Engineered wood products in New Zealand: Trends, perceptions and resources

Engineered wood products (EWPs)

What are EWPs?

BRANZ survey on EWP uptake and usage

EWP resources

- Codes and standards
- Manufacturer information
- BRANZ
- Universities
- Organisations

Summary and moving forward

What are EWPs?

Wide range of timber-composite materials and manufacturing possibilities

Primarily structural applications

- Laminated veneer lumber (LVL)
- Glue-laminated timber (glulam)
- Cross-laminated timber (CLT)
- Finger-jointed timber

What are EWPs?

Panel products

- Plywood
- Oriented strand board (OSB)
- Strandboard (NZ)
- Particleboard
- Fibre-cement

What are EWPs?

Composite products and systems

- I-joists
- Structural insulated panels (SIPs)
- Wood plastic composites (WPCs)
- Triboard (NZ)
- Timber concrete composites (TCC)
- Post-tensioned timber (Preslam)
- Stress-skin panels
- Box beams

BRANZ survey on EWP uptake and usage

- Survey in early 2019
- Collaboratively developed (Gary Raftery, Kate Bryson and BRANZ)
- 17 questions
- Nearly 500 respondents
- Wide range of participants
  - Architects and designers
  - Builders
  - Engineers
  - Government
  - Others

- Extensive comments included
- Outputs: Study Report SR453 *Usage and uptake of engineered wood products in New Zealand* www.branz.co.nz/pubs/research-reports/sr453/

BRANZ survey on EWP uptake and usage

- What EWPs are being used and for what applications?
- What are potential barriers to increased EWP usage?
- How can EWP update be increased?
- Major themes
  - Cost
  - Availability
  - Regulation
  - Information
  - Education

BRANZ survey on EWP uptake and usage

- Primarily positive responses
- Pros and cons of using EWPs
  - Cost
  - Stability and consistency
  - Reduced waste
  - Increased speed of construction
  - Site alterations
  - Compliance
  - Lack of knowledge
- Durability and treatment options
- Environmental/carbon impacts
- Allowable substitutions
- Comparisons with other materials
- Options for prefabrication

BRANZ survey on EWP uptake and usage

Recommendations

- More information, education and tools – design and performance
- Develop detailed case studies
  - Economics (end to end)
  - Environmental impacts
  - Range of buildings
- Increased cost-effectiveness
- Update standards
  - Acceptable Solutions
  - Verification Methods
- Simplify compliance pathways

EWP resources – codes and standards

NZS 3604:2011 *Timber-framed buildings*

- Revision initiated
- Acceptable Solution

NZS 3603:1993 *Timber structures standard*

- Revision nearly completed

NZS 3602:2003 *Timber and wood-based products for use in building* and NZS 364:2003 *Chemical preservation of round and sawn timber*

- Revisions nearly completed
- Acceptable Solutions for durability and treatment
- Production standards

New Zealand Building Code (E2/AS1 etc.)

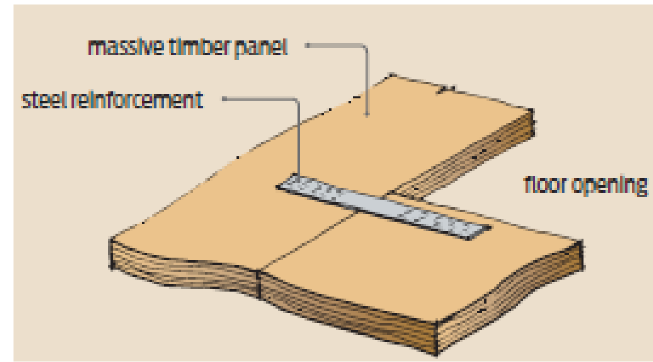
EWP resources – manufacturer information

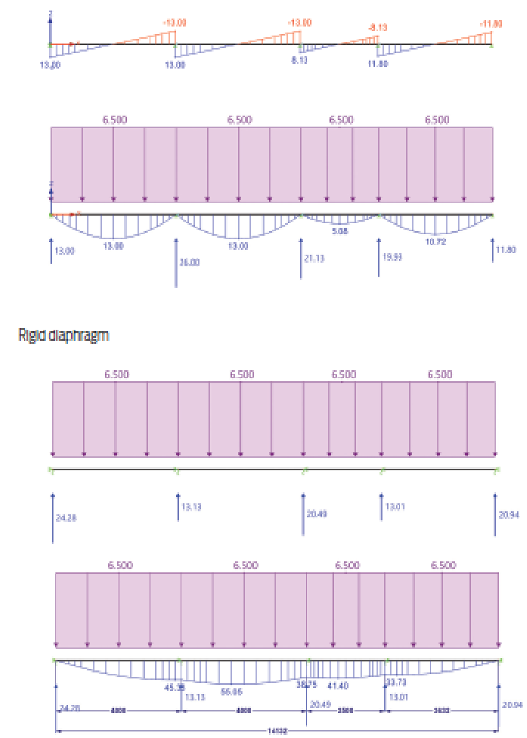
EWP manufacturers and fabricators

- Technical literature
  - Span tables
  - Carbon footprint
  - Durability
- Online design software
  - Different levels available

Component manufacturers

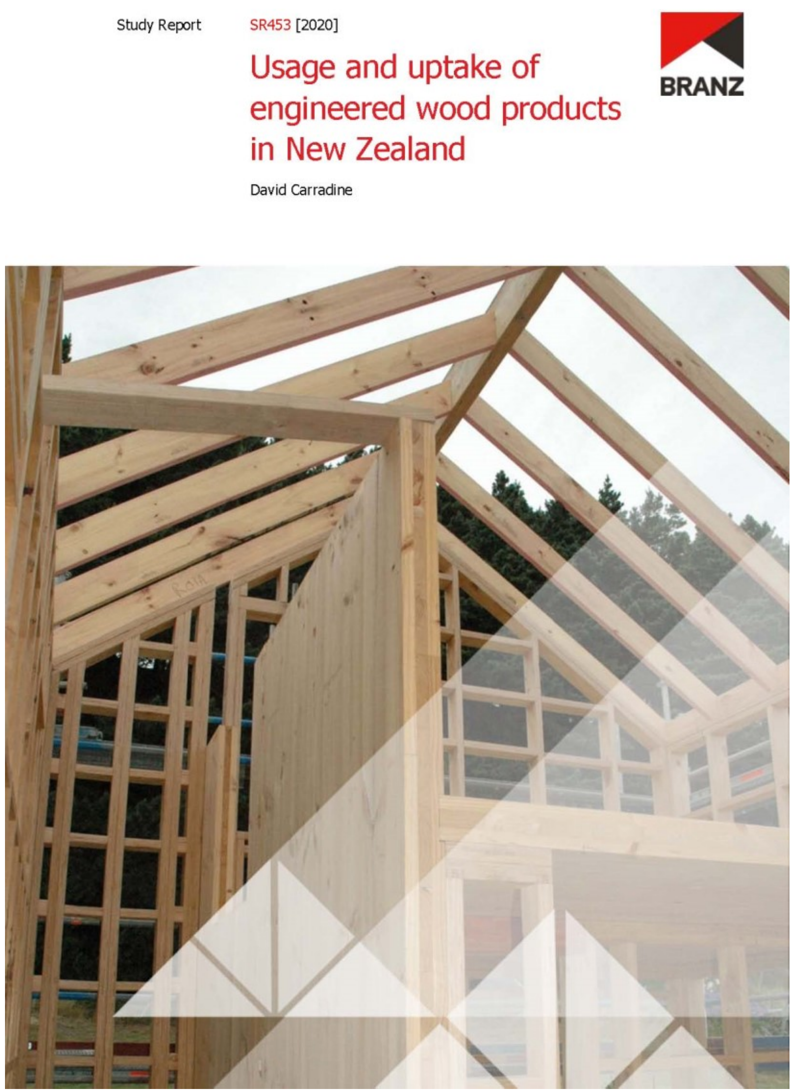
- Fastenings and fixings
- Literature and software
- New Zealand-specific information

