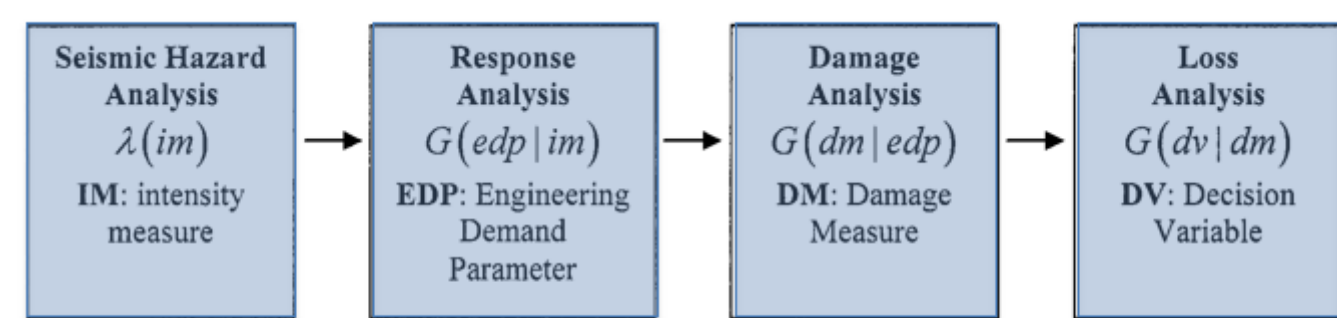


Principal Investigators: Vesna Terzic, Ass. Professor, CSU Long Beach & Kristijan Kolozvari, Ass. Professor, CSU Fullerton  
Student Investigator: Daniel Saldana, CSU Long Beach  
CSU Long Beach & CSU Fullerton

## Problem Statement

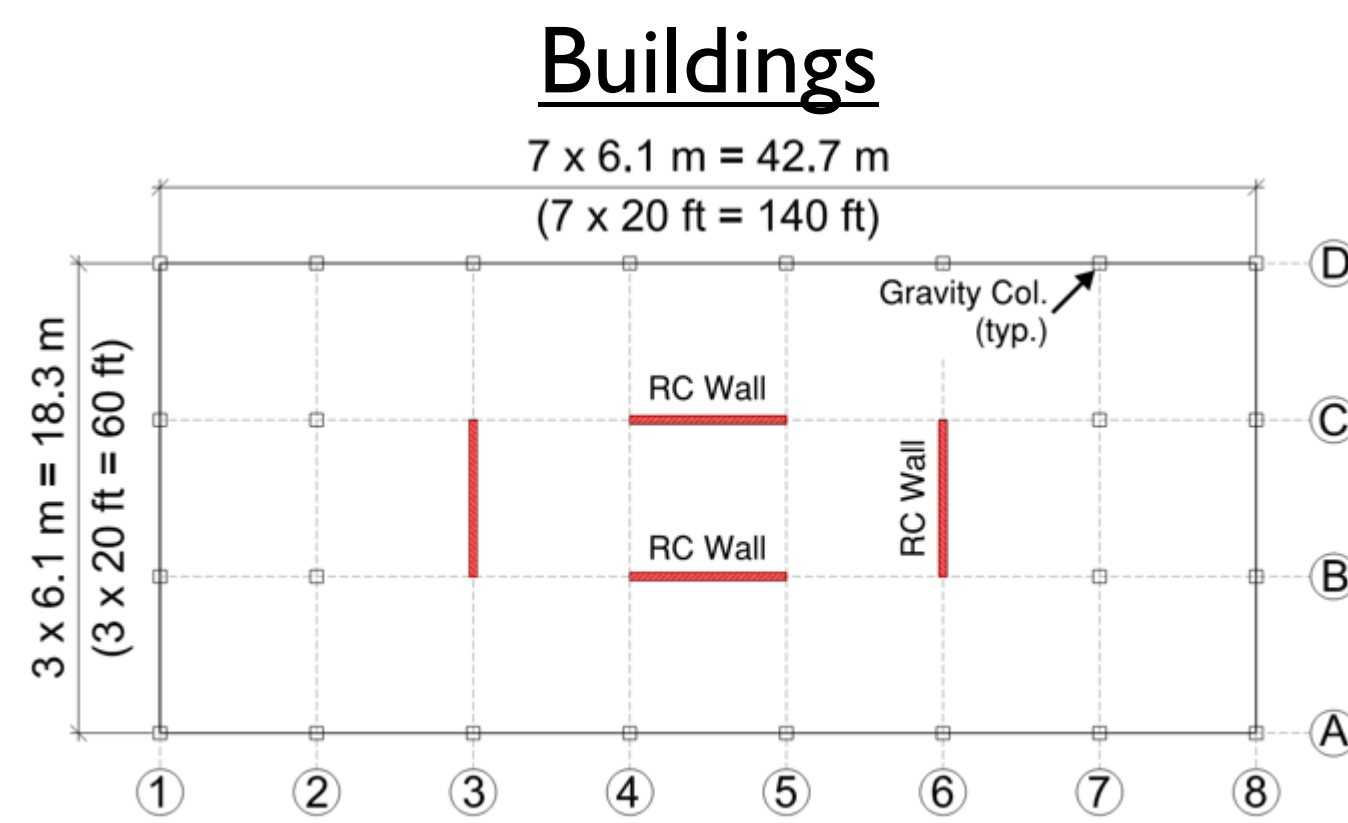
In recent earthquakes in Chile, New Zealand, and Japan, modern buildings were generally quite safe. While code-compliant structures are generally designed to provide safety and prevent collapse at minimum costs, in case of severe ground shaking, the damage to contents, nonstructural components, and the structural system can result in loss of function, which can have a dramatic impact on the occupants, owners and community.

