Vibration Control

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Module - 2
Basic of Vibration Control
Lecture - 1
Reduction at Source – I

Hi, this is Dr. S. P. Harsha from mechanical and industrial department, IIT Roorkee. Now we are in the module 2, in which our main focus is to reduce the vibration. How we can reduce the vibration or in other way, how we can control the amplitude of vibration. So, in that you see here, the first part today we are going to discuss about the basic vibration control, the reduction at the source.

As we discussed in the previous lecture, the series of lectures of four, we have discussed about the mainly, what exactly the basic principles of the vibrations are, how the physics is really involved in execution of the vibration, how we can physically signify the basic mechanism of the vibrations, and as we know that, we were just discussing about the discrete one, so the masses or the damper or the springs, how they are really putting the forces for execution or control of the vibrations.

So, again you see here in this lecture, we are just going to discuss about the basic features that, if the vibration is starting then what exactly the root source of the vibration is. And then how we can reduce or how we can apply straight way the isolator, which is nothing but the control of vibration applied to the source itself. So, as we know that, the vibration appears in many of the situations, where sometimes it is fruitful, sometimes it is harmful. Generally, we are putting the vibration as a harmful feature, but even you see, when we are doing say, we want to drill the things or we want the massage feature on the human, they are all you see the vibration like the signature analysis.

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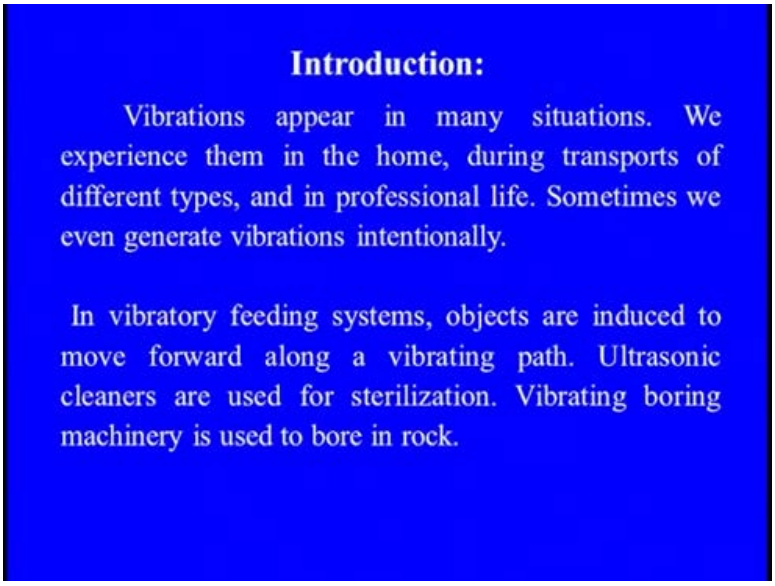

So, when we are just saying that, we experience vibration exactly at the home, during transport of the different tyres like you see, when we are driving our vehicle or when we are in the train or we are in the buses or even in our professional life, sometimes like say we are working on our system and fan is creating some kind of vibration. Or else, you see the mobile, we are always keeping our mobile when we are working into the vibrating mode.

This mode is pretty common and we know that, the vibration transmission is always a molecular phenomena, it needs the domain, it needs the support to transmit in a effective manner. So, sometimes even we want to generate the vibration intensely, in vibration whatever the vibratory feeding system is, objects are induced to move forward along the vibrating path. Ultrasonic cleaners are used for sterilization, vibrating boring machinery is also used to bore in the rock. So, these are the two systems, in which we intensely generate the vibrations for that.

In vibration testing, the components and the entire even the finished products are even exposed to high vibration amplitude, just to evaluate their ability to function in their service condition under the severe vibrations, whatever you seen, the severe vibrations or the severe environment. So, this vibrations which we just want to see, we want to apply and we were just want to see the effect on the finished product, nevertheless vibrations are usually unwanted or harmful.

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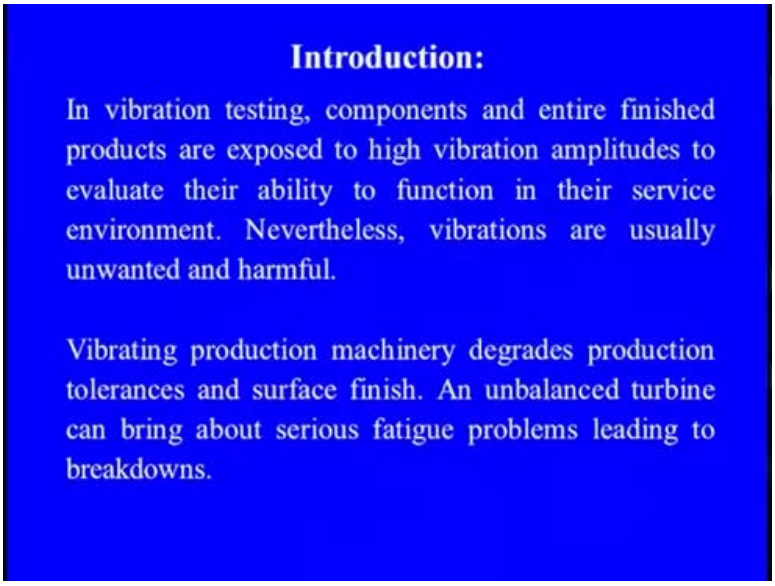

Because, we know that, when the vibrations are being there, they are generally termed under the cyclic loading or the fatigue features are being there. And under that, under this harmonic motion, the design of any component will certainly not safe, even we are taking more, the higher number of factor of safety. So, vibration, whatever the production machineries are there, they certainly degrade, the production tolerances and surface finishes all along with that.

So, an unbalanced even the turbine can bring about the serious fatigue problems leading to the breakdowns. So, we know that, whenever the vibration is there or when the vibrations are being coming out from the system itself, there is some problem. The problem may be from the source, may be it is coming under the transmission feature or maybe because of some surroundings. And the vibration is not only causing the problem on the machine, but also it has direct impact on animals, man or the surrounding itself.

So, our main theme here, like you see here as we are talking about the human being, the vibration of handheld machine can cause the blood circulation problems in the hands. And even we can see that, the outcome of this blood circulation features, the problem in our arteries or the veins is creating the white finger syndrome. But, this frequency, as we know that, this vibration which is with the human characterization or even with the machine, they are absolutely categorized under two main features.

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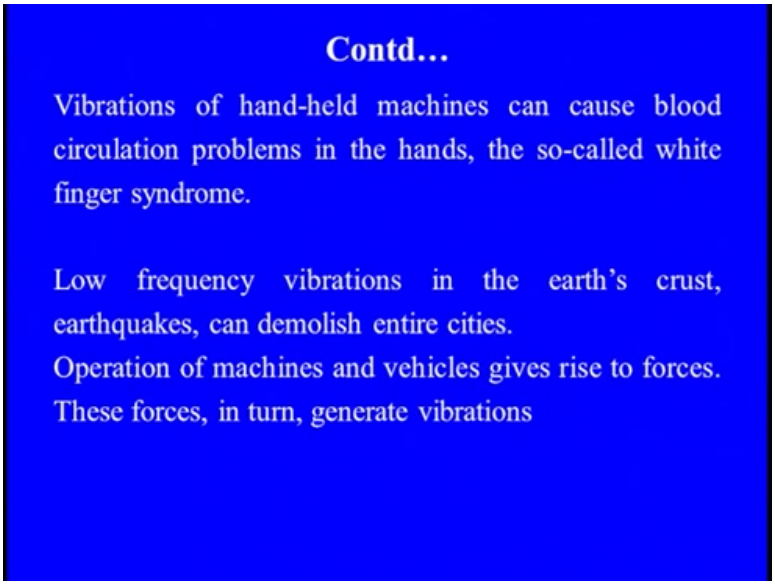

One, when we are talking about the machine vibration and you see whatever the frequencies are being coming out, they are always in kilo Hertz, the high frequency vibrations. But, when we are talking about the human vibration, they are of the low frequency vibrations. The low and high, since like we technocrat are always talking in terms of the quantity, when we are dealing the vibration in terms of frequency, we are not talking about the amplitude.

We know that, if you want to characterize the vibration, there are two main features, one is the amplitude, other one is the frequency, but here we are talking about the frequency only. So, when we are dealing with the human vibration, the characterized frequency is starting from 0.5 Hertz, where the motion sickness is there from 0.5 Hertz to we can go up to say 150 Hertz or 200 Hertz. But, when we are talking about the machine vibrations, they are always starting from say 500 hertz, 1 kilo Hertz or more than kilohertz only.

So, when we are talking about the low frequency vibration, even it is with the earth crust or the earthquakes and even this low frequency vibration, which is coming with the earthquake feature or the earth crust, they can demolish the entire cities or the big buildings are. So, it is highly in material that, the vibration is of low frequency cannot damage, they can damage. Even the human discomfort like if you are talking about say, when we are travelling to this buses or something and if you are talking about the

discomfortness of the human, the frequencies are of level of, we can say 4 Hertz, 5 Hertz only.

