Earth Surf. Dynam. Discuss.,
https://doi.org/10.5194/esurf-2020-70-RC2, 2020

Earth Surface Dynamics Discussions
Open Access
EGU

Interactive comment on "Stability assessment of degrading permafrost rock slopes based on a coupled thermo-mechanical model" *by* Philipp Mamot et al.

Anonymous Referee #2

Received and published: 22 December 2020

"Stability assessment of degrading permafrost rock slopes based on a coupled thermos-mechanical model" by Mamot et al.

The manuscript reports on the influence of temperature changes on the stability of permafrost affected rock walls. The authors combine rock mechanical and geophysical investigations and numerical studies to explain temperature induced destabilization of deep-seated rock slope instabilities. The study is based on a case study in South Germany (Zugspitze). The paper provides interesting insight to the permafrost situation at the studied site and a series of new laboratory results. However, the paper contains a series of major flaws suggesting that the paper cannot be published in its current form.

Printer-friendly version

Discussion paper

The modelling approach used in this study is an uncoupled approach and thus the title and text are misleading. Regions with anticipated temperature and rock property changes are simply assumed and not modelled. While adjusting rock properties based on temperature changes is an appropriate assumption, a thermo-mechanical coupled approach (as claimed in the title and many times in the text) also requires modeling temperature propagation. Transient temperature and rock property changes may lead to completely different results and may also modify the hydraulic situation. A strongly simplified approach, as used in this paper, needs to be confirmed by truly thermo-mechanical coupled numerical simulations. The required confirmation has not been provided. Thus, the validity of the approach is highly questionable. The black line in Figure 2b indicates the modelling cross section. The cross section ends in the steep rock slope south of the ridge. Thus, the modelling domain is certainly too small and boundary effects must be anticipated. A validation of the size of the model domain is not provided, but mandatory. In addition, the kinematic analysis suggests a combined planar sliding and wedge failure mode. What is dominant? Wedge failure cannot be analyzed in 2D models. Consequently, the results are unreliable. The author′s state that many of the above points are under considerations (chapter 5.3) but clearly beyond the scope of this paper. Unfortunately, I disagree. It is mandatory to investigate these issues before claiming a general approach.

Additional list of major issues: The term “fracture displacement” is used in both the main body of the paper and the supplementary material. From the text it seems that linear strains (fracture opening) have been measured and no displacements (neither relative nor absolute displacements). The factor “D” in the GSI approach was set to zero, because no blasting was performed. Although the GSI approach is highly uncertain, it is clearly stated that in unstable rock slopes “D” equals 1. The derivation of rock mechanical properties for both intact rock and rock mass remain unclear and uncertain. Many rock properties are derived indirectly, although laboratory tests have been performed, which allow a direct determination of static rock properties (e.g. Young′s modulus and Poisson′s ratio, the normal/shear stiffness and shear resistance of frac-

tures). The primary aim of the model is on stability considerations, where elastic properties are typically irrelevant. This can easily be shown in a simple numerical study. Instead, assumptions are made for defining elastic properties, which are not valid. For example, it is assumed that the ratio E/G is analogous to kn/ks. There is no theoretical justification for such an assumption (this is also stated in the cited paper). Saturation plays a major role on how the rock properties changes with changing temperature. I strongly doubt that assuming saturated rock mass conditions in a steep alpine ridge is valid. The natural saturation degree should be measured before performing laboratory tests on frozen samples and should be documented for all test specimens. The influence of the saturation degree and loading rate on the rock properties needs to be analyzed.

Interactive comment on Earth Surf. Dynam. Discuss., https://doi.org/10.5194/esurf-2020-70, 2020.

Printer-friendly version

Discussion paper