

# Seismic Retrofit of New York State Hospital

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## ABSTRACT

This poster presents current research on seismic retrofit of New York State Hospitals, sponsored by MCEER at University at Buffalo. Based on an inventory screening of hospitals in New York State, 259 public hospitals across the entire New York State are classified in different structural type and seismic vulnerability, followed by a case study of a hospital located in central New York State-- a four story reinforced concrete moment resisting frame structure was used to evaluate seismic performance of structural system, different retrofit schemes were applied and the efficiency, feasibility were compared. A platform of hospital operation model was established. The engineering demands are being used on the platform to define damage state of medical services, (mainly from non-structural system).

## BACKGROUND

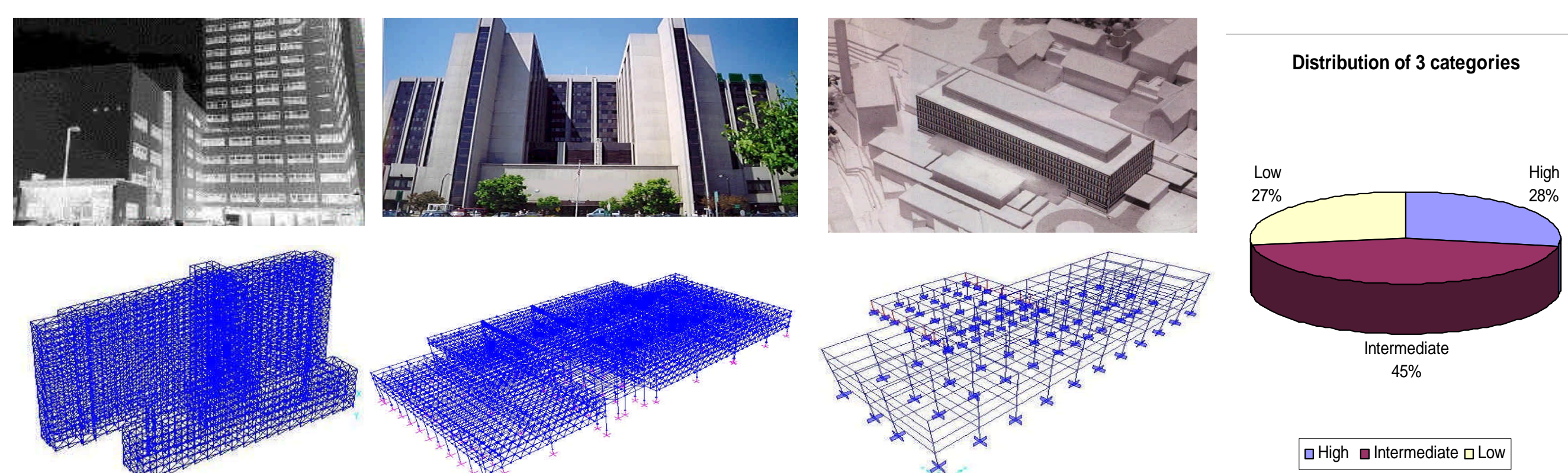
MCEER hospital project is to understand seismic performance of hospital building and to develop various modification and retrofit technologies to protect hospitals from damage during earthquake. The project addresses two specific types of earthquake hazard locations: the first is for hospitals located in regions with high seismic hazard levels such as California State in west coast. The second type of hospitals is those located in regions with low and moderate seismic hazard levels such as New York State in eastern United States.

### • Different issues faced by eastern hospitals and western hospitals

	Hazard risk and likelihood	Seismic vulnerability of existing building	Seismic retrofit decision
Eastern Hospitals	Low and moderate, a magnitude 5 earthquake is likely to occur within 50 miles of New York City every 100 to 300 years.	High, since the earthquake effect was not considered in optimal building design in New York State until 1990s.	Not required by law. An management issue.
Western Hospitals	High, the 30-year probability for San Francisco Bay area to be subjected to an earthquake with a magnitude of 7.0 or larger has been estimated to be about 67%.	Relatively low, since seismic design has been used from late 1920s.	Required by Law, SB1953

### • Inventory of hospitals in New York State

Total 259 public hospitals are divided into 3 categories as high, intermediate and low vulnerability. Four typical hospitals located at different city, built in different ages are selected and analyzed in New York State hospital project.



High vulnerability Intermediate vulnerability Low vulnerability

## OBJECTIVES

- Evaluate seismic performance of existing hospital building in New York State
- Analyze the structure under what-if (retrofitted) condition, test efficiency of various retrofit techniques and to get simple and cost-effective solutions to update hospitals in New York State
- Connect engineering demands with damage state of non-structural system and effect of hospital operation. Therefore, give better presentation of seismic performance under different scenarios (original, retrofitted with different measures) to policy maker, hospital owner etc. in New York State

