

# WASAFE BUILDING SAFETY EVALUATIONS (ATC 20/45 PLUS)

WABO ANNUAL EDUCATION INSTITUTE  
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WASAFE BSE MODULE 1

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## PROGRAM PHILOSOPHY



Photo: Source Unknown

Allow people to reoccupy safe buildings

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## RESOURCE DOCUMENTS (EARTHQUAKE)



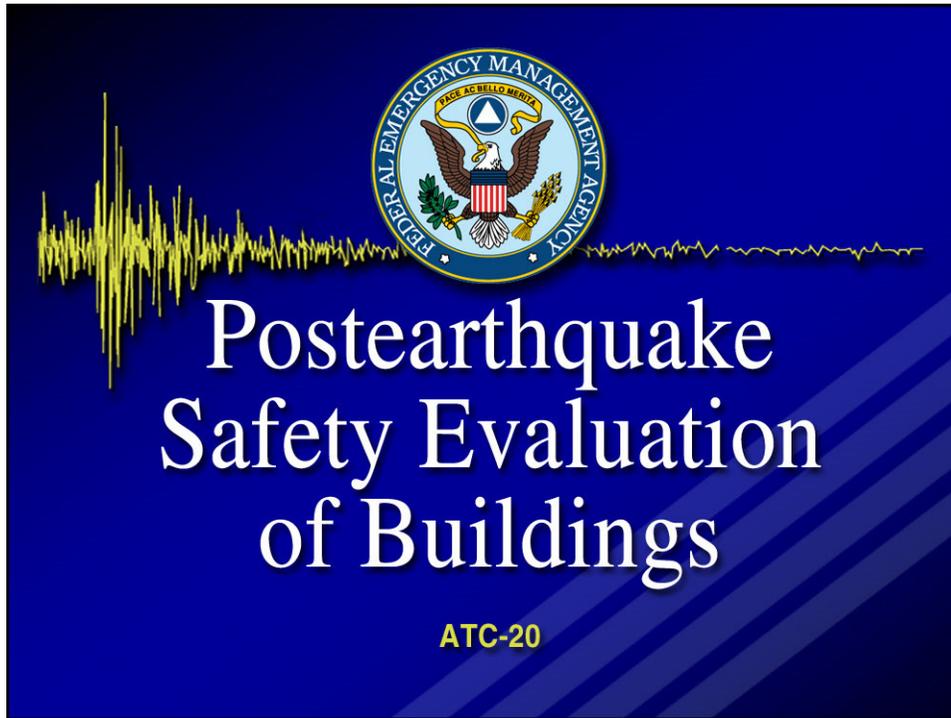
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## RESOURCE DOCUMENT (WIND & FLOOD)



WASafe BSE Module 13

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**Original ATC-20 Document Developed by:**  
APPLIED TECHNOLOGY COUNCIL

**With Funding From:**  
FEDERAL EMERGENCY MANAGEMENT AGENCY  
OFFICE OF EMERGENCY SERVICES, STATE OF CALIFORNIA  
OFFICE OF STATEWIDE HEALTH PLANNING AND  
DEVELOPMENT, STATE OF CALIFORNIA

**ATC-20 PowerPoint® Presentation Funded by:**  
FEDERAL EMERGENCY MANAGEMENT AGENCY  
Under the Technical Assistance and Research Contract

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**This PowerPoint® Presentation Is Based on Original ATC-20  
Training Materials Developed by:**

APPLIED TECHNOLOGY COUNCIL  
Redwood City, California  
Principal Investigator: Christopher Rojahn



**Prepared for ATC by:**

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San Francisco, California  
Principal-in-Charge: Ronald P. Gallagher

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**Original ATC-20 Presentation Modified by:**

WAsafe Coalition Steering Committee and class instructors

California Governor's Office of  
Emergency Services (CalOES)

With thanks to Reid Middleton (Everett, WA) for many of the  
updated graphics

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LOGISTICS

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Restrooms  
Breaks and Lunch  
Tech devices to silent mode  
Registration, forms, **photos**

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WASAFE BUILDING SAFETY EVALUATOR (BSE)  
TRAINING OUTLINE

---

Introduction  
Intro to WAsafe  
Field Safety  
Posting System & Evaluation Procedures  
(Break)

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WASAFE BUILDING SAFETY EVALUATOR (BSE)  
TRAINING OUTLINE

---

Politics of Response & Habitability  
Seismic Hazard Overview  
Structural Basics  
(Lunch)

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WASAFE BSE TRAINING OUTLINE (CONT.)

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Wood-Frame Structures  
Masonry Structures  
Non-seismic Hazards  
Concrete Structures  
Politics of Recovery  
(Break)

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## WASAFE BSE TRAINING OUTLINE (CONT.)

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- Steel-Frame & Hybrid Structures
- Manufactured Housing
- Nonstructural Elements
- Geotechnical Hazards
- WAsafe Program & Procedures
- WA State Law & EMAC
- Group Exercise
- Closing

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*WAsafe is a resource for  
Emergency Managers  
performing post-disaster  
building safety assessments*

Washington State Safety Assessment Facility Evaluators

### OBJECTIVES

- Assist building officials with building safety assessments following a disaster (earthquake, flood, storm)
- Develop a group of qualified volunteer evaluators
- Provide WAsafe volunteer evaluator training
- Maintain registry of volunteer evaluators
- Assist WA State EMD in calling up and dispatching volunteer evaluators

### COALITION

WAsafe program was developed by the Department of Health (DOH) in cooperation with the Washington State Department of Emergency Management (WABO) and the Washington State Board of Building Officials (WABO).

Coalition members include:

- American Institute of Architects, Washington Council (AIA-WA)
- American Society of Civil Engineers, Seattle Chapter (ASCE)
- Washington State Board of Building Officials (WABO)
- Washington State Department of Emergency Management (WABO)

The database of volunteers is established and maintained on the DOH WAserv system.

### CONTACT

For additional information or to contact us, visit the WAsafe Coalition webpage at [www.wasafecoalition.org](http://www.wasafecoalition.org) or by using the QR code above.

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## WHO IS WASAFE?

Coalition formed in 2015

- Washington Chapter, American Institute of Architects (AIA Washington)
- Structural Engineers Association of Washington (SEAW)
- Washington Association of Building Officials (WABO)
- American Society of Civil Engineers (ASCE) Seattle Section (2019)

Washington State Department of Health (DOH) => WAserv registry

MOU with WA EMD => WAsafe recognized as a resource

Other programs exist in CA, OR, and MO

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## WASAFE OBJECTIVES

Assist building officials with building safety assessments following a disaster (earthquake, flood, storm, etc.)



Photo: Cal OES SAP

Develop a group of qualified volunteers

- Provide WAsafe BSE training
- Include information on authority, liability & field safety
- Maintain registry of volunteers

Assist WA State EMD in calling up and dispatching WAsafe responders to where they are needed in large events

- Share resources

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## WASAFE PROGRAM FOCUS



Photo: Cal OES SAP



Photo: Source Unknown

Reoccupy safe buildings

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## WASAFE CAPABILITIES

Volunteer enrollment managed by WASafe member orgs



Response/deployment managed by WA State Emergency Management Division (EMD)



Photo: Source Unknown

Multi-Hazard



Photos: Cal OES SAP

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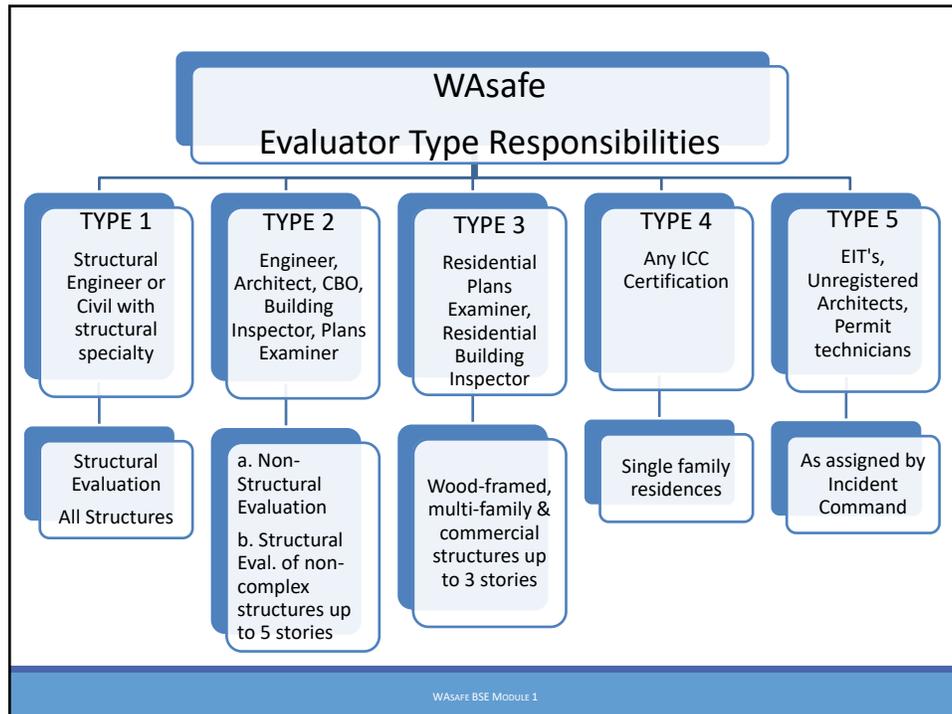
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## WASAFE BSEs – DESIRED QUALIFICATIONS

- General knowledge of construction
- Professional experience
- Broad building review capability
- Good judgment
  - Balance

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## FEMA IS TRAININGS

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Independent Study (IS), Online, Free <https://training.fema.gov/is/>

WAsafe BSEs (Boots-on-the-Ground)

↓

WAsafe Coordinators

↓

○	X	IS-100	Introduction to the Incident Command System (2 hours)
○	○	IS-200	ICS for Single Resources and Initial Action Incidents (3 hours)
○	○	IS-230	Fundamentals of Emergency Management (6 hours)
○	X	IS-700	An Introduction to the National Incident Management System (NIMS) (3.5 hours)
○	○	IS-800	National Response Framework, An Introduction (3 hours)
○	○	IS-2200	Basic Emergency Operations Center Functions (4 hours)

X - Required; ○ - Recommended

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## WASAFE – ENROLLMENT

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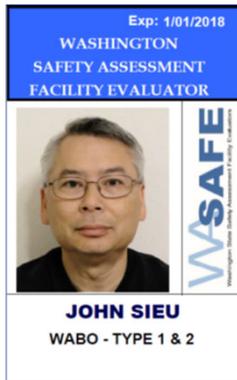
Associated with a professional organization (WABO, SEAW, AIA, ASCE) or “Other”

Meet minimum qualifications, including WAsafe BSE class taught by approved trainer

**Digital picture** & documentation

Enroll through WAserv

Refresher training (online) every 5 years



Exp: 1/01/2018  
WASHINGTON  
SAFETY ASSESSMENT  
FACILITY EVALUATOR

JOHN SIEU  
WABO - TYPE 1 & 2

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JOIN WAsafe AT <https://www.waserv.org/>

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Washington State Emergency Registry of Volunteers is for citizens who are willing and able to help during disasters and significant events. Register now to partner with your local Public Health, local hospital, neighbors, and others who need assistance.

For additional information, [View the FAQ's](#) and [Privacy / Disclaimer / Copyright Policy](#) for this site.

**LOG IN**

Forgot Password?

or

**REGISTER**

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See <https://wasafecoalition.org/volunteer/how-to-enroll> for "How-To" guide

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# FIELD SAFETY

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## FIELD SAFETY

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Travel in teams of two

- Watch for stress symptoms
- Take care of yourself (eat, sleep, take breaks, pace yourself)

Use safety equipment

Survey building before entering

Enter only if safe

Avoid hazardous materials

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## FIELD SAFETY (CONT.)

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Be alert for falling objects

In case of fire, evacuate area and alert fire department

Avoid downed power lines

Report gas leaks

Dangerous animals or pets

Flood response – don't wade through standing water

Fire response – create carcinogens

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## FIELD SAFETY – ROAD CONDITIONS



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## FIELD SAFETY – HAZARDOUS MATERIALS

- Recognition – Type of facility  
National Fire Protection  
Association (NFPA) diamond  
marker  
Fumes, odors  
Visible spills
- Actions – Leave **immediately**  
– Post building/area  
– Notify jurisdiction (usually Fire Department)

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## COMMON FAILURES CAUSING HAZMAT RELEASES

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- Building structural failures
- Dislodged asbestos
- Underground pipeline breaks
- Short connector pipe breaks
- Elephant's foot buckling of vertical cylindrical tanks
- Overturning of elevated tanks
- Sloshing from open-topped tanks
- Falling containers
- Equipment sliding or overturning

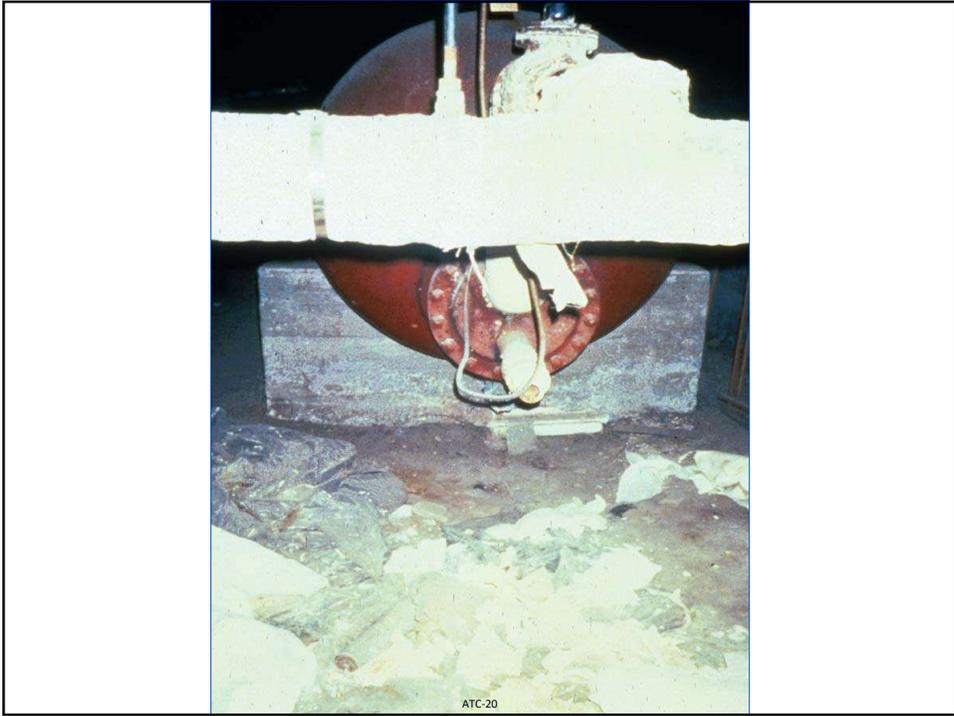
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## USDOT HAZMAT LABELS

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### Nine Classes of Hazardous Materials

**Class 1: Explosives**  
Divisions: 1.1, 1.2, 1.3, 1.4, 1.5, 1.6

**Class 2: Gases**  
Divisions: 2.1, 2.2, 2.3

**Class 3: Flammable Liquid and Combustible Liquid**

**Class 4: Flammable Solid, Spontaneously Combustible, and Dangerous When Wet**  
Divisions 4.1, 4.2, 4.3

**Class 5: Oxidizer and Organic Peroxide**  
Divisions 5.1, 5.2

**Class 6: Poison (Toxic) and Poison Inhalation Hazard**

**Class 7: Radioactive**

**Class 8: Corrosive**

**Class 9: Miscellaneous**

**Dangerous**

Revised 08/05

Federal Motor Carrier Safety Administration
U.S. Department of Transportation  
www.fmcsa.dot.gov

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## NFPA DIAMOND (CHEMICALS)

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**HEALTH HAZARD**

4 - Deadly  
3 - Extreme Danger  
2 - Hazardous  
1 - Slightly Hazardous  
0 - Normal Material

**FIRE HAZARD - Flash Point**

4 - Below 73F  
3 - Below 100F  
2 - Below 200F  
1 - Above 200F  
0 - Will Not Burn

**SPECIFIC HAZARD**

OXY - Oxidizer  
ACID - Acid  
ALK - Alkali  
COR - Corrosive  
W - Use NO WATER  
☢ - Radiation Hazard

**REACTIVITY**

4 - May Detonate  
3 - Shock and Heat May Detonate  
2 - Violent Chemical Change  
1 - Unstable If Heated  
0 - Stable

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## HMIS/OSHA LABELS

Sodium Aluminum Tetrafluoride	
<b>HEALTH</b>	2
<b>FLAMMABILITY</b>	0
<b>PHYSICAL HAZARD</b>	0
PERSONAL PROTECTION	F



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## US&R MARKING SYSTEM

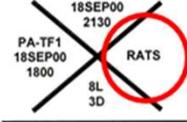
US&R/USAR teams generally on site before BSA teams

Building Safety Evaluators (BSEs) may encounter markings on buildings

Understanding the markings

BSEs are not to mark the buildings





- Right - hazards
- Bottom - # of victims

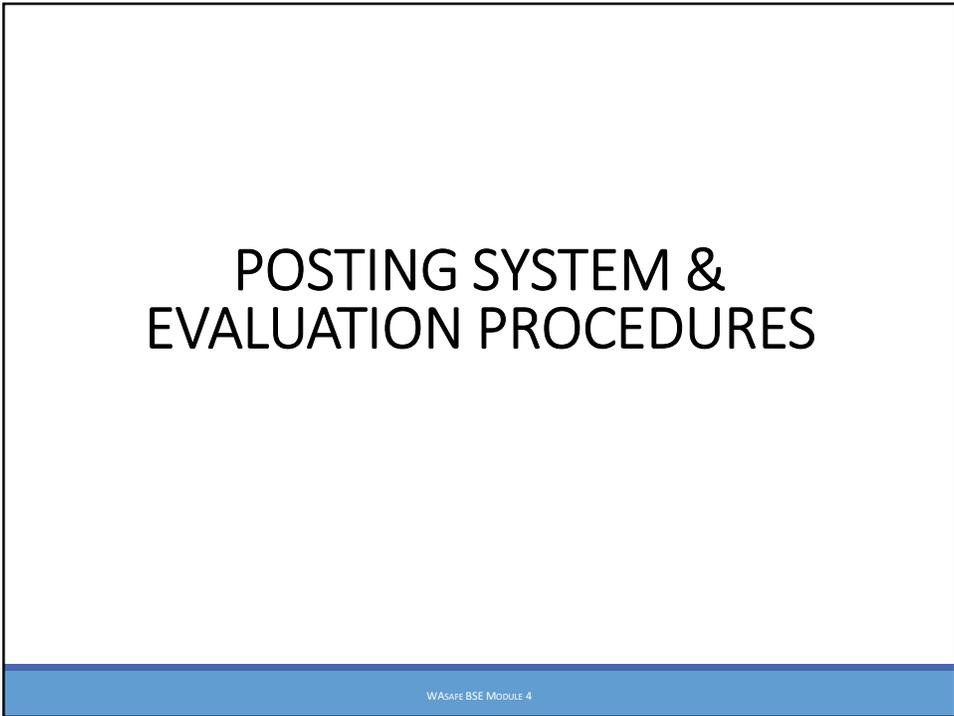
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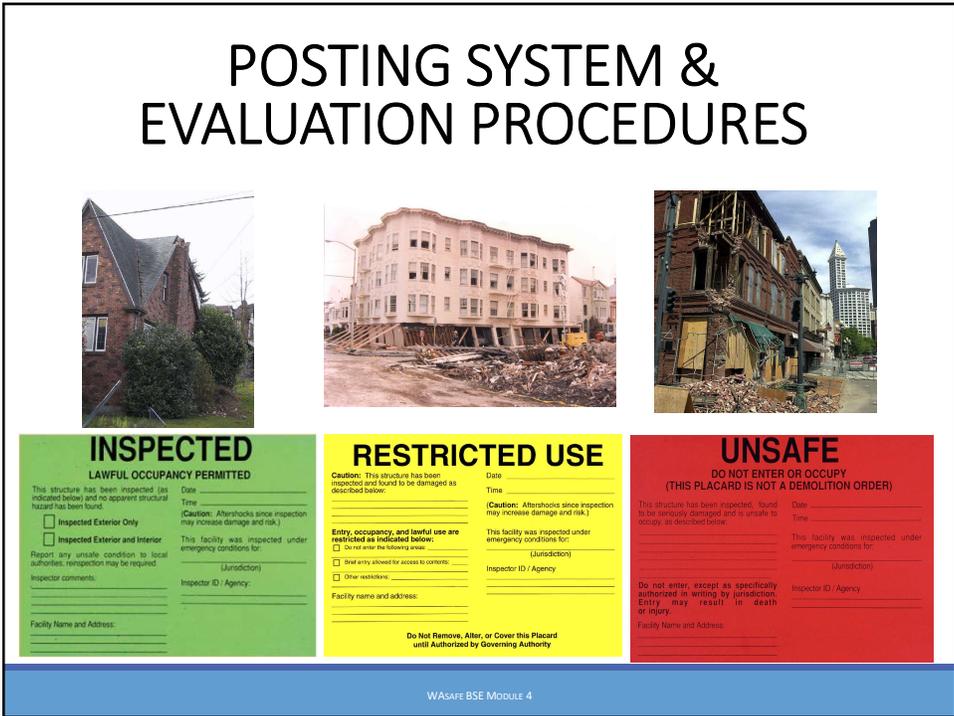
# FIELD SAFETY



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## PRINCIPAL SAFETY CONCERNS

Collapse

Falling hazards

Other hazards



**RESTRICTED USE**

Caution: This structure has been inspected and found to be damaged as described below.

Date: \_\_\_\_\_ Time: \_\_\_\_\_

Caution: Aftershocks since inspection may increase damage and risk.

This facility was inspected under emergency conditions for: \_\_\_\_\_ (Jurisdiction)

Inspector ID / Agency: \_\_\_\_\_

Entry, occupancy, and lawful use are restricted as indicated below:

No entry allowed for access to contents

Other restrictions: \_\_\_\_\_

Facility name and address: \_\_\_\_\_

**Do Not Remove, Alter, or Cover this Placard until Authorized by Governing Authority**

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### BASIC APPROACH

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- Right to evaluate
- Observe expected damage
- Quickly assess unexpected damage
- Methodically evaluate structure
  - Assume that significant aftershocks will occur, depending on EQ mechanism (if known)
- Utilize checklists and safety criteria
- Exercise judgment in assessing risks from damage
- Communicate risks to public with posting system
- Collect and report damage data to jurisdiction

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## JUDGMENT IN ASSESSING RISK FROM OBSERVED DAMAGE

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Amount of risk is not always proportional to amount of damage

Structural aspects of assessing risk from damage

- Redundancy
- Brittleness and Ductility

Over-conservatism

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## GOOD POSTING PRACTICES

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Be timely

Be consistent

Be visible

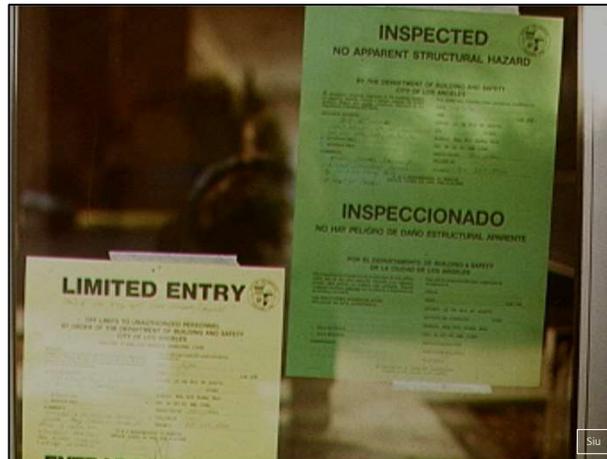
Be clear

Who's the audience?

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## THIS IS NOT CLEAR



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## POSTING SYSTEM

**INSPECTED/NO APPARENT HAZARD (Green):**  
Appears safe for occupancy, unrestricted use or entry allowed

**RESTRICTED USE/LIMITED ENTRY (Yellow):**  
Some restriction/limitation on use or entry

**UNSAFE (Red):**  
Entry not allowed

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# STANDARD EVALUATION PROCEDURE

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## EVALUATION LEVELS

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- |              |  |
|--------------|--|
| Windshield   | – Overall scope of damage                                |
| <b>Rapid</b> | – <b>Assessment sufficient for most buildings</b>        |
| Detailed     | – Closer assessment of difficult and essential buildings |
| Engineering  | – Consultant engaged by owner                            |

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## EVALUATION STEPS

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1. Examine entire exterior of building
2. Examine ground for distress or other geotech hazards
3. Enter if safe and continue evaluation
4. Discuss observations; evaluate by criteria
5. Tape off hazardous areas
6. Complete forms and post building at all entrances
7. Inform occupants and management of hazards

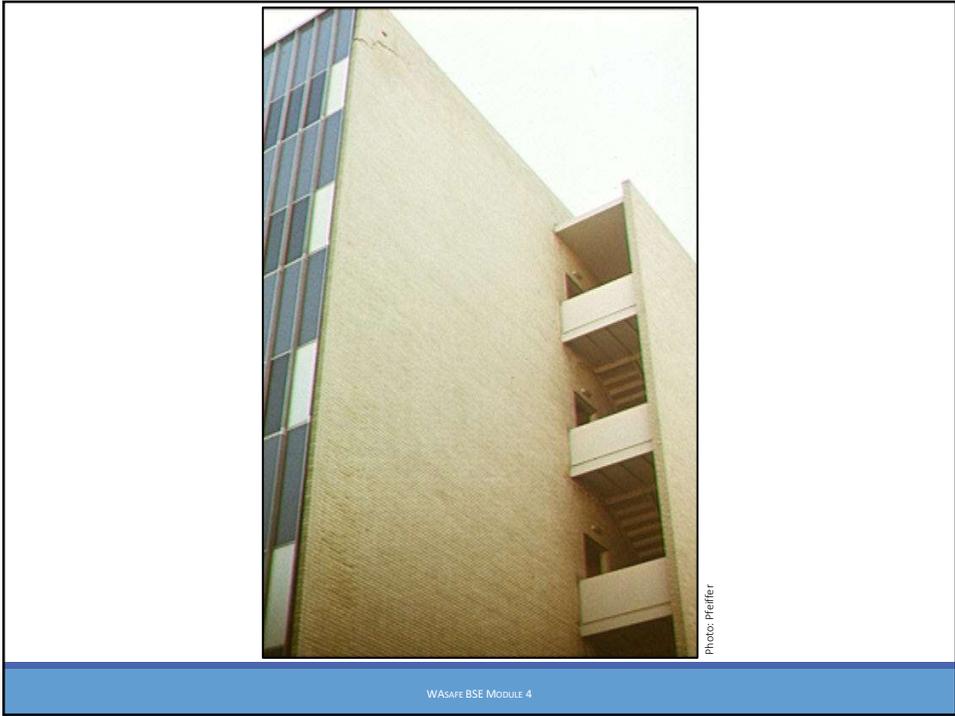
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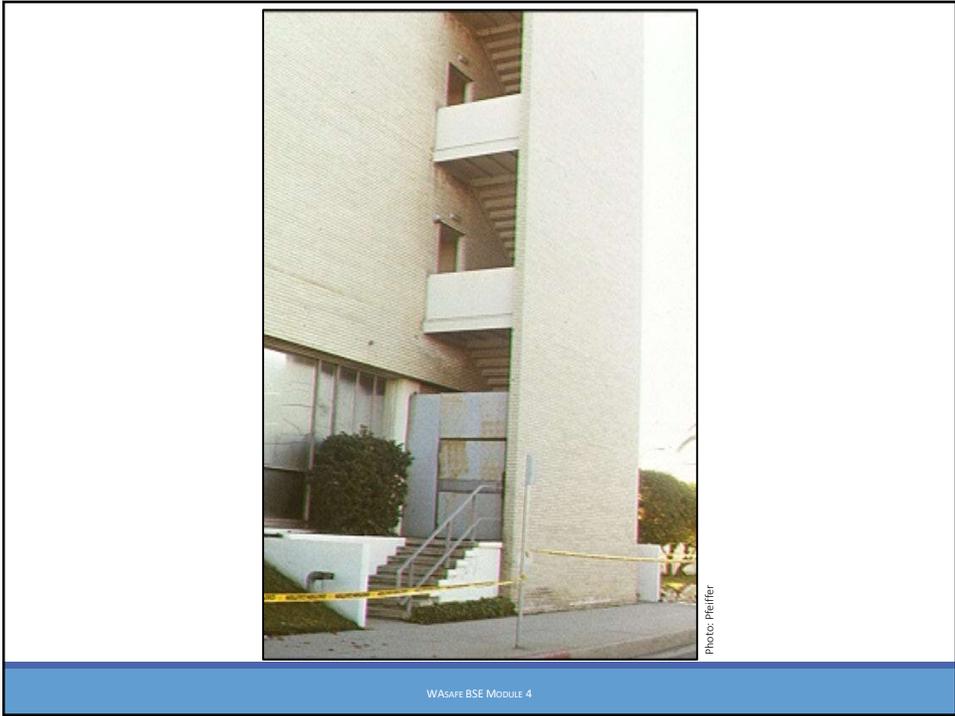


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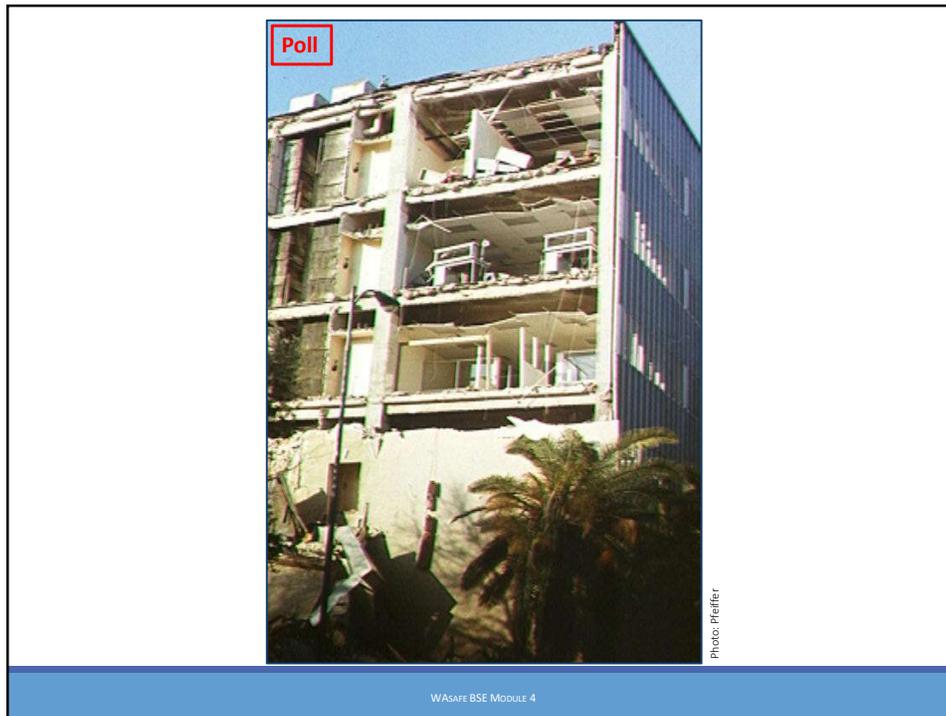
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## RAPID EVALUATION

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Cursory evaluation (~20-30 minutes), focus on big-picture structural damage

Sufficient to evaluate and post most buildings

Recommend detailed evaluation for questionable buildings

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## RAPID EVALUATION CRITERIA

- Collapse, partial collapse
- Building/foundation displacement
- Building or story noticeably leaning
- Severe racking of walls, obvious severe damage
- Chimney, parapet, or other falling hazard
- Severe ground displacement or foundation damage
- Other hazard present

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Poll

**EXAMPLE – PARTIAL COLLAPSE**



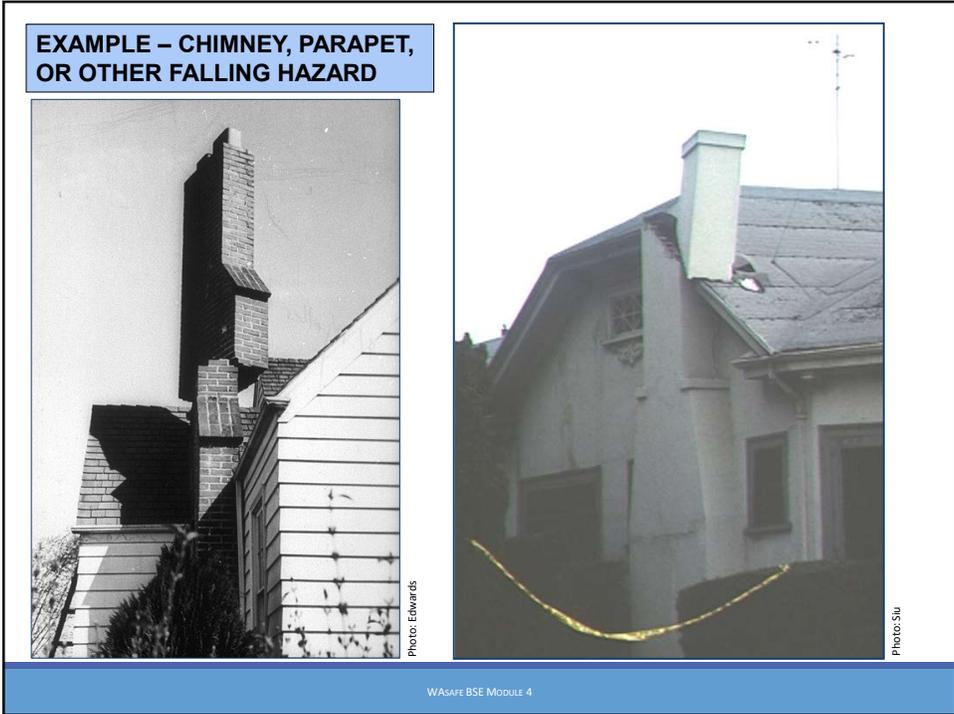
Source: Unknown



Photo: Su

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**INSPECTED/NO APPARENT HAZARD**

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Observed damage, if any, does not appear to pose a safety risk

Unlimited entry, occupancy, and use permitted



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**INSPECTED/NO APPARENT HAZARD**

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Original vertical-load or lateral-load carrying capacity not significantly decreased, no potential instabilities

No falling or other life-safety risks

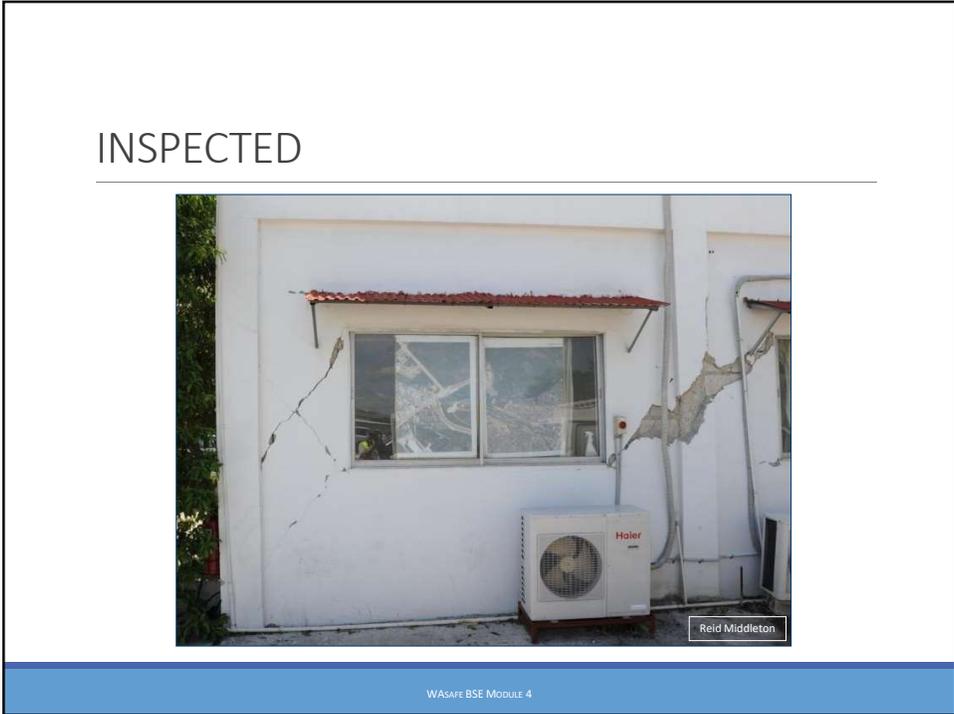
No evidence of significant foundation damage, uplifting, erosion, or ground displacement

Main exits operable and accessible

No other apparent unsafe condition

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# INSPECTED

## LAWFUL OCCUPANCY PERMITTED

This structure has been inspected (as indicated below) and no apparent structural hazard has been found.

Inspected Exterior Only
  Inspected Exterior and Interior

Report any unsafe condition to local authorities; reinspection may be required.

Inspector comments: \_\_\_\_\_

Facility Name and Address: \_\_\_\_\_

Date \_\_\_\_\_  
 Time \_\_\_\_\_  
 (Caution: Aftershocks since inspection may increase damage and risk.)  
 This facility was inspected under emergency conditions for:  
 \_\_\_\_\_  
 (Jurisdiction)  
 Inspector ID / Agency: \_\_\_\_\_

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## LIMITED ENTRY/RESTRICTED USE

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Some risk from damage in all or part of building

Restricted

- duration of occupancy
- areas of occupancy
- usage

Restrictions enforced by owner / manager

**RESTRICTED USE**

Caution: This structure has been inspected and found to be damaged as described below.

Date \_\_\_\_\_

Time \_\_\_\_\_

(Caution: Aftershocks since inspection may increase damage and risk.)

Entry, occupancy and lawful use are restricted as indicated below.

This facility was inspected under emergency conditions for \_\_\_\_\_

(Jurisdiction)

Inspector ID / Agency \_\_\_\_\_

Facility Name and Address: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Do Not Remove, Alter or Cover this Placard until Authorized by Governing Authority

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## LIMITED ENTRY/RESTRICTED USE

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Safety issues can only be resolved by removal of architectural elements or by an Engineering Evaluation

Cladding damage may result in further damage

Interior finishes or ceilings...may lead to falling hazards or air quality issues

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## LIMITED ENTRY/RESTRICTED USE

Possibility of further damage due to foundation conditions & occupant load

Possible presence of other risks (toxic materials release, etc.)

Portion of the building cannot be safely occupied

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## LIMITED ENTRY/RESTRICTED USE



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Source Unknown

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# RESTRICTED USE

**Caution:** This structure has been inspected and found to be damaged as described below:

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Entry, occupancy, and lawful use are restricted as indicated below:**

Do not enter the following areas: \_\_\_\_\_

Brief entry allowed for access to contents: \_\_\_\_\_

Other restrictions: \_\_\_\_\_

Facility name and address: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Date \_\_\_\_\_

Time \_\_\_\_\_

**(Caution:** Aftershocks since inspection may increase damage and risk.)

This facility was inspected under emergency conditions for: \_\_\_\_\_

\_\_\_\_\_ (Jurisdiction)

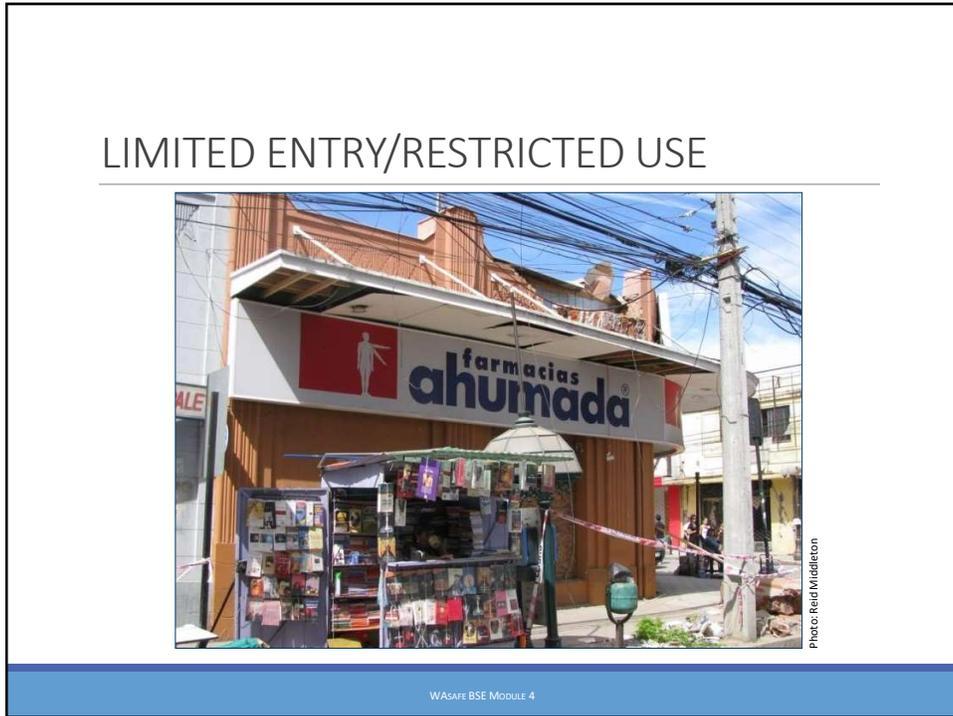
Inspector ID / Agency \_\_\_\_\_

\_\_\_\_\_

**Do Not Remove, Alter, or Cover this Placard until Authorized by Governing Authority**

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**UNSAFE**

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Falling, collapse, or other hazard

Does not necessarily indicate that demolition is required

Owner must mitigate hazards to satisfaction of jurisdiction to gain entry



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**UNSAFE**

---

Obvious safety risks are present

Structure is believed to be in danger of collapse from static conditions, subsequent events, or addition of occupant loads

Another unsafe condition is present

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# UNSAFE



Photos: Reid Middleton

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# UNSAFE



Photo: Reid Middleton

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# UNSAFE

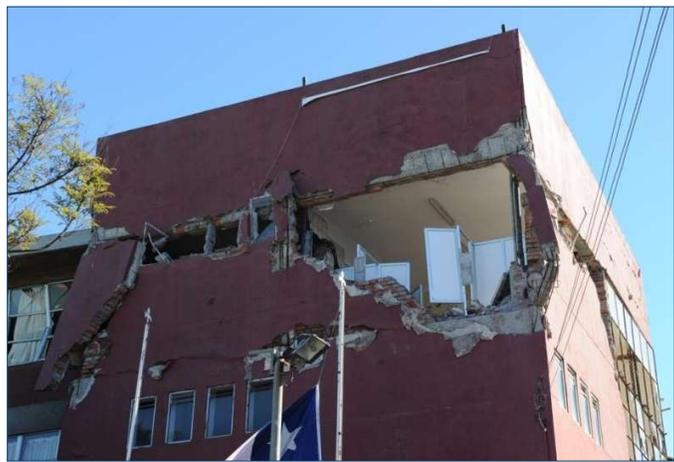


Photo: Reid Middleton

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# UNSAFE

**DO NOT ENTER OR OCCUPY  
(THIS PLACARD IS NOT A DEMOLITION ORDER)**

This structure has been inspected, found to be seriously damaged and is unsafe to occupy, as described below:

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Date \_\_\_\_\_

Time \_\_\_\_\_

This facility was inspected under emergency conditions for:

\_\_\_\_\_ (Jurisdiction)

**Do not enter, except as specifically authorized in writing by jurisdiction. Entry may result in death or injury.**

Inspector ID / Agency \_\_\_\_\_

Facility Name and Address:

\_\_\_\_\_

\_\_\_\_\_

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## NOTES ON POSTING

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Consider earthquake mechanism

- Large aftershocks very unlikely in deep event (e.g., Nisqually)
- Aftershocks likely in subduction or shallow fault events (i.e. Cascadia & Seattle Fault)

Consider if other hazards or political issues are greater

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## JUDGMENT IN ASSESSING RISK – OVER-CONSERVATISM

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“There is a benefit to the community if a building can safely be posted Restricted Use instead of Unsafe.”

