SUBMISSION FROM THE STANDARDS COUNCIL

APPENDICES

Prepared for the Royal Commission of Inquiry into the Building Failure Caused by the Canterbury Earthquakes

APPENDIX A

Short form glossary for standards and related terminology

Short form glossary for standards and related terminology

Prepared for the Royal Commission of Inquiry into the Building Failure Caused by the Canterbury Earthquakes

13 October 2011

Category	Term	Definition
Framework	Building Act 2004	The Building Act 2004 sets the legislative framework for building in New Zealand. Its purpose (as described in section 4) includes providing for the regulation of building work, and the setting of performance *standards* for buildings. The Act authorises the making of regulations by the Crown, including the *Building Code*. The Act also contains provisions about how the *Building Code* is to be complied with, including through the issue of *compliance documents*.
	Building Regulations 1992	The Building Regulations 1992, and subsequent amendments, were made under the Building Act 1991 but are now treated as if they were regulations made under the *Building Act 2004*. The only part of the 1992 Regulations continuing in force is Schedule 1, which contains the *Building Code*.
	New Zealand Building Code, or Building Code	The Building Code applies to all new building in New Zealand. It is in the form of statutory regulations, and forms Schedule 1 of the *Building Regulations 1992*. The Building Code is performance based (stating how a building must perform, rather than specifying how it must be built). Compliance with the Building Code is dealt with under the *Building Act 2004*.

	Compliance document	A compliance document is a document issued by the *Chief Executive* of the *Department of Building and Housing* under section 22 of the *Building Act 2004*, for use in establishing compliance with the *Building Code*. A compliance document may contain an *acceptable solution*, or a *verification method*.
	Verification method	A verification method is a method by which compliance with the *Building Code* can be verified (*Building Act 2004*, section 7). A verification method may be in a *compliance document*, but may also be prescribed in regulation (in which case it is known as a 'prescribed verification method').
	Acceptable solution	An acceptable solution is a building solution that must be accepted as complying with the *Building Code*. An acceptable solution may be in a *compliance document*, but may also be prescribed in regulation (in which case it is known as a 'prescribed acceptable solution').
Standards	Standard	A Standard is an agreed, repeatable way of doing something. It is often encapsulated in a published document that contains a technical specification or other precise criteria designed to be used consistently as a rule, guideline, or definition. Standards help to make life simpler and to increase the reliability, quality, and the effectiveness of many goods and services we use.
	New Zealand Standard 'NZS'	New Zealand Standards are developed in accordance with the Standards Act 1988. A New Zealand Standard means a *Standard* promulgated by the Standards Council as a New Zealand Standard under the *Standards Act*

		1988 or as a Standard specification under the Standards Act 1965. A New Zealand Standard is also called a national Standard and is denoted by an 'NZS' label, with a corresponding number. A New Zealand Standard is a voluntary document created by a New Zealand Standards technical committee which represents the various interests of the stakeholder community. All New Zealand Standards are developed using a *public comment* period and with the concept of achieving general *consensus* on the final document.
	Sector standard	Sector stakeholders can develop a sector *standard* for a material, process, or practice. This might include industry codes of practice, industry specifications, or industry technical requirements developed using a range of processes and with various levels of formal process and consultation.
	Cited New Zealand Standards and sector standards	*Standards* are those that have been cited or incorporated by reference into the *Building Act 2004*, *Building Code*, *acceptable solutions*, or *verification methods*. Any decision to cite or incorporate a *standard* is made by the regulator responsible for the legislation concerned. This may give the *New Zealand Standard* or *sector standard* a status beyond voluntary such as an agreed means of compliance.
Regulator	Department of Building and	The Department of Building and Housing is the government

	Housing, or DBH	department to be responsible for the administration of the *Building Act 2004* (and the associated regulations, including the *Building Code*). The *Building Act* refers to the Department as 'the Ministry' (see Building Act 2004, section 7).
	Chief Executive of the Department of Building and Housing	Under the *Building Act 2004*, the chief executive of the *Department of Building and Housing* has a number of statutory functions for building regulation. The functions include issuing *compliance documents*.
Standards Council and the New Zealand Standards process	Standards Council	The Standards Council operates as an autonomous Crown entity under the *Standards Act 1988* and the *Crown Entities Act 2004*. The *Standards Act 1988* charges the Standards Council with developing, promoting, and facilitating the use of *Standards* and standardisation to help deliver social and economic benefits, including increased productivity, enhanced market access for producers, promoting innovation, and improved consumer safety. The Council is an appointed body, with representatives from a wide range of sectors as well as ministerial appointees. The Standards Council operates under the monitoring of the Ministry of Economic Development as a key institution of the wider New Zealand *standards* and conformance infrastructure. Other key institutions within this infrastructure include the International Accreditation New Zealand (IANZ), Joint Accreditation System of Australia and New Zealand (JAS-ANZ), and the

		Measurements Standards laboratory of New Zealand (MSL). The Standards Council functions as New Zealand's national Standards body.
	Standards New Zealand	Standards New Zealand is the operating arm of the *Standards Council* established to discharge some of its functions under the *Standards Act 1988*.
	Standards Act 1988	The Standards Act 1988 sets the legislative framework and policy settings for the national Standards body. Its purpose is to: • facilitate domestic and international trade • minimise risks to health, safety, and the environment • facilitate innovation and economic development • reduce compliance costs. The Act defines the processes and mandate for standardisation as part of a wider role within the *standards* and conformance infrastructure.
	Crown Entities Act 2004	The Crown Entities Act 2004 sets the legislative framework for the establishment, governance, and operation of entities owned by the Crown and to clarify accountability relationships.
	Consensus	Consensus is the level of general agreement. For *New Zealand Standards*, the minimum consensus threshold is 80% of the committee members providing approval of a view, and is characterised by the absence of sustained opposition to substantial issues by any major stakeholder interest.

	Public comment	A period, usually of 8 weeks, where the public is invited to comment on a draft *New Zealand Standard*. The development committee considers these comments and revises the text of the draft *New Zealand Standard* as appropriate before balloting on the document, and publication. Approval by the *Standards Council* for due diligence of the development processes as set out in *Standards Act 1988* is then sought
	Nominating organisation	A national organisation or association with broad membership of a particular stakeholder interest group.
	New Zealand Standards technical committee	A group of experts that have been nominated by a selection of organisations and associations (*nominating organisation*) representing the wider stakeholder community interests.
	Best practice	Generally accepted knowledge of techniques, methods, or processes that can be informal or formally codified through *standards* or *New Zealand Standards*. Best practice may be in line with the minimum legislative requirements or deemed to be over and above the legislative requirements.
	Informative	Information content within a *New Zealand Standard* that has been provided as additional guidance. This includes appendices subtitled ‘informative’ and clauses with the verbal forms of ‘should’ and ‘should not’ or ‘may’ and may not’.
	Normative	Information content within a *New Zealand Standard* that has been provided as mandatory requirements of the *New Zealand Standard*.

		This includes appendices subtitled ‘normative’ and clauses with the verbal forms of ‘shall’ and ‘shall not’.

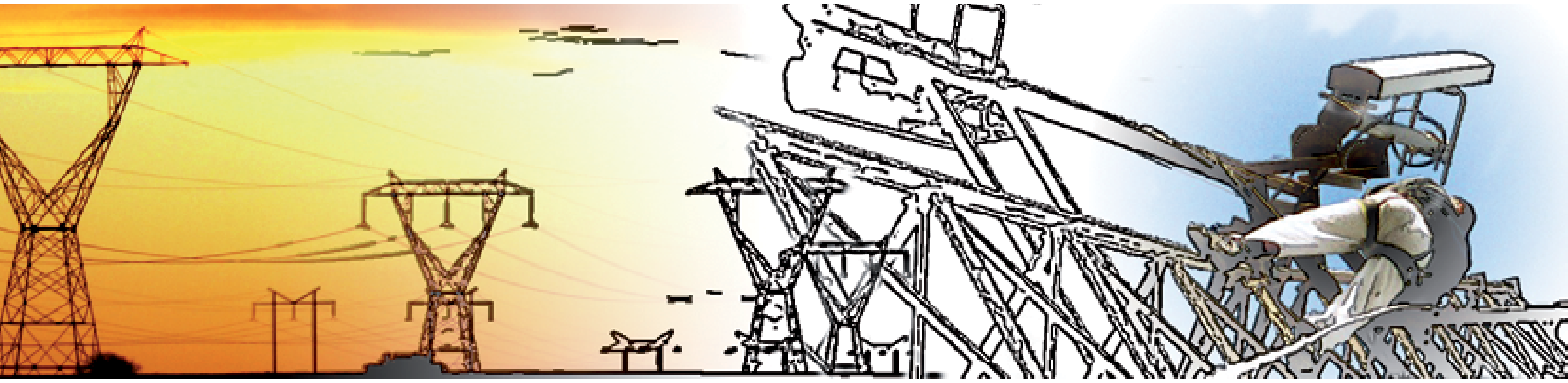
APPENDIX B

Standards Development committees

Standards New Zealand

Standards Development Committees

STANDARDS
NEW ZEALAND
PAEREWA AOTEAROA



Standards New Zealand

Standards Development Committees

This document provides an overview to guide Standards development committee members and nominating organisations on their roles and responsibilities. It also outlines the role Standards New Zealand plays in facilitating the development of Standards.

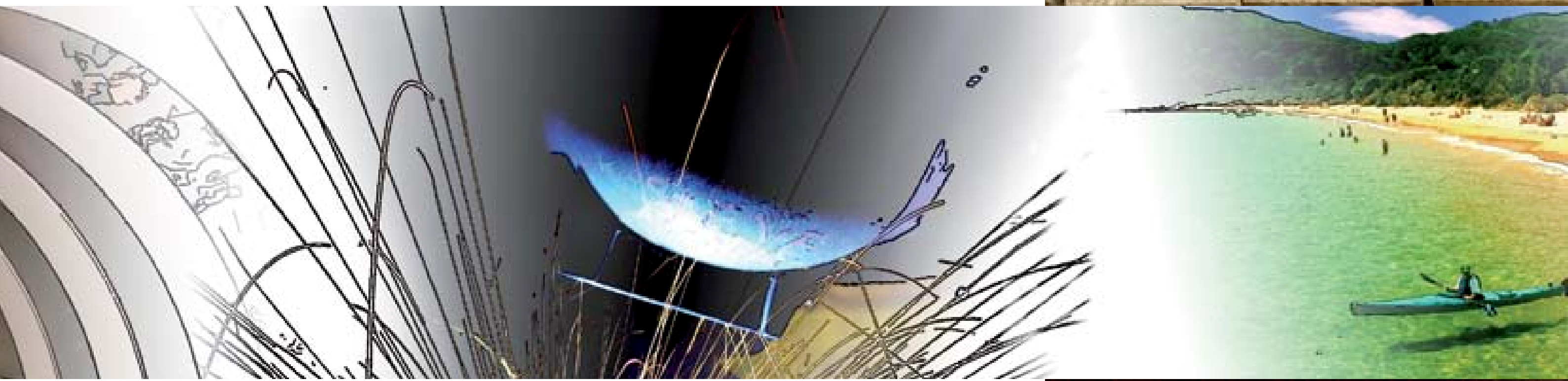
Developing Standards

Committee members are central to the Standards development process. They make an immense contribution to their sector and to New Zealand as a whole.

Standards result in wide-ranging benefits for all, including improved safety, quality, convenience, efficiency, prosperity, and increased trade opportunities.

A Standard is a document that defines materials, methods, processes, practices or outcomes and, in doing so, sets quality and safety levels.

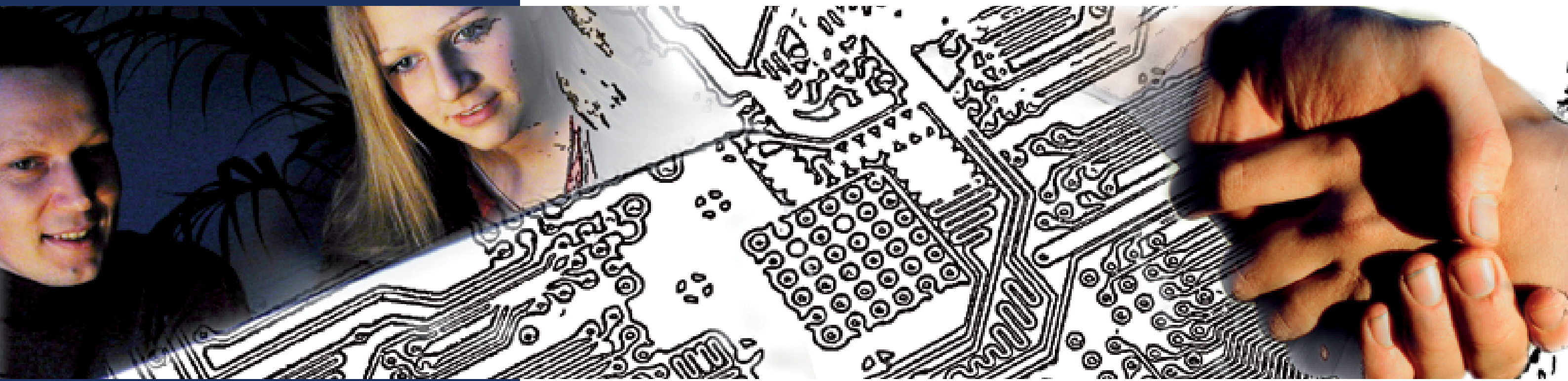
Standards span an enormous breadth of subject areas, including engineering, building, bungy jumping, organic production, health and disability services, gas and electricity, energy efficiency and risk management.



They range from technical guidelines for earthquake resistant building design to safety specifications for household electrical appliances and screening and intervention guidelines for family violence.

Standards are generally voluntary, but can be mandatory when cited in legislation or regulation. Standards may also be cited in regulation as one means of compliance without being mandatory. As Standards are developed independently, and involve industry representatives, they are often more workable and accepted among industry than prescriptive regulation.

Partnership



SPONSORS
fund development

COMMITTEE MEMBERS
develop Standards

USERS
implement Standards

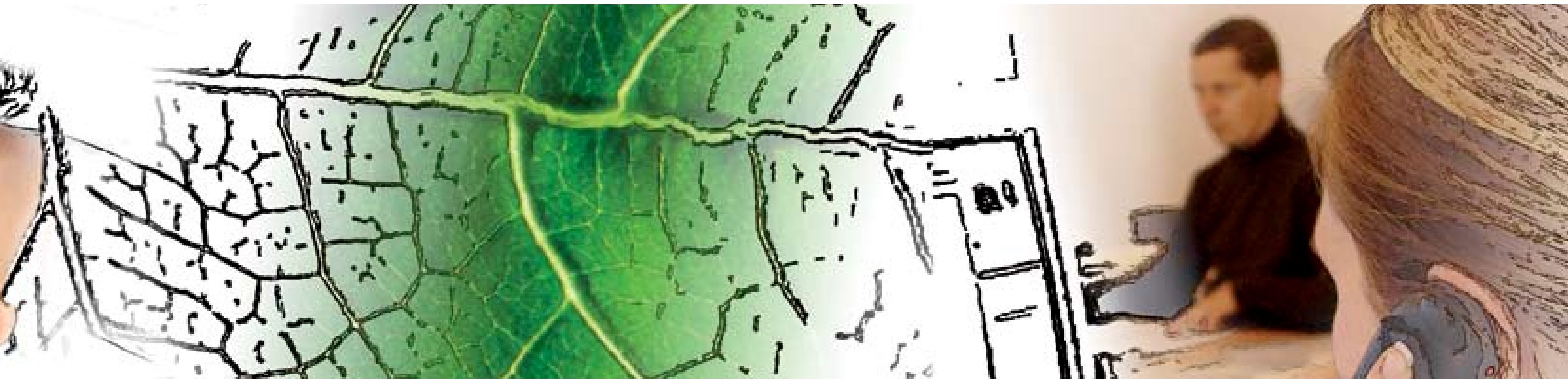
CONSUMERS
benefit from Standards

Partnership is fundamental for the development of Standards. Standards NZ works with a range of public and private sector organisations, professional associations and industry groups.

The Standards ‘value chain’ begins with sponsoring organisations from relevant sectors, which help fund the development of Standards. A balanced committee of sector experts then develop Standards. Organisations and individuals use and implement Standards, and all New Zealanders benefit from Standards in many different ways.

The Standards development process is consensus-based and transparent, and involves wide consultation. Committee members, from organisations that are directly affected by the Standard, work together to develop the content, with input from other interested parties during the public consultation period. This inclusive process generates wide support and recognition for the resulting document and ensures the content is practical and workable.

Nominating Organisations



Standards NZ invites organisations that represent the views of a large, usually national, group with a common interest in the subject area to nominate a representative for the Standards development committee. These organisations may be regulators, professional bodies, research agencies, manufacturers, end users or others with an interest in the subject.

Examples of nominating organisations include the Institution of Professional Engineers New Zealand, District Health Boards New Zealand, the Timber Industry Federation, the Fire Protection Association of New Zealand, the Building Research Association of New Zealand and Master Builders. Government agencies that act as nominating organisations include the Energy Safety Service, the Ministry of Health, the Accident Compensation Corporation, and the Department of Building and Housing.

