An approximate method to define the critical state line using direct simple shear laboratory data

M Llano¹ and D Johns²

1. Geotechnical Engineer, KCB, Brisbane QLD 4101. Email: mllano@klohn.com
2. Senior Geotechnical Engineer, KCB, Brisbane QLD 4101. Email: djohns@klohn.com

ABSTRACT

Recent high-profile tailings dam failures have highlighted the relevance of measuring the critical state line (CSL) of tailings. CSL is considered today as one of the most accepted methods to assess the liquefaction susceptibility of soils. Conventional triaxial compression (CTC) test results are often used to define the boundary between collapsible and dilatant soils. It is noted however that CTC defines only one point of the Haigh–Westergaard stress space. The Haigh–Westergaard space is a 3-dimensional space in which the three spatial axes represent the three principal stresses for a body subject to stress. Like CTC, simple shear testing offers the opportunity to trial the plasticity surface. Simple shear testing is usually performed using the Direct Simple Shear (DSS) apparatus. DSS offers the opportunity to test tailings samples at a stress state that is rotated 30° from CTC, this is, when measuring the stress states in the Haigh–Westergaard plane and rotating it using the Lode angle. This paper presents an approximated method that use the conceptual similarities between the stress state defined by CTC and DSS to define a CSL using DSS only. The method is tested using tailings from a TSF in Australia for which both CTC and DSS tests were performed. The results are positive in the sense that both CSL obtained are considered to be comparable, however, the method must be used with caution. Further experimental evidence would be required to discuss the wider applicability of the methodology presented in this study.