B.ARCHITECTURE

BUILDING SERVICES -2

ILLUMINATION AND LIGHTING (AR6511)

LECTURE 4

Methods of Mounting Lamps:

So there are **various methods of mounting lamps, mounting in** the sense fixing the lights. So based on the way you fix the light, you give names for the lamps. It is called **ceiling dome**. Under ceiling dome you have **open ceiling dome and enclosed ceiling dome**. Then you have **recessed light, surface mounted light**. Under surface mounted light you have various features like **pendant light, scone, track lighting, under cabinet light, emergency lighting or exit lighting, high and low bay lighting, strip** lighting **and soffit.**

Now coming to the methods we will see each one in detail. This is a **ceiling dome.** In this picture, this is the light fixed to the ceiling and it has a cover on top of it. That is what we call it as dome. The light source is hidden behind a translucent dome. Translucent is light will pass through it .this will be made typically of glass, along with something of fibre also. So it will either be clear or frosted, depending on the type of lighting. Now this is another type of ceiling dome. This can be flush mount. Flush mount means in line with the ceiling or it can be pushed down. That is one way of doing this.

Then you have **recessed lighting**: - Recessed lighting is if you see here, there will be a protective housing on this. If this is going to be your room, this is particularly called cove fixture because you take it inside and the light defuses to the ceiling and then it is reflected here. So this is what we call it as recessed lighting. The protective housing will be behind the ceiling or wall. So only the fixture will be exposed. The ceiling-mounted version, this type of light is called as down light as it comes down. Cans, cove light, troffers come under this category.

Then you have **surfaced- mounted light**. Surfaced- mounted light, the covering the housing is not flushed or it is not covered. So you see pendant is just like it hangs down from the ceiling. So this is a kind of indirect pendant where the light reflects to the ceiling and then comes down. This is both ways, direct and indirect, partly it comes down and partly it goes to the ceiling and then comes down. So this is a kind of surface mounted pendant light.

And **the scone**: - Scone are you're like wall mounting. It covers up and down lighting, it has 2 directions the light can come to the scone. This is visually used to illuminate any art work, any architectural details for that you will use this, particularly in hallways and if in a place you want overhead lighting you can replace that with the scones.

Then **track lighting**: - Track lighting is where track heads will be there, a railing like this will be there. And lights like this will be fixed from here and wirings will run through the pipes. You can position anywhere, the light can be positioned anywhere along the track, because the track is powering the electric power. You can shift this also.

Now next is **under cabinet lighting**: - As the name says this will be under the cabinet. So if this is going to be a cabinet, and below that the light will be fixed and down lighting will be provided here. Generally under cabinet is like provided in work spaces or in kitchen units generally use this under cabinet lighting.

Then comes your **emergency lighting or exit sign: -** So emergency lighting generally it will not have electric power. This will always have a battery backup. So that in case of emergency you can only see these lights because it has battery backup. Even if the main power fails, this will guide you to the exit.

Then you have **high and bay lighting**: - This is like in warehouses or industrial buildings you will have these kinds of lighting, everything is exposed. This is like half way pendant, where it is not completely hanging from the ceiling but fixed to the ceiling. These lights will always be fixed in a bay like in rows.

Similar to that you have something called **strip lighting**: - These will be like long strips continuously for the area the light will continue. If you see this picture you can see a fluorescent light, you have various colours in it. All

through the ceiling the light will be continuous in a strip form. That is why you call it strip lighting.

Then you have **soffit: -** Usually we use it for decorative walls, to decorate the walls. If you have a textured wall to highlight the texture you use soffit. Soffit is the underneath part of the roof. The light will be placed there so it is called soffit light. It will give a very dramatic effect for the building.

Luminaries Classification:

Now coming to the **luminaries classification**: - Luminaries are nothing but light fixtures. The housing component, the filament. The bulb, and everything put together we call it luminaries. It is classified **based on the function of the light, the type of the lamp, the installation method and the percentage of light output, whether the light is coming above or below**. In this the lamp type and installation method we have already seen. The lamp type is what we saw in the last lecture – incandescent light and the electric discharge lights also. Installation method we just saw how it is fixed, how we fix the lights. Now we look into these two things- the light function and the percentage of light output.

Based on the function there is **ambient or general lighting**, **task lighting, accent lighting, informational lighting or guidance lighting and decorative lighting.**

Ambient lighting: - the general lighting that we provide for any place like work place or residential area. It will illuminate the overall place .it will give a very comfortable brightness. There will not be any glare and you can walk and see things there safely. Generally here you use a pendant and you see a thing hanging from the ceiling. So mostly you will be using a pendant type fixture and down lights, chandeliers, and ceiling on the fixtures will be used for this.

