IQRA NATIONAL UNIVERSITY PESHAWER

paper:

INTRODUCTION TO EARTHQUAKE ENGINEERING

B-tech(civil)

6th semester

From: Asadullah

ID#14024

Submitted to: Engr. Khurshid Alam

Q.NO: (01)

Part (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

Seismic waves are the waves of energy are that generated by an earthquake or other earth vibration and that travels with in the earth or along its surface caused. 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:

1. **Body waves**
2. **Surface waves**.

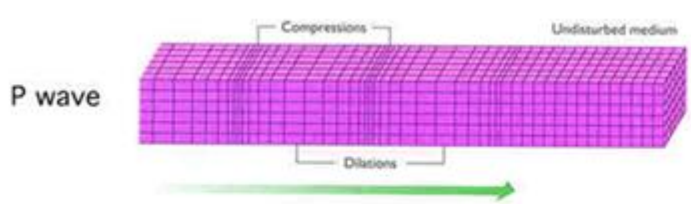
1. **BODY WAVES**

Body waves can travel through the earth's inner layers, but surface waves can only move along the surface of the planet like ripples on water. Earthquakes radiate seismic energy as both body and surface waves.

1. P waves
2. S waves

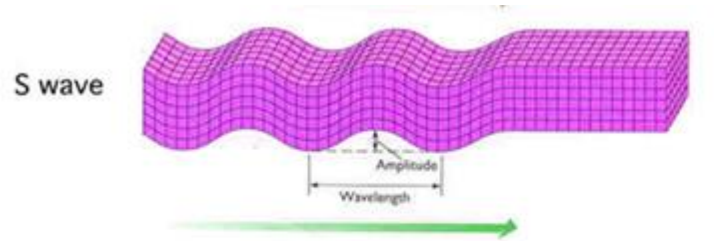
1. **P WAVES**

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. Its motion is the same as that of a sound wave in that, as it spreads out, it alternately pushes (compresses) and pulls (dilates) the rock. These P waves are able to travel through both solid rock, such as granite mountains, and liquid material, such as volcanic magma or the water of the oceans.



2. **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).



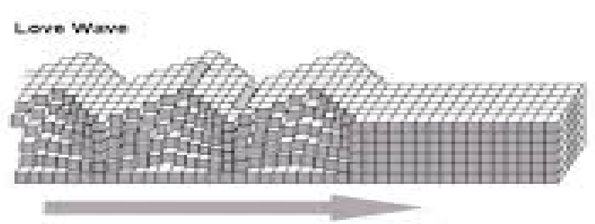
2. **SURFACE WAVES**

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 earthquakes. There are two types of surface waves.

1. **Love waves**
2. **Rayleigh waves**
3.

1. **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 motion.



2. **RAYLEIGH WAVES**

The other kind of surface wave is the **Rayleigh wave**, named for John William Strutt, Lord Rayleigh, who mathematically predicted the existence of this kind of wave in 1885. 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.

Part (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 directly depends upon Seismic Hazard, Seismic Vulnerability, and Exposure of elements at risk. For the purpose of simplicity, we will discuss only first two parameters Seismic hazard and Seismic vulnerability.

Seismic hazard

Seismic hazard depend on the geology of site and, therefore, cannot be controlled. A seismic hazard is the probability of ground shaking due to earthquakes and other effects including griund rupture landslides tsunamis and soil liquefaction. Seismic rick is likelihood that humans might sustain injuries and fatalities plus economic losses due to the hazard

Seismic vulnerability

Seismic vulnerability belongs to structures and can, therefore be reduced by appropriate design and construction

Increasing of seismic rise

The current building stock is constantly enlarged by the addition of new buildings, many with significant, or even excessive, earthquake vulnerability. This is 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 unawareness, convenience or intentional ignorance As a result; the earthquake risk continues to increase unnecessarily.

Urgent Actions Needed

“Seismic risk can be minimized by reducing seismic vulnerability of structure’’

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.

Q.NO: (02)

Part (a)

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

Ans:

Soft storey effect:

A soft storey is defined as a storey in a building that has comparatively less resistance or stiffness than the stories above or below it.

A soft storey has inadequate shear resistance or inadequate ductility (energy absorption capacity) to resist earthquake induced building stresses. Usually the location of soft storey is at ground floor of building. Soft storey buildings are characterized by having a storey which has a lot of open space.

Preventing soft storey effect

In constructions where it is necessary to build a soft storey, lateral rigidity of this particular storey should be brought to the rigidity level of the other storeys. To be able to do this, the number of columns and shear walls should be increased. Because of this increase, longitudinal and lateral reinforcement should also be increased. These raise the cost of the construction. Soft storey is an irregularity which affects the behavior of a construction during a quake and also increases the construction costs. For this reason, soft storeys should be avoided as much as possible. In case it is necessary, by the controls to be performed as a result of calculation made, irregularities can be eliminated as follows:

1. Building additional walls
2. Increasing the rigidity of the columns and the shear walls on the soft storey
3. Regulating the dimensions of the columns and shear walls by longitudinal and lateral reinforcement so that the soft floor would show a ductile behavior.
4. Preventing cracking by placing the wall at a certain distance from columns and walls that are on the soft storey

