Probabilistic seismic hazard analysis on long fault source

*ChengYu Pan[1], YuanChei Wu[1]

1.INER

When we are defining the geometry of a long fault source in PSHA, we seek for the geological or geophysical evidence. In a complex tectonic environment such as plate boundary region, the defining of the fault is important, thus logic tree combining the evidence of existing geological or geophysical survey is added in. We then use these facts to divide a fault system into several segments or defining two faults individual even though they are close to each other. But we often face a situation that the earthquake does not always occur on existing fault. And sometimes the magnitude of an earthquake does not go with the length of a fault as we expected. It seems like the applying of logic tree may still miss some of the possibility of one source due to the incompleteness of field survey. However, as we know that the principle of PSHA already considered the possibility of different size of length and magnitude of a fault. So, another way to describe a long fault source is to consider the fault system as a whole and setting up a range of length and magnitude.

In this study, we apply both method mentioned above to two cases in Taiwan. One is on the east boarder of Taiwan, the Longitudinal Valley fault. The other located in Taiwan Strait is called Binhai fault. And the comparison of these two methods will be shown as result.

Keywords: Probabilistic Seismic hazard analysis

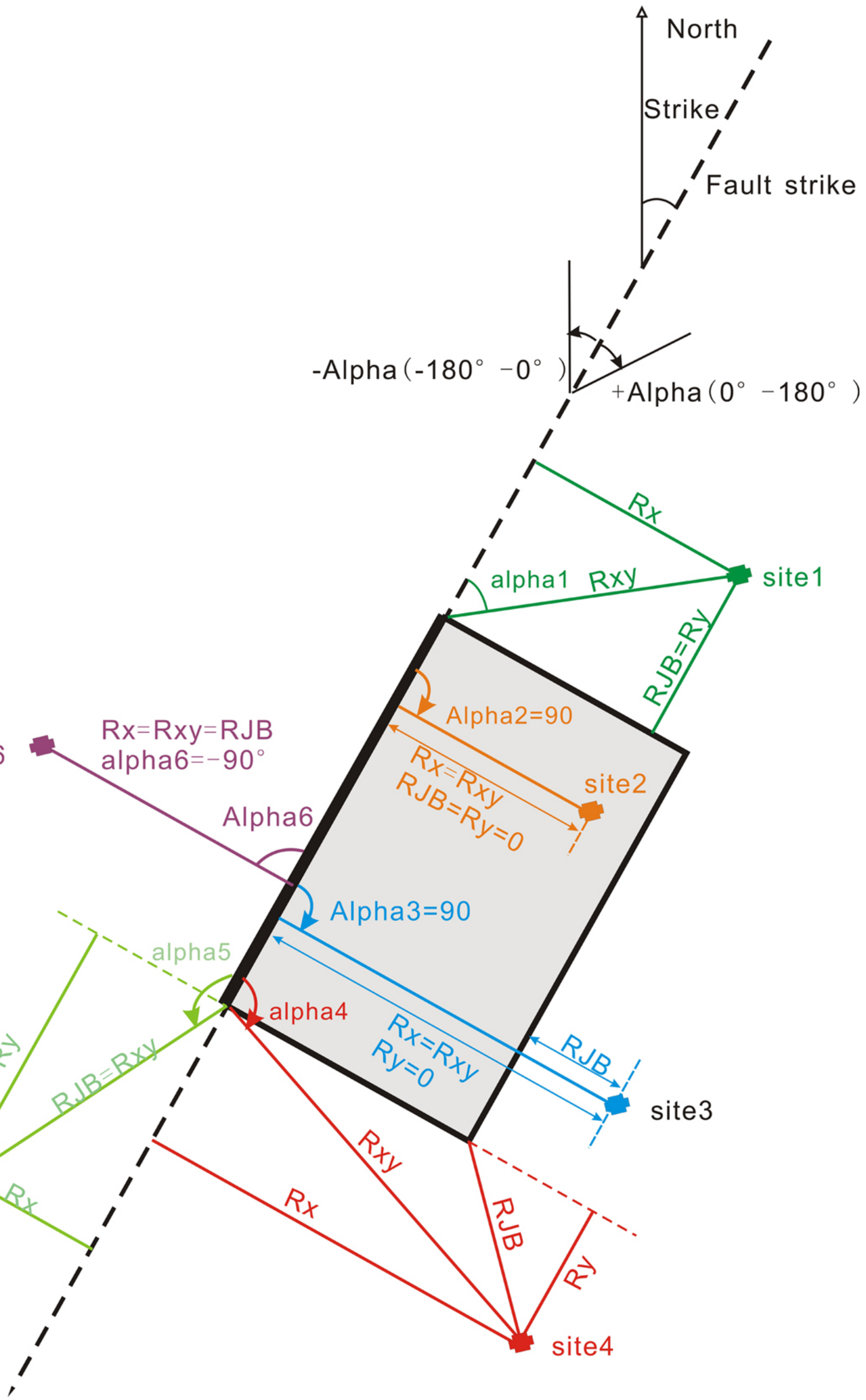
Physical equations for calculating fault-to-site distances used in NGA GMPEs based on earthquake source geometry

