Architectural Acoustics
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Lecture – 36
Environmental Acoustics

So, welcome friends, welcome students now, where in the 8th lecture, the 8th week lecture and the this last week we have kept the module on the Environmental Acoustics. So, in this module in the 5 segment of those lecture starts from the lecture number 36 which, will deal with the Environmental Acoustics 1.

We will go to the Environment Acoustics 2 in the next lecture and then we will go to the, some urban noise and the some of the dealing with the urban noise and the mitigation of the noise.

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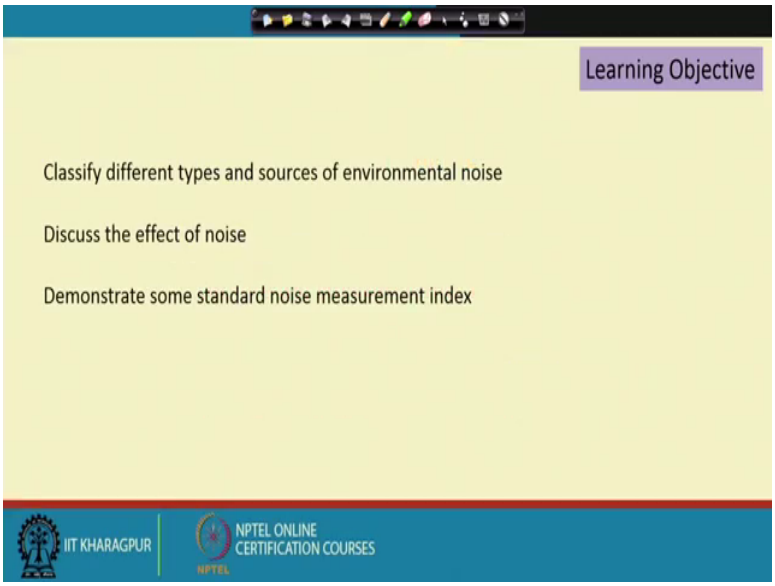

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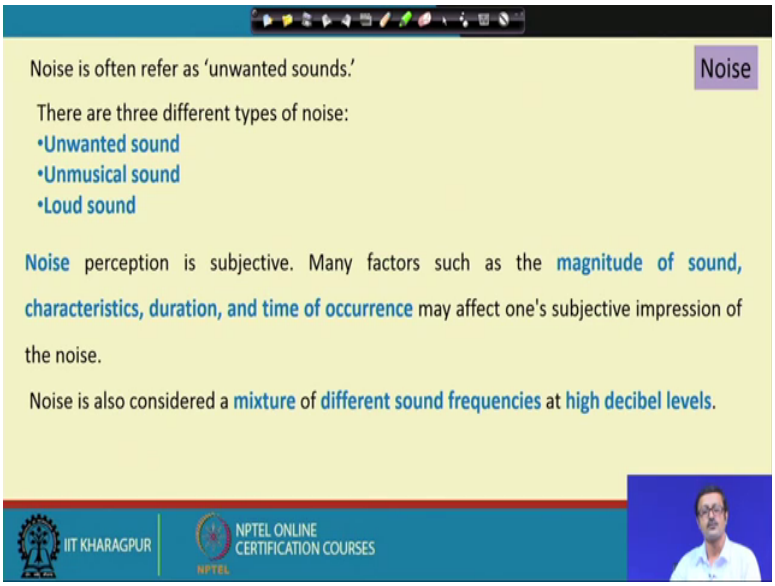

So, as usual will start with the learning objective; so, here, the we will initially classify the various types of environmental noise and then will discuss the effect of the noise and some of the measurement techniques and the measurement indexes. The first one is which comes in our mind is that what is the noise; noise is actually an unwanted sound. It has typical three parameters, if the sound is very loud then it is the unwanted in that way and sometimes it is the unwanted incense of this unmusical kind of a sound which cannot create, that kind of a sensation, that kind of an interest in our brain or interest in our mind; so, that a typical sound will be treated as a noise kind of a thing.

So, it is again a, very much subjective criteria, but even though if it is a subjective criteria, there are some kind of characteristics. in this criterion, where the magnitude of the sound and the duration of the sound and typical frequency of the sound and also the when its particular sound is actually going to be occur. The time of occurrence is very important, to know about that particular or the judge about that particular sound is a noise or a music.

The actually the opposite word of the noise may be a music which, we can treat as a subjective one always and, the wanted sound or the sound we make prefer to here can be treated as or defined as a music. And, which is not at all wanted or not at all preferred for hearing or cannot create any kind of interest in our mind or in my our brain or in our sensation is called noise.

So, most of the time if you can go to a, outdoor or maybe if it is if you walk in the urban area or maybe a township or may be any area where that this is exposed to a lot of noise and if you see the that particular character of the nose is actually, typically comprises of different frequencies of the sound and also, the wearing of decibel levels also.

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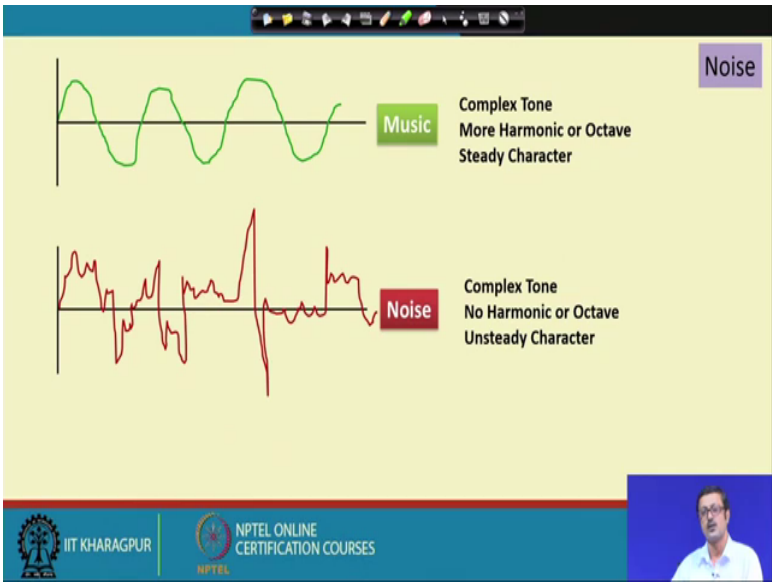

So, I have drawn here a particular curve or the sinusoidal curve which is very much irregular in shape and which is very much going to be a periodic in nature. And in another one which I have drawn which is typically periodic ups and downs.

The fluctuation of the sound fluctuation of the pressure is also differentiating which is also a propagation of the sound, but, there is a difference between this green color graph and this red color graph. The red color, graph is very much scattered or very much on and wanted in that sense and it is very much you can say uncertain then when it will be a peak and when it will be a another thought those kind of a scenario.

So, because of this particular second graph is a mixed of a complex tone and there is absence of the harmonics and the octaves. And, it is a very on steady in character, from the amplitude point of view and as you know the amplitude varies the differential presser level will be there or the differential dB level will be there.

So, these can be treated as this kind of a spectrum as, or the sound spectrum can be treated as noise whereas, if it is a complex tone, but it is a more of harmonics and the octave, which

gives a kind of a smoother. The repetitive kind of a periodic curve and a steady character of the particular curve from the amplitude and this particular amplitude and the frequency point of view it says, the music or which is it may want to hear.

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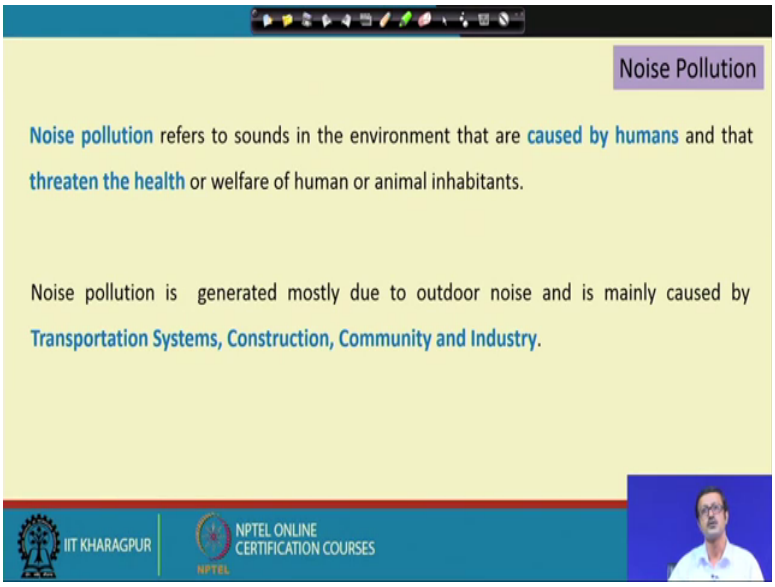

So, next comes the noise pollution, because noise pollution is very much related to the urban noise and noise pollution is one of the prime factor nowadays every, every citizen of the country in our country and also in the other countries very much bother about and, the what is the noise pollution? It is a the its kind of an environmental, cause which due to the sound and that is a kind of a given kind of a threatening to the health of the human and also for the animal inhabitants, because of the not only from the dB level, is the one of the criteria hm.

It is the, it is a kind of a criteria, it is not only the dB level, but also the particular frequency in built in it and the repetition of that particular frequency is, quietly unsteady kind of a think and create a, kind of a noise. Because, if I give example a guitar give you music and if I start playing guitar sometimes, it may be a noise to you, because I do not know how to play guitar. So, if I play then it will be different frequency, unsteady way it will follow and then that can be a noise, but we cannot may be tolerate for a, the more than minute also.

So, noise pollution is actually associated with the outdoors, scenario or that is called as an outdoor noise and that are having different the cause or the different sources will discuss in every detail of that. So, out of the causes is the industry, community, construction and transportation sector is the major source of the noise pollution.

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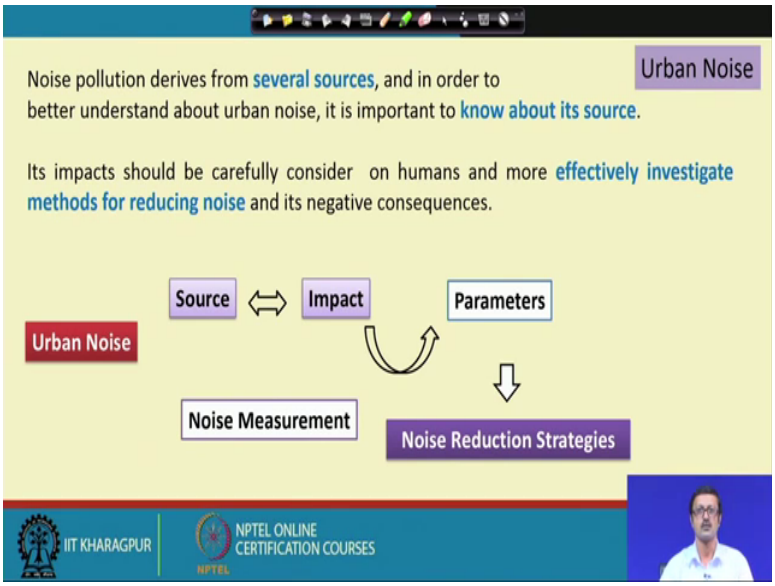

Next, let us go to the urban noise there is very not very much significant change between the noise pollution and the urban noise is concerned. The noise pollution is that if you are, the particular noise level is above a certain particular limit, which was prescribe by some of the pollution board also which is can be act as or can be, threatening to the health and that can be treated as a noise pollution.

Whereas, in case of the urban noise there are some areas which may be a kind of a polite among kind of annoyed which may not go, beyond that particular limit and sometimes it may go sometimes it may go in the night time sometimes may go in a specific duration of the day. So, there are lot of the parameter associated with the those activities the urban activities and all. And due to that particular activities, there are source and there is kind of a the, environmental noise has been concerned or has been the perceived. And that particular act, the noise which is, triggered by some kind of an urban activities are in a bracketed term in a domain terms called the urban noise.

So, what is our, main concern is that in our lecture in the, consecutive lecture of this last module is that, how to investigate effectively investigate that particular noise. And, we have to actually know about the sources of the urban noise and also, we need to know the, how you have to mitigate those or reduce this particular noise urban noise.

So, in that we have, we can have this kind of a flow diagram and let us know what are the typical the flows and the components of a urban noise mitigation strategies. The first one we

must know of the, know about the urban noise source and the impact of the urban noise. This is very much important. Some source may not give any kind of impact which is impact I am talking about which is very much, threatening to the health of a particular human being or may be an animal.

So, sometimes a particular source maybe having a very high impact. So, we need a kind of a noise measurement technique and that is very important to know between the relation between the source of the noise and the impact of the noise and then there are some parameters which parameters are actually influencing. The sometimes it is going to add or sometimes, it will be going to give some kind of advantage towards the propagation of the noise and sometimes those parameters are actually going to rages this particular noise.

So, it know about those parameters which and, we have to actually in design that particular, particular built environment such away the resistance - parameter are potentially increase and that can be reduced the amount of noise or the urban noise. And, based on that only I have already told based on this those parameters on only this noise reduction strategies can be thought of or can be implemented.

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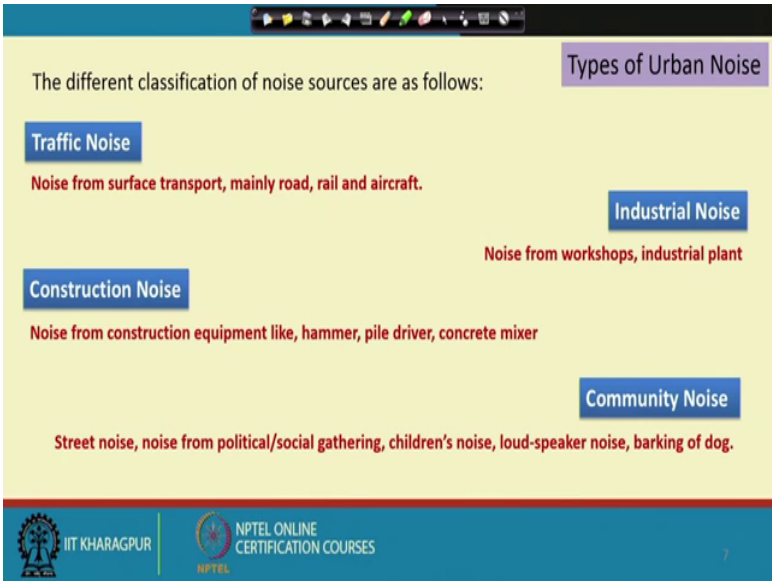

Now, as we have to know about the different source of the noise. So, let us first, talk about some kind of the noise which is called as a I mean the. So, different, classification of the urban noise and the first one is the traffic noise each one of you are actually exposed to this

is, is a noise which comes from the surface transport, mainly from the road railway and the maybe some kind of the aircraft movement also the second it has actually.

So, typical sub divisions or classification second one is the industrial noise which comes from the workshop in the kind of an industry plant and all, because of the activity and the operation of those industry the third one is called the construction noise which is sometimes very-very bothering in the noise, comes from the construction equipment like hammer jack pile, jack hammer and the pile driver concrete mixer and lot more. And, those who are actually, the stay very close by those constructions, the activity areas maybe for years or 2 years also.

It is really sometimes bothering the fourth and last one in this classification is called the community noise which is actually a noise generated by a community which are the street noise, noise from the any gatherings maybe it is a social gathering or may be a political gathering some kind of a rally or some kind of a the chi noise from the children. They are playing in a particular park or maybe a school whatever and the loudspeaker noise from any particular area. Then some kind of a comes something like a barking of a continuous barking of a dog or those kind of a things, it is very irritating in the time in the night times if the dog barking for a long-long duration. So, those are, has to also taken care of very carefully

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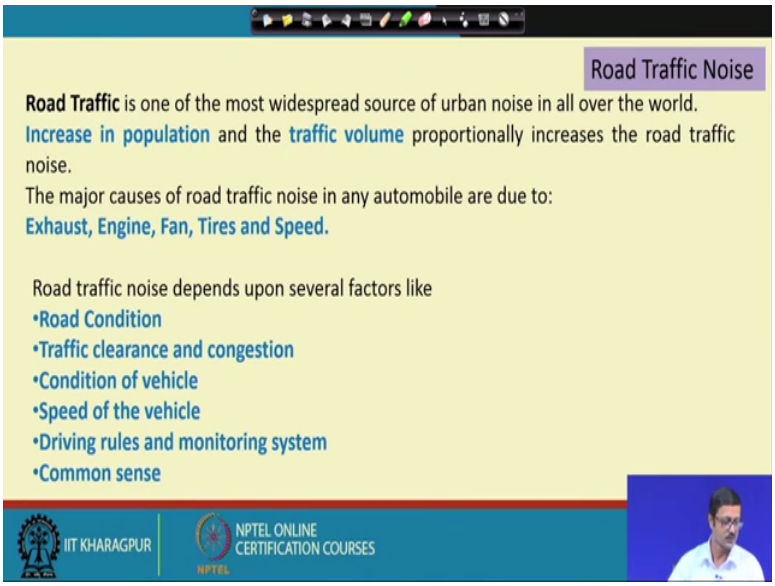

Now, let us go to the first one that is a traffic or the road traffic noise and there are different, significant the amount of the noise is develop in the road and its actually the one of the major source of the noise pollution in any city or any urban area, it is there are different cause of

this part. Suppose, if you take an automobile if you take a car or if you take a lorry or if you take a, kind of a bus.

So, there are different, noise producing, EQU, the component unit there are, the exhaust there are some kind of a the yeah, the engine fan and those tires. And, also it is depend upon the speed of the particular vehicles also, but it actually depend upon several, other factors, like the what is the road condition. If the road condition is good definitely the amount of noise created by the traffic or may be by the vehicle will be less the congestion of the traffic, the traffic clearance and all those kinds of a things are also creating a noise. If the there is almost this uniform speed maintaining in a particular path of road the amount of noise again, will be going down the sudden breaking an all those things actually create the noise the.

So, kind of breaks and all, the condition of the vehicle is another one the speed of the vehicle is another one, and as you know the speed of the vehicle if it is an increased, noise is not proportionally. But, some what it is increased there are driving rules and monitoring systems are also, as a may be the in direct parameter that increase the urban noise or the urban road traffic noise and the last one is not the list its the common sense of people or the citizen is also one of the one of the important factor which contributes in the is domain.

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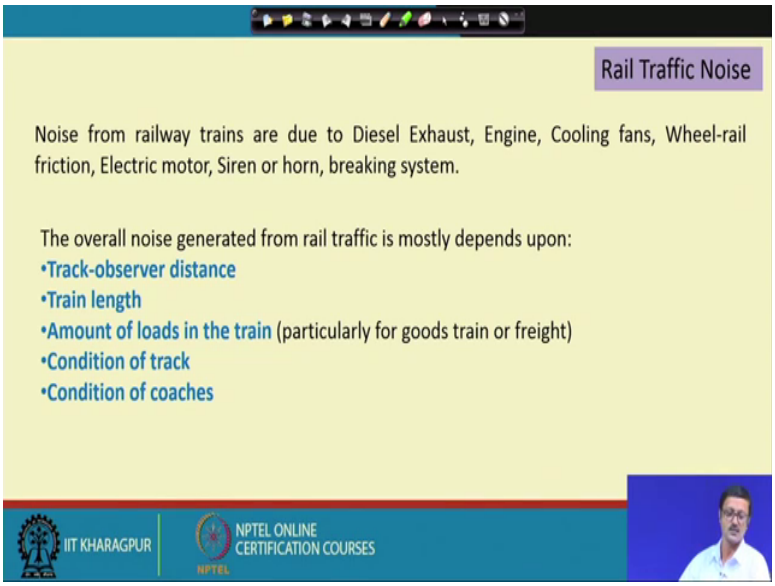

And in the case of the railway traffic, there are again, there are some, the components which comes from a particular source itself that is a railway itself that is the diesel exhaust engine

cooling fan etcetera. The wheel rail fiction, that is another one which create some kind of irritating sound electric motor which actually drive the train.

The siren horn breaking system everything, which is the, each one of each one of those are the integral part of any kind of a, railway system or the railway mo, motion know which is going to give some kind of a noise and other then that the track to observer distance, that is one track length is another one the amount of load in trains of particularly for the goods train or the freight.

Train suppose a goods train is empty sometimes it is noisy if it is not empty it is full then may, may not be noisy its sometimes not that decrease the load is huge then the noise is more no sometimes less. The empty vessel sounds much we all know, and the other, other conditions are the some of the condition of the track and sometimes the condition of the coaches and everything also import.

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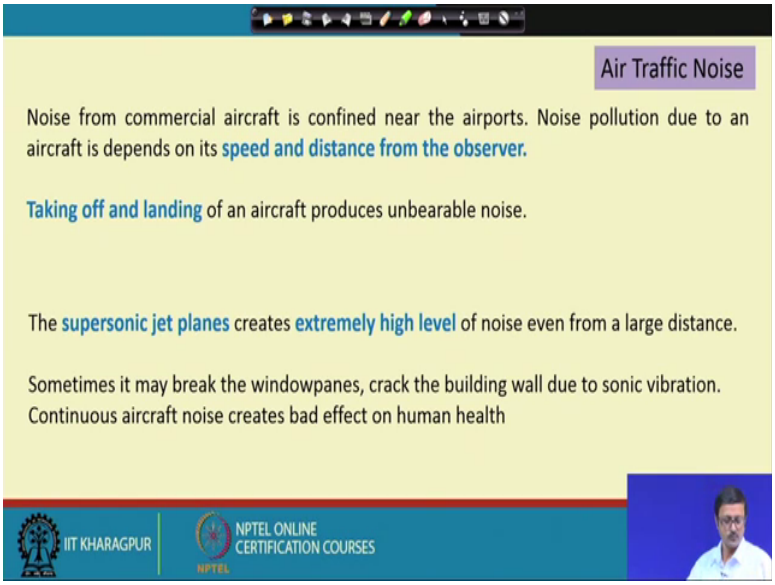

Some kind of a noise air traffic noise this is a third component of the transportation noise is concerned, it is actually depending upon the speed of the air traffic and the distance and the distance from the observer to the source, by virtue of, the traffic the air traffic and air steep in a particular area.

It is depending upon the what is the distance from the source to the observer and in time of if it is very near to if the receiver, receiver the observer is very near to a the airport then it is the

taking off and the landing time the air aircraft produces the much noise are which sometimes unbearable. Yes, supersonic jet planes if it is a very high distance also from a very high distance also its extremely high level of noise will be into produce sometimes, it is may break the windowpanes and it may, some minor cracks may appear in the very, the building walls and all, because of that sonic, wave propagations also.

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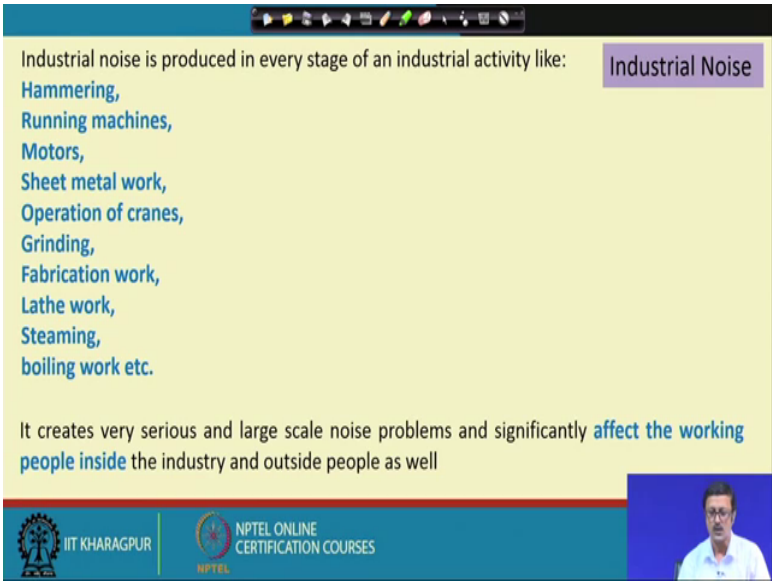

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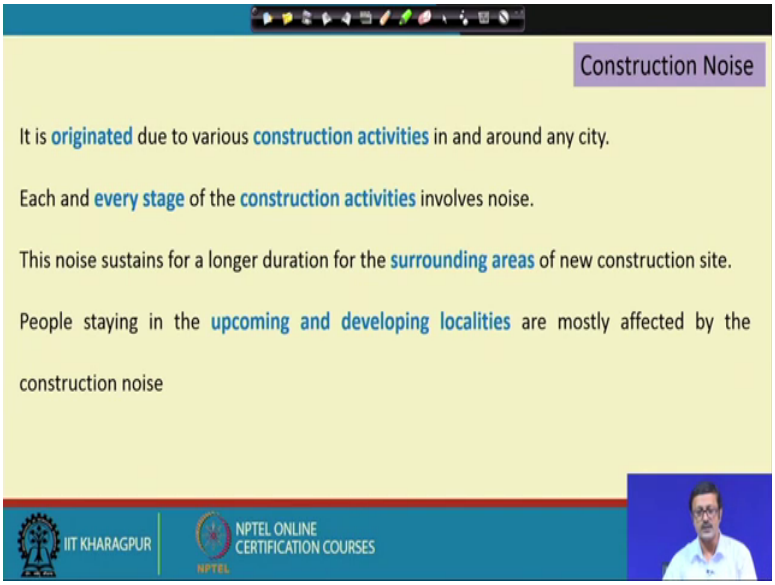

Then next, comes the industrial noise we already talked about that and those are the typical, different part of the activity or, the with different stage of the industrials activity which

actually produce some kind of the industrial noise which includes the some running machines hammering grinding.

Then lathe works the steaming boiling work, also see the next one is the construction noise which again, is, depend upon lot of construction activities an, as you all know, that the each and every construction stage required some kind of a manual or maybe some kind of an equipment for operation and it is not silent process its gives you a kind of a, noise and its actually.

So, when it is actually, the area which is surrounded by those the construction activity is prone to the, those kinds of construction noise and, it is actually, the people who are staying in a newly developing or the upcoming area is mostly affected by this construction noise. And those are the list which, can create a very annoying kind of a noise in construction activities the earth moving work the demolition of some existence structure.

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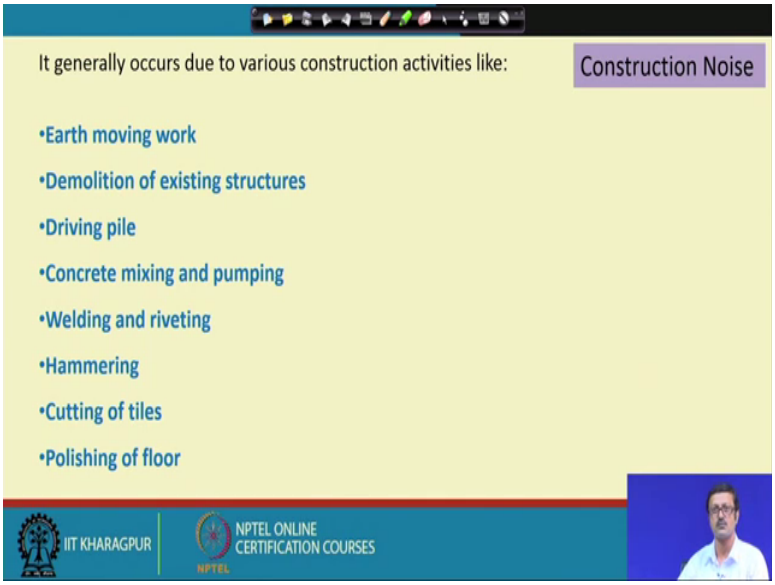

Driving of the pile is very-very monotonous in noise point of view, concrete mixer pumping of the concrete the any, any kind of the welding, welding is probably a kind of a bit of silent process. But, the riveting and the next one is a hammering is very bothering it is from the noise point of view.

The last one last, but one that is the cutting of tiles, is another one which is, produce a lot of very high frequency sound and which is a, very high level the from the dB level point of

view. It is very high and also very much, effecting I mean the physiologically or may be the psychological it is very much effecting if you stand for a quiet a one minute also it is may not be unbearable sometimes.

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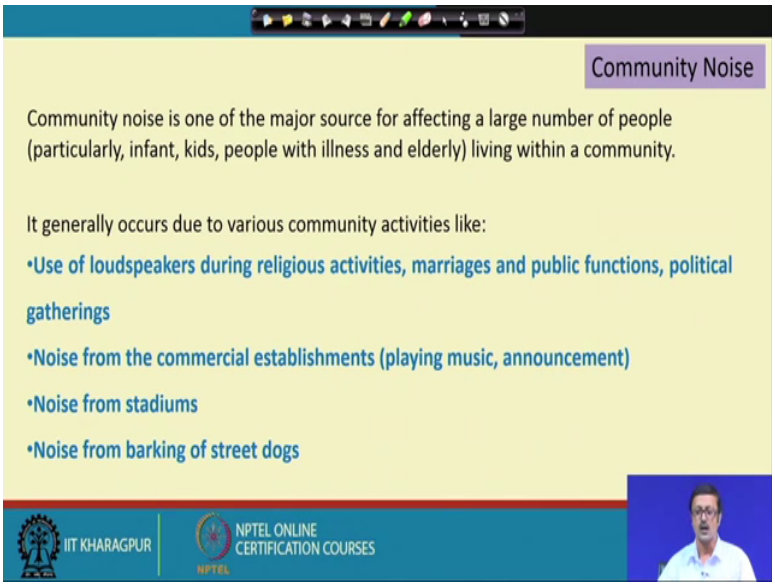

Then the community noise, it is the part of the community part of the activity in the community, and due to that of this community noise also, sometimes our common sense is responsible yes. And, the enforcement authority are, may not be very must strict and they allow people to run the loudspeaker in the very let night or which play a create a problem to the people, like the elderly people, people with illness the kids and infant and all.

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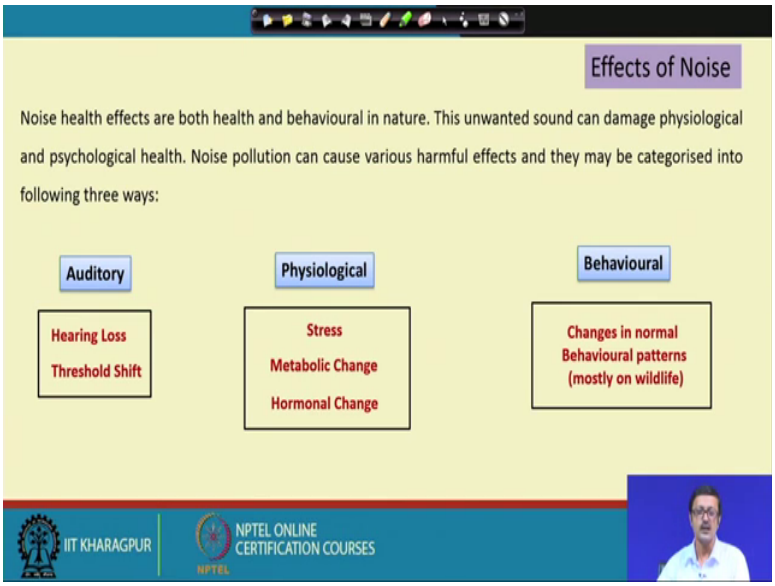

So, those are the sum of the activities I have already told you, the those are the community noise, point of view. And there are, some effect, of the noise I told you in the very beginning. The noise pollution has defined as it is something, above some kind of a criteria of the dB level criteria and which gives you a kind of a harmful effect in a, particular human health.

So, its, there are three types of human health as per the who, has stated that its some kind of a auditory which is the hearing loss and the threshold of, shift kind of a scenario can be happen, there is a psychological which is a stress, there is a metabolic change there been hormonal change also. There may be a some kind of a gastric problem due to the if you are exposed to very, longer duration in the noisy atmosphere.

There will be a behavioral change if you are, prone to a noisy atmosphere very long duration like may be a, month or more than that then there may be a changes in the normal behavioral pattern, mostly it is have been filled in the wild life, but also it has been filled in the people who are exposed to the industrial noise and the transportation noise, in a longer duration period.

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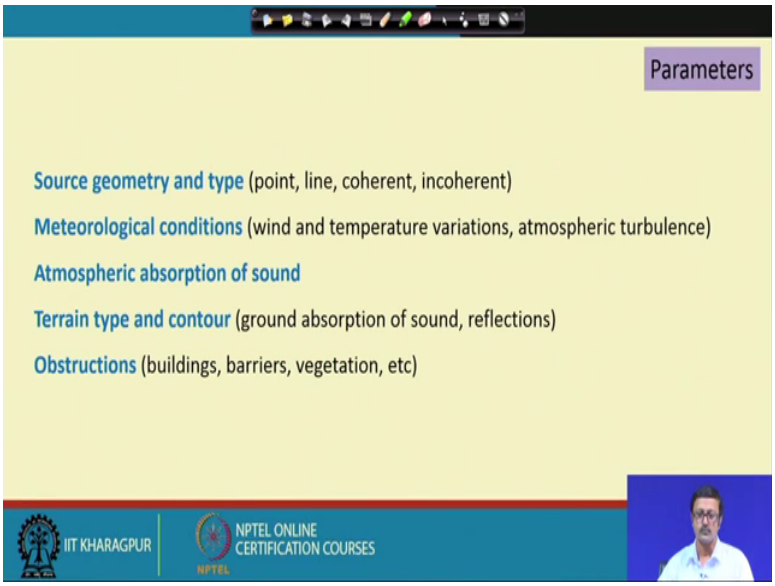

Next, the parameters we have already talked about there are some parameters which would going to affect dispute in a propagation of the, this the noise which is the urban noise the it is the source geometry and the type it is a one of the things that is the point line actions coherent and the inherent kind of a criteria.

The meteorological conditions there wind temperature the flow of the wind and the speed of the wind is also going to be a matter, the propagation of that particular noise atmospheric absorption of the sound which is due to maybe some kind of a humidity or some kind of a other, suspended matter in this, available in the air the terrain type and the contours ups and down hilly areas.

So, they are can be some kind of the noise shielding zone noise shadow zone and the finally, it is some kind of an obstruction this may be a manmade obstruction. There may be a kind of a in natural obstruction, obstruction by the vegetations also. So, that also can help sometimes propagation.

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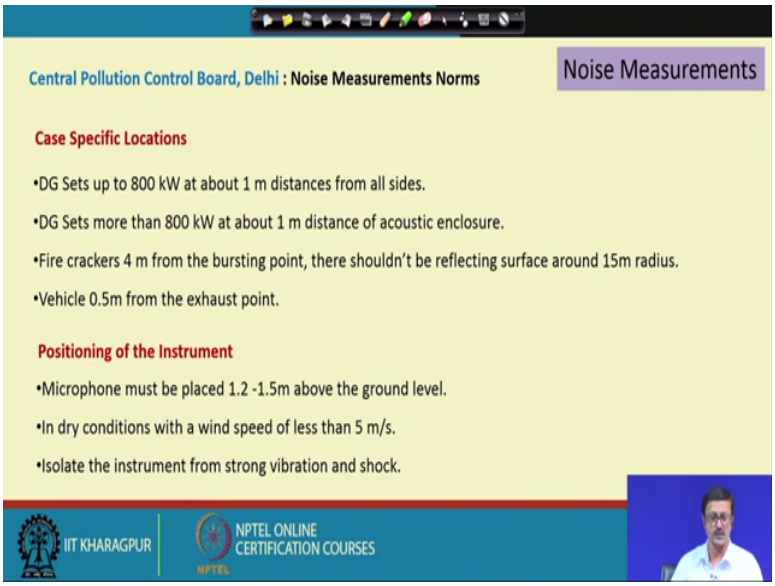

Next one is the measurement of the noise. So, I have just check down some of the, case specific and also the positioning of the instrument as per the directive of the central pollution control board Delhi, this is CPCB. So, they have stated some kind of the criteria's, suppose if you are taking some kind of a sound for any d g set that is the diesel generator set or maybe any machines it is one meter from the distance, from the all the side and, if it is more than that.

So, about 1-meter distance from the acoustical enclosure, we have to take the measurement for any kind of a fire crackers which is again, one of the concerned, sometime supreme court say some kind of a the rules or the, kind of a guidelines for that. So, for that particular measurement of that particular sound, the blasting sound of the fire crackers, it is 4 meters from the blasting point has to be taken. And, there should be the should not be any kind of a reflective surface in and around the 15 meter of the radius that is around the criteria or because if there is a reflective surface, the total amount of sound actually recorded, in that particular microphone will be very much high.

For any kind of the vehicle for the road noise measurement 0.5 meter from the exhaust point of the vehicle has to be taken. It is very near to that particular an exhaust point of the vehicle has to be taken and the microphone point should be placed at around 1.2 to, 1.5 meter, which is almost about 5 feet 4 to 5 feet level above of the ground which is more or less of our ear,

level also and, in case of it has to be taken in the dry condition, because their you know that the wind velocity also plays important role.

So, any conditions, which we should be the wind less than 5 meter per second velocity should be, the that should be the criteria of the measurement and this instrument should be free from any kind of the vibration or any kind of a shock.

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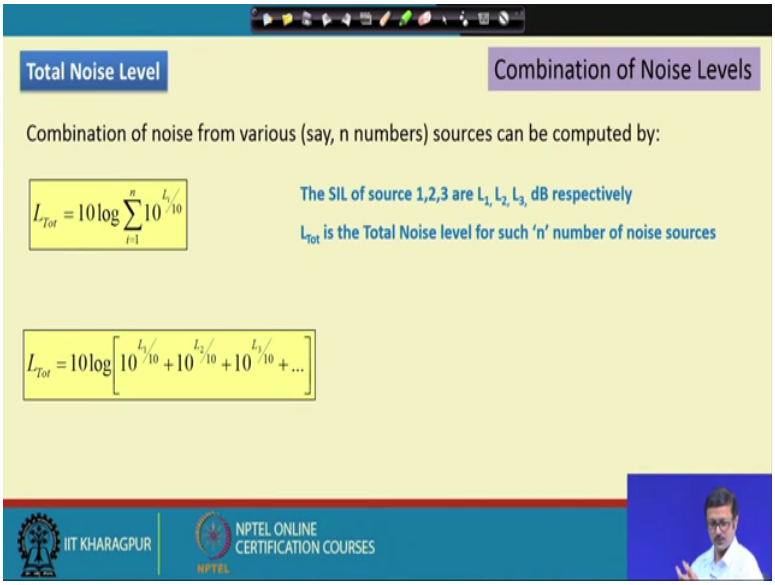

So, if and as we know this particular noise is having a combined frequency and also very much of combined the levels dB level suppose some source gives you some dB level l one then some other source gives l 2 l3 like that. So, we cannot judge each one individual, we have to give a come one particular the number which is can be a either it total noise level or maybe a average noise level this is the formula to calculate the total noise level if there are n number of sources gives you the l 1 l 2 l 3 and l n.

So, those are the l 1 by 10 and this 10 to the power that, has to be added arithmetically and that has been log logarithmic of that and has be multiplied by 10 will be the simple way to find out the l totals the total, noise level of a particular, the area for a particular instant problem. Actually this 10 to the power l 1 by 10 is nothing, but the intensity of a, the particular sound in that particular time or, that particular, source of which is actually producing l 1. But there is average, noise level also which just that which I have added in the very, the other slide the previous slide, we have to divide this by the total number of sources n.

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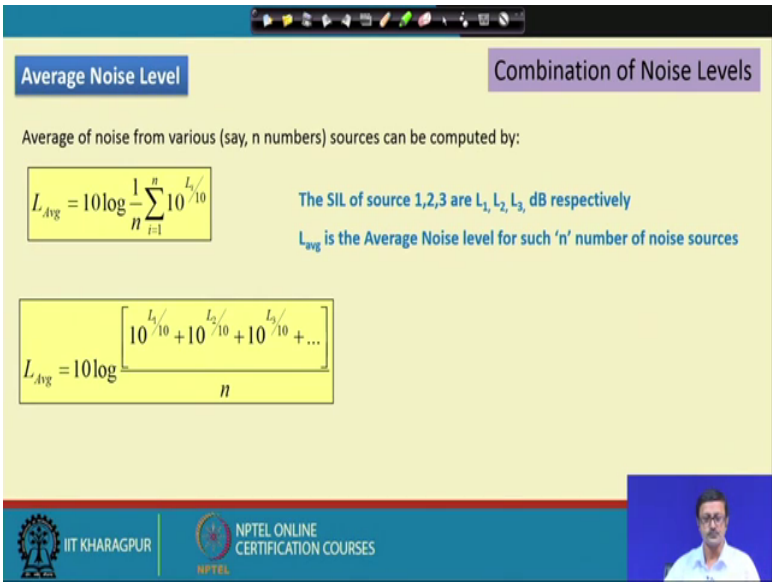

So, suppose this is comes from a bus this one is coming from some kind of a, some, road note for some kind of a another source this is some kind of a shop maybe it in the stretch of a, road. So, there are three such sources, and then you divide that by 3 and take the logarithmic of that and then multiply by n. So, this is the average of the noise average, the average noise level of the particular, segment of the road for a particular segment of the particular movement on when you are taking for that particular, reading.

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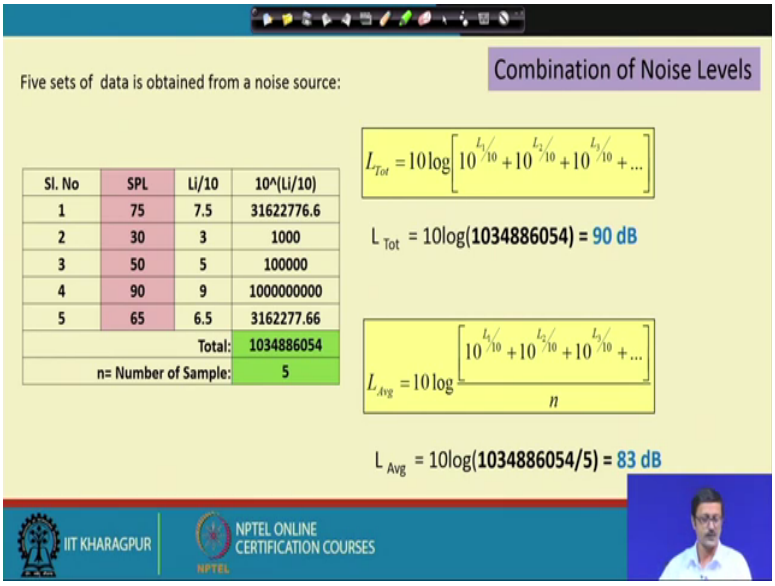

So, I have a small-small, example for you I have five sources suppose in a roadside and or maybe it maybe a kind of five machines that produce, the noise in a particular industry and one the first one gives you 75, the second one 30, 50, 90 and 65 like that. So, this is by 10 is 7.53 then 5 9 and 6.5 and 10 to the power of that is this and I have added it up and number of samples are n is 5.

So, if I now want to find out the total. So, have to logarithm you have taken take of the log of this whole big number and then multiply that by 10 and that gives me almost about the ninety dB is the total noise level, but if I want to find out the average have to divide this, divide this by 5 then, divide this big number 5 that is the and then I take the logarithmic and then multiply by 10 and I will get little less little less amount of as an average noise level average 83.

So, what I find out from here is that the l total is always going to be little higher, from the average point of view, but is not the just the, this actual the half of that not like that it is a kind of a little less than the average little less, than the total again. Again, there is a the very, one of very fundamental, the criteria which comes in our mind is that the human hearing system is not equally sensitive to all the frequencies as you all know.

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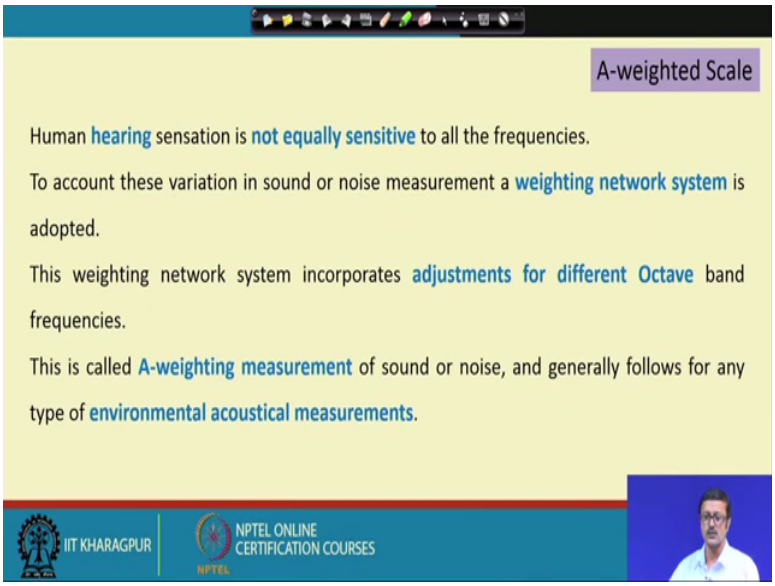

So, if I just take that average, if I take all this weighted, this particular total of all the frequencies, of all the l 1 1 2 l 3 all well sound pressure level. It may not give you the actual indication of the noise or actual indication of the total noise or the average noise.

So, for that an adjustment has been made for different octave band frequencies and those octave band adjustment finally, measured in a, I mean this adjustment is called A weighting adjustment there are B weighting also C weighting also, but the a weighting adjustment are the measurement are very much, the, very much effective for our noise calculations and environmental noise calculations and all and how it is can be done. We can just give you a, kind of a statement is that, there are 10 octave band and for this octave band this correction is given in dB.

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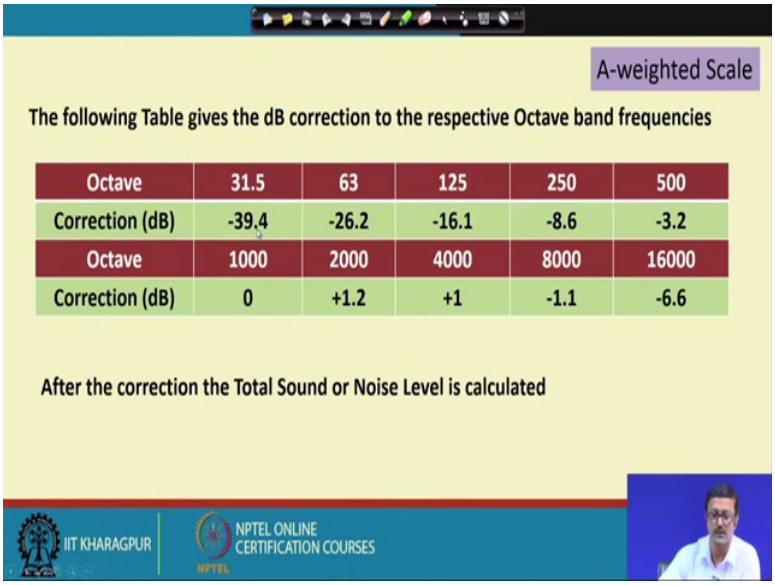

So, suppose, you have and this correction these are mostly in negative correction. So, if you have some decibel level for 31.5 corresponding to 31.5 with their upper and lower band; if you remember we have an octave band which is upper hand and lower hand that is the upper lower band within that, if any frequency comes which comes under the 31.5 you have to subtract 39.4 dB from that, because those low frequencies not that much sensibly in our brain.

Suppose, something is with an around in an around 2000 frequency then you have to add 1.2 frequency whatever maybe your recording from the dB meter you have to add 1.2 decibels. If it is 1000 in an around 1000, you need not to do any kind of a correction. So, mostly you see there are negative corrections and there are only for 2000 and 4000 there are some positive increment.

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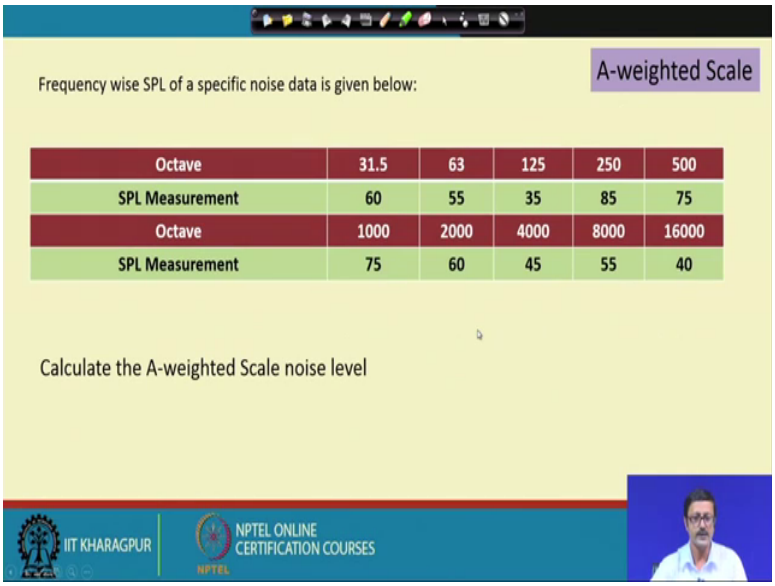

So, if I take a another example suppose I have majorly particular band of frequency in a noise for a particular moment in a particular, road, or may be industry or may be any community and if I analyze that particular spectrum of the noise I found 31.5, the hertz sound majors contribute almost about 60 dB 63 55 is 125 hertz sound in an around is 35 dB also something like that all the 10 frequency 10 octave band frequency these are given.

So, I want to find out the what is the, a weighted scale. So, I cannot just, take the previous formula and just calculate and that I can, find out the total, but that will not be the actual reflection of the actual reflection of the noise actually we here.

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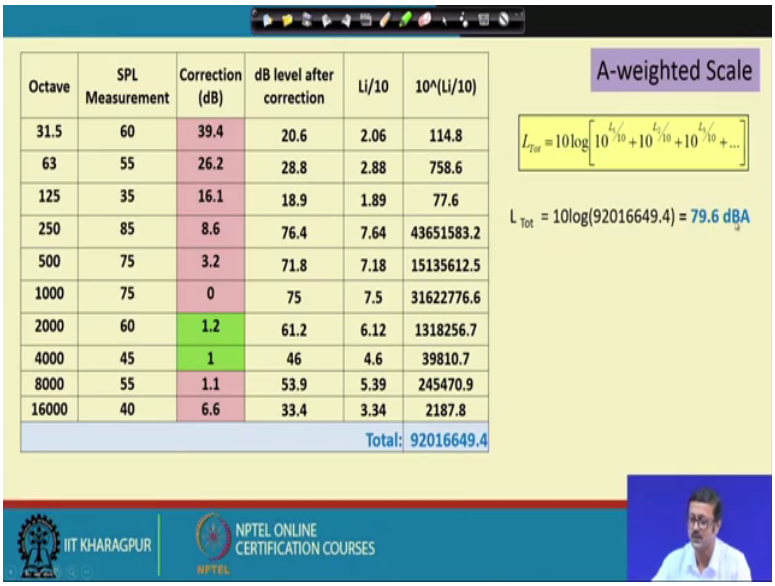

So, we need some kind of a correction. So, those are the 60s to 40 which is in the given in the, this particular slide, measure I mean, I have put over in this particular column second column. This is the octave band and these are the correction factors rate or that this purple colours or the negatives and this green colours are the positive. So, if it is 60. So, if to 60 minus 39.6 is 20.6 39 and 55 minus 26.2 is 28.8 something like that if you take the negative I mean if take, the subtract from this to that 75 does not have any corrections it will remain as75. 60 is plus 1.2, 61.2 254 is 45 e plus 146.

So, you get the corrected dB level. So, even a particular found in a roadside which is having a 31.5, frequency which measures as 60 dB actual effectively it is impact in our in our brain as per the, a weighted scale is 20.6 dB also that that this will corrections remains that. And now from that this column if found that l by 10. So, this is 2 naught 6288 like that and then to the power of that. So, this big numbers and I add up this big numbers. So, is a very big number and then this very big number is log the logarithmic of that very big number in multiplied by 10, is the that is the formula for the l total. So, I will write this as a 79 I found it as a 79.6 and when I write it I will not write dB I will write dB a why a A, because it is a weighted scale.

So, any, environmental noise is actually weighted in a scale, the a weighted scale and, finally, as you know if I just if I do this, this logarithmic of the addition where the l total with the second column which is actual reading could have been much-much higher, there can be a kind of a confusion there can be kind of a, relative, the higher value we will get.

So, to avoid that kind of a confusion and avoid that kind of a relatively higher values in our calculations or in our understanding a weighted scale is has been proposed. And finally, we will write that particular unit as a, dB decibel a weighted a so, that is the end of this lecture of lecture number 36, which talks about the environmental acoustics part 1.

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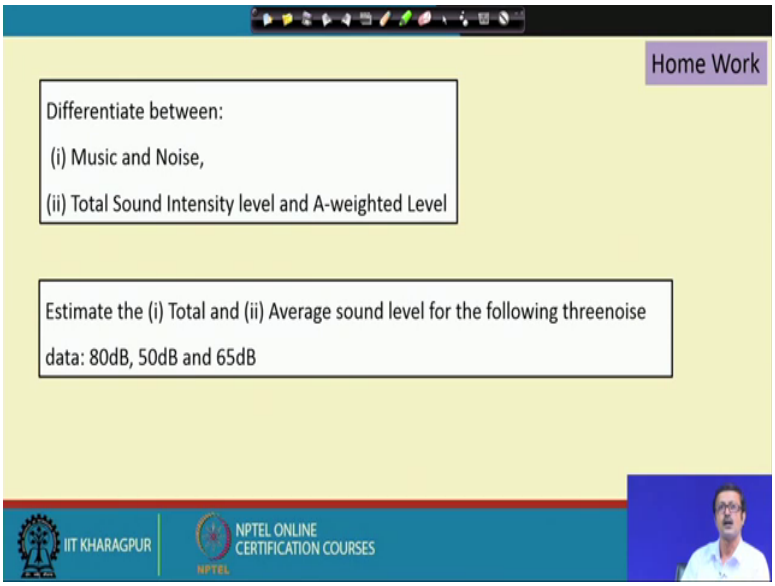

So, as I have some homework for you like other lectures, let us first differentiate between the music and noise, what you understand from your, I mean the understanding of this particular, lecture. And, from your own understanding on the music and noise, how you can differentiate of between those between these two terms, may be physically or maybe incase in case of some objective definition wise or maybe any kind of a subjective way.

The second one is also, interesting and also very much required to know I mean what is the actual the difference between the total sound intensity level which is I have wrote at, l total and A weighted level. And why, these two are required and why, what are the significant, difference between these two; this is the one and the second homework for you is that suppose I have three noise data, one is 80 dB one is 50 dB 165 dB.

If just find out the what is the total noise level and the average noise level, because of this three sources. If I ask that what is the A weighted noise level for this particular second problem or second assignment or the second homework. It is very big because you cannot actually find out because why, because I have to give, the corresponding frequency how

much is which frequency contribute 80 which frequency contribute 50 or 65, because base based on that without frequency cannot go for the a weighted.

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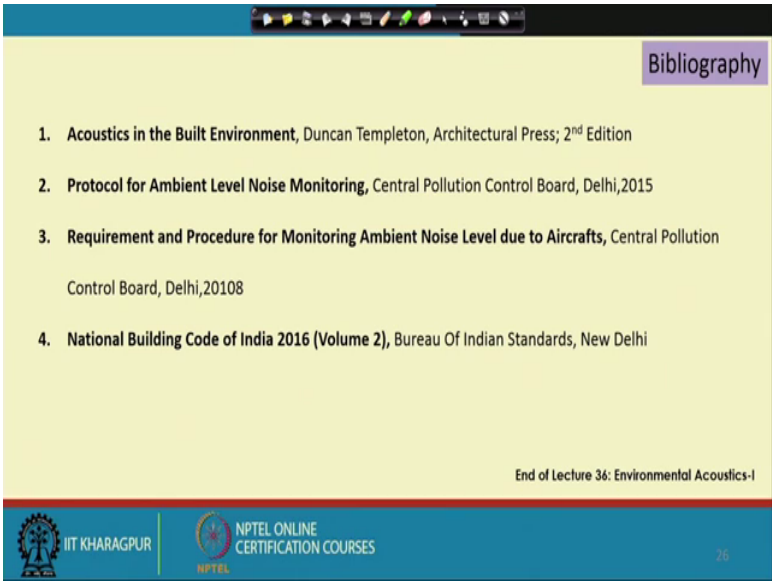

Because, if you know the frequency and corresponding, the l value that is the level value and then can you can apply those correction and then you can go for the adding or totaling of that. So, I have taken some help from those books very good books and also two such, I mean the resources one is this CPWD.

I am sorry, CPCB, Central Pollution Control Board their, some documents which is one of the protocol for the noise monitoring and for the aircraft noise kind of a thing that also they have given in their website. And, also the very new one, this is the National Building Code 2016, Volume 2 deals with the acoustics and the noise. This is those are the some, the sources I have taken help for this particular lecture you can also go through. That is all for this particular lecture.

Thank you very much.