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Modelling the efficiency of a drainage gallery work in a large landslide with respect to hydrogeological and geomechanical parameter heterogeneity

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This study describes transient hydrogeological and geomechanical models realized jointly in 2006 by the EPFL and GEOMOD SA in the framework of the stabilization work of the La Frasse landslide (VD, Switzerland) (NCG+EPFL, 2003). These models evaluate the efficiency of the drainage gallery below the sliding mass during a crisis in terms of reduction of the deformation velocities and increase of the factor of safety of the landslide.

First, based on a conceptual hydrogeological model, a flow computation including geology and transient hydraulic conditions has been carried out with FEFLOW®. The field parameters (permeability, porosity) were generated stochastically after geophysical and well-core data, enabling in this way to represent the geological variability. Then, the model has been used to evaluate the impact of a deep drainage gallery with subvertical pipes towards the surface in terms of hydraulic pressure on the behaviour of the landslide. Finally thanks to a coupled elastoplastic 3D finite element model (Z_SOIL, 2004) the hydro-mechanical behaviour of the landslide under drainage during a crisis could be evaluated and factors of safety calculated.

As suggested during the feasibility study in 2002-2003 (NCG+EPFL, 2003), the hydrogeological models are very sensitive to the geometry of the field heterogeneities, principally to the connectivity of the permeable structures. In the sliding mass, the flows are represented by a system of multiple aquifers more or less connected. The extension of these hydraulic networks can be metric as well decametric. Moreover, the calibration of the models and the pumping tests realized in 2002-2003 (NCG+EPFL, 2003), show that apart from these metric to decametric permeable structures, it exists locally hectometric structures, resulting from the junctions of small ones. In these conditions of particular high heterogeneity and of complex hydraulic relations, the remediation design has to be able to intercept both the water from the sliding surface and the waters in the whole mass.

In this context, the models cannot in principle define the exact location of the pipes, but enable to establish the mean spacing which should be adopted in function of the local geological conditions encountered during the execution. The results show that a mean spacing between the pipes of the order of 15 m (variant 1) is capable to lower the hydraulic head about 36 m along the work at the sliding surface, and to intercept around 45% of the hydraulic flux of the sliding mass. The variants increasing the spacing to 30 m (variant 2) and then to 60 m (variant 3), indicate a lowering of the hydraulic head from 34 and 30 m respectively. These differences are low from a hydraulic point of view, in return, present implications more obvious in terms of factor of safety (FoS).

Concerning the deformation (hydro-mechanical coupled calculation) the presence of the drainage gallery induces a strong diminution of the predicted displacements (from 101cm for the model without drainage to around 15-20 cm for the drained models (i.e. variant 1, 2 and 3)). The influence of the pipe spacing on the maximal predicted horizontal displacements is very low (14 cm for the variant 1 and 19 cm for the variant 3). In the meantime, only a spacing of 15 m enables a significant gain of security. The variant 1 indicates a FoS=1.30, again FoS =1.15 for the two other variants. For memory, the non remediate model has a FoS of 1.05.

In conclusion, this study enables to validate and confirm the recommended solution in (NCG+EPFL 2003), namely a drainage gallery equipped with pipes with a mean spacing of 10m (pipes mean spacing of the execution project). Indeed the fineness of the mesh used in the numerical models did not enable to insert as many pipes. The results of variant 1 – with a mean spacing of 15m – are considered to be representative of the expected efficiency of the execution project.

REFERENCES

NCG+EPFL 2003: Association technique « NCG+EPFL pour l'étude du glissement de la Frasse », février 2004, Glissement de la Frasse, communes d'Ormont-dessous et de Leysin. Assainissement: Etude de faisabilité 2002-2003. Rapport final.