Human Factors Engineering
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Lecture - 35
Direct and Indirect Glare or Reflection, Illumination for Inspection and Quality Control Activities

The dear students and participants now I will be discussing the 5th lecture on the design of visual environment and in the context of measurement and evaluation of physical environment.

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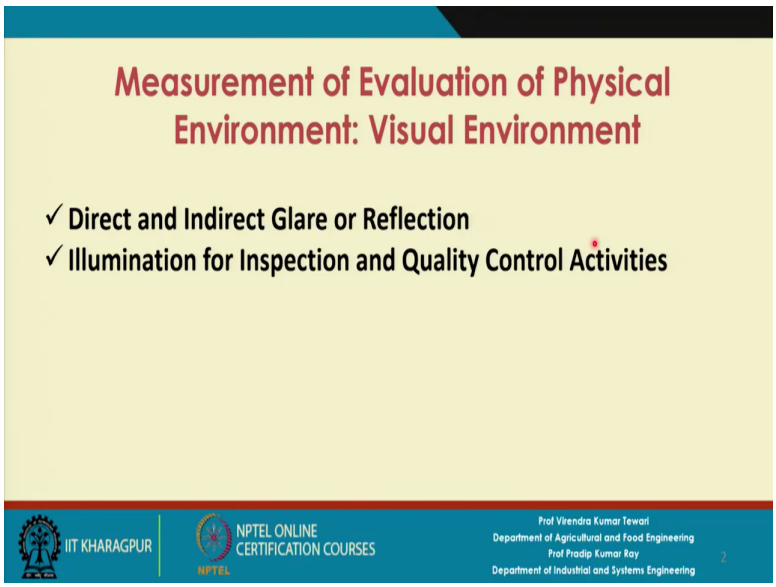

And because of this glare or reflection on the screen, your visibility is affected and there is every chance when you do some work on the computer that you make errors. The second important aspect is there are many kinds of jobs we do at work places.

And if the reflection or the glare occurs with respect to those jobs; obviously, the interaction quality will be very poor and hence the performance with respect to the job will be affected.

Now, the second important topic I am also going to discuss that is illumination for inspection and quality control activities.

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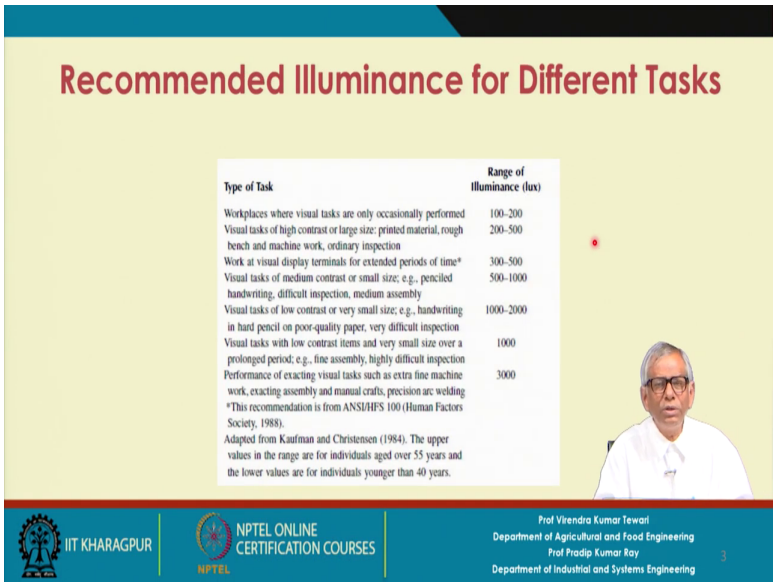

As we have been mentioning all the time that essentially when we talk about this physical environment design, visual environment design in almost all cases, we are referring to interface design. With respect to the design of the physical environment, we have highlighted the basic issues and then with respect to the design of visual environment at work places of different kinds.

Again, what are the design parameters that also we know like say the illumination level or luminance contrast or the contrast ratio, or the level of the glare, or the amount of the reflections, these are all the defining or determining the interface.