*xiaoliang zhang[1], yushan zhang[1]

1.China earthquake disaster prevention center

NGA GMPEs (NGA-West1, 2008 and NGA-West2, 2014) are beginning to be widely used in seismic hazard analyses. However, these new models are considerably more complicated than previous GMPEs, and they require several more input parameters. Users are faced with the challenge of estimating unknown input parameters when implementing NGA models.
In this paper, we are interested in fault-to-site distances parameter. Scherbaum *et al*. (2004) (termed “SSC04”) ever developed empirical expressions for converting source-to-site distance measures using simulated source geometries. The conversion equations are in the form of polynomial functions of M, R_{JB}, and style of faulting. Kaklamanos *et al*. (2011) (termed “KBB11”) derived physical equations relating the three distance measures (R_{JB}, R_{RUP}, and R_X) found in the NGA 2008 models using various geometric principles. KBB11 used the Joyner-Boore distance (R_{JB}) as the primary distance measure to compute other distances (R_{RUP}, R_X) by characterizing the earthquake source by the geometric parameters down-dip rupture width *(W)*, depth-to-top of rupture (Z_{TOR}), fault dip (), and source-to-site azimuth (*alpha*). When R_X is also needed (as in the AS08 and CY08 models), KBB11 method is advantageous, because R_X cannot be estimated using the SSC04 relationships (because R_X had not yet been introduced as a distance measure in 2004). One other potential issue is that the SSC04 equations are technically only applicable for R_{JB}<100 km, whereas KBB2011 equations are physically derived and are applicable for any distance range at which the flat-earth assumption is valid (typically, several hundred kilometers).
KBB11 used the Joyner-Boore distance (R_{JB}) as the primary distance measure to compute other distances (R_{RUP}, R_X). But in one situation R_{JB} is equal to zero, which means the site is located directly above the ruptured area; either R_X or R_{RUP} must be specified in order to calculate the third distance parameter using KBB11. In some other situations, when the fault trace and site location is known, we need to simulate the ground motion caused by different segment rupture of the whole entire fault. In these cases, the R_X and R_{XY} are easily measured by GIS tools but the R_{JB} is dependent on the down-dip rupture width *(W)*. In this paper we introduce a new distance measure R_{XY} (the closest distance from top of rupture) which is used to estimate source-to-site azimuth *alpha* (sin(*alpha)*= R_X/ R_{XY}) and R_Y (R_Y= R_{XY}·cos()). Based on KBB11 we derived distance equations using the R_X and R_{XY} to compute R_{JB}, R_{RUP}, R_X, and R_{Y0}.

