City of West Hollywood Community Meeting

Presented by
Daniel Zepeda, SE
Jeff Roi, SE

Date: November 29, 2016

Non-Ductile Concrete

1971 SYLMAR EARTHQUAKE

http://www.photolib.noaa.gov/htmls/cgs02103.htm

Non-Ductile Concrete

1985 MEXICO CITY EARTHQUAKE

http://www.gettyimages.it/evento/years-since-the-mexico-city-earthquake-572224691#toppled-by-one-of-the-deadliest-earthquakes-of-the-century-mexico-picture-id107295750

Non-Ductile Concrete

1989 LOMA PRIETA EARTHQUAKE

https://en.wikipedia.org/wiki/1989_Loma_Prieta_earthquake

Non-Ductile Concrete

1994 NORTHRIDGE EARTHQUAKE

http://sfvmedia.com/sfv/ventura-blvd-buildings-earthquake-risk/#lightbox/0/

Non-Ductile Concrete

1995 KOBE EARTHQUAKE

http://www.ngdc.noaa.gov/hazardimages/event/show/19

Non-Ductile Concrete

1999 CHI-CHI EARTHQUAKE

https://www.youtube.com/watch?v=8cqQJCmcLWQ

Non-Ductile Concrete

2003 BINGOL TURKEY EARTHQUAKE

http://hutpedia.blogspot.com/2011/10/earthquake-72-magnitude-hits-turkey.html

Non-Ductile Concrete

2005 PAKISTAN EARTHQUAKE

http://www.nydailynews.com/news/world/quake-terrorizes-pakistan-india-afghanistan-2005-article-1.2369675

Non-Ductile Concrete

2010 HAITI EARTHQUAKE

https://www.wired.com/2010/02/earthquake-proofing-haiti/

Non-Ductile Concrete

2011 CHRISTCHURCH NEW ZEALAND EARTHQUAKE

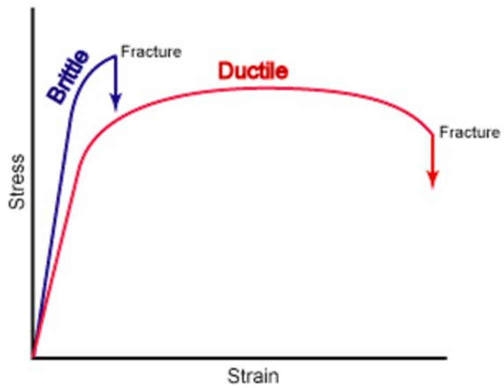
http://www.stuff.co.nz/the-press/news/christchurch-earthquake-2011/66404258/Christchurch-quake-survivors-lives-irrevocably-changed

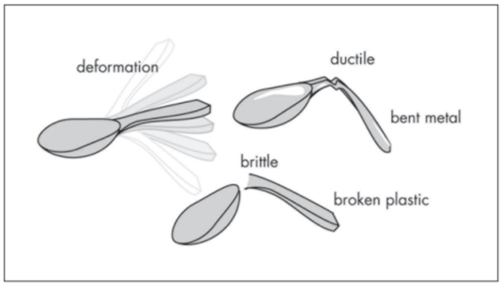
Non-Ductile Concrete

2016 TAIWAN EARTHQUAKE

https://sputniknews.com/asia/201602101034481762-taiwan-arrests-developers-earthquake/

Ductility vs Strength



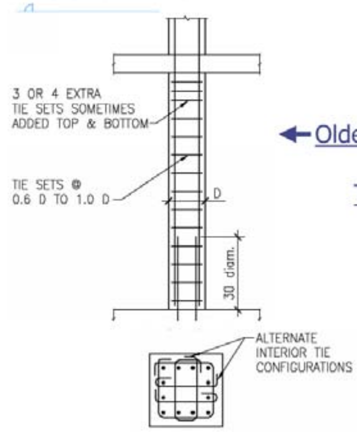


http://ficientdesign.com/wp-content/uploads/2010/06/Brittle-Ductile-Stress-Strain.gif
https://www.fema.gov/media-library-data/20130726-1556-20490-5679/fema454_complete.pdf

