New Zealand Society for Earthquake Engineering

# Building Management After Earthquakes

## Submission to the Canterbury Earthquakes Royal Commission

## 31 July 2012

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### INTRODUCTION

1 The New Zealand Society for Earthquake Engineering (NZSEE) is a learned society that provides a forum for technical debate, promotes learning from local and overseas earthquakes, is involved in the evolution of relevant legislation and regulations, and contributes to planning for, response to, and recovery from earthquakes. The mission and objectives in the Society's Constitution and Rules are paraphrased as "To gather, shape and apply knowledge to reduce the impact of earthquakes on our communities by:

a. Fostering the advancement of the science and practice of earthquake engineering across all disciplines;

b. Promoting co-operation among scientists, engineers and other professionals in the broad field of earthquake engineering through interchange of knowledge, ideas, results of research and practical experience".

2 The Society has over 700 Members who are professional engineers, scientists or others with an interest in earthquake phenomena or in the mitigation of the effects of earthquakes. Members include consultants, government officials, academics, and researchers.

### NZSEE RESPONSE TO THE CANTERBURY EARTHQUAKES SEQUENCE.

3 Many Society members have been engaged in the response and recovery following the Canterbury earthquakes. Including the rapid emergency building safety evaluations, damage assessments, detailed engineering evaluations, the Ministry of Business, Innovation, and Employment's Engineering Advisory Group and Technical Review teams, as well as supporting the Commissions inquiries.

4 Given the almost total engagement of members in response to the Canterbury earthquakes, the Society did not mobilise a standard *Learning from Earthquakes* field team. Instead learnings and sharing of information were coming from the direct experiences of members and the many debriefs, reviews, investigations, physical and online Clearinghouse, as well as the findings of the Commission.

5 Communications supported by the Society following earthquakes of the Canterbury sequence include two special issues of the Bulletin that reported on

preliminary learnings from the September 2010 Darfield (Canterbury) earthquake sequence - 43/4; and the February 2011 Canterbury earthquake sequence – 44/4. The Society has made access to the papers in these Bulletins freely available from www.nzsee.org.nz.

6 The NZSEE Pacific Conference on Earthquake Engineering (PCEE) was held in Auckland during April 2011 with the title "Building an Earthquake Resilient-Society", and the NZSEE Annual Conference for 2012 was held in Christchurch during April 2012 with the title "Implementing Lessons Learnt". Both these conferences provided a forum for the presentation and discussion of scientific and engineering investigations and practice as a consequence of the Christchurch earthquakes.

7 The NZSEE provided virtual and actual technical Clearinghouse facilities from September 2010. The actual Clearinghouse facility in Christchurch provided an opportunity for local, national and international investigators and researches to meet and compare findings on a daily basis. The website provided a repository for interim data as it was collected from the field, and an opportunity to comment on the data as it was posted.

8 The support the Society has received for these initiatives leads the Society to believe our activities, as well as others groups and societies, provided a worthwhile contribution to the recovery of Christchurch and the development of greater knowledge of earthquakes and their effects. There is much to be done, but the Society, with the support of its membership, will continue to strive for a 'resilient New Zealand'.

## MANAGEMENT OF BUILDINGS FOLLOWING EARTHQUAKES

9 It is the Society's opinion that the process of managing the risk to buildings following an earthquake should be treated as a special case of the general and ongoing requirements for managing the earthquake risk to buildings. The risk assessment principles are the same, and the same options are available for treating the risk. The major difference is that the level of risk is higher than normal, and rapid decisions must be made to addresses these risks.

10 The particular circumstances that confront the controlling authorities, building owners, building users and other stakeholders following an earthquake include:

a. The actual seismic hazard in the region may be significantly higher than the hazard assessed by the adopted national seismic hazard model and reflected in design standard,

b. The vulnerability to damage of the buildings in the affected region may have been increased by earthquake effects,

c. There will be a heightened awareness and reduced tolerance of earthquake risk,

d. Rapid decisions must be made on the management of risk and communicated to stakeholders.

