



# Presentation to EWPAA Conference 16<sup>th</sup> November 2009



Robert Finch – CEO, Structural Timber Innovation Company





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## STIC Vision

- The implementation of innovative & sustainable multi-story, large span timber buildings in Australia & New Zealand

### This will be achieved through:

- The development of prefabricated structural timber members, made from LVL and Glulam, and viable pre-stressed timber construction systems for frames, walls and floors
- Promotion and technology transfer of the systems developed to the relevant sectors of the building industry



## STIC Mission

- Contract and manage the required research and development
- Manage the IP developed and its availability
- Facilitate and promote the implementation and transfer of the newly developed IP into the Trans-Tasman building and construction industries



## Resulting in:

- Demand stimulation for Trans-Tasman Engineered wood products. Increased sales of LVL & other timber
- Widely available sustainable building solutions



# STIC Shareholders & Stakeholders

## Shareholders

Carter Holt Harvey Ltd

Nelson Pine Industries Ltd

Wesbeam Pty Ltd

Building Research Association on NZ

Pine Manufacturers Assoc.

Auckland Uniservices

University of Canterbury

## Stakeholders

Forest & Wood Products Australia

Foundation Research Science & Technology



## STIC Total Project Investment

Project Investors	Total NZ\$*
Shareholders and FWPA (Australia)	\$5.2m
Foundation Research Science Technology	\$5.2m
Total Investment over 5 years	\$10.4m

\* All investments excluding GST



## STIC Ltd People

- **Board of Directors:**
  - Clive Tilby (Chairman)
  - Peter Law (Wesbeam)
  - Alan Bones (Carter Holt Harvey)
  - Lawrie Halkett (representing Nelson Pine Industries)
  - John Duncan (Building Research Association NZ)
  - Michael Davies (Auckland Uni, UoA / UC rotating)
  
- **Management:**
  - Robert Finch (CEO)
  - Andy Buchanan (Research Director)



## Background – Clive Tilby

- 40 years experience in design and construction industry NZ and offshore
- Strong working contacts with major constructors, designers and building owners in NZ (and to a lesser extent in Australia)
- Experienced in Board governance and company strategic direction
- The only Independent Director of STIC Board

## Background – Robert Finch

- Wide experience in research and development organisations
- Identification and exploitation of IP
- Business management skills
- Technology Marketing Experience



## Background – Andy Buchanan

- Professor “Timber” of NZ industry, plus international profile & contacts
- Key knowledge holder of all STIC developing technology
- Champion of the technology transfer process



## STIC Ltd Status & Key Facts

- STIC commenced in Jul 2008 and is proposed to continue until Jun 2013 (present budgeted life)
- All Shareholder and Stakeholder agreements have been negotiated and signed
- R&D Service agreements are in place with University of Technology Sydney, University of Auckland & University of Canterbury
- Robert Finch, incumbent STIC CEO, commenced on 15<sup>th</sup> Jun 2009
- STIC has just had its Year 1 Governance Review with FRST in Oct 2009 – Report will be available later in Nov.

# Significant Project Achievement to date



- Design, construction & preparation of 2-story large-scale post-tensioned timber building in Lab.
- Project managed by industry
- Large-scale testing now in progress
- 2.5 days to construct!

## 2/3 Scale Post-tensioned bld in Lab



# The Technology



## What is it?

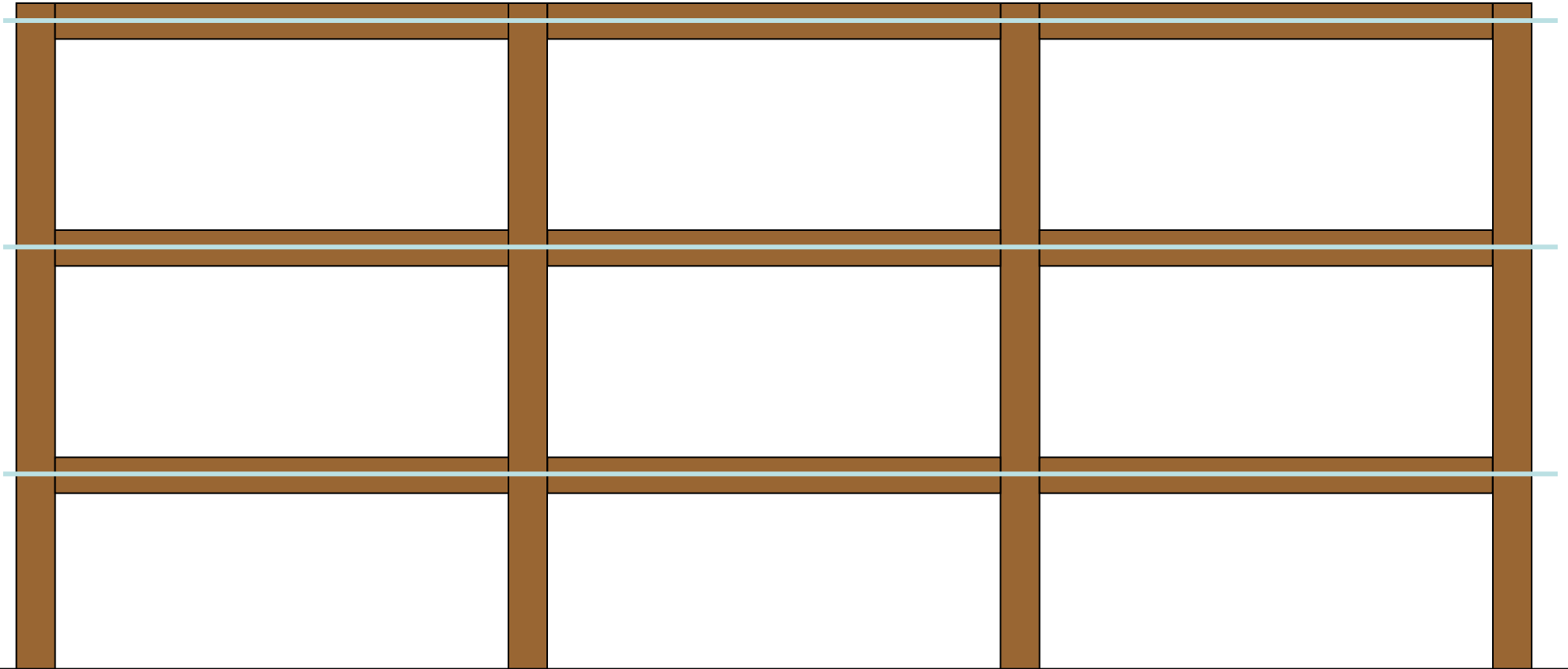
- An engineered timber design & construction platform that enables fit-for-purpose LVL / Glulam commercial & industrial buildings to be technically & commercially competitive with comparable steel & concrete buildings

