Architectural Acoustics
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Lecture – 37
Environmental Acoustics (Contd.)

So, good morning this is the lecture number 37, in our the Architectural Acoustics NPTEL course. Welcome to the; welcome to this lecture we will discuss about the Environmental Acoustics also in this lecture. As, the lecture topic says this is environment ac environmental acoustics 2.

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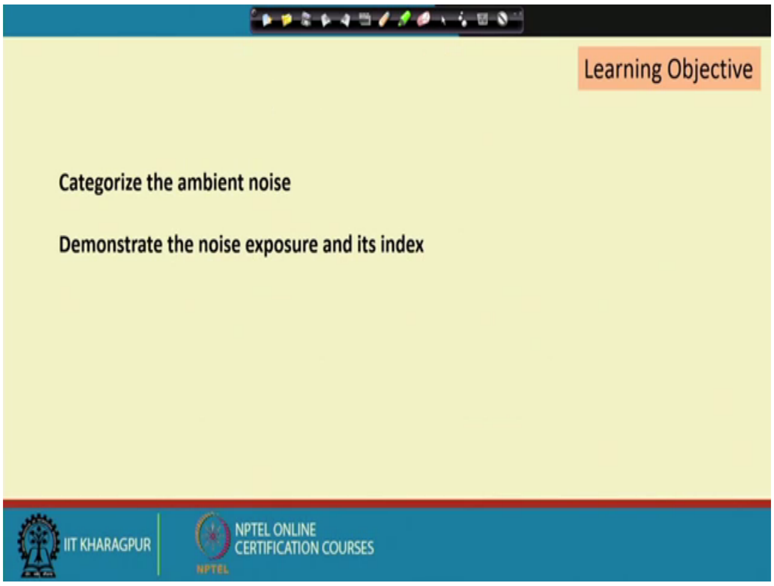

So, if you remember in the previous lecture, you have just the figure out and the outline the particular the acoustical phenomena's, which actually import are the sources which actually import the noise and the noise pollution in the environment.

So, in this particular lecture also we will go into bit of detail and also we will try to do some kind of the indexes for the noise exposure and all. So, that will be demonstrated in this lecture as a lecture objective or the learning objective. And, also we will categorize the ambient noise, what are the different types and how it will be actually functional in those the type of ambient noise.

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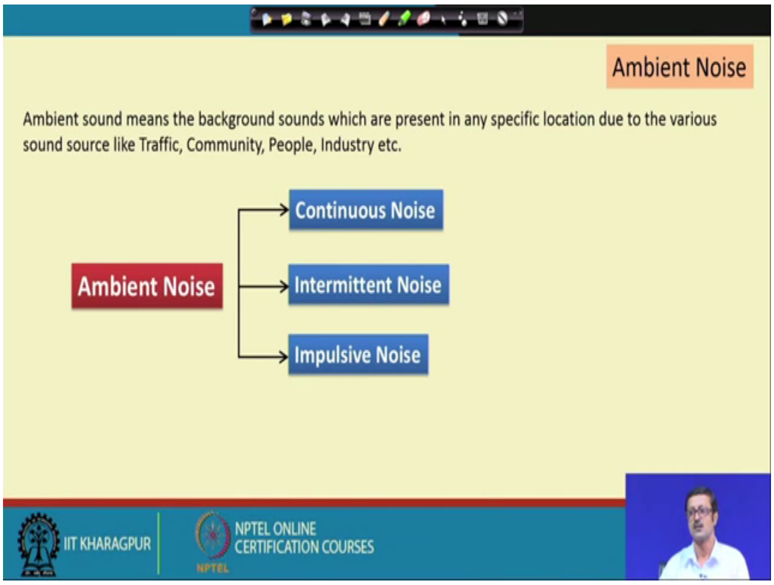

So, if I go with this ambient noise this is defined as, this means that this kind of a background noise, which sustain for sometimes or maybe a longer duration the time is also very important of course, and it is presence in a specific area and it is kind of a geographical area. Or maybe sometimes, it is also specified in a in and around surrounding a building built up environment, or it may be a community, or it may be sometimes industry, or it may be a kind of a suppose if you take a the shopping area, or may be a bazar or kind of a market area those are another area.

So, what is the ambient noise level of that area? So, that is the particular geographical conditions, which may or may not have that kind of the built environment, but its may should have some kind of background noise. Presence and duration is also important maybe a for a smaller duration of the time and for it is sometimes for a whole day or whole night also.

So, those are the typical the definitions are the which you can start with ambient noise, but ambient noise if you just go or if you just think or if you just remember. This ambient noise is are time is specific and also the nature specific; that means, it has 3 types as such; one is called a continuous nice ambient noise and one is intermediate, intermittent noise which is not continuous.

But, tend to be a continuity having kind of a continuity. And, the third one is not at all continuous, which is impulse if kind of a noise, which is a noise it is comes sometimes in some uncertain way or sometimes, it may not come may be in a day sometimes.

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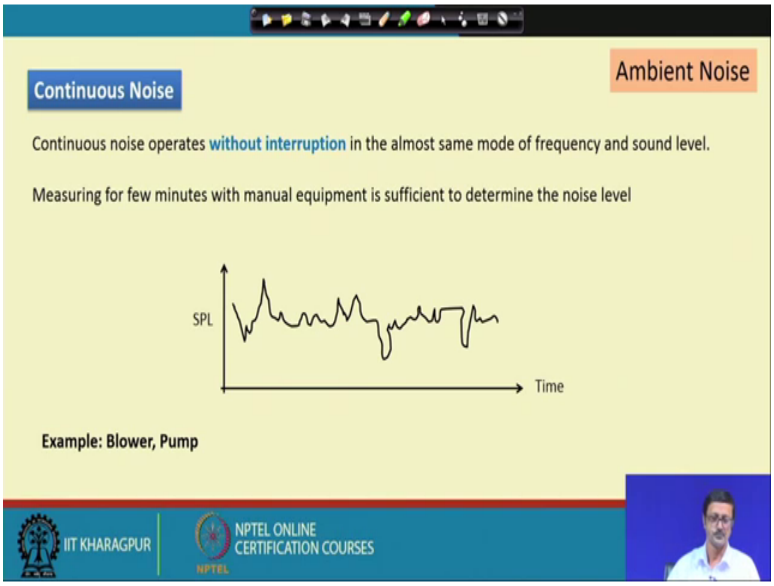

So, it is with that particular definitions and with that particular ambient noise ambient noise a classification.

Let us discuss this 3 type of the noise ambient noise. First one is continuous as you know continuous meaning is without interruption. So, this noise comes almost in a mode same mode of frequencies or same group of frequencies. And, it is actually an interrupted from the timeline point of view an in interrupted. And, also almost similar amount of the sound pressure level with exist. So, almost everything is similar the time specifics it is not time specific, it is a continuous, it is a not specific frequency specific, it is a kind of a band of frequency which go for a longer deviation of the time.

