Glass Processing Technology
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Lecture – 02
Glass as Building Material

So, today's session this will be very specific towards glass called Glass as Building Material. So, today's in modern architecture glass has been effectively utilized for the facade.

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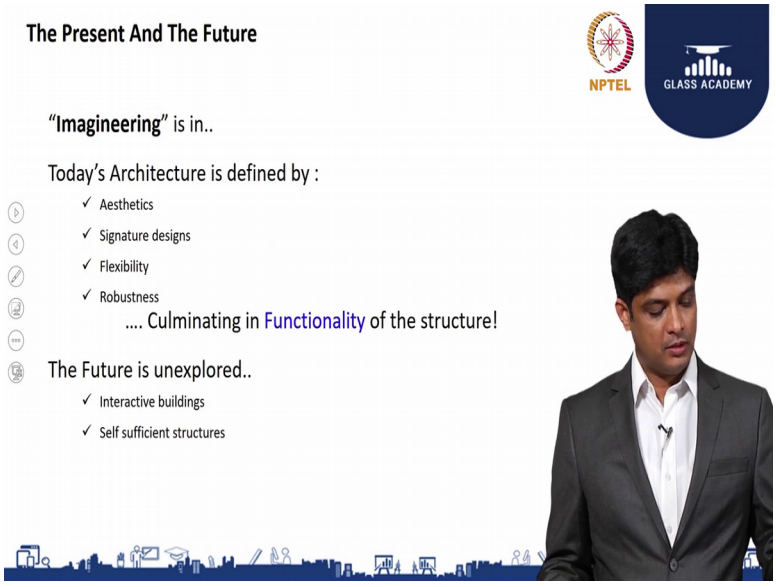

So, we call that as instead of engineering we call it as Imagineering where architects imagination has to match with the design and the facade the glass. So, it is very clear that today's architecture very precisely need very different and unique our aesthetics, we can even call it as signature designs or they wanted to be a material which is used for envelope which is very flexible in the sense of various options to be evolved in using the material and, the robustness in the time of the way it has to be getting constructed, whether it can be the speed or the availability or the replacability has to be very robust.

So, this creates a lot of challenge in the functionality of the structure. Still we would say the future is unexplored because there will be huge involvement or in the development has to happen in the facade engineering which will end up in giving a plot of interactive buildings or we can even call it a self sufficient building or a net zero building, this is all

possible if we can spend a lot of time in basic understanding the material that used for construction especially the glass.

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Today, we need to understand very clearly before the project going to come up based on the material used say for example, if glass going to be the envelope material of a building then we need to understand this material by design, by analysis, by the need, by benefit it going to bring in or by the function it going to execute during the process of construction or even after the construction process.

Unless we are not able to understand any of these parameters then there will be a challenge in handling glass as a building material. Why and how I will take you through.

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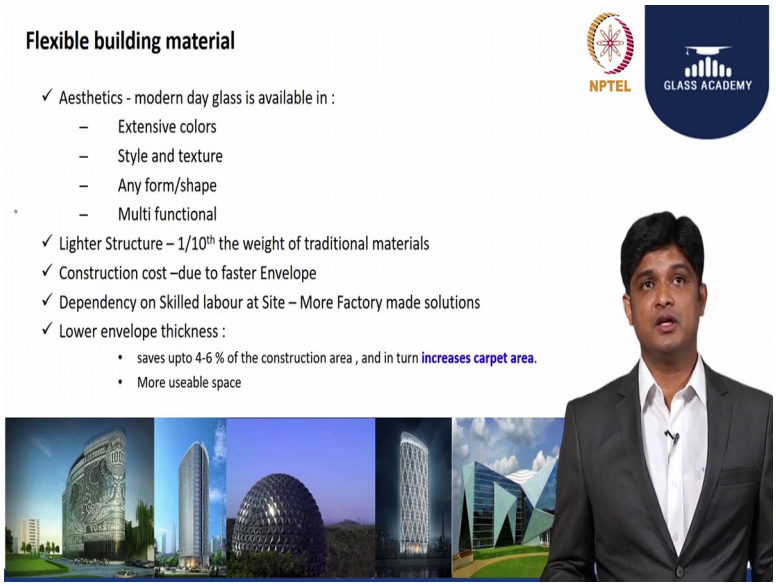

Because, today's modern architecture you can see as the pictures below there is a huge challenge in the way this it has to be visualized whether on the colors, whether on the style, the texture, the shape or the multifunction because now we are looking forward to have a facade which has to be used like a digital media or it has to be dynamically controlled. So, all this functions has to be integrated in the initial phase of design. Why glass as an envelope material or why we wanted to understand glass as a building material? Because glass has it is very unique advantage when compared to any other equivalent envelope materials there is no equivalent envelope material I would say.

