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Lecture - 34
Measures of Contrast, Contrast ratio under Different Work Situations

So, now, you have already come to know that why do we need designing visual environment or illumination system at a work place.

Why do you need to consider illumination, illumination level or illuminance as well as the contrast ratio and what are the measures you may have to use for assessing the visibility of a person related to a particular job.

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Now we will be discussing measures of contrast, contrast ratio under different work situation.

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Now, we already know that there are three possible measures of the contrast, we must have thorough idea about that possible or the recommended values of illuminance as well as the contrast ratio for all these work situations, different work places, different kinds of jobs.

Only certain important the jobs we will select and against each job, we will specify or the contrast ratio values and the reason of selecting a particular contrast ratio.

From physical environment perspective and visual environment perspective Contrast ratio between large objects, a large value may cause discomfort glare. e.g. between window and adjacent wall, ratio is 100:1; glare may not be harmful to eye (oscillation of pupil), but annoying and discomforting.

Contrast ratio between task and large items/adjacent surroundings at a workstation should be less than 10:1, upto 3.1.

At office, ratio should not be more than 40:1.

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Photometer is a measuring instrument which you can use to measure illuminance, luminance and contrast ratio. Photometer is so designed as colour correction. Less sensitive to violet and red that you have to check; more sensitive to green and yellow, like violet and red you can avoid; that means, even if it is not properly say displayed, is it known. But it should be more sensitive to green and yellow. There is a typical photometer. You have these characteristics. Matching with human eye sensitivity to colours in colour spectrum.

Photometer has two settings: one for measuring illuminance and other for luminance

For illuminance measurement, one must consider light from a variety of sources, like luminaries, windows, wall reflections at different angles; light direction to be vertical and photometer should be cosine-corrected.

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For luminance measurement, photometer should have a narrow-angle (say 1 degree) attachment, allowing measurement of precise readings of adjacent areas with different reflections.

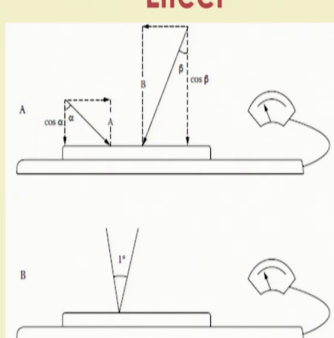For contrast ratio measurement, two luminance readings are collected and ratio is calculated.

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What are the ways you can measure the contrast ratio? Here is just one example- you just look at this figure. The direction of the light is mentioned for the surface A and the surface B. In the surface A, you measure the contrast ratio, one is for A. That is $cos\ \alpha$ and B, that is again another way you can do that.

The inclination and for luminance, obviously there is 1 degree angle. So, that you have to use; 1 degree for maintaining the precision.

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So, just you look at this the two figures and you get this idea that what is referred to as the cosine correction. So, the vertical direction the light should fall and you measure that the illumination; So, these are the standard practices you do and photometer is used. Now, the contrast ratio measurement for characters on computer screen is another situation. So, as I have told you that we will look at the different conditions and understand how to measure the contrast ratio.

Contrast ratio measurement for characters on computer screen is difficult to measure, characters are represented by a rectangular array of dots, called pixels: a special kind of photometer with micro-image slit is needed to measure luminance of a pixel: (ANSI/HFS 100 standards)

General conclusion: Illuminance level be within 1,000 lux.

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Next one is what we conclude we always say that this the illuminance the level as well as the contrast ratio, these two factors determine the visibility and visibility is also directly or indirectly determining the performance of a person with respect to a particular job. So, when you say that the performance, what could be the performance related the measures. one such measure is obviously the task completion time.

So, if you find that the task completion time is increasing for the same job given a particular person. You may conclude that yes, the environment may be responsible. You focus on that and more specifically, when you study the visual environment design from the ergonomics point of view, you will conclude visual environment or the illumination system, the current or the existing illumination system may be responsible. For this dilemma, you first check that whether the task completion time is dependent on the illumination level or not.

