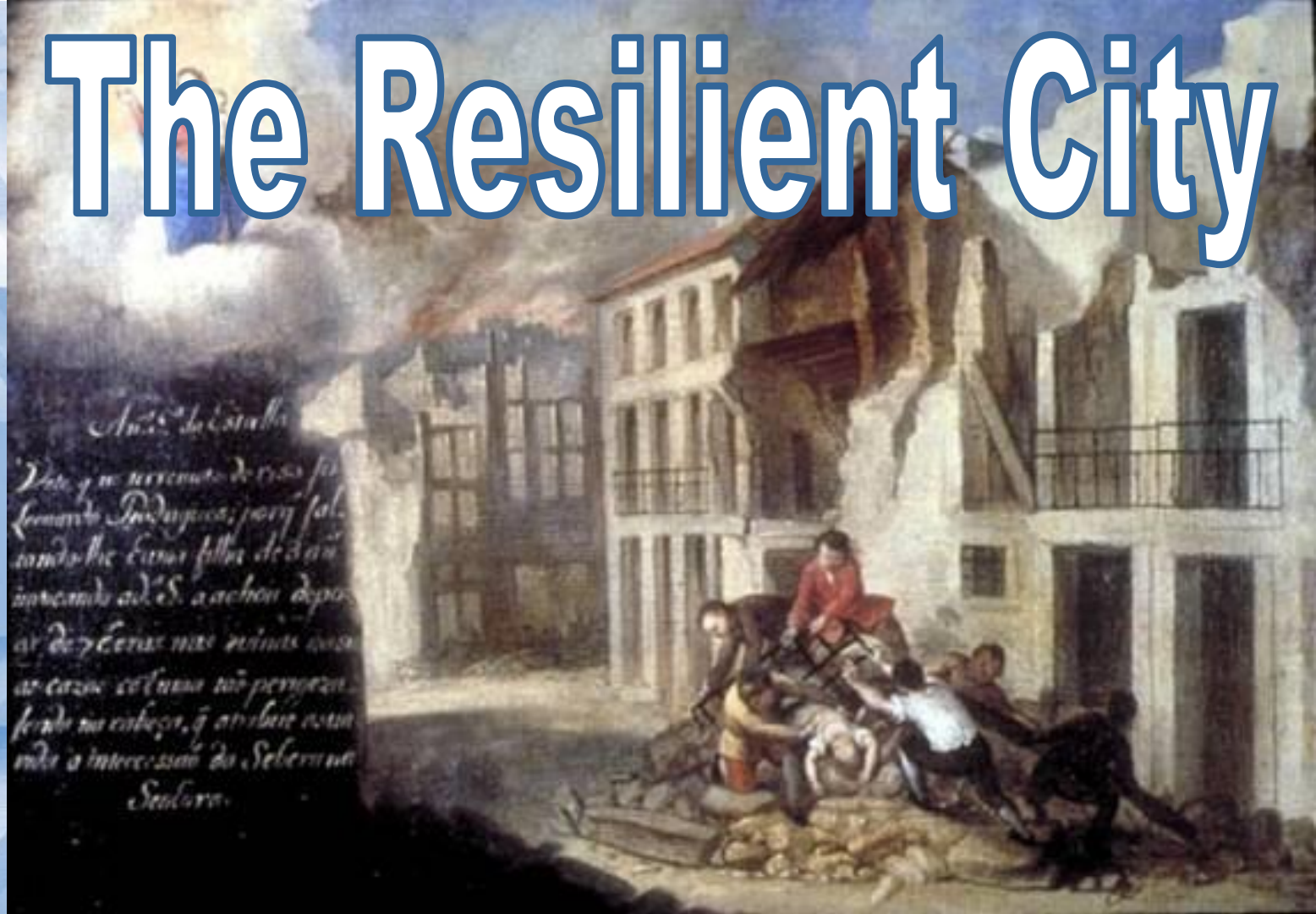
The Resilient City



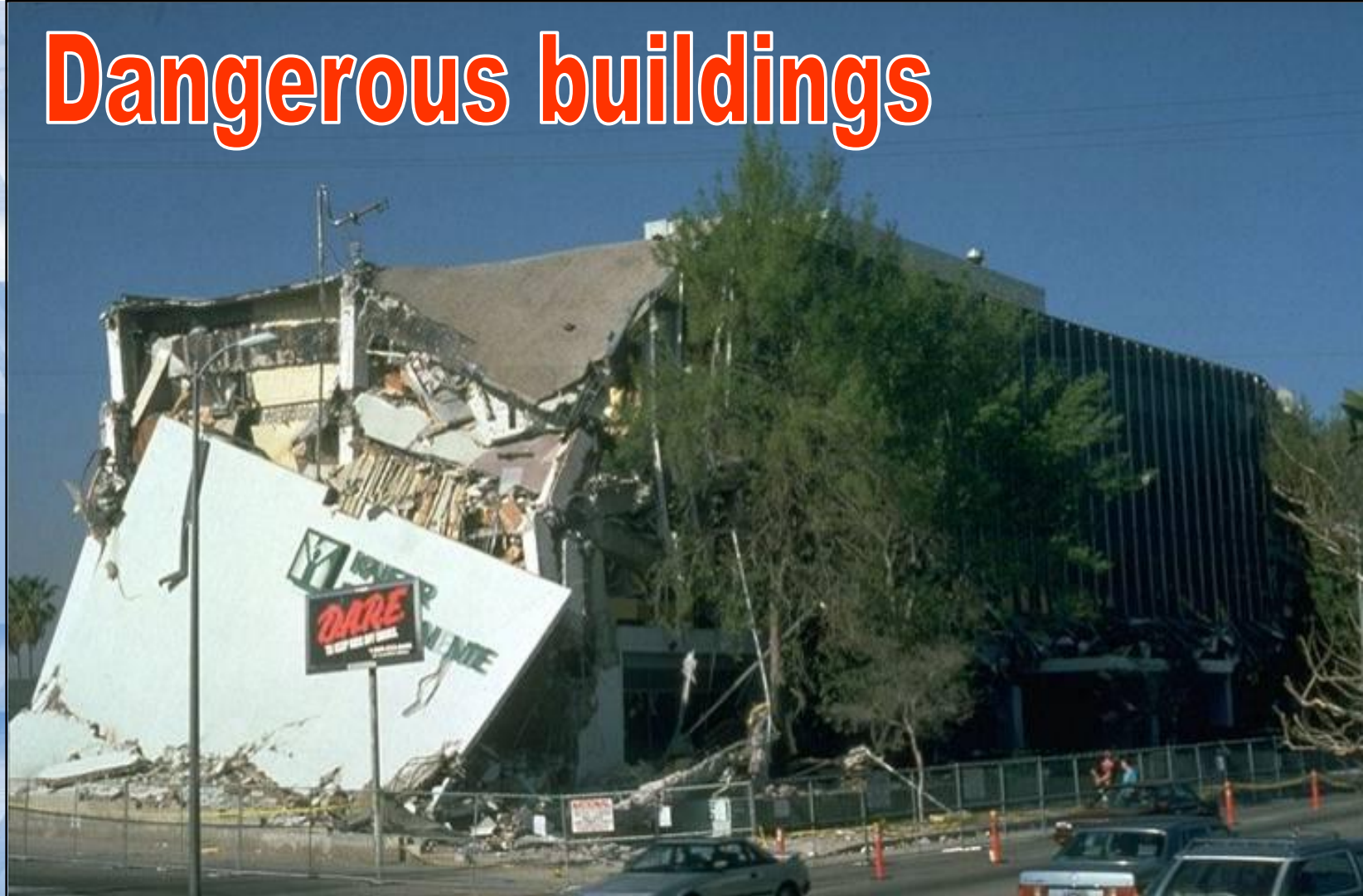
NZSEE
CONFERENCE
2009

Jack Moehle
University of California, Berkeley

Why do we still tolerate buildings that are unsafe in earthquakes?

