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A physical model for measuring thermally-induced block displacements

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A new model for thermally-induced block displacement in discontinuous rock slopes has been recently suggested. The model consists of a discrete block that is separated from the rock mass by a tension crack and rests on an inclined plane. The tension crack is filled with a wedge block or rock fragments. Irreversible block sliding is assumed to develop in response to climatic thermal fluctuations and consequent contraction and expansion of the sliding block material. While a tentative analytical solution for this model is already available, we are exploring here the possibility of obtaining such a permanent, thermally-induced, rock block displacement, under fully controlled conditions at the laboratory, and the sensitivity of the mechanism to geometry, mechanical properties, and temperature fluctuations.

A large scale concrete physical model (50x150x60 cm^3) is being examined in a Climate-Controlled Room (CCR). The CCR permits accurate control of ambient temperature from 5 to 45 Celsius degrees. The permanent plastic displacement is being measured using four displacement transducers and a high resolution (29M pixel) visual range camera. A series of thermocouples measure the heating front inside the sliding block, hence thermal diffusivity is evaluated from the measured thermal gradient and heat flow.

In order to select the appropriate concrete mixture, the mechanical and thermo-physical properties of concrete samples are determined in the lab. Friction angle and shear stiffness of the sliding interface are determined utilizing a hydraulic, servo-controlled direct shear apparatus. Uniaxial compression tests are performed to determine the uniaxial compressive strength, Young's modulus and Poison's ratio of the intact block material using a stiff triaxial load frame. Thermal conductivity and linear thermal expansion coefficient are determined experimentally using a self-constructed measuring system.

Due to the fact that this experiment is still in progress, preliminary results will be available in the next few months. The obtained results may explain sudden triggering of rock slope failures that are not correlated with common failure triggers such as seismic activities, pore pressure build-up, or freezing and thawing of water inside rock joints.