Basics of Noise and Its Measurements

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Lecture - 46
Anechoic Rooms

Hello, welcome to Basics of Noise and its Measurements. This is the last week of this particular course and today what we are going to discuss is anechoic chamber or anechoic rooms. So, we have seen that for noise related measurements, there are lots of tools; microphones, A to D convertors, sound level meters and so on and so forth. But there are, we also need to make some, at least some of these measurements in specific environments. And in certain types of applications, what we want is that there should not be any reflections of sound while the noise measurement is being made. These types of environments are provided by rooms, which are known as anechoic rooms.

In that sense anechoic rooms are not just rooms, but they also are tools to make certain types of noise related measurements happen. You know, they ensure the goodness and the accuracy of certain specific types of noise related measurements. That is what they do. So, what is anechoic? So, there is this echo in embedded in this word ‘anechoic’; is this word ‘echo’ and ‘a n’ stands for ‘no’. So, anechoic means that a room where there are no echoes. So, that is what an anechoic room is.

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This is the picture of an anechoic room, which we have at IIT, Kanpur and what the picture shows us a surface on which you can stand. And below this surface, this is porous surface. This; there is a grill, a strong grill on which you can stand. Below the grill, there are cones made of foams. So, these are all cones made up foams. So, you have foams; foam cones also below this surface. And then, you have foam cones. These cones of a foam also on the top surface. So, all the six surfaces have these type of cones.

And, behind the cones you have other sound absorbing materials. And, the purpose of this elaborate construction is that whenever I generate a sound in the room, once that sound hits the wall or the floor or the roof, it just gets sucked in there. And, it does not return as through reflections. So, that is the purpose of the these. This type of topology of the walls, the floor and the roof. Now in reality, that is the ideal goal. But, in reality that does not happen always and to perfection.

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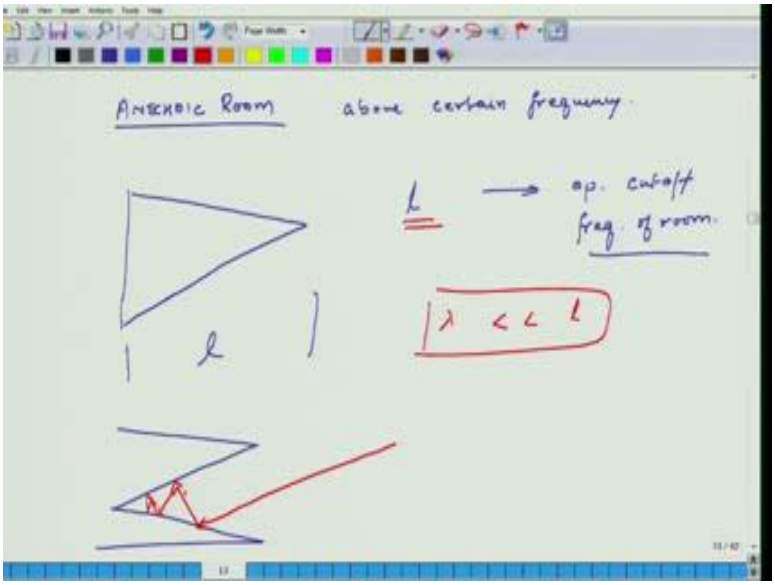

So, you always say that I have an anechoic room, which operates above a certain frequency. Why is that because typically the size of this cone, you know the size of this cone, this l has some relationship with operating cutoff frequency. If the value of l is larger, then the cutoff frequency of my anechoic chamber will be lesser. Essentially, what happens is that you have these two cones. And when sound comes in, it gets reflected, and then it gets reflected again and gets reflected. But, it is somehow trapped inside these two cone surfaces, and it never gets a chance to come out.

