Structure, Form, and Architecture: The Synergy

Prof. Shubhajit Sadhukhan
Department of Architecture and Planning
Indian Institute of Technology, Roorkee

Lecture - 33
Structure and Architectural Forms in Flood Prone Areas

Hi everyone, welcome back again to online NPTEL course on Structure Form and Architecture: The Synergy. Today we are at lecture number 33 and will be discussing on different structural form and architecture in platform area. So, before starting this lectures just let us quickly recap the things we have discussed in last two discussions that is the structure for the wind area and earthquake prone area.

So, how we can make our building safe during that hazard and different structural system, different building shape considerations are found to be instrumental like that we will be getting some insight in this discussion today, where we will see the you know building form and different technology by which we can make our building little bit resilient to the flood vulnerability. So, let get started.

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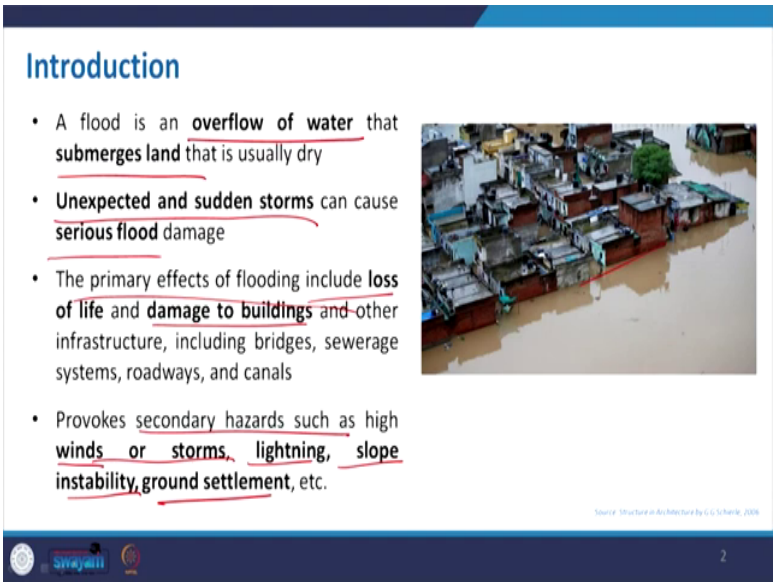

So, what is a flood? So, we all know and recently in this year, we have seen if you just search by the flood in 2019, so, we will get many such pictures. If just go to Google image and you will get the image of the floods scenario and I have picked up this one. So, in this slide what we can get, few definitions or just concept of that.

So, flood is an overflow of water that submerge the land that is usually dry. So, flood is a condescend where it is a waterlog situation and due to the overflow the of the water, it may be due to the overflow of the river mostly that the case. Sometimes, it may be some unprecedented rain which will just you know submerge the city. If the drainage system is poor and then that may be very much catastrophe.

Unexpected and sudden storm can also like create this kind of situation and recently if you just search about some flood scenario in recent time like Patna in India, so, it is a basically some

rain that is that has happened after a long year and the whole city that affected badly. The primary effects of flooding include the loss of life. It is a direct one where is the heavy flow that blown away the people that may or it may be something where it is after effects. Like, during the flood there will be no problem with the health and then that may lead to the life loss that also damage the buildings different property different infrastructure. So, we will be focusing on the building in this lecture, but yes this floods scenario will essentially be a thread to deduce the economy.

And also it provokes the secondary hazards such as winds, if you see in this slide, the winds storms, then lightning, slope instability, ground settlement due to that liquefaction that we have just discussed in like in the previous lecture of the earthquake and here you can see the pictures where is very badly waterlog situation and then you can imagine that problem one may face where it is really area is flooded.

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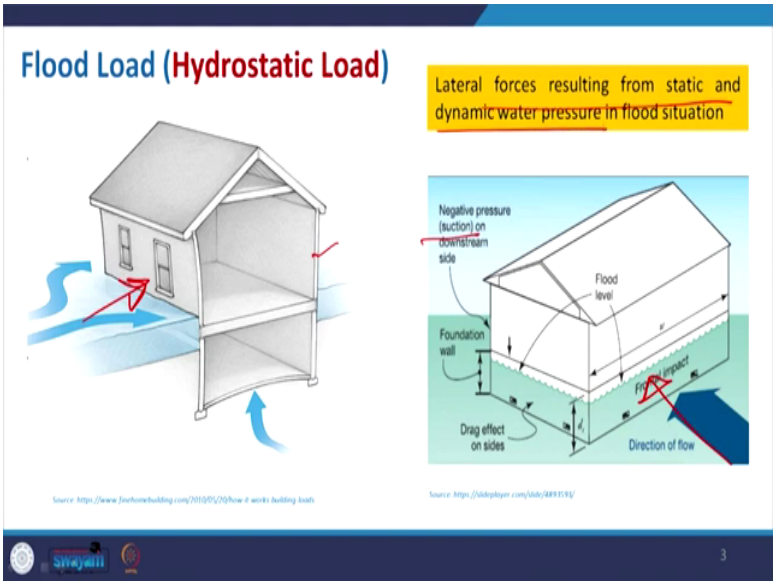

Coming to the flood problem and fundamentals the flood load are that is there. So, whenever there is a waterlog situations, so, water will try to pass. So, it will have a direction, it will have a flow with a slope natural slope and on its way if it gets some obstruction definitely that will create some thrust here and at the opposite side, it will have a negative pressure or the suction like the wind. So, again here if you can see the direction of the flow and then the opposite side, it will have the problem.

So, lateral forces resulting from static and dynamic water pressure in flood situation is very dangerous and it may be really catastrophic.