So, even this small amount of lower frequency can create a huge problem with the human feelings or even for the earth crust, they can damage the entire cities. The operations of machine and vehicles gives rise to these forces, through which the excitations are coming. And these forces, when they are being coming out from these machineries or from the vehicles, they are creating or they are generating the vibrations.

So, in order to describe the vibrations, we need to know their amplitudes, amplitudes may be of in meter per second square, because the acceleration is there, may be in terms of velocity, may be in terms of displacement and their frequencies and sometimes even their mode shapes. Because, as we discussed in the previous part, when we are talking about even the first natural frequency or second or any degrees of freedoms natural frequency, we need to check it out that, what is the relative position of their masses are.

And this simply gives you that, how much dangerous is, because if there are various modes, which are being coming out from that, may be we have axial mode, maybe we have shear mode, maybe we have that the binding mode. Various modes are there, which are being straightaway reflecting with these natural frequencies.

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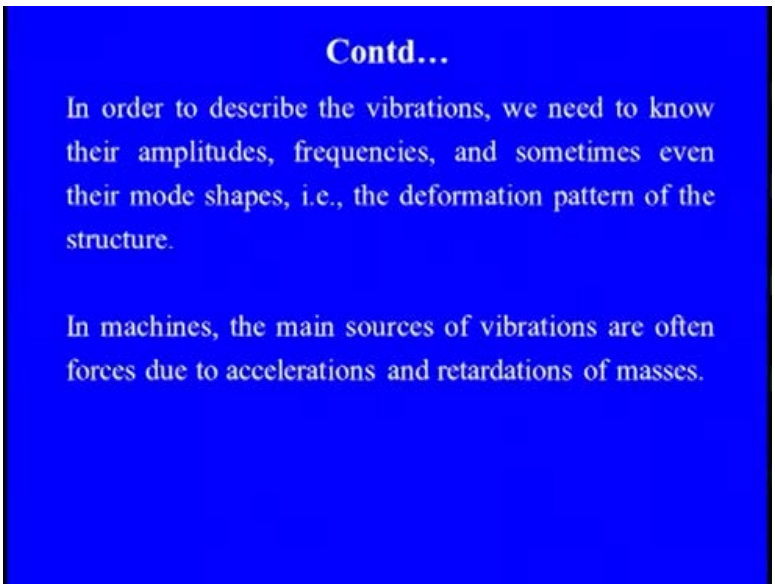

So, you see here, not only we need to compute the amplitude and the frequency, but how the deformation, what is the deformation pattern of the structure is. And in machine, the main source of vibrations are often, forces due to acceleration or retardation of the masses only. Because, mass is one of the important figure, through which the inertia forces are being generated. And these inertia forces are always causing the relative displacement of all the components of the object. And due to that, either is accelerating or decelerating retardation, it is generating the vibrations in the machine itself or any component.

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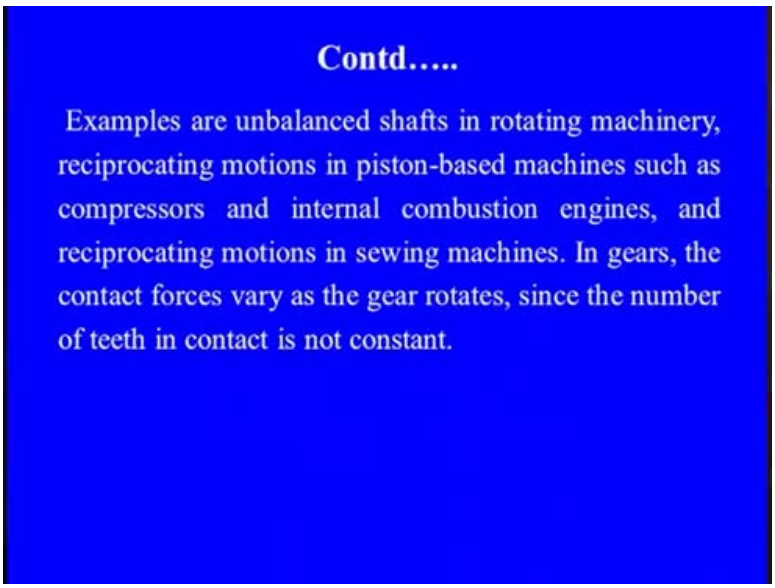

Very simple example of this is an unbalanced shaft, when you know that, there is a unbalanced feature is there in the shaft in any rotating machinery, even microns levels or any misalignment is there of any we can say, the component, these reciprocating motions may be out of the piston based or anything such as, compressor or IC engine or even any reciprocating motion in sewing machine, they are creating the huge vibrations.

As the more and more inertia forces are generated and they are inducing, because you see more inertia forces are generated at the contacts points, the restoring forces are being there, because more and more deformations are there. And we know that, the natural frequency which is nothing but the combination of these mass distribution and the stiffness is, huge excitations are there, and since if the unbalance is more, we know that

the unbalanced force is nothing but equals to mass into omega square into e that is nothing but the eccentricity.

So, we know that, the huge amount of forces being generated, as the more speed is there and more eccentricity is there, so with these, the huge amount of vibrations can be generated. Even in the gears, the contact forces according to the gear tooth profile and the number of teeths may be vary with these, as the gear is rotating at the speed and something and the number of teeth. Because, they are continuously coming into the contact, may be the contact is line contact or point contact or even surface contact. The huge amount of force transmission is there and huge amount of vibrations are generated, because of the stiffness variation with the force transmission.

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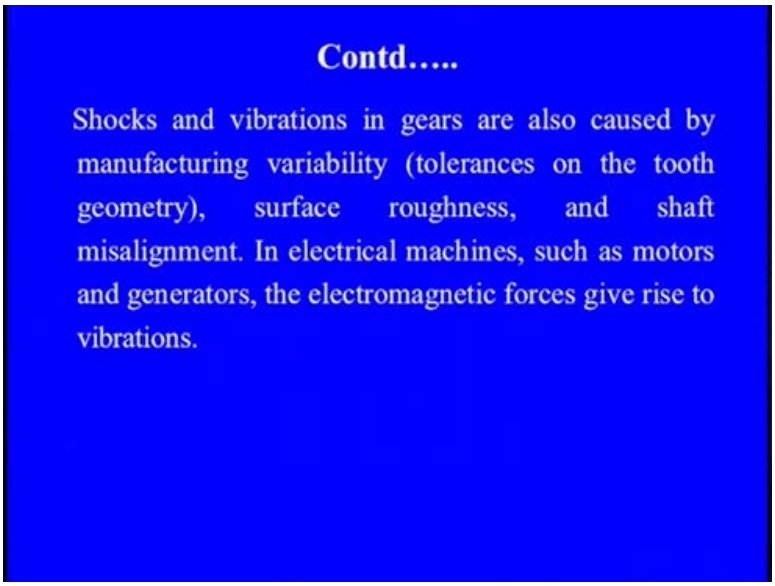

Shock and vibrations, in gears are also caused by the manufacturing, variability, because we know that, the tolerances are different in those and they are always being there with the tooth geometry. Like, if we are talking about the involutes profile, cycloidal profile or anything, they are always being causing that, at the time of matching of the gears or at the leaving, the shock and the vibrations are being generated. And due to the stiffness variation, the higher number of excitation frequencies are being coming.

Even the surface roughness, even the shaft misalignment, they are all creating the vibration generations. And in the electrical machines if you are talking about such as, the motors or the generators, the electromagnetic forces are always leading towards the

vibrations. So, in short, if you are talking about, wherever the rotary or the translatory motion is there, wherever the electromagnetic or electrostatic or any kind of the dynamic forces which are being coming, they are always creating some kind of vibration phenomena.

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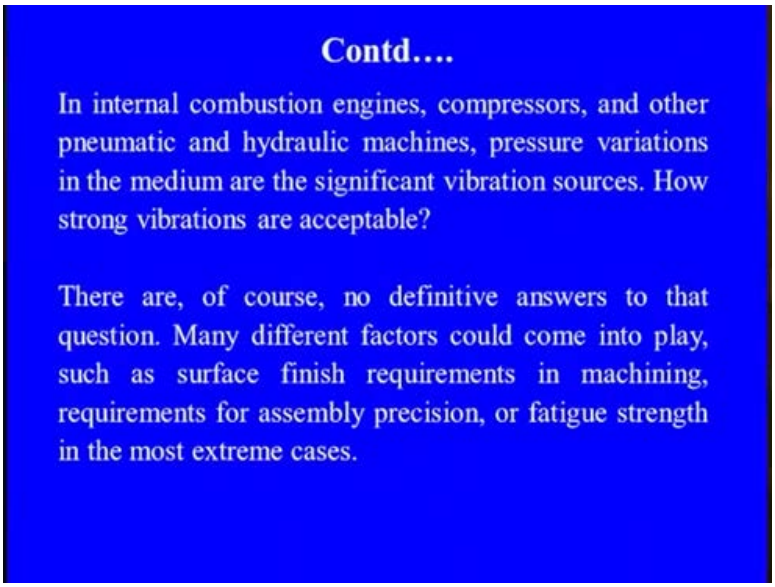

Or even if you are talking about our main mechanical machine from the IC engine feature, the compressor or any other pneumatic or hydraulic machines, the pressure variation in the medium are significant vibration sources. So, these pressure variations are simply creating the stiffness variation and the huge vibrations are being coming out. All is the thing is coming that, how much vibration is acceptable means, what could be the possible limit level in that and how much frequencies are being absorbed or we can say, transmitted through this.

