Chapter 5 Implementation Process and Results of Seismic Hazard Assessment and Seismic Risk Assessment

5.1 Evaluation Policy

In both seismic hazard assessment and seismic risk assessment, it is required that state-of-the-art technology be duly reflected in the project and procedure transferred to CPs be fully conductible so that CPs can carry out the assessments by themselves after completion of the project. Outline of each assessment is described below.

(1) Seismic Hazard Assessment

Empirical method that employs attenuation formula for ground motion prediction, is used in this project, in order to correspond to future findings related to active faults. Seismic zone model in this project is the current one proposed by RCAG. Attenuation formula will be selected considering the compatibility to the existing hazard evaluation and to the risk evaluation of various type of structures of concern.

(2) Seismic Risk Assessment for Buildings

The Limit Strength Method (LSM) is used to evaluate building damage state accurately. Since ground motion is modeled by the response spectrum at site and building is modeled by skeleton curve of the equivalent single degree of freedom system in LSM, further revisions in ground motion and in building will be easily reflected to the evaluation. Calculation procedure is also relatively simple and the result is stable compared to the dynamic response analysis. This means that the technical transfer can easily be done.

(3) Seismic Risk Assessment for Infra-structures

All the bridges have their seismic risk evaluated separately based on the static analysis and dynamic response analysis of some representative bridges. In the static analysis and dynamic response analysis, Japanese software is utilized with data assembled in UB city. Damages to structures such as roads, water lines, sewage, electric lines are evaluated by the product of the length and damage rate that is given corresponding to the ground motion intensity.

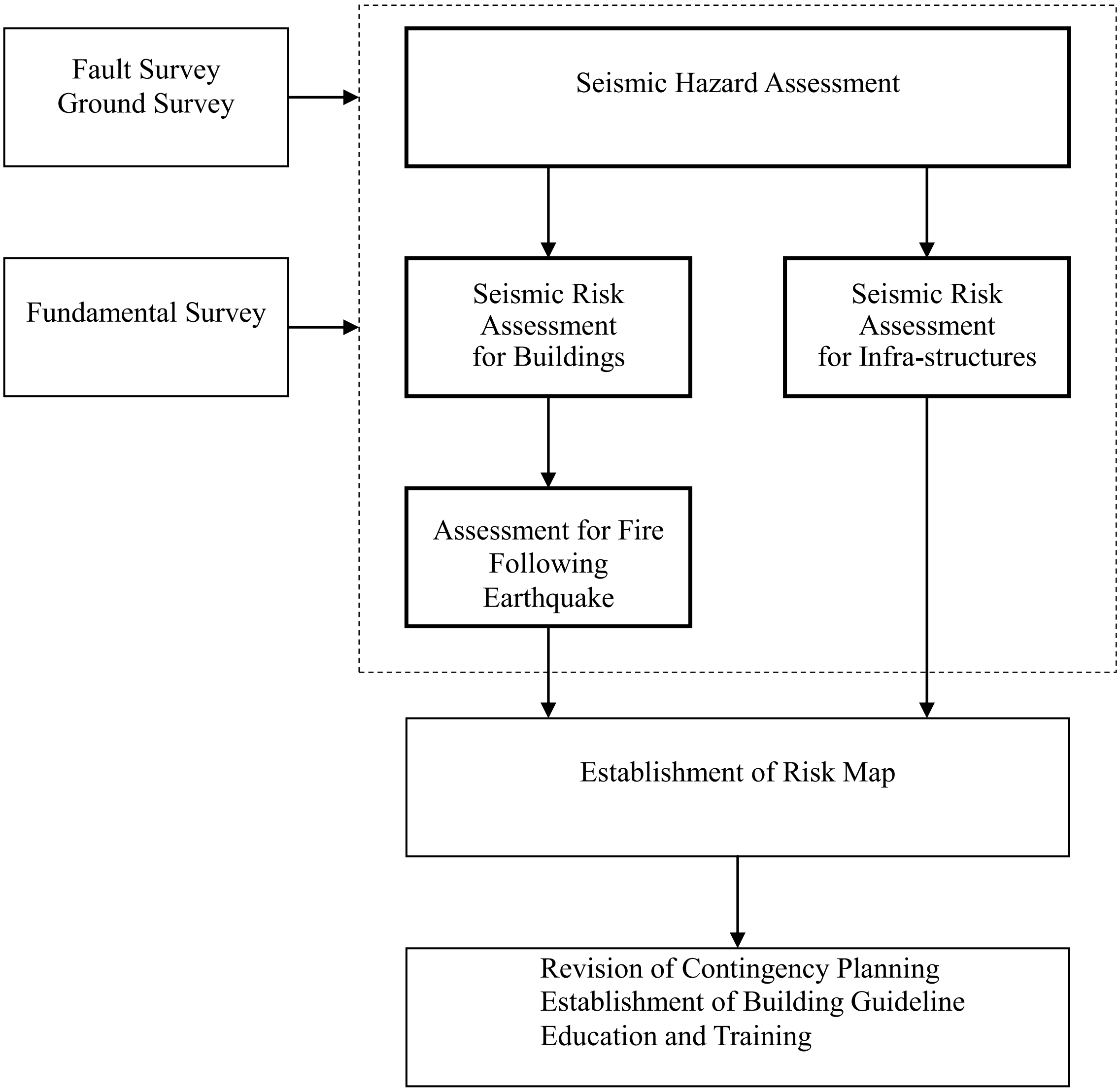
Though pipeline for heating in out of scope of this project, the risk evaluation procedure will be arranged, since it is a critical structure for support lives in UB city, especially in the winter time.

(4) Assessment of Fire Following Earthquake

Japanese method is used to evaluate the number of break out and the area of fire spreading for collapsed buildings and uncollapsed ones. It is noted that the method will differ corresponding to the area of concern, namely, urbanized area or Ger area. Causes of ignition will be identified after site investigation.

(5) Flowchart of Assessment

Flowchart of the assessment and relation to the other surveys are shown in Figure 5.1.1.



Ref: JICA Project Team

Figure 5.1.1 Flowchart of seismic hazard assessment and seismic risk assessment

5.2 Seismic Hazards Evaluation

5.2.1 Review of Seismic Intensity Map of Mongolian Academy of Sciences

(1) Outline of evaluation method

In this section, the used data, methods and results of seismic hazard maps created by the RCAG (Seismic Hazard Assessment of Ulaanbaatar, capital city of Mongolia, Seismic Microzonoing map), hereafter "RCAG Report 2006" was reviewed.

The project related to the RCAG Report 2006 was supported by Department of City Construction in the Agency of Land Affairs, and conducted by the RCAG. Except the RCAG, Department Analyze Surveillance, Environment of France (DASE), EOST of France and Mongolian university of Science and Technology (MUST) also participated in this project. The project was composed of 3 parts, of which this report was the third part. The work was supported by Ulaanbaatar city in May 2001.

In the RCAG Report 2006, seismic hazard results were obtained based on deterministic and probabilistic methods.

(2) Result of Deterministic Study

Table 5.2.1 shows the results from four scenarios considered in this report. Scenario 1 assumed that the Hustai fault would initiate an earthquake with a maximum magnitude of Ms7.5. Scenarios 2 to 4 estimated an earthquake with a maximum magnitude of Ms6.5 would occur on the Songino-Sonsoglon, where the observed active seismicity is now recognized as Emeelt fault. In these scenarios, the results were observed at the surface of the fault, center of Ulaanbaatar city and the eastern side of Ulaanbaatar, respectively.

Due to a small number of strong motion records in Mongolia, the report applied the attenuation law according to Fukushima *et al.*, (2003)[1] in order to calculate the PGA because the availability of few observation data.

The results of deterministic analysis in each scenario are summarized in Table 5.2.1.

In the case Ms7.5 earthquake occurs on the Hustai fault, seismic intensity of VII-VIII will be observed in central Ulaanbaatar city. If earthquake of Ms6.5 occurs in the active zone of the Songino-Sonsoglon, which is near to Ulaanbaatar city, seismic intensity of VIII-IX will be observed in central Ulaanbaatar city. In this case, the seismic intensity in central Ulaanbaatar city will larger than that of the case of the Hustai fault rupture larger earthquake but located far from the city area.

Table 5.2.1 Summary of results of the deterministic analysis

Event		Magnitude Ms	Distance to the fault（km）	PGA at rock (G) Related MSK intensity
1	Scenario 1 : Maximum earthquake on Hustai fault	7.5	47	0.12G VII-VIII
2	Scenario 2: Maximum earthquake on seismogenic zone of Ulaanbaatar city or on the Songino-Sonsoglon active area considering a site at surface	6.5	0	0.62G X
3	Scenario3: Maximum earthquake on the Songino-Sonsoglon active area observed at the center of Ulaanbaatar city	6.5	10	0.25G VIII-IX

[1] Fukushima Y., Berge-Thierry C., Volant Ph., Griot-Pomera D.A and Cotton F. (2003): Attenuation relation for west Eurasia deterministic with recent near-fault records from California, Japan and Turkey, Journal of Earthquake Engineering, Vol.7, No.4, p.573-598.

4	Scenario 4: Maximum earthquake on Songino-Sonsoglon active zone observed in the eastern part of Ulaanbaatar city	6.5	20	0.15G VIII

Ref: RCAG

(3) Probabilistic Analysis

In this analysis, the RCAG conducted a seismic hazard evaluation for Hustai fault; Deren fault and Agit fault (Figure 5.2.1) and evaluated PGA corresponding to return period. The attenuation law by Fukushima *et al*. (2003) was for the probabilistic analysis.

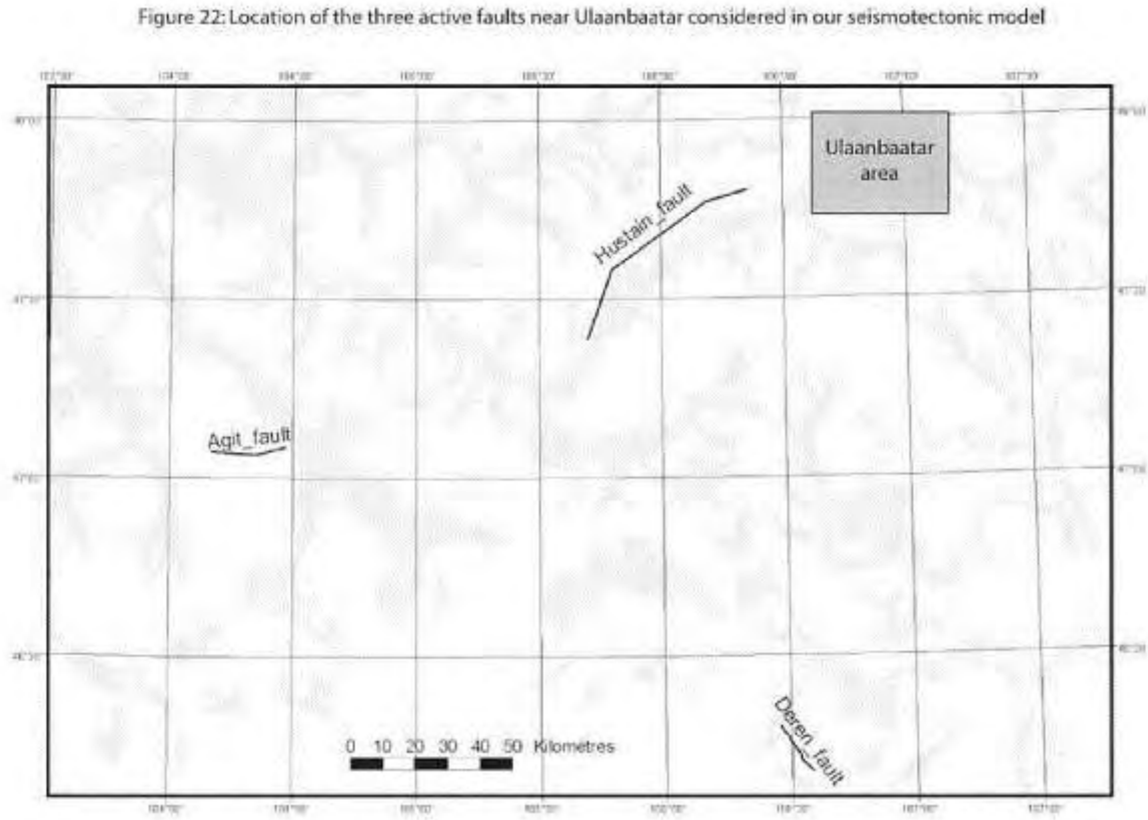
For the site effect of UB basin, the shear wave velocity at rock was estimated as 3 km/s based on existing geological map. According to existing boring data, it was estimated that the thickness of sediments in Ulaanbaatar basin is about 10-80 m, reach 120 m in deeper cases. Within the sediments in Ulaanbaatar basin, site effects characteristics were calculated based on micro seismic data and microtremor observation data.

Ulaanbaatar basin can be divided to 4 frequency zone.

- Zone 0-2Hz: the average amplification factor is about 6 (4-8)
- Zone 2-4Hz: the average amplification factor is about 6.6 (3-9)
- Zone 4-8Hz: the average amplification factor is about 4.3 (2.5-8)
- Zone 8-15Hz: the average amplification factor is about 3.4 (1.5-5)

However, due to the amplification factor is very high, fixed amplification of 2 in the zone 8-15Hz and 4 for other zones.

The results obtained by probabilistic analysis are shown in
Table 5.2.2. The seismic intensity map of UB city for the 475 year return period and 50 year exceed a probability of 10% (Figure 5.2.2 Seismic intensity map of Ulaanbaatar city with 475 return period, 50 years accident probability 10%.



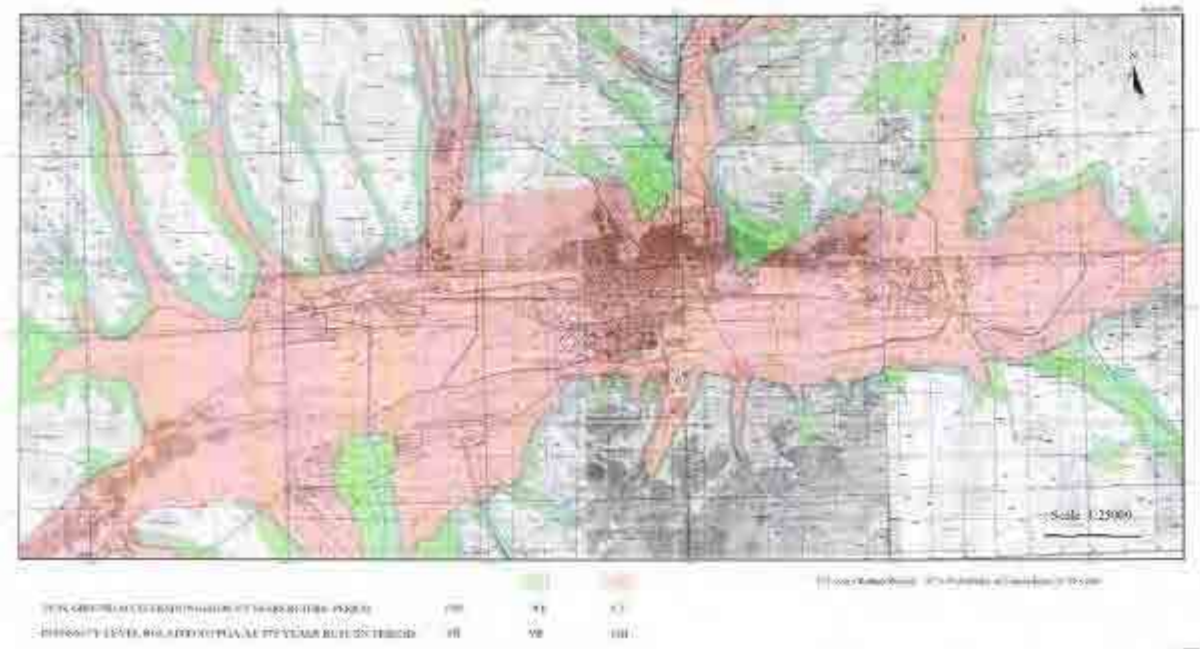
Ref: RCAG

Figure 5.2.1 Fault model used in probabilistic analysis

Table 5.2.2 Summary of results of the probabilistic analysis

Return Period (years)	PGA at rock (G)	MSK Intensity at rock	MSK Intensity at zone 0-0.2Hz	MSK Intensity at zone 2-4Hz	MSK Intensity at zone 4-8Hz	MSK Intensity at zone 8-15Hz
475	0.05	VII	VIII	VIII	VIII	VII
975	0.06	VII	VIII～IX	VIII～IX	VIII～IX	VII～VIII
1975	0.07	VII	IX	IX	IX	VIII
5000	0.08	VII	IX	IX	IX	VIII
10000	0.09-0.12	VII～VIII	IX～X	IX～X	IX～X	VIII～IX
Maximum	0.62	X	XI	XI	XI	XI

Ref:RCAG



Ref:RCAG

Figure 5.2.2 Seismic intensity map of Ulaanbaatar city with 475 return period, 50 years accident probability 10%

5.2.2 Seismic Hazard Evaluation

(1) Outline of Evaluation Method

Generally, seismic hazard calculation takes two steps.One is seismic intensity at a point distance from source and the other is considered the influence of surface ground. Below are the typical methods for seismic hazard evaluation (Japan Cabinet Office, 2005[2]).

Method A: estimates ground motion using "the empirical method for estimation of ground motion intensity based on distance from epicenter" and "empirical method for estimation of ground motion amplification based on surface ground"

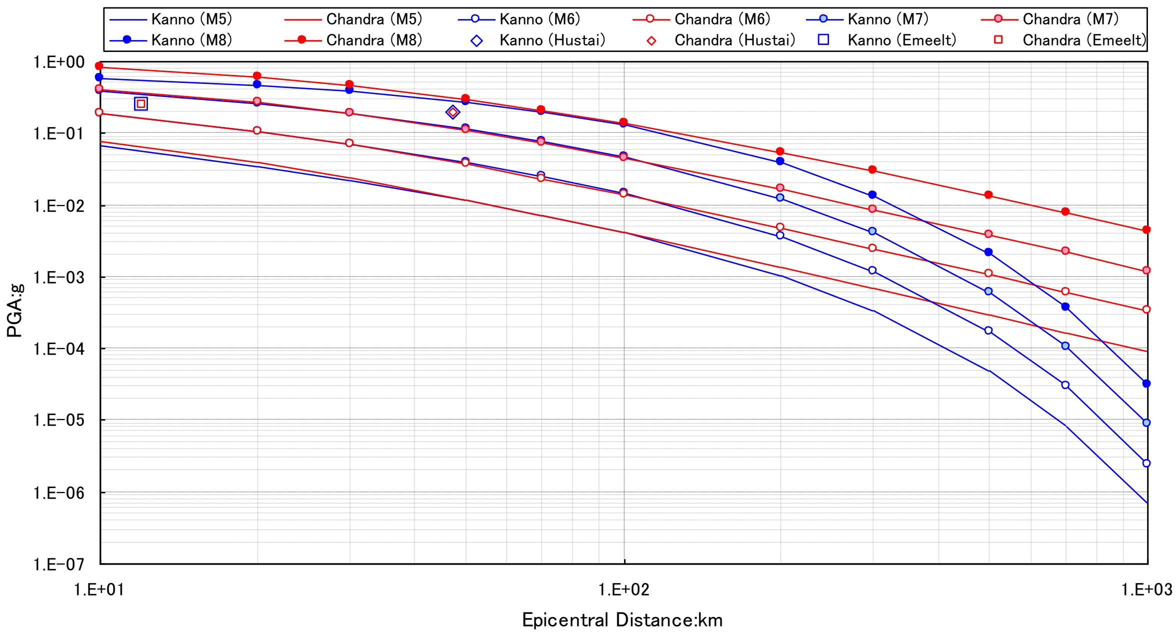
Method B: estimates ground motion using the "Calculate seismic waveform based on source model" and "Empirical method for estimation of ground motion amplification based on surface ground".

Method C: estimates ground motion using the "Calculate seismic waveform based on source model" and the "Calculate seismic waveform by setting surface ground structural model".

Method D: assesses long-period ground motion, add method for long-period ground motion estimation method to Method C.

Methods B, C and D need detailed investigation results for seismic source fault, detailed crust structure and surface ground data. In this project, there are no detailed seismic observation data and investigation results of the source faults. Method A was selected taking into consideration of these conditions for the seismic hazard evaluation. Therefore, since UB city could be expected to conduct the evaluation.

The Kanno *et al.*, (2006)[3] attenuation law was selected since risk evaluation in this project uses not only the maximum ground acceleration (PGA) but also the maximum ground velocity (PGV) or response acceleration. The MAS used Chandra's attenuation law (type of method use PGA) for estimation of ground motion. In the case of within 100 km from the epicenter, the Kanno and Chandra obtained almost the same results in the scenarios (Figure 5.2.3). Based on these situations, the method of Kanno is considered an appropriate method for ground motion evaluation in this project.



Ref: JICA Project Team

2 Cabinet office of Japan (2005): Technical material for earthquake hazard prevention mapping, March, 2005

3 Kanno, T., A., Narita, N., Morikawa, H., Fujiwara and Y. Fukushima (2006): A New Attenuation Relation for Strong Ground Motion in Japan Based on Recorded Data, Bulletin of the Seismological Society of America, Vol. 96, No. 3, pp. 879–897.

Figure 5.2.3 Comparison of attenuation laws of Chandra and Kanno

(2) Scenario Earthquake

Two scenario earthquakes were set in this project. One is considering the Hustai fault, and the other is considered the Emeelt fault and the Gunjiin fault from the active faults around Ulaanbaatar city.

1) Scenario 1: The case of Hustai fault generates its maximum earthquake (Mw7.6)

About the length of Hustai fault, RCAG report indicated 70-80 km, Demberel (2011)[4] showed 92 km, and Ferry et al. (2012)[5] suggested 112 km. But based on active fault topography, RCAG report and Demberel (2011), the length of the Hustai fault should be about 80 km.

However, there is no detailed report of seismic activities of the fault. Therefore, the possible maximum earthquake magnitude was estimated based on the confirmed fault length. According to Matsuda (1975[6]), there is a relationship between active fault length and earthquake magnitude as shown in Formula 5.2.1.

$$\text{LogL}=0.6\text{M}-2.9 \qquad (5.2.1)$$

Where, M is the Japan Meteorology Scale of earthquake magnitude (JMA scale). According to this formula, the maximum magnitude possibly occurs on the Hustai fault is M8.0. There is a relationship between JMA scale of magnitude and moment magnitude as shown in Formula 5.2.2. From this Formula, the maximum magnitude possibly occurs on the Hustai fault is Mw7.6.

$$\text{Mw}=0.879\text{M}+0.536 \qquad (5.2.2)$$

2) Scenario 2: Integrated maximum value of maximum earthquakes occurs on Emeelt fault (Mw7.0) and Gunjiin fault (Mw6.6)

In this Scenario, considering the comments given on WG1, say the Gunjiin fault has much more influence in the city area when it generates earthquakes, and take into consideration of result of the 2nd Domestic Supporting Committee of JICA, the larger value of the intensity of the two earthquakes will be selected. Note that this scenario does no mean the two earthquakes will occur simultaneously, but it is only an estimation of the maximum hazard potential.

The length of the Emeelt fault is about 30 km, while the Gunjiin fault is about 18 km. Based on fault length, the estimated maximum magnitude of earthquake for Emeelt fault and Gunjiin fault is Mw7.0 and Mw6.6, respectively.

(3) Attenuation Law

In this project, a deterministic method was used to calculate the maximum acceleration, maximum velocity and maximum MSK intensity of each scenario.

The attenuation law based on formula 4.3.3 and 4.3.4 (Kanno *et a.,l* 2006) was used in the calculation).

$$\log(a_{max}) = 0.26 + 0.56M_w - 0.0031X - \log[X + 0.0055 \cdot 10^{0.5M_w}] + G \qquad (5.2.3)$$

$$\log(v_{max}) = -1.93 + 0.70M_w - 0.0009X - \log[X + 0.0022 \cdot 10^{0.5M_w}] + G \qquad (5.2.4)$$

Where, a_{max} is PGA）, M_w is moment magnitude, X is the shortest distance from source fault.

4Demberel (2011): Vp/Vs ratio and seismic activity structure of Ulaanbaatar area, the capital city of Mongolia, Comprehensive Nuclear Test-Ban Treaty, Science and Technology, 2011, 8-10, June, Vienna.

55Ferry M, A.Schlupp, U. Munkhuu, M. Munschy and S.Fleury (2012):Tectonic Morphology of the Hustai Fault (Northern Mongolia), Vol.14, EGU 2012-5803, EGU General Assembly, 2012

6Matsuda T., 1975. Magnitude and recurrence interval of earthquakes from a fault, *Journal of the Seismological Society of Japan*, 28: 269-292. (inJapanese with English Abstr.)

The *G* is an additional correction term based on site characteristic, which is derived as formulas 4.3.5 (PGA) and 4.3.6 (PGV).

$$G = -0.55 \cdot LOG(AVS30) + 1.35 \qquad (5.2.5)$$

$$G = -0.71 \cdot LOG(AVS30) + 1.77 \qquad (5.2.6)$$

Where, AVS30 is average S wave velocity from surface to 30m deep.

The MSK scale intensity is converted from Formula 4.3.7 based on PGA.

$$PGA = 2^{I-7} \qquad (5.2.7)$$

Where, *I* is the MSK scale intensity, unit of PGA is m/s^2

(4) Seismic Hazard Evaluation Results

1)PGA

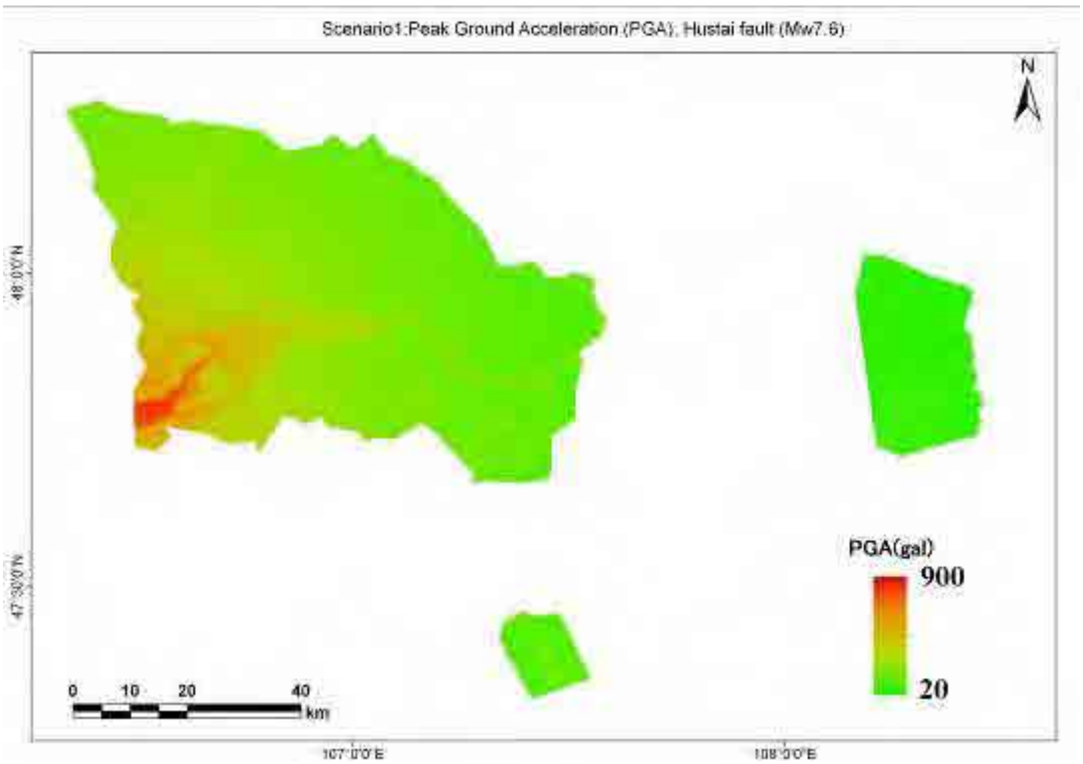
The results of PGA calculation are shown in Figure 5.2.4 (Scenario 1), Figure 5.2.5 (Scenario2), respectively.

In the case of the Scenario 1, the PGA ranges from 28.0 to 881.1gal. Relatively higher values appeared in the western side of UB city, along the Tuul River.

In the case of Scenario 2, the PGA ranges from 39.1 to 867.8gal. Same as Scenario 1, higher values appeared in the western side of the city. However, in the northwestern side, near Emeelt fault, and in the northeastern part of the city near to the Gunjiin fault.

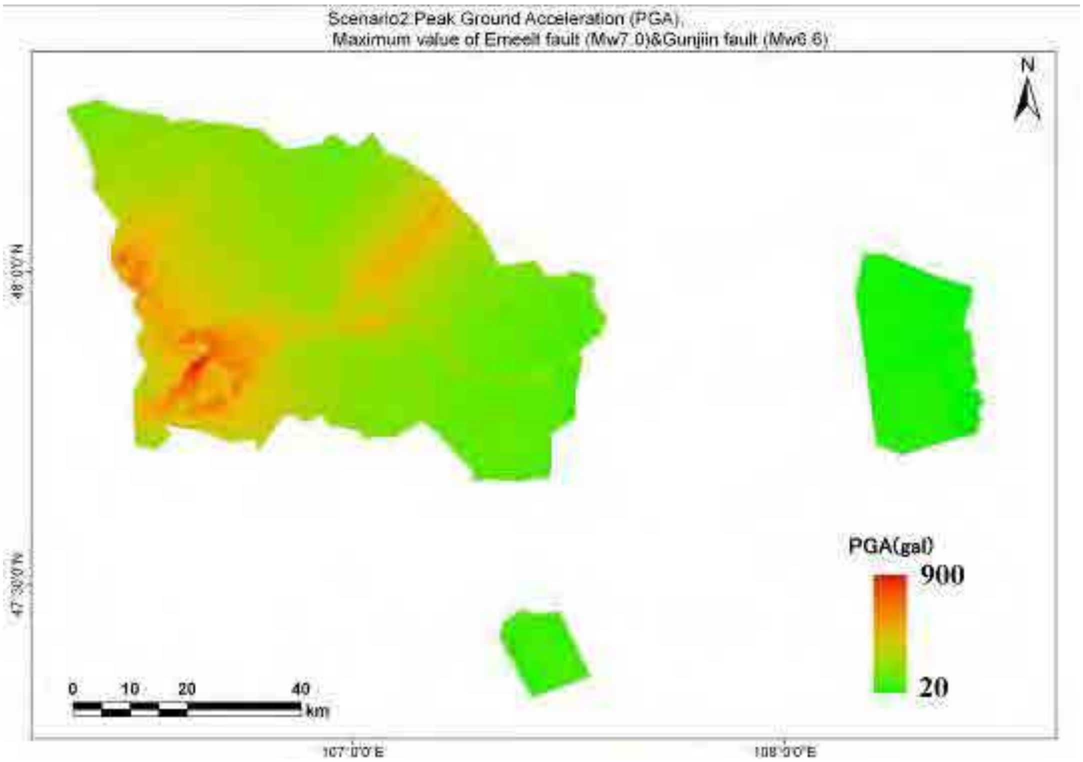
The PGA of central city of UB is shown in Figure 5.2.6 for Scenario 1,and Figure 5.2.7 for Scenario 2.

In the two cases, there is no remarkable difference of the PGA distribution in central city area. The PGA ranges from 205.2 to 506.3 gal in the Scenario 1, and from 227.7 to 559.6 gal in the Scenario 2. In the city center of Sukhbaatar square, the PGA is 300.5 gal in the Scenario1, and 313.2 gal in the Scenario 2.



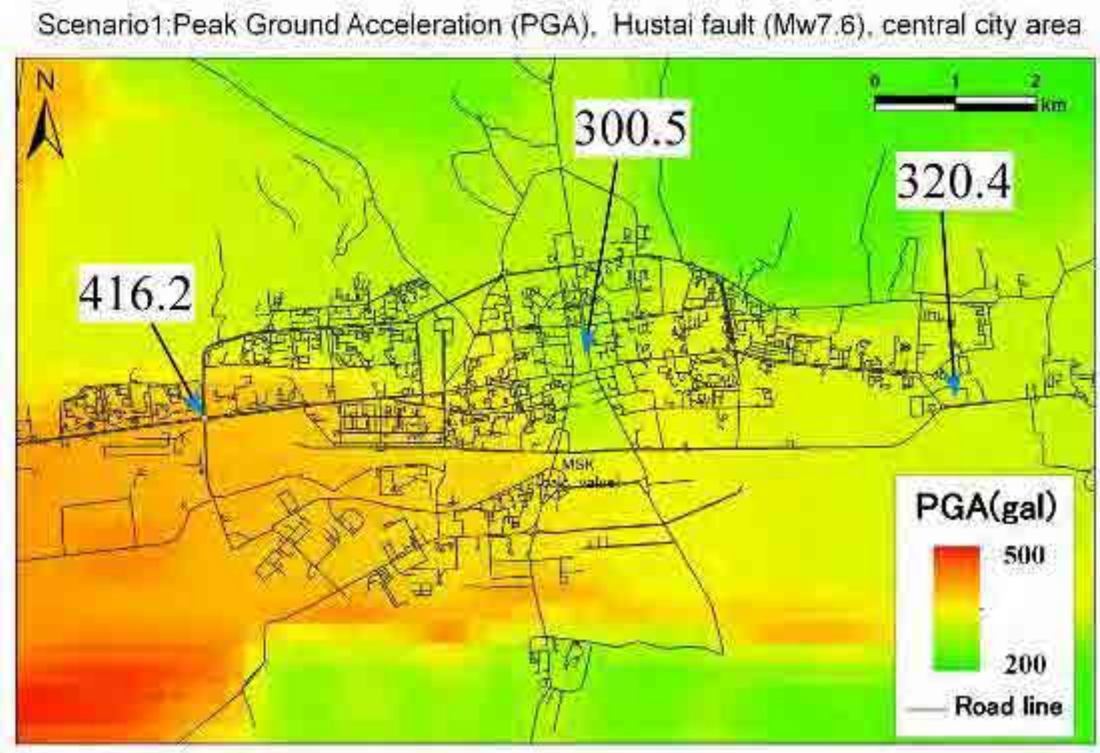
Ref: JICA Project Team

Figure 5.2.4 PGA distribution of Scenario 1



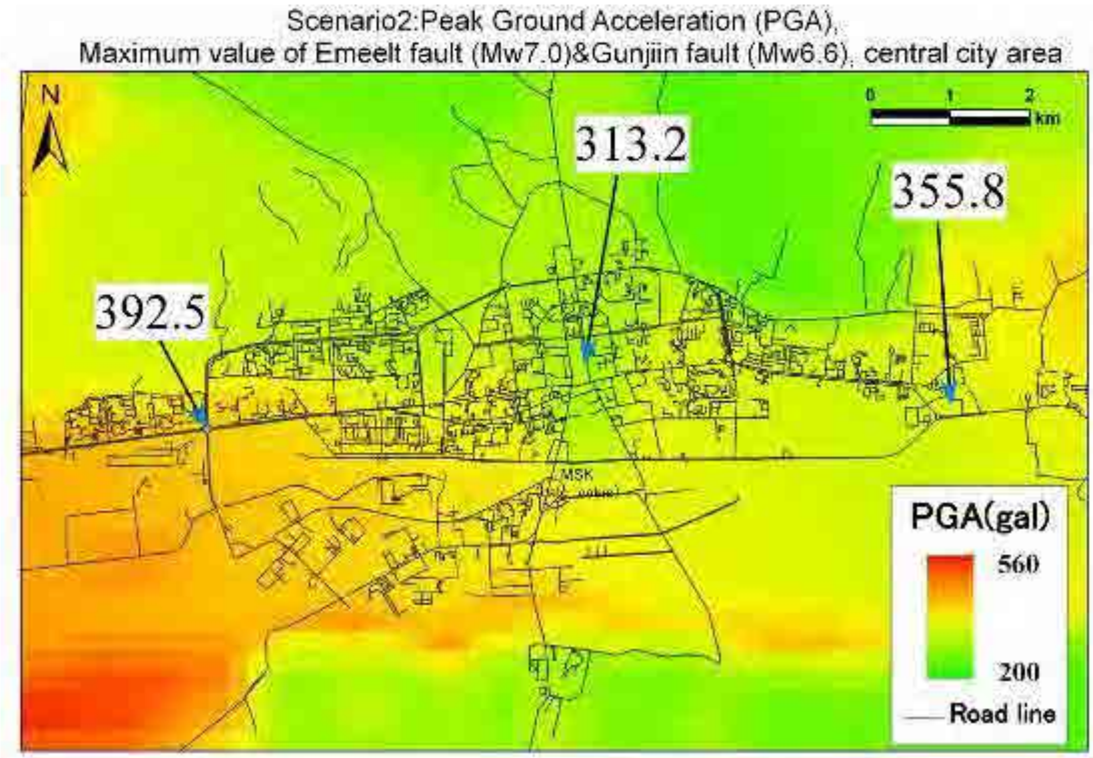
Ref: JICA Project Team

Figure 5.2.5 PGA distribution of Scenario 2



Ref: JICA Project Team

Figure 5.2.6 PGA distribution of UB central city area in the case of the Scenario 1



Ref: JICA Project Team

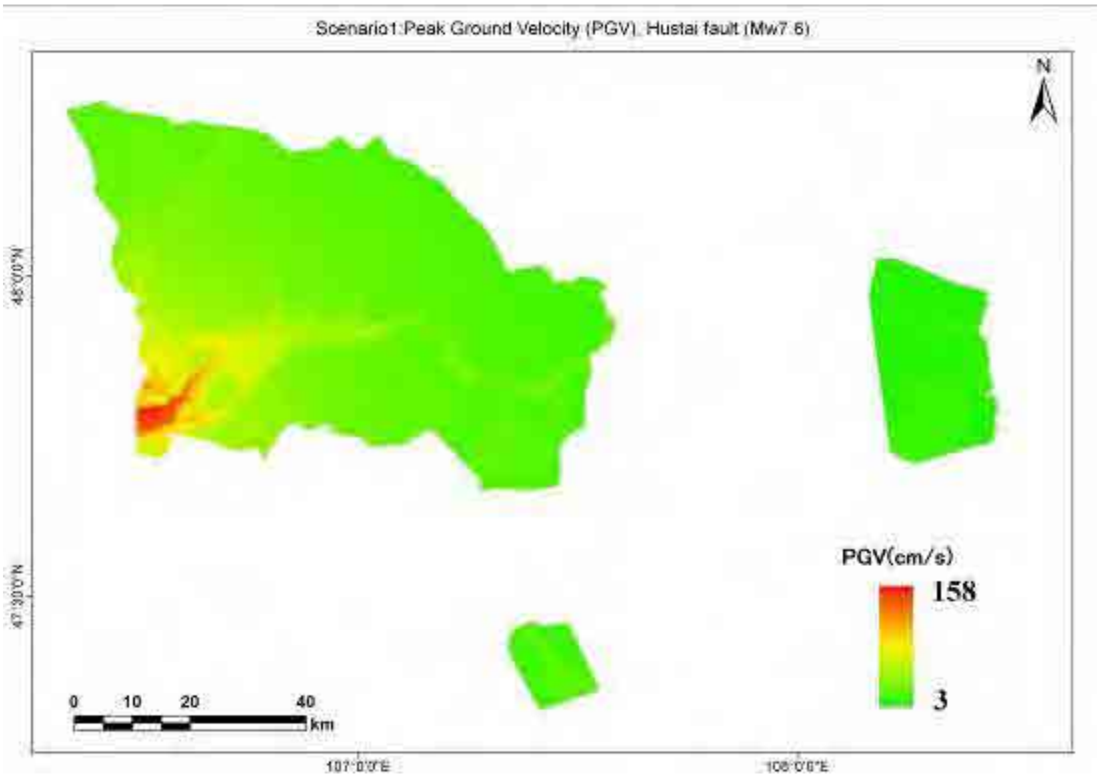
Figure 5.2.7 PGA distribution of UB central city area in the case of the Scenario 2

2)PGV

The calculation results of PGV are shown in Figure 5.2.8 for Scenario 1 and in Figure 5.2.9 for Scenario 2, respectively.

In the case of Scenario 1, The PGV ranges from 6.4 to 158.0 cm/s. In the case of Scenario 2, the PGV ranges from 3.21 to 45.0 cm/s. The distribution of PGV showed similar distribution characteristics with the PGA distribution.

The PGV of UB central city areas is shown in Figure 5.2.10 for Scenario 1 and in Figure 5.2.11 Scenario 2, respectively. In the city area of Ulaanbaatar, the Scenario 1 shows higher value compared to the Scenario 2. For example, in Sukhbaatar square, the center of Ulaanbaatar city, the PGV is 37.7 cm/s in Scenario 1 and 30.1 cm /s in Scenario 2, respectively.



Ref: JICA Project Team

Figure 5.2.8 PGV distribution of Scenario 1

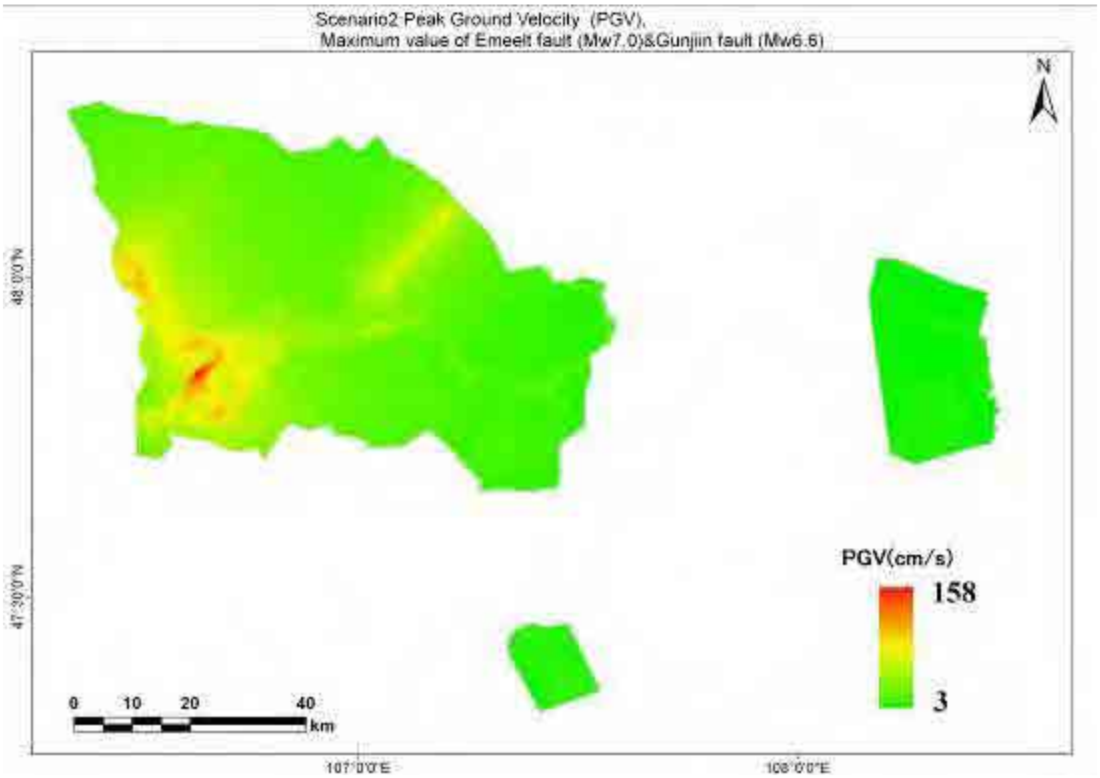


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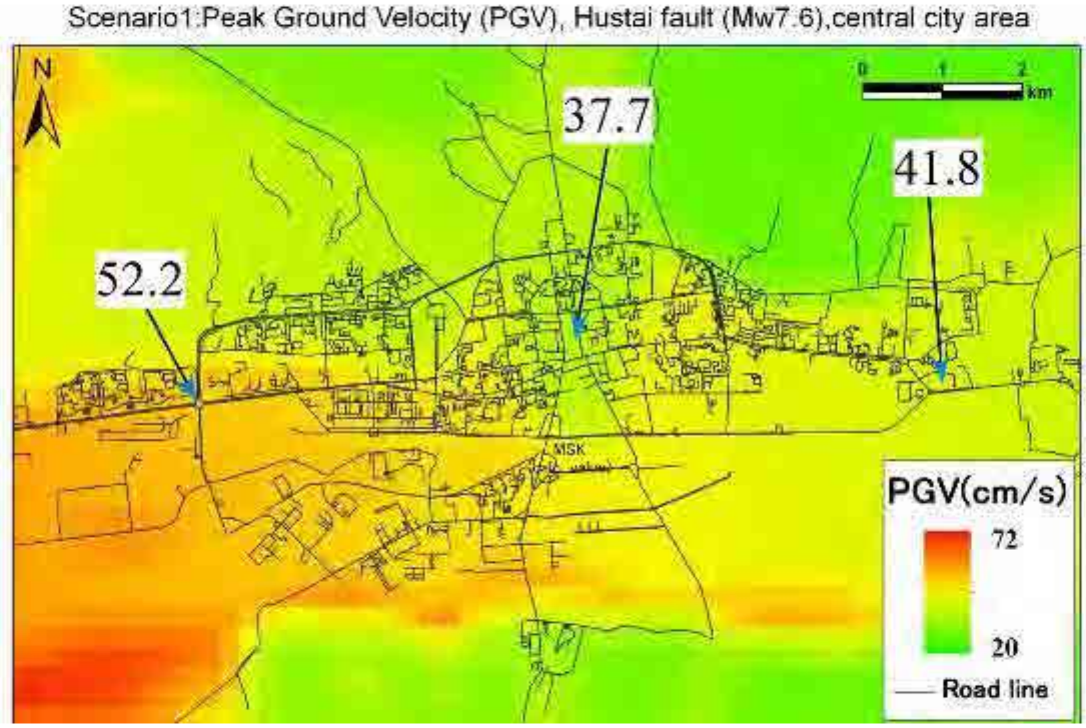
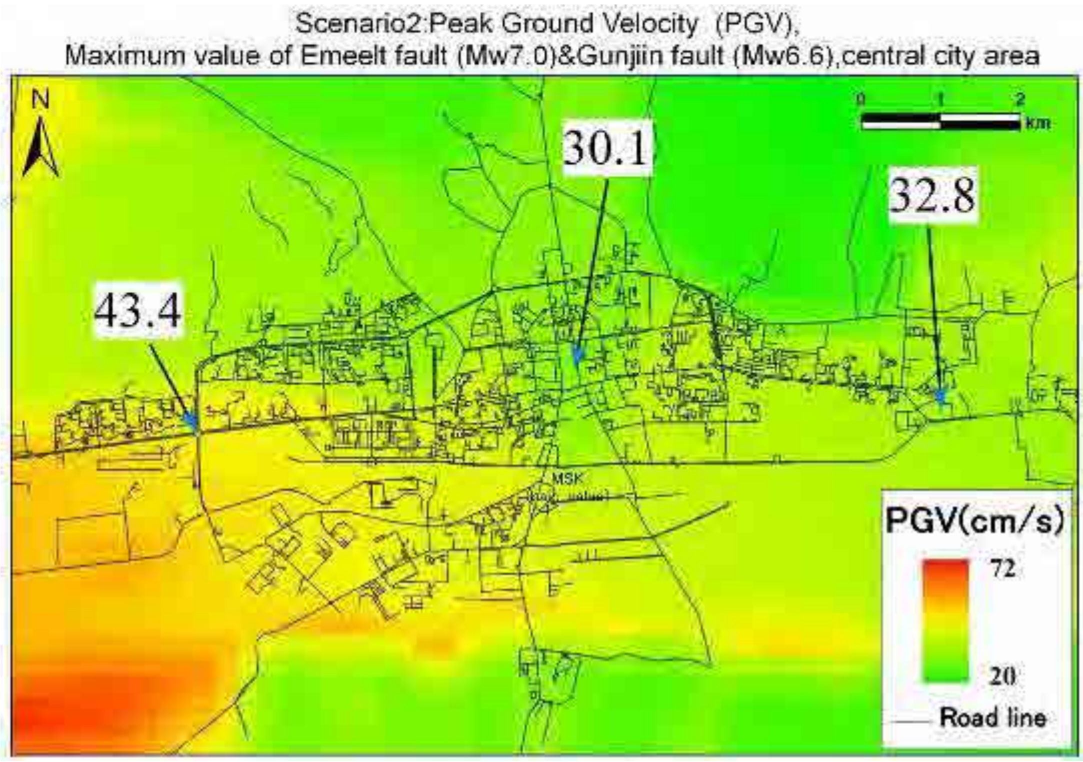
Figure 5.2.9 PGV distribution of Scenario 2



Ref: JICA Project Team

Figure 5.2.10 PGV distribution of UB central city area in the case of the Scenario 1



Ref: JICA Project Team

Figure 5.2.11 PGV distribution of UB central city area in the case of the Scenario 2

5.2.3 Evaluation of Ground Liquefaction

(1) Base Consideration for Liquefaction Evaluation

The following four methods were used to evaluate ground liquefaction: (a) a subsidiary method using geomorphology/geology and liquefaction history; (b) a general method which uses the results of soil survey and test; (c) a detailed method of conducting a dynamic survey, test and analysis; (d) a method using model experiment and site experiment.

In this project, the method "a" was used to classify the rank of liquefaction possibility, and while method "b" was used to confirm and certify the results.

(2) Simple Evaluation of Ground Liquefaction

For those earthquakes with strong motion and long duration, the targeted area for liquefaction evaluation would be: (1) reclaimed land and alluvial deposit, (2)high level of groundwater, (3)low density of ground soil, (4)and the grain size is distributed within the liquefactionable range.

1) Evaluation Using Microtopography

2) Liquefaction generally related to microtopography. The liquefaction possibility based on microtopography classification is defined as follows (National Land Agency of Japan, 1999). In this project, the liquefaction evaluation was conducted for the liquefaction possibility larger than "low".

Table 5.2.3 Microtopography and liquefactionable possibility

Possibility of liquefaction	Classification of microtopography	Classification in this study
Very high	Landfill, embankment, former channel, a former swamp, point bar, sandy dry river bed, low land within the dunes, low land within levees, land with resurgence	Flood plain, Riverbed deposits, Aeolian deposits
High	Natural levee, wetland, dune, back swamps, river delta, reclaimed land, gentle fan, delta-type valley basin	Valley basin deposit and 2
Low	Fans, dry riverbed with sand and gravel, sand and gravel bars, dune, Fan-type valley basin	Fan deposit, talus deposit
None	Plateau, terrace, hills, mountains	Mountain, Neogene gravel, terrace deposit

Ref: National Land Agency of Japan (1999)[7]

3) Evaluation Using Groundwater Level

Generally, liquefaction occurs in layers composed of loose sandy soil and gravelly soil. The possibility of liquefaction is defined as layers shallower than 20 m in sandy and gravelly soils. The groundwater level of those layers is within a depth of 10m from the ground surface. The corresponding layers were selected according to this criteria.

The results from the boring survey were used. The groundwater level of each boring hole are shown in Table 5.2.4

[7] National Land Agency of Japan (1999): Manual for zoning of liquefaction region, p123, Earthquake Disaster Countermeasure Division of Disaster Prevention Bureau, National Land Agency of Japan

Table 5.2.4 Classification of Microtopography and the groundwater level

Boring location	Area	Microtopography	Groundwater (GL-m)	Remarks
UB_BO_01	Ulaanbaatar city area	Flood plain	6.00	
UB_BO_02	Ulaanbaatar city area	Neogene gravel	4.70	No possibility of liquefaction according to Microtopography classification
UB_BO_03	Ulaanbaatar city area	Flood plain	8.00	
UB_BO_04	Ulaanbaatar city area	Valley basin deposit 1	3.20	
NH_01	Nalaikh	Riverbed deposit	0.00	
NH_02	Nalaikh	Riverbed deposit	2.83	
BI_01	Bagakhangai	Flood plain	14.5	The groundwater level deeper than -10m
BI_03	Bagakhangai	Mountain	21.1	No possibility of liquefaction according to Microtopography classification The groundwater level deeper than -10m
BR_01	Baganuur	Flood plain	11.2	The groundwater level deeper than -10m
BR_02	Baganuur	Riverbed deposit	3.47	

Ref: JICA Project Team

4) Evaluation Using Soil Density

Generally, the higher soil density the lower Liquefactionable possibility in ground. When oil type and control press of soil are constant, N value of soil will be larger with increase of soil density. Based on this, liquefaction possibility will be lower in those layers where N value is high.

In this simple evaluation method, the N value range where exists the possibility of liquefaction, was considered N lower than 15-20 concerning the gravel affection. However, in Japan Road Association (2012), estimation of the N value for liquefaction possibility was lower than 10-15.

5) Evaluation Using Grain Size Distribution

The figure is an example of grain size distribution of soil which liquefaction and possibly liquefactioned soil in Japan (Japan Road Association, 2012).

Meanwhile, about quantitative grain size distribution range, in the case of Alluvial sandy soils, liquefaction occurs which affect structural engineering co-seismically when satisfied all following 3 conditions.

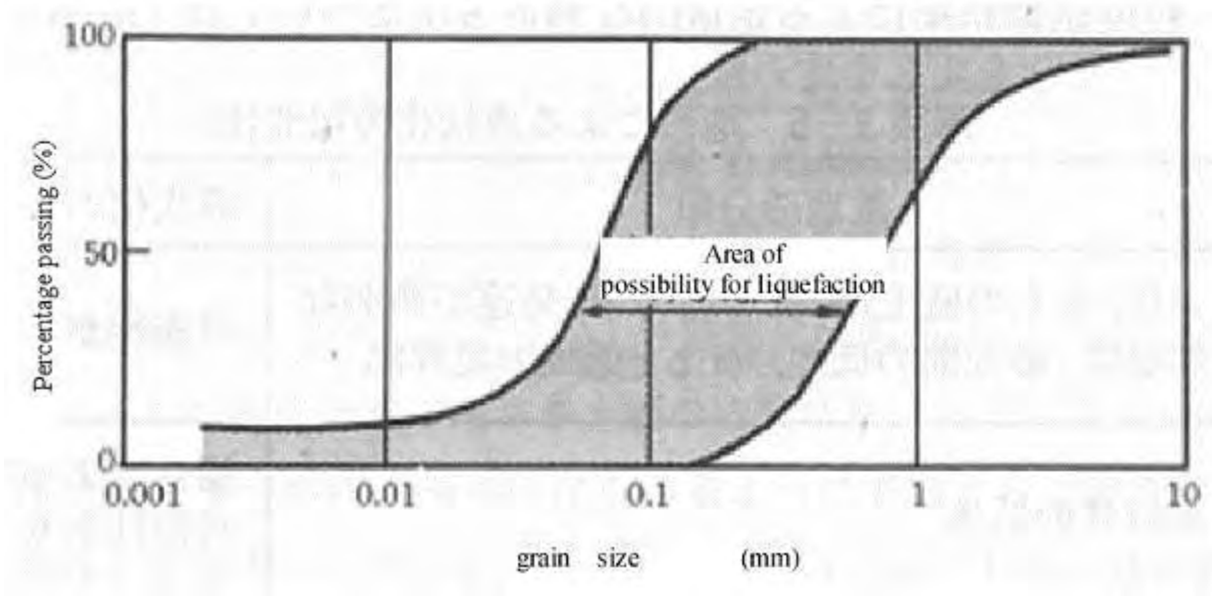
① The groundwater level is located within 10m from ground surface, and saturated layer within depth of 20m

② Soil Layer in which fine contents FC is lower than 35%. Or, soil layer in which although the FC is larger than 35%, but plasticity index Ip is smaller than 15.

③ Soil layer in which the average grain size D50 is smaller than 10 ㎜ and the 10% grain size D10 is lower than 1 ㎜

(Japan Road Association, 2001)[8]

[8] Japan Road Association (2001): Specifications for highway bridges, Part 5, Seismic design, pp. 318.



Ref: Japan Road Association (2012)[9]

Figure 5.2.12 Grain size distribution of possible liquefaction

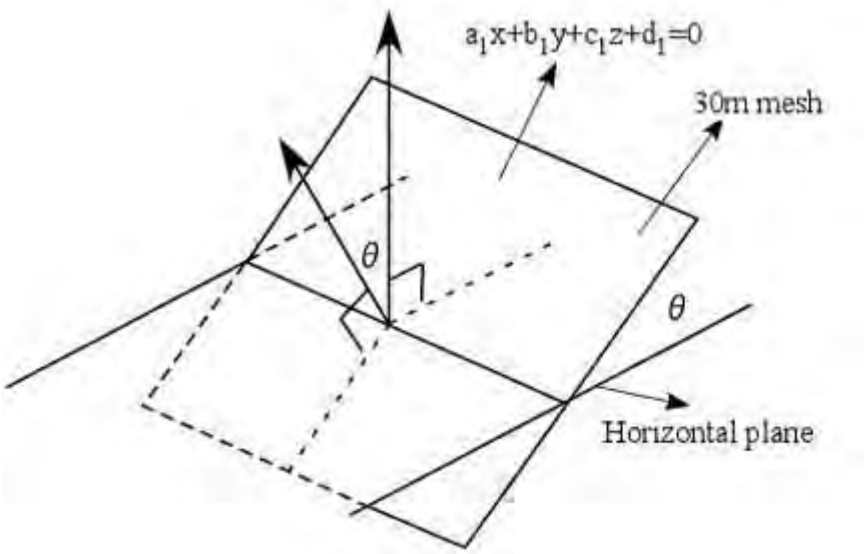
9 Japan Road Association (2012): General guidance for soft ground countermeasures, Version of 2012, pp. 396.

