Concrete Buildings: Risk Reduction

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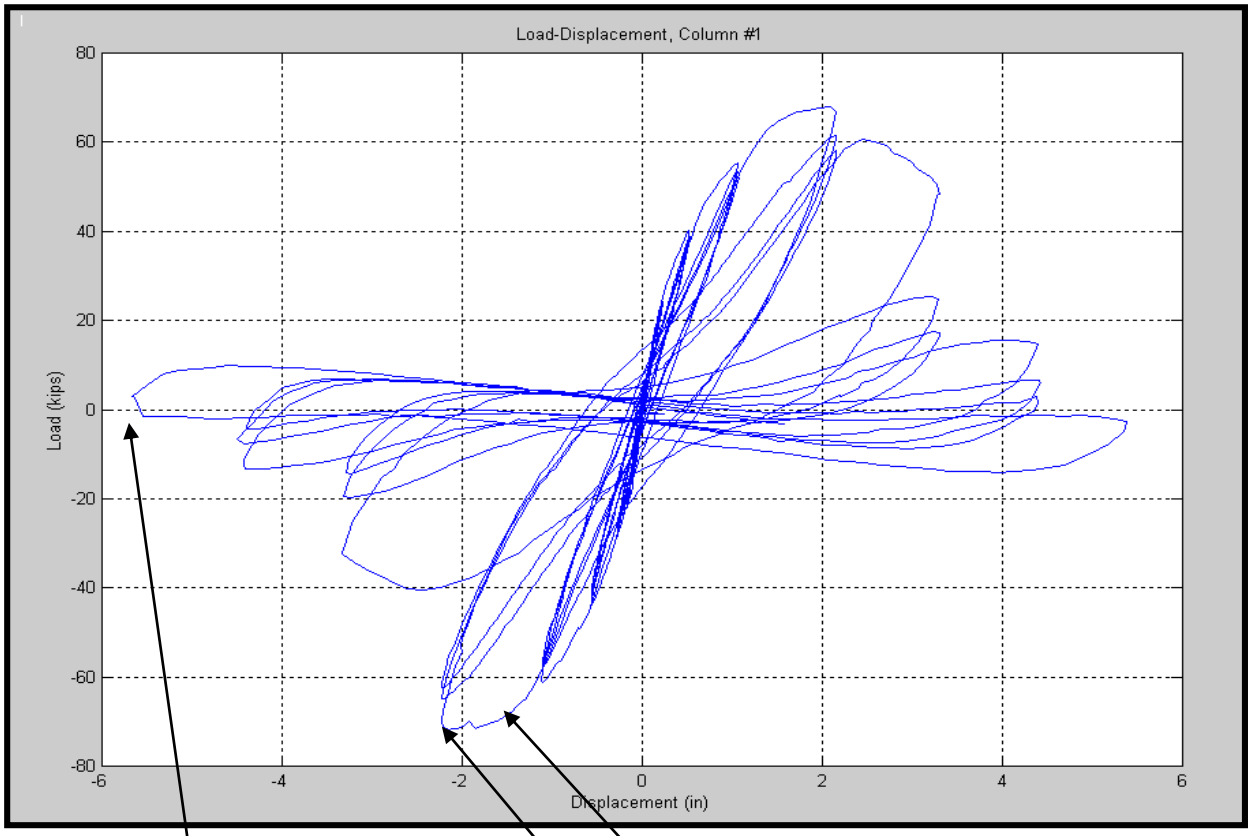
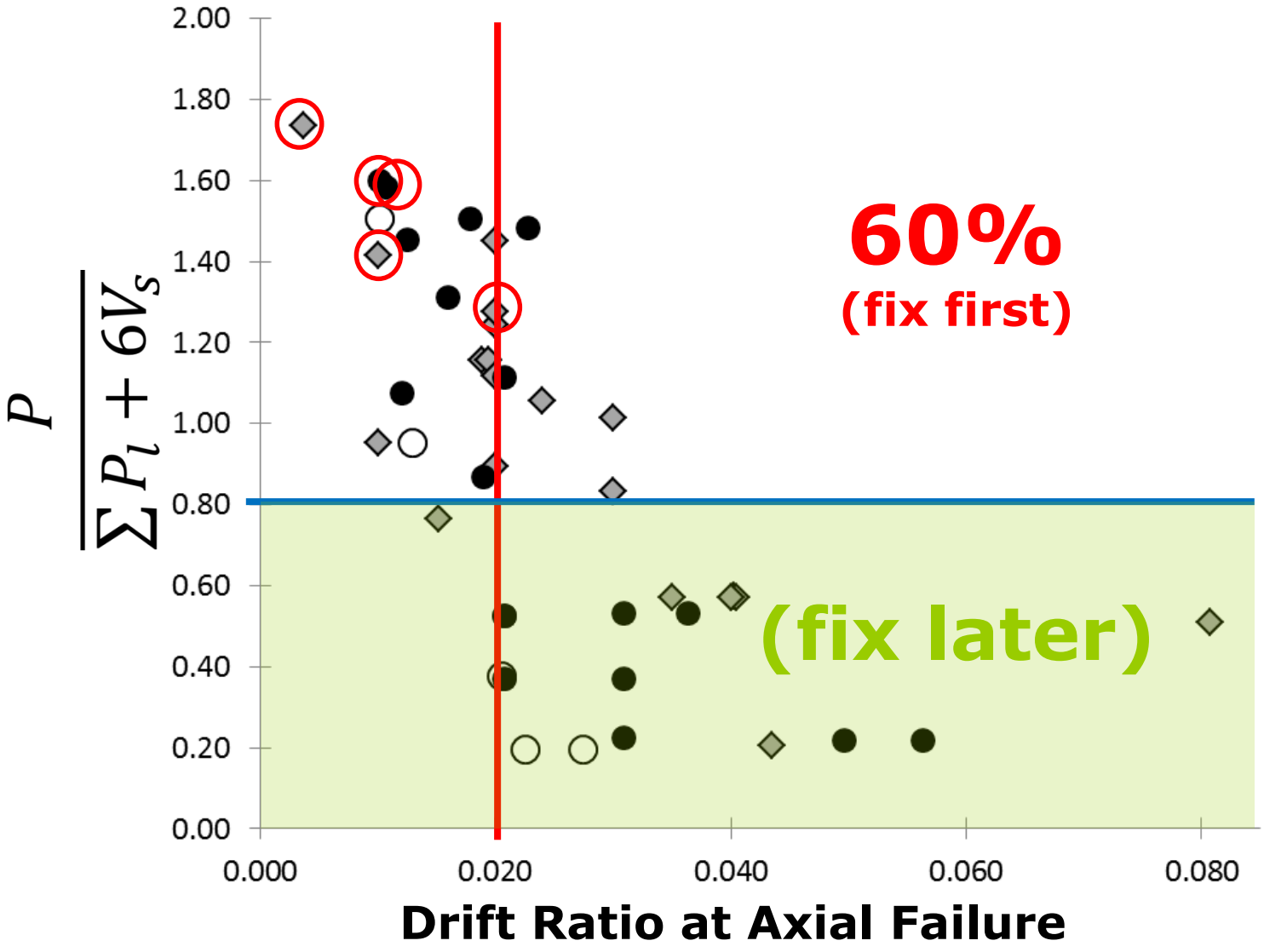
KAISER
PERMAN

