Glass in buildings Design and Application.
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Lecture - 26
Daylighting Strategies/Techniques - II

Hello everyone, welcome to this session on Daylight Strategies and Techniques part II. Before we get into the details of the strategies and these techniques, let us understand the solar spectrum. Here you see the solar spectrum you see that it consists of three main regions the ultraviolet region, the visible region and the near infrared region.

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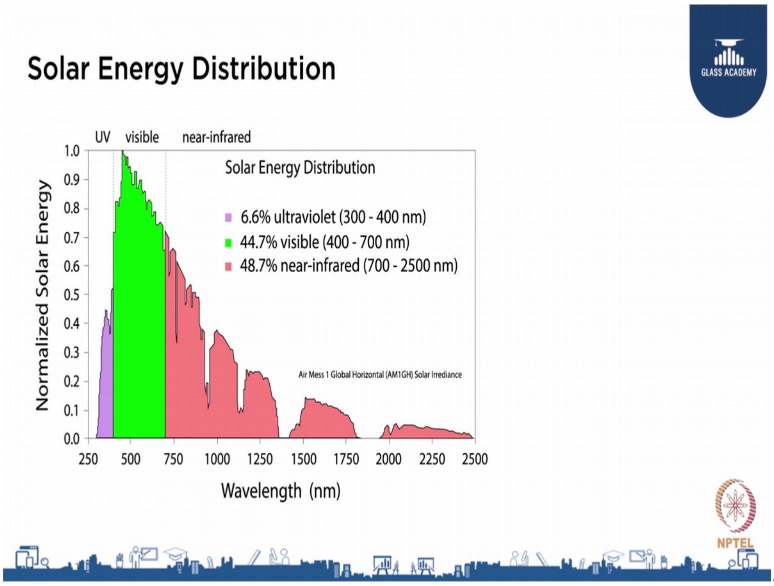

And if you pay attention you will see that this graph shows you the energy distribution in these three regions.

So, the ultraviolet region consists of 6.6 percent of the total energy that the solar radiation brings in. The visible part of the spectrum consists of 44.7 percent energy and the near infrared region constitutes 48.7 percent of the total solar energy that is falling onto a building. Now our interest is to bring in as much visible part of the spectrum as possible and to stop all the ultraviolet and near infrared part of the spectrum because that does not aid in vision and in the places like in tropics where most of the time of the year we are doing cooling, we do not want this radiation to enter because that will only increase our air conditioning load.

So, our ideal glass will be the one which allows all the visible part of the spectrum to come inside and does not allow the ultraviolet and the infrared part of the spectrum. This is our ideal glass, but in reality there is nothing like ideal glass in real life we have glasses we will have some transmittance in all the wavelengths.

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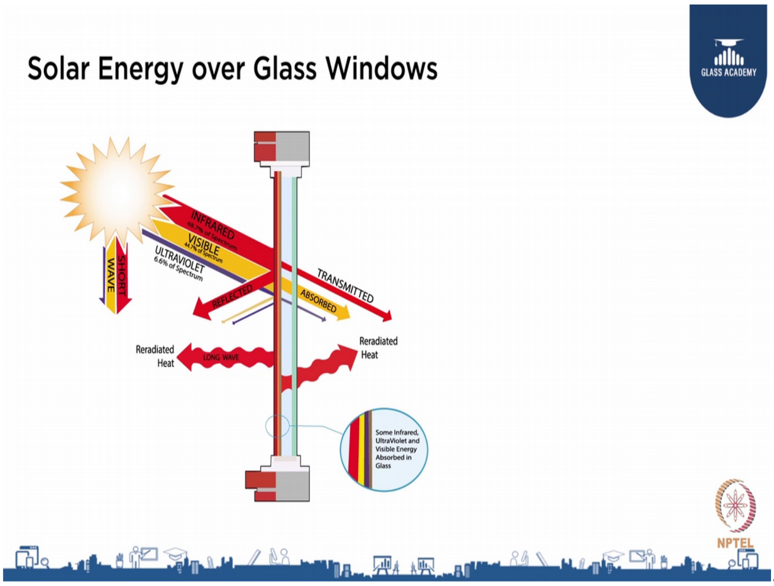

So, let us try to understand how does the glass behave when the solar radiation falls on it. So, when the solar radiation falls on the glass, three things can happen some of the radiation can pass through the glass, some of the radiation can be reflected from the glass and there would be some which will be absorbed by the glass there are only three possibilities.

