Introduction to Engineering Seismologyles
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Lecture-61
SHA - Source and Source-Site Distance

So, vanakam, so will continue our lecturer in Engineering Seismology. So, we been discussing about the estimation of the seismic hazard, so we started with how to prepare a seismo tectonic map. So, we discussed with you about the seismic study area. So where you need to estimate a seismic hazard, then we also discuss the seismic so study area, so SSA, so where you have to consider all the source on seismic data to estimate hazard at study area.

That is the SC like I told you that they Bangalore is your study area. Tectonic study area the seismic study area can cover a Mysore, Chennai nearby lodge areas depends upon the past year. We also discuss how to select your seismic study areas? What is the logic behind that? So, what are the parameters we should consider so we discussed and then followed by; we also discuss about the seismicity data, how to collect the earthquake data, out merganser, so what are the conversion equations are available.

So, then; how to estimate maximum Magnitude? What are the parameters should consider? What are the methods are available? We also discuss to what is the method I have developed ok. So then followed by the Mx is first and prime importance in the seismic hazard analysis. First if we established maximum magnitude. Ok at any region. Ok. The next step is to estimate a distance that the second important parameter in the hazard analysis.

The distance means where likely to earthquake going to occur and from that point to the; your study area. Ok. So that distance varies from generally zero from your starting part of the study area if there is any source in that study area itself and then it goes to the maximum to up to the end of the seismic study area. Ok, so sometime it may be 450, 500, 300 it depends upon the seismic study area what you consider.

So, today class we are going to discuss about the source to site distance and then the recurrence relation. Ok. So this is the third important parameters in the seismic hazard analysis.

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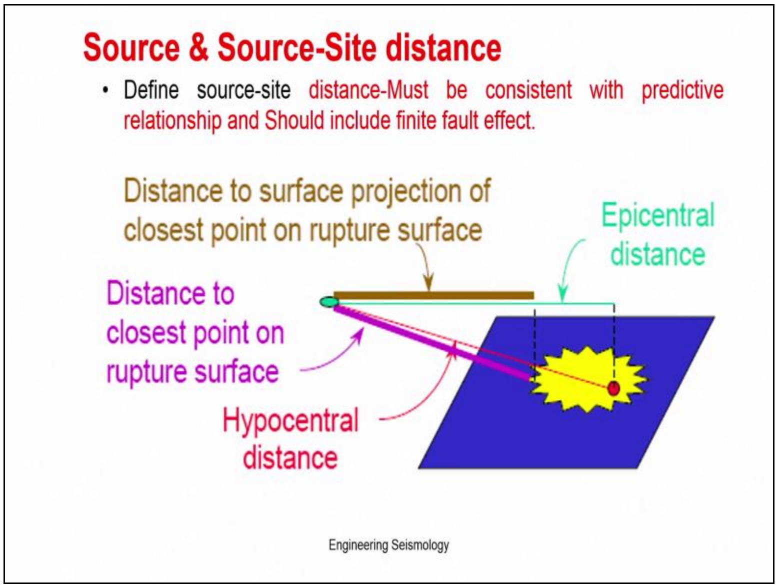

So the distance should be as we discussed earlier that it is a point between the basically your epicenter. So, the epicenter to the site so the site is basically your study area, so, this point will be anywhere in your seismic study area SSS. The origin where it is called as your focus, we discuss that focus point so the projections epicenter. Ok, the distance can be so that there are several way people will take.

For example a epicenter to you are a point of interest is the epicenter distance the focus point of interest is called as a ipocenter distance. As I told you that the beginning part the Johiner and Bore they told that the shortest distance from the rapture to the site. So, for example this is the focus but they end up in the rapture area like this. This is repute area. Then this point will called as the distance closest to the rapture surface.

