Human Factors Engineering

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Lecture - 42
Noise Exposure and Hearing Loss, Noise Analysis and Noise Reduction using Engineering Measures at Manufacturing Plants

The dear the students and participants now in the second lecture sessions, I am going to discuss few more important topics related to the design of auditory environment at a work place.

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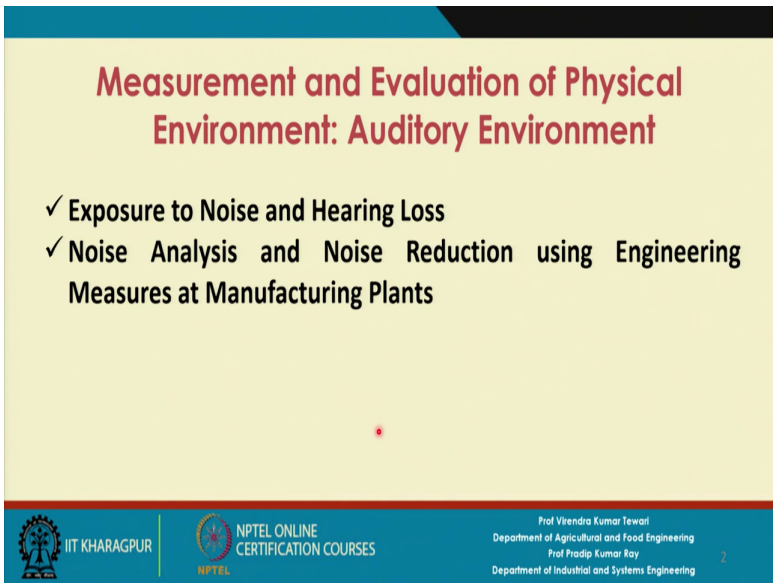
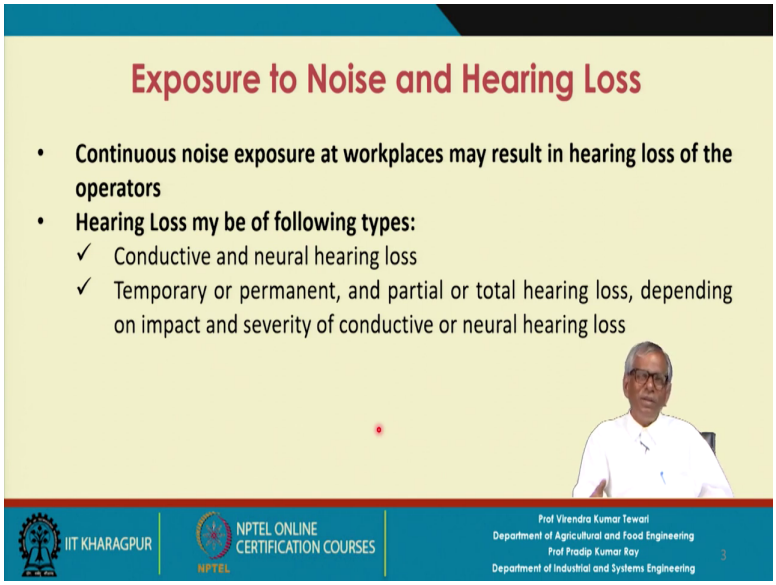


So, the topics I am going to discuss in next half an hour or so is the Exposure to Noise and Hearing loss and the next topic I am going to discuss is the Noise Analysis and Noise Reduction using engineering measures at manufacturing plants. And many a time this is referred to as the noise analysis. And why manufacturing plants because majority of the manufacturing plants you will find that the environment is very noisy. So, that is why I am referring to the manufacturing plants.



Now, continuous noise exposure at work places may result in hearing loss of the operators. For example, someone is working at a work place for 10 years or the 15 years and he or she is suffering this particular health hazard called hearing loss.

Hearing Loss may be of following types:

a) Conductive and neural hearing loss.

b) Temporary or permanent, and partial or total hearing loss, depending on impact and severity of conductive or neural hearing loss.

