COST-EFFECTIVE MITIGATION STRATEGY FOR EARTHQUAKE RISK

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THE PROJECT IS ADDRESSING THE NEED FOR AN EVIDENCE BASE TO INFORM DECISION MAKING ON THE MITIGATION OF THE RISK POSED BY AUSTRALIAN BUILDINGS SUBJECT TO EARTHQUAKE

EARTHQUAKE BUILDING LOSSES

Many of the existing Australian buildings have been constructed prior to the introduction of seismic design regulations in the early 1990s and have proved to be vulnerable to earthquakes. In the 1989 Newcastle Earthquake, 70,000 properties were reported to have been damaged, with an associated total economic loss of AU$ 4 billion. The majority of the building damage was focused on unreinforced masonry (URM) buildings. More intense destruction of URM buildings were also observed in the 2010-2011 earthquake sequence in New Zealand, which is considered to have similar settlement history to Australia.

Dust clouds of the Feb 2011 Christchurch earthquake (© Gillian Needham)

In addition, the NZ earthquake resulted in the collapse of two poorly designed reinforced concrete (RC) buildings.

COST-BENEFIT ANALYSIS

Building earthquake damage include:

- Direct economical loss
- Indirect losses due to business interruption, human injury, etc.

Fragility curves that represent building damage ratio versus an earthquake intensity measure are being developed for URM and RC buildings. Estimates of repair costs and indirect losses are also being calculated, respectively, by consulting Australian industry and by interrogating empirical data from previous earthquakes. The total calculated loss is compared to the cost of preventive seismic retrofit to determine cost-effective retrofit strategies.

In the course of this project, a precinct case study will also be completed for Melbourne city center.

URM BUILDINGS

Revisiting seismic demand calculations

Seismic loading code improvements have been focused on "engineered" buildings, and therefore many of the provisions do not cater for URM buildings. A part of this project has involved numerical analysis of building models to improve the seismic demand calculation methods for URM buildings.

Seismic capacity prediction by in-situ testing

A series of in-situ tests have been conducted on URM chimneys and walls in Adelaide. These tests were used to evaluate the in-situ capacity of chimneys and out-of-plane loaded walls.

It was found that existing methods in the Australian Masonry Standards, AS3700, provide a reasonably conservative estimate of wall out-of-plane strength.

Chimneys

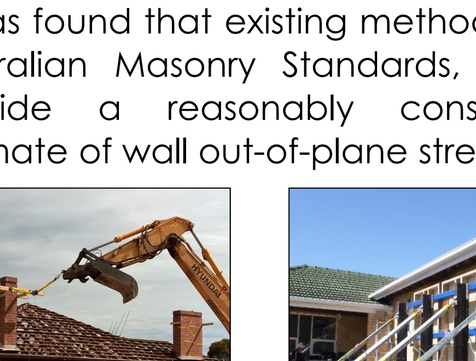
Walls

In-situ testing in Adelaide

LIMITED-DUCTILE RC BUILDINGS

Irregular RC buildings

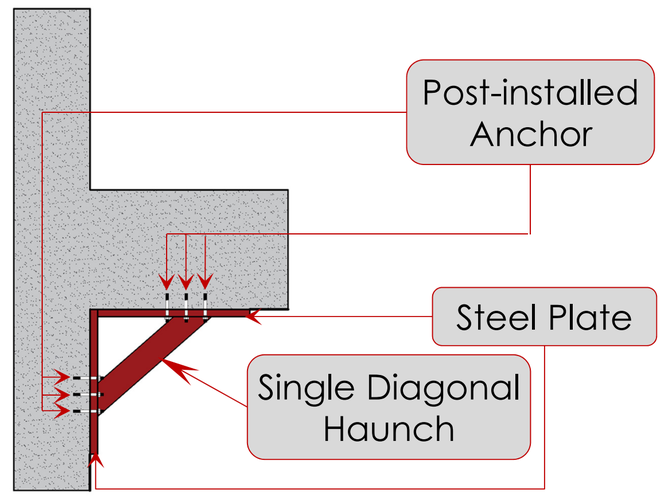
Many of the existing RC buildings in Australia have been designed with little to no considerations of ductile detailing. These buildings also possess irregularities which will increase their vulnerability to earthquakes. To address the need for the assessment of these irregular buildings, a simplified analysis method was developed to provide estimates of displacement demand.



Computer model of an irregular RC building

Retrofitting of RC frame buildings

Limited-ductile RC frame buildings are another category of earthquake risk buildings. The weakest link in this type of buildings are the beam-column joints. Part of this project is aimed at investigating the use of metallic diagonal haunch elements to enhance the seismic behaviour of these joints. The method is considered to be a less-invasive and effective technique that also improves the overall structural response.



Exterior RC Beam-Column Joint

UTILIZATION PROJECTS

The core findings of this project are used in the following End User Projects:

- Earthquake Mitigation Case Studies for the historic town of York in WA

Western Australia Department of Fire and Emergency Services is the End User.

York Motor Museum (Google Earth)

- Rapid Visual Screening procedure for Australian buildings

This project will be of the interest to state and federal emergency services departments if a large-scale evaluation of buildings becomes necessary.

FURTHER INFORMATION

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