Earthquake Resistant Architecture

Lecture 1

Earthquake

First and foremost if you can see in the slide you can see maximum destruction of an earthquake happens because of a building and the buildings it falls the defray of the building falls in the people they might be sleeping inside, they might people on road on home this falling so if u see the maximum death toll comes in an earthquake happens of a defray of building that actually breaks and falls on a human being or on people or animals whatever its is and that is the reason why the maximum death tolls comes in an earthquake.

Any disaster seeds is very important to understand how a building actually affects how a building reaction Re disaster .what can happen because of a particular disaster to a buildings very important to understand this particular concept in order to understand why we particularly trying to understand how to deal with earthquake when it comes , So what is an earthquake it is a sudden violent shaking of the ground which is typically cause great destruction as a result of movement within the earth crust or may be volcanic actions and an Earthquake can have multiple reasons the major reason for it is a movement within the earth crust the major of the major earthquake happens because of the major of movement of the Deck Tony place is the reason why the earthquake happens and its of violence Taking Off The Ground which actually whatever is above the ground everything is destructed because of the particular phenomenal of the earthquake. So rupturing rocks release huge amount of energy and the sudden release of energy is what is felt in an earthquake. So what happen this particular energy is so much whatever is the above is not able to withstand the amount of energy that comes out of the earthquake and that is why everything about dropped the earthquake energy is in the form of seismic waves which the definition of which will be seeing in the other part of this particular lecture.

The seismic wave what happen it radiates from a central point that particular point called focus or the hypo center, So this are like the ripples moving out word from a pebble which stores into a lake so when you cross a table on the lake you can see certain ripples that form on this particular where were the Pebble touches the lake has exactly how the earthquake action happen so there will be a focus or hypo center epicenter whatever we'll call it and then there will be around it and that is called a basic idea of how an earthquake happens , so the location Which is directly about the Hippo sandal on the earth surface is called the epicenter every time you listen about an earthquake of your that earthquake happened before the form of thing that happens when you listen to In anything let be anything you will be here about the epicenter of

the earthquake epicenter is nothing but the location directly about the hippos and the focus that lies on the surface of the earth that is called the epicenter of the particular earthquake.

Next thing that you will seeing is the Earth structure in order to understand how an earthquake happens what is the phenomenon behind the earthquake it's very important to understand what the earth consists of what is the structure of the earth so as you might have in your school time you know the earth actually consist of different layer or different part so basically if you see in this picture the earth consists of crust that is thinner outer layer then the mantle the outer Core and inner core is are the major part of the of the inner core is basically solid and the other is the liquid things with the more density actually floors in and moves and comes in the lowermost level as what you know and Signs exact same phenomena happens you are more than the most dense part with density is the inner core and then there is a outer core liquid outside the mantle and then there is a thinner part called crust .

The Crust and Mantle there is a layer called there is a part which actually the upper Mantle and the class together they called in lithosphere and then there is something all the Asthenosphere of a which is the other next part of the Mantle moving on CSS are the interior structure of the Earth is spherical shell like an onion if you see this layers can be defined by the chemical and biological properties. The Earth has an out of a liquid solid crust a highly wishes Mantle a liquid outer core and much wishes then the Mantle lest and solid in inner core so what is the crust so basically first will understand what's is the crust. The crust ranges from 5 to 70 inches depth and is the outermost layer the thin parts of the oceanic crust which underline the ocean basins and the thicker crust is continental crust, which is less density then the other parts so the uppermost mantle together in the crust constitution lithosphere which I mention the previous diagram that you saw so basically oceanic crust is thinner crust and the continental crust is thicker crust what is the mantle that is the next part.