So similarly the distance of surface projection of the closest point to rapture, so these are the 4 widely used distance is adopted in most of the predictive equations but the modern equation whatever today they call most of them they adopt a hypocentre distance. So, we should be clear on river to estimate this distance. This is typical examples shown with the first earthquake for the future earthquake basically, you should characterize the seismic source and then take where it can rupture, how long it can rupture then you can estimate basically the distance of closest to the rupture disk surface are ipo-central distance.

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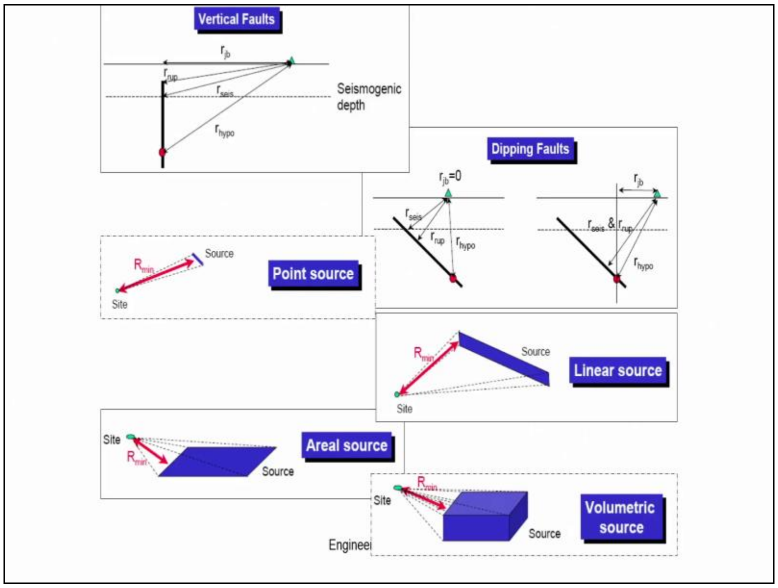

So this distance should be feeded in the predictive equation. So there are typical examples how this can be taken, for example, if you have the vertical fault. Ok, if you are the vertical fault how the distance can see the ipocentral distance, seismic response, the rupture distance and RJP Joiner and pore where the surface projected. So you can see that so among these basically which ever shortest can be considered for the highest worst scenario kind of things.

This is the point source again there is a like far away point R minimum so this is so much. So, the R maximum so much; so, the R minimum should be always consider. So when the M max comes you will be considering the maximum magnitude. When the distance come will be considered in the minimum distance why because R minimum will give the more hazard when compared to the R max.

So when you have the probabilistic approach basically you consider your minimum to maximum with variation in the distance that is what we do. This is a typically the dipping faults so you can see the dipping faults or seismic or rapture or hypocenter so then this is another dipping where you can see the jp type of; so this is again the source of linear source where R minimum R Max the minimum of should be taken if it is the DSH.

If is PSHI will be making a small, small grid and take each grid a the distance minimum so the volumetric source. We can see here. So like that are different shape and size of the source will influence on your distance. So you should appropriately estimate a different possible distance and take a R minimum ok, which will be the hypocentral distance or hypocentral distance minimum should be taken as a measurement for estimating the any hazard values.

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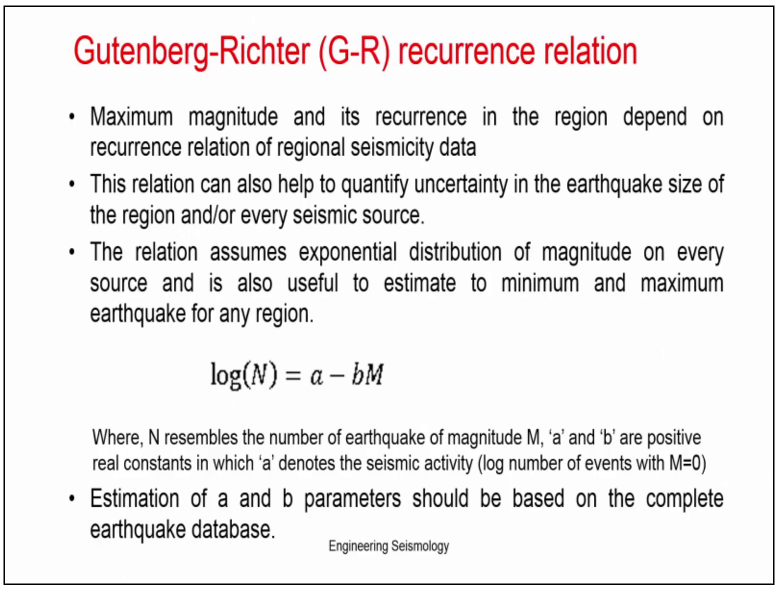