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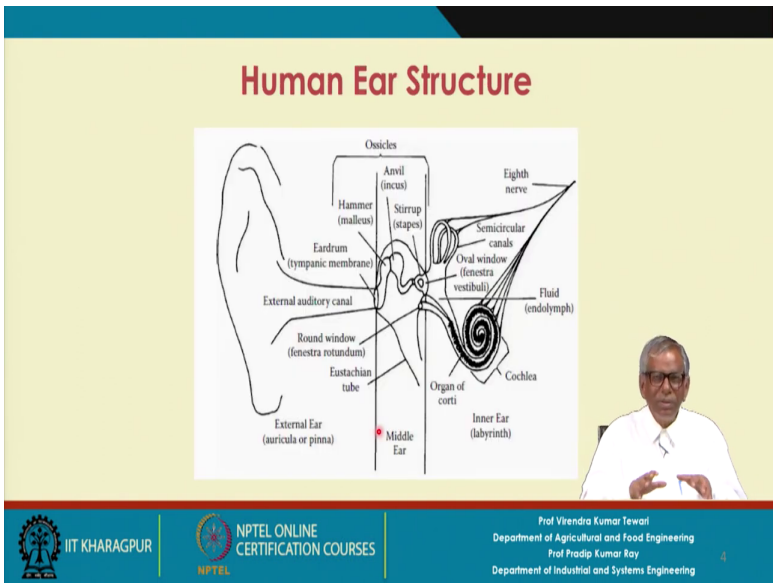

So, now when you say we try to explain 2 kinds of losses. You also must have the certain knowledge in a human ear structure. So, certain important issues related to human ear structure that there are 3 types first is the external ear, then you have the middle ear, in the total the hearing system that the ear is having 3 specific inter related subsystems or components.

The first one is the external ear, then followed by the middle ear and followed by the inner ear. Now there is external auditory canal and there is an ear drum and you have 3 bones like anvil stirrup and hammer, then you have these organs of corti and there are the hair cells.

So, the organ of corti within inner ear. Refer to particular diagram and now you will find that when I explain that the different kinds of say hearing loss, now you can you will come to know that what happens to which part of the ear. And why it may be considered as the partial or total hearing loss or temporary or permanent hearing loss.

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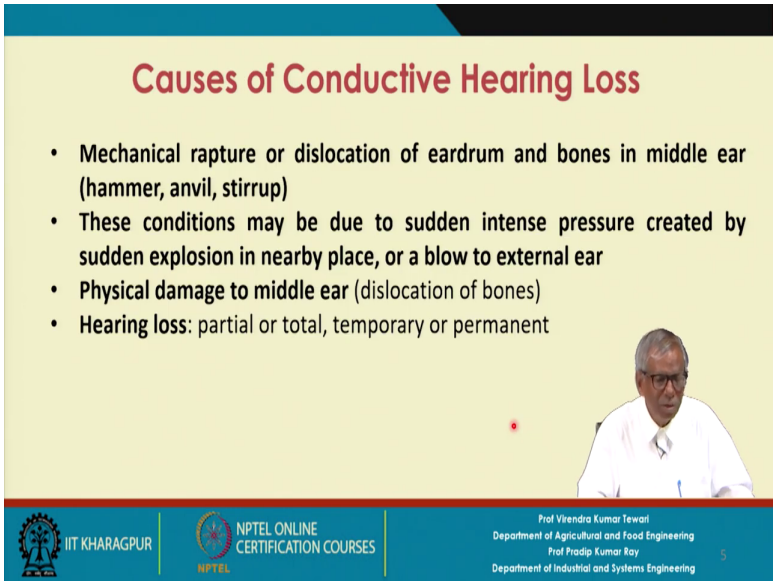

Now, let us talk about the Conductive Hearing Loss. Now, what is it and what are the reasons that why you have this particular condition? This is basically due to Mechanical rapture or dislocation of eardrum and bones in middle ear (hammer, anvil, stirrup).

These conditions may be due to sudden intense pressure created by sudden explosion in nearby place, or a blow to external ear.

Physical damage to middle ear (dislocation of bones).

Hearing loss: partial or total, temporary or permanent.