Because, glass is about one tenth lighter than any other available building envelope material on the construction site if you take the time that it going to construct a envelope with glass, it is going to be extremely economical because with the current technology even there is a possibility to glaze 2 to 3 flows per day. Then the dependency on the labor is a huge challenge for today's construction whereas, when the glass buildings which glass structures which is moving more towards factory made products which can make it viable or a no need to have a dependency of the skilled labor at site. So, there is a fact limit product which is going to get just assembled or hooked inside.

The major most important advantage of glass it is the envelope thickness. The traditional building material which is are more than 300 to 400 mm thick to watch a particular performance values and plus an inverse as to behave as an envelope material. Glass can

simply does that with 24 mm thick double glazing unit or worst case it can go up to 30 to 35 mm thick. This has a huge impact on the over raj overall carpet area there is a scope to increase about 4 to 6 percent on the usable floor area if glass can be used as an envelope material. So, ideally it increases your more usable area.

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So, who are the key stakeholders in glass industry? Yes, ideally it is an architect who imagined the building. Yes, there is a consultant who guides us and helps us to identifying how to and what to type what kind of glass has to be selected. Then the execution or the fabricators who go in to execute or erect the glass at the site based on all the different design constraints and the developer or the builder who going to invest money on the building and the envelope material. And finally, they are going to maintain the building or going to sell the building in whatever the case how energy efficient or how green the entire building is going to be and all this four important stakeholders in the market has a huge or different needs I would say.

When I go with an architect he would be always looking for a very futuristic design or he wanted to challenge his own design and come out with a very new unique design. The safety is a major construction constraint for them to achieve when glass brings as a material. What is the eco friendliness they are going to make with the building or the footprint carbon footprint the building going to make, or what are new shades they

wanted their building to stand out from the crowd, so, what is the new shade they can go on.

Then the consultant comes in to picture whether it can be a green consultant or can be a facade consultant they always look for reference of international quality both on the production and both on the execution both of the supply of materials. There is many projects nowadays has a huge challenge in achieving the acoustics with the current speed on the construction happening or even we have a group of projects near airports or the hotels near airports has a huge challenge against acoustics. Safety again is important aspect that consultant wanted to address always, fine of course.

Finally, the cost and the availability which is the local sourcing been a very important parameter for them to select any glass manufacturer. When it goes to the fabricator the glaziers they always worry about the international quality products which is tested and various laboratories or the availability perennial availability of the materials around the year and how effective their design when compared to the availability of the standard sizes. So, from the standard sizes currently even the jumbo sizes are getting produced so, how effective or the usage or the yield can be improved.

When it goes to the developer he much worried about the sustainability factor or the footprint or the eco label or the cost the overall cost of the façade, what are the ways that they can save money or how they have to effectively invest on glass and how the savings can be measured.

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So, getting more deeper glass to understand glass. To start with the glasses as basic float clear glass which is manufactured and we can have tinted glasses where we can add coloring agents to the base float glass where I can produce green, blue, bronze and gray. So, this is ideally the base glass this can be used for a coating purpose or this can be then after coating it can be processed and the same process glass get executed for the site. So, getting into the coating technology as a process if I say the base glass manufacturing which is a process 1, then the coating happening which is a process 2, then the processing ideally I am doing some value addition on the structural property of the glass which is 3 then 3 action 3.

So, in this first which is a float glass as we all know it is a very old technology, where the glass has been the basic raw materials are being grinded fine grinded, placed into the furnace at a very high temperature of about 1600 degree Celsius that the complete material gets into the mold liquid state, from there it has been poured into the bath which is ideally called the float bath the name comes because, here the glass as a liquid material is floating over a material called tin. That is why it is called float glass and then by just controlling the temperature the glass is able to get it its size, thickness and then it is allowed to cool on its natural process which is called the annealing process which is the third process in glass manufacturing.

Once I do this then I have to decide whether I am going to do the coating on the line or off the line. On the line as it indicates during the float glass manufacturing process when the glass is going to exit the float bath and before it going to enter into the annealing layer, I have to apply a specific metals and oxides in the form of vapor to get deposited on the surface of the glass which is called the on line coating technology.