“It is important that posting decisions be carefully considered, particularly those that will displace individuals and businesses.”

“Unnecessarily conservative postings must be avoided”

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## CHANGING A POSTING

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- Correct oversight or mistake in judgment
- Removal of hazard
- Significant aftershock
- Engineered reevaluation and repair

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### ATC-20 Rapid Evaluation Safety Assessment Form

**Inspection**  
 Inspector ID: \_\_\_\_\_ Inspection date and time: \_\_\_\_\_  AM  PM  
 Affiliation: \_\_\_\_\_ Areas inspected:  Exterior only  Exterior and interior

**Building Description**  
 Building name: \_\_\_\_\_  
 Address: \_\_\_\_\_  
 Building contact/phone: \_\_\_\_\_  
 Number of stories above ground: \_\_\_\_\_ below ground: \_\_\_\_\_  
 Approx. "Footprint area" (square feet): \_\_\_\_\_  
 Number of residential units: \_\_\_\_\_  
 Number of residential units not habitable: \_\_\_\_\_

**Type of Construction**  
 Wood frame  Concrete shear wall  
 Steel frame  Unreinforced masonry  
 Tilt-up concrete  Reinforced masonry  
 Concrete frame  Other: \_\_\_\_\_

**Primary Occupancy**  
 Dwelling  Commercial  Government  
 Other residential  Offices  Historic  
 Public assembly  Industrial  School  
 Emergency services  Other: \_\_\_\_\_

**Evaluation**  
 Investigate the building for the conditions below and check the appropriate column.  
 Observed Conditions:

	Minor/None	Moderate	Severe	
Collapse, partial collapse, or building off foundation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> None
Building or story leaning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> 0-1%
Racking damage to walls, other structural damage	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> 1-10%
Chimney, parapet, or other falling hazard	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> 10-30%
Ground slope movement or cracking	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> 30-60%
Other (specify) _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> 60-100%
Comments: _____				<input type="checkbox"/> 100%

**Estimated Building Damage (excluding contents)**

Download forms: [www.atcouncil.org/placards-and-evaluation-forms](http://www.atcouncil.org/placards-and-evaluation-forms)

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**Posting**  
 Choose a posting based on the evaluation and team judgment. *Severe* conditions endangering the overall building are grounds for an Unsafe posting. Localized *Severe* and overall *Moderate* conditions may allow a Restricted Use posting. Post INSPECTED placard at main entrance. Post RESTRICTED USE and UNSAFE placards at all entrances.

INSPECTED (Green placard)    
  **RESTRICTED USE** (Yellow placard)    
  UNSAFE (Red placard)

Record any use and entry restrictions exactly as written on placard: \_\_\_\_\_

\_\_\_\_\_

**Further Actions** Check the boxes below only if further actions are needed.

Barricades needed in the following areas: \_\_\_\_\_

\_\_\_\_\_

Detailed Evaluation recommended:    
  Structural    
  Geotechnical    
  Other: \_\_\_\_\_

Other recommendations: \_\_\_\_\_

Comments: \_\_\_\_\_

\_\_\_\_\_

ATC-20

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## DETAILED EVALUATION

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Careful exterior and interior visual examination by more qualified team

Follows rapid evaluation when required

Important for essential facilities

ATC-20

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## DETAILED EVALUATION OF ESSENTIAL FACILITIES

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- Health care facilities
- Police and fire stations
- Jails and detention centers
- Emergency operations centers
- High-occupancy shelters
  - Schools, community centers

ATC-20

45

## DETAILED EVALUATION CRITERIA

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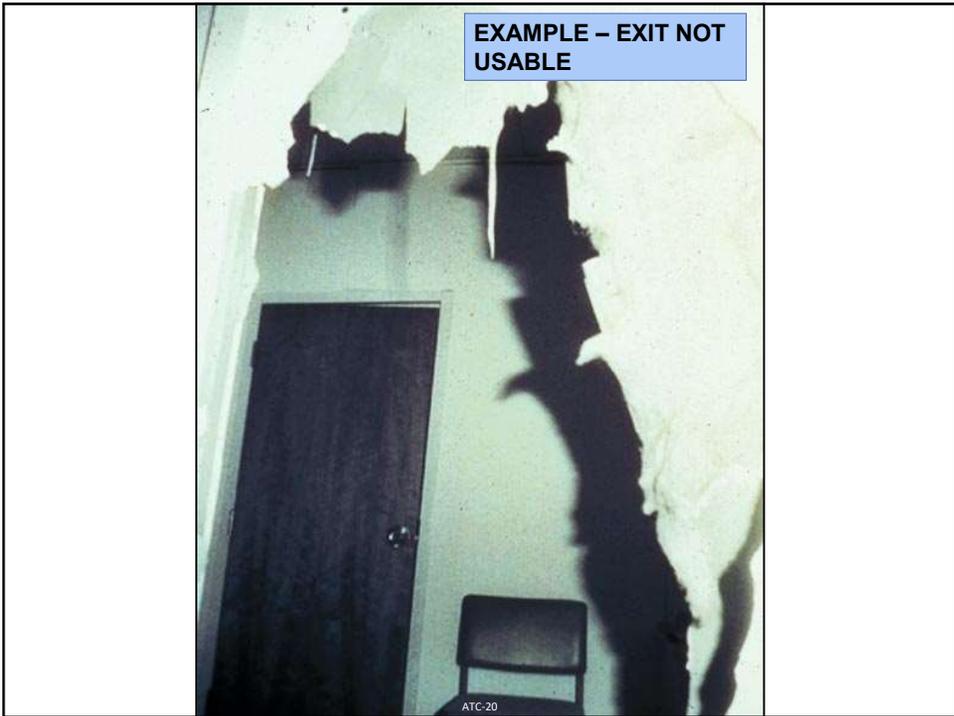
- Vertical load capacity not significantly decreased
- Lateral load capacity not significantly decreased
- No falling or other hazards present
- No evidence of foundation damage or ground displacement
- Main exits are usable
- No other unsafe condition

ATC-20

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ATC-20 Detailed Evaluation Safety Assessment Form

<b>Inspection</b> Inspector ID: _____ Affiliation: _____ Inspection date and time: _____ <input type="checkbox"/> AM <input type="checkbox"/> PM	<b>Final Posting</b> from page 2 <input type="checkbox"/> Inspected <input type="checkbox"/> Restricted Use <input type="checkbox"/> Unsafe
---	---

<b>Building Description</b> Building name: _____ Address: _____ Building contact/phone: _____ Number of stories above ground: _____ below ground: _____ Approx. "Footprint area" (square feet): _____ Number of residential units: _____ Number of residential units not habitable: _____	<b>Type of Construction</b> <input type="checkbox"/> Wood frame <input type="checkbox"/> Steel frame <input type="checkbox"/> Tilt-up concrete <input type="checkbox"/> Concrete frame <input type="checkbox"/> Concrete shear wall <input type="checkbox"/> Unreinforced masonry <input type="checkbox"/> Reinforced masonry <input type="checkbox"/> Other: _____ <b>Primary Occupancy</b> <input type="checkbox"/> Dwelling <input type="checkbox"/> Other residential <input type="checkbox"/> Public assembly <input type="checkbox"/> Emergency services <input type="checkbox"/> Commercial <input type="checkbox"/> Offices <input type="checkbox"/> Industrial <input type="checkbox"/> Other: _____ <input type="checkbox"/> Government <input type="checkbox"/> Historic <input type="checkbox"/> School
--	---

ATC-20

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**Evaluation**

Investigate the building for the conditions below and check the appropriate column. There is room on the second page for a sketch.

	Minor/None	Moderate	Severe	Comments
<b>Overall hazards:</b>				
Collapse or partial collapse	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Building or story leaning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Other _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
<b>Structural hazards:</b>				
Foundations	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Roofs, floors (vertical loads)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Columns, pilasters, corbels	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Diaphragms, horizontal bracing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Walls, vertical bracing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Precast connections	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Other _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
<b>Nonstructural hazards:</b>				
Parapets, ornamentation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Cladding, glazing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Ceilings, light fixtures	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Interior walls, partitions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Elevators	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Stairs, exits	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Electric, gas	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Other _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
<b>Geotechnical hazards:</b>				
Slope failure, debris	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Ground movement, fissures	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Other _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
<b>General Comments:</b> _____				

ATC-20

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WAsafe Building Safety Evaluations (ATC-20/45 Plus) - Module 4

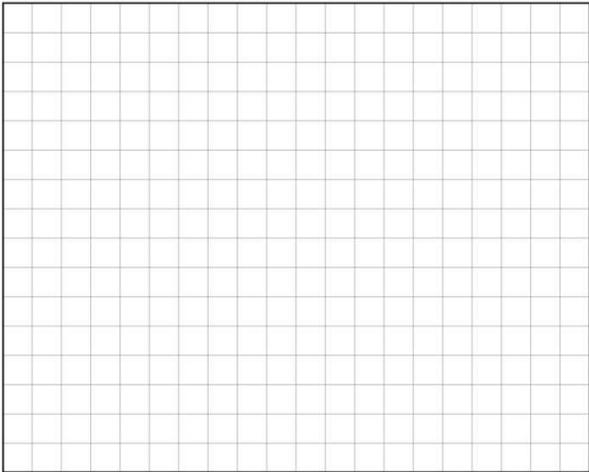
25

Building name: \_\_\_\_\_ Inspector ID: \_\_\_\_\_

**Sketch (optional)**  
Provide a sketch of the building or damaged portions. Indicate damage points.

**Estimated Building Damage**  
If requested by the jurisdiction, estimate building damage (repair cost + replacement cost, excluding contents).

None  
 0-1%  
 1-10%  
 10-30%  
 30-60%  
 60-100%  
 100%



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**Posting**  
If there is an existing posting from a previous evaluation, check the appropriate box.

Previous posting:  INSPECTED  RESTRICTED USE  UNSAFE Inspector ID: \_\_\_\_\_ Date: \_\_\_\_\_

If necessary, revise the posting based on the new evaluation and team judgment. *Severe* conditions endangering the overall building are grounds for an Unsafe posting. Local *Severe* and overall *Moderate* conditions may allow a Restricted Use posting. Indicate the current posting below and at the top of page one.

INSPECTED (Green placard)  RESTRICTED USE (Yellow placard)  UNSAFE (Red placard)

Record any use and entry restrictions exactly as written on placard: \_\_\_\_\_

---

**Further Actions** Check the boxes below only if further actions are needed.

Barricades needed in the following areas: \_\_\_\_\_

Engineering Evaluation recommended:  Structural  Geotechnical  Other: \_\_\_\_\_

Other recommendations: \_\_\_\_\_

Comments: \_\_\_\_\_

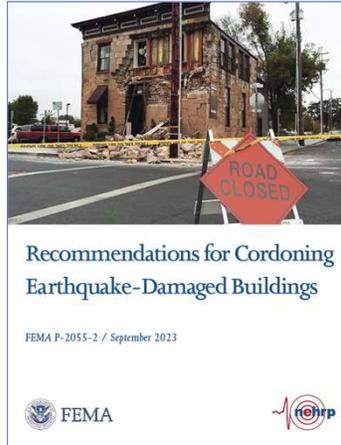
ATC-20

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## ESTABLISHING CORDON AREAS

### FEMA P-2055-2

- Guidance on how far to cordon from failed buildings (“collapse/fall shadow,” “debris shadow”), how to manage cordon areas
- Based on research on how buildings and components fail and lessons from multiple-year closure of Christchurch central business district

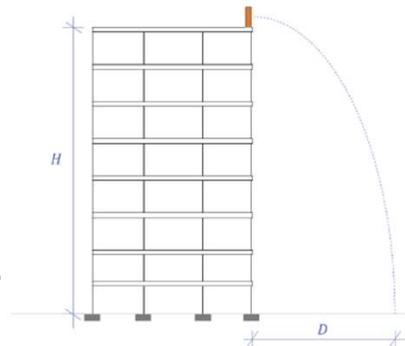


WASAFEBSE MODULE 4

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## INITIAL CORDON DISTANCE (RAPID EVAL)

“Immediately after the damaging event, armed only with the knowledge of obvious serious damage or visible lean of a building, **an initial emergency cordon distance,  $D$ , equal to the height of the building above the significant damage or hinge point is prudent.**”

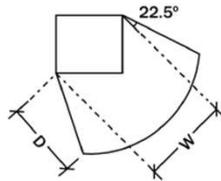


Source: FEMA P-2055-2

WASAFEBSE MODULE 4

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## REFINED CORDON DISTANCE (ENGINEERING EVAL)

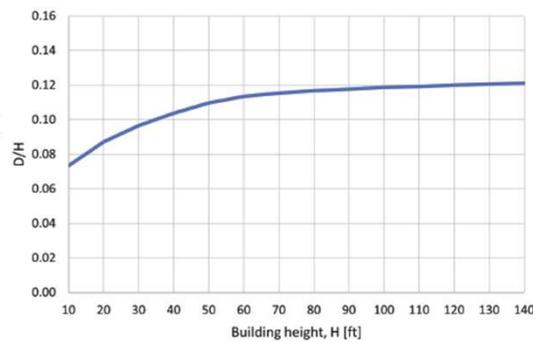
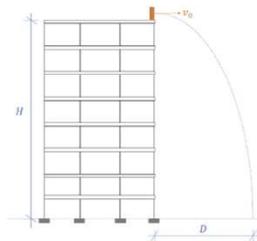
Structure Type	Visible Damage and Potential Collapse Mode	Collapse Shadow Cordon Area
Frame (steel, concrete, wood)	 <p>Sideways mechanism: Progressive collapse mechanism likely per engineering evaluation <b>See Section 3.2.2: Story Mechanism</b></p>	 <p>45-degree circular wedge area, oriented along azimuth of tilt, with cordon distance <math>D</math>, where: <math>D</math> = height of building</p>

Source: FEMA P-2055-2

WASAFBSE MODULE 4

55

## DEBRIS SHADOW



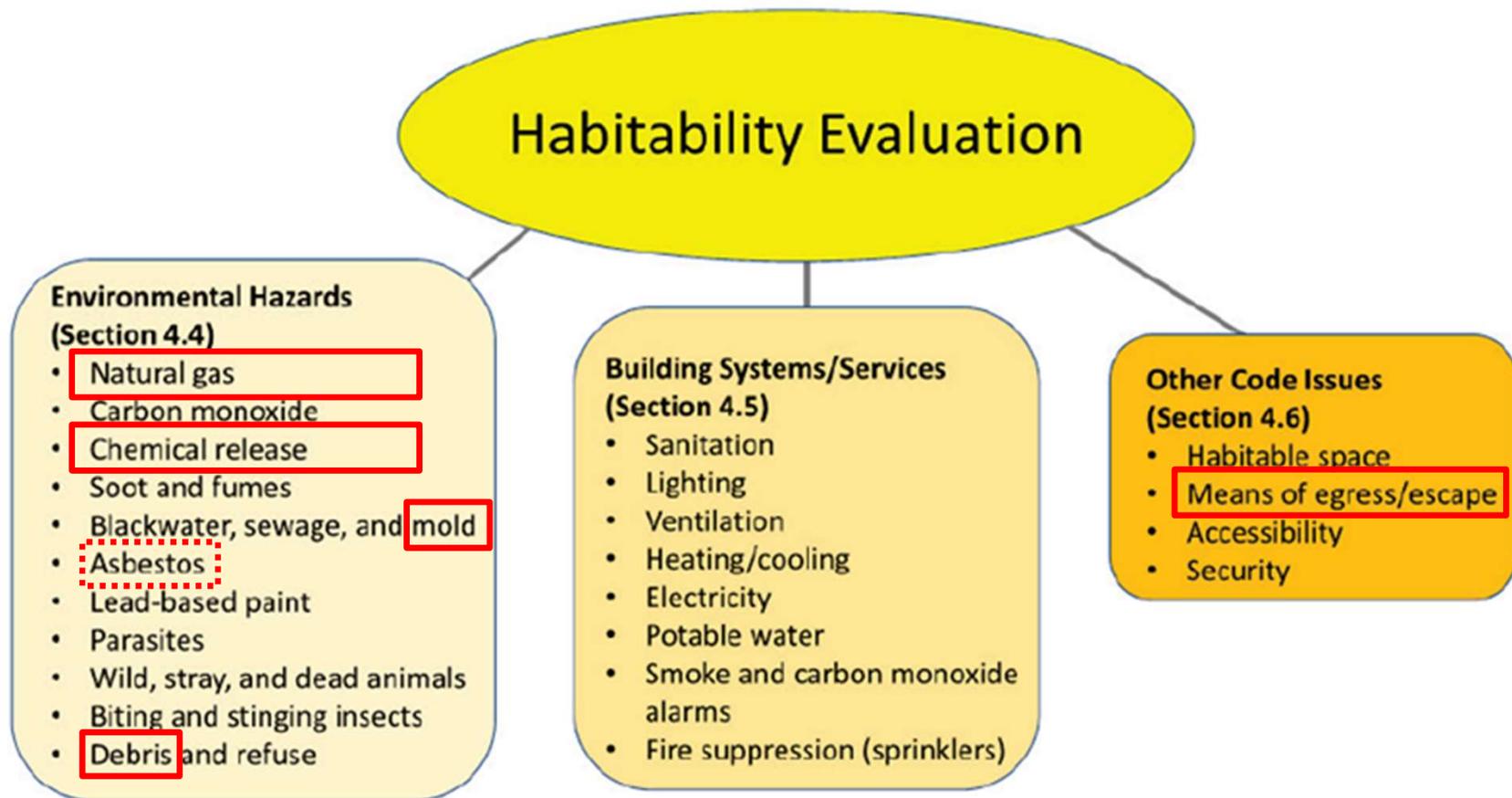
Source: FEMA P-2055-2

WASAFBSE MODULE 4

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# HABITABILITY EVALUATION

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Source: FEMA P-2055-1

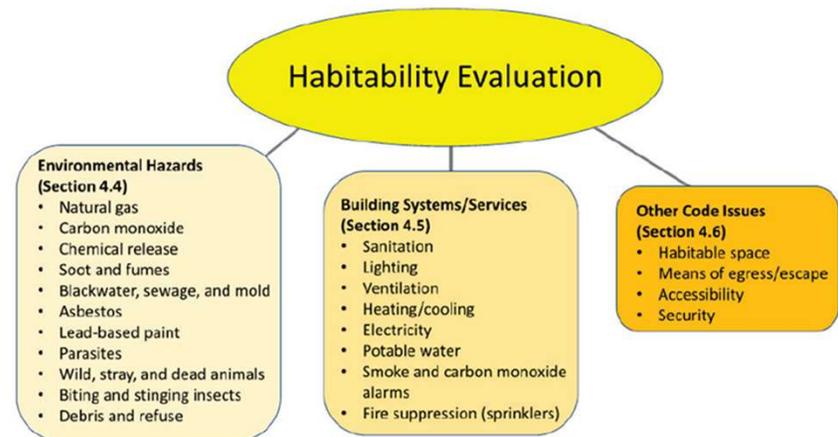
# HABITABILITY POLICIES

---

Building Official needs to decide:

- Add habitability as a criterion for placards?
- Which issues must be evaluated?
- What is unsafe?
- Flexibility in larger events?

Develop and communicate standards to BSEs



Source: FEMA P-2055-1

# HABITABILITY POLICIES (POLITICS!)

---

Building Official needs to decide:

- Add habitability as a criterion for placards?
- Which issues must be evaluated?
- What is unsafe?
- Flexibility in larger events?

Develop and communicate standards to BSEs

WAsafe encourages erring on side of allowing safe buildings to be reoccupied

## PROGRAM FOCUS

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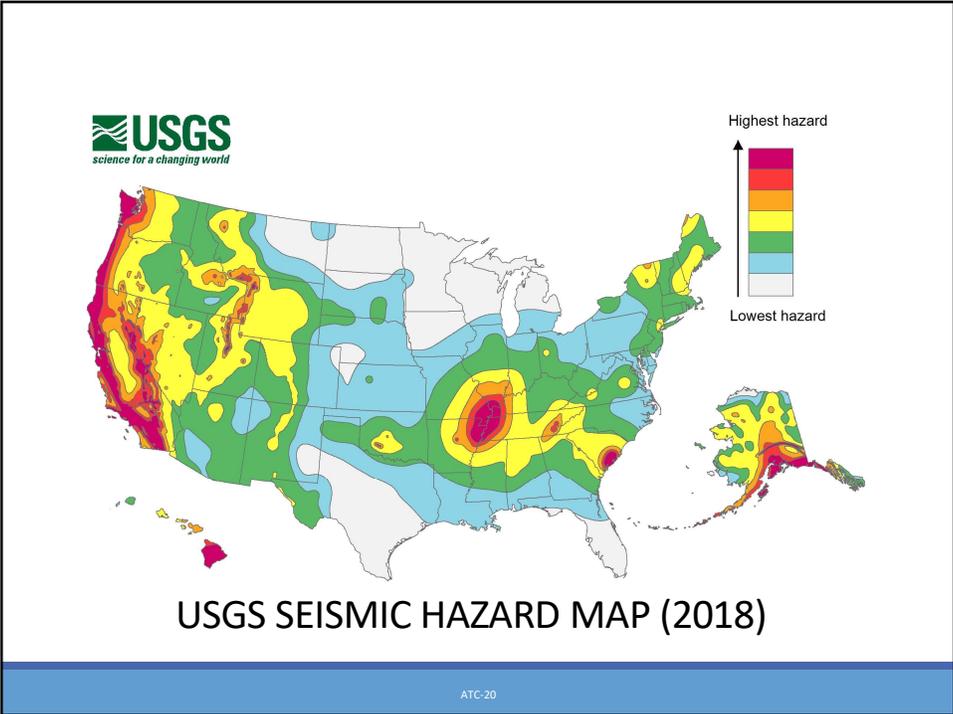
Reoccupy safe buildings

WASAFE BSE MODULE 1

# SEISMIC HAZARD OVERVIEW

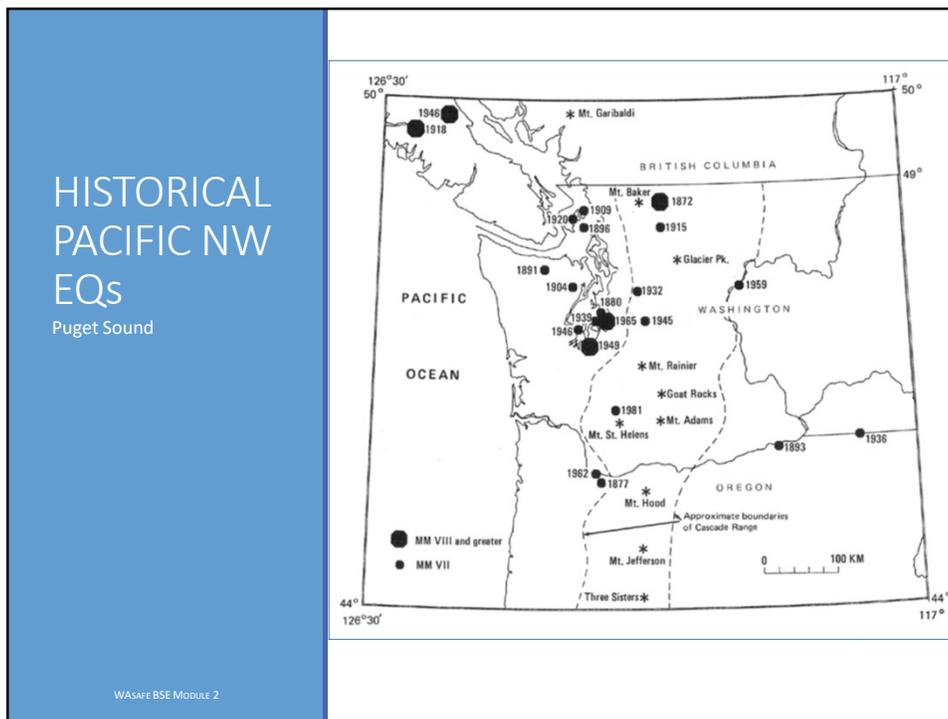
WASAFE BSE MODULE 2

1

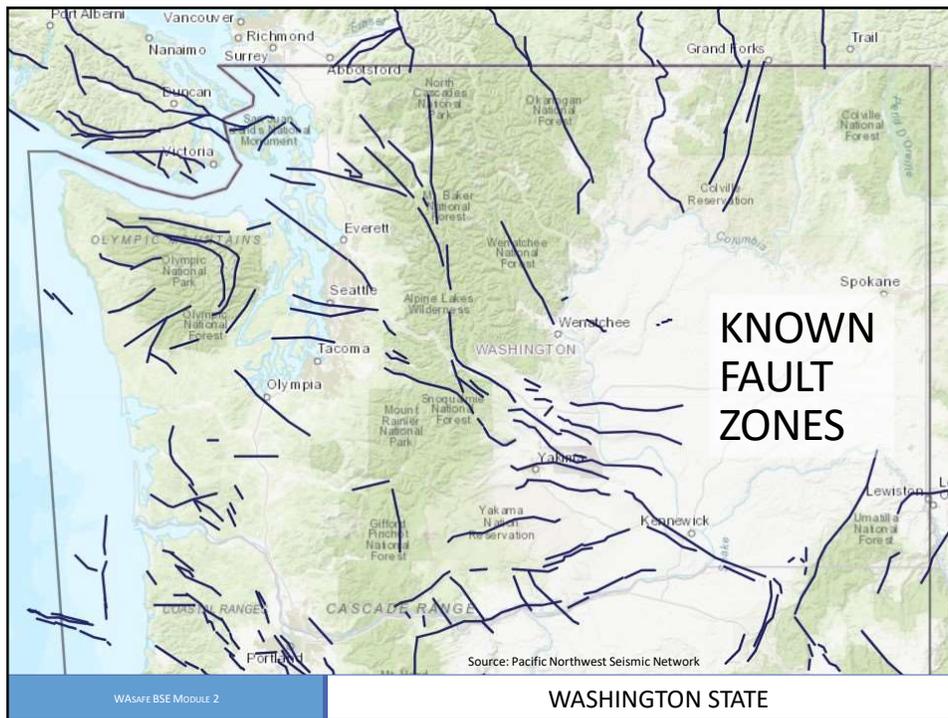


ATC-20

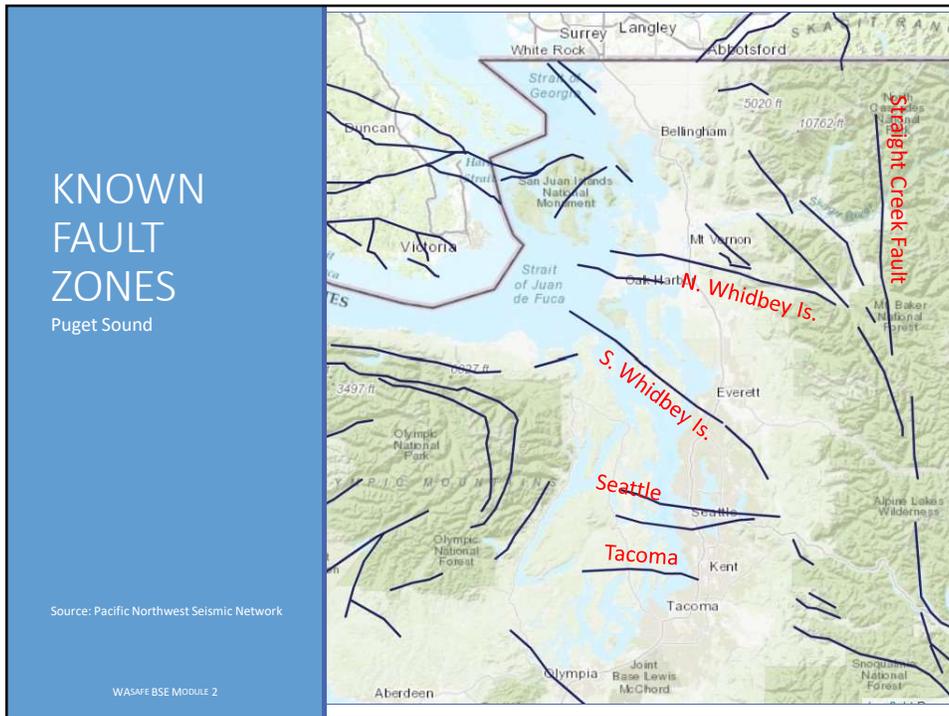
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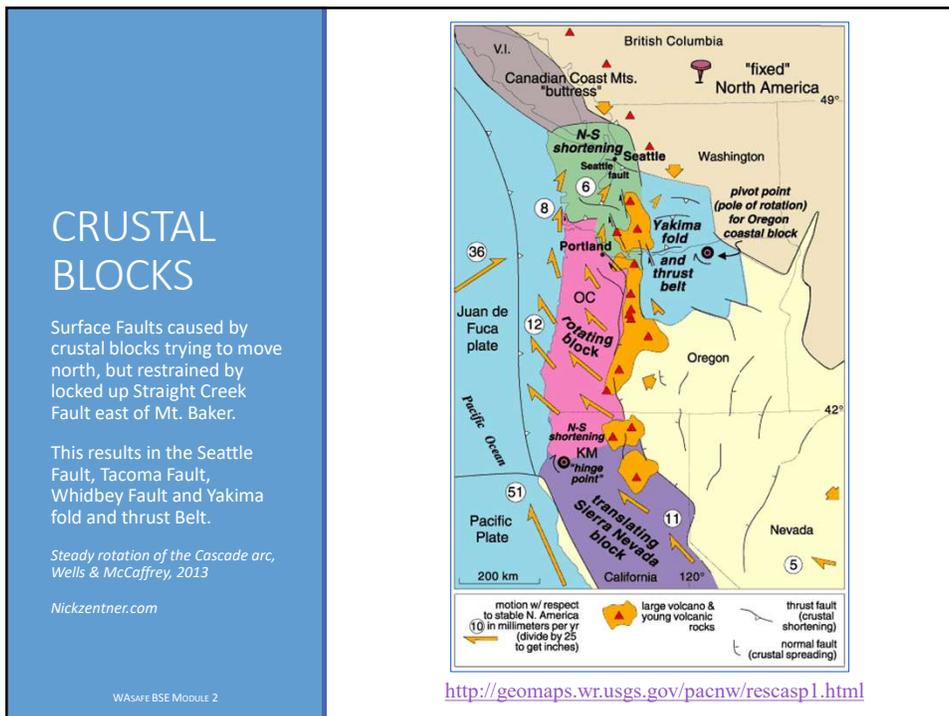
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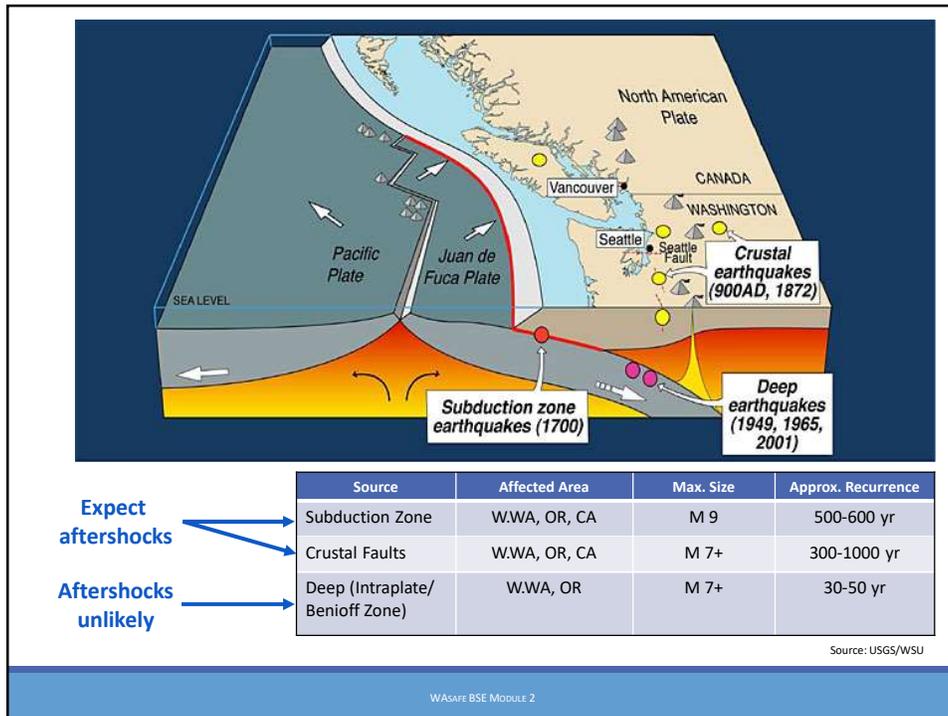
4



5



6



7

### RICHTER SCALE

---

Richter Magnitude ( $M_L$ )      4       $\rightarrow$       6       $\rightarrow$       8

Energy Increase Ratio              1,000              1,000

**Moment Magnitude ( $M_w$ ) more commonly used today**

### MODIFIED MERCALLI INTENSITY SCALE

---

**MMI VI**      Windows broken. Books off shelves. Weak plaster cracked.

**MMI VII**      Damage to weakest masonry. Weak chimneys broken. Fall of plaster, loose bricks, tiles, unbraced parapets.

**MMI VIII**      Damage to weak masonry, partial collapse. Frame houses moved on foundations.

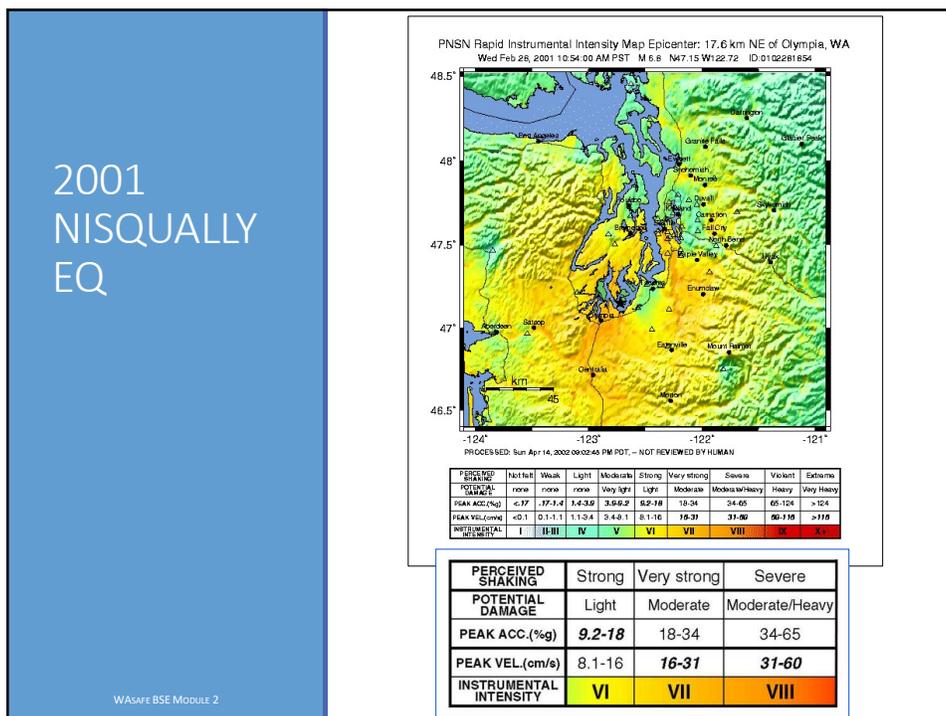
ATC-20

8

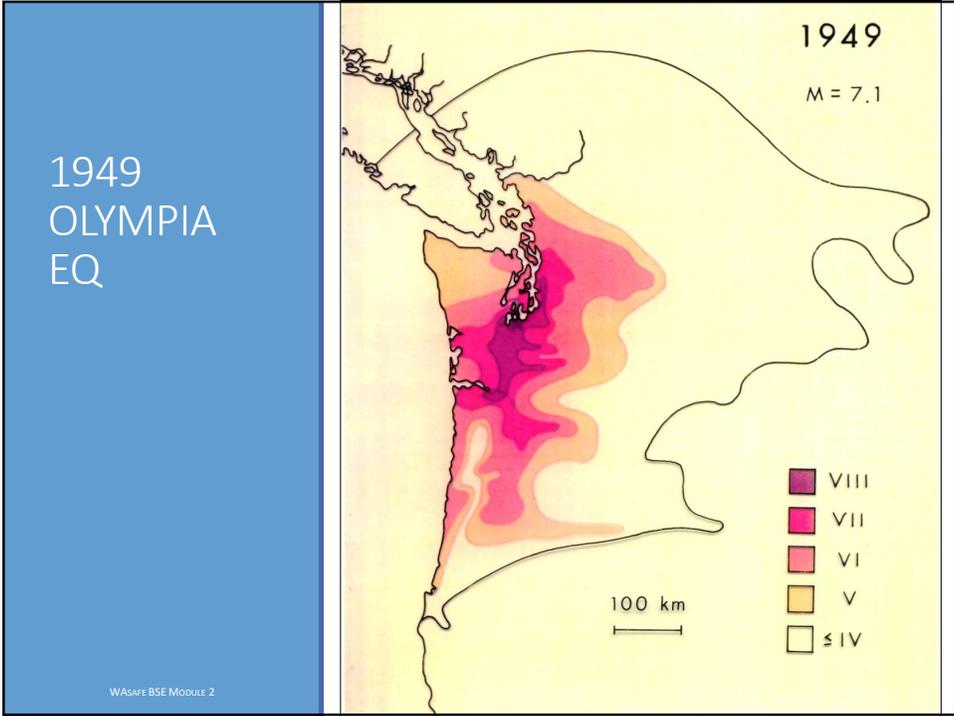
CIM Intensity	People's Reaction	Furnishings	Built Environment	Natural Environment
I	Not felt			Changes in level and clarity of well water are occasionally associated with great earthquakes at distances beyond which the earthquakes felt by people.
II	Felt by a few.	Delicately suspended objects may swing.		
III	Felt by several; vibration like passing of truck.	Hanging objects may swing appreciably.		
IV	Felt by many; sensation like heavy body striking building.	Dishes rattle.	Walls creak; window rattle.	
V	Felt by nearly all; frightens a few.	Pictures swing out of place; small objects move; a few objects fall from shelves within the community.	A few instances of cracked plaster and cracked windows with the community.	Trees and bushes shaken noticeably.
VI	Frightens many; people move unsteadily.	Many objects fall from shelves.	A few instances of fallen plaster, broken windows, and damaged chimneys within the community.	Some fall of tree limbs and tops, isolated rockfalls and landslides, and isolated liquefaction.
VII	Frightens most; some lose balance.	Heavy furniture overturned.	Damage negligible in buildings of good design and construction, but considerable in some poorly built or badly designed structures; weak chimneys broken at roof line, fall of unbraced parapets.	Tree damage, rockfalls, landslides, and liquefaction are more severe and widespread with increasing intensity.
VIII	Many find it difficult to stand.	Very heavy furniture moves conspicuously.	Damage slight in buildings designed to be earthquake resistant, but severe in some poorly built structures. Widespread fall of chimneys and monuments.	
IX	Some forcibly thrown to the ground.		Damage considerable in some buildings designed to be earthquake resistant; buildings shift off foundations if not bolted to them.	
X			Most ordinary masonry structures collapse; damage moderate to severe in many buildings designed to be earthquake resistant.	