So, you required some kind of a manual equipment to for some supposing if you just go for a testing for those particular or the recording those particular noise and try to measure that particular noise. So, if you just spend some minutes of time and find out what is the total level of the sound. So, its look like this it is very steady kind of a the SPL level and if you just frequency if you analyze also it will be some kind of a steady. So, the examples are some kind of a blower, or some kind of a pump, you know the same kind of the mixed frequency as comes in a specific longer duration of the time.

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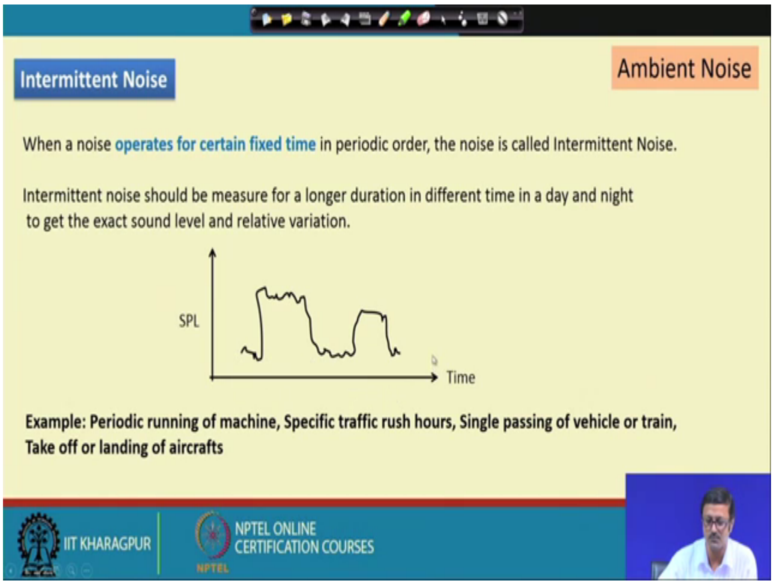

Intermittent Noise; Intermittent noise is that which is tend to be continuous it is a kind of a continuity, but there is some the gaps or some drops. So, it is operates for a some certain time which in that there is a plateau kind of a thing and then it is drops and then again it is goes like that.

So, to measure this particular sound you required a longer duration, little bit longer duration the time and for the those specific 2 3 hours' time, it is of course, depend upon the source, my specific also and you take the particular duration for the measurement for those duration longer duration and then analyze that one, it is look like this. It is a some steady portion sometime this minimum particular time, it exit and there is a drop and again this goes. So, you need at least some longer duration measurement and then you have to find out.

Now, what are the if you take a very small duration measurement suppose your measurement duration is here, you cannot actually sense the actual measure or if you can actually do not go to do not we will not get the actual measurement also. So, it actually see the longer duration measurement. Periodic running of machines, specific traffic rush hour is another suppose it is morning some 8 to 10:30 or 11, and this is a evening time and in the afternoon time it is little bit low because of there is no traffic in the road. Some pass train movement or those kind of a thing, and of course, the landing and the takeoff are some kind of a aircraft, which is also that kind of a specific.

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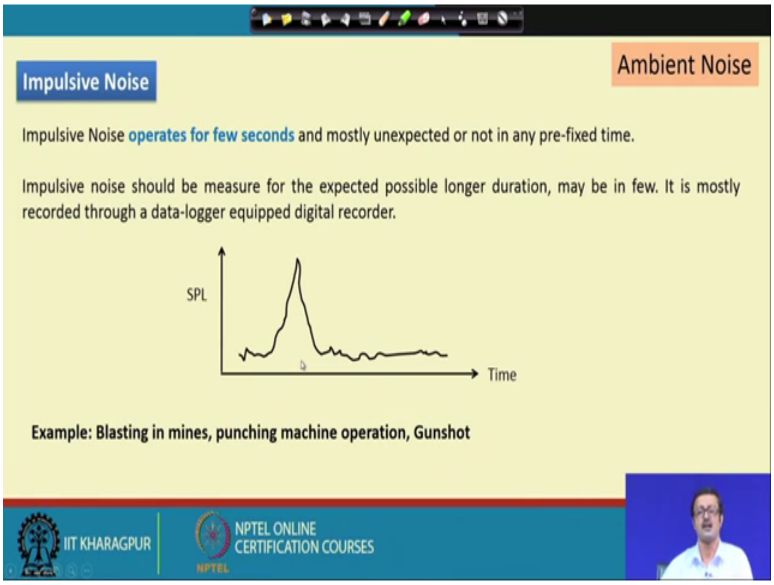

Last one is impulsive noise. Impulsive noise is a kind of a noise which operate for a few second or may be a very few second and it is very much uncertain when actually it will be going to occur unexpected. So, it is monitoring also very tough, because suppose for a full day there is no such noise, but there may be a day where there are 3 or 4 such noise going to be a, may be happened for that particular area.

So, you manual operations manual recording is impossible. So, you required a kind of a data logger with equip data logger digital recording machines and data logger which can take for longer period of data. And, after you receive those data and you analyze then what is the peak values also it sometimes look like this. So, there is a very few second there is a this huge or the high amount of noise and for a longer duration there is no and the occurrence of base is also un expected.

So, suppose there is blasting of mine, in the mine there are blasting some punching machine operation gunshot those kind of a thing or I may say suppose a the very high speed bike that moves in a particular road gives a very tremendous amount of sound. But it does not move sports bike are those kind of a thing is may not move very frequently, it can be it may be a example of impulsive noise or so.

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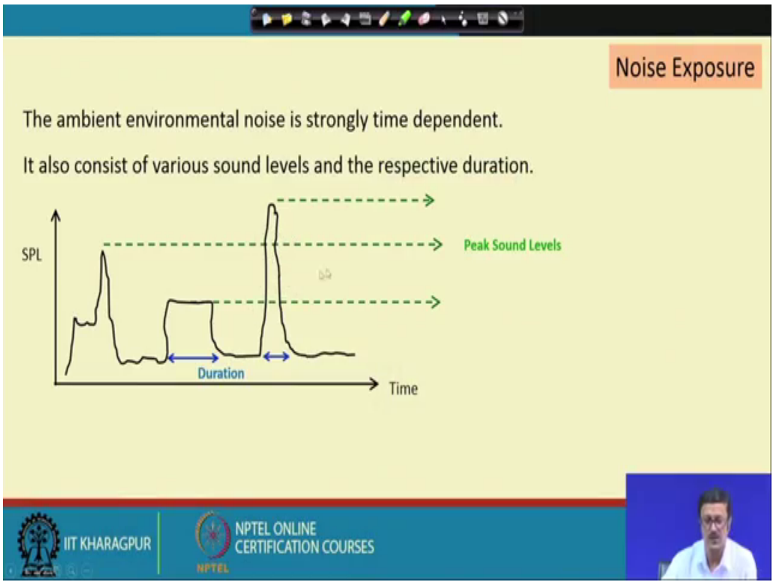

So, as we understand from the earlier 3 slides, it is not only the amount of noise that is a SPL of the noise, it is not only the frequency of the noise. And also the character of the noise and the source and all those kind of a thing, it is one of the important the character of the urban noise or the environmental noise is that is exposed time the, it is very much time dependent.

