5.6 CYCLONE HAZARDS

Cyclone is violent wind rotating round a central area.

The word *cyclone* is derived from the Greek, word *cyclos* meaning 'the coils of a snake'.

In the northern hemisphere, a cyclone refers to an area of low atmospheric pressure surrounded by winds moving in a counter-clockwise direction, while a corresponding area of high atmospheric pressure with windsblowing in the clockwise direction is called an *anti-cyclone*.

In the southern hemisphere, the wind directions are reversed. The intensity of the cyclones and the strength of winds depend on the amount of pressure drop in thecentre of the cyclone and the rate at which this pressure increases outwards.

Severe troptical cyclones cause storm surges. A *storm surge* is an abnormal rise of sea level near the coast due to which sea water inundates low-lying areas of coastal region causing damage to human life and property.

Classifications of cyclones

They are classified as

(i) extra tropical cyclones (temperature cyclones) and

(ii) tropical cyclones.

World meterological organisation uses the term 'Tropical cyclone' to cover weather systems in which wind speed (exceeds 63 kmph).

Tropical cyclones are the progeny of the ocean and atmosphere, powered by the heat from the sea and driven by earterly trades and temperate westerlier, high winds and their own fierce energy.

In India cyclones deals with

- **Strength of associated winds.**
- **Strom surges**
- **Exceptional rainfall occurences.**

Extra tropical cyclones occur in temperate zones and high latitude regions. Cyclones that develop in the regions between the tropics of capricorn and cancer are called **tropical cyclones**.

Effects

The following are some of the adverse effects of cyclones

- Cyclones are associated with high pressure gradients and consequent strong winds, which, in turn, generate storm surges. This causes sea water to inundate low-lying area of coastal regions drowning human beings and livestock.
- This erodes beaches and embankments.
- It also destroys vegetation and reduces soil fertility.
- Very strong winds associated with cyclones may damage installations, dwellings, communication systems, trees, etc., resulting in loss of life and property.
- Heavy and prolonged rains due to cyclones may lead to river floods and submergence of low-lying areas causing loss of life and property.
- Floods and coastal inundation due to storm surges pollute drinking water sources causing outbreak of epidemics.

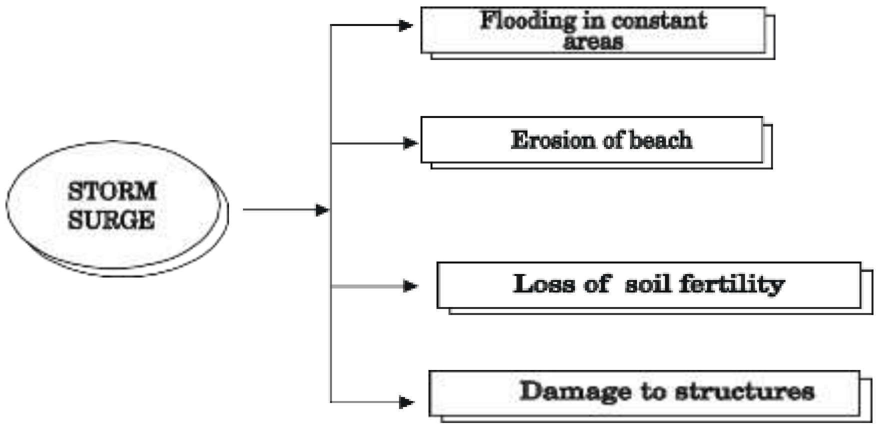

Fig. 5.6.1 Effect of cyclone

Preventive measures of cyclone (cyclone management)

- Cyclone is a natural hazard and it is beyond human control. However, the damages caused by these cyclones can be minimized by using the following measures:

- Some long term defence measures can help to protect us from devastation. Such measures include planting more trees on the coastal belt, construction of dams, strom shelter, wind breaks, proper drainage and wide roads for quick evacuation.

Forecasting and warning

- Forecasting a cyclonic event is the best measure of minimizing the losses due to a cyclone. Advanced systems of cyclone forecasting are now available to almost all the developed nations of the world.
- Warning should be issued immediately to the concerned government agencies and to the general public.

Construction

- Special care should be taken while constructing houses, bridges, roads, and communication networks in cyclone-sensitive areas.
- Cyclone shelters should be constructed in cyclone-prone areas and arrangements must be made to evacuate people in case of an emergency.

Relief tasks

- Relief measures such as economic help and support by individuals, community and government and non-governmental organizations should be ensured to help in resettlement and rehabilitation of affected people.
- Awareness should be spread at all levels of the community to prepare everyone for emergencies.

5.2 EARTHQUAKE GROUND MOTION

The terms earthquake motions, earthquake ground motion, or ground motion is the vibrational motion of the ground near the ground surface, which is caused by earthquake waves propagated away from the earthquake source. Earthquake ground motion is a complicated phenomenon which arises due to several factors such as (i) Dynamics of source breakage (ii) Details of the transmitting media. The ground motion varies from source to source, from path to path or from site to site and therefore introduce large scattering in numerical values of ground motion.

Earthquake ground motion – basic concepts

Ground motion at a particular site is influenced by four main elements; viz.

(i) Source, which describes how the size and nature of the earthquake source controls the generation of earthquake waves.

(ii) Directivity, which describes the direction at which the earthquake ground motion, is affected.

(iii) Travel path, which describes the effect of the earth on these waves as they travel from the source to a particular location.

(iv) Local site condition, which describes the effect of the uppermost several hundred meters of rock and soil and the surface topography at that location on the resultant ground motion produced by the emerging or passing earthquake waves.

Earthquake source

The earthquake source consists of a circular fault of radius ‘r’ that begins rupturing everywhere along the fault at the same time. After an earthquake begins, the accumulated strain resulting from tectonic stresses is too large for the rocks to bear.

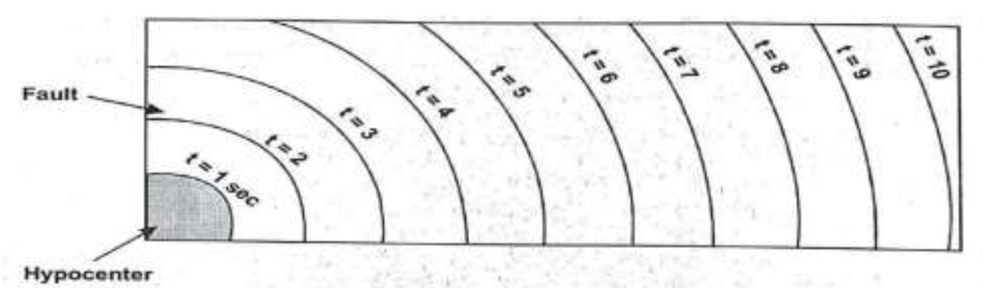

Fig 5.2.1- Earthquake source

The process of starting, propagation and ending of earthquake is as follows.

1. The hypocenter, is the point of rupture nucleation, where in which the earthquake starts and is shown near the lower left hand corner.
2. As the earthquake continues the rupture propagates away from the hypocenter to other parts of the fault.
3. The curved lines represent the locations of the rupture front, or boundary between the broken and unbroken parts of the fault, at different times after the initiation of rupture or origin time of the earthquake.
4. The rupture process stops at locations where it breaks the surface of the earth or where the rock is strong enough to bear the strain without breaking.
5. The rupture usually proceeds at a rupture velocity somewhat less than the velocity of S waves in the adjacent rock.
6. An increase in rupture velocity result in an increase in the amplitude of ground motion, particularly at high frequencies.
7. It is obvious that the rupture did not progress at the same velocity because of the heterogeneity in rock properties, fault geometry and stress release along the fault.

Faults consists of stronger parts [which are called barriers and asperities] and weaker parts, which rupture during an earthquake.

Barrier hypothesis

Before earthquake: The fault is in a state of uniform stress as shown Fig. (a).

During earthquake: The rupture propagates leaving unbroken stronger patches as shown in Fig.(b).

Asperities hypothesis

Before earthquake: The fault is not in a rate of uniform stress as shown in Fig (c) and hence having strong patches by the release of extensive stress.

During earthquake: The patches asperities are broken resulting in a smoothly slipped fault(bare land) as shown in Fig. (d).

Barriers and asperities are significant to earthquake ground motion because they represent locations of concentrated stress release and localized stopping.