## How does it work?

- Large, prefabricated beam, column, frame, floor and wall units are rapidly assembled on site using post-tensioned tendon systems, similar to post-tensioned pre-cast concrete techniques



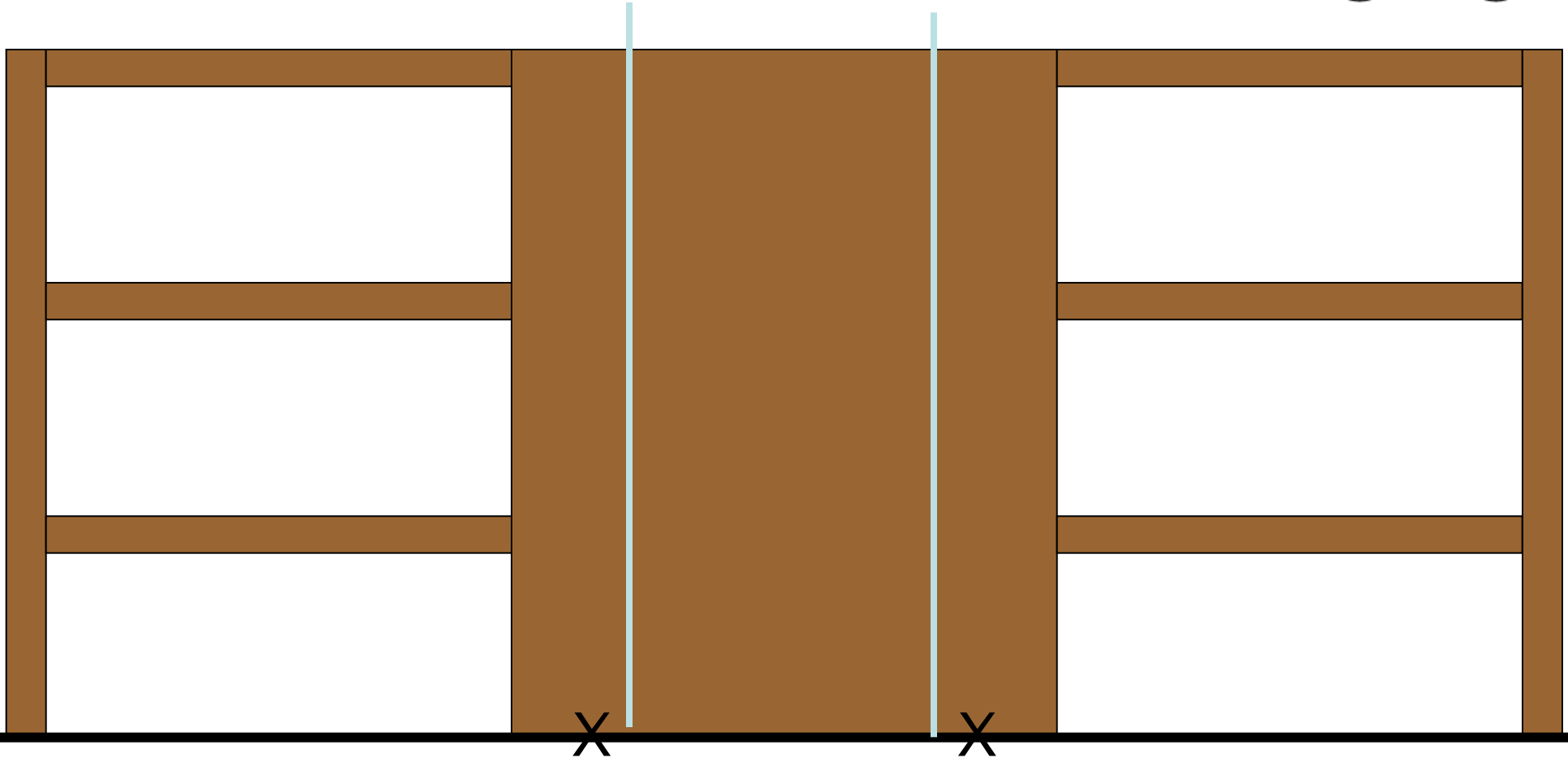
# Post-tensioned timber frames



Post-tensioning solves the problem of moment connections for heavy timber



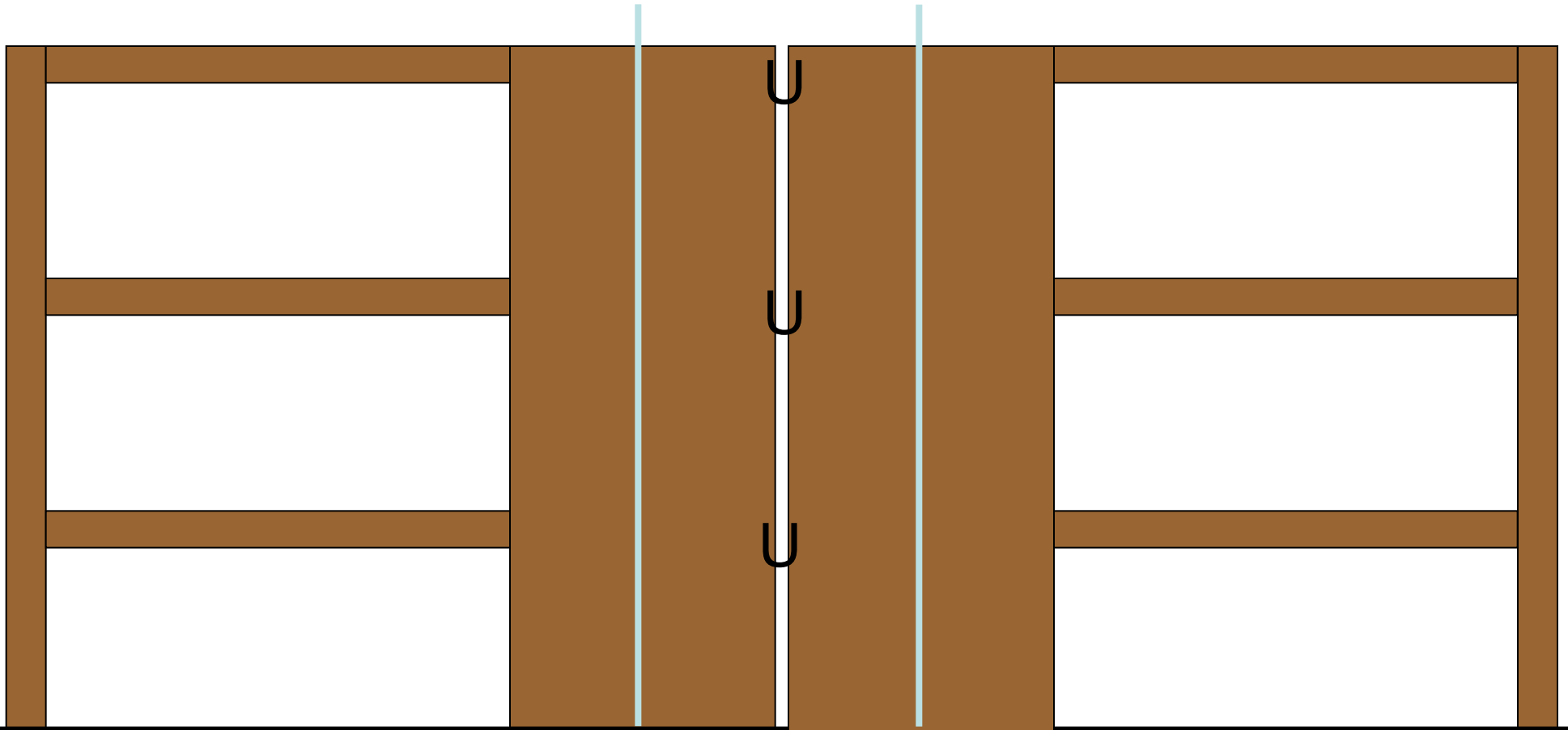
# Post-tensioned timber wall



Post-tensioning solves the problem of moment connections for heavy timber



# Post-tensioned timber walls



Post-tensioning solves the problem of moment connections for heavy timber





## The Research Team

- There are presently 3 research providers engaged:
  - University of Technology, Sydney (led by Prof. Keith Crews)
  - University of Auckland (led by Prof. Pierre Quenneville)
  - University of Canterbury (led by Assoc. Prof. Stefano Pampanin)

