Glass in buildings: Design and Application
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Lecture – 77
Sustainable Building and Facades

Inside the outset I like to thank glass academy for inviting to give a lecture on Sustainable Building Facades.

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In next 40 minutes or so, I am going to talk about sustainable facade and people aware how the facade looks when you look at building from exterior in various places in this country. But, the facade design has to be a climate pacific depends on the location the facade designs would vary to reap the maximum benefit on the building performance and indoor environment, besides, aesthetics.

So, you cannot have a same design replicated everywhere the country are across the globe. It should be decoded indigenous to the local climatic condition. This how the facade should be designed to take care of your building operational energy and building occupant comfort.

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What is sustainable facade? It can be defined as an exterior enclosure that use least possible amount of energy to maintain a comfort environment for the building occupants without having any negative impact to the indoor environment. And the building material what you used for building facade designs should have very minimal negative impact to the environment.

So, not only operational energy performance other building occupant comfort the facade material should be eco friendly, should have very minimal negative impact. You cannot eliminate the effect of environment where is we are using origin material, but you should know how to compare 2 materials and select the one which has got very less negative impact to the environment.

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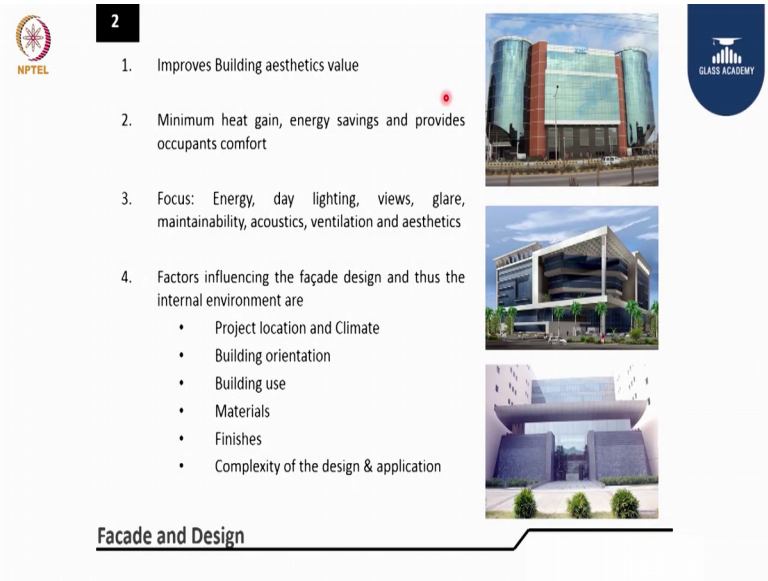

When you look at why you need a facade proper facade for a building? Why not just a building and leave it? It improves the building aesthetic value you can look at different building in different locations country you get a wav factor when you see from exterior to certain building. Early days we used to see LIC building in Chennai about 20-22 years back tall building and elegant look.

So, that is also required so, that is why the architect play a major role in improve the aesthetic value of the building. And also the facade due to the tropical climate in this country, we need to minimise the heat gain to the building. When you minimise the heat gained you will be saving energy during occupancy and also when you have facade which gives a comfort to the environment indoor you can improve the occupant comfort and productivity.

There by the focus will be on energy how do you bring a daylight to the interiors? How do you provide a view to the exterior environment? How do you minimise the glad to the occupant? Otherwise, you are to put the blinds and cut down the daylight and the beauty of aesthetics and work in a dark environment with artificial lighting. It should be easy to maintain, you cannot bring some element for the facade and it brings a lot of difficulty for you to maintain.

Acoustics is very critical when you have building across any major roads and traffic. Ventilation and aesthetic of course, the ventilation is a playing major role where you

need to have a sea water level is maintained and you know water level is maintained indoor. So, that people have a proper ventilation to breathe and operate.

In a nutshell if you look at it what are the factors influencing the facade design, how do you choose a facade? Material are kind of the specification required to be maintained. One is project location and climate, what kind of climate in which your building is going to sit and operate? Orientation of the building, building usage type what for your building is it day operated or night operated? Kind of material which you were going to use it for the particular climatic condition, how you are going to finish it? And how complex is a design and application of the building?

So, all these important factors should be mapped right at the beginning of the building designed so, that you can bring the proper facade to the building it is like person wearing your clothe. So, that very very essential to be part of right from design the facade engineers and all other system engineers to ensure that facade is properly conceived to get the maximum benefit out of it.

