Earthquake Resistant Architecture

Lecture 5

Building Configurations

Every time in earthquake strikes actually everything get damaged and the maximum damage usually cause because of the man made buildings of the building that we construct in a very well and thoughtful manner because one building collapse on top of another one and such a way there is a lot of building because one building collapse on each other that creates kind of a debris that causes the major damage during an earthquake. It is very important for us to understand the configuration of a building and how and why a building affect the earthquake and how to actually regularize that and making something out of it which will not which might have small non structural damage but the structural damage will not occur.

The first and foremost think I'll be seeing today is the building configuration, the extent of damage to a building depends must on the strength ductility and integrity of a and stiffness of the ground when it is given intensity of the earthquake motion. so every time a building falls to an earthquake on it reacts with earthquake how well it with stands the earthquake depends only on the strength of the building as well as the strength of the ground Beneath.

We already saw the site selection and the soil selection and how to go on a designing earthquake residential buildings in a firm soil rather than weeks oils that part of the discovered we decided on how to choose a site for the building in that part of its also covered now the strength of the building is very important for us to understand the building configuration and how the building is actually configure and made in site. Almost any building can be designed to be earthquake resistant provided its site is suitable building suffer during earthquake primarily because horizontal force is exerted on a structure refinement to contain only with the vertical stress every time a building is assigned that building is designed in such a way that it can react from the vertical forces but we usually don't design a building inside so that it can with stand the horizontal forces that is what has to be kept in mind while designing an earthquake resistant building because the what are the forces that is gone and it is horizontal and important features regularity and symmetry in the overall shape of the building.

A building shaped like a box as rectangular both and elevation is inherently stronger than the one that is L-shape or U-shape which is a building with wings.

Every time a building is asymmetrical or there is a cantilever In as part of the building one part of the building in earthquake prone areas that is like A-listed in the earthquake prone areas in such areas it's better we avoid such kind of a construction. And go for a much linear rectangular building which is not to Linear but which has a proper proportion which is not to linear. If we go for a very linear building which is compartment life and make it into two separate buildings and making a very linear building because such buildings are also very prone to giving up during earthquakes and irregular shaped building will twist remix increasing the damage.

Next major thing is the opening size in general openings in walls of a building tends to weekend the walls and few of the opening less the damage it will suffer during an earthquake. So like we read in the previous lecture what happens is whenever there is a earthquake happening.

From the opening of the wall there is a kind of a creak that forms on either side of the opening such as the number of opening increases that kind of a non structural cracks can actually occurs and that maybe we can the walls of the building for this is better to reduce the amount of openings to a certain number and then increase the number of openings of a building in earthquake prone areas .if it is necessary to have large opening to a building or if an open first floor is desire in special provisions should be made to ensure structural integrity, So next major thing that we seeing is horizontal reinforcement in walls.

The horizontal reinforcement of walls is required for imparting to the horizontal bending strength against plate action for out of plane for inertia the perpendicular altogether as I said before usually every building flying the perpendicular walls as I said before usually every building normal buildings are designed with vertical reinforcement and in order to in order to with stand vertical forces so in our earthquake resistant building is very important that earthquake load happens horizontal plane is very important

The horizontal reinforcement involve the partition preventing shrinkage and temperature crash of the following reinforcement are very necessary,

So a horizontal bands or ring beams the most important horizontal reinforcing is through reinforced concrete band provided continuous through all load bearing longitudinal and transverse wall at blink lintel and roof level also over the top of gables according to requirement stated.

Plinth band is very important Bin bag it is very important to consider the three major bands and to provide horizontal bands in all three major areas the first and foremost one is plinth band this should be provided in those cases where the soil is soft and an even proposal as usually happens in hill tracks it will also serve as damp proof course band is not too critical to be provided.

The next one is the lintel band this is important band and it will incorporate itself the door the window lintels reinforcement of which should be extracted to lintel band steel the it must be this is a very important band must be providing all the stories.

The next one is Roof band this band is required at eave level of truest roof also below are in level of such floor which consist of joys and covering elements as to properly integrate them at ends and fix in to the wall.