Non-Ductile Concrete

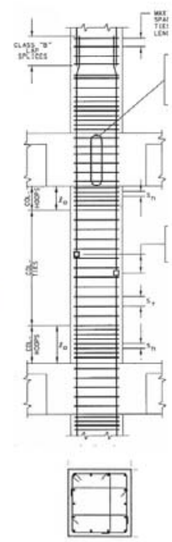
Non-Ductile Concrete

Columns



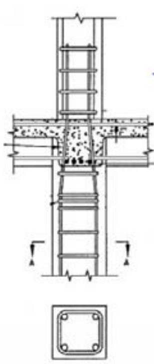
← Older

Today →



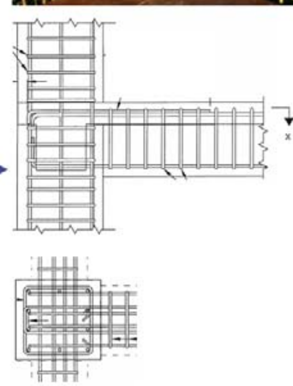
Non-Ductile Concrete

Beam-column connections



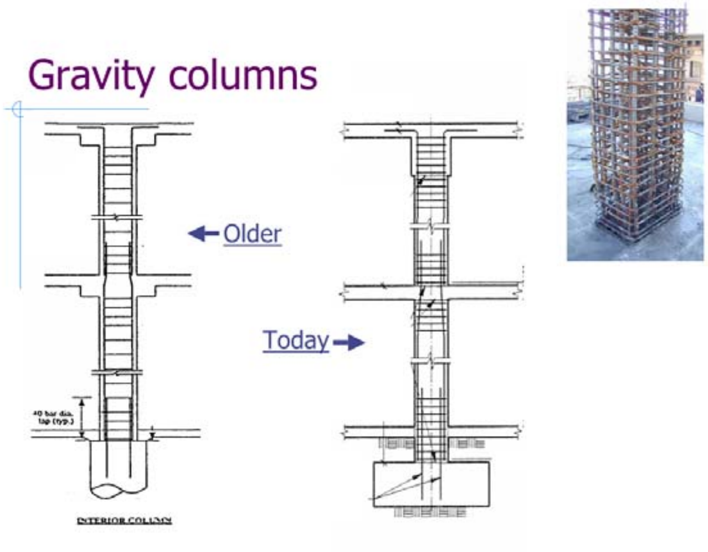
← Older

Today →



Non-Ductile Concrete

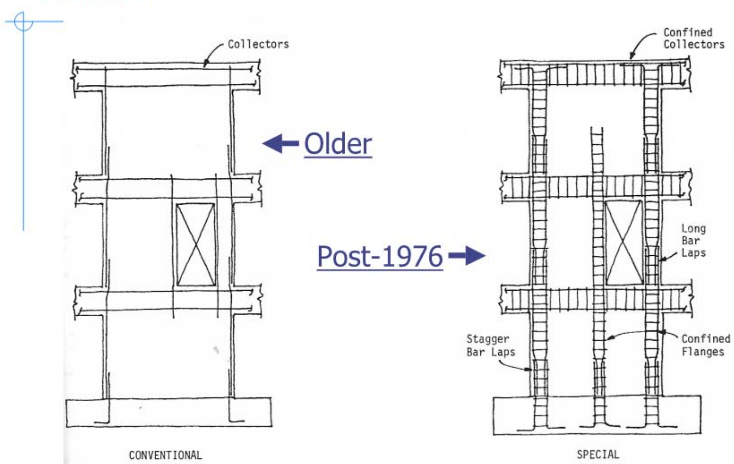
Gravity columns



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

Non-Ductile Concrete

Walls

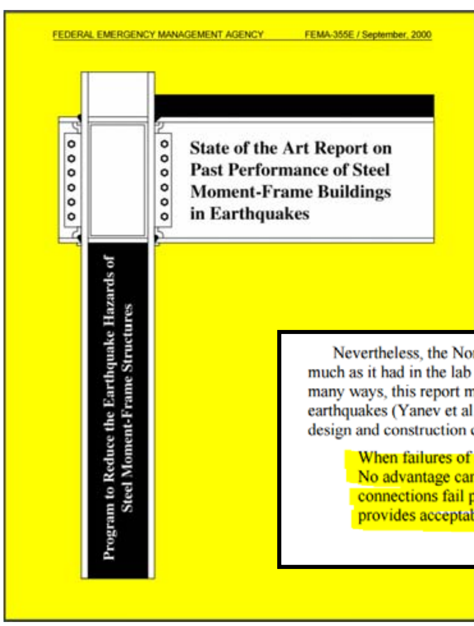


EERI / PEER Historic Overview Presentation by Jack Moehle, UC Berkeley

Pre-Northridge Steel Moment Frames

1994 NORTHRIDGE EARTHQUAKE

Pre-Northridge Steel Moment Frames



Nevertheless, the Northridge earthquake exposed a faulty detail that performed in the field much as it had in the lab for twenty years. Most of the connections survived. Too many failed. In many ways, this report merely updates a 1991 study of the past performance of steel structures in earthquakes (Yanev et al., 1991). That report captured the pre-Northridge thinking of the entire design and construction community—both the right and wrong of it—in a single short paragraph:

> When failures of steel structures occur, connection failures are the most common cause. No advantage can be derived from the strength and ductility of a steel member if its connections fail prematurely. However, use of industry-standard details generally provides acceptable performance.