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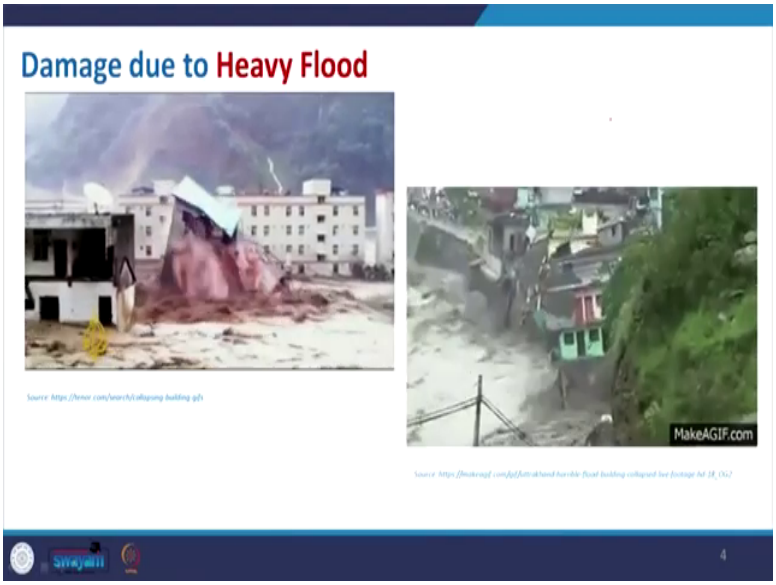

And here you can see two such images where you can see the heavy flow of water how it really damage the building and it is a total collapse and you can gets such example many numbers if you just search. So, this is really very risky wherever the situation is like that.

So, first of all with this water, the ground the soil will very much loose and then that will really suddenly loose the bearing capacity and that may result to the collapse of the building.

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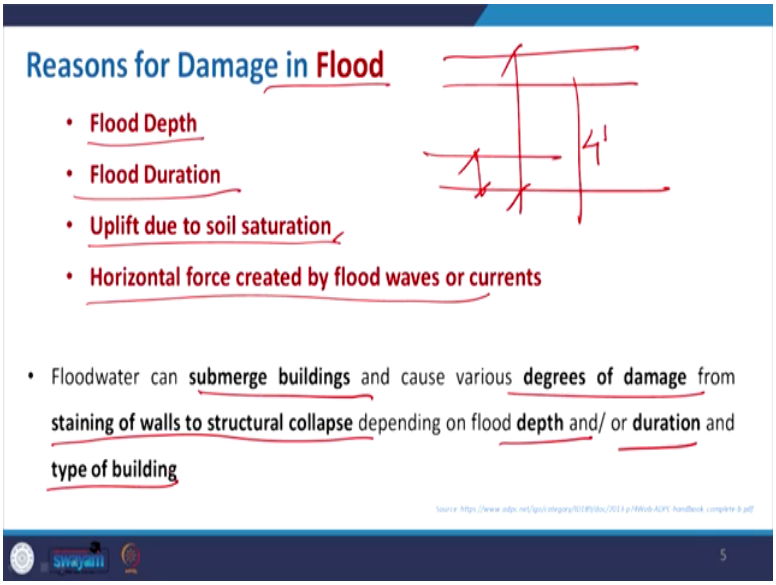

And the reason for damaging flood if you see that in this slide, so, it will depend on the flood depth like what is the level of the flood. So, if it is the surface level and the flood is for say 4 feet or may be the 6 feet whatever the depths. So, that will have.

So, if it is very low, so, again the you know again it will depend on the slope that will decide the a movement, that will also decide the velocity and then the depth and based on that

whatever the damage of the building that may occur. So, whenever it is low considerably low may be half feet or 1 feet; so, normally the buildings they are having plinths, so, but it will not really go inside to the room and we can just then also deal with that situation. But if it is beyond that a 4 feet 5 feet depth is basically very much vulnerable.

So, if the plinths of not that height at that height, so, that will damage the building very badly; then the flood duration. So, if we have very proper drainage system or some mechanism to ease off the situations, so, then the risk will be less, but if there is a very bad infrastructure or there is a nothing to do the duration is so long, so, for last 7 days or something the situation exist then the damage and loss will be more. Then uplift due to the soil saturation that is also related to the your liquefactions. So, whenever flood stay for a longer duration, so, this kind of scenario will happen. Then horizontal force created by the flood waves or currents.

So, this is basically what you can see in these two image and whatever I have described here, the direct thrust and the negative suction at the back where or the flow is being obstructed by a building. The floodwater can submerge building and cause various degrees of damage from you know staining the wall to the structural collapse. So, gradually it will create the stain in the building, it will deform the well building and then that will collapse and it will also depend on the depth of the flood and the duration of the flood and also the type of the building. If your building is kacha type, normally if you consider the case of the rural area, so, normally they are making the brick, maybe a making of made of earth or may be sometimes it is like some kind of you know I mixed a cement to that.

So, they will be more vulnerable because they will not have that resistance to deal with that flow and the thrust provided by the you know water. But compared to that if you have some structure of RCC or maybe some very strong material, that can again resist something. Provided that the foundation is well anchored and then the duration is not that much. Even if the duration is too much, the subsoil will get liquefied and then even the strong building will collapse and they just uprooted from that.

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So, here are some of the pictures which actually depicts the scenario where the situation is really not welcoming the buildings whenever it is new or old, so that badly affected with a flow.

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And here is the situation during the flood, how we can see that everywhere is the water and you can see how people they are threatened and if this will continue again the heavy rain and all, so, this building may also collapse like this video.

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Here is another image where you can see that the situation during the flood.

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It is from some different country, here also you can see that how the whole area is now submerged.

