

MIN E 650: Special topics in Mining Engineering

Title: Geotechnical Aspects of Mine Tailings

Course Outline Winter 2027

Instructor: Dr. Mohammadali Sepehri, P.Eng.

Lectures: Lectures will be held on NREF 2-80 (Mon-Fri 9:30-11:50) from January 4 to April 9, 2027. There are no classes from February 15 to 19 (Family Day and Reading Week).

Grade Distribution:

Individual assignments	3 × 10%	30%
Individual midterm examination	1 × 20%	20%
Integrated term project	Proposal and brief 3%; final report 12%	15%
Project presentation and defence	Team presentation + individual evaluation	5%
Final examination	1 × 30%	30%
Total		100%

Course Description

This graduate-level course examines the geotechnical behaviour, design and management of mine tailings facilities throughout their life cycle, from site characterization and technology selection to operation, closure and post-closure. Emphasis is placed on Alberta oil sands and Canadian hard-rock mining, supported by case studies from elsewhere in North America, Australia and other mining jurisdictions.

Topics include tailings and foundation characterization; solids and water balances; settling, dewatering and large-strain consolidation; critical state interpretation of strength and liquefaction susceptibility; seepage; static and seismic stability analysis; and analytical and numerical modelling. The course integrates these technical topics with risk assessment, monitoring, dam safety governance, regulatory requirements and closure planning. Particular attention is given to cold-climate conditions, uncertainty, environmental performance, Indigenous rights and affected communities.

Through engineering calculations, interpretation of laboratory and field data, modelling exercises and critical review of research and industry case studies, students develop evidence-based recommendations for safe and responsible tailings management.

Course Objectives

The objective of this course is to develop graduate level competency in the characterization, design, analysis and stewardship of tailings facilities over their full life cycle. Students will apply geotechnical principles and analytical tools, critically assess design alternatives and model limitations, and communicate practical recommendations for safe operation, monitoring and closure in a Canadian setting. The course is designed to help students critically evaluate designs, assumptions, analysis results, and the findings of failure investigations and consultant reports.

Learning Outcomes

Upon successful completion of this course, graduate students should be able to:

1. **Characterize tailings and foundation materials** using laboratory, field and processing data, and explain how mineralogy, fabric, pore-water chemistry and deposition influence the engineering behaviour of different tailings types.
2. **Quantify solids and water balances, settling and consolidation** to estimate storage capacity, water recovery, settlement and dewatering time, applying large-strain self-weight consolidation theory where appropriate and evaluating the limitations of simplified methods.
3. **Evaluate tailings management alternatives** and justify the selection of dewatering technologies, deposition methods and facility concepts using site conditions, production requirements, climate, safety, environmental and social impacts, and life-cycle costs.
4. **Interpret laboratory and in situ test data to select defensible geotechnical parameters** and assess drained and undrained strength, strain-softening, and static and cyclic liquefaction susceptibility within appropriate soil mechanics and critical state frameworks.

5. **Analyze seepage, stability and deformation under static and seismic** conditions using appropriate analytical and numerical methods, including assessment of liquefaction triggering and post-liquefaction behaviour; verify model results and evaluate sensitivity, uncertainty and limitations.
6. **Develop risk-informed design criteria, monitoring and response plans** that connect credible failure mechanisms to applicable regulatory requirements, dam safety responsibilities, construction quality, instrumentation, performance thresholds and emergency preparedness, distinguishing legal obligations from technical guidance.
7. **Develop and justify closure and post-closure concepts** addressing soft-tailings capping, settlement, landform stability, erosion, water management and geochemical constraints, with consideration of cold-climate processes, climate change and long-term monitoring and maintenance.
8. **Critically evaluate research, failure investigations and professional reports to develop and defend engineering recommendations**, individually and collaboratively, communicating evidence, assumptions and uncertainty while demonstrating ethical judgement, accountability for public safety, and consideration of Indigenous rights, knowledge and affected communities.

Detailed Assessment, grade distribution with LO mapping (LO refers to the 8 learning outcomes developed above)

Assessment	Weight	Main tasks	Learning outcomes assessed	Proposed timing
Assignment 1	10%	Tailings characterization, water balance and consolidation	LO1, LO2	Week 4
Assignment 2	10%	Seepage and static stability computer laboratory	LO4, LO5	Week 7
Assignment 3	10%	Numerical modelling and seismic assessment (RS2 staged-construction/consolidation exercise, with verification and sensitivity checks; Slide2 seismic and post-liquefaction scenarios using supplied hazard and material data.)	LO4, LO5	Week 10
Midterm examination	20%	Individual written examination covering characterization, balances, consolidation, technology selection, strength interpretation and introductory seepage/stability. Combine calculations with explanation of assumptions and engineering choices.	LO1–LO5	Week 6
Integrated project: Design-basis and alternatives brief	3%	Team submission defining the site, applicable requirements, alternatives, preliminary design criteria and allocation of responsibilities.	LO3, LO6, LO8	Week 8
Integrated project: Technical report	12%	Team report integrating alternatives assessment, selected analyses, regulatory/governance considerations, monitoring, closure and critical review of relevant evidence.	LO3, LO5–LO8	Week 12
Integrated project: Presentation and individual defence	5%	Team presentation, individually answered technical questions, and a short individual contribution/reflection statement.	LO8, LO3, LO5–LO7	Week 13
Final examination	30%	Individual cumulative examination emphasizing interpretation, integrated analysis and defensible decisions across the facility life cycle.	LO1–LO7	Official examination period
Total	100%			