Section 1: Summary and recommendations – Volumes 5–7

In these last three Volumes of our Report, we make a number of recommendations for changes to the legislation, policies and practices for the prevention or minimisation of the failure of buildings in earthquakes, on the legal and best-practice requirements for the management of buildings after earthquakes and for the design of new buildings. The numbering of the recommendations we make continues sequentially from the recommendations made in Volumes 1 to 4 of our Report

Volume 5: Christchurch, the City and approach to this Inquiry

Section 2 of Volume 5 provides a brief history of the city of Christchurch, its buildings and its economy. It also describes the impact the Canterbury earthquakes have had on the city and its population.

In section 3 of this Volume we have set out our approach to this Inquiry, including communications with the families of those who lost their lives in building failures in the 22 February 2011 earthquake, the public hearings we conducted and the other ways in which we gathered information, investigated matters and received submissions. We have also described the way in which we managed the thousands of documents we received in the course of our Inquiry, and the reporting structure we have followed.

Volume 6: CTV building

The CTV building, designed and constructed in the mid-1980s, collapsed during the earthquake that struck Christchurch at 12:51pm on 22 February 2011. The collapse resulted in the death of 115 people and others suffered serious injuries.

Our Terms of Reference directed us to inquire into:

- whether the building as originally designed and constructed, and as altered and maintained, complied with legal and best practice requirements;
- whether the building was identified as earthquake-prone or was subject to any measures to make it less susceptible to earthquake-risk before 4 September 2010;
- the nature of the land associated with the building;
- the nature and effectiveness of assessments and remedial work after the earthquakes on 4 September and 26 December 2010;
- why the building failed on 22 February 2011;
- why the failure caused extensive injury and death;
- why it differed from other buildings in the extent to which it failed; and
- whether any particular features of the building contributed to the failure.

The Terms of Reference precluded any inquiry into questions of liability. However, this did not prevent consideration of errors or failings in design, permitting, construction, inspection or any other matter that might explain why the CTV building failed and why the failure caused such extensive injury and death.

In Volume 6 we have set out our findings on these matters. The collapse of the CTV building caused much more injury and death than any of the other building failures on 22 February 2011. Even though it was designed under relatively recent building codes, its failure was severe and resulted in the floor slabs collapsing on top of one another, leaving most of those inside the building with no chance of survival.

We do not summarise our conclusions here. Readers wanting to see a summary of those findings are directed to section 9 of Volume 6, where we set out the principal conclusions we have reached. That section was also written with a view to it being translated into the languages spoken by many of the bereaved. Unusually for a New Zealand tragedy, many of those who died were foreign nationals. Resources have not permitted the full report to be translated. However, section 9 of Volume 6 has been translated into Japanese, simplified Chinese, Thai and Korean.

The engineering design of the building was deficient in a number of respects. While there were elements of the applicable codes that were confusing, a building permit should not have been issued for the building as designed. There were also inadequacies in the construction of the building. The post-earthquake inspections of the CTV building also illustrated areas in which building assessment processes could be improved. As noted above, a summary of all our findings in respect of the CTV building is set out in section 9 of Volume 6 of this Report.

We mention here matters that are the subject of specific recommendations arising from our inquiry into the CTV building.

The CCC issued a number of permits and consents (including resource consents) for work on the CTV building between the time of its original construction and the September earthquake. In most cases, the approved work would have had no impact on the structural performance of the building in an earthquake. A penetration was cut in the floor of level 2 for installation of an internal staircase during a fit-out in 2000. We are satisfied that the penetration would not have affected the seismic performance of the building. However, in our view particular care should be taken to ensure that damage to critical reinforcing does not occur when buildings are altered.

Recommendation

We recommend that:

107. Where holes are required to be drilled in concrete, critical reinforcing should be avoided. If it cannot be avoided, then specific mention should be made on the drawings and specifications of the process to be followed if steel is encountered, and inspection by the engineer at this critical stage should be required.

Following the earthquake, Urban Search and Rescue engineers working on the CTV site, Mr Graham Frost, Dr Robert Heywood and Mr John Trowsdale, took extensive photographs and labelled building elements. Their public-spirited initiative created an excellent record of the state of the building and individual elements following collapse. There was no formal system whereby this information was collected and the Royal Commission commends these engineers for their very thorough documentation and assessment of the collapse debris.

