AN INVESTIGATION ON THE EFFECT OF SLIP VELOCITY OF FAULT ON ITS PROPAGATION THROUGH SOIL

Mohammad AHMADI
PhD Student, IIEES, Tehran, Iran
mo.ahmadi@iiees.ac.ir

Meysam FADAEE
Assistant Professor, Islamic Azad University, Science and Research Branch, Tehran, Iran
m.fadaie@iiees.ac.ir

Mohammad Kazem JAFARI
Professor, IIEES, Tehran, Iran
jafari@iiees.ac.ir

Keywords: Fault Rupture, Slip Velocity, Quasi-Static Behavior, Inertial Effect

Due to the damages of many structures like buildings, bridges, dams, tunnels and etc., by the permanent relative displacement of surface fault, it is too important to investigate fault rupture propagation. The occurrence of three tremendous earthquakes of 1999 in Turkey and Taiwan was the start of a comprehensive study of the fault rupture propagation and its effect on the structures on the ground and also underground facilities.

There were conducted many study to have a more insight view on the effect of surface fault rupture by using physical and numerical modelling. In these studies a relative dislocation were applied to the two plane of the fault to simulate fault propagation. It is a serious question that how should this faulting applied to the model? Is the faulting a static phenomenon or a dynamic one?

By a comprehensive review in fault rupture literature it can be concluded that in many research the inertial effect of fault in not considered. Many studies declare that fault rupture propagation is in quasi-static mode. For instance, Loukidis et al (2009) suppose that its numerical simulation for fault rupture propagation is quasi-static and this implies that any inertial effect due to rupture propagation is ignored. He notice that this is due to the order of slip rate of fault rupture and it is small enough in soil so the hypothesis of quasi-static behaviour of fault rupture propagation can be fully be true. In his study the increment of displacement was chosen as small as possible for simulate it in a quasi-static mode. Despite of this supposition in almost every study for fault rupture propagation, it needs more studies to light shed on this assumption.

In this investigation an exclusive search was done to more shed light on this assumption. It is noticed that there is a difference between two definitions in the fault rupture literature, Slip Rate and Rupture Velocity. Rupture velocity is the velocity of the propagation of rupture of bedrock and can be as large as more than half of shear wave velocity of rock. But slip rate is the velocity of the displacement of two plane of fault in comparison with each other. The main goal of this study is reaching to a truly value of slip rate as it was known this parameter can make a better decision on the static or dynamic behavior of faulting. It was reviewed many researches that contain a topic about slip rate in faulting. It can be concluded their measured and calculated slip rate in their studies show a value of less than 2 m/s that mostly of them are in the range of 1-0.5 m/s. Also this speed reduced by decrease of shear wave velocity of earth material. As it was known the soil's shear wave velocity is much less than rock so the sleep rate will decrease rapidly through soil. This can be as a conclusion that behavior of fault rupture slip can supposed to be quasi-static. So the inertial effect of fault rupture is negligible. This means that in numerical simulation and physical modeling test the speed of faulting is less important and can be slow enough.

Table 1. The mean value of slip rate versus seismic magnitude (Trifunac, 1995)

Mean value of slip rate (cm/sec)	Earthquake magnitude
1-2	3
4-9	4
17-22	5
72-90	6
104-157	7

In the other part of this research the assumption of static behavior of faulting validated through numerical simulation by using powerful finite element method software. In these series of simulations the speed of faulting changes to investigate the effect of it on the behavior of faulting. This test will be simulated in the dynamic mode. Also a series of static test conducted to be compared with the dynamic ones. The comparison of results show that in the small value of faulting speed, the dynamic simulation of faulting act like a simulation in static mode but by increasing of the faulting speed much more than a determined value, the inertial effect of soil mass can affect the propagation of faulting. Figure 2 shows displacement distribution contours through soil during faulting as an example of output data.

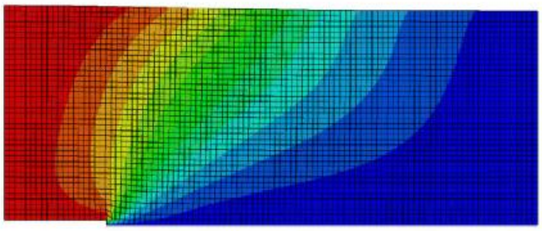

Figure 1. Displacement distribution contour through soil during faulting

REFERENCES

Ani Anil-Bayrak NIA (2009) Fault Slip Velocities Inferred from the Spectra of Ground Motions, *Bulletin of the Seismological Society of America*, 99 (2A): 876–883

Day S (1982) Three-dimensional finite difference simulation of fault dynamics: rectangular faults with fixed rupture velocity, *Bulleting of the Seismological Society of America*, 72 (3): 705–27

Loukidis BP (2009) Analysis of fault rupture propagation through uniform soil cover, *Soil Dynamics and Earthquake Engineering*, 29: 1389–1404

Trifunac MD (1995) Duration of Earthquake Fault Motion in California, *Earthquake Engineering and Structural Dynamics*, 24: 781-799