Unreinforced Masonry Building Seismic Retrofit Policy



Jonna Papaefthimiou, PBEM | Amit Kumar, BDS | Shelly Haack, Prosper Portland

May 9, 2018

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KPFF Consulting Engineers

* Left committee before final meeting.

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David Bugni and Associates

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Mike Hagerty, P.E., S.E.
Structural Engineer

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Building Owners and Managers Association

Mike Hagerty, P.E., S.E.
Structural Engineer

Presentation Overview

- Risk Overview
- URM Building Inventory
- Policy Process
- Recommended Retrofit Standard and Financial Support
- Public Notification
- Resolution Summary

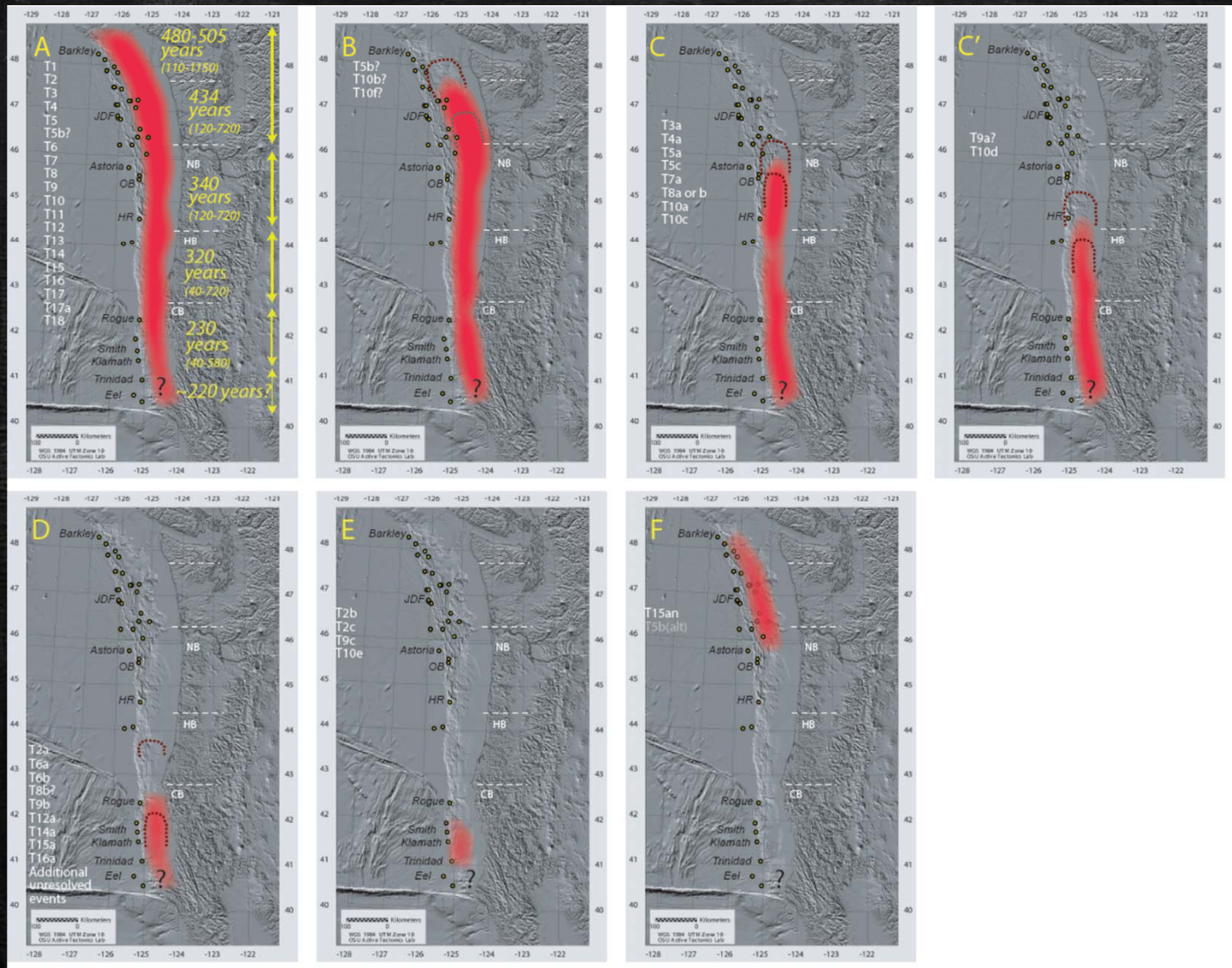
Cascadia Subduction Zone Risk to the City of Portland

Chris Goldfinger
College of Earth, Ocean and Atmospheric Sciences, Oregon State University
Active Tectonics Group, Ocean Admin Bldg 104, Corvallis OR 97333

The Basics

Cascadia risks come from three earthquake sources:

- 1) The subduction zone: "The Really Big One". Repeat time ~ 240 years. Evidence based on numerous land and marine sites with very good correspondence.
- 2) Subducted slab tension earthquakes, i.e. Nisqually 2001. M=~ 6-7, repeat time, a few decades in Washington, unknown in Oregon.
- 3) Crustal Faults, i.e. Portland Hills Fault, Oatfield Fault, 1962 Portland (~Vancouver) earthquake (fault unknown) etc. M= 4-7, repeat time probably several thousand years for each fault, but could be a few decades for aggregate of all nearby faults. Poorly known.



Cascadia earthquake rupture modes.

31 of the 47 earthquakes represented here reach the latitude of Portland. Many others (16) occur further south, and will be felt in Portland, but may or may not cause damage.

The Really Big One

- Cascadia has gone from unknown in 1985, to one of the best known faults in the world today. The basis for probability estimates is very strong.
- Probability for affectin PDX is ~ 22-26% in the next 50 years (2017 *Marine Geology* paper), similar to Japan in 2011. These values are the ***minimum***, and do not include the other two poorly known sources, or smaller (< M8) quakes offshore.
- Magnitudes are highly variable, ranging from M7.1-M 9.2. M9 earthquakes are the most powerful events on Earth, dwarfing the largest volcanic eruptions, hurricanes and nuclear tests. Presently however, there is no way to estimate magnitude of the *NEXT* earthquake.
- About half of the 46 earthquakes of the past 10,000 years are thought to be M 8.8 or greater, about half are smaller. About two thirds have reached the latitude of Portland.
- The last great Cascadia earthquake was 317 years ago, and the average repeat time for M7.5 or greater earthquakes is ~ 240 years.

What will it be like in Portland?

- For reference, the earthquake that destroyed San Francisco in 1906 was a M 7.9, at the low end for Cascadia. Much damage was also from fires which could not be put out. The comparison is not fair because the San Andreas is much closer to SF, only 1 mile. Portland is ~ 50 miles from the eastern end of the Cascadia rupture zone.
- The long duration and larger magnitude of Cascadia earthquakes makes up for the distance, and may shake Portland for up to 4 minutes. Ground motions could exceed 0.3 G, well beyond the ability of URM structures to stay together. These structures are designed only for gravity and wind loads typically, that is, to not fall over on their own or in a breeze.

URMs in Cascadia

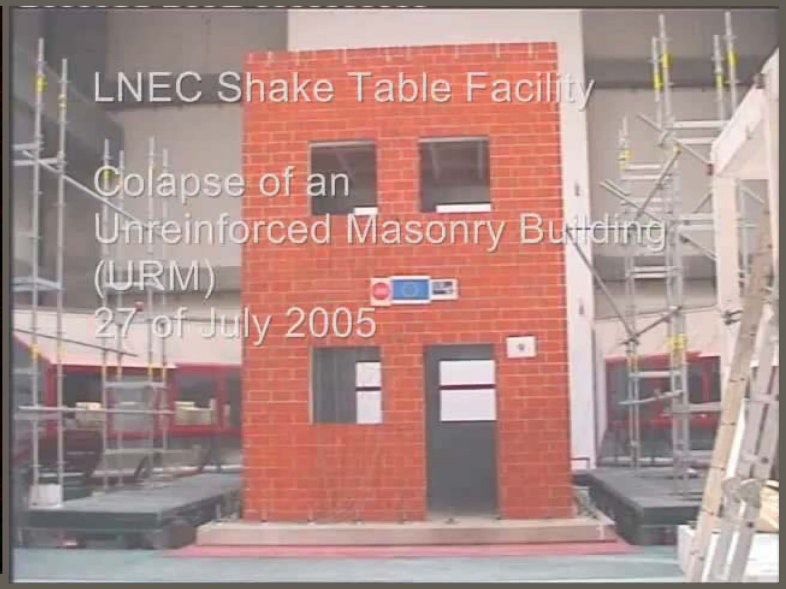
Kent Yu, PhD, S.E.

