Research Proposal on Heavy Timber Frames with BRBs

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Background

ESB, Canada

TREET, Norway

Umass, USA

- Multi-storey timber buildings become popular due to the advent of the engineered timber.
- Multi-storey heavy timber buildings with braces have been used in some places.

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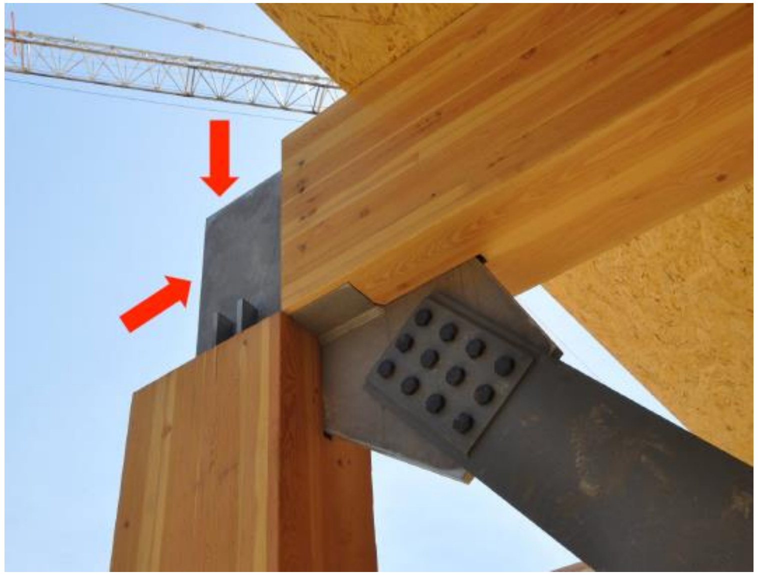
Motivation

