

Concrete Building Safety Program

Working Group Meeting #3

January 12, 2023

In the chat, please share your name, organization, your role or title, and something you enjoyed over the most recent holidays.

Outline

Brief refresher from previous meetings

Non-ductile concrete buildings

- Characteristics
- Retrofitting

Overview of Southern California ordinances

What buildings to include in (or exempt from) SF's program

What level of retrofit to require



Refresher from previous meetings

Tilt-up buildings (focus of previous meeting)



Bonowitz



Bonowitz

* We use “tilt-up” in this presentation as shorthand for the engineering term **Rigid-Wall Flexible-Diaphragm** buildings.

Non-ductile concrete buildings (focus for today)



Overview of Feedback from the previous meeting:

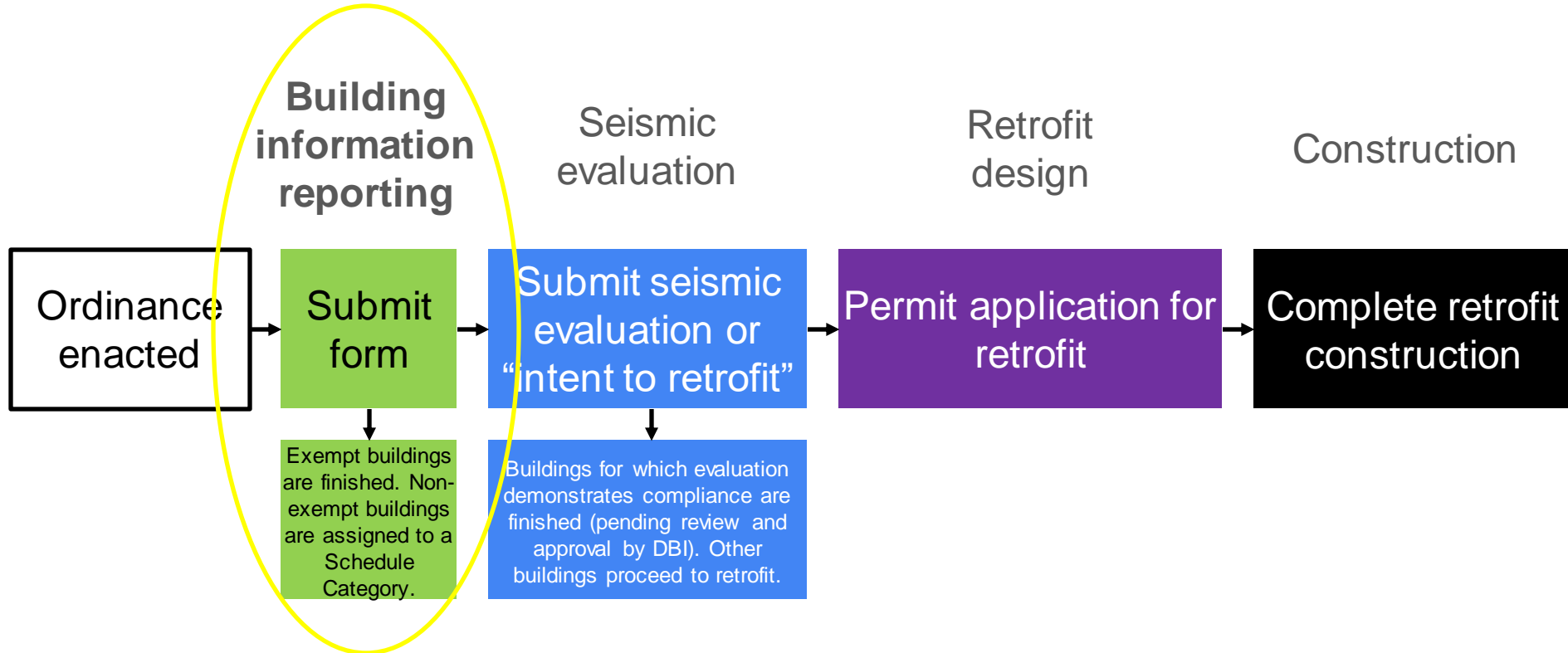
Tilt-ups

Should some tilt-up buildings be retrofitted to a higher standard?

Group leaned toward one single retrofit standard, because a building's use can change over time. But the group was not universally against having different retrofit standards or scopes. Important uses identified:

- Buildings important to disaster response and recovery
- Grocery stores and food banks
- Infrastructure (cell towers, BART, ambulance)
- Medical (pharmacies and medical clinics)
- Buildings with high occupancy

Refresher: Building Information Reporting



Refresher: **Building Information Reporting**

Objectives:

- Determine "In" vs. Exempt
- Assign to Schedule Categories
- Improve the City's database
- Begin engagement with an engineer

About the form:

- Requires an engineer (PE or SE) to complete.
- Engineering cost to complete the form is on the order of **\$275-\$2,500** (tilt-up), **\$475-\$3,200** (concrete).
- No calculations are required.

Overview of Feedback from the previous meeting:

Building Information Reporting Form

What is a reasonable timeline for owners to complete?

1-3 years

How should we determine schedule categories?

Group gravitated towards strategies connected to risk rather than randomized:

Ideas raised:

- By soil class
- By life safety
- By year of construction
- By occupancy

What we are looking for your feedback on today

	Tilt-up	Non-Ductile Concrete
What buildings are “in” vs exempt?		★
What level of retrofit?		★
What is the timeline?		
How will we determine schedule categories?		
How will we incentivize action?		★



Characteristics of non-ductile concrete Buildings

Building types

(previous meeting)

(today)

	Tilt-up (RWFD)	Non-ductile concrete
Key vulnerabilities	Roof-to-wall connections	Numerous: Column shear, punching shear, story mechanism, wall shear...
Average cost to retrofit	\$ Tens per sf	\$ Hundreds per sf
Access to do retrofit work	Typically good	Typically poor
Retrofit while occupied	Typically yes	Typically no
Code years of interest	1991 UBC, 1997 UBC	1976 UBC, 1997 UBC
Typical uses in SF	Industrial, retail, grocery	Residential, office, public
Number in SF	700?	4000?
Average floor area		50,000 sf
Ease to identify	High	Medium
Variability of performance	Moderate	High

