

# SESOC Higher Qualification & Improved Practice Working Group

Revision Draft 01

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## EXECUTIVE SUMMARY

SESOC has formed a Working Group to prepare this discussion document which focuses on raising professional standards in the structural engineering profession in New Zealand.

In part this document has been prepared in response to the Canterbury Earthquakes Royal Commission report on Training and Qualifications for Structural Engineers. Regardless, it is a widely held view among our members that professional standards warrant review.

In preparing this discussion document the Working Group has reviewed the practice of Structural Engineering in New Zealand and a number of Overseas Jurisdictions. Of particular relevance are the qualification procedures and restrictions on practice developed for, and implemented in the Canadian province of British Columbia. These were developed in response to a Commission of Enquiry that was held to investigate a major building collapse in that province.

The key recommendations contained in this discussion document are summarised below:

- 1 SESOC will work with universities, the registration authority and NZSEE to develop and administer an examination covering “Fundamentals of Structural Engineering” that can be used for structural candidates undertaking assessments for CPEng, and previously assessed candidates at their next Continuing Registration Assessment.
- 2 SESOC will work with IPENZ and the Registration Authority to develop Improved Technical Training of CPEng Structural Practice Area and Staff Assessors.
- 3 A working group be established to investigate the development of a programme for improving post graduate training of Engineers, particularly those that are not familiar with the NZ engineering environment.
- 4 There is an immediate need for training on earthquake assessment and seismic retrofit.
- 5 An additional tier of qualification be introduced above that of CPEng, known as the 'Recognised Structural Engineer (RSE) qualification, with an RSE qualification required to design and approve restricted design work.
- 6 SESOC will work with IPENZ and the Registration Authority and NZSEE to develop competencies for establishing the 'Recognised Structural Engineer (RSE)' quality mark for engineers competent to undertake restricted design work.
- 7 SESOC will take the lead in setting up a working group to determine restricted works to be classified as “Designated Structures”.
- 8 Candidates for 'Recognised Structural Engineer' be are required to pass an assessment process in order to be able to design “Designated Structures”.
- 9 SESOC will work with MBIE, IPENZ and the Registration Authority and BCA’s to promote wider use of Independent Peer Review.
- 10 A centralised policy be developed for BCA’s addressing Building Consent policy.
- 11 SESOC will work with IPENZ to develop procedures for undertaking random auditing of CPEng and RSE practitioners.
- 12 The requirements for and standard of Continuing Professional Development (CPD) and the maintenance of currency for structural engineers should be reviewed.



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- 13 SESOC will work with IPENZ to establish clear definitions of prescribed standardised Practice Areas for structural engineers.
- 14 Improved ethical guidance.

Whilst it is envisaged each of these recommendations if implemented individually will have a positive impact on the structural engineering profession. It is the view of the Working Group that for the greatest positive impact they should be considered as a suite of solutions and implemented collectively.

## 1 INTRODUCTION

### 1.1 OBJECTIVES & SCOPE

This discussion document has been prepared in part as a response to the Canterbury Earthquakes Royal Commission of inquiry (CERC) request to the structural engineering profession to review the current arrangements for the education and training of structural engineers in New Zealand. The competency standards and registration processes used by IPENZ, and the occupational regulations that govern the structural engineering profession are also considered.

The purpose of this discussion document is to seek comment from those with an interest in the profession. Following a period of consultation comments will be consolidated and SESOC's final recommendations published. The overarching aim of this review is to improve the standard of structural engineering in New Zealand.

It is recognised by the authors that some of the recommendations made in this discussion document may be considered contentious. Indeed, when considered individually some recommendations may be deemed by some to be ineffective. However, the authors are of the view that when considered collectively the recommendations contained herein will have a significant and positive impact on the profession of structural engineering in New Zealand. Therefore, the recommendations contained in this discussion document should be considered as a suite of measures aimed at effecting a step change improvement in professional standards of structural engineering in New Zealand rather than a shopping list of items to be considered for individual and less effective implementation.

### 1.2 PREAMBLE

Change to building regulatory frameworks is often driven by structural failures. This Working Group has been prompted by the CERC recommendations to consider all aspects of the structural engineering profession as a consequence of its enquiry into the performance of structures in the Canterbury earthquakes. Interestingly, the regulatory framework and qualifications system developed by the government of British Columbia, was created from a similar set of circumstances to that currently being encountered in New Zealand. A Commission of Inquiry was commissioned in response to the collapse of a major structure that occurred 5 minutes after its opening ceremony on April 23rd, 1988. Amongst the recommendations resulting from that inquiry were:

- Higher standards for consulting engineers.
- Provincial standards of practice be established for the preparation and submission of all building design drawings and calculations
- Creation of a Review Panel that at random or for good reason reviews 10% of all submitted design projects.

Acting on these recommendations the Association of Professional Engineers and Geoscientists of British Columbia (APEGBC) developed an additional qualification that is required in order to undertake the design of high risk or complex design structures.

Some of the conclusions reached by this commission are similar to findings reached by the CERC. The Working Group believes that aspects of the British Columbian structural engineering

profession's response to a major building collapse serves as a good reference for New Zealand's response following the Canterbury earthquakes.

This discussion document has been organised to examine the framework of the New Zealand Structural engineering

- Training and Education.
- Assessment of competence of structural engineers
- Professional Ethics
- Regulations and Review
- Administration.

As discussed earlier the reader is encouraged to reflect on all elements of the framework and consider the recommendations collectively.

## **2 HISTORIC CONCERNS ABOUT THE QUALITY OF STRUCTURAL ENGINEERING IN NEW ZEALAND**

There has been discussion about the perceived poor quality of Structural Engineering in New Zealand for some time. An open letter on the subject in 2002 [1] gained considerable publicity and led to the formation of an IPENZ led task force to investigate the state of structural engineering in New Zealand. This resulted in publication of the “Report of the Structural Engineering Taskforce enquiring into the State of Practice in Structural Engineering in New Zealand” in 2003 [2]. This report contained the following recommendations;

- *Identification of competent structural engineers* - Competence assessments must be rigorous and stringent. Engineers working outside their level of competence should be identified and censured where appropriate
- *Improved Consent and Audit Process* - The variability in enforcement standards between Territorial Local Authorities and unacceptable low standards in some cases, must be eliminated. This could be by ensuring that consent approvals and code compliance certification take place only after high quality evaluation processes, including peer review by appropriately qualified structural engineers where the building has non- standard features.
- Territorial Local Authorities must establish a culture of complaining about the competence of engineers who present sub-standard work repeatedly, so that such practice can be investigated by the registering authority under the Chartered Professional Engineers of NZ Act 2002

Despite this report, significant evidence points to poor quality structural engineering still occurring in New Zealand, as evidenced by:

- Structural failures of buildings following severe snow events in the Canterbury and Southland areas
- Evidence of poor practice that is suppressed due to legal/insurance confidentiality requirements
- The performance of some structures during the Canterbury Earthquakes, as has been considered in detail by the Canterbury Earthquakes Royal Commission.

### **3 CANTERBURY EARTHQUAKES ROYAL COMMISSION RECOMMENDATIONS**

As a result of its review of the performance of buildings during the Canterbury earthquakes the Canterbury Earthquakes Royal Commission (CERC) has made a number of recommendations in respect of professional standards of structural engineering in New Zealand. This discussion document responds to the recommendations contained within Volume 7 of the CERC report that deals with 'Training and education of civil engineers and organisation of the civil engineering profession'. In the preparation of this discussion document the Working Group has examined the CERC recommendations. These are as follows:

*'... 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 subject to seismic actions"*

*No. 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.*

*No 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*

*No. 181: Legislation should provide for Recognised Structural Engineers to be responsible for the certification of the design of complex buildings as described in Recommendations 162-182.*

*No. 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 appropriate regulation.*

These recommendations suggest there is a need for change in the regulation, education, and registration of structural engineers.

## **4 TRAINING AND EDUCATION OF ENGINEERS**

### **4.1 EXISTING NEW ZEALAND TERTIARY EDUCATION SYSTEM**

The current New Zealand tertiary education system provides the opportunity for students to gain experience across a broad range of civil engineering including structural engineering. Whilst more structural engineering subjects would be welcomed, it is recognised that there is finite time in the Bachelor programme, and the universities principal focus is to produce well rounded individuals with the potential to develop. We recommend the bachelor programme be reviewed to assess how well it prepares Structural Engineers for practice, identify potential shortcomings and post-graduate training programmes developed to address these shortcomings.

### **4.2 POST GRADUATE EDUCATION AND TRAINING**

CERC have recognised the importance of post graduate training in the development of competence and have stated 'The Royal Commission is of the opinion that post-graduate training for all engineers is an essential factor in developing and maintaining competence'.

The Working Group supports this view and recommends collaboration between the structural engineering profession and academic institutions to develop targeted training programmes for structural engineers. SESOC has identified an immediate need to provide training in various aspects of the structural engineering profession. However, there is a pressing and immediate need for training in the assessment of existing structures and up-skilling of engineers in all aspects of seismic engineering.

It is noted that the provision of CPD courses/seminars in New Zealand is uncoordinated and provided by a number of organisations. Providers include Technical Groups such as SESOC, NZSEE, Concrete Society, Timber Design Society; Professional Organisations including IPENZ; Industry Groups including HERA, SCNZ, CCANZ and private providers. The Working Group consider that there needs to be better co-ordination and planning of these events along with the possible establishment of a Training Organisation to undertake this role.

Structured post graduate training programmes can be used to ensure that engineering fundamentals are being understood, and can cover aspects of engineering not specifically addressed in the undergraduate curriculum. Through collaboration between academia and the engineering profession a series of structured lectures, workshops or tutorials can be developed specific to New Zealand's requirements. A selection of training sessions would then form the basis of determining compliance with the relevant core competencies of the IPENZ assessment procedure. Measured components at the end of each session or module, such as a test or assignment would be factored into the assessment process. Similarly, training modules (or block courses) can be developed for topics not addressed at the undergraduate level and for advanced engineering techniques or concepts. Web based training modules are also worthy of consideration, and would make training more accessible to practicing engineers.

Training courses need to be designed to meet the needs of overseas or non-New Zealand trained engineers to achieve competency in seismic and New Zealand practice.

An example of a similar training system exists in Canada where the Structural Engineering Association of British Columbia (SEABC) has developed a programme aimed at preparing structural

engineers for practice. This training programme has successfully operated since 2000. More details on this programme can be found in Appendix D of this paper.

It is worth noting that a similar system to that promoted above is used by the New Zealand Institute of Chartered Accountants to ensure that their candidates have an understanding of both basic and advanced accounting principles. After graduation accountants undertake a series of training modules to step them through the process of becoming a Chartered Accountant [3].

**Pros:**

- Training can be tailored to suit the needs of the profession. Feedback from training courses can be used to improve University course content.
- Training can be tailored allowing candidates to build their knowledge and experience towards achieving a professional qualification.
- Engineers can gain access to training that may not be available in their respective work places (particularly important for small practices).
- Reduce burden on assessors.

**Cons:**

- Difficulty in recruiting trainers with the appropriate level of experience/ability.
- Access to training may be difficult due to work/geographical considerations.

