A TWO DIMENSIONAL COUPLED MODEL FOR SUBMARINE DEBRIS FLOW AND ITS INTERACTION WITH SUBSEA INSTALLATIONS

Himangshu S. Das, US Army Corps of Engineers, himangshu.s.das@usace.army.mil

OBJECTIVE

Debris flow are gravity driven mass flows which can create catastrophic geohazards along their overriding paths. Driven by the gravity, debris flow can travel long distances on favorable continental slopes. Their frontal velocity can be very high which may pose significant threat to offshore installations such as subsea pipelines, communication cables and offshore platforms (Yuan et. al., 2012). Therefore, understanding their dynamic behavior is critical in order to mitigate potential geohazards. The specific objective of this paper is to present a coupled two dimensional numerical model that characterizes debris flow movement, rheological properties and its interaction with subsea installations. For demonstration purpose, the coupled model has been applied to schematized settings representing generalized continental shelves with canyons.

MODEL

Debris flows are simplified as a two-phase (shear and plug layer) flow with thin layer approximation of the N-S Equations, which assumes that the runout distance of the flow is much greater than its depth. Widely used Herschell-Bulkley model has been used to describe the rheology of debris flow. For the structural interaction, the flow velocities are converted into impact forces to obtain shear strain rate to evaluate potential movement or failure. An empirical relationships has been proposed to relate shear strain rate as a function of Young's modulus of material and impact force applied by debris flow. Model results are validated against laboratory experiments.

MODEL VALIDATION

Comparison of debris flow deposit thickness between the numerical and experimental result is shown in Figure 1. In the same figure, results simulated using a widely used one dimensional debris flow model are also presented (De Blasio et al. 2004a). From these results, it can be seen that the present model is capable of representing laboratory experiments with reasonable accuracy.

MODEL APPLICATION

The coupled model is then applied to a schematized continental shelf with sinuous canyons of varying dimensions. Debris flow deposition patterns along with its interaction with subsea installations (e.g., pipeline) at different time intervals are shown in Figure 2. It has been observed that for deep settings, debris flow travels along the thalweg of canyon, and no overspill occurs. However, for shallow depth condition, significant overspill of flows takes place. Thus the section of the pipeline that is located at the edge of the canyon is significantly affected by overspills. It has been demonstrated that the coupled numerical model can serve as a useful tool to evaluate potential geohazards to subsea installations.

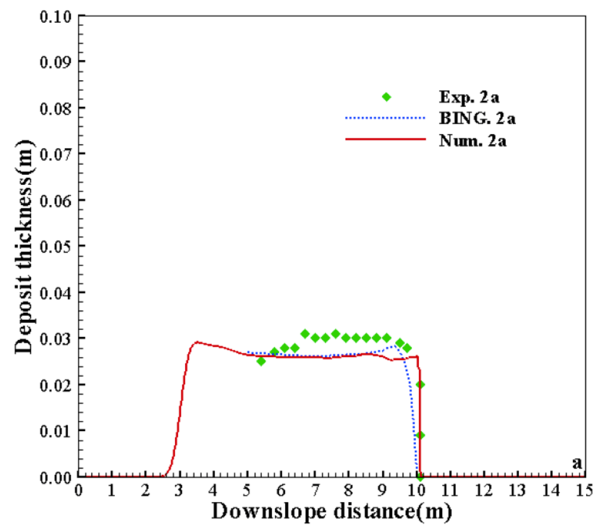

Figure 1 – Comparison of final debris flow deposits

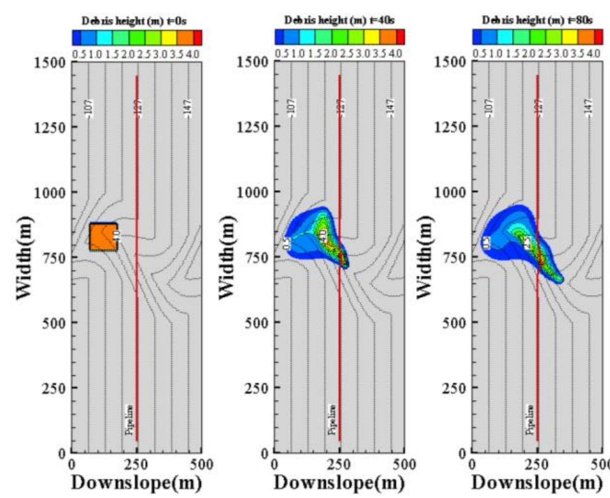

Figure 2 – Deposition patterns and pipeline displacements at different time interval as the flow travels downslope.

REFERENCES

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