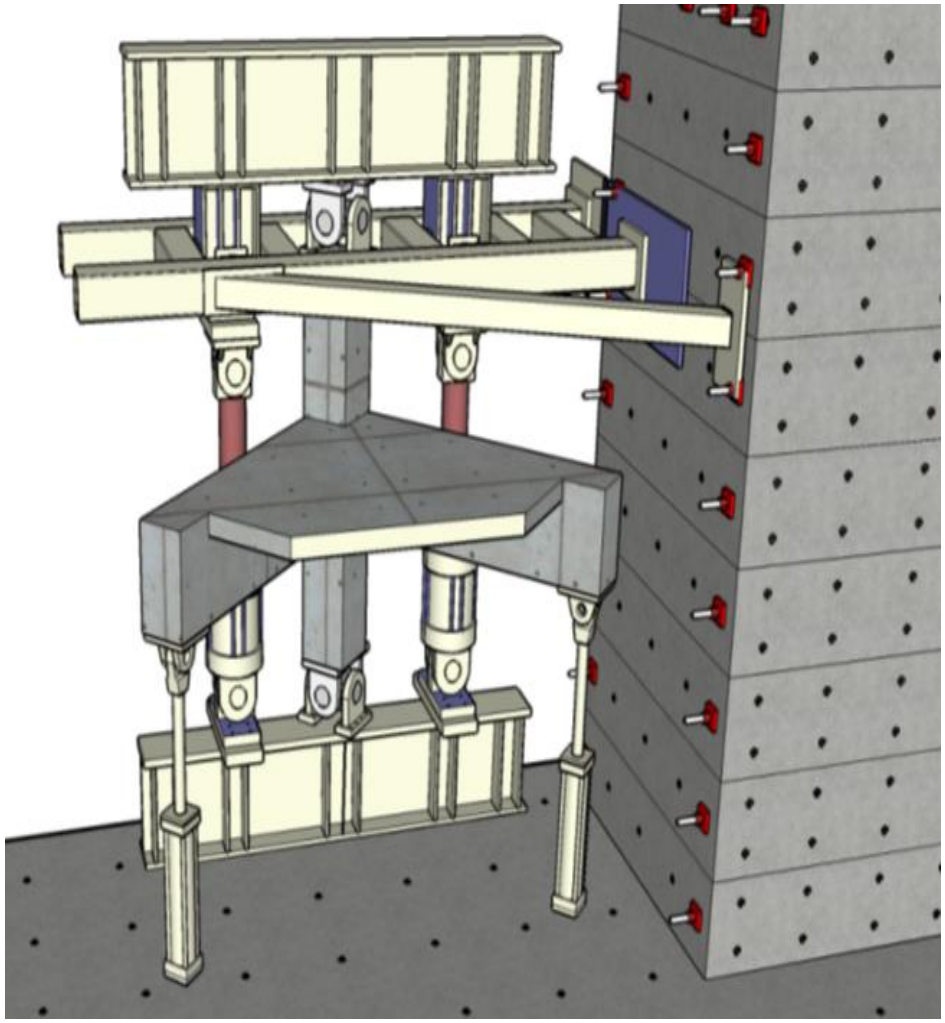

L'S UNIQUE CREATIONS
OLYMPIC WEST PHARMACY

Older-type column tests

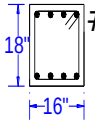
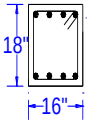
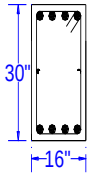
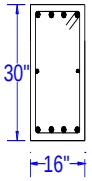


