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Study on the Influence of Hydrodynamic and Morphological Factors on the Stability of Reservoir Landslide

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Abstract: *This paper took the reservoir landslide as the research object, and analyzed the influencing factors of the stability of reservoir landslides, and determined the influencing factors as the ratio (k/v) of k (i.e., permeability coefficient) to v (i.e., reservoir water-level rise and fall rate) and slope morphological factors (slope shape, slope angle, slope overburden thickness). In this paper, by combining different combinations of the above factors with orthogonal tests and numerical simulation, the characteristics and laws of landslide stability and displacement evolution were studied. The sensitivity ranking of the factors affecting slope stability coefficient and displacement is k/v > slope angle > slope shape > slope overburden thickness and k/v > slope overburden thickness > slope shape> slope angle, respectively. Then, this paper took k/v as the main factor and slope angle, etc. as secondary factors and focused on analyzing the influence law of different reservoir water-level decline changes on the slope stability and displacement evolution.*

Keywords: *Reservoir landslide, k/v, Morphological elements of slope, Orthogonal experiment, Stability*

1. Introduction

As a large-scale, widely distributed, and catastrophic soil landslide, reservoir colluvial landslide is a kind of landslide that occurs in the loose mound formed by the Quaternary and recent geological action on the bank of the reservoir [4]. For this kind of landslide, the structure of such landslide is loose and porous, and the mechanical properties are obviously changed by hydrodynamic influence. In China, reservoir colluvial landslide not only occupies a considerable proportion of landslides but also is the principal type of landslide in China. As China's Three Gorges Project was completed, the natural geological conditions of the reservoir bank and the operating water environment in its area were changed. Under the combined effect of geological conditions and water-level changes, it will increase the frequency of landslides [3]. Water is the most important and active factor of landslide. Among all reservoir hydrodynamic factors, the coupling of the permeability coefficient (k) in the slope and the rate of water-level rise and fall (v) outside the slope directly determines the characteristics and patterns of changes in the seepage field, stress field, and displacement field in the slope, thus profoundly affecting the stability and evolution pattern of this kind of slope. In addition to the above hydrodynamic factors, morphological factors of the slope are also important influencing factors leading to landslides. The influence of morphological factors of the slope, including slope shape, slope angle, and slope overburden thickness, on the stability of the slope cannot be ignored.

In recent years, domestic and foreign research on the hydrodynamic and morphological factors of the reservoir landslide has made great progress in the study of the characteristics and influence laws on its stability. For example, Desai (1977) [2], Lane (2000) [6] obtained the reservoir slope catastrophe law under the reservoir water-level drop condition by using the finite element numerical calculation method. Viratjandr (2006) [14] took the soil slope as the object of study and analyzed the change law of slope stability under the condition of reservoir water decline. Bonzanigo et al. (2006) [1] introduced rheological theory to express the characteristics of the reservoir slope from creeping slowly to the final instability, and believed that water plays a key role in the process of slope displacement. You (2006) [16] focused his research on stability analysis of soil landslides based on the basic principle of the variational method, and then calculated the slope height and slope angle thresholds for slope instability. Timpong et al. (2007) [13] used a centrifugal model test to prove that the change of the groundwater

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level in the reservoir slope has a certain impact on its stability. Picarelli (2007) [9] found that the change of pore water pressure caused by reservoir impoundment controls slope displacement and mechanical change behavior. Zhang et al. (2011) [17] determined the influence law of slope height, slope angle, and slope shear strength parameters on the stability of landslides in loess areas through finite element calculations, respectively. Singh et al. (2012) [12] found that supersaturated slope bodies, soft rocks, and soils with high absorption and swelling properties, and high slope angles are the main causes of reservoir landslides based on case studies of reservoir landslides. Liang and Chen (2012) [7] analyzed the distribution law of the infiltration line of landslides with different permeability coefficients under the effect of the rise and fall of the reservoir water-level and the resulting changes in landslide stability, which showed that the changes in the stability of water-related landslides in the reservoir area are closely related to their permeability coefficients. Paronuzzi et al. (2013) [8] found that the stability of the reservoir slopes is strongly influenced by the rate of reservoir water-level fluctuations and the permeability of the reservoir slope.Yang et al. (2017) [15] found that the annual variation of landslide stability tends to coincide with the change of reservoir water level. Hu et al. (2019) [5] found that during reservoir water drawdown, continuous infiltration reduces slope stability by dissipating matric suction, increasing pore water pressure, and weakening shear strength. Shen (2022) [10] demonstrated reservoir water level changes significantly affect pore water pressure below the water table (minimal impact above) and exert inverse effects on slope stability versus pressure measurements. Zhang (2024) [11] further identified steeper slopes parameters as direct stability influencers, with faster drawdown rates correlating to lower minimum safety factors.