11 The risk management process should take account of all of these factors. This submission is focussed largely on item b. above, i.e. the assessment of post earthquake building vulnerability. However it is our view that developments are also required in the following areas:

a. Rapid re-assessment of the post-earthquake seismic hazard in the potentially affected region. We note that the hazard was re-assessed by GNS following the 22nd February 2011 earthquake events, and this has been beneficial for assessing and managing building risk.

b. Understanding acceptable levels of earthquake risk and communicating risk. We acknowledge that quantifying acceptable risk is difficult. Nevertheless it is vital step in developing a process to manage the risk. It is possible that it should be benchmarked to the risk levels implied by the Building Act earthquake prone building provisions. The risk of injury or death cannot be eliminated without potentially great cost and it is desirable that building owners and users understands this. These are matters that would benefit from behavioural science-based research.

12 Risk management should be a continuous process that starts well before the earthquake. The process should include cataloguing of building data, assessment of buildings and developing programmes for the retrofit of vulnerable buildings.

## BACKGROUND TO THE RAPID ASSESSMENT PROCESS

13 The NZSEE document Building Safety Evaluation During a State of Emergency: Guidelines for Territorial Authorities[1] was prepared by NZSEE for publication in August 2009, with support from the then Department of Building and Housing (DBH) and the Ministry of Civil Defence & Emergency Management (MCDEM). The guidelines were developed in 2008 and are based on the arrangements and structures adopted in the USA for building safety evaluations. Their stated focus is on the rapid assessment components of the overall building safety evaluation process. The procedures continue to be developed in the USA and elsewhere as experience and knowledge is gained from damaging earthquake events. Further discussion of the development of the Guidelines is included in the NZSEE's report on "Building Safety Evaluation Following the Canterbury Earthquakes" to the Royal Commission dated 26 September 2011. NZSEE continues to support the recommendation contained in this report on the basis of further experience from Christchurch and internationally.

14 The basis of this building safety evaluation system is to visually identify damage that could compromise the pre-earthquake resistant capacity of the building structure. The building evaluation process is founded on the premise that if a building has not been severely damaged in the initial earthquake, it should be capable of surviving an aftershock or aftershocks without serious damage or collapse.

15 The generally successful implementation of the building safety evaluation process (triage) after the earthquakes of 4 September 2010 and 22 February 2011, was a result of the preplanning that had occurred by members of NZSEE, supported by member's employers, EQC, the (then) Department of Building and Housing, and by the Ministry of Civil Defence & Emergency Management. The pre-planning included: adaptation of rapid response building triage procedures developed for the New Zealand environment; drafting guidelines that were tested following the Gisborne earthquake of 2007; amendment and publication by NZSEE of the first New Zealand Guideline in 2009[1]; testing of that Guideline in Padang, Indonesia; gathering further experience from Samoa and L'Aquila, Italy; delivery of introductory training, including to senior Christchurch City Building Managers and others from Wellington and Dunedin, all of whom were involved in

[1] NZSEE 2009 "Building Safety Evaluation During a State of Emergency: Guidelines for Territorial Authorities" - http://www.nzsee.org.nz/publications/building-safety-evaluation-in-emergencies/

applying the accumulated experience in the area of Greater Christchurch under the States of Emergency that followed the earthquakes there of 4 September 2010 and 22 February 2011.

16 The NZSEE 2009 Guidelines have also been used following the 2011 floods and landslides in Nelson/Tasman and in 2010 in Hawke's Bay.

17 The current triaging system has achieved important publicly beneficial outcomes in the required short time frame. In order to further improving the current framework, it is however fundamental that, given the processes reliance on volunteers, robust pre-event education and training is provided, along with post-event updating, calibration and verification of the process and associated tools. Furthermore, more readily available information on each building is required to assist assessments at all stages of the process, and communication of the building 'tagging' (red, yellow and green stickers) purpose and status. More specific recommendations for improvement will be provided in the paragraphs below.