WASAFE BSE MODULE 2

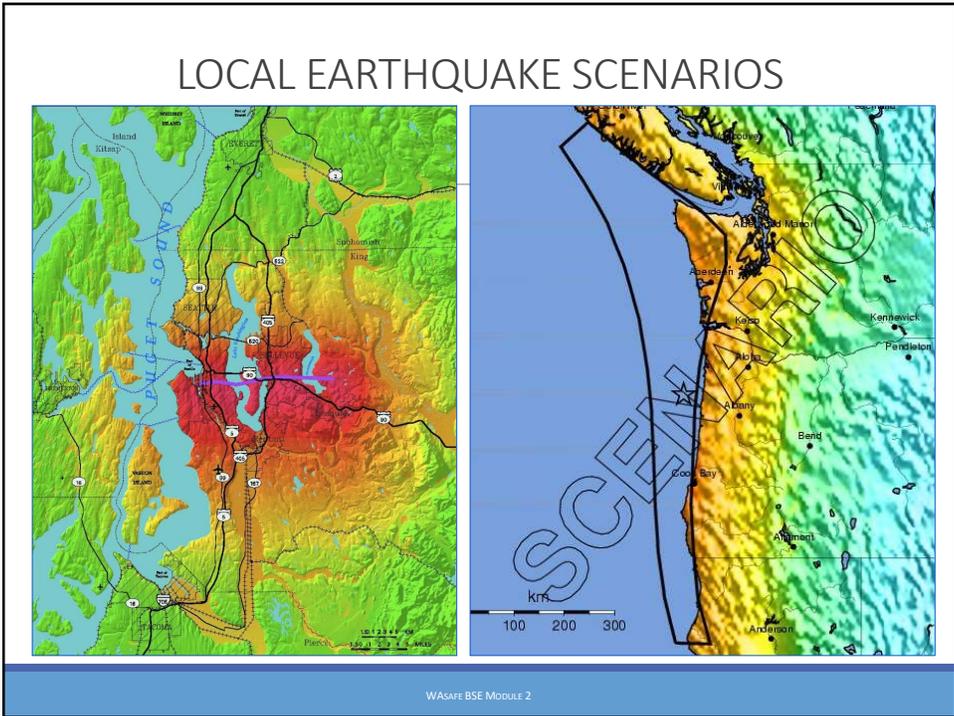
9



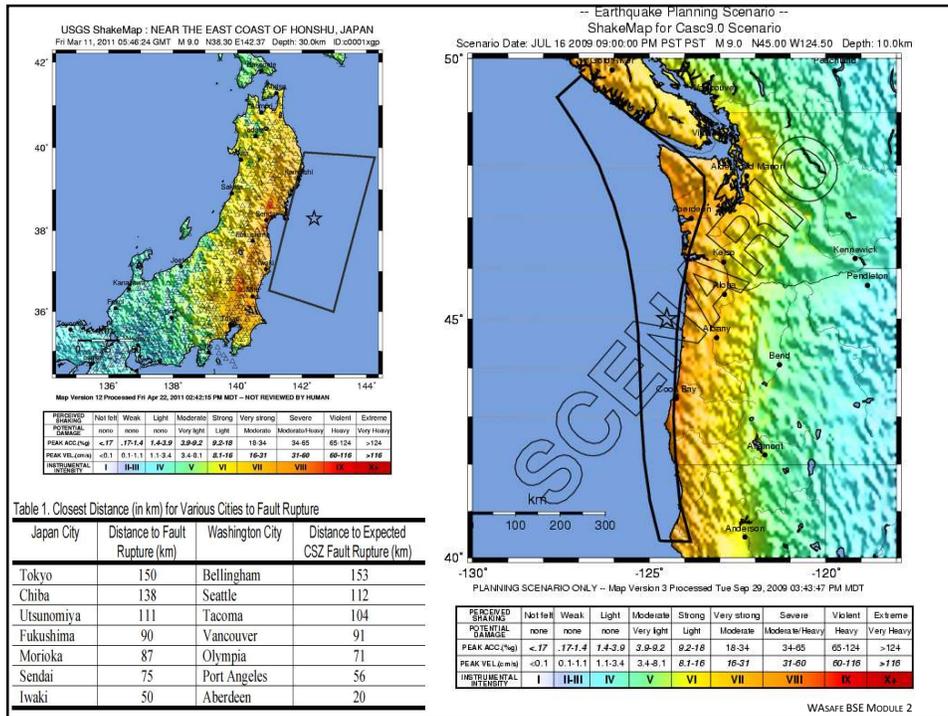
10



11



12



13

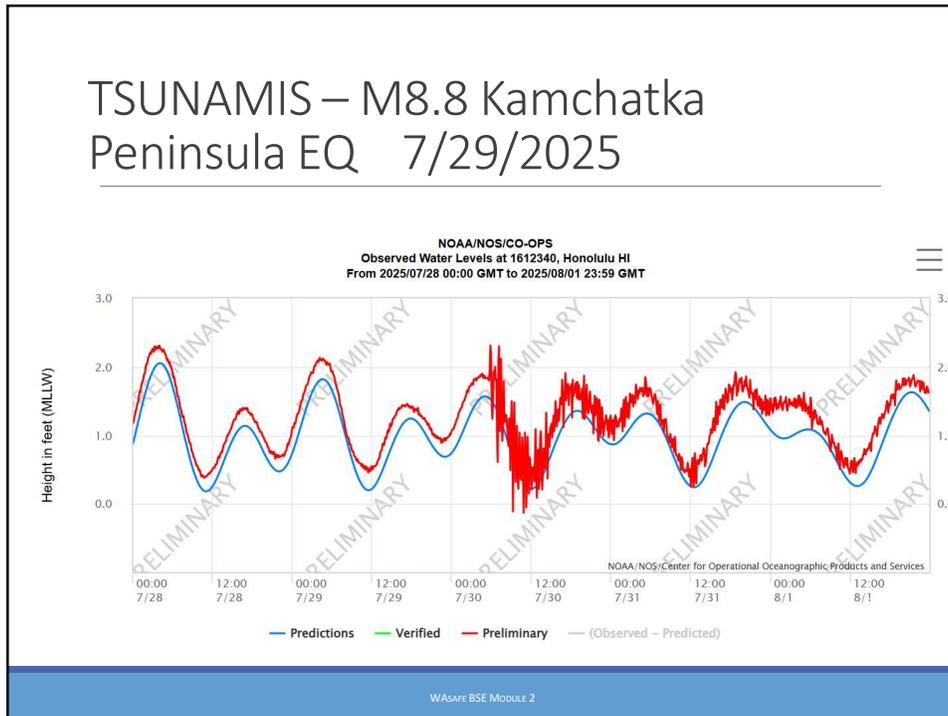
## TSUNAMIS

Southern Puget Sound – shallow crustal events e.g., Tacoma or [Seattle Fault](#) event

Major issue on coast, northern Puget Sound, Hood Canal, in [Cascadia](#) subduction event

WASAFE BSE MODULE 2

14



15

## TSUNAMIS

Tsunami-resistant design provisions in ASCE 7-16 (2018 WSBC), ASCE 7-22 (2021 WSBC)

Mandatory for RC III & IV  
Optional for RC II

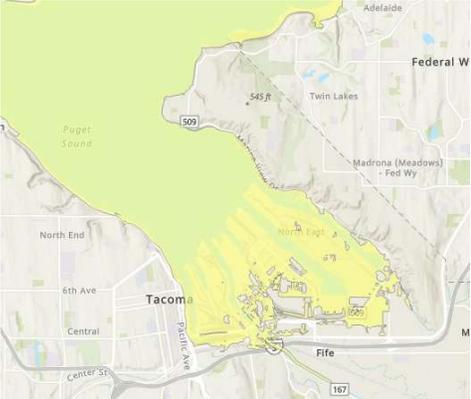
<https://www.dnr.wa.gov/wa-tdz>

WASAFE BSE MODULE 2

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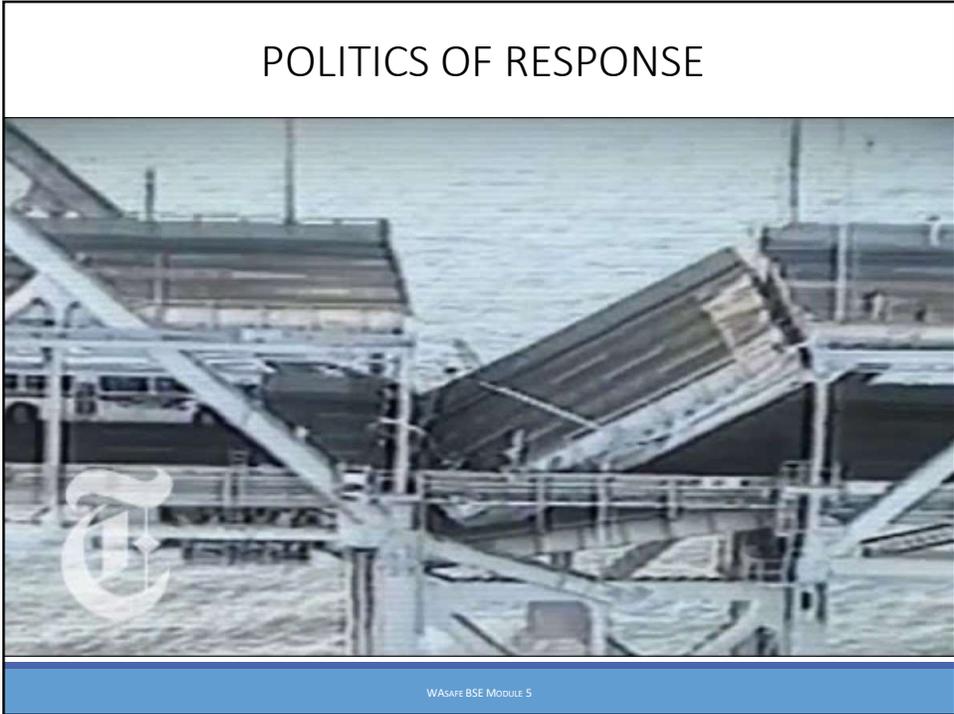
# TSUNAMI HAZARD - TACOMA

## Cascadia & Tacoma Faults

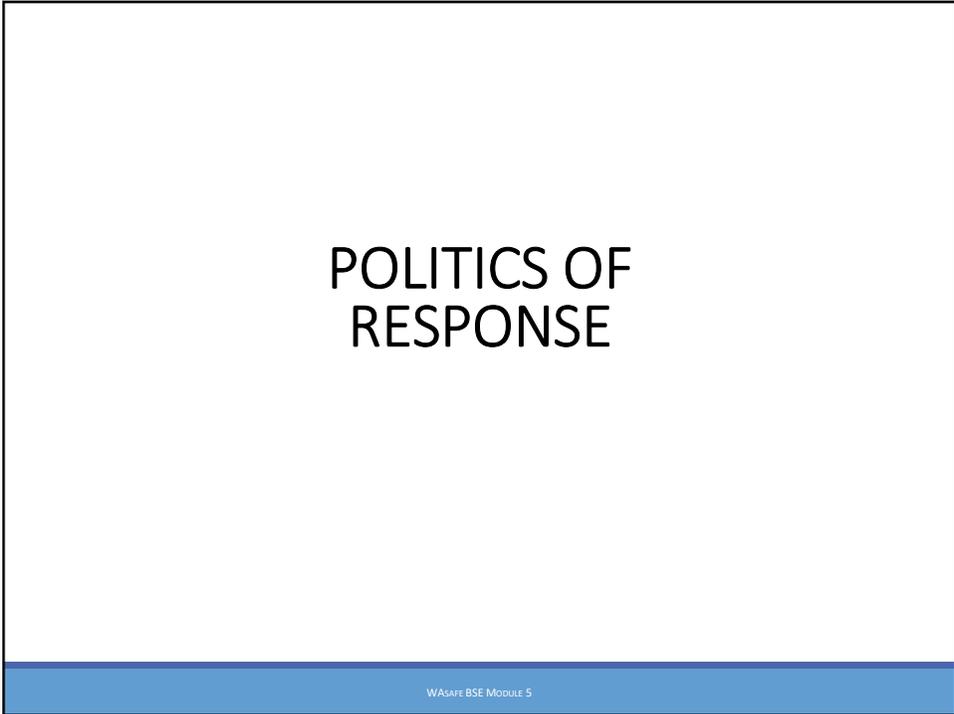


Washington Geologic Information Portal

WASAFE BSE MODULE 2



1



2

## POLITICS OF RESPONSE



Photo: Nourok



Photo: Nitikin

WASAFE BSE MODULE 5

3

### “THE LOMA PRIETA QUAKE: WHAT ONE CITY LEARNED” (R. Wilson)

“The city was ... under enormous pressure to provide access to damaged buildings.”

“Residents wanted to remove ... valued personal belongings ... cash and essential documents.”

“Business owners wanted to remove inventory ... computers ... files.”

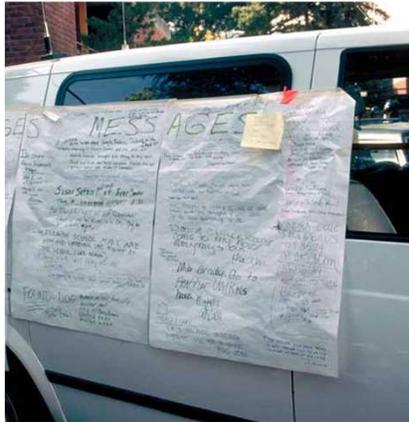
“At each afternoon’s city council meeting they pleaded for access.”

“We had to decide whether to err on the side of access or safety. The needs for access were urgent and compelling, but the dangers were real and manifest.”

ATC-20

4

## “THE LOMA PRIETA QUAKE: WHAT ONE CITY LEARNED” (R. Wilson)



“Many of the occupants of even the three most seriously damaged buildings were **more than prepared to risk their lives** to remove contents.”

“Final decisions about access of course fell to me.”

ATC-20

5

## MANAGE EXPECTATIONS

Expect chaos in the beginning

Police/Fire/Emergency Management call the shots

1st priority – to establish \$ value of damage for Presidential declaration (limited timeframe)

**Tagging is not a first response**

Pre-plan priority buildings

Plan before doing

Manage upwards (don't let politicians make promises w/o checking with you)

Manage public expectations (esp. in moderate event)

WASAFE BSE MODULE 5

6

## COSTS & FEMA

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Begin tracking costs immediately

FEMA will reimburse for consultant contracts, and supplies/equipment

Includes inspection kits, supplies for volunteers, etc.

FEMA will not reimburse for regular staff time – only overtime

WASAFE BSE MODULE 5

7

## DEALING WITH OUTSIDE HELP

---

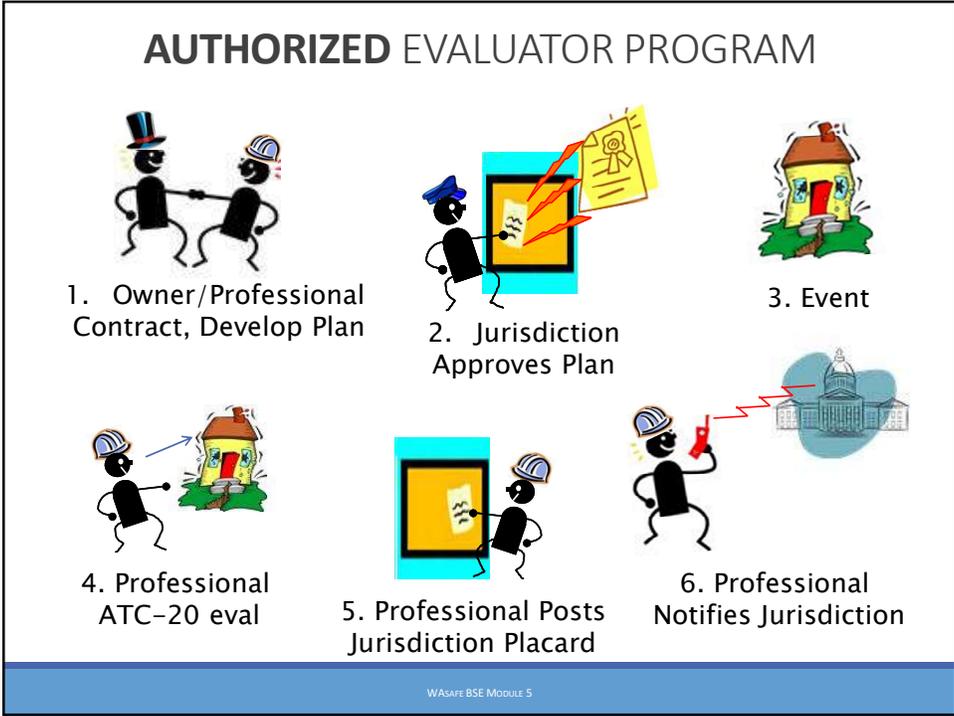
Options for deploying:

1. Deputize mutual aid & volunteers *ad hoc*
  - WAsafe
2. Accelerated Building Reoccupancy (ABR) Programs
  - a. FEMA P-2055-1 (January 2023)
  - b. Authorized Evaluator Program
    - Pre-deputize private sector professionals
  - c. Advisory Evaluator Program
    - Owner/private sector professional agreement
    - WABO/SEAW White Paper 5-2021  
[www.wabo.org](http://www.wabo.org) or [www.seaw.org](http://www.seaw.org)

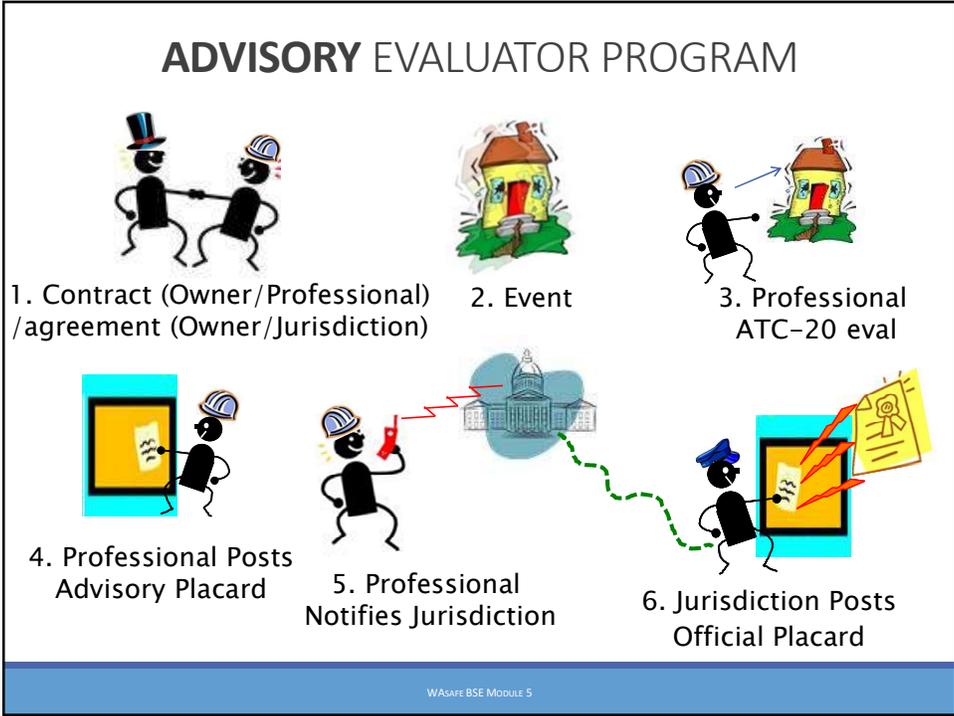


WASAFE BSE MODULE 5

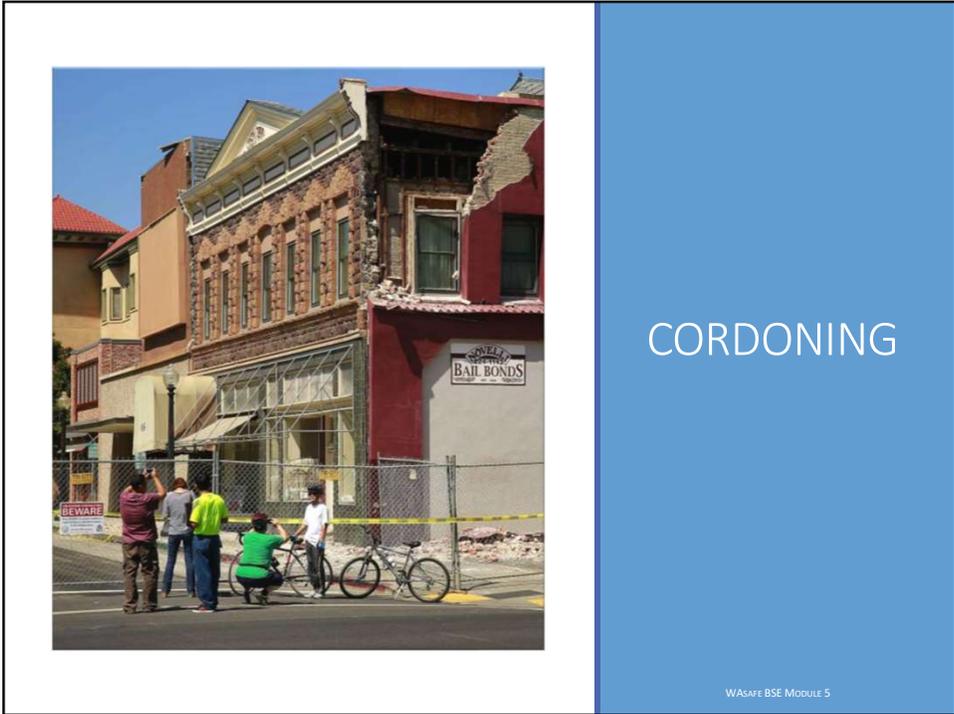
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9



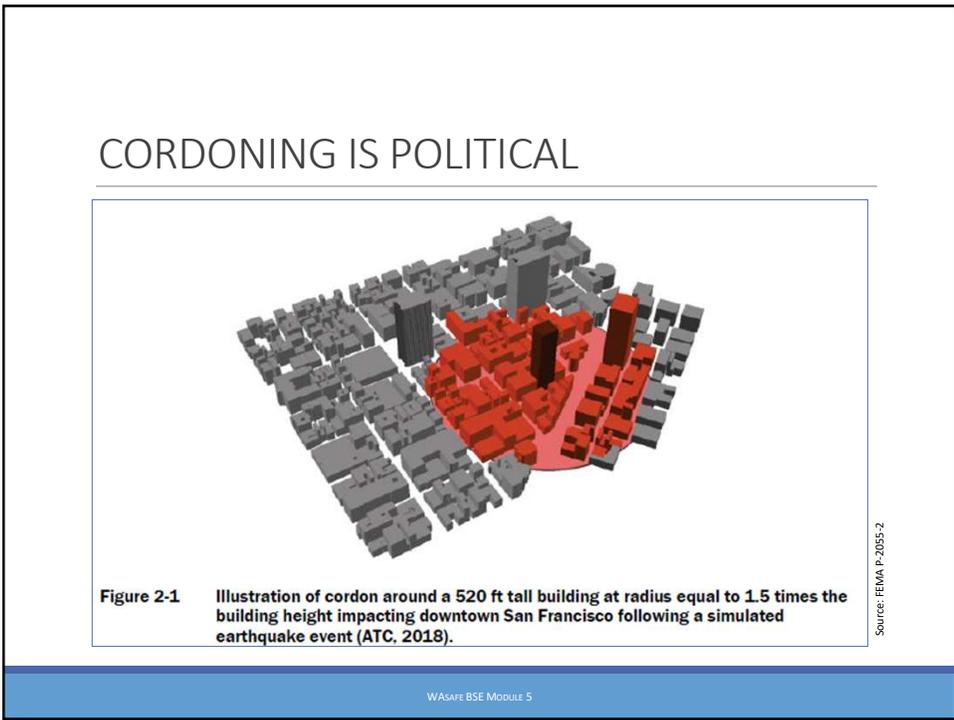
10



# CORDONING

WASAFE BSE MODULE 5

11



WASAFE BSE MODULE 5

12

# CORDONING IS POLITICAL CHRISTCHURCH, NEW ZEALAND



By Stefan Kracke SCK 2010 - Flickr: Grand Chancellor

WASAFE BSE MODULE 5

13

# CORDONING IS POLITICAL

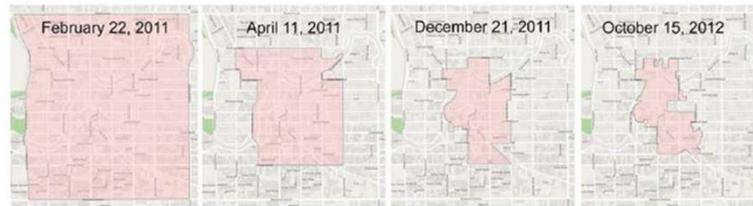
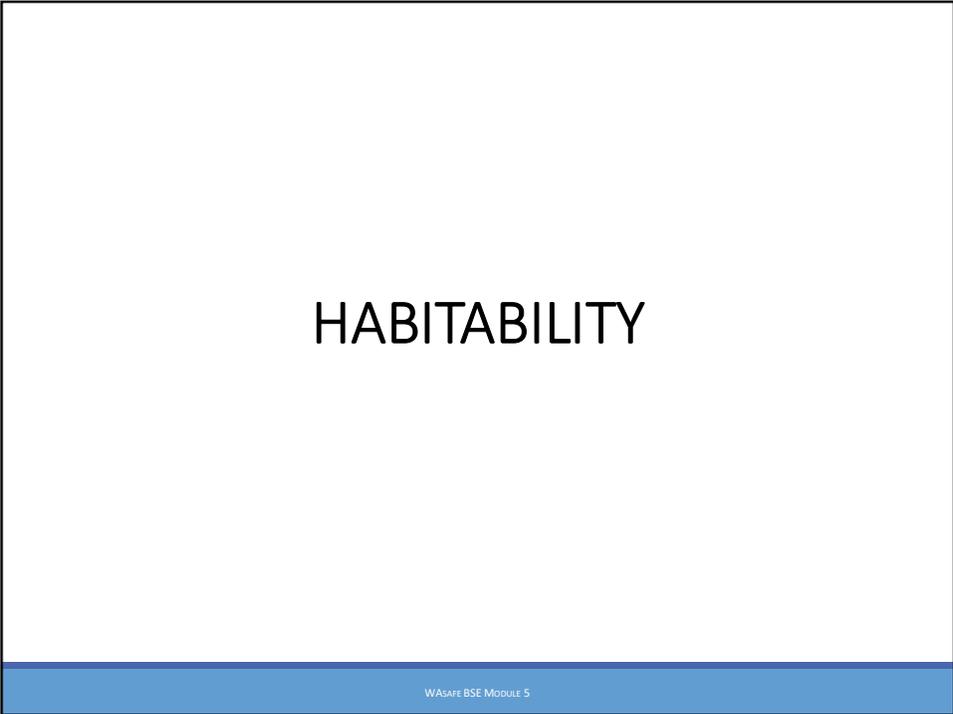


Figure 2-2 Evolution of the CBD cordon in Christchurch (Image from (Shrestha et al. 2022)).

Source: FEMA P-2055-2

WASAFE BSE MODULE 5

14



15

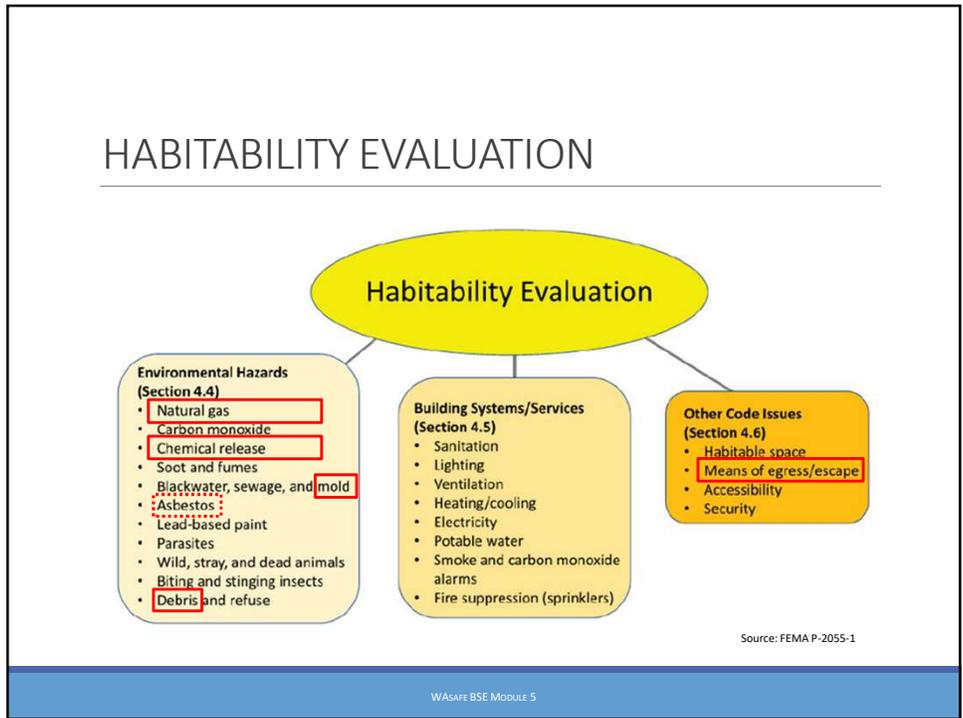
HABITABILITY – WHAT IS IT?

---

Used in FEMA P-2055  
Equated with “occupiability”  
Not limited to residential  
Evaluation based on factors other than structural

WASAFE BSE MODULE 5

16



17

## HABITABILITY POLICIES

Building Official needs to decide:

- Add habitability as a criterion for placards?
- Which issues must be evaluated?
- What is unsafe?
- Flexibility in larger events?

Develop and communicate standards to BSEs

Source: FEMA P-2055-1

WASAFE BSE MODULE 5

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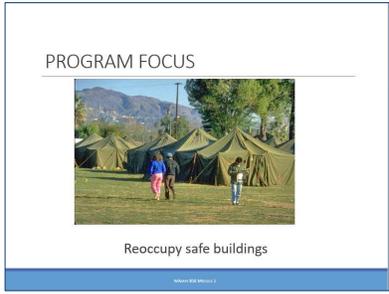
# HABITABILITY POLICIES (POLITICS!)

Building Official needs to decide:

- Add habitability as a criterion for placards?
- Which issues must be evaluated?
- What is unsafe?
- Flexibility in larger events?

Develop and communicate standards to BSEs

WAsafe encourages erring on side of allowing safe buildings to be reoccupied



STRUCTURAL BASICS

ATC-20

1

STRUCTURAL BASICS

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Walls and frames

Redundancy

Brittleness/ductility

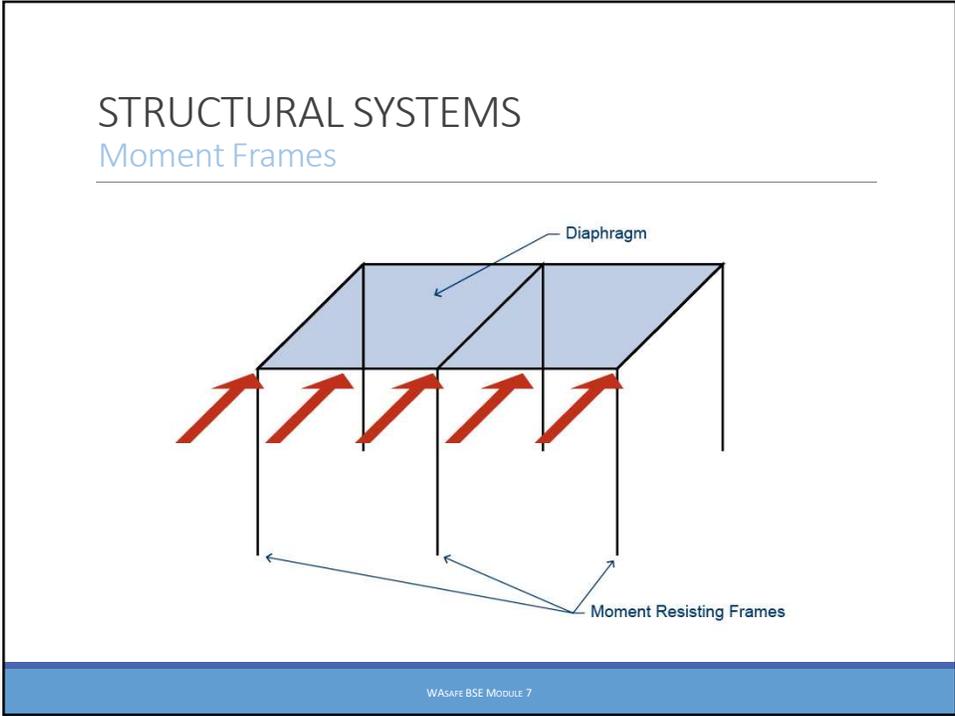
Dynamic behavior

Degradation of structural

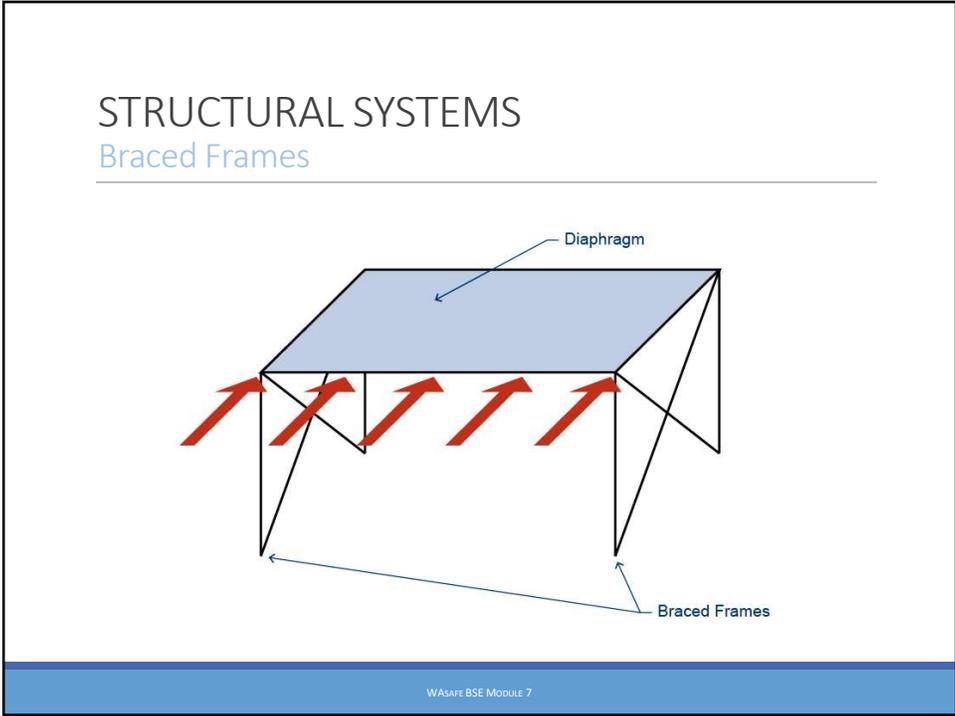
- Strength
- Stiffness
- Stability

ATC-20

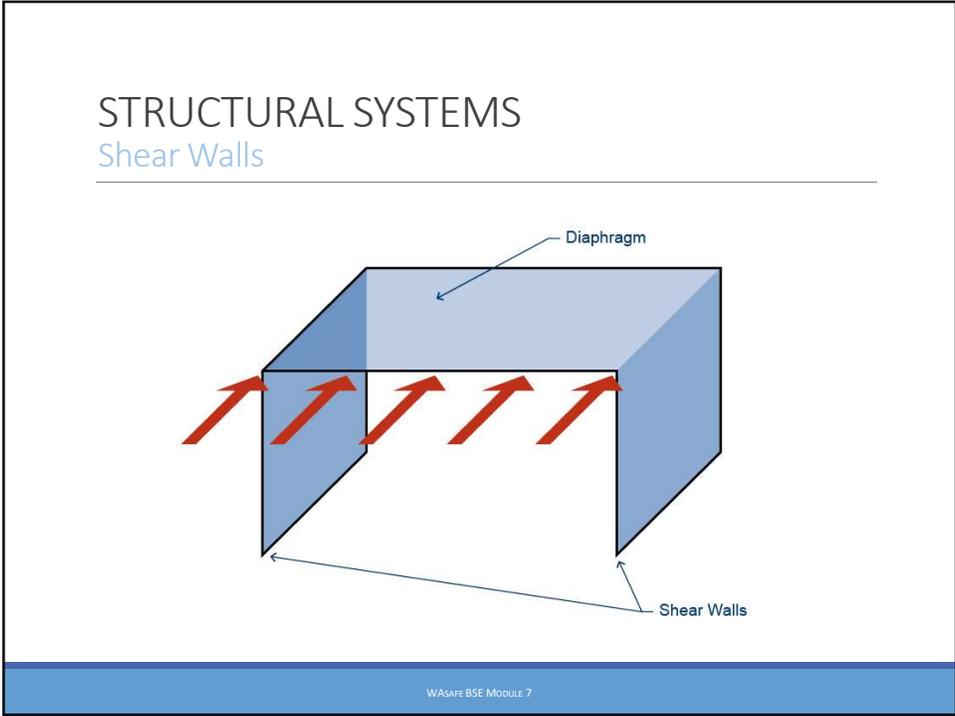
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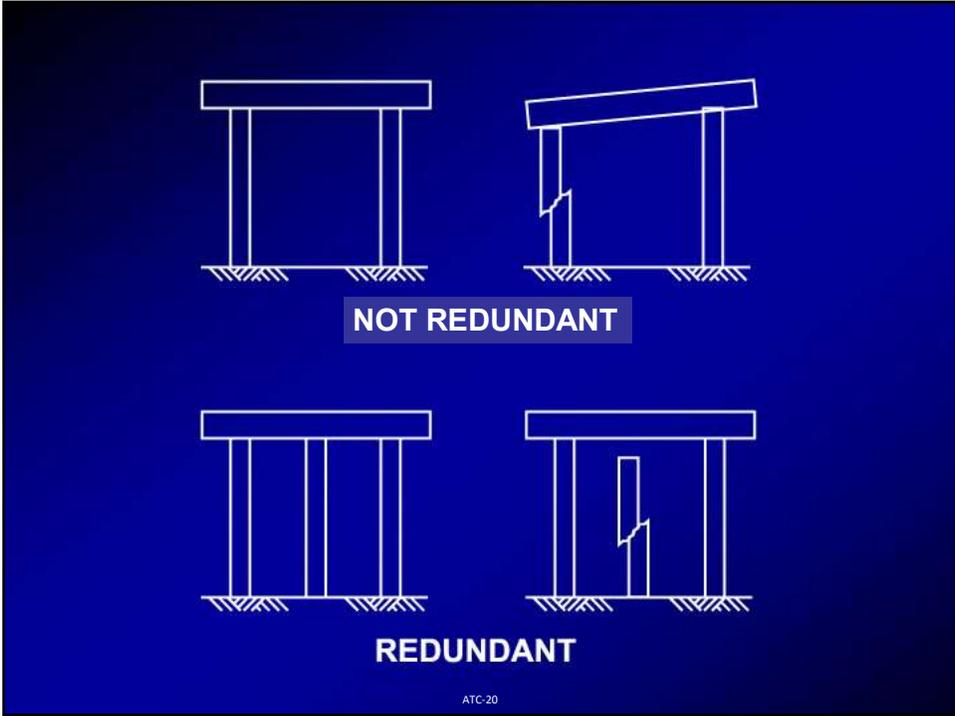
3



4



5



6

# REDUNDANCY



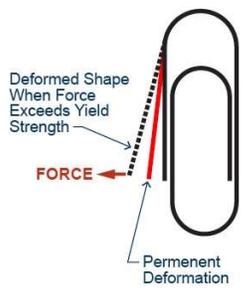
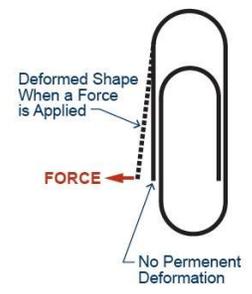
WASAFE BSE MODULE 7

7

# DUCTILE BEHAVIOR

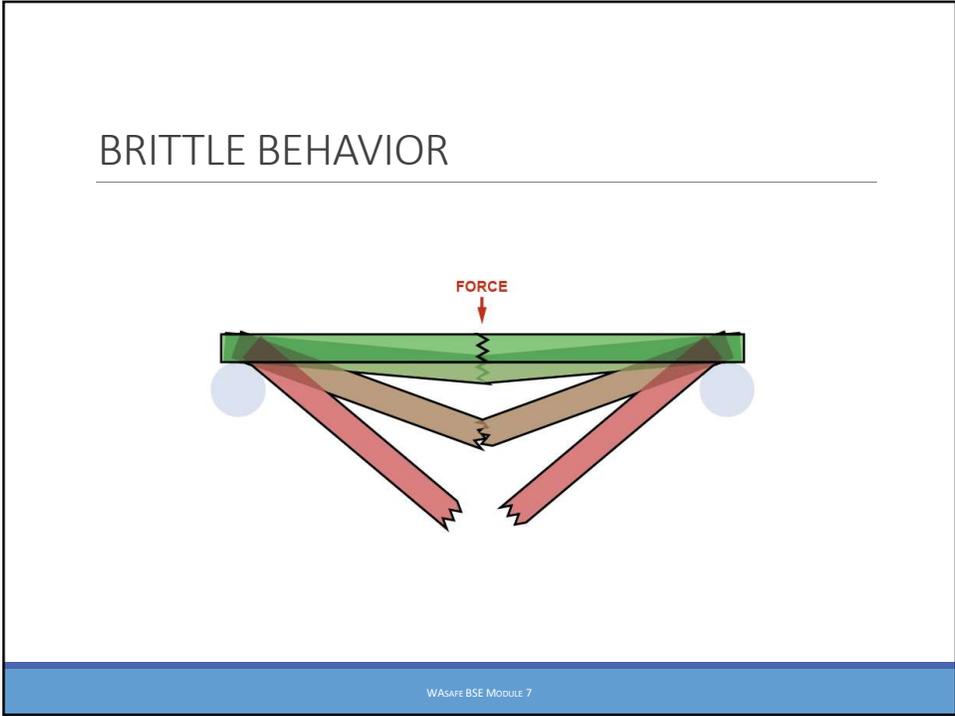
FORCE < YIELD STRENGTH

FORCE > YIELD STRENGTH



WASAFE BSE MODULE 7

8



9



10

## BUILDING DYNAMIC BEHAVIOR

ATC-20

11

## RESONANCE

WASAFE BSE MODULE 7

12

# BUILDING RESPONSE

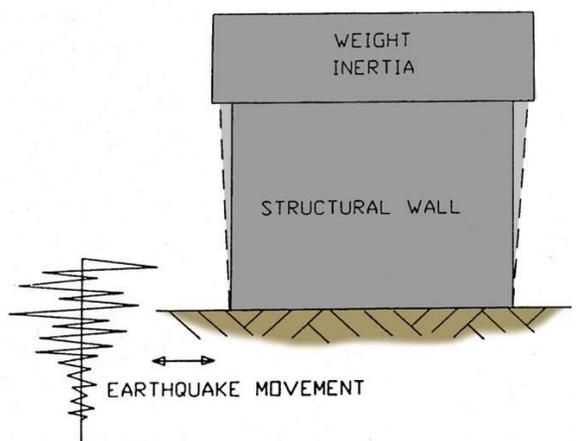
[https://youtu.be/LV\\_UuzEznHs](https://youtu.be/LV_UuzEznHs)



WASAFE BSE MODULE 7

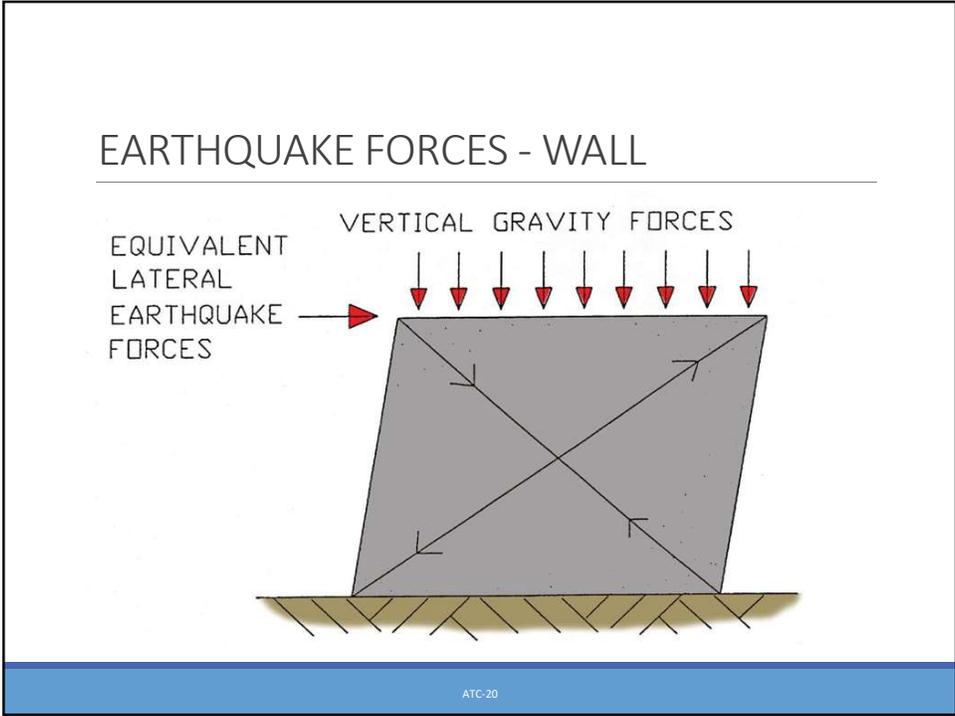
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# EARTHQUAKE FORCES

