Soil Mechanics for Stress Analysis and Pipeline Design
Presented by Dr. Jim Oswell, Ph.D., P.Eng.

DURATION: approximately 7.5 hours

TIME SCHEDULE: 9 a.m. to 5:30 p.m.

ROOM: Oppian

PURPOSE:

The purpose of this one-day seminar/workshop is to educate pipe stress engineers and analysts, mechanical engineers and non-geotechnical engineers regarding general principles of soil mechanics and geological hazards as they relate to the design and stress analysis of pipelines. In many cases the communication between the pipe stress team and the geotechnical engineers is weak and complicated by miscommunications and misunderstanding of technical terms on both sides.

Following this seminar, the participant will have a strong grasp of basic geotechnical definitions and soil mechanics and understand how the equations used to develop soil-springs and yield displacements are derived from geotechnical and foundation engineering analogies. The stress engineer will understand the issues and limitations of soil mechanics as they relate to pipe stress analysis and be able to communicate with the geotechnical engineers on an informed level. Through the use of numerous case histories and examples, the concepts of soil mechanics as they interact with pipeline design are illustrated.

EXPECTED PARTICIPANTS:

Pipe stress engineers/ analysts, and mechanical and pipeline engineers who use geotechnical information in the design and analysis of pipelines.

OUTLINE OF PRESENTATION:

- **Soil classification and definitions**
  - ASTM D2487/ASTM2487/Eurocode soil classification
  - Other classification systems, as required (for example, Russian GOSTs and SNiPs)
  - Definitions and descriptions
  - Soil laboratory tests
  - Typical soil properties
  - Effect of ground water and pore water pressures
- **Geotechnical Investigations for pipeline design and analysis**
- **Soil – pipeline interaction scenarios**
  - Landslides and rate effects
  - Lateral spreading (liquefaction) and sensitive soils
  - Upheaval buckling
  - Frost heave and thaw settlement
  - Thermal expansion into side and vertical bends
  - Seismic (earthquake) fault crossings

Examples for illustrative purposes, not extended details

- **Soil strength testing and interpretation**
  - Effective stress principle
  - Drained versus undrained strengths
  - Effective stress versus total stress strengths
  - Soil tests and deformation plots
  - Mohr Circles and stresses
  - Field interpretation of soil strength
  - Strength correlations to soil index properties
- **Pipeline deformation scenarios**
  - Examples of soil-pipe interactions
- **Maximum soil strength derivation and soil pipe interaction relationships**
  - Strength and deformation relationship development
  - Maximum soil strength and yield displacements
  - Bilinear versus hyperbolic soil strength-displacement relationships
  - Spring constants
- **Soil-Pipe Interaction Considerations**
  - Thaw settlement and frost heave (pipelines in permafrost)
  - Deep burial (HDD)
  - Effect of trench width
  - Effect of backfill properties
  - Effect of frozen soils
  - Multiple spring stiffnesses
  - Strain softening in soil strength
  - Soil-pipe loading rate effects – drained versus undrained soil loading
- **Mitigation strategies of selected geohazards**
- **Summary and key messages**

SEMINAR FEEDBACK FROM PREVIOUS PARTICIPANTS:

- "Overall it was a very good presentation by Jim".
- "The [seminar] was definitely of value. I believe it is very good to be given a very broad overview of the key points; this way as engineers we can be more confident that we are not missing something important."
- "I found the seminar to be very useful; thanks for putting it on. I feel way more confident when looking at a soils report now."
- "I thought the soil seminar was useful and I learned some useful information from it. I was able to follow and stay engaged throughout."

PRESENTER BACKGROUND

Dr. Oswell has worked on many pipeline projects in western and northern Canada, and internationally for over 30 years. Many of these projects involved site investigations, laboratory testing, extensive analysis and evaluation and development of engineering study reports.

Dr. Oswell has extensive pipeline geotechnical engineering and geological hazard assessment experience. He provided specialist permafrost engineering for pipeline projects in northern Canada, Alaska, and Russia. He is presently part of the Strain Based Design team for the Alaska LNG pipeline project. He has senior consulting experience on the following major pipeline projects: Mackenzie Gas Project (Canada), Norman Wells oil pipeline (Canada), Alaska North Slope Project (United States), Denali Pipeline Project (United States, Canada), Alaska Gas Project (United States, Canada), Mohe-Daqing oil pipeline (China), Baydaratskaya Bay Gas Pipeline Crossing (Russia) and the ExxonNeftigaz Sakhalin to DeKastri oil pipeline (Russia) .

As an expert in geohazards interaction with pipelines, Dr. Oswell conducted studies or acted as a senior reviewer/advisor for projects with significant engineering and technical challenges such as frost heave and thaw settlement, geohazard management including landslides, earthquake faults, and liquefaction. He has experience in the interpretation of geological hazards in LiDAR imagery. He is a recognized expert in geotechnical issues related to soil-pipe interaction. He has further experience in strain-based design issues for pipeline design, and geological hazard (risk) assessment. He has conducted forensic investigations involving pipeline integrity issues in Ecuador, Colombia, Canada and United States.

Dr. Oswell has published over 30 technical conference and peer-reviewed journal papers, and was the keynote speaker at the 63rd Canadian Geotechnical Conference/6th Canadian Permafrost Conference. He is presently Associate Editor of the Canadian Geotechnical Journal. He has recently published the text book “Soil mechanics for pipeline stress analysis” (ISBN: 978-0-9952410-0-8).