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STABILITY EVALUATION METHOD OF HIGH FILL LOESS FOUNDATION BASED ON NUMERICAL SIMULATION

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Abstract. In order to understand the stability evaluation method of high fill loess foundation, the author proposes a study on the stability evaluation method of high fill loess foundation based on numerical simulation. The author first established a three-dimensional finite element model of a multi-level high fill slope using PLAXIS 3D software based on a loess high fill slope engineering project in a certain section of northwest China. The study investigated the effects of changes in fill materials, fill boundaries, slopes, and unloading platforms on slope stability. Secondly, based on the vertical and horizontal displacement of the top and foot of each level of slope under step-by-step filling, the distribution pattern of the most dangerous points of each level of slope and the overall deformation trend of the slope were analyzed. The results indicate that the cohesion and internal friction angle of the filling material are key factors affecting the stability of high fill slopes. Reducing the height of the steps at the boundary between the filling and the undisturbed soil, deepening the width of the steps, reducing the slope, and widening the unloading platform can all improve the stability of the slope. During the construction of lower slopes, there is a significant vertical displacement mutation, while the horizontal displacement mutation is relatively slow; After the construction is completed, the deformation situation is good, and the vertical and horizontal displacement of the higher slope during construction changes greatly, with uneven distribution; After the completion of construction, the consolidation settlement period is long and the deformation is large; Emphasis should be placed on strengthening deformation monitoring at high altitudes after construction is completed. Finally, the platform width can be selected within this range based on the actual engineering situation. After the platform width is greater than 3.6m, as sufficient platform width has been reached at this point, further increasing the platform width has little impact on the safety factor, and the curve gradually flattens out. The research results have determined the stability influencing factors, deformation trends, and development laws of loess high fill slopes in the northwest region, providing a scientific basis for further research on deformation control of loess high fill slopes.

Key words: Numerical simulation; Stability assessment; Loess land

1. Introduction. Loess is widely distributed, covering an area of approximately 640000 km2, accounting for 6.6% of the total land area, with the Northwest Loess Plateau being the main distribution area of loess. The Loess Hilly and Gully Region is the most vast landform area on the Loess Plateau. Due to the combined influence of internal and external dynamic geological processes and water flow erosion, the area is mainly characterized by longitudinal and horizontal gullies, and scattered beam shaped hills. In recent years, with the development of the national economy and society and the deepening of the Western Development, the speed of urbanization construction has been continuously accelerating, and the expansion of western cities has also been parallel to it. Due to the unique terrain and geomorphic conditions of the Loess Plateau, there is a shortage of available land resources in the area, which greatly hinders social development. Therefore, "cutting mountains, filling ditches, and creating land" is essential.

Large scale land filling projects have become common in China. Based on the existing engineering experience and practical engineering characteristics, several issues need to be paid special attention to when carrying out high fill projects in loess hilly and gully areas, including:

(1) Changes and impacts of groundwater environment. The gullies in the loess hilly and gully areas are developed, with steep slopes and deep gullies. Most gullies have surface water flow exposed in the form of descending springs. The main types of groundwater are Quaternary phreatic water and bedrock pore and fissure phreatic water. The practice of "cutting mountains, filling ditches, and creating land" in loess hilly and gully areas will inevitably block channels and springs, thereby changing the original groundwater seepage path

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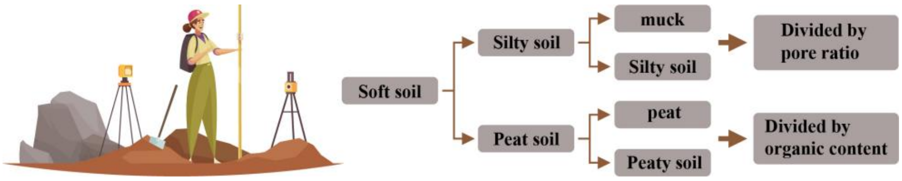

Fig. 1.1: Numerical simulation of stability evaluation of high fill loess foundation

and breaking the groundwater seepage balance. Moreover, the compacted loess fill itself has poor drainage conditions, this is likely to cause surface water and groundwater to seep into the fill, causing the water level inside the fill to rise, and affecting the deformation and stability of the high fill foundation.