Overall, we consider that the evidence provided an adequate basis to make findings about the state of the building after its collapse and to draw conclusions about possible collapse scenarios. However, implementation of practice guidelines for forensic engineering is warranted to ensure that high quality forensic work is guaranteed for future investigations.

Recommendation

We recommend that:

108. The Ministry of Business, Innovation and Employment should consider developing guidelines for structural failure investigations, including circumstances in which sites should be preserved for formal forensic examination.

It is important to identify other buildings in New Zealand that have characteristics that might lead to their collapse in a major earthquake, so that appropriate steps can be taken to reduce the potential hazard posed by these structures.

Recommendation

We recommend that:

109. In the assessment of buildings for their potential seismic performance:
    - the individual structural elements should be examined to see if they have capacity to resist seismic and gravity load actions in an acceptably ductile manner;
    - relatively simple methods of analysis such as the equivalent static method and/or pushover analyses may be used to identify load paths through the structure and the individual structural elements for first mode type actions. The significance of local load paths associated with higher mode actions should be considered. These actions are important for the stability of parts and portions of structures and for the connection of floors to the lateral force resisting elements;
    - the load path assessment should be carried out to identify the load paths through the different structural elements and zones where strains may be concentrated, or where a load path depends on non-ductile material characteristics, such as the tensile strength of concrete or a fillet weld where the weld is the weak element;
    - while the initial lateral strength of a building may be acceptable, critical non-ductile weak links in load paths may result in rapid degradation in strength during an earthquake. It is essential to identify these characteristics and allow for this degradation in assessing potential seismic performance. The ability of a building to deform in a ductile mode and sustain its lateral strength is more important than its initial lateral strength; and
    - sophisticated analyses such as inelastic time history analyses may be carried out to further assess potential seismic performance. However, in interpreting the results of such an analysis, it is essential to allow for the approximations inherent in the analytical models of members and interactions between structural members, such as elongation, that are not analytically modelled.

110. Arising from our study of the CTV building, it is important that the following, in particular, should be examined:
    - the beam-column joint details and the connection of beams to structural walls;
    - the connection between floors acting as diaphragms and lateral force resisting elements; and
    - the level of confinement of columns to ensure that they have adequate ductility to sustain the maximum inter-storey drifts that may be induced in a major earthquake.

In sections 8 and 9 of Volume 2 and section 6.2.5 of Volume 4 of our report we discuss other issues related to the assessment of the potential seismic performance of existing buildings.

Volume 7: Roles and responsibilities

Section 2: Building management after earthquakes

This section considers the management of buildings after an earthquake, both during and after a state of emergency. We briefly outline New Zealand's civil defence and emergency management framework and give an overview of the building safety evaluation process used to assess buildings after an earthquake.

We consider that, overall, New Zealand was very well served by the engineers, building control officials and others who volunteered in the building safety evaluation process carried out after the Canterbury earthquakes. We appreciate the valuable evidence many of these volunteers gave the Royal Commission to assist us to make recommendations for improvements to the management of buildings after earthquakes.

The Royal Commission considers that life safety should be the main objective for managing buildings after earthquakes. We consider that current legislation provides for New Zealand's building safety evaluation process, but we recognise that proposals to introduce new emergency management provisions into the Building Act 2004 may address some of the problems that occurred when the process transitioned from civil defence to normal building control arrangements controlled by territorial authorities.

Recommendations

We recommend that:

111. Life safety should be the overarching objective of building management after earthquakes as communities both respond to and recover from the disaster.

112. The building safety evaluation process should be used following a range of disasters.

113. Legislation should provide that a building safety evaluation operation should only be commenced during a state of emergency.

114. The Ministry of Business, Innovation and Employment should progress its proposals to incorporate new emergency risk management provisions into the Building Act 2004 to:
    - make the Ministry of Business, Innovation and Employment responsible for the development and maintenance of New Zealand's building safety evaluation process;
    - make territorial authorities responsible for delivering a building safety evaluation operation; and
    - give the Ministry of Business, Innovation and Employment a formal role within national civil defence and emergency planning arrangements.

115. The Ministry of Business, Innovation and Employment should continue working with the Ministry of Civil Defence and Emergency Management on the detail of the above proposals.

