**Earthquake Resistant Architecture**

**Lecture 2**

**Historical Experience**

Moving on in this particular lecture you will be seeing the historical experiences regarding the earthquake what are the various earthquakes happen before what are those actually see the historical experiences regarding the earthquake what are the various earthquakes happen before what are those earthquake that actually created in impact so much impact the society that we actually need to learn about them I need to understand certain things from them based on which we need to create structures because of which those that happen will not happen again.

We will understand about the site selection and development of the site how a particular site is understood if this particular site can with stand earthquake will the site itself be the reason why even if the building is earthquake resistant it might come down because of the side itself so if the site can actually with stand it and what are the various factors that we should keep in mind while developing a particular site why I am create something that is earthquake resistant then what are the effects of the earthquake on the ground what happens when earthquake strikes what are those effect that actually an becomes a Repercussion an earthquake on become an aftermath of an earthquake will understand various factors like soil rupture. What is the structure and how is that happening what is liquefaction and what is the how is that happening and majorly what are landslides and how an earthquake in cause landslide which will in turn causes a major damage to the area and people and the life and money and everything.

Historical Experience, site selection and development so the choice of the site of a particular building from this is Seismic point of view is mainly concerned with the stability of the ground so only when the ground stable will the building this Stable even though if we will do we feel that the building is seismically design there is no attribute is we have in actually taken care of while designing a building if you miss the site then how much of a good the building is how much strong the building is it won't we stand and earthquake because soil of the ground is a major major part of an earthquake resistant architecture and that particular understanding is very very important in doing this particular design.

Why it is important for us to understand what are the past earthquake that happened because of past earthquakes shows the site condition and how the site condition significantly would affect the damage of the earthquake the quit study is the most in variable shown in the intensity of a is directly into the type of soil layers supporting the building so basically from the previous things we understood that everything that you are the major major calamities occurred because of the soil level and intensity with which Earthquake affects a particular area structures built on solid Rock and form soil frequencies better than the one that build on shop ground what we call week soil.

This is dramatically demonstrated in the 1985 Mexico city earthquake with the damage on the soft soil in the Mexico City and epicenter distance of 400 km is substantially higher than that close location. This particular earthquake in 1985 shows how places where the soil was formed was less affected even though it is closer to the epicenter but the places where the soil was soft even though it is way farther than the epicenter affected a lot and so cause so much damage and lots of lives were lost in this particular earthquake.

Talk about the most Mexico earthquake in 1985 so from the studies of the July 28 1957 earthquake in Mexico. it was already known as an examples that the Damage of the soft soil in the centre of the city would be 5 to 50 times higher than the firmer soil in the surrounding area as you can see this picture you can see.

Each and Every building gave up have and one building have been up fall on top of another building that is the major reason how the life is lost in an earthquake because things fall on you and you the under the debris people in our kind of get stuck so when building fall on another building and that create a kind of debris and that is the major major cause of the damage of because of an earthquake.

Moving on another example that occurred in 1976 is it Tangshan, China earthquake in which 50% of the buildings on the thick soil sites where razed to the ground while 12% of the building on the rock subsoil near the mountain areas totally collapsed. This particular earthquake actually gave the land slid also brad down lot of lives during this earthquake.

Rigid masonry building felled resting masonry building that rested on a rock and a on the contrary show more Sevier damage than the one is when build on the soil near the earthquake as in Koyna in the earthquake in 1967 and North Yemen Quicken 1980 this particular factors were very well understood so the lesson learnt from the reason of earthquake that happen shows in the topography of a building and also have a direct impact of the damage. end of this particular lecture will understand what is Lance landslide in how that is affecting the earthquake and why there is happening because of the earthquake so when the building site is on the topography and it is not a plane what happen , there actually kind of things fall on them and actually the soil and then kind of give up and they fall further so this kind of topography is actually wale of higher so when the buildings built on Open of plain surface so they usually less than damage and such building try at least thriving the earthquake living through it back compared to the ones one is other on the steeper topography.

