Noise Management & Its Control
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Lecture - 58
Noise from Adjacent Room

Hello, welcome to noise control and its management. Today is the fourth day of this particular week and starting today, we will discuss about enclosures and partitions as to how these types of approaches can be used to reduce noise.

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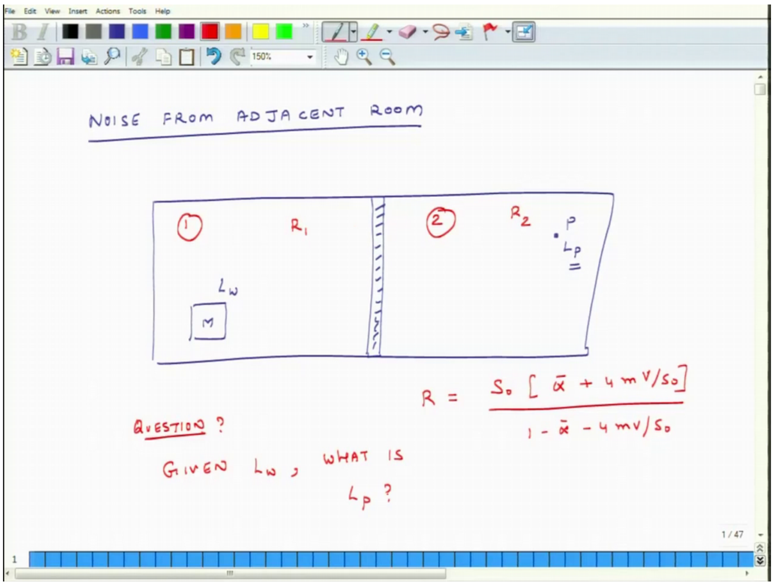

So, what we will discuss today is noise in an adjacent room or noise from an adjacent room. So, here is the context suppose, I have a room. So, big room and there is some machine which is producing noise and there is a person here and we are measuring sound power level or sound pressure level at this location and suppose the sound pressure level is very hard high. So, we going to reduce noise and of course, noise is coming because of vibro-acoustic as well as air bound mechanism. So, one way to reduce this noise is I create a wall here. So, now, I have instead of 1 room 2 rooms. So, the question is that once I have a wall. So, once I have noise coming from this room and I have a wall I am interested in finding out that how much the value of L P is once I introduce a wall and I make this into a partition room.

So, that is why the title is noise from adjacent room that there is a source there is a wall and there is another room there is a wall with separate this 2 rooms how much noise is coming in this room this the problem. So, let us say this machine produces some watts of sound power and associated with that power the sound power level is L W. Now these are 2 rooms. So, this is room number 1, this is room number 2 and each of these rooms has a room constant. So, this is room constant 1 and room constant 2, if you remember the definition of room constant; earlier, we had given that that room constant for any room is what the total of internal surface area of the room times average absorption coefficient of the room and plus 4 m V divided by S naught where m is the energy absorption coffi attenuation constant due to air divided by one minus alpha bar minus 4 m V by S naught. So, V is volume S naught is this thing internal surface area of the room alpha bar is the mean average surface absorption coefficient of the room.

So, the question is given L W what is L P this is what we are trying to figure out. So, the answer to this question comes from a lot of mathematics and also based on analytical formulations as well as statistics as well as some empirical data and what I am going to write down is directly the result. So, in this room, I will call the sound pressure level L P 2.

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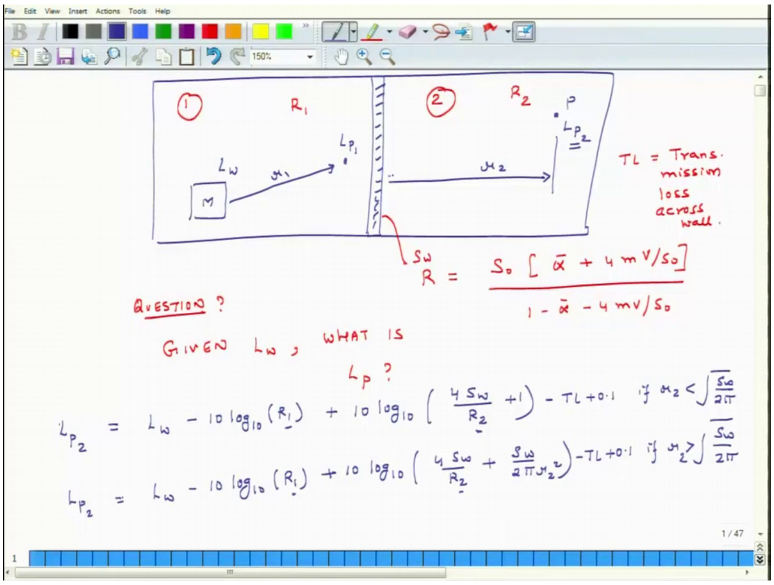