So, once you estimated the hazard values. The next part is actually estimating the recurrence relation. So, the recurrence relation basically gives you the repeatability of the earthquake in the regions. As we have seen that from the San Francisco the observed continuous data. So they are highlighted that is why it is not possible to predict the earthquake the recurrence very precisely but how still for the calculation purpose. We have to follow some kind of pattern.

So that region the Guttenberg Richter recurrence relation is widely used in the engineering seismology and for the hazard estimation. So, the Guttenberg Richter recurrence relations, so he what he related actually, so he related the number of earthquake and then a particular magnitude he followed a trend so that trend basically, gives you the how the recurrence rate in the region. So, the relation assumed that the potential distribution of the magnitude and every source it also useful to estimate minimum and maximum earthquake for any region based on the available data.

When N reassemble the number of earthquake of magnitude M and A B positive real constant with A denotes a seismic activity say a log number of event M equal to 0. The estimation A and parameter should be based on the complete data set. So you should know that the Guttenberg Richter relation to the recurrence model is applicable to the only a complete data set. That means you cannot consider that incomplete data set.

So this limitation one has to remember when you do the hazard analysis. Ok, so you cannot take all the data simply fit a curve. We should be done only for the complete data. That is why we do here step method of completeness analysis to find out the data is complete for how many year so that we follow know.

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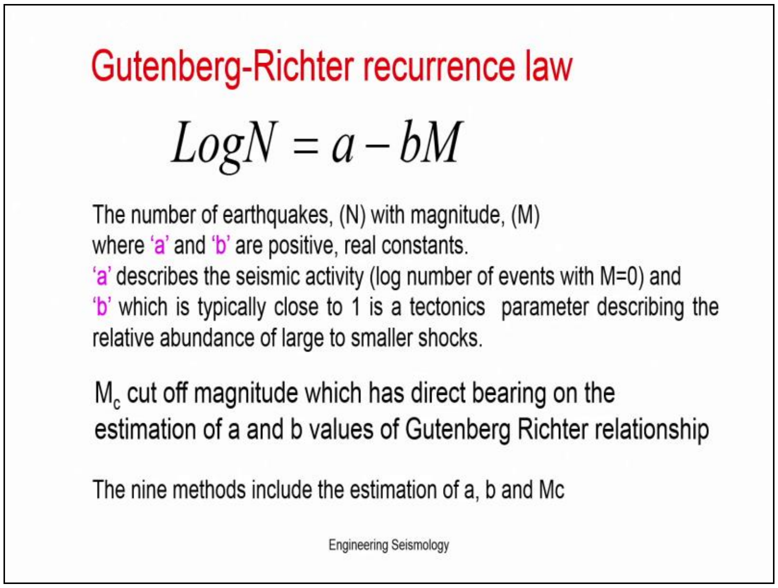

So, that data; so, after doing the completeness analysis, so you can take a data and try to plot log N versus M and then you get a line. Ok. So that line straight line you get that line the A and B will indicate what is the seismic recurrence of the region? So, number of earthquake N with the magnitude M a b are positive and real constant, a describe the seismic activity log number of event with M equal to 0 and b which typically close to the one with the tectonic parameters describing the relative abundance large to smaller shock ok.

