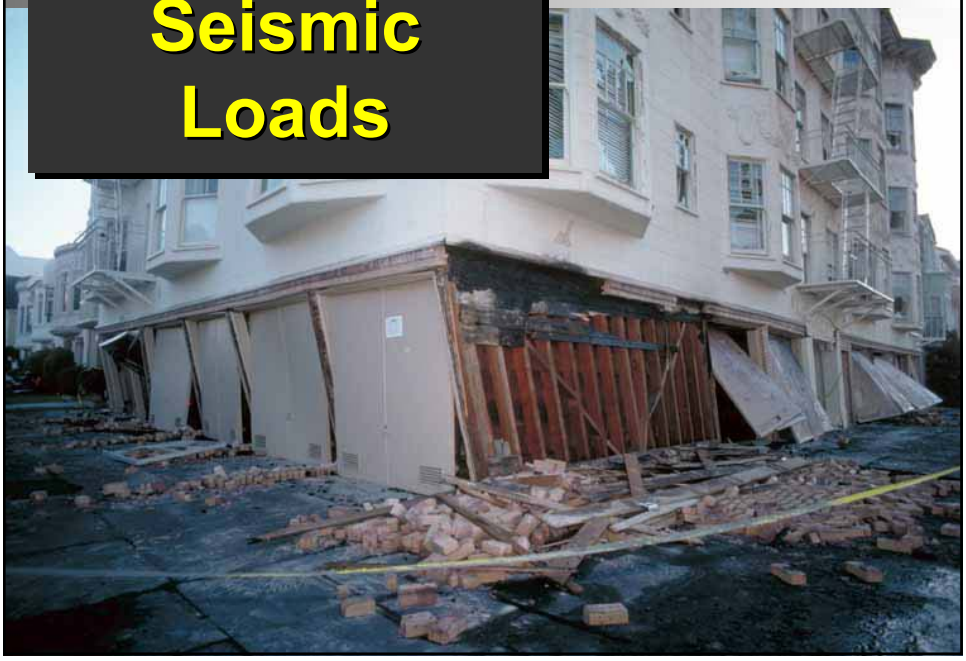
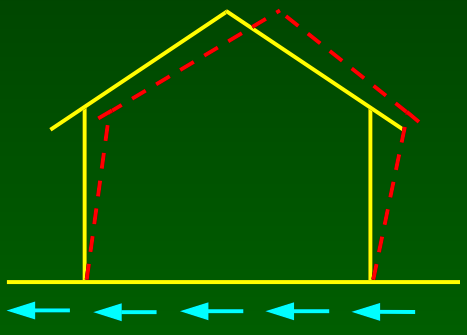
Seismic Loads



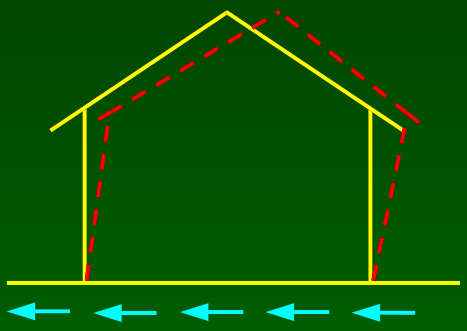
Background

- Earthquake forces are lateral forces
- Ground moves suddenly horizontally (also vertically)
- Inertia of the building tries to keep it from moving



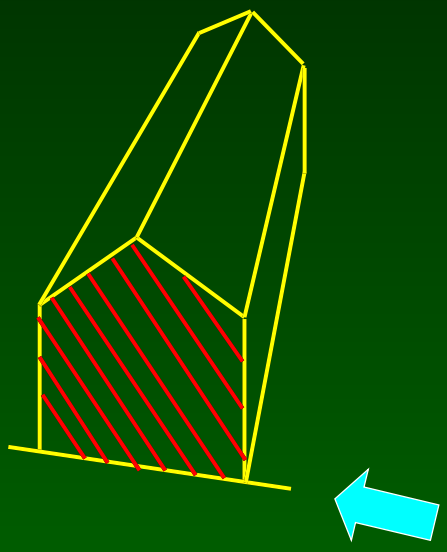
Background

- Resulting force on the building can be simplified to be a lateral force - a shearing force on the base of the structure
- Force depends on:
  - earthquake intensity
  - soil conditions
  - stiffness of building