From the above research status at home and abroad, it can be seen that previous scholars have accumulated a large number of studies on the stability of landslides under reservoir water rise and fall conditions. However, the current existed research still lacks a systematic understanding of landslide stability evolution law. Although the influence of reservoir water-level rise and fall rate "*v*" and permeability coefficient "*k*" on the stability of the slope has been considered in the research process, these studies often lack the consideration of the influence of the coupling of internal and external hydrodynamics (*k* and *v*) of the slope on its stability evolution law. Moreover, they lack the coupling research and analysis of internal and external hydrodynamics and morphological factors of the slope. Therefore, this paper established the coupled internal and external hydrodynamic evaluation parameters (*k*/*v*) of landslides by organically coupling the internal and external hydrodynamics (*k*, *v*) of the slope. In addition, this paper also determined the influence of each slip-causing factor on the stability and displacement of the slope by combining its morphological factors of the slope (slope shape, slope angle, slope overburden thickness). Moreover, this paper also focused on the influence law of different reservoir water-level declines on the stability and displacement of the slope, taking *k*/*v* as the main slip-causing dynamic factor.

2. Sensitivity analysis of factors influencing the stability of reservoir colluvial landslides

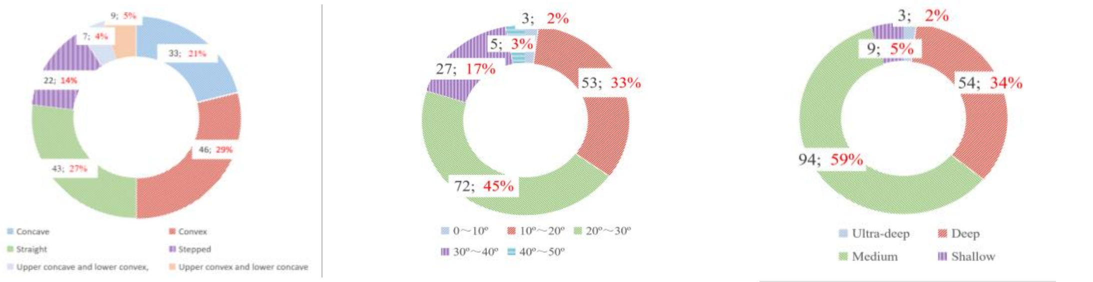
2.1 Selection of the finite element calculation model and related parameters

Under the action of reservoir hydrodynamics, the hydrodynamic coupling parameter *k*/*v* has a direct loading or unloading effect on the slope, which influences the stability of the slope. According to the engineering analogy method, the geological situation of the colluvial landslide in the Three Gorges Reservoir area is synthesized by analogy. It is well known that the permeability coefficient of the accumulation mass in the Three Gorges Reservoir area is between 10^{-4}-10^{-6} m/s magnitude. For the convenience of calculation, the permeability coefficients of k=1.04×10^{-4} m/s, k=1.04×10^{-5} m/s, and k=1.04×10^{-6} m/s are chosen for the study in this paper. According to the reservoir water scheduling scheme of Three Gorges Reservoir, the falling rate parameter *v* is selected as 1.0 m/d (slow falling rate), 1.5 m/d (fast falling rate), and 3.0 m/d (falling rate during the regulated flood). Their *k/v* under different working conditions are given in Table 1.

Table 1. Comparison relationship of k and v under different working conditions

v / k/v / k	1.0/ (m d)	1.5/ (m d)	3.0/ (m d)
1.04×10^{-4} (m s)	9	6	3
1.04×10^{-5} (m s)	0.9	0.6	0.3
1.04×10^{-6} (m s)	0.09	0.06	0.03