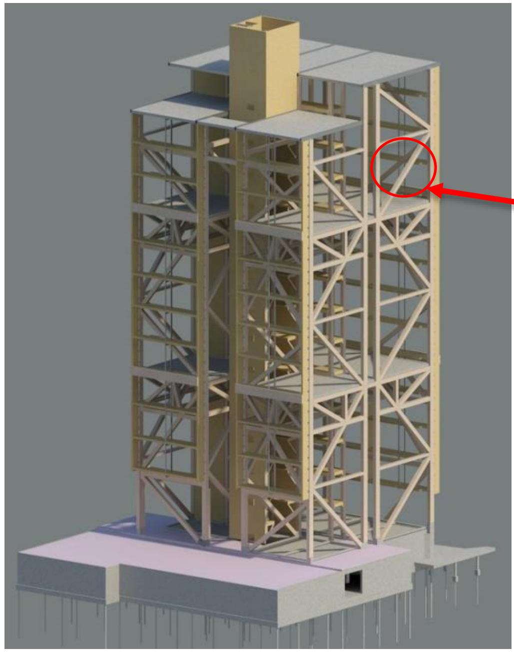
The wood brace



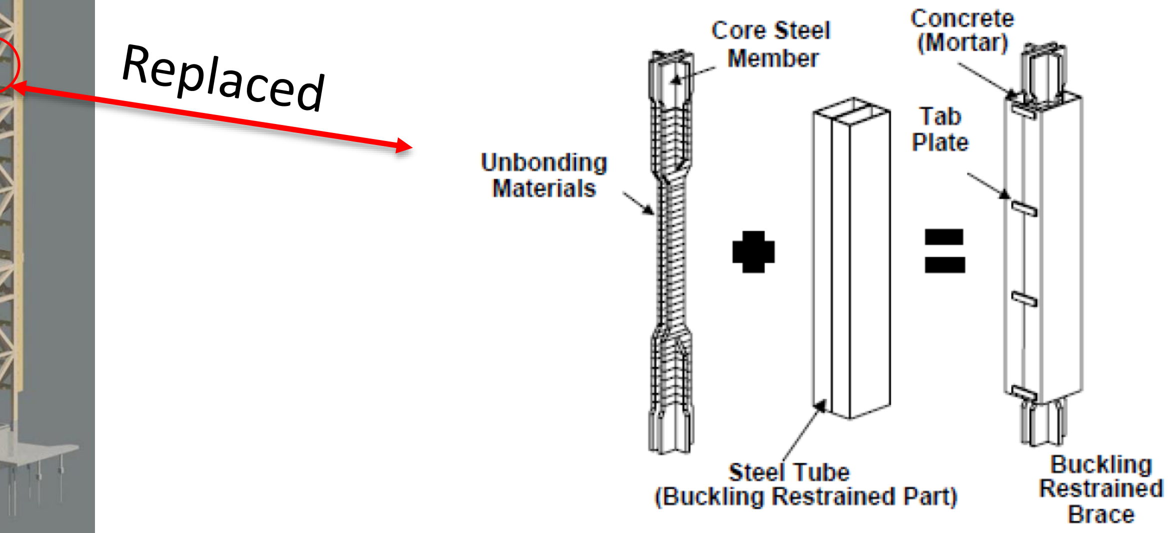
The steel brace

- Most current multi-storey timber buildings are located in low seismic zones.
- Wood braces have relatively low ductility level due to brittle characteristics in tension.
- Both steel braces and wood braces have buckling problems under compression and asymmetric tensional and compressional behavior.

Motivation



The heavy timber frame building with braces



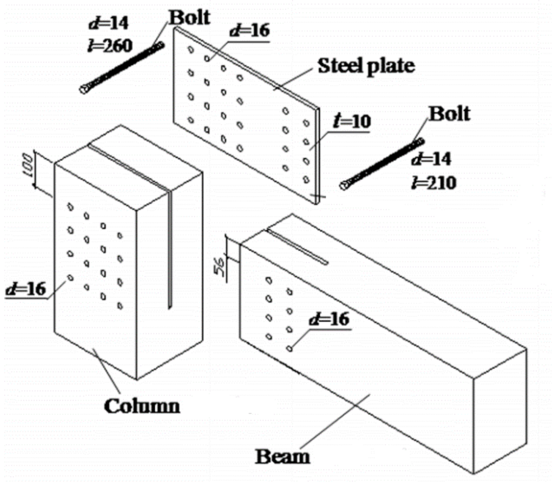
Buckling Restrained Brace (BRB)

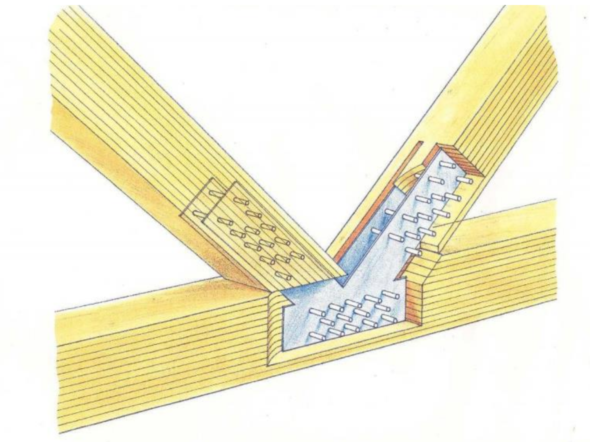
- BRBs have full hysteresis loops because of the similar tension and compression behavior.
- BRBs with timber casing are investigated in University of Auckland as an alternative.
- The heavy timber frames with BRBs can be a feasible solution for New Zealand.
- No previous research has been done on the heavy timber frames with BRBs.

Research Questions

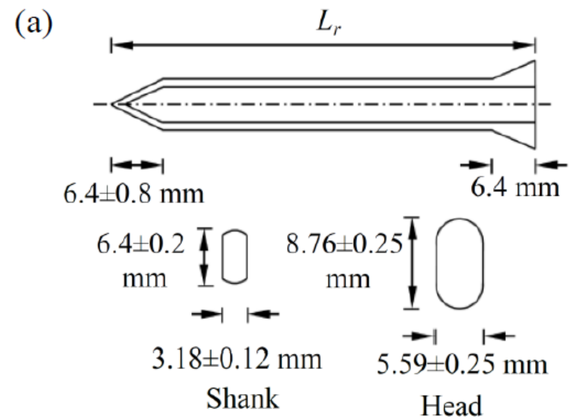
- Which kinds of timber-BRB interface connections requiring high strength and stiffness are suitable for the timber-steel hybrid system under the seismic loading?
- What is the appropriate overstrength factor for the connection design in this hybrid system?
- How will this hybrid system perform under seismic loading, such as, strength, stiffness, ductility, failure mode, residual deformation, etc. ?