## LESSONS TO BE LEARNT FROM THE CANTERBURY EARTHQUAKES

18 Given the experience following the earthquakes of 4 September 2010 and 22 February 2011 in the Canterbury area, it is evident that the procedures can be improved, by:

a. Amending and extending the two phased (Level 1, Level 2) "Red", "Yellow", "Green" of the building triaging process to cater for significant damaging aftershocks, and support all stakeholders;

b. Improving communications among building owners, occupiers, businesses, territorial authorities, building officials, engineers, architects, building officials, the building sector, CDEM sector, the insurance sector, the media, Central Government and the public ;

c. Requiring the improvement of the information management system, including having a fully functional secure computer database of property, building, and address information operating as part of normal Territorial Authority/Building Consenting Authority day-to-day processes and accessible securely from the internet;

d. Requiring pre-event understanding and knowledge of critical buildings (Building Importance Level 4, and those critical to emergency functions including functions of lifeline utilities); and also

e. understanding and knowing of vulnerable buildings such as those assessed as "Earthquake Prone" and/or "Dangerous", with priority given to reducing risks, particularly those from critical weaknesses (parapets, gable ends, chimneys, foundation systems), non-structural elements (ceiling tiles, light fittings, air conditioning), and storage rack systems. Buildings that could adversely affect lifelines should also be identified and be included on a priority list for assessment following a damaging event;

f. Providing National standard operating procedures for the effective management of cordoning of dangerous buildings;

g. Training and exercising of building management officials, including staff of Territorial Authorities/Building Consenting Authorities, engineering and architecture consultancies, and property managers and CDEM staff;

h. Amending the Building Statutes to enable procedures for the "normal" management of dangerous buildings to be utilised seamlessly between "normal" business, of one or two dangerous buildings a year, and civil defence emergencies involving upwards of thousands of dangerous buildings.

i. The current model focus on buildings does not adequately consider the hazards associated with the environment – ground failure, slope stability etc. The triage system was extended in Canterbury to include such hazards for example, rock fall and slope failure. There are reported instances where placards placed for reasons of such geotechnical hazards being removed and replaced during subsequent inspections where the inspectors did not consider the hazards from the surroundings. It would be important to explicitly include consideration of such hazards in the guidelines and training for future post-earthquake building inspections.

19 Society must determine the level of protection it requires from any particular natural hazard, and understand all the associated cost for any particular level, noting that a "hazard free" and thus "risk-free" environment is not achievable. Knowledge from science and technology is used to set standards and to specify, design, and construct buildings to withstand "design-level" hazard events to protect life – the "Ultimate Limit State" – even if the building then needs to be demolished – as in Christchurch as a consequence of the Canterbury earthquake sequence. Design levels have already been modified upwards as a consequence of the Canterbury earthquakes. More recently developed building technologies and design methods can further assist in achieving a superior seismic performance (e.g. less level of damage) at negligible additional initial costs.

20 Re-event knowledge of the buildings in the impacted area is particularly critical to their management at the time of an emergency response. Territorial Authorities or their Building Consenting Authority have a responsibility for maintaining property and building information records (Resouce Management Act, Building Act, Local Govt & Meetings Act). Property and building information management is an evolving domain with developments occurring to address the shortcomings that are known nationally. For efficient emergency management of buildings, electronic records should be accessible via the internet from secure and backed-up computer databases that enable the Territorial Authority access to details on:

a. the location and legal description of the property;

b. any hazards associated with the property;

c. the description of the building or buildings on the property, including details of the form and materials of construction, additions and/or modifications and associated dates, as well as known hazards, earthquake proneness, storage or use of hazardous materials;

d. the location of the building or buildings on the property, noting that a property may have one building, or many buildings, or one building may straddle many properties;

e. the address(es) associated with the property, buildings, and occupiers (Refer AS/NZS 4819:2011[2]).

[2] AS/NZS 4819:2011 Rural and urban addressing

21 The lack of a single, national, authenticated, maintained, and publicly discoverable address database (that references the relationships between property, buildings, and addresses) is a major shortcoming in New Zealand that compromises personal and business, postal and courier, communications, asset management, community social and health service delivery, as well as the emergency management of buildings and emergency services responses, including to 111 calls. The National Geospatial Strategy (2007)[3] sets out to rectify this shortcoming but it has yet to be delivered on.

As a minimum, it is recommended that all buildings should be required to display a street address, or at least a street number.

22 Deficiencies in ready access to appropriate property and building information limited the management of buildings following the impacts of the Canterbury earthquakes and contributed to inefficiencies and uncertainties for owners, occupiers, businesses, and officials. Developments since February 2011 now enable improved internet access to relevant information related to managing buildings. A national property information system is required.

