Earthquake Resistant Architecture

Lecture 4

Roof on Two Walls

Now we will be saying what will happen if there two walls is not enclose its just two walls and the roof

The this picture shows a devastating earthquake that happened a few years back and how everything fell on each other right now in this picture you can see two walls that is not attached to each other they are standing on the opposite like sitting on the opposite side and the so they are both B's there are no a wall and then on top of that there is the roof.

In the figure a roof slab is shown to be resting on two parallel B walls and the earthquake forces acting on the plane of the walls this is the earthquake happening on the plane also walls the earthquake force that's happening on the plane the walls, assuming that there is enough adhesion between the slab and the walls that and as soon as I'm assuming that there is enough stability of motor enough or whatever is sticking the wall in the roof together that is strong enough Assuming that is strong enough this slab will transfer is inertia force at the top of the walls. Wall B causing the sharing and overturning actions and then what happens when something is that something is resting on top of something that something kind of transverse its load and kind of tense to taken to take support from what it is sitting on so the roof that is the heavy roof that is sitting on top of this and it is way completely strongly connected to each other that is strongly bonded to each other that hand that has a strong then what happens then roof gets the earthquake on it the inertia that is created inside the roof that roof tries transferring into the top of this particular walls.

That what happens when the roof is as such save it won't crack but this will create an overturning action in the walls to which was transferred to transfer so are to be able to transfer is inertia force to its two end. The slab must have in a strength in the buildings in the horizontal plane transaction of the slab is known as a diaphragms reinforced concrete or reinforced brick slab substring from so what happened The inner so the slab should be strong enough and that shouldn't the moment of inertia acts Earthquake acts on the roof that slab usually it is very thin is not strong enough that bends first so then is that is strong enough like a reinforced brick .The concrete of the reinforced brick slab then that will be strong enough and that will have enough to strong enough inertia into the walls that is holding them however they are the types of roofs of floors timberline would want to join with Rick file covering will be very flexible so that means those walls as easily give up themselves and they won't bother and try transfer in their roles in there in inertia into the walls that is supporting them they themselves give up and a crack the joints will have to be connected together and fix to the world suitably so that there able to transfer there inertia force on the wall as I said before between the wall and roof is very important than that has to be strongly fix together so that the joins will be is enough connected in the for the inertia to be transferred to be support at the same time the wall B must have enough strength as shear wall to withstand the force on the roof and its own inertia force.

so what happens when the earthquake strikes these walls will have its own inertia acting on it so as long as this particular wall doesn't act as a shear wall what happened they bent because of the inertia is coming from the top of the roof to the corner of the wall as well as inside a inertia that happening on the wall they try to over so as if this is wall strong enough and access shear wall then that would happen and they I will have enough strength their own inertia as well as the inertia from the roof of the wall.

Moving on to the next particular section that is roof on wall in enclose so now what we saw previously first we saw just a wall then we saw just a wall enclose than we thought to was in a room and now we're seeing an enclosure and a roof on top of it and then what happens consider to a complete enclosure with the roof on top and subject to the earthquake force acting in the x-axis if you can see in this particular diagram you can see this is wall A and there is another wall A here so that there are two parallel A's and then there is the roof from and then you can see this is the x-axis the y axis and the earthquake forces acting along the x- axis exact as per the diagram you can see on top of the earthquake forces acting towards the x-axis. If the roof is rigid acts as a horizontal diaphragm, its inertia will be distributed its inertia will be distributed to the four walls in the proportion to this stiffness.

So what happens to the roof was completely and has to the wall of the bonding is really strong and the roof is able to transfer it strong enough to transfer its inertia into the supporting walls what happens if the room is almost entirely regent who is the room is almost entirely then the horizontal the roof will transfer or distribute this inertia to the four walls in proportion to the stiffness of those walls so it will equally distributed for distributed based on the stiffness for walls how much did the rule almost entirely go to the walls B the stiffness of the wall B is much greater than the wall A in the X direction .

In the X direction stiffness of wall B stronger than wall A and the earthquake forces acting towards the wall the roofers reject they would almost entirely distribute the stiffness of the inertia Into both The parallel B Walls not A walls so in this case the plate action of the walls will be restrained by the roof at the top and horizontal banding of wall A will be reduced.

so on the other hand off the roof is flexible and then the roof inertia will go to the wall on which it is supported the support provided to plate action of wall A will also be little zero already there is a plate action is happening on wall and so that will be restrained by the room because that were transferred load to that particular wall in the first case and we discussed about. If in case the wall the roof is not as rigid as we discussed it is flexible then what will happen fabric is hydrogen as we discussed and its normal then what will happen in town would be that the innovation would be going to all the walls with circular roof and action for will be zero a little or zero played action and reaction decreasing in value as the floor plan dimensions of the enclosures increase.