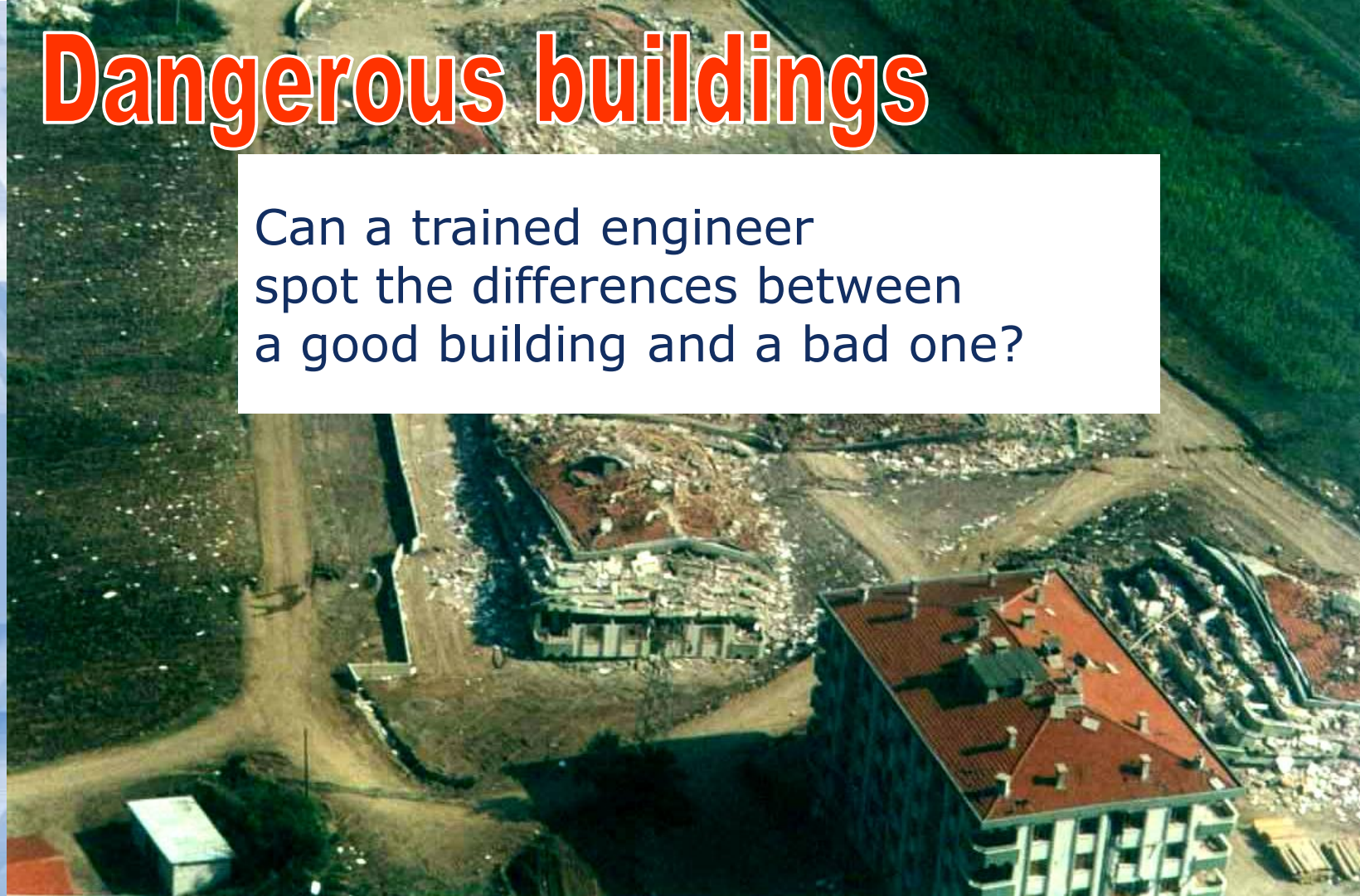
- Can we really identify the unsafe buildings?
- What can earthquake professionals do?
- What do we expect of our cities after the next earthquake?