Standards NZ will review nominations and appoint committee members from the nominations received. In doing so, we will ensure the committee is balanced and has the appropriate diversity of expert knowledge and experience.

Nominating organisations should regularly communicate with their committee member about the views of the nominating organisation so they can be effectively represented throughout the development of the Standard.

Committee Members

Teamwork is central to developing Standards. Being an effective and considerate team member is essential to the success of the project. The process relies on reaching consensus, which involves the need to consider other views and a willingness to compromise.

Committees responsible for developing Standards comprise individuals who want to contribute to their sector and to New Zealand as a whole in the areas of:

- Health, safety and welfare of users and consumers;
- The environment;
- Industry best practice; and
- New and emerging technologies.

Benefits of Participation

Committee members benefit from the opportunity to:

- Contribute to the content of the Standard, which provides benefits for their sector, employer, and consumers;
- Enhance their professional experience, and maintain and develop their competence;
- Build networks and learn from the expert knowledge of others in their field;
- Contribute to, and learn from, the latest international knowledge;
- Help create trade opportunities;
- Be part of an inclusive, collaborative and consensus-based project, which involves public consultation and generates wide support; and
- Represent and protect the public interest.

Roles and Responsibilities

Committee Members

Standards NZ aims to make the most efficient use of committee members' time. We will ensure that the project is well run, so that content is of high quality and consensus has been reached.

To achieve the best possible outcome, committee members are encouraged to:

- Attend all meetings. There are typically up to four one day meetings to develop a draft Standard for public consultation and one two day meeting to update the draft as a result of the comments received during the public consultation period;
- Prepare thoroughly prior to committee meetings;
- Consult with nominating organisations and other interest groups they may represent; and
- Contribute to committee work between committee meetings – this may include researching, drafting, or reviewing sections of the Standard.

The Committee Chair

Standards NZ may act as an independent Chair or appoint a Chair from the Committee. The Chair must act as an impartial facilitator. The Chair will ensure all committee members have the opportunity to have their say, and that committee consensus is reached through reasonable compromise.

The Chair is responsible for:

- Helping to achieve consensus on content where there are differing views and ensuring all views are heard;
- Facilitating the resolution of technical issues; and
- Assisting with answering enquiries about the Standard post-publication.

Standards NZ Project team

The Standards NZ Project team is responsible for:

- Ensuring the objectives and scope of the project are clearly understood and agreed by all involved in the project;
- Developing and implementing a plan to achieve the project objectives within an agreed time frame and budget;
- Facilitating the well established Standards development process;
- Being in regular contact with committee members and sponsors;
- Ensuring the committee stays focused on quality of content to achieve the project objective; and
- Managing risks and issues that arise during the project.

Committee member

Dr Richard Fenwick

Dr Richard Fenwick has contributed research and knowledge to Standards over a number of years. He was a member of the Loadings Standard committee (NZS 4203:1992), the committee working on the replacement of this Standard, and the committee revising the Structural Concrete Standard.

After working as a structural design engineer in New Zealand and the UK, Richard took up structural research and a teaching position in the Department of Civil Engineering at Auckland University.

In 2002, Richard joined Canterbury University's Department of Civil Engineering, and has spent a considerable portion of this time on the committee for the Loadings Standard for earthquake actions (NZS 1170.5), and the revision of the Structural Concrete Standard (NZS 3101).

Richard's background in practical design and research combined with retirement has placed him in a good position to contribute to the revision of the structural Standards.

The Process

Initiate and Plan

New projects to develop, amend or revise Standards are initiated after wide consultation. Standards NZ works with sponsors and interested parties to clearly define the problem or opportunity and identify the need for a Standard. For example, the Accident Compensation Corporation and Sport & Recreation New Zealand met with Standards NZ to discuss risk management gaps in the recreation industry, which initiated the very successful Risk Management in Sport and Recreation Guidelines, published in 2004. A clear and simple statement is developed at the beginning of projects to describe the objective and scope, what will be developed, who will use it, and the benefits it will provide.

Development

Standards NZ approaches relevant organisations to nominate committee members. Committees develop Standards by discussing and agreeing on content. Often proposed content is prepared by individual committee members as a starting point for the committee to consider. During the development stage, committee members refine and elaborate on the draft Standard. This process occurs during meetings but also through conference calls, working groups, or by individuals working on specific sections of the document.

Standards development committees are driven by a consensus-based approach. The overall goal is to ensure that all committee members agree that the Standard will achieve the outcome it was designed to achieve.

Public Comment

Once the committee has agreed on the draft Standard, the public can submit comments during a widely advertised public comment

period. The 2005 public comment period for the revised Automatic fire sprinkler Standard resulted in 1,000 comments, from minor edits to significant recommended changes. The committee carefully considers all comments, and agreed changes are made.

Consensus

Consensus involves collaborative problem-solving and debate to reach a generally-accepted solution. The credibility and effectiveness of a Standard is a result of the content being agreed to by all key parties affected by it. The committee, under the leadership of the Standards NZ project manager, will make every attempt to achieve consensus. Full consensus is almost always achieved, but in rare circumstances a Standard may be published without 100% positive votes, provided at least 80% are positive.

Standards Council Approval

All documents require final approval from the Standards Council, which is responsible for ensuring that the Standards development process has been independent, balanced and consensus-based.

Publication and Promotion

The published Standard is available in electronic or hardcopy format. Standards can be purchased online, by e mail or phone, or through the online Subscription Service, which automatically updates revised Standards. New Standards are promoted throughout the sector to ensure the benefits are enjoyed as widely as possible.

Committee member
Karen Davis

Karen Davis was the first Infection Control Nurse to achieve Nurse Clinician status with the New Zealand Nurses Organisation (NZNO) in 1998.

Karen chaired the Infection Control Standard committee in 1999, and is currently chairing the committee responsible for reviewing this Standard. She also chaired the Infection Control Audit Tool (P 8150) committee, and was a valuable member of the Processing of Endoscopes (P 8149) committee.

Karen applies practical experience and academic research skills to Standards committees. She is always well prepared, and refers to national and international research. Karen is a clear communicator, and is professional and generous in sharing her knowledge, skills and time.

"Participating in the development of Standards can be challenging but also fun," says Karen. "Standards help to promote accepted good practice. They also help individuals and workplaces to realistically assess where they are positioned in relation to their competitors, and they can also help consumers make decisions. You can certainly make a valuable contribution to your sector and to society as a whole by participating in Standards committees."

Committee member

John Stark

John Stark has made a significant contribution to Standards, industry and government.

He represented New Zealand on the joint Australia New Zealand Pressure Equipment committee (ME-001) for nearly 20 years, chairing the committee for three years. He was a member of the Qualification tests for metal arc welders (4711) committee for 15 years, and put in a huge amount of work on the New Zealand Standard to match ISO 16528 on boilers and pressure vessels. He also represented Standards NZ on ISO committees and working committees.

As Chair of the Joint Pressure Equipment committee, he had the challenging task of achieving consensus among widely differing viewpoints.

"Contributing to the safety components of Standards is a top priority," says John. "It's important to prepare well for meetings and solve problems methodically."

International Standards

It is only possible to ensure that international and joint Standards are suitable for use in this country when New Zealand participates in their development.

Standards NZ is a member of the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC). Standards NZ will continue to encourage and nominate New Zealanders to stand on international and joint Standards committees.

Achieving appropriate representation on joint and international Standards committees can be challenging, as there are often only one or two New Zealanders willing to participate. Standards NZ works hard to identify appropriate representatives and encourage them to actively participate for the good of all New Zealanders.

Australasian (Joint) Standards

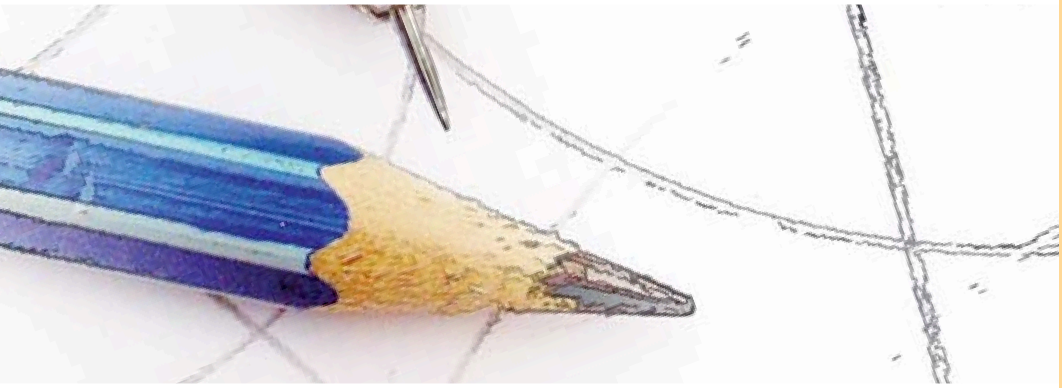
A Memorandum of Understanding between Standards New Zealand and Standards Australia ensures the continued development of joint (or Australasian) Standards and focuses on facilitating trade.

Joint Standards projects managed by Standards Australia may at times involve some differences in the process, but the same overall principles apply.

In addition to the usual benefits of Standards, joint Australian/New Zealand Standards help to:

- Remove technical barriers to trans-Tasman trade.
- Improve quality and efficiency through shared resources.
- Remove barriers to international trade with a shared commitment to align with internationally recognised Standards.

Funding



Standards NZ is a not-for-profit, self funded Crown entity. We do not receive direct funding from government. The cost of developing Standards is therefore spread widely amongst those who sponsor the Standards development process, contribute 'in kind' as committee members, purchase the documents, pay membership fees and attend seminars.

The 'in kind' contributions from organisations that sponsor committee members, and committee members themselves, are especially valuable. This contribution involves time and expert knowledge. It enables the development of Standards to continue, which ultimately benefits all New Zealanders.

The costs of travel, accommodation and time spent attending committee meetings are typically met by committee members, their employers or nominating organisations.

Committee member

Reg Darrough

Reginald Darrough has made a valuable contribution to 13 Standards committees, which all enhance safety and quality.

Reg's vast involvement includes: 30 years participation and 20 years as Chair for *Safety of electronic equipment* (TE-001); 20 years as Chair for *Microwave oven performance* (EL-015-8); Chair since 1988 for *In-service testing and inspection of electrical equipment* (EL-036); 30 years participation in *Safety of household and similar electrical appliances* (EL-002); and 25 years participation in *Fire hazard testing* (EL-002-10).

"I enjoy imparting the fundamentals of the committee's thinking behind those wonderful words of wisdom within the Standard," says Reg.

"I can say with a great deal of pride and personal satisfaction, that from the past 30 years of involvement within the Standards arena, and having represented Australia and attended meetings in many countries, I am contributing to the Standards family and paying back for the original training given to me by my mentors of yesterday," says Reg.

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APPENDIX C

Overview of the history of New Zealand loading Standards

OVERVIEW TIMELINE OF NEW ZEALAND STANDARDS RELATING TO DETERMINATION OF LOADS AND METHODS OF DETERMINING LOADS

Compiled by Standards New Zealand 2011

1935

N.Z.S.S 95:1935 Model building bylaw

Part IV – Basic loads to be used in design and methods of application

1939

N.Z.S.S 95:1939 Model building bylaw

Part IV – Basic loads to be used in design and methods of application

Supplement added in 1951

Amended in 1951 & 1953

1955

N.Z.S.S 95:1955 Model building bylaw

Part IV – Basic loads to be used in design and methods of application

Amended in 1956, 1961, and twice in 1962

1965

NZS 1900:1965 Model building bylaw

Part 8 – Basic design loads

Amended twice in 1966 and again in 1970

1976

NZS 1900:1976 Model building bylaw

Part 8 – Basic design loads

NZS 4203:1976 General structural design and design loadings for buildings

Amended in 1977 and 1979

1984

NZS 4203:1984 General structural design and design loadings for buildings

Reprint of the 1976 edition incorporating amendments

Further changes also included in 1984

An erratum was published in 1985

1992

NZS 4203:1992 General structural design and design loadings for buildings

2002

AS/NZS 1170:2002 Part 0

Structural design actions

AS/NZS 1170:2002 Part 1

Structural design actions

Permanent, imposed and other actions

AS/NZS 1170:2002 Part 2

Structural design actions

Wind actions

Commentary supplements published

Part 0 amended twice in 2003

Part 1 amended in 2005 and 2009

2003

AS/NZS 1170:2003 Part 3

Structural design actions

Snow and ice actions

Commentary supplement published

Part 3 amended in 2007

2004

NZS 1170:2004 Part 5

Structural design actions

Earthquake actions New Zealand

Commentary supplement published

2011

AS/NZS 1170:2011 Part 2

Structural design actions

Wind actions

Limited revision of the 2002 edition

1935–1984: Voluntary adoption and implementation by local authorities including boroughs, town boards, and counties

1992: Referenced* 1992

2002–2004: Referenced* 2008

2011: Not referenced

*Rerenced within the compliance documents of the NZBC

APPENDIX D

The NZS 1170.5:2004 development process

Development history of NZS 1170.5:2004

Structural design actions – Earthquake actions – New Zealand

Prepared for the Royal Commission of Inquiry into the Building Failure Caused by the Canterbury Earthquakes

Initiation

The project to develop a joint Australia/New Zealand Earthquake Actions (also known as the Earthquake Loadings) Standard was initiated following the publication of the Strategy for Preparing Joint Australian/New Zealand Structural Standards in or around 1995.

The strategy emerged from the Active Co-operation Agreement between Standards New Zealand and Standards Australia dated 1 May 1992, which provided a basis for joint preparation and marketing of Standards in line with the objectives of the Closer Economic Relations (CER) agreement. It was prepared jointly for the Structures and Contracts Joint Standards Advisory Committee of Standards New Zealand and Standards Australia, in the recognition that a joint earthquake loading standard was an important test of the new trans-Tasman approach.

The Joint Technical Committee BD/6/4 'Earthquake Loads' first met in Melbourne in November 1995, and agreed to a new joint Australian/New Zealand Earthquake Loading Standards which could be the basis of regional Standards. Standards Australia was assigned secretarial responsibility for the general provisions, dead and live load provisions, wind load provisions and the snow load provisions, while Standards New Zealand was assigned responsibility for the earthquake loading provisions.

With the agreement of the then Building Industry Authority ('BIA') in New Zealand and its Australian equivalent, the Standard was to be developed in a format that allowed it to be cited as a means of compliance with the building codes of both countries without amendment.

In the case of the loading Standards, their development between 1991 and 2004 was subject to guidelines promoted by the BIA that included requirements such as 'It is preferable to clarify what is sufficient to just comply with the NZBC…' and that it '… needs to contain information only on what is the minimum for Building Code compliance.'

These directives steered the committee away from providing a best solution towards providing a minimum set of requirements.

The requirement 'be specific and prescribe what is required clearly and fully' within the agreement between BIA and Standards New Zealand meant that descriptions of methodologies could not be included in the Standard if they left some aspects to the designer's informed decision.

As King and Jury reported to the New Zealand Society for Earthquake Engineering Conference in 2001:

'The standard is to be cited as a verification method in the Building Codes in each country. A verification method is intended to define a minimum standard and not necessarily best practice. It is also intended that a verification method define a standard that can be reproduced by all designers. This is a departure from the situation that has prevailed in New Zealand in the past where the earthquake loadings standard has attempted to convey best practice and has provided guidance on the use of a number of design techniques that have not always been well defined.'

Working groups

The following working groups were then established to develop drafting briefs for the various parts of the Standard.

Working Group 1	Elastic response spectra
Working Group 2	Seismic zonation systems
Working Group 3	Soil modification effects
Working Group 4	Levels of design
Working Group 5	Inelastic structural response
Working Group 6	Structural regularity
Working Group 7	Methods of analysis
Working Group 8	Deformation controls
Working Group 9	Seismic response of building parts and components
Working Group 10	Codification of displacement-based design.

It was the intention to involve as many of those who could provide relevant input to both ensure complete coverage of available knowledge and to help ensure acceptance of the outcome.

The joint Standards development procedures required that members of Standards Technical Committees and Subcommittees be nominated by a nationally representative body.

Members of the working groups could be appointed or coopted without the need for such a national nominating organisation.

The membership of the subcommittee and working groups varied over time, but the table below is a snapshot of the memberships at 11 June 1999.