With respect to the certain important tasks that you carry out, what could be the recommended illumination level, or illuminance? As you may be knowing that if you use SI units for its measurement, illuminance is measured with respect to its lux.

If you work at work places where visual tasks are only occasionally performed, then 100 to 200 lux is recommended as far as the illuminance is concerned. If the visual task of high contrast or the large size like printed material, rub bench and machine work.

The table work that you find the at different workplaces. These are referred to as ordinary inspection. The illumination level is anywhere between 200 to 500 lux. These values are recommended.

Work at visual display terminals for the typical and the computer work for extended period of times. Like say data entry operator, or someone is working on the software development. So, for them we recommend that the illumination level should be 300 to 500 range.

Visual task of medium contrast or the small size like penciled handwriting. Difficult inspection medium assembly; then as the job becomes the difficult to do, you will find that the illumination level increases. 500 to 100 lux, any value in this range is recommended.

Similarly, one extreme you find that the performance of exacting visual task. These are very common at many workplaces. Extra fine machine work exacting assembly and manual crafts precision welding.

For this, illumination level could be as high as 3000 lux mainly when you are involved yourself in exacting jobs. Similarly, the visual task of low contrast of very small size 1000 to 2000 lux you recommend. The context is visual environment design.

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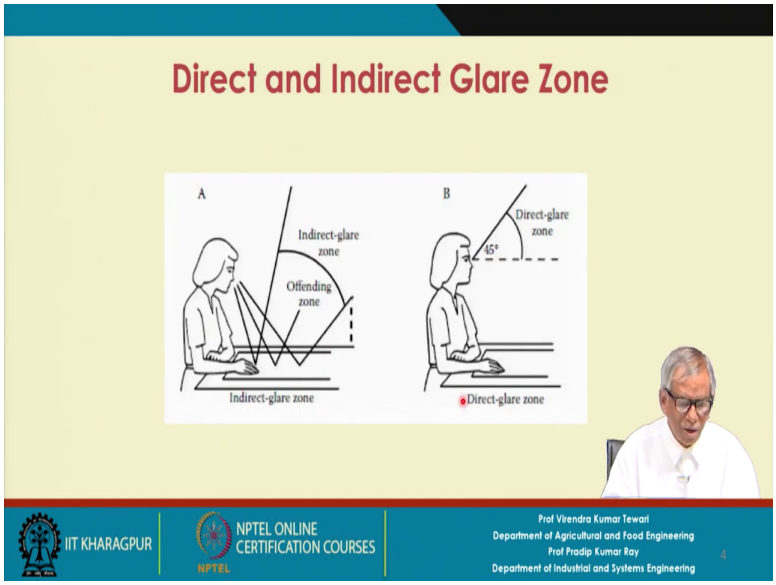

Why glare is a problem? The glare aspect already we have discussed. There could be direct glare there could be indirect glare on the visual screen and this problem needs to be solved. Like say in figure A the person concerned is having this indirect glare zone.

So, how to define this indirect glare zone? This is also referred to as offending zone. Whereas, if you refer to figure B you get the direct glare zone when the person is looking at the screen or looking at certain objects.

You have to mark first the direct glare zone like this is a 45° direct glare zone. The light is directly falling on your eye and the source is on behind and then on the screen or on the screen you look at the object and you will find that this is not directly falling, but indirect glare you notice or the reflection on the screen or on the object.

