopted the classic sliding stability analysis method to determine the stability of the retaining wall. According to the classic sliding stability analysis, we can divide the retaining wall into two categories: one is the anti-slip stable retaining wall, and the other is the anti-overturning stable retaining wall. In the slip stable retaining wall, we calculate the anti-slip stability safety factor $K_y$to measure the anti-slip stability ability of the retaining wall. [3]

Calculation method of retaining wall overturning coefficient:

$$K_y = \frac{M_y}{M_c} \geq [K_y] \tag{3}$$

Overturning moment calculation method:

$$M_c = \sum \chi y = \sum \chi \frac{1}{3} H = \frac{1}{3} H[P_0 - (P_0 - P_a)(2 - \frac{W_0}{G_a})]\cos(\alpha + \delta) \tag{4}$$

$$[K_y]=1.8 \tag{5}$$

K_y——It is a safety factor used to ensure the stability of retaining walls against overturning; Anti-overturning moment KN·M, which has a significant effect on the retaining wall, its magnitude is$KN \cdot M$

M_c- For retaining walls, the overturning moment it generates is enormous$KN \cdot M$

K_y- is the minimum safety factor of the retaining wall to ensure that it has good overturning stability; H - The height of the retaining wall is meters to ensure safety; When the retaining wall remains stationary, the earth pressure it is subjected to will increase significantly; When the retaining wall is in active limit equilibrium, the earth pressure it is subjected to will reach ;KN , which is a value that cannot be ignored; When G_a- is in extreme equilibrium, it will work its best. KNThe weight is composed of the structure of the retaining wall and the filler on it; W_0- The thickness of the retaining wall can be measured byKN. According to the shape of the retaining wall, its own weight is calculated per square centimeter of thickness, the W point of action is located in the center of the wall, perpendicular to the ground, the weight of steel is 7.85 g/cm ³ and the weight of mortar masonry is 23,000 N/cm ³

From the calculation of the anti-overturning stability of the retaining wall, the stepped retaining wall can enhance the integrity of the retaining wall, which is stronger than the gravity retaining wall. From the material point of view, the materials required for the retaining wall are basically unchanged. However, we planted various plants on the basis of the retaining wall, and the materials used were also adapted to local conditions. We chose abundant blocks from the plateau, which cost less. Through the renovation of the wall, we found that it is stepped and excellent in appearance, size and weight. This makes construction easier and has high practical application value; Although the stepped retaining wall has certain advantages, it also has some shortcomings, for example, it is larger and occupies a relatively large area. In recent years, due to the frequent disasters, in order to better cope with these problems, we have had to retrofit and upgrade the existing retaining walls. The methods presented in this paper can help us transform and improve these retaining walls more efficiently and quickly; Through the evaluation of the entire system, we found that the structure of the retaining wall is stronger and has higher protection capabilities.

4.4 Stability verification of retaining walls

The stability verification of retaining wall is one of the important means to evaluate the stability of retaining wall. For the ecological stepped retaining wall in Lhasa, the researchers analyzed it by using the stability check method. Firstly, the researchers carefully studied the type, structural parameters, construction conditions, slope stability and other factors of the retaining wall, and conducted a detailed analysis of the stability of the retaining wall. Secondly, the researchers used the stability test method to check the stability of the ecological stepped retaining wall in Lhasa to determine its stability. Starting from the stability verification method, the researchers calculated the stability coefficient of the retaining wall and compared it with the minimum stability coefficient of the retaining wall, so as to evaluate the stability of the ecological stepped retaining wall in Lhasa. Finally, the researchers used the stability verification method of retaining wall to verify the stability of the ecological stepped retaining wall in Lhasa to judge its stability. After stability verification, the researchers concluded that the stability coefficient of the ecological stepped retaining wall in Lhasa is greater than the minimum stability coefficient of the retaining wall, so the stability of the ecological stepped retaining wall in Lhasa can be

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considered reliable[4].

4.5 Economic benefit analysis

When conducting an economic benefit analysis, it is first necessary to determine the basis for it. The economic benefit analysis of the type of retaining wall in Lhasa is mainly based on three aspects: first, the economic benefit of the existing retaining wall type in Lhasa, the second is the cost of construction and renovation of the retaining wall in Lhasa, and the third is the economic and social benefits of the type of retaining wall in Lhasa. First, it is necessary to collect the economic benefits of the existing retaining wall types in Lhasa, including the protective effect of flood control, typhoon prevention, debris flow prevention and other disasters, as well as the ecological protection effect of the retaining wall. It has been found that the ecological retaining wall has a strong waterproof effect on soil erosion, and the ability to protect against other natural disasters is slightly weaker than that of gravity retaining wall, but it still has good protection ability. By analyzing the economic benefits of existing retaining wall types in Lhasa, the feasibility of retaining wall types in Lhasa can be better assessed. Secondly, it is necessary to collect the cost of the construction and renovation of the retaining wall in Lhasa, such as engineering design fees, material costs, construction costs, and so on. These costs will directly affect the economic benefits of the type of retaining wall in Lhasa, so the impact of these costs must be considered when conducting an economic benefit analysis. Lhasa is located on a plateau, and the prices and labor prices are much higher than those in the hinterland, and the economic benefits are slightly lower than those in the hinterland. Finally, it is necessary to collect the social benefits of the type of retaining wall in Lhasa, such as the operation and maintenance cost of the retaining wall, the role of the retaining wall in promoting social and economic development, and the maintenance role of the retaining wall on the ecological environment. Through our research, we can obtain ecological retaining walls with good landscape effects, which play a role in beautifying the city, and citizens are generally more willing to accept ecological retaining walls. We combine ecological retaining walls with local cultural characteristics to obtain ecological retaining walls with local characteristics, which can be used as an attraction to attract residents and tourists and drive consumption. In summary, the economic benefit analysis of the type of retaining wall in Lhasa mainly includes the economic benefits of the existing retaining wall type in Lhasa, the cost of the construction and renovation of the retaining wall in Lhasa, and the economic and social benefits of the retaining wall type in Lhasa. Through the analysis of these evidences, it is concluded that the ecological stepped retaining wall in Lhasa has high implementability.

5. Conclusion

Through an in-depth investigation of Lhasa, we found that the use of ecological stepped retaining walls can not only effectively prevent natural disasters, but also significantly improve the environmental quality of the city. The major breakthroughs of this paper are: For the ecological stepped retaining wall in Lhasa, we explore the feasibility and stability of the ecological stepped retaining wall through quantitative analysis, and propose a series of improvement measures, which provides an important reference for the environmental protection of Lhasa. In summary, the innovation points of this paper are reflected in the above aspects, which effectively improves the accuracy of the feasibility analysis of the ecological stepped retaining wall in Lhasa, and provides an effective reference for the construction of the ecological stepped retaining wall in Lhasa. [5] However, this paper also has some shortcomings and cannot fully cover the feasibility of the ecological stepped retaining wall in Lhasa. First, the construction of an ecologically stepped retaining wall may affect the land use of Lhasa, which will adversely affect the local economic and social development. Secondly, this paper does not analyze the environmental impact of the ecological stepped retaining wall in Lhasa in detail. Therefore, when considering the feasibility of the ecological stepped retaining wall in Lhasa, it is necessary to comprehensively consider factors such as its implementation and maintenance costs, environmental impact, and social impact to ensure the sustainable development of the construction and operation of the ecological stepped retaining wall in Lhasa.

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