Glass in buildings Design and Application.
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Lecture - 25
Daylighting Strategies/Techniques - Part I

Daylight enters the building through penetration such as windows and skylights. Since most of the light that enters a building is through a window is just simple guiding, principles for determining the size of these windows.

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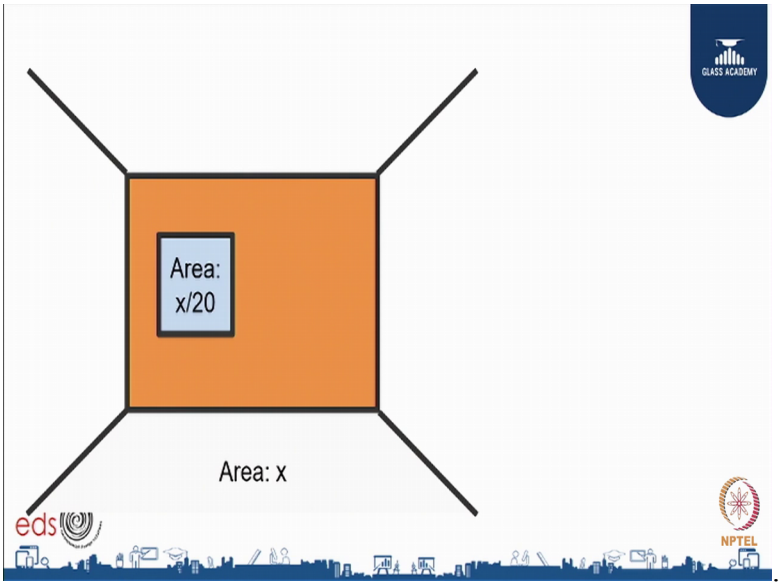

The area by 20 rule; the first rule that helps determining the size of penetrations says, to avoid somehow overheating and winter heat loses. It is best to have window area approximately equal to 20 percent of the floor area. This is largely also adequate for ventilation as well this will help determining the overall window to wall ratio, that can get you start working on the facade elevation options.

The guidelines we further correlated with the other rules that I am going to talk about in the in the next section, the 2 h rule is probably the most important rule.

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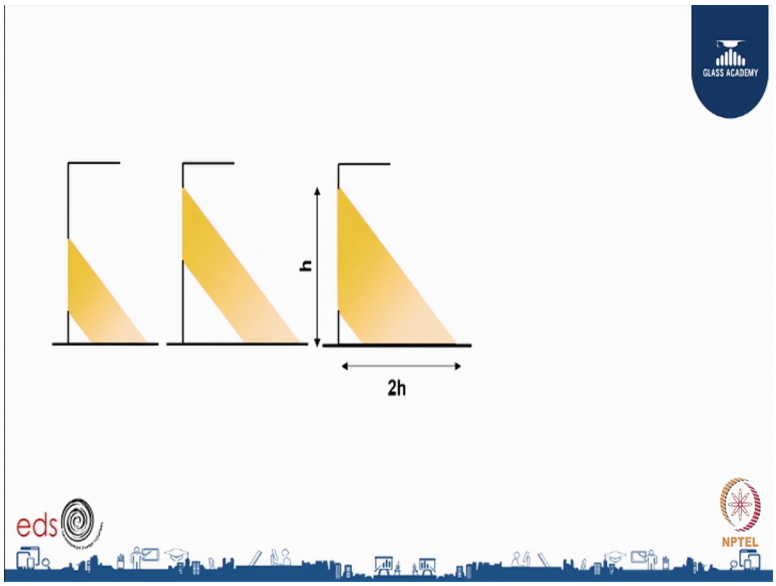

That says that illumination spaces direct correlation with the size and distribution of window in the wall. So, if the useful depth of daylight is limited to about 2 times the height of the window measured from the floor as the head height increases light can reach, deeper areas in the room. You can correlate this with the 15/30 rule and you can determine therefore, the day lighting zone as per the height of the building and the height of the window within the space.

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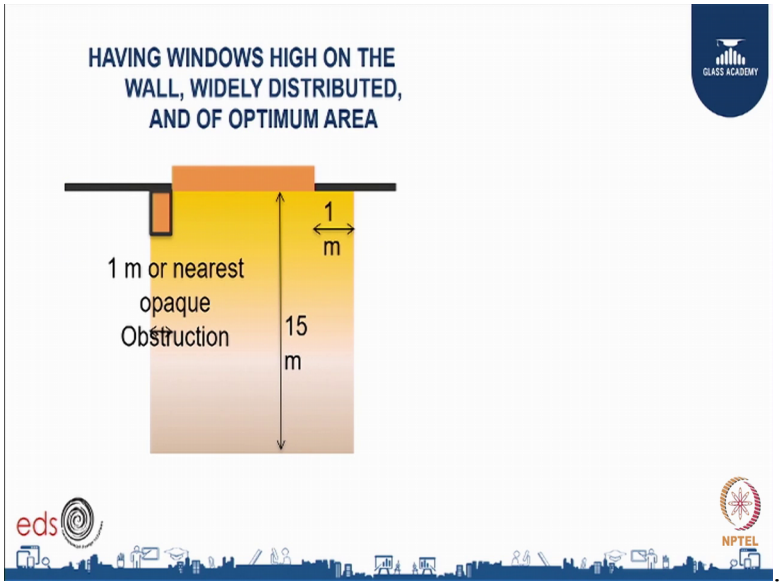

There is another rule that pertains to this which is a 1 meter rule for horizontal penetration of light. So, having windows high on the wall and widely distributed give you the optimum performance. So, horizontally the daylight area is considered as 1 meter on either side of a width over window. So, if you have a window you can look at both sides and say daylight will go on the plan say 1 meter around each side. So, from height it is 2 meters 2 times the height of the window into the space and on the size it is 1 meter on both sides.

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So, this gives us a very good idea about the space within the building, which gets this. So, this is an example of a ribbon window which is very often used Corbusier used this Vella Savoy to achieve a more even spread and no light and dark spots within the building.