### 4.3 ENGINEERING FUNDAMENTALS

Section 4 of Volume 7 of the CERC report examines the existing IPENZ CPEng assessment process. The Royal Commissioners 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 subject to seismic actions" [4].*

This recommendation echoes the sentiments of members of SESOC who have also observed a worrying lack of fundamental engineering knowledge amongst members of the structural engineering community. The CERC recommendations concern knowledge that should already be encompassed by elements 1 & 2 of the IPENZ CPEng core competency requirements [5], which are:

Element One - Knowledge - specifically the candidates ability to *'Comprehend and apply knowledge of the accepted principles underpinning widely applied good practice in professional engineering (Washington Accord degree level)'*.

Element Two - Local Knowledge - specifically the candidates ability to *'Comprehend and apply knowledge of the accepted principles underpinning good practice for professional engineering that is specific to the jurisdiction in which he/she practices (NZ)'*.

Based on the specific mention of engineering fundamentals in the CERC report it can be inferred that the existing CPEng core competencies are not adequately investigated during the existing assessment process. If engineers are passing the existing assessment process without an adequate understanding of the fundamentals the process itself may require substantive revision or increased rigour.

Two possible methods of achieving the CERC recommendations have been investigated and are discussed in the following sections.

#### 4.3.1 Enhanced Interactive Assessment

Fundamental engineering knowledge is consistent across all structural practice areas and is primarily obtained through undergraduate level university teaching. Consequently, a 'defined minimum standard of fundamental knowledge', and 'local knowledge' specific to New Zealand needs to be well defined. Improvements can be achieved through explicit consideration of this minimum standard during the assessment process. Training of assessors on the technical expectations of differing practice areas would also improve conformity of assessments.

The Working Group expresses reservations over the sole use of what is a largely subjective review of a candidate evidence for use in determining competence for technical roles.

##### Pros:

- Requires the least change to the existing CPEng assessment process.
- Cheapest and quickest to implement.

##### Cons:

- Assessment of a candidate's knowledge would be subjective in nature.
- Concerns have been raised over the conformity/consistency of assessment achieved under the current IPENZ assessment process.

#### 4.3.2 Formalised Examination

Included as part of an assessment, a formalised examination of engineering fundamentals would provide a more consistent and measureable means of determining a candidate's knowledge, and promote conformity in assessments. Examinations are used by some internationally comparable engineering qualifications to determine a candidates understanding of engineering fundamentals, most notably the United States of America where candidates must pass a 'Fundamentals of Engineering (FE) Exam' in order to be able to apply for the professional qualification. This is an 8 hour examination covering a broad range of Civil, Structural, Electrical, Chemical & Material engineering topics.

A standardised examination of all candidates could be developed for inclusion as part of the CPEng assessment process. However, unlike the United States examination which covers a broad range of topics it is the Working Group's view that any examination in New Zealand should be focused on structural and seismic engineering fundamentals including practical engineering knowledge as it relates to the New Zealand engineering environment. We acknowledge the concern some may have with respect to examinations and their potential limitations. Therefore, we propose moderation of the exam process to address these concerns.

##### Pros:

- Provides a measure of knowledge.
- Assists with consistency in assessments.

**Cons:**

- Resourcing the examination process.
- Introduces additional costs associated with setting/marking the examination.

It is the Working Group's recommendation that a formalised examination be adopted as part of the assessment for structural engineering professional qualification.

## 5 QUALIFICATIONS & ASSESSMENT OF ENGINEERS

### 5.1 TIERED QUALIFICATIONS

The CERC stated that an additional, higher level qualification should be required for those that design significant structures. Specifically, it was stated.

*Buildings whose failure in an earthquake poses a significant risk of loss of life should be designed by the most capable of engineers, in the interests of public safety. We are therefore of the view that the law should provide for 'Recognised Structural Engineers' who have acknowledged expertise in structural design, with a specified role in respect to complex structures' [4].*

The Working Group supports this view, although it is believed that the term 'Complex Structures' taken in isolation can be misleading and taken out of context does not adequately convey the intent of the CERC. There are buildings whose failure could have significant life safety impact and/or consequences for society due to their size or usage, despite not being considered complex with regard to analysis, load paths, design or construction. These structures should be the subject of restricted work and defined as 'Designated Structures'. Consistent with the recommendations of the Royal Commission these works should be undertaken by a suitably qualified engineer. Therefore, we support the Royal Commission's recommendation for the adoption of a higher qualification 'Registered Structural Engineer' to undertake this work.

The adoption of the 'Recognised Structural Engineer (RSE)' concept would create a tiered qualification/register system with the existing CPEng arrangement being considered the entry level qualification into the profession, and would be regarded as the minimum standard to undertake 'specific' structural engineering designs. For more significant structural engineering designs the Working Group support a higher level qualification "Recognised Structural Engineer".

#### 5.1.1 Implementation

Questions arise over how an additional tier in the qualification system can be applied and administered. Tiered qualification systems exist overseas, notably in North America. Through review of these systems it is envisaged that a system can be developed for New Zealand.

##### 'Designated Structures'

The definition of 'Designated Structures' is one that warrants further discussion. Factors such as consequence of failure, importance, and complexity of design influence the designation of what design work should be restricted to a RSE. Careful consideration is required as not all structures require the skill and experience commensurate to that proposed for a RSE, and too broad a definition could stifle the profession. It is proposed that a working group be commissioned to investigate and develop a designated structures schedule.

CERC recommendations 162-168 address this issue and detail possible steps for managing the design and approval requirements for 'complex structures' (referred to as 'Designated Structures' in this document), and for the purpose of clarity these are listed below.

*Building consent applications for:*

- o buildings in importance levels 3, 4 and 5 in Table 3.2 of AS/NZS 1170.0:2002;*

- o commercial buildings comprising three or more storeys; and*
- o 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:*
- o 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*
  - o 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.*

The Working Group consider that the CERC proposals above are a prudent and sensible method for approaching and managing the consenting process for 'Designated Structures', although believe that rather than having reliance on a BCA determining what is a 'Designated Structure' there should be clear guidance on what constitutes restricted design work. As such, engineers can determine if they are appropriately qualified to accept work, rather than relying on others. It is also noted that it is SESOC's view that Design Features Reports (DFR) should be submitted for Building Consents for the designs of significant structures [6]. SESOC has developed recommended DFR templates for the industry.

What constitutes restricted design work varies considerably in the regulatory frameworks examined. In the United States the requirements are set by each individual State, although further restrictions can be applied by regulatory bodies within a State, for example, the city of Seattle (Washington State) which requires all structural work to be undertaken by an S.E. Table 2 in Appendix C

summarises a selection of licence requirements and provisions for use in a selection of American states. A summary of what constitutes restricted design work in British Columbia, Canada can also be found in Appendix C.

With respect to the definition of a 'Designated Structure' it is the Working Group's view that the recommendations of the Association of Professional Engineers and Geoscientists of British Columbia (APEGBC) concerning restricted design work closely reflects the intent of the CERC recommendation (no. 165) and the needs of the profession in New Zealand. A great deal of thought and discussion has been undertaken by APEGBC in order to develop these guidelines and as such they could serve as a useful starting point for discussion on the definition of 'Designated Structures' for the New Zealand environment. Details on APEGBC recommendations are included in Appendix B.

Possible additions to the APEGBC definition of restricted design work include;

- Bridge structures - based upon importance level, size of vehicle and span.
- Seismic assessment and retrofit design of structures - restrictions commensurate with level of qualification required to design a similar structure.
- Non-building structures - civil infrastructure, water retaining structures, industrial structures (silos etc...).

The Working Group recommend reference be made to the British Columbia definitions of types of structures that fall into the Recognised Engineer category with the provision that these be modified to suit the New Zealand context.

## 5.2 COMPETENCY STANDARDS FOR CHARTERED PROFESSIONAL ENGINEERS

CERC has identified several areas for improvement in the existing IPENZ Chartered Professional Engineer assessment process and administration of the Chartered Engineer Register. By addressing these issues and the issues discussed below the Working Group consider the existing CPEng process can be augmented to provide a robust assessment methodology suitable for the assessment of competence. Issues discussed are;

- Qualification requirements
- Assessor training and selection
- Fundamentals of engineering
- Defined knowledge
- CPD and maintenance of currency
- Practice area

### 5.2.1 Qualification Requirements

Knowledge equivalent to a Washington Accord Bachelor of Engineering degree should be regarded as the minimum standard to undertake specific structural engineering designs. For degree courses without specific earthquake engineering content candidates must demonstrate seismic knowledge equivalent to that obtained from a Bachelor degree course. This would also apply to New Zealand engineering degree graduates who have not undertaken structures or seismic engineering papers as part of their degree course.

### 5.2.2 Assessor Training and Selection

The Working Group has concerns over the level of technical training given to both Practice Area and Staff Assessors involved in the CPEng assessment process (for Structural Engineers) along with the appropriate selection of assessors for particular practice areas.

Assessors are members of the profession who have either been nominated by another member or volunteer and are approved by IPENZ. There is no formal process whereby potential assessors can be gauged against the professional requirements of his/her practice area. A Practice Area Assessor (PAA) is selected based upon the similarity between their 'practice area' and that of the candidate. Errors in judgment could result in unsuitable assessors being approved or being assigned to unsuitable practice areas.

Practice areas are often sufficiently broad or non-specific to make their use as a PAA selection criteria flawed. Personal interpretations of the core requirements, particularly with regard to measuring compliance with 'Complex Engineering Problems' can vary considerably along with the expectations of each assessor.

Existing assessor training undertaken by IPENZ focuses on procedural aspects of the assessment process rather than aspects of technical proficiencies. Additional assessor training concentrating on technical aspects would serve to improve consistency in assessments and help to identify assessor proficiencies for the purpose of matching a PAA with a candidate. A panel of PAA would go some way to alleviating the subjectivity in assessment and would improve on the current level of conformity in assessments and is worthy of further consideration.

#### Pros:

- Greater conformity in assessment.
- Improved standards of assessment.

#### Cons:

- Cost and time required to develop training programmes.
- Requires additional investment of time for volunteer assessors - may discourage participation.
- Availability of suitable assessors.

### 5.2.3 Defined Knowledge Requirements

A candidate's ability is measured against a prescribed set of core competencies. However, there is no quantitative measure for assessing the candidate's technical ability, nor is there any defined minimum level of technical knowledge (either in regard to specific practice areas, or to fundamental engineering principles). Without specific guidance on the required knowledge specific to the candidate's practice area an unsuitable PAA may have little ability to effectively investigate the candidate's abilities, or ensure conformity and consistency across a number of assessments. It is recommended that efforts be made to define the minimum levels of knowledge (both technical and non-technical) required for defined practice areas. An emphasis should be placed on the understanding of the fundamentals of engineering knowledge during this stage and methods of implementing this are discussed in Section 4.

#### Pros:

- Improved conformity and consistency in assessment.