Dangerous buildings



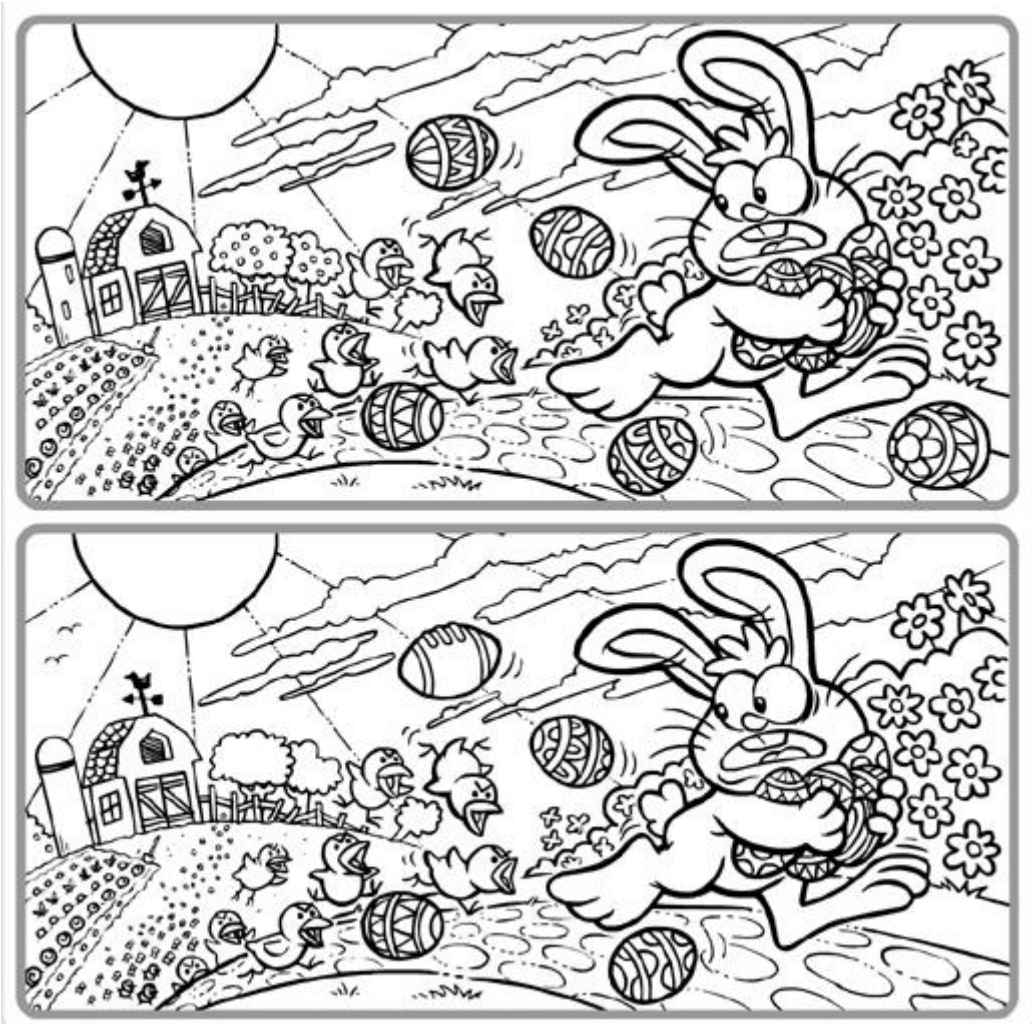
Dangerous buildings

Dangerous buildings

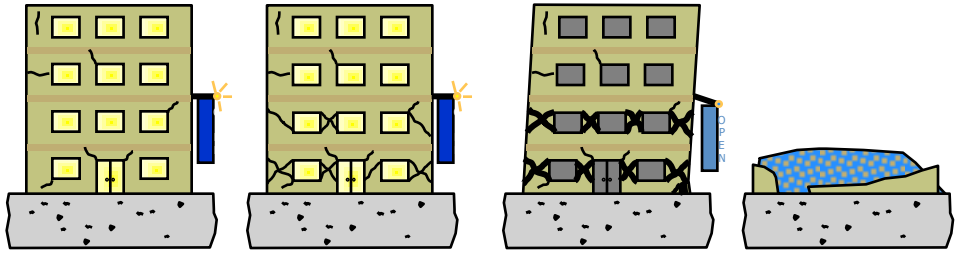


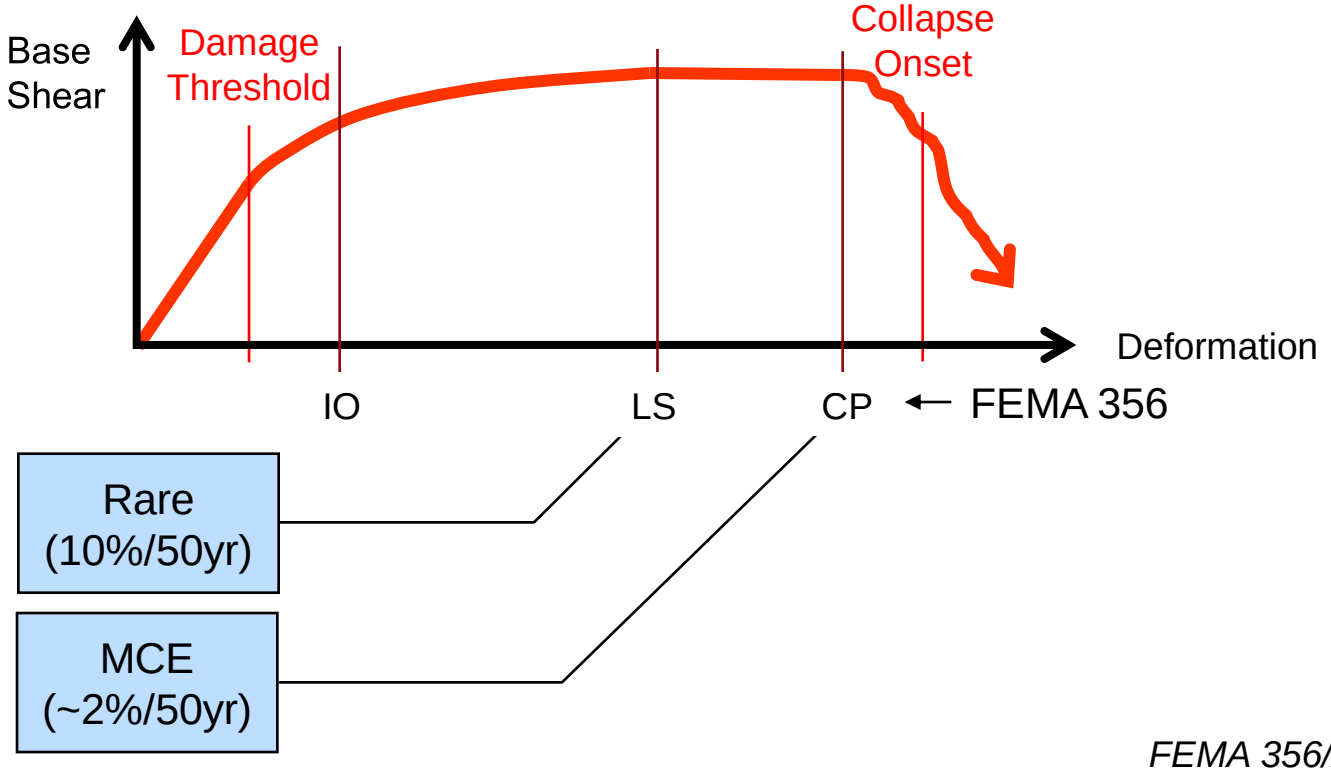
Can a trained engineer
spot the differences between
a good building and a bad one?

Can you spot the differences?

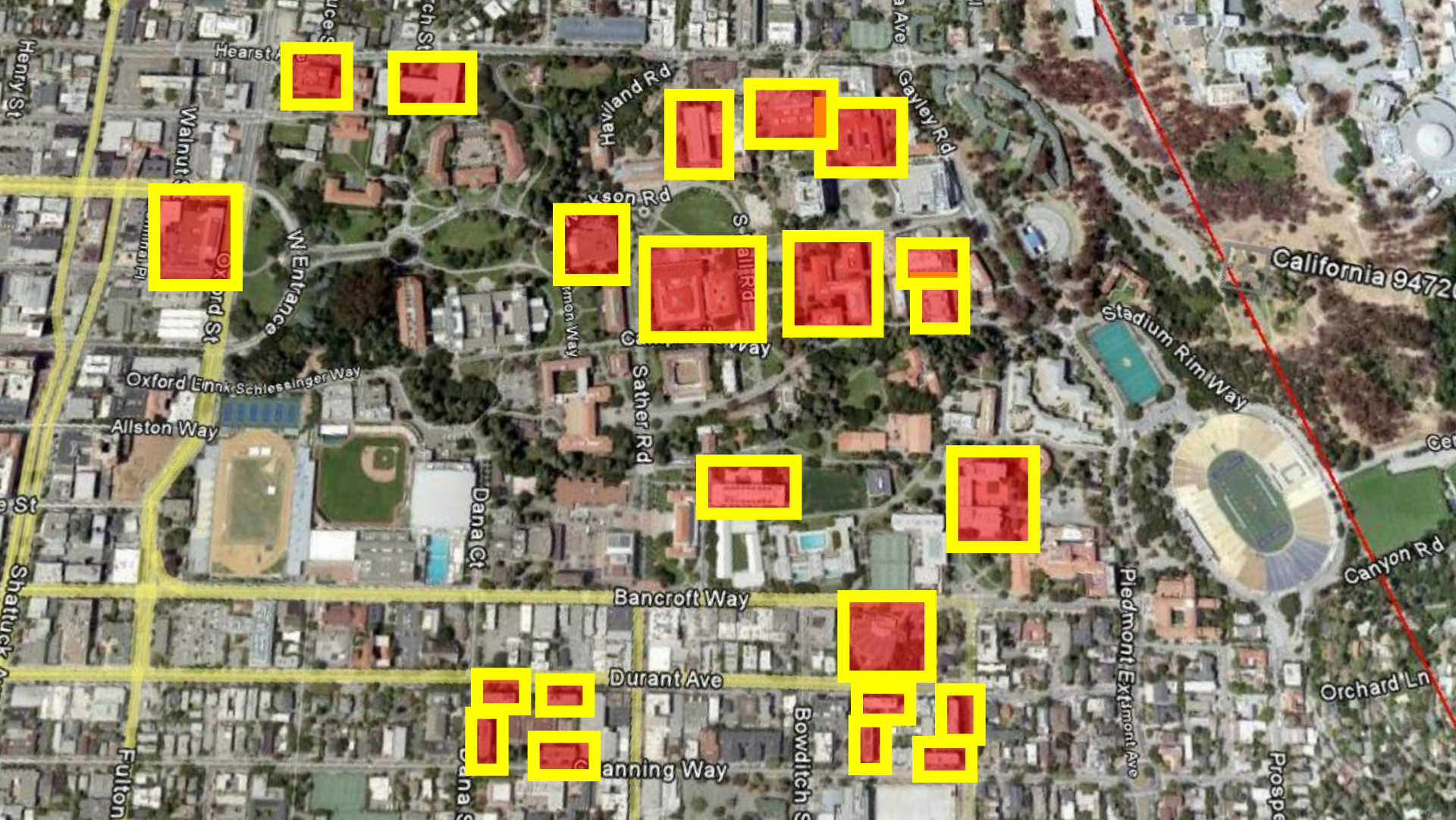


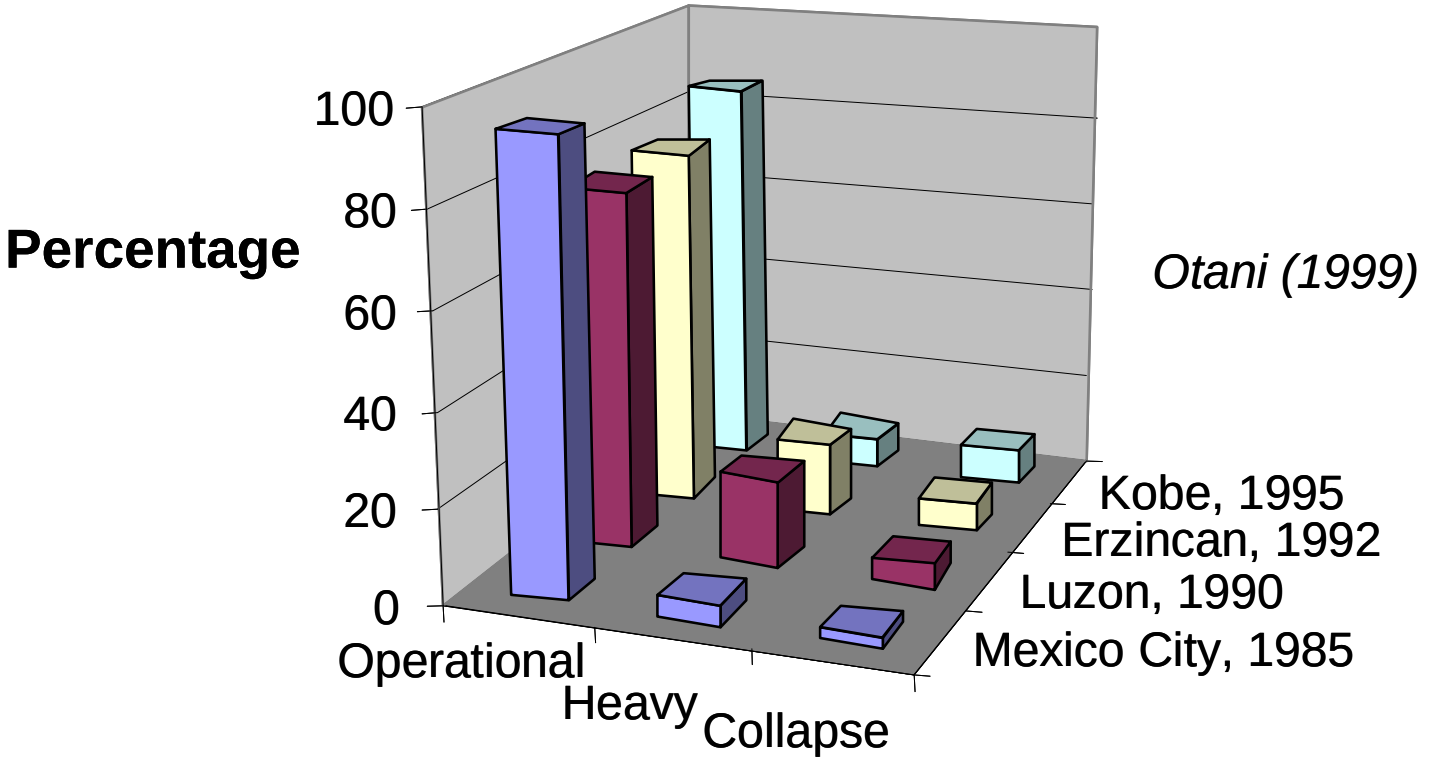
Can you spot the differences?