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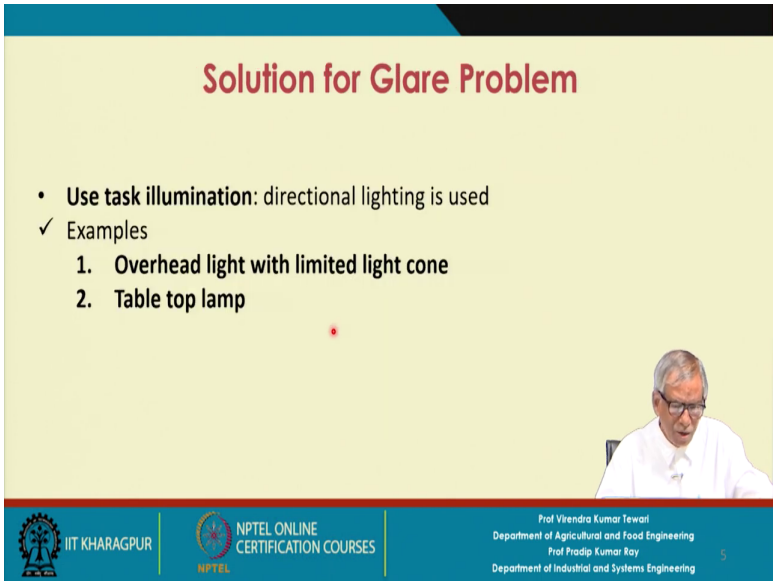

There could be many kinds of solutions depending on a particular situation you come across at a particular work place. You need to give a particular glare related problem you face at your workplace. You have to suggest solutions.

First thing, use task illumination and for task illumination say direct lighting you have to use the table top lamp and there will be no glare problem. Another solution could be overhead light with limited light cone. The limited light cone and this cone angle could be around 110° or this cone angle can be slightly reduced to 100°. You will get directional lighting and, in the process, you are basically illuminating your task or the work place.

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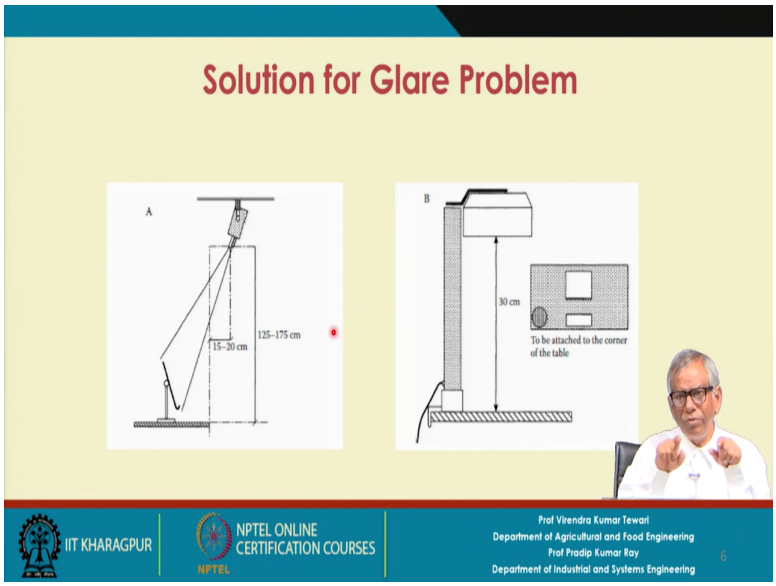

Where you are focusing? Looking at the object. The direct lighting you can control, like solution for the glare problem to be attached to the corner of the table, essentially the task is illuminated. And you use a particular light source with a particular cone angle. The directional lighting you get.

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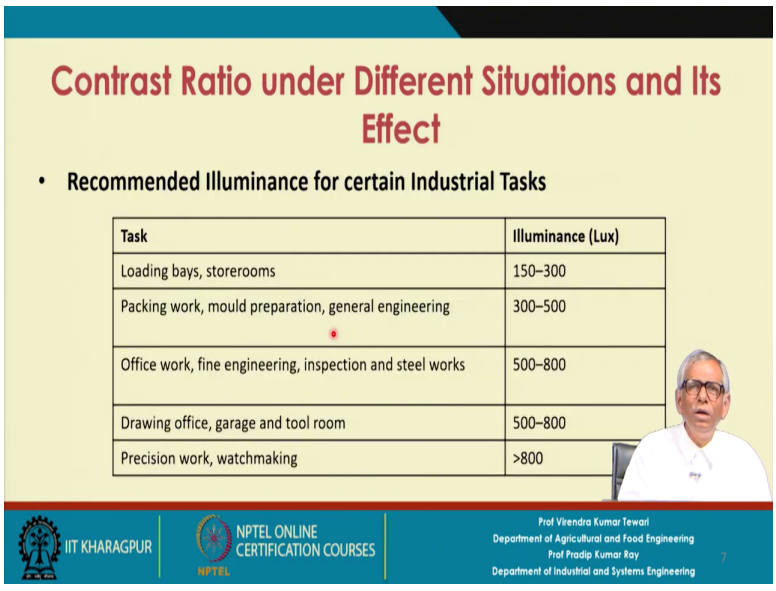