23 The building control system sets out, via the Loadings Standard, a range of Building Importance Levels, dependent on the intended use at the time of consent. The Building Importance Levels in an impacted area, and the information on actual usage of buildings are of tactical importance in prioritising rapid emergency impact assessments.

24 The Building Control System (Building Act, Regulations, Codes, and Standards) has limited provision for addressing numerous dangerous and insanitary buildings that are anticipated following a major hazard event such as earthquake. This situation has existed and been recognised for two decades. As a consequence the New Zealand Society for Earthquake Engineering (NZSEE) championed and published "Building Safety Evaluation During a State of Emergency: Guidelines for Territorial Authorities" (2009). Both DBH and MCDEM have endorsed these Guidelines and, together with NZSEE, provide access to the Guidelines on their respective websites for times of need.

25 As presented at the request of the Commission (Brunsdon 2011[4]), the NZSEE Guidelines, with improvements, were utilised in the Greater Christchurch area following the 4 Sep 2010 and the 22 Feb 2011 earthquakes. Waimakariri District Council accessed the Guidelines from the web.

26 A workshop that reviewed the building safety evaluation process implementation was held in the Christchurch Response Centre on 27 June 2011 with the principal building evaluators. The resulting high level recommendations are reflected in this submission.

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[3] LINZ 2007: Understanding Our Geographic Information Landscape - A New Zealand Geospatial Strategy - http://www.linz.govt.nz/geospatial-office/geospatial-strategy

[4] D.G. Brunsdon, September 2011: Building Safety Evaluation Following the Canterbury Earthquakes: Technical Report by the New Zealand Society for Earthquake Engineering, - http://canterbury.royalcommission.govt.nz/documents-by-key/20111003.44

27 The resources required for rapid emergency building evaluations exceeded a thousand volunteer engineers, Building Consenting Officials, and support staff. While a few had been on introductory training courses prior to the Canterbury earthquakes, the majority were only inducted on their first day. There is a need for formalised training in rapid emergency building evaluations and for a register that holds contact details and information on the currency of engineers, building control officials, architects, property managers, and CDEM staff who have been trained.

28 The NZSEE Guidelines are based on the US ATC-20 "Building Safety Evaluation following earthquake". However the NZSEE Guideline is deliberately written to cater for all hazards that damage buildings - "Building Safety Evaluation During a State of Emergency: Guidelines for Territorial Authorities". Both ATC and NZSEE refer to "building safety evaluations". Following the Greater Christchurch experience, since 4 Sep 2010, it is evident that there is confusion over what is meant by "safe", see Galloway & Hare 2012[5]. Based on the experience from the Greater Christchurch area, and developments in engineering evaluations of buildings, it is recommended that the expression "Building Safety Evaluation" be replaced by "Rapid Evaluation of Buildings in an Emergency", because the evaluations judged necessary immediately following a damaging hazard event, such as earthquake, are rapid, and are under emergency conditions, and may be in high risk situations. The outcomes are thereby compromised, hence the need, as stated in the NZSEE Guidelines, for a subsequent "Detailed Engineering Evaluation" as has now been implemented in the Greater Christchurch area under the Department of Building and Housing Engineering advisory Group[6].

29 Both the US ATC-20 Guidelines and the NZSEE Guidelines detail a two staged (Level 1, Level 2) building triage process depending on the evaluation of damage and assessment of usability. The result of the triage is displayed on the evaluated buildings by placards coloured Red – "Unsafe", Yellow – "Restricted", or Green – "Inspected". Following the Greater Christchurch experience, since 4 Sep 2010, it is evident that there is confusion over what is meant by the labels on the placards and by the meaning of the "Green" placard. The recommendations in this regard that are made by Galloway and Hare (2012)[5] are endorsed.

**30** The Greater Christchurch experience, since 4 Sep 2010, has shown that improvements to the rapid emergency building evaluation process are required to address the needs and understandings of building owners, occupiers, territorial authorities, building consenting authorities, engineers, building officials, the emergency services (with respect to allowing access or not to "Red" or "Yellow" placarded buildings), the media, and the public. The process warrants revision and development to better cater for all stakeholders as listed above, particular attention to the communication process is needed.