Talking about site selection as I said the choice of a site for a building from the seismic point of mainly concerned with the stability of the ground how stable is the ground is what actually should be kept in mind while designing a building for the seismic point of view. so in order to design a particular building in a place where which is basically from like me whip and you should actually keep in mind that you know those buildings are actually made on firm ground then weaker ground where the soil is actually firm in composed rather then week.

To have several blocks on terraces that has one large block with footing those very different elevations one criterion. A site subject to the danger of Rock falls on them as I said that is what basically happens when the topography is longer because the rocks kind of give up and fall on this building event so that can actually nothing but debris.

So that can be a another reason why this is happening so this particular location of a building where you know the rocks might fall on them should be avoided so very loose sand or sensitive clays are liable to be destroyed by the earthquake or maybe liquid is also possible for such kind of clays as much as that original structure and thereby and the kind of compaction image of the buildings of this also should be avoided. so therefore the conclusion is that side is sufficient bearing capacity and the free from the above defects that which I just mansion should be chosen and Drainage condition improves so that no water accumulation the ground level the easily become soil becomes soft and they actually give a while and earthquake happen.

**Effects on Ground**

What are the earthquakes effects on the ground when earthquake strikes basically a building collapse, a ground give up and maybe fire can happen 3 major things that actually happened because of on earthquake.

Right now we discussed on the buildings in how a building actually goes through an earthquake what are the things that we have to be avoid while creating a building selecting a site for a building. Now will understand effects of the earthquake on the ground. And how that will affect in the point of seismic point of view in that particular area.

Major Earthquake Effects on Ground that can be ground shaking, fire they can be land slide, they can be ground displacement they can be liquefaction they can be ruptured I can be Tsunami they can be aftershock. Aftershocks we learnt in the previous lecture and now will be seeing a some major effects of these and how that can be tackle.

Ground Shaking the principal cause of the earthquake induced damage is nothing but the ground shaking, so what happens the earth vibrates all the buildings in the ground surface response to the particular vibration in varying degrees. So as it becomes taller vibration response will be more as when is a short it means I was standing, Earthquake acceleration velocity is displacement can cause or destroy building unless it is been design and construction or strengthened to be earthquake resistance. The reason why we design a building to be earthquake resistance is much is earthquake resistance at least seismically designed to be earthquake resistance it might actually give a fight and try this standing that for how much ever disasters earthquake would be if nothing is not seismically designed then what happened while the ground displacement then ground shaking happen a building on its kind of reacts to the shacking, Vibrate which actually would maybe give up the structure and may under following therefore the effect of ground shake is the principle area of consideration for design of the earthquake resistant building. You can see that normal building and shot building before earthquake both of them are study both of them are sitting on the ground and once

earthquakes try their with this is how each building would react so what happens when as a builder is taller as I said displacement due to the ground shaking becomes more than the one that is the proportion short the same on the other side so the next is Ground Failure.

Earthquake induce Ground Failure has been observed in the form of Ground rupture, fall zone, landslide, settlement and soil liquored fraction. Ground rupture along a fault zone maybe very limited or me extend 100 kilometer depending , Ground displacement along the fault may be horizontal vertical or both in centimeter or even meters so such area of the ground rupture might should be avoided while creating of buildings of that is the reason why we are actually learning this biggest building is directly affect on building is directly proportional to the effect on the ground so why landslide can destroy building the settlement only damage the building. Soil liquefaction can occur in low density saturated sands of relatively uniform size. The phenomenon of liquefaction is particularly important for dams, bridges in underground pipelines and building standing on such ground. so what are tsunamis a Tsunami is as you know that India had faced Tsunami recently and around a lot of damage a lot of property was lost money was lost everything is lost so many people around the sea so the major cause of Tsunami is nothing but earthquake. Tsunami is nothing but seismic sea waves are generally produced by a sudden movement of the ocean floor.