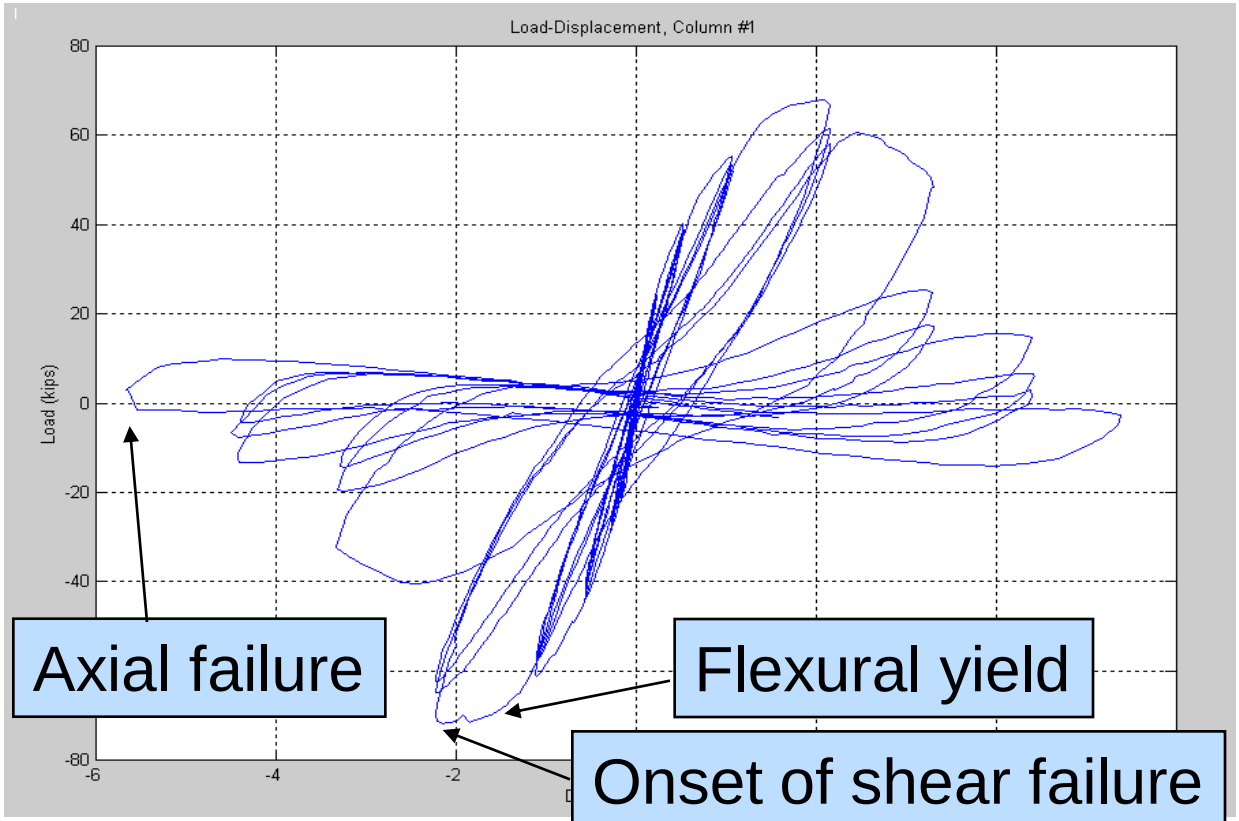


FEMA 356/ASCE 41

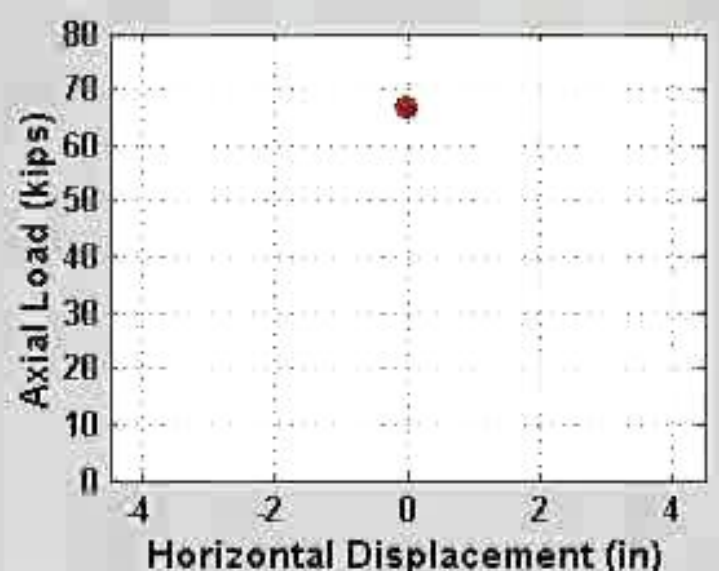

Hearst Ave
Henry St
Walnut St
Oxford St
W Entrance
Haviland Rd
Gayley Rd
Stadium Rim Way
California 9472
Oxford Ln
Schlessinger Way
Allston Way
Dana Ct
Bancroft Way
Durant Ave
Canyon Rd
Orchard Ln
Piedmont Ave
Bowditch St
Fulton St

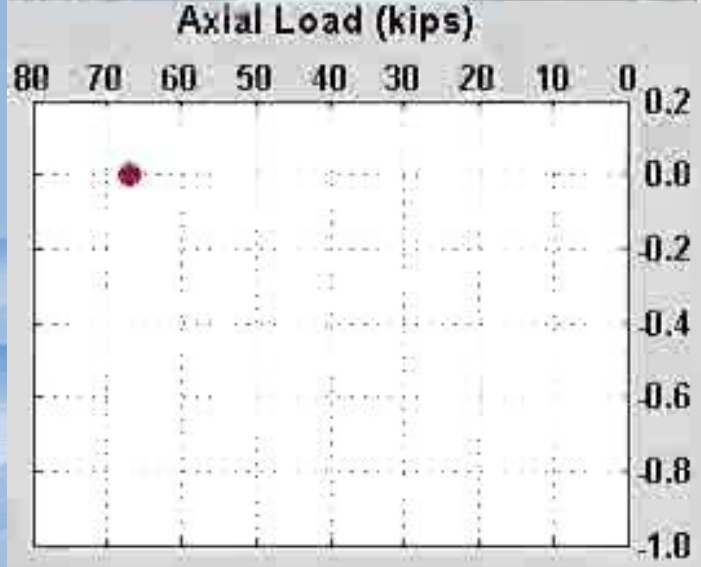

Percentage
100
80
60
40
20
0
Operational
Heavy
Collapse
Kobe, 1995
Erzincan, 1992
Luzon, 1990
Mexico City, 1985
Otani (1999)
Older Concrete Building Damage Rating

