Noise Management & Its Control
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Lecture – 03
Nature of sound

Hello, welcome to Noise Management and its Control.

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Today is the third day of the first week of this course and what we plan to do is continue our discussion on some of the important terms and terminologies associated with acoustics, sound and noise. So, in the last class we had just started discussing as to what is the nature of sound and we had explained that when sound is being generated and essentially physically what it means is that the pressure of air in the room or the pressure of medium, in the pressure in the medium it fluctuates about the mean position.

So, specifically for instance if I am talking in a room, the mean pressure would be atmospheric pressure and then the pressure in the air would fluctuate about that mean position and that small fluctuation in the pressure, which I designate in the slide has small p. So, that is through which. So, if I can measure that small fluctuations which is small p, then I am able to measure the magnitude of sound.

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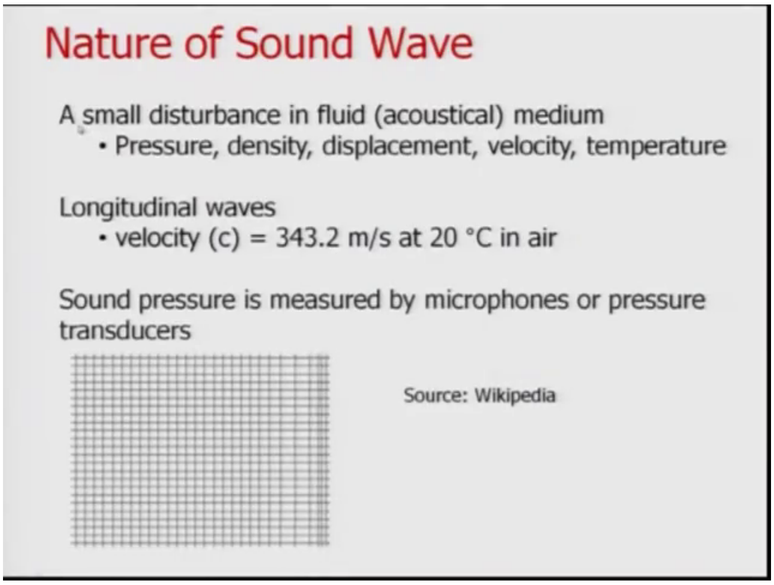

Now remember that this small p depends on position. So, x is in general I mean it in strictly speaking it will be x y and z. So, it is depends on position and it also depends on time. It is P 0 which is atmospheric pressure at least in case if the medium is here that does not change with position in time. So, the total pressure is P total which depends on x and time is nothing, but sum of P naught plus small p. So, P total is also a function of x and time. So, that is the physical understanding. So, whenever I say oh there is sound or sound is travelling essentially what; that means, is that the small p is getting generated it has a non zero value and this disturbance which is small p is travelling in space as well as time.

So, with that understanding I can call sound; as a small and please remember that whatever we will be discussing at least in this course will be about small disturbances these disturbances could be extremely large, but 99.999 percent of the sound which we encounter that is associated with very small disturbances. So, it is so in that sense we say that sound is nothing, but a small disturbance in fluid medium or acoustical medium and these disturbances can be in pressure they can be in density in displacement of the particle in velocity and temperature.

Because when pressure changes then density will also change in fluids displacement and velocity will of course, change and also temperature is going to change. So, this is there and specifically in fluids like air and water because they cannot take shear forces. So, in such types of waves, the sound when it travels it travels as longitudinal waves and for air at 20 degree centigrade, the velocity of propagation of sound or this pressure disturbance is 343.20 meters per second. So, that is the standard velocity of sound.

How we dev calculated we will discuss all this later in the course, but at this point of time its it will suffice that velocity of sound in air at standard temperature and pressure conditions is 343.2 meters per second. And how do we measure sound pressure? So, when we say we measure sound pressure essentially we are measuring the small p. We measure this sound pressure using instruments known as microphones and sometimes these microphones are also known as pressure transducers espec. So, microphones there are two different types of microphones; one set of microphones can measure pressure changes in pressure other set of microphones measure indirectly velocity of air particles.

So, the microphones which measure pressure they are known as pressure microphones or pressure transducers. So, most of the times when we measure sound we measure it in terms of pressure and for that we use microphones or pressure transducers for that purpose. So, once again to recap P total is P naught plus small p and P naught at standard room temperature and pressure conditions is 101325 pascals. So, that is there.