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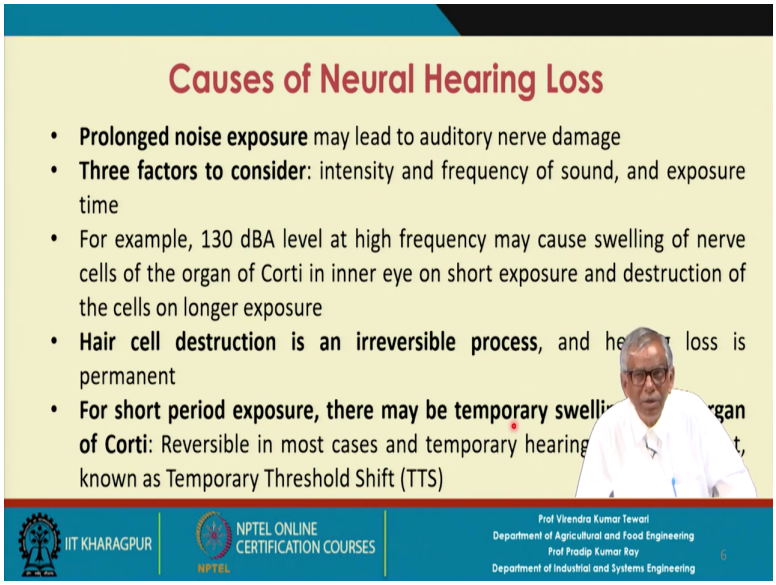

What is neural hearing loss? Causes of neutral hearing loss may be because of many reason:

Prolonged noise exposure may lead to auditory nerve damage. Three factors to consider: intensity and frequency of sound, and exposure time.

For example, 130 dBA level at high frequency may cause swelling of nerve cells of the organ of Corti in inner eye on short exposure and destruction of the cells on longer exposure

Hair cell destruction is an irreversible process, and hearing loss is permanent. For short period exposure, there may be temporary swelling of the organ of Corti: Reversible in most cases and temporary hearing loss/impairment, known as Temporary Threshold Shift (TTS).

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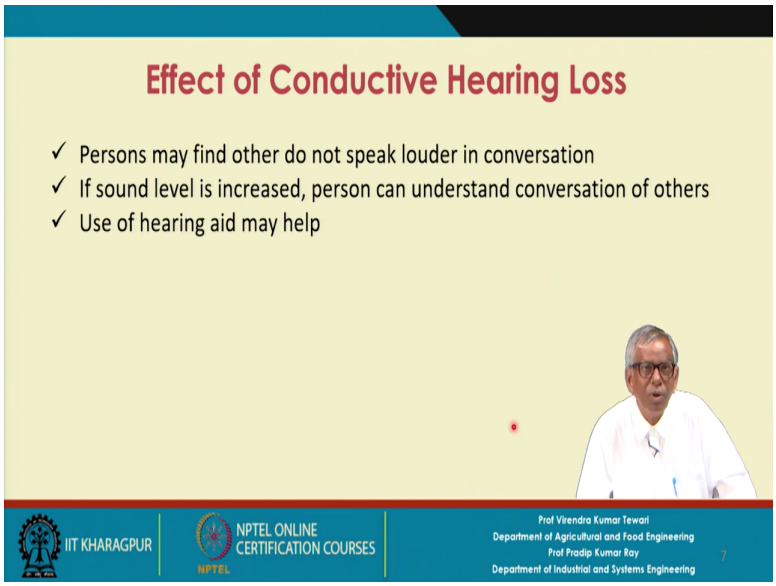

The effect of conducting hearing loss are as follow:

Persons may find other do not speak louder in conversation.

If sound level is increased, person can understand conversation of others.

Use of hearing aid may help.

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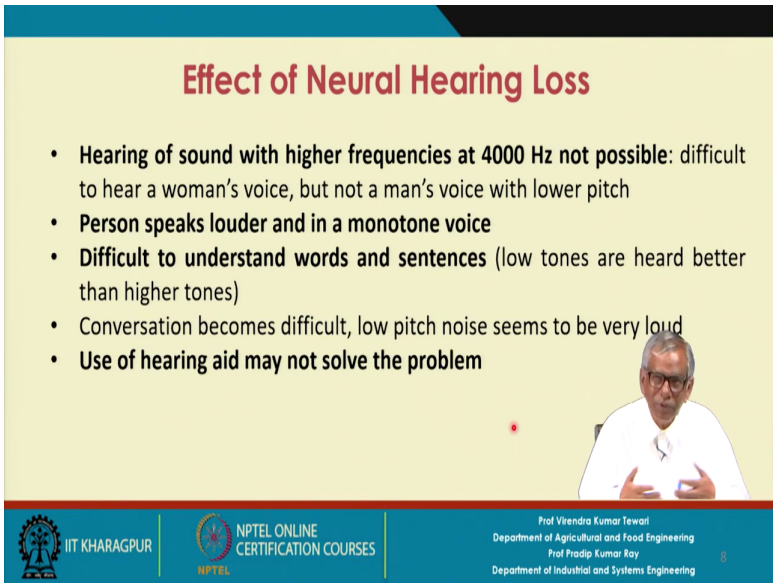

Other effect of the neural hearing loss are as follow:

Hearing of sound with higher frequencies at 4000 Hz not possible: difficult to hear a woman's voice, but not a man's voice with lower pitch.