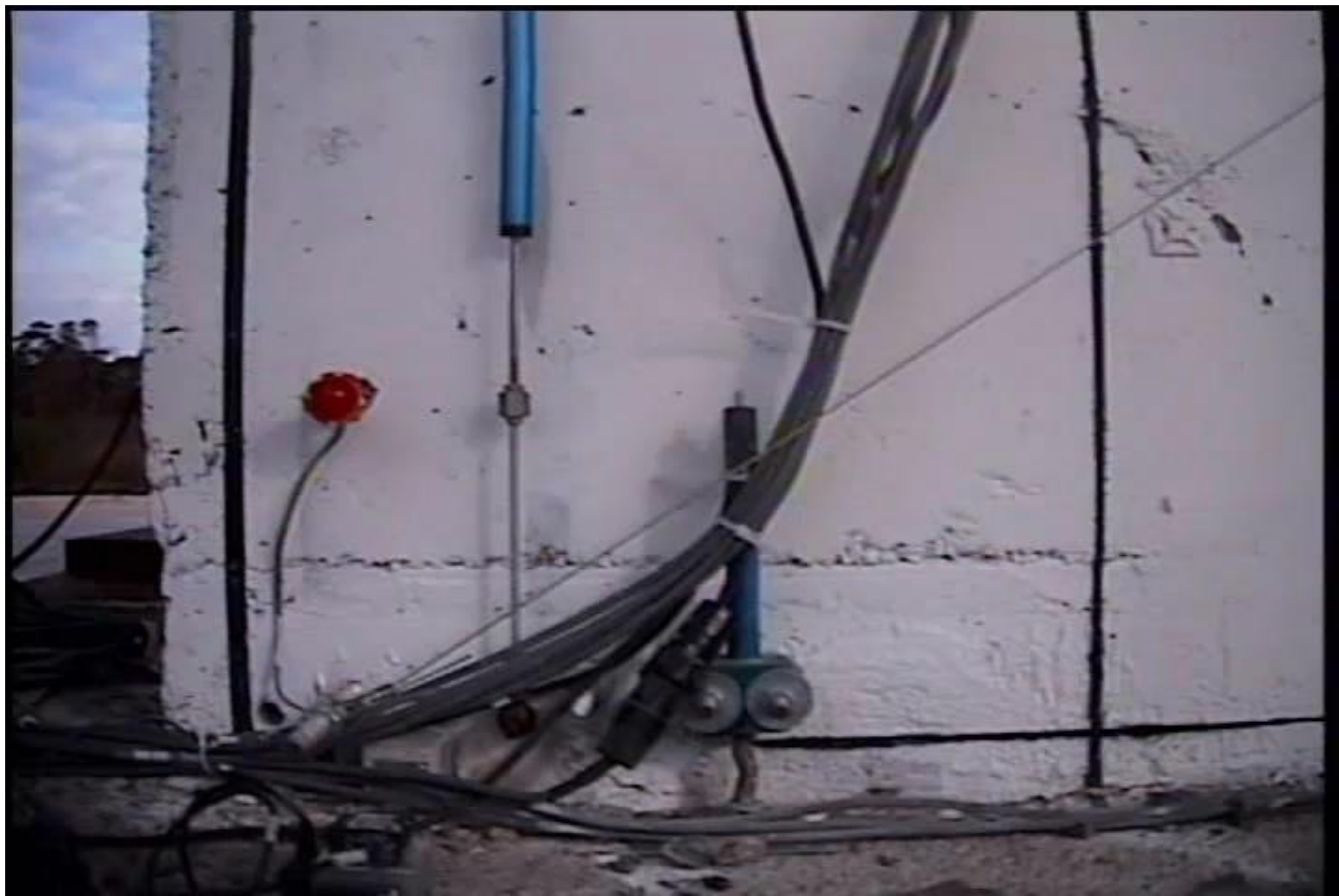
Ductile concrete structures

Flexural yielding of
reinforcement in tension and
compression

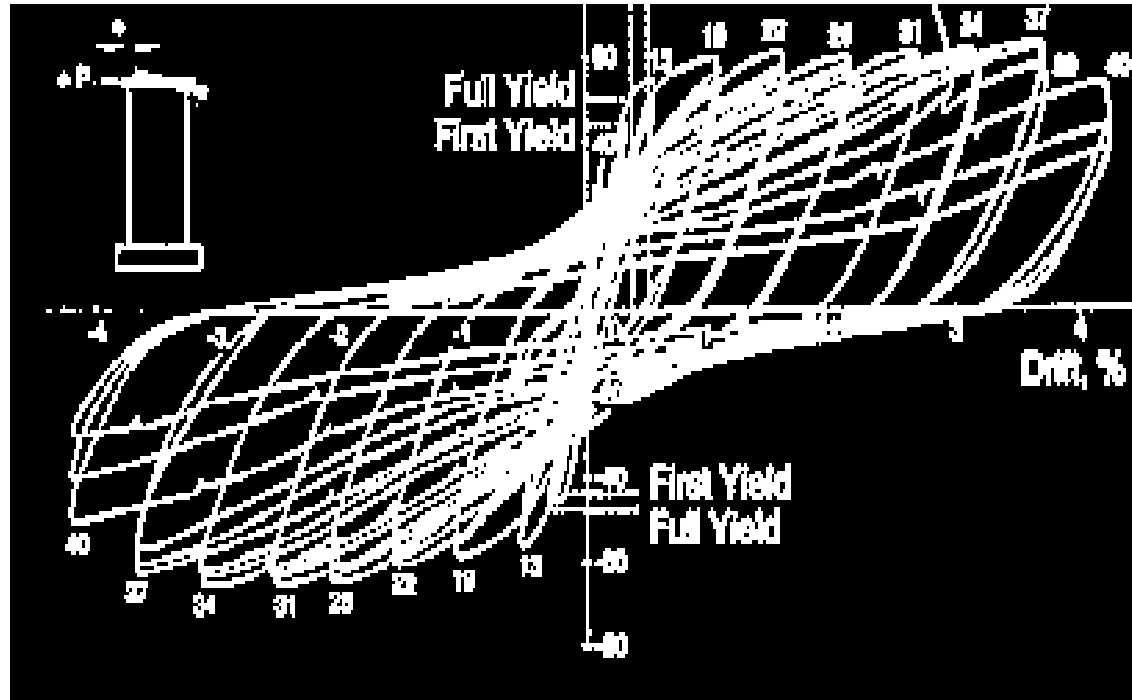
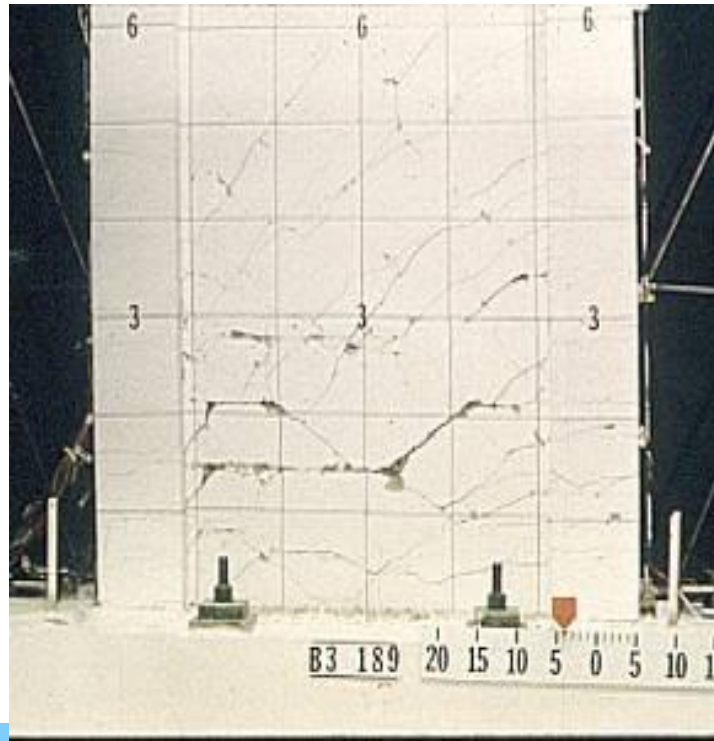
Source: Professor Jose Restrepo UCSD







Ductile: Flexure-governed wall



Non-ductile concrete structures

Sudden strength loss

Concentration in one or two stories





NIED 独立行政法人防災科学技術研究所



NIED 独立行政法人防災科学技術研究所



E-Defense shake table, Japan

Non-ductile: Column shear



Western Honshu Japan, 2007

Non-ductile: Weak-pier story mechanism



1995 Kobe
earthquake

Non-ductile: Weak-story moment frame



(a)



(b)



(c)



(d)



(e)



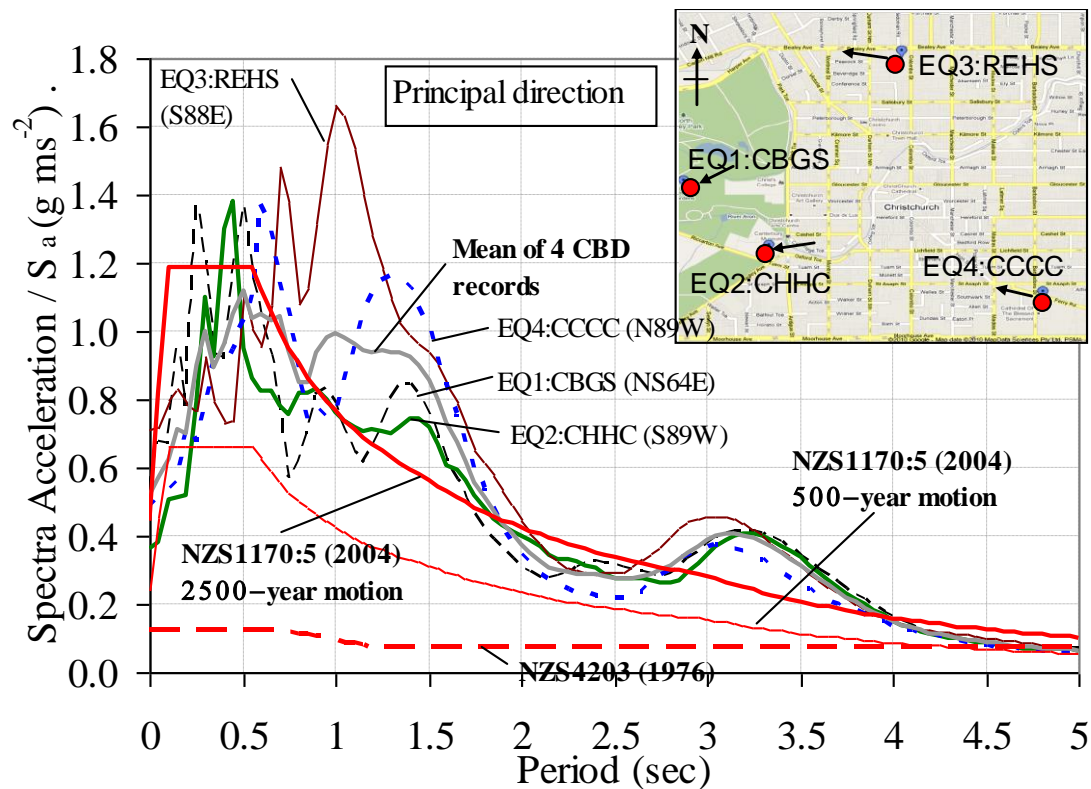
(f)