(2) Settlement deformation of loess filling body. Settlement deformation is one of the most concerned issues in high fill engineering, which mainly involves the following aspects. Due to the high height of the filling and the high self weight stress, the additional stress generated by the filling body on the original foundation is also large, which will lead to significant post construction settlement deformation of the original foundation; Due to the high self weight stress of the filling body, it will also experience compression settlement under the influence of its own gravity. In addition, due to the differences in engineering properties between the original rock and soil mass and the filling body, uneven settlement is prone to occur at the overlap between the filling body and the original valley slope.

The post construction settlement of high fill is influenced by various factors such as the engineering properties of the original foundation soil, the properties and compactness of the fill soil, the height of the fill, the geometric form of the fill area, construction technology, and surrounding hydrogeological conditions. In the hilly and gully areas of the Loess Plateau, loose loess is used as the main filling material, and the water sensitivity of loess can cause its strength to decrease and deformation to increase when immersed or humidified. Therefore, it is particularly important to consider the impact of changes in hydrogeological conditions on settlement deformation, especially when the water level inside the filling body continues to rise. For the settlement of the original foundation and the settlement of the filling body itself, predecessors have done a lot of research work and proposed various settlement calculation and prediction methods. However, there is very little research on the settlement deformation of the loess filling body under the continuous rise of water level. Therefore, it is necessary to conduct further research and exploration to guide engineering practice.

(3) Stability of Loess High Fill Slope. Filling the ditch will form a high fill slope at the mouth of the ditch. Due to the development of gullies and complex geological conditions in the loess hilly and gully areas, the issue of slope stability is quite prominent. The stability of the fill slope is also affected by factors such as the weak structural plane of the original foundation, rainfall, earthquake, filling engineering properties, construction technology, and surrounding hydrogeological conditions. As analyzed above, the filling project in the loess hilly and gully area has destroyed the original natural drainage system, obstructing the original drainage channels, which is highly likely to cause water to seep into the filling soil and flow towards the slope. At the same time, due to the infiltration of water, the shear strength of the filling soil is also reduced, which can easily induce instability of the loess high fill slope. Therefore, it is particularly important to analyze the stability of the loess high fill slope in this situation [1,2].

The stability of high fill slopes is another core issue of concern in high fill engineering. In order to ensure the stability of high fill slopes, the slope gradient is sometimes designed to be very small, which results in a large land area for the entire slope, wasting land resources and increasing engineering costs. If the slope gradient is increased, it will also bring hidden dangers of slope instability. In order to solve such problems, certain support measures can be applied to high fill slopes, and the use of high-strength, low-cost, corrosion-resistant, and flexible geogrids to form reinforced soil slopes is an economical and practical method.

The existing engineering practice has also proven the superiority of reinforced soil slopes, as shown in Figure 1.1.

2. Literature Review. The settlement deformation of high fill foundation is mainly composed of the settlement deformation of the original foundation under the influence of the self weight stress of the filling body and the settlement deformation of the filling body itself.

There are many engineering practices for predicting the settlement and deformation of the original foundation, and the classic layered summation method is often used as one of the more mature methods. However, there is currently no mature method for predicting the settlement and deformation of the filling body itself.

The settlement deformation of the filling body mainly consists of three parts: instantaneous settlement, consolidation settlement, and creep settlement. Instantaneous settlement and consolidation settlement mainly occur during the construction process and have little impact on engineering construction, but creep settlement mainly occurs after construction and lasts for a long time, which has a serious impact on the safe use of fill sites. Nevertheless, numerous scholars have never interrupted their research on predicting the settlement and deformation of filling bodies, and have achieved fruitful results, proposing various prediction methods.

