The globe is criss-crossed by millions of kilometres of oil and gas pipelines, traversing continents beneath remote, inhospitable, and often mountainous terrain. Interaction with a variety of geotechnical hazards makes some ground movement inevitable. But what did that landslide actually do to your pipeline? Is that subsidence sufficient to compromise safety? BMT has come up with a way to give pipeline operators accurate intelligence about what's going on underground. Aaron Dinovitzer and Abdelfettah Fredj explain.

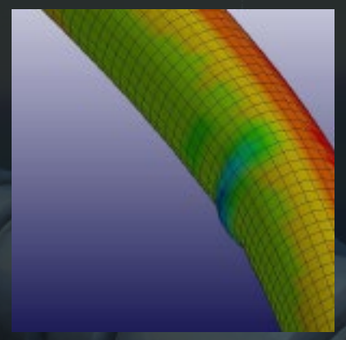
Pipeline vs ground movement

taking the guesswork out of geotechnical hazard assessment

Applying the science

The modelling tool can be used to inform pipe design pre-construction to ensure maximum resistance to likely hazards, but is mostly called in where unforeseen ground movement has raised concerns about damage. It explains behaviours that its predecessors cannot.

- A major slope in southern Manitoba, containing five large diameter crude oil lines, was found to have moved by up to three metres since the pipeline installation. The pipe-soil interaction tool was used to show that one of the pipelines was close to the limit of its strain tolerance.
- Could a light railway be built over a particular pipeline? The loading was simulated with the modelling tool to demonstrate the performance and acceptability of the design to ensure success.
- Would taking material out of the ground below a pipeline cause subsidence, leading to bending and eventual failure? Predictive modelling showed the long-term impact of the mining operation.



Forest fires, floods, and drought are just some of the hazards that put buried pipelines at risk of deformation when unexpected ground movement exerts stresses and strains on the infrastructure. But when they can't see the pipeline, how can operators be sure what's happened?

Geotechnical assessment will tell them how the soil is moving, and data from inspection tools inside the pipeline will provide clues about the pipe's integrity, but until now there has been no way to connect the dots for a clear 3D assessment of the likely effects of the event.

The advanced modelling tool we have developed gives operators the missing piece of the jigsaw. It simulates the ground movement process and predicts the pipe deformation and accumulated strains in the pipeline, today and in the future if the movement continues. This novel technique for looking at displacement patterns and understanding the soil-pipe interaction is much more precise than soil spring-based modelling.

When operators can see clearly what's going on, they can properly evaluate the pipeline's potential for failure – imminently or at a later date - and make better decisions about what needs to be done and when. Does the pipeline need repair or repositioning? Does the slope require stabilisation?

Decisions are driven by scientific calculation, which enrich expert opinion, and means operators need not rush in to carry out work "just in case", but can be confident there is no immediate threat to supply, safety, or the environment.

BMT has a long history of dealing with pipeline integrity, especially in the USA and Canada where more than half the world's oil and gas pipelines are located, and major pipeline operators have expressed interest in – and employed - the new tool.

We have validated our models against field observations and full-scale field tests to prove the tool simulates reality, and we are now applying these advanced models in a range of projects with great success.

We have also worked with the Pipeline Research Council International (PRCI) and the US Department of Transport to develop a simplified version of the tool for relatively quick assessment of some standard scenarios with the aim of reducing pipeline failures due to natural forces.