Glass in buildings: Design and Application

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Lecture - 13
Design Tools for Glass Selection Part I

Welcome everyone to today's session. So, today we will be covering about the Design Tools that can be used for Glass Selection.

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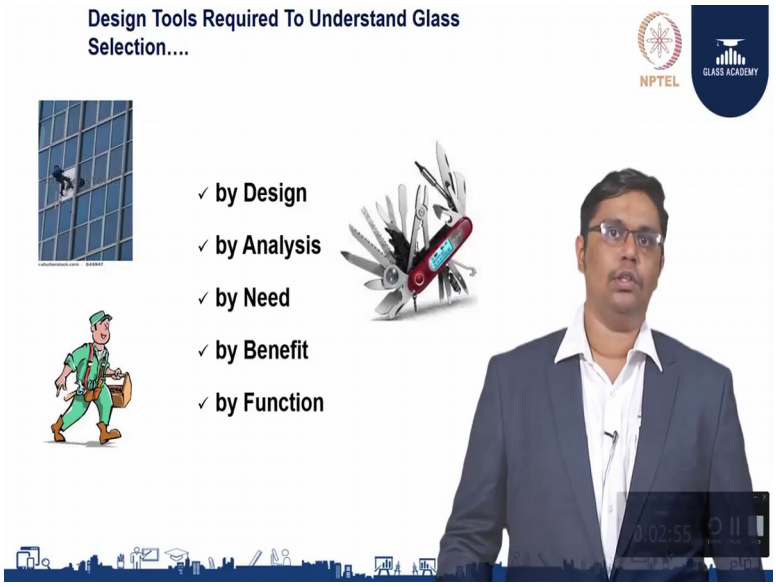

So, when it comes to selecting glass, we need to consider the design of the building and we need to do some analysis of the impact of the glass on different aspects, such as structural sustainability, ascetics and then, economic. I mean how much money you are going to spend on the glass and all these aspects needs to be addressed based upon the need the benefit and the function. So, this session will be covering about the different analysis we can do for selecting glass.

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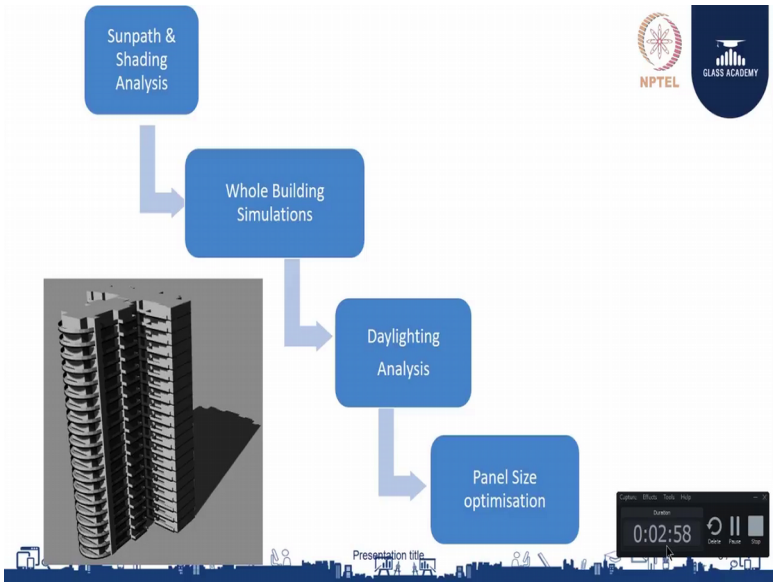

So, this will be the flow of the presentation. So, we start with the Sunpath and Shading Analysis followed by whole building simulations and then, day lighting analysis and then, panel size optimization.

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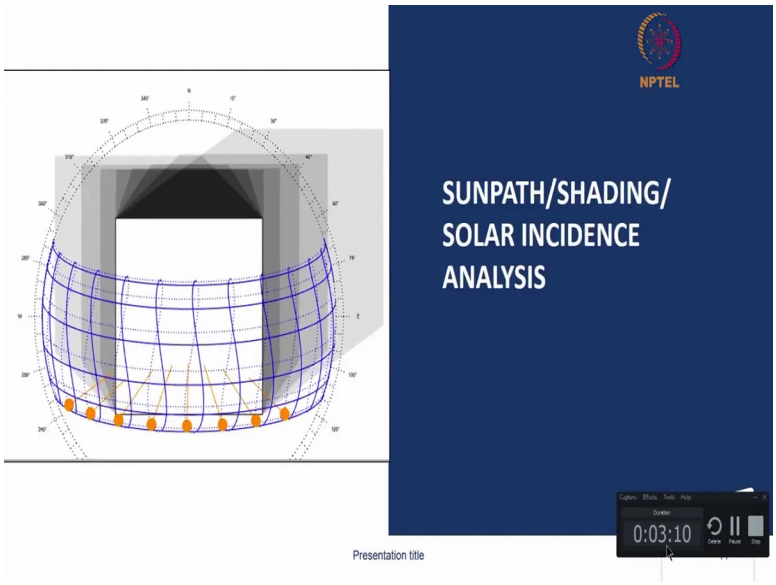

Let us start with Sunpath Shading or Solar Incidence Analysis.

