Canterbury Earthquakes
Royal Commission
Te Komihana Rūwhenua o Waitaha

Discussion Paper: Training and education of engineers and organisation of the engineering profession

1. Introduction

This paper discusses the training and education of engineers and the organisation of the engineering profession in the context of considering the performance of buildings in earthquakes. It is a discussion paper only and does not express any concluded views of the Royal Commission.

Respondents are asked to contribute views, evidence and well supported analysis on any or all of the topics documented in this paper. The paper is set out as follows:

Part 1: Legislation – The Chartered Professional Engineers of New Zealand Act 2002:

- powers and functions of the Act;
- registration as a Chartered Professional Engineer (CPEng); and
- duties and obligations of CPEngs.

Part 2: Training and Education of Engineers:

- competence requirements for engineers to become registered as CPEng and re-register over time;
- education requirements to enter the engineering profession and, in particular, from the Universities of Canterbury and Auckland;
- the extent to which seismic engineering and emergency preparedness and management are relevant to the training and education of engineers.

Part 3: The Role of Professional Societies in the Engineering Sector.

Submissions can be sent by email or post as follows, and are required to be received by the Royal Commission by 12pm 27 July 2012.

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2. Purpose

The purpose of this paper is to seek feedback, views, evidence and analysis on the following issues set out in this paper:

a) the educational and training requirements for engineers to attain specific competency levels to achieve registration as a CPEng;

b) any potential omissions and shortcomings in the training and regulation of engineers that have been identified through the experience of the Canterbury earthquakes; and

c) the role of professional societies in the training, ongoing education and guidance of the engineering profession.

3. Background

The Royal Commission previously sought submissions on the topic of the training and education of engineers and the organisation of the industry. In response, four submissions were received from interested parties, including one from the Department of Building and Housing and three from private parties.

At the Royal Commission's request, the following information was provided prior to submissions being sought:

- a technical report from IPENZ setting out the history and current requirements for the education and ongoing competence and assessment requirements for engineers; and
- letters presenting the educational framework underpinning the Bachelor of Engineering degrees offered by the Universities of Canterbury and Auckland and Unitec.

The submissions and reports can be viewed on the Royal Commission's website at www.royalcommission.govt.nz.

The Royal Commission has reviewed and analysed the information provided, and now seeks further information on specific issues, options for change and questions noted at the end of each section in this discussion paper.

A public hearing on the regulatory framework governing the building and construction industry is planned to be held within the weeks of 3 September and 10 September 2012. The hearing will include matters covered in this discussion paper.

The Royal Commission may call any provider of a submission to present any compelling and well-evidenced research and analysis contained in submissions either received to date or submitted in response to this discussion paper.

4. Framework for Defining Problems and Analysing Possible Solutions

In seeking comment on the issues discussed in this paper, it is important to include where possible:

- identification of any problems, omissions or risks that arose in the Canterbury earthquakes or could arise in a future event for which proposed solutions or changes may result in a materially improved outcome in the future;
- evidence and/or analysis underpinning the characterisation of problems and proposed solutions;
- risks and impediments to implementation of proposed solution(s), as well as advantages, disadvantages and the nature of costs and benefits of those solutions if possible;
- identification of those who, or that which, benefit(s) and those who, or that which, pay(s), including downstream consequences (for example, engineers, students of engineering, building owners and investors, the New Zealand economy, wider construction industry, providers of engineering education and professional societies – there may be others);
- evidence of successful implementation and/or operation of proposed initiative(s) in other jurisdictions, including identification of key differences and similarities between the New Zealand and other jurisdiction(s);
- reference to any third parties that have been consulted or have contributed to the proposals being submitted.

In addition, it may be relevant to draw distinctions between engineers of large and small engineering firms, and engineers of urban and rural or small town locations.

When considering the issues raised in this paper, it is important to consider the costs, benefits and risks associated with options for change in the context of the likelihood of earthquakes occurring that have significant detrimental impact on buildings.

5. Part 1: Legislation – The Chartered Professional Engineers of New Zealand Act 2002

5.1 Powers and Functions

The Chartered Professional Engineers of New Zealand Act 2002 (CPEng Act) created:

- IPENZ - the engineering industry's professional body and registration authority; and
- The Chartered Professional Engineers Council (the Council).

The Council reports to the Minister of Building and Construction on the performance of IPENZ and the Council in exercising their respective powers and functions under the CPEng Act. The Council is also an appeals body on registration and disciplinary matters.