5.2.4 Landslide Susceptibility Evaluation

(1) Calculation Method of Topographical Evaluation Factors
The calculation methods for factors included formula *F* is shown as following.

$$F = 0.075I - 8.9C + 0.0056a_{\max} - 3.2 \qquad (5.2.8)$$

1) Slope Angle: This is a topographical factor indicating the inclination of each mesh from horizontal plane. Slope angle was based on a plane that the distance from surrounding 4 points is shortest, and the steep angle of the plane as the slope angle of the mesh (Figure 5.2.13, Uchida *et al.,* 2004[10]). The equations of the plane and horizontal plane are shown in Formula 4.2.9 and 4.2.10, respectively. The angle (θ) between these two planes will be the slope angle of the mesh, could be shown as Formula 4.2.11.



Ref: Uchida et al. (2004)
Figure 5.2.13 Calculation method for slope angle

$$a_1x + b_1y + c_1z + d = 0 \qquad (5.2.9)$$

$$a_2x + b_2y + c_2z + d = 0 \qquad (5.2.10)$$

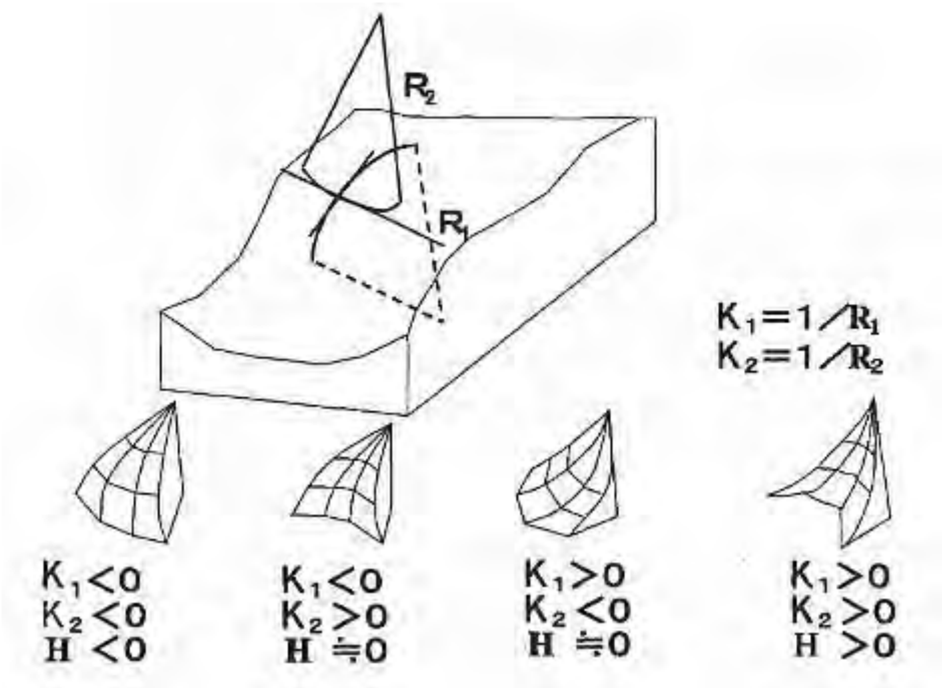
$$\theta = \cos^{-1} \frac{a_1a_2 + b_1b_2 + c_1c_2}{\sqrt{(a_1^2 + b_1^2 + c_1^2)(a_2^2 + b_2^2 + c_2^2)}} \qquad (5.2.11)$$

2) Average Curvature: This factor is used as an index of roughness of topographical surface. The average curvature was determined as the average value of the maximum and minimum values of curvatures of the all geodesic lines (the shortest line linked between 2 points on the surface) which through one point on the surface (Figure 5.2.14). The calculation method is shown in Formula 4.2.12 (Uchida *et al.*, 2004).

[10] Uchida, T., S. Kataoka, T. Iwao, O. Matsuo, H. Terada, Y. Nakano, N. Sugiura and N. Osanai (2004): A study on methodology for assessing the potential of slope failures during earthquakes, Technical Note of National Institute for Land and Infrastructure Management, No.204, pp. 91

$$H = \frac{h_{xy}(1+h_y{}^2) + h_{yy}(1+h_x{}^2) - 2h_x h_y h_{xy}}{2(1+h_x{}^2 + h_y{}^2)^{\frac{3}{2}}} \qquad (5.2.12)$$

$$h_x = \frac{\partial h}{\partial x},\ h_y = \frac{\partial h}{\partial y},\ h_{xy} = \frac{\partial h}{\partial x},\ h_{xx} = \frac{\partial^2 h}{\partial x^2},\ h_{yy} = \frac{\partial^2 h}{\partial y^2},\ h_{xy} = \frac{\partial^2 h}{\partial x \partial y}$$



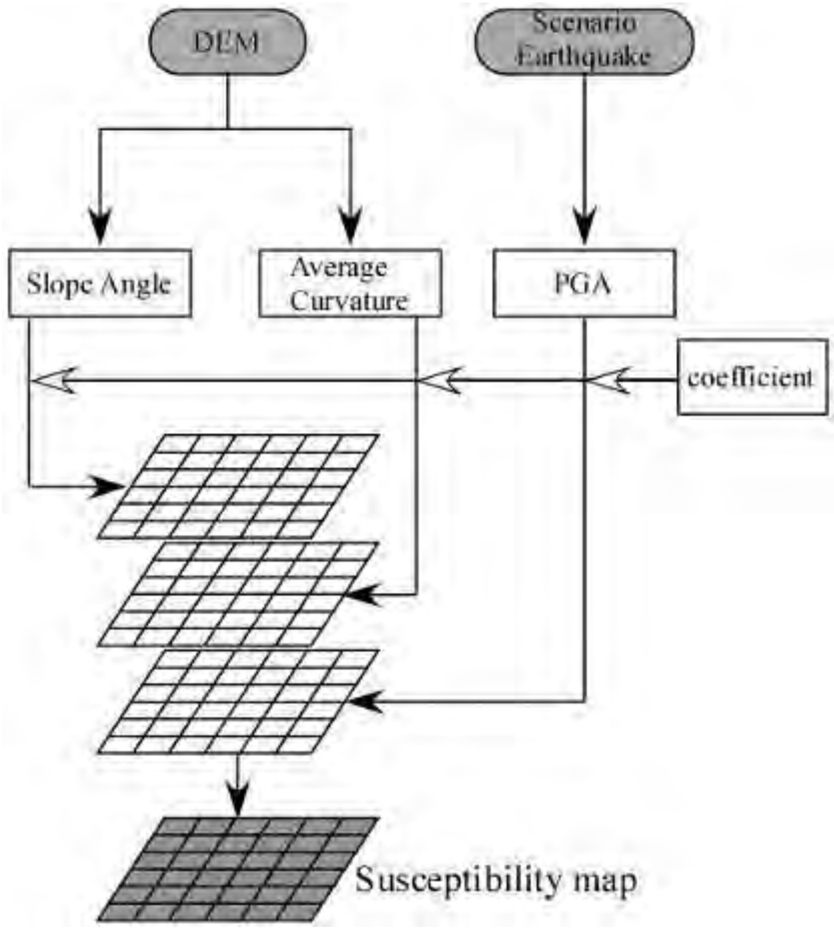
Ref: Uchida et al. (2004)

Figure 5.2.14 Schematic image of average curvature (R_1 ,R_2 are radius of curvature; K_1 ,K_2 are curvatures)

(2) Data and Calculation of Evaluation Factors

In the study area, the topographical factors were calculated from ASTER GDEM 30 m (free data, which is a product of METI and NASA) mesh elevation data. The PGA is calculated in this project based on scenarios is 250 m mesh originally. However, PGA is influenced by gentle slopes when the mesh size is bigger. Therefore, we selected a 30m mesh for landslide susceptibility evaluation. In this case, the 30 m mesh PGA was obtained after resampling the original 250 m mesh data.

The landslide susceptibility evaluation flow is shown in Figure 5.2.15.



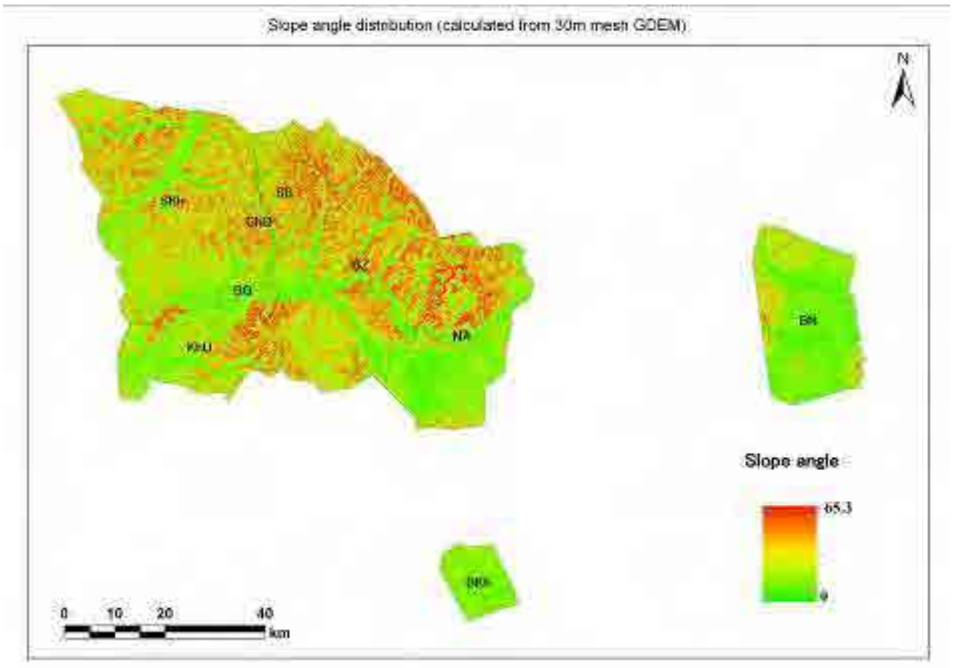
Ref: JICA Project Team

Figure 5.2.15 Flow of landslide susceptibility evaluation

The slope angle of the study area is shown in Figure 5.2.16. Slope angle is larger in north and western faced slopes of northern side of the Boghod Mountain, also in the eastern side of the city, along the northern mountain area of the Nalaikh district, northern mountains in Bayanzurkh district. The slope angle renges from plain to 65 degrees. However, based on field survey, it was considered that the slopes those angles smaller than 5 degrees have no possibility of land sliding.

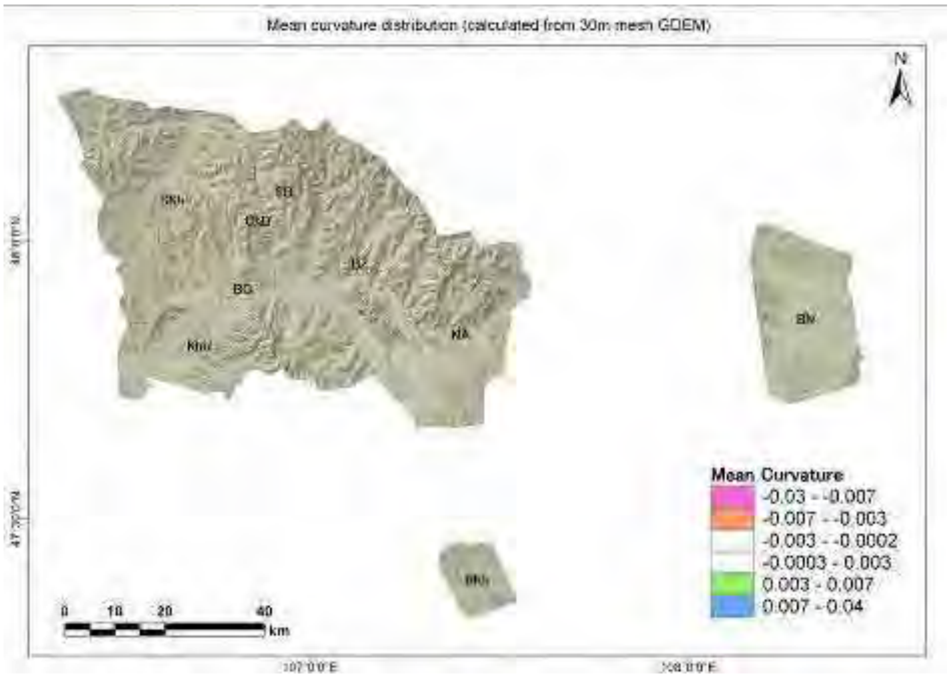
Figure 5.2.17 is shows the distribution of average curvature of the study area. The value is ranging from-0.03 to about 0.04. In the mountain area, it has a large number of meshes that average curvature is about -0.0.

In the cases of Scenario 1 and 2, the PGA of 30 m mesh ares shown in Figure 5.2.18 and Figure 5.2.19, respectively. In the case of Scenario 1, in the mountain areas of western Ulaanbaatar, the value ranges about from 300 to 500 gal, while from 100 to 150 in the eastern mountain areas. In the Scenario 2, the value ranges from 350 to 500 gal in western mountain areas and from 150 to 500 gal in the eastern mountain areas.



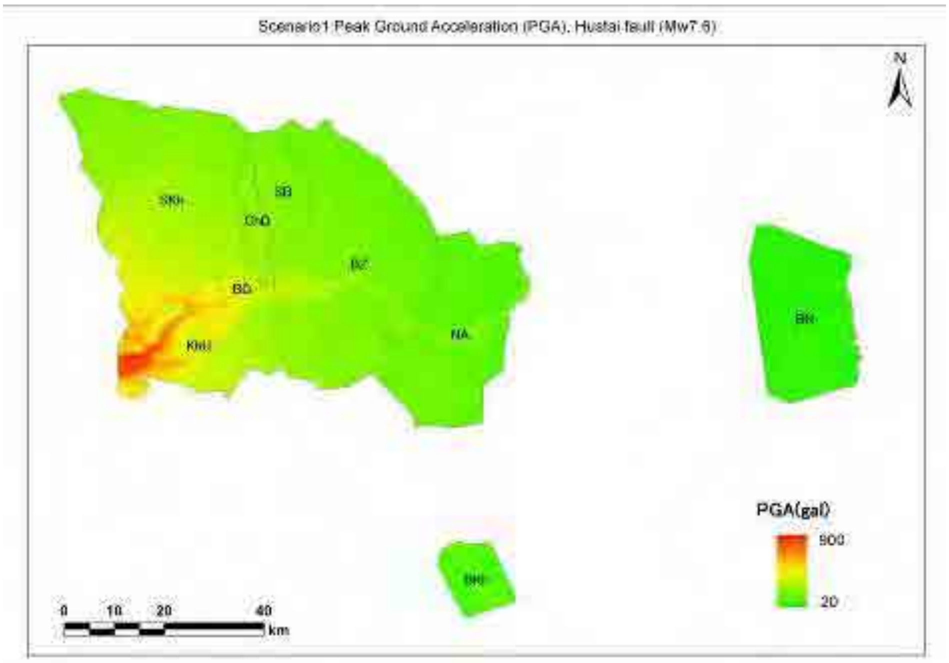
Ref: JICA Project Team

Figure 5.2.16 Distribution of slop angle in the study area (calculated from 30 m mesh GDEM)



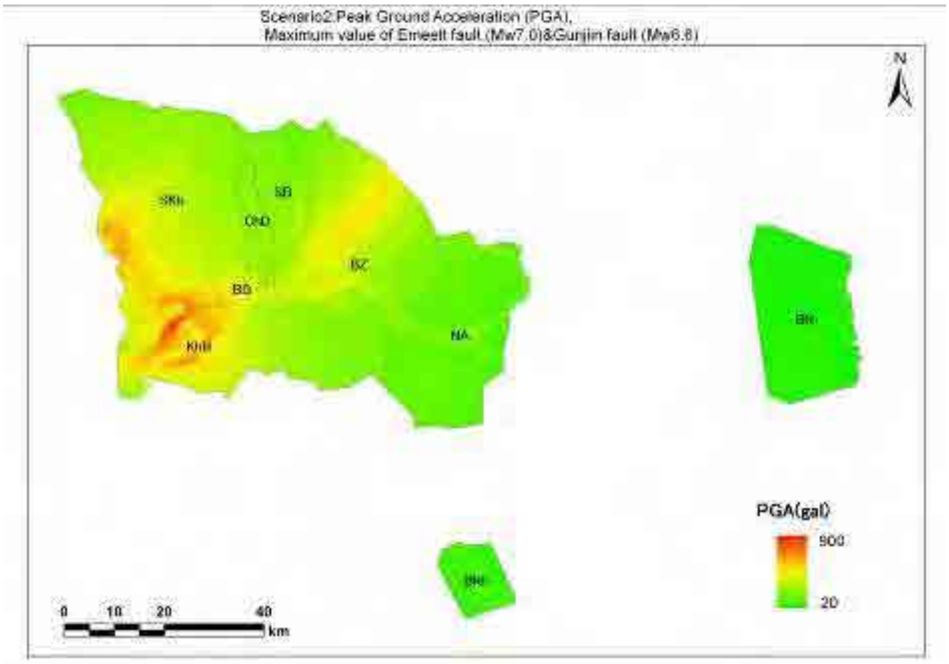
Ref: JICA Project Team

Figure 5.2.17 Distribution of average curvature in the study area (calculated from 30 m mesh GDEM)



Ref: JICA Project Team

Figure 5.2.18 PGA distribution of Scenario 1



Ref: JICA Project Team

Figure 5.2.19 PGA distribution of Scenario 2

5.3 Seismic Risk Evaluation for Buildings

5.3.1 Survey of Building's Actual Condition and Material Testing

(1) Review of Safety of existing Apartment house

Report on seismic capacity evaluation for existing buildings conducted by UB city was assembled and examined. The evaluation method is based on three-dimensional finite element method. In order to incorporate the condition properly, following surveys are also conducted.

- Measurement of material strength: Material strength of concrete, reinforcement, steel, brick or other is measured by UB city, using Schmitt Hummer method. Strength test as well as adhesion test for brick is carried out by MUST.
- Inspection of deterioration of connection portion of pre-cast large panel: Visual test is conducted for the purpose. Inspections are done by some private companies which produced large panel in the era of the former Soviet Union.

As well as the deterioration of material, it is important to check the change in building's strength by the change in building's usage. For example, walls in the first floor in some buildings are removed after democratization in 1992, so that the buildings can be used as shops. Removal of walls makes the buildings unbalanced both in elevation and in plane. Seismic capacity evaluation by UB city duly reflects the real situations described above.

Result of the seismic capacity evaluation by UB city is the ground motion intensity in MSK scale that corresponds to the state that the building reaches to the elastic limit. This ground motion intensity will be compared with the design intensity, to judge if the building is safe or not.

(2) Quality of Design and of Construction

As one of the important factor to control the building seismic capacity, mentioned are the quality of design and that of construction. In order to grasp the above quality in Mongolia, hearing survey was conducted to the following three companies.

- Himon
- Bridge Construction
- Tulga Project

Himon is a design and construction company whose name comes from the combination of Japan and Mongolia. The owner of the company once studied in Japan, and now is implementing Japanese quality control method. Bridge Construction is a construction company whose name "Bridge" means a bridge connecting Japan and Mongolia. Bridge Construction has some Japanese engineers and also provides very high quality of construction. Tulga Project is a design office which deals with relatively difficult structural design such as high-rise buildings or large-span structures.

In hearing survey, Table 5.3.1 and Table 5.3.2 were employed to obtain basic ideas for quality assurance in each company. Some issues related to quality are also investigated. Results of hearing survey were summarized in Table 5.3.3.

In order to assure quality it is important to design a proper system as well as to raise the level of engineers. For the former some systems exist, however, for the latter it is not sufficient from the reasons listed below.

- The number of engineers is not sufficient for the current construction rush.
- It is difficult to be an expert since construction is limited in season.
- Budget is insufficient.

It is commented that some companies dare to construct buildings with poor quality for the reason above.

On the other hand, three companies to which hearing survey conducted feel the necessity to assure the seismic capacity and to conduct seismic evaluation of the buildings. However they do not feel the necessity to increase the design seismic load and to introduce new technology such as base-isolation or vibration control.

Table 5.3.1 Hearing survey item for design

Item	Concrete Questionnaire
On Company System	How do you confirm the keeping of standards?
	Do you have in-house standards for seismic- and fire- proofing?
	How do you establish the company system for quality assurance?
	Do you have formal license for building design?
	Do you have in-house license for building design?
	How do you implement education for design engineers (OJT, Off-JT)?
On Control for Outsourcing	How do you control the quality of outsources?
	Do you have qualification standards for techniques and skills of outsources?
	Do you have qualification standards for results from outsource?
	What do you do if the outcomes from outsources do not reach to the given standards?
On Upgrading of Building Seismic Capacity	Is current seismic design loads sufficient to withstand future earthquake?
	Is current seismic design method sufficient?
	Is introduction of dynamic analysis into design method necessary?
	Are some new technology such as base-isolation and vibration-control necessary?
	How do you assure seismic performance?
	Is evaluation of seismic capacity necessary?
	Do you have concrete plan to increase seismic capacity? And what is it?

Ref: JICA Project Team

Table 5.3.2 Hearing survey item for construction

Item	Concrete Questionnaire	
On Company System	Do you have formal license for quality control?	
	Do you have in-house license for quality control?	
	How are your system and organization to assure the quality?	
	Do you have in-house license for technology and skill?	
	Do you have in-house education system?	
	On concrete checking procedure	Concrete
		Reinforcement
		Form Work
		Concrete Filling
		Steel Member
		Welding
		Brick Material
		Brick Raying
		Wood work
		Water-proofing
		Fire-proofing
On Control for Outsourcing	How do you control the quality of outsources?	
	Do you have qualification standards for techniques and skills of outsources?	
	Do you have qualification standards for results from outsource?	
	What do you do if the outcomes from outsources do not reach to the given standards?	
On Upgrading of Quality Control	What are the issues to assure the quality?	
	Do you have concrete plan to increase seismic capacity? And what is it?	

Ref: JICA Project Team

Table 5.3.3 Outcomes of hearing survey

Item		Answer
On Quality of Design and Construction	How to confirm the keeping of standards	Check by the designer him-/herself
		Check by the other in-house engineer
		Check by experts
		Keeping ISO
		Keeping Japanese specifications
	In-house standards for waterproofing and fireproofing	In-house standards for the purpose of upgrading are acceptable from law point of view.
		Three companies to which hearing survey conducted do not have in-house standards.
	In-house organization to assure quality	Quality assurance team conducts in-house severance.
		In-house control division conducts site-survey weekly or bi-weekly.
	In-house license for design	Based on Mongolian national license
		No in-house license is available.
	Education and training for design engineer	Make newcomers experience all the jobs
		Attendance to domestic and international training course/ Collaboration with foreign engineers
		Training course to obtain license to conduct the work at construction site
		Operate training course not only for in-house engineers but also for outsources
	Control of outsource	In-house standard for quality control of outsources
		Selection of outsource is based on license, workers and equipment
		It is difficult to control the quality of foreign outsources. Quality control for foreign outcome sometimes remains in checking if the outcomes are suitable for Mongolian natural conditions.
		Keep the in-house technical specification
		Resubmit of outcomes is requires in case they are of insufficient quality.
		Structural calculation may sometimes be ignored in construction. This is due to the fact that contractor wants to finish the construction earlier.
Quality Check	Concrete	No check
		Based on Mongolian standard → 3-day, 1-week, 4-week strength are checked.
		In case of ODA-related construction, conducted are material check, mixture planning and sample mixing
		Concrete shall not be filled in winter time → It is noted some companies do it in winter.
		Curing is essential. Over drying in summer shall also be avoided.
	Reinforcement	Based on inspection certificate
		Based on Japanese standard → Some companies reduce the amount of reinforcement illegally to save money.
	Formwork	No check
		Employ Japanese method of construction
	Steel member	Based on inspection certificate. In case, material testing may be requested.
		Fabrication is done in foreign countries.
		Bolted connection is generally employed. Material test for bolts may be requested in case.
	Welding	By visual inspection
	Brick	Based on inspection certificate
		Construction is based on Mongolian standard, and done by workers trained.
		Allowable to the buildings of 5 stories or less → Some companies use brick for higher buildings. → It is necessary to change the consensus that brick has high capacity.
		No reinforcement is added.

Item		Answer
		→ There is no idea on seismic capacity of brick. → Japanese hollow block is expensive and its feature is not understood by Mongolian constructors.
	Water-proofing	No check
		Preparation of standard and specification for the new material is considerably delayed though some new and good material has been imported from Germany.
	Fire-proofing	Heat insulator mounted outside of buildings can be a cause of fire.
		Especially in case of earthquake, the heat insulator may cause bug issues.
Technology Related to Seismic Design	Current design seismic load	It is enough.
		No comment from the stand point of designer
		Privately against the RCAG's comment on occurrence trend of earthquake, by the following reason; ・Occurrence trend of earthquake may be affected by installing on many seismometers. ・The comments may aim to obtain budget for RCAG.
		Earthquake survey is highly needed.
		It may have better to increase loads to avoid the case as Armenian earthquake.
	Current seismic design method	Dynamic response analysis is needed for high rise building.
		Nonlinear analysis is not highly desired.
	Base-isolation/ Vibration-control	These are not necessary.
		They may be necessary from the viewpoint of damage prevention.
	Evaluation of seismic capacity	Necessary
		Evaluation for existing buildings is important and shall be done by administrative organizations.
		In the years around 2000, construction quality was extremely bad. For example dump trucks instead of concrete-mixer trucks carried concrete.
		Some of large precast panels are not connected correctly.
		Deterioration at basement and 1st floors of brick masonry buildings is extremely high.
		Corrosion of reinforcement is also big issue for RC structures.
		Due to the low quality of material in 2002 to 2003, seismic capacity of all the existing buildings were judged insufficient.
		Seismic capacity of buildings designed by the former Soviet Union code may be judged insufficient, since current Mongolian code requires a little bit higher seismic capacity.
Others	Difficulty in quality control	Being different from Japanese construction companies, Mongolian ones conduct every types of work. → They can be applicable various types of construction work, but cannot be expertized. → This is because construction period is very limited and they need to find various types of jobs.
		Small budget → If they work under national budget, they have to get into red. → They can construct buildings of good quality if budget is enough.
	How to manage quality	It needs to bring up consultants that manage the quality → Quality and technique management is conducted by construction companies. → Management by government cannot handle the buildings being constructed in current rush.

Ref: JICA Project Team

(3) Safety Assessment

Thirty (30) buildings shown in Table 5.3.4 were selected for Evaluation of seismic capacity through the WG activity.

Table 5.3.4 Candidate buildings for seismic capacity evaluation

№	District	Building Name	Story	Structural Type
1	Sukhbaatar	Kindergarden No. 135	2	Steel
2	Bayangol	School No. 96	3	Brick
3	Sukhbaatar	Zuun ail, Kindergarden No. 69	2	Brick
4	Chingeltei	School No. 50	4	Brick
5	Bayangol	School No. 20	4	Steel
6	Songinokhairkhan	Kindergarden No. 118	2	Brick
7	Bayangol	Building No. 27, Micro 6	6	RC
8	Bayangol	6th khoroo, Building No. 45	6	RC
9	Bayangol	Bogd-Ar 204	16	Steel
10	Sukhbaatar	Building No. 7	9	RC
11	Sukhbaatar	Bayanmongol Area Buildings	12	Steel
12	Sukhbaatar	5th khoroo, Building No. 21	9	Steel
13	Chingeltei	6th khoroo, Building No. 2	9	RC
14	Chingeltei	The Chamber of Commerce and Industry	12	RC
15	Sukhbaatar	Central Culture Center	14	RC
16	Bayanzurkh	13th khoroo, Building No. 13	9	RC
17	Bayangol	Golden park、Buildng No. 101	14	Steel
18	Nalaikh	Airport, Yellow Residence, Building No. 10	5	RC
19	Baganuur	Building No. 4	9	RC
20	Khan-Uul	Aioport, Building No. 4	5	RC
21	Khan-Uul	1st khoroo, Building No. 4	12	Steel
22	Songinokhairkhan	Building No. 13	9	RC
23	Songinokhairkhan	1st khoroo, Building No. 18	12	RC
24	Songinokhairkhan	21st khoroo, Building No. 69	7	Steel
25	Chingeltei	Chingeltei ward office	4	RC
26	Sukhbaatar	5th khoroo, Building No. 24	12	Steel
27	Bayangol	14th khoroo, Building No. 23B	9	RC
28	Bayanzurkh	3rd khoroo, 12th Area, Building No. 8a	12	RC
29	Khan-Uul	Sky tower	16	Steel
30	Khan-Uul	Anoma Construction, Building No.72	5	Steel

Ref: JICA Project Team

(4) Building Material Testing

At first, strength test for concrete members were planned. However, by considering the building inventory in UB city, it was concluded that it is necessary to investigate the strength of steel member and of brick as well as of concrete member. So ten (10) buildings listed in Table 5.3.5 were selected for material testing. It is noted that concrete strength test will be done for all ten (10) buildings.

Table 5.3.5 Candidate buildings for material testing

№	District	Building Name	Story	Structural Type
1	Bayangol	4th khoroo, apart.no 6A	5	RC
2	Bayanzurkh	3th khoroo, apart.no 5	5	Brick
3	Bayanzurkh	1st khoroo, apart.no 16	5	RC
4	Bayanzurkh	10th khoroo, apart.no 3	3	Brick
5	Sukhbaatar	6th khoroo, apart.no28	4	Brick
6	Songinokhairkhan	12th khoroo, apart.no 1	9	RC
7	Bayanzurkh	4th khoroo, apart.no 2/44	6	Steel
8	Bayanzurkh	15th khoroo, apart.no 1	12	Steel
9	Sukhbaatar	4th khoroo, apart.no 62	4	Brick
10	Bayangol	2nd khoroo, apart.no 31	3	Brick

Ref: JICA Project Team

5.3.2 Building Inventory Survey

(1) Outline of Building Database Provided by UB City

Building inventory was established by combining the database provided by UB city and that by UBMPS. UB city's database was established in 2010 by KOICA and now is being modified by UB city. It is a very reliable database but has less information on buildings in Ger area since the target area of this database is central area in UB city. On the other hand, UBMPS's database was established in 2007 and includes building data outside of central city, however its reliability is a little bit low since data upgrading has not been done.

Attributes included in the databases are as follows.

- General information on building
    - Address
    - Usage
- Information on structure
    - Structural type
    - Story number
- Information on building's equipment
    - Electricity
    - Water supply and sewage
    - Internet
    - Telephone
    - Number of stove
    - Elevator
    - Garage

Example of attribute is shown in Figure 5.3.1. It must be noted that the entire attributes do not assigned to all the buildings. A lot of data are missing for the buildings in Ger area.

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FID	Shape *	DIVISION	KIND	PURPOSE	BLDG_NAME	FLOOR	MATERIAL
83421	Polygon	Соёл/Боловсрол	Орон сууцны бус барилга	Сургууль	С?хбаатар д??ргийн 6-р б?рэн...	2	Тоосго
83422	Polygon	Соёл/Боловсрол	Орон сууцны бус барилга	Сургууль	С?хбаатар д??ргийн 6-р б?рэн...	1	Тоосго
83423	Polygon	Соёл/Боловсрол	Орон сууцны бус барилга	Сургууль	С?хбаатар д??ргийн 6-р б?рэн...	1	Тоосго
83424	Polygon	Соёл/Боловсрол	Орон сууцны бус барилга	Сургууль	С?хбаатар д??ргийн 6-р б?рэн...	1	Тоосго
83441	Polygon	Соёл/Боловсрол	Саравч буюу хангаг?й барилга	Сургууль	С?хбаатар д??ргийн 6-р б?рэн...	1	Т?м?р
83466	Polygon	Соёл/Боловсрол	Саравч буюу хангаг?й барилга	Сургууль	С?хбаатар д??ргийн 6-р б?рэн...	1	Т?м?р
83467	Polygon	Соёл/Боловсрол	Саравч буюу хангаг?й барилга	Сургууль	С?хбаатар д??ргийн 6-р б?рэн...	1	Т?м?р
83251	Polygon	Соёл/Боловсрол	Саравч буюу хангаг?й барилга	Цэцэрлэг/Ясли	С?хбаатар д??ргийн 54-р цэцэ...	1	Т?м?р
83252	Polygon	Соёл/Боловсрол	Орон сууцны бус барилга	Цэцэрлэг/Ясли	С?хбаатар д??ргийн 54-р цэцэ...	2	Тоосго
83253	Polygon	Соёл/Боловсрол	Орон сууцны бус барилга	Цэцэрлэг/Ясли	С?хбаатар д??ргийн 54-р цэцэ...	2	Тоосго
83552	Polygon	Олон нийтийн байгууллага	Саравч буюу хангаг?й барилга	Хороо	С?хбаатар д??ргийн 5-р хороо	1	Т?м?р
83553	Polygon	Олон нийтийн байгууллага	Орон сууцны бус барилга	Хороо	С?хбаатар д??ргийн 5-р хороо	2	Тоосго
83571	Polygon	Олон нийтийн байгууллага	Саравч буюу хангаг?й барилга	Хороо	С?хбаатар д??ргийн 5-р хороо	1	Т?м?р
83347	Polygon	Соёл/Боловсрол	Машины гараж	Сургууль	С?хбаатар д??ргийн 45-р дунд...	1	Тоосго
83349	Polygon	Соёл/Боловсрол	Орон сууцны бус барилга	Сургууль	С?хбаатар д??ргийн 45-р дунд...	1	Тоосго
83351	Polygon	Соёл/Боловсрол	Орон сууцны бус барилга	Сургууль	С?хбаатар д??ргийн 45-р дунд...	3	Тоосго
83352	Polygon	Соёл/Боловсрол	Орон сууцны бус барилга	Сургууль	С?хбаатар д??ргийн 45-р дунд...	1	Тоосго
83353	Polygon	Соёл/Боловсрол	Орон сууцны бус барилга	Сургууль	С?хбаатар д??ргийн 45-р дунд...	1	Тоосго
83354	Polygon	Соёл/Боловсрол	Орон сууцны бус барилга	Сургууль	С?хбаатар д??ргийн 45-р дунд...	4	Тоосго
85386	Polygon	Соёл/Боловсрол	Орон сууцны бус барилга	Сургууль	С?хбаатар д??ргийн 45-р дунд...	1	Мод
85387	Polygon	Соёл/Боловсрол	Орон сууцны бус барилга	Сургууль	С?хбаатар д??ргийн 45-р дунд...	1	Тоосго болон мод
85388	Polygon	Соёл/Боловсрол	Орон сууцны бус барилга	Сургууль	С?хбаатар д??ргийн 45-р дунд...	1	Т?м?р
85389	Polygon	Соёл/Боловсрол	Орон сууцны бус барилга	Сургууль	С?хбаатар д??ргийн 45-р дунд...	1	Тоосго болон мод
85390	Polygon	Соёл/Боловсрол	Орон сууцны бус барилга	Сургууль	С?хбаатар д??ргийн 45-р дунд...	1	Мод
85429	Polygon	Соёл/Боловсрол	Орон сууцны бус барилга	Сургууль	С?хбаатар д??ргийн 45-р дунд...	1	Тоосго
83343	Polygon	Соёл/Боловсрол	Орон сууцны бус барилга	Биеийн тамирын зал	С?хбаатар д??ргийн 45-р дунд...	2	Тоосго
85391	Polygon	Соёл/Боловсрол	Орон сууцны бус барилга	Биеийн тамирын зал	С?хбаатар д??ргийн 45-р дунд...	2	Тоосго
82162	Polygon	Соёл/Боловсрол	Орон сууцны бус барилга	Сургууль	С?хбаатар д??ргийн 4-р б?рэн...	1	Тоосго
82163	Polygon	Соёл/Боловсрол	Орон сууцны бус барилга	Сургууль	С?хбаатар д??ргийн 4-р б?рэн...	3	Тоосго
82227	Polygon	Соёл/Боловсрол	Бусад	Сургууль	С?хбаатар д??ргийн 4-р б?рэн...	1	Тоосго
23512	Polygon	Соёл/Боловсрол	Орон сууцны бус барилга	Сургууль	С?хбаатар д??ргийн 31-р б?рэ...	1	Тоосго
75073	Polygon	Соёл/Боловсрол	Орон сууцны бус барилга	Сургууль	С?хбаатар д??ргийн 31-р б?рэ...	1	Т?м?р
75074	Polygon	Соёл/Боловсрол	Орон сууцны бус барилга	Сургууль	С?хбаатар д??ргийн 31-р б?рэ...	1	Т?м?р
75075	Polygon	Соёл/Боловсрол	Орон сууцны бус барилга	Сургууль	С?хбаатар д??ргийн 31-р б?рэ...	1	Т?м?р
75076	Polygon	Соёл/Боловсрол	Орон сууцны бус барилга	Сургууль	С?хбаатар д??ргийн 31-р б?рэ...	1	Тоосго
75079	Polygon	Соёл/Боловсрол	Орон сууцны бус барилга	Сургууль	С?хбаатар д??ргийн 31-р б?рэ...	1	Тоосго
75080	Polygon	Соёл/Боловсрол	Саравч буюу хангаг?й барилга	Сургууль	С?хбаатар д??ргийн 31-р б?рэ...	1	Т?м?р
75081	Polygon	Соёл/Боловсрол	Орон сууцны бус барилга	Сургууль	С?хбаатар д??ргийн 31-р б?рэ...	1	Тоосго
75189	Polygon	Соёл/Боловсрол	Орон сууцны бус барилга	Сургууль	С?хбаатар д??ргийн 31-р б?рэ...	1	Т?м?р
75201	Polygon	Соёл/Боловсрол	Орон сууцны бус барилга	Сургууль	С?хбаатар д??ргийн 31-р б?рэ...	1	Т?м?р
79513	Polygon	Соёл/Боловсрол	Саравч буюу хангаг?й барилга	Цэцэрлэг/Ясли	С?хбаатар д??ргийн 25-р цэцэ...	1	Т?м?р
79534	Polygon	Соёл/Боловсрол	Саравч буюу хангаг?й барилга	Цэцэрлэг/Ясли	С?хбаатар д??ргийн 25-р цэцэ...	1	Т?м?р
79535	Polygon	Соёл/Боловсрол	Орон сууцны бус барилга	Цэцэрлэг/Ясли	С?хбаатар д??ргийн 25-р цэцэ...	2	Тоосго
79536	Polygon	Соёл/Боловсрол	Орон сууцны бус барилга	Цэцэрлэг/Ясли	С?хбаатар д??ргийн 25-р цэцэ...	1	Мод
79387	Polygon	Соёл/Боловсрол	Орон сууцны бус барилга	Цэцэрлэг/Ясли	С?хбаатар д??ргийн 2-р цэцэр...	2	Тоосго
79388	Polygon	Соёл/Боловсрол	Бусад	Цэцэрлэг/Ясли	С?хбаатар д??ргийн 2-р цэцэр...	1	Тоосго
79389	Polygon	Соёл/Боловсрол	Х?лэмж	Цэцэрлэг/Ясли	С?хбаатар д??ргийн 2-р цэцэр...	1	Шил
81115	Polygon	Соёл/Боловсрол	Орон сууцны бус барилга	Цэцэрлэг/Ясли	С?хбаатар д??ргийн 17-р цэцэ...	2	Тоосго
83072	Polygon	Соёл/Боловсрол	Саравч буюу хангаг?й барилга	Цэцэрлэг/Ясли	С?хбаатар д??ргийн 160-р цэц...	1	Т?м?р
83078	Polygon	Соёл/Боловсрол	Саравч буюу хангаг?й барилга	Цэцэрлэг/Ясли	С?хбаатар д??ргийн 160-р цэц...	1	Т?м?р
83079	Polygon	Соёл/Боловсрол	Орон сууцны бус барилга	Цэцэрлэг/Ясли	С?хбаатар д??ргийн 160-р цэц...	2	Тоосго

Ref: JICA Project Team

Figure 5.3.1 Attributes of buildings (partial)

(2) Establishment of Building Inventory

Based on the two (2) databases mentioned before, building inventory for risk assessment was constructed. In combining databases, following policy was employed.

- UB city's database is principal, on which UBMPS's data are added if they are not included UB city's database.
  - ・ Principal is given to more reliable database.
  - ・ UBMPS's database supplements the UB city's database.
  - ・ Overlapping of data will be duly checked by GIS software.
- For attributes, UB city's attributes are principal, on which UBMPS's attributes are added if they are not included.
- New attributes listed below are evaluated from shape files and included in database for risk assessment.
  - ・ Longitude and latitude of the building
  - ・ Building area (projection area)
- Only attributes related to risk assessment shall be included.

In accordance with the policy above, building inventory was re-arranged as shown in Table 5.3.6.

Table 5.3.6 Attributes to be included in building inventory

Attribute	Description	Number of Attributes
Building ID	6-digit-number, for data management	
Longitude	Longitude of centroid of projection [deg.]	
Latitude	Latitude of centroid of projection [deg.]	
Building Area	Projection area of building [m^2]	
Usage_1	Large classification of building usage	7 categories
Usage_2	Small classification of building usage	21 categories
Structure_1	Classification of structure (UB's DB)	8 categories
Structure_2	Classification of structure (UBMPS's DB)	
Story	Number of story of building	
Year	Design year or year of service supply	
Fireproofing	Flammable/Inflammable	2 categories

Ref: JICA Project Team

For data management, six-digit-number is employed. Longitude, latitude and building area are calculated from the shape file, respectively.

Usage_1 is the large classification of building use and is summarized in Table 5.3.7. Usage_2 is the small classification of building use and is summarized in Table 5.3.8. For structure, 8 categories shown in Table 5.3.9 are assigned based on the structural type. In case of the complex structure that is expressed as “Holimog (Mixed in Mongolian)”, dominant structural type is assigned for the structure. For example, RC is assigned to the structure of category “RC + Block wall”, and Brick is assigned to the structure of category “Brick + Wooden roof”, respectively.

Building usage map and building structural map in the central city are shown in Figure 5.3.2 and in Figure 5.3.3, respectively.

Table 5.3.7 Attribute related to building usage (1)

No.	Description
1	Residence
2	Green house
3	Non-residence (Commerce, Industry)
4	Temporary
5	Hut
6	Under construction
9	Others

Ref: JICA Project Team

Table 5.3.8 Attribute related to building usage (2)

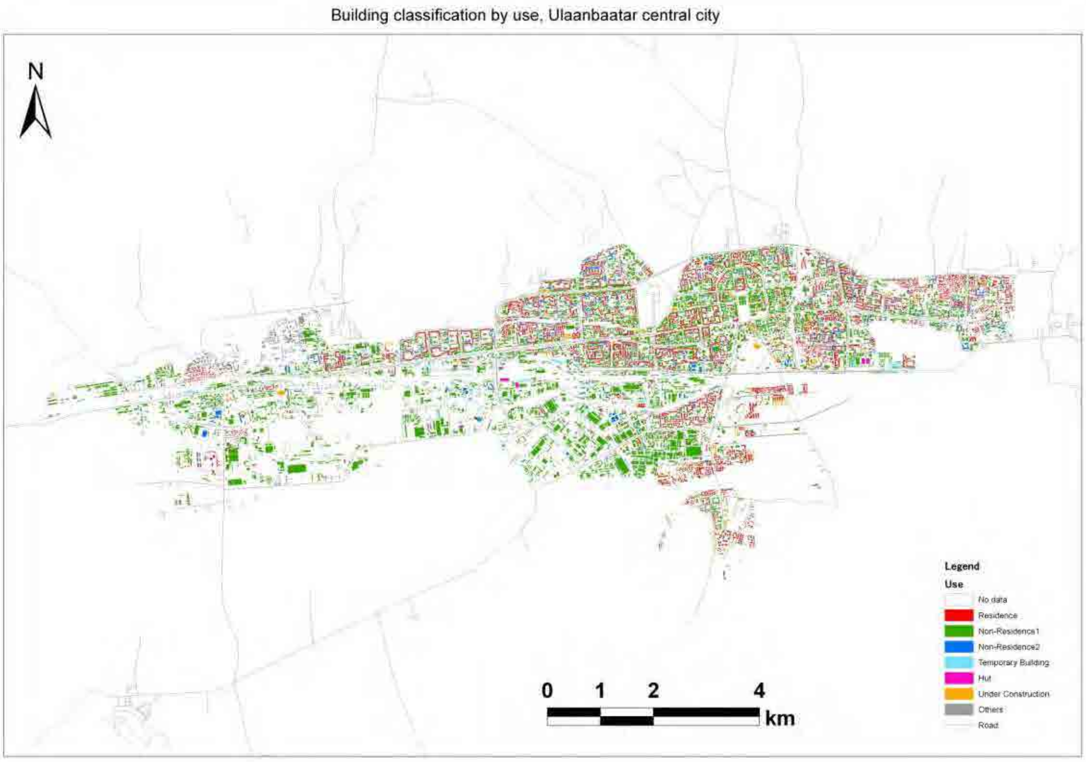
No.	Description	Note
11	Public facility	Entire public facility
21	kindergarten	Entire school facilities
22	School	
23	University	
24	Gymnasium	
31	Hospital	
41	Residential house	Individual building
42	Apartment house	
51	Apartment house with office	Office-related Including residential portion
52	Office	
61	Apartment house with store	Commerce-related Including residential portion
62	Restaurants	
63	Hotel, dormitory	
64	Department store	
65	store	
71	Factory	Industry- related
72	Warehouse	
81	Temple, church	Buildings where many people are assembled
82	Museum, library, theater	
83	Station	
91	Others	Others or building with no description

Ref: JICA Project Team

Table 5.3.9 Attribute related to structural type

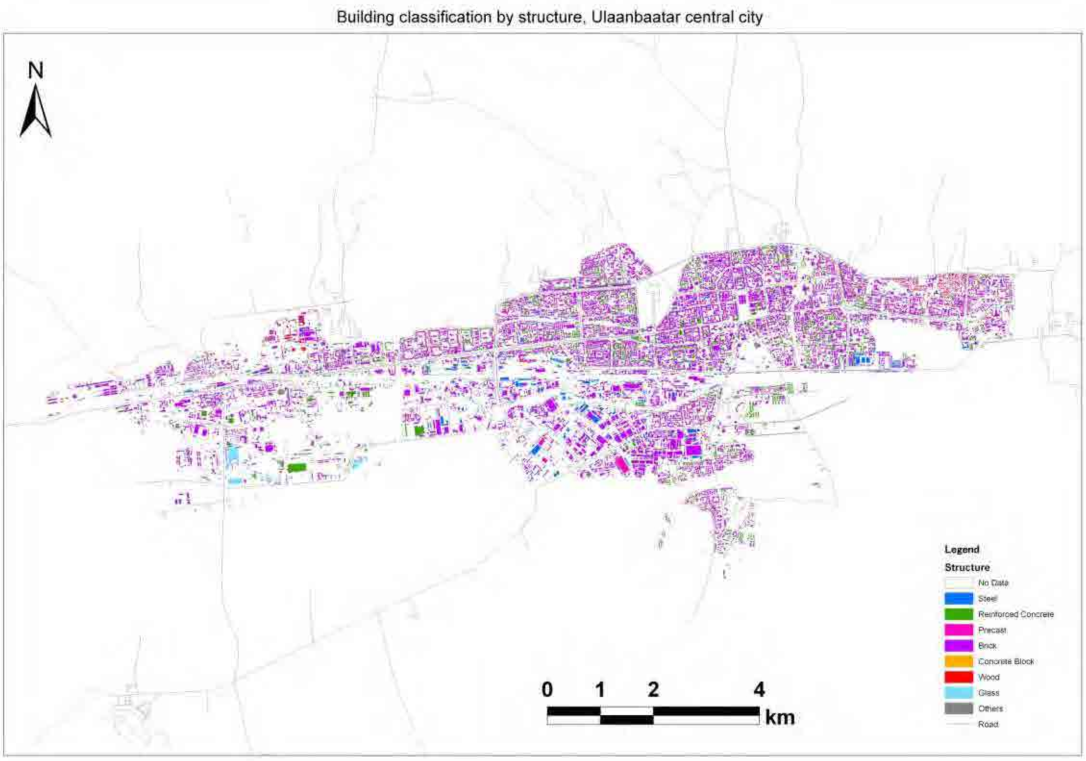
No.	Description
1	Steel
2	RC
3	Large PC panel
4	Brick masonry
5	Concrete block masonry
6	Wood
7	Glass
9	Others

Ref: JICA Project Team



Ref: JICA Project Team

Figure 5.3.2 Building usage map (Central city)



Ref: JICA Project Team

Figure 5.3.3 Building structural type map (Central city)

5.3.3 Seismic Risk Assessment for Buildings

(1) Policy of Seismic Risk Assessment

In accordance with the number of buildings and required accuracy, various methods are proposed and utilized in risk assessment. For risk assessment for region, where numerous buildings exist, a method employing vulnerability functions is often used for its easiness in calculation. A vulnerability function shows a relationship between ground motion intensity, such as peak ground acceleration (PGA) or peak ground velocity (PGV), and damage ratio that is a proportion of the number of damaged structures to that of total ones. In many damage evaluations conducted in Japan, logarithmic normal distribution is applied for the function so that only two (2) parameters, logarithmic mean and standard deviation, are needed to be estimated.

As stated above, a method utilizing vulnerability function is a quite simple, however, there are some disadvantages. Namely, results may change by selecting the ground motion parameter, and the method is not proper to estimate individual buildings. By the way, it is said that damage of rigid buildings had a good correlation with PGA and flexible building does with PGV, so that employing unique ground motion parameter may bring the large uncertainty in the risk assessment of region including many buildings with various natural period. Since this project handles a lot of buildings, and it must be noted that natural period of buildings differs with damage condition, the method applicable to the wide range of natural period is desired.

In this project, the Limit Strength Method (LSM) is employed for the reasons listed below.

- Use of response spectrum as ground motion index
  Since response spectrum (RS) includes more information on ground motion, such as amplification and frequency characteristics), It can be applicable to various buildings in various damage conditions. Though duration time and time domain characteristics are also important, above characters are more important for damage estimation.
- Use of skeleton curve to express building characteristics
  Severe damage such as building collapse will be dominated not by force acting on building, but deformation. Therefore a method that can evaluate building deformation is preferable.
- Stability in evaluation
  Compare to the dynamic response analysis, LSM has less room in which engineering judgment exists, so that it can give more stable results.

(2) Outline of Limit Strength Method

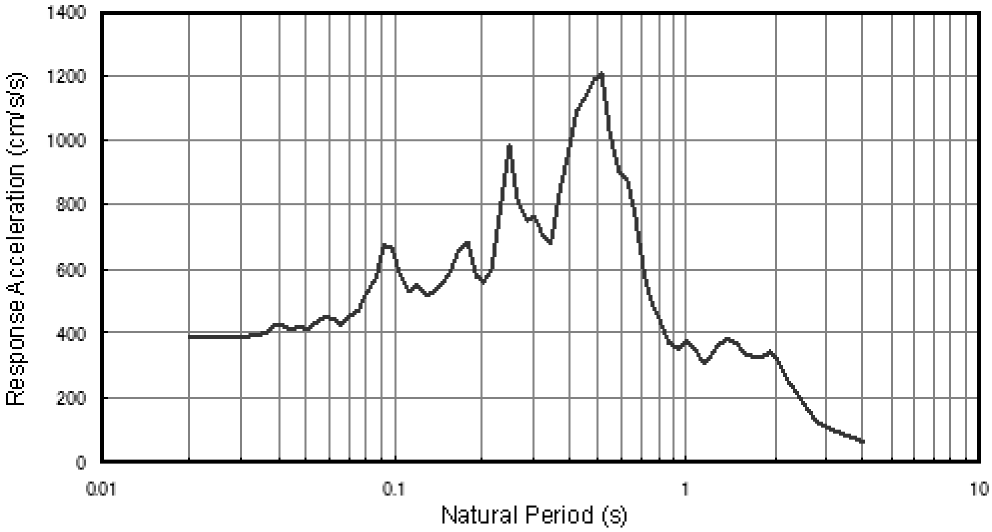
Limit Strength Method (LSM) is a procedure to obtain the response displacement and response acceleration from the intersectional point of combined spectrum and skeleton curve of equivalent single degree of freedom system.

1) Combined Spectrum

Acceleration response spectrum is given as a relationship between natural period of single degree of freedom system and its peak response acceleration as illustrated in Figure 5.3.4. Response acceleration is converted into response displacement by the following formula.

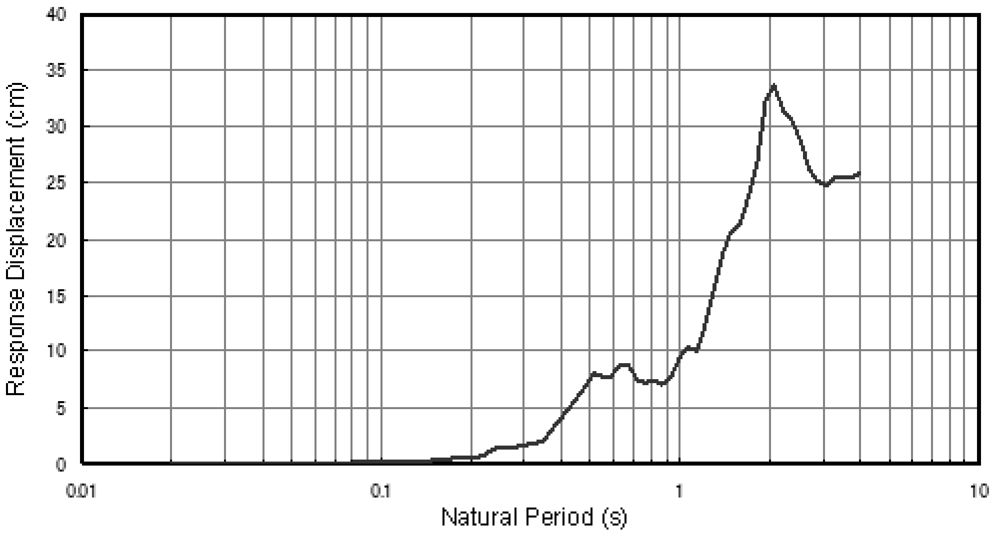
$$S_d(T) = \frac{S_a(T)}{\omega^2} = \frac{S_a(T)}{(2\pi / T)^2}$$

where, T is a natural period, $S_a(T)$ and $S_d(T)$ are response acceleration and response displacement, respectively. Response displacement spectrum is the relationship between natural period of single degree of freedom system and its peak response displacement as shown in Figure 5.3.5. By combining response displacement and response acceleration through common natural period, the combined spectrum shown in Figure 5.3.6 is calculated.



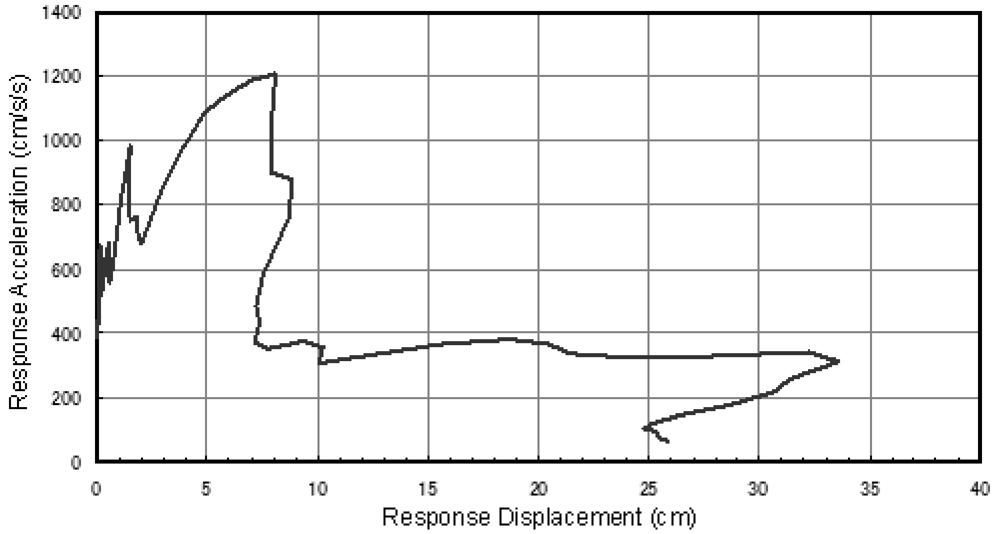
Ref: JICA Project Team

Figure 5.3.4 Example of response acceleration spectrum



Ref: JICA Project Team

Figure 5.3.5 Response displacement spectrum estimated from response acceleration spectrum



Ref: JICA Project Team

Figure 5.3.6 Combined spectrum estimated from response acceleration spectrum

It must be noted that the response will be decreased by increasing damping due to the inelastic behavior. In LSM, this reduction by inelastic behavior is considered in the calculation as the reduction of input ground motion.

For this purpose, the response reduction factor F_h is multiplied to $S_a(T)$ and $S_d(T)$. F_h is given by the following formula.

