Glass in buildings: Design and Application
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Lecture – 78
Sustainable Building and Facades

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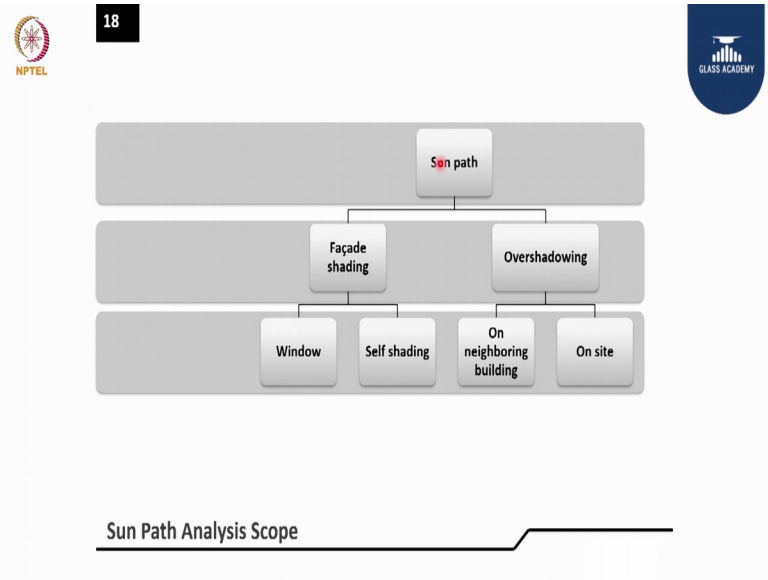

Sun path yes it is very vital for a building, when you have a mass development like a campus or a city. The sun path analysis required to talk about facade and shading, how much is the overhanging required? Then kind of windows how much is a self-shading, how you can see the building impact from the neighbouring building, how the shading is having impact and on site how this individual buildings are overshadow effect is happening.

So, sun path is critical for any building when you have multiple development, you can have a you will have benefit in doing all this by doing a sun path analysis, insights do not for the building right from beginning.

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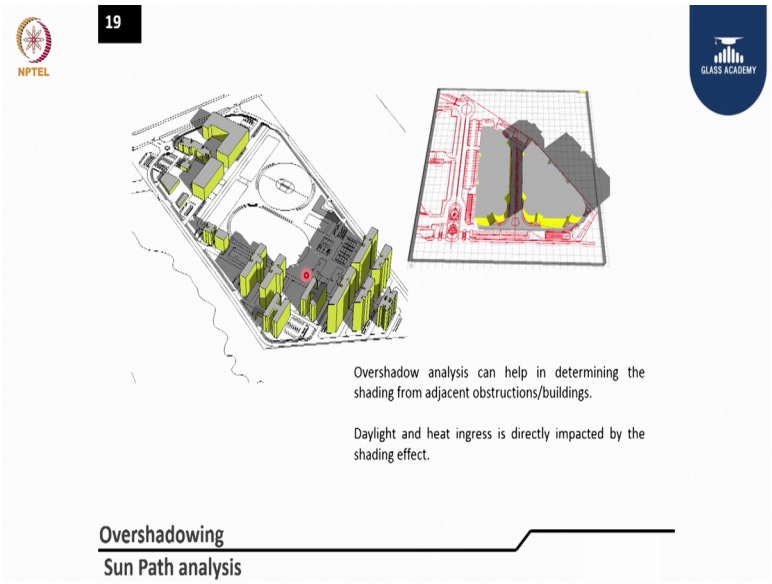

You can look at this picture how this study has been carried out? One is the heat island effect. You can see the heat from the surfaces, when you build this like a small concrete jungle how the heat island effect and temperature rise around the building is happening. And, over shading you can see the how this buildings giving the benefit to the adjacent building? How they shading is happening to the different building from building to building.

So, this answer can be studied moment you have this master plan ready with the building element and you can little bit adjust your orientation, and get the best out of this kind of campus design by doing overshadow from building to building and get benefit out of it.

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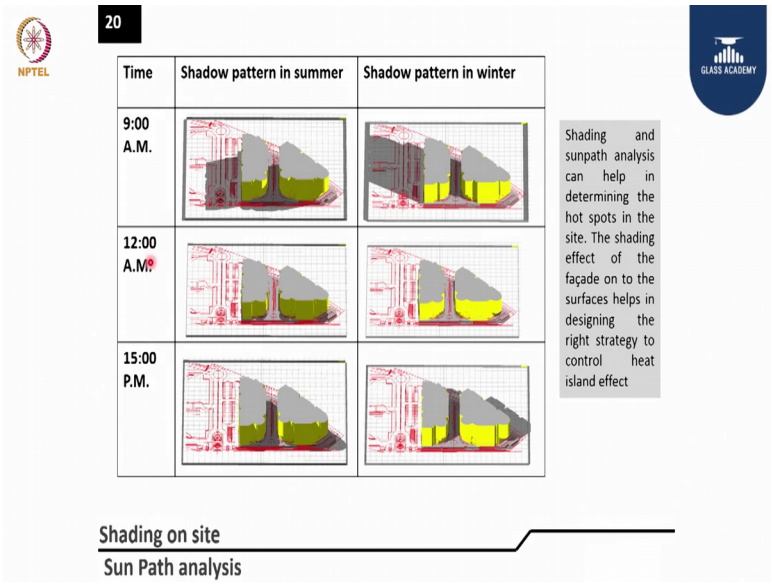

And, this shadow pattern you can study and I can 9 am 12 and 15, how this an angle is moving and the shading is you know getting accepted from one place to another slowly can see which direction it goes.