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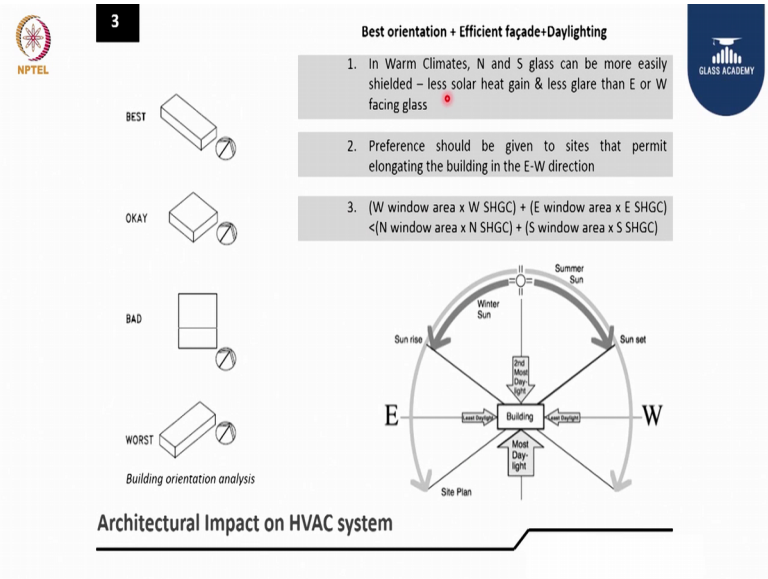

Let us talk one by one like orientation, how the orientation has to be in India? For our warm climate normally we get cool light on the North and South can be managed easily. You cannot have more exposed area in East and West.

If at all you have an opportunity in a site orient your building, we normally go with the more North and South orientation and put less in load on the East and West. Even if we get East and West some areas to be protected we can create the some sort of you know the space which can be utilise for services like a service core lift and toilet facilities will act as a heat sink so, that the heat from the East and West, the morning and the evening can be arrested to large extent.

So, normally our exposed areas should be more of North and South, North will be a cool light you can have more glazing to get that daylight fenestration to the interior. South can be managed with some sort of facade design in terms of projection material.

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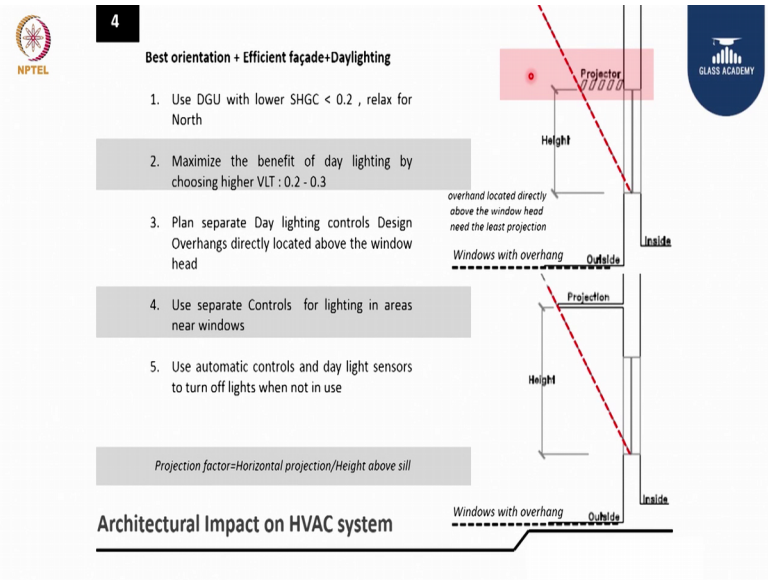

The orientation once you have an orientation normally look at we have 2 standard we follow for the glass selection one is energy conservation building codes of India the latest 2017 standard and ASHRAE 2010 latest standard has come into the market. Both is defined in the specification for our climate, ECBC defines our Indian to 4 climatic zone and ASHRAE defines 1, but more or less we are talking about SHGC of 0.25 is a standard for India.

So, our study with 400, 500 building we need to target around 0.2 to 0.25 is a solar heat can coefficient to optimise the heat increased to the building and bring their optimum day light. So, North S though the standard says 0.25 SHGC, but North still you can relax go

up to 0.5, 0.6 where there we are getting a cool light and rest of the areas like East and West preferably reduced to 0.2 to maximise the benefit.

Also you can have a overhanging wherever required on the facade, you can look at here. So, that the projection angle can be optimised or designed based on the heat increase and sun path study to get the sun angle heating the bottom not the glass. So, the projection angle for the chajja has to be designed. So, that the sun angle will never heat your glass, in that way you can get the diffuse light to the interior not the direct heat came to the glass which affect your indoor building performance.

So, projection angle and projection depth has to be decided based on the glass height and width. So, this is a very very critical for you to design a facade element with respect to the glass facade what you have in your building. And once you have this kind of you know light fenestration indirect light fenestration not direct then you can have proper daylight zone to the interior and you are to plan your interior design accordingly. So, that this daylight fenestration to the glass diffuse to one is not control or what I mean to say is do not put a cabins here to cut down the daylight fenestration to the interior.

