Course Name: Architectural Approaches to Decarbonization of Buildings

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Lecture 2

Daylighting- Case studies 1

Hello students. So, in our last class we saw the basics of day lighting and we also saw how use of efficient day lighting can be, incorporated into buildings And by incorporating daylight into buildings, we can reduce the load on electricity that is required to use for artificial daylighting. Thereby reducing the operational energy and therefore reducing the operational emissions. Today we will look at some of the case studies in India. where the intent of design itself was to provide efficient day lighting. So, the first case study that we will look at is the Indra Pariyavan Bhavan in New Delhi.

So, the Indra Pariyavan Bhavan is a 5 star rated Griha Green building. It is located in New Delhi. It has been designed to be a net zero building and is considered a perfect example when it comes to looking at the latest and green technologies. Almost two thirds that is 75% of the building and its floor space is lit with natural lighting.

This reduces the dependence on artificial sources of lighting and therefore, this building becomes a net zero building. The inner courtyard of this building serves like a light well. So, this inner courtyard serves like a light well. And this courtyard is provided with a skylight. That skylight is shaded and it becomes like an interaction space.

The ground floor plan has different common as well as public facilities which are all right with limited natural light. For example, there is an auditorium. Anyways, inside the auditorium natural light is not preferred for all the events. So, there are events and the blue ones are the service areas. So, the pressure of wanting to have natural light is limited.

you can see that all these yellow spaces are circulation spaces. And therefore, these circulation spaces do not require task lighting as one would require in say office spaces. Also, the recreation areas are located on the ground floor. which is the exhibition hall. No, these are the ones shaded in blue are the recreational areas and even here there is no need for task lighting because there are not important tasks which are related to natural

daylight happening there.

The most important function where natural lighting is important is the office space here. So, the office spaces here require natural lighting and by and large they get natural lighting from the outside area. The ground floor is designed to be in such a way that dependence on natural lighting is very limited. Also, they have energy efficient lights provided in the interior as well as exterior lighting system of the building. And to maximize energy efficiency in lighting, the artificial lighting in the building is regulated by having a lux level sensor.

The lighting power density is kept close to 5 watts per meter square, which is 50% more efficient than the ECBC requirement on light power density. So, now we know light power density is 11 watts per meter square. The lighting load whatever is required is supplied with the help of photovoltaic cells through a power plant. This is the higher level and at the higher level you can see that there are more office spaces. and spaces which rely on natural ventilation and natural lighting and all these spaces have access to the exposed outside wall through which it gets its natural lighting and Now all these are windows through which the office areas get natural lighting.

Besides this is a large cutout here which provides adequate lighting and ventilation. This is the courtyard through which all other spaces get natural lighting and ventilation. So you can see that staircases and service areas. Service areas are the toilet areas and the staircase areas. Now these are the services and toilet areas.

They are kept in areas where low levels of natural light enters which is all right. So, this building has efficiently used its outer perimeter which is pretty much a long outer perimeter through which natural lighting enters the building. and therefore it reduces the load on electricity. On the higher floors you can see how the how this area is like a light well it looks here and again here you can see that the long perimeter provides an opportunity for natural light to enter the office thereby ensuring that the office spaces get lit by natural light and the load on the electricity comes down considerably. Now let us look at the strategies apart from simple passive because simple passive strategies we saw that the building has a long perimeter which is exposed to the outside and therefore the office spaces adjacent to those walls get natural lighting.

If we look at the planning we can see that there is a central courtyard. and the building is pretty much porous and this courtyard actually is provided with a skylight and it provides indoor natural light. So, the building envelope is designed to ensure that daylight enters the building and at least 75% of the occupied spaces get daylight. So, 75% of spaces are naturally lit. Besides can see here in this plan that there is this courtyard and there are

multiple smaller courtyards here.

You can also know that this building has light shelves. We have already seen what light shelves are. This building also has light shelves and it has very simple roof overhangs. So the roof overhangs are provided which acts as a shading device on the south side of the building. So it acts as a shading device and also helps in eliminating glare by cutting off very high and harsh sunlight.

So, north facing glazing receives only diffuse light. The light shelves also help in bringing diffused light because it is not direct light but it is through multiple reflection. The facade has been designed to receive at least 75% of natural daylight inside and there is use of high efficiency glass. We have already seen what is high efficiency glass in our previous slides. So, it has low U value and the it has very high visible light transmission.

All these contribute to further enhancing indoor lighting. The reflected light does not carry as much as intense solar energy. Because some of the solar energy or would already have been absorbed when it strikes the initial surface. And therefore these light shelves as well as having large roof overhangs ensure that the light that enters in is not very harsh filled with glare. But it is diffused light and it is convenient and appropriate for working conditions.

This reflected light is very useful when you consider lighting in a building which has to be naturally lit. Also, the building has very well designed exterior landscaped areas and having good landscaped areas is very important. The building has very well landscaped areas on the outside as well as any of the surfaces which is not covered and therefore the intensity of solar radiation is less because it is reflected light which enters the building. Here in this picture you can see the light shelves which reflects multiple, which undergoes multiple reflection before it enters the building giving it a very diffused lighting effect. Now, the building has optimized building envelope.

So, the U value is 0.49 watts per meter square Kelvin and UPVC windows. These are used with double sealed, double glazed and low heat transmitting index glass. Rockwool insulation is used with the along with the high efficiency glass and these light shelves multiple light shelves also have a reflective surface which reflects the solar I mean reflects the daylight and it brings in diffused daylight as you may be aware Delhi the intensity of solar radiation can be very high and the light can become very harsh to the eye if it is not diffused. Now this is the section of the building and in this section you can see how the building is very well landscaped. the landscape areas outside wherever there is a possibility the building is very well landscaped which ensures that the harshness of solar radiation is decreased.