As well as considering the process of building safety evaluation, we have discussed and made recommendations about the way in which engineers evaluate buildings when carrying out rapid assessments and detailed engineering evaluations after earthquakes. We also make recommendations about the way that building safety evaluators should be identified and trained.

Recommendations

We recommend that:

How evaluators assess buildings after earthquakes

116. The Ministry of Business, Innovation and Employment, the Ministry of Civil Defence and Emergency Management, GNS Science, the New Zealand Society for Earthquake Engineering and other engineering technical groups should research how and when building safety evaluators should account for aftershocks.

117. The building safety evaluation process should set out the factors evaluators need to take into account when considering how a building will respond in an aftershock, including:
    - how close the main shock was to an urban centre that could be affected by an aftershock;
    - the direction of the main shock and any likely aftershocks; and
    - how soil, ground conditions and any other relevant factors may affect the intensity of the ground motions in an aftershock.

Mobilising a sufficient number of skilled building safety evaluators

118. The Ministry of Business, Innovation and Employment should progress their proposal to establish a core team of building safety evaluators that the Ministry could call on.

119. The Ministry of Business, Innovation and Employment should carefully consider the merits and detail of any proposals about the size of this group of building safety evaluators.

120. The ability to supplement this team with more evaluators who have received basic training should be maintained.

121. Legislation should continue to provide for a waiver of liability for building safety evaluators carrying out rapid assessments.

122. The liability waiver for building safety evaluators should be aligned with the building safety evaluation process instead of being restricted to an operation carried out in a state of emergency.

Guidelines for building safety evaluators

123. The Ministry of Business, Innovation and Employment should work with the New Zealand Society for Earthquake Engineering, the Structural Engineering Society New Zealand and others with appropriate experience and expertise to finalise guidelines for Detailed Engineering Evaluations as soon as possible.

124. Guidelines should be developed that assist building safety evaluators to assess when and how to enter a damaged building.

125. These guidelines should be based on the Urban Search and Rescue training on when and how to assess entry to a damaged building.

126. These guidelines should be attached to the guidelines that the Ministry of Business, Innovation and Employment is developing on the way in which engineers should carry out Detailed Engineering Evaluations after earthquakes.

127. New Zealand's building safety evaluation guidelines should incorporate detailed guidance to engineers about the way they should assess the damage to particular building types.

128. The field guide for building safety evaluators should be finalised.

Training for building safety evaluators

129. The building safety evaluation process should incorporate a training programme for all building safety evaluators.

130. Such training should cover:

- what the building safety evaluation process is and how it works; and
- how to identify and assess the damage evaluators observe in buildings after an earthquake.

131. This training programme should be developed using the New Zealand Society for Earthquake Engineering's building evaluation resource and training capability objectives framework, in which building safety evaluators are split into three different groups and each group receives a different level of training.

132. The core group of building safety evaluators who are a national resource capable of leading a building safety evaluation operation, and those Chartered Professional Engineers, structural engineers and senior building officials who wish to be building safety evaluators, should be required to attend compulsory training.

133. Only trained building safety evaluators should be authorised to participate in a building safety evaluation operation unless the circumstances of a particular disaster make this impractical.

134. If the scale of the emergency requires the mobilisation of the largest group of potential building safety evaluators, who have not received the compulsory training, these evaluators should work, wherever practicable, under the supervision of those evaluators who have attended the compulsory training.

135. Territorial authority staff with civil defence and emergency management responsibilities should be required to attend the compulsory building safety evaluator training as part of their job training.

Indicating that evaluators have the right skills

136. The Ministry of Business, Innovation and Employment should keep a list of the people who complete the compulsory training for building safety evaluators and should make this list available to all territorial authorities.

137. Where available, only Chartered Professional Engineers should carry out Level 2 Rapid Assessments.

Despite some problems, we consider that, overall, the building safety evaluation operations after the Canterbury earthquakes were well delivered. We recommend that a number of changes are made to improve the delivery of New Zealand's building safety evaluation process, which follows current international best-practice.

Recommendations

We recommend that:

138. The Indicator Building model should be incorporated into New Zealand's building safety evaluation process.
139. The Ministry of Business, Innovation and Employment should provide guidance to territorial authorities to support their plans to carry out a building safety evaluation process.
140. Territorial authorities should be required to plan their building safety evaluation process as part of their civil defence and emergency management plans.
141. Only official building safety evaluators should be authorised to place, change or remove placards, and to carry out rapid assessments for this purpose.