## Background IP

- STIC has the exclusive right to commercialise the UC background IP (patent) in Aust. & NZ
- Elsewhere, STIC has non-exclusive rights to commercialise UC background IP on reasonable commercial terms
- All improvements to UC background IP arising from STIC activities owned exclusively by STIC

## Industry impact to date

- Discussions & a workshop resulted in design of world's first pre-stressed laminated timber building (Nelson, NZ).
- First application of post-tensioned walls
- To be constructed next year (2010)



NMIT – Arts & Media Building

# Milestones & Achievements to date

Testing of fastener systems & portal frame knee joints

New proposals for building code submitted to Standards NZ

Jun 09

✓

## Embedding strength of New Zealand timber and recommendation for the NZ standard

Dr. Hufien Franka, Prof. Peter Queneyville  
University of Auckland, New Zealand

### 1 Introduction

For all connections it is important to predict the failure strength as accurately as possible. This includes both the ductility and in some cases especially in timber construction, the failure failure as well. For the calculation of the ductility failure strength, the European Yield Model (EYM) is used in many standards and accepted as a very accurate model. It forms the basis of the European timber standard Eurocode 5 (EN 1995-1-1:2004). The development of this is based on a multitude of embedding and joint tests with different European and North American wood species by many researchers. Furthermore a continuous adaptation and improvement is expected because such as in Hübner et al. (2000) [7]. The most important parameters for the EYM are the failure yield moment and the timber embedding strength, which are known for most of the softwoods and tropical hardwoods.

In the current NZ timber standard NZS 3903 (10) the design concept for bolted connections is not based on the EYM, but depends only on the diameter and the timber thickness. It doesn't predict the different types of failure and overstates the joint strength partially. There are no embedding strength values, which can be used for the designer's responsibility to estimate the yield strength of joints. Furthermore, no formulae are available for the design of joints with the engineered wood product Laminated Veneer Lumber (LVL), which are becoming more important in structural structures. To implement the EYM design concept in the current New Zealand design standard for mechanical connections, it is then necessary to investigate the material behaviour and to determine the embedment values for Radiata Pine timber and also for Radiata Pine LVL, the two main products used in New Zealand construction.

Embedding tests parallel, perpendicular and under various load-to-grain angles with different diameters with LVL, were conducted and compiled together with results of NZ Radiata Pine to build a database of embedding strength values to implement the European Yield Model into the NZ standard. The embedding strength was evaluated using the 5°-offset method, the classical proportional limit load according to EN 12512 and the maximum load, which is either the ultimate load or the load up to 2 mm displacement, according to EN 383 (199) and EN 1995-1-1 (2004) respectively. For the embedding strength from Radiata Pine lumber, results from other researchers were used. There is also a comparison with the predicted embedding failure from Eurocode 5. Moreover, the paper presents a comparison of the different available test standards for determining the embedment strength.

Proposed Section 4 on Joints – NZS 3903

STIC – June 2009

### 4. Joints

#### 4.1 General

Section 4 provides the criteria for the engineering design and analysis of joints using dowel fasteners (nails, screws, bolts) and surface fasteners (split ring, shear plates, girth or knee timber, structural glued laminated timber, timber poles and piles, LVL, and structural wood panels except where limitations are specified). Alternatively, fasteners may be used where their design conforms to the requirements of Section 300.

#### 4.1.1 Fastener Requirements

##### 4.1.1.1 Material

The design of connections shall take into account factors that affect the strength of the material used. It is assumed that the presence of knots, splits or other defects be limited in the region of the connection such that the load-carrying capacity of the connection is not reduced.

##### 4.1.1.1.1 Non-Wood Material

All parts and details of wood participating in a load transfer, shall be designed in accordance with the applicable material design standard approved in the Building Code.

##### 4.1.1.1.2 Corrosion

All metal fasteners and parts of a connection shall, where necessary, either be corrosion-resistant or be protected against corrosion.

##### 4.1.1.2 Resistance Factors

The resistance factors  $\beta$  as a function of failure mode and type of force are as follows:

Lateral load  $\beta_{L_1} = 0.7$  for brittle failure modes

$\beta_{L_2} = 0.8$  for ductile failure modes

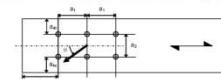
Withdrawal load  $\beta_{W_1} = 0.8$

##### 4.1.1.3 Geometry

The design of connections shall take into account geometrical factors that affect the strength of the connection. A row of fasteners consists of one or more units of the same type and size aligned with the direction of the load. A group of fasteners consists of one or more rows of fasteners arranged symmetrically with respect to the axis of the load.

##### 4.1.1.3.1 Configuration Variables

The various connection dimensions and spacing variables are defined as shown in Figure 4.2.2.1.