The next thing that will be seeing is roof and floor so we already saw the wall, wall enclosed, wall and roof, wall enclosure and roof, now we see is a roof and floor. So roof is coming floor is coming and then what happens. Earthquake induced inertia force can be distributed to the vertical structural elements in proportion to stiffness as we disused provided the roof and the floors are rigid to act as horizontal diaphragm.

if you can see your particular picture Earthquake one is acting there is a floor there is a roof so if the roof is rigid if the floor is rigid then they would and then the as i said the horizontal diaphragm Action happen and they split their inertia equally into the wall that has the maximum capacity, shearing capacity based on their structural strength they will be getting the loops based on which building will actually staled and staying here this is the way these two are the parallel B walls and these two other parallel A walls so what happens otherwise is the roof on the floor inertia will only go to the vertical elements on spotted so the kind of completely split and then the small wall kinds of the week wall gives up and the building collapse therefore the stiffness and integrity of rooms and floors an important for the earthquake resistant .The rules and floors which are rigid and the flatter bonded on and tied to the missionary we have a positive effect on the walls it is the slab and being can directly the walls or jack arch floors or roof for provided with horizontal tries and laid over the masonry walls through good quality Motors.

That simply rest of the masonry walls will offer resistance to on the relative motion only through friction which may or may not be adequate depending on the earthquake intensity so what happened it is very important for the roof and floor to be rigid it and they should be bonded really I know it with the masonry wall as a difference between then we really strong and also the roof on the floor be strong then only does horizontal diaphragm can happen and equals splitting, Splitting based on the strength of the walls can occur . if not what happened it is very flexible or if it very simple roof what happens that can only react only through friction and that if the earthquake intensity is less. it may be able to stand and but if it is more it may not be able to with stand.

Seismic Design Code

When earthquake Strikes in a particular area what happens is from the roads to the dames To The bridges to the building everything collapses so once that happens became like a regular occurrence in a particular country or particular area any country usually device that particular country in to seismic zones usually in Four seismic zones and each seismic zones as we said in the first lecture will define how much prone in your area to the earthquake. There are really highly prone areas in the country as well is really less prone areas in a country based on which is the codes assigned for those areas of the country.

Basically the experiences in the past the history and earthquake history happened in the past as demonstrated that many common building the typical methods of construction lacks the basic resistance to the earthquake forces so when the earthquake strikes if you have a simple building or normal building that usually construct without understanding the seismic load and the same problem that actually happens those kind of then will be design a building what happens is such kind of a building may not be able to with stand the earthquakes like other the building that is actually designed for the wearing the seismic zone so this kind of things as actually happened and that's the reason why the Government of major countries come up with the loss for construction.

So most causes this is resistance can be achieved by following simple inexpensive principles of good building construction practice so not everything, needs to be very expensive to do so this is a very small step towards your own safety and the safety of the society and safety the people so that architect I usually pushed or encourage to use the same to understand the codes a seismic design codes and buildings based on that at least in the seismically prone area that the higher damage due to the earthquakes can be avoided.

Adherence to be simple rules will not provide all damages in moderate or large earthquake but life-threatening collapses should be prevented and damage limited to repair and proportion. what happens when a very minor major earthquake strikes is that all the buildings give up people by like people die all their profession for purpose goes off and everything that the Irreversible happens because of the natural calamity but such things can be reduced and Irreversible things can be avoided and reversible think I might happen which actually can be repaired and bring back to how it was originally so a first and foremost thing that we should understand while understanding the seismic design code special of India other seismic zone.

There are basically four seismic zones in a place that is zone A , zone B, Zone C and Zone D.

Zone A is a risk of widespread collapse and destruction happens in that particular area when area is highly prone to the earthquake then that area would be under zone A wherein there is high risk of widespread collapse and destruction of that particular area if when and if quake strikes in the zone B you can see there is risk of collapse and heavy damage that can happen so as we see from zone A to Zone D the risk factor reduces and Zone C is always very minor damage in March laser disk so in zone B there is a heavy damage and collapse can happen but the amount of destruction would be much less than what would be in zone A the hilly areas the mountains Areas where there is earthquake there which are prone to earthquake would be under zone A. In zone B there it will be prone to earthquake but then it might be a flatter area where in the landslide can be avoided in zone C the risk of damage is there but then the collapse and destruction can be avoided and zone D there will be very minor damage they can be damage but that will be very minor.

