Industrial Engineering

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Module - 03
Lecture - 16
Working Conditions Lights and Vibrations

Dear students, you know that the productivity of any organization to a great extent depends upon how effectively it is resources are used, the common resources which are used in manufacturing organizations such as the man, material, machines are to be used effectively for increasing the productivity of the organization. An efficient man machine production system is formed when a worker efficiently works on a very nicely designed system and when man works in a good system, and they are working in properly designed working conditions.

The working conditions will help the worker to continue the job for long time without need of a break, unnecessary improper working conditions will need to the spoilage of the work, the frequent breaks of the worker from the work due to the mental and the physical fatigue caused by the improper working conditions. Therefore, it is very important that proper working conditions are developed in the working environment, where man and machine are suppose to interact together to deliver the desired output.

And, if we have to look in to the working conditions which are necessary and which should be developed in the working environment for efficient working of the worker, then the first of all it is the requirement of the light and the vibrations. Vibrations, which a worker will be experiencing during the work and the light, which is a required to see the things to recognize the object and to take the decisions accordingly. So, first of all in this presentation I shall be talking about the quality, visual, environment and the components the which are important to have the quality usually environment.

And, the adverse effects on the productivity and the operator if the proper visual environment is not maintained in the work place and in the second part of this presentation I shall be talking about the kind of vibrations which are experienced by the operators during in the work and they are effect on the performance. So, here first of all I

shall take up the quality usual environment, as we know that the good visibility of the equipment and the product involved in work process is essential.

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We should be able to or worker should be able to see the things, equipments and the product which are to be used in the work process, this will help to accelerate the production and at the same time reduce the number of defects and the related wastages. It will also help in reducing the visual fatigue, if the worker can see that the components to be processed.

The tools which are to be used very clearly easily without any difficulty, then he will to continue to work without any need of break and the related fatigue will also be reduced. And he will have to work in the very poor conditions, then headache can also be their and the poor light conditions in the areas where frequent movements are suppose to, we taken place by the worker or workers are moving in the areas, very frequently. Like in a stores or in the shop floor, proper lighting should be maintained; otherwise, it will lead to the increased chances of accidents.

Therefore, the good quality visual environment helps to accelerate the production, increase the productivity by reducing the wastages and defect and increases the worker, worker's efficiency by reducing his visual fatigue headache and the chance of the accidents. Why because the 80 percent of the information required for carrying out a particular job is perceived by the worker visually.

If the proper visual environment is there, he will be able to perceive the things clearly and easily without any difficulty and there after he will be able to interrupt the information and a take the decision suitably for carrying out the job and get giving the desired output. Therefore, the quality visual environment is very important for the success of the operation and for prolonged operation by the worker.

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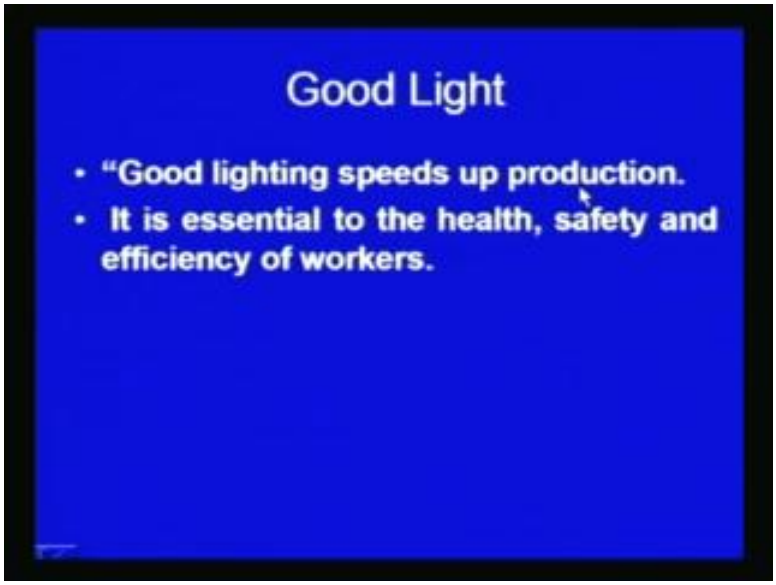

Good lighting, therefore speeds up the production if the worker can perceive the information easily without any difficulty, then it will help him in taking the easy and quick decisions which will further increase the production rate or the speed of the production. The proper lighting is also important for the health, safety and the efficiency of the worker; therefore, the proper level of the light and the kind of light should be maintained in the work environment.

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If it is not done, then the poor lighting system will need to the eye damage of the worker and if the poor lights have been maintained in the areas where frequent movements of the worker and material is suppose to take place. Then, it will lead to the accidents also for example, in the stores and in the shop floors if the poor light has been maintained it will cause very frequent accidents.

The poor light can also lead to the spoilage of the material and, then which will finally slow down the rate of production due to the increased scrap. Therefore, the poor light is not good in any of the ways for any production system, any organization or the office where work is expected to be done by the worker.

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The efficient performs of the tasks in variety in the activities for example, in business, offices, industries etcetera, to some extent dependents upon the quality of the visual environment. The way by which workers will be carrying out the different jobs in different sectors to great extent govern by the quality of the visual environment and this quality of the visual environment is a determined by the amount of the light which is there.

In the work area what is the level of the light which has been provided or what is the level of light which should have been there, this to a great extent decides the quality of the visual environment. At thus, in addition to the amount of the light, which is present in the work area or in the room or in the bench or in the floor or in the table were work is expected to be done by the worker. The amount of light significantly dictates the quality of the visual environment and decides the way by which work will be done.

And, easily the ease with which work will be done by the worker during the operation, the second important point which affects the quality of visual environment is the contrast between the object being processed and the immediate surroundings. The contrast between the object and the surrounding helps the worker to recognize easily to identify and to see the object easily without making much effort.

So, this helps to reduce the visual fatigue of the operator, the different level of the contrast lead to the different kinds of the effects very low contrasts are always

problematic to the worker and in to recognize the object during the job. The presence or absence of the glare is very important even the even if the amount of the light is sufficient with the contrast is good, but the glare if the glare is present or the flickering is taking place.

Then, this can also adversely affect the ease with which objects can be seen clearly during the work and if they cannot be seen they cannot be observed and detected easily clearly by the worker during the operation. Then, they will adversely affect the production rate and the productivity of the organization that is, why it is necessary that the quality of the visual environment in the workers space is properly maintained by controlling the amount of the light that is required for a given job, the proper contrast between the object being processed and the immediate surrounding and the presence or the absence of the glare and flicker.

In general, for fine work the in the large amount of the light is required while for the course or rough work, less amount of the light is required the contrast between the job and the surrounding if it is low, then it increases the visual strain. And, it should be at an optimum level, so that the object can be detect and identified easily by the worker during the operation, the glare should be minimized in order to have any adverse effect on the visibility of the object.

In the same way flicker should also be reduced or it should be minimized in order to have any adverse effect on the quality of the visual environment, one by one all these three aspects will be taken up in the coming slides. Here the amount of the light actually significantly dictates, the way by which the operator will be able to see the object.

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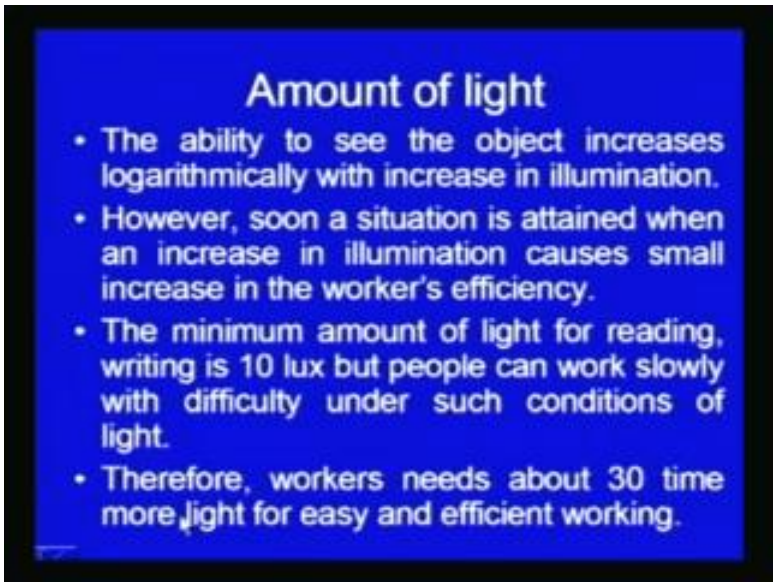

The ability to see the object increases logarithmically with increase in illumination, the illumination indicating the amount of light that is present and it is unit a normally given is lux. So, here if the illumination is increased the visibility of the object or the ability to see the object increases, but logarithmically under such conditions situation is very rapidly attained when an increase in illumination causes small increase in worker's efficiency.

So, for low level of illumination it is all right, but when it increases to the sufficiently high level, then the increase in visibility or the worker's efficiency with the increase in illumination becomes minimum. And, here therefore, it is set that a situation is attained when increase the illumination causes small increase in worker worker's efficiency, a minimum amount of the light for reading, writing is about 10 lux that is the unit of the light.

