

#### Seismic Hazards

Many seismologists have said that

"earthquakes don't kill people. Earthquakes really pose little direct danger to a person. People can't be shaken to death by an earthquake.. then question is: what are the causes of death by earthquake?

## Earthquake doesn't directly hit a person

• This is because most deaths from earthquakes are caused by buildings or other human construction falling down during an earthquake.



#### EQ HAZARDS RISKS DEPENDS ON

- Construction standards
- Emergency preparations
- Population density

#### **EXAMPLE**

Worst earthquake in the 20th century occurred in China (T'ang Shan Province), killed 240,000 in 1976. Occurred at 3:42 AM, Magnitude 7.8 Earthquake. Deaths were due to collapse of masonry (brick) buildings

#### Hazards associated with earthquake are referred to as seismic hazards

- Ground shaking
- Surface rupture
- Structural hazards
- Liquefaction
- Landslides
- Retaining structure failures
- Lifeline hazards
- Tsunami

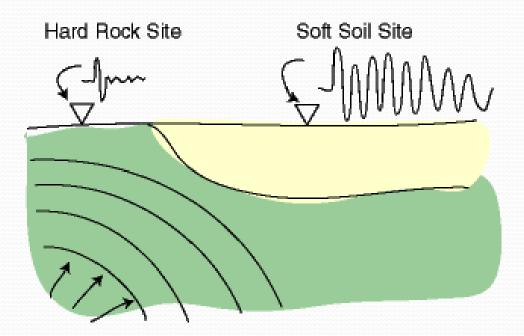
## **Ground Shaking**

- When an earthquake occurs, seismic waves radiates away from source and travel rapidly through the earths crust. When these waves reach the ground surface they produce shaking that may last from seconds to minutes.
- Ground shaking can be considered to be the most important of all seismic hazards because all the other hazards are caused by ground shaking.

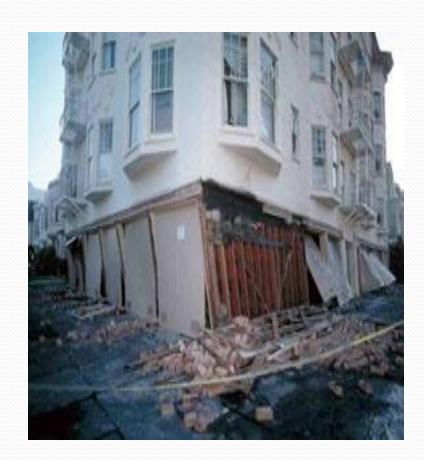
# Effect of ground shaking

The strength and duration of shaking at a particular site depend on:-

- Characteristics of site (local geologic conditions in the area) generally shaking in soft sediments is larger and longer than when compared with the shaking experienced at a "hard rock" site.
- Size of the Earthquake
- Location of earth quake(distance from the epicenter)







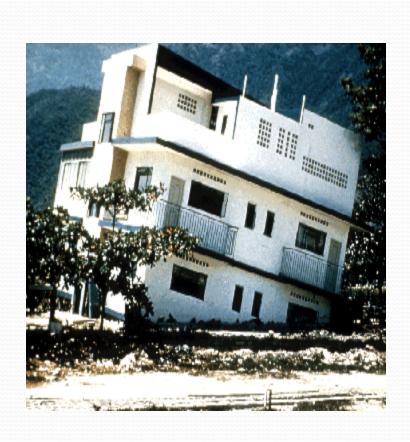
## **SURFACE RUPTURE**

• Surface rupture generally occurs only along the fault zone that moves during the earthquake, and are thus a primary effect.



#### Structural hazards

- Structural damage is the leading cause of death and economic loss in many earthquakes.
- Falling objects such as brick facings and parapets on the outside of a structure or heavy pictures or shelves within a structure have caused casualties in many earthquakes.
- Interior facilities such as piping, lighting and storage systems can also be damaged during eq.
- Considerable advances have been made in eq resistant design of structures(strength and ductility)

