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Experimental Study on Evaporation of Mixed Soil with Different Proportion

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Abstract

The problem of dealing with slopes is often encountered in engineering construction. It is necessary to achieve long-term slope protection through ecological slope protection. The proportion of mixed soil is very important in the process of ecological slope protection. Through the evaporation test, the optimal mixture ratio was selected to protect the slope more effectively Evaporation experiments were carried out using loess, diatomite, and straw as test materials. It was found that the addition of diatomite and straw can effectively improve the water holding capacity of the mixed soil, but the diatomite has better water holding capacity. Considering that the straw can increase the strength of the mixed soil, it is considered that 30% of loess, 14% of straw, and 56% of diatomite are the optimal solutions for configuring the mixed soil.

Keywords

Ecological slope protection, Evaporation, Mass ratio.

1. Introduction

In the engineering construction, a lot of treatment work is usually required for the construction site before the construction, such as excavation and filling work [1], but when dealing with some large construction sites, if the construction site is still treated according to the common treatment method, not only the treatment effect is not good, but also the slope instability caused by the excavation will cause serious damage to the original ecological environment, intensified soil erosion [2]. In recent years, many countries have a full understanding of various disasters caused by slope instability, and have made a lot of explorations and bold attempts on how to carry out more effective ecological protection of slope.

China has a preliminary idea of slope ecological protection for a long time, usually planting some plants beside the river, so as to protect and strengthen the bank slope to a certain extent, mainly using the root system developed by plants to strengthen the soil. In the 17th century, when China was protecting the riverbank slope of the Yellow River, it creatively used the plant ecological slope protection technology for the first time. In the 1930s, there were some new slope protection technologies in Japan. People used to plant grass or small saplings on the slope to control the slope when they were controlling the barren slope. Americans used the wattle fences in the slope treatment of the Angeles crest highway, using plants to maintain the stability of the slope. In some special bad slopes, such as stone slopes and some hard slopes, plants cannot be directly planted on the original natural slopes. In the 1950s, there was a hydraulic spray seeding technology [3], which can spray mixture to the slope surface of the poor slope, so that the plants on the slope surface can grow well, so as to solve the limitations of the methods in the process of slope greening. In the 1970s, Japan developed a new method suitable for rock slope greening to improve the local slope. Since then, a lot

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of research on rock slope greening has begun. In the following 20 years, Japan has also conducted a lot of experiments to study the influence of the ratio of the initial materials of the green slope on the slope strength. At the beginning of the 20th century, people developed a new vegetation slope protection engineering technology high-order aggregate technology for the protection of special slopes. This technology has been used in the ecological protection of rock slopes in different areas, and achieved very good results. Schoenholtz [4] found that the improved organic fertilizer can provide more stable nitrogen (N) source for the soil. Leiros [5] conducted soil restoration experiment when studying a coal mine in Xihong, northwest Spain. The experiment showed that the application of organic fertilizer had more obvious effect than inorganic fertilizer, and when the soil was treated with animal manure, their growth was more rapid, the activity of microorganisms in the soil was strong, and the physical and chemical properties of the soil were better. Pamukcu [6] found that vegetation can dilute and decompose the refractory organic matter in soil. In arid and semi-arid areas, the application of water retaining agent vegetation restoration technology can effectively improve the survival rate and preservation rate of plants, promote the growth status of plants and effectively improve the water holding capacity of soil [7, 8]. The water content of the slope will be reduced due to evaporation after spraying and sowing, and the soil will crack due to water loss, leading to the failure of the slope engineering [9-12]. The evaporation of soil mass is mainly divided into three stages [13], the first stage is a relatively stable constant evaporation rate stage [14], the second stage is a falling stage of evaporation rate, the third stage is to maintain a lower evaporation rate stage, we hope to test the water holding capacity of soil mass under different mixing components through evaporation test, select the optimal soil mixture ratio to improve the spray the composition of soil.