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And this is something from Patna. So, in recent flood, so, you can see that construction like some of the buildings already submerged.

So, you can only see the roof and half of them are already damage. So, again this is really not welcoming to the society.

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And this is another example where you can see the buildings how it is submerged.

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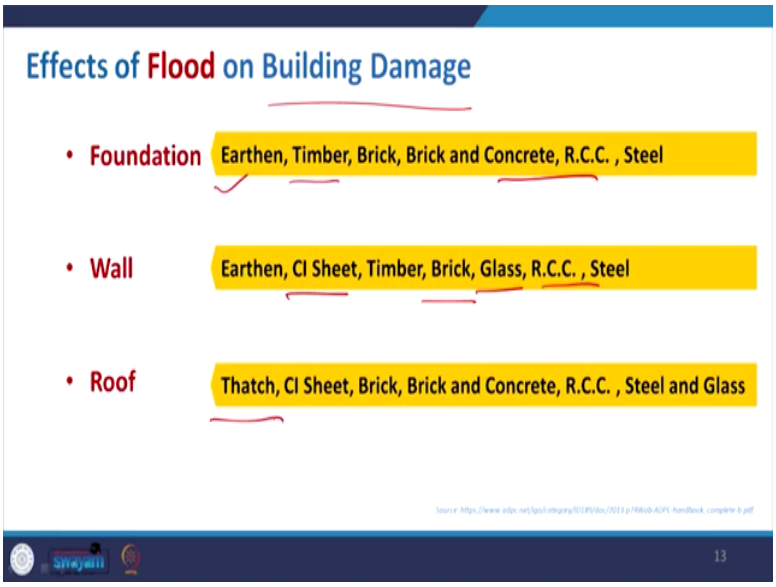

Now, effect of flood on building damage, it may damage the foundation, it may damage the wall and the roof or everything together. So, it depends on the material that we use like for the foundation, for the rural area specially, where the loss is more. So, we have to rebuild your structure once the flood scenario as you know gone. So, you have to rebuild the structure.

So, this is something you know really serious, but even sometimes if you make it with a timber or light material and not anchored properly, so, the whole building can be blown away with a flow and there are many instances of that. So, it maybe a brick or maybe brick and concrete kind of foundation which may sustain bit and if it is like the RCC or may be the steel. So, that will sustain depending on the depth whether you go for isolated foundation or pile foundation. So, depending on the foundation, it will depend. Now the wall where the you know at the ground above the ground the water will first you know stucked with that particular portion.

So, if it is of earthen material that will have become porous, if the duration is quiet low. So, that will be soften and then there will we collapse, then it may be of the cast iron sheet specially for the low cost construction this being used, which we also not be strong enough to protect it like the brick, even depending on the structural age of that construction machinery work. So, it will depend whether it is glass or RCC. So depending on that the collapse and the degree of the damage will depend, so, as too with the roof if it is a thatch roof and all so, with a heavy rain and all, so, it will not really sustained, whereas you have a concrete roof, flat roof that may sustained and sometimes it is also you know advisable like whenever your building is to be built in flood prone area, so, better to go for a flat roof structure, so, that at least during that situation like people can just accumulate there at the roof top and that we have seen you know one of the images. And whatever we have discussed there, so, in this like the design and construction of flood prone building structure.

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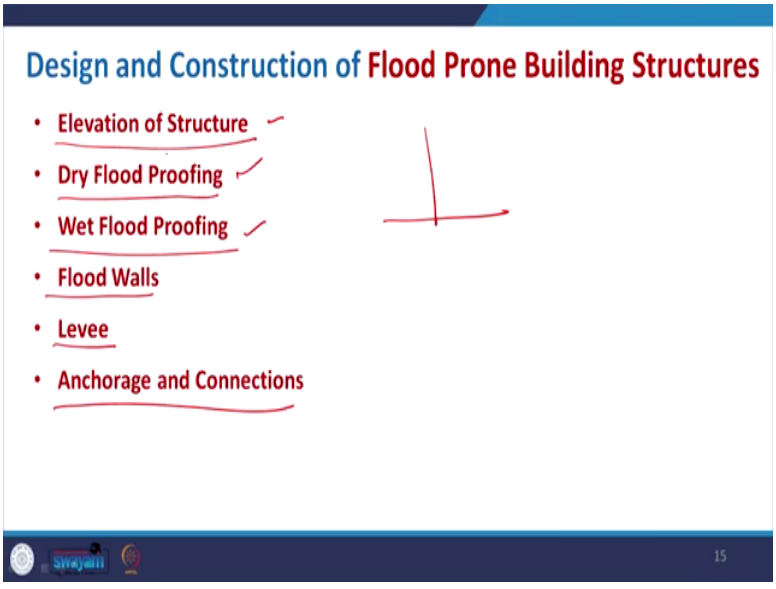

So, we can work on the elevation of the structure. So, this elevation is different from the elevation that normally we use in architectural design, that the found view or something. This elevation is relate to the height of the building with a is corresponding to the surface or the flood level. Then the dry flood proofing is one of the technique, we will be discussing that, wet flood proofing may be one of the solution to reduce the risk during the flood. It may be the flood walls that being constructed to protect it to certain level, it may be the levee that we can create to control it and then another is the anchorage and connection.

So, whenever you make any light structure that should be anchored very perfectly with a foundation and if you make your structure with different materials, so, those connections joint should be proper. So, beam should be well connected with the columns and columns are well connected with a footings and then the so, as for the roof or the ceiling or the floor. So, that is there. So, we will go one by one to just see what exactly it means the dry flood proofing or the wet flood proofing and we will try to understand.