In recent years, the development of computer technology has improved the applicability of numerical simulation methods, and the application of strength reduction methods based on numerical simulation technology in slope stability analysis is becoming increasingly mature. The so-called strength reduction method refers to the gradual reduction of the shear strength parameters of rock and soil in an ideal elastic-plastic calculation, until the slope loses stability and fails.

Firstly, it is an improvement based on the classic hierarchical summation method. Tang, L. et al. improved the layered summation method based on the characteristics of phased settlement deformation of fill soil, and found through calculation that the settlement curve of the filling body itself was not significantly different from the actual situation, and this method was simple and fast to use. However, the prerequisite for using this method is to assume that the fill only undergoes vertical deformation and ignores lateral deformation, which is inconsistent with the actual stress-strain state of the fill [3]. Another method for predicting the settlement and deformation of filling bodies is the numerical calculation method. By numerical calculation, the complex constitutive relationship of soil can be considered, and the complex on-site construction process can be simulated. It is an effective method to solve the nonlinear problem of settlement deformation of foundation soil. Sun, J. Q., and others used the high fill project of Jiuzhai Huanglong Airport as an example to analyze the settlement deformation of the high fill foundation using FLAC3D finite difference software, the settlement of high fill foundation is closely related to the original foundation stiffness and fill thickness, and the maximum settlement is directly proportional to the fill thickness [4].

This study takes a slope engineering project in a certain section of Longnan City as the background, and uses PLAXIS 3D three-dimensional finite element software to conduct finite element numerical simulation analysis on the deformation of loess high fill slopes without support. By changing the physical and mechanical properties of the slope filling material, the boundary between the filling and the original soil, the slope of the filling body, and the width of the unloading platform, the variation law of the safety coefficient is analyzed, and real graded construction conditions are simulated to study the deformation of various points on different levels of slopes. The deformation law of loess high fill slopes is analyzed, with the aim of benefiting the design and construction of loess high fill slopes in the northwest region [5,6].

3. Methods.

3.1. Principles of Safety Analysis. The PLAXIS 3D software uses the finite element strength reduction method to calculate the overall stability of the slope. In the initial soil strength parameters, the internal friction angle tangent $\tan\varphi$ tangent and cohesion c gradually decrease until the slope undergoes instability and failure, and the slope safety factor and optimal sliding surface position are obtained. The reduced soil strength parameter values in each calculation stage are defined according to the total multiplier $\sum m_s F$, that is Equation (3.1):

$$\sum m_s f = \frac{\tan\varphi}{\tan\varphi_r} = \frac{c}{c_r} \tag{3.1}$$

In the formula, $\sum m_s F$ is the reduced total multiplier; c, φ is the cohesion and internal friction angle of the fill; C_r and φ_r are the reduced cohesion and internal friction angle.

At the beginning of the program calculation, all soil strength parameters are taken as initial values, $\sum m_s F$ =1.0. During the calculation process, the total multiplier $M_s f$ is controlled by the load increment process, and

Table 3.1: Soil Layer Parameters

Soil layer name	severe $(kN \cdot M^{-3})$	cohesionc /kpa	internal friction angle $\varphi/(°)$	Elastic modulus E/mpa	Poisson's ratio u
Plain loess	18	13	21	15	0.33
Loess like silt	18	13.3	21	16	0.4
pebble	23	11	36	85	0.026

the increment multiplier Msf is used to control the reduction of soil strength parameters, that is, $\tan\varphi$ and c are synchronously reduced. The default first step is 0.1. The strength parameters are automatically gradually reduced until all steps are completed, and then the model is checked to see if the slope has reached a complete failure state. If complete failure is achieved, a constant $\sum m_s F$ safety factor F_s is given in the calculation step immediately following the occurrence of failure. From this, Equations (3.2) and (3.3) are obtained.

$$Fs = \frac{\tau m}{\tau b} = \sum M_s f_d \tag{3.2}$$

$$\tau = C + \sigma \tan\varphi \tag{3.3}$$

In the formula, π_m represents the maximum shear strength of the soil when it is not damaged, and τ_b represents the shear strength of the soil when it is in equilibrium; $\sum m_s F$ is the incremental multiplier when the soil undergoes failure; τ is the shear strength of the soil; σ is the normal stress.