The extent of specified earthquake strengthening should be great earthquake strengthening should be greatest in Zone A and for reasons of economy can we decrease in Zone C with relatively little special strengthening in Zone D.

Importance of building

So I for earthquake resistant design it's you always to categories a building in two different sectors one is where like they'll be maximum public will there would be a lot of people and there will be always a lot of people accumulated in a particular area and two other ordinary buildings where there won't be many people all the time all throughout day particular area So the important buildings are hospital, the clinic, communication building, fire and police station, water supply, cinemas, theaters and meeting halls, schools, dormitories, cultural treasures such as museums, monuments and temples etc. An ordinary building the nothing but housing, hostels, officers, warehouses, factory etc.

Bearing capacity of foundation soil as we discussed in the previous lecture to the soil where it in a particular site and how a soil response to the earthquake and how that gives up on that wished up on the earthquake it what is actually a major factor in the site of earthquake resistant building from the seismic parameter point of view.

There are three types of soil that we are seeing based on a seismic point of view make understanding. One is a firm soil the other one is soft soil and third one is weak soil. Firm soil is nothing but they have an allowable bearing capacity of more than ten and there's a very strong and the ones built upon them were kind of not give up give away your building because of them. the building might fall but that may not be because of the soil because of that particular area really firm available bearing capacity hot and that is there moderate they can withstand the intensity of the earthquake and then there is weak soil are liable to large differential settlement or liquefaction during an earthquake and that I soil liquefaction as we discussed before nothing but when background when it mix with the ground water call solid soil slowly move my becomes liquid and soil liquefaction that happens and based on way because of which tents to pull down the building make it sink within it into it in that particular area and that happens in weak soils a lot. Buildings can be constructed on firm as well as of soft soils but it will be dangerous to build them on weak soil hence appropriate soil investigations should be carried out with double bearing capacity and nature of soil. Compactor to improve them as to qualifiers firm of soft soil.

Plan of the building as we discussed before the plan of the building matters a lot in earthquake resistance design and very linear building should be avoided asymmetric building should be avoided. Many any of the unsymmetrical projection should be avoided long buildings is better if broken into compartment and compound when lies in two different buildings.

The Next is fire resistance it's not usual during earthquake that due to snapping of electrical fittings, short circuiting takes place gas pipe liquids be develop leaks and catch fire. Fire could also be started due to kerosene lamps in kitchen fires so all these things can happen during the earthquake and fire resistance hence is very important areas that are prone to earthquakes, because of the earthquake when fire happens, it's very difficult to extinguish The Fire sometimes could even be more serious than the earthquake damage that happens because the earthquake may be minor and because of with many repacurtion my lap and find them and because of other things happening around it is very difficult to control the fire. fire might be one among women because of other things that is happening around it is very difficult to extinct used to control the fire so hence fire may cause more damage to the area rather than the earthquake because it cont be stop the building should therefore preferably be constructed with fire resistance materials system so this table shows the categories of building show the categories of buildings for strengthening purposes.

In category one give important buildings on soft soil in Zone A. in category two we have important buildings on firms soil in Zone A important building on soft soil zone B. ordinary building on soft soil in zone A.

Seismic zone A, B and C are important buildings and moving on the last and the major factor that affects the stability of a building. Purpose a building truly earthquake resistant it will be necessary to choose an appropriate foundation type for that particular building foundation type is usually they directly proportional to the load bearing and to the load ability of the soil and water the water the soil bearing capacity of soil what is the soil in a particular area

Since loads from typical low height building will be light providing the required baring area will not be usually a problem. For choosing the type of putting from the earthquake angle the soils maybe group performance of week soil unless compacted and brought a soft and firm condition so weak soil can be taken in and they we can be compacted and made to a soft of firm soil but usually while choosing the foundation is always better to go for designing a building. An earthquake resistant building is specially it's better to go for sites where the soil is firm or soft.

Hence is based on that the foundations are designed and foundation should be shouldn't be Shallow and deep enough so that look you faction doesn’t happen on top of the foundation.

While discussing

In the firm soil condition any type of footing (individual or strip type) can be used. It should of course have a firm base of lime of cement concrete with requisite width over which the construction of the footing may start. It will be desirable to connect the individual reinforced concrete column footing in zone A by means of RC beam just below plinth level intersecting of right angles. And in soft soil the it will be desirable to use up plinth band in all walls were necessary it is necessary to connect individual column footings by means of plinth beams as suggested above.

It may be mentioned that continuous reinforced concrete footings are considered to be most effective from earthquake consideration as well as to avoid differential settlement under normal vertical loads.