Short Abstract

A substantial quantity of mine tailings (MT) is generated as a byproduct during the extraction of minerals and metals from their respective ores. Due to their hazardous nature, MT are commonly disposed of in large impoundments known as tailings ponds (TP). However, challenges arise with the disposal of MT in TP, as these ponds pose safety risks due to potential breaches and contribute to soil degradation and groundwater contamination. Moreover, the stability of TP is significantly reduced by the excess pore water pressure (EPWP) developed during the frequent raising of embankments, which may lead to the ultimate collapse of such geo-structures. This thesis presents a detailed stability analysis for the embankments of an existing TP, the height of which was increased twice utilizing downstream (D/S) and upstream (U/S) construction techniques. A rigorous two-dimensional transient-fully-coupled-stress-pore pressure analysis is performed in the finite element-based package RS2 to examine the build-up of EPWP during different stages of construction. Furthermore, an attempt is made to investigate the feasibility of future height raising, with due consideration given to the influence of embankment raising rates. MT can be effectively utilized in various raw material intensive applications thereby reducing the volume of MT that would otherwise need to be stored in TP. Given their mineralogy and chemical composition, MT present themselves as suitable materials for alkali activated applications. This thesis also presents the potential utilization of three distinct MT i.e. red mud (RM), iron tailings (FeT), and zinc tailings (ZT) in three different field applications. Firstly, the applicability of RM, FeT and ZT stabilized through alkali activation is investigated for use as TP embankment material. A series of laboratory experiments including unconfined compressive strength (UCS), direct shear test (DST), alternate wetting-drying tests and permeability tests are performed to evaluate the strength, durability and hydraulic properties of alkali activated MT. While doing so, the influence of alkali activator concentration, curing conditions and curing period is also investigated. Furthermore, the overall performance of alkali activated MT as TP embankment material is compared with that of pozzolana Portland cement (PPC) stabilized MT. Secondly, this thesis also explores the feasibility of RM, FeT and ZT as geopolymer binder for stabilizing the soil for road subgrade. The performance of soil amended with various MT geopolymers is evaluated through various tests including UCS, California bearing ratio (CBR), wetting-drying, permeability, and leachability tests. Finally, this thesis explores the potential utilization of alkali activated RM, FeT, and ZT as paste backfill materials for underground mine cavities. A series of experiments including tests for UCS, drying shrinkage, workability, and setting time are conducted to assess the suitability of alkali-activated paste backfills (AAPB) for filling mine cavities. Overall, this thesis not only discusses the stability aspects of TP but also provides alternative methods for utilizing MT in various field applications through alkali activation.

Keywords: *Mine tailings; tailings pond stability; alkali activation; soil stabilization; mine paste backfills; unconfined compressive strength, shear strength, durability.*