3.2. Project Overview. The project is located in a certain section of Longnan City, with a height of 30 meters and a slope ratio of 1:1 for manual slope cutting at section K0+460. It is divided into three levels of slopes, with each level of 10 meters. An unloading platform is set between the slopes, with a width of 3 meters. The site is classified as a Class II site, with a seismic fortification intensity of Class III. The design earthquake group is the second group, and the characteristic period is 0.40 seconds. The site strata are divided into three engineering geological layers from top to bottom, namely the plain fill layer, the Quaternary Holocene loess like silt layer, and the pebble layer. The main mechanical parameters of the site soil layer are shown in Table 3.1.

3.3. Establishing a finite element analysis model. Establish a numerical analysis model using PLAXIS 3D software. The slope height H is 40 meters, the top boundary is 30 meters, the bottom boundary is 16 meters, and the width is 20 meters, which can effectively weaken the boundary influence. Simplify the actual engineering terrain and establish an unsupported three-level fill slope, with the original slope surface steps having a height and width of 3m; 4 meters of unloading platform between slopes; The slope ratio is 2:2. When analyzing the factors affecting stability, modify the height and width of the steps, slope, and unloading platform width based on different conditions, using the Mohr Cou lomb model and Boit consolidation theory, the uniform compaction degree of the filling material is used. The groundwater level in this area is relatively low, so the influence of groundwater is not considered in the simulation process. The boundary condition of the model is a fixed constraint on the bottom surface, which controls the deformation in the c, y, and z directions; Horizontal constraints in the y-direction on both sides of the model; The upper surface deformation is open. During the calculation process, the corresponding filling layer is gradually activated to simulate the real construction process. The slope is filled in three stages, and the first, second, and third filling conditions are used to simulate the first, second, and third layers of slopes with heights of 20, 30, and 40 meters [7,8].

4. Analysis of software calculation results.

4.1. Impact of different c values on slope stability. The variation curve of slope safety coefficient is shown in Figure 4.1 when the value is fixed at 25° and the c values are 10, 20, 30, 40, and 50kPa, respectively. When the cohesion c value is o kPa, the safety factors of the three heights of slopes are not significantly different, all of which are the lowest, and even one layer of slope is less than 0.4. At this point, there is no cohesive force

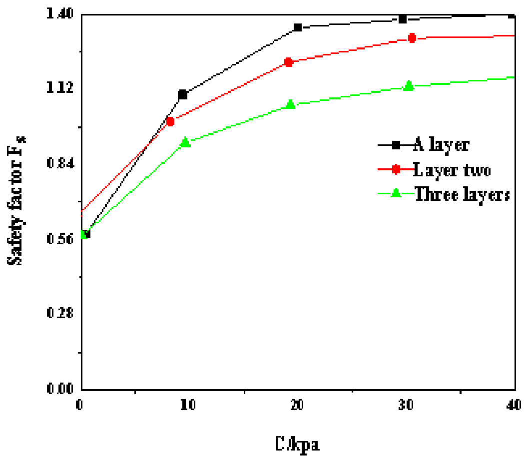

Fig. 4.1: Effect of Cohesion on Safety Factor

inside the filled soil, which is approximately pure sand and gravel, and there is also no cohesive force between it and the original soil. A large amount of filled soil is extremely unstable and very dangerous. When the cohesion c value increases to 10 kPa, the stability of the slope changes greatly, and the safety factor suddenly jumps to twice that of close to 0 kPa. When the cohesion is low, slightly increasing the cohesion of the fill can effectively improve the stability of the slope. Subsequently, as the cohesion increases, the safety factor slowly increases, and the upward trend gradually slows down and tends to stabilize. At this point, the cohesive force reaches a certain limit, which is sufficient to stabilize the slope. Increasing the cohesive force of the fill again has a smaller effect on improving the stability of the slope. When the cohesive force of the fill is less than 2300 kPa, the safety factor of the slope is small and the slope is not stable enough; When the pressure is higher than 30 kPa, the increase in cohesion has a slightly smaller impact on the safety factor. Therefore, it is most reasonable to choose a filler with a cohesive force of 30 kPa.