Earth mantle up to 2890 km making the thickest layer of the earth so that is the mantle is divided into upper Mantle and the lower Mantle the upper and lower mantle separated by a something a kind of a transition zone so the mantle composed of nothing but silicate rocks which in iron and magnesium let it to the overlying crust so connection of the Mantle expressed of the surface of the motion of tectonic plates basically the motion of the tectonic plates is directly related to the Mantle is actually nothing but the Convection of the mantle that is what learn as the motion of the tectonic plates so what is the core , the core is a third part and core is divided into the upper core outer core and inner core so the dense material as I said exist within the earth's core seismic measurement so that the course divided into parts solid inner core and the liquid outer cores the inner core was discovered in 1936 by Lehmann and is generally believed to be composed primary of iron and nickel so it no necessarily a solid, but because it is able to deflect some seismic waves . it has some solid fraction in its behavior in

early stages of formation what happen about 4 and half million years ago melting would have caused the dental substances to sink towards the middle why less than the material would have migrated to the crust that is what would have formed is crust Mantle core distinction in the Earth formation that's what is understand the next.

Seismic Waves is the focus of the hippo center and directly above the focus on the top is epicenter so epicenter does nothing but the part on the surface is directly about the focus so these are the ripples of the way from server spoke about in the previous part of the lecture and right now you will be seeing what is the fault what is fault scarp everything will be seeing this coming part of the lecture to talk about seismic waves.

Seismic waves of energy that travel through the earth's layers and a result of earthquakes volcanic eruptions magma movement last landslide and large man made explosions at low frequency acoustic energy , so seismic wave as I said can have multiple causes of multiple things that might cause this is seismic wave so earthquake can one of those causes which is the major was actually volcanic eruption can get the causes and Magma moment or even some manmade extrusions of high intensity can be the reason of the seismic wave so what are the types of seismic waves, Four type of seismic wave is generated when faulting triggers and all the seismic wave generated at the same time but travel at different speeds at different ways to that are different ways where with way in which the seismic waves traveling waves can cause lesser Trouble for the seismic wave that can cause major problems that will be seeing now body wave template the earth travels through it while surface waves travel along with surface of the ground so now you understand there are two basic types of seismic wave the body wave and service way what happen the body was penetrate the earth and travels through the earth and the seismic wave does nothing but travel along the surface of ground. Among the many types of seismic waves one can make a broad distinction between body wave and surface waves the body waves travel to the interior of the earth surface wave travel across a surface service wave they came most slowly with the distance than the body waves so the body travel within three dimensions so particle motion of surface waves is larger than that of the body wave service wave tense to cause more damage than the body waves among these two types of waves the surface wave causes more damage than the body wave because it actually has more particle motion than that of the body waves so the body wave can be differentiated into primary waves and secondary ways primary waves of P-waves as we call it a travel the fastest and can move throw the solids as well as the liquid and the P wave energy courses the ground to move in a compression motion in the same direction that the Wave is traveling if you can see in this picture you can see how the p-wave travel so it is medium this is how the p-wave of the compression the wave that causes compression travels and the secondary wave is nothing but as we call the S-wave slow and travels through only through solids they don't travel throw liquids so S-wave comes to the ground to move in a sharing motion which is

perpendicular to the direction of the movement it moves in a shearing motion and that particular movement is perpendicular to the direction of the wave movement so you see in this

picture this is how do I S-wave move and in its motion if you can see the surface wave is against split into Rayleigh and love waves and these are the most destructive kind of waves seismic waves so Rayleigh causes a complex heaving a rolling motion while love wave energy causes is sideways movement so the combination of Rayleigh and love waves result in the ground sawing of building. And surface wave cause the most devastating them is in the building bridges and Highways as I said if you can see in this picture the picture shows love wave moves and this is shows how Rayleigh wave moves, Rayleigh waves moves in kind of a rolling motion love wave moves in a the sideways movement and what happened to this particular waves actually creates a lot of destruction on the surface of the earth and that is the reason why we consider the surface waves the most devastating kind of a waste is made waves and that will cause high destruction and high intensity of destruction in the building even bridges ,highways whatever is man made on earth.

Tectonic Plates

Here you can see the major tectonic plate on the earth crust , the earth crust mainly has 7 major tectonic plates and those are the Pacific plate the North American plate , European plate the African plate the Antarctic plate the Indo- Australian plate it can also be splitting the in the Indian plate and the Australian plate but together we call the Indo Australian plate and the South American plate these are the major tectonic plates on the earth before you understand how are tectonic plates fix the earthquake directly you should understand what is a plate tectonics theory.