The amount of light that is present, but the people can work slowly with the difficulty under such conditions of the light, it may we may found it good enough to have a good enough to have light of the 10 lux just for reading or writing purpose, but if the worker has to worker for long with a such low level of the light. Then, he will be working with this difficulty and the slowly under such kind of working conditions in such level of low level of the light.

Therefore, in general worker's need to have a about 30 times more light, then that of the 10 lux level of the light which is required for just reading and writing purpose. So, workers depending upon the kind of precautions required and the kind of the job size which is there, the workers may need 30 to the 300 times of the light required for easy efficient working, in general it is 300 times or 30 times of the light which is required just for reading purpose, for efficient working and the easy operation.

So, the level of light which will be required to a great extent, to a great extent will be dictated by the size of job the contrast between the object and the immediate environment. And, the distance from which is to be viewed the age of the worker the reflectance which is their or there are so many effectors which effect the amount of light which should be there for carrying out a given job, in coming light slides we will see the many other aspects related to this, here we can see the visibility and the illumination level relationship.

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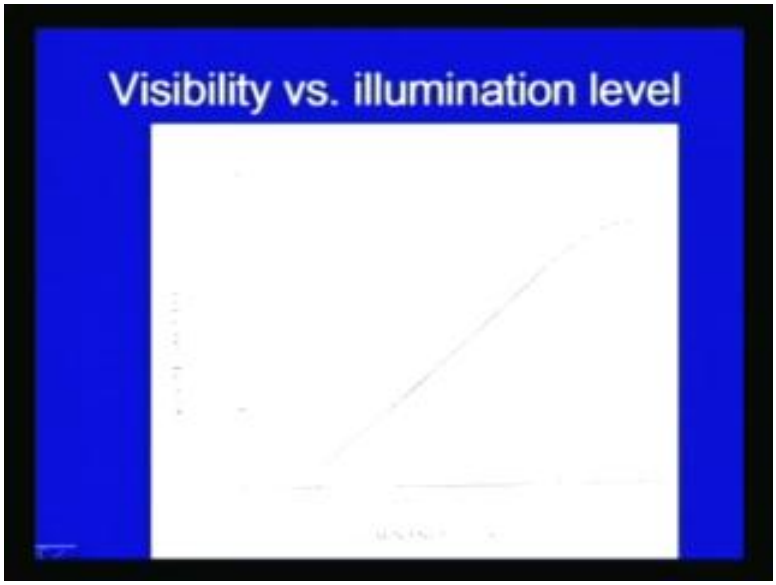

Here, the visibility improves with the increase in illumination level, but here this curve is starts to become flatten where after reaching to a certain level there is no significant increase in the visibility with the further increase of the illumination. So, here initially at low level of the illumination, increase illumination increases the visibility.

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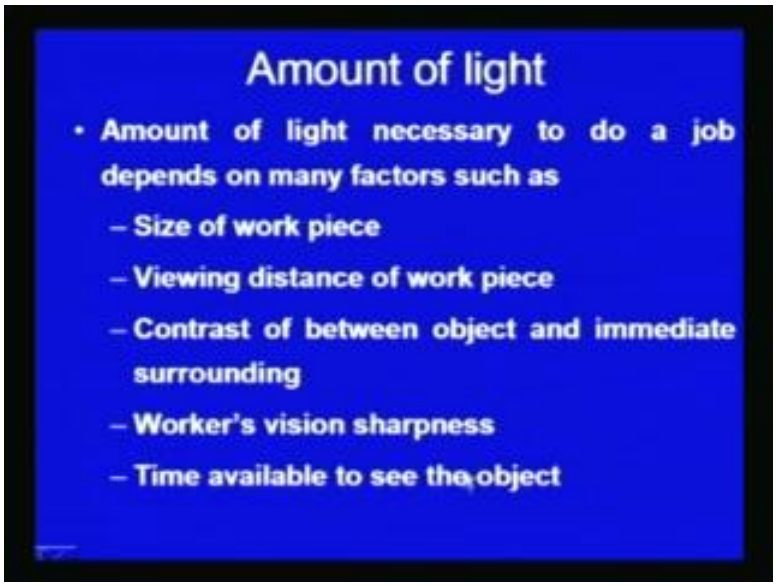

The amount of the light necessary to do a particular job depends upon the many factors as I have said the size is one of them the contrast between the object and the work, immediate surroundings, environment is the another factor, the distance from which it is to be viewed, the age of the worker etcetera, are thus other factors which effect the amount of light required to do a job and to detect the job, so that the operation can be done successfully.

The size of the work piece is a first factor, in general reduction in size increases the requirement of the light means, the finer the job greater is the amount of the light which is required. It may go up to the third 1000 to 3000 lux while for the course job greater than 1 mm even 200 or 300 units of the light may be enough, so increase in size of the job reduces the light requirement, but for the fine jobs the more light is required.

The viewing distance in general increase in viewing distance of the worker increases the amount of light that is required, the contrast between the objects and the immediate surroundings, if the contrast between the object and the immediate surrounding is low, then the more a light is required otherwise the low light is required. The worker's vision sharpness depending upon the age of the worker the amount of the light required for doing a particular job also varies significantly, because of variation and vision sharpness of the worker.

Here, in coming slides will see that the how age of the worker affects the amount of light required to see the object clearly, the time available to see the object is the another import factor, a fine jobs in general takes a longer time to get recognized while the large size of job can be recognized easily. In the same way like a, if very small defect is to be identified in moving object, object which is moving on the convey conveyer may be difficult to detect because of it is color similar to that of the object.

So, that is why if the time available to see the object is less, then the light requirement increases higher larger amount of the light is required for to detect the object in less time otherwise, if the amount of the light is less, then it will take longer time to detect the object and to see it clearly. So, if we see here one by one the different factors that are effecting to the amount of light required for carrying out the job.

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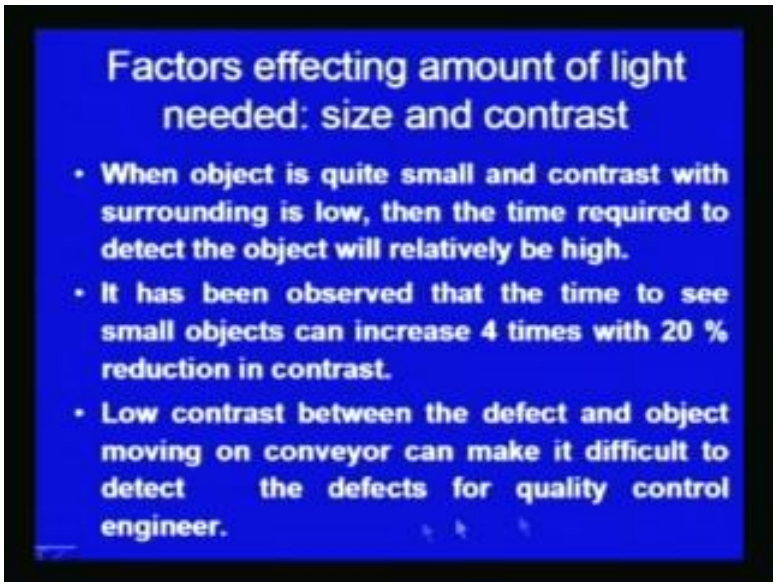

First one is the size of the object, the size of the object significantly effects it is ability to be seen, in general smaller the size of the object lesser the visual angle and therefore, more will be the difficulty to see the object. So, if the object is of is fine sized means, if it is of less than say 1 mm, then it will take larger amount of the light it will need larger amount of the light to detect in to see clearly.

So, that it can be process efficiently by the worker, but if the job size is more and if it is to be seen from the closer distance it will take a less amount of the light. So, the a smaller the size of the job lesser will be the viewing angle or the visual angle and

therefore, it will require more light to see the object clearly; therefore, with the low level of the light it will be difficult to see an object and the light requirement in general increases with the reduction in the size of the object.

When the object is of reasonably big size say for greater than 1 mm and if it is to be viewed from half meter of distance, then and at the same time of the contrast with the surrounding or the immediate is working environment is high. If the contrast is a high, job size is big then the object can be detected easily and under such conditions low level of the light will be required.

So, means if the fine pins or the balls or to be searched fine, a still balls are to be searched which are placed on them white paper, then it may be difficult to see because of the similarity in the color and the fine s. So, here the low level of the contrast and the finer size will increase the difficulty in detecting the object and then later on it is a processing, so here where the job size is big and the surrounding contrast of the object with the surrounding is high, it can be easily detected.

And therefore, the assist conditions low level of the light is required, on the other hand when the object size is quite a small and the contrast with the surrounding is low, then the time require to detect the object will relatively increase or it will be more. So, the more time is required in cases where job size is small and the contrast with the surrounding is low under such conditions more time is required to detect the object.

And therefore, under such conditions more light is needed it has been observed that the time require to see the object can increase to about 4 times with just 20 percent reduction in contrast. So, it indicates that even a small decrease in the reduction contrast percentage a small reduction in the contrast, you can lead to the significant increase in the time required to detect the object especially the fine object, in the fine objects are found to be difficult to detect with the low level of the contrast.

