SEISMIC PERFORMANCE OF CONCRETE WALL-STEEL FRAME HYBRID BUILDINGS

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1 | BACKGROUND

- A trend of hybrid buildings that combine concrete walls and steel frames has started to emerge in New Zealand, especially after the Canterbury Earthquakes.
- Despite the growing number of such hybrid buildings, the seismic performance of this building type has not been extensively investigated.
- Current structural design standards are compartmentalised into materials and do not explicitly address the design of buildings with mixed-material structural systems.
- Moreover, the applicability of existing international research to the New Zealand context is questionable.
- Given the research gaps, this emerging trend of hybrid buildings must be investigated to ensure that they will behave as intended by design.

2 | OBJECTIVES

- To quantify the performance of connections in existing concrete wall-steel frame buildings and develop improved connection details if required.
- To quantify the expected seismic performance of concrete wall-steel frame buildings, focusing on the system deformation compatibility and the demands on connections and diaphragms.
- To develop a reliable design procedure for concrete wall-steel frame connections.

3 | EXPERIMENTAL TESTING

- Experimental tests will be conducted on a typical concrete wall-steel beam connection (Fig. 1) with the aim of quantifying its rotation capacity.
- Four full-scale specimens will be tested (Fig. 2). The following variables will be investigated:
  - » Effect of the slab and floor starters
  - » Round holes vs. slotted holes on the web side plate
  - » Improved anchorage

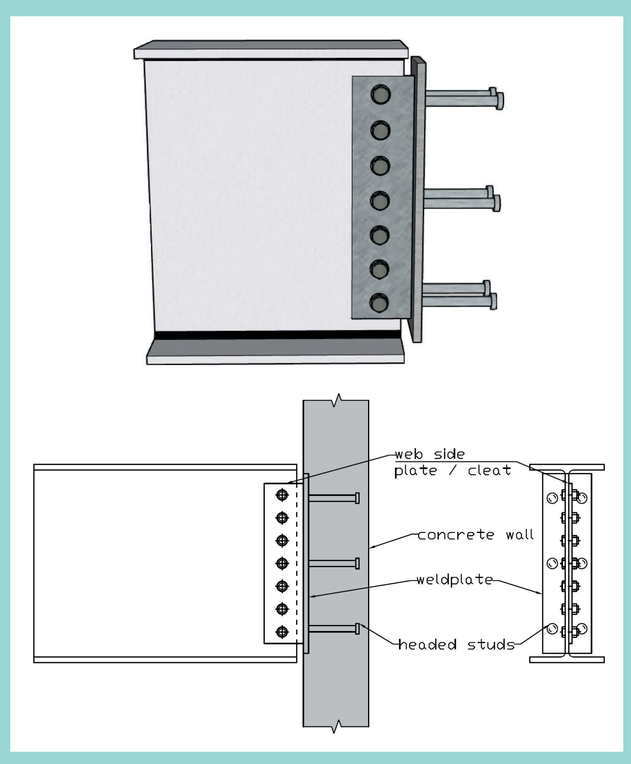

Figure 1. Typical concrete wall-steel beam connection detail consisting of headed studs and a single web side plate / cleat.