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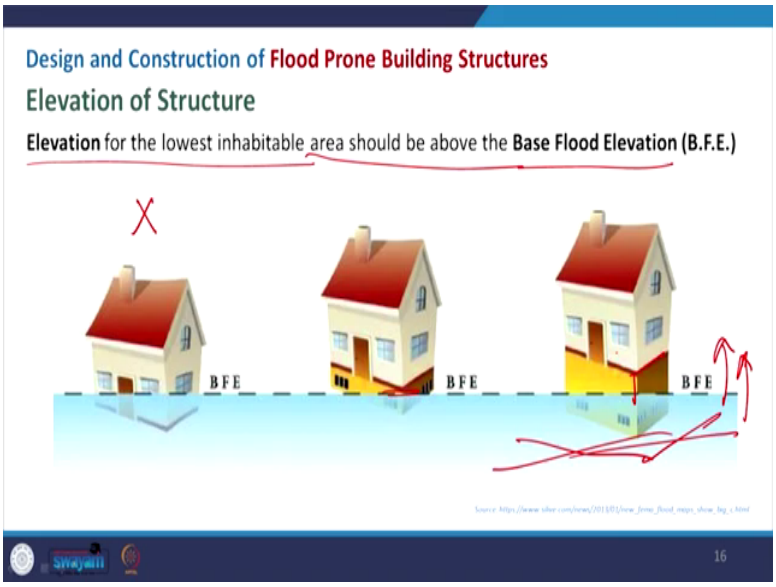

Coming to the elevation of the structure in the slide, so, elevation for the lowest inhabitable area should be above the base flood elevation. So, this is very important.

So, in this case if you see that this is the base flood elevation level, so, you can easily see in the case of the first one. So, your building is emerged. So, this is not advisable and in this case you have plinth up to this, this is just at the base flood elevation. So, this is somehow better, but when this level will go up because a continuous rain and also this may definitely subject to go up. So, you should make your structure like quiet above from this particular B F E. So, then you can make your structure like risk free to some extend during the flood. But definitely when you make your building little bit raise from the surface may be this is the you know the land surface.

So, when you make this plinth of that height, definitely cost will be additional. You can easily make your plinth low, but if you consider the risk associated with this flooding situation it may occur occasionally means unpredictable then it is different, but if you know that your building is your site where you will make your building is really having this fit of the water logging or the flooding situation, so, definitely spending little bit initially will really safe a lot in long run.

So, you can really sustain during this situation. So, elevation of the structure is one of the important measurement by which you can reduce the risk during the flood.

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This is the example what I am just I have shown, this is the picture where you can see that this situation is water log. But as because you have a risk platform and you can see that this particular height where this is raised; so, may be this bottom portion you may use for some

basement and you can see that ventilation. So, the access to your room is quiet above to the base flood elevation.

So, this is considered to be safe or having better performance during the flood.

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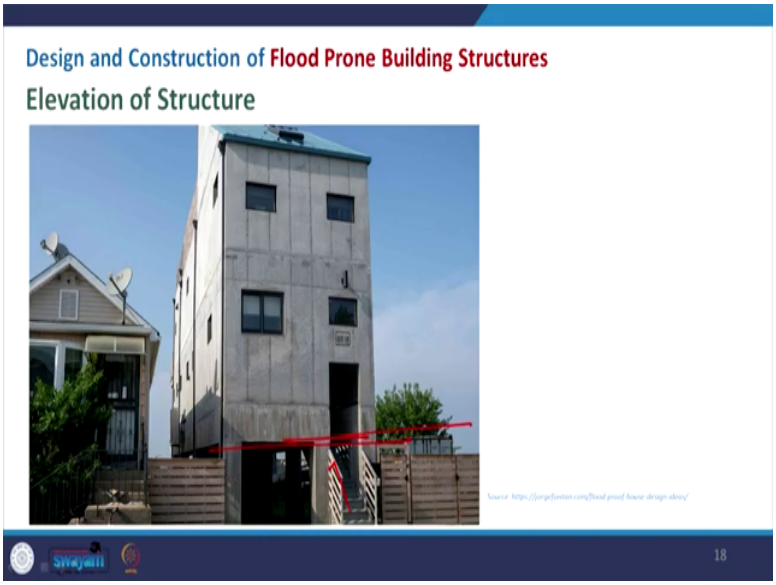

This is again the same case where you can see with this particular steer, you have the level quiet high and this could help during the you know a flood may be of the 4 feet depth or something. So, this heavy depth flood situation also this buildings can be survived. Coming to the dry flood proofing, so, here is basically to protect the house against flood without allowing water to penetrate.

So, we make our building, we do not allow water to pass on. So, you we make our building so, strong that it will resist that particular flow, so, that is something where you can use some additional food flood panel.

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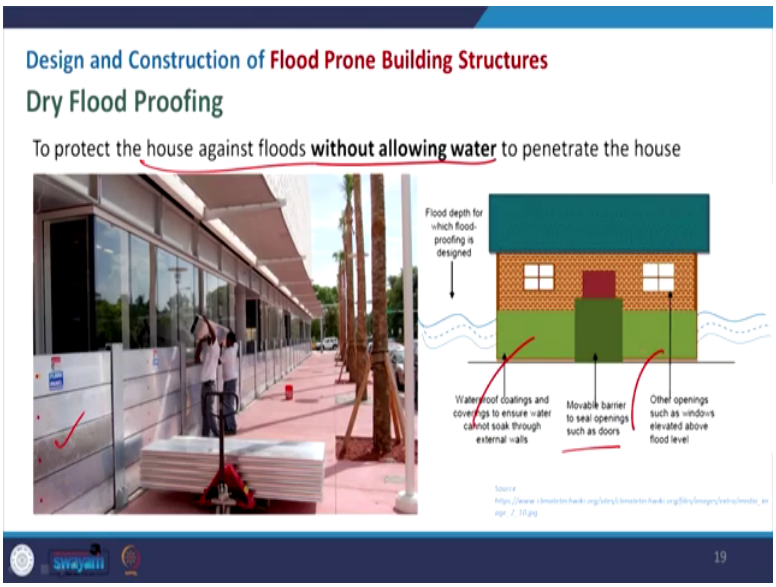

So, this flood panel will protect that direct thrust of the flood water towards that building and even here you can see like the doors and other thing is being protected with a movable shield, which will be removed when the flood level reduced and then the risk will be no reduce or that will be lower down.