Principal

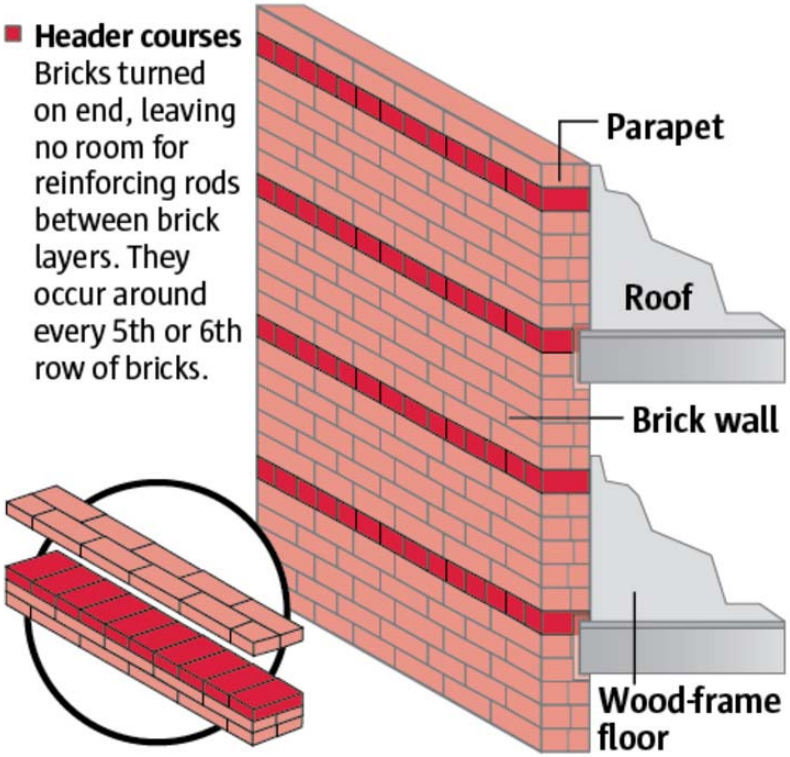
SEFT Consulting Group, Beaverton Oregon

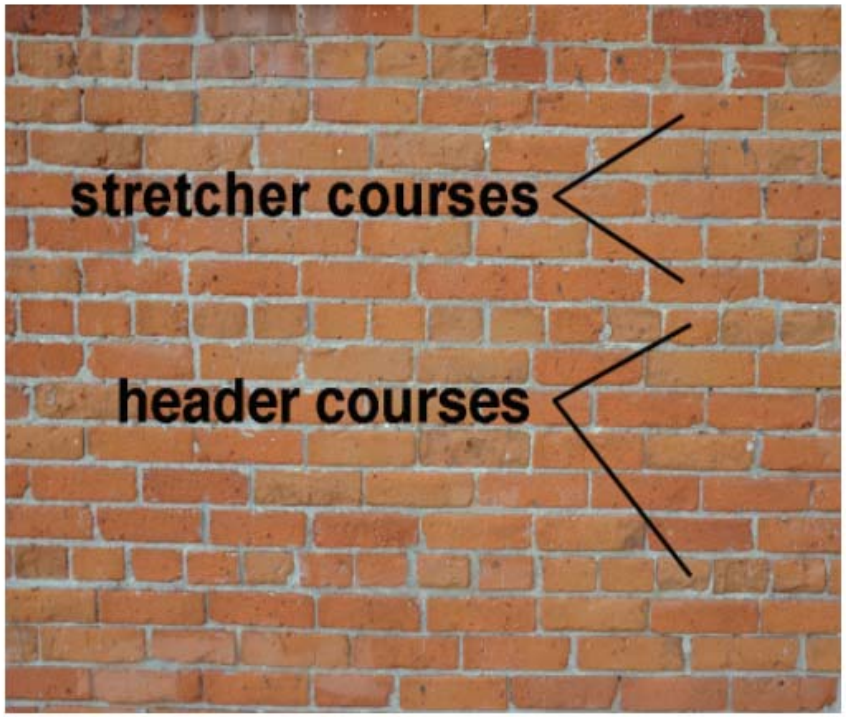
kentyu@seftconsulting.com

Wood Building vs. URM Building

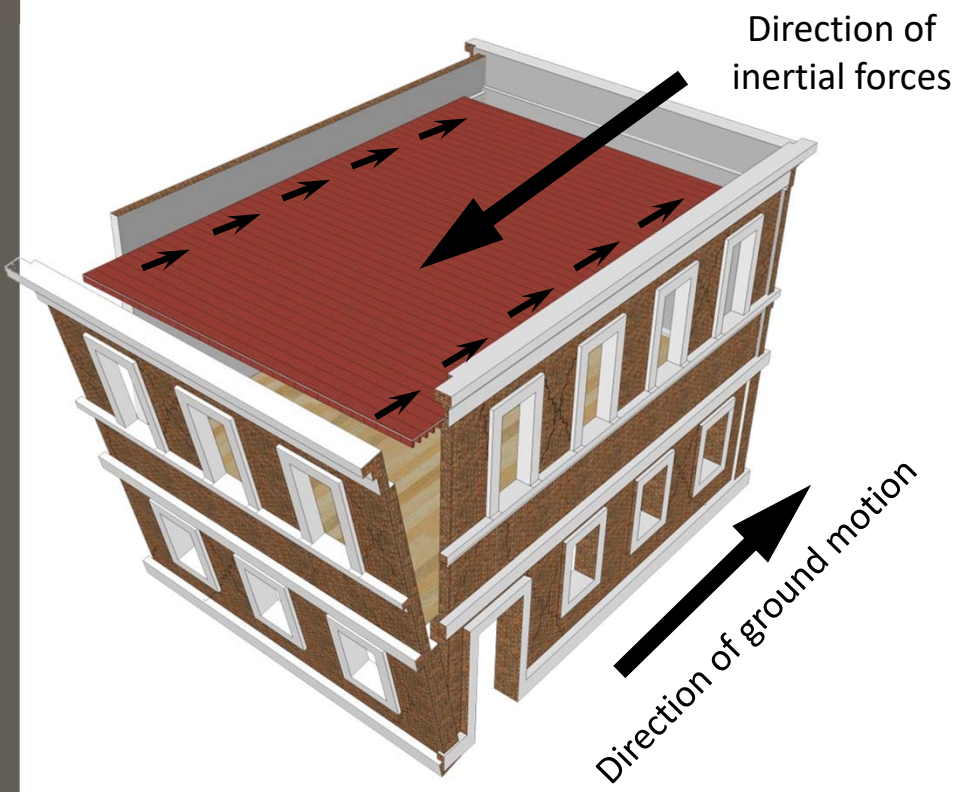


What is a URM?


