Fundamentals of Acoustics
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Lecture – 72
Noise Reduction Coefficient (NRC)

Hello, welcome to Fundamentals of Acoustics. Today is the last day of this course and today we want to cover some brief topics which are important form the stand point applications. So, the first topic I am going to discuss is NRC.

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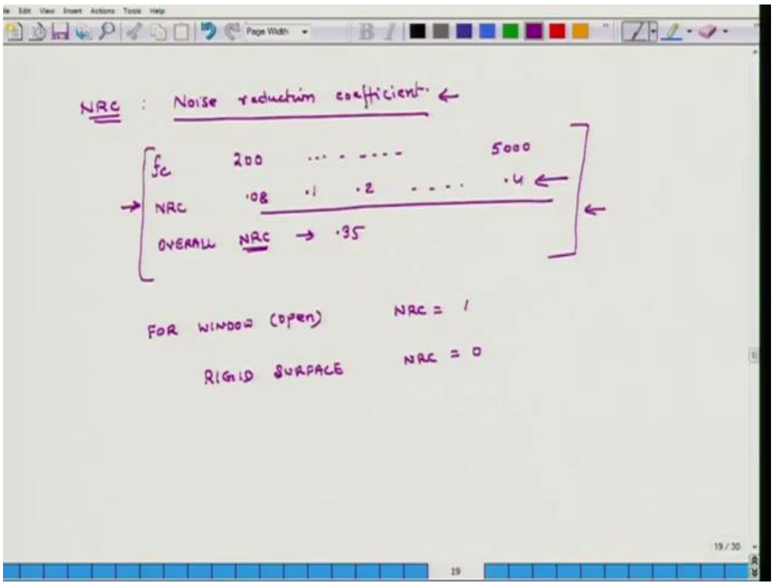

What is NRC? It is an acronym for Noise Reduction Coefficient. So, what is a context? Suppose you were go to a market and you say that I want some tiles for a room and these tiles should have good sound absorption properties. So, the shopkeeper will go back and look at his store and let us say he gives you this kind of a tile which is shown here. So, he gives you this tile.

And you say how good this tile is in terms of reducing noise. So, we will say I will give you the NRC data for this. So, what is NRC? He will give you some numbers and those numbers will look something like this. So, he will give you for different frequencies 200 and it goes on till. So, these are all central frequencies and the next frequency will be 200 times 2 to the power of 1 by 3. So, these are central frequencies for one-third octave bands. So, he will give you for 200 then 200 times 2 to the power of 1 by 3 and so on and so forth. So, it will go up to 4 5000 and for each frequency he will give you a NRC noise reduction coefficient and he will say this is 0.08 to 1.2. So, 1.1 and so on and so forth and here may be 0.4.

And then he may also give an overall NRC value which will be some sort of an average for all these values and that will be may be 0.35. So, using these data, this is noise reduction coefficient and this is for that particular tile or that material which you are purchasing from the store to build your room or auditorium or whatever. So, based on this NRC data you can compare different materials and it is important especially if you are constructing a room or an auditorium or a theater where acoustical properties of the room are important.

While when that context understanding, what is NRC and then using NRC parameters to compare different sound absorbing materials is important by the way for windows when the window is open, what is the NRC for that? NRC equals it does not absorb it does not reflect any energy whatever energy it goes it just goes out. So, NRC is equal to one and for rigid surface NRC equals 0, all the energy gets reflected back. So, that is the first topic for discussion.

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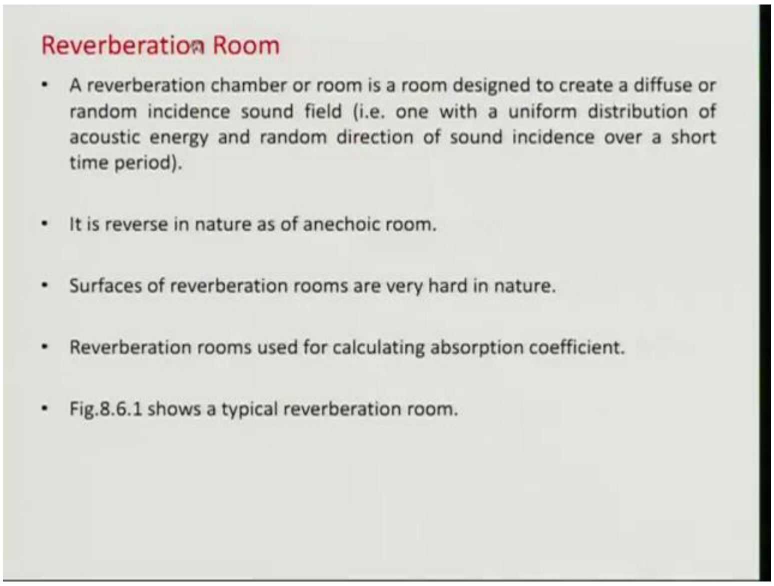

