Introduction to Engineering Seismology
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Lecture - 04
Different Earthquake Hazards (contd)

So vanakkam. So we will start today lecture. So you may be wondering, so what I say by vanakkam, okay. So I thought of telling you in the first video itself, it is okay. So I will tell you. So basically you wish the opposite person okay by good morning or good afternoon or good evening or goodnight. So this is actually not a wish, or you are not respecting kind of things okay?

It is only you are blessing them or you are telling them it should be like good morning to you. So in our tradition, okay, so in our tradition means I talk about the oldest language of Tamil. So if you want to respect a opposite person okay you have to basically fold hand like this and say vanakkam. So which is does not have any tense with respect to morning, evening or night.

So all the time is the same if you want to say so wishing the opposite person you should say vanakkam. That is why I start my lecture with vanakkam okay. So with it today lecture we are going to start. So last class we have discussed about the different earthquake hazards. So we have seen that there was a direct earthquake hazard as well as the indirect induced earthquake hazard which causes a different damages to the structure as well as human losses and economical losses okay.

So this has to be precisely known at a particular place so that you can design your structure against that and or you prepared yourself to handle this kind of hazard okay. So before going to study this earthquake physics and then how to estimate all those things. So let we review okay what are the different earthquakes or hazards are occurred in the world. How this hazards are basically distributed and which are the hazard causes a more economic as well as human losses in the world.

So today we are going to talk about that in the title called earthquake hazard distribution in the world.

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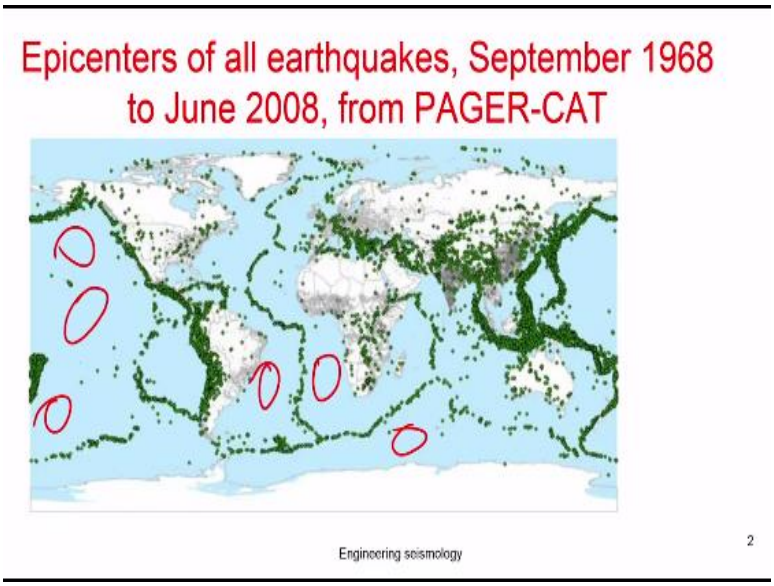

So basically this is the earthquake okay epicenters of the major earthquake in the world. You can see that the earthquakes almost located throughout the places except some regions where this one. So I believe that here actually the earthquake are not reported maybe this is may not have a human felt there earthquake there. Earthquake maybe occurred, but there may not be people to notice that one thing or there may not be the instruments to record earthquake occurred at this location okay.

So you can see most of the places okay particularly places where you can see the human settlements are large you have the more number of earthquake. So this was actually studied from data from 1968 to 2018. The people collected a different earthquake on this period and tried to understand which earthquake hazard caused more damage and human losses for the project called PAGER-CAT, okay.

So these are all the location of the earthquakes by means of epicenter. I will explain you what is the epicenter in the later classes.