So, suppose a very high level noise of suppose 90 dB also, it is act for a very few second it may not give you a that much amount of impact in your brain, but suppose a little bit of lower decibel level in 65 decibel level sound, stay for a continuous period, continuity. So, that particular noise may be for a half an hour also that particular we are exposed to a particular that particular environment 65 dB noise also may give you a very much problematic from the point of view of the health or so.

So, the noise exposure how much time you are exposed to noise is also important. So, what we have seen in the earlier lecture is that, I am going to find out the average and the total amount of noise and the evaluated noise or so.

Which, now in this particular exposure point of view has to be taken in consideration of the in the time so, what frequency and, which amount of the decibel level stays for how much amount of time? So, time factor has to be also embedded or the in builted with this particular the index system and find out the what is the total noise exposed.

So, I have told you, if this is the character characteristics of the SPL and the noise some is stay for a longer duration, some is not stay for a longer duration, but the total SPL level is very much peak very much peak is very high. So, maybe this is problematic this may not be, not this may not be. So, now how I can actually now tell of the SPL and the time, this is a fusion between the SPL and the time is required for this kind of the noise exposure.

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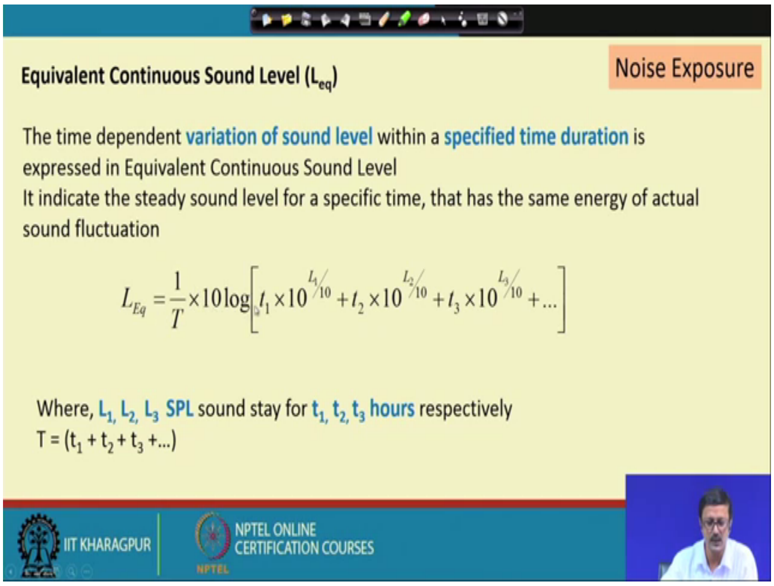

So, what we have can do is that we can actually find out the continuous sound level, which is equivalent continuous sound level. A noise may be a bip and again after some time there is a bip and again there is a another bip. So, each high level noise stays for how much and then let us convert that to equivalent continuous sound level, it has been done.

This various specific sound level and the specific time duration point of view. And, this formula has been given like this is the E L equivalent, which is a time dependent phenomena is T 1 into 10 to the power L 1 by 10 this; 10 to the power L 1 by 10 we have already experience in the last lecture. And, that has been multiplied by t 1, what is t 1? The t 1 is exposure time of the L 1 sound.

So, some source of sound having a L 1 SPL level, stays for t 1 hours. So, this will be the cumulative effect exposure effect of that particular sound. This is the cumulative exposure effect of the second source of the sound, third source of the sound; like that you add it up. After, you add it up log make the logarithmic of that big number multiply by the 10.

Very usually what we did in the log the this the totaling of the particular noise level. And finally, after multiplying by this by 10 divide this one happen capital T. And this capital T is nothing, but the hours' time this is equal to this exposure time the arithmetic some of the exposure time.

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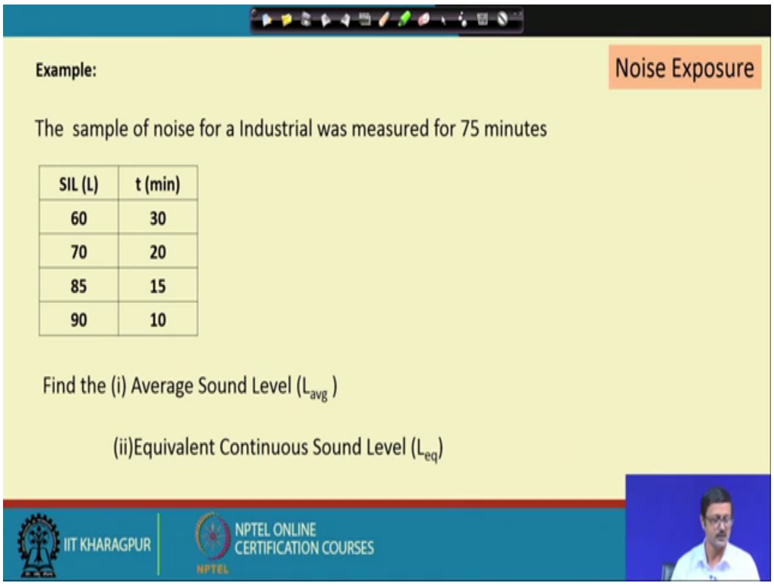

So, I have some, I have suppose measured some 75 minutes noise sample in a any locations may be industry. So, it has 60 dB and that stay for 30 minutes, this 30 minute may not be continuous 30 minutes, it may be a 2 minutes and then there are again some gap of then there are some 70 dB or 70 dB for 2 minutes and then 85 dB for 1 minute.

And, then again 60 dB for 5 minutes something like that ups and downs, but totally this 30 60 dB is stay for 30 minutes. And, total amount of 70 dB sound stays for 20 minutes, 85 dB s for 15 and this 90 dB is for 10 minutes. So, by I need to find out the, what is the L average and the L equivalent.

