EXPERIMENTAL INVESTIGATION OF FAULT RUPTURE- SOIL- STRUCTURE INTERACTION

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In an earthquake, the rupture of a fault generates two types of ground displacement: permanent quasi-static deformation nearby the fault itself, and transient dynamic waves away from the fault. On the past decades, less attention has been paid to the direct consequence of the fault-rupturing on the overlying soil and structures located on or nearby it. The recent Turkey and Chi-Chi (1999) and Wenchuan (2008) earthquakes offered numerous examples of devastating effect of fault-rupturing to many structures constructed over the outcrop of faults.

Due to its practical importance, the issue of fault rupture propagation through a soil layer, has recently attracted considerable attention in the technical literature consist of field studies, physical and numerical modelling. So many research in all above fields, have been performed to study the fault rupture- soil- foundation- structure interaction problem.

The other important point is that in most of previous studies, the effect of presence of structure has not been modeled directly in the analyses. Considering relatively enough background literature in the field of fault rupture- soil- foundation interaction, in the present study, the effect of modelling of structure has been investigated by experimental method. Physical modelling is done by 1g test apparatus at IIEES Geotechnical Lab. The selected structure, is a steel frame which representing a moment frame building standing on a sand layer. The structure is designed and made by scale 1/10 and tests are also performed by this scale. Beams and column elements are made by rectangular sections and are connected to each other by bolts as shown in Figure 1. The plastic hinges during the fault rupture, are formed at these connection joints. The moment capacity of each connection can be adjusted by screwing the bolts.

In order to study the coupled effect of fault rupture on structural elements and the structure on propagating of rupture through the soil layer, first a reverse faulting test for free field has been done. Then, the effect of changing the position of structure relative to fault outcrop and foundation type are investigated by performing three reduced-scale tests. The results of these tests are presented for parameters such as location of fault rupture outcrop, story drifts, rotation of foundation and relative rotation of structural elements. These results are obtained from image processing technique and are checked by output data of digital sensors. The instrumentation is consist of four LVDT inserted at both stories of the front structural frame and also strain gauges type TML-FLA-5-11 used for all columns and one of beams.

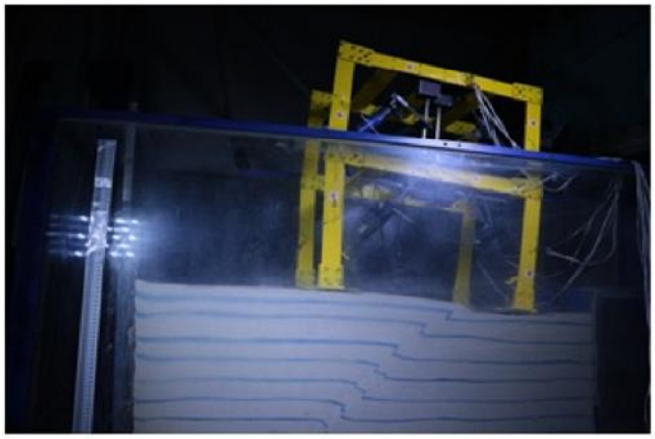

Figure 1. Photo of deformed shape of soil and structure at the end of reverse fault rupture

Figure 1 shows the arrangement of structure instrumentation and deformed shape of soil layer and structural frame for fault rupture- soil- structure system cases.

Finally the results of these two cases (free field and coupled fault rupture- soil- structure system) have been compared to each other to study the effect of presence of structure on fault outcrop and rupture mechanism in soil layer. Comparison between the results of coupled tests, shows that surface fault rupture has been diverted more effectively for strip foundations. Using single footings result more deflection and rotation in structural elements whereas strip foundations causes more global rotation in whole structure. Also the position of structure with respect to fault outcrop has a significant role on it's response such as structural rotation and drift.

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