1994 NORTHRIDGE EARTHQUAKE

http://www.nehrp.gov/pdf/fema355e.pdf

Pre-Northridge Steel Moment Frames

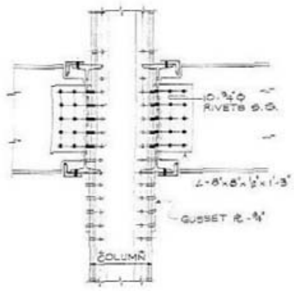


Figure 2-1 Riveted Beam-Column Connection, Pre-1920s

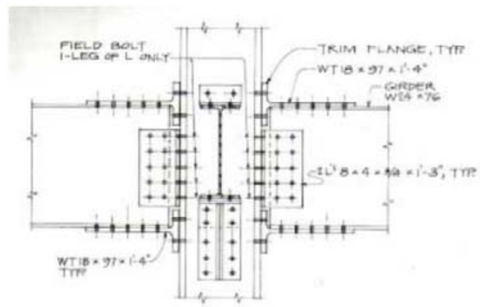


Figure 2-2 Bolted and Riveted Connection, 1930s

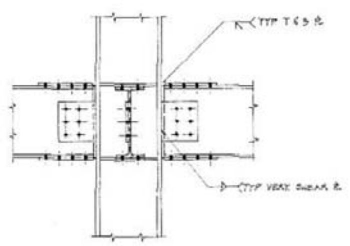


Figure 2-3 Welded and Bolted Moment Connection, 1950-1960

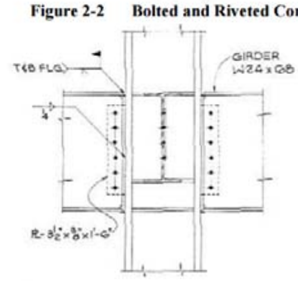


Figure 2-4 Welded Moment Connection, 1980s

1994 NORTHRIDGE EARTHQUAKE

http://www.nehrp.gov/pdf/fema355e.pdf

Pre-Northridge Steel Moment Frames

Table 5-2 Damage by Structure Type in Selected North American Earthquakes of the WSMF Era

Earthquake	Wood frame residential	Unreinforced Masonry	Precast Concrete	Concrete frame or wall	Steel frames
Prince William Sound, 1964	Excellent performance (Wood, 1967).	Not a common construction type in the area.	Typically slight to moderate damage, less than expected (Wood, 1967).	1-5 story: generally no significant structural damage, one partial collapse. Taller: considerable structural damage.	Inconclusive. Considerable structural damage, but only a few buildings had complete steel frames.
San Fernando, 1971	Majority of buildings under 20% loss. Most structural damage in foundation anchorage and open fronts.	Moderate or severe damage to half of brick buildings in downtown San Fernando.	Multiple tilt-up collapses.	Many collapses generally caused by poor ductility and irregularities.	No significant structural damage was observed in general. Cracked welds observed in two buildings under construction.
Mexico City, 1985	Not a common building type in the area.	Many URMs severely damaged. Wall-floor connections and out-of-plane failures.	Not a common construction type in the area.	7-15 story, frame and infill structures heavily damaged or collapsed. Similar low-rise structures perform better (Bertero and Miranda, 1989).	Some pre-1950 steel frames collapsed. Collapse of isolated braced frame buildings due to column failure. Little other moment frame damage reported.
Loma Prieta, 1989	Severe damage to wood structures with open fronts or tuck-under parking, especially on soft soils.	Many URMs severely damaged or collapsed. Wall-floor connections and out-of-plane failures.	Many examples of connection damage although collapses were uncommon.	Nonductile frames and wall structures damaged, including fatal freeway collapse. Newer structures generally performed well.	Five buildings known to have slight to significant weld damage, some discovered only upon post-Northridge inspection.
Northridge, 1994	Severe damage to multi-story wood structures with tuck-under parking.	Many URMs damaged but many collapses avoided by previous retrofits.	Many examples of connection damage and several significant collapses.	Older structures damaged, including freeways. Newer structures generally performed well. Deflection compatibility issues noted.	Widespread, unexpected connection damage, several buildings declared unsafe, at least one irreparable. No collapses.

Note: See Table 5-1 for additional information and refe

inspection.
Widespread, unexpected connection damage, several buildings declared unsafe, at least one irreparable. No collapses.

1994 NORTHRIDGE EARTHQUAKE

http://www.nehrp.gov/pdf/fema355e.pdf

Pre-Northridge Steel Moment Frames

ABOUT 60% OF INSPECTED BUILDINGS
HAD SOME LEVEL OF DAMAGE

Table 6-2 Number of WSMF Buildings with Various Northridge Earthquake Damage Rates

	1 story	2-4 story	5-12 story	13+ story	All
All buildings	13	69	47	26	155
No damage	11	26	16	12	65
0 < DR ≤.05	0	7	6	5	18
.051 < DR ≤ .10	0	10	8	1	19
.11 < DR ≤ .20	0	12	11	6	29
.21 < DR ≤ .50	2	13	4	2	21
DR > .50	0	1	2	0	3
Shear damage	0	9	10	4	23
Panel zone damage	1	16	8	4	29