## Performance-Based Seismic Evaluation Methodology



$$\lambda(DV > dv) = \int \int \int \int G(dv|dm) dG(dm|edp) dG(edp|im) d\lambda(im)$$

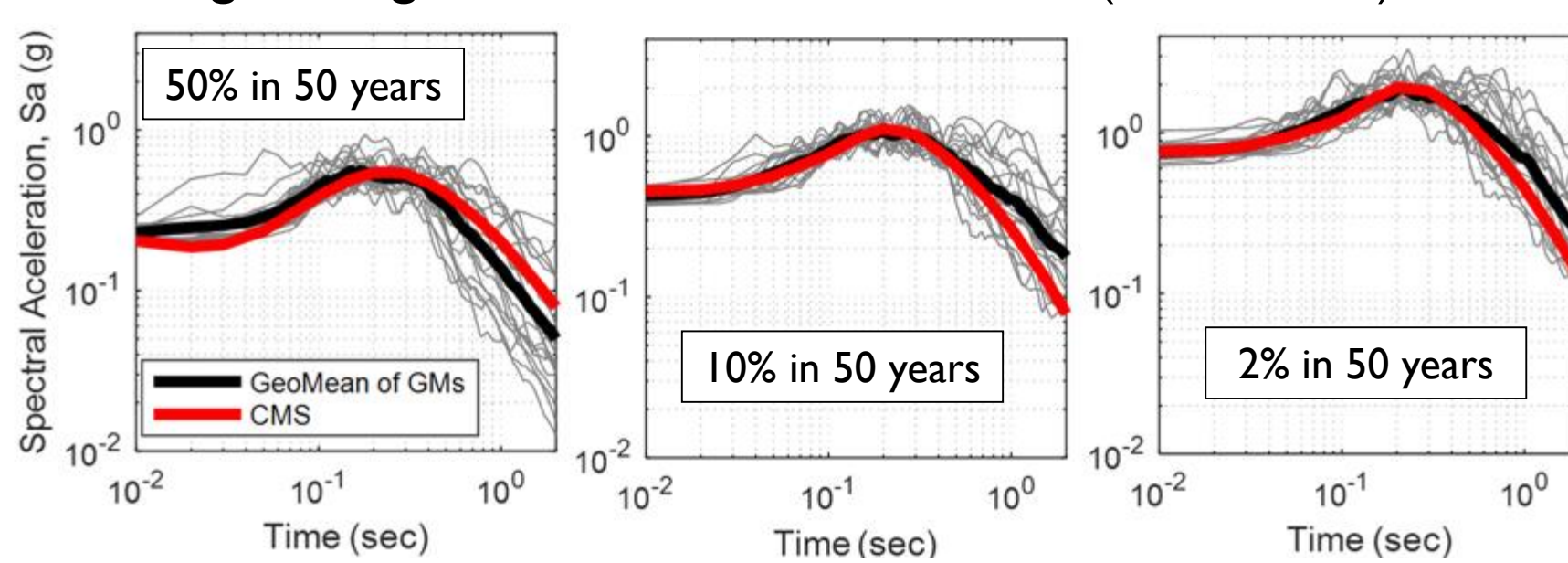
## Low-Rise(3-Story) & Mid-Rise(5-Story) Buildings



Buildings	3-Story			5-Story		
	Office	eOffice	Hospital	Office	eOffice	Hospital
Importance Factors, $I_e$	1	1.5	1.5	1	1.5	1.5
Building Periods (sec)	0.261	0.252	0.252	0.573	0.453	0.453
Max design ISD	0.004	0.004	0.004	0.017	0.01	0.01
Allowable ISD <sup>1)</sup>	0.025	0.025	0.015	0.02	0.02	0.01

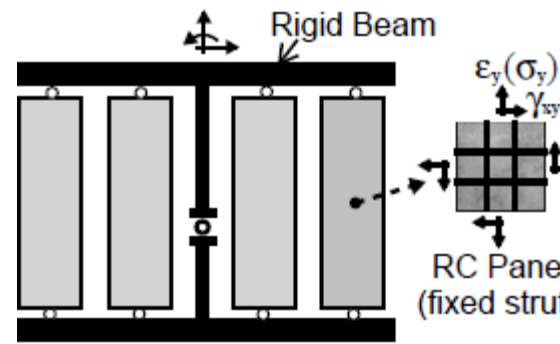
## Ground Motion Selection

- Selected following FEMA P-58 recommendations (2012)
- Using PEER ground motion database tool (PEER, 2013)



