Critical state line testing of Olympic Dam tailings: challenges and general considerations based on index testing

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ABSTRACT

The use of the critical state approach to characterise the susceptibility of tailings to liquefaction has increased dramatically over recent years. The approach has been used to investigate failures of recent tailings storage facilities and is becoming one of the leading practices adopted by the industry to characterise tailings. The approach requires determination of the critical state line, which is commonly undertaken in triaxial element testing using test methods based on Jefferies and Been (2015). This requires preparation of loose specimens (generally via moist tamping), use of oversized lubricated end platens to promote sample uniformity during shearing, and end-of-test soil freezing to accurately calculate void ratio. This technique has been successfully applied in tailings of non-plastic sand and silts but is less routine for tailings containing a complex pore fluid chemistry and appreciable plasticity, as the Olympic Dam tailings. The effect of the pore fluid chemistry on the critical state line as well as on geomechanical behaviour in term of stress-strain and brittleness is not well understood and requires special considerations.

This paper will describe the testing of the Olympic Dam tailings, which have appreciable plasticity and pore fluid containing high total dissolved solids (TDS) and low pH. The paper will detail the considerations to account for this based on a comprehensive index testing characterisation involving particle size distribution (PSD) testing by laser and sieve, Atterberg limits, scanning electron microscope (SEM) and X-ray diffraction (XRD) testing.

The paper will outline the procedure adopted to develop the critical state line of the Olympic Dam tailings that involves measuring the TDS of the tailings to enable correction of the void ratio using different salt correction techniques. The modifications to the procedure adopted in this study for sample preparation to enable reproducing the pore fluid chemistry expected in situ will also be described.