Key requirements of the CPEng Act are as follows:

- Section 39 sets out the functions of the registration authority (ie IPENZ), which include making and always having rules relating to CPEngs, carrying out registration functions, keeping and maintaining the CPEng register and receiving, investigating and hearing complaints about, inquiring into the conduct of, and disciplining CPEngs;

- Section 40(1) states that the Registration Authority must make, and always have, rules containing the following minimum standards (CPEng standards), as approved by the Council under section 41:

  a) minimum standards of competence (including standards relating to knowledge and skills) in professional engineering that must be met for each class of registration; and

  b) minimum standards of demonstrating current competence in professional engineering that must be met for continued registration in each class, and for the frequency at which assessments of current competence must be carried out; and

  c) a code of minimum standards of ethical conduct for CPEng.

- Section 41 requires the registration authority to consult with engineers, and any persons that it reasonably considers affected by, the proposed rule and take into account international best practice and New Zealand's international obligations when setting rules. Proposed rules containing a CPEng standard must be approved by the Council before becoming a rule.

IPENZ advises that standards of competence are outcomes-based (that is, demonstration that a candidate can perform certain tasks to specific levels of competence, rather than demonstrating such competency by pointing to educational qualifications or projects worked on in general).

5.2 Registration as a Chartered Professional Engineer (CPEng)

'Chartered Professional Engineer' (CPEng) is New Zealand's only statutory-backed mark of quality indicating an engineer has proven his or her current competence to practise as a professional engineer within New Zealand.

In order to gain registration as a CPEng, a candidate must meet the 'competence standard' by demonstrating an ability to practise competently in his or her practice area to the standard of a reasonable professional engineer. This requires both an assessment of educational qualifications and capability, which are discussed further below.

An engineer does not need to register as a CPEng although the absence of the quality mark may adversely affect the engineer's employment opportunities.

The CPEng Register is available for public inspection. It records the name of the engineer and the date at which he or she was last registered or re-registered as a CPEng. It has been suggested that identification of the CPEng's scope of practice would be useful for the public.

From its hearings to date, the Royal Commission has become aware of instances in which engineers have undertaken and completed work in engineering specialities outside their area of expertise. Disciplinary measures are in place to deal with such a breach of the profession's Code of Ethical Conduct; however, it may not become evident until an adverse event occurs (eg collapse of a building), which may be many years after the building's design and construction.

In addition, it is apparent that not all engineers engaged in the post-earthquake assessment of buildings were CPEng-registered. This means they are not subject to the governance mechanisms (eg disciplinary procedures) imposed on the industry by IPENZ.

CPEng-registered engineers are reassessed for competency towards re-registration every 5-6 years. It may be desirable to consider whether there should be an interim measure of competence assessment, or an earlier re-registration requirement. This would require information about the risks that have or may arise in the intervening period as more frequent assessment is likely to be a costly exercise.

The extent to which the candidate is able to do each of the following in his or her practice area is taken into account in assessing whether the overall standard is met:

- comprehend and apply knowledge of accepted principles underpinning (i) widely applied good practice for professional engineering; and (ii) good practice for professional engineering that is specific to New Zealand;
- define, investigate, and analyse complex engineering problems in accordance with good practice for professional engineering;
- design or develop solutions to complex engineering problems in accordance with good practice for professional engineering;
- exercise sound professional engineering judgement;
- be responsible for making decisions on part, or all, of one or more complex engineering activities;
- manage part, or all, of one or more complex engineering activities in accordance with good engineering management practice;
- identify, assess, and manage engineering risk;
- conduct his or her professional engineering activities to an ethical standard at least equivalent to the Code of Ethical Conduct;
- recognise the reasonably foreseeable social, cultural, and environmental effects of professional engineering activities generally;
- communicate clearly to other engineers and others that he or she is likely to deal with in the course of his or her professional engineering activities;
- maintain the currency of his or her professional engineering knowledge and skills.

5.3 Duties, Rights and Obligations of a CPEng

A CPEng is required to act in accordance with the Rules formulated by the Registration Authority under the CPEng Act 2002. Part 3 of the Rules sets out a Code of Ethical Conduct with which a CPEng must comply, as follows:

- rules 43–45 set out a CPEng's general obligations to society, including taking reasonable steps to safeguard health and safety and have regard to effects on the environment;
- rules 46-49 provide general professional obligations, including not misrepresenting competence and specifically requiring a CPEng to "undertake engineering activities only within his or her competence" (clause 46(b));

- rules 50-52 record obligations to employers and clients; and
- rule 53 provides obligations owed to other engineers.

