Analysis of quantitative methods for assessing functional recovery post earthquake

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BACKGROUND

Current building codes focus on the life safety of communities. There is a need for a 'better than code' building design that would allow the buildings damaged by an earthquake to restore to the desired functionality (i.e. functional recovery) within an acceptable timeframe.

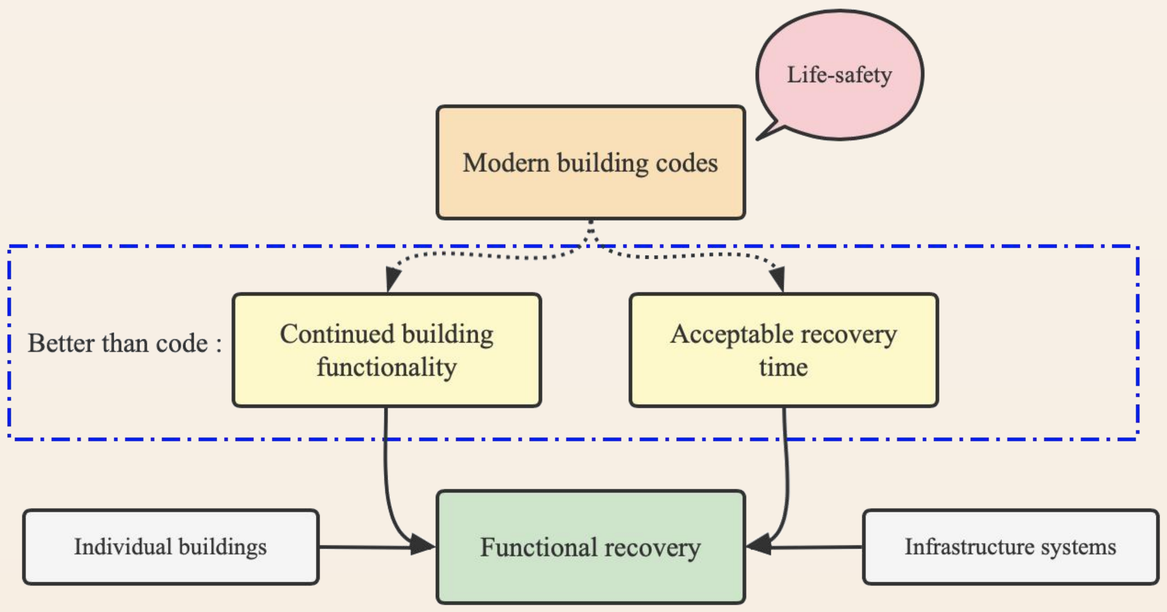


Fig 1. Overview of a 'better than code' building design post earthquake

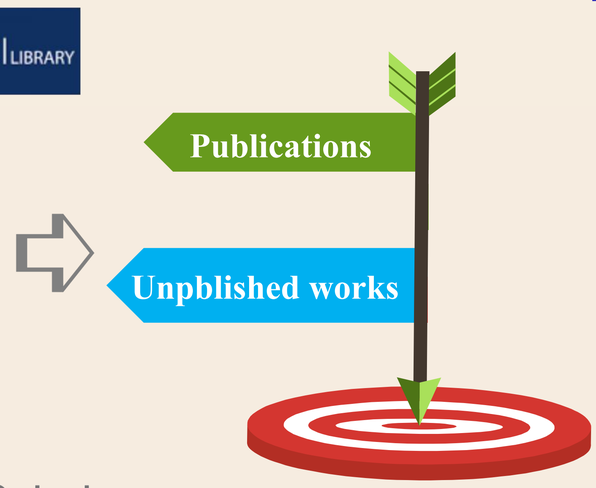
RESEARCH AIM

This research presents a critical review of existing methodologies that quantify functional recovery, and comparing their application areas, advantages and limitations.

METHDOLOGY

Applied Technology Council

FEMA · Scopus · ASCE Library · nehrp · IEEE Advancing Technology for Humanity · ICC International Code Council · QuakeCoRE NZ Centre for Earthquake Resilience Te Hiranga Rū · Elsevier · SEAOC · NIST National Institute of Standards and Technology · Clarivate Web of Science · EERI Earthquake Engineering Research Institute Dedicated to reducing earthquake risk · Springer Link · Google Scholar



RESEARCH FINDINGS

Simulation-based method

- CTMC
- Markov/semi-Markov process
- Hierarchical Bayesian network
- Variable Elimination
- Monte Carlo simulation

Risk-based method

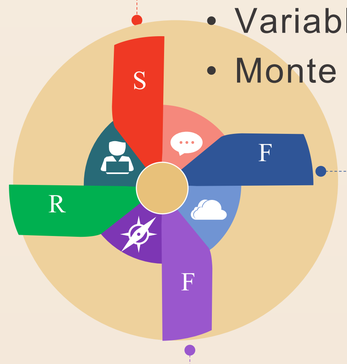
- Dysfunctionality hazard curve

Fragility-based method

- Time-to-functionality fragility
- Seismic Fragility analysis

Functionality-based method

- Event tree analysis
- Fault tree analysis
- Recover function model



Simulation-based method

- Quantifying interdependencies multi-dimensionally.
- Make full of limited data to generate reliable converged results.
- Pervasive uncertainties and potential random algorithms errors still exist.

Fragility-based method

- Capture uncertainties driven from fragilities to account for decision variables.
- Reveal the effects of EDPs on building recovery time.
- A limited number of fragility curves are available.

Functionality-based method

- Discussing different functionality states directly.
- Link the building system and subsystems to functionality values and building recovery time.
- The determination of indicators, factors and subsystems is flexible.

Risk-based method

- Metrics are derived from the concept of resilience.
- Give insights on different shapes of recovery curves with the same resilience value but different functions.
- Adapt to various hazard scenarios and structures easily.

CONCLUSIONS

1. Linking building functionality and community resilience with the building recovery time provides a direction to quantify the functional recovery timeframe.
2. The availability of data and the types of built system that is being investigated determine the types of methodology that can be used for quantifying functional recovery timeframe.
3. Existing methodologies feature quantitative analysis combined with qualitative data collection.
4. There are uncertainties to be addressed which result from ground shaking, building component fragilities, and the building restoration process.

FUTURE RESEARCH DIRECTIONS

- ☑ There is a need for an indicator-based approach to quantifying functional recovery timeframe.
- ☑ Building damage and recovery data, especially big data is key for establishing accurate quantification for functional recovery timeframe.
- ☑ It is essential to address the uncertainties resulting from the hazard itself and the building restoration process with more advanced algorithms, such as neural networks.
- ☑ It is also needed to consider the interdependencies between the built environment and the socio-economic conditions of local communities.

ACKNOWLEDGEMENTS

This project was partially supported by QuakeCoRE, a New Zealand Tertiary Education Commission-funded Centre with QuakeCoRE publication number 0774. The study would not be made possible without the doctoral scholarship provided by the China Scholarship Council (CSC).

QuakeCoRE NZ Centre for Earthquake Resilience