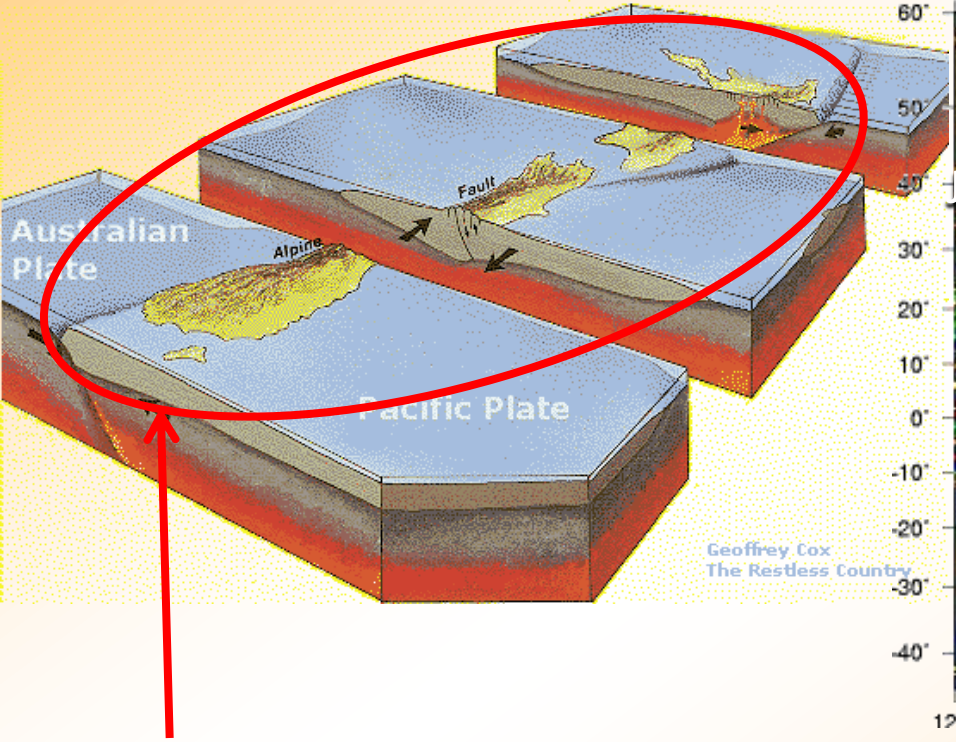
FAO Seminar on Forests and Natural Disasters

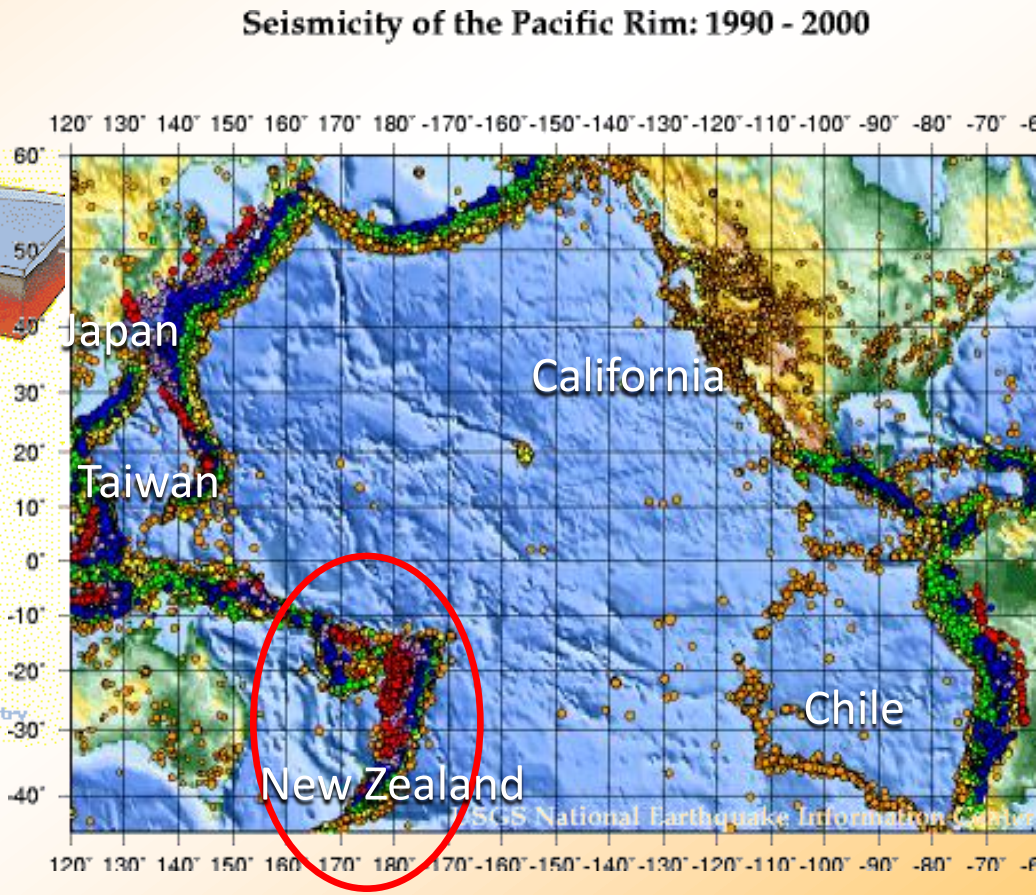
Disaster-Resistant Timber Construction

4 November 2013 - Rotorua

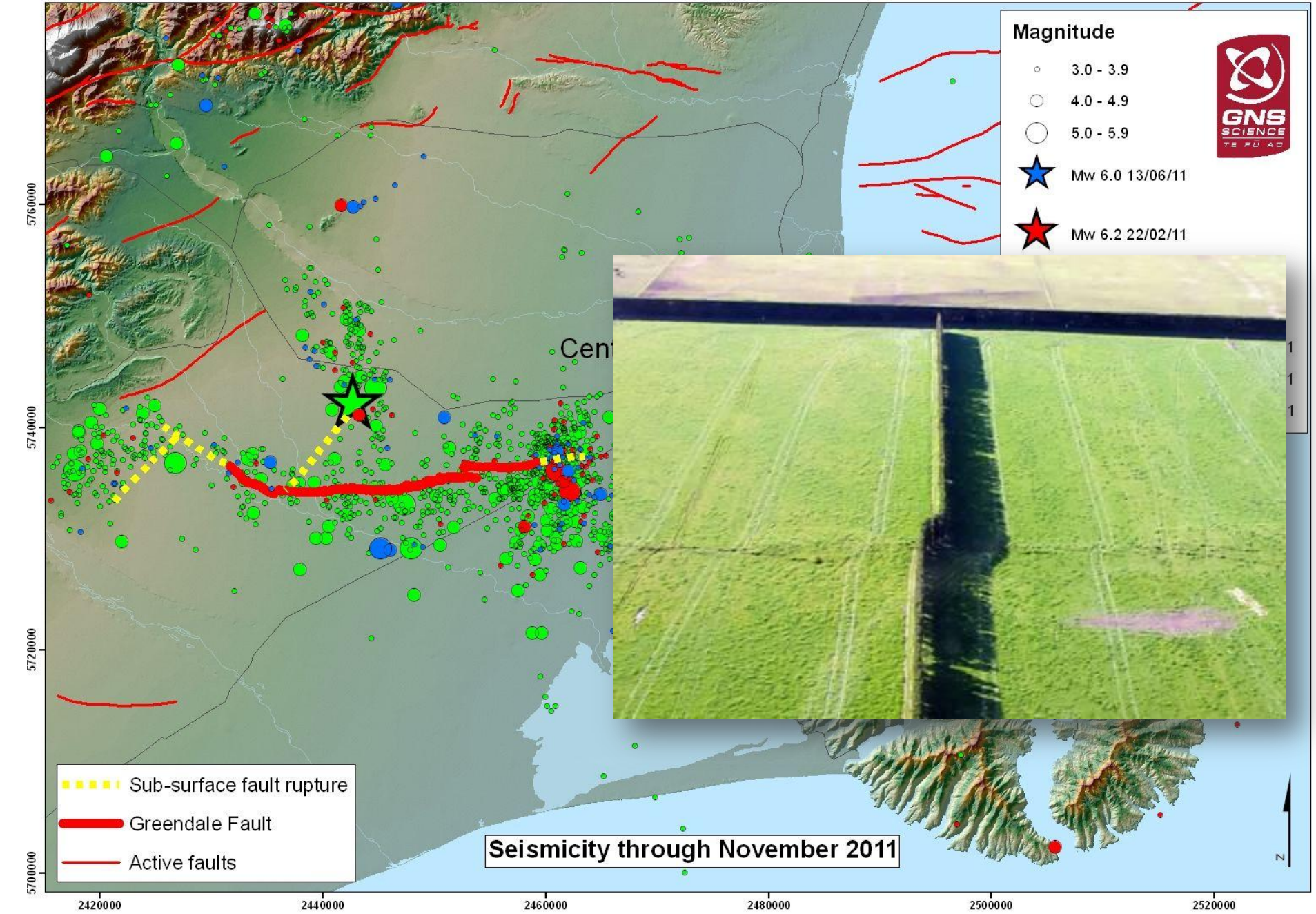
Professor Andy Buchanan
University of Canterbury

