Technical Considerations for the DPD URM Policy

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by

Michael A. Wright, SE

Peter Somers, SE

SEAW Existing Buildings Committee

Technical Considerations for URM

- URM definition (what bldgs to include)
- Structural elements to be considered
- Seismic hazard level
- Site class effects (difference from previous codes)
- Grandfathering prior retrofits

URM – Proposed Bearing Wall Building Definition

These buildings have perimeter bearing walls that consist of unreinforced clay brick, stone, hollow clay tile or concrete masonry. Interior bearing walls, where present, also consist of unreinforced clay brick, stone, hollow clay tile or concrete masonry. The masonry walls provide the vertical support for the reaction of floor or roof-framing members. The masonry walls rely on the tensile strength of the masonry units, mortar, and grout in resisting design loads, and in which the area of reinforcement is less than 25 percent of the minimum ratio required by the building code for reinforced masonry.

the underlined portions may lead to inclusion of building types not intended by the policy committee

URM Bearing Wall Building Example

Traditional URM Building - -Pioneer Square

URM Bearing Wall Building Example

Traditional Commercial URM Building -- Capital Hill

URM Bearing Wall Building Example

Traditional Residential URM Building -- First Hill

Not URM Bearing Wall Building Example

Wood Frame Structure with Masonry Veneer

Not URM Bearing Wall Building Example

Concrete Frame Structure with Masonry Infill

Not URM Bearing Wall Building Example

Concrete Frame with Hollow Clay Tile Infill

Not URM Bearing Wall Building Example

Steel Frame with Masonry Infill

Under-Reinforced CMU Building Example

Commercial Building – Capital Hill

Under-Reinforced CMU Building Example

Typical Mid-20th Century School Building

Structural Elements of URMs

- High priority risk
  - Parapets
  - Wall Anchorage
  - Major load path deficiencies (open store fronts)
- Moderate priority risk
  - Slender walls
  - Weak or limited shear wall length
  - Straight-sheathed diaphragms
- Lower priority risk
  - Substantial, but still insufficient shear walls
  - Other diaphragms
  - Secondary support for gravity framing

Structural Elements

Common scoping table for URM elements (from 2006 IEBC, Appendix A1)

As the seismic hazard (S_{D1}) increases, more types of elements are considered potential risks to life safety.

S_{D1} depends on magnitude of seismic event, geographic location, and local soil type.

TABLE A1-A—ELEMENTS REGULATED BY THIS CHAPTER

BUILDING ELEMENTS	S_{D1}			
	≥ 0.067$_g$ < 0.133$_g$	≥ 0.133$_g$ < 0.20$_g$	≥ 0.20$_g$ < 0.30$_g$	> 0.30$_g$
Parapets	X	X	X	X
Walls, anchorage	X	X	X	X
Walls, *h/t* ratios		X	X	X
Walls, in-plane shear		X	X	X
Diaphragms[a]			X	X
Diaphragms, shear transfer[b]		X	X	X
Diaphragms, demand-capacity ratios[b]			X	X

a. Applies only to buildings designed according to the general procedures of Section A110.
b. Applies only to buildings designed according to the special procedures of Section A111.

Seismic Hazard

- Commonly expressed in terms of X% chance of being exceeded in Y years
- 2%/50yr (2500 year event)
  - 2/3 of this hazard used for new buildings
  - Generally not used for existing buildings
  - Captures risk of Seattle Fault and all others
- 10%/50yr (500 year event)
  - Typical for existing buildings
  - Used for Substantial Alteration
  - Captures risk of Cascadia Subduction Zone event but not Seattle Fault
- 50%/50yr (72 year event)
  - Roughly comparable to the Nisqually EQ level
  - Approx 40 percent of the 10%/50yr event shaking
  - Typical “frequent” deep crustal fault (2001, 1965, 1949)

Possible Upgrade Scenarios

- Bolts Plus
  - Addresses wall anchorage and parapets
  - Typically would not catch open storefront deficiency
- Full Upgrade
  - Addresses all deficiencies
  - Similar in scope to req’ts for Substantial Alteration
- Limit scope of elements considered
- Reduce seismic hazard for all elements

Upgrade Standards

- ASCE 31-03 “Seismic Evaluation of Existing Buildings”, Special Procedure for Unreinforced Masonry
- 2006 IEBC Appendix A1, “Seismic Strengthening Provisions for Unreinforced Bearing Wall Buildings”
- Both are generally similar to the UCBC and local building codes used in CA for URM retrofit ordinances and voluntary upgrades
- Both are full scope documents but could be used for reduced scope or reduced hazard

Previous Upgrade Standards

- FEMA 178 Appendix C, 1992
  - Av = 0.3 (later) or Av = 0.2 (earlier)
- UBC and other hybrid or rational approaches
  - Common prior to 1990's, but rarely used afterward

Comparison Among URM Standards

- Following three slides compare possible standards for the URM policy and for grandfathering prior retrofits
- Comparisons normalized to ASCE 31 for 10%/50yr event (typical design basis for Substantial Alteration).
- IEBC Appendix A1 is generally similar
- Comparisons for three soil types common in Seattle (C, D, and E)
- Comparisons for three typical URM elements (wall anchorage, shear walls, and diaphragms)
- Comparisons to FEMA 178 (Av=0.2 and Av=0.3) and the San Francisco URM ordinance.

Wall Anchorage Comparison

Normalized to ASCE 31, 10%/50yr hazard

Standard	Site Class		
	C (firm)	D (med)	E (soft)
FEMA 178, Av=0.2	0.6	0.5	0.3
FEMA 178, Av=0.3	1.0	0.8	0.5
ASCE 31, 50/50	0.4	0.4	0.4
SF URM	0.8	0.7	0.5

Shear Wall Comparison

Normalized to ASCE 31, 10%/50yr hazard

Standard	Site Class		
	C (firm)	D (med)	E (soft)
FEMA 178, Av=0.2	0.6	0.5	0.3
FEMA 178, Av=0.3	0.9	0.7	0.4
ASCE 31, 50/50	0.4	0.4	0.4
SF URM	1.3	1.1	0.6

Diaphragm Comparison

Normalized to ASCE 31, 10%/50yr hazard

Standard	Site Class		
	C (firm)	D (med)	E (soft)
FEMA 178, Av=0.2	0.6	0.5	0.3
FEMA 178, Av=0.3	1.0	0.8	0.5
ASCE 31, 50/50	0.4	0.4	0.4
SF URM	1.3	1.0	0.6

Thoughts on Grandfathering

- Typical code philosophy is to give existing buildings a break compared to new buildings due to shorter life span.
- Also, typical to use a somewhat lower standard for evaluation, then if retrofitting is required the work is done to a slightly higher standard
- Therefore, could be acceptable to allow prior retrofits at a lower standard than ordinance standard. But, how much lower?
- Mandatory retrofit ordinance philosophy should focus on the worst of the worst. Any prior retrofit is generally much better than no retrofit. But, older retrofits could be much less than current standards.
- We want consistency:
  - Don't want grandfathered buildings too much worse than newly mandated building upgrades
  - Want to minimize expensive additional retrofits to prior retrofitted buildings
  - Don't want to have the retrofit standard for URM buildings too much higher than other potentially hazardous buildings not subject to the ordinance