Limit equilibrium method and strength reduction in stability analysis of tailings dam in the different stack heights

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Abstract. To analyze the impact of stress and seepage field coupling effect on the stability of the tailings dam, Finite element analysis software MIDAS-GTS, build analytical models Mohr-Coulomb criterion. Coupling of different pile heights than the stress field and seepage field analysis of the tailings dam at the same slope, by limit equilibrium method and finite element analysis of tailings dam stability strength reduction. By comparing the results of the analysis showed that the two methods: In the same conditions, the limit equilibrium method and finite element strength reduction conclusion is consistent; Meanwhile in the slope ratio unchanged, with an in-crease in the accumulation of the tailings dam damdam safety factor decreases, is not conducive to the tailings dam safety. The results for the tailings dam design and practical use has a certain value.

1. Introduction

As a permeable tailings dam dam, Tailings dam is a special industrial building (structure) building materials, It is one of the three basic mining engineering [1]. Tailings operations related to the quality of not only its own mine production safety and economic benefits, but also with the lives and property of residents and the surrounding environment downstream reservoir area are closely related, so the study has important implications for the stability of the tailings. Many scholars study the stability of the tailings dam by the reliability [7], the finite element method, Sweden circular arc method, Bishop Method, briefing method and other methods of fractal geometry. According to "Tailing Dam geotechnical engineering and technical specifications", "tailings safety technology." and other relevant technical requirements. A proposed tailings dam project in Yunnan Province by MIDAS-GTS software using limit equilibrium method and finite element strength reduction was carried out security and stability analysis.

2. Tailings Project Overview

A proposed tailings dam upstream type using natural alluvial tailings law, Library and outside the flood take decontamination triage mode. The total height of the tailings 175.00m, eventually accumulate elevation 2500.00m, a total capacity of 60,359,700 m3. According to the relevant provisions of "tailings safety technology" which is rated two tailings. Early in the tailings dam is a pile dam, dam crest elevation of the early 2380.00m, dam bottom elevation of 2325.00m, height of 55.00m (Text only foundation excavation depth), the dam axis length of 163.47m, crest width 8m, on the downstream slope is 1: 2.0. The final design fill dam elevation 2500.00m, stacking height of 120.0m, slope ratio of 1: 4, deposited beach slope ratio of 1: 100. The tailings dam dam accumulation of silt from the tail, the tail silt, silty clay end of three layers, and each layer of the physical and mechanical properties of the tailings index values in Table 1.

Tailings dam stability analysis. Stability Analysis tailings dam is an important part of its evaluation of the stability of the current sliding stability analysis includes limit equilibrium method and finite element methods. Which limit equilibrium method, including Sweden arc method, simplified Bishop method, Janbu method [6]. Finite element method mainly refers to strength reduction [2], also known as the shear strength reduction strength reduction method to reduce the strength parameters. In this study, the safety factor against sliding fluid-solid coupling theory [3], based on limit equilibrium method and strength reduction of sliding stability of the tailings dam were

analyzed, tailings dam solving, evaluation limit equilibrium method and intensity fold the validity of subtraction in tailings stability against sliding analysis.

Table 1 mechanics parameters of tailings material

Index / Geotech-nical name	Severe	Static		Shear Strength		Permeability coefficient	
		Elastic Modulus	Poisson's ratio υ	Effective stress		Level Kh	Vertical Kv
	γ(KN/m^3)	E(MPa)		C′ (KPa)	Φ′ (°)	cm/s	cm/s
Tailings sand	21.6	48	0.40	5	35	6.74×10^{-4}	5.64×10^{-4}
Tail silt	21.3	52	0.40	15	33	1.79×10^{-4}	1.17×10^{-4}
Tail silty clay	20.9	36	0.42	10	27	6.3×10^{-7}	4.05×10^{-7}
Rockfill dam	22	500	0.32	10	37	2×10^{-2}	2×10^{-2}
Bedrock (mountain)	26.5	12000	0.22	/	/	/	/

3. tailings dam stability analysis

3.1 tailings dam seepage model

Established according to the typical geological section tailings finite element model, taking the center of the largest section of the tailings dam as a research object, the top beach tailings deposition of tailings beaches, the accumulation slope surface, beginning at the top of the dam and the dam downstream slope early identified as permeable boundary surface, the reservoir area identified as impermeable bedrock boundary. Since the tailings are two tailings, according to "tailings safety technology" requirement under normal conditions of minimum safe dry beach length of 150m. In order to analyze the stability of the tailings dam development trends in its different stack heights, the establishment of the tailings dam using MIDAS-GTS software generalized finite element model shown in Figure 1.

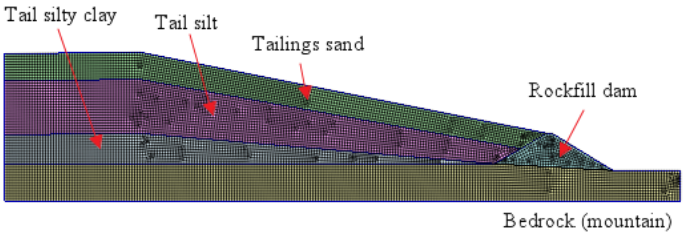

Fig.1 tailings dam finite element model

3.2 Numerical simulation results analysis

(1) Limit equilibrium method is assumed to be rigid landslide analysis, by dividing the strip, assuming no deformation between the division bar, bar established by the force balance equation to solve the stability factor of the dam or slope. Strength Reduction, also known as shear strength reduction, strength reduction method parameters. The basic principle is to gradually reduce the shear strength parameters of soil slope until shear failure, while at the same get undermine the sliding surface of the dam.

Sweden arc limit equilibrium method and finite element strength reduction over the tailings were sliding stability analysis, the results shown in Table 2.

Table 2 the results of calculation

Calculation Method	Operating status	Minimum safety factor		
		Tailing Dam 1/3 piled high	Tailing Dam 2/3 piled high	Tailing Dam whole heap high
Strength Reduction	Normal operation	1.693	1.572	1.473
Sweden arc method		1.765	1.639	1.524

(2) The finite element method and limit equilibrium method to calculate the result of the comparison

Minimum safety factor based on "Tailing Dam geotechnical engineering and technical specifications" requirement secondary slope stability against sliding 1.25 in normal operating conditions. From the results in Table 2, the tailings dam safety factor and strength reduction factor of safety calculated from the three reactors to compete with Swedish law arc method are calculated to meet regulatory requirements. Meanwhile Tailing Dam safety factor in three different stack heights are two ways to calculate the less, the overall relative error is about 4.5%. And with the increase in height of Tailing Dam slope ratio under the same circumstances, the tailings dam safety factor is gradually decreasing. This shows a safety factor of two methods are reliable.

4. Conclusion

This article will MIDAS-GTS finite element analysis software is applied to the tailings dam stability analysis, the results indicate that there is a certain degree of feasibility. The software analyzes the results of the selection of the various physical parameters of reliability and great links. According to the results of the simulation analysis software, you can draw the following conclusions:

Limit equilibrium method and finite element strength reduction tailings dam safety factor generally come close to the results obtained slightly less strength reduction. In the actual calculation juice, you can combine both methods, for comparative analysis, increasing the reliability of the results;

Fill dam slope ratio in the same situation, tailings dam safety factor with highly elevated accumulation decreases;

Limit equilibrium method and strength reduction dam stability calculations show that the design heap compete in the current fill dam, good overall stability of the dam.

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