ID# **6954**

PROGRAM **B-TECH (civil)**

SUBJECT **Introduction To Earthquake**

Question # 01(a)

What Are Seismic Waves?

Seismic waves are the waves of energy caused by the sudden breaking of rock within the earth or an explosion. They are the energy that travels through the earth and is recorded on seismographs.

Types of Seismic Waves

There are several different kinds of seismic waves, and they all move in different ways. The two main types of waves are **body waves** and **surface waves**. Waves.

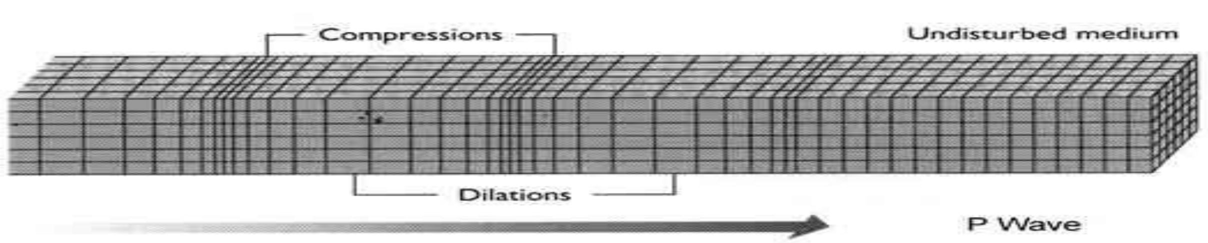
BODY WAVES

Traveling through the interior of the earth, **body waves** arrive before the surface waves emitted by an earthquake. These waves are of a higher frequency than surface waves.

P WAVES

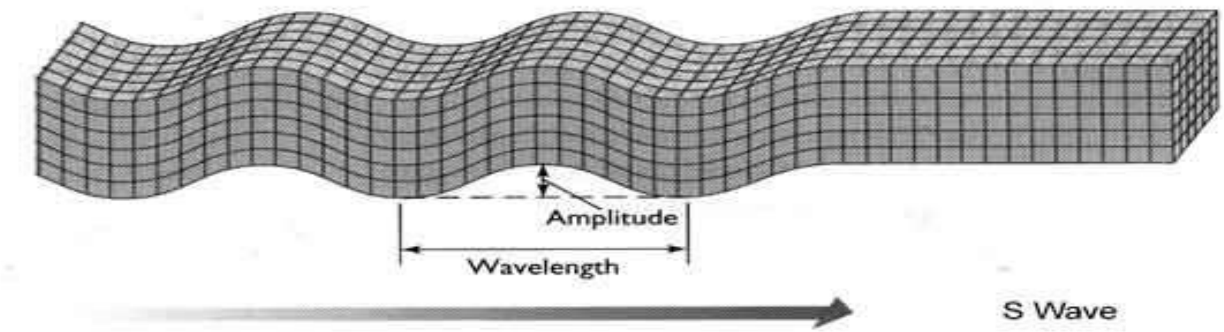
The first kind of body wave is the **P wave** or **primary wave**. This is the fastest kind of seismic wave, and, consequently, the first to 'arrive' at a seismic station. The P wave can move through solid rock and fluids, like water or the liquid layers of the earth. It pushes and pulls the rock it moves through just like sound waves push and pull the air. Have you ever heard a big clap of thunder and heard the windows rattle at the same time? The windows rattle because the sound waves were pushing and pulling on the window glass much like P waves push and pull on rock..

The P waves are also known as **compressional waves**, because of the pushing and pulling they do.



S WAVES

The second type of body wave is the **S wave** or **secondary wave**, which is the second wave you feel in an earthquake. An S wave is slower than a P wave and can only move through solid rock, not through any liquid medium. It is this property of S waves that led seismologists to conclude that the Earth's **outer core** is a liquid. S waves move rock particles up and down, or side-to-side--perpendicular to the direction that the wave is traveling in (the direction of wave propagation).