Header courses
Bricks turned on end, leaving no room for reinforcing rods between brick layers. They occur around every 5th or 6th row of bricks.
Parapet
Roof
Brick wall
Wood-frame floor

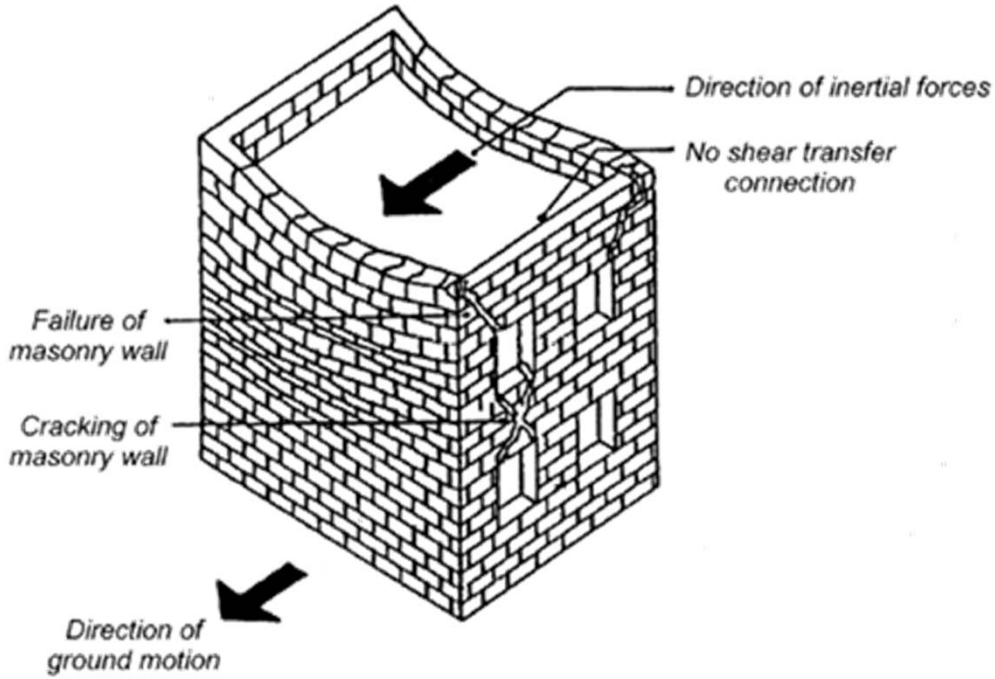

stretcher courses
header courses

Seismic Load Path



LOAD PATH: OOP Walls >> Tension anchors >> Diaphragm >> Shear Anchors >> In-plane walls

(Courtesy of Prof. Jason Ingham, University of Auckland)



Return wall separation and two way out-of-plane failure (FEMA 306, 1998)

URM Performance in PNW Earthquakes

- March 25, 1993 Scotts Mills Earthquake

The Seattle Times
Winner of Nine Pulitzer Prizes

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Thursday, March 25, 1993 - Page updated at 12:00 AM

E-mail article Print

Quake Cracks Oregon Capitol -- Temblor Registers 5.4, Causes Minor Injuries

AP: Times Staff

PORTLAND - An earthquake centered in the Cascade foothills east of Silverton rattled northwest Oregon and parts of Western Washington early today, cracking the rotunda of the Oregon Capitol in Salem and causing minor injuries.

The quake, focused about 12 miles deep and about 30 miles southeast of Portland, registered 5.4 on the Richter scale of ground motion at 5:34 a.m. and lasted about 45 seconds.

"It felt like I was on a boat going down rapids. It woke me right up," said Bill Holder, a cook at Rod's Lafayette Restaurant in Lafayette, near the epicenter.

The original wing of the state Capitol in Salem was closed after serious cracks were found in the rotunda, House Speaker Larry Campbell said. A newer wing remained open. Engineers were considering removing the gold-plated pioneer statue on top of the Capitol.

Two people came to the emergency room at Salem Hospital with minor cuts from falling glass.

In Molalla, 27 miles southeast of Portland, two walls at the high school partially collapsed. Bricks and a chimney fell from the school, which was built in 1925.

Brick planters and windows also were broken at some homes and businesses in the town of 3,800, and goods were knocked off grocery store shelves.

URMs in Nisqually

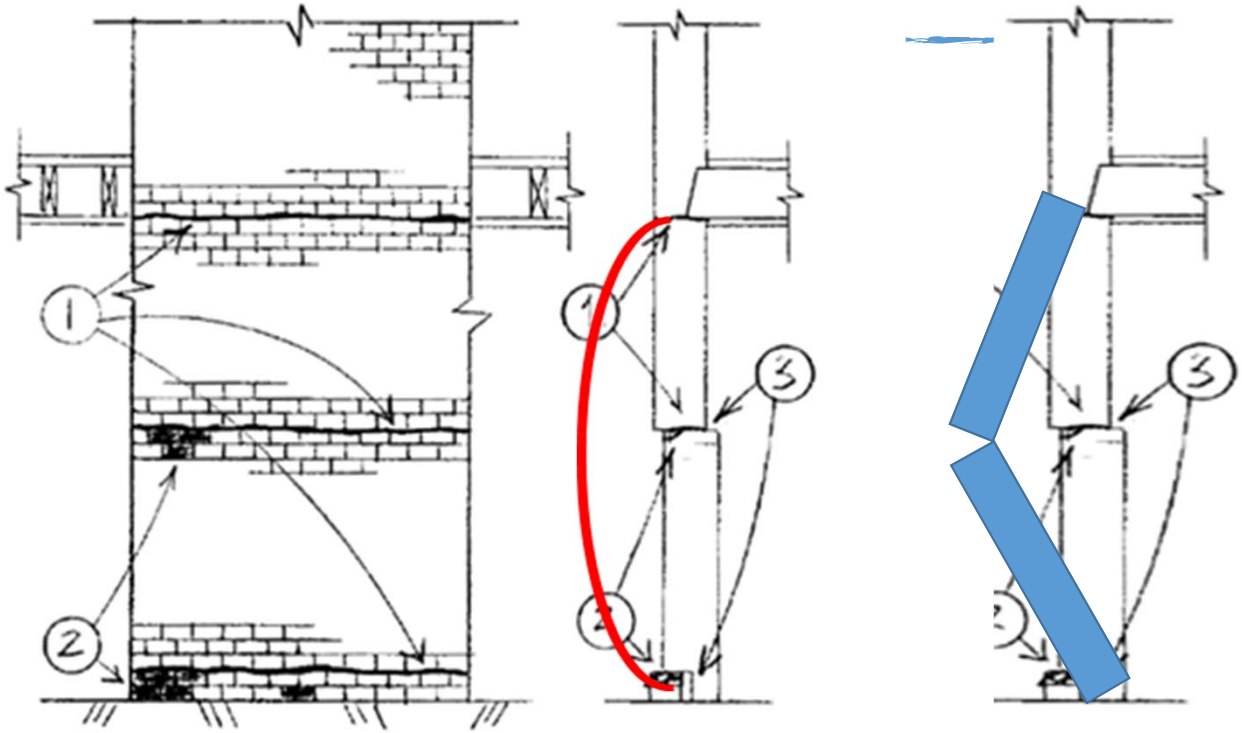
URM Commercial Buildings in Christchurch

(Courtesy of Cale Ash, Degenkolb Engineers)