So, ideally we have to study for the worst day in a year March, April few days we have to study and see how this having impact? At same time you can study the energy performance as a building. When you have shading happening from one building to another the energy consumption causes building is coming down. And, when you have you do not have any kind of shading you can see the building consumption goes out with the same occupancy and load.

So, that gives an indication how this shading and sun path analysis is helping you for understanding your energy performance of the building.

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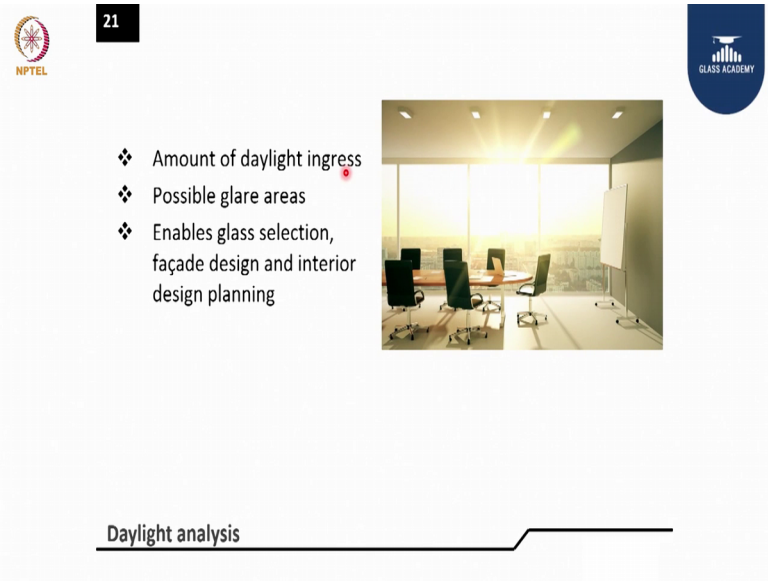

And, daylight is very very whiten be normally 90 percent with a live in a day we sit in road either at home or in offices. So, we are very comfortable are our productivity course when you work in outdoor environment that serve the human beings are bought into this world.

So, we like to have more and more daylight inside. So, possibly we should get a more daylight, but not glare this where we have to really balance both daylight and glare. So, the facade design and facade element plays a major role for glare just by having a glass you get the day lighting, but glare cannot be arrested without facade design. So, this very vital to balance both parameters to get the beautiful daylight indoor spaces.

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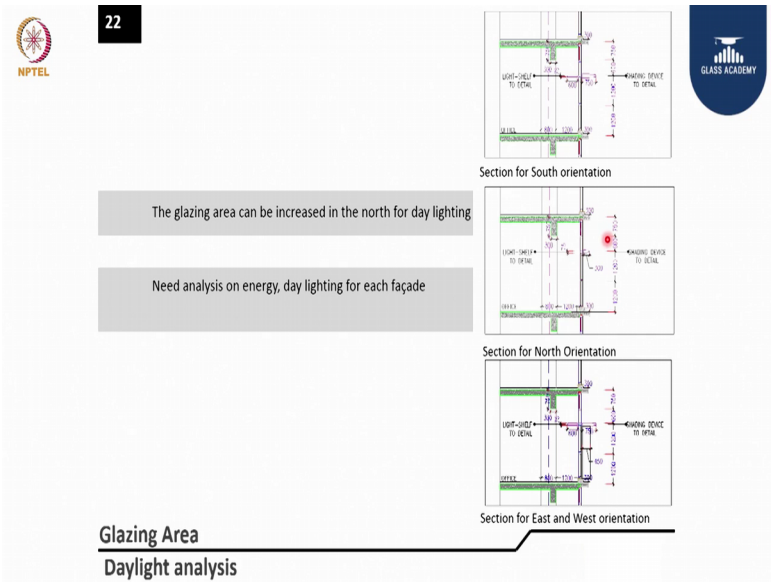

Now, the glazing areas if we locate bare how much is the glazing area, depends on your the projection angle and type of facade kind of orientation, you can get the glass fixed for a particular façade. And, very important thing is when you have a glass though you have a shading devices whereas, the daily penetration and the perimeter will be little higher always in terms of 2200 lux you can see here, but this is little strange for a occupant sitting in the facade of this area are adjacent to the perimeter area. So, we prefer to have some sort of light shelf's to deal this axes daylight penetration here, and put this daylight concentrated daylight and the perimeter to the interior space by providing light shelf's.

So, light shelf will effectively help us to minimise the some sort of discomfort or access light and the perimeter and allow this access daylight to be penetrate to the interior space where we have an artificial light. So, in addition to your facade pins, we need to have the synchronise design of light shelf to penetrate daylight to the deep interior to minimise the discomfort for the occupant and the perimeter, at the same time increase your daily penetration to the interior spaces to optimise energy performance.