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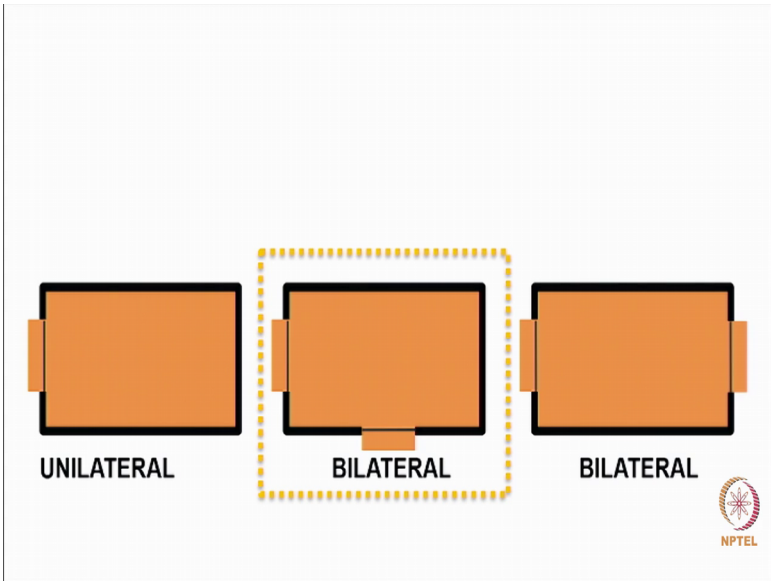

The location of the window also influences the daylight as per this rule that if possible place windows on more than one wall. Bilateral lighting which means lighting coming from two direction is better than unilateral lighting, this helps to reduce glare and minimizes a shadow formation, windows on adjacent walls are specially effective in reducing glare.

So, if you have one from the front and one from the side it is a much better situation. Another cause of glare is a sharp contrast between the windows and it is surrounding areas.

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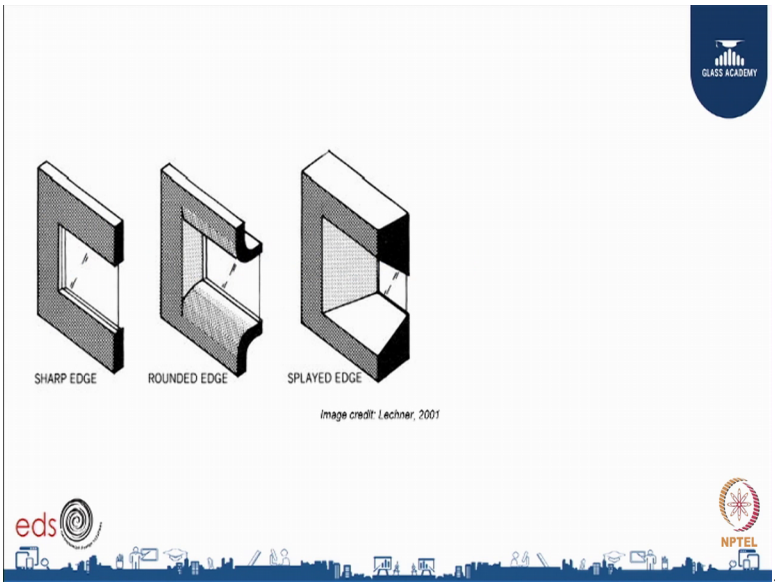

So, if you look at a window, a it has a very clear demarcation where the window ends there are lot of light into the space, and the wall next to it with becomes dark. So, again Cubusier and any architects they have used the same principle, to soften the contrast by splaying the window by putting the interior of the window wall in a way.

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That light gets a diffused and redirected through this play, and it in it creates a nice reflecting surface to even port light deeper into the space.

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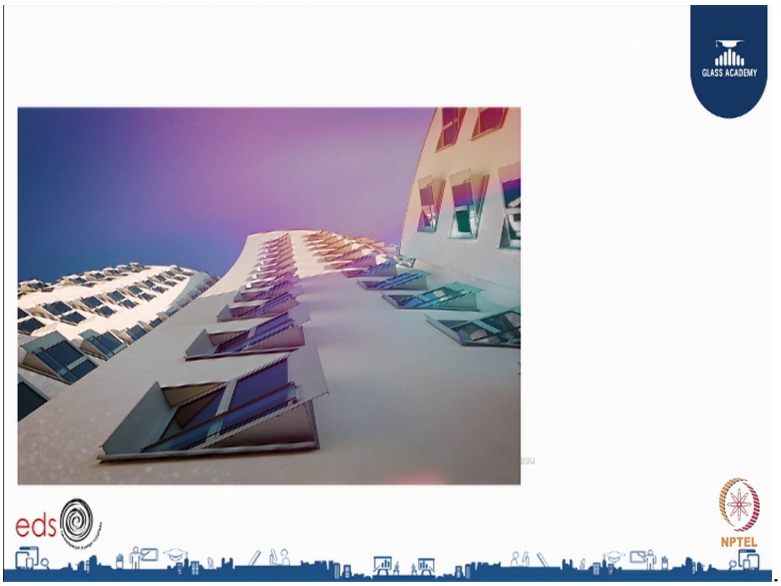

You can see this can also be done vertically vertical plane.

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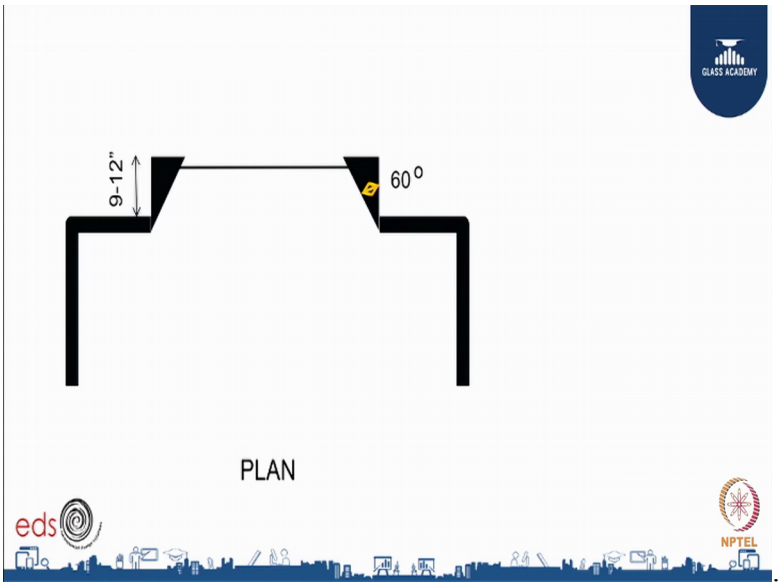

However the area of gradation around the window is only useful up to a distance you make it very deep it really does not does not help and its roughly more or less the 10 times the dimension of the window. So, if you say a window is about 30 centimeters or 20 to 30 centimeters wall deep a wall depth, then a 60 degree angle will gave you the best the best splay angle. Also of course, the color of splays is important it needs to be light to get the optimum reflection.