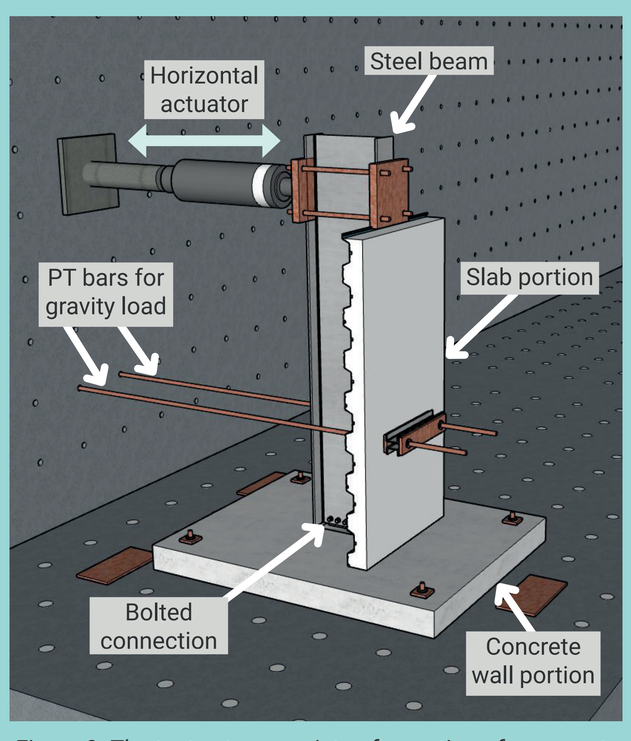

Figure 2. The test setup consists of a portion of a concrete wall, a steel beam and a portion of the slab. Specimens will be tested horizontally (i.e. the wall will lay flat on the strong floor).

4 | NUMERICAL MODELLING

- A prototype building was selected based on a review of concrete wall-steel frame buildings in New Zealand (Fig. 1). It is a six-storey office building in Christchurch with core and perimeter walls and steel moment frames.
- A 2D model of the prototype building is being developed using OpenSees software. It consists of fibre-based wall elements and elastic beam-column elements with concentrated plasticity hinges. Pushover and time history analyses will be performed.
- Results of the experimental tests will be applied to the model.

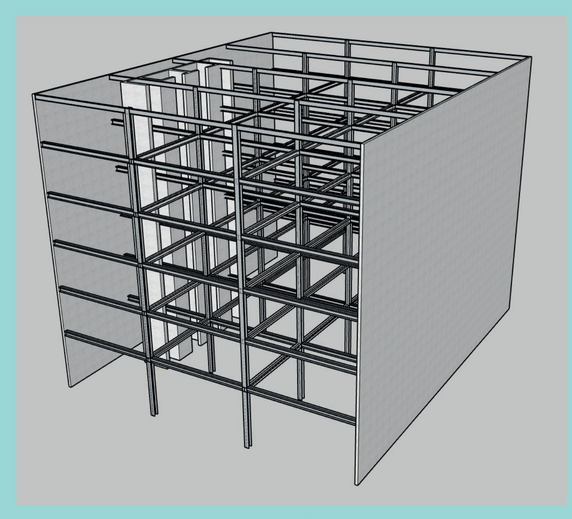

Figure 3. Model sketch of the prototype building

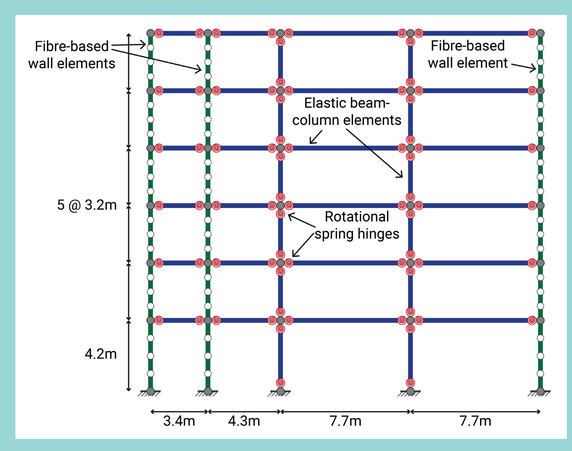

Figure 4. Schematic of the OpenSees model.

5 | EXPECTED OUTPUT & FUTURE WORK

- An assessment of the seismic performance of this emerging building type will result in identification of possible vulnerabilities while the design practice is still emerging.
- Experimental testing will provide validation on existing connection detailing. If any vulnerabilities are observed, improved connection details can be developed.
- Outputs will be used to develop a design procedure for connections between concrete walls and steel frames which can be used to revise New Zealand design standards.
- Experimental tests will commence this year. Specimen and test details are currently being finalised. Numerical models are being developed and refined.

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