Name	Country	Address	Nominating organisation	Committee
Dr J Berrill	New Zealand	I of Civil Engineering University of Canterbury		WG 3
Mr I Billings	New Zealand	Beca Carter Hollings and Ferner		WG 4
Mr B Boyce	Australia		AEES	BD/6/4
Mr I Brewer	New Zealand	Standards New Zealand	Standards New Zealand	BD/6/4, WG 1 – 10
Mr S Matthews	Australia		The Association of Consulting Engineers Australia	BD/6/4
Mr D K Bull	New Zealand	Holmes Consulting Group	IPENZ	BD/6/4
Dr A Carr	New Zealand	Department of Civil Engineering University of Canterbury		WG 7
Mr C Clifton	New Zealand	HERA	HERA	BD/6, BD/6/4 WG 5
Dr B Davidson	New Zealand	CaRE University of Auckland		WG 9
Mr D Dowrick	New Zealand	IGNS	IPENZ	BD/6, BD/6/4 WG 1, 2, 3
Prof R C Fenwick	New Zealand	CaRE University of Auckland		BD/6, WG 6, 8
Mr G Gibson	Australia	Seismology Centre	Seismology Centre	BD/6/4 WG1,2, 3
Mr P Gow	Australia	Building Management Authority of WA	Department of Local Government WA	BD/6/4
Dr M Griffith	Australia	Department of Civil and Environmental Engineering University of Adelaide	University of Adelaide	BD/6, BD/6/4 WG 5, 8, 10
Mr J Hare	New Zealand	Holmes Consulting Group		WG 9
Mr G Horoschun	Australia		Australian Construction Services, Department of Administrative Affairs	BD/6/4 WG 5, 9

Name	Country	Address	Nominating organisation	Committee
Prof G L Hutchinson	Australia	Department of Civil & Environmental Engineering, University of Melbourne	University of Melbourne	BD/6, BD/6/4 WG 6
Prof M Irvine	Australia	Structural Mechanics and Dynamics		WG 7
Mr Adrian Jones	Australia	Connell Wagner	Institution of Engineers Australia	BD/6/4, WG 4, 8
Mr R Jury	New Zealand	BECA	IPENZ	BD/6, BD/6/4, WG 5
Mr A King	New Zealand	BRANZ	Building Research Association of New Zealand	BD/6, BD/6/4 WG 1- 10
Dr N Lam	Australia	University of Melbourne, Department of Civil & Environmental Engineering		WG 6, 9
Dr J Loke	Australia	Department of Public Works and Services NSW	Department of Public Works and Services NSW	BD/6/4
Mr D Love	Australia	Mines and Energy, South Australia	Mines and Energy, South Australia	BD/6/4
Dr T Matuschka	New Zealand	Engineering Geology Ltd		WG 3
Mr K McCue	Australia	Australian Geological Survey Organisation	Australian Geological Survey Organisation	BD/6/4 WG 1, 2, 3
Dr Graeme H McVerry	New Zealand	IGNS		WG 1, 2, 3
Prof P J Moss	New Zealand	Department of Civil Engineering University of Canterbury		BD/6, WG 6, 8
Dr Arthur O'Leary	New Zealand		NZNSEE	BD/6/4, WG 10
Professor M Pender	New Zealand	CaRE University of Auckland		WG 3
Dr Lam Pham	Australia	CSIRO – DBCE	CSIRO – Division of Building, Construction & Engineering	BD/6, BD/6/4 WG 4, 5

Name	Country	Address	Nominating organisation	Committee
Mr R J Potter	Australia	Cement & Concrete Association of Australia	Cement & Concrete Association of Australia	BD/6, BD/6/4 WG 4
Professor H Poulos	Australia	Coffey and Partners		WG 3
Professor N Priestley	New Zealand	Department of Civil Engineering University of Canterbury		WG 10
Mr T Robertson	New Zealand	Kingston Morrison		WG 9
Mr L Robinson	New Zealand	Hadley and Robinson		WG 5, 7, 10
Mr P Sanders	Australia	Steel Reinforcement Institute of Australia	Steel Reinforcement Institute of Australia	BD/6/4 WG 4, 5, 9
Mr G K Sidwell	New Zealand	Connell Wagner		WG 7
Dr M Somerville	Australia	Australian Geological Survey Organisation	Australian Geological Survey Organisation	WG 1, 2
Mr T Twyman	Australia	ABCB	Australian Building Codes Board	BD/6, BD/6/4
Mr R Weller	Australia	Standards Australia	Standards Australia	BD/6, BD/6/4 WG 1 -10
Mr J L Wilson	Australia	Department of Civil & Environmental Engineering, University of Melbourne	University of Melbourne	WG 4, 5, 6

Standard development

The role of the working groups was to prepare detailed drafting statements, which were then developed into a draft of the complete Standard under a contract with Beca Carter Hollings and Ferner starting in August 1999. The Joint Technical Committee considered an initial draft in October 1999.

The Committee also considered a companion commentary volume providing background, explanations, references, and approaches to be used when applying the Standard. This volume was not designed to be developed as a compliance document and, as such, was not required to undergo the same rigorous public comment process. Nevertheless in this case it was made available and had the support of the Technical Committee before publication.

Public comment

The draft Standard was initially advertised for public comment from 17 November 2000 to 16 February 2001. The period was then extended to April 2001 at the request of commentators. A total of 481 comments were received on the draft Standard, running to 122 pages. A total of 78 comments were received on the commentary, running to 19 pages.

Further development and publication

Due to the substantial changes made to the draft from responses to these comments, a 'calibration' draft was sent to selected practitioners from March to May 2002 to elicit further comment. Comments received were considered in further draft development.

The public comment process raised two major issues of contention. The first, which related to the situation in New Zealand, was the limitation in the scope of the Standard because of the need to comply with the BIA's stipulation that only procedures that were specific and complete should be included. This had resulted in the omission of a number of accepted design and analysis methods that required the application of engineering judgement. The approach provoked criticism in the public comment process and in other forums (King*, McVerry, Fenwick, Bull, O'Leary, Jury, Clifton, and Brewer*. 2004).

The second issue arose from the extreme ranges of earthquake risk from areas of Australia (where the earthquake risk is low to negligible) to New Zealand (where the Alpine Fault presents among the world's highest earthquake risk). This made the layout of the draft more complex that its predecessors. Capacity design was needed for New Zealanders to deal with high levels of seismic actions but was considered a method not needed nor well understood in Australia.

The latter issue proved irreconcilable, and in August 2003 Standards Australia decided to withdraw from the process. Standards New Zealand and Standards Australia agreed that AS 1170 Part 4 would be an amendment to AS 1170.4-1990 for use in Australia, with the revised New Zealand-only Earthquake actions part being designated NZS 1170.5.

Following this development, Professor Peter Moss of Canterbury University was coopted onto the Committee in August 2003 as technical editor, and substantially rewrote the Standard into close to its current form. Development continued through a succession of drafts until a postal ballot of members recommended publication of the Standard for which approval was given by the Standards Council on 21 December 2004.

The completed Standard excluded the simplified methods that had only been applicable to Australia, and (in response to the criticisms of the BIA's limitation) included a number of methods requiring engineering judgement. This resulted in the Department of Building and Housing (which had by this time succeeded the BIA) accepting the Standard for use for compliance purposes only by a suitably qualified and experienced engineer.

The following were the New Zealand Subcommittee members at the time the Standard was published:

- Mr Andrew King (Chair)
- Prof Des Bull
- Mr Charles Clifton
- Dr David Dowrick
- Mr Rob Jury
- Dr Graeme McVerry
- Prof Peter Moss
- Dr Arthur O'Leary

References

King, A. B., Jury, R. D. (2001) *Future Earthquake Loadings Standards*, New Zealand Society for Earthquake Engineering Conference Proceedings. http://db.nzsee.org.nz/2001/papers/60101paper.pdf

King, A., McVerry, G., Fenwick, R., Bull, D., O'Leary, A.D., Jury, R., Clifton, C., Brewer I., (2004) *Where is that new loadings Standard?* New Zealand Society for Earthquake Engineering Conference Proceedings. http://db.nzsee.org.nz/2004/Paper18.pdf]

APPENDIX E

New Zealand Construction Industry Council 2009 submission on the Building Act 2004 Review

CONSTRUCTION INDUSTRY COUNCIL CIC

REVIEW OF BUILDING ACT 2004

Introduction

The Construction Industry Council[1] (CIC) wishes to make representations to the Department of Building and Housing (DBH) in relation to the Building Act Review (BAR) as announced by the Hon Maurice Williamson, Minister for Building and Construction on 27 August 2009.[2]

We know that the review process is non-public at this point of time, but having discussed the opportunity to make a submission with senior officials at DBH, it was mutually agreed that it would be constructive and worthwhile for the CIC to table our position(s) – if only to act as a sounding board at this stage of the review process.

We should note that all CIC members are naturally very interested in the BAR exercise, and will undoubtedly express their own views on the BAR as and when they consider appropriate. We believe, however, that in this stage of the process there is considerable merit in us tabling this CIC view on the BAR – even while acknowledging that there is much more input and discussion still to go as the review process continues, and that the position of the CIC (and its members for that matter) is more than likely to evolve and change over time.

We therefore very much appreciate the opportunity to present this submission, and look forward to further dialogue with DBH on the points we have made and the next steps of the BAR.

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[1] The New Zealand Construction Industry Council is a non-governmental organisation promoting the interests of the broader construction industry to central Government, and a listing of our membership is attached as Appendix 1.

[2] A summary of the Terms of Reference of the Review are in Appendix 2.

Executive Summary

The general starting point for the CIC's approach to the BAR is that the Building Act 2004 (the Act), as a response to the leaky building crisis that preceded it, was a highly regulatory intervention. That intervention, coupled with the conservatism adopted by BCAs in response to the risks they faced and the industry's own response to leaky buildings, has resulted in a higher initial cost structure, unknown lifecycle costs, inconsistencies in the application of the consent and compliance process around the country and has inhibited industry productivity and innovation.

It could well be argued that some of those effects were/are acceptable because they have – anecdotally at least – resulted in a lift in quality across the industry. Unfortunately, there is no ready measuring of industry quality such that we can properly assess the cost/benefit of the policy interventions as contained in the 2004 Act – nor how we can assess the cost/benefit of future changes. The CIC recommends that a proper analytical study is done of the 'building and construction industry value chain' and how it works and optimally should work, such that future cost/benefit analyses can be done with a measure of certainty and accuracy.

Despite the lack of empirical quality/outcomes data, there remains a broader view in the industry that the level of regulation is higher than it should be – and therefore the BAR is a timely opportunity to redesign the regulatory framework to encourage productivity improvement, reduce costs and smooth out administrative pathways.

Much of the detailed submission that follows, therefore, focuses on the re-design of that regulatory framework, to ensure an optimal working environment for the building and construction industry.

Much of our focus is also on where risk – and the associated potential liability – should fall within the various components of the industry. A fundamental shift is required to ensure a more appropriate balancing of risk and liability.

Building Regulations

We consider that more detailed consideration should be given to the approach to regulatory intervention in the building and construction sector.

We recommend that Government and DBH work with industry stakeholders to develop a more staged "intervention model" – which would help identify the most appropriate level of regulatory intervention that should be implemented to address an identified issue, rather than DBH reverting to a high regulatory approach on every occasion.

We consider that there is a need to maintain a correct balance between regulator-developed compliance documents and consensus-based industry standards, guidelines and best practice documents.

We support a risk-based framework for product and systems assurance which aligns the methodology with the level of risk associated with use of the product.

We encourage a stronger focus on industry-driven quality assurance to encourage and imbed improvements within the industry.

Allocation of Risk & Liability

We consider that serious consideration should be given to changing the current legal framework from one of “joint and several liability” to one of “proportional liability”, which more appropriately recognises each party’s contribution to defects. We appreciate that this is a fundamental legal shift for New Zealand (although it has been implemented successfully in other jurisdictions), and therefore suggest that this matter be referred to the Law Commission for review, with a view to seeing a proportional liability framework introduced within 5 years.

We support the proposal that consumers should be protected by warranties for defects in building work, including design, for a period of 10 years i.e. aligned to the implied warranties of the Act. Such warranties should be provided from all parties involved to provide seamless protection – designers, builders, specialist contractors, material manufacturers, etc – and be backed by insurance.

We would be prepared to be involved with the design of a suitable warranty scheme(s).

We consider that licensing/registration of building practitioners is fundamental to the provision of a warranty scheme backed by insurance coverage.

Streamlining Administration of Building Consent/Compliance Monitoring

We consider that since the implementation of the provisions of the 2004 Act providing for the accreditation and registration of Building Consent Authorities (BCAs), that timeframes for processing of building consents have lengthened unduly; and that inconsistencies in approach to the processing of alternative solution building products have added significant costs to the materials supply chain.

We recommend stronger monitoring of and transparency around BCA consent processing timeframes.

A primary issue affecting consent processing consistency and certainty has been conservative and risk-averse behaviour by BCAs – which in part is understandable given the ‘last-man-standing’ risk(s) that they face.

We consider it worthwhile to explore the concept of a single agency to provide building control functions nationwide through a network of local offices. Such a **National Building Consent & Compliance Authority** would:

- Ensure consistent interpretation of the Building Code;
- Provide uniform processes and procedures for building consents and compliance monitoring;
- Allow for volume builders to obtain national multiple-use consents (foundations excluded);
- Good use of limited suitably qualified building consent officers
- Provide for the implementation of smart technologies on a nationwide basis, thus avoiding unnecessary duplication.

Streamlining Building Consents/Compliance Processes
We submit that the procedures for varying/amending the design of a consented building must be simplified.

We also consider that the shift introduced in the Act in 2004 – namely that the design needs to be in compliance with the NZ Building Code, and that the building needs to be in compliance with the consent – needs to be reviewed to ensure it is not creating unintended consequences. The underlying principle behind this shift in the 2004 Act is appreciated – namely that a greater emphasis was required on the quality of the building design to be consented – but we consider a brief review, if only to confirm the status quo, has merit.

We endorse the proposal within the review of the Resource Management Act 1991 that the management of building consents and resource consents be better integrated to streamline the issue of consents for new buildings.

Protecting the Consumer
We consider that the Licensed Building Practitioners (LBP) Scheme is an important element of consumer protection which must be related to definitions of “restricted building work”. We consider that the continued licensing of practitioners must be dependent on demonstration of current competency.

We believe that much more can be done to now promote public awareness of the LBP Scheme, how to access the Register and the complaints and disciplinary processes. We consider that widening of the Building Practitioners’ Board’s (BPB’s) role and functions might be helpful in allowing it to provide an overall responsibility for the LBP Scheme.

We consider that DBH should start exploring under what criteria it would consider transferring the administration of the LBP Scheme to the industry, so that, where appropriate and with the right protections, industry can self-manage the licensing process under a suitable statutory framework.

We continue to believe in the value of the licensed practitioner scheme in, over time, providing a valuable pathway to a better skilled industry, and therefore will support continued implementation and refinement of the scheme to deliver optimal industry – and consumer – benefit.

Incentives for Building Practitioners
We recommend that the form of certificate/ memorandum required for restricted building work under s.88 of the Act be developed in consultation with practitioners and the BPB.

We consider that robust licensing/registration schemes for building practitioners complemented by disciplinary procedures should provide a pathway towards:

- More expeditious and less costly consent processing;
- Recognition of licensing/registration as a quality mark;
- Reduced costs of monitoring construction (fewer inspections);
- Self-certification, where appropriate and with the right supporting procedures and safeguards, of certain types and/or elements of construction;
- Implementation of a building warranty scheme underwritten by insurers.

The imperative for the licensing of building practitioners to work effectively is the introduction of "restricted building work" and the requirement that this be performed by a LBP. We note that it is the Government's intention to implement this policy from March 2012 – however, we believe an earlier date is preferable, and we are willing to assist in developing the detailed concepts of this policy.

Use of "Smart" Technology
We consider that the adoption of new technology has the potential to reduce the time and cost of building consents and compliance monitoring. Ideally a single technology solution should be implemented across the country which would facilitate the implementation of national multiple-use consents.

Matters Outside Terms of Reference for the Review
We recommend that the BAR include the governance and accountability arrangements relating to the collection and use of the building levy under s.53 of BA04.

Detailed Submission

Background to Building Act 2004 (BA04)

The Hunn Report[3] into weather tightness in 2002 identified systemic failure of weather tightness of buildings. It stated that weather tightness failures were due to either deficiencies in the (1991) Building Act and Regulations or the way they were administered.

The (then) Government's response to the Hunn report was to review the 1991 Building Act and replace it with the Building Act 2004. The 2004 reforms were aimed at:

- Improving performance of the building and construction sector; and
- Providing better protection for consumers.

There were 5 main policies in the 2004 Act to achieve these aims:

- Review of the Building Code;
- Accreditation and Registration of BCAs;
- Product certification Scheme;
- Licensing of Building Practitioners; and
- Introduction of statutory implied warranties for consumer protection.

What has happened?

At the present time, we understand that there is no evidence which can identify whether these measures have addressed the problems they were intended to resolve. We understand that DBH is unable to say with certainty if the problems of "leaky buildings" has been resolved and, if not, the size of the problem that remains. We believe more empirical analysis and data to clarify and then monitor the actual 'quality position' of the industry is critical – both to inform Government policy but also to drive industry self-awareness and strategy.

The Building Code (BC) has been reviewed, but no fundamental changes have been made to its structure or content – as perhaps was first envisaged when the BC review was first being worked through. We consider that there is scope to further refine the BC and to make greater use of NZ Standards and industry guidelines and best practice documents. (See later comments).

While the accreditation and registration of BCAs has improved their processes and procedures (via better consistency and standardization), it has also resulted in unintended consequences of delays in processing and risk-averse behavior. We consider that the performance of some BCAs remains a matter of concern and needs addressing. (See later comments).