Now, I want to refer to certain values of the contrast ratio for a number of representative tasks or jobs.

We have already defined what is this contrast ratio between two adjacent surface A and surface B and. It is essentially luminance of A / luminance of B. There could be other measures of the contrast ratio.

Different task means different situations, different conditions. These are the typical industrial task; in an industrial work environment or work places you have to consider all these tasks. The first one is the loading bears the store rooms, 150 to 300 illumination level.

Packing work mould preparation, general engineering, 300 to 500 illumination level you have to ensure. You have to maintain these standards. Office work, fine engineering, inspection work like say inspection quality control related activities you carry out and the steel works you have 500 to 800 illumination level. You have to ensure drawing office like the typical draftsman, working at the drawing office.

Many a time you will find even the designers are also working the time. Garage and tool room like typical tool creep you have in a manufacturing workplace, 500 to 800 illumination level that we have to ensure. And the last one is the precision work- watch making-it should be at least 800 illumination level.

So, the task are categorized as per the illumination level. Each category of task is defined in terms of the illumination level.

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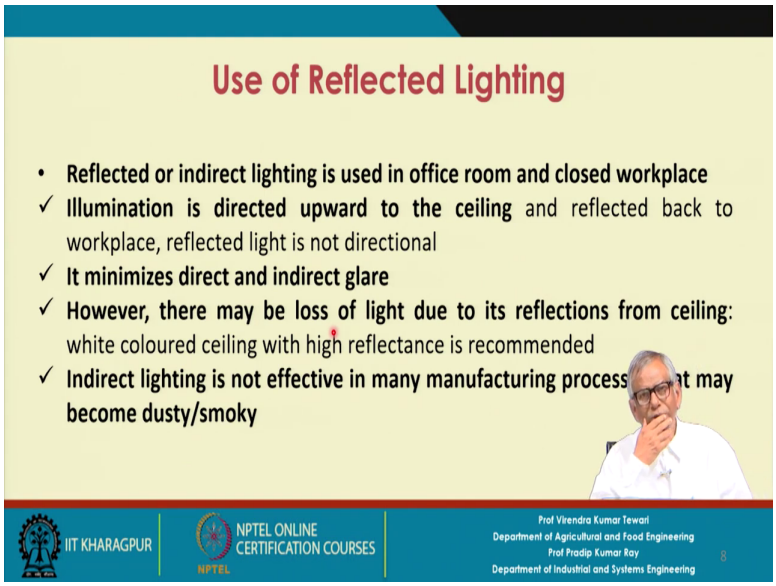

How to use this reflected lighting? The reflection you cannot avoid. Sometimes if it is unavoidable. Then you can use the reflected lighting in a number of ways.

The reflected or indirect lighting is used in office room and closed works space. The work space could be either open or a closed one. For both cases we will find that this indirect lighting or reflected lighting you may use. Illumination is directed upward to the ceiling and reflected back to the workplace. But the reflected light is not directional.

Here there will be reflection, but the reflected light, you will find in the white space not in a particular location or it may not be directional. It minimizes direct and indirect layer. What is the advantage? There will be hardly any glare. However, there may be loss of light due to its reflection. The reflected light we will have less illumination level.