According to the statistical analysis of the samples of 160 landslides in 16 districts and counties of the Yangtze River mainstream and major tributaries in the Three Gorges Reservoir area, the slope shape is divided into 6 types: concave, convex, straight, upper concave and lower convex, upper convex and lower concave, and stepped; the slope angles were classified into 5 intervals: 0~10°, 10°~20°, 20°~30°, 30°~40°, and 40°~50°; the slope overburden thickness was classified into 4 categories: shallow (within 10 m), medium (10 m-25 m), deep (25 m-50 m) and ultra-deep (more than 50 m). The number of landslides for each type of slope morphological element and its proportion to the total sample size was determined statistically and shown in Figure 1. By analyzing the sample statistics, it was found that slopes with concave, straight, and convex slopes, slopes with slope angles between 10° and 40°, and slopes with medium and deep overburden thickness were more developed and had a higher probability of landslides. Therefore, the combination of the slope with a higher percentage of landslides is selected as the numerical simulation condition, and the selected morphological factors of the slope are concave slope, straight slope, and convex slope; slope angles of 15°, 25°, and 35°; slope overburden thickness of 18 m, 38 m, and 58 m.



(a)Slope shape *(b)Slope angle* *(c) Slope overburden thickness*

Figure 1. Number and proportion of different morphological factors of the slope distribution (number of landslides; proportion)

2.2 Sensitivity analyses of slip-causing factors based on orthogonal test

According to the basic theory of orthogonal test design, this paper analyzes *k/v* and its slope shape, slope angle, and slope overburden thickness by orthogonal test. By establishing an orthogonal table and the solution of extreme difference, the above four factors are ranked according to sensitivity magnitude.

Table 2. Orthogonal table L9(34) and its calculation method

Test number		Test factors				Test index
		Slope shape	Slope angle (°)	Slope overburden thickness (m)	k/v	
1		1	1	1	1	Y1
2		1	2	2	2	Y2
3		1	3	3	3	Y3
4		2	1	2	3	Y4
5		2	2	3	1	Y5
6		2	3	1	2	Y6
7		3	1	3	2	Y7
8		3	2	1	3	Y8
9		3	3	2	1	Y9
Test index	K1=Ij	I1=Y1+ Y2+Y3	I2=Y1+ Y4+Y7	I3=Y1+ Y6+Y8	I4=Y1+ Y5+Y9	N.A.
	K2=IIj	II1=Y4+ Y5+Y6	II2=Y2+Y5+ Y8	II3=Y2+Y4+ Y9	II4=Y2+Y6 +Y7	
	K3=IIIj	III1=Y7+Y8+Y9	III2=Y3+Y6+ Y9	III3=Y3+Y5+ Y7	III4=Y3+Y4 +Y8	
	k1=Ij/t	I1/t	I2/t	I3/t	I4/t	
	k2=IIj/t	II1/t	II2/t	II3/t	II4/t	
	k3=IIIj/t	III1/t	III2/t	III3/t	III4/t	
	R	Rj=max{Ij/ kj, IIj/ kj ,… }-min{Ij/ kj, IIj/ kj ,… }				

(1) Basic theory of orthogonal test design

The orthogonal test is based on the orthogonal theory. Based on the selected orthogonal table,

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select a small number of representative, uniform, balanced and comparable factors from a large number of test factor combinations to calculate the test indexes. We can rank the sensitivity of each test factor to the test index through range or variance calculation, so as to realize the objective evaluation of the test index with the minimum number of variable changes. The specific steps are as follows: 1) We first select a suitable orthogonal table denoted as $L_n(t_m)$. Each letter here has a clear definition: "L" represents the designation of the orthogonal table, "n" refers to the reduced number of experiments, "m" stands for the number of factors, and "t" indicates the number of levels (i.e., the number of possible states for each factor). 2) After filling each influencing factor and its corresponding levels into the table in accordance with the labels of the orthogonal table, we conduct calculations for each experiment one by one, and obtain the experimental results for each factor combination, which are referred to as experimental indicators. Calculate the extreme difference of each factor, and the ranking of the sensitivity of each factor in the test results is the ranking of the size of the extreme difference of each factor. Table 2 shows the orthogonal table $L_9(3^4)$, and its polar difference calculation method is given in Table 2.