So, you have to collect data and the illumination level under the different conditions and the person will be the asked to carry out the same job under different illumination level. So, you will get the data and then, you check to what extent the illumination level affecting the task completion time or the work time for a particular job. So, the different types of tasks are designed in terms of required illumination level, like in the previous case, so the computer screen, someone is working. So, they say that illumination level should be within 1000 lux.

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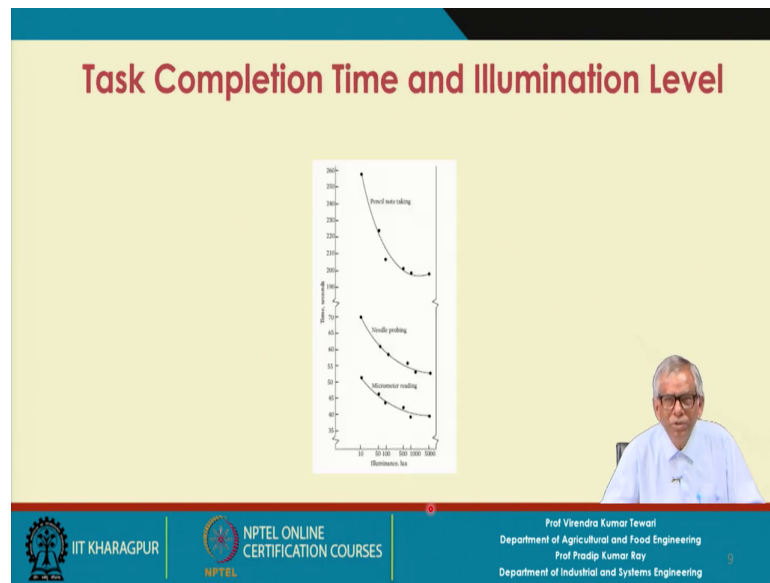
Now, we look at this particular figure. Here, y axis is showing the task completion time and x axis is the illumination level in lux. It may be 10, it may be 5000.

There are three specific jobs we have mentioned. Few data points like say 1, 2, 3, 4, 5, 6. So, 6 data they have collected - One at 10 illumination level and the other extreme is the 5000 lux level; The two extremes and in between there are intermediate levels. Similarly, the next job is obviously, the time, it takes more time; overall; whether it is at 5000 lux or at 10 lux.

We will find that the task completion time is more; whereas, if it is needle probing, then the task completion time is substantially reduced. But again, this task completion time is dependent on the illumination level. If it is a microscope, micrometre reading, the task completion time is very less. But, this work is also affected by illumination level.

Usually, there is an indirect relationship; decrease in task time is directly proportional to increase in the illumination level. So, one is decreasing, another one is increasing. Obviously, the task completion time should be as minimum as possible.

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In that case, the work rate will be more. So, it is basically related to the work rate; task completion time, illumination under different situation and its effect.

How to design under direct and indirect glare or reflections?

So, there could be glare or there could be reflections on the screen; There could be direct glare, the light coming from the light source directly falling on the screen; whereas, the reflected or indirect glare also could be there.

