Analysis on Influence of Tailing Pond Construction on Stability of Surrounding Loose Waste Dump

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Abstract: Tailing pond is one of the important facilities of mine production, which is used to stack the tailing waste discharged by the concentration plant. China's mines produce more than 300 million tons of tailing every year, and the amount of tailing discharged is huge. Due to the limitation of land resources, tailing pond location will face more and more challenges. In this paper, the scheme of building tailing pond on the loose deposits is studied, and the influence of the load produced by the new tailing pond on the stability of the loose yards is analyzed. According to the analysis conclusion, tailing pond is built on the loose yards, and the accumulation of tailing is beneficial to the stability of the slope of the loose yards. However, if strict anti-seepage measures are not taken, the infiltration of pond water into the slope will reduce the stability of the slope, but in general, it is still greater than the safety factor of its own stability.

1. Introduction
Due to the diversity of metal processing technology, and a large number of solid waste discharged during the selection process, there are not only large-scale waste dump, but also heap leaching yard around the tailing pond. These yards are often not subject to any rolling or reinforcement treatment measures, and occupy a lot of arable land, which makes it increasingly difficult for enterprises to locate the yard under the background of increasingly tense land resources.

For the construction of tailing pond on the loose yard, not only the additional load will have an impact on the stability of the yard, but also the rise of the saturation line inside the yard and the possible seepage damage caused by the water infiltration of the pond [1][2] will have a direct or indirect impact on the stability of the yard [3~5]. In view of the above problems, this paper studies the influence of tailing pond construction near the heap leaching site on its own stability, and provides a new idea for tailing pond location.

2. Analysis on the Influence of Tailing Pond Construction on Loose Accumulation

2.1. General situation of the project
The waste dump is discharged layer by layer from bottom to top, the outer slope ratio of each step is 1:2.0, and the platform is set at the elevation of +475.0m, +450.0m, +425.0m, +400.0m, +375m, +365m, +340m respectively.
2.2. Influence analysis

2.2.1. Only considering tailing pressure. Three typical tailing stacking elevations of 330m, 390m and 450m are selected to calculate the stability of gold mine slag dump under the action of tailing pressure. See Figure 1 for the calculated minimum safety factor and corresponding sliding arc position.

![Image](a) The tailing elevation is 330m (320–410m) ![Image](b) The tailing elevation is 330m (310–470m)

![Image](c) The tailing elevation is 390m (320–410m) ![Image](d) The tailing elevation is 450m (310–470m)

![Image](e) The tailing elevation is 450m (320–410m) ![Image](f) The tailing elevation is 450m (310–470m)

Figure 1. Analysis of the influence of tailing pressure with different pile height on the stability of yard when only considering tailing pressure

2.2.2. Considering seepage. The stability of the profile under seepage condition is calculated by selecting 330m, 390m and 450m water level elevations respectively. See Figure 2 for the calculated minimum safety factor and corresponding sliding arc position.
Figure 2. Analysis of the influence of different water level and elevation on the stability of yard when considering the infiltration of pond water

(a) The water level is 330m (320~410m)  
(b) The water level is 330m (410~470m)  
(c) The water level is 390m (320~410m)  
(d) The water level is 390m (410~470m)  
(e) The water level is 450m (320~410m)  
(f) The water level is 450m (410~470m)

Figure 3. Rule of safety factor of elevation 320~410 changing with tailing elevation

Figure 4. Rule of safety factor of elevation 410~470 changing with tailing elevation

See Figure 3 to Figure 4 for the change rule of slope stability safety factor at different elevation of loose slag yard with tailing elevation and water level elevation. It can be seen from the figure that with the gradual increase of tailing accumulation elevation, the safety factor of slope stability of stock dump increases gradually. When considering seepage, the change rule of safety factor is the same as only considering tailing, but the quantity value decreases, which indicates that the pond water infiltration will have adverse effect on the stability of slope.

3. Conclusion
The influence of tailing pressure on the slope stability of loose accumulation is studied, and the following conclusions are drawn:
(1) During the operation period of the tailing dam, with the elevation of tailing in the pond increasing, the safety factor of anti sliding stability of the low slope (320~410m) of the slag yard gradually increases, which is related to the fact that the tailing pressure acts vertically inward on the surface of the gold mine slag yard, which is a favorable factor for the stability; the increase of tailing has little effect on the stability of the high slope (410~470m). When the tailing is accumulated to the elevation of 450m, the stability safety factor of the high slope can be increased to 1.591.

(2) Under seepage condition, the minimum safety factor is 1.231, which occurs at the slope with elevation of 320~410m in section 2 when the water level is 330m. The stability safety factor of gold mine slag dump under seepage condition is much smaller than that only considering tailing pressure, which is related to pore water pressure in saturated area. With the increase of tailing and pond water level, the safety factor of anti sliding stability increases gradually, which is the result of the comprehensive effect of tailing pressure, water pressure and pore water pressure.

Acknowledgments
This research was funded by the National Key R&D Program of China (No.2018YFC0604605) and Scientific Researching Fund Projects of BGRIMM Technology Group (NO.JTKJ1812).

References
[1] SUN G.W., YU G, YIN G.Z.. Factors and Countermeasures of Fine-grained tailing dams stability Safety[J]. Mining Safety and Environmental Protection, 2006, (01):69-71.
[2] WANG W.X.. Study on stability analysis and safety countermeasures of tailings dam[D]. Central South University, 2007.
[3] LI Z.W., HU Z.Q.. Stability analysis of tailings dam based on seepage theory[J]. Journal of Water Resources and Architectural, 2010, 8(1):56-59.
[4] HUANG G.H.. Analysis on the stability of complex landfills under heavy rainfall infiltration[J]. Chinese Journal of Geotechnical Engineering, 2013(s2).
[5] HAN Y.B., ZHOU H.M., CUI X.. Analysis on stability reinforcement measures of tailings dam on deep soft soil foundation[J]. Nonferrous Metals(Mining Section), (s1):68-72.