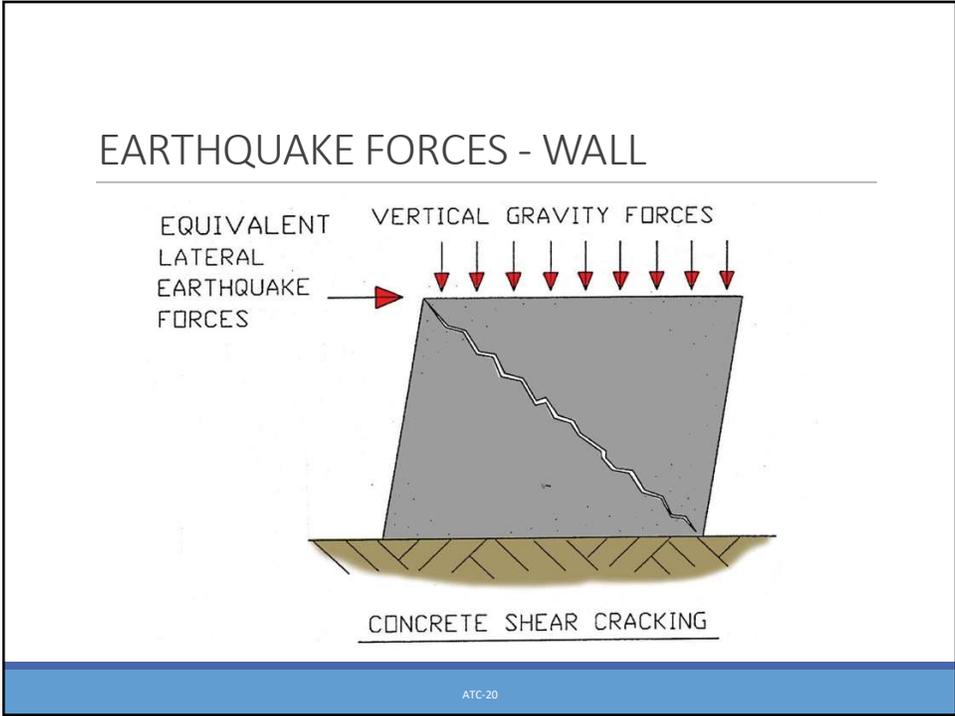


ATC-20

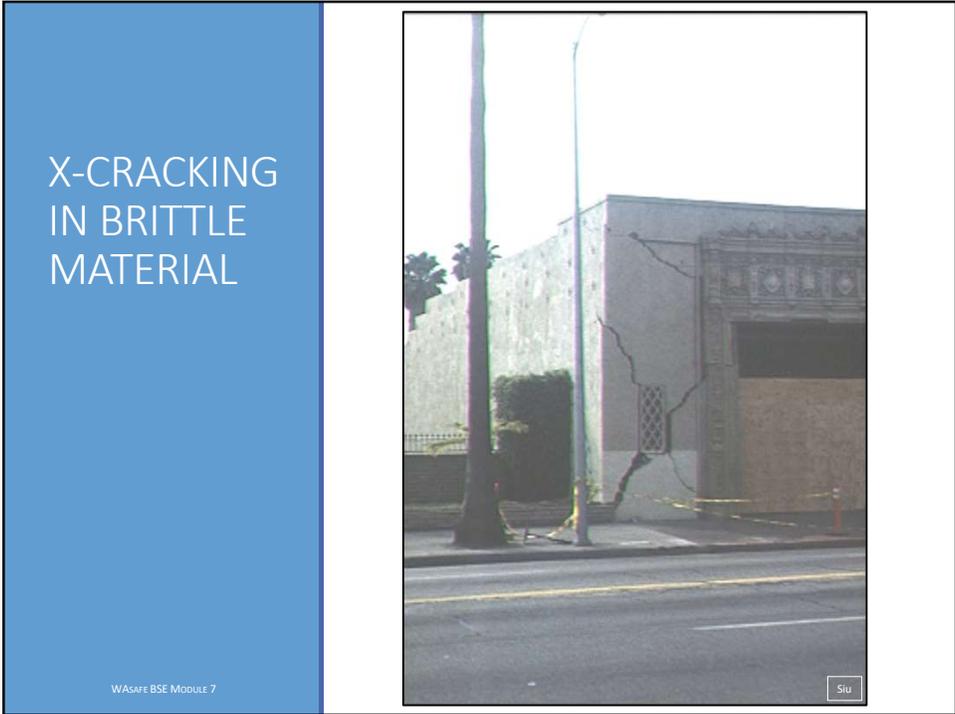
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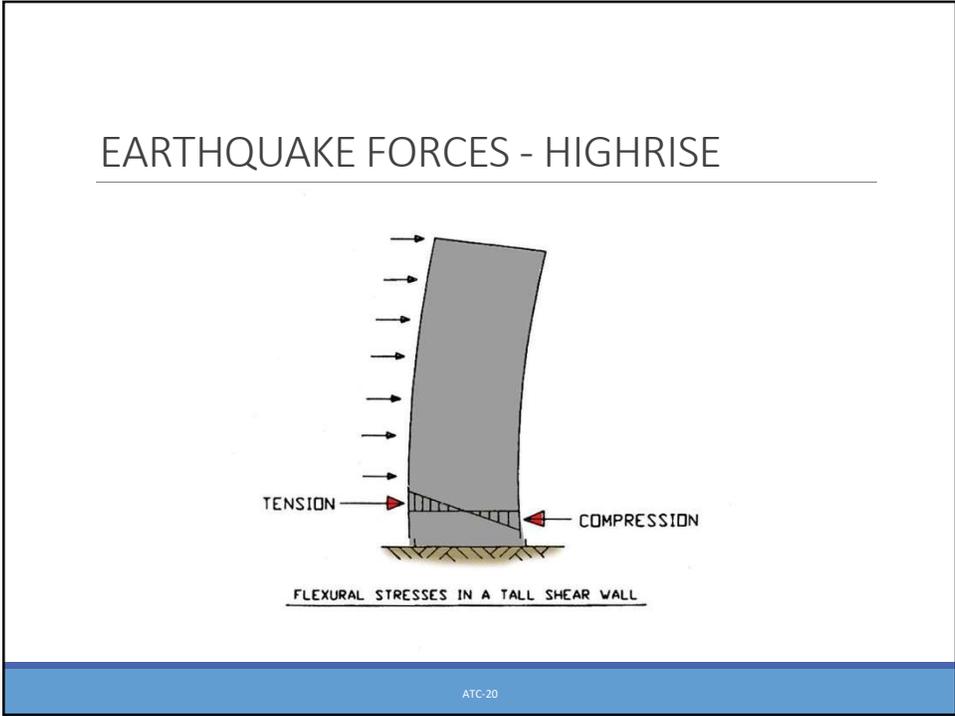
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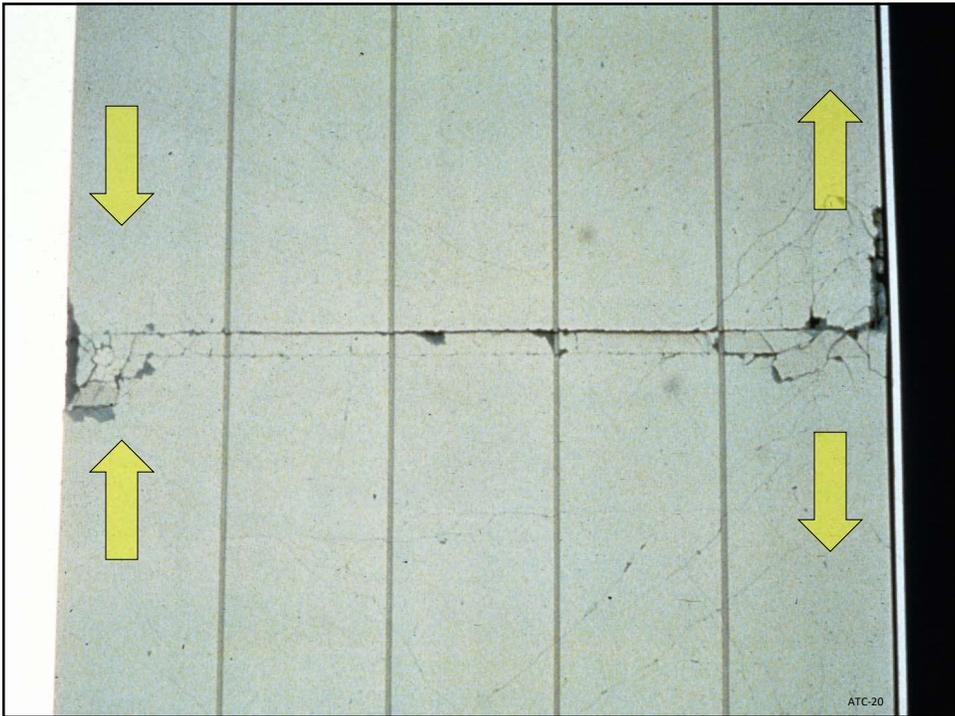
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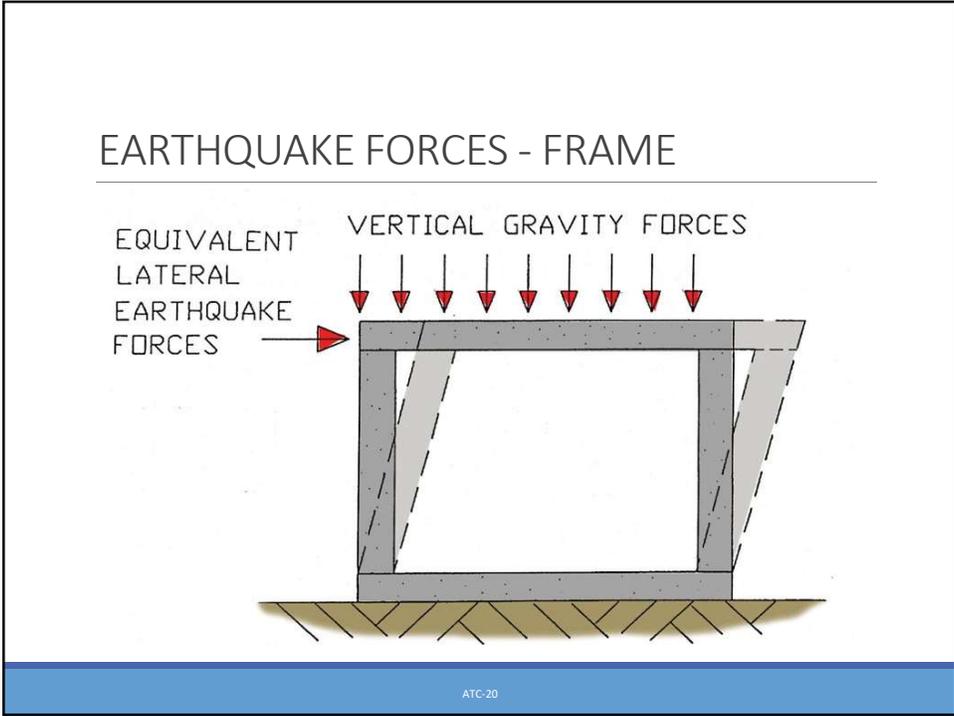
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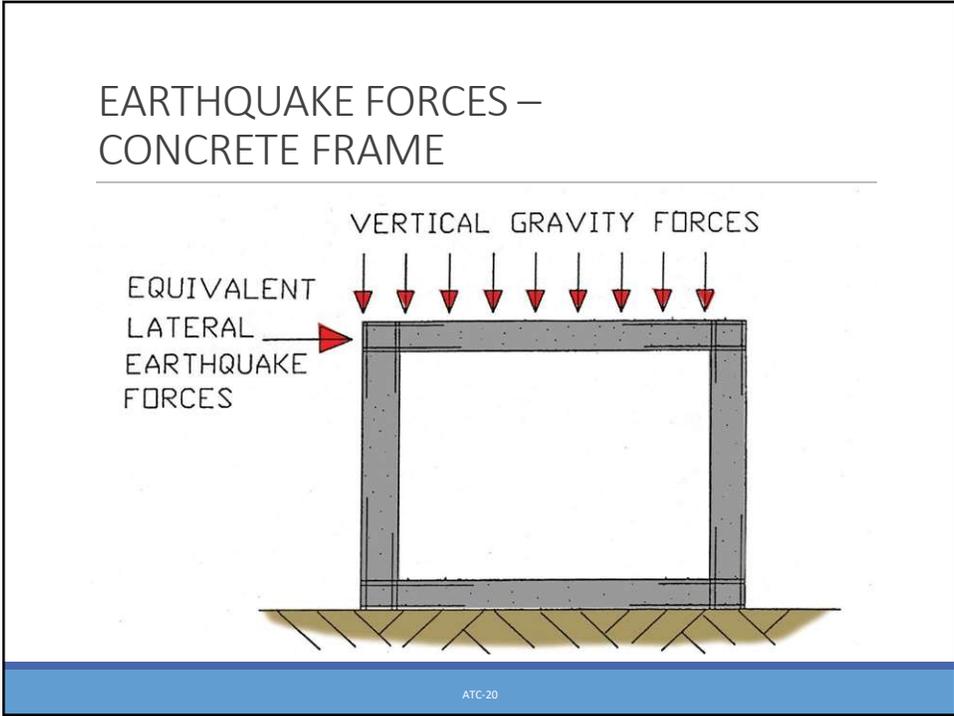
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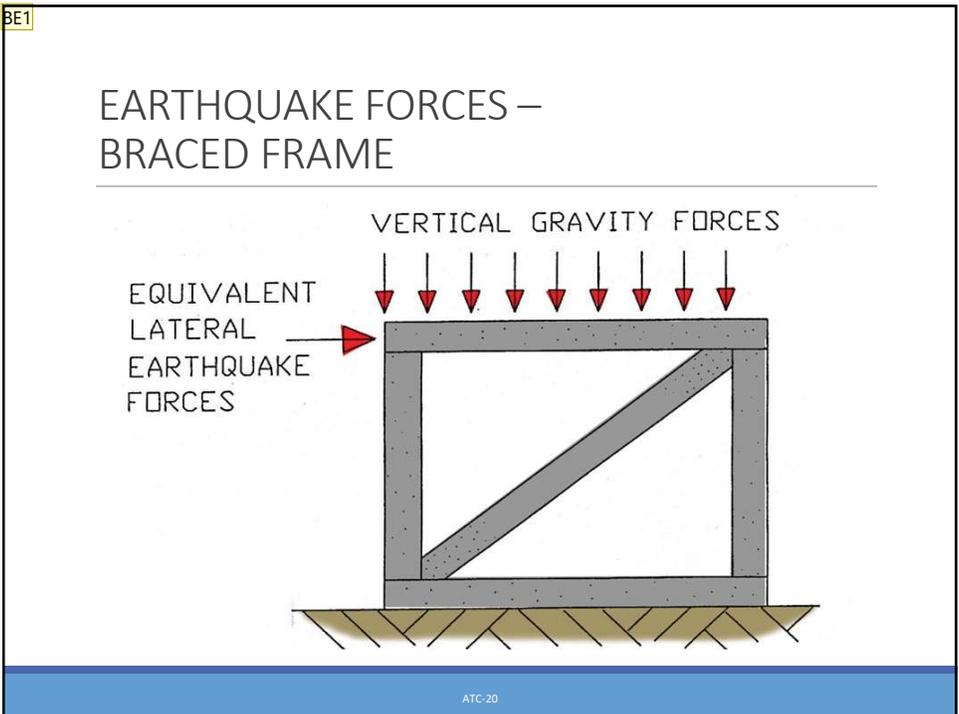
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22



23



24

## Slide 23

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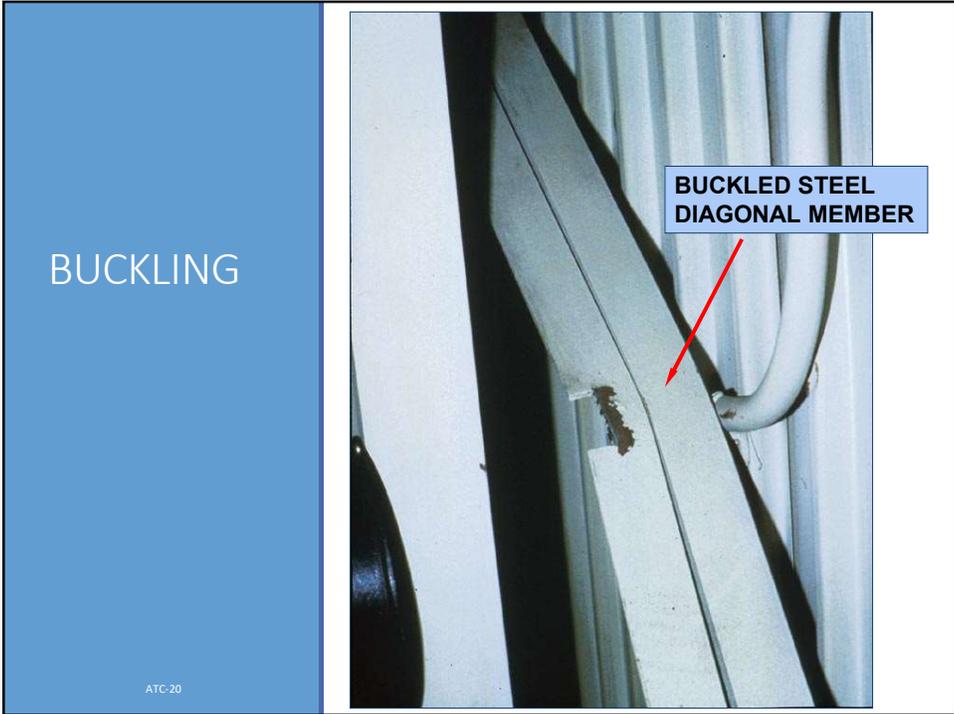
**BE1** I added a carriage return between eth second and third bullet points.  
Enfield, Benjamin, 2024-02-27T01:07:31.315

## Slide 24

---

**BE1** Common brace failure methods include brace buckling, brace connections, column failures, and anchorage failures. The notes discuss the first two, but miss the last two.  
Enfield, Benjamin, 2024-02-27T01:09:31.097

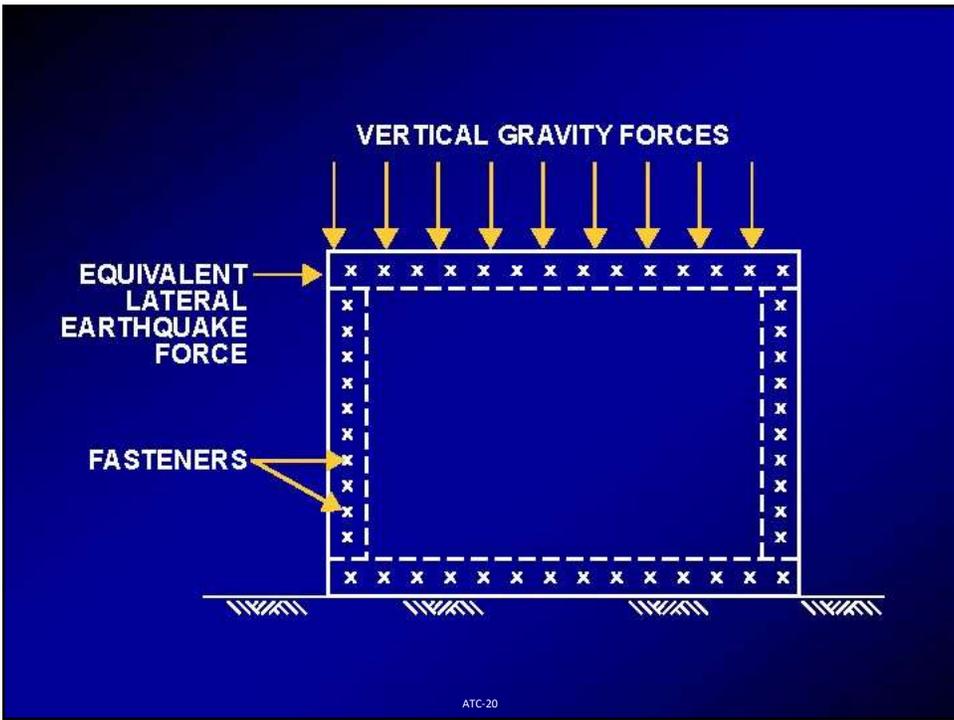
**jo1 0** Probably because they didn't have any photos of those. We don't either, as far as I know.  
jon.wabo@wasafecoalition.org, 2024-02-29T21:54:17.786



BUCKLING

ATC-20

25

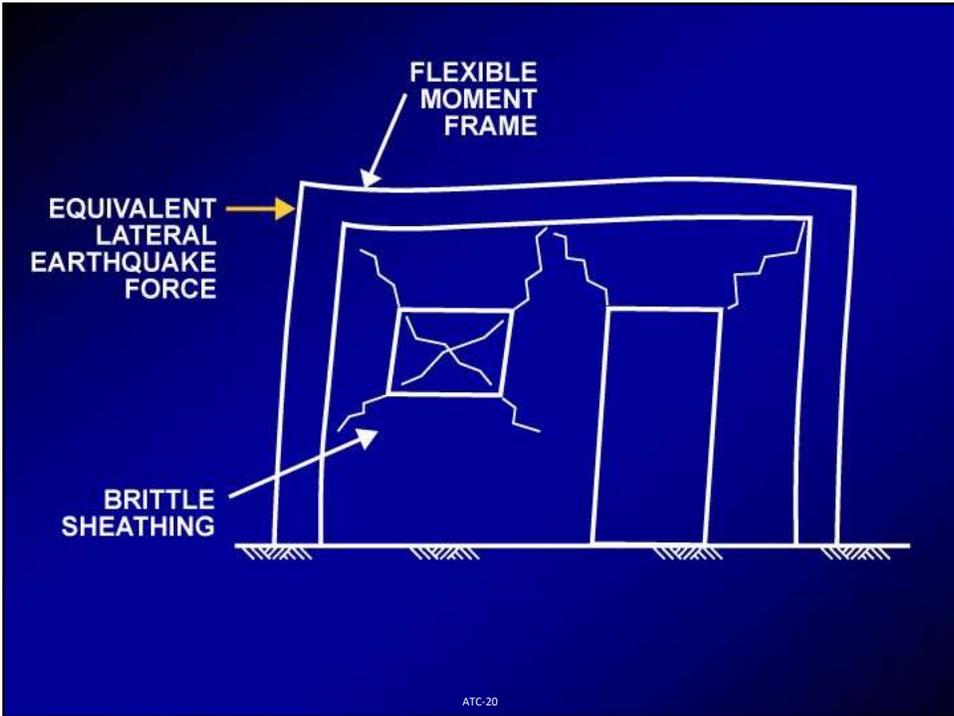


ATC-20

26



27



28

STRUCTURAL STABILITY

---

P-DELTA EFFECT ON RECTANGULAR FRAME

ATC-20

29

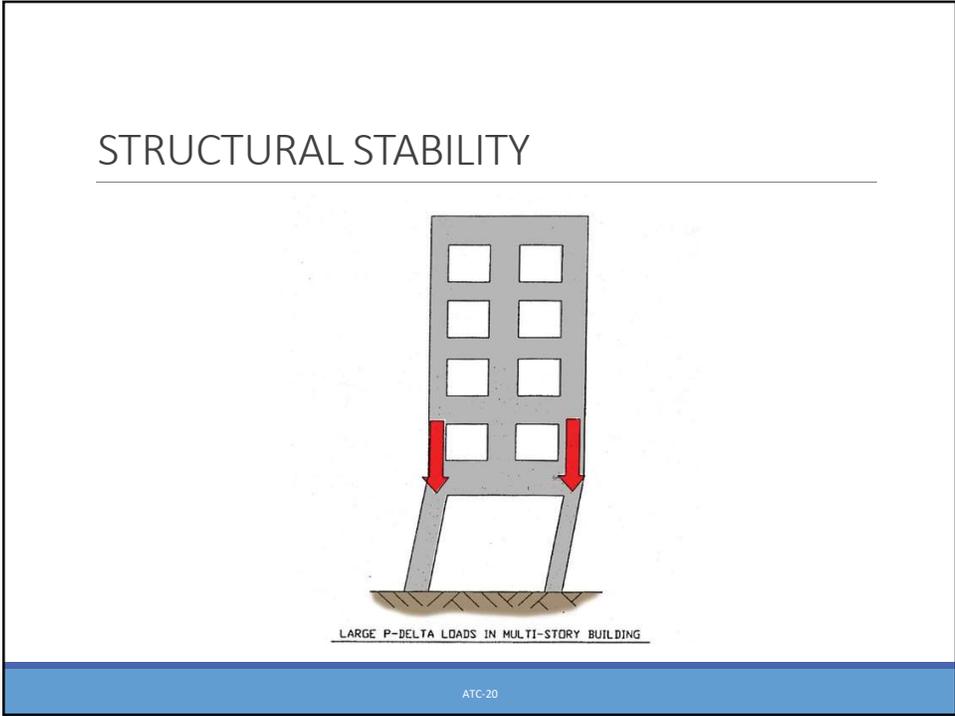
STRUCTURAL STABILITY

---

SMALL P-DELTA LOADS IN A GARAGE

ATC-20

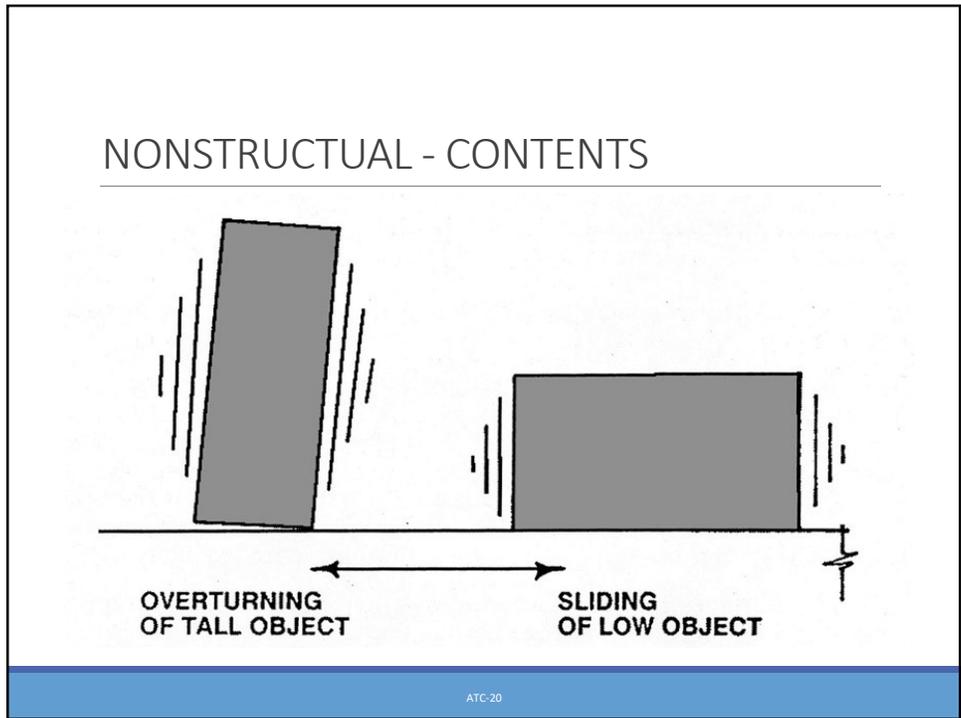
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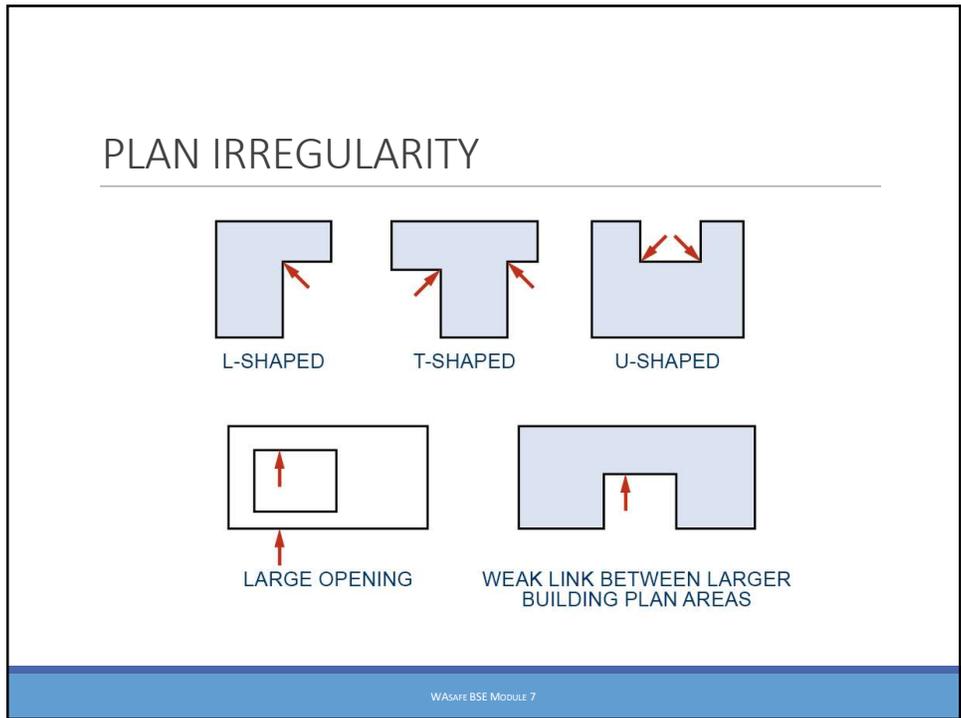
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32



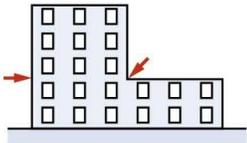
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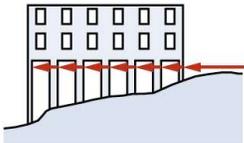
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### VERTICAL IRREGULARITY

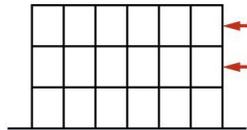
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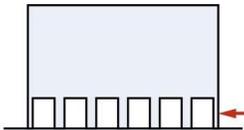
SETBACKS



HILLSIDE



SHORT COLUMN



SOFT STORY

WASAFE BSE MODULE 7

35

### VERTICAL IRREGULARITY – SOFT STORY

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ATC-20

36

### VERTICAL IRREGULARITY – SOFT STORY



WASAFE BSE MODULE 7

37

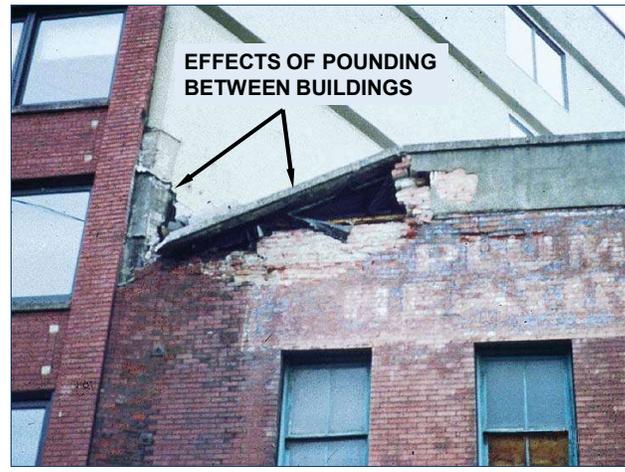
### VERTICAL IRREGULARITY - SETBACK



WASAFE BSE MODULE 7

38

## OTHER STRUCTURAL ISSUES - POUNDING



WASAFE BSE MODULE 7

# WOOD-FRAME CONSTRUCTION

ATC-20

1

## WOOD-FRAME CONSTRUCTION

Single-family residential

Multi-unit residential and commercial



ATC-20

2

## COMMON WOOD FRAME FAILURES

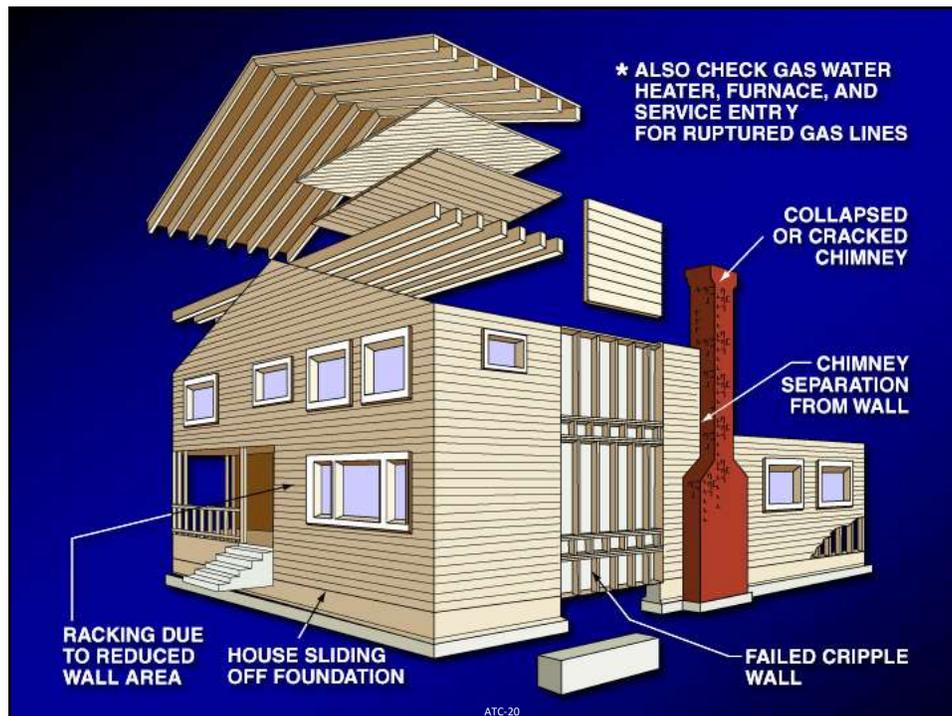
Inadequate bracing => collapse or shifting

- Cripple walls
- Reduced wall area
- Material failure (e.g., GWB)
- Soft stories
- Hillside construction
- Appendages
  - Porch roofs
  - Unanchored/unbraced masonry chimneys
  - Veneer

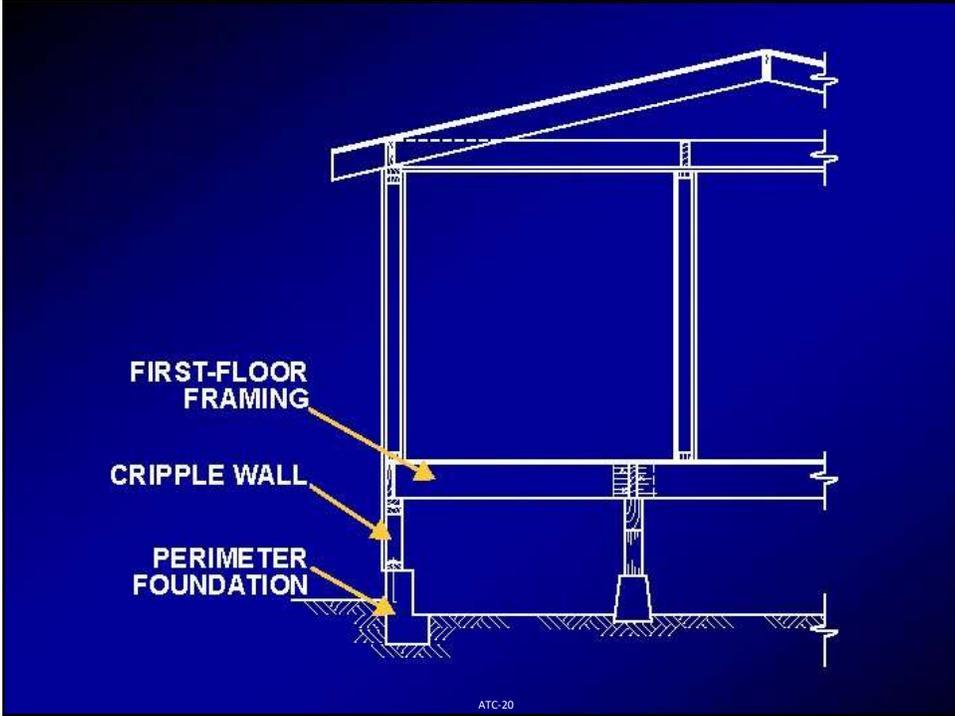
Inadequate foundation anchorage => sliding