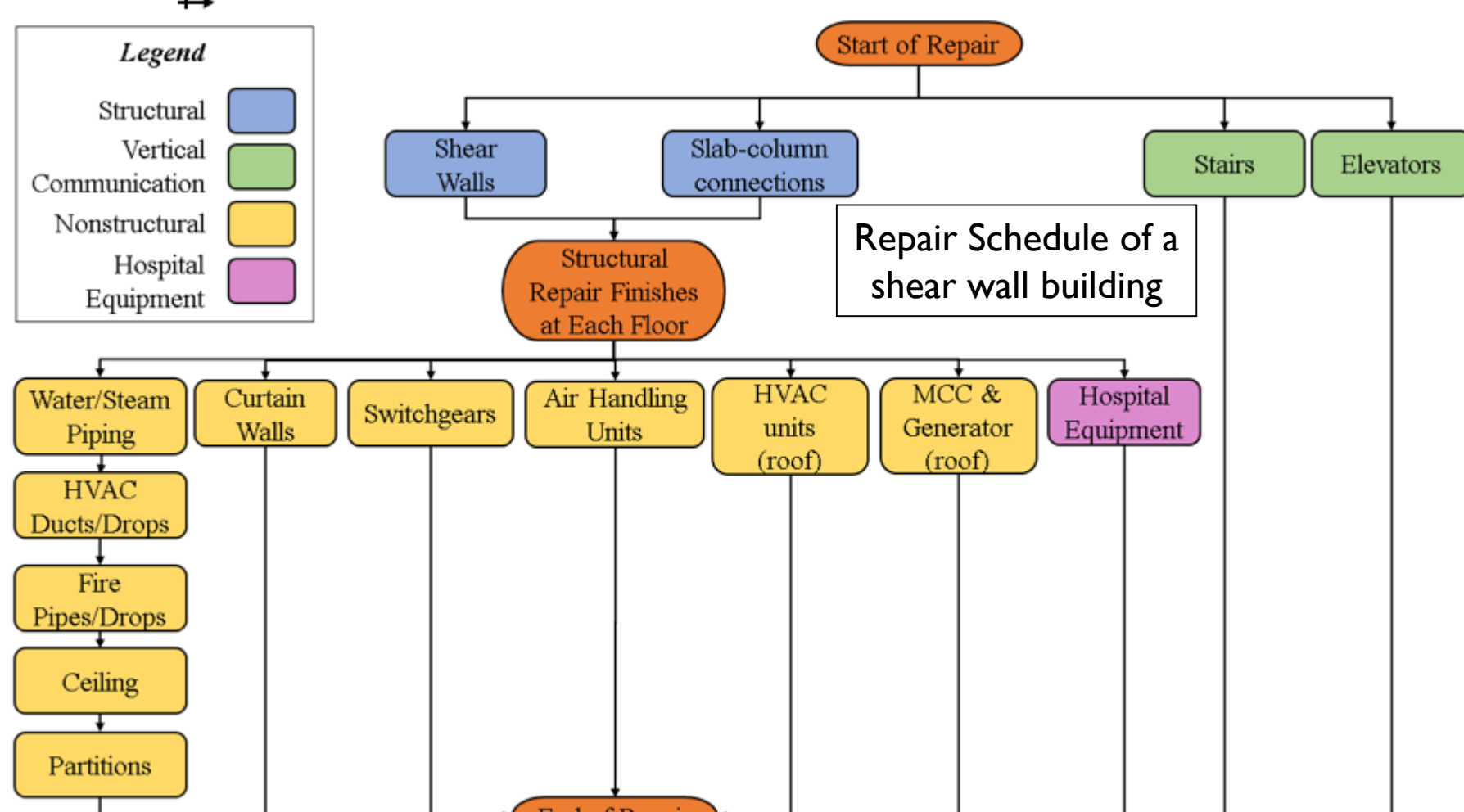
## Analytical Model

Shear Flexure Interaction Model  
Kolozvari et al. (2015)

