Critical State Soil Mechanics in Filtered TSF Design

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Following the tragic events of the Brumadinho tailings dam failure, there has been a substantial increase in investor and public focus on the management and safety of tailings storage facilities (TSFs), particularly upstream raised slurry dams. As such, many mining companies have reconsidering its tailings management drivers, resulting in an increased adoption of best available technology (BAT), namely filtered tailings placement. Placement of filtered tailings provides the opportunity for compaction with the aim of achieving dilatant conditions in line with the BAT principals. However, as the TSF rises, the increase in stress changes the state of the compacted tailings. This change in state may result in an initially dilative material progressing to a contractive condition. Where dilative conditions are crucial to the ongoing performance of the TSF (i.e. structural zone), the designer must understand how increasing stress affects the state of compacted tailings to allow specification of an appropriate degree of compaction.

This paper outlines a laboratory based design method, founded in critical state soil mechanics, for identification of an appropriate compaction specification to ensure dilative conditions prevail across the design TSF stress range. The method makes use of the critical state line (CSL) and consolidation tests prepared at varying compactive efforts. The CSL and consolidation curves are plotted together in e-log p’ space, with the compaction curves transformed from vertical effective stress to mean effective stress using the coefficient of earth pressure at rest ($K_0$). Consideration is given to the sensitivity of $K_0$ as it is generally not measured during the design phase. An example of the design method is illustrated with laboratory data.