And suppose this is a point then this room. So, this is L P 1 and the distance between the machine and the point here is a LP R 1 and the distance from the wall. So, in this case the distance from the wall to this thing is R 2. So, with this context here is the; I directly give the result and then we learn how to use it because that is more important thing about this course. So, L P 2 which is the sound pressure level at any point in room 2 is equal to L W minus 10 log 10 of room constant R 1 plus 10 log 10 of 4 S w and I will explain that divided by room constant R 2 plus 1 if R 2 is less than S w by 2 pi and this is L P 2 equals L W minus 10 log 10 of R 1 plus 10 log; 10 of 4 S w by R 2 plus S w by 2 pi R 2 square; oh, I am sorry, this is I miss some terms here minus T L plus 0.1 if R 2 is less than S w divided by 2 pi and this is again minus T L plus 0.1.

If R is more than S w divided by 2 pi and I will explain what all this thing means. So, S w is the surface area of the wall it is the surface area of the wall T L is transmission loss across wall then this is R 2. So, let us look at these relations and try to get a physical understanding of it R 1 and R 2 are room constants and look at the room constant the room constant will increase if alpha bar goes up.

What does that mean it will increase if alpha bar goes up or if S naught goes up if alpha bar goes up what will happen to the factor in the to the numerator it will go up what will happen to the denominator it goes down. So, R will increase as alpha bar goes up which means if I have more sound absorbing materials in the room then R will the room constant will increase similarly if the internal surface area of the room is large then room constant will increase in context of noise level at this point p what do you think if there is more surface area in the room what will happen more sound energy will get absorbed and which means the sound pressure level at this point P will be lesser and that is what this relation also tells us that as R increases R 1 increases sound pressure level goes down similarly as R 2 increases R 2 is in the denominator sound pressure level again goes down.

So, sound pressure level can be reduced if I can increase my room constants R 1 and R 2 and the room constants can be increased in 2 ways either by increasing the surface area of the room or by increase having better sound absorbing materials in the room. So, this is one thing about this relation the second thing is T L transmission loss. So, what is transmission loss; suppose I will explain that; what is transmission loss.

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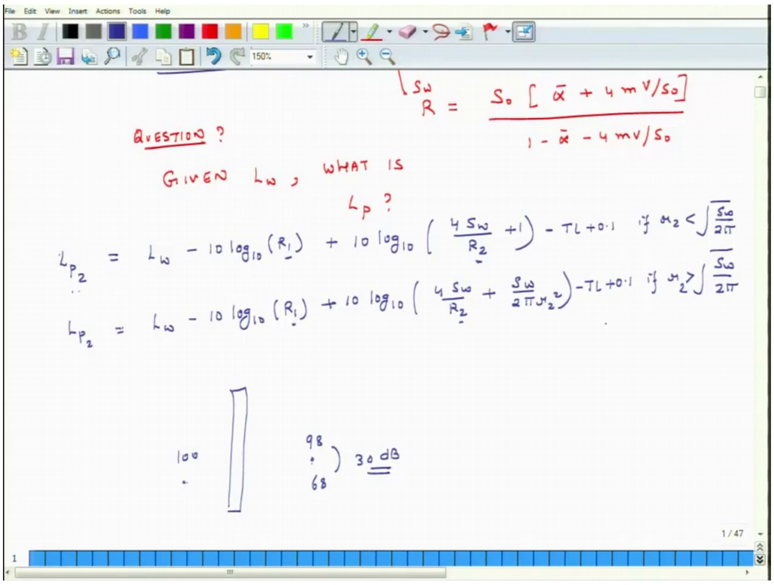

Suppose I have a wall and here it is 100 decibels, suppose, there was no wall suppose, there was no wall and here it was 100 decibels and at this point, it was 98 decibels in absence of wall, then as sound travels from here to hear it falls by 2 disable, right, suppose I introduce a wall and then all of a sudden it becomes 68 which means that the wall is causing a loss of transmission of how much thirty decibels of sound.

So, the decrease in power on the logarithmic scale which gets transmitted across the wall is known as transmission loss; now how do you get this transmission loss it depends on the material properties of the wall it also depends on how thick the wall is. So, there is no hard and fast formula, right. Now we will talk about right now, but if we know the transmission loss of the walls and sometimes you can actually buy some of these petitions from the market and they will specify; what is the transmission loss of those partitions.

So, either you calculate the transmission loss using finite element analysis of things like that or if you are buying a purchase product, they will actually specify; what is the transmission loss. So, transmission loss if transmission loss is known, then you can calculate the sound pressure level in the adjacent room using these 2 relations, if the value of R 2 is more, then this ratio S w divided by 2 pi the whole thing under square root, then you use the second relation otherwise you use the first relation. So, this relation helps us calculate; what is the sound pressure level in an adjacent room if there is a machine which is creating a lot of noise.