2. Materials and Methods

The loess used in the test was taken from the Yellow River Delta area, the diatomite was taken from the Changbai Mountain area, and the straw was taken from Weifang, Shandong Province, China. The loess needs to be dried and crushed before use, and passed through a 2mm sieve. The properties of the materials used in the test are shown in Table 1. The test area is located in Qingdao, Shandong Province. The average temperature during the test was 25.3 ℃. The mixed soil samples with different proportions were respectively configured and loaded into the hair pan for testing. The evaporation pan was 10 cm high and 5 cm in diameter. A small hole with a diameter of 0.5 cm was opened at the bottom to facilitate the saturation of the sample. A sheet was placed at the bottom of the evaporation pan. Filter paper to prevent soil particles from falling out of the pores. When filling the mixed soil, compaction filling should be carried out in layers, and the density of the sample in the evaporation pan should be calculated. The loaded sample needs to be saturated in the saturation tank, the saturation time is 48h. After saturation, put it in a sealed box and let it stand for 48h to discharge the gravity water. After the gravity water is drained, the weight of the evaporation pan is calculated by a balance (accuracy 0.01g). For the amount of evaporation, in addition to the mixed soil sample, a sample of deionized water should be set up to observe the potential evaporation rate. The test adopts a method of mixing the three materials in pairs to find the best ratio. The test sets of the mixed soil are shown in Table 2.

Table 1 Physical properties of the material

Material	Maximum dry density (g/cm^3)	Specific gravity	Sand	Slit	Clay
Loess	456	456	26	63	11
Diatomite	789	213	4	55	41
Straw	-	-	-	-	-

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Table 2 Samples with different mixing ratios

Sets	Materials	Diatomite mix proportion (%)
S1	Pure water	-
S2	Mixed loess with diatomite	0,5,10,20,30,40,50,70,80,100
S3	Mixed loess with straw	0,5,10,20,30,50,80,100
S4	Mixed diatomite with straw	0,5,10,20,30,50,80,100

