

# Dunedin's earthquake prone buildings

The pressure is on councils around the country to identify and assess earthquake-prone buildings and implement seismic retrofits. One study in Dunedin looks at unreinforced masonry.

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Dunedin's Bendix Hallenstein's building, built in 1884.

**UNREINFORCED MASONRY (URM)** buildings constitute a large portion of New Zealand's building stock and are widely acknowledged as the most earthquake-prone class of buildings. Their poor seismic performance during the Canterbury earthquakes highlights the danger they pose.

### Council changes rules

The Dunedin City Council has introduced an earthquake-prone buildings policy and,

after an initial review, sent letters to owners of potentially earthquake-prone buildings advising them to get their buildings assessed. Strengthening is also needed if there is improvement work or the building is undergoing a change of use.

The policy outlines a three-stage approach for potential earthquake-prone URM buildings - preparing and updating the earthquake-prone buildings register and implementing a seismic retrofit (see Figure 1).

This study by Otago Polytechnic identified and recorded the characteristics of the unreinforced masonry buildings in the central business district and assessed their seismic vulnerability. This will aid in the preparation of an earthquake-prone building register.

### History of the city buildings

Early settlers founded Dunedin in 1848, and by 1861, the gold rush prompted rapid growth of the city. Several major retail businesses were developed during this period before a decline in population and development in the early 1900s.

A few hundred pre-1935 unreinforced masonry buildings remain, built without consideration for earthquake loading.

### Dunedin's seismicity and geology

Dunedin may be subjected to two types of seismic events:

- Distant, large events originating on or near the Alpine Fault, which could cause significant property damage and loss of life.
- Local events, probably originating from the Akatore Fault, which could cause ➤

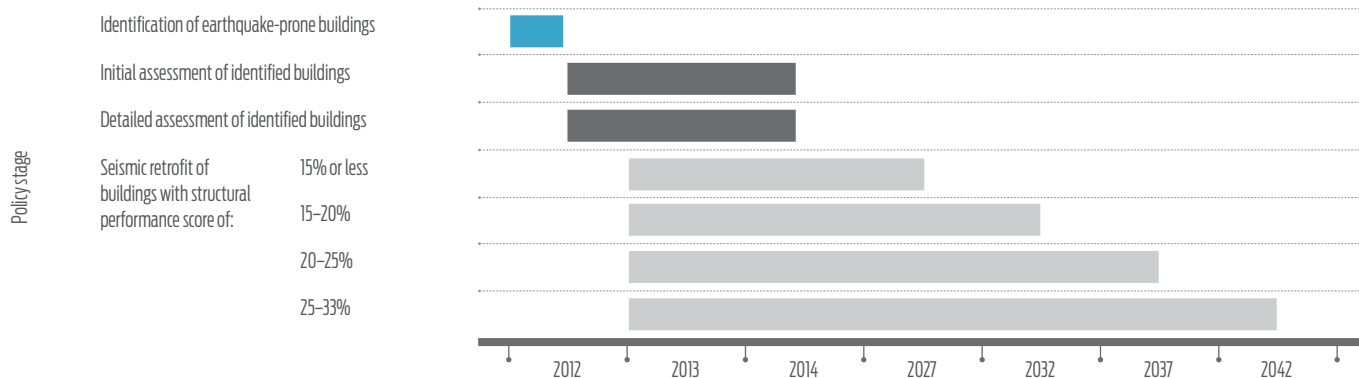


Figure 1: Dunedin City Council earthquake-prone buildings policy and timeline. Note: These are the minimum required retrofits. Building owners are encouraged to upgrade to the highest economically viable level possible.

extensive property damage and some loss of life.

**CDB and historic precinct chosen**

The study area, covering the Dunedin CBD and some of the historic precinct, was selected in consultation with Dunedin City Council staff based on:

- geotechnical details and liquefaction potential
- unreinforced masonry building population and associated value
- safety risk to occupants of the buildings and pedestrians on the adjacent streets.

The geology of the area includes rock and alluvial deposits that were once waterfront.

**Characteristics of the buildings**

Data was gathered from the Dunedin City Council information portals, real estate websites, technical literature and field inspections. It was used to populate the earthquake-prone buildings register, to analyse characteristics of the building stock and to establish their seismic vulnerability.

Each surveyed building was assigned a typology from the seven main typologies suggested by Russell and Ingham to categorise the non-residential New Zealand unreinforced masonry building stock.

A prevalence rank was assigned to each typology and compared with the national context (see Table 1). Two-storey row buildings (typology D) are by far the most prevalent in Dunedin, whereas row buildings (B,

D and F) are far more common than isolated buildings (A, C and E).

