Student ID: 13727 **Program:** B.Tech (civil).
Semester: 6TH **Exam:** Mid Term.
Subject: Introduction To Earthquake Engineering.
Instructor: Engr Khurshid Alam.

Question # 01 :

(a) What is meant by seismic waves. Discuss the various types of seismic waves with diagrams. Is primary waves are faster than secondary waves.

Ans: Seismic waves: Waves that transmit the energy released by an earthquake.

Seismic wave is wave of energy that is generated by an earthquake or other earth vibration and that travels within the earth or along its surface.

Earthquake shaking and damage is the result of two basic types of elastic waves. They are:

1. Body Waves. 2. Surface Waves.

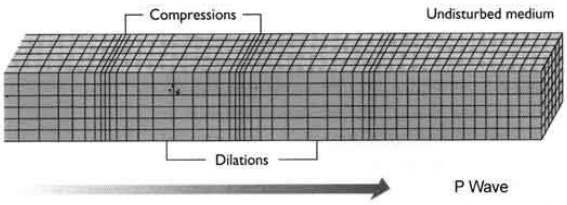
A. BODY WAVES:

Body waves can travel through the earth's inner layers. Body waves are of two types:

1. P-Waves. 2. S-Waves.

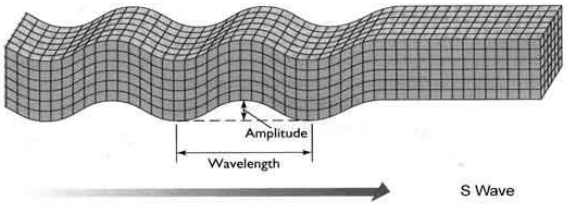
1. P-WAVES:

They propagate within a body of rock. The faster of these body waves is called the primary or P wave.



2. S-WAVES:

The slower wave through the body of rock is called the secondary or S wave. As an S wave propagates, it shears the rock sideways at right angles to the direction of travel.

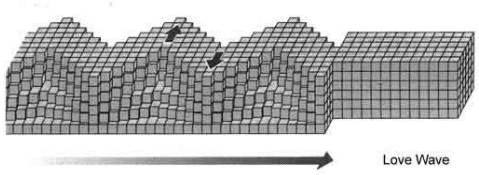


B. SURFACE WAVES:

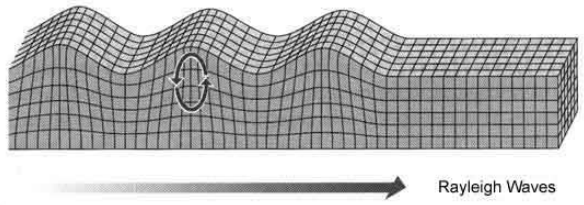
Surface waves can only move along the surface of the planet like ripples on water. Surface waves travel more slowly than body waves (P and S). Surface waves are also of two types.

1. Love Waves. 2. Rayleigh Waves.

1. **LOVE WAVES**
   Its motion is essentially that of S waves that have no vertical displacement; it moves the ground from side to side in a horizontal plane but at right angles to the direction of propagation.



2. **RAYLEIGH WAVES**
   Rayleigh waves are Like rolling ocean waves, Rayleigh waves move both vertically and horizontally in a vertical plane pointed in the direction in which the waves are travelling.



Is primary waves are faster than secondary waves, Yes because the major differences between P waves and S waves include wave speeds, wave types, travel capabilities, and wave sizes. Primary waves travel faster, move in a push-pull pattern, travel through solids, liquids and gases, and cause less damage due to their smaller size. Secondary waves travel slower, move in an up-and-down pattern, travel only through solids, and cause more damage due to their greater size.

(b) Define seismic risk. How seismic risk is increasing day by day? Discuss in detail how seismic risk be minimized.

Ans: Seismic risk : Seismic risk refers to the risk of damage from earthquake to a building, system, or other entity.

Seismic risk increasing day by day: 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.