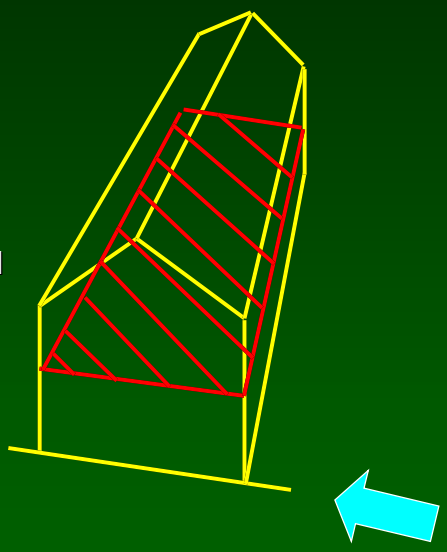


Loma Prieta (San Francisco) - 1989

Shear walls help resist lateral forces on building

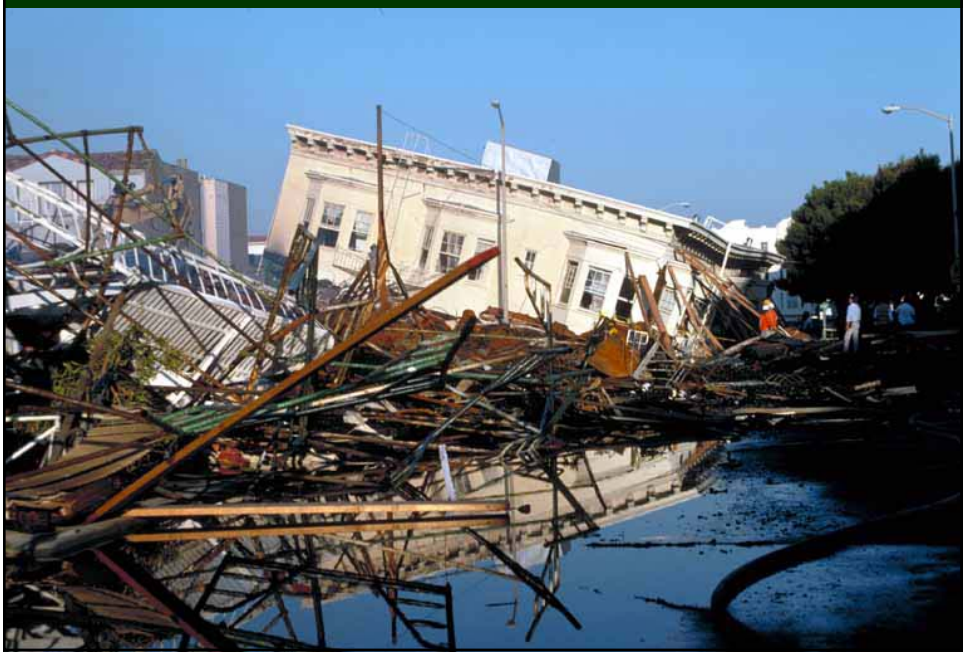


Floor and roof diaphragms resist lateral movement of building



Loma Prieta (San Francisco) - 1989

Loma Prieta (San Francisco) - 1989



Loma Prieta (San Francisco) - 1989

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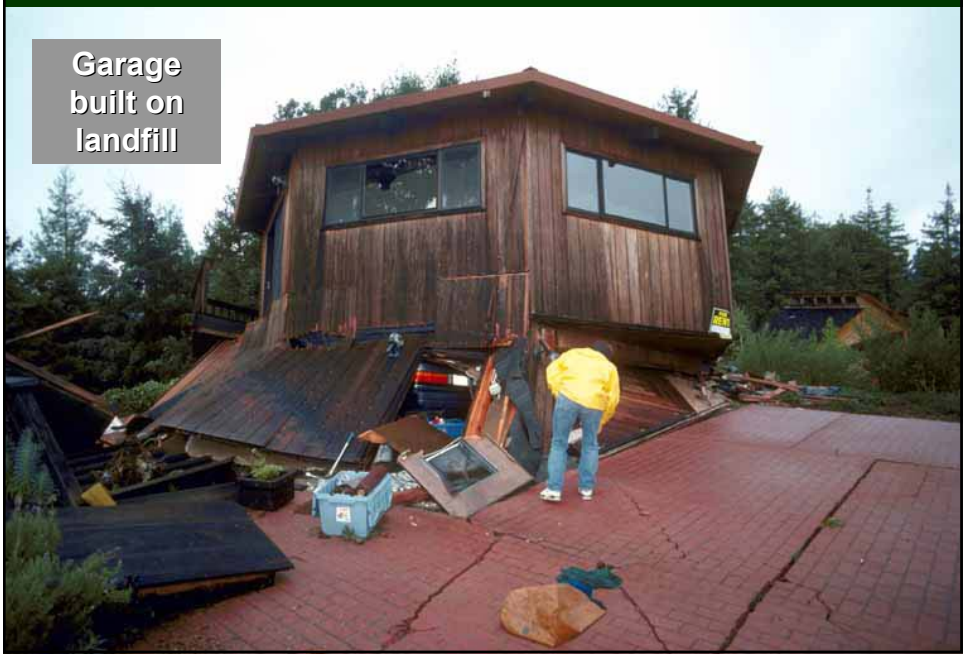
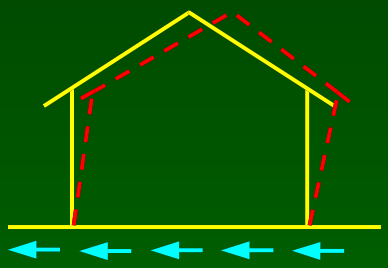
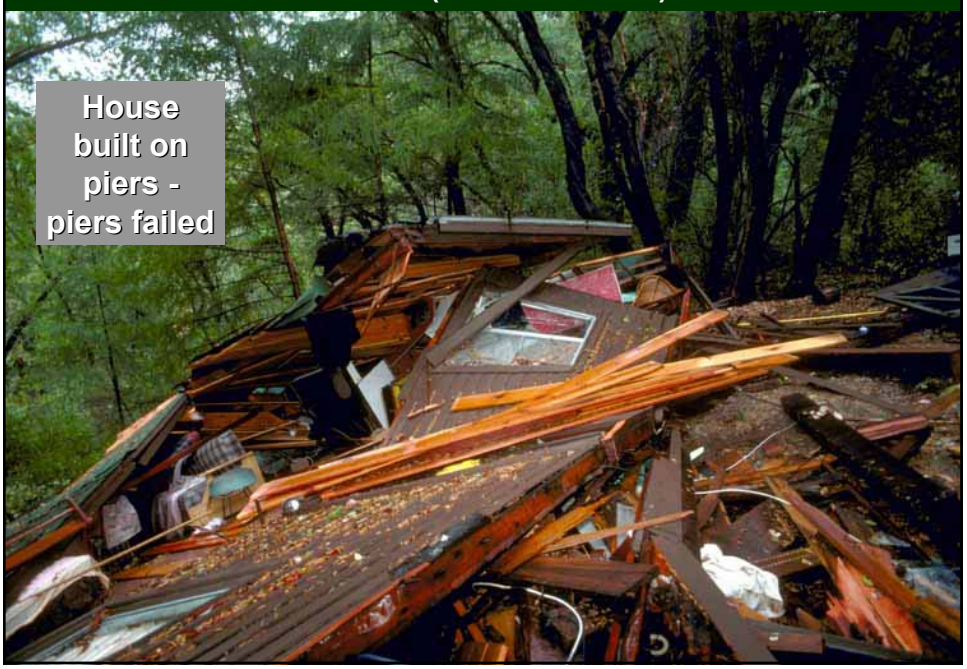


