Two-Day Symposium/Workshop on Earthquake Engineering In Malaysia and Asia Pacific Region 2013

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The Two-Day Symposium cum Workshop on Earthquake Engineering in Malaysia and Asia Pacific Region is the continuation of the series of earthquake lectures and courses held in 2011 and 2012. This sequel earthquake Symposium was organised by the Civil & Structural Engineering Technical Division of IEM, in collaboration with IEM Technical Committee on Earthquake. The lectures delivered by various renowned Speakers were held on 10 and 11 April 2013 at Armada Hotel, Petaling Jaya and was well attended by 93 participants. The event kicked off with the opening speeches by the specially invited guests, En Mahadir Mohamed (representing Standards Malaysia, the main sponsor of the event), and the IEM Deputy President, Ir. Choo Kok Beng, who officially launched the opening of the symposium and workshop.

The introductory paper was delivered by Ir. Prof. Dr. Jeffrey Chiang from The Institution of Engineers, Malaysia. The **history of the earthquake occurrence** recorded in 1906 at San Francisco up to the recent earthquakes at Kobe in 1995, Aceh Sumatra in 2004 and the Great East Japan earthquake and tsunami in 2011 were highlighted.

The first Speaker, Professor Friedemann Wenzel from Karlsruhe Institute of Technology, Germany, gave a lecture on **Seismic Hazard Assessment in Europe**. The presentation began with the engineering demands on the seismic hazard results in terms of no-collapse and damage limitation requirements, classification of structures and site classification of soil/rock types. The EC8 Response Spectrum together with the seismic zoning and Hazard Map and the current code for Germany were explained in relation to the main principles of probabilistic hazard assessment in low to moderate hazard areas. Also, the work on the Seismic Hazard Harmonization in Europe (SHARE) Project and its components such as databases, source models, maximum magnitude determination, ground motion prediction equations and the computational procedures were highlighted.

The second Speaker, Professor John Wilson from Swinburne University of Technology, Melbourne, presented a paper on **Performance of Structures in Region of Lower Seismicity**. The lecture covered displacement based design principles and checking procedure for regions of low and moderate seismicity as experienced in Australia and Malaysia.

The concept of displacement controlled behaviour has been introduced for regions of lower seismicity which in turn restricts the peak displacement demand (PDD) imposed on structures. The resulting normalized response spectrum and the return period (RP) in regions of lower seismicity and the use of a deterministic or probabilistic approach to quantify the appropriate effective ground acceleration scaling factor to define the hazard map were discussed.

Finally, case study examples investigating the lateral drift behaviour using both experimental and analytical techniques and the use of capacity curves were presented.

The third Speaker Dr. Nguyen Dai Minh from Vietnam Institute for Building Science & Technology (IBST) Hanoi, Vietnam, presented a paper on **Determination of the Seismic Loads based on TCXDVN 375:2006 and Comparisons with those obtained from other codes**. The simplified procedures to calculate seismic loads based on Vietnam Code TCXDVN 375:2006 was presented for the lateral force and response spectrum method of analysis. Also the computed seismic loads based on TCXDVN 375:2006, UBC: 1997, ASCE 7-05 and the Russian Code SNiP II-7-81 for most regular tall buildings in Vietnam were compared.

The fourth Speaker Professor Nelson Lam from The University of Melbourne lectured on **A Global Approach to Ground Motion Predictive Relationships for Structural Design Applications**. The lecture covered the description of the evolution of the seismic hazard assessment methodologies from the global perspectives with specific reference to conditions of low and moderate seismic regions such as Australia and Malaysia. The challenge over lack of data for modelling ground motion behaviour was discussed with references to the development of the seismic hazard model for Australia and to studies being conducted elsewhere in the Asian region. The Speaker explained the inter-disciplinary dimension after which he highlighted issues relating to integrating the Global Approach development of the seismic hazard model with the aid of Ground Motion Prediction Equation (GMPE), global benchmarking with major cities of the world with 2500 years RP and an independent check with geophysics strain rate map. A new approach in constructing a response spectrum based on PDD was also introduced. Finally, the drift predictions of structures were presented, with some information on the new discovery on torsional amplification in displacement controlled conditions.

The fifth Speaker Dr. Srikanth Venkatesan from Victoria University delivered his lecture on **Seismic Hazard Assessment for Sri Lanka**. The Speaker introduced the code proposal for Sri Lanka and described the seismotectonic nature and differing boundaries and both the long-distant and intra-plate characteristics of Sri Lanka. The Ground Motion models, broadband data and recorded events and the data processing procedure using multiple linear regression as well as the results from residual plots were explained. Also the research approach and challenges and the analysis of results of PGVs were compared using the Atkinson & Kaka model (2007). In summary, the Speaker concluded that the Sri Lankan seismicity might be similar to Malaysia's, the stochastic modeling approach has been found to be reliable, and there have been significant improvements in seismic hazard estimations in the Asia Pacific Region.