So, when it would get reflected, part of it gets absorbed and part gets reflected again and it gradually gets more and more absorbed and it gets lost in that. But, this will happen only if the wavelength of the sound is sufficiently smaller compare to l. So, that is why the size of these cones is extremely important. And, if I want to make sure that my anechoic chamber works at low frequencies, then these cones have to be very large. If the chamber has to work at may be even 512 hertz enough, then I do not need to have very large cones. So there; that is the basic operating principle of these anechoic chambers.

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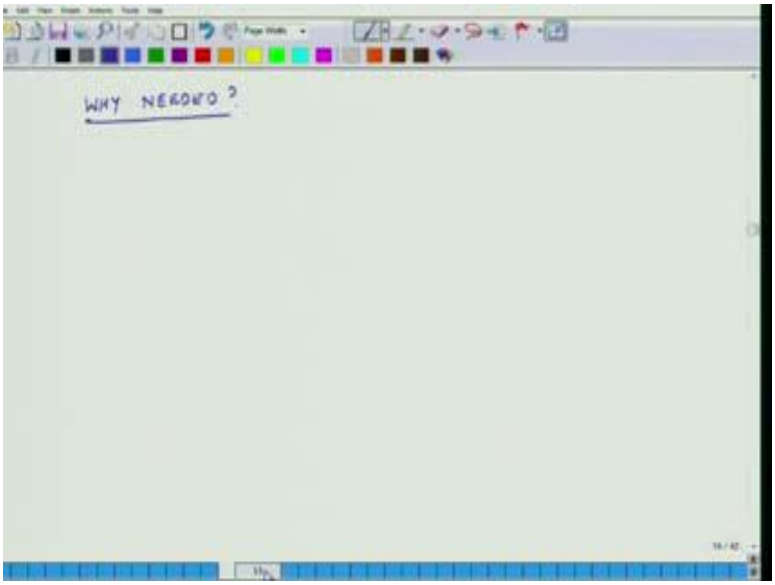

Why do we use these anechoic chambers? So, why do we? Why are they needed? So, consider an instrument or equipment. Let say I have an engine, an I C engine and I want to make sure that I want to measure how much sound it is generating. Also, I want to see that what kind of sound or what kind of directivity pattern this sound source has. So, in front of. So, it could be that the engine is generating a broadband spectrum of noise and some components are getting radiated more strongly in one direction and other components are getting radiated more strongly in some other direction. And, I want to have this characterization of the noise source. In this case, it could be an engine.

Now, if I place this equipment in a regular room and I have a microphone to measure it, what will the microphone measure? It will measure partly the direct sound, which is coming from the engine and part of the sound which it will measure will be all the reflected sound from the engine. So then that microphone, let say I put that microphone at with using some coordinate system. I put it at 0 degree angle. It measures some decibels, but it is not measuring. And, let say it is a directional microphone. So, it is sensitive to noise coming from 0 degree direction only, but all that noise need not be coming directly from the engine. A lot of that may also we reflected in nature.

So then, whatever measurements I make, I cannot say with certainty that those measurements are purely corresponding to the 0 degree direction of the engine. They may also be related to other sources, but they are, we are still getting that noise because the source is before I am getting reflected sounds also. So, that is one thing.

The second thing is that the noise amplitudes for each frequency. They can also get substantially altered because what happens is that when I measure direct sound, I will take some measurement. I will get some reading and then, when part of the sound it goes to the wall and it gets reflected, part of it gets absorbed and part of it gets reflected back. This absorption is not same for all frequencies. So, it could be that at 100 hertz less sound is getting absorbed; at 1000 hertz more sound is getting absorbed; at 1500 hertz even larger amount of sound is getting absorbed. So, the reflected sounds characteristics may be significantly different than the characteristics of the original sound which is being emitted by the source. So, when I make measurements of this type of a sound what I am measuring may not be reflective of the actual sound, which is being generated by the original source, but because it is being colored or transformed by the environment also.