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[5] B.D. Galloway & H.J. Hare 2012: A review of post-earthquake building control policies with respect to the recovery of the Christchurch CBD. NZSEE 2012 Conference - http://www.nzsee.org.nz/db/2012/Paper036.pdf

[6] Advice for Canterbury building owners: Assessing the seismic performance of non-residential and multi unit residential buildings in greater Christchurch - http://www.dbh.govt.nz/canterbury-earthquake-assess-seismic-performance

# DISCUSSION PAPER:

# BUILIDING MANAGEMENT AFTER EARTHQUAKES

## RESPONSE TO SPECIFIC QUESTIONS

### New Zealand building safety evaluation framework

**1. What objectives should the safety evaluation framework target: should its main objective be ensuring public safety, or should it incorporate other aims?**

The primary objective of the safety evaluation framework should be public safety. Other objectives are to provide central and local government with accurate information on the extent of damage in a Civil Defence emergency as quickly as possible, and to inform local government of damage levels that allow local government to assess a time frame for restoring business as usual.

In general building vulnerability cannot be assessed by using Rapid Assessment processes, even by experienced structural engineers. As discussed a Rapid Assessment procedure only provides information on the diminished capacity when compared to a pre-earthquake state. In the future it would be appropriate to be able to derive an absolute value of the post-earthquake capacity/vulnerability of the building and thus assess the risk based on the combination with the renewed seismic aftershock hazard. The Detailed Engineering evaluation (DEE) process is an example of what is required to determine an absolute value . For the Rapid Assessment an experienced engineer can make an approximate qualitative assessment that would have a high level of uncertainty. Indeed, any assessment would be enhanced by rapid access to and consultation of construction drawings .

**What would the process look like if other objectives were added?**

The process should not be changed significantly to achieve the other objectives. Once again, the quick availability of electronic information on the characteristics and pre-earthquake vulnerability of the building would substantially increase the potential and reliability of the triage method.

**What are the risks associated with focussing on one objective over another?**

Providing the process is overviewed by a high level group experienced in Civil Defence emergencies, the assessment of the current hazard and the vulnerability of the building stock in respect of public safety and the safety of occupants we do not see any unmanageable risks that may jeopardise the reliability of the process.

If voluntary resources are used to assess too many criteria, inaccuracies may occur, unless the volunteers belong to a pre-trained sample of engineers with a special licence. Well prepared field information and broad sheets can assist in obtaining comprehensive information.

Volunteers and/or any resources should not work excessive hours during a period of Civil Emergency.

## 2. How did the building safety evaluation operation after the Canterbury earthquakes highlight any weaknesses in the system?

The Canterbury earthquake series provided a unique opportunity to review the effectiveness of the building safety evaluation operation for the following reasons

- Fortunately significant earthquakes in major settlements are rare events.
- Typically aftershocks are of lower magnitude that result in lower levels of shaking in the area of previous damage.

While the building safety evaluation operation significantly enhanced public safety following the initial event, the more severe shaking that occurred in the February 2011 earthquake did provide the opportunity to identify areas where the process can be improved. In particular it has become evident that a higher level of inspection is required for unreinforced masonry buildings and buildings with structural irregularities and critical structural weaknesses.

The Canterbury series of earthquakes highlighted the impossible task of accurately assessing the strength and timing of aftershocks. In the period immediately following a significant earthquake public safety can never be provided with certainty. The economic cost of achieving such an outcome needs to be carefully balanced against the ability to reduce and minimize the risk of (further) loss of life in the event of a significant aftershock.

### Can these failures be addressed, or should we move to a different building safety evaluation model?

The existing building safety evaluation operation is effective in determining the extent of damage that has occurred to buildings in the affected area. What the system does not achieve is an assessment of individual building vulnerability to damage that may cause loss of life in an aftershock.

Such an objective requires the ability to predict the level of shaking likely to occur in an aftershock along with an assessment of individual building vulnerability. While predicting the level of shaking is unlikely to be achievable in any future event, the current territorial authority earthquake prone building policies are collating some basic building vulnerability information in the form of IEP's. In addition many building owners, both in Christchurch and elsewhere have engaged engineers to undertake Detailed Engineering Evaluations (DEE).