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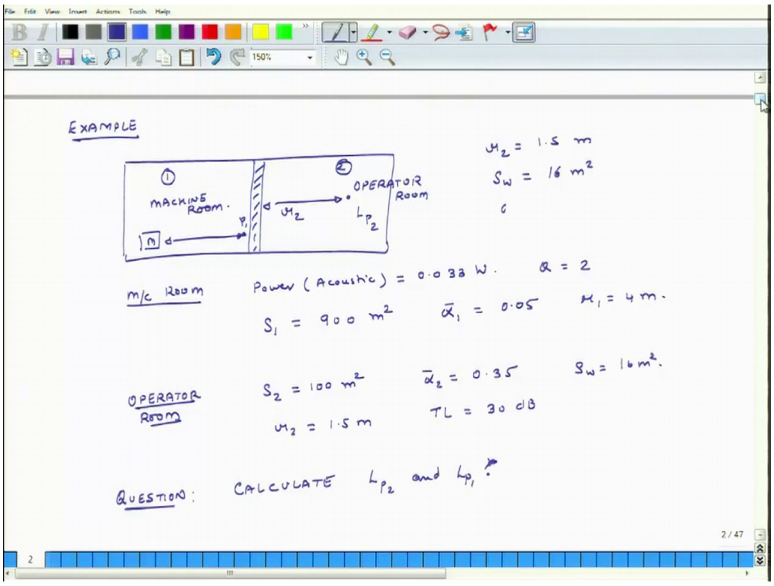

So, let us look at an example. So, consider a large room which has a partition. So, this is room number one this is room number 2, actually before we do this, I would like to specify one more relation because what I said was that what we will discuss is we will tell us; will discuss how to compute L P 2 and also how to compute L P 1.

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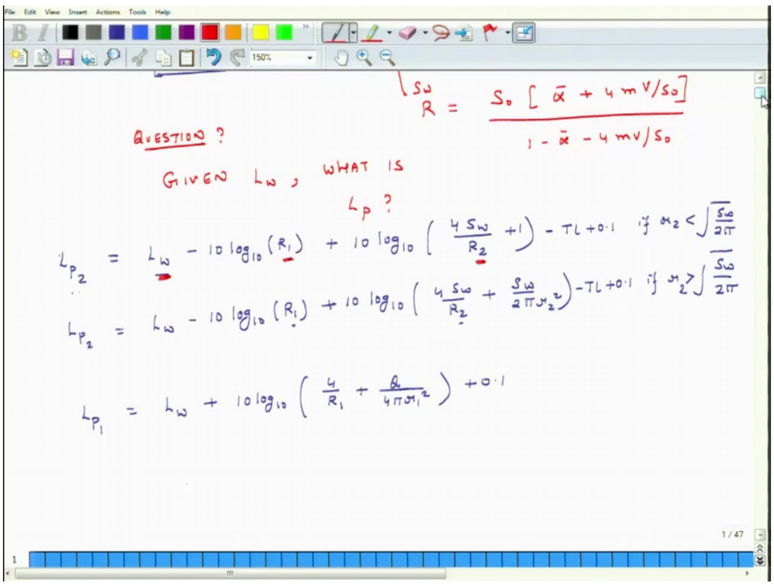

So, to compute L P 1, we have another relation L P 1 equals L W and this is something which we have explained in one of our earlier classes also plus 10 log 10 for close rooms 4 over R 1 plus directivity factor q divided by 4 pi R 1 square plus 0.1. So, now, we go back to our problem which we were just starting to define. So, suppose there is a machine here m and there is a person operator. So, this is the room. So, this is an operator room and this is the machine room this is an operator room and there is the machine room and the machine generates a lot of noise. So, we want to make sure that the operator which is con controlling this machine electrically and through electronics and instrumentation this person is not exposed to a lot of sound pressure. So, we are interested in finding out what is pressure level in this room and the distance. So, this guy is R 2 is this distance.

So, R 2, he is about one point five meters away from the wall the other thing, we know is that this wall is having a surface area of S w is 16 square meters 16 square meters and then we look at different rooms. So, first we will look at the machine room and we will look data in the machine room. So, this machine is generating power and this is acoustic power and it is generating 0.033 watts remember this small amount of energy, but because we have to do if we have to compute it in decibels we divided by the reference power level which is 10 to the power of minus 12. So, the decibel level becomes very large. So, do not just ignore this 0.033 watts. So, this machine is generating 0.033 watts; its directivity factor Q is 2, the area internal area of the room is S 1 and that is equal to 900 square meters the average absorption coefficient in the first room is 0.05.