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So, we do this Sunpath analysis to understand the behavior of the sun with respect to the building, how the building is getting shaded by the nearby buildings and how at what part of the year the building gets maximum sunlight and maximum radiation on its surface. So, all these can be understood based upon this analysis. So, if you can see here, we have done the analysis for two different tasks; tower 1 and tower 2. So, over here as we can see that both the towers are quite adjacent to each other and the one tower has an effect of shading on the other tower at different parts of the time, so this analysis can be done at different parts of the day.

So, from 9 am to 12 pm and 3 pm so, 3 different parts of the day; morning, noon and afternoon. So, you can see that this is the north of the building and you can see that the shading is happening in the south-west region at 9 am because a sun is towards here and the same you can see in during 12 noon, it is almost at top and you can see that almost the mid-south and the mid-west is getting shaded over here and towards the evening you can see that sun moves towards the west and your south-east gets shaded. So, this kind of analysis we can understand for different seasons as well. So, this is a typical day in a summer season. So, this we can name it as summer shading. So, from here we can understand that during the summer months, the south-west and south-east faces of the building gets shaded at different parts of time.

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So, this is during the winter months. So, here you can see that during the mornings, your north-west gets shaded and in the noon also the north-west gets and during the evening, your north-east gets shaded. This is quite different from your summer months. So, from this we can understand that at which month, which face of the building is getting maximum radiation etcetera.

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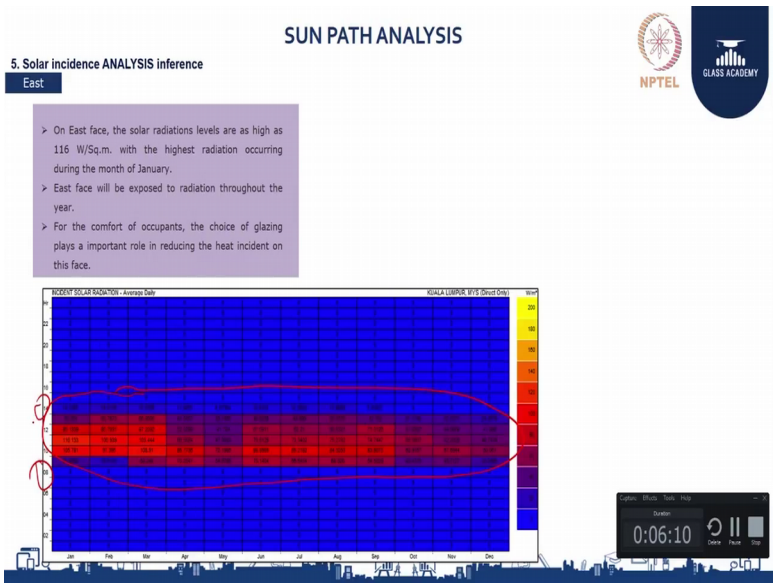

So, this is at typical radiation result taken from software called Ecotech. So, here you can see that on the x axis there are lot of numbers that you can see over here all along the

graph. On the x axis, we have the months and on the y axis, we have the hours of the day. So, this is from the north face and you can see that in the months of April, May, June, July and August from 8 am to you know evening 6 pm at different magnitudes of radiations received by the north face of the building. So, similar analysis can be done for all the 4 faces. So, here you can see that the east face of the building getting radiation in the morning hours from 8 am to 2 pm. So, this kind of unique analysis we can understand from this graph.