WASAFBSE MODULE 8

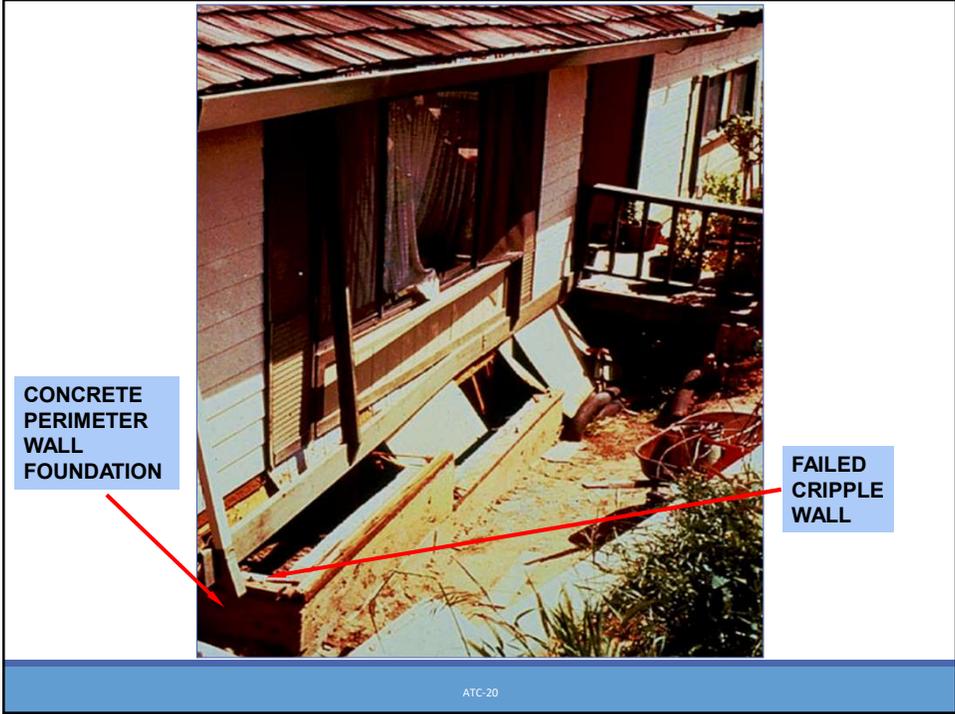
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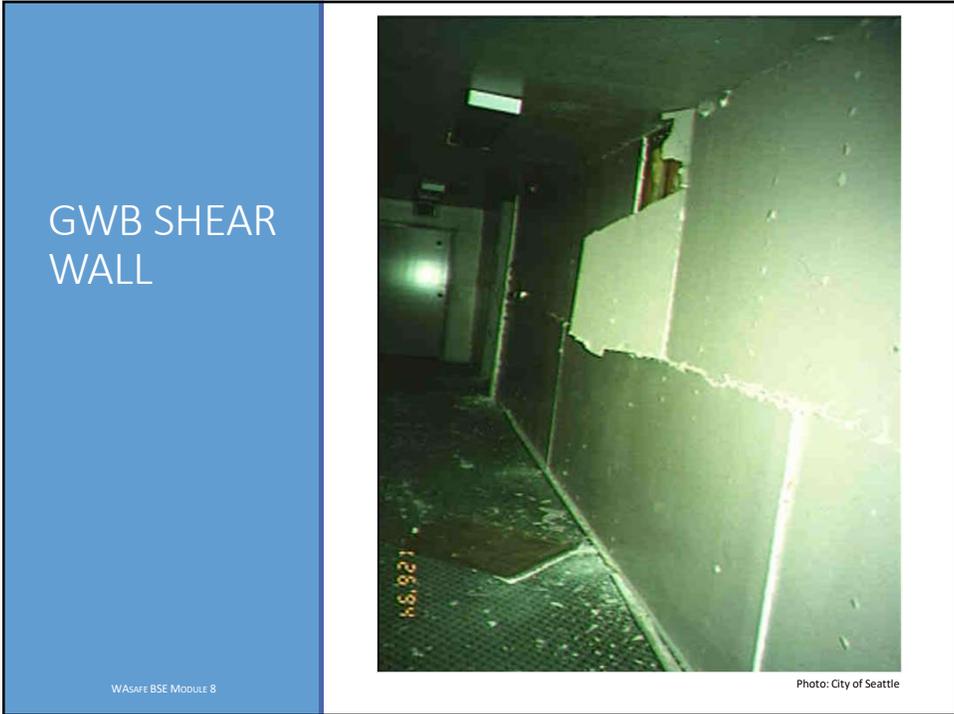
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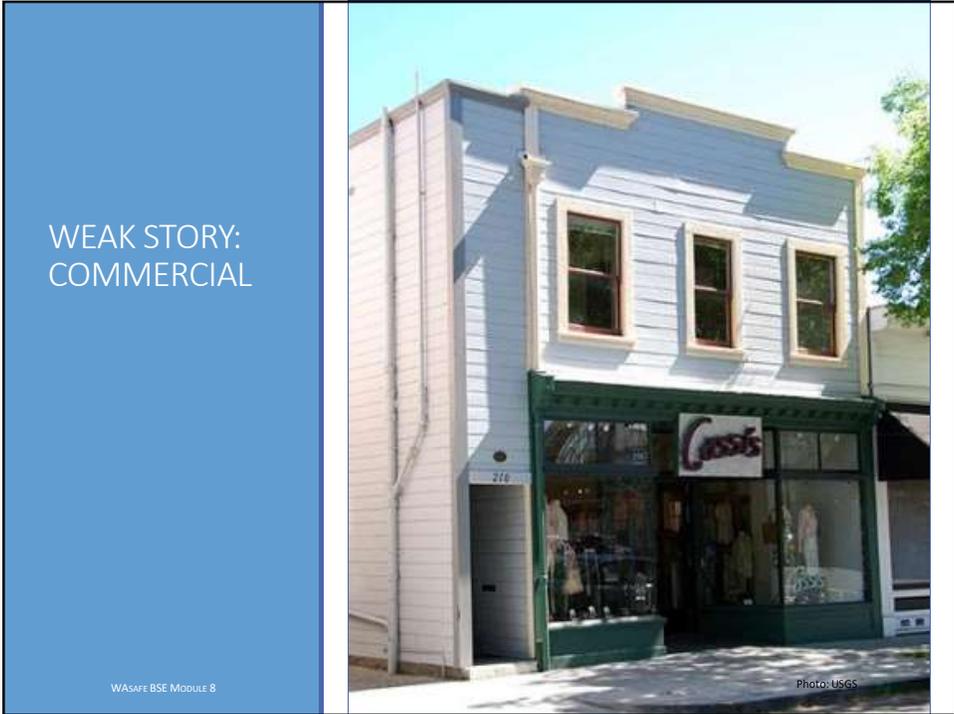
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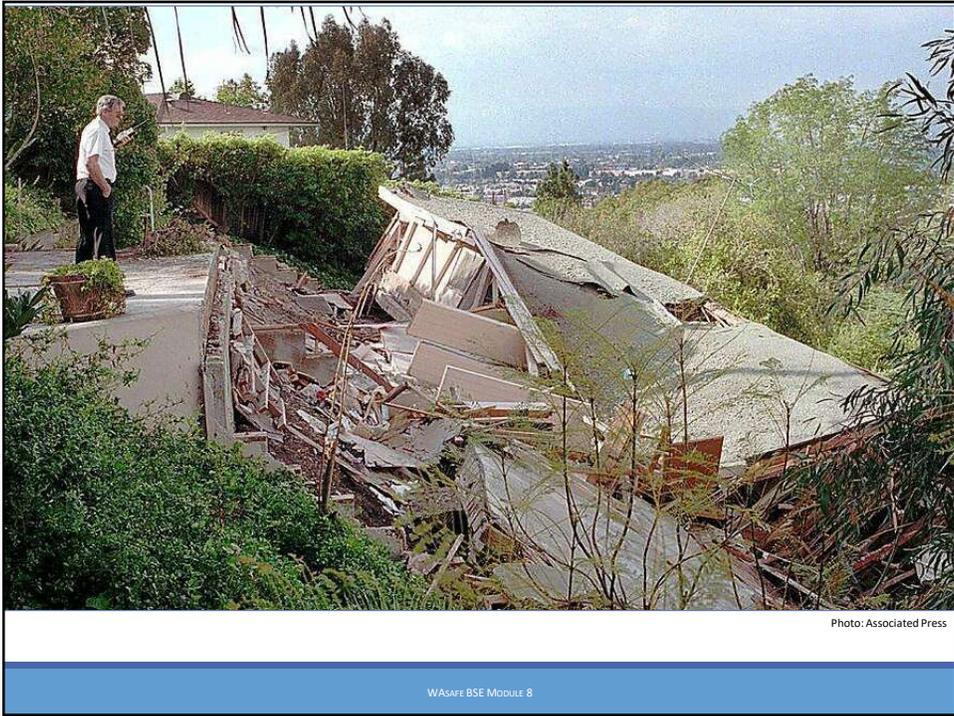
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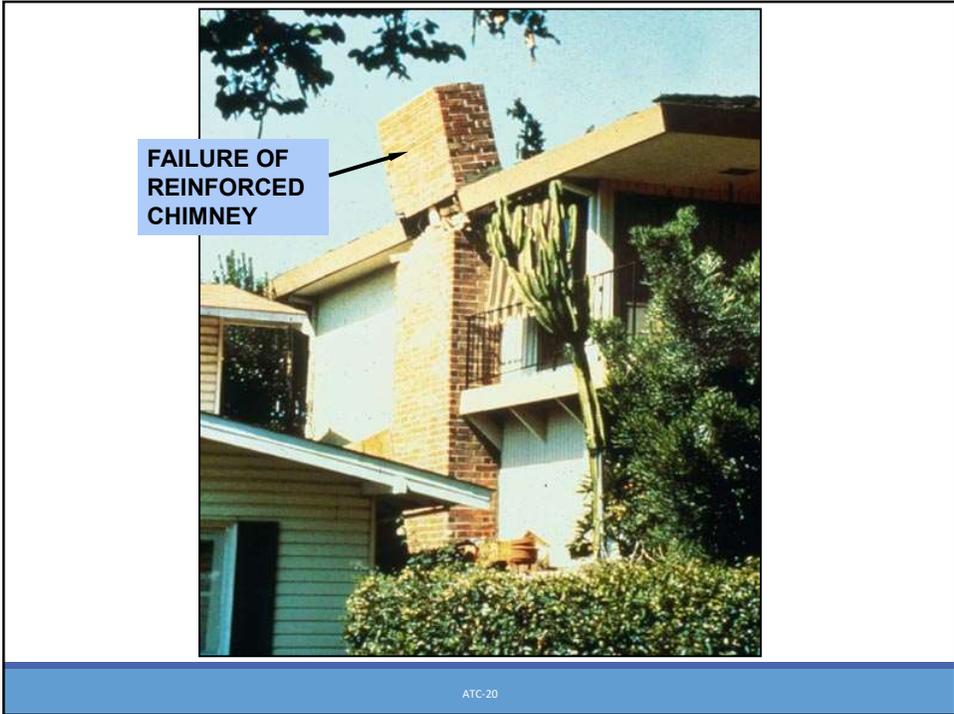
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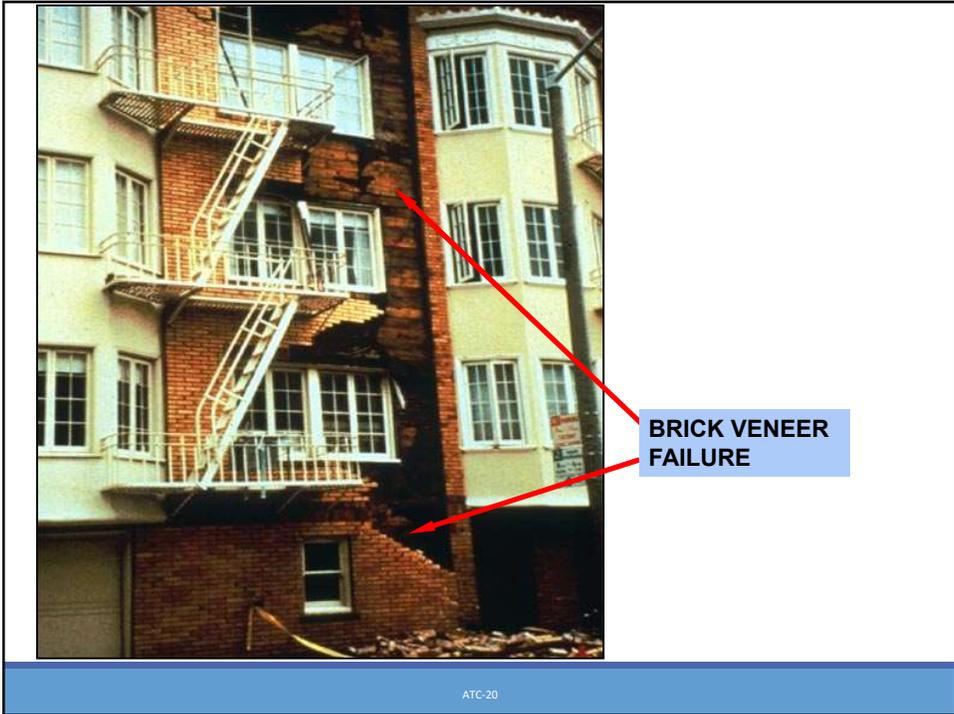
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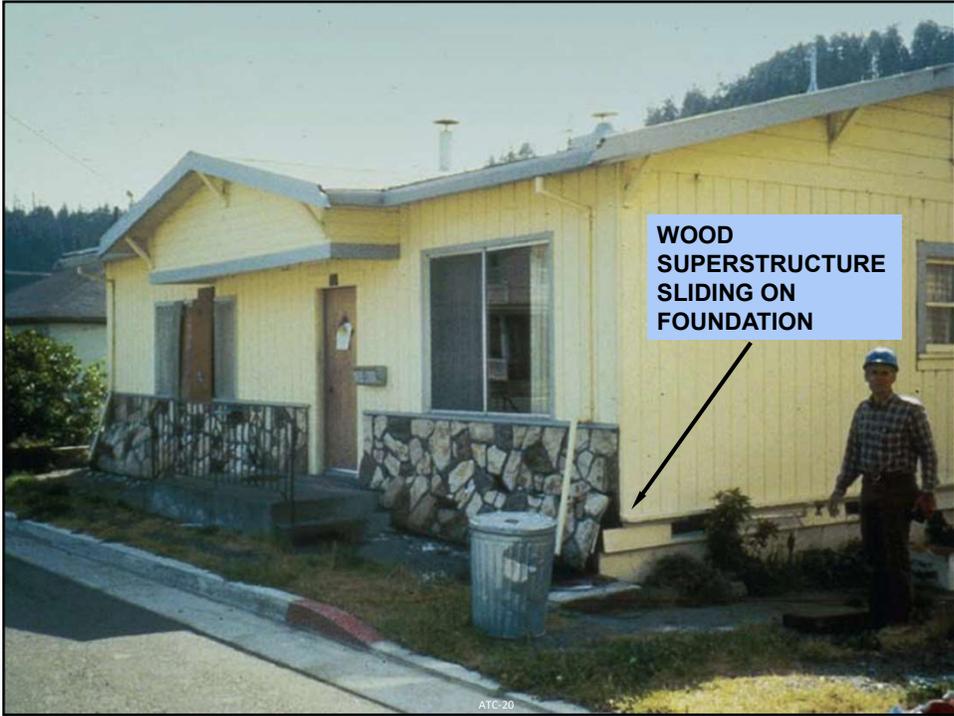
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21

## MASS TIMBER

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Heavy timber/mill construction (old)

- Lateral systems unlikely to be designed for seismic

Engineered wood products

- Glu-lam beams/columns
- Composite laminated timber (CLT)
- Other composite components

Evaluate connections for damage, gaps, displacement

Source: Havel, Fire Service Magazine

Photo: Magnusson Klemencic Associates

WAsafe BSE MODULE 8

22

MASONRY  
CONSTRUCTION

ATC-20

1

MASONRY CONSTRUCTION

---

Unreinforced brick masonry bearing wall buildings  
Unreinforced concrete block masonry bearing wall buildings  
Reinforced masonry buildings

ATC-20

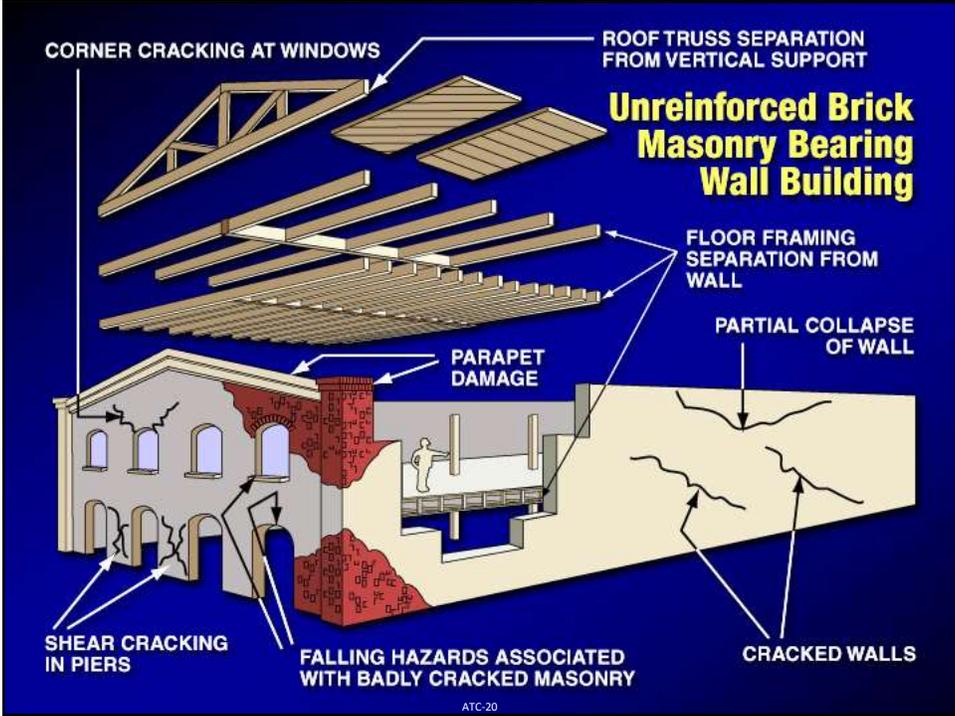
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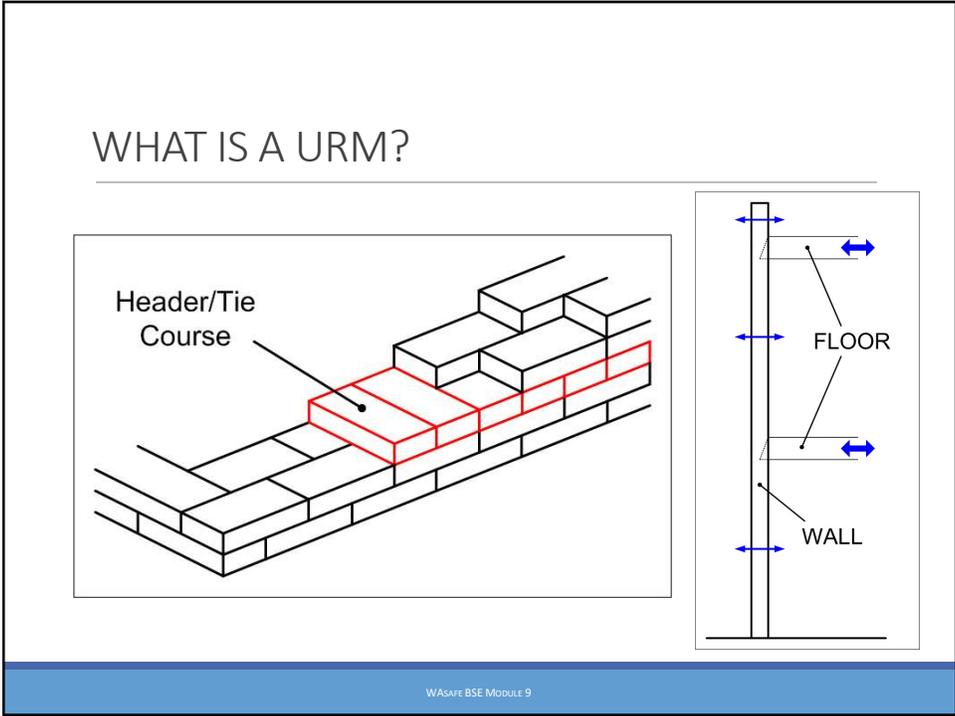
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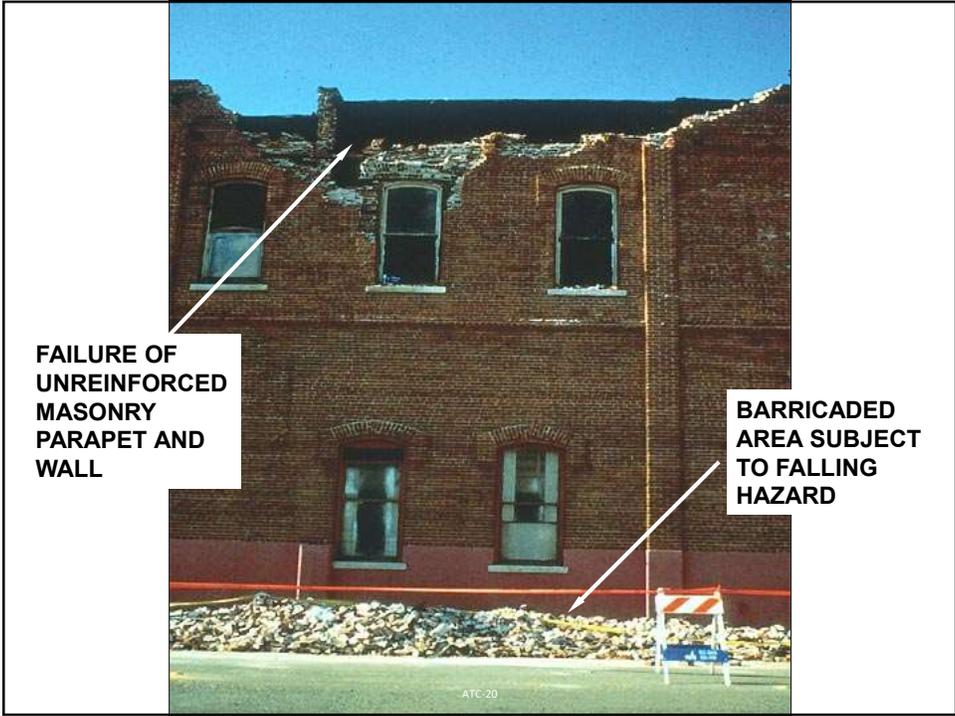


7

### EARTHQUAKE (MIS)BEHAVIOR

WASAFE BSE MODULE 9

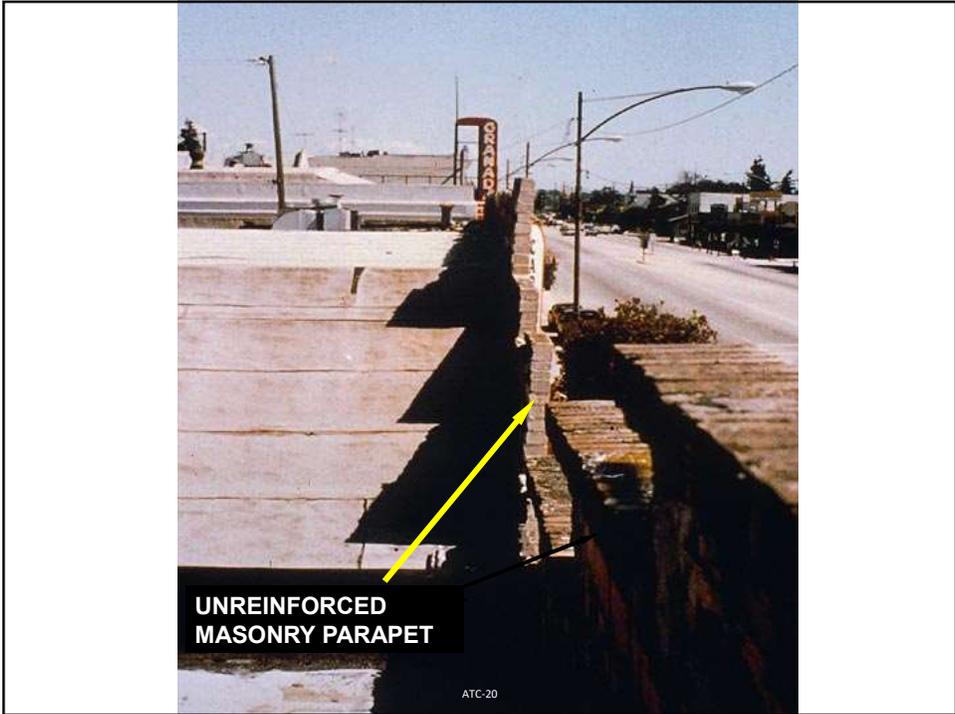
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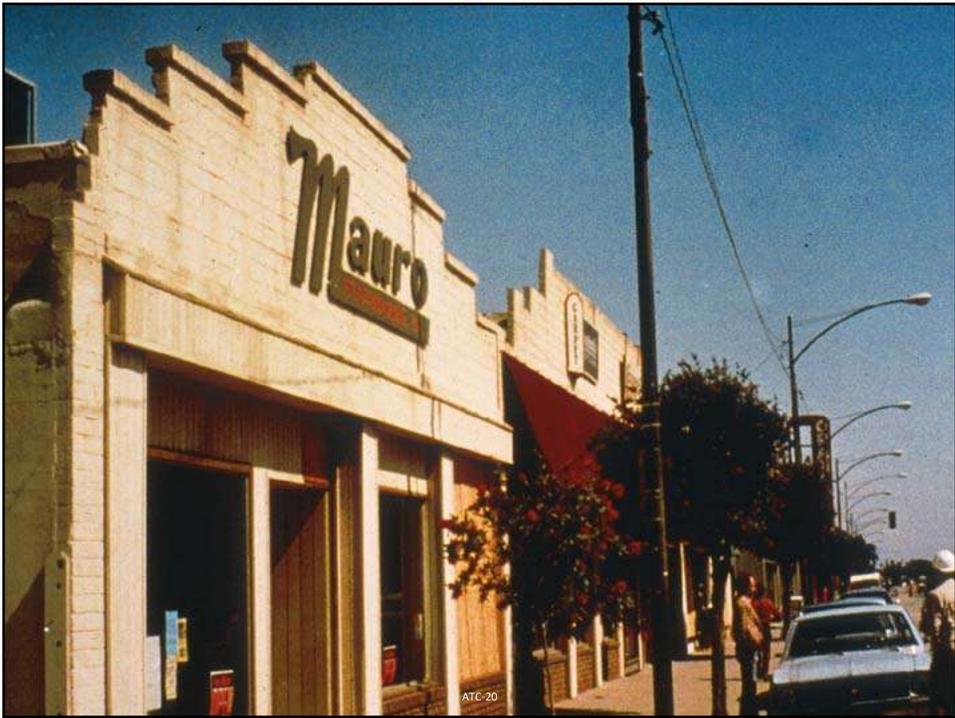
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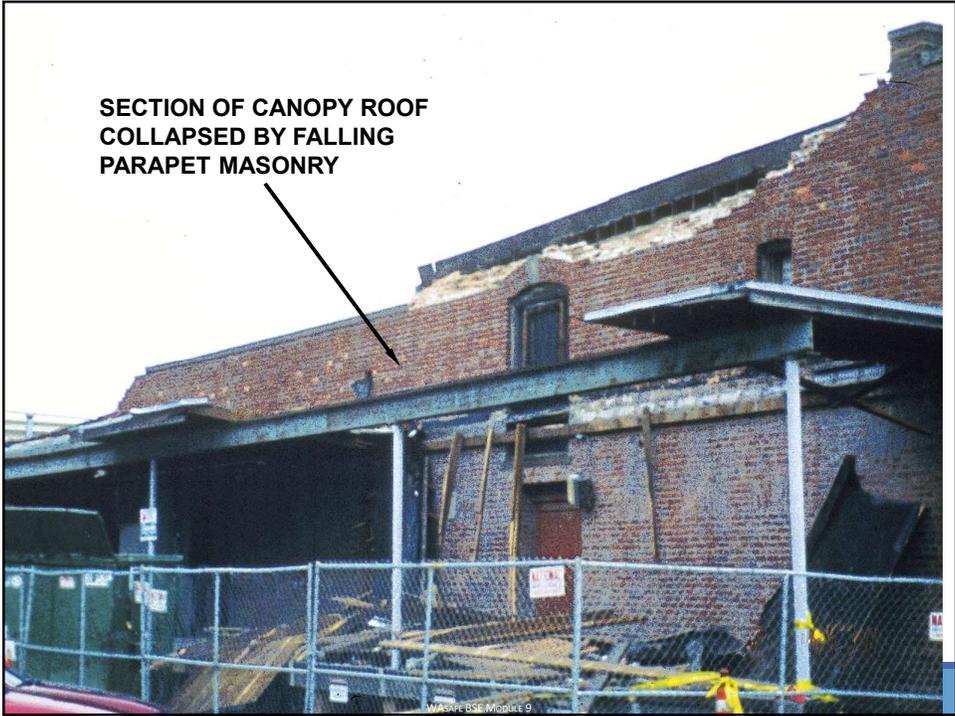
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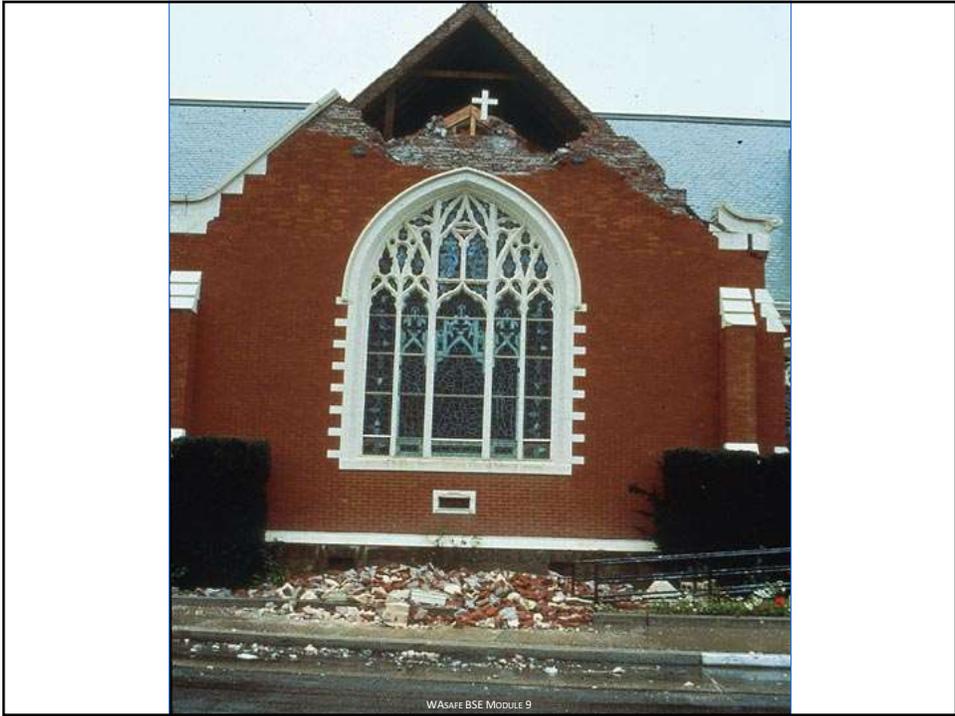
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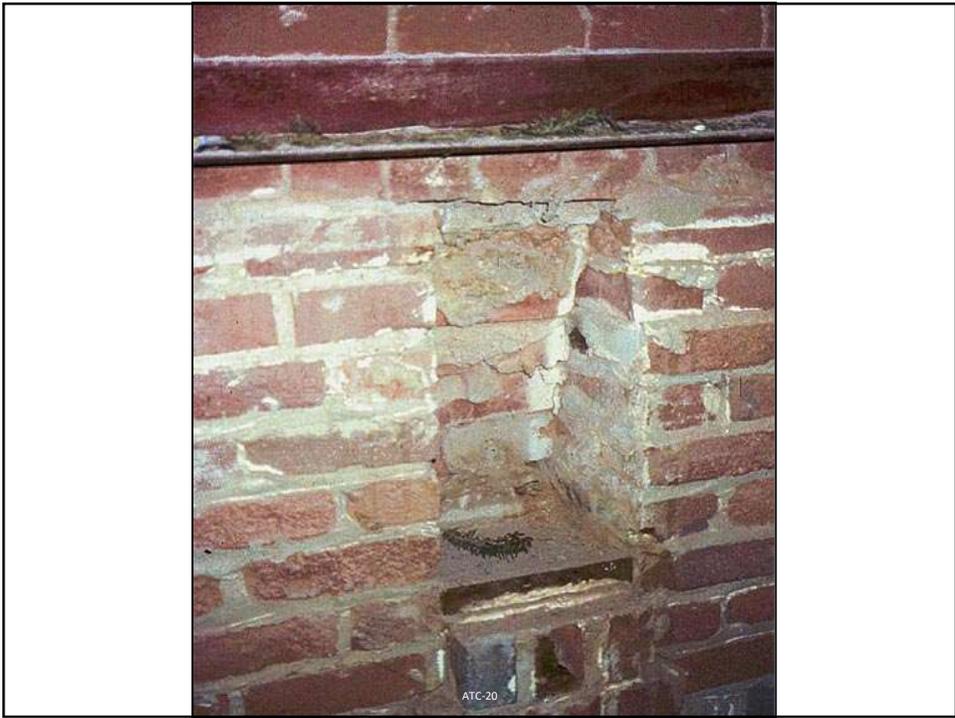
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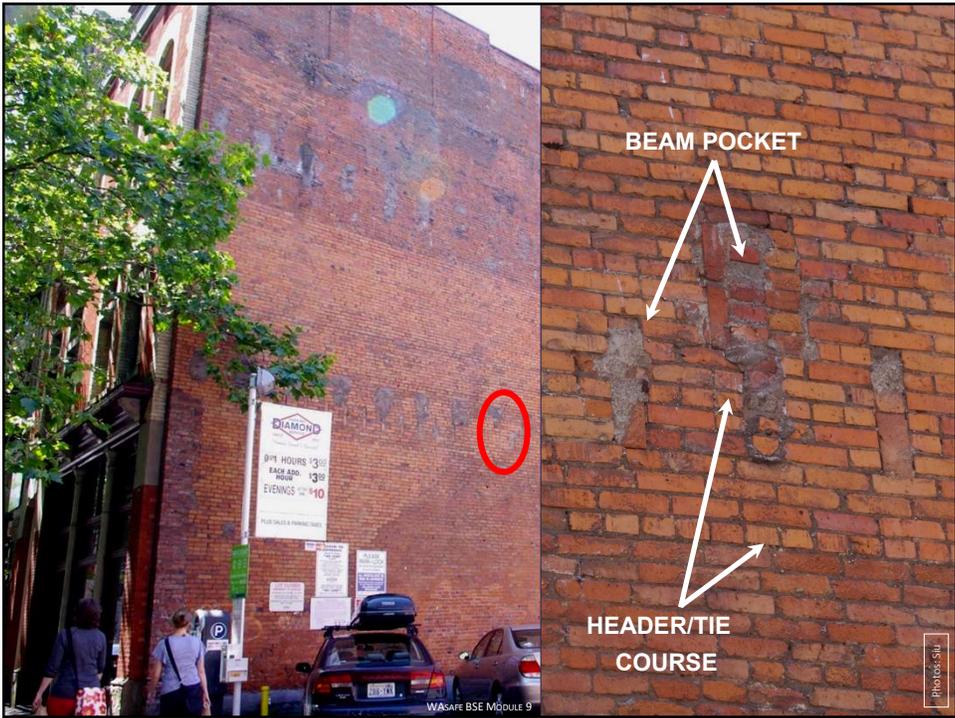
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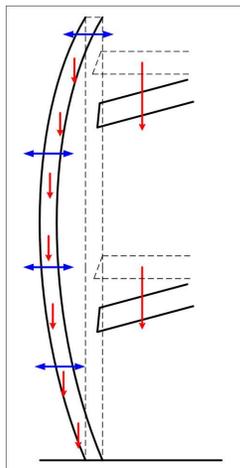


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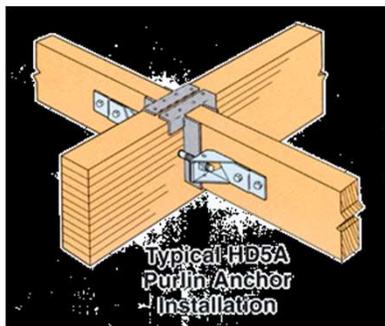
## EARTHQUAKE (MIS)BEHAVIOR



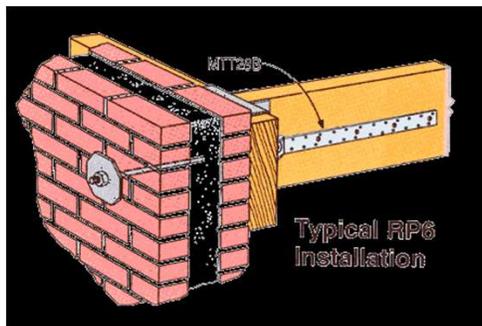
WASAFE BSE MODULE 9

17

## MASONRY WALL ANCHORAGE



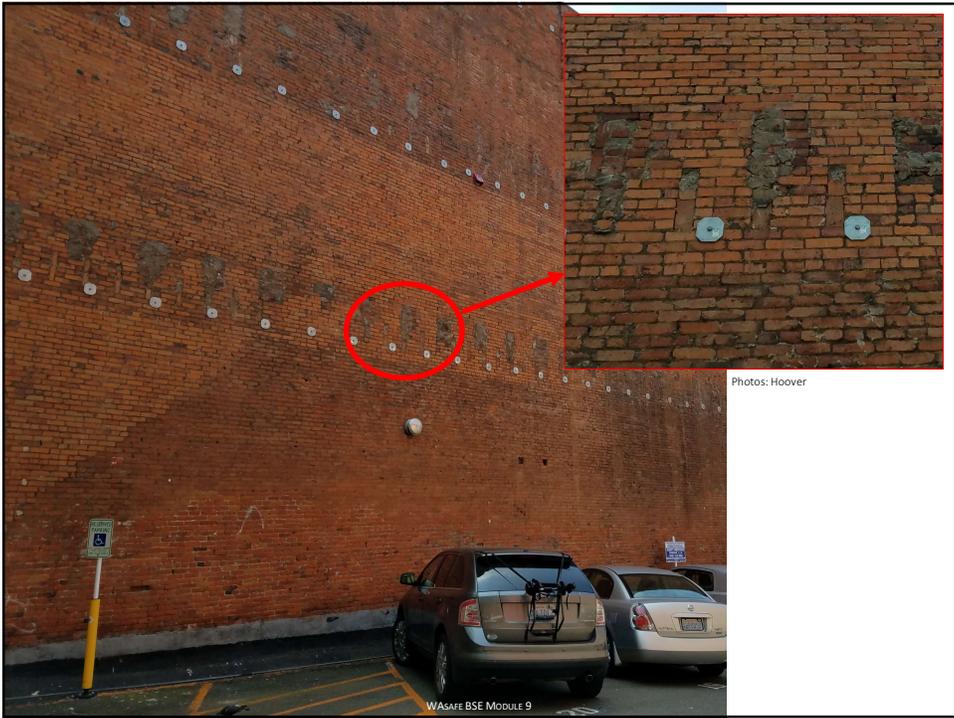
Typical HD5A Purlin Anchor Installation



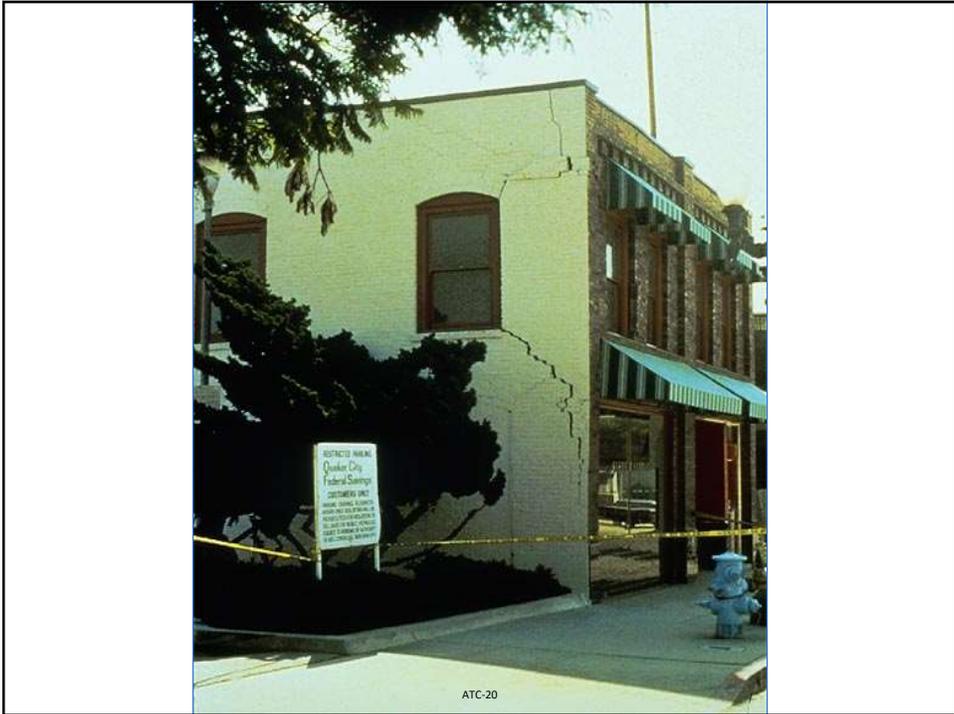
Typical RP6 Installation

ATC-20

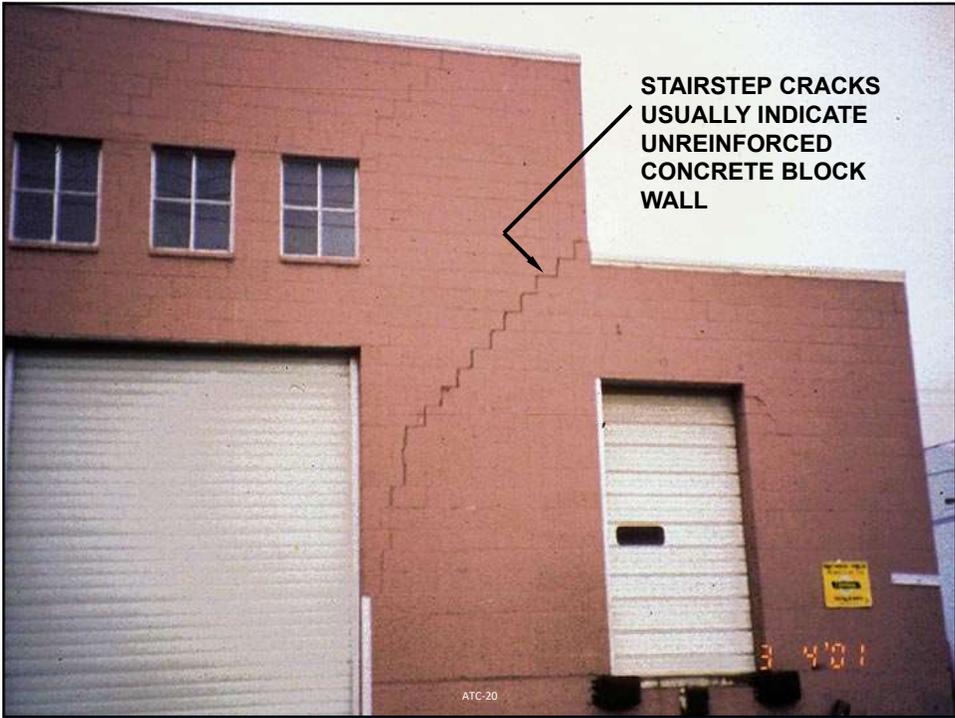
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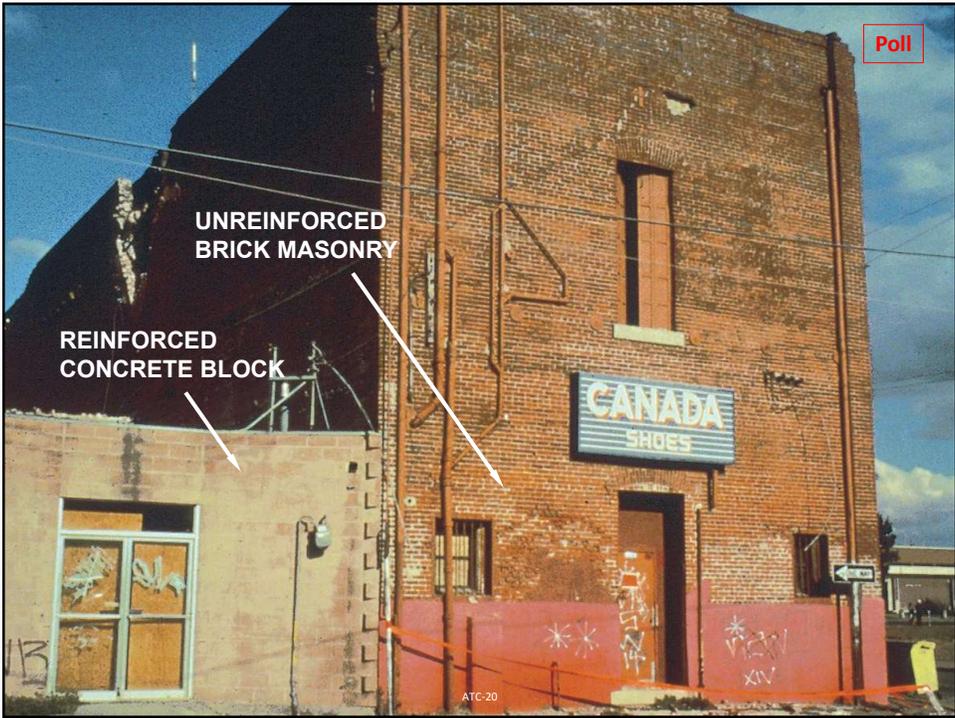
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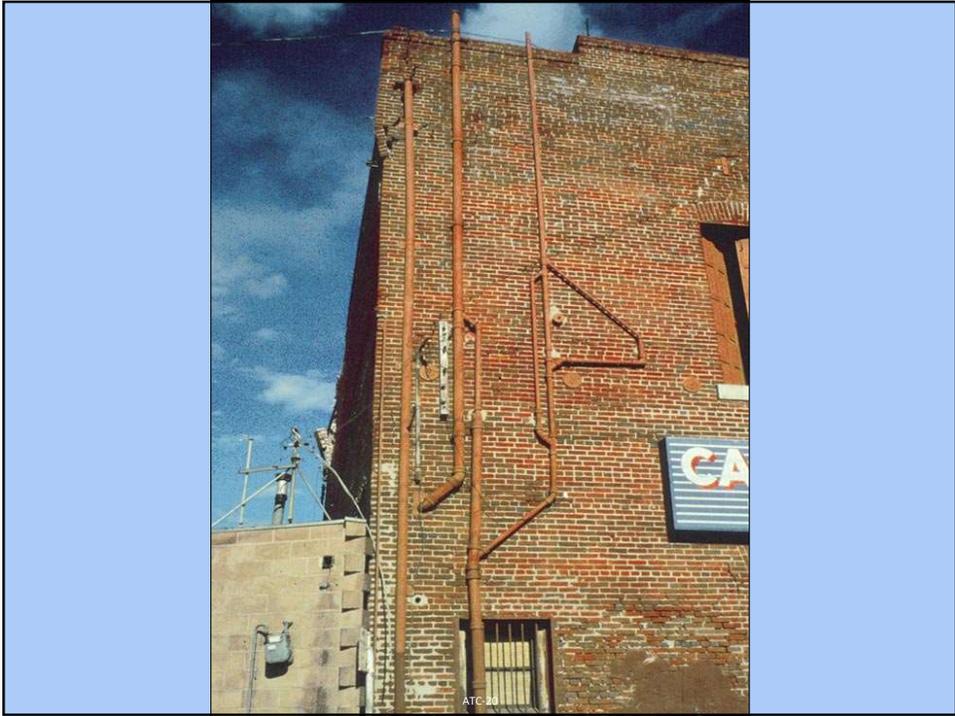
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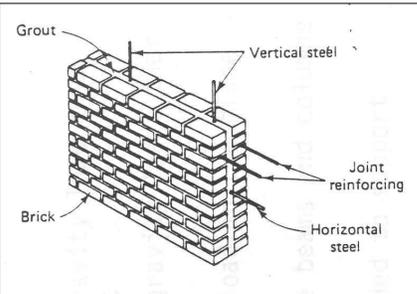
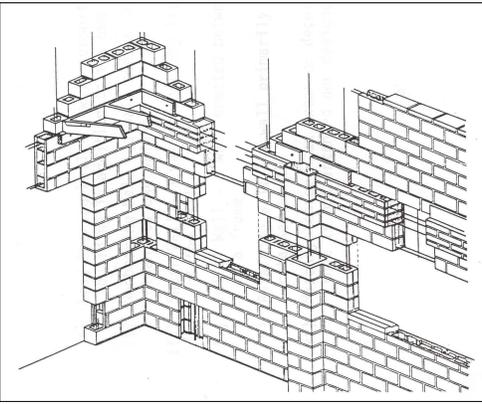


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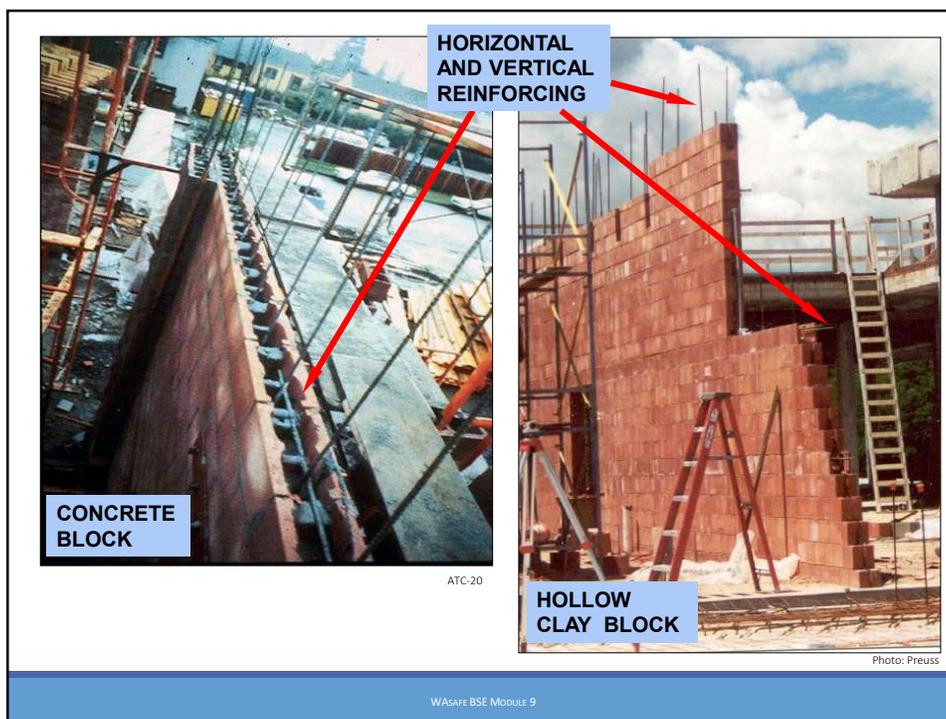
23

### REINFORCED MASONRY BEARING WALL (RM)



WASAFE BSE MODULE 9

24



25

## RM BUILDING DAMAGE

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Diagonal shear cracking

- Cracks  $\geq 1/8$  inch => Red (unsafe)

Failed piers

- Multiple in any one story => Red (unsafe)

Out-of-plane leaning => Red (unsafe)

Wall/pilaster cracking or spalling

- Jeopardizing vertical support of roof/floor => Red (unsafe)

Wall-roof separation => Red (unsafe)

WASAFE BSE MODULE 9

26

# MULTIPLE FAILED PIERS IN ONE STORY



Photos: Preuss



WASAFE BSE MODULE 9

# OTHER NON-SEISMIC HAZARDS

WASAFE BSE MODULE 13

1

## NON-SEISMIC HAZARDS

### Wind Events (ATC-45)

- Hurricanes
- Tornadoes
- Other Wind Storms

### Floods (ATC-45)

### Blast (explosions)

### Fires



Photo: CAL OES SAP

WASAFE BSE MODULE 13

2

## GENERAL PRINCIPLES

---

Structural safety principles are same as seismic

- Focus on immediate stability/imminent hazard
- Assume no immediate following event

Follow instructions/policies of local jurisdiction

- Placards required, even if no structure remaining?
- Do we know the structure belongs on the site?