So you have the mixed data. Ok. So all the magnitude of mixed data whatever happens in the region and you can; b will be close to the unity. Ok. You can see here. So M C is a cut of magnitude which has direct bearing on the estimation of a and b values the Gutenberg-Richter relation. So the 9 method includes estimation of a and b and M C which is suggested by Kicko and Selvel. So where there they given a many statistical method similar to a M max estimation so even there is a ready-made program call zed map.

So, that gives a calculation. So, you can run using that code using the metlab but how that works is this is how it works basically. Statistically they also given a explanation.

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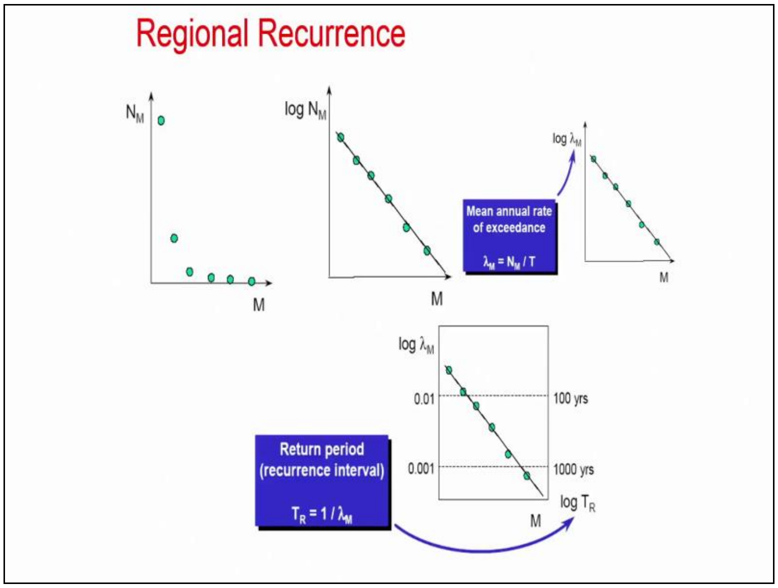

So, this shows that the N M versus M plot follow this term. So, when you plot log N M in this follow this term, this term basically the log M if you take a Lambda up M that is annual rate of recurrence where N M by T so this follows a run, this gives return period of any particular earthquake magnitude. You can see the log M and their reciprocal is that period shows the M. So, if you want to know what is the M return period?

So, you can see this ok. So generally the smaller magnitude will have the shorter return period a larger magnitude will have the longer return period this is what is estimated from the regional recurrence model. Ok. So you should make basically divide a magnitude as a different bin like

4.5 to 5.5. or 4.5 to 5 and take average value of 4.75 and then plot how many number of earthquake here and take a log M and then plot the next value.

So finally after plotting that you can see that it follows a perfect straight line equation, which is like we have seen a - b into M. Ok log M. So that a and b is your recurrence model coefficients and the equation is called as recurrence relation.

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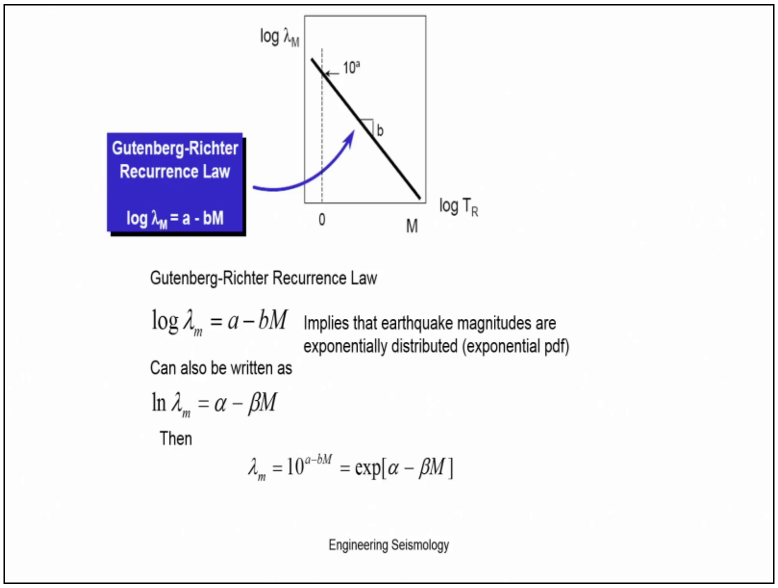