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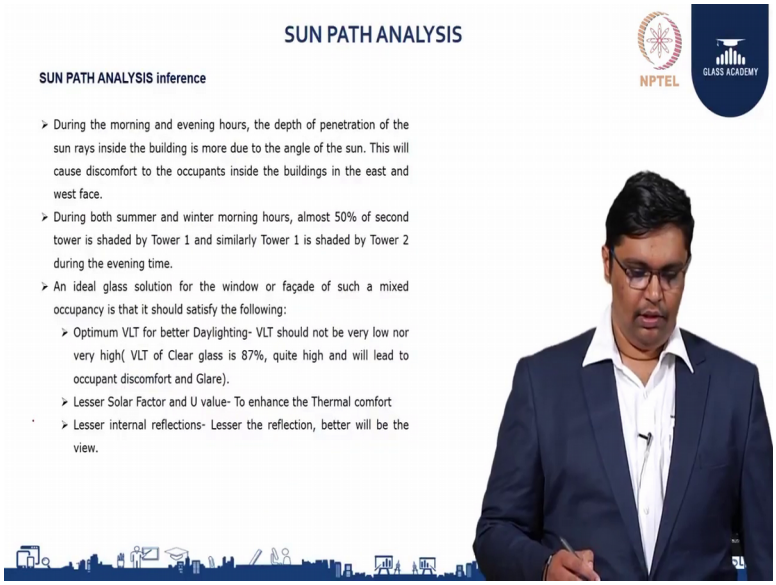

So, let me show you a small demo of how to do analysis using the software.

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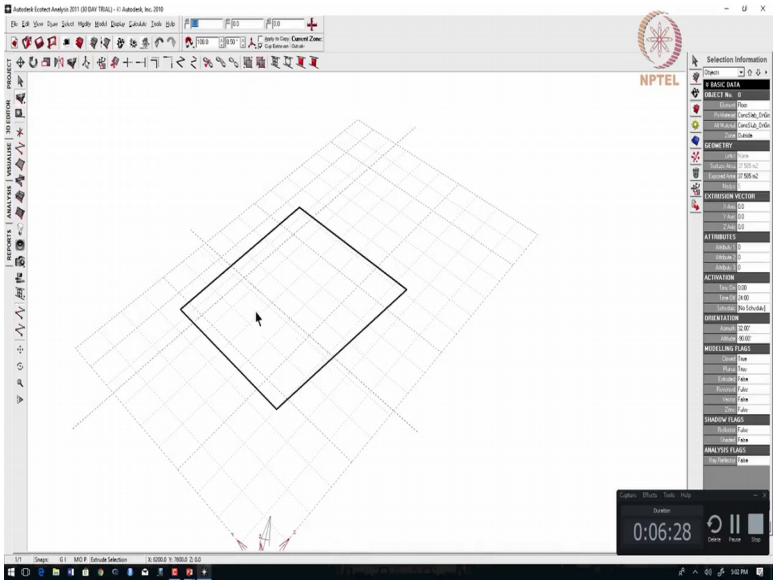

So, here I have made small rectangular box. You can even import an AutoCAD drawing. So, this is how you import the AutoCAD drawing and you can draw the plan over here and I am going to just give an exclusion, say let me give some 3 4 3 floor building of say 3.1 meter floor each. So, I am giving some 10,000 mm extrusion.

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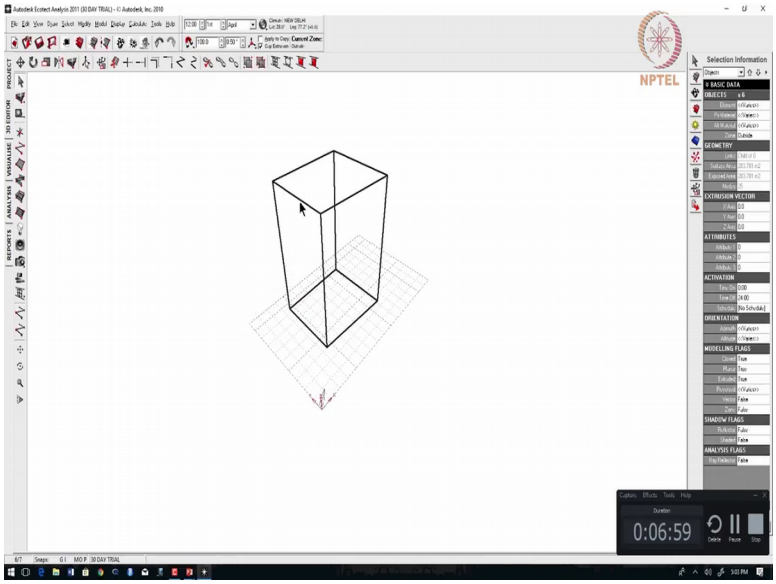

This is just an example. So, I am making it easier. So, over here on the left side, you can see a lot of tabs as project, 3D editor, visualize, analyze reports, etcetera. So, first I go to the project so, I want to set the north face. So, here on the right side I can set which is the

north of set. So, like for example my building's north and the true north are varying. So, if my building's north, the north side is say 30 degrees from the true north, then I can indicate here saying it is 30 degree inclined from the normal north.

