

Project 17137 - Usage of Seismic Loss Assessment to Motivate High Performance Building Solutions

Project Title

Usage of Seismic Loss Assessment to Motivate High Performance Building Solutions

Research Team

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Project Description

To achieve widespread implementation of low-damage systems, the economic benefits of such systems must be demonstrated. This requires a long term outlook and an assessment of life-cycle costs. To address this need, this strategic project will firstly highlight the potential benefits of adopting a life-cycle costing framework. By applying an assessment framework that permits comparison of both up-front and long-term costs, including future losses from earthquakes, to a selection of case study buildings realized with different design alternatives, it can be demonstrated that life-cycle cost analysis could be used to effectively quantify the improved performance offered by low-damage construction technologies.

Secondly, in order to assist the NZ engineering profession make a smooth transition towards such probabilistic seismic loss assessment, the project proposes to test and develop different simplified loss assessment methods.

Finally, recognizing that the accuracy of any loss assessment will depend on the quality of the inputs used, the project will identify and develop loss and fragility functions for elements typical of NZ construction practice.

Key Objectives

The main objectives of this project are as follows:

1. Demonstrate, via loss-assessment of a selection of case study buildings, how loss assessment could be an effective means of quantifying the benefits of innovative construction technologies.
2. Test and develop options for simplified loss-assessment appropriate for preliminary design phase, thus assisting the NZ engineering profession make a smooth transition towards probabilistic seismic loss assessment.
3. Identify and develop loss functions for non-structural elements that will assist with the application of loss assessment in New Zealand.
4. Review procedures for the definition of fragility functions, identify functions from literature suitable for NZ construction, and develop fragility functions for components unique to NZ buildings.

Case Study Building Plans

Most up-to-date version of the case study building plans are provided below.

Four-Storey Office Building

Summary Report

- In draft

Ground floor drawings

- [Floor Plan and Partition Layout](#)
- [Above Ceiling Details](#)
- [Sprinkler Layout](#)
- [HVAC Layout](#)
- [Ceiling Layout](#)

Upper floors drawings

- [Floor Plan and Partition Layout](#)
- [Above Ceiling Details](#),
- [Sprinkler Layout](#)
- [HVAC Layout](#)
- [Ceiling Layout](#)

Case Study Component Quantity and Assumed Fragility/Loss Functions

IMPORTANT NOTE: There are two sets of component quantities and assumed fragility/loss functions presented herein. One was used for a case study on the cost-effectiveness of steel beam-column friction joints by Yeow et al. (submitted). The other is a more updated version for general use.

Data used by Yeow et al. (submitted)

- Non-structural elements: [quantities, fragility/loss functions](#)
- Traditional steel moment resisting frame structural elements: [quantities, fragility/loss functions](#)
- Steel moment resisting frame with friction connections structural elements: [quantities, fragility/loss functions](#)

Ground Motion Records (IN DRAFT)

Please reference the following publication if you are using the ground motion records provided below:

Yeow TZ, Orumiyehi A, Sullivan TJ, MacRae GA, Clifton GC, and Elwood KJ. (submitted). Seismic performance of steel friction connections considering direct-repair costs. Bulletin of Earthquake Engineering.

Documentation - IN DRAFT

Auckland (subsoil class C)

- Sa(0.5s): Hazard levels [1-3](#), [4-6](#), and [7-9](#), [scaled vertical components](#) [[hazard data](#)]
- Sa(1.0s): Hazard levels [1-3](#), [4-6](#), and [7-9](#), [scaled vertical components](#) [[hazard data](#)]
- Sa(2.0s): Hazard levels [1-3](#), [4-6](#), and [7-9](#), [scaled vertical components](#) ([pt1,pt2](#)) [[hazard data](#)]
- Sa(4.0s): Hazard levels [1-3](#), [4-6](#), and [7-9](#), [scaled vertical components](#) ([pt1,pt2](#)) [[hazard data](#)]

Christchurch (subsoil class D)

- Sa(0.5s): Hazard levels [1-3](#), [4-6](#), and [7-9](#), [scaled vertical components](#) [[hazard data](#)]
- Sa(1.0s): Hazard levels [1-3](#), [4-6](#), and [7-9](#), [scaled vertical components](#) [[hazard data](#)]
- Sa(2.0s): Hazard levels [1-3](#), [4-6](#), and [7-9](#), [scaled vertical components](#) [[hazard data](#)]
- Sa(4.0s): Hazard levels [1-3](#), [4-6](#), and [7-9](#), [scaled vertical components](#) [[hazard data](#)]

Wellington (subsoil class C)

- Sa(0.5s): Hazard levels [1-3](#), [4-6](#), and [7-9](#), [scaled vertical components](#) [[hazard data](#)]
- Sa(1.0s): Hazard levels [1-3](#), [4-6](#), and [7-9](#), [scaled vertical components](#) [[hazard data](#)]
- Sa(2.0s): Hazard levels [1-3](#), [4-6](#), and [7-9](#), [scaled vertical components](#) [[hazard data](#)]
- Sa(4.0s): Hazard levels [1-3](#), [4-6](#), and [7-9](#), [scaled vertical components](#) [[hazard data](#)]

NOTE: Hazard levels 1 to 9 corresponds to (1) 80%, (2) 50%, (3) 20%, (4) 10%, (5) 5%, (6) 2%, (7) 1%, (8) 0.5%, and (9) 0.2% probability of exceedance in 50 years, respectively. The conditioning IM value at each hazard level is provided in the hazard data.