4.2. Impact of Different Values on Slope Stability. Change the internal friction angle φ value of the filling soil parameter in the model, and analyze the impact of different internal friction angles of the filling soil on slope stability. The above analysis shows that when the cohesive force is 30 kPa, the trend of changes in the slope safety coefficient before and after is more obvious, at this point, a cohesive force of 30 kPa is selected to analyze the impact of different φ values on slope stability. When the value of φ is calculated every 20° from 0° to 60°, the variation curve of the slope stability coefficient is shown in Figure 4.2. When filling the first layer of slope, the height is low, the amount of filling is small, and only the self weight of the soil is sufficient to support the deformation of the slope. The growth of the safety coefficient is gentle, and the change of the internal friction angle φ value has little impact on the stability of the slope. When filling the second and third layers of slopes, the curve increase is basically the same, and the overall safety factor of the third layer slope is slightly lower than that of the second layer slope [9,10]. When the internal friction angle is small, the slope increases linearly due to the large number of layers, high height, large amount of filling, and significant changes in safety factor; After the internal friction angle reaches 20°, the slope tends to stabilize. Increasing the cohesive force of the fill again has a small effect on improving the stability of the slope, and the safety coefficient curve grows slowly. The internal friction angle of the soil is directly proportional to the safety coefficient.

4.3. Impact of boundary changes between fill and undisturbed soil on slope stability. In the filling slope, in order to avoid the formation of sliding surfaces between the filled soil area and the original surface area, the natural ground needs to clean the surface and build steps. The cohesive force c value of the filled soil in the model is 30 kPa, and the internal friction angle φ value is 30°. Analyze the trend of slope

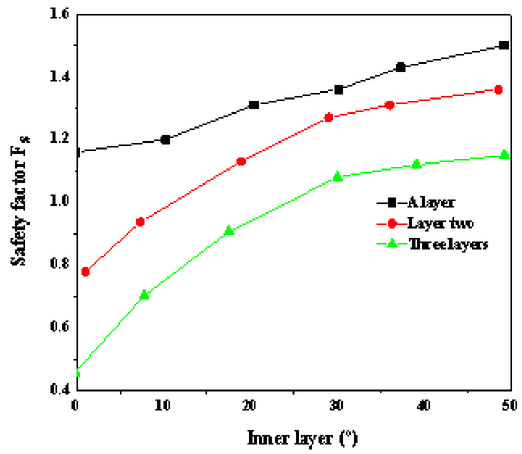

Fig. 4.2: Effect of internal friction angle on safety factor

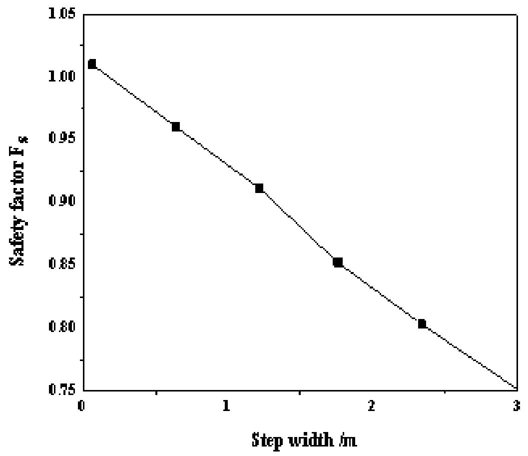

Fig. 4.3: Influence of changing step height on safety factor

stability by changing the height and width of steps at the fill boundary [11,12].

