Report on talk on "Seismic Hazard Assessment Considering Geotechnical Conditions for Earthquake Resistant Design of Structures in Malaysia"

By: Ir. Lee Eng Choy

IEM had the honour of having with us Prof. Dr. Azlan Adnan from the Structural Earthquake Engineering Research of Universiti Teknologi Malaysia to deliver an important lecture on "Seismic Hazard Assessment Considering Geotechnical Conditions for Earthquake Resistant Design of Structures in Malaysia". Prof. Dr. Azlan pointed out that whilst Malaysia is situated on the southern edge of the Eurasian Plate and is located in a stable Sunda Shelf with low to moderate seismic activities, it is close to active seismic zones in Indonesia and the Philippines. In fact, Malaysia is separated from these zones by a distance of less than 300 km. It is bordered to the west by the seismically active inter-plate boundary (subduction zone) between the Indo-Australian and Eurasian Plate and to the east of Sabah by the inter-plate boundary between the Eurasian and Philippines Plate. Major earthquakes originating from these zones have been felt in Malaysia.

Prof. Dr. Azlan pointed out that seismic hazard assessment plays a major role in identifying the potential consequences of an earthquake both in relation to existing facilities as well as in the planning and location of new structures. The consideration is a part of the earthquake resistant design requirement to obtain the probable safety factor against earthquake hazards which considers not only geological and seismological conditions, attenuation of earthquake wave propagation in base rock, and specific acceleration time histories, but also geotechnical conditions which involve site specific soil profiles. He discussed the methodology and results of recent seismic hazard assessments in Malaysia and the design response spectrum to be used in earthquake resistant design of structures especially for buildings in Malaysia. The methodology adopted for the assessment include: i) data collection of soil data and structural elements, ii) verification of models generated by previous studies, iii) preparation of macrozonation maps which will involve determination of soil dynamic properties and analysis of dynamic soil response.