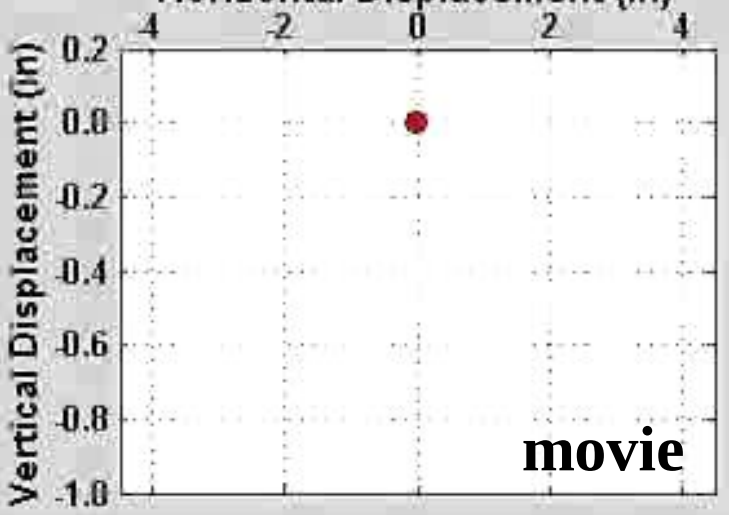
Behavior of older-type columns



NCREE

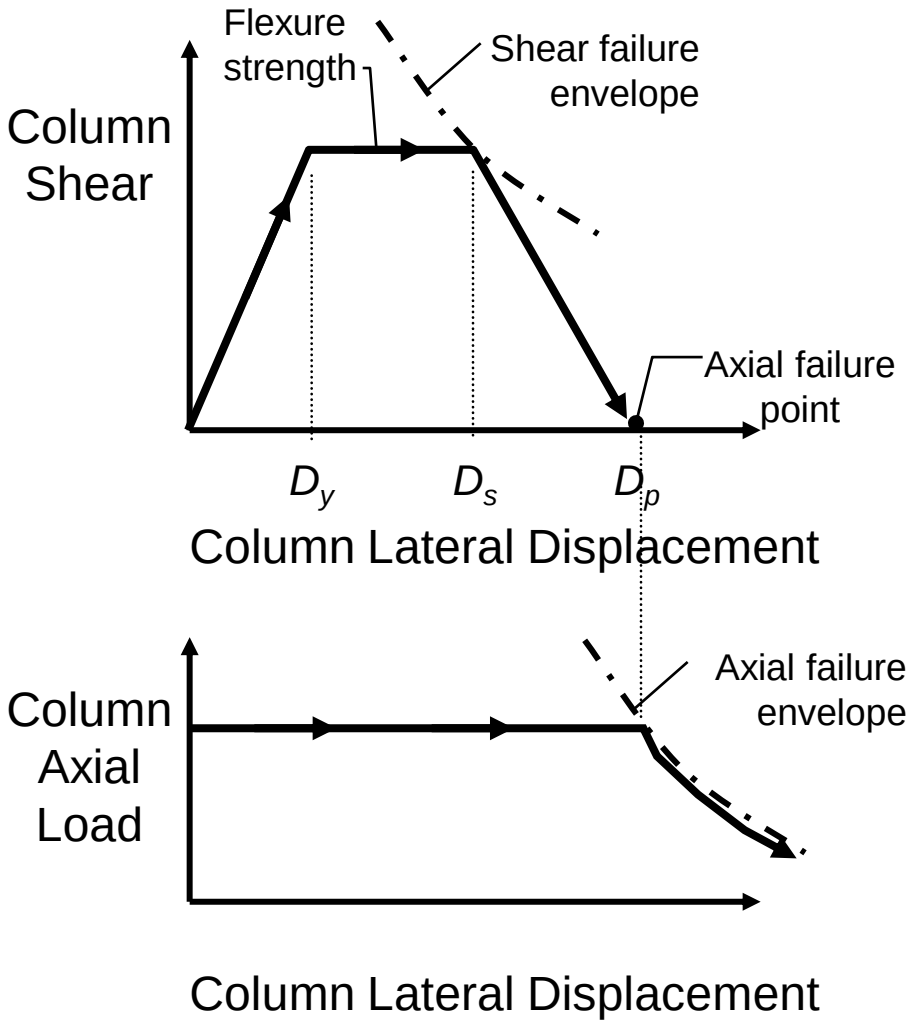

Axial Load (kips)
80
70
60
50
40
30
20
10
0
-4
-2
0
2
4
Horizontal Displacement (in)


Axial Load (kips)
80
70
60
50
40
30
20
10
0
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-1.0

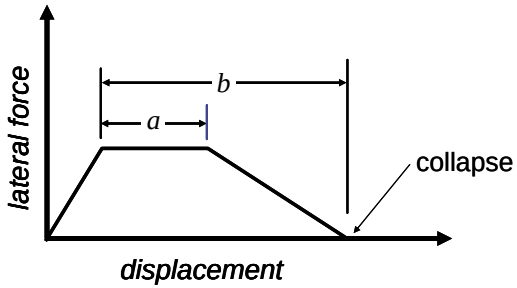

Vertical Displacement (in)
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
-4
-2
0
2
4
movie

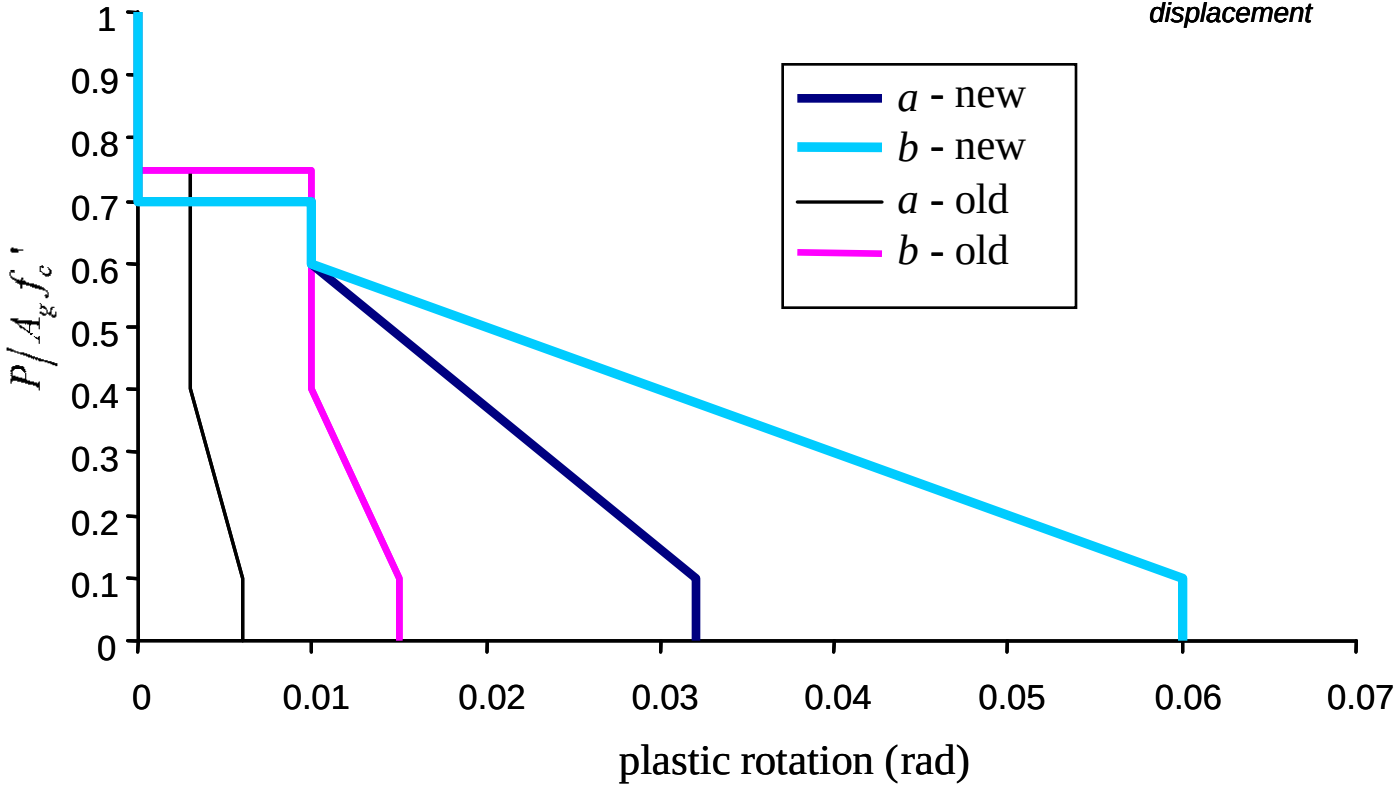
PEER

Constitutive Model for Column Failure



Improved ASCE 41





Technical advances unimportant if unimplemented

Concrete Coalition

www.concretecoalition.org

Home | Background | Get Involved | City Programs | Resources & Links | News Feed

News

Retrofit of Berkeley Building Dept

Welcome to the Concrete Coalition

The Concrete Coalition is a network of individuals, governments, institutions, and agencies with shared interest in assessing the risk associated with dangerous non-ductile concrete buildings and developing strategies for fixing them. It is a program of the Earthquake Engineering Research Institute, the Pacific Earthquake Engineering Center at UC Berkeley, the Applied Technology Council and their partners, including the Structural Engineering Association of California, The American Concrete Institute, BOMA of Greater Los Angeles and the U.S. Geological Survey.

Click Here for news and recent activities

Recent Posts

- Successful LA Workshop
- January 2009. Get Involved! Come to a workshop to learn how.
- Update from Project Director November 2008
- Update from Project Director August 2008
- June 2008: For Building Officials
- April 2008: Update from Concrete Coalition
- February 2008: Concrete Coalition receives FEMA/OES support-Seeking Participation

Volunteers Needed for Community Risk Profiles

The Concrete Coalition is now at a point where it is

Concrete Coalition and the City of Los Angeles

The City of Los Angeles, under the leadership of

Top Ten Deficiencies

As part of the challenge of defining and

Top Ten Deficiencies

Concrete Coalition Inve

Nonductile Con Top Ten Deficiencies Survey

As part of the joint activity of the Concrete Coalition and the NEES GC project, we are aiming to develop classifications for the most dangerous types of older existing concrete buildings. Of course, such classification schemes are imperfect, as the range of building sizes, framing systems, and details is la and disorganized.