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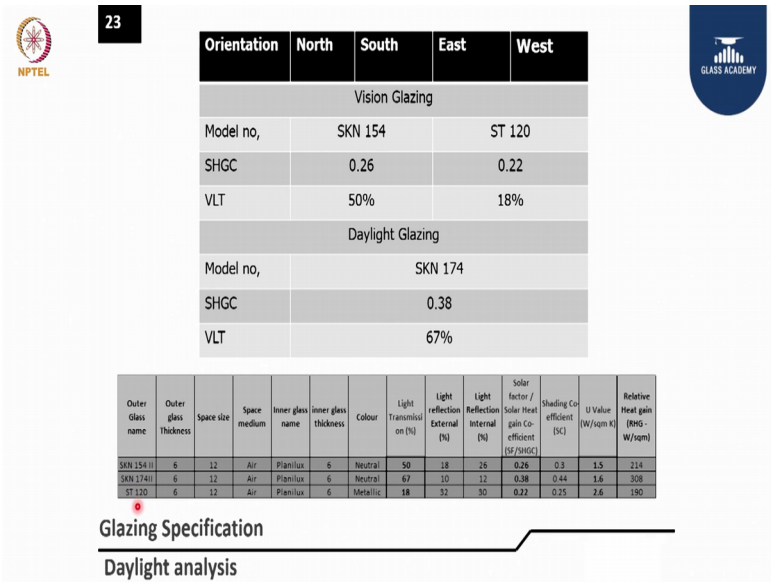

This one more analysis in terms of how the relative heat gain for a particular facade and with the type of glass what you are selected. So, you can have multiple glasses and parameter like (Refer Time: 05:18) SKN 154, we just got 0.26 SHGC and ST 120 about 0.22. By looking at this people will definitely go for 0.22 for energy when you look at daylight people get into 50 percent, but this is you cannot do it just manually in random basis.

You have to see how this glass is having impact on the particular façade. And, this one having impact both and energy and day lighting. And, we look at heat gain then SKN 154 is about 240 watts per square metre relative heat gain, and when you use the same ST 120 just 190, because this SHGC is more. So, these also give a relative heat gain give some direction for us to choose a particular glass for a particular facade.

So, relative heat gain analysis is vital in addition to daylight analysis for a selection of glass. So, we this project they have gone for a separate vision glazing for a different for North and South SKN 154, because I need more daylight from North and East be reduced to 18 percent day lighting VLT with more stringent glass. Then, we have a view glass and daylight, daylight glass we are conquered with more on the upper portion of your wall where you get a more day lighting and view glasses vision glazing is little more stringent. So, that you will have avoid glare as well as heat gain.

So, 2 layers little relax one for the upper portion of the wall get the daylight penetration without blind and lower portion will be a little better efficient glass. In that way you can optimise the daylight and glare for a indoor environment.

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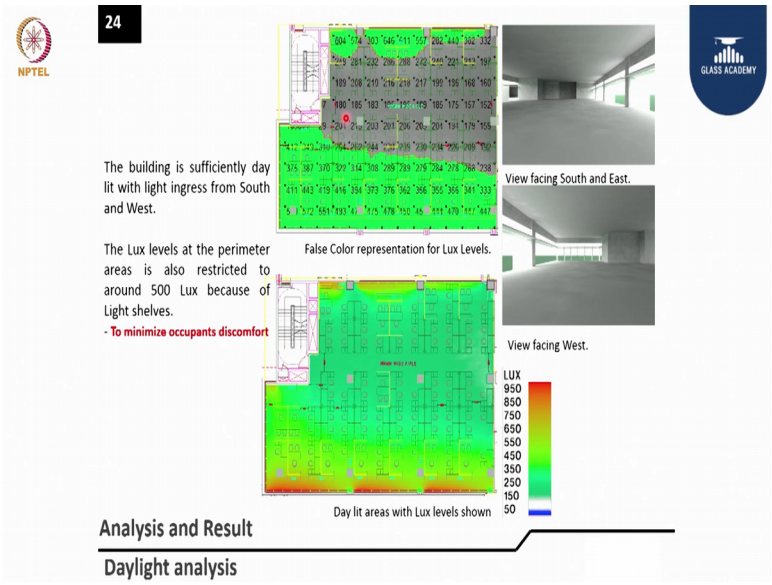

This is a simple one like how the daylight is penetrating to the interior spaces and you can do this with the Di-Lux and various software's available to understand the Lux level in your work plane from different facade. So, these are the areas we have a day lighting and you can understand the lux level here. So, this also helps you to get into the glass selection. Depends on and if you have a more daylight penetration suppose here you have a 6040, suppose you are getting 1000 1200 you can put a light shelf and make this space also little more day lighting.

So, this gives a design direction for you, after doing the daylight analysis for a particular work plane. Then, you can get into your shading depth as well as light shelf's and it is impact on your building overall performance.