So, in this case we will not allow any water to penetrate. So, this is the dry flood proofing technique that we can adopt.

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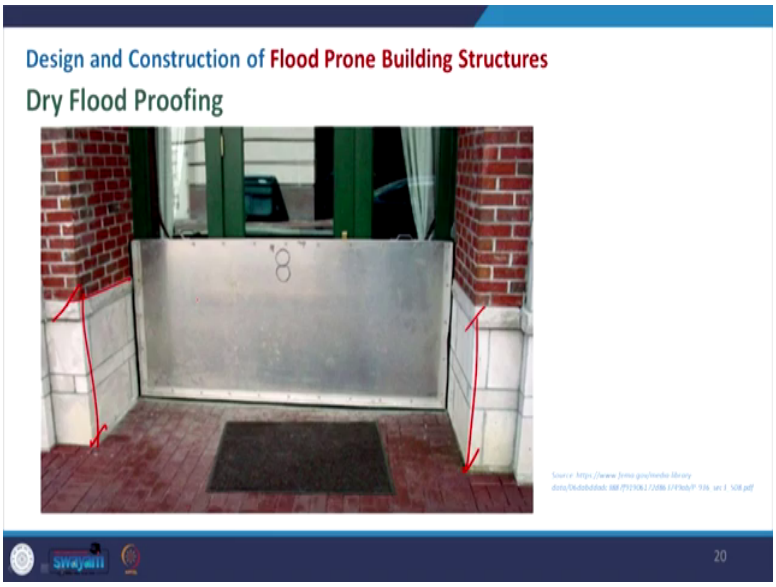

This is another picture of that where this being protective. So, this is removable and this is the entry. So, this is already being made with a some you know plinth made of some stone, which will not really allow to penetrate the water. We have to remember if you go for the machinery work or the brick work it will be porous. So, that may also affect that may also get affected, but whenever you go for this plinth of stone or RCC that will be. But wherever there is intrusive you cannot have this plinth and then you can go for with this flood panel.

So, this is the way we can go with our dry flood proofing.

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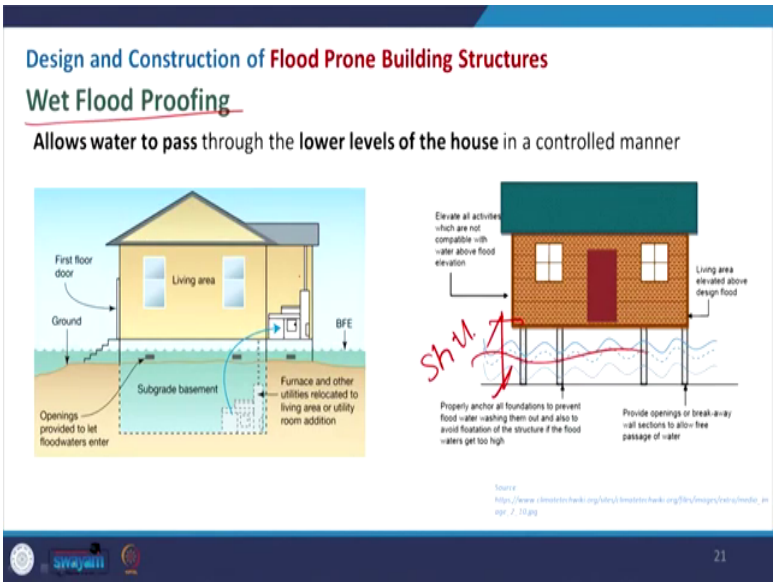

Now, coming to the wet flood proofing: So, in this case we will just take that there is a flow of water let water flow, we will not disturb and there will be and that if that flow is not disturbed that will not also disturb us. So, the concept is to allow water to pass on. So, that is why it is called wet proofing. So, here what you need to do? You do not need to make any plinth at such you have to make your structure still. So, still structure to be made where you know this is having a good height considered to the base flood elevation and then allow water to pass on.

So, in this case this being made and here is whenever there is no flood situation we may use as a basement where the basement and this kind of structure being made and during the flood situation as because the flood is not very uncertain like earthquake. So, there will be forecast and there will be a you know scenario that this water level is getting high. So, that is giving a alarm to us and then if something is very much of that utility in the basement kept, so, we can

shift it in upper portion. So, that is it is what is there. So, in this case we allow water to pass on.