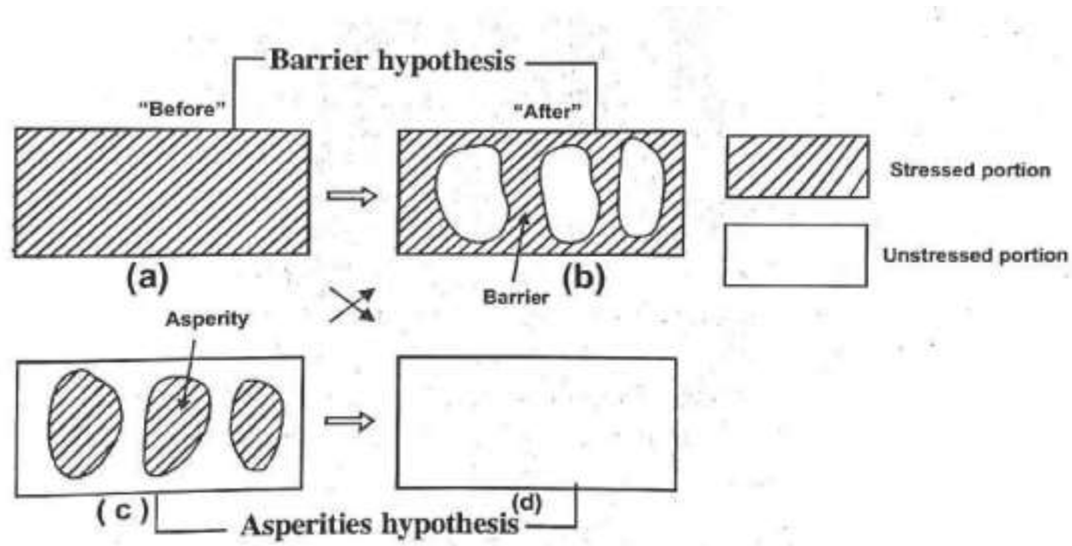

Fig:5.2.2- Barriers and Asperities

(ii) Directivity (or) focusing of Seismic energy

Another source characteristic which can affect earthquake ground motion is called directivity, also referred to as focusing. Directivity occurs because the source of seismic waves. Directivity occurs because the source of seismic waves (fault rupture) is a moving source travelling along a fault at a finite rupture velocity.

1. The propagation of ‘seismic energy from the epicenter will have the following effects. The direction of fault rupture affects ground motion. Simply to say, if a fault rupture propagates towards a particular site the ground motion at that site will be greater than if a fault rupture propagates away from it as shown in Fig. (a)
2. Here, when the fault ruptures, or earthquake source moves, from right to left from the epicenter, it generates ground motion from each part of the fault.
3. The pulse which began the earliest, near the epicenter, has spread the farthest, while the pulse that began the latest at the end of the fault rupture has spread the least.
4. Although they originated at different times, the wave fronts, and therefore the pulses generated, tend to arrive close to the same time at receiver A (in the direction of rupture propagation) because the pulses that started the latest have the least distance to travel, as shown in Fig (b).

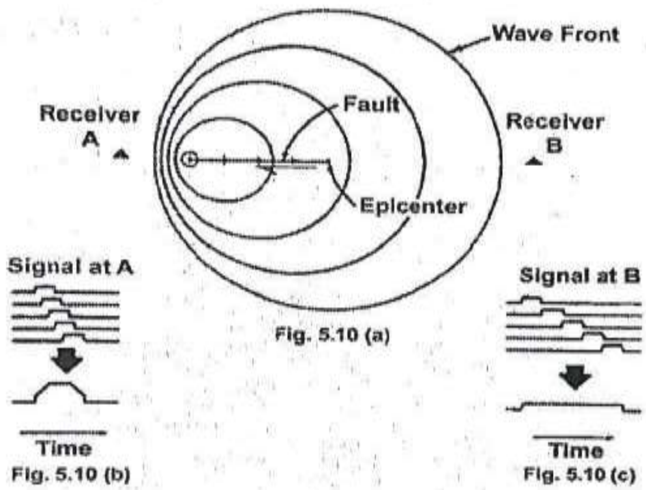

Fig:5.2.3- Directivity of seismic energy

5. At receiver B (opposite to the direction of rupture propagation) the pulses that started last have the greatest distance to travel, so that pulses originating from different parts of the fault tend to arrive spread out over time, as shown in Fig (c).
6. The constructive interference of the ground motion at receiver A results in high amplitude motion. Thus the effect of directivity is to yield the highest ground motion (and shortest total duration) in t] direction of rupture propagation and the lowest ground motion (at longest total duration) opposite to the direction of rupture propagation.
7. This effect increases as the rupture velocity approaches the seismic wave velocity and as the angle between the point of observation an: the direction of rupture propagation becomes smaller.

(iii)Travel path effects

The effects of the travel path on earthquake ground motion are primarily related to the attenuation of the propagating seismic waves.

Seismic wave attenuation consisting of two major element, viz., (a) Geometric spreading and (b) Absorption (sometimes called damping).

(a) Geometric spreading

Geometric spreading results from the conservation of energy as waves and wave fronts occupy more area as they spread out form the seismic source. If the earth were homogeneous and isotropic (the same properties in all directions) body waves would have spherical wave fronts and their amplitudes1 would decrease as E, where R is the distance to the earthquake source.

Similarly if the earth was both uniformly layered and flat, surface waves would have cylindrical wave fronts and their amplitudes would decrease as 1/ R The nonuniform, spherical nature of the earth modifies these factors

(b) Absorption

Absorption is a net loss of energy as seismic waves propagate. Absorption is caused due to intrinsic physical loss mechanisms such as sliding friction across cracks, internal friction, and grain boundary effects which occur, as a seismic wave passes through the rock. The rate at which seismic wave amplitude attenuates (due to absorption) with increasing distance, is given by

$$r = \frac{\pi f}{QV}$$

Where, f → Frequency,

V → Seismic wave velocity and

Q → Quality factor which varies with wave type and is a function of material.

Q increases with frequency and the relation between

them is given by $Q = Q_0 f$

5.3 EARTHQUAKE GROUND MOTION: ESTIMATION TECHNIQUES

Measuring Earthquake Ground Motion

Seismic waves and the resulting ground motion were divided into weak motion (from distant or small earthquakes) and strong motion (from nearby or large earthquakes).

In seismic hazard analysis estimates of ground motion are dealt with strong motion. Strong-motion instruments are designed to make usable records of earthquake ground motion which can destroy whole cities.

Instrumentation technique

Strong motion instruments are specially designed seimographs (accelerographs) configured to provide useful records of acceleration (accelerogram) from nearby earthquakes.

The heart of the accelerograph is a high frequency seismometer (accelerometer), the output of which is directly proportional to ground acceleration over a wide frequency range.

In Digital instruments, data can be easily processed. The earthquake ground motion can be estimated by the following techniques viz.,

1. Statistical regression techniques.
2. Theoretical ground motion modelling.
3. Semi-empirical techniques.
4. Semi-Theoretical techniques.

Statistical regression technique

Statistical regression techniques allow bringing together the available strong motion data, recorded under different source, travel path, and local site conditions, to define empirical correlations that permit the estimation of ground motion for many earthquake scenarios.

The basic functional form for ground motion regression equation is given by

$Y \,\alpha\, f_1 (M)\, f_2 (R)\, f_3 (M, R)\, f_4 (P_i)\, \varepsilon$ [or]

$Y = \mathbf{B}\, f_1 (M)\, f_2 (R)\, f_3 (M, R)\, f_4 (P_i)\, \varepsilon$

Where,

Y ⟶ Strong motion parameter to be estimated (dependent variable).

B ⟶ Constant scaling factor.

f_1 (M) ⟶ Function of the independent variable M (magnitude or earthquake source size).

f_2 (R) ⟶ Function of the independent variable R (source to site distance).

f_3 (M, R) ⟶ Joint function of M and R.

f_4 (P_i) ⟶ A function, or functions, representing possible source, site, and building effects and

ε ⟶ An error term representing the uncertainty in Y.

Almost all ground motion regression analyses assume a relationship of this form. The different variable or parameters used in these regressions and their estimation technique is as follows.

Estimation of f_1 (M), f_2 (R) and f_3 (M, R)

For computing the strong motion parameter "Y", two parameters are very important viz,

1) The earthquake size which is, usually described by magnitude (M).
2) The second necessary parameter is source to site distance (R).

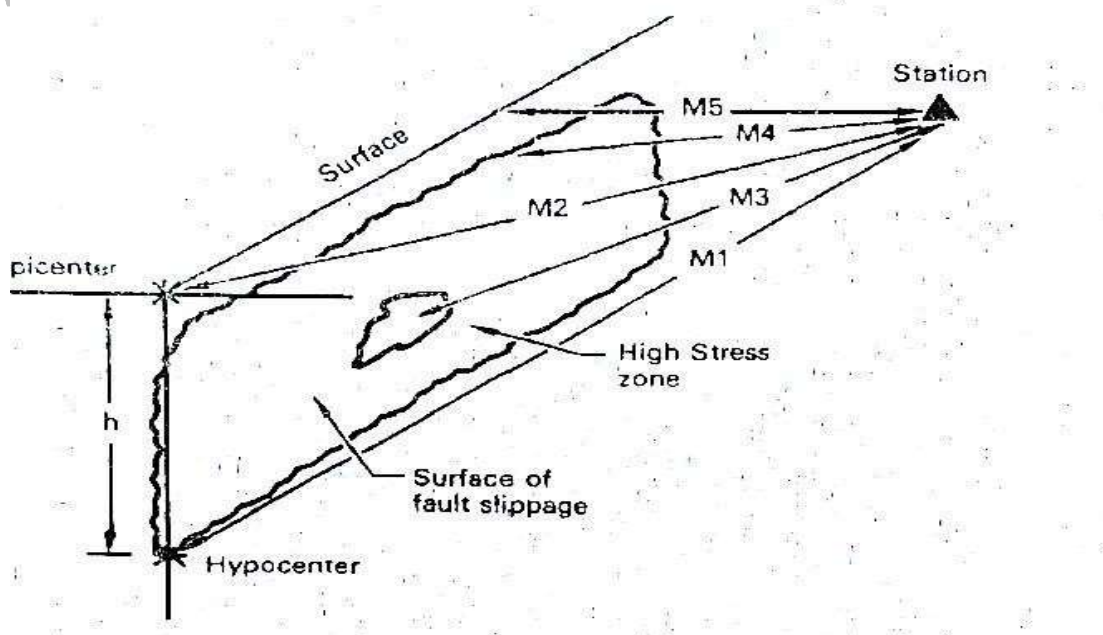

Fig:5.3.1- Estimation of f_1 (M), f_2 (R) and f_3 (M, R)

Fig.shows the schematic illustration of methods of distance measurement used in the determination of the distance value to be associated with a ground motion observation.