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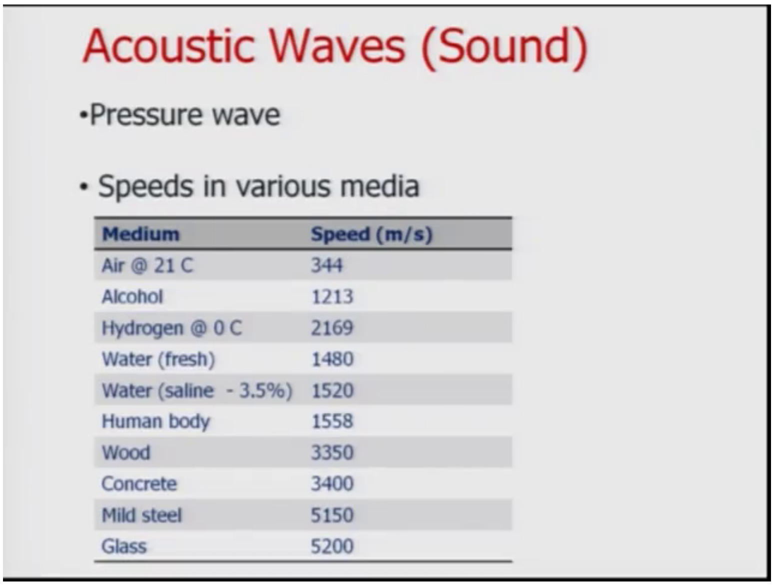

Medium	Speed (m/s)
Air @ 21 C	344
Alcohol	1213
Hydrogen @ 0 C	2169
Water (fresh)	1480
Water (saline - 3.5%)	1520
Human body	1558
Wood	3350
Concrete	3400
Mild steel	5150
Glass	5200

Now, this is a good slide and I think it will be important if you remember some of these numbers you do not have to remember all the numbers, but some of the numbers are important and you should internalize them. So, in air sound travels. So, these are around numbers approximate numbers, in air sound travels at 344 metres per second that is an important number you should remember. In alcohol it is about 1213, in hydrogen 0 degree centigrade it is about 2100 meters per second.

Now, the second number which is important to remember is how fast does sound travel in water. So, that is about 1500 meters per second. In freshwater which has no salt it is about fertility; when you add salt it travels a little faster say in sea water and things like that it is about 15-20 meters per second. In human body now our bodies are essentially water, if I take a body and I break it up into all the constitution constituents most of us most of the stuff which we are made up of is water.

So, for that reason the speed of propagation of sound in human body is about 1500 meters again 15-80 of course, there is other stuff bones and some salts and other things. So, because of that it is a little higher, but it is dictated by the speed of sound in water then there are numbers for wood and concrete. So, you should definitely remember the speed of sound in air you should remember speed of sound in water, because that is very common phenomenon and then the other number to remember is because a lot of our structures are made from steel.

So, in steel the speed of sound is about 5000 meters per second, the same for thing for glass also. Steel and glass 5000, water 1500, air 340 meters per second these are some of the numbers we should remember because when you go in your field and you do your work, if you have these numbers in your head and then you can do some quick calculations. So, this is there.

So, next what we are going to look at is some of the other things, which are interesting about sound. So, for that I am going to open up this presentation and as we have discussed sound is it travels as a wave and whenever we have a wave what are the attributes of waves?

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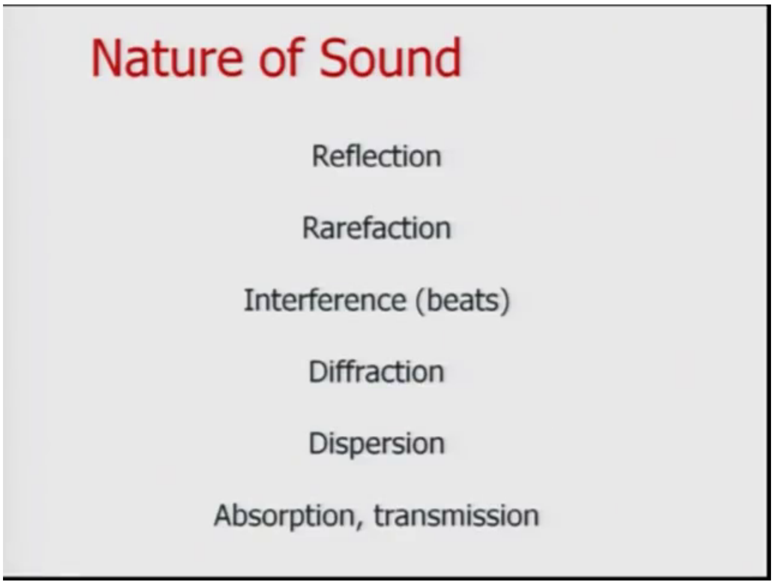

Waves reflect right. So, you have a light wave and it hits the surface it reflects and when it reflects then what law does it follow, it follows the law for reflection which is angle of incidence is equal to.

