Glass in buildings : Design and Application
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Lecture - 49
National Building Code 2016

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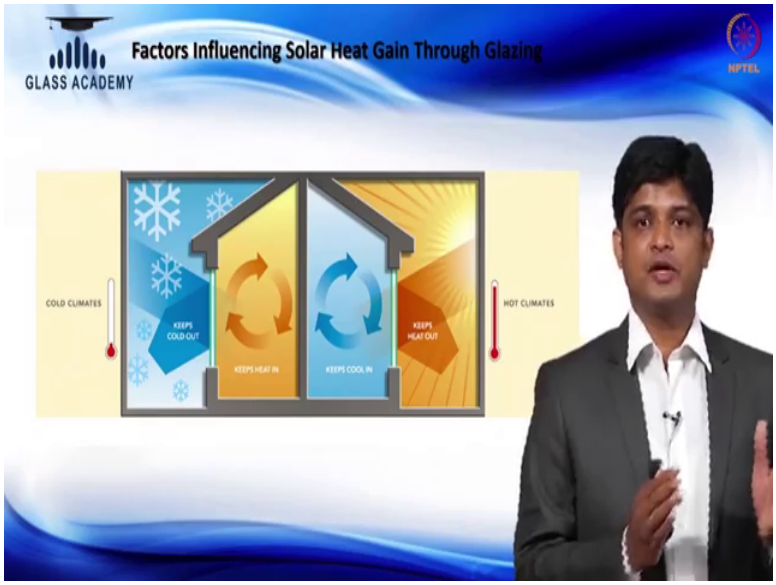

So, one is safety so, we addressed we know how to select glass based on the application, based on the location. And then how to test the glass what are the test procedures available or what are the kind of test available to go through it. So, once the safety is done then I have to move on towards a energy or the sustainability. So, how can I make my building more energy efficient or sustainable yes there are options available. In fact, NBC starts with a very clear note saying the glass selection has to be done based on the location.

For example there are different kinds of glasses available in the market, it has to be precisely selected based the climatic conditions. In fact, ECBC very clearly defined five climatic zones and based on the five climatic zones how the glass selection can be happen which I will take you through.

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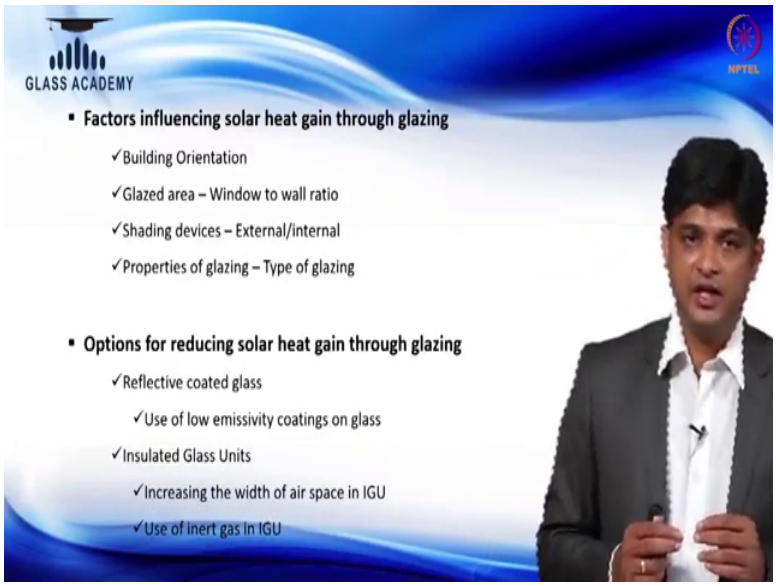

So, there are key parameters which is going to influence or which is going to influence overall heating load or the cooling load ideal in India we much worried about the cooling capacity or the cooling load of the building which is inside. So, the important parameters which going to influence that the first parameter which we call the solar factor which is the direct heat transmission ratio for a glass. So, as I said for a clear glass it has 83 to 85 percentage of transmission. So, how can we minimise this impact you cannot reduce the source value you have a glass. So, there is a possibility of the heat entering into your building. So, how can we what are the choices that we have to minimise this heat coming into your building.