Here,

- M_1 is the hypocenter distance (focal depth is h).
- M_2 is the epicenter distance.
- M_3 is the distance to the center of high-energy release (or high localized stress drop).
- M_4 is the closest distance to the slipped fault; in this case, the fault rupture does not extend to the surface.
- M_5 is the closest distance to the surface projection of the fault rupture.

Measurement:

1. The hypo central distance (M_1) and epicentral distance (M_2) can be determined easily from knowledge of the recording station location and the earthquake catalog.
2. M_3 which is the distance to the energetic zone, in turn represents the strongest source of ground motion can be measured by the distribution of strong-motion recordings with respect to the magnitude and distance used in regression analysis.
3. M_4 and M_5 which are the closest distance to the lipped fault or its surface projection will be widely measured using experimental methods.
4. The joint distance magnitude function f_3 (M, R) shown in equation (1) implies the relative change in ground motion due to change in magnitude and distance and are not independent of each other.
5. A function, or set of functions f_4 (P_i) which is shown in equation (1), has to be included

in the regression to account for local site conditions, source characteristics other than size, and the effect of structure upon the motion. By calculating the above functional, parameter we can estimate the earthquake ground motion.

(2)**Theoretical Ground Motion Modeling**

Theoretically based numerical ground motion modeling techniques are used in applied seismic hazard analysis Theoretical ground motion models may be classified into two main types viz., (i) Dynamic and (ii) Kinematic.

Kinematic model

This is a very Simple model in which simple uniform slip (dislocation), travels at a constant rupture velocity on a rectangular fault as shown in Fig. 5.3.2 The following steps are adopted to determine the total ground motion by using kinematic ground motion modeling.

1. Initially the slip functions are measured at various points on the hypothetical fault surface (F) with respect to the Hypocenter.

2. Graph is drawn by taking time along X-axis and slip along Y axis for the various points as shown in Fig. 5.3.2

3. For each plot (graph), depictions of Green's functions in an x,y,z Co-ordinate system was made as shown in Fig. 5.3.3

4. From Fig. 5.3.3, we can see that the individual points on the fault surfaces at A,B,C,...F undergo instantaneous unit-amplitude slip resulting in ground motion (Green's functions) at observation point X_0.

5. The slip functions for each fault segment dF is convolved with the appropriate Green's function.

- The resulting ground motions from each segment are summed to get the total ground motion at X_0 as shown in Fig. 5.3.4

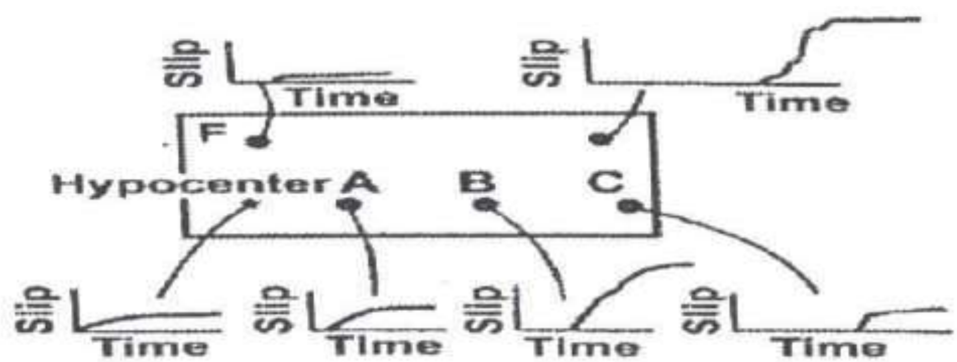

Fig:5.3.2- Kinematic ground motion modeling.

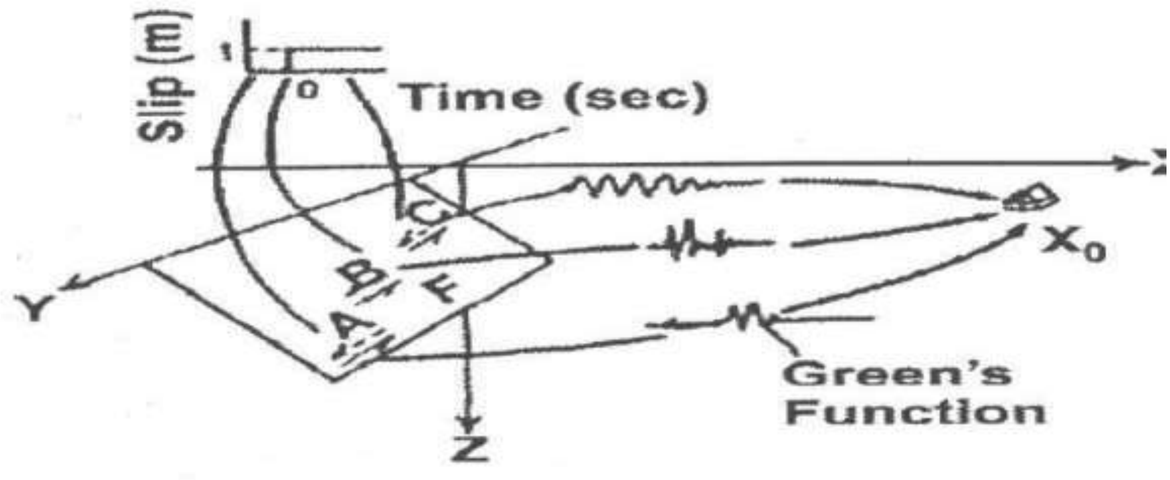

Fig:5.3.3- Depictions of Green's functions in an x,y,z Co-ordinate

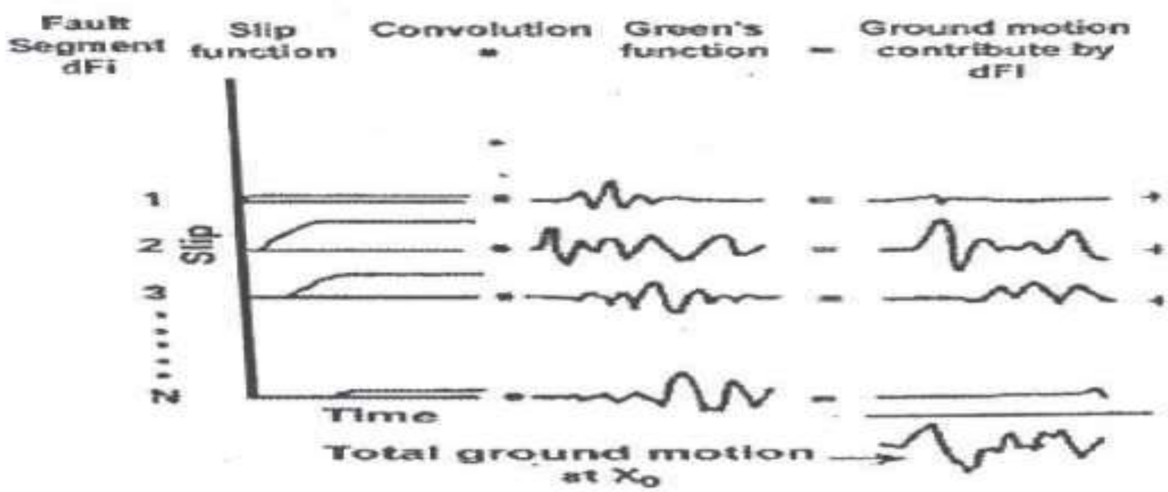

Fig:5.3.3- Total ground motion

Limitations

1. It is not possible to accurately estimate the ground motion in the near field.

2. Close to the earthquake source the contribution of high frequencies to the overall level of ground motion can be quite high.

3. It is limited only to low frequency ground motion.

4. The relative lack of close-in data results in large uncertainties at these distances.

5.11 FIRE FIGHTING EQUIPMENT

Technical equipment designed to rescue people and protect valuable goods and natural resources from fire is called fire lighting equipment.

Examples

The basic apparatus are fire trucks, tire-fighting trains, fireboats, and lire-lighting airplanes and helicopters.

Types of fire fighting equipments and its uses

It is important to have fire safety equipment at hand both at home and at work. You never know when a fire is going to start, and so having fire extinguisher could save your life.

Here is an overview of the different types of fire lighting equipment that are currently available.

1. Fire Extinguishers

A fire extinguisher is on firefighting equipment, which is used to extinguish fire. The different types of fire extinguishers are given below

- Carbon dioxide extinguishers (CO_2)
- Foam extinguishers.
- Powder extinguishers.
- ABC fire extinguishers
- Wet chemical extinguishers.
- Fire blankets.