#### 5.2.4 CPD & Maintenance of Currency

The engineering profession is constantly evolving, and as such the ongoing enhancement of skills and knowledge is required in order to maintain competency. Although there is no specific number of hours required for Continuing Professional Development (CPD) in New Zealand it is generally thought that at least 50 hours of good quality CPD is required annually to maintain competency. This figure is generally commensurate with the requirements of other jurisdictions examined as can be seen in Table 1 in Appendix A. However, it is essential that CPD be relevant to the engineers' area of practice. In some jurisdictions investigated, there exist a prescribed minimum number of specific CPD hours relative to certain competencies such as technical or managerial. It is considered that this approach may have merit and could be considered for New Zealand professional engineers.

#### 5.2.5 Practice Area

Self-assessment has been identified as a potential weakness in overseas jurisdictions. There is a natural tendency for the least competent individuals to over-estimate their capabilities – a psychological phenomenon known as the Dunning-Kruger effect. As such, we are not always best placed to make objective decisions on the level of work we should be undertaking. This effect has been a consideration in the development of the professional qualification assessment system adopted in the United States. Further information on the Dunning - Kruger effect and its relationship to structural engineering competency assessment can be found in Appendix E.

The notion of 'Practice Area' in the context of structural engineering needs review (refer to IPENZ Discussion Paper by Brett Williams [7]). In the interest of consistency it is recommended that a limited number of standard Practice Area Descriptions be prepared for Structural Engineers.

Under the current system Chartered Professional Engineers are assessed as being competent within a particular practice area that is defined by the candidate and then verified by the assessors. Despite practitioners competence being directly linked to a particular practice area, the practice areas of professional engineers are not published on the CPEng Register. Without publication of this information it is not possible for others to discern whether an engineer is competent for a particular task. The generic nature of the qualification creates the false impression that CPEng guarantees competence across a broad range of practice areas, which is not the case. This has been recognised by the CERC who has made the following recommendation.

*No. 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 [4].*

The Working Group supports this recommendation, and believes that Practice Area information should be publicly available. In addition we recommend a limited number of standardised Practice Area Descriptions for structural engineers is developed (by appropriate technical bodies) and published by IPENZ.

## 5.3 COMPETENCY STANDARDS FOR RECOGNISED STRUCTURAL ENGINEERS

We recommend well defined competency standards are developed for Recognised Structural Engineers, which shall include the following key components:

- Qualification requirements
- Assessor training and selection
- Assessment methodology
- CPD and maintenance of currency

### 5.3.1 Qualification Requirements

It is considered that an RSE should have suitable practical experience in their role as well as ability. Therefore the Working Group recommends that candidates have attained a minimum of six years relevant post graduate experience prior to qualifying for RSE assessment. It would be expected that in order to apply for the RSE qualification a candidate should have already satisfactorily completed the CPEng assessment procedure.

### 5.3.2 Assessor Training and Selection

Due to the higher knowledge base required for the RSE qualification, it is expected that Practice Area Assessors will be selected from a pool of appropriately experienced existing Recognised Structural Engineers. Naturally, special consideration would be required to be given for the first RSE assessments, although it is believed that this could be managed through a specially convened 'expert review panel' for the first batch of assessments.

It is anticipated that additional training modules for RSE assessors would be developed and implemented.

IPENZ has had difficulty in recruiting Practice Area Assessors in the past, which is in part due to the time commitments required, and possibly due to the role being unpaid. To encourage recruitment of Assessors two possible alternate models could be considered, which are;

- Paying assessors for their time (costs to be added to the total assessment cost).
- Including as a condition of acceptance of the RSE qualification a requirement to act as a PAA for 'x' number of assessments per year (or bi-annually).

### 5.3.3 Assessment Methodology

This discussion document considers two methods of assessing the competencies required for a Recognised Structural Engineer (RSE). These methods are as noted below and are discussed in detail in the subsequent sections;

- An enhanced interactive assessment, or
- A formal technical examination of technical competencies complimented by an interactive assessment.

### 5.3.3.1 Interactive Assessment

Enhanced interactive assessment requires the incorporation of a panel of highly skilled and experienced assessors responsible for determining the level of competence of a candidate with respect to the 12 core competencies currently defined by IPENZ as being required for the existing CPEng qualification. It is envisaged the panel would consist of two to three currently practicing Recognised Structural Engineers with significant experience in practice areas compatible with that of the candidate.

Structural engineering is a highly technical profession that covers a broad range of concepts, materials and philosophies. Assessment demands for the RSE qualification are expected to be considerably more demanding than that currently undertaken during existing CPEng assessments. It is acknowledged that it is currently difficult to attract an adequate number of suitable assessors for the current CPEng assessment process and clearly by increasing the number of assessors per candidate combined with a vastly increased interactive requirement would be both impractical and unsustainable under the current volunteer system.

#### Pros:

- Ease of implementation – little change to existing methods.

#### Cons:

- Requires additional investment of time for volunteer and structural staff assessors - may discourage participation.
- A largely subjective assessment.

Assessment methodologies such as interactive assessments are not ideally suited to the practical determination technical competence. This is as a consequence of the nature of the assessment approach which has inherent deficiencies with regard to ensuring conformity/consistency with regard to assessment of technical ability or knowledge. These flaws would at best only be mitigated through the addition of more assessors. Consequently sole reliance on an interactive assessment procedure is not supported by the authors as being suitable for the assessment of competence to the level required for a RSE.

### 5.3.3.2 Interactive Assessment Plus Examination

The importance and benefits of an interactive assessment are recognised by the authors. However we consider that the assessment process would be strengthened by the addition of an examination of technical competency.

#### Interactive Assessment

The design of 'Designated Structures' requires specialist skills and experience. For a typical candidate it is not likely these skills and experience will be sufficiently developed at the time at which an application for CPEng is made. As such it is recommended that candidates for the proposed RSE qualification be required to undergo and pass an interactive assessment in a similar manner to the existing process for chartered professional engineers. This assessment would act as a precursor to a formalised technical examination.

**Pros:**

- Interactive assessments can examine skills and abilities not readily assessed through set examinations.

**Cons:**

- Difficulty in recruiting RSE assessors from a much smaller pool of potential assessors.

Examination

It is considered that a formal examination of technical ability will provide a robust measure of competence. Examinations are common in overseas jurisdictions, particularly in regions where there is a significant seismic hazard as is the case in New Zealand. A benefit of an examination is that it can provide a benchmark of technical ability and knowledge at one stage in an engineer's career.

The Working Group considers that the prime focus of any examination would be to investigate the candidate's knowledge of engineering principles and concepts rather than to investigate knowledge of codified design requirements. The format of such an examination warrants further study, however, it would be expected that it would include the examination of principles of seismic analysis and design for structural candidates.

The difficulty of implementing such an exam would be a function of the standard of knowledge deemed appropriate for the design of designated structures.

**Pros:**

- Technical competencies will be the subject of a more thorough objective assessment.
- More consistency in assessment of technical competencies.

**Cons:**

- Cost associated with developing and administering an examination.
- Reduced number of assessment opportunities - only annual assessments will be practical.
- Not all candidates perform well in exam environments despite being competent.

It is recognised that there are flaws in any assessment system and that some competent engineers may not be suited to performing well under an examination based assessment system. However it is considered that engineers disadvantaged by such an assessment approach will be small in number and would be outweighed by the number of engineers of unsuitable ability that would obtain qualification under a solely interactive based assessment process.

### **5.3.4 CPD & Maintenance of Currency**

The recommendations of Section 5.2.4 relating to Chartered Professional Engineers are applicable for Recognised Structural Engineers. A RSE would be considered as being a specialist role requiring more in-depth technical knowledge to be proficient. Therefore, a higher component of CPD relating to technical matters is recommended.

## 6 PROFESSIONAL ETHICS

All Chartered Professional Engineers (CPEng), and IPENZ members subscribe to a defined code of ethics [8][9]. However, the Working Group is aware of examples where the ethics of holders of the CPEng qualification practicing in the field of structural engineering can be called into question.

The Working Group considers that the vast majority of CPEng Engineers strive to carry out their work in an ethical and responsible manner. However, a number of engineers may not be complying with the IPENZ Code of Ethics, possibly because many of the boundaries of ethical and unethical conduct are not sufficiently clear.

The following are a few examples of situations/questions that commonly arise

- Am I practicing in an area of my competence? (The Dunning-Kruger effect previously outlined may be a factor) For example, reviews of numerous seismic assessments of existing buildings have demonstrated that many structural engineers lack the necessary knowledge and skill to undertake this work.
- I review another engineer's work and find significant design deficiencies in respect of building code compliance and in particular the potential to threaten the life safety of the occupants of the facility. After informing the engineer of the findings of the review and after reviewing any comments received and I am still concerned about life safety, do I notify IPENZ or the appropriate body?
- As an Expert Witness, am I working as an Expert Witness or am I an Advocate?

The boundaries of ethics in these situations, and many others, often get very 'grey' for structural engineers, particularly since the Christchurch earthquakes. Therefore, the Working Group considers it is appropriate to develop guidelines for many of the common ethical dilemma and provide training in ethics for structural engineers. We note that current IPENZ programme on ethics are poorly attended.

It is recommended that there be a strong focus on improving ethical standards and behaviour. This could be achieved through a nationwide programme aimed at effecting a cultural change in competency self-assessment standards and greater emphasis on verification and peer review.

## **7 REGULATION & REVIEW**

### **7.1 REGULATION**

Recommendations and best practice guidance has been available over wide ranging aspects of the engineering profession, and continues to be developed. Despite guidance being available, examples exist where this guidance has not been followed. The Working Group considers that this is a consequence of commercial pressures and the lack of any effective regulation governing the practice of engineering in New Zealand.

This discussion document contains a number of recommendations that, if implemented, will result in significant improvements to the quality and integrity of the engineering profession. However, in order to be effective these recommendations must be adopted in conjunction with legislation that compliments and supports these recommendations. It is recommended that;

- Recognised Structural Engineer is recognised as an additional tier within the framework of the CPEng Act.
- Designated Structures are recognised as being restricted building/design work with the appropriate definitions of a Designated Structure recognised under the Building Act.

Inconsistencies between Building Consent Authority (BCA) regulation and review requirements are seen as a contributing factor in the design and construction of deficient engineering designs. It is recommended that a centralised policy be developed by MBIE that addresses;

- What structures require an independent third party peer review.
- Who can act as a peer reviewer, and requirements for independence.
- What documentation is required for consent.
- Clearly defined procedures for obtaining a Building Consent.
- Auditing requirements for consent.
- Obligations and situations where engineers' performance or conduct should be reported to the governing body (IPENZ) for investigation.

Communication between BCA's and IPENZ CPEng Council with regard to deficient design and design documentation for the purpose of disciplinary action/censure is encouraged.

### **7.2 REVIEW OF BUILDING CONSENT DOCUMENTATION**

Many jurisdictions in New Zealand require structural engineering designs to be independently reviewed for compliance with the Building Code. We support the wider application of this process.

As an extension to project specific peer review, we recommend consideration be given to auditing professional practices, CPEng engineers, and Recognised Structural Engineers undertaking structural engineering design. It is envisaged that random audits be undertaken on designs that have either been undertaken or approved by CPEng and RSE Engineers that have been submitted for Building Consent. This audit, whilst including procedural aspects should focus primarily on technical proficiency.