So, there are of course you see, no definite answer to these questions, because we know that, when we are simply playing with the various factors, through which the vibrations are generated, we could not straight way say that, if you control this much, we can control this much vibration. Any of the parameter, may be if you are saying that, the surface roughness if you are simply going with the micron level of this surface roughness, we can say that, the vibration can be controlled, but how much. So, even you see here, if any we can say the assembly precision or any fatigue strength, if we are

going up to any extreme cases, we could not easily figured out that, what is the possible remedies of these vibrations generation.

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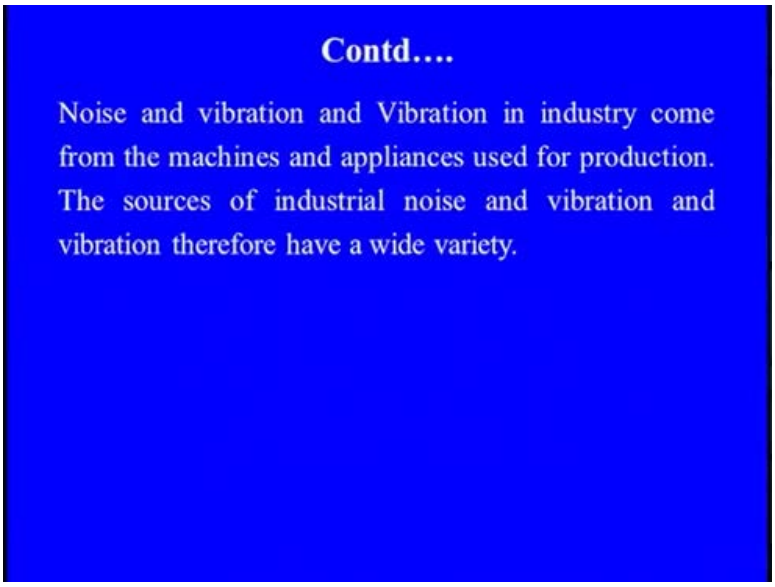

So, noise and vibration in any of the vibration industry come from the machine, their appliances, which are being used for productions and you see, whatever the transmission features, that how much solid or rigid bodies are being connected through these sources. And the sources of the industrial noise and the vibration, and whatever the vibrations are being coming out, are of various variety. And also you see here, when we are talking about the vibration, which is a molecular phenomena, there is always noise is associated with that, which is even the energy phenomena.

Because, whatever the acoustic radiations are being coming out due to deformation of the vibration, we cannot control straight away, even by putting any kind of material damping. So, that is why you see here, the noise and vibration is the two simultaneous operations, which are always being there along with that. Like you see here, I am speaking, when I am speaking the air pressure, which is being coming out through my vocal cord is always being varied.

And this you see, I am giving the proper kind of, we can say modulation or whatever, we can say the words are coming, it is due to the oscillatory motion of my tongue. So, you see both the sound and vibration phenomena are just moving together, as we discussed.

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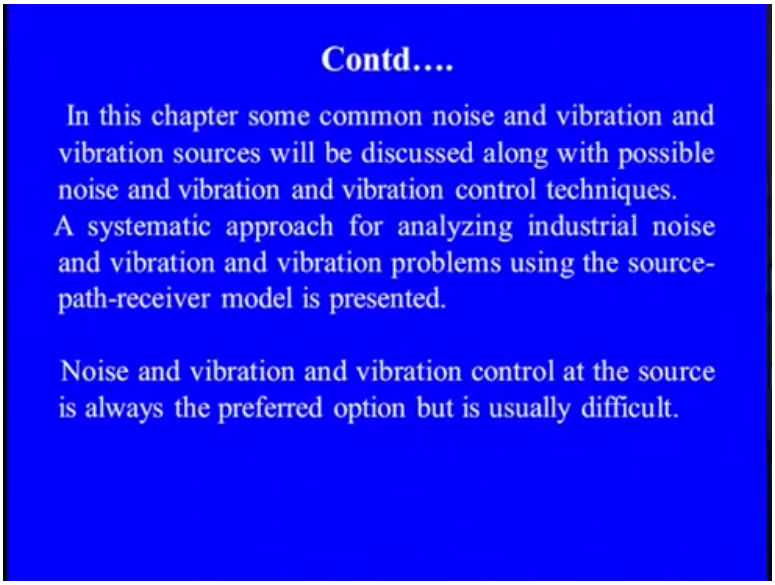

So, now you see here, in this chapter, in which our main theme is to control the vibration at the source, is having some common noise and vibration sources, we are going to discuss and also you see here, we are going to discuss about, what the techniques are. A systematic approach for analyzing the industrial noise and vibration, and the vibration problems using any of the feature is one, in which the source path receiver model.

Means, we know that, there is a source from where the vibration is generating, there is a receiver or we can say the end, where the vibrations are being coming out and there is a transmission feature. And the effective feature is the transmitter only, because if our path is so rigid and it has a good conductor, because of the molecular feature, immediate transmissions are there. So, noise and vibration or the vibration control at the source is always the preferred option, but it always difficult also. Because, we know that, this is my source is, how could I control that, because this is sometimes the rotary element, sometimes the reciprocating element. Sometimes it is moving in the both the directions or any other directions, so how could we control the sources.

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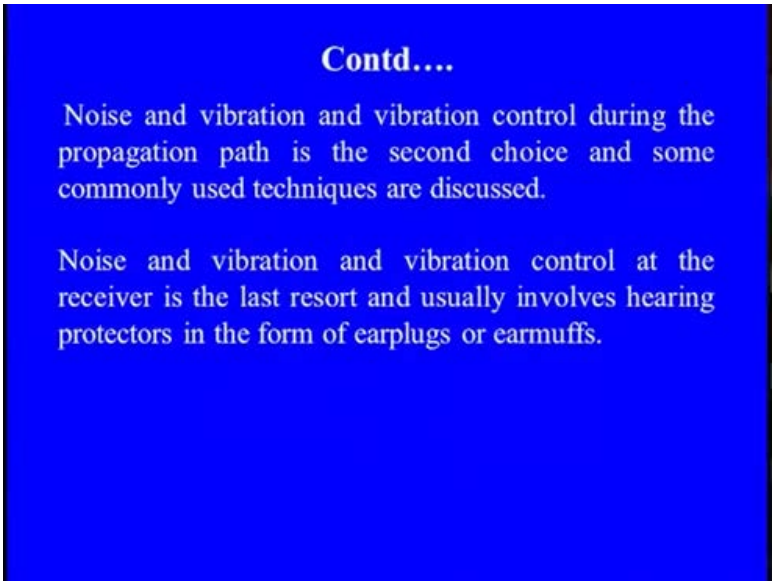

So, noise and vibration and the vibration control during propagation path is a second choice and some commonly we can say, the techniques are there, which we are going to discuss in that. And these you see, in that at the receiver end is our last resort, because it involves the hearing protectors, because we know that, say the human being is working near the turbo generator unit, we cannot control the use, whatever the forces which are being generated during the rotation of our rotor.

Because, the rotor is almost of the mass of more than 50 tons and when this is rotating say, even at the 1000 rpm, the huge amount of the inertia forces are generated. And when these forces are being generated at this point we know that, this is our source, but we could not control that, as we can see in many of our thermal plant. So, in that case, we need to see that, at receiver end, what we can do when a person is working near the turbo generator unit, in any of the thermal power plant.

So, what we are doing, we are simply putting the ear plugs or ear muffs so that, even the noises and even they are wearing good, big sole of the shoes is. So that, the vibration can be absorbed through the, we can say the sources, where you see the feet and the surfaces in the contact. Or else you see here, whatever the sound is coming off, the huge amount of energy is coming towards the receiver end, it could be easily controlled by these things.