In completing the survey on the next page, you should restrict your thinking to pre-1973 code-designed concrete buildings that have been reviewed by your office or firm including frames, infilled frames, walls mixed systems; precast construction structural framing systems are not a major focus of this effort. If you experience base in the geographic region selected is limited such that you feel your responses would n necessarily be representative, you may extend the geographic scope so that you feel you have a represe sample in mind, and should note this in your comments.

Los Angeles is currently the primary focus of this inventory during the summer of 2008 however, forms f other geographic regions will also be accepted.

Concrete Coalition

EERI PEER ATC

Looking for something in particular?

To search, type keywords and hit enter...

Home | Background | Get Involved | City Programs | Resources & Links | News Feed

News

California Inventory Project

4 pieces of information:

- # of total buildings
- # of pre-1980 buildings
- # of concrete buildings
- # of pre-1980 concrete buildings

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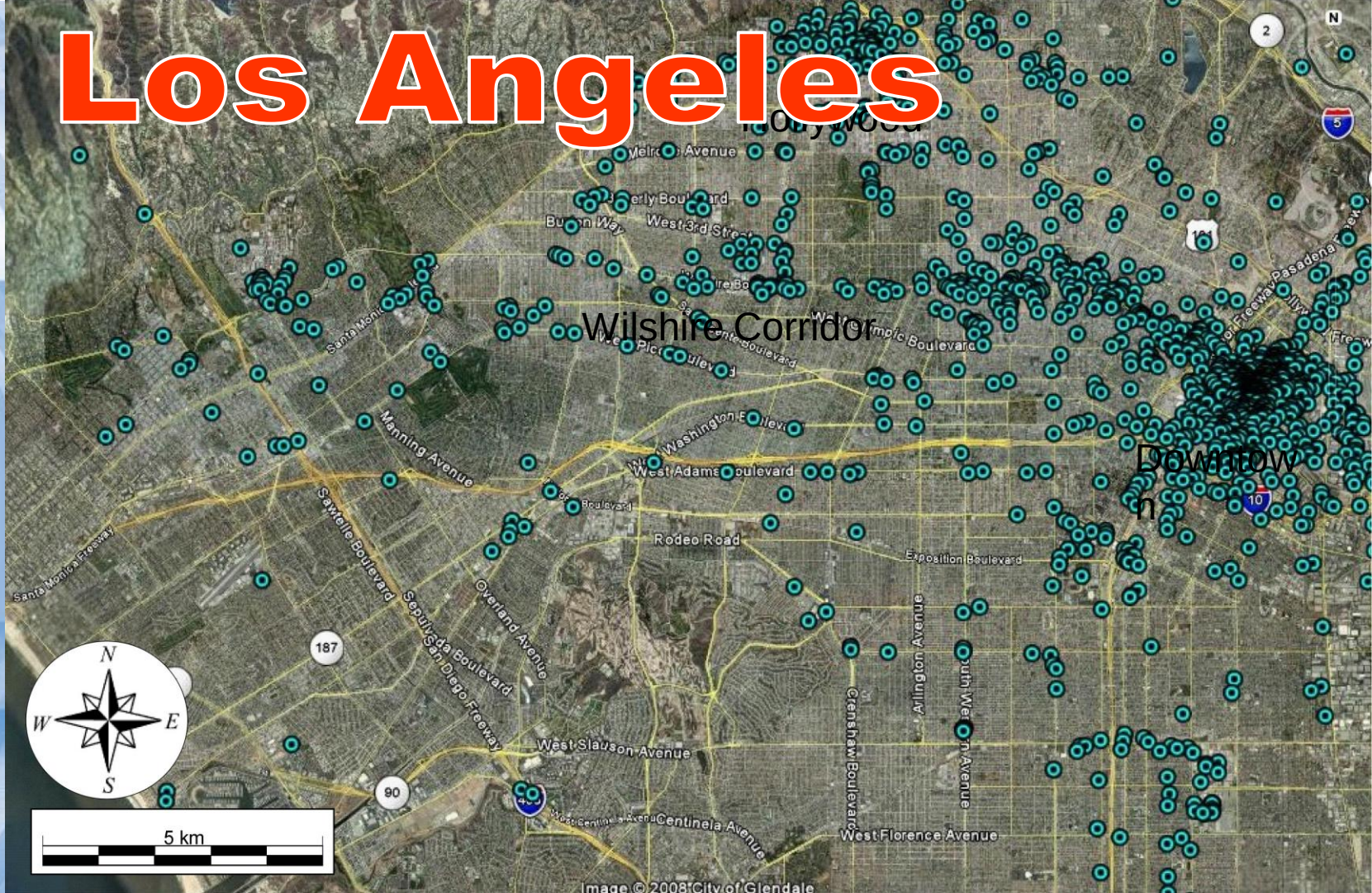
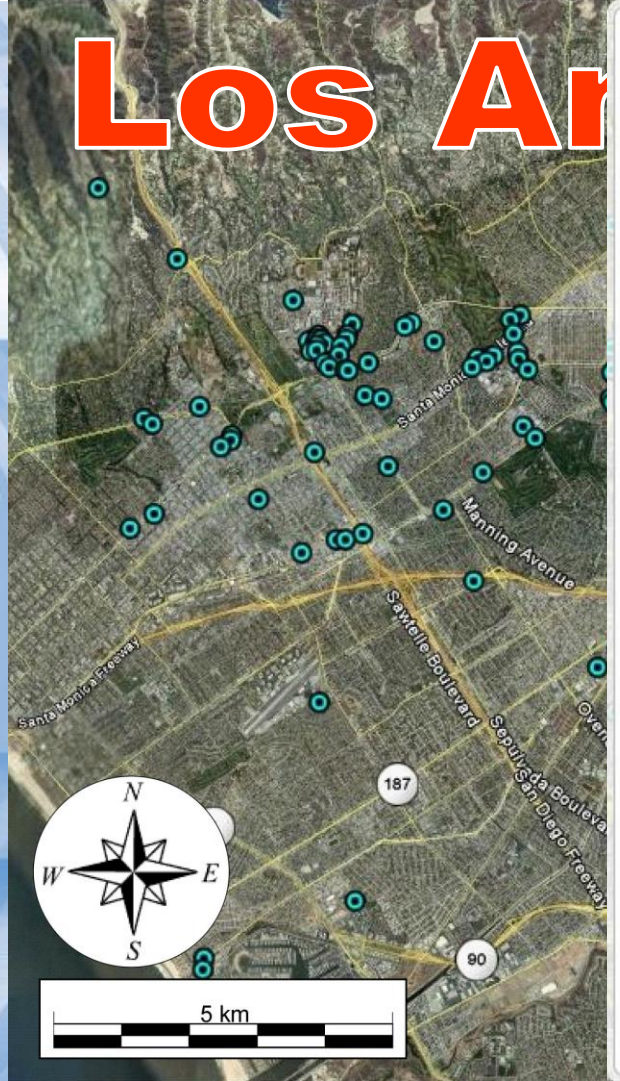
Los Angeles


Hollywood
Wilshire Corridor
Downtown
Melrose Avenue
Beverly Boulevard
Burton Way
West 3rd Street
Santa Monica Freeway
West Pico Boulevard
Manning Avenue
Washington Boulevard
West Adams Boulevard
Rodeo Road
Exposition Boulevard
Sawtelle Boulevard
Sepulveda Boulevard
Overland Avenue
San Diego Freeway
Arlington Avenue
Crenshaw Boulevard
South Western Avenue
West Slauson Avenue
Centinela Avenue
West Florence Avenue
Pasadena Freeway
187
90
10
5
2
N
W
E
S
5 km
Image © 2008 City of Glendale

