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The influence of dessication and stress history on monotonic and cyclic shear response of thickened gold tailings

In thickened tailings technology, tailings are dewatered to the point where they exhibit a yield stress such that they form gently sloping stacks during deposition. Post-deposition, these tailings may densify due to settling, desiccation, and drainage. Fresh tailings subsequently deposited over the desiccated layer and this procedure is continued to facilitate construction of a stable stack. Tailings placed in the stack therefore undergo variable stress histories in terms of degree of desiccation and consolidation. A better understanding of the effects of this stress history on the geotechnical behaviour would lead to safe and economical designs. Most common design objectives in thickened tailings deposition are to improve stability, minimize deformation during earthquakes, facilitate reclamation, and maximize the deposition volume (stack slope).

This study investigated the influence of stress history on the monotonic and cyclic shear strength of thickened tailings. The field deposition process was simulated by desiccating layers to different degrees, and subsequently overlaying them with fresh tailings. This was done in a small column, as well as in a 0.7 m by 1 m plan “drying box”, in which 5 layers were subsequently deposited, desiccated to different degrees, before placement of the next layer. Extracted samples were consolidated prior to shearing under simple shear and triaxial loading modes. Vane shear tests were also employed to complement the experiments. The effects of overconsolidation ratio (OCR) associated with desiccation and mechanical loading were also compared.

A profound effect of the degree of desiccation on the stress-strain behaviour of the tailings was measured. Tailings that have not experienced any desiccation exhibit strain-softening response under simple shear loading. A small degree of desiccation was enough to transform the response from contractive to dilative, and generally the degree of strain hardening increased with the degree of desiccation. Desiccated samples also exhibited more stiffness, and had a higher void ratio at a given consolidation pressure, than non-desiccated samples. These results have practical relevance, as the contribution of desiccation stress history has either been previously discounted or underestimated at best.

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