Laboratory, small-scale simulation of debris flows to understand pore pressure development in flowing sediment

Debris flow are a hazardous type of landslide characterised by complex interactions between the solid and the fluid phases. Debris flows are common in many Alpine catchments and often occur repeatedly in susceptible areas. High pressures in the pore fluid facilitates the movements of solid particles past each other, making the flowing mass highly mobile and destructive[1]. The presence of only a few percent clay in the flowing mixture is enough to decrease the hydraulic conductivity, which is key for pore pressures to remain high[2,3]. The development of these high pore pressures is a process which is poorly understood and needs further investigation.

At the Swiss Federal Institute WSL in Birmensdorf, a new debris flow flume with a 2-m long channel is being used to simulate debris flows at a small scale. A volume of approximately 0.1 m^3 of sand, clay and water is released into this channel and allowed to deposit on a platform at the end of the channel. A range of sensors are used during experiments, including pore pressure transducers, laser or ultrasonic depth sensors and infrared depth cameras.

The student would participate in conducting at least two or three experiments from start to finish and would then perform an analysis of selected sensor data. Experiments may be varied by, for example, varying the clay content to change the hydraulic conductivity of the mixture. This project is suitable for a student with an interest in natural hazards and laboratory work.

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Figure 1. Example of the real debris flow from the Illgraben torrent in Valais.

Figure 2. Channel of the debris flow flume with bottom covered in sandpaper to increase the basal friction.

Figure 3. Side view of the WSL debris flow flume channel and deposition platform.

References:

[1] Iverson, R.M., 1997. The physics of debris flows. *Reviews of geophysics*, *35*(3), pp.245-296.

[2] Costa, J.E., 1984. Physical geomorphology of debris flows. In *Developments and applications of geomorphology* (pp. 268-317). Springer, Berlin, Heidelberg.

[3] Major, J.J., 2000. Gravity-driven consolidation of granular slurries: implications for debris-flow deposition and deposit characteristics. *Journal of Sedimentary Research*, *70*(1), pp.64-83.