White coloured ceiling with high reflectance is recommended, maybe the value of reflectance could be as 0.85 or 0.90. lighting is not effective in many manufacturing process. That may become dusty or smoky. In a smoky place or in dusty workplace, indirect lighting is never recommended.

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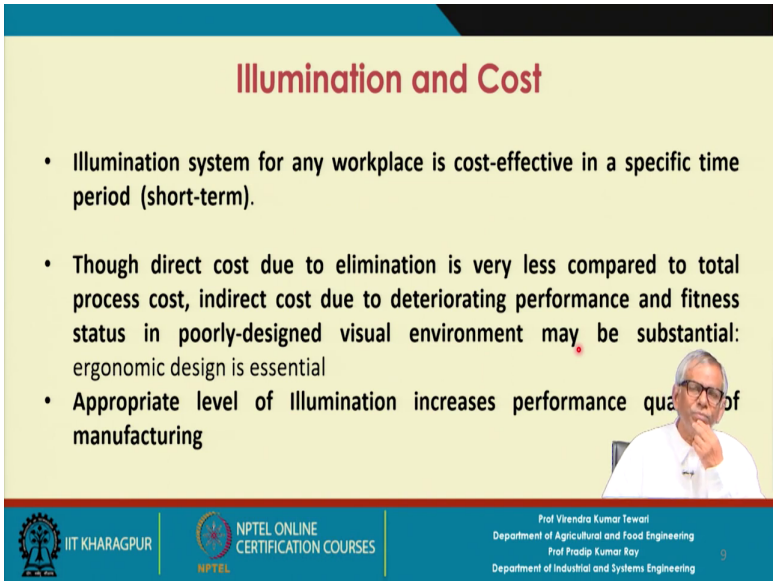

Illumination system for any workplace is cost-effective in a specific time period which is short-term. Though direct cost due to elimination is very less compared to total process cost, indirect cost due to deteriorating performance and fitness status in poorly-designed

visual environment may be substantial as ergonomic design is essential. Appropriate level of Illumination increases performance quality of manufacturing.

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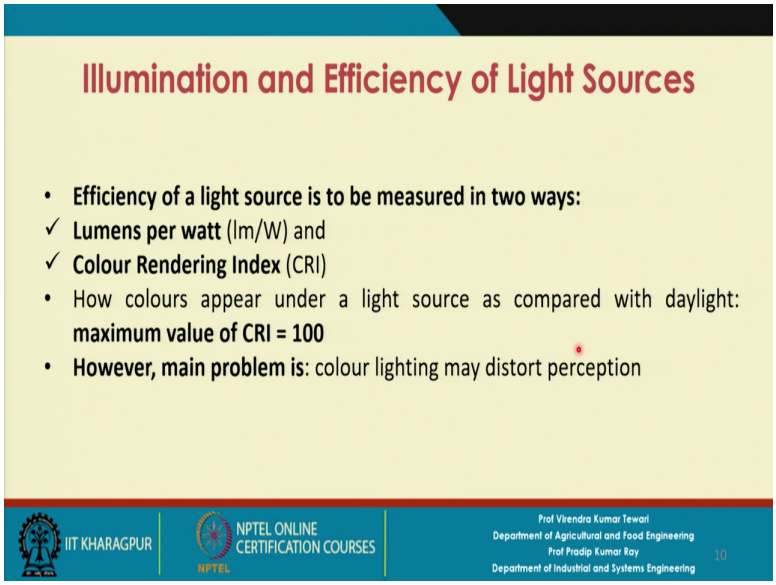

In a given situation to accept this hypothesis. You have to collect data and you have to prove that in a given situation, for the kinds of task dealing with, the kinds of illumination systems we have created, there is hardly any negative effect.

There is a positive effect as far as the human performance is concerned. Then you conclude the visual environment as designed is ergonomically acceptable. Efficiency of a light source is to be measured in two ways- one is the Lumens per watt and the second one is colour rendering index or CRI. How colours appear under a light source as compared with daylight. Day light is your standard. In the daylight, you look at one particular colour of an object when the light source you use.