2010 & 2011 earthquakes





Movement of fault = 40mm per year


Magnitude
3.0 - 3.9
4.0 - 4.9
5.0 - 5.9
Mw 6.0 13/06/11
Mw 6.2 22/02/11
Sub-surface fault rupture
Greendale Fault
Active faults
Seismicity through November 2011
5760000
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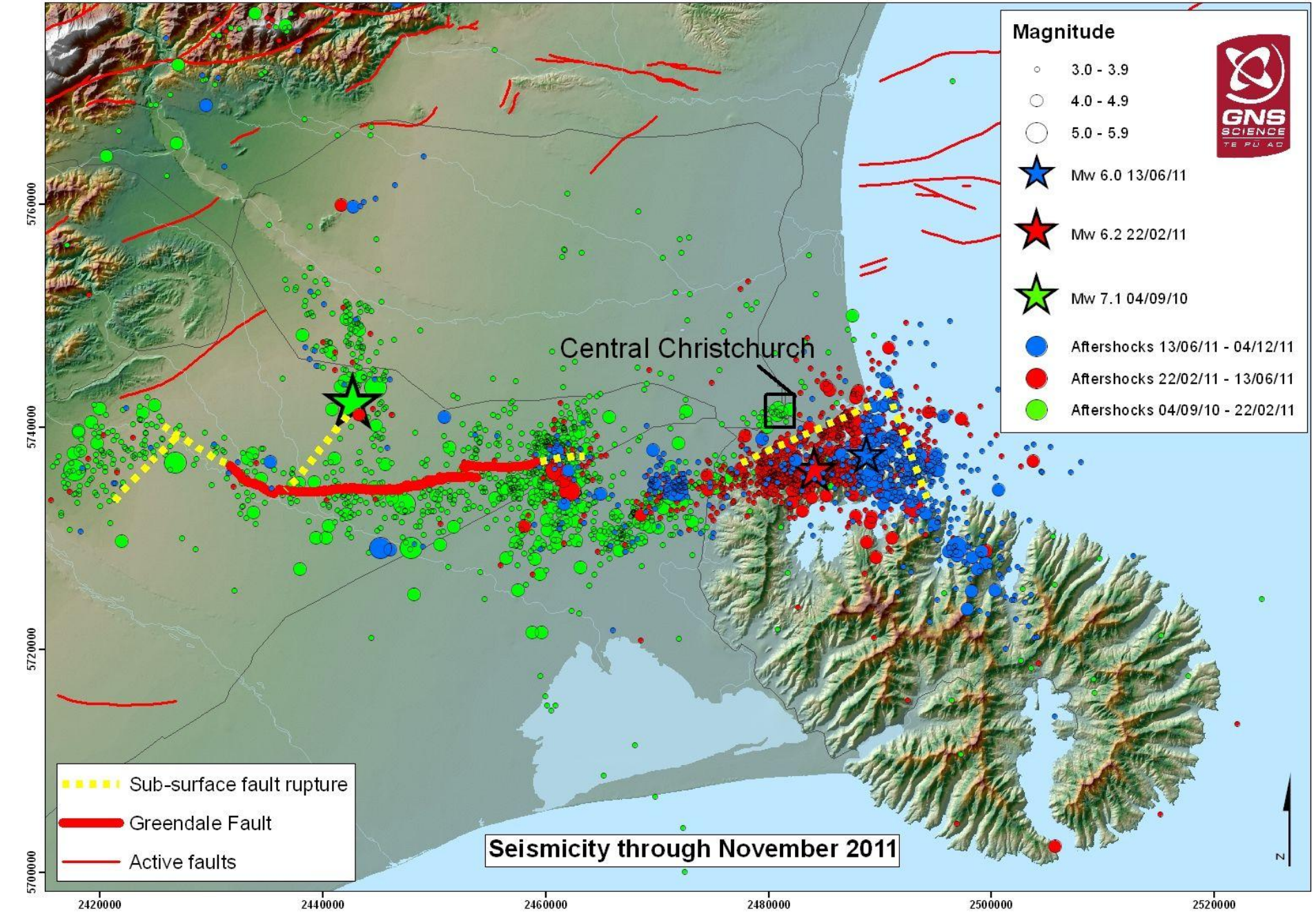
Magnitude
3.0 - 3.9
4.0 - 4.9
5.0 - 5.9
Mw 6.0 13/06/11
Mw 6.2 22/02/11
Mw 7.1 04/09/10
Aftershocks 13/06/11 - 04/12/11
Aftershocks 22/02/11 - 13/06/11
Aftershocks 04/09/10 - 22/02/11
GNS SCIENCE
TE PŪ AO
Central Christchurch
Sub-surface fault rupture
Greendale Fault
Active faults
Seismicity through November 2011
N
5760000
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Christchurch earthquakes

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Main quake:
4 September 2010,
4.30am. M 7.1
No deaths

Aftershock:
22 February 2011,
1 pm. M 6.3
182 deaths

Building collapses. Loss of life

115 deaths in CTV.

18 deaths in PGC

42 deaths in other buildings (masonry)

7 deaths in rockfall etc.