As the water waves approach land their velocity decreases and their height increases from 5 to 8 m, or even more. even more so that won't happen so obviously Tsunami is can be the devastating for the building build The coastal area, so when the earthquake happens under the sea the velocity of the water decreases height of wave kind of increases and they fall on the land and devastate Around The coastal area. Another major effect that an earthquake in causes a fire so when the fire following an earthquake happens it is very it's not very common it becomes very difficult to extinguish a strong earthquake want to exchange a strong earthquake is accompanied by the loss of water supply and traffic jam and such things happen because of that the fire is very difficult to control because so many other things kind of happen stopping of fire kind almost not possible therefore the earthquake damage increases with the earth induce fire in addition to the damage of the buildings which directly happens due to the earthquake so what happened in such cases is that they will be earthquake related ground failure earthquake related building failure there earthquake related fire so all these three together becomes like the most fatal effect in earthquake in actually cause , so in the case of the 1923 Kanto Earthquake 50 % of Tokyo and 70% of the total number of houses were burnt and more than 100,000 people were killed by the fire.

**Soil Liquefaction**

Another Major factor that we would be learning in this particular letter is nothing but soil liquefaction so what is soil liquefaction why does that fraction why does that occurs.

Soil liquefaction occurs when, because of the shaking water saturated granular material (such as sand) temporality loses its strength and transforms from soil to liquid. So while the

earthquake happens because of the shacking and there would be a water saturated granular solid area and this particular solid areas likes sand would slowly converter into liquid and that has a make it soft and that kind of gives up and the buildings on it fall buildings of bridges shrink into the liquid soil which is the most likely chances of an occurrence of a if soil liquid fraction happened for example the Alaska earthquake solid liquefaction cost many building and eventually building many building to sink into the soil and eventually these buildings called her up of each other and so many lives and properties were lost so that is why we should actually avoid soil is where the liquefaction possibilities is more. Such to be avoided while creating a building.

Another major and the four most important factors the Landslides. when earthquake in India even when recently an earthquake in India there is caused landslide then that is the major reason why so many lives were lost so what are landslides how are happening only because of earthquake no .Earthquake is not the only reason why the landslide can happen by the major landslides usually happens because of the earthquake then the other reason is so nothing has nothing but while earthquake happens will be tension cracks on top of the particular a land and airwaves the ground and kind of give up and their roll down to the bottom of the particular valley and they create a kind of a table which actually will fall in oil will have buildings and Anita then all these things will fall on the buildings are the settlement below the land area endings order settlement below the line or land area of the area with the IEEE topography and the double kind of fall on top of it incredibly Paisa considered an excellent meaning damaged by human activity of the environment landslide a defined as the downward or out with the flow forming materials including Rock soil artificial fill a combination of all the action me second of motion by many factors it is earthquake flooding volcanic activities and human .

Manipulation of earth surface right now will be concentrating on earthquake in how earthquake would cause Allianz life the manner in which matter is a moving forward during in a landslide is dependent on the composition of the landmark in that particular area the amount of water in that particular area and the cause of the initial energy the passes the particular area.

Landslides are a risk factor Around the World major criteria for a landslide is a slope or a cliff and was defined as discussed about slides may be put in the motion by a few different triggers. Damage from landslides cost the United States before approximately 3.5 billion dollars for year and this landslides also cause dozens of death as in US for per year so following the mass of earthquakes in China in May 12 2008 landslides, Persisted across the area and that created a second blow of destruction to the people structures and the environment involved so we should basically consider the on how is earthquake how we should choose the site which has less prone to the landslide if the particular area is landslide if the particular area is a zone is sold in the major earthquake prone areas in the country of the world . so you can see in this picture how the landslide actually created ruptures and the buildings kind of grave up and debris created at bottom.

This particular image shows the satellite images of the devastation caused by the may 12 2008 earthquake in China Sichuan and that resulted in the landslides if you can see this is how it was it and after the earthquake. So where do landslide occur, landslide of a disaffect as I said around the world and the main criteria for a landslide in the slope and Cliff and that is where the earthquake landslide occur.