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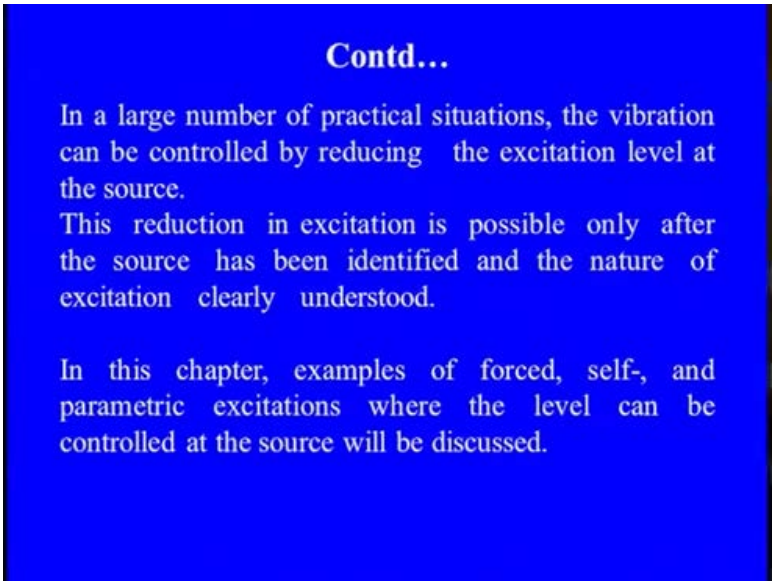

In a large number of practical situations, even the vibration can be controlled at the source upto the excitation level. And this reduction is only possible when we know that, what exactly the exciting features are, we need to understand the basic mechanism of that. So, either the vibrations which are being generated by the forced or the self or even the parametric excitations are there, we need to see that, how we can control these things accordingly.

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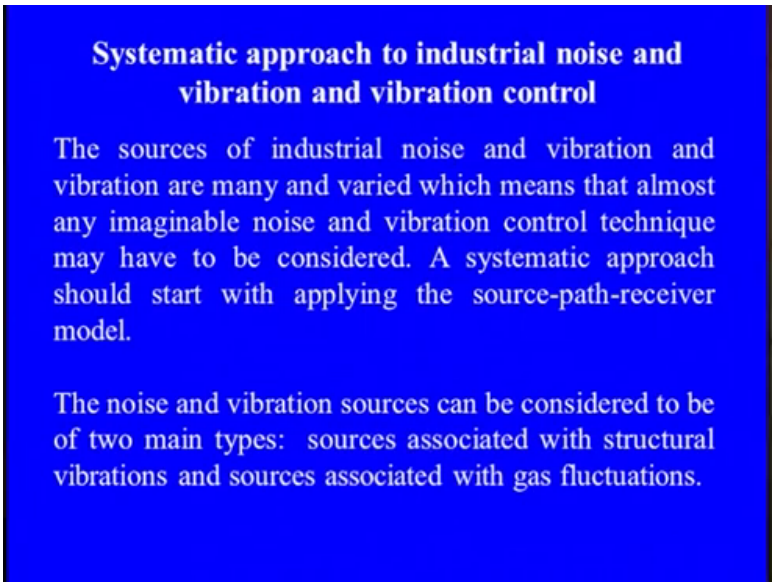

So, you see here, there is a systematic approach for that, the sources of industrial noise and vibrations are as we discussed that, it is a variety of features. So, when we are just trying to consider those things, there are two main types of that, one the sources which are associated with the structural vibrations. Because, we know that, when they are associated with the structural vibration, there is a clear transmission path, as you see the rigid body connections are there and we can get the receiver end a very speedy feature.

Just like you see here, when my mobile is just hanging in the air, there is no problem whatever you see the vibration, the vibration generations are there, it has no transmitting media. Their molecules are just, because of their compressible one, no solid molecules are being there, through which this is transmitting. But, the same mobile when I am keeping on the solid surface, it gets the media, immediately it will transfer. So, what is the structural feature is there along with the vibration, the molecular features.

Second, the sources which are associated with the gas fluctuation, as you see when the the mobile is hanging in the air. So, both the types of sources, in which you see the noise and vibrations are generating, can be considered here. First, when the sources are just connected with the structural vibration and the example is machine surface.

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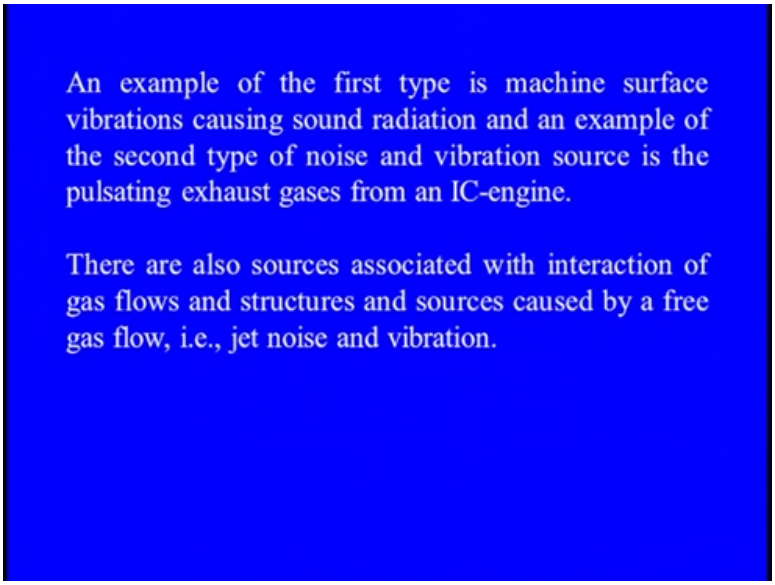

They are causing the sound radiation as a simple feature and we know that, when we are just moving on the production floor of any heavy industries, there is huge amount of vibrations, which are being generated and transmitted through these structural features.

And the second time, which is we have the gas fluctuation is simply the pulsating exhaust gases from IC engines. And there are also some sources associated with the interaction of these gas flows and the structure, which are simply causing the free gas flow like the jet noise and vibrations. So, when we are dealing with these things, we have to be just checking out that, what exactly the phenomena is…

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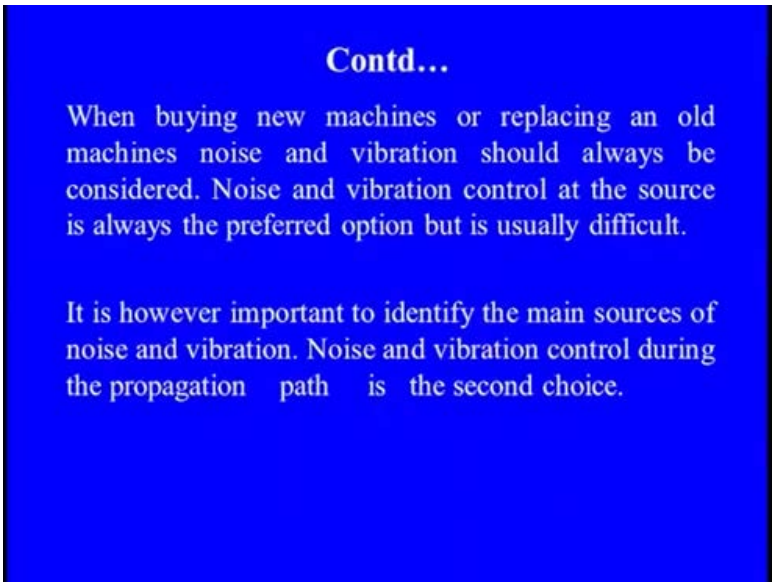

And when buying the new machine or any replacement of old machine, the noise and this vibration level is always being a considered level. So, when we are talking about this, we know that, what exactly our preferred options is. Means, what is the range, in which we want to control the vibration and it is upto the buyer that, what exactly means, say if you want to buy a common machine or if you want to buy the CLC control machine, we need to put the sensitivity level of vibrations for any kind of operation. And noise and vibration control during propagation path is the critical one, that how we can control these things.

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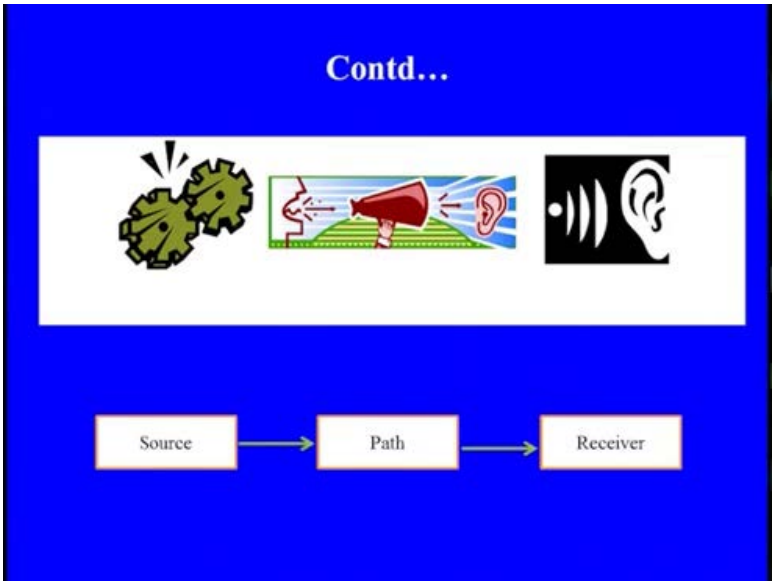

So, as you can see in the figure that, we have a clear source, from where the vibrations are generated, either from the bearings or from the gears or even the rotation of the shaft itself. And then it is transmitted through these materials only, again it depends on what the material properties are that means, what exactly the path is, whether it is a supportive one or it is the observed one. Because, we know that, along with any material property, there is a material damping together and then it is coming to the receiver end.