182 total deaths

Liquefaction damage

Vertical accelerations

Roof shaken off

Timber house structurally safe

Wall bracing failures

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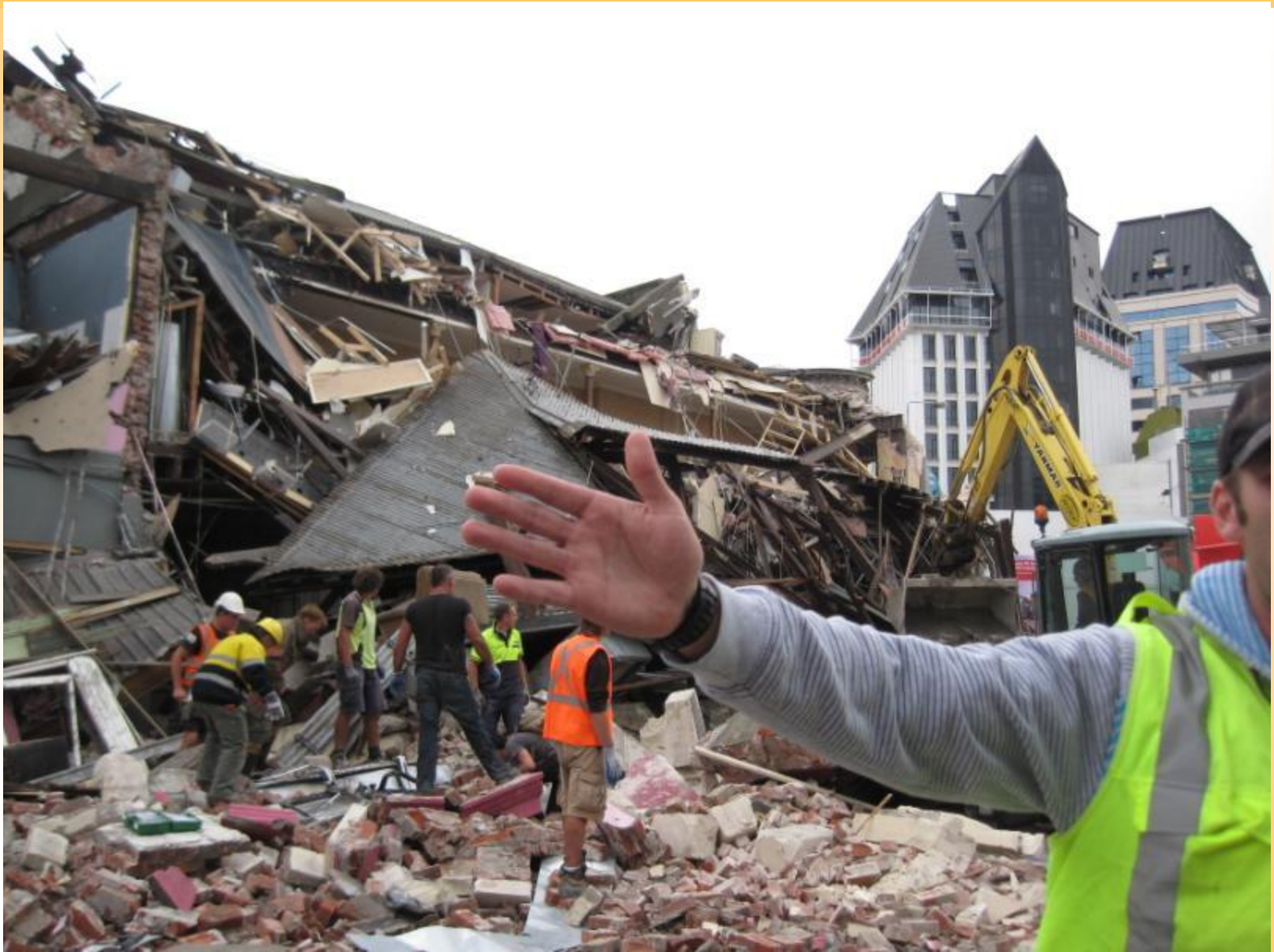
Soft storey collapses

Before

After

Masonry buildings



Christchurch after the quake

Re-building Christchurch

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What kind of city do we want?

Warren and Mahoney

Re-building Christchurch

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Wood is part of the solution

Old Government Buildings, Wellington, 1876

International

7 storeys – Berlin
(Glulam)

6 storeys – Switzerland
(Light timber frame)

9 storeys – London
(X-Lam panels)

New technology

- New materials
  - LVL
  - CLT
- New fasteners
  - Screws
  - Rivets
- New structural concepts
  - Post-tensioning
- Hi-Tech manufacturing

New materials

- Glulam

- LVL

Laminated
Veneer
Lumber

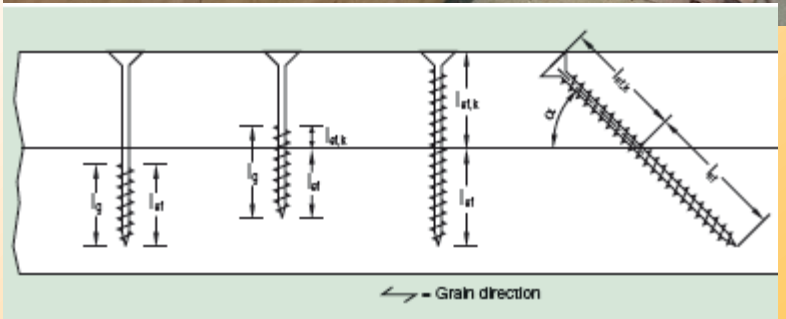
- CLT

Cross
Laminated
Timber

New fasteners

Rivets

Screws



Rocking Concrete Systems

University of California, San Diego

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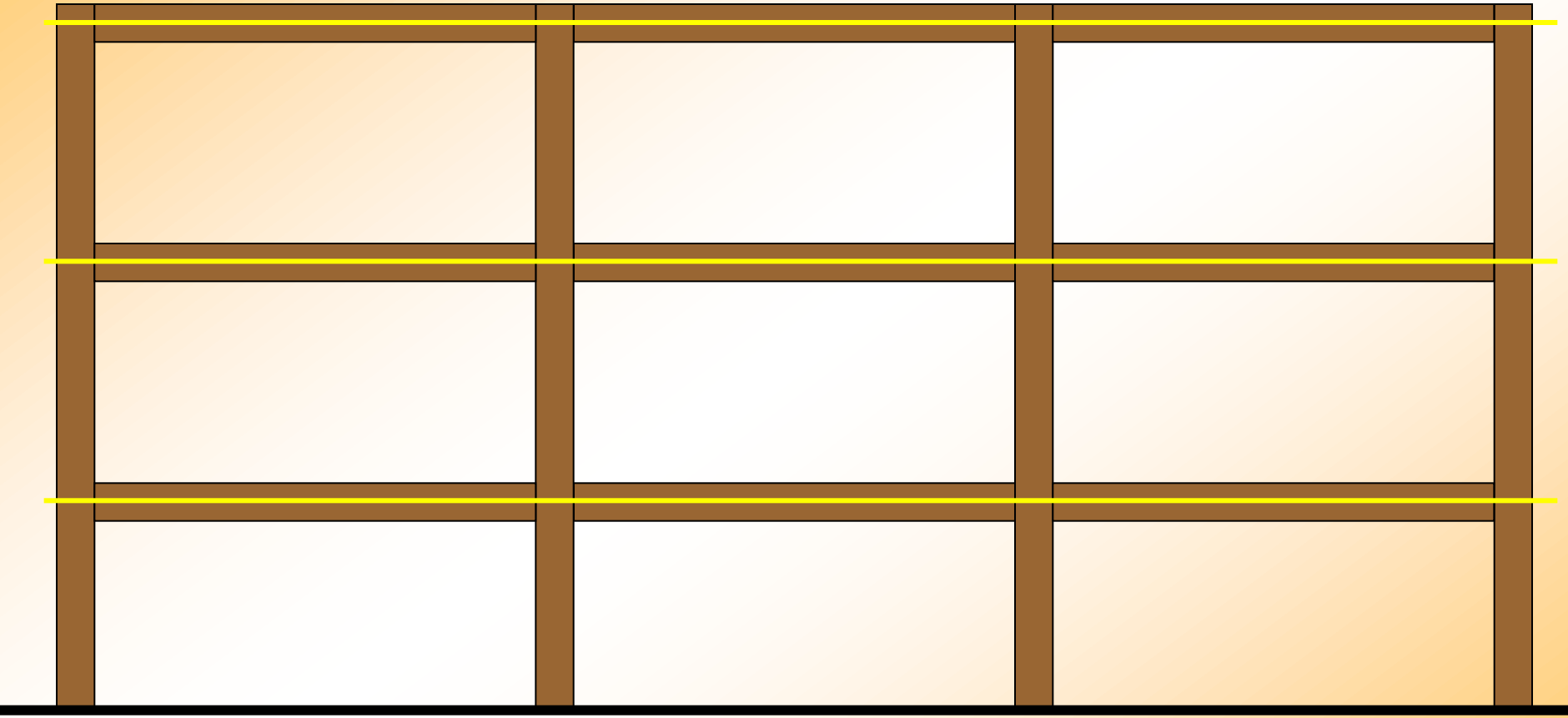
Post-tensioned timber frames