Now coming to **task lighting**: - It is a directional lighting. The light will be directed to one particular point. So it is aimed at a specific task. Your table lamps will be a good example for task lighting. So only specifically to this area you will have only light. And particularly in large workshops where they are doing critical work and very detail work, you will be using task lighting. It is focused only on a task. Now this can be provided with either recessed or track lighting will be used for this. Pendant or under cabinet lighting also in work spaces where there is cabinet on top, the task lighting will be provided below the cabinet. Portable desk and floor lamps can be used for task lighting. The main thing because it is going to be very close to the working surface, you should be careful that there should not be any glare, distracting glare or shadows should not form. It should be bright enough there should not be any eye strain.

Then comes your **accent lighting**: - Accent means that you should accentuate or give an extra feeling to it. So again this is also directional lighting because it focuses only on one point and it adds drama to a place, that means it gives interesting ambience to a place and it creates visual interest also. So this is like textured wall that you want to highlight or if you have any wall hangings or some art works that has to be highlighted, you provide accent lighting to that. Now this accent lighting if you really want to make it effective, you should make sure that the light is at least 3 times more than the general lighting present in that area. Then only the focus will be more. Otherwise it will not give that accent feeling. And this is usually provided by recessed and track lighting. Now this is a track lighting and wall mounted picture lights will be a part of this.

Now **informational lighting**: - This we also call guidance lighting because it is to see in case of emergency or if you going to a new place these lights are going to guide you through the place. So you will be taken to the place safely. Usually this is used in your emergency lighting. This is functional and creates a dramatic statement. Like how it can create is if there is going to be a flight of stairs, you can set these kinds of lights underneath the stairs that will enhance the pathway, it will guide you, and this is the path that you will have to take for this staircase. So that you can enhance the aesthetic value using informational lighting.

Now then comes your **decorative lighting**. Decorative lighting is like the fixtures will attract the attention towards the fixture itself. Large strips can

be used, pendants, chandeliers, all these things come under the decorative lighting. In many places we also use the decorative lighting for general lighting also.

Now according to the **percentage of light output** now we are going to see the classification one is a direct lighting, semi- direct, general diffuse lighting, semi-indirect and in direct lighting. So what happens is direct lighting means when luminaries direct the light 90 to 100% of their output downward. So if you see this light is on the ceiling, you can see the light is fully downward you don't see any light on the ceiling. So this is direct lighting the light is coming directly from the source. So this distribution will vary depending on the concentration of the light, reflective material that is inside because without the reflective material you cannot have downward lighting then finish come to the texture of the place. The troffers and down lighting will come under direct lighting. Reflected glares and shadows will be a problem in this because it is directed towards only one direction so more focus will be there unless closed spacing is not there you will have more of a glare and shadow problem in this type of lighting.

In a **semi direct lighting**, you see here the distribution is predominantly downward but there is also some upward lighting like 60 % - 90% is downward lighting the rest is upward so this upward cooperate will illuminate the ceiling. So in the previous one we saw the ceiling was dark but when you have the semi direct lighting a part of the light will illuminate the ceiling also. So when you use it close to ceiling mount if you are going to use a very close to ceiling mount and it's going to be a semi direct lighting then you should make sure that the ceiling is not becoming very bright.

In general **diffuse lighting** this will be like both the sides will have light like upward and the downward you see the occur of light is equal. So it is like 40 % - 60% of the total luminaire output. This will have both the characters of direct lighting and indirect lighting. Like it also has negative points like shadows and glare will be there and positive effects like the ceilings are also illuminated.

In **semi indirect lighting**, you see here this is a direct light, but most of the light is focused on the ceiling only a part comes down. This is the reverse of the indirect lighting. So 60 to 90% of the output is upward. So the downward component will be giving you a luminance. So that will be more or less similar to whatever is reflected from your ceiling.

Then you have **indirect lighting**: - Here 90 to 100% will be focused on top. Here you see all the lighting is focused on top not much will be coming here. So if you really plan it well this will be the primary source for the entire space because you will not have any shadows at all, because everything is focused upwards. So light is not going to fall on any object to create shadows. So it is a very effective lighting if properly designed.

Lighting Control:

We saw all the different types of lights now there is something called **lighting control**. We have to control these lighting. You cannot have complete direct lighting every time. So what are the lighting controls, generally lighting controls traditionally it was used to create moods, to have different type of ambience. Now they are also used as part of high quality energy efficient lighting system. Now we are all about energy efficiency and all those things. So this lighting control will go way ahead to save energy. So it integrates daylight and electric light sources to provide a comfortable and visually interesting environment. So your control system will integrate your day lighting and your electric light source together and it will modify the light and will give you the required light automatically.