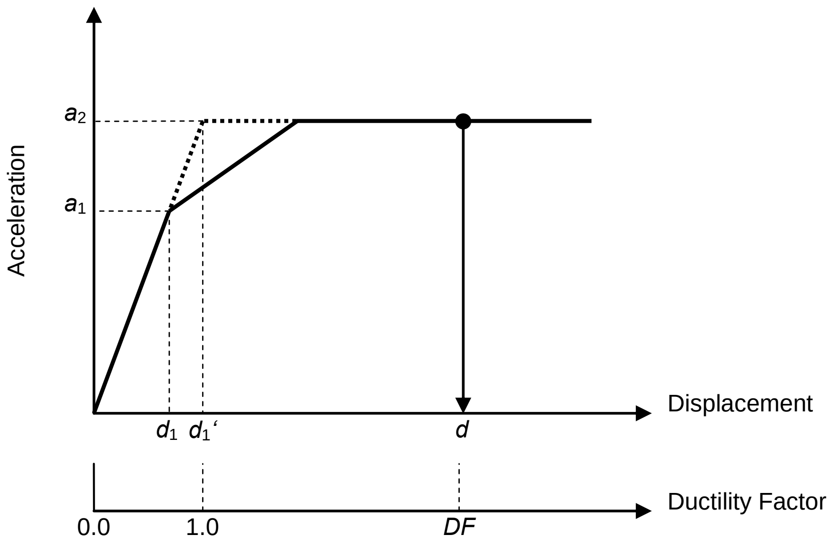
$$F_h = \frac{1.5}{1+10h}$$

$$h = 0.25 \cdot \left(1 - \frac{1}{\sqrt{DF}}\right) + 0.05 \quad \text{if} \quad DF > 1.0$$

where, DF is ductility factor which is given as below.

$$DF = \frac{d}{d_1}\frac{a_1}{a_2} = \frac{d}{d_1 \cdot (a_2 / a_1)} = \frac{d}{d_1'}$$

The concept of DF mentioned above is illustrated in Figure 5.3.7.



Ref: JICA Project Team

Figure 5.3.7 Relationship between displacement and ductility factor

2) Modeling of Building

In LSM, building is modeled as an equivalent single degree of freedom system (eSDOF). In Japanese seismic design or evaluation, building is often modeled as multi degree of freedom system (MDOF), and the eSDOF is derived from the MDOF.

Let *m*, *k* and *h* be mass, spring coefficient and story height of MDOF, respectively. And let *d* and *Q* be relative displacement and base shear under design seismic load, respectively. Then equivalent mass *M* and equivalent displacement *D* with the same base shear *Q* are given by following formula.

$$M = \frac{\left[\sum m_j d_j\right]^2}{\sum m_j d_j^{\,2}}$$

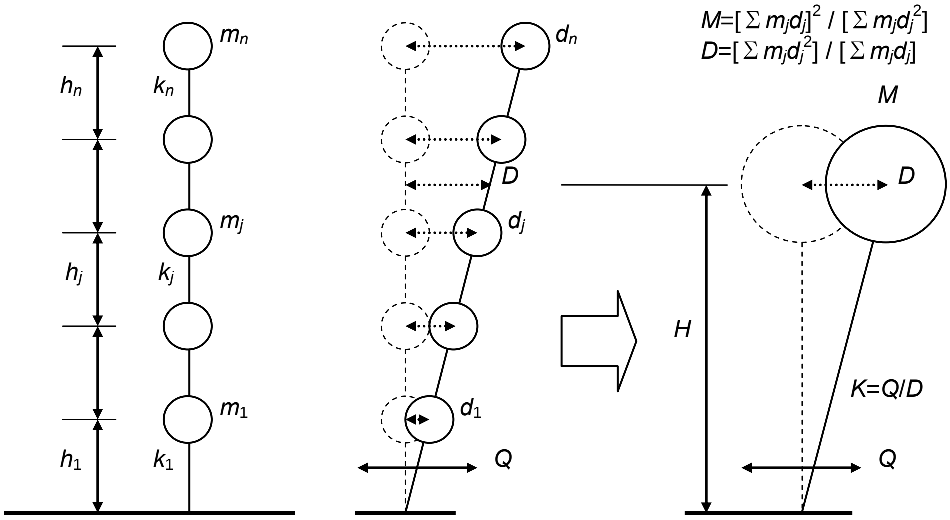
$$D = \frac{\sum m_j d_j^{\,2}}{\sum m_j d_j}$$

where, subscript *j* denotes story. Spring coefficient *K* of eSDOF is calculated as $K = Q/D$.

The equivalent height *H* of eSDOF is obtained as the height in which relative displacement of MDOF is equal to *D* of eSDOF. In case that mass and story height of MDOF is identical in elevation, H can be obtained by the following formula.

$$H = \frac{2n+1}{3n}\sum h_j = \frac{2n+1}{3}h$$, where *n* is the number of the story.

The above explanation is illustrated in Figure 5.3.8.



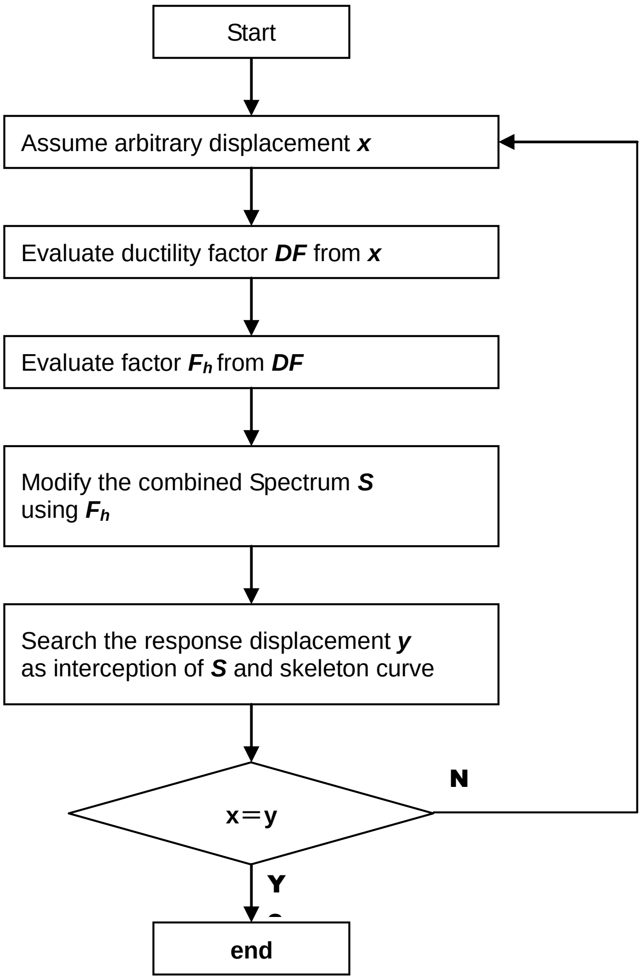
Ref: JICA Project Team

Figure 5.3.8 Illustration to evaluate eSDOF from MDOF

3) Search for Response Displace

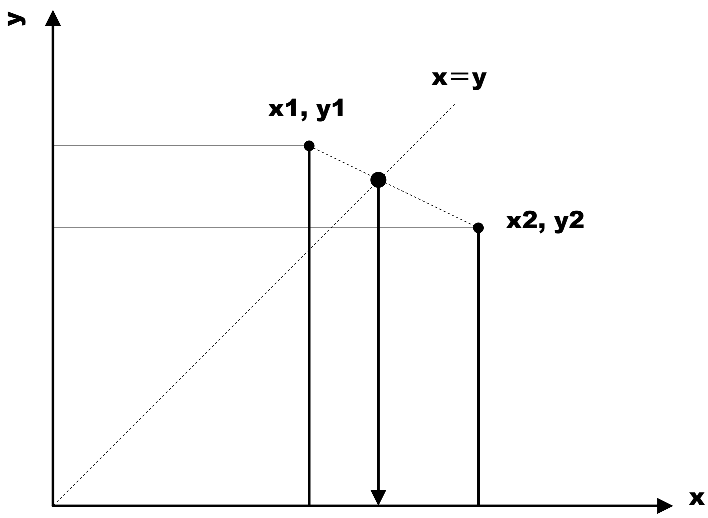
Since the combined spectrum changes its magnitude according to the displacement of the structure, the search for the intersectional point of the combined spectrum and the skeleton curve of eSDOF requires try & error procedure as shown in Figure 5.3.9. In the software, two (2) response displacements are evaluated by increasing displacement *x*, one is just before *x* exceeds *y* and the other on just after *x* exceeds *y*, where, *x* is assumed displacement and *y* is displacement based on LSM. Finally response displacement is calculated as illustrated in Figure 5.3.10.

Process of search is illustrated in Figure 5.3.11. In case that *x* is equals to 0.5, no modification of combined spectrum is done since *DF* is less than the unity. In case that *DF* exceeds 1.0, the combined spectrum gets smaller with increasing *x* from 2.0 to 4.0. In case that *x* is equals to 5.0, estimated *y* is equals 4.4 so that magnitude correlation of *x* and *y* gets reversed and it can be found that response displacement is between 4.0 and 5.0. In case that *x* is equals to 4.461, y is also equals to 4.461 that is the response displacement to be evaluated.



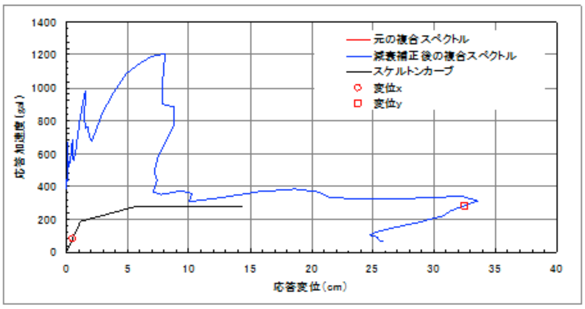
Ref: JICA Project Team

Figure 5.3.9 Iterative procedure to obtain response displacement by LSM

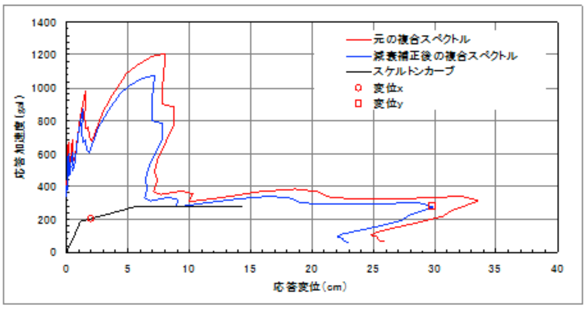


Ref: JICA Project Team

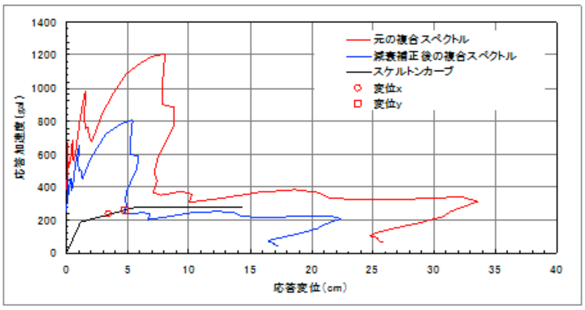
Figure 5.3.10 Evaluation of response displacement from adjacent two points



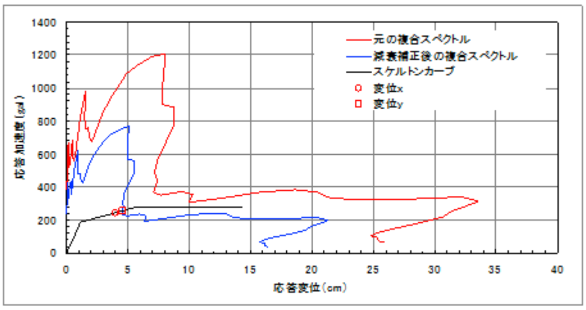
x=0.5, y=32.5



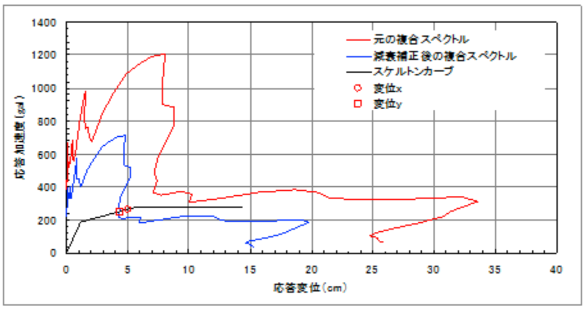
x =2.0, y=29.8



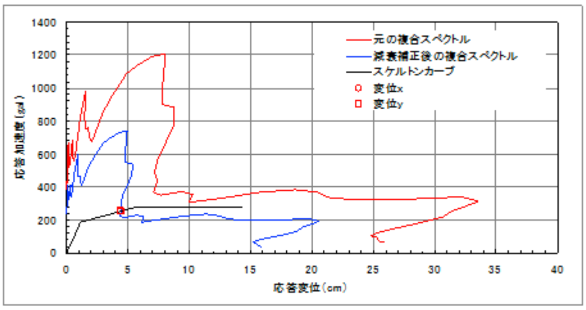
x=3.5, y=4.8



x=4.0, y=4.5



x=5.0, y=4.4



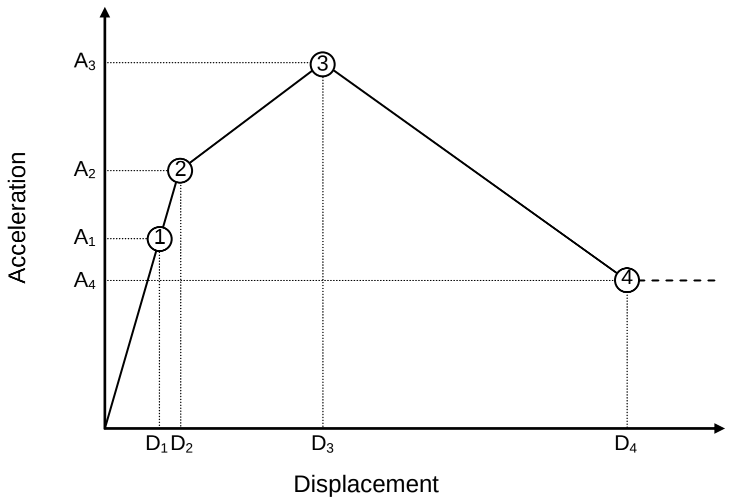
x=y=4.461

Ref: JICA Project Team

Figure 5.3.11 Process of search for response displacement

(3) Modeling of Building

As mentioned before, buildings are modeled as a skeleton curve of eSDOF. The shape of skeleton curve is regulated by four (4) points shown in Figure 5.3.12. Point [1] is a reference point, which is given based on Mongolian design standard. Point [2] to [4] is employed to regulate the behavior after exceeding the design capacity. It is assumed that building will maintain the capacity when the displacement exceeds point [4].



Ref: JICA Project Team

Figure 5.3.12 Point to regulate skeleton curve of eSDOF

1) Determination of Point [1]

Point [1] is defined as an elastic limit that corresponds to the "damage limit" in LSM. Displacement and acceleration of eSDOF is obtained from the design acceleration and displacement of MDOF designed by Mongolian standard in its design year.

Design acceleration above is given reflection design conditions such as design year, soil condition, structural behavior factor and so on. Though current Mongolian design standard and former Soviet Union's one require eigenvalue analysis of three-dimensional model to obtain seismic load, this project employs Ai distribution of story shear instead of eigenvalue analysis for its easiness in evaluation. It is noted that Ai distribution corresponds to modal combination and gives close result in response acceleration.

Setting of design displacement is equals to setting of shear stiffness of each story. Shear stiffness of each story on MDOF is determined so that the natural period T of MDOF is equal to the given one that is estimated by the following formula.

$$T = \alpha \sum h_j$$

Coefficient α is given in accordance with structural type as shown in Table 5.3.10.

Table 5.3.10 Coefficient α for setting natural period

	Steel	RC	Large PC panel	Brick	Concrete Block	Wood	Glass
α	0.03	0.02	0.018	0.018	0.018	0.04	0.02

Ref: JICA Project Team

For steel structure and RC structure, Japanese factors are employed. For large PC panel structure, the factor is set based on the report on disaster by "Lessons learned from 1999 Armenia, Colombia earthquake (in Japanese)". For brick structure and concrete block structure the same factor in applied considering their rigidity. For wooden structure, the factor is given so that natural period of two (2) story building is about 0.3s. For glass structure, it is assumed that the rigidity is close to RC structure.

Story height is given based on the usage, namely, 3.6m for residential building and 4.0m for others.

2) Determination of Point [2]

Point [2] is defined as a realistic elastic limit reflecting the some margins in design procedure and in material strength.

Factors in Table 5.3.11 are used to obtain point [2] by multiplying them to the values of point [1]. These values were set based on Japanese design practice, US HAZAS, and Mongolian experts' opinions.

Table 5.3.11 Factors multiplied to point [1] to obtain point [2]

	Steel	RC	Large PC panel	Brick	Concrete Block	Wood	Glass
D_2/D_1	1.2	1.3	1.3	2.0	2.0	1.5	1.1
A_2/A_1	1.2	1.3	1.3	2.0	2.0	1.5	1.1

Ref: JICA Project Team

3) Determination of Point [3]

Point [3] is defined as the point where the acceleration reaches maximum strength.

In Mongolian and former Soviet Union design standards, factor k_1 is introduced. This factor has the same meaning of factor *Ds* in Japanese standard. In many buildings k_1 is set as 0.25, however this value requires very ductile behavior as steel moment frame, therefore, it may not be appropriate to consider uniform factor to various structures shown in Table 5.3.11. So, above-mentioned *Ds* is introduced for each structure and the ratio of *Ds* to k_1 that is 0.25 is multiplied to acceleration of point [1]. Also, the ductility factor derived from Ds using Newmark's formula is applied to the displacement of point [1]. Derived factors in the manner are summarized in Table 5.3.12.

Table 5.3.12 Factors multiplied to point [1] to obtain point [3]

	Steel	RC	Large PC panel	Brick	Concrete Block	Wood	Glass
Ds	0.35	0.40	0.45	0.5	0.5	0.5	0.45
D_3/D_1	4.6	3.6	3.0	2.5	2.5	2.5	3.0
A_3/A_1	1.4	1.6	1.8	2.0	2.0	2.0	1.8

Ref: JICA Project Team

For steel structure and RC structure, Ds were set considering that bracings and shear walls are provided. For large PC panel structure, it is assumed that ductility is less than RC structure. For brick and concrete block structure, the values were set considering that they are not reinforced by re-bars. Many of wooden structures exist in Ger area and are non-engineered, so it is assumed they are not ductile as engineered wooden building in Japan. For glass structures the same values as large PC panel structure are applied.

4) Determination of Point [4]

Point [4] is defined as a "safety limit" in LSM, which corresponding to the building's collapse.

Displacement of point [4] is a product of limit drift angel *r* and height of eSDOF. Acceleration of point [4] is a product of strength reduction factor F and the maximum acceleration that is the one of point [3]. Values employed are summarized in Table 5.3.13. It is noted that limit drift angel *r* is determined through the domestic support committee and the process examination committee in Japan.

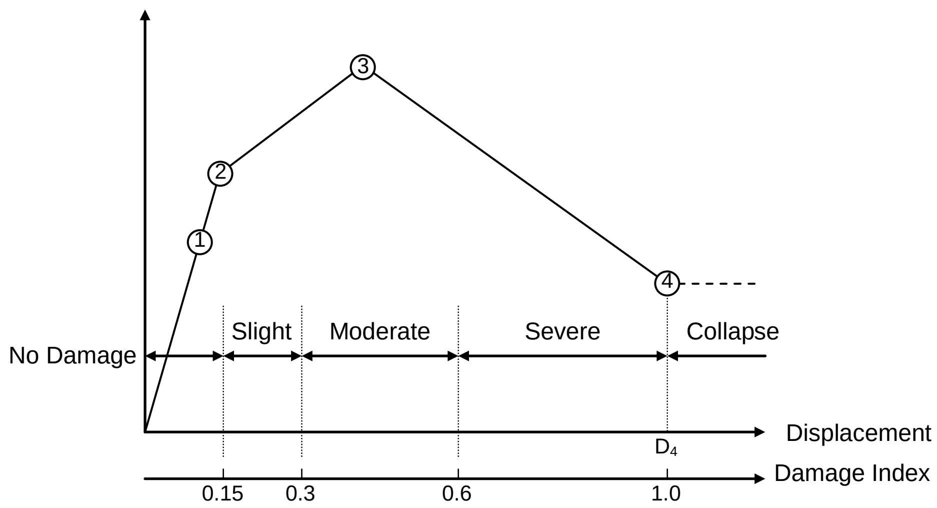
Table 5.3.13 Factors to determine point [4]

	Steel	RC	Large PC panel	Brick	Concrete Block	Wood	Glass
$1/r$	30	60	60	60	60	30	60
F	0.75	0.75	0.75	0.5	0.5	0.25	0.1

Ref: JICA Project Team

(4) Quantification of Damage

In the seismic risk assessment, it is important to judge if the building is available immediately after earthquake or not, as well as to evaluate how much the lives and properties are injured. For this purpose, damage state is quantified by the index that is a normalized displacement; the ratio of displacement to the one of point [4], as illustrated in Figure 5.3.13.



Ref: JICA Project Team

Figure 5.3.13 Relationship between damage index and damage

It is noted that Figure 5.3.13 gives the damage state of individual buildings, however it is not impossible to assess the amount of damage in a set. For example, if there are 100 buildings whose damage indices are 1.0, the amount of the damaged buildings are not null or 100, but 50. Therefore, it needs to employ the concept of probability and to assess the amount of damage as an expectation.

As probabilistic distribution function employed is the logarithmic normal distribution which is often used as damage function in the field of damage estimation. Let x and X be damage index and threshold, respectively. Then damage rate p can be obtained by the following formula.

$$p = \Phi\left[\frac{\ln(x/X)}{\beta}\right]$$

where, $\Phi[\cdot]$ denotes the normal Gaussian distribution function and β is the logarithmic standard deviation expressing the uncertainty of damage rate. Following assumption is employed to obtain logarithmic standard deviation; p is 0.5 if x is equals to 1.0, and p is 0.01 if x is equals to 0.3. The latter assumes that if the displacement remains within the threshold of moderate damage, the probability that the building collapses is quite low. From this assumption, β is set to 0.52. Of course it may not adequate to compare the variability of vulnerability functions to above variability, however, they are not so much deferent to each other (see Table 5.3.14 and Table 5.3.15).

Table 5.3.14 Materials on vulnerability functions

No.	Authors	Title	Reference
1	Murao, Yamazaki	Development of Fragility curves for buildings based on damage survey data of a local government after 1995 hyogoken-nanbu earthquake	J. of constr. Eng. AIJ No.527, P.189, 2000.1
2	Hayashi, Miyakoshi, Tasai, Oono	Seismic performance of RC buildings during hyogoken-nanbu earthquake	J. of constr. Eng. AIJ No.528, P.135, 2000.2
3	Saeki, Midorikawa	Development of vulnerability functions for economic losses to residential buildings	J. of constr. Eng. AIJ No.545, P.79, 2001.7
4	Masuda, Nagato, Kawase	Study on construction of vulnerability functions by earthquake response analysis for reinforced concrete buildings	J. of constr. Eng. AIJ No.558, P.101, 2002.8
5	Kashima, Takada, Mizukosi, Ishida, Tagami, Hayasaka	Macroscopic Study on Building Damage at the 1995 Hyogo-ken Nanbu Earthquake : (Part 2) Evaluation of Fragility Curve of Buildings	Proc. of AIJ B-2, p.3, 1996
6	Nakamura, Nakamura	Study on a Characteristic of Earthquake Motion and Logarithmic Standard Deviation of Seismic Fragility Curve(SFC) Based on Dynamic Response Analysis	Proc. of AIJ B-1, p.39, 2000
7	Hayashi	Statistical analysis of SRC building damage in Hyogo-ken Nanbu earthquake (Performance of existing buildings and target performance)	Proc. of AIJ B-2, p.47, 2000
8	Miyakoshi, Kanbara, Fukuwa, Yamaguchi	Vulnerability functions of buildings using damage data of structural damage ranks	Proc. of AIJ B-2, p.25, 2003

Ref: Proceedings of Architectural Institute of Japan

Table 5.3.15 Outline of existing vulnerability functions

No.	Building			Ground Motion Index	Distribution function	Damage Condition					
	Structure	Story	Year			Slight		Moderate		Severe	
						Median	Variability	Median	Variability	Median	Variability
1	RC	-	-1971	PGV	Log-Normal			112	0.69	167	0.65
			1972-81	PGV	Log-Normal			128	0.61	206	0.58
			1982-94	PGV	Log-Normal			206	0.79	403	0.79
			All	PGV	Log-Normal			147	0.72	148	0.71
	S	-	-1971	PGV	Log-Normal			70	0.71	104	0.62
			1972-81	PGV	Log-Normal			89	0.55	144	0.49
			1982-94	PGV	Log-Normal			150	0.73	281	0.73
			All	PGV	Log-Normal			109	0.67	171	0.63
2	RC (Non-Piloti)	2-5	-1971	PGV	Log-Normal	330	1.27	392	0.90	567	1.02
			1972-81	PGV	Log-Normal	596	1.47	1012	1.23	508	0.71
			1982-	PGV	Log-Normal	750	1.04	1153	0.88	1108	0.80
		6-7	1972-81	PGV	Log-Normal	176	0.53	189	0.32	196	0.26
			1982-	PGV	Log-Normal	354	1.25	226	0.35	446	0.60
		8-12	1982-	PGV	Log-Normal	151	0.96	191	0.49	473	0.73
	RC (All)	-	-1971	PGV	Log-Normal	293	1.25	361	0.94	483	0.98
			1972-81	PGV	Log-Normal	314	1.14	416	0.92	327	0.58
			1982-94	PGV	Log-Normal	469	1.06	358	0.57	483	0.58
			All	PGV	Log-Normal	344	1.05	450	0.88	652	0.94
3	Non-wooden	-	-	JMA Intensity	Normal	5.48	0.11	6.46	0.12	7.07	0.12
4	RC	3	Old	PGA	Log-Normal					954	0.23
				PGV	Log-Normal					138	0.29
				SI	Log-Normal					378	0.33
			New	PGA	Log-Normal					875	0.09
				PGV	Log-Normal					163	0.28
				SI	Log-Normal					381	0.22
		6	Old	PGA	Log-Normal					848	0.28
				PGV	Log-Normal					117	0.12
				SI	Log-Normal					315	0.19
			New	PGA	Log-Normal					748	0.03
				PGV	Log-Normal					136	0.18
				SI	Log-Normal					314	0.06
		9	Old	PGA	Log-Normal					701	0.27
				PGV	Log-Normal					115	0.28
				SI	Log-Normal					282	0.27
			New	PGA	Log-Normal					788	0.15
				PGV	Log-Normal					128	0.15
				SI	Log-Normal					326	0.17
		12	Old	PGA	Log-Normal					765	0.17
				PGV	Log-Normal					145	0.27
				SI	Log-Normal					348	0.25
			New	PGA	Log-Normal					745	0.27
				PGV	Log-Normal					127	0.29
				SI	Log-Normal					311	0.29
5	All	-	-	PGA	Log-Normal	600	0.16	690	0.14	710	0.12
				JMA Intensity	Normal	5.14	0.12	5.26	0.11	5.30	0.10
6	RC	3	-	PGA	Log-Normal	182	0.70	292	0.76	986	0.67
				PGV	Log-Normal	17	0.53	30	0.21	75	0.32
				SA	Log-Normal	322	0.12	475	0.18	1508	0.05
				SV	Log-Normal	47	0.10	66	0.20	203	0.12
		7	-	PGA	Log-Normal	308	0.73	546	0.45	1652	0.60
				PGV	Log-Normal	31	0.27	44	0.28	116	-
				SA	Log-Normal	308	0.17	557	0.26	1690	-
				SV	Log-Normal	65	0.11	110	0.22	313	-
		11	-	PGA	Log-Normal	449	0.48	77	0.63	-	-
				PGV	Log-Normal	36	0.14	57	0.29	-	-
				SA	Log-Normal	217	0.35	381	0.05	-	-
				SV	Log-Normal	71	0.12	105	0.10	-	-
7	SRC	7-15	-1970	PGV	Log-Normal	67	0.40	92	0.38	114	0.42
			1971-80	PGV	Log-Normal	78	1.04	134	0.47	172	0.43
			1981-	PGV	Log-Normal	107	1.39	211	0.68	354	0.63
8	RC	2-5	-1971	PGV	Log-Normal			392	0.90	567	1.02
			1972-81	PGV	Log-Normal			1012	1.23	508	0.71
			1982-	PGV	Log-Normal			1153	0.88	1108	0.80
		6-7	-1971	PGV	Log-Normal			202	0.68	260	0.79
			1972-81	PGV	Log-Normal			189	0.32	196	0.26
			1982-	PGV	Log-Normal			226	0.35	446	0.60
		8-12	-1971	PGV	Log-Normal			148	0.53	209	0.71
			1972-81	PGV	Log-Normal			147	0.38	213	0.52
			1982-	PGV	Log-Normal			191	0.49	473	0.73
	S	1-2	-1981	PGV	Log-Normal			126	0.61	211	0.78
			1982-	PGV	Log-Normal			215	0.39	281	0.48
		3-4	-1981	PGV	Log-Normal			124	0.73	235	0.97
			1982-	PGV	Log-Normal			237	0.60	330	0.67
		5-6	-1981	PGV	Log-Normal			82	0.58	158	0.91
			1982-	PGV	Log-Normal			171	0.53	242	0.62
		All	-1981	PGV	Log-Normal			122	0.64	213	0.84
			1982-	PGV	Log-Normal			230	0.58	317	0.65
			All	PGV	Log-Normal			121	0.70	281	0.84

Ref: Proceedings of Architectural Institute of Japan

(5) Result of Seismic Risk Assessment

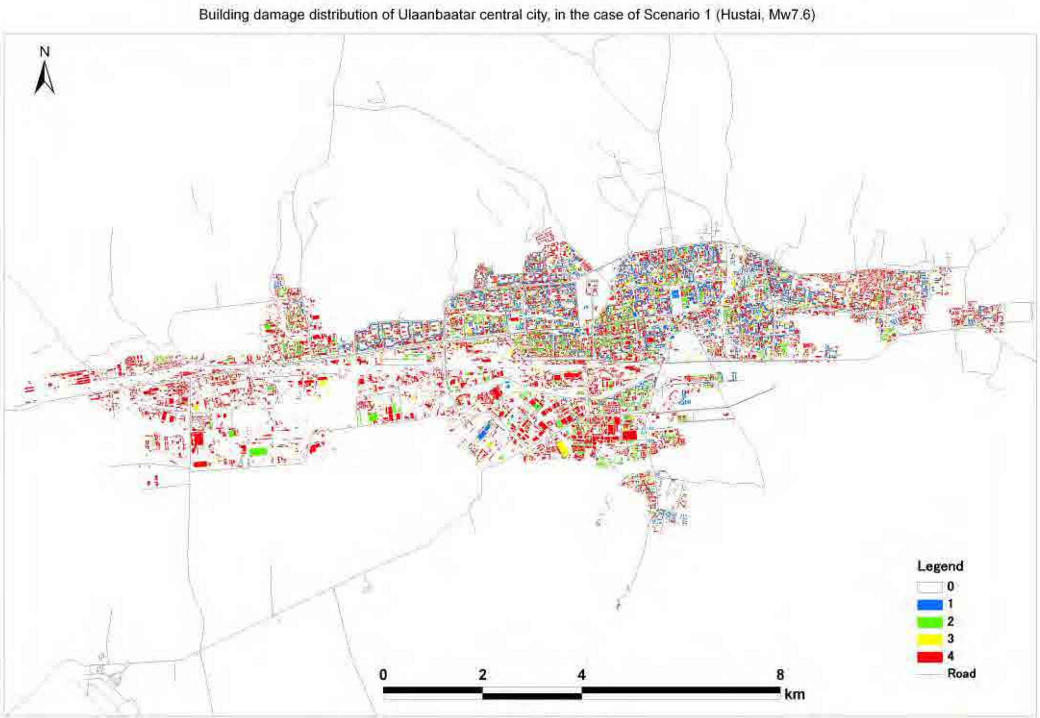
Damage state of each building due to scenario I earthquake and scenario II earthquake is shown in Figure 5.3.14 and Figure 5.3.15, respectively. Numbers in the figures, 1, 2, 3 and 4 correspond to slight, moderate, severe and collapse, respectively. From the figures it can be seen that damage in case of scenario II is smaller than that of scenario I, and western part of central city is damaged more than central and eastern parts. Figure 5.3.16 and Figure 5.3.17 show the distribution of building collapse in case of scenario I and II, respectively. The building judged “collapse” may survive and the building judged “severe” or less may collapse. It is noted that in making Figure 5.3.14 to Figure 5.3.17, buildings whose usage number is 1 to 3 in Table 5.3.7 were evaluated.

Damage rate for building collapse is summarized in Table 5.3.16. The figures come from simple statistics, namely, proportion of collapsed building number to total building number. For relatively large buildings whose building area is 200[m^2]or greater, such as residential building and office, the damage rate is about 53% in case of scenario I and 26% in scenario II. The cause to bring the high damage rate in case of scenario I will be discussed in the following paragraph.

Table 5.3.16 Damage rate for building collapse

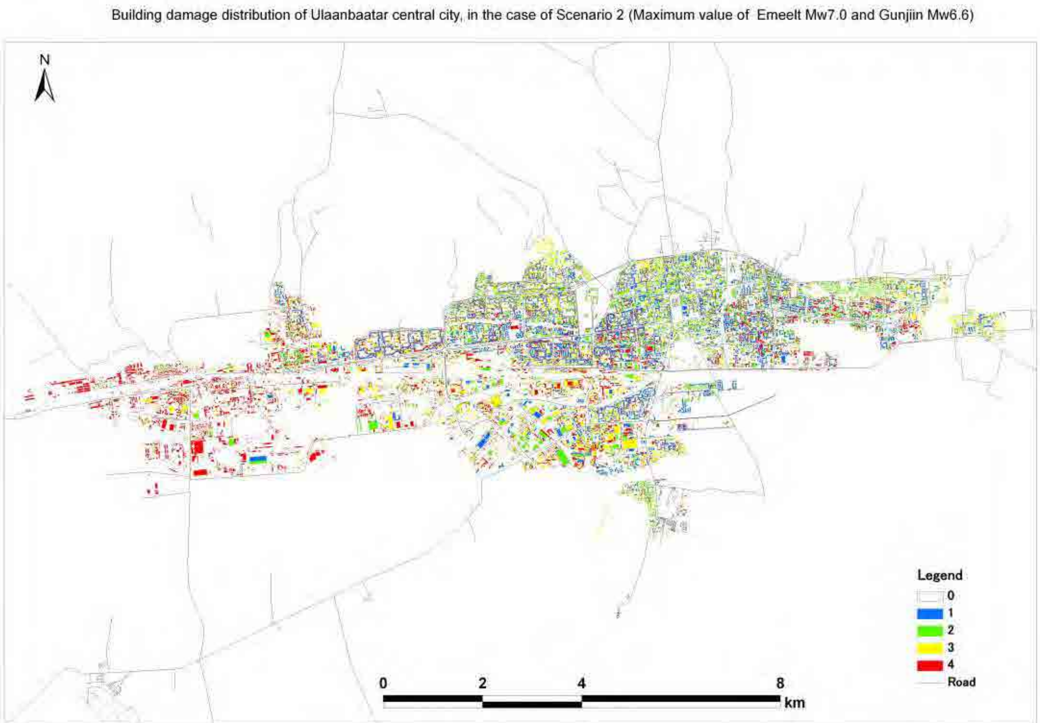
Earthquake Scenario	Building Area [m^2]							
	-50	50-100	100-200	200-500	500-1000	1000-2000	2000-5000	5000-
Scenario I	75.4	85.5	81.7	60.1	44.8	47.9	53.9	59.4
Scenario II	41.6	47.6	46.5	31.0	20.8	23.6	23.4	33.1

Ref: JICA Project Team



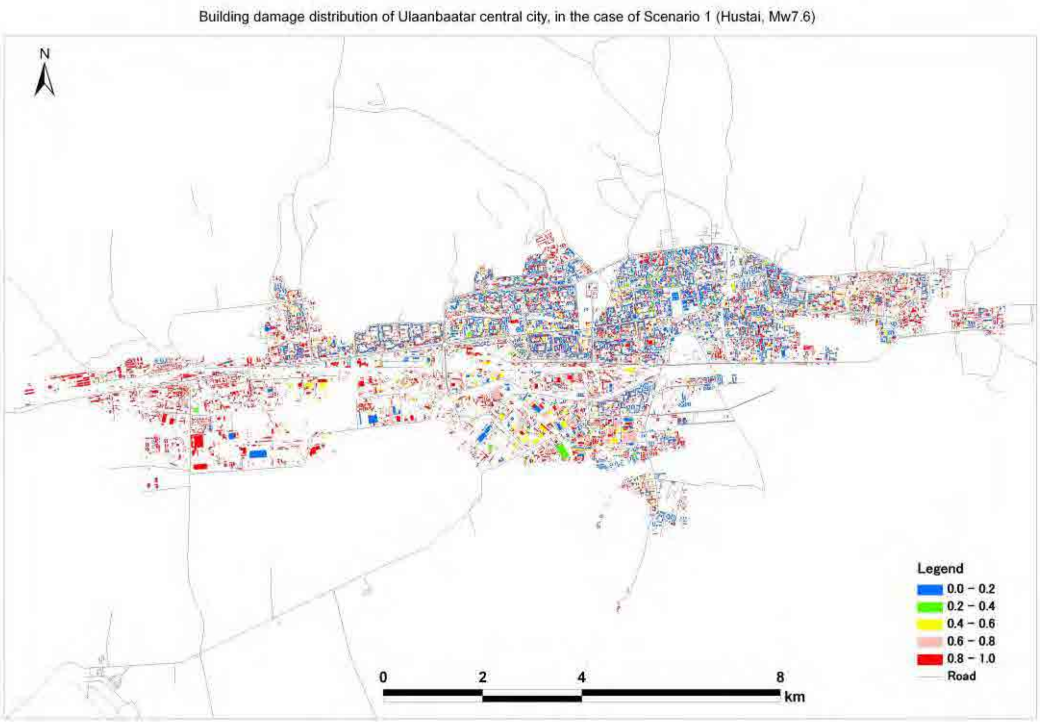
Ref: JICA Project Team

Figure 5.3.14 Distribution of building damage in central six districts (scenario I)



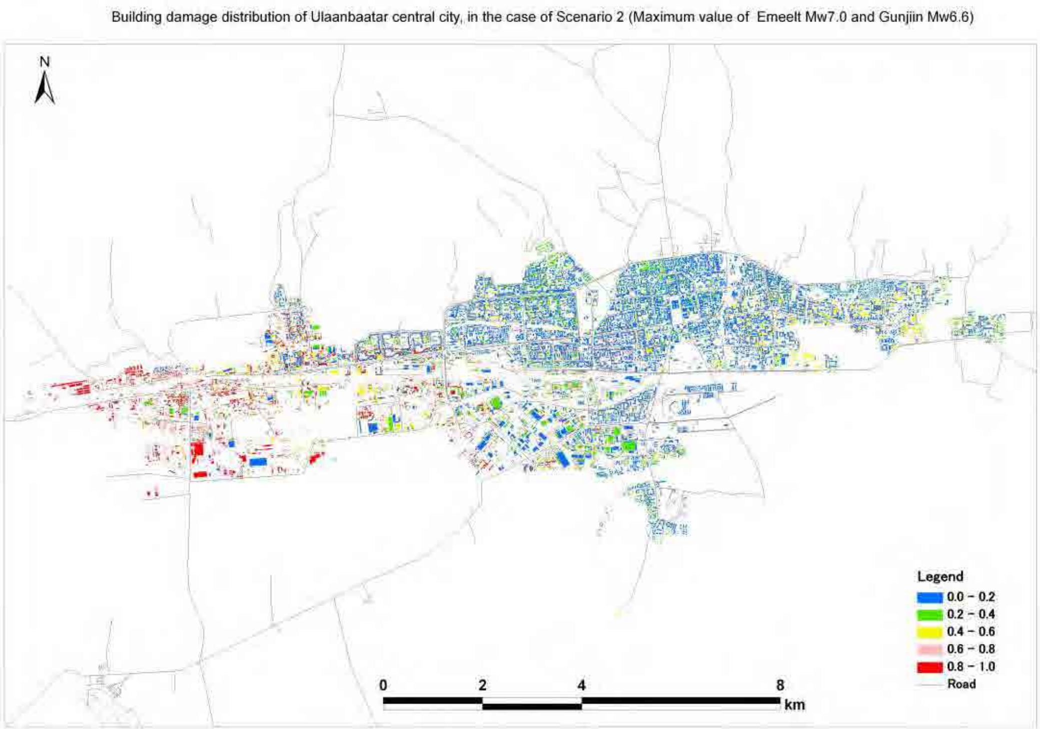
Ref: JICA Project Team

Figure 5.3.15 Distribution of building damage in central six districts (scenario I)



Ref: JICA Project Team

Figure 5.3.16 Distribution of building collapse probability in central six districts (scenario I)



Ref: JICA Project Team

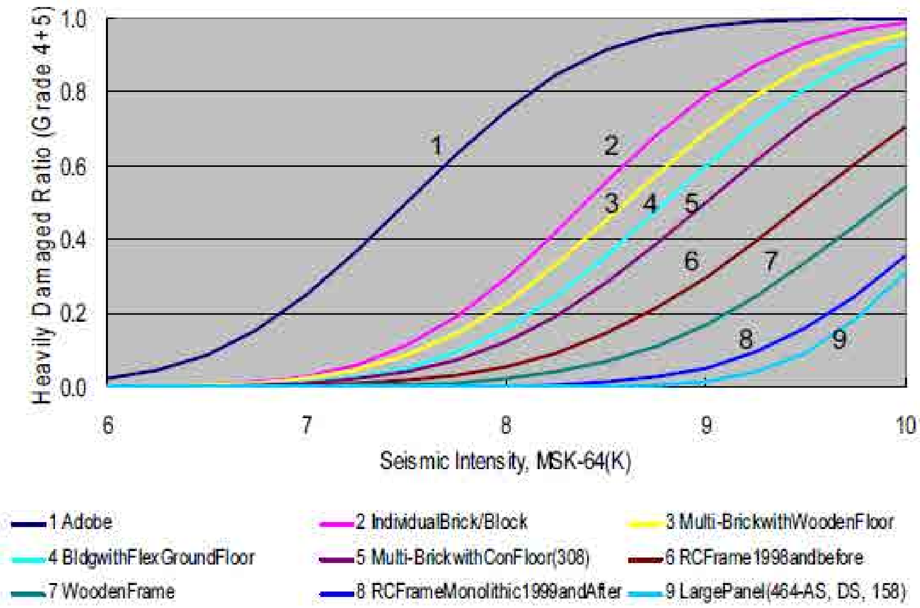
Figure 5.3.17 Distribution of building collapse probability in central six districts (scenario II)

(6) Discussions on the Results of Seismic Risk Assessment

The damage rate shown in Table 5.3.16 are considerably larger than those in the damage estimation conducted for Almaty, Kazakhstan, in which damage rate was assessed 11% for apartment house and 33% for individual residential house. Discussion is given to this difference.

1) Comparison of Seismic Capacity of Building

In the damage estimation for Almaty, Kazakhstan (Almaty D.E) , the vulnerability functions shown in Figure 5.3.18 were used. Vulnerability function is the cumulative distribution of ground motion intensity corresponding the given damage state. At the ground motion intensity when the damage ratio is equals to 0.5, the building reaches to the given damage state in average.

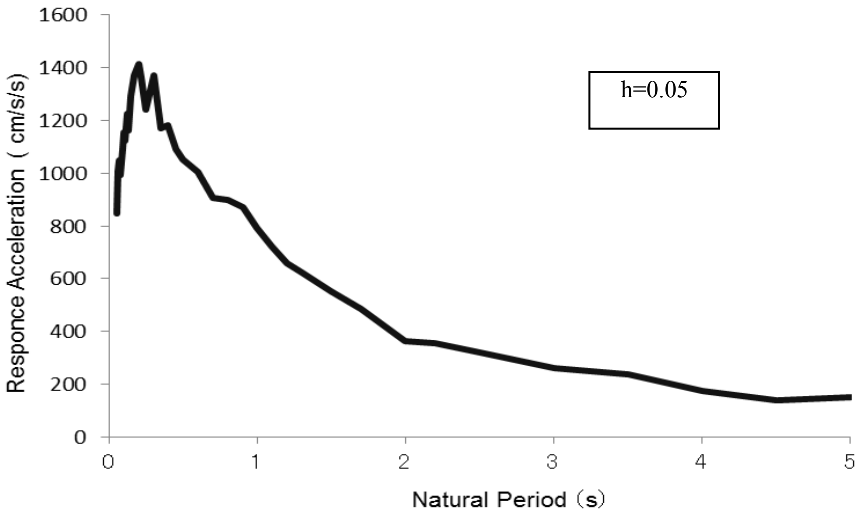


Ref: JICA Report 09-13

Figure 5.3.18 Vulnerability function used in Almaty damage estimation

On the other hand, LSM employed in this project estimates the deformation or displacement of the building for the given response spectrum. This means that the response spectrum that deforms the structure to its collapsed displacement is the ground motion corresponding to the damage ratio of 0.5.

So, by comparing the ground motion intensity corresponding to the damage ratio of 0.5 of the vulnerability function and that making structure deform up to the given displacement, the difference in building capacity used in Almaty D.E and in this project. It is noted that MSK intensity used in Almaty D.E and response spectrum in this project are compared through peak ground acceleration *PGA*. MSK intensity *I* and *PGV* are related by the relationship that $PGA=2^{I-7}$. On the other hand, there is no explicit relationship between response spectrum and *PGA*, therefore, the reference site was selected for examination to relate response spectrum and *PGA*. As reference site, Nomin department store was selected for the reason that it locates in the center of the UB city and on the soil of medium hardness categorized as soil type 2. The response spectrum at Nomin department store is shown in Figure 5.3.19. Using the same conditions to obtain the response spectrum, such as focal distance, magnitude and AVS30, *PGA* at the site is determined 332.6[cm/s/s].



Ref: JICA Project Team

Figure 5.3.19 5% damped response spectrum at Nomin department store

The following structures with some variations in height are employed for the comparison.

- Steel : 5 floors, 10 floors, 15 floors
- RC : 5 floors, 10 floors, 15 floors
- Brick : 2 floors, 5 floors
- Wood : 2 floors

The limit drift angles for collapse are set as in Table 5.3.17, in which Case 1 shows the values proposed in the domestic support committee and process examination committee in Japan, and Case 2 shows the values that are the halves of Case 1

Table 5.3.17 Limit Drift angle for collapse

	Steel	RC	Brick	Wood
Case 1	1/15	1/30	1/30	1/30
Case 2	1/30	1/60	1/60	1/60

Ref: JICA Project Team

The factors to be multiplied to the response spectrum shown in Figure 5.3.19 so that the structure reaches to the limit drift angle for collapse were obtained for two cases above. Further the factors were multiplied to *PGA* of 332.6[cm/s/s] to estimate *PGA* for building collapse. The factors and the PGAs are summarized in Table 5.3.18 and Table 5.3.19, respectively.

On the other hand, MSK intensity *I* corresponding to the vulnerability functions used in Almaty D.E were derived from Figure 5.3.18 and summarized in Table 5.3.20 with *PGA* estimated from *I*. Comparison of *PGAs* are shown in Figure 5.3.20. From the comparison, it can be seen that Case 2 and vulnerability function show a good agreement for reinforced concrete structure and brick structure, and Case 1 and vulnerability function show a good agreement for wooden structure.

The limit drift angles in Case 1 are for the Japanese buildings, so that these values may not applicable to the buildings constructed with poor quality. Though the full scale experiment for brick masonry building gives useful information on limit drift angle, the result may overestimate the limit drift angle since building will be shaken dynamically and in two (2) directions simultaneously. Wooden structures are built without calculations in general, so that difference by the country is considered small. Though no basis is available to examine the drift angle for the collapse unfortunately, it may be concluded that the deformation ability as shown in Case 1 is not achievable because of the poor construction quality and of lack of the practice to maintain the ductility.

For the reasons above, it is considered adequate to employ the values shown in Table 5.3.13

Table 5.3.18 Factors and *PGAs* for collapse (Case 1)

Structure	Steel			RC			Brick		Wood
Story	5	10	15	5	10	15	2	5	2
Factor	6.6	12.4	18.0	3.5	6.1	9.0	1.5	3.3	1.5
PGA	2195.2	4124.2	5986.8	1164.1	2028.9	2976.8	515.5	1097.6	502.2

Ref: JICA Project Team

Table 5.3.19 Factors and *PGAs* for collapse (Case 2)

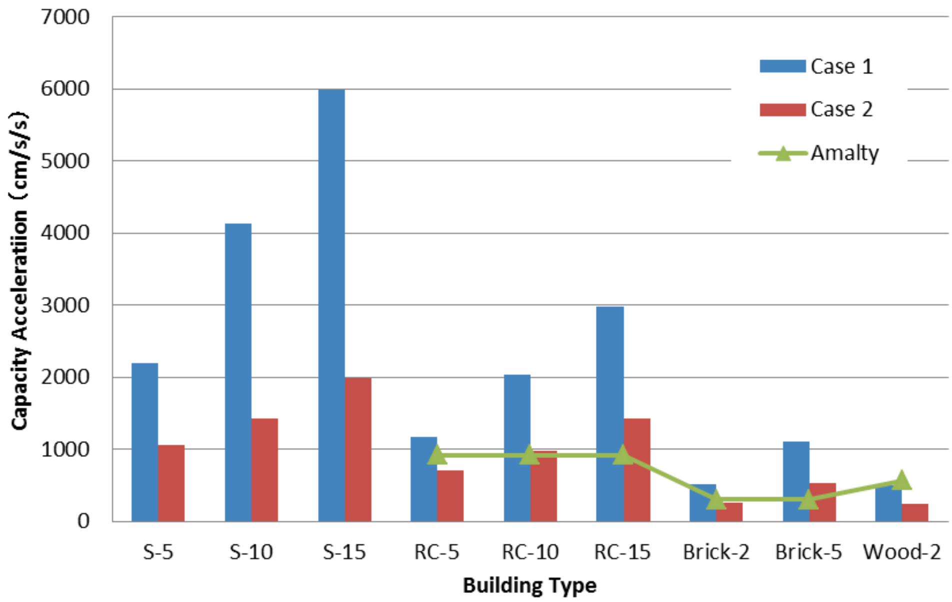
Structure	Steel			RC			Brick		Wood
Story	5	10	15	5	10	15	2	5	2
Factor	3.2	4.3	6.0	2.1	3.0	4.3	0.8	1.6	0.7
PGA	1064.3	1430.2	1979.0	698.5	981.2	1430.2	249.5	532.2	246.1

Ref: JICA Project Team

Table 5.3.20 Medians of vulnerability functions used in Almaty damage estimation

Structure	Adobe	Brick	Brick+ Wooded Floor	Piloti	Brick+ RC Floor	RC Before 1998	Wood	RC After 1999	PC Panel
MSK intensity	7.48	8.37	8.58	8.77	8.96	9.46	9.87	10.25	10.35
PGA	141.4	263.9	303.1	348.2	400.0	527.8	565.7	919.0	1055.6

Ref: JICA Project Team



Ref: JICA Project Team

Figure 5.3.20 Comparison of *PGA*

2) Comparison of Risk Assessment Method

The previous comparison was conducted from the viewpoint of seismic capacity of building. This comparison aims to the examine the difference in results by the different risk assessment method.

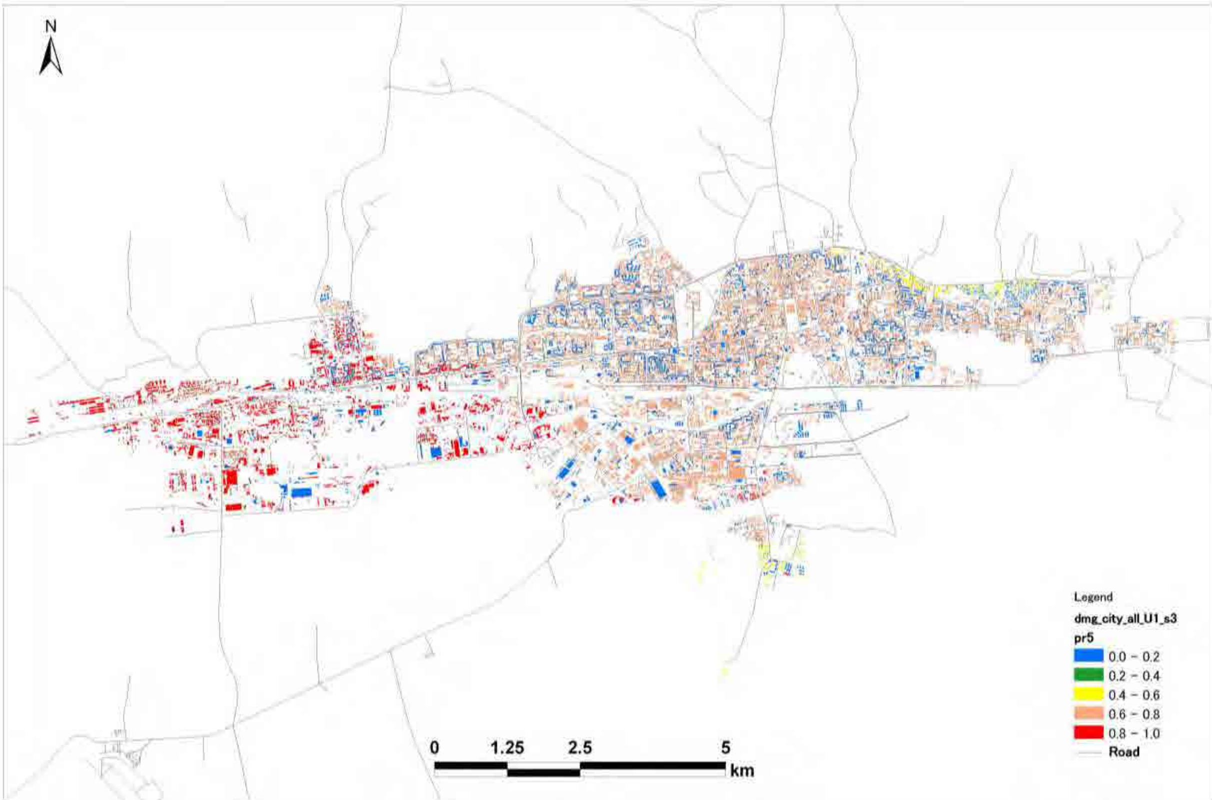
Instead of conducting LSM, vulnerability functions used in Almaty D.E are employed to assess the seismic risk of UB city for scenario I. Normal Gaussian distribution is assumes for vulnerability functions with their parameters shown in Table 5.3.21.

Distribution of building collapse probability is shown in Figure 5.3.21, and damage rates are shown in Table 5.3.22, respectively. The results by LSM are also indicated in the table for reference. The trends of damage distribution are similar to the one by LSM, for example, higher damage probability is observed in the western part. Also, it can be seen that method using vulnerability functions gives the high damage rate as LSM does.

Table 5.3.21 Parameters for vulnerability functions for Almaty damage estimation

Structure	Adobe	Brick	Brick+ Wooded Floor	Piloti	Brick+ RC Floor	RC Before 1998	Wood	RC After 1999	PC Panel
Average	7.48	8.37	8.58	8.77	8.96	9.46	9.87	10.25	10.35
Standard Deviation	0.754	0.731	0.800	0.777	0.845	0.937	0.914	0.777	0.685

Ref: JICA Project Team



Ref: JICA Project Team

Figure 5.3.21 Distribution of building collapse probability in central six districts using vulnerability functions

Table 5.3.22 Damage rate for building collapse using vulnerability functions

Method	Building Area [m^2]							
	-50	-50	-50	-50	-50	-50	-50	-50
Vulnerability Function	44.1	58.9	66.3	59.1	53.4	56.2	61.0	63.4
LSM	75.4	85.5	81.7	60.1	44.8	47.9	53.9	59.4

Ref: JICA Project Team

3) Conclusion

From the comparison explained above, it can be seen that evaluation of seismic capacity of buildings are not so much different regardless of methods.

As stated before, the damage rate of apartment house was 11% and that of individual residential housing was 33% for 1887 Verny scenario in Almaty D.E. This can be due to the fact that ground motion intensity in in Almaty D.E is less than that in this project, for example, MSK intensity ranges from 8 to 9 in Almaty D.E and 9 to 10 in this project.

Therefore, it can be concluded that the main cause to bring the high damage rate in case of scenario I is that ground motion intensity estimated is relatively high.

5.4 Risk Assessment for Transportation and Lifeline Structures

5.4.1 Survey of Existing Structure

The objective survey structure is bridge. Ahead of this project, JICA project "The Project for Construction of Ajilchin Flyover in Ulaanbaatar City" completed a similar survey and kindly provided their results, such as, survey sheets, design drawings as well as concrete strength test results, etc, which were used here as the basic information for bridge inventory and risk assessment. Static and dynamic analysis for a total of eight bridges were performed for the purpose of risk assessment. The eight bridges, shown in Table 5.4.1, were selected in consultation with the road department from those whose design drawings were available. Field survey for the selected bridges was carried out, where the design drawings, bearing and deterioration were confirmed. The detailed information of the selected bridges were summarized in Section 2 of the Databook.

