

BUILDINGS AND COMMUNITIES

LESSONS AND NEW APPROACHES SINCE LOMA PRIETA

DAVID BONOWITZ, S.E.

Loma Prieta Earthquake Commemorative Symposium
October 17, 2009

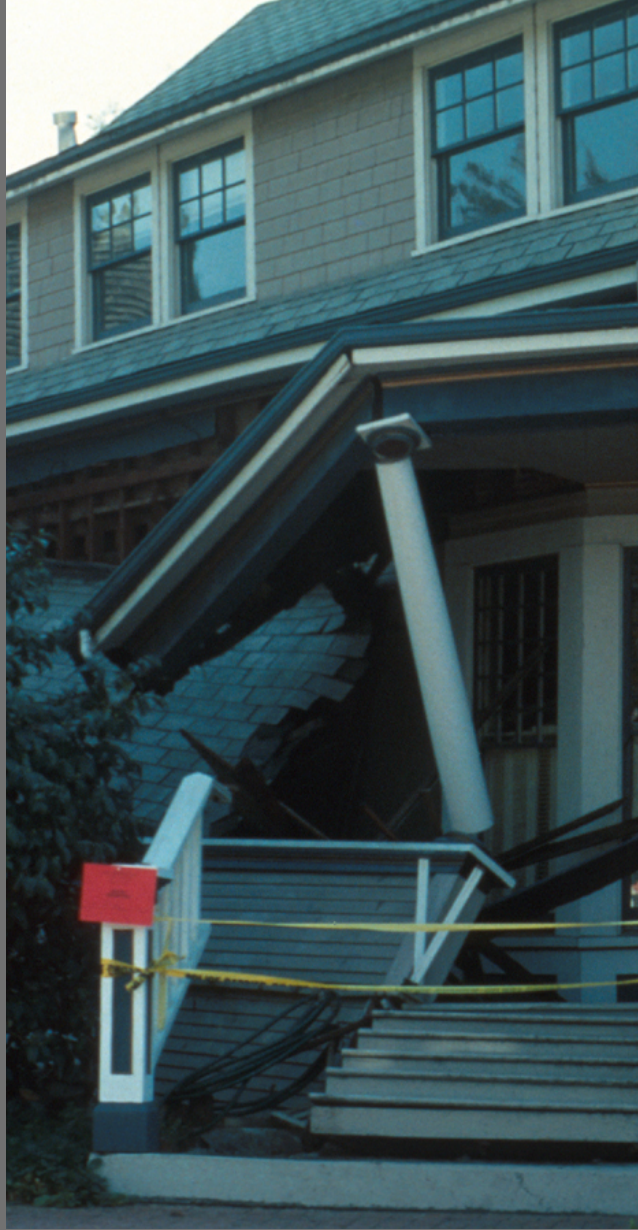


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LESSONS?



UNREINFORCED MASONRY



1989



1933

UNREINFORCED MASONRY



1989

1983

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UNREINFORCED MASONRY



1994



2003

UNBRACED CRIPPLE WALLS



UNBRACED CRIPPLE WALLS



1933

1989



UNBRACED CRIPPLE WALLS



1983

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1994

NONSTRUCTURAL COMPONENTS



VULNERABLE STRUCTURE TYPES

- Unreinforced masonry
- Unbraced cripple walls
- Soft story wood frame
- Non-ductile concrete frames
- Tilt-ups
- Hillside houses
- Parking structures (precast concrete)
- Pre-Northridge steel frames
- Thin-wall steel braced frames

APPLYING OLD LESSONS: URM

- 1933 Long Beach earthquake
 - Field Act, 1933
 - Riley Act, 1933
- SB 547, 1986
- 1989 Loma Prieta earthquake
 - San Francisco, 1992
 - 90% complete
 - Risk reduction
 - Other cities