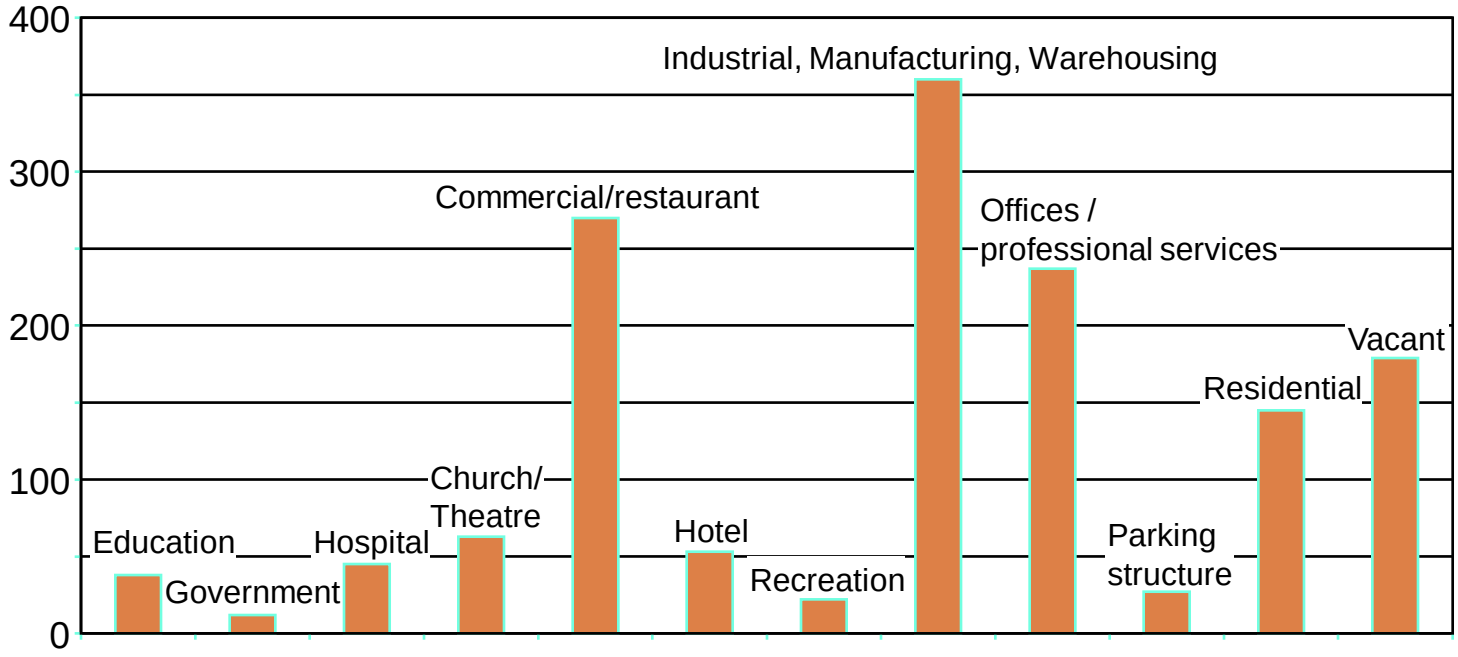
Los An



First_Floor_Building_Use = Commercial
Second_Floor_and_Above_Building_Use = Office Space
Year_Built = 1966
Approximate_Length_and_Width__ftxft_ = unknown
Number_of_Stories__without_Penthouse_or_Mezzanine_ = 10
Additional_Levels = 1 penthouse
Number_of_Basements = 3 (parking)
Tall_First_Floor = no
Signs_of_Retrofit = no
Building_Narrows_as_it_Gets_Taller = no
Building_Includes_Address_Range = no
Building_Type = Shear wall around elevator? Gravity columns above pedestal.
Additional_Observations = Vertical discontinuity. 10 columns on 1st floor, 29 above. Saw shear wall around elevator and stairs.

D1 =

Usage summary



Concrete Coalition

EERI PEER ATC

We need your help to really understand the nature of this problem

THE CONCRETE
COALITION PRESENTS:
LIL
BOOSIE
YOUNG
JEEZY
Boss Talk
EX-DRUG DEALER... STILL A THUG NIGGA
PRODUCT OF THE STREETS V.1

San Francisco 1906

New Orleans 2005
www.KatrinaDestruction.com

SPUR

SAN FRANCISCO
PLANNING + URBAN RESEARCH
ASSOCIATION

The Resilient City:

Defining what San Francisco needs from its seismic mitigation policies

SPUR's Disaster Planning Initiative

- Hazard Mitigation → Hazard Mitigation Task Force
- Emergency Preparedness
- Rebuilding

Hazard Mitigation Task Force

- > Overarching Framework
- > Existing Buildings
  - 120,000 existing buildings
  - ¼ could be damaged beyond repair in “expected” earthquake
- > New Buildings
- > Lifelines

Simple and direct approach:

- Define ***resilience*** in the context of disaster planning and recovery
- Establish ***performance goals*** for the "expected" earthquake that supports our definition of resilience
- Define transparent ***performance measures*** that help us reach our performance goals
- Suggest ***next steps*** for new buildings, existing buildings, and lifelines

What is seismic resilience?

Seismic resilience is the ability of the city to…

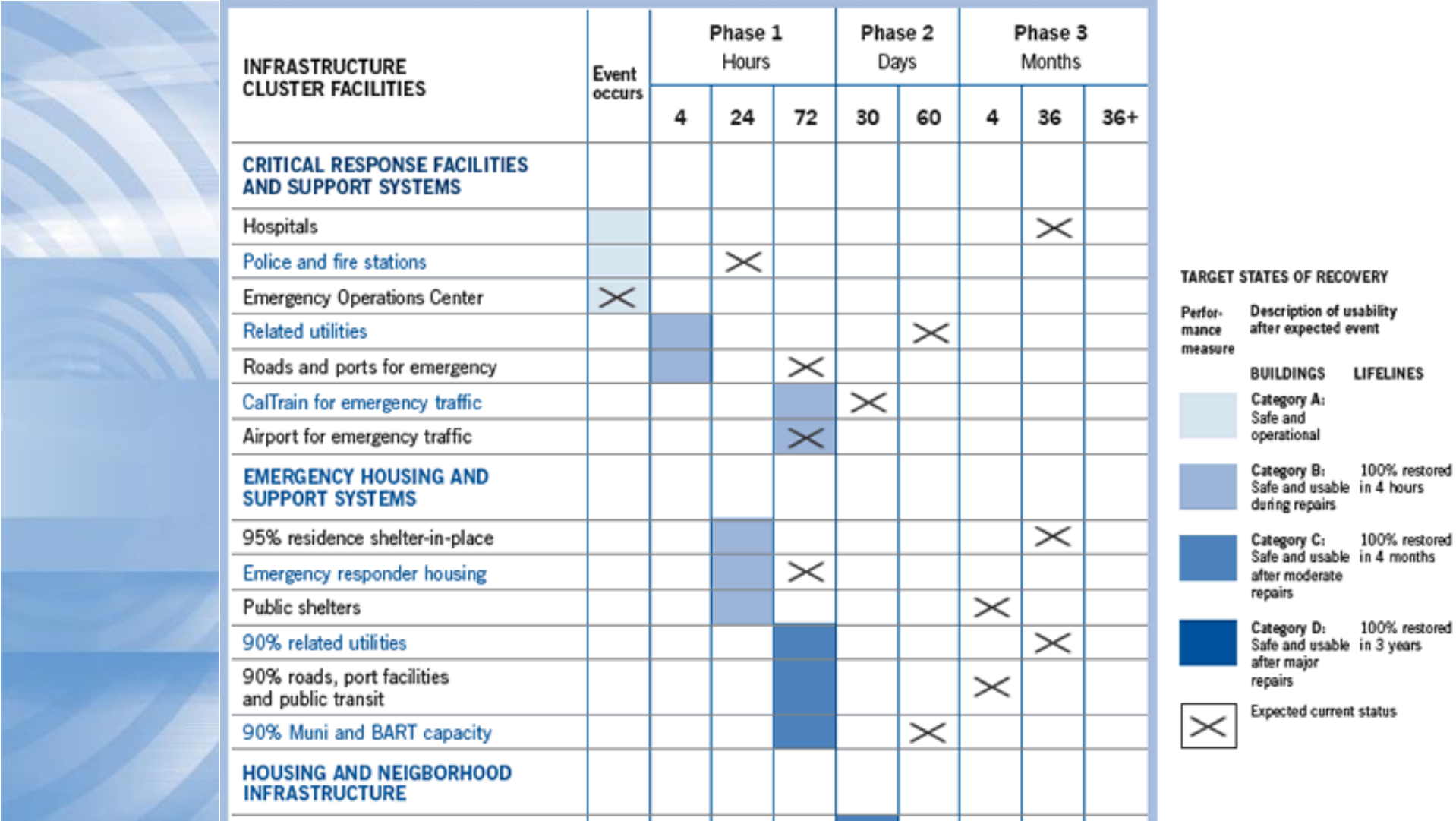
- ***contain the effects*** of earthquakes
- ***carry out recovery*** activities in ways that minimize social disruption
- ***rebuild*** in ways that mitigate the effects of future earthquakes.