Table 5.4.1 Bridges for static and dynamic analysis

Bridge No.	Name of bridge	Length (m)	Construction year
4	Arslantai Bridge	34.2	1962
5	Uliastai tsaad Bridge - Left	96.2	1967
18	Dund gol Deed Bridge	50.2	1975
19	Ikh Tenger Bridge	258.0	1994
24	Sonsgolon Bridge	289.4	1971
26	Poultry farm Bridge	256.0	1989
34	Sharga Morit Bridge	50.4	1982
56	Uliastai tsaad Bridge - Right	96.2	2010

5.4.2 Inventory of Transportation and Lifeline Structures

The inventory of transportation and lifeline structures covers road, bridge, water supply, sewerage, power and hot water pipeline. The inventory was made basically from the data provided by UB city. In the case of road and pipeline, the inventory was arranged according to district and khoroo.

The inventory of following lifeline structures are summarized in Section 2 of the Databook.

(1) Road
(2) Bridge
(3) Water supply
(4) Sewerage
(5) Power
(6) Hot water pipeline

5.4.3 Seismic Risk Assessment for Transportation and Lifeline Structures

(1) Approach and objective structures

Seismic risk is the function of seismic hazard and the fragility of structure. The fragility can be evaluated either with the past earthquake damage or through analysis. It is generally preferable to use the fragility specified for the country or region concerned. Unfortunately, there is neither earthquake damage data nor exist of fragility in Mongolia. As an alternative, the fragility, used in Japan by the central disaster prevention council or local authorities, was adopted here. Table 5.4.2 compares the approaches of this project with those from the other JICA similar projects, i.e. “the basic study on earthquake disaster risk management for Istanbul (2002)”, “the study on earthquake disaster risk management for Almaty city (2009)” and “project for seismic risk assessment and risk management planning for Yerevan (2012)”. The approach used in this project was considered basically in consistency with the other JICA projects.

The lifeline structures concerned here were water supply, sewerage, hot water heating system and power system. The seismic risk of the lifeline is composed of the risk from a wide range of facilities, such as, water station, pump station, sewerage plant, pipeline, power plant, substation, transmission and distribution line, etc. On the other hand, noticed that the risk assessment for complicated facilities, who have buildings, civil structures and machines, were difficult because there was no statistical fragility and a detailed quantitative analysis was needed, the risk assessment here was then focused on the pipelines due to the availability of the statistical fragility.

The risk of road and pipeline was first evaluated for a 250m×250m area with the seismic hazard and ground condition of the area and the results were then summarized according to districts for the purpose of risk management plan. The risk for bridges was estimated individually for each bridge.

Table 5.4.2 Risk assessment approach of this project and the other JICA projects

<table>
<tr><th rowspan="2">Facility</th><th colspan="4">City</th></tr>
<tr><th>Istanbul (2002)</th><th>Almaty (2009)</th><th>Yerevan (2012)</th><th>UB (this project)</th></tr>
<tr><td>Road</td><td></td><td></td><td></td><td>・Method of Saitama city</td></tr>
<tr><td>Bridge</td><td>・Katayama method</td><td>・Katayama method</td><td>・Katayama method</td><td>・Katayama method and ductility ratio method</td></tr>
<tr><td>Water</td><td>・For pipeline
・Method of Japan Water Works Association</td><td>・For pipeline
・ Method of HAZUS (Max.) and Tokyo (Average)</td><td>・For pipeline
・ Method of HAZUS (Max.) and CDPC (Central Disaster Prevention Council) (Average)</td><td>・For pipeline
・ Method of CDPC</td></tr>
<tr><td>Sewerage</td><td>・Ditto</td><td>・Ditto</td><td>・Ditto</td><td>・Method of CDPC</td></tr>
<tr><td>Power</td><td>・For distribution line
・Overhead: Damage rate from Turkey data
・Underground： Method of HAZUS</td><td>・For distribution line
・Overhead：Method of HAZUS (Max.) and Saitama Pref. (average)
・Underground：Method of Tokyo</td><td>・Same as left</td><td>・For distribution line
・Overhead and underground：Method of CDPC</td></tr>
</table>

(2) Risk assessment of road

The damages of road, such as crack, upheaval and slope collapse, are mainly caused by ground deformation and can be considered more related to roadbed (embankment, earth cut) and ground condition (hard, soft) than road pavement. Since the embankment and earth cut are not the majority of UB road, the damage estimation method, which can take into account the effect of ground condition, was used here. By the method, the road damage was estimated by the road length and damage rate, a function of JAM intensity and ground classification (Table 5.4.3, ref: damage estimation investigation report of Saitama city, 2010). Due to JMA intensity was not the output of hazard analysis, it was calculated from the ground velocity (Vmax) by

$$I_{JMA}=2.519+1.931*\log(Vmax)$$

(ref: Fujimoto and Midorikawa, empirical method for estimating JMA instrumental seismic intensity from ground motion parameters using strong motion records during recent major earthquakes, 2005). The damage of road in terms of damage spot was estimated with the formula below.

Number of damage spot = road length (km) × damage rate (spot/km)

The number of damage spot was first estimated for each 250m×250m mesh area based on the seismic analysis results and they were then summarized according to the district. The results are shown in Table 5.4.4.

It was estimated there were 66 damage spots for scenario I and 60 damage spots for scenario II. The average damage rate was about 0.07 spot/km. Khan Uul district had the longest road length, damage rate and damage spots for both scenario I and II earthquakes, followed by Bayangol, Bayanzurh and Songino districts. Nalaih and Baganuur districts had little damages.

Table 5.4.3 Road damage rate

<table>
<tr><th colspan="2">Ground classification / Ground motion</th><th>Type 1-2</th><th>Type 3</th><th>Type 4</th></tr>
<tr><th>JMA Intensity</th><th>Vmax (cm/s)</th><th>Tg ＜ 0.4s</th><th>0.4s ≦ Tg ＜ 0.6s</th><th>0.6s ≦ Tg</th></tr>
<tr><td>7</td><td>116 ≦ Vmax</td><td>0.11</td><td>0.16</td><td>0.25</td></tr>
<tr><td>6+</td><td>64 ≦ Vmax ＜ 116</td><td>0.09</td><td>0.13</td><td>0.20</td></tr>
<tr><td>6-</td><td>35 ≦ Vmax ＜ 64</td><td>0.07</td><td>0.10</td><td>0.16</td></tr>
<tr><td>5+</td><td>20 ≦ Vmax ＜ 35</td><td>0.05</td><td>0.07</td><td>0.12</td></tr>
<tr><td>5-</td><td>11 ≦ Vmax ＜ 20</td><td>0.03</td><td>0.04</td><td>0.06</td></tr>
</table>

Note: Tg - dominant period of ground

Table 5.4.4 Damage estimation results of road

Scenario I			
District	District	District	District
Baganuur	38.767	0.029	1
Bayangol	124.234	0.087	11
Bayanzurh	152.135	0.082	12
Chingeltei	72.407	0.061	4
Khan Uul	158.519	0.101	16
Nalaih	32.475	0.035	1
Songino	144.957	0.088	13
Sukhbaatar	116.198	0.065	8
Bagakhangai	—	—	—
Total	839.692		66
Scenario II			
District	District	District	District
Baganuur	38.767	0.000	0
Bayangol	124.234	0.079	10
Bayanzurh	152.135	0.068	10
Chingeltei	72.407	0.054	4
Khan Uul	158.519	0.099	16
Nalaih	32.475	0.022	1
Songino	144.957	0.088	13
Sukhbaatar	116.198	0.055	6
Bagakhangai	—	—	—
Total	839.692		60

(3) Risk assessment of bridge

The risk assessment of bridge was conducted by (1) girder falling possibility by a statistical method and (2) pier strength by means of response ductility ratio. The final judgment was made by combining the two results. The detail procedure is described below from (i) through (ix).

According to JICA "the project for construction of Ajilchin flyover in Ulaanbaatar city", there were 67 bridges in UB city. The bridge damage caused by an earthquake can be generally attributed to ground shaking and ground failure, such as land subsidence and liquefaction. Since the liquefaction was not predicted, the damage caused by ground shaking was concerned here. The static analysis (8 bridges) and dynamic analysis (3 bridges) were carried out to obtain a relationship between response ductility ratio and damage for the purpose of risk assessment. The bridges for static analysis were selected from those whose design drawing had been collected after discussion with road department. The bridges for dynamic analysis were chosen from the static analysis bridges with considering the difference on ground motion intensity. According to "design specifications for highway bridges, Japan", the analysis was performed for a single standard pier because the bridges were simple girder type and for both axial and transverse directions. The results of weak direction were used.

(i) Girder falling assessment

Girder falling possibility was assessed by a statistical method. The items, score and damage criteria are shown in

Table 5.4.5 (ref: report of earthquake damage estimation of Miyagi prefecture, 2004). The damage level was defined by total score, shown as below.

Level A － Collapse or significant deformation

Level B － Partially deformed

Level C － No damage or slight damage which has little effect

The possibility of girder falling was considered high for damage Level A, low for Level B and non for Level C.

The girder falling possibility was estimated for each bridge with the data listed in bridge inventory and the maximum ground velocity from seismic hazard analysis. The results are shown in Table 5.4.6.

The damage level for all bridges was C. It was considered there was no girder falling possibility for the scenario earthquakes.

Table 5.4.5 Items, score and damage criteria for girder falling possibility

Items and score

Category	Item	Score
Ground classification	Type 1 (Tg<=0.2s)	0.50
	Type 2 (0.2s<Tg<0.4s)	1.00
	Type 3 (0.4s<Tg<0.6s)	1.50
	Type 4 (0.6s<=Tg)	1.80
Liquifaciton	No	1.00
	Possible	1.50
	yes	2.00
Costructure	Arch, frame	1.00
	Continuous bridge	2.00
	Simple bridge	3.00
Bearing	Fall prevention	0.60
	Conventional	1.00
	Two moving bearing	1.15
Height of pier	<=5m	1.00
	5-10m	interpolation
	>=10m	1.70
No. of span	= 1	1.00
	>= 2	1.75
Girder support	Long (support length (cm)/span length(m)>=1)	0.80
	Short (support length (cm)/ span length (m)<1)	1.20
JMA Intensity	5- (11 ≦ Vmax ＜ 20)	1.00
	5+ (20 ≦ Vmax ＜ 35)	1.70
	6- (35 ≦ Vmax ＜ 64)	2.40
	6+ (64 ≦ Vmax ＜ 116)	3.00
	7 (116 ≦ Vmax)	3.50
Foundation	Other than pile	1.00
	Pile	1.40
Substructure Member	Brick・Concrete	1.40
	Others	1.00

Total score (= product of scores of all item) and damage criteria

Damage level	Total score
A	More than 55
B	Between 35and 55
C	Less than 35

Table 5.4.6 Results of girder falling estimation

No.	Bridge ID	Vmax (cm/s)	Scenario I		Scenario II	
			Total score	Damage	Total score	Damage
1	4	35.1	15	C	15	C
2	5	36.9	15	C	15	C
3	6	41.0	9	C	9	C
4	7	40.4	15	C	15	C
5	8	25.6	7	C	7	C
6	9	21.3	4	C	4	C
7	10	37.9	15	C	15	C
8	11	34.5	3	C	2	C
9	12	34.4	9	C	6	C
10	13	36.3	20	C	20	C
11	14	44.2	18	C	18	C
12	15	52.0	15	C	15	C
13	16	46.3	15	C	15	C
14	17	37.1	15	C	15	C
15	18	36.8	15	C	15	C
16	19	35.8	19	C	19	C
17	20	33.1	9	C	6	C
18	21	41.4	16	C	16	C
19	23	44.8	15	C	15	C
20	24	52.9	17	C	17	C
21	25.1	63.2	10	C	10	C
22	25.2	65.0	13	C	13	C
23	26	86.2	22	C	19	C
24	27	43.9	22	C	22	C
25	28	40.5	10	C	10	C
26	29	43.3	15	C	15	C
27	30	43.9	10	C	10	C
28	31	25.3	4	C	4	C
29	32	28.6	6	C	4	C
30	33	24.2	4	C	4	C
31	34	24.6	7	C	7	C
32	35	28.8	10	C	7	C
33	36	28.8	10	C	7	C
34	37	32.3	15	C	11	C
35	38	26.6	7	C	7	C
36	39	22.7	7	C	7	C
37	40	35.3	11	C	15	C
38	41	29.6	2	C	2	C
39	43	16.1	4	C	2	C
40	44	36.1	9	C	9	C
41	45	47.4	15	C	15	C
42	46	47.9	15	C	15	C
43	47	37.5	3	C	3	C
44	48	21.6	4	C	4	C
45	49	22.4	4	C	4	C
46	50	32.2	10	C	7	C
47	52	37.8	5	C	5	C
48	53	50.7	15	C	15	C
49	54	36.3	15	C	15	C
50	55	29.7	6	C	4	C
51	56	36.9	15	C	15	C

No.	Bridge ID	Vmax (cm/s)	Scenario I		Scenario II	
			Total score	Damage	Total score	Damage
52	57	74.1	19	C	19	C
53	58	24.9	2	C	2	C
54	60	40.6	15	C	15	C
55	63	23.4	2	C	2	C
56	77	115.3	19	C	22	C
57	78	24.5	7	C	7	C
58	89	32.3	10	C	7	C
59	90	58.1	19	C	15	C
60	93	30.7	10	C	7	C
61	95	35.3	5	C	5	C
62	96	25.1	7	C	7	C
63	97	23.8	7	C	7	C
64	98	23.7	7	C	7	C
65	99	23.1	4	C	4	C
66	100	32.0	5	C	4	C
67	103	28.8	10	C	7	C

(ii) Flowchart of pier damage assessment

The pier damage was assessed by making use of the static and dynamic analysis results. Since the number of analysis was limited, a method was proposed to apply the static and dynamic results to all the bridges. The flowchart for pier damage assessment is shown in Figure 5.4.1. The pier damage defined by the public works research institute (PWRI), Japan, was employed.

(iii) Bridges for static and dynamic analysis

Eight bridges for static analysis have been shown in Table 5.4.1. Three bridges for dynamic analysis were selected from the static analysis bridges in order to consider the difference in ground motion characteristics. The three bridges are No. 5, 19 and 26. Their acceleration response spectra are shown in Figure 5.4.2.

(iv) Model of bridge pier

The static and dynamic analysis were performed by a popularly used software named UC-win/ FRAME(3D). The pier was modeled as a lumped mass model. The dimension and bar arrangement of the pier are given in Section 2 of the Databook. The schematic diagram of the model is shown in Figure 5.4.3. Since the stiffness of foundation and the beam bearing superstructure was higher than pier, they were modeled as elastic beam. The pier was non-linear M-φmodel. Takeda model was applied to consider the hysteresis characteristics of pier in dynamic analysis.

The parameters necessary for non-linear analysis, defined in the "design specifications for highway bridges" of Japan, were used here because there was no such parameters in Mongolia seismic code. The parameters of concrete were that most close to the Schmidt Hammer test conducted by "the project for construction of Ajilchin flyover in Ulaanbaatar city". The reinforcing bar, according to design drawings, is A-I and A-II, which are Russian (former Soviet Union) standard. The yield strength of A-I is 235N/mm^2 and the ultimate strength is 373N/mm^2. The yield strength of A-II is 300N/mm^2 and the ultimate strength is 500N/mm^2. A-I and A-II are approximately corresponding to SR235 (yield strength: 235N/mm^2, ultimate strength: 380 - 520N/mm^2) and SD295A (yield strength: 295N/mm^2, ultimate strength: 440 - 600N/mm^2) of the Japanese standard, respectively. The strength of concrete and reinforcing bar used in the analysis is shown in Table 5.4.7.

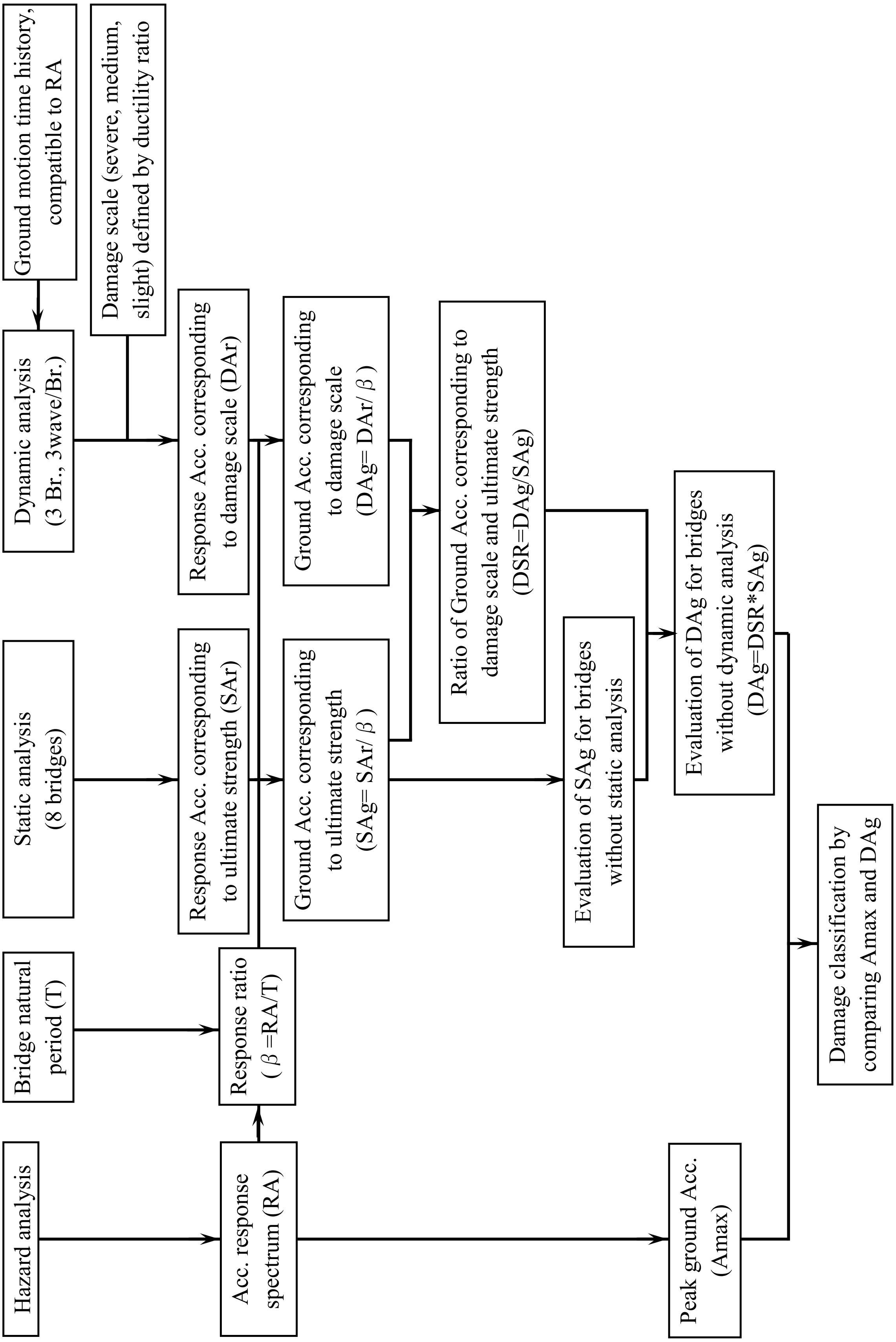
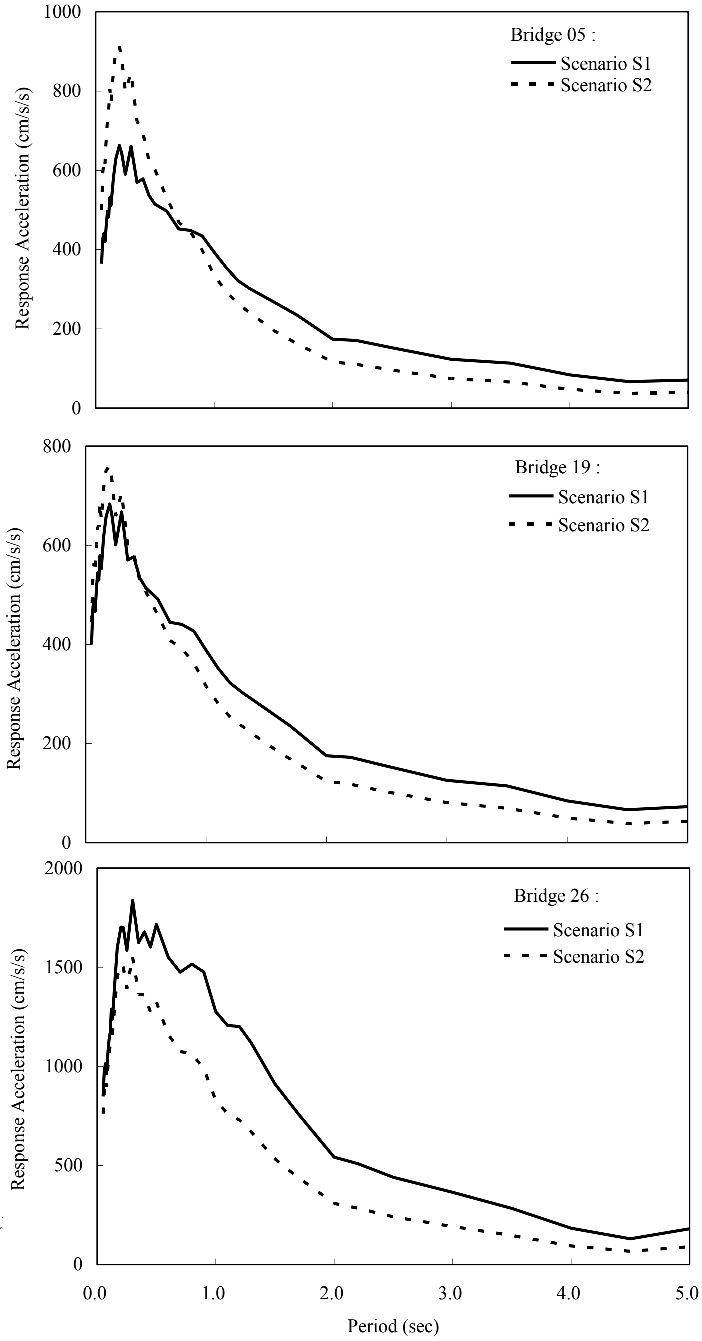


Figure 5.4.1 Flow chart of bridge damage assessment



Figu s bridges

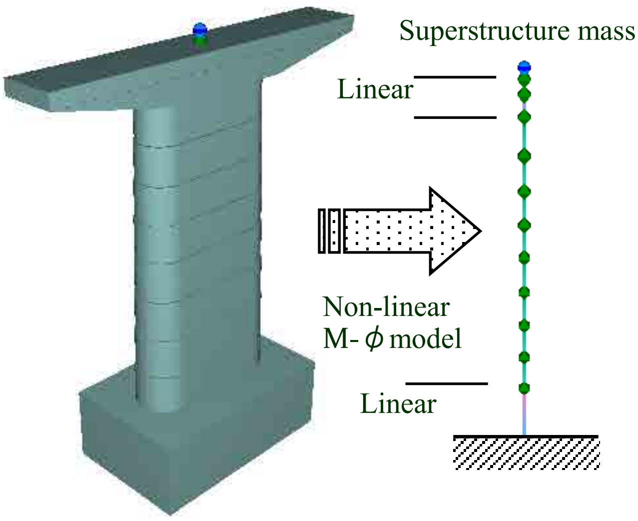


Figure 5.4.3 Schematic diagram of pier model

Table 5.4.7 Strength of concrete and reinforcing bar used for analysis

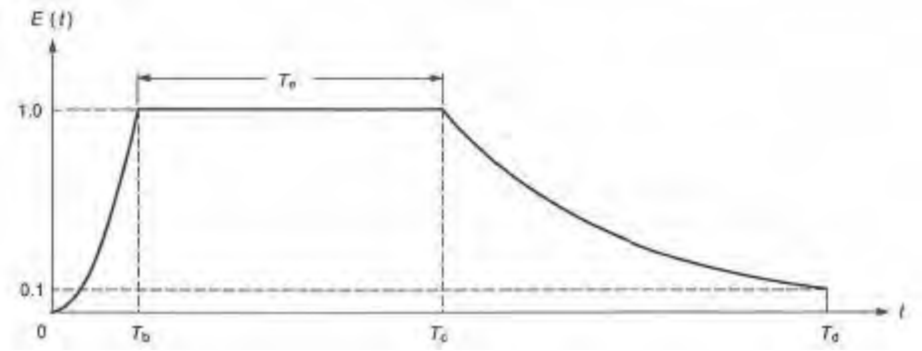
Bridge No	Construction year	Concrete		Reinforcing bar		Bar diameter
		Schmidt Hammer test (N/mm2)	Used for analysis (N/mm2)	GOST grade	Equivalent Japan grade	
4	1962	32.7	30	-	-	-
5	1967	32.7	30	A-II	SD295A	φ10
24	1971	29.5	30	A-II	SD295A	φ10
18	1975	23.1	24	A-II	SD295A	φ12
34	1982	21.5	21	A-I	SR235	φ8
26	1989	31.1	30	A-II	SD295A	φ22
19	1994	29.5	30	A-II	SD295A	φ32
56	2010	31.3	30	SD390	SD390	φ29

(v) Time history for dynamic analysis

According to the “design specifications for highway bridges”, the time history for dynamic analysis can be that of the typical strong motion records and modified to fit the response spectrum of concerned site. To consider the phase effects on non-linear response, it is recommended to use the average of three waves. Since there was no strong motion records in Mongolia, two waves were chosen from the records of Japan. another one was artificially created for both horizontal and vertical components in order to see the effects of vertical component. Considering the earthquake type (local earthquake) and ground condition of bridge site (type 2), the two strong motion records were selected from those widely used in Japan (Table 5.4.8), i.e. Takatori railway station, NS (II-II-1) and Fukiai gas transfer station, N27W (II-II-3). The artificial wave was created with uniform random phase. Since vertical response spectrum was not available, the shape of horizontal spectrum was used and amplitude of vertical spectrum was assumed to be a half of the horizontal spectrum according to the past research and Mongolia seismic code. The envelope for artificial wave, proposed by Osaki (ref: Osaki, new edition of introduction of ground motion spectrum analysis, 1994) was used and shown in Figure 5.4.4. An example of time history and the spectrum is given in Figure 5.4.5.

Table 5.4.8 Time history used in Japan for dynamic analysis (level 2 and type II earthquake)

Ground type	Earthquake	Record site and component	Name
1	Great Hanshin earthquake	Kobe marine observatory, NS	II-I-1
		Kobe marine observatory, EW	II-I-2
		Inagawa bridge, NS	II-I-3
2		Takatori railway station, NS	II-II-1
		Takatori railway station, EW	II-II-2
		Fukiai gas transfer station, N27W	II-II-3
3		East Kobe bridge, N12W	II-III-1
		Port island, NS	II-III-2
		Port island, EW	II-III-3



ここで、 $E(t) = (t/T_b)^2$ $\quad 0 <= t < T_b$

$= 1$ $\quad T_b <= t < T_c$

$= e^{-a(t-Tc)}$ $\quad T_c <= t < =T_d$

$Tb = [0.12-0.04(M-7)]T_d$

$Tc = [0.50-0.04(M-7)]T_d$

$Td = 10^{0.31M-0.774}$

$a = -\ln 0.1/(T_d-T_c)$

Figure 5.4.4 Envelope for artificial ground motion

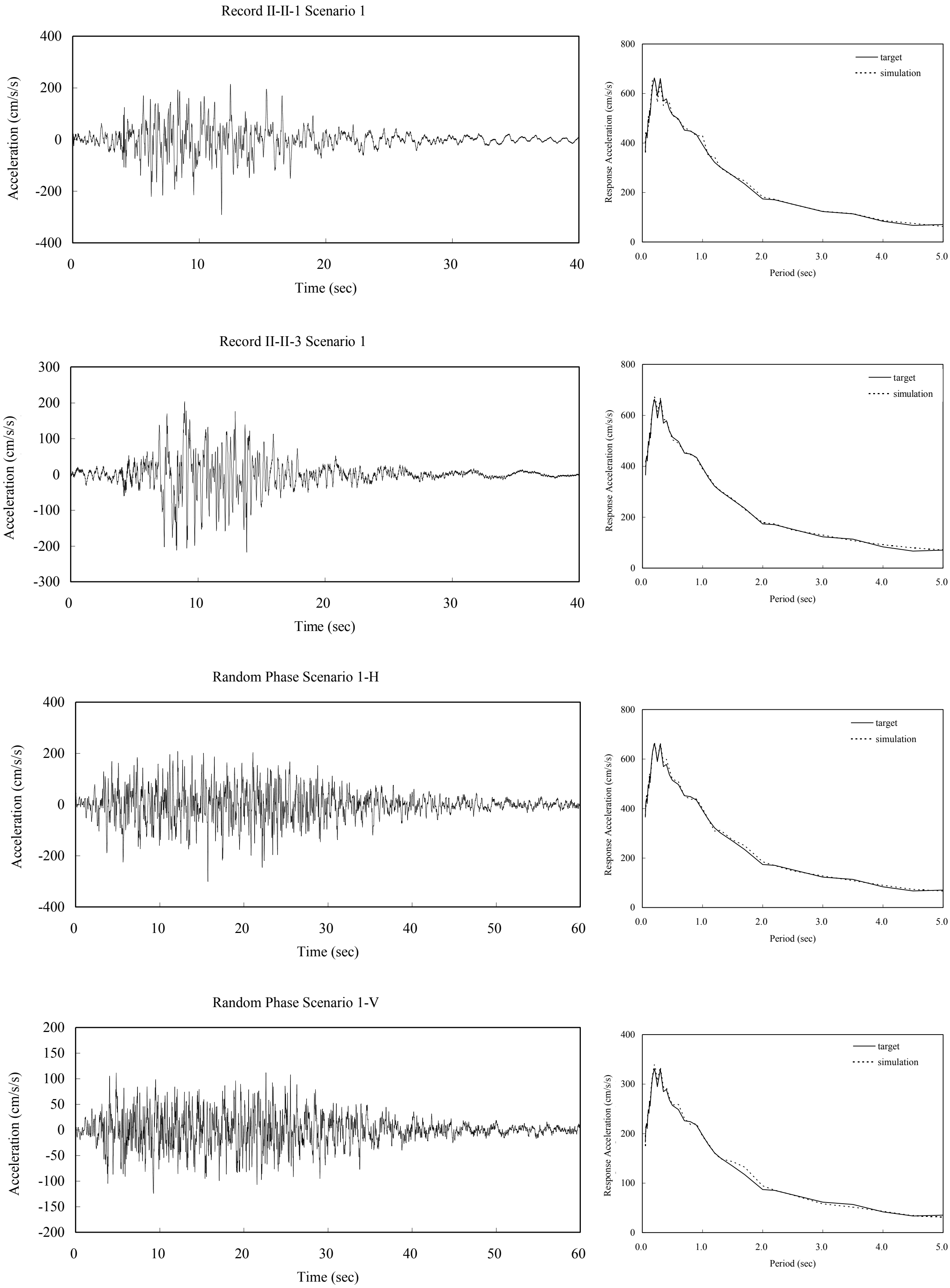


Figure 5.4.5 Example of time histories used for dynamic analysis
(top-down: Takatori, Fukiai, artificial(H), artificial (V))

(vi) Static analysis and the results

Pushover analysis was carried out for static analysis with 10 cm/s/s response acceleration as increment. At each step, the section force (moment, shear force) and section stress (concrete, reinforcing bar) were calculated and compared with the corresponding ultimate strength and allowable stress. The ultimate bending strength and ultimate shear strength were evaluated based on the method of the “design specifications for highway bridges”. During analysis, when the section stress reached the allowable stress, the corresponding response acceleration was specified and called elastic limit response acceleration. When the section force reached the ultimate strength, the corresponding response acceleration was defined and called ultimate strength response acceleration (SAr). The elastic limit response acceleration and ultimate strength response acceleration for the analyzed eight bridges are shown in Table 5.4.9. The ultimate strength response acceleration was plotted in Figure 5.4.6. From analysis, it was noticed the pier reached its ultimate bending strength before ultimate shear strength. It is also observed the axial direction was weaker than transverse direction.

The ultimate strength response acceleration could be used for damage assessment for the analyzed bridges but, for the other bridges, it was not an appropriate choice because the response acceleration could not be decided due to unknown natural period. To solve the problem, one consideration was to use ground acceleration instead of response acceleration. Thus, the ultimate strength response acceleration (SAr) was divided by response ratio (β) and ultimate strength ground acceleration (SAg) was obtained. The natural period, response ratio and ultimate strength ground acceleration of the eight bridges are listed in Table 5.4.10. The ultimate strength ground acceleration is shown in Figure 5.4.7. From the figure, it was found the ultimate strength ground acceleration had different trend for before and after around 1992, when Mongolia introduced its own seismic code. The dash line in the figure represents the average and it will be used to evaluate the ultimate strength ground acceleration for the not-analyzed bridges.

Table 5.4.9 Response acceleration corresponding to elastic and ultimate strength

Bridge No.	Construction year	Response Acc. corresponding to elastic strength (cm/s/s)	Response Acc. corresponding to ultimate strength (cm/s/s)
4	1962		140
5	1967	110	150
24	1971	90	120
18	1975	120	180
34	1982	110	150
26	1989	260	480
19	1994	160	280
56	2010	290	510

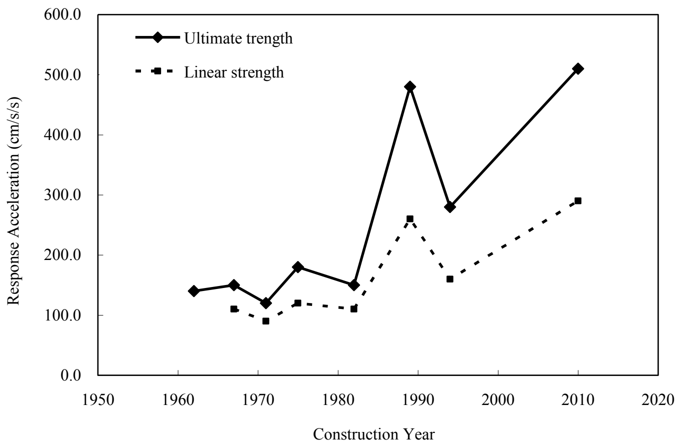
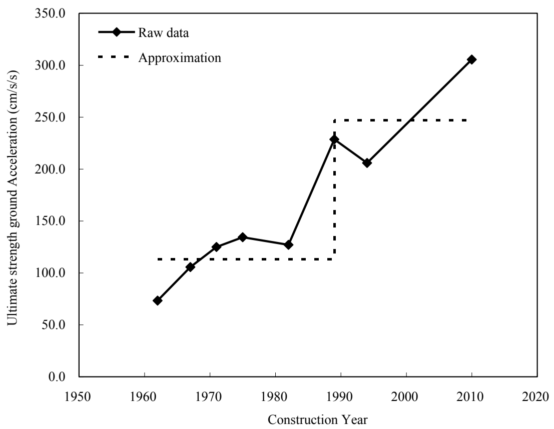


Figure 5.4.6 Response acceleration corresponding to elastic and ultimate strength

Table 5.4.10 Ground acceleration corresponding to ultimate strength

Bridge No.	Construc-tion year	Natural period (sec)	Ultimate strength response Acc. (cm/s/s)	Scenario I		Scenario II	
				Response ratio	Ultimate strength ground Acc. (cm/s/s)	Response ratio	Ultimate strength ground Acc. (cm/s/s)
4	1962	0.16	140.0	1.91	73.3	2.05	68.3
5	1967	0.7	150.0	1.42	105.6	1.15	130.4
24	1971	1.3	120.0	0.96	125.0	0.78	153.8
18	1975	0.83	180.0	1.34	134.3	1.09	165.1
34	1982	0.66	160.0	1.26	127.0	1.06	150.9
26	1989	0.24	480.0	2.10	228.6	2.13	225.4
19	1994	0.68	280.0	1.36	205.9	1.17	239.3
56	2010	0.46	510.0	1.67	305.4	1.52	335.5



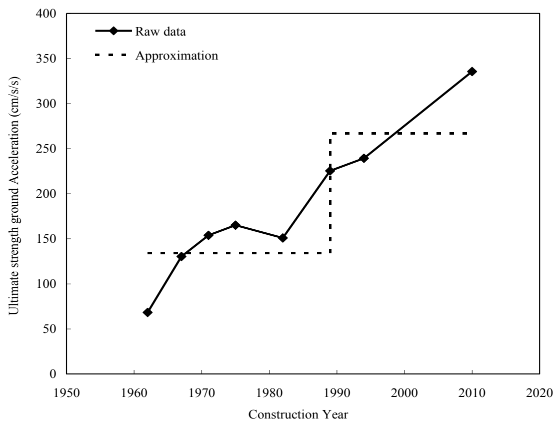
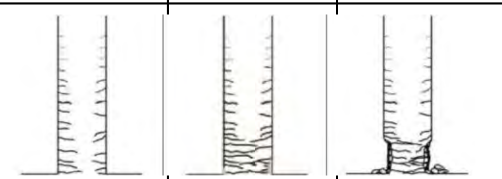


Figure 5.4.7 Ultimate ground acceleration
(Left: Scenario I, Right: Scenario II)

(vii) Damage criteria

Bridge damage is usually classified into severe, medium and slight damages. The Japan road association proposed a damage criteria by eye inspection after an earthquake (ref: handbook for dealing with road disaster, recovery section). The public works research institute suggested a quantitative damage criteria based on the relationship between damage degree and response ductility ratio (Figure 5.4.8). The latter was employed since it was possible to estimate the response ductility ratio through dynamic analysis.

From Figure 5.4.8, it was noticed the damage criteria differed from the bridges that what design code was applied. The questions raised that the Mongolia seismic code corresponded to which seismic code of Japan. The seismic code of Japan before 1980 was based on the elastic design concept. The examination of deformation performance was introduced in the revision of 1980. The examination of ultimate lateral strength was required when revised in 1990. The seismic design was further strengthened in the following revisions by introducing level 1 and level 2 ground motion. In Mongolia, the seismic code of former Soviet Union was directly used from 1960 to 1991 and Mongolia introduced its own seismic code in 1992. Neither of the seismic codes stipulated the examination of deformation performance and it was considered the pier did not have enough deformation capacity. In this regard, the seismic code of Mongolia was supposed to equivalent to that of Japan before 1980. The damage criteria became: slight damage: ductility ratio 1.0 - 1.5; medium damage: ductility ratio 1.5 - 3.0; severe damage: ductility ratio more than 3.0.

Damage	Slight	Medium	Severe
Ductility ratio	1 - 1.5	1.5 - 3	3 -
Damage image	 Small cracks	Peeling-off of concrete	Peeling-off of concrete, buckling of rebar

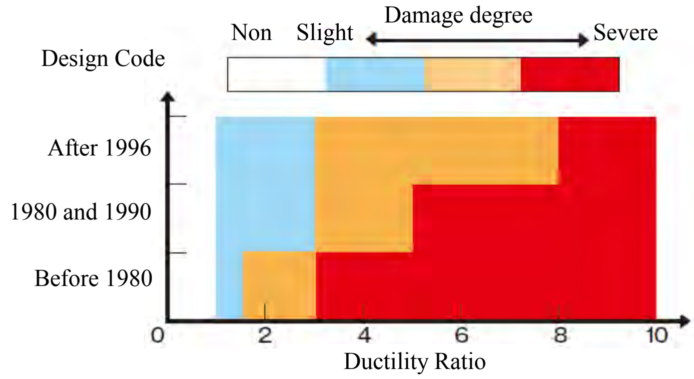


Figure 5.4.8 Relationship of pier damage and response ductility ratio

(viii) Dynamic analysis and the results

The damage caused by an earthquake is generally considered dominant by the horizontal ground motion. In order to examine the effects of the vertical ground motion, a set of artificial horizontal and vertical time histories had been created. The effects of vertical ground motion was examined by comparing the displacement response of horizontal input with that of horizontal and vertical simultaneous input. A total of 12 cases were calculated, which were two bridges (No 5 and No.19), two kinds of ground motion (scenario I and scenario II) and three response levels (ductility ratio 1.0, 1.5 and 3.0). Figure 5.4.9 shows the comparison of the 12 cases. Except for one case, where a little difference was observed, all the other cases had the same results for horizontal input only and horizontal and vertical simultaneous input. The results showed the effects of vertical ground motion could be neglected.

In order to apply the dynamic analysis results to the damage assessment of other bridges, the bridges for dynamic analysis were selected to have different ground motion and strength. The target bridges were bridge No.5, No.19 and No.26. An example of input and response time histories and load - displacement hysteresis is shown in Figure 5.4.10. During the analysis, the amplitude of input time history was adjusted to make the response having the ductility ratio of 1.0, 1.5 and 3.0. For each ductility ratio, the input response acceleration was calculated and called damage response acceleration (DAr). Same as the conversion from SAr to SAg, the damage response acceleration DAr was converted to damage ground acceleration (DAg) for the later use. The damage ground acceleration versus ductility ratio is shown in Figure 5.4.11. For each ductility ratio there were 9 results for 3 bridges and 3 waves. There were big difference among the 9 results due to the difference of ground motion and phase.

In order to link the results of static and dynamic analysis for damage assessment, the ratio (DSR) of damage ground acceleration (DAg) to ultimate strength ground acceleration (SAg) was calculated (DSR=DAg/SAg), shown in Table 5.4.11 and Figure 5.4.12. Comparing with Figure 5.4.11, it was found the ratio was stable for different ground motion and phase. Therefore, the average of the ratio (DSRa) for the 9 cases (3 bridges * 3 waves) was calculated. It would be used to estimate the damage ground acceleration for the bridges without dynamic analysis.

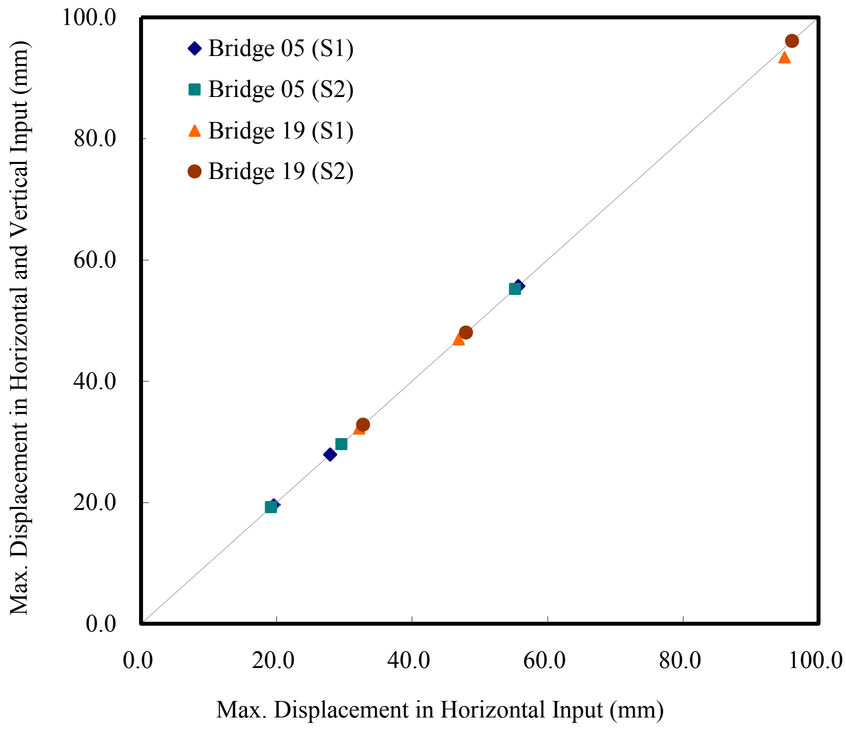


Figure 5.4.9 Response displacement for horizontal only and horizontal and vertical input

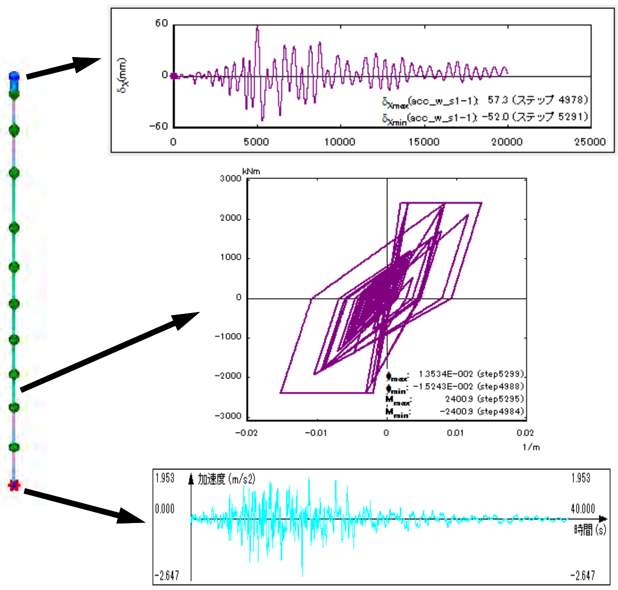


Figure 5.4.10 Example of dynamic analysis

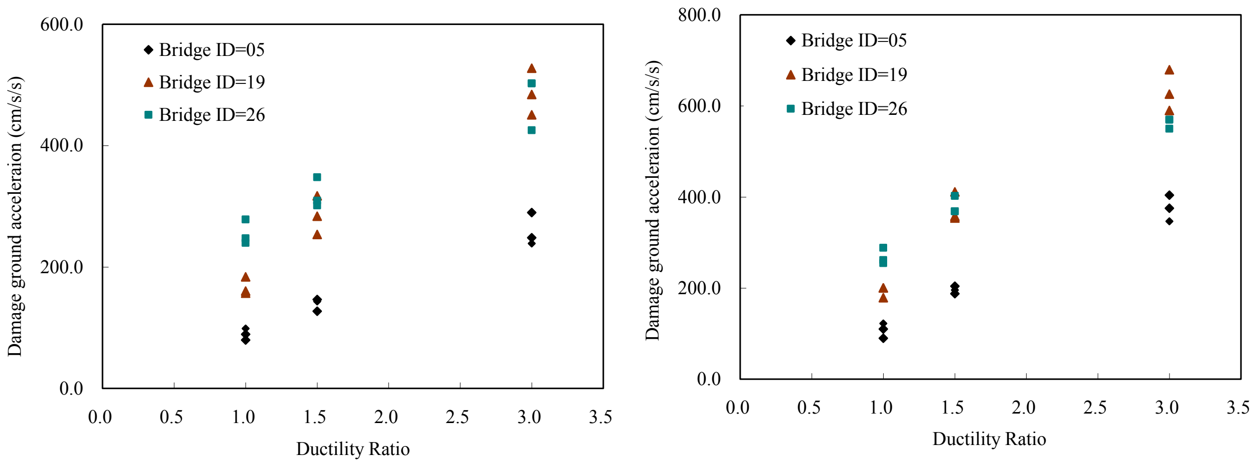


Figure 5.4.11 Damage ground acceleration and ductility ratio
(Left: Scenario I, Right: Scenario II)

Table 5.4.11 Ratio of damage and ultimate ground acceleration

Bridge No.	Time history	Scenario I			Scenario II		
		Ducktility ratio			Ducktility ratio		
		1.0	1.5	3.0	1.0	1.5	3.0
05	Random	0.753	1.205	2.350	0.688	1.438	2.877
	II-II-1	0.843	1.386	2.741	0.844	1.564	3.096
	II-II-3	0.934	1.356	2.259	0.938	1.501	2.658
19	Random	0.762	1.378	2.351	0.747	1.479	2.615
	II-II-1	0.778	1.540	2.562	0.837	1.494	2.839
	II-II-3	0.892	1.232	2.189	0.837	1.718	2.465
26	Random	1.083	1.319	1.861	1.160	1.637	2.529
	II-II-1	1.049	1.353	2.199	1.131	1.637	2.440
	II-II-3	1.218	1.522	2.199	1.279	1.785	2.529
Average (DSRa)		0.924	1.366	2.301	0.940	1.584	2.672

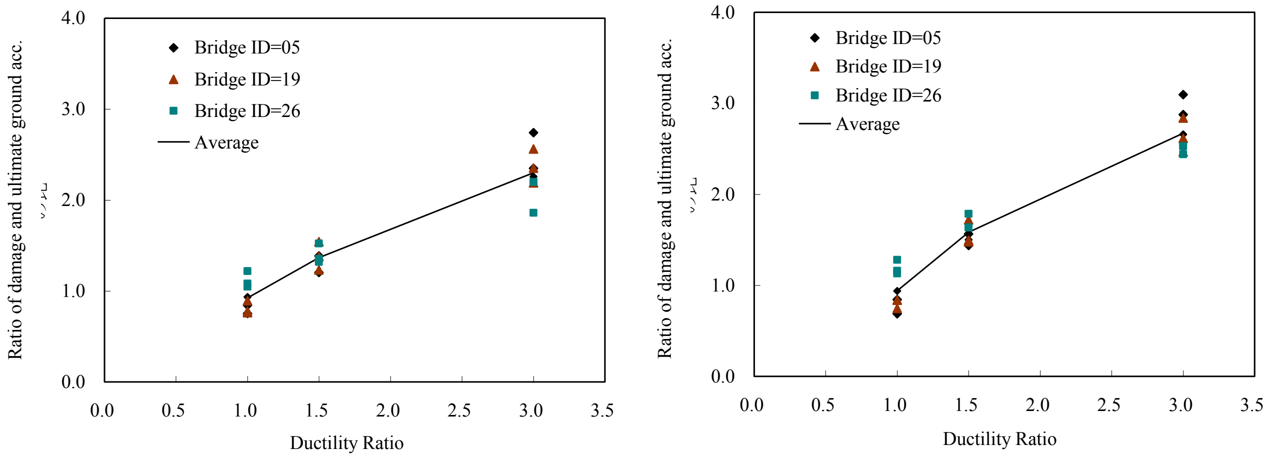


Figure 5.4.12 Ratio of damage and ultimate ground acceleration
(Left: Scenario I, Right: Scenario II)

(ix) Seismic risk of bridge

Seismic risk of bridge was estimated by the static and dynamic analysis results obtained before. The procedure is as below.

- Estimation of ultimate strength ground acceleration (SAg)

  For the bridges where the static analysis were performed, their ultimate strength ground acceleration were directly used. For the other bridges, the ultimate strength ground acceleration were evaluated by the dash line in Figure 5.4.7.

- Estimation of damage ground acceleration (DAg)

  For the bridges where the dynamic analysis were performed, the average of 9 cases was directly used. For the other bridges, the damage ground acceleration was evaluated by the average ratio (DSRa, Table 5.4.11) and the ultimate strength ground acceleration obtained at the first step.

  DAgi = DSRai * SAg

  Where i is the subscript, representing ductility ratio and having the value of 1.0, 1.5, and 3.0.

- Damage assessment

  Bridge damage was estimated by comparing the damage ground acceleration (DAg) with the maximum ground acceleration (Amax) obtained from seismic hazard analysis.

  no damage: Amax < DAg1.0
  Slight: DAg1.0 <= Amax < DAg1.5
  Medium: DAg1.5 <= Amax < DAg3.0
  Severe: DAg3.0 <= Amax

The damage estimated for each bridge is shown in Table 5.4.12. The summary of the damage is shown in Table 5.4.13. The location of bridges in central area is given in Figure 5.4.13. For scenario I, 28 bridges were estimated severe damage. The damage rate was 42%. For scenario II, the severe damage bridges were 22 with the damage rate of 33%.

It was difficult to verify the damage estimation because there was no damage data in Mongolia. The relation between design intensity and the intensity of scenario earthquake, the damage of bridges in Armenia earthquake (1994), which was considered under the similar seismic design code, were examined to explain indirectly the reason of the damage.

・Design intensity and the intensity of scenario earthquake

According to Mongolia seismic code, the MSK intensity is used for seismic design. The standard MSK intensity of UB is VI, VII and VIII. It is not clear for the design intensity of each bridge. In case of the design intensity of VIII, the input acceleration is 0.125g. The design acceleration of MSK VIII together with the response acceleration of the scenario earthquake is shown in Table 5.4.14. It was found that the scenario earthquake doubled the design acceleration at minimum and reached, at maximum, as large as eleven times. In most cases, the differences were about three to five times. Note that the acceleration is not PGA but the response acceleration which directly leads to the earthquake load, the far more exceedance of the design acceleration could be one reason of the damage.

・Bridge damages of Armenia earthquake

The damage in "JICA Armenia Spitak earthquake investigation report of international emergency aid team" was referred and detail data were not available.

According to the report, there were 140 bridges in the affected area and seven bridges had slight damage. When taking look at the photos of the damaged bridge (Figure 5.4.14), there were peeling-off of concrete and buckling of reinforcing bar. Although the damage was described as slight in the report, it should be classified as severe here. This means, under the damage definition of this project, there was severely damaged bridges in the Armenia Spitak earthquake.

The acceleration response spectrum of Spitak earthquake has the peak around 0.2 - 0.3 second and decreased rapidly. The spectrum for more than 0.3 second is relatively small (Figure 5.4.15). Comparing with that, the acceleration response spectrum of the scenario earthquake (Figure 5.4.16) includes more components for the period longer than 0.3 second. Taking into account the range of the natural period of the bridges (0.16 – 1.3 second), it was considered that UB might have more damages than Spitak earthquake in whole.