1994 NORTHRIDGE EARTHQUAKE

http://www.nehrp.gov/pdf/fema355e.pdf

Pre-Northridge Steel Moment Frames

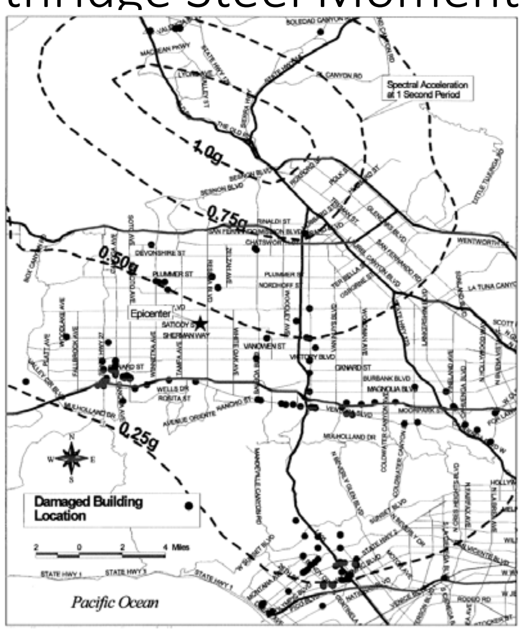


Figure B-4 Spatial Distribution of Damaged Buildings

1994 NORTHRIDGE EARTHQUAKE

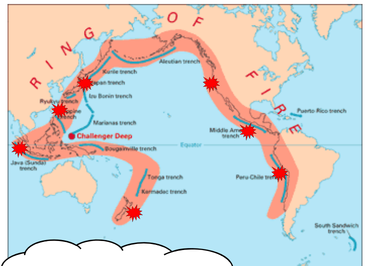
http://www.nehrp.gov/pdf/fema355e.pdf

3/11/2011 M 9.1 Tohoku Japan (2016 M7.0)

8/24/14 M 6.0 NAPA, USA

11/07/2012 M 7.4 Guatemala and Mexico

12/26/2004 M 9.1 Sumatra, Indonesia (2005 M8.6, 2007 M7.9, 2007 M8.4, 2010 M7.9)



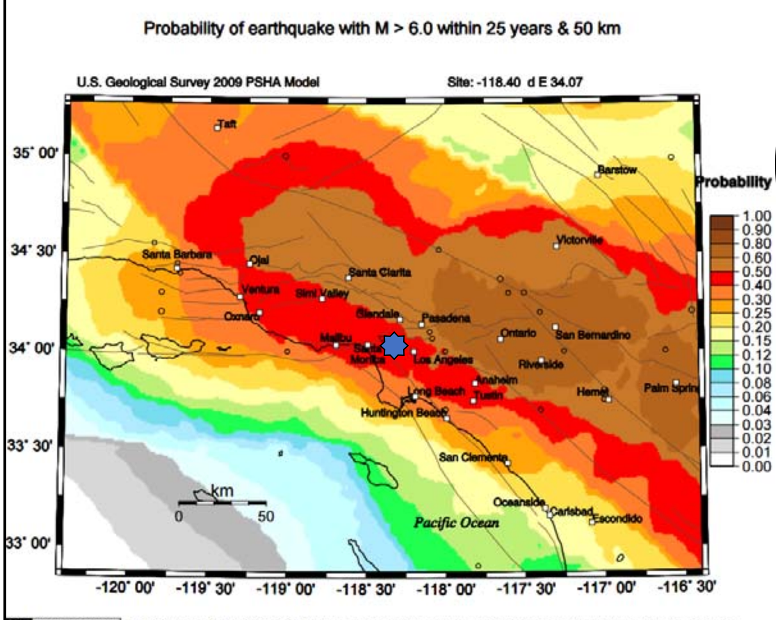
2/27/2010 M 8.8 Maule, Chile (2014 M8.1)

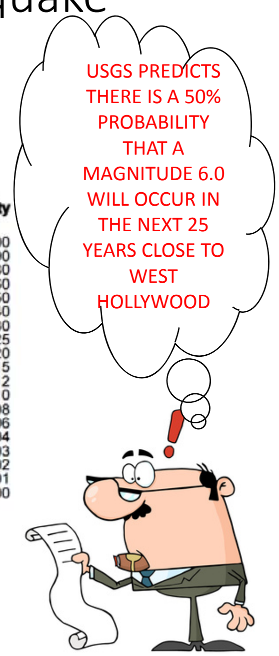
2/6/2016 M 6.4 Meining, Taiwan (2016 M)

https://www.usgs.gov/

2/22/2011 M 6.3 Christchurch, New Zealand (2013 M6.6)

Probability of Next Earthquake

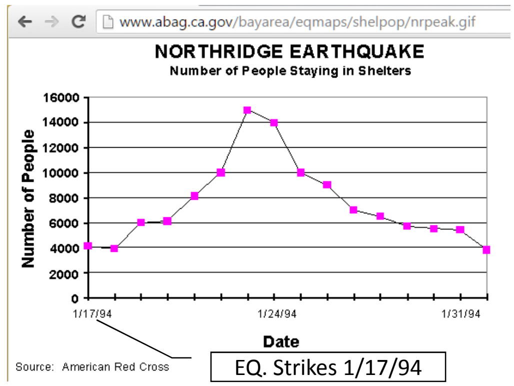


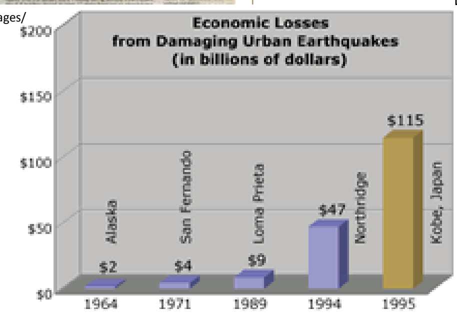


https://www.usgs.gov/

Why does it matter?

http://graphics.latimes.com/northridge-pages/





http://pubs.usgs.gov/fs/fs-046-03/fs-046-03.html

Why does it matter?