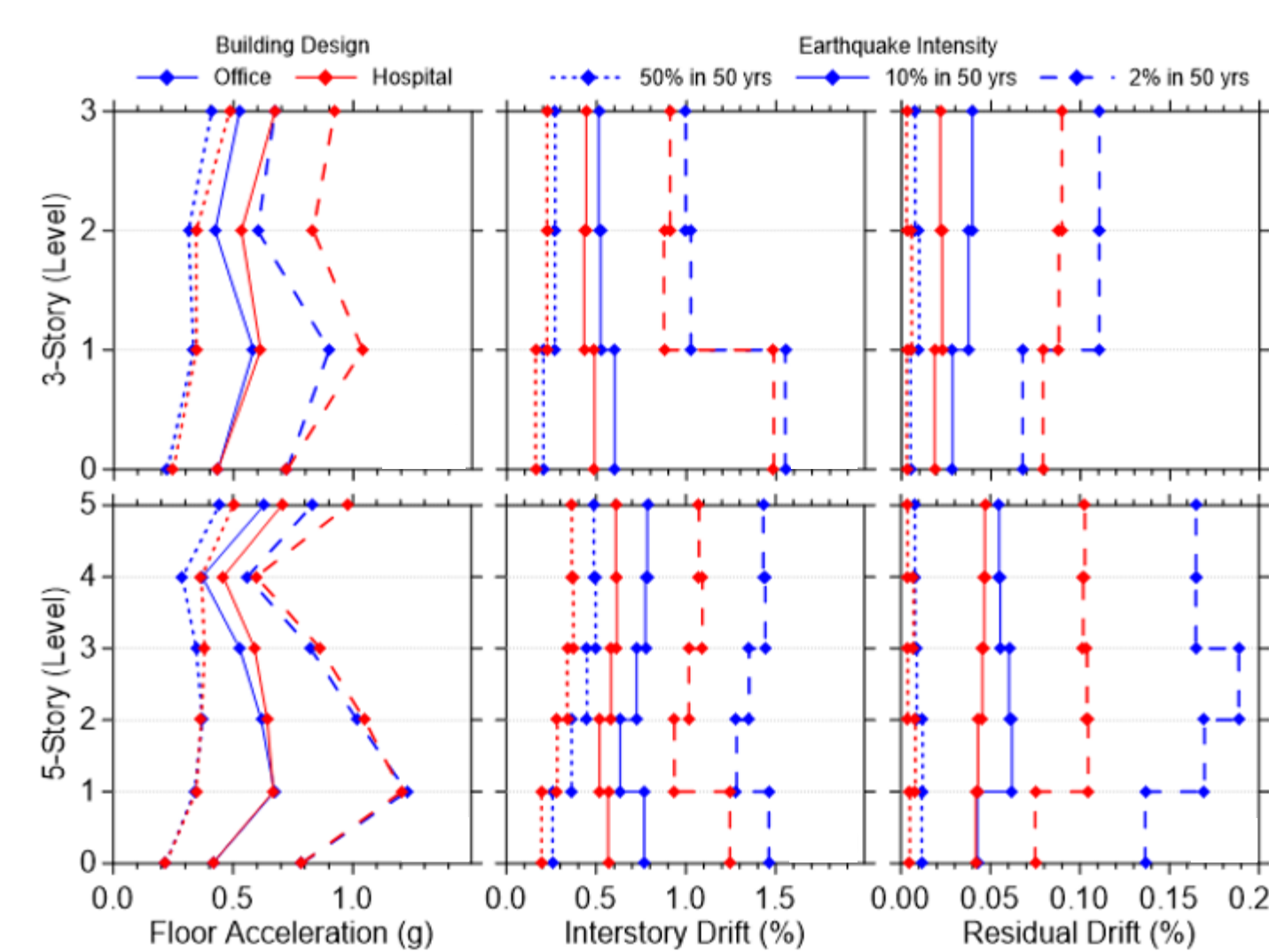


## Loss Models

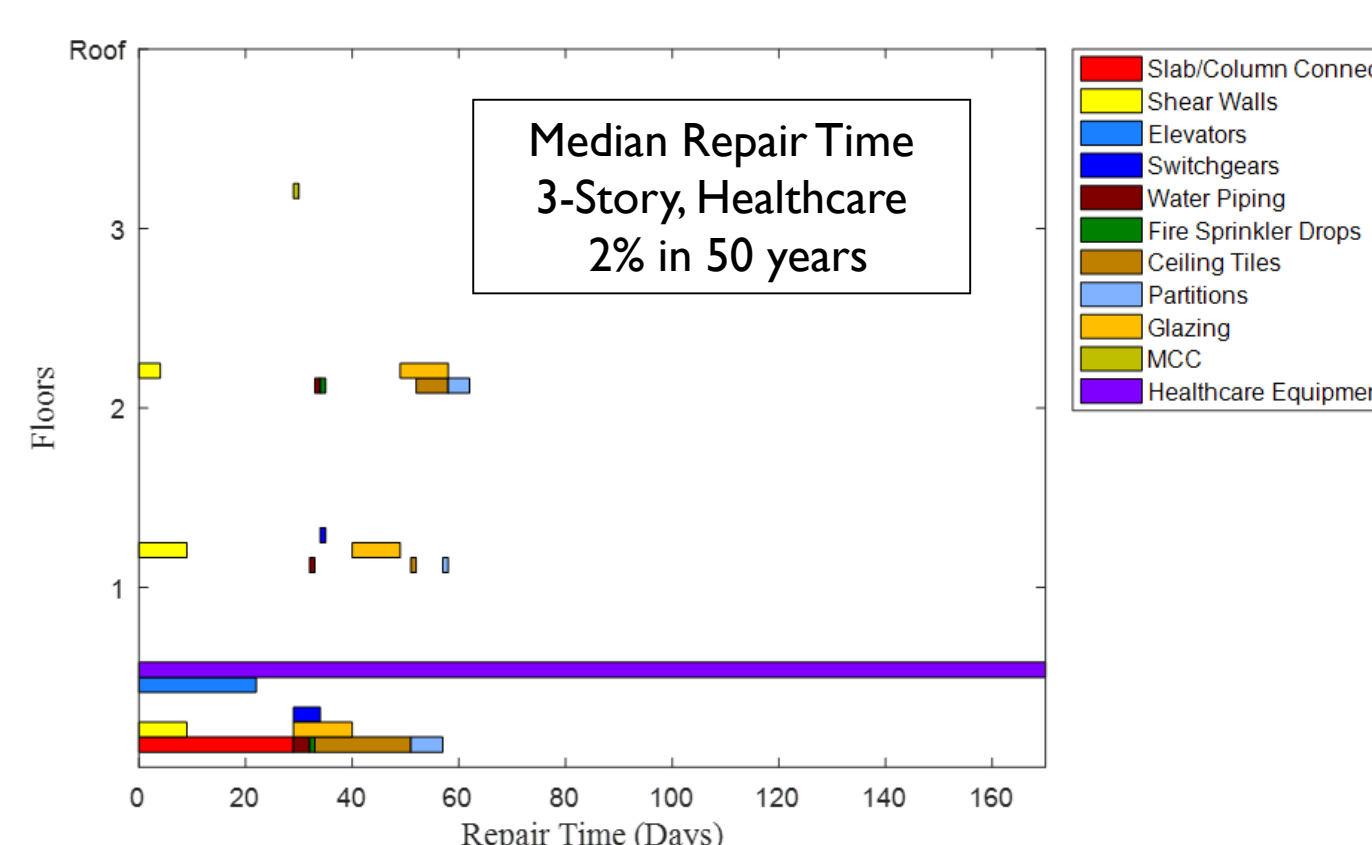