So, better to have an open offices in the Northern facade side. So, that North area you will get a cool light. So, that all open offices can enjoy here rather than having a cabin and in a enclosed spaces which cut the daylight fenestration to the interior. Moment you get the daylight and perform the daylight analysis, see how much is the daylight fenestration based on the glass specification and the window to wall ratio here.

And wherever you have a daylight try to go for daylight sensors. Once you have a daylight sensor you an artificial lighting can be controlled based on the lucks what you have on the work table here.

So, what surface we have to design based on the type of application and you can controlled the daylight fenestration and optimise the artificial lighting consumption in this area. This how the general approach for the facade design and projection ah chajja plus glass selection.

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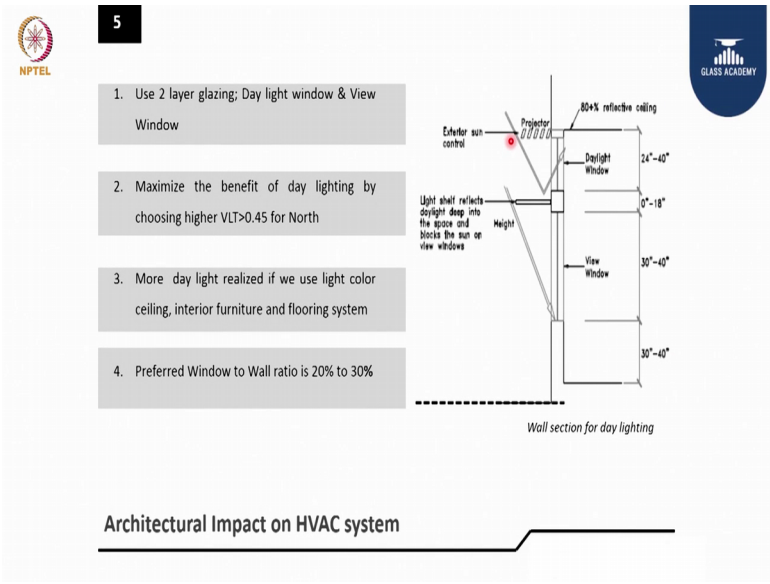

You can see the projection angle it will be small like here since the window height is small and when you have window height is more the projection angle has to be little more so, than light will not heat the glass directly. So, in particular when I talk about other than North side you can go up to 0.45 even 0.5 sometime. But, rest of the areas you can controlled predominantly you have to reduce it to 0.2. So, that the light fenestration can be optimised at the same time heat increase can be minimised.

So, ultimately, I look for a window to wall ratio of say around 20-30 percent that is the best number to be achieved for optimise the heat gain to the building. So, 20-30 percent window to wall ratio is the best want to design for a building to optimise a heat gain.

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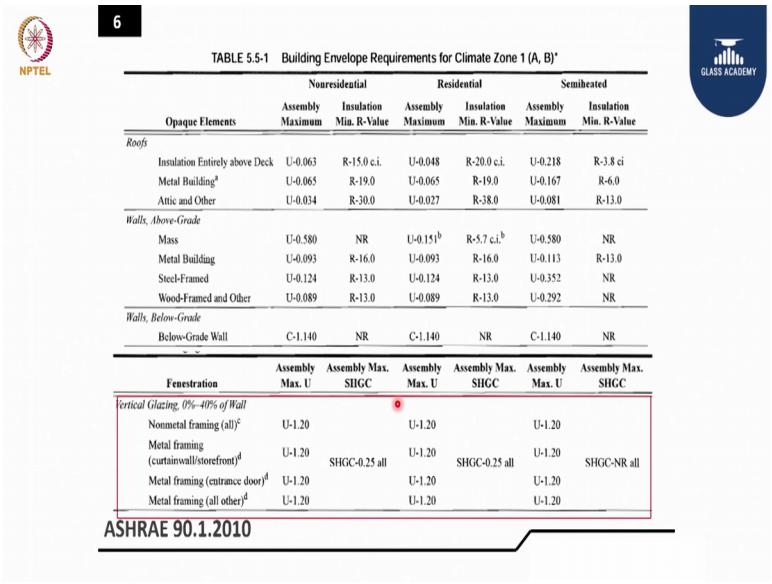

Then when you talk about the U factor the 3 major factor we normally look at it for a glass. One is U value, second one is SHGC, the third one is you can see here this is what the U value. Then you have an SHGC and one more factor is a visible light transmittance. So, all 3 to be balanced to get the best out of glass facade, what you have. Glass is very vital for a building where in we need to get the view to the exterior and the daylight fenestration at the same time how do you optimise a heat increase.