If the place is illuminated artificially to what extent the same colour you can observe for the object. The maximum value of CRI is 10. However, main problem is colour lighting may distort perception.

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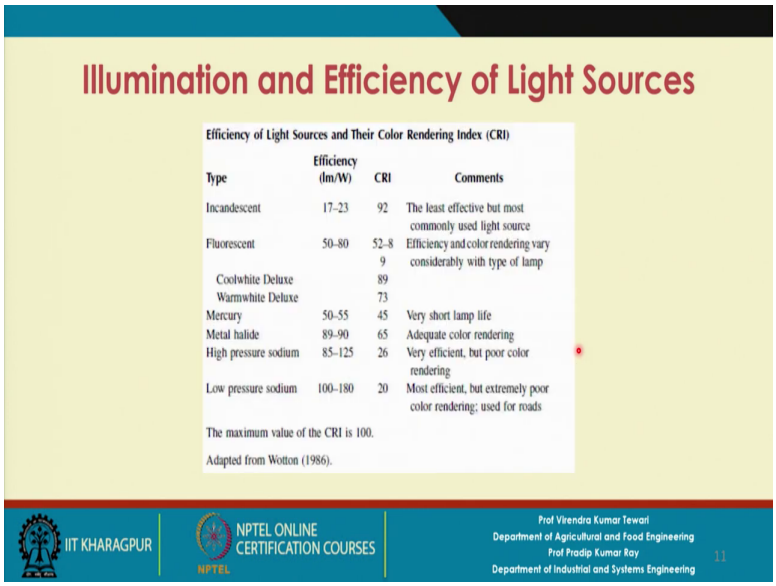

If there is a distortion; obviously, your ability to see the object perfectly will be affected. Here you can use different kinds of light sources. If you use incandescent light, the efficiency could be between 17 to 23 and the CRI value is 92. It is very high.

Whereas for the fluorescent the CRI value is between 52 to 58. Efficiency of colour rendering vary considerably with the type of lamp. It is between 50 to 89. There are other conditions, other types of the light sources like for the mercury the CRI value is just 45, metal halide it is 65, high pressure sodium 26.

The maximum value of the CRI is 100 with respect to your ability to see the colour a particular colour perfectly.

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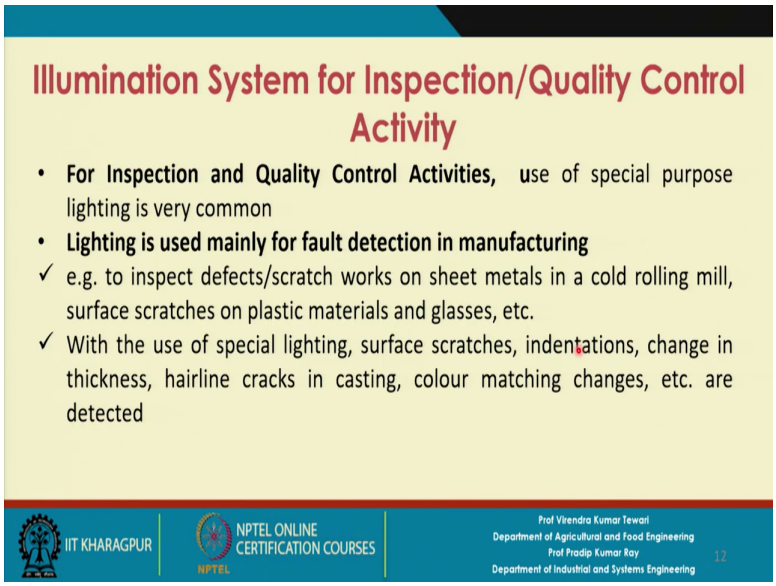

The illumination system for inspection and quality control activity are considered a special activity. Certain basic issues you should keep in mind because you have to design the visual environment. For inspection and quality control activities use of special purpose lighting is very common.