(2) Ranking of slip-causing susceptibility factors for reservoir colluvial landslides

In this paper, GeoStudio software is used to establish a two-dimensional plane model of the colluvial landslide, which is divided into 2 layers. The upper layer of the accumulation's physical and mechanical parameters is taken according to the physical and mechanical parameters of a typical reservoir landslide, i.e., the Shuping landslide. Lower overlying bedrock layer is set as an impermeable layer, and its morphological parameters are taken according to different slope morphological factors. The saturation permeability coefficient of the slope is taken as k=1.04×10^{-4} m/s, k=1.04×10^{-5} m/s, and k=1.04×10^{-6} m/s, respectively. The period of slope numerical simulation analysis is that the reservoir water-level drops from 175 m to 145 m, and the slope variable head boundary conditions are 1.0 m/d, 1.5 m/d, and 3.0 m/d (each period lasts for 30 d, 20 d, and 10 d), respectively. The calculation models for different working conditions are shown in table 3, 4 and 5. The values of slope material parameters were taken as showed in Table 6.

Table 3. Finite element calculation model of convex slope under different working conditions

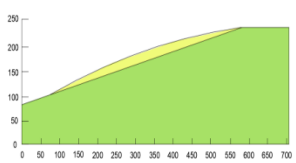
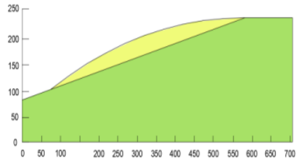
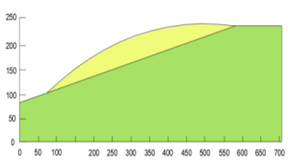
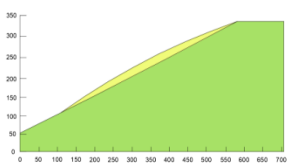
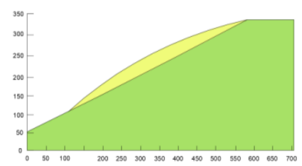
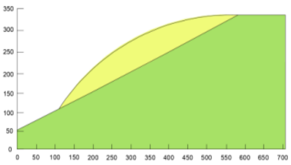
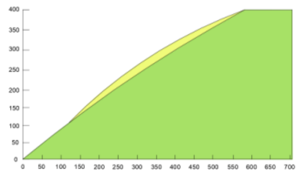
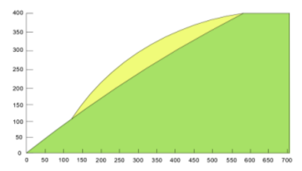
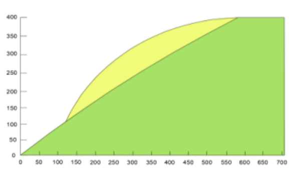
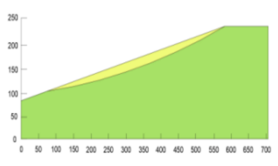
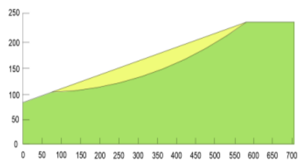
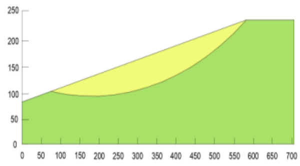
Average slope overburden thickness/(m)		18	38	58
Slope angle/ (°)	15			
	25			
	35			

Table 4. Finite element calculation model of concave slope under different working conditions

Average slope overburden thickness/(m)		18	38	58
Slope angle/ (°)	15			

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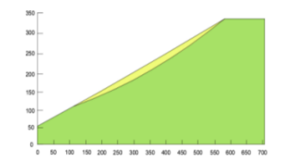
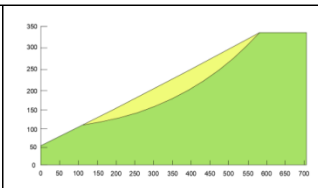
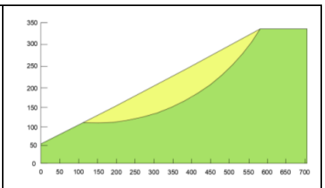
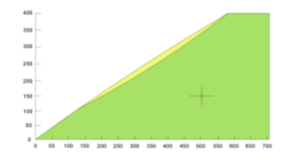
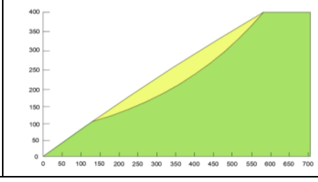
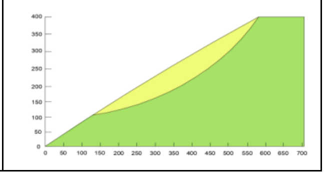
	25			
	35			

Table 5. Finite element calculation model of straight slope under different working conditions