So, what we want to make sure is that we want to immunize the effect of environment on the sound. And, we do that immunization by conducting these type of experiments in an anechoic chamber. So, this is very important to understand. So, a lot of these chambers are used for noise characterization, directivity measurements, noise characterization of sources, directivity related measurements, a charity of measurements and so on and so forth. So, the next thing we will like to understand is, how do we specify an anechoic chamber. Suppose, you are interested in developing an anechoic chamber in your lab or in your company, then how do you do? What are the important specifications?

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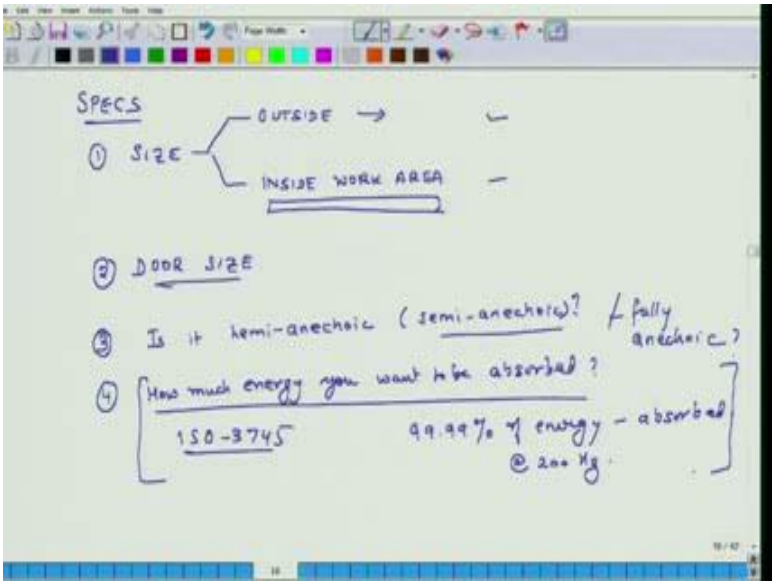

So, the first thing to worry about is size. Suppose, your application is to test mixies or vacuum pumps or washing machines, then may be you do not need a very large size. But, if you want to test the truck in an anechoic chamber, then you have to have a much larger thing. Size has two components; one is outside and the other one is inside work area. These are significantly different dimensions because in a large number of these chambers, the length or the dimension occupy, the volume of the size occupied by these cones is fairly large. So, your inside work area could be significantly different than the outside boundary of your anechoic chamber. And, it is not that you only have these cones, while constructing these chambers. Behind the cones, you have several layers of noise absorbing materials and noise filtering materials. So, the significant fraction of the volume of the outside area of the outside room is consumed by all these construction materials.

So, it is important to understand and specify that my outside area, within which I am going to construct my anechoic chamber is going to be a times b times c. And, my inside area which is driven by my requirement is going to be e times f times g. So, you have to make these specifications very clearly.

Second thing you have to worry about is what is the size of the door you want because if you have a truck, then your door should be large enough that it should let a truck enter. Third is hemi-anechoic or some people call it semi-anechoic. So, this is another consideration. So, what does that mean? So, the picture which I had shown earlier, it had all the six surfaces. It is like a rectangular box, the chamber. And, all the six surfaces were lined with noise sucking geometries. It is not just noise absorbing, it just sucks in and it does not let any noise go out.

So, in some rooms the floor is not of that (Refer Time: 13: 26), the floor is still a hard floor. So, so those types of chambers are known as semi-anechoic chambers. They are somewhat less expensive because you do not need a grill and below the grill you have to put all these cones again. So, they are somewhat less expensive, but they are not truly anechoic; one surface is reflecting surface. So, we want that will that do for you or you still are interested in fully anechoic chambers. So, is it hemi-anechoic or is it fully anechoic.

Fourth parameter is; and this is extremely important. How much energy, how much energy do you wanted to be, to want a chamber to absorb? So, suppose those 1 watt of energy, it is impinging on the wall or we okay if point 1 watts are reflected back or are we okay if zero point zero one watts are reflected back or are we okay if or do we want even lesser. So, you have to make sure that you specify this very clearly.