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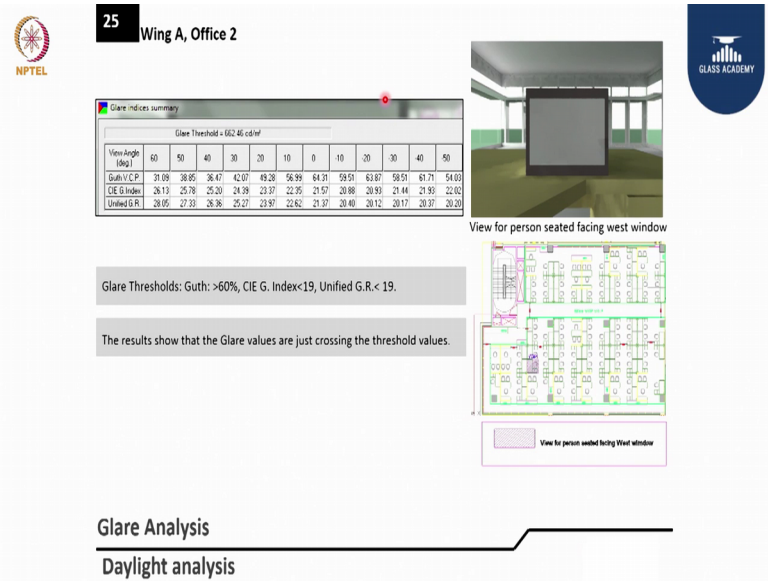

And, their last important analysis before you get into the selection the glare analysis, recently you have a bell rating and even lead version 4 is really directing to at this direction out how the windows should be position depends on the window to wall ratio, the glare control devices needs to be implemented which is be automatic control, it can be like a blind.

And also the angle in which you place your computer working about 200 I think about 2120 degree angle from the façade, where in you will get a less glare. So, every computer every work station and the perimeter where the daylight penetration is there need to be focused and adjusted, you cannot have a uniform design for the interior space and work, work player spaces and the perimeter, it should be angled such a way that the glare is completely arrested.

So, the person sitting on the perimeter area will have a less strain on eyes and working in the computers. So, there is a new dimension is given for the given from the well rating program and, now started practicing this in your in majority of the building design and construction in this country. So, this going to be ruled the interior design for most of the building very vital, when you look at the building occupant comfort and their productivity and help.

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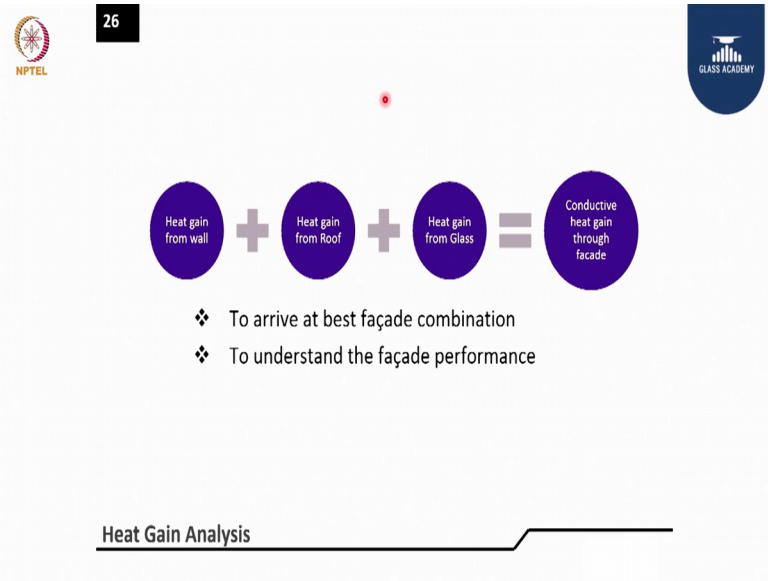

So, basically to look at overall when you look at conductive heat gain overall if you want the estimate, how this facade is performing for me? How much is a heat gain from this facade first you start with heat gain from wall plus heat gain from the roof. Then heat gain from glass, the overall you look at your building envelope, how this is having an impact on your overall heat gain.

So, we need to focus on wall roof and glass. All 3 put together, if you try to reduce this number conductive heat gain to minimise this heat incurs of the building, then you can really work on you are active components to save energy like air conditioning lighting and equipment. This of the building has to be approached, less conductive heat gain for the building element, then efficient active element to reduce overall energy performance and provide better performing building.

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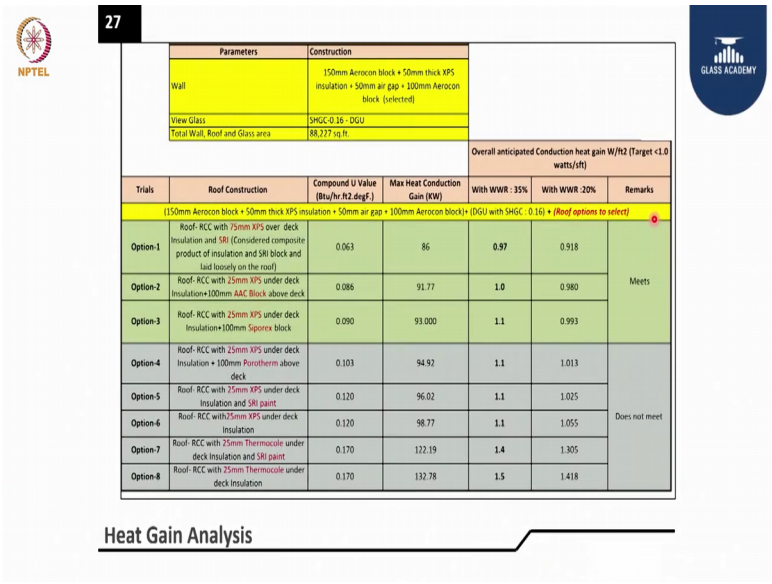

There is another project where the we set a tone of the relative heat can you if look go back to the previous slide you can understand conductive heat gain.