Seismic risk be minimized by :

- 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 # 02:

(a) Define soft storey effect. Explain how the soft storey effect can be minimized in the following diagram.

Ans: soft storey effect is defined as, In shaking a building, an earthquake ground motion will search for every structural weakness. These weaknesses are usually created by sharp changes in stiffness, strength and/or ductility, and the effects of these weaknesses are accentuated by poor distribution of reactive masses.

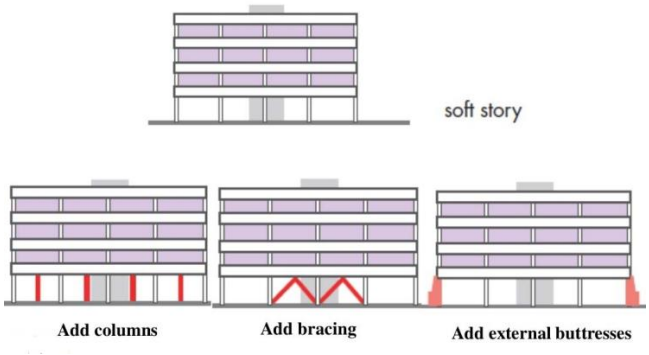
A soft storey is one in which the lateral stiffness is less than 70% of that in the story above or less than 80% of average lateral stiffness of three storey above. The soft storey effect minimized by following methods.

a) Add Column
b) Add bracing
c) Add external buttresses

a) **Addition of Column:** columns are added in soft storey to resist horizontal and gravity forces of above storey.

b) Addition of Cross Bracing: Braced frames are used for trussing to resist sideway forces on structure. Trussing or triangulation, is formed by inserting corner to corner (diagonal) structural members into rectangular zones of a structural frame. It helps to stabilize the frame against sideway forces from earthquakes and strong winds.

c) Addition of External uttresses: Buttresses provided to soft storey to resist above story load acting on a soft storey



(b) What are the various mechanisms adopted to dissipate energy imparted to a structure by earthquakes?

Ans: Mechanisms to dissipate energy imparted to a structure by earthquake:

There are two mechanisms which dissipate energy imparted to a structure by earthquake. They are:

1) Base Isolation.
2) Seismic Dampers.

1) BASE ISOLATION:

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.

Types of base isolation: Base isolation is carried out mostly by using:

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

2) 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

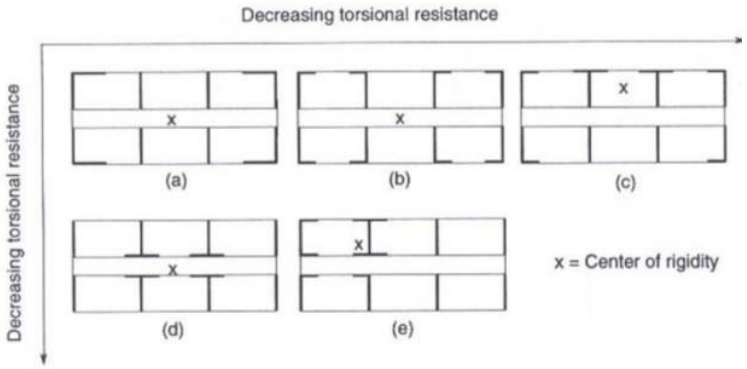
Ground movement forces the lead to pass through a narrow gap. When the direction of movement changes, the flow of lead is reversed. The principle is still the same as the lead rubber bearing, with kinetic energy being converted into heat energy, thereby preventing the building absorbing the kineticenergy.

Seismic damper classified in three part.

1) Viscous Dampers
2) Friction Dampers
3) Yielding Dampers

Question # 03:

In the given diagram discuss in detail what is the effect of shear wall arrangement on the torsional resistance of building.



Ans: effect of shear wall arrangement on the torsional resistance of building

- **For Fig.a :** 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.

- **For Fig.b :** 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.

- **For Fig.c :** 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.

- **For Fig.d :** 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.

- **For Fig.e :** 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.

THE END