Seismic Vulnerability Assessment of Irregular Reinforced Concrete Buildings in Australia

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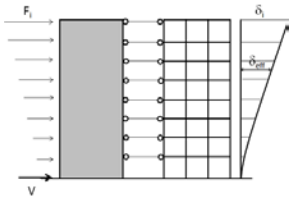
THIS POSTER INTRODUCES A RAPID SEISMIC ASSESSMENT METHOD FOR REINFORCED CONCRETE BUILDINGS IN REGIONS OF LOW TO MODERATE SEISMICITY SUCH AS AUSTRALIA. THE METHOD HAS BEEN USED TO ASSESS THE SEISMIC VULNERABILITY OF IRREGULAR REINFORCED CONCRETE BUILDINGS. THIS TYPE OF BUILDINGS MAKE UP MOST OF THE AUSTRALIA'S MEDIUM TO HIGH-RISE BUILDING STOCKS AND ARE GENERALLY CONSIDERED TO BE VULNERABLE IN AN EARTHQUAKE.

INTRODUCTION

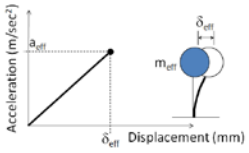
This poster presents interim findings of a study on the seismic vulnerability of reinforced concrete buildings featuring vertical irregularities caused by discontinuities of the load resisting elements. A generalised lateral force analysis method is introduced. Rapid seismic vulnerability assessments were conducted based on the proposed analysis method to determine the probability of limited and moderate damage limit states to be exceeded under a given intensity of earthquake shaking.

GENERALISED LATERAL FORCE METHOD OF ANALYSIS

1. Apply the equivalent static analysis method in accordance with the standard design procedure (e.g., AS1170.4:2007, SA 2007)



2. Idealise the multi-storey building response into a single-degree-of-freedom response (construct capacity diagram)

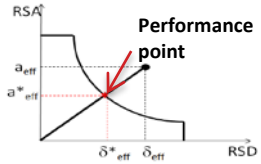


$$\delta_{eff} = \frac{\sum m_i \delta_i^2}{\sum m_i \delta_i}$$

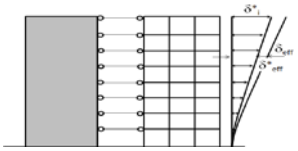
$$m_{eff} = \frac{(\sum m_i \delta_i)^2}{\sum m_i \delta_i^2}$$

$$a_{eff} = \frac{V}{m_{eff}}$$

3. Superpose the capacity with the demand diagram to determine the performance point



4. Re-calculate the displacement demand on the building based on the performance point.

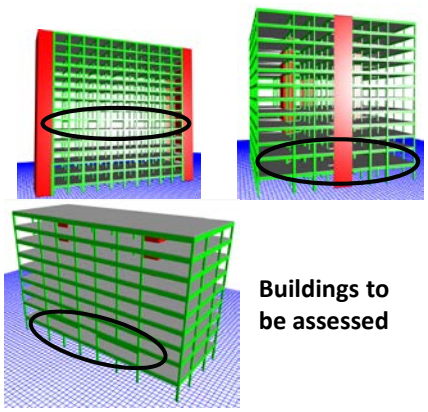


CONSTRUCTION OF FRAGILITY CURVES

Fragility curves take the form of lognormal cumulative distribution function having a median value and logarithmic standard deviation:

$$P(DS \geq ds_i | k_p Z) = \varphi\left(\frac{\ln(k_p Z) - \ln(\overline{k_p Z})}{\beta}\right)$$

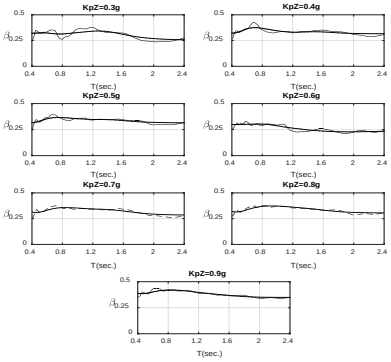
$P(DS \geq ds_i | k_p Z)$ is the probability of a ground motion with a certain level of $k_p Z$ causing a damage level of ds_i to be exceeded, $\overline{k_p Z}$ is the level of $k_p Z$ that has 50% chance to cause the damage level to be exceeded and β is the standard deviation of the lognormal function.



Buildings to be assessed

Uncertainties in fragility functions (β)

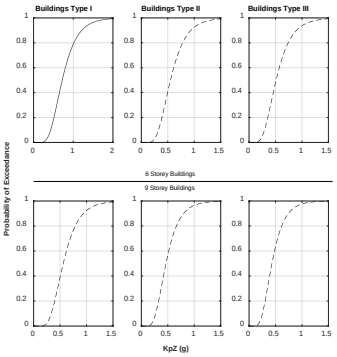
A study has been conducted to produce estimates of standard deviation values for fragility functions representing the total dispersion arising from record-to-record variability.



Record-to-record dispersion factor

Fragility curves

Fragility curves were constructed for three reinforced concrete buildings featuring vertical irregularities. The fragility curves represent the probability of slight and moderate damage of the buildings being exceeded. The inter-storey drift limits of 0.5% and 1.5% in accordance with Vision2000 recommendation (SEAOC, 1995).



Fragility curves – moderate damage limit state (1.5%) (site class D)

REFERENCES

SEAOC (1995), Vision 2000: Performance Based Seismic Engineering of Buildings, San Francisco, April 1995

Standards Australia (2007). AS 1170.4-2007 *Structural design actions, Part 4: Earthquake actions in Australia*. Sydney: Standards Australia.

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