So why do we use these light controls? - To achieve a high quality energy efficient system, to give the occupants the control of lighting. You need to give the control to the occupants, provide appropriate lighting, to minimize the glare and you have to balance the surface brightness and enhancing the surrounding architecture. So you tune an environment for the individual occupants or if it is going to be a group's visibility. When you do that the productivity increases and the work whatever they do will be better. They are also used to save energy. When you save energy you also extend the life of the lamp and ballasts, reduce the amount of power used during the peak demand. Peak demand in the sense when everybody is going to use the power at the same time, this is what we call peak demand. So the power that is going to be use during that time can be reduced if you have control. Reduce the number of hours per year if the lights are on. If you have control you can switch it on or off whenever required. You can reduce the internal heat gain. So part of the heat generated inside a room or any space

is from these lights. So that also can be controlled. Lighting control also provides flexibility in multi-use rooms we will have this because the conference room is big and the entire room will not be full any time. So depending on the number of people using the room you can alter the lights. Turn lights on with the help of exterior motion detectors and interior occupancy sensors. When you say lighting control it is automated now-a-days. So when you have an exterior motion detecting sensors lights, it will automatically turn on the lights and switch it off when the person leaves. That is one of the advantages of having lighting control.

Now when you take **up lighting control** you have the standard on or off switches or relays, the occupancy sensors, daylight sensors or clock switches, manual and automatic dimming devices and centralized control are also there. The standard on and off switches is what we usually have to switch on and off. This can be used to turn groups of lights on and off together. If it is going to be an office you don't have to have one switch for every light it can be grouped together and used. Creative design options can be developed with this simple tool. You can make a creative out of it. Some lamps in each fixture like grouping you can make it interesting. Like each fixture can be fixed together or can be fixed as a group. The lighting near the window can be turned off in the day time because day light will be more. You can design it and have the circuit arranged like that.

Occupancy Censors: Occupancy censors basically does three functions it automatically turns on when a room is occupied. It keeps the light on without interruption till the person is there whoever is using the room and then it turns off the light if you have preset time it turns off the light automatically or when the person is vacated. Based on the various characteristic we have yNR various types of occupancy censors a few of the things will be passive infra-red censors so the lights will have the censors these censors will detect the motion of the people who are coming in. These are triggered by the heat emitting body through their field of view. So when there is a heat emitting body coming inside it will detect that ok that a human person has entered so the light will switch on. Otherwise you have ultrasonic censors so this will emitted an in audible sound pattern as we saw like light we cannot see all the waves that is present around us even sounds we cannot hear all the sounds that is around us. So these ultrasonic centres give an inaudible sound pattern. So when there is a moving object that

pattern will be disturbed and that will pick up the signal and it will switch on the light.

Now in this you have **daylight sensors** particularly if you see that is also called photo sensors. This is used to turn lights on or off automatically, depending on the day light available. So when you set the day light illumination or lumens value, it will switch on and off based on that level. So that is again automatic. So the daylight dimming can maintain the desired light level while providing a smooth and barely noticeable transition to and from an electric. When you are setting the daylight thing it has to be transferred to where there is not enough daylight. So that transmission will be even better, when you give daylight dimming option also along with your daylight sensors. So the dimming option will be like a gradual change from you know whatever daylight is there to when the electric lights come on there will be a gradual change.

Clock Switches: - This is like you can set a period of time. So you know that the people are going to work from 9 to 5, you can set the time from 9 to 5 and then the light will switch on automatically at 9 and switch off at 5. This is specially used for turning off photo cell activated exterior serial lighting. That is your solar lighting which we have in exterior areas we generally have this that we can switch it on, after the day light is gone we know that it generally goes say 5:30 or 6 you can switch it on and in the morning around that 5:30 or 6 you can switch it off. So you do not need any manual people to go and switch it on the exterior lighting it will be done automatically, for that you can use these clock switches.

Then **manual dimming**: - Manual dimming will be like there is more control for the occupant or the person who is using the light. So he can reduce the amount of light that is coming for his work depending on his usage. So it provides the flexibility it instantly changes the characteristics. So if you say they put everything automatic, there is everything pre-set. The user does not have any control over it. It is going to be manual thing, it has the flexibility to instantly change and gives a very comfortable degree of control over the environment.

Even in **dimming y**ou have a **remote control**. This is like another form of manual. You don't have to bring it to the light and do it. You can use it as a remote as you use a remote for your TV. Wherever you are you can use the remote and you can have the features from it. So we have to use infra-red

and radio frequency technology similar to your television remotes. And then when you say remote control, you can have a multi zone control, if it is a huge 0ffice zone area you can have a zone depending on the zones control can be done using the remote.

Now **centralized controls** are, this is used again to automatically turn on or off. This is particularly under certain load conditions. Centralized controls will be like for huge offices, shopping areas they will use centralized controls particularly they say conference room or a building wide scale. So if we want to have a control in that scale, you can have a centralized control. They also integrate lighting controls with other building system, mechanical system and security systems. These centralized controls will be integrated in the sense along with the building security system it will be integrated. Maybe if there is any fire or something or the electricity when it gets cut off like these light will also go off. That kind of an arrangement can be made when you have a centralized control.