Be aware of, protect self from additional hazards

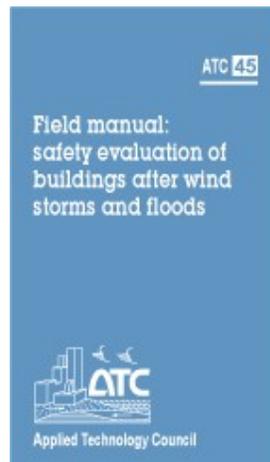
- Mold, chemicals (floods)
- Hazardous dust (blast)
- Airborne carcinogens (fire)

WASAFE BSE MODULE 13

3

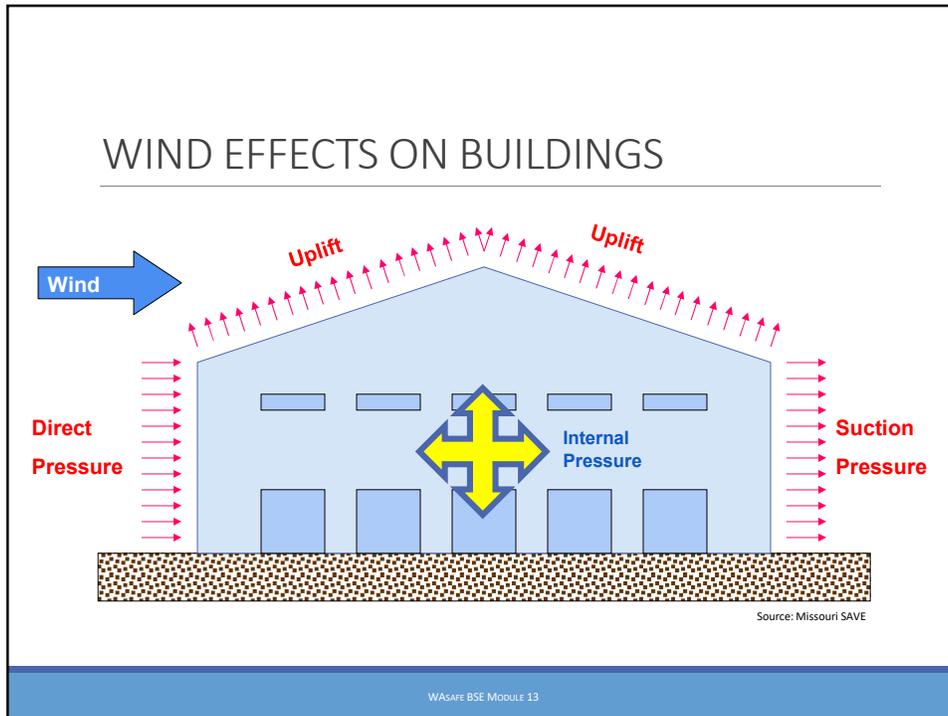
## RESOURCE DOCUMENT (WIND & FLOOD)

---



WASAFE BSE MODULE 13

4



5

## ATC-45 HURRICANES

≥ 74 mph winds

Building damage from:

- External & internal pressures (wind force)
- Storm surge/flooding
- Debris impact

CAL OES SAP

The diagram shows a cross-section of a hurricane with labels: 'convection currents' (upward arrows), 'eye' (center), 'cool dense air' (top), 'hurricane winds and rain' (outer ring), and 'warm moist air' (bottom). Below the diagram is a satellite image of a hurricane.

6



7

<p>ATC-45 TORNADOS</p> <p>Smaller area, greater intensity vs hurricanes</p> <p>Building damage from:</p> <ul style="list-style-type: none"><li>Strong winds near center (<math>\geq 200</math> mph)</li><li>Pressure drop at center</li></ul> <p><small>CAL OES SAP</small></p>	  <p><small>NOAA</small></p>
---	---

8

# TORNADO DESTRUCTION



Photo: CALOES SAP

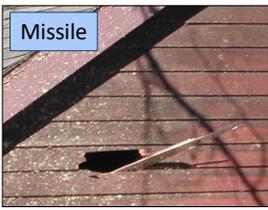


Photo: Preuss

WASAFE BSE MODULE 13

9

# TORNADO DAMAGE



Photos: Preuss



WASAFE BSE MODULE 13

10

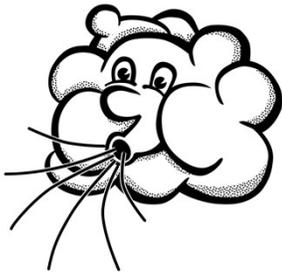
ATC-45  
WINDSTORMS

Linear windstorms  
(West Coast)

Building damage  
from:

- High wind
- Wind-driven waves

CAL OES SAP




11

## LINEAR WINDSTORM DAMAGE

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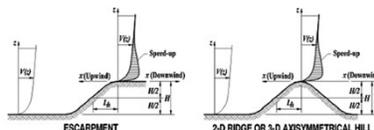
Photo: Preuss

WASAFE BSE MODULE 13

12

## WIND SPEED-UP EFFECT

Expect increased damage behind tops of escarpments, ridges, and hills



ASCE 7-22, Figure 26.8-1. Topographic factor,  $K_{zt}$



Photo: Adams

WASAFE BSE MODULE 13

13

## ATC-45 FLOODS

Flash floods/other swift water

Inundation (slow-moving water)

Building damage from:

- Water force on lateral force resisting system
- Foundation scour
- Unanchored buildings
- Mold, contaminated water

Cal. OES SAP



14



15



16



17

**BLAST/  
EXPLOSIONS**

Building damage from:

- Overpressure on/in structures

Evaluate nearby buildings

WASAFE BSE MODULE 13

18

## FIRE

Large-scale (wildfire)  
Individual buildings

WASAFE BSE MODULE 13



Photo: lafire.com



Photo: National Park Service

19

## FIRE – LARGE-SCALE (WILDFIRE)

---

May still require placarding

- See AHJ

Free-standing masonry/concrete walls & chimneys



Photo: CAL OES SAP

WASAFE BSE MODULE 13

20

## FIRE – INDIVIDUAL BUILDINGS

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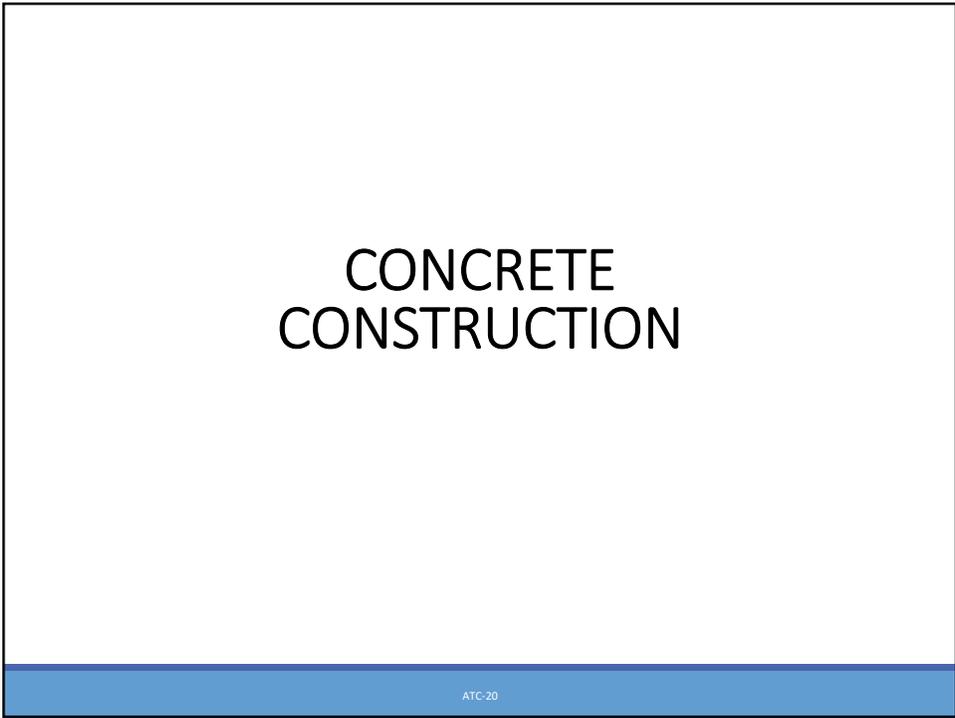
Assess effect on structural stability

- Sagging floors
- Spalled concrete
- Burned wood beams/bearing walls
- Out of plane wall stability



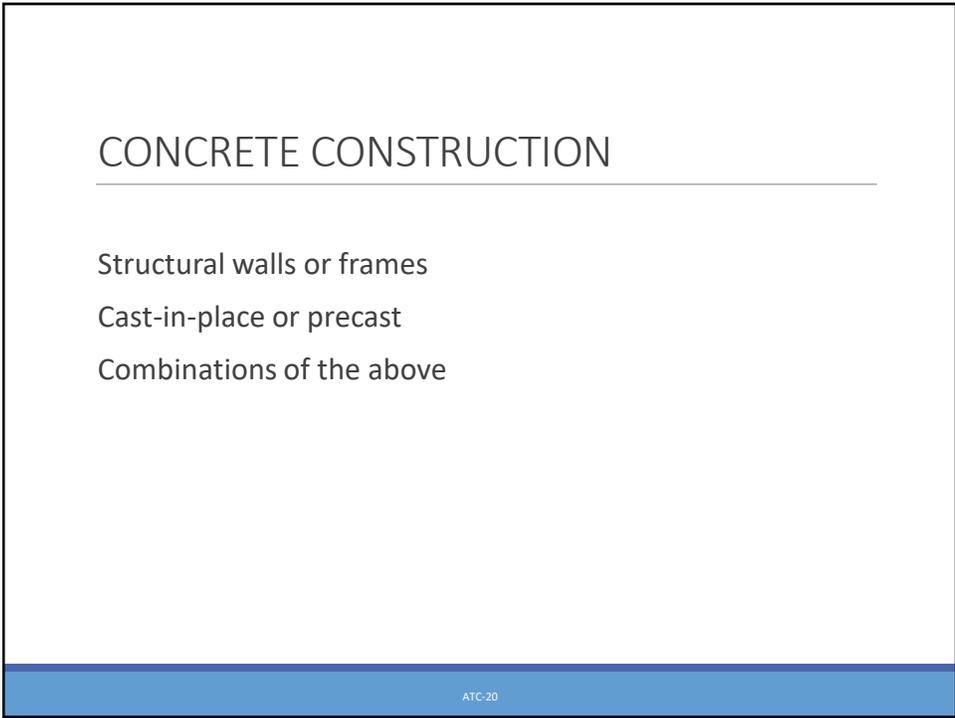
Source: FEMA/US Fire Administration

WASAFE BSE MODULE 13



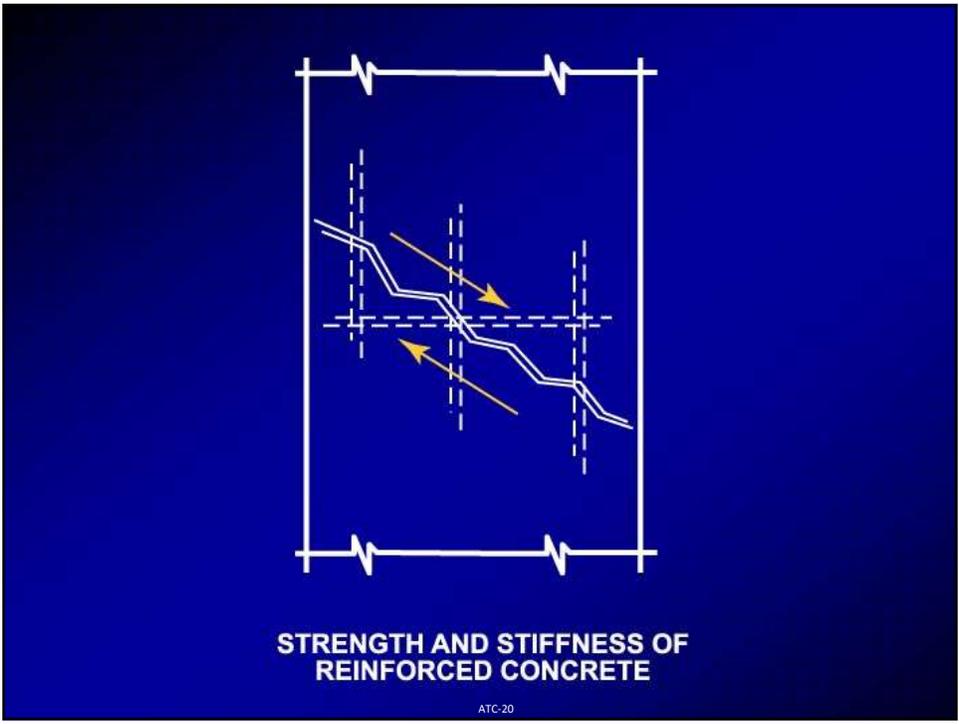
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1

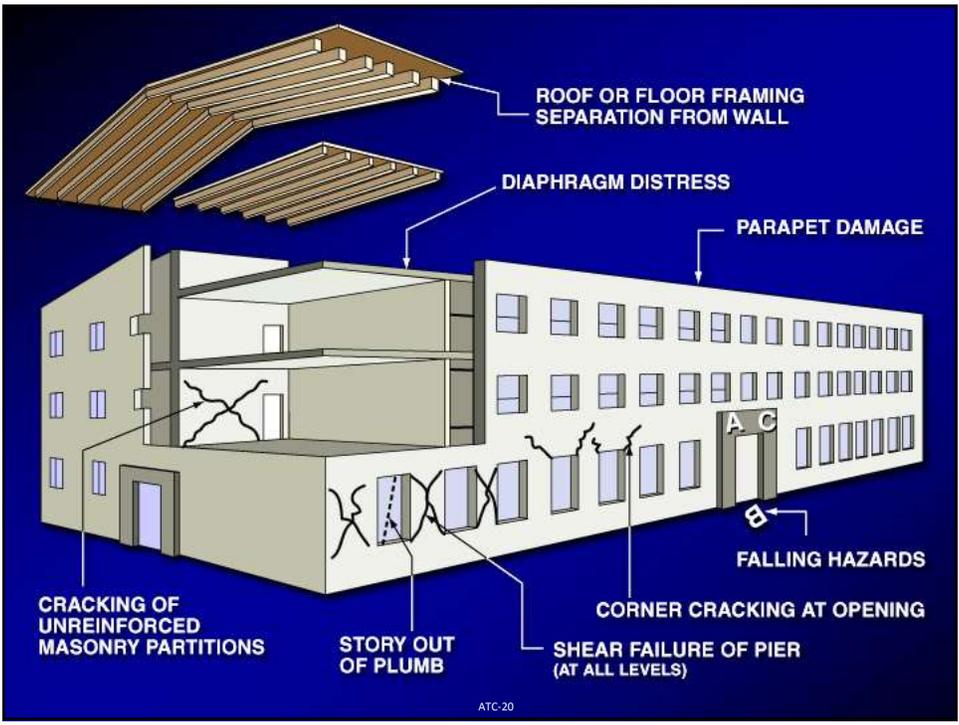


A large rectangular slide with a white background and a blue footer bar. The text "CONCRETE CONSTRUCTION" is centered at the top, underlined. Below it, three lines of text are listed: "Structural walls or frames", "Cast-in-place or precast", and "Combinations of the above". The footer bar contains the text "ATC-20" in a small, white font.

2



3



4



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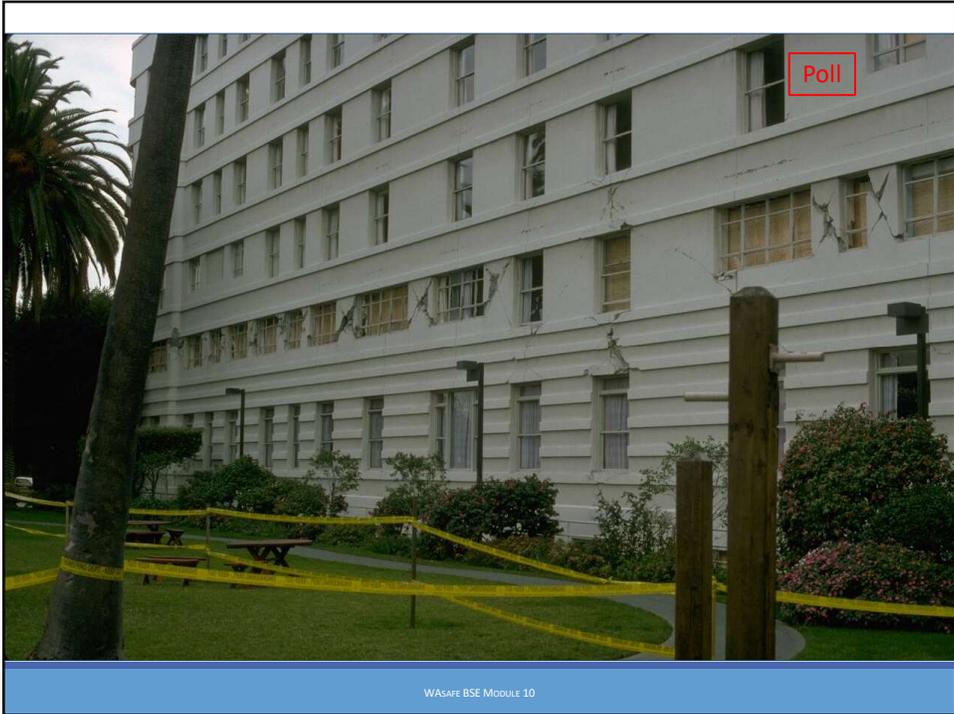
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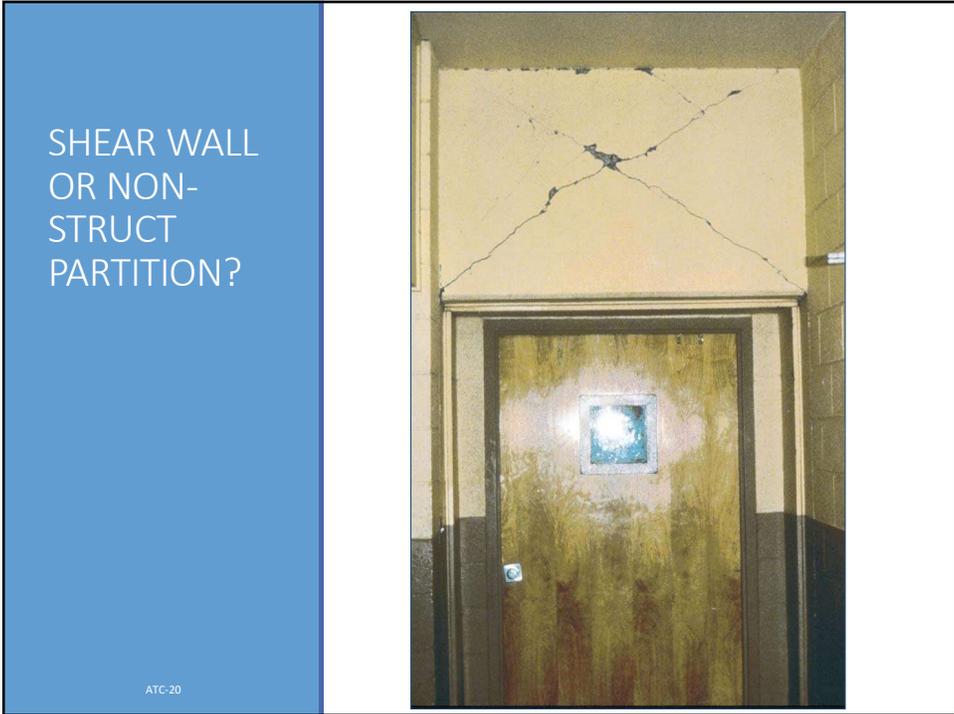
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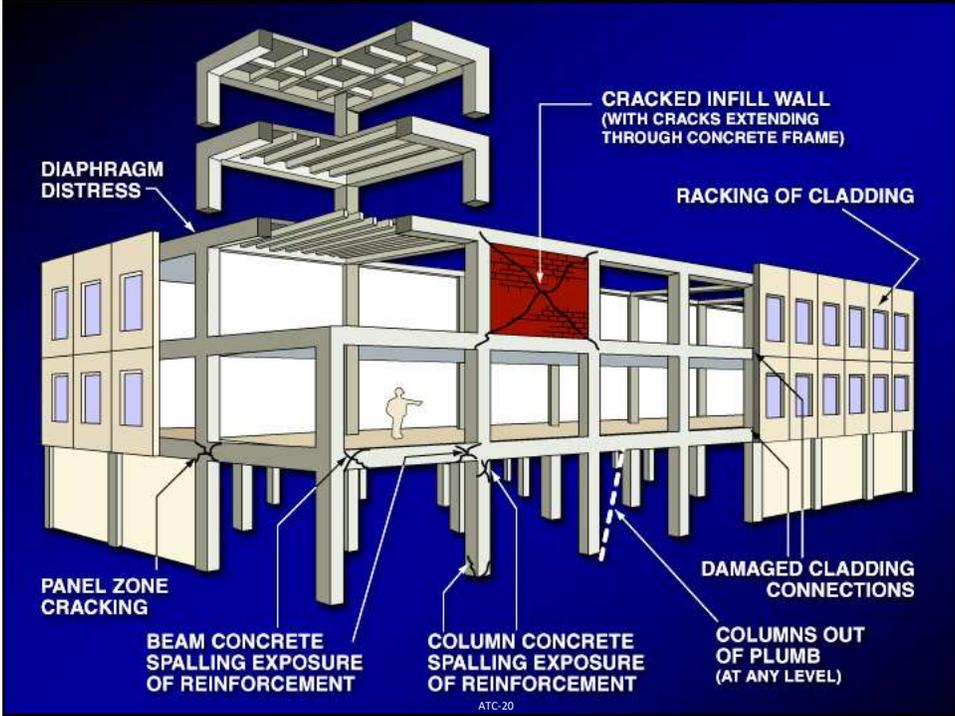
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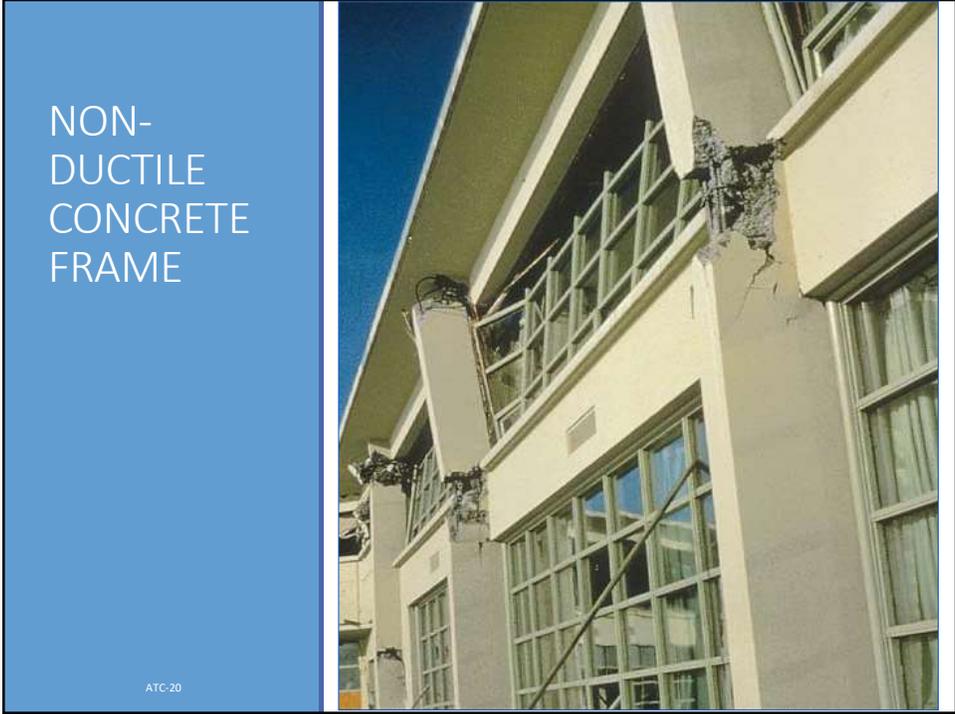
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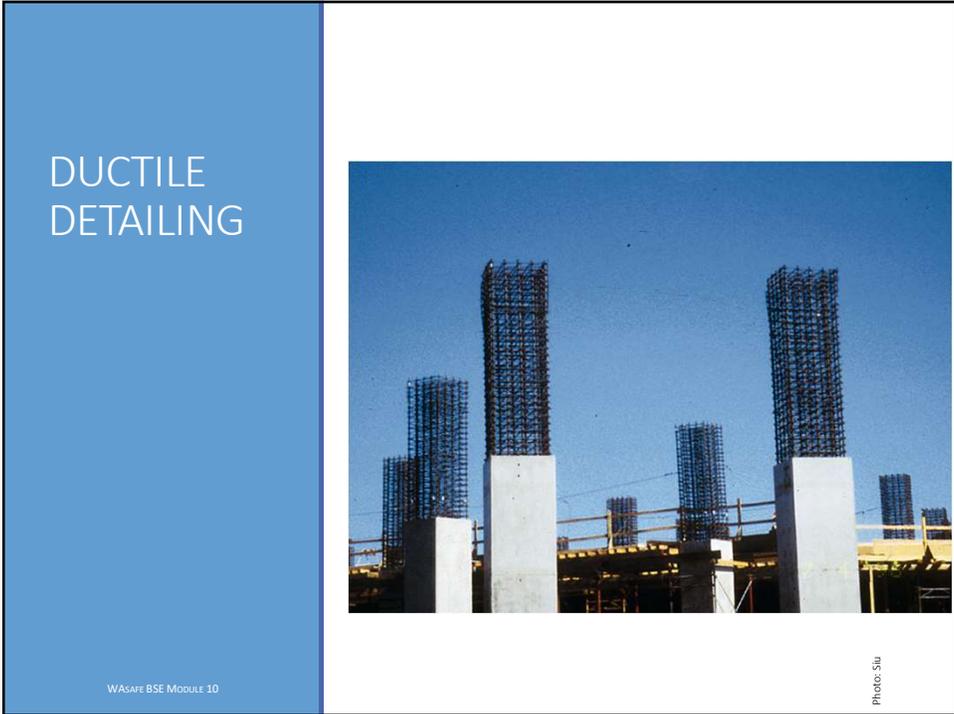
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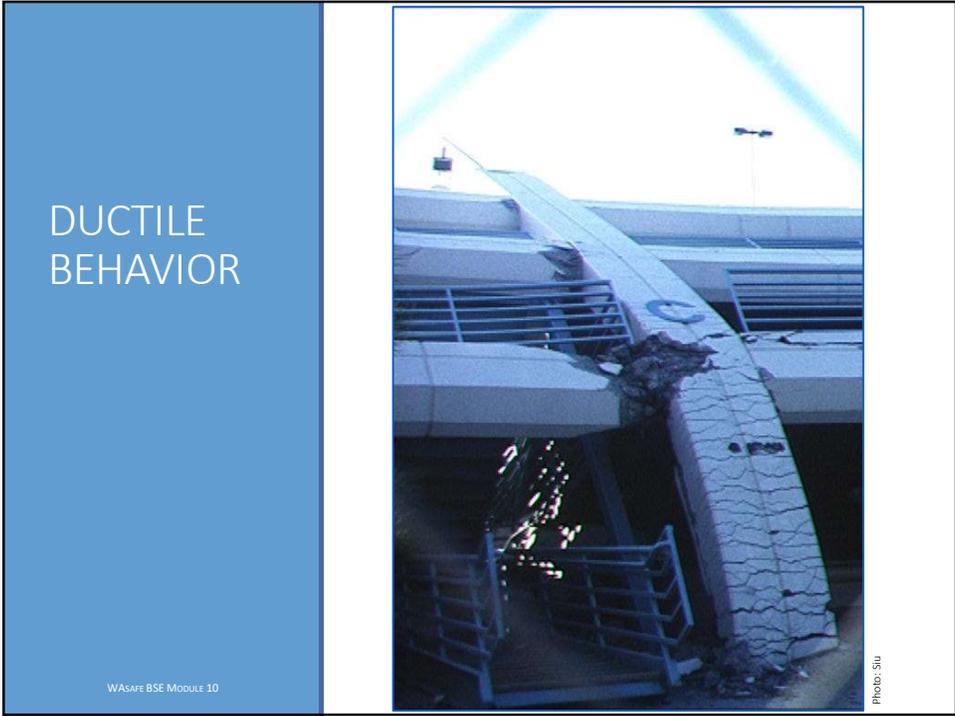
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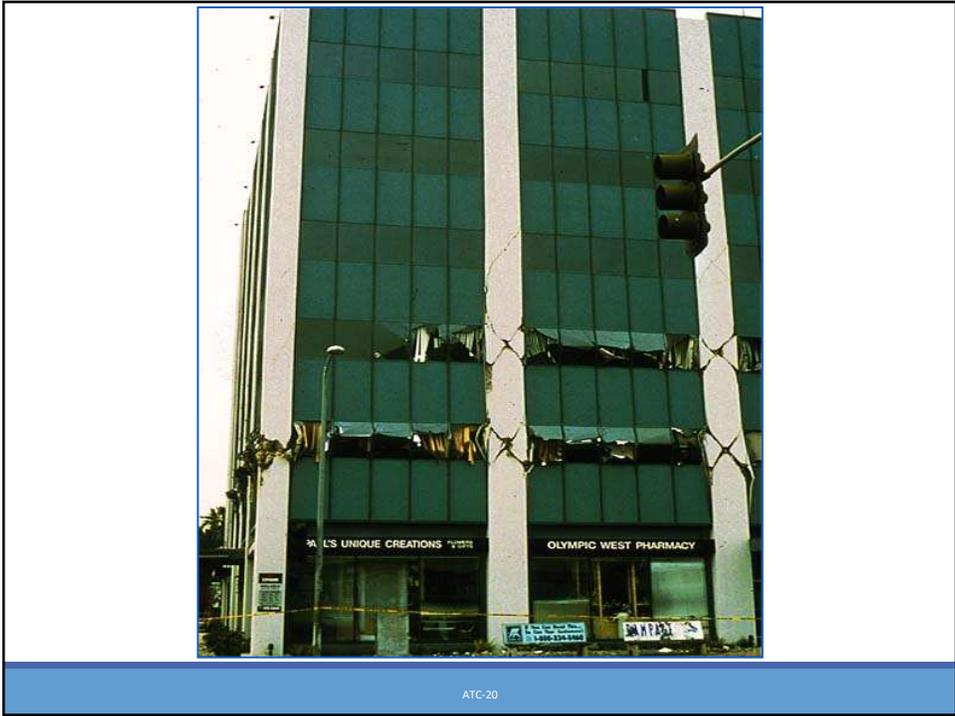
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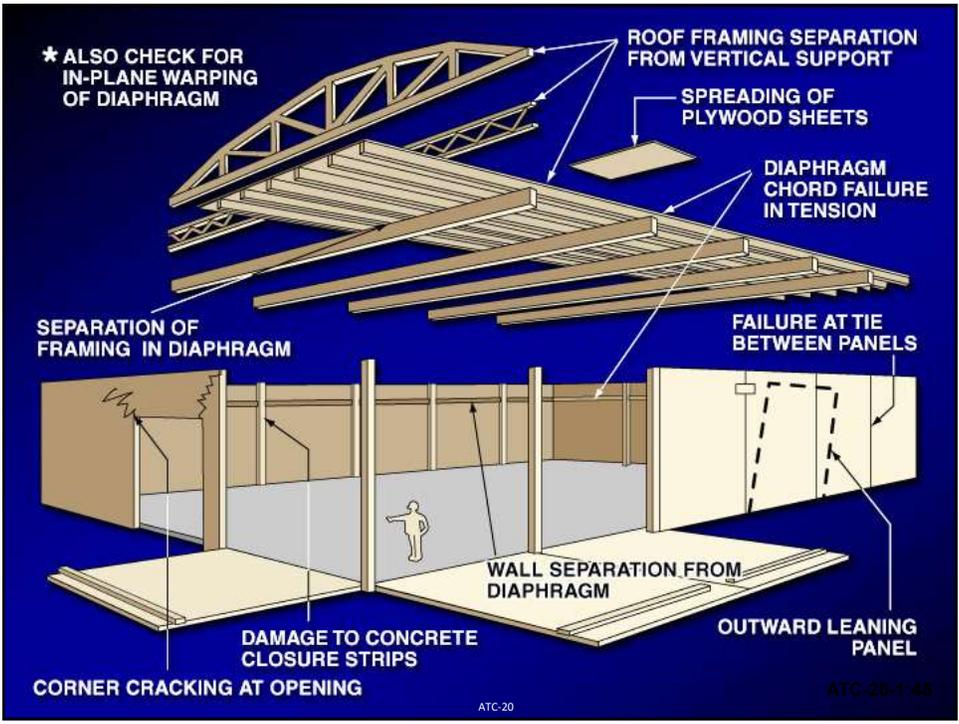
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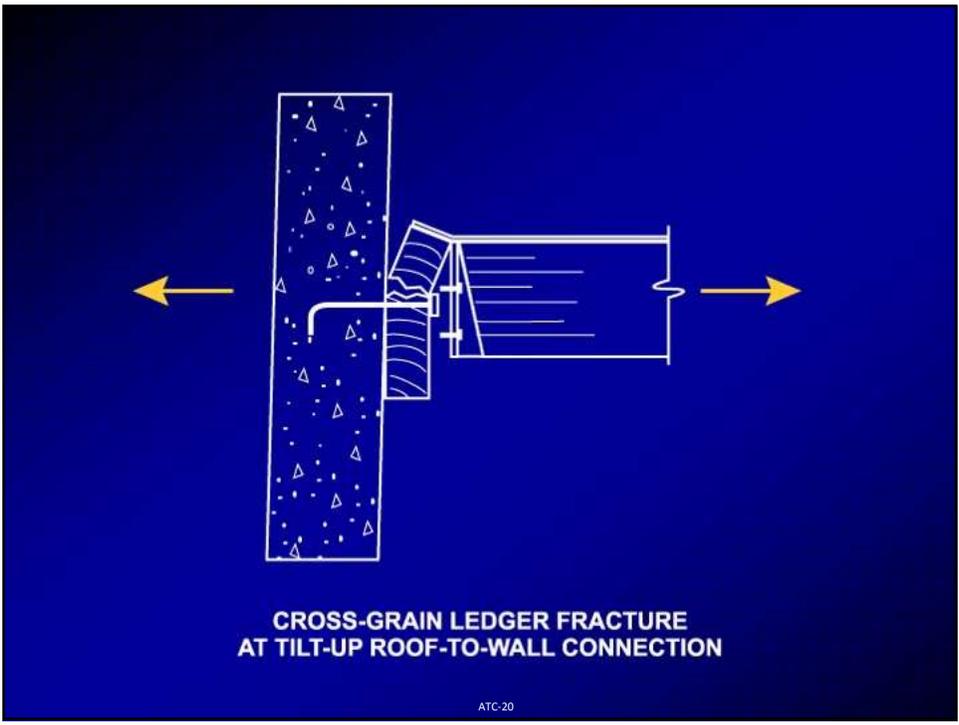


