EFFECT OF INCREASED VERTICAL STRESS ON THE STATE OF GRAINS IN TAILINGS

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Abstract

Tailings storage facilities (TSFs) serve as structures for storing tailings, i.e., waste materials generated by the mining industry. In recent years, tailings dam failures and collapse of these constructions have been reduced due to the establishment of regulations to control these structures, nevertheless the consequences are catastrophic when tailings dam failures occur. There are some different construction methods for tailings dams. One common construction method is the upstream method; where the dam is raised by constructing embankments on top of the tailings stored in the impoundment. Thus, it is essential to understand the mechanical and geochemical behavior of deposited tailings to be able to perform safety assessments of tailings dams. Material properties must be assessed for the present time as well as over a longer time since aging and continuous deposition might change the mechanical behavior over time. Continuous deposition leads to continuous increased vertical stress on particles, and there is a need to study if increased vertical stress can lead to a possible change of the mechanical properties of tailings. Therefore, this study has investigated the characteristics of tailings particles after being subjected to vertical stepwise loading.

This study focuses on investigating the impact of particle breakage (or crushing) on tailings by analyzing material recovered from a tailings dam in Sweden. The research was performed on disturbed tailings material from a borehole of approximately 40 m depth. The study was conducted on four samples recovered 10 m apart, developing a characterization of the material and laboratory tests on each of them. The characterization consisted of the determination of intrinsic properties such as particle size distribution, particle shape, and mineralogy before and after testing; while the laboratory tests were conducted by means of the odometer test. The laboratory tests employed the oedometer test, which applies a vertical load in slow increments under K0 conditions to simulate the behavior of tailings consolidated in the impoundment.

The results obtained from the oedometer tests showed interesting observations regarding changes in particle size distribution (PSD) before and after testing. Based on this study it is hard to conclude if the change in PSD solely is caused by crushing. Three samples show a PSD after oedometer which have slightly more fines than before oedometer, while the last sample has neglectable change in PSD. Theoretically, this small change in PSD indicates that larger tailings particles exhibited a higher susceptibility to some degree of crushing, but since the change is so small it cannot be excluded that the changes origins from the accuracy of determining the PSD.

The samples taken at different depths were prepared using the tamping method, and the oedometer testing indicated minimal differences in their compression characteristics, and since the soil fabric was destroyed under sampling and then reconstituted through tamping this is expected. To investigate the influence of particle arrangement on the compression and potential crushing, one of the samples was tested in a slurry configuration. This test demonstrated that particle arrangement appears to be a contributing factor to crushing, as it showed less deviation in particle size distribution compared to the tamped sample.

To contextualize and validate the findings, the results were correlated, evaluated, and compared with previous studies conducted on tailings from the same tailings storage facility (TSF). Although, future research on crushing in correlation of mineralogy respectively and changes in particle shape are needed, this comparative analysis has provided input that can contribute to enhanced understanding of tailings behavior under increased vertical load.