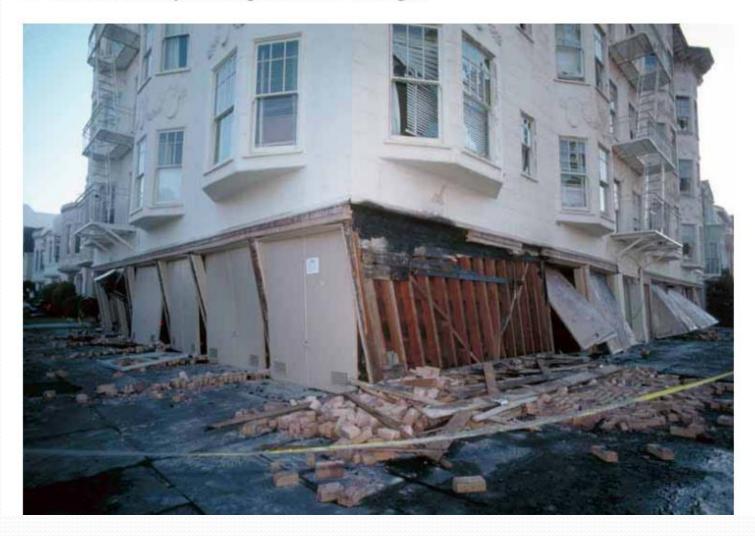




## Soft storey hazards

 Soft storey hazards:-if only one weak storey come down it is known as soft storey hazard.

#### 1. Soft first story/inadequate shear strength





Northridge earthquake soft first story (parking level) damage. (Photo from: <a href="http://www.ngdc.noaa.gov/seg/hazard/slideset/earthquakes/">http://www.ngdc.noaa.gov/seg/hazard/slideset/earthquakes/</a>)



Mid-story collapse, Kobe earthquake. (Photo from: The January 17, 1995 Kobe Earthquake: An EQE Summary Report. April 1995, http://www.eqe.com/publications/kobe/kobe.htm)

 Pancaking:-if foundation is not strong enough to support overlying strong storeys and due to earth quake whole structure come down phenomena is called as pancaking.

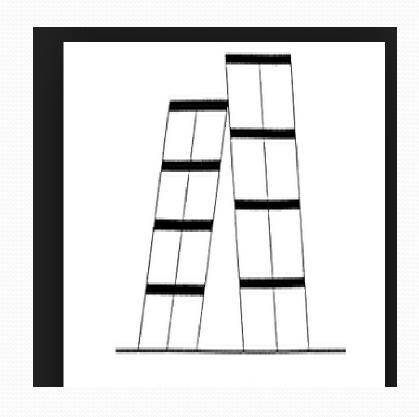


House shifted off its foundation, Loma Prieta earthquake. (Photo from: http://earthquake.usgs.gov/bytopic/photos.html)

• Torsion:- tilting will occur in a single building

## Pounding

- pounding damage occur where two buildings are constructed close to each other.
- two buildings collapse from upside not from foundation.

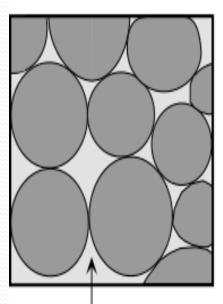


## Liquefaction

- In liquefaction soil deposits lost their strength and appeared to flow as fluids.
- In this phenomenon strength of soil is reduced often drastically, to the point where it is unable to support structures or remain stable.
- Because It only occurs in saturated soils, liquefaction is most commonly observed near rivers, bays, and other bodies of water.

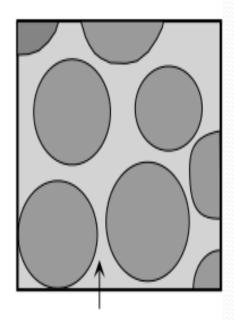
- In liquefaction following conditions are present
- Sands are saturated
- 2. Vibrations are present
- 3. Water table is shallow
- 4. Material is coarser.

Water-Saturated Sediment



Water fills in the pore space between grains. Friction between grains holds sediment together.

Liquefaction



Water completely surrounds all grains and eliminates all grain to grain contact. Sediment flows like a fluid.

## Remedy of liquefaction

- Retaining walls are made to stop the water.
- We can also stop liq by densifyng the soil

#### Landslides

- Strong earthquakes often cause landslides.
- Majority of such landslides are small, earthquakes have also caused very large slides.
- In a number of unfortunate cases, earthquake induced landslides have buried entire towns and villages.
- Earthquake induced landslides represent failure of slopes that were marginally stable under static conditions.

## Retaining Structure Failure

 Anchored bulkheads and other retaining structures are frequently damaged in eq.