And therefore, in the contrast between the object and the immediate surrounding is very important otherwise, even a small reduction in the contrast can significantly increase the time required to carry out the job. And, it has been observed that this time can be as highest 4 times with the reduction of just 20 percent in the contrast of the object with the immediate surroundings, low contrast between the defect and the object on moving conveyer can make it difficult to detect the defect for quality control engineer.

So, quality control is also affected by the visual environment by the quality of the visual environment, if the proper lights have not been maintained. Then, it may be difficult for the quality engineer also to detect the presence of defect in object which is moving slowly on the conveyer, the conveyer will continuously moving and carrying object from one place to another and it will be the responsibility of the quality engineer to identify the presence of the defect on a moving object.

So, if the time available to identify the presence of object to see the presence of object is less, then it will difficult for the quality engineer to do his job. Therefore, and under such condition since the contrast between the defect and the object will be low and therefore, it will be difficult for the quality engineer to detect the defects and the role of quality of visual environment can be seen here in the, in the job of the quality engineer were his job becomes difficult when the contrast between the defect and the objects is low and especially when the job is moving at certain speed on the conveyer.

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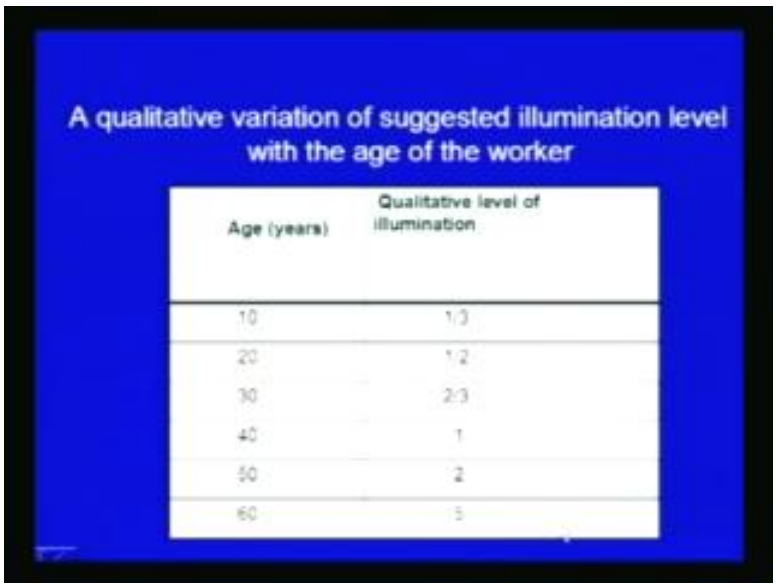

So, here if we see that how the illumination level required for carrying out a job varies with the age of the worker, because the age of the with the age of the worker the sharpness of the vision changes and therefore, for the people or worker's of the different ages, the different level of the illumination is required for carrying out the same job. If we can see here, the quality level of illumination required for the people having, then the people of the different ages which have been given in this column.

And, the illumination required this been given the ratio of the illumination required with the respect to the optimum level for a person of say 40 age, so here if we see that the illumination required for carrying out the particular job is considered as unit, for a worker of the 40 years old. Then, the with respect to that level of write required here the person with just 10 worker or the person who is of 10 year old will need just one third level of the light.

While 20 years old person will need half level of the light and the 30 years old will required two third level of light compare to the level of light or illumination level required for carrying out the job by the 40 years old person. And, the and further increase in the age to the 50, from 40 to 50 the person who is 50 years old will require, then the illumination level double of what is required for the 40 years old worker.

And, the 60 years old worker will require about five times the level of light compare to that of the 40 years old person for carrying out the same in job, so if we see depending upon the age of the person the illumination require, illumination level required for carrying out the same job can vary significantly. So, here as per the age of the person the suitable level of the light should be maintained, so that job can be done successfully for long time by the worker.

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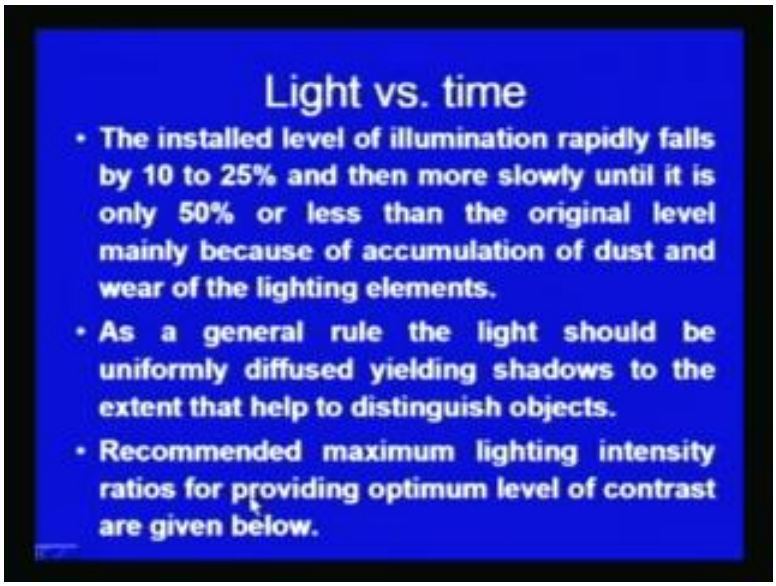

The amount of the light which is received from light source also varies with the time, on the installed level of the illumination rapidly falls by 10 to 25 percent with the increase

of time. And, then more slowly until it is only 50 percent or less than the original level and this reduction in the level of the illumination which is offered by a given light source is found mainly, because of accumulation of the dust and the wear of the lighting elements.

As a general rule, light should be uniformly diffused, so that the objects can be distinguished easily and diffuse light is of the, is obtained and here the recommended maximum lighting intensity ratios for optimum level of the contrast for carrying out the job effectively has been given.

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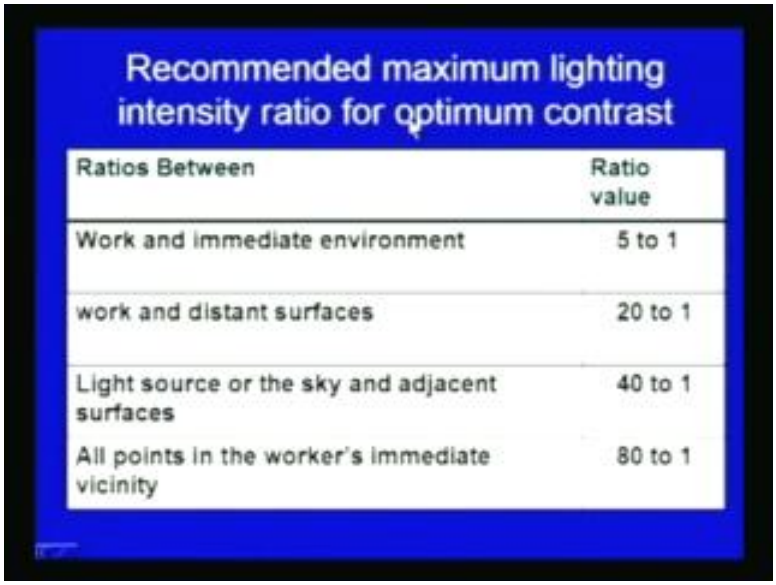

In this slide, here the ratio of the light intensity is which should for optimum contrast between the object and the surrounding should be maintain according to this table, as if as a for the different kind of the, with respect to the different kind of the surrounding environments like ratios between the work and immediate environment this light intensity ratio should be 5 is to 1, 5 to 1 and the work or the object and the distance surface is this light ratio should be maintain 20 is to 1.

While the light source of the sky or the adjacent surfaces, the light intensity ratio should be maintain 40 is to 1, while all points in the worker's immediate vicinity should be maintained with the light intensity ratio of a 8 is to 1. And, these ratios are the recommended values for obtaining the optimum contrast between the object and the surrounding environment.

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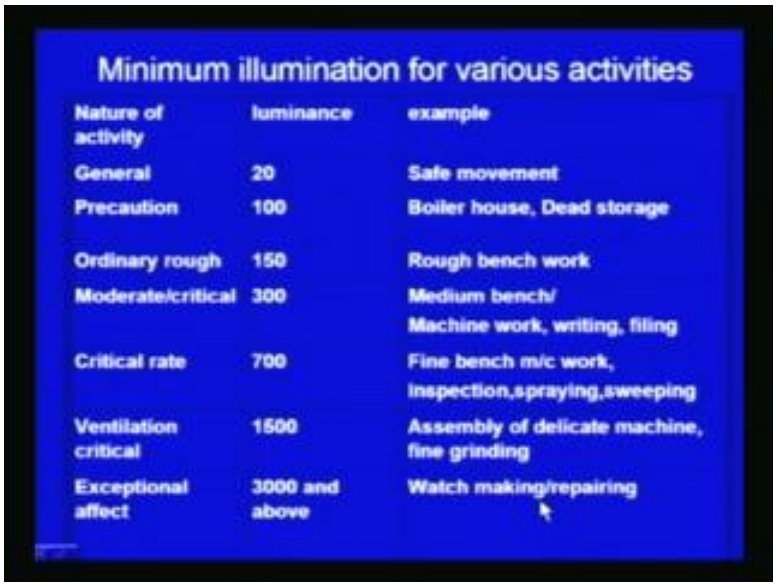

Here, we will see the minimum level of the light required for the different activities for the general light, the 20 lux light is required like the safe movement, where precaution is involved the 100 units of the light is required like boiler house and the dead storage. And ordinary rough work, 150 units of the light like rough bench work and the moderate and the critical activities like 300 units of the light is required for medium for example, medium bench work, machine work, writing and filing.