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

Post-tensioned timber walls

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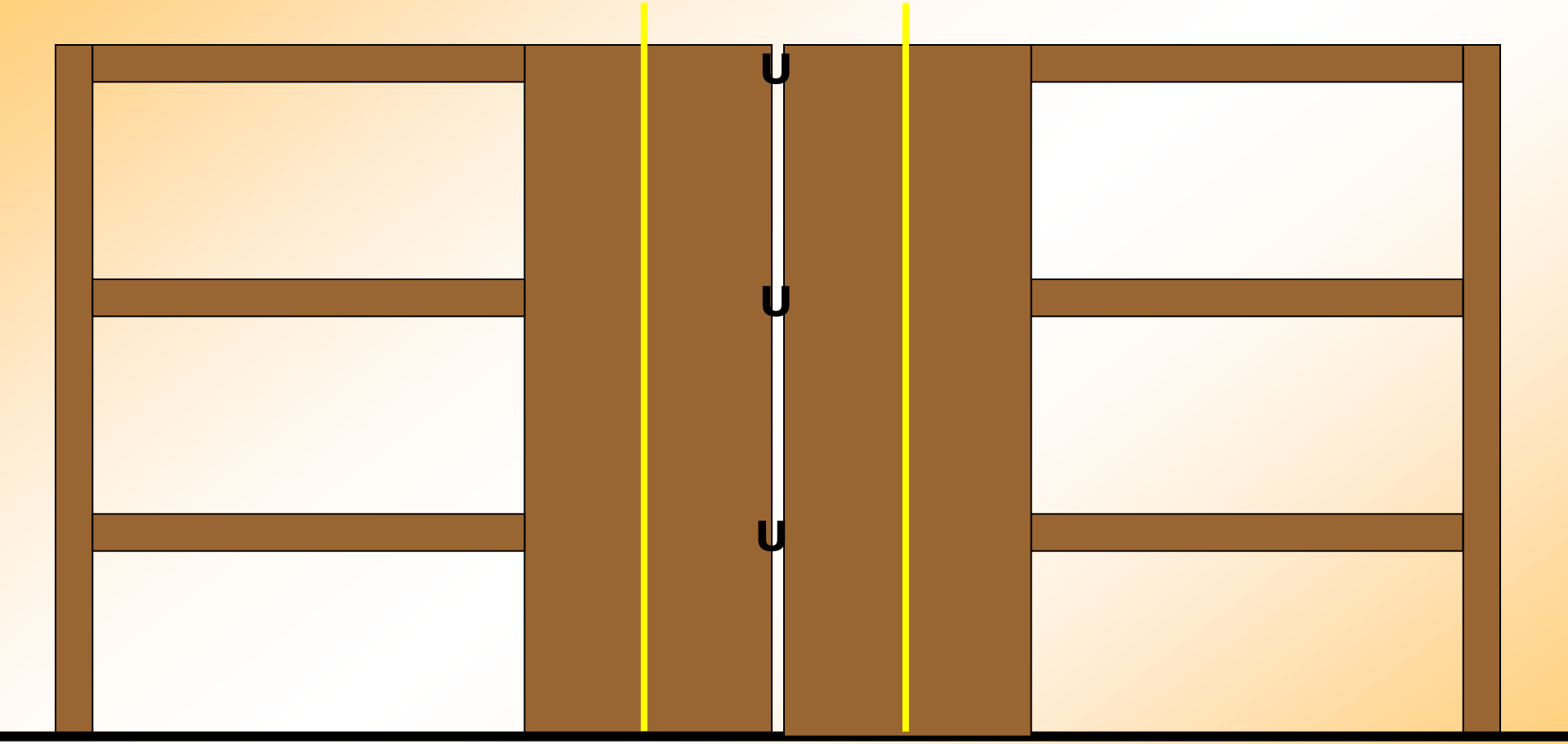
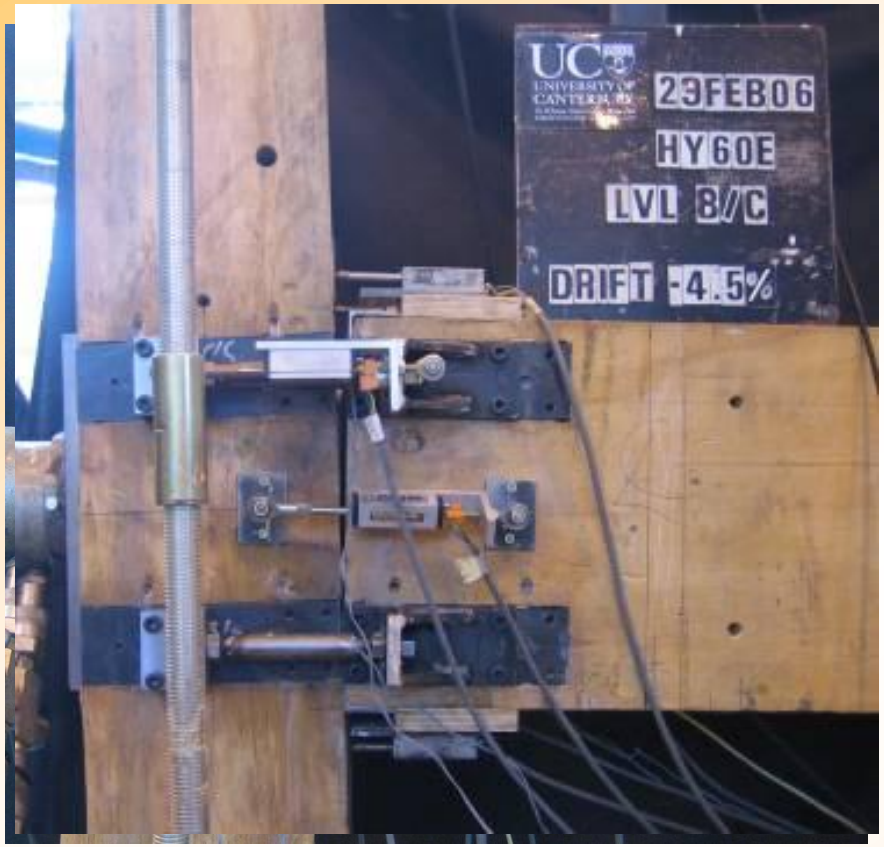
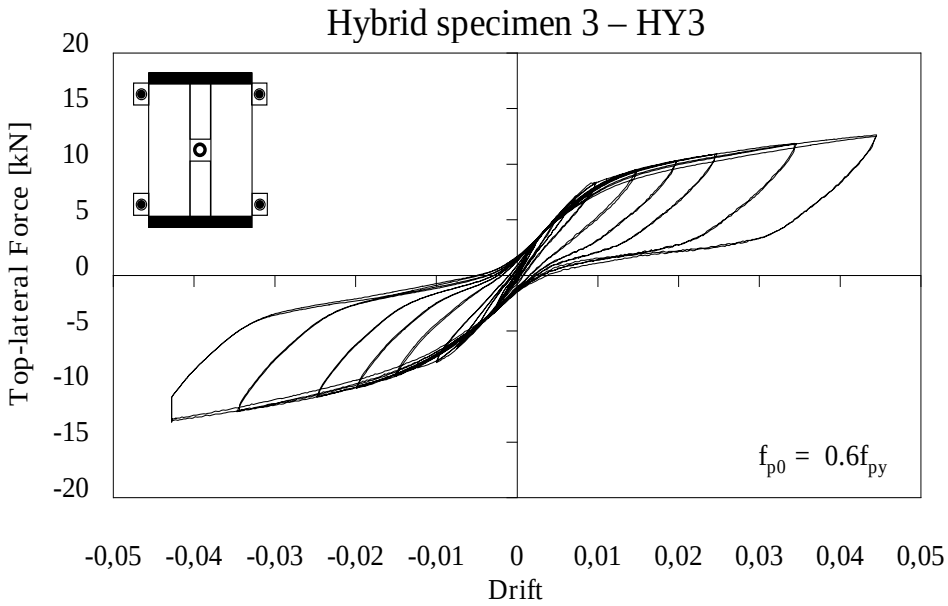
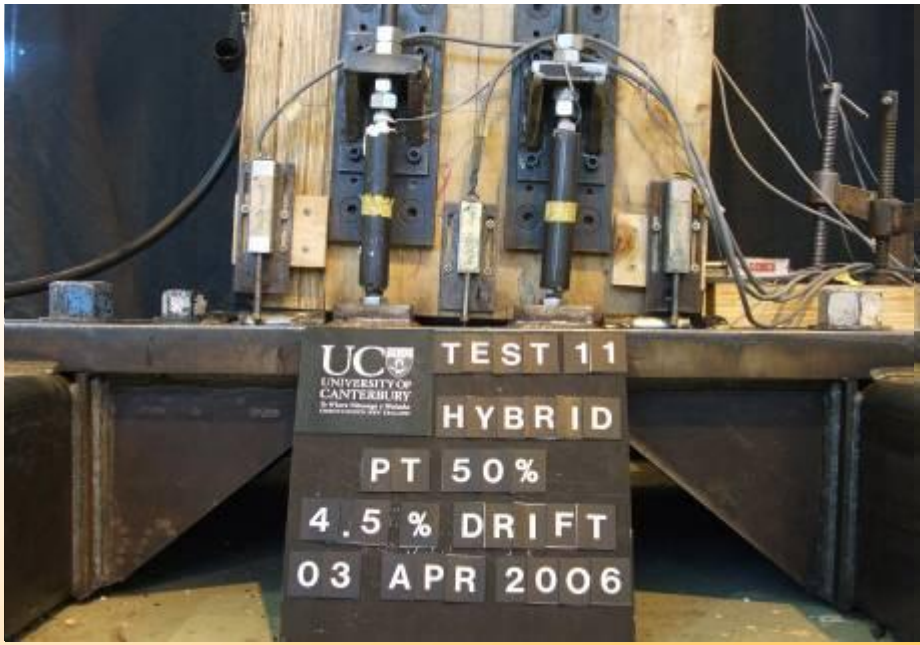