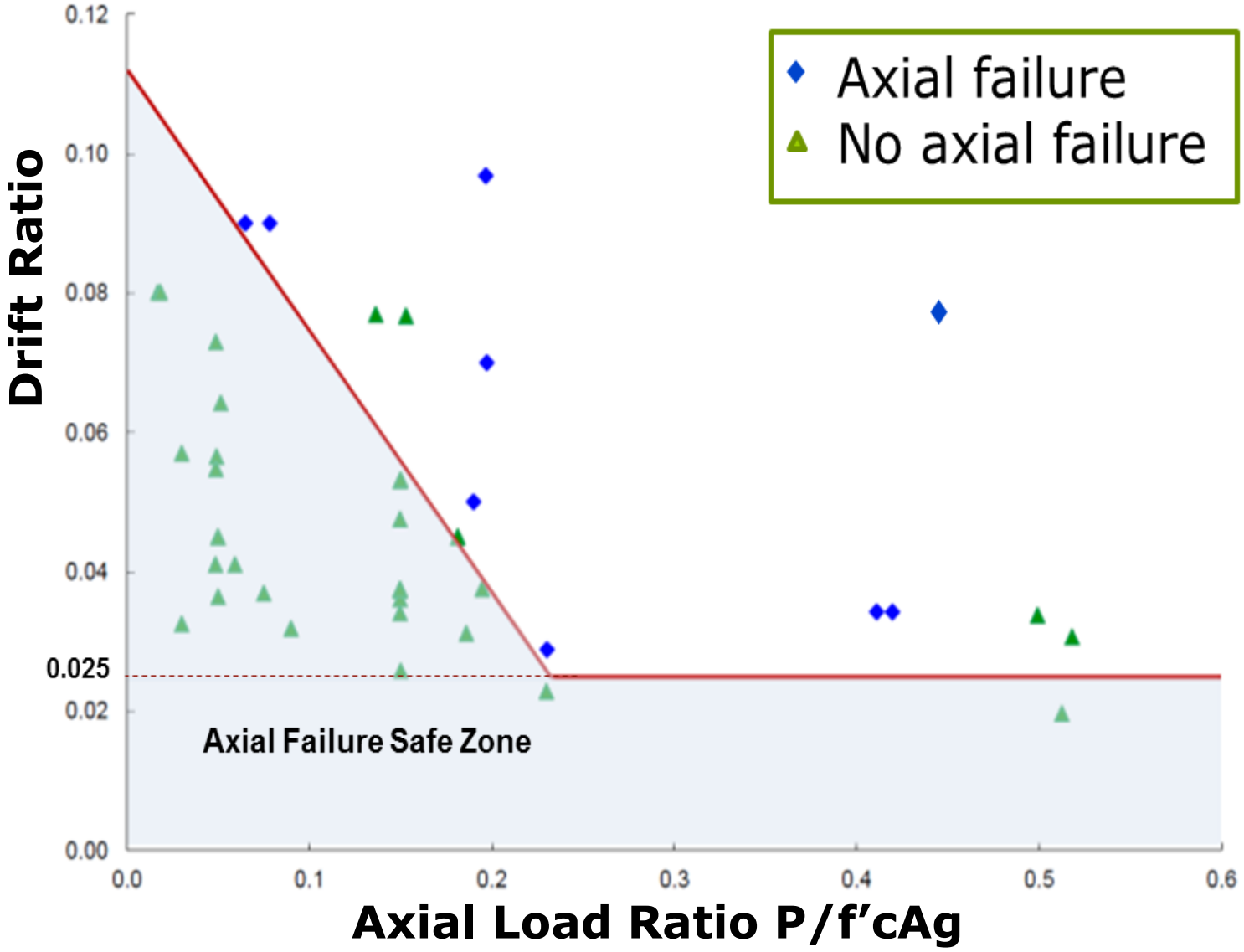

$\frac{P}{\sum P_l + 6V_s}$
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.000
0.020
0.040
0.060
0.080
Drift Ratio at Axial Failure
60%
(fix first)
(fix later)

Beam-column joint tests

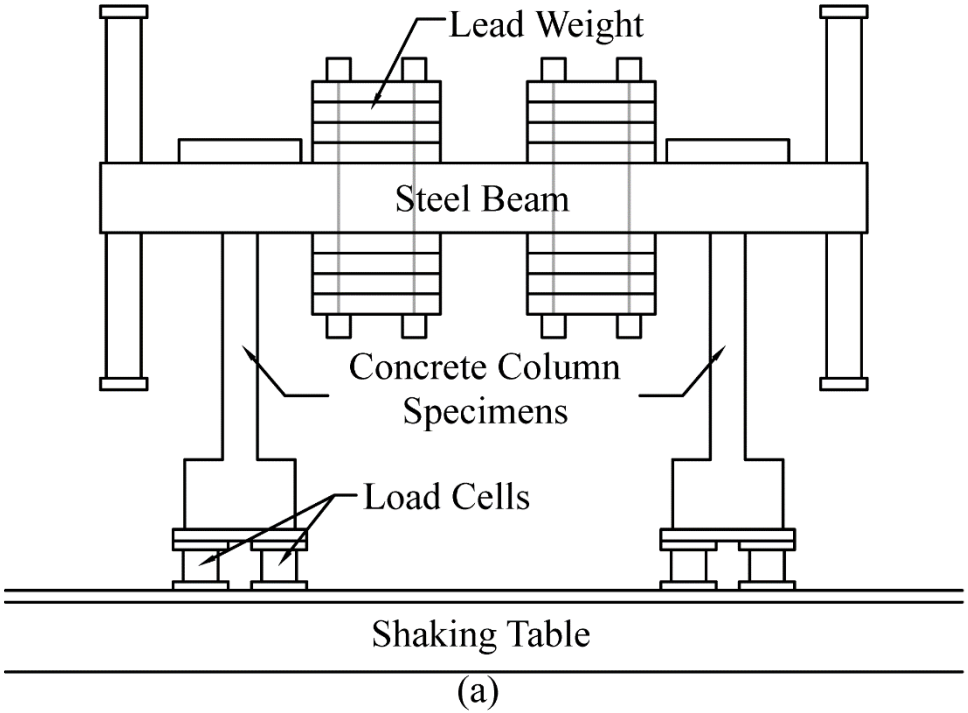


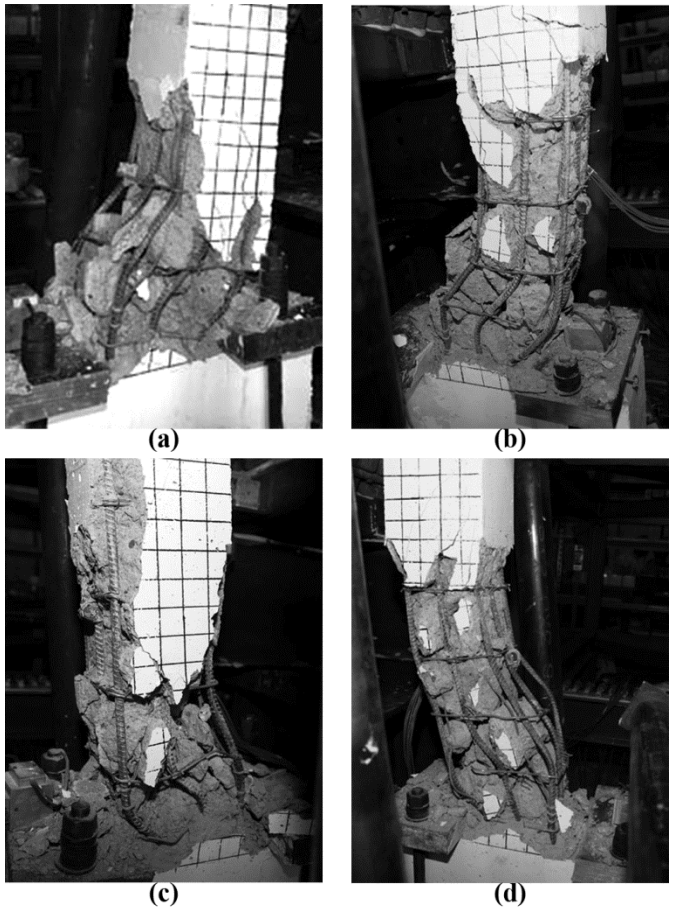
Typical Beam Sections

Aspect Ratio (h_b/h_c)	Reinf. Ratio	
1/1	 #6	 #8
5/3		


Axial failure
No axial failure
Drift Ratio
0.12
0.10
0.08
0.06
0.04
0.025
0.02
0.00
0.0
0.1
0.2
0.3
0.4
0.5
0.6
Axial Failure Safe Zone
Axial Load Ratio P/f'cAg