4.3.1. Impact of step height on slope stability. The width of the step is fixed at 1 m, and the height gradually increases to 4 m with a difference of 0.6 m. The safety coefficient variation curve of the three layer slope is shown in Figure 4.3, and the step height shows a linear trend with the safety coefficient of the slope. Due to the fixed width and height of the steps, the original slope angle becomes larger, and the contact interface between the fill and the original soil becomes steeper. The original slope cannot provide good support, and only relying on the gravity and cohesion of the fill itself to support, the safety factor decreases, and the stability of the slope deteriorates. The height of the steps is inversely proportional to the safety factor, and there is no obvious sudden change trend.

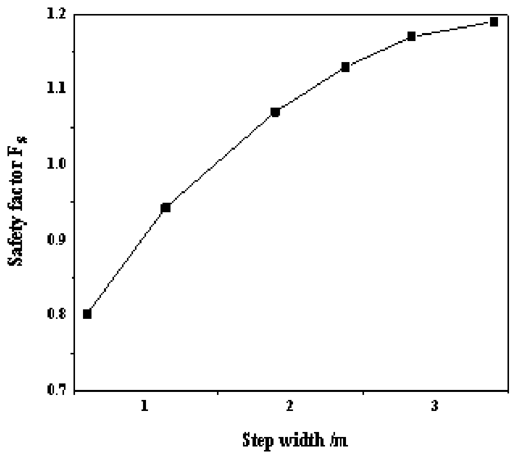

Fig. 4.4: Impact of changing step width on safety factor

4.3.2. Impact of step width on slope stability. The height of the step is fixed at 1m, and the width gradually increases to 4m with a difference of 0.6m. The safety coefficient change curve of the slope is shown in Figure 4.4. When the height of the step is fixed and the width increases, the original slope angle decreases and the slope slows down. The overall curve presents a parabolic shape, with an increase in safety coefficient and a strengthening of slope stability. When the width of the step is small, the amount of filling is small, but the original slope is steep and the support force is insufficient, increasing the width of the step has a significant effect on improving the safety factor of the slope; When the width of the step is greater than 1.6m and the slope angle is less than 34°, the filling amount is large but the slope surface is gentle, and a large amount of soil accumulates on the original slope surface. The original slope surface can provide good support force, which can be balanced by the self weight of the filling and the friction force between the original slope surface. Continuing to increase the step width and slow down the support force provided by the original slope surface is weak, and the safety coefficient increases slowly and tends to stabilize [13,14].

4.4. Impact of Different Slopes on Slope Stability. Change the fill slope in the model, establish a model every 6° from 25° to 90○, and analyze the variation curve of slope stability as shown in Figure 4.5. As the slope increases, the fill surface gradually steepens and the safety factor decreases. When the slope changes between 25° and 45°, the slope of the curve is steeper and the safety factor changes significantly. At this time, changing the slope has a significant impact on the safety factor; When the slope exceeds 38° and changes towards 90°, the slope of the curve gradually flattens out and the rate of safety factor change is small. At this point, changing the slope has a small impact on the safety factor, indicating that the slope has a significant impact on the stability of the fill slope. When the slope is small, changing the slope has a significant impact on the safety of the fill slope. However, when the slope is greater than 38°, the slope continues to increase. Although the safety factor still shows a continuous decreasing trend, the rate of change decreases and gradually tends to be gentle [15,16].

4.5. Impact of different unloading platform widths on slope stability. Change the width of the unloading platform in the model, and establish a model every 0.6 meters from no platform to a 6 meter wide platform. The slope stability change curve is shown in Figure 4.6. As the width of the platform increases, the safety factor continues to increase, presenting a parabolic form as a whole. From no platform to a 0.6 m platform, the slope is decomposed from one whole into three secondary slopes, and the overall damage is dispersed, borne by the secondary slope, significantly improving the overall safety. Subsequently, the platform width continued to increase to 3.6 meters, and the safety factor gradually increased, with a relatively stable