So Gutenberg-Richter recurrence relation this is how it comes like a 10 power of a and then the slope equal to be b. So, this can be also written like log M up as I told you that it implies that earthquake magnitude is exponentially distributed. So, also can be written like Alpha into b that like Alpha is equal to; so that you can see right side. So, you can rewrite this by modifying like this. Ok. So this is about the recurrence relation.

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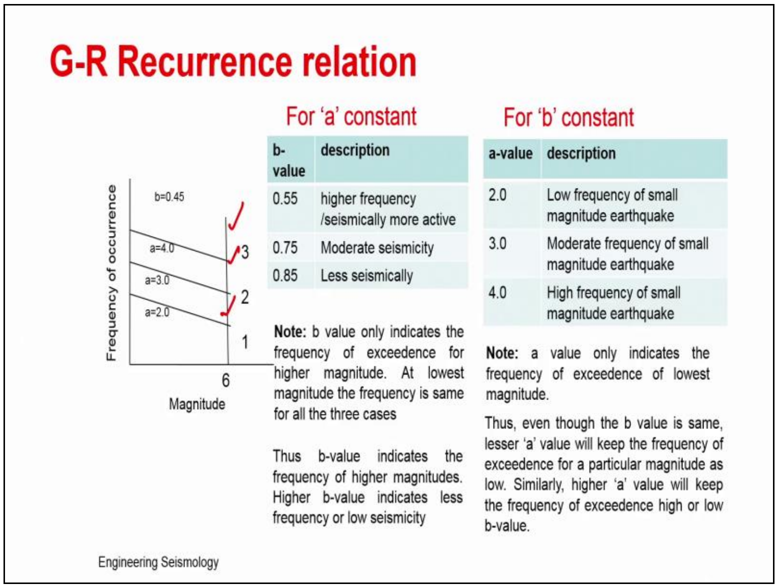

Recurrence relation what really it means? The frequency of occurrence and magnitude, so if you assume that there is a 3 curve 1, 2, 3. Ok, let us see how the b value varies so you can see that b value indicates a slope, so b value varies but what about the show the magnitude for the given magnitude of 6, what is the a value correspondingly you can see. So, here this b value indicates that high frequencies seismically mean more active which indicates that there is a large magnitude of the earthquake.

So, moderate seismicity and less seismicity where the mixed events are there. So, this is about the b value description. So if you go to the; b value only indicate the frequency of accidents of higher magnitude at lowest magnitude the frequency is same for all the three cases. So the b value indicates the frequency higher magnitude and higher b value indicates low frequency and low seismicity ok. So this is what about the b value and how it varies. So the similarly you can take the b value as your constant and then map estimated a value.

So we can see that a this 3, 4, and 5 the low frequency low frequency of small magnitude earthquake will have that low value. So the moderate frequency of small magnitude earthquake 3 and high frequency of small magnitude estimate 4. So a value indicates frequency of exceedence strength of lowest magnitude so even though the b value is same lower a value will keep frequency exceedence particularly magnitude as low similarly higher a value will keep frequency exceedence high as low b value. So, this is about the how the b value and a value for the constant one parameter. Ok. So this makes you to understand.