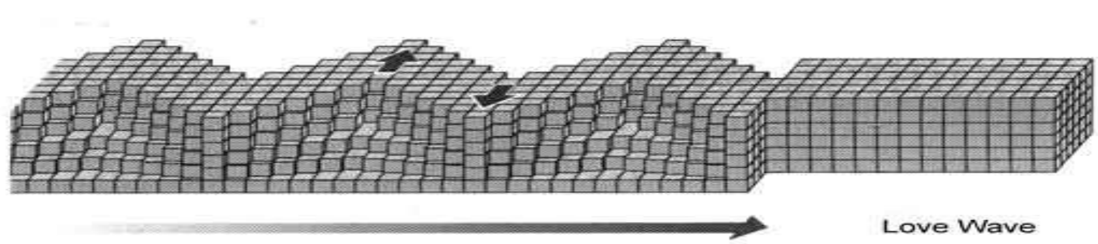


SURFACE WAVES

Travelling only through the crust, **surface waves** are of a lower frequency than body waves, and are easily distinguished on a seismogram as a result. Though they arrive after body waves, it is surface waves that are almost entirely responsible for the damage and destruction associated with earthquakes. This damage and the strength of the surface waves are reduced in deeper earthquake

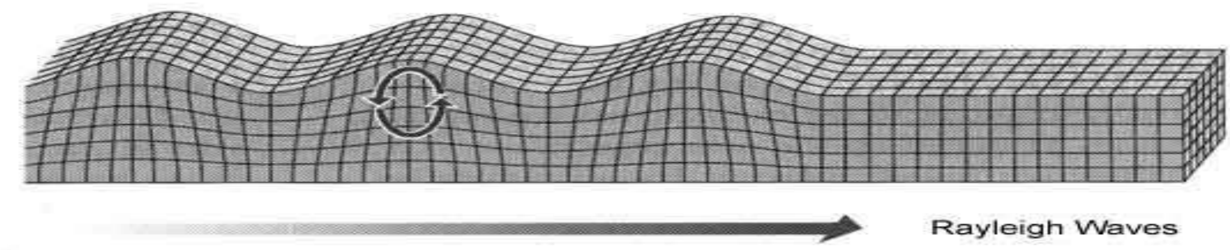
LOVE WAVES

The first kind of surface wave is called a **Love wave**, named after A.E.H. Love, a British mathematician who worked out the mathematical model for this kind of wave in 1911. It's the fastest surface wave and moves the ground from side-to-side. Confined to the surface of the crust, Love waves produce entirely horizontal



RAYLEIGH WAVES

The other kind of surface wave is the **Rayleigh wave** A Rayleigh wave rolls along the ground just like a wave rolls across a lake or an ocean. Because it rolls, it moves the ground up and down, and side-to-side in the same direction that the wave is moving. Most of the shaking felt from an earthquake is due to the Rayleigh wave, which can be much larger than the other waves.



QUESTION # 1 (b):

Seismic risk

Seismic risk refers to the risk of damage from earthquake to a building, system, or other entity. Seismic risk has been defined, for most management purposes, as the potential economic, social and environmental consequences of hazardous events that may occur in a specified period of time.

Seismic risk directly depends upon

- Seismic Hazard.
- Seismic Vulnerability.
- Exposure of Elements at Risk

The Seismic Risk Keep On Increasing`

- The current building stock is enlarged by the addition of new buildings, many with significant or even excessive, earthquake vulnerability. This above all due to the fact that for new buildings, the basic principles of earthquake resistant design and also the earthquake specifications of the building codes, are often not followed.
- The reason is either **unawareness, convenience or intentional ignorance**
- As a result the, the earthquake risk continues to increase unnecessarily.

Reduction of Seismic Risk:

Seismic risk can be reduced by active programs that improve emergency response, and improve basic infrastructure. The concepts of earthquake preparedness can help plan for emergencies arising from an earthquake. Building codes are intended to help to manage seismic risk and are updated as more is learned about the effects of seismic ground motion on buildings. This type of active improvement of mitigation of damage from earthquakes is known as seismic retrofit. However, the changes generally do not immediately improve seismic risk in a community since existing buildings are rarely required to be upgraded to meet the revisions.

