A STUDY OF SEISMIC STRENGTHENING COSTS OF EQPBS: **REDUCING UNCERTAINTIES AND IMPEDIMENTS FOR FASTER SEISMIC STRENGTHENING COMPLIANCE**

Olga Filippova and Qing Tong

Department of Property, The University of Auckland



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Rationale

Earthquake-prone buildings (EQPBs) are a major concern for public safety and community resilience. The Building Act requires EQPBs owners to remediate/remove seismically vulnerable building structures by specific deadlines, however, owners are often reluctant to carry out remedial works¹. The decision-making of seismic strengthening implementation begins with owners' choice among three options (of sell, lease, or comply). While the decisionmaking process is influenced or impeded by multiple stakeholders, uncertainties involved in cost is the most significant impediment for seismic strengthening implementation². Owners generally perceive the cost too excessive to initiate any remedial works, yet the lack of accuracy in cost estimation due to hidden or additional works exacerbates the uncertainties involved in seismic strengthening.

EQPB OWNERS

Professional

Option 1: Do Nothing & Sell 'As-Is'. LOSS IN SALES PRICE due to Developers



The URM Programme

After the 2016 Kaikoura Earthquake, the URM Programme was established in response to a heightened risk of further earthquakes occurring in four territorial authorities (Wellington City, Lower Hutt City, Marlborough District, and Hurunui District). The affected councils issued 189 s124 notices, requiring seismic strengthening of dangerous URM parapets and facades on major thoroughfares within a strict 18-month deadline. With a concerted effort by building owners, the URM Programme successfully lifted 188 out of 189 notices, eliminated falling hazards of URM building elements³. Government **funding** and local councils' Cross-Organisational Collaborative Approach (COCA) played the crucial roles to the success via providing effective financial and technical supports that owners needed under the URM programme.

	Description	Funding Cap (excluding GST)				
Category A	No remedial work required	Max. \$1,500 for engineering assessments				
Category B	1 or 2 storey bldgs	Max. \$25k for a façade/parapet per listed street				
Category C	3 or 4 storey bldgs	Max \$65k for a facade/parapet per listed street				



The recent URM [Unreinforced Masonry] Programme provided actual construction invoices and the funding administration data, which enabled the investigation of seismic strengthening cost. The study aims at reducing the uncertainties involved and providing useful insights to motivate owners in going forward with complying strengthening requirements. The cost pattern suggests that cost varies depending on the typology of **building** classifications (i.e. physical characteristics of buildings and building use). A regression model is also developed to identify cost factors significant in seismic strengthening, which serves to formulating more flexible funding options for future government-led programmes. In additions, three case studies of the most common scenarios are discussed contributing to the understanding of challenges & opportunities ahead for EQPB owners.

Seismic Strengthening Cost Factors

Cost Factors	Building Size	Building Use	Building Location	Heritage Status	Building Owner Types	Economies of Scale	Multi-staged Strengthening Programme	have an in on cos
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Cost Indications



The above factors can help in setting up more flexible funding
options for future seismic strengthening programmes.

Factors suggest different ways for seismic strengthening.

Three Building Owner Types were identified. Large buildings (3&4-storey) cost ≈25% Wellington buildings cost ≈16% higher than small bldgs (1&2-storey) higher than similar bldgs located in Lower Hutt. Since construction 2-storey buildings cost 13%-45% higher cost in Wellington is already than 1-storey bldgs. fueled by the region's economic

Funding Option: separate funding for 2storey bldgs rather than having a bundled funding category with 1-storey bldgs.

averagely.

Residential buildings cost ≈27% lower than similar commercial bldgs. Funding Option: differentiate funding for residential & commercial constructions.

and population growth, the cost of seismic strengthening projects is inflated at a higher rate. unding Option: increase financial support for Wellington buildings to ensure participation in future strengthening programmes.

Heritage buildings cost ≈8% higher than non-heritage bldgs due to retention requirements and design restrictions. In some cases suggest that the cost can be more than 500% more than the funding capped amount. <u>Funding Option</u>: increase financial support for heritage owners; allow & qualify funding from more than one funding source.



Cost-saving is achievable through **economies of scale.** The regression result shows a negative relationship between the total cost and building owners who involved in the Jackson Street Programme (where a community working group recruited a professional building company to carry out seismic strengthening for its members at the same time).

No cost premium for owners who decide to carry out seismic strengthening in a multistaged manner. The result shows a nonsignificant relationship and a low coefficient when comparing buildings that strengthened entirely, indicating no difference in costs for strengthening only a part of the building (URM façades/parapets) or the whole building. Therefore, owners can consider the option of spreading out the work into smaller and financially manageable sizes.

Case Studies – Challenges & Opportunities



CS#1 bldgs are generally 2-storey commercial or mixed-use properties. They are popular renovate/convert the upper-level office space.



CS#2 bldgs are multi-storey residential apartments. Unit-title ownership is associated among purchasers who look for home-and-income properties and developers who || with this scenario and any seismic strengthening decisions have to be made through Body Corporates.

CS#3 Three+ Storey Commercial bldgs



CS#3 bldgs are large commercial bldgs. The building complex consists of multiple tenants which typically has retail shops on the ground level and office spaces on the upper levels. Some bldgs have a basement area as storage or car parking spaces.

Challenges:

- It is hard to secure necessary engineers & contractors for seismic strengthening since the project is relatively small and risky.
- Owners are lacking of construction & project mgmt experience to navigate the work.

Opportunities:

- Converting the vacant space upstairs into residential flat for added income.
- Undertaking seismic strengthening through economies of scale to save on cost. E.g. The Jackson Street Programme - a community working group engaged a professional building company to carry out strengthening for its members at the same time.



Example: This is a mixeduse building originally built n the 1920s. The upperevel space was converted nto a residential apt, while the ground level remained as a retail space. The property has an estimated rental of \$60k + ST in Sep-17.

Challenges:

- The majority of owners tend to be the retired population, and the unit is their primary residence.
- Each owner has different financial status; if one owner decided not to strengthen or to sell 'as-is', then the project will be delayed.
- Insurance premium has become unsustainable with natural disaster covers.

Opportunities:

- Government offer a low-interest loan scheme to help with the strengthening cost.
- Stable rental returns and long-term growth projection for apartments.



Example: The Bond Store is a former industrial bldg. It was modified into residential apts in the late 90s. During the URM Programme, their initial contractor walked away the day before the work started. Although another contractor was secured promptly, the work itself was challenging. It was carried out around occupied units. Structural steels had to be lifted through narrow window openings, and furniture has to be moved around to allow installation

Challenges:

- Increased complexity in building structure which requires sophisticated engineering solutions for future seismic strengthening stages.
- Needs to accommodate various tenants' requirement and to work around their working hours for minimum business disruption.

Opportunities:

- Owners are professional operators and property developers who have the means and expertise to strengthen the building to maximise returns.
- Strengthen the bldg to >67%NBS eliminates uncertainties and attract more tenants.



Example: This bldg is currently undertaking a redevelopment. Given a large-scaled strengthening work is required, the developer has chosen only to strengthen the heritage façade rather than carry out seismic strengthening for the 100-year-old building structure. The redevelopment includes the rebuilding of an entirely new structure to 130%NBS and shop fit-out for new tenants.

References

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Correspondence: Olga Filippova Email: o.filippova@auckland.ac.nz