Non-ductile: Slab punching shear





Christchurch, 2010-2011







Retrofitting Concrete Buildings

Column wrapping



Elliptical column jackets



UC Berkeley Eshleman Hall



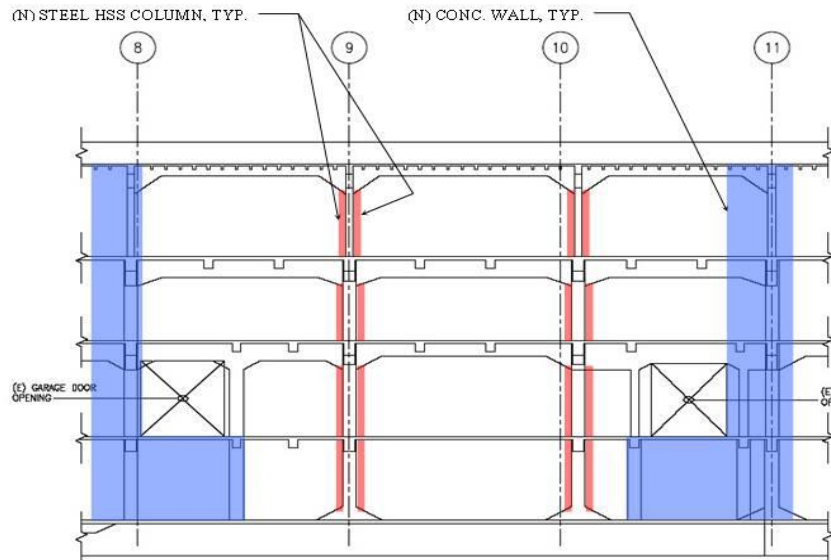
Rutherford + Chekene







Strengthening concrete walls







Challenges of retrofitting concrete buildings

- Often requires vacating the building.
- Construction can be loud and dusty (drilling for rebar dowels, roughening existing concrete).
- Adding or thickening concrete walls often affects architectural layout, floor area, windows, or exterior appearance.
- Work area is sometimes throughout the building (e.g. strengthening all columns).



Clarifying Questions?

5 minutes



Southern California ordinances

Southern California Non-Ductile Concrete Ordinances

2015 LOS ANGELES

2017 SANTA MONICA

2017 WEST HOLLYWOOD

Sec. 2. Division 95 of Article 1 of Chapter IX of the Los Angeles Municipal Code is amended in its entirety to read as follows:

ARTICLE 1, DIVISION 95

MANDATORY EARTHQUAKE HAZARD REDUCTION IN EXISTING NON-DUCTILE CONCRETE BUILDINGS

SEC. 91.9501. PURPOSE.

The purpose of this division is to promote the public welfare and safety by reducing the risk of death or injury that may result from the effects of earthquakes on existing concrete buildings. In the Northridge Earthquake, many concrete buildings constructed prior to the 1976 Los Angeles City Building Code provisions performed poorly and collapsed, causing loss of human life, personal injury and property damage. Similar loss of life, injury and property damage occurred in the Great Hanshin Earthquake, Mexico City Earthquake, and Christchurch New Zealand Earthquake due to the outdated building codes in those communities. The poor performance of these older concrete buildings is typically due to deficiencies in the lateral force resisting system (beams, columns and joints) that render the building incapable of sustaining gravity loads when the building is subjected to earthquake-induced lateral displacements. This division creates minimum standards to mitigate hazards from these structural deficiencies. Adherence to these minimum standards will improve the performance of these buildings during earthquakes and reduce, but not necessarily prevent, the loss of life, injury or earthquake-related damage.

SEC. 91.9502. SCOPE.

The provisions of this division shall apply to any existing concrete building built pursuant to a permit application for a new building that was submitted before January 13, 1977, or, if no permit can be located, the structure is determined by the Department to have been built under building code standards enacted before January 13, 1977.

EXCEPTIONS: This division shall not apply to detached single-family dwellings or detached duplexes. Moreover, notwithstanding any provision of this Code, compliance with this division shall not require existing electrical, plumbing, mechanical or fire-safety systems to be altered to comply with existing code unless they constitute a hazard to life or property.

SEC. 91.9503. DEFINITIONS.

The following words and phrases, whenever used in this division, shall be construed as defined in this section. Words and phrases not defined here shall be construed as defined in Division 2 of this Code.

Ductile Concrete Buildings

8.80.010 Purpose.

The purpose of this Chapter is to promote the public welfare and safety by reducing the risk of death or injury that may result from the effects of earthquakes on existing concrete buildings. Older concrete buildings are typically vulnerable in seismic events due to deficiencies in the lateral force resisting system (beams, columns and joints) that render the building incapable of sustaining gravity loads when the building is subjected to earthquake-induced lateral displacements. This Chapter creates minimum standards to mitigate hazards from these structural deficiencies. Adherence to these minimum

standards will improve the performance of these buildings during earthquakes and reduce, but not necessarily prevent, the loss of life, injury or earthquake-related damage.

8.80.020 Scope and Applicability.

- (a) The provisions of this Chapter shall apply to any concrete building built under building code standards enacted before January 11, 1977.
- (b) Buildings described in subsection (a) above that have completed all required seismic retrofit with a lateral load resisting analysis and structural design plans, and obtained valid final approval from the City of Santa Monica prior to the adoption of this Ordinance, are exempt from the requirements this Chapter.
- (c) An owner of any buildings within the scope of this Chapter shall demonstrate

Ordinance No. 17-____
Page 1

ORDINANCE NO. 17-____

AN ORDINANCE OF THE CITY OF WEST HOLLYWOOD ESTABLISHING SEISMIC STRENGTHENING REQUIREMENTS FOR TWO CATEGORIES OF EXISTING BUILDINGS IN THE CITY AND AMENDING TITLES 13 AND 9 OF THE WEST HOLLYWOOD MUNICIPAL CODE

The City Council of the City of West Hollywood does hereby ordain as follows:

Section 1. A new Chapter 13.36 is added to Title 13 of the West Hollywood Municipal Code to read as follows:

Chapter 13.36 Mandatory Seismic Strengthening Provisions for Non-Ductile Concrete Structures.

13.36.010 Purpose.

The provisions of this Chapter are intended to promote the public welfare and safety by reducing the risk of death or injury that may result from the effects of earthquakes on older existing concrete buildings. The poor performance of older concrete buildings is well documented and typically attributed to the non-ductile detailing of structural elements that render the building incapable of sustaining gravity loads when the building is subjected to earthquake-induced lateral displacements. This Chapter creates minimum standards intended to improve the performance of these buildings during earthquakes and reduce, but not necessarily prevent, the loss of life, injury or earthquake-related damage.