Recommendations related to the placards

142. The placards placed as a result of the building safety evaluation process should be rewritten in a plain English format.
143. In principle, the colour of the green placard should be changed to white. The Ministry of Business, Innovation and Employment should consult with the international building safety evaluation community about the merits and detail of the change before deciding whether or not to do this.
144. Formal procedures should be developed that set out when and how the status of a building could be changed. The placard on a building should only be changed if the formal procedures are followed.

Communication and information management

145. The Ministry of Business, Innovation and Employment should be responsible for developing and releasing public communication materials about building management after earthquakes and other disasters during and after the state of emergency.
146. GNS Science should develop protocols and plans to ensure that it is ready to advise the Ministry of Business, Innovation and Employment, other government agencies, local authorities and the wider public after an earthquake.
147. Information management systems should be developed as part of planning for New Zealand's building safety evaluation process.
148. The Ministry of Business, Innovation and Employment should work with territorial authorities and other relevant agencies to develop a way for territorial authority building records to be electronically recorded and stored off-site.
149. A clear system for identifying individual buildings should be developed and included in the plans for a building safety evaluation process.
150. Land Information New Zealand should continue to work on initiatives that develop consistent national addressing protocols and make this information available to the general public.

The Royal Commission heard evidence that there were significant issues in the transition of responsibility for the building safety evaluation process from civil defence to normal building management arrangements governed by territorial authorities. We discuss and make recommendations about the need for transition mechanisms and about the way in which territorial authorities should manage buildings after earthquakes. We consider that all buildings should be assessed further after the rapid assessment phase of the building safety evaluation operation. This assessment should be based on the nature of the event, the type of structure and the level of damage observed. The Royal Commission has heard evidence regarding the barriers faced by some building owners motivated to address the damage to their building after the September earthquake. We consider that some of these barriers are indicative of issues with the management of earthquake-prone buildings and we make recommendations about these specific issues in Volume 4 of our Report.

Recommendations

We recommend that:

151. After an earthquake that has given rise to the declaration of a state of emergency, buildings should be assessed in accordance with the following process:

    a all buildings should be subject to a rapid assessment process;

    b for the purposes of subsequent steps, buildings should be placed in the following categories:

        i) Group 1: non-unreinforced masonry buildings that do not have a known critical structural weakness, and either,

            - in the case of concrete buildings, were designed to NZS 3101:1995 or later editions of that Standard;
            - in the case of structural steel buildings, were designed to NZS 3404:1992 (informed by the Heavy Engineering Research Association guidelines published in 1994) or later editions of that Standard;

        or have been subject to an evaluation that has shown that the building has 67% ULS or greater (we discuss the term "ULS" in section 6.2.4 of Volume 4);

        ii) Group 2: buildings designed between 1976 and the mid-1990s, but not included in Group 1;

        iii) Group 3: buildings designed before 1976, but not included in Group 1; and

        iv) Group 4: unreinforced masonry buildings;

    c buildings used for residential purposes that are three or less storeys in height should be excluded from Groups 2 and 3. In the case of those buildings, a pragmatic approach needs to be taken to assessment and occupancy, which balances the need for shelter with safety considerations. Other commercial and residential buildings should not be occupied unless approved for occupancy in accordance with the process outlined below;

    d legislation should require territorial authorities to classify buildings in their districts in accordance with the preceding Recommendation within the timeframes established under Recommendation 82 in Volume 4 of our Report (Recommendation 82 requires the assessment of earthquake-prone and potentially earthquake-prone buildings);

    e where the rapid assessment process had identified the need for further evaluation of a building in one of these defined Groups, the building should not be occupied until the Civil Defence Controller or the territorial authority (as appropriate) has approved the occupancy of the building after the following assessments:

        i) for Group 1 buildings:

            - where no significant structural damage was seen, a Level 2 Rapid Assessment;
            - where significant structural damage was seen, a Plans-Based Assessment for lower levels of structural damage and a Detailed Engineering Evaluation for higher levels of structural damage;

        ii) for Group 2 buildings:

