

CASE STUDY

WIREBmr™ to Infer Tailings Saturation

Laboratory Study, The University of Western Australia

The Situation

Tailing storage facilities (TSF) are reservoirs that store mine tailings which is fine-grained waste material in suspension that is discharged from an ore processing plant or coal preparation plant. The safety of TSF is an increasing concern owing to their potential danger to the environment and the lives of those living downstream, as evidenced by a series of recent failures. A common cause of TSF failure is liquefaction, which can occur in loose tailings that are near-saturated, with 80% degree of saturation often being taken as the required value for liquefaction to be possible.



Brumadinho Dam Disaster: 25 January 2019 tailings dam at the Córrego do Feijão iron ore mine, Brazil, suffered a catastrophic failure releasing a mudflow killing 270 people.

Quantifying saturation (S_r) in tailings can be made with three variables: bulk Gravimetric Water Content (GWC), bulk Volumetric Water Content (VWC) and the specific gravity (G_s) of the solids component of the tailings. The relationship is:

$$S_r = \frac{VWC}{1 - \left(\frac{VWC}{G_s}\right)}$$

Measurement of GWC and G_s can be performed on disturbed samples taken from the TSF. These measurements are commonly performed, with the process and application well understood. However, due to the loose condition of many tailings, disturbance on sampling makes in situ VWC challenging. Consequently, one of the primary challenges for determining saturation is obtaining a useful measure for VWC.

Technical Solutions

There are no widely used and reliable methods for successfully characterising VWC in a TSF. Alternatively, degree of saturation is sometimes estimated by means of partially disturbed samples or tensiometers, however both suffer from significant uncertainty.

Orica Digital Solutions WIREBmr™ Borehole Magnetic Resonance tool is a downhole geophysics tool that measures water contained in subsurface environments safely and accurately. WIREBmr™ is specifically tuned to sense fluids within the pore network, enabling precise determination of the formation's total water content, i.e. VWC.

A hole drilled through the TSF, either specifically for purpose or as part of larger studies, can therefore be used to calculate the degree of saturation of tailings through:

- Laboratory measurements on bulk samples to calculate GWC and G_s on samples acquired during drilling.
- WIREBmr™ run post drilling and casing with PVC, to obtain a continuous downhole log of VWC.

The Result

A collaborative program was conducted in partnership with The University of Western Australia to assess the efficacy of WIREBmr™ in characterising Volumetric Water Content (VWC) within tailings.

This involved conducting laboratory analysis to estimate Groundwater Content and VWC at varying levels of water saturation. Subsequently, identical samples were transferred in a purpose-built vessel enabling the utilisation of the WIREBmr™ system to estimate volumetric water content.

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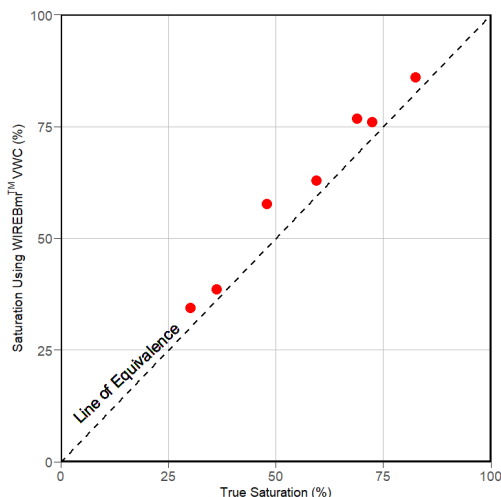
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Lab Test Setup: Test vessel during filling (Left) and during WIREBmr™ tool insertion (Right)

The following findings illustrates the successful characterisation of saturation by employing WIREBmr™ during this laboratory-scale demonstration. Accordingly, it is possible to greatly increase the understanding of the saturation state, as a large component of liquefaction risk, of a Tailings storage facility through the application of WIREBmr™ supported by laboratory analysis.



Testimonial

The determination of volumetric water content with Orica Digital Solutions WIREBmr in Tailings is a very promising technology to better characterise tailings.

Dr David Reid
Research Fellow
The University of Western Australia

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