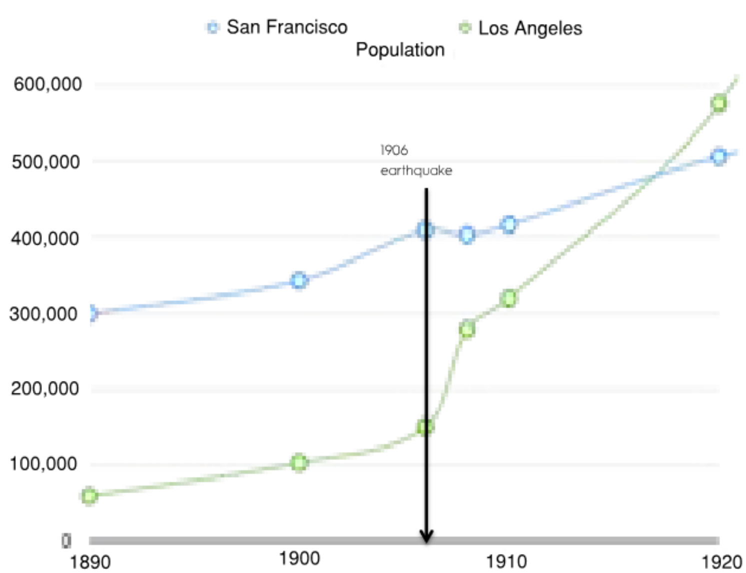


Figure 1-4. The population of the Cities of San Francisco and Los Angeles (U.S. Census Data). The population of Los Angles grew fivefold in the decade after the 1906 earthquake struck San Francisco.

https://d3n8a8pro7vhmx.cloudfront.net/mayorofla/pages/16797/attachments/original/1420504740/Resilience_by_Design_Full_Report_Dec_11_FINAL.pdf?1420504740

California Code Requirements

Additions

3403.4 Existing structural elements carrying lateral load. Where the addition is structurally independent of the existing structure, existing lateral load-carrying structural elements shall be permitted to remain unaltered. Where the addition is not structurally independent of the existing structure, the existing structure and its addition acting together as a single structure shall be shown to meet the requirements of Sections 1609 and 1613.

Exception: Any existing lateral load-carrying structural element whose demand-capacity ratio with the addition considered is no more than 10 percent greater than its demand-capacity ratio with the addition ignored shall be permitted to remain unaltered. For purposes of calculating demand-capacity ratios, the demand shall consider applicable load combinations with design lateral loads or forces in accordance with Sections 1609 and 1613. For purposes of this exception, comparisons of demand-capacity ratios and calculation of design lateral loads, forces and capacities shall account for the cumulative effects of additions and alterations since original construction.

Alterations

3404.4 Existing structural elements carrying lateral load. Except as permitted by Section 3404.5, where the alteration increases design lateral loads in accordance with Section 1609 or 1613, or where the alteration results in a structural irregularity as defined in ASCE 7, or where the alteration decreases the capacity of any existing lateral load-carrying structural element, the structure of the altered building or structure shall be shown to meet the requirements of Sections 1609 and 1613.

Exception: Any existing lateral load-carrying structural element whose demand-capacity ratio with the alteration considered is no more than 10 percent greater than its demand-capacity ratio with the alteration ignored shall be permitted to remain unaltered. For purposes of calculating demand-capacity ratios, the demand shall consider applicable load combinations with design lateral loads or forces per Sections 1609 and 1613. For purposes of this exception, comparisons of demand-capacity ratios and calculation of design lateral loads, forces, and capacities shall account for the cumulative effects of additions and alterations since original construction.

UPGRADES ARE ONLY REQUIRED WHEN SIGNIFICANT CHANGES ARE MADE TO STRUCTURE

Repairs

3405.2 Substantial structural damage to vertical elements of the lateral force-resisting system. A building that has sustained substantial structural damage to the vertical elements of its lateral force-resisting system shall be evaluated and repaired in accordance with the applicable provisions of Sections 3405.2.1 through 3405.2.3.

Exceptions:

1. Buildings assigned to Seismic Design Category A, B, or C whose substantial structural damage was not caused by earthquake need not be evaluated or rehabilitated for load combinations that include earthquake effects.
2. One- and two-family dwellings need not be evaluated or rehabilitated for load combinations that include earthquake effects.

3405.2.1 Evaluation. The building shall be evaluated by a registered design professional, and the evaluation findings shall be submitted to the building official. The evaluation shall establish whether the damaged building, if repaired to its pre-damage state, would comply with the provisions of this code for wind and earthquake loads.

Wind loads for this evaluation shall be those prescribed in Section 1609. Earthquake loads for this evaluation, if required, shall be permitted to be 75 percent of those prescribed in Section 1613.

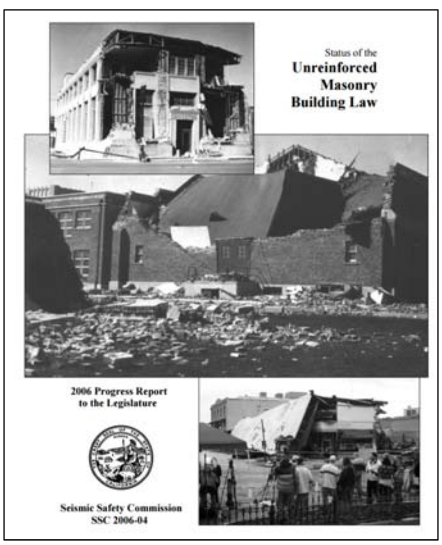
Change in Occupancy

3408.4 Seismic. When a change of occupancy results in a structure being reclassified to a higher risk category, the structure shall conform to the seismic requirements for a new structure of the higher risk category.