The first choice will be if there is a possibility playing with a orientation of the building because traditionally with the sun path understanding, you can identify that the east and west of the building has more impact compared to the north and south. In fact, compared to south the north even becomes a negligible direction for the sun to penetrate. So, is it possible for us to play with the glass area or the orientation of the building as such so, that the amount of heat coming in can be reduced.

Second one important parameter is the window wall ratio of the glass window to the wall ratio. So, what is the percentage of window compared to the percentage of your wall? So, a NBC says from 0 to 40 percent in case of prescriptive or anything more than 40 even up to 60 65 percent it has to be as per prescriptive. So, the challenge is which direction I

have what is the window wall ratio. Based on the window wall ratio what is a kind of product we going to use.

So, that the amount of heat coming in is going to be reduced. Is there possibility to have a shading device which is a permanent shading device which can reduce the amount of direct heat and light to an extent which is going to enter into your building or finally, the property of the glass as I said what is the light transmission what is the solar factor and what is U value of the glass.

So, to again recap to influence the amount of heat coming in the key factors influencing the solar heat gain is the orientation which is ideally you have to play with the east and west to north and south. So, you can try to place the building more towards north and south than towards east and west.

Then the window wall ratio, what is the percentage of window wall ratio respect to the orientation. Then is there any possibility to have a shading device. So, that it can help you to cut the heat coming in and the fourth important parameter is what is the performance of the glass going to be used in the building based on the purpose or the occupational pattern.

Second one is what are the other options that we can do to reduce the solar factor one is I can play with how to reduce the heat coming in there are some provisions available. There is I have a restricted orientation or I need a particular window wall ratio I am not able to have a shading device still I wanted to reduce the heat coming in then I have to play with a solar factor of the glass. So, what are the things that I can do in reducing the solar factor which is ideally going to cut the heat coming in from outside to inside.

The first option is you can use the coatings the reflective coatings. Whether it can be an online coating or an offline coating, but the current generation offline coating as a lot of generations has developed and it has a very precise numbers or a precise solar factors can be achieved based on the type of building.

So, ideally you can use reflective coating which is can be again used in a insulator format ideally it is called double glazing unit. So, you have an outer coated glass you have twelve mm mere gap and you have an inner clear glass s, which helps you to disconnect the solid member.

So, that the amount of heat transfer has to pass through a solid and then the vacuum and then solid member. So, its helps you to reduce the percentage of heat transferring from outside to inside.

So, option one is your coated glass which helps you to reduce the solar factor directly because of the coating you use second one is use it in a double glazing format which can help you to reduce the heat to an certain extent. Or the third option which can we can have an use inert gas into the air space medium between the two glasses which can further delay or reduce the amount of heat transferring.

So, option one is to this content is we need to identify what is a possibility as a designer or as an architect or as an engineer we have in selecting the glass. So, first option is to identify how to reduce the heat coming in by changing over all the aesthetics of the building, here I mean aesthetic is orientation, window wall ratio and your shading devices.

If I cannot play with that much my plot sizes so, I have a constraint on the plot size I cannot turn around the building or the plot itself are quite rectangular and I am not able to turn it around, then the case then you have to have a huge impact on how you going to reduce the solar factor of the glass.

So, the options available again is you can have a coating on the surface of the glass you can. In fact, use tinted based coatings which will help you drastically reduce the solar factor. Second option is you can still use this in a double glazing format. So, you have an outer coated glass and inner clear glass with an air gap third option is the air gap can be filled with an inert gas. So, there is three options for the buildings to address there is three options in the glass to reduce the solar factor.