Person speaks louder and in a monotone voice.

Difficult to understand words and sentences (low tones are heard better than higher tones).

Conversation becomes difficult, low pitch noise seems to be very loud.

Use of hearing aid may not solve the problem.

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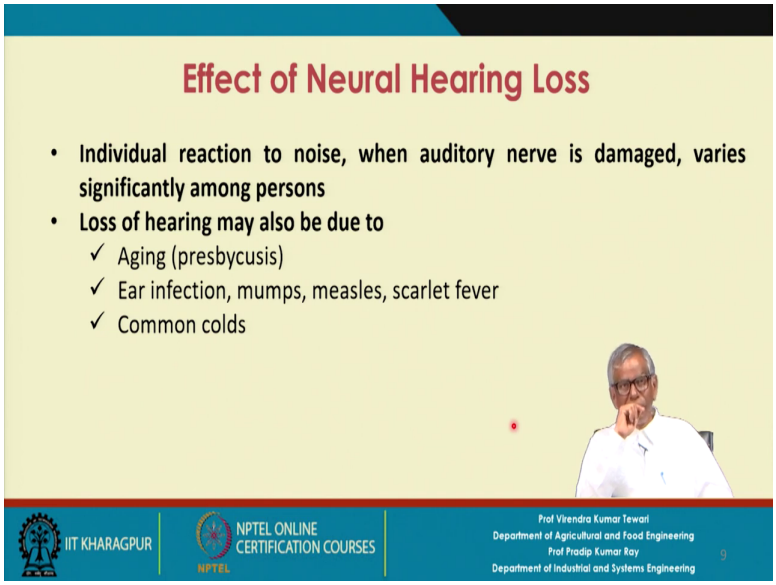

Individual reaction to noise when auditory nerve is damaged varies significantly among persons. Loss of hearing may also be due to

a) Aging (presbycusis)

b) Ear infection, mumps, measles, scarlet fever

c) Common colds

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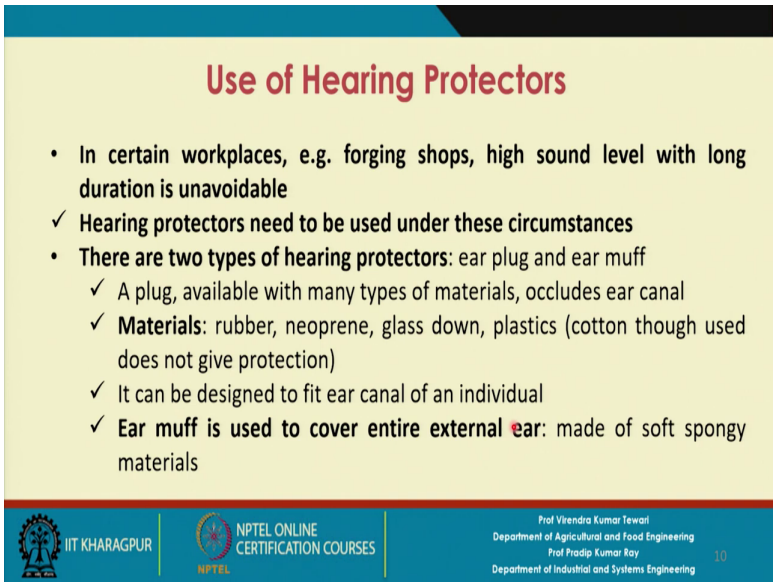

In certain workplaces, e.g. forging shops, high sound level with long duration is unavoidable

Hearing protectors need to be used under these circumstances

There are two types of hearing protectors: ear plug and ear muff

A plug, available with many types of materials, occludes ear canal

Materials: rubber, neoprene, glass down, plastics (cotton though used does not give protection)

It can be designed to fit ear canal of an individual

Ear muff is used to cover entire external ear: made of soft spongy materials.