13.36.020 Scope.

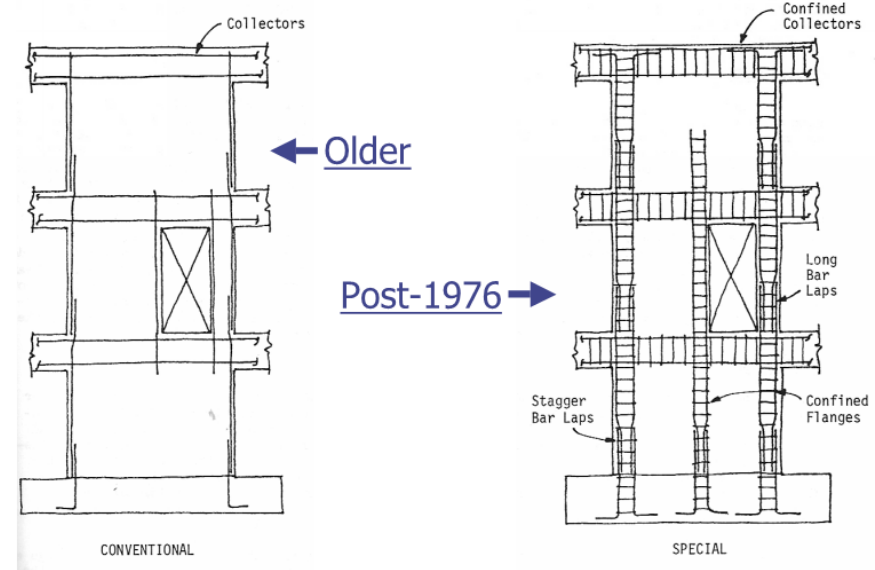
The provisions of this Chapter shall apply to any existing concrete building determined by the Building Official to have been built under Building Code standards enacted before the 1979 Uniform Building Code with local amendments.

Exceptions: This Chapter shall not apply to the following structure types:

1. Concrete structures with flexible diaphragms.
2. Single Story structures, unless the lateral system contains concrete moment frame elements.
3. Wood structures over concrete podium unless the podium contains a Major Deficiency as specified in section 13.36.050.a.
4. Buildings with a steel lateral resisting system encased in concrete.
5. Residential common interest developments as that term is defined in the West Hollywood Municipal Code Section 19.90.020, except

Targeted Buildings

- **LA:** Pre-1976 UBC w/ Concrete Gravity System
- **SM:** Pre-1976 UBC w/ Concrete Gravity System
- **WEHO:** Pre-1979 UBC w/ Concrete Lateral System w/ Following Exceptions:
 - Flexible Diaphragms
 - Single Story Concrete Shear Wall Structures
 - Concrete Podium Unless they Contain “Major Deficiencies”
 - Concrete Encased Steel Structures
 - Condominiums



EERI / PEER Historic Overview Presentation by Jack Moehle, UC Berkeley

Mixed Systems

Generally: If building is flagged. Full building needs evaluation or retrofit

LA and SM: Case-by-case base clarifications

WEHO: Building may be excluded if NDC element shear capacity is less than 10% of story shear.



Evaluation / Retrofit Criteria

Los Angeles:

- *ASCE 7 : 75% Base Shear w/ 100% Drift*
- *ASCE 41: BPOE Structural Criteria w/ Minimum 75% ASCE 7 Hazard*

Santa Monica:

- *ASCE 7 : 75% Base Shear w/ 100% Drift*
- *ASCE 41: BPOE Structural Criteria*






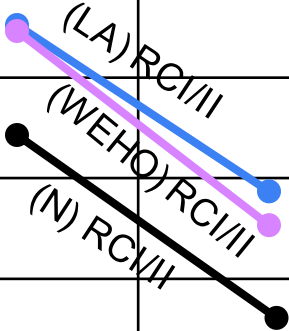
West Hollywood:

- *ASCE 41: Similar BPOE Structural Criteria*










Table C: Seismic Performance Requirements by Risk Category

Risk Category	Hazard Level 1	Hazard Level 2
I & II	BSE-1E, S-3	BSE-2E, S-5
III & IV	BSE-1E, S-2	BSE-2E, S-5

Evaluation / Retrofit Criteria

PERFORMANCE LEVEL		FULLY FUNCTIONAL 	IMMEDIATE OCCUPANCY 	LIFE SAFETY 	COLLAPSE PREVENTION 	COLLAPSE 
EARTHQUAKE HAZARD	BSE-1E (FREQUENT)					
	BSE-1N					
	BSE-2E					
	BSE-2N (VERY RARE)					

Evaluation / Retrofit Criteria

PERFORMANCE LEVEL		FULLY FUNCTIONAL 	IMMEDIATE OCCUPANCY 	LIFE SAFETY 	COLLAPSE PREVENTION 	COLLAPSE 
EARTHQUAKE HAZARD	BSE-1E (FREQUENT)					
	BSE-1N					
	BSE-2E					
	BSE-2N (VERY RARE)					



ASCE 41-13 Approach

HIGH

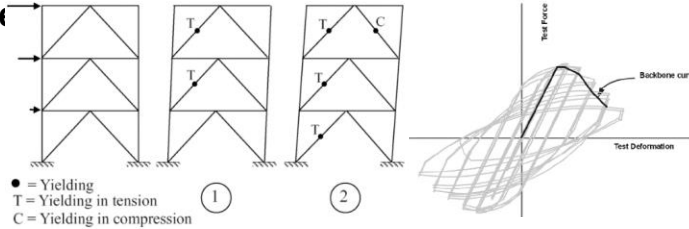
ANALYSIS EFFORT

LOW

TIER 3 Non-Linear Analysis (MONTHS)

Non-Linear Dynamic Procedure
(Time History)

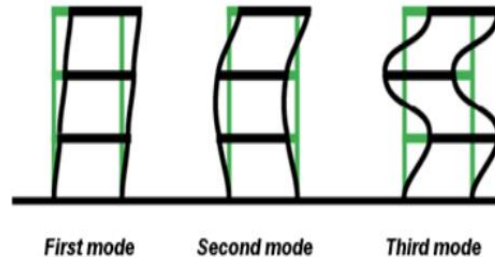
Non-Linear Static Procedure
(Push-Over)



TIER 2 & TIER 3 Linear Analysis (WEEKS)

Linear Dynamic Procedure
(Response Spectra)

Linear Static Procedure
(Hand Calculations)



TIER 1 Checklist (DAYS)

Check List Evaluation
(Quick Hand Checks)

Chapter 16.0
Tier 1 Checklists

16.1 BASIC CHECKLISTS

16.1.1 Very Low Seismicity Checklist

This Very Low Seismicity Checklist shall be completed for all building types in levels of very low seismicity being evaluated to the Life Safety Performance Level only. Tier 1 evaluation shall

LOW

TYPICAL RETROFIT COST

HIGH

Compliance Paths

Generally:

- *Previous Retrofits Must be Full Retrofits by Approved Standard or Previous Ordinance*

Los Angeles:

- *ASCE 41 Tier 3*
- *ASCE 41 Tier 2 and Benchmarking (Not Allowed)*

Santa Monica:

- *ASCE 41 Tier 3*
- *ASCE 41 Tier 2 and Benchmarking (Silent)*

West Hollywood:

- *ASCE 41 Tier 3*
- *ASCE 41 Tier 2 and Benchmarking*

Table 5.2-1: Retrofit Performance Objectives by Risk Category^{1,2,3}

Compliance Method	Risk Category	Hazard/Performance Level 1	Hazard/Performance Level 2
Tier 1 & Tier 2	I & II	BSE-1E, S-3	Deemed to Comply
	III & IV	BSE-1E, S-2	Deemed to Comply
Tier 3	I & II	BSE-1E, S-3	BSE-2E, S-5
	III & IV	BSE-1E, S-2	BSE-2E, S-5