            - where no significant structural damage was seen, a Plans-Based Assessment;
            - where significant structural damage was seen, a Detailed Engineering Evaluation;

        iii) for Group 3 buildings:

            - for all levels of damage, a Detailed Engineering Evaluation;

        iv) for Group 4 buildings:

            - where no significant structural damage was seen and the building has been retrofitted to 67% ULS or greater, a Plans-Based Assessment;
            - where significant structural damage is apparent and where the building has not been retrofitted to 67% ULS or greater, a Detailed Engineering Evaluation;

f arranging for the Plans-Based Assessments and Detailed Engineering Evaluations should be the responsibility of the owner of the buildings concerned; and

g the Ministry of Business, Innovation and Employment should further develop the Plans-Based Assessment concept, in consultation with the New Zealand Society for Earthquake Engineering and the Structural Engineering Society New Zealand, and set out the Plans-Based Assessment in published guidelines.

152. Plans-Based Assessments and Detailed Engineering Evaluations should include checking the vulnerabilities observed after the Canterbury earthquakes that the Royal Commission describes in Volume 2, section 6.2.5 of Volume 4, and section 6.3.8 of Volume 6 of this Report.

153. Any Plans-Based Assessment and Detailed Engineering Evaluation of a building after an earthquake should begin with a careful examination of the building's plans.

154. The Plans-Based Assessment and Detailed Engineering Evaluation should confirm that all known falling hazards and other vulnerabilities have been assessed and secured or removed.

155. A copy of the Plans-Based Assessment and the Detailed Engineering Evaluation should be given to the relevant authorities.

Cordon management

156. Civil defence and emergency management should be responsible for setting up and maintaining cordons during the state of emergency.

157. Territorial authorities should be responsible for maintaining any cordons that are in place at the end of the state of emergency until the public space or building they surround is made safe.

158. Territorial authorities should be able to recover the costs of maintaining any necessary cordons from the building owner after three months.

159. The roles and responsibilities of decision makers should be described in the building safety evaluation process. The roles and responsibilities should allow for flexibility of operation according to the circumstances and scale of the event.

Buildings that act as one structure in an earthquake

160. The building safety evaluation process should direct evaluators to assess properties that act as one structure in an earthquake as one structure, rather than as separate buildings.

Transition mechanism

161. The building safety evaluation and wider building management after earthquakes (and other disasters) framework should be developed and provided for in legislation.

Section 3: Roles and responsibilities

Through the course of our Inquiry, we identified some systemic issues relating to the regulatory framework for buildings, such as misunderstanding of the framework, a complex and confusing suite of regulatory documents, and quality assurance issues. These issues relate to the design and construction of complex, new buildings.

Quality assurance is vital in the structural design of complex buildings. Quality assurance occurs at a number of levels throughout the design and construction of such buildings. The currently large number of building consent authorities results in inconsistent application requirements and consent decisions around the country, and varying levels of capability within these authorities.

The experience and skill of structural engineers designing such structures also may vary, with reliance placed on the building consent authority to provide a check.

This poses risks for the quality of our buildings. We have concluded that the design of complex buildings (as defined in section 3.3.8.2 of Volume 7 of this Report) requires a higher level of competence. We consider the appropriate regulatory procedure to ensure this occurs is through the preparation and submission of a Structural Design Features Report at the start of the building consent authority's assessment of a building consent application. The building consent authority would, on the basis of this report and criteria to be developed, determine if the structure is a complex one. If it is determined to be a complex structure, a "Recognised Structural Engineer" would be required to certify the structural integrity of the design. The building consent authority would then determine whether it has the staff with the appropriate competency to process the consent application in-house (and whether any additional peer review certified by a Recognised Structural Engineer is required), or whether it needs to refer the application to another building consent authority that has the staff with the appropriate competency to process the application. If the structure is determined to be not complex, the engineer who provided the Structural Design Features Report would certify the structural integrity of the building's design. These recommendations would give further assurance of building quality and reduce reliance on the building consent authority.

Recommendations

We recommend that:

162. Building consent applications for:

- buildings in importance levels 3, 4 and 5 in Table 3.2 of AS/NZS 1170.0:2002;
- commercial buildings comprising three or more storeys; and
- residential buildings comprising three or more storeys with three or more household units

should be accompanied by a Structural Design Features Report, which describes the key elements of the design, including the foundations and gravity and lateral load resisting elements.