Lack of independence between reviewers and designers is seen as a concern. Situations whereby a pair of companies review each others work is open for abuse and can result in a reluctance to 'rock the boat', particularly where a firm relies on review work as a significant stream of income. These situations should be actively discouraged. Peer reviews should be undertaken by engineers who are, as near as practicable independent from the designer. Random allocation of review documentation to members of a centralised pool of eligible peer review firms/individuals would alleviate many concerns over independence. A need for specific selection of peer reviewers is recognised for specialist projects or engineering fields, however it is recommended that except in a small number of special circumstances peer reviewers should be allocated by the BCA.

The New Zealand Construction Industry Council (NZCIC) Design Documentation Guidelines, developed in 2004, sought to benchmark project delivery standards across a range of consulting disciplines. The NZCIC guidelines achieve a measure of consistency in the determination of project scope, methodology and deliverables, and the determination of consulting fees for these services. We recommend the scope of a 'standard' peer review be well defined, in a similar way to the NZCIC Design Documentation Guidelines, but specifically for peer reviews, to ensure consultants are competing for the same level of service. As an alternative it may be more appropriate for peer reviews to be undertaken on a time and disbursement basis to reflect the iterative nature of the review process and the scope uncertainty that this can often create.

## **8 ADMINISTRATION**

### **8.1 EXAMINATION/ASSESSMENT**

It is anticipated that concerns could be expressed by members over the financial costs of administration for an examination based assessment process. It is not the role of IPENZ to prescribe technical standards within an engineering discipline, and the inclusion of an examination would be an anomaly in the standardised IPENZ assessment process. Universities are well placed to develop and administer examinations of fundamental and advanced engineering concepts given their role in teaching the subject matter. However, as a component of a young engineer's knowledge comes from post degree learning, it is essential that input is obtained from technical societies and employers so that a robust examination content is developed. It is proposed that a 'Structural Engineering Examination Board' or SEEB be established to oversee all matters associated with the administration of exams. This would ideally comprise members of accredited engineering schools, SESOC and NZSEE representatives, and representatives from contractors and consultancies.

The adoption of part or all of the recommendations contained within this document would increase the overall cost of assessments. The extent of increase is somewhat dependant on the format and extent of the adopted assessment process. It is difficult to establish ball park estimates via comparison with internationally recognised assessment procedures due to economies of scale and economic factors. Those involved in the administration of the exam would need to be paid for their time, although costs could be reduced by operating on a non-profit basis. Other measures to reduce the cost could include; reducing the number of assessments per year (exams could be an annual event), selling copies of sample questions etc. However it should be noted that the existing IPENZ CPEng assessment costs are considerably less than that required for other NZ professions such as Accounting [10] and Medicine, and as such it is considered that it would not be unreasonable to expect an increase in assessment costs.

It is expected that the incorporation of web based training modules would increase the costs associated with administering training programmes. The extent of increase has not been investigated however it is noted that for the SEABC training program in Canada the costs associated for users of the online training modules is in the order of 1.6 times that associated with physical attendees.

### **8.2 TRANSITIONAL ARRANGEMENTS**

With a higher level qualification deemed necessary, then the implementation of such a qualification, particularly for incumbent CPEng engineers, requires careful consideration. When adopting new qualification standards, overseas jurisdictions have opted for varied approaches to the prequalification requirements of existing professional engineers. These approaches have included:

- Selective grandfathering based upon a set of pre-qualifying criteria.
- In-depth interactive assessments of existing professional engineers.
- Grandfathering of existing professional engineers.
- Full reassessment of existing professional engineers against the new qualification requirements.

Selective grandfathering is seen as being problematic on a number of levels. Determining fair and equitable performance criteria for grandfathering can be difficult given that experience is not a guarantee of competence. Also, problems with selective grandfathering have arisen overseas where legal challenges have arisen from candidates not being grandfathered when there was a personal expectation that they would be.

In depth interactive assessments have been used for a relatively small number of incumbent engineers in British Columbia wanting to attain a higher level qualification without going through the examination process, although it is noted that the pass rates for these assessments have been low. These assessments have proven to be costly to administer and use considerable resources. In addition, concerns over the limitations of interactive assessments which have been discussed elsewhere in this document.

Experience has shown that the driver for a higher level qualification stems from an event or a series of events that provide evidence that the safeguards against defective designs are not acting as effectively as they should. In New Zealand's experience this event manifested itself as the Canterbury earthquakes, although concerns have been raised over the quality of structural designs well before September 2010. Whilst undertaking a review into the structural design and certification process of British Columbia incumbent engineers were identified as being a key problem with the production of deficient designs. This was also recognised by CERC who observed evidence of structural engineers working outside of their areas of competence during their investigation into the building performance during the Canterbury earthquakes. Grandfathering of existing CPEng engineers into a higher level qualification would not address the problems identified with incumbent engineers.

Given the limitations of grandfathering or partial grandfathering discussed above and the problems identified with incumbent engineers the authors recommend that ALL 'Recognised Structural Engineers' undergo and pass the same selection criteria i.e. no grandfathering.

The reasons for this are as follows:

- It has been acknowledged that the existing CPEng assessment does not adequately assess competencies suitable for the design of 'designated buildings'. Therefore existing CPEng holders have never been assessed adequately for competence in this area.
- It is known that some Chartered Professional Engineers have undertaken work that is outside of their area of competence. By requiring formal assessment of all those wishing to undertake specific designated design the chances of this reoccurring will be reduced.
- If an engineer is designing complex buildings then it is a reasonable expectation that they demonstrate that they are competent for the task. Merely having 'x' years of experience is not a measure of competence.

For any adopted RSE assessment system it is expected that a transition period (say 3-5 years from inception) would be required whereby existing Chartered Professional Engineers could continue to operate under the current arrangements, to allow time for RSE assessments to be undertaken.

It is anticipated that there will be reluctance from some members of the profession to undertake an additional examination in order to undertake work that they have been undertaking for a number of years. However provided existing CPEng holders are competent in specific designated structural design then it would be expected that they would pass any RSE competence assessment. As part of the establishment of the higher qualification the minimum standards of technical knowledge

expected would be required to be published which would allow applicants to undertake the additional learning necessary in order to pass. In addition, it is envisaged that training modules would be established aimed at bringing CPEng holders up to the required standard. It should be noted that many existing CPEng engineers would not need to have a higher level qualification e.g. managers, site engineers, those not involved in the design of specific designated structures.

### **8.3 AUDITING OF STRUCTURAL ENGINEERING PROFESSION PRACTICE**

Under existing IPENZ rules the ability to audit or review a CPEng holder exists, although the requirements to trigger such a review are very specific and primarily relate to review the performance of an engineer who has had concerns expressed about their work. This is seen as a passive approach to ensuring quality as it relies upon others to identify a potential shortcoming in performance, which may not occur despite inadequacies being present. The Working Group considers that a more active approach is necessary to ensure the quality of engineering work is being maintained. It is considered that provision for random audits of CPEng and RSE qualified engineers would serve to encourage best practice and act as a deterrent to the production of substandard design and documentation. Auditing of Building Consent documentation is seen as the most logical step, although the provision for auditing of an individual should also be included.

In order to develop and implement a robust auditing process of design work a number of challenges must be overcome.

- Auditors must remain independent and be free of commercial bias.
- Auditors must be recognised as being competent in their field.

Auditing is already a common occurrence in other professions, most notably for Accounting. Accountants who hold practicing certificates are subject to regular audits of their practice by auditing teams organised by the professional body [11]. Projects are selected at random and reviewed for compliance with relevant statutes and good practice. The auditing team has the ability to issue corrective actions and initiate sanctions if deficiencies in work are identified. This process is paid for by the holder of the practicing certificate and is treated as an operational expense.

The Working Group consider that the accounting auditing model could be adapted for application to the engineering environment. Auditing of CPEng and RSE qualified engineers work as part of random building consent submissions could be developed and employed to ensure that standards are being maintained.

#### **Pros:**

- The expectation of an audit will promote quality in design and documentation.

#### **Cons:**

- Difficulties in recruiting suitable auditors.
- Training of auditors.
- Administration of audit process.

## 9 RECOMMENDATIONS

The following contains a summary of the key recommendations of this document. It is the expectation that SESOC will work with all relevant technical, regulatory, and governing bodies to ensure that these recommendations are implemented for the betterment of the structural engineering profession.

### 9.1 TRAINING AND EDUCATION

- *Recommendation 1:* Improve post graduate training of Structural Engineers, particularly those that are not familiar with the NZ engineering environment
- *Recommendation 2:* Meet the immediate need for training on earthquake assessment and seismic retrofit
- *Recommendation 3:* Develop and administer an examination covering “Fundamentals of Structural Engineering” that can be used for structural candidates undertaking assessment for CPEng and previously assessed candidates at their next Continuing Registration Assessment.
- *Recommendation 4:* Develop and publish minimum standards of knowledge for practice areas.
- *Recommendation 5:* Develop Improved Technical Training of CPEng Structural Practice Area and Staff Assessors.
- *Recommendation 6:* Investigate methods to encourage participation as Structural Practice Area and Staff Assessors.

### 9.2 QUALIFICATION & ASSESSMENT OF ENGINEERS

- *Recommendation 7:* The CERC recommendation for the introduction of an additional qualification tier, to a level above that currently afforded by CPEng and known as a 'Recognised Structural Engineer (RSE)' is fully supported and recommended for adoption.
- *Recommendation 8:* All structures that are considered to be significant to society or involve advanced knowledge of structures to design should be restricted to being designed or approved by RSE qualified engineers.
- *Recommendation 9:* SESOC will take the lead in setting up a working group to determine what structures shall constitute restricted design work requiring design and approval by a RSE. These structures to be classified as “Designated Structures”.
- *Recommendation 10:* Develop competencies for establishing the 'Recognised Structural Engineer (RSE)' quality mark for structural engineers competent to undertake restricted design work.
- *Recommendation 11:* Develop clear definitions of prescribed standardised Practice Areas for Structural Engineers.

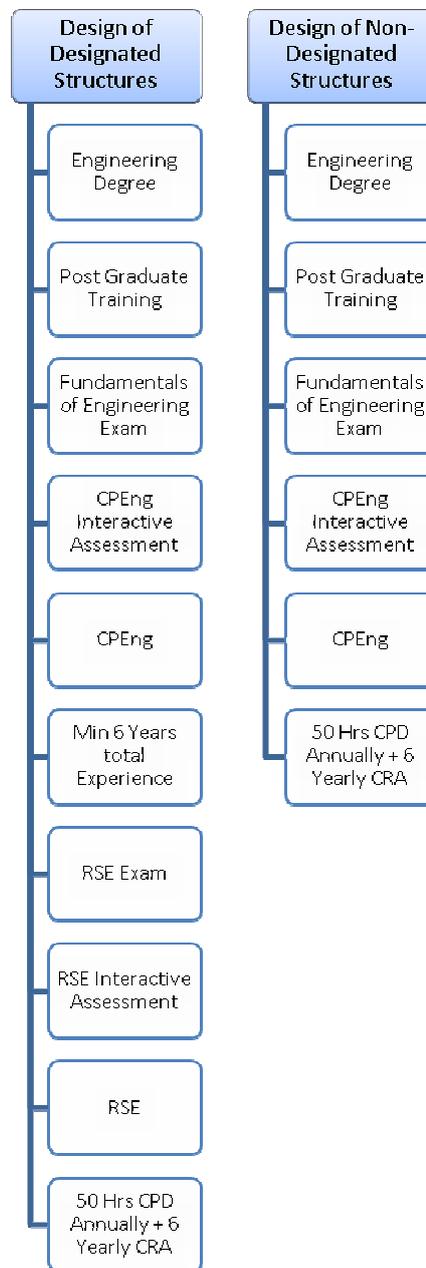
#### 9.2.1 Chartered Professional Engineers (CPEng)

- *Recommendation 12:* CPEng qualified engineers should be responsible for designing 'specific engineering design' not classified as a Designated Structure.
- *Recommendation 13:* A formalised annual CPD requirement with targeted requirements for specific competencies.

