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MICROZONING OF LIQUEFACTION POTENTIAL BASED ON THE QUANTIFICATION OF QUALITATIVE DATA PROCESSING

S. M. Fatemi Aghda*, A. Suzuki**, T. Akiyoshi**, Y. Kitazono**

*Graduate school of science and technology, Kumamoto university, SM.JSCE
**Department of Civil and Environmental Engineering, Kumamoto university, M.JSCE

Introduction

The most important problem in the risk analysis is how to predict unstable area. There are numerous methods to hazrd potential delineation, include on-ground monitoring, photogrametry, satellite imagery, remote sensing techniques, deterministic, statistical and probabilistics, overlay methods, and numerical modelling by the computer.

A using method in this work, is a method based on the application of the quantification theory method II(Hayashi, 1952), which is a mathematical–statistical method in order to convert qualitative data into quantitative relations. Two effective items in liquefaction potential in terms of seismic, and geotchnical items are considered to express the basic characteristics of liquefaction potential of the study area.

Based on the data taken from two zones of the area which suffered earthquake in the past include, liquefied and non liquefied zones, the degree of contribution to liquefaction phenomena of each category in the selected items, is evaluated through the quantification of qualitative data processing. The obtained results compared with other method's results and also with induced result by earthquake in the past.

Study area

The selected area for study is located in northwest of Iran(Gilan plain), which suffered catastrophic earthquake on June 20, 1990. The widesperead liquefaction phenomena due to ground failure induced by earthquake with Ms=7.6, caused damages to foundation of buildings, differential settlements of structures, channels of water, farm lands and so on in the plain area.

Data analysis

The study area is divided into about 104 meshes of 1250m*1250m on the geological map of the scale 1:250,000. Among many factors which may have some influence on liquefaction, the seismicity and geotechnical items are selected from a review of the various literatures, engineering judgment, available statistical data, and previous studies. The selected items, have two to five factors, which each has two to five category. The total of 21 categories were adopted for evaluation of liquefaction potential. The selected factors, categories, and value to each category given in Tables 1 to 3.

Based on these categories, the items are determined on each mesh by using, obtained data from boreholes log, graine size distribution curves of soils, and seismic behiviour of soils. Using quantification method II, and obtained data from liquefied and nonliquefied zones, the category weights were determined, and these two zones of probability variables were separated with success rate of 94.23%. The calculated category weights(x_{jk}) for total of categories given in Table 4.

Table 1. Item of relative site amplification (after Shima 1978)

geological units	given value to categories*
Peat	1
Humus	2
Clay	2
Loam	3
Sand	4
Others	5

* Liquefaction susceptibility rate of categories: 1= very high; 2= high; 3= medium; 4= low; 5= very low

Table 2. Item of intensity incerments(after Medvedev 1962)

geological units	given value to categories*
Granites	5
Limestone,sandstone, shales	4
Gypsum, marl	4
Coarse material ground	3
Sandy ground	3
Clayey ground	3
Fill	2
Moist ground	2
Moist fill and soil ground	1

* Liquefaction susceptibility rate of categories: 1= very high; 2= high; 3= medium; 4= low; 5= very low

Table 3. Item of geotechnical characteristics

Thickness of sandy layers	Water table (W.T)	given value to* categories
T > 3m	W.T < 1m	1
2 < T ≦ 3m	1 < W.T ≦ 3m	2
1 < T ≦ 2m	3 < W.T ≦ 5m	3
0.5 < T ≦ 1m	5 < W.T ≦ 10m	4
T < 0.5	W.T > 10m	5

Continue of Table 3

Thickness of surface layer	Type of soil D_{50}	given value* of categories
T.S < 3m	SP .02 ≦ D_{50} <.4	1
3m ≦ T.S < 5m	SW .4 ≦ D_{50} < .8	2
5m ≦ T.S < 7m	SM .8 ≦ D_{50} < 1.2	3
7m ≦ T.S < 9m	SC 1.2 ≦ D_{50} < 2	4
T.S > 9m	Others D_{50} ≧ 2	5

* Liquefaction susceptibility rate of categories: 1= very high; 2= high; 3= medium; 4= low; 5= very low

Then based on this classification and characteristics of liquefaction susceptibility and liquefaction opportunity, the simillarity of the data of other meshes whose liquefaction potential is unknown, were analysed.

Table 4. Calculated category weights

Items	Category No. (jk)	Category weight (x_{jk})	Range
I	1.1	0.000	0.015
	1.2	-0.051	
	1.3	-0.045	
	1.4	-0.022	
II	2.1	0.000	0.188
	2.2	-0.022	
	2.3	-0.188	
III	3.1	0.000	0.051
	3.2	-0.016	
	3.3	-0.035	
	3.4	-0.051	
	3.5	-0.006	
IV	4.1	0.000	0.248
	4.2	0.084	
	4.3	0.149	
	4.4	-0.099	
	4.5	-0.033	
V	5.1	0.000	0.057
	5.2	0.057	
	5.3	0.019	
	5.4	0.044	
	5.5	0.011	
VI	6.1	0.000	0.377
	6.2	0.377	
VII	7.1	0.000	0.686
	7.2	-0.305	
	7.3	-0.348	
	7.4	-0.686	

I= Relative site amplification item; II= Intensity incerments item; III= Thickness of sandy layer; IV= Water table; V= Thickness of surface layer; VI= D_{50}; VII= Type of soil,

Conclusions

As the results of analysis, the values of category weights are obtained. The category with large value has a low contribution to liquefaction. On the other hand, the category having small value of category weight means that the contribution of it to liquefaction is high. The values of difference between maximum and minimum values of category weights in the item, is as a range and show the degree of contribution of items for judgement whether a mesh is classified to the liquefaction zone or nonliquefaction zone. It corresponds with our common knowledge on area that which items have more large effects.

Based on the analysis, factors of type of soil, D_{50}, water table, and intensity incerments have larger range among others, and show the high degree of contribution to liquefaction susceptibility. The results of analysis using method II, show high degree of agreegation to results of other analysis methods, specially with geological engineering data base system results in the Gilan plain.

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