Timeline



Jurisdiction	Expected No. Buildings	Submit "Evaluation" or "Screening" Report	Submit Retrofit Plans	Obtain Building Permit	Complete Construction	Total Time
Los Angeles	1,326 NDC Reported	3 Years From Notice to the Owner	10 Years From Notice to the Owner	N/A	25 Years From Notice to the Owner	25 Years for Total Retrofit
Santa Monica	66 NDC & 80 PN-SMF Reported	3 Years From Notice to the Owner	4 Yrs NDC & 12 Yrs PN-SMF From Notice to the Owner	N/A	10 Yrs NDC & 20 Yrs PN-SMF From Notice to the Owner	10 Years NDC 20 Years PN-SMF
West Hollywood	55 NDC & 31 PN-SMF & 60 Undefined Reported	3 Years From Notice to the Owner	10 Yrs Phase 1 & 20 Yrs Phase 2 From Notice to the Owner	7 Yrs Phase 1 & 15 Yrs Phase 2 From Notice to the Owner	10 Yrs Phase 1 & 20 Yrs Phase 2 From Notice to the Owner	10 Years Major Deficiencies 20 Years Full Retrofit

Prioritization

SANTA MONICA

Building Type Categories	Date Notice Sent	Quantity (Approx.)	Compliance Date - Evaluation Report Due	Compliance Date - Plans Submittal	Compliance Date - Retrofit Complete
Concrete Tilt Up*	August 14, 2017	30	December 2017	May 2018	August 2020
URM*	August 28, 2017	100	November 2017	February 2018	August 2019
Soft Story - >2 Stories and ≤ 16 units	Sept 25, 2017	400	September 2021	September 2022	September 2025
Soft Story - 16 or more units	October 23, 2017	150	October 2021	October 2022	October 2025
Non-Ductile Concrete*	October 23, 2017	70	October 2020	April 2022	October 2027
Steel Moment Frame*	October 23, 2017	80	October 2020	October 2029	October 2037
Soft Story - 2 Stories, 7 to 15 Units	November 27, 2017	350	November 2021	November 2022	November 2025
Soft Story - 2 Stories, <7 Units	February 19, 2018	350	February 2022	February 2023	February 2026
	May 7, 2018	200	May 2022	May 2023	May 2026
	July 30, 2018	250	July 2022	July 2023	July 2026

*Projects with a pending application as of March 13, 2020, or submitted between March 13, 2020 and the expiration of COVID-19 emergency are entitled to a two-year extension to all applicable compliance dates.

WEST HOLLYWOOD

PRIORITY DESIGNATION

Priority	Description
Priority I.	Buildings with 8 or more stories
Priority II.	Buildings with 3 to 7 stories
Priority III.	Buildings with 2 or less Stories

NOTE: LOS ANGELES DOES NOT HAVE A PRIORITY TABLE/SCHEDULE

Evaluation Reports

Los Angeles:

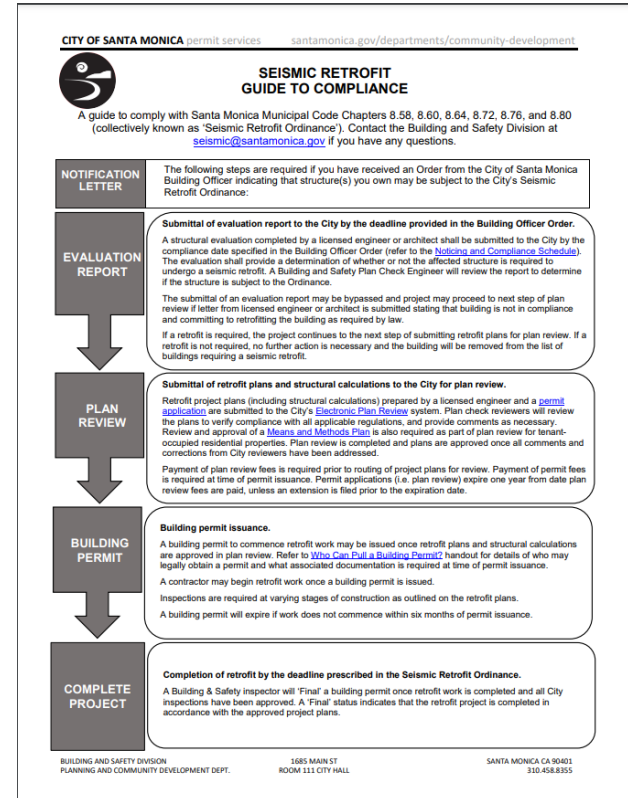
- *Confirm Building is In Scope*

Santa Monica:

- *Confirm Building is In Scope*
- *or Evaluate Building ok As-Is*

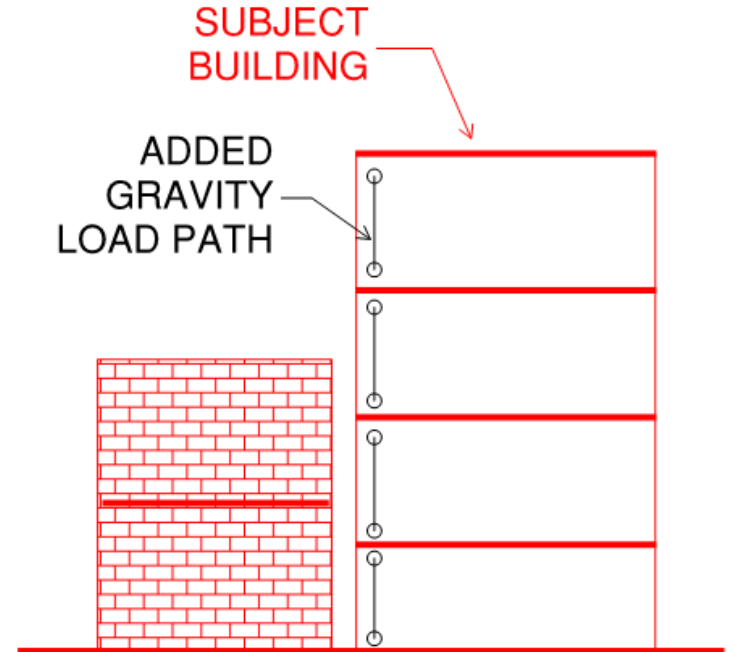
West Hollywood:

- *Confirm Building is In Scope*
- *Define Retrofit Scope*

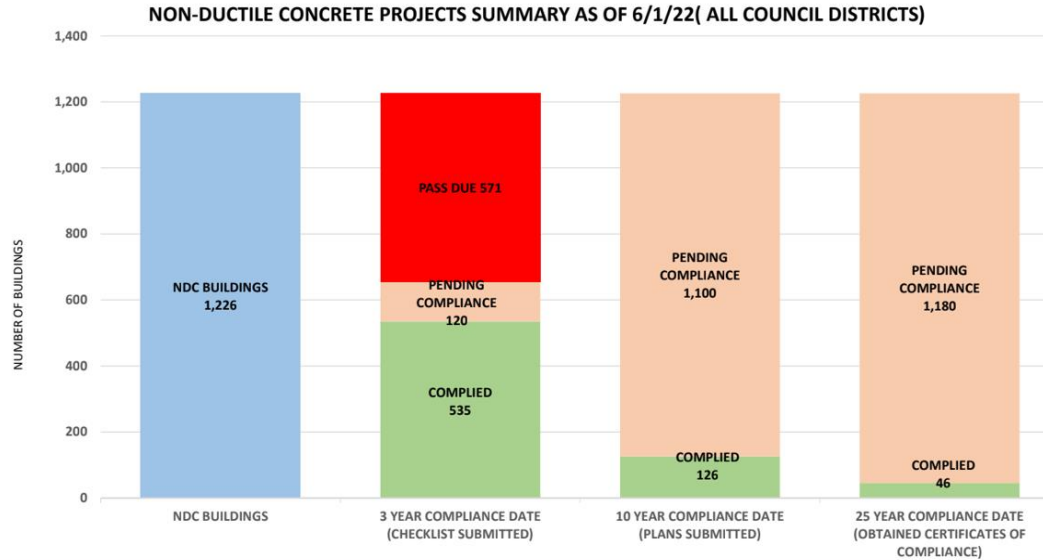


Peer Review and/or External Review

- Los Angeles
 - All Buildings Internally Reviewed
 - Peer Review Non-Linear Analysis
- Santa Monica
 - All Buildings Externally Reviewed
 - Peer Review Requirements Not Clear
- WEHO
 - All Buildings Externally Reviewed
 - Peer Review Requirements For Certain Triggers:
 - Non-Linear
 - Alternate Design Criteria
 - Advanced Systems
 - Pounding
 - Etc.

