Unreinforced Masonry Buildings
Seismic Risk and Mitigation Technologies

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MISSION
CRITICAL INFRASTRUCTURE

EARTHQUAKE RESPONSE
Police
Fire fighters
Rescue workers
Medical practitioners

EARTHQUAKE RECOVERY
Power
Water
Gas
Transportation infrastructure

NOT UNIQUE TO 2016 MUISNE EQ
Loma Prieta, 1989
Northridge, 1994
Kobe 1995; etc.

OUTLINE

POINT 1
Subtopic ● Subtopic ● Subtopic
Subtopic ● Subtopic

POINT 2
Subtopic ● Subtopic

POINT 3
Subtopic ● Subtopic
Subtopic ● Subtopic ● Subtopic

CONCLUSIONS

HOSPITALS
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HOSPITALS

Lateral force-resisting systems
Concrete moment frames
Infill URM walls, interior and exterior

Gravity systems
Waffle slabs common

GEER reconnaissance
Manta (no)
Bahai de Caraquez, N of Manta on coast (no)
Chone, NE of Manta (no)
Portoviejo (IESS), E of Manta (yes)
Portoviejo (SOLCA), E of Manta (1 floor yes)
EARTHQUAKES
A WEST COAST PROBLEM?

Inevitable, like it or not
- Death
- Taxes
- No cabs in the City when raining
- Earthquakes that will impact NYC

Earthquakes in the City
- Rare
- Consequences could be catastrophic
- How to manage the risk?

WHAT IS AT RISK?

Buildings, bridges and infrastructure
- Why?

Non-engineered building structures
- Schools
- First responder buildings, including fire houses
- Unreinforced masonry (URM) buildings

Engineered building structures

Nonstructural components and systems
- Non engineered
2016 M_{w} 7.8 Ecuador Earthquake: Relevance to NYC & US Critical Infrastructure

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NON-ENGINEERED BUILDINGS

Population
Building stock
Seismic hazard

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URM BUILDINGS IN NEW YORK CITY

Federal Era buildings
Row houses 1830-1840
Mercantile lofts 1845-1895
Tenements 1880-1930

T. Lynch, NYCDoB, 2012

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NON-ENGINEERED BUILDINGS

Row houses 1830-1840

T. Lynch, NYCDoB, 2012

T. Lynch, NYCDoB, 2012

Ingham, 2011

Ingham, 2011

www.cnbc.com
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Engineered Buildings

Attributes
- Lateral resistance
- Lateral load path
- Continuity
- Robustness
- Redundancy

Vulnerability
- Can be assessed
- ATC-58

Nonstructural Components

Why engineer this Stuff?

- Cabinets, 1%
- Bookcases, 1%
- Roof Equipment, 1%
- Cladding, 2%
- Partitions, 27%
- Elevators, 21%
- Ceiling, 32%
- Moment Frame, 2%

S. Mahin, 2013

Nonstructural Components

Schools

M. Phipps, 2014

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GSMT, New York City
May 30, 2017

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NONSTRUCTURAL COMPONENTS

Business

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2011 Mw7.8 Ecuador Earthquake: Relevance to NYC & US Critical Infrastructure
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WHY WORRY?

2011 Mineral earthquake below Manhattan

Gross damage to non-engineered buildings
- Fire houses in NYC impacted
- NYC will have a homeless problem
- Physical and social impact on the City
- Loss of life could be significant

Damage to engineered buildings and infrastructure
- Delivery of water, gas, power
- Nonstructural systems impacted
- Business interruption

Financial losses will be immense
- Port of Kobe, Japan, post the 1995 earthquake

NONSTRUCTURAL COMPONENTS

Monumental Structures

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2011 Mw5.8 Mineral Earthquake
110 km from DC

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ECUADOR EARTHQUAKE

- GEER Team, including R. Gilsanz, GMS; S. Nikolaou, WSP USA
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- Dr. E. Morales Moncayo, Ecuadorian ACE
- Dr. E. Miranda & Students, Stanford

NYC & VA EARTHQUAKE

- Maryann Phipps, Estructure, NCSEA webinar, mphipps@estruc.com
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Information