So, you can see in this particular figure, we have the source, we have the receiver and this is being transmitted through this path ((Refer Time: 22:56)). So, noise and vibration control during the propagation path can involve the measures such as, the enclosures, barriers, adding room absorptions. And noise and vibration control at the receiver even can involve the protecting the worker using the hearing protectors, in form of earplugs as we discussed or earmuffs.

And even you see we can say that, it can also involve the enclosures towards that, because they are either in terms of the sound energy or in terms of the vibrations. They can absorb the any kind of this energy involved with that and through that, there is a reduction of the vibration amplitude.

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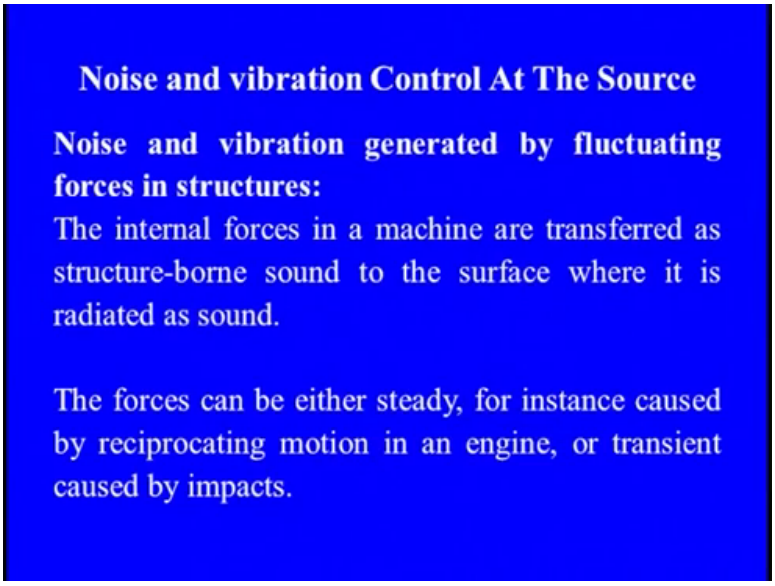

So, you see here, when we are coming to the vibration control at the source, we know that first, what exactly the generation media is. The fluctuating forces in those structure means you see here, when it is in the rotation feature, there is a fluctuating force, the fatigue kind of forces are there, the cyclic loading is there. Certainly we know that, this motion or this dynamic these dynamic forces can create the vibrations. So, the internal forces in any machine are transferred as a structure borne sound to the surface, where it is radiated as the sound.

And the same you see here, the forces can either be steady or instance caused by reciprocating motion in an engine or transient caused by the impacts. So, it has any kind of, we can say the nature, it may be the transient one, it may be the steady state one or sometimes you see here, it may be in the continuous manner through the reciprocating motions. So, the forces can also come from the work performed on the work piece by the worker or you see here, any machine when it is being rotating. More noise and vibration is produced, if the task is carried out with the great force for the shorter time than with the less force for the longer time. Because, we know that, the huge amount of energy is being involved when the huge amount forces, the inertia forces or any kind of forces, which are being coming out even for the shorter time as well.

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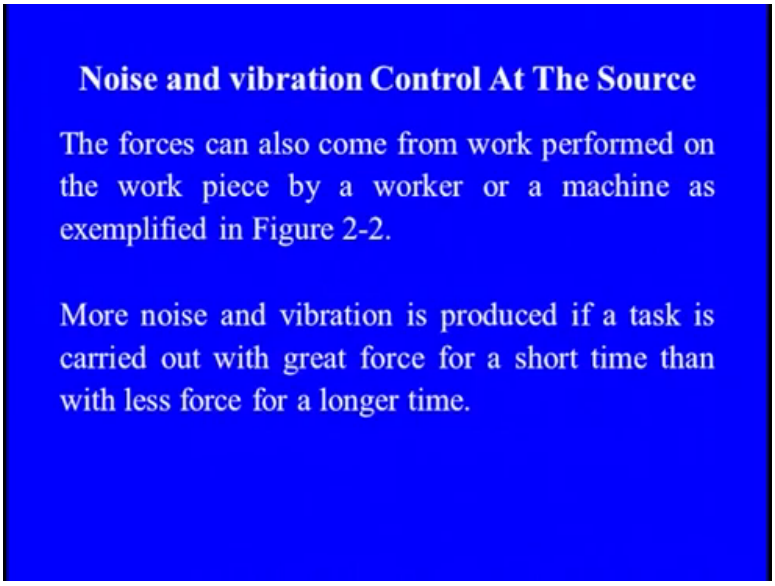

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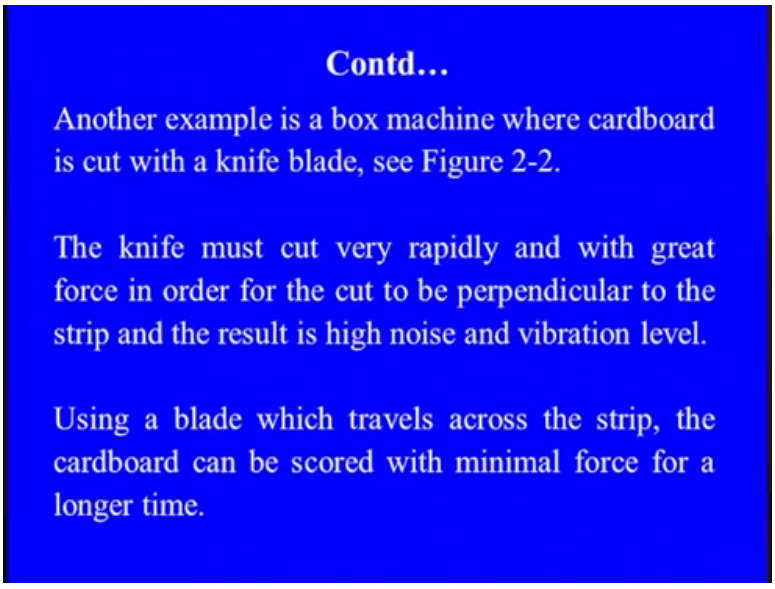

So, another example, the box like the cardboard with the blade knife, the knife must be, when we know that, the knife which is being simply putting the cutting forces, it must be just do it is operation very rapidly with the great amount of force, in order to cut the whatever, perpendicular to the strip and the result is the high noise and the vibration level. And using a blade, which travels across the strip, because it is a solid media, the cardboard can also scored with the minimum forces with the longer time. And since the cardboard strip, this is very common example, which we people are using for cutting those things.

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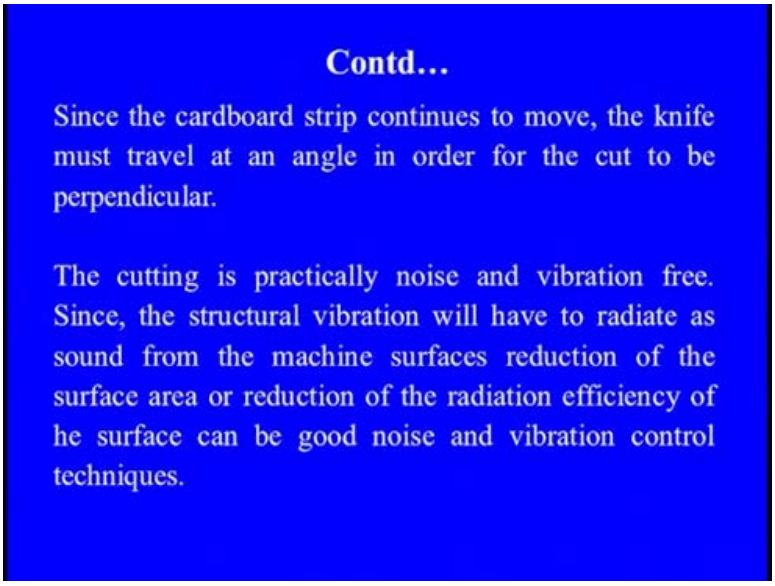

This cardboard strip continues to move and knife must travel at the angle in order to cut the entire things perpendicular, the cutting is a particular noise and the vibration free. Since the structural vibration will have a radiation, because we know that, when they have been deformed, there is a acoustic radiating feature is there. So, in this sound which is in the radiating form, is always being coming out from the machine surfaces. Reduction of the surface area or the reduction of any radiation efficiency of the surfaces can be generated a good noise and you see here, we can simply control the vibration or this.