Plate tectonics theory is the theory that the outer rigid layer of the earth is divided into couple of doesn't tectonic plates that move around across the Earth surface related to each other like this laps of eyes or a lake so what happens as I said the crust is nothing but a very thin outer layer that is not a solid layer so the major out or rigid layer of the Earth is the lithosphere that is the outer if you can see in the major the previous picture I show you it is nothing but the crust and the outer together to forms a lithosphere and this is a particular layer than has a particular tectonic plates that create the movement and with the you know that actually intern affect the earthquake directly so as I said lithosphere divided into couple of tectonic plates it moves around across the earth surface related to each other . So the earth lithosphere composed of 7 major tectonic plates so I said 7 ,8 and Indian and Australian plates divided it if it’s not eight plates and there are many minor place along with it which is also work in the same way so where plates the place with the place need the relative motion determined a kind of boundary and that can be convergent It can be divergent or It can be a transformer earthquakes volcanic activities mountain building and oceanic transformation all this occurs along the plate

boundary so the location where two plates meet is called plate boundary and the plates boundary is commonly associated with a geological events such as earthquake and the creation of the topographic features that is mountain as I said before . Now and after understanding tectonic place you can now we should understand what the continental drift is and what causes the continent drift why understands continent drift is important.

Continent drift is the movement of the earth continents relative to each other thus appearing to drift across the ocean bed if you believe that the continents previously where all 1 to 1 mass of the earth and will be later based on this is seismic ways of tectonic activities of the tectonic plates shifts if the continent actually split and removed separately and major and minor tectonic plates were form the amazing process of the plate tectonics

which we use land masses moves slowly across the earth crust is still continuing in that is nothing but what we call the continental drift so that they can move around on the earth surface and everyone join together as one single super continent this is how you can say you have the Mantle and then you have that crust, then you can see there will be a kind of movement along where the plates meets and they moves in different directions towards different parts and that actually in turn causes the earthquake coming to the seismic zones in India and concentrating on what is happening in our country India like the North Western and the Indo Australian plate like I said which encompasses India Australia and a major part of the Indian Ocean and other smaller countries, so this plates is colliding against the huge Eurasian plate this is been happening to the Indian subcontinent has a history of devastating earthquake like as you know before the geographical statistics of India so that 54% of the land of vulnerable to earthquake that like a huge session of land if you compare to the Indian map so the earthquake zoning map of India device itself basically in to 4 seismic zone 2 3 4 5 ,zone 1 is not there what happening there according to the present zoning map zone 5 expect the highest level of a seismic activity where zone 2 expect the lowest layer of seismicity.

So the center for seismology by the Ministry of earth sciences the nodal agency of the Government of India dealing with the various activities in the field of seismology and allied disciplines who identifies which is the most prone zone which is the least phones on the earthquake in India ,if you can see this is the map of India where in it is which is been split based on the probability of the earthquake that can happen the parts in blue is the zone with least probability of the earthquake that is the zone 2 in India. And the part that see in red are the most you know a major part that is affected by the highest level of seismicity and from the possibility of the earthquake is more here, if you can say majority of the part in the North Eastern region of the Earth of Indian subcontinent that is the seven sister States all of them are very prone to the earthquake and if you can see many parts of Tamilnadu and the light areas are much less prone to earthquake whatever you see yellow there are zone three Areas where

earthquake might is I'm almost towards not happening of lesser seismically affected area and the one in oranges is the zone four which is almost close to the area with the maximum more probability of an earthquake happening in the future so understanding the predictability intensity and measurement of earthquake is very important .

Predictability, Intensity and Measurement

An earthquake is the perceptible taking off the surface of the earth resulting from the sudden release of energy in the earth crust that creates seismic waves like I said before earthquake can be while enough to Toss people around and destroy the whole of the city a complete City can be destroyed with earthquake or maybe it can be Either so that nothing actually happens if you just come and go there are two extreme happen the seismicity or seismic activity of an area refers to the frequency the type and size of the earthquake experience over a period of time the earthquake measured using observation from the seismometers and the Richter scale is mathematical device to compare the size of earthquake. In the Magnitude of an earthquake is determine from the logarithm of the amplitude of the Waves recorded by the seismograph so the tectonic earthquake occurs anywhere in the earth where there is sufficient stored elastic Strain energy to drive fracture propagation along the fault plane so now you should know what are false so earthquake occur on false when the fault occur that is way the earthquake occur a fall is a thin zone of earth crust Rock separating blocks of the earth crust so when an earthquake occurs on one of these walls The Rocks on one side of the falls splits with respect to each other that what happen.