So, here there is one more thing that you can do is load a weather file. For example, here there is already default set of weather files and in that I am loading the India weather files. So, there are also city wise weather files available from the energy plus website, I can give the link of the website in the notes and over here next tab is 3D editor, where we have done the modeling earlier and you can see that there are many sub tabs over here on the right side. So, here I can click on daily sun path, annual sun path display shadow etcetera.

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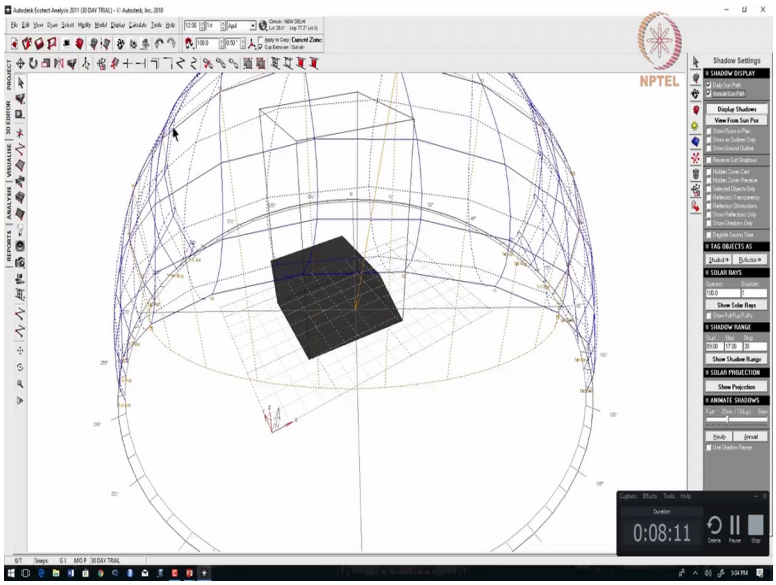

So, if I go to visualize, you can see that the building is, imagine that this is the massing of the building. So, I can understand at different angles, sun angles.

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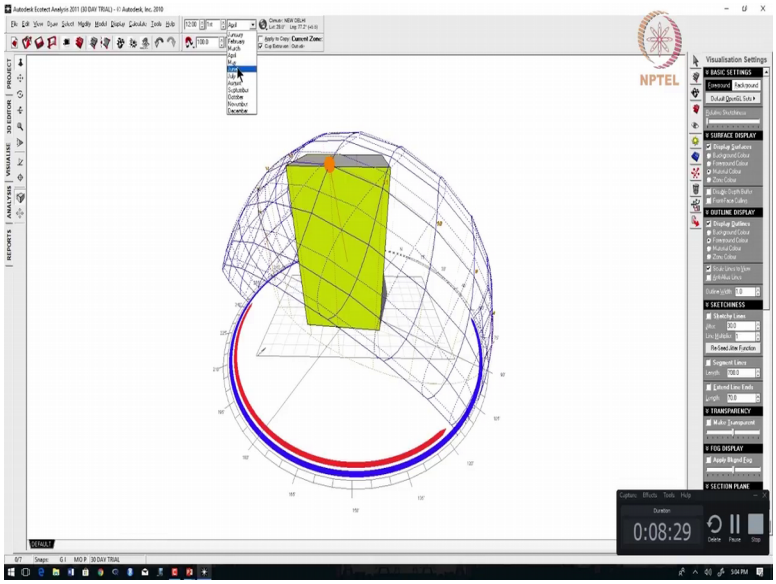

So, over here I just go and change the month, say I am changing it to June 21st, 9 am. So, I press F5 for plan view.

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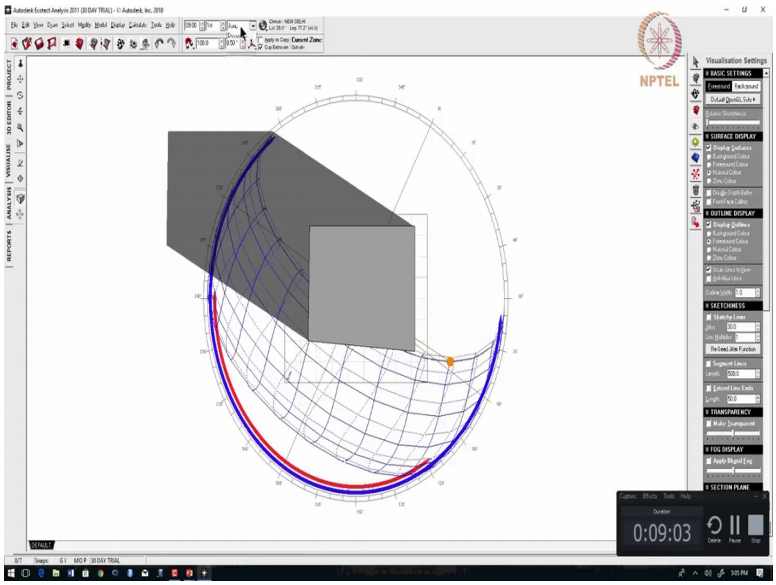