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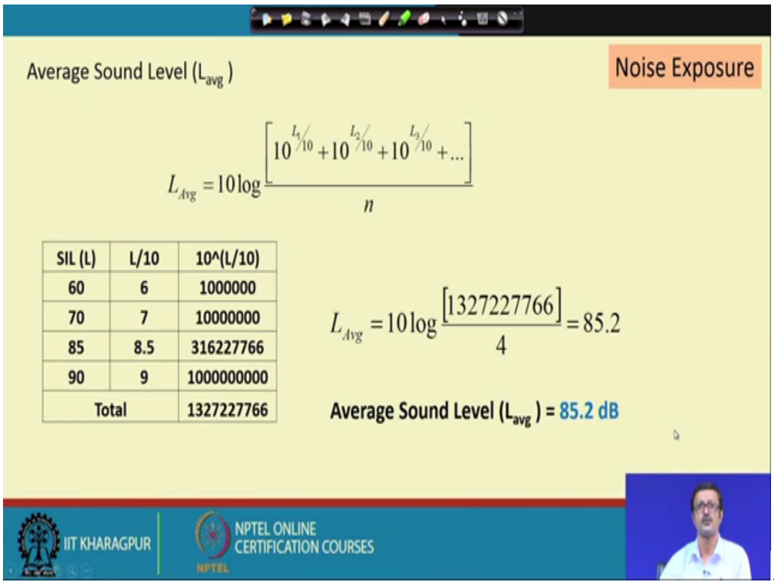

The L average I know I have already done this in the earlier lecture. So, all this by 10 and then logarithmic sorry 10 to the power of that big numbers totaling of that big number is a huge number, and this huge number is divided by 4, because there are 4 the data set or maybe the 4 observations. And, I am getting around 85.2 dB is the average sound level of that particular situation which, but I have not taken any exposure time into account.

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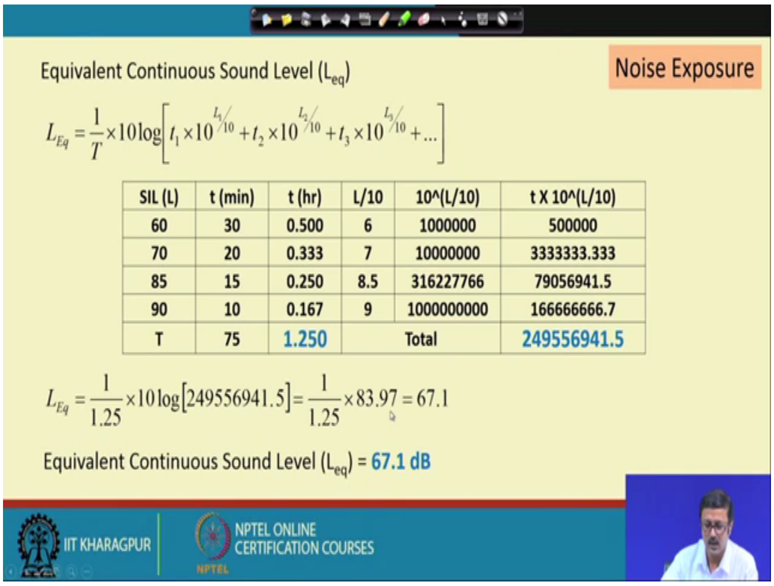

So, next what I will do, I will go for the l equivalent, which is I am taking the exposure time into account. So, this particular the, that particular table is expanded. Now, t are also mentioned over here in minutes and t is also mentioned in hours and this t in hours is multiplied with the respective 10 to the power L. And, then this number are created and again you have to add it just like this, you have to add this t 1 multiplied by 10 to the power L 1 by 10 this number.

So, there is a huge number and this has to be next is the logarithmic of that into 10 is 83.97 and that has to be divided by capital T. The capital T is nothing, but this plus this plus this plus this which is 45 minute I am sorry, 75 minute and the 75 minute is nothing, but have to be converted into the hour which is 1.25 hour.

So, finally, this is the result this L equivalent is 67.1 decibel; that means, if you are exposed to 60 dB with sound level for 30 minutes 70 dB for 20 minutes, 85 for 15 minutes, 90 for 10 minutes is almost like you are exposed to that 75 minutes in a sound environment equivalent to 67.1 dB. So, the noise exposure has been taken into account.

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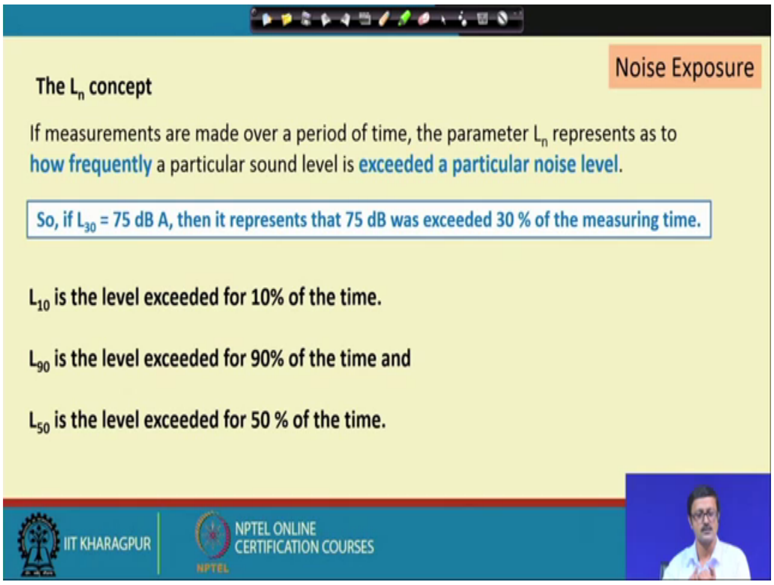

Then, there is a another way people has looking to it is called as a L n concept that is L n is the 3 L s the levels. And, this is how much noise is the above of that particular level. So, suppose if I say L is 30 75 dB A, this evaluated scale point of view. That means, the 75 dB represent this L 30 equal to 75 dB A represent that, the 30 percent of the measurement time, 75 dB the noise was more than exceeded the 75 dB.

So, similarly there are 3 such levels has been considered, the L 10 amount of sound dB in dB A that exceeded 10 percent of the sound 10 percent of the time. And L 90 is the 90 percent of the time, how much sound is exceeded of that particular level more than that level. And, L 50 is the averages this is the median point of view, the 50 percent of the time how much is the more than that particular level.

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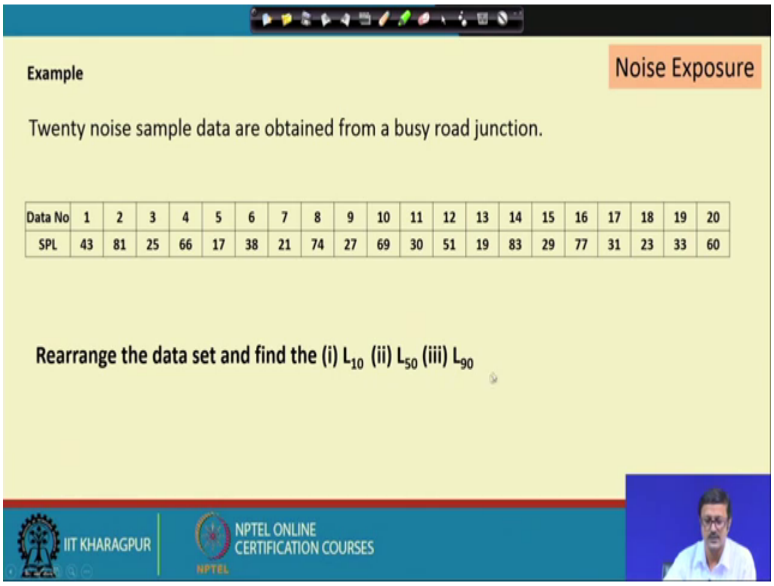

So, let us I have 20 noise sample data I have obtained suppose for my bus busy road station junction, road junction and those are the data number 1 2 3 4 to 20 and those are the SPL level or of those particular, and I want to find out this 3 levels L 10, L 50 and L 90.