CO_2 Fire extinguisher

Principle

Carbon dioxide is extracted from the atmosphere and stored at high pressure in the liquid state within a fire extinguisher. When the extinguisher is let off, the liquid is released into the air neutralizing the oxygen and disable the fires ability to spread.

Construction

CO_2 fire extinguisher cylinders are red. They range in size from 5 lbs to 100 lbs or larger (1bs=pound; 11bs=0.454 Kg).

(i) It consists of a steel cylinder in which the liquefied CO_2 gas is filled as shown in Fig.5.11.1

(ii)A control valve is provided to allow a clear passage for CO_2.

(iii) In addition to this it is also provided with a discharge horn, which is designed to stop the entrainment of air with CO_2 and to reduce the velocity.

(iv)The function of dip tube is to deliver liquid carbon dioxide outside the bottle. It protects CO_2 from evaporation and freezing.

Working

(i)Take the extinguisher as close as possible to the fire.

(ii)Hold the horn with left hand.

(iii) Open the control valve.

(iv) Direct the jet at the base of the fire with sweeping action from as close as possible to the fire.

(v) If flammable liquids aim the horn at the base of the fire and move across the area, be careful not to splash the burning liquid with the powerful jet of the CO_2 extinguisher.

(vi) If electrical equipment, switch off the power (if safe to do so) and then direct the hose straight at the fire.

(vii) CO_2 is very cold as it comes out of the extinguisher, so it cools the fuel as well.

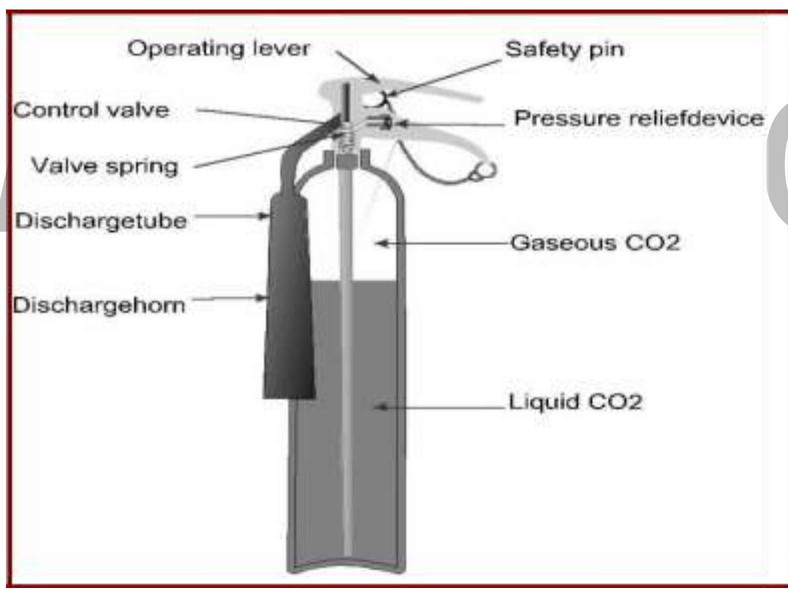

Fig:5.11.1- CO_2 Fire extinguisher

Advantages

(i) CO_2 gas is electrically non conductive and therefore safe for fighting fires in electrically powered equipment.

(ii)CO_2 does not contaminate food, valuable materials and leaves no residue.

(iii)CO_2 is non-corrosive and nonconductor of electricity.

(iv)No residues left after application and no deterioration will happen with age of the appliance.

Disadvantages

(i)CO_2 is highly suffocating 9% concentration causes unconsciousness within minutes.

(ii)Very little cooling effect. So there is danger of re-ignition

(iii) When discharged, solid CO_2 particles present and generate sufficient static electricity to produce spark.

iv)A CO_2 fire extinguisher may be ineffective in extinguishing a class A fire because it may not be able to displace enough oxygen to successfully put the fire out.

Uses of CO_2 fire extinguisher

(i) CO_2 fire extinguisher are designed for Class B and C (Flammable Liquids and Electrical Sources) fires.

(ii) CO_2 fire extinguisher will frequently be found in laboratories, mechanical rooms, kitchens, and flammable liquid storage areas.

(iii)Low and high pressure CO_2 is used for the fire protection of machinery spaces, pump rooms, cargo holds, paint stores and galley exhaust ventilation ducts on board ships.

Fire Hoses

The fire hoses lets out a powerful stream of water that extinguishes large fires. The hoses usually come in a fire hose reel, which holds 30 metres of tubing. This makes the hose easy to unravel so a fire can be fought quickly. Fire brigades can also attach different nozzles to the end of the hose to fight a variety of fire situations. A fire hose is one of the standard types of firefighting equipment, and it is efficient against even the largest fires.

Fire Buckets

A fire bucket is considered the simplest piece of fire fighting equipment, but still serves a purpose. The standard red bucket has the word 'Fire' written on it and it is made of metal or plastic. It can be filled with water or you can fill it with a flame smothering powder like Flamezorb.

Fire Blankets / Welding Blankets

- Fire blankets are used to smother small fires that start in the workplace or at home. Economy fire blankets or white kitchen blankets are a good choice for a small kitchen or for a caravan.
- These blankets have a special pull tab that allows you to open them quickly.
- Welding blankets are used to protect welders from sparks and splatter. These blankets come in three different weights and sizes.

Flamezorb

- Flamezorb is a powder that effectively smothers tires.
- It's non-toxic and easy to clean up.
- Each bag of Flamezorb has enough powder to fill a ten litre fire bucket.
- If you work in an area like a garage forecourt where this is a high potential of spillage, Flamezorb is good to have around.

Fire sprinklers

- The fire sprinklers are the latest fire protecting devices used in hotels, houses etc.
- It consists of a sprinkler.
- During tire, the liquid tilled bulb burst and it allows the water to pass through the plug.
- This water is sprinkled through the sprinkler and fire is extinguished.

5.8 FIRE HAZARDS

A material, substance or action that increases the likelihood of an accidental fire occurring is called fire hazard. In other words, an object, building etc that could easily catch fire or cause a fire and thereby endanger life is called fire hazard.

Examples

(i)The large number of dead trees poses a fire hazard.

(ii)Smoking in toilets is a fire hazard.

Fire hazards pose threats to life and property. It is therefore, the prime object of safety systems to detect, remove or reduce the risk of fire threatened by those potential hazards. A fire can happen at any time at any place irrespective of its occupancy status. You can expect a fire at any structure, may be at your home or at your workplace or at a hospital or in public places like theatres, malls, etc.

Causes for Fire Hazards

The fire hazards are caused due to the following reasons, viz.,

1. All types of flames used for any work like cooking, smoking, etc causes fire.
2. Electric wires, higher loads, loose connections and old electrical equipment's also cause fire.
3. All works and situations where fire is essential such as welding, cutting, metal casting etc. causes fire.
4. Improper storage of tools, equipment and items may cause fire.
5. Improper and unauthorized storage of flammable and hazardous materials and chemicals especially the flammable ones like fireworks and explosives will lead to fire.
6. Insufficient capacity and number of emergencies exits and stairs and absence of fire detection and alarm system will also be a root cause for fire.
7. In sufficient numbers and types of fire extinguishers and hindrance to sight or reach Fire fighting equipment,markings and alarm systems will also cause fire.
8. Violation of building and fire codes are also the main reason for the occurrence of fire.

Classification of Fire Hazards

Fire hazards are classified by the types of fuel they burn.

Class A: Class A Fires consist of ordinary combustibles such as wood, paper, trash or any thing else that leaves an ash.

Remedy: Pouring water is the best method to extinguish a Class A fire.

Class B: Class B Fires are fueled by flammable or combustible liquids, which include oil,gasoline, and other similar materials.

Remedy: Smothering effects which deplete the oxygen supply is best to extinguish Class B fires.

Class C: Energized electrical fires are known as Class C fires.

Remedy: Always de-energize the circuit then use a non-conductive extinguishing agent such as Carbondioxide.

Class D: Class D Fires are combustible metal fires. Magnesium and Titanium are the most common types of metal fires. Once a metal ignites, do not use water in an attempt to extinguish it. Only use a Dry Powder extinguishing agent.

Remedy: Dry powder agents work by smothering and eat absorption and hence reduces tire.

Class K: Class K Fires are fires that involve cooking oils, grease, animal fat etc.

Remedy: It can be extinguished using Purely K, the typical agent found in kitchen or galleys extinguishers.

Fire protection

Fire protection is the study and practice of mitigating the unwanted effects of potentially destructive fires. In other words, the measures and practices for preventing or reducing injury and loss of life or property by fire is called fire protection.

Fire protection maintains safety and reduces hazards associated with fires. Fire protection studies the behavior, suppression, and investigation of tire and related emergencies, as well as the research and development activities. There are three basic essentials of fire protection,

- **Study of Fire:** We should learn the causes of tire, lire extinguishing techniques, detection and extinguishing equipment and their uses, and the rules and regulations related to building construction.
- **Active Fire Protection:** Includes manual or automatic detection of fire, the use of fire and smoke alarms, firefighting and first aid.
- **Passive Fire Protection:** It includes design of building and infrastructures, use of fire resistance material in construction, provision of isolating fire, fire walls and doors, smoke doors, training of firefighting, signage, markings and evacuation of building in case of fire.