Gable Band masonry gable end must have the triangular portion of masonry enclosed in a band so the horizontal part will be continuous with the eave level band and longitudinal networks so if you can see on the lintel band the roof band and the gable band so is very important to give reinforcement in all these three area there is plinth Band which may and may not it can be given in be given to the others 3 reinforcements a very important and has to be given.

Moving to the next one is the vertical reinforcement involved in it need for vertical reinforcing of shear wall critical sections was established and the critical section was established and the critical sections of the opening and the corners of the walls what happened every time in the corners of the wall when two walls joining of the two worlds is not strong enough and it is not have enough then that area can create a crack and that can actually cause the wall to topple or fall that also create a problem.

Amount of vertical reinforcing stable depend upon several factors like the number of storey, storey heights how the effective sees me Coefficient based on seismic zone importance of building and soil Foundation types. Steel bars are to be installed at the critical sections that are the corners of the world in James of the doors right from the foundation and concrete covered with cement concrete in cavities and made around them during masonry construction. The concrete mix to be kept 1:2:4 by volume or even richer

Inertia Forces

The next important thing that we will understand in this particular lectures the inertia forces, As I explained previous lecture that inertia forces is the major cause that actually act when an earthquake strikes and when there every particular section of a building let it be roof let it be wall inside inertia forces the acting within it for example the roof that is connected to the wall tries transferring the inertia load of inertia of that particular the roof to the walls to the joint the top of the walls and the walls that will if the wall is strong enough the wall is shear wall the wall will be able to with stand the inertia and transferred from the and we'll be able to withstand or not overturn in spite of that understanding inertia forces and how that performs is very important in a designing an out quake resistant building.

Buildings are fixed to the ground as shown in the figure so this is the section of the building and this particular building is to the ground so as the base of the building moves the Super structure including its contents tends to shake and vibrate from the position of rest in a very irregular men are due to the inertia of the masses so when the base of the building suddenly moves the right the building moves to the left related to the base so as if it is been pushed to the left by unseen force which we call the inertia force. if you can see their force so if you can see in that there will be a particular type of course I will be acting up on up on it because of which the base of the particular building kind of tense to move in the opposite direction which kind of top of the building and if the building in is not strong enough and not begin with stand that particular load it top this particular force is called the inertia force. Are you there is no push it all but because of it mass building resist any motion the process is much more Complex because the ground moves simultaneously in three mutually perpendicular directions during an earthquake. so you can see that the ground particular leaves in 3 different direction during the earthquake and the building moves in opposite direction that kind of causes the usual you had that that is when the cracks or structural failure happen in this kind of non seismic designs the next major thing is a seismic load . seismic load is represented by force F as shown in the figure the force is distinctly different from the dead live from win and impact on every time we design a building we usually see the live load the dead load the snow load the wind load and the impact load so all of these are the vertical loads so whatever force that acts as a lateral force from the seismic load is actually they are horizontal force like that is to be treated as a very different from the dead load and live load snow load and impact load that we usually see for any construction general.

The horizontal ground motion can we usually see for any construction in ground motion action is similar to the effect of the horizontal force action is similar to the effect of the horizontal force acting on the building and hence the term seismic load, so as a base of the building moves in extremely complicated manner inertia forces are created throughout the mass of the building and it contain it is   reversible forces that cause the building to move and sustain damage or collapse, so once a seismic wave hits the building and the building tends to stay particular position with it because of the heavy way that posses so that is when does inertia force is created in every small parts of the building including walls, the floor, the roof everywhere

so when such reversible forces occur that is when the building tries to move away from the seismic load and tries to sustain the damage tries from collapsing additional vertical load affect is cost on beams and columns due to vertical vibration being reversible absurd instance of time the effective load is increased and others is decrease the earthquake loads a dynamic and impossible to predict precisely in advance the important parameters in seismic design. The following properties and parameters are most important from the point of a seismic design so the first and foremost property that is very important reasoning design as a building material properties so that this building material properties include strength in compression tension and shear including dynamic affect, unit weight and modulus of elasticity . ace of elasticity modulus This properties of a building and other major factor that affect the parameters in seismic design is a dynamic characteristics of the building, system including period and damping and third and the last one is load deflection characteristics of building components.