There are some standards for that. So, there is one standard called ISO-3745. In terms, how do you characterize this? And, a lot of times people say and I am just throw out a number that I want that 99.99 percent of energy to be absorbed. And then, they go beyond this and then, they said I want this thing to happen at let say 200 hertz. And, you can convert this into decibels that I want this; you know absorption characteristics for so many decibels at 200 hertz. So, you have to make that specification very clearly because that is the fundamental function of anechoic chamber. How much energy it is absorbing? It is not that just to make a room and put lot of cones and you send anechoic. It is characterized like that.

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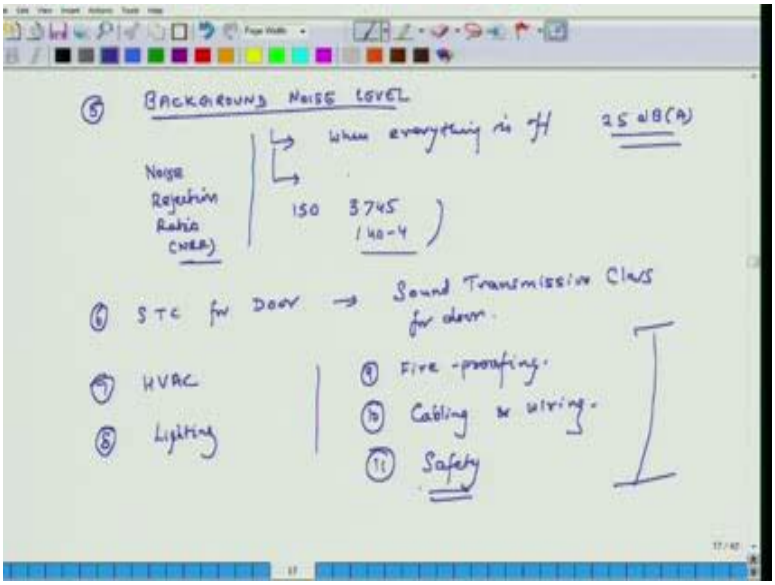

The next one is what is the background noise acceptable. What is the background noise, what kind of noise is acceptable. So, you can make any chamber. There will be always some noise; some noise will come from outside, some noise will be generated by internal mechanism, electric circuits, ACs and all that things. So, you have to specify that I want that in my room background noise level when no equipment is playing, it should be so many decibels. And then there a people who specify it at in two ways. One is when everything is off. Then, how many in decibels is acceptable? You can say that I want only 25 db.

Then or then some other equipment is running, may be you have an air conditioner in your anechoic chamber and that itself will generate noise. So, when some may and, but you cannot avoid that because may be you have to work in the room for 5 to 6 hours to set up your equipment. So, for that you have to then, you have to make sure that you when you specify this, you are able to verify it correctly. There are some ISO standards to verify these things. So, one ISO standard is 3745 and then there is also 140-4; were some standards. And, what these standard say? That inside noise level is going to be 25 db, when outside noise level is 70 db. So, they always characterize in context of what is the noise present outside, so that is important.

Sixth parameter is, see lot of times everything is sealed in your anechoic chamber, but some noise because you have a door, it will come through the door; the door opens and closes. So, S T C for door. What does this mean? It means sound transmission class for door. So, this is what it means. So, if our door has an S T C value of 65 roughly, it means that it will reject 65 decibels of sound, with reference to outside. Roughly. It is not one and one number, but roughly.

Then, suppose you want to test your, use your anechoic chamber for using for engines or first some things which have exhaust gases. So, you have to specify some detail things for HVAC systems. You know, heating, ventilation, AC, all that stuff. What else? Oh, there is one. So, this is also known as noise rejection ratio. You always specify it in decibels. That I want outside noise to be rejected by 70 decibels something like that. Then you should have very clear specifications for lighting. A lot of times these tube lights, they themselves generate noise. So, is that acceptable or what kind of lights you want?

