Standardizing Vulnerability Assessments of Tailings Dams:   
Advancing Beyond Trigger Analyses

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# ABSTRACT

The assessment of tailings dam vulnerability to flow liquefaction has evolved from deterministic factor-of-safety approaches to more sophisticated numerical deformation analyses. Following the proposal introduced at PCSMGE 2024, this study refines the framework for standardized vulnerability assessments by integrating recent advancements in constitutive modeling, Eurocode 7 (Second Generation) reliability principles, and performance-based design concepts. This paper presents an enhanced methodology for assessing tailings dam vulnerability, replacing traditional trigger analyses with a structured vulnerability assessment framework. The methodology prescribes a uniform set of deteriorating actions—crest loading, toe contraction, and phreatic surface rise—regardless of site-specific conditions. These actions are applied systematically in pushover-style analyses to quantify the dam’s susceptibility to flow liquefaction, moving toward a limit state-driven design philosophy akin to Load and Resistance Factor Design (LRFD). To ensure consistency in material parameter selection, the approach aligns with Eurocode 7’s hierarchy of values, distinguishing measured, derived, and representative parameters. Advanced numerical modeling techniques, including element test simulations for parameter calibration, enhance robustness while incorporating spatial variability and epistemic uncertainty. The transition from trigger-based assessments to vulnerability quantification enables a risk-informed, performance-based evaluation of tailings dams. This approach addresses key challenges in current industry guidelines (ICOLD, CDA, ANCOLD, GISTM), providing a reproducible and transparent framework adaptable across diverse geotechnical environments. By standardizing vulnerability assessments, this methodology facilitates more objective risk management, improving dam resilience and regulatory compliance. The paper concludes with case studies illustrating practical applications of this framework in operational tailings storage facilities.