Now that we cannot leave the already present buildings, we should turn them into resisting ones according to the new Code of Earthquake. Since the codes and regulations are changed as a result of technological advances and examination of the quake results, those constructions which are considered resistant according to the previous regulations can be weakness according to the new regulations. To be able to do this, present irregularities should be eliminated. Upon investigation in the quake region, it was observed that constructions built in accordance with the previous Code of Earthquake (1975) underwent greater damage, and those built in accordance with the new Code (1998) underwent less damage, and some did not even undergo any damage. to bring the present buildings into resistant state of being, proper one of the following method is applied:

1. **1.** Increasing the lateral rigidity of this storey by putting up additional walls between single structural elements on the soft storey
2. **2.** Increasing the lateral rigidity of this storey by placing steel diagonals between the columns and shear walls
3. **3.** Putting flexible material between columns and walls on the storey atop the soft storey thus preventing it to work together with the soft storey
4. **4.** Increasing the rigidity of the soft storey by reinforcing the columns of the soft storey.

____

____

Part (b)

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

Ans:

There are two mechanisms which dissipate energy imparted to a structure by an 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 supers structure from its sub structure resting on a shaking ground thus protecting a building or non-building structure's integrity. Base isolation system consists of isolation nits with or without isolation components, where

- Isolation units are the basic elements of abase 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.

Principle of base isolation

The main principal of base isolation is to try and isolate the structure from the ground movement so you could just about put it on ball bearing s if you like and the ground could move underneath it and the building stays still.

Types of base isolation

Base isolation is carried out mostly by using:

i. Laminated rubber bearing (LRB)
ii. Spherical Sliding Isolation Systems

i. Laminated rubber bearing (LRB)

Lead-rubber bearings (LRB) are among the frequently-used types of base isolation bearings. An LRB is made from layers of rubber sandwiched together with layers of steel. In the middle of the bearing is a solid lead "plug." On top and bottom, the bearing is fitted with steel plates which are used to attach the bearing to the building and foundation. The bearing is very stiff and strong in the vertical direction, but flexible in the horizontal direction.

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. In other words, the lead plug reduces, or dissipates, the energy of motion i.e., kinetic energy by converting that energy into heat.

ii. Spherical Sliding Isolation Systems

Lead-rubber bearings are just one of a number of different types of base isolation bearings which have now been developed. 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. Base isolation is most effective for short to medium rise buildings located on hard soil.

2. Seismic dampers

Another method for controlling seismic damage in building s 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 an arrow 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
  2. Friction Dampers
  3. Yielding 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

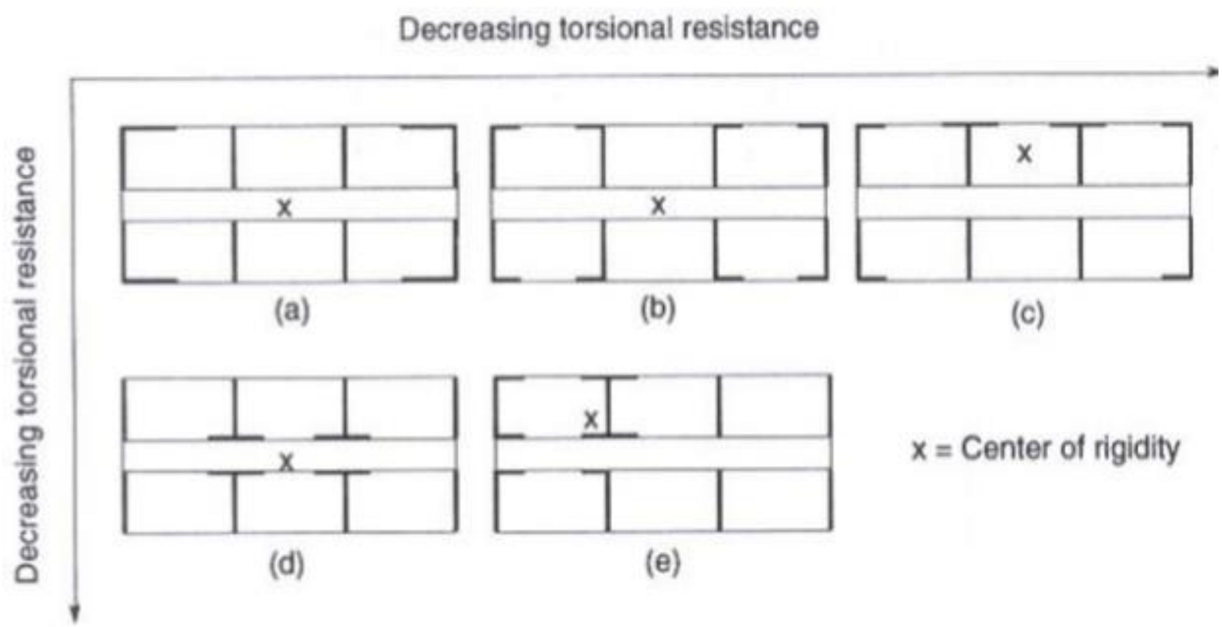
Q.NO: (03)

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 walls arrangement on the torsional resistance of buildings

Effect of shear walls arrangement on the torsional resistance of buildings Effect of shear walls arrangement on torsional resistance (the same total length of longitudinal wall is distributed in a different way for each layout).



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 centre 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 torsion a 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.