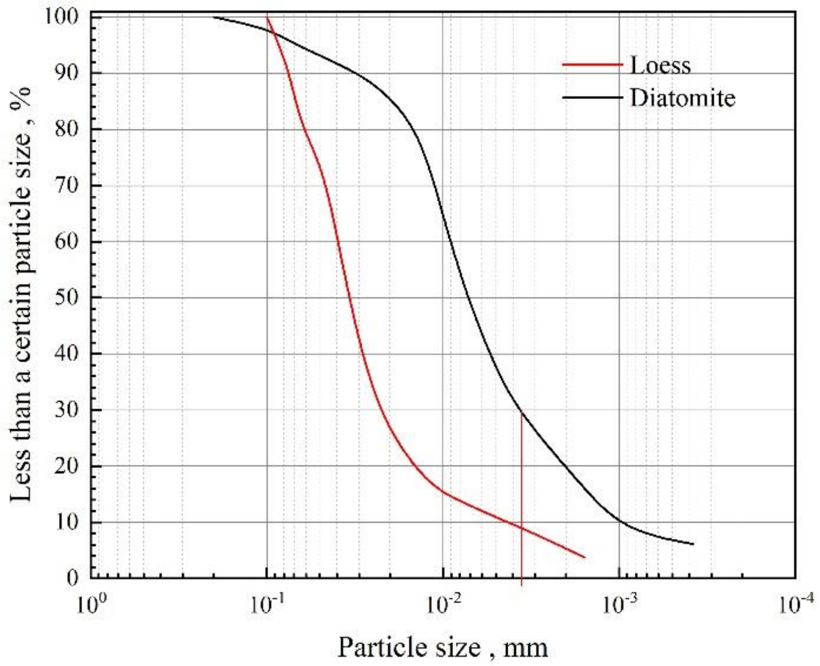

Fig. 1 Particle size grading curve of test material

3. Results and Discussion

3.1 Mixed loess with diatomite

When diatomite mixed with loess, it can be seen from the observation in Fig. 2 that the overall trend is that with the increase of diatomite content, the cumulative evaporation is higher, and each curve in the figure has a relatively stable slope section and a section that tends to be gentle gradually. When the slope changes little, it indicates that the evaporation rate of the sample is relatively stable, and when the cumulative evaporation curve tends to be gentle, it indicates that the evaporation rate begins to decline when the mass ratio of diatomite is less than 20%, the difference between the cumulative evaporation and the loess is not large. When the mass ratio of diatomite is less than 20%, the volume ratio of converted diatomite is less than the volume ratio of loess in the mixture. When the mass ratio of diatomite reaches 30%, the cumulative evaporation of the mixture is 43.1% higher than that of loess. When the mass ratio of diatomite reaches 30%, the cumulative evaporation of the mixture is 43.1% higher than that of loess When the mixing ratio is more than 30%, the diatomite becomes the main part of the mixed soil, and the evaporation characteristics of the mixed soil are mainly controlled by the diatomite whose volume proportion is the dominant part. However, when the volume proportion of diatomite reaches more than 70%, the increase of cumulative evaporation is no longer obvious. By comparing the cumulative evaporation curves of different proportions of loess and diatomite mixed soil, it can be found that the principle of diatomite evaporation for improved soil is to improve the soil's soil properties by improving the soil's water holding capacity, so as to provide sufficient water for plant growth.

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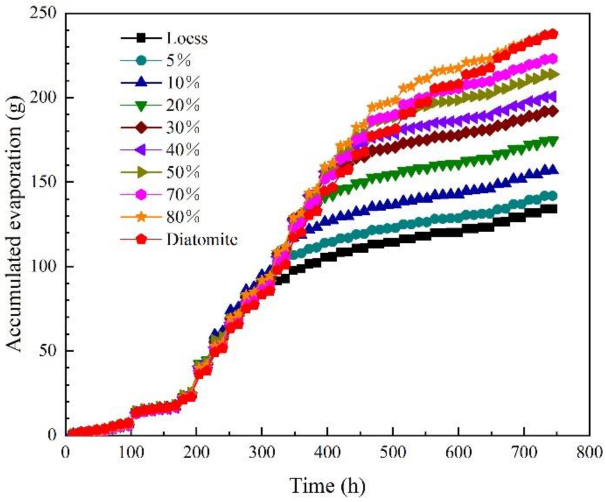

Fig. 2 Cumulative evaporation of mixed samples with loess and diatomite

3.2 Mixed loess with straw

According to Fig. 3, the evaporation rate of each sample has little difference in the first stage of evaporation, so the slope of the cumulative evaporation curve has little difference, but the cumulative evaporation curve starts to show difference after 400h. When the mass proportion of straw is less than 10%, the cumulative evaporation of the sample has little difference. At this time, the Loess occupies the main position in the volume of the mixed sample. When the mass of straw When the proportion reaches 20%, the cumulative evaporation of the mixed samples is 30.8% more than that of the loess, and the cumulative evaporation of the mixed samples increases with the increase of the straw mass ratio. When the proportion of the straw mass reaches 80%, the cumulative evaporation of the mixed samples is 45.1% more than that of the loess, but the cumulative evaporation of the straw samples is not much different from that of the 20% straw samples, It shows that there may be many pores in straw samples, which can not store gravity water. When loess and straw are mixed, loess occupies a part of straw pores and retains a lot of gravity water, which is better than pure straw samples.

