# Current Earthquake Engineering Issues in Australasia

*David Brunsdon, Spencer Holmes Ltd, Wellington (drb@spencerholmes.co.nz)*
*and Andrew King, BRANZ (a.king@branz.org.nz)*

*David Brunsdon* is the current President of the New Zealand Society for Earthquake Engineering, and is the National Lifelines Co-ordinator. He is Director, Special Projects of Spencer Holmes Ltd, a consulting engineering, surveying and planning practice. He spent two years assisting in Newcastle following the 1989 earthquake.

*Andrew King* is the Immediate Past President of the New Zealand Society for Earthquake Engineering. He is Manager of the Structural Engineering Section of the Building Research Association of New Zealand (BRANZ). He is also convenor of the seismic loadings sub-committee of the Joint Australian and New Zealand Loadings Standard.

## SUMMARY

The New Zealand Society for Earthquake Engineering has recently undertaken a strategic planning review in order to establish a conscious forward planning process. This paper outlines the issues arising, some of which are thought to be of interest to the Australian Earthquake Engineering Society as it enters its second decade of existence.

This paper also touches on the other current NZSEE Working Group activities. These include the development of operational frameworks through which members would be deployed following a major earthquake in New Zealand – or Australia!

The draft joint Australian and New Zealand earthquake loadings standard provides a platform for a more unified approach to earthquake design in the lower seismicity regions of Australia and New Zealand. While a simpler approach for structures in some parts of New Zealand will result, a more conscious and structured seismic design process will be required for parts of Australia. Some of the process issues and implications are outlined.

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## 1. INTRODUCTION

Following on from the highly successful 12th World Conference on Earthquake Engineering in Auckland in February 2000, the NZSEE Management Committee has focused on the future direction of the Society. Many of the Society's activities have historically evolved in response to issues of the day, and so it is considered essential that a conscious forward planning process be established.

This paper outlines the issues arising from the strategic planning process, some of which are thought to be of interest to the Australian Earthquake Engineering Society as it enters its second decade of existence.

A number of interesting questions have also emerged from the current joint seismic loadings standard process. One of the most challenging is the extent to which common design procedures should be encouraged in those parts of Australia and New Zealand with comparable seismicities.

## 2. NZSEE STRATEGIC PLANNING

The New Zealand Society for Earthquake Engineering (NZSEE) was formed in April 1968. The Society has approximately 640 members at present, with about 160 of these members being based overseas. A further 40 are student members. The total budget for the 2000/ 01 financial year is $125,000.

A Strategic Planning Workshop involving current and past Management Committee members and invited guests from other organisations involved with the Society was held at the end of March 2000. All aspects of the Society's activities were reviewed, and a wide range of ideas and options discussed. Four key themes emerged, highlighting where the Society needs to place emphasis in terms of its future activities:

- ***Communications*** - the Society needs to upgrade its communications, both internally with its members and externally with other agencies and the wider community
- ***Broadening our Involvement*** – the Society should make better use of its strong reputation as a knowledgeable and independent body in helping shape public perceptions of seismic risk and in promoting and supporting research
- ***Technical Development*** - the Society needs to be more active in producing technical publications for the benefit of its members, and in participating internationally to keep NZ's earthquake engineering at the forefront
- ***Involvement of Others*** – the Society needs to actively seek the involvement of people from related fields in its activities, especially from the social sciences

The common issue from these themes is the need to increase the level of outputs across many of the Society's activity areas. This desire is however set against the backdrop of reduced technical production by the Society in recent years due to increasing workplace demands upon key personnel. The resulting lower level of voluntary inputs is a common problem for professional societies of this nature. The Management Committee has responded by making funds available from reserves to promote ‘output growth’ – to encourage the production of a wider range of technical tools for the use by members, and to upgrade communications mechanisms to promote and convey information.

A series of specific communications initiatives are being implemented during the current year. These include the establishment of a new and more interactive website (by December 2000) and the launch of a regular electronic newsletter (by June 2001).