Exceptions:

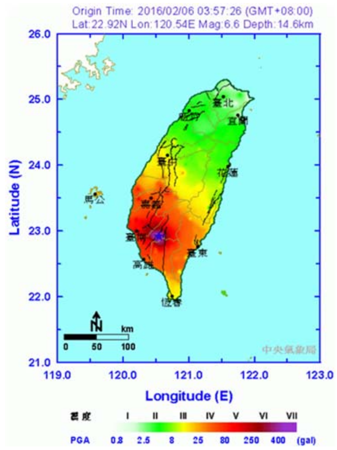
1. Specific seismic detailing requirements of Section 1613 for a new structure shall not be required to be met where the seismic performance is shown to be equivalent to that of a new structure. A demonstration of equivalence shall consider the regularity, overstrength, redundancy and ductility of the structure.
2. When a change of use results in a structure being reclassified from Risk Category I or II to Risk Category III and the structure is located where the seismic coefficient, S_{DS}, is less than 0.33, compliance with the seismic requirements of Section 1613 are not required.

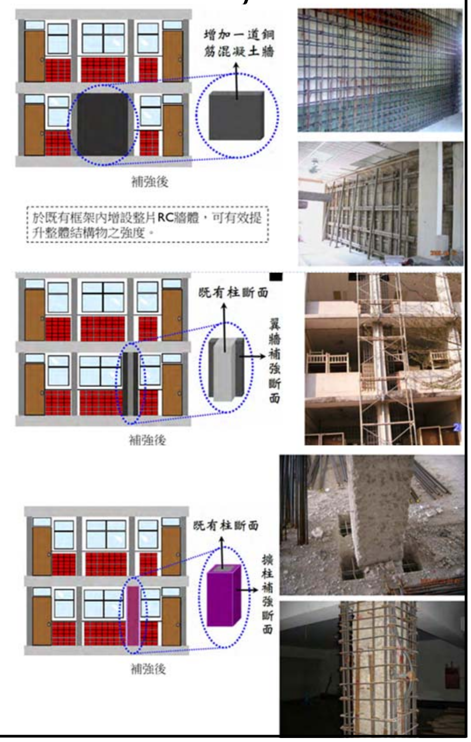
URM Retrofit Ordinance



http://www.seismic.ca.gov/pub/CSSC%202006%20URM%20Report%20Final.pdf

Seismic Programs Case Study





__School Building Seismic Program:__

- 334 "Safe" Buildings: 1 Damaged
- 75 "Unsafe" Buildings: 18 Damaged

Images provided by Justin C.H. Shih Structural Engineer & Associates 施忠賢

Retrofit Strategies

DUCTILITY

Retrofit Strategies

STRENGTH

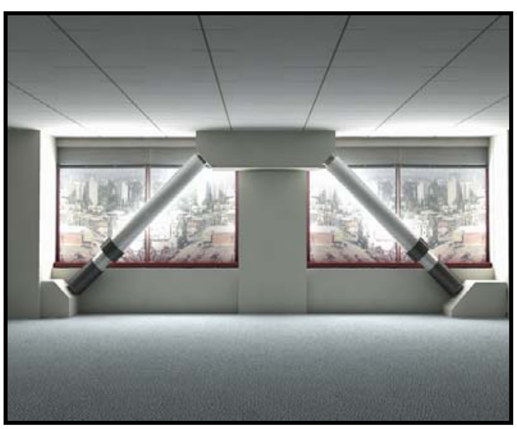
Retrofit Strategies

STRENGTH

Retrofit Strategies

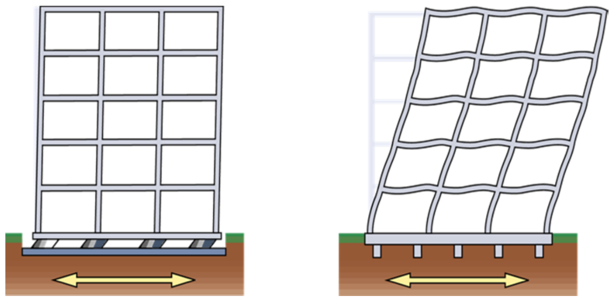
DUCTILITY

Retrofit Strategies



DAMPING

Retrofit Strategies



Movement is concentrated at isolation level in seismic isolation bearings. Ideally, building above moves a rigid body with little amplification of deformations and accelerations up the height.