Now, the radiation that has been transmitted to the glass comes into the space, the radiation that has been reflected from the glass remains outside, the radiation that has been absorbed by the glass it raises the temperature of the glass. And then this energy is dissipated by the glass in the form of long wave. Now this long wave some part of this long wave can come inside this space and some part of this long wave can go outside.

So, in totality if you see when you are looking from inside, you are getting infrared radiation directly transmitted, you are getting visible radiation directly transmitted, a little bit of ultraviolet radiation directly transmitted, and the radiation which is being absorbed being reemitted as long wave radiation.

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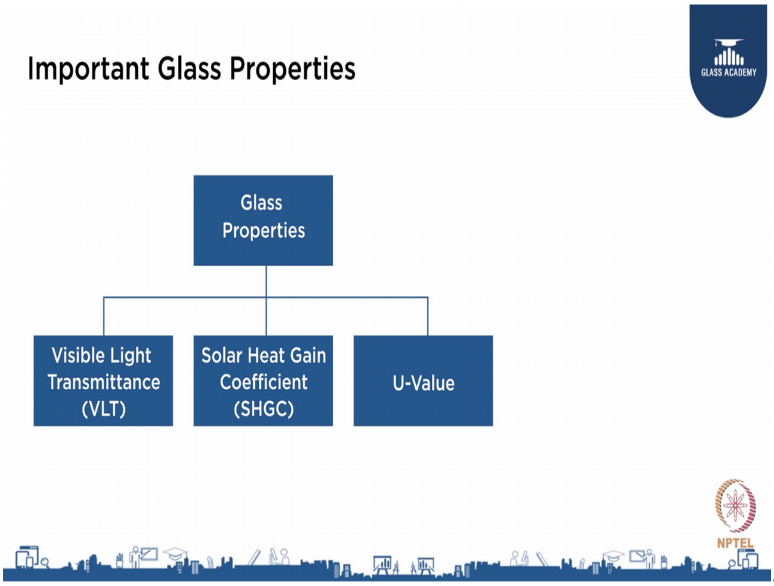

So, if we want to see the glass properties especially from the point of view of daylighting, we are interested in visual light transmittance. However, we just cannot look glass from the visual light transmittance point of view, we have to also see how much energy it brings in and for that there are two properties, one is solar heat gain coefficient and the another one is U value. We will understand all these 3 and then we will proceed further.

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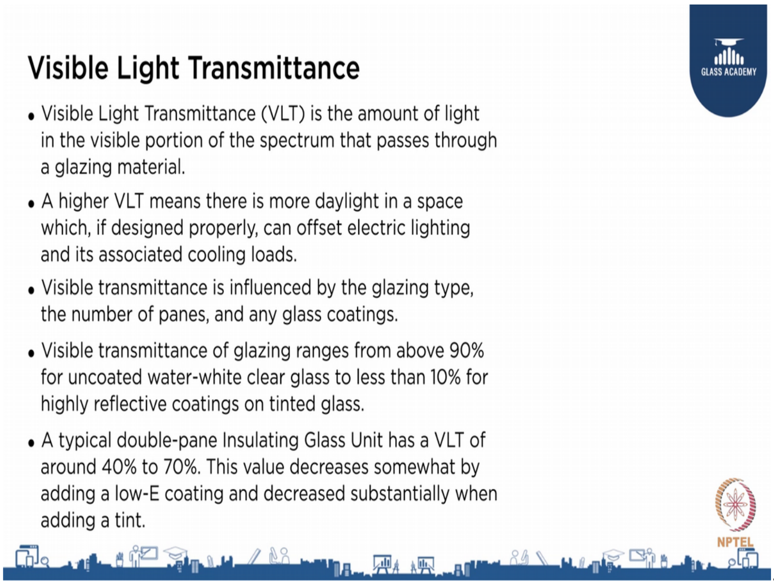

What is visible light transmittance? Visible light transmittance is the amount of light in the visible portion of the spectrum that passes through the glazing material. So, suppose there are x units of visible light that is falling onto the glass and x by 2 passes through then we can say that 50 percent is the visible light transmittance of the glass. Higher the VLT it is good for day lighting because we will get more illumination indoors and we will be able to save on the artificial electrical light energy consumption.