So, we normally go for lower SHGC, lower U value, higher the VLT that is of the combination is going to be worked out for a building to optimise. This is from ASHRAE 90.1 2010 standard.

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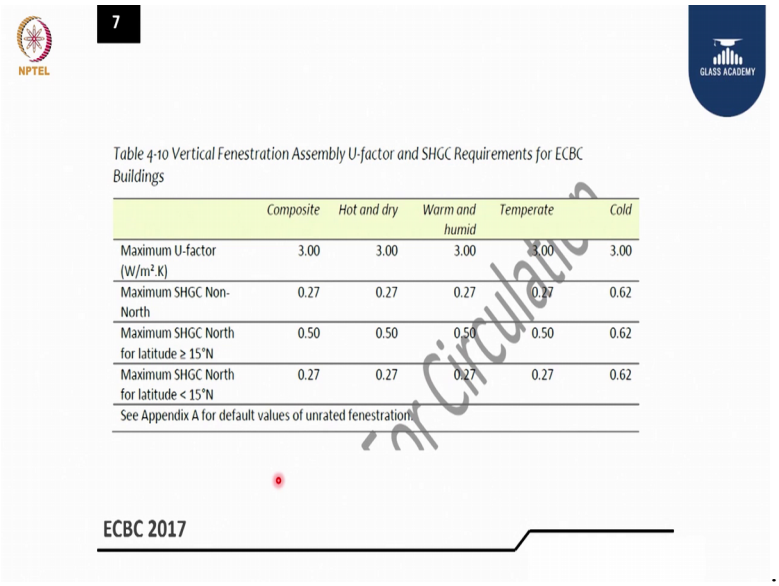

Even ECBC it classifies these 4 climatic zone composite hot and dry warm tempered and cold. So, these are the major 5 climatic zones and the factors of designed defined here very clearly, what kind of glass needs to be selected for this building. Moment you have a facade design are the chajja has been designed these values can be a composite value including your projection factor plus glass together, you can even relax little bit and your glass to get the total performance of the building.

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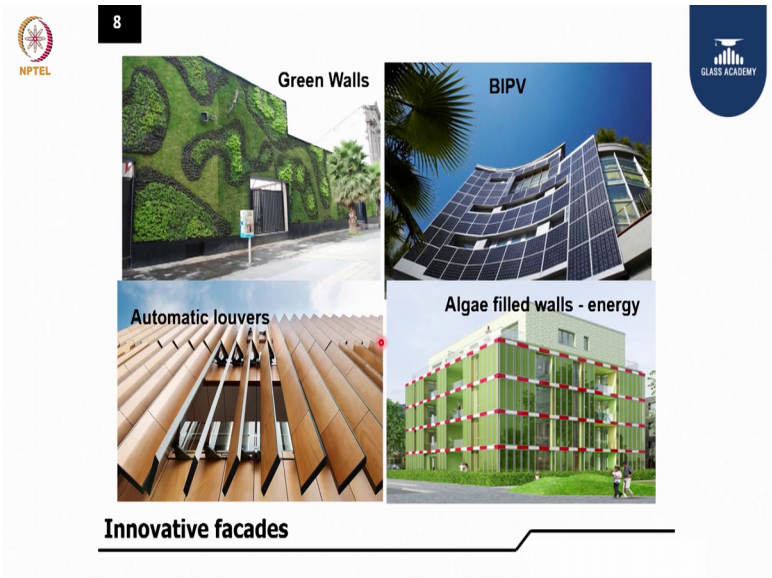

You can look at some of the facade design what is happening and this is a unconventional way. You would have seen all conventional designs here, plain wall, glass resource to glaze windows. Then the shading chajja's and pins etcetera these are some of the unique thing you can see the green walls, fully covered green walls and here you can see the pins made out of wood which is motorized.

And depends on the day of the sun angle you can adjust this blinds and control the sun light heat increase. At the same time you can allow that light to fenestrate plus heat can be arrested. And this is a BIPV, building in the gear photovoltaic very new generation solar the energy from the solar panels which will arrest the heat increase at the same time it allowed light fenestrate.

Now, you have a thin film technology, you can place it on the glass which will generate. And now they people are coming with the glass which has caught in build solar thin film where in you can generate power and also act as a glass. And this is another one R and D work is happening.

Somewhere I remember about in German algae is formed in the glass in between 2 layers and which will arrest the heat increase to the building and bring the beauty to the building. And this algae will be removed often to make it is a menu for garden and again regrowth and they supply oxygen once in a while to per they algae to subway.

So, these are some of the unique designs are happening to bring the beauty to the building at the same time improve the building performance and aesthetic value.

