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Finite Element analyses of soil bioengineered slopes

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Soil Bioengineering methods are not only effective from an economical point of view, but they are also interesting as fully ecological solutions. The presented project is aimed to define a numerical model which includes the impact of vegetation on slope stability, considering both mechanical and hydrological effects.

In this project, a constitutive model has been developed that accounts for the multi-phase nature of the soil, namely the partly saturated condition and it also includes the effects of a biological component. The constitutive equation is implemented in the Finite Element (FE) software Comes-Geo with an implicit integration scheme that accounts for the collapse of the soils structure due to wetting. The mathematical formulation of the constitutive equations is introduced by means of thermodynamics and it simulates the growth of the biological system during the time. The numerical code is then applied in the analysis of an ideal rainfall induced landslide. The slope is analyzed for vegetated and non-vegetated conditions. The final results allow to quantitatively assessing the impact of vegetation on slope stability. This allows drawing conclusions and choosing whenever it is worthful to use soil bioengineering methods in slope stabilization instead of traditional approaches.

The application of the FE methods show some advantages with respect to the commonly used limit equilibrium analyses, because it can account for the real coupled strain-diffusion nature of the problem. The mechanical strength of roots is in fact influenced by the stress evolution into the slope. Moreover, FE method does not need a pre-definition of any failure surface. FE method can also be used in monitoring the progressive failure of the soil bio-engineered system as it calculates the amount of displacements and strains of the model slope. The preliminary study results show that the formulated equations can be useful for analysis and evaluation of different soil bio-engineering methods of slope stabilization.