PRES-LAM

Testing at Canterbury University







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Post-tensioned timber beams

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UC Test Building

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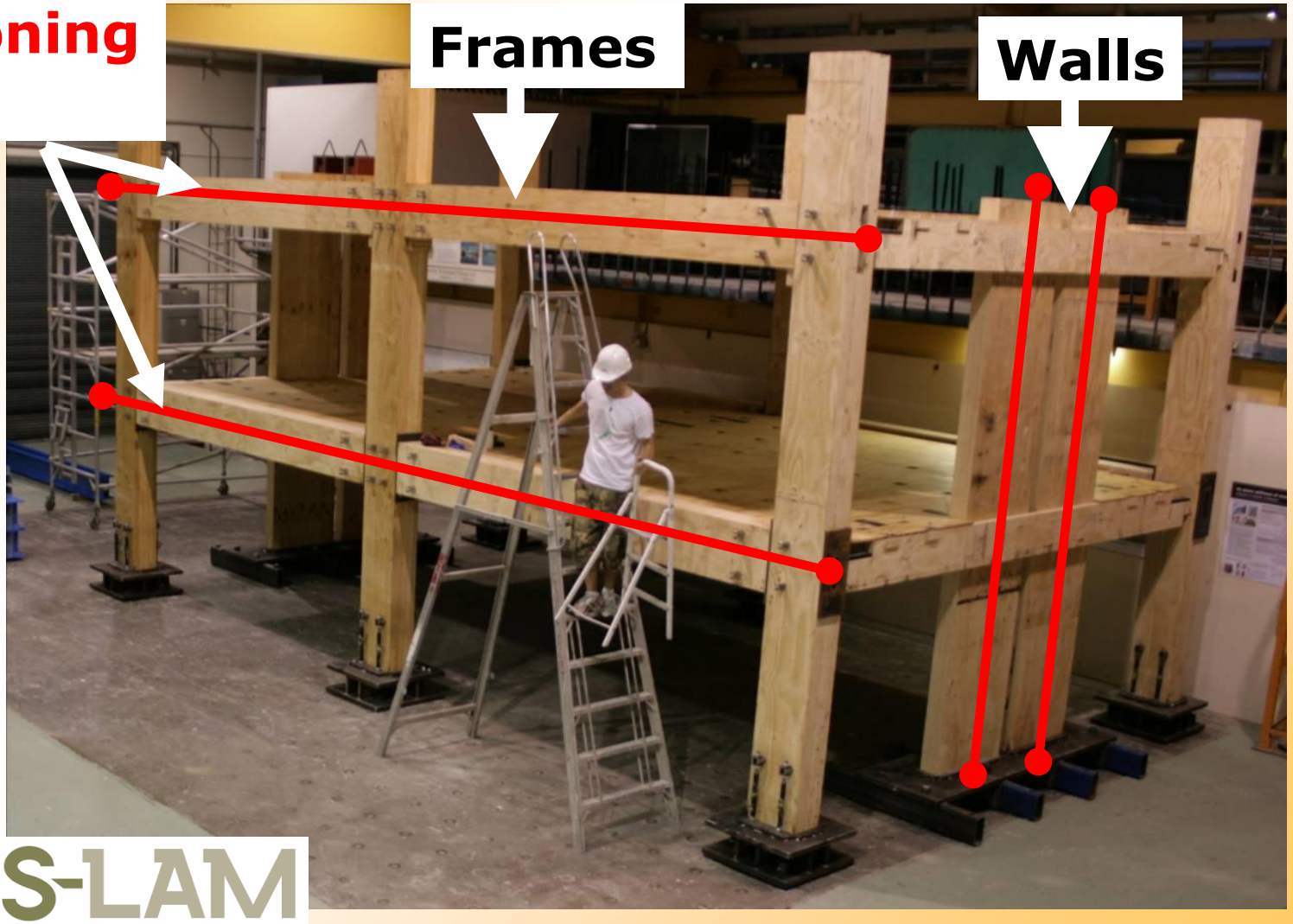
Post-tensioning tendons