Background

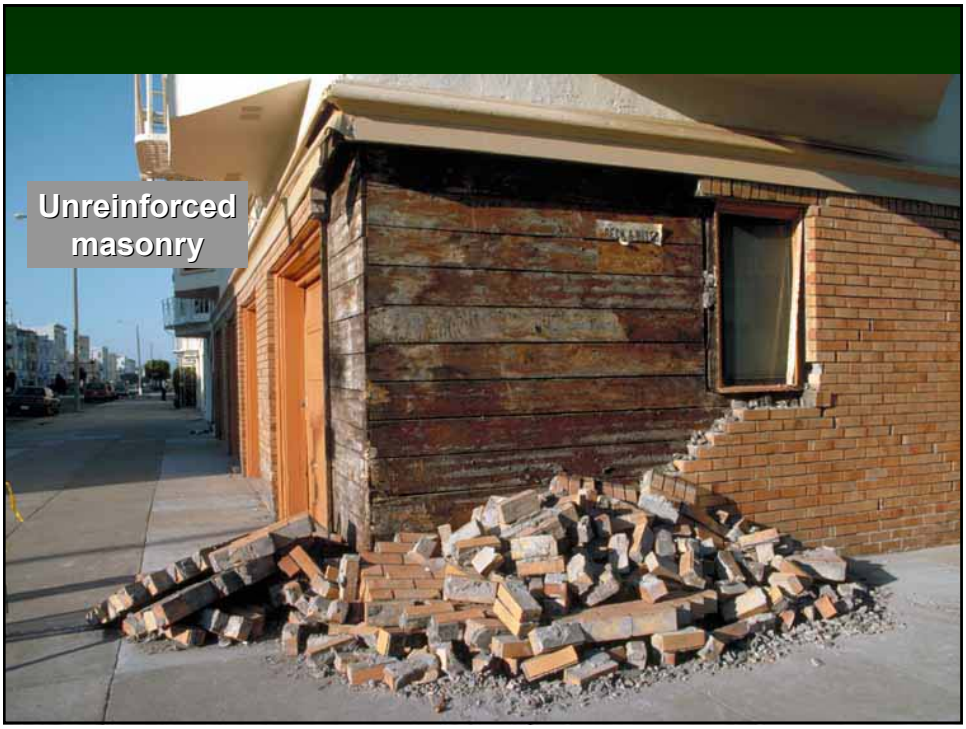
- Forces on buildings depend on underlying soil conditions
- Rock = lower seismic forces
- Mud and silt = much higher forces on structure