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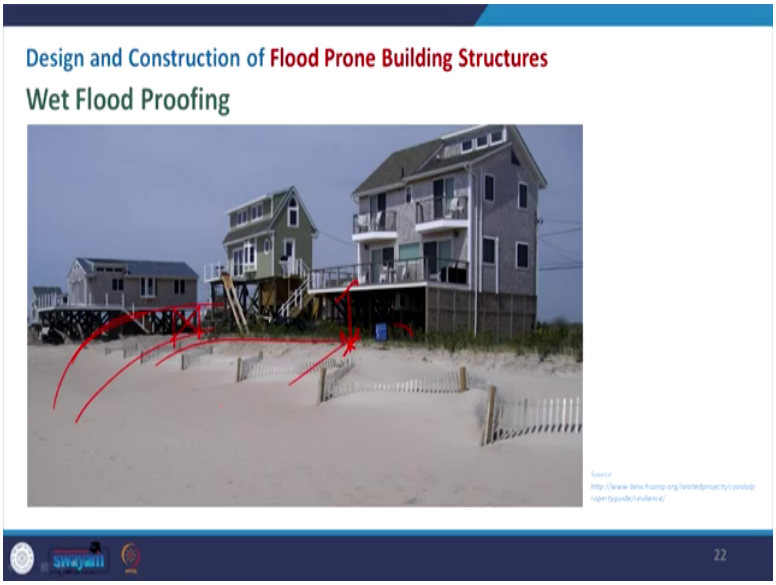

So, here is the example where you can see that is all the structures that being made at quiet not at the surface, it will have a height and we have only this particular columns and some base in to just hold the load and then during the flood normal for the area who are in the coastal area or near the bank of the river this kind of structure will help. So, during the flood levels, water can pass on and then there will be no such damage. So, this can be one of the way out during this flood scenario. So, wet flood proofing is one of the option.

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So, this is another same you know example under this wet flood proofing, where you can see that in absence of the flood scenario that may be used as a parking and all. And then these are the you know panels that is removable during the flood we can remove it. So, that water can easily pass. So, whatever the direction there will be a predominant direction depending on the slope.

So, everything is well calculated that if there is a resource where from the water will go and in which direction accordingly this can be oriented. So, this could be helpful. So, this wet flood proofing technique may be adopted and that will reduce the risk during the flood. Coming to the flood walls it is not the buildings. So, we will not allow water to enter to my campus enter to my one premises.

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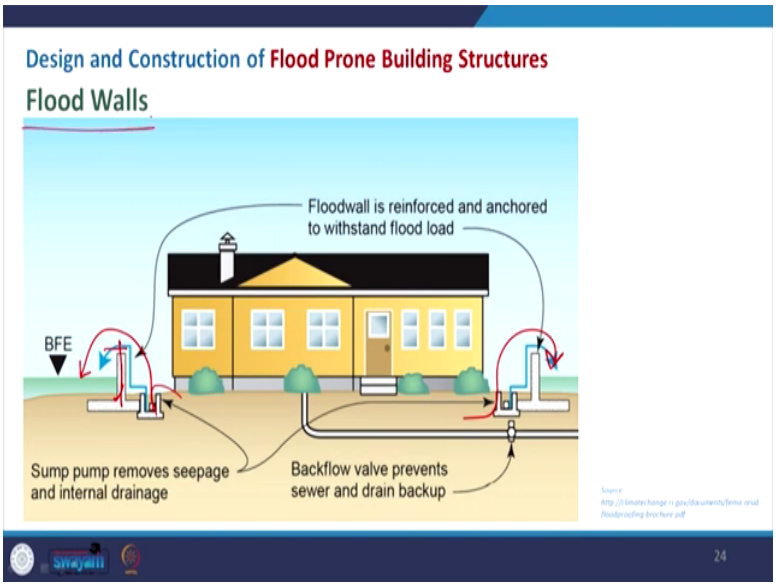

So, then we create some R C C wall or some wall of them you know some metal which will not allow water and they will have a considerable height and then whatever the water logged in my premises so, that will have some you know pumping system which will plus out the water outside. So, by which if you create the boundary well sealed during the flood so, that may also sustained.

So, a boundary water proof or flood proof boundary wall or that is also referred as a flood walls will be helpful.

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So, here you can see that how this can be. So, this area is basically having this no water and this is very dry. So, with the help of this panel and then the continuous you know barrier. So, this will act as a flood wall and that will protect. So, that similar kind of system we can adopt it is may be temporary structure or we can make the R C C wall so, that we will reduce the risk during the flood.

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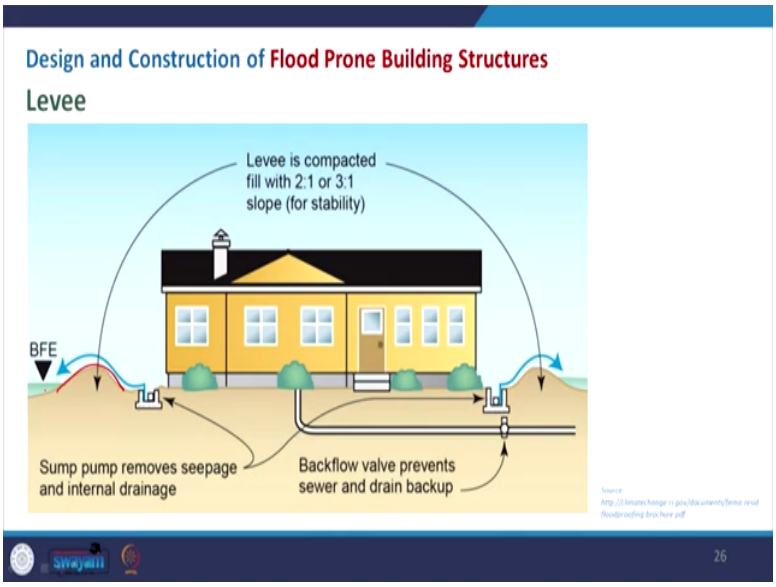

Now, coming to the levee: So, here it is not basically the wall form, this is a (Refer Time: 22:59) that we can make a bump. We can create a natural slope with some kind of soil, so, that we will not allow water to come inside and whereas, again like the previous example. So, whatever the water accumulate within my premises we can just you know drain out that water with a pump to this site so, that by this also we can make our structure safe not the wall just amount.