### 9.2.2 Recognised Structural Engineer (RSE)

- *Recommendation 14:* A minimum of 6 years relevant practical experience and CPEng is required prior to being able to apply for the RSE assessment procedure.
- *Recommendation 15:* RSE candidates are required to pass a formal examination of technical knowledge.
- *Recommendation 16:* RSE candidates pass an interactive assessment involving Staff and Practice Area Assessors who are qualified as an RSE, and have compatible practice areas as the candidate.
- *Recommendation 17:* A formalised annual CPD requirement with targeted requirements for specific competencies, with an emphasis on technical competencies.]

With the adoption of recommendations above the qualification pathways required for engineers wanting to design designated and non-designated structures will be as shown in Figure 1.



**Figure 1: Proposed qualification path for structural engineers**

### 9.3 PROFESSIONAL ETHICS

- *Recommendation 18:* Improve ethical guidance for Structural Engineers.

### 9.4 REGULATION AND REVIEW

- *Recommendation 19:* Designated structures be identified and restricted by legislation to design and approval by RSE qualified engineers.
- *Recommendation 20:* A centralised policy be developed through MBIE governing BCA consenting procedures and requirements.

- *Recommendation 21:* Development of the obligations and requirements for BCA's to report repeated substandard engineering performance to IPENZ for investigation.
- *Recommendation 22:* Promote the wider use of Independent Peer Reviews, through the allocation of peer review responsibilities by the BCA to a pool of appropriately qualified engineers/firms.
- *Recommendation 23:* Develop procedures for undertaking random auditing of CPEng and RSE practitioners, through samples of Building Consent documentation. Audits to be technically focused.
- *Recommendation 24:* Guidance to be developed governing the scope of peer reviews to ensure a more consistent, reliable review is undertaken. Due to the iterative nature of peer reviews a time and disbursement reimbursement model may be more appropriate.

## 9.5 ADMINISTRATION

- *Recommendation 25:* Creation of a 'structural engineering examination board' or SEEB be established to oversee all matters associated with the administration of exams.
- *Recommendation 26:* All candidates applying for the RSE qualification to be subject to the unabridged RSE assessment procedure.
- *Recommendation 27:* Develop auditing procedures for RSE and CPEng holders covering all aspects of professional structural engineering.

Whilst it is envisaged each of these recommendations if implemented individually will have a positive impact on the structural engineering profession. It is the view of the Working Group that for the greatest positive impact they should be considered as a suite of solutions and implemented collectively.

## **10 ACKNOWLEDGEMENTS**

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Nic Charman - Technical Director, BECA

Gregory MacRae, P.E. - University of Canterbury

Ed Huston, S.E. - Smith and Huston, Inc, Chair of Structures Exam Committee, NCEES

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## **Appendix A: Summary of Professional Engineering Practice for NZ and International Jurisdictions**

### **A.1 NZ Practice**

The Building Act 2004 underpins the building industry in New Zealand and sets out the current law in respect of buildings and building construction, and provides the framework for building controls. The Building Act is principally concerned with ensuring that buildings can be used safely, they are appropriately durable, and can be evacuated safely in the event of fire. The Building Regulations were made under the Building Act 1991, confirmed by the Building Act 2004 and contain the Building Code. The Building Code defines building functional requirements, describes the minimum performance requirements that buildings must achieve, and sets out the means by which compliance may be achieved.

The Institution of Professional Engineers of New Zealand (IPENZ) is the professional body that represents professional engineers across all disciplines in New Zealand. As the structural engineering profession in New Zealand is self-regulated IPENZ aims to promote the interests of structural engineers via support services to its members and through collaboration with Technical Discipline groups such as SESOC and NZSEE. Primary support services include career development for members, the implementation of competence and ethical standards, dealing with complaints, and implementing disciplinary procedures. Members are bound by the IPENZ code of ethics.

Chartered Professional Engineer (CPEng) is the current-competence quality mark for engineers at the professional level (engineers who usually have a four-year Bachelor of Engineering or equivalent qualification). The Chartered Professional Engineers of New Zealand Act (CPEng Act) was enacted on 1 July 2002 and established IPENZ as the Registration Authority to assess and register Chartered Professional Engineers (CPEng). Engineers meeting the relevant minimum standards of competence may be eligible for CPEng certification. However, to retain registration an engineer must demonstrate regularly to IPENZ (six yearly) that they are still able to practise competently.

The practice of structural engineering in NZ is reliant on engineers working ethically and within the limits of their own competency. Currently, very few restrictions exist as to who can design a structure in New Zealand.

### **A.2 Practice in other International Jurisdictions**

The preparation of this document considers the practice from a number of different international jurisdictions particularly those that have a similar heritage and regulatory environment. Special consideration has been given to jurisdictions that have a similar seismic hazard to New Zealand. The requirements of each of the jurisdictions reviewed are summarised in the following sections.

#### **A.2.1 Canada (British Columbia)**

In Canada the administration and regulation of professional engineers is undertaken by provincial bodies and is overseen by the Canadian Council of Professional Engineers (CCPE) which represents the 12 provincial and territorial associations in Canada. The professional qualification for structural engineers in Canada is Professional Engineer (P.Eng), and once obtained grants the right to practice as an Professional Engineer.

The designation Professional Engineer can only be used by Licensed Engineers and each province has laws that govern the practice of engineering

In order to qualify as a Professional Engineer, candidates must undergo an assessment process that involves the following;

- 15 Obtain a degree from an Canadian Engineering Accreditation Board (CEAB) accredited program.
- 16 Complete an Engineer in Training program under the direction of a P.Eng, which is typically 4 years in length.
- 17 Have their work experience reviewed
- 18 Pass a Professional Practice Exam.

The content and format of the Professional Practice Exam varies by province, although this does not typically involve technical content unless the candidate's education was not accredited by CEAB.

Following the recommendations of a Commission of Inquiry that was formed in response to the collapse of the Save-On-Foods car parking structure the Association of Professional Engineers and Geoscientists of British Columbia (APEGBC) developed an additional qualification system that is required in order to undertake the design of high risk or complex design structures. This qualification is referred to as "Designated Structural Engineer" (Struct Eng.) and is required for specifically designated structured engineering work. This qualification has not been legally recognised by the Province of British Columbia, instead leaving its adoption up to individual Municipal Bodies. Since 2007 a number of Municipal Bodies have adopted the Struct.Eng qualification and regulations most notably the city of Vancouver.

Further information on the requirements to become a Designated Structural Engineer can be found in Appendix B.

### **A.2.2 United States of America**

The U.S.A. has a two tier system of licensing structural engineers which is administered by state bodies. The first tier of license is known as Professional Engineer (P.E.). The second tier of license is for those who specialise in specific types of structural design, and is referred to as the Structural Engineer (S.E.) qualification.

There are significant legal restrictions in the U.S.A. regarding who can undertake different levels of structural design work. Typically an engineer must be licensed as a P.E. in order to:

- Act as a principle of an engineering firm.
- Lead engineering work in the private sector.
- Offer engineering services to the public.
- Submit plans and drawings to regulatory agencies.

In order to submit an application for P.E. licensure a candidate must have successfully completed the following tasks;

- 1 Obtained an engineering degree from an Accreditation Board for Engineering and Technology (ABET) accredited university course.

- 2 Passed the Fundamentals of Engineering (FE) Exam. The FE Exam is an 8 hour examination set by the National Council of Examiners for Engineering and Surveying (NCEES). It covers a broad range of engineering related topics such as, mathematics, chemistry, materials, engineering principles, materials, management, economics, and ethics. Following this exam an engineer receives an Engineer in Training (E.I.T.) certification from their state engineering licensing board.
- 3 Completed a prescribed amount of qualifying progressive work experience. The duration of experience is set by state law and is typically 4 years, but varies depending on type of academic qualification attained (BE, ME, PhD etc.) and the state.
- 4 Pass the Principles and Practice of Engineering (PE) Exam. PE Exam requirements vary from state to state; however most states adopt the 8 hour NCEES PE Exam as the benchmark required to demonstrate competence. This examination covers a broad range of civil, geotechnical, structural, and transport problems.

The requirements for Structural Engineer (S.E.) licensure vary from state to state. In order to qualify as an S.E., candidates must first pass a S.E. examination. In contrast to the broader PE Exam this exam is focused on structural design, detailing and analysis, along with some construction administration, and is 16 hours in length.

States with a significant seismic hazard have additional examination requirements in order to obtain P.E. or S.E. licensure. An example of this is California which requires candidates to pass two additional 2.5 hour long examinations on seismic principles and engineering surveying in order to qualify as a P.E.. A seismic examination is required to be passed in order to obtain an S.E. License. This examination is known as the California Structural Laws and Rules Exam (CSLRE), which is 8 hours in length.

Once qualified, many states require engineers to comply with continuing education (CE) requirements. Documentation of CE hours is required which is reviewed through an auditing system.

### **A.2.3 United Kingdom**

The Institution of Structural Engineers upholds the standards of structural engineering in the United Kingdom and administers the means by which Chartered Professional status in structural engineering is attained and maintained. These requirements are similar in many respects to those administered by IPENZ in New Zealand. However, a significant difference is the IStructE requirement to pass a professional Chartered Member examination.

The professional qualification for structural engineers in the U.K. is Chartered Engineer (CEng). The register of Chartered Engineers is maintained by the Engineering Council, but admittance to the qualification is administered by the Institution of Structural Engineers (IStructE). A candidate who passes the assessment process is entitled to use the designation Chartered Structural Engineer, and also Member of the Institution of Structural Engineers (MIStructE).

In order to qualify as a Chartered Structural Engineer, candidates must undergo an assessment process that involves the following;

- 1 Demonstration that they have acquired knowledge equivalent to that obtained from a Washington Accord Bachelor of Engineering degree in their chosen field,
- 2 Demonstration of competence in 13 core objectives, including such topics as communication, design, and management.

- 3 Successful completion of a professional review consisting of an oral examination.
- 4 Pass the Chartered Member Examination (also known as the 'IStructE' exam). The IStructE examination is seven hours in length and is designed to investigate a candidate's understanding of structural engineering principles, their ability to undertake and communicate structural design, and to provide an effective solution to a structural design problem.