© 1998 NZS

## Milestones & Achievement to date

New structural solutions & connections for TCC floors developed & tested

Progress on new connection systems for TCC floors presented to TDS seminars  
Mar 09

3 X Timber Design Society seminars delivered:  
Floors, Connections, Seismic

Jun 09

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# Milestones & Achievement to date

## 5-storey shaking table test



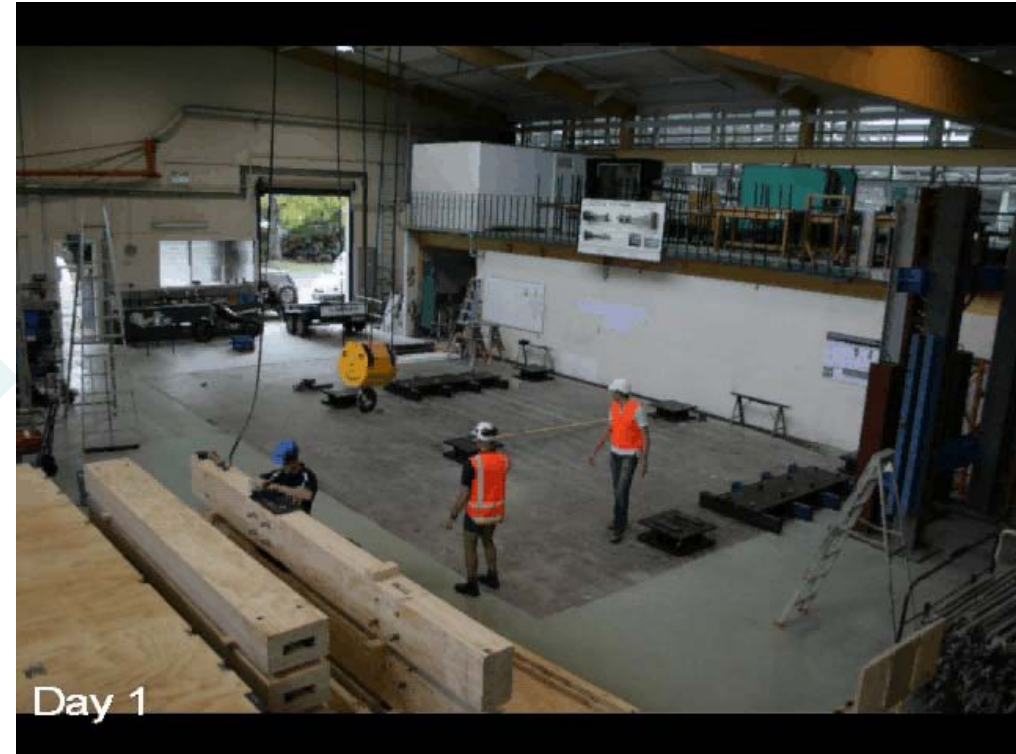
# Milestones & Achievement to date

New beam-column connections developed for post-tensioned frames

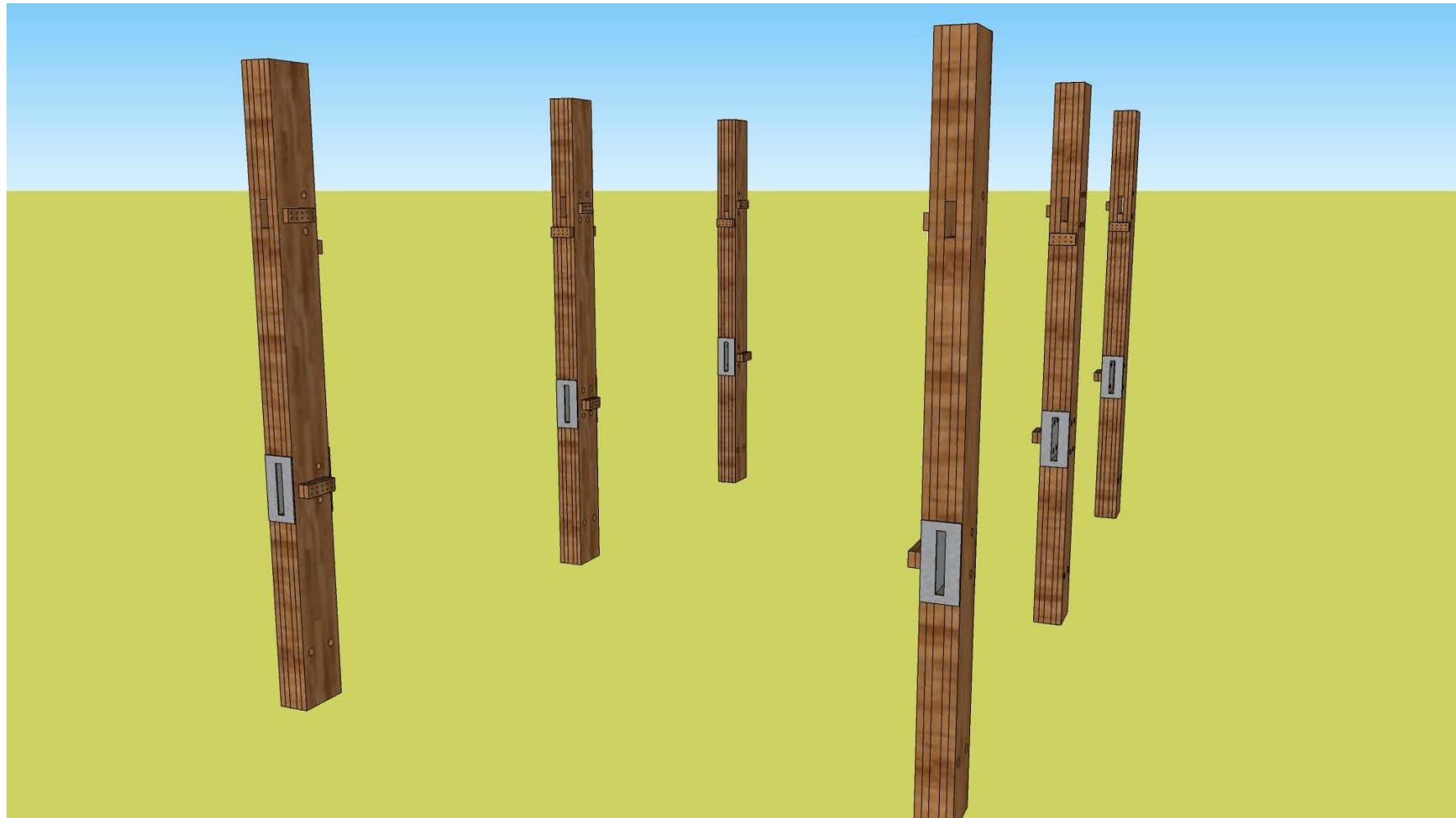
Progress on new connections for frames presented to TDS