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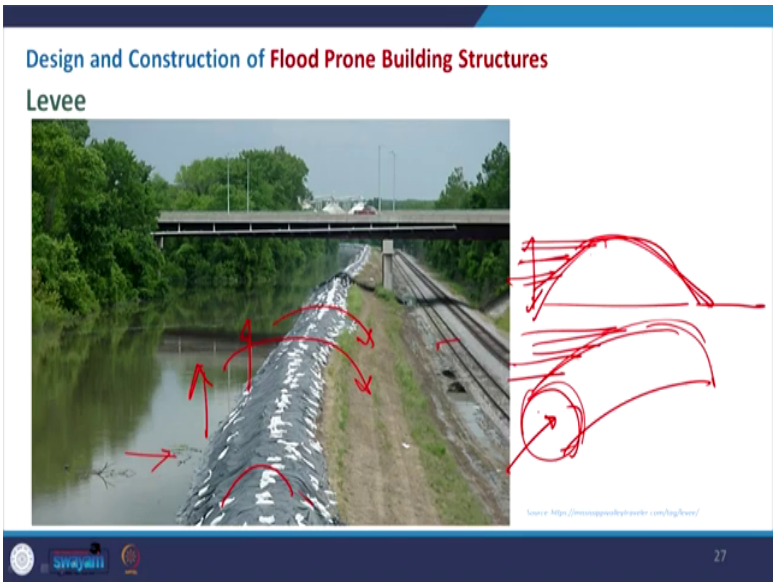

So, here you can see that this is a railway track and there is some water body and this is being protective. So, if there is increase in water during the flood. So, this will initially help to not you know overflow this water to this site. So, this is the profile is being maintained like this.

So, where water raise. So, this being calculated what would be the maximum flood level for rainy scenario and based on that this levee can be created so, that the other site will get the protection. So, this can be used for the road, it can be used for city bounded like a initial like similar to a dam, but that can also be used for like where we do not prefer to have a boundary wall for my building we can use this. Along with that sometimes we also use that flood barriers. So, its nothing, but a tube. So, this tube is filled with water and that will have wet. So, that will have enough strain to just resist the flow of the water and that can really help.

So, this is the hollow balloon like structure we either can put air or else we can put some water already. So, that will act as a barrier during the flood. So, it may have the flood wall as a system we can use the levee we can also have this temporary tube that may act as a barrier.

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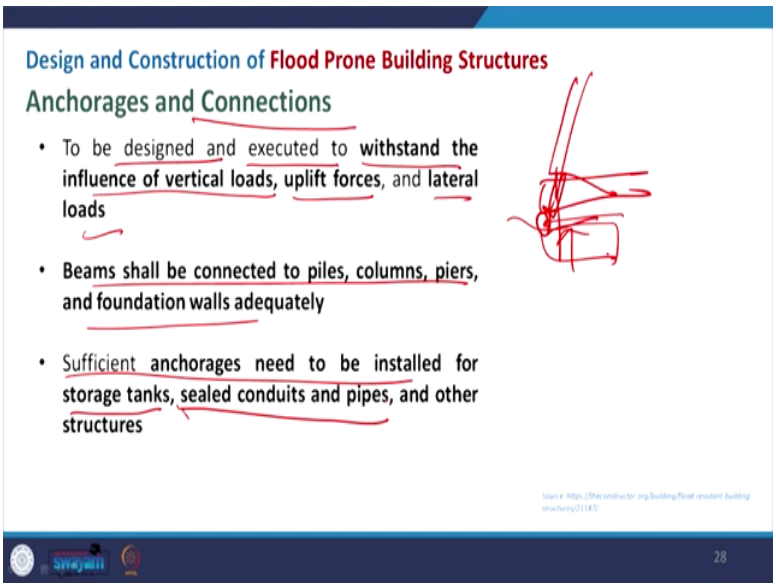

Now, coming to this anchorage and the connection. So, here what we need to remember that, design should be like that which to be designed and executed to withstand the influence of vertical load, uplift force and lateral loads.

So, vertical loads definitely that will happen whenever like there is some you know force acting on it and there will be some saturation soil saturation scenario. So, there will be some kind of change in the subsoil. So, we have to make it very strong. So, they should not be something like where the building will tilts and then the foundation that will come out. So, that should be anchored properly. Beam shall be connected to the piles columns piers to the

foundation accurately so, that they will act very you know strongly against that particular load whenever it is applicable during the flood scenario.

Then sufficient anchorage need to be installed for the storage tank and other sealed conduit pipes and other thing. Because with the motion if this anchorage is not there so, that will be blown away. If you have a water tank just in your premises or somewhere like it is at top of your root or, but it is just simply placed, so wherever there is heavy thrust or so; so, heavy wind thunderstorm that may also create the problem.

If it is like a conduit pipe and all so, that is also exposed. So, that may damage. So, if there is any leakage. So, that may also get affected during the flow of water and inflate a situation and then definitely that will create multiple problem for the drinking water or the daily services and that create the environment really unhealthy. So, we should avoid the scenario with a proper anchorage. Now coming to the summary, here we have seen that again the flood is something where it is the overflow of the water, that may cause due to the overflow of the river or it may be like due to the unprecedental rain in a closed form where the damage system is not adequate.

So, all of as sudden a heavy rain and storm will make the scenario. And then the it will affect the foundation, it will affect the your wall, it may really affect the total building as a whole and then what we need to do basically, we have to just make us ready we have to prepare our self to reduce the risk of that and there are different ways that we have seen in this discussion by which we can reduce the risk.