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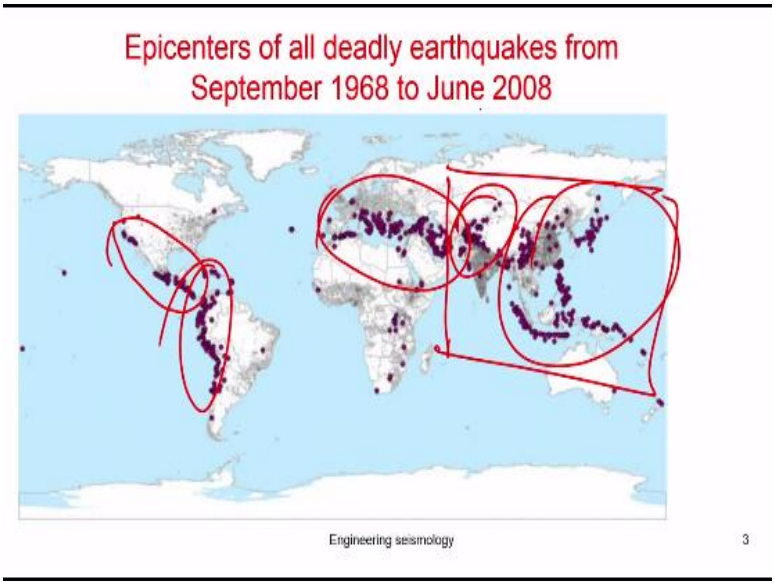

So if you look at among all those earthquakes, which of the earthquakes are deadly earthquake. So deadly earthquake means the people die more than 10 or the more than 10 means it may be extend to the one lakh, two lakh, five lakh, 10,000, 20,000 like that. Minimum is above 10 is called as a deadly earthquake. You can see these earthquakes most of the deadly earthquakes are you can see in the human settlement area.

Because you are talking the earthquake classification terms of the human settlement area. You can see the Asia basically has a many deadly earthquake between this 40, 50 years okay.

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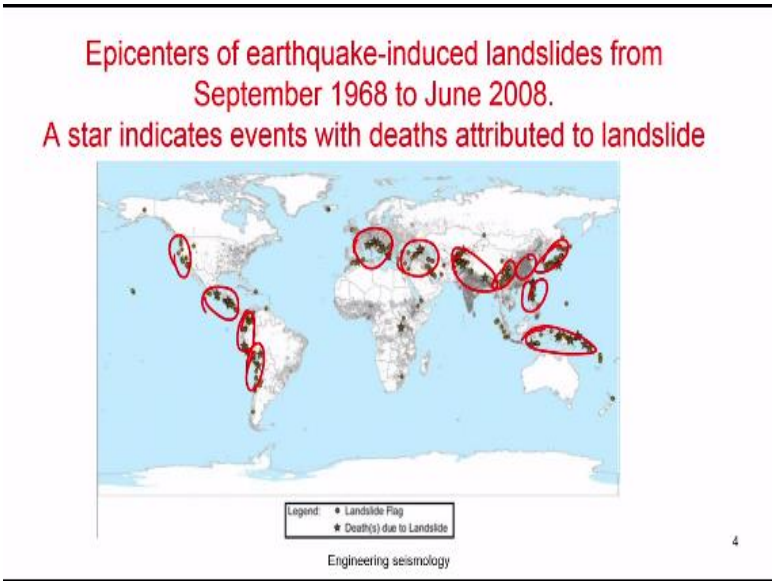

So if we look at among this deadly earthquake, the earthquake which caused the landslide, okay that means people died due to the landslide are caused by the earthquake. So okay, the earthquake which caused a landslide and many people died. So those are all the earthquake, again you can see here. So you can see these are all the regions.

So it is narrowed down to the region where you can see most of the mountain region, not the plain terrain. You can see here, okay. These are all the places where these deadly earthquakes are caused landslide and many people have died.

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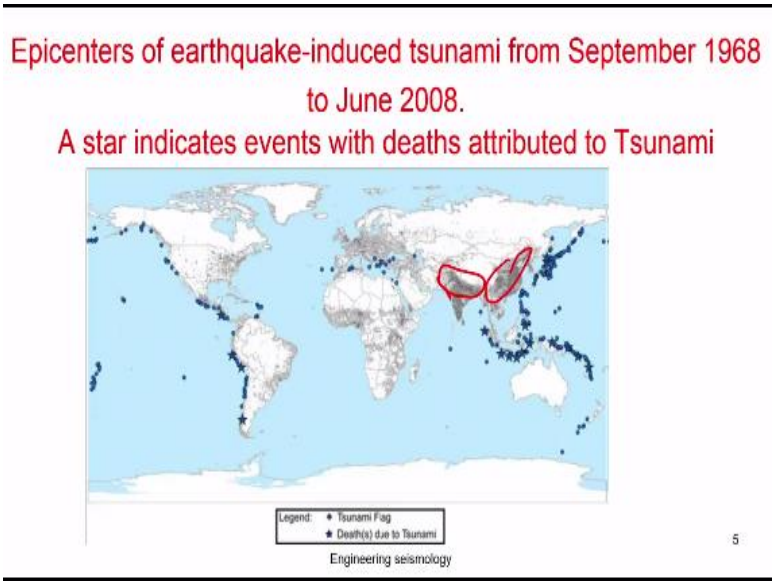