Visible light transmittance is influenced by the glazing type the type of coating number of panes etcetera generally for a regular glass, we will see visible light transmittance of the order of 80 to 90 percent and for a heavily tinted glass we might get it down to as low as around 10 percent.

Typically we would be expecting this value to be around 50 to 70 percent in the buildings where the glazing areas are small and if you have large glazing areas then you would like to keep it low around 20 to 30 percent.

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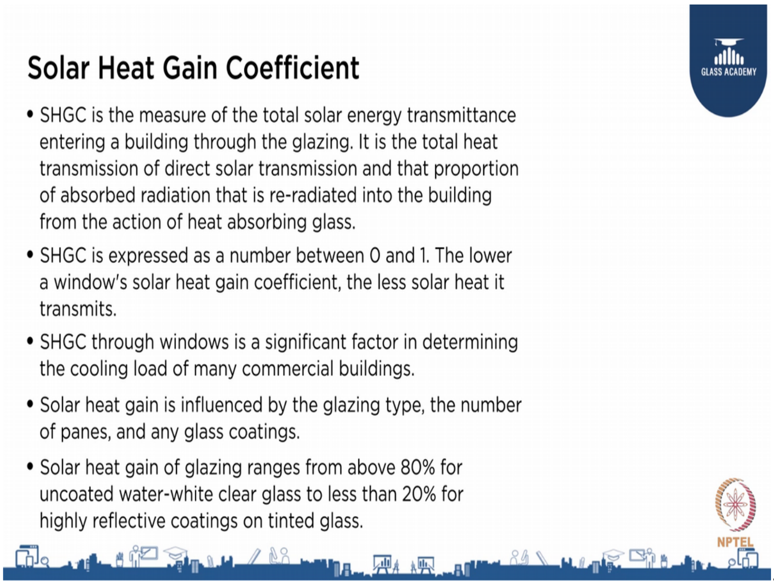

Now, let us look at solar heat gain coefficient. Solar heat gain coefficient is the measure of total solar energy that is transmitted through the glazing into the building. So, it is basically a number between 0 and one lower the number; that means, lower amount of solar energy is being transmitted higher number means more amount of solar energy is being transmitted we will like to keep this number as small as possible.

Just like visual light transmittance, the solar heat gain coefficient property of the glass also varies with the type of coating, number of panes etcetera. Therefore, when we are selecting the glass, we should look at how we can get low solar heat gain coefficient and high visual transmittance. Generally for clear glass we can get solar heat gain coefficient around 80 percent in high performance buildings, we would like to target the solar heat gain coefficient around 20 percent. Now these two properties are very important because they tell us how much light the glass will bring in and how much energy it will bring in through direct solar transmittance.

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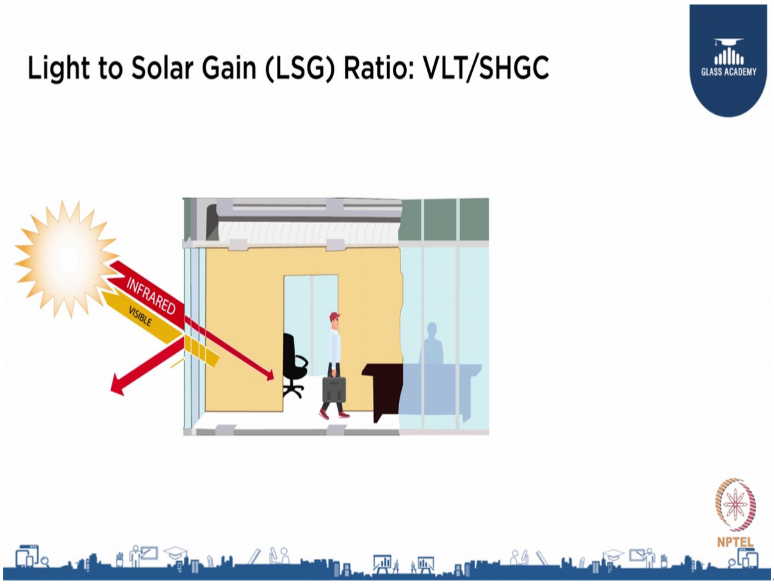

We can combine these two values into one value and we can call it Light to Solar Gain ratio LSG ratio this is nothing, but VLT divide by SHRC. So, suppose a glass is having 50 percent visual light transmittance therefore, the VLT will be 0.5 and if the solar heat gain coefficient is 30 percent then SHGC would be 0.3, then the LSG ratio will be 0.5 divided by 0.3. Higher the LSG ratio better it is because it is bringing in more light for lesser amount of heat gained through direct solar radiation.