Jun 09

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# Milestones & Achievements to date



# Milestones & Achievements to date



# Milestones & Achievements to date



## Fire Resistance Testing



# “Green Buildings” - 6 storey timber design project



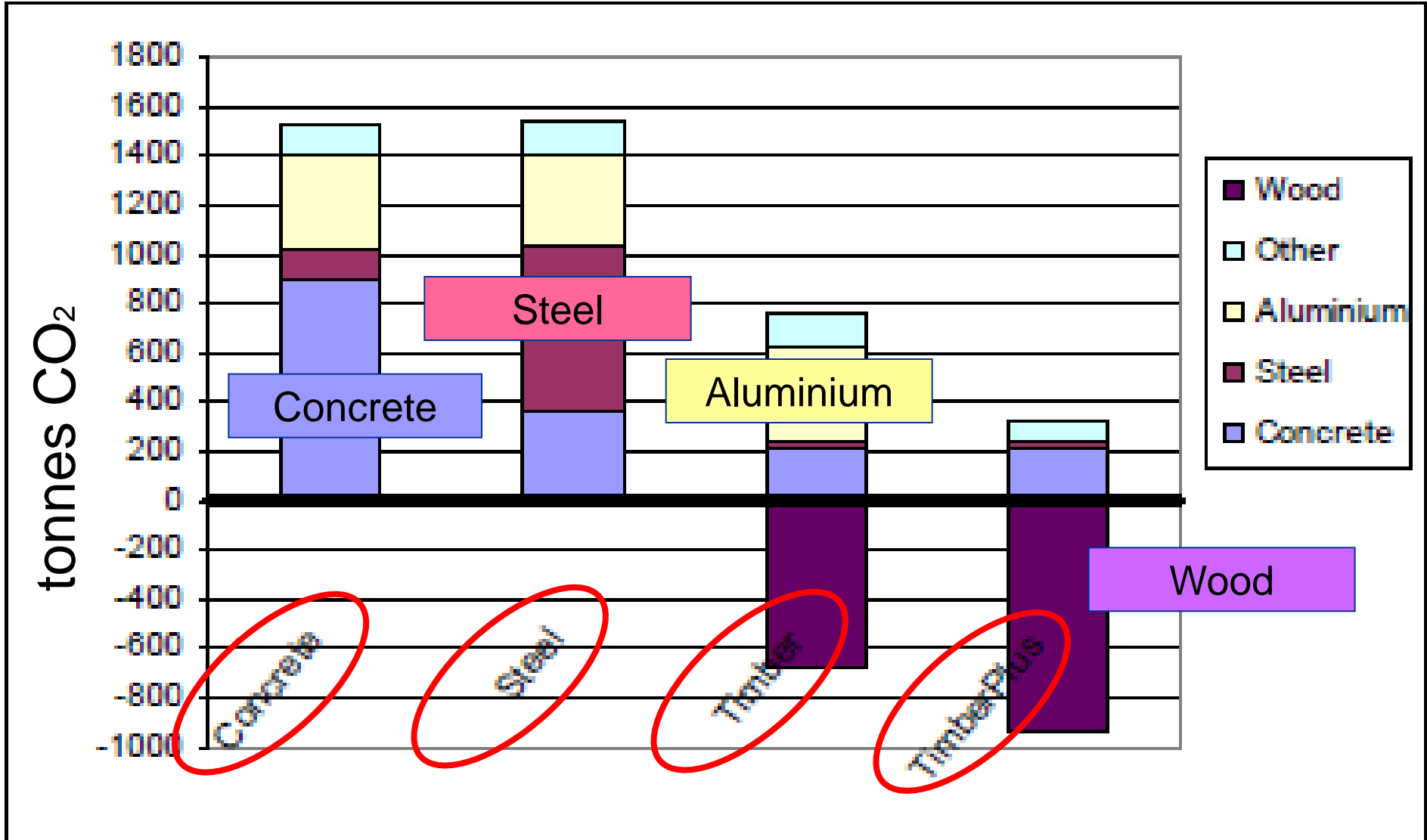
## Timber alternative

- Structural design
- Fire and earthquakes
- Heating and cooling
- Carbon footprint
- Time and cost