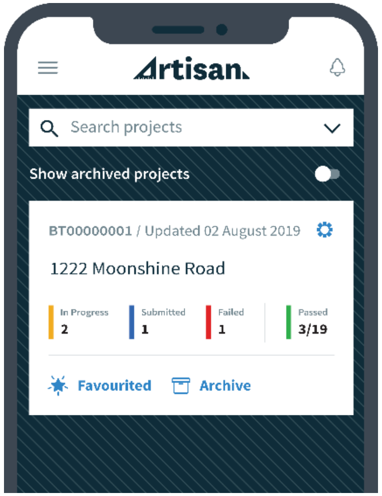




EWP resources – BRANZ

- Website
- Publications
- Tools and calculators
- Life cycle and carbon evaluation tools
- Research
- MyBRANZ Knowledge
- Appraisals and CodeMark





EWP resources – BRANZ

BRANZ website (www.branz.co.nz)

Calculators and tools | Quick links

- Research reports
- Appraisals
- Build magazine
- Publications
- MyBRANZ Knowledge
- eLearning modules
- Climate change
- Artisan
- CodeMark
- BRANZ Maps

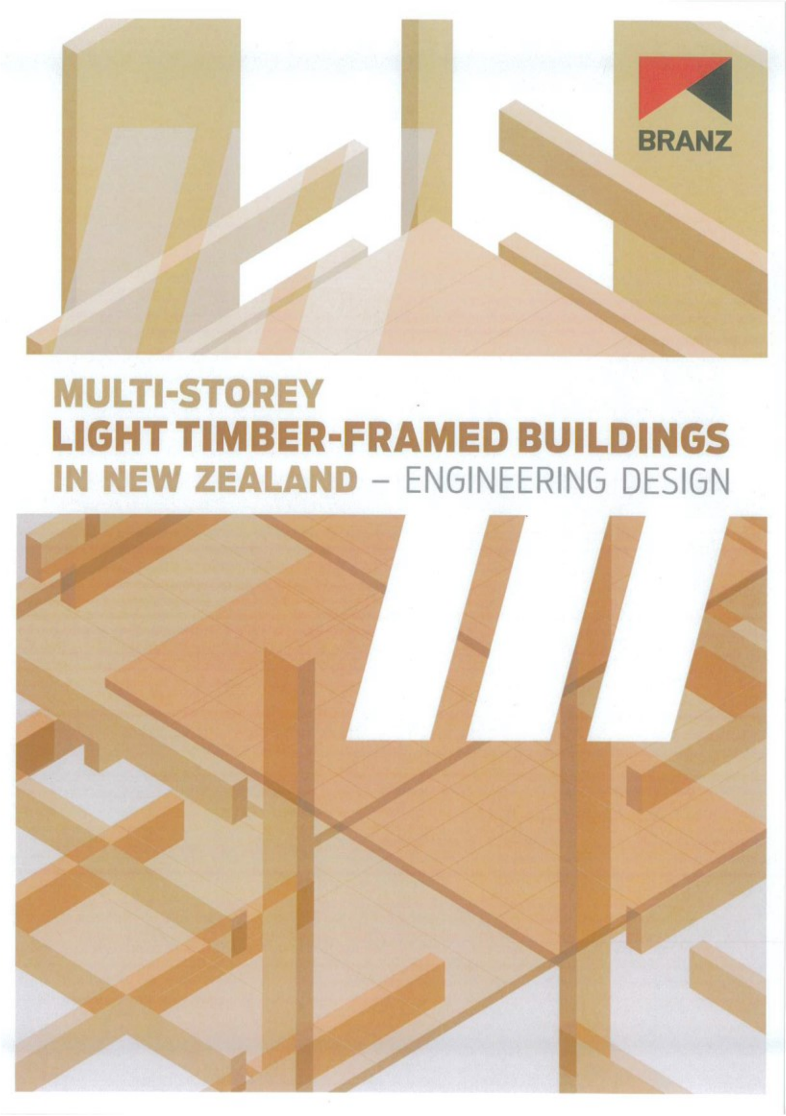
Calculators and tools | Quick links

- BRANZ CO_2NSTRUCT
- BRANZ Maps: zone information tool
- ALF (Annual Loss Factor)
- LCAQuick: Life cycle assessment tool
- Universal design cost estimator

EWP resources – BRANZ

BRANZ publications

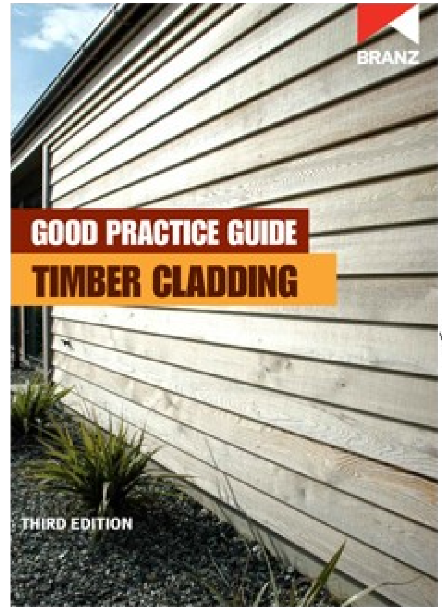
- *Build* magazine
- Study reports
- Research Now (summaries)
- BRANZ bulletins
  - Corrosion (including geothermal)
  - Wall bracing
  - Connections
  - Timber treatment
- Building and design books
  - Multi-storey LTF guide
  - Selecting timber
  - Engineering basis of NZS 3604