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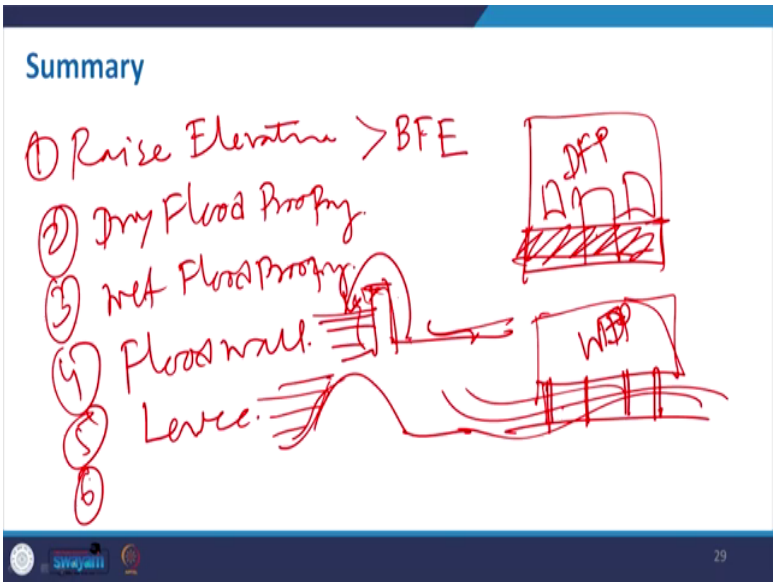

One is the raise the elevation is the technique ok. So, where this elevation should be your base flat elevation and like increase in the plinth this is one, then we have also see in the dry flood proofing technique where like we will not allow water to penetrate and for that whatever the openings and other elements are there.

So, we have to protect with a you know movable flood panel so, that will help. So, whenever there is no risk or risk is now not at that label. So, then we can remove it, then we can go for a wet flood proofing. So, in wet flood proofing, it is contrast to the dry proofing. So, we will allow water and that is why we take our building at different height. So, water can easily pass through and whenever there is no water this can be used as a basement, this can be used as your parking etcetera.

So, this is your wet dam, wet flood proofing and this is your dry flood proofing. Now apart from this what we can do extra that is your flood wall and also we can go with the levee. So, we can create the flood wall at the boundary so, that water level that will not go out and whatever the water accumulated inside that will be pumped out to the external and in the levee it is a mount again in that will actually you know help for the city level or the individual level and the six one is the anchorage, which will taken care of with the structure and also the nonstructural elements like the pipe and other thing so, that the damage will be less so, that we can do it.

Now considering the form, there is no such basing for basic form that being described here, but the thing is all related to whether we will allow water to flow, which will help to get lays impact on the surface and if you do not have this option to lift it up or you have other concerns, then probably you have to go with the dry flood proofing where you have to provide the proper sealed during this flood situation by which we can reduce it. And definitely the with the previous discussion is well the wind then (Refer Time: 30:44) activity this flood even area is of multi disaster prone area.

So, definitely we should be very much careful like maybe we cannot stop the phenomena to you know get offered if it is a natural in nature not manmade, but at least we can make our building taking those kind of you know concept and following different guidelines which are available so, that we can reduce the risk during that hazard.

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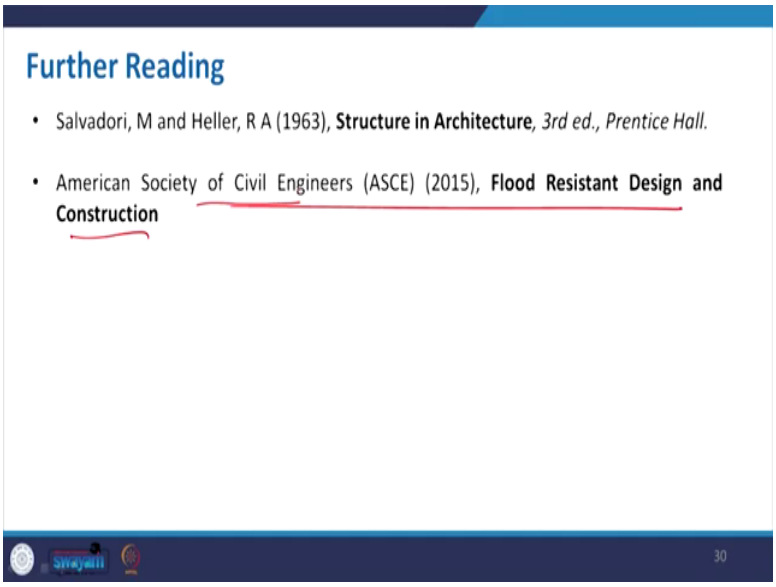

So, with that I conclude this thing for study you can go through some of the phases of flood resisting design and construction guideline from American society of civil engineers publications we will get such more information even you can search some of the reports that being developed like in the context of Indian cities.

So, that it will help you and even the risk what we have discussed today is in very general, but this you know phenomena like this flood and the risk associated in the rural area is quiet high as because the building materials they use the technology, they used they will fail to resist during that. So, with that we will have a discussion we will discuss in one lecture of cost effective you know your structure and architecture. So, well we will discuss again how to make the structure with the cost effectiveness and even without compromising all these threats.

So, basically how to make your building earthquake resistance or flood resistance with the low cost technology, even for the rural housing that we will be discussing in the next lecture. So, that is the lecture that is upcoming which is lecture number 34, cost effective structure and architecture. So, this will be very much helpful to know not only the high raise skyscraper and different beautiful structure, now also this can be achieved with some cost effective technique in terms of material, in terms of technology and we will be discussing that in the next lecture. Again I thank you all to take part in this course and definitely like I will be waiting for meeting you in the next lecture.

Thank you.