So, here I can see the extent of the shadows, how far the shadows are going and you can change this scroll this down to different parts of the year and check what will be the shadow and what will be the sun's position. So, this is one analysis that can be done.

Suppose you have another building nearby and you want to see the effect of that building that can also be done. So, I just draw another building nearby.

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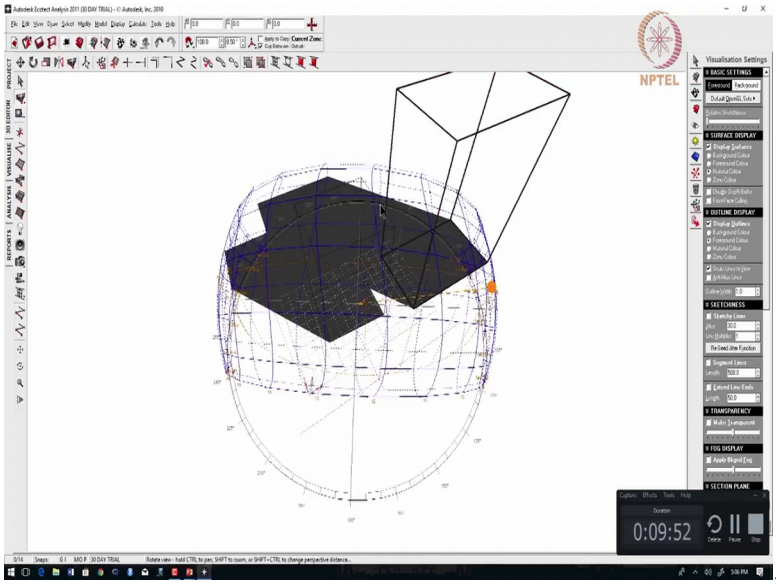

You can actually import 3D, import 2D drawing and you can model it as well. So, let us now give a bigger height for this say let me give 15,000 mm. This is just for example. So, you can see that the effect of this building at different times, say in April in summer month, let us say in June let us say that from 9 am, it the East the north-east faces come almost completely shaded and you can also change it to different parts of day and you can see that now the north-east is not shaded in the afternoon.

So, your south-east and north-east are now completely shaded for both the buildings. Let us see where this will have an impact. So, let us do something called as a solar incidence analysis. So, for that I am going back to 3D editor and I am pressing, selecting a particular face say for example, this is your south-east face, almost south-east face and I am going to analyze solar exposure average daily.

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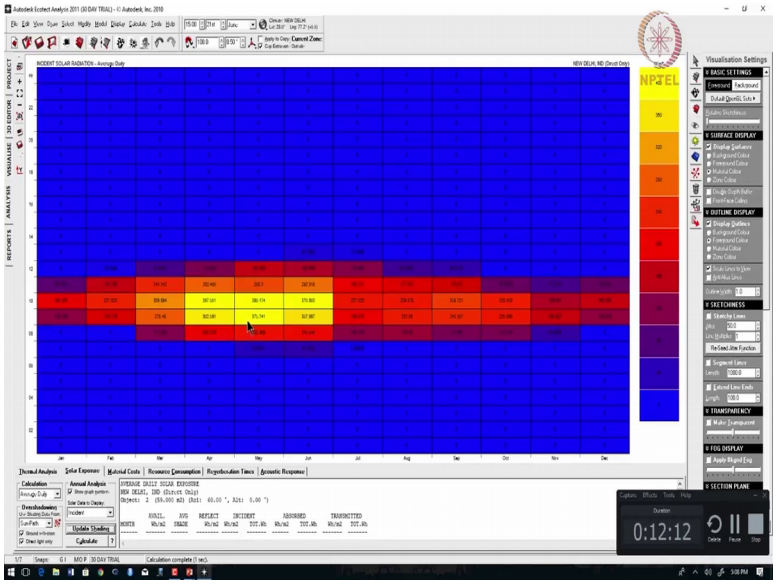

So, this gives me an idea of how much is the radiation monthly from January till December and hour wise 0 to 24. So, let us take this faces for actually getting shaded by the nearby building, right so let us see what shading. So, please note these numbers like 184, 189 are the peak. 189 is a peak radiation and it happens in March with the shading of the nearby building.

