Physical Modeling of the Effects of Various Boundary Conditions on the Block Displacements in the Natural Rock Slopes

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1. INTRODUCTION

Physical modeling is widely used in geotechnical practice mainly to study interactions between structure and soil (rock). These studies are mostly focused on particular projects and models are thus prepared with intension to study particular structure –bedrock interaction. From previous studies on natural rock slopes emerged idea to design and develop modeling device capable to model various natural slope failure mechanisms in convenience of laboratory within limited financial resources and able to simulate wider range of boundary conditions.

2. DESIGN AND DEVELOPMENT OF 2DPMD

The Design of new 2DPMD is based on tilting table concept with added new features as toe slope movement in horizontal and vertical directions with variable separation point distance. The device was designed as "sandwich" type construction with

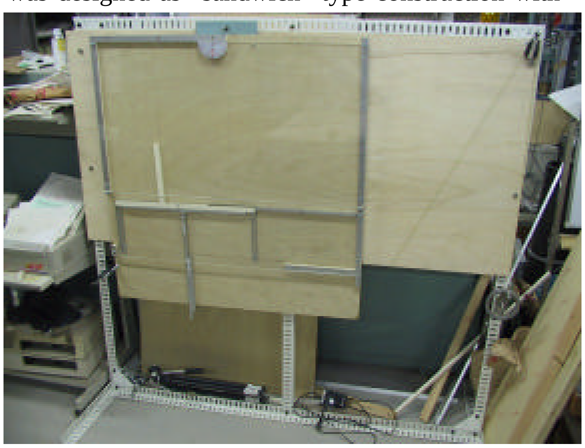

Fig.1 Photograph of 2D physical modeling device

slope model enclosed between wooden base and front acrylic glass. System of sliders is capable of simulating toe slope failure in horizontal and vertical directions with range of 200 mm. The slider system is designed to be even capable of simultaneous movement in both directions. The failure of the toe area is at this point induced manually. Further the separation point which is controlling the volume of sliding mass is possible to change in range -10 to +10 mm where 0 coincides with the toe of the slope and positive direction is towards the slope. The 2DPMD is accepting models of slope with model height up to 675 mm and width 812 mm.

After careful consideration of various factors a proper material was selected to be two-component silicon rubber (omega-hydroxypolydimethylsiloxane) with commercial name LUKOPREN N 1522. This material is often used in mould casting industry and therefore is possible to easily prepare various kinds of models. The density of material is 1250 kg/m^3, friction angle between two blocks is 29° and friction angle between material–base and material–acrylic glass are 37° and 33° respectively. The contacts with base and front surfaces can be however neglected in vertical position.

3. PHYSICAL MODELING METHODOLOGY

After creating a model of slope with desired parameters the blocks are cut representing joints in the field. After block cutting is finished a marker is glued to each block centroid to ease the identification of each block during movement. To record the movements a video camera on stand is used. The distance of digital video camera is about 2 m from device. The desired movement is induced manually whether it is rotation or toe slide failure. Various toe volume masses are controlled by changing the distance of separation point. The continuous video recording is brought to computer where it is cut into slides and selected slides are analyzed.

The device was used in the study of various boundary conditions on the failure mechanism and the block displacements of the upper slope triggered by toe slope failure. Altogether 72 physical model tests were performed while changing parameters such as toe slope angle, toe slope movement direction, toe slope volume and block shape and size. To study the input parameter effect on the upper slope block displacement cumulative displacement of reference point (located in the toe slope area) were compared to cumulative displacement of measured point (located in the lower portion of the upper slope).

4. RESULTS AND CONCLUSIONS

From the conducted test it was concluded that it is possible for the failure mechanisms like toppling and reverse toppling to develop even in conditions where the basal plane of the blocks is oriented horizontally. Furthermore, the study of the boundary effects on the upper slope block displacements revealed the fact, that gentler oriented toe slope movement directions generated smaller displacements in the upper slope compared with steeper toe slope movement directions. The study of the toe slope angle effect revealed tat there is an increase in the upper slope block displacement with increasing toe slope angle, however, this increase is rather small.