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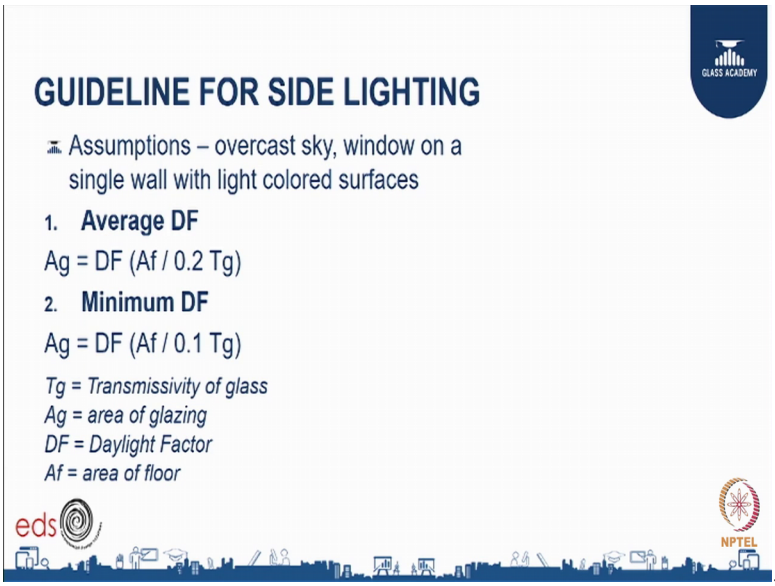

It is important to note the strategies we have discussed so, far do not help in quantifying the illumination, but certainly help in achieving adequate daylighting. Is a simple guide line that can be used to roughly estimate the daylight factor in a in a space, if fenestration size is known or it can be useful determine fenestration size of the daylighting factor is known.

So, let us do a simple exercise if you assume it is an overcast sky, and you get the average daylight factor which is dependent on the overall transmission of the glass, the type of glass used the area of the glass and the area of the floor. So, you can use these thumb rules for first designing the daylighting, then once you have the rough idea of the size of the windows height of the building you can using a thumb rule without doing any simulation analysis, estimate what is the daylighting factor that you are achieving.

Also on the other hand if there is a requirement which is very often the case in terms of say green building rating system that requires you to get certain daylight factor, you can work backwards to say ok. Now with this given shape of the building, what is the area of the glass, what is the height of the window that will give me this particular daylighting factor.

Just discuss now the quality of light. The fuse light is usually desired inside the space because it has enhanced color enduring properties and it is not harsh. After you

determine the size of the fenestration, it is important to access the opportunities to regulate this quantity of light.

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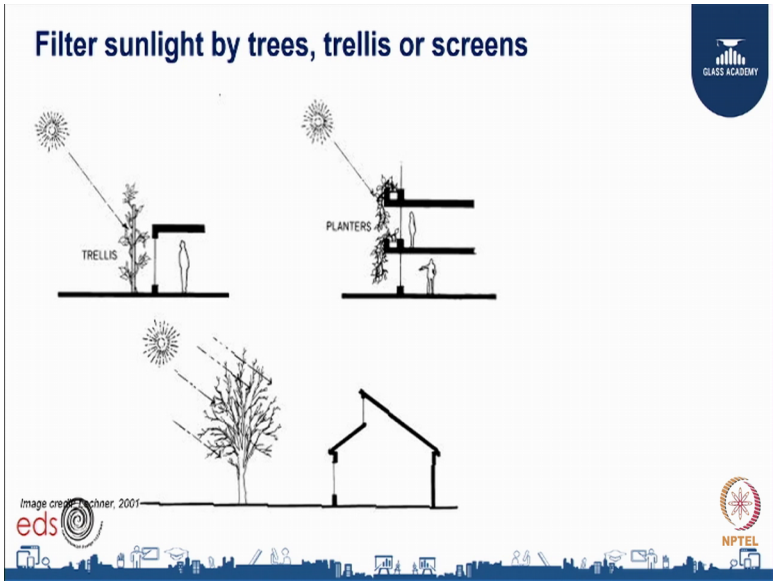

So, let us discuss some of the strategies to achieve this we can filter sunlight by trees of course, or by devices such as trellises and screens.

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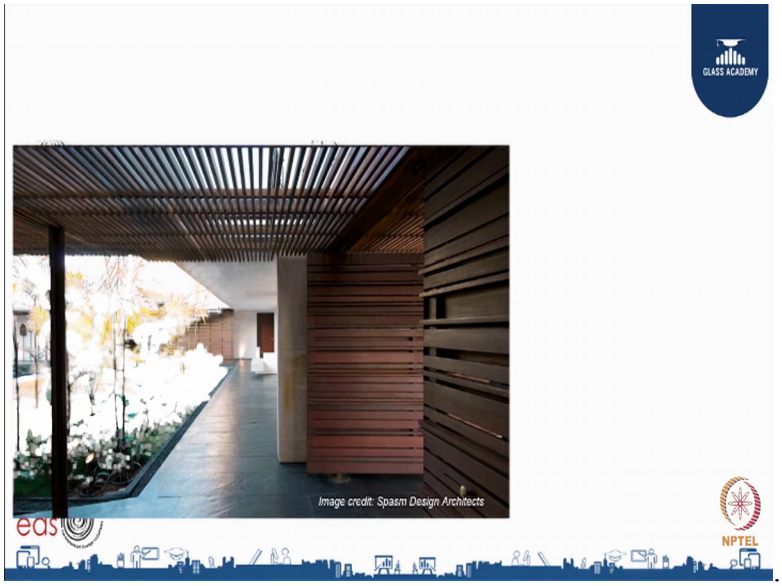

Here is an example of a trellis used to interrupt direct sunlight.

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Or if a large solid overhanging is used its undersized provides the shade, and it also can reflect if it is a painted light.

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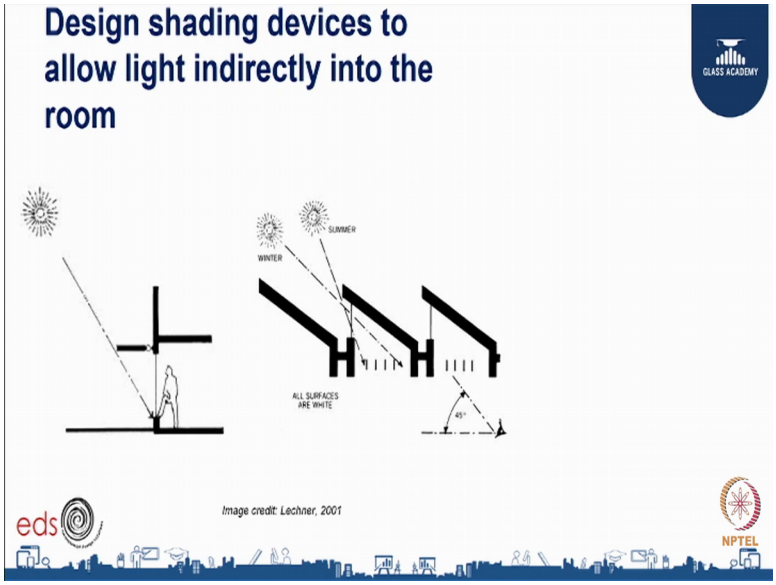

Design shading devices to allow light indirectly into the room; for example by having an overhang or louver on the south for example or by having vertical louvers for sky lights clear story on top

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Moveable shading devices are another way, where you have a facade that that requires dynamic or varying amounts of lights through the day, and the orientation is such that you cannot control it easily. In this case you need to be able to provide a dynamic shade that can control the shade throughout the day.