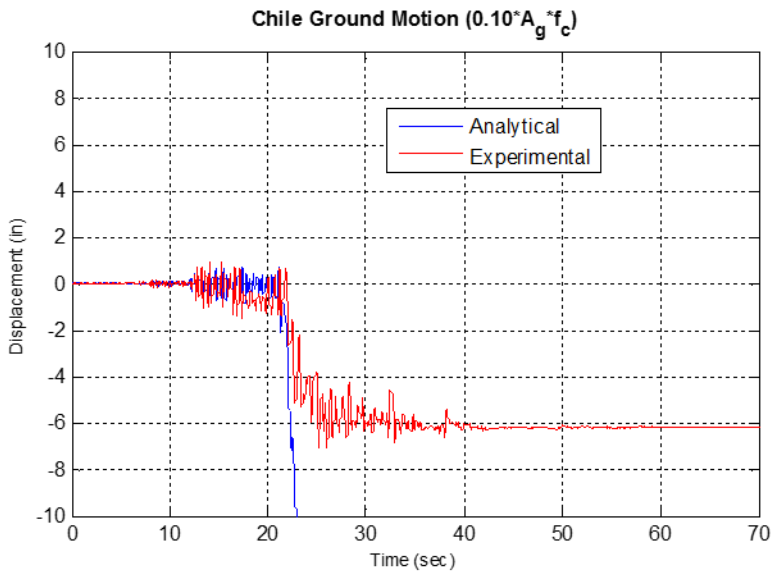
Simple dynamic tests

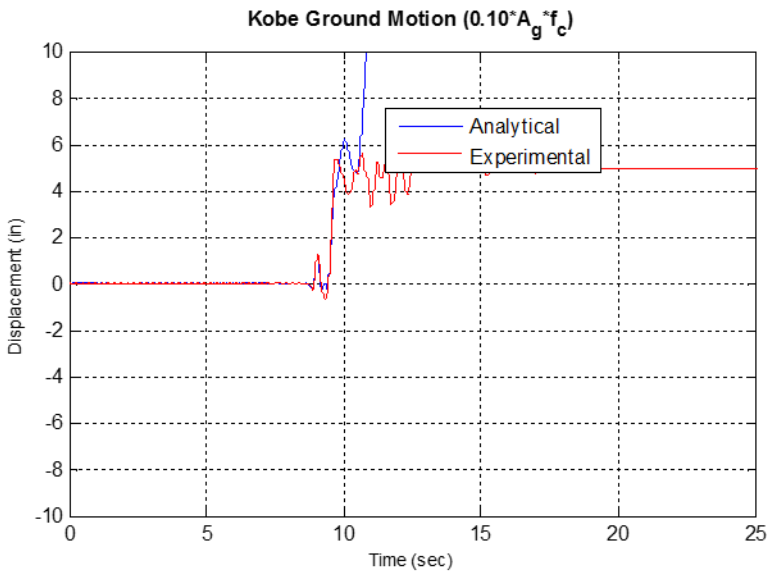




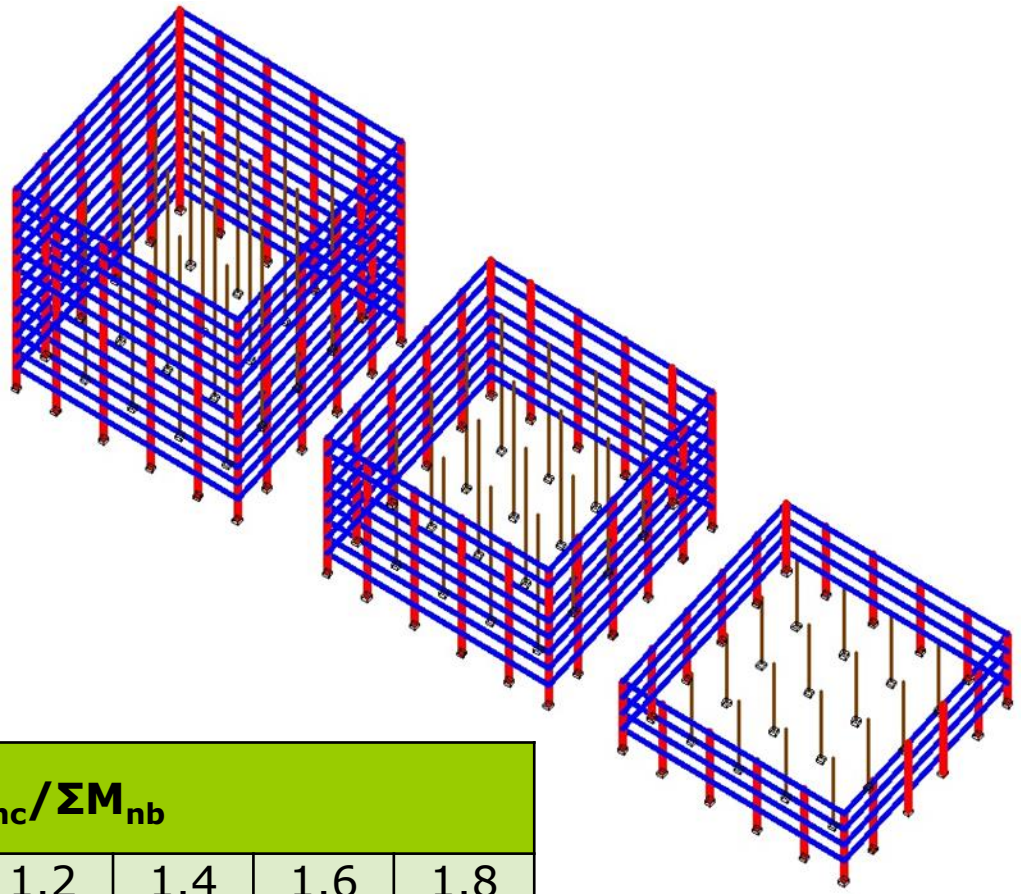
Analysis vs experiment

Non-Ductile - Non-Ductile Frame



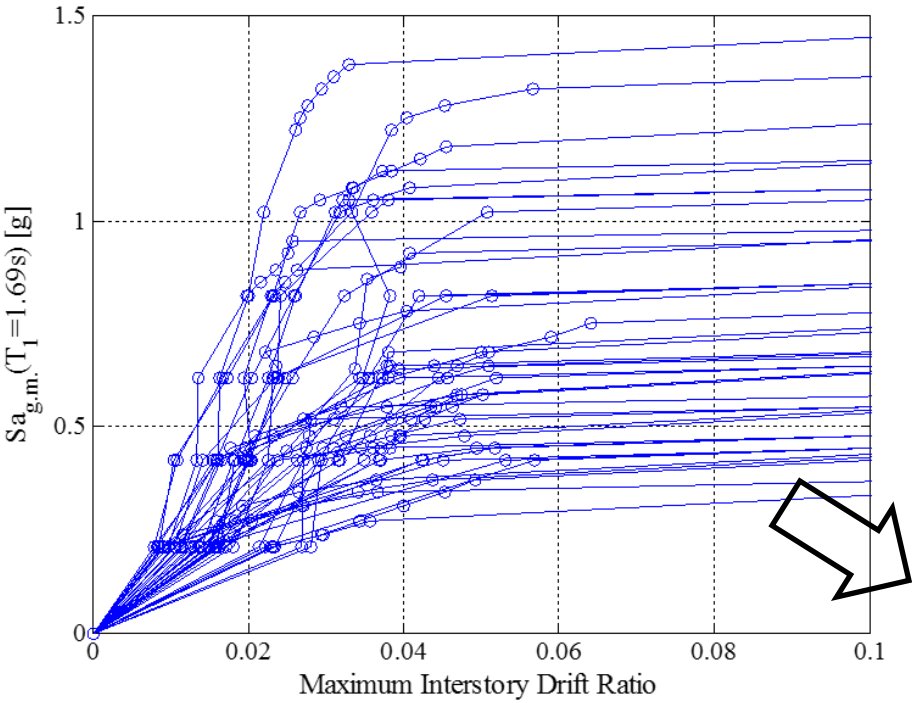