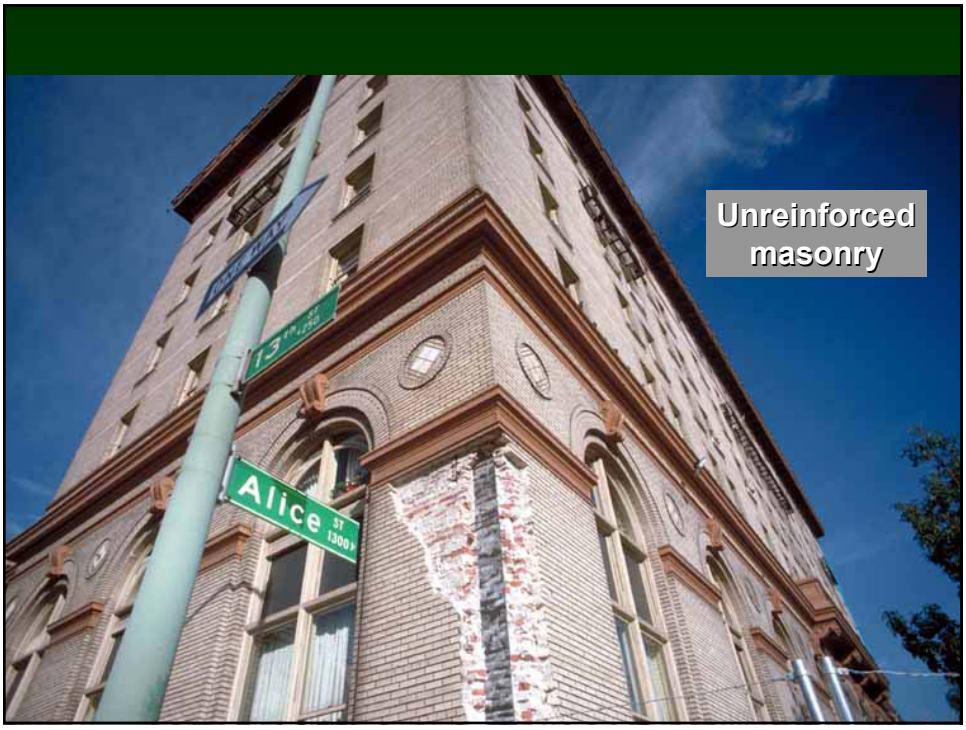


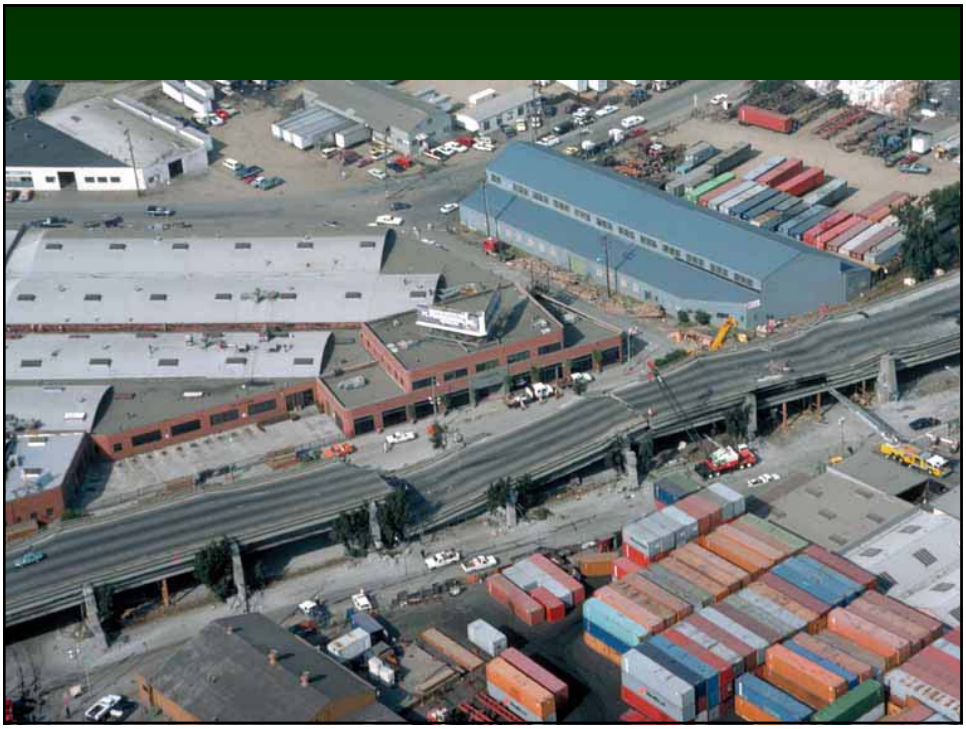
Loma Prieta (San Francisco) - 1989



Loma Prieta (San Francisco) - 1989

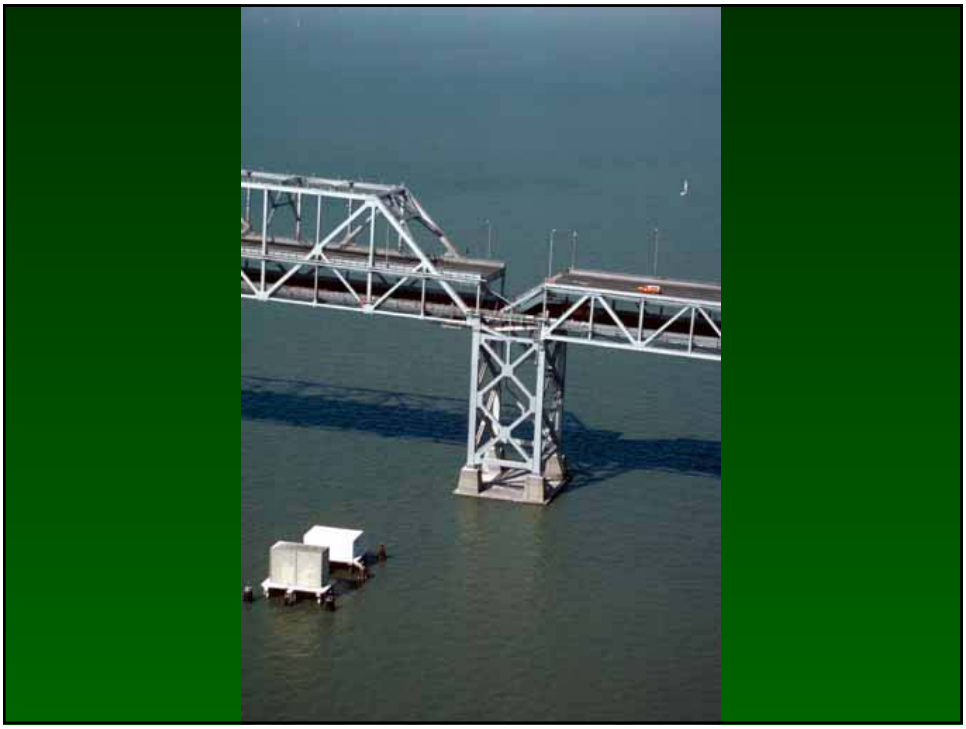

Unreinforced
masonry


Unreinforced
masonry
13TH ST
Alice ST 1300 E

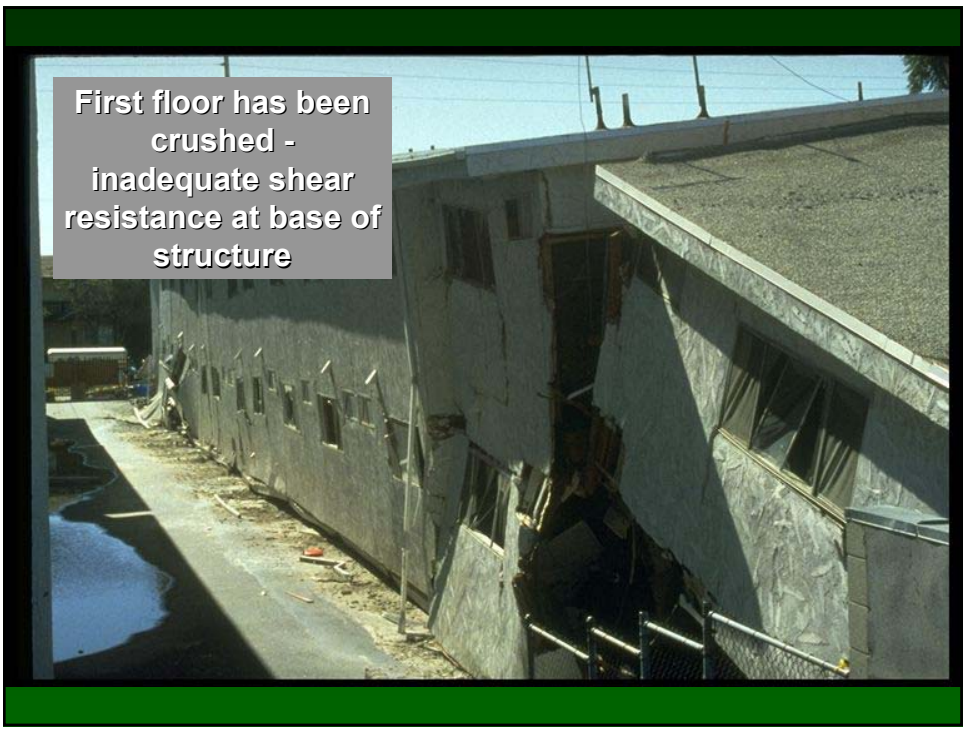



Seismic forces compressed barriers
Foothill Expwy
Grant Road