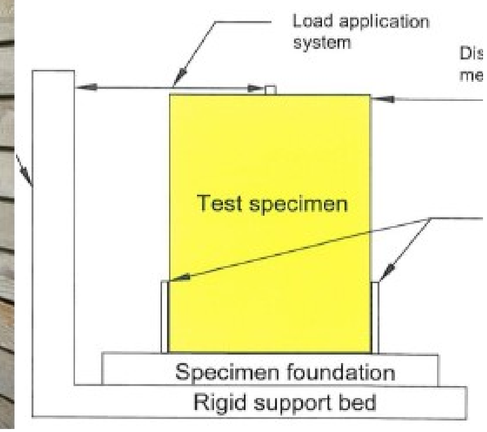


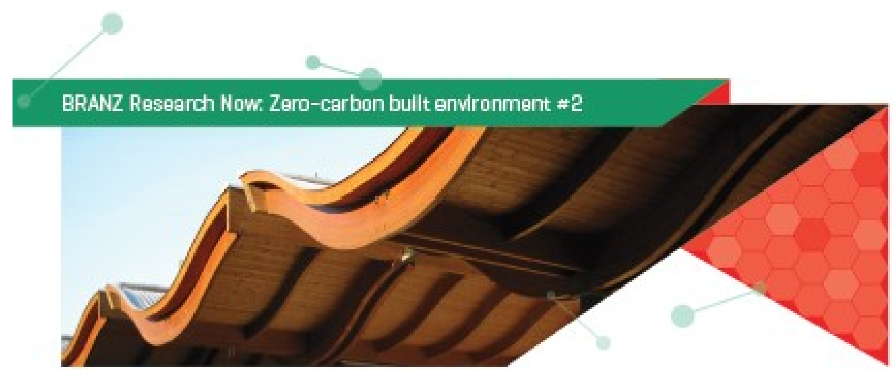
EWP resources – BRANZ

BRANZ publications

- eLearning modules
  - Timber framing
  - Bracing
- Good Practice Guides
  - Timber cladding
- Evaluation methods
  - Mid-rise cladding (EM7)
  - Structural joints (EM1)
- Technical papers and recommendations
  - P21 evaluation procedure
  - Fire resistance of LTF walls and gusset connections





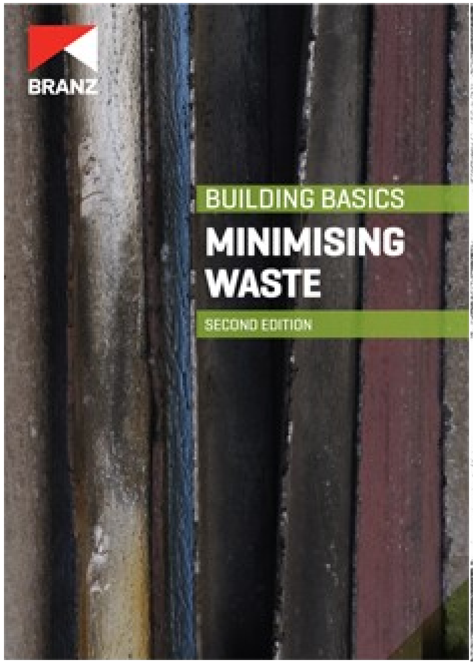


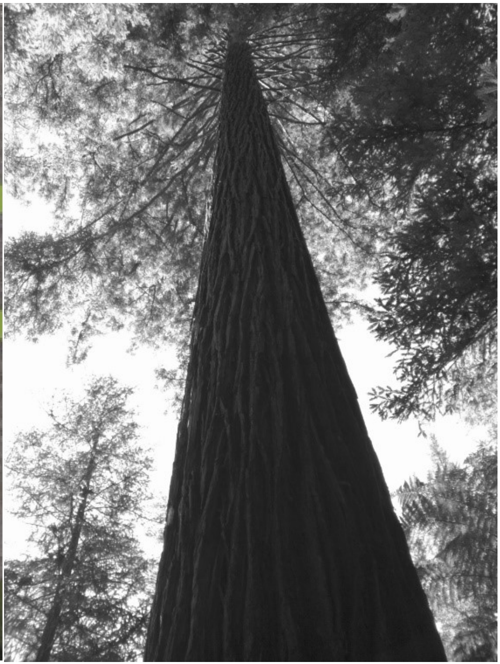
Usage and uptake of engineered wood products in New Zealand

EWP resources – BRANZ

BRANZ publications

- Building Basics (series)
  - Minimising waste
  - Weathertightness
  - Compliance
- Level Sustainable Building Series
  - Floor coverings
  - Materials
- Previous seminars/webinars
  - Talking timber
  - Bracing
- Good Repair Guides (series)

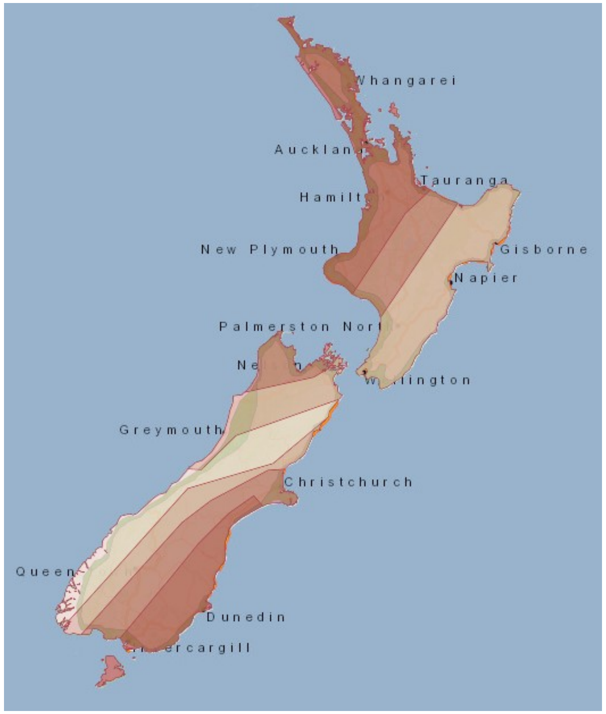




EWP resources – BRANZ

BRANZ tools and calculators

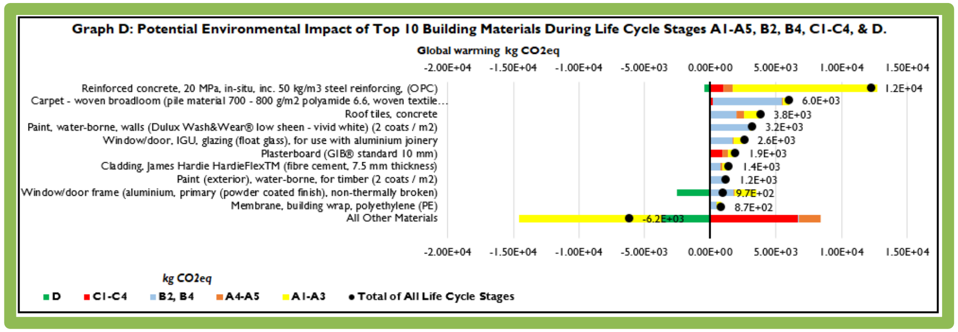
- BRANZ Maps
  - Wind
  - Earthquake
  - Corrosion
  - Climate
- Lintels and beams calculator
  - Spreadsheet only
  - www.branz.co.nz/lintels-and-beams/
- B-RISK
  - Fire simulation