Faults can be centimeter to thousands of kilometer long depending and the fault office can be vertical horizontal at some angle of a surface of the earth so faults can extend deep into the earth may or may not extend earth surface so once the faults has locked. you continue relative motion between the plates leads to the increase stress and therefore store energy Strain energy in the volume around the falls office so this continuous until the stress has risen sufficiently to break throw the asperity and suddenly allowing a sliding over the lock portion of the fault and that particular form in a phenomenon releases a stored energy and that in turn causes the earthquake. so the energy is released as a combination of the radiated elastic strain of seismic waves frictional heating of the falls office and the cracking of the rock like I said before thus crossing the earthquake the process of the gradual build up of strain and stress function by the occasion sudden earthquake failure is referred to as elastic rebound theory.

So there are major types of faults ,there are three main types of fault all of which may cause the interplay to earthquake there a normal fault the reverse of the trust fault and Strike slip fault .these are the three major fault and you can see in this picture this is the three kinds of for the Strike slip fault the normal fault other crust fault so where the craft is being pulled apart then the normal fault occurs in which the overlying the block moves down with respect to the

lower block nothing but when the crust actually is being pulled apart by nothing but just be normal fault happen only one portion of the moves down to the respect other portion of the earth is called hanging wall.

Then the next type of Faulting is When The crust is being compressed so that is reverse faulting cause or so what happens the Hanging wall blocks moves up over the footwall block so that is almost like a reverse lift so again be inclined plane is occurring that is called crust faulting. The curst block also moves in sideways passed each that we call the Strike slip so it is usually only vertical for that is when this happens that's right leg movement is described as a sinisterly where the fast side movement to the left and dextral where fast side moves to the right so it's nothing happens but it's lift to the other side so basically normal in the normal one part goes down in the trust one another person goes up and the striking goes to the left to the right based on the fall, so what are Fore socks. The Fore Shock of an earthquake that occurs before the main shock and is related to it in both time and space so the is the means seismic wave event that happens in this particular area.

Fore Shock is of related to both time as well as space if you see fore shock from a matter of males today even longer before the main shock for example if you see in the 2002 Sumatra earthquake that is regarded as foreshock 2004 Indian ocean earthquake with the delay of more than 2 years between the two events so what happens when a foreshock actually becomes a major if there is main shock happens and there is another earthquake happen aftershock happens which is more intensity then the after shop becomes a main shock and the main shock becomes the because the major earthquake in a particular area earthquake the maximum destruction of the maximum intensity is considered as the main shock of an earthquake that happened before in the around area with the light of intensity compared to the major shock is considered as the foreshock of the particular earthquake . Sometime we actually thinking followed main shock is followed by large earthquake so that the original earthquake is considered as a foreshock. These foreshock is officially recognized as a short term predictions of an earth quick and these are the only none prediction for an earthquake so if you see aftershocks the part of living with the aftershocks so earthquake, As I said there is foreshock there is main shock there is aftershocks.

Showing any earthquake last the largest man opens after a code after the previous large earthquake in same area as if you can see in this or graphic inside the me when the main store because there are multiple aftershock that my locker the behavior of a time goes by the amount of the intensity of the aftershock you coming down moving out the magnitude and intensity of earthquake the occurs and that cause the destructive a scale of the earthquake is considered as a magnet is the magnitude is nothing but the quantitative measure of the size of the earthquake of and source and the intensity is nothing but when an earthquake occurs

magnitude can be given a single numerical value on the richer scale however the intensity is variable over the area where is towards the epicenter the intensity will be more and as the area for the intensity will be less. So if we can see this is what something that will show the intensity of the earthquake at 5 maximum intensity at 2 they'll be minimum intensity so it’s like a intensity is relative where is magnitude is not that is the major difference .