Lighting is used mainly for fault detection in manufacturing e.g., to inspect defects/scratch works on sheet metals in a cold rolling mill, surface scratches on plastic materials and glasses, etc.

With the use of special lighting, surface scratches, indentations, change in thickness, hairline cracks in casting, colour matching changes, etc. are detected.

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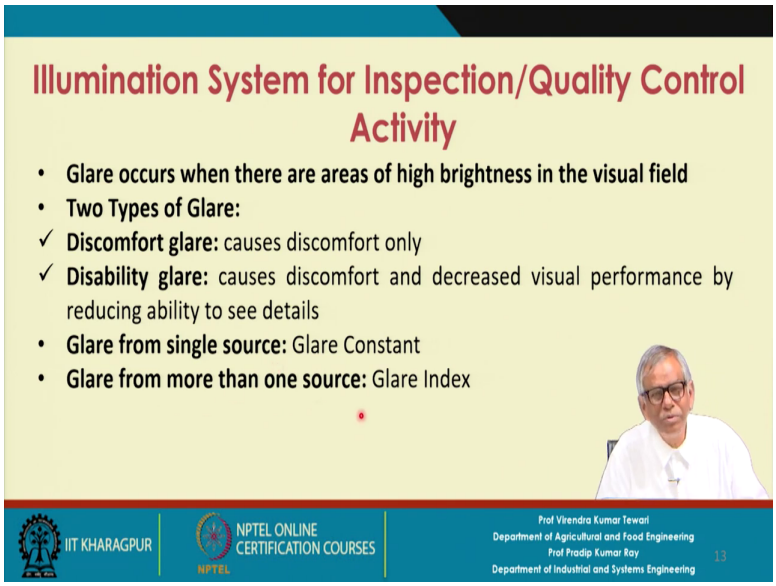

The glare occurs when there are areas of high brightness in the visual field. So, there are two types of the glare. One is the discomfort glare and the second one is the disability glare. Discomfort glare may cause discomfort only. Disability glare causes discomfort and decreased visual performance by reducing ability to see details. Glare from single source is Glare Constant. Glare from more than one source is Glare Index.

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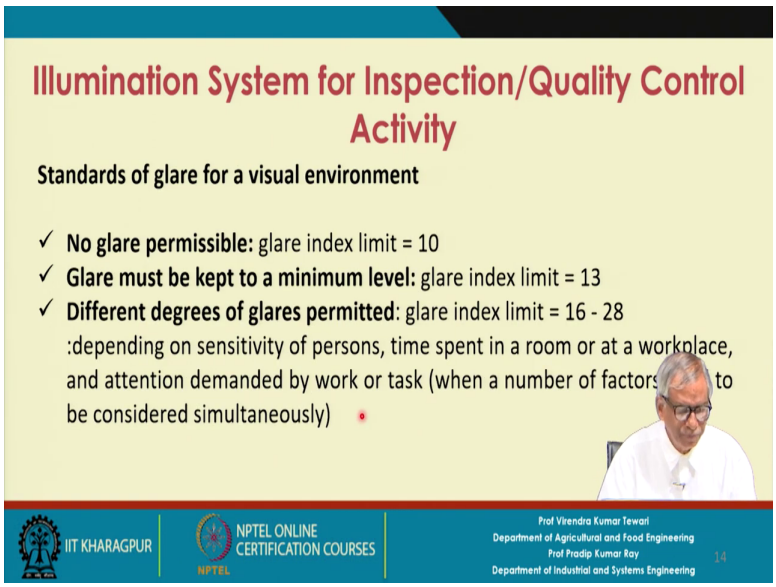

Now, there are certain standards of glare for a visual environment we have to comply with standards.

No glare permissible: glare index limit = 10

Glare must be kept to a minimum level: glare index limit = 13

Different degrees of glares permitted: glare index limit = 16 - 28

Depending on sensitivity of persons, time spent in a room or at a workplace, and attention demanded by work or task (when a number of factors need to be considered simultaneously).