So, be set a target normally in India if you look at building will be around 2 watts per square meter. Here, we set a tone of basically target is 2 watts per square feet in Indian numbers normally we get. Now, here we set a target of 1 watt per square feet is the conductive heat gain to the building. Then, we started doing various combination of wall Roof-RCC 75 mm over deck insulation SRI paint, then we reduce 25 mm like this we have gone with the roof different kind of roof. And, what are the u value of the wall, then what is the maximum conductive heat gain, window to wall ratio will changed, then if it is 20 percent, if it is 35 percent.

So, we keep changing the combination of different element roof wall and window to wall ratio, then we thought these 2 3 options, these are the options be created based on the material and technology available, then these 3 options are meeting these other 4 to 8 which are in going beyond my target of 1 watt.

So, without doing this you cannot have the understanding of your building as a whole how the conductive heat gain or relative to heat gain is having impact on a building. So, you need to bring this kind of chart to the beginning select best suited wall roof and glass option for you, to get this overall conductive heat gain below my target. So, this gives a direction or gave a direction for the design to go with one of these 3 options and

eliminating this 5 options from the shortlisted design. So, this how the approach should be for a building in terms of how the building can be designed to get the maximum operational efficiency.

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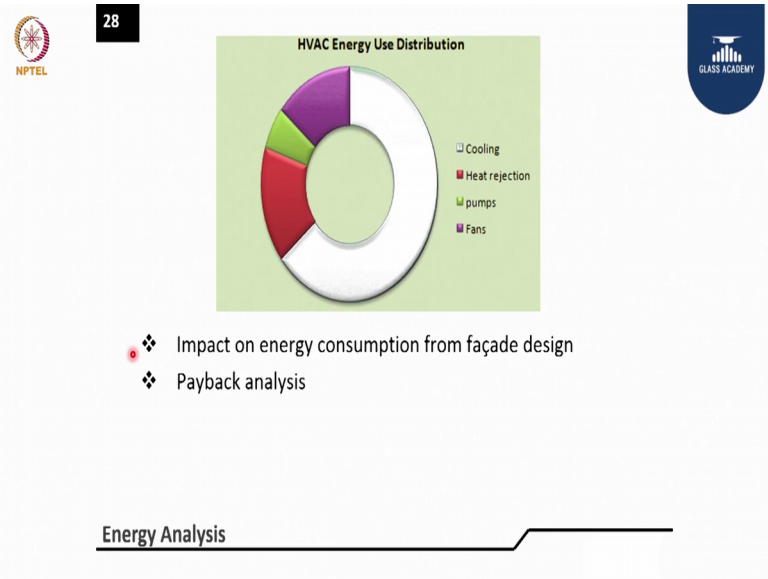

And, you know very well in the HVAC design having direct impact from the facade. So, you need to work on the ones you know the heat increase and you have optimise with the facade and window to wall ratio and the different element and the façade. Then, you can look at how do you optimise this cooling keep working on the cooling and see how we can bring the cooling down for our (Refer Time: 13:26) country, then you adjust your facade accordingly.

There is always a saturation comes beyond that, if you can ask inside 600 and why not thousand 200 mm chajja or why not 2000 mm, but beyond suddenly made saturation occurs, we were to stop with that then get into the cooling design so, that you can optimise overall cost.

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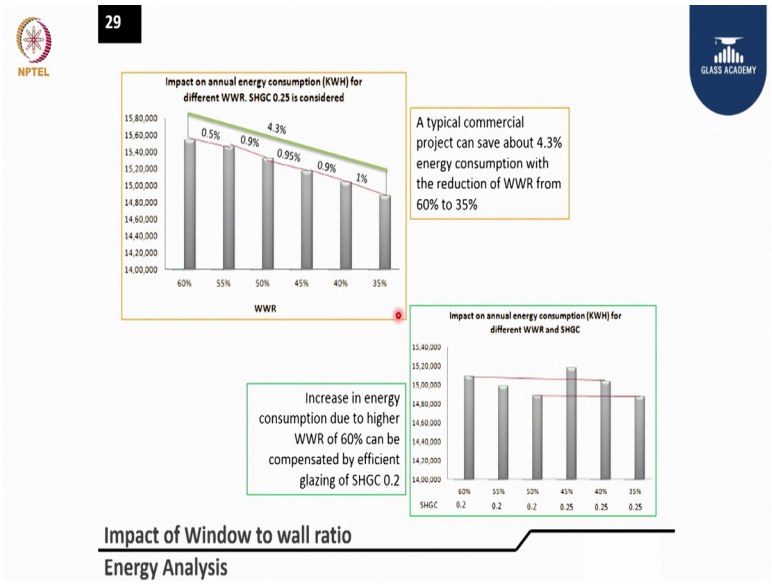

This is a very interesting slide in terms of how this solar heat gain coefficient having impact on your HVAC kilowatt hour consumption overall energy. I will straight away come here this is 60 percent window to wall ratio. I gone with 0.2 SHGC there is the best glass available. So, 60 percent and 0.2, if I get into the window to wall ratio of just 30 or 40 percent so, one is 60 percent window to wall ratio another one is a 40 percent, when you have a more window to wall ratio. I need to go for more stringent glass, where the glazing area is more.