5.9 FIRE PROOFING OF MATERIALS

Fire proofing is something resistant to fire or incombustible or material for use in making anything fire proof.

Passive Fire Protection (PFP) is an integral components of structural fire protection and fire safety in a building.

Fire proofing is a type of fire protection measure. It refers to the act of allowing materials to be more resistant to fire outbreaks.

There are a huge variety of fire proofing materials used to make clothes, construction materials and many other items.

A material may be fire proof due to an infused chemical whereas others are fire proof by nature.

- Fire proof materials are designed to resist burning and withstand heat.
- Natural fibers like wool and cotton can also be treated with fire proof chemicals or even fire inhibiters to provide effective fire resistance.
- Fire blankets are also made with fiber glass and are most appropriate for smaller household kitchen fires or a small fire that starts from clothing.
- Nearly 40% of fire victims have been killed in their sleep due to smoke inhalation of fire. There is a high demand for fire proof building materials such as dry wall, paint, roofing materials and exterior sides.
- There are also many other types of fire proof building materials used on interiors, exteriors, roofs of a house such as cast iron, steel brick, stone, concrete and fire proof wood products.
- Fire proof materials that are used in construction are all designed to maintain their durability, strength and structural intensity as the temperature rises during a fire outbreak.

- Fire proof materials used for buildings also include a dry wall where by non-combustible material and glass fibers have been fused into the core of the gypsum. This prevents the wall board from disintegration and slows down the spread of a fire.
- There is also fire proof brands of paint made available. Most of these brands are fire resistant.

Fire-proofing properties of common building materials

The fire-resisting properties of common building materials such as stone, brick, timber, cast-iron, glass, steel and concrete are mentioned below.

1. Stone

The stone is a bad conductor of heat and it is also a non-combustible building material. But if suffers appreciably under the effect of a fire. The stone is also liable to disintegrate into small pieces when heated and suddenly cooled.

2. Brick

It is found that the bricks are not seriously affected until very high temperatures of 1200°C to 1300°C are reached. This is due to the fact that a brick is a poor conductor of heat.

3. Timber

As a general rule, the structural elements made of timber ignite and get rapidly destroyed in case of fire. Further, they add to the intensity of fire.

4. Cast-iron

This material is rarely used as structural material at present. This material flies into pieces when heated and suddenly cooled. @LS10B = 5. Glass

This material is a poor conductor of heat and its expansion due to heat is small. The cracks are formed in this material when heated and then suddenly cooled.

5.Steel

The steel is a non-combustible building material, but it is a good conductor of heat and hence, it is rapidly heated in case of a fire.

6. **Aluminium**

This material is a very good conductor of heat. But it possesses poor fire-resisting properties. Hence, its use is restricted to those structures which have very low fire risks.

7. **Asbestos cement**

This is a non-combustible building material with low coefficient of expansion. It therefore possesses high fire resistance. Hence, the asbestos cement products are widely used for the construction of fire-resistant partition walls, roofs, etc.

8. **Concrete**

This material is a bad conductor of heat and it is an effective material for fire-resisting construction. The concrete offers a much higher resistance to a fire than any other material.

5.10 FIRE SAFETY

Fire safety refers to planning and infrastructure in an organization that's designed to reduce fires and their effects. Simply, Fire Safety is the science of fire and the means of protection against it.

Fire safety regulations

1. Fire Safety in Home and Other Places

- Strike matches away from the body.
- Keep a lighted match ready before turning the knob of a gas burner.
- Stoves should be placed on a raised platform and not on the ground.
- Connect only one electric plug in a socket.
- Storage shelves should be away from the burner o that you do not have to lean over the flame to fetch the items.
- Never play with children or allow children to play in the kitchen.
- Do not keep a lighted stove or burner near a gas cylinder.
- Always close the regulator when the gas is not used.
- Replace the rubber tubes regularly so that it does not leak.
- Never place the cylinder in a horizontal position. Keep it vertical.
- Good housekeeping with proper arrangement of furniture, vessels and kitchen arrangements itself is a good fire safety measure.

2. In case of a gas leak from the LPG Cylinder

- Do not take any naked flame or allow a spark if you smell a gas leak.
- Do not operate any electrical switch as the spark.
- Open the door and windows and allow the gas to escape (LPG is heavier than air and so it tends to settle down on the ground or floor level)
- If possible, try to remove the leaking cylinder to a safe and open place so that the gas goes out and escapes.

3. In case of a fire in Cinema Hall

- When you enter the auditorium check the place at which normal exits and where the emergency exits.

- Rush out as soon as possible, through the exits and reach a place of safety.
- Do not panic.
- If there is smoke, lie on the floor as a smoke is usually lighter than air and tends to float.
- Use the stairs while running down.
- Do not smoke in the auditorium, toilet, refreshment halls etc.
- Locate the place of fire extinguishers and use them to put out the fire.

Safely tips against fire in Hotels

- Ask the porter / room boy about the ordinary as well as emergency passages, particularly the escape routes in the event of a fire.
- Find out the nearest escape route from your room.
- Electrical equipment must not be adjusted or altered without the permission of the management.
- Do not smoke in the bed. In case you small smoke, raise an alarm.
- On the outbreak of fire, do not panic. You may sometimes be safer in your room.
- Leave the hotel by the staircase.
- Do not walk through smoke but crawl with your hands and knees on the ground and keep moving along the wall on the exit side.
- Read fire safety instructions/ fire plan, if available.

5.7 FLOOD HAZARDS

A flood is an overflow of water that submerges land which is usually dry. Floods are the most common natural disaster (or) Hazard in India. The heavy south west monsoon rain causes the Himalayan river basin distend their bank , often flooding surrounding areas. It results heavy losses for both economic and lives.

TYPES OF FLOOD HAZARDS

The types of flood hazards are given below

(1) Riverine floods or Fluvial

(2) Estuarine floods

(3) Coastal floods

(4) Various catastrophic causes.

1. Riverine floods. or Fluvial

Fluvial, or riverine flooding, occurs,.when excessive rainfall over an extended period of time causes a river to exceed its capacity. It can also be caused by heavy snow melt and ice jams.

There are two main types of riverine flooding

- ❖ Overbank flooding occurs when water overflows over the edges of a river or stream. This is the most common and can occur in any size channel from small streams to huge rivers.
- ❖ Flash flooding is characterized by an intense, high velocity torrent of water that occurs in an existing river channel. Flash floods are very dangerous and destructive not only because of the force of the water, but also the hurtling debris that is often swept up in the flow.

2. Estuarine floods

Estuarine floods usually result from the combination of a tidal surge at sea, caused by storm-forced winds and river flooding caused by rainstorms in inland.

3. Coastal floods

Coastal floods can be caused by hurricanes and other severe sea storms or by tsunami waves.

4. Various catastrophic causes

Various catastrophic causes can be identified, such as dam-burst or the effects of earth quake or volcanic eruption, can also lead to flood hazard.

EFFECTS CAUSED DUE TO FLOOD HAZARDS

There are 3 major effects that are caused due to flood hazard. They are

1. Primary effects that occur due to contact with water.
2. Secondary effects that occur because of the flooding, such as disruption of services, health impacts such as famine and disease.
3. Tertiary effects such as changes in the position of river channels.

1. Primary Effects

The primary effects of floods are due to direct contact with the flood waters. Here, water velocities tend to be high in floods.

- Water entering human built structures cause water damage. Even with minor flooding of homes, furniture, floors and walls are damaged.
- Anything that comes in contact with the water is likely to be damaged or lost. Flooding of automobiles usually results in damage that cannot easily be repaired.
- Massive amounts of erosion can be accomplished by flood waters. Such erosion can damage bridge structures, and buildings.
- The high velocity of flood allows the water to carry more sediment as suspended load. When the flood waters retreat, velocity is generally much lower and sediment is deposited. After retreat of the floodwaters everything is usually covered with a thick layer of stream deposited mud, including the interior of buildings.
- Flooding of farm land usually results in crop loss. Pets and other animals are often carried away and drown by the flood.
- Humans that get caught in the high velocity flood waters are often drowned by the water.
- Floodwaters can concentrate garbage, debris, and toxic pollutants that can cause the secondary effects of health hazards.

2. Secondary Effects

Secondary effects are those that occur because of the primary effects and tertiary effects which are the long term changes that take place. Some of the secondary effects of a flood are as follows: Drinking water supplies may become polluted. This may result in disease and other health effects, especially in under developed countries.

- Gas and electrical service may be disrupted.
- Transportation systems may be disrupted, resulting in shortages of food and clean-up supplies. In under developed countries food shortages often lead to starvation.

3. Tertiary effects (long term effects)

- As the result of flooding, new channels may develop, leaving the old channels dry.
- Sediment deposited by flooding may destroy farm land.
- Jobs may be lost due to the disruption of services, destruction of business, etc.
- Insurance rates may increase.
- Destruction of wildlife habitat may occur.