163. A structural Chartered Professional Engineer should be engaged at the same time as the architect for the design of a complex building.

164. After consideration of the Structural Design Features Report, the building consent authority should decide whether or not the structure should be regarded as complex.

165. The Ministry of Business, Innovation and Employment should develop criteria to be applied in determining whether a structure is complex, in consultation with the Structural Engineering Society New Zealand, the New Zealand Society for Earthquake Engineering, the New Zealand Geotechnical Society and other relevant groups, including building consent authorities. When developed, the criteria should be given regulatory force.

166. If the structure is determined to be not complex, the engineer who provided the Structural Design Features Report should certify the structural integrity of the building's design.

167. If the structure is determined to be complex, a Recognised Structural Engineer should be required to certify the structural integrity of the design.

168. On receipt of the building consent application, the building consent authority should decide:
    a whether it has the staff with the appropriate competency (qualifications and experience) to process the application in-house (including any decision as to whether the structure is complex and whether any additional peer review certified by a Recognised Structural Engineer should be required); or
    b whether it needs to refer the application to another building consent authority that has the staff with the appropriate competency (qualifications and experience) to process the application.

We have also reviewed the leadership structures within the building sector, as they relate to the matters we are concerned with, and consider that the role of Chief Engineer within the Ministry of Business, Innovation and Employment should be strengthened and supported with additional capability.

Recommendations

We recommend that:

169. The role of Chief Engineer should be renamed Chief Structural Engineer to reflect a greater focus on the structure of complex buildings and should be further strengthened and supported with additional capability.
170. The Chief Structural Engineer should have the statutory power to collect consent applications for complex structures (as part of the Policy and Regulatory Work Programme in Recommendations 173 and 174 below) for the purpose of analysing trends, identifying issues and risks, and sharing knowledge with the building and construction sector.
171. The Engineering Advisory Group should continue as an ongoing function to provide expert advice to the Chief Structural Engineer.
172. The Ministry of Business, Innovation and Employment should consult with learned societies, such as the New Zealand Society for Earthquake Engineering, the New Zealand Geotechnical Society and the Structural Engineering Society New Zealand, about the ongoing membership of the Engineering Advisory Group. The membership of the Group should always include senior practising structural engineers.

We discuss the role of Standards in New Zealand's "performance-based" regulatory system and note that the suite of Standards supporting the Building Code plays a vital role in ensuring our buildings are designed well and built well. We have concluded that these Standards should be regularly reviewed and updated.

Recommendations

We recommend that:

173. The Ministry of Business, Innovation and Employment should develop, lead and fund a Policy and Regulatory Work Programme in consultation with the Institution of Professional Engineers New Zealand, the New Zealand Construction Industry Council, Standards New Zealand, the Building Research Association of New Zealand, the New Zealand Geotechnical Society, the New Zealand Society for Earthquake Engineering and the Structural Engineering Society New Zealand.
174. The Policy and Regulatory Work Programme should identify the priorities for the development, review and update of compliance documents and Standards, and define the status of compliance documents and guidance material. Work relating to Standards prioritised for update as part of the Policy and Regulatory Work Programme should be funded as part of the work programme.

175. Standards referenced in the Building Code should be available online, free of charge.

176. The Policy and Regulatory Work Programme should be the responsibility of the Chief Structural Engineer.

177. A communications plan should be developed by the Ministry of Business, Innovation and Employment to communicate the Policy and Regulatory Work Programme and ensure information is effective, and targeted for different participants in the sector. There should be clarity about the status of information provided to the sector; for example, whether it is a compliance document, Standard or guidance.

Section 4: Training and education of civil engineers and organisation of the civil engineering profession

In this section of our Report, we have reviewed the training and education of civil engineers and the organisation of the civil engineering profession.

International agreements underpin the nature and content of engineering education in New Zealand. The Royal Commission has heard nothing that suggests there should be a change in the structure of the Bachelor of Engineering degree. Rather, key matters for further consideration are in post-degree training and continuing education through provision of tailored block courses for those who are working, and mentoring within engineering firms.