Once chartered, structural engineers are required to undertake a minimum of 30 hours of CPD per year

The authors know of no legal requirement in the U.K. for engineers to have a professional qualification in order to undertake design or site supervision work.

#### **A.2.4 Australia**

The various Australian states have different requirements, acts, and regulations governing the engineering profession. The following covers practice in Queensland.

An engineer providing a professional engineering service in Queensland must be a Registered Professional Engineer of Queensland (RPEQ) or be directly supervised by an RPEQ. Australia has a National Professional Engineers Register (NPER). However, membership is voluntary and does not cover practice in Queensland. It is understood there is pressure to move toward a formal national registration system. The process for demonstrating compliance with the relevant Building Regulations is as follows:

- Certificate of Design or Certificate of Compliance is prepared and signed by the RPEQ.
- This Certificate of Design/Compliance is issued to the 'Building Surveyor' or 'Building Certifier'. These are specialist consultants engaged by, or on behalf of, the owner/developer.
- The Building Surveyor issues the Building Permit, occupancy permits, and final inspection certificate. They are responsible for ensuring the building complies with the relevant acts, regulations, standards and required to carry liability insurance.
- Certificates of Compliance may only be issued by designers practicing within their limits of competence
- The Building Surveyor may elect to have the design independently reviewed. If the certificate is issued by an entity registered to undertake the work the Building Surveyor may rely on the certificate in good faith, and is protected in law to do so.
- There are different classes of buildings and high rise buildings are given special consideration.
- Where a certificate of compliance is not submitted it is the responsibility of the Building Surveyor to check the design as part of the permit process.

#### **A.2.5 Summary**

A summary of the professional qualification requirements of the jurisdictions reviewed can be found in Table 1 below.

**Table 1: International Jurisdiction Comparison**

Country	Qualification	Pre-Qualifying Exam	Minimum Experience.	Interactive Assessment	Professional Exam	Average Pass Rate	Annual CPD	Restricted Design Work
Canada - BC [12]	P.Eng.	No	Yes - 2 to 4 yrs	No <sup>1</sup>	PPE + law & Ethics Seminar <sup>2</sup>		80PDH's	Yes
Canada - BC [13]	Struct.Eng	Yes - interview	Yes - 6 yrs	Yes	Oral + local knowledge + IstructE or SE	Varies	50PDH's	Yes <sup>3</sup>
Hong Kong <sup>4</sup> [14]	Ir	No	Yes - 4 to 6 yrs <sup>5</sup>	Yes	Yes - essay based <sup>6</sup>	65% <sup>7</sup>	45hrs	
NZ	CPEng	No	No	Yes	No <sup>8</sup>	94%	50hs	No
Singapore [15]	PE	Yes - FFE	Yes - 4 yrs	Yes	PPE	35%	40hrs	Yes
UK [16]	CEng	No	No	Yes	IstructE	37%	30hrs	No
USA [17][18]	P.E.	Yes - FE	Yes - varies (typ 4 yrs)	No	P.E.	64% (38% Calif)	Varies	Yes
USA [19][18]	S.E.	Yes - FE	Yes - varies (typ 4 yrs)	No	S.E.	64% (38% Calif)	Varies	Yes

- Notes
1. Candidates may be interviewed
  2. Ethics seminar is a 2 day seminar in BC
  3. Not required by state law, but required by an increasing number of municipal authorities
  4. Uses IPENZ competencies and assessment system
  5. 4 yrs if formal training is undertaken. Candidates must be 25 yrs old or older
  6. For candidates > 35yrs old an essay is not required although a paper is required to be submitted for review
  7. Average for all disciplines from 2007-2012
  8. Not mandatory, in practice approximately 50% of candidates sit a 3 hr essay type exam

## **Appendix B: British Columbia Designated Structural Engineer**

This appendix briefly details the registration and licensing requirements in British Columbia, Canada. Excerpts of this section have been taken from the Association of Professional Engineers and Geoscientists of British Columbia (APEGBC) website -

<http://www.apeg.bc.ca/reg/structeng.html#WhatIsRequired>

### **History of the Struct.Eng. Designation**

In September 2001, APEGBC members approved a new bylaw which gave Council the authority to establish the application and review process for a new Designated Structural Engineer status, and to proceed with its implementation.

It is up to the relevant Authority Having Jurisdiction (e.g. municipality) as to when the services of a Designated Structural Engineer (Struct.) Eng.) will be required. APEGBC has recommended to municipalities in B.C. that, effective January 1, 2007, the Structural Engineer of Record for Part 3 Buildings, as described by Clause 2.1.2.1 (1) (a) and (b) of the 1998 BC Building Code, be required to have the Struct. Eng. designation.

Following a positive by-law amendment vote by the membership, effective January 1st, 2004, the designation Structural Engineer of Record (Struct.Eng.) has been renamed Designated Structural Engineer (Struct. Eng.).

On November 14, 2006, Vancouver City Council approved a report to adopt the 2006 British Columbia Building Code with amendments as the next edition of the Vancouver Building By-law. These amendments include a requirement for designers responsible for the design of a Part 3 building, carried out in accordance with Part 4 of Division B to have a Structural Engineer Designation in accordance with APEGBC's By-laws. The new 2007 Vancouver Building By-law is mandatory for all building permit applications submitted to the City on and after May 1, 2007. The Vancouver Building By-law with the referenced amendments can be found at

<http://vancouver.ca/commsvcs/CBOFFICIAL/vbbl/index.htm#amendments>

Other cities/municipalities that require the Designated Structural Engineer in some capacity

### **What is required to become a Struct.Eng.?**

A candidate for the Struct.Eng. designation must:

- be registered as a Professional Engineer (P.Eng.) in BC;
- demonstrate 6 years of structural engineering experience, at least two of which must be in responsible charge of significant engineering work;
- demonstrate a commitment to Continuing Professional Development;
- have completed one of the following requirements:
  - a. Be licensed through examinations as a Structural Engineer (SE) in California or Washington States; or

- b. Have successfully completed the Institution of Structural Engineers' Chartered Membership Examination; or
  - c. Have successfully completed the Washington State Structural III Examination (available until October 2011); or
  - d. Have successfully completed the NCEES Structural Exam (available April 2011)
- successfully complete the BC Codes and Practices Examination; and
  - Pay all associated fees and dues.

### **When is a Struct.Eng. required?**

Where an Authority Having Jurisdiction (e.g. municipality) has passed a by law requiring the seal of a Designated Structural Engineer (Struct. Eng.).

APEGBC has recommended that, effective January 1, 2007, all municipalities in B.C. require the professional seal of a registered Struct. Eng. for the Structural Engineer of Record for a Part 3 Building.

Under the current 2006 *BC Building Code*, the Part 3 buildings would include those as described by Clause 2.1.2.1(1) (a) and (b) of the 1998 *BC Building Code*.

The flow chart in Figure 1 below is from the APEGBC Designated Structural Engineer Application Guide and summarises the requirements for the Struct.Eng qualification.

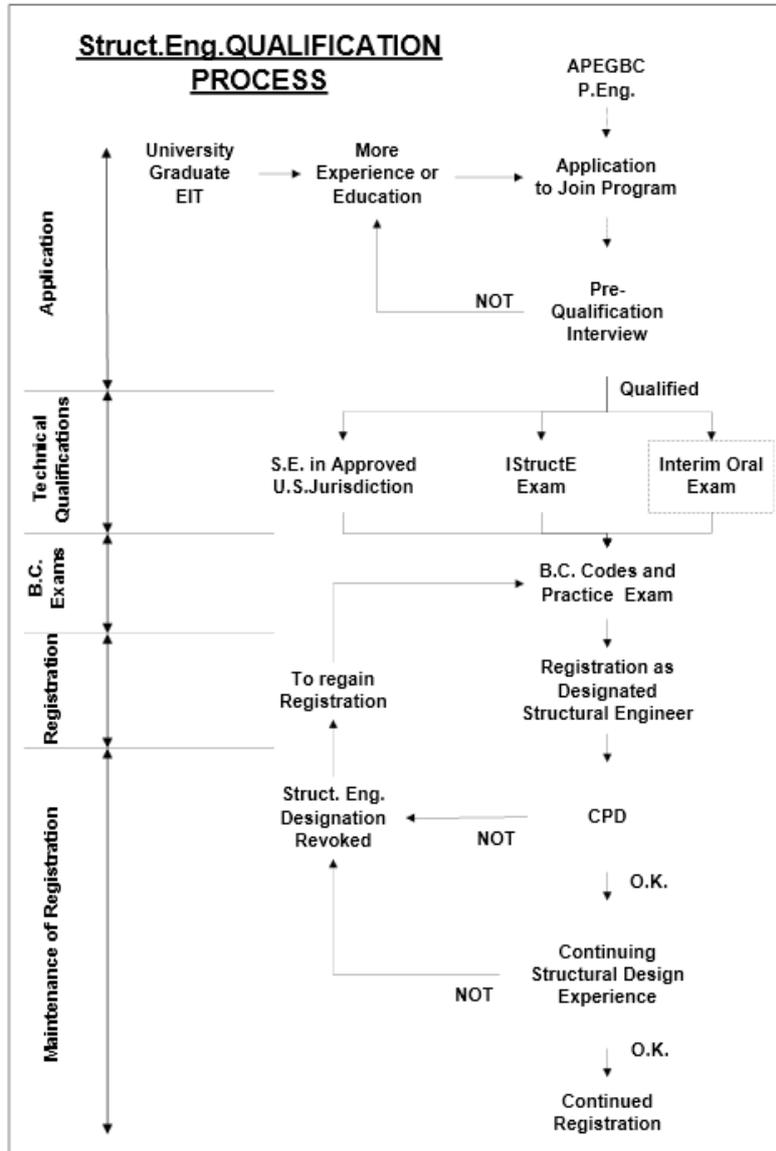


Figure 1: APEGBC Struct Eng qualification flow chart

The APEGBC Designated Structural Engineer Application Guide detailing qualification requirements can be found at;

<http://www.apeg.bc.ca/reg/docs/StructEngAppGuide2011.pdf>

## Appendix C: Restricted Building Work

### United States of America

United States of America state licensing guides including requirements for restricted design work are summarised for a selection of States in Table 2 below.