And the distance of the machine from this point of interest. So, this is p one. So, this is R 1 is 4 meters and then we look at operator room. So, what are the details of the operating room? So, internal surface area of the room is 100 square meters, the surface absorption coefficient on an average for the entire room alpha 2 bar and we know how to compute it. So, I am just giving you directly the value of it is 0.35 the area of the wall S w is 16 square meters and the distance I will just rewrite that is one point five meters and the transmission loss is thirty decibels. So, how do we get this transmission loss either we use f a or we use data from supplies to compute this transmission loss.

So, given this information the question is calculate we have to calculate L P 2 and L P one and the second thing we have to do is yeah this is what we have to calculate and if we think that the pressure in the second room is very high sound pressure level then how do we further reduced this sound pressure level in the second room. So, this is the problem to do all these calculations, let us look at these relations, we have to know L W; we have to know R 1, we have to know R 2, we already know transmission loss, right.

But we have to compute these L W R 1 and R 2 before we can say something concrete about sound pressure level in the rooms.

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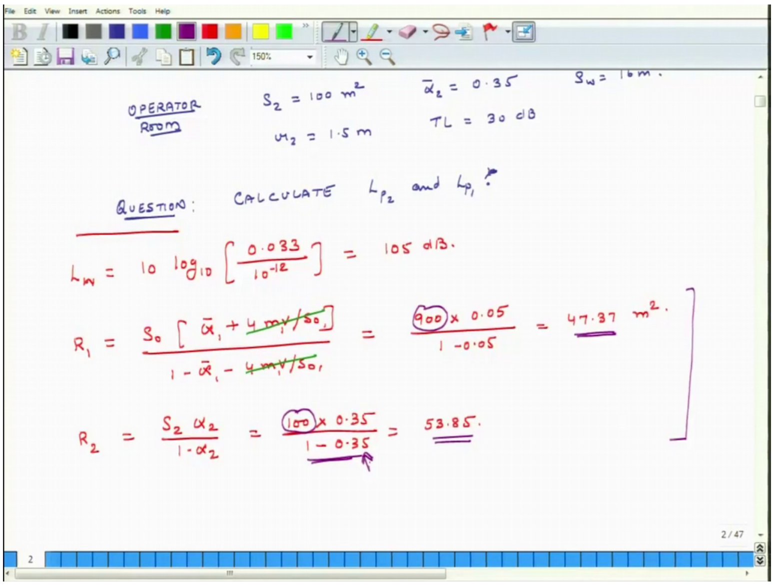

So, L W equals 10 log of 10 power level how much is power 0.033 divided by reference power 10 to the power of minus twelve and if you do all the math this comes to be 105 decibels. So, the sound power level attributable to this machine is 105 decibels; next we compute R 1. So, what is R 1? R 1 is S naught times alpha bar plus 4 m V divided by S naught divided by S; excuse me 1 minus alpha bar minus 4 m V by S naught and this is for room 1. So, I am going to specify these things. Now here we have seen couple of earlier times also that this is not a very large room right. So, the role of air is not significant air does not absorb a lot of sound does not observe a lot of sound. So, we can ignore the contribution of air.

So, that is why; so, we will not bother about it, but if we want to be more accurate we can include the contribution of air, but then we have to know the value of m and then once we know that then and of course, we also have to know the value of V. So, we can. So, that is there. So, with that thing in mind we compute this thing S naught is how much 900 square meters times alpha 1; what is alpha 1.05; this the surface absorption coefficient of the first room divided by 1 minus 0.05. So, this comes out to be 47 point three seven meters square and then R 2 equals S 2 times alpha 2 divided by one minus alpha two. So, once again when I am computing the room constant for the second room there also I am ignoring the contribution of air. So, that is equal to 100 times 0.35 divided by 1 minus 0.35 and that is equal to 53.85.

So, remember just its important to understand something here the room constant for the first room is 47 and for the second one is 53, if you look at the size of the room the first room its internal surface area is nine times more you look at this number 900 is 9 times more than that of the second room, but still the room constant for the second room is slightly more than that because the surface absorption coefficient of the second room is 0.35 compare to 0.35 and because it comes in the denominator as this number becomes larger and larger and becomes closer to one this room constant value goes up very rapidly very high.

So, if you can increase alpha rather than work on increasing surface area you will get much better benefits. So, this is important to understand. So, I think now what we have done is we have set up our problem correctly and we will continue this calculations also in the next class and finish this and then try to learn something from this example which will help us understand; how can we design effective enclosures in situations like this where we have a large room with the separation of a wall and we want to make sure that the sound coming from the adjacent room where we may have a machine or something is as less as possible in the room where people are staying. So, that concludes our discussion and I look forward to seeing you tomorrow.

Thank you.