So, let us remove this building and assume that this building is not there. Let us do the analysis for the same building. We can see that it is going as highest 397. So, this is because we have removed the shadows from the nearby building. So, it is what is the take away from this is we need to also consider the nearby buildings and the surroundings of the site. So, we should try to incorporate that in your analysis and then only you will get close to reality results. So, that is one thing that you need to consider and also, in this tool you can even simulate what will be the effect of shading.

For example, you are having a overhang. I am just making random over hang. Please do not, so I am running the analysis again. You can see that it has a reduction from 397 it became somewhere 287. So, even the effect of your shading device can be analyzed. How will this effect your glass selection because when you design a building with for the envelope, so your envelope consist of your glass, your wall, your roof, all these elements and when you introduces shading element that will also effect your decision making on what should be the performance values of your glass.

So, that is why this is quite important. So, let us get back to presentation. So, now we know how to do a small sun path analysis using a simple tool and understand the shading effects and take out the solar incidence values. So, next we move on to the next topic Whole Building Simulation.

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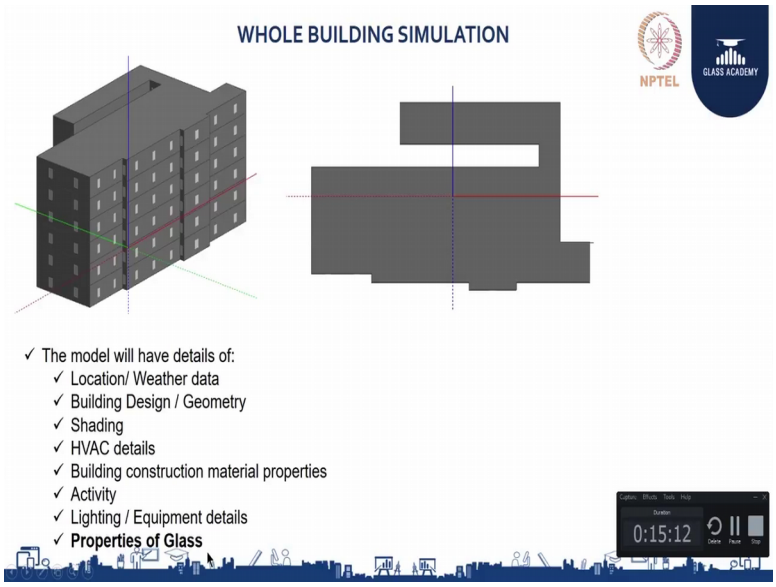

So, whole building simulation is actually concept where you can incorporate all the details, like your location or weather data, your building design and geometry, your shading, your HVAC details, your building construction material properties like your roof, your wall, what prop your glass, what properties will they have. And then, what is the type of activity that is going to be there in that space, say is it a office space or is it a residential or is it going to be a hospital. So, depending on that your patterns of activity will change the number of hours you occupy and the number of people who are going to be there. So, all that can be input given as inputs in this and even you are lighting and equipment details because they also consume energy so, that also needs to be considered. And, keeping all these, so, how were we going to study the impact of glass? So, what we do, we will model all these parameters like the geometry will be modeled and then, we will freeze the shading that is going to be say there is going to be overhang or there is going to be a fin that can also be modeled in the software and we will feed in all the HVAC details, your properties of other materials and we will only vary the glass properties to understand what the effect glass will have on your design. So, that is how

we can choose what range of solar factor or value you need to consider for the particular building.

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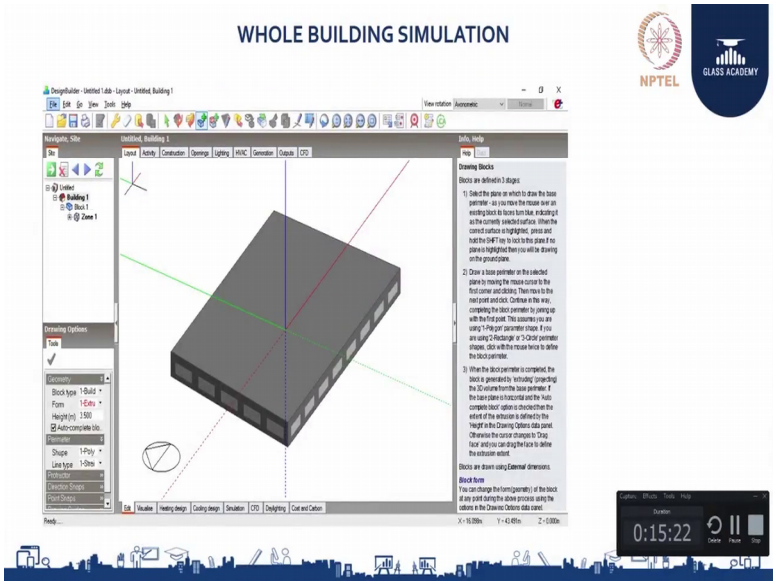