And, when I went to 40 percent I relax class from 0.2 to 0.2 5 to get the same level of energy consumption. So, by relaxing my glass reducing window to wall ratio I am maintaining the same level of energy consumption to the building. So, this is the direction in which you can optimise your window to wall ratio and relax your glass. More the glazing, more stringent required to optimise your energy, if less window to wall ratio and you can really optimise your cost towards initial investment on glass.

Similarly, 50 and 35. So, this is the balancing act your what to do for a building design looking at the window to wall ratio VISA VIS their SHGC and energy consumption. You set the tone for energy consumption, it can be ninety EPI or energy performance index it can be 90 it can be 100 and 20. So, moment you have that number, then you can play with the window to wall ratio and glass specification and look at how to optimise your overall the energy and also the initial investment.

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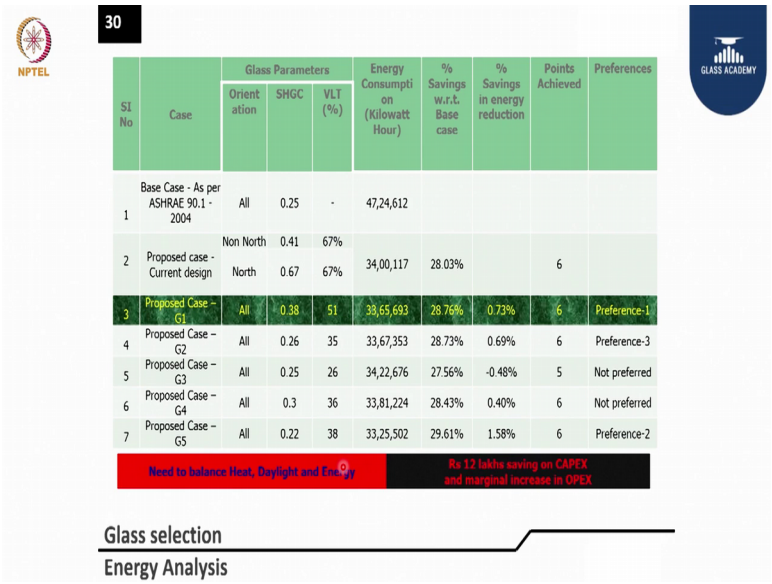

Sl No	Case	Glass Parameters			Energy Consumption (Kilowatt Hour)	% Savings w.r.t. Base case	% Savings in energy reduction	Points Achieved	Preferences
		Orientation	SHGC	VLT (%)					
1	Base Case - As per ASHRAE 90.1 - 2004	All	0.25	-	47,24,612				
2	Proposed case - Current design	Non North	0.41	67%	34,00,117	28.03%		6	
		North	0.67	67%					
3	Proposed Case – G1	All	0.38	51	33,65,693	28.76%	0.73%	6	Preference-1
4	Proposed Case – G2	All	0.26	35	33,67,353	28.73%	0.69%	6	Preference-3
5	Proposed Case – G3	All	0.25	26	34,22,676	27.56%	-0.48%	5	Not preferred
6	Proposed Case – G4	All	0.3	36	33,81,224	28.43%	0.40%	6	Not preferred
7	Proposed Case – G5	All	0.22	38	33,25,502	29.61%	1.58%	6	Preference-2

Need to balance Heat, Daylight and Energy

Rs 12 lakhs saving on CAPEX and marginal increase in OPEX

This is another very interesting project we get in Noida. The, those in a standard says how the glass various glasses be selected for building, how this has carbon energy consumption impact, how much is a reduction, what is the percentage reduction, how many point in lead they achieved and what is our preference? So, this in addition to your up recruitment by doing the selection based on the cost is this gives a direction for them, which glass suppose this guy is getting the best glass out of this and getting the L 1, that is the best one to choose. So, we have given our preference 1 2 3 not preferred.

So, this guy gone with the preferred one glass at lower cost, this preferred one glass it is even less stringent than the standard 0.25 is the standard per India ASHRAE standard I went in for 0.38, that mean a relax to specification reason is one very critical factor to be seen here is this building and got a 45 percent window to wall ratio.

Out of which 65 percent glass sitting on the north facade; that means, this has got a beautiful design wherein I can go for relaxed glass from the standard to get the best performance in terms of 28 percent, and energy reduction overall I am talking about and about 0.7 3 from the base case. And, I am getting all 6 point required. Then, why I need to go for stringent glass 0.25 or 0.26, where the energy difference is hardly anything 28 28.73 76.