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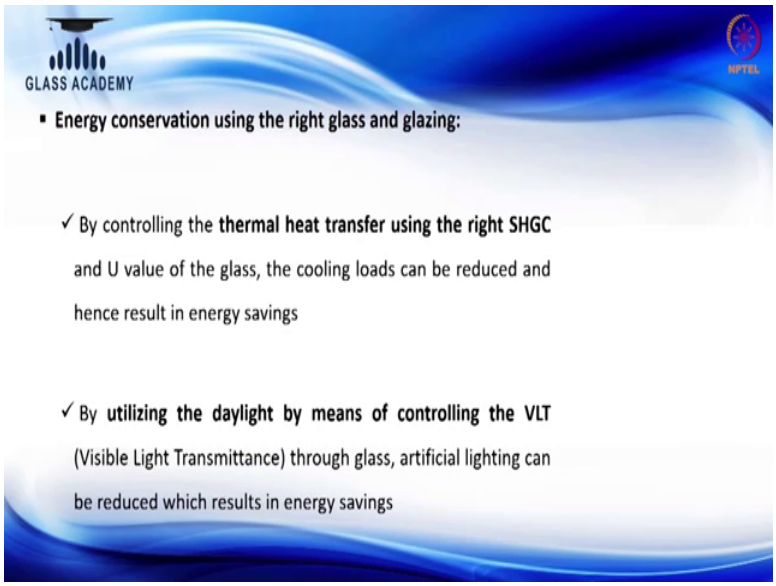

So, what this code trying to convey? It says by controlling the thermal heat transfer using the right solar heat gain coefficient or solar factor. And the U value of the glass the cooling load can be reduced and hence result in a huge energy saving for the overall building, this saying instead of allowing more heat into the system and then trying to optimise the efficiency of the cooling system.

There is an provisions available you can play with a type of the glass or you can with that orientation of the building to reduce the amount of heat coming in which going to impact overall cooling system.

Second important parameter is the functionality of the glass to harvest more daylight moment we harvest more daylight there is a critical point for it which we call the glare. So, when the amount of light coming in is extremely higher which is go more than what I needed for the particular occupancy zone then it becomes a disturbance and it becomes a glare.

So, the ideal or minimum or optimisation in the glide transmission is very important. So, based on the window wall ratio of the building, based on the floor plate of the building we need to identify what accurate visual light transmission is required for the facade glazing so, that the amount of light that coming in has to be distributed fairly in the entire floor plate area without creating a glare into the boundary area.

So, there are concepts like you can have a day lighting devices or day lighting paints which can help you to have a deeper penetration of the light without disturbing the overall comfort of the occupant.

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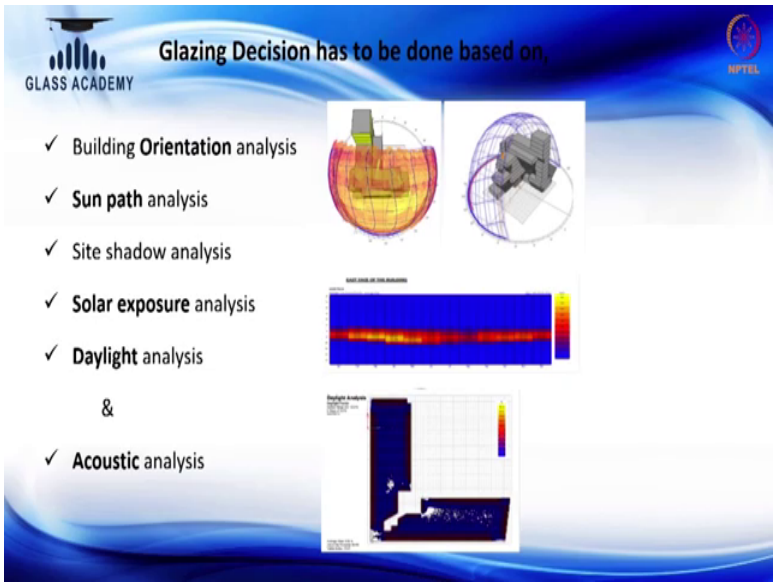

So, to do the glazing analysis or to select a proper glazing we can in fact, the NBC has very clearly given a direction how can we select glass. So, today with the modern tools available we can do a simple building orientation analysis, we can do a sun path analysis, we can do a side shadow analysis, we can do a solar exposure analysis even the day lighting analysis which helps you to identify the directions which is more vulnerable angles which are very vulnerable or the number of days in a year which we need to address that as a constraint.