So the next a tsunami earthquakes, okay. The earthquake which caused damage due to the tsunami. So the earthquake caused the waves which created tsunami and many people died due to that, okay. So you can see again these are all the star or basically death directly due to the tsunami earthquake. So the flag actually the tsunami waves are hit those locations where the dark locations are tsunami hit this location and people have died, okay.

These are all the tsunami earthquake. So this you can see most of the places are located close to the coastal part, not on the hilly part. You can very clearly if you saw, you see this place, nobody was died because as we told in the last class tsunami never occur on hilly region okay. So no people have died. Similarly here. But those regions people are died earlier due to the landslide we have seen okay.

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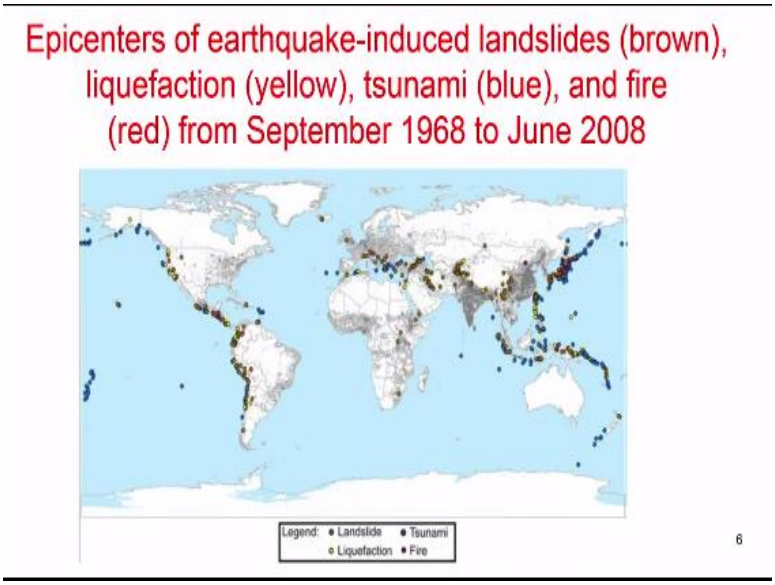

The next is this is basically the epicenter of the earthquakes which caused landslide, tsunami, liquefaction and fire okay. So you can very clearly see that so the fire hazard also included here. Actually this differentiated with color. So where you can see basically the red color is actually the fire earthquake. So where the other green one is liquefaction. Then the dark blue is tsunami and then the landslide. You can see the combination of all those places where this hazards are occurred.

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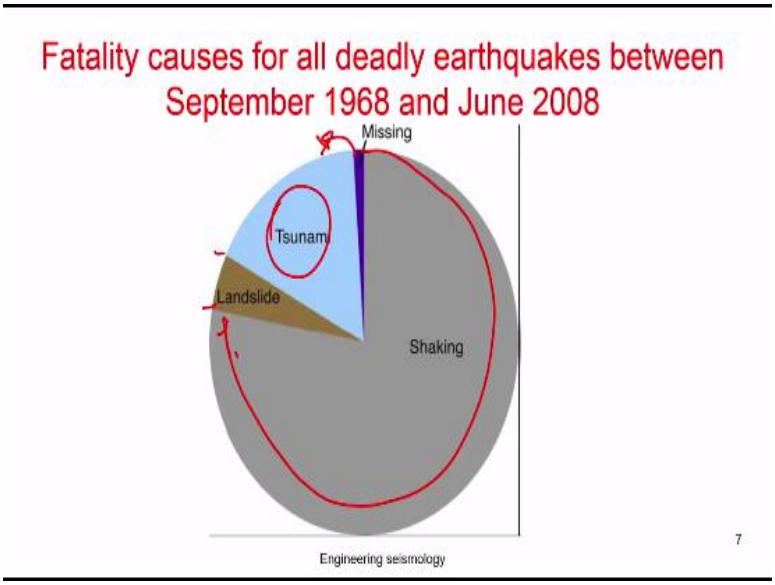