Fire proofing because some of these materials may be flammable. So, you have to be very careful about those. There is an electric spark, it should not go into fire. So, you have to; while specifying you have to make sure that you specify that only for retardant materials are going to be used. And then, there is a category of different types of our retardant materials. So, you have to be careful about that.

Then, what else? cabling and wiring. How do you run the cables inside the room, how do you make sure that if some cables get damaged, you should be able to replace them usually and if you have an equipment inside the room, how do you get the signal from inside the room to somewhere outside where you may be monitoring the experiment from outside. So, cabling is important.

Then, an extremely important consideration which has to be provided in specifications is safety; because these are rooms, they are like virtually like sealed boxes. If something happens inside, it is very difficult for anyone to listen to outside. So, if in case of an emergency what kind of methods and protocols are there and field safety mechanisms are there; so, all these are important considerations for anechoic chambers. So, once you

have this, then you can use these to do all these experiments and conduct whatever experiments you have to do in context of your needs.

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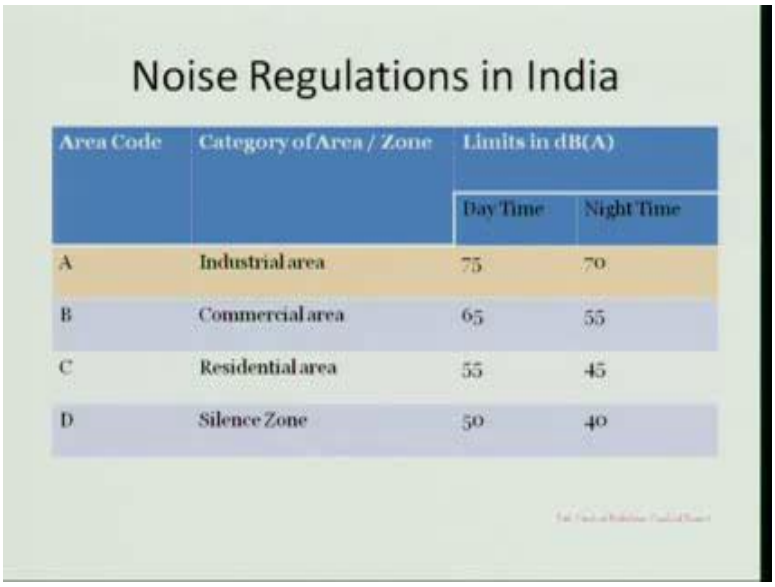

Lot of times you need these type of a facilities to characterize noise sources. And lot of times you need such characterization to be done because you have to reduce noise levels for because of some government rules also. So, in some cases you may actually choose to do it on a voluntary basis, but a lot of times there are government enforced regulations that noise in the neighborhood of a hospital or on a road or in a commercial area will not be beyond this thing. So, if you are using a particular types of equipment in that area, you should know what kind of noise signatures they have. So, you can use these anechoic chambers to characterize them.

What you see on the screen right now is a very brief summary of different types of noise regulations in our country. So, what people have done? This Central Pollution Control Board; that it has classified the whole country in four different types of zones. So, every area is either an industrial area or a commercial area or a residential area or a silence zone. Silence zone would include places in neighborhood of hospitals and things like that. And then, they say that in the day the noise should not be more than 75 dba; in the night, it should not be 70 dba for industries. And then for commercial, the numbers are

different. For residential areas, the numbers are different. So, we have to meet these regulations. And, you still want to use the equipment which you want to use. You have to make sure that they have the right type of appropriate noise characteristics. So, that is one context in which an anechoic chambers come in handy.

So, that is pretty much what I wanted to discuss today and we will now continue this discussion tomorrow also. And, tomorrow what we will discuss? Some noise related parameters known as S T C, N R C, sound at innovation, transmission loss, things like that and because those terminologies are extremely important in the industry. And, it will be helpful for you to get a pair of those.

Thank you very much and have a great day.