**Table 2: A selection of state licensing provisions**

State	Licensing Requirements	License Provisions
California	Passing NCEES PE & SEII Exams, CA state Civil & Seismic Exams (29hrs)	Requires SE license for schools and hospitals. CE license required for all other types of structures. <a href="#">CA Building Design Authority</a>
Hawaii	Passing NCEES Civil or SEI & SEII Exams (16hrs)	Requires SE license for anyone practicing structural engineering.
Idaho	Passing NCEES Civil PE + 2yrs, SEI & SEII Exams (24hrs)	Does not specifically require SE license to practice structural engineering. <a href="#">Selected Laws &amp; Rules</a>
Illinois	Passing NCEES SEI & SEII Exams (16hrs)	Requires SE license for anyone practicing structural engineering. <a href="#">Structural Engineer Act</a>
Nebraska	Passing NCEES SEI & SEII Exams (16hrs)	Does not specifically require SE license to practice structural engineering. <a href="#">NE Board of Eng FAQ</a>
Nevada	Passing NCEES Civil PE, SEI & SEII Exams (24hrs)	Requires an SE license on specialty structures such as radio towers and signs over 100ft in height and buildings more than three stories or 45ft in height. <a href="#">Nevada Administrative Code</a>
New Mexico	Passing NCEES PE + 4yrs of structural experience (8hrs) or NCEES SEI & SEII (16hrs)	Does not specifically require SE license to practice structural engineering.
Oregon	Passing NCEES PE & SEII Exams, WA state Seismic Exam (24hrs)	Requires an SE license for hazardous facilities, special occupancy structures, essential facilities over 4,000sq ft. in ground area or 20ft in height, structures with irregular features, and buildings over 4 stories or 45ft in height. <a href="#">Oregon Revised Statutes 672</a>
Utah	Passing NCEES Civil PE, SEI & SEII Exams (24hrs)	Requires SE license for buildings and other structures representing a substantial hazard to human life, essential facilities, and buildings requiring special consideration. <a href="#">Utah PE &amp; PLS Licensing Act</a>

State	Licensing Requirements	License Provisions
Washington	Passing NCEES PE & SEII Exams, WA state Seismic Exam (24hrs)	Requires an SE license for hazardous facilities, special occupancy structures, essential facilities over 5,000sq ft. in ground area or 20ft in height, structures with irregular features, and buildings over 5 stories or 100ft in height, bridges with spans over 200ft, piers with surface area greater than 10,000sq ft. and structures where 300 people or more congregate.

## Canada – British Columbia

### Canadian - British Columbia - APEGBC restricted design recommendations

In Canada, the Association of Professional Engineers and Geoscientists of British Columbia (APEGBC) recommends that a Struct.Eng. (their equivalent to the proposed 'Recognised Structural Engineer) be the Engineer of Record for a Part 3 Building. With a part 3 building being:

All buildings used for major occupancies classified as

Group A: Assembly occupancies

Group B: care or detention occupancies, or

Group F: Division 1, high hazard industrial occupancies, and

All buildings exceeding 600m<sup>2</sup> in building area or exceeding 3 storeys in building height used for major occupancies classified as

Group C: Residential occupancies

Group D: business and personal services occupancies,

Group E: mercantile occupancies, or

Group F: Division 2 and 3, medium and low hazard industrial occupancies



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## **Appendix D: APEGBC Post-Graduate Training Program**

Information on the Association of Professional Engineers and Geoscientists of British Columbia post graduate training program can be found at the following websites;

<http://www.seabc.ca/certificate.html>

<http://www.seabc.ca/courses.html>

## **Appendix E: Dunning-Kruger Effect**

Information on the physiological phenomenon known as the Dunning Kruger effect, and how it relates to structural engineering can be found in the following locations.

<http://www.apa.org/monitor/feb03/overestimate.aspx>

[www.structuremag.org/article.aspx?articleID=1340](http://www.structuremag.org/article.aspx?articleID=1340)

[www.structuremag.org/article.aspx?articleid=1220](http://www.structuremag.org/article.aspx?articleid=1220)

[www.structuremag.org/Archives/2011-7/C-InFocus-Schmidt-July11.pdf](http://www.structuremag.org/Archives/2011-7/C-InFocus-Schmidt-July11.pdf)

[www.structuremag.org/article.aspx?articleID=1246](http://www.structuremag.org/article.aspx?articleID=1246)

## Appendix F: Correspondence

The following section contains correspondence between the panel members and overseas correspondents with knowledge pertinent to the working group objectives. In some instances correspondence may have been amalgamated for ease of reading, however content remains largely unaltered.

### G.1 SEABC (David Harvey, SEABC President) correspondence with SESOC (Dale Turkington)

The following are the relevant questions from Dale Turkington and answer from David Harvey in March 2013:

- 1 **I understand there is a new qualification in BC a Registered Profession Structural Engineer (Struct. Eng.); is this correct?** The StructEng program was introduced into BC following the Closkey Commission's recommendation (Station Square collapse). The City of Vancouver had pressured APEGBC into taking action for some time. Details of the program are at: <http://www.apeg.bc.ca/reg/structeng.html>
- 2 **What is the criteria to attain the level of Struct. Eng.; education, experience, examination, etc?** See the application guide: <http://www.apeg.bc.ca/reg/docs/StructEngAppGuide2011.pdf>
- 3 **Who administers the Struct Eng registration; APEBC?** APEGBC
- 4 **Is a Struct. Eng. Required to approve the design of all new buildings in BC?** No – the BC Government has ducked the issue and left it up to individual municipalities to enact bylaws if they believe that they require StructEng. Vancouver set the ball rolling in 2007 (after 5 years of APEGBC registering StructEngs.) So far Burnaby and Langley cities have joined Vancouver; there are several other municipalities interested in adopting it but they typically have other priorities and so this tends to be a “back burner” matter.
- 5 **Was there a ‘grandfather’ clause when the Struct. Eng registration was put in place?** No. APEGBC Council demanded that the standard of practice problem that the Task Force identified be addressed. Incumbent practitioners are the problem. Grandfathering delays problem solving until incumbents have ceased practicing. Several states have adopted the SE requirement (usually for large buildings) often with grandfathering as the only way to gain popular support. Oregon did so recently, but adopted “selective grandfathering”. The selection process was pretty fair but generated lawsuits. So far in BC, we have not had any lawsuits. The fallacy with restricting large building design to qualified practitioners is that there are seldom problems with design or quality control on large buildings. In BC its more typically involved small buildings, often with seismic design (or the lack of it) but also with gravity loads, load path continuity, and stability.
- 6 **How often are Engineers capability assessed?** Admission to StructEng requires one-time qualification (assessment of experience plus passing two exams). Continued competency is assessed through a mandatory CPD program, AND the requirement that Struct Engs MUST be actively practicing for at least 750 hours / year (generally supported by billable project time). StructEngs not meeting the CPD and CAP requirements will lose their StructEng registration (but not their PEng). They can reapply if they become able to meet the requirements. To date, to my knowledge, there have not been any reports of practice irregularities with any registered StructEng. Also, I do not know of any program that requires requalification of registered specialist practitioners.
- 7 **What is the assessment criteria and procedures?** Experience is assessed by the Structural Qualifications Board (SQB); acceptable qualifying experience is in the Guide. The in-depth

structural exams (IStructE or NCEES) are externally controlled by those organizations. The BC Codes and Practices exam is controlled by the SQBs Examinations Sub-committee which writes and grades an annual knowledge-based multiple-choice exam, and works hard to maintain consistency.

- 8 **I understand Vancouver City requires all building to have an independent Senior Concept Design Review carried out; is this correct?** No. Vancouver dropped its peer-review program which applied to a sample of its building permit design submissions when the StructEng bylaw was passed. Anecdotal information support the belief that the quality of designs being built has been maintained.
- 9 **How is this independent design review work for sole practitioners?** It is the responsibility for sole practitioners to arrange for independent checking of their designs. Many work with other sole practitioners or possibly with recent retirees still practicing. Checking is a practice reality these days and I'd say everyone in practice has adapted to APEGBC Bylaw 14b:  
<http://www.apeg.bc.ca/resource/publications/governancepolicies/documents/bylaws.pdf>
- 10 **Is the practice of Senior Concept Design Review going to be adopted across the province?** Not quite sure what you mean. Bylaw 14b applies to all APEGBC members wherever they practice. The StructEng program applies to any BC jurisdiction that passes an enabling bylaw. Any client, owner or employer can require the services of a StructEng regardless of where the project is located – many do, especially for post-disaster facilities.
- 11 **Are other independent design reviews required for buildings?** See APEGBC Bylaw 14b.
- 12 **Is there an auditing (policing) process in BC where structural engineer capability and quality of their respective design assessed?** The primary responsibility for quality rests with individual practitioners and Bylaw 14b. APEGBC has a practice review (audit) program that focuses on quality, and targets all registered members, with a much higher sampling rate of those that declare structural engineering as an interest or area of practice. Any client or owner can also request an independent design review (usually called a Category 3 check) on known complex designs, which the client/owner pays for. (The recent Port Mann Highway 1 project involved several Category 3 checks).
- 13 **Have the steps taken in BC improved the performance of Structural Engineers i.e. is it working?** There are no objective measures, but the SQB is in dialogue with the City of Vancouver regarding the quality of designs submitted. No issues have been forthcoming and no complaints against a StructEng has emerged to date from any source.
- 14 **What are the key lessons should NZ learn from your experiences?** Pick a good program! The StructEng program is I believe, the best out there. (We had the benefit of being able to design a customized program since nothing was already in place). The US SE programs are cumbersome children of the state boards and are necessarily political, but not necessarily effective. Hawaii has the most effective US program – all structures in the State, including temporary works, must be designed by an SE. Many US programs exclude the majority of buildings and are heavily dependent on checking by the authorities which varies from excellent in the major centres to non-existent elsewhere. The UK also is heavily dependent on checking by the authorities with similar variation in effectiveness. In the UK, Scotland and Jersey have specialist register programs which are run by IStructE, funded by a levy on building permit applications. England and Wales is considering a similar program. If you cannot get the program implemented quickly enough (in BC we allowed 5 years to attract a pool of specialists) you may need to consider grandfathering (which will take 20 years to be effective), but if you do, consider Oregon's selective grandfathering, which took one year to implement (but only applies to large buildings).

- 15 **What remains as the biggest problem in BC impeding the attainment of good structures and structural engineers?** At this stage, only adoption by more municipalities – the SQB continues to trying to get their attention! It would be ideal if StructEng eventually becomes a BC Building Code requirement, but we will need a lot more municipal support before that happens. Fortunately, the young structural engineers designing buildings (and many immigrating to BC) are all targeting StructEng registration for marketability reasons.

In addition to answering the above questions David Harvey provided his further comments on requalifying structural engineers;

When we introduced the StructEng program in BC, we essentially were requalifying incumbents, although this was (and is) an entirely voluntary process. Of course, those choosing to avoid specialist registration may eventually lose their ability to be the EoR on structural designs in some jurisdictions.

We recognized that some incumbent practitioners were well beyond the normal age at which they can perform well in in-depth examinations (the optimum exam performance age range is believed to be 30 - 45). Note though, that we have had several 50 year-olds local candidates, and one 63 year-old, pass the IStructE exam. Accordingly, we introduced the Interim Oral Examination, which was intended to apply for the 5-year introductory period. You can see some details under iv-a of the application guide. This applied to candidates with 15 years of qualifying experience. The Interim Oral Examination was discontinued after about 7 years because those applying had tailed off significantly by then.

An Interim Oral Examination was quite expensive (I think we charged \$1500). The candidate was interviewed for 3 to 4 hours by two senior practitioners which must have been intimidating except for the most experienced candidates. As I recall, there were quite a few failures, and one or two re-tests where things went haywire. However, it is an effective form of selective grandfathering, but cannot be used on a widespread basis because the IOE is demanding on resources.