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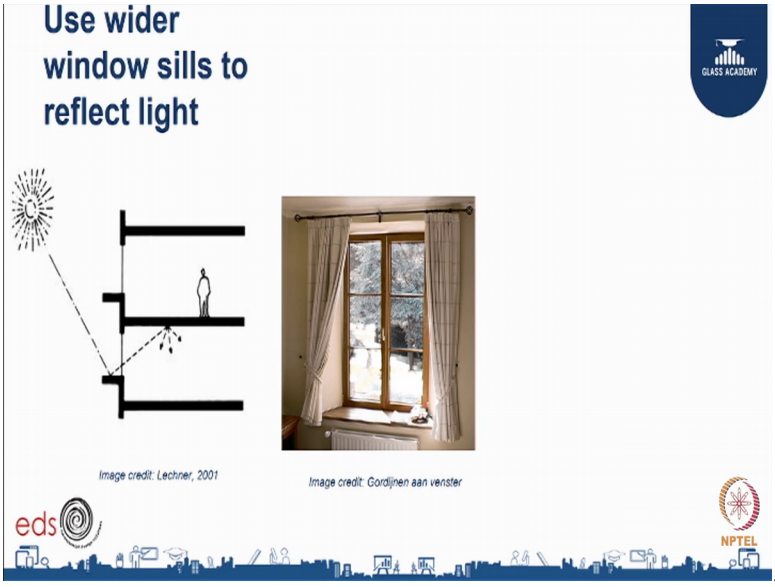

Deep windows sills can also be very effective they work as a splay. So, you can add a wide windows sill to reflect light on to the ceiling and deeper on to the space.

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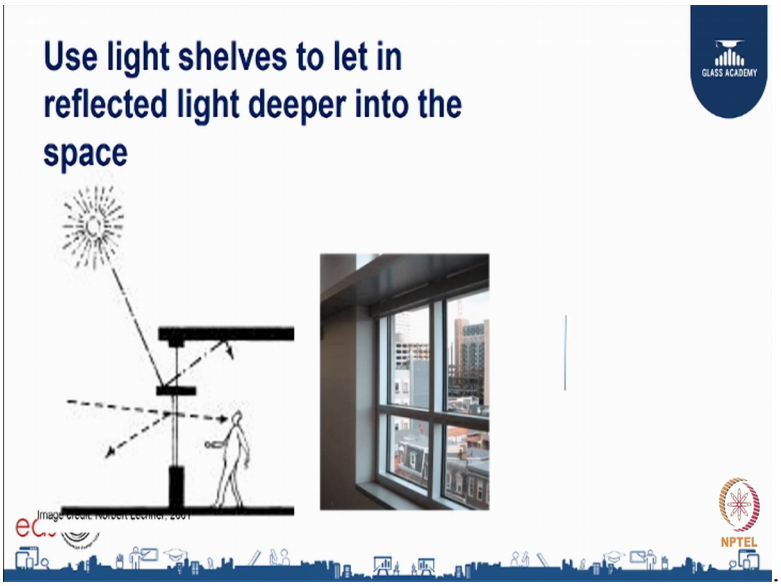

Light shelves are one of the most effective ways, they work on the same concept, but are provided above the eye level to avoid glare. So, a light shelve is a reflector of light which is usually above the head height, let us say over 1.8 meters usually at about 2 to 0.1 meter and it divides the window into 2 it allows the light from the higher ups sun angles to reflect off bounce off into the ceiling and then provide a uniform, daylight in into the space it reflects light and reduces glare.

So, there are some very interesting examples you will find it one of the most common daylight device which is used in buildings, and it is not only daylight device, if it is used properly it also provides a proper shading to cut down on heat gain.

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This is a very famous building its a Ventura Coastal Corporation Administration Building in Ventura California designed by a Scott l n (Refer Time: 09:44). It uses light shelves for daylight and it owns it owns several award for design for simply for the simple way in which it works both for shading daylighting.

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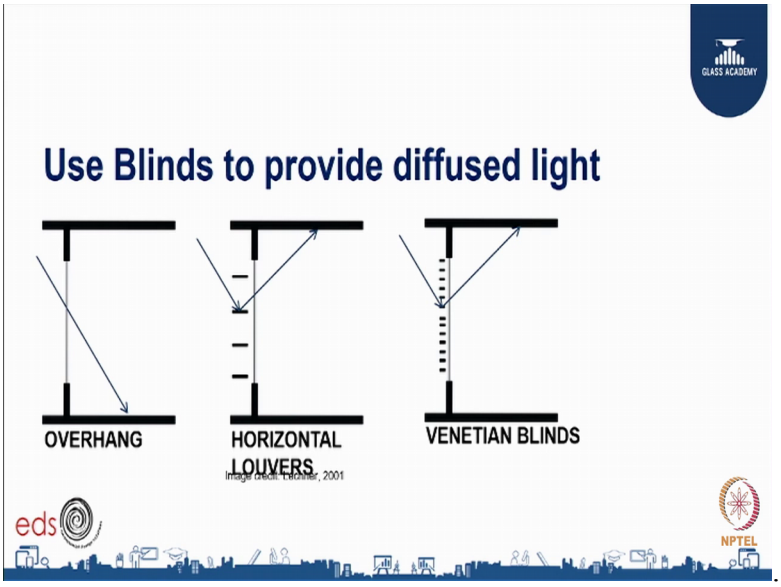

The venetian blinds are also another way we of course, need to ensure that these blinds or shading devices are always on the outside and not on the inside because if it is on the

inside although it will do more or less the same function for daylighting, it will allow a lot of heat to come inside the glass.