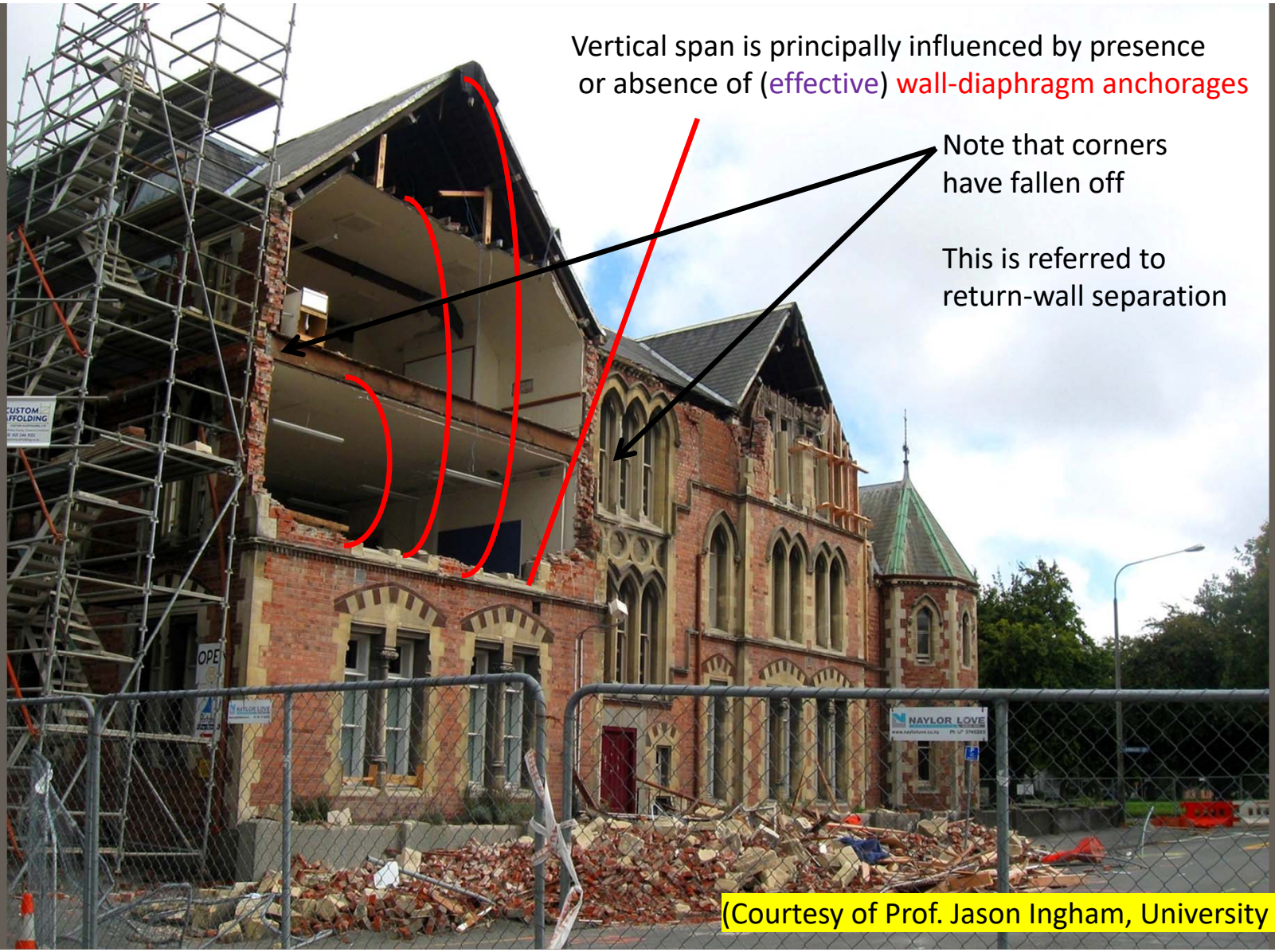
URM Commercial Buildings in Christchurch

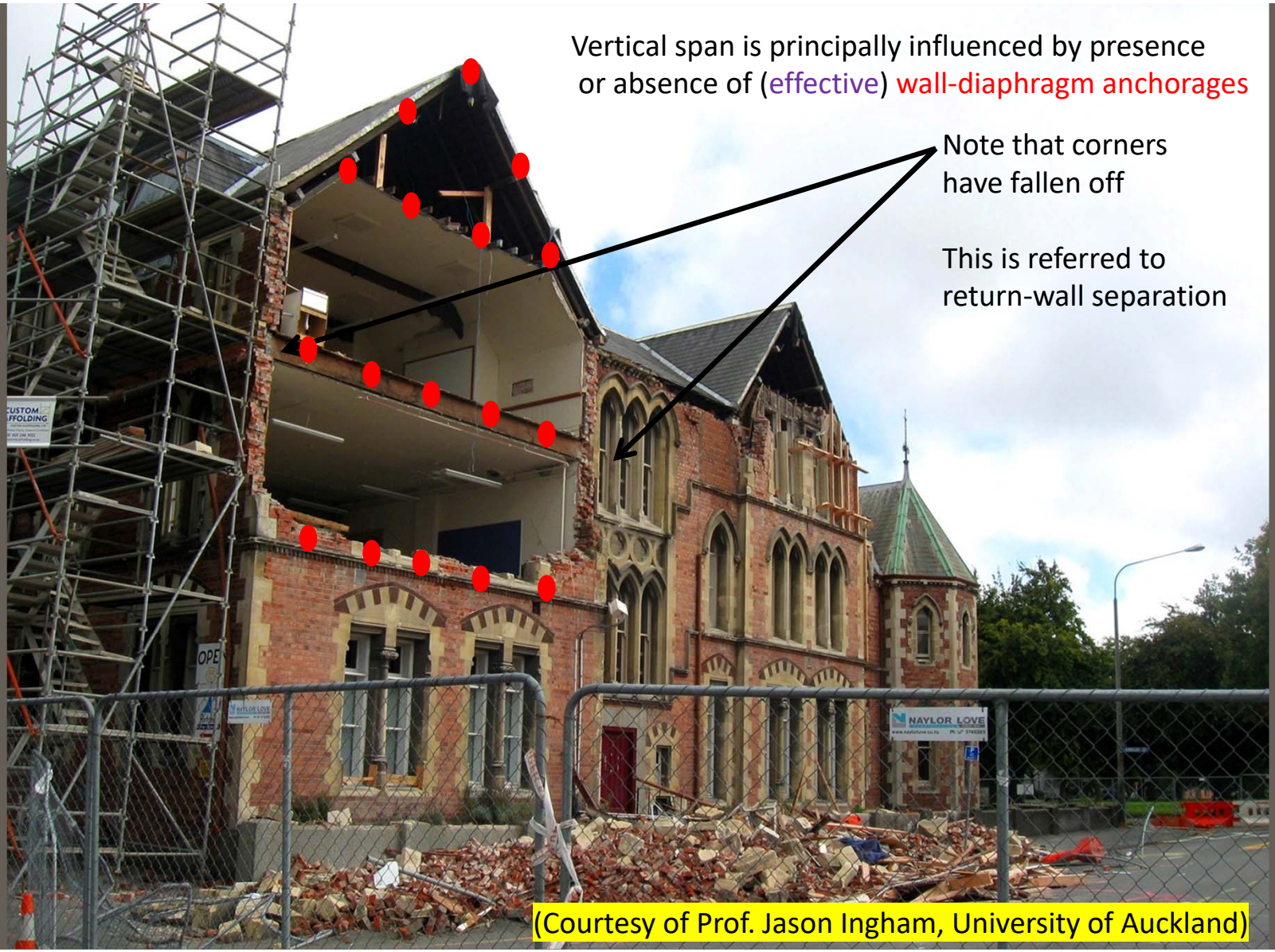
(Courtesy of Cale Ash, Degenkolb Engineers)

URM Out-of-Plane Bending



- One-way bending (2 supports) is the lower bound value for situations where 3 or 4 edge supports may exist