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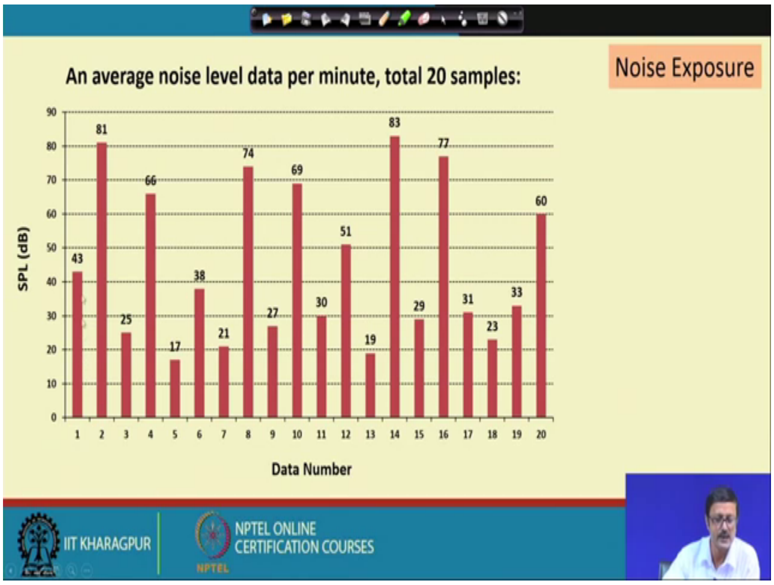

So, what I did I did a bar diagram? So, those 20 data and this SPL so, this is first one is 43 81 25 66 like that. So some of the very high, some of the very low, some of the in the medium category medium range.

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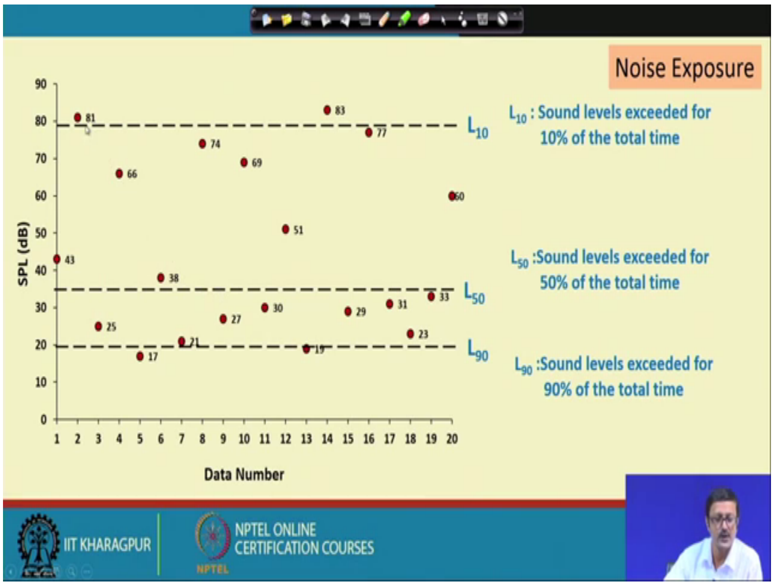

So, I plotted those particular thing and I know that this is through I have 20 data. So, 10 percent of the 20 data is 2 and so, this two the highest two are 81 and 83.

So, the 10 L 10 is this line, because everything is more than 81, I mean 10 percent of the time is the sound level of that particular data is more than 81 decibel. Very similarly 90 percent of those 20 is 18. So, if I draw a line over here this two 19 and 17 are below. So, those 18 are above this 99.

So, I can say this L 19 is 21 decibel, because 90 percent of the all the data or the all the time I mean involve the this things the exposure or more than 21. Similarly, I have drawn another line over here 50, because 50 percent of 20 is 10. So, if you see above this particular line there are 10 dots and below this particular line is 10 dots. So, I can say the L 50 is 38, because 50 percent of the time the noise is more than 38, 38 or more than that. So, L 50 is 38, L 90 is 21, because 90 percent of the time is either 21 or more and more than that and L 10 is 81.

Because, the 10 percent of the time the total of the total the it is more than 81 or more than 81 so, 81 83 or above that. So, how can you easily do that, if you have this data in sure that data in the descending order so, from the highest to lowest.

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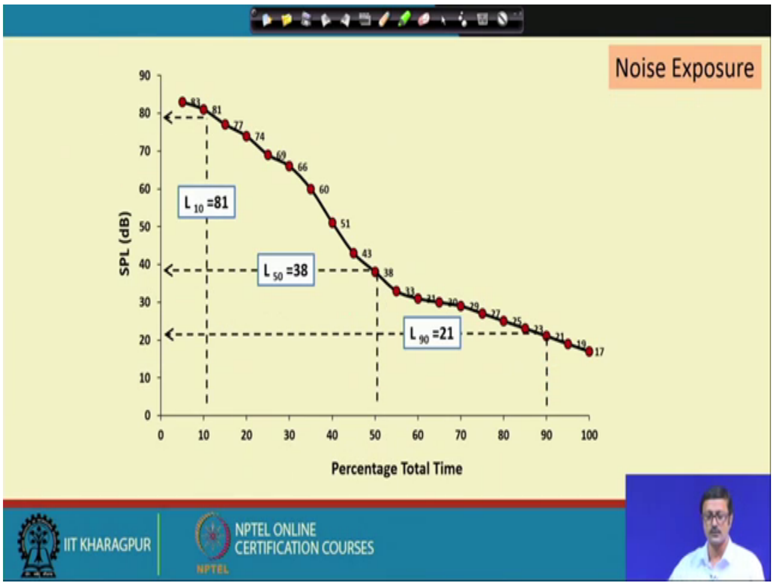

So, you know this is the sample is 10 sorry 20 sample. So, this 2 so, this 81 will be the take to a part. So, 81 will be your L 10 this 38, because this is the total 10 total 10 numbers dots above that 38 is the L 50. And, this two or bellows 21 22 or below. So, this 21 is this one, I think this line has to be shifted little bit here. So, this it is more than 21, is more than that is the 90 percent of the level or so.