Compression of grate



Northridge - 1994

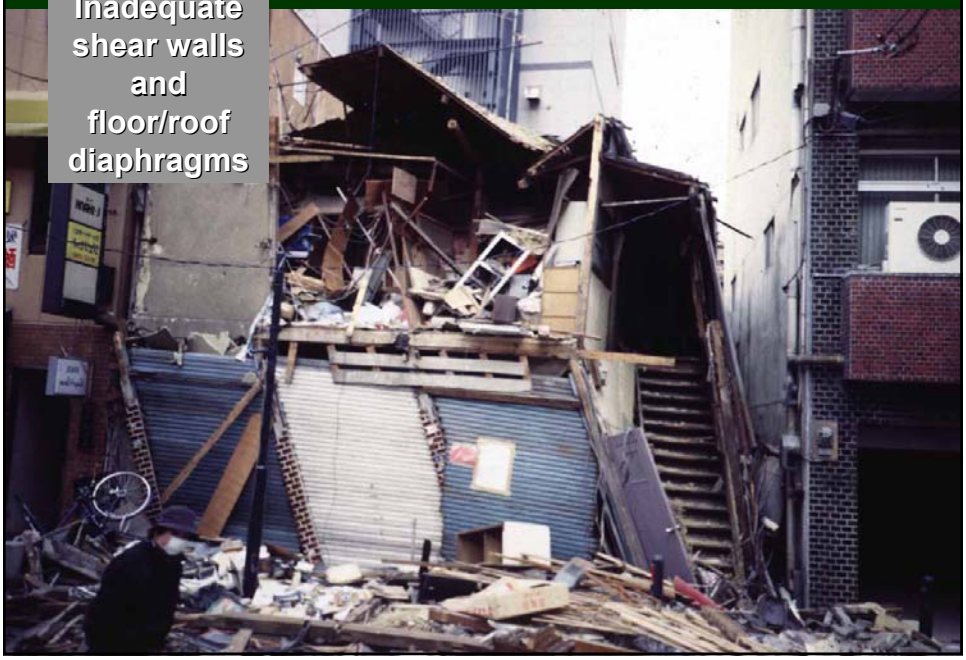

First floor has been crushed - inadequate shear resistance at base of structure

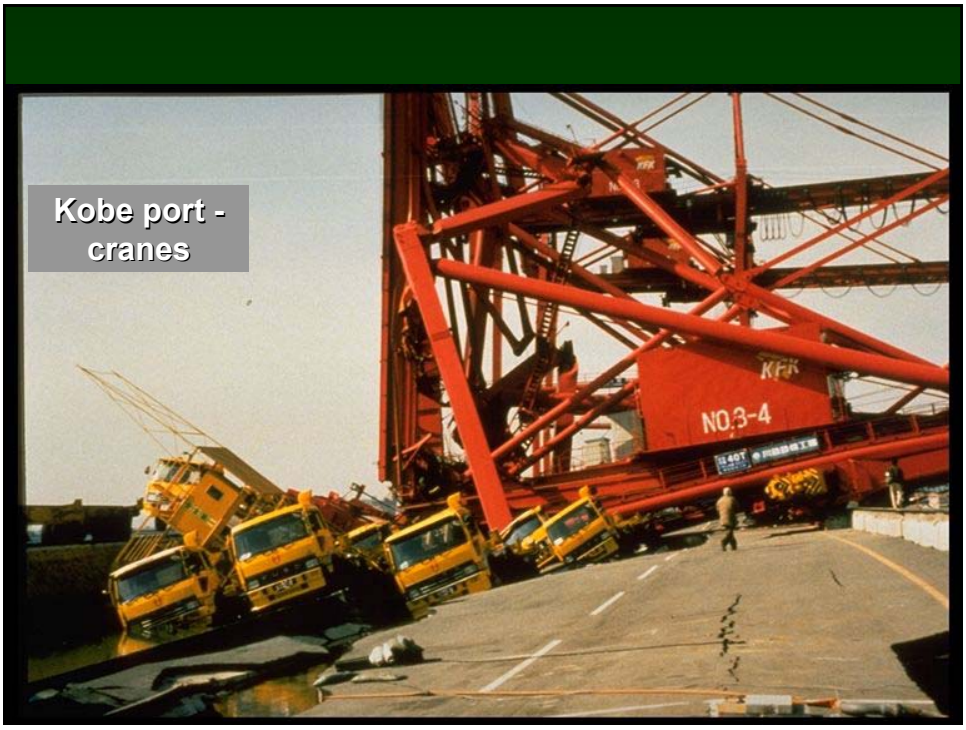

EXIT ONLY
STOP

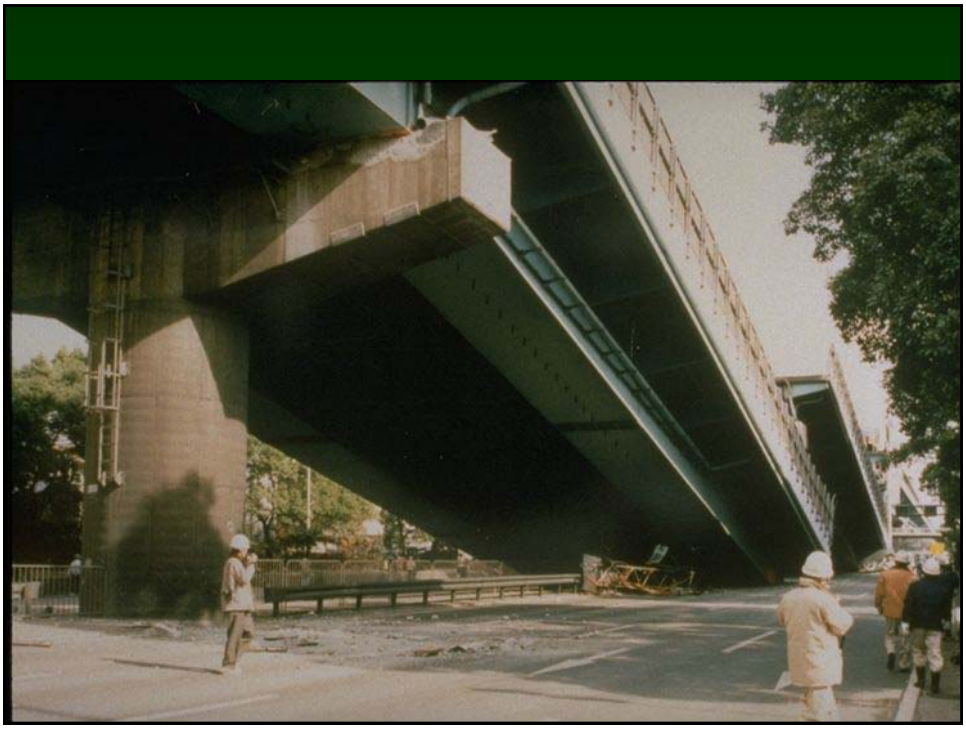
Kobe - 1995


Large dead loads - inadequate structural members

Inadequate shear walls and floor/roof diaphragms