PRES-LAM

UC Test Building

Post-tensioning

University of Canterbury laboratories

Expan Head Office

PRES-LAM

Expan Head Office

No damage in Feb earthquake

NMIT Building, Nelson

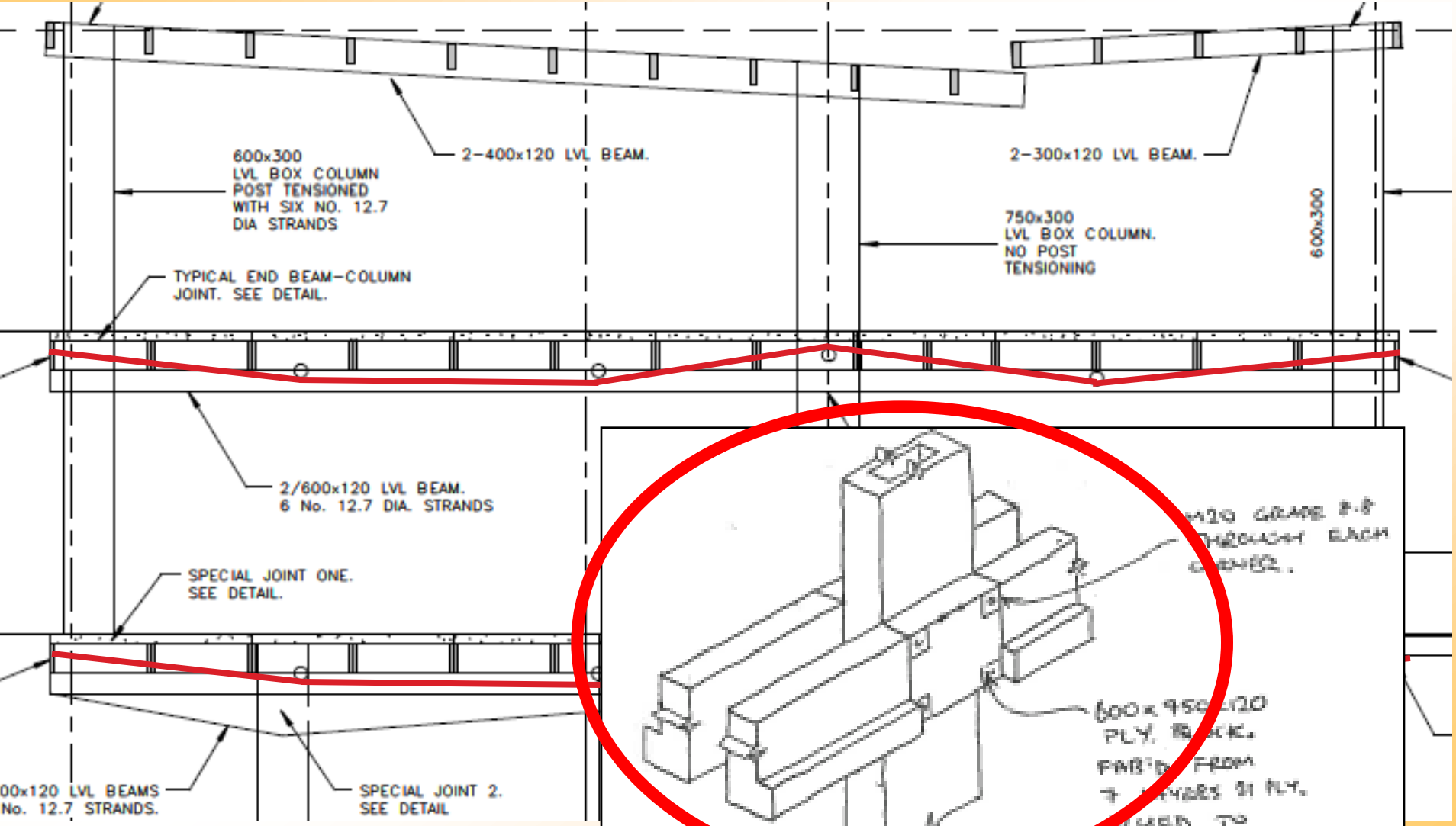
NMIT Arts a

ISJ Architec

nal

PRES-LAM

Massey University, Wellington



Massey University, Wellington

Ma

Athfield Architects, Dunning Thornton

PRES-LAM

Massey University, Wellington

Massey University, Wellington.

Athfield Architects, Dunning Thornton

Carterton, Wellington

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Opus architects and engineers

Kaikoura

Museum, library, council offices, Kaikoura DC

All timber. No concrete. CLT + LVL walls.

Re-building Christchurch

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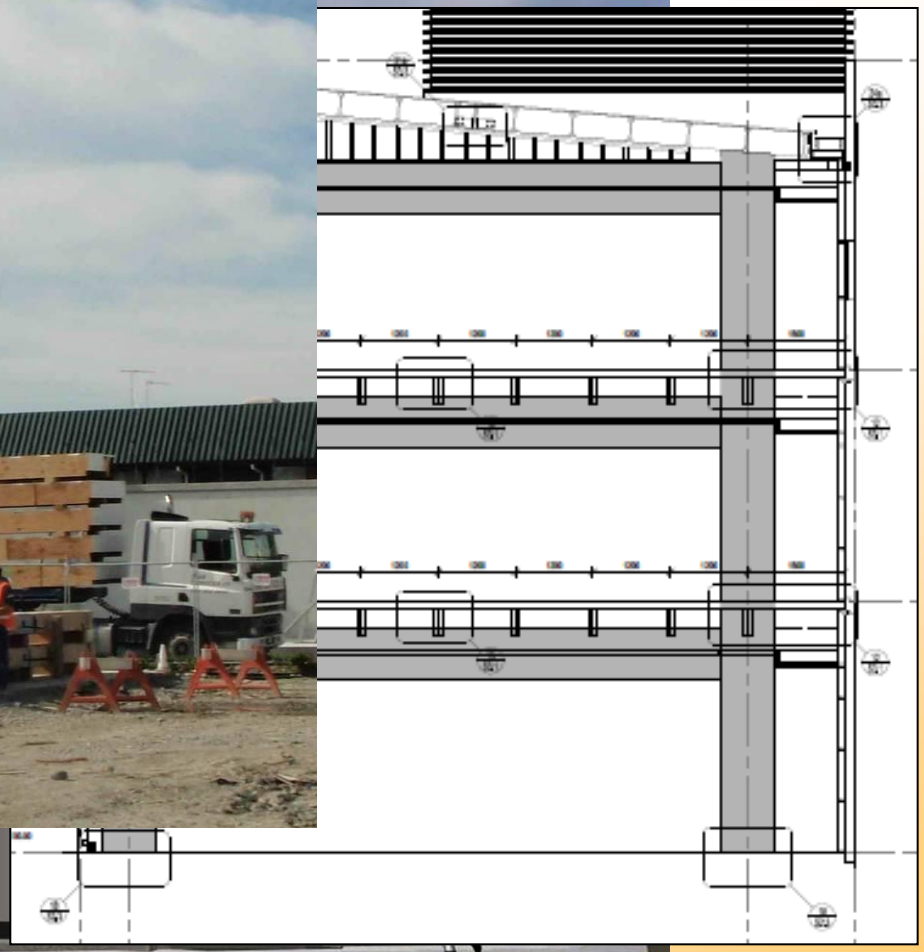

Sheppard and Rout Architects, Kirk Roberts Engineers

134 VICTORIA ST DEVELOPMENT VIEW 6

Re-building Christchurch

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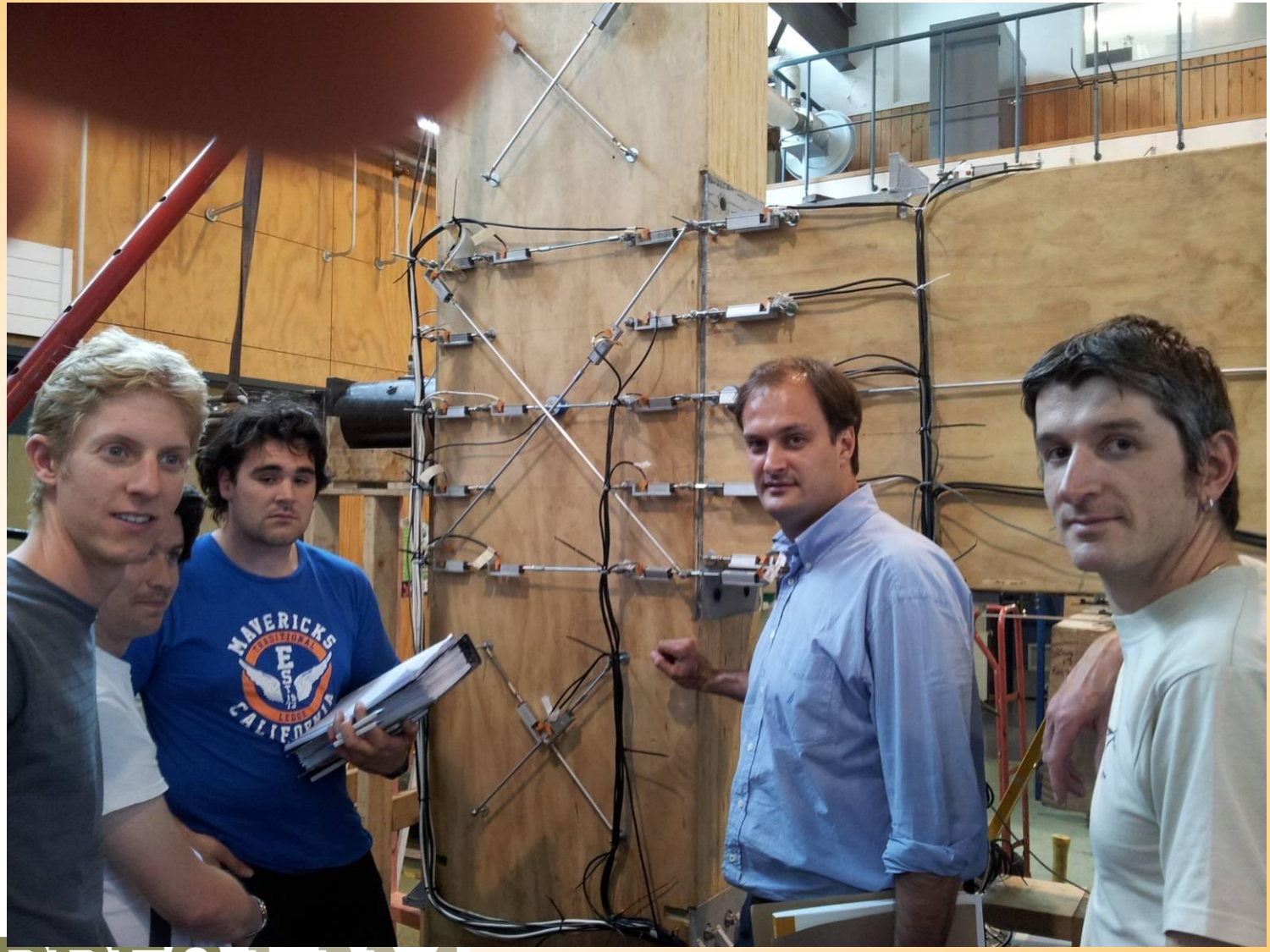