Lumen Method of Lighting:

Now when you see all these things we have so many types of lights available, lamps available, so many factors must be considered before selecting a light for a particular task.

Now **how do you calculate what kind of light**, or kind of light depends on the task and what number of lights do you have to use in a particular area or room?:- So for that you have many calculations, but a very well-known tried and tested calculation is lumen method of lighting design. So here the lumen method will be used to determine the number of lamps that should be installed for a given area or room. This is a very common technique used in lighting design and the light fittings for this, whatever we calculate will be mounted only overhead and will be in a regular pattern. So that is one limitation that we have here.

Then coming to this **type of lumen method**, we should know certain details. You should know the luminous flux output. What is the lumens of each lamp that you are planning to use in the room? As well as the details of the luminaries and the room surfaces. Because the surface is going to reflect

the light and that is what we are seeing it. What type of surface is there and what will be the reflecting ability of the surface? And all those details have to be gathered first. Usually the illuminance is already specified. So we know when we say this particular task if it is going to be office, you need so much of illuminance. For office it would be 500 lux, for kitchen you need 300 lux, so that is already there like a standard or a thumb rule you can say. So the designer chooses suitable luminaries to fix that purpose and then they will find out how many you require. So this is a formula you have to determine the number of lamps. So $E=n\times N\times F\times UF\times LLF$ by A. the explanation is E is the illuminance level required. What illuminance level is required is already given here. N is the number of lamps in each luminaire. We are talking about one single lamp, a number of lamps together can form a luminaire like a chandelier. Too many lamps you can see in one chandelier. So the number of lamps in each luminaire and N will be the number of luminaire. So if you have 5 lamps in one luminaire, how many luminaries like that will you are going to have? Area at working plane height, If the desk light is going to be at working plane height, what is the area that will be covered at that particular height. Then F will be the average luminous flux from each lamp. So each lamp has its own flux level, that average can actually be taken. Then you have utilization factor and light loss factor.

We will see this in detail, how you actually go about it. **So first what we do is divide the entire room into 3 parts. One is floor cavity, room cavity and ceiling cavity**. H is going to be your total height, the distance from the ceiling to the luminaire that will be your ceiling cavity height. The height from the luminaire to the working plane that will be your room cavity height, and then from your working space to the floor, is the floor cavity height. You need to know these details first. This will be your first step divide the room into layers and cavities.

Second step is to determine the cavity ratios by formulas. Each cavity whatever we divided it has its own formula. Like RCR is your room cavity ratio. Room cavity ratio is $5\times HRC$. H is the height between the R and C. Here you see the HRC and you have formulas for all the 3 cavity ratios and you calculate this and you arrive at CR.

Now this CR**, this is the effective ceiling and floor cavity reflectance we have to find.** For this you already have a table formed by Illuminating Engineering Society of North America. They have all the values for that

particular cavity ratio, what will be the reflectance value. That we can take it from the table.

Then **fourth is <u>to select the CU from fixture's manufacturer's data</u>.** CU is the co-efficient of utilization. Whatever fixture you are going to use, the manufacturer would have given the CU for this particular lamp. Now you take that CU also and put all these together, first you have to find F. F is E×A/ (CU×LLF). This light loss factor LLF is the final thing that you have to find. It is the depreciation factor, we saw what the depreciation factor is. That is the loss that you have from the luminaire when it was new and after sometime. That is LLD×LDD where LLD is lamp lumen depreciation and LDD is luminaire dirt depreciation. Because of the collection of dirt there will be depreciation and the lumen will drop after continuous usage. That also has to be factored into the calculation. So this is how you calculate and find out. So you have all the details now, you have found of F, UF,LLF, you know the area, n and E. so with all these things you can find out what is the number of lamps either this n or this N. this is how you calculate the design or find out the number of lamps needed.

Now when you do all these things, another thing that you have to have in mind is **<u>room reflectance.</u>** This is generally expressed in percentage. So if you see this picture, you see whatever light is coming, it will be reflected by the objects and whatever surface it comes into contact with. So when it is reflected only 80% is reflected and 10% will be scattered or absorbed by the object and 10 % of the light will be transmitted. So this is the phenomenon behind room reflectance, the difference between absorbed or transmitted by the surface that is what we call reflectance. So this is again the CU the co-efficient utilization values you have this. Every surface will have its own reflectors. If you take the floor cavity reflectors it will be between 0.2 to 0.3. If it is going to be a table, the task illuminance will be 0.1. So for each and everything it is already done based on the material. So with this room reflectance value we take it into account and then we calculate the co-efficient of utilization values and then you find the number of luminaries required.