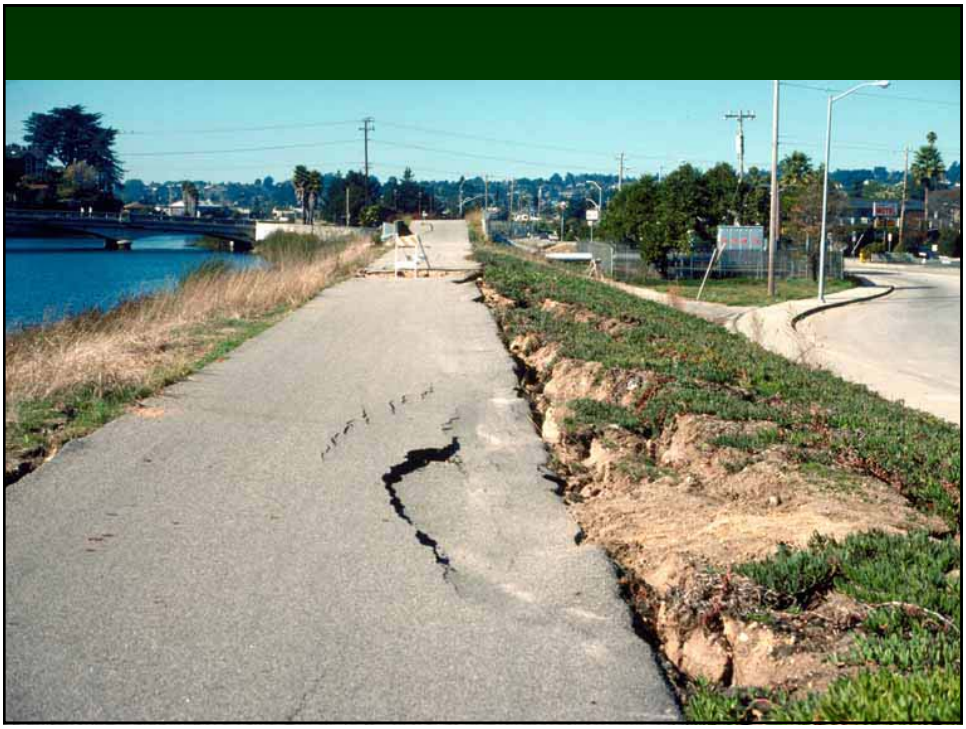



Kobe port - cranes
KHI
NO.3-4



Background

- Earthquakes also cause soil to liquefy
- Water mixes with soil particles and soil loses strength
- Structures can collapse and or sink into soil




ONE
LANE
BRIDGE

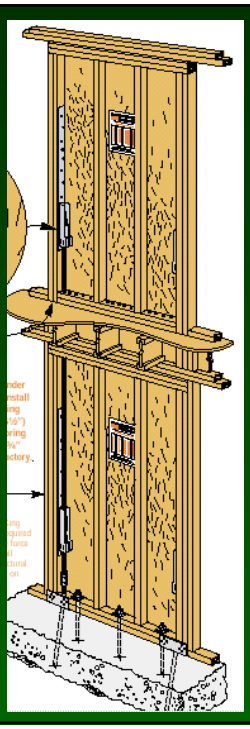
History

- San Francisco earthquake - 1906