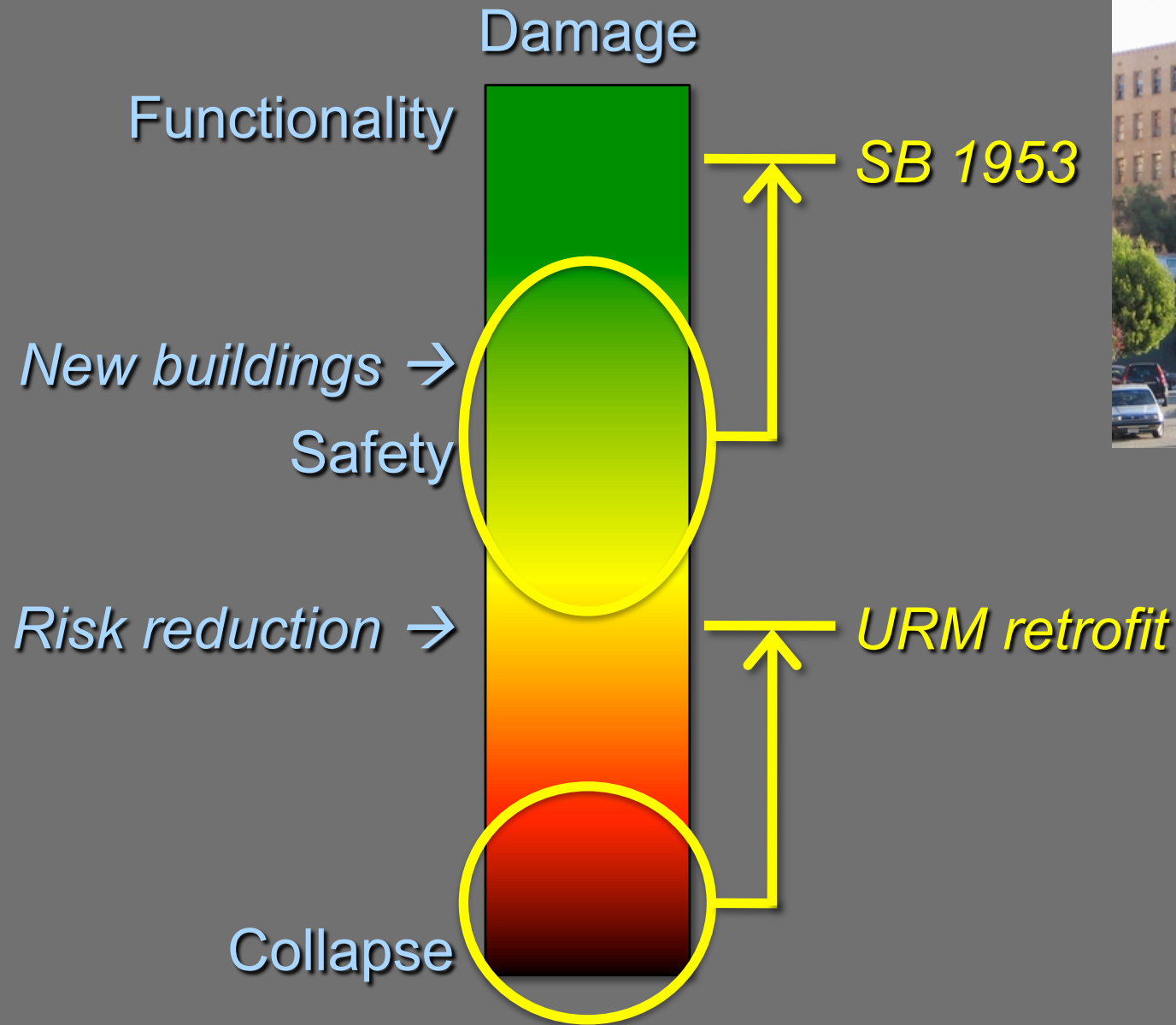


APPLYING OLD LESSONS: HOSPITALS

- 1971 San Fernando earthquake
 - Alquist Hospital Safety Act, 1973
- 1994 Northridge earthquake
 - SB 1953, 1994



GAUGING PERFORMANCE



SETTING GOALS

Damage

Functionality

New buildings →

Safety

Risk reduction →

Collapse



RETHINKING PERFORMANCE

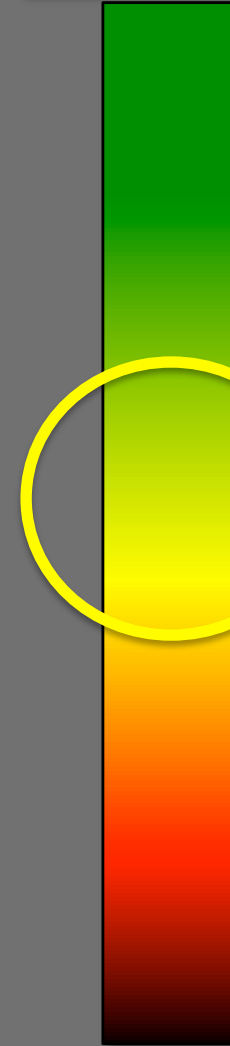
Safety



Economy



Continuity



WHERE DO WE START?



RECOVERY TARGETS

<u>Service</u>	<u>Target</u>
Hospitals operational	0 hrs
95% housing habitable	24 hrs
Emergency shelters open	24 hrs
Essential City services restored	1 mo
Schools reopened	1 mo
Social services reopened	1 mo
Community retail reopened	1 mo
All businesses reopened	4 mo

OCCUPANCY & VULNERABILITY

	URM	Soft story	ND conc.	Cripple Wl	Tilt-up	Gas line	Non-struc
Hospitals			Orange				Red
SF Res'l		Orange		Yellow		Red	
MF Res'l	Red	Red	Yellow	Yellow		Red	
Shelters	Yellow		Orange		Orange	Yellow	Yellow
City svcs			Orange		Yellow		Orange
Schools			Orange		Orange		Orange
Social svcs	Orange		Orange			Yellow	Yellow
Retail/Office	Yellow	Yellow	Yellow		Yellow	Yellow	Yellow

SOFT STORY RESIDENTIAL



1989

SOFT STORY RESIDENTIAL



1989

SOFT STORY RESIDENTIAL



SOFT STORY RESIDENTIAL

- 1971 San Fernando earthquake
- 1989 Loma Prieta earthquake
- 1994 Northridge earthquake
- Bay Area programs
 - Fremont
 - Berkeley
 - Alameda
 - Oakland
 - San Francisco



1. MANDATE: SOFT STORY MULTI-UNIT



2. MANDATE: SHELTERS



3. RECOVERY-PHASE SERVICES



4. NON-DUCTILE CONCRETE



5. GAS LINES & EQUIPMENT



6. UNREINFORCED MASONRY