A draft Strategic Plan has been produced by the Society, drawing together the issues raised at the workshop. This plan will be discussed at the feature session of the Society’s next Annual Conference to be held in Wairakei in March 2001. The theme of this conference is *Future Directions: A Vision for Earthquake Engineering in New Zealand*.

## 3. CURRENT AND PROPOSED NZSEE WORKING GROUP ACTIVITIES

The traditional mechanism for the production of technical information and tools for members is via Working Groups (or Study Groups). The Society currently has Groups underway in the following areas:

***Earthquake Risk Buildings*** – technical guidelines to assist practitioners in assessing and strengthening buildings constructed prior to modern codes (mid-1970’s)

***Storage Tanks*** – guidelines for determining design loadings for the seismic design of storage tanks, with particular emphasis on large steel tanks for the storage of bulk fuels

***Industrial Plant*** – seismic loadings and typical details for the restraint of items of major industrial plant and equipment

***Integrated Planning for Earthquake Response*** – the development of a framework for co-ordinating the post-earthquake response of technical personnel, including clarification of the roles and responsibilities of various agencies

Some of the possible topics for future Study Groups identified at the recent strategic planning workshop included *performance based design, displacement based design, torsion in buildings, dynamic analysis methods* and *public perception of risk.*

Whereas traditionally most of the work carried out by these groups has been undertaken on a voluntary basis, there is now a recognition that at least partial payment for key group members is necessary to ensure focus is maintained and progress made.

The Earthquake Risk Buildings Study Group is being supported financially by the Building Industry Authority, which is essentially NZ's equivalent of the Australian Building Codes Board. Funding is currently being sought from industry sources for the Storage Tanks and Industrial Plant groups.

The reality however is that while some of the Study Groups will be able to attract funding due to the appeal of their subjects to broader industry sectors, others from the above list will not. It is cases in this latter category to which the Society's reserves funding will be targeted.

## 4. EARTHQUAKE RESPONSE PREPAREDNESS

Despite the generally high awareness of the threat posed by earthquake in many parts of New Zealand, there are distinct weaknesses in many of the country's arrangements for responding to a significant event. The scarce resource that experienced earthquake engineers represent was highlighted by the Society in 1995 as one such weakness. This led to the creation of the Working Party on Integrated Response Planning as outlined above.

A NZSEE project funded by the Ministry of Civil Defence in 1997 developed the framework for the establishment of a national register of engineers. Such a register could enable local emergency managers to have first priority on senior engineers in the hours and days following a major earthquake. Due to the limited number of engineers in NZ with experience of actual earthquake situations (eg. from the Society's Reconnaissance Teams to international events), engineers from other Pacific countries with comparable experience will be sought for this register.

While this register has yet to be formally established, work over the subsequent years has focused on encouraging the managers of key facilities such as hospitals to set up *priority response agreements* with engineers.

## 5. SUMMARY OF THE PROPOSED SEISMIC DESIGN PROCEDURES FOR AUSTRALASIA

This section summarises the essential aspects of the seismic design provisions of the new draft joint Australian and New Zealand earthquake loadings standard, which is currently available for public comment.

The minimum acceptable verification method (refer Table 1 following) is determined by reference to:

a) *the site hazard spectra*, $C_h(0.5)$, from tabulated period-dependent data for each of 4 soil types normalised to 0.5 seconds (Note: for NZ conditions these range from 1.0 for rock sites to 1.35 for soft soils, and for Australia from 0.78 for stiff rock to 2.4 for soft sites).
*b)* *the seismic zone factor*, Z, by reference to isoseismal zonation maps (Note: for NZ, Z ranges from 0.15 in Northland to 1.1 in the Alpine fault region (but currently has a minimum set at 0.3); for Australia Z ranges from 0.0 to 0.2)

c) *the return period factor*, R, by reference to the building classification table given in Part 0 of the loadings standard and a magnification factor which adjusts the base spectra (Note: for Ultimate Limit State considerations, R ranges from 0.5 to 1.8 for NZ buildings and 0.3 to 1.9 for Australian buildings)