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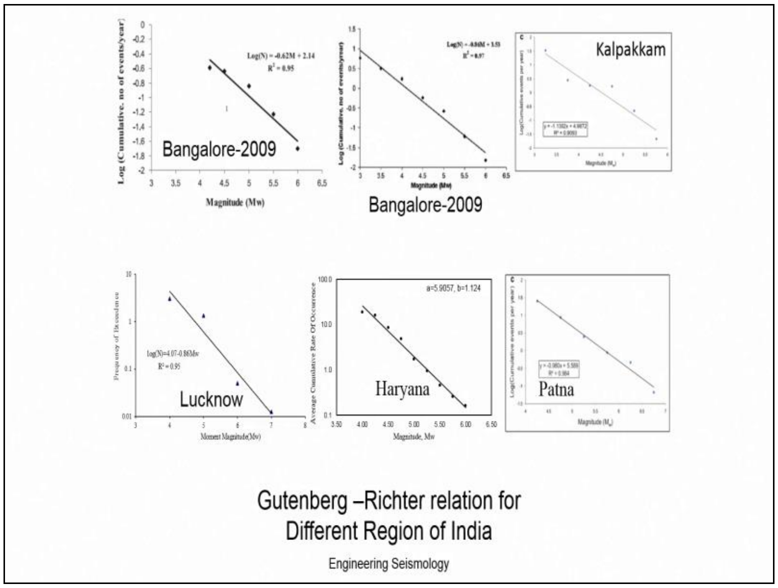

Let us see what are the different b values? We have got for the Indian region for the different researcher my own work also. You can see that this is actually the Bangalore 2009. Ok. So we got the b value of -0.62 and a value of 2.14. So, then again in 2009 there is a one more publication where we got b value close to the 0.9 and then 3.55. So, then Kalpakkam you can see the b value of like a 1.13 and 4.98 is a value.

So, Lucknow again you can see the values so this much. So, then Haryana 5 and 1.25 Patna you can get 0.18 and 5.5.

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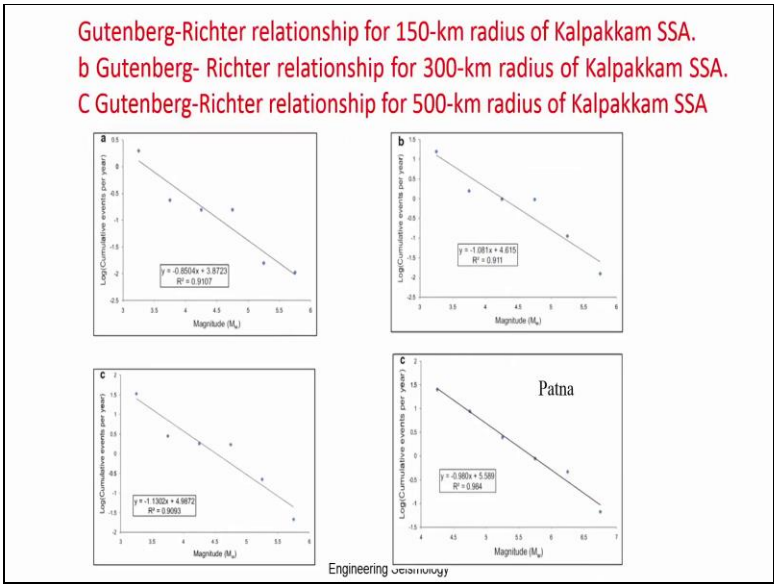

So, then this is again Gutenberg-Richter 150 kilometre radius also he is telling that the seismic study area influence is your M max not only a max your recurrence relation also why because the number of data considered for the recurrence relations are different for different region. So let us see, the a actually shows that recurrence relation for the 150 kilometre where b values is 0.85 a value is 0.378, b represents -1.08 and a value of 4.6 and c represents 1.13 and 4.98.

So, you can see the a value b value difference so the 85 then 1.08 and 1.13. So this is about the b value. So, the a value will be the 3.87 so than the 4.62 and then the 4.99. So, this will alter your recurrence rate of the earthquake estimation. So this is the again a Patna for the; so the entire 500 kilometre radius for typical; but this details you can find in so of our papers related to Patna and Kalpakkam how this will influence your hazard values.

