Mine waste: Consolidation behaviour of precious metal tailings

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Abstract

All mine processing plants generate waste. These byproducts include waste rock and a fine-grained slurry referred to as 'tailings'. The primary objective of treating tailings is to remove water, to enhance strength and stiffness. Studying the geotechnical properties of tailings is essential to understand consolidation behaviour and facilitate land reclamation. Moreover, the geochemical characteristics of tailings should be examined to examine the potential onset of acid rock drainage (ARD). Acid rock drainage occurs when pH falls below 4, which can cause metal heavy leaching as they become present in solution. This study investigates both the geotechnical and geochemical behaviour of precious metal tailings in atmospheric conditions. The geochemical parameters of interest are pH, redox potential (Eh) and electric conductivity (Ec). The Large Strain Consolidation test (LSC) was implemented to characterize the compressibility behaviour of the sample. Accordingly, the amount of deformation that the tailings underwent was measured as they were loaded to different effective stresses. In addition, the hydraulic conductivity or the velocity of water flow was measured at the end of each consolidation step. Furthermore, the chemical parameters were evaluated using standardized probes. The tailings exhibit high compressibility during self-weight consolidation due to a combination of high initial void ratio and a high initial saturated hydraulic conductivity. In addition, hydraulic conductivity decreases nonlinearly as the samples are loaded because loading reduces the pore volume. The permeability decreased two orders of magnitude during loading, from $2.14*10^{-05}$ m/s to $1.60* 10^{-7}$ m/s. From the geochemical point of view, there is no significant change in pH as the tailings consolidate. In this scenario, the presence of calcium carbonate has an acid-neutralizing capacity. Moreover, there is a slight increase in both redox potential and electric conductivity due to exposure to the atmosphere. The increasing trend of redox potential had a slope of 10 mV per day. While the slope of electric conductivity was 9 mS/cm per day.

Key words:
precious metal tailings, compressibility, saturated hydraulic conductivity, geochemical tests

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Mine Waste: Consolidation Behaviour of Precious Metal Tailings

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Introduction

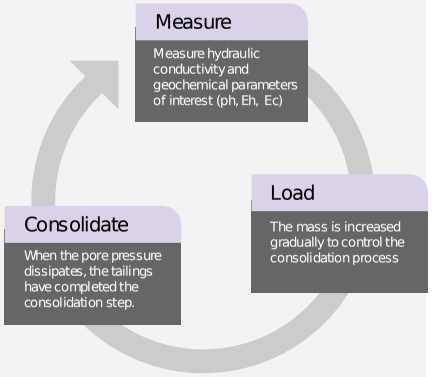
All mine processing plants generate waste. These byproducts include waste rock and a finer grained slurry called 'tailings'" (Beier, 2015). The primary objective of treating tailings is to **remove water,** to enhance strength and stiffness (Sobkowicz and Morgenstern, 2009). Studying the geotechnical properties of tailings is essential to understand consolidation behaviour and facilitate land reclamation. Moreover, chemical characteristics of tailings should be examined to establish the potential of acid rock drainage (ARD).

Objectives

The purpose of this study is to investigate the **consolidation and geochemical behaviour** of precious metal tailings in atmospheric conditions. The geochemical parameters of interest are pH, redox potential (EH) and electric conductivity (EC).

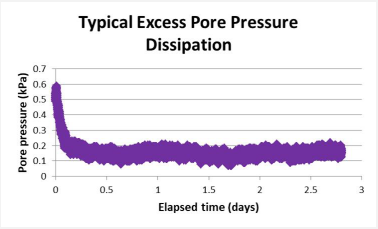
Methodology

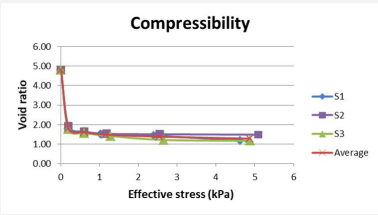
Large Strain Consolidation (LSC) test

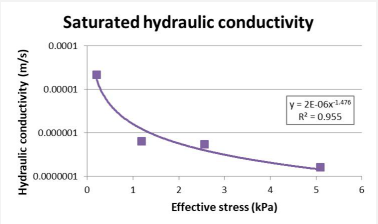


Results

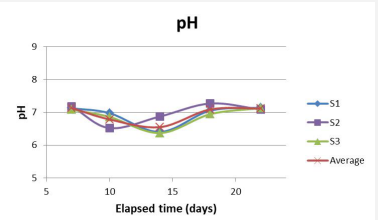
Geotechnical Parameters

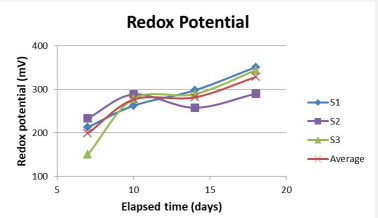


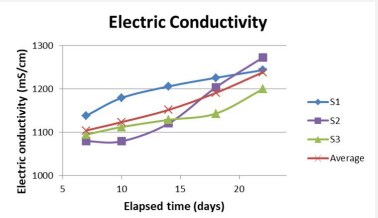




Geochemical parameters







Water flow rate

2.14E-05 m/s (Initial value) =2 meters/day
1.60E-7 m/s (Final value) =5 meters/year

*Water flows through sand at a rate of 6 meters a day

Drinking water limits

Drinking water has an acceptable pH range of 7.0 to 10.5.

Conclusions

Geotechnical Parameters:

Compressibility: The tailings exhibit greater compressibility during self-weight consolidation due to a combination of high initial void ratio and a high initial saturated hydraulic conductivity.
Hydraulic conductivity: hydraulic conductivity decreases nonlinearly as the samples are loaded because loading reduces the pore volume.

Geochemical parameters

- **pH**: There is no significant change in pH as the tailings consolidate. In this escenario, the presence of calcium carbonate has an acid neutralizing capacity
- **EH** Slight increasing trend in redox potential with a slope of 10 mV per day.
- **EC:** Electric conductivity exhibited an increasing trend with a slope of 9 mS/cm per day.

Increases in EH and EC are due to the sample coming in equilibrium with atmospheric conditions

Acknowledgements

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