### Lifeline hazards

- Networks which include electrical power and telecommunications, transportations, water and sewage, oil and gas distribution, water storage systems have collectively come to be known as lifelines.
- Lifeline hazards can cause disruption and economic losses that greatly exceed the cost of repairing facilities directly damaged by eq shaking.
- Lifeline failure can also hamper emergency response and rescue efforts immediately following damaging eq.

## Examples

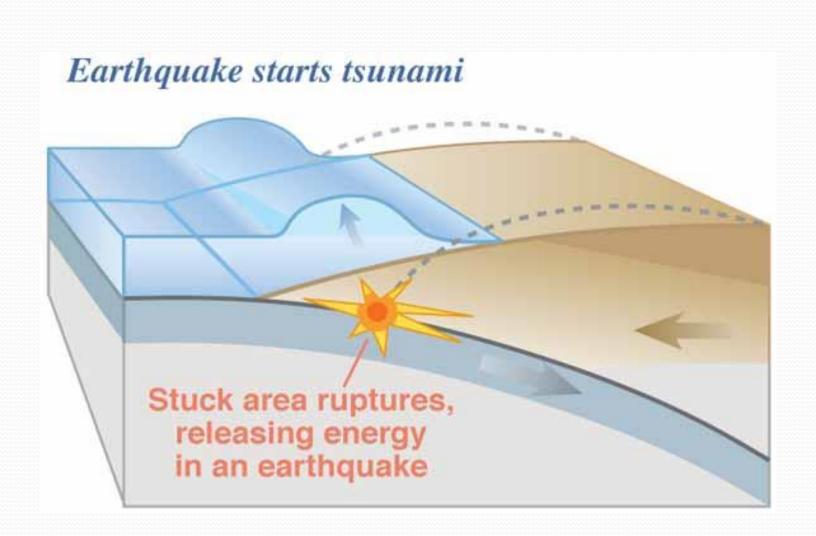
- Most of damage in 1906 san Francisco eq was caused by a fire that could not be fought properly because of broken water mains.
- Loma Prieta eq is another example, fires were caused by broken natural gas pipes and again fire fighting was hampered by broken water mains.

# FIRE



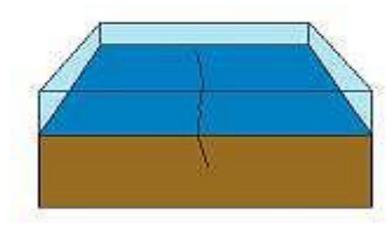
#### Tsunami

- rapid vertical seafloor movement caused by fault rupture during earth quake can produce long period sea waves called tsunami.
- In the open sea tsunamis travel great distances at high speeds but are difficult to detect, they usually have heights of less then 1 m.
- As tsunami approaches shore, the decreasing water depth causes its speed to decrease and the height to increase

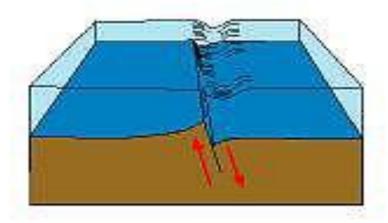




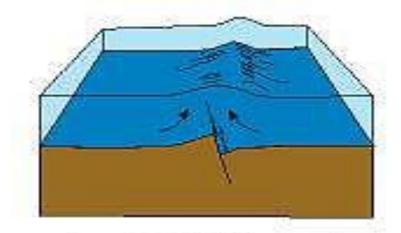
#### EARTHQUAKE-INDUCED TSUNAMI



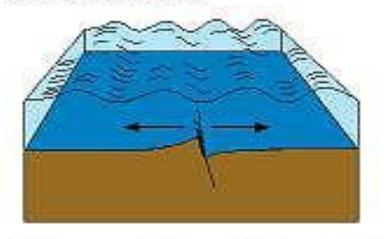
Earthquake occurs along an ocean floor fault.



Vertical displacement on fault results in momentary drop in local sea level.



Water rushes in to fill depression; overcompensates, resulting in a raise in sea level.



Water oscillates before stabilizing. Resulting oscillations are tsunami waves.

#### Causes of tsunami

- **Earthquakes**
- volcanic eruptions
- glacier calving (is breaking off of chunks of ice at the edge of glacier)
- > meteorite impacts

## Mitigation of seismic hazards

- Ultimately goal of earth quake engineer is to mitigate seismic hazards
- For slopes, dams, embankments and retaining structures earth quake resistant designs are made.