The final Speaker for the day was Dr. Hing-Ho Tsang from Karlsruhe Institute of Technology, Germany, and his lecture was on **Local Site Effects on Earthquake Loading Model in Regions of Low-to-Moderate Seismicity**. His lecture covered the basic phenomena of local site effects on soil and rock, the amplification effects by near-surface sediments and the soil response in case of distant, long-duration earthquakes. The inertial and kinematic effects on soil-foundation-structure interaction analysis using 3D finite element modelling and the key concepts for site effects evaluation were explained in detail. Finally the design spectrum models in the Codes of Practice for Eurocode 8 (2004), Australian Standard (2007), International Building Code (2012) and New Zealand Code (2004) were shown and their deficiencies identified.

A Workshop was conducted on the second day which consisted of three forums as follows:

Forum 1: "Seismic Hazard and Design Spectrum Model for Peninsular Malaysia"
Forum 2: "Site-Specific Design Spectrum Model"
Forum 3: "The Way Forward"

Forum 1: "Seismic Hazard and Design Spectrum Model for Peninsular Malaysia"

The first forum was chaired by Ir. MC Hee. The session commenced with "Updates on the development of design spectrum model for Peninsular Malaysia" which was presented by Engr. Looi Ting Wee on behalf of the Task Force comprising Ir. MC Hee, Dr Hing-Ho Tsang and Professor Nelson Lam. The presentation was a sequel to the paper delivered in the previous forum held in 2011 in which a hybrid approach was endorsed, and it primarily reported on the updates of research work that has been undertaken in the past 18 months. The presentation was fully based on the paper written by the Task Force and published as the cover story in the April 2013 issue of IEM *Jurutera*.

The modified distant earthquake model was first introduced with rigorous steps involved to determine the period dependant correction factor, forming a probabilistic Uniform Hazard Spectrum (UHS) with a 2500 year return period (RP). It was followed by a detailed discussion on local earthquake modelling, which is linked to Professor Nelson Lam's "global approach on seismic hazard model". An explanation was provided on adopting the deterministic approach which was based on Peak Displacement Demand (PDD) and a magnitude-distance combination of M6R20-30, resulting in a notional peak ground acceleration (PGA) of 0.13g. Finally, the process of unifying the two response spectrum models into a single hybrid response spectrum of displacement (RSD) was explained. The distance effects were discussed, taking KL and Penang as examples. The recorded earthquake data, Eurocode 8 (EC8) type 1 and 2 spectrum and 1.5% of notional load were also compared to the proposed hybrid model. In the final discussion, the task force suggested to further unify the model by harmonizing the short period (taking KL as the benchmark at notional PGA 0.13g) and the long period (taking Penang as the benchmark at 400km from the Sumatra Subduction fault) throughout the whole of Peninsular Malaysia for engineering design simplicity.

The second invited presentation entitled "Study on Hypocenter relocation of the local earthquake in the Malay Peninsula using the Modified Joint Hypocenter Determination (MJHD) and HYPOCENTER Programmes" was presented by Dr Mohd Rosaidi from the Malaysian Meteorological Department (MMD). The calibration work of relocating 13 hypocenters of local earthquakes using the MJHD approach and HYPOCENTER programmes were presented.

Forum 1 ended with an open discussion and a 'reaching of consensus' session. Some key issues raised were on the margin of civil protection from the perspective of the engineering consultant, theoretical input by academics from universities, and the view of the non-engineering society (eg: insurance industry) on the proposed model. A fair amount of different opinions was given on the proposed uniform standardized hazard model or the use of hazard level contour map. Questions were raised on the cost implication of the structures in Malaysia if the seismic model is implemented. The IEM committee took note of the above questions and suggestions, and recommended that an impact study on structures be carried out before any conclusions are made related to an increase in cost of structures.

Forum 2: "Site-Specific Design Spectrum Model"

The second forum was chaired by Professor Nelson Lam. Dr Hing-Ho Tsang presented a paper on "Recommended Site-Specific Design Spectrum Model for Malaysia". The site classification and site factor in EC8 were first discussed. Other alternatives of site amplification were presented by introducing the German spectrum with site factors, non-linear model for the next European GMPE, readily available computer programmes like SHAKE and SIREN, and site effect terms as continuous functions of the site period. Finally, the use of a simplified non-linear formula for S-factor which can be further simplified into two design charts or programmed into a spreadsheet was discussed by using an example of one of the sites in Hong Kong, along with comparisons using SHAKE and EC8 models.