That second topic is reverberation room. So, what is a reverberation room? I will show you picture first. So, first we will describe, what is a reverberation room? It is a room designed to create a diffuse or random incidence sound field. So, first thing, sound field which means that at every point in the room, the pressure is same because there are reflections. So, happening all over the place seen a rectangular room you have standing waves in a rectangular rooms. So, at some point pressure will be high and at some point pressure will be low.

For instance as wave travels through a closed tube at some locations you have a standing wave in a closed tube and at some locations the amplitude of pressure is very high and at other locations the amplitude of the pressure is theoretically 0. So, the absolute magnitude of pressure changes, if I change the position in a reverberation room what we want is that at every point in the room the amplitude of the pressure should not be changing.

How do we acquire it? First thing is that a standing wave tense to develop in rectangular rooms. So, we make rooms which are not rectangular in nature. So, they may have angular walls and things like that. So, because of that standing waves do not tend to develop easily in such rooms. So, that is one thing.

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Fig. 8.6.1 Reverberant room

The second thing is you see this room; this is a picture of a reverberation room. So, this surface and all this walls are rigid surfaces. So, when sound comes here, it gets reflected easily and does not get absorbed a lot and then all these angles are not necessarily at 90 degrees. So the standing waves do not tend to develop easily and the third thing what they do additionally is that is sound is going here you pout an additional reflecting surface here these are transparent reflecting surfaces and they are also somewhat rigid. So, when sound comes here it does not get a chance to hit here, it reflects, it hits this curved surfaces. So, sound bounces off in all directions and as a consequence sound pressure uniformly gets distributed in the whole room in the whole room.

That is the attribute of a good reverberation room that if the sound field at different points in the room is diffused and it is not like that of a standing wave. So, in these kinds of rooms what is the sound field? We have discussed this earlier it is a diffuse sound field or a random incidence sound field right because sound is coming at every point from all directions. So, surfaces of reverberation rooms are very hard in nature and what do we use this reverberation rooms. So, suppose I have absorption a material with unknown absorption coefficient I can use a reverb room to compute its absorption coefficient how do I do that?

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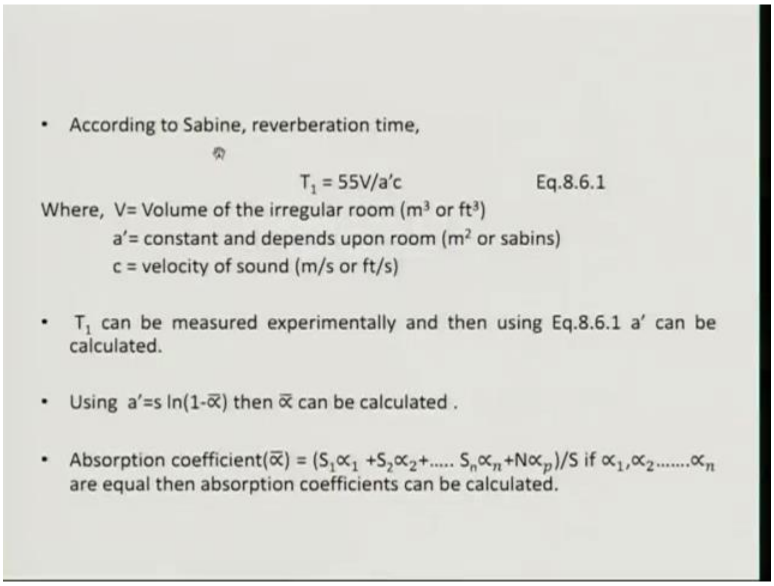

First what I do is I go to the room and I do not put any absorbing material and I will get its reverberation time, I can measure its reverberation time and I know the volume of the room I know c. So, from that I can compute a prime the next thing is. So, once I know a prime I can also calculate it alpha bar of the room. So, this is the first step one measure T one using microphones. So, when you are doing the recording initially the pressure in the room will be high and slowly it will decay the time it takes for the sound pressure level to decay by a factor the sound energy to decay by a factor of 60 decimals that correspond to the reverberation time.