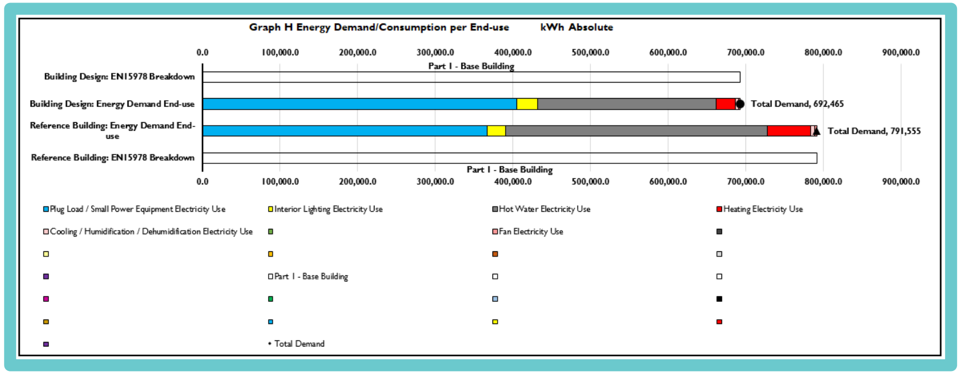


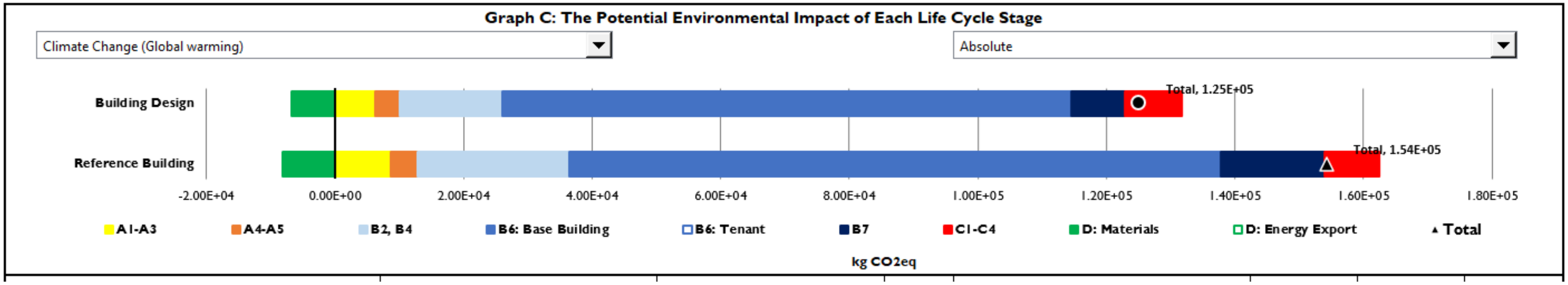
EWP resources – BRANZ

BRANZ life cycle and carbon evaluation tools

- LCAQuick
  - Life cycle assessment tool
  - Whole-of-life evaluation
  - EPD data
  - Integration with BIM data
  - Training and project support
  - Library of buildings
  - Comparisons
  - Impact factors







EWP resources – BRANZ

BRANZ life cycle and carbon evaluation tools

- BRANZ CO_2NSTRUCT
  - Embodied carbon and energy only
  - EPD data
  - Updated annually
  - Variable data quality

Projects underway

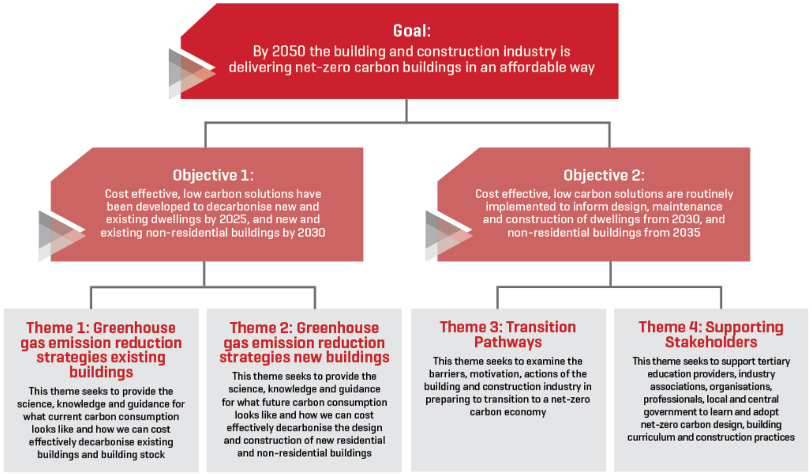
- MACC tool
  - Residential
  - Systems data
- Dashboard tool
  - Comparisons
  - Top five materials
- Early decision-making tool

Return to summary of material classes	Metal – steel					
Material (see notes below table)	Embodied carbon kg CO_2eq/kg	Embodied energy (total) MJ (NCV)/kg	Embodied energy (non-renewable) MJ (NCV)/kg	Embodied energy (renewable) MJ (NCV)/kg	Source	Data quality
Steel, bar (Pacific Steel)	3.97	55.88	50.20	5.68	8.3	A
Steel, coil (Pacific Steel)	3.75	52.65	47.40	5.25	8.3	A
Steel, rod (Pacific Steel)	3.78	53.95	47.70	6.25	8.3	A
Steel, wire (Pacific Steel)	3.90	56.23	49.40	6.83	8.3	A
Steel, structural, columns and beams (BlueScope Steel)	2.85	31.86	31.50	0.36	8.4	A
Steel, primary (galvanised, both sides, 0.02 mm each, coating class Z275), profile metal sheet, generic all profiles, 0.4 mm BMT	3.74	47.45	42.80	4.65	8.1	G
Steel, primary (galvanised, coating class Z275), cold rolled profile metal sheet, trough section 56mm deep at 305mm ctrs, 0.75 BMT	3.30	40.96	36.80	4.16	8.1	G

EWP resources – BRANZ

Transition to a Zero-Carbon Built Environment programme

- New Zealand whole-building whole-of-life framework
- Opportunities to contribute
- Website coming
- Resource hub in planning stages
  - One-stop shop
- Eco Design Advisor
  - www.ecodesignadvisor.org.nz



Research programme:	www.branz.co.nz/environment-zero-carbon-research/transition/
Building LCA:	www.branz.co.nz/buildinglca
BRANZ CO_2NSTRUCT:	www.branz.co.nz/co2nstruct
LCAQuick:	www.branz.co.nz/lcaquick
LCA case studies:	www.branz.co.nz/pubs/case-studies/lcaquick/
Contacts:	david.dowdell@branz.co.nz, casimir.macgregor@branz.co.nz

EWP resources – BRANZ

BRANZ fire resistance and performance research

- B-RISK
  - www.branz.co.nz/fire-safety-design/b-risk/
  - Recent enhancement to support fire design of exposed mass timber in enclosures
  - Considers contribution of burning timber surfaces to the fuel load
  - Enclosure fires dependent on ventilation and fuel load – includes growth, fully developed and decay phases of fire
  - Calculates expected depth of charring in the enclosure fire

EWP resources – BRANZ

BRANZ fire resistance and performance research

- Global technical guidelines on the fire safe use of wood in buildings
  - International state-of-the art guidance
  - Information for fire and structural engineers, architects, regulatory authorities
  - Fire resistance, reaction to fire, connections etc.
  - Experts contributing from 10 countries
  - New Zealand main contributors – Andy Buchanan (editor, author) and Colleen Wade (author)
  - Planned publication 2022
- Fire-safe densified housing research programme

EWP resources – BRANZ

BRANZ fire resistance and performance research

- Fire-safe use of timber
  - Developing calculation models to predict fire temperatures versus time in mass timber enclosures and depth of char
  - Facilitating fire resistance testing of post-tensioned beam column connection with Canterbury University
  - Investigating the impact of various amounts of timber linings on the early fire hazard development

EWP resources – BRANZ

BRANZ fire resistance and performance research

- Combustible façades fire safety
  - Managing external fire spread risk
  - How do different test methods and classification criteria compare?
  - How should the potential external fire spread contributions of typical combustible materials (e.g. timber and EWPs) to external fire spread be controlled?