Vertical span is principally influenced by presence or absence of (effective) wall-diaphragm anchorages
Note that corners have fallen off
This is referred to return-wall separation
NAYLOR LOVE
(Courtesy of Prof. Jason Ingham, University of Auckland)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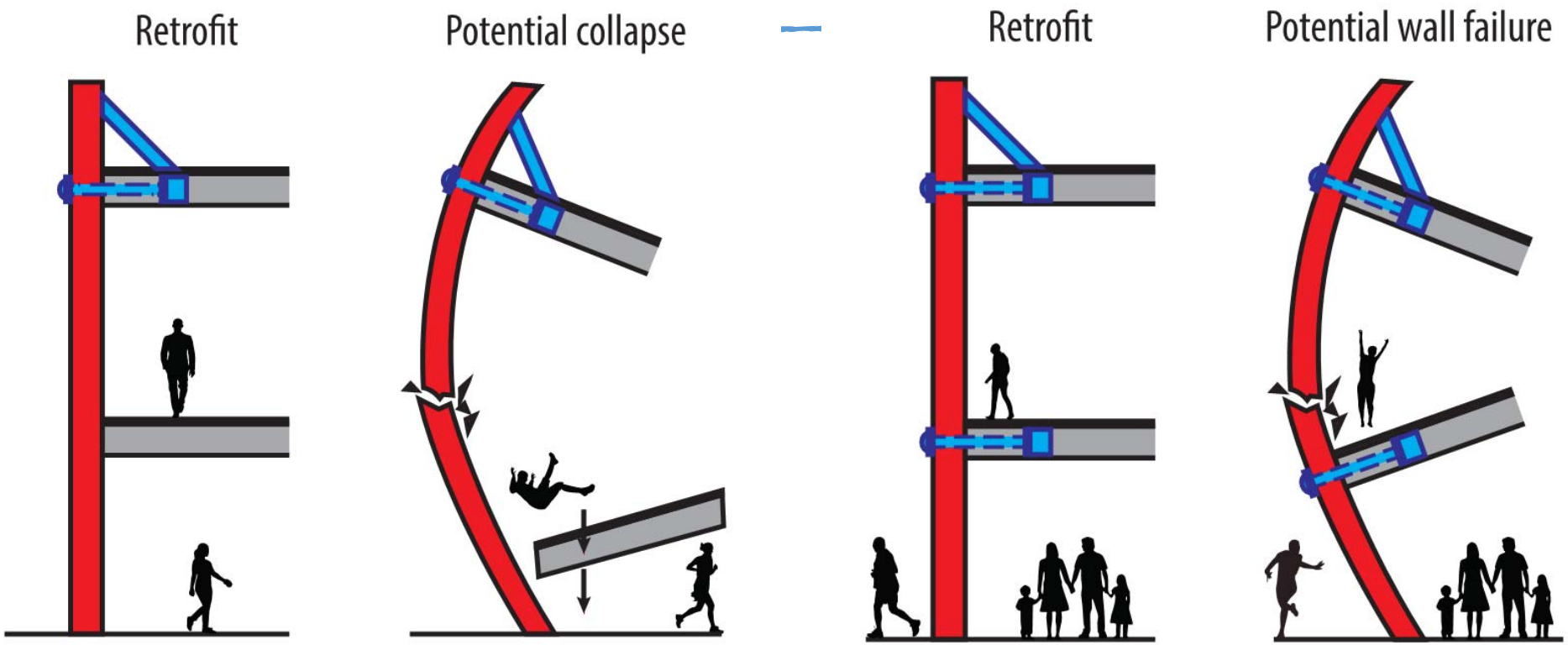
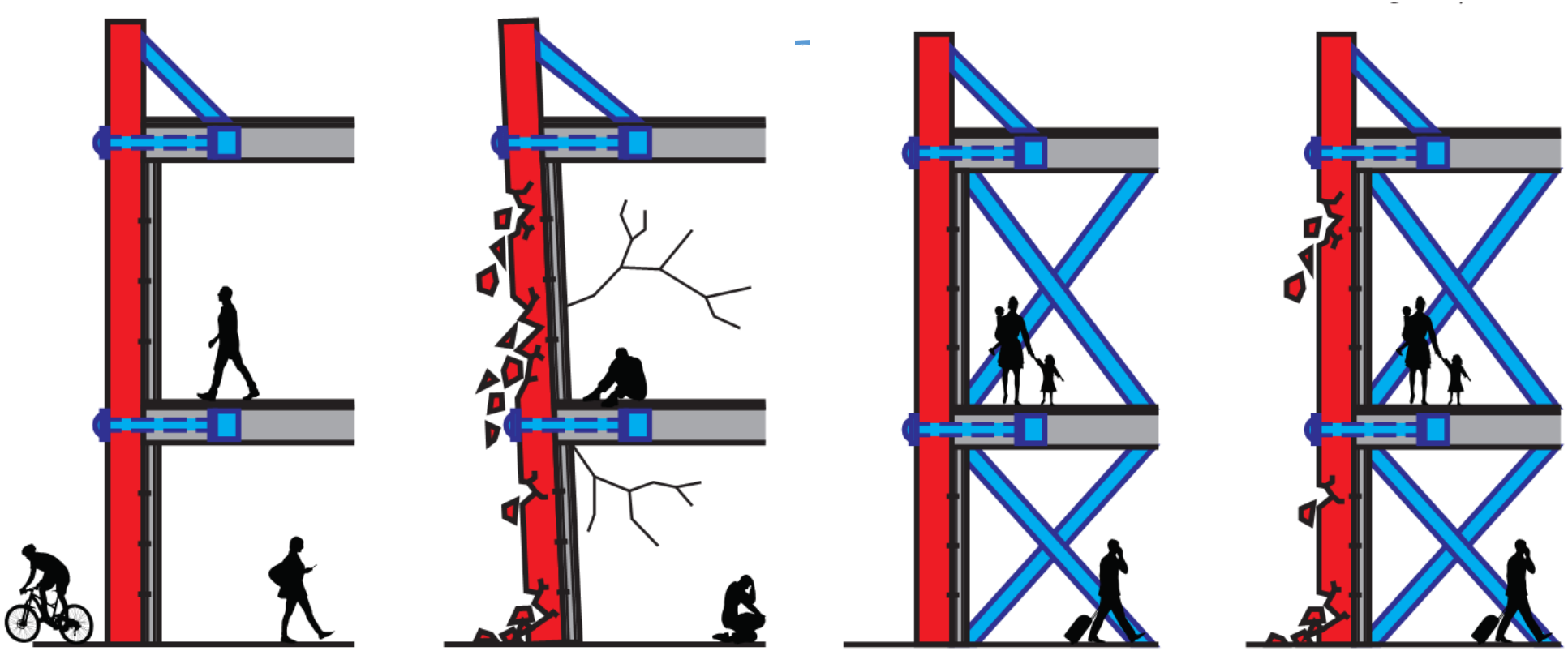
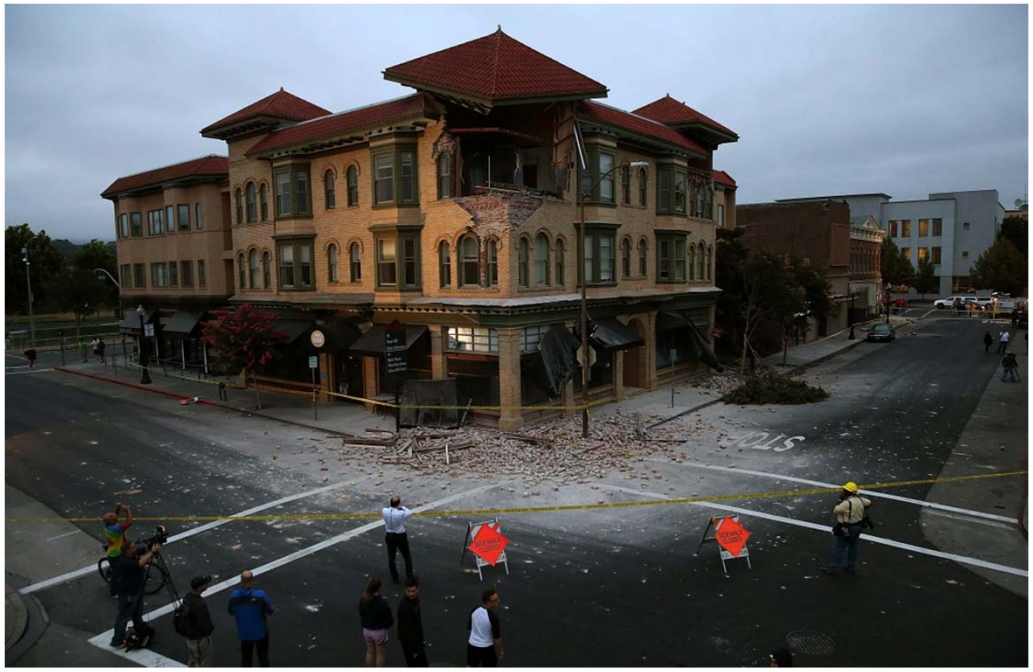
Level of Seismic Strengthening vs Performance