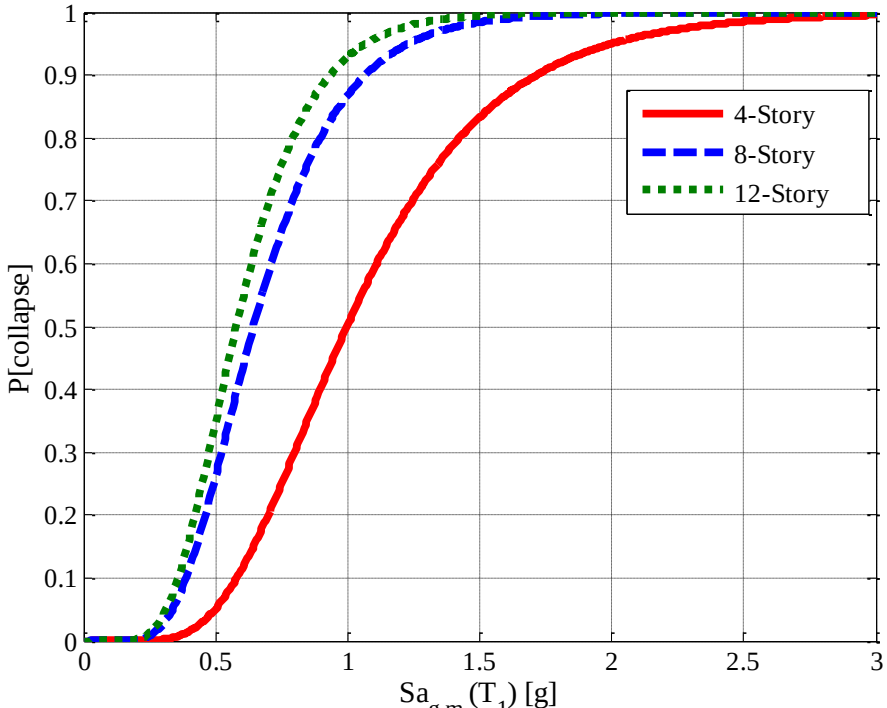
Collapse indicator studies



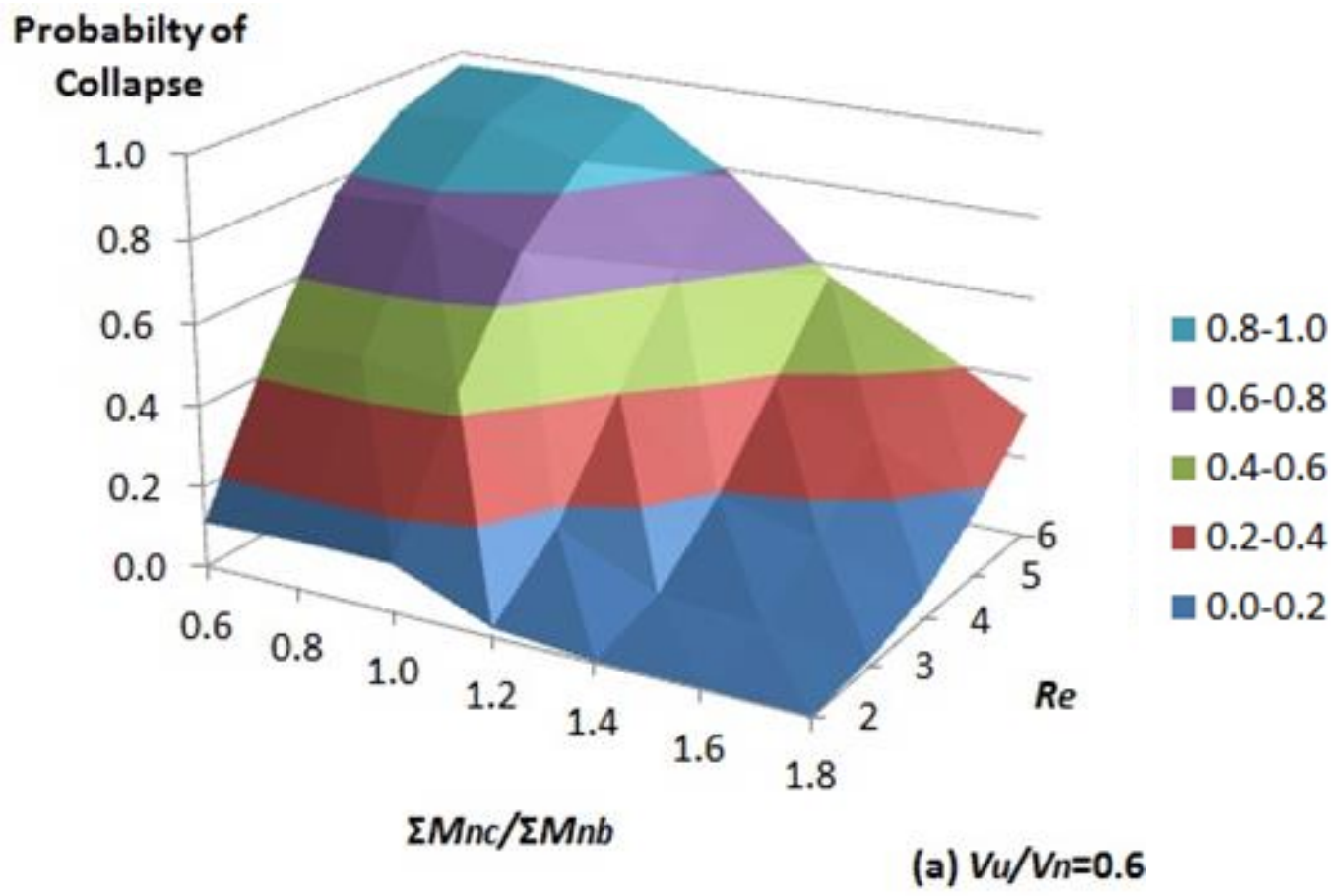
		$\Sigma M_{nc}/\Sigma M_{nb}$						
		0.6	0.8	1.0	1.2	1.4	1.6	1.8
V_u/V_n	0.6	√	√	√	√	√	√	√
	0.8	√	√	√	√	√	√	√
	1.0	√	√	√	√	√	√	√
	1.2	√	√	√	√	√	√	√