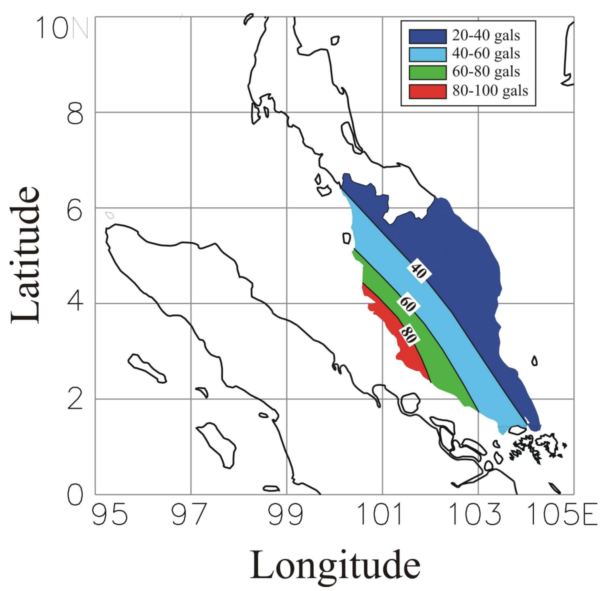

Fig. 1: Macrozonation map for Peninsular Malaysia for 500 year return period

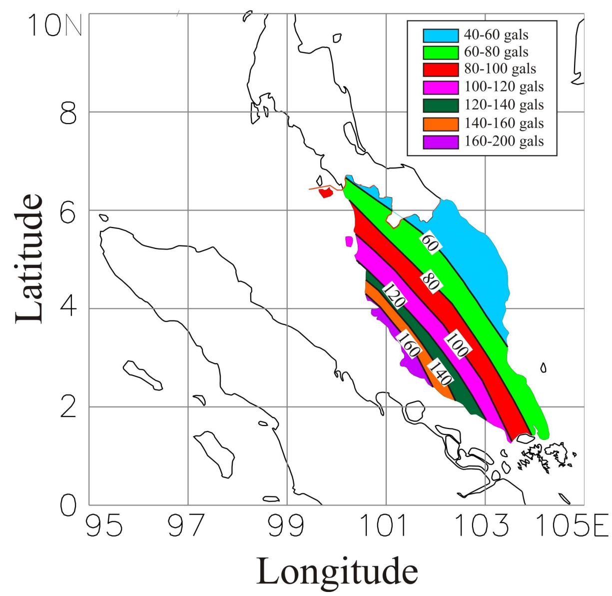

Fig. 2: Macrozonation map for PeninsularMalaysia for 2500 year return period

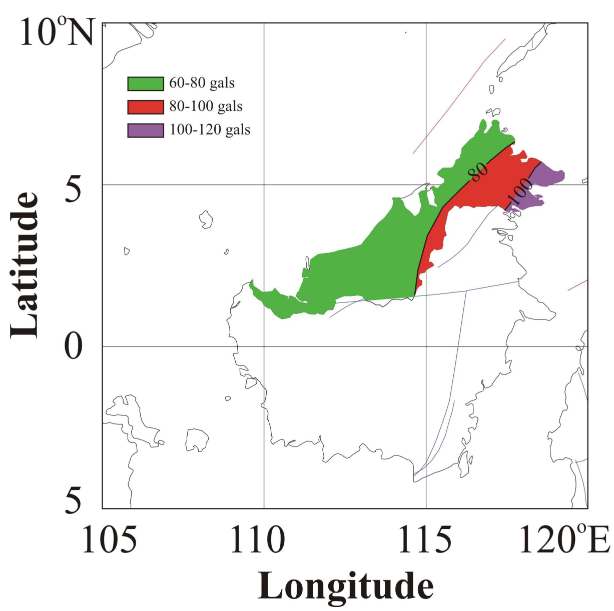

Fig. 3: Macrozonation map for Sabah & Sarawak for 500 year return period

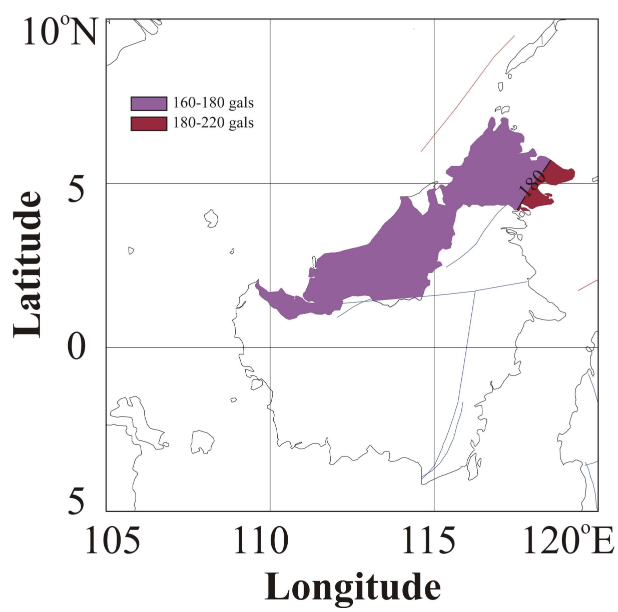

Fig. 4: Macrozonation map for Sabah & Sarawak for 2500 year return period

Prof. Dr. Azlan mentioned that macrozonation maps provide input for seismic design, land use management as well as estimation and prediction of potential for liquefaction and landslides. It also provides the basis for estimating and mapping the potential damage to buildings.

Prof. Dr. Azlan discussed the ground response analyses which are to predict ground surface motions for the development of macrozonation maps and design response spectrum, to evaluate dynamic stresses and strains for evaluation of liquefaction hazards, and to determine earthquake-induced forces that can lead to instability of earth and earth-retaining structures. He mentioned that several methods have been used to analyse ground response. He also mentioned that most of these methods are based on the assumption that the main response in a soil deposit is caused by the upward propagation of horizontally polarised shear waves (SH waves) from the underlying rock formation. The refraction of these waves produces nearly vertical wave propagation near the ground surface, as illustrated in Figure 5.

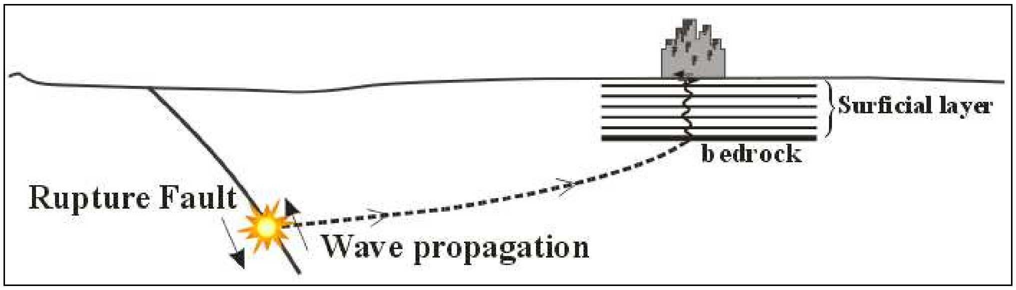

Fig. 5: Refraction of waves near ground surface

Prof. Dr. Azlan illustrated with an example of seismic hazards asssessment which is provided in terms ground acceleration contours, design response spectra, surface ground accelerations and surface response spectra. Macrozonation maps for Putrajaya were used for illustration (Figures 6 and 7).