Level of Seismic Strengthening vs Performance



Why Act – Resilience Role

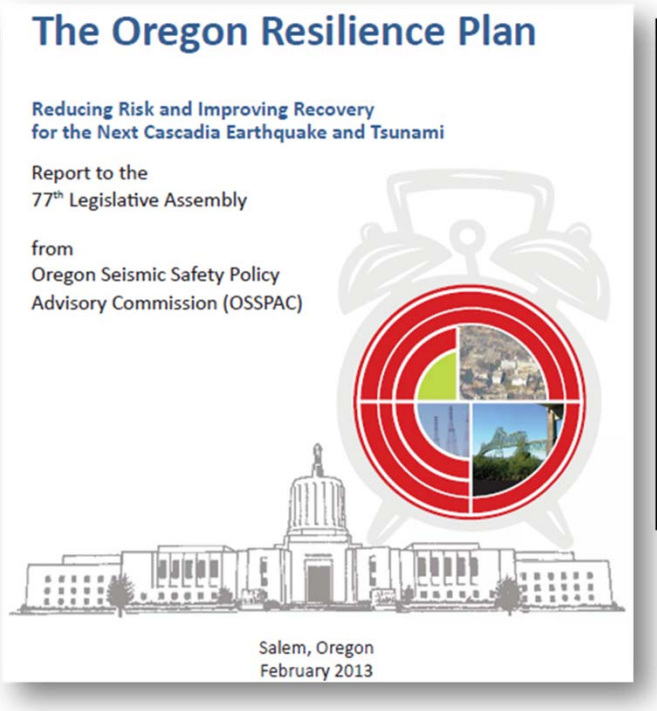


Source: Carmen Merlo

Light Rail Tracks

Why Act – Resilience Role

- Oregon Resilience Plan (Chapter 4 Critical and Essential Buildings)



- **Accelerate the Retirement or Full Upgrade of Vulnerable Buildings**
  - *Finding:* Unreinforced Masonry (URM) and non-ductile concrete buildings are generally the most dangerous types of buildings in an earthquake, and should not be allowed to remain in service indefinitely unless they are fully upgraded.
  - *Recommended:* Initially, the danger of URM and non-ductile concrete buildings should be disclosed at the time of building sale or lease. Through market pressures and upgrades triggered by other building repairs and changes, upgrades can be made to many of these structures.

Conclusions

- URMs house a variety of critical services & businesses in Cascadia
- Earthquake performance is well-documented
- Variety of retrofit options exist with varying performance level
- Life safety and response and recovery for our community

URM Buildings in Portland

Inventory

- About 1,650 URM buildings (9% of building stock)
- About 7,200 residential units
- About 40 URMs City-owned

URM Buildings by Use

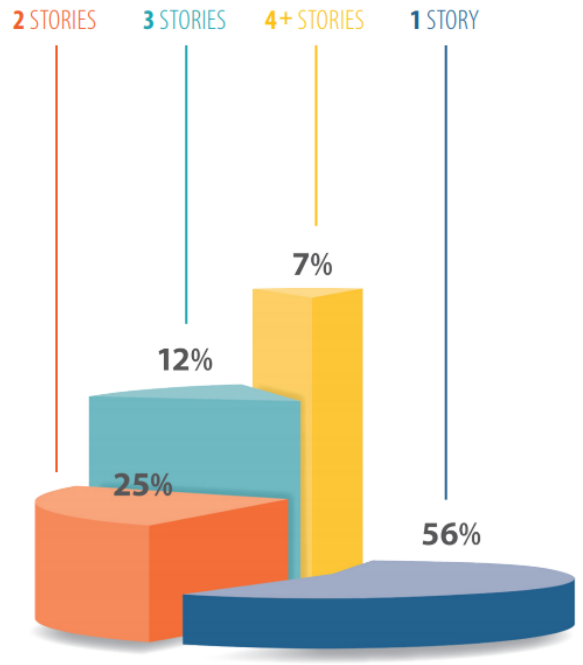
Commercial	1415
Multifamily	248
Schools and community centers	54
Other	14

URM Building Characteristics

Inventory

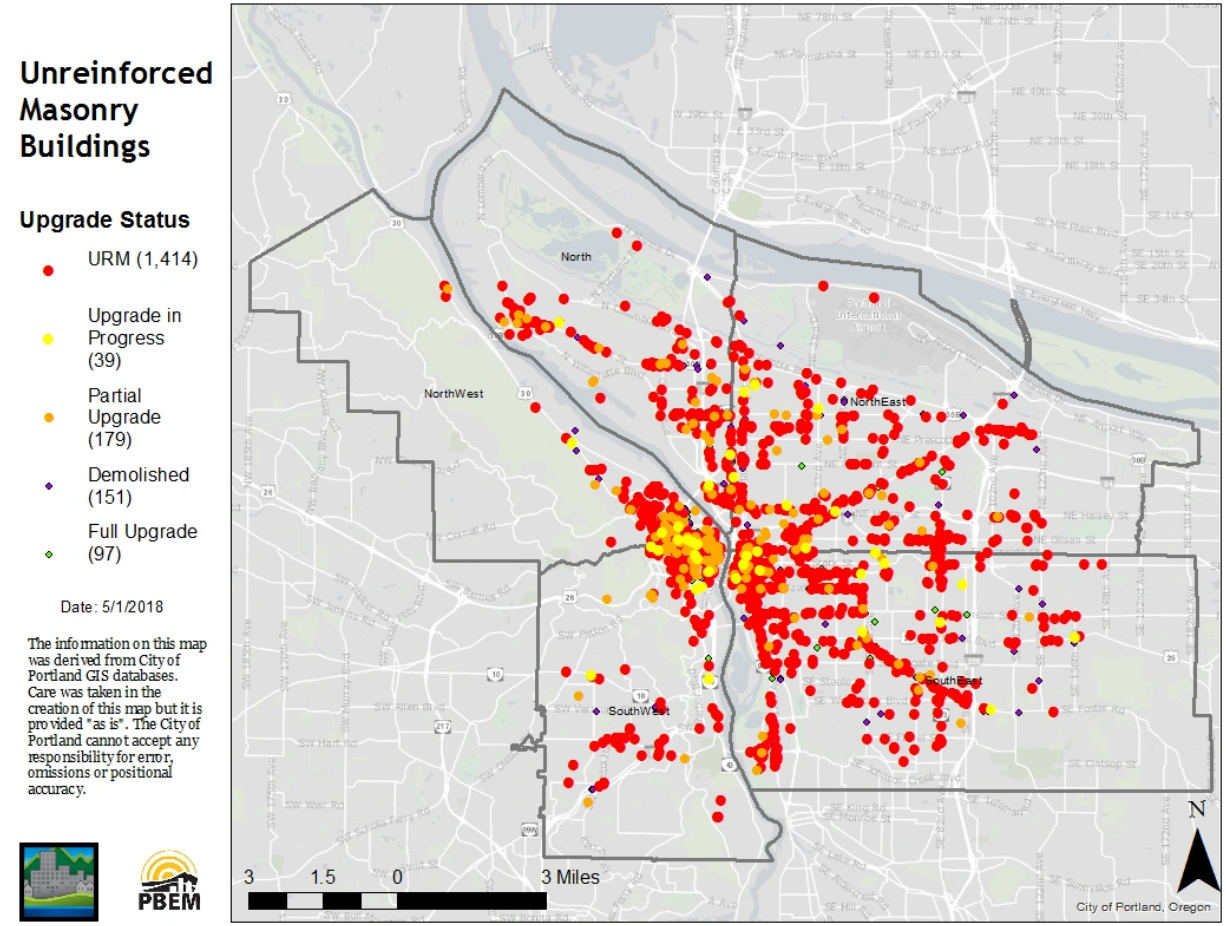
- Average age 89 years
- About 567 historic buildings
- More than half single-story