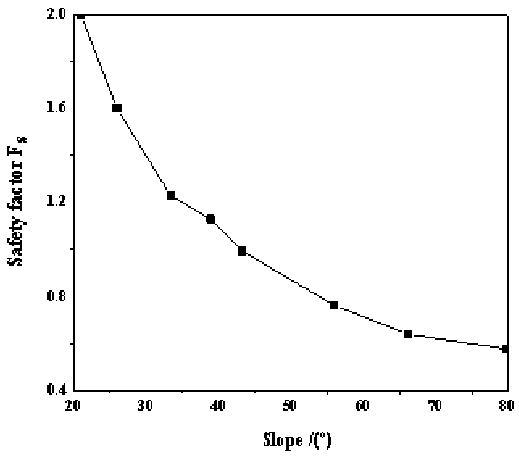

Fig. 4.5: Impact of Changing Fill Slope on Safety Factor

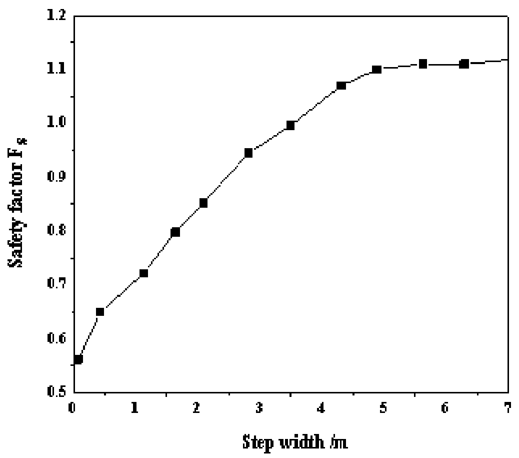

Fig. 4.6: Impact of changing the width of the unloading platform on the safety factor

trend and the curve showing a linear trend.

According to the actual situation of the project, the platform width can be selected within this range. After the platform width is greater than 3.6m, as sufficient platform width has been reached at this point, further increasing the platform width has a small impact on the safety factor, and the curve gradually tends to flatten [17,18].

4.6. Deformation and displacement of various points on the slope during the filling process. Select the original slope top A, fill the third layer of slope top B, slope surface C, and slope foot D, the second layer of slope top E, slope surface F, and slope foot G, the first layer of slope top H, slope surface I, and slope foot J, as well as a total of 13 points K, L, and M inside each layer of filled soil as the analysis objects.

4.6.1. Vertical displacement. When filling the first layer of slope, due to the disturbance of the original slope body during construction, the vertical displacement at the top A of the original slope changes the most. The surface and internal points of the fill gradually increase with the vertical displacement of the first layer of slope construction, and there is a small amount of compaction settlement in the fill. G. The two points H are at the same height, but due to the presence of the unloading platform, the displacement of point G is slightly smaller than that of point H.

Fill the second layer of slope, add an unloading platform in the middle of the two layers of slope, apply the self weight pressure of the filling soil at the slope, and the filling amount reaches more than half of the entire slope. The vertical displacement of point A is effectively controlled, and the settlement increment at each point of the first layer of slope is significantly reduced, tending to be stable. The point G is located at the foot of the second layer of slope, and is affected by the self weight pressure of the second layer of slope filling, resulting in a second settlement phenomenon. The vertical deformation slightly increases, and the points on the first layer of slope are less affected and tend to stabilize. The points D, E, F, and L are located at the key points of the newly added second layer of slope. The consolidation settlement of the fill begins, and the vertical displacement gradually increases with the progress of construction conditions, with a clear curve trend.

4.6.2. Horizontal displacement. The horizontal displacement curves of the filling soil correspond one-to-one with the construction conditions, with an overall trend of displacement towards the direction away from the soil. Only a small portion of the soil in the early stage moved towards the soil. The maximum displacement point is at the foot of the third layer of slope, which is within the maximum displacement required by the specifications.