Preventive & Protection measures to the taken during and after flood hazards

1. We should keep calm and do not panic.
2. We should always keep an emergency kit, enough supply of food and drink for the family to last the estimated length of the emergency situation.
3. We should listen to the radio but does not use the cell phone without reason.
4. Switch off electricity, gas and central heating. If there is enough time, move valuable or delicate objects and pollutant products to the higher levels of the strongest parts of the building.
5. Take the essential items like emergency baggage, identity and personal papers, medicines etc.
6. Do not cross flooded areas on foot or in a vehicle. If necessary secure yourself by holding on to ropes or cables.
7. Collaborate with public safety bodies and the services helping the homeless.
8. Check and see if there are any injured people in the vicinity and, if possible, help them.
9. Make yourself available to help with rehabilitation work.

5.12 Prevention and safety measures:

Each year, in India more than 250000 die in fires, more than 50,000 are injured in fires and more than 100 fire fighters are killed while on duty. Eighty three percent of all civilian fire deaths occurred in residences. In order to protect yourself from fire, it is important to understand the basic characteristics of fire.

- Fire is FAST. In just two minutes, a fire can become life threatening. In five minutes, a residence can be engulfed in flames.
- Fire is DARK. Fire produces gas is that make you disoriented and drowsy. Instead of being awakened by a fire, you may fall into a deeper sleep. Asphyxiation is the leading cause of fire deaths, exceeding burns by a three-to-one ratio.
- Fire is HOT. Heat and smoke the super hot air can be more dangerous than the flames. Inhaling the super hot air can sear your lungs.

Fire prevention

Before fire

The following are things you can do to protect yourself, your family, and your property in the event of a fire.

Smoke alarms and carbon monoxide detectors

- Install smoke alarms. Properly working smoke alarms decrease your chances of dying in a fire by half.
- Place smoke alarms on every level of your residence, including the basement.
- Install a working carbon monoxide detector in the common area of the bedrooms.
- Test and clean smoke alarms once a month and replace batteries at least once a year. Replace smoke alarms once every 10 years.

Cooking safety

- Never leave cooking unattended.
- Always wear short or tight-fitting sleeves when you cook.
- Keep towels, pot holders and curtains away from flames.
- Never use oven to heat your home.
- Do not overload extension cords or outlets.

- Place space heaters at least three foot away from flammable, combustible materials.
- Use only the type of fuel designated for your space heater.

Electrical Wiring

- Inspect extension cords for frayed or exposed wires or loose plugs.
- Make sure outlets have cover plates and no exposed wiring.
- Make sure wiring does not run under over nails, or across high traffic areas.

During Fire

- If your clothes catch on fire, you should stop, drop, and roll until the fire is extinguished.
- Do not panic. Call the Fire Department.

Escaping from fire

- Check closed doors with the back of your hand to feel for heat before you open them.
- If the door is hot do not open it. Find a second way out, such as a window. If you cannot escape through a window, hang a white sheet outside the window to alert firefighters to your presence.
- Stuff the cracks around the door with towels or tape and cover vents to keep smoke out.
- If there is a phone in the room where you are trapped, call the fire department again and tell them exactly where you are.
- If the door is closed slowly open it and ensure that fire and smoke is not blocking your escape route. If your escape route is blocked, shut the door and use another escape route.
- If clear, leave immediately and close the door behind you. Be prepared to crawl.

After fire

- Once you are out of the building, stay out do not go back inside for any reason.
- If you are with a burn victim or are a burn Victim yourself call, cool and cover your burns until emergency units arrive.
- Tell the fire department if you know of anyone trapped in the building.
- Enter your home, only when the fired apartment tells you it is safe to do so.

5.5 SEISMIC HAZARD

Seismic hazard is defined as a natural phenomenon such as ground shaking, fault rupture, or soil liquefaction that is formed by an earthquake.

The term seismic hazard in engineering practice can refer specifically to strong ground motions produced by earthquakes that could affect engineered structures. Seismic hazards are very severe and damaging, which depend on the magnitude of the earthquake, local site conditions and the response of the system of interest (For example, dams, buildings, powerplants).

Seismic hazard analysis

Seismic hazard analysis often refers to the estimation of earthquake induced ground motions having specific probabilities over a given time period.

In simple, Seismic hazard analysis refers to the estimation of some measure of the strong earthquake ground motions expected to occur at a selected site.

Importance of seismic hazard analysis

(i) The seismic hazard analysis is important for earthquake resistant design of a new structure such as dams, nuclear power plants, high rise buildings, long-span bridges, etc. at that site.

(ii) The seismic hazard analyses also important in estimating the safety of existing structures .

Types of seismic hazard analysis

There are two basic methods for seismic hazard analysis, viz., (a) Deterministic Seismic Hazard Analysis (DSHA) (b) Probabilistic Seismic Hazard Analysis (PSHA)

(a) Deterministic Seismic Hazard Analysis (DSHA)

In Deterministic Seismic Hazard Analysis (DSHA) approach, the strong-motion parameters are estimated for the maximum credible earthquake, assumed to occur at the closest possible distance from the site of interest, without considering the likelihood of its occurrence during a specified exposure period.

Description

The deterministic seismic hazard analysis method uses geology and seismicity to identify earthquake sources and interpret the strongest each source is capable of producing regardless of time.

The main Objective is to identify the largest earthquake that appears along a recognized fault as a result of known (or) presumed tectonic activity.

Deterministic seismic hazard analysis usually requires four separate steps that are illustrated in Fig. 5.5.1

Step 1 Identification of earthquake sources

Identify and characterize (geometry and maximum magnitude) all earthquake sources capable of generating significant shaking at the Site.

Step 2 Calculation of source-to-site parameters

Calculate the appropriate source-to-site distance parameter such as R_1, R_2, and R_3 for each source identified in Step 1.

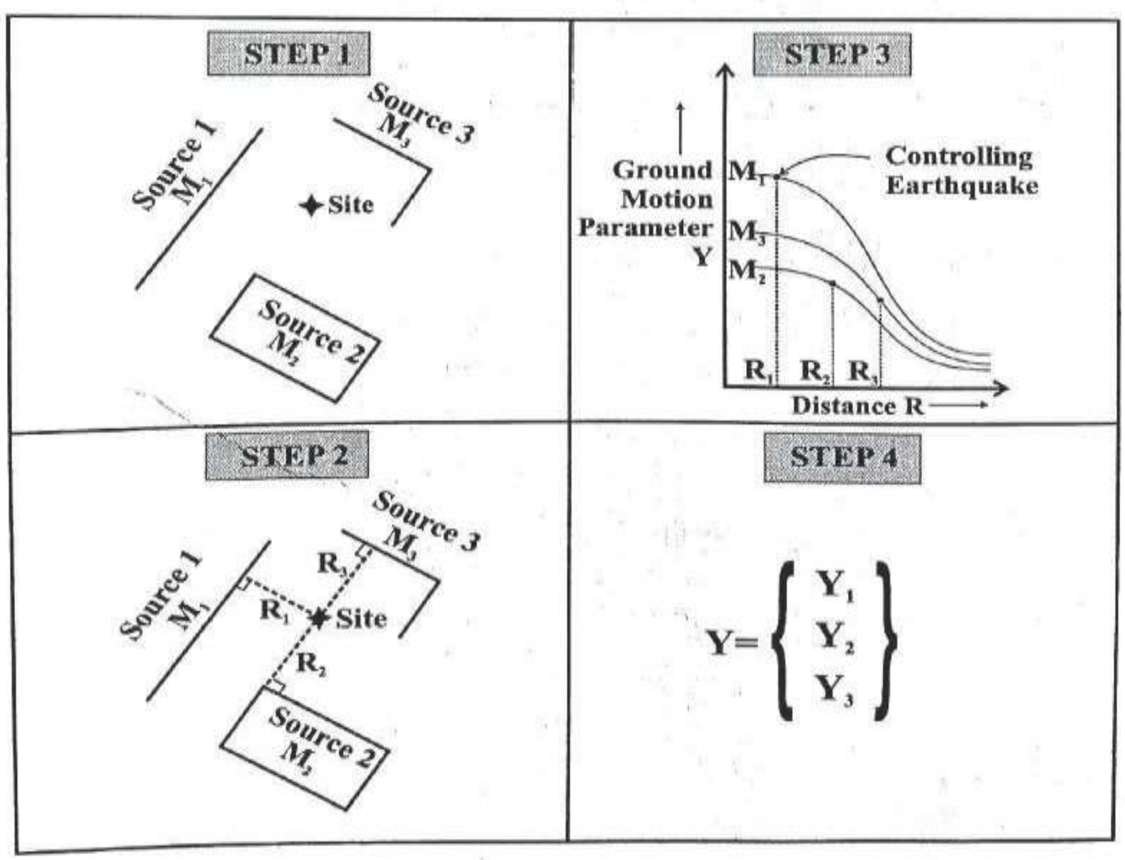

Fig:5.5.1- Deterministic seismic hazard analysis

Step 3 Determination of ground motion parameters

Select the controlling earthquake, i.e, the ground motion parameter (Y) at the attenuation model appropriate for the region.

Step 4 Estimation of seismic hazard

Define the hazard at the site based on the controlling earthquake. The hazard at the site can be expressed in terms of maximum spectral ordinates, maximum ground displacement, and so on.

Advantages

The advantages of the deterministic seismic hazard analysis procedure are as follows.