Or based on the kind of a building or the neighbouring building and their impact over the builder how can we get the benefit of the neighbouring building shadows, this can be precisely understood with a current tools technology. I mean the technology which is available with the tools which this the detail about this tools can be used we will be covering it in another section which is called the design tools.

So, even in this solar and daylight you have tools which helps to understand the heat transfer ratios and you have a day lighting tool which understands to help you to calculate the lux level on your entire floor plate or a tower working table height or the tables height table tops.

The both will help you to understand what is a bandwidth of products that you have to select for satisfying above the light demand on the energy demand which again the both has to comply your energy efficiency code or has to comply as per the national building code.

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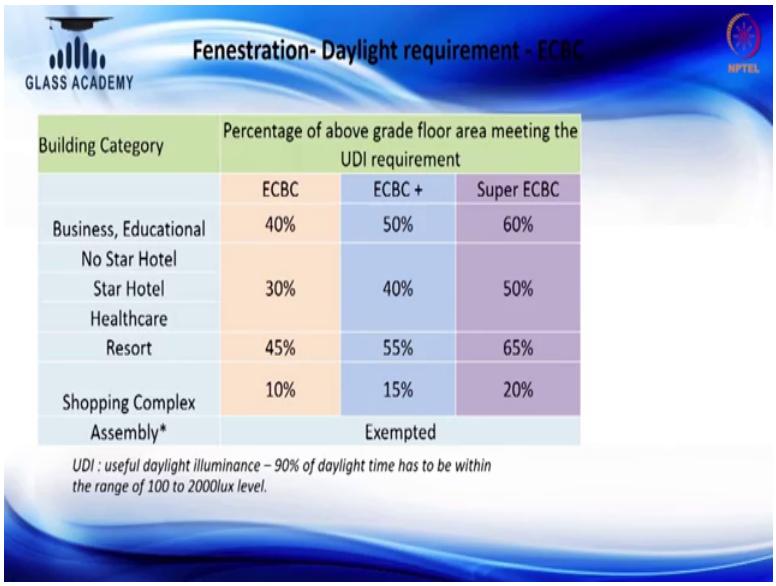

Building Category	Percentage of above grade floor area meeting the UDI requirement		
	ECBC	ECBC +	Super ECBC
Business, Educational	40%	50%	60%
No Star Hotel Star Hotel Healthcare	30%	40%	50%
Resort	45%	55%	65%
Shopping Complex	10%	15%	20%
Assembly*	Exempted		

UDI : useful daylight illuminance – 90% of daylight time has to be within the range of 100 to 2000lux level.

So, just to take you through what is covered in energy conservation and building code of India which is recently revised in 2017. So, the basic difference version from the current old to the new version is the old version has only one kind of a building where you can do it as per prescriptive or you can do it as per simulation under prescriptive you have a trade off.

So, new template which has slightly been upgraded so in fact, in this you have you can design the building as ECBC or ECBC plus or super ECBC building. Mean ideally you can improve the energy efficiency of the building by just doing simple measures which is covered in your ECBC specific to the glass. So, based on the different category they have even given what has to be the precise requirement on a lighting and the precise requirement on your solar factors.

So, the first the lighting this time we are working on the UDI which is ideally called useful daylight illuminance, which is ideally between a particular bandwidth of 100 to 2000 lux. So, what we do is I have a building and I have a particular window wall ratio. When I have a glass with very high light transmission when I do the day lighting

calculation the percentage of area above 2000 is not considered. The percentage of area below 100 flux is also not considered. So, I will be calculating very precisely which is the comfort zone between 100 to 200 flux what is the percentage of area in my building for the whole year.

So, ECBC says for a for an example to a business or an educational building if I have to comply a building for ECBC 40 percent of the floor area has to has a light transmission between the range of 100 to 2000 lux. If I have to make my building more efficient more naturally litter if you which is called ideally the ECBC plus in that case I have to comply this for 50 percent, how it is possible? Just by increasing light transmission it is not possible is I increase light transmission then it will increase the percentage above 2000 which will which is not a solution.