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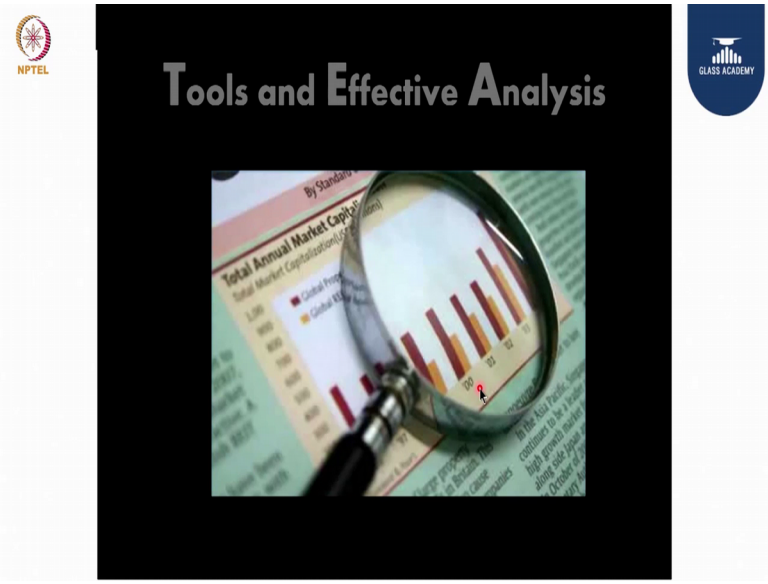

What are the tools available normally we do in India?

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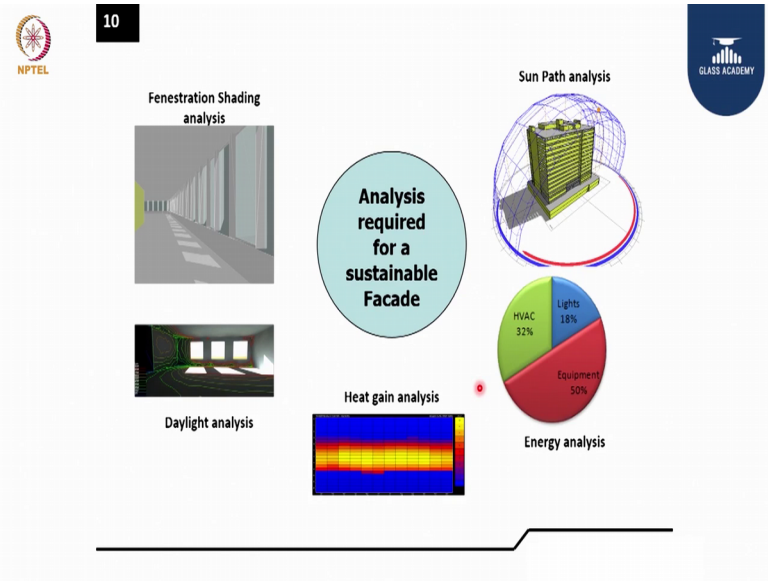

Basically, we have to go for the facade shading analysis. How that day entire 24 hours you can check for every day of the year. How the shading and sunlight fenestration to the building then daylight analysis, how this facade is giving a daylight to the interior environment where in you can control the artificial light and save energy.

Then the heat gain analysis, how the heat from the facade is having impact on your indoor environment and air conditioning load, then sun path analysis, understand the sun

angle then you can orient your building or design your facade to cut the heater directly into the building. Then after all these analysis done finally, you come to how this building is performing over on an energy. How much is a check energy is consumed in this building, how much from lighting, how much from equipment even you can divide further into ventilation system, occupancy.

So, you have to bring this number then revisit again, see how we can optimise to control this energy. So, 32 percent in a commercial building is a good number can be do 29? Moment you have this analysis you can keep revisiting and come back to the overall energy performance.

So, this is how the approached should be for a facade selection and implementation tomorrow for any building.

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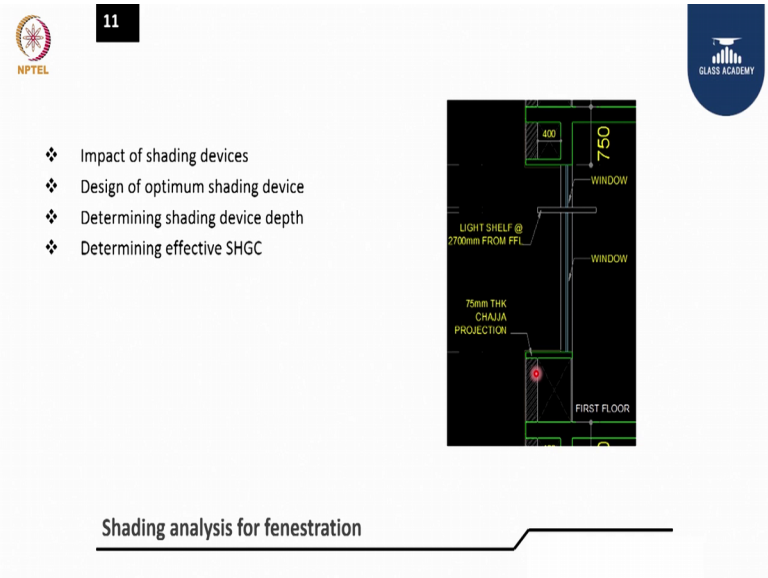

