A Study on the New Evaluation Method for Liquefaction Considering Topology and River Basin

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1. Introduction

The liquefaction hazard maps based on Japanese national method have been published by local governments. The national method has three grades; the first grade is very simple method which uses just normal topographic data, the second grade uses microtopography, and the third grade uses microtopography and PL (Potential of Liquefaction) value using the results of Standard Penetration Test (SPT). The PL value is accumulated the FL (Factor of Liquefaction) value from surface to 20m depth. And the FL values are calculated through N-value of SPT in simple method.

The third grade method has enough accuracy for estimation of damages by liquefaction, however, many SPT data are required to associate the PL value with the microtopographic data, however, the many SPT data are concentrated around urban area. Therefore, the most of local governments evaluates liquefaction potential using the first grade method.

On the other hand, many geographical data, such as watershed, have been published by Japanese Geographical Survey Institute as well as the microtopography. J-SHIS (Japan Seismic Hazard Information Station) has also published AVS (Average of Shear Velocity) distribution by 250m mesh of topographical map.

The ground are constituted of sedimentation by river activity. Then it is seemed to be available for improvement of Geo-hazard estimation that the river basin is considered into topographical classification. In this study, new evaluation method, which is based on new classification of topography using river basin, is proposed.

2. Comparison with Existing Liquefaction Potential Map around Kanazawa City

Cooperation of Hokuriku branches, Land Infrastructure and Transportation Ministry and Japan Geotechnical Society, have published high accuracy Liquefaction potential Map at July in 2013 as shown in Figure 1. In this map, the technical judgment by local professional engineers were adopted, the liquefaction potentials for each microtopographies were not estimated only by PL value.

The rank of liquefaction potential is classified into four ranks, rank 1 means very low potential of liquefaction and rank 4 is highest potential. The rank -1 means out of evaluation, such as mountainous area.

The distribution of SPT data is shown in Figure 2. It is found that most of borehole logging are concentrated around urban area, then the estimation of liquefaction potential using PL value in suburban area has only one or two SPT data. In case of very few SPT data, the evaluation leads to unrealistic estimation, therefore the local professional engineers have to correct the estimation of the rank.

However, the judgment by professional engineers has also uncertainty, the establish of clear routine for evaluation of liquefaction potential is required. In Figure 3, the polygons of topography are divided by river basin, the estimation of liquefaction potential have been carried out by average of PL value including each polygons. There are some polygons which have no PL data, and the rank of such polygons is also set to -1.

Some polygons of topography in the highest accuracy map are divided by local professional engineers, then the topographical polygons are not same in Figure 3.

The automatic evaluation using PL value in Figure 3 seems to have enough accuracy compared with the highest accuracy map, though the topographical classification is not enough even divided by river basin.

As mentioned above, we need more information to classify the topography into more detail. The J-SHIS map provides AVS as well as rough topography in 250m mesh. As the AVS is concerned with ground stiffness, this information is available to classify the topography. In the
many 250m mesh, the AVS value and topographical classification are same, then those meshes are dissolved through GIS tool. Moreover the dissolved polygons are divided by river basin, and the estimation of liquefaction potential rank using $P_L$ value is shown in Figure 4.

Although the J-SHIS map has not enough details, the estimation rank around dune and top of alluvial cone is same as the highest accuracy map.

### 3. Concluding remarks

The new routine estimation methods were compared with the highest accuracy map.

The new division of topography using river basin is seemed to be available for the clear routine estimation method, though more borehole logging are required for improvement of accuracy. If the borehole data have corrected much more, this method will indicate realistic estimation.

The J-SHIS map with AVS and rough topography is also seemed to be available for detail classification of topography.

The combination of topographical classification by AVS will be useful for complementarity of river basin classification. However, the topographical classification in J-SHIS map is very rough and the region is different from other topographical map. Then we need some ideas for combination of these data.

The comparison should be performed another area to confirm the accuracy of classification and estimation method. The highest accuracy map of liquefaction potential for Niigata prefecture was also published. This area was subjected to liquefaction damages at Niigata Chuetsu Earthquake in 2004 and Niigata Chuetsu-oki Earthquake in 2007, therefore we can check our routine method. In near future, we will perform the comparison using the Niigata liquefaction potential map.

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### References