URM Buildings by Height

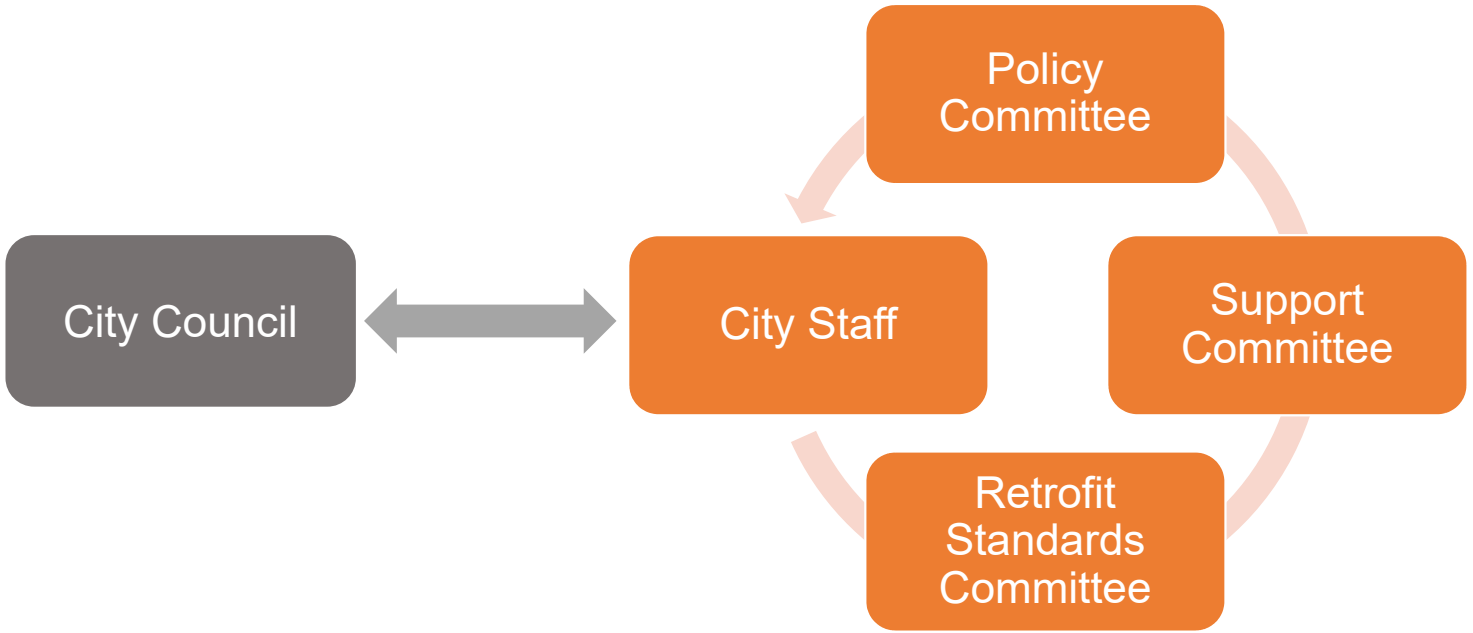


URM Building Locations

Inventory



Council Charge



Policy Development Process

Policy Process

- Broad range of stakeholders worked on consensus basis.
- Subcommittees on affordable housing, non-profits, and historic buildings.
- Outreach to tenants and building owners: open house events, mailings, policy committee meetings.

Public Outreach

Policy Process

- 40+ different items in local media
- 20+ community presentations, including:
  - Development Review Advisory Committee
  - Historic Landmarks Commission
  - Building Owners and Managers Association
  - Portland Business Alliance
  - Portland Downtown Neighborhood Association
  - Central Eastside Industrial Council Land Use Committee
  - SE Uplift Land Use Committee
  - Northeast Coalition of Neighbors
  - Pearl District Neighborhood Association
  - Portland Public Schools Board
  - American Institute of Architects
  - League of Women Voters


FIRE LINE DO NOT CROSS


835
Flowers
Julia's
Gifts

Retrofit Progress Under Current Code

Inventory

- Parapets braced and roof tied to walls when 50% + of roof replaced.
- Retrofits to higher standard only in major renovation or change of use.
- Limited success. Since 1994:
  - 9% partially upgraded (roofs)
  - 5% fully upgraded.

Mandatory retrofits based on risk

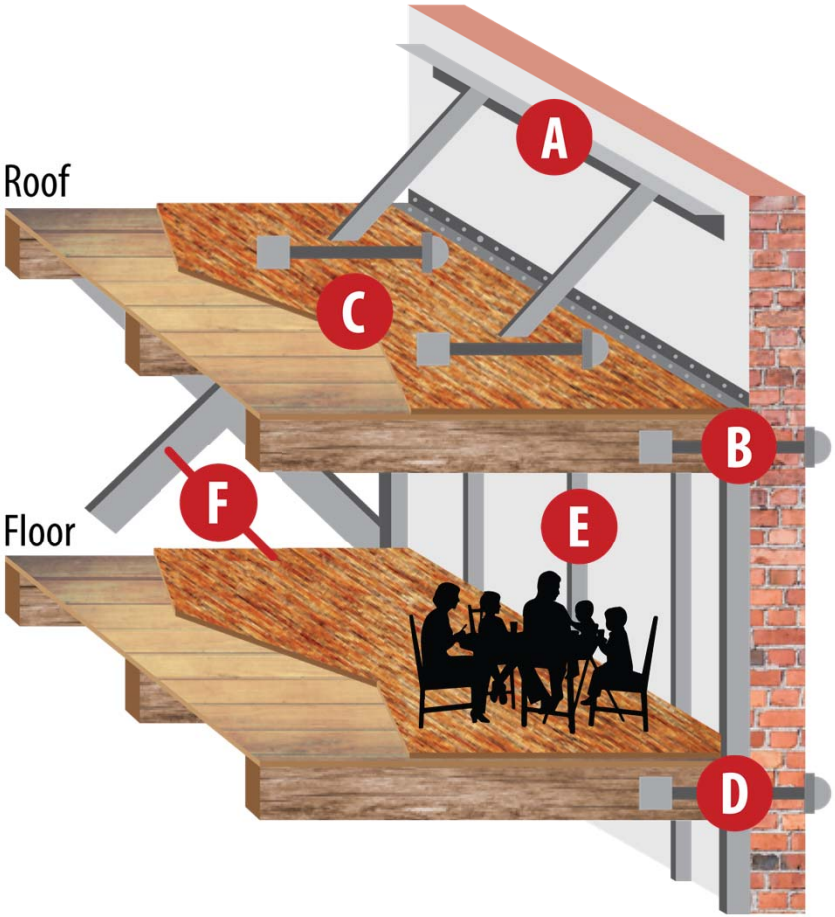
Proposed Standard

Tiered system based on **purpose, use**, and **number of occupants**:

- **Class 1** – Critical public safety and emergency response (**6** in Portland)
- **Class 2** – Schools and community centers (**94**)
- **Class 3** – Most commercial and residential buildings (**1,332**)
- **Class 4** – Small URM buildings <10 occupants, <3 stories. (**201**)

Key Elements of a URM Retrofit

Proposed Standard



A Brace parapets

B Attach wall to roof

C In-plane shear attachments and roof sheathing, ties and cross ties

D Attach wall to floor

E Out-of-plane wall bracing

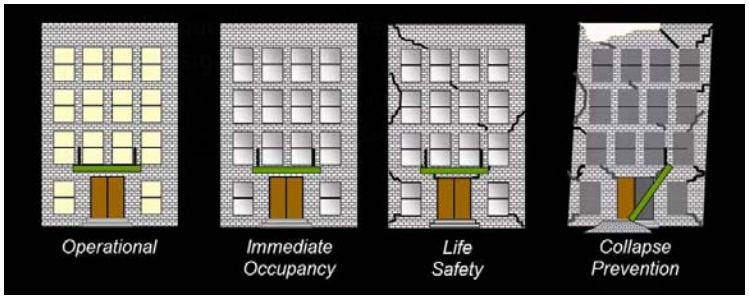
F Other upgrades as required

Levels of URM Retrofit

Proposed Standard

American Society of Civil Engineers:

- **Immediate occupancy:** building can be immediately operational.
- **Damage control:** building is damaged and needs repairs, but can be occupied and function with minor repairs.
- **Life safety:** building is damaged but threat to life is minimal; building may or may not be repairable. *(Current standard for major remodel.)*
- **Collapse prevention:** building is severely damaged, may be on the verge of collapse. Will likely be demolished.