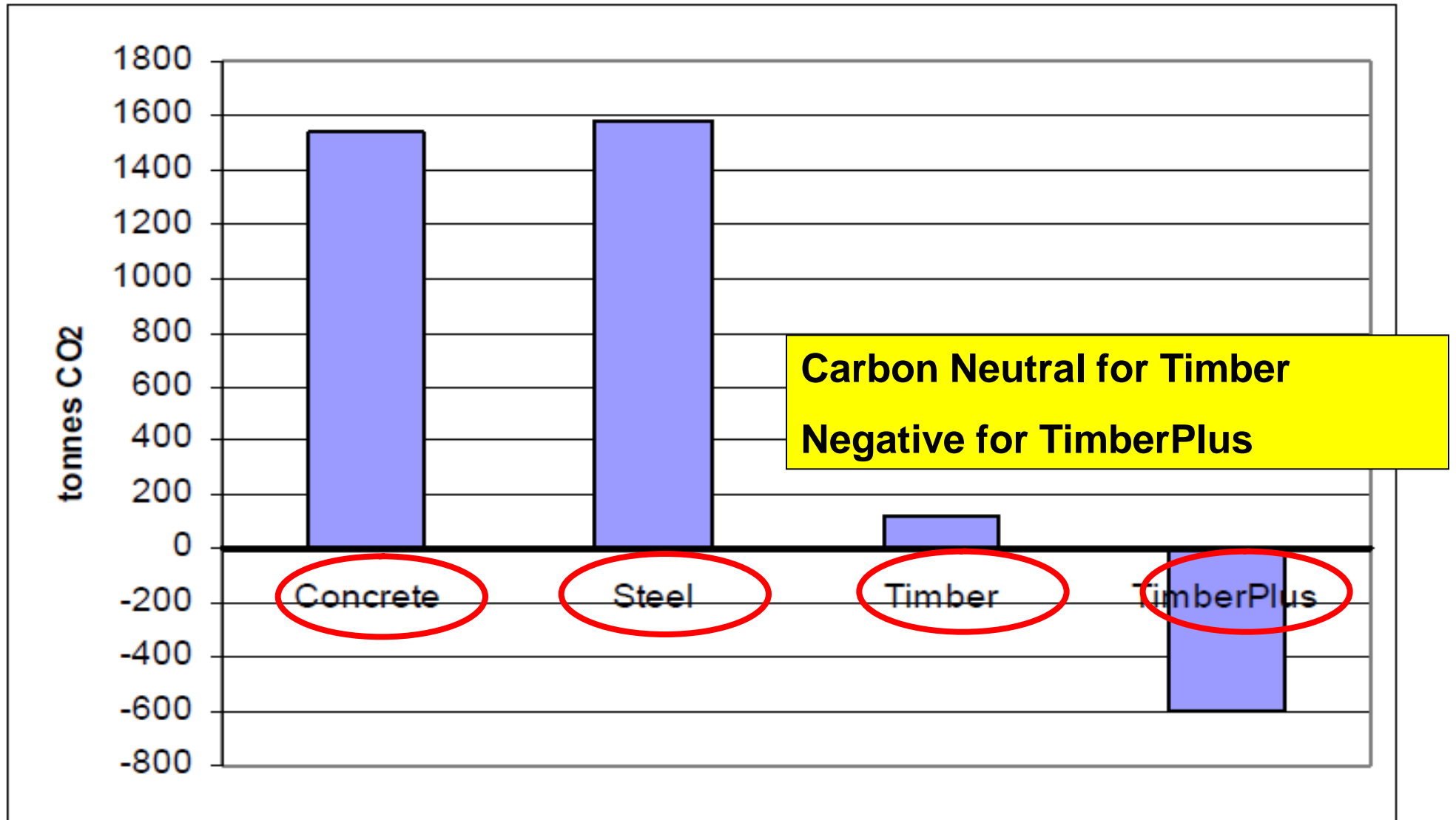


**University of Canterbury  
Biological Sciences**

# Embodied CO<sub>2</sub>



# Overall CO2 emissions



## Achievement to date - Capability building

FTEs	Under-grads	Masters	PhDs	Post-Docs	Total
Uni Tech Sydney			2	2	4
Uni of Auckland		3		2	5
Uni of Canterbury	0.2	5	4		9.2
Total	0.2	8	6	4	18.2

## Other Output Achievements to date

Output	Number
Workshop & transfer of IP / knowledge	3
Trade Journal / Magazine articles	3
Peer reviewed Journal articles	3
Masters theses	4
Published conference proceedings	10
Keynote presentations (Aust / NZ)	17
Keynote presentations (international)	4
Science achievement awards	1
Process implemented by a user	1

## Future Milestones & Targets – Objs 1 & 2

Nov  
2010

Design guide  
for large  
span roofs &  
portal frames  
distributed to  
Aus & NZ  
industries

Nov  
2011

TCC floor  
systems  
accepted in  
Aus & NZ  
regulatory  
authorities



## Future Milestones & Targets – Objs 1 & 2

Jun  
2013

Comprehensive design strategy for long span post-tensioned roofs subjected to severe loads published.