Life safety is and should remain the paramount objective in the design and construction of buildings to resist earthquake motions. This is best achieved by having highly experienced people performing the highest risk activities. In this regard, the Royal Commission has heard proposals and views from interested parties as to the merits, issues and risks of implementing a two-tier certification system that would raise the level of training and experience required of a structural engineer who certifies engineering design plans for complex structures. We consider there is merit in this concept and recommend the creation of the role of "Recognised Structural Engineer" for these purposes (see also section 3 of Volume 7 of this Report).

We have also reviewed the competence requirements against which engineers are assessed for registration as a Chartered Professional Engineer (CPEng). We recommend the introduction of an additional competence measure against which every structural engineer must be assessed – "a good knowledge of the fundamental requirements of structural design and of the fundamental behaviour of structural elements subjected to seismic actions".

Recommendations

We recommend that:

178. The Institution of Professional Engineers New Zealand (as the Registration Authority) should publish on the Chartered Professional Engineer register information about a Chartered Professional Engineer's area of practice, and any other information that may further inform consumers of engineering services of the competence of individual engineers, under section 18(1)(d) of the Chartered Professional Engineers of New Zealand Act 2002.

179. There should be ongoing provision of post-graduate continuing education for engineers through the provision of block courses, mentoring within engineering firms and courses suitable for those who are working.

180. The universities of Auckland and Canterbury should pursue ways of increasing the structural and geotechnical knowledge of civil engineers entering the profession.

181. Legislation should provide for Recognised Structural Engineers to be responsible for the certification of the design of complex buildings as described in Recommendations 162–168.

182. The Ministry of Business, Innovation and Employment should develop prescribed qualifications and competencies for "Recognised Structural Engineers" in consultation with the Chartered Professional Engineers Council, the Institution of Professional Engineers New Zealand, the Structural Engineering Society New Zealand and the New Zealand Society for Earthquake Engineering. These prescribed qualifications and competencies should be a more specific prescription of the qualifications and competencies of the role, and require more extensive design experience of the type required for the design of complex structures than that required for a Chartered Professional Engineer. These should be included in an appropriate regulation.

Members of the Institution of Professional Engineers New Zealand (IPENZ) are required to act in accordance with the IPENZ Code of Ethics, and Chartered Professional Engineers (CPEng) are bound to a Code of Ethical Conduct. Both codes are identical in the obligations they impose on the registered engineers. The key matters of interest to the Royal Commission have been the clauses governing the requirement not to misrepresent competence (IPENZ clause 4 and CPEng rule 46) and the obligations to report buildings and structures that place the public's health and safety at risk (IPENZ clause 11 and CPEng rule 53). We consider that reviewing structural engineers should have a clearly expressed ethical duty to disclose the existence of a critical structural weakness, in a process which protects them from any liability where they have acted in good faith.

Recommendation

We recommend that:

183. The Institution of Professional Engineers New Zealand should provide clarification of its codes of ethics, in respect of the following matters:

    a the test for taking action should be well understood by engineers – i.e. ensuring public health and safety;

    b each clause in the codes of ethics stands alone and no one clause can override another. In the case of a perceived conflict between two or more clauses, the question as to which clause should carry most weight in the circumstances presented should be a carefully considered matter of judgement; and

    c reporting obligations of engineers when a structure has been identified that presents a risk to health and safety. There should be clarity as to the point at which an obligation of a reviewing engineer to report is extinguished, and where the accountability for addressing the matter and rectifying any weaknesses rests.

184. Part 3, clause 6 of the Institution of Professional Engineers New Zealand Code of Ethics and Rule 48 of the Chartered Professional Engineers Rules of New Zealand (No 2) 2002 should be amended to provide for an obligation to advise the relevant territorial authority and the Institution of Professional Engineers New Zealand in circumstances where a structural weakness has been discovered that gives rise to a risk to health and safety.

A particular feature of the engineering profession is the existence of learned societies dedicated to particular fields of engineering practice. Membership of the individual societies largely consists of engineers practising within the society's particular field, although many engineers are multi-disciplinary and are therefore members of more than one society.

These learned societies include the Structural Engineering Society New Zealand (SESOC), New Zealand Society for Earthquake Engineering (NZSEE), New Zealand Concrete Society (NZCS), New Zealand Geotechnical Society (NZGS), New Zealand Timber Design Society Incorporated, Cement and Concrete Association of New Zealand (CCANZ), the Heavy Engineering Research Association (HERA) and others.