In some locations there is no direct light sources and are at behind the screen; but there could be reflections that you can notice within the screen. Right now, there is on this particular screen, I do not find any the direct glare or indirect glare.
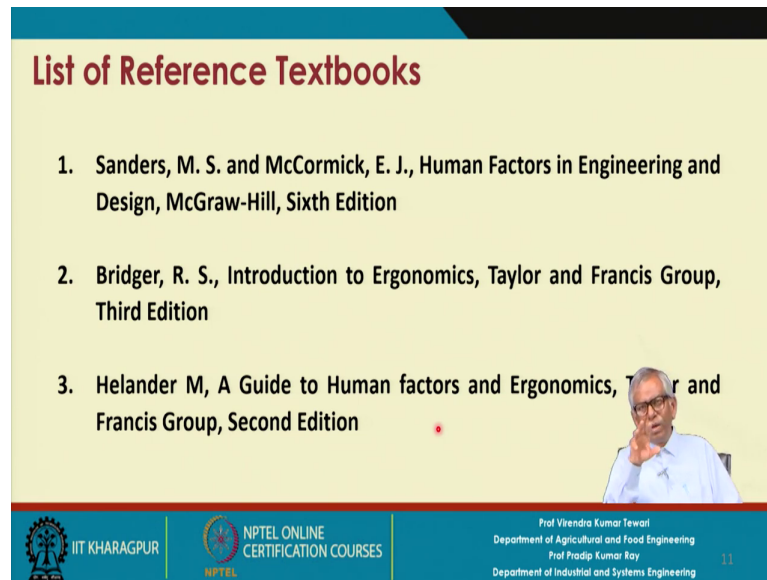
Because this is a recording studio; obviously, it is to properly designed. So, here, the visual environment is most appropriately designed and I do not know find any problem. My visibility is perfect and obviously, so there is the comfort and convenience.

So, how to design under direct and indirect glare or reflections. These types of glares are very common in workplaces; one is the direct layer, which is directly into operator's eyes.

So, there will be direct glare is it on the screens operator's eyes.

Indirect glare: From light reflected at work place from plastic and glass cover is also possible and the shiny metal, key caps on keyboard etc. So, there could be reflections, and it might affect your performance. So, direct glare as well as the indirect glare.

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So, different work places may have the different contrast ratio. Now, whenever you say that the contrast ratio is to be measured; That means, your main purpose is how to improve the visibility and why you are bothering about visibility because if the level of visibility is acceptable, that means, to the person concerned and what we are assuming that he or she will say that the visibility is acceptable, only when he is he or she is feeling comfortable and not making any errors.

So, that is the basic understanding and also his or her the performance is assured; that means, with respect to the job, with respect to the illumination level, illumination level is directly related to the visibility and the way you have prescribed the illumination level for the job, the task completion time is minimum.

But make sure that what are the other factors might affect along with the illumination level. Supposing illumination level, say 1000 lux, you cannot control and when you look at that with 1000 lux, see the task time could be 30 minutes and with 500 lux, the task time could be one factor at a time. If you do experiment that it is 30 minutes and it is reduced to 20 minutes.

Now, the question is that will you go for only the reducing the illumination level? No. You try to find out another the critical factor. What is the critical factor in this case? One is obviously, the contrast ratio. So, along with the illumination level, you try to change the contrast ratio and for which combination of illumination level and contrast ratio, you get the best possible performance. But then again this is at the second level.

Now, it may so happen that with all these combinations, whatever may be the combinations with respect to these two factors illumination level and the contrast ratio, you get the same performance. There is no improvement.

Third factor could be the glare or the either direct glare or the indirect glare; So, first you consider the direct glare. So, if the direct glare is not there, is it then whether there is an improvement in the performance. You may find that yes, there is no improvement in the performance; then you just verify whether there is indirect glare or not.

Then, how to control the indirect glare? You are considering the fourth factor and obviously, there could be different combinations. So, for against each combination, we try and you find that one particular combination indirect glare along with illumination level, along with the direct glare, along with your the contrast ratio, you get the best possible performance.

So, several factors you come across you and the main purpose is, suppose the task completion time and one after another, you consider all these factors and ultimately, you have to suggest is it the combination of factors or the combination of factors and their levels. So, such experiments they carry out and the state is that each work situation is a unique one and the special conditions you must be able to identify as a researcher, as an investigator and there you apply these rules.

So, once the system is created for creating an ideal visual environment, the set of norms you can apply to any work places; So, there is always a scope for research and there are many other situations will come across; particularly, inspection and quality control related activities.