

# Earthquake Resistant Architecture

## Lecture 11

### Quality Safety and Earthquake

urban planning and design is a very broad term and it cannot be covered in one particular or two it's a very wide subject project so in this particular subject what are we seeing is a how to do town what happens if we try making an existing town and earthquake resistant town what happens if we want to restore a building in an earthquake affected area what happens when we try to strengthen buildings in earthquake affected area what happens if we try designing one full area as an earthquake resistant and what are the various parameters that we need to follow in order to do the same and planning is a technical and political process concerned with the development and use of land planning permission protection in use of the environment public welfare and the design of the urban environment including air water and infrastructure passing into and out of an urban areas, So just transportation communication and distribution network so first and foremost thing that will be discussing is quality and earthquake safety .

Quality and earthquake safety critical for ensuring safety of the building during earthquake appropriate measures are required to control quality in all activities related to development of earthquake resistant buildings if not the weakest linked will feel, while quality control is important also for the buildings meant to resist effects other than those meant to resist earthquake shaking there is difference.

Buildings meant to resist only gravity loads are designated to resist loads much higher say about 2 to 3 times more than the gravity loads that may raise during lifetime of the building so once a building is created usually of building the first and foremost know that we consider while creating a building is the gravity load the other load that we can consider win load usually these are the two major loads that affects of buildings especially when it comes to high rise building and that's what are the major rules that we consider while creating the building so when a building is design just to support resist the gravity load alone then it's so happens that throughout the lifetime of the particular building it tends to put to resist the load that is 2 to 3 times more than the load that is design to resist alone. So snow damage occurs in buildings with mineral structural deficiencies in individual members because the availability of adequate marginal design.

That some error can be tolerated in design over workmanship without serious consequences of getting noticed on the other hand buildings meant to resist earthquake affect our design for lateral earthquake loads much smaller than 10 times smaller than what may be experience during severe shaking the building way to sustain no damage during severe earthquake shaking.

This is because earthquake occur rarely and hence ordinary building the expected to undergo damage during strong shaking every structural element is expected to respond in a certain way and tested to Limit when strong shaking is experience the deficiency is a structural elements can result in premature unwanted or unwarranted failures because there is no marginal effects of poor quality or clearly noticed the negative consequences of poor equality a most visible during severe shacking.

Therefore, quality is more important building exposed to earthquake effect than in those exposed only to other load effects example gravity load.

So basically when we design a building in an earthquake prone area it's always important that we consider you know the load that of an earthquake and rather than designing of building that resist only smaller earthquake load is very important that we design building that actually tends to resist from shaking for the damaging when really hard earthquake sticks the area.

So what is quality control quality control means adopting and ensuring formal procedures and processes that are based on scientific principles and professionally agreed norms the need to ensure quality crisis of every step of the building developers at every step of the building development process, These steps including conceptualizing the structural configuration basically the architectural structural engineers needs to work together to adopt a good configuration.

The Next is the designing the structure. Structure engineers need to take utmost care while performing required calculation as per sound structural safety concepts and relevant design standard preparing structural drawing structural engineers and draughtsman need to comprehensively and accuracy present structural design in well detail drawings.

Selecting construction materials - contractor need to take at most care in selecting the intended construction materials and adopting construction procedure as per the standard specification so as I discussed in the previous lectures there are certain building configuration that is that has been understood and that has been identified as the best configuration for the building earthquake resistant building earthquake prone areas.

So that Architect designed that particular building they need to make sure that that particular configuration is followed and the bring out a building the kind of help configuration the kind of help building to visit and the force load by the earthquake and the structural engineers should be taken utmost care while deciding the structures for that particular building in those areas then again the comprehensively adequate drawings should to be made in order to build an incline also the contractors to procure the best materials in construction materials required to do such building.

Converting structural drawings to site comprehended site engineer need to faithfully follow the structural drawings to ensure the design intent is actually realized in the building working with certified Artisans as per good construction practices let down the standards and specifications.

The next is undertaken post construction activities maintenance engineer need to be embed long-term maintenance steps like preventing leaks by avoiding structural damage in post construction handling of structures and preventing damage of building the specially due to critical structure movement.

Next is Quality Assurance so what is quality assurance regress independent monitoring and correction needs to be undertaken by competent third party professional or professional Agencies other than those involved the quality control effort to ensure that the design in tenders actually realize in buildings.

This is certified quality assurance and is required in each of the activities mentioned above, how Quality can be ensure in developer of Responsibility in ensuring that the building the function safe and durable in addition to being economic and Aesthetic. so once the architect in the structural engineer and the draughtsman and the contractor have done the job very important that whatever the design intent is exactly the same way replicated the site and the same building is been made so that particular process of assuring that is called quality assurance. So quality must be ensured by all stakeholders involving in the building delivery process including Architects structural engineers draftsman contractors site engineers artisans example Bar benders carpenters and Masons extra and also maintenance engineer. Each activities need to hire a pre specified and procedure laid down in design codes and Standards there is no single activity that is more important than the others which alone determine the quality of the building being the building owners need to seek professional services that comply with proper understanding and estimation of earthquake hazard of the site because Regress resign compliance with prevalent standard specifications and bylaws independent design review this pure review and procurement of intended quality materials also careful construction of a building independent construction Audit and approved Occupancy and use of the building so any shortfall the understanding or implementing any of the aspects leads to compromising safety and life and the property of the building so each of these kind consideration has to be kept in mind while during quality assuring an earthquake resistant building.