## METHODS & RESULTS

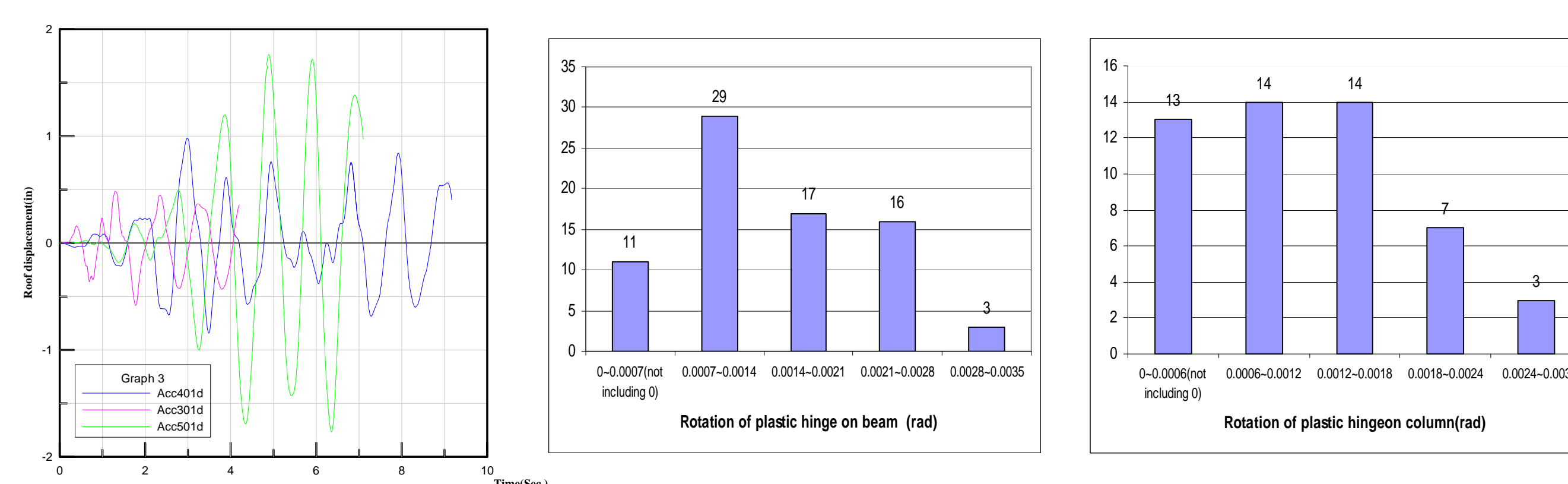
- Seismic evaluation before retrofit
- The structure is modeled using SAP2000, slab-column frames are modeled as equivalent beam-column frames according to the experimental study of Shyh-Jiann Hwang and Jack P. Moehle.

- Response spectrum analysis was carried out per NEHRP 2000 and FEMA356 respectively.

### Numbers of overstressed columns

	NEHRP2000	FEMA356 (Controlled by Flexural)		
		IO	LS	CP
Shear failure (Force-controlled action)	12	15	15	15
Flexural failure (Displacement-controlled action)	19	13	15	4

- Time-history analyses were addressed using eastern U.S. ground motion records developed by MCEER researchers
- Nonlinear static "push-over" analysis were performed and plastic hinge rotation of beams and columns under target displacement were checked per criteria of FEMA356

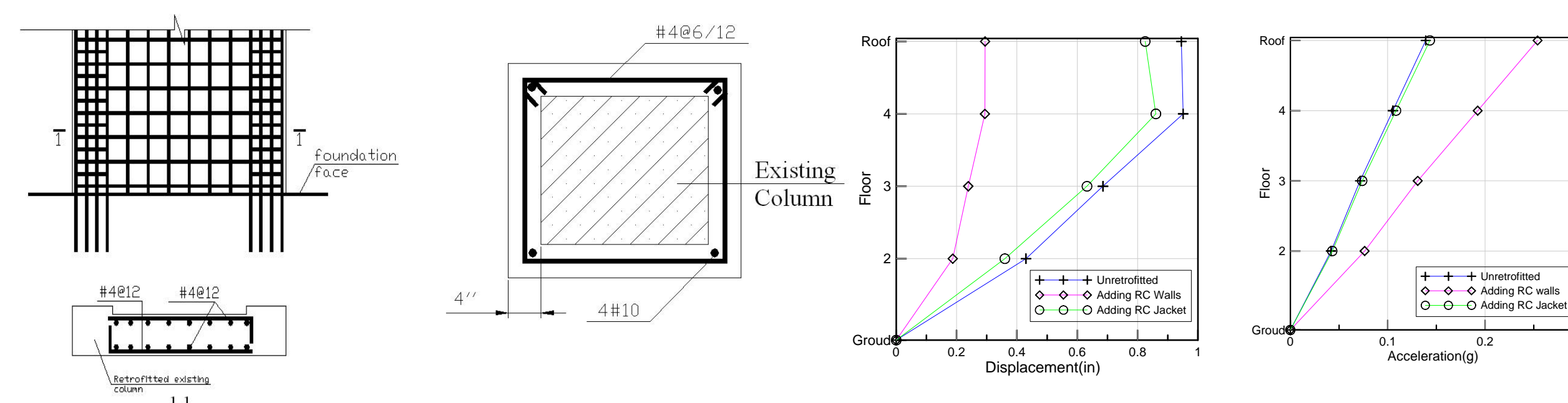


### • Retrofit schemes

- Adding new lateral load resisting elements and system
- 10.5" thick reinforced concrete shear walls are considered as a retrofit option. In N-S direction, the walls shall be located between axis 6 and axis 6.7 on B and C axis, in E-W direction, the walls shall be placed between axis B and axis C on axis 3 and 9. Existing columns which become boundary elements of infilled walls shall be retrofitted by providing new confinement per ACI318.

### • Upgrading existing components and system

- For overstressed columns, 4" thick concrete jackets are considered to wrap around the overstressed columns. 4#10 and #4@6/12 rebars shall be added as longitudinal and transverse reinforcements.



## Summary

In this research, the structural seismic performance of existing hospitals in New York State were evaluated. The study concluded even under life safety level, retrofit design objective is necessary to protect hospitals from damage, with the considered retrofit options, the performance level of hospitals could be enhanced to immediate occupancy or operational during future earthquake. Seismic retrofit could be designed by simple and cost-effective solutions. In context of a eastern hospital retrofit, adding new shear wall system is a desirable option for reinforced concrete moment frame structure. Current results will be used to further study of seismic performance of non-structural components and systems.

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