Characteristic	BS 8414-2	NFPA 285	Implication
Fire size	~ 3 MW	~ 1.3 MW	• 1.3 MW is not representative of a ventilation-limited fire for the compartment and opening geometry • Not consistent with C/VM2 design fire requirement
Heat exposure	~ 75 kW/m²	~ 40 kW/m²	• Some materials of known fire risk not sufficiently challenged with NFPA 285 • 40 kW/m² does not meet C/VM2 design fire requirement

EWP resources – BRANZ

BRANZ fire resistance and performance research

- Does timber framing contribute to external fire spread?
  - Large-scale experiments
  - Encapsulation approaches
  - Comparisons to fire behaviour in real buildings

Evaluating lining encapsulation robustness with furnace tests

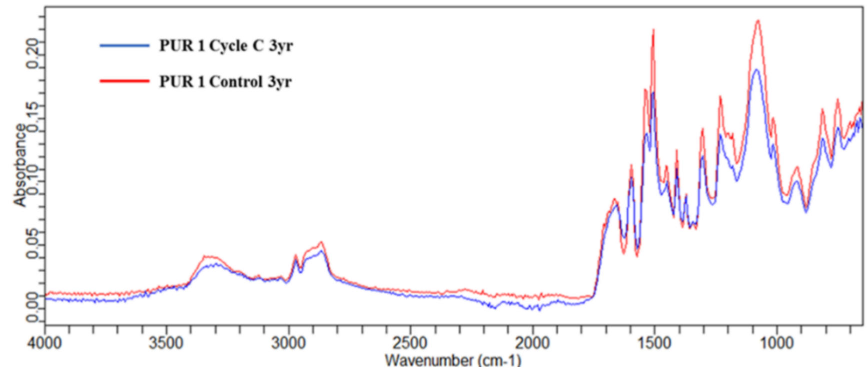
Large-scale experiments to evaluate encapsulation/timber contributions

Fire behaviour in real buildings

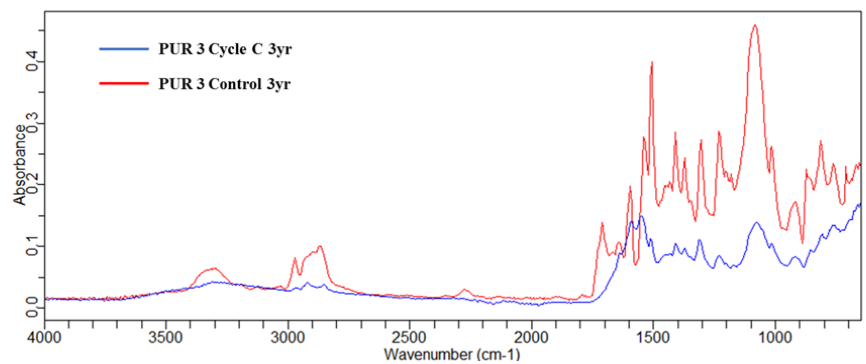
EWP resources – BRANZ

BRANZ materials research

- Structural adhesives
  - 50-year durability requirement
  - Polyurethane-based (PUR) adhesives
  - Ageing regime
  - FTIR spectroscopy
  - Differences in composition
  - Differences in ageing cycles
  - Screening test established
  - Mechanical testing
  - Treatment effects
  - Delamination, shear and fracture energy
  - Conference paper available – full results later this year



Highly resistant to hygrothermal degradation



Significant hydrolytic degradation

EWP resources – BRANZ

BRANZ materials research

- Effects of geothermal environments
  - Timber products and fastenings
- Durability within wall cavity and subfloor spaces
  - Catalogue of building environmental profiles
  - Specifications and maintenance
- Structural insulated panels (SIPs) – durability, fire and seismic performance
  - Test methods and compliance pathways

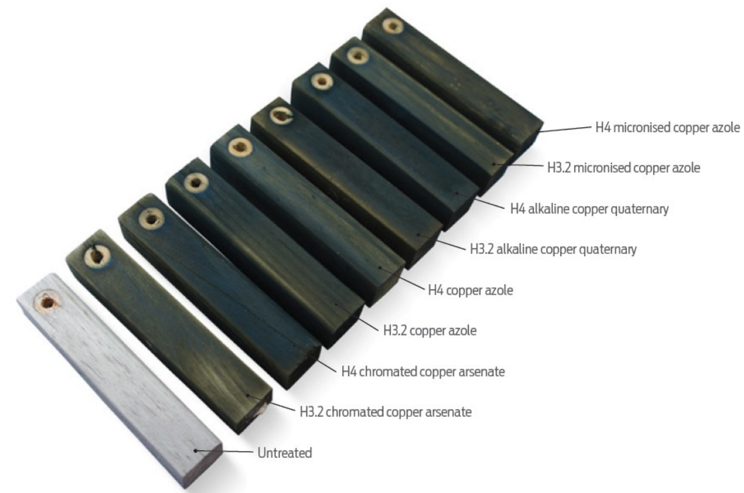
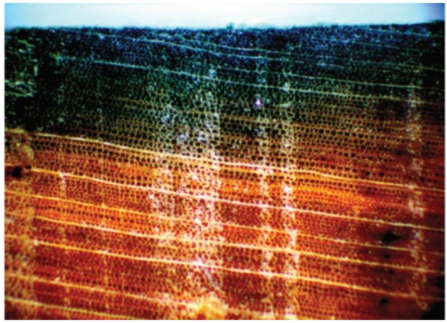


Figure 2. Discolouration of untreated and treated wood blocks exposed at a location approximately 5 m away from a fumarole in Scion campus.

EWP resources – BRANZ

BRANZ materials research

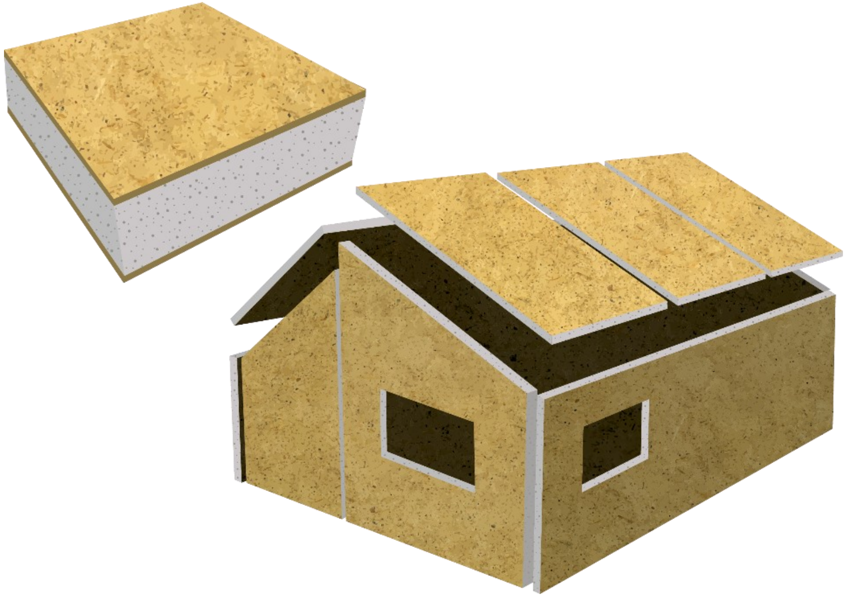
- Towards durable timber structures I and II
  - Baseline database – moisture dynamics in timber
  - Metal corrosion and dimensional changes
  - Preservative leaching
  - Chemical and structural timber degradation
  - Accelerated testing methods for NZBC compliance
  - Develop modelling systems
  - Verification Methods
  - Whole-building focus
  - www.buildmagazine.org.nz/articles/show/towards-durable-timber-structures
  - www.buildmagazine.org.nz/articles/show/advancing-durable-timber-structures



