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A CONTACT DYNAMICS APPROACH TO ANALYSING SLOPE COLLAPSE TRIGGERED BY HEAVY VEHICLES

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Abstract

A heavy vehicle operating near a steep slope alters the stress distribution and might cause the slope to collapse. The result can be catastrophic for the operator, the machine, and for other units in the area. Computational methods for assessing the risk for slope collapse has existed for a long time in geotechnics but are limited to static conditions without mobile equipment [1].

We explore a contact dynamics [2] approach to slope failure analysis. The method searches a space of potential failure surfaces for the most critical one. The soil in each potential failure surface is treated as a rigid body supported by contact forces with the interfacing (static) terrain. The body is subject to gravity and contact forces from any multibody systems, such as a vehicle, interacting with it. A Signorini-Mohr-Coulomb contact model is assumed, stating that the relative normal and tangential velocity should be zero along the interface unless the normal and tangential forces reach their limit conditions, that depends on the (internal) friction and cohesion parameters, in which case the body is prone to acceleration. The discretized equations of motion, constrained by the contact model, form a linear complementarity problem that is solved numerically. The solution reveals whether the configuration is unstable or stable, and is factor-of-safety (FOS). A search algorithm for finding the most critical failure surface, in terms of smallest FOS or highest acceleration, is developed and analysed. The method was implemented in the realtime physics engine AGX Dynamics. The tests shows that it gives reliable results, comparable with conventional LEM methods, and is computational efficient enough for being used with a realtime simulator of terrain vehicles [3].

Keywords: realtime simulation, slope stability analysis, mobile earthmoving equipment.

Presenter: Martin Servin

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