Estimation of 3D shape of bedrock around Hsinchu-city, Taiwan using gravity survey

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To estimate the earthquake ground motions, it is important to know the ground structure. For this purpose, we have many kinds of technique for the geological survey, though some of them may be costly. The gravity survey is suitable for the survey of very large area and can provide detailed configuration of bedrock.The geological setting of Taiwan is really complicated because there is a boundary between the Eurasia plate and the Philippine plate, and there are so many active faults in the Taiwan island. Thus we carried out the gravity survey around Hsinchu city, and estimated the 3-D bedrock structure. Furthermore, we show preliminary results of numerical simulation of earthquake ground motions in this area.

The observation area is located in 24^o39'N to 24^o55'N and 120^o50'E to 121^o12'E where is 30km of NS and 40km of EW. This area includes Hsinchu-city,and Hsinchu-county. The observation sites with 1km interval were set. We spent 20 days for the observation during 7th to 28th September, 2006 and got values of the gravity at 393 sites. For the survey, we used Automated Burris Gravity meter by ZLS Corporation and Type G Gravimeter by LaCoster & Romberg. Positions of the observation sites were determined by the differential survey of GPS. The horizontal and vertical error of the position is less than 1m.

We analyzed our own data at 393 sites with the 60 existent gravity data. After some corrections such as corrections for height of the instrument, tide, drift, terrain, free-air, and Bouguer correction, the Bouguer anomaly can be obtained.

To determine the density of sediment, we used a method to examine the correlation between the Bouguer anomaly map and topography(Komazawa, 1988). As a result, the assumed density is determined as 2.10[t/m^3].

The Bouguer anomaly in the target area is negative and the absolute value of the anomaly increases from north-west to south-east. This trend is independent of the topography of the hilly area. Around the south-eastern area of the Hsinchu city, minimum value of the Bouguer anomaly is observed. This minimum value seems to correspond to the local minimum which is shown in the Bouguer anomaly map for whole Taiwan island. In this area, furthermore, it is observed that the steep change in Bouguer anomaly corresponds to the topography.

Then, we estimate the 3-D gravity basement under the assumption that the ground consists of two layers which consist of the homogeneous sediment with density 2.1[t/m^3] and basement with 2.4[t/m^3]. To obtain a realistic model of gravity basement, we consider the follows: to remove the contribution for the Bouguer anomaly from the deep structure such as upper mantle and to constrain the depth to the bedrock. For the former, a band-pass filter is applied to the Bouguer anomaly. For the latter, we give three control points using deep borehole data. In this analysis, we assumed that the boundary between the sediment and basement is upper surface of the Cholan formation. Thus, we calculated the 3-D shape of the gravity basement by using a method proposed by Komazawa(1998).

Consequently, depth of the gravity basement reaches to more than 1200m at the south-eastern area and about 200m around the downtown of Hsinchu city. Furthermore, steep slopes of the gravity basement are observed around the southern area of Hsinchu city, whose location corresponds to the known fault; Hsinchu and Hsincheng faults.

Using the obtained structure, we simulate numerically the ground motions by an earthquake whose epicenter is located in the target area. Comparing the numerical results with the motions observed at a site in Hsinchu city, we modified slightly the model of the bedrock to fit the travel time of P- and S-waves. In this calculation, since we have the observed data at only one site, the further calculations will be carried out to obtain more appropriate model of the ground structure.