So, there is no major difference I relax glass to go for 0.38 to optimise the overall investment cost, without compromising on the energy performance and day lighting, this

how the balancing of heat day light and energy parameter to be considered for a building. So, you need to have more and more analysis varieties of glasses and here also you can add wall and roof and overall you can see the performance, these are purely and the glass selection.

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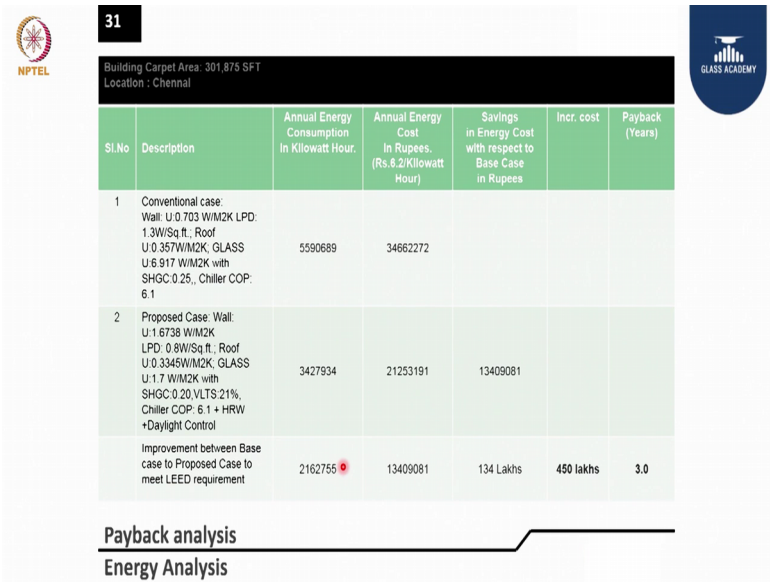

This, another building is a government building, we did this with around 450 lakhs investment and pay back is the 3 years. Just optimising the conventional building inter proposed and keep changing the parameters chiller we kept same thing add a heat recovery wheel, daylight sensor got added and this glass was VLT of 21 percent, SHGC 0.2 and whereas, here SHGC is 0.25. So, we started optimising it, LPD 0.8 watt per square feet and in shell design was 1.3 watts per square feet. And, similarly roof wall everything we start this is what the proposed building, then we started doing various iteration to see how we can optimise it?

So, we played between both and with 450 lakhs addition investment gone to the building. And, they got it in 3 years. In fact, this was the predicted energy performance, you be the pay back by 3 years actual case we studied for 1 year operation, it was just 2 years to 2 months. So, that was the level of benefit you get, when you do the optimising of your proposed building not nearly going with the standard and you have to balance between standard and what is really actually required for a building.

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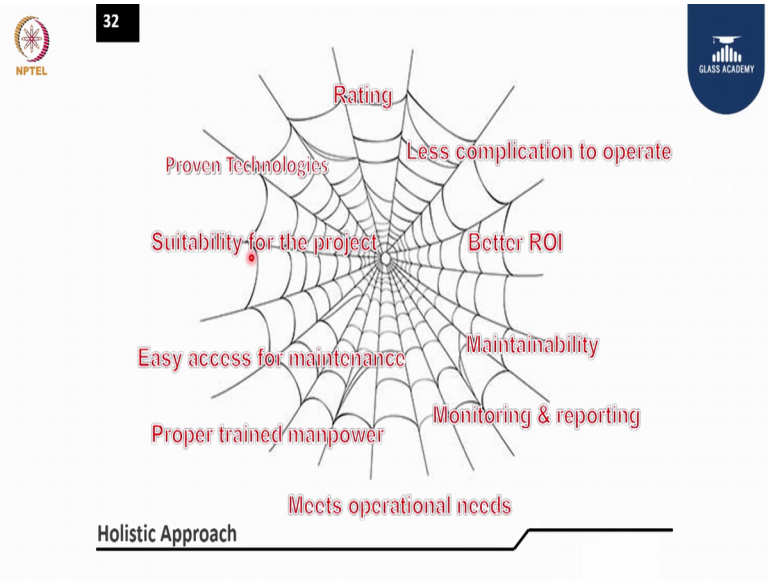

So, in a nutshell if you look at any building for that matter, you have to look at various parameter. You cannot only look at aesthetics or only, you cannot look at only the occupant comfort or energy performance. Of course, you need the rating, but rating should not be the driving force for the building design.

And, less complicated to operate, tomorrow you cannot bring some system which brings lot of complication for the occupant or operators to operate, then they will bypass. You need to have an ROI to make it sustainable, it should be easy to maintain and is it has to be monitored and reported in terms of performance, very very vital otherwise the sustainability will be on the paper only. And, also we have to look at operation needs what they want from building. And, you need to have a people operating building should be properly trained and handover the system to them to operate.

And, also the maintenance, they should be easy to access the building equipment to maintain our way they will leave it for long and it does not give the required performance and suitably for the project. So, you have to adopt the technologies, yes you need a proven technology with the technologies adopted suitably for the project, you cannot bring some system which is not suiting for the particular operation.

Sometime you require a VRF, sometime you require window duct able split with the pressure provision, did with depends on the, you cannot have a centralised system for all the building, when you have only 10 000 square feet air condition space. So, according

you have to select the system suitable for a particular project looking at all this parameters, when you take a project for design.