Keywords: NGA GMPEs, source-to-site distances, RJB


North
Strike
Fault strike
-Alpha (-180° -0°)
+Alpha (0° -180°)
Rx
alpha1
Rxy
site1
RJB=Ry
Alpha2=90
Rx=Rxy
RJB=Ry=0
site2
site6
Rx=Rxy=RJB
alpha6=-90°
Alpha6
Alpha3=90
alpha5
alpha4
Rx=Rxy
Ry=0
RJB
site3
Ry
RJB=Rxy
site5
Rx
Rxy
Rx
RJB
Ry
site4

A comparison of USGS National Seismic Hazard Maps with observed ground motions

*Sum Mak[1], Danijel Schorlemmer[1]

1.Helmholtz-Zentrum Potsdam Deutsches GeoForschungsZentrum GFZ

People’s confidence to scientific models accumulates through continuously validating the models’s predictions by observations. We compared the seismic hazard forecasts of the four published versions of USGS National Seismic Hazard Maps with the observed ground motions since 2000, which are largely prospective to the models. We verified that the observed seismic hazards computed from macroseismic intensity records were comparable to those from instrumental records. This provides a usable source of data for model testing for the Central and Eastern United States, where instrumental records are almost nonexistent. The observed hazards were found to be generally consistent with the forecasted ones for peak ground acceleration. The forecasted hazards for spectral acceleration at 1 s for California appeared to be conservative. Recent versions of the model were often in better agreement with the observations. Small earthquakes, as expected, were found to have insignificant impact on spectral acceleration at 1 s. Induced earthquakes showed an obvious impact to seismic hazard for short return periods, while that for long return periods was less clear. We examined the sufficiency of data amount by computing the statistical power of tests.

Keywords: Probabilistic seismic hazard assessment

A study on introducing epistemic uncertainties to National Seismic Hazard Maps for Japan

*Nobuyuki Morikawa[1], Hiroyuki Fujiwara[1], Jun'ichi Miyakoshi[2], Mitsutaka Oshima[2], Takeshi Morii[2]

1.National Research Institute for Earth Science and Disaster Prevention, 2.Shimizu Corporation

After the 2011 great Tohoku earthquake, consideration of epistemic uncertainties in seismic hazard assessment has been one of the most important problems in Japan. In this study we show an example of the probabilistic seismic hazard assessment which considered epistemic uncertainty.
In National Seismic Hazard Maps for Japan published by Earthquake Research Committee of Japan (ERCJ), epistemic uncertainties such as probability of earthquake occurrence, modeling of fault geometry, modeling of earthquake activity are partially taken into consideration, in accordance with the long-term evaluation. If enough information is lack in long-term evaluation, then certain measures should be taken against epistemic uncertainties, by taking complementary information into account. However, the current seismic hazard assessment does not meet such demands. In our study, we show an example of treatment of such uncertainty in modeling the probability of simultaneous activity of multiple segments and resultant seismic hazard.
In the new version of long-term evaluation of active faults by ERCJ, probability of earthquake occurrence caused by simultaneous activity of multi-segment faults are indicated as “unknown”. As to these multi-segment faults events, two models shown below are proposed (Oshima et al., 2015).
Model1: Assign probability of earthquake occurrence for each segment's independent activity to multi-segment faults events.
Model2: Assign occurrence frequency of each segment estimated by average slip velocity to multi-segment faults events.
The model1 takes into account the long-term evaluation saying that “the probability of earthquake occurrence does not become larger than that of each segment’s independent activity”. Thus, the probability for multi-segment faults events that contain the segment with zero-probability of occurrence are also set to zero. However, the activities of neighboring segments have the potential to trigger the event at the segment where the possibility of independent activity is evaluated as “almost zero”. In model2, probabilities for such events are not set to zero.
As to the results of hazard analysis for aforementioned two models, the difference in hazard curves can be seen only in quite low probability range (e.g., exceedance probability of 0.1% in 30 years). Because information on rare events tend to be short and indicated as “unknown” in long-term evaluation, modeling with consideration of epistemic uncertainty is essential to take aim at hazard analysis that calls extremely rare events into account.

Keywords: Probabilistic seismic hazard assessment, Epistemic uncertainty, Seismic activity model, National Seismic Hazard Maps for Japan

