POST-TENSIONED TIMBER BUILDINGS IN NEW ZEALAND: RESEARCH, DESIGN AND IMPLEMENTATION INTO REAL CASE STUDIES

ABSTRACT

The recent growth of cross-laminated timber (CLT) panel systems in Europe has launched timber as a sustainable and cost-effective alternative to concrete and steel buildings, however CLT panel systems require a large number of internal structural walls which limits the flexibility of architectural design. CLT and other engineered timber materials such as Laminated Veneer Lumber, high-grade glue-Lam make the use of post-tensioning a feasible and cost-effective connective technique for timber buildings. Post-tensioned timber beams and frames give opportunities for much greater use of engineered wood products in large buildings by creating large open spaces, excellent living and working environments, and resistance to hazards including earthquakes and extreme events. The post-tensioning provides for rapid erection, simple and economical connections between the large timber elements. The novel concept has been developed at the University of Canterbury and is named PRES-LAM. The post-tensioned structural system uses unbonded steel tendons in ducts in large timber box beams and/or flooring panels. Beams and suspended floors can be designed similarly to concrete structures for sustaining vertical loading. The technology, if additional supplemental damping is provided, can also be used for earthquake resistant systems, such as moment resisting frames and walls. In moment-resisting timber frames, the steel tendons pass through the columns, providing the moment resistance, while in walls, vertical post-tensioning with vertical ducts for the tendons passes through the concrete foundation. Post-tensioning only provides excellent post-earthquake re-centering capability of the buildings but not dissipation, therefore additional external/internal steel bars, respectively placed at the beam-to-column and wall-to-foundation interface for frames and walls, serves as dissipative fuses. The present research overviews the benefits of post-tensioning for low-rise multi-storey timber buildings through an extensive experimental campaign carried out at the University of Canterbury and illustrates the implementation of research into real practice by showing technical details adopted for the several timber buildings already been designed in New Zealand.

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Alessandro Palermo is Associate Professor (Reader) at the Department of Civil and Natural Resources Engineering at the University of Canterbury, Christchurch, New Zealand. His academic degrees include a Structural Engineering Laurea, MSc and PhD from the Technical University of Milan. He specializes in earthquake engineering with particular focus to the implementation of innovative low damage technologies. His fields of research range from bridge engineering to multi-storey timber buildings. His publication record includes 3 international patents, over 45 publications in refereed journals, and 170 more in books and conference proceedings. Alessandro also has extensive professional experience and is co-funder and director of a University spin-off company, Prestressed Timber Limited. During the last 6 years, he has been involved as external consultant, peer reviewer and numerical modeling analyst in innovative projects in New Zealand such as, the Wigram-Magdala bridge link in Christchurch (the world's first hybrid PRESSS bridge), Nelson Marlborough Institute of Technology Arts and Media building (the world's first commercial post-tensioned timber structure), followed by and many projects related to post-tensioning techniques for timber buildings: Carterton Event Centre (Carterton), STIC building (Christchurch), Kaikoura Civic Centre (Kaikoura) and K-MART building (Richmond, Nelson).Alessandro also enjoys his teaching and he has received several student nominations for the "University Lecturer of the Year" award. He is recipient of the 2013 *Ivan Skinner award* by New Zealand Earthquake Engineering Society for his research advances on earthquake bridge engineering and winner (co-recipient with Profs. Andy Buchanan and Stefano Pampanin) of the *2013 University of Canterbury Innovation Medal* for the research and commercial developments on post-tensioned timber buildings.