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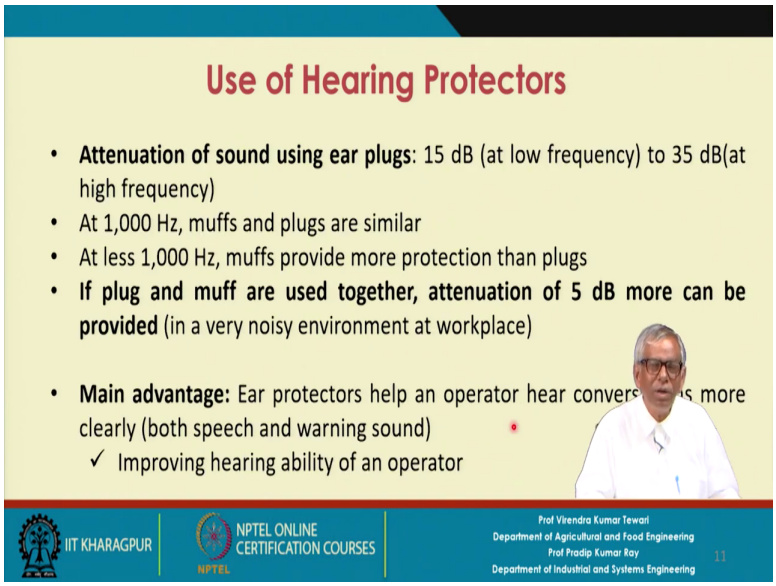

Now, what is the attenuation level of sound using ear plug is 15 dB. So, that is the reduction you will get at low frequency. And at high frequency it may be as high as 35 dB.

At 1000 hertz muffs and plugs are similar and at less 1000 hertz frequency muffs provide more protection than plugs. So, if plug and muff are used together, attenuation of 5 dB more can be provided in a very noisy environment at work place.

The main advantage are ear protectors helps an operator hear conversation more clearly; that means, your hearing ability will be more and improving hearing ability of an operator.

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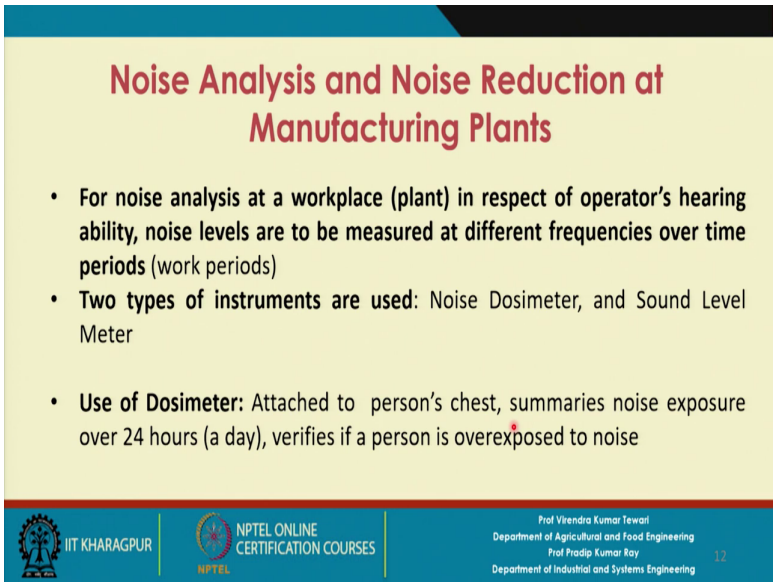

And so, ear plug as well as the ear muff you may use, but then again there must be also the engineering solutions. You have to carry out noise analysis.

For noise analysis at a workplace (plant) in respect of operator's hearing ability, noise levels are to be measured at different frequencies over time periods (work periods).

Two types of instruments are used that is Noise Dosimeter, and Sound Level Meter.

Use of Dosimeter that is Attached to person's chest, summaries noise exposure over 24 hours (a day), verifies if a person is overexposed to noise.

