ESTIMATING THE RISK TO LIFE SAFETY DURING EARTHQUAKES FROM NON-STRUCTURAL ELEMENTS IN COMMERCIAL BUILDINGS IN NEW ZEALAND

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Background and objectives

The Ministry of Business, Innovation and Employment (MBIE) commissioned a research programme to better understand the seismic performance of non-structural elements (NSE). As part of this programme, a collaboration project was undertaken between Beca and the University of Canterbury's Quake Centre (UCQC) to investigate the risk to life-safety from NSE damage in commercial buildings from recent New Zealand earthquakes.

Project outputs

The deliverables from this project consist of:

- A detailed report to MBIE summarizing research approach and key findings
- An NZSEE2017 conference paper
- A paper in an internationally recognized journal publication.

Project benefits

The benefits from the project's outputs include providing:

- Information detailing the influence of non-structural element damage on injury numbers and severity as a basis for MBIE to form policy decisions
- Data to supplement tools for estimating injures due to non-structural element damage in future events, which may be useful for insurers.

Adopted categorization of injuries

Injuries were categorized according to the damaged building component which caused the injury and the level of treatment received. Building components were categorized as shown in Table 1, while treatment categories are defined as follows:

- Received treatment (outside hospital)
- Attended emergency department (ED)
- Hospitalised
- Fatal

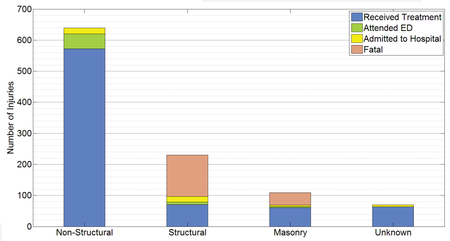
Non-structural damage following the M 6.3 2011 Christchurch earthquake

Table 1

BUILDING ELEMENT CATEGORY	NON-STRUCTURAL ELEMENT CATEGORY	DESCRIPTION / EXAMPLES
Non-structural Elements	Ceilings and Services	• suspended ceilings and tiles • HVAC equipment and ducting • pipework and plumbing • fire sprinkler systems • lighting systems • cable trays
	Interior Walls	• internal partitions
	Contents	• furniture • shelving • electronics • generic items
	Appendages	• signage • ornamentation
	Exterior	• cladding systems • exterior glazing
	Other	• plant • roof tiles • doors
Structural Elements	NA	• beams • columns • floor
Masonry	NA	• bricks • infill walls
Unknown	NA	• debris • rubble

Injuries by building component

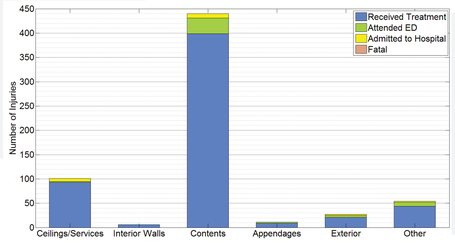
- NSE damage accounts for 61% of all injuries caused by damage to building components.
- NSE damage causes the most injuries across all non-fatal injury categories, the financial implications of which have been shown in past research to be greater than that of deaths.
- Most fatalities were caused by the structural collapse of the CTV and PGC buildings; emphasizing the importance of collapse prevention for life-safety protection.
- Remaining fatalities were caused by masonry damage.



Breakdown of injury severity by building component

Injury severity by NSE component

- Contents were the greatest cause of injuries across all non-fatal injury categories.
- Ceilings/services were the second largest contributor of injuries requiring hospitalization.
- The percentage of appendages and exterior damage-related injuries that required advanced treatment was highest among all NSE components.
- Injuries attributed to interior walls were rare and minor in severity.



Injury Breakdown by Non-structural Element Type

Conclusions

Key findings from this project:

- Collapse-prevention and restraining masonry fall-out is critical in preventing deaths.
- NSE damage caused the most non-fatal injuries, the financial implications of which have been shown in past research to be greater than that of deaths.
- Content movement was the greatest cause of NSE damage-related injuries, followed by ceilings and services.

Acknowledgements

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