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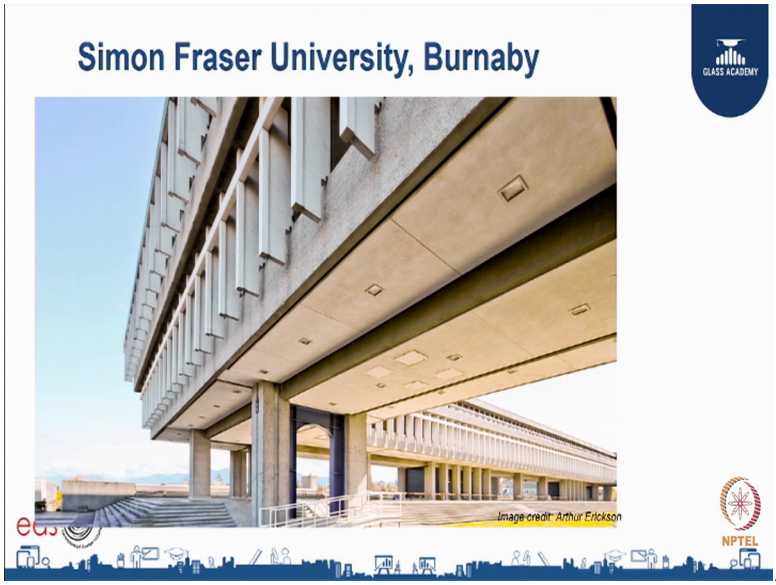

So, a blind can be used on the outside to provide a redirected daylight through the ceiling. On an east and west orientation it makes sense to use vertical blinds in the same way for example, in this example building of Simon Fraser university in Burnaby and a ultimately a combination of daylighting from windows needs to be incorporated with top lighting with some sort of a skylight if required.

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Because the skylight can require can allow a more uniform and more intense daylight. So, therefore, a smaller amount of skylight can in fact, get you a lot more daylight. So, for buildings that are storey, it makes perfect sense to have a combination of daylight and skylight or on top floors of high rise buildings.

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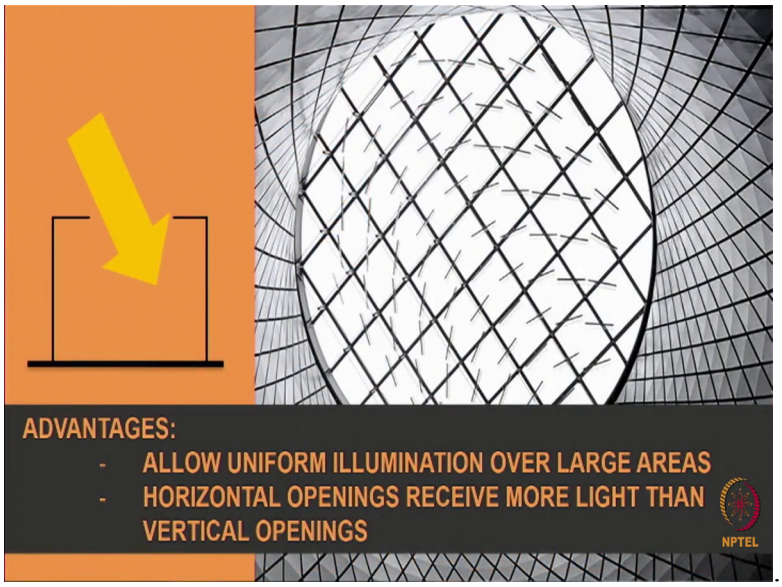

So, the advantages are it allows uniform illumination over large areas.

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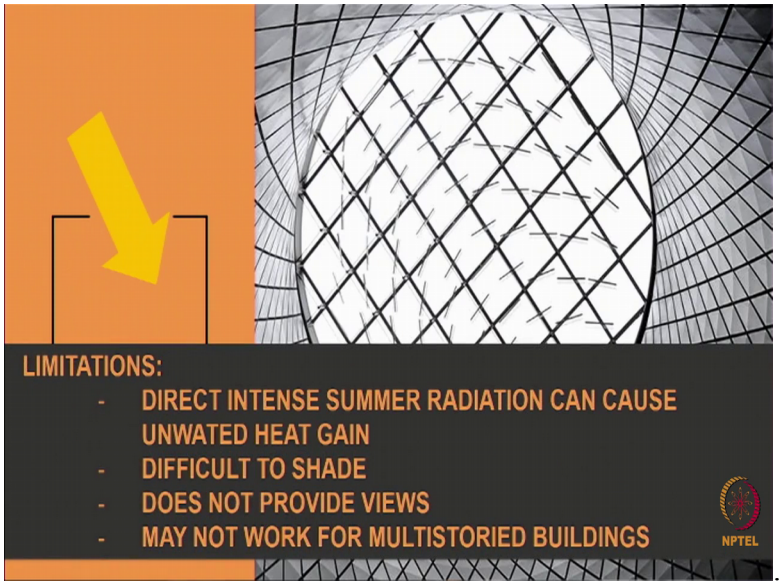

And disadvantage is that of course, it can create a intense summer radiation if not done properly it is difficult to shade and it does not work for multi storey buildings.

So, in an ideal situation you will use this for top store top floors or for single storey buildings.

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So, just like side lighting there are design guidelines for top lighting.

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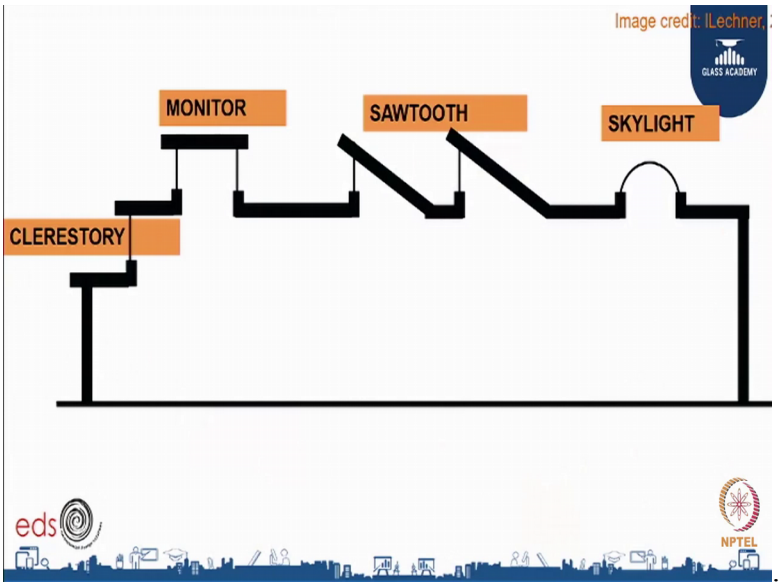

You can use the clerestory a monitor a sawtooth or skylight these are different terms, that you will come across and each one has a certain advantage or disadvantage.