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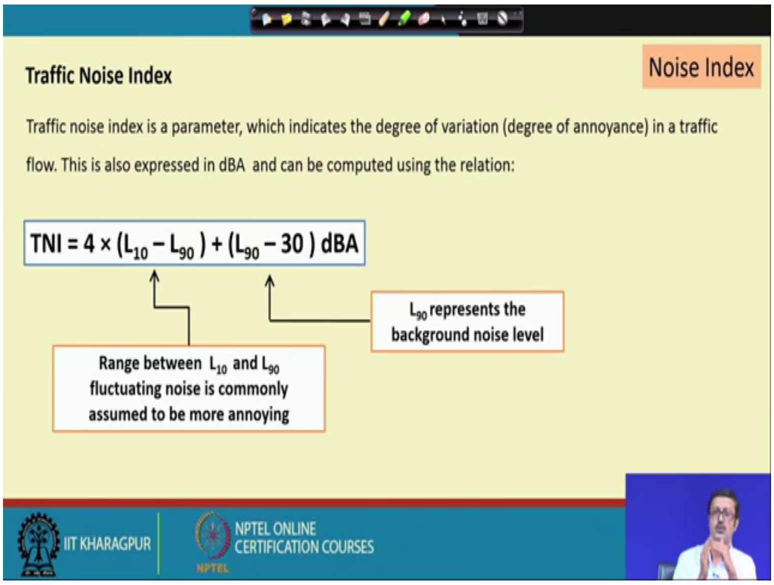

So, from this point of view the traffic noise index is has been derived, which is given as the T N I traffic noise index is this formula 4 times L, 10 and L minus L 90, what is this L 10 and L 90? The upper limit and the lower limit this is the between this particular upper limit and the lower limit, this range is gives you the range between the L 10 and the L 90. The fluctuating noise between these 2 particular point plus L 90 minus 30 and this total has to be expressed in dB A view why it is L 90 minus L 30?

Because, L 90 what L 90 is not the upper limit, L 90 is the lower limit. So, L 90 is referred as the represent the background noise. So; that means, the L 90 is the lower 10 percent and the all 90 percent of those are above that. So, we can say that this particular noise level always going to be there. So, that is the background noise.

So, this is the second part of this equation confirm the background plus. The first part of the equation confirms the range and that is give the T N I index of a traffic noise index.

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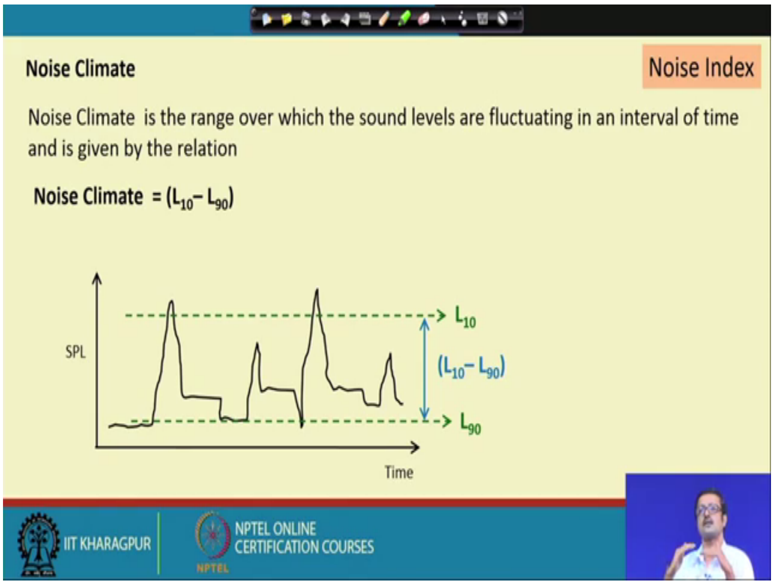

Very similarly, you also there is in index called the noise climate. It is the relation is difference between this is range in L 10 by the minus L 90. So, if there is a kind of a time line is SPL given for a particular the noise source or may be a mix noise source. So, you have to find out what is the L 10 and what is the L 90 and the difference between them L 10 minus L 90 is your the noise climate.

So, you can actually understand what is the you remove the top 10 percent, you remove the bottom 10 percent. So, the middle 80 percent is within what zone it is gives you kind of a indication? What is the fluctuation of the noise climate or the noise you are expose to or a particular area is expose to.

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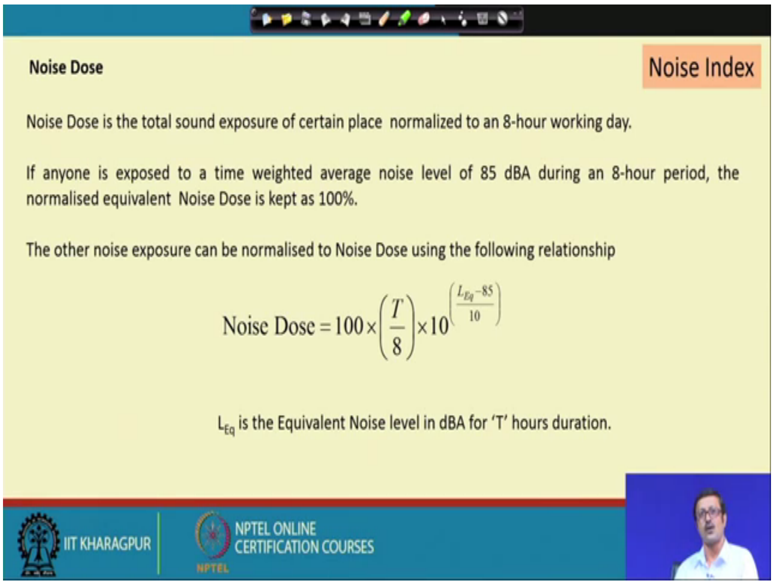

Then, next is the noise dosing this is also very important, sometimes it is very important from the industrial noise point of view. It is says that it is as it is the defined as are the noise dose is how much noise and how much duration, what is the time duration of that noise, both are taken together for a particular the level.

So, what we have seen in the equivalent L equivalent. It is the totaling it is the totaling of if you have a n number of SPL level and dose n number of SPL level have t 1 t 2 t 3 t n. Then, it is gives you a kind of a average scenario what should be the actual equivalent level of the noise for dose timeline, but here it is not for the different noise level, it is for a particular single noise level and single noise level is exposed for that particular time.

So, it is particularly very much important for industry industrial noise calculations also. It is what you have given here is that or what is the benchmark is that a time weighted noise level for 85 dB A for 8 hours period is taken as a 100 percent dose. That means, if I am exposed to 85 dB a sound for 8 hours, morning 8 o clock to evening 4 o clock 8 hours, I mean exposed to that particular noise 85 dB noise. And; that means, that particular total amount of the noise exposure to me is almost over 100 d 100 percent.

And, suppose next day I am exposed to 90 dB or may be 95 dB noise, but for only for 1 hour so, definitely what will be the corresponding change in the noise dozing, it will not be definitely going to be 100 percent, it may be less or may be more because of the ninety dB is more and time then again the time duration is less t.

So, how that it can be calculated, it can be calculated by the simple equation 100 into T by 8 the T has to be mention in hours. And, this is L equivalent of that particular noise level minus 85 divided by 10. And, that will give you a percentage dozing suppose if you just put I mean I think, I have it in the yeah, I have a it in this particular format I mean this particular slide.