You can also see that there is appropriate shading there is grid here so there is a shading from summer sun and the winter sun is allowed inside. So, the inside as well as outdoor lighting, whichever needs external electricity, the photovoltaic cells help in the interior and exterior lighting for the remaining period or remaining parts of the buildings. Now this picture shows what all areas have natural lighting and you can see that all of these areas which are shown in yellow are daylight areas where daylight alone is sufficient to light these areas. If you are able to correlate this picture, this drawing with the floor plan, you will notice that all these shaded areas, hatched areas are primarily office workspace and all the red areas are also office workspaces or they are, so they are either office workspaces or corridors in the office. And therefore, we say that more than 75 percent of the floor is lit by natural daylight and therefore it reduces the dependency on active lighting devices. This central atrium which is located between the two blocks allows natural movement of air too. It makes the building very porous and there is movement of air too because At the ground floor level, there are no blocks on, there is no block on these two sides. So, the provision of windows further enhances the process of cross ventilation. Again, basic principles using high efficient glass, high VLT glass and glass with low U value along with proper shading, optimized shading.

It helps in the building being energy efficient overall too. We will look at another case study which is the Infosys office at Pocharam, Hyderabad. Now Infosys has the largest building area as a green building rated office space. And it also has the second highest number of LEED platinum awards for a corporate. This is a green building rated green rated building by LEED and it is globally accepted benchmark for design construction and operation of a very high performing green building.

And therefore, this Pocharam campus is also a green building. It is located on a very large piece of land spread across 447 acres. This is the basic plan of the Infosys building at Pocharam. And our concerns would be largely the office building which is located here. This would be the office building which would be our primary concern.

So, it is the total extent is 447 acres on which there is a office building. Now, when it comes to daylight, the windows are split into an upper pane that lets in natural light. and a lower pane which provides outside view. So, the windows are very high and tall and it has a upper pane and a lower pane. So, through the upper pane there is continuous natural light.

The windows are completely shaded and these are shaded with horizontal louvers and vertical fins too and this both combination of horizontal and vertical shading devices where you can see in this picture you can see that it has horizontal shading device and it

also has this vertical fins. So this combination of horizontal and vertical shading device ensures that the entire office has a natural daylight without glare. So almost from 8 am to 5 pm there is natural daylight without glare which is very important in its workspace. Now above each window a light shelf which is actually just a flat pane -a light shelf, these are the light shelves. So above each window there are light shelves like this.

And these are installed which reflects the incoming sunlight. And it is coated with the reflective surface. And it reflects it onto the ceiling thereby distributing deeper into the space. So, you have this.

You have the light shelf. which reflects the light because the area above the light shelf is also glazing and it gives in diffused glare fill light inside the workspace. So, the lighting control for which gives rise to green results. These include daylight panels and vision panels for the windows. The light shelves, these are the light shelves. They aid in reflecting the light inside, giving a diffused light.

And these, improve natural light. They help in creating good working spaces. The plan of the building is also such that a large perimeter is exposed onto the outside. And therefore, the building itself is designed in such a way that it facilitates natural light inside.

The building is stepped. building is in the form of it steps in inside and you can see that on the east and western side these places are all service areas such as toilets. So, all the areas which are exposed to the harshness of the sun along east and west are all service areas. So, the window is split into two types of glass. The upper glass is called as the daylight panel and it gives natural light with less amount of glare this part. This part has a glass Now that gives less amount of glare.

The lower glass is called as vision panel and it has low visible transmittance. Low visible transmittance. This type of windows, they conserve energy as they allow less heat inside the building but they allow ample daylight. Since these are larger sized windows, These windows have glass which will allow more of light and it will cut the heat. Besides you already have light shelves which is a overhang fixed between the daylight panel and the visible panel and it extends both on the inside as well as outside the building.

It helps reflect natural light deep into the office spaces and provides maximum protection from the glare. So they have achieved a reduction of at least 40% in energy intensity just because of the way the building is planned. So, the building is - you can see in this picture clearly how every window is made up of two parts. The upper one where diffuse light goes in and the lower one which cuts the heat but allows ample daylight.

Besides you can see the light shelves too. So, The building has been designed with highly efficient day lighting system and it has removed the need for any artificial lighting system during the day which is not compulsory in this office. This has been done with the help of as I repeat the light shelves and narrow floor plans. The floor plans if you see very narrow and that allows the building perimeter to take in as much light from outside as possible. Now daylight savings - a number of features have been included to maximize the daylight harvesting which leads to the attainment of 90% of natural light in the office space. The design itself was conceptualized to make the interiors look brighter.

And therefore, I had been telling that decisions at an early design stage are very important to ensure that the operational carbon and the embodied carbon is reduced. because once this building is done it is it is difficult to retrofit it one might as well think well ahead during the early design stage to have a proper plan which will ensure energy efficiency of the building. So, today we have seen two important case studies First is the Indra Pariyavaran Bhavan and the second is the Infosys Office Pochavaram. The Indra Pariyavaran Bhavan just by virtue of its design reduces 75% load on electricity due to natural lighting and Infosys Pochavaram has at least 90% of its lighting through natural means. And both these buildings have resulted like this only due to the effort of the designer and the architect.

So, we will stop today's class with this and we will continue tomorrow. next week with yet another set of case studies which show how daylighting by virtue of design can be enhanced in the building and that can help us cut the demand on electricity for lighting. Thank you.