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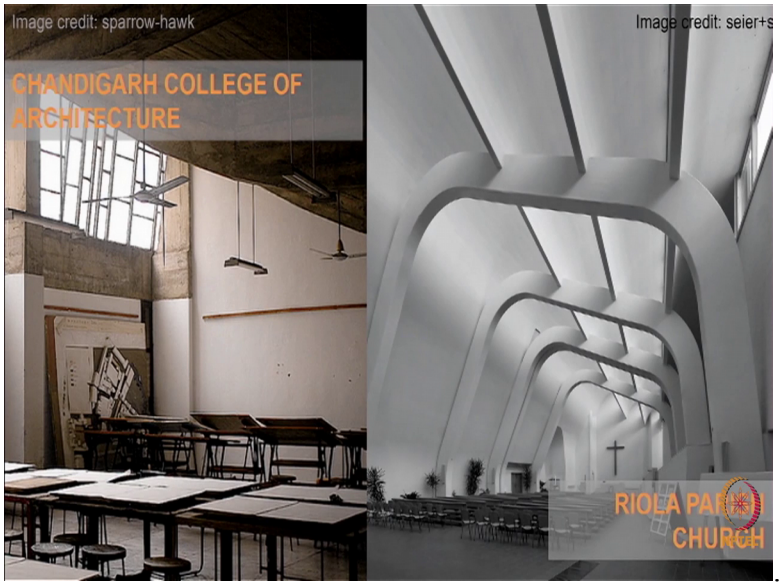

Some examples Chandigarh college architecture has a replica of the design by (Refer Time: 12:24) college of fine art and uses a clerestory window to let north light into the class room.

Another example of a Paris church designed by Alvar Aalto which sawtooth where the openings are used for a wide spread of daylight inside the space. So, it is you will see a very similar example in the Bangalore airport a atrium if you go you will find the sawtooth design.

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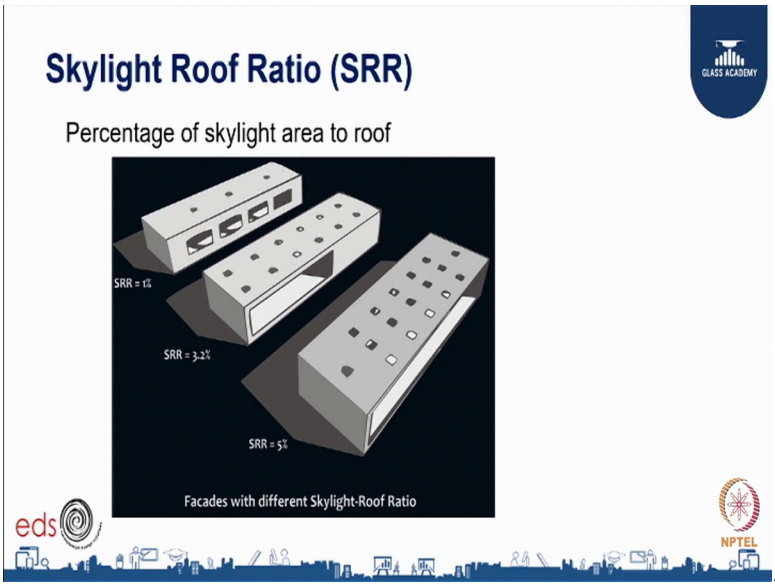

So, then to quantify this the term used is a skylight roof ratio, which is the amount of skylight available the area of skylight divided by the overall area of the roof.

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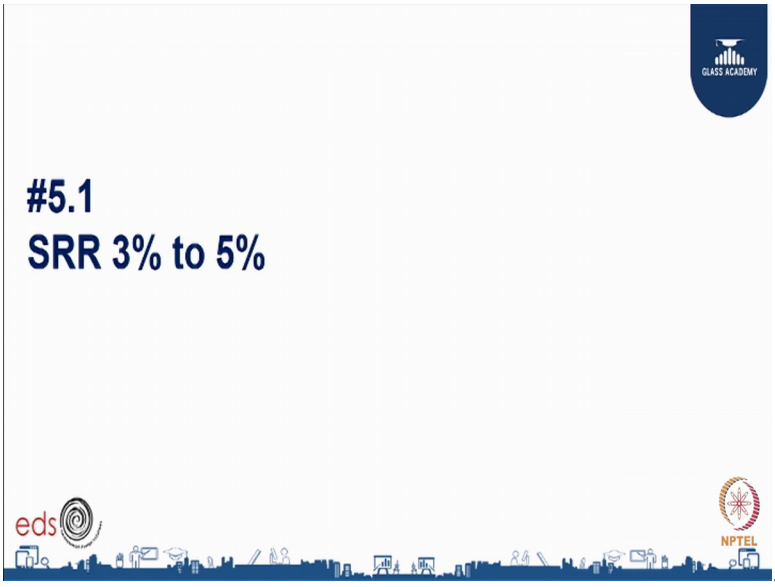

And the thumb rule is the skylight roof ratio should usually should never exceed 5 percent and between 3 to 5 percent.

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You would get adequate daylight into a space in most cases in most climates for uniform daylight distribution we must ensure that adequate distribution of skylight is done.

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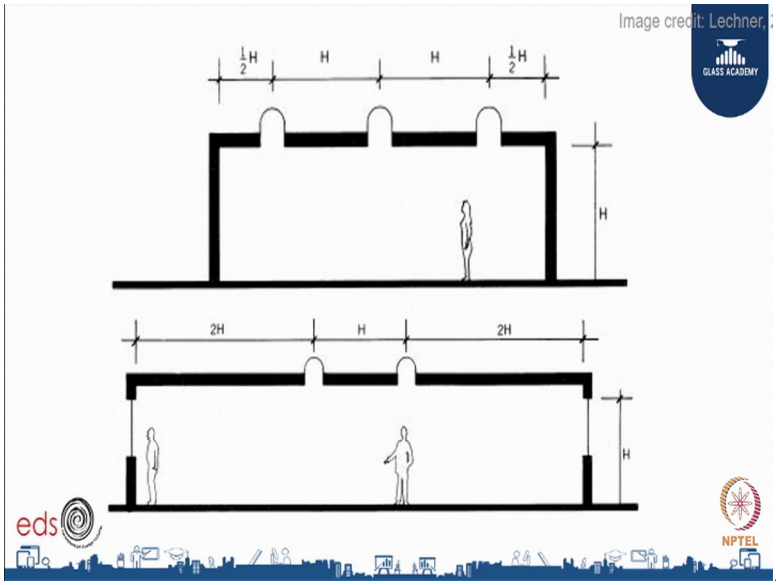

So, that you know this 3 to 5 percent is not all concentrated in one area, but is distributed all across in different in different positions different locations so, that you get a uniform distribution of light.

So, where the combination of a skylight and windows you can optimize and put skylights in areas where daylighting is not available from the windows, where the other thumb rules of 2 h or 15/30 are limits the daylight availability.