So if we look at the number of people died, okay so due to this 50 years earthquake on different hazard, okay. So then if you plot them together, if you try to share them okay, how many people died on what? Okay, you can see that that direct ground shaking, basically the direct ground shaking hazard comes basically from here to here, see. So more than 75% of the people die due to the direct shaking of hazard okay.

So then there is a portion of the people who die, so it will be maybe about 15% of the total death in the deadly earthquakes. And then about again, about 20 to 25% of the 20% okay 18 or 20% of the people die due to tsunami. These are all the things where the reason is not known. So the ground shaking hazard is one of the major concern which caused several death and caused several deadly history of the earthquake okay. So that has to be understood.

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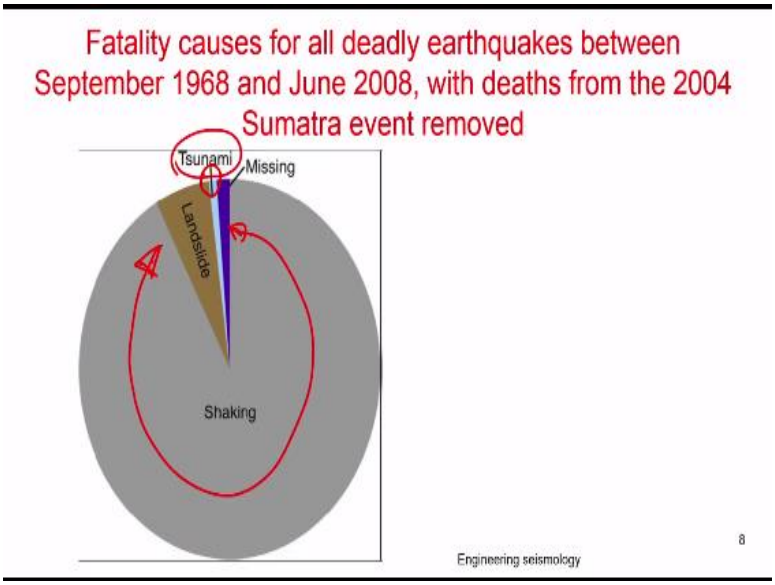

So the similar fatality model all the deadly earthquake between the September 69 to 2008 with death from the 2004 tsunami event is removed okay. So the previous one includes all the death from 68 to 2008. So basically you can see that the tsunami plays a major role among this particular portion, okay. So one fourth you can see this portion actually plays a major role.

But when you remove the 2004 tsunami, you can see the tsunami people died due to tsunami is very less. So according to me, okay so based on my experience and the research, tsunami kind of death can be almost bring to the zero level if you have the proper setup on tsunami warning system.

So unfortunately, even though we have advanced in scientific knowledge and other things, because of the perception, okay people perception and even though we have very active government and we had a very good scientific knowledge and then lot of

things before 2004, but we do not have the knowledge of the past tsunami in the region.

So we thought that there is no need of having the tsunami warning system in the sea or nobody was taken initiative to install a tsunami warning system. So since there is no warning system, so this waves are came to the seashore and many people died. So tsunami related things because you can predict about a hour and two hour after the earthquake so where people can easily escape.

People can easily move okay, so by using a alert. So that is why if you remove the 2004 tsunami, the number of people die due to tsunami is actually very thin. So the most of the people die due to the ground direct ground shaking, not by the other induced hazard. So which is major of we said tsunami is a major one. The another one is actually the landslide.

Because landslide mostly occurs on the hilly region, that percentage remains same irrespective of the tsunami earthquakes are removed, 2004 tsunami events are removed or excluded. So this is the one of the big lesson. So now our government implemented lot of Tsunami Warning System in the coast. It is not only the installation basically, it is also a maintenance, okay.