And when you do the shading analysis, what shading analysis bring you on to the table for you to optimise your facade? Impact and shading devices, what kind of shading devices you have for the facade? And optimum shading, can I go with a 600 mm chajja or 400 mm or 200 mm or 1000 mm that will be a decided based on the shading analysis. And how much is the depth and what be the effective SHGC and what should be the glass selection for a particular pin or chajja or projection devices.

So, that overall impact has to be seen and implemented to not only save energy and also save on you are the investment part.

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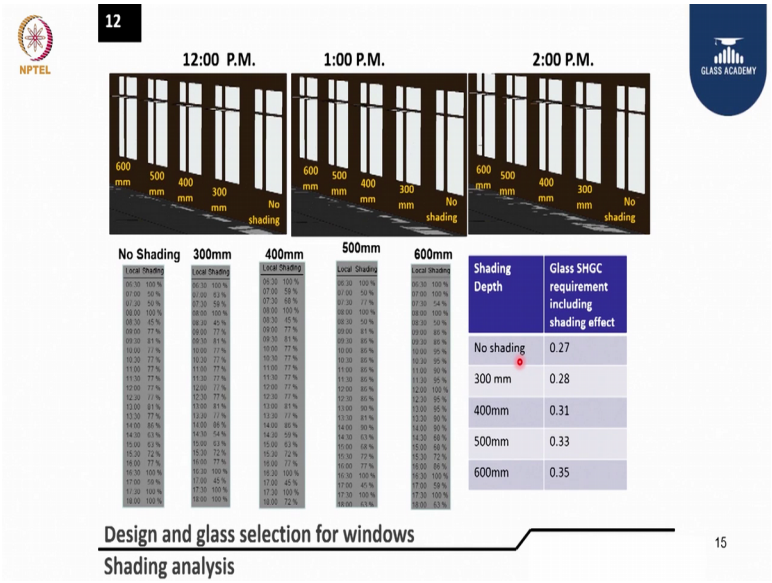

You can look at this typical analysis performed for one of the commercial building in Andhra Pradesh. When you have a no shading devices you can see here how the daylight fenestration is happening, some places 100, some places 77, 61 a good daylight fenestration. And if it increases 300 mm you can see again the shading impact on the overall performance. And 400 mm, 600 so, you can keep increasing in your simulation package and see. Here if overall look at it here is a result, if there is no shading you need to have a glass of 0.27 solar heat gain coefficient, double glaze unit.

So, when you increase your shade into 300 mm you can relax on your glass be as we are shielding your glass from the direct sunlight. So, 400 mm, 500, 600 mm just we need a 0.34 SHGC whereas, no shading same building required 0.27 to get the day lighting, to get the required energy performance. So, this way you look at it these 2 you can very well see 0.27 to 0.35 will definitely will have a impact on your investment on the class. This will be costlier in terms of glass performance and this investment for 0.35 is relaxed in terms of investment.

So, these are the element so, the facade translate into the glass selection investment is more critical. You cannot have facade in isolation design in isolation and glass selection has to be a combination of facade pins and the selection of final glasses SHGC value.

This way you can optimises to the finally, if you look at overall in this building the 400 mm projection angle or projection depth is ideally suited for this building in Andhra Pradesh, where we optimise a investment on the glass and also we got enough day light fenestration and savings on the edge back during operation.

So, this out the facade design needs to be conceived and implemented for a building.

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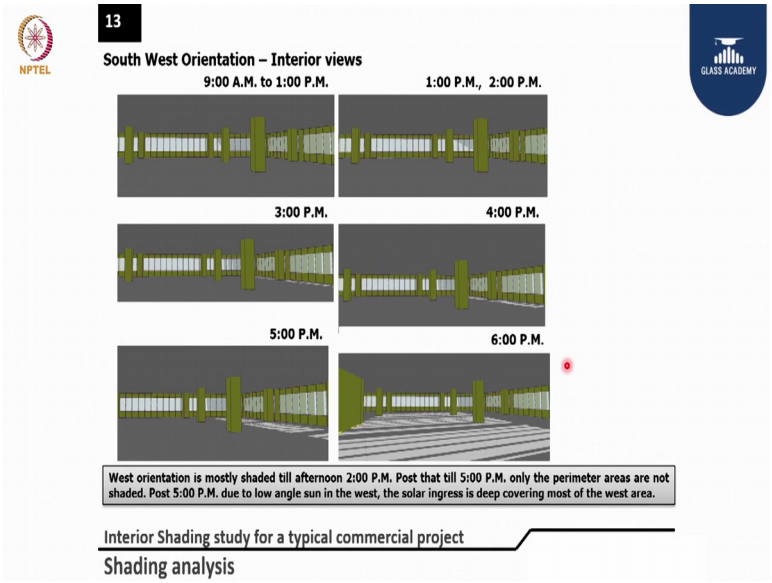