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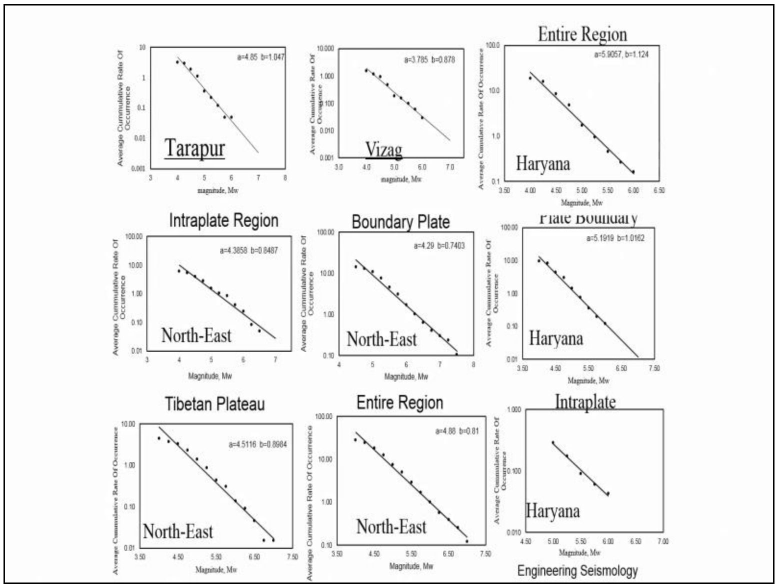

Ok. That is what you have done. So, this is typically the other studies for the different part of India. So, Tarapur for the seismic study area of 500 kilometre. So 4.85, 11.04 Vizag you can see then the Haryana you can see, intra plate region. So, northeast boundary plate Northeast, so the plate boundary, Haryana so the Northeast actually I told you that there is a complex seism tectonic.

So we considered as a two part 1 is at Northeast intraplate region, so another is northeast the plate boundaries region and see that difference in the a and b value it makes a lot of difference in your recurrence calculation in the PSHI analysis particularly. So, the Tibetan plateau the entire region and then intraplate Haryana so like that in our plate boundary Haryana and intraplate Haryana I can see that b and a value ok.

So here you should see that the a, b values are the function of how much study area considered and based on the your occurrence of earthquake in the region. Ok. So this will give you the indicate the how much the values are. So, you tentatively obtain particular place which is the function of the several earthquake reported in the any region. So, they estimating a, b value and their values are very important particularly DSH a concern if you want to go for the max estimation by incremental method, then your b value you need to know.

So otherwise in DSH b value are less used but in PSHA, this ab values are used to get year annual exceedence, the model whatever you are getting that is the function of your recurrence model. So PSHA analysis probabilistic seismic hazard analysis, so; where you get a very important for the b value. So, PSHA basically probabilistic seismic hazard analysis, you need to estimate a proper b value that influences your result of PSHA.

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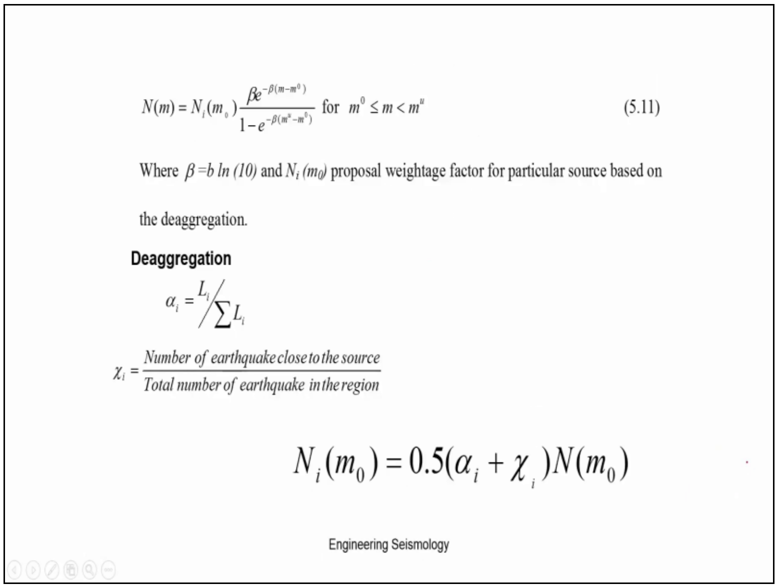