And, the for the critical work 700 units of the lights are required like for fine bench, machine work, inspection, spraying, sweeping, etcetera in the for the those jobs which require very critical and ventilation. And, that is very critical like an assembly of the delicate machines, fine grinding operations and 1500 units of the light or required for excess exceptional cases where extremely fine jobs are to be done like watch making and repairing 300 units 3000 units of the light or above is required for carrying out the job efficiently.

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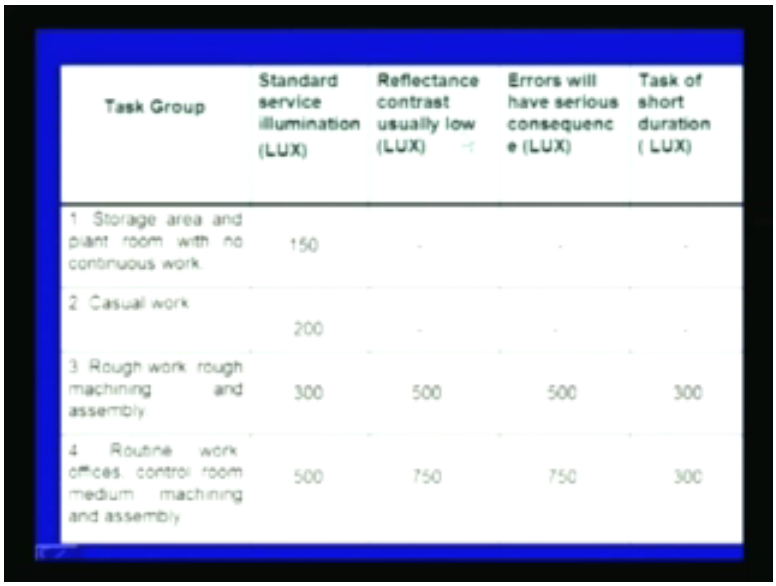

Task Group	Standard service illumination (LUX)	Reflectance contrast usually low (LUX)	Errors will have serious consequence (LUX)	Task of short duration (LUX)
1. Storage area and plant room with no continuous work	150	-	-	-
2. Casual work	200	-	-	-
3. Rough work rough machining and assembly	300	500	500	300
4. Routine work offices control room medium machining and assembly	500	750	750	300

Like here depending upon the category of the work, like the standard service illumination reflectance contrast usually low, errors will have serious consequences and the task of the short duration for the different category of the activity and for the different types of the jobs here we will see the level of the light required for carrying out the job. Here, these four categories will be maintained for all these kind of the kinds of the jobs.

Like a storage area, plant room with no continuous work 150 units of the lights, casual work 200 units of the light, rough work for all these four categories a very light 300 500 500 and 300 routine work in offices, control room, medium and machine medium machining and the assembly operations like 500 750 750 and 300 units.

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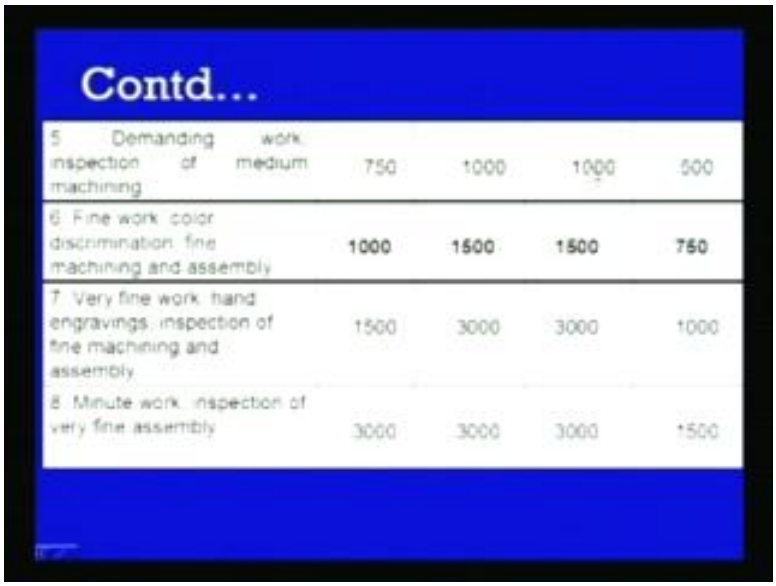

The same way for all these four categories the work which are demanding in nature and inspection of the medium machining jobs like 700 1000 1000 and 500 units of the lights are required. In the same way, we can see depending upon the finest of the job light require criticality of the job and the kind of errors and precautions errors which are excepted, the different level of the lights are require for minute work inspection of very fine assembly 3000 units of the lights are required.

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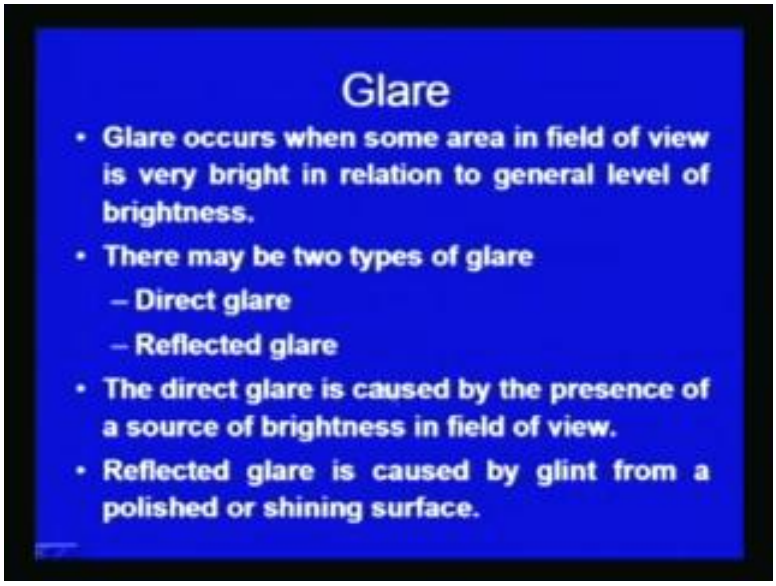

So, here depending upon the nature of the job and the kind of activities which are to be done by the worker the different level of the lights have been recommended, so that job can be done by the worker's efficiently and easily for long time without need of undue fatigue. The glare is the another aspect related with the quality of the visual environment and it is found to occur, when some area in the field for view is very bright in relation to the general level of the brightness.

Brightness in localized brightness a causes the glare in the field of view, so here there may be two types of the glare like direct glare or reflected glare, direct glare is caused by the presence of a source of the brightness in field of view. When a light source is present when source of the brightness is present in the field of view, then it is called a direct glare or the direct is glare is caused by the presence of the source of brightness in the field of view.

While the reflected glare is caused by glint from the polished or shining surface, so here different methods are used to reduce the adverse effects related with the glare. Glare whatever type of the glare is there, it is consider to be reduce the quality of the visual environment and that is why and the proper steps are taken to the reduce the glare.

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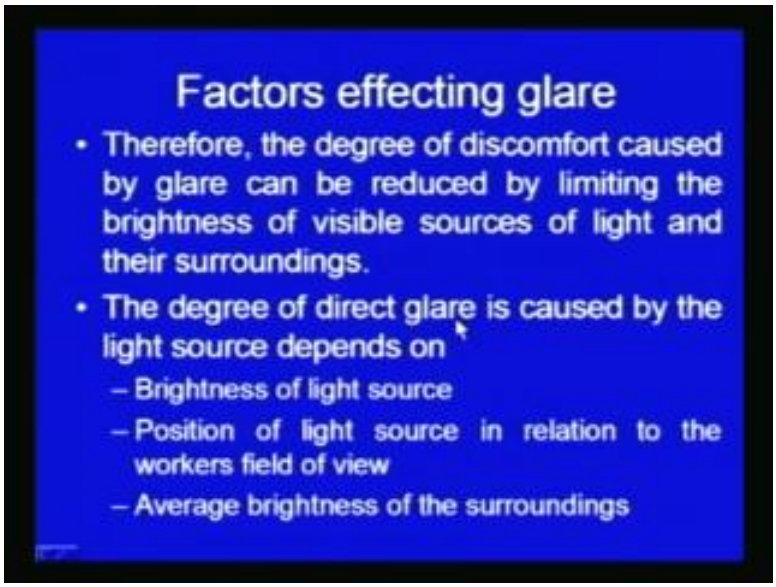

And therefore, if we is if we have seen we have seen that the glare is largely caused by the brightness of the by source of the brightness in the field of a view. So, if this brightness is controlled then the discomfort caused by the glare can be reduced, the

degree of discomfort caused by the glare can be reduced by limiting the brightness of the visual source of the light and the and their surroundings.