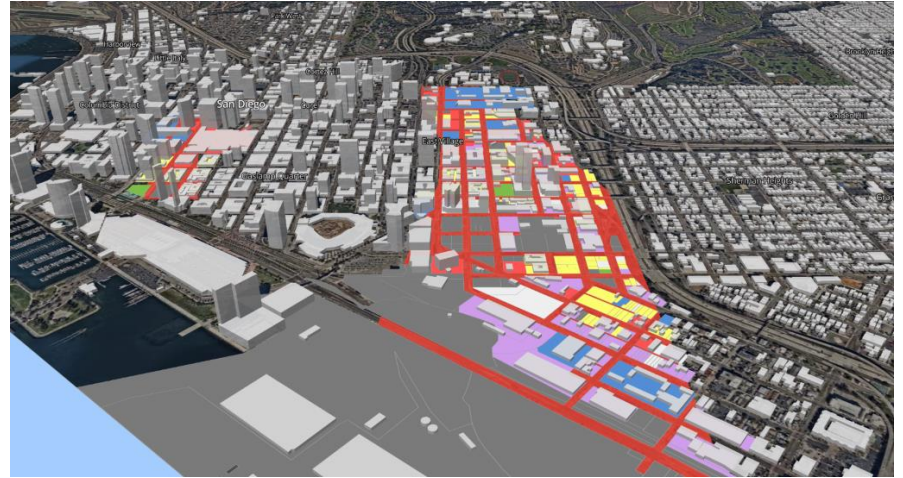


Los Angeles Compliance Status (As of 6/1/22)



Other Efforts

- **San Diego** – SEAOSD Conducted Survey
- **Long Beach** – Currently Conducting Survey
- **Torrance** – Currently Conducting Survey and Developing Draft NDC Ordinance





Questions about Southern California ordinances?

10 minutes



Break

5 minutes



Retrofit ordinances

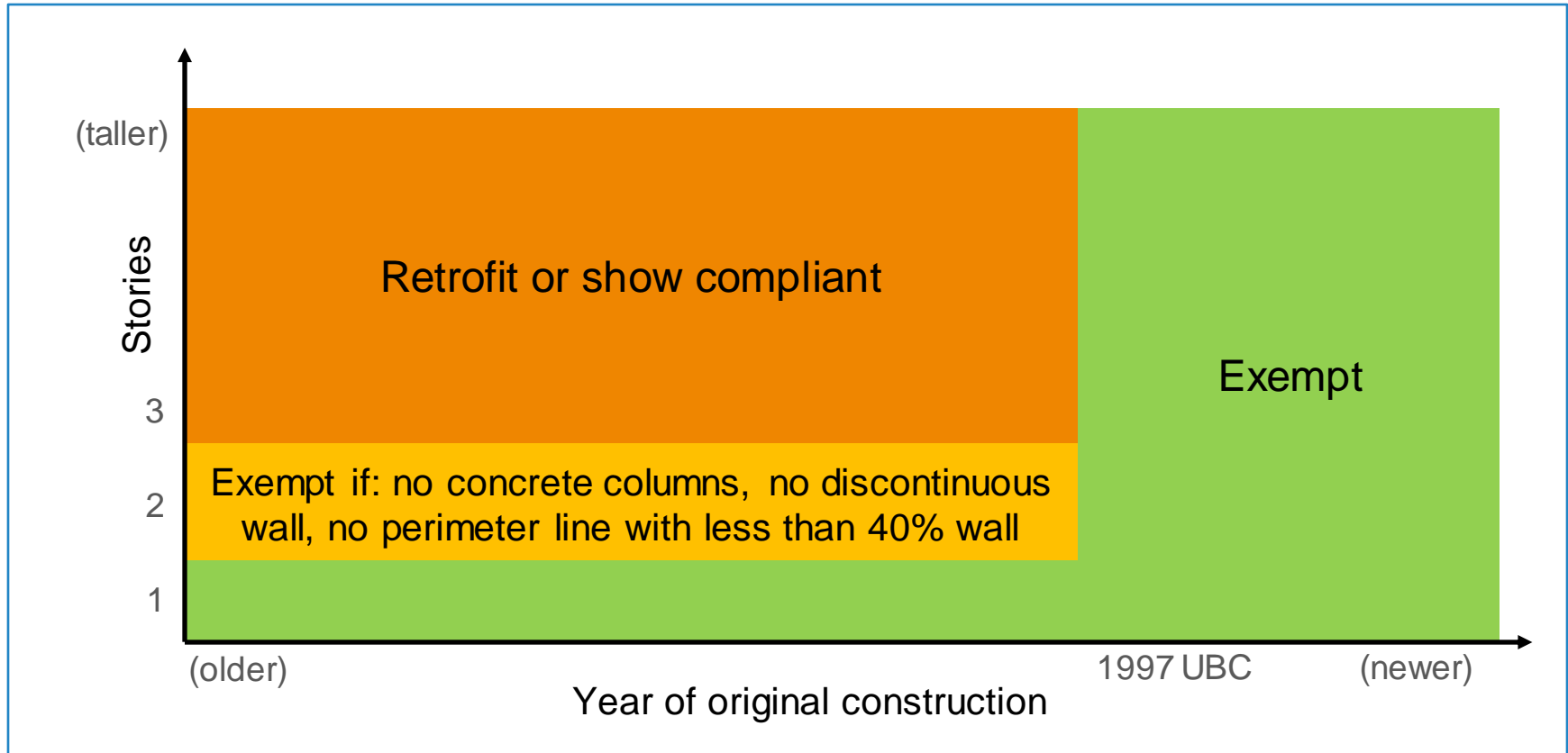
Two key points for a retrofit ordinance

- What buildings must comply with the program?
- What retrofit level?



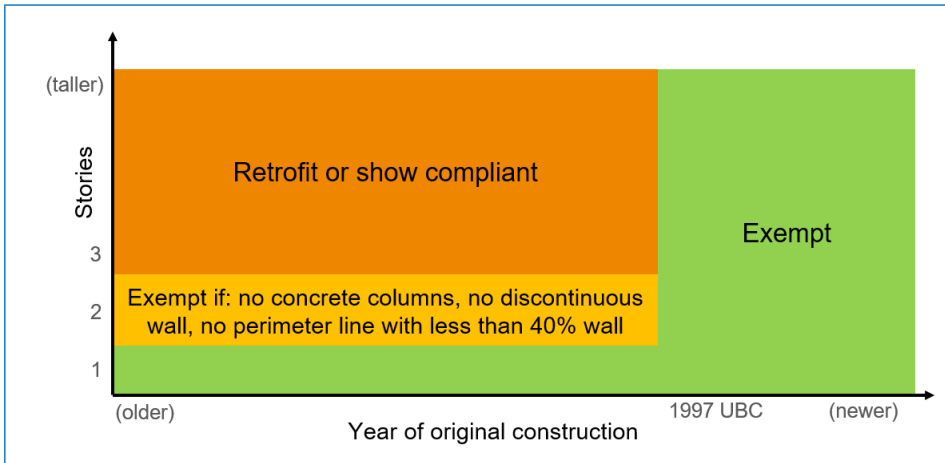
Concrete buildings in the program

Concrete buildings included in the program (draft)

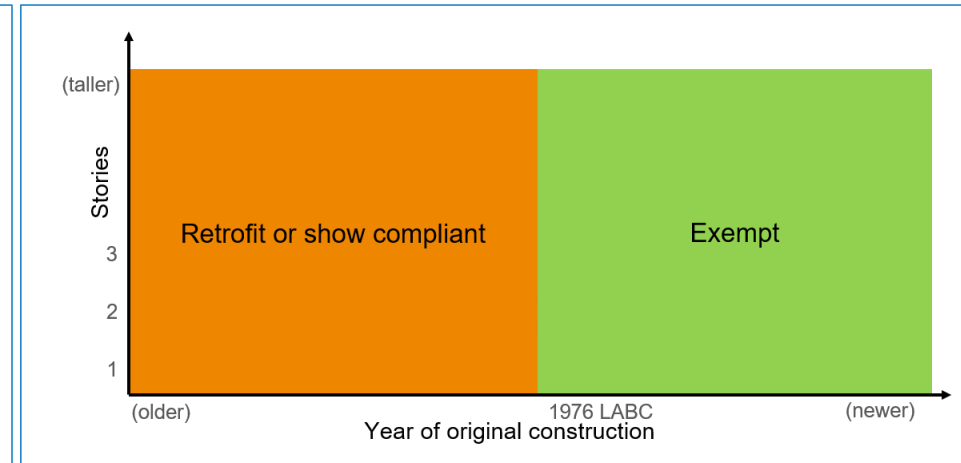


Concrete buildings included in the program (draft)