Table 5.4.12 Results of bridge damage estimation (Scenario I)

Bridge ID	Name of bridge	Amax (cm/s/s)	Damage ground Acc.: DAg (cm/s/s)			Damage degree
			Slight	Medium	Severe	
4	Arslantai Bridge	338.9	67.7	100.1	168.7	severe
5	Uliastai tsaad Bridge /Left/	318.9	89.1	139.0	258.8	severe
6	Uliastai tsaad Bridge	343.0	104.4	154.4	260.0	severe
7	Uliastai tsaad Bridge	336.8	104.4	154.4	260.0	severe
8	Bridge over the Hol river	238.6	104.4	154.4	260.0	medium
9	Chuluut am Bridge	226.8	104.4	154.4	260.0	medium
10	Bayanzurkh Bridge	316.3	104.4	154.4	260.0	severe
11	Zaisan West am Bridge	325.6	104.4	154.4	260.0	severe
12	Bridge in front of the 14th khoroo	331.2	104.4	154.4	260.0	severe
13	Enkhtaivan Bridge	344.9	104.4	154.4	260.0	severe
14	Yarmag Bridge	389.0	104.4	154.4	260.0	severe
15	Yarmag Bridge to Airport	425.7	104.4	154.4	260.0	severe
16	Tolgoit Parallel Bridge	408.4	104.4	154.4	260.0	severe
17	Selbe dund Bridge	351.9	228.2	337.4	568.3	medium
18	Dund gol Deed Bridge	348.1	124.1	183.5	309.0	severe
19	Ikh Tenger Bridge	334.5	166.9	284.9	487.4	medium
20	Ikh Tenger dwon stream Bridge	314.4	104.4	154.4	260.0	severe
21	Zaisan Bridge	374.1	104.4	154.4	260.0	severe
23	Dund gol Dood Bridge	400.0	104.4	154.4	260.0	severe
24	Sonsgolon Bridge	423.9	115.5	170.8	287.6	severe
25-1	Turgen river Bridge-1	417.0	104.4	154.4	260.0	severe
25-2	Turgen river Bridge-2 (closed to traffic)	595.2	104.4	154.4	260.0	severe
26	Poultry farm Bridge	774.8	255.2	319.6	476.8	severe
27	Gurvaljin Bridge	393.2	228.2	337.4	568.3	medium
28	Naran Bridge	369.1	104.4	154.4	260.0	severe
29	Bridge behind of Meat Factory	384.7	104.4	154.4	260.0	severe
30	Nairamdal Bridge	369.8	104.4	154.4	260.0	severe
31	Rashaant Bridge	269.3	228.2	337.4	568.3	slight
32	Khailaast Bridge	293.8	104.4	154.4	260.0	severe
33	Chingeltei Bridge	259.4	104.4	154.4	260.0	medium
34	Sharga Morit Bridge	260.6	117.3	173.5	292.2	medium
35	Selbe gol Deed Parallel Bridge -1	292.4	104.4	154.4	260.0	severe
36	Selbe gol Deed Parallel Bridge -2	292.4	104.4	154.4	260.0	severe
37	Bridge behind Chinggis hotel	318.1	228.2	337.4	568.3	slight

Bridge ID	Name of bridge	Amax (cm/s/s)	Damage ground Acc.: DAg (cm/s/s)			Damage degree
			Slight	Medium	Severe	
38	Dambadarjaa Bridge	279.8	228.2	337.4	568.3	slight
39	Dambadarjaa naad Bridge	248.1	228.2	337.4	568.3	slight
40	Gachuurt Bridge	257.7	104.4	154.4	260.0	medium
41	Gachuurt Bridge	233.9	104.4	154.4	260.0	medium
43	Nalaikh Bridge	190.8	104.4	154.4	260.0	medium
44	Zaisan East Bridge	337.5	104.4	154.4	260.0	severe
45	Milk factory Bridge	414.9	228.2	337.4	568.3	medium
46	Baruun-uul Dithc Bridge	414.1	104.4	154.4	260.0	severe
47	Bridge over the ditch west behind the 1st khoroo	351.0	228.2	337.4	568.3	medium
48	Bridge to Khandgait-Sanzai	228.9	228.2	337.4	568.3	slight
49	South Bridge to Khandgait-Sanzai	236.5	228.2	337.4	568.3	slight
50	Tolgoit ger area road Bridge	306.9	228.2	337.4	568.3	slight
52	Bridge behind the 1st district	353.6	228.2	337.4	568.3	medium
53	Naran river Bridge	424.8	228.2	337.4	568.3	medium
54	Damdinsuren street Bridge over the Selbe river	346.9	228.2	337.4	568.3	medium
55	Bridge over the ditch west of the 39-th secondary school	301.1	228.2	337.4	568.3	slight
56	New right side Bridge of the Uliastai river Bridge	318.9	282.2	417.2	702.7	slight
57	Morin/Horse/Hill Bridge	505.2	228.2	337.4	568.3	medium
58	Khailaast 1.1 km length road Bridge-1	263.7	228.2	337.4	568.3	slight
60	Bridge behind 1st khoroolol over drainage ditch	371.2	228.2	337.4	568.3	medium
63	Bridge on Chingeltei KhaiIaast Road	251.4	228.2	337.4	568.3	slight
77	Wooden bridge for front side of the Songino's nursing station	635.6	228.2	337.4	568.3	severe
78	Belkh river's RC bridge direction to Dambadarjaa-Belkh road	247.1	228.2	337.4	568.3	slight
89	Bridge for Bayanhoshuu ger area	315.4	228.2	337.4	568.3	slight
90	RC bridge Direction to the Orbit-Takhilt	465.7	228.2	337.4	568.3	medium
93	Golden park bridge of selbe river RC bridge	306.6	228.2	337.4	568.3	slight
95	Songino khairkhan	330.4	228.2	337.4	568.3	slight

Bridge ID	Name of bridge	Amax (cm/s/s)	Damage ground Acc.: DAg (cm/s/s)			Damage degree
			Slight	Medium	Severe	
	district .4th and 5th khoroo's borderline road					
96	Shadivlan, for Selbe bridge	267.4	228.2	337.4	568.3	slight
97	Goodoin bridge	255.5	104.4	154.4	260.0	medium
98	Upper bridge of Sharga morit	250.7	104.4	154.4	260.0	medium
99	Upper bridge of Chingeltein am	249.8	228.2	337.4	568.3	slight
100	behind the 4th khoroolol flood channel's bridge	313.9	228.2	337.4	568.3	slight
103	Bridge for Bayanhoshuu ger area(north) under construction	288.4	228.2	337.4	568.3	slight

Table 5.4.12 Results of bridge damage estimation (Scenario II)

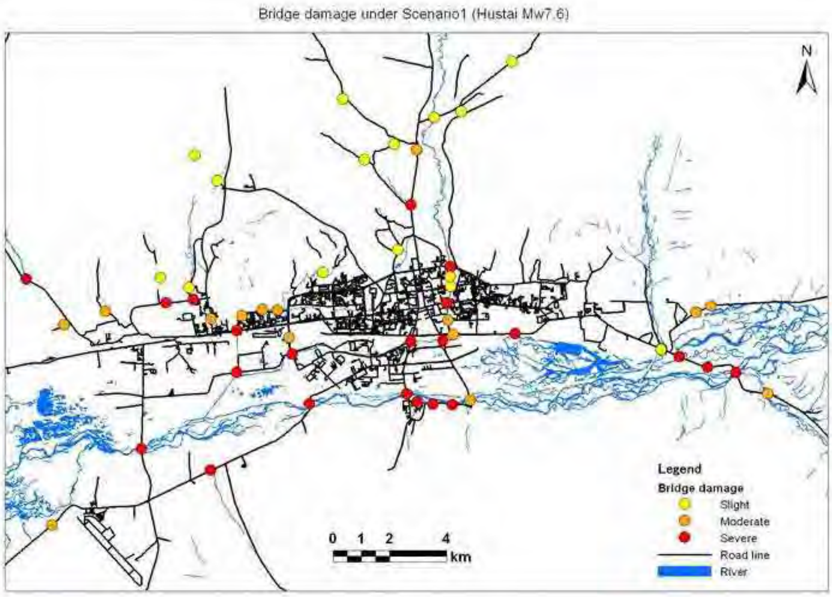
Bridge ID	Name of bridge	Amax (cm/s/s)	Damage ground Acc.: DAg (cm/s/s)			Damage degree
			Slight	Medium	Severe	
4	Arslantai Bridge	353.3	64.2	108.2	182.5	severe
5	Uliastai tsaad Bridge /Left/	409.4	107.4	195.8	375.3	severe
6	Uliastai tsaad Bridge	445.1	126.0	212.3	358.0	severe
7	Uliastai tsaad Bridge	442.9	126.0	212.3	358.0	severe
8	Bridge over the Hol river	312.3	126.0	212.3	358.0	medium
9	Chuluut am Bridge	269.3	126.0	212.3	358.0	medium
10	Bayanzurkh Bridge	423.3	126.0	212.3	358.0	severe
11	Zaisan West am Bridge	349.6	126.0	212.3	358.0	medium
12	Bridge in front of the 14th khoroo	347.1	126.0	212.3	358.0	medium
13	Enkhtaivan Bridge	363.8	126.0	212.3	358.0	severe
14	Yarmag Bridge	420.9	126.0	212.3	358.0	severe
15	Yarmag Bridge to Airport	473.8	126.0	212.3	358.0	severe
16	Tolgoit Parallel Bridge	436.2	126.0	212.3	358.0	severe
17	Selbe dund Bridge	369.7	251.0	422.9	713.4	slight
18	Dund gol Deed Bridge	366.5	155.2	261.5	441.1	medium
19	Ikh Tenger Bridge	358.1	193.1	374.2	631.7	slight
20	Ikh Tenger dwon stream Bridge	337.4	126.0	212.3	358.0	medium
21	Zaisan Bridge	400.9	126.0	212.3	358.0	severe
23	Dund gol Dood Bridge	427.1	126.0	212.3	358.0	severe
24	Sonsgolon Bridge	474.9	144.6	243.6	411.0	severe
25-1	Turgen river Bridge-1	516.5	126.0	212.3	358.0	severe
25-2	Turgen river Bridge-2 (closed	540.8	126.0	212.3	358.0	severe

Bridge ID	Name of bridge	Amax (cm/s/s)	Damage ground Acc.: DAg (cm/s/s)			Damage degree
			Slight	Medium	Severe	
	to traffic)					
26	Poultry farm Bridge	671.2	268.2	380.0	563.2	severe
27	Gurvaljin Bridge	418.2	251.0	422.9	713.4	slight
28	Naran Bridge	394.0	126.0	212.3	358.0	severe
29	Bridge behind of Meat Factory	412.7	126.0	212.3	358.0	severe
30	Nairamdal Bridge	408.2	126.0	212.3	358.0	severe
31	Rashaant Bridge	271.9	251.0	422.9	713.4	slight
32	Khailaast Bridge	301.4	126.0	212.3	358.0	medium
33	Chingeltei Bridge	264.1	126.0	212.3	358.0	medium
34	Sharga Morit Bridge	265.0	141.8	239.0	403.2	medium
35	Selbe gol Deed Parallel Bridge -1	302.5	126.0	212.3	358.0	medium
36	Selbe gol Deed Parallel Bridge -2	302.4	126.0	212.3	358.0	medium
37	Bridge for behind of Chinggis hotel	330.4	251.0	422.9	713.4	slight
38	Dambadarjaa Bridge	283.6	251.0	422.9	713.4	slight
39	Dambadarjaa naad Bridge	263.2	251.0	422.9	713.4	slight
40	Gachuurt Bridge	391.2	126.0	212.3	358.0	severe
41	Gachuurt Bridge	343.0	126.0	212.3	358.0	medium
43	Nalaikh Bridge	180.2	126.0	212.3	358.0	slight
44	Zaisan East Bridge	362.4	126.0	212.3	358.0	severe
45	Milk factory Bridge	443.4	251.0	422.9	713.4	medium
46	Baruun-uul Dithc Bridge	446.9	126.0	212.3	358.0	severe
47	Bridge over the ditch west behind the 1st khoroo	371.9	251.0	422.9	713.4	slight
48	Bridge to Khandgait-Sanzai	236.8	251.0	422.9	713.4	no damage
49	South Bridge to Khandgait-Sanzai	244.2	251.0	422.9	713.4	no damage
50	Tolgoit ger area road Bridge	328.2	251.0	422.9	713.4	slight
52	Bridge behind the 1st district	374.1	251.0	422.9	713.4	slight
53	Naran river Bridge	461.6	251.0	422.9	713.4	medium
54	Damdinsuren street Bridge over the Selbe river	363.2	251.0	422.9	713.4	slight
55	Bridge over the ditch west of the 39th secondary school	311.5	251.0	422.9	713.4	slight
56	New right side Bridge of the Uliastai river Bridge	409.1	315.4	531.4	896.5	slight
57	Morin/Horse/Hill Bridge	594.5	251.0	422.9	713.4	medium

Bridge ID	Name of bridge	Amax (cm/s/s)	Damage ground Acc.: DAg (cm/s/s)			Damage degree
			Slight	Medium	Severe	
58	Khailaast 1.1 km length road Bridge-1	270.2	251.0	422.9	713.4	slight
60	Bridge behind 1st khoroolol over drainage ditch	394.8	251.0	422.9	713.4	slight
63	Bridge on Chingeltei – KhaiIaast Road	256.3	251.0	422.9	713.4	slight
77	Wooden bridge for front side of the Songino's nursing station	778.1	251.0	422.9	713.4	severe
78	Belkh river's RC bridge direction to Dambadarjaa-Belkh road	299.5	251.0	422.9	713.4	slight
89	Bridge for Bayanhoshuu ger area	330.5	251.0	422.9	713.4	slight
90	RC bridge Direction to the Orbit-Takhilt	511.7	251.0	422.9	713.4	medium
93	Golden park bridge of selbe river RC bridge	317.7	251.0	422.9	713.4	slight
95	Songino khairkhan district 4th and 5th khoroo's borderline road	352.2	251.0	422.9	713.4	slight
96	Shadivlan, for Selbe bridge	269.7	251.0	422.9	713.4	slight
97	Goodoin bridge	258.3	126.0	212.3	358.0	medium
98	Upper bridge of Sharga morit	257.1	126.0	212.3	358.0	medium
99	Upper bridge of Chingeltein am	255.4	251.0	422.9	713.4	slight
100	behind the 4th khoroo flood channel's bridge	328.1	251.0	422.9	713.4	slight
103	Bridge for Bayanhoshuu ger area(north) under construction	303.0	251.0	422.9	713.4	slight

Table 5.4.13 Summary of bridge damage

Scenario		Bridge damage			
		No damage	Slight	Medium	Severe
		$\mu<1$	$1<\mu<1.5$	$1.5<\mu<3$	$3<\mu$
S1	No. of damage	0	19	20	28
	Ratio (%)	0	28	30	42
S2	No. of damage	2	25	18	22
	Ratio (%)	3	37	27	33



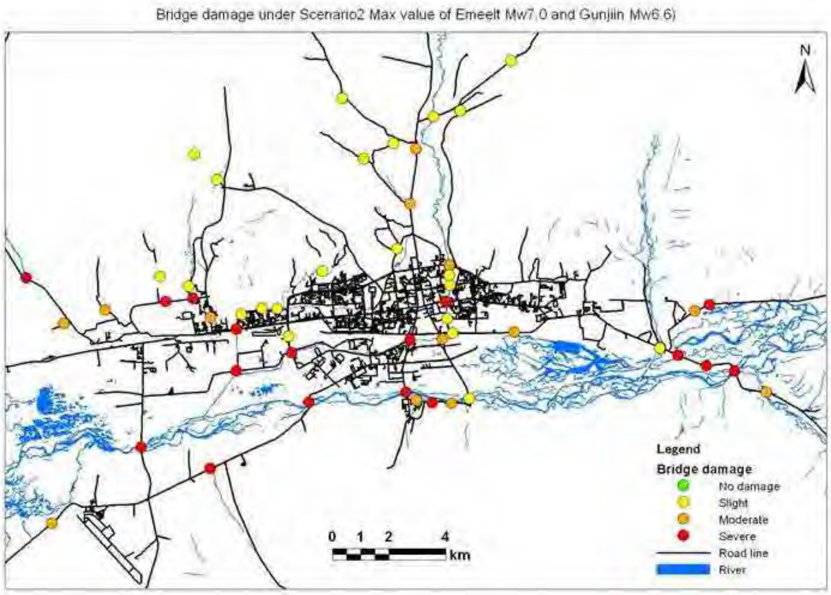
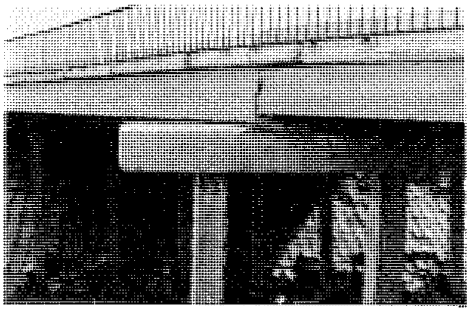


Figure 5.4.13 Results of bridge damage estimation
(Upper: Scenario I, Lower: Scenario II)

Table 5.4.14 Comparison of response acceleration between design and scenario earthquake

Bridge No.	4	5	18	19	24	26	34	56
Design (MSK VIII)	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125
Scenario 1 (S1)	0.646	0.452	0.466	0.454	0.407	1.624	0.328	0.532
Scenario 2 (S2)	0.723	0.469	0.401	0.418	0.368	1.428	0.280	0.620
S1/Design	5.166	3.615	3.726	3.632	3.255	12.99	2.624	4.259
S2/Design	5.788	3.753	3.205	3.347	2.947	11.426	2.241	4.959



- Peeling-off of concrete at the top of column
- Buckling of reinforcing bar at the bottom of column

Figure 5.4.14 Bridge damage of Spitak earthquake

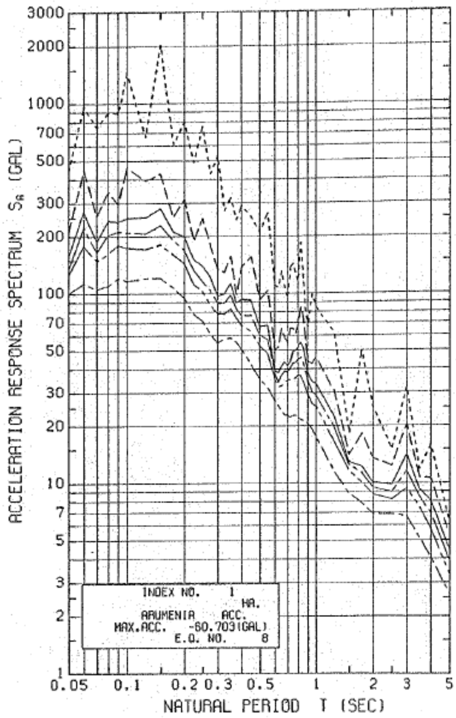


Figure 5.4.15 Acceleration spectrum of Spitak earthquake

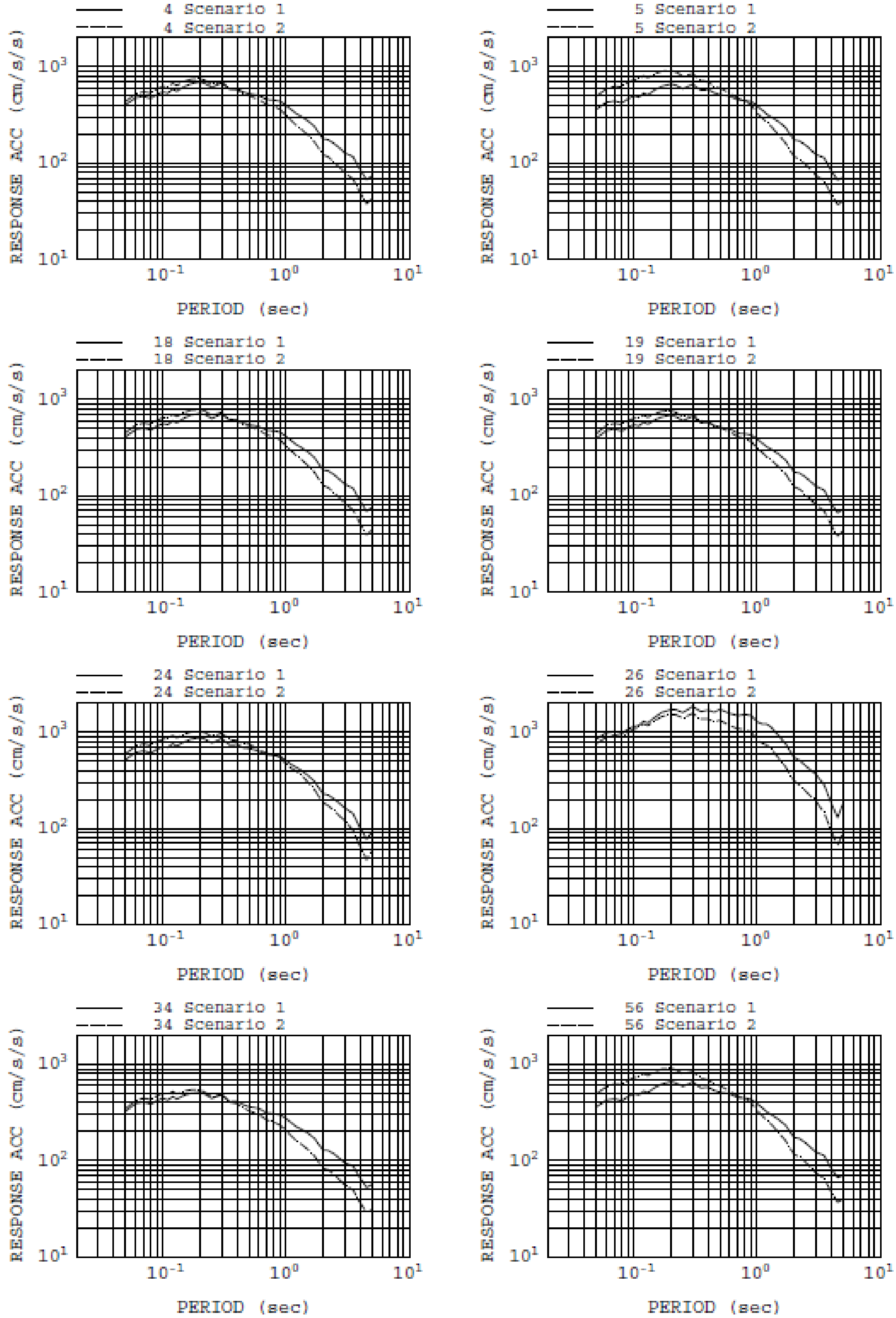


Figure 5.4.16 Acceleration spectrum of eight bridge sites

(4) Risk assessment of water pipeline

The damage of water pipeline was calculated as below.

Number of damage spot = damage rate (Rsm, spot/km) × pipe length (km)

Where, Damage rate (Rsm) was calculated by standard damage rate: Rs (spot/km) and the modification factors for liquefaction, pipe material and pipe diameter.

$Rsm = Cl \times Cpd \times Rs$

$Rs = 2.24 \times 10^{-3} \times (Vmax - 20)^{1.51}$ (Vmax >= 20cm/s)

Cl : Modification factor for liquefaction and being 1.0 because no liquefaction.

Cpd : Modification factor for pipe material and diameter, shown in Table 5.4.15.

The damage estimation of water pipeline was based on the GIS data provided by UB city. The total length of the pipeline was 718.6km and only 65km (about 9%) had pipe material and diameter information, which is shown in Table 5.4.16. For the pipe without material and diameter information, the material was supposed being steel and cast iron and the weighted average diameter was used. The average diameter of steel was 491mm and cast iron 393mm.

The damage estimation of water pipeline is shown in Table 5.4.17. There were 68 damage spot for scenario I (damage rate 0.09) and 44 damage spot for scenario II (damage 0.06). Since there was no damage data in Mongolia, the results was compared with that of Almaty, Kazakhstan, performed by another JICA project. The conditions of Almaty damage estimation were Mw=7.3 and acceleration between 300 - 800 cm/s/s, similar to this project. The damage rate of Almaty was 0.21. Since most pipe diameter were unknown here, the weighted average diameter was used. The average diameter could be considered relatively big because it was larger than the medium value of maximum and minimum. If a smaller diameter was used, the damage rate would become 0.18, closing to that of Almaty. In this regard, more pipe material and diameter data are needed to improve the results.

Table 5.4.15 Modification factor for water pipeline (Cpd)

<table>
<tr><th>Diameter / Material</th><th>- 75mm</th><th>100-250mm</th><th>300-450mm</th><th>500-900mm</th><th>1000mm -</th></tr>
<tr><td>Ductile iron</td><td>0.60</td><td colspan="2">0.30</td><td>0.09</td><td>0.05</td></tr>
<tr><td>Cast iron</td><td>1.70</td><td>1.20</td><td colspan="2">0.40</td><td>0.15</td></tr>
<tr><td>Steel</td><td>0.84</td><td>0.42</td><td colspan="3">0.24</td></tr>
<tr><td>PVC</td><td>1.50</td><td colspan="4">1.20</td></tr>
<tr><td>Asbestos cement</td><td>6.90</td><td>2.70</td><td colspan="3">1.20</td></tr>
</table>

Table 5.4.16 Distribution of pipe material and diameter of water pipeline

Material	Length (km)	Diameter (mm)		
		Max.	Min.	Average
Steel	50.197	800	25	491
Cast iron	11.036	500	150	393
Ductile iron	2.275	500	500	500
Plastic	0.941	150	133	138
Total	64.449			

Table 5.4.17 Damage estimation results of water pipeline

Scenario I			
District	District	District	District
Bayangol	190.202	0.112	21
Bayanzurh	168.530	0.056	9
Chingeltei	40.271	0.055	2
Khan Uul	129.031	0.126	16
Nalaih	3.961	0.001	0
Songino	107.866	0.135	15
Sukhbaatar	78.752	0.059	5
Baganuur	—	—	—
Bagakhangai	—	—	—
Total	718.613		68
Scenario II			
District	District	District	District
Bayangol	190.202	0.072	14
Bayanzurh	168.530	0.026	4
Chingeltei	40.271	0.026	1
Khan Uul	129.031	0.091	12
Nalaih	3.961	0.000	0
Songino	107.866	0.097	11
Sukhbaatar	78.752	0.027	2
Baganuur	—	—	—
Bagakhangai	—	—	—
Total	718.613		44

(5) Risk assessment of sewerage pipeline

The damage of sewerage pipeline was calculated as below.

Damage length (km) = damage rate (Rsm, %) × pipe length (km)

Where damage rate (Rsm) is showing in Table 5.4.18 for different pipe material, liquefaction and intensity.

The damage estimation of sewerage pipeline was based on the GIS data provided by UB city. The total length of the pipeline was 734km and 136km (about 19%) had pipe material information, shown in Table 5.4.19. Since the pipe material was classified into two types in damage rate table, the pipes of concrete, tile, asbestos and plaster were considered equivalent to PVC and ceramic, the pipes of steel, cast iron, plastic and RC were the others. For the pipes without pipe material information, it was assumed to be PVC and the others with a proportion of 77:58.

The damage estimation of sewerage pipeline are shown in Table 5.4.28. The damaged pipe of scenario I was 192km (damage rate 0.26) and that of scenario II was 176km (damage 0.24). Although the meaning of damage rate here and that of water pipeline are different, the damage of sewerage pipeline can be considered more severe than that of water pipeline. The fragile pipe material, like tile, asbestos and plaster, may be one reason of the damage.

Table 5.4.18 Damage rate of sewerage pipeline

Material	Liquefaction	Intensity and ground velocity (cm/s)				
		5-	5+	6-	6+	7
		11≦V＜20	20≦V＜35	35≦V＜64	64≦V＜116	116≦V
PVC, ceramic	All	19.0	30.8	39.3	48.6	57.0
Others	15<PL	11.4	17.4	23.1	28.0	33.4
	5<PL≦15	8.7	13.6	17.0	20.8	24.6
	0<PL≦5	8.0	12.6	15.6	19.1	22.5
	PL=0	7.6	12.1	14.6	18.1	21.2

Table 5.4.19 Distribution of pipe material and diameter of sewerage pipeline

Material	Length (km)	Diameter (mm)		
		Max.	Min.	Average
Steel	8.640	800	89	753
Cast iron	5.700	500	150	288
Plastic	6.101	300	100	261
RC	37.766	1400	400	1123
PVC	0.253	150	150	150
Ceramic	0.033	150	150	150
Concrete	8.945	1000	500	793
Tile	38.301	400	150	255
Asbestos	15.036	500	150	353
Plaster	14.782	600	80	223
Total	135.557			

Table 5.4.20 Damage estimation results of sewerage pipeline

Scenario I			
District	District	District	District
Bayangol	194.967	25.561	49.835
Bayanzurh	166.405	24.961	41.536
Chingeltei	39.733	27.687	11.001
Khan Uul	126.317	26.826	33.886
Nalaih	0.218	22.817	0.050
Songino	111.567	27.817	31.034
Sukhbaatar	94.607	25.723	24.335
Baganuur	—	—	—
Bagakhangai	—	—	—
Total	733.814		191.677
Scenario II			
District	District	District	District
Bayangol	194.967	24.020	46.831
Bayanzurh	166.405	21.690	36.093
Chingeltei	39.733	23.175	9.208
Khan Uul	126.317	26.545	33.531

Nalaih	0.218	14.110	0.031
Songino	111.567	26.687	29.774
Sukhbaatar	94.607	21.724	20.553
Baganuur	—	—	—
Bagakhangai	—	—	—
Total	733.814		176.019

(6) Risk assessment of power system

Since the data are not obtained yet, the risk assessment will be done when the data is available.

(7) Risk assessment of hot water pipeline

Central heating system are provided to the central area of UB through hot water pipeline. About 82% of the hot water pipeline was under ground and the remained part (18%) was over ground. There are two types of underground pipeline: buried type and common duct type. The over ground pipeline is supported by supporting strut and the pipe are not fixed to the strut in most cases.

There is no such central heating system in Japan and no statistical fragility for damage estimation. Since the mechanism of damage is different, It is necessary to estimate the damage differently for under ground part and over ground part.

There are two kinds of strut for over ground pipeline. One is low, generally around 1m, and another is high, generally more than 4m. (Figure 5.4.17). The damage of over ground pipeline is considered including the damage of pipe itself, the damage of the strut and falling off. The way for damage estimation of over ground pipeline is under investigation.

The damage of under ground pipeline was estimated by the method used for water pipeline because they were similar in pipe material and both deliver the water with pressure. The damage estimation of hot water pipeline was based on the GIS data provided by UB city. The total length of the pipeline was 1109km and 218km (about 20%) had the pipe material and diameter information, which are shown in Table 5.4.21. For the pipe without material and diameter information, the pipe material was supposed to be steel. The weighted average diameter from the known data was used for the pipes without diameter information.

The damage estimation of underground hot water pipeline are shown in Table 5.4.22. There were 97 damage spot for scenario I (damage rate 0.09 spot/km) and 59 damage spot for scenario II (damage rate 0.05 spot/km).

Figure 5.4.17 Over ground hot water pipeline

Table 5.4.21 Distribution of pipe material and diameter of hot water pipeline

Material	Length (km)	Diameter (mm)		
		Max.	Min.	Average
Steel	217.201	800	32	313
Cast iron	0.206	150	150	150
Ceramic	0.140	300	300	300
Asbestos	0.606	120	98	108
Total	218.153			

Table 5.4.22 Damage estimation results of hot water pipeline

Scenario I			
District	District	District	District
Bayangol	301.547	0.090	27
Bayanzurh	225.288	0.062	14
Chingeltei	67.568	0.063	4
Khan Uul	210.766	0.103	22
Songino	152.440	0.140	21
Sukhbaatar	151.405	0.057	9
Nalaih	—	—	—
Baganuur	—	—	—
Bagakhangai	—	—	—
Total	1109.014		97
Scenario II			
District	District	District	District
Bayangol	301.547	0.056	17
Bayanzurh	225.288	0.029	7
Chingeltei	67.568	0.030	2
Khan Uul	210.766	0.071	15
Songino	152.440	0.100	15
Sukhbaatar	151.405	0.027	4
Nalaih	—	—	—
Baganuur	—	—	—
Bagakhangai	—	—	—
Total	1109.014		59

5.5 Fire Risk

State of fire in UB City form EMDC fire statistic report, fire using equipment in house in developed area and Ger area by field survey is done to estimate Fire Breakout Risk and Fire Spread Risk in the case of Earthquake Scenario 1 and Earthquake Scenario 2.

According to the statistic survey of and field survey, Risk of Fire Breakout and Risk of Fire Spread are calculated.

5.5.1 State of Fire in UB city

Table 5.5.1 to Table 5.5.3 is the past 8 year's fire statistics in UB city. Number of fire breakout has increased since 2004. It may be because increase of population of UB city. Table 5.5.4 to Table 5.5.5 shows the cause of fire breakout and Category of objects.

Table 5.5.1 Number of fires of 8 years from 2004 to 2011

Year	Number of Fire	Rescued persons	Number of Casualty	Amount of Damage (million Togrug)
2004	1328	202	24	744.3
2005	1593	41	29	962.8
2006	1523	56	39	886.4
2007	1622	50	58	1854.5
2008	1426	170	22	1739.8
2009	1318	65	33	1867.4
2010	1703	176	39	1863.76
2011	2073	513	38	1677.63
合計	12586	1273	282	11596.59

Table 5.5.2 Distribution of time of Fire Breakout

Time	Number
0-6	366
6-12	381
12-18	716
18-24	610

Table 5.5.3 Number of fire call

District	Year 2010	Year 2011
Bayanzurkh	30	32
Bayangol	25	35
Songinokhairkhan	28	34
Sukhbaatar	29	31
Khan-uul	26	33
Chingeltei	28	36
Nalaikh	15	23
Baganuur	11	9
Bagakhangai	3	3

Table 5.5.4 Cause of fire in 2011

Cause	Number
Outside, Ash	973
Stove, Chimney	281
Unknown	189
Insufficient Electric Contact	239
Insufficient connect of Electricity	155
Trouble of Machine	40
sparking of welding, burner	37
Trouble of Electricity	56
Candle, Lamp, cigarette, match	16
Violation of Technical Procedure	6
Spark from exhaust pipe of automobile	19
Intentional	25
Petroleum, Flammable Materials	4
Accidental action of Children	5
Others	14

Table 5.5.5 Type of Fire in 2010

Type of Fire	Number of Fire
Individual Residence	474
Gavage	272
Automobile	149
Warehouse	94
Ger	189
Small Shop	50
Electric products	88
Furniture	56
Building	46
Garage	17
Others	272

5.5.2 Field Survey

(1) Field survey of Fire Equipment in Residential Houses

Questionnaire survey and visiting survey of fire using equipment in house are done.

1) Fire using equipment and electronic equipment in Ger and individual houses in Ger area

- Coal stove are mostly used (Figure 5.5.1). A few propane gases are used in some Ger.
- Coal stove is used for cocking. In summer time, electric heater are also used (Figure 5.5.2).
- Refrigerator, TV, Radio, Iron, Washing Machine, Vacuum cleaner Personal Computers are used as electric equipment in house (Figure 5.5.3).
- Hot water for bath is warmed by Coal stove. 10 l/person to 20 l/person used.

Figure 5.5.1 Coal Stove

Figure 5.5.2 Electric Heater

Figure 5.5.3 Refrigerator

Also hot water supply system using coal stove is find in apartment house in Ger area (Figure 4.5.4).

2) Fire using equipment and electric equipment in apartment houses in Developed are
Mostly electric heater is used in kitchen. There are few propane gas is used (Figure 4.5.5).

- .
- Heating system is hot water heating system in all apartment houses in developed area in UB city (Hot water is supplied from October to April)
- Refrigerator, Iron, Washing machine, Vacuum cleaner, Dryer, TV, Radio, Personal Computers are used as electric equipment in house.
- Bath is by hot water supply system as same as heating system.

Figure 5.5.4 Hot water supply system in Ger

Figure 5.5.5 Kitchen in apartment in developed area

(2) Building field survey in Ger area
Building survey was implemented to develop the fire spread risk in Ger area. 3 case study areas were selected from different density of houses. Case study 1 is Zuun Naram area which is located near developed area and Case study 3 is Komsul area which also is located near development area. Case study 2 is Dambadarjaa area in Chingeltei District which is located on the hill side far from developed area. Case study area are shown in Figure 5.5.6.

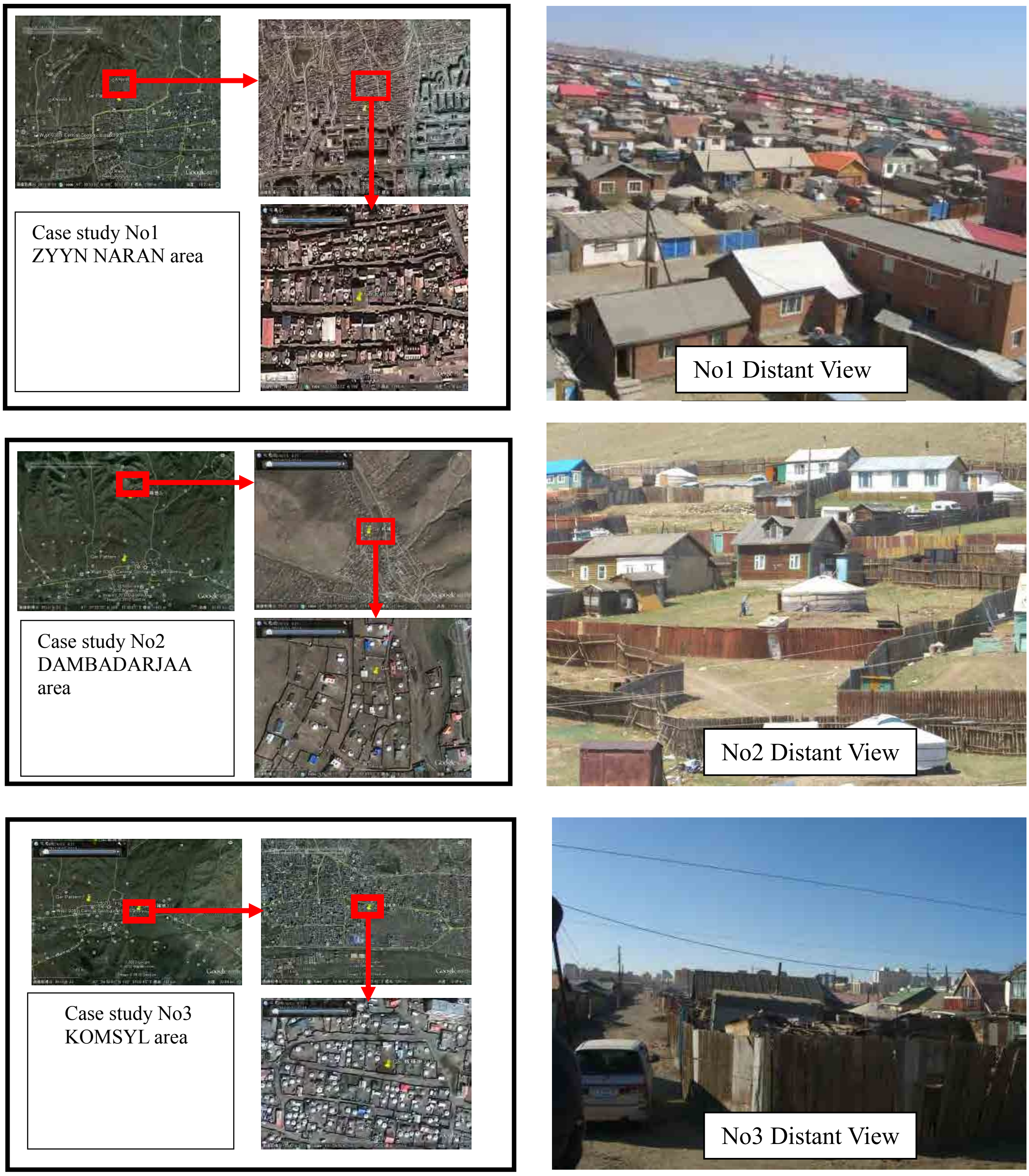


Figure 5.5.6 Locations and Distant Views of Case Study Areas

1) Building Structures in Ger area

Existing building structures in Ger area are Ger, Wooden houses, Brick or Adobe reinforced by wood. There are combined type bricks or adobe structures with wood above wall part and roof (Figure 5.5.7).


Ger area


Outside of Ger site


Building structures in Ger


Wood


Adobe


1st floor is brick、2nd is wood

Figure 5.5.7 Building Structures in Ger areas

As the result of this survey, Ger, wood and combine of brick and wood are recognized as flammable buildings. Adobe and brick structures are recognized as inflammable buildings.

2) Distribution of buildings by type of structures

In Figure 5.5.8 to Figure 5.5.10 shows the distribution of buildings by type of structures in Case study 1 to 3. ○ mark indicates Ger, red mark indicates wood buildings, Brue mark indicates inflammable buildings. Table 5.5.6 indicates the number of buildings by 3 categories, site average area by m^2 and percentage of Ger and flammable buildings for all building.

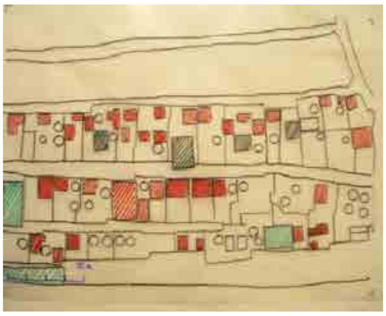


Figure 5.5.8 Case Study 1 ZYYN NARAN Area Distribution of Building Type

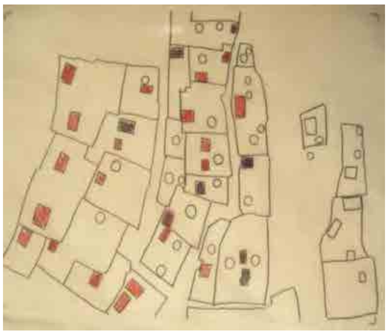


Figure 5.5.9 Case Study 2 DAMBADARJAA Area Distribution of Building Type

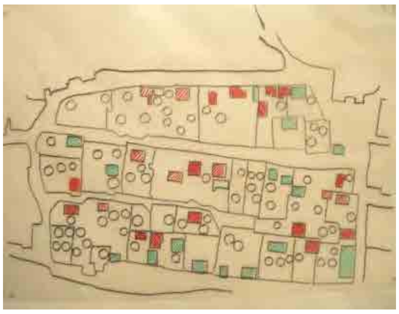


Figure 5.5.10 Case Study 3 KOMSYL Area Distribution of Building Type

Table 5.5.6 Building Survey Result in 3 Case Study Areas

	No 1 ZYYN NARAN area	No2 DAMBADARJAA area	No3 KOMSYL area
Case study area（ha）	2.41	2.34	2.65
Residential site area（ha）	1.76	2.156	1.82
Non residence area (ha)	0.65	0.184	0.83
Estimated site number	41	24	43
Average site area ($m^{2)}$	430	898	421
Total number of buildings	84	50	117
Number of Ger	36	23	78
Number of wooden buildings	19	21	14
Number of combined buildings	22	0	8
Number of inflammable buildings	7	6	17
Ger/Total buildings (%)	43%	46%	67%
Flammable buildings/ Inflammable buildings (%)	92%	88%	85%

(2) Field survey of Residential Fire occurred on 11th of May in 2013 in UB city

Actual fire occurred on 11th of May near the Gandan temple of Bayangol district. Project team had a chance of field survey of this fire; following is the report of the fire. Report of this fire by EMDC has not opened yet.

(a) Outline of the fire

- ✓ Time of fire break out: 2013.5.11(Sunday), 18:30
- ✓ Place: Bayangol district, UB city, about 100m of south west of Gandan Temple
- ✓ Wither: Cloudy, Wind: NNW, about 5m/sec
- ✓ Cause of Fire Break Out
  - ➢ There was the comment from man who we interviewed at fire site that child who was in the room of fire break out told that TV got the fire suddenly.
  - ➢ 86 years old lady and 3 grandchildren lived in the house.
- ✓ Injured
  - ➢ Grandmother was hospitalized.
  - ➢ Two ladies lived burned house were taken medical care of pain of throat by smoke.

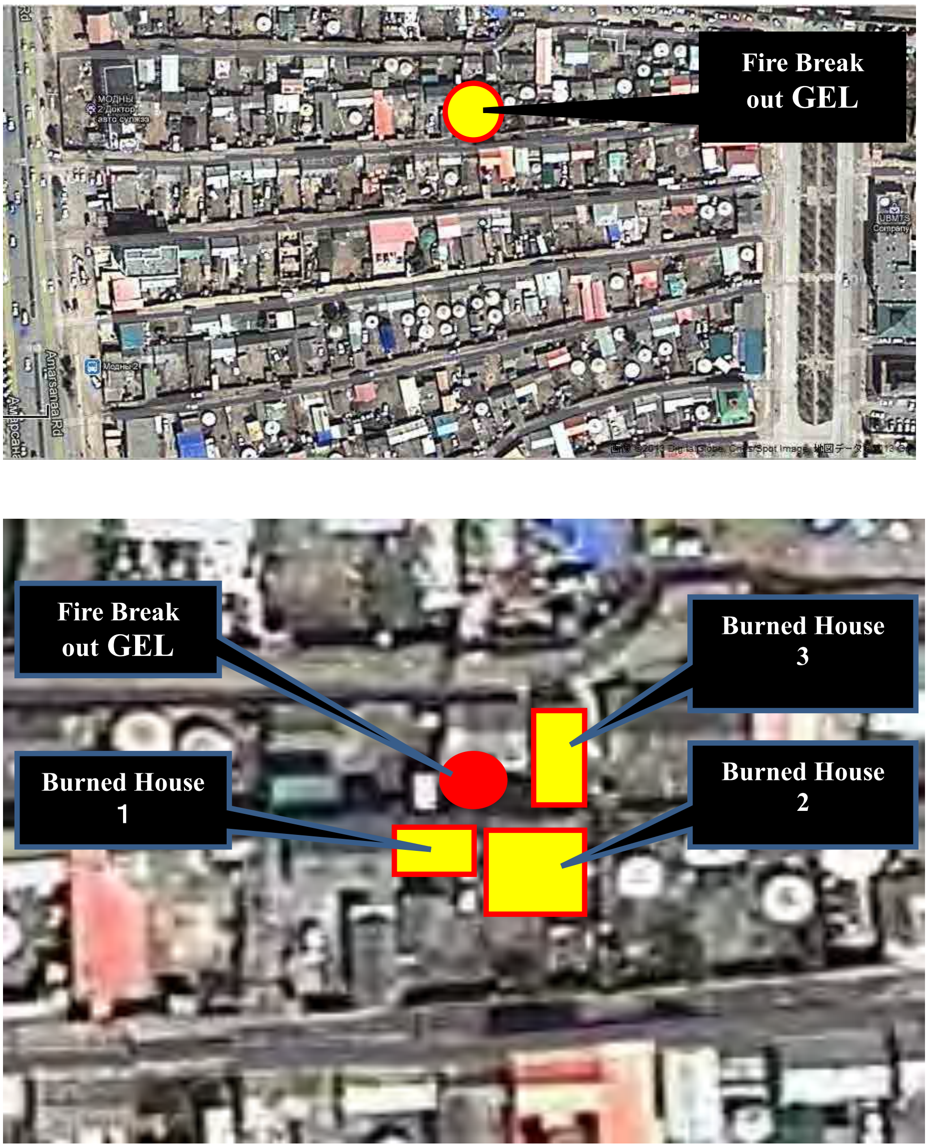


Figure 5.5.11 Aero photo of the place of fire break out

(b) View of Fire

Figure 5.5.12 2013.5.12.18:43

Figure 5.5.13 2013.5.12.18:45

Figure 5.5.14 2013.5.12.18:48

Figure 5.5.15 2013.5.12.18:49

Figure 5.5.16 2013.5.12.18:51

Ger after fire

Carbonized narrow wooden poles which are used as the flame of Ger, washing machine, coal stove and electric stove were remained at the ruins of the fire.

Figure 5.5.17 the ruins of fire

(c) Burned Houses in a spreading fire

✓ Burned House 1

This house located south of first Ger. Outside wall viewed from Ger side looks as brick wall but wooden wall with mud. The other side of wall viewed from inside made by stone block of 20cm x 30cm.

Figure 5.5.18 North side wall of burned house 1

Figure 5.5.19 Southside of burned house 1

Figure 5.5.20 Inside view of North side wall

Figure 5.5.21 Inside of house was fully burned

Figure 5.5.22 Ceiling and roof was burned out


Figure 5.5.23 Ceiling of south side room

✓ Burned House 2

Burned house 2 was located south south west of Ger and lied leeward of Ger. There is no fence of this house and facing directly to burned house 3


Figure 5.5.24 Southside view of house 2


Figure 5.5.25 View of house 2 from Ger

As first floor wall of house2 was made by non-inflammable material, house itself did not collapse. Inside of house was completely burned out. Carbonated depth of wooden beam and column reached 2cm from surface. Roof was remained but top of wall made by wood was burned out.


Figure 5.5.26 View of inside of house 2 (1)


Figure 5.5.27 View of inside of house 2 (2)

Figure 5.5.28 Look sky through burned Ceiling

- Burned House 3

This house located east side of the Ger and distance between house 2 and house 3 is 5m to windward. South part of house 2 extended about 2m. Only south part of house 3 was burned and West side and North side of house 3 was not burned. Therefore it is assumed as the fire spread from house 2 to house 3.

Figure 5.5.29 House 3 looking from west direction

Figure 5.5.30 Windows of Westside wall

Figure 5.5.31 House 2 from inside of house 3

Figure 5.5.32 North side room

(d) Estimation of Fire Spread

1) Scale of Houses

- ✓ Ger: Diameter of Ger is 6m
- ✓ House 1: 8m(East-West) and 4m(North-South)
- ✓ House 2: 10m square
- ✓ House 3: 5m(East-West) and 8m(North-South)

Distance between Houses

It is estimated as follow from Google map

- ✓ Ger and House 1: 2m
- ✓ Ger and House 2: 2m
- ✓ Ger and House 3: 5m
- ✓ House 1 and House 1: Narrow past of 1m width
- ✓ House 2 and House 3: 3m

2) Estimation of fire spread path

- ✓ Under north north west wind with 5m/sec velocity, fire spreader from Ger to House 1 and also House 2
- ✓ House 2 fire spread to House 3 because north side of House 2 is facing to south side of House 3.
- ✓ Following point should be mentioned that Fire spreader from House 2 to House 3 which located windward under 5m/sec wind velocity even 5m distance between House 2 and House 3.

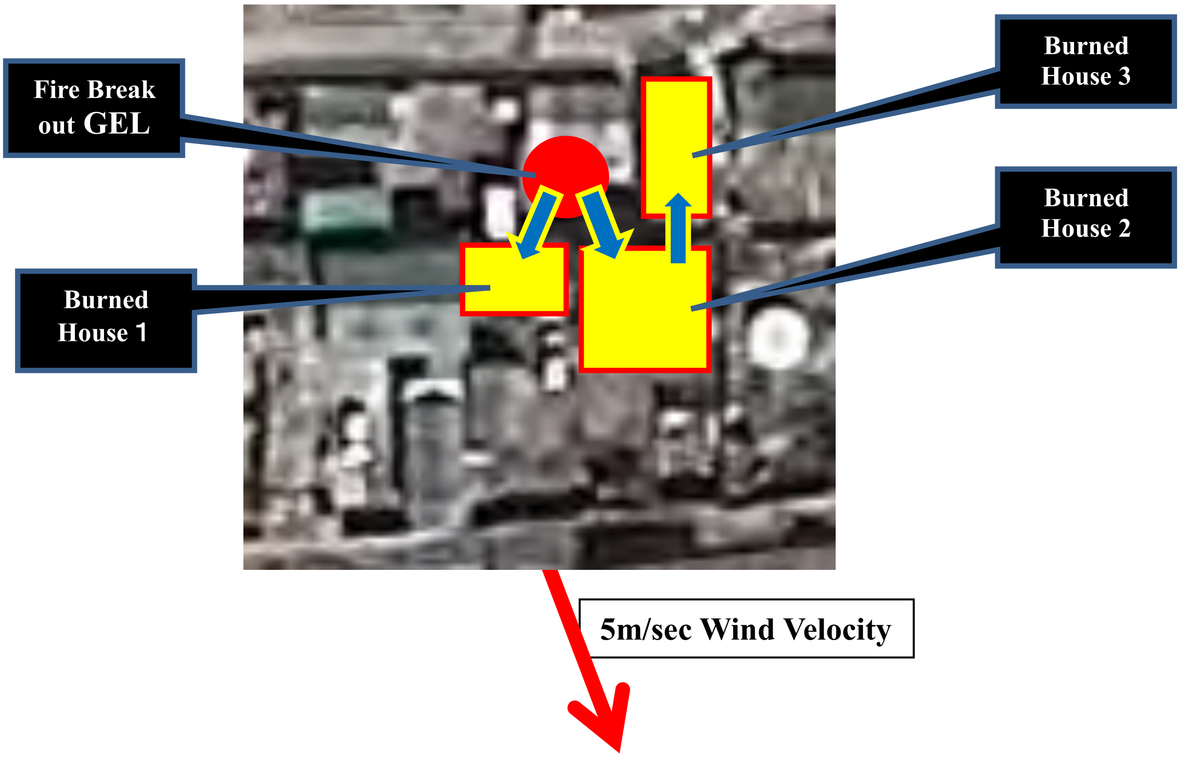


Figure 5.5.33 Estimation Path of Fire Spread

5.5.3 Risk of Fire

Earthquake Fire is the fire caused by ground motion of Earthquake. There are many direct cause of fire breaks such as the fire from coal-burning stove inside of house by collapse of house, the fire spread by falling down flammable materials or furniture’s on the coal stove or gas heater, the fire of short circuit of electricity, mixture of chemicals, the fire from manufactures or plants using flammable materials, the fire by sparkling in petroleum refineries and so on.

The characteristics of Earthquake fire are high risk of the simultaneous multiple fires break out and no firefighting activities because of the equipment and facilities for firefighting are suffered damages by Earthquake and also fire engines may not reach fire site by road damages and congestion by Earthquake.

The risk of fire break out and fire spread are depended on seasons and weather conditions. Fire break out in winter becomes high because of usage of fire using equipment such as coal stoves or heaters are increase. Also in high wind season, fire is easily spread to houses located in downwind side. In dry seasons, fire is easily spread because of law humidity. Fire spread will be reduced by rain when it is raining.

We should understand that risk of earthquake fire is usually estimated by past few experience of large Earthquake and it is difficult to ensure the result of estimation by the experimental method

(1) Flow of fire risk estimation
Fire risk consists of fire breakout risk and fire spread risk.

(2) Fire Breakout Risk
Fundamental data for Fire Breakout Risk estimation do not exist in UB city because UB city has not been suffered by large earthquake until now. Therefore fire breakout risk estimation method using in Tokyo Metropolitan with consideration of characteristic of UB city.

1) Estimation of number of fires breakout in Earthquake
Fire breakout consists of fires from collapsed buildings and fires from non-collapsed buildings. The number of fires breakout is therefore sum of fires from collapsed and not collapsed buildings.

The number of fire breakout from collapsed buildings is calculated as the fire breakout ratio of collapsed building multiple numbers of collapsed buildings. The fire breakout ratio used here is made by Tokyo Fire Department based on 1995 Great Hansin Awaji Earthquake.

The number of fire breakout from non-collapsed buildings is calculated as the fire breakout ratio from collapsed building multiple numbers of non-collapsed buildings. The fire breakout ratio is determined for each building use respectively. This ratio is also by Tokyo Fire Department.

Table 5.5.7 Fire Breakout Ratio by Building Use (%) (Winter, Evening)

Note F : Flammable, I : Inflammable

Use of Building	Ground acceleration					
	0-80	80-142	142-253	253-450	450-800	800-
Public facility	F	0.0003	0.0011	0.0046	0.0194	0.1590
	I	0.0003	0.0012	0.0052	0.0216	0.1770
Kindergarten, nursery	F	0.0002	0.0007	0.0030	0.0100	0.0340
	I	0.0002	0.0008	0.0033	0.0111	0.0380
School	F	0.0004	0.0010	0.0040	0.0149	0.0750
	I	0.0004	0.0011	0.0044	0.0166	0.0830
University	F	0.0008	0.0037	0.0154	0.0509	0.1160
	I	0.0009	0.0041	0.0171	0.0565	0.1290
Gymnasium	F	0.0000	0.0000	0.0000	0.0000	0.0000
	I	0.0000	0.0000	0.0000	0.0000	0.0000
Hospital	F	0.0007	0.0016	0.0064	0.0335	0.4760
	I	0.0008	0.0017	0.0072	0.0372	0.5290
Individual House	F	0.0009	0.0031	0.0101	0.0332	0.1040
	I	0.0010	0.0034	0.0109	0.0351	0.1150
Apartment house	F	0.0004	0.0011	0.0052	0.0180	0.0640
	I	0.0006	0.0019	0.0061	0.0195	0.0470
House with Office	F	0.0004	0.0011	0.0052	0.0180	0.0640
	I	0.0006	0.0019	0.0061	0.0195	0.0470
Office	F	0.0003	0.0011	0.0046	0.0194	0.1590
	I	0.0003	0.0012	0.0052	0.0216	0.1770
House with Store	F	0.0004	0.0011	0.0052	0.0180	0.0640
	I	0.0006	0.0019	0.0061	0.0195	0.0470
Restaurant	F	0.0042	0.0141	0.0487	0.1491	0.4580
	I	0.0047	0.0157	0.0541	0.1657	0.5090
Hotels, student dormitory	F	0.0010	0.0020	0.0083	0.0460	0.5480
	I	0.0025	0.0115	0.0283	0.0834	0.7130
Department store	F	0.0018	0.0057	0.0230	0.0837	0.4690
	I	0.0020	0.0064	0.0255	0.0930	0.5210
Store	F	0.0006	0.0020	0.0077	0.0272	0.1430
	I	0.0007	0.0022	0.0085	0.0302	0.1580
Factory	F	0.0004	0.0017	0.0075	0.0261	0.0820
	I	0.0006	0.0030	0.0113	0.0377	0.1090
Warehouse, storehouse	F	0.0000	0.0000	0.0000	0.0000	0.0000
	I	0.0000	0.0000	0.0000	0.0000	0.0000
Temple, church,	F	0.0000	0.0000	0.0000	0.0000	0.0000
	I	0.0000	0.0000	0.0000	0.0000	0.0000
Museum, library, movie theater	F	0.0008	0.0027	0.0089	0.0338	0.2680
	I	0.0009	0.0030	0.0098	0.0376	0.2980
Station	F	0.0008	0.0027	0.0089	0.0338	0.2680
	I	0.0009	0.0030	0.0098	0.0376	0.2980
Other	F	0.0000	0.0000	0.0000	0.0000	0.0000
	I	0.0000	0.0000	0.0000	0.0000	0.0000

Ref : Made by Project team based on the Regional Earthquake Fire Risk Investigation of Tokyo (No3)

Table 5.5.8 Fire Breakout Ratio by Building Use (%) (Summer, Noon)

Note F : Flammable, I : Inflammable

Use of Building		Ground acceleration					
		0-80	80-142	142-253	253-450	450-800	800-
Public facility	F	0.0005	0.0016	0.0075	0.0281	0.1650
	I	0.0005	0.0017	0.0083	0.0313	0.1830
School (Kindergarten, nursery)	F	0.0003	0.0003	0.0011	0.0033	0.0190
	I	0.0003	0.0004	0.0013	0.0037	0.0210
School	F	0.0013	0.0024	0.0099	0.0317	0.1090
	I	0.0015	0.0026	0.0110	0.0352	0.1210
University	F	0.0013	0.0041	0.0195	0.0645	0.1280
	I	0.0015	0.0046	0.0216	0.0717	0.1420
Gymnasium	F	0.0000	0.0000	0.0000	0.0000	0.0000
	I	0.0000	0.0000	0.0000	0.0000	0.0000
Hospital	F	0.0008	0.0015	0.0063	0.0267	0.2820
	I	0.0009	0.0016	0.0070	0.0296	0.3130
Individual House	F	0.0002	0.0003	0.0013	0.0043	0.0160
	I	0.0003	0.0003	0.0014	0.0045	0.0210
Apartment house	F	0.0001	0.0001	0.0003	0.0011	0.0080
	I	0.0001	0.0001	0.0005	0.0018	0.0120
House with Office	F	0.0001	0.0001	0.0003	0.0011	0.0080
	I	0.0001	0.0001	0.0005	0.0018	0.0120
Office	F	0.0005	0.0016	0.0075	0.0281	0.1650
	I	0.0005	0.0017	0.0083	0.0313	0.1830
House with Store	F	0.0001	0.0001	0.0003	0.0011	0.0080
	I	0.0001	0.0001	0.0005	0.0018	0.0120
Restaurant	F	0.0026	0.0068	0.0312	0.1037	0.2980
	I	0.0029	0.0076	0.0346	0.1152	0.3310
Hotels, student dormitory	F	0.0001	0.0001	0.0005	0.0034	0.0580
	I	0.0007	0.0013	0.0053	0.0231	0.2600
Department store	F	0.0017	0.0046	0.0209	0.0769	0.4370
	I	0.0019	0.0051	0.0232	0.0855	0.4850
Store	F	0.0005	0.0014	0.0064	0.0288	0.1110
	I	0.0005	0.0015	0.0071	0.0258	0.1230
Factory	F	0.0004	0.0015	0.0070	0.0245	0.0800
	I	0.0006	0.0025	0.0122	0.0420	0.1020
Warehouse, storehouse	F	0.0000	0.0000	0.0000	0.0000	0.0000
	I	0.0000	0.0000	0.0000	0.0000	0.0000
Temple, church,	F	0.0000	0.0000	0.0000	0.0000	0.0000
	I	0.0000	0.0000	0.0000	0.0000	0.0000
Museum, library, movie theater	F	0.0007	0.0015	0.0068	0.0265	0.1980
	I	0.0008	0.0017	0.0076	0.0294	0.2200
Station	F	0.0007	0.0015	0.0068	0.0265	0.1980
	I	0.0008	0.0017	0.0076	0.0294	0.2200
Other	F	0.0000	0.0000	0.0000	0.0000	0.0000
	I	0.0000	0.0000	0.0000	0.0000	0.0000

Ref : Made by Project team based on the Regional Earthquake Fire Risk Investigation of Tokyo (No3)

Risk of fire breakout from Ger area is considered beside above stated method. UB city has unique urban structure which area of urban developed area consist of inflammable buildings such as Bricks, RC or Steel Structure buildings and Ger area which consist of mostly flammable structures such as Ger, wooden house. Also coal stove is indispensable for Ger area to heating and cooking. Therefore electric stove ratio is applied for breakout ratio in Ger area.