Angle of.

Angle of reflection. So, similarly when you have sound and it hits a reflecting surface and a fair then that also gets reflected and an angle of incidence it follows the same law, angle of incidence equals angle of reflection when sound travels from one medium to other medium and if the direction of propagation is not normal. So, if this is the boundary and if sound is hitting like this then it will just travel straight, but if it comes at an angle then like light that also refracts and the law of refraction says that sin r over r sin i equals angle this refractive index of the material. So, similar laws now refractive index for sound material and light there may be different values because these are different types of waves, but the laws are same. So, sound waves reflect they refract also when two sounds mix and you know you have a sound source here you have a sound source here, they come and they can they generate interference patterns when there when they meet and one interesting pattern amongst different interference patterns is the phenomenon of beats actually we will do an experiment today and we will show you what it means.

So, sound waves reflect, they refract they interfere they diffract they disperse and as they propagate through mediums they also get observed and of course, they get transmitted. So, all these things whatever you have learnt about waves in general they are also applicable to sound waves. The difference between a light wave and a sound wave is that light wave is a transverse wave and sound wave is a longitudinal wave. So, that is an important distinction.

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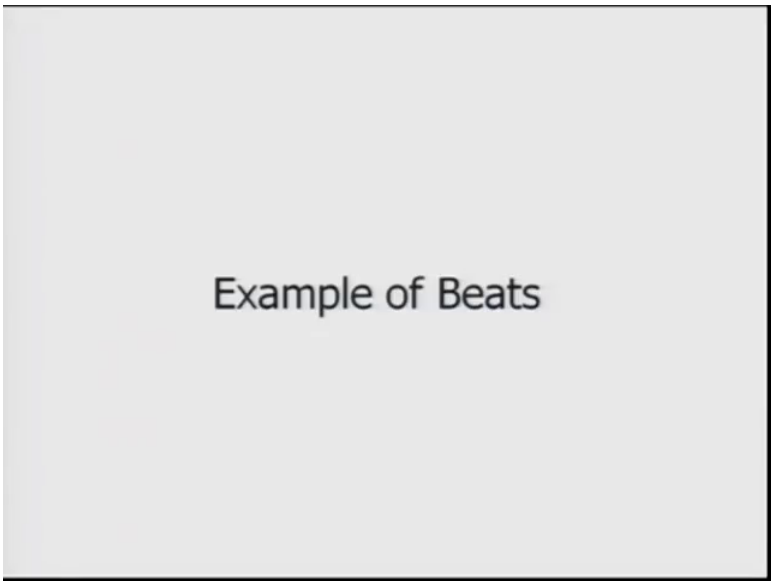

So, let us look at this example of beats. So, first I mean by beats. So, beat is an example of interference. So, what do I mean by that suppose I have. So, what I will do is we will talk very quickly about beats.

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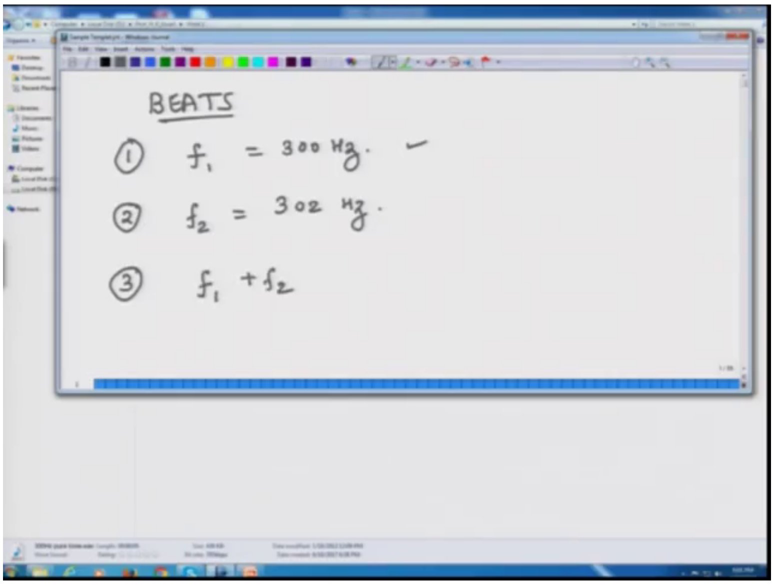

So, in the first case I am going to play a sound file where the frequency of the sound wave let us say f 1 is 300, then I will play another sound file where the frequency of the wave will be slightly different 302 hertz and then I will play a sound file.