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[3] Hunn D, Bond I & Kernohan D, (August 2002); *"Report of Overview Group on Weather tightness of Buildings in New Zealand"*.

DBH has published updated information on the introduction and workings of the new building product certification scheme (Code Mark) as required under the 2004 Act. It appears this can be made a workable model for a particular part of the product assurance spectrum. However, outstanding issues remain to be resolved in the wider product assurance area, and we are aware that the industry is continuing to work with DBH on these.

While the licensing of building practitioners has been implemented, the uptake has been significantly lower than anticipated – essentially because aspects of the scheme's design were initially flawed eg the application of the scheme to DIYers. These now appear to have been remedied, so it is now appropriate for DBH to work with the industry to fully focus on licensing uptake. Sufficient incentives and imperatives to licensing have been lacking to date. There is a need to implement the "restricted building work" provisions of the Act as soon as possible.

Overall, CIC considers that the BAR must seek to resolve current shortcomings in the policy implementation embodied in the 2004 Act, addressing the matters identified in the Hunn Report. We need to address the right systemic failures and re-design the regulatory framework so it best optimizes the industry response to deliver quality buildings while appropriately managing risk – and so the Hunn Report should always provide a useful 'touchstone' on the previous systemic failures that we have been looking to fix in the last 7 years or so.

<u>Scope of CIC's representations</u>
These representations from CIC are structured as follows:

1. Building Regulations.
2. Allocation of Risk and Liability.
3. Streamlining Administration of building consent/compliance monitoring.
4. Streamlining building consents/compliance processes.
5. Protecting the Consumer.
6. Incentives for Building Practitioners.
7. Matters outside the Terms of Reference of the Review.

1. <u>Building Regulations</u>

1.1 CIC considers that more detailed consideration should be given to the approach to regulatory intervention in the building and construction sector. When an issue is identified, there should be broadly based consideration of the form of intervention that is appropriate to resolve the issue based on the principle that the minimum level of intervention necessary to address the issue be used.

Ultimately, the level of intervention can be upgraded if required, but in general *"a sledge hammer should not be used to crack a nut"*.

CIC supports the Government Statement on regulation (August 2009):

> *"We will introduce new regulation only when we are satisfied that it is required, reasonable and robust".*

1.2 In considering a regulatory response to an identified issue, Government has available to it a range of possible options:

- No action;
- Non-regulatory solutions;
- Self-regulation by the Sector (eg industry or sector developed voluntary standards);
- Quasi-regulation (eg standards endorsed by Government);
- Co-regulation (eg mandatory standards cited in regulations);
- Direct regulation.

1.3 CIC recommends that Government and DBH work with industry stakeholders to develop an "intervention model" which would assist in identifying the most appropriate level of regulatory intervention that should be implemented to address an identified issue – and ensure a monitoring regime is implemented to check that the chosen intervention actually delivers the outcome being sought.

1.4 CIC has noted that the Review is seeking:

> *"Quality homes and buildings are produced through a business enabling and efficient regulatory framework".*[4]

It also noted that a means proposed to achieve this result is:

> *"Improving the alignment of the Building Code with NZ Standards"*.[5]

CIC submits that the current regulatory model which aligns the Building Act, Building Code, compliance documents and reference to NZ Standards is not fundamentally flawed. The "pyramid" structure of the building control framework does provide a robust conceptual model. Performance requirements are described in regulation, following prescriptive compliance documents provides one means of complying with the Building Code, but alternative solutions are possible, provided they demonstrate performance requirements are met.

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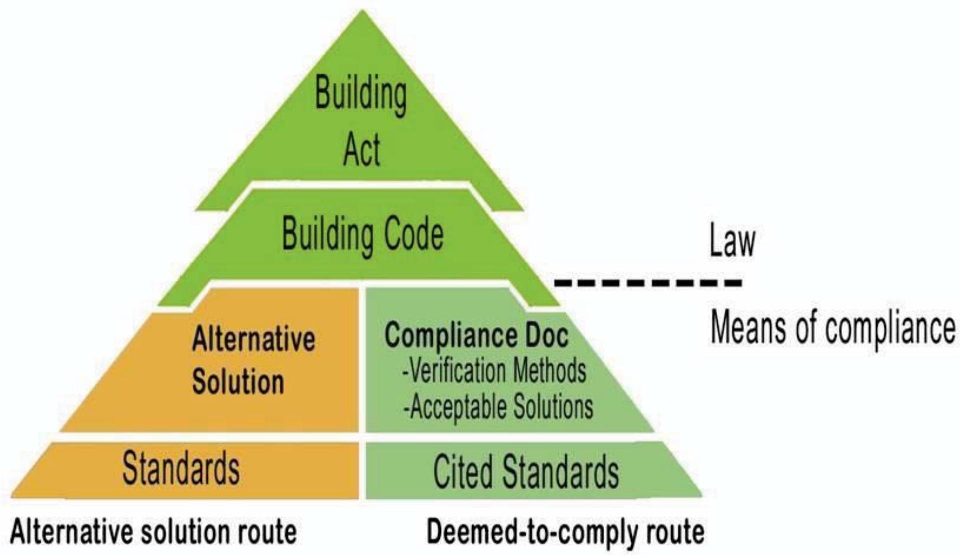
[4] Source: *"Review of the Building Act 2004: Terms of Reference"*, paragraph 7.
[5] Ibid. Refer sub-paragraph 7(c).

The hierarchy of compliance documents is shown in the following figure.



HIERARCHY OF COMPLIANCE DOCUMENTS

(Source: DBH – used by permission)

1.5 In its 2006 submission to the Government Standards and Conformance Infrastructure Review, CIC stated:

"Standards are critically important for the building and construction industry – they provide a level of certainty and consistency welcomed by practitioners".

At that time CIC noted its preference for a regulatory framework comprising –

- an overarching Building Code operating at a higher outcomes level;
- a coherent, comprehensive and up-to-date suite/portfolio of standards supporting the higher-level Building Code, providing the next level of detail;
- an appropriate mix of international standards, joint Australian/New Zealand Standards, and industry guidelines/best practice documents.

CIC maintains this view and considers that there is a need to maintain a correct balance between regulator-developed compliance documents and consensus-based industry standards, guidelines and best practice documents – provided the system works effectively and efficiently. There are current examples where this is not occurring eg BCAs are more readily approving building consents for an earth home under E2 – because an Acceptable Solution exists – and conversely Consents for concrete masonry homes are much harder to get.

This level of perverse outcome/behaviour needs to be reconciled and resolved.

1.6 The regulatory framework should, the CIC suggests, provide controls – or at minimum, transparency – around the imposition of Ministerial directions of content of the BC eg “shower heads” water consumption.

1.7 CIC notes that it is more economic for industry to develop guidelines and best practice documents than NZ Standards or Regulatory Industry documents, etc which are able to progressively evolve into consensus-based NZ Standards over time.

1.8 The funding of Standards development is a matter that CIC considers warrants discussion. There are substantial elements of “public good” in this work and consideration should be given to funding development of building standards from the building levy collected by DBH under s.53 of BA04. Similarly, mechanisms for improving access of building practitioners to Standards and other compliance documents should be considered.

1.9 We are in the unfortunate position that, since the announcement of the review of the BC in 2003/2004, there has been no real progress in sorting out the agreed relationship between the Code and Standards, and no real progress in reviewing the 600 or so directly and indirectly cited Standards. This ‘limbo’ phase has continued for far too long, and some concrete decisions need to be taken with urgency to properly sort out the BC/Standards connection(s), so that the industry can get the required consistency and certainty from having a clear “BC and associated standards/documents” framework and methodology.

1.10 CIC submits that an effective and robust product assurance framework is an essential element to achieving the outcomes sought by Government for buildings. The level of product (and system) assurance should be commensurate with the risk of the product/system used. A tiered system of assurance is favoured as risk increases:

Increasing risk ↓	• Product information – self-registration by manufacturer; • Product testing – basic “fit for purpose”; clarity of technical information and instructions for application and use; • Product/system Appraisals – extensive BC fit for purpose assessment; • Product certifications – from an appropriately accredited Product Certification Body.

This “risk framework” model allows manufacturers, designers, specifiers, builders and clients to align the relevant product assurance methodology with the appropriate level of risk, and is supported by the CIC.

The CIC considers that the regulator should set – or, at minimum, give good guidance as to – the ‘tier” of the framework that a building element must meet, and it should be the manufacturer’s obligation to satisfy the relevant information requirements associated with that tier.

2. Allocation of Risk & Liability

2.1 The current legal framework which applies to building and construction is one of joint and several liability. The parties involves in addition to the building owner are:

- Principal designer,
- Secondary designers,
- Project manager,
- Main contractor,
- Subcontractor,
- Building consent authority (BCA).

2.2 As a general principle of good construction management, risk should be allocated to the parties best able to manage it.

2.3 Currently, in the event of a building defect, the owner (which may be a subsequent owner, rather than the original) will seek redress from all the parties and leave it to the Courts to apportion liability. This has, in the past, proved to be problematic with many parties no longer in existence as legal entities (i.e. liquidated companies). Liability has fallen on those parties still in existence with sufficient financial resources to pay damages. This is often the BCA (often a territorial local authority) which is the “last man standing”. Such an outcome is not equitable to either owner or BCA as frequently the party/ies responsible have been able to avoid liability.

2.4 In order to redress the current situation, the CIC considers that there are two matters that need to be considered:

- Warranties for building owners, and
- The liability framework.

2.5 The provisions of s.396-399 of the Act – “Implied Terms of Contract” – are considered by CIC to be helpful, but are limited to the construction or sale of “household units”. S.393(2) provides a limitation period of 10 years for civil proceedings.

2.6 In the case of building work for other than household units (ie commercial work), the Act has a presumption that such contracts are between informed parties who have the benefit of professional advice and are therefore capable of agreeing appropriate commercial terms to protect their interests.

CIC is aware of very large amounts or residential construction work that is undertaken without any written contract. Some overseas jurisdictions have made it mandatory to have written contracts above a certain value. It may also be worth considering introducing statutory conditions of contracts as default clauses, for the protection of all parties, where there is no written contract in place.

2.7 CIC considers that serious consideration should be given to changing the current legal framework from one of joint and several liability to one of "proportional liability" which recognises each party's contribution to defects. CIC recognises that this is a highly complex matter that will take time to consider and to change and, therefore, suggests that this matter be referred to the Law Commission for review, with a view to seeing a proportional liability framework introduced as soon as practicable.

2.9 CIC also considers that consumers should be protected by warranties for defects in building work, including design, for a period of 10 years ie aligned to the implied warranties of the Act. Such warranties should be provided from all the key parties involved to provide seamless protection and backed by insurance. Consumers should be able to choose a warranty system, as they will bear the cost. The warranty should remain with building (ie transfer to any subsequent owners).

2.10 CIC would be prepared to be involved with the design of suitable warranty schemes, and will continue to do background work as considered appropriate to facilitate an optimal solution.

2.11 CIC considers that licensing/registration of building practitioners is fundamental to the provision of a warranty scheme backed by insurance coverage. Underwriters will require some confidence about the competency of the practitioners they are insuring.

3. Streamlining Administration of Building Consent/Compliance Monitoring

3.1 CIC considers that, since the implementation of the provisions of the Act providing for the accreditation and registration of BCAs, the timeframes for processing of building consents have lengthened unduly. The causes of this are multiple.

3.2 A primary issue has been conservative and risk-averse behavior by BCAs (particularly those who are local authorities), because they are ultimately liable for defects. The issues with joint and several liability have been discussed earlier and the potential for the local authority's BCA to be the "last man standing".

3.3 The CIC considers that conservative and risk-averse behavior by BCAs has been the result of several factors:

- The BCA accreditation processes which have emphasised the need for BCAs to implement rigorous policies, procedures and practices. While many of these constitute "good practice", it is possible that they have led to a bureaucratic and inflexible approach that has little regard for project risk and competence of building practitioners.
- Internal legal advice to BCAs which has resulted from Court precedents. Overly conservative practices have developed, irrespective of risk and competence of building practitioners, such as the refusal of many local authority BCAs to accept national competency registration, e.g. Chartered Professional Engineers, unless their competency has been assessed by the local authority. Refusal to accept "Producer Statements" is an example of such behaviour.
- Insurers' attitudes and policies have also been a significant contributor to risk-averse practices of BCAs. The recent withdrawal of the major insurer of local authorities (Risk Pool) from offering insurance for leaky buildings has only served to further exacerbate risk-averse behaviour by some BCAs.

3.4 Until the issue of joint and several liability and the BCAs position as "last man standing" has been addressed, it is unlikely the local authority BCAs will be less risk-averse.

Some members of the CIC consider that there should be sanctions for BCAs who do not perform their consent processing functions within the required statutory timeframes.

CIC does acknowledge a significant improvement in processing where some BCA's have adopted a front-end triage or vetting procedure, before consents applications are even accepted.

There remains, however, a lack of consistency amongst BCAs in relation to information requirements, documentation, interpretation of the BC, acceptance of Producer Statements (refer later) and administration of building control functions.

Suggested provisions for improvements include:

- Provision to extend the processing period by up to a maximum of 10 working days for specified reasons;
- Forfeiture of BCA's consent processing fee for delayed consents;
- Standardised consent application forms;
- Consistency of information requirements;
- Consistency of approach to "Certificates of Public Use";
- Introduction of a Building Ombudsman.

3.5 The CIC does not consider that it is the core business of local government to provide building consent and compliance issues. The purpose of local government is –

" (a) to enable democratic local decision-making and action by, and on behalf of, communities; and

(b) to promote the social, economic, environmental, and cultural well-being of communities, in the present and for the future."[6]

3.6 While it may be argued that administration of building consents and compliance monitoring may contribute to aspects of community well-being, the historical involvement of local authorities in these functions dates to a time when building controls were based on local by-laws, usually comprising the relevant NZ Standards.

3.7 It may be preferable that building consents and compliance is better administered by a national agency. The CIC has noted the Minister's encouragement of regional clustering of BCAs and, notwithstanding that this would be an improvement of the status quo, it suggests a more radical move.

3.8 The CIC encourages exploration of the concept of a single agency to provide building control functions nationwide through a network of local offices. Such a **National Building Consent & Compliance Authority** would:

- Ensure consistent interpretation of the Building Code;
- Provide uniform processes and procedures for building consents and compliance monitoring;
- Allow for volume builders to obtain national multiple-use consents (foundations excluded);
- Provide for the implementation of smart technologies on a nationwide basis, thus avoiding unnecessary duplication.

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[6] Local Government Act 2002, refer s.10.

4.5 The 2004 Act introduced a new approach to compliance with consented design. S.17 requires all building to comply with the NZ Building Code, but s.40 (1) requires that the building work must comply with the building consent. If economies are proposed during construction, these must be treated as an amendment under s.45 (5), and if a minor variation may be considered under s.45A (yet to come into force).

4.6 CIC submits that the procedures for varying/amending the design of a consented building must be simplified. It also considers that compliance with the NZ Building Code (not the consent), should be the fundamental test, and the CIC recommends that the BAR should address this matter, as it represents a potential for significant economies and innovation to be implemented more easily.

4.7 CIC understands from anecdotal advice that a large proportion of building consents are also subject to resource consents. Examples are earthworks, site stability, daylighting and building height. There is a need to ensure a seamless approach to both the building and resource consents. This issue will need to be considered if a National Building Consent & Compliance Agency is established, but also with national multiple-use consents and regional consenting agencies.

4.8 CIC recommends that the further review of the Resource Management Act 1991 should consider how the issue of building consents and resource consents may be better integrated to streamline the issue of consents for new buildings.

5. <u>Protecting the Consumer</u>

5.1 CIC considers that there is a need to ensure that the consumer who is a home owner (first or subsequent), has protection or assurance concerning the quality of building work, including renovations.

5.2 Commercial consumers are usually "informed purchasers" who exercise judgement and/or take professional advice when selecting designers and builders. They also usually ensure that the terms of contracts provide appropriate standards and warranties of performance.

5.3 The average "man-in-the-street" consumer is usually not so well informed. He/she places reliance on –

- The provisions of the Building Code, and
- The diligence of the BCA.

This has traditionally led to claims against the BCA when defects become evident, which has been discussed in section 2 of this submission.

3.9 If implemented, the CIC considers that the proposed national agency should be separate from DBH to allow the latter to retain the functions of policy advice, regulation and providing determinations currently provided for under BA04. The functions of the national agency would be delivery of services. Whether the national agency would be a Crown Entity, Crown Company or State-owned Enterprise, would require more detailed evaluation.

The national agency could enter into contracts with other parties for delivery of services in local areas, either on a general or specific basis. Such parties could be private companies or council-controlled organizations (CCOs).

4. <u>Streamlining Building Consents/Compliance Processes</u>

4.1 The risk-averse and conservative behaviours and practices of many BCAs have been referred to in section 3. CIC considers that the creation of a National Building Consent & Compliance Authority will provide a number of benefits –

- Consistency of interpretation of the building code;
- Uniform processes throughout the country;
- Economies of scale of a single agency with lower overheads;
- Potential for greater efficiency;
- Potential for single technological solution for lodgement of consents online.