EWP resources – BRANZ

BRANZ structures research

- Seismic performance of SIPs
  - Quantify and qualify lateral load performance
  - Compliance pathways
- LTF multi-storey guideline
- Seismic design of low-rise and mid-rise hybrid residential buildings
  - Guidance and detailing
  - Podium structures
  - Terraced buildings
  - Hybrid bracing systems
  - Feeds into NZS 3604 revision
- Sloping site foundations
  - Guidance developing and upcoming project



EWP resources – BRANZ

MyBRANZ Knowledge

- Profile creation
- Personalised responses

Appraisals and CodeMark

- List of products and systems
- Specific applications
- Full NZBC consideration
- Technical literature
- Appraisals – BRANZ administered
- CodeMark – externally audited

BRANZ Appraised
Appraisal No.1234 [2021]

CODEMARK™

EWP resources – other publications

STIC and Expan – series of design guides

- Post-tensioned timber
- Timber concrete composite floors
- Long-span roofs
- Quick-Connect and rivets
- Floor diaphragms
- EWPs and fabrication
- Fire performance
- http://pres-lam.com/
- https://www.ptlnz.com/

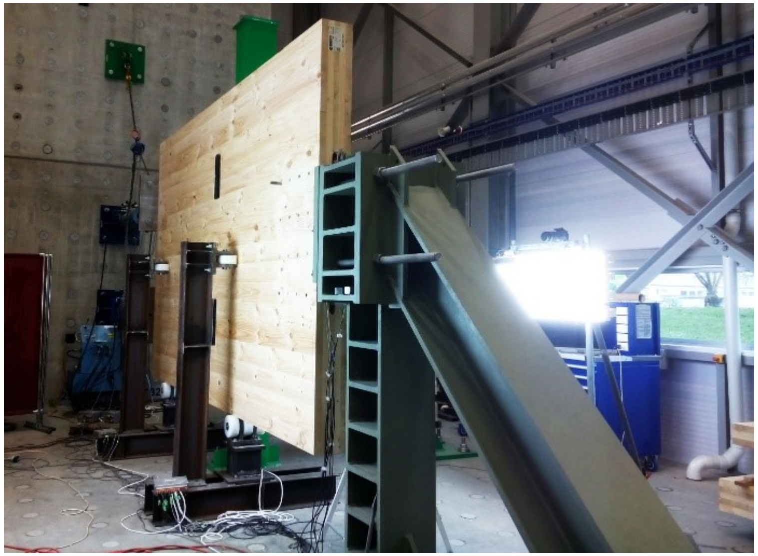
New Zealand Timber Design Guide (Andy Buchanan)

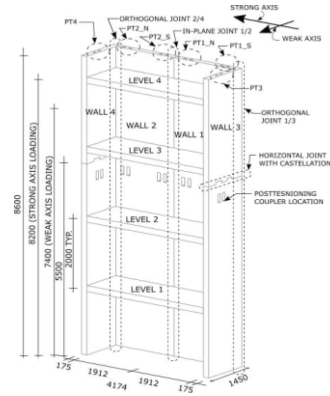
- www.timberdesign.org.nz/design-aids/timber-design/timber-design-guide-2007/

EWP resources – University of Canterbury

Evaluating ductility and overstrength of dowelled CLT hold-down connections (Lisa Ottenhaus, PhD thesis, 2015–2019)

Post-tensioned CLT core-walls for high-performance low-damage lateral load resisting systems
(Justin Brown, PhD thesis, 2017–2021)

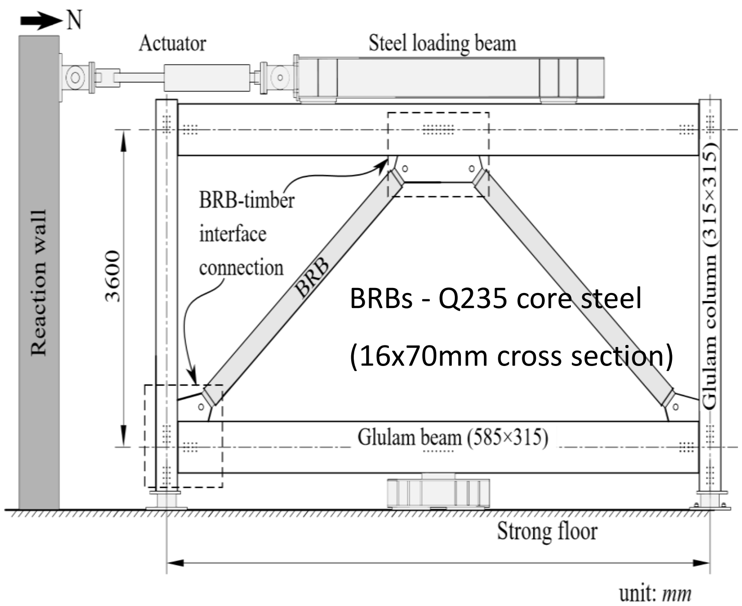




Images provided by Minghao Li

EWP resources – University of Canterbury

BRB-braced glulam frames to improve performance of conventionally braced heavy timber frames
(Wenchen Dong, PhD thesis, 2017–2021)

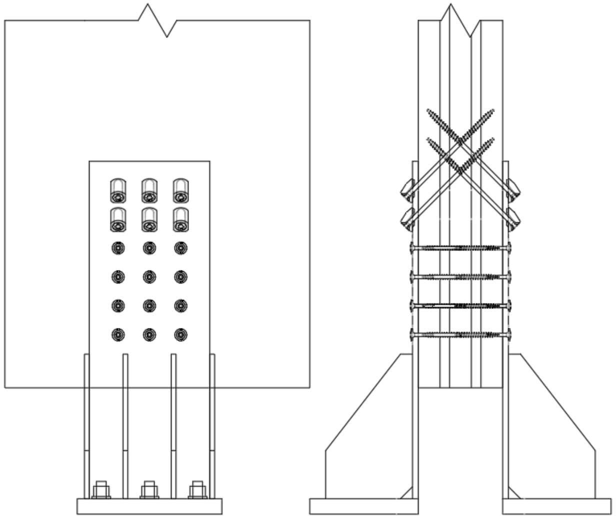


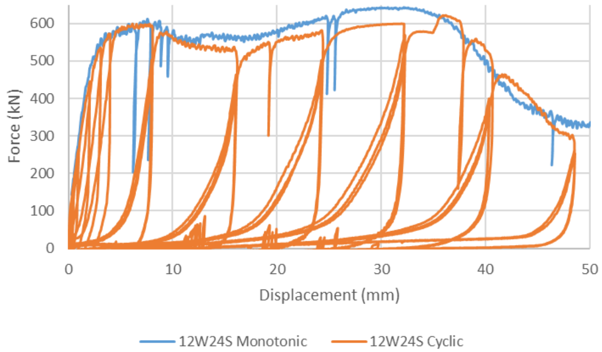
Images provided by Minghao Li

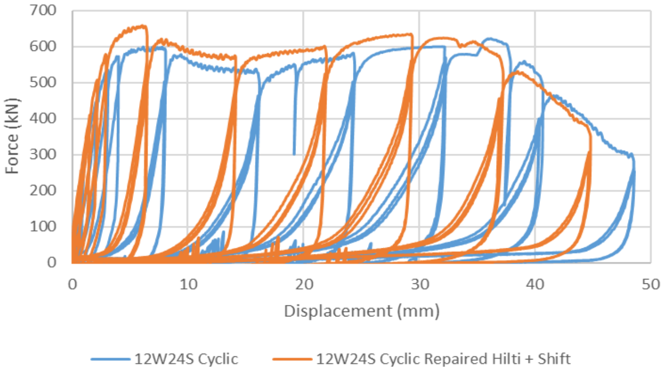
EWP resources – University of Canterbury

