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Investigating Shear Bands Propagation in Sands by Using the Developed Elemental-like Direct Shear-faulting Box

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ABSTRACT

This study investigates faults propagation in granular soils using the developed elemental-like direct shear-faulting box by detecting shear bands formation within soil samples. For this sake, first, some modifications are applied to the direct shear box in the Earthquake Research Institute. In this regard, two blocks are built at an angle of 45 degrees that can be moved relative to each other. Transparent walls are employed to increase the static resistance. Moreover, four screws are installed on the floor of the device. The friction in the test is reduced by using several ball bearings. The required thickness for the box walls is determined using a numerical simulation in ABAQUS software. To investigate faulting in granular soils, Firoozkooh sand is utilized and placed in the developed shear box. The overhead load is modeled by applying air pressure to a rubber membrane containing water. By continuous imaging of soil profiles, alterations in the soil surface are recorded, and an image correlation method is employed to predict the amount of fault-induced displacements, strains, and dilations. Results verify that the dilation effect elevates with increasing moisture content and wanes with the addition of fine-grained percentage and by boosting vertical loads. Moreover, various behavior has been observed without softening for cementitious sands.

Keywords: Faults propagation Developed elemental-like direct shear-faulting box, Firoozkooh sand, Digital image correlation method

1. INTRODUCTION

Available studies acknowledge that due to the movement of bedrocks and faults, rupture spreads to the earth's surface, which is usually accompanied by relative displacements. In most cases, these relative displacements create irreversible damage to the structures. Two earthquakes in Turkey [1], [2], and Taiwan [3] indicated that shallow faults have deleterious effects on structural buildings and infrastructures. To alleviate these effects, one should avoid constructing in the danger zone. It needs to determine the location of a potential earthquake-induced by a surface fault rupture. To analyze faults rupture propagation, the localization of shear deformations known as shear bands should be studied [4]. The localization of shear strain theory is developed by Tomas for non-elastic porous media [5]. This theory has been utilized to forecast shear bands propagation [6]. Investigating shear bands still has various unknown aspects; nevertheless, it can lead to a more accurate prediction of surface faulting [7]. Owing to the inherent heterogeneity of soil materials and varieties in the type of sands, different reports have been mentioned in the technical literature, claiming that a comprehensive model for estimating the shear bands in all sandy soils has not yet been developed. Investigating the key factors related to shear bands propagation can contribute to a better understanding of the constitutive models of sandy soil. By assessing the existing faults and the amount of safety provided in the structures, it is plausible to estimate the