So, in this case I have to play with a design precisely whether I can divide the vertical facade into two as a daylight and vision pane or I have a light shelf which can penetrate the light deeper. So, the third category which is called the super ECBC which I have to achieve 60 percent of the floor area with 100 to 2000 lux which is called the UDI for the whole area, mean I have to precisely from the day 1 when the building designed my intention has to be I am going to make a super ECBC building.

So, the intention to satisfy or to make three different types is one is with the basic design or the confirmed the design. We can make simple alterations to the product selection and you can make the building energy efficient. Or the next step is we can introduce some kind of basic accessories like your shading device or a daylight panes to improve the efficiency, the third category which is the super ECBC ideally from the day one from the design phase it has to be done otherwise it is not easy to make a building super ECBC.

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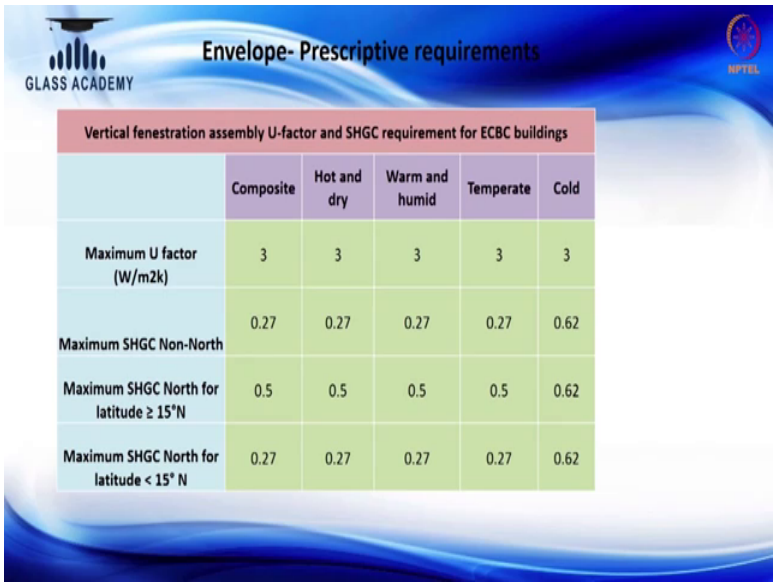

Vertical fenestration assembly U-factor and SHGC requirement for ECBC buildings

	Composite	Hot and dry	Warm and humid	Temperate	Cold
Maximum U factor (W/m2k)	3	3	3	3	3
Maximum SHGC Non-North	0.27	0.27	0.27	0.27	0.62
Maximum SHGC North for latitude ≥ 15°N	0.5	0.5	0.5	0.5	0.62
Maximum SHGC North for latitude < 15° N	0.27	0.27	0.27	0.27	0.62

So, then on energy what is recommended as per ECBC is you have U value requirement which is ideally 3watts per square metre degree Kelvin and for the solar heat gain coefficients for the non north areas up to for the standard ECBC buildings. The solar factor requirement minimum requirement is 0.27 lower the solar factor it is going to be a better building.

Similarly for based on your orientation you can understand what kind of a compromise you can do it on your solar factor which is very detailed out in your energy conservation code. And it has five different climatic conditions for even some time based on the climatic condition you can you can play with or you can compromise the solar factor values.

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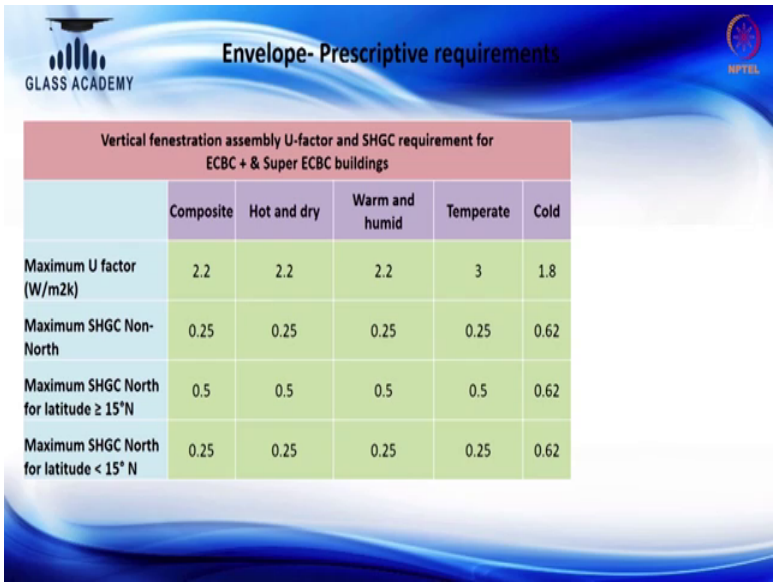