Buildings respond to earthquake shaking by deforming beams, columns, braces, walls. Sometimes these deformations cause damage/fracture and displacement can be permanent

ISOLATION

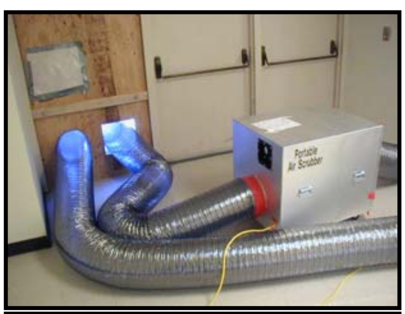
Other Considerations

FOUNDATIONS

Other Considerations

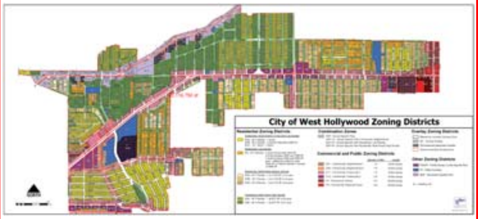
COLLECTORS/CONNECTIONS

Other Considerations

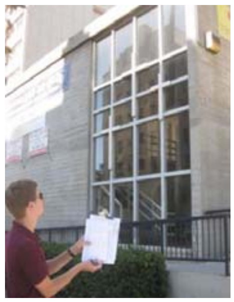


USERS

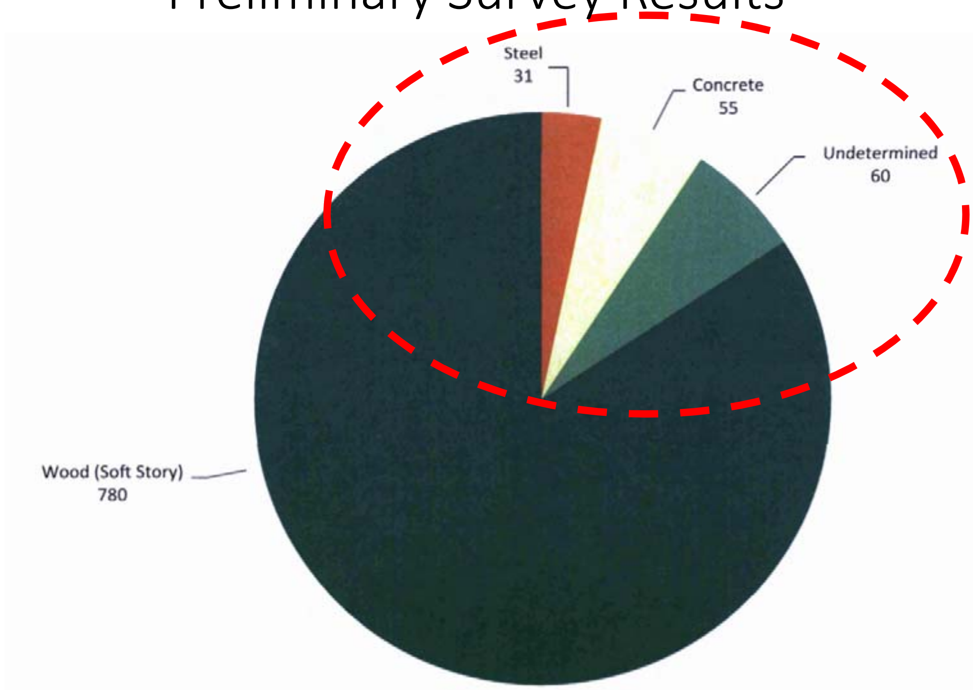
City of West Hollywood
Seismic Retrofit Program Process



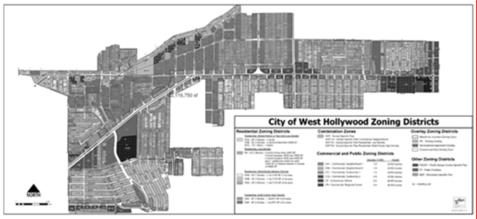
SITE SURVEY & RECORD RESEARCH → POLICIES → IMPLEMENT



Preliminary Survey Results



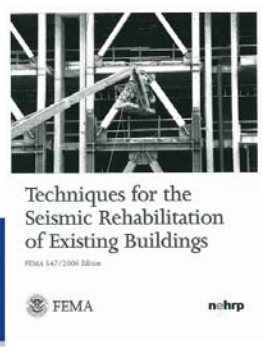
City of West Hollywood
Seismic Retrofit Program Process

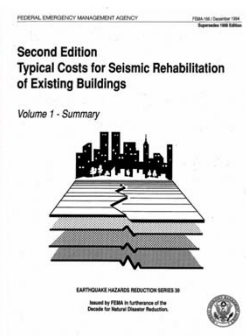



SITE SURVEY & RECORD RESEARCH → POLICIES → IMPLEMENT



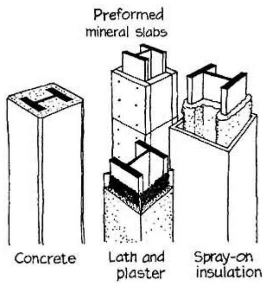

Policy Considerations





STRUCTURAL ENGINEERS ASSOCIATION
SEA
SOUTHERN CALIFORNIA

Non- Ductile Concrete Scope



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.

Pre-Northridge Steel MF Scope

13.40.020 Scope.

The provisions of this Chapter shall apply to any building utilizing a Steel Moment Frames that are determined by the Building Official to have been built under building code standards enacted before December 1995.

This Chapter shall not apply to the following structure types:

1. Unreinforced Masonry Buildings previously strengthened with Steel Moment Frames
2. Residential Wood-Framed Buildings utilizing Steel Moment Frames.

Notwithstanding any provision of the Building Code, compliance with this Chapter shall not require existing electrical, plumbing, mechanical or fire-safety systems to be altered to comply with the current Building Code unless they constitute a hazard to life or property as determined by the Building Official.