- The preceding remarks clearly illustrate that there is a large deficit in the structural measures for seismic protection in many parts of the world.
- New buildings must be designed to be reasonably earthquake resistant to prevent the constant addition of new vulnerable structures to a

  building stock that is already seriously threatened.

QUESTION # 2 (a):

SOFT STOREY:

- Soft story is a story whose lateral stiffness is less than 70% of the story

  above it or 80% of average of three stories above it.

- A soft storey, also known as a weak story, is defined as a story in a building that has substantially less resistance, or stiffness, than the stories above or below it. In essence, a soft story has inadequate shear resistance or inadequate ductility (energy absorption capacity) to resist the earthquake-induced building stresses.

SOFT STOREY EFFECT:

Soft story effect occurs when any story has substantially less lateral stiffness as compared to stories above it.

- The most prominent of the problems caused by severe stress concentration is that of soft storey. the term has is commonly applied to building whose ground level is less than those above.
- The building code distinguishes between “soft” and “week” stories. Soft storey are less stiff or more flexible then the storey above ;week stories have less strength.

Solution:

How to avoid the soft storey effect:

1: Adding Columns

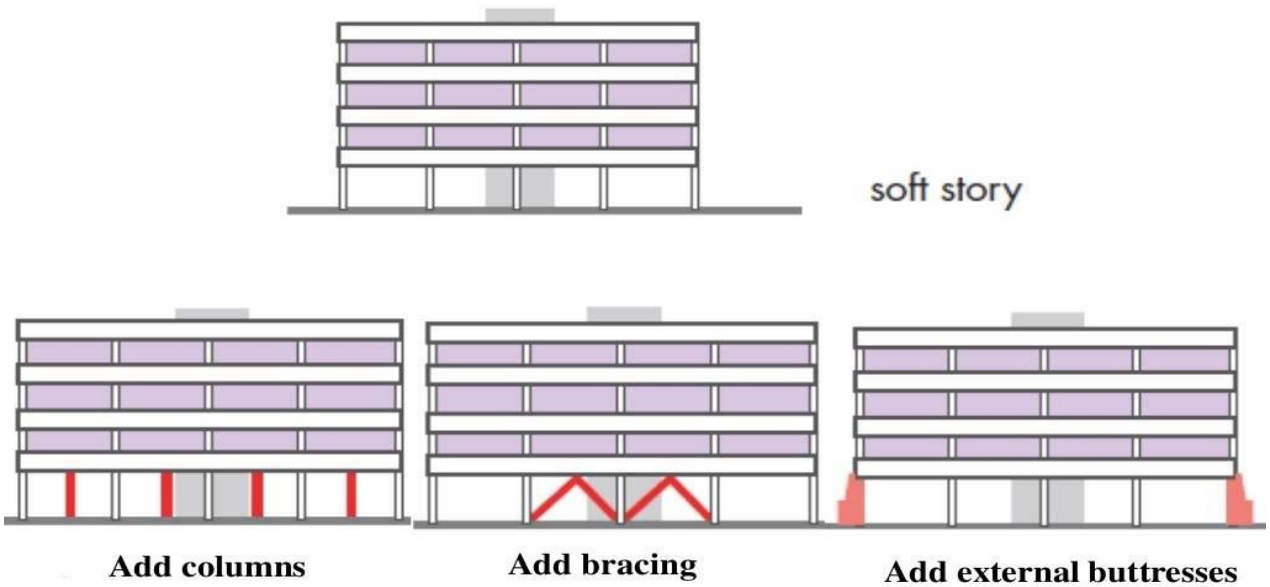
This is the soft storey son we have design a building so we have design a building and we made a mistake and we provide soft storey is here so the soft storey effect and be minimize by using by providing the columns.so here you can see they have provide columns and middle of these columns so it can be decrease the soft storey effect by adding columns.

2: Adding Bracing

You can also reduce the soft storey effect by adding bracing between different columns so here they have brace many of the columns. If you want to reduce the soft storey effect you can provide the bracing between different columns if the first storey of the building is need.

3: Add External Buttresses

You can also minimize the soft storey effect by adding external buttresses so here they have provide a buttresses like a bridge.there we provide am buttresses so here they have also provide the buttresses to the all building to minimized the soft storey effect.



