Technical Review of JKR's "Handbook on Seismic Design Guidelines for Concrete Buildings in Malaysia"

By: Engr. Dr. Jeffrey Chiang, M.I.E.M., P. Eng and Engr. M. C. Hee, F.I.E.M., P. Eng

BACKGROUND

In recent years, Malaysia has experienced the effects of earthquake originated mainly from epicenters in the western subduction zones of Sumatra. East Malaysia also has its fair share of local earthquakes which are considered as moderate. Recently, Jabatan Kerja Raya Malaysia (JKR) has drafted a document which presented the proposed seismic design guidelines for concrete buildings in Malaysia in April 2007. It was then sent to The Institution of Engineers Malaysia (IEM) for their technical review and feedback.

INTRODUCTION

This paper represents the views of two members of the IEM Technical Committee on Earthquake, which was formed in early 2006 to study the possibility of producing a design guideline on earthquake design suitable for the construction industry in Malaysia. The objective of the IEM Technical Committee on Earthquake is two-fold – to ensure adequate protection of the community in the event of earthquake tremors, as well as to ensure that the design provisions and construction practices (whether existing or amended) are suitable and practical for Malaysian professional practices.

The review presented herein will not focus on style and format of presentation, for example, the inconsistency in the title. The front page cover title may be "Handbook on Seismic Design Guidelines For Concrete Buildings in Malaysia" but the header title inside the handbook is "Development of Seismic Design Guidelines for Concrete Buildings in Malaysia for JKR". These types of inconsistencies can be sorted out by the author/s. The scope of review is on the content itself or the lack of consistencies in the methodology. This review will be followed by a more comprehensive comments on the detailed calculations found in the Guidelines, which will be forthcoming in future issue of IEM Jurutera Bulletin.

COMMENT ON THE INTRODUCTION OF THE DESIGN HANDBOOK:

The Introduction section consists of:-

- Seismic Historical Background of Malaysia
- Scope of Handbook
- National Annex
- Standard Code Applied

As a general guide, the seismic historical background is informative, but it would be more appropriate to place it in the foreword or in the appendix. Furthermore, it is also misleading in one particular paragraph, in which it stated, "The 9.0 magnitude earthquake on 26 December 2004, about 100 miles from the western coast of Indonesia's Sumatra Island, has generated tsunami in the Indian Ocean. The worst affected areas in Malaysia were Penang and Kedah, where 68 people had been killed and more than 100 people were injured." Now, an impartial reader on reading it may be alarmed as it gives the impression that the Aceh's earthquake has caused over 100 casualties in Malaysia, whereas the reality is that these number of casualties are due to the tsunami which hit the shores in Penang and Kedah. Therefore this piece of information would be more appropriate for a design guideline for tsunami effect, and not seismic.

On a more technical note, as a guide, readers may need to have more information on how to use the Guidelines, such as basic design criteria, and design requirements. These are not clearly defined or outlined, neither in the introduction nor in the guideline proper. After the introduction section, the guideline jumps straight into the procedures of design and analysis of buildings, and followed by analysis and design examples.

Basic terms and definitions are not presented, neither at the beginning nor at the end of the Guidelines. As a first Malaysian's reference document on seismic design, basic terms and definitions are necessary, for example, the use of the word 'gals' (in the macrozonation seismic mapping), 'peak ground acceleration' (PGA), seismic response spectrum, g-term, and many others are very useful not only for the designers but also for the general readers.

Another important aspect of seismic effect not clearly stated or defined is "Far field effect of earthquake", which is exactly the seismic effect experienced by population in Peninsular Malaysia because of the distance effect transmitted from a far epicenter of earthquake in Sumatra. This has implication on whether to adopt a full-scale design approach for seismic actions (as if Malaysia experiences direct earthquakes, with local active fault lines and epicenters) or to use a minimized design approach (as in a far field or distance seismic effect). This should be clearly explained at the beginning so as to justify the design approaches to be specified in later sections.

On the use of National Annex, it is more suited if there is an intention to adopt the Eurocode 8 on seismic design, which again is not stated clearly. This is because in the standard code to be applied, two international design codes for seismic actions were cited as references, i.e. Eurocode 8 and the American-based IBC 2000. This is not the usual and accepted norm in adopting a design guideline, as both "...shared the same objectives but may produce different results' as clearly stated in the guideline. So, the reasons and justifications in adopting either or both design approaches has to be given, otherwise readers and designers would come away more confused. Engineers may even query on why the Australian or the New Zealand seismic actions codes of practice were not considered, given their proximities to our region. Hence, their design codes may be of more relevance to Malaysian practice. Therefore, it is very important for readers to be given all the necessary facts and justifications on the basis of the Guidelines. Otherwise, the Guidelines would raise more questions than answers.