As well as being of considerable financial value, 103 of the 226 surveyed buildings have some form of classification from the Historic Places Trust and are regarded as having significant heritage value.

**680 buildings may be earthquake-prone**

Based on the data analysis and the findings from the initial evaluation of the 226 buildings surveyed for the project, 21 can be classed as not earthquake-prone, while the remaining 205 buildings are likely to be earthquake-prone.

Therefore it can be estimated that, of the approximately 750 unreinforced masonry buildings in Dunedin, 680 of them are likely to be earthquake-prone.

The large number of parapets, if not adequately restrained, present the largest risk to life. The risk is increased by the concentration of buildings in the CBD area, which has the highest foot traffic.

Given the large number of historic buildings in the Dunedin CBD, if the city experiences a significant earthquake that damaged these buildings beyond repair, the architectural history of the city and the CBD environment would be drastically affected. ◀

**Table 1**

**PREVALENCE OF BUILDING TYPOLOGIES**

| TYPOLGY | DESCRIPTION                            | PREVALENCE RANK IN NZ | PREVALENCE RANK IN DUNEDIN | IN DUNEDIN |
|---------|--|-----------------------|----------------------------|------------|
| A       | One-storey isolated building           | 4                     | 7                          | 1%         |
| B       | One-storey row building                | 3                     | 3                          | 6%         |
| C       | Two-storey isolated building           | 2                     | 4                          | 4%         |
| D       | Two-storey row building                | 1                     | 1                          | 58%        |
| E       | Three or more storey isolated building | 7                     | 6                          | 4%         |
| F       | Three or more storey row building      | 6                     | 2                          | 23%        |

Note: Russell and Ingham categories.

# Councils tackle earthquake-prone buildings

Under the Building Act 2004, all local authorities are required to adopt an earthquake-prone buildings policy. But in 2012, only 23 of 66 councils had any information on the number of earthquake-prone buildings in their district.

The earthquake-prone buildings policy aims to reduce the level of risk to people from earthquake-prone buildings by ensuring the buildings are better able to withstand a seismic event.

## WHAT IS EARTHQUAKE-PRONE?

According to the Act, a building is earthquake-prone if it:

- a. will have its ultimate capacity exceeded in a moderate earthquake and
- b. would be likely to collapse causing:
  - i. injury or death to persons in the building or to persons on any other property or
  - ii. damage to any other property.

This only applies to buildings intended for commercial use and excludes residential properties, unless the building is two or more storeys high and contains three or more household units.

## THREE-STEP PROCESS

To assess buildings, councils typically adopt a three-step identification process.

1. Search building files and use information such as land condition, building age, construction materials and so on to identify potentially earthquake-prone buildings.
2. Order a field inspection to determine if the building is less than 34% of the strength a new building would require under the New Zealand Building Code. The New Zealand Society of Earthquake Engineering's Initial Evaluation Procedure is a widely accepted method to do this.
3. Notify the building owner and determine the building's final earthquake-prone status following a review of the inspection results.

A building owner may engage an engineer to provide additional detail or a counter position.

## NUMBERS ADDING UP

It's estimated that 15,000–25,000 or 8–13% of New Zealand's non-residential and multi-unit, multi-storey residential buildings could be earthquake-prone. Other estimates place this

figure as high as 40,000 buildings.

The following potentially earthquake-prone buildings have been identified:

- Auckland Council – approximately 4,500.
- Wellington City Council – approximately 4,800, including 570 inner-city commercial buildings that may require strengthening.
- Christchurch City Council prior to September 2010 had identified approximately 7,600, of which 960 unreinforced masonry buildings were at high risk of collapse.

Most territorial authorities choose to further categorise their earthquake-prone buildings according to the level of risk, with the highest priority usually given to critical infrastructure.

The exact method of building categorisation, acceptable timeframe for remediation and the action taken for failure to comply varies from council to council, within the legislation.

## COMPLEX BALANCING ACT

While compulsory, the viability of strengthening earthquake-prone buildings is a balance between seismic resilience and economics. There are several non-statutory drivers that may influence a council's approach.

Earthquake strengthening requires capital investment that may not increase the value or the floor area of the building. This can be a problem for building owners. It can raise issues for banks considering lending for earthquake strengthening work and for insurers considering indemnifying an earthquake-prone building or for commercial tenants who may be unwilling or unable to bear the cost of more earthquake resilient premises.

## CHANGES AHEAD

In response to the recommendations from the Canterbury Earthquakes Royal Commission and a policy review, the government has released a consultation paper on changes to the future legislative framework and approach to earthquake strengthening (see page 10 and [www.canterbury.royalcommission.govt.nz](http://www.canterbury.royalcommission.govt.nz)). ◀