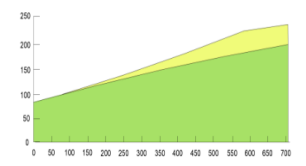
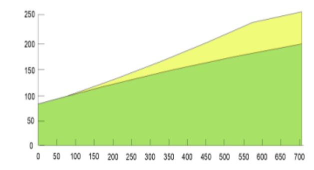
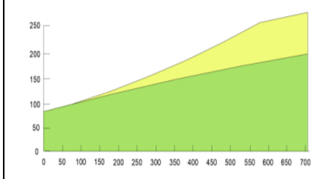
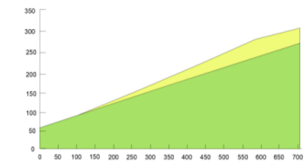
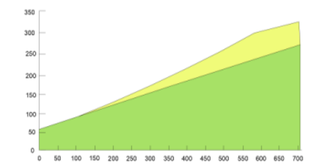
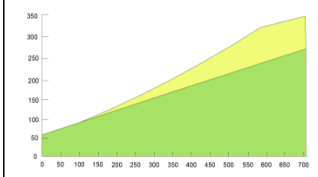
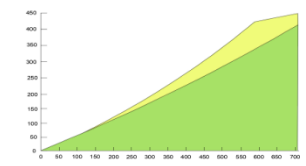
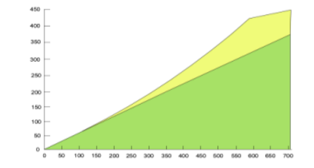
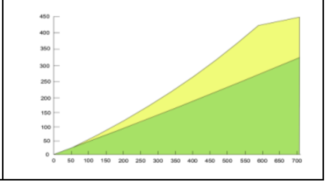
Average slope overburden thickness/(m)		18	38	58
Slope angle/ (°)	15			
	25			
	35			

Table 6. Values of the slope material parameters

Rock and soil properties	E/Mpa	μ	c/Kpa	φ/°	γ / (KN•m^{-3})	γ_{sat} / (KN•m^{-3})
Accumulation soil	0.12×103	0.35	30	30	20.2	22.4
Bedrock	5×103	0.22	45	42	25.0	26.0

Table 7. Orthogonal test scheme and numerical simulation calculation results statistics

Test number		Test factors				Test index	
		Slope shape	Slope angle (°)	Cover thickness (m)	k/v	Slope displacement at 160 m (cm)	Stability factor
1		convex	15	18	9	16.94	2.095
2		convex	25	38	0.6	23.31	1.395
3		convex	35	58	0.03	19.16	1.075
4		straight	15	38	0.03	24.97	1.185
5		straight	25	58	9	23.54	1.560
6		straight	35	18	0.6	10.82	1.201
7		concave	15	58	0.6	28.72	1.218
8		concave	25	18	0.03	11.49	1.139
9		concave	35	38	9	19.81	1.518
Stability factor	K1	4.565	4.498	4.435	5.173	N.A.	
	K2	3.946	4.094	4.098	3.814		

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	K3	3.875	3.794	3.853	3.399	
	k1	1.522	1.499	1.478	1.724	
	k2	1.315	1.365	1.366	1.271	
	k3	1.292	1.265	1.284	1.133	
	R	0.230	0.234	0.194	0.591	
Slope displacement at 160 m elevation/cm	K1	6.028	5.940	7.063	3.925	N.A.
	K2	6.285	5.933	5.833	6.809	
	K3	5.562	6.002	4.978	7.141	
	k1	2.009	1.980	2.354	1.308	
	k2	2.095	1.978	1.944	2.270	
	k3	1.854	2.001	1.659	2.380	
	R	0.241	0.023	0.695	1.072	

Taking the above-mentioned *k*/*v* and its slope shape, slope angle, and slope overburden thickness as the landslide sensitivity factors, three levels of each factor are selected, and the orthogonal test is used to simulate the evolution law of landslide displacement and stability under different combination conditions. The slope stability coefficient of the above-mentioned nine tests and the displacement at 160 m slopes are calculated, respectively (Table 7). Through the comprehensive analysis of the data in the table, the influence degree of each landslide sensitivity factor on the test indexes, i.e., stability coefficient and displacement, was determined as follows: 1) The sensitivity of the stability coefficient was ranked as follows: *k*/*v* > slope angle > slope shape > slope overburden thickness. 2) The displacement's sensitivity was ranked as follows: *k*/*v*> slope overburden thickness > slope shape > slope angle.