4.2 Government actions have already provided improvements by expanding the scope of work, which does not require a building consent. Similarly, providing for standardised designs to be consented on a national multiple-use basis (foundations excepted) will provide significant benefits to the sector.

4.3 It has been well established by research that the maximum opportunity to achieve innovation, efficiency and economy in the building process occurs at the design phases. Experience has shown that the collaboration of designers and constructors is most likely to provide tangible benefits to building owners. This is evidenced by the behaviours of “smart purchasers”, usually commercial, utilising contractual arrangements such as “design-build” contracts, partnering value workshops and relationship contracts.

4.4 While a cultural paradigm shift by building owners is desirable, this will have only limited application to bespoke residential buildings. What is also needed is the ability for variations to design to be expeditiously implemented during construction to incorporate economies identified by builders.

5.4 CIC supports the implied warranties contained in BA04 for household construction (s.396-399), but these warranties required underwriting through insurance. This has been discussed in section 2.

5.5 Consumers also need protection to ensure that critical building work is performed by competent practitioners. CIC considers that the Licensed Building Practitioners (LBP) Scheme is an important element of consumer protection which must be related to definitions of "restricted building work". CIC considers that the continued licensing of practitioners must be dependent on demonstration of current competency.

5.6 Other building practitioners who are licensed and/or registered are:

- Chartered Professional Engineers;
- Registered Architects;
- Registered Plumbers and Gasfitters;
- Registered Electricians/Electrical Workers.

These classes of building practitioners have robust assessment schemes for registration and complaints and disciplinary procedures.

Other technical practitioners, such as "independently qualified persons" (IQPs) and Registered Engineering Associates, need to be subject to similar registration/complaints and disciplinary procedures as apply to LBPs.

Some CIC members consider that the Act should recognise other statutory registers.

CIC also considers that there may be some merit in better aligning the registration schemes like the CPENG model of additional registers for the technician and associate levels. There would then be four broad groups – ie Engineering, Arch/design, Construct, and BCA. It is acknowledged that such alignment would require consequential changes to Acts of Parliament other than Building Act 2004.

5.7 CIC considers that much more can be done to promote public awareness of the LBP Scheme, how to access the Register and the complaints and disciplinary processes. The CIC does note the recent advertising by DBH for a fixed term appointment to fill an "LBP scheme promotion" role, and this is welcomed.

5.8 The CIC notes that the Building Practitioners' Board (BPB) has closely defined functions in relation to the LBP Scheme, which do not provide for it to promote the scheme to the public. CIC considers that widening of the BPB role and functions might be helpful in allowing improved industry ownership of and buy-in to the LBP Scheme.

5.9 There has been some discussion about the possibility of Alternative Dispute mechanisms being introduced for building disputes, as is the case in some other jurisdictions. CIC is aware of significant moves within the legal system to streamline access to dispute resolution, including the raising of the Disputes Tribunal thresholds, improvements to District Court procedures, and proposals to streamline arbitration processes – all of which are all fully supported. CIC would recommend implementation of these proposed enhancements to existing processes and test how they are working, before moving to another entirely new system.

6. Incentives for Building Practitioners

6.1 The CIC supports the concept that the BAR should provide incentives for competent building practitioners who are licensed/registered. Such incentives may include:

- More expeditious processing of building consents which accepts "producer statements" from practitioners as a means of compliance;
- Public recognition of licensing/registration as a mark of quality;
- Self-certification of construction compliance;
- Recognition by underwriters of any home warranty insurance.

6.2 At the present time there are few, if any, incentives or imperatives for practitioners to be licensed/registered. In fact, little is known by the general public and many practitioners about the Licensed Building Practitioner Scheme. The need for public education has been referred to earlier and the current fragmentation of roles between the BPB and DBH, in relation to the Scheme should be reviewed.

CIC does acknowledge the recent consultation regarding streamlining of the LBP scheme and processes announced concurrently with the BAR. Many CIC members did make submissions on those proposals and have so far confirmed their commitment to promoting the system to their members once the final decisions post that consultation are announced/finalised.

6.3 Under the (now repealed) Building Act 1991, "Producer Statements" were a defined means of helping provide evidence of compliance with the BC to BCAs. They can be written by a wide range of building practitioners to cover design, design review, construction, construction review, installation and inspection of building work.

Under the 2004 Act, producer statements have no statutory status. Nevertheless, they remain in widespread use and can cover an extensive range of building activities.

Because they have no statutory status, the acceptance of producer statements is discretionary for BCAs. As a result, there is no standardised practice, but there is currently such a variation in the way that BCAs accept and/or rely on producer statements that there is a degree of confusion amongst practitioners. This confusion will be contributing to time and costs of compliance of building work.

BCAs should be able to rely upon statement from a licensed/registered building practitioner to assist them to reach a decision that the design and/or elements of the construction of a building complies with the requirements of the BC, a building consent or the Act.

Because of the current apportionment of liability for building defects (referred to earlier), many BCAs adopt a risk-averse approach to Producer Statements because there is no transfer of liability to the practitioner if a Producer Statement is accepted.

S.88 of the Act requires the LBP to certify or provide a memorandum about restricted building work. This document will replace producer statements. CIC recommends that the form of certificate/ memorandum required for restricted building work under s.88, be developed in consultation with practitioners and the BPB.

6.4 BCAs do not appear – most likely due to their perceived liability – to accord sufficient weight to the work of building practitioners who are licensed/registered, such as:

- Chartered Professional Engineers,
- Registered Architects,
- Licensed Building Practitioners,
- Registered Plumbers and Drainlayers.

Notwithstanding that Chartered Professional Engineers and Registered Architects are deemed to be LBPs – namely Design Class 3[7] – many BCAs also require designers to be accredited by the BCA as a pre-requisite to accepting their work without undertaking a peer review. This practice is adding time and cost to the consenting process, and is generally not adding any extra value, as the BCAs are ill-equipped to re-assess the competency of a practitioner who is already licensed/registered.

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[7] Refer Clause 6 of Building (Designation of Building Work Licence Classes) Order 2007.

Clearly, the root cause of such practices is the concern of BCAs that they may be held liable in the event of design defects and will be "last man standing". (Refer earlier comments).

6.5 CIC considers that robust licensing/registration schemes for building practitioners complemented by disciplinary procedures should provide a pathway towards:

- More expeditious and less costly consent processing;
- Recognition of licensing/registration as a quality mark;
- Reduced costs of monitoring construction (fewer inspections);
- Self-certification of construction;
- Implementation of a building warranty scheme underwritten by insurers.

6.6 CIC considers that under the present regulatory regime, there has been insufficient imperative for building practitioners to take up licensing. The uptake has been substantially lower than predicted, largely because of the uncertainty surrounding the future of the scheme. The Minister's announcements in August 2009 are welcomed by CIC, as they have removed that uncertainty.

6.7 Notwithstanding, the imperative for licensing of building practitioners, is the introduction of the "restricted building work" and the requirement that this be performed by a LBP. CIC notes that it is Government's intention to implement this policy from March 2012. Desirably, an earlier date would be preferred and CIC is willing to assist in developing the detailed concepts of this policy.

CIC would observe that there are already mechanisms within Schedule 1 of the Act to create incentives to encourage earlier uptake of licensing – for example, by allowing certain eligible work to be exempt from consenting requirements, if performed by LBPs.

7. <u>Use of "Smart" Technology</u>

7.1 CIC considers that new technology has the potential to reduce the time and cost of building consents and compliance monitoring. Significant capital investment is required for on-line systems to be implemented.

7.2 With more than 70 BCAs currently registered, there is a risk for unnecessary duplication of investment and different systems[8]. This will be counter-productive and a waste of scarce capital resources.

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[8] North Shore City Council has implemented the first on-line consent processing system.

Furthermore, differing systems could frustrate the use of national multiple-use consents proposed by the Government. Existing examples of the plethora of information systems implemented by local authorities includes financial systems, asset management systems and geographic information systems.

7.3 CIC considers that ideally a single technology solution should be implemented. It is known that DBH has been investigating such a solution. CIC considers that a National Consenting & Compliance Authority will provide the opportunity for application of technology solutions to be implemented across the whole country.

8. Matters Outside Terms of Reference for the Review

8.1 Although outside the published Terms of Reference of the Review, CIC wishes to raise the following matters for consideration:

- Application of the Building Levy;
- Dam Safety.

8.2 S.53 of the Act requires an applicant for a building consent to pay a levy (collected by the BCA) to the Chief Executive of DBH for the performance of functions under the Act. CIC considers that there is a lack of transparency concerning the level and use of this levy at the present time which needs to be addressed.

The levy should also be applied to "public good" elements of building and construction beyond the functions of DBH which may include:

- Research;
- Development of NZ Standards, industry guidelines and best practice documents;
- Access by building practitioners to compliance documents;
- Capital expenditure on smart technology solutions for national implementation.

CIC recommends that the BAR include the governance and accountability arrangements relating to the collection and use of the building levy under s.53 of the Act.

8.3 Some CIC members believe there is scope for a reconsideration of details of the Dam Safety Scheme[9] and the associated Regulations[10], with a view to implementing a more light-handed regulatory regime such as ISO 9001[11] or equivalent self-certifying approach.

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[9] Refer BA04, Subpart 7, s.133-168.
[10] Building (Dam Safety) Regulations 2008.
[11] AS/NZS ISO 9001:2008; *"Quality Management Systems – Requirements"*.

It has been noted that large corporate dam owners have concerns that regulation management processes already in place are having unintended consequences and there are inconsistent interpretations of the Act and Regulations.

Whilst the inclusion of dam safety within the framework of the Act is supported, it is considered that the special nature of dams should be recognised and treated in a different manner to buildings.

It is clear that the role of the regulatory authority should be to ensure that through the processes defined in the legislation and the subsequent regulations, owners have an adequate dam assurance regime in place and monitor ongoing compliance. Rather than judging the adequacy of any documentation, the regulator's role should be to assess whether sound processes have been implemented. It is, therefore, the role of the "recognised engineer"[12], rather than the regulator, to assess the adequacy and quality of these processes and documentation.

Concerns have also been raised over the role of Category A and B recognised engineers in determining the Potential Impact Classification (PIC) borderline between low and medium potential impact classification.

When passed in 2004 the Act contained clauses relating to dangerous and leaky dams. These clauses were amended in 2008 and the categories of dangerous, earthquake and flood-prone dams. In the case where a dam is not considered dangerous, but is considered "prone", the owner must inform the relevant regional council who can request the owner to review the Dam Safety Assurance Programme. However, there appears to be some concerns that these powers are not sufficient.

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[12] Refer BA04, s.149.

Concluding remarks

As noted at the beginning of this submission, the CIC very much appreciates the opportunity to present our current thinking and approach to DBH. We look forward to continued dialogue with DBH as the BAR progresses.

On behalf of the Construction Industry Council,

Pieter Burghout
Chairman
27 November 2009

APPENDIX 1

NZ CONSTRUCTION INDUSTRY COUNCIL CIC

MEMBERSHIP

Association of Consulting Engineers NZ

Building & Construction ITO

New Zealand Building Industry Federation

Certified Builders Association of NZ

Cement & Concrete Association of New Zealand

designers institute of new zealand

Fire Protection Association NZ

Heavy Engineering Research Assn

Institution of Professional Engineers NZ

National Association of Steel-Framed Housing Inc.

New Zealand Contractors' Federation

New Zealand Green Building Council

New Zealand Institute of Architects Incorporated

New Zealand Institute of Building Surveyors (Inc)

NZ Institute of Landscape Architects

New Zealand Institute of Building

NZIQS

Property Council New Zealand

Property Institute of New Zealand

Registered Master Builders Federation

Site Safe

Specialist Trade Contractors Federation

Wood Processors Association of New Zealand

ASSOCIATE MEMBERS

BRANZ

The NZ Centre for Advanced Engineering

InfraTrain New Zealand

OBSERVER MEMBERS

Department of Building and Housing
Te Tari Kaupapa Whare

NZ Building Trades Union

Standards New Zealand
Paerewa Aotearoa

APPENDIX 2

FOCUS OF BUILDING ACT REVIEW

The review will identify reforms to reduce costs, but not the quality of the building control system.

It will consider:

- *removing building regulation that adds costs, but is of little benefit;*
- *streamlining building consent requirements to reflect risk and complexity, including reducing the amount of work requiring a consent;*
- *improving the allocation of risk and liability across parties in the building and construction sector;*
- *providing consumers with more information about their rights and responsibilities and improved dispute resolution mechanisms;*
- *greater incentives for professional performance, including self-certification of licensed building practitioners' work (i.e. fewer inspections);*
- *streamlining administration of building regulation, including options for consenting processed to be carried out by groupings of councils;*
- *how the use of smart technology could improve consenting processes.*

(Source: Department of Building & Housing, August 2009)

GLOSSARY

CIC	Construction Industry Council
DBH	Department of Building & Housing
BCA	Building Consent Authority
BC	Building Code
BRANZ	Building Research Association NZ
LBP	Licensed Building Practitioner
BPB	Building Practitioners' Board
The Act	Building Act 2004

APPENDIX F

Structural Engineering Society of New Zealand letters to the editor

LETTERS TO THE EDITOR

9th April 2003

The Editor
SESOC Joumal

Dear Sir

RE: DRAFT LOADINGS STANDARD, PT. 4, EARTHQUAKE LOADING

Recently I read the first two thirds of draft 8 of this standard. It was released as a "calibration test version", so that a number of structural designers could assess the proposed code requirements against those in the existing code by considering recent structures that they had designed. This draft standard is intended to he close to the fmal version. On the basis of this reading I sent in a number of comments to Standards. Some of these were minor but a few were of major importance. Similar comments on several of the previous drafts have also been sent. Firstly I note that my comments, along with all the other individuals who have submitted comments, have not once been acknowledged. Secondly I note that many of the points that I have raised have been ignored, even when pointing out basic errors in equations. The process of producing a standard lacks transparency, and I believe it needs to be revised.

Three major points in my last submission to Standards are briefly outlined below:

1. For many structures, which include the group that resist seismic forces by moment resisting frames, the specified minimum design strengths are considerably smaller than the corresponding values found in major international codes of practice. These codes include the Uniform Building Code (UBC 1997), the International Building Code (IBC 2000) and Eurocode 8 (draft 2002) and many others which are based on these documents. Why are the minimum required strengths in New Zealand so much lower than the corresponding values in major international codes? Where is the published peer reviewed research showing that the rest of the world has it wrong? If the currently proposed low strengths cannot be justified by peer reviewed research why are they included in our draft standard?

2. Serviceability requirements are given in the code. In many cases the structural actions corresponding to the serviceability limit-state are appreciably greater than the corresponding actions for the ultimate limit-state. In some cases they are 50% higher. However, nowhere in the document is there a requirement to check the strength required to resist these actions. As a minimum some check is required for the serviceability strengths and some guidance needs to be given as to how such a check should be made. For example what should a designer use as a strength reduction factor? Should one use the value specified for the ultimate limit-state, or should it be 1, or some higher value to allow for mean material strengths rather than the lower characteristic strengths? A value of 1 or greater of course implies that some inelastic deformation is permissible. Hence the level of inelastic deformation that is permissible needs to be indicated for the different situations that a designer may need to consider.

3. In major international codes (UBC, IBC and Eurocode 8) a whole series of requirements are given to establish if a given structure satisfies plan regularity. This version of the draft code just has one criterion, down from the two in the previous standard. So again, where is the peer reviewed research showing that these international codes of practice have it wrong, while this draft has it correctly assessed?

It is my hope that these and other concerns will be satisfactorily sorted out in the proposed standard. If this is not the case then I would hope that SESOC would ask Standards New Zealand to withdraw the Standard. I have raised my concern over the low strength levels in several submissions to Standards as well as in the literature (see SESOC Journal Vol. 15 No. 2 Sept. 2002, pp. 5-6 and Bulletin NZSEE Vol. 35, No. 3, Sept. 2002, pp. 190-203) and in the recent IPENZ convention.

Yours faithfully

Richard Fenwick

LETTERS TO THE EDITOR

The Editor
SESOC Journal

17 August 2008

Dear Sir,

Re: Structural Standards

I believe that the process that has been followed in recent years in writing and revising structural standards in New Zealand could be improved. I hope that SESOC will consider this issue and enter into discussion with IPENZ and Standards New Zealand on this matter. At the end of the letter I have made suggestions.

During the last 5 years I have been involved in voluntary work for Standards New Zealand. From 2002 to 2004 I worked with the committee, but not as a member of the committee, on the New Zealand Earthquake Actions Standard, NZS 1170.5. From 2003 to 2008 I was on the committee for the revision of the Concrete Structures Standard, NZS 3101:2006, and for the Second Amendment to this Standard (2008). During this period I have spent considerable time on this work, which I believe has given me some insight into the process and difficulties involved in writing structural standards.