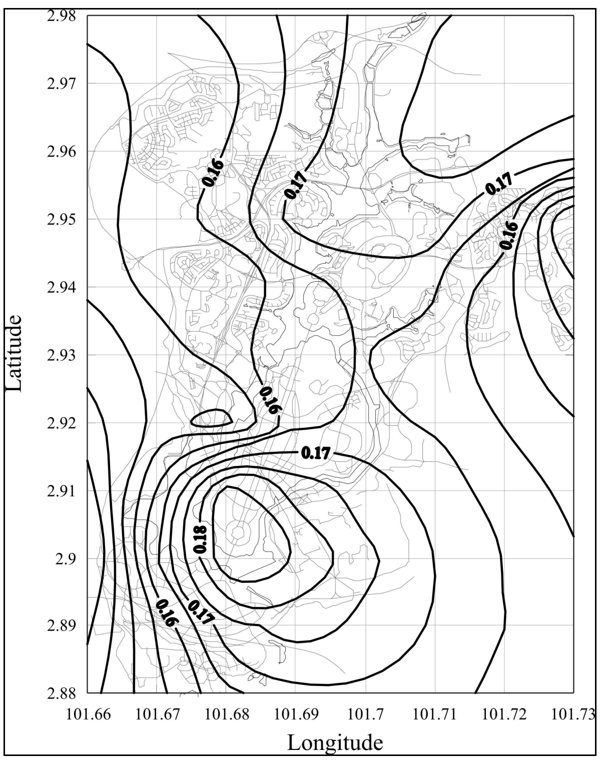

Fig. 6: Contour of acceleration at ground surface in Putrajaya (T_R=500 years, PGA=0.073 g)

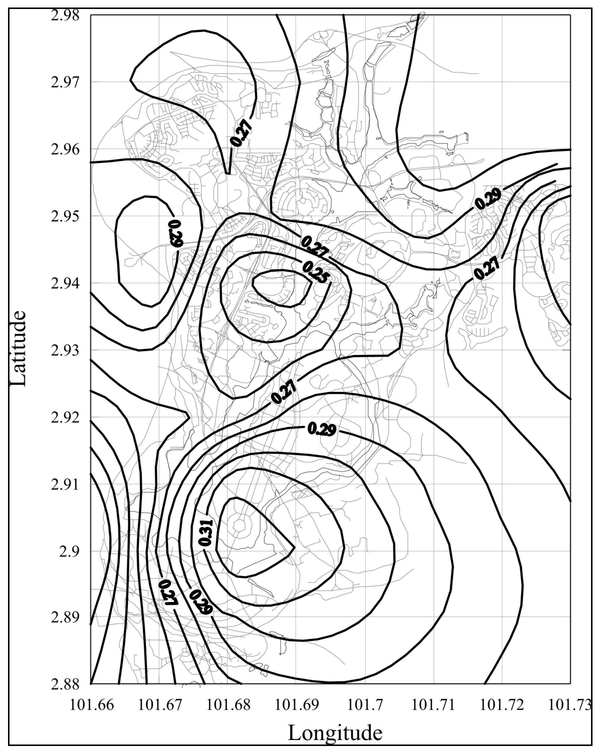

Fig. 7: Contour of acceleration at ground surface in Putrajaya (T_R=2500 years, PGA=0.073 g)

Prof. Dr. Azlan concluded his lecture by highlighting the results of ground response analysis for several major cities in Peninsular Malaysia (Table 1).

No.	City	Return Period 500 year			Return Period 2,500 year		
		PGA (g)	PSA (g)	AF	PGA (g)	PSA (g)	AF
1	KL City Centre	0.073	0.11-0.20	1.5-2.7	0.149	0.20-0.33	1.3-2.2
2	Putrajaya	0.073	0.15-0.19	2.1-2.6	0.149	0.24-0.32	1.6-2.1
3	Georgetown	0.052	0.06-0.07	1.2-1.3	0.100	0.11-0.13	1.1-1.3
4	Ipoh	0.053	0.11-0.12	2.1-2.3	0.107	0.16-0.23	1.5-2.1
5	Johor Bahru	0.042	0.07-0.08	1.7-1.9	0.084	0.12-0.21	1.4-2.5
6	Melaka	0.076	0.10-0.17	1.3-2.2	0.151	0.160-0.31	1.0-1.8
7	Seremban	0.077	0.15-0.17	1.9-2.2	0.155	0.26-0.34	1.7-2.2
8	Alor Setar	0.039	0.10-0.185	2.5-2.75	0.073	0.16-0.19	2.0-2.4
9	Shah Alam	0.083	0.10-0.18	1.2-2.2	0.167	0.21-0.36	1.3-2.2
Note: AF = Amplification Factor							

Active discussions were exchanged with the audience at the end of his lecture as everyone was keen to gain a better understanding on seismic hazard assessment.