Table 5.5.9 Fire breakout Ratio in Ger area (%)

	Ground acceleration	80-142	142-253	253-450	450-800	800-
Winter, Evening	wooden house	0.00	0.49	0.49	0.49	0.49
	Non wooden houses	0.00	0.00	0.00	0.00	0.00
Summer, Noon	wooden house	0.0009	0.0013	0.0098	0.0333	0.0895
	Non wooden houses	0.00	0.00	0.00	0.00	0.00

Ref. made by Project team

2) Procedure of number of Fire Breakout

Procedure of number of Fire Breakout is shown in Table5.5.9. Developed area and Ger area will be calculated separately and sum. Please note that the fire breakout ratio of apartment house is per each household. Therefore ratio of fire breakout for apartment should be multiplied by number of household in apartment. To estimate number of household in apartment, each household building area is set as $100m^2$/house.

Table 5.5.10 Procedure of Number of Fire Breakout

Individual Building				
	a	Location		All buildings
	b	Developed area or Ger area	Identify each building locate in Developed area or Ger area from (a)	All buildings
	c	Khoroo	Identify each building locate in what khoroo	All buildings
	d	Building Use	Identify Building Use from Building DB	Buildings in Developed area
	f	Building Structure	Identify Building Structure from Building DB	
	g	Number of household in apartment house	Number of household =Building Area × number of Floors	Buildings in Developed area
	h	Ground acceleration	Estimated Ground Acceleration on building site	All buildings
	i	Category of Accelerations	Category of Acceleration by Table 5.5.7	All buildings
	j	Fire Breakout Ratio by Building Use	Fire Breakout Ratio by Building Use from Table 5.5.7	Buildings in Developed area
	k	Fire Breakout Ratio for Ger area	Identify Type of Building Structure in Ger area	All buildings
Calculation of number of Fire Breakout				
	l	Number of Fire Breakout in each Mesh	Sum of fire breakout ratio of each buildings in each Mesh	Total number of Buildings in Mesh
	m	Number of Fire Breakout in	Sum of fire breakout ratio of each	Total number of

		each Khoroo	buildings in Khoroo	Buildings in Khoroo
	n	Number of Fire Breakout in UB city	Sum of fire breakout ratio of each buildings in UB city	Total number of Buildings in UB city

3) Result of Estimation of number of Fire Breakout
The result of estimation of number of fire breakout is shown in 5.5.4 .

(3) Fire Spread Risk
1) Fire Spread Risk Evaluation Method using "Inflammable area ratio"
Common method of Fire Spread risk estimation is so called "Inflammable area ratio method". This method is based on the ratio of inflammable zone area against whole area in Figure 5.5.34. This method was developed by Ministry of Construction of Japan in 1980th.

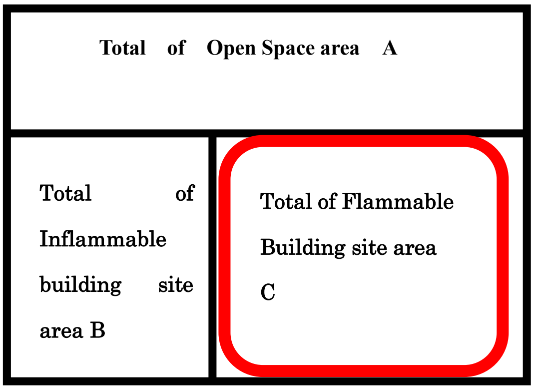


Figure 5.5.34 Concept of Inflammable area ratio method

<u>Application of Inflammable area ratio method to UB city</u>
This method basically applicable to estimate in UB city. Slight modification is done because of building data availability. B is inflammable building area and C is flammable building area instead of building site area. Therefore the ratio of inflammable zone area against whole area becomes (inflammable building area)/(whole building area).

<u>Number of Burned buildings estimated by Inflammable area ratio method</u>
Number of burned buildings estimated from relation of inflammable area ratio and number of burned buildings (%) as indicated in Figure 5.5.35.

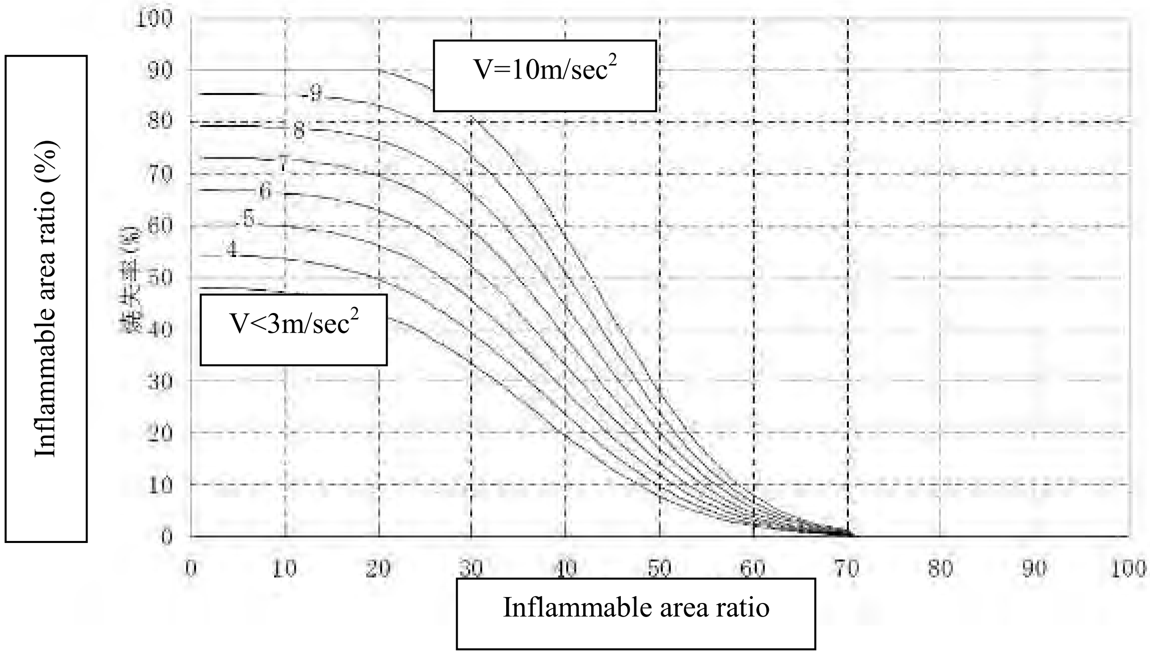


Figure 5.5.35 Relation between Number of burned buildings and inflammable area ratio
Ref. Earthquake Damage Estimation Report of Miyagi Prefecture

2) Development of fire spread risk in Ger area
Most buildings are made of RC buildings or reinforced brick buildings in developed area. Therefore it is obvious that fire spread risk in developed area is very low. On the other hand, Ger area which widely exist surrounding of developed area of UB city, more than 60% of population of UB city living consist of mostly flammable buildings including Ger. Therefore Ger area is also obviously high risk of fire spread risk. Even so, the density of buildings in Ger area are quite various according to the field survey and this difference does no come clear from “Inflammable Area Ratio Method”. Therefore, it is needed to develop new method to express the difference of fire spread risk by density of building in Ger area.

Estimation of Fire Spread Area by “Fire Spread Cluster”
“Fire Spread Cluster” is developed by Tokyo Fire Department which identifies the possibility of fire spread from adjacent building by the distance between buildings using GIS map. The developed method is to estimate fire spread risk by density of buildings using “Fire Spread Cluster”.
Fire Spread Cluster is calculated by grouping the buildings which distance between adjacent buildings less than maximum distance (Fire Spread Limited Distance) which given by width and structures of buildings. Cluster has the meaning that once one fire breaks out then whole buildings will be burned. Concept of “Fire Spread Cluster” is shown in Figure 5.5.36.

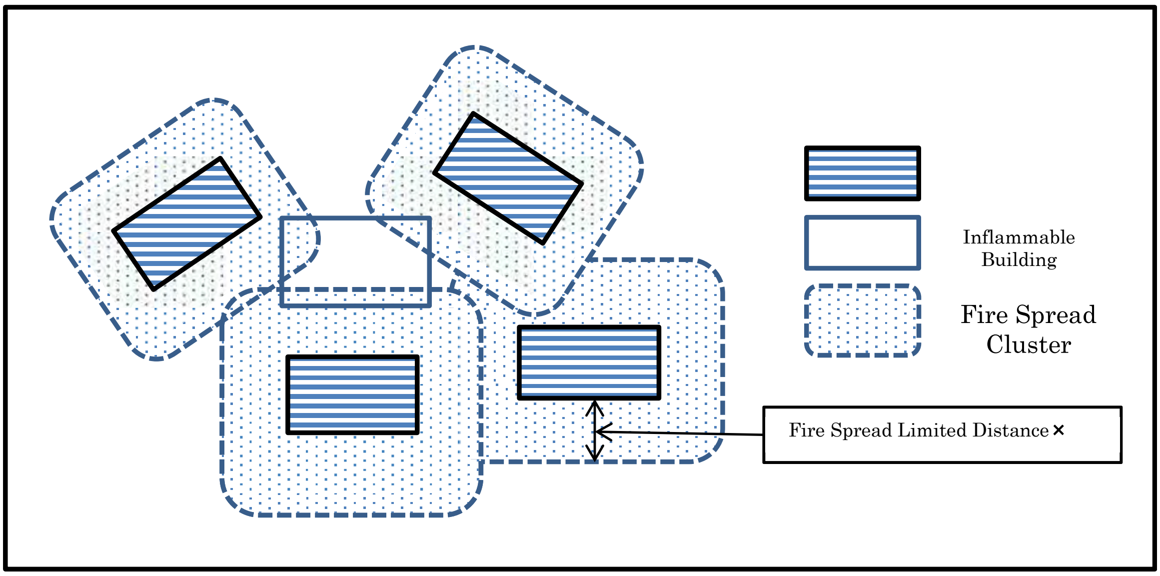


Figure 5.5.36 Concept of “Fire Spread Cluster”

Fire Spread Cluster is made in 3 case study areas and one of the examples is shownFigure 5.5.37.

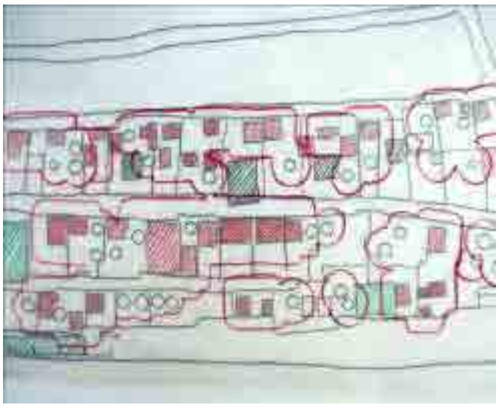


Figure 5.5.37 Example of Fire Spread Cluster

Next step is to estimate the number of buildings expected to be burned by one fire occurs in this area. In one area there are several clusters exist as shown in Figure 5.5.37, from what cluster fire will breaks out is not determined. Therefore if assume one fire occurs in some cluster, number of expected burned buildings is the number of the buildings which belong in one cluster. After repeated same calculation to give one fire to each cluster, we can get the expected burned buildings from the area. Figure 5.5.35 shows the expected number of burned buildings in the relation of number of expected burned buildings (%) and density of buildings in the area.

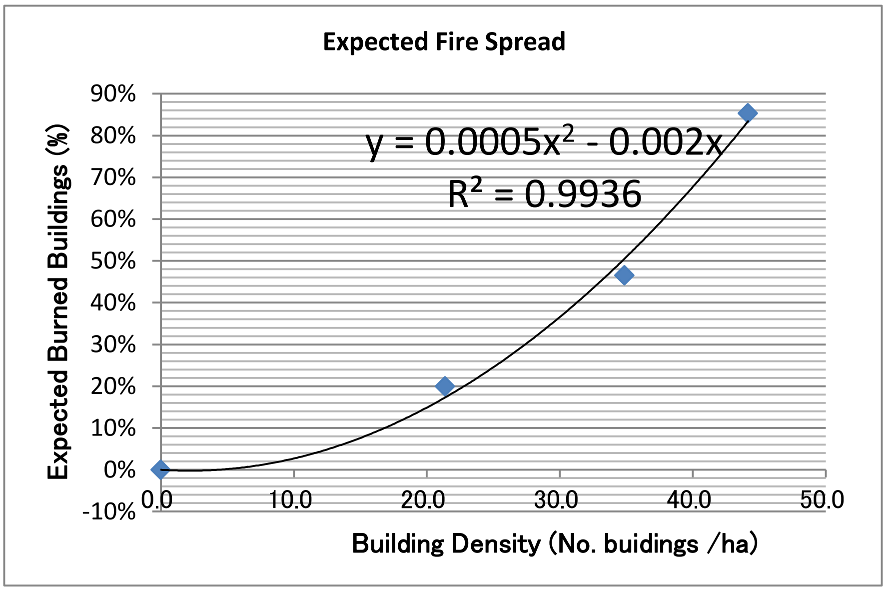


Figure 5.5.38 the relation of number of expected burned buildings (%) and density of buildings in the area (number of buildings/ha)

(4) Fire risk considered seasons, time, weather conditions Earthquake Fire risk is very dependent to seasons, time, and weather conditions. Therefore two case, which moderate condition and extreme condition are considered.

Condition 1 Earthquake occurs at noon in summer time and with wind velocity 3m/sec

Condition 2 Earthquake occurs at evening in winter time and with wind velocity 10sec

5.5.4 Estimation of number of fire breakout and number of houses burned by fire spread

Simulation result is shown in Table 5.5.11 and Table 5.5.12. Figure 5.5.39 shows fire breakout and fire spread risk in 5 ranking for each 250m mesh of UB city. 1st rank is 0.00-0.01 houses/mesh, 2nd rank is 0.01-0.1 houses/mesh, 3rd rank is 0.1-1.0 houses/mesh, 4th rank is 1.0-10 houses/mesh and 5th rank is over 10 houses/mesh.

Table 5.5.11 Fire Risk of Scenario 1

Scenario 1 Earthquake	Evening of Winter, Wind velocity 10m/sec		Noon of Summer, Wind velocity 3m/sec	
	Number of Fire Breakout	Number of houses burned	Number of Fire Breakout	Number of houses burned
Baganuur	0	0	0	0
Bagahangai	0	0	0	0
Bayangol	13	1067	13	648
Bayanzurh	27	1654	24	884
Nalaih	0	0	0	0
Songinohairhan	27	1541	26	792
Suhbaatar	15	886	14	453
Hun Uur	7	49	7	26
Chingeltei	25	2404	23	1531
UB city Total	114	7601	107	4334

Ref: JICA Project Team

Table 5.5.12 Fire Risk of Scenario 2

Scenario 2 Earthquake	Evening of Winter, Wind velocity 10m/sec		Noon of Summer, Wind velocity 3m/sec	
	Number of Fire Breakout	Number of houses burned	Number of Fire Breakout	Number of houses burned
Baganuur	0	0	0	0
Bagahangai	0	0	0	0
Bayangol	9	883	6	280
Bayanzurh	20	1297	8	305
Nalaih	0	0	0	0
Songinohairhan	25	1434	17	530
Suhbaatar	11	725	3	95
Hun Uur	7	64	5	23
Chingeltei	19	1938	7	478
UB city Total	91	6341	46	1711

Ref: JICA Project Team

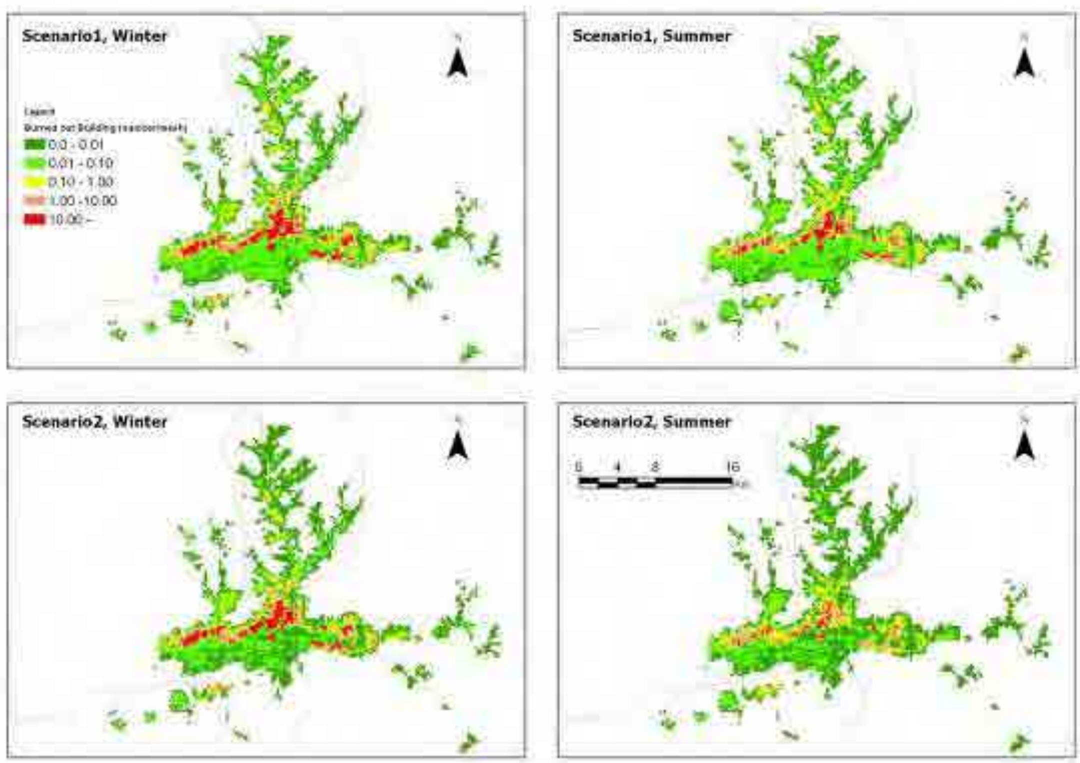


Figure 5.5.39 Fire Risk

5.5.5 consideration

High risk rank meshes are Ger areas locate near city center in every case. Ger areas near city center are convenient and therefore density of houses is high. These Ger areas expand on the hill where basic infrastructures such as road networks, water supply, and sewerage system are not provided. Therefore Firefighting activities may face difficulty. If actually earthquake occurs, houses burned by spread fire may increase much more.

5.5.1 Estimation of human casualties caused by fire

(1) Method for estimating the human damage casualties caused by fire

(a) Concept of assumption of human casualties

Human casualties of the earthquake fire is estimated as being the same as the human casualties in the fire of the past of normal times.

The number of human casualties caused by the earthquake fire, is determined by multiplying the number of fires caused by the earthquake in the occurrence rate of injuries

(b) Number of injuries and deaths from fire of normal time in Ulaanbaatar

Data of human damage caused by fire was provided from Ulaanbaatar EMDC. Classification by fire place in fire statistics of UB city has become houses, garbage, car, warehouse, gel, kiosk, electrical products, furniture, building, parking, and other. Building of which is meant a structure of a small shed shape. Fire in the hot water piping is included in the waste classification. Place of occurrence of electrical products is a housing complex nearly. Data, including the human casualties is only worth two years of 2012 and 2011.

Table 5.5.13 shows the number of injuries and deaths from fire of normal time in Ulaanbaatar.

Table 5.5.13 The number of injuries and deaths from fire of normal time in Ulaanbaatar

	2011	2012	Total
All notification of fire number (Consistent with the fire incidents)	2073	2511	4584
Total number of deaths	38	35	73
Total number of injured	39		
Notification of fire number of the dead occurred	26	24	50
Notification of fire number of injured has occurred	21	21	42
Notification of fire number from houses	507	603	1110
Notification of fire number of deaths occurred in houses	14	8	22
Notification of fire number of injured has occurred in the houses	10	8	18
Notification of fire number from Ger	198	190	388
Notification of fire number of deaths occurred in Ger	9	10	19
Notification of fire number of injured has occurred in Ger	7	7	14
Notification of fire number generated from the electrical products	135		
Notification of fire number of deaths generated from the electrical products	0	0	0
Notification of fire number of injured generated from the electrical products	0	0	0

There is a lack of data in 2012, but some will be referred to with the value of 2011, it tries dead and injured from the building fire,

The ratio of the human casualties per one fire from all notification of fire number.

Ratio of Death＝73 person/4584 fires ＝ 0.016 person /fire

Ratio of Injured=39 person/2073 fires ＝ 0.019 person /fire

The ratio of the human casualties per one fire from Ger.

Ratio of Death＝19 fires /388 fires×73 person /50 fire ＝ 0.071 person /fire

Ratio of Injured＝14 人/388 fires×39 person /21 fire ＝ 0.067 person /fire

The ratio of the human casualties per one fire from House.

Ratio of Death＝22 fires /1110 fires 73 person /50 fire ＝ 0.029 person /fire

Ratio of Injured＝18 fires /1110 fires×39 person /21 fire ＝ 0.030 person /fire

According the explanation from EMDC, Most fires from electrical products are break out from apartment houses, the ratio of human casualties per one fire from apartment house assumed as same as from electrical products. From the data of the year of 2011 and 2012 are 0 from electrical products.

As umber of fire break out from Ger area is not estimated separately from Ger and houses, therefore the ratio of the human casualties per one fire from Ger area is used the average of Ger and houses.

The ratio of the human casualties per one fire from Ger area

Ratio of Death＝（0.071＋0.029）/2 person / fire＝0.05 person /fire

Ratio of Injured＝（0.067＋0.030）/2 person / fire＝0.0485 person /fire≒0.05 person /fire

People may be able to escape from spread fire because of time delay of fire spread, But in some case people may not able to escape because of building damages by earthquake. Therefore human casualties from spread fire assumed 10% of break out fire.

(2) Result of human casualties by fire

Scenario 1 Earthquake, Evening of Winter

Number of fire break out=114 fires →

Number of Death=114 fires×0.05=6person,

Numbers of Injured =114 fires×0.05=6 persons

Number of houses burned by spread fire =(7601-114)houses=7487 houses →

Number of Death=7487 houses×0.005=37 persons、

Numbers of Injured=7487 houses×0.005=37 persons

Scenario 1 Earthquake, Noon of Summer

Number of fire break out=135 fires →

Number of Death=107 fires×0.05=5 persons,

Numbers of Injured=107 fires×0.05=5 persons

Number of houses burned by spread fire=（4334-107）houses=4227 houses →

Number of Death=4227 houses×0.005=21 persons,

Numbers of Injured=4227 houses×0.005=21 persons

Scenario 2 Earthquake, Evening of Winter

Number of fire break out=91 fires →

Number of Death＝91 fires×0.05＝4 persons,

Numbers of Injured＝91 fires×0.05＝4 persons

Number of houses burned by spread fire＝（6341-91）houses＝6258 houses →

Number of Death＝6258 Numbers of Injured×0.005＝31 persons,

Numbers of Injured＝6258 houses×0.005＝31 persons

Scenario 2 Earthquake, Noon of Summer

Number of fire break out＝46 fires →

Number of Death＝46 fires×0.05＝2 persons,

Numbers of Injured＝46 fires×0.05＝2 persons

Number of houses burned by spread fire＝（1739-74）houses＝1665 houses →

Number of Death＝1665 houses×0.005＝8 persons,

Numbers of Injured＝1665 houses×0.005＝8 persons

Table 5.5.14 human casualties by fire (persons)

	Scenario 1 Earthquake		Scenario 2 Earthquake	
	Winter, Evening	Summer, Noon	Winter, Evening	Summer, Noon
Death by fire	43	26	35	10
Injured by fire	43	26	35	10

Chapter 6 Earthquake Disaster Scenario

6.1 Policy and Method for Establishing Earthquake Disaster Scenario

The purpose of establishing earthquake disaster scenario is to show the concrete image of disaster and to provide basis for construction and/or revision of contingency planning. Therefore, extremely severe situations against which no counter measure can be conducted and less severe situations useless to upgrade the capacity shall be avoided.

In this project, the earthquake scenario that is helpful to give some suggestions to UB city's contingency plan will be established based on the scientific results of seismic risk assessment carried out with state-of-the-art knowledge and techniques.

(1) Physical Damage Estimation

Based on the amount of damage obtained from the seismic risk assessment, the physical damages are estimated. Items of concern such as damage to buildings, peoples and lifeline structures will be arranged according to condition of disaster occurrence.

(2) Social and Economic Loss Estimation

As a consequence of the physical damage estimation, social and economic loss is estimated. The loss is evaluated by the reduction in General Domestic Product (GDP) consisting of GDP reduction by losing productivity and that by losing consumers. The method employed is based on the one used in Central Disaster Prevention Council in Japan.

(3) Establishment of Earthquake Disaster Scenario

Using physical damage estimation and social and economic loss estimation, earthquake disaster scenario for UB city is established. Considering the probability of disaster occurrence, season and time will duly be determined. It is noted that some scenarios will be necessary according to the aspects of disaster.

(4) Comprehensive Earthquake Risk Maps

Based on the information obtained in this project, the comprehensive earthquake risk maps will be established. It is noted that the number of risk maps may be changed according to the amount of information displayed on the maps.

Followings are basic information shown on maps.

- Disaster risk: Seismic Hazard/Land Slide hazard/Fire Hazard
- Amount of Disaster: Injured and Dead/Collapsed Building/Burnt Building

Also some information necessary for disaster prevention and reduction, such as police stations, fire stations, refuges and evacuation routes are overlaid.

These maps are handled and displayed easily by ArcGIS software.

(5) Flowchart of Establishment of Disaster Scenario

The flowchart of each item in this chapter and relationship with other investigations are illustrated in Figure 6.1.1.

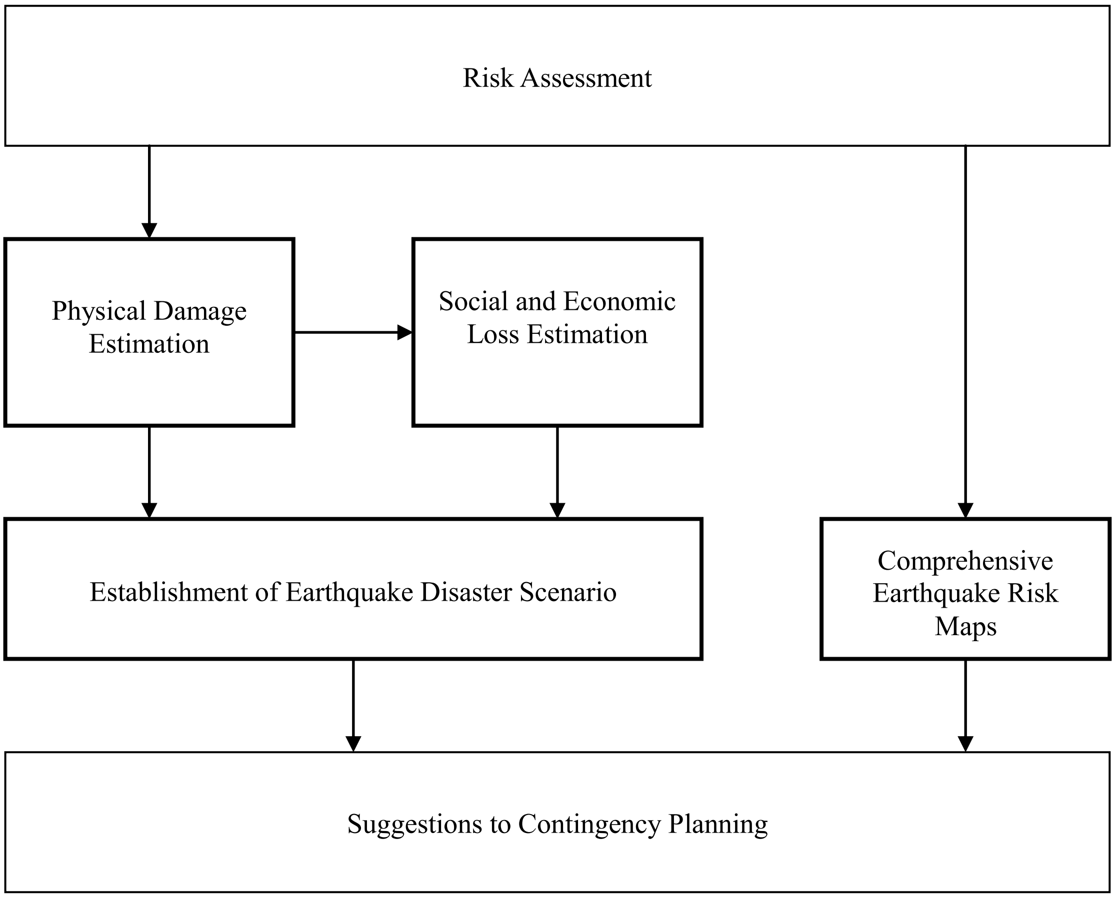


Figure 6.1.1 Flowchart of establishing earthquake disaster scenario

6.2 Physical Damage Estimation

6.2.1 Damage to Buildings

The number of collapsed buildings are evaluated for residential buildings, commercial buildings and industry buildings to examine the human safety. On the other hand, disaster base buildings such as government buildings, police stations and fire stations, and refuge buildings such as schools may be estimated individually to examine their availability just after earthquake.

6.2.2 Damage to Human

Human damage is evaluated as a product of damage rate and population within a building. Damage rate is given according to the situation of building damage. On the other hand, population in buildings are estimated from the total building floor area that is a product of building area and the number of story, and UB city's population.

It is noted that the population in the building may change according to the time of earthquake occurrence.

6.2.3 Damage to Infra-structures

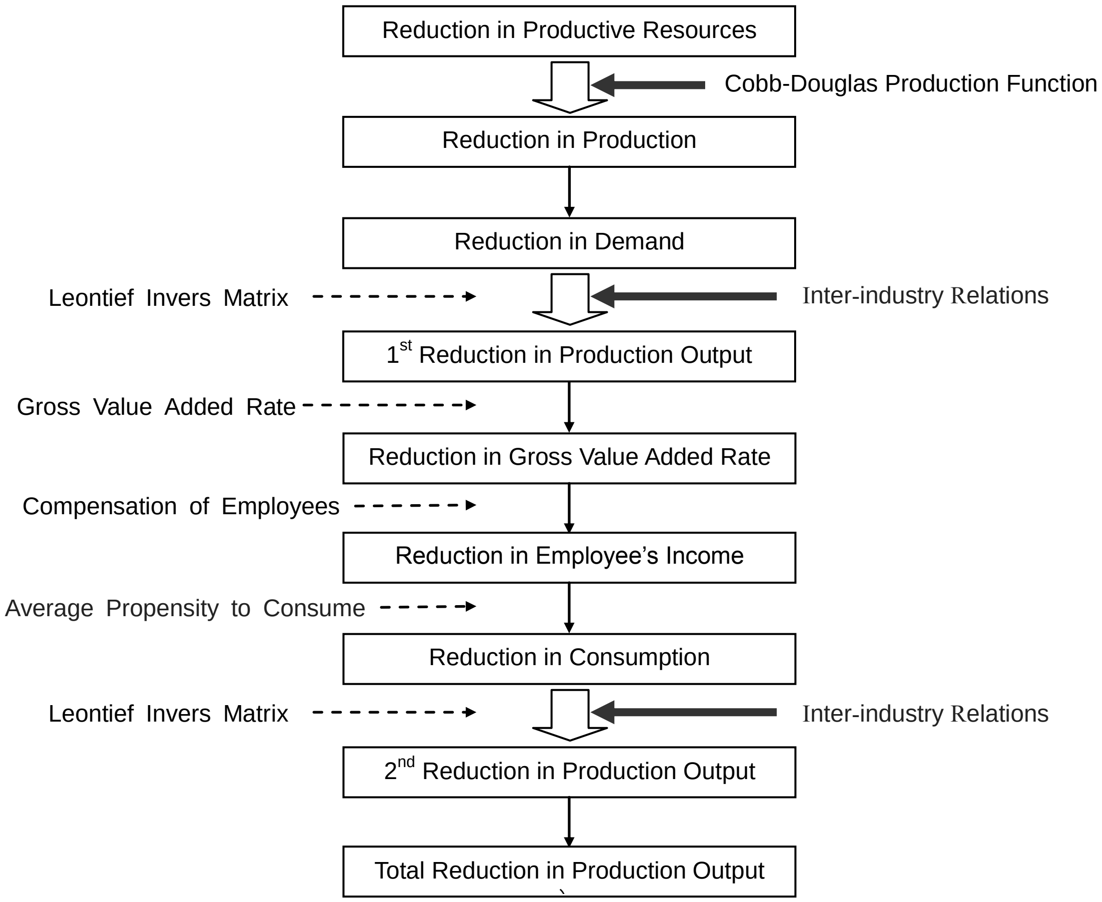
Bridges are evaluated about their availability after earthquake considering the magnitude correlation of strength and ground motion intensity for each scenario earthquake.

For structures forming network such as roads, electricity, water supply and sewage, the damages to them are evaluated mesh by mesh, so that the results can be used to grasp the area where given services are not available.

6.3 Social and Economic Loss Estimate

6.3.1 Method to Estimate Social and Economic Loss Estimation

Method used in Central Disaster Prevention Council in Japan is employed illustrated in Figure 6.3.1, in order to estimate social and economic loss.



Ref: JICA Project Team

Figure 6.3.1 Flowchart to estimate the reduction in GDP

(1) Reduction in Final Demand at Disaster Site

Reduction in final demand at a disaster site is assumed to be equals to reduction in the production at the site reduction in the production ΔGDP is estimated using the following equation.

$$\Delta GDP = GDP_0 - GDP_1 = \left(1 - \frac{GDP_1}{GDP_0}\right) GDP_0 \quad (6.3\text{-}1)$$

where, GDP_0 is a production in the ordinary time and GDP_1 is a production after earthquake. Assuming local product is estimated by Cobb-Douglas production function; $Y = A \cdot K^{\alpha} \cdot L^{1-\alpha}$, then,

$$\begin{aligned}\Delta GDP &= \left(1 - \frac{A \cdot K_1{}^{\alpha} \cdot L_1{}^{1-\alpha}}{A \cdot K_0{}^{\alpha} \cdot L_0{}^{1-\alpha}}\right) GDP_0 \\ &= \left[1 - \left(1 - \frac{k}{K_0}\right)^{\alpha} \cdot \left(1 - \frac{l}{L_0}\right)^{1-\alpha}\right] GDP_0 \end{aligned} \quad (6.3\text{-}2)$$

where, K_0 and K_1 are capital stock in ordinary time and that after earthquake, L_0 and L_1 are labor input in ordinary time and that after earthquake. A and α are the parameters. k and l are the reductions in K_0 and L_0, namely, it can be concluded that reduction rates are the important parameter to estimate ΔGDP.

(2) Reduction Rates of Capital Stock and Labor Input
Reduction rate for capital stock is estimated from the damage rate of buildings just after earthquakes. Also, reduction rate on labor input is estimated from the number of collapsed residential building.

(3) Reduction in Production (1st Spread of Effect)
Let reduction in final demand of each industry be $\Delta F = \Delta GDP$, and let $\mathbf{\Delta F}_1$ be a vector consisting of ΔF. This is the first step of spread of effect, as $\mathbf{\Delta X}_1(1) = \mathbf{\Delta F}_1 \ (= \mathbf{\Delta GDP})$. Next, Production $\mathbf{\Delta X}_1(2)$ necessary for $\mathbf{\Delta X}_1(1)$ stops. $\mathbf{\Delta X}_1(2)$ is obtained by the following formula.

$$\mathbf{\Delta X}_1(2) = \mathbf{A} \cdot \mathbf{\Delta X}_1(1) = \mathbf{A} \cdot \mathbf{\Delta F}_1 \quad (6.3\text{-}3)$$

where, $\mathbf{A}$ is an input coefficient matrix obtained from input-output table, whose element a_{ij} is an amount of i^{th} product to produce j^{th} product by unity.

Further, Production $\mathbf{\Delta X}_1(3)$ necessary for $\mathbf{\Delta X}_1(2)$ stops.

$$\mathbf{\Delta X}_1(3) = \mathbf{A} \cdot \mathbf{\Delta X}_1(2) = \mathbf{A}^2 \cdot \mathbf{\Delta F}_1 \quad (6.3\text{-}4)$$

The same spread is repeated, and the final reduction in production $\mathbf{\Delta X}_1$ is obtained from the following formula.

$$\mathbf{\Delta X}_1 = \mathbf{\Delta F}_1 + \mathbf{A} \cdot \mathbf{\Delta F}_1 + \mathbf{A}^2 \cdot \mathbf{\Delta F}_1 + \cdots = (\mathbf{I} - \mathbf{A})^{-1} \cdot \mathbf{\Delta F}_1 \quad (6.3\text{-}5)$$

where, $(\mathbf{I} - \mathbf{A})^{-1}$ is called Leontief invers matric and $\mathbf{I}$ is a unit matrix.

(4) Reduction in Production (2nd Spread of Effect)
As shown in Figure 6.3.1, reduction in production due to the reduction in income is called 2nd spread of effect. Let reduction in consumption be $\mathbf{\Delta F}_2$, then $\mathbf{\Delta F}_2$ is obtained by the following formula.

$$\mathbf{\Delta F}_2 = \mathbf{f}_1 \cdot \mathbf{f}_2 \cdot \mathbf{f}_3 \cdot \mathbf{\Delta X}_1 \quad (6.3\text{-}6)$$

where, $\mathbf{f}_1$ is a coefficient to express reduction in gross value added and derived from input-output table. $\mathbf{f}_2$ is a coefficient to express reduction in employees' income and also derived from input-output table. $\mathbf{f}_3$ is a coefficient to express an average propensity to consume.

As same as in case of 1st spread of effect, the final reduction in production $\mathbf{\Delta X}_2$ of 2nd spread of effect is obtained with the following formula.

$$\mathbf{\Delta X}_2 = (\mathbf{I} - \mathbf{A})^{-1} \cdot \mathbf{\Delta F}_2 \quad (6.3\text{-}7)$$

6.4 Method and Result of the Estimation of Debris

6.4.1 Method of the Estimation of Debris

Based on the typical 4 stories office building or apartment houses in UB city, Estimation method was calculated.

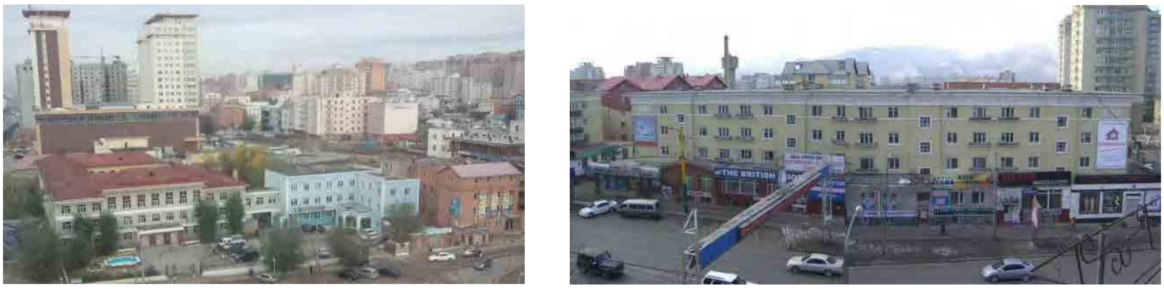


Figure 6.4.1 Typical 4 stories buildings in UB city

Amount of Debris is calculated based on the volume of wall, floor and roof of buildings made of masonry or reinforced concrete column and beam with brick wall structures.

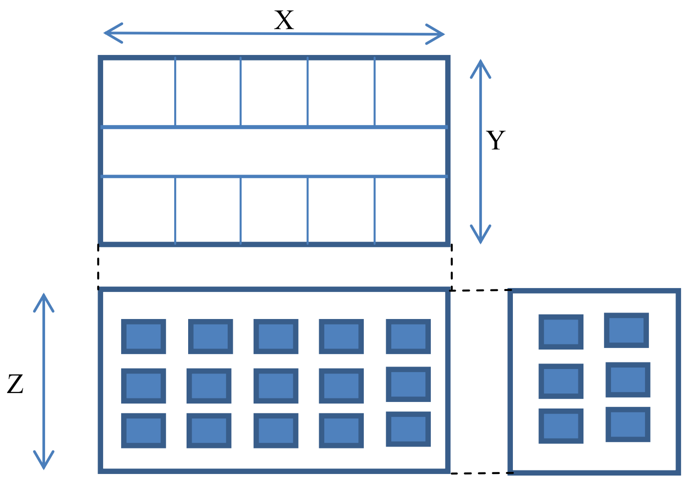


Figure 6.4.2 Model building for debris estimation

6.4.2 Assumption for estimation

- ✓ Inner corridor path through in case of office building and 3 houses units have one doorway in apartment building
- ✓ Debris estimation is calculated per unit length as same layout is repeated in long side building.
- ✓ 3.6m x 3.6m is standard one room size in office or apartment building.
- ✓ Outer wall thickness is 0.6m, inner wall thickness is 0.4m, average thickness is 0.5m
- ✓ Open area of wall is based on window as 1.8m x 1.8m per one room
- ✓ Floor height is 3m

- Wall area per one floor
  - Number of wall
  - ✓ Number of walls is 4 in long side building
  - ✓ Number of walls is X/3.6+1 (X is length of short side building) assuming one room length is 3.6m
- Wall area ratio after subtracted open area of wall

- ✓ Wall area is wall area(height 3m x width 3.6m) – open area of wall(height 1.8m x width 1.8m) = （3x3.6-1.8x1.8）/3x3.6 = 0.7
- ● Volume of wall considering open area of wall
  - ✓ Volume of long side wall＝4walls×length Xｍ×floor height 3m×wall ratio0.7×width 0.5m=4.2Xm^3
  - ✓ Volume of short side wall =number of walls (X/3.6+1)×length Ym×floor height 3m×wall ratio 0.7×width 0.5m＝0.29X＋1.05）Ym^3
- ● Floor area
- ● Floor volume
  - ✓ Assume floor depth is 0.1m, then area of floor per floor is 0.1XY
  - ✓ Number of floors is Z/3 (Z is height of building)
  - ✓ Volume of total floor is 1/30XYZm^3
  - ✓ Roof thickness is 0.2XY assuming thickness of roof is 0.2m
- ● Estimation of debris for one building
  - ✓ Long side length is X m, short side length is Y m, height is Z m
  - ✓ Volume of Wall＝4.2X×Z/3m^3＋(0.29X＋1.05)Y×Z/3＋1/30XYZm^3＋0.2XY m^3
    ＝(4.2/3)XZ＋（1.05/3)YZ＋（0.2）XY＋（0.29/3＋1/30）XYZ
    ＝1.2XZ＋0.3YZ＋0.2XY＋0.13XYZ

6.4.3 Example estimation

- ✓ X=40m, Y=12, Z=9
- ✓ Volume of debris
  ＝1.2×40×9＋0.3×12×9＋0.2×40×12＋0.13×40×12×9＝1120 m^3
- ✓ As the volume of building itself is 4320 m3, as the debris height will be 26% of building volume. In other ward, height of debris is reduced to 26% and after earthquake ruined building height is still 1/4 height of building before collapse.

6.4.4 Total volume of debris in UB city

- ✓ Total volume is estimated assuming average height is 3.4m in office buildings and 3.0m in residential buildings
- ✓ Total debris (m^3) ＝Floor area ×number of floor×0.25×3.2（average height per floor）

6.4.5 Result of estimation

Estimation is done using the result of damage estimation of UB city building. Collapse and severe damage buildings will be source of debris.

(1) Result of estimation

Estimation result is shown in Table 6.4.1.

Table 6.4.1 Estimation result of debris (m^3)

Name of district	Building area x floor height	Total debris
Baganuur	-	
Bagahangai	-	
Bayangol	2987351	2389881
Bayanzurh	3378844	2703075
Nalaih	1226	980.8
Songinohairhan	3219103	2575282
Suhbaatar	1570847	1256678
Hun Uur	2191497	1753198
Chingeltei	1836012	1468810
UB city Total	15184880	12147904

(2) Abstract of Debris

Main source of debris are masonry and reinforced concrete column and beam with brick wall. Volume of debris is estimated as building floor area x number of floor x 0.8 (m^3) and total volume from UB city will be 1214 m^3. If debris will be reclaimed, 243mirion 10ton trucks are needed to carry the debris to reclamation place.

6.5 Manual for Earthquake Disaster Information System [Simple Viewer]

(1) About Simple Viewer

Simple Viewer is an add-on tool on which data is displayed in a menu style on ArcGIS.
It can be displayed by data in switching on and switching off a check box.

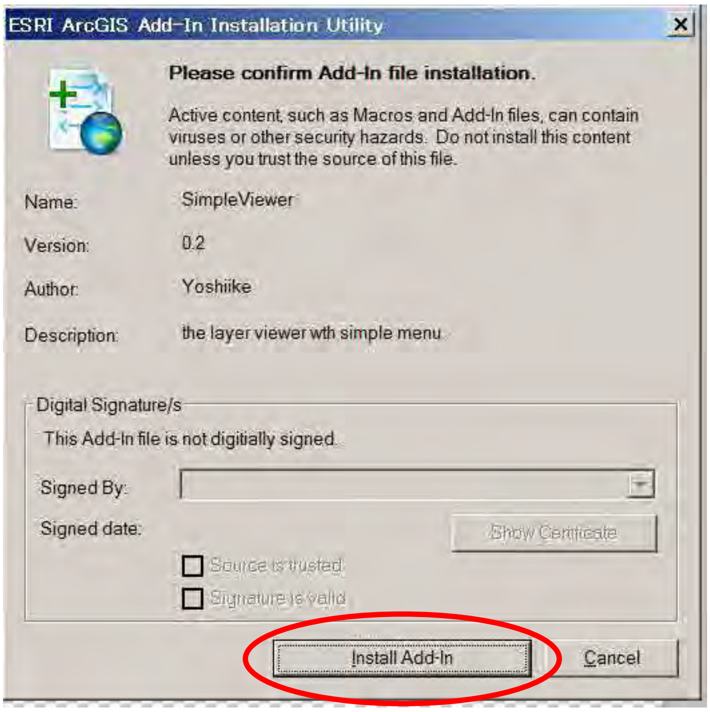
(2) Setup

A database "UB_Seismic_Hazard_Information_Database" is copied to *D* Drive the whole folder.
The "SimpleViewer" folder is copied to the "My Document" folder of C drive.

(3) Installation

・"SimpleViewer.esriAddIn" in the folder of "SimpleViewer" is double-clicked.

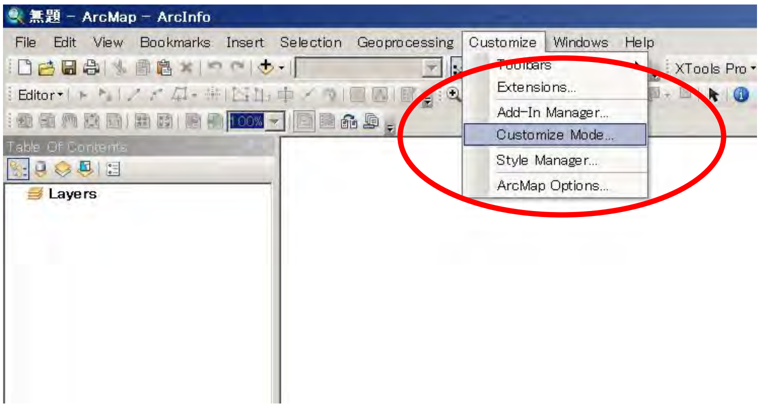
・Push the "Install Add-In" button.



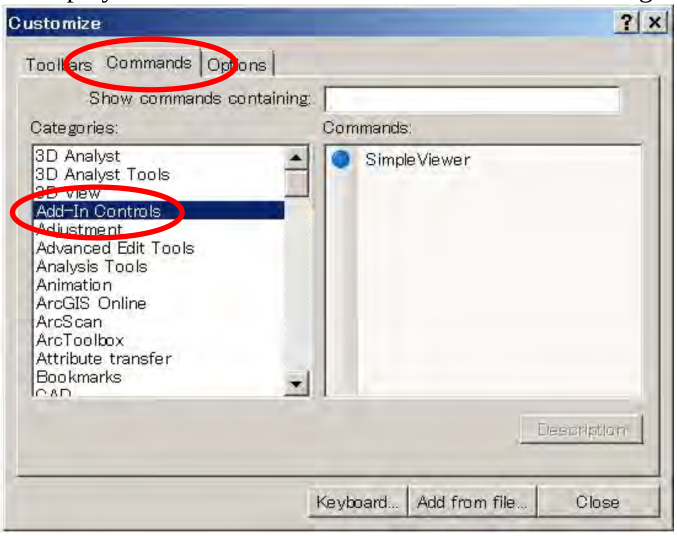
・A success of installation of the following screens. The "OK" button is pushed.

・Start ArcGIS.

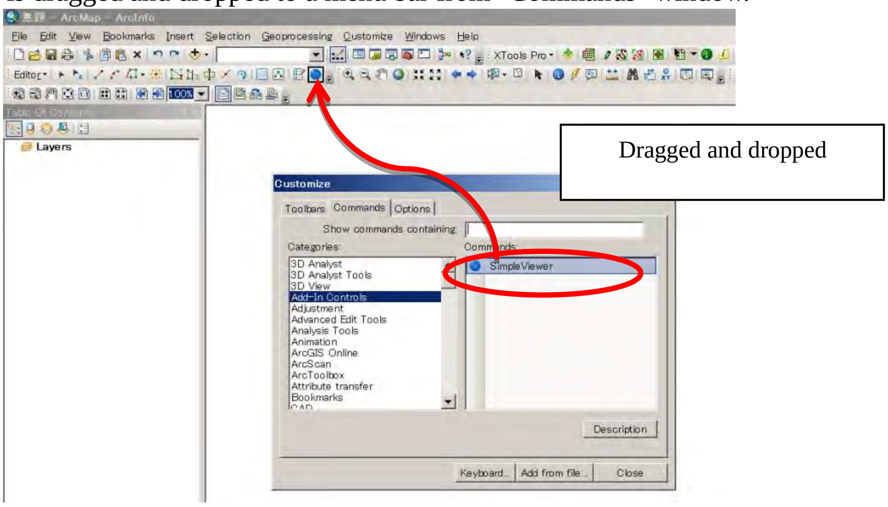
The "Customize Mode" in "Customize" of a menu is clicked. A "Customize" window opens.



・A "Commands" tab is displayed and "Add-In controls" is chosen from "Categories".

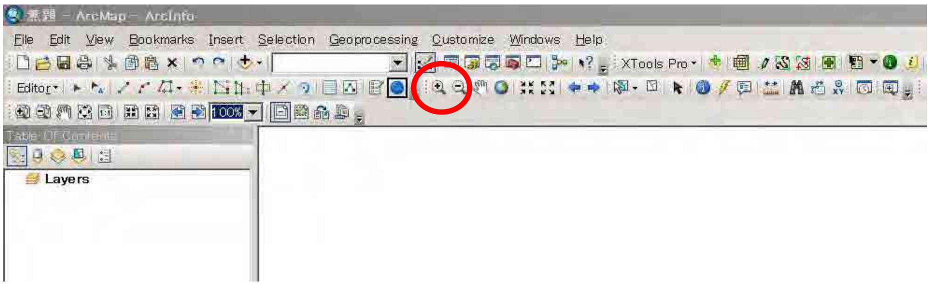


・"SimpleViewer" is dragged and dropped to a menu bar from "Commands" window.

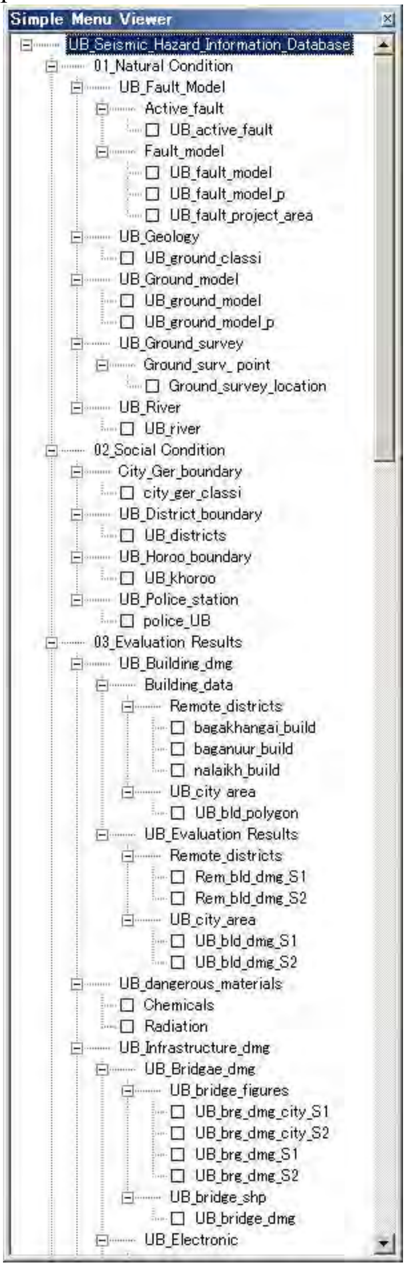


(4) How to use

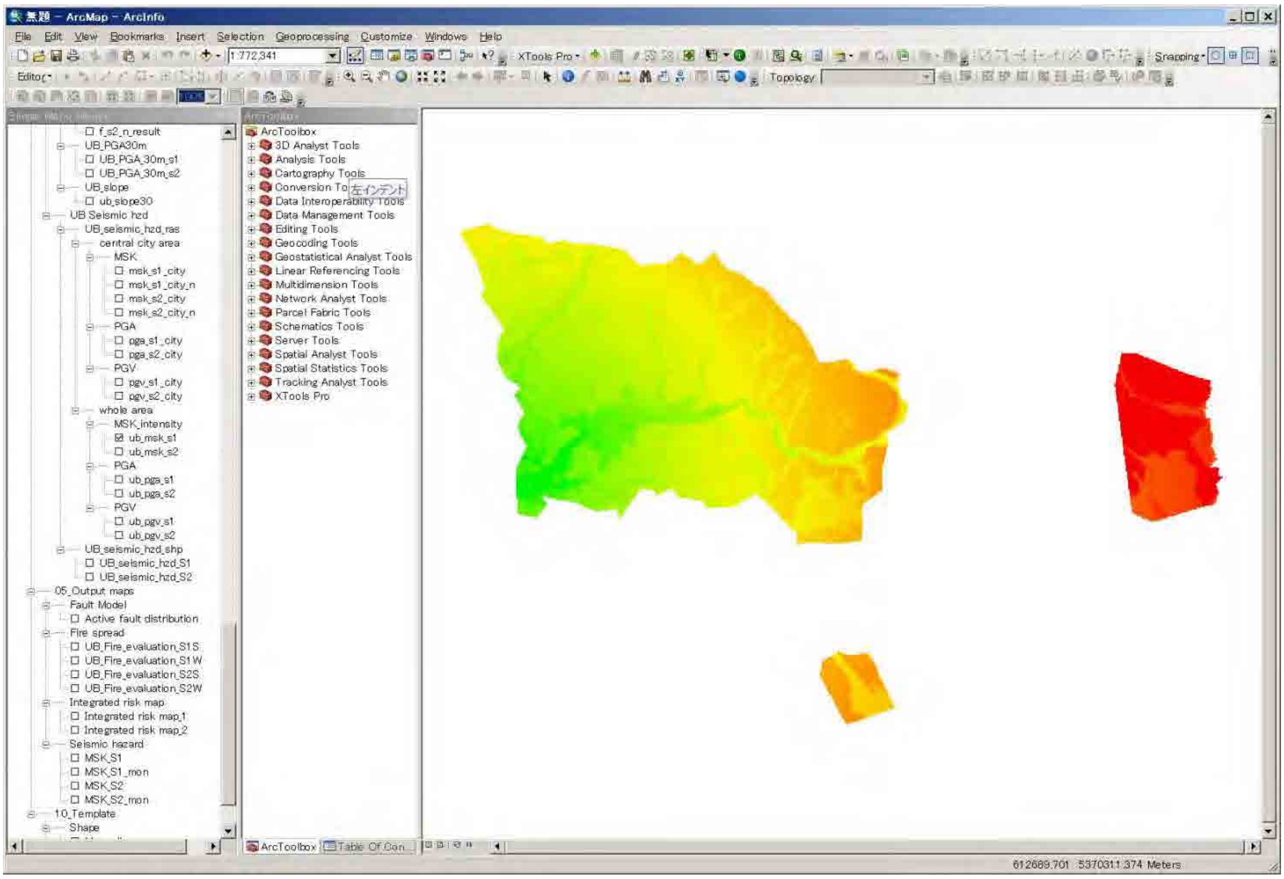
・The button of "SimpleViewer" in a menu bar is clicked. “SimpleViewer” is started.



