

PROTECTING LIFE AND PROPERTY

STRUCTURAL BEHAVIOR AND THE POST-DISASTER ASSESSMENT OF BUILDINGS

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Safety and Cultural Heritage Summit

Preserving Our Heritage and Protecting Our Health

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B&O Roundhouse Museum Collapse

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STRUCTURAL BEHAVIOR AND THE POST-DISASTER ASSESSMENT OF BUILDINGS

Agenda/Topics of Discussion:

1. What does the Building Code Protect?
2. Extraordinary Events/Disasters
3. Expected Structural Performance
4. Disaster Response vs Recovery
5. Response, Recovery and Safety
6. Case Studies/Scenarios



Cultural Heritage "Cleansing"

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Questions to Audience:

1. Do you have a Response and Recovery Plan?
2. What is your role if a disaster occurs?
3. Who is responsible for your facility maintenance and security?
4. Do you know their contact information, and do they have yours?
5. How long has it been since you updated the contact information?



Fire and fire during reconstruction

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Building Code Summary:

- Established to promote **life safety**
- Protection of interior **property** is not included
- Building Envelope damage level restrictions are limited
- Environmental Control Systems survivability is generally not mandated
- Most older buildings do not need to meet current codes

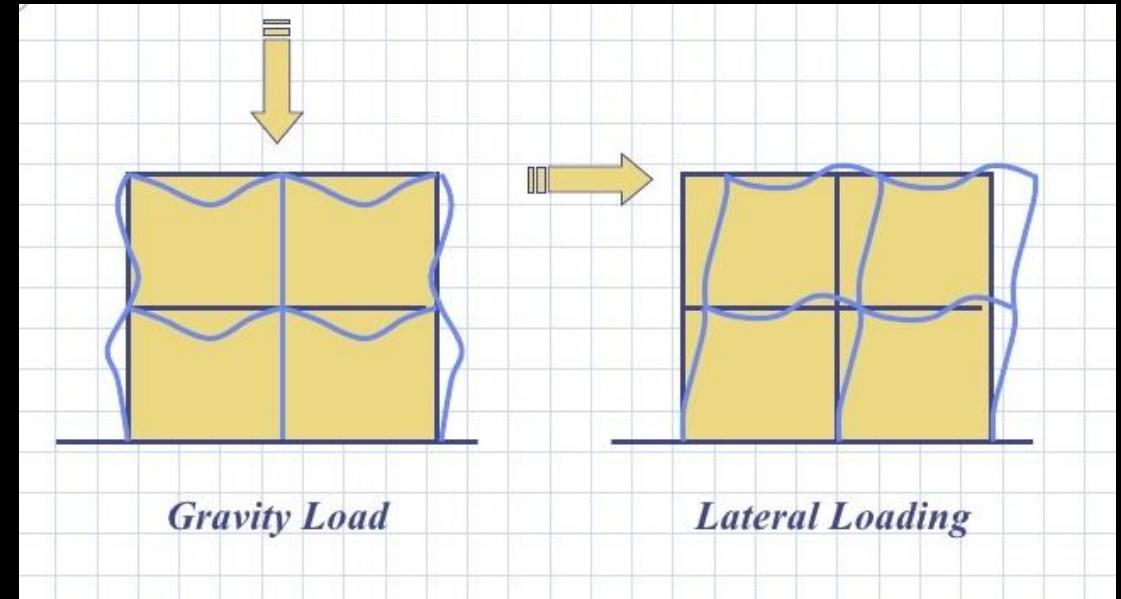


Forest Fire

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Structural Behavior Basics:

- **Gravity Loadings vs Lateral Loadings**
- Behavior During Extraordinary Event
 - Earthquakes
 - High Wind Events
 - Flooding
 - Fires
 - Explosions



Movements of buildings when loaded

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Structural Behavior Basics:

- Gravity Loadings vs Lateral Loadings
- **Behavior During Extraordinary Event**
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Loma Prieta Earthquake left building in hazardous condition

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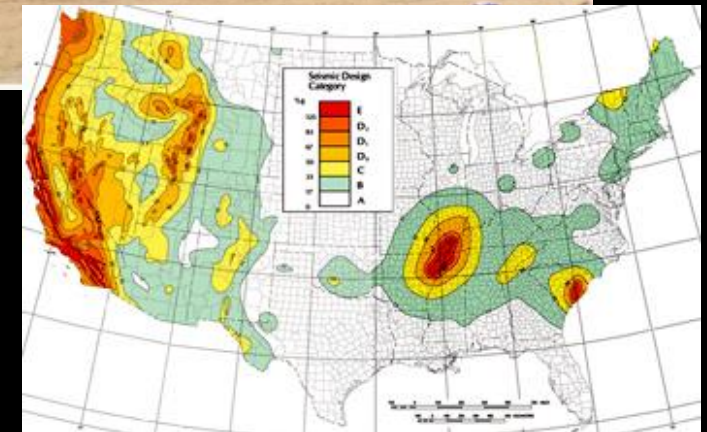
Earthquakes