Many times what happen in India so people do the installation and setting up soon after the earthquake and talk widely, after that they will forget okay. So they will forget. So the things will happen then people will suffer. So you should carry forward a knowledge throughout the generation, okay. So if we carry forward a knowledge throughout the generation then people will be aware.

So what should be all the coastal should be knowing that all the coastal region should know that there is a possibility of tsunami in the coast. If the tsunami going to come what we should do? So I told you that last class people are went and see in the how the sea is going back okay. You should not do that okay. So something happens unusual in the water body particularly sea or any places you should immediately run away from that place.

So that kind of knowledge should be carried forward to the all the generation. So I hope this generation have that knowledge. So we should be carry forward irrespective of that, because the tsunamis are happening once in a 500 years, once in a 1000 years, once in a 2000 years. Since we do not know what was the last tsunami, it is very difficult to say when the next tsunami going to come, okay. So be better prepared for those kind of things.

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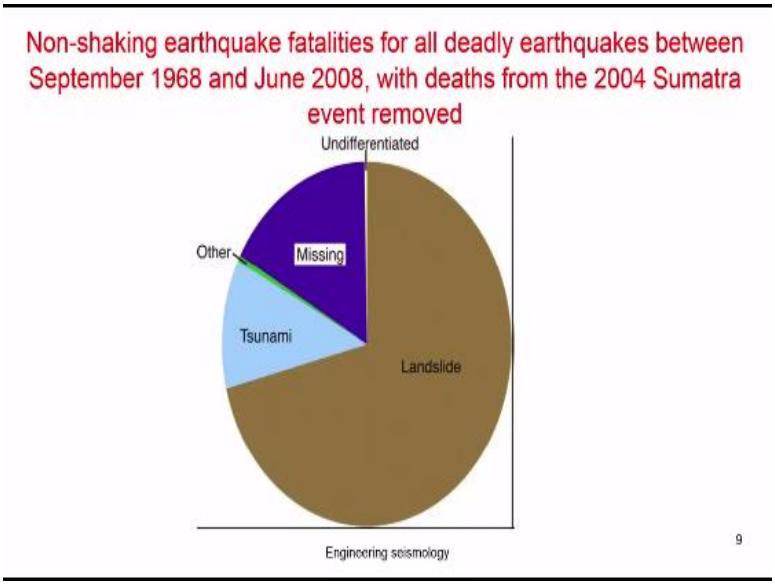

So this is hazard again you see that here also the major component is actually the ground shaking hazard, which causes a human loss like deadly earthquakes. So if we remove the ground shaking completely, the which one causes a major actually the landslide, you can see. So if you completely remove, so major component due to the landslide only. The another one is basically a tsunami, okay.

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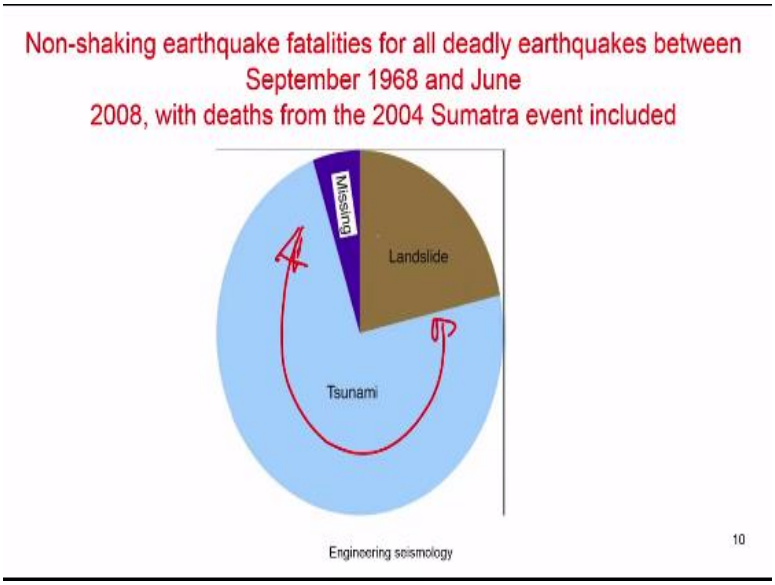

So again, here also including 2004 tsunami and then excluding 2004 tsunami. So the previous one is actually this one is basically 2004 tsunami is not included. So this one is 2004 tsunami is included. So when you include your 2004 tsunami you can see that the people died if you remove the ground shaking hazard people died due to the landslide is negligible, basically okay when compared to your tsunami.