Ductility, Deformability and Damageability

Now will be seeing the concept of ductility, deformability and damageability and how this particular factor affect seismic design.

A desirable property of earthquake resistance design includes ductility deformability and damageability. ductility and deformability and related concepts signify in the ability of a structure to sustain large   divisions without collapse and damageability refers to the ability of a structure to undergoes substantial damage without partial or total collapse so in case of a very

Sevier earthquake there will be like very intense damage so how much can a building with stand that intensity of a damage in yet not collapse what damage ability talks about it. This is decidable because it structures can absorb mode is the deformation to be observed and repair of evacuation to proceed prior to collapse in this sense warning is received the life saved the first we'll talk about ductility. Formally ductility the first to the ratio of the displacement just prior to ultimate placement are collapse to displacement its first damage and yield so basically once the earthquake hits it will displacement and then only it will collapse so what is the displacement ratio of that this is what we call ductility.

Some materials are inheritably ductile Steel cast iron and wood materials and not ductile that is Brittle is cast iron plane is inside of a country than that is the brakes suddenly without warning and it won't gives a warning to escape from there and it won't sustain for a while and then fall so such materials are ductile and one without warning falls out are not ductile. Brittle materials can be made ductile usually by the addition of modest amount of ductile elements such as wood elements in Adobe construction of Steel reinforcement masonry and concrete constructed by adding ductile materials and non ductile elements we can make the non ductile element can make more or less ductile and that is what is very important in a designing buildings for seismic to withstand seismic load. For this ductile materials to achieve with the overall behavior of the component they must be proportional and placed them come intention and object yielding.

Thus a necessary requirement of good earthquake resistant design is to have sufficient ductile materials at points of dentistry to wherever there is dentistry we should provide the tensile stress please provide sufficient ductile materials in order to make it well designed.

The next Factor is a deformability the deformability is a less formal term referring to the ability of a structure displace or deform substantial amount without collapsing.

Besides inherently relying on ductility of materials and components, deformability requires that structure be well proportioned , regular and tied are avoided and forces are capable of being transmitted from one component to another even through large deformations.

sword awarded and forces of being transmitted from one component to another event last deformation for example like a when is connected to the wall if the ideas of the wall to the roof so that they will be able to transfer group will be able to transfer the loads of the based on the strength of roof search when will find out openings can be avoided much in the in the plan can be proportional a rectangular and nonlinear that small factor can actually help the building to actually have a better deformability they have a better deformability and then relying completely on the ductility fractures which is inherent in a material.

Ductile is a term applied can be ductile material and structure while deformability applicable only to the structure. A structure can be the ductile and deformable and material can't be deformable .even when ductile material are present in sufficient amount in structural components such as beams and walls overall structure deformable requires that requires that geometrical and material instability be avoided.

That is component must have proper Aspect Ratio that is not be adequately connected to the element that everything should be everything I should be at the adequately of each material to reach other should be high by which component to each other should to be high and must be wall ties together for example positive connection at beam seats deformation do not permitted to simply fall off a post from large deformation dynamic motion occur without sudden collapsing of the building.

Damageability is also a desirable quality for construction and refers to the ability of a structure to undergo substantial damages, without partial or total collapse.

A Key to good damageability is redundancy or provisions of several support this structural member such as ridge beams and avoiding of Central columns and wall supporting excessively large portions of a building.

A key to achieving good damageability to all this as the question of this be more column wall collection Foundation etc falls like what is the what is the consequence of that way prevent what is this fails what will happen after that so every time the question is asked the other one will be stand the consequences total collapse of the structure additional support or alternate structural layout should be examine an additional factor of safety

be furnished for such political members of connection so basically is very important to use ductile materials in seismic design building is very important to add ductile materials and non ductile materials to make it almost ductile is very important to create an overall deformable, non deformable structure of by you know considering the plan the shape of the plan the propose of the plan for the size of the building the height building and the various factors that affect that also is very important and give the desirable quality of construction additional factor that and actually help the building to be to perform better in the damageability .