So, here the brightness is to be limited in order to reduce the discomfort being caused by the glare effect, so here the degree of the direct glare is caused by the light source depends upon the brightness of the light source. Here, if we have to reduce the direct glare and the extent of the direct glare effect is determined by the brightness of the light source, so this brightness is to be reduced the position of the light source in relation to the worker's view field.

If the a position of the light source is a adjusted in such a way that the, that the bright source of the light the brightness of the light source position is shifted with the respect to the field of view of the worker, then it is effect can be reduced. And, the average brightness of the surrounding also affects the degree of the direct glare, so work is done on all three components in order to reduce the degree of the direct glare.

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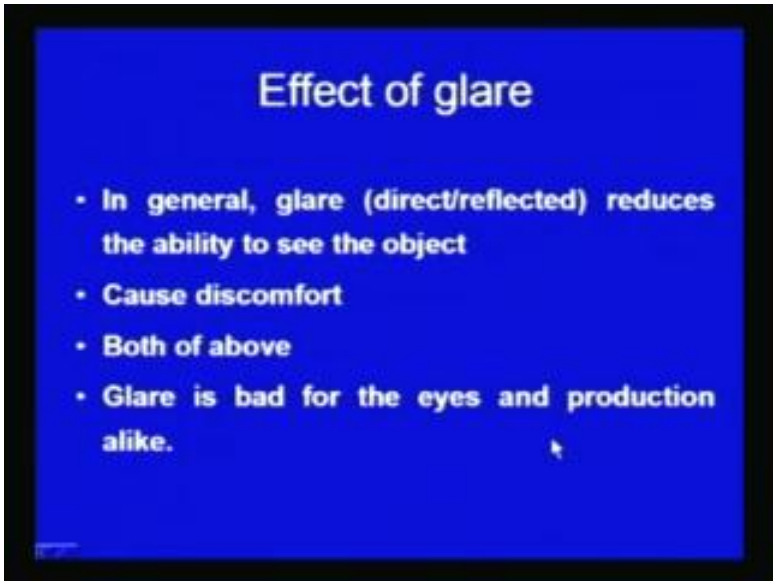

And, it is effect on the worker in general glare, whether it is direct or reflected reduces the ability to see the object, here in addition to reducing the visibility of the object the glare also increases the discomfort of the worker, because he for he finds a difficult to recognize and to detect the object clearly and easily. So, in general these are the two effects which are observed two effect, these are two effects of the glare these are the two ways by which glare can affect the visibility or the quality of the visual environment.

Like it can reduce the ability to see the object and it can cause the discomfort and to the worker and in some cases the both of these effects are caused by the glare. And therefore to reduce the adverse effect of the glare, the glare should be reduced whether it is direct or reflected glare, the glare is consider to be bad for eye and production alike in this. So, it if adversely effects to the visual fatigue or it causes the visual fatigue adversely effects to the eyes, in the same time because it takes a worker takes longer time to recognize the object and to see the things clearly here, it increases the time required for producing unit job, so at adversely effects the production also.

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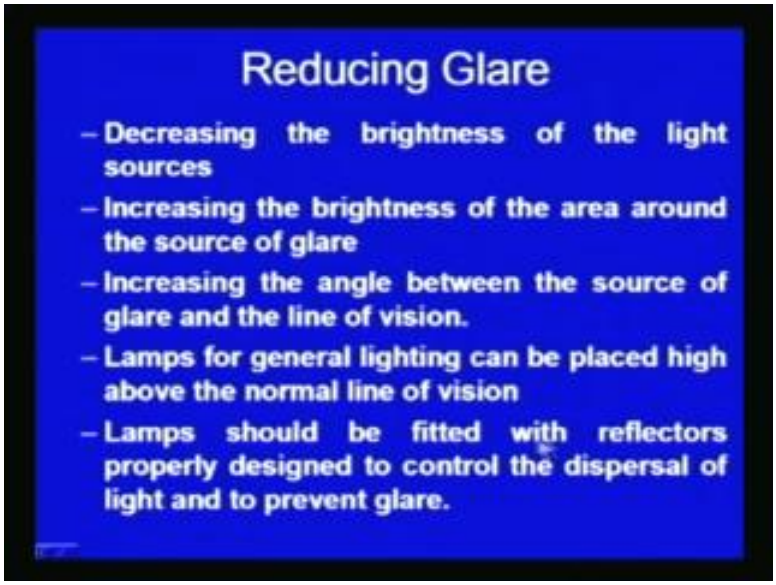

For reducing the glare some of the techniques are used and these techniques will be discussed one by one in the coming slides, for example gradual change in color or brightness have seen reducing the effect of the glare, changing the position of the light source also have to change the reflections in such a way that the glint or the glare is outside the field of view.

So, changing the position of the light source can be one way to reduce the effect of the glare or gradual change in color or brightness also have to reduce the glare. And therefore, moderately color work surface is generally preferred over the dark highly colored and the polished surfaces, because there will be more chances of getting the reflections from the dark highly colored and the polished surfaces compare to the light colored work surfaces.

And, these are the some of the things which can be done to reduce the adverse effect of the glare, so in addition to these points we can see that decreasing the brightness of the light source is another way, increasing the brightness of the area around the source of the glare like increasing the brightness of the immediate surroundings is the another way of reducing a glare effect. Increasing the angle between the source of the glare and the line of vision is the third method of a reducing the glare and the lamps for general lighting can you can be placed high above the normal line of vision to reduce the glare. And, the lamps should be properly fitted with reflectors and design to control the dispersal of the light and to prevent the glare, so these are the other things which can be applied in order to reduce the adverse effect of the glare and the recommended reflectance for reduced glare.

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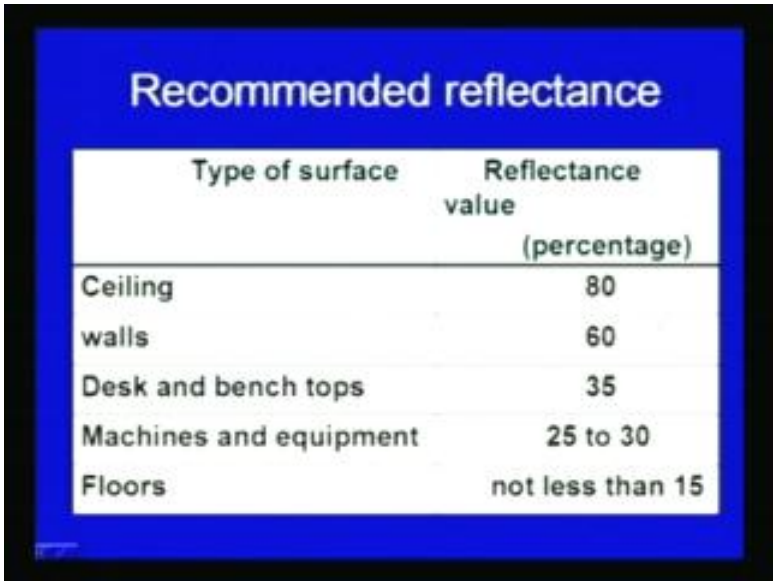

An improved quality of the visual environment like ceiling reflectance should be 80 percent, the walls reflectance 60 percent, the desk and batch benched tops reflectance 35 percent and the machines and equipment reflectance 25 to 30 percent, the floors should not be less than 15 percent. So, here these reflectance levels will help to reduce the adverse effects of the glare and improve the quality of the visual environment.

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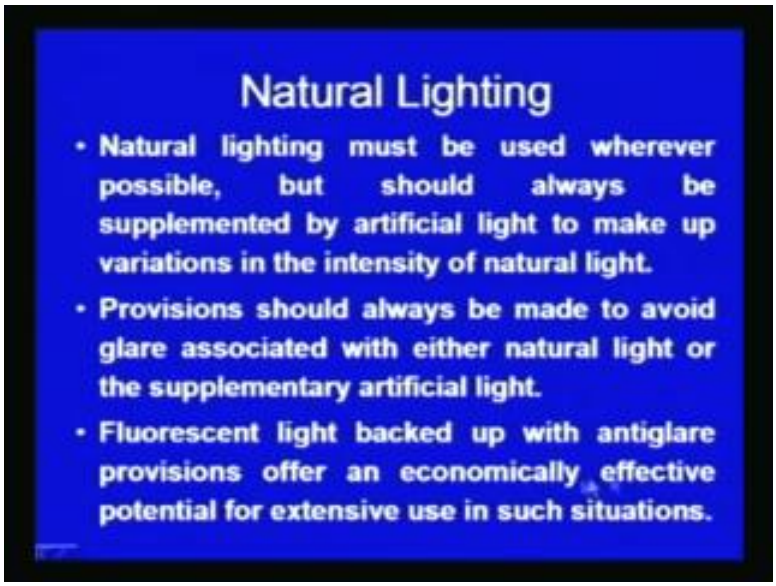

As for as possible natural light should be used and, but it should be taken care of that the artificial light is also use to make up the variation in the intensity of the natural light. In whole of the day, because at one location the intensity of the natural light will be varying, therefore the artificial sources of the light should be used in order to accommodate those variations in the intensity of the natural light.