So, in the first case I will play only f 1, in the second case I will play only have f 2 and in the third case I will play f 1 plus f 2 and then you should listen to it and you should get a perception, you will get the clear understanding that what is this beat phenomenon.

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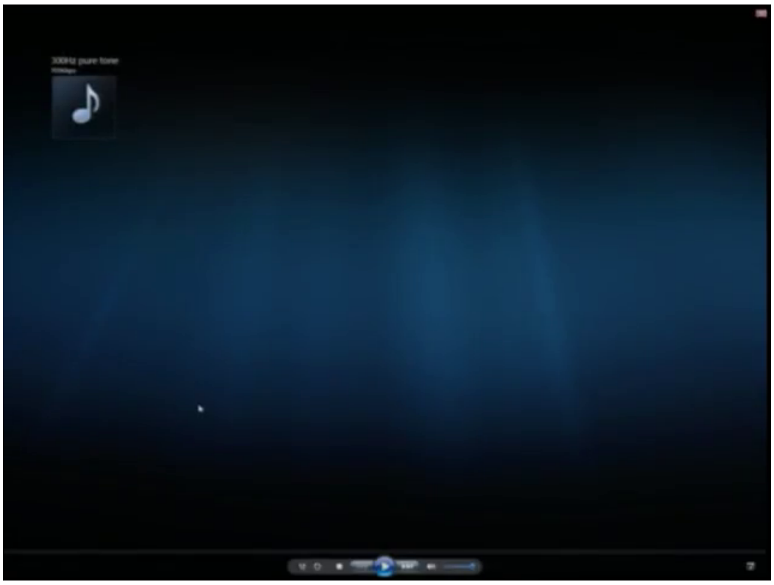

So, this is. So, what I am going to play right now is a pure tone 300 hertz your tone.

So, what does a tone what do we mean by tone that it is just a sinusoidal frequency. So, the wave is just a sinusoidal wave. So, this is how it sounds like and the frequency is right now 300 hertz. So, I will play it a one more time and one last time. So, that you remember what it sounds like. So, the next one will be 302 hertz.

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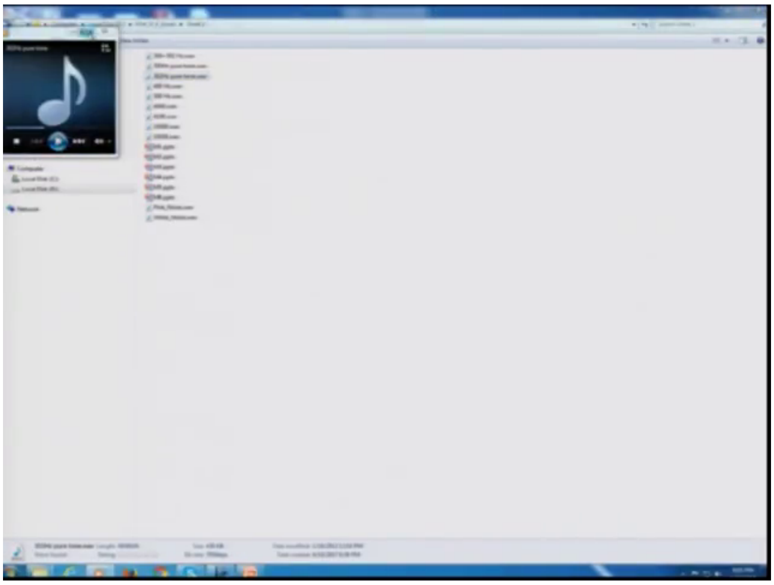

So, this is 302 hertz, slightly different the first one was 300 this is 302. So, your ears would not be able to figure out the difference between 300 and 302 hertz ok.

if. So, you would see that the sound pretty much the same you cannot sense the difference. Now what becomes interesting is that if I play this 300 hertz and 302 simultaneously. You would expect that what you will hear is same, but here you will hear something different. So, first let me play and then we will see the mathematics of it and what you are hearing is. So, if you hear it carefully what you realize is that the type of sound is same as 301 302 hertz, but it is going up and down right the volume is going up and down, but the type of sound if you hear is same, but its volumes goes up and goes down and then it goes up and goes down and so on and so forth.

Thank you and have a great day bye.