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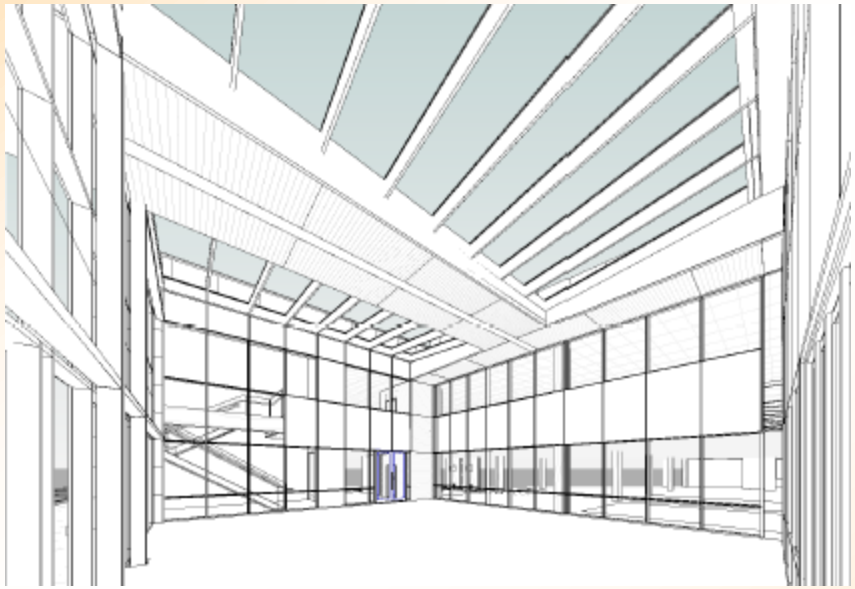
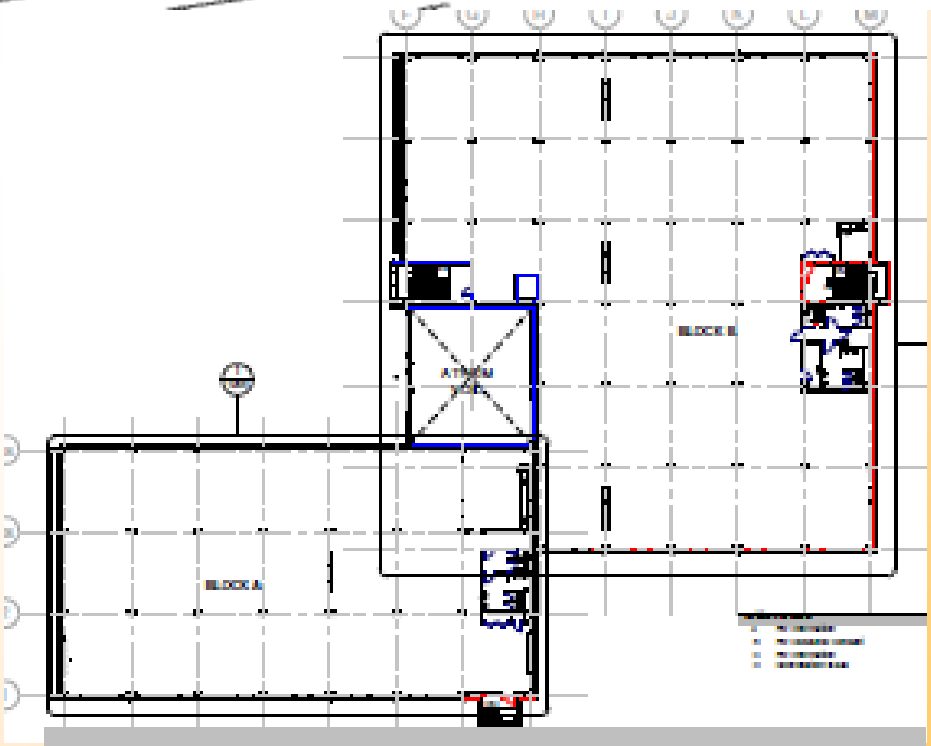
Re-building Christchurch