Where I by this coating technology I can make a product whether it can be a solar control or it can be a thermal insulation or a low-e glass. In case off line as we see as the name indicates it is off the line means the coating has to be done precisely in a separate location where you have multiple chambers to have a different materials which can be deposited on the surface of the glass to achieve a particular color, particular performance, particular reflection values or event a particular solar factor and new values.

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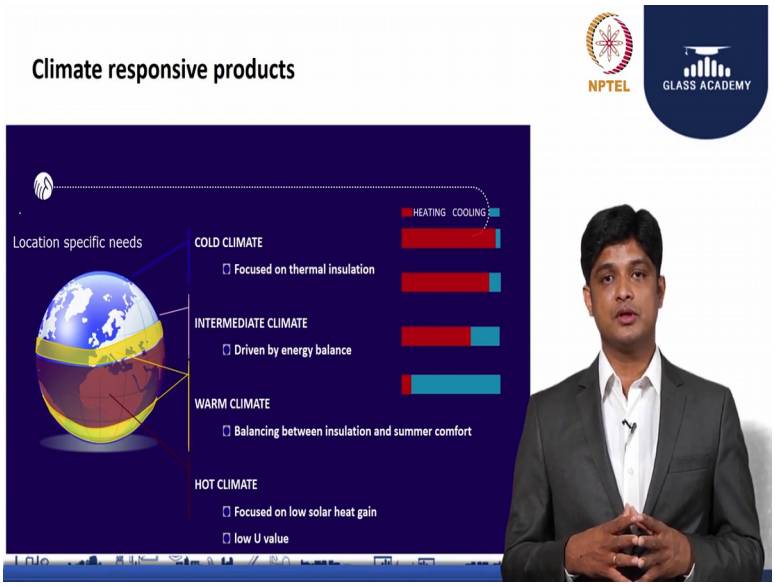

So, how do we decide what kind of glass to be produced and how do we decide what kind of performance is requirement for a different parts of the world. So, it is specific about Asian countries. Our climate is very unique and very different compared to the rest of the world. We can say our climate is very typically a hot and a humid climate where you need where you need a glass coating which can help you to reduce the as much as heat that going to or trying to enter into your building.

So, based on the different climatic condition they are all different products are getting manufactured like solar control and thermal insulation glass. As the name indicates solar

control is where you have a direct solar which is going to allow you or it going to penetrate more heat into your building has to be addressed, then it is solar control glass. As the name indicates if it is a low-e glass or thermal insulation glass, then we are going to play with a difference in the temperature which is ideally not the climatic condition for India or even the Asian countries.

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So, what is the challenge in India we have? We have two different challenges one I would say the light, another one we say the heat. When you say when you calculate the of energy spend in any building 40 percent of the energy is spent on cooling the building and 25 to 30 percent of the energy spending in giving natural light to the building and remaining 30 percent is left to the occupancy load and the other internal heat loads which is because of the any other electrical appliances.

So, the 70 percent of the energy which is spent which is the cause of the contribution through your envelope material which is your light and heat. Even though as a country we have enormous light still we spend heavily on artificial lighting and similarly, on the other side we have a source called sun which is going to allow a lot of heat into your building. So, you are going to spend lot of energy on cooling the space.

So, what is a common material which going to address both? It is ideally the glass. That is why glass became and modern envelope material I can say. Moment I say glass as an

envelope material or a building material the important parameter it has to be addressed is the light transmission and the heat transmission portion.

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So, to understand when you select a product there are three important parameters we are supposed to go through or we are supposed to understand before selecting glass. One is the light transmission, another one is a directly transmission, the third one is indirectly transmission.

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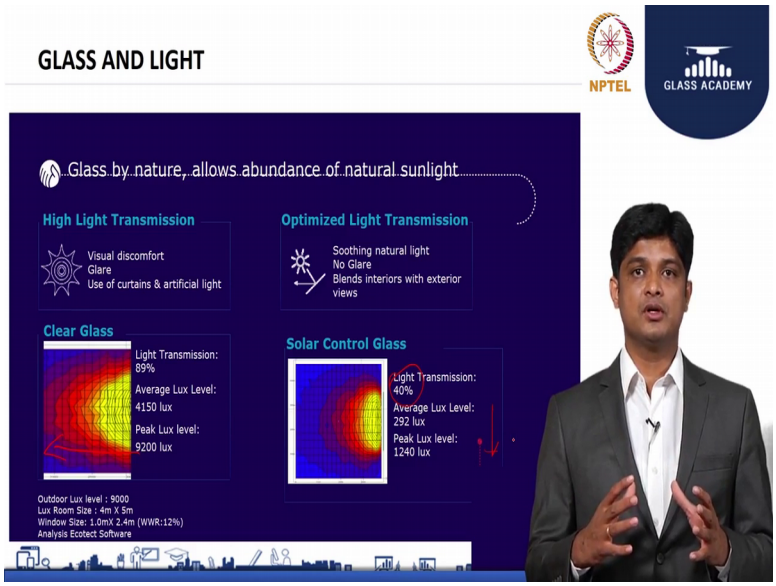

So, what is the light transmission? The percentage of light that pass through the glass and going to reach into an interior inner space of your building; the percentage of light transmission happening through the material is called the light transmission visual light transmission of a glass.