High-capacity mixed-angle screwed connections in CLT

- Combining 45° and 90° screws – high initial stiffness and displacement capacity
- Repaired screwed connections with epoxy





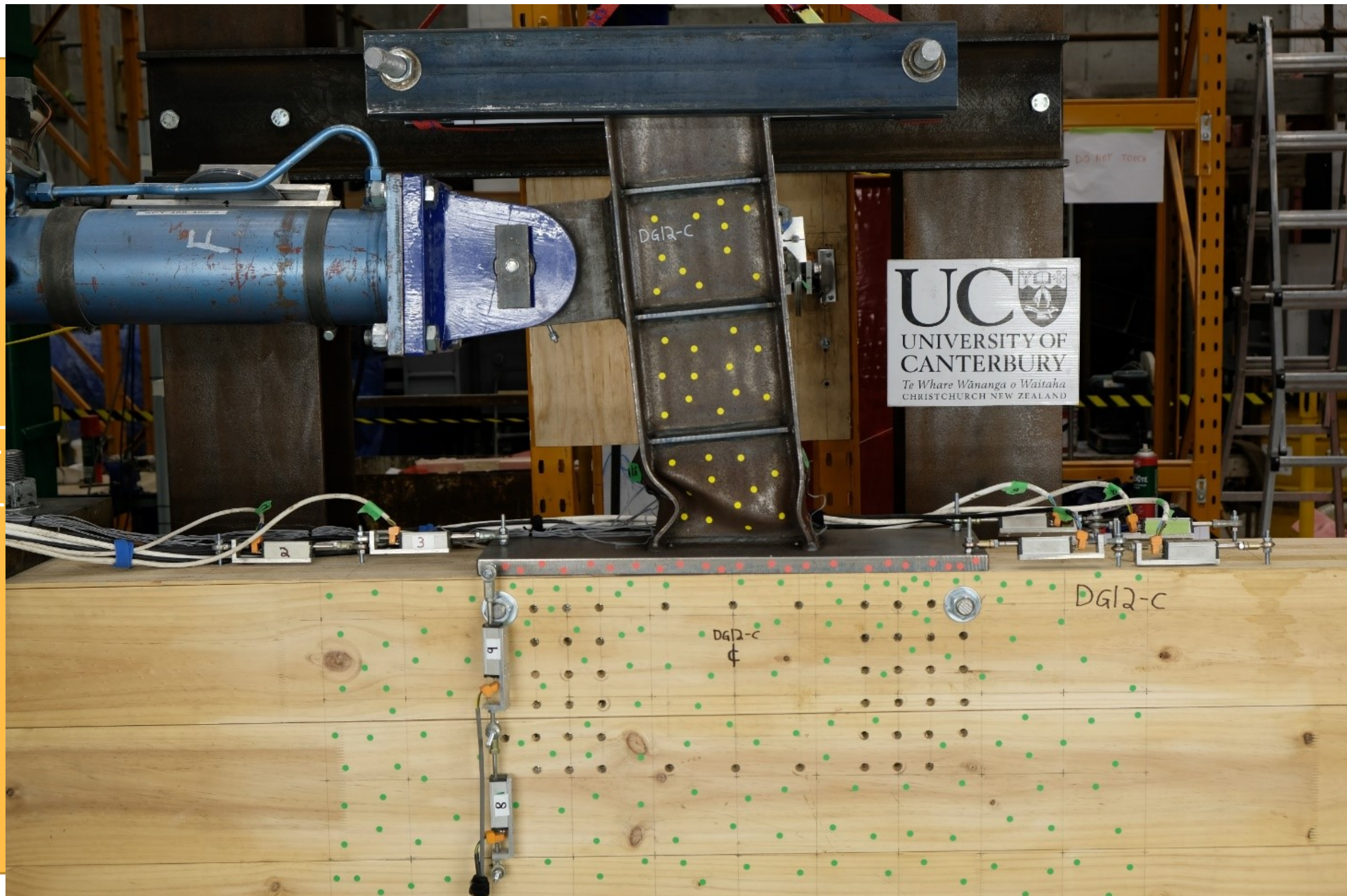


Images provided by Thomas Wright

EWP resources – University of Canterbury

Coupled CLT walls using steel beams

CL
WAL



eel beams
nd and are
maged

Images provided by Ben Moerman

EWP resources – University of Canterbury

Recent publications

- Brown, J., Li, M., Tannert, T. & Moroder, D. (2020). Experimental study on orthogonal joints in cross-laminated timber with self-tapping screws installed with mixed angles. *Engineering Structures*, 228, 11560. DOI: 10.1016/j.engstruct.2020.111560.
- Brown, J., Li, M., Palermo, A., Sarti, F. & Pampanin, S. (2020). Experimental testing of a low-damage post-tensioned C-shaped CLT core-wall. *ASCE Journal of Structural Engineering*, 147(3). DOI: 10.1061/(ASCE)ST.1943-541X.0002926.
- Brown, J. & Li, M. (2020). Structural performance of dowelled cross-laminated timber hold-down connections with increased row spacing and end distance. *Construction and Building Materials*, 271, 121595.
- Brown, J., Li, M., Karalus, B. & Stanton, S. (2020). Withdrawal behavior of self-tapping screws in New Zealand Douglas-fir CLT. *New Zealand Timber Design Journal*, 28(2), 25-32.
- Dong, W., Li, M., He, M. & Li, Z. (2021). Experimental testing and analytical modelling of glulam moment connections with self-drilling dowels. *ASCE Journal of Structural Engineering*. (In Press).
- Dong, W., Li, M., Lee, C-L., MacRae, G. & Abu, A. (2020). Experimental testing of full-scale glulam frames with buckling restrained braces. *Engineering Structures*, 222, 111081.