The work undertaken by the societies' members includes both contributing to formal processes for reviewing and updating New Zealand Building Standards, and issuing guidance on best-practice for the profession and industry, some of which is paid work but much of which is not. Society members also contribute technical papers for conference proceedings

and provide guidance on best-practice to industry. Processes in which guidance is given are informal, and do not pass through the scrutiny of a regulatory review process: the best-practice advice is not formalised as legal requirements, and therefore may or may not be utilised or taken into account by practitioners.

There are risks in the informal component of this approach. These include whether the necessary expertise will remain available on a voluntary basis to enable the process to continue over time, and the absence of an objective process that tests the content and assesses the consequences of the best-practice guidance by formal regulatory review. Assessment of consequences would include examining the costs of the best-practice standards and requirements to determine value in the context of the risks being managed. In addition, without any formal recognition, the adoption of the recommended best-practices is difficult to monitor and cannot be enforced. This makes it unlikely that they will be consistently applied by practitioners.

As discussed above, we consider that the Ministry of Business, Innovation and Employment (MBIE) should develop a policy and regulatory work programme to identify priorities and clarify roles. In doing this work, MBIE should consult with the engineering profession's learned societies as to where best-practice guidance is required, and the appropriate process for achieving it, including the need to codify any parts of the advice into regulations or Standards, and whether the issues should be led by the regulator, or left to the societies.

The professional and learned societies play an important role in facilitating information sharing, debate, and problem resolution across the various disciplines within the engineering profession. Of particular interest to the Royal Commission is the need for collaboration between structural and geotechnical engineers. The societies also endeavour at times to bring engineers together with other intersecting professions within the construction industry (for example, constructors, manufacturers and architects).

The Royal Commission considers there is a reasonable level of constructive engagement between the different branches of engineering. However, there is scope for more constructive, and early, collaboration between architects and engineers.

Recommendation

We recommend that:

185. The Institution of Professional Engineers New Zealand, the New Zealand Institute of Architects, and the New Zealand Registered Architects Board, supported by the Ministry of Business, Innovation and Employment, should work together to ensure greater collaboration and information sharing between architects and structural engineers.

Section 5: Canterbury Regional Council and Christchurch City Council – management of earthquake risk

As part of our Inquiry into the Canterbury earthquakes, we considered it would be inappropriate to ignore entirely the fact there has been unnecessary damage and costs sustained as a result of the development of land subject to a risk of liquefaction without duly considering that risk. Apart from anything else, an understanding of how that has been possible under the existing regulatory system might enable better outcomes in the future.

As a result of our Inquiry into these matters, we conclude that there should be better provision for the acknowledgment of earthquake and liquefaction risk in the various planning instruments that are made under the Resource Management Act 1991. One way of minimising the failure of buildings in the future is to ensure that the land on which they are developed is suitable for the purpose. Having said that, we need to emphasise that it is not possible to predict with any certainty when an earthquake will occur and, in reality, the public and private investment in the country's cities is such that it is not realistic to redirect development from the existing central business districts. However, when zoning for new development areas is in contemplation, we consider that it would be appropriate for the risks of liquefaction and lateral spreading to be taken into account.

Recommendations

We recommend that:

186. Sections 6 and 7 of the Resource Management Act 1991 should be amended to ensure that regional and district plans (including the zoning of new areas for urban development) are prepared on a basis that acknowledges the potential effects of earthquakes and liquefaction, and to ensure that those risks are considered in the processing of resource and subdivision consents under the Act.

187. Regional councils and territorial authorities should ensure that they are adequately informed about the seismicity of their regions and districts. Since seismicity should be considered and understood at a regional level, regional councils should take a lead role in this respect, and provide policy guidance as to where and how liquefaction risk ought to be avoided or mitigated. In Auckland, the Auckland Council should perform these functions.

188. Applicants for resource and subdivision consents should be required to undertake such geotechnical investigations as may be appropriate to identify the potential for liquefaction risk, lateral spreading or other soil conditions that may contribute to building failure in a significant earthquake. Where appropriate, resource and subdivision consents should be subject to conditions requiring land improvement to mitigate these risks.

189. The Ministry for the Environment should give consideration to the development of guidance for regional councils and territorial authorities in relation to the matters referred to in Recommendations 186–188.