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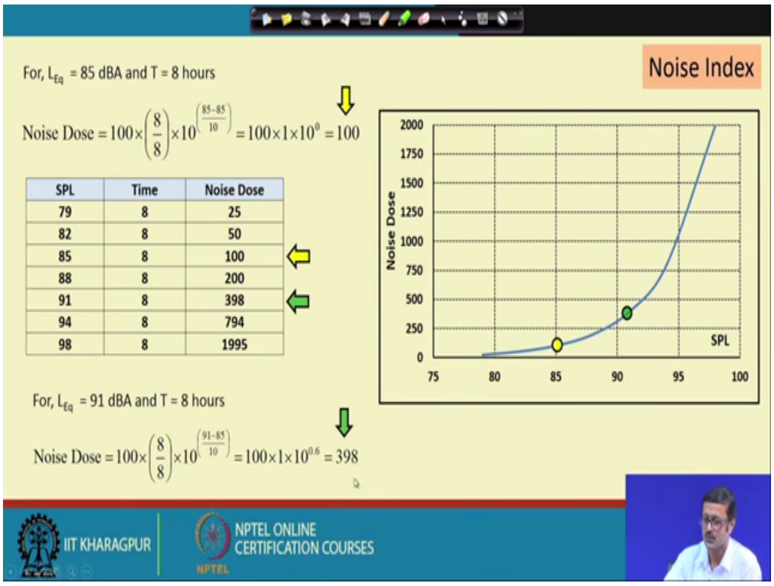

Suppose, I have SPL levels 79, 82, 98 like that and all are having suppose expose time of 8 hours duration. So, the suppose a case of suppose I have taken 85 and 8 hours. So, I put T capital T as 8 and this t if you just go through the earlier slide is T and this L E q has to be changed. So, here this is 85 minus 85 by 10 is 0. So, 10 to the power 0 is 1 and this 8 by 8 is also 1. So, it is 100 and so, that is 85 dB and for a time of 8 hours is equivalent to 100 percent of the dosing.

So, this 100 and this 100 and that particular point in this graph is 100 85 of 8 hours and this is 100. And, next is suppose I have exposed to a 91 dB sound and also I am expose for 8 hours for 91 dB next day. So, what is my equivalence, equivalent dosing the on that particular 85 100 percent dosing. So, I as put 91 over here and minus 85, which gives me 10 to the power 0.6, because 91 minus 85 this 6 and this 8 by 8 remain 1 and this 100 so, it is gives me almost 300 and 98 almost 400.

So, if I expose to 91 dB sound for 8 hours. My noise dozing is almost 4 fold 4 times. So, this is over here 400. So, this graph shows a from a 79 to 98, I have drawn this blue colour and shoot up it is this the fold is shoot up in it is a logarithmic increasing kind of a scale it is exponential kind of a scale. So, even that gives a particular understanding or that a high level noise. And, for a minimum time or a small time is almost equivalent to a low level noise of a high amount of time exposure.

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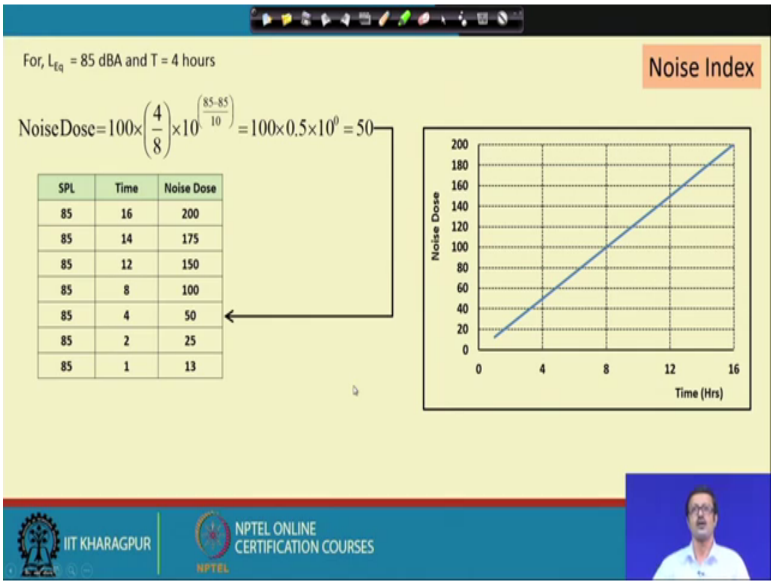

Next, what I did is that I have kept this SPL level same so, just reverse of this table where this SPL changes time has been kept. So, equal here this fill is kept 85, itself and time is now I am varying from 16 hours to almost 1 hour. And, as you know the 85 with 8 hours is 100, which is the correspondingly is the benchmark.

So, let us calculate if it is 85 dB and for 4 hours. So, then this T become 4 and this 85 minus 85 this will be 0 10 to the power 0 is 1 this is 0.5 so, 50. So, it is from 8 hours to 4 hours is drastically dropped by half and if you see it is T is a linear, if T is does not come on the 10 to the power. So, we will get a very linear graph, very linear graph if it is 16 hours, which is twice of the 8 hours your noise dozing is twice of 100 that is 200. And, if it is 1 hour that is the one-eighth of your duration of 8 hour, which is one-eighth of 100, which is 11 12.5 I have just make it as 13 12.5.

So, it is a very linear kind of a graph we will get. So, that is a noise dose which is one of the another index noise index.

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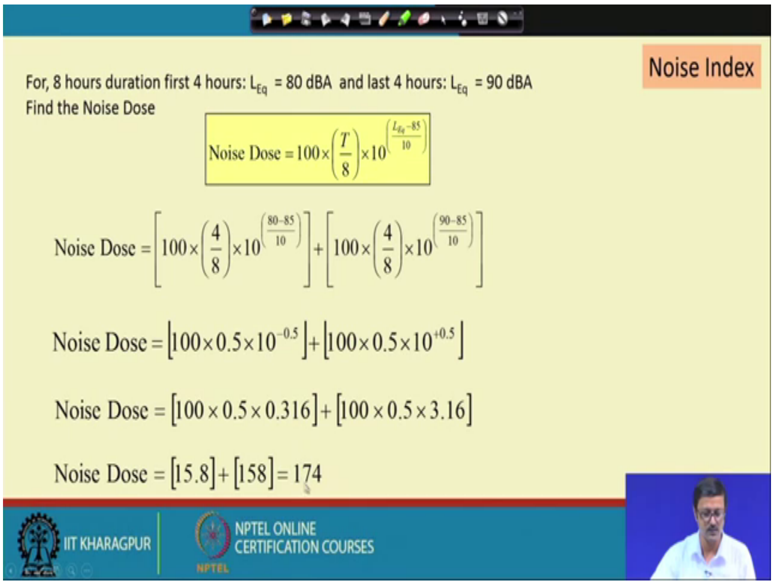

The noise dose is now, let us have a noise dosing of 2 different noise having 2 different time. Suppose L equivalent if it is for first 4 hours is I am exposed to 80 dB sound and the last 4 hour I am exposed to 90 dB sound.