・The box of "SimpleViewer" is opened.



・The box of "SimpleViewer" is opened. A check is put into the data to display. Data is displayed.

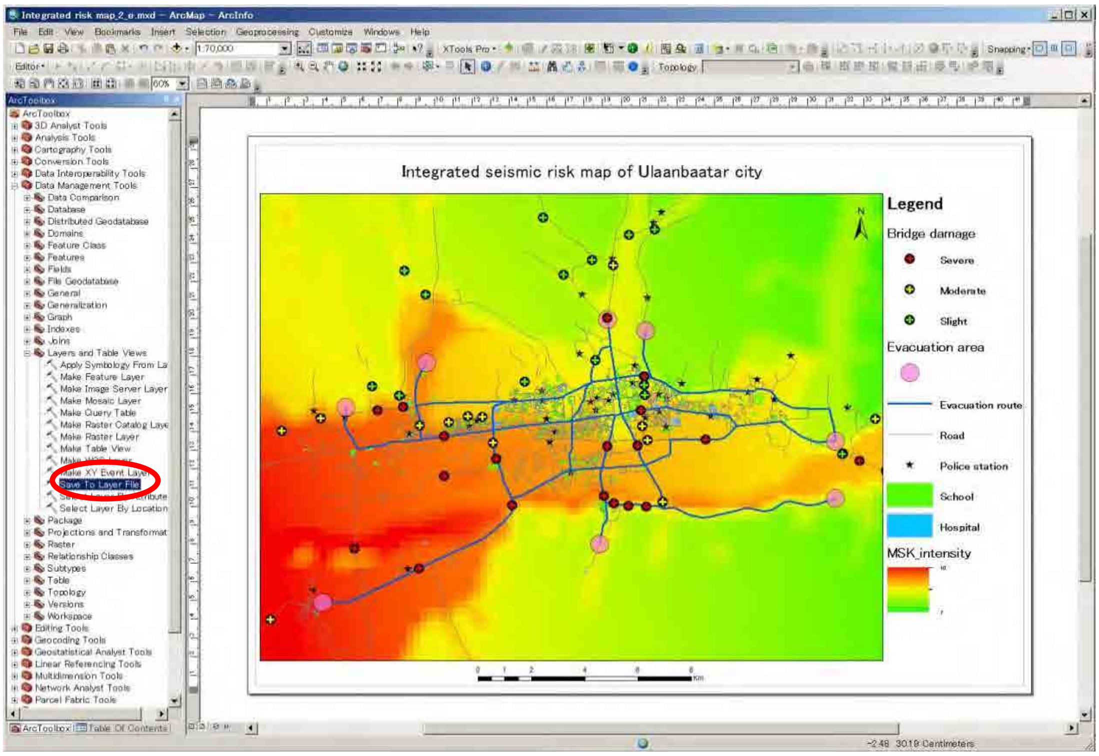


(5) How to make layer file

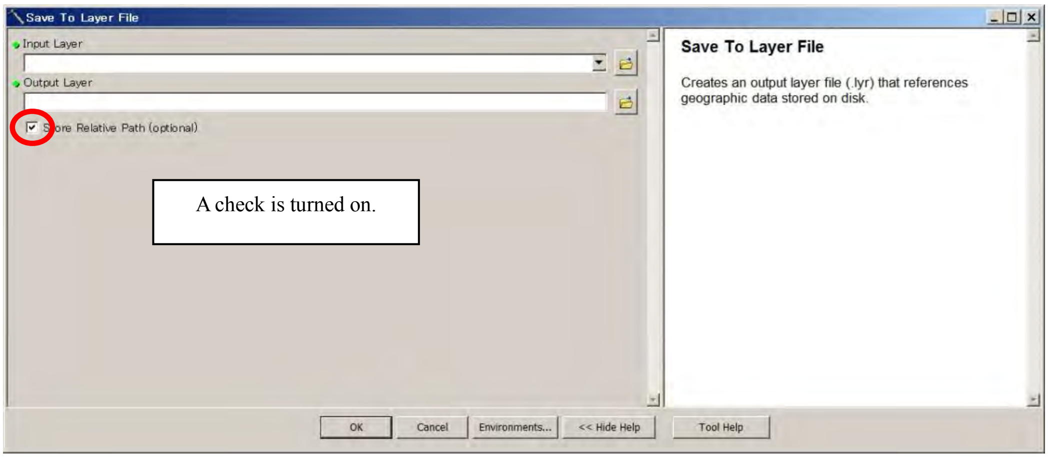
Simple Viewer is controlled by the layer file. When data is added, a layer file is created newly. A layer file is updated when data is corrected.

The creation method of a layer file

“Arc Toolbox” → “Layers and Table Views” → “Save To Layer File” is clicked.



Input Layer and Output Layer are chosen, a check is put into Store Relative Path, and OK is clicked.



※ A layer file is putting into the ssame folder as a shape file.
It is displayed now on Simple Viewer.

(6) xml file

A xml file (SimpleViewer-NoMenu.xml) can be rewritten using an editor etc.

The work folder in a default is "D:¥UB_Seismic_Hazard_Information_Database."
This description is rewritten when changing a work folder.

```
<?xml version="1.0" encoding="utf-8"?>
<?xml-stylesheet type="text/xsl" href="SimpleViewer.xsl"?>
<simpleviewer
       xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
       xsi:noNamespaceSchemaLocation="SimpleViewer.xsd">

    <title>Simple Menu Viewer</title>
    <datafolder>D:¥UB_Seismic_Hazard_Information_Database</datafolder>

</simpleviewer>
```

Chapter 7 State of Seismic Disaster Risk Management Plan and its subjects

7.1 Approach for the state and its subjects

Following 4 approaches are taken to grasping state of Seismic Disaster Risk Management Plan and its subjects

- ✓ Analysis of the present Seismic Disaster Risk Management Plan
- ✓ Analysis of the disaster awareness survey
- ✓ Analysis of the earthquake scenario based on the earthquake risk of UB city
- ✓ Comments of Working Group 2 referring above analysis

7.1.1 Grasp of coverage of the Plan

Present Seismic Risk Management Plan for UB city was drew up based on the Earthquake Disaster National Capacity Strengthening Plan which was authorized on 30th of March, 2011 made by National Security Council. Issues to be taken in seismic risk management plan are indicated in the national plan and the seismic risk management plan for UB city are drew according to this instruction. The Seismic Risk Management Plan for UB city was just started and is in the cradle period as the Earthquake Disaster National Capacity Strengthening Plan was authorized in 2011 and UB plan was draw after that. The Seismic Risk Management Plan for UB is reviewed in March of every year periodically and reviewed in March 2013.

In this review procedure, new information and knowledge learned from the training Course in Japan and proposed ideas from our project team are introduced into reviewed 2013 year's Seismic Risk Management Plan for UB city. The Plan of UB city has three components, disaster prevention and preparedness plan, counterplan for disaster response and disaster recovery plan. Confirmation of coverage of the Plan was done as Table 7.1.1 indicates the coverage of the plan. The raw and column in this table respond to each plan.

Table 7.1.1 Coverage of National and UB city plan

Disaster Phase			1)Prevention	2)Reduction	3)Warning	4)Damage Evaluation	5)Emergency Response	6)Recovery	7)Reconstruction
Self Help		Hard							
		Soft							
Mutual Help		Hard							
		Soft							
ublic He	UB City	Hard							
		Soft							
	National	Hard							
		Soft							

"Disaster Prevention" (counterplan for prevent the occurrence of disaster damage) and "Damage Mitigation" (counterplan for reduce the disaster damage, or to prevent to expand the disaster damage and secondary damage) are major field of the national plan and some are disaster warning and disaster response. In UB city plan, major field of the plan are "Hard" (Infrastructures or equipment) counterplan from emergency respond to recovery and a few are in disaster prevention and mitigation field. Both of national and UB city plan are mainly putting force to "Hard" counter plan. The plan for enforcing citizens and community (including private sectors) counterplan are few which recently considered important issue in Japan.

7.1.2 The subjects from analysis of Present Seismic Risk Management Plan for UB city

- ✓ Wide-ranging countermeasures are covered in the Plan. These are mainly the countermeasures which are responsible to implement by Emergency response section of UB city.
- ✓ The target of disaster reduction (how much damage will be reduced by implement the plan), the role of stakeholder, issued to be taken and its action plan are not clearly described.

- ✓ Grouping of countermeasures by the related departments or bureaus is recommended to clarify of responsible section in charge. Each departments or bureaus are recommended action plans according to the Seismic Risk Management Plan for UB city.

7.1.3 The subjects from analysis of the disaster awareness survey

Following are the subjects from analysis of the disaster awareness survey

- ✓ Earthquake is very uncommon for UB Citizens and most peoples have not experienced big earthquake. Evacuation, firefighting, living after disaster is all out of expectation. Therefore Proper action can not to be expected to be taken by citizens. Education and Awareness of fundamental earthquake disaster are needed to be done not only for citizens but also private sectors and governmental staff.
- ✓ UB city people consider that school may be collapsed from the result of questionnaire that slight damage is 46% and severe damage is 42%. Therefore many people anxious school buildings and demand to strengthening of school buildings is high. Promotion of strengthening of school buildings is highly needed.

7.1.4 Analysis of the earthquake scenario based on the earthquake risk of UB city

The earthquake scenario was made based on the earthquake risk of UB city. Following are the subjects come out from the analysis.

- ✓ Considerable building damage may occur. Emergency response capacity may deteriorate by suffering damage on important facilities such as governments, schools, hospitals
- ✓ There is risk of fire damage in Ger area.
- ✓ Break of roads which are especially important for emergency response activities because of bridge damage by earthquake.
- ✓ Function loss of lifeline facilities is expected. Lack of water for firefighting, lack of information communication functions and etc. may cause difficulties of emergency response.

7.1.5 Comments of Working Group 2 referring above analysis

Following comments are come out from member of the working group 2.

(a) Subject when earthquake occurs in UB city

Two points are mentioned when earthquake occurs in UB city.

- ➢ Buildings collapse by insufficient seismic capability.
- ➢ Proper action can not to be expected to be taken by citizens because of lack of experience of earthquake.

(b) Subjects occur following points mentioned above

Two points are mentioned when earthquake occurs in UB city.

- ➢ Related lack of seismic insufficiency
  - ➢ High risk of collapse of old buildings
  - ➢ High risk of suffering damage on important facilities such as governments, schools, hospitals
  - ➢ High risk of suffering damage on schools, kindergartens
- ➢ Related to lack of experience of earthquake
  - ➢ People do not know where be evacuated
  - ➢ People might be thrown into confusion with anxiety

(c) Comments for the countermeasures and present situations

Following comments come out related to the countermeasures and present situations

- ✓ Comments for the seismic countermeasures of building

- Old buildings reconstruction is now promoted by urban redevelopment project according the master-plan for 2020.
- 7 urban redevelopment projects are now promoted in Ger area.
- Urban rearrangement in Ger area is planned but not yet started.
- 80 old school buildings constructed before 1989 reconstruction plan is now going and some school are under construction.

(d) Relation of the countermeasures of strengthening Urban structure and UB city Master plan

- Risk management view point is not explicitly described in Urban Master Plan for 2020 and 2030.
- Renovation plan of old buildings is in the Master Plan
- Road plan is mainly aiming sort out traffic jam and not clear from risk management view point.
- There is the plan to set 8 sub city centers to disperse urban function. This is effective from risk management view point.
- Urban development of UB city has been expanded toward west direction. But according the result of the academy of science research result, urban development of UB city is now toward east direction.
- There are two approaches for renewal of Ger area. One is to construct public apartment buildings near developed area of UB city. The other is to make plan of outer Ger area according to the Land Use Plan made by national government.

(e) Disaster Information System

- Importance of disaster information transmission is fully understood.
- Speaker system exists but system is old. Present operation situation is very low.
- Problem of information system between disaster response organizations not only information transmission to residents.
- Disaster information center is started recently in NEMA.
- Same frequency wireless system between emergency management agency and police department.
- Information transmission network system using telephone as same as Japan may effective in Mongolia.

(f) Experts of disaster management

- Very few expert of earthquake disaster exist in Mongolia.
- Staffs of emergency management agency are trained through training and lectures.

(g) Present disaster management system

- There is criterion of emergency assembly in present disaster management system, but it is not based on MSK scale.
- Priority of facilities is decided if accidents or disasters occur same time. Power plants, Chemical plans, Government offices (there is priority list among these) are first priority and schools and hospitals are followed.
- Each officials are requested to prepare pack of 3 days goods (hand light, compass etc.) as the stock against emergency for emergency response officials.

(h) Comments by Working Group Leader related the draft of recommendation of earthquake disaster management plan

- Earthquake disaster management plan is not only government but also citizens and private sectors. Therefore plan must be written in each standing points.
- Earthquake disaster management plan is to be opened for public because citizens and private sectors are also stakeholder of the earthquake disaster management.
- Proposal from JICA team will be incorporate into the earthquake disaster management plan of UB city. And it is not necessary to wait until annual review period.

Above subjects are summarized in Table 7.1.2

Table 7.1.2 Earthquake Disaster Management Plan and its Subjects

State		
	Effort of Earthquake Disaster Management	It is highly laudable that the emergency countermeasures progressed tremendously since national earthquake disaster management policy started recently
	Drawing of Earthquake Disaster Management Plan	It is highly laudable that plan was started in 2010 and revised every year periodically.
	Items of Earthquake Disaster Management Plan	Items of countermeasures are widely covered of disaster management.
Subjects		
	Subjects from Earthquake Disaster Management Plan	Object of Plan become more clear by describe the target of disaster reduction (how much damage will be reduce by implement of countermeasures)
		Countermeasures done by residents and private sectors will be included more.
		Practical and concrete method is useful for actual implementation of countermeasures.
		Grouping of countermeasures by implementation bureaus and departments is necessary to grasp contents of the Plan.
	Subjects from the disaster awareness survey	Proper action can not to be expected to be taken by citizens because of lack of experience of earthquake.
		Many people anxious school buildings safety.
	Subjects from earthquake risk in UB city	Building damage is expected by earthquake.
		Disaster response activities becomes difficulty if important facilities suffer damages
		There are high risk of fire breakout and expand of fire to other houses in Ger area.
		Bridge damage is expected and important roads for emergency response activities will not able to use.
		Suspension of fire water supply because of water pipe will be broken.
		Information collection may become power failure.
		Winter life becomes difficult if hot water system suspension.
	Comments of working group 2	Insufficient seismic capacity of old buildings Reconstruction of old apartments is started. Redevelopment of Ger area also started. Sub center plan is undergoing
		Much comments about (Earthquake) disaster consideration in Urban Master Plan of UB city of 2030 Practically many issued written in Master Plan are quite effective for disaster management.

		Lack of experience of earthquake. Need of citizen's disaster education Prepare Information transmission system to citizens
		Trainer's Training for emergency management agency staff as experts of disaster management
		stakeholders of the Plan as government, residents and private sectors
		Earthquake disaster management plan is to be opened for public
		Revision of the earthquake disaster management plan will be done as soon as possible.

7.2 Disaster awareness survey for residents for clarify UB city Earthquake Disaster Management Plan

7.2.1 Implementation of disaster awareness survey

It is basic information to prepare the Earthquake Disaster Risk Management Plan to grasp the knowledge of earthquake disaster and the preparedness. The questionnaire survey is implemented for citizens of Ger area and for citizens of the developed area to grasp the awareness for the earthquake disaster, risk preparedness, existing problems and needs and to use as the baseline of policy implementation evaluation.

This survey was implemented as following schedule.

2012. April Design of Questionnaire sheet
2012. April Pre-survey in MOST
2012. June Modification of Questionnaire
2012. July Implement for Ger area, Delivered 100 sheets and Collected 82 sheets
2012. September Implement for Developed area, Delivered 150 sheets and Collected 133 sheets
2012. December Implement for UB city Officials, Delivered 50 sheets and Collected 32 sheets
2012. December Implement for EMDC Officials, Collected 38 sheets
2012. December Implement for NEMA Officials, Collected 32 sheets

Questionnaries and the summary of the result of survey are shown in Chapter 4 of Databook.

7.2.2 Subjects come clear from survey and needed actions against those subjects

Table 7.2.1 Earthquake Disaster Management Plan and its Subjects

Items	Subject come clear	Comments	Acton to be needed
Experience of Earthquake	- Earthquake is very uncommon for UB Citizens. - Most peoples have not experienced big earthquake	- Evacuation, firefighting, living after disaster is all out of expectation. - Proper action can not to be expected.	- Education and Awareness of fundamental earthquake disaster are needed to be done not only for citizens but also private sectors and governmental staff.
Knowledge of Earthquake	-57% of Ger residents, 18% of apartment residents, 5% of government officials do not have the knowledge of earthquake. - TV, newspaper is main souse of knowledge in the apartment residents	- Some deference is recognized depend on area of living in UB city. - Need of education of earthquake for Ger residents	- Education and awareness of earthquake is highly needed. - It is suitable to take leadership by government officials.
Occurrence of Earthquake	- 60% of the Ger residents answered that earthquake may not occur in UB city.	- Recognition of earthquake occurrence is low in Ger residents and apartment	- Education and awareness about hazard risk is highly needed.

in UB city	- 20% of the apartment residents answered that earthquake may not occur in UB city.	residents。	
Damage of House	- No damage 11%, slight damage 58%, severe damage 23% for apartment residents, - No damage 12%, slight damage 47%, severe damage 33% for government officials. - 46% suffer damage in Ger residents. - Place to live for questionnaire of difficulty after earthquake is highest in Ger residents.	- Damage of houses is highly concerned issue in both Ger and apartment residents. - On the other hand, 70% apartment residents answered their house may get no damage or slight damage. - Public assistant and relocate much strong building	- Contents of public awareness for apartment residents may renew correspondent to the result of Earthquake Hazard. - Seismic assessment, retrofit, urban planning for disaster proof city will be needed
School Buildings	-Many people consider that school building will be collapse. 46% slight damage, 42% severe damage	- Many people anxious school buildings and demand to strengthening of school buildings is high.	- Promotion of strengthening of school buildings is highly needed.
Difficulty after earthquake	- "Rescue from collapsed building"," Electricity and water supply loss" in the apartment residents. - "Rescue from collapsed building", "Firefighting", "Relief Materials" in Ger residents -lack of information is not recognized as difficulty.	- Strong fear for public assistant after earthquake. Fear of supply of Lifeline, is recognized. -Difficulty of Information after earthquake is less conscious.	- Strengthening of Search and Rescue system for earthquake. - Strengthening Emergency Road and Hydrants system Need of urban planning for earthquake disaster to make UB city strengthening against earthquake disaster. - awareness of importance of information and development of information infrastructure are needed
Activities during earthquake	- Most residents will go out from house and /or stay in garden.		- Education of action during earthquake is needed.
Activities after earthquake	- Most residents answer to try to help others. - Stay in garden or clean house are higher in the apartments residents.		
Response to the fire	- 67% people make fire call when fire break out and only 17% fight to fire in Ger area. - Both fire call and firefighting activity are taken in the apartment residents. - firefighting activity is 57% in government officials	- People react as same as normal time fire. Many government officials fight fire. - Few people fight fire	- Educate the earthquake fire such as simultaneous multiple fire occurrence and wide spread of fire - Initial firefighting by community needed to train.
The place if their house collapse	- When houses were collapsed about 40% of residents will go their relative's houses both in the apartment residents and Ger residents.	-It might be reason that half of population live in UB city that 40% of people answer to go to relative' house.	- Need to evacuate to school may reduce because of many people evacuate to relative's house
Preparedness against earthquake	Prepare stock for emergency is low. Drinking water 12%, food 5. In Ger area, water 9%, food 0%	- Water, food stock is low. in Ger area,	- Stock of water, food for earthquake needs to be promoted to people. Importance of houses to be made seismic resistance is needed to be promoted. Awareness of damage of houses by earthquake.

Participation to the disaster drill	- Are there some reasons that many people have relatives in UB city? Relatives might also suffer damages by earthquake.	- Drill was started recently and come active by the effort of national government and UB city government.	- Continuous practice to public is needed.
Information from government	Residents recognize booklets related disaster information or earthquake risk from government. - But government side recognizes not only these but also disaster drill, risk of buildings, action to be taken during earthquake. - There are some gap exist between residents and government.		
Request to government about earthquake disaster	- Disaster knowledge, risk of earthquake occurrence, high risk place in UB city is requested from citizens.	- Much wider information is needed to offer from government.	- Disaster knowledge, risk of earthquake occurrence, high risk place in UB city is needed to offer for public.
Community organizations	- Community organizations exist about 20% and not common in UB city. - Most common activity is to transfer information from government to residents. Second is cleaning of garbage	- Strengthening community organization activities in case of disaster is important if big disaster such as earthquake, it is difficult to manage completely by government. - Strengthening of Mutual cooperation in community level such as Search and rescue, mutual cooperation in evacuation or activities in evacuation place and disaster preparedness are highly needed.	- Importance of community activities in case of earthquake disaster should be educated. - Formation of community organization for disaster should be promoted. - Communities in Ger seem to establish already close relation with local government. It will be good base to promote good cooperation for earthquake disaster.

7.2.3 Subjects to be mentioned in Earthquake Disaster Management Plan

- Earthquake is very uncommon for UB Citizens and most peoples have not experienced big earthquake. Evacuation, firefighting, living after disaster is all out of expectation. Therefore Proper action can not to be expected to be taken by citizens. Education and Awareness of fundamental earthquake disaster are needed to be done not only for citizens but also private sectors and governmental staff.
- 57% of Ger residents do not have knowledge, it means education and awareness of earthquake is highly needed especially in Ger area. On the other hand government officials have much knowledge of earthquake. Therefore it is suitable to take leadership by government officials.
- UB city people consider their houses may suffer damage by earthquake from the result of questionnaire that 81% of (slight damage +severe damage) for apartment residents and 80% of (slight damage +severe damage) for government officials.
- UB city people consider that school may be collapsed from the result of questionnaire that slight damage is 46% and severe damage is 42%. Therefore many people anxious school buildings and demand to strengthening of school buildings is high. Promotion of strengthening of school buildings is highly needed.
- Lack of information is not recognized as difficulty. Difficulty of Information after earthquake is less conscious. Awareness of importance of information and development of information infrastructure are needed
- 67% people make fire call when fire break out and only 17% fight to fire in Ger area. People react as same as normal time fire. Few people fight fire. Education of the earthquake fire such as simultaneous

multiple fire occurrence and wide spread of fire is needed. Initial firefighting by community needed to train.

- When houses were collapsed about 40% of residents will go their relative's houses both in the apartment residents and Ger residents. It might be reason that half of population lives in UB city that 40% of people answer to go to relative' house. Need to evacuate to school may reduce because of many people evacuate to relative's house
- Disaster knowledge, risk of earthquake occurrence, high risk place in UB city is requested from citizens. Much wider information is needed to offer from government. Disaster knowledge, risk of earthquake occurrence, high risk place in UB city is needed to offer for public
- Community organizations exist about 20% and not common in UB city. Most common activity is to transfer information from government to residents. Strengthening community organization activities in case of disaster is important if big disaster such as earthquake, it is difficult to manage completely by government. Strengthening of Mutual cooperation in community level such as Search and rescue, mutual cooperation in evacuation or activities in evacuation place and disaster preparedness are highly needed. Importance of community activities in case of earthquake disaster should be educated.
- Formation of community organization for disaster should be promoted.

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Chapter 8 Disaster Information Distribution System

8.1 Current Situation of Disaster Information Distribution

The governments of Mongolia and UB city formulate the development plan of disaster information distribution system for the response of earthquake disaster. In this section, current situation of the disaster information distribution system is clarified as follows based on the development plan of early warning system made by the Information and Communications Infrastructure Development Project in Information, Communications Technology and Post Authority (ICTPA), and other hearing data from NEMA and EMDC.

(1) Current disaster distribution system is aged
The defense alarm system developed in UB city during 1970-80 is aged without maintenance and no spare parts, therefore the system is not working now.

(2) There is no specific channel of information exchange and sharing for disaster related organizations
Due to no specific channel between disaster related organizations such as NEMA, EMDC, RCAG, etc., emergency communication is insecure.

(3) Undeveloped legal system
Legal system for disaster information, implementing organization, investigation and check systems are not developed.

(4) Emergency information is not distributed immediately
Emergency information is distributed with document of telephone from NEMA and Mongolian Metrological Agency to Mass Media. Information value is abused with slowed transmission.

(5) Undeveloped emergency disaster information distribution tower
There is no emergency disaster information distribution tower in population concentrated UB city.

8.2 Development policy of disaster information distribution system

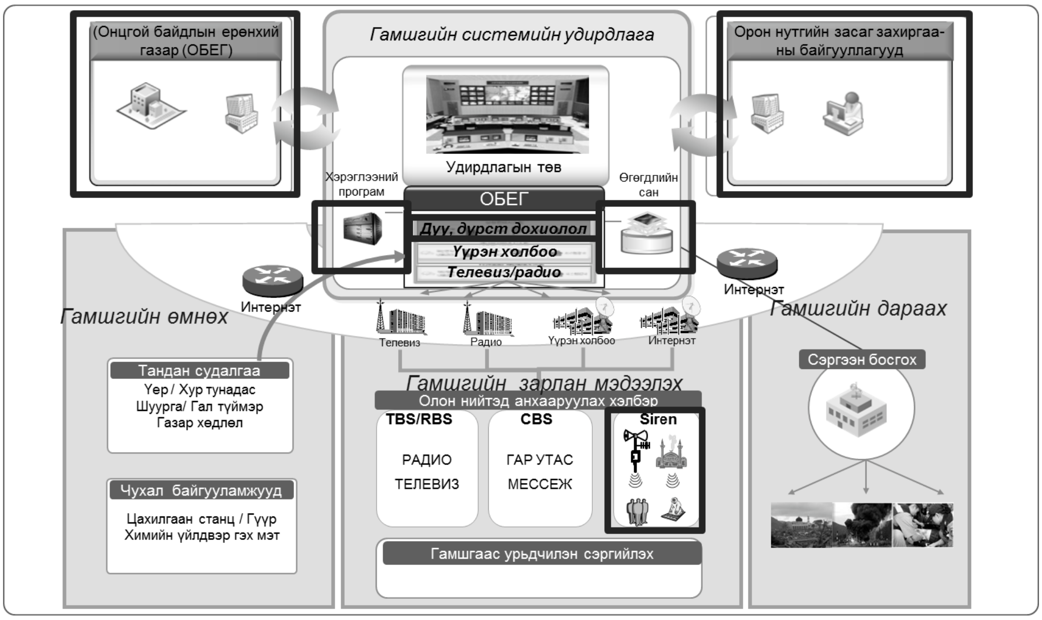
Based on the document of ICTPA, following two (2) objectives are set as the early warning system.

(1) National Alert System for earthquake disaster
(2) Development of Disaster Information Accumulation and Disaster Exchange System

Duration of project period is nine (9) months, and following four (4) items are expected to develop in this project.

(1) Establishment of Disaster Alert System Management Center
(2) Development of Emergency Disaster Information Distribution Tower in UB city
(3) Establishment of Earthquake Recording Station at Epi Center
(4) Development of Disaster Information Network connecting to official information equipment, TV, and Radio

Figure 8.2.1 is whole system image, and Figure 8.2.2 is layout image of Emergency Disaster Information Distribution Tower.



Source: Development of Early Warning System, ICTPA

Figure 8.2.1 Concept of UB city Disaster Information Distribution System

Source: Development of Early Warning System, ICTPA

Figure 8.2.2 Layout image of Emergency Disaster Information Distribution Tower

To support this development plan, the lecture and visiting of new alert system and laud speaker were set in the training course in Japan (see 10.2 Implementation of the Training course in Japan). Trainees asked to reflect this to development of disaster information distribution system.

8.3 Structure of operation and maintenance of disaster information distribution system

The system redundancy for earthquake disaster such as main/sub operation center and basic/alternative network is considered in the development plan. However, there are no mention about quakeproof level of buildings and networks.

According to the estimated results of earthquake hazard and building risk in previous chapters, detailed structure of operation and maintenance of disaster information distribution system will be discussed.

Chapter 9 Disaster Education and Capacity Development

9.1 Public Awareness on Seismic Disaster Risk Reduction

9.1.1 Making Presentations in the Japan-Mongolia Joint Seminar on Preparedness and Mitigation to the Seismic Disaster

The "Japan-Mongolia Joint Seminar on Preparedness and Mitigation to the Earthquake Disaster" was held in cooperation with relevant organizations both in Japan and Mongolia between February and March 2012, prior to the start of the project. The Joint Seminar was consisted of two parts, "Training in Japan" and "Seminar in Mongolia". The training program was provided by inviting the counterparts of Mongolia for the project to Japan from 2 to 10 February 2012 for the purpose of field survey and exchange of opinions on Japan's efforts in the subject area. The seminar was conducted from 21 to 22 March 2012 in Ulaanbaatar with the attendance of the stakeholders of the project.

In the first day of the "Seminar in Mongolia", members of the project team introduced activities of the project and the efforts of community-based disaster risk management (CBDRM) activities in Japan. On 22 March, the second day of the program, a large-scale evacuation drill involving disaster response agencies, schools, and residents (at the Railway University and the surrounding area), simulation exercise of simultaneous warning (around the city), and evacuation drill (at the Chingeltei district) were conducted. The project team provided advices to conduct the evacuation drill. Further, in conjunction with the evacuation drill, the project team held a workshop for public awareness on seismic disaster risk management.

As a kick-off event, the Joint Seminar provided a good opportunity and significant contribution to the project for building a collaborative relationship among the persons concerned in both countries and to widely introducing the project activities to the stakeholders.

Figure 9.1.1 Introduction of Project Activities

Figure 9.1.2 Consultation on Evacuation Drill

9.1.2 Preparation for Public Awareness Campaign for Seismic Disaster Risk Reduction (DRR)

As mentioned in the section 8.1, a workshop for public awareness on seismic disaster risk management was conducted as one of the activities of the Japan-Mongolia Joint Seminar on Preparedness and Mitigation to the Earthquake Disaster. As a reference for conducting public awareness campaign in the project, a review of the activities of the workshop was carried out.

Participants of the workshop were approximately 70 residents and stakeholders who participated in the evacuation drill which was conducted just before the workshop. The workshop aimed to enhance the capacity and knowledge for disaster response of residents and provided the following lectures; (1) Understanding of the earthquake using the photos of the Great Hanshin-Awaji Earthquake, (2) Emergency survival kit (evacuation bags), (3) Actions to be taken in the event of a disaster by using a disaster risk management game called "Catfish School", and (4) Preventive measures for falling furniture.

Explanation of importance of preparation and measures to be taken for earthquake disaster was made with maximum use of illustrations and pictures, and demonstration for easily understanding for the residents who have no experience of earthquake. As a result, many participants could maintain their interest and actively joined in the program until the end of the workshop. Also, they eagerly received the brochure to learn the skills introduced in the workshop, which was prepared by the JICA Mongolia office. It is considered this positive attitude as a good sign to expand and transfer knowledge at home or in the community in the future.

On the other hand, the following points were recognized as critical for conducting this kind of public awareness workshop. It is important to carefully consider how to encourage the residents with little knowledge of the earthquake to come to the venue and participate in the event. And it is required to facilitate the participants easily to have an image of earthquake damage around them. Once people have a clear image of possible damage around them, they can easily think to learn more knowledge on seismic risk management.

Figure 9.1.3 Participants actively joined in the Workshop

Figure 9.1.4 Use of many pictures facilitated the understanding

Following the review, a consultation meeting was conducted for discussing the activities of public awareness campaign in the project among the members of the working group (WG) 4 which is in charge of implementation of the campaign as one of the tasks. Through the discussion, the members of the WG4 basically agreed to have the following activities; (1) to conduct preparation workshop inviting stakeholders in September 2012 to review the public awareness activities for disaster risk reduction in Mongolia and to identify and discuss how to learn necessary skills, and (2) to design and implement public awareness campaign in the form of “disaster risk reduction expo” in May 2013 based on the discussion in the workshop.

Then, the outline of the preparation workshop in September 2012 was discussed.

9.1.3 Implementation of the Preparation Workshop for Public Awareness Campaign

Based on the discussion in the WG4 meeting in June, a preparation workshop for the public awareness campaign was conducted as follows.

<Outline of the Workshop>

(1) Purpose:

- To enhance understanding of the relevant organizations (government and educational agencies, mass media, NGO, and International organizations) on seismic disaster risk management and public awareness on seismic disaster risk reduction.
- To discuss the activities in the public awareness campaign on seismic disaster risk reduction to be held in May 2013.

(2) Date (2 days): 20-21 September 2012

(3) Venue: EMDC Atrium

(4) Participants: About 50 persons

- Members of the WG4
- Officers in charge of training and public awareness in EMDC
- School communities (incl. teachers)

- Staff members of International organizations and NGOs which are conducting disaster risk reduction activities
- Mass media (in charge of education and public awareness)

(5) Program of Activities

Thursday, 20 September 2012

09:00-09:15 Opening Remarks
－Mr. Chantsal Namsraijav, Deputy Head, EMDC
－Ms. Miki Kodama, JICA Project Team

09:15-10:30 [Introduction] Video of Earthquake Situation in the Cases of the Great Hanshin Awaji Earthquake and the Spitak Earthquake in Armenia
[Lecture] Mechanism of the Earthquake and Seismic Disaster Risk Management: Dr. Yujiro Ogawa, JICA Project Team

10:45-11:10 [Lecture] Problems Caused by Large-scale Earthquake and Response: Mr. Toshinori Tanabe, Plus-Arts

11:10-12:10 [Group Discussion] Training Program for Imaging Earthquake Disaster Situation utilized "Meguromaki" method

13:10-14:10 [Group Discussion] Discussion on the Preparedness and Response for Earthquake utilized an earthquake disaster management educational tool "Namazu no Gakko"

14:10-15:10 [Group Discussion] Discussion on Emergency Bag Appropriate for the Citizens of UB City

15:25-16:10 [Lecture] Measures for Preventing Falling Furniture and Reducing Damage caused by Earthquake: Ms. Miki Kodama, JICA Project Team & Mr. Toshinori Tanabe, Plus-Arts

16:10-17:00 [Lecture & Exercise] Leaning Importance of Seismic Retrofitting utilizing the Educational Tool "Bururu-kun"

Friday, 21 September 2012

9:00-9:30 [Explanation] Brief Outline of Proposed Public Awareness Campaign on Seismic Disaster Risk Reduction in UB City

9:15-9:45 [Lecture] Public Awareness Activities for Disaster Risk Reduction in Japan: Ms. Miki Kodama, JICA Project Team

9:45-10:30 [Lecture] Knowledge and Skills Necessary for Saving Lives from Earthquake Disaster – How the activities of "Iza! Kaeru Caravan!" (A set of learning tools and activities for disaster risk reduction education and drills) was developed.- : Mr. Toshinori Tanabe, Plus-Arts

10:30-12:00 [Experience] Trial of Some Tools and Activities of "Iza! Kaeru Caravan!"

13:00-14:00 [Group Discussion] Discussion on Knowledge and Skills Required for the Citizens of UB City to Make the Earthquake Disaster Resilient City

14:00-15:00 [Group Work] Planning of the Public Awareness Campaign on Seismic Disaster Risk Reduction

15:00-16:00 [Plenary Discussion] Presentation by Each Group and Discussion

16:00-16:30 Wrap Up & Closing

Figure 9.1.5 Participants of the Workshop

Figure 9.1.6 Trial for An Educational Tool

The workshop was attended by around 50 participants, including of the officers in charge of training and public awareness in EMDC, school teachers, and staff members of International organizations and NGOs which are conducting disaster risk reduction activities in Mongolia.

In the workshop, the first program was provided for the participants to have a concrete image of earthquake situation. At the beginning, they were exposed to the reproduced movies, real movies and various pictures of the damages caused by the Great Hanshin-Awaji Earthquake in 1995 and the movies and pictures of the field survey conducted just after the Spitak Earthquake in Armenia in 1989. Then, lecture on the mechanism of the earthquake was made as a basic knowledge.

The program was followed by the image training utilized "Meguromaki" method which was developed as a tool for imaging the disaster situation. The participants tried to think about what will be happened and what actions will be taken in chronological order if the earthquake occurs. Further, they discussed disaster response and preparedness by the residents in UB city utilizing the educational tool "Namazu no Gakko" which was developed for learning what should be done by citizens in case of disasters based on the lessons learned in the Great Hanshin-Awaji Earthquake. Also, they discussed about standard items for emergency bag to be prepared by the citizens of UB City.

The participants had great interests to the activities conducted with use of the Japanese good learning tools which could lead to active discussion. Through the discussion, the participants could identify some unique aspects for disaster risk reduction in Mongolia. The main identified points were 1) The most of the residents of UB city think disaster risk management is the task of public agencies, 2) No one around them have experiences of earthquake. This makes difficult for them to think earthquake will occur in UB city, and 3) There are not so many events in UB city, therefore, the event to enjoy with the family members can attract many participants. These points are useful for considering disaster risk reduction in UB city.

After the sessions to learn and discuss knowledge and skills for disaster risk reduction, the participants were introduced some Japanese practices on public awareness activities. Then, based on the information, they discussed in groups about concrete ideas for the Public Awareness Campaign for Seismic Disaster Risk Reduction to be conducted in May 2013.

Figure 9.1.7 Group Discussion

Figure 9.1.8 Discussion on Ideas for the Campaign

The following points are the main ideas for the Campaign.

- To raise awareness on "Self-help" for disaster risk reduction, prepare a leaflet on "Save Own Life from Earthquake" to be distributed in the Campaign
- To promote sound understanding of the residents about the current situation of stockpile for disaster response in each district which had not been realized well
- To prepare the items for exhibition in each district for the purpose to promote and raise interests to the campaign in each district
- To create a song for disaster risk reduction for getting more interest from many people to the

Campaign
- To conduct the competition among schools (the representatives from each school join the competitive games like the Olympic) to get more attention to the Campaign
- To implement various preparatory events for raising people's awareness for the Campaign, for example, training for leaders or contest on the development of various games for learning
- To award those who get high scores in 10 kinds of games for learning disaster risk reduction.
- To conduct a concert or a music show at the end of the Campaign event to get more participants
- To develop a dice game for learning disaster risk reduction, which can be a good attraction for the participants
- To introduce a basic skills and knowledge on disaster risk reduction, such as standard items for emergency bag, skills of jack-up for rescue people, CPR, blanket stretcher, basic firefighting, rope knots
- To conduct a questionnaire survey to analyze current situation of people's knowledge on disaster risk reduction to take advantage of gathering of many people
- To prepare a manual on disaster risk reduction for schools considering the effectiveness of conducting activities in schools
- To visit Japan for studying disaster risk reduction activities in Japan to get more concrete image of the Campaign since a picture is worth a thousand words.
- To get involvement of Police and Public Health Department in order to conduct the event safely, and
- To ask donation from enterprises to fill the gap in necessary budget

Further, the following main ideas were proposed for localizing the introduced Japanese programs.
- Instead of blanket, deel (Mongolian traditional costume) will be utilized for stretcher
- Dried meat and dried dairy products will be utilized as emergency foods
- Canned beef with pull-tab, which is one of the popular foods for Mongolian, will be utilized as emergency food
- Ger can be utilized as temporary housing. We need to stock enough numbers of Gers for the purpose and teach to younger generations how to set up a Ger

9.1.4 Discussion on the implementation of the Public Awareness Campaign on Seismic Disaster Risk Reduction

On 10 December 2012, a meeting for discussing on the implementation of the Campaign based on the workshop in September was conducted among about twenty-five participants, including of members of WG4 and staff members of Mongolian Red Cross. As a result of the discussion, the following outline for the Campaign was proposed. And they decided to start the preparation for realizing the Campaign from middle of January, including of occasional preparatory meetings.

<Outline of the Public Awareness Campaign>

(1) Date of the Campaign

The school holiday starts from June in Ulaanbaatar. It would be difficult to get much participation on Saturday and Sunday even in May. Further, at the end of May, the Presidential Election will be conducted. Considering the above situation, the participants agreed to conduct the Campaign on 22-23 May 2013. They also decided to conduct pre awareness activities targeting schools in each district in the former half of May, and to select the schools with high scores in the activities as the participants of the event on 22-23 May 2013.

(2) Venue of the Campaign

Use of the Sukhbaatar Square needs approval from many stakeholders such as head of the district, mayor of UB city, traffic police, department of urban development, and etc. Also it is difficult to conduct demonstration of fire fighting vehicles there due to heavy traffic condition. Considering the situation, the participants agreed to choose the Victory Square which is neighbor of the EMDC as the venue for the Campaign. The square with wide space is located good place to gather many people, and has advantages for easy preparation for EMDC.

(3) Programs to be Implemented:

The four kinds of programs, i.e., "Competition", "Experience", "Exhibition", and "Seminar" were selected for the program of the Campaign. The proposed activities in each program are as follows.

1) Competition
- A card game named "Duck for Disaster Risk Reduction" for learning actions to be taken in case of emergency (target: kindergarten pupils and school children)
- Bucket relay game for firefighting and competition for fire fighting
- Rescue utilized Jack
- Blanket (Deel) Stretcher
- Quiz on standard items for emergency bag (Individual, team, or relay competition)

2) Experience
- Simulation of earthquake shake (for example, "Jishin Zabuton" which was developed for simulate earthquake shake sitting on the chair with a view of synchronized movies of real or simulated earthquake).
- Warm food preparation after disasters (How to cook survival food)
- Tasting of stock foods (dried meat, dried dairy products, canned meat with pull-tab)
- Lectures on utilization of plastic bags for emergency medical care
- Making dishes by newspaper
- Experiment of shaking table for Ger structure (Shaking the frame of Ger on a dolly)
- "Bururu-kun", an educational tool to learn earthquake shake used miniature Ger (Demonstration of the shake of a one-tenth-scale model Ger on a dolly)
- Demonstration of rescue from a building
- Community participated evacuation drill with exercise for rescue and first aid to injured
- Purification of water
- Fire smoke experience (how to evacuate from the building in case of fire)

3) Exhibition
- Past earthquake disasters (the Great Hanshin Awaji Earthquake, Spitak Earthquake, the Great East Japan Earthquake, and etc.)
- Seismic retrofitting housing
- Importance of fixing furniture and how to fix the furniture
- Actions before, during and after earthquake
- EMDC vehicles and equipment's
- Posters for disaster risk reduction awarded in the contest
- How to protect Ger when your neighbors get fired (Prevention of the advance of the fire by disassemble of Ger or utilization of wet blanket)
- Demonstration of extinction of fire during cooking with oil in the kitchen

4) Seminar

The proposed themes of lectures in the seminar are as follows.
- Mechanism of earthquake
- What happened in the past earthquakes in Japan
- What situation will be brought in UB city in case of earthquake
- What can be done now for the preparation of earthquake

9.1.5 Preparation of the Public Awareness Campaign

Instruction order for the campaign was issued by UB City on 6 January 2013, concrete preparatory activities had began. Several preparatory meeting had been conducted for the coordination among the relevant departments of the EMDC and cooperative organizations led by EMDC deputy director until the date of implementation of the campaign in May.

In addition, as part of the preparation activities, the EMDC deputy director and Mr. Turmandakh, a EMDC staff member participated in the training program in Japan, as representatives of WG4, and had deepened the understanding of public awareness activities on DRR in Japan.

In March 2013, "Outline for Implementation" of the campaign was compiled based on the discussion result of the preparatory meetings and distributed to the relevant staff members to clarify the detailed preparation and essential consideration.

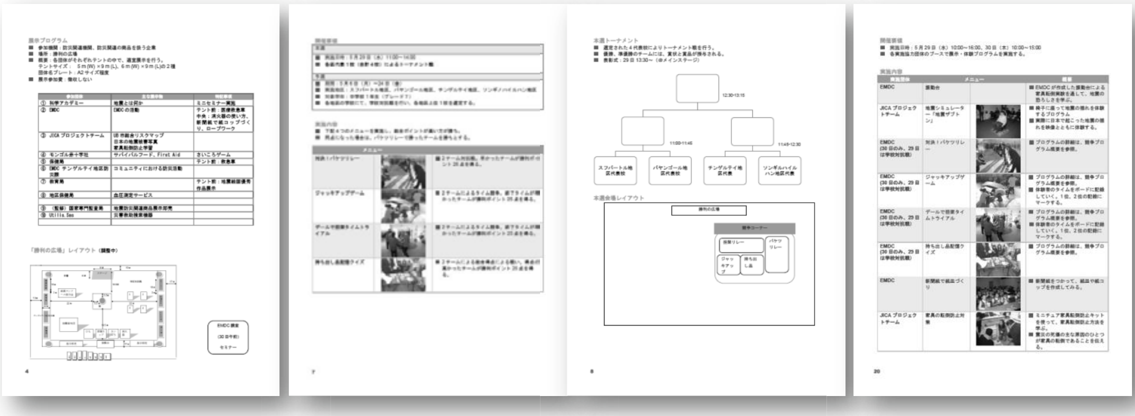


Figure 9.1.9 "Outline of Implementation" of the Campaign

9.1.6 Implementation of the Public Awareness Campaign for Seismic Disaster Risk Reduction

At the end of April, just a month before the campaign, due to sudden request from UB city side, the date of the campaign was postponed for a week. The campaign was eventually conducted on 29-30 May 2013. The outline of the implementation of the campaign was as follows.

(1) Purpose

There is a tendency that frequency of the occurrence of earthquake has been increased in recent years in Mongolia. In Ulaanbaatar city, felt earthquake has been increased as well. While rapid urbanization has progressed in recent years in the capital city home to 30% of the total population, disaster preparedness is still insufficient. The public awareness campaign for seismic disaster risk reduction would be conducted for the following purposes.

- ✓ Fostering awareness of the earthquake risks in Ulaanbaatar
- ✓ Enhancing understanding of persons involved in disaster risk management and the general public on preventive measures for possible disasters, and actions to be taken in case of disasters.

(2) Outline

Date and time: 29 May (Wed) 10:00 - 16:00 and 30 May (Thurs) 10:00 - 15:00
Venue: "Victory Square" in Ulaanbaatar
Implementation Program:
Opening Ceremony: 29 May (Wed) 10:00 - 10:45
School Tournament: 29 May (Wed) 11:00 - 12:30 (12:30 - 13:00 Awards Ceremony)
Exhibition and Experience Program: 29 May 10:00 - 15:00 and 30 May 10:00 - 15:00
Seminar: 30 May 30 (Thu) 10:00 ~ 11:30 (@ EMDC Auditorium)
Target Participants: Ulaanbaatar citizens, Officials involved in DRM
Implementing Organizations:
Organizers: EMDC, UB city, JICA Project Team
Co-organizers: Mongolia Red Cross, Mongolian Academy of Sciences, UB City Health Department, UB City Education Department, National Audit Office
Cooperative Organizations: Nomin Co., Mongolia Insurance Company, Utilis.Sas (Open Mongolia)

(3) Programs of the Campaign

(a) Opening Ceremony

After the opening remarks from Administrator of the NEMA, Deputy Mayor of the UB city, Chief Representative of the JICA Mongolia Office, school students sang in chorus with the play of musical band of Songinohairhan district and then warm up exercise with the participation of all the relevant

Figure 9.1.10 Opening Ceremony

staff members of the campaign was conducted. Through the program, the relevant agencies and participants of school tournament enhanced their willingness for implementation of the campaign activities.

(b) School Tournament

From early May, preliminary round was conducted by grade 7 students in each of the 4 target districts, Sukhbaatar district, Bayangoru district, Chingeltei district, and Songinohairhan district. Then, one school selected from each district participated in the final round on 29 May.

Four programs; Bucket brigade, jack-up rescue race, blanket stretcher transportation competition and memory competition of emergency bag goods are conducted. Based on time and score, the result of the competition was calculated. The first place was won by Bayangoru district representative, the second place was Songinohairhan district representative, and the third place was Sukhbaatar district representative, and Chingeltei district representative was the 4th place.

Figure 9.1.11 School Tournament

(c) Experience Program

The campaign provided the various experience programs, such as "shaking table" experimentally developed by the EMDC for the campaign, fire fighting training used water extinguisher, making paper dishes, dice games, vibration education teaching material "Paper Bururu", leaning of furniture fall prevention, first aid practice in case of emergency including artificial respiration, rope works to help in the event of a disaster. The developed "shaking table" needs further improvement for simulating the real earthquake shake, however, helped to generate participants' interest in earthquake shake.

Furthermore, as one of the experience programs, self-propelled earthquake simulator, "Jishin The Vuton" was brought from Japan and provided opportunity for experiencing ground motion with simulation video in accordance with the earthquake data recorded in the past. In total, 290 people (178 males, 112 females) experienced the simulator. Some of them felt scary wondering "what we can do if we have this kind of shakes?" or expressed the needs for the improvement of measures for earthquake with the comments like "the current buildings in UB city are not seismic resistant. More experiments of the buildings for earthquake resistance and development of guideline for safe building are required.

Figure 9.1.12 Experience Program (Left: "Shaking Table", Right: "Jishin The Vuton")

(4) Exhibition

As the exhibition program, emergency items and equipments are introduced. They included emergency response first aid set, first aid supplies, sample disaster prevention goods in Japan, survival food, emergency food, emergency response vehicles, search and rescue equipments, and various fire extinguishers. Also pull-tab canned beef and dried meat, unique emergency food in Mongolia which was discussed in the preparatory meetings were introduced. In JICA Project team booth, many people interested in portable radio with hand-cranked power generator and windup LED light as disaster prevention goods of Japan.


Figure 9.1.13 Exhibition of Survival Food, Search and Rescue Equipments

Besides, in the exhibition booths in EMDC, Mongolian Academy of Sciences, Education Department and JICA Project team, introduction of their DRR activities and/or explanation of the earthquake and possible damages in UB city were provided. In the booth of Mongolian Academy of Sciences, technical explanation of the earthquake with the exhibition of the observation equipments was provided. Not only the general public but also the staff members of the organizations involved in the campaign could enhance their knowledge on earthquake by the explanation.

Further, the picture and essay contest on earthquake disaster risk reduction was conducted along with the campaign activities for getting more participation and involvement in the event. The awarded pictures (refer to the table) were exhibited at the venue. Also awarded ceremony was conducted for the prize winners for the picture and the essay contest at the closing ceremony. The awarded essay (refer to the table) will be introduced in the government radio program for disaster risk reduction.

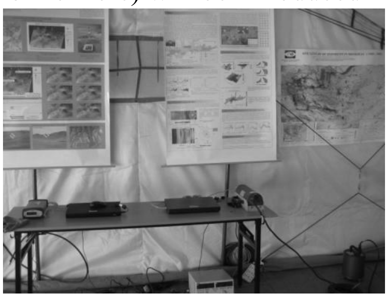


Figure 9.1.14 Left: Exhibition of Mongolian Academy of Science, Center: Awarded Pictures, Right: Seminar

(d) Seminar

As one of the campaign activities, a seminar for seismic disaster risk reduction was conducted aiming at enhancing DRR knowledge and sharing outcomes of the Project. Also, it was considered the implementation of seminar could help getting more participants of the campaign. The target participants of the seminar were the school teachers and district officers in charge of disaster risk management and total 300 persons were attended.

In the seminar, a lecture on the technical knowledge of the earthquake was provided by a representative from Mongolian Academy of Science at the beginning. Then, lectures on the estimated earthquake damage in UB city and impact to the life of the people were made by the project team members based on the outcomes of the Project activities.

Table 9.1.1 Awarded Pictures of the Picture Contest

		
Highest Award	Second Prize	Second Prize
Sukhbaatar district Mongolia-Russian Integrated High School 9G Class N.Anar	Sukhbaatar district No. 29 School 7B Class D.Davaasuren	Special Athletics & Sports Training School 5A Class S.Ariusakh
		
Second Prize	Second Prize	Second Prize
Sukhbaatar district No. 29 School 5B Class B.Zolboo	Sukhbaatar district No. 58 School 10C Class Ts.Sharavdorj	Bayangol district No. 47 School 2G Class N.Narangarav

			
“NEMA” Prize	“EMDC” Prize	Education Dep. Prize	“JICA” Prize
Sukhbaatar district No. 2 school 10D class B.Enkhjin	No.72 school 10D Class D.Dulguun	No. 58 School 10C Class G.Munkhbayar	Special Athletics & Sports Training School 10D Class M.Agiimaa

Third Prize Awarded Students (10 persons)
Songinokhairkhan district No. 67 School 7G class B.Temuujin, No. 29 School 3B class B.Telmen
Sukhbaatar district No. 58 School 8B class A.Orgil, No. 17School 5G class N.Narangarav
No. 47School 1G class O.Enkhkhuslen, No. 37 School 10C class N.Enkhzaya
Sukhbaatar district No.35 School 8A class E.Khaliunaa,
Sukhbaatar district No.2 School 5E class B.Bujin
No. 47 School 2B class M.Azzaya, Setgemj School 3A class O.Khulan

Table 9.1.2 Awarded Essays of the Essay Contest

N	Awarded Students	Outline of the Essays
1	Bayangol district “Oyunii Undraa” Integrated School 10G class M.Enkhgerel	It describes that people need to cherish nature and think about the measures for the natural disasters.
2	Bayangol district No. 93 School Altanbagana	It expresses the concerns that earthquake disaster occurs since human is destroying nature.
3	Songinokhairkhan district No. 62 School 11A class M.Khuslenzaya	It describes 10 major earthquakes that occurred in the world and they claimed peoples lives, wealth and happiness of life. In addition, it mentions the current Mongolian buildings have no seismic resistance and need earthquake disaster risk reduction measures.
4	Chingeltei district No. 72 School 10B class Kh.Amartuvshin	It mentions Mongolia is located in the areas that will be affected by ground motion and old buildings are dangerous in case of earthquake occurence.
5	Songinokhairkhan district No. 106 School 10A class G.Baldorj	The essay describes it is the weakness that Mongolians have never experienced an earthquake. It refers Japan improved earthquake measures based on the frequent earthquake experiences, and suggests preparation of earthquake preparedness plan in each family.
6	Songinokhairkhan district No. 106 School 10 class A.Battogtokh	It examines the earthquake mechanism, the possible occurence of the earthquake in Mongolia and what should be done by students.
7	Bayangol district No. 93 School 10A class E.Jargalmaa	It desctibes earthquake claims people’s life, destroys buildings, and triggers fires, therefore, earthquake risk reduction measures is essential.
8	Chingeltei district No. 72 School 9C class B.Khongorzul	It states brief explanation of earthquake and a strong earthquake occurred in Mongolia. Then, it expresses importance of acting with calm during the earthquake.
9	Bayangol district No. 93 School 9B classA.Bujindei	It explains the earthquakes occurred in the world and Mongolia, and then, concluded that the buildings in Mongolia are vulneble to earthquakes and will get serious damages in case of earthquake.
10	Bayangol district No. 93 School 9B class T.Anujin	It describes the measures to be taken during and after the earthquake in relation to the earthquake disaster risk reduction measures submitted to the Energy Agency by the organization relevant to energy management.
11	Sukhbaatar district No. 4 School 11A class M.Bolor-erdene	It raises the questions that the earthquake occurs due to ignoring nature, whether we can take necessary measures for earthquake disaster risk reduction and preparedness for emergency response.
12	Songinokhairkhan district No. 62 School 10A class Ts.Purevjargal	It descibes that the importance of earthquake prevention measures mentioning that we cannot know when an earthquake occurs however we can prepare for the damages.

9.1.7 Review Meeting for the Public Awareness Campaign for Seismic Disaster Risk Reduction

From 11:00 a.m. on 31 May 2013, the next day of the Campaign, a review meeting of the Campaign was conducted among 40 representatives of the implementing organizations and agencies including of WG 4 members. The following comments were expressed on the pros and cons and recommendation for future improvement.

(1) Major good points

- The campaign could get the participation of all ages from children to the elderly and provide opportunity for them to have an image of earthquake disaster through various activities.
- The various organizations which had not worked together could collaborate for the campaign event and share knowledge and information of each organization. The staff members of the implementation organizations and agencies could enhance their knowledge on earthquake disaster risk reduction.
- There were no past experiences on the implementation of this kind of activities, and were many difficulties in the preparatory process. However, each of the participated organizations and agencies could make their best efforts for the successful implementation and learned for improvement of their DRR activities.
- From the event implementation, we could learn a variety of educational activities that you cannot even spend money. There were many points learned from efforts of Japan.
- We could find out many ways for getting participants to the event, such as school tournament, seminar, and lottery.
- What I learned in the training in Japan was very helpful in this activity.