When filling the first layer of slope, the original slope itself is in a state of consolidation settlement. Point A is at the highest point of the original slope, and the initial filling of the lower layer slope has little impact on it, showing a natural consolidation settlement trend, and a horizontal displacement trend towards the interior of the slope. The horizontal displacement of each point on the first layer of slope gradually increases with the working conditions, and the deformation at the shoulder is guided by vertical displacement. The horizontal displacement changes little. The vertical displacement at the foot of the slope is supported by the lower undisturbed soil layer, and the change is small. The upper part is squeezed by the vertical settlement of the newly added fill, and horizontal thrust is applied. The horizontal displacement increases rapidly towards the outer side of the slope. As the height of each point on the first layer of slope decreases, the displacement gradually decreases.

When filling the second layer of slope, a large amount of soil was filled at the bottom, and a horizontal thrust was applied to the original slope. The displacement of point A towards the inside of the slope was affected, resulting in a trend of displacement towards the outside of the slope. At this point, the settlement trend of the first layer of slope is similar to vertical displacement and tends to stabilize. E. The F and L points are located at the key points of the second layer of slope. At the beginning of the filling condition of the second layer of slope, the filling soil was not stable, and the horizontal displacement suddenly increased to 6 mm. In the later stage, the trend was relatively slow, and the displacement gradually increased.

During the construction period of filling the third layer of slope, the increased filling pressure slightly slowed down the displacement trend of point A towards the outside of the slope. After the construction was completed, the compaction degree of the filling gradually increased, and the horizontal displacement of point A rapidly increased with the newly filled third layer of slope towards the outside of the pit. The horizontal displacement trend of each point on the first layer of slope continues to the filling condition of the second layer of slope, slightly increasing, and overall stabilizing. Points D, E, F, and L produce horizontal creep deformation under the large sliding thrust of the third layer of slope, and the displacement trend is similar to the vertical displacement change trend. During construction, the sudden change trend of points stops, and gradually increases after completion. The displacement trend of each point on the third layer slope during construction is similar to the vertical displacement trend, and after completion, consolidation settlement and creep continue to occur under high self weight stress. At this time, it is the period of post construction settlement of the fill slope. The fill has a large self weight, a long consolidation time, and a large amount of displacement change. In addition, external factors in the later stage are prone to deformation, cracks, and even landslides and collapses [19,20].

5. Conclusion. Based on actual engineering, numerical simulations were conducted on loess high fill slopes in the northwest region to study the factors affecting slope stability, simulate actual filling conditions, and analyze the deformation patterns of displacement at various points on the slope. The conclusions obtained are as follows:

1. The cohesion of soil, internal friction angle, boundary between fill and undisturbed soil, slope, and width of unloading platform all have significant effects on the safety factor of loess high fill slopes. The relationship curves between soil cohesion, internal friction angle, step width, and unloading platform width and slope stability all exhibit a parabolic form. When the values are small, increasing their values significantly improves slope stability; When the numerical value is large, further increase has a small impact on slope stability. The height of the step, the slope of the fill, and the safety factor show an inverse trend. Increasing the height of the step and the slope of the fill will cause a decrease in slope stability.
2. During the filling period of the first and second layer slopes, there is a significant sudden change in vertical displacement, and the impact of consolidation settlement is relatively small after the construction is completed; During the filling period of the third layer slope, there is a significant difference in the vertical displacement mutation at different points. In the later stage, the soil gradually consolidates and settles, resulting in a large amount of deformation. It is necessary to strengthen deformation monitoring of the lower layer slope during slope construction, and strengthen deformation monitoring at the top of the high-rise slope after construction is completed.
3. During the filling period of the first layer of slope, the horizontal displacement is small and the growth is slow. After the filling is completed, other working conditions have little impact on it; During the filling period of the second and third layers of slopes, there is a significant sudden change in horizontal displacement. After the construction is completed, the consolidation settlement period is long, the deformation trend is obvious, and the displacement is large. In the later monitoring, it is necessary to pay attention to the horizontal displacement of each point in the middle layer of the slope.

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