EWP resources – University of Canterbury

Recent publications

- Dong W., Li, M., Ottenhaus, L. & Lim, H. (2020). Ductility and overstrength of nailed hold-downs in CLT. *Engineering Structures*, 215, 110667.
- Ottenhaus, L., Li, M. & Smith, T. (2020). Analytical derivation and experimental verification of overstrength factors of dowel-type timber connections for capacity design. *Journal of Earthquake Engineering*. DOI: 10.1080/13632469.2020.1781711.
- Ottenhaus, L., Li, M. & Smith, T. (2018). Structural performance of large-scale dowelled CLT connections under monotonic and cyclic loading. *Engineering Structures*, 176, 41-48.
- Ottenhaus, L., Li, M., Smith, T. & Quenneville, P. (2018). Mode cross-over and ductility of dowelled LVL and CLT connections under monotonic and cyclic loading. *Journal of Structural Engineering*, 144(7), 04018074.
- Ottenhaus, L. & Li, M. (2018). Embedment strength of New Zealand cross laminated timber. *New Zealand Timber Design Journal*, 26(1), 12-16.
- Ottenhaus, L., Li, M., Smith, T. & Quenneville, P. (2018). Overstrength of dowelled CLT connections under monotonic and cyclic loading. *Bulletin of Earthquake Engineering*, 16(2), 753-773.

EWP resources – University of Auckland

- CLT floors
- Seismic dampers for timber lateral load resisting systems (LLRS)
  - Connections to CLT walls
  - Numerical analysis
  - Ductility – flag-shaped hysteresis

EWP resources – AUT

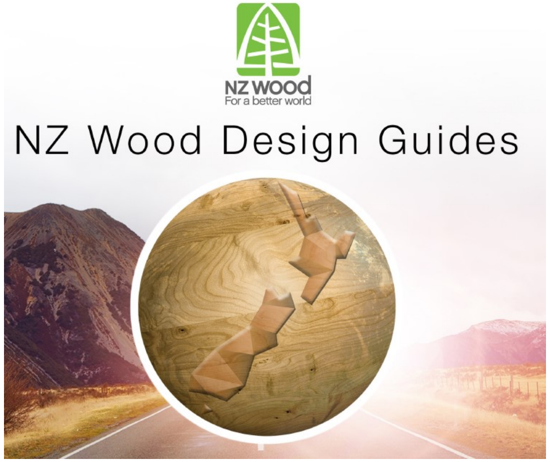
- Resilient slip friction joints (RSFJ)
- Used with LVL, glulam, CLT, etc.
- Multi-storey applications
- Collaboration with others
  - University of Auckland
  - EQC
  - MBIE
  - Tectonus
- Fully functional buildings following 2500-year event

BRANZ

EWP resources – other organisations

NEW ZEALAND TIMBER DESIGN SOCIETY

- New Zealand Timber Design Society (TDS)
  - www.timberdesign.org.nz
  - Technical literature
    - Website and journal
    - Calculators
    - Worked examples
- Wood Processors and Manufacturers Association of New Zealand (WPMA)
  - Series of timber design guides (NZ Wood) www.wpma.org.nz/timber-design-guides.html
  - New Zealand EPD www.epd-australasia.com/epd/solid-finger-jointed-and-laminated-timber-products-including-timber-preservation-options



EWP resources – other organisations

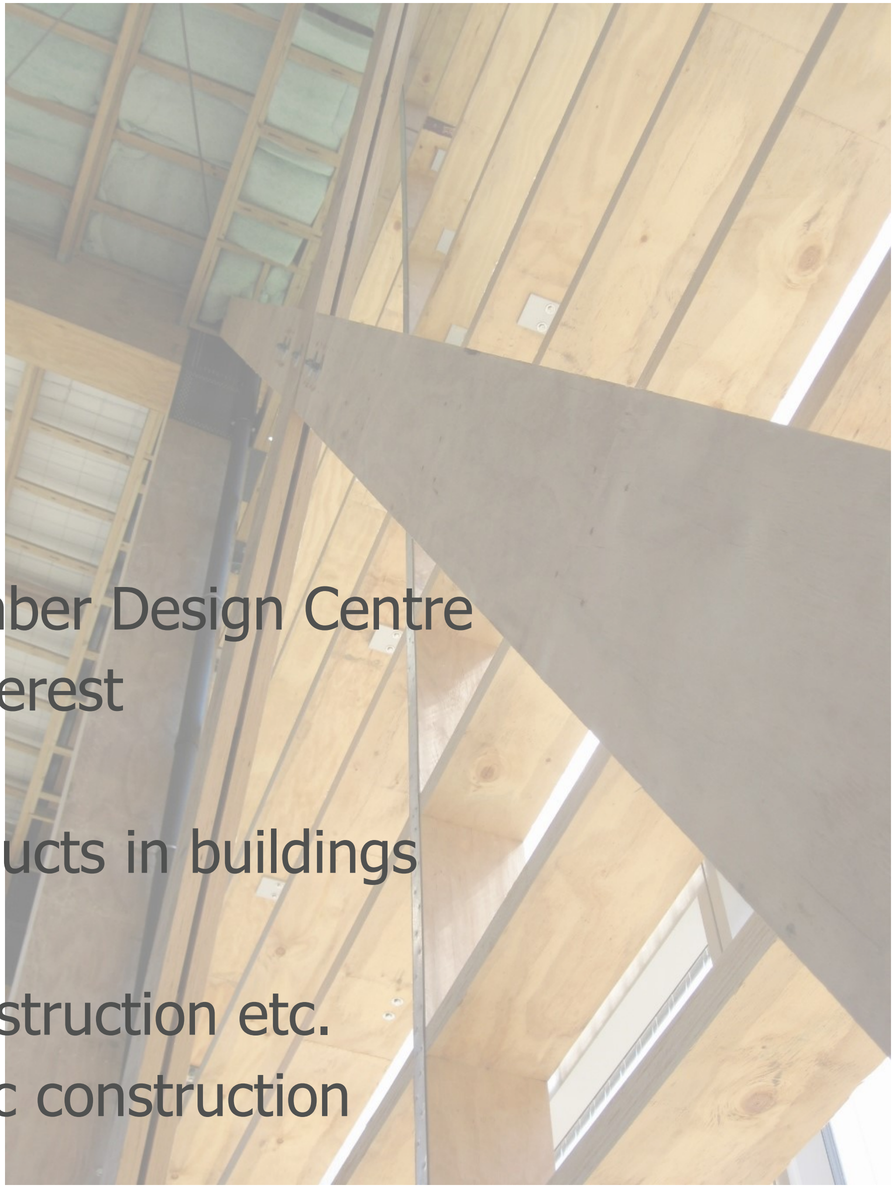
- WoodWorks NZ
- Scion
  - Durability
  - Processing
  - Sustainability
  - Innovation in timber
- Engineering New Zealand
  - Technical groups
  - SESOC, NZSEE, General Practitioners Group

Images provided by Ged Finch

EWP resources – other organisations

- Wood Solutions (Australia)
  - www.woodsolutions.com.au
  - Design guides
  - Webinars/podcasts
  - Design assistance
- Think Wood and WoodWorks (North America)
  - www.thinkwood.com
  - www.woodworks.org
- Canadian Wood Council (Canada)
  - www.cwc.ca
- TRADA (UK)
  - www.trada.co.uk

Summary and moving forward



Survey and webinar

- Areas for improvement
- Abundance of resources
- What else is needed?
- Follow-up survey?
- Maybe a centre …

Ministry for Primary Industries – Timber Design Centre

- Current call for registrations of interest
- Timber advisory service
- Accelerate use of low carbon products in buildings
- Knowledge dissemination
- Mid-rise, mass timber, off-site construction etc.
- Increase use of timber in domestic construction

Thank you

David.Carradine@branz.co.nz