And therefore, in natural light should be used in association with the artificial light to deals with the variation, variations in the intensity of the natural light and the provisions should be made to avoid glares associated with the natural or supplementary artificial lights, in order to avoid the adverse effects related with the glare. In the fluorescent light backed up with the antiglare provisions are recommended and often used in order to avoid the adverse effect of the glare and improves the quality of the visual environment.

So, here in this in this second part I will be talking about the different sources of the vibrations, the view by which vibrations are transmitted to the human being. There adverse effects on human beings and the way by which the performance of the operator is effected by the vibrations which are experience by the worker during the operation.

During the operation worker frequently comes across the different types of the vibration and these vibrations sometimes cause a problem to the worker, these problems may be related to the efficiency of the worker related to the help health of the worker.

And, the speed of the operation and sometimes these all the vibrations also adversely affect the performance of the worker in terms of the visibility or in terms of the ability to recognize the objects.

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The human exposure, human body exposure to the vibrations can take place in three ways one is that when vibrations or transmitted in very localized manner to the body like operator is holding the machine through which vibrations are transmitted to the body through the hands. So, here when the vibrations are being transmitted to the body through the localized area for example, operator handling the hand drill.

Operator is using hand drill for drilling the, for drilling a hole either in rough, wood or in piece of the metal, so the vibrations from the drill will be transmitted to the operators hand. And, that is a form of the localized area means the transmission of vibration to the human body through a localized area, where a worker will be firmly holding the hand drill or any machine which is vibrating during the operation.

Vibrations can also be transmitted through the support areas like worker or the person is sitting in a car and the same time he is driving also or a person is standing near machine which is vibrating. So, in the standing or sitting position also vibrations can be transmitted to the body through the support systems like in the legs or the buttocks, so here the vibrations transmitted through the support areas like in the sitting positions,

when driving a car or standing near vibrating machinery or in some cases whole of the body or major portion of it is exposed to the vibrations.

Like, when we are performing the journey by air the whole of the body is exposes to the high frequency vibrations in the same way journey by sea the ship whole of the body is also exposed to in the vibrations. So, the vibrations can be transmitted to the human body in through the localized areas like hands or the feet or through the transfer through the support areas like through the legs when we are standing near the vibrating machinery or sitting in a car which is vibrating during the driving or when whole of the body is exposed to the vibrations.

So, depending upon the working conditions and the area where work is being done by the worker his body may be exposed partially or totally to the vibrations of the different degrees. So, the vibrations are characterized by the two important parameters, these are frequency and the amplitude, so depending upon the frequency and the amplitude its adverse effects are observed on the human being in the different way.

Low frequency vibrations are considered to be more harmful and consider to be considered to cause more discomfort to the worker than the high frequency vibrations. So, here now one by one we will see that how these vibrations affect the human beings.

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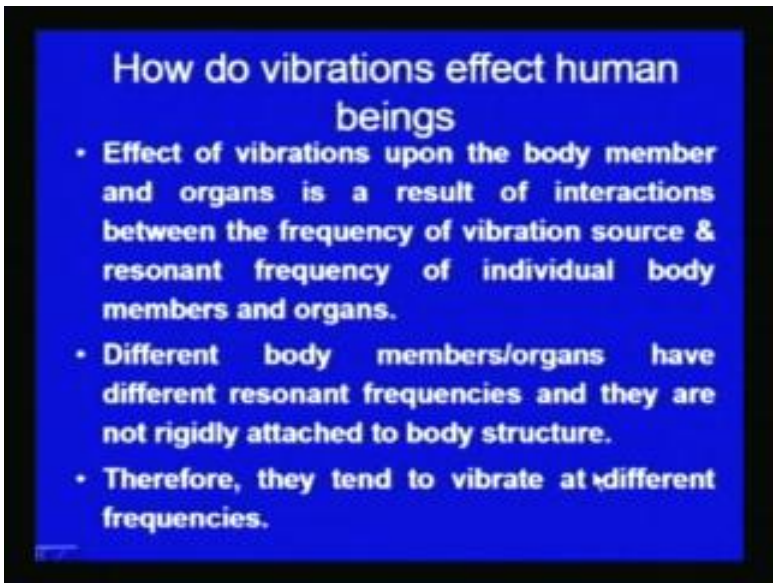
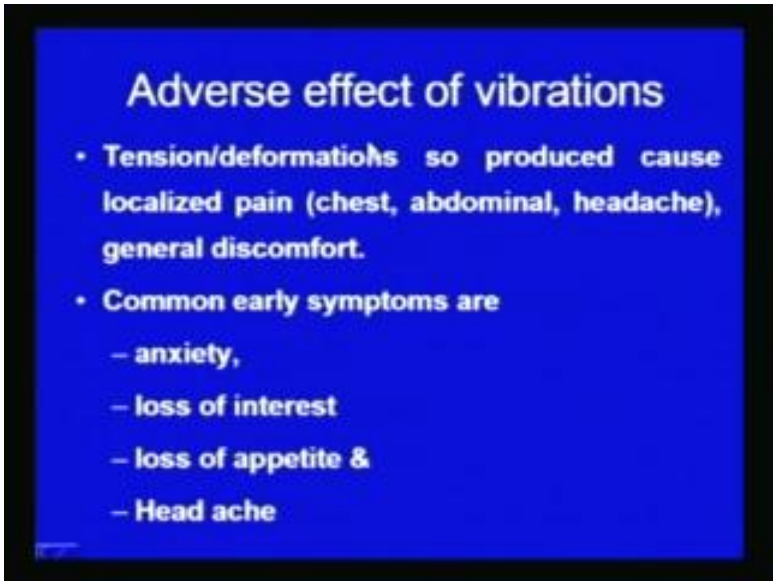


The effect of the vibrations upon the body member and the organs is a result of interactions between the frequency of the vibration source and resonant frequency of the individual body member and the organ. So, here this is very important point like the kind of interactions which is there between the vibrations of the between the frequency of the vibrating source and the resonant frequency of the individual.



So, and which in turn causes the localized pain the tensions and deformations if tissues due to the vibrations at different frequencies of the different body parts leads to the localized pains. And, these localized pains may appear in chest, abdominal zone or in may appear in form of headache and which in general appears or causes the discomfort to the operator being exposed to the vibrations.

The common symptoms which are experienced under the effect of the vibrations are anxiety the loss of interest, loss of appetite and the headache, so here the adverse effect of the vibrations on the human being appears inform of pains and the loss of interest, loss of appetite, head and an anxiety to reduce these effects adverse effect on the operator, the vibrations should be isolated. So, that worker can perform for long without much need of a break.

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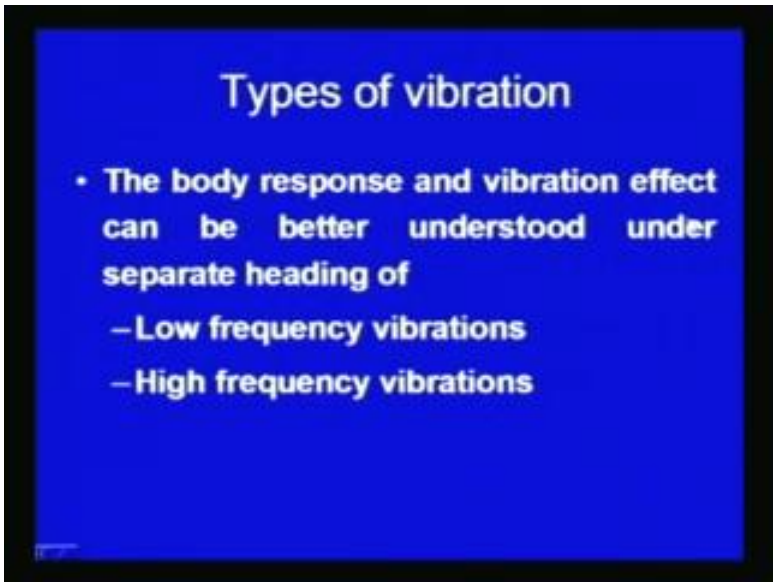

The body response and the adverse effect of the vibrations can be better understood, if they are seen if the vibrations are seen separately in the two categories the vibrations which are of low frequency, the vibrations below the 10 hertz frequency or consider under the low frequency vibrations and the vibrations above the 10 hertz frequency fall in category of the high frequency vibrations.

