Probability models of asperity constructed in terms of co-seismic displacements along surface rupture zones

Zhengfang Li¹ and Bengang Zhou²

¹Institute of Geology, China Earthquake Administration, Beijing, China (lizhengfang07@163.com)
²Institute of Geology, China Earthquake Administration, Beijing, China (29878086@qq.com)

Usually, an earthquake of magnitude Mw6.0 or greater can produce a rupture zone on the surface of the Earth's ground. And displacements can be observed along such a rupture zone, called co-seismic displacements. Although these surface displacements are somewhat different from slip on the rupture plane of the causative fault, which is often vertical or sub-vertical, there exists a certain proportional relationship between them. It means that major slip at depth can produce bigger co-seismic displacements on the ground. As assumed above, major fault slip is generated by asperities. Thus it is possible to establish an asperity model in terms of data of ground co-seismic displacements.

Asperity models can be used to describe heterogeneities of the rupture plane of the fault as an earthquake source. This work follows such an idea that an asperity is defined as a region in which the slip is larger by a prescribed amount than the average slip over the entire fault. Because co-seismic displacements along a surface rupture zone depend on slip on the subsurface fault, we attempt to construct probability distribution model for a seismic source in terms of such displacements observed on the ground. Using data of 10 historical earthquakes of Ms7.0 or greater in western China, we make a statistical analysis to distributions of co-seismic displacements on surface rupture zones, yielding the probability distribution model based on a series of ratios of maximum displacements to the average ones in intervals on the rupture. Then, upon the lower and upper limit values of these ratios, we infer the asperities along the rupture zones and analyze further the relationships between asperity parameters, rupture geometries, and earthquake magnitudes based on real data of more earthquakes. Finally, we use the data of the 2001 Kunlunshan Mw7.8 event to test this approach for construction of probability model of asperity and discuss its possible application to assessment of seismic hazard.

Keywords: Probability model of asperity, fault slip, surface rupture, co-seismic displacement