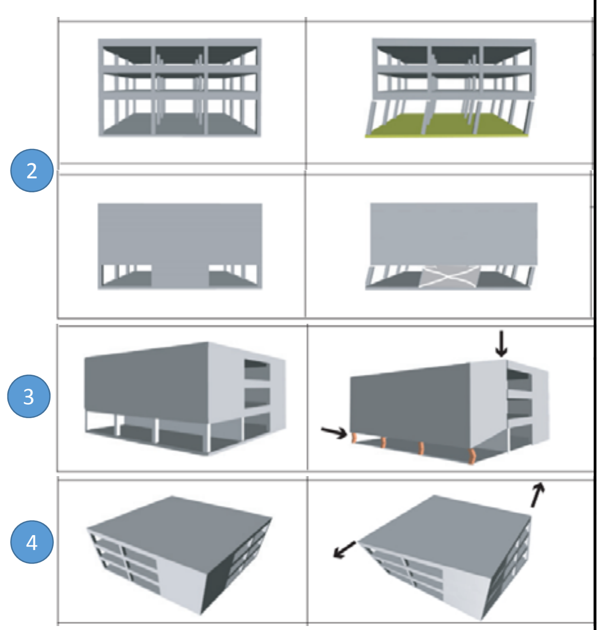
Proposed Policy

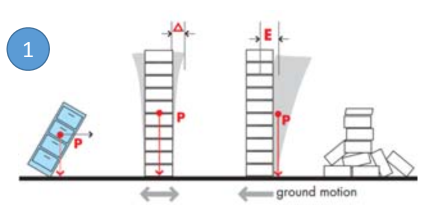
Policy Items	Los Angeles	West Hollywood
Voluntary or Mandatory Retrofit	Mandatory	**Mandatory**
Timelines	25 Years for Full Retrofit of 1,500 Bldgs	**10 Years for Major Deficiency Retrofit and 10 Additional Years for Full Retrofit of ~146 Bldgs.**
Priority Tiers	3 Tiers	**3 Tiers**
Incentives and Facilitation Programs	Financial programs are being explored	**Financial programs are being explored**
Architectural Improvements	Waived with exception of ADA	**Waived with exception of ADA**
MEP Improvements	Waived	**Waived**

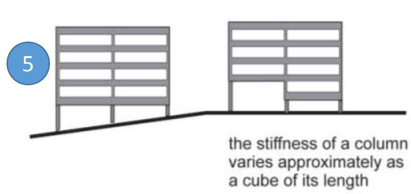
Major Deficiencies

Major Deficiencies:

1. Load Path
2. Weak or Soft Story
3. Vertical Irregularity
4. Torsion
5. Captive Column

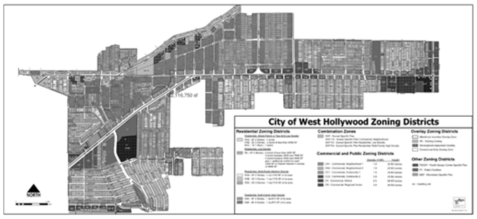




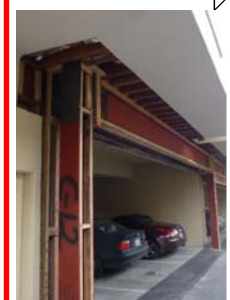


https://www.fema.gov/media-library-data/20130726-1556-20490-5679/fema454_complete.pdf

City of West Hollywood
Seismic Retrofit Program



SITE SURVEY & RECORD RESEARCH → POLICIES → IMPLEMENT



Implementation

NOTIFICATION → SCREENING → RETROFIT DESIGN → RETROFIT CONST. → CLOSE OUT

Summary

TABLE A

TIME PERIOD FOR COMPLIANCE

	Phase 1: Engineering Report & Major Deficiency Mitigation[a, b]				Phase 2: Complete Retrofit[d]		
Phase	Submit Engineering Report & Determine All Structural Deficiencies	Submit Retrofit Plans for Major Deficiency Mitigation	Obtain Building Permit & Commence Construction	Complete Major Deficiency Mitigation Construction[c]	Submit Retrofit Plans	Obtain Building Permit & Commence Construction	Complete Construction
Milestone	3 Years from notice to the Owner	5 Years from notice to the Owner	7 Years from notice to the Owner	10 Years from notice to the Owner	13 Years from notice to the Owner	15 Years from notice to the Owner	20 Years from notice to the Owner

a. All buildings within the scope of this Chapter are required to submit an engineering report & determine all structural deficiencies. Buildings that do not contain any of the Major Deficiencies as defined in this Chapter are not required to submit Retrofit plans for Major Deficiency mitigation, commence construction, and complete construction in Phase 1, but shall provide Retrofit plans and complete construction within the time limits provided in Phase 2.

b. Phase 1 Retrofit plans must indicate preliminary Phase 2 Retrofit extents. Minimum Phase 2 scoping requirements shall be as specified by the Building Official.

c. Completion of Phase 1 may be extended by 3 years if Retrofit plans in accordance with the scope of Phase 2 are designed, approved, permitted and constructed within Phase 1.

d. The Building Code version governing Phase 1 shall be permitted to be utilized in Phase 2.

TABLE B

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

Let's Talk about it

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