So, what is a traditional mistake I would say we will be doing? We have a clear float glass 6 mm or even 5 mm thick which has a light transmission of about 89 percent. If you see through here the problem we can understood very clearly is based on the color code the more yellowish means there is amount of the lux level which is above 4000, is more in the zone. What it indicates? It indicates that when the light transmission happening the depth of the light penetration this restricted as much as to 1 to 1.5 times of the height of the window. So, the entire that zone is going to get accumulate the amount of light coming in. That is why the average light lux level is very high and even the peak is going up to 9200.

The ideal light transmission level lux level that we can hold it or we can be comfortable inside the space has to be around 2000 – 2500 lux max. So, this is a traditional mistake we do. We have a clear glass 5 mm or 6 mm which has very high light transmission say like 89 percent; 89 percent to what? 89 percent to about 1.1 lakh lux of light which is a source; so, when my glass has a tendency to allow 89 percent which is approximately we are going to get 1 lakh lux inside the space. 1 lakhs lux versus what I need to read and write it is hardly 500 lux.

So, there is a huge gap between what I need and what my source is going to give me, this will create glare. Anything more than 1 is to 10 ratio will affect the comfort of your user. How can I address or currently what a solution I have? I will have a different kinds of blinds which going to cut the light. But, is it am I going to cut the light alone? No, I am going to cut the complete visibility.

Any building when it has been designed the basic need to design the building with glass is for two; one is to have a see through or the transparency for the inner occupant to see through the external world and the second one is the light transmission, so that the natural light comes into my space which has huge impact on individuals comfort and productivity even on both physical and psychological actions. How can I address it now? I do not want it to cut the light completely, but I cannot have a glary situation. So, that is

where this kind of high performance glass comes into picture, where I can have a glass which is with ideally 30 to 40 percent light.

So, just for this example if we can see here I have a light transmission which is at 40 percent which has dropper to the entire lux level, whether it is both average or your peak lux level to an extent. So, that now I am going to give you the same natural light, but intensity of the light is lower, so that you no need to worry about as a disturbance without glare.

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One more design aspects I can bring it to is, traditionally we do not want it to have a larger windows because we believe moment we increase a glass area I am going to increase more heat coming in. But, with the today's modern sophisticated products available in the market I have a window wall ratio about a 16 percent which is I need to spend about 4.2 kilowatt hour of electricity consumption in the same building I have an provision to increase the window wall ratio to 25 percent, still my energy consumption is lower because I can have a solar control glass, it is going to cut the heat and the amount of heat coming in is less inside. So, automatically it has a huge impact on the overall energy of the building.

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This there is an, another important parameter to be addressed when it comes to light transmission. So, what are the other things that we can do to create a better environment? One is we should understand what does ideal light transmission or marginal light transmission. When I use a very high light transmission glasses it will end up and giving your extreme visual discomfort which is called glare or it will promote you to or it will it will create an habit for you to have a different kinds of blinds, curtains and it will improve your artificial lighting, end of the day having a glass getting defeated.

How to understand what is the impact when you have an marginal lighting? It will be very soothing and still you can enjoy the natural lighting, you can control glare to an extent and the functionality of the glass which is going to blend the interior with exterior that is all still alive. So, there are lot of other ways even though if there is a requirement to have a higher light transmission in a project as a design intent there are there are other ways to address this constraint of higher light transmission.

For example we can have a simpler ceramic dots or a stripes on the top surface of the glass above your vision area which can help you to block the direct light coming in, still it allows the diffuse light getting into it or you can divide the vertical panel vertical facade into two panes; one has a daylight pane and another one as a vision pane. So, that the daylight pane can have an higher light transmission glasses and the vision pane have a lower light transmission glasses, so that the people occupying near the facade may not

have any disturbance due to light, but still there is a daylight pane with higher light transmission can have low the light to get deeper more.

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