Incremental dynamic analyses

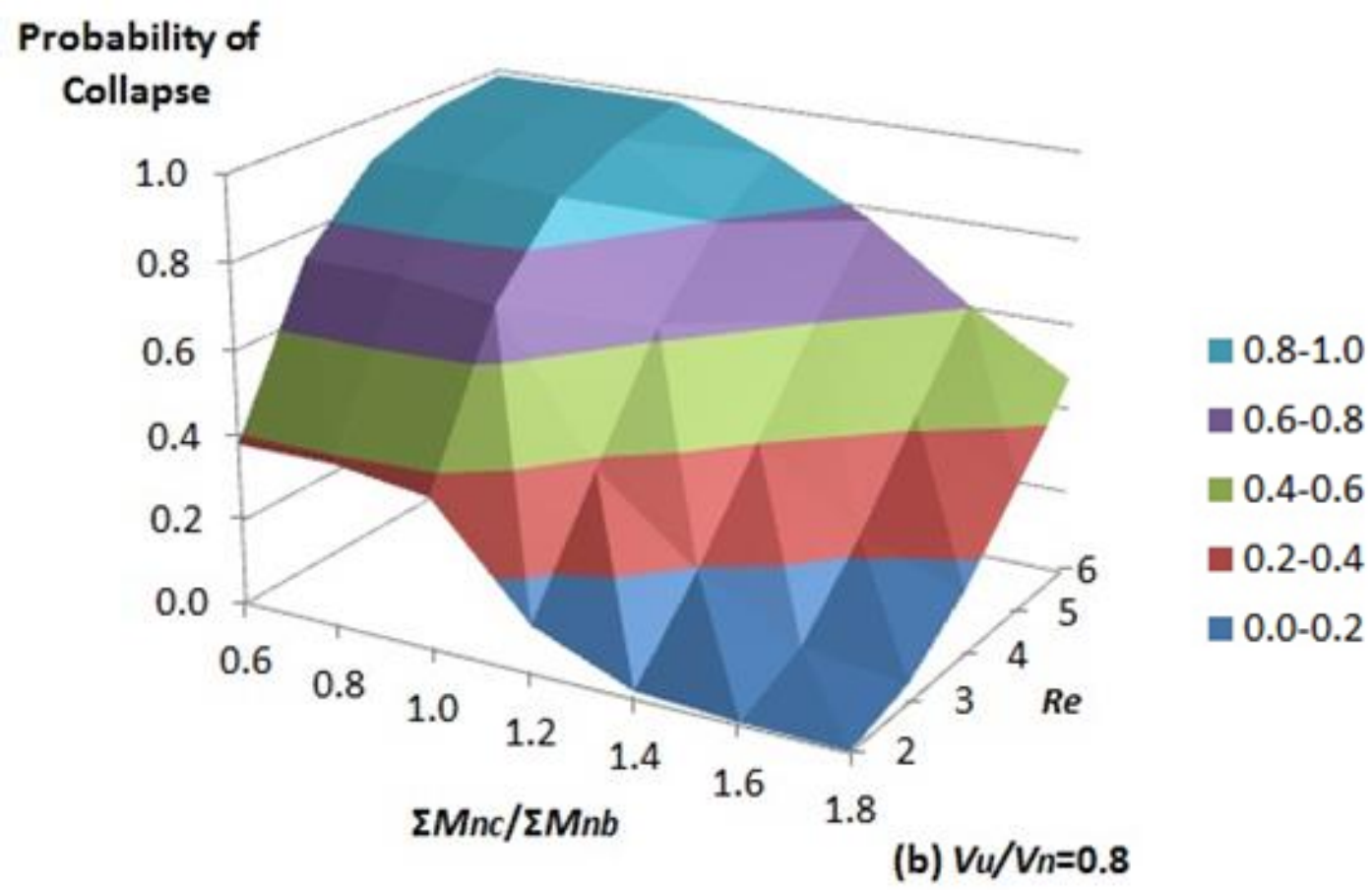




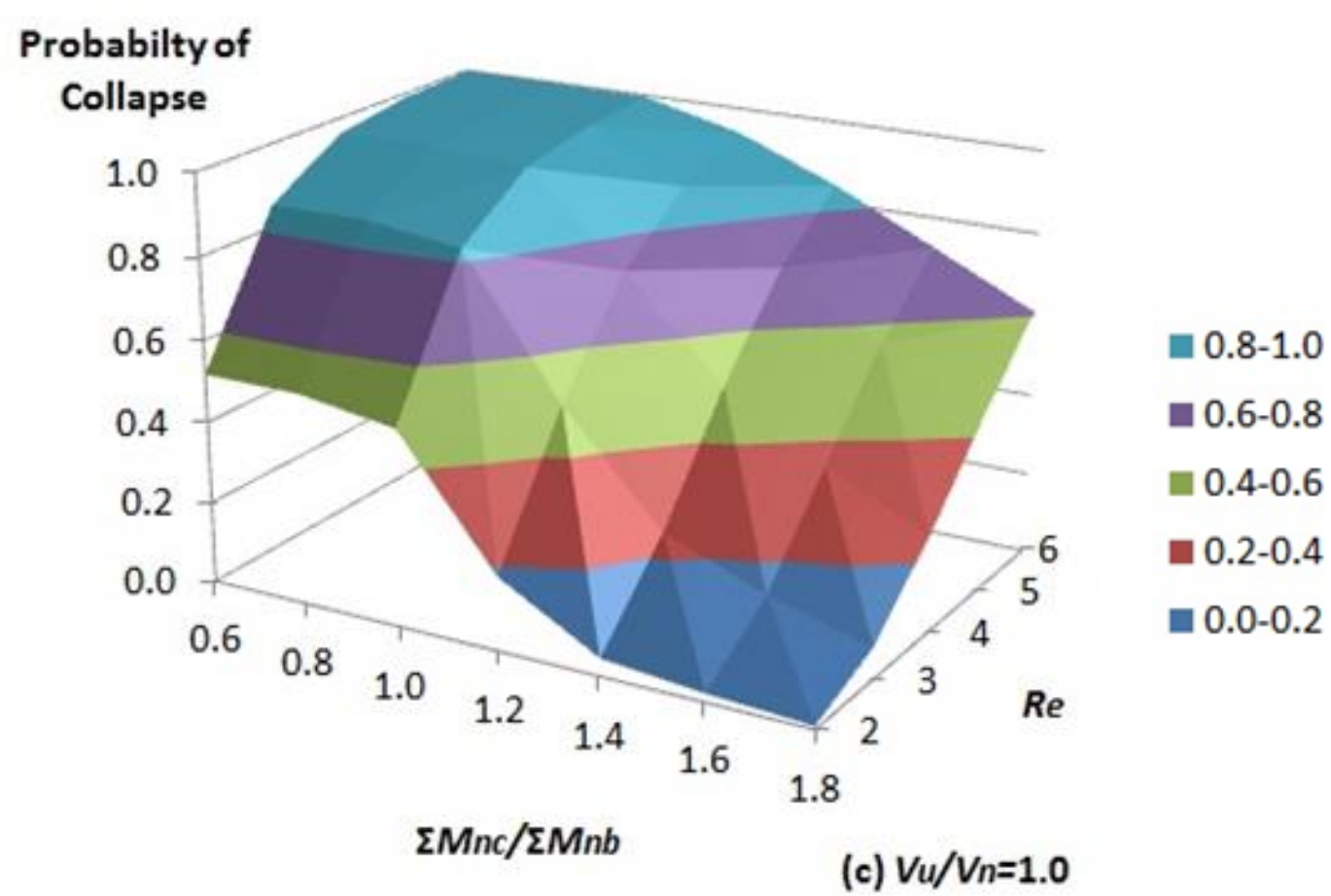
Probability of collapse: $V_u/V_n = 0.6$