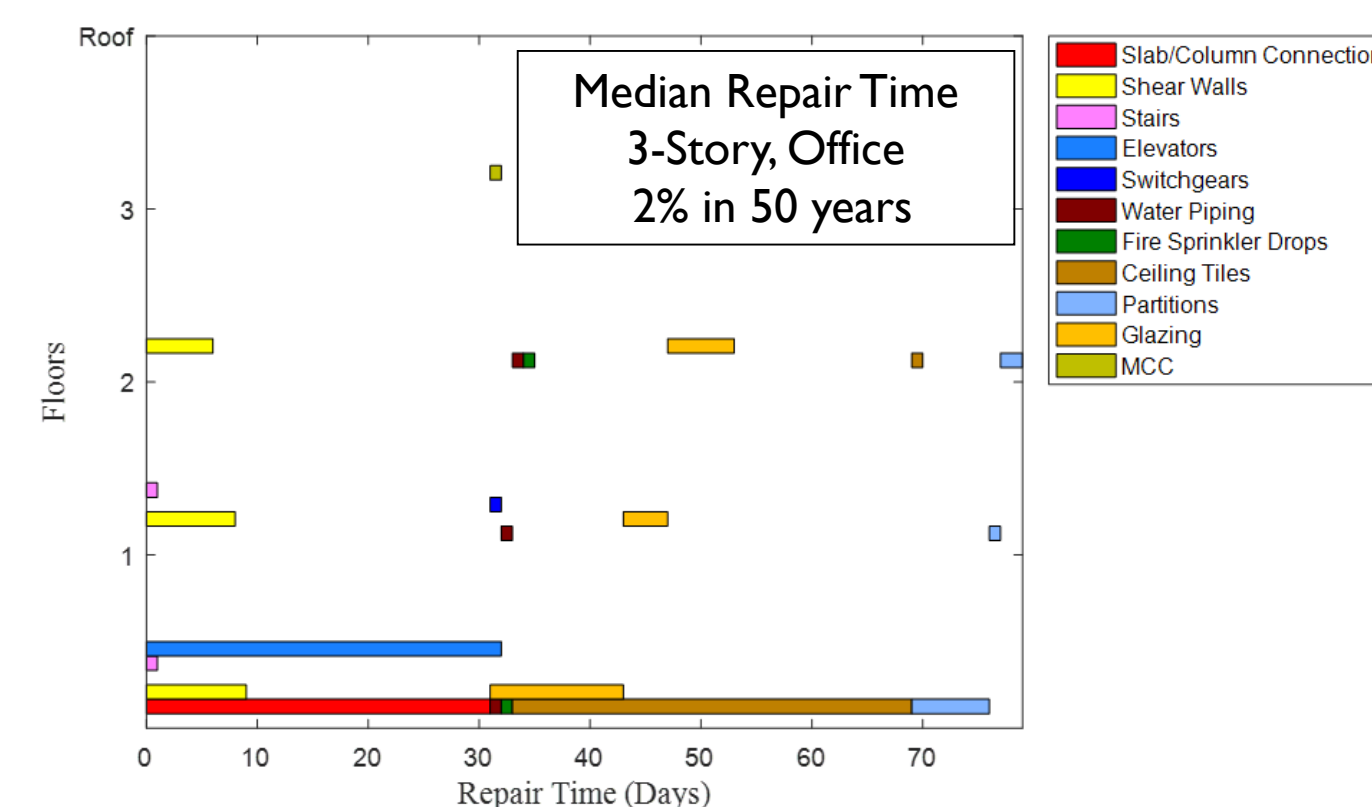
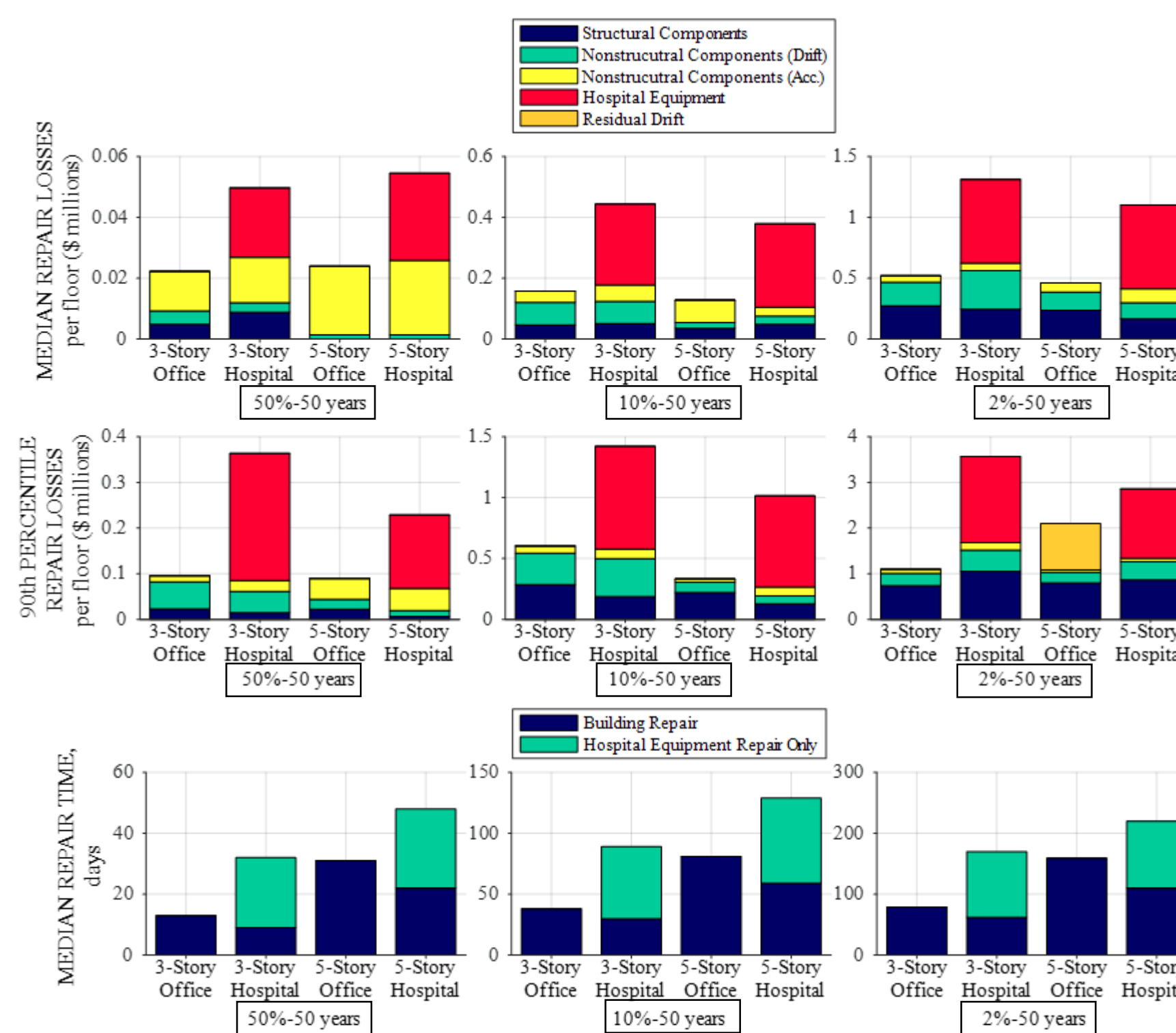
- Two loss metrics: 1) Repair Cost
- 2) Repair Time
- Determined by: FEMA P-58 computer software PACT (2012) and repair model developed by Terzic et al. (2016)