The Rules also set out matters such as registration and competence assessment procedures, disciplinary procedures, and other administrative matters.

5.4 Disciplinary Procedures

Section 21 of the CPEng Act 2002 sets out the grounds for the disciplinary measures for CPEngs that include, among other things, that the person:

- has breached the Code of Ethical Conduct contained in the Rules; and
- has performed engineering services in a negligent or incompetent manner.

Section 22 provides that the Registration Authority may order that:

a) the person's registration be removed, and that re-registration may not be applied for before the expiry of a specified period;

b) the person's registration be suspended for a period of no more than 12 months or until the person meets specified conditions relating to the registration;

c) the person be censured;

d) the person must pay a fine not exceeding $5,000.

Section 22(5) provides that, in addition to notifying the order in the Register, the Registration Authority (a) must notify the Registrar of Licensed Building Practitioners appointed under the Building Act 2004 of the order and the reasons for it; and (b) may publicly notify the order in any other way it thinks fit.

Complaints to the Registration Authority are assessed against criteria to determine whether they should be progressed, and if so, are referred for investigation. If upheld, a complaint is referred for disciplinary action by the Registration Authority.

IPENZ may deem a matter worthy of inquiry (eg if information was provided to it) under CPEng Rule 55 or IPENZ Disciplinary Regulation 4.

The Royal Commission notes that there have been very few cases of engineers being disciplined for the most severe of infringements – the performance of engineering services in a negligent or incompetent manner. This could be due to the inherent difficulty in demonstrating poor professional performance (eg the collapse of a building). The lack of disciplinary action could reflect, or be a cause of, an apparent reluctance by engineers to publicly criticise each other.

Encouraging the reporting of poor performance to the registration body, IPENZ, may enhance the effectiveness of the current procedures. Building Consent Authorities and peer reviewers could have a recognised role in this respect.

Questions:

1. What additional information, if any, should the CPEng Register disclose about a CPEng and how would this information improve, or potentially improve, earthquake building performance? What are the advantages and disadvantages of providing this additional information?

2. Comment, if possible, on the processes that Building Consent Authorities, and any other entities that have significant dealings with engineers, take or should take in reporting substandard performance of engineers to the Registration Authority which could underpin a future case taken by the Authority against a CPEng. What are the benefits, disadvantages and costs of creating mechanisms for reporting and recording poor performance in addition to those already available?

3. Provide well supported views and/or evidence about the potential magnitude of the problem of engineers practising outside their scope of expertise and what regulatory measures might be better employed to deter such behaviour.

4. Comment on the effectiveness of the current disciplinary procedures. What balance should be struck between deterring adverse behaviour and ensuring people are not deterred from entering the profession?

5. What are the key issues that arise from a voluntary registration process? How aware are consumers of engineering services of the differences between CPEng and non-registered engineers? What are the costs and benefits of formally requiring registration to enable an engineer to practice? Are there any other ways of increasing knowledge among consumers as to the merits of acquiring services from CPEngs over non-registered engineers?

6. Part 2: Training and Education of Engineers

6.1 Competence Assessment

The competency of a candidate is assessed by a panel that comprises of assessors experienced in the candidate's specific practice area and assessors that are expert in assessment methodology. IPENZ advises that it draws on learned societies (voluntary organisations that promote academic or professional discipline) for good assessors and to develop guidelines for the competence standard.

The Assessment Panel's recommendations on whether candidates have met the competence standard are submitted to the Competence Assessment Board for moderation.

In order to continue to be registered as a CPEng, a candidate must demonstrate that he or she has both taken reasonable steps to maintain currency of knowledge and skills and remains able to practise competently evidenced by recent work samples. It is expected that it will take a time period in the range of 4-8 years for a graduate engineer to achieve an appropriate level of competence that would permit registration. Prior to gaining registration, the graduate engineer (and any other engineer that opts not to register) participates in the engineering profession outside the jurisdiction of the CPEng Act. However, it is likely that the graduate engineer will be supervised by a CPEng in his or her place of employment.