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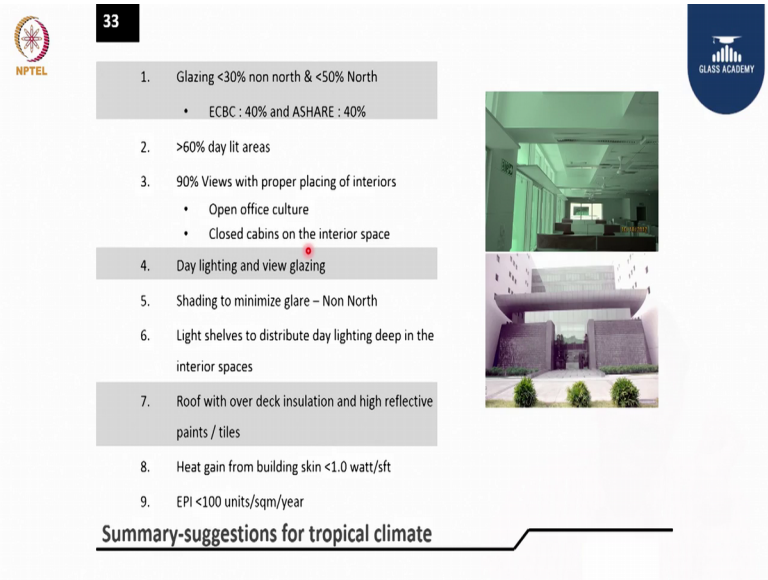

So, it is some of ladies and gentlemen, I always preferred about thirty percent glazing I am debating little from that is standards though ECBC and ASHARE is 40 glazing 30 percent non north less than 30 percent, and north you can go to 40, but overall you can achieve this 40 percent.

And, I prefer naught 95 percent day lighting, which increases the energy consumption in the building, looking at the current design of said 20000 square feet and 25 000 square feet of floor plate. I think about 60 percent is ideal number to achieve you can balance definitely you should look for 90 percent views for the building occupant to the exterior more and more open office culture, and minimise the cabins and enclosed spaces it can be in the middle of the building floor plate not on the perimeter, which controls are as the heat daylight penetration to the interior spaces and prefer to have a day light and view glazing.

So, that you can avoid glare and get the day light for the entire day and shading to minimise a glare on the non-north to you have to have a shading devices, if you have a glazing of 40 percent and more. Light shelves to avoid discomfort to the perimeter area where excess day light penetration, you can have light shelves to get this day light from

perimeter to deep interior where people are not having daylight. And roof with the over deck insulation to arrest the heat getting into the building before it hits your body.

So, we do not prefer under deck insulation over deck is better to arrest before heats up your building. And, also you can have a green roof or reflective tile for the roof and overall heat gains should be set it less than one around 0.9 watt per square feet. And, the energy performance index for our kind of climate about if we have a cooling about hundred units per square metre per year and there are many corporate HEV 80 and 70.

So, ideally overall we should look at less than 100. These are the around 9 very important parameter for a building design, if you look at these numbers and your building will be really super performing in addition you can go for solar energy as a substitute make it really sustainable for long run.

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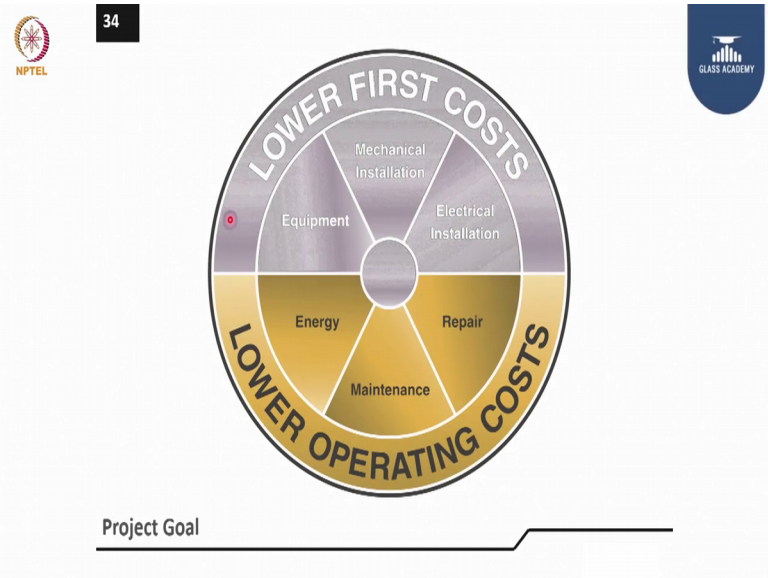

So, ultimately we have to look at lower first cost and lower operating cost is like very critical parameter to be considered in the building designed right from beginning set a tone that I will invest where there is an ROI, I will invest where my operating cost is going to be less. I invest where my occupant comfort; comfort is taken care health and well-being is taken care.

So, you have to balance your investment and operation cost if you do the opex and capex well balanced and sustainability will be very good economic option for anybody to

adopt. So, with that I thank class academy for this wonderful opportunity, I hope the listeners and viewers are getting benefit out of it.

Thank you so, much for patient hearing.