You can see more than 70% of the people died okay if you consider the this hazard, tsunami, landslide and missing scenario the tsunami. So the 2004 you may realize that how many people died, what are the consequences is caused actually okay. So this scenario will give you the overall okay, so view of how the tsunami and landslide and direct ground shaking hazard resulted a deadly earthquakes.

Or how many people have died. So it is necessary to understand the earthquake to know or design our structure or prepared ourself to avoid all these kind of hazard or loss of human as well as economic okay losses to be minimized if you study these things, okay. So the one of the way as we discussed earlier that so we should try to understand a earthquake okay. So how the earthquake origin okay.

How the waves are propagating and how you can predict this earthquake hazard. I am not talking about the prediction of the earthquake, I am talking about the prediction of earthquake hazard which we have discussed. So that is what we are going to do in this course. So we are tried to understand a earthquake, okay. How the earthquakes are occurring? How the physics the earthquakes are work.

Then how the seismic waves generated by the earthquakes are traveling? How you can measure that seismic waves? How you can quantify the earthquake, okay. So then how to predict earthquake hazard, okay. So that is our whole objective of this course. Once you predict the hazard, basically you can design and retrofit and reconstruct all your structures to minimize your loss due to the earthquake.

So that is what we are aiming in this course, okay. So this is basically the last four lectures we are talking about the introduction about the earthquake and earthquake hazard and different type of natural hazard, what you should do to minimize these kind of hazard okay. So this you given you the importance of the your subject, okay.

So as I told you that whatever so you are going to learn from this, it is not simply getting a grade, it also helps a personal level improvement of your knowledge to prevent yourself from this kind of hazard. So you should put more concentration on this okay and see. So now I try to give you some assignment. So what you can see that you look at the last six month, okay, what was the major earthquake reported in the world, okay.

Then after locating that earthquake and then go through the that earthquake details and list what are the different earthquake hazards are caused in that particular earthquake. For example, last six months the biggest earthquake happened in India is the Nepal earthquake, okay. So the Nepal earthquake what are the different hazards are caused, okay.

So the hazards means like what we discussed earlier, the direct ground shaking, amplification, liquefaction, landslide, fire okay then the flooding and then tsunami. So among this which are the hazards are reported due to that earthquake. Because if you find a scientific article or Google so if you type in the Google like the largest magnitude earthquake in the last six month it will give you the which earthquake and name.

Then if you type that earthquake magnitude and date in the Google you will find lot of report. Then you have to go through report and find out and list what are those

hazards. And then relate whatever we discussed in the class. For example, I told you that the city which is located middle of the any place not on the shore may not experience a tsunami hazard. The city which is located non-hilly regions may not expect a landslide.

For example, Bangalore. So Bangalore you do not expect tsunami and landslide okay. And then as I told you that liquefaction occurs at a cohesionless soil deposit. The places where you have the rich in clay deposit soil you can you there is a liquefaction reported or not. Which are the places are liquefaction reported, what type of soil deposits okay. So that you can see.

So we by knowing doing this exercise, so you will be clear that if I say that a city name at a particular place, you could able to list what are the expected earthquake hazard on that particular city. For example, I say Haryana okay. So Haryana state what are the different earthquake hazard you can expect okay. Then Agartala what are the different earthquake hazard you can expect. Himachal Pradesh what are the different earthquake you can expect okay.

So then Bhubaneshwar okay or Puri what are the different earthquake hazard you can expect. So that you should see the city geographical location, what type of soil there generally found in the literature. Based on that you can write these are all the hazard possible that particular location which will give you the.

So if you understand that then you know what kind of hazard parameters we need to predict or estimate so that you can avoid the damage due to this hazard even if earthquake comes in the future okay. So that is this exercise will help you for that. So with that we will close this lecture. So I will thank you for watching this lecture. So we will meet you in the next class.