Things to consider

- Masonry and Concrete – higher risk
- Buildings 4-10 stories – higher risk
- Contents tossed like sudden stop in a car
- Anchoring contents to building structure protects contents



Earthquake in Turkey



Seismic Activity Probability Map

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High Wind Events

Things to consider

- Light structures – higher risk
- Buildings 5 & less stories – higher risk
- Façade Breach can cause building failure
- Protection from Projectiles key
- Recorded wind history



Hurricane Fran



Hurricane Andrew high winds

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Flooding

Things to consider

- Light structures – higher risk
- Contents severely impacted
- Gently letting water in may save building – but not contents
- Protection from debris can be important
- Recorded flood history



Czech Republic
Floods



Hurricane Katrina



Hurricane Katrina
storm surge

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Fires

Things to consider

- Protection from fire does not necessarily mean protected from heat
- Contents severely impacted
- HVAC systems may make the impact worse



Pentagon 9/11



Kenya Mall
Terrorist Attack

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Explosions

Things to consider

- Pressure waves are + & -
- Pressures can drop quickly as you move from point of detonation
- Expect excessive cracking close to the blast
- Hidden damage if standing - Structure may have lifted up and set down



Embassy in
Kenya
Terrorist
Attack



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Disaster Response Overview:

- First Responders (Rescue)
- Pre-Recovery Stage (Rapid Assessment for Occupancy)
- Recovery Process (In-Depth Assessment for Occupancy)



Pentagon 9/11 – First Responders with a start on Recovery

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First Responders

- **Important Considerations**

- Cooperation amongst varying entities with differing goals required
- Pre-Disaster Preparedness pays off
- Potential unexpected issues during disaster
- Considerations of protection of collections at this stage



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- Pre-Recovery Stage(Rapid Assessment for Occupancy)

The image shows three overlapping safety signs. The top sign is red and reads "UNSAFE DO NOT ENTER OR OCCUPY". The middle sign is yellow and reads "RESTRICTED USE". The bottom sign is green and reads "INSPECTED LAWFUL OCCUPANCY PERMITTED". Each sign contains fields for "Date" and "Inspector ID / Agency". The green sign also includes checkboxes for "Inspected Exterior Only" and "Inspected Exterior and Interior", and a note: "If not inspected, interior, exterior, or structure may be unsafe." At the bottom of the green sign, it says "Do Not Remove, Alter, or Cover This Placard Until Authorized by Governing Authority".



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- Recovery Process

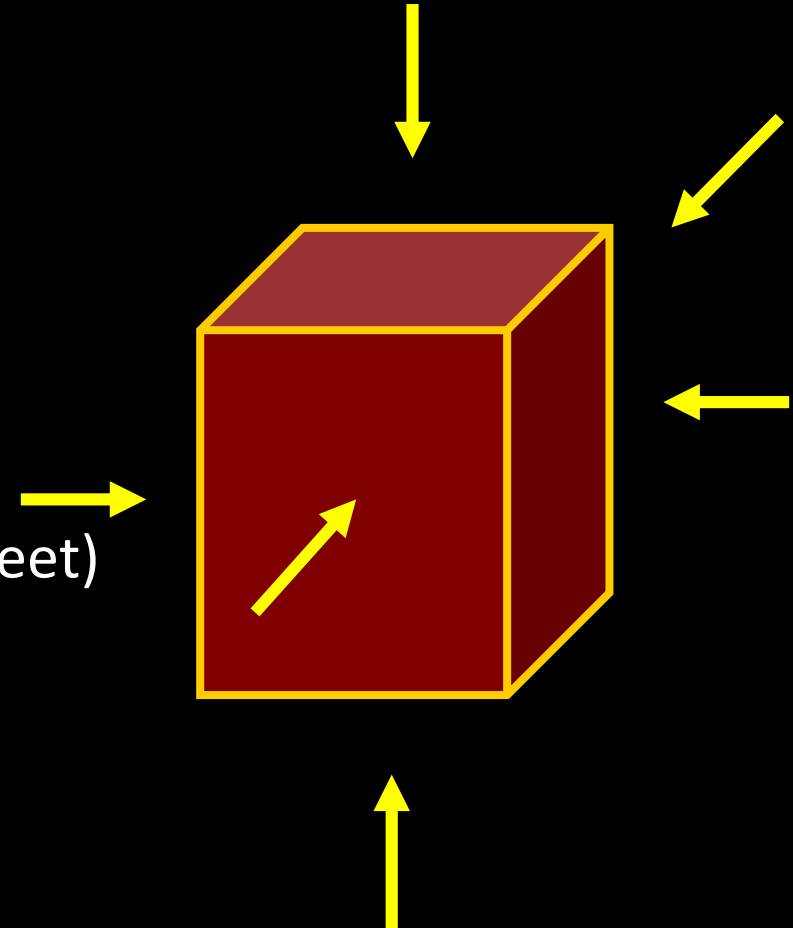
- Condition Assessment
- Site Safety
- Shoring & Repair Design
- Materials Testing
- Reconstruction