1) It is simple to apply.
2) It yields conservative results for well-defined tectonic feature (e. g. line sources).
3) Largest Earthquake shall be easily analyzed using this method.

Disadvantages

The disadvantages of this type of analysis are as follows

1) It is difficult to apply this analysis for distributed sources close to the site where the source-to site distance is difficult to establish.
2) It provides no information on the controlling earthquake occurring at the site of interest.
3) It provides no information on the level of shaking a structure.

(b) Probabilistic Seismic Hazard Analysis (PSHA)

The Probabilistic (an ensemble of earthquakes) Seismic Hazard Analysis (PSHA) involves integrating the effects of all the earthquakes expected to occur at different locations during a specified life period, with the associated uncertainties and randomness.

Description

The application of the probabilistic seismic hazard analysis usually requires four steps, illustrated in Fig.5.5.2

Step 1 Identification of the seism genic sources

For a given site, geographic zones representing seism tectonic sources are drawn. For each zone, it is assumed that the probability of earthquake occurrence is the same for the entire surface area (a seism genic source). Thus, we have to identify the earthquake sources.

Step 2 Determination of seismicity

For each source, a magnitude-recurrence relation of the type log N = A –bM is defined for various distances say R_1, R_2 and R_3. Historical seismicity is used to establish the parameters of this relation. A maximum (cut-off) magnitude M_{max} is also defined for each source.

Step 3 Determination of attenuation

An attenuation relation is determined between each source and a given site. Often the same attenuation relation is used for the entire region.

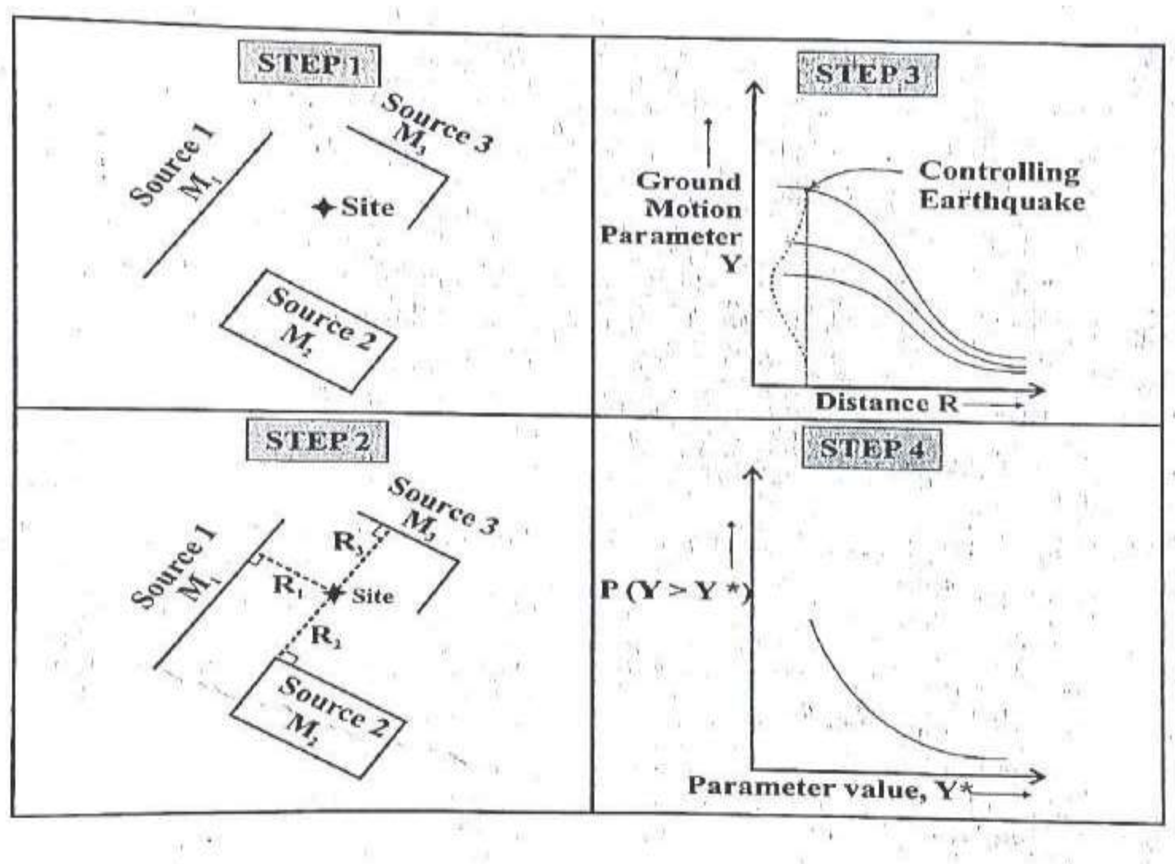

Fig.5.5.2- Probabilistic Seismic Hazard Analysis

Step 4 Calculation of the hazard curve for the site

The attenuation relations are combined with the magnitude-recurrence relations to calculate the annual number of earthquakes exceeding a chosen ground motion level at any given site (i.e. the recurrence rate). The total recurrence rate at the site from all sources is obtained by adding up the recurrence rates from each source.

The four steps above are then repeated on a grid for each given site in a region. Contour lines are then plotted for the chosen seismic parameter. These contour lines, based on the same annual probability of exceedance, creating a seismic hazard map for the region.

1) The probabilistic seismic hazard analysis procedure (PSHA) provides a systematic frame work for the treatment of uncertainty.

2) Two types of uncertainties need to be considered in the development of seismic hazard maps viz.,

(i) Uncertainty due to the randomness of the model parameters and

(ii) Epistemic uncertainty due to uncertainty in the knowledge of the model parameters.

5.1 SEISMOLOGY

Seismology is the scientific study of earthquakes and seismic waves that move through and around the earth, by both naturally and artificially generated seismic waves.

Seismograph

Seismograph or seismometer is an instrument used to detect and record earthquakes. Generally, it consists of a mass attached to a fixed base. During an earthquake, the base moves and the mass do not. The motion of the base with respect to the mass is commonly transformed into an electrical voltage. The electrical voltage is recorded on paper, magnetic tape, or another recording medium.

This record is proportional to the motion of the seismometer mass relative to the earth, which can be mathematically converted to a record of the absolute motion of the ground. Seismograph generally refers to the seismometer and its recording device as a single unit.

Seismic gap

A seismic gap is a section of a fault that has produced earthquakes in the past but is now they are quiet. However the fault segment is capable of producing earthquakes on some other basis, such as plate-motion information or strain measurements.

Seismic moment

The seismic moment is a measure of the size of an earthquake based on the area of fault rupture, the average amount of slip, and the force that was required to overcome the friction sticking the rocks together that were offset by faulting. Seismic moment can also be calculated from the amplitude spectra of seismic waves.

The seismic moment can be measured using the following relation. Seismic moment $M_o = \mu AD$

Where, μ – Rigidity modulus,

A – Fault rupture area,

D – Average dislocation

Uses of Seismology

1. Seismology is useful to measure the speeds at which seismic waves travel through the earth
2. Seismology is used in prospecting for oil deposits. The first oil field to be discovered by this method was found in Texas in 1924.

3. Seismic methods are used to locate subsurface water and do detect the underlying structure of the oceanic and continental crust.
4. With the development of underground testing of nuclear devices, seismographic stations are used to collect seismic wave data during nuclear tests conducted under (or) below the earth.

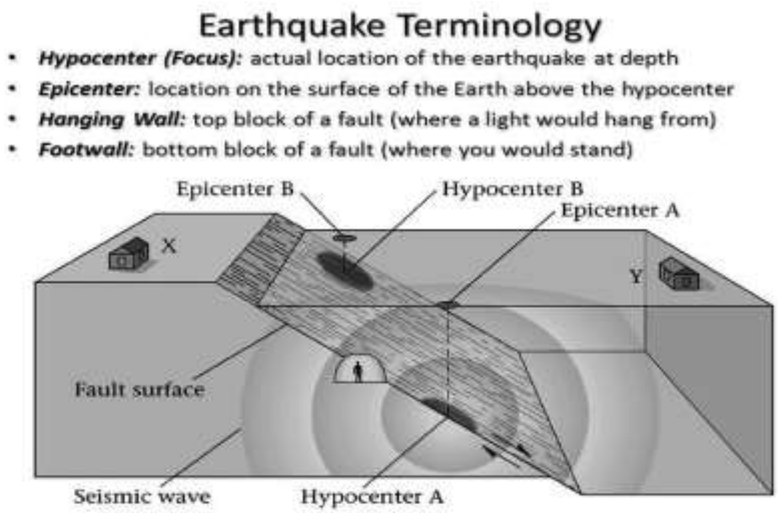

Fig:5.1.1-Earthquake Terminology

Seismic waves

Seismic waves are low frequency waves that travel through the earth's interior generally caused by the following, viz. (i) tectonic earthquake (ii) volcanic eruptions (iii) Magma movement (iv) Large landslides (v) Large man-made explosions.

Types of seismic waves

Seismic waves can be classified into two basic types, viz. (i) Body waves (ii) Surface waves.Waves that are most destructive are surface waves which generally have the strongest vibration.

(i) Body waves

Waves which travel through the earth are called body waves.