Opus International Architects and Engineers

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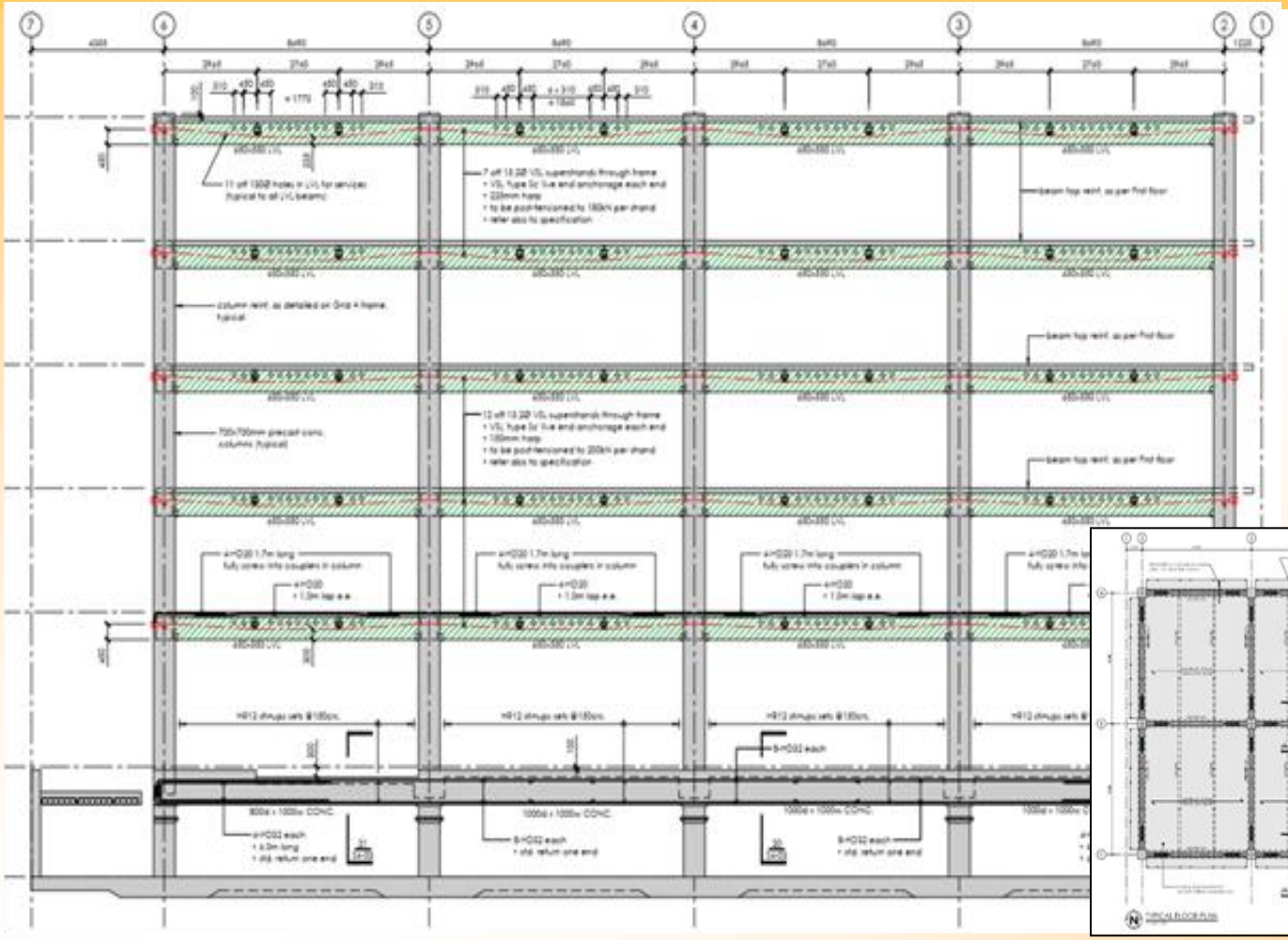
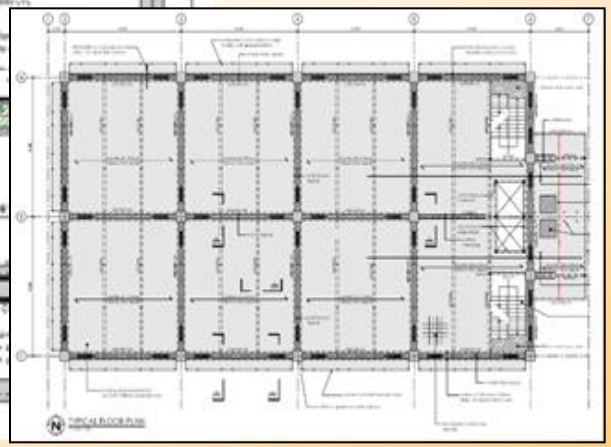
Rick Proko Architects, Ruamoko Engineers

Re-building Christchurch





Base-isolated building.
Frames both directions with concrete columns and post-tensioned LVL beams.

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PRES-LAM

Why use wood ?

- Constructability
- Sustainability
- Renewability
- Availability
- Weight
- Cost
- Fire safety, durability, acoustics, energy

Cost effective

High performance

Timber building systems

How to make it happen?

The Supply Chain

- Forest owner

Logs

- Processor

Wood products

- Fabricator

Structural elements

- Erector

Structural skeleton

- Contractor

Whole building

- Building owner

They may have to take some risks

How to reduce the risk ?

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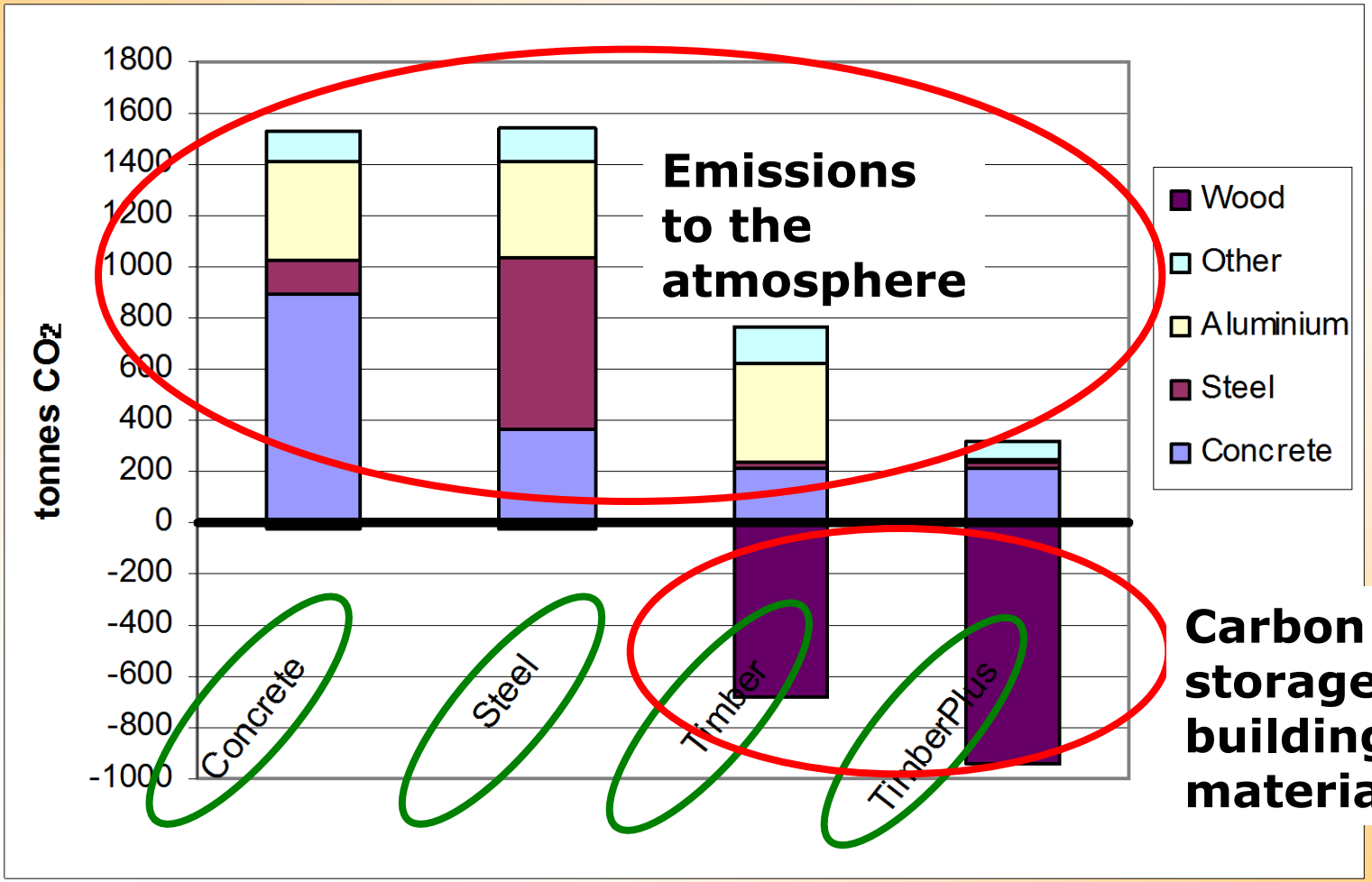
PROVIDE CONFIDENCE

- Government support
- Research funding
- Support designers
- Educate new players
- Share knowledge
- Codes and Standards
- Design Guides

Fire safety

Heavy timber has excellent fire resistance

Sustainability



Sustainability

Timber buildings can be carbon-neutral

Alternative to steel and concrete

Concrete - 8% of global CO_2 emissions

Kyoto Protocol - harvested wood products

Carbon Tax or Emissions Trading Laws

Low-damage wood solutions

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Cost effective

High performance

Timber building systems

- Residential buildings
- Commercial buildings
- Educational buildings
- Industrial buildings

Resistance to wind and earthquakes

Conclusions

- We have the technology, more coming
- We have the materials, hybrids coming
- We have the structural systems
- We need help from industry and government

Low-damage timber buildings

for a sustainable future