During the Forum 2 open discussion session, a few guidelines for site factor were highlighted in order to make a decision on the format to be coded into the future Malaysia earthquake standard. The displacement based approach was put into discussion, and whether or not the Malaysian code should adopt this approach. This approach was used by some of the engineers attending the forum who have had experience in seismic design. They have adopted a force based design approach and have used the displacement based approach as a performance check, and they have arrived at a logical, reasonable and satisfactory result. The international panellist Professor John Wilson suggested that irrespective of whether RSD or RSA was used, the response spectrum model forming the Acceleration Displacement Response Spectrum (ADRS) must be robust.

Another important point which was brought up for discussion was the option of hand calculation for non-linear site factor formula (presented by Dr Hing-Ho Tsang) or the use of SHAKE or SIREN site factor programme. Some practising consultants preferred the use of SPT (due to the abundance of bore-log data) as reference to the site class table and the use of the simplified formula for hand calculation. Professor John Wilson remarked that one needed to have the whole sub-surface geological profile in order to perform the options above. Professor Friedemann Wenzel suggested that in order to relate the site factors to the geological features of the country, as carried out for example in Germany, the site factor can be pre-fixed by coordinates, and engineer then does not need to calculate the site factor. The chairman Professor Nelson Lam suggested that the conventional code approach of specifying site factor in tables in accordance with SPT and shear wave velocity can be applied for simple and general structures as a first tier approach. A higher tier approach using hand calculation of non-linear site factor incorporating site period parameter can be proposed for very important structures and for very bad soil conditions at site. There was no further opposition on the suggested two-tier method.

Further to the decision of the option of dynamic soil column hand calculated S-factor to be the higher tier method, the decision on bi-linear format, site corner period and site factor were all put up for discussion. It was noted that bi-linear format would be the way to go and further work was needed on the site corner period and site factor. A suggestion was made by practising consultants to eventually have the urban areas of Malaysia mapped using bore-log archived data. The above discussions were endorsed in the workshop in Forum 2 (see Figure 1).

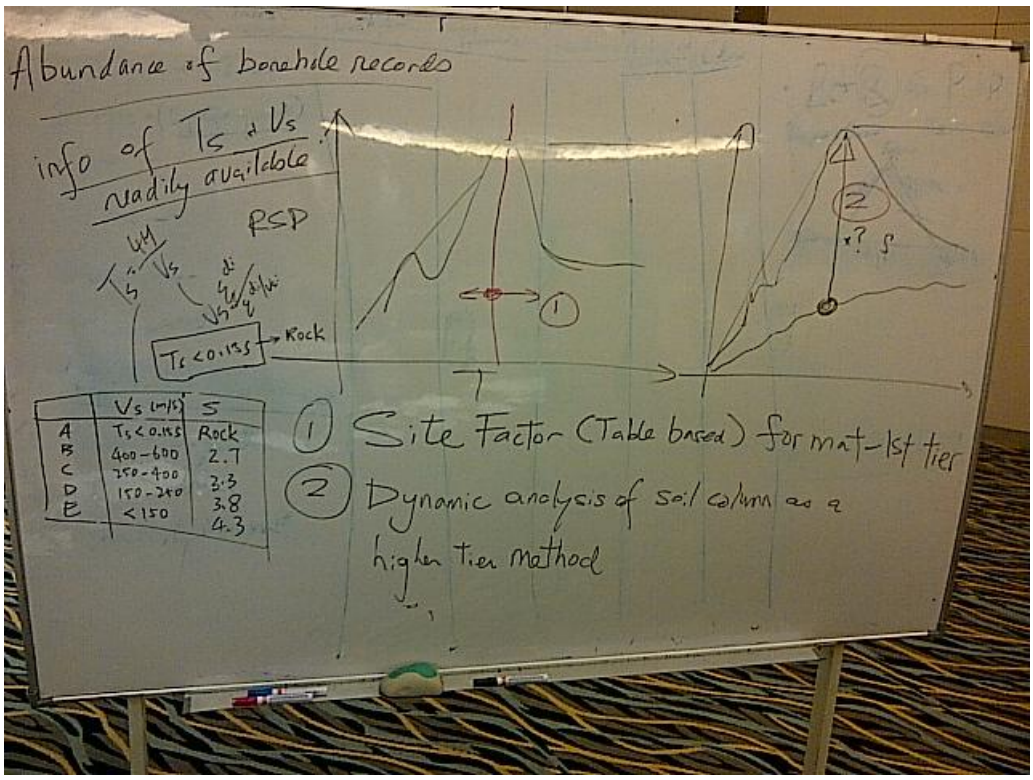

Figure 1: Forum 2 site factor discussion and endorsement

Forum 3: "The Way Forward"