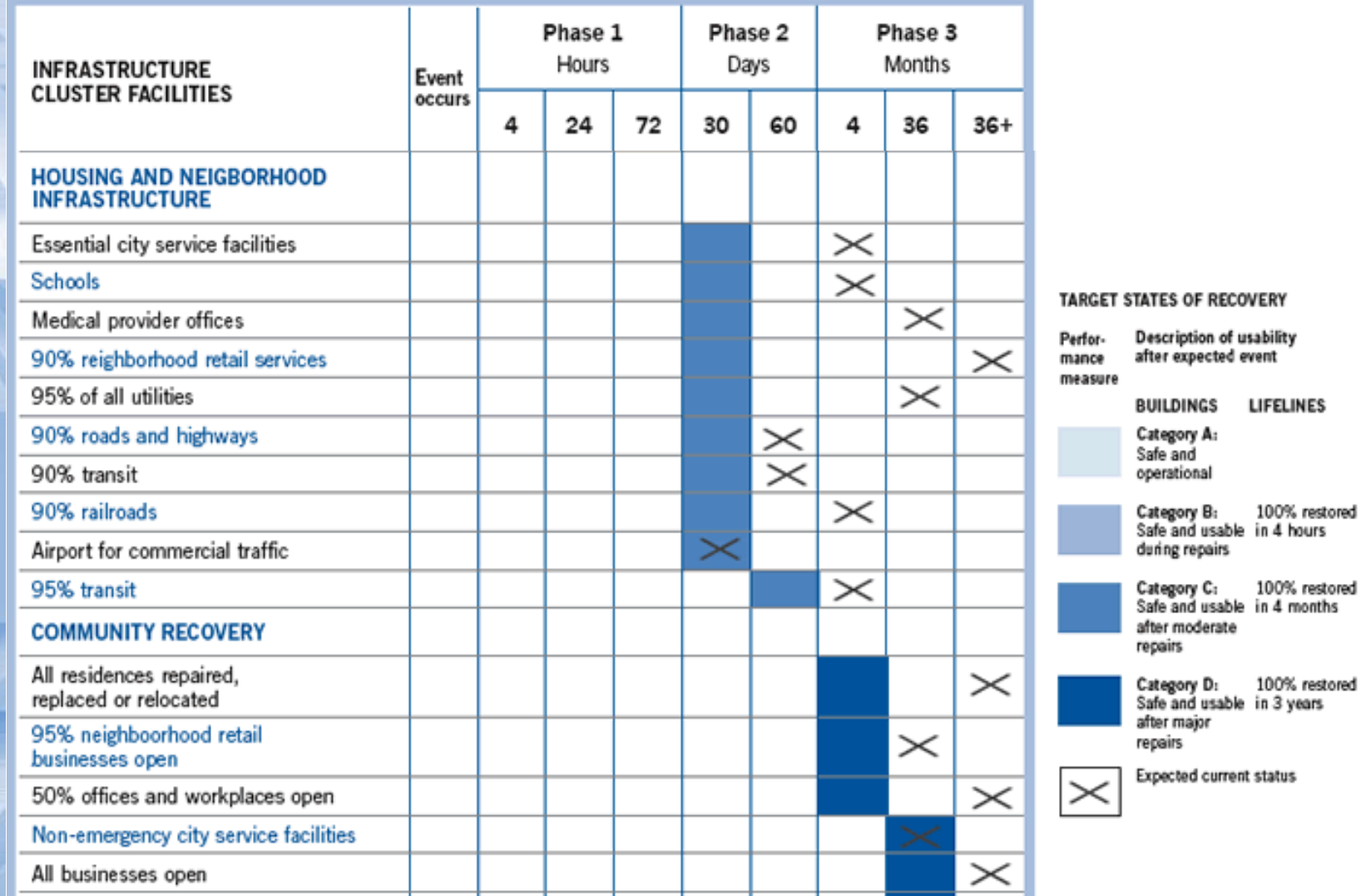
Performance goals for the “expected” earthquake

Phase	Time Frame	Condition of the built environment
I	1 to few days	Initial response and staging for reconstruction
II	few to 30 days	Workforce housing restored – ongoing social needs met
III	Several years	Long-term reconstruction

Transparent Performance Measures for Buildings

Category	Performance Standard
Category A	***Safe and operational**:* Essential facilities such as hospitals and emergency operations centers
Category B	***Safe and usable during repair**:* "shelter-in-place" residential buildings and buildings needed for emergency operations
Category C	***Safe and usable after repair**:* current minimum design standard for new, non-essential buildings
Category D	***Safe but not repairable**:* low end of acceptability for new, non-essential, buildings.
Category E	***Unsafe**:* damage that will lead to significant casualties in the "expected" earthquake


INFRASTRUCTURE CLUSTER FACILITIES
Event occurs
Phase 1 Hours
Phase 2 Days
Phase 3 Months
4
24
72
30
60
4
36
36+
CRITICAL RESPONSE FACILITIES AND SUPPORT SYSTEMS
Hospitals
Police and fire stations
Emergency Operations Center
Related utilities
Roads and ports for emergency
CalTrain for emergency traffic
Airport for emergency traffic
EMERGENCY HOUSING AND SUPPORT SYSTEMS
95% residence shelter-in-place
Emergency responder housing
Public shelters
90% related utilities
90% roads, port facilities and public transit
90% Muni and BART capacity
HOUSING AND NEIGBORHOOD INFRASTRUCTURE
TARGET STATES OF RECOVERY
Performance measure
Description of usability after expected event
BUILDINGS
LIFELINES
Category A: Safe and operational
Category B: Safe and usable during repairs
100% restored in 4 hours
Category C: Safe and usable after moderate repairs
100% restored in 4 months
Category D: Safe and usable after major repairs
100% restored in 3 years
Expected current status


INFRASTRUCTURE CLUSTER FACILITIES
Event occurs
Phase 1 Hours
Phase 2 Days
Phase 3 Months
4
24
72
30
60
4
36
36+
HOUSING AND NEIGBORHOOD INFRASTRUCTURE
Essential city service facilities
Schools
Medical provider offices
90% reighborhood retail services
95% of all utilities
90% roads and highways
90% transit
90% railroads
Airport for commercial traffic
95% transit
COMMUNITY RECOVERY
All residences repaired, replaced or relocated
95% neighboorhood retail businesses open
50% offices and workplaces open
Non-emergency city service facilities
All businesses open
TARGET STATES OF RECOVERY
Perfor-mance measure
Description of usability after expected event
BUILDINGS
LIFELINES
Category A: Safe and operational
Category B: Safe and usable during repairs
100% restored in 4 hours
Category C: Safe and usable after moderate repairs
100% restored in 4 months
Category D: Safe and usable after major repairs
100% restored in 3 years
Expected current status

What are the next steps?

- Existing buildings
- New buildings
- Lifelines

Define the unique attributes of your existing building stock

> For San Francisco….

- Prevalence of soft-story, multi-unit buildings and house-over-garage conditions.
- Non-ductile concrete frame buildings probably house every critical occupancy. Need more complete inventory.
- ….

What are your building occupancies?

SERVICE/OCCUPANCY	Target time to recovery	VULNERABLE CONDITION: Compliant unreinforced masonry	Soft-story wood frame	Non-ductile concrete frame	Unbraced cripple wall	Rigid wall-flexible diaphragm	Pre-Northridge steel systems	Steel or concrete frame w/ URM infill	Major falling hazards (chimneys, cladding)	Vulnerable gas lines and gas-fired equipment	Vulnerable nonstructural components
First responders	4 hrs										
Medical services	12 hrs										
Singe-family residences	24 hrs										
Multi-family residences	24 hrs										
Emergency shelters	24 hrs										
Essential city services	3 days										
Schools	30 days										
Social services	30 days										
Retail	30 days										
Businesses	4 mos										

Critical: The vulnerability is prevalent for the occupancy and is likely to hamper response and recovery.

Possibly critical: The vulnerability is common for the occupancy and could affect response and recovery.

Potentially critical: The vulnerability is unknown but could be prevalent enough to hamper response and recovery.

Not critical: The vulnerability is not typically associated with the occupancy or critical to its response and recovery.

Policies for achieving resilience

- Existing Buildings - A balance of voluntary, triggered, encouraged with incentives, and mandatory requirements
- New Buildings - Add transparency, almost free
- Lifelines – Community developed program based on new national standards and incentives

Policies for Existing Buildings

> Recommended for San Francisco….

- Mandated retrofit of soft-story woodframe multi-family housing
- Mandated retrofit or redundancy for designated shelters
- Mitigation program for essential city services
- Inventory of pre-1980 concrete structures of all occupancies.
- Retrofit of gas lines and gas-fired equipment
- Assessment of the unreinforced masonry program

Paying for mitigation

- In general, whoever owns the risk and benefits from mitigation should pay for it.
- … but why should the owner have to bear the cost if the object is to improve resilience of the city?
- Clearly, the city should bear some portion of the mitigation cost.

100 years of planning and still not ready…

- Seismic risk is clearly understood
- Building codes protect lives and can do more
- Dangerous buildings can be rehabilitated
- Major lifelines are being rehabilitated but more consistent regional strategies are needed
- Need for “resilience” is being discussed