Timber-BRB Interface Connection Options



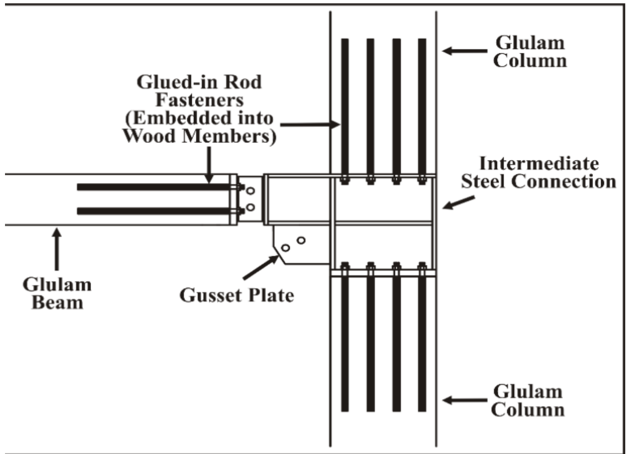


The dowelled type connections



The timber rivet connections

The SFS self drilling dowel connections



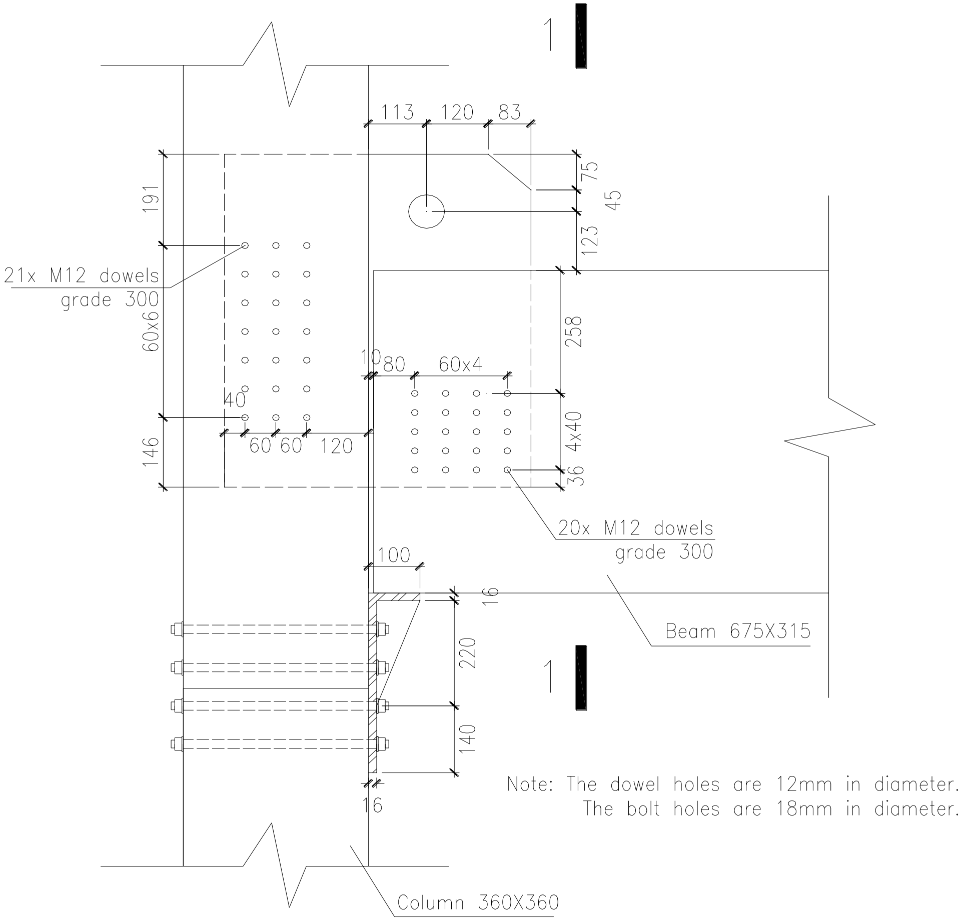
Glue-in steel rod connections

Connection Comparison

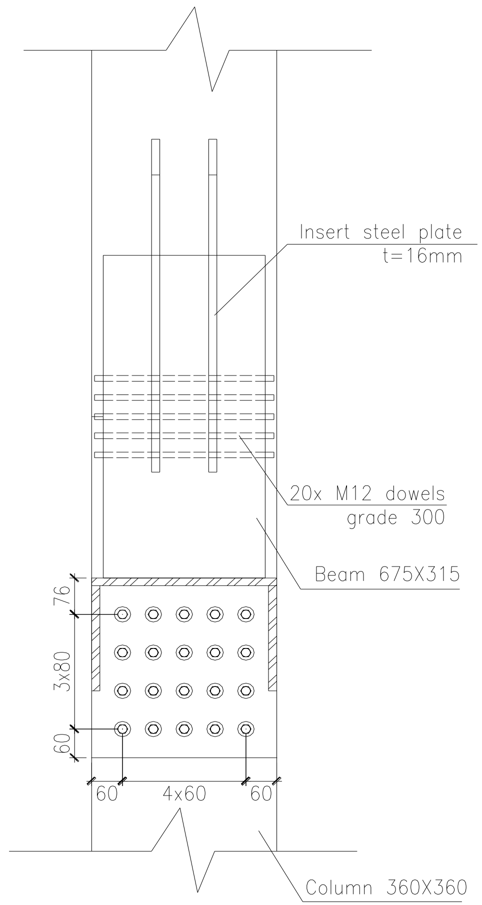
Connection type	Bolted connections	Dowel connections	Timber rivet connections	SFS self drilling dowel connections	Glue-in steel rod connections
Available size	Φ12-Φ20	≥Φ6	L=40mm/65mm /90mm	Φ7mm×73mm-Φ7mm×233mm	≥Φ6
Advantages	Highest strength	High strength	Cheap and easy to install	No pre-drill work	High strength and stiffness
Limitation	Low initial stiffness, much pre-drill and groove cut work	Much Pre-drill and groove cut work	More rivets are required due to low strength	Up to three thin steel plates (<5mm)	High cost and much on-site bonding work

- There is no existed connection for this hybrid system's interface connection.
- Three types of connections will be tested for selecting the optimal connection.