- Initial earthquake killed many
- Fires following quake destroyed the city

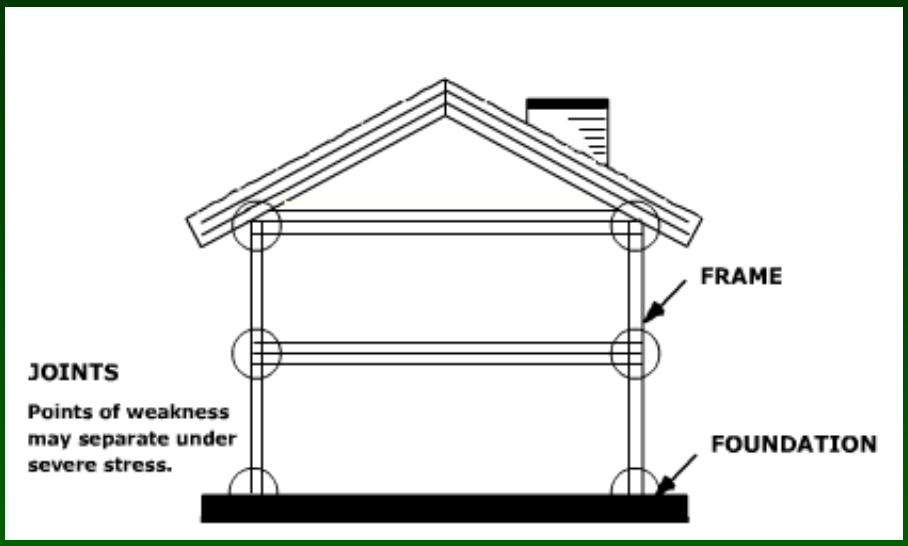

ALEXANDER.

Resisting Seismic Forces

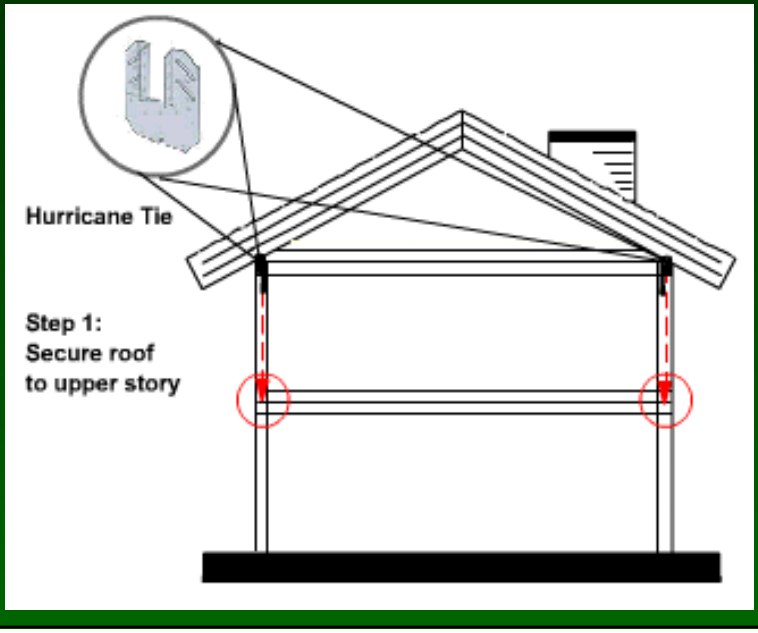
- Don't build on landfills or soft, silty soil
- Use adequate shear walls and diaphragms
- Maintain continuous load path to foundation
  - this applies to wind loads and seismic loads