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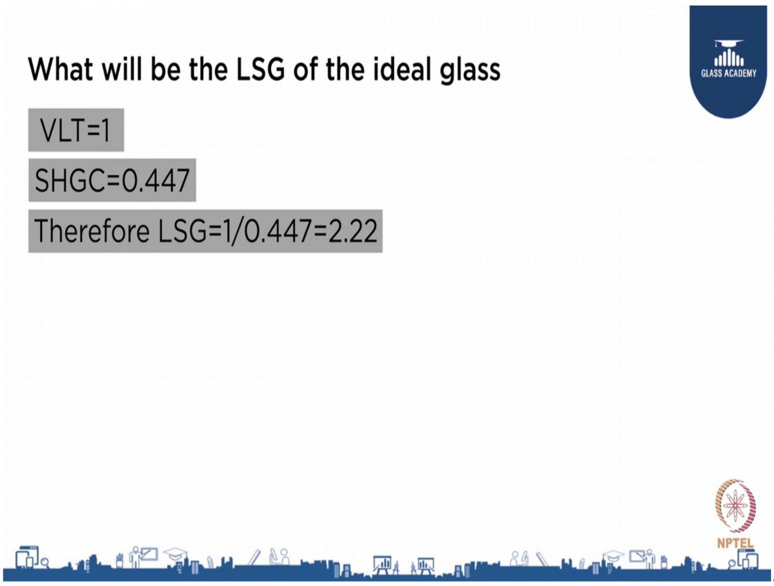

Let us now look at what will be the ratio for our ideal glass. In case of ideal glass we said that it allows 100 percent visible light to come in therefore, the VLT of the ideal glass would be 1.

We also saw the visible component of the solar spectrum consists of 44.7 percent of the total energy therefore, 44.7 percent of the energy will get transmitted through the glass therefore the SHGC of the glass would be 0.447. Hence LSG of the glass would be one divided by 0.447 which is equal to 2.22. So, this is the LSG of the ideal glass usually in real life we will not get glass which will have LSG hitting so, high.

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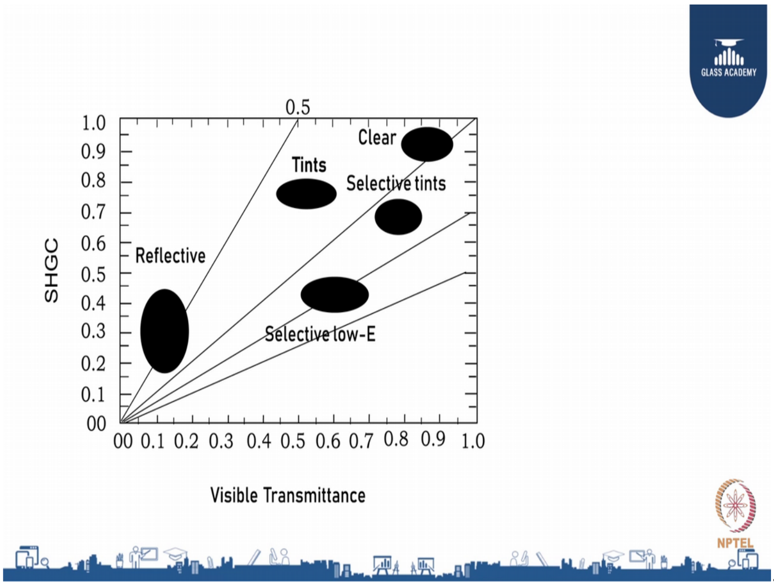

What does a real life glass look like? So, if you see this graph which shows on the x axis, visual transmittance and on the y axis SHGC. You will see that normal glass which is not spectrally selective or tinted, would generally have SHGC and VLT of the similar order and they will lie on this line.

If you have a glass which is tinted or which is reflective in nature, you will see that these glasses are towards the higher end of the shading coefficient the solar heat gain coefficient, they will have higher SHGC and lower VLT. These are the glasses that we would like to avoid in buildings because they do not bring in light they bring less light and they bring more heat.