Jun  
2013

Long term creep deflection & relaxation of TCC floor systems & frames established & published.

Acoustic performance & design methods for TCC floor systems developed & published



## Future Milestones & Targets – Obj 3

Jun  
2011

Design methods for fire safety in multi-story pre-stressed timber blds developed & changes to Aus & NZ building codes recommended

Jun  
2012

Design guide for pre-stressed multi-storey blds for low seismic areas published & recommendations for Aus & NZ Bld codes made

Jun  
2013

Design guide for pre-stressed blds in high seismic areas published & distributed in Aus & NZ





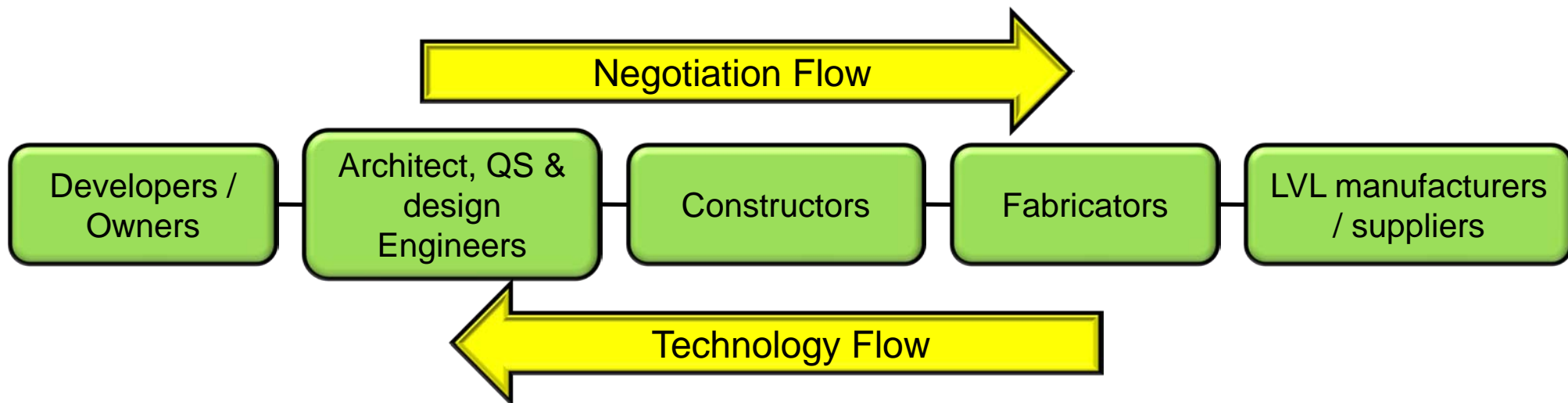
# Projected Technology implementation initiatives

- Engagement with Developers & influential Architects in Australia & NZ
- Workshops & seminar series with influential design & construction Engineers in Aust. & NZ
- Engagement with key industry associations in Aust. & NZ
  - EWPAA
  - GLTAA
  - WPA
  - NZPMA, etc.
- Annual roadshow in Aust. & NZ to promote technology status & new opportunities available

# Projected Technology implementation initiatives

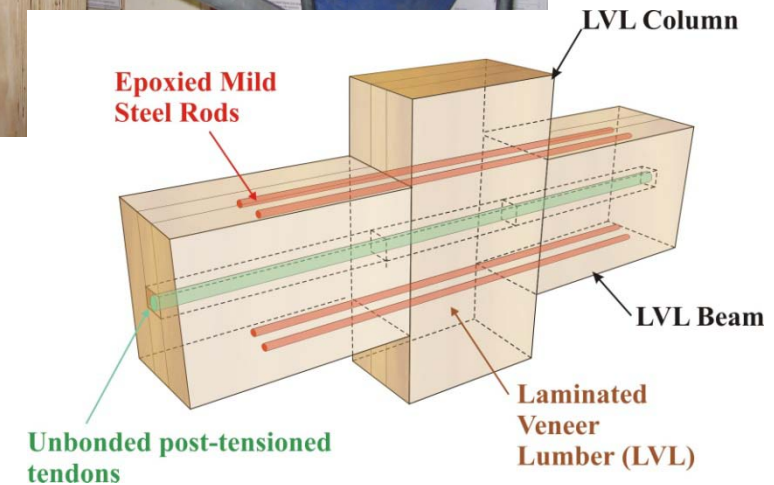


- Commitment by 2 – 4 developers / designers / construction companies in Aust / NZ by 3<sup>rd</sup> Qtr 2010
- Commitment by 2 – 4 fabricators in Aust / NZ by 3<sup>rd</sup> Qtr 2011 to ensure component fabrication capacity will meet projected future demand
- Target commitment by further developers, designers, fabricators & constructors during 2012 & 2013



## Summary

- 1 year in and STIC has made good progress
- All objectives are on track
- May need to introduce small number of new projects to address durability & further work on connections



## Questions & Discussion ?



Thank  
You

