Backanalysis of the 1929 Grand Banks Submarine Slope Failure

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Abstract:

The 1929 Grand Banks Slide was triggered by a major earthquake and resulted in a turbidity current of about 1000 km travel distance. Landslides of this kind can definitely be considered as a serious potential hazard to human life and economical resources along the coastline. Based on preliminary geophysical and geotechnical data, backanalyses of the Grand Banks Slide are performed using two different methods of slope stability analysis: a) Limit Equilibrium Analysis, and b) Numerical Modelling using a state-of-the-art finite element program, DYNAFLOW. This research is part of COSTA-Canada, a contribution to the study of continental slope stability, aimed at increasing the reliability of economic activities along Canada's continental margin and coastline.

DYNAFLOW is a finite element analysis program for the static and transient response of linear and nonlinear two- and three-dimensional systems. The solid and fluid coupled field equations are based on an extension of Biot's formulation in the nonlinear regime, and are applicable to multidimensional situations. A multi-yield constitutive model is used for simulating the behaviour of soil materials. It is a kinematic hardening model based on a simple plasticity theory, and is applicable to both cohesive and cohesionless soils. The yield function is described in the principal stress space by a set of nested conical yield surfaces. A non-associative plastic flow rule is used for the dilatational component of the plastic deformation. Accurate simulation of shear-induced plastic dilation and hysteretic effects under cyclic loading, together with full coupling between solid and fluid equations, allow capturing the build-up and dissipation of pore water pressures and modelling the gradual softening and hardening of soil materials.

Due to considerable uncertainty in both soil data and actual seismic loading, as well as the inherent variability of soil properties, the study includes stochastic treatment of both loads and soil properties, so that a set of more reliable input data be provided to predict the failure potential of submarine slopes under earthquake loads.