The guidelines also fail to provide readers with information on the current practice by local design engineers to provide for horizontal resistance in building structures. Besides designing for wind forces, design engineers also do have to consider the notional horizontal forces taken as equal to 1.5% of characteristic dead load for a particular floor level based on the British Standards BS 8110. Otherwise the general public may be under the impression that all existing buildings are not designed to resist horizontal forces (although seismic forces are not considered specifically). Assurances should be given to the general public on why this Guidelines is published, and that existing buildings in Malaysia should not fall down like a pack of cards, given the history of earthquakes experienced to date.

COMMENT ON THE DESIGN AND ANALYTICAL PROCEDURES IN THE DESIGN HANDBOOK:

Coming to the core contents of the Guidelines, which are the design and analytical procedures given in detail, based on the two codes of practice, i.e. Eurocode 8 and IBC 2000. The reviewers are of the view that the Guidelines has placed an over-emphasis on detailed design procedures, formulas, design flow charts, etc – which are really not necessary for a design guidelines document. It is strictly not a Malaysian code of practice or design standards. All the detailed formulas and procedures are straight out of the two international codes of practice. Again, the same questions arise – are these formulas and approaches appropriate for Malaysian practice? Mind you, the Guidelines go to the extent of detailing design for reinforcement layout in columns and beams, as though Malaysia is experiencing full-scale seismic forces on a regular basis.

It may be well-advised that the Guideline should be giving emphasis on how existing design practices may have to be revamped, readjusted or even modified, so that practicing engineers can easily adopt a practical approach, without prejudices against such detailed design procedures, which may be deemed by many as unnecessary and to be an over-reaction. The reviewers are of the opinion that such detailed design steps and insertion of many design formulas may be put in place in a proper design standards or code of practice in the future, but not in a design guideline as such.

The use of other technologies / design experiences may also be more useful and appropriate. As Malaysia is a rubber-producing country, some points should be raised on the use of rubber-based material as dampeners in buildings as a mean to minimize the effect of earthquake. These are commonly done in USA, Europe and Japan. Experiences from our neighbouring countries such as Singapore, Indonesia should also be documented, as a guide. Far-field effect may be a suitable aspect for consideration instead of adopting a full-blown seismic design approach, in Malaysian context.

For the uninitiated, the term 'gals' refers to the acceleration experienced in a ground motion due to the seismic effect from a certain distance away from the epicenter. 1000 gals = 1 g = 9.81 m/s^2. Hence, in the macrozonation maps, as shown in the guidelines, values of 200 to 250 gals have been quoted in the extreme cases for Peninsular Malaysia in the west coastal regions, for 500 years return period at natural period of 0.2 sec. This means that the peak ground acceleration or PGA is between 0.2g to 0.25g – which is relatively high. As a comparison, the Penang link bridge was designed to resist a seismic effect of 0.03g, which is

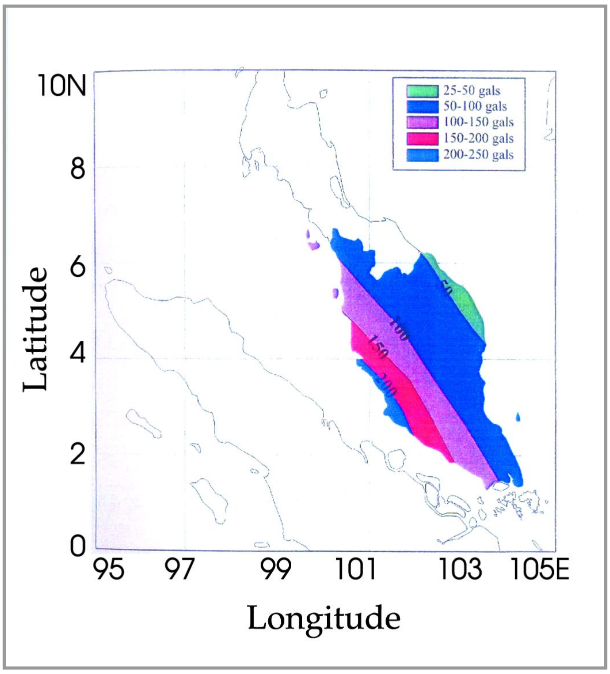

Figure A1.1: Macrozonation Map for 500 years return period at T=0.2 sec.