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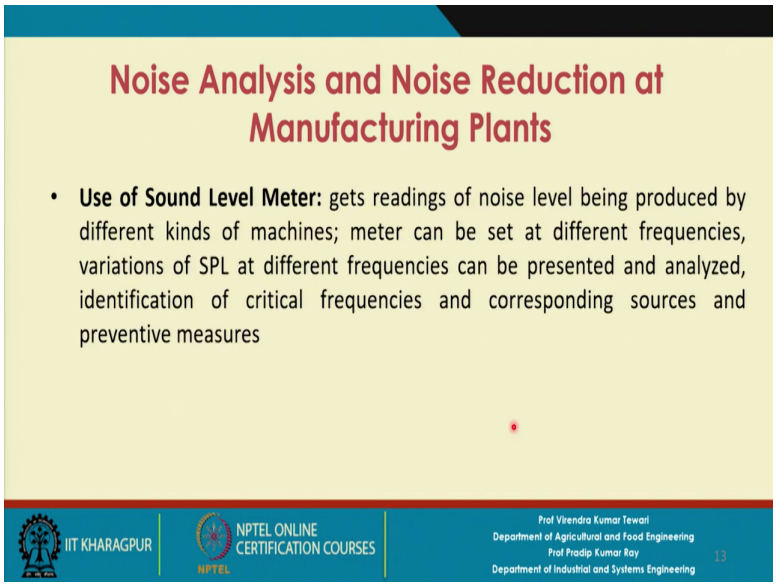

Now use of sound level meter, sound level meter gets readings of noise level being produced by different kinds of machines, because meter can be set at different frequencies, variations of SPL sound pressure level at different frequencies can be presented and analysed, identification of critical frequencies and corresponding sources and preventive measures.

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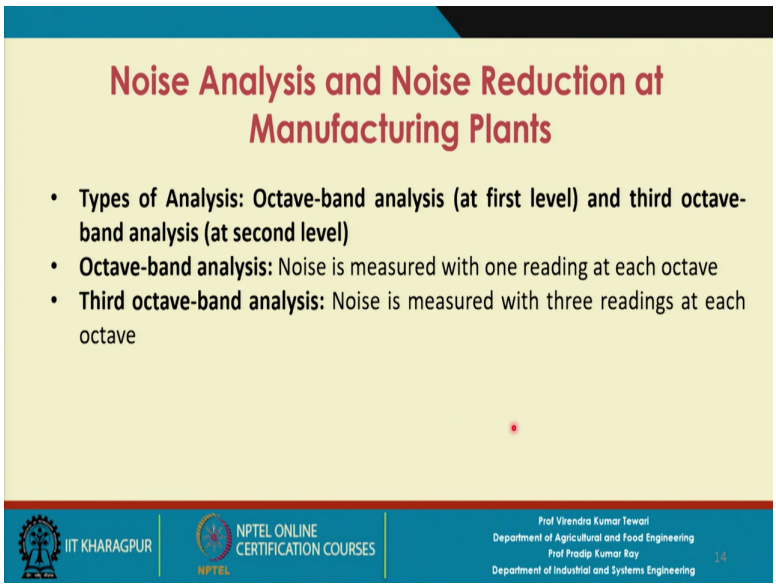

So, there are two types of analysis one is the octave band analysis at the first level and third octave-band analysis at the second level.

Octave-band analysis: Noise is measured with one reading at each octave.

Third octave-band analysis: Noise is measured with three readings at each octave.

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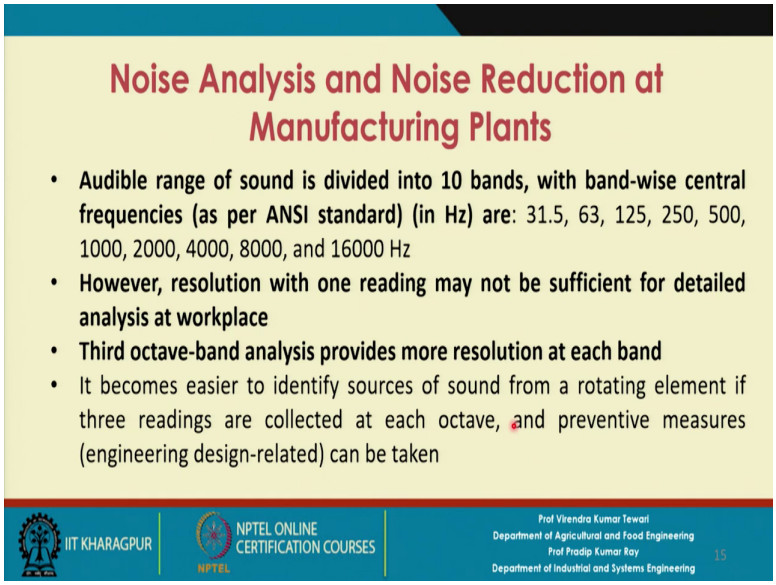