Professor John Wilson chaired the final forum, Forum 3, "The Way Forward". Key points to reach consensus discussed were as follow:

1. The use of 2500 years RP and the displacement-based approach
2. The further unified model for the whole of Peninsular Malaysia
3. Two-tier site factor approach
4. Behaviour/Ductility "*q*" factor
5. Equivalent seismic base shear design for a simple structure
6. Other issues: non-structural elements, adoption of EC8

1. <u>The use of 2500 years RP and the displacement-based approach</u>

The discussion was focused on the use of 2500 year, 500 year and 100 year RPs as the life-safety limit state, damage control limit state and serviceability limit state respectively. The international panel (Professor John Wilson, Professor Nelson Lam, Dr Nguyen) and IEM WG1 Chairman Ir MC Hee explained on the different types of RP and the displacement based design approach. It was suggested to check the life-safety (survival) limit state using a 2500 year RP where the displacement component should be taken into consideration. For design, it was suggested to scale it down to a 500 year RP as the damage control limit state using the q factor. The representative from oil and gas industry further affirmed this approach and quoted that the ASCE code uses a factor of 2/3 (=0.67) to scale the maximum considered earthquake 2500 year RP spectrum into design earthquake spectrum.

2. <u>The further unified model for the whole of Peninsular Malaysia</u>

As presented in Forum 1, the task force had proposed a more unified model for the whole of Peninsular Malaysia and this was put forward for discussion to reach a consensus. Various opinions were given; in general there were two schools of thought. The practising structural consultants preferred the use of one standardized hazard model for the ease of design. However remarks were made that it must be subjected to an impact study on existing structures for cost implication. The non-engineering fraternity had raised concerns on the social security impact, and preferred the use of the hazard map. A point was raised that the use of the contour hazard map would only be feasible for long distance earthquakes in the case of Peninsular Malaysia (and not for local earthquake due to paucity of recorded data). Professor Friedemann Wenzel agreed to the idea of having a single value as of now due to the uncertainties at this point associated with a low and moderate seismic area such as Peninsular Malaysia. This could be reviewed in the future should further recorded data and scientific justification become available. There was general agreement on the proposed spectrum using a hybrid approach, and on the need to finalise the National Annex (NA) of EC8 for Malaysia as soon as possible for the good of the industry. Other refinements (e.g. inclusion of contour maps, and benchmark M-R combinations) could be made in the future.

3. <u>Two-tier site factor approach</u>

This decision was made in Forum 2 and again endorsed in Forum (3).

4. <u>Behaviour/Ductility "*q*" factor</u>

Professor John Wilson suggested the *q* factor should be a minimum from current Malaysian practice. Ir MC Hee suggested that a value of 1.5 (as also stipulated in EC8) would be a fairly conservative value in the absence of a seismically detailed joint, mainly due to inherent ductility/robustness of existing structure. It was highlighted by the bridge structural designers who were present that the *q* factor related to bridges could be different. However, the spectrum for both buildings and bridges should be the same. Further work ought to be carried out by the IEM C&S earthquake TC WG2 committee.

5. Equivalent seismic base shear design for a simple structure

The equivalent seismic base shear design method was put out for discussion. Taking the example of Australia, Professor John Wilson stated that for an ordinary building with height of less than 15m, this simplified approach would be handy for designers. It was agreed that the simplified method applicable for ordinary buildings should be made available as the earthquake engineering knowledge of consultants in Malaysia might not be quite established yet.

6. Other issues: non-structural elements, adoption of EC8

The concern associated with non-structural elements was raised. The forum was informed by IEM TC Earthquake Chairman Professor Jeffrey Chiang that this issue will be taken into consideration and WG4 would be formed to tackle the issue of non-structural elements under seismic load.

One of the key concerns of the industry is the adoption of EC8 in Malaysia. The IEM organisers explained that EC0, EC1, EC2 and EC7 part 1 had all been submitted for implementation and was awaiting Parliamentary reading and approval. Once approved, the industry is expected to go through a transitional or adjustment period. EC8 will then follow the same route.

Professor John Wilson summarized all the points mentioned above at the end of Forum 3. It was noted that the benchmark impact study would be essential to justify the use of the proposed spectrum, for community protection (saving lives) and for understanding the cost implication. Also, one of the aims of the workshop was to achieve a coded standard which would be fairly simple and not overly complicated for all relevant engineering industry stakeholders to adopt and apply.

The workshop ended at with a round of applause by the participants to the panel of invited international experts, and presentation of tokens of appreciation to the speakers.

Participants and speakers during the 2-day earthquake symposium and workshop