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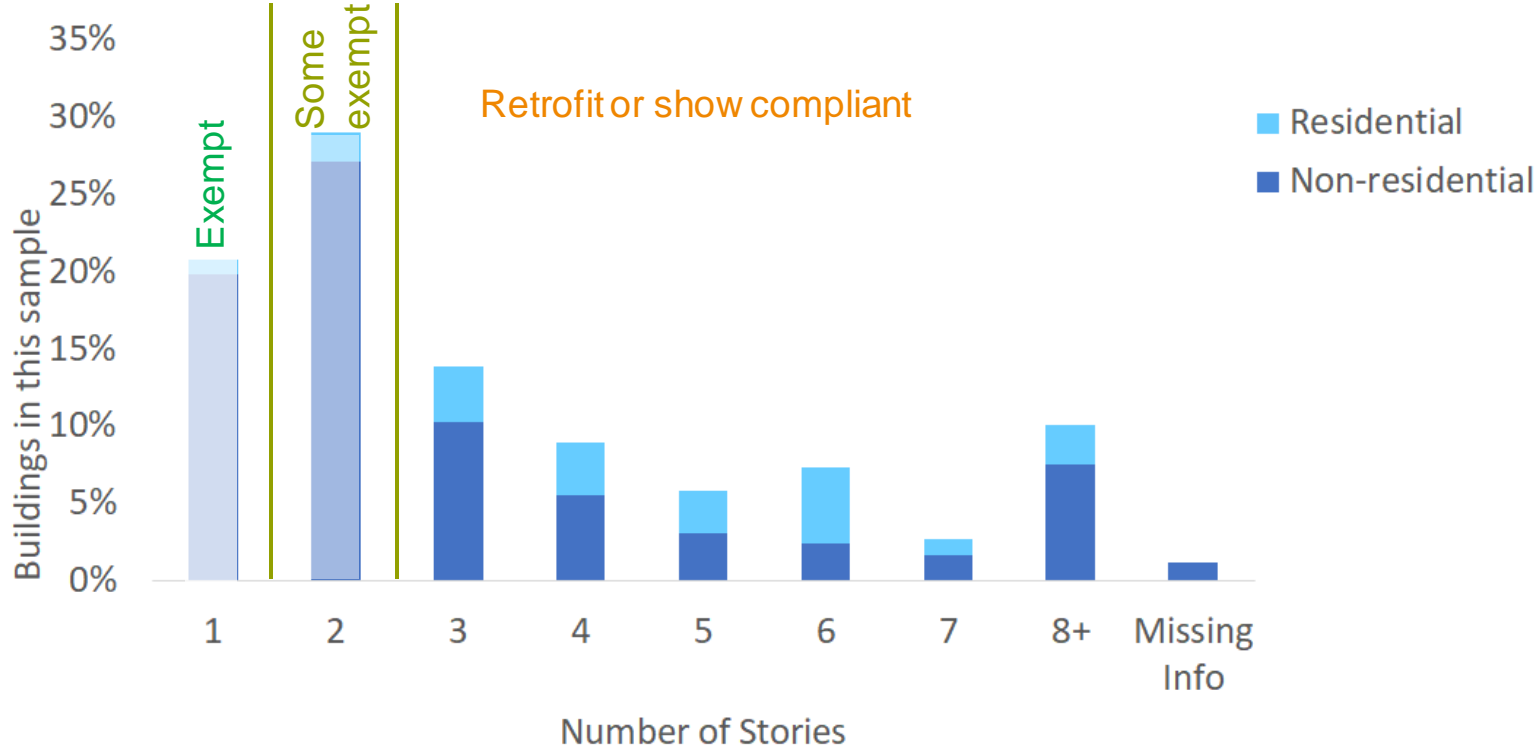


Concrete buildings included in Los Angeles program



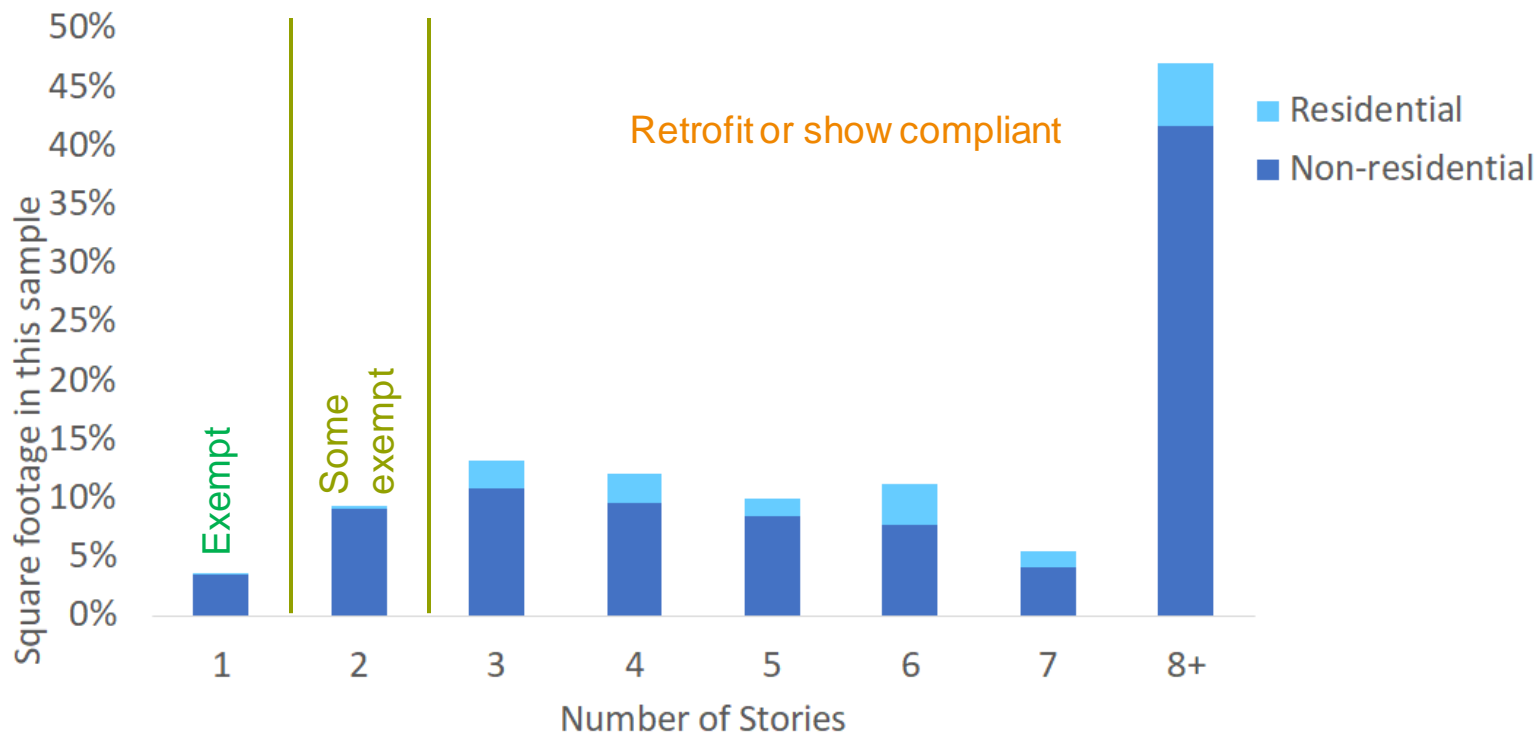
From Concrete database (work in progress)