Inevitably a major part of the work involved in writing a structural standard falls on one or two individuals in the committee. This cannot be avoided as it is difficult to find individuals who have the necessary background, the time to commit to the task, are not subjected to commercial pressure and are prepared to spend time without financial reward. Other members of the committee are essential to provide feed back and critical assessment during the writing process, but given commercial pressures they cannot be expected to find the time necessary to make major contributions. In the past this was not a serious problem as the Ministry of Works saw it as part of their duty to contribute to Standards as did the Schools of Engineering at Canterbury and Auckland. The demise of the MOW, the change in attitude within the universities and the reduction in consulting fees, which has increased the financial pressure on consultants, have all contributed to the problem of finding suitable individuals for committees for structural standards.

The approach that has been followed in recent years for writing and revising structural standards appears to be unsatisfactory to me in a number of respects and I believe a new approach is desirable. Below I have outlined changes which could be considered.

1. The typical life of a structural standard between major revisions appears to be about 11 years. The production of a standard is followed by approximately 9 years of relative calm and then within a 2 year period there is a rush to revise the standard and bring it up to date. Inevitably problems are uncovered, which require research. However, there is little time for this and consequently short cuts have to be made. My suggestion is that when a standard is written or revised, problem areas are identified and sub-committees are set up to research these in depth. In some cases this work will involve studying overseas codes of practice and adapting one or more of these approaches to suit New Zealand practice. In other cases it will be necessary to undertake detailed research projects. Hopefully in this case SESOC, IPENZ and Standards New Zealand would indicate their support for research applications made in connection with such work.

   To be specific for the Earthquake Actions Standard there is scope for committees considering:

   - Methods of Analysis for seismic actions, equivalent static, modal, time history and displacement based approaches;
   - Uniformity of application in material standards to ensure that with the different materials the same level of performance is achieved. In particular this would involve ensuring that principles such as capacity design were applied to produce comparable levels of seismic performance.

   For the Concrete Structures Standard subcommittees could be established for:

- Design for walls and wall structures;
- Material properties, including creep and shrinkage characteristics of NZ concretes;
- Shear and torsion in concrete members;
- Capacity design of concrete structures;
- Use of precast concrete elements;
- Bridge structures.

2. Standards New Zealand should not be involved in the writing of new structural standards, or revision of existing standards, until the production and distribution stage of the document has been reached. Standards New Zealand was clearly under considerable financial pressure during the preparation of NZS 3101:2006 (but not Amendment No. 2). They were very concerned with the financial implications of not reaching their target date for completion but less concerned with the implications of the quality of the document. Given the lack of staff with technical education in engineering this attitude is not surprising. Financial pressure reached the stage where Standards ceased to employ any engineers on a full time basis in 2005. The time permitted for checking the standard was inadequate and pressure was placed on those who rejected the first draft of the standard. Staff working for Standards on the second Amendment of NZS 3101:2006 did not have the background to understand or interpret equations, engineering drawings and technical text. This placed them in a very difficult position and caused considerable frustration to them and committee members with the frequent redrawing of diagrams and revision of equations etc. I do however, commend the staff for the effort that they put in and their willingness to repeat tasks and their efforts to minimise the time commitment of committee members. The work involved in putting the text together and drawing the diagrams would have been completed more efficiently by any number of engineering organisations who have the necessary skills readily available.

3. The Department of Building and Housing were represented on the NZS 3101 committee, one of the few (and possibly the only) members paid to contribute time to the project. There was limited input from the DBH during the writing process. However, when the final draft of NZS 3101:2006 was published the DBH were able to employ an individual to spend several weeks checking through the document in great detail and raising questions about the content. This seemed to be out of place and this contribution would have been more valuable if it had been carried out nearer to the final draft and certainly before the standard was published. This would have allowed exchange of ideas between the committee and checker, which would have added considerable value to the document, and ensured the checker was aware of the more difficult technical aspects covered in the standard.

There are a number of other issues concerned with Standards:

(a) The main purpose of structural standards is to protect the community. Given this, should standards be written by unpaid volunteers, or by industry funded individuals, who can be under pressure to change standards for the benefit of industry rather than for the public good?

(b) Should the financial viability of Standards New Zealand rest on the voluntary contribution of individuals in the community, which inherently results in pressure being put on those individuals to produce a standard within a minimum time so that it can be sold for profit, rather than concentrating on producing a sound document for the public good? Surely as standards are for the public good there should be appropriate funding to prevent capture by industry and to prevent inappropriate pressure being applied to individuals who give their time freely to this task.

(c) Should we be trying to produce standards that do not require engineering judgement? The pressure was on to do this particularly from the DBH, who wanted nothing left to engineering judgement (no open clauses). I feel this approach is leading to poor quality engineering. It is not possible to envisage or cover in a standard of some 700 pages all the situations which will be met in practice, nor is it possible to come up with standard solutions which will cover all situations. In some cases knowledge has not advanced far enough to answer some problems. However, engineers who are instructed to satisfy the clauses in such a standard are unlikely to develop the skills necessary to allow them to spot or solve the many situations which are not covered. I think we need to assess very carefully what we should be expecting from our standards. I don't think we should be trying to give a cook book which replaces the need for continuing education, many text books and research papers and the need to keep up to date. I consider that if we want quality engineering we need to get away from standards (or other documents) or organisations which foster or required a tick box type operations as a means of trying to ensure good structural design.

Yours faithfully
Richard Fenwick

STRUCTURAL ENGINEERING SOCIETY
NEW ZEALAND

12 December, 2008

The Editor
SESOC Journal

Dear Sir

Re: Structural Standards – Response to Letter of 17-08-08 received from Richard Fenwick

INTRODUCTION

The Management Committee of the Structural Engineering Society (SESOC) thanks Richard Fenwick for his timely letter stating his concerns about the process of developing structural Standards relevant to the building and construction industry.

Richard Fenwick is one of the foremost researchers in the field of structural concrete design in New Zealand. Several of our SESOC Management Committee, including the writer, have served with Richard on recent structural Standards committees and can attest to the great work that he does and the significant contribution that he has made. For that reason we place considerable weight on the comments and suggestions that he has made in his letter to SESOC.

For those who are not aware SESOC is the Collaborating Technical Society with the Institution of Professional Engineers New Zealand (IPENZ) with primary responsibility for development and sharing of knowledge in respect of structural engineering. We have approximately 1400 members who are largely professional engineers, and one of the stated purposes of the Society is to participate in the development of New Zealand Standards, Codes of Practice and Guidelines related to the design, construction and materials used in structural engineering.

Our intention in writing this response is not only to acknowledge Richard's contribution, but to make other key players in the industry aware of Richard's experiences and to make further recommendations for improvements in the Standards process.

To summarise, the major issues raised by Richard as interpreted by SESOC are:

1. Time pressures to produce new structural Standards, Richard notes two years of frantic development every eleven years or so. Sometimes more often. A more measured and coordinated approach is required.

2. Lack of willing and able "voluntary" Standards committee members; resulting from the demise of the old Ministry of Works, the change in attitude and lack of support provided by Universities for their staff to work on these programs, and the reduced fees and increased time pressures on consulting engineers.

3. Inadequate funding from independent sources.

4. Lack of coordination with DBH prior to new Standards being published.

5. The style of future Standards, and the necessity for "engineering judgment".

BACKGROUND

In 2003 the IPENZ Structural Engineering Taskforce, in which SESOC was a key participant, published their report including seven major recommendations to overcome systemic failures in the regulatory environment for the Building Industry in New Zealand. The first of those major recommendations was:

"Development of Standards and Codes of Practice:

> *There is an urgent need to develop more comprehensive standards (for practices that can be described in a prescriptive way) e.g. through Standards New Zealand processes; and codes of practice (for practices requiring substantial professional judgment) through the professional body. A funding model independent of commercial interests within the industry is required. The development of standards for the building industry should be controlled and commissioned by the Building Industry Authority or its replacement."*

As a follow-up, in our April 2007 journal, the SESOC Management Committee published an "Update" on the current status and outstanding issues from the 2003 IPENZ Structural Taskforce report. Included in that April 2007 SESOC journal article were the following statements regarding Standards:

"The following are outstanding issues for SESOC, with ideas for improvement and further work proposed:

a) SESOC would like to lobby for a general Building Levy to fund:

- *Development and maintenance of structural standards;*
- *Nominal/reasonably paid industry representation;*
- *Sustainable funding base for Standards New Zealand (or other alternate organisation).*

b) SESOC must have active participation in the selection of committee members for ALL structural standards and codes of practice. This has been happening informally for recent standards but needs to be formalised. There always needs to be a balance of personnel on committees including academics, industry reps, authority reps and practicing design consultants. We also need to formalise the process for deciding when and what structural standards and codes of practice to update i.e. there needs to be a planned review process.

You will see that some of the key recommendations made by the 2003 IPENZ Structural Taskforce, and by SESOC in their 2007 Taskforce Update paper have yet to be implemented and relate directly to current issues that Richard Fenwick has raised.

CURRENT INDUSTRY ENVIRONMENT

Progress with implementation of the IPENZ Structural Taskforce recommendations has perhaps been limited by the rapidly changing industry environment. For example, since the IPENZ Structural Taskforce report was published we now have the Department of Building and Housing (DBH) in place of the old Building Industry Authority, we have a new Building Act and the DBH are also currently developing a new Building Code. SESOC has been an active participant in the consultation process for all these developments, with our primary focus for the Building Code being the provisions for Structural Safety.

In addition we are aware that the Ministry of Economic Development (MED) is currently carrying out a review of New Zealand's Standards and Conformance Infrastructure. We understand this review has now progressed to a consultation stage with stakeholders prior to recommendations being presented to government. We understand that the following changes are proposed by MED to the organizational structure:

- The Standards Council will now comprise only six members to be appointed directly by the Minister of Commerce.
- Reporting to the Standards Council will be four Sector Advisory Boards (SABs) for the Building, Energy, Environment and Health sectors.

- The next tier down will be Industry Advisory Groups that will report to each SAB. It is understood that the Industry Advisory Groups for the Building Sector, which is SESOC's main focus, will comprise design and construction, fire and protection, piping and plumbing, timber, cement and concrete, steel etc.

SESOC RECOMMENDATIONS and INTENTIONS

The make up and organization of the proposed Industry Advisory Groups that will report to the Building Sector Advisory Board will be of critical importance to enable a more coordinated approach to the production and maintenance of structural design Standards than has been achieved in the past. We believe that SESOC has a key role to play in coordinating this work and should be represented on the Industry Advisory Group for Design and Construction.

At the last SESOC Management meeting it was suggested, as a possible means to progress item 1 by Richard Fenwick, that a standing committee should be set up for each of the key structural design Standards below:

- AS / NZS1170 Structural Design Actions
- NZS 3101 Concrete Structures
- NZS 3404 Steel Structures
- NZS 3603 Timber Structures and
- NZS 4230 Concrete Masonry Structures
- AS / NZS 4600 Cold-formed Steel Structures

The concept of the standing committee is that it would be the recipient of all correspondence from users of the Standard, receiving criticism and helping with interpretation of clauses. In this position, the committee would be able to assess which aspects of the current Standards require further research and would be able to assist, for example with lobbying for funds for that research. It is hoped that this approach, would alleviate the "time and financial pressures" as both could then be spread more evenly over the "eleven" years.

A coordinated approach is required to prioritise the required development and research for these standards and SESOC is the best placed technical society to facilitate this. We acknowledge the key role that other organisations have to play, including in particular NZSEE, NZCS, HERA, SCNZ and NZTDS and we would seek to work cooperatively with those organizations throughout this process. It is envisaged that the standing committees would also have representatives from those other organisations – as relevant to the Standard concerned.

SESOC is willing to sponsor one representative onto a standing committee for each of the above key structural Standards and looks forward to discussing with other interested parties (notably the recipients of this letter) how this may be implemented.

In addition to promoting standing committees the SESOC Management Committee has resolved to create a website forum for each of the above structural Standards. Our intention with these website forums is to collate and display the comments received so that they are accessible to all in the public area of the SESOC website (i.e. not only the SESOC member's area). Users of each Standard could log their comments and suggestions for improvement and further research. Structural engineering practitioners, technical societies, research organizations, government, and indeed anyone else who might be interested, would be able to access the comments pages at any time to check current developments and work in progress. SESOC is currently upgrading its website to enable this feature and we would appoint an expert for each Standard to collate the comments received. It is not intended at this stage to provide answers to queries, although other commentators may choose to do this.

Regarding Richard Fenwick's items 2 and 3, a large part of the problem, in this "user pays" society is in fact a lack of adequate government funding for the development of Standards. In 2003 both SESOC and IPENZ made submissions to the Building Bill so that funding for the development of Standards would be provided for the Building Industry. This idea was not accepted and the financial shortfalls that Richard speaks of are now seriously affecting our ability to develop and maintain quality Standards. It seems there is a lack of appreciation of the public good that is served by the development and maintenance of Standards, in particular the key structural Standards listed above.

While SESOC notes the support of the Department of Building and Housing to the Industry in the development of guidelines in some areas, for example, the Retrofit of Precast Flooring Systems, it appears that an annual budget item for the Department to support Standards committees and further research would be a valuable investment in the future of New Zealand construction.

Adoption of international Standards is always considered where practical. However, for structural design Standards overseas examples often do not relate to current practice in New Zealand and do not always incorporate the findings of recent research. New Zealand is a world leader, particularly with research and design for earthquake loads and has the ability to incorporate new developments and the findings of recent research into Standards relatively quickly compared to other countries. This is a competitive advantage that we should retain.

Previously, it was hoped that more “joint Standards” arrangements with Australia would overcome some of our funding problems. Successful joint Standards have indeed been developed, notably AS/NZS 1170 in the structural arena, and this is certainly of benefit to the industry with increasing joint trade arrangements. However, we understand that in this case the Standard development process was no less expensive for New Zealand and so the need for adequate independent funding remains.

On the style of future Standards and the issue of “engineering judgment”, professional structural engineers acknowledge that no set of Standards can provide a “cook book” solution for all situations. We do require key “standard” values to design to, for example, wind speeds and allowable deflections, and it should be the primary scope of a design Standard to define these. SESOC Management feel that the best solution is to limit the content of the Standards to the essentials and to produce more comprehensive “Commentary” documents that are a companion, but not mandatory, part of the Standard. The commentary should describe the intent of the Standard and give direction as to where designers may find more relevant information to help them make good design decisions.

We would welcome any feedback or discussion on the above. We trust that you will treat our comments above as constructive recommendations for a way forward. We look forward to working with you all to improve the current situation.

Yours faithfully
Structural Engineering Society (SESOC) NZ

Ashley Smith
President

The Editor
SESOC Journal

Dear Sir,

RE: Paper by Chang et Al, "Fire performance of hollow-core floor systems in New Zealand"

The paper describes an interesting application of the fire analysis program "SAFIR", to the performance of hollow-core floors subjected to fire. However, the writers believe that the results of the analyses should be treated as a first step in an investigation, and more detailed analysis is required to investigate the structural implications. In particular one of the recommendations is contrary to requirements in the Structural Concrete Standard, NZS 3101:2006, and if it was used in design it would compromise the seismic performance of the floors.

Problems arise from the modelling assumption that each hollow-core member with the hollow-core units being represented by a number of individual I beams, see Figure 4 in the paper. With this assumption, as noted in the paper, the program does not give direct information on the critical stress and strain conditions in the webs, which in tests have been found to be critical. However, in addition it does not allow adequate representation of torsional behaviour of the hollow-core units. The authors have recommended that edge beams to floor slabs be cast against the side of the first hollow-core floor unit, as shown in Figure A. The detail is specifically forbidden in the Structural Concrete Standard, NZS 3101:2006 in clause 18.6.7. This clause requires a thin linking slab to be designed to bridge a gap of typically of 600 mm between the beam and the closest hollow-core unit to the beam. The intent behind this clause is to limit the force that can be transferred between the beam and hollow-core unit to a safe level. In a test of a hollow-core floor, a differential movement of a few millimetres between an edge beam and the mid-line of an adjacent hollow-core floor was found to result in high shear transfer between the two elements, which resulted in splitting of the webs, as illustrated in Figure B. This type of splitting was one of the leading causes of collapse of the floor in the Matthews test[1], see Figure C.

Figure 10 in the paper shows that the fire analyses predict that high displacements develop between the mid region of the hollow-core floors and the edge beams. These displacements are of the order of 200 mm. Simple approximate calculations indicate that the forces required to prevent differential displacement of beam and the edge of the adjacent hollow-core unit cast against the beam are in excess of the value which could be expected to result in extensive splitting of the webs. Hence the detail recommended by the authors of casting edge beams against the sides of hollow-core floors may have a detrimental influence on fire performance of the floor and it will certainly have a serious detrimental influence on the seismic performance of the floor. In the seismic case smaller differential displacements are critical due to the high forces induced in the hollow-core by the units being constrained to follow the deflected shape of an adjacent beam at a plastic hinge or a local region of high curvature. There is in fact some evidence indicating that splitting of the webs was initiated before a plastic hinge formed in the Matthews test[1].

The relative displacement between the edge beam and the centre of the hollow-core floor, shown in Figure 10 in the paper, indicates that the hollow-core units are subjected to considerable torsional twist. The extent of this twist is well in excess of the twist of close to 0.001 radians per metre, which has been observed to be sustained just before collapse occurred[2]. In the fire situation the longitudinal compression induced in the member by restraint of the structure to thermal expansion would increase the twist limit but not sufficiently to account for the order of deformation indicated in Figure 10.