Sensitivity analysis shows variability in test indices' responses to four slip-causing factors. R-value comparison reveals hydrodynamic condition k/v has a dominant influence on slope stability and displacement (extreme difference far exceeding slope shape, angle, and overburden thickness). The latter three factors exhibit similar range, indicating comparable impacts on stability and displacement. Further analysis shows slope angle and shape have greater influence on stability coefficient than overburden thickness; overburden thickness affects displacement more significantly, while slope angle has minor displacement impact relative to other factors.

3. Case study

This paper takes Bazimen landslide as an example and selects *k*/*v* as the main slip-causing dynamic factor for the instability of reservoir colluvial landslide, and systematically analyzes the influence law of different reservoir water-level decline changes on the slope stability and displacement.

3.1 Project Overview

The Bazimen landslide is a typical reservoir colluvial traction landslide with irregular fan-shaped morphology (Figure 2). Its slope material consists mainly of clayey soil-sandwiched stone blocks, overlying interbedded J1x sand shale, sand mudstone, and quartz sandstone bedrock. Key parameters: length 450 m, front/rear edge elevations 70/260 m, average thickness 15 m; front slope angle 20-25°, middle-rear 35-40°. Long-term reservoir water action affects its stability, with monitoring section I showing slope structure/composition in Figure 2.

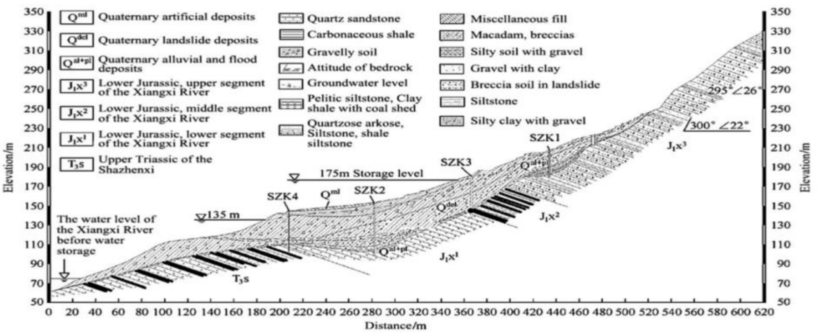

Figure 2. Engineering geological profile of Bazimen landslide monitoring section I

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3.2 Numerical simulation of stability coefficients and displacement fields under different k/v hydrodynamic conditions in Bazimen landslide

In this paper, a generalized numerical simulation model was established using Geo-studio software with Bazimen landslide monitoring section I as a prototype (Figure 3). The values of its slope material parameters were taken as showed in Table 6. The saturation permeability coefficients of the slides were taken as k=1.04×10^{-4} m/s, k=1.04×10^{-5} m/s, and k=1.04×10^{-6} m/s, respectively. The slope is simulated from 175 m to 145 m, and the slope head variation boundary conditions are established by using the slope water-level drop rate of 1.0 m/d, 1.5 m/d, and 3.0 m/d (lasts 30 d, 20 d, and 10 d, respectively) as the slope head variation boundary conditions. The Geo-studio software SEEP/W, SLOPE/W, and SIGMA/W modules were utilized to analyze the variation law of stability coefficient and displacement field under the changing conditions of reservoir water in Bazimen landslide.

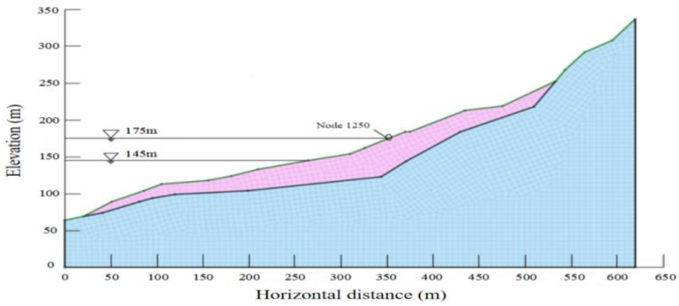

Figure 3. Numerical simulation generalization model of Bazimen landslide

(1) Calculation analysis of landslide stability coefficients under different *k*/*v* hydrodynamic conditions

By using SLOPE/W coupled with SEEP/W module to analyze the stability of Bazimen landslide, the changing pattern of its reservoir level from 175 m to 145 m slope stability coefficient under different *k*/*v* hydrodynamic conditions were analyzed respectively, as showed in Figure 4.