So, going forward let us see that interface of this tool, this tool is called as design builder which works based on simulation engine called as Energy Plus. So, you can see different tabs over here on the top, like layout activity construction, openings lighting, HVAC generation outputs etcetera.

So, in this the most first and foremost thing is the layout, where you actually model the building. So, here I have modelled small case study building. So, here in this building you can see that the windows are default model etcetera. So, after this is done, you need to mark what is the north, which side is the north because that is also important. The orientation of your building is one of the most important criteria you need to consider in the start of the design. Next, what will I do is, fill in the activity details over here. So, when I click on the tab, I can feed in the details like how many people will be occupying a particular area and what will be the working hours, what will be the profile of that particular space say going to be your office etcetera. All those details will be able to enter there.

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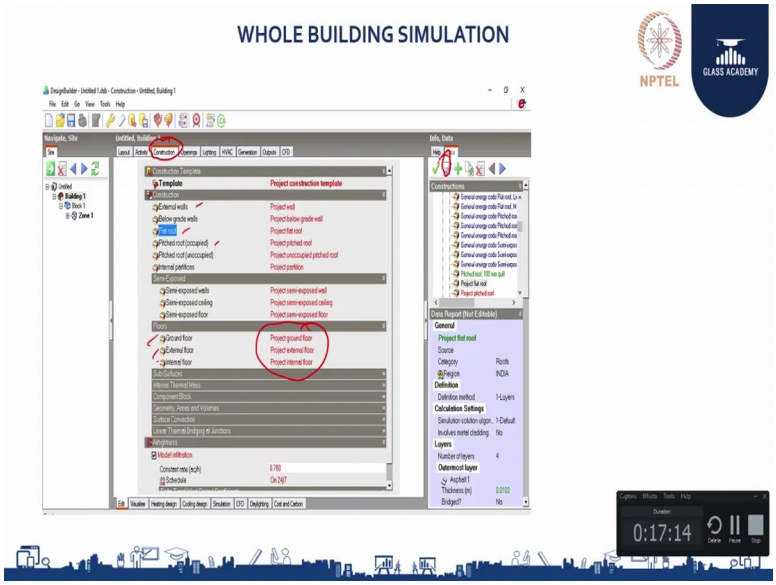

So, after that we come to the important part called construction. So, this is where we enter the properties of your wall, your roof etcetera where you will consider the insulation that you are going to give to your wall. So, here you can see this is a very user friendly interface. So, when I click on this construction, it gives a lot of options like external walls, flat, roof, pitched roof, what are the type of floors that are there, for which floor what material you need to assign so, all that can be done. So, when I click on one of these and I give edit, I can go there and edit the properties like your U-Value and how much will be the insulation thickness all that can be altered here. Next comes the lighting.

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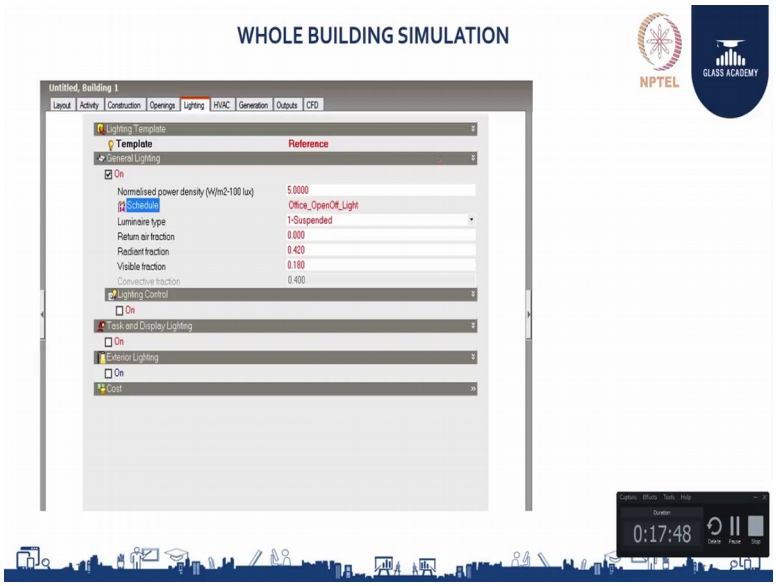

So, when it comes to lighting, your artificial lights that are going to be there will have an impact on your energy consumption. So, what is very important here is the lighting power density. So, how much watts of energy is consumed for giving output of so much lux. So, that will be your lighting power density that you need to enter here because that will add into your energy consumption.