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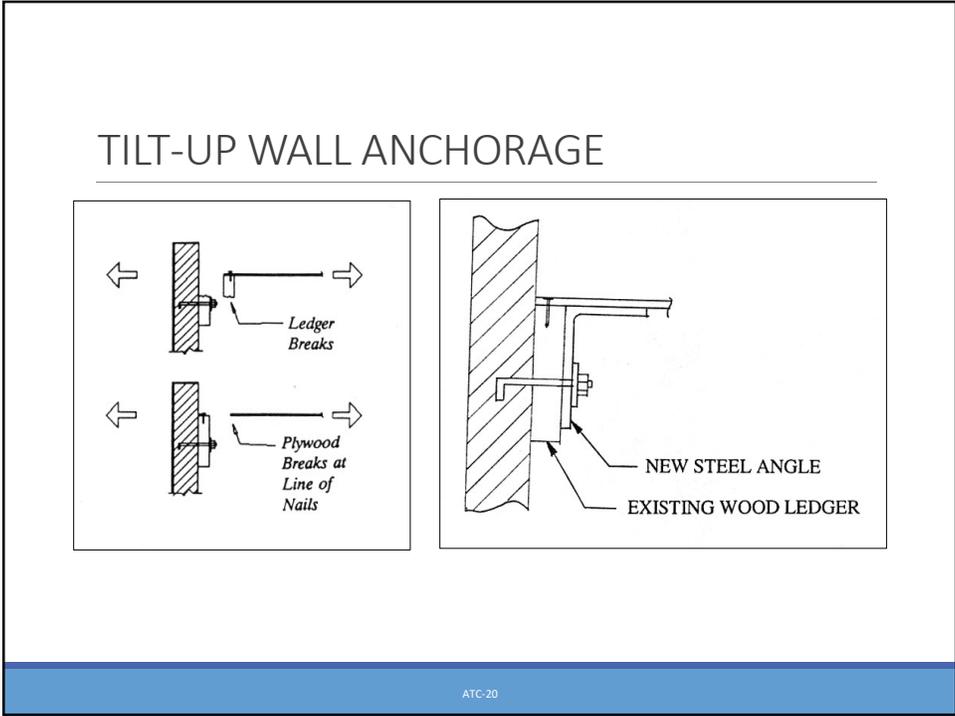
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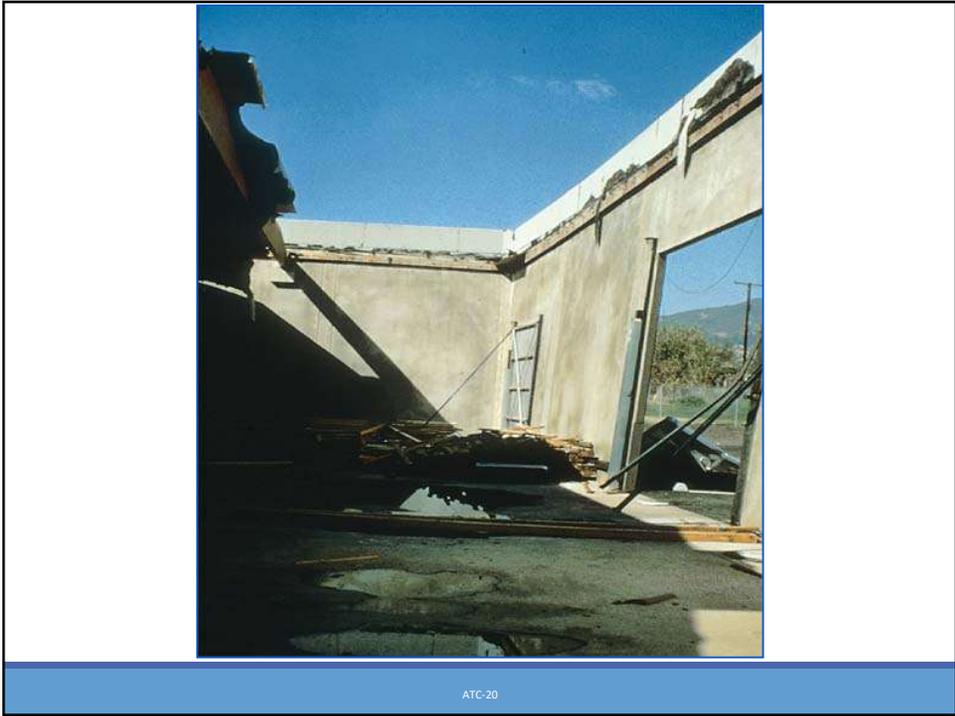
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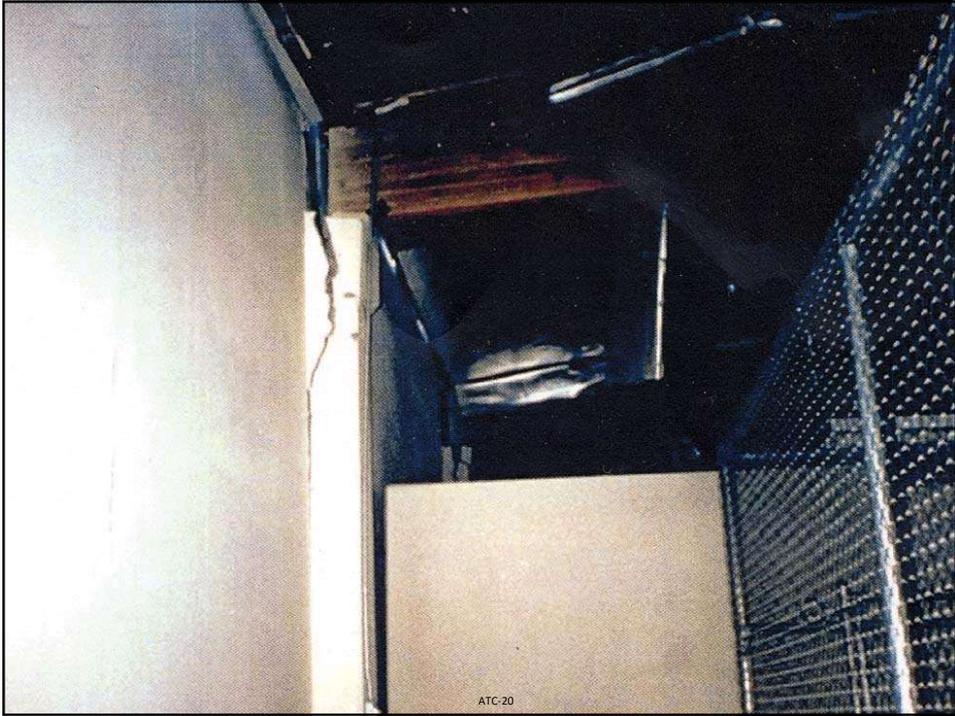
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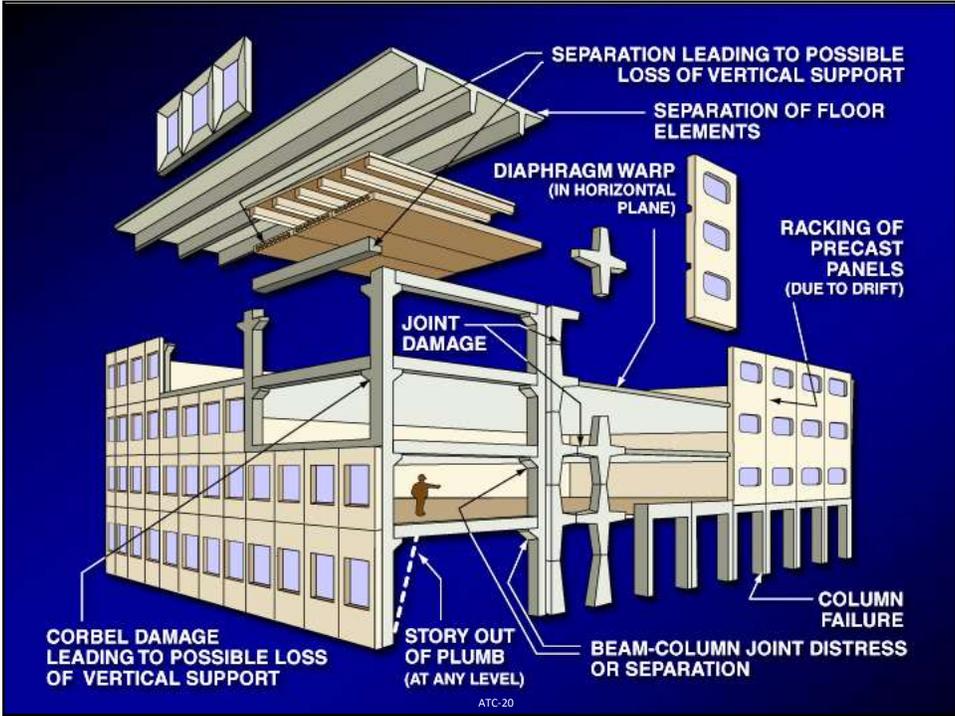
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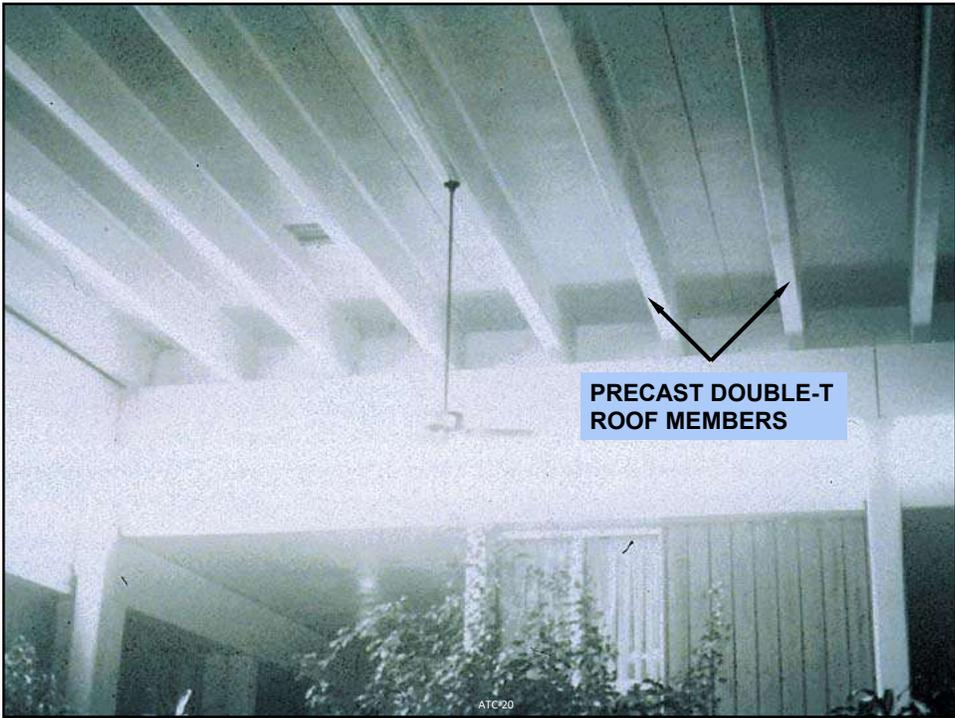
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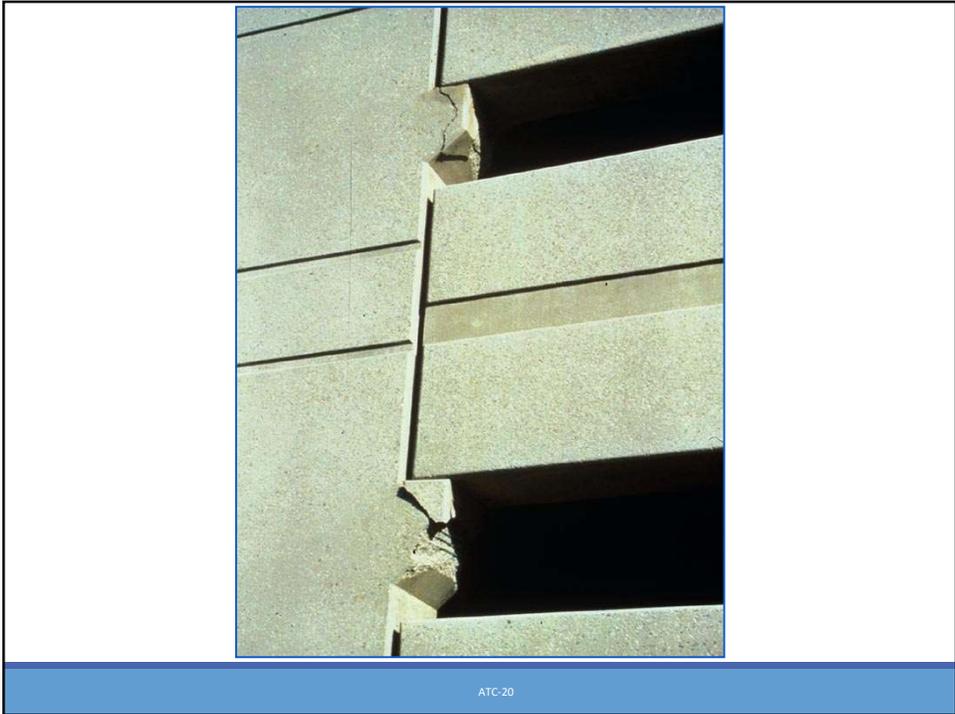
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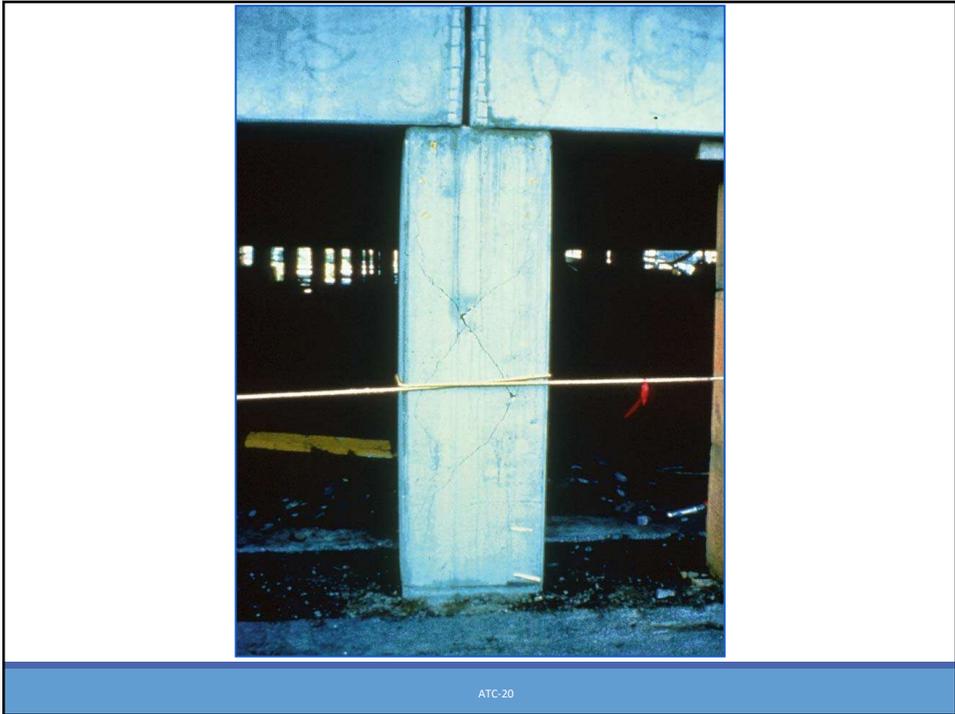
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# POLITICS OF RECOVERY

WASAFE BSE MODULE 14

1

## DEALING WITH FEMA

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Pressure to get federal funds to repair government and non-profit buildings

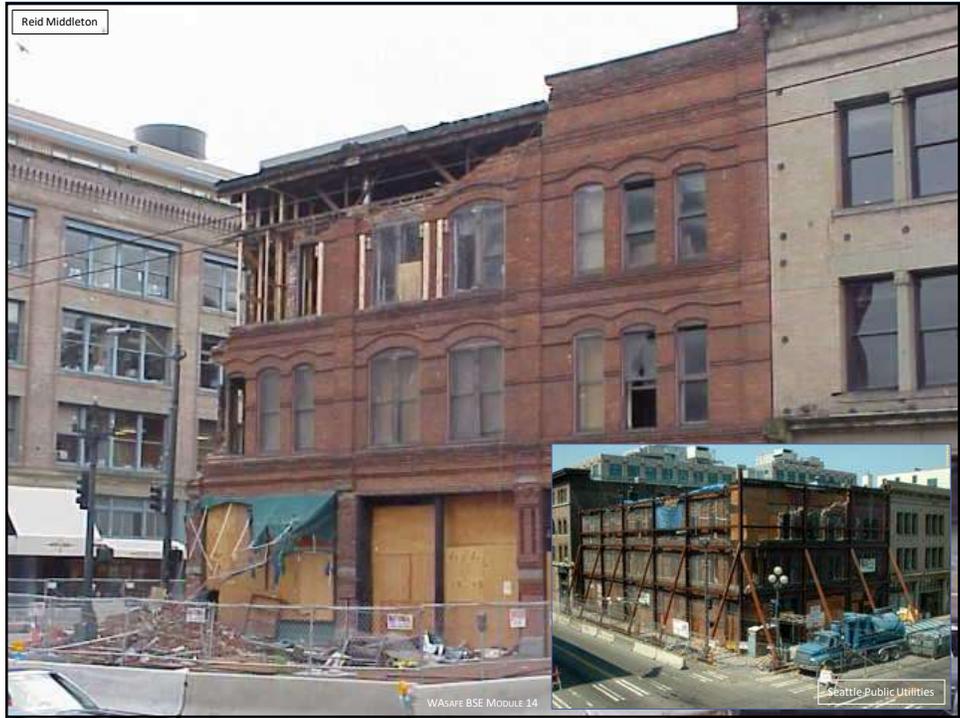
Have repair policies in place before the event

- Non-discretionary thresholds for upgrades
- Apply to all forms of damage, not just earthquakes
- Damage % in IEBC may not be analyzed consistently, per structural engineers

Only costs for supplies, contracts, overtime are reimbursable

WASAFE BSE MODULE 14

2



3

## PUBLIC SAFETY VS ECONOMIC RECOVERY

### Pressure to reopen businesses

- ATC-20 by contract engineers for building owners (WP 5-2009)

### Pressure to reopen streets

### Hazard mitigation/abatement of unrepaired, tagged buildings (enforcement)

- Adjacent buildings affecting undamaged property
- Coordinate with Public Works departments on hazards to public right-of-way
- Historic preservation

### Beware fly-by-nighters



Photo: Reid Middleton

WASAFE BSE MODULE 14

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# STEEL FRAME CONSTRUCTION

ATC-20

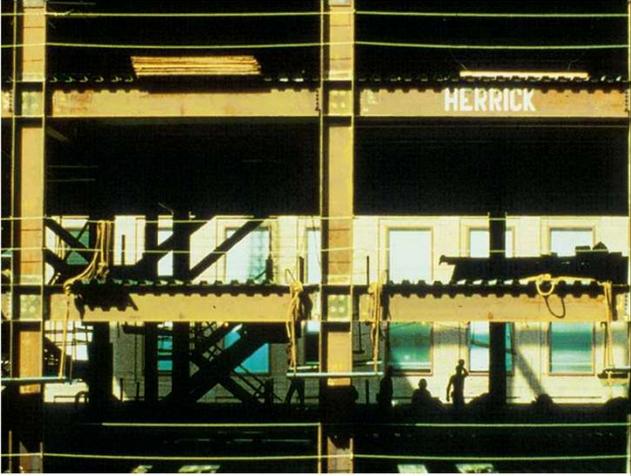
1

STEEL-  
FRAME

Multi-story fire  
resistive frame

Pre-engineered  
light frame

ATC-20



2



3



4

# STEEL MOMENT FRAMES

**FEMA Building Type S1 STEEL MOMENT FRAMES**

Vertical shafts of nonstructural materials

Steel beams and columns

Nonstructural exterior cladding often window wall or panelized construction

Selected bays in each direction constructed as moment frames. See chapter 3.

Floors: most often concrete over metal deck

These buildings consist of an essentially complete frame assembly of steel beams and columns. Lateral forces are resisted by moment frames that develop stiffness through rigid connections of the beam and column created by angles, plates and bolts, or by welding. Moment frames may be developed on all framing lines or only in selected bays. It is significant that no structural walls are required. Floors are cast-in-place concrete slabs or metal deck and concrete. This building is used for a wide variety of occupancies such as offices, hospitals, laboratories, and academic and government buildings.

The S1A building type is similar but has floors and roof that act as flexible diaphragms, such as wood or untopped metal deck. One family of these buildings are older warehouse or industrial buildings, while another more recent use is for small office or commercial buildings in which the fire rating of concrete floors is not needed.

WASAFE BSE MODULE 11

5

## BRITTLE STEEL??

ATC-20

### Quake Cracks Steel Buildings

In past earthquakes, unreinforced brick and stiffly designed concrete buildings were considered more vulnerable to collapse. Buildings made of steel were deemed safer, because they tend to bend but not break. The Northridge earthquake shattered those assumptions. Engineers have identified a dozen more steel buildings as high as 10 stories with badly cracked welds and supporting steel columns. Although they did not collapse, they were seriously weakened.

**Two types of cracks**

Column Flange

Stiffener Bolt

Weld Beam

Weld

Fracture near interface of weld and column flange

Column

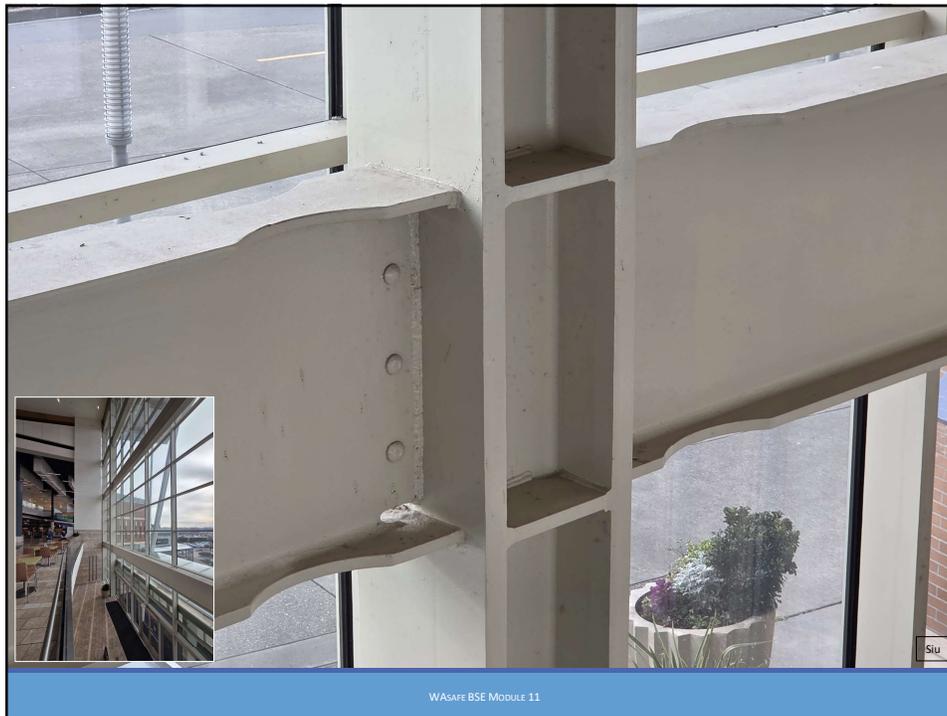
Beam

Fracture through column

**Moment resisting frame**

A steel moment resisting frame is a rectangular assemblage of beams and columns. The beams are welded and bolted to the columns.

6



7

## STEEL BRACED FRAMES

**FEMA Building Type S2 STEEL-BRACED FRAMES**

Braced frames often placed within shaft walls

Steel beams and columns

Nonstructural exterior cladding often window wall or panelized construction

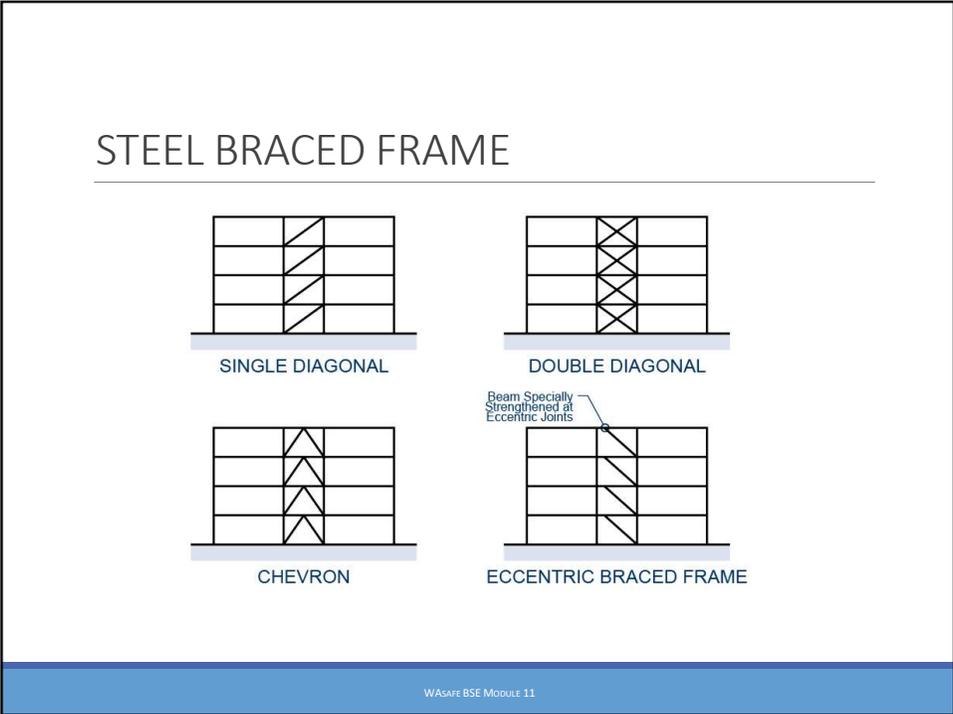
Selected frames in each direction constructed as braced frames. See chapter 3.

These buildings consist of a frame assembly of steel columns and beams. Lateral forces are resisted by diagonal steel members placed in selected bays. Floors are cast-in-place concrete slabs or metal deck and concrete. These buildings are typically used for buildings similar to steel-moment frames, although are more often low rise.

The S2A building type is similar but has floors and roof that act as flexible diaphragms such as wood, or topped metal deck. This is a relatively uncommon building type and is used mostly for smaller office or commercial buildings in which the fire rating of concrete floor is not needed.

WASAFE BSE MODULE 11

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## BRACED FRAME DAMAGE

Concentric braced frame (gusset buckling)

Photos: Reid Middleton

WASAFE BSE MODULE 11

11

Poll

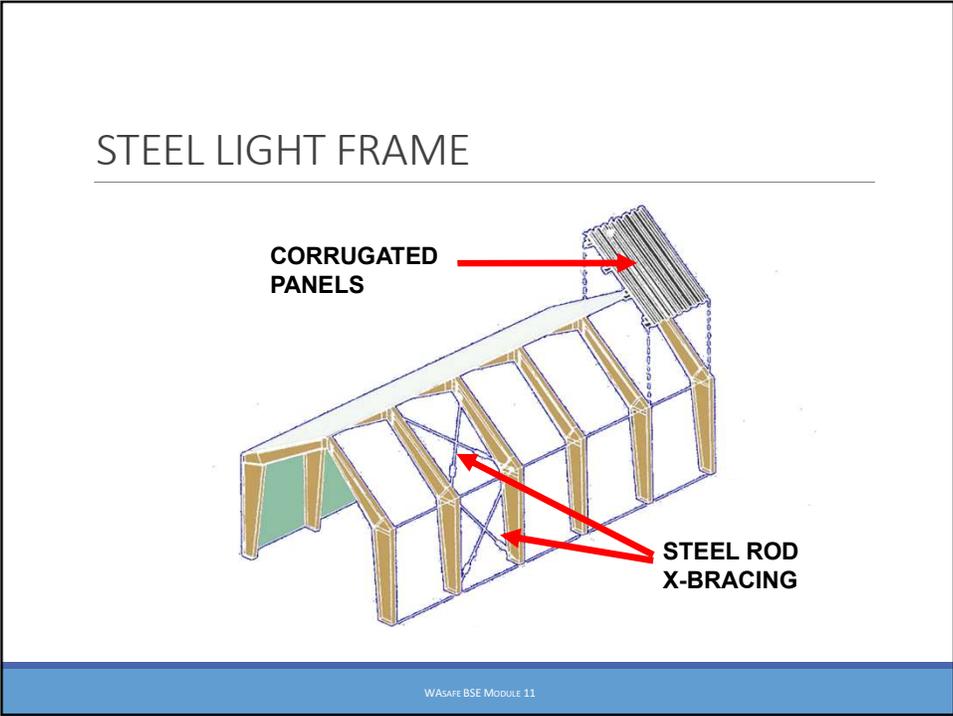
## BRACED FRAME DAMAGE

Eccentric braced frame (link beams)

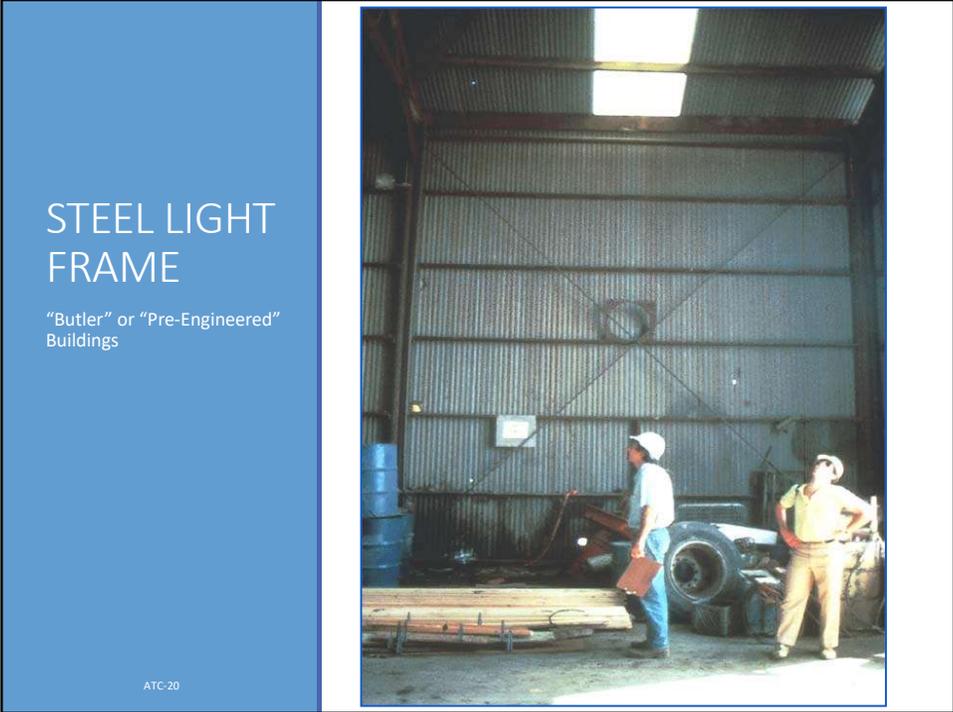
Source: Steel Building Damage from the Christchurch Earthquake of February 22, 2011, NZST; Bruneau, et al

WASAFE BSE MODULE 11

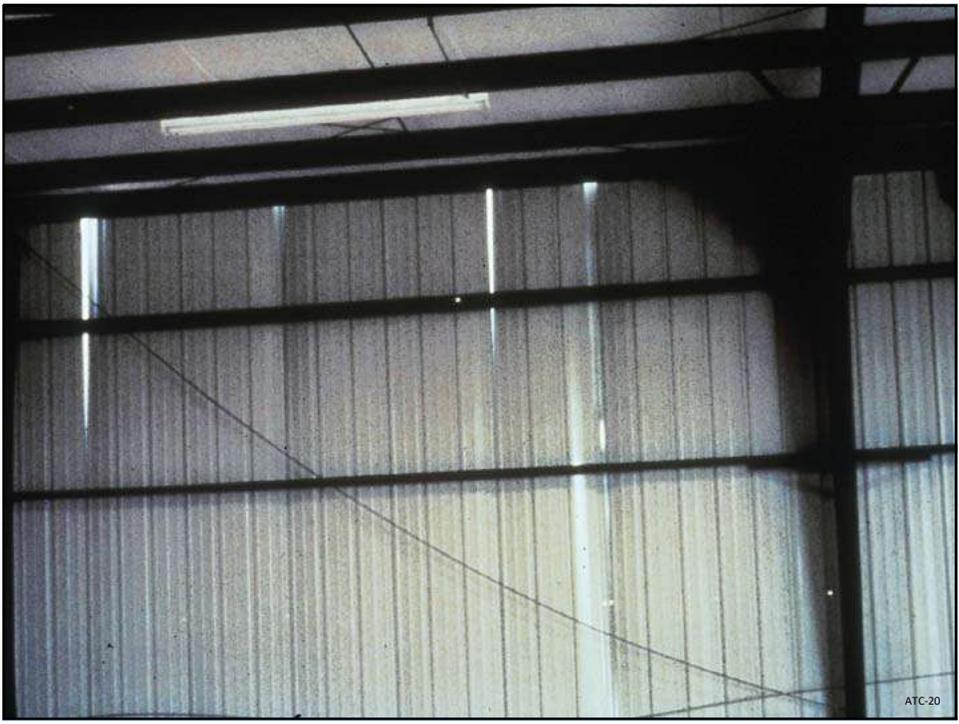
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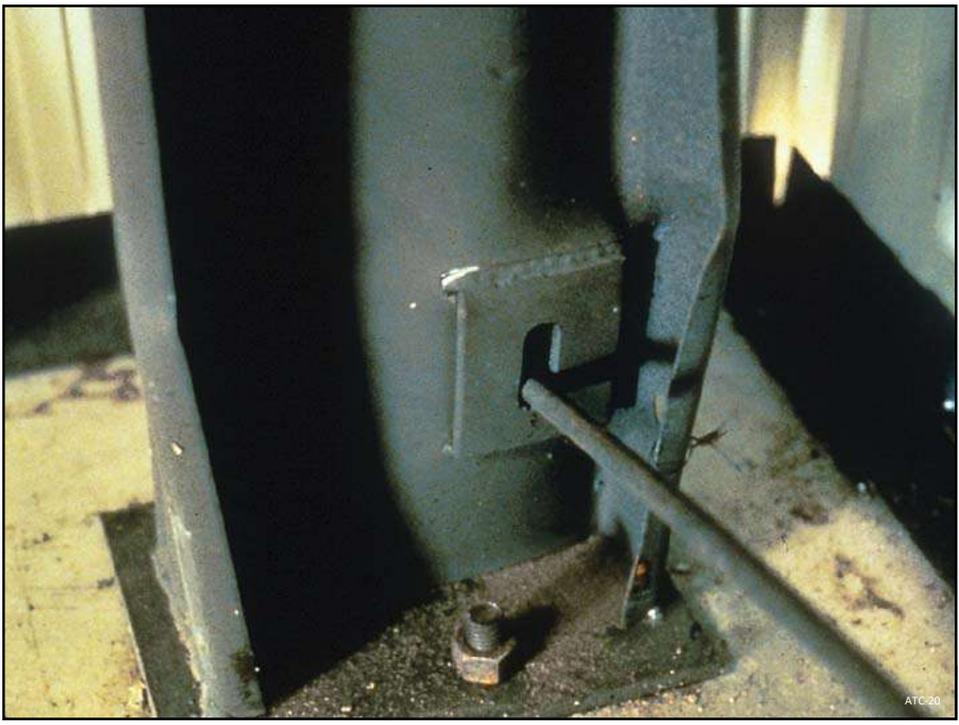
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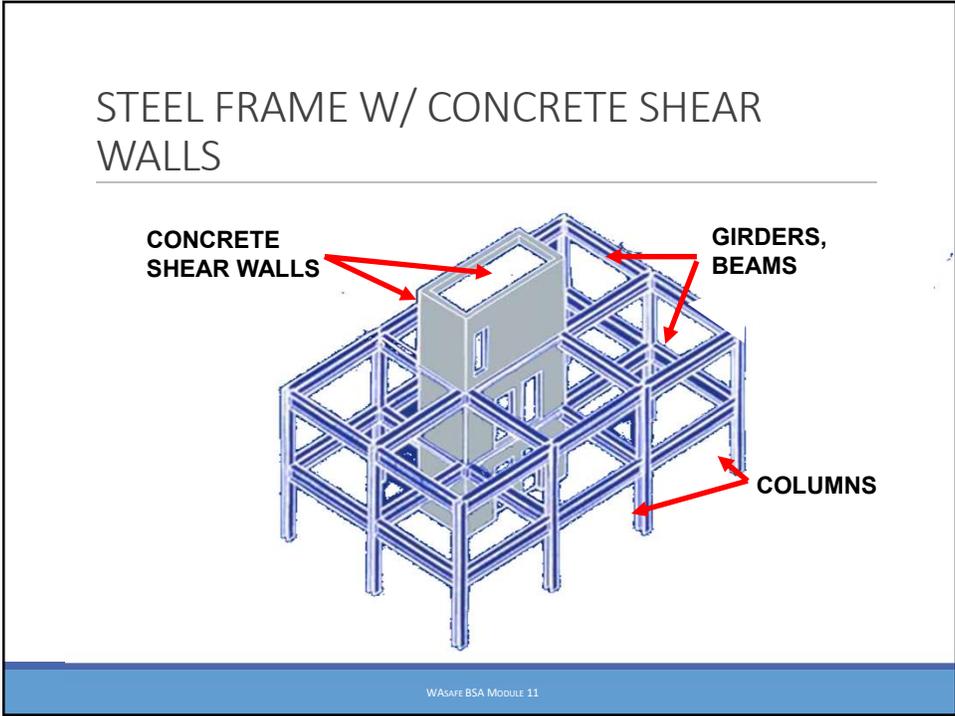


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# HYBRID CONSTRUCTION

ATC-20

17



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**BE1**

## STEEL FRAME W/ MASONRY INFILL WALLS

**FEMA Building Type S5 STEEL FRAMES with infill masonry walls**

This is normally an older building that consists of an essentially complete frame assembly of steel floor beams or trusses and steel columns. The floor consists of masonry flat arches, concrete slabs or metal deck, and concrete fill. Exterior walls and possibly some interior walls, are constructed of unreinforced solid clay brick, concrete block, or hollow-clay tile masonry infilling the space between columns and beams. Windows and doors may be present in the infill walls, but to act effectively as shear-resisting elements, the infill masonry must be constructed tightly against the columns and beams. Although relatively modern buildings in moderate or low seismic regions are built with unreinforced masonry exterior infill walls, the walls are generally not built tight against the beams and columns and therefore do not provide shear resistance. The buildings intended to fall into this category feature exposed clay brick masonry on the exterior and are common in commercial areas of cities with occupancies of retail stores, small offices, and hotels.

The S5A building type is similar but has floors and roof that act as flexible diaphragms, such as wood or topped metal deck. These buildings will almost all date to the 1930s and earlier, and were originally warehouses or industrial buildings.

WASAFE BSE MODULE 11

20

## Slide 19

---

**BE1** This alludes to the idea that the steel frame is a part of lateral system. I'm unaware of an actual dual system in Seattle.

This slide has always bothered me in the Steel module. It seems to be a good concrete section photo. I like how it shows non-spalled concrete, spalled and non-rubblized concrete, then the corner has rubblized concrete that won't be able to withstand gravity loading. The most damage is in the corner, which is as anticipated.

Enfield, Benjamin, 2024-02-26T23:31:32.530

**jo1 0** There may be older dual frame buildings in other jurisdictions, and since this is in the hybrid section, is probably OK here. Note clarified to say this is in older dual-frame systems.

jon.wabo@wasafecoalition.org, 2024-02-29T23:58:19.465

## Slide 20

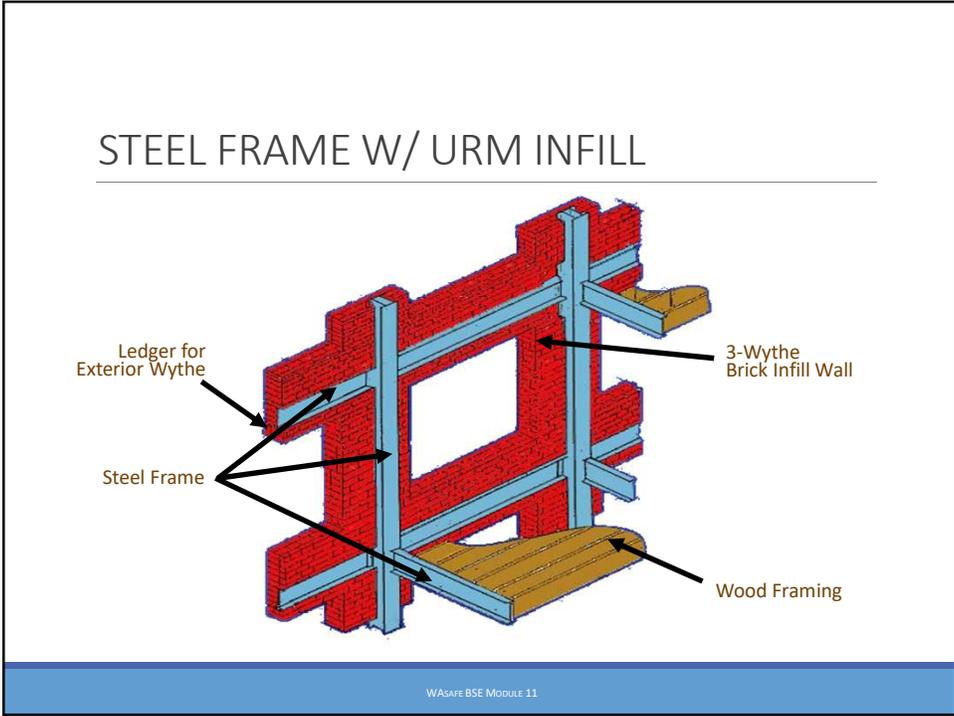
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**BE1** I provided a possible alternate phrasing of the slide notes.

Enfield, Benjamin, 2024-02-26T22:20:36.717

**jo1 0** OK

jon.wabo@wasafecoalition.org, 2024-03-01T00:10:48.840



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# MANUFACTURED HOMES

ATC-20

1

## DAMAGE TO MANUFACTURED HOMES

---

Off their piers, blocks, or jack stands either partially or totally

Piers penetrating the interior floor decking

Fully or partially burned

Energizing of metal skin in older units

Utilities damaged and turned off

Water heater movement effecting venting and/or gas supply

Displaced sewer connections

ATC-20

2

## MANUFACTURED HOME EVALUATION PROCEDURES

---

- Stability of the jack stands
- Safety of accessories, awnings, etc.
- Condition of utilities
- Home ingress and egress
- Geotechnical

ATC-20

3



Example of a well-worn jack stand used to support manufactured home.