# What to do before, during and after EQ

#### What to Do Before an Earthquake

- Make sure you have a fire extinguisher, first aid kit, a batterypowered radio, a flashlight, and extra batteries at home.
- Learn first aid.
- Learn how to turn off the gas, water, and electricity.
- Make up a plan of where to meet your family after an earthquake.
- Don't leave heavy objects on shelves (they'll fall during a quake).
- Anchor heavy furniture, cupboards, and appliances to the walls or floor.
- Learn the earthquake plan at your school or workplace.

### What to Do During an Earthquake

- **Stay calm!** If you're indoors, stay inside. If you're outside, stay outside.
- If you're indoors, stand against a wall near the center of the building, stand in a doorway, or crawl under heavy furniture (a desk or table). Stay away from windows and outside doors.
- If you're outdoors, stay in the open away from power lines or anything that might fall. Stay away from buildings (stuff might fall off the building or the building could fall on you).
- Don't use matches, candles, or any flame. Broken gas lines and fire don't mix.
- If you're in a car, stop the car and stay inside the car until the earthquake stops.
- Don't use elevators (they'll probably get stuck anyway).

## What to Do After an Earthquake

- Check yourself and others for injuries. Provide first aid for anyone who needs it.
- Check water, gas, and electric lines for damage. If any are damaged, shut off the valves. Check for the smell of gas. If you smell it, open all the windows and doors, leave immediately, and report it to the authorities (use someone else's phone).
- Turn on the radio. Don't use the phone unless it's an emergency.
- Stay out of damaged buildings.
- Be careful around broken glass and debris. Wear boots or sturdy shoes to keep from cutting your feet.
- Be careful of chimneys (they may fall on you).
- Stay away from beaches. Tsunamis sometimes hit after the ground has stopped shaking.
- Stay away from damaged areas.
- If you're at school or work, follow the emergency plan or the instructions of the person in charge.
- Expect aftershocks.

# IMPACT ASSESEMENT Of Earthquake

### Impact assessment

- Impact of earthquake on ecology and environment
- ✓ Terrestrial ecology( felling of tress, threat to wild life)
- ✓ Aquatic ecology( aquatic animals are disturbed)

- Impact of earthquake on education system
- damaged school buildings
- ► Lack of shelters
- Damaged approach
- Affected teachers

- Impact of earthquake on tourism
- Food supply
- > Transport
- **≻** Accommodation
- ➤ Increased travel risk

- Impact of earthquake on economic resources.
- > Tourism and employment
- Natural medicines

### Prediction of earthquakes

- Change in the earth surface and earth crust
- Change in speed of earthquake waves
- Change in geomagnetic field
- Change in electrical field
- Change in level of ground water
- Change in river flow and river course
- Change in frequency of earthquakes
- Anomalous behavior of animals.

# Geomagnetic Force and EQ Prediction

- According to the scientists, temperature of earth surface surrounding epicenter get increased due to the force, stress and movement of rocks below the earth surface.
- Due to this increase in rock's temp the geomagnetic force of nearby area decreases. Radio transmission could also get affected in area surrounding epicenter.
- A continuous sound disturbance on the radio.

#### Animal and earthquake prediction.

- The belief that animals can predict earthquakes has been around for centuries.
- In 373 B.C., historians recorded that animals, including rats, snakes and weasels, deserted the Greek city of Helice in droves just days before a quake devastated the place.

 Accounts of similar animal anticipation of earthquakes have surfaced across the centuries since. Catfish moving violently, chickens that stop laying eggs and bees leaving their hive in a panic have been reported. Countless pet owners claimed to have witnessed their cats and dogs acting strangely before the ground shook—barking or whining for no apparent reason, or showing signs of nervousness and restlessness.

- Researchers around the world continue to pursue the idea, however. In September 2003 a medical doctor in Japan made headlines with a study that indicated erratic behavior in dogs, such as excessive barking or biting, could be used to forecast quakes.
- There have also been examples where authorities have forecast successfully a major earthquake, based in part on the observation of the strange antics of animals. For example, in 1975 Chinese officials ordered the evacuation of Haicheng, a city with one million people, just days before a 7.3-magnitude quake. Only a small portion of the population was hurt or killed. If the city had not been evacuated, it is estimated that the number of fatalities and injuries could have exceeded 150,000.