Reverberation time T 1 gets measured, we already know v of the room we know c. So, from that I can calculate alpha prime once, I have alpha prime, I use this relation and from this alpha prime s is the surface area of theorem that again can be measured. So, from that I can calculate alpha bar which is the absorption coefficient of the room for a reverberation time room it will be very small now what I do is I put a sound absorbing material on some wall somewhere in the room and once I put that the absorption coefficient of the room will change. So, initial absorption coefficient is alpha bar and it is this number, it is this number.

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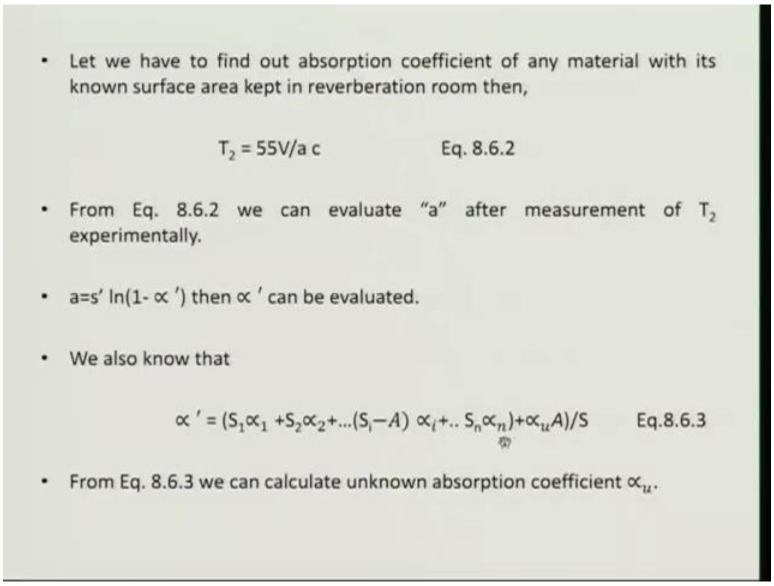

If I put an extra material then what is this the new absorption coefficient will be alpha prime which will be all the initial components plus alpha of the unknown material times its area divided by s agreed. So, if I can find.

Now, alpha prime for the room then from that I can back calculate alpha u which is the sound absorption coefficient. So, I how I do that I once again now again measure the reverberation time of the room with the absorption coefficient and in this relation from T to I compute the new which is the modified parameter a and this parameter a is log of s prime times log of 1 minus alpha prime. So, alpha prime can be re calculated and in this equation I know the left side I know all the terms on the right side except alpha u. So, I can go back and measure the absorption coefficient of the unknown material and this absorption coefficient will be for a particular frequency.

I have to do this experiment for several frequencies and then I can characterize the material. So, with this we can use a reverberation room to characterize materials with unknown absorption coefficients. So, these where the 2 important topics which I wanted to discuss today and with this we conclude our discussion for this course what we have done over this entire course is a series of things we started discussing in this course by making some introductory comments. Then we introduced you to important mathematical concepts which have been frequently used in this course and then we went on and discussed the one dimensional wave equation solve the one dimensional wave equation; use this one dimensional wave equation solution and associated transmission line equations to make important observations about standing waves and waves which are traveling freely and then new went ahead and explode the idea of impedance both for radial waves as well as planar waves and we also described the Kundt's tube apparatus which can be used to measure the impedance of a material.

And after that we came to the area of applications and from the stand point of applications, we touched upon a variety of topics is starting with mufflers how to measure impedance of an unknown material how to radial waves propagate and what do they physically imply and a slew of several other topics.

I hope this course which is introductory in nature has been of benefit to both people who are studying in colleges and universities as well as to people in the industry and please feel free to ask question if you have to the Ts or to be and I think next week or few days from today, you will be having your final examination. So, please study well for your final examination. It will be a multiple choice type of an examination and I hope you do good in the exam.

Thank you and best wishes for the future, bye.