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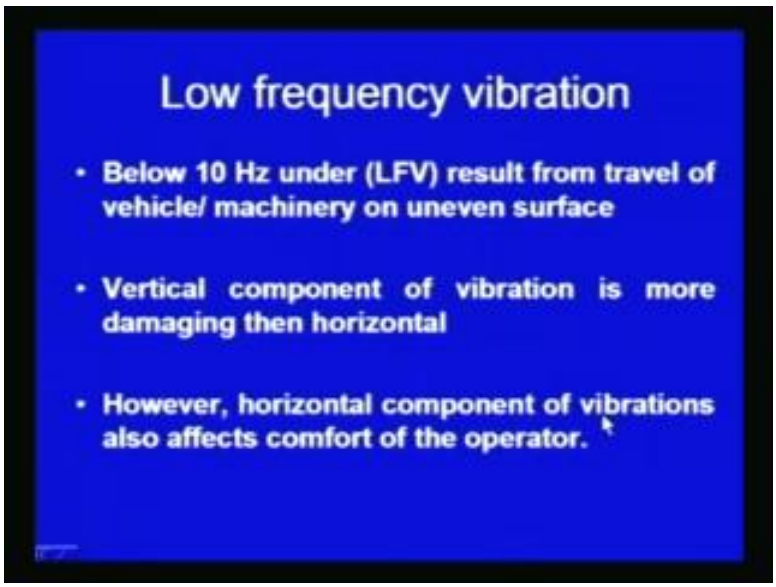

The below 10 hertz frequency, the low frequency vibrations mainly result from the travel of the vehicle or machinery on uneven surface, so low frequency vibrations are consider

to be more harmful and cause more discomfort to the operator or to the person which being exposed to the low frequency vibrations. And, these low frequency vibrations occur below the 10 hertz frequency and these are experienced is specially, when the person is traveling on vehicle or machinery on uneven surface.

The vehicle is travel, the moving on the uneven surface or the machine raise moving on uneven surface, when the vibrations occur it is vertical component is suppose to be more damaging then the horizontal one and the horizontal component of the vibration also considered to cause the discomfort to the operator. So, of the both the vertical and the horizontal components should be taken care of to avoid the adverse effect of the vibration, on the operator and the discomfort of the operator.

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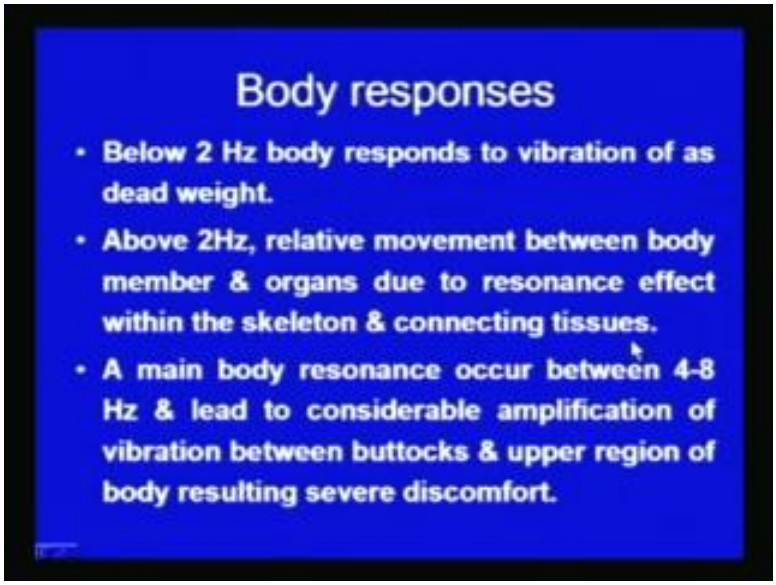

Below the 10 hertz frequency, the vibrations the body for the vibrations below the 2 hertz, the body response to the vibrations as dead weight, so for the vibrations below the 2 hertz the body response to them as a dead weight, but the vibrations which are more than 2 hertz, the relative movement between the body member and organs due to the resonance effect within the skeleton and connecting tissues is found to be cause more discomfort to the operator.

The main body resonance occurs between the 4 to 8 hertz and lead to be considerable amplification of the vibrations between the buttocks and the upper region of the body parts resulting in severe discomfort. So, in general 4 to 8 hertz of the frequency is

suppose to cause more discomfort to the operator during the operation, so here this is the level of the vibration which is to be taken care of very carefully to avoid adverse effect of the vibrations on the human body.

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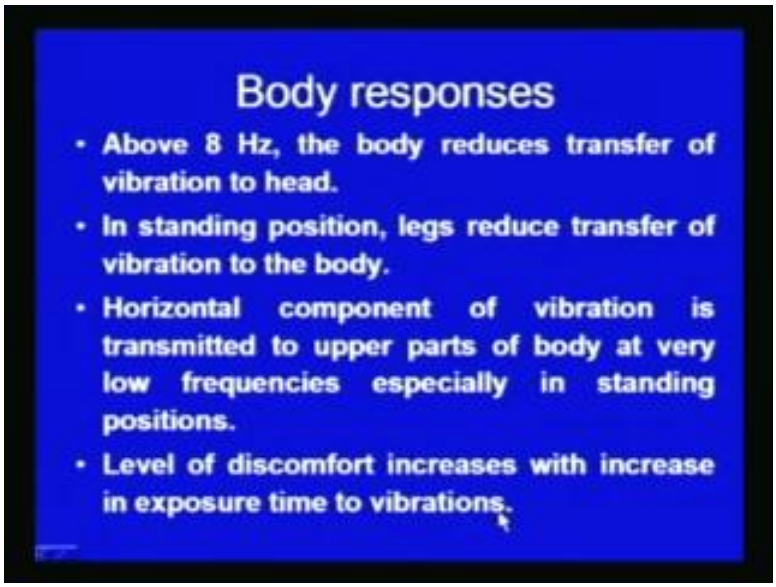

And, above 8 hertz the body reduces the transfer of the vibrations to the head and in the standing position legs reduce the transfer of vibrations to the body, but in the horizontal component of the vibration is transmitted to the upper part of the body at very low frequencies is specially in a standing position. So, in a standing position the transfer of the vibration to the body is reduced, but the horizontal component of the body vibration is transmitted to the body on only in a standing of position. So, here the low level of the discomfort even if the observe worker is a having the low level of the discomfort initially, this discomfort will increase gradually with the increase of exposure time to the vibration. And therefore, the level of the discomfort increases with the increase in exposure time to the vibrations.

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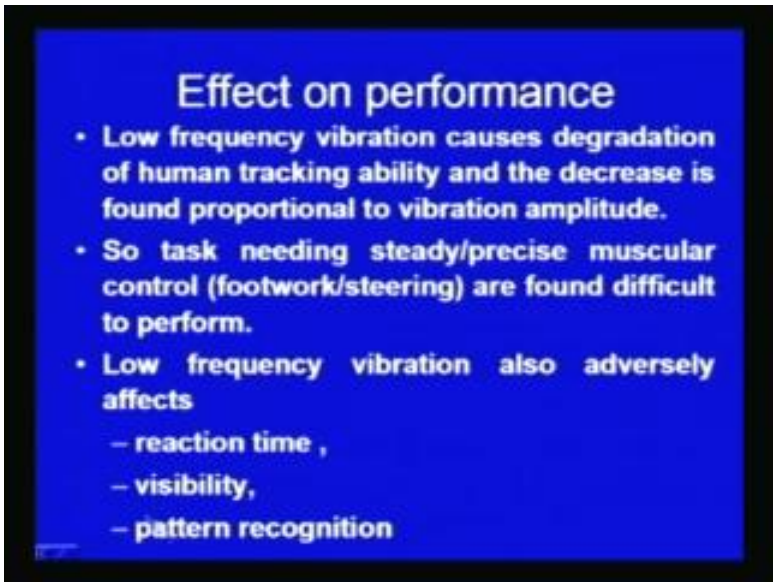

We can see here with the increase in frequency of the vibrations their transmissibility decreases, if a person is standing on legs the transmissibility decreases with the increase in frequency, the same it is true for the seat and cushioned chairs, where increase in at higher frequency the transmissibility of the vibrations decreases. The low frequency vibrations I known to are known to cause the degradation of the human tracking ability, and then this decreases the visibility of the object.

And, this human decrease in human tracking ability is found to be proportional to the amplitude of the vibration, greater is the amplitude of the vibration, greater will be the decrease in human tracking ability to a particular object. So, the tasks which are needs precise muscular control are found to be difficult to perform under the low frequency vibration conditions, low frequency vibrations are adversely are known to adversely affect the reaction time that is required to see the object and take decision what is to be done. Visibility of the object is also reduced and the pattern recognition of the object becomes difficult, so these are very adverse effects of the low frequency vibrations.

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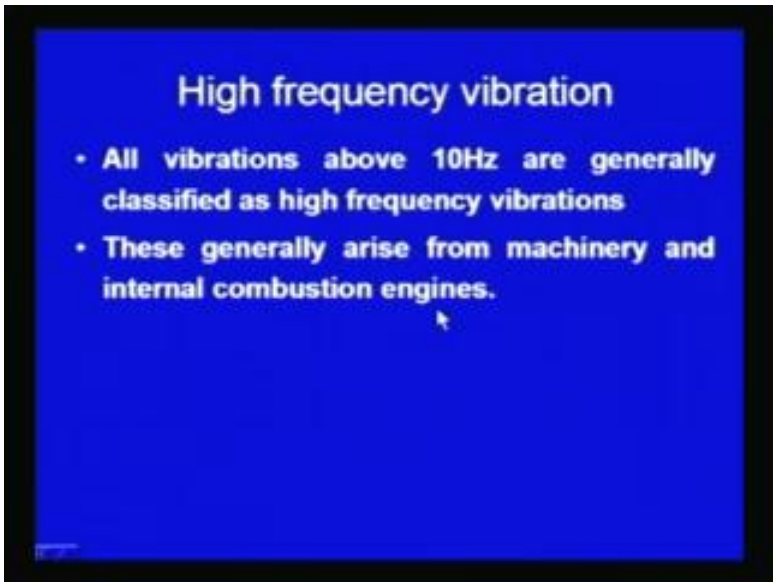

And, the vibrations which are of above 10 hertz fall generally fall in category of the high frequency vibrations, and these generally arise from the machinery and the internal combustion engines.