### **Washington State Registration Issues**

#### **Summary of discussion between**

##### **Ed Huston**

Edwin T. Huston, S.E. (WA, CA, HI, OR, NV, UT), P.E. (AK, NM)  
Smith and Huston, Inc  
Consulting Engineers  
Chair of Structures exam committee, NCEES (National Committee for  
Examinations for Engineers and Surveyors)

##### **and Greg MacRae**

Gregory MacRae, P.E. (WA)  
Civil and Natural Resources Engineering  
University of Canterbury

**on 13 March 2013 about 2pm (NZ time)**

## Prior to meeting

Greg sent an email to Ed on 12 March, 2013. It was based on the email that Dale Turkington sent to the Canadians, with suggestions also from Derek Bradley.

The email is given below.

Dear Ed,

Sorry to disturb you. I am writing to you on the suggestion of Mark Pierepiekarz (I worked with him on the Seattle Fault Scenario when I was employed at the University of Washington, and I met him in Japan last week).

After the collapses during the 2010-2011 Christchurch earthquakes I am working with the NZ Structural Engineering Society (SESOC) and IPENZ (Institute of Professional Engineers of NZ) as we undertake self-examination. We are gathering information about overseas practice what could be done better in NZ relating to structural engineering professional issues. In particular, I am writing to you about issues related to the state of Washington. While am a registered PE in Washington, I am not up to date with what the latest information. The issues that our SESOC committee are interested in are:

- what restrictions are there on what a structural engineer can do,
- what qualifications are required,
- how are these qualifications attained,
- what training is available to assist graduates or foreign engineers in attaining these qualifications.
- Has there been any issues/problems with regulation of the profession
- Is there anything that could be tweaked to improve the existing system.

In particular, I have the following questions where we would like to learn from your experience and obtain your feel of the issues. Then, I would suggest a phone call to discuss the issues more openly.

1. What sort of designs/assessments/reviews are permitted by a structural engineer with a PE, SE or other qualification?
2. What is the current criteria to attain the PE/SE in terms of education, experience, examinations, etc?
3. Who administers the PE/SE registration; Is it the State of Washington Department of Licensing?
4. How often are Engineers capability assessed? (I don't recall any regular assessment for my PE, but I know that there are continuing education credits provided at conferences, and I am not sure what they are used for)
5. What is the assessment criteria and procedures?
6. Do specific cities/entities require higher levels of qualification than that for the state itself?
7. Is there an auditing (policing) process where structural engineer capability and quality of their respective design is assessed?
8. How often are peer reviews required, and how is the peer reviewer selected?
9. What qualification does a reviewer need?
10. Does the licencing system work?
11. What are the key lessons should NZ learn from your experiences?
12. What remains as the biggest problem in WA impeding the attainment of good structures and structural engineers?

Hopefully you will be able to address most the questions above.

Can I call you tomorrow at your office regarding this?

Kind wishes,  
Greg

### The meeting

Ed kindly responded to the email indicating a willingness to discuss these issues. During the meeting, on 13 March (NZ time), the issues in the email were worked through in turn. Points from the meeting are summarized below:

- All states have a generic professional engineering (PE) registration. Some states offer the 16 hour structural engineering (SE) examination.
- The SE may be used to provide *title authority* in some states
  - i.e. only those people with an SE can call themselves structural engineers
- The SE may be used to provide *practice authority* in some states
  - i.e. only those people with an SE can design specific types of structure

Some states have

*complete practice authority*

which means that all structures need to be designed by an SE (E.g. Hawaii and Illinois)

Other states have

*limited practice authority*

which means that all structures need to be designed by an SE (E.g. Washington and many others)

The types of structure that need to be designed by a SE are listed

- on the “accesswashington” website under legislation, or
- on the WA department of licencing board of registration engineers website.

In general, significant structures are required to be designed by an SE. These include those:

- > 4 stories tall
  - > 100 feet tall
  - Bridges > 200 feet in total length
  - Piers/wharfs > 10,000 square feet in plan
- 
- Some cities may have more rigorous requirements than those of the state as specified in their *practice acts*. For example, the city of Seattle requires all structures (except perhaps for some houses) to be designed by a SE.
  - The SE exam (from April 2011) is over two days:
    - Day 1 – vertical and incidental lateral loads
    - Day 2 – lateral loads (high seismic and high wind)
    - Exams have 40 multichoice questions in the morning and 4 hours of essay in the afternoons
    - Students need to pass both portions

- The pass rate is around 30%
- Professional licencing involves the following exams:
  - Engineer in Training (EIT), often taken by undergraduate students
  - Professional engineering (PE) exam which can be taken by those
    - with EIT plus 4 years' experience after bachelor's degree
    - with EIT plus 3 years' experience after postgraduate degree
  - Structural engineering (SE) exam which can be taken by those with
    - with PE plus 2 years' experience
    - 6 years' experience after degree (with no PE)
    - Note: WA, OR, CA, NV, UT, ID require a PE first

A licensed engineer is permitted only to practice in their area of competence

- Applicants for professional exams have their credentials checked by the *Board of Registration*, but the exams are written by the *NCEES* (National Committee for Examinations for Engineers and Surveyors). The current fee to take the SE exam is US \$1000.
- Currently there is no national requirement to update a licence obtained, except by paying a fee.
- Thirty nine (39) states require evidence of continuing development. In general this is checked by an audit of a certain percentage of the applications for renewal. Things checked are those such as:
  - The type of course
  - Who taught the courses
  - How much was paid
- If the city obtains some information about a building design submitted which is substandard, then evidence of this will be submitted to the Board of Registration (BOR). Typically the BOR will have the building design in question reviewed as well as two other building designs from the same designer. If these are in-fact found to be substandard, then the engineer will lose their registration.
- Engineers have a responsibility to report any practice they believe does not meet professional standards. In Ed's words: "If you know someone acting outside their area of competence there is an obligation to report".
- Peer reviews are not generally required except for some taller or irregular structures as determined by the appropriate authority. The reviewers need to be acceptable to the authority having jurisdiction. Ed is not very familiar with Peer review requirements and suggested John Hooper as perhaps being able to comment more.
- Ed's opinion is that the SE licencing method works well overall.
  - Limitations are:
    - Some engineers are poor test takers but good engineers
    - Some engineers are good test takers but poorer engineers

- Continuing professional development does not necessarily keep people up to date. For example, some people may take courses in management, rather than in the technical areas.
- There have been very few cases of people making intentional errors
- When there are alternative code methods/clauses to consider the same thing, then there is pressure on engineers to use the method that will result in the least conservative sizes, whether or not this is rational.
- Ed's thoughts for a better system are:
  - Requiring regular recertification
    - Physicians do it, as do many other professions
    - It keeps everyone up to date with latest methods
    - It reduces the possibility of overconfidence which can have undesirable consequences (see the Dunning-Kruger effect)
    - It is difficult to require regular recertification once a system is established. It is much easier to introduce it when the system is introduced.
    - There has been huge resistance regarding the introduction of regular recertification from the consulting industry. It is possible that the only way it can be introduced is after a major disaster.
  - Encouraging attendance at local structural engineering society meetings.
    - Many states have courses and meetings that are generally well attended
    - These meetings are a good way to disseminate lessons to half the membership
    - SEAW provides 24 two hour sessions to prepare for exams or to refresh. This is also useful for out-of-state engineers who are not familiar with seismic issues.
    - Technical sessions on new codes are often run
- Ed's thoughts regarding generic vs specialized licencing:
  - The national society for professional engineers (NSPE) wants generic licencing. Their membership has gone from 150,000 down to 50,000 people possibly as a result of people emphasizing specialized licencing more than the generic licencing.
  - The Dunning-Kruger effect shows that problems due to overconfidence can be overcome by education, and this is consistent with speciality licencing and regular recertification (e.g. <http://www.structuremag.org/Search.aspx?q=dunning-kruger&cx=013519588201024648843%3aIrt20pegiks&cof=FORID%3a11>).
- Other specialized qualifications
  - The UK IStructE qualification is used in a number of countries. It has about the same pass rate as the US SE exam. It requires an exam with 8 questions over 8 days. These relate to things such as:
    - Seismic
    - Calculations
    - Drawing
    - Load paths
    - Key details
    - Method statements (showing how something is to be constructed)

- There is an impossible design question that the engineer must deal with and communicate to the client about, etc
  - Ed has both US and IStructE qualifications and believes that the US NCEES SE exam process is more rigorous.
  - The NCEES exam
    - Is used in Egypt, Japan and other places
    - sample information is available at [https://app.ncees.org/study\\_materials/?exam=SE](https://app.ncees.org/study_materials/?exam=SE).
  - The advantages of the IStructE qualification are that:
    - It is in metric units
    - It is not tied to the US codes (- in fact taken with be used with any code)
- 
- Ed Huston would be happy to come to NZ to talk about these/related issues

**From:** Nicholas Charman  
**Sent:** Wednesday, 13 March 2013 9:10 p.m.  
**To:** Neil Horsfield  
**Cc:** Mark Nankervis  
**Subject:** RE: Australian Building Regulatory Framework

Neil,

Brief summary of my understanding:

- Certificate of Design or Certificate of Compliance (previously a Form 13 in Victoria?) prepared and signed by the registered designer (or person directing the design = Building Practitioner in Victoria, RPEQ here in Queensland and whatever name they go by in NSW etc, similar to CPEng engineers who we have sign producer statements in NZ I guess).
- This Certificate of Design/Compliance is issued to the 'Building Surveyor' or 'Building Certifier'. These are specialist consultants engaged by, or on behalf of, the owner/developer.
- The Building Surveyor issues the Building Permit, occupancy permits, final inspection certificates etc and are responsible for ensuring the building complies with relevant acts, regulations (including BCA, Oz standards etc). Presumably they are required to have their own liability insurances.
- Seems to be up to the Building Surveyor as to whether they accept the design certificate as is or whether they consider any further reviews, check calculations, peer review or similar be carried out. Expect it is likely to depend on the level of complexity, size of building etc.
- We would provide a letter or similar certification with respect to our construction monitoring obligations.
- I have not worked on any building projects here that have had independent peer review (or not that I know of anyway), including buildings we have designed of up to 60,000m<sup>2</sup>.
- We had an independent verifier on the Airport Link project and they were part of the team based in the project office. Infrastructure projects do seem to require peer review or independent verification as opportunities often come up for 'IV roles'.

Different states have different requirements, acts, regulations.

Queensland is the only state where engineers must be registered to provide professional engineering services ie. if you are providing a professional engineering service in Queensland you must be a Registered Professional Engineer of Queensland (RPEQ) or be directly supervised by an RPEQ. This is regardless of whether you are working in the state or remotely, which means NZ needs to ensure RPEQs are directly supervising any Queensland project design being done in NZ, it is not seen as just being a sign-off exercise. Oz has a National Professional Engineers Register (NPER) but membership is voluntary – and it does not cover practice in Queensland, need to be an RPEQ. I think there is a push to go to some sort of formal national registration system.

Auditing of CPEngs etc is notionally every five years.

Mark will be able to provide a bit more info (has been here a lot longer than me).

Regards,

Nicholas

[http://aibs.worldsecuresystems.com/careers\\_and\\_employment/what\\_building\\_surveyors\\_do](http://aibs.worldsecuresystems.com/careers_and_employment/what_building_surveyors_do)