So, with this I can find out this first 4 hours of 80 dB and then 90 dB and then I can calculate this is all 0.5 this is 10 to the power minus 0.5 and 10 to the power plus 0.5. And finally, I can find out this noise dosing is 100 and 74 100 and 7 4 that is the dosing.

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So, ambient aircraft noise is also one of the issue nowadays and this particular noise is monitored by the civil the airport authority of India. And those noise can be carried out where this particular airport is as per hour C P C V at 50,000 aircraft per an year. And, that particular aircraft, air strip or may be this airport has to be taken under consideration.

And, for that a D N L that is the day night average sound level has to be considered for that particular thing, where the L equivalent has to be measured for the 24 hours period with the 10 dB penalty for the night time I will explain that in the next slide. So, this time duration night time duration is the 10 PM to I mean the this 6 AM this night.

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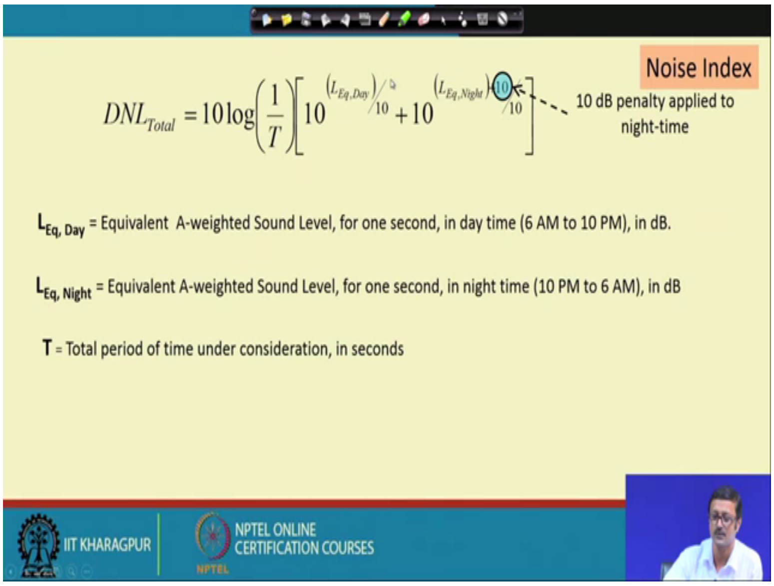

So, this D N L total is given by this formula, where this equivalent noise level for the day, which is this, the equivalent a weighted sound level for 1 second in a day equivalent for 1 second in a day the impact is of 1 seconds, because in a day for 6 AM to 10 PM in dB. So, it is taken care of the impact of the sound or impact of the time and also the E equivalent of the night is also taken care of and that is also taken care of and that time duration is 10 PM to 6 AM.

Because, as you know the airport, which airport are actually taking care of the 50,000 aircraft passenger aircraft per day is definitely the whole day, and night there are some takeoff and the landing is operation is there. And, as it is for the night it has to be taken a penalty I mean we have to take a 10 dB plus with this particular number, which is actual number, which is actual the measurement from this airport plus 10, the 10 dB penalty applied for the night time only this no penalty for the daytime.

And, this total period of the time in consideration in second that how much second we have consider for this particular time data, that has to be taken into accounts, L equivalent for how much period of the time duration has to be taken care of.

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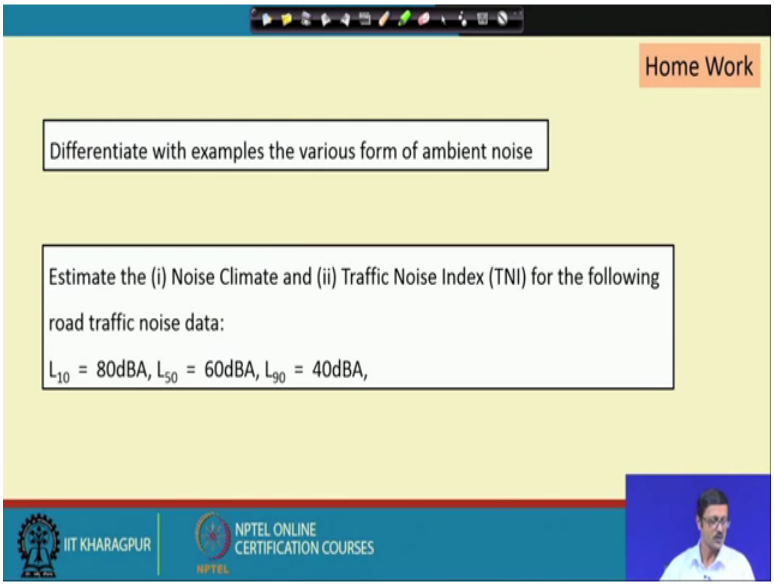

So, at this end of this particular lecture number 2 of our environmental acoustics again I have some homework for you, this some theoretical questions, that is what is the differentiate with the example the various forms of ambient noise with example. And, the second one is that the estimate the noise climate and the traffic noise index that is T N I with this following data if the L 10 is 80 L 50 is 60 and L 90 is 40 dB A. So, find out the what is the noise climate and what is the traffic noise index?

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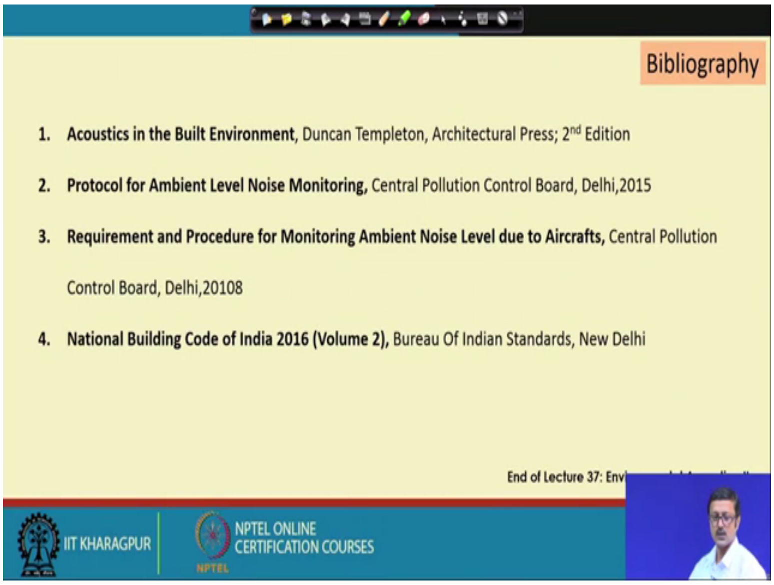

For this particular lecture also I have the consulted the similar books with some publications available in the net from the central pollution control board New Delhi and our national building code. And, those one books of the acoustics in built environment. So, thank you for joining in this lecture number 37 ends here.

Thank you.