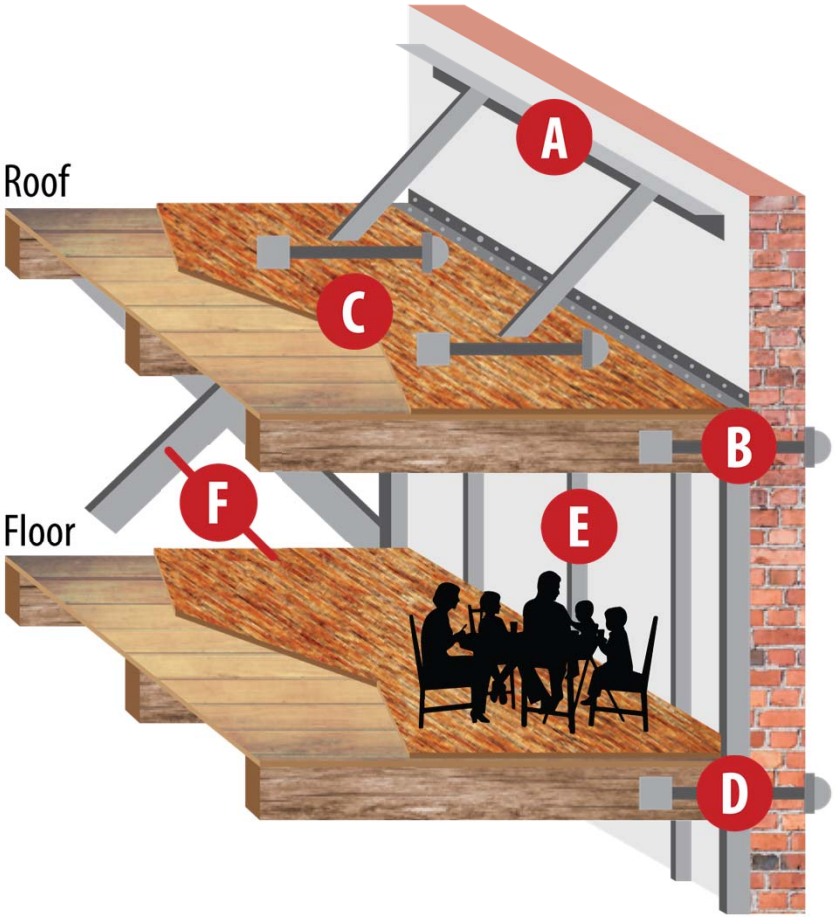
Levels of URM Retrofit

Proposed Standard

- **Collapse risk reduction:** Prescriptive modifications strengthen the building, but do not assure it will not collapse.
- **Parapet bracing**: Prescriptive modifications mean that architectural elements are less likely to break off. Reduces risks to bystanders. Buildings 2+ stories still likely to collapse. *(Current standard at re-roofing.)*

Key Elements of a URM Retrofit

Proposed Standard



A Brace parapets

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URM Building Classification

Proposed Standard

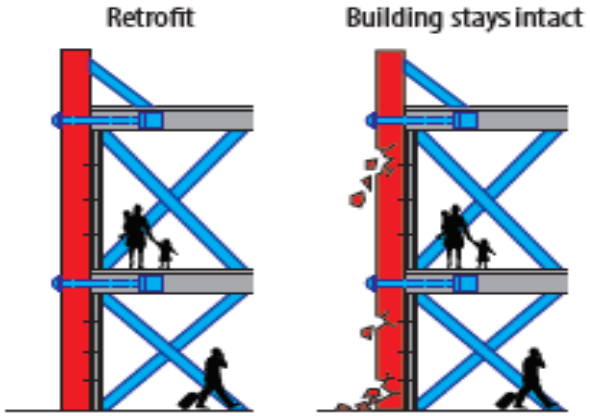
Proposed Standard	Building Class	Approx. # of Buildings
Immediate Occupancy	1: Critical Buildings + essential facilities	6
Damage Control	2: Schools, community centers, high occupancy structures	94 44 schools, 37 churches, 13 other
Collapse Risk Reduction	3: All URM buildings not in 1,2, or 4	1,332 Plus 37 churches and other buildings owned by non-profits (but not schools) may choose this standard.
Parapet bracing only	4: 1 and 2-story buildings with 0-10 occupants.	201

Class 1 and Class 2 Buildings Will Last

Proposed Standard

- **Class 1 critical buildings with immediate occupancy:**
  - 10 years to complete all steps
  - Est. cost $70 - $110 SF

- **Class 2 schools and community centers with damage control**
  - 10 years for parapets
  - 20 years for full retrofit
  - Est. cost $48 - 81 SF



Class 3 Collapse Risk Reduced

Proposed Standard

Collapse risk reduction for 85% of buildings

- **10 Years** for parapet bracing, wall to roof attachment, roof sheathing
- **15 Years** for wall to floor attachment

Estimated $11/SF additional during re-roofing.

Class 3 – Estimated Cost Summary

Proposed Standard

COST COMPONENT	COST RANGE PER SQUARE FOOT		
	Min	Max	Median
Existing Ownership Expense			
Re-roofing	$ 31	$ 36	$ 34
Existing Code Requirement			
Parapet Bracing	$ 1	$ 7	$ 2
Roof-to-wall attachment	$ 1	$ 8	$ 2
New Code Requirement			
Sheathing	$ 8	$ 9	$ 9
Floor-to-wall attachment*	$ 3	$ 5	$ 2
Total Estimated Cost Per SF	$ 43	$ 65	$ 48

Minimal retrofits for small buildings

Proposed Standard

- URM buildings with less than ten occupants brace parapets and tie roof (current code).
  - Ten years to complete.

Strengthen existing triggers

Proposed Standard

Triggers in existing seismic regulations (Title 24.85):

- **Roof replacement** – removal of greater than 50% of total roof area within a ~~5~~ 15 year period requires wall anchorage for both in plane and out of plane forces and parapet bracing.
- **Costs of alterations or repair** - When costs associated with building alterations or repair in a ~~two~~ five year time period or fifteen year time period exceeds, entire building shall be improved to resist seismic forces to meet ASCE 31 41 criteria.

Fairness in implementation

Proposed Standard

- Notice and opportunity to appeal URM building status.
- Timeline extension for class 3 and 4 with newer roof.

Independent Cost-Benefit Study

Proposed Standard

- Used simple costs and benefits: construction costs and fees versus property damage, injuries, and deaths.
- Used higher retrofit standard than now proposed.

Cost-benefit ratios 1:1.4 to 1:1.9.

Avoided death and injury are greatest benefit (55%).

Support for URM Building Owners

Proposed Support

- Seismic C-PACE – Authorized and implemented
- Property Tax Exemption (SB 311) – Authorized
- State historic tax credit – Introduced, failed, try again
- State seismic tax credit – in exploration
- Capital pool to provide financial assistance – in exploration
- City staff as advocates at BDS and Prosper Portland

Public Notification: Lease Agreement

Proposed Policy

- Information will drive the market to greater retrofits.

Notify renters in the lease agreement if a URM is not retrofitted to Collapse Prevention.

Public Notification: Placards

Proposed Policy

- Buildings retrofitted to a standard less than collapse prevention still pose a life-safety risk to the public.

Placard non-residential URM buildings not retrofitted to Collapse Prevention.


Earthquake Warning
This is an unreinforced masonry building.
You may not be safe inside or near unreinforced masonry buildings during an earthquake.

Resolution before Council

Next Steps

Return to Council within a year with:

- **Building code** to implement mandatory seismic retrofit program:
  - Critical building to immediate occupancy in 10 years
  - Schools and community centers to damage control in 20 years
  - Most buildings to collapse risk reduction in 15 years
  - Small buildings brace parapets in 10 years.
- Program to implement **property tax exemption** for URM building retrofits.
- Proposal for seismic retrofit **revolving loan fund**.

Resolution before Council

Next Steps

Return to Council within a year with:

- **Staff program to assist URM owners**.
- **City to assess its own URM buildings**.
- **Legislative agenda** to support additional tax credits:
  - Historic building tax credit
  - Seismic retrofit tax credit.

Resolution before Council

Next Steps

- Ordinance for **placarding** of non-residential URM buildings not retrofitted to prevent collapse.
- Ordinance requiring URM building owners to **disclose URM status to renters**, for buildings not retrofitted to prevent collapse.

Portland Fire and Rescue

Fire Chief Mike Myers

URM Building Policy Committee

Margaret Mahoney, Chair


ROYAL HOTEL
DANGER KEEP OUT
NO PARKING
KEEP CLEAR
AT ALL TIMES
NO PARKING
KEEP CLEAR
AT ALL TIMES

Message from Christchurch

Mayor Lianne Dalziel