So how it influence basically we calculate a magnitude density function. So in the magnitude density function you can see that the beta, so that the beta what to estimate basically from the; your b value, you see the b value. So, this is actually what you get a b for the relation is actually the entire region so that has to be reduced to the particular source. Ok to know that how much the magnitude density function, varies with the source.

So that is like considering the length of the source and total length in the region number of earthquake in the particular source, number of earthquake in the entire region. So, that reduction is taken as this one. So what you get the ab value for that is for the entire seismic study area that will be narrowed down to the particular source based on the this de-aggregation procedure. So this comes in the PSHA.

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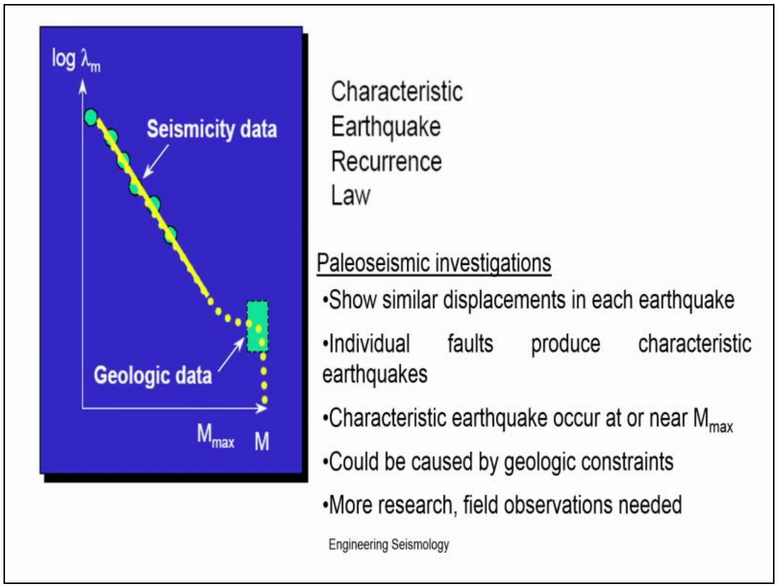

So when we will; there are also discuss about that. So, the scientist found that the recurrence model whatever we said straight line. It is not always true for all the earthquake. They found that the zoological evidence shows that is not a complete straight line. Ok. So it is not a complete straight line there is a change in the pattern of b value when you consider a very long period data are their earthquake. So show a similar displacement of each earthquake individual fault produces characteristics earthquake.

So, that characteristic likes zoological data are to be modelled on this location which does not follow this pattern. So, it is good because geological constraint more research and field observation needed to take care of this but right now the said that it is not yet straight line to come and hit your M max. So, we can see that one of the M max we use extrapolation of the M max recurrence model so that they say that it is not always true.

Ok. So that is are the characteristics occurrence of the earthquake model you can see. So with this basically we talk about the distance the seismic hazard analysis now the distance are very important. We have also seen that how to estimate a different way distance for different point sources and then we discuss about the recurrence model which is Gutenberg-Richter recurrence relation. So, widely known as GR relation which is estimated from the complete catalogue where you get a a b log N is the function of M.

If you draw a line; that line will give you a b value regions that is called as a recurrence model or recurrence law. How the a, b varies for the different region we have seen. Ok, the next part is so once we establish that the magnitude, the distance and recurrence relation. The next is basically the predictive equation, which you are going to use for the hazard analysis, so that part will be discussed in the next class. So thank you very much for watching this video. I will meet you in the next class. Thank you.