In several places in the text it is stated that tensile membrane action will improve the fire resistance of the floor slab. This assumption appears to have been based on test results of flat slabs and not on a consideration of the forces induced by tensile membrane action in a composite floor made up of hollow-core units and insitu concrete topping. The example shown in Figure 3 in the paper illustrates membrane action in a relatively thin slab with the membrane action arising from bottom bars in the slab. However, with hollow-core floors if membrane action can contribute it must come from reinforcement located within 40 mm of the top surface of the insitu concrete topping in a composite section typically 375 mm thick. Extrapolating tensile membrane action from the illustration, which shows a thin slab, to the hollow-core floor is inappropriate as the heavy composite floor is well outside the range of tests used to establish this action. With tensile membrane action high deflections and curvatures are involved. The hollow-core units, even when softened by high temperatures, would not be capable of bending into the required deformed shape for tensile membrane action to develop. The result would be that the units would separate from the topping concrete, either by a tensile failure at the interface of the precast and cast insitu concrete or by snapping of the webs, as illustrated in Figure D.

In conclusion the writers believe the results of the analyses should not be used for design at this stage as there are a number of structural aspects which require more detailed investigation. In particular;

- The suggestion that beams be constructed against the sides of hollow-core floors to increase their fire performance should not be followed as this action will compromise the seismic performance to the extent that a premature collapse may occur in an earthquake;
- Reliance should not be placed on tensile membrane action to prevent collapse of a hollow-core floor under either fire or seismic conditions.

Yours faithfully,

Richard Fenwick and Des Bull

References:

1. Matthews J, "Hollow-core floor slab performance following a severe earthquake", PhD thesis, Civil Engineering, University of Canterbury, 2004.

2. Broo H, Lundgren K and Engstrom B, "Shear and torsion interaction in prestressed hollow-core units", Structural Concrete, Vol. 8, No. 2, pp.87-100.

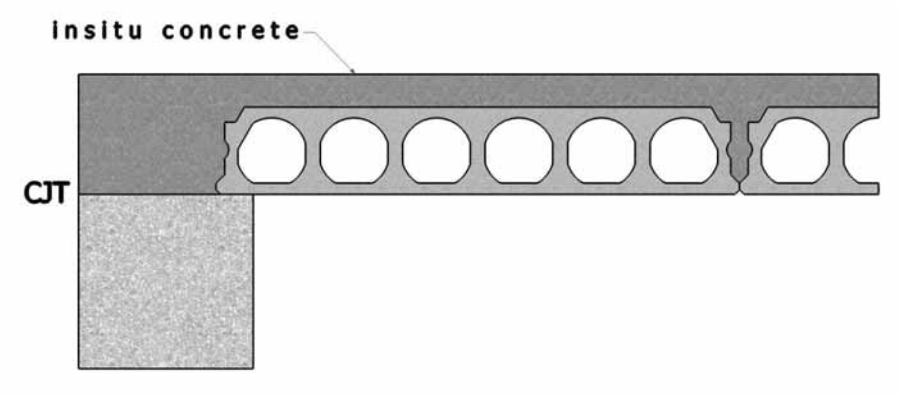

Figure A.

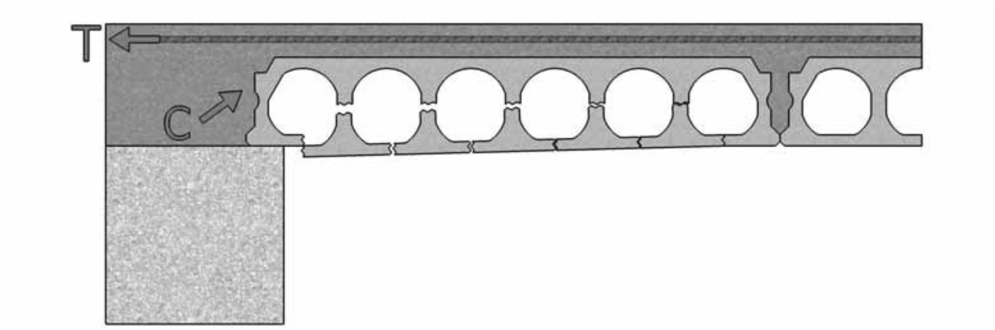

Figure B.

(Matthews 2004)

Figure C.

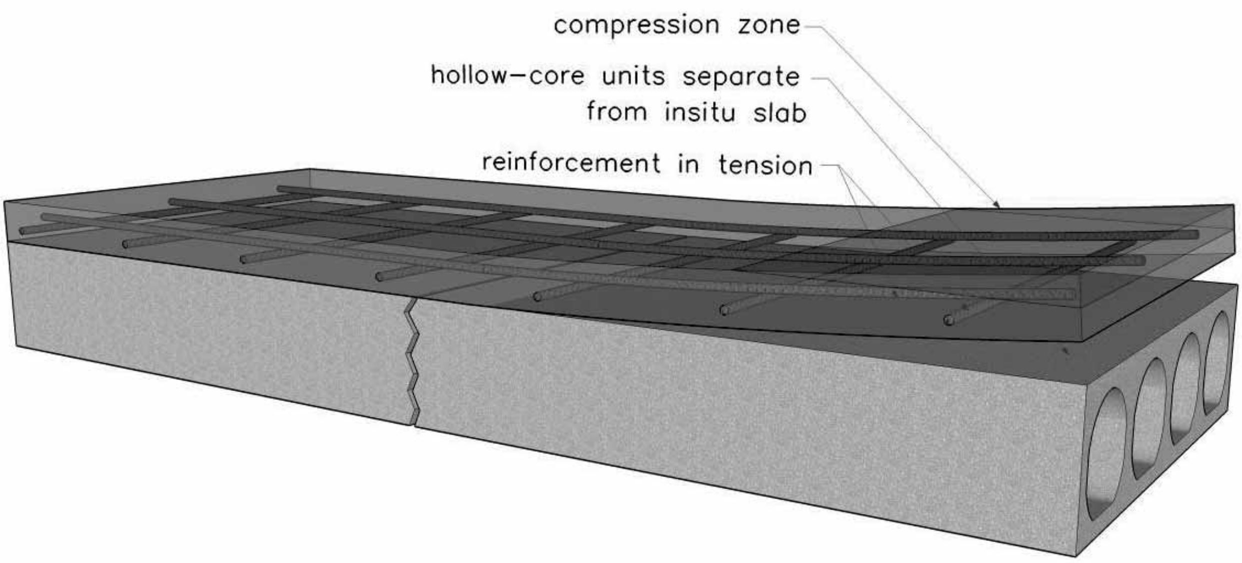

Figure D.

The Editor
SESOC Journal

RE: Paper by Chang et Al, "Fire performance of hollow-core floor systems in New Zealand

Dear Sir,

The structural behaviour in fire is a relatively young research area compared to studies on material or seismic effects on structures. It is a welcome sign to see papers in this field attracting such discussion.

The original paper investigates whether two-way tensile membrane action can be established in the topping of hollowcore concrete slabs, subsequently increasing the fire resistance. The paper is clearly an analytical study with no experimental component. It compares the fire resistance of slabs with different support conditions at the ends and sides of the hollowcore units.

The experimental behaviour of floor slabs using hollowcore units has been studied in several international testing facilities (e.g. BRE[1,2,3], DIFT[4,5], BEF[6] and VTT) as well as several universities (e.g. Liege, Ghent[7,8,9,10], Delft[11,12] and Perugia), and our analytical research is an elaboration of these experimental studies. The background to recent UK fire tests on hollowcore units can be found in http://www.concretecentre.com/PDF/CFF_Hollowcore_NB_08.pdf.

We highly recommend Fellinger's thesis on the shear and anchorage behaviour of hollowcore units in fire, which collects more than one hundred test results on floors with hollowcore slabs. We understand that our background research cannot cover all the fire tests conducted in the world, and we are very interested in any fire test results showing alternative failure modes. We are unaware of any fire tests on earthquake-damaged hollowcore floors.

As the editor pointed out (in a note below the original article) the paper does not consider seismic behaviour of the hollowcore floors. We would like to state clearly that seismic effects should never be underestimated or omitted in the building design, and we certainly do not wish to see our paper used to justify inadequate seismic design.

The reviewers correctly point out that any tensile membrane action can only develop in the reinforced concrete topping. The SAFIR analytical model does not consider the possibility of separation of the topping from the hollowcore units or failure of the hollowcore webs, so the catastrophic failures shown in the photographs from seismic tests were not considered in the analysis.

Our analysis did not consider other possible failure modes such as splitting of the webs, delamination of the topping, or torsional failure, based on the test results described in Fellinger's thesis[11,12] as well as the fire test results from BRE on hollowcore units with topping conducted in 2003[1], 2004[1] and 2007[2,3]. To our knowledge, web splitting has not been observed in fire resistance tests. However, as we stated earlier, we welcome any test results showing otherwise.

The overall conclusion of the analysis is that, if an increase in fire resistance is to be obtained using tensile membrane action, the greatest improvement will be achieved with stiff support details at the ends and at the sides of the hollowcore units. The benefits of tensile membrane action will only become useful if the building has regularly spaced side beams. Such side beams are not often designed into buildings with large floor plates, so they would need to be added as "fire emergency beams" if the extra fire resistance was required, and the possible effects on seismic behaviour would need to be considered. Most designers just use the specified fire resistance from the manufacturers of hollowcore units, in which case tensile membrane action is not considered.

In summary, the authors and the reviewers all agree on using stiff end connections as the recommended end support conditions. The reviewers' concerns are related to the side support conditions, so those designers who need to consider additional fire resistance from tensile membrane action must take both fire and seismic recommendations into account.

We welcome any new research being done in this field. In order to resolve the differences between the different recommendations for fire resistance and earthquake design, future analytical fire studies should be expanded to consider tensile stresses at the topping-hollowcore interface and tensile stresses in the webs of the hollowcore units, and the analytical results should be verified with full-scale fire tests.

We would like to recommend the following selected readings to anyone who wishes to understand more about the fire behaviour of hollowcore concrete floor slabs:

1. Lennon, T. (2003) "Precast Hollowcore slabs in fire", *The Structural Engineer* Vol. 81 No. 8, pp. 30-35, also conference presentation at www.concretecentre.com/PDF/Hollowcore_26_03_04.pdf.
2. Lennon, T. (2007) "The need for large-scale fire tests", Workshop of Fib WP 4.3, Coimbra, Portugal, related presentation at http://www.concretecentre.com/PDF/CFF_Hollowcore_TL_08.pdf.
3. Bailey, C.G. & Lennon, T. (2008) "Full-scale fire tests on hollowcore floors", The Structural Engineer, Vol. 86, Issue 6., http://www.istructe.org/thestructuralengineer/abstract.asp?pid=7622.
4. Andersen, N.E. & Lauridsen, D.H. (1999) *Danish Institute of Fire Technology Technical Report X 52650 Part 2 - Hollow core Concrete Slabs*, Danish Institute of Fire Technology, Denmark.
5. DIFT (2004), *Test report, File no. PG11304*, DIFT, Denmark.
6. Danish Prefab Concrete Association (2005) *Hollow Core Slabs and Fire – Documentation on Shear Capacity*, Birch & Krogboe A/S, Copenhagen.
7. Dotreppe, J-C. & Van Acker, A. (2002) "Shear resistance of precast prestressed hollow core slabs under fire conditions", *The First fib Congress*, Japan, pp.149-158.
8. Dotreppe, J-C. & Franssen, J-M. (2004) "Precast hollow core slabs in fire: numerical simulations and experimental tests", *Third International Workshop "Structures in Fire"*, Ottawa, Canada, May 2004, paper S5-1.
9. FeBe Studiecommissie SSTC (1998) *Résistance au Cisaillement de Dalles Alveolées Précontraintes*, Laboratorium voor Aanwending der Brandstoffen en Warmteoverdracht, Belgium (A detailed report that Dotreppe & Van Acker's paper is based on).
10. Van Acker, A. (2003) "Shear resistance of prestressed hollow core floors exposed to fire", *Structural Concrete- Journal of the fib*, vol 4, pp. 65-74.
11. Fellinger J.H.H. (2000) *Shear and Anchorage Behaviour of Fire Exposed Hollow Core Slabs, Test report: Fire tests on bare hollow core units*, TNO report 2000-VB-R001147-TUDelft report 25.5-00-5, Delft.
12. Fellinger J.H.H (2004) *Shear and Anchorage Behaviour of Fire Exposed Hollow Core Slabs*, DUP Science, the Netherlands.

Yours sincerely

Jeremy Chang, Andy Buchanan, Rajesh Dhakal, and Peter Moss

Journal Editor
Structural Engineering Society New Zealand
P O Box 6508
Auckland

15 December 2008

Dear Sir

SESOC Journal Letter to Editor – Precast Double Tees

We refer to two recent industry publications, *Precast News 07,* published November 08 by Precast New Zealand Inc, and the *Golden Bay News Spring 2008,* by Golden Bay Cement. Articles in both these publications comment on flange hung double tees and in particular the 'Pigtail' hanger detail. Work carried out by Beca some 36 years ago was referenced in both these articles. We wish to point out that there was no communication with Beca seeking either approval of, or input to, these recent articles.

We are concerned that work carried out approximately 36 years ago is being quoted – with the implication that such work is still entirely relevant today. Clearly, since 1972 there have been significant advances in technology and knowledge, as well as numerous amendments and revisions to both loadings and materials design codes. In light of such advances, where products or practices are no longer covered by current codes of practice, the manufacturer and industry has a responsibility to address such matters in a considered and professional manner.

Whilst we acknowledge the generally acceptable performance of double tee units in-service; to quote work carried out some decades ago potentially denies the knowledge and advancement of the engineering profession over the subsequent period.

Yours faithfully
Richard Aitken
Group Chief Executive

on behalf of
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The Editor,
SESOC Journal

Dear Sir,

Re: Use of Semi-rigid Flange Bolted Joint at Auckland Airport

The author of this paper, A S Beer, describes in the SESOC Journal, Vol.20, No.2, 2007, an interesting form of structural steel construction, which has been used for the Auckland International Airport Terminal Building. The flanges of I beams are connected to columns by bolting them to carefully detailed connector plates. These plates were shaped so that in the event of a major earthquake the inelastic deformation is confined to the connector plates. While the author describes some of the problems involved in designing these plates he does not touch on a number of aspects, which are of fundamental importance to the design concept. These aspects must have been sorted out to enable the structure to be designed so that its performance will meet the levels specified in New Zealand structural standards. The author's comments on the points raised below would be welcome.

1. Figures 1 and 8 in the paper clearly show that the "Beca Bump" ductile connector plates were bolted to the top and bottom flanges of each beam at each column. The text indicates that in the event of a major earthquake these plates are subjected to yield in both tension and compression to enable the required level of inelastic deformation to be sustained. However, the floor slab, which is supported by both the longitudinal and transverse beams, would prevent any inelastic deformation being sustained by the top plate. Though not stated in the paper clearly all the inelastic deformation is sustained by the bottom plate. Why was the special "Beca Bump" plate used with the top flange when it cannot sustain inelastic deformation?

2. Figure 5 shows the results of axial tension tests on a number of plates with different configurations. The tests were made in direct tension tests. How do you modify the measured inelastic displacement results obtained in the direct tension tests to give a design value allowing for the effects of cyclic yielding in tension and compression, which can be expected to lower the fracture strain due to low cycle fatigue, or possibly by buckling.

3. Only one test is reported of the "Beca Bump Plate" that was used in the structure. However, for seismic design it is essential to establish a value consistent with a lower characteristic property (19 out of 20 have a greater extension at fracture). Given the appreciable variation which occurs in fracture strain how was the safe design value of extension found for the plate? Normally this would be established by carrying out a number of tests on different batches of steel made to the same grade (see Appendices A and B in NZS 1170.0).

4. The tests that were reported were for the flange plates. The web plate carries high gravity load shears and the text indicates that in the event of a fracture of the flange plates it will sustain some bending moment. The web plates, see Figures 5 and 8, are subjected to the same rotation and nearly the same strain level as the bottom flange plates, which were specially shaped to enhance its strain capacity. What evidence is there that the web plate, which has not been especially shaped, will sustain the required level of inelastic strain without fracturing?

5. Self strain actions, such as shrinkage of concrete, overall temperature change, differential temperature and fire, will tend to concentrate strains in relative weak sections. In this case this will be in the connector plates. What spacing of expansion joints is required to prevent these actions from causing yield in the plates and consequently reducing their deformation limit due to low cycle fatigue?

Yours faithfully
Richard Fenwick

ED. We received Responses to this letter from both the Author of the paper and the people involved in the development of the joint. Subsequently there was additional correspondence between the parties regarding the issues raised. To aid clarity, I have kept the responses to each point together and provided annotation to identify the person making the comments using the following key:

AB — Aaron Beer, Paper Author,
RF — Richard Fenwick, University of Canterbury
CC — Charles Clifton, Developer of the FBJ system, University of Auckland
JB — John Butterworth, University of Auckland

Responses to Richard Fenwick's Letter

AB Indeed all of the points raised by Richard were considered in the design for this project. The design philosophy of the Semi-rigid Flange Bolted Joint is described in detail in Hera Report R4-134. This report was authored by Charles Clifton and is founded on a programme of large scale pseudo static tests and small scale pseudo static and seismic dynamic tests undertaken at Auckland University.