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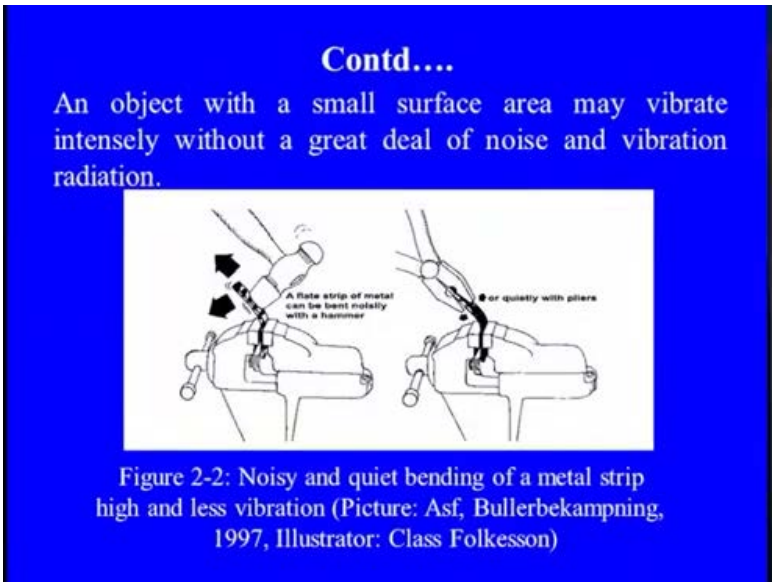

So, this is what you see the things are, an objective with any small surface area may vibrate with the huge amount of intensity, even without the great deal of noise and vibration radiation. So, we can see that, when we are working on that, the noise here when the impact of these, the forces are there on this strip, the huge amount of acoustic radiations are there and the vibrations are being transmitted there itself. While you see here, when we are just doing quietly, the very small forces you can look at that, this is what the affected zones are, this is the another effected zones are. So, how the things are being dealt on the strip of the metal strip, this is important feature there. Or even you see, when any of the these transmission is there in that cutting forces, when it is being there in the open surfaces, you see that, the huge amount of the vibration and the noise is generated.

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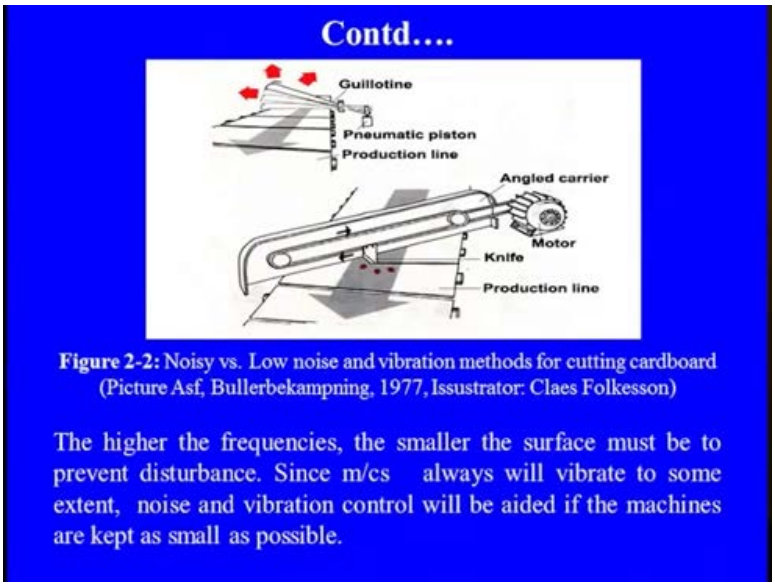

So, the higher the frequencies for that, the smaller the surface must be prevented with the disturbances. And since these machines are always vibrate upto certain extent, it can be only controlled by adding some of the feature, which can be absorb the vibrations. So, you see that here, along with these machines here in the transmission, the vibrations are generated. But, you see here, when we are simply put the profiled one, they can be simply absorbs the, whatever the vibration features are being coming out even at the higher frequencies as well.

So, in this you see here, as we discussed already that, the vibration and the sound generation is always being propagated, when they have certain base. The simple example is showing that, when we have this saver, the electrical saver is, because it has a cutting motion, so it is generating the vibration and the noise together.

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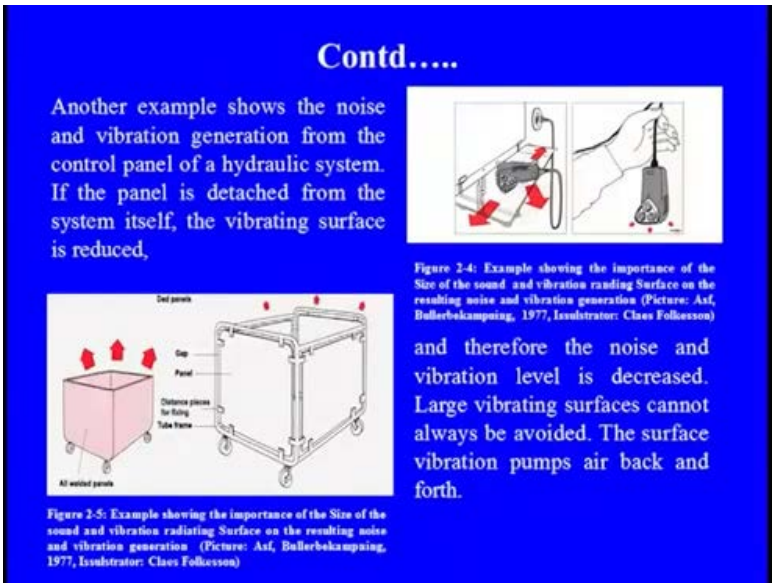

And when it gets the media, say this is what the solid base is, the domain is very the rigid one. And when it gets this one, certainly it will propagate immediately and the huge amount of, you can see on the screen here, the huge amount of sound and vibrations are being generated and propagated immediately in a effective manner. Since you see here, the same kind of vibration in terms of amplitude and frequency is generated from this, on the other side in the hand.

But, the compressibility of air is not supporting in such a way that, as it is supported by the solid structure. So, you see the very less amount of propagation is there, similarly if we are just looking to other side, when we have this particular machine, in which we have the vibration sources. So, when it has this solid support along with this part, it is immediately transmitted and this transmission is so rapid and it is simply amplifying the vibration and the sound together.

But, you see here, if we remove this and if we simply kept on other side, the entire control panel and these solid surfaces, you see the transmission of this is any way, it is going towards downward. And we have see all the material damping for that isolators are

there, but on other side you see here, this support is not there to propagate this. So, large vibrating surfaces are always be avoided just to decrease the level of vibration and the surface vibration pumps and this air break or any other solid surface is supporting, we need to remove to control that, to reduce the vibration at the surfaces. And you see, this is absolutely depending on, what the vibration pattern is.

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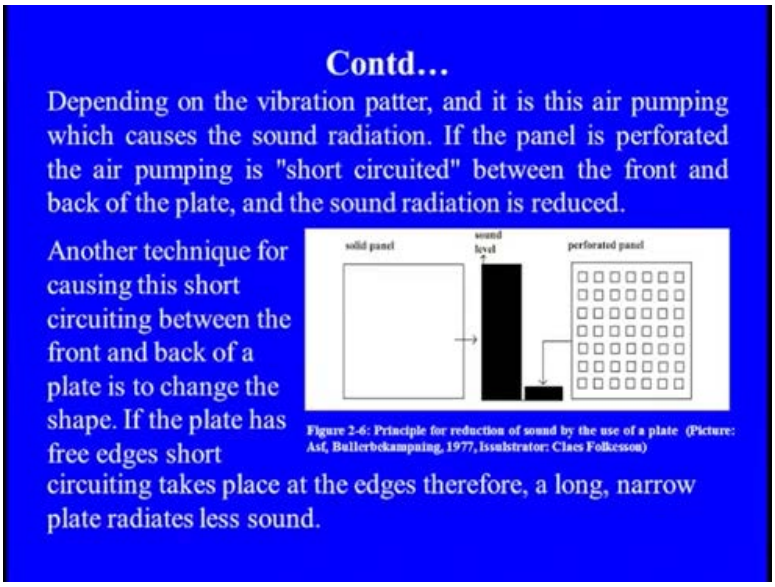

And you see here, we can see that, on this our screen that, if we have the perforated surfaces that means, if we have say the solid panel, this entire solid panel is supporting, because it is a continuous molecular structure. So, whenever you see these oscillatory features are being coming to the molecular, they will immediately transfer. A good conductor is always transmit in a speedy manner, so we need to break the path of the transmission.

So, this is one of the good technique that, you see here, we need to put the perforated panels there itself. So that, it can be immediately deviated from it is path and then when it is just causing any kind of vibration, we need to just change whatever the propagation path is. And if the plate, whatever as you can see on your screen, we have a solid panel and you see here, we have a perforated panel. If the vibration is transmitted there, it is you see here, the sound level and vibration is so huge in that, when you have a solid structure.

But, when you have a perforated panel you can see that, since the deviation is so high and it is being absorbed when it is being transmitting from these things, you see the drastic reduction is there at that point. So, this is also one of the good technique and that is why you see here, you can see that in many of these passive control, the perforated panels are always being used in place of the solid panels.