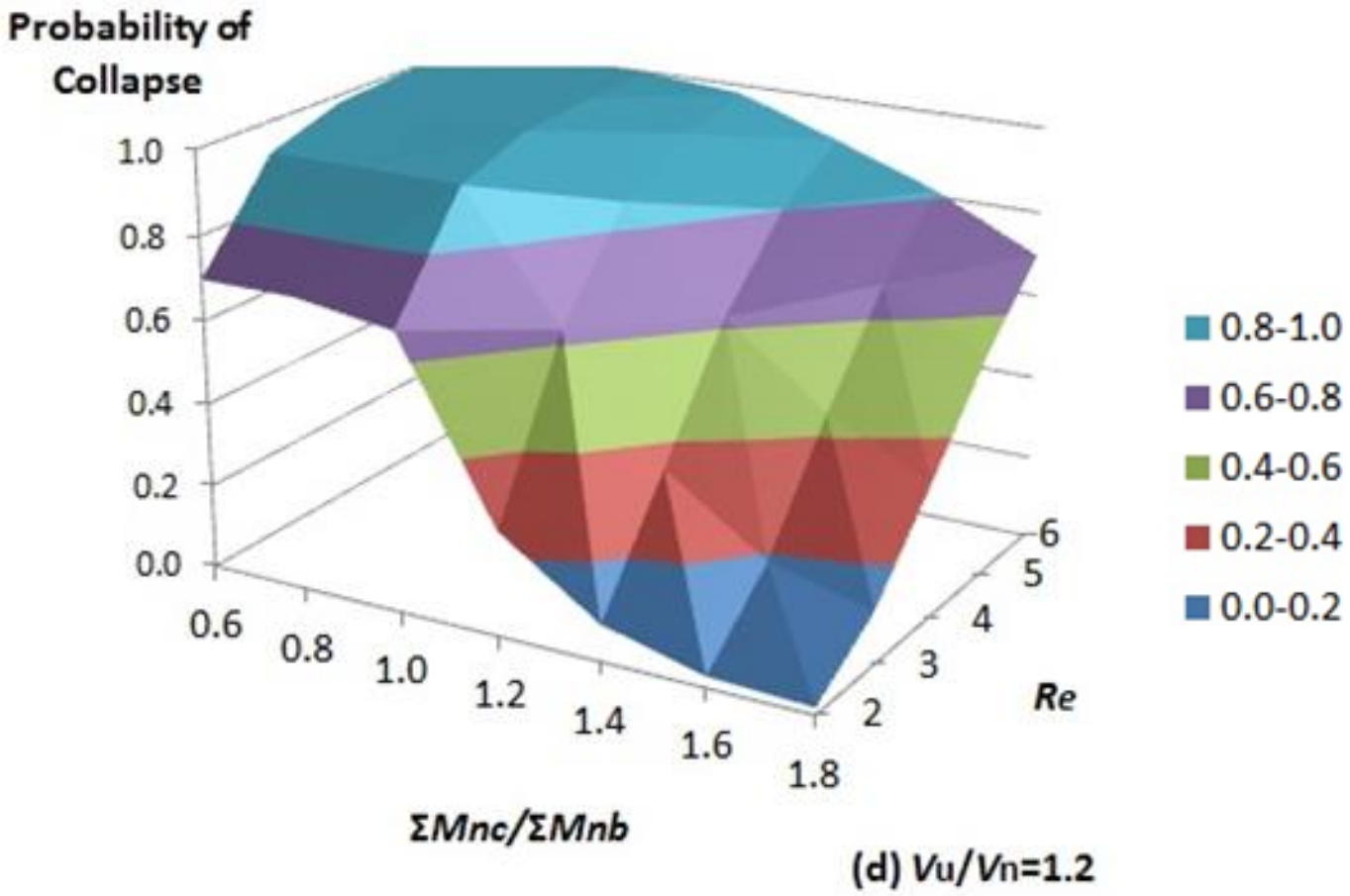
Probability of collapse: $V_u/V_n = 0.8$