As stated in the paper, we identified some issues with the joint when seeking to apply it to a project with "gravity dominated" frames. These issues were resolved in collaboration with Charles, resulting in some amendments to the R4-134 procedures for this specific application. We also looked at some detailing provisions to improve the rotational capacity of the joint in light of the dominance of gravity loading which was beyond the scope of the original joint development. It was the dissemination of these adaption's that was the focus of the paper, not the underlying design philosophy for the joint.

RF This may be interesting but it was not a concern that I raised.

CC However it is an explanation for why the paper did not delve into some of the details of the FBJ.

AB We note that Richard has raised several points that are relevant to the underlying design theory, so to ensure a thorough reply, we forwarded the letter to Charles Clifton and John Butterworth as the original developers of the Semi-rigid joint, and their reply follows after ours below.

Point 1 is answered in Charles' response below. The slab has been isolated from the column.

RF This is an essential feature of the design and as such I believe it should have been mentioned in the paper. I think it should be noted that isolating the slab from the column allows the column to rotate about the beam centreline. Such rotation imposes relative twist between the slab and top flange of transverse beam it does not induce lateral displacement. The twist of the flange will induce local bending of the web. Presumably this bending is not critical.

AB Correct. Yes we should have mentioned the isolation detail, although I recall this issue is discussed in detail in R4-134. At least the readers will pick this up in reading the response letter.

CC This twist is not critical when the transverse beam is an open I section. It may be more significant if the beam was a closed box section however the FBJ in its current form would not work with such an incoming beam shape.

AB In response to points 2 & 3, as stated in the paper, a limited programme of testing was carried out to establish comparative performance only, not an absolute elongation limit. There were three tests on each profile. A more rigorous cyclic testing programme was carried out in Charles' work and the overall rotational demands were found to be within the limits set by NZS 3404.

RF If I have understood you correctly then the standard detail without the Beca bump was adequate in terms of meeting the requirements of Building Code and the standard detail had previously been shown to meet the requirements of AS/NZS 1170.0 Appendices A and B.

AB That is indeed our understanding. Charles might wish to comment here, but the rotations/demands on the materials are not believed to be outside the scope of NZS 3404.

CC That is correct.

AB In response to point 4, the demands on the flange plate and web are low, especially when compared to the web of a moment joint in a mu=6 frame (we used mu = 1.5 in design). The web plates in Charles' tests sustained large strains appropriate to mu=6. The strain demand on the deep FBJ web plate is perhaps no different to that imposed on a conventional deep web cleat used to connect a heavy gauge gravity beam in a building subject to earthquake drift, although in the semi-rigid application, the detailing rules suppress brittle bolt failure.

RF This response surprises me. The required lateral displacement of the upper and lower bolts on the web plate are of a similar order of magnitude (at least 75%, see figure 6) of the movement of the flange plate bolts due to bolt bearing and yielding of the flange plate. How is it that the web plate bolts and plates are expected to sustain this order of displacement without failing when specially shaped flange plates, specifically designed to spread yielding and hence extend movement capacity, are expected to fail. The critical issue is the expected relative movement of the bolts and the relative detailing to spread yield in the two distinctly different elements that are relevant.

AB There are two points I would like to make here, firstly, the overall demand on the joint is relatively low in terms of overall rotational demand. Secondly, Charles' tests demonstrated that the flange plate tends to fracture sooner than the web plate. This is due to the pronounced effect of the stress concentration around the end two bolt holes (see comments in the paper). The web plate does not suffer from this same effect and actually performs quite well. What we did was profile the flange plate so it could perform better and lift the overall joint performance closer to that of the web. The down side of this is an elevated overstrength factor (as noted later). We still expect that the flange plate would fracture before the web plate if the profiled joint was to be full scale tested.

CC The original FBJ concept used the fracture of the flange plate in advance of the commencement of fracture of the web plate as a way of avoiding the overstrength contribution from both components coinciding. The key difference is that the flange plates are under uniform and maximum strain from bending and so they will yield first locally around the bolts, then strain harden locally and finally start to grow fracture cracks. These cracks are growing transverse to a uniform strain field and so tend to propagate relatively rapidly with increasing rotation. In contrast the web plates are in in-plane bending and so the strain profile is a maximum at the top and bottom and reduces to zero about the plastic neutral axis. This remains the same as the rotation demand increases. The fracture crack when it forms is therefore growing towards a region of reducing strain and hence the rotation must increase for this to continue to grow (assuming the material is notch tough which is a fundamental requirement). This is why the web plates are able to continue to deliver moment and shear resistance at high levels of rotation on the joint. The flange plates are designed and detailed not to fracture until at least twice the design ductility demand on the joint is reached at which time the web system is able to deliver the original design moment capacity of the joint and hold that for at least double again the rotation demand. This is expected to cover the MCE case including any P-delta effects.

AB In response to point 5, these actions occur in any steel framed building which will often contain “weak spots” such as beam splices or web cleat welds that may attract extra strains. In our case we have detailed the end connection in a way that enhances its ability to elongate.

The rotational demand on the joint is well within the limits permitted by the standards. It is important to note that the large increases in elongation achieved in our flange plates was not used to support a higher ductility factor in design (mu = 1.5 adopted), rather this improvement was "banked" as an increased margin against plate fracture. Our principle objective being to arrive at a conservative and robust solution while still enjoying the benefits of the semi-rigid design approach.

RF This does not answer the question. It is not the deformation in one span that is being questioned. It is the accumulative deformation in all the bays that creates the problem as they are tied together between expansion joints. On top of this, and probably only of concern for the top level, is the problem of differential temperature. For example if the span of each longitudinal beam was 15 m and if you had 6 bays, and I have no idea what the actual values were or the number of bays involved as these values are not indicated except in a general sense by the photo on the cover, and assume an overall temperature change of 15°C (winter to summer change) and on the top level in the sun a differential temperature of 25°C on the top surface, the average effective temperature of concrete and steel beam is likely to be of the order of 15+ 8 degrees (without structural details I can only estimate these values). This temperature rise will cause a thermal expansion of 25 mm together with an added rotation due to differential temperature. Clearly there is a limiting length of structure that can be tolerated between expansion joints, and I was trying to find out what this length was as it seems to be to be a fundamental question that must have been sorted out in the design given that a considerable portion of this deformation could be imposed on one of the weak links. The question arises as you made no mention of any expansion joint or the problem, but it is clearly fundamental to the design concept.

AB Yes we spent some time considering the spacing between our expansion joints. We don't have shearwalls or rigid bays so the accumulative deformation will tend to pull the outsides of the building inwards. This level of movement is quite low compared to the drift capacity of the moment joints to the extent that the level of resistance offered by each moment frame is low and will not trouble the heavy flanged connections under the resulting accumulative tension. This issue would be of more concern in a building with say web cleats and more than one braced bay. Hence my comment that our detailing of the end connections can only improve this situation. I wasn't wanting to extend the scope of this discussion to the expansion behaviour of steel frame buildings in general (by the way, this would be an excellent topic to cover in your steel course notes Charles/John/Richard).

As an aside, the top slab on our project is not exposed to the sun. There is another steel roof some 2 m above this. The temperature of the main structural mass is not expected to vary too much as most of it is encapsulated within the air-conditioned building envelope.

CC I have two comments. First the size of this building does not exceed the size recommended by HERA for air conditioned buildings for which expansion joints are required. These provisions are based on widely used USA and UK recommendations. The second and more significant comment relates to a single level building of 150 m square which carries cars on the roof and for which the client did not want to put expansion joints in due to durability and suppression of leaks reasons. All beams were composite with the concrete slab. HERA undertook comprehensive Finite Element Analysis of the building response under recommended temperature variations published by the Univeristy of Adelaide. These were based on the temperature of the steel beam remaining close to the operating temperature inside the building while the temperature at the top of the slab varied from over 50°C to 0°C. The concern was what the accumulated lateral movement around the sides of the building and especially in the corners would be. The results showed that because the beams are composite and the temperature of the steel beams does not change significantly, the thermal effects show up as vertical deflection rather than lateral elongation. The results showed that the accumulated lateral movement was minimal (from memory (this study was undertaken around 1990 and I don't have the report written for the client) the total value was only 2 to 3 mm). The effect shows up as a rotation of the beam ends, however this rotation is not more than around 2 milliradians maximum which is well within the FBJ capability to withstand. Therefore I am confident in stating that the thermal effects on the joints will be minimal. Similarly concrete shrinkage in a composite beam causes a downwards vertical deformation and an end negative rotation of up to 1.5 milliradians rather than a change in length. The FBJ in general and this design in particular will easily resist the effects of both.

CC/JB Before starting on these, it is important to note that the Beer paper needs to be read in conjunction with the reference [Clifton 2005] from that paper. That reference is to HERA Report R4-134, 2006, Semi-rigid Joints For Moment-resisting Steel Framed Seismic-resisting Systems incorporating Revision 1 and Revision 2 to the SHJ Design Procedure. The basis of the HERA Report is the PhD Thesis by Clifton published in 2005, however the HERA Report does include subsequent revisions arising from further developmental work on the Sliding Hinge Joint, which is not the subject of this letter. In the rest of this reply it will be referred to as R4-134.

RF I can accept that engineers planning to use this approach should study the report you refer to but to require engineers to read this in conjunction with the paper is over the top. Sure the paper can refer to the report for further information on certain aspects. No such references were made concerning the questions I asked.

AB I guess we are guilty of assuming that the average reader has a passing knowledge of the work Charles has done to date as published in the Hera bulletins, etc. In section 2 of the paper we provide an overview of this work and direct readers to the work done by Charles accordingly. I agree a few more references would have been better.

CC I agree.

CC/JB Point 1: How is the floor slab effect on the joint rotation accounted for?

Answer to point 1: Richard comments that the floor slab, which is supported by both the longitudinal and transverse beams, will prevent any inelastic action being taken by the top plate. This would be correct if in an earthquake the column stayed stationary and the floor slab as a rigid body moved relative to the column. However, in an earthquake the floor slab remains level and the column rotates relative to the slab and beams. There is no net lateral movement between the column and the floor system. At the slab level, the rotation of the column is resisted by compression against the slab concrete (but only if this is cast directly against the column) and by twisting of any transverse beams connected to the column, in addition to the design in-plane resistance of the FBJ. I section transverse beams connected to the column are so flexible in torsion that their contribution to the resisting column rotation will be negligible and any contribution will be about the centreline of the beam, therefore it will not raise the point of rotation of the connection towards the top flange. The contribution of the slab in compression is much more important and, for the Beca connection, this effect was eliminated to ensure the joint can rotate close to the beam centroid as intended in the procedure presented in R4-134. This was achieved with a slab isolation detail comprising a ceramic fibre blanket some 20 mm thick wrapped in plastic and pinned around the column before casting the slab concrete. Thus the concrete is separated from the column by a compressible layer which prevents this slab contribution.

RF Beer's comment that the column is isolated from the slab answers this question. Unfortunately this explanation appears to be missing from the paper. With this detail all that a designer has to consider is the implication of local bending in the web due to restraint of slab restricting torsional rotation of the upper flange.

As noted above twisting of transverse beams in torsion is restrained and localised deformation of top flange and webs must occur. This problem is not mentioned but is unlikely to be critical unless there are very high shears.

CC Shear is never critical in steel I section beams. They are moment dominated. Torsion will not be important when the transverse beams are open I sections because of their flexibility in torsion and hence the very small change in stress as the beams take up the seismic imposed twist.

CC/JB Point 2: Figure 5 of the paper shows direct tension tests. How are these modified for cyclic performance to take account of cyclic yielding in tension and compression?

Answer to point 2: The scope of these tests was to simply show the improvement in elongation capability between the modified flange plates and those originally developed. The original plates were subjected to large scale cyclic testing, small scale cyclic testing at pseudo-static and seismic-dynamic rates of loading. Details are given in section 4.3 of R4-134. The authors considered that to show the difference in elongation capability, static tension tests on the original plates and the modified plates was sufficient given that the design and detailing requirements developed from the original research and reported in R4-134 to ensure satisfactory cyclic performance were not being amended in this application. Furthermore, given that the concern was initial preloading of the joint in negative rotation by the gravity loading, tension testing was the appropriate axial loading for this comparative testing.

RF OK if it was clearly stated in the paper that detailed cyclic testing had been carried out to meet the requirements of AS/NZS 1170.0 and that additional details were contained in reference…

CC This would have been beneficial.

CC/JB Point 3: Only one test is reported.

Answer to point 3: The same as to point 2, namely that this is a comparison test only not a test to establish an allowable elongation limit. However three tests were undertaken on each of the plate types to determine variability and there was very little variation found.

CC/JB Point 4: How will the web plate cope with the required inelastic level of strain without fracturing?

Answer to point 4: The web plate is designed and detailed in accordance with the FBJ concept developed by Clifton. When flange and web plates are in tension the design concept requires the flange plate to reach peak load, neck and start to lose strength before the web plate reaches its peak in-plane bending strength. This is to avoid the joint flexural overstrength being the sum of the peak flange and peak web contributions. However, the aim was for the web plate to be able to develop at least the design moment capacity of the joint at a maximum considered level of rotation (in excess of 40 milliradians).

This concept was tested in two large scale tests and worked well. For example, the actual yield moment capacity of the second joint tested (which was fully compliant with the final design procedure and detailing provisions) was 408 kNm and the design rotation demand on that joint was 8 milliradians. The final load test on that joint was 6 cycles of loading to +/- 48 milliradians of rotation. At the first cycle of rotation the top flange plate fractured at 43 milliradians of negative rotation and the bottom flange plate at 43 milliradians of positive rotation. For the next 5 cycles of loading the web plate alone developed the moment, with this plate necking and a fracture developing between the outer bolt and free edge of plate in the first cycle of loading and propagating into the centre of the web plate with each subsequent cycle. It took until the third cycle for the moment capacity at 48 milliradians of rotation to drop below 408 kNm in positive rotation and the fourth cycle for negative rotation. These rotations correspond to a structural displacement ductility demand of 6 compared with the design structural displacement ductility demand of not more than 2. Thus the web plates used on the Beca project have more than adequate inelastic strain capacity.

However, the Beca Bump modification does increase the overstrength capacity of the joint. This is because the flange plates will be developing their maximum capacity at a rotation sufficient for the web plates to also develop their maximum capacity. This increased overstrength was allowed for in the Beca design. An alternative approach might be to form the web holes as short slotted holes in the horizontal direction so that the web plate contribution to moment is delayed.

RF See comments to Aaron regarding this point. But were the holes actually slotted to enable this detail to work? No mention is made in the paper and it still seems strange to me that the web plate bolts can sustain greater lateral displacement before failing than the flange plate bolts where the flange plate was deliberately designed to enhance spread of yielding but there was no such consideration for the web plate. What basic mechanics point am I missing?

CC See my answer above in regard to this point made to Aaron's letter.

CC/JB Point 5: What spacing of expansion joints is required to prevent self strain actions from causing yield of the plates and subsequently reducing their deformation limit due to low cycle fatigue?

Answer to point 5: Richard mentions a number of self strain actions, principally temperature change and concrete shrinkage. The beams in this building (and in all steel moment –resisting framed seismic-resisting systems) are tied into the slab with shear studs for diaphragm transfer and sometimes for positive moment composite action. The shear studs are stopped off typically 1.5 d_b before the column face. Concrete shrinkage will cause a negative rotation at the beam ends, up to around 2 milliradians maximum.

Differential temperatures between steel beam and concrete slab will have a similar maximum effect although the rotation could be positive or negative depending on the relative temperature of the beam and slab. Temperatures induced by fire will impose greater rotation demands, comparable to those from the design earthquake.

Any yielding of the plates due to shrinkage or in-service temperature changes will correspond to a rotation demand of up to 2 milliradians which is well within even the original plate deformation capability without degrading its subsequent seismic performance, including under low cycle fatigue. This is the case even if the plate is on the point of yielding due to negative beam end rotation from imposed gravity loading. For negative rotation, if it makes the joint yield then the joint rotational stiffness for further imposed negative rotation will be reduced. If the joints have high gravity loads then this could reduce the lateral stiffness of the building under, for example, wind serviceability loading. On the Beca project this was considered by making the negative moment end of all MRF joints pinned for assessing lateral deflection under the wind serviceability loading condition.

RF This answer does not address the question that I raised. The question is about the accumulation of thermal movements with small addition of movement due to shrinkage of concrete displacements from adjacent bays as all the bays between expansion joints are joined together. See comments in response to Beer's proposed response.

CC See my answer above in regard to this point made to Aaron's letter.

RF I greatly appreciated the detailed responses that Aaron Beer, Charles Clifton and John Butterworth have put together in response to my questions. I hope readers may gain from the considerable additional effort that they have gone to in amplifying the concepts behind the innovative structure that they have designed or helped design.