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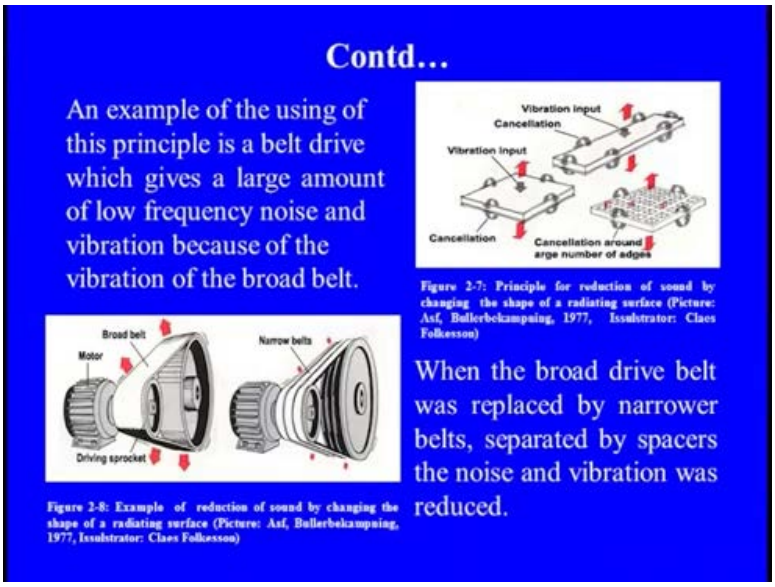

Or in other example, in which the belt drive is there, we know that, when the belt derives are moving, they are always creating the low frequency, noise and vibration, because of the broad belt. But, when you see the broad belt drive is being replaced by the narrow belt, there are the various pressures are there to just separate that and you see we can straight way reduce that.

So, in this particular diagram you can see that, what we have, we have the broad belt and you see it is creating the huge vibration, because of the stiffness variation is quite significant at the point of contact, when the rollers are moving and it is just generating the huge amount of that. But, if we are just putting these narrow belts, if the strips one, even it is transmitting the similar amount of forces, but there is a breaking in the path of the transmitting forces or we can say in other terms, whatever the energy which is being generated at the contact features, the restoring forces, they are not dominating in that way.

So, the exciting frequencies are less or even on the topper side you see here, we have a clear reduction of the source by simply changing. If we have a solid feature, certainly the huge amount of transmission is there, but if we are just using the stepped one, they are all the preferred panels. Certainly, the vibration and the noise level can be straight way reduced in that way, so these examples are the practical examples. And we know that, if we can deviate the path of the sound or vibrating feature, certainly it can straight away absorb whatever the energy or though the molecular features, which are being associated with the transmission and through that, we can control the amplitude of the vibration.

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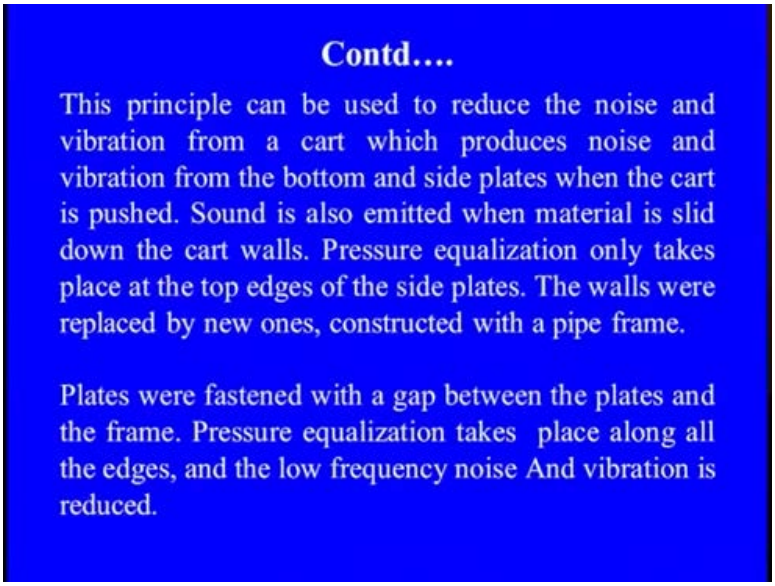

So, this principle can be used straight away to reduce the noise and vibration from a cart, which produce a huge amount of vibrations from the bottom and the side plates. And when the cart is pushed, we know that, because of the interaction of the cart with the ground, is a rigid feature and through that, so much variations are there in the forces, the huge amount of excitations are there. So, what we can do, we can simply put the preferred panels there itself and we can control that.

And sound is also emitted, where the material is just slid down from the cart walls, the pressure equalization also, not only takes the place at the top edges, but also the side plates are creating these features. And the these walls can now be replaced by the new ones, whatever the pipe frames are and the plates, which were fastened with the gap

between the, we can say this plates and frame, they can also deviate the path of the, we can say sound or the vibration features.

And this pressure equalization, which takes place along the edges, they can also reduce the low frequency noise and also along with the vibrations. There is a simple theme, when we know that, there is a solid media along with the source of the vibration, the propagation is very fast and in the amplified manner. So, first theme is coming that, we need to reduce this and for that, we need to just apply the basic domain in such a way that, the path can be deviated to get absorb the energy or the structural one.

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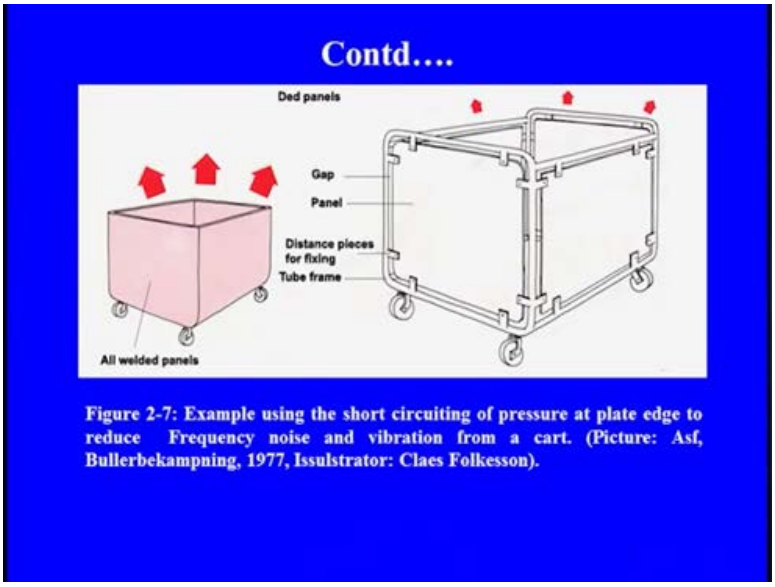

Figure 2-7: Example using the short circuiting of pressure at plate edge to reduce Frequency noise and vibration from a cart. (Picture: Asf, Bullerbekampning, 1977, Issulstrator: Claes Folkesson).

So, you see here, that is what we were discussing, if we have a solid frame with the cart, since the structural features are coming from this base and you see here, the excitations is quite dominating, the huge amount of excitations are there. But, when this cart is there and these are the gaps, which we were discussing in between the plates, they are just deviating the path, they can be good absorber as well. And then you see here, there is a very less amount of the sound is there along with this and the vibrations are there. So, this is the practical examples, in which we know that, how do we, how we can control that.

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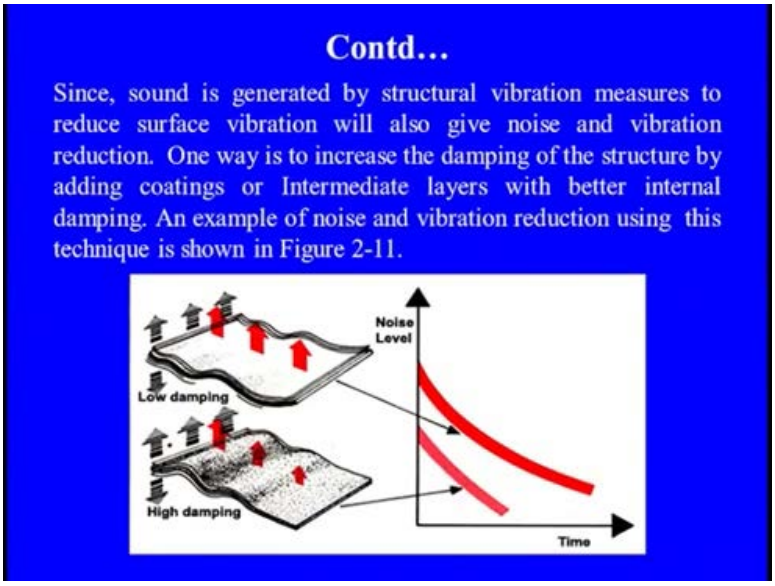

And since these sound which is straight away generated by the structural vibration, can also measure to reduction surface vibration and gives a clear vibration reduction. So, if we know that, this is the solid media and they are creating so much sound or less sound in other way. More sound generation, more vibration featured are being there, less sound generation less vibration featured are there. There is also one of the example to reduce the vibration level or reduce the sound intensity, is by increasing the damping, because we know that, the damper is one of the good performer in that.