There is no structured programme of formal development or training for graduate engineers. IPENZ, as the registration authority, recommends that CPEngs, or those training towards

becoming CPEngs, undertake 50 hours of CPD per year, which underpins a candidate's ability to demonstrate competence for registration or re-registration purposes (but is not, by virtue of completion, a measure of competence). This approach suggests that value has been placed to date on the ability of an engineer and his or her employer to determine the appropriate ongoing education and training programme for the engineer's development in the context of his or her work requirements.

6.2 The Royal Commission's Hearings

In hearings to date, the Royal Commission has noted the following potential issues which we would like to explore further:

1. pressure on the availability of suitably qualified engineers to assess the integrity and safety of structures after the earthquakes;
2. the probability that there is a lack of focus on training engineers to adequately assess the structural integrity of buildings based on the differences in:
    - the age and nature of the buildings (eg URM versus modern);
    - emergency versus 'business as usual' conditions; and
    - the purpose of structural assessment (eg building design versus assessment of completed structure);
3. shortcomings in the communication that took place between engineers and building owners, tenants and other interested parties on a number of issues, including the nature of the structural assessment undertaken; the constraints on the integrity of the assessment (eg absence of referral to the detailed plans of the building); and the requirements that the building owners need to follow to ensure the structural integrity of their buildings; and
4. lack of consistency between engineers in the approach taken to assess buildings for structural integrity, including actual outcomes of assessments as well as processes undertaken.

6.3 Emergency Management

The Royal Commission seeks feedback as to whether the formal training of engineers should include emergency management, and whether engineers should be specifically trained to respond to post-earthquake response and recovery needs. Such training could include assessment of the structural integrity, and therefore public safety, of buildings and structures, and the co-ordination and procedures and processes for attending to the necessary tasks in a uniform and organised fashion. These matters are discussed in further detail in the Royal Commission's discussion paper 'Building Management after Earthquakes', specifically in relation to training practising engineers in the task of assessing buildings after earthquakes. Comments are encouraged on both papers.

Questions:

1. Should a graduate programme of development (continuing professional development) be prescribed? There are a number of questions underpinning this question:
   - Where would responsibility lie for prescription of a graduate programme?
   - How would a prescribed programme be quality assured?
   - Compare the advantages and disadvantages of this approach to the status quo, which includes the tacit approval of employers for courses selected (since the employer pays).
   - How would a prescriptive approach manage the differing needs of engineers in their respective workplaces, if any?
   - How could competency requirements be provided where those skills are considered valuable by the New Zealand public but have less or no value to an employer? Who would pay?
2. Comment on, and where possible, provide evidence or well supported analysis on the issues raised above by the Royal Commission.
3. Comment on the current process of development of continuing professional development course options. In particular, what roles are taken by employers, engineers and education providers in determining the appropriateness of content to be taught and the demand for courses?
4. Should CPEng re-registration, with its associated competence assessment, be required at shorter intervals than the current 5-6 years, and what are the associated issues? Could some other method of competence confirmation be implemented mid-term instead?

6.2 Education

There are two main New Zealand providers of tertiary education for engineering students – the Universities of Canterbury and Auckland. There are a number of other institutions, such as Unitec Institute of Technology and AUT, that provide education for engineers in a wide range of disciplines, and for technologists and technicians.

The degrees offered by the Universities of Canterbury and Auckland are nationally and internationally benchmarked and accredited to the standards of the Washington Accord, to which IPENZ is a signatory. The Accord allows international accreditation for professional engineering academic degrees and has been the subject of in-depth benchmarking across jurisdictions to ensure substantial equivalency of programmes offered by the signatories.

Any changes to the content and duration of a formal engineering qualification must meet the requirements of the Accord, which undergoes review and amendment over time. In its report to the Royal Commission, IPENZ noted "the prospect that professional engineering

education might well lengthen in the next decade" should it be so required to "maintain New Zealand's international standing in professional engineer education"[1]

Signatories to the Accord are Canada, United Kingdom, Ireland, United States of America, Australia, New Zealand, Hong Kong, South Africa, Singapore, South Korea, Taiwan, Malaysia and Japan.

The consequence of the Accord arrangement is that engineers from any of the signatory countries can practise as engineers in another signatory country, although there may be additional requirements to be met in order to become registered in that country. For example, an applicant from a signatory country seeking New Zealand registration as an engineer must work in New Zealand for 12 months to gain knowledge and experience of the New Zealand working environment, prior to becoming eligible for registration.