### **Fire After Earthquake**

The next major thing that we would be seeing today is fire after earthquake so like in the previous lectures I have told spoken about the various aftermath of the earthquake there are multiple problems that can happen as a result of the earthquake. Earthquake might not be the directing that might be taking life and might be damaging properties but the aftermath of the

earthquakes as or even more dangerous than that of the earthquake so some of the aftermath that we discussed where landslide liquefaction and again Fire.

The fire after earthquake is a very common phenomenon that happens after the earthquake if you can see in the picture you can see this picture shows the fire after the earthquake this can be cause because of multiple reasons most of which is a gas leak or electrical failure that's what usually gives rise of this during earthquakes so if you can see this is a picture on Japan after earthquake happened and fire happened this kind of thing can spread very easily especially in areas with the wooden buildings of wooden houses the fire 1 started very difficult to contain it because it's really fast and really difficult to save life and property, damage due to infrastructure to infrastructure after an earthquake is a major loss Trigger one of the consequence of the such damages is 5 following a seismic event this can be caused not only by damage to piping and tanks but also impairment of fire fighting system example damage to water supply system piping, tanks pumps as well as firewalls in other words on earthquake and not trigger a fire by releasing combustible materials but also impair passive or active fire fighting system.

So basically I said before the major reasons are piping damage, electrical damage or gas leak etc. so what are the hazards of the fire after earthquake insufficient or missing gaps between the piping and wall at penetration and this can cause shearing of the pipe and release contains during an earthquake.

Improper bracing of piping is critical piping must be braced against swaying to prevent impact against each other pipes. Structural elements except replacing should be done with tension wires or rigid element so what happens when we do piping with a hazardous materials or anything that might cause fire later we don't give structural element to hold its study So when that happens an earthquake sticks this might kind of like mix with other pipes and it might actually make the fire spread faster in inadequate design of fire fighting pump room bank account suspended ceilings inadequate gaps of pipe wall penetrations lack of Anchorage of the day tank are some of the common issues and define fire fighting pumps acceptable damage during seismic shaking.

Poor anchorage of tank and equipment piping tall equipment or liquid containers especially susceptible to damage if not properly anchored piping connected to such equipment if not proper provided with proper flexible joint suitable brazing are also susceptible damage so what happens is a when any of these pipes are not properly anchored and any of the liquid containers are not properly anchor to the building that also kinds of tense it to you know in a trip and fall are kind of leak which might also cause a fire to actually spread faster.

Critical piping to be brace from swaying by means of supporting frame tensioned wires etc. Attention to be given to the connection of the bracing to the pipe as I said before that can control the spreading of the fires provide adequate gap around critical piping of penetration of walls gaps to be filled with suitable noncombustible fire stopping material that can be formed under seismic loading example acrylic sealants so when the sealants are actually given in between this will kind of stop the fire from spreading because these are non combustible materials and their stop the fire there so all production critical equipments including fire fighting pumps to be properly anchor to foundations anchor wall configuration foundation design are to be checked by qualified structural engineers.

This should avoid connection of critical piping including fire fighting water walls and equipment under reinforced masonry or concrete block walls, Such components are to be supported by engineering frame and cut the concrete for slab load bearing elements columns beams extra

Since these components may alter the seismic performance of the load bearing elements a quality structural engineering should control the adequacy of this element other thing we should do

In order to control the fire after earthquake is seismic gas shut off wall is caution these should be designed for the pressure temperature pipe diameters extra prevail and at the facility in which they are to be installed.

Impact of sudden gas shut off on operation of facility and handling of gas already inside the facility etc at just some of the issues that should be considered during the wall selection installation and maintenance can only be performed by qualified technicians in some countries the components must be approved by regulatory authorities which is also very important before we will keep something before we install something we need to measure the we call a qualified technician in order to install that itself kind of make sure that the fire is control. So flexible connection should be provided connection of piping to the equipment seismic join another critical location.

### **Socio Economic Impacts of Earthquake**

Other Major topic that will discussing are the socio-economic impact of earthquake so what is an earthquake strikes then the laws of life you know and many people losing their lives there are lot of other factors that actually happens because of the earthquake there are lot of social economical implications to the earthquake the laws of Property happens in the locations of the building Falls they won't be money and people will be on the street so those kind of social economic impacts of very much when an earthquake strikes does not have to go for a back in time to get reminder of the Great force of mother nature and the havoc an earthquake can cause in terms of direct damage the natural environment over the past decade earthquake

costlier both in terms of social and economic cause which is really tough so that makes tough for certain people many people in fact to come up from that one that strikes and such things happen .

This picture shows like what happens when an earthquake strikes is like everything falls off and people I like you know stuck in streets with nothing but with their price and property and their relations everything gone.

So what are the basic social economic impacts of earthquakes first is the macroeconomic impact the macroeconomic after that then GDP Falls drastically after an earthquake, so once an earthquake strikes an area, Area is kind of bankrupt and the GDP of a particular area falls down drastically and that kind of makes the people even more difficult for them to survive in a particular area so it is very difficult earthquake strikes in one area is really bad earthquake strike and area for them back and bounce back and lead a normal life, So likewise multidimensional poverty is likely to receive great impact going to huddles of drinking water and sanitation services school in Healthcare facilities and increase food insecurity so other than all these monetary and life impacts a lot of issues, education issues, food issues happened that area Where the disaster struck .

Balance of payment is estimated to receive negative effect as a result of increased imports against Low export volume does making the domestic production falling to meet higher demand of the construction and the other social economic impact of earthquake are the impact of Agricultural so once that strike the completely ruined also there won't be like no money and no water and sanitation and water for the agriculture to come back and impact on commerce and industries, and impact on tourism for example in a very tourism also in the areas where is which is very prominent tourism when the earthquake strikes people generally get scared of the aftershock of the earthquake then not to go to that place that itself causes the decrease in tourism.