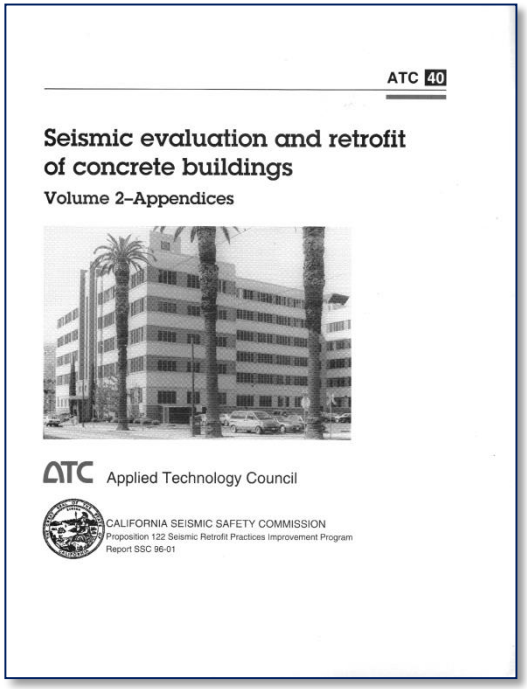
Probability of collapse: V_u/V_n = 1.0



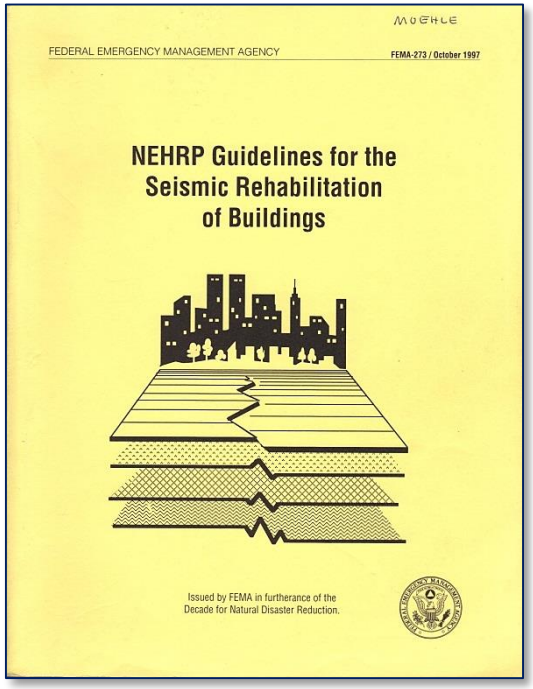
Probability of collapse: V_u/V_n = 1.2



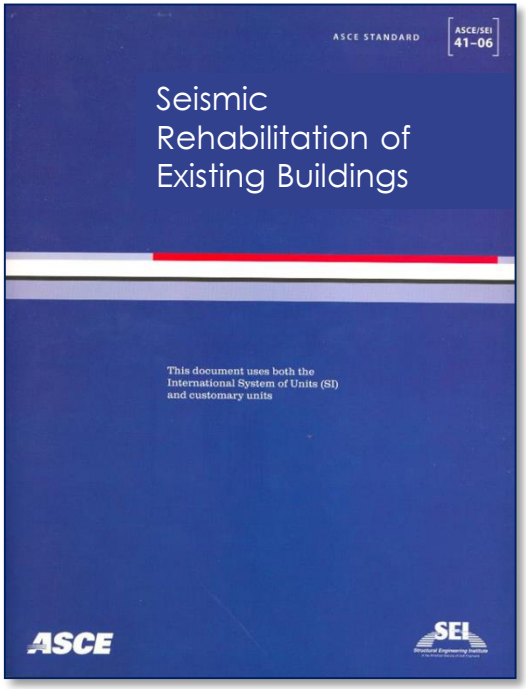
Seismic retrofitting guidance



1996



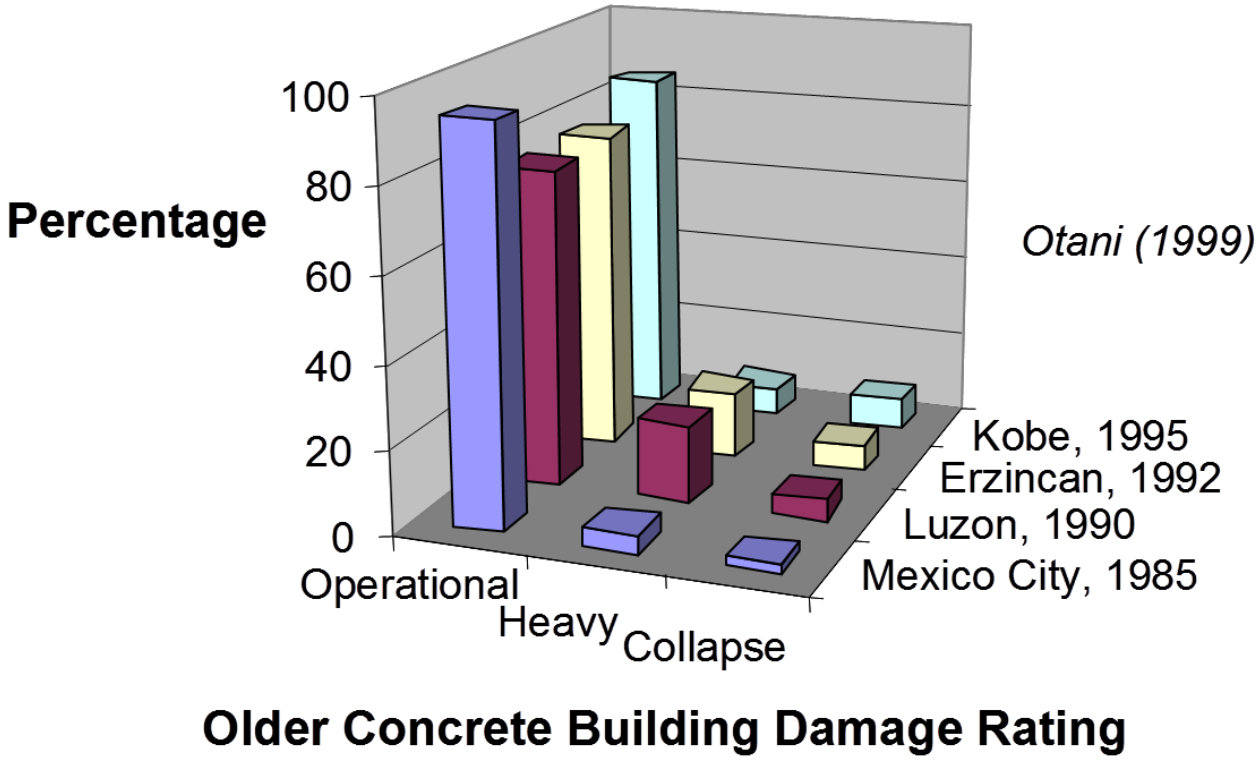
1997



2006, 2013

"Nonductile" concrete buildings

- For 22 CA counties – 18,000 buildings[1]
- City of Los Angeles – [redacted] buildings[2]



[1]EERI Concrete Coalition; [2]NEES GC

Synergies

NIST GCR 10-917-7

Program Plan for the Development of Collapse Assessment and Mitigation Strategies for Existing Reinforced Concrete Buildings

NEHRP Consultants Joint Venture
A partnership of the Applied Technology Council and the Consortium of Universities for Research in Earthquake Engineering

nehrp

NIST
National Institute of Standards and Technology
U.S. Department of Commerce

ATC 78

Identification and mitigation of seismically hazardous older concrete buildings: Interim methodology evaluation

ATC Applied Technology Council

Funded by
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FEMA