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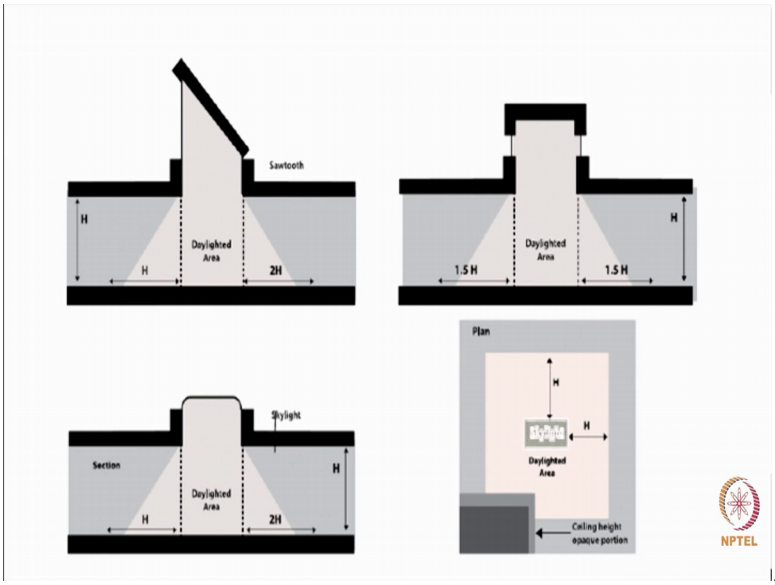

So, some of these images will tell you the daylight zones for various top openings, they are very similar to the 15/30 and the 2 h rule if you have designed skylights in the overall daylight zone can be further increased.

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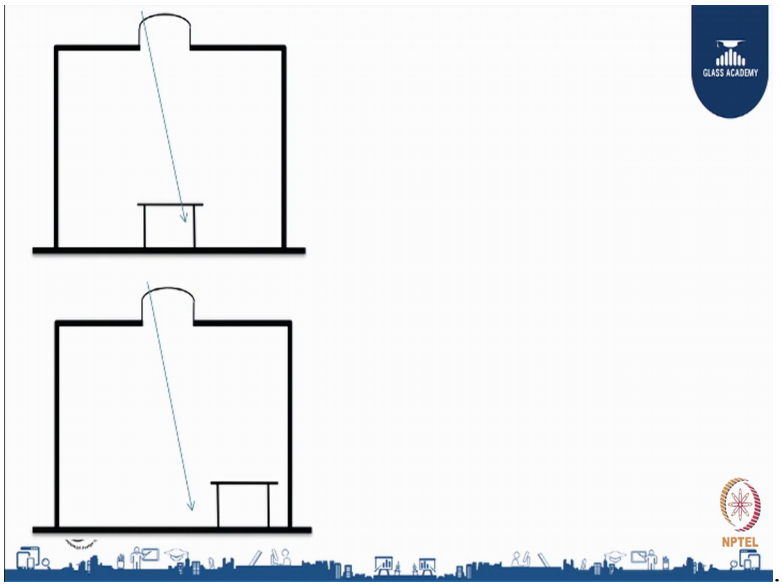

And to discuss the daylight in terms of skylight the top lighting does require some sort of a glare control because you can get wheeling reflections which see when you know there is a even from a daylight.

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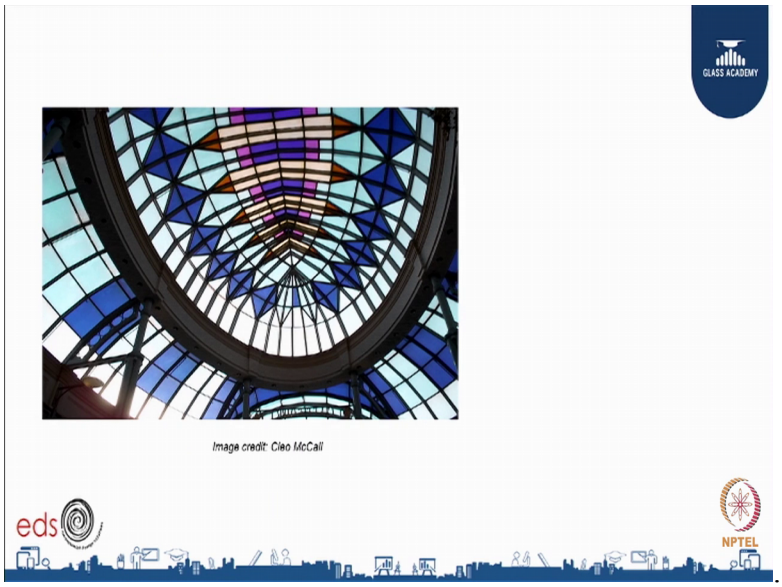

From a source of say artificial light when you looking at a book or a magazine you will get a reflection of the surface of the book.

So, to avoid that it is recommended never to use clear glass, but to use a translucent or diffused glass this can reduce and eliminate the glare.

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Also it is better for skylight to be made in a place so, that there is a splay just like the splay in the vertical fenestration.

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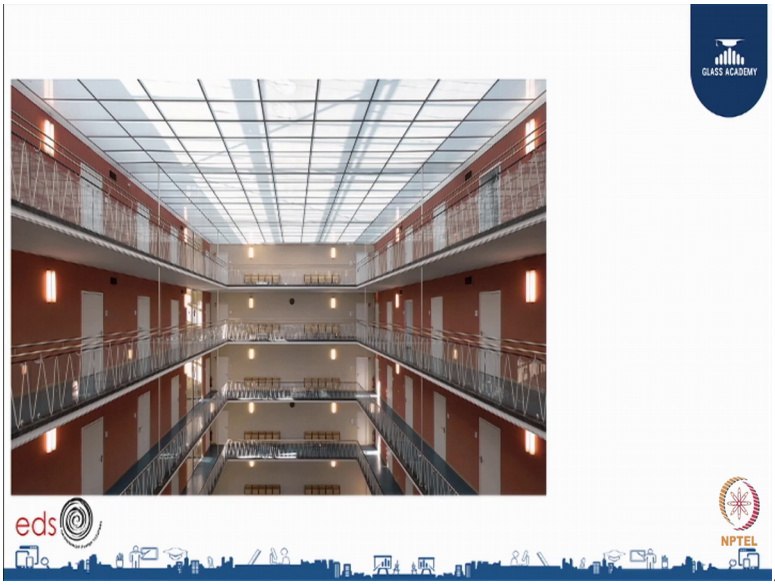

Also they can be distributed so, that they can be combined with an atrium and combined with some sort of a reflector. So, that we are getting not just the direct space direct light into the space, but it is reflected sideways as you can see here in these examples.

