Targeting Dilatancy in Upstream Construction

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The use of Best Available Technology (BAT) was promoted by the Independent Expert Engineering Investigation and Review Panel for the Mount Polley tailings dam failure (the panel) as the means to eliminate the risk of tailings liquefaction failures in future. Examples of BAT quoted by the panel were filtered, unsaturated, compacted tailings and reduction in the use of water covers in a closure setting. The panel listed three components defining BAT that derive from first principles of soil mechanics:

1. Eliminate surface water from the impoundment.
2. Promote unsaturated conditions in the tailings with drainage provisions.
3. Achieve dilatant conditions throughout the tailings deposit by compaction.

Well managed upstream construction in dry climates can achieve the first two components, even using slurry based tailings deposition but the third component is not so easily achieved (even for “dry-stacked” tailings).

Field trials and theoretical analysis demonstrate that reasonable densities can be achieved by well controlled tailings beaching, solar drying and consolidation. However this may not achieve dilative state conditions, leaving the potential for tailings to be liquefiable under earthquake or other static trigger condition. This means that significant buttressing may be required to design stable embankments using upstream construction.

However there are methodologies to further densify the tailings by mechanical means with potential to achieve the goals of BAT without the expense of filtering and so called “dry stacking”. This paper presents a methodology for establishing target tailings density to ensure dilative behaviour at all future overburden pressures. This methodology is consistent with the critical state soil mechanics framework and can be implemented through commercially available field and laboratory testing for real dam projects.

The paper presents an example of field density achievements using thin layer deposition and solar drying and compares this with compaction data from laboratory and field trials of mechanical densification processes.