(2) Major points to be improved

- It was the first time for conducting this kind of activity, and difficult to have the image of the preparation process. Thus, preparatory activities were concentrated in one month before the event.
- Also since the budget estimation was not well calculated and additional expenses were caused or some change for the activities are required for the budget constraints.
- Due to the delay of the selection process of the picture contest, information to the awarded students was delayed, and the award ceremony originally planned in the opening ceremony was extended.
- Without proper advance consultation to the EMDC and JICA Project team, Department of Education had conducted the essay contest together with the picture contest. The selection of the essays to be awarded was also delayed and it couldn't provide a venue for introducing the essays in the campaign event. (The selected essays will be introduced in the government radio program for disaster risk reduction.)
- Advance publicity for the event was not enough, although the event could generate interest of mass media. Press release with detailed information in advance should have been conducted. Most of the participants did not know the special service for blood-pressure check which was conducted for getting more participants to the event.
- The date of the event was overlapped with the national examination, the awarded school students could not participate in the award ceremony conducted in the closing ceremony.

(3) Major suggestions for expansion of the activities

- To update the awareness program in the context of the actual situation of Mongolia based on this experience and conduct it on a regular basis
- To utilize the video recorded the event activities for further expanding of the event nation wide
- To report the result of the event activities to the UB City for further understanding of the high officials of the UB city and getting more budget allocation for conducting this kind of events
- To take advantage of the organizations' network that has strengthened in this activity, and promote disaster awareness activities
- To make effective use of the awarded pictures in the contest such as using them in posters and calendars of EMDC
- To introduce the selected essays in the government radio program
- To utilize the posters developed by JICA project team for the campaign event in their own activity

(Mongolian Red Cross)

- To improve the "shaking table" for simulating real earthquake shake and enhancing safety, and then use it in the activities in the regions
- To consider the venue of the event to get more participation of the residents in each district

As a whole, the campaign event could get much participation and a lot of media coverage by the efforts of various relevant organizations. The event could serve the objectives for fostering public awareness of the earthquake risks in Ulaanbaatar and enhancing understanding of persons involved in disaster risk management and the general public on preventive measures for possible disasters, and actions to be taken in case of disasters. It is expected that he event program will be improved in consideration of the condition in Mongolia based on the experiences in this activity and expanded for the activities in other districts in UB city or regions prone to earthquake disasters.

9.2 Capacity Development Plan

In this project, 4 WG are activated. Each WG has held study meetings for capacity development not only for WG member but also other persons who has interested in the special knowledge and techniques.

The study meetings of earthquake hazard, building risk evaluation, road and bridge risk evaluation, lifeline risk evaluation, fire risk, earthquake disaster management plan have been held. Furthermore, the new study meetings of earthquake risk and measures for EMDC staffs will be held in 2013. The objective, period, content are as follows;

1. Objective

   It is expected the big earthquake will occur, and UB city will be damaged. The capacities against earthquake disaster in personnel and organization level shall be enhanced by preparation in advance against the earthquake, with learning earthquake mechanism, expected damages, and impacts

2. Period and expected dates

   From February to June, 2013

   (1) 26th February, Tuesday
   (2) 19th March, Tuesday
   (3) 2nd April, Tuesday
   (4) 14th May, Tuesday
   (5) 28th May, Tuesday

3. Expected Contents

(1) What is Earthquake?
- Mechanism of earthquake
- World historical earthquake records and damages
- Historical earthquake records in Mongolia

(2) What kinds of damage are expected?
- Expected earthquake to occur at UB city
- Expected property damages (Building, Fire, Road and Bridge, Lifeline)

(3) Effects on daily life
- Scenario from occurring earthquake, response, and rehabilitation
- Daily life as evacuee
- Disaster medical care
- Traffic system
- Economic growth

(4) How about present seismic countermeasure?
- Present seismic countermeasure
- Future disaster management plan

- BCP of EMDC

(5) What is Self-help and Mutual-support against earthquake disaster?

- Disaster Education
- Awareness campaign

4. In order to ensure the sustainability of outcomes
   - To award a certificate to those who attended all lecture.
   - Taking video of lectures, then utilize for e-education for other staffs in remote places and new staffs.
   - Not only by JICA project team, but also RCAG and MUST will cooperate as lecturer as one of the technology transfer.

Materials and programs used in these study meetings will be arranged for future capacity development in Mongolia. In formulating capacity development plan, keep in mind for further additional components of knowledge and techniques after the project.

Chapter 10 Training Course in Japan

10.1 Planning of the training course in Japan

As part of supporting capacity building of relevant organizations, training for persons involved in the Project to be conducted in Japan was approved at WG4. The objective of the training course in Japan is that trainees obtain understandings for Japanese seismic disaster management so that smooth implementation of the Project will be achieved. Also it is paid attention that the techniques and knowledge are utilized in the Project, therefore all participants should be selected from WG members of this project or direct staffs of WG members.

Furthermore, implementation period of the training course was approved that the trainees can attend the relevant events including the Great Hanshin-Awaji earthquake memorial event to be held on January 17, and also visit Hokkaido to learn seismic disaster management during midwinter. The detail plan was not decided by only WG4 in charge of disaster education, so that the letter of intent and draft schedule are distributed to all WG member, then the training contents was fixed at WG4 meeting.

The implementation period of training, field, contents, and organization in charge is as follows.

Table 10.1.1 Training course in Japan

Organization	Field	Contents	Period
ADRC	Administration in Disaster Management	Law and policy related to earthquake Disaster management Cooperation of government, community and citizens	Early and Middle of Jan, 2013
NHK	Earthquake Bulletin Disaster Awareness	Lecture of earthquake bulletin and development of disaster educational programs	
Disaster Reduction and Human Renovation Center	Cultures in disaster management	Visit to the facility transmitting the Kobe earthquake disaster	
Disaster reduction exhibition by Kyoto city	Education regarding Disaster reduction	Visit to the facility where emergency drill is held	
Asahikawa City	Education regarding Disaster reduction	Disaster reduction activity in the cold area Measures for heavy snow and cold wave Experience of staying refuge in winter	
Northern Regional Building Research Institute	Disaster management planning	Lecture of disaster management plan and challenges in the cold area	
Takenaka	Building code of quakeproof	Lecture of seismic isolation/resistant building, and visit existing case	
Hakusan	Personal Earthquake Simulator	Experience-based lecture of portable and personal earthquake simulator	
TOA	Disaster Information Distribution	Visit the latest model of disaster information distribution system	
Hanshin Expressway	Road and bridges	Visit earthquake library of road and bridge.	
Plus-arts	Emergency Drill	Emergency Drill for children	
Fire Dept. in Kobe City	Emergency Drill	Emergency Drill for medical welfare community	

Source: JICA project team

Table 10.1.2 Schedule of Training Course in Japan

Date	Fields	Contents
2013/1/15, Tue	Arrival	
2013/1/16, Wed	AM JICA Kansai 13:00-15:00 ADRC 15:30-17:00 Hanshin Expressway	Orientation Disaster Countermeasures of Japan Damage of Road and Bridge
2013/1/17. Thu	10:00-12:30 Memorial walk 15:30-17:00 E-Defense	Transfer earthquake experiences 3 dimensional shaking table
2013/1/18, Fri	10:00-12:00 NHK 14:00-16:00 Plus Arts	Disaster news, earthquake bulletin Pre-lecture of Kaeru Caravan
2013/1/19, Sat	10:10-12:00 Disaster Reduction and Human Renovation Center	Taking over experiences and technologies
2013/1/20, Sun	AM Fire Dept. in Kobe City PM Kobe -> Asahikawa	Emergency Drill for medical welfare community
2013/1/21, Mon	AM Asahikawa City PM Disaster relation places	Disaster Countermeasure at Municipality Level
2013/1/22, Tue	ALL Northern Regional Building Research Institute	Disaster management plan and challenges in the cold area
2013/1/23, Wed	Asahikawa -> Kobe	
2013/1/24. Thu	10:00-12:00 Takenaka 13:30-15:00 Takenaka 16:00-17:30 Hakusan	Lecture of seismic isolation/resistant building, visiting existing building Portable Earthquake Simulator
2013/1/25, Fri	AM Making Action plan report PM TOA	New technology for disaster information distribution
2013/1/26, Sat	09:40-11:10 Kyoto City Disaster Prevention Center 12:30-14:00 Traditional housing 14:30-15:30 Kinkakuji Temple	DRR learning facilities for citizens DRR for cultural and historical heritage
2013/1/27, Sun	13:00-16:00 Plus Arts	Kaeru Caravan, new type Disaster Drill
2013/1/28, Mon	AM Presentation of action plan PM Evaluation and Closing	
2013/1/29,Tue	Return	

Source: JICA project team

10.2 Implementation of the Training course in Japan

The training course in Japan planed at 10.1 was conducted on Jan. 2013. Members are basically selected from WG members (see Table 10.2.1). Since the general election on Jun. 2012, most of members who had participated the training course in Japan on Feb. 2012, left or retired, JICA and the project team asked to nominate new Mayer, Deputy Mayer, and Chief of NEMA as trainee of the training course in Japan. However, their schedule couldn’t be arranged with training period, therefore their represents participated.

Table 10.2.1 Members of the Training in Japan

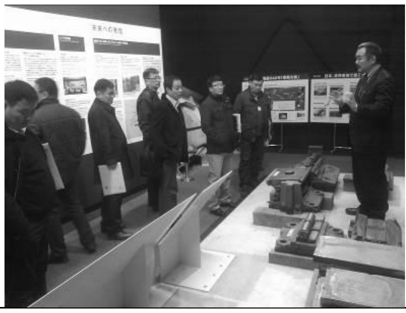
No.	Name	Organization	Position	Reference
1	Togtuun ERDENETUYA **(Cancelled)**	Construction, Urban development and Planning Agency of UB	General engineer	Leader of WG1
2	Mijid SUKHBAATAR	Disaster management department, NEMA	Head of Infrastructure and earthquake risk reduction unit	Advisor of WG2 and 4
3	Medekhgui NYAM-OCHIR	Metropolitan Specialized Inspection Agency of UB	Deputy Head	Member of WG3

4	Chantsal NAMSRAIJAV	EMDC	Vice principle	Leader of WG4
5	Bakhit ARDABYEK	Construction, Urban development and planning agency of UB	Specialist, Quality and safety division	Member of WG1 In charge of earthquake risk in master plan of UB
6	Dandar TULGA	Construction, Urban development and planning agency of UB	Senior Specialist, Quality and safety division	Member of WG3
7	Minjuurdorj BATSAIKHAN **(Cancelled)**	Land Agency of UB	Chief	Advisor of WG2 (on behalf of deputy Mayer)
8	Demberelsuren BAYASGALAN	Road department of UB	Deputy chairman	On behalf of chairman (WG1)
9	Tserenpil BATSAIKHAN	RCAG	Head of research and development laboratory, Seismological department	Supporter of mapping team of the project
10	Tsedendamba OTGONBAGANA	Education department of UB	Director general	Drill and educational program (WG4)
11	Tsegeedei TURMANDAKH	EMDC	Head of rescue team	Plan, Education, Drill, Campaign (WG4)
	Total 11 persons			

Source: JICA project team

10.2.1 Overview of each training session

Date:	16 January 2013 (Wednesday) 13:00 - 15:00
Title:	Disaster Countermeasures of Japan
Lecturer:	Mr. Kiyoshi Natori, Executive Director of ADRC
Contents of Lecture:	The damages, technical countermeasures, and legal systems by historical natural disasters in disaster prone country Japan are explained. In particular, it is pointed that countermeasures after the Great East Japan Earthquake and the Great Hanshin-Awaji Earthquake, and trainees realize the importance of efforts to avoid same damage from repeating natural disasters.
Main questions:	Who is main body to make legal system? What is technical rationale? Also, trainees asked to take presentation file for their reference.
Remarks:	Trainees took memo diligently.
Pictures:	 

Date:	16 January 2013 (Wednesday) 15:30 - 17:00
Title:	Damage of Road and Bridge
Lecturer:	Mr. Masaru Kawamura, International Head of Engineering Department, Hanshin Expressway
Contents of Lecture:	Mr. Kawamura briefly introduced, and the video showed damages of road and bridge in case of the Great Hanshin-Awaji earthquake. After that, trainees visit a show room of actual damaged structures, and have more detail explanations.
Main questions:	There were many questions for emergency response and alternative transportation. In particular, trainees asked for inspection of bridge and reinforcement.
Remarks:	Mr. Bayasgalan, deputy chairman of road department made many technical questions. It seems to have big shock about the damage of large scale bridge. Also, trainees could feel sense of awe to Japan for very short period recover after so big damage.
Pictures:	 

Date:	17 January 2013 (Thursday) 10:10 - 12:00
Title:	Memorial Walk
Lecturer:	
Contents of Lecture:	Trainees attended Memorial Walk to hand down experiences of the Great Hanshin-Awaji Earthquake. At first, the purpose of memorial walk was explained, then stretching exercises at Oji park. After that, participants marched toward HAT-Kobe. Along the way, trainees understood the importance of this walking project to convey the past experiences to the future while talking with local residents. Also, they visited the tents of government, private sectors, school, and NPOs, at the goal point, and they gathered much knowledge towards disaster prevention campaign in May.
Main questions:	Main body of the memorial walk, root selection, and song data that school children sang at memorial ceremony
Remarks:	Trainees were impressed that handing down earthquake experiences and many stakeholders participated to the ceremony. Also they were impressed the song: “Let’s carry happiness” by school children.
Picture:	 

Date:	17 January 2013 (Thursday) 15:30 - 17:00
Title:	E-Defense
Lecturer:	Mr. Umehara, SEI-TEC
Contents of Lecture:	The objective and structure of 3-D Full-Scale Earthquake Testing Facility, nicknamed "E-Defense" was introduced, and watched past examines by video. Then, visited used building, main body of the E-Defense, and hydraulic unit.
Main questions:	Size of shaking table, Initial cost, running cost, experiment schedule. Also some technical questions: why E-Defense can simulate shaking of tower building, even though it can treat up to 5 levels?
Remarks:	They were impressed for experimental facilities, search& rescue training facility beside E-Defense, and it would be a disaster prevention base in case of huge scale disaster. They recognized the necessity of 3-D shaking table.
Pictures:	 

Date:	18 January 2013 (Friday) 10:00 - 12:00
Title:	Disaster news, earthquake bulletin
Lecturer:	Mr. Seiji Kondo, Osaka branch, NHK
Contents of lecture:	Trainees were explained for responsibility of NHK, history of disaster reporting, disaster education, with experiences of past disasters. Also they learned that mass media must play the part of connecting the government, residents, and experts. Because of lacking this, the warning of big scale tsunami from expert had not conveyed effectively to residents and government before the Great East Japan Earthquake.
Main questions:	Why is dead body shown at Japanese TV news? NHK strongly considers the psychological trauma experienced by victims and their associates than lesson from the video of dead bodies.
Remarks:	In Mongolia, there is no division of roles and mechanisms of disaster reporting, and low awareness about it. Therefore trainee pointed that they shall start creating system of disaster reporting. Furthermore, they also recognized the importance of conveying the lessons by the disaster program.
Pictures:	 

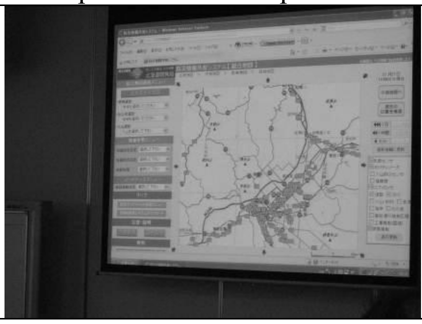
Date:	18 January 2013 (Friday) 14:00 - 16:00
Title:	Pre-lecture of Kaeru Caravan
Lecturer:	Mr. Hirokazu Nagata, Chairman, Plus Arts
Contents of lecture:	As the preparation of the "On-site training for organizing the "Iza! Kaeru Caravan!" event" at 27th January, Kaeru caravan study is conducted with other training course members. At first, the background and objective of Kaeru Caravan, then key points of development, experiences and expanse in Japan and abroad are explained. After the explanations, they tried to demonstrate the activities they'll conduct at 27th. Through a series of lectures and experience, trainees recognized the significance and meaning of the Kaeru Caravan.
Main questions:	How to create tools of Kaeru Caravan, and the meaning of Kaeru Caravan, etc.
Remarks:	In Mongolia, NEMA has been already incorporated Kaeru Caravan into disaster drills. Therefore, trainees tried to get more concrete experience, how to proceed, absorb knowledge.
Pictures:	

Date:	19 January 2013 (Saturday) 10:10 - 12:00
Title:	Visit to the Great Hanshin-Awaji Memorial Disaster Reduction and Human Renovation Institute (DRI)
Lecturer:	(DRI)
Contents of lecture:	The trainees made a tour of the facility which visitors can learn the effects of the Great Hanshin-Awaji Earthquake and lessons learned from the experience that should be shared with younger generation. First, from a storyteller aged 80 years old , they heard about overview of the DRI, a story about her experience in the Great Hanshin-Awaji Earthquake, and what she think important for disaster preparedness based on her lessons learned. Then, they watched the video which was reproduced the earthquake situation at the 1.17 Theater. They also learned challenges leading to recovery and reconstruction at the Great Earthquake Hall. Further, they enhanced their knowledge for public awareness by the exhibit and demonstration of methods and tools for learning disaster risk reduction. In addition, they also visited the floor which introduces the information on water related disasters and risk reduction, including storms and Tsunami.
Main questions:	(Q) Is there any display on how to transfer information in the event of a disaster? (A)There is a display of information dissemination during the time when the means of communication is limited.
Remarks:	Many of the trainees thought this kind of facility is effective for learning the threat of earthquake after watching the movies to give physically experience of earthquake damage. Also, they were very interested in the exhibit and demonstration of methods and tools for learning disaster risk reduction. They seemed to consider the future introduction of such facility in Mongolia.

Pictures:	 

Date:	20 January 2013 (Sunday) 9:30 - 11:30
Title:	Observation of Community-based Disaster Risk Management Drill
Lecturer:	Disaster Risk Management and Welfare Community in Shinyo (supported by Kobe Fire Department)
Contents of lecture:	The trainees observed the community-centered disaster risk management drill conducted in Nagata ward in Kobe city. The drill was conducted in collaboration with the Shinyo elementary school using the school ground. The programs of the drill included a training how to use fire extinguisher, experience of smoke from a fire, bucket relay for firefighting, musical performance of the band of fire brigade, and singing of the song named “Bring Happiness to the World” by school students. Besides of the community program, the school also conducted lessons for studying disaster risk reduction and evacuation exercise for Tsunami. The trainees not only observed these activities but also experienced some of the activities in the program. Also, they took a closer look of the warehouse for emergency response equipment at the school ground. Further, the trainees made a courtesy visit to the school principal.
Main questions:	(Q) Do all the schools have the warehouse for emergency response equipment? (A) In Japan, usually each community disaster risk management (and welfare) organization equips this kind of warehouse with necessary equipment
Remarks:	The drill was conducted mainly by the coordination of the Volunteer Fire Brigade and attended by a few residents. Therefore, it was not a good example for observing. However, the trainees could learn the preparation of the warehouse, and were interested in singing of the “Bring Happiness to the World (a memorial song of the Great Hanshin-Awaji Earthquake)” by students and experience of smoke from a fire used portable equipment.
Pictures:	 

Date:	21 January 2013 (Monday) 13:00 - 17:00
Titles:	Lecture: Disaster Planning and Measures of Local Government Visit: Asahikawa Housing Exhibition (Housing in Low-temperature Area)
Lecturer:	Headquarter of Asahikawa Fire Dept.
Contents of Lectures:	After having a lecture on Asahikawa Comprehensive Disaster Center, whose facilities and equipment, such as monitors, emergency vehicles and so on were introduced. Also stock piles in the operation base in case of disaster are explained.
Main questions:	Main concerns were given to the organization and equipment for disaster operation base. Some questions on information collection and management were made.
Remarks:	Many of trainee ware interested in disaster information management system that grasps

	all the information, and had questions on system itself as well as the way of operation. Also, emergency vehicle that played an important role in case of Great East Japan earthquake was attractive for them. Stock piles for low-temperature area seemed uninteresting for trainees.
Pictures:	 

Date:	22 January (Tuesday) 9:00 - 14:00
Titles:	Lecture 1: Outline of Northern Regional Building Research Institute Lecture 2: Earthquake Disaster Evaluation in Hokkaido Lecture 3: Evacuation Place in Winter Season Lecture 4: Emergency Assessment of Damaged Buildings Lecture 5: Walking Speed during Evacuation in Winter Visit: Testing Machines of Northern Regional Building Research Institute
Lecturers:	Hiromichi Takida: Director of Northern Regional Building Research Institute, Yoshiki Ooyagi: Director of Planning and Coordination Division, Shin-ichi Minami: Director of Performance Evaluation Section, General Affairs Division, Masahiro Hayashi: Residential Planning Group, Residential Planning Division
Contents of Lectures:	Damage Estimation, Rapid Assessment of Damaged Buildings and Evacuation in cold area in winter season are given and field trip to observe Test Machines such as Outside Environment simulation Room, Wind Sealing and Air Sealing Test Device, Wind Tunnel and Full Scale Vibration Table.
Main questions:	There are some questions about the distribution of faults in Hokkaido and the intensity calculation method. Also many questions related Rapid Assessment of Damaged Buildings are made and express of will to introduce this method to Mongolia.
Remarks:	Trainees have been interested in the Earthquake Risk Management of the Asahikawa city which has similar environmental situations as UB city. Many trainees have high interest about Rapid Assessment of Damaged Buildings. Northern Regional Building Research Institute kindly offers the Posters showing Assessment Result. PT decided to discuss with CP about the Rapid Assessment of Damaged Buildings to introduce into the Earthquake Disaster Prevention Planning. During moving, Bus stacked in to snow at side of road; Trainees get together and push out the Bus from snow. Trainees relaxed to face similar atmosphere in Mongolia (Photo below).
Pictures:	 

Date:	24 January 2013 (Thursday) 10:00 - 15:00
Titles:	Lecture: Seismic Upgrading Visit: Shoin Women's High and Junior High School (Seismic Upgrading)
Lecturers:	Takaaki Shiratori, Takenaka Corporation
Contents of lectures:	After learning on the past earthquake damage in Japan and on transition of seismic design, trainees had a lecture on seismic evaluation and target performance in case of earthquake. Also they fully understood the method to upgrade the capacity of building through lecture and site visit.
Main questions:	For the question how much seismic upgrading can increase the capacity of existing building, the lecturer answered that the capacity corresponding to the current Japanese code will be given, followed by the fact that there was little damage to buildings designed by current code in case of 1995 Kobe earthquake. Also size of reinforcement was asked, and standard size was explained by the lecturer.
Remarks:	Many trainees were interested in Japanese design practice. On the other hand, seismic upgrading was not attractive, since current issue in Mongolia is upgrading of large PC panel structure which is a very rare structural type in Japan.
Pictures:	 

Date:	24 January 2013 (Thursday) 15:30 - 17:30
Title:	Portable Earthquake Simulator "Jishin Zabuton"
Lecturer:	Mr. Naoki Kusano, Leader of Earthquake Disaster Risk Reduction Project, Hakusan Corporation Mr. Shingo Kuroda, Planning and Public Relations Division, Hakusan Corporation
Contents of lecture:	The trainees got explanation and experience of a portable earthquake simulator named "Jishin Zabuton". The cost of the equipment is less expensive than the earthquake simulation vehicle. Also we can easily transport it by a small-sized trolley, and maintain it at lower cost. It can reproduce not only short-period earthquakes but also long-period earthquake ground motions which is impossible by the simulation vehicle or normal fixed-type simulator. They experienced 12 types of earthquake shakings and learned features of the equipment.
Main questions:	(Q) What is included in the proposed cost? (A) It includes the equipment, programs of earthquake ground motion & audio-visual movies for 12 pre-installed earthquakes. As option, additional programs based on the past earthquake data and additional CG animation movies can be created.
Remarks:	The trainees did not get interested in the equipment as originally expected. However, they could deeply learn the differences of shaking by the types of earthquakes and by the location.
Pictures:	 

Date:	25 January 2013, 13:00 - 16:00
Title:	Radio System for Disaster Risk Management Information (Horn Array Speaker)
Lecturer:	Mr. Akihiro Yamauchi, Audio Production Manager, Audio Development Department, TOA Corporation
Contents of lecture:	They learned difficulty to deliver information in case of a disaster and the way to effectively deliver the messages utilizing TOA's equipment with excellent function. The detailed explanation of the "Horn Array Speaker" developed by TOA for delivering clear emergency broadcasts even to distant locations including its function and effectiveness. Also, the other technology to deliver the visual message with sound was introduced to them. The trainees could have deep understanding of the equipment with a closer look of the real speaker and explanation used the movie of comparative trial of the function.
Main questions:	(Q) The trainees asked weight, duration for cold weather, and cost (A) The detailed explanation of the weight for each model was provided. Also, they explained the duration for cold weather with the current performance of the equipment in Russia. As for the cost, they proposed negotiation over the e-mail communication.
Remarks:	The trainees had great interests with the speakers with excellent function by listening to the real sound from the similar type of the speaker.
Pictures:	 

Date:	26 January 2013 (Saturday) 9:20 - 11:30
Title:	Disaster Risk Reduction Learning Facilities for Citizens "Kyoto City Disaster Prevention Center"
Lecturer:	(Kyoto City Disaster Prevention Center)
Contents of lecture:	The trainees visited a permanent facility for the citizens to learn disaster risk reduction. After introduction of outline of the facility, they experienced some education programs with the lectures on basic important points, including of evacuation simulation from smoke, firefighting training utilized fire extinguisher, and earthquake simulation by the shaking table. Further, they tried some games to learn disaster risk reduction with fun, including of watching three-D movies of the simulated possible Kyoto earthquake, listening simulated sound of landslide, and virtual firefighting in the Self-study Section. Through the visit they could gain enhanced knowledge of public awareness for disaster risk reduction.
Main questions:	(Nothing particular)
Remarks:	All the trainees were actively involved in the programs with high interest. Some of them wanted to build this kind of learning center in Mongolia. Also, some of them were surprised that they can learn disaster risk reduction with it just like playing games.

Pictures:	 

Date:	26 January 2013 (Saturday) 12:30 - 14:00
Title:	Disaster Risk Management for Cultural and Historical Heritage (Traditional Housings "Machiya": Nishijin Hikobaenoie)
Lecturer:	Mr. Yoshihide Tamura, Representative of Kansai Association for the Research in Traditional Housings (KARTH)
Contents of lecture:	The trainees learned about originally equipped fire preventive function of traditional housing in Kyoto called "Machiya" and how to enhance functions for fire prevention and seismic resistance of the housings by renovation. The Nishijin Hikobaenoie is a "Machiya" renovated through testing of the effect of retrofitting. The trainees enhanced their knowledge by the introductory movies during the testing and observation of the housing.
Main questions:	(Nothing particular)
Pictures:	 

Date:	26 January 2013 (Saturday) 14:30 - 15:30
Title:	Disaster Risk Management for Cultural and Historical Heritage (Kinkakuji Temple)
Lecturer:	(Kinkakuji Temple)
Contents of lecture:	The trainees visited a traditional temple which takes necessary disaster prevention measures for conservation of the historical heritage from disasters, such as installment of automatic fire alarm system, fire hydrants, drenchers, and water cannon.
Main questions:	(Nothing particular)
Remarks:	(The trainees had interest in the Kinkakuji temple building, however, no attention to the garden or the other historical buildings.)
Pictures:	

Date:	27 January 2013 (Sunday) 12:00 - 16:00
Title:	On-site training for organizing the “Iza! Kaeru Caravan!” event
Lecturer:	(Committee for implementation of “Iza! Kaeru Caravan!”, a collaborative event in HAT Kobe)
Contents of lecture:	The trainees had on-site training for organizing disaster risk management exercise targeting children. They helped implementation of some programs as one of the organizers together with the trainees of the other JICA training course. Also, they observed and experienced the programs utilizing their free time. Through the activities, they could learn various creative efforts for teaching skills for disaster risk management and for raising public awareness. Further they got information of the mechanism of “Kaekko” (exchange of toys) which is effective for gathering people to the event.
Main questions:	(Nothing particular)
Remarks:	All the trainees enjoyed the experience of various programs. Also some of them get excited to collect points and learned the effectiveness of the “Kaekko” system. It could provide incentives for conducting the campaign event to be conducted on 22-23 May in UB city in the project.
Pictures:	 

10.2.2 Presentation Session of the Training in Japan

According to the structure of WGs, four groups made presentations as of the results of the training course on 28th January, the last day of training in Japan.

Each group has expressed to utilize the contents of this training course for further WG activities and UB City Disaster Prevention plan.

The presentations materials are shown in Appendix-2.

Chapter 11 Disaster Management Register for Mongolia

11.1 Updating of Disaster Management Register for Mongolia

Disaster Management Register for Mongolia is been updating reflecting the information collected in section 3 and in other activities. Disaster list is updated and current situation of five priorities for action of the HFA is been also updating in collaboration with NEMA. Furthermore, international supporting activities including coordination with other organization are been updating though UN donor meeting and so on.

11.2 Submission of Updated Disaster Management Register for Mongolia

Disaster Management Register for Mongolia updated during the first survey mission is attached. This register is being queried to NEMA.

Disaster Information List of Mongolia

Current Situation and Challenges

1. Disaster Characteristics

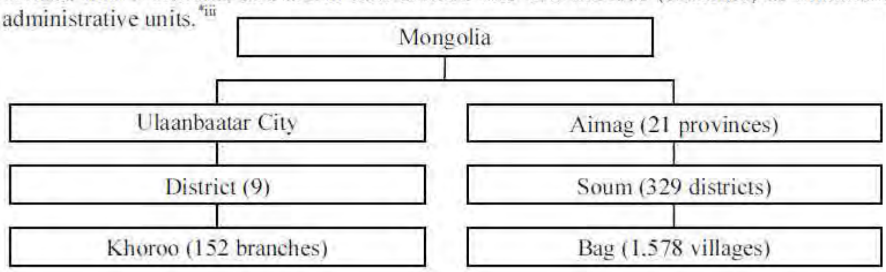
- The natural disasters with high incidence and big damage in the national level of Mongolia are storms and floods. In addition, suffered from drought, earthquakes, epidemics, famine, and forest fires. [*i,*ii]
- On the other hand, unfelt earthquake tends to increase since 2005 in Ulaanbaatar; especially it has increased significantly since 2009.
- 10 catastrophic numbers of dead natural disasters from 1900 to 2000 are as follows.

10 catastrophic numbers of dead natural disasters from 1900 to 2000[*ii]

Disaster	Date of disaster	Number of dead
Earthquake	02 December 1957	1,200
Flood	11 July 1966	57
Storm	26 May 2008	52
Flood	09 August 1996	41
Storm	21 April 1990	36
Flood	16 July 2009	26
Wild fire	08 April 1996	25
Storm	December 2000	19
Storm	07 April 2001	16
Flood	21 July 2003	15

2. Administration

- Mongolia is divided into 21 aimags (provinces), which are in turn divided into 329 sums (districts), and are in turn divided into bags (villages). The capital Ulaanbaatar is administrated separately as a khot (municipality) with provincial status, which is in turn divided into 9 districts, and are in turn divided into 152 khoroos (branches) as minimum administrative units.[*iii]



3. Disaster Prevention

	Current Situation	Challenge
Disaster Risk identification	• Ministry of Environment and Nature indicates and evaluates natural disaster. The satellite photo is received every day. And under the National Emergency Management Authority (NEMA) supervision, the institution of water resource and meteorology conducts making meteorological disaster map at Henthi pref. • Disaster Research Institute of NEMA receives Satellite data in case of emergency as a part of the Sentinel Asia Program through the secretariat of Sentinel Asia. They receive big amount data from WINDS hi-speed communication satellite with receiving station set by JAXA.. • The National Research Center of Astronomy and Geophysics developed earthquake hazard map of UB city	• Seismograph network is not enough, meteorological observation data is not collected with real-time. • Utilization of collected data is not sure. • Hazard map is not distributed to residents.
Sharing risks in the region and community	• Disaster management service is developed, tasks in relation to mitigation and indication is distributed to communities in local areas. [*iv] (not updating)	

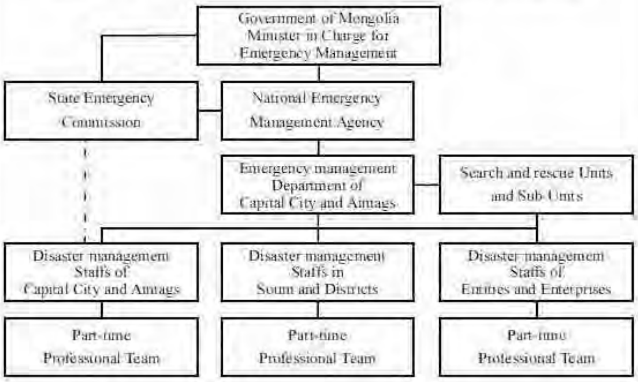
Current Situation and Challenges	Disaster related law, policy	Policy: • As a basic policy, Mongolia government, the State disaster protection policy and the state plan to strengthen capacity of disaster management are formulated, and promoting to develop state strategy in related to disaster management by law. *v Development of Laws: • The Parliament of Mongolia adopted the Law on Disaster Protection on 20 June 2003, and following the Law there are established the National Emergency Management Agency of Mongolia on 7 January 2004. *i • The services related to disaster management is independent from other ministries, personal responsibility and duty in charge of it are apparently defined. *vi (not updating) • This system efficiently supports activities of disaster management in National level. *vi (not updating) • Development of laws technically supports humanitarian aids of disaster management/reduction by other countries and international organizations. *vi (not updating) • This system is very effective for relationship with international organizations. *vi (not updating) • The Earthquake Preparedness plan has been developed by the National Emergency Management Agency of Mongolia and the National Research Center of Astronomy and Geophysics, and approved by the Government in 2010. • The permanent coordinating council for earthquake disaster prevention, reducing risk, providing preparedness (the council) was set up in cabinet, then the council formulated and promoting the implementation of the state plan of capacity development for earthquake disaster prevention. • The objective of setting the council is to establish the integrated management structure including disaster prevention, risk reduction, and preparedness through local government such as prefectures in Mongolia. • According to the plan in national level, UB city formulated the earthquake management plan. Related Plan: • The government had asked UNDP to conduct the earthquake disaster management, and it had been completed at 1999. *vi (not updating) • Livestock is very weak to natural disaster such as heavy snow, Dzud, heat wave, and drought in Mongolia. The government operates measure to protect from natural disaster, and achieves effects. *vi (not updating) • Laws of civil health, health insurance, immunity, organ donorship, sanitary, and medicine, furthermore rural development plan and civil health protection plan are established in Parliament. *vi (not updating) • Mongolian government approved following document: reorganization of Ministry of Health (MOH), development of public health services, support living family as normally, response to epidemic, protection people from epidemic by immune function. *vi (not updating) • MOH issues guideline for alert and protection of wildfire. Functions such as providing medicines, clear water, healthy food, and logging house to protect people who lives wildfire prone area, could be decrease disaster impact. *vi (not updating)	• The Earthquake disaster prevention plan is not opened as state secrets; therefore correspondence in case of disaster is ambiguous. (IFRC).

Current Situation and Challenges

Structure

Organization

National Emergency Management Structure in Mongolia [*1]



<Central Level>

National Emergency Management Authority, NEMA:

- NEMA, handled by Deputy Prime Minister, top of disaster management in Mongolia, is the responsible agency for the implementation of the State disaster protection activities. The departments of emergency management are set in 21 aimags and capital.[*1]
- The state board for civil defense, firefighting department and state reserve agency are merged into NEMA.[*1]
- Main duties of NEMA are as follows:
  - To develop legislative environment on disaster protection.
  - To provide strategic management.
  - To evaluate disaster risk and vulnerability.
  - To implement activities on disaster prevention, disaster reduction, disaster preparedness in all levels,
  - Organizing search and rescue work, response, restore main infrastructures and rehabilitation.
  - Strengthening capacity of national disaster protection.
  - Cooperation with foreign countries and international organizations in disaster protection field.
  - Monitoring laws and legislations, and implementation policy on state reserve.
- Also NEMA conducts following activities;
  - To formulate and implement Strategy plan, Relevant law, Policy guidance, Policy, and Planning, etc.,
  - Planning various kinds of training programs in relation to disaster management.
  - To conduct specialized operation management for disaster prevention activities,
  - Establish disaster information database and national network, provide information distribution service.
  - To conduct investigation of fire prevention and protection.
  - Research past disaster cases, analysis radiation disease and chemical poisoning in laboratory, maintenance and arrangement of necessary equipment.
  - Research and evaluate past fire cases.
  - Policy proposal and arrangement of state reserve.
  - Formulating policies of economic aspects, quality, and technology of reserve
  - Management of administration and human resources
  - Monitoring, evaluation, and internal audit planning of disaster management policy, plan formulation, program, project, agreement of cooperation, and contract
  - Technical advice, support, and providing service for deepen relationship with foreign countries and international organizations
  - Distributing disaster management policy, emergency information of disaster and forecast to citizens.
  - Management of budget of NEMA.

Current Situation and Challenges		Medical System • The standard system of structure and role of medical center in soum level, general and particular medical center in Aimag level as well, are approved by the government. [*vi] • For improvement of medical quality and adaptability in rural area, exchange-style medical centers for diagnosing and curing are established at Dornotu, UberHangai, and Kobdo aimag on 2001. It aims to provide special medical system in case of emergency at each area. [*vi] • MOH made the diseases list at 2002 which is life-threatening and emergency cases. And MOH made guideline to make precautions of those diseases to all medical institution. [*vi] • The Minister of Health signed at 2004 on the implementation plan of protection on infection of influenza and microbism from 2004 to 2007, then it had been conducted.	
	Hard component, land use		• Land is wide, with scattered population in Mongolia. If natural disaster such as wild fire, flood, drought, Dzud occurs, it would take long for response and medical act. The vulnerable point of Mongolia is the infrastructure such as communication system and road network. [*v]
	Early Warning System, Evacuation	<Disaster Awareness, Education, and Drill> • To transfer traditional methods and knowledge of estimation for disaster phenomena to younger generation, and developing handbook of disaster management manual based on herder. [*v] (not updating) • The mechanism which the results of observation, analysis, and research from experiences, disseminated through media is developed. [*v] (not updating) • At 16:00, the forth Thursday, March, every year, the evacuation drill with disaster warning drill, confirmation of loudness speaker system, and awareness of emergency, is conducted. Furthermore, the festival of the United Nations Disaster Risk Reduction Day is held at 14th October every year. [*vii]	• NEMA conducts disaster drill, however due to lack of past earthquake disaster experience, people participated without practical visualization. (IFRC) • Evacuation drill of UB city is based on no collapsing. (IFRC)
	Budget	• Current budget situation to conduct disaster management is as follows: [*v] • State budget is accounted for countermeasures to reduce damages by natural disasters; provincial budget is also as well. • Loan aid by donor countries and international organizations are appropriated to mitigate damages. • Also the gain from daily farming and ranch rental fee are as well. • The funds are set up by industry for keeping productivity even in case of emergency. • Also the money from individual and organizations are as well.	• With wild weather condition, nomads move around. The medical budget for them is not enough. [*v]
	4. Response		
		Current Situation	Challenge
	Structure of response	• NEMA is established. NEMA has responsibilities to disaster prevention, rescue, relief, and rehabilitation. [*v] • Coverall state organizations and civic organizations, the State council is organized to prevent steppe and wildfire. [*v]	
	Rescuer		
	Support for Victims		
	5. CBDRM		
		Current Situation	Challenge
		• Conducted with ADRC in 2010-11	

Current Situation and Challenge

6. Climate Change Adaptation

- According to extreme continental climate and because of impact by global level climate change, Mongolia has severe environmental disruptions and economical losses caused by drought, heavy snowfall, desertification, extreme Dzud, sandstorm, and steppe/wild fires.[*v]
- During past 60 years meteorological observation, annual temperature increases 1.9～2.1 deg. C. It is the trigger of desertification process, pastural devastation, and the water depletion in lake, river, and fountain.[*v]
- Mongolia applies to international communities to adapt for desertification, sandstorm, and removal sand-hill according to climate change. It is not only the thread of climate change for Mongolia, but also surrounding countries, therefore measures should be taken in cooperation with them.

Cooperation to solve problems

7. Project with JICA

<Technical Cooperation Project>[*vi]

Name of Project	From	To
Development of Human Capacity for Weather Forecasting and Data Analysis	2005	2008
Training of veterinary specialists on the reliable and instantaneous diagnosis of animal infectious diseases	2006	2009
The River Basin Management Model Project for the Conservation of Wetland and Ecosystem and Its Sustainable Use	2005	2010
The Study on City Master Plan and Urban Development Program of Ulaanbaatar City (UBMPS)	2007	2009
The Project on Capacity Development in Urban Development Sector in Mongolia	2010	2013
The Project for Strengthening the Capacity of Seismic Disaster Risk Management in Ulaanbaatar City	2012	2013

8. Projects with Other International Donors, NGOs, Organizations

- "Strengthening the Disaster mitigation and management system in Mongolia" conducted by UNDP[*v]
- Strengthening the Disaster Mitigation and Management System in Mongolia (MON/02/305) conducted by Luxembourg[*viii]
- "Improving Emergency Management Capacities at both up (policy development)and downstream (community) level" (2002-) conducted by UNDP[*ix]
- "Primary and secondary school risk reduction, disaster preparedness and response"(2005-) conducted by IFRC/MRCS[* vii]
- "Provision of Incident Command Systems Training for NEMA"(2012) conducted by USIAD/OFDA[*iv]
- "Livestock Early Warning System, Insurance, Information Systems against Dzud", (2005-2017) conducted by WB[*iv]
- "Flood Risk Mapping, DRM Planning, Flood Protection Channels in Ger Areas"(2012-2017) conducted by WB[*iv]
- "Community-Led Ger Area Upgrading in Ulaanbaatar City"(2003-) conducted by UNHABITAT[*x]

9. Problems, cooperation, and utilizations with ADRC, ISDR

Current Situation	Challenge
• ADRC member country, Counterpart is Foreign Relation Division of NEMA[*i] • VR program (2003, 2007, 2011, 2012) • ADRC peer review survey (2010) • Project on Transfer of Disaster Management Measures of Japan to Enhance DRR Capacity in Asia 2010	

[*i] ADRC Country Report (2011), http://www.adrc.asia/countryreport/MNG/2011/FY2011B_MNG_CR.pdf
[*i] EM-DAT: The OFDA/CRED International Disaster Database, Universite Catholique de Louvain – Brussels, (http://www.emdat.be) (accessed on 21 June 2012)
[*i] Yearbook2011, National Statistical Office of Mongolia
[*i] National Report on the implementation of the HFA (2007) (http://www.preventionweb.net/english/countries/asia/mng/?x=11&y=8)
[*i] National Emergency Management Agency of Mongolia, National Report on the Implementation of the Hyogo Framework of Action, Mongolia, Web (2007)
[*i] Activities in Mongolia, JICA, http://www.jica.go.jp/mongolia/english/activities/index.html(accessed on 23 June 2012), MOF. ODA data book 2011
[*i] The order of permanent coordinating council for earthquake disaster prevention, reducing risk, providing preparedness
[*i] STATEMENT BY HIS EXCELLENCY MR. M. ENKHBOLD, DEPUTY PRIME MINISTER OF MONGOLIA AT THE SECOND SESSION OF THE GLOBAL PLATFORM FOR DISASTER RISK REDUCTION GENEVA, SWITZERLAND, 16-19 JUNE 2009
[*i] The UN coordination meeting on "Disaster Risk Reduction Management Partners", Disaster Risk Reduction Management Database, 6 June 2012
[*i] UNHABITAT, http://www.fukuoka.unhabitat.org/projects/mongolia/detail02_en.html (accessed on 23 June 2012)

Chapter 12 Capacity Assessment

12.1 Business Continuity Planning (BCP) survey for DRR organization

12.1.1 Implementation of BCP survey

To grasp current situation for business continuity of DRR organizations, interview survey was conducted at NEMA on 2 April 2013, by utilizing BCP checklist (Table 12.1.1). This checklist had been made by cabinet office of Japan to support the study pertaining to the business continuity management in local government. It is a good opportunity for NEMA to evaluate current condition against disaster.

Table 12.1.1 The simplified checklist for investigation of Business Continuity Planning (BCP)

Check points	Reference
Target of investigation	
1. Have you determined (assuming event, organizations) what to consider business continuity system?	
Business continuity system	
2. Do you set the feasible business continuity system of emergency for routine work as well as emergency operations?	
Damage estimation	
3. Did you set the scenario earthquake and the disaster conditions?	
4. Did you estimate damage situations (seismic intensity, building damage, traffic function difficulty, trouble lifeline, etc.)?	
Selection of emergency priority operations	
5. Do you set the period for which to make business continuity plan?	
6. Did you select the emergency priority operations for each operation start time?	
7. Did you select the priority operations for routine work as well as emergency operations?	
Study of measures and analysis for resources needed	
8. Did you predict staff gathered that assumes the disaster at night and holidays?	
9. Did you assume staff damage caused by building damage in the daytime?	
10. Did you check building availablity at the disaster time?	
11. Did you check power availablity at the disaster time?	
12. Did you check tele communication availablity at the disaster time?	
13. Did you check radio communication availablity at the disaster time?	
14. Did you check disaster information system availablity at the disaster time?	
15. Did you check office space availablity at the disaster time?	
16. Did you check toilet for staff availablity at the disaster time?	
17. Did you check water and food for staff availablity at the disaster time?	
18. Did you check consumables (such as paper) availablity at the disaster time?	
19. Do you have concrete evidences for the analysis to ensure necessary resources?	
20. If it is considered necessary resources is insufficient, do you have alternative plan?	
21. For disrupts an important decision-making in the disaster, do you appoint the duties agent?	
Study of emergency response	
22. For rapid communication and coordination with stakeholders at the time of the disaster, do you have emergency contact list?	

12.1.2 Result of survey

Result of survey is shown in Table 12.1.2.

Table 12.1.2 Result of BCP survey

Check points	Answer
Target of investigation	
1. Have you determined (assuming event, organizations) what to consider business continuity system?	Assuming event is M6-7.5 earthquake around UB city, hazard map was made by RCAG. All organization is targeted.
Business continuity system	
2. Do you set the feasible business continuity system of emergency for routine work as well as emergency operations?	Mongolia has disaster prevention low, detail system is written.
Damage estimation	
3. Did you set the scenario earthquake and the disaster conditions?	Seasons (winter and summer), day and night time are considerd.
4. Did you estimate damage situations (seismic intensity, building damage, traffic function difficulty, trouble lifeline, etc.)?	Estimated with numeric simulations. Passport of each building is conducted, inventory surveys for lifelines are on the way in UB city.
Selection of emergency priority operations	
5. Do you set the period for which to make business continuity plan?	2, 6, 12, 24, 48, 72 hours after event are determined.
6. Did you select the emergency priority operations for each operation start time?	yes
7. Did you select the priority operations for routine work as well as emergency operations?	no
Study of measures and analysis for resources needed	
8. Did you predict staff gathered that assumes the disaster at night and holidays?	Staff call system is determined. In case of no telecommunication, staff will go to each colleague house to inform going to office. Automatic staff gatherd sysytem is none.
9. Did you assume staff damage caused by building damage in the daytime?	NEMA HQ building was investigated for the earthquake, and the collapse risk is low (0-0.2).
10. Did you check building availablity at the disaster time?	If the building is not in use, alternative place is planed.
11. Did you check power availablity at the disaster time?	Self-generator and fuel are prepared.
12. Did you check tele communication availablity at the disaster time?	NEMA has contracts with multiple telecommunication companies.
13. Did you check radio communication availablity at the disaster	Military radio system will

time?	be available in case of dis-tele-communication.
14. Did you check disaster information system availablity at the disaster time?	Disaster information system is developping.
15. Did you check office space availablity at the disaster time?	Data is backuped at central database center, office equipments are not fixed.
16. Did you check toilet for staff availablity at the disaster time?	At present, water shortage is not estimated. If not, big water tank will be setted.
17. Did you check water and food for staff availablity at the disaster time?	Each staff prepare food and water for 3 days in emergency bag.
18. Did you check consumables (such as paper) availablity at the disaster time?	Unknown, maybe no.
19. Do you have concrete evidences for the analysis to ensure necessary resources?	Yes
20. If it is considered necessary resources is insufficient, do you have alternative plan?	Yes
21. For disrupts an important decision-making in the disaster, do you appoint the duties agent?	Yes
Study of emergency response	
22. For rapid communication and coordination with stakeholders at the time of the disaster, do you have emergency contact list?	Yes

Ref: CAO,Japan

12.2 Disaster awareness survey for residents for clarify UB city Earthquake Disaster Management Plan

12.2.1 Implementation of disaster awareness survey

It is basic information to prepare the Earthquake Disaster Risk Management Plan to grasp the knowledge of earthquake disaster and the preparedness. The questionnaire survey is implemented for citizens of Ger area and for citizens of the developed area to grasp the awareness for the earthquake disaster, risk preparedness, existing problems and needs and to use as the baseline of policy implementation evaluation.

This survey was implemented as following schedule.

2012. April — Design of Questionnaire sheet
2012. April — Pre-survey in MOST
2012. June — Modification of Questionnaire
2012. July — Implement for Ger area, Delivered 100 sheets and Collected 82 sheets
2012. September — Implement for Developed area, Delivered 150 sheets and Collected 133 sheets
2012. December — Implement for UB city Officials, Delivered 50 sheets and Collected 32 sheets
2012. December — Implement for EMDC Officials, Collected 38 sheets
2012. December — Implement for NEMA Officials, Collected 32 sheets

12.2.2 Result of Survey

Questionnaires and result of survey is summarized in Databook.

12.2.3 Subjects come clear from survey and needed actions against those subjects

Table 12.2.1 Subjects come clear from survey and needed actions against those subjects

Items	Subject come clear	Comments	Acton to be needed
Experience of Earthquake	- Earthquake is very uncommon for UB Citizens. - Most peoples have not experienced big earthquake	- Evacuation, firefighting, living after disaster is all out of expectation. - Proper action can not to be expected.	- Education and Awareness of fundamental earthquake disaster are needed to be done not only for citizens but also private sectors and governmental staff.
Knowledge of Earthquake	-57% of Ger residents, 18% of apartment residents, 5% of government officials do not have the knowledge of earthquake. - TV, newspaper is main souse of knowledge in the apartment residents	- Some deference is recognized depend on area of living in UB city. - Need of education of earthquake for Ger residents	- Education and awareness of earthquake is highly needed. - It is suitable to take leadership by government officials.
Occurrence of Earthquake in UB city	- 60% of the Ger residents answered that earthquake may not occur in UB city. - 20% of the apartment residents answered that earthquake may not occur in UB city.	- Recognition of earthquake occurrence is low in Ger residents and apartment residents。	- Education and awareness about hazard risk is highly needed.
Damage of House	- No damage 11%, slight damage 58%, severe damage 23% for apartment residents, - No damage 12%, slight damage 47%, severe damage 33% for government officials. - 46% suffer damage in Ger residents. - Place to live for questionnaire of difficulty after earthquake is highest in Ger residents.	- Damage of houses is highly concerned issue in both Ger and apartment residents. - On the other hand, 70% apartment residents answered their house may get no damage or slight damage. - Public assistant and relocate much strong	- Contents of public awareness for apartment residents may renew correspondent to the result of Earthquake Hazard. - Seismic assessment, retrofit, urban planning for disaster proof city will be needed

		building	
School Buildings	-Many people consider that school building will be collapse. 46% slight damage, 42% severe damage	- Many people anxious school buildings and demand to strengthening of school buildings is high.	- Promotion of strengthening of school buildings is highly needed.
Difficulty after earthquake	- "Rescue from collapsed building"," Electricity and water supply loss" in the apartment residents. - "Rescue from collapsed building", "Firefighting", "Relief Materials" in Ger residents -lack of information is not recognized as difficulty.	- Strong fear for public assistant after earthquake. Fear of supply of Lifeline, is recognized. -Difficulty of Information after earthquake is less conscious.	- Strengthening of Search and Rescue system for earthquake. - Strengthening Emergency Road and Hydrants system Need of urban planning for earthquake disaster to make UB city strengthening against earthquake disaster. - awareness of importance of information and development of information infrastructure are needed
Activities during earthquake	- Most residents will go out from house and /or stay in garden.		- Education of action during earthquake is needed.
Activities after earthquake	- Most residents answer to try to help others. - Stay in garden or clean house are higher in the apartments residents.		
Response to the fire	- 67% people make fire call when fire break out and only 17% fight to fire in Ger area. - Both fire call and firefighting activity are taken in the apartment residents. - firefighting activity is 57% in government officials	- People react as same as normal time fire. Many government officials fight fire. - Few people fight fire	- Educate the earthquake fire such as simultaneous multiple fire occurrence and wide spread of fire - Initial firefighting by community needed to train.
The place if their house collapse	- When houses were collapsed about 40% of residents will go their relative's houses both in the apartment residents and Ger residents.	-It might be reason that half of population live in UB city that 40% of people answer to go to relative' house.	- Need to evacuate to school may reduce because of many people evacuate to relative's house
Preparedness against earthquake	Prepare stock for emergency is low. Drinking water 12%, food 5. In Ger area, water 9%, food 0%	- Water, food stock is low. in Ger area,	- Stock of water, food for earthquake needs to be promoted to people. Importance of houses to be made seismic resistance is needed to be promoted. Awareness of damage of houses by earthquake.
Participation to the disaster drill	- Are there some reasons that many people have relatives in UB city? Relatives might also suffer damages by earthquake.	- Drill was started recently and come active by the effort of national government and UB city government.	- Continuous practice to public is needed.
Information from government	Residents recognize booklets related disaster information or earthquake risk from government. - But government side recognizes not only these but also disaster drill, risk of buildings, action to be taken during earthquake. - There are some gap exist		

	between residents and government.		
Request to government about earthquake disaster	- Disaster knowledge, risk of earthquake occurrence, high risk place in UB city is requested from citizens.	- Much wider information is needed to offer from government.	- Disaster knowledge, risk of earthquake occurrence, high risk place in UB city is needed to offer for public.
Community organizations	- Community organizations exist about 20% and not common in UB city. - Most common activity is to transfer information from government to residents. Second is cleaning of garbage	- Strengthening community organization activities in case of disaster is important if big disaster such as earthquake, it is difficult to manage completely by government. - Strengthening of Mutual cooperation in community level such as Search and rescue, mutual cooperation in evacuation or activities in evacuation place and disaster preparedness are highly needed.	- Importance of community activities in case of earthquake disaster should be educated. - Formation of community organization for disaster should be promoted. - Communities in Ger seem to establish already close relation with local government. It will be good base to promote good cooperation for earthquake disaster.

12.2.4 Subjects to be mentioned in Earthquake Disaster Management Plan

- Earthquake is very uncommon for UB Citizens and most peoples have not experienced big earthquake. Evacuation, firefighting, living after disaster is all out of expectation. Therefore Proper action can not to be expected to be taken by citizens. Education and Awareness of fundamental earthquake disaster are needed to be done not only for citizens but also private sectors and governmental staff.
- 57% of Ger residents do not have knowledge, it means education and awareness of earthquake is highly needed especially in Ger area. On the other hand government officials have much knowledge of earthquake. Therefore it is suitable to take leadership by government officials.
- UB city people consider their houses may suffer damage by earthquake from the result of questionnaire that 81% of (slight damage +severe damage) for apartment residents and 80% of (slight damage +severe damage) for government officials.
- UB city people consider that school may be collapsed from the result of questionnaire that slight damage is 46% and severe damage is 42%. Therefore many people anxious school buildings and demand to strengthening of school buildings is high. Promotion of strengthening of school buildings is highly needed.
- Lack of information is not recognized as difficulty. Difficulty of Information after earthquake is less conscious. Awareness of importance of information and development of information infrastructure are needed
- 67% people make fire call when fire break out and only 17% fight to fire in Ger area. People react as same as normal time fire. Few people fight fire. Education of the earthquake fire such as simultaneous multiple fire occurrence and wide spread of fire is needed. Initial firefighting by community needed to train.
- When houses were collapsed about 40% of residents will go their relative's houses both in the apartment residents and Ger residents. It might be reason that half of population lives in UB city that 40% of people answer to go to relative' house. Need to evacuate to school may reduce because of many people evacuate to relative's house
- Disaster knowledge, risk of earthquake occurrence, high risk place in UB city is requested from citizens. Much wider information is needed to offer from government. Disaster knowledge, risk of earthquake occurrence, high risk place in UB city is needed to offer for public

- Community organizations exist about 20% and not common in UB city. Most common activity is to transfer information from government to residents. Strengthening community organization activities in case of disaster is important if big disaster such as earthquake, it is difficult to manage completely by government. Strengthening of Mutual cooperation in community level such as Search and rescue, mutual cooperation in evacuation or activities in evacuation place and disaster preparedness are highly needed. Importance of community activities in case of earthquake disaster should be educated.
- Formation of community organization for disaster should be promoted.