Audible range of sound is divided into 10 bands, with band-wise central frequencies (as per ANSI standard) (in Hz) are 31.5, 63, 125, 250, 500, 1000, 2000, 4000, 8000, and 16000 Hz

However, resolution with one reading may not be sufficient for detailed analysis at workplace

Third octave-band analysis provides more resolution at each band

It becomes easier to identify sources of sound from a rotating element if three readings are collected at each octave, and preventive measures (engineering design-related) can be taken

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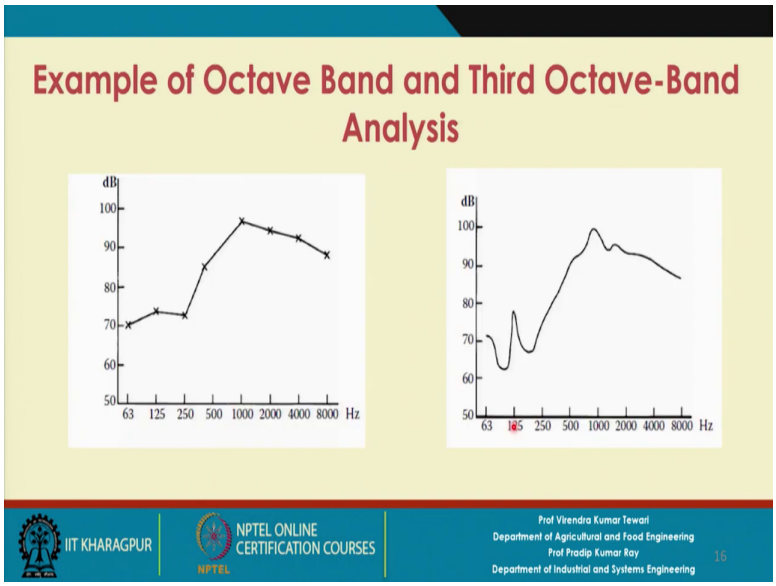

So, this is the typical analysis, on the left-hand side you get through octave band data and mid frequencies are mentioned. So, you can identify you observe the variations. And in the second figure what you find that against each there will be 3 readings at each octave. So, and there will be variations among these 3 readings in each octave. So, it will help you and identify the source of noise or the critical which noise with the critical frequency.

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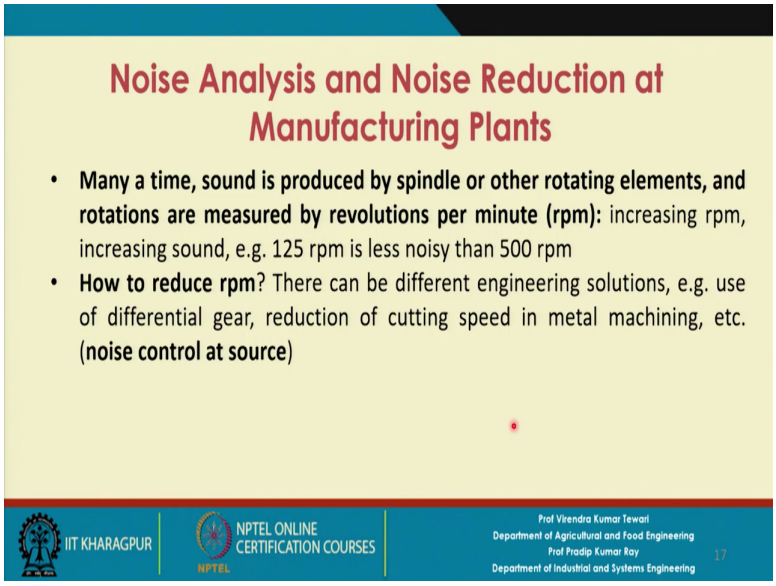

Many a time, sound is produced by spindle or other rotating elements, and rotations are measured by revolutions per minute (rpm): increasing rpm, increasing sound, e.g. 125 rpm is less noisy than 500 rpm.

How to reduce rpm? There can be different engineering solutions, e.g. use of differential gear, reduction of cutting speed in metal machining, etc. (noise control at source).

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