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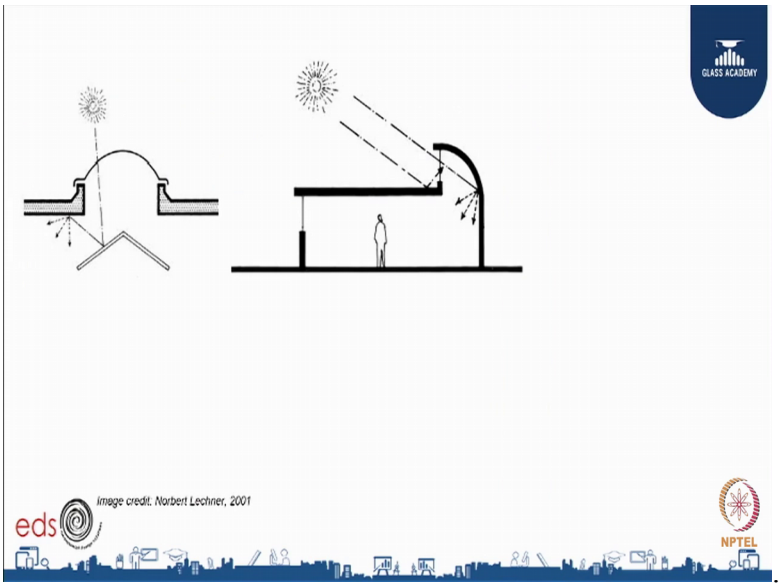

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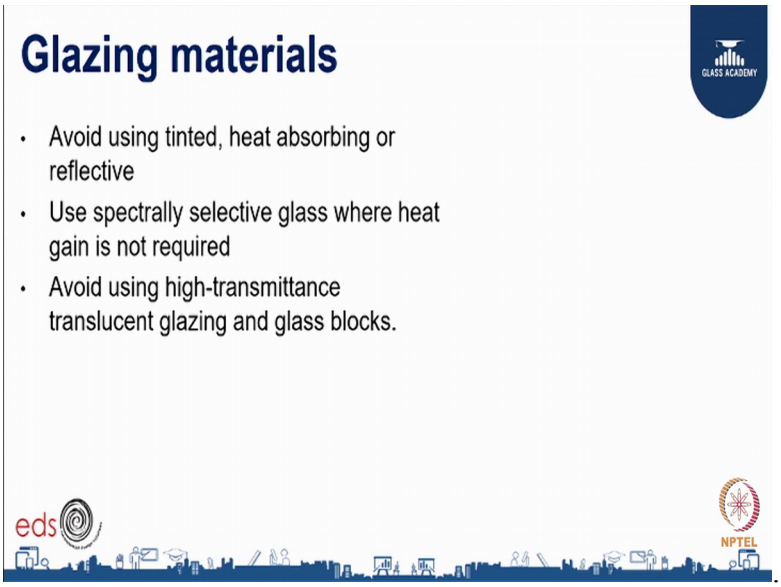

Finally if you come to glass the choice of glazing material is imperative of course, this course had a lot of discussion of on the choice of glass and the visual light transmittance that is important.

So, we should avoid dark or tinted glasses because they absorbed heat, and at the same time they limit the amount of daylight that is coming in. So, assuming that the window wall ratio is not you know is about 20 to 40 percent at the most. Glass valt or the light transmittance should be about say not less than 50 percent, and the as we increase the amount of glazing it creates a problem because you would want to limit the amount of overall heat gain and excessive glare. So, you need to then go for spectrally selective glasses where the heat gain is eliminated, but you get more daylight.

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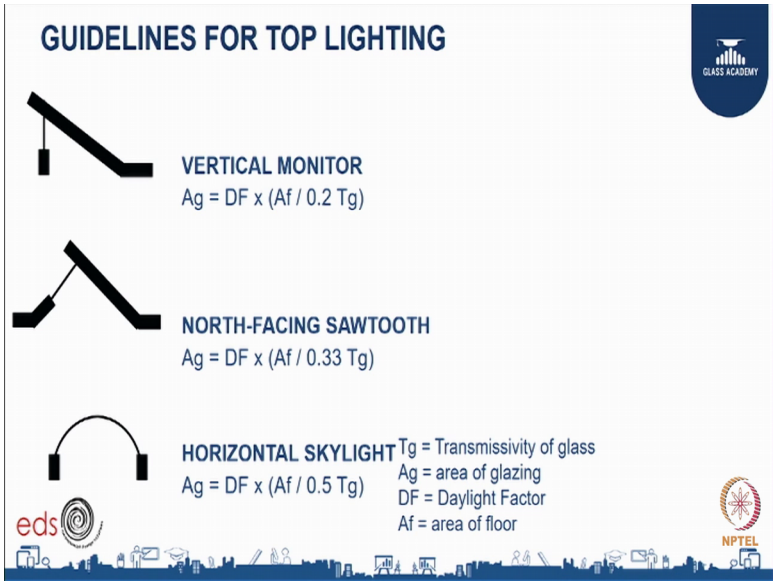

So, therefore, you get glass that is has lower solar factor lower, heat gain and high light transmittance. The guidelines for top lighting against similarly just like we are able to quantify the amount of daylighting coming in or the daylighting factor through vertical fenestration over a window, the similar thumb rule are available for estimating roughly the amount of daylight or luminance that we can get inside the space using skylights.

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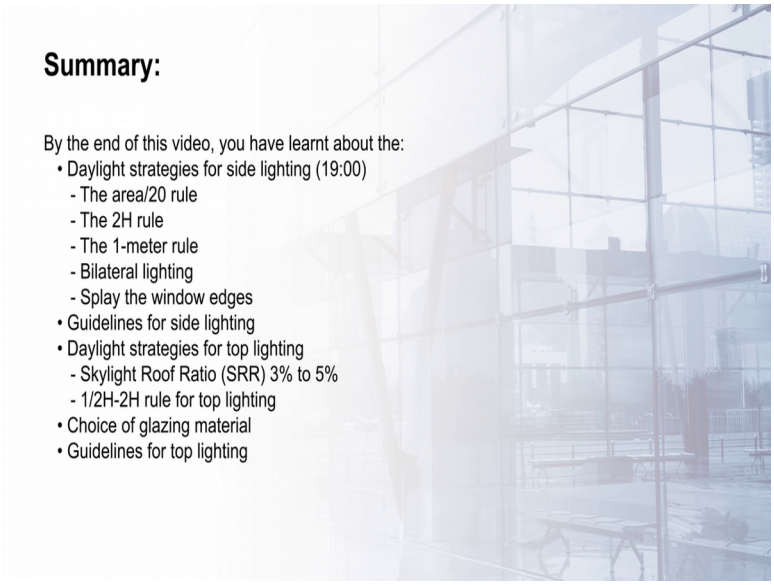

Thank you.