Such information, if collected and recorded by the territorial authority, could be made available electronically to engineers undertaking the building assessments immediately following a significant earthquake. This information also has the potential to form a basic building (earthquake performance) grading system to inform the public in the future, and in particular immediately following a significant earthquake.

A grading system may also create the commercial influence to encourage building owners to strengthen and upgrade low strength buildings in advance of territorial authority policy timeframes.

**What are the advantages and disadvantages of these models and approaches, and how do they compare with our current framework?**

The suggested modifications should significantly enhance the current framework.

3. **Who would be responsible for setting up and/or implementing any new framework?**

The NZSEE is not convinced that any dramatically new framework is necessary and supports better resourcing in the preparation of processes and databases that would significantly enhance the potential of the current framework in a future event. The society supports the Ministry of Civil Defence and Emergency Management being assigned the role of developing and administering processes associated with understanding and managing the hazard with the Ministry of Business Innovation and Employment being assigned the role of developing and administering the processes for managing the assessment of building vulnerability, earthquake prone building policy and criteria to apply during the recovery phase of the event.

**Should the roles and responsibilities in the building evaluation system be set at national or local level?**

The Society is of the view that for consistency of response the roles and responsibilities should be set at national level.

4. **What are the risks, costs and benefits of using a building safety evaluation system that uses volunteer engineers who have a liability waiver?**

The Society recognises some limitations in respect of this issue, which is however the standard one at international level. A diametrically opposite approach would be to have professionals with pre-earthquake engagement. Other intermediate configurations could be possible.

Nevertheless the Society is strongly of the view that the present volunteer basis in the initial emergency phase is the preferred option as any alternative might not be able to provide the necessary resources or assessments within the timeframe required. If engineering companies are to be hired to provide those resources, any request would be competing with those firms commitments to clients and insurers. Health and Safety issues arising from staff entering buildings in a period of increased seismicity is already a concern for Engineering firms (as well as for the individual engineers and their families).

The most important step would be to guarantee high levels of training (continuously updated to state-of-art knowledge) and benchmarking for consistency.

The volunteer response was a significant public gesture following the initial event and main aftershocks that has not been given the public recognition that it deserved. The tragic loss of life in the February 2011 earthquake was as a result of a failure of the Christchurch community to address the risk that many of the Christchurch buildings posed in the event of a significant earthquake.

The enforcing of liability on engineers under a civil defence emergency is likely to deter engineers from becoming involved  The engineer evaluation of the status of a building would be different (becoming more or less conservative) depending on the insurance liability, but would be consistent with the to-be-agreed expectations and criteria set by the whole society.

Important aspects of the engineers role during an emergency is that they individually place their own life at risk in entering damaged buildings in order to serve society. They are expected to make crucial decisions on damaged buildings without access to the plans and specifications or the ability to prepare accurate documentation of damage. Outside the period of civil emergency the engineers may take weeks to complete DEE assessments.

### Are there any options that address the risks associated with using voluntary engineers that do not discourage them from volunteering?

While the Society is unable to identify other options, the Society will be interested in reviewing other responses to the Discussion Paper. The Society would make a plea for the development of comprehensive territorial authority databases that would provide engineers with the information they require to improve the reliability of building assessments for the benefit of greater public safety.

The Society would emphasise that the best action that can be taken by society is to meaningfully progress the securing of building facades and low strength buildings.

### 5. What framework should be used to evaluate buildings when a state of emergency is not declared but buildings are damaged (for example, after an aftershock)?

In the event that the level of damage is not sufficient to declare a state of emergency, engineering inspection of buildings is still necessary for public safety. It is suggested that the primary responsibility should remain with the building owner and that the owner should be required to obtain an engineering approved occupancy report and forward the report to the territorial authority as a condition of occupancy. It is likely that the territorial authority should nominate the area over which engineering approved occupancy reports are required, with a mechanism to identify any building which has significant damage outside the nominated area.

## FURTHER CONTACT

The New Zealand Society for Earthquake Engineering is available to provide further comments if required. For more information please contact:

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