Buildings in the Concrete Database by Height and Use Type



From Concrete database (work in progress)

Floor area in the Concrete Database by Height and Use Type



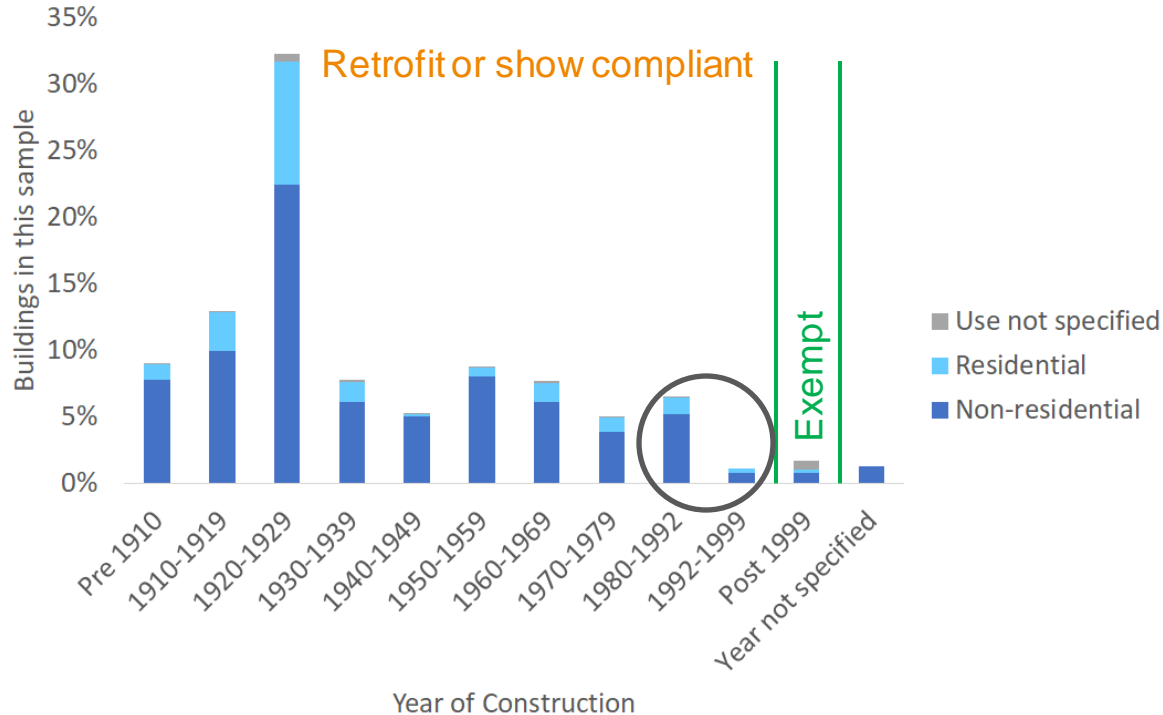
Reasons to include buildings up to 1997 UBC

- Consistency with the “Benchmark Year” in ASCE 41. Prior codes did not adequately address “gravity” framing.
- Post 1980 buildings collapsed in Northridge and New Zealand.
- Not that many added buildings in SF.



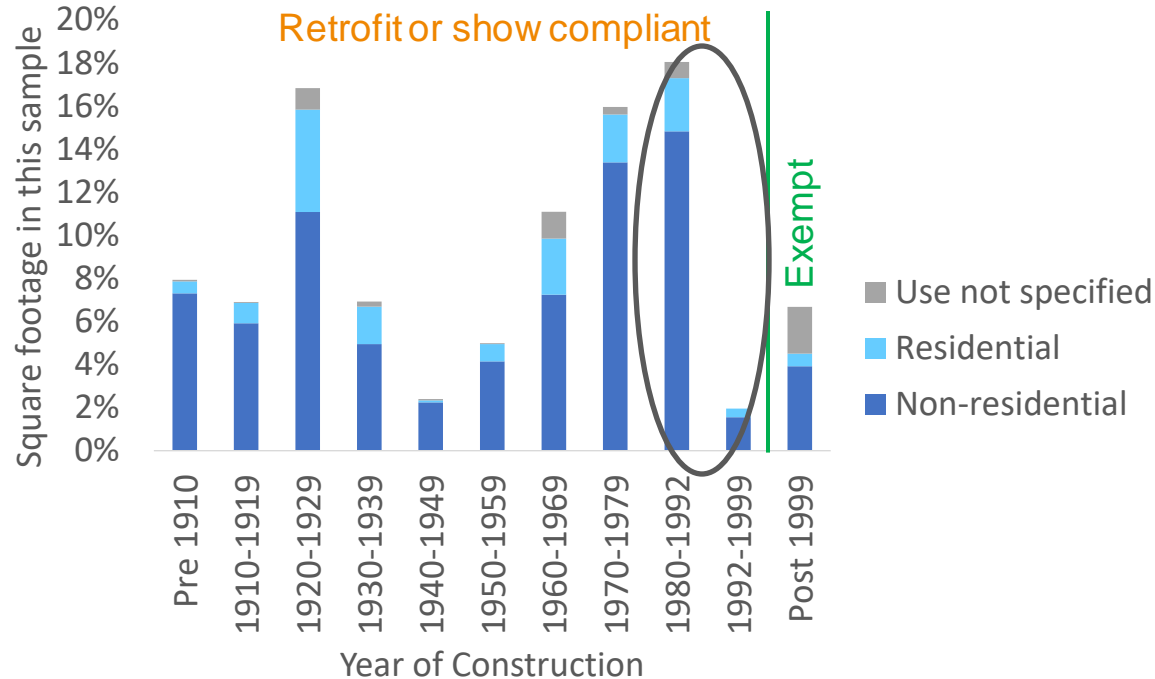
From Concrete database (work in progress)

Buildings in the Concrete Database by Year of Construction
(greater than 1 story)



From Concrete database (work in progress)

Floor area in the Concrete Database by Year of Construction (greater than 1 story)





Discussion

Discussion Questions

What questions or reactions do you have about the City's draft proposal?

What are we missing with this proposal?

What are the potential blind spots?



Concrete retrofit scope and level

Example criteria for compliance

Requirements	Relative level	Exemption from future ordinances* <i>(Example of potential incentive)</i>
Minimum requirement: Collapse Prevention in 475-year earthquake motions	Approximately 70% of new building standard	15 years
Voluntary higher standard: Collapse Prevention at the BSE-2E level (BSE-2E = 975-year motions in San Francisco.)	Approximately 90% of new building standard	35 years
* Measured from the operative date of the new SFEBBC chapter created by the ordinance.		

Exemption from future ordinances—prior examples

Soft story

Requirements	Exemption from future ordinances
Retrofit structure or show compliant.	15 years

Private school

Requirements	Exemption from future ordinances
Voluntary retrofit of structural and nonstructural components.	20 years



Discussion

Discussion Questions

What questions or reactions do you have about the City's draft proposal?

What are we missing with this proposal?

What are the potential blind spots?

Discussion Question (time permitting)

What might incentivize a building owner to retrofit to a higher level (or sooner)?



Wrap Up & Next Steps

Road map for the next few meetings

Meeting 4 <i>February</i>	Meeting 5 <i>April</i>	Meeting 6 <i>June</i>	Meeting 7 <i>August</i>	Meeting 8 <i>October</i>
Non-ductile and Tilt-up: <ul style="list-style-type: none">What is the timeline? Tilt-up: <ul style="list-style-type: none">Share updated program proposal	Topic to be determined: <ul style="list-style-type: none">(see next slide)	Non-Ductile: <ul style="list-style-type: none">Share updated program proposal Non-ductile and Tilt-up: <ul style="list-style-type: none">Share timeline proposal	Topic to be determined: <ul style="list-style-type: none">(see next slide)	Final Meeting: <ul style="list-style-type: none">Finalize Recommendations to executive panel

Follow-up survey: Help us have these important conversations

Let us know on which topics you can offer resources, case studies and expertise:

- Communications with building owners and tenants
- Financing information and resources for building owners
- Temporary tenant relocation
- Process streamlining (for example, permitting and design review)
- Labor and building trades
- Historic preservation requirements