**Table 1 Earthquake Design Verification Methods**

| **Base Parameter $C_h(0.5)ZR$** | **Verification Method** | **Implications** |
|---|---|---|
| ≤0.1 | No earthquake provisions | |
| ≤0.15 | VM I | • A primary lateral load resisting system capable of resisting 1% of the seismic mass.<br>• Connections capable of resisting 5% of the vertical self weight and imposed actions. |
| <0.35 | VM II | • Earthquake action from equivalent static or multi-modal analysis.<br>• Strength and detailing from material standards but with structural ductility ≤ 3.0 |
| ≥0.35 | VM III | • Earthquake action from equivalent static or multi-modal analysis.<br>• Yielding and non-yielding primary structural elements differentiated (ie capacity design approach implied)<br>• Detail in yielding zones according to material standards |

Verification Methods II and III require either a equivalent static analysis or a multi-modal analysis to be undertaken to determine the base shear and/or modal shape upon which the base shear is to be distributed up the structure.

Drift limits for both serviceability and ultimate limit states are to be checked to ensure interstorey drift does not impair functionality (at SLS), and that overall lateral deformation is maintained within acceptable limits to avoid either significant P-Δ effects or pounding with adjacent properties.

The effect of earthquakes on parts and components has been tiered to permit either a simplified (conservative) approach or a more complex detailed approach as necessary.

## 6. ISSUES RELATING TO LOW SEISMICITY REGIONS IN AUSTRALIA AND NEW ZEALAND

The joint loadings standard provides a platform for a more unified approach to earthquake design in the lower seismicity regions of Australia and New Zealand. This will enable a simpler approach for structures in some parts of New Zealand, but will require a more conscious and structured seismic design process for parts of Australia.

The commentary relating to the earthquake provisions identifies that while damage under design intensity events is considered acceptable, collapse is to be avoided in extreme events. These provisions have implications for designs which do not use capacity design to eliminate the potential for rupture of key support elements. Such buildings are expected to be prevalent in low seismicity regions. In New Zealand, avoidance of collapse under extreme events is addressed by limiting the Zone factor to be not less than 0.3. In Australia, this additional provision is not considered to be necessary.

Within low and moderate seismicity regions (ie where the base coefficient < 0.35, which for New Zealand includes Auckland, North Auckland, coastal South Canterbury and Dunedin and in most of Australia on all but soft or very soft soil sites, capacity design provisions can be waived provided the ductility level is not greater than 3). In such cases compliance is required with the limited ductility provisions within the various materials standards. In such cases, concurrent actions (100% plus 30% orthogonal) is required for elements that are common to two orthogonal primary load resisting systems. This is in recognition that without a rational capacity design, elements cannot be relied upon to maintain their load-carrying capacity under overload conditions. Conversely, the additional detailing required within plastic hinge zones (for structural ductility of $\mu>3$) can reasonably be expected to limit the consequences of concurrent actions.

## 7. SUMMARY

This paper has outlined a number of areas where NZSEE is placing emphasis in terms of its future development. These include:

- Improving communications with members by taking full advantage of information technology
- Improving international connectivity, with particular emphasis on technical issues and code development
- Encouraging greater production of technical output for the benefit of members
- Establishing and maintaining appropriate response arrangements for engineers and scientists for a major earthquake event in our region

It is hoped that progress in a number of these areas will be explored further in papers presented at the Pacific Conference on Earthquake Engineering to be held in Christchurch in March 2003.

The key elements of the draft joint Australian and New Zealand earthquake loadings standard, currently available for public comment, are also summarised. This standard provides a platform for a more unified approach to earthquake design in the lower seismicity regions of Australia and New Zealand, and has important implications for structural designers and others.