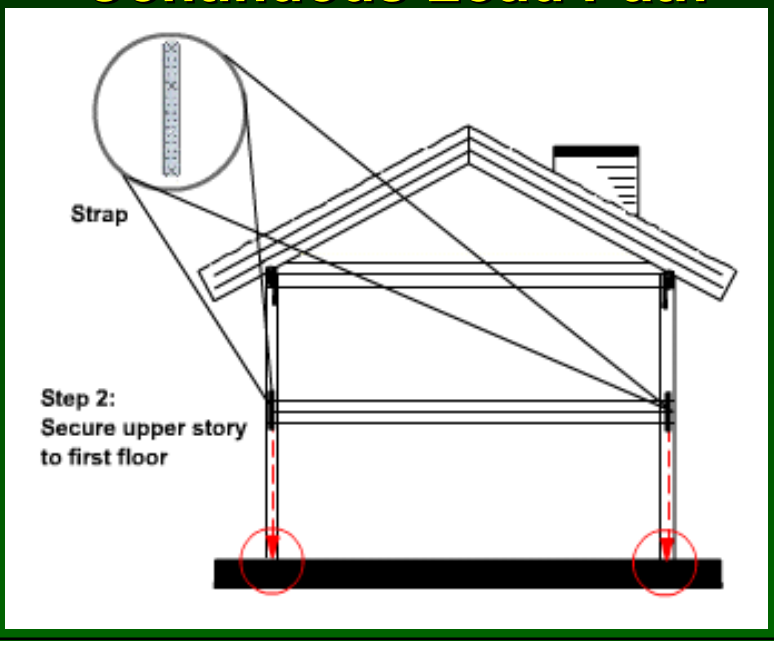
Continuous Load Path



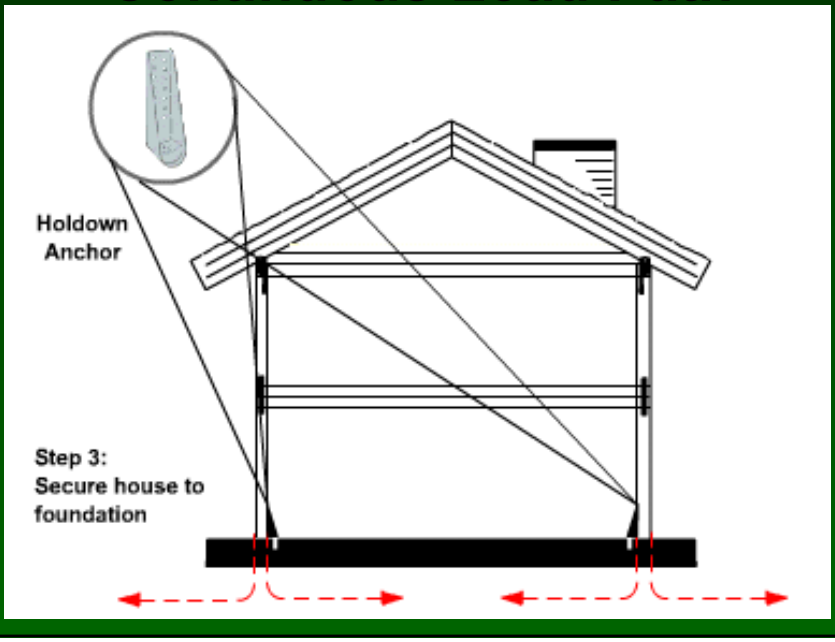
Continuous Load Path



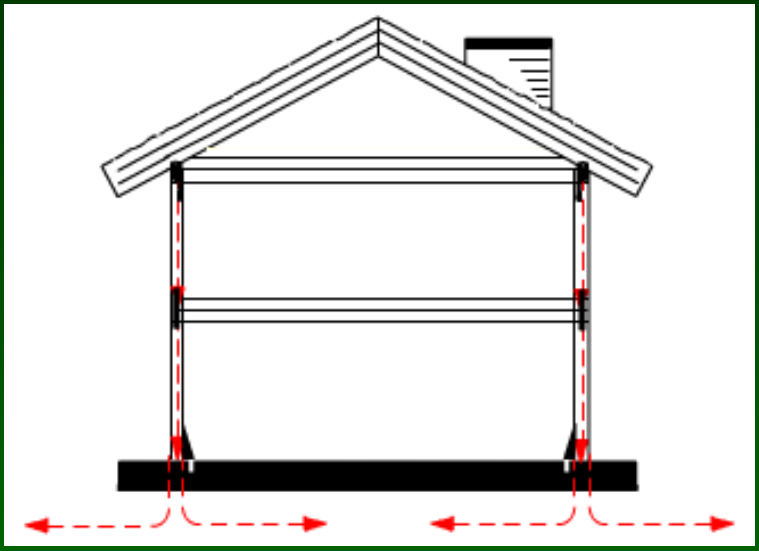
Continuous Load Path



Continuous Load Path



Continuous Load Path



Determining Seismic Forces

- ASCE 7 serves as the basis for calculating seismic forces
- We'll use the Standard Building Code
  - methods in SBC limited to buildings < 35 ft high
- Methods determine:
  - seismic forces on members and connections
  - story drift

Determining Seismic Forces

- Two methods for determining seismic forces (in SBC)
  - equivalent base shear
  - modal analysis

- Base Shear calculated by (1999 Standard Building Code):

$$V = C_s W$$

- V = equivalent shear force acting on the base of the structure (lbs)
- C_s = seismic design coefficient
- W = total dead load of the building (lbs)