The next one you can see this how the shading has impact on your daylight fenestration inside. If you can look at these 9 am then you can see 3 pm, 4 pm, 5 pm and 6 pm. And if you look at it after 2 if you look at it after 3, I think 2 pm there is no sun light you can see there is no fenestration of sun light. Whereas, here if you look at here started getting the sunlight fenestration inside and gradually increasing it.

And 5 pm and you can look at 6 pm it is West orientation. When you have a West it is a direct sunlight a 90 degree heating on your glass. So, whatever pin you provide I am talk about vertical you cannot arrest this kind of this sunlight fenestration, it has to be a vertical pins on the facade and it should be a motorized or a movable facade design to cut down this heat gain or sunlight fenestration beyond 3-4 pm.

So, this gives an idea for you to understand how your facade and glass really behave in your building and what kind of facade metalized it have for different orientation to arrest

the heat gain and also minimise a daylight fenestration when excess day light is coming in to the building and you can see the again the same way we did for East.

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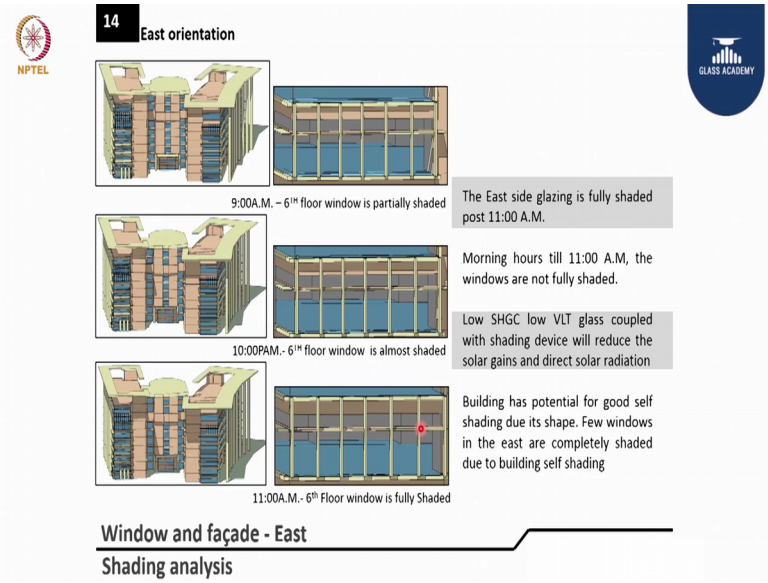

The very interesting picture you can see here the building self shading also happening here you can see 9 am there is no shading this facade glass is fully exposed to the sun in East. When it comes to slowly you can see here there is a self shading happening here. And slowly you can come down and see here also there is a shading happening on this facade.

So, this building is protected from this building there is a shading happening. So, this glass is protected similarly here it started happening. So, in that ways self shading and overshadow from the nearby building also to be really calculated so, that the facade design can be effectively implemented for the entire life of the building. So, the self shading and overshadow also has to be seen in detail when you do the facade design.

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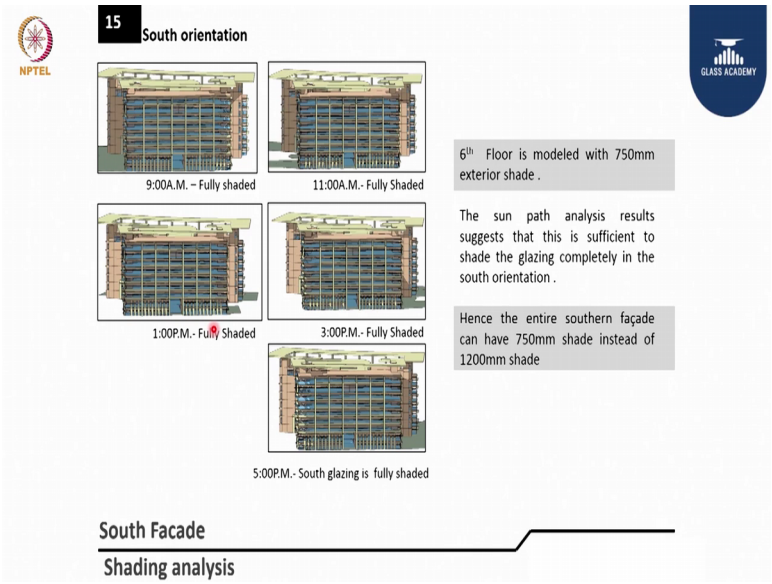