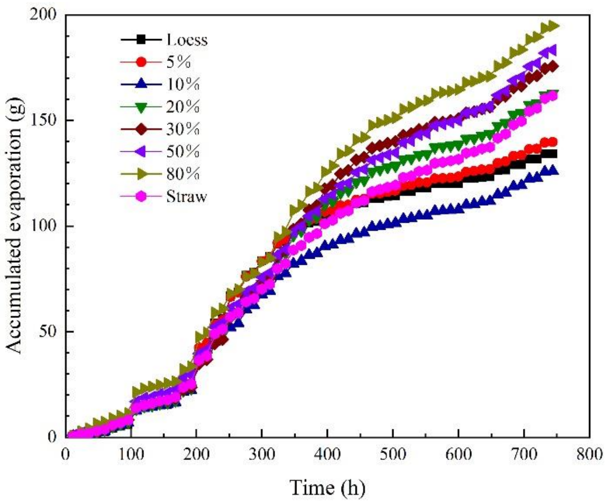

Fig. 3 Cumulative evaporation of mixed samples with loess and straw

3.3 Mixed diatomite with straw

Fig. 4 shows that with the continuous improvement of the proportion of straw quality, the cumulative evaporation of the mixed soil is declining, especially when the proportion of straw quality is greater than 30%, the cumulative evaporation of the mixed soil is significantly reduced. When the proportion of straw quality is 30%, the volume proportion reaches 51.3%, and straw begins to become the main component of the mixed sample. It can be seen from the figure that the water holding capacity of

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diatomite is better than that of straw. However, straw may provide better structural force to the mixed soil and increase the stability of the mixed soil due to its plant fiber. Therefore, straw can be properly added to the mixed soil. When the mass proportion of straw is less than 20%, the cumulative evaporation capacity of the mixed soil is equal to that of straw The cumulative evaporation of diatomite samples is similar, so we can consider the ratio of straw to diatomite mass ratio of 1:4 to add to the loess. Combined with the results in Figure 1, we think that we can choose the proportion of 30% loess, 14% straw and 56% diatomite to configure the mixed soil to improve the soil for spray seeding.

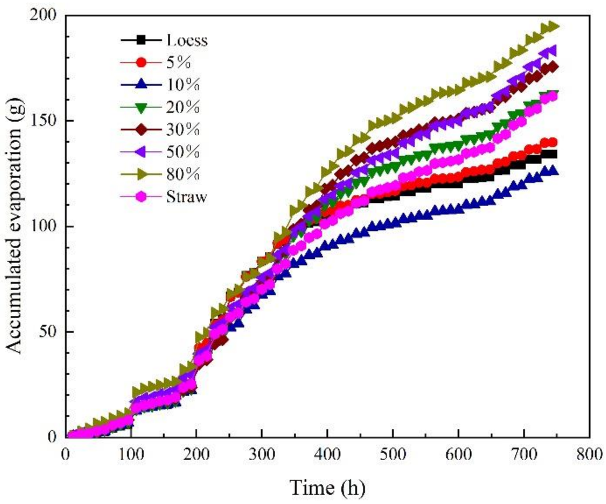

Fig. 4 Cumulative evaporation of mixed samples with diatomite and straw

4. Conclusion

In order to explore the optimal soil mix ratio to improve the composition of sprayed soil, an evaporation test was carried out to determine the water holding capacity of the soil under different mixed components, and the following conclusions were reached:

1. When diatomite is added to loess, diatomite improves the water holding capacity of the mixed soil, but at the same time the evaporation rate is also improved. When the diatomite mass incorporation ratio is greater than 20%, diatomite plays a dominant role in the volume of mixed soil, and the cumulative evaporation of the mixed soil increases with the increase of the diatomite content. However, when the diatomite mass ratio is greater than 80%, the difference of the cumulative evaporation becomes smaller.

2. When straw is added to the loess, the straw improves the water holding capacity of the mixed soil. When the mass ratio of the straw is greater than 10%, the straw plays a dominant role in the volume of the mixed soil. Increasing the cumulative evaporation of the mixed soil increases, and the lower cumulative evaporation of the straw sample may be related to the more pores left.

3. When straw is added to diatomite, the cumulative evaporation of the mixed soil decreases with the increase of the straw mass ratio. When the straw mass ratio is less than 20%, the cumulative evaporation of the mixed soil is different from that of the diatomite sample. There is not much difference in the cumulative evaporation. Considering that the straw will increase the soil strength, we choose 30% loess, 14% straw, and 56% diatomite to configure mixed soil to improve the soil for spraying.

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