The Royal Commission does not see a need to question the content or duration of the tertiary education offered, as we consider there are adequate checks and balances in the current internationally recognised system of accreditation. Rather, the matters of concern arising from the Canterbury earthquakes are relevant to the training of engineers, occupational regulation of the industry and regulatory framework. This paper has focussed on these issues. However, comment on the education of engineers is nevertheless welcome.

The engineering faculties of the Auckland and Canterbury Universities and Unitec have previously provided information to the Royal Commission addressing the following key issues:

- the weighting given to the subjects of structural and geotechnical engineering in the Civil Engineering degree;
- how training continues after graduation; and
- opportunities available or desirable for continuing education programmes.

This information is available for review on the Royal Commission's website. These reports include descriptions of the course make-up for each institution.

7. Part 3: The Role of Professional Societies in the Engineering Sector

Learned or professional societies are voluntary organisations formed to promote a particular academic or professional discipline. They often play key roles for their particular industry by facilitating communication of new research by sponsoring or publishing journals, and holding regular conferences for the presentation and discussion of new research or trends. They are often represented at the highest levels by individuals who are in the later stages of their careers with accordingly high levels of experience, knowledge and respect within their field, and where they may be in a position to undertake voluntary professional contribution.

[1] IPENZ report to the Royal Commission entitled 'Standards and Regulation for Building Construction in New Zealand, page 45.

7.1 Institution of Professional Engineers New Zealand (IPENZ)

As well as being the registration body for New Zealand's engineers, IPENZ is also the professional body for engineers of all disciplines with membership including engineering students, practising engineers and senior members in positions of responsibility in business. Members are classified into various membership classes according to their levels of education and extent of experience in engineering practice.

The entry standards for professional membership of IPENZ are the same as to be registered as a CPEng. Membership of IPENZ is voluntary but all professional members must be registered as CPEngs. There are other membership categories available, one of which is for engineers that have not yet attained a level of competence sufficient for admission as a professional member (ie have not yet attained CPEng). IPENZ advises that of approximately 2,800 CPEng-registered engineers, around 80 are not members of IPENZ.

As the professional body for engineers of any discipline, IPENZ notes (on its website) that it provides members with support services to assist members to "develop and enhance their careers, promote themselves as competent and ethical professional practitioners, apply engineering best practice and contribute to the standing of the engineering profession in the community".

IPENZ undertakes a number of activities to enhance the professional standing of engineers including:

- setting internationally benchmarked qualifying standards for degree qualifications and assessing foreign qualifications;
- representing engineers' interests with government;
- providing contact with other professionals through branches and technical groups;
- maintaining a publication and conference programme; and
- developing good practice guidance and design guidelines for the industry.

7.2 Other Professional Societies and Organisations

There are a number of other professional societies and organisations that are dedicated to particular engineering specialties, such as the New Zealand Society for Earthquake Engineering, the New Zealand Geotechnical Society, the Structural Engineering Society New Zealand, the New Zealand Concrete Society, Heavy Engineering Research Association, Structural Timber Association and others.

Among other things, the societies provide forums dedicated to the particular engineering specialty that assists with the:

- promotion and debate of relevant issues;
- dissemination of information and knowledge and education opportunities; and
- communication of issues amongst the members and to the public.

They also provide opportunities for engagement with wider industry participants, including both members of other engineering societies and construction industry professions.

The societies generally participate at several levels of policy and standards development, including:

- providing views of the society, and therefore its members, on policy proposals by the Government for which the Government seeks industry views and comment;
- working with government agencies to identify and characterise key issues that need to be addressed by the Government in the industry's interests (eg legislative or regulatory changes);
- developing guidelines for specific aspects of industry participation (eg NZSEE guidelines and practice for assessment of buildings; SESOC practice notes); and
- participating in Standards New Zealand standard-setting processes.

Questions:

Comment on the efficacy and efficiency of the conduct of the engineering learned or professional societies in respect of the:

- interactions between structural engineers and geotechnical engineers and others, and between engineers and architects on the construction of buildings;
- engagement by learned or professional societies, both internally and with one another for the purposes of bringing attention to and resolving contentious issues, and achieving improved outcomes across the industry;
- the appropriateness and durability of, and risks that could arise through, the engagement of volunteers (society members) to formally inform or develop policy and/or standards of practice; and
- the standing of guidance or advice issued by societies, and monitoring and consequences (if any) of non-compliance.