So, the damping you see here, if we can add to any structure by adding the coatings or any intermediate layers, because we know that, the damping is having three main mechanism, one the intermolecular. So, we can simply put any intermediate layers for that, that is nothing but the material damping. Second is a structural damping, so we can put any kind of coatings or else, even the fluid features are there like the damping part. So, by adding, either the coating or any intermediate layers with the better internal damping, we know that, the amplitude of the vibration can be effectively reduced, just an example here on that screen that we have a simple, this base sheet is there, and when it is under any dynamic action, they can create, because it is a solid feature. And it can propagate this with the faster rate and it can even amplified those, the vibration feature.

So, when it is under the dynamic action we know that, this damping because it has a very low damping, the huge amount of vibration generations are there, you can see that. But

when you see here, we have a higher damper, any layers which are being added and through which you see here, the energy can be absorbed of that vibration. There is a straight reduction of the vibration is, so this is also one of the good way in the reduction of that.

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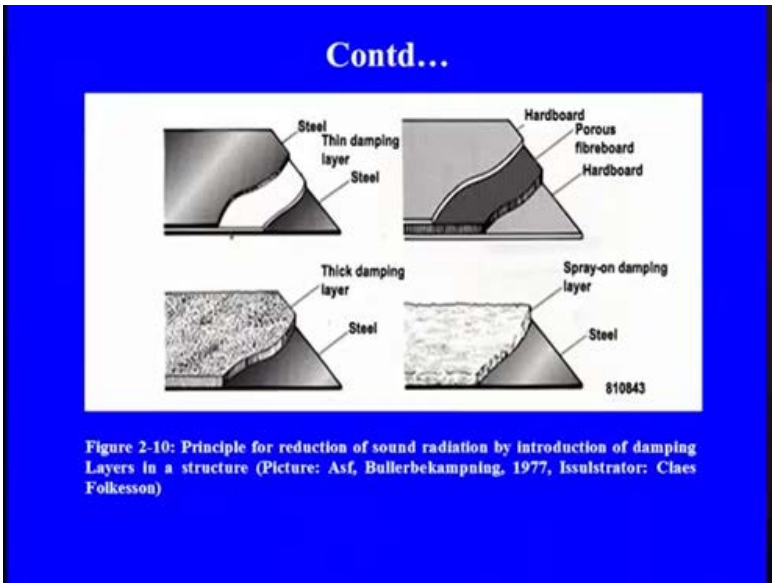

Figure 2-10: Principle for reduction of sound radiation by introduction of damping Layers in a structure (Picture: Asf, Bullerbekampning, 1977, Issulstrator: Claes Folkesson)

Or else you see here, you can see that, the sound radiations, how it can be reduced when the damping is added there. So, in this feature you see here, when you have the steel and the thin damping feature and then you see the another steel, so this thin damping cannot give you a proper deviation in the path or in the absorber part. But, this one you see here, when you have the fire board or any good damping material, there is a straight reduction of the excitation is there.

Or in the another feature you see here, when your thick or the thin layer, there is a straight deviation in the path or the energy absorption is there during excitation. So, this is a clear example, where we know that, the excitation is significant and we want to reduce the transmission of the excitation or even their level of the excitation. The material damper or the isolators are the perfect one and this type of control is called the passive vibration control.

Or even if we are considering the pump, we know that, when the pump is under the operation, there is a huge amount of vibration is coming out and upto the large extent

you see here, when it is coupled with the guard or any the sheet metal, it is a huge amount of vibration, we can say transmission is there.

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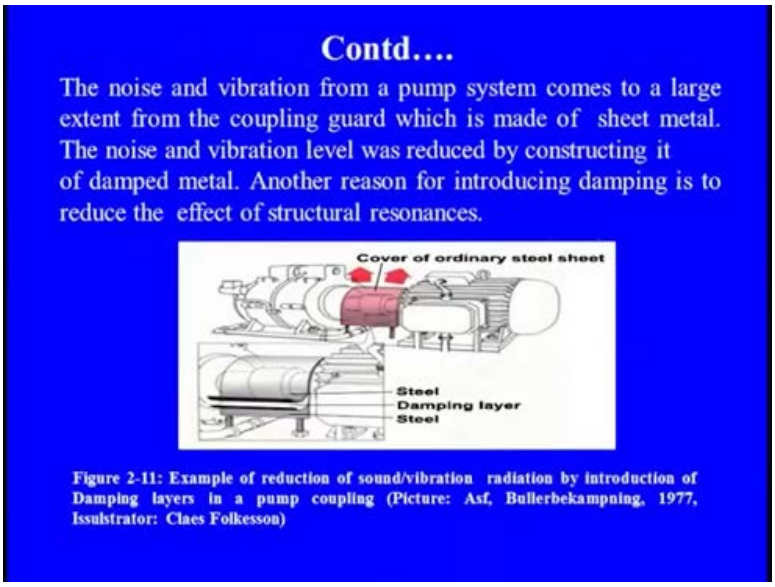

And the noise and vibration level can be controlled by simply adding any damping feature, the damped metal. And then you see here, you can look at this, we have this say, it is a coupled one, when it is coupled this pump with any of this feature we know that, the intermediate, whatever the coupling is there, they are also creating huge amount of that. If we are adding any material in that, say you can look at that this part, so when you see these things are being added there, the huge amount of whatever the sound or the vibration, which are being generated at the featured couple, it can be straight away reduced thereby.

This is another example, when you see, we have a vibrating plate and when we are simply putting any kind of damper there, it can be straight away absorb, whatever the exciting energies are. And through this absorbing the exciting energy, the excitation level can be absorbed. Just like you see on this screen, we have a cup, when you excide that by any small impact, the huge amount of the vibration or the sound can be generated.

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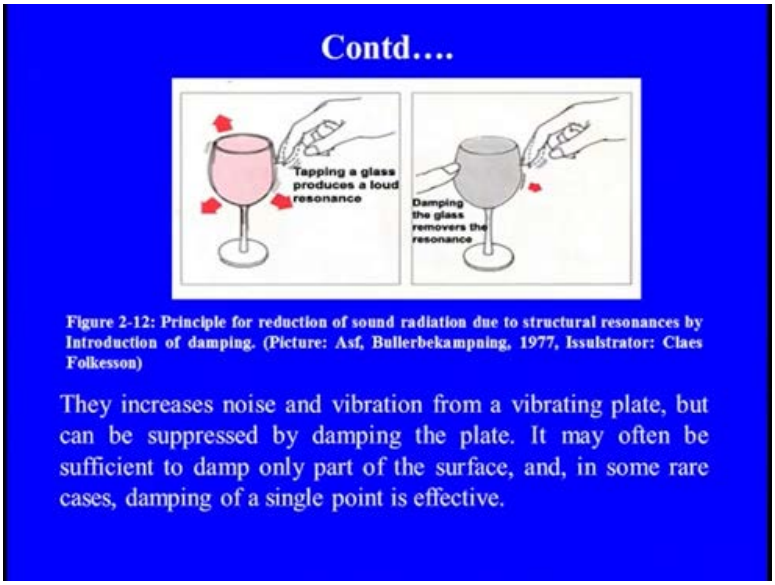

But, the same time, even we are exciting this, we are putting another finger, which can be act as a damper, whatever the source is or you see whatever the forces, which are being coming under the excitation due the excitation by finger, they can be absorbed by the another finger as the intermolecular features. So, this is you see here, these are the practical examples, through which we can say that, the vibration can be controlled effectively by two things.

One, when we know that, this source which is creating the huge amount of vibration or the sound, we can simply put the isolator there if it is feasible, because the isolator can straight away absorbed, whatever amount of energy which is being coming out from that. Second, when it is transmitting and we know that, when the machine or any the practical feature here rotating or the reciprocating part component, they are being connected.

So, they have a solid media for transmission, when such kind of arrangements are there, we need to put any perforated feature, so that the deviation can be happen with the molecular feature. So, you see here, as we discussed in this that, through the source, the vibrations are being coming out, we can apply any kind of isolator on that, when it is transmitting. If it is having a solid media, we know that, immediately it will transfer, so we need to apply some kind of the isolators there.

Isolators of any kind, even by the perforated plates or even though material damping by putting that or even you see here, we can put the structural damping there by putting

some kind of the passive vibration isolator. Or else you see, if we cannot do that in both the condition means, at the source and this path, the transmitter then we can straight away go to the receiver end and we can out the earmuffs or earplugs or something.

And then we can straight away wear such kind of, those either the shoes or the clothes so that, whatever the vibrations which are coming out, it should not hamper or hammer your nerves featured. So, you see here, these are the common practices we can say, which we are adopting for control of the vibrations and these are very practical. So, you see in this today's lecture, our main theme was that, how we can control that, this is very practical cases that you see.

These vibrations are generated and we cannot avoid these generation of vibration, because of the mechanical motion, but we can apply some external feature to effectively control these oscillation or the amplitude of vibration. In the next lecture, we will again continue the various ways, still you see here in this chapter, we were only discussing about the ways. We would like to go some more inner features of the vibration control at the source, at the receiver end or even at the during that. So, till now you see here, we just discussed about the basic mechanical machinery or the components about that. In the next lecture, we are going to discuss in detail about these effective ways of controlling the vibration, either by isolator or either by putting the various components along with may be damping or may be spring itself as well.

Thank you.