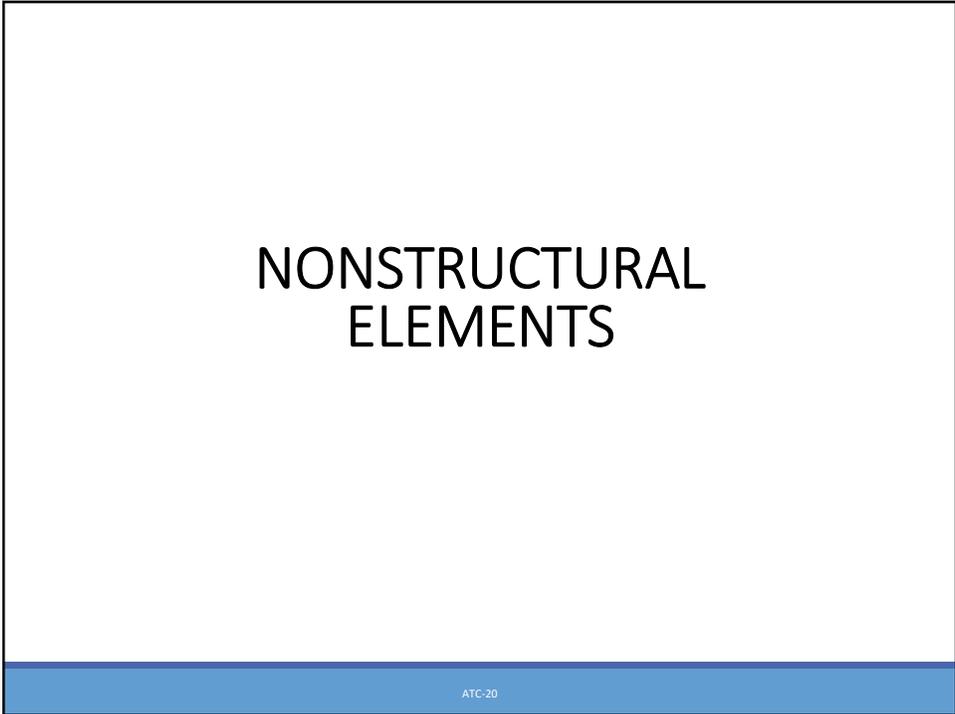
C/O RES S&P

WASAFE BSE MODULE 12

4



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## NONSTRUCTURAL ELEMENTS

---

Parapets, chimneys, ornamentation

Cladding and glazing

Partitions

Suspended ceilings, raised floors

Tanks, piping, and ductwork

Equipment

Furnishings and contents

ATC-20

7



8



ATC-20

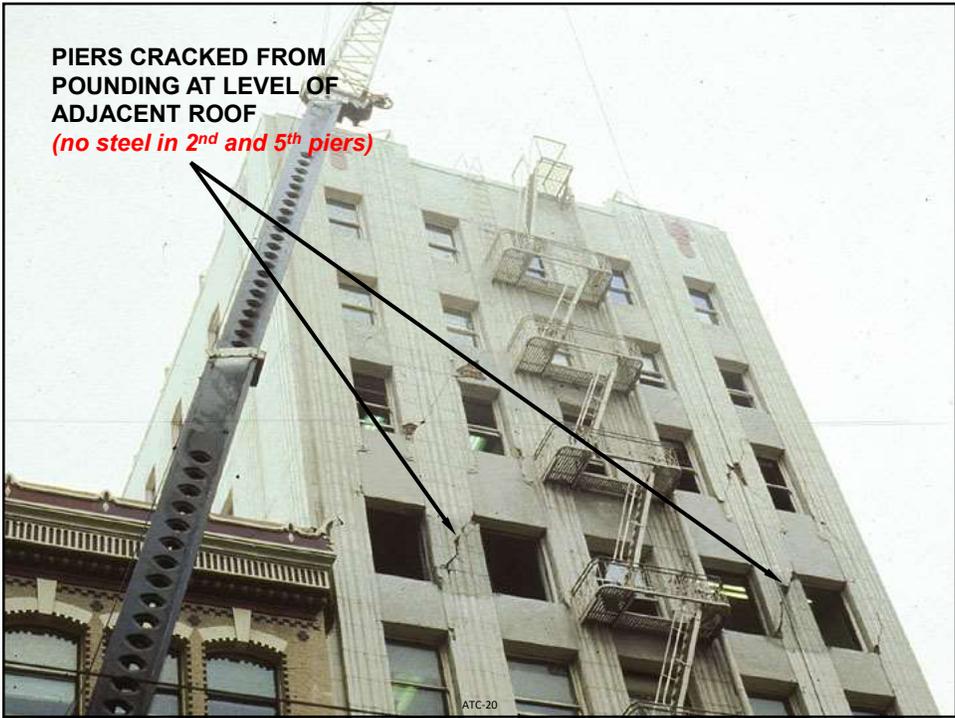
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Photos: Sju

WASAFE BSE MODULE 12

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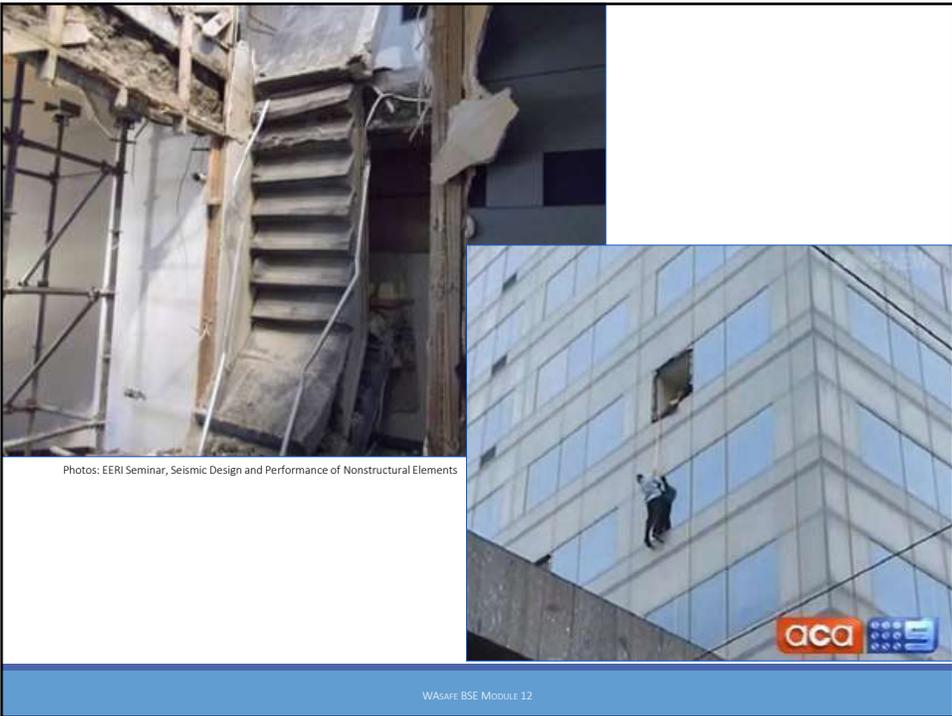
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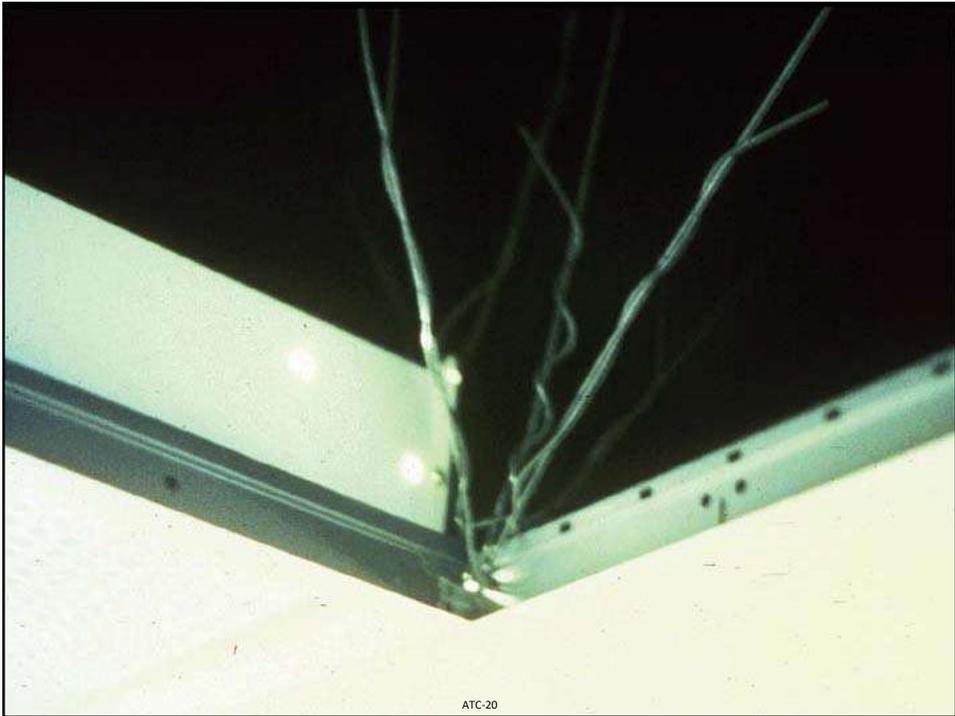
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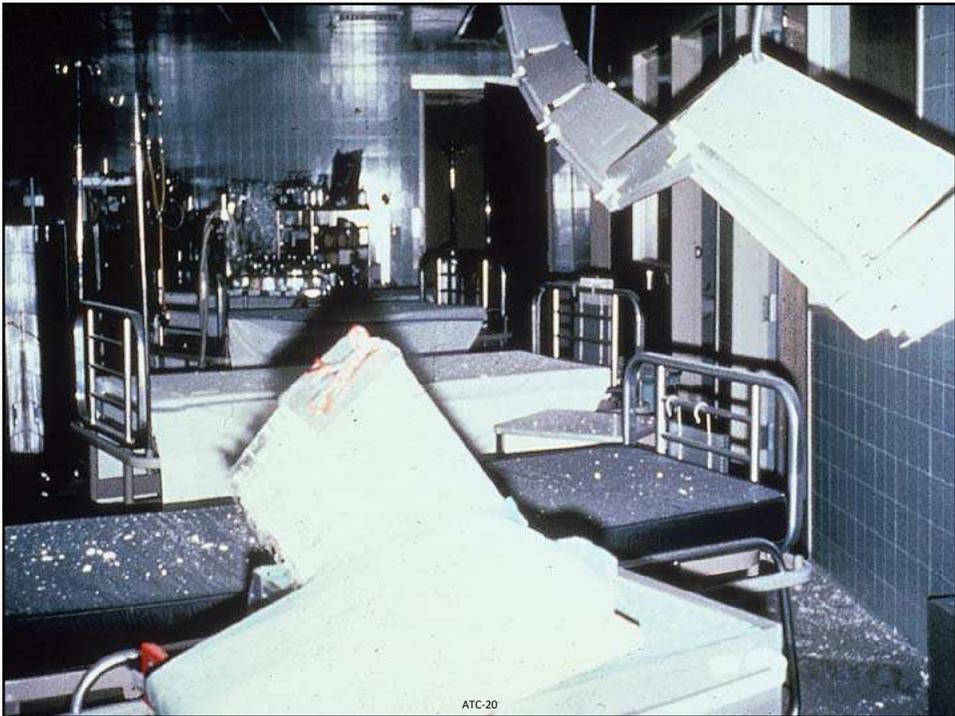


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ATC-20

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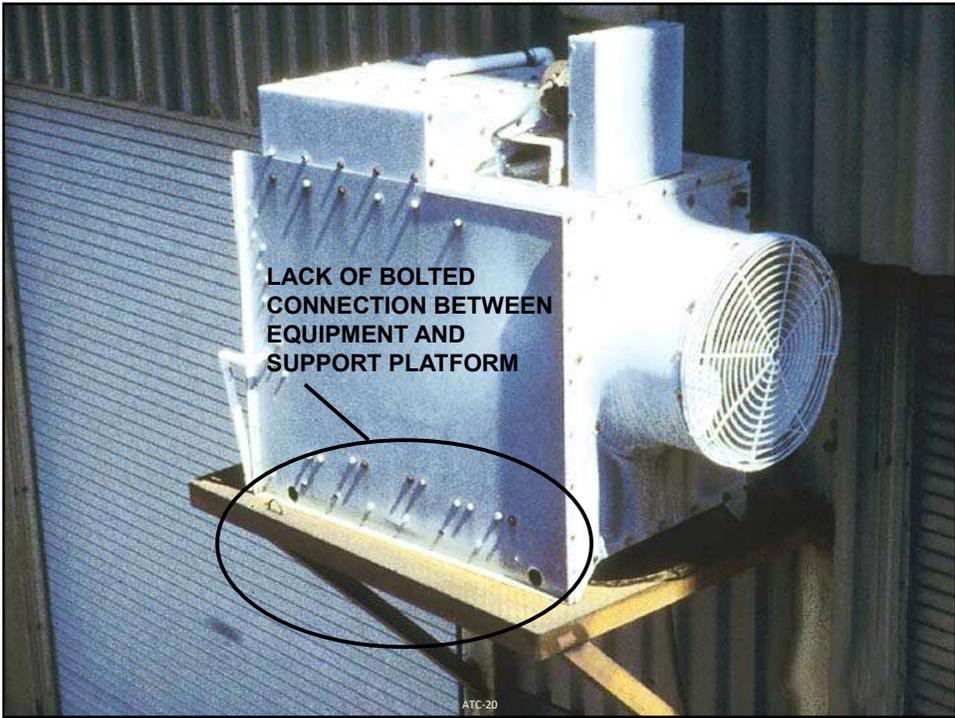


ATC-20

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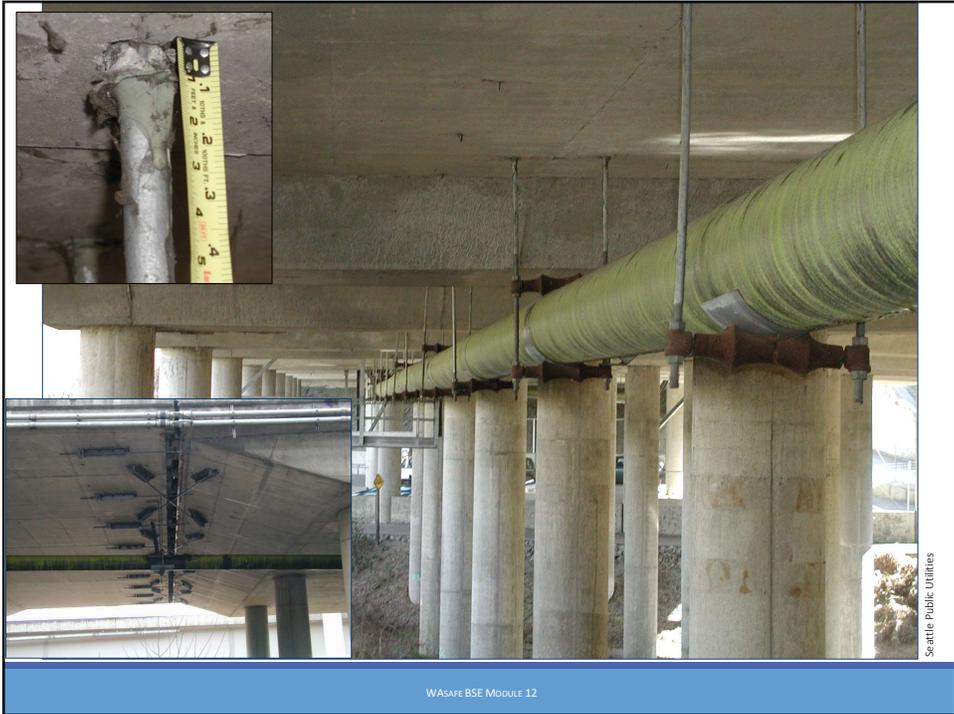
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# ELEVATORS

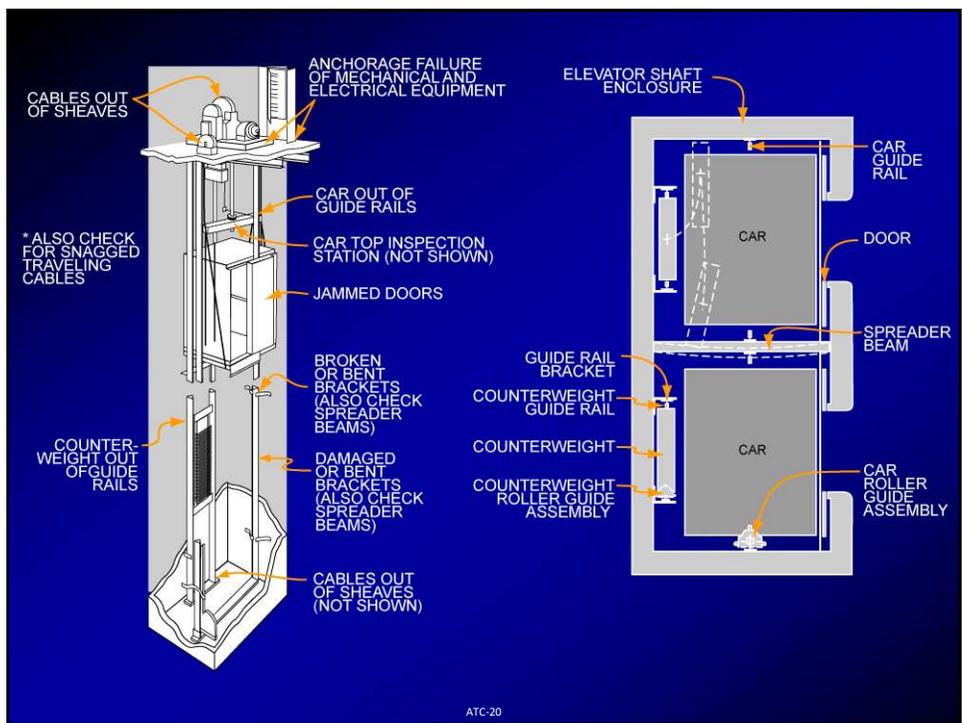
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Counterweight failure captured on security video:

- <https://www.youtube.com/watch?v=ccXELXyJT7E>

WASAFE BSE MODULE 12

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# GEOTECHNICAL HAZARDS

ATC-20

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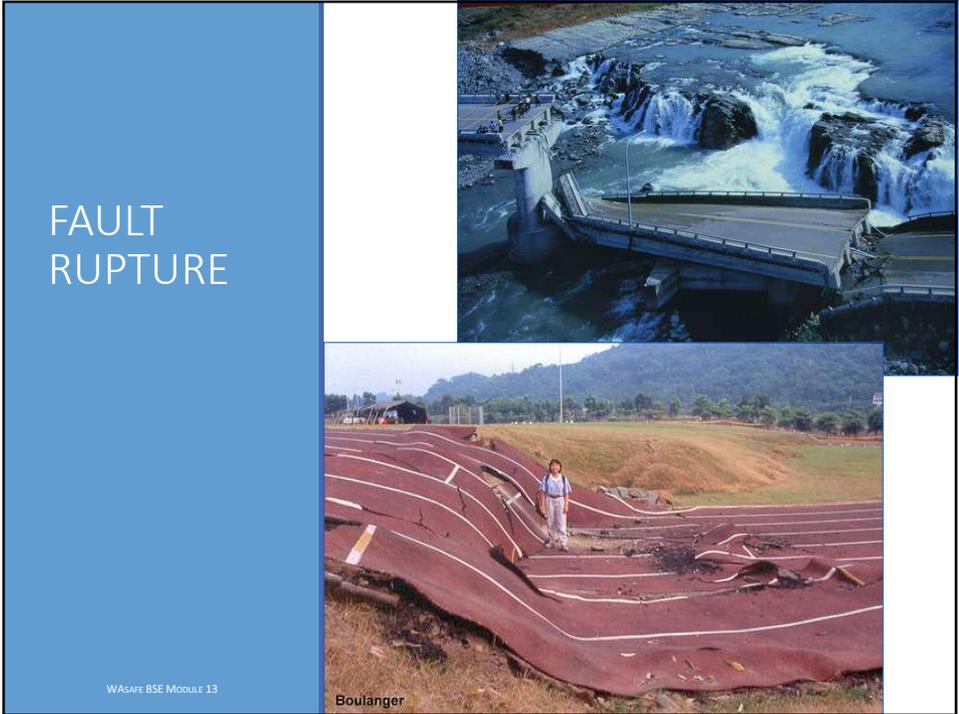
## GEOTECHNICAL HAZARDS

- Fault rupture
- Basin amplification
- Soft Soil Effects
  - Increased shaking
  - Liquefaction/Lateral spreading
- Landslides

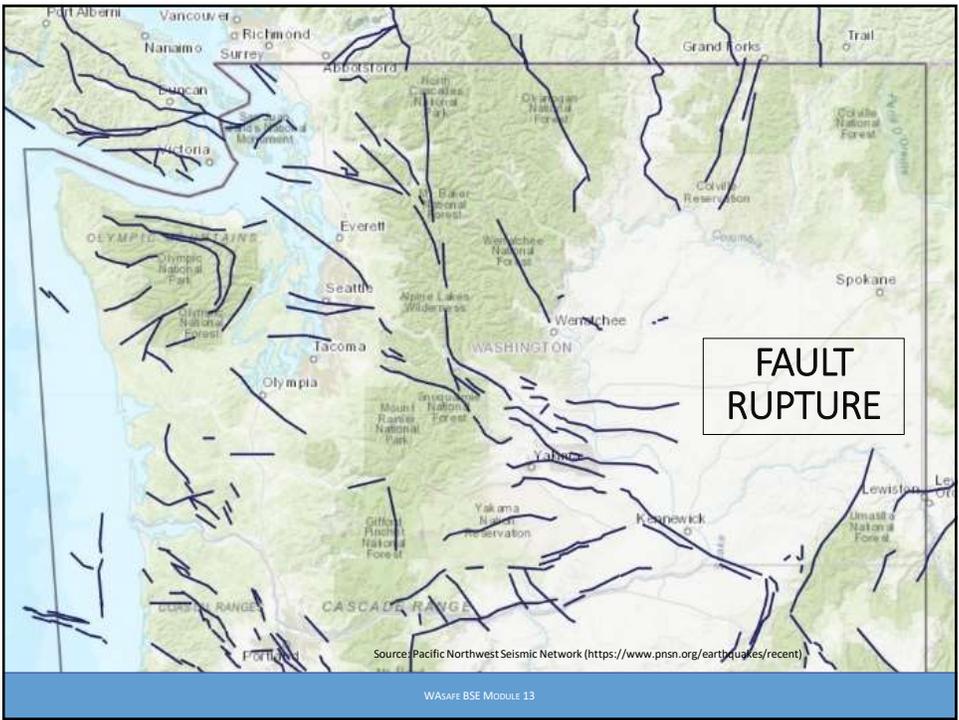


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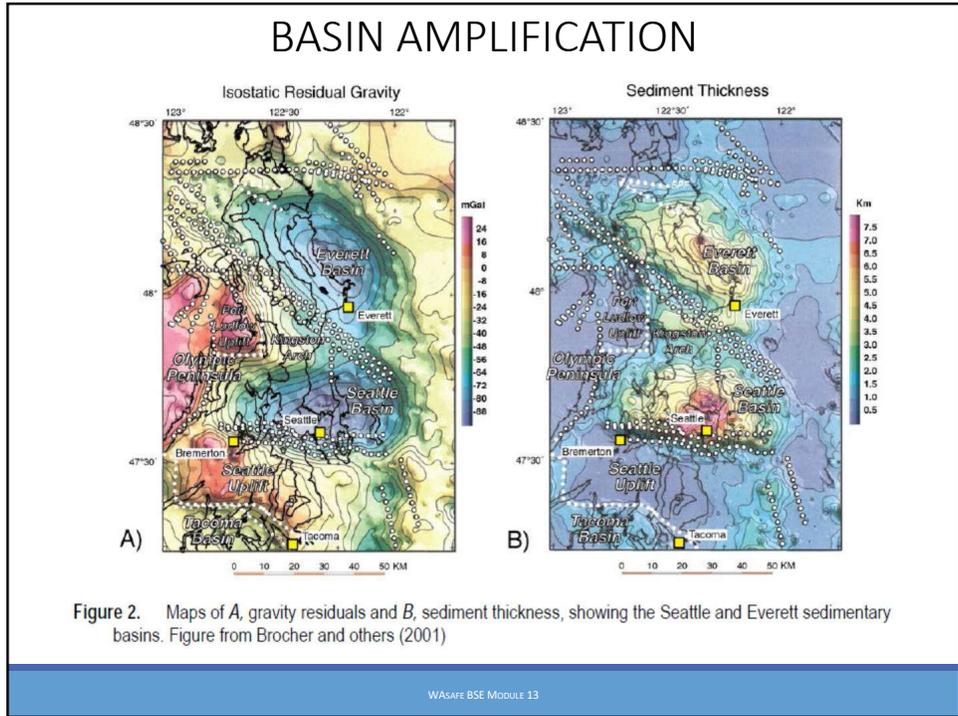
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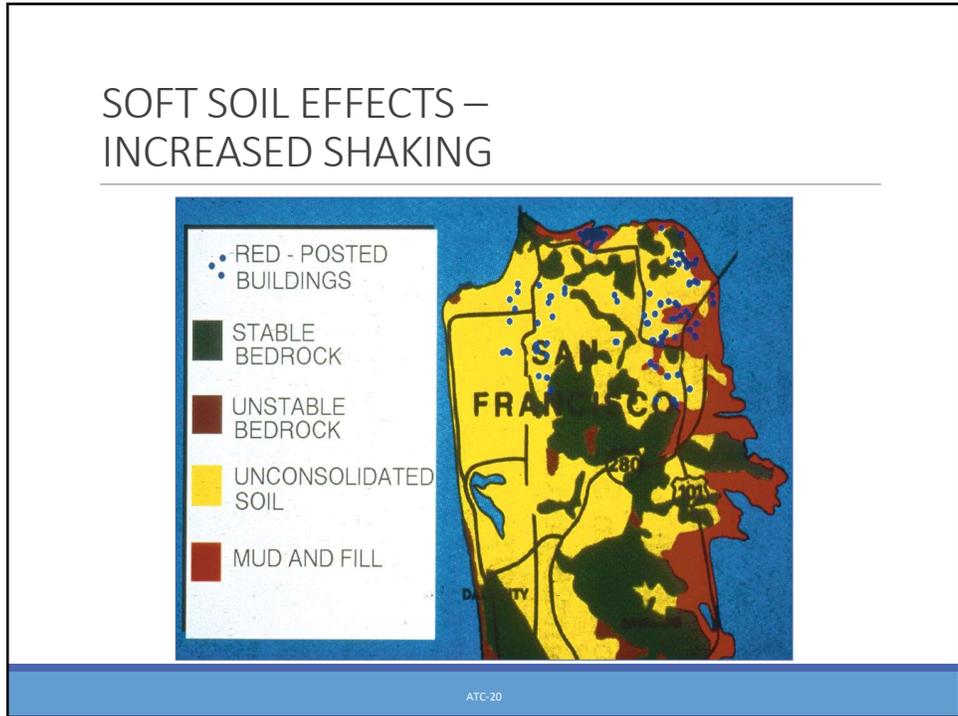
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## SOFT SOIL EFFECTS - LIQUEFACTION

Phenomenon in which soil strength and stiffness are significantly reduced by earthquake shaking

Strength loss in soil due to build-up of water pressure

Occurs in *loose, saturated, sandy and silty soils*



Source: <http://throughthesandglass.typepad.com>

WASAFE BSE MODULE 13

7

## LIQUEFACTION EFFECTS

Settlement and differential settlement (bearing capacity failure)

Loss of deep foundation capacity (settlement or breakage of piles)

Lateral spreading

Slope failure

Effect on ground motions

Flooding and uplift of utilities

Damage over very large areas



SEAW Tohoku Reconnaissance Team

WASAFE BSE MODULE 13

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# LATERAL SPREADING EFFECTS



ATC-20

11




 Photo courtesy of Prof. Misko Cubrinewski  
 University of Canterbury, New Zealand

WASAFE BSE MODULE 13

12

## LIQUEFACTION/ LATERAL SPREADING

Puget Sound

<http://geologyportal.dnr.wa.gov/>

WASAFE BSE MODULE 13

13

## LANDSLIDES

WASAFE BSE MODULE 13

Photo: Los Angeles County

14

## LANDSLIDES

---

### **Considerations for tagging:**

Risk to life-safety - potential for near-term sliding

Cause of slide

Geology, groundwater, typical slide types in area

Cracks, leaning trees, running groundwater, bulges at toe of slope



USGS

WASAFE BSE MODULE 13

15

## LANDSLIDES

---

### **Considerations for tagging (cont.):**

Likelihood of aftershocks

Foundation system of structure

May be able to be conservative because of limited effect of tagging

May need help from geotechnical consultant

Likelihood of damage to buildings above/below

WASAFE BSE MODULE 13

16

## LANDSLIDE EVALUATION



Photo: USGS

WASAFE BSE MODULE 13

17

## LANDSLIDES

### Structure Evaluation:

Undamaged but threatened=>  
Yellow tag (Restricted Use) for  
recovery of belongings

Evaluate damaged buildings  
using standard structural  
criteria

Heavy damage, loss of  
foundation support => Red tag  
(Unsafe)



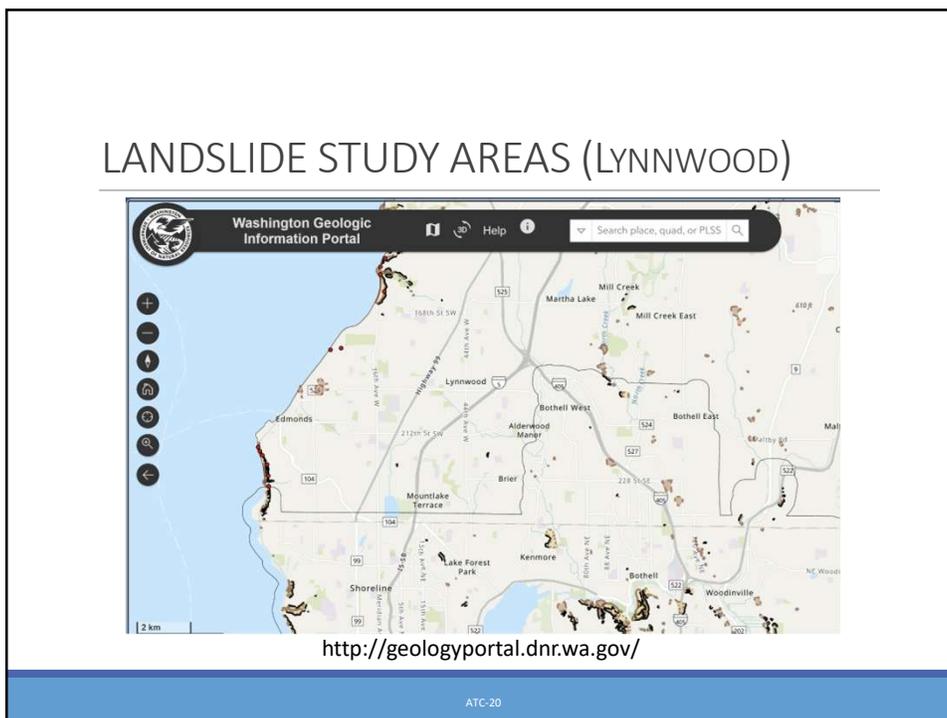
USGS

WASAFE BSE MODULE 13

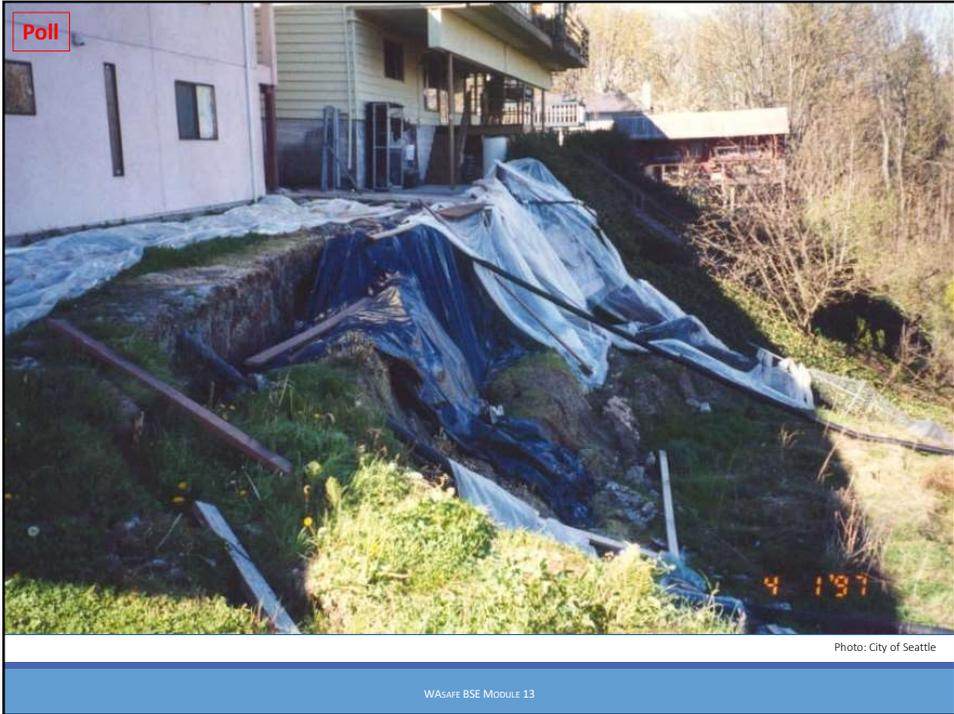
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Washington State Safety Assessment Facility Evaluators

# WASAFE AND VOLUNTEER DEPLOYMENT

WASAFE BSE MODULE 15 1

1

# CONCEPT OF OPERATIONS

WASAFE BSE MODULE 15

2

## EMERGENCY RESPONSE HIERARCHY

---

Local Government is always in charge in emergency response.

- Upper levels supply aid to local level
- Hierarchy established by the ***Incident Command System (ICS), a standardized, all-hazards incident management concept.***

WASAFE BSE MODULE 15

3

## WASAFE – PART OF A LARGER SYSTEM

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### What Is ICS?

---

#### ICS:

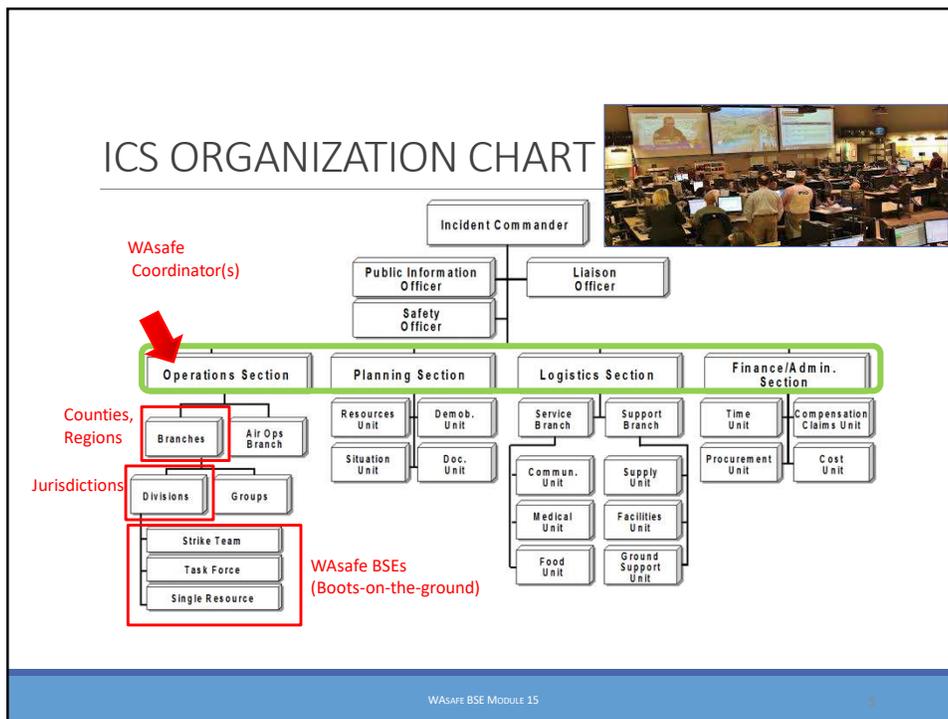
- Is a standardized, on-scene, all-hazards incident management concept.
- Enables a coordinated response among various jurisdictions and agencies.
- Establishes common processes for planning and management of resources.
- Allows for integration within a common organizational structure.



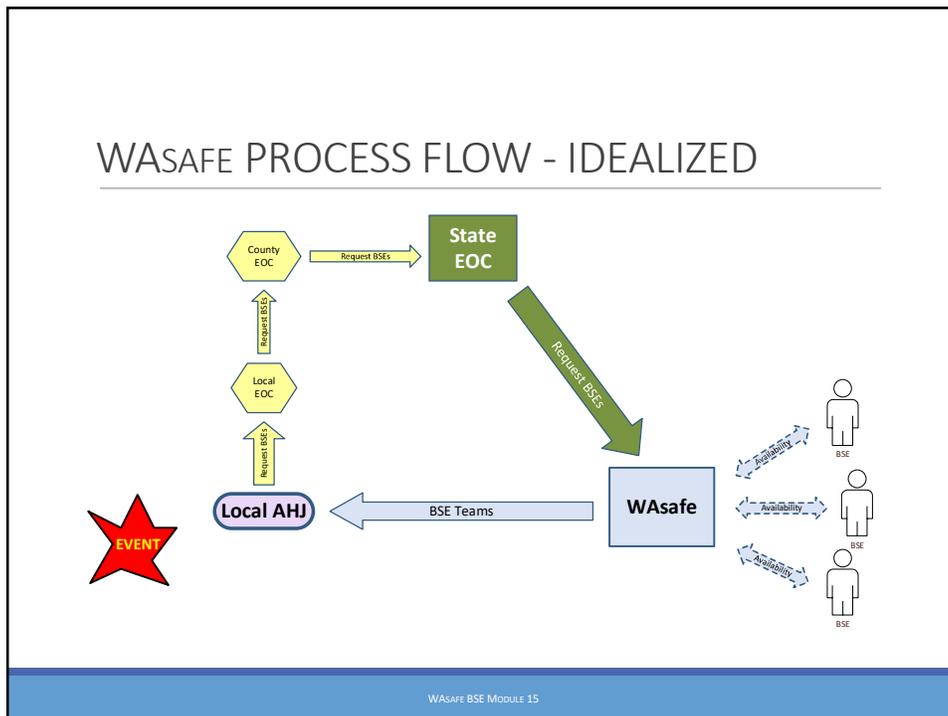
Visual 2.4  
ICS Overview

WASAFE BSE MODULE 15

4



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## WASAFE BSE EXPECTATIONS

Each day (until assignment is done):

- Report to staging area (local EOC or building department)
- Sign in
- Receive assignments
- Follow guidance of jurisdiction while in field
- At the end of the day
  - Report to staging area to review assessment forms with jurisdiction
  - Sign out



Photo: Cal OES SAP

WASAFE BSE MODULE 15

9

## WASAFE – DEPUTIZING



Photo: Cal OES SAP

- Non-jurisdiction personnel cannot post official jurisdiction placards unless deputized

WASAFE BSE MODULE 15

10

# WASAFE BSE'S ROLE

Provide rapid evaluation of buildings

Provide detailed evaluations as directed by the local jurisdiction

11

# WASAFE BSE'S ROLE (CONT.)

Do NOT provide COST estimates

- DO provide % DAMAGE estimates, if required by jurisdiction

Do NOT evaluate compliance of existing conditions to current code

Do NOT provide escort or property retrieval services

Do NOT leave business cards

**ATC-20 Rapid Evaluation Safety Assessment Form**

Inspection: Requester ID: \_\_\_\_\_ Inspection date and time: \_\_\_\_\_  No  Yes

Attiliation:  Areas inspected  Exterior only  Exterior and interior

**Building Description**

Building name: \_\_\_\_\_ Type of Construction:  Wood frame  Concrete shear wall  Reinforced masonry  Steel frame  Heavy concrete  Reinforced masonry  Other: \_\_\_\_\_

Address: \_\_\_\_\_  Concrete frame

Building characteristics: \_\_\_\_\_  Dwelling  Commercial  Government

Number of stories above ground: \_\_\_\_\_  Other residential  Office  Historic

Approx. "strong" and "light" floor: ~~XXXXXX~~  Public assembly  Industrial

Number of residential units: \_\_\_\_\_  Emergency services  Other: \_\_\_\_\_

Number of residential units not habitable: \_\_\_\_\_

**Evaluation**

Investigate the building for the conditions below and check the appropriate column.

Observed Condition:	Minor/None	Moderate	Severe	Estimated Building Damage (including contents)
Collapsed panels, beams, or building off level/stable	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> None
Building or story leaning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> 1-14%
Roofing damage to walk, other structural damage	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> 15-20%
Chimney, parapet, or other falling hazard	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> 21-40%
Structural displacement or cracking	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> 41-100%
Other (specify): _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> 100%

Comments: \_\_\_\_\_

% Damage estimate

12

## LOCAL GOVERNMENT ROLE

---

- Obtain a mission number from EMD
- Provide jurisdictional contact
- Issue local placards
- Deputize WAsafe Responders
- Coordinate WAsafe Responder activities

WASAFE BSE MODULE 15

13

## LOCAL GOVERNMENT ROLE (CONT.)

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### Briefing information

- Key contact information for Building Official, law enforcement, fire, hazmat, utilities, and animal control
- Relevant local policies

### Lodging & Meals information

- Ensure necessary authorization exists to allow WAsafe work
- Provide EMD with Disaster Data if requested

WASAFE BSE MODULE 15

14

# WASHINGTON STATE LAW

WASAFE BSE MODULE 15

15

## WA EMERGENCY WORKER PROGRAM

---

Established, regulated by state law

### Legal Foundation

- RCW 38.52 – Emergency Management Act (Authority)
- WAC 118-04 – Emergency Worker Program (Rules)

<http://www.leg.wa.gov/CodeReviser>

The WA Emergency Management Division (EMD) developed and runs the Emergency Worker Program

WAsafe is set up to comply

WASAFE BSE MODULE 15

16

16

## WA EMERGENCY WORKER PROGRAM

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### State coverage:

- Immunity from liability (“Good Samaritan”), and
- Injury/Damage to Individual (Workers’ Comp)

### Must be a **registered** Emergency Worker

- Typically this is “temporary registration” under a State-issued Mission Number
- The jurisdiction gets the Mission Number from EMD
- WAsafe BSEs register when reporting to jurisdiction!

WASAFE BSE MODULE 15

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## WA EMERGENCY WORKER REGISTRATION (WAC 118-04-080)

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### **Government employees – Covered!**

Considered as registered with local emergency management agency if:

- Working within own jurisdiction, OR
- Working outside their jurisdiction AND
  - Acting under a mutual aid arrangement; OR
  - Dispatched through WAsafe

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**WASAFE – REIMBURSEMENTS**

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Housing, meals, travel, and other necessary expenses may or may not be reimbursed by requesting agency

Volunteers must be on their own time (e.g., vacation)

Public employees may be reimbursed by the requesting jurisdictions

WASAFE BSE MODULE 15

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**INTERSTATE EMERGENCY  
MANAGEMENT (EMAC)**

WASAFE BSE MODULE 15

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## EMERGENCY MANAGEMENT ASSISTANCE COMPACT (EMAC)

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- State-to-state mutual aid agreement through which states can assist one another directly
- All 50 States are signatories to EMAC and can provide or receive aid
- Workers' comp and immunity coverage is carried forward through EMAC, along with licenses

WASAFE BSE MODULE 15

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## EMAC – HURRICANE KATRINA (2005)

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Photo: Cal OES S&P

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EXERCISE

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NEXT STEPS & CLOSING

WASAFE BSE MODULE 15

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## NEXT STEPS (Individuals)

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### Personal preparation (work and home)

#### Decide if want to volunteer

- In-state – WAsafe
  - See WAsafe Coalition website (<https://wasafecoalition.org/volunteer>)
  - Apply through member organization (AIA, ASCE, SEAW, WABO) via WAserv database ([www.waserv.org](http://www.waserv.org))
  - Unaffiliated => apply through WABO
- Out of state (private sector)
  - California Office of Emergency Services Structural Assessment Program (Cal OES SAP) ([www.caloes.ca.gov](http://www.caloes.ca.gov))
    - Search for Safety Assessment.
  - Disaster Response Alliance (ICC/NCSEA) ([www.disasterresponse.org](http://www.disasterresponse.org))

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## NEXT STEPS (Building Officials)

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### Personal preparation (work and home)

#### Prepare before the event happens

- Gather supplies (or plan how to procure them quickly)
  - ATC-20 placards, forms
    - Electronic or paper forms (or both)
  - Other supplies (e.g., barrier tape, clipboards, volunteer ID cards, waterproof markers & tape)
- Prepare policies/procedures for onboarding volunteers
- Engage with local/regional Emergency Managers
  - Preparation to request, register/deputize, and care for WAsafe BSEs
- See WAsafe Coalition website for more information (<https://wasafecoalition.org/requesting-help>)

#### Explore mutual aid agreements with neighboring jurisdictions

Engage with local building owners and design professionals to explore establishing Accelerated Building Reoccupancy programs

WASAFE BSE MODULE 15

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## NEXT STEPS (Emergency Managers)

### ~~Personal preparation (work and home)~~

#### Engage with/support local/regional building official(s)

- Preparation to request, register/deputize, and care for WAsafe BSEs
  - See WAsafe Coalition website for more information (<https://wasafecoalition.org/requesting-help>)
- Prepare for post-event supply procurement/resupply
- Explore mutual aid agreements with neighboring jurisdictions
- Engage with local building owners and design professionals to explore establishing ABR programs

WASAFE BSE MODULE 15

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## SLIDE CREDITS

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ASCE/SEI Chilean Earthquake Assessment Teams  
 Christopher Arnold  
 J. Marx Ayres  
 Ross Boulanger/UC Davis  
 Gregg Brandow  
 California Office of Emergency Services  
 Prof. Misko Cubrinovski/University of Canterbury  
 H. J. Degenkolb Associates  
 Jon Egan  
 Ronald P. Gallagher  
 Geotechnical Extreme Events Reconnaissance (GEER) Teams  
 GeoEngineers (J. Gordon)  
 Dr. Les Harder  
 Doug Lindquist  
 Los Angeles Department of Building and Safety  
 Los Angeles County Department of Building and Safety  
 John Meehan  
 National Fire Protection Association  
 National Oceanic and Atmospheric Administration  
 National Paint and Coatings Association  
 National Research Council

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## SLIDE CREDITS (CONT.)

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Pacific Northwest Seismic Network  
 San Francisco Bureau of Building Inspection  
 Seattle Department of Construction and Inspections  
 Shannon & Wilson, Inc.  
 Stephen D. Pfeiffer  
 RDD Consultants, Inc.  
 Reid Middleton, Inc.  
 Robert Reitherman  
 Jonathan C. Siu  
 Yet M. Siu  
 SEAW Tohoku Reconnaissance Team  
 Steinbrugge Slide Collection, EERC  
 James Stratta  
 U.S. Geological Survey (Art Frankel)  
 Tom Wangerin  
 Washington Department of Labor & Industries  
 Wiss, Janney, Elstner Associates  
 Kit Wong

ATC-20

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**WASAFE**  
**BUILDING SAFETY EVALUATIONS**  
**(ATC 20/45 PLUS)**

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THANK YOU FOR ATTENDING!

WASAFE BSE MODULE 15

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