The glasses that we would be interested in would be on the lower side of this line, and they will have higher visual transmittance and lower solar heat gain coefficient. So, they can have this ratio around 1.5, 1.7, 1.8 likewise. You will also see that there is a limit below which you cannot find any glass because of the obvious reason that if the glass has a high VLT, it will have at least some minimum SHGC corresponding to the energy that the visual light brings it with itself right.

So, you cannot have a glass below this theoretical limit.

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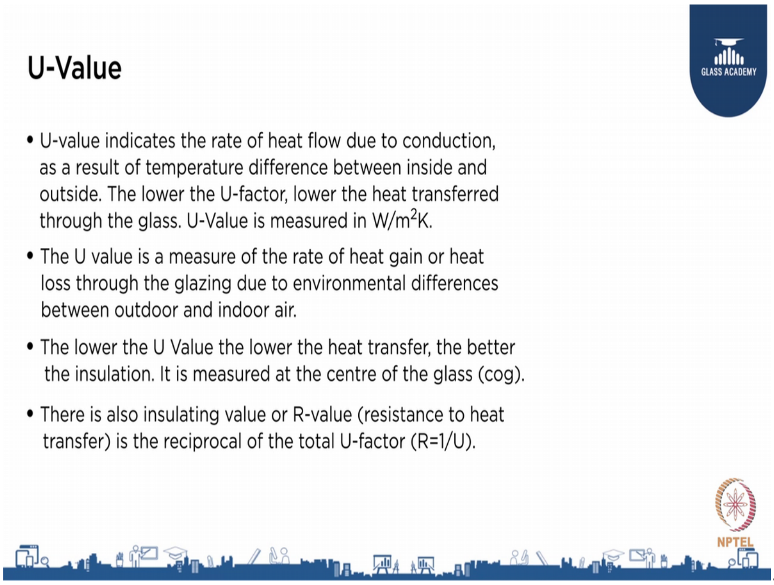

Now, let us look at U value. So, U value indicates the rate of heat flow due to conduction as a result of temperature difference between inside and outside. This is different than SHGC here the heat is getting transferred by virtue of conduction, because of the difference in the temperature between inside and outside. Normally in case of summers outside will be hotter than inside and therefore, heat will be flowing from outside to inside and this will be measured the U value will be measured in the units watts per meter square Kelvin.

We would like to have lower U value so, that we get less heat conducted into the building. Again the U value depends on the number of panes the type of gas that is filled inside the two panes and other factors. Lower the U value more insulating is the glass pane or the glass assembly.

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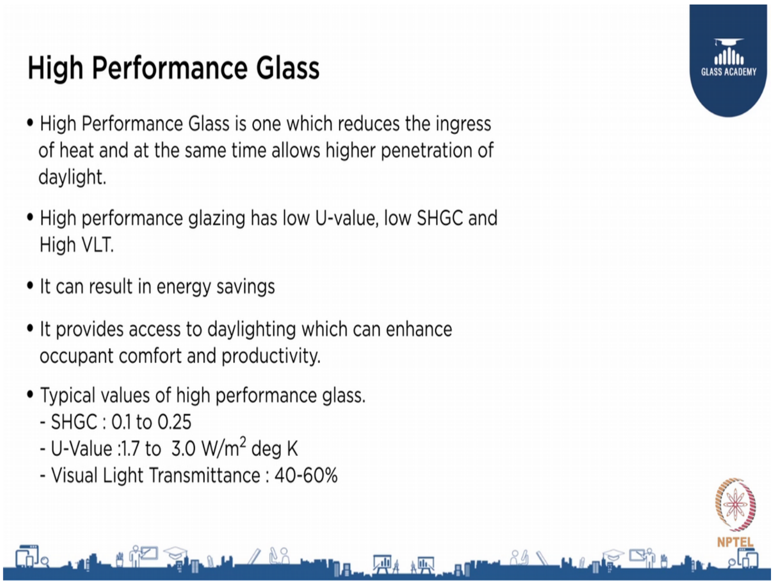

So, what is the high performance glass? A high performance glass for us that is in the tropical regions would be the one which reduces the heat ingress and at the same time allows lot of light to come in; that means, it should have high visual light transmittance it should have low solar heat gain coefficient, and it should also have low U value. A typical high performance glass would have value of solar heat gain coefficient of about 0.2, 0.25 U value of about 1.7 and visual light transmittance of about 40 percent. Now we have understood the glass and we have understood the solar spectrum, now let us see how we can enhance the performance of our windows.

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