Connection Experiments



Connection design



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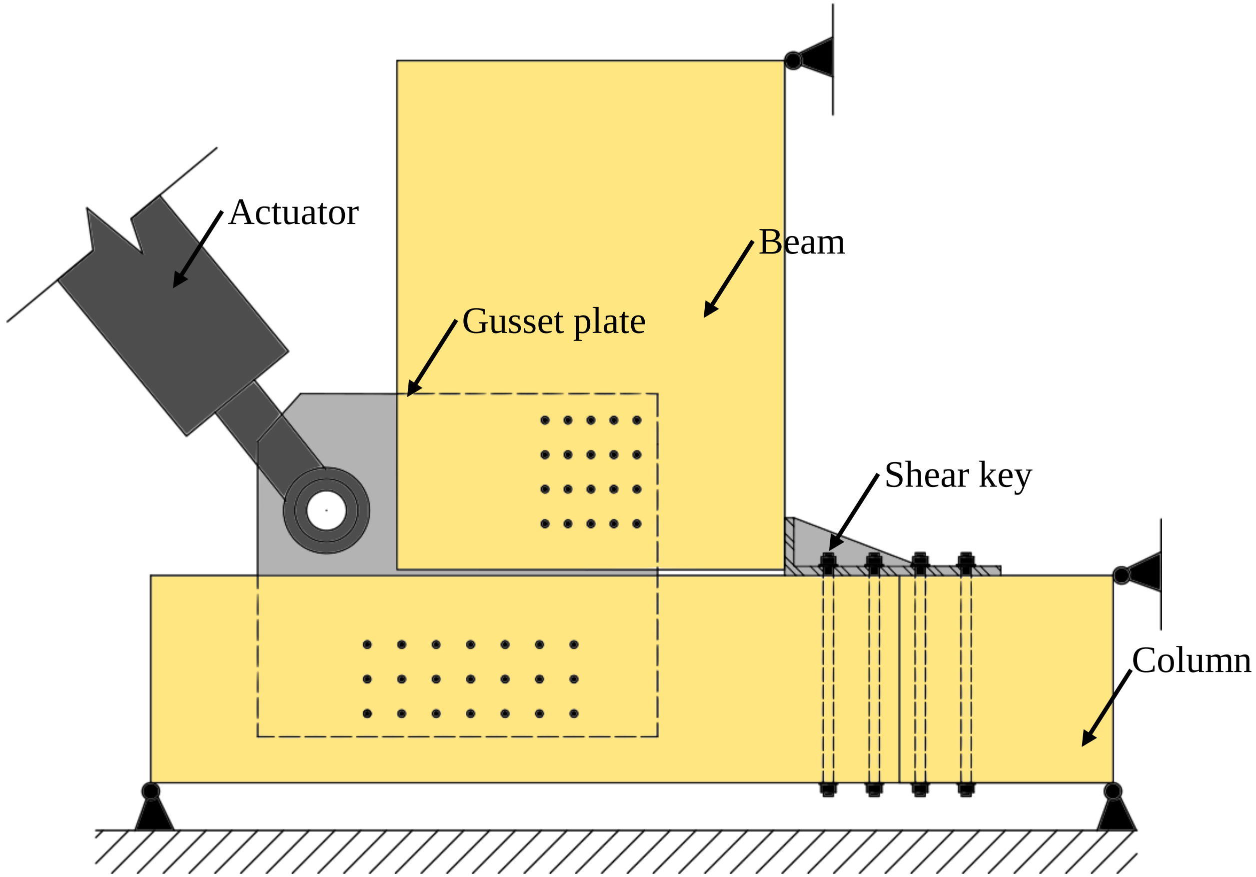
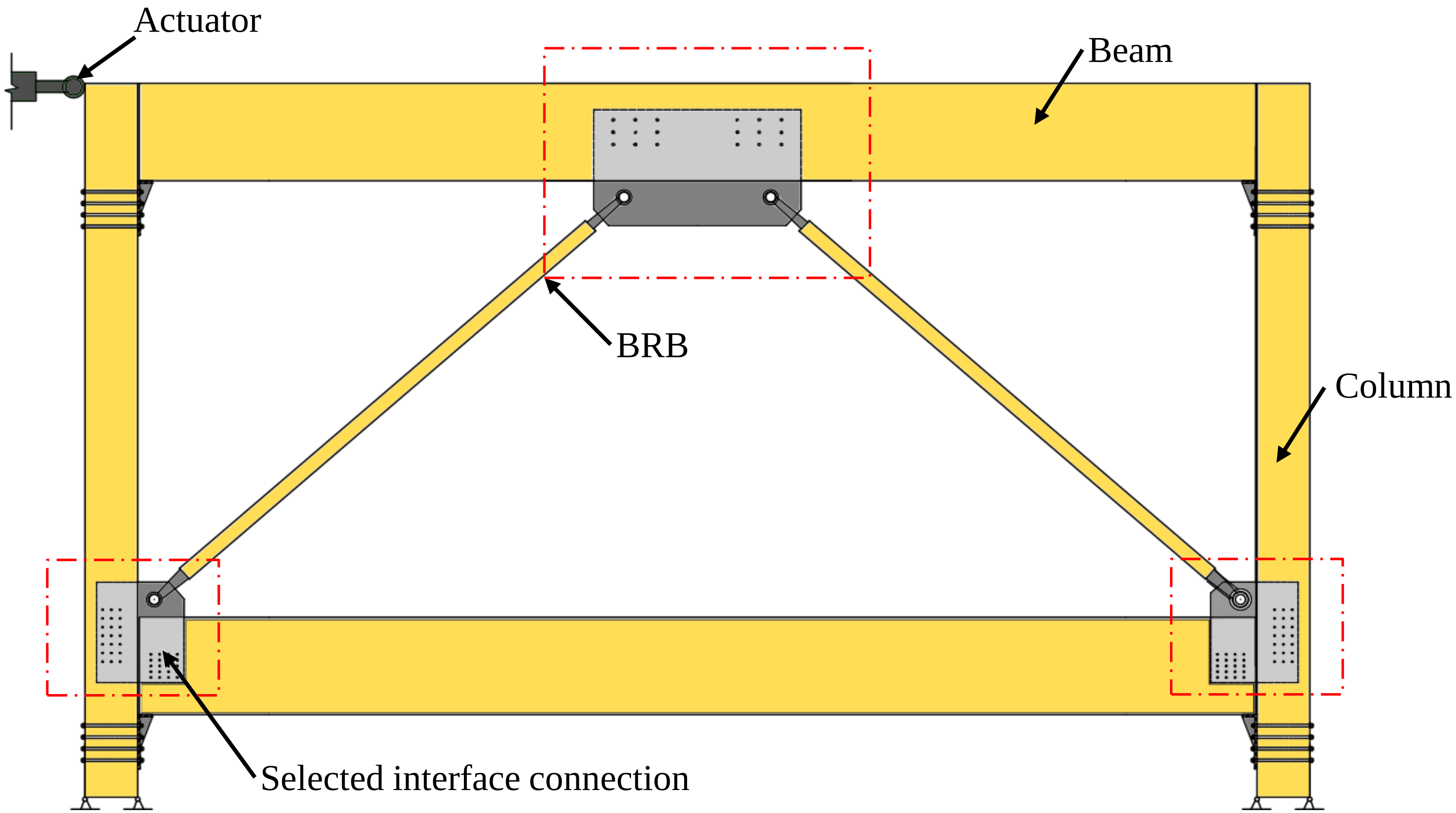
Connection Experiments



Connection experiment set-up

System Experiments



System experiment set-up

- The selected connection will be used in system experimental tests.
- Hybrid systems with conventional BRBs and BRBs with timber casing will be tested.

The Future of Tall Wood …

Sumitomo Forestry Co. Ltd, Japan, http://sfc.jp/english/

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Thank you!

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