## Office ( $I_e=1.0$ ) and Hospital ( $I_e=1.5$ ) Office ( $I_e=1.0$ ) and eOffice ( $I_e=1.5$ ) Shear Wall Buildings Median Structural Response



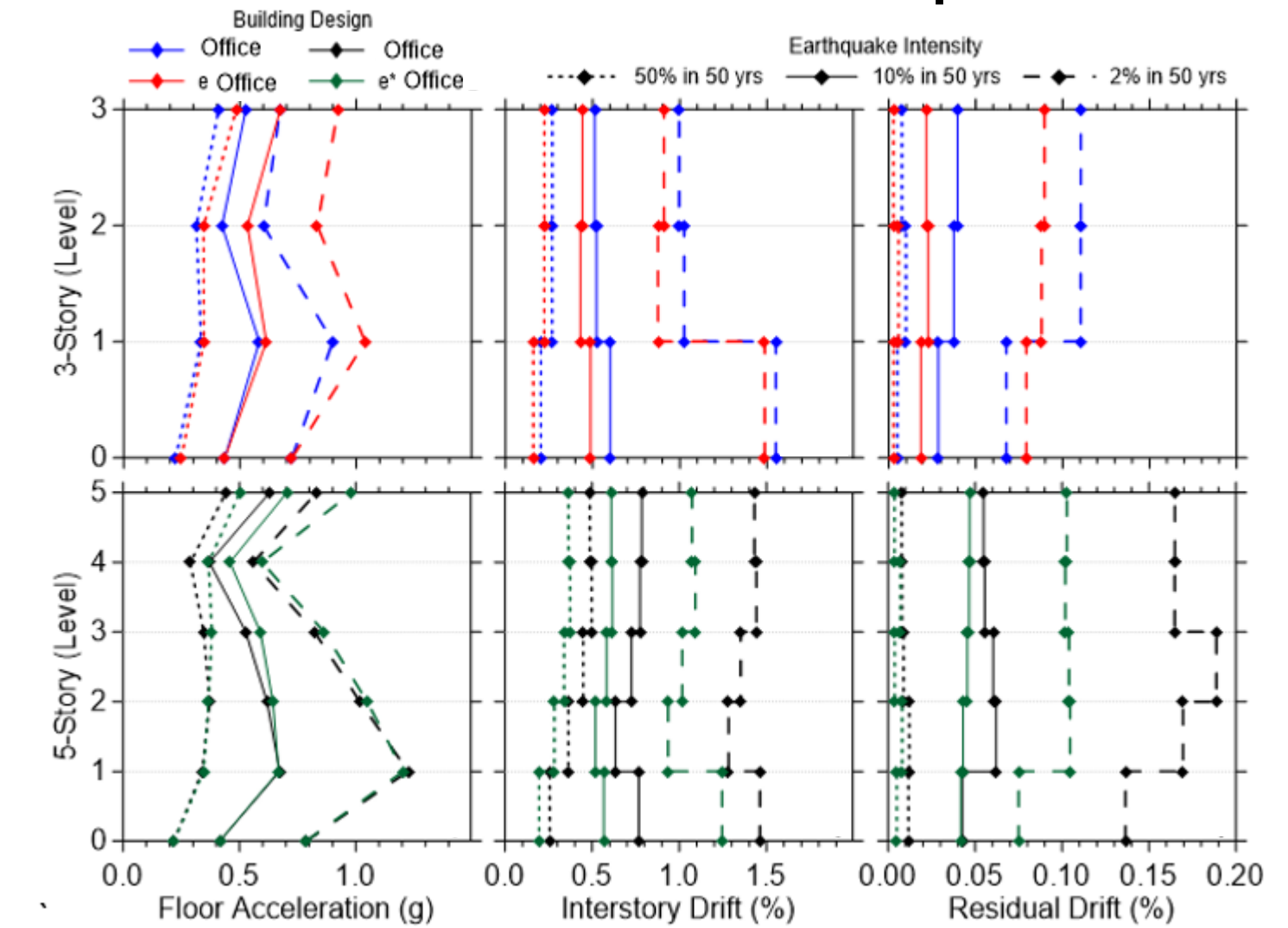
## Loss Evaluation



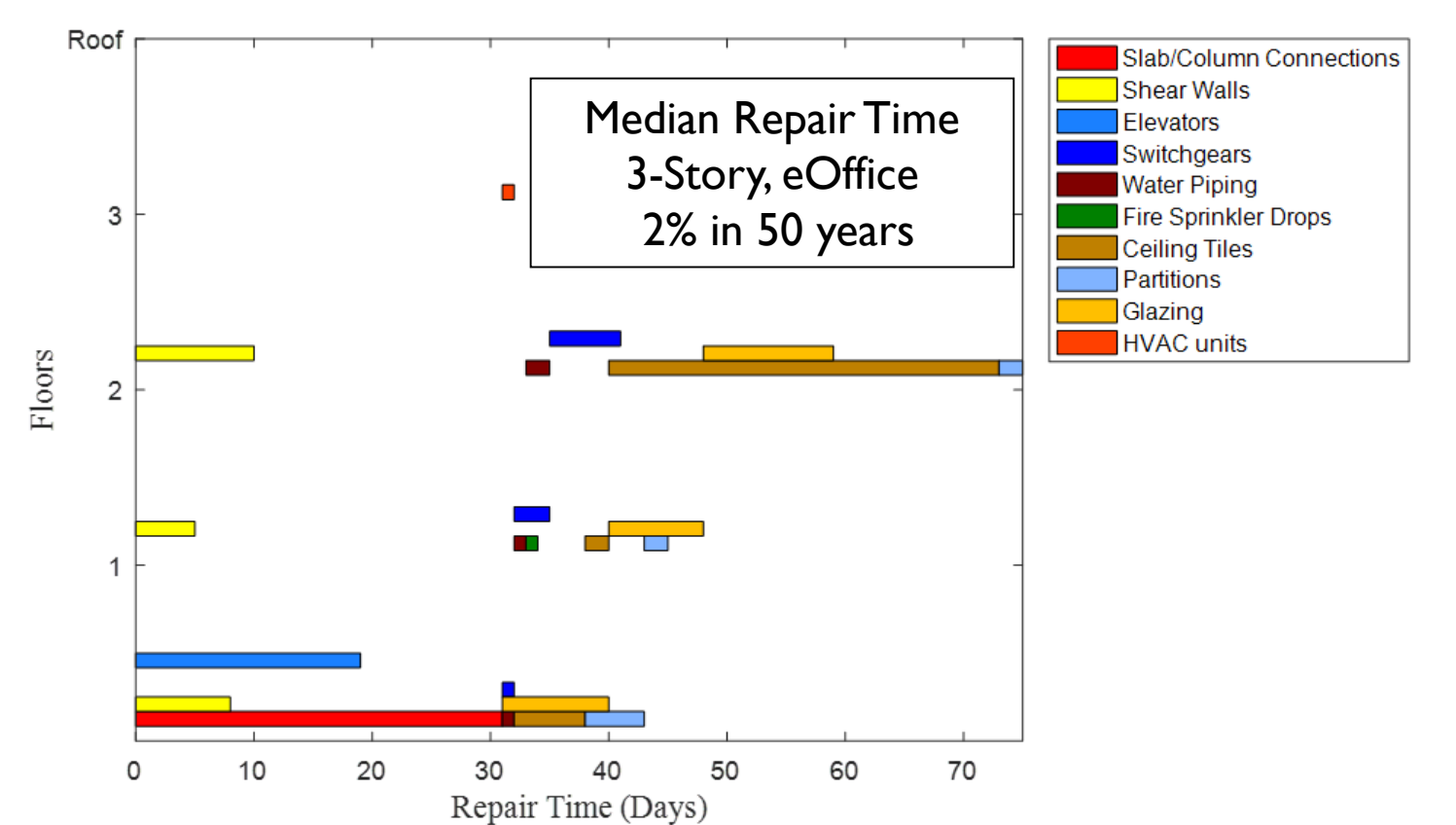
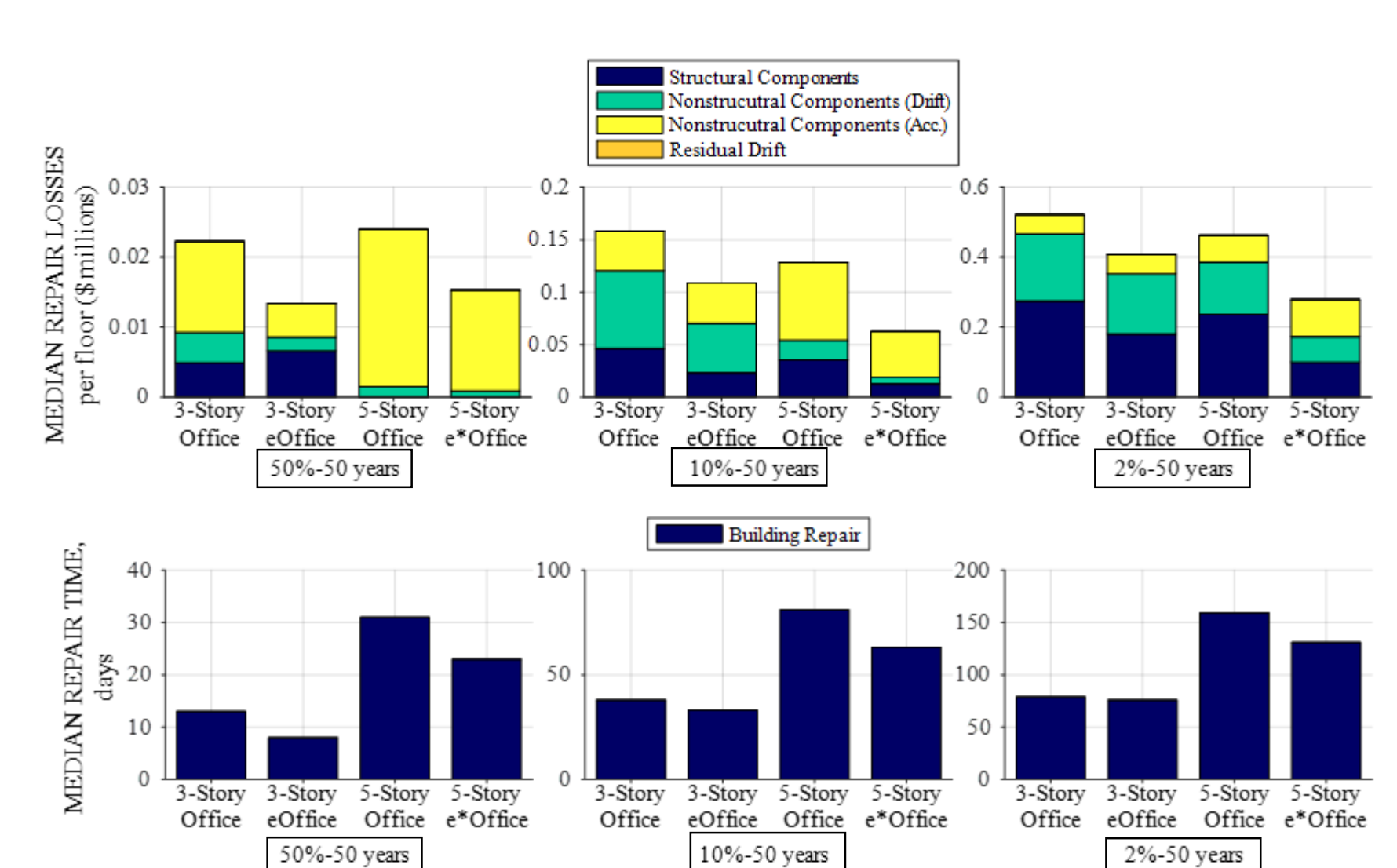
## Objective

- Evaluate the implications of building occupancy type and lateral load-resisting system behavior on seismic performance of low-rise and mid-rise reinforced concrete office and hospital shear wall buildings.
- Evaluate the effects of increased strength and stiffness beyond code minimum requirements on seismic performance of low-rise and mid-rise office RC shear wall buildings.

## Median Structural Response



## Loss Evaluation



## Conclusions

- Repair cost and repair time are approximately 2-4 times larger for the hospital than for the office buildings.
- Hospital buildings have smaller probability of replacement due to irreparable residual drifts than the office buildings.
- Enhanced office designs notably reduce repair cost across all intensities; however they generate slight reduction in repair time and have a great probability of impaired functionality for 10% in 50 years and 2% in 50 years hazard levels.

This project was made possible with support from: