Noise Management & Its Control
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Lecture – 63
Acoustic Barriers – I

Hello, welcome to noise control and its management. Today is the third day of the 11th week of this course. This is the second last week of this course and over last several weeks we have been exploring different ways to control noise and reduce the overall level of noise both indoors or both indoors as well as outdoors. So, we have been discussing several ways to reduce noise and one way we have focused over last couple of weeks is to reduce noise by putting enclosures now these enclosures essentially are you cover the surface or you know the source of the noise from all the sides, but in a lot of applications it may not necessarily be feasible to enclose the overall source of the noise from all the sides in other cases it may be feasible, but it may be very expensive.

So, today and also remaining part of this week we will discuss how to reduce noise by having barriers. So, essentially barriers are vertical walls between the noise and the place where we are interested in deducing the overall noise level.

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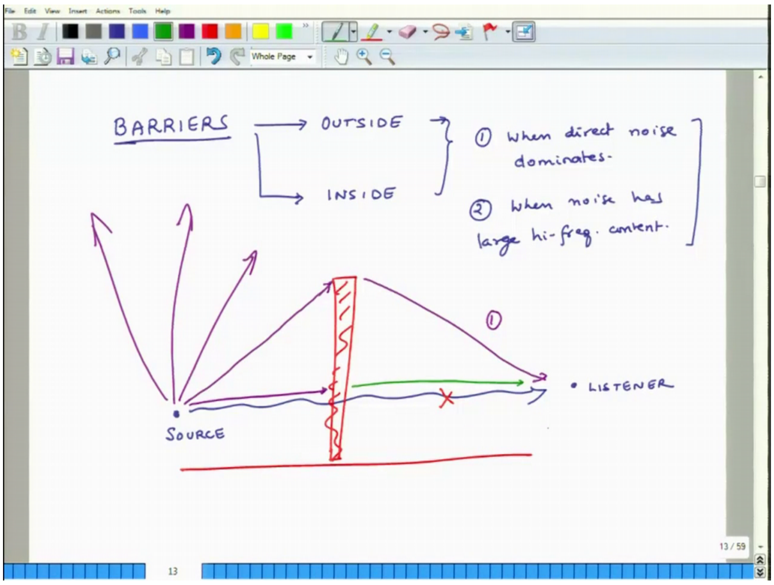

Let us see how these barriers work out and how can we design these barriers to meet our specific applications. So, what we are going to discuss today are barriers.

Now, you can have barriers either outside the room you know or you can have barriers inside if you have barriers outside then you would not expect a lot of reflections to be occurring. So, here the job of the barrier is to reduce direct sound which is coming from the source, but when you have barrier on the inside the barrier does 2 things it not only stops its job is not only to stop the direct sound which is coming, but it is also there to somehow also reduce the reflected sound which comes to the point of listening.

Now, in either cases both these both these situations barriers work well in if both these conditions are present first condition is when direct noise dominates if most of the noise is not direct, but coming from reflections then if you put a barrier between the source and the listening position it will not help much because the noise has other pass to reach the point of listening. So, when there is most of the noise is direct then barriers work well the second thing is that barriers work well and both these condition should be present. So, first is when direct noise dominates and the second one is when noise has large high frequency content barriers are do a very poor job in terms of stopping the propagation you know spread of noise especially if most of the noise is at low frequencies, but if it is high frequencies they are do a very good job.

So, we should understand these 2 things before we start designing barriers. So, if we think that our situation is such that we have a lot of low frequency noise then probably we should not worry too much about barriers as a way to reduce the overall noise level and also if we think that a lot of noise is not because of direct transmission. But it is coming because of reflections because of reverberations then again we should not worry too much about having barriers to solve the noise problem what we will discuss today and probably tomorrow also is barriers which are located out door, but before that I wanted to again point out 2 or 3 things as to how barriers prevent spread of noise.

So, suppose you have a source and this is we have a listener; what happens. So, noise can directly reach there this is a direct noise once I put a barrier this is a barrier then this transmission direct transmission gets stopped then noise reaches the listener in 2 ways one is it goes here and then from here it diffracts and it comes like this what is diffraction it is the bending of waves as they travel around sharp corners. So, this we have seen in case of light also light diffracts it bends around corners. So, when there is a barrier sound waves diffract and then they reach. So, this is one path through which they reach the listener and then of course, a lot of noise will be going out in air and if there are no reflecting surfaces will never come back.

So, this is path one it comes goes there by diffraction; the second thing is the sound comes here and some of it gets absorbed.

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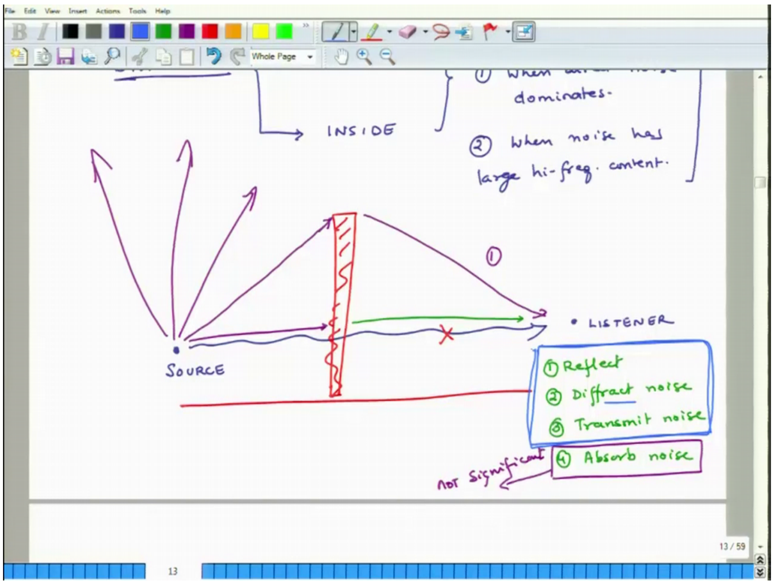

And then it gets transmitted and then part of that sound gets transmitted part of that sound gets transmitted. So, what do barriers do typically to sound they reflect the noise they diffract the noise; they transmit noise and they do not transmit all of the noise. So, depending on how good a barrier is it will transmit only. So, much amount of noise and then finally, they absorb noise, but the absorptive effect of barriers on noise is not significant particularly if we are thinking of outdoor applications it is not a whole lot.

So, when we are worried about barriers on outdoor applications what we are particularly concerned are about these 3 factors how much of a sound is getting reflected how much of it is getting transmitted because absorption is nothing not much. So, whatever is coming in either gets reflected or it gets transmitted and then of course, if their sound reaches end of the barrier it gets diffracted and some of the; that sound reaches the listener. So, these are the 3 things particularly important for outdoor applications.

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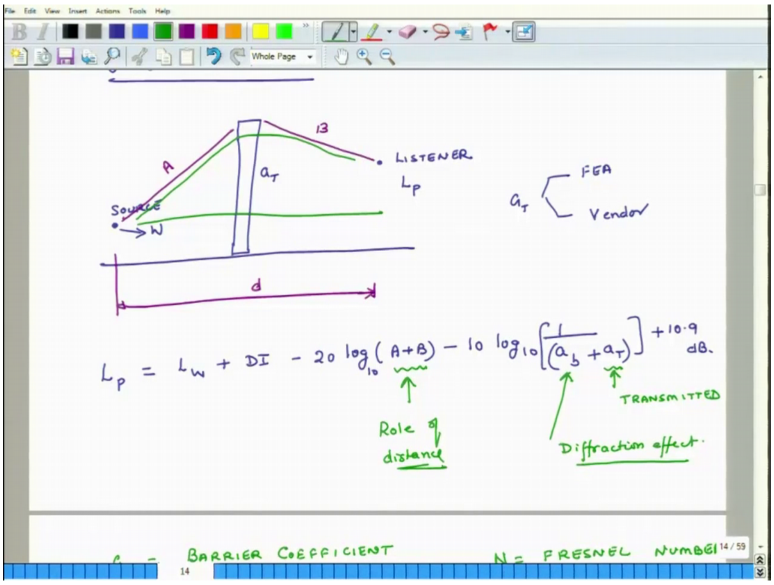

So, with that introduction let us look at barriers for outdoor applications and what I will do is. So, first let us look at a picture. So, this is a barrier and let us say this is a sound source and I have a listener here and let us say this distance with respect to ground is d in the horizontal direction is d and this distance from the source to the top of the barrier we will call that a and from the top of the barrier to the location of the listener we call that b. So, we are all these dimensions are in meters all these dimensions are in meters and let us say that the absorptive coefficient no a transmission coefficient of this barrier is a T and how do we find what is the transmission coefficient we find a T either through fea or if we are purchasing it from vendor then we should ask the vendor what that number is.

So, either we get it form fea; if we do it ourselves or we when if we are purchasing it then the vendor should give us the value of a T if not a t, then we should know the transmission loss from transmission loss we can compute what is this parameter. So, if this is the situation and let us say this sound source is producing w watts of energy. So, the sound power level is L W then the value of sound pressure level at the listener location I will write that directly and that equals L W plus directivity index and what is directivity index is 10 log of directivity factor minus twenty log of A plus B minus 10 log of 10. So, all these are to base 10; 10 log of 1 over a b plus a T plus 10.9. So, this is again in decibels and then explain; what is a b.

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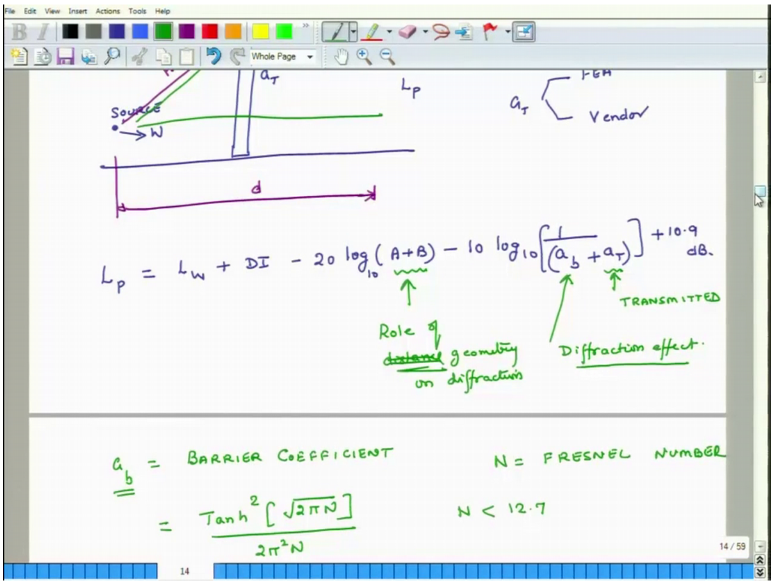

So, this term it accounts for how much sound is getting transmitted through the barrier a T if a T is large, then L P will be large and vice versa. So, we want a T should as less as possible this term. So, this term is related to the fact that how much of the sound is getting diffracted. So, how of the sound gets bent and it actually reaches the listener; so, it captures the diffraction effect captures the diffraction effect and how do we calculate it I will explain it to you.

So, once again if a b is large, then it is not a good thing we want a b to be as small as possible and of course, A plus B tell us how far the listening point is relative to that top of the barrier. So, if a is large and b is large, then it is a good thing for us. So, this is the role of distance . So, if I have to in reduce my L P I should increase a I should increase b I should reduce a b and I should reduce a T as much as possible. Now a b is called barrier coefficient is called barrier coefficient and you can actually calculate it in this way. So, it is tan hyperbolic square of it of 2 pi N the entire thing you have to take a square root divided by 2 pi square 10 when N is less than 12.7 and N is called Fresnel number.

So, if you do some studies on diffraction you will see this term Fresnel number and this is equal to 0.004 for N more then 12.7 and what is N and N equals 2 over lambda.

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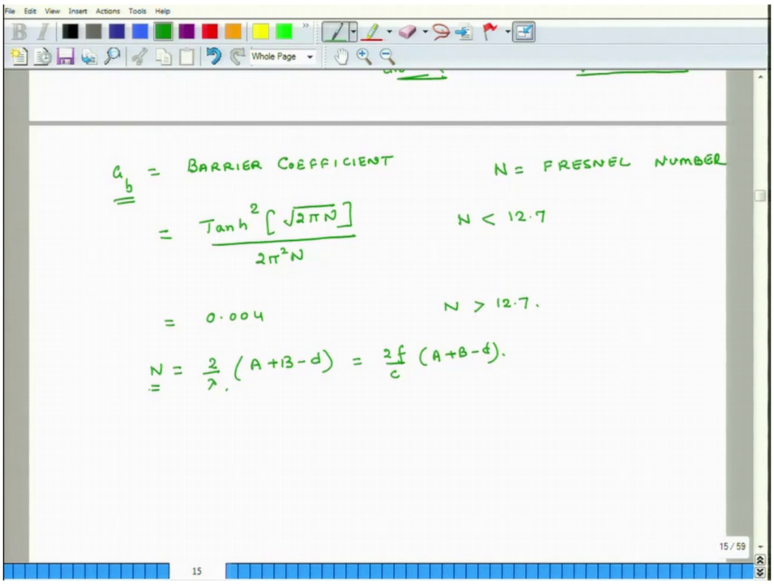

So, again; so, now, here the wavelength comes into picture 2 over lambda times A plus B minus d or if you want to express lambda in terms of frequency then it is 2 f over c times A plus B minus d. So, for each frequency a band width of interest you calculate N that will help you calculate a b that a b you put in this relation and of course, if you know a T then you can calculate L P, I wanted to show you the how does a b change with respect to N. So, I have a graph for that.

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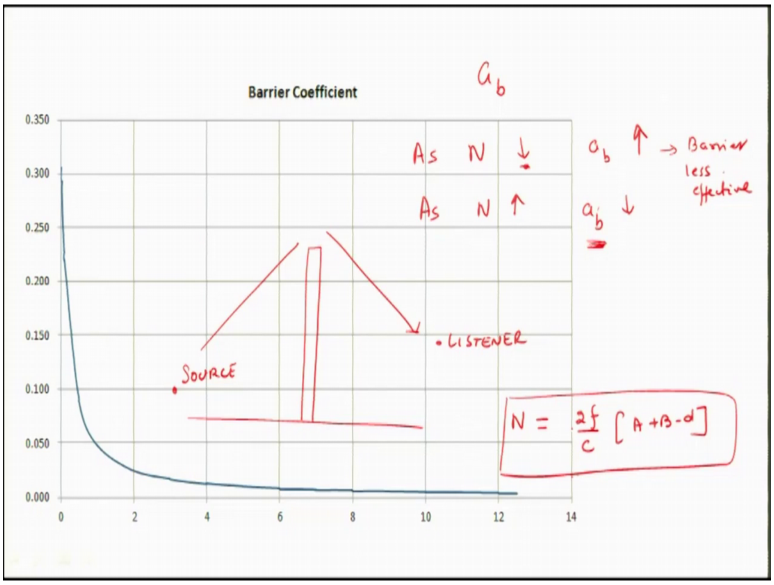

So, this is the group for barrier coefficient. So, what does it show that as N becomes small as N becomes small the barrier coefficient. So, this is a b as N becomes small as N goes down a b goes up the maximum value if possible for a b is 1; it is 1, but as it becomes as and after 12.7, it does not change much. So, it remain at around 0.004. So, that is why we have given 2 conditions if it is more than 12.7; it is 0.004 and so, forth like that and as N goes up a b goes down what does this mean if a b is going down remember; what did we say about. So, this is by source and this is a listening position. So, if a b goes up then more sound gets diffracted right if a b goes up then more sound bends around and it reaches the listener. So, the barrier becomes less and less effective.

So, as N is becoming less a b is going up a b is becoming more and barrier becomes less effective due to diffraction effects and what does and how does a b become how does N become less now we have shown or we have written that N equals twice of frequency divided by c times A plus B minus d. So, as I reduce my frequency as I reduce my frequency N becomes less N a b becomes more. So, more diffraction happens at low frequencies. So, if we have are very low frequencies probably the barrier will not be effective at all it will be just transparent to noise all the sound will just go there and reach there.

So, this is important to understand, but if the frequency is high if the frequency is high then this becomes a b becomes small and we get the benefits out of it. So, what we will do is. So, I wanted to give you this understanding of the physical understanding of what is implied by a b. So, the other thing is look at this term A plus B minus d. So, this is the other term A plus B minus d means the difference between the path.

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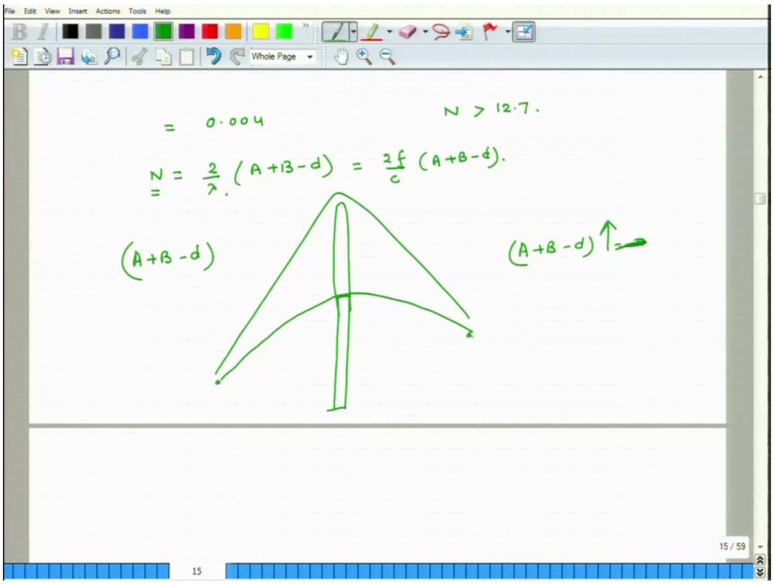

If the sound goes like this or if the sound goes straight away right as this wall becomes higher; so, you can have case one let us say this these are the 2 positions then the sound has to do this that is not an so much of difficult thing to do, but as the wall becomes taller the sound has to take a very sharp turn has to take a very sharp turn and as it keeps on becoming taller and taller it has to take more and more sharp turn and it becomes things become more difficult for the sound to do that.

So, and how do we know whether it is going to take a sharper turn, it will depend on this parameter A plus B minus d if A plus B minus d is equal to 0, then the sound will just go straight away, but as a plus d goes up the sound is taking a more sharp turn. So, this is another thing. So, this is the role of geometry in this relation not only role of geometry I mean yeah role of geometry. So, it should be geometry on diffraction. So, the point is that we should make as high a wall as possible you know for this barrier to be efficient the last thing, I wanted to talk about is traffic noise.

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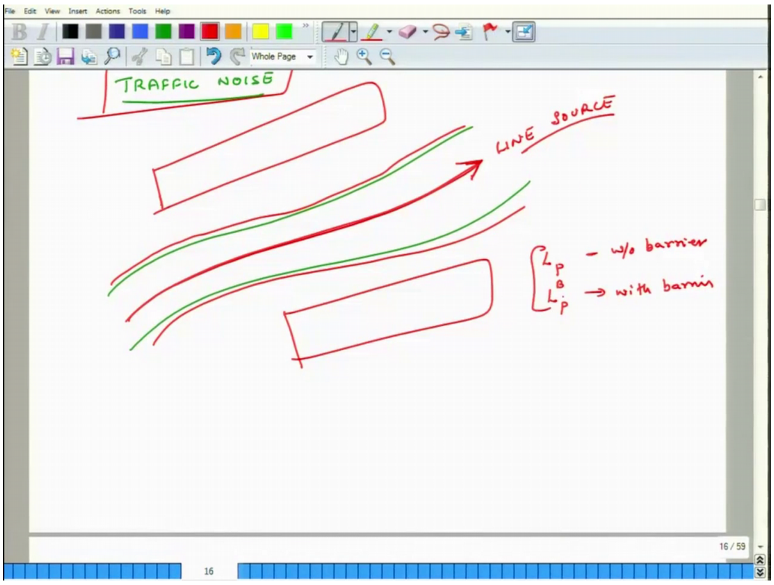

In context of barriers you may have seen specially on bridges or some high ways that sometimes next to the high ways or if the if a high way is going through a very populated area nowadays at least in our country people are putting barriers across the roads. So, you have a road and they put some barriers especially if there is high population density in this area and the purpose of those barriers if the all the noise which is coming out from the cars continuous stream of cars these barriers are there to reduce the noise propagation to these populated areas.

So, this is the problem of traffic noise now in case of traffic noise, we do not have a point source because till. So, far the relation which we discussed was for a point source, but in traffic noise it is a line source it is a line source and if we are creating barriers to stop the noise from a line source then with barrier and without barrier. So, if with barrier let us say without barrier let us say the sound pressure level is L P and with barrier let us say sound pressure level is L B P with barrier and this is without barrier then in both these cases. So, then we would expect that L B P should be less than L P. So, what is their improvement in sound level?

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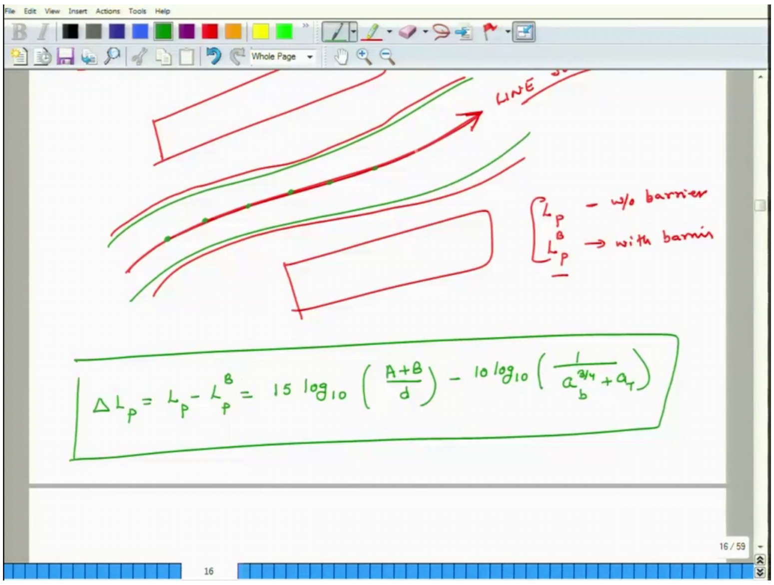

Because of barriers it is delta L P which is equal to L P minus L P in presence of barriers and that equals fifteen log of 10 A plus B by d minus 10 log of 10 one over a b 3 fourth plus a T.

So, this relation is good for traffic noise this relation is good for traffic noise because noise is not just coming from a simple point its coming from several points which are there in a line. So, that is why it is a line source this relation is for noise coming from a single point. So, we cannot use this particular relation for traffic noise and because barriers are used very more often for traffic; so, this is the relation you should understand. So, that concludes our discussion on barriers tomorrow we will do actually an example of barrier noise and how we can use barriers to reduce the overall noise level.

So, with that we conclude for today and I look forward to seeing all of you tomorrow, bye.