QUESTION #2(b):

MECHANISMS TO DISSIPATE ENERGY
IMPARTED TO A STRUCTURE BY EARTHQUAKE:

The following two mechanism which dissipate energy imparted to a structure by earthquake. They are:

1. Base Isolation
2. Seismic Dampers

1. <u>Base Isolation</u>

Base isolation, also known as seismic base isolation or base isolation system, is one of the most popular means of protecting a structure against earthquake forces. It is a collection of structural elements which should substantially decouple a superstructure from its substructure resting on a shaking ground thus protecting a building or non-building structure's integrity.

Base isolation system consists of isolation units with or without isolation components, where

- Isolation units are the basic elements of a base isolation system which are intended to provide the aforementioned decoupling effect to a building or non-building structure.
- Isolation components are the connections between isolation units and their parts having no decoupling effect of their own.

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TYPES OF BASE ISOLATION

Base isolation is carried out mostly by using:

1. Laminated Rubber Bearing (LRB)
2. Spherical Isolation Sliding Bearing

LAMINATED RUBBER BEARING:

The bearing is very stiff and strong in the vertical direction, but flexible in the horizontal direction.

Laminated rubber bearing (LRB). Lead-Rubber Bearing Lead plug in the middle of bearing experiences the same deformation as the rubber. However, it also generates heat as it does so

SPHERICAL ISOLATION SLIDING BEARING

- Spherical Sliding Isolation Systems are another type of base isolation. The building is supported by bearing pads that have a curved surface and low friction.
- The force needed to move the building upwards limits the horizontal or lateral forces (Transformation of K.E into P.E & vice versa) which would otherwise cause building deformations.
- It should be noted that base isolation is not suitable for tall high rise buildings or buildings located on soft soil.

SEISMIC DAMPERS

- Another method for controlling seismic damage in buildings is the installation of seismic dampers. In this case, the dampening is provided by a lead-based device
- Ground movement forces the lead to pass through a narrow gap. When the direction of movement changes, the flow of lead is reversed. The principle is still the same as the lead rubber bearing, with kinetic energy being converted into heat energy, thereby preventing the building absorbing the kinetic energy.

TYPES OF SEISMIC DAMPERS

There are three types of seismic dampers

1. **VISCOUS DAMPERS**
   Energy is absorbed by silicone-based fluid passing between piston-cylinder arrangements
2. **FRICTION DAMPERS**
   Energy is absorbed by surfaces with friction between them rubbing against each other
3. **YIELDING DAMPERS**
   Energy is absorbed by metallic components that yield

QUESTION 3(a):

EFFECT OF SHEAR WALL ARRANGEMENT ON THE TORSIONAL RESISTANCE OF BUILDING:

- Greatest torsional resistance is obtained by concentrating the longitudinal walls at the comers of the building, as in Fig. **a**. The center of rigidity is at the center of the plan (from symmetry) and the longitudinal walls, being placed as distant as possible from this center, produce the greatest torsional resistance.

- Although the position of the center of rigidity of the symmetrical arrangement in Fig. **b** remains at the center of the plan, the longitudinal walls are not entirely placed at the extremities thus resulting in a reduced torsional resistance

- Because of lack of symmetry about one axis in Fig. **c**, the center of rigidity will move slightly off centroidal axis and lateral forces will have an increased torsional effect due to this offset of the center of rigidity. Also the distances from the center of rigidity of the flanged sections created with longitudinal walls have been reduced, thus reducing the torsional resistance.

- Although the arrangement of walls in Fig. **d** is symmetrical, the longitudinal walls have been moved close to the center of rigidity and the sections produced have a greatly reduced influence on the torsional resistance of the total arrangement.

- A very poor arrangement of longitudinal walls is shown in Fig. **e**. Here they are clustered toward one comer, displacing the center of rigidity a large distance from the center of the plan and greatly increasing the torsional effects of the lateral loads. In addition, the longitudinal walls are at a short distance from the center of rigidity and therefore contribute less to the overall torsional resistance.