And you can look at the South orientation here we gone for little more about initially projected 1200 we optimise to 750. With the sun path analysis you can really do this kind of study and see how much is the depth required for a particular of a facade. Here up to you can see almost entire day from 9, 11, 1 pm, 3 pm up to 5 it is all fully shaded in the South.

So, that is what I said in the beginning South and North can have an more exposed area and you can have more glazing, South can be treated effectively with the pins and chajjas. In West you cannot do it after 4 it will heat directly on the glass. So, minimise the opening on the West and East and you can go more on South and North to get effectively implementing the daylight fenestration.

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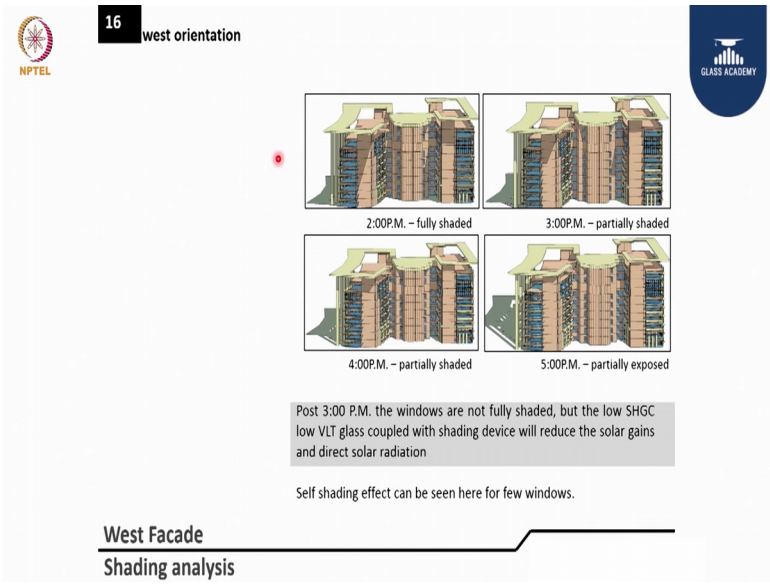

And West orientation a it is similar to East here you can see the exposed and the areas. Yes, you have a self shading and up to 2 pm you can say fully shaded. These are all shaded you can see this glass and moment is good after 3 you can see the sunlight is directly coming and hitting and after 5 we can see almost it is getting exposed.

So, this is where the problem in the West side you need to have the building orientation minimum glazing and the West so, that you can avoid sunlight directly hitting on your facade and creating discomfort for indoor environment.

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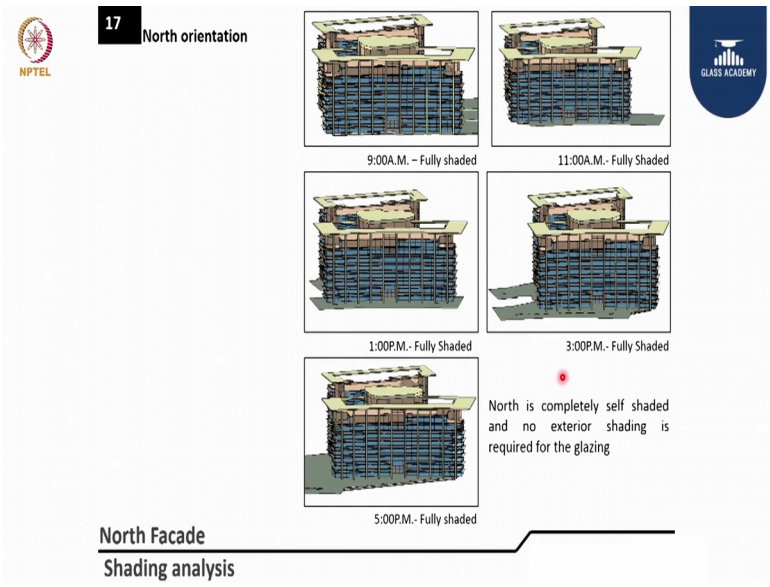

And North so, no where you can see the sunlight hitting on the glass. It is a completely shaded and cool light. So, here you can relax your glazing parameters like SHGC and U value co with a more VLT and you more day light cool light in this North facade for the indoor environment. So, more glazing and the North is better for the building performance.

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