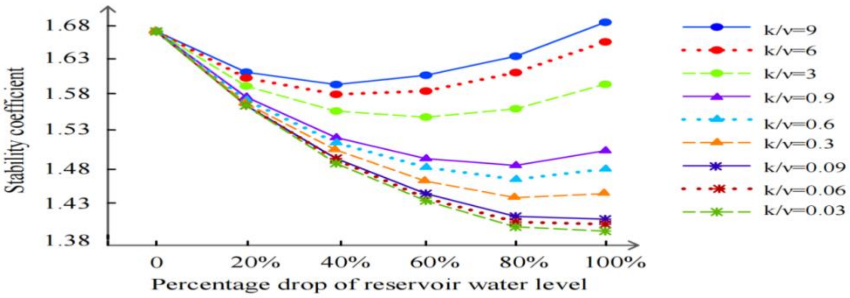

Figure 4. Time-series curve of slope stability when the reservoir water-level decreases

As can be seen from Figure 4:

1) The slope stability coefficient is positively correlated with *k*/*v*. Under the same conditions, the larger *k*/*v* is, the higher the landslide stability coefficient is, and the more stable the slope is.

2) When *k*/*v* is much less than 1, and the slope stability coefficient gradually decreases with the decline of water-level. With the increase of *k*/*v*, the slope stability coefficient begins to show an inflection point in the process of reservoir water-level decline. That is, the slope stability coefficient shows a decreasing trend with the decline of reservoir water-level, but when it drops to the extreme value point, the slope stability coefficient starts to increase slowly again. From 175 m to 145 m, the slope stability coefficient decreases first and then increases, which indicates that the slope has experienced two processes of loading and unloading in the process of reservoir water decline: the loading process is in the early stage of water-level decline, and the unloading process is in the middle and late stage of water-level decline. The main reason for this phenomenon is that the generalized model in the numerical simulation is based on the Bazimen landslide, which has a gentler front edge and middle section of the landslide bedrock and a steeper back edge, and the 145 m water-level line is at the back of the middle section, so the reduction of buoyancy on the slope at the beginning of the reservoir water drop is greater than the increase of matrix suction in the part above the infiltration line,

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which makes the landslide stability coefficient lower. At a later stage, due to the gradual increase of the unsaturated area, c and φ increase, making the anti-slip force gradually increase, while the floating support weight loss effect gradually weakened, and its slide force increase is relatively small, especially after the infiltration line reaches the middle section of the landslide and the front edge of the more gentle anti-slip section, making the increase of the anti-slip force is greater than the increase of the slide force so that the landslide stability coefficient gradually increased.

3) With the increase of *k*/*v*, the inflection point of slope stability coefficient from low to high also changes under the combined effect of hydrodynamic force and slope shape. That is to say, the larger the *k*/*v* is, the earlier the inflection point appears, and the reservoir water-level corresponding to the minimum stability coefficient is gradually increasing. Therefore, based on the relationship between *k*/*v* and slope stability coefficient during the decline of reservoir water-level, the stability of the slope at the most dangerous water-level can be judged. When the stability coefficient of the slope corresponding to the most dangerous water-level does not reach the safety coefficient, the rate of reservoir waterfall can be regulated to ensure the stability of the landslide within the range of reservoir water regulation.

(2) Calculation analysis of landslide displacement field under different *k*/*v* hydrodynamic conditions

The dissipation of pore water pressure in Bazimen landslide under the action of reservoir water was analyzed by using SIGMA/W coupled with SEEP/W module for consolidation settlement displacement, and the node 1250 in the landslide with a large change of front displacement was selected as the research object, the variation law of the reservoir water-level from 175 m to 145 m under different *k*/*v* hydrodynamic conditions is analyzed, and its displacement change trend is shown in Figure 5.