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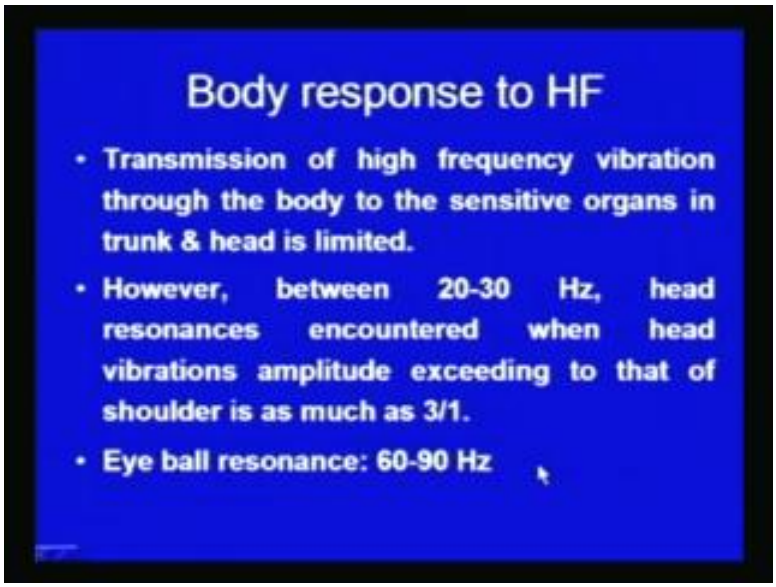

The transmission of high frequency vibrations through the body to the sensitive organs in the trunk and head is very limited; however, between the 20 to 30 hertz head resonance is encountered, while eye ball resonance is an encountered at 60 to 90 hertz frequency.

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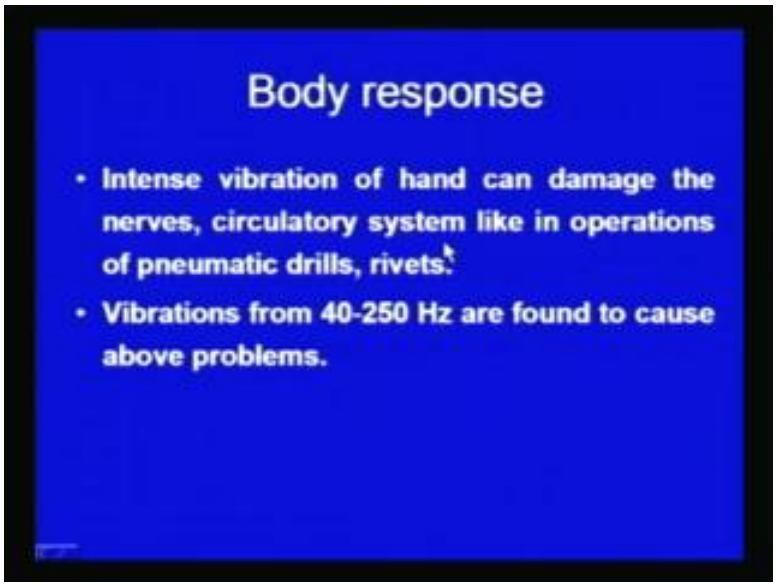

The intense vibrations of the hand can damage the nerves and circulatory system like in operations a pneumatic drill and the pneumatic rivet tightening systems, the vibration from 40 to 250 hertz are found to cause these adverse effects like damaging the nerves and the circulatory system under the intense vibration effects.

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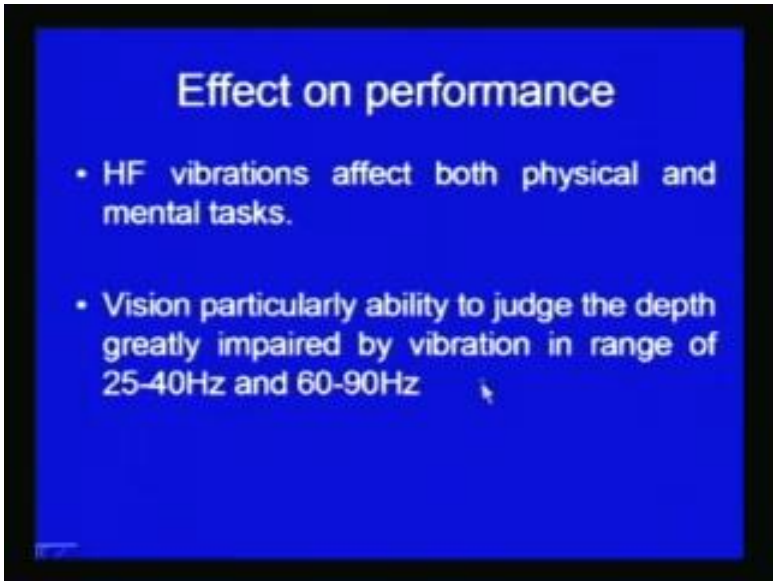

The high frequency vibrations affect both physical and mental tasks and it particularly reduces the ability to judge the depth especially when the vibrations are found in the range of 25 to 40 hertz and 60 to 90 hertz.

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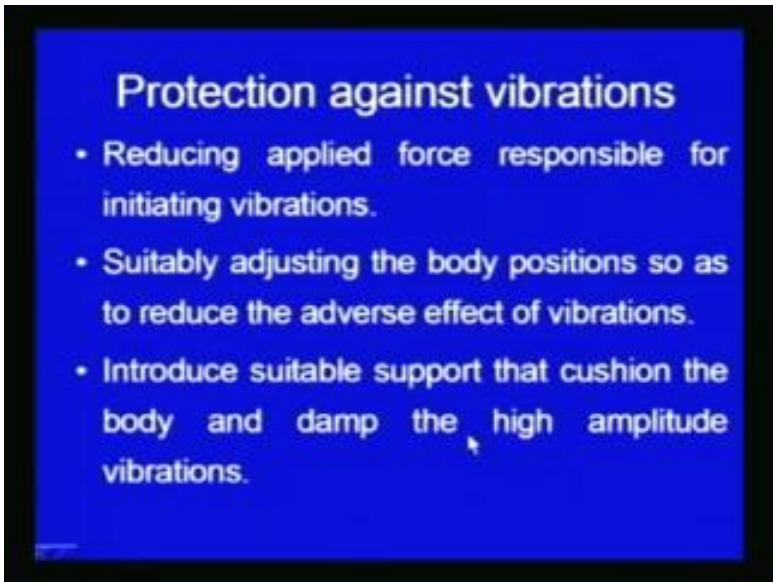

To protect the human body from the vibrations we can use various strategies like a reducing the applied force responsible for the initiating vibrations, suitably adjusting the body positions, so as to reduce the adverse effect of the vibration and introduce the suitable support that cushion the body and damp the high amplitude vibrations.

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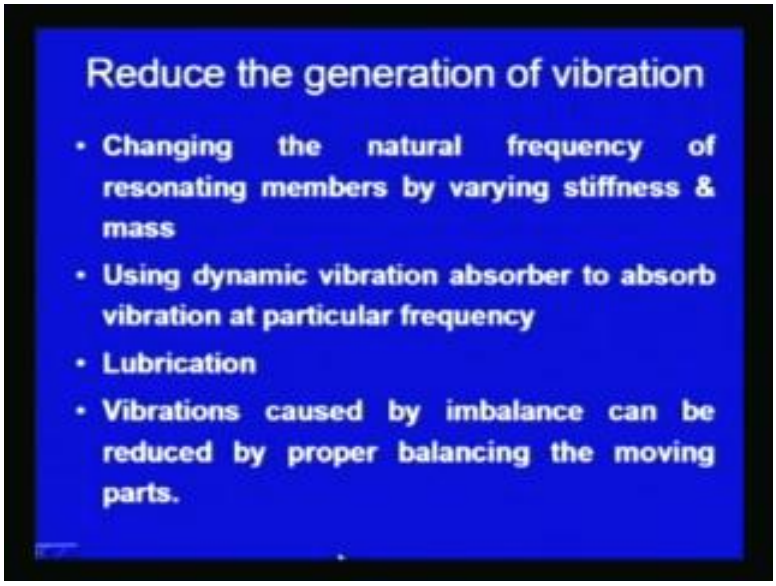

And, to control the generation of vibrations like change the natural frequency or resonating member by varying it is stiffness and mass using the dynamic vibration absorber to absorb the vibration at particular frequency and use a lubrication. So, that the

vibrations can be reduced and vibrations caused by imbalance can be reduced by proper balancing the moving part. So, now here I will conclude this presentation, this presentation I have mainly covered the importance of the quality visual environment and the affect of the vibrations on the human performance or the performance of the operator.

Thank you for your attention.