(a) Compressional or primary (P) waves

1. Sound waves are usually called P – waves and are heard but not often felt.
2. Expect in the most powerful earthquakes they generally do not cause much damage.

3. P – Waves shake the ground in the direction they are propagating as shown.
4. The P wave, or compressional wave, ultimately compresses and expands material in the same direction it is travelling.
5. P – Waves travel very fast, at speeds between 4-8 km/ secin the earth's crust.
6. The P – Wave is the first to arrive at a location, as it is the fastest.

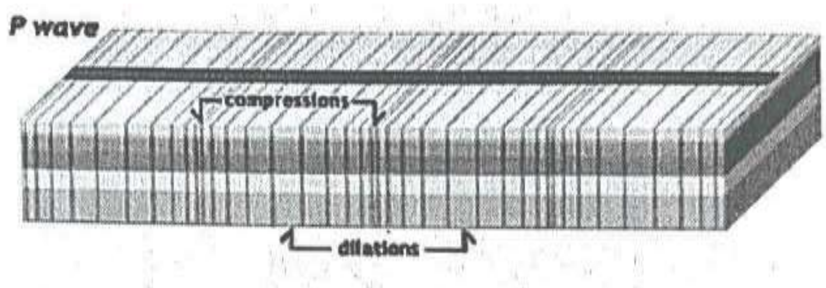

Fig 5.1.2-P Waves

(b) Shear or Secondary (S) waves

1. S wave is shear wave which causes particles to oscillate.
2. S waves can travel through solid material but not through liquid or gas.
3. S – Waves shake perpendicularly or transverse to the direction of propagation.
4. They displace material at right angles to their path.
5. S – Waves travel more slowly, usually at 2.5-4 km/ sec.
6. S – Waves arrive slower than P – Waves

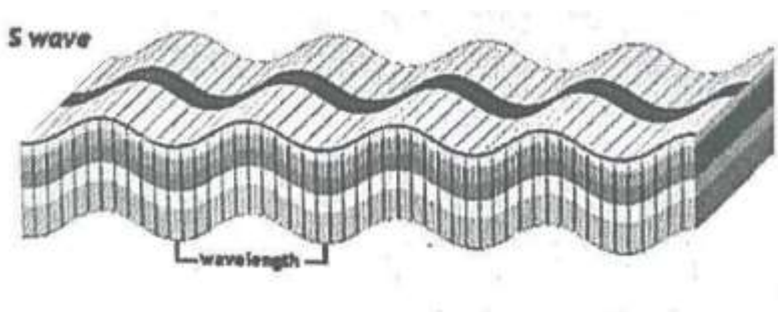

Fig 5.1.3-S Waves

(ii)Surface waves

Waves which travel along the earth's surface are called as surface waves. They arrive after the main P and S waves and are confined to the outer layers of the earth. They cause the most surface destruction.

Earthquake surface waves are divided into two categories,

(a) Love waves

1. Love waves are the fastest surface waves that move on the ground from side to side, which are confined to the surface of the crust.
2. Love waves have purely transverse motion in the horizontal plane. Hence love waves results most damage to structures.

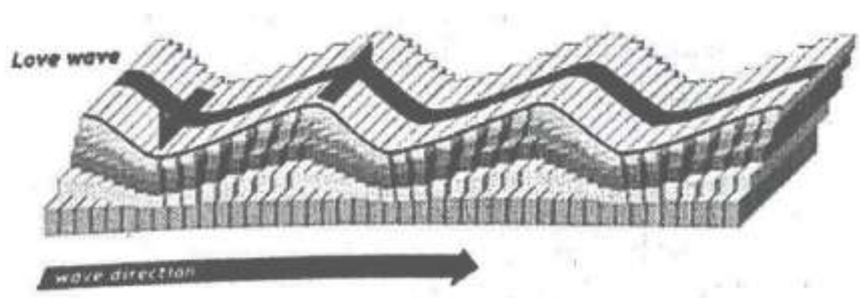

Fig 5.1.4-Love Waves

(b) Rayleigh waves

1. A Rayleigh wave rolls along the ground just like a wave rolls across a lake or an ocean.
2. Because it rolls, it moves the ground up and down, and side to side in the same direction similar to a wave motion.
3. Most of the shaking felt from an earthquake is due to the Rayleigh waves, which can be much larger than the other waves.
4. Rayleigh waves have retrograde particle motion confined to the vertical plane of motion.

Fig 5.1.4-Rayleigh Waves

5.4 EARTHQUAKE GROUND MOTION – SITE EFFECTS

Site effects play a very important role in characterizing seismic ground motions, because they may strongly amplify (or) de amplify seismic motions at the last moment just before reaching the surface of the ground or the basement of man-made Structures.

Some of the methods are,

1. Amplification Factor.
2. Non-linearity of soil response.
3. Empirical Modeling of Site Effects.
4. Topographic Effects.

1. Amplification Factor

When there are sharp changes in rock properties below the earth's surface, several things happen. First, there is a change in amplitude (usually an increase) as the upwardly propagating seismic wave traverses then, there is a change in impedance (usually a decrease).

Here the amplification factor is twice the inverse of the impedance contrast. The amplification factors in the frequency domain for two thicknesses, [t= 100m & t = 15m] of alluvium is shown in Fig .

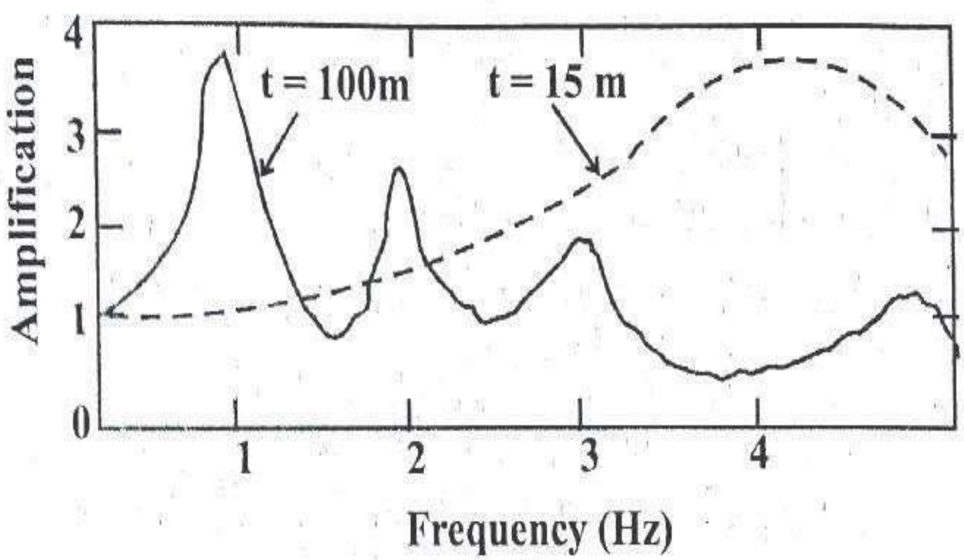

Fig:5.4.1-Graph amplification vs frequency

From the curves obtained, we can find that the amplication factor is higher at lower frequency & vice versa. Further, we can notice that the amplification factor is higher at lower thickness and vice versa.

2. Non-linearity of soil response

Nonlinearity is the phenomenon which allows for changes in soil properties and therefore changes in soil response as the level of ground motion increases. Nonlinearity of soil response is also called strain dependence, because the strain in the soil during an earthquake increases with the level of stress or ground motion.

Therefore, the soil nonlinearity is characterized by the following factors

(i) Reduction of shear rigidity.

(ii) (ii) Reduction of shear wave velocity.

(iii) (iii) Increase of damping factor.

3. Empirical Modeling of Site Effects

If we obtain site effects directly from observed data; such an approach is called an empirical modeling approach.In the empirical modeling of site effects, we must observe strong or weak ground motions due to one or more earthquakes and analyze data to extract site effects.

4. Topographic Effects

There are so many different observations on the strength of the topographic effect. The observations are

1. Even a rock site has strong site effects due to the upper surface structure.
2. Further it may be difficult to distinguish the effects of the subsurface structure and those of the topography from observed site effects, unless we know the subsurface velocity structure of the site in detail.
3. Surface waves, or body waves, is likely to happen but more than two arrivals with the same phase rarely meet at the same location.
4. Strong topography can be found only in the mountain area, where amplification itself is basically low compared to the bottom in surface.

Conclusions

1. The essential aspects of the site-effect studies are reviewed by focusing mainly on the physical modeling scheme to reproduce wave propagation phenomena in the shallower part of the Earth.
2. Physical properties of the actual complex structures of the Earth can be obtained by various geological, geophysical, and geo technical methods, which can be used in the physical modeling scheme.
3. Once a physical model of the whole area of interest is calibrated to actual observation, then such a model of the ground will be a common property of people, on which we can depend forever.
4. To conclude, physical modeling of the ground is now a realistic and effective approach for practical evaluation/ prediction of site effects.
5. The advantage of the physical modeling approach is that it can predict site amplification for any hypothesized sources that have not yet happened but will happen in the near future.
6. Thus, we may need to develop a way to translate site effects evaluated by a physical modeling approach into simple but with effective engineering representations for better seismic design of structures.