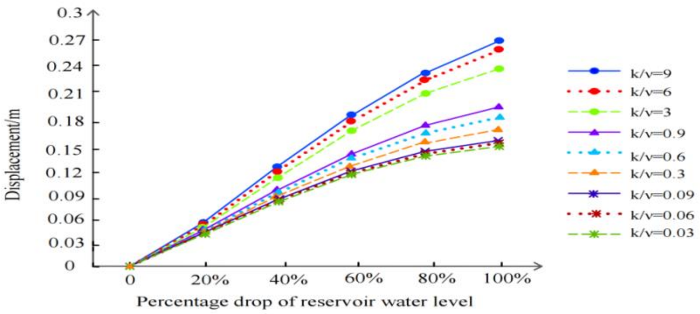

Figure 5. Time-series curve of slope displacement when the reservoir water-level drops

As can be seen in Figure 5:

1) In the process of reservoir level decline, the settlement displacement of the slope gradually increases as the pore water pressure gradually dissipates.

2) The slope settlement displacement value is positively correlated with *k*/*v*. The larger *k*/*v* is, the larger the slope settlement displacement is within the same reservoir water-level drop range. This is because the process of slope consolidation and settlement is essentially the process of gradual dissipation of pore water pressure, and its consolidation and settlement rate depends on the slope permeability coefficient and drainage path, the larger the permeability coefficient, the smaller the rate of reservoir water-level drop. In other words, the larger the *k*/*v* is, the faster the pore water pressure dissipates, the faster the consolidation settlement rate is, thus making the settlement displacement larger within the same reservoir water-level drop.

3) By comparing the stability change law in the process of slope reservoir water-level decline, it is found that the consolidation settlement displacement and slope stability are positively correlated, which is because the consolidation settlement displacement in the process of slope pore water pressure dissipation is not the overall sliding deformation of the slope, and the change of consolidation settlement displacement does not represent the development trend of slope stability. Therefore, if the consolidation deformation is treated as the overall slope slip, it is easy to misjudge the slope stability when judging the slope stability only according to the change law of slope displacement.

4. Conclusion

On the basis of the analysis above, some conclusions can be made as follows:

(1) In this paper, the internal and external hydrodynamic forces (*k*, *v*) of the slope are organically coupled, and the evaluation parameters (*k*/*v*) of the internal and external hydrodynamic forces of the landslide are established. The influencing factors of the slope stability are determined as *k*/*v* and the morphological factors of the slope. Through the statistical analysis of the Three Gorges Reservoir area colluvial landslide samples, a representative combination of *k/v*, slope shape, slope angle, and slope overburden thickness was selected as its numerical simulation conditions, and the orthogonal test was combined to study the characteristics and laws of landslide stability and displacement evolution, and it was found that the slip-causing factors affecting the stability of reservoir slopes were mainly *k/v* and morphological factors of the slope (slope shape, slope angle and slope overburden thickness), and the sensitivity ranking of factors affecting the stability coefficient and displacement of the slope are *k/v* > slope angle > slope shape > slope overburden thickness and *k*/*v*> slope overburden thickness > slope shape > slope angle, respectively.

(2) The orthogonal test results show that the influence of hydrodynamic conditions *k/v* on slope stability and displacement is dominant, and its influence is much better than that of slope shape, slope angle, and slope overburden thickness. Further analysis of the influence of slope shape, slope angle, and slope overburden thickness on the sliding factors shows that the influence of slope angle and slope shape on the slope stability coefficient is close to each other, and their influence is greater than that of overburden thickness. The change of slope overburden thickness has a greater influence on the slope displacement value, and the slope angle has minor influence on the slope displacement compared with other landslide factors.

(3) In this paper, taking Bazimen landslide as an example, *k/v* is selected as the main slip-causing factor for the instability of reservoir colluvial landslide, and the effect law of different reservoir water-level drop changes on the stability and displacement of the slope is systematically analyzed. The calculation results show that: 1) the stability coefficient of the slope is positively correlated with *k/v* under the same conditions, the larger *k/v* is, the higher the stability coefficient of the slope is, and the more stable the slope is. With the increase of *k/v*, the inflection point will appear in the change curve of slope stability coefficient during the decline of reservoir water-level, and the larger *k/v* is, the earlier the inflection point will appear. That is, the minimum stability coefficient corresponds to the reservoir water-level is gradually increasing. 2) During the decline of reservoir water-level, the landslide consolidation settlement displacement gradually increases, and its displacement value is positively correlated with *k/v*. The larger *k/v* is, the larger the slope consolidation settlement displacement is. The settlement displacement in the process of pore water pressure dissipation does not represent the overall slip deformation of the slope, so when judging the stability of the slope only according to the change law of the slope displacement in this process, if the consolidation deformation is taken as the overall slip of the slope, it is easy to cause misjudgment.

Acknowledgments

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