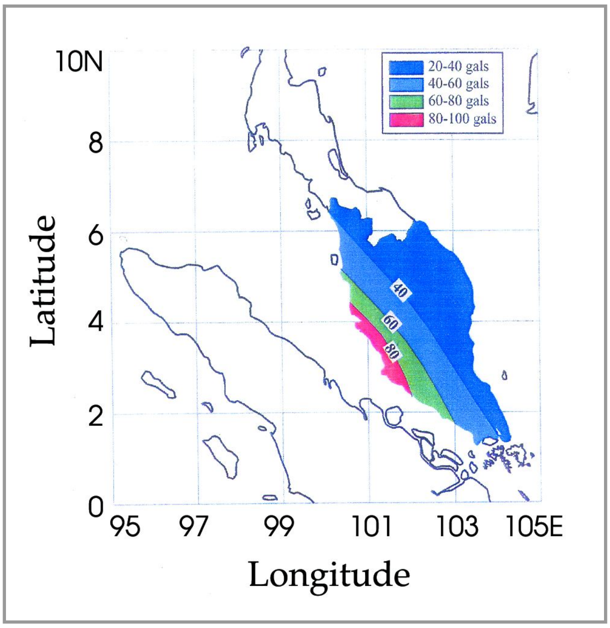

Figure A1.11: Macrozonation Map at 10% PE in 50 years on rock site conditions for the Peninsular Malaysia. (TR = 500 year) ***(Source: CIDB report)***

considered moderate by usual practice. A design for 0.2g to 0.25g would be regarded as medium to high risk seismic effect, which is not practical for building structures in Peninsular Malaysia. Refer to Figure A1.1 for the macrozonation map mentioned.

In another macrozonation map of the Peninsular Malaysia for a 10% probabilistic effect (PE) in 50 years on rock site conditions (refer to Figure A1.11), the worse case scenario is also along the west coast at a quoted range 80 to 100 gals – which is also considered on the high side of between 0.08g to 0.1g. Even the Bakun Dam in Sarawak was said (by a speaker in a recent IEM seminar on Earthquake and Tsunami) to have a seismic design PGA of 0.075g, and mind you, East Malaysia do experiences direct seismic forces unlike Peninsular Malaysia, which at best experiences only far field seismic effect from Sumatra.

Hence, the quoted PGA values as given in the various macrozonation maps have to be explained and justified before they can be accepted for design practice on a practical basis by local engineers.

On a final note, other researchers on determining the local ground acceleration have cited much lower values compared to that published in the draft guidelines. For instance in an IEM course conducted recently in Petaling Jaya on 7 December 2007 on Seismic Design using Eurocode 8, the invited speaker, Dr. Jack Pappin from Ove Arup & Partners, now based in Singapore, came up with his own developed model to determine the PGA in Kuala Lumpur in comparison to those quoted in Eurocode 8. As an example his model (for a 5% damping effect) gave a spectral acceleration of only 0.4 m/s^2 (equivalent to 0.04g) for Kuala Lumpur compared to 1 m/s^2 to 2 m/s^2 or 0.1g to 0.2g (for EC 8). His model is said to match quite closely to those of other noted academic researchers in a well known Singapore university. Hence, based on these findings, local designers may not even have to consider effect of seismic action in building design.

What does this mean? In other words, the Guidelines may have to be re-looked, to consider other research findings or bases, before such detailed design procedures and methodologies can be accepted by local engineers.

CONCLUSION

The JKR design guidelines is something new to the industry, and many of the proposed detailed design steps, formulas and procedures may not be so appropriate at this stage. More realistic studies are needed to get practical results or findings, so that practitioners can use such Guidelines with more confidence in the design of building structures to resist seismic effect. Only then, all stakeholders including the end users would be satisfied that their safety and economical concerns are well-addressed. ■

REFERENCES

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[2] IEM Position Statement on Issues Related to Earthquake, approved and endorsed by IEM Council, January 2008.

[3] International Building Code 2000, International Code Council, International Conference of Building Officials, Whittier, CA and others, 2000.

[4] Eurocode 8 European Standard Design of Structures for Earthquake Resistance, Part 1: General Rules, Seismic Actions and Rules for Buildings, ENV 1998-1-1.