Vertical fenestration assembly U-factor and SHGC requirement for ECBC + & Super ECBC buildings

	Composite	Hot and dry	Warm and humid	Temperate	Cold
Maximum U factor (W/m2k)	2.2	2.2	2.2	3	1.8
Maximum SHGC Non-North	0.25	0.25	0.25	0.25	0.62
Maximum SHGC North for latitude ≥ 15°N	0.5	0.5	0.5	0.5	0.62
Maximum SHGC North for latitude < 15° N	0.25	0.25	0.25	0.25	0.62

Similarly, to achieve ECBC plus or super ECBC buildings in case if you wanted to do in the design stage then very precisely the code says the solar factor has to be less than 0.25 for the non north direction orientation see south east and west similarly you can play with your solar factor for north or based on the kind of a location.

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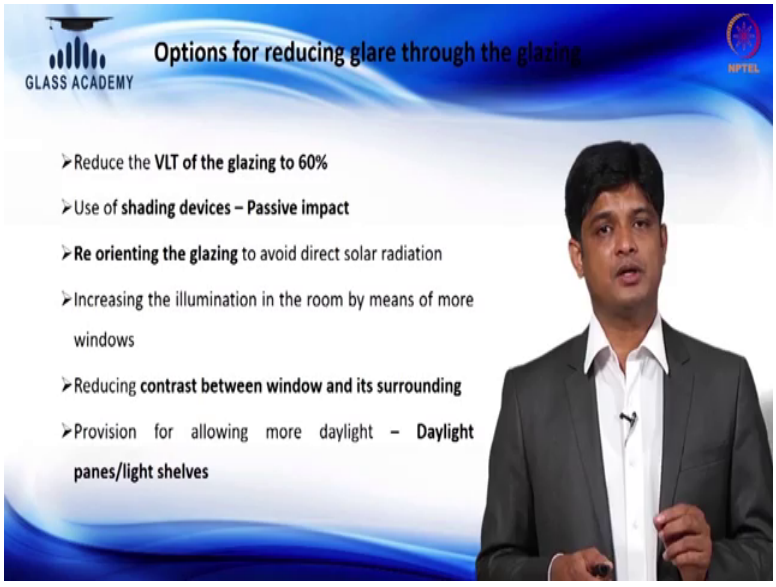

So, the three important parameters that actually covered in ECBC which has reference in your NBC 2016 is the solar factor requirement, the U value requirement and the light transmission requirement for three different types of building. Which is the basic ECBC

plus and super ECBC. As I said to make a building ECBC we need to address or we need to find a proper energy efficient materials so, that the current design we can make it as an ECBC building.

Whereas if I have to make ECBC plus I have to do some kind of a trade off, it can be on the window wall ratio it can be on the shading devices or I have to introduce something like daylight shelves or I have to introduce something like high performance glazing which has a higher selectivity to make the building ECBC plus. If I have to make super ECBC building then it has to be start from the day one starting based on the orientation even orientation wise the window wall ratios can be played or orientation wise different products can be used to achieve or to make the building as super ECBC buildings.

There are some kind of suggestions also been given in the code, which helps you to make the design in the basic stages itself to make it more ECBC complaints let us say ideally try to make your window wall ratio in the ratio of 0 to 40 or 40 to 60 in this 2 bandwidth. So, that you can play with the materials to make the building more energy efficient or you can use a shading devices.

Which ideally have a huge impact on your overall light and heat coming in, as I said orientation or we need to play with the light transmission of glass to control the external lighting level with the inside lighting level requirement or we can use shading device or day light paints to harvest more or you cut the light source either or options.

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