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- **Site Safety**

- 360 degree walk around and pay attention to overhead conditions
- Remember where you are – A Hazardous Place
- Where are structure and utility hazards?
- Protect yourself with proper clothing and breathing apparatus
- 3-points of contact over rough terrain (hands/feet)
- Don't enter if you don't need to



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- **Site Safety**

- Activities w/ Higher Risk
 - Working from Ladders
 - Working from Scaffolding
 - Unprotected Leading edges
 - Holes/Openings
- Follow OSHA Fall Protection Guidelines

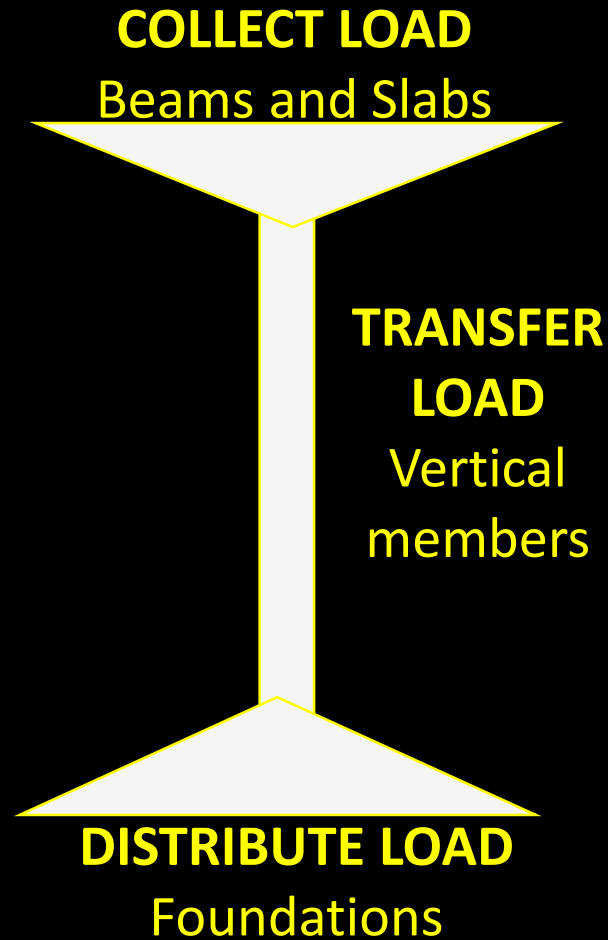


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- **Shoring Design**

- Space and positioning
- Conflicting priorities

- Double Funnel Shoring Philosophy



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Case Studies/Scenarios:

1. Oklahoma City Bombing

- Truck bombing on April 19, 1995
- Alfred P. Murrah Federal Building
- 168 fatalities, > 680 injured
- Damaged 328 other structures in 16 block radius
- Rescuer vs Law Enforcement mindset/goals
- Working in hazardous areas with trained disaster workers



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1. Oklahoma City Bombing

- Concerns for Native American Artwork
- Issues with hardcopy records storage at one location



October (J. Pardington)



Double Layers (J. Knight)



Morning at Taos (Billy Jo Kidson)

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Case Studies/Scenarios:

2. Pentagon

- Plane impact on September 11, 2001
- 184 fatalities, numerous injured
- Extensive destruction of exterior and multiple interior office rings
- Damage from Aircraft help spread the fire



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2. Pentagon

- Fire-proof file cabinet contents burned (on exposure to air)
- Computer system Battery Packs created hazards (electrical shock)
- Understanding damage
- Trapped heat and flammable materials ignited when exposed to air



Pentagon

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STRUCTURAL BEHAVIOR AND THE POST-DISASTER ASSESSMENT OF BUILDINGS

Summary:

- Modern codes can allow older buildings to not be brought up to current life safety standards (i.e. **Historic Building Exclusions**)
- Codes do not directly protect housed items from damage during an event
- Understanding what the expected performance of your structure is critical in determining **potential risks to collections**

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STRUCTURAL BEHAVIOR AND THE POST-DISASTER ASSESSMENT OF BUILDINGS

Can you provide a positive answer to :

1. Do you have a Response and Recovery Plan?
2. What is your role if a disaster occurs?
3. Who is responsible for your facility maintenance and security?
4. Do you know their contact information, and do they have yours?
5. How long has it been since you updated the contact information?