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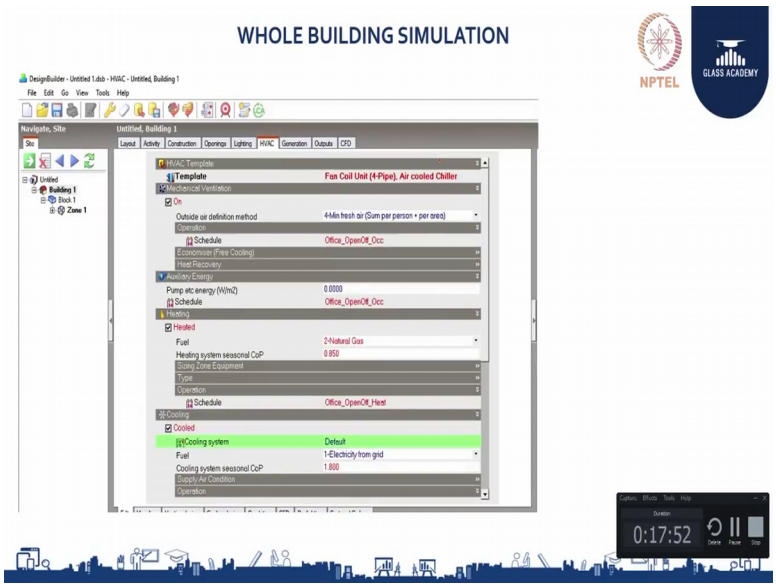

Next comes your HVAC. So, this is an important part where you will be entering the efficiency of your AC like your COP or whether it going to be your you know VRV

technology or VAV technology kind of HVAC. So, all those details you can enter here and that will be considered in your energy calculation. So, here you can even give the variation as to whether the set point is going to be 24 degrees or 26 degrees. So, all those details can be filled in here.

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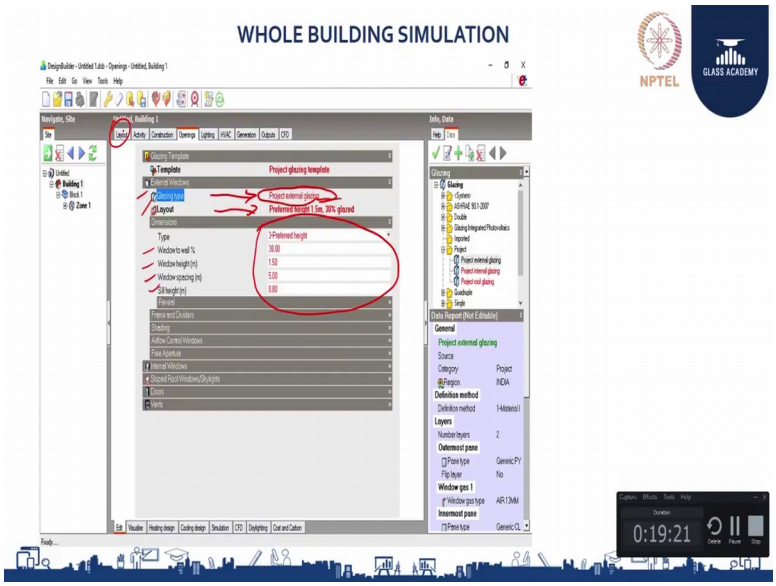

Next we come to the important part you need to decide on the openings. So, here you can see that there is something called project external glazing for glazing type and for layout you have something called as 30 percent glazed. So, these two are important factors that you need to consider. So, here what we will enter is what is the window to wall ratio. So, how much area of the wall is going to be opened with windows or you know fazed etcetera, so that you need to key in here, if you have any particular still height that can be mentioned here, what is the window spacing, what is the window height or WWR, everything is keyed in here, so that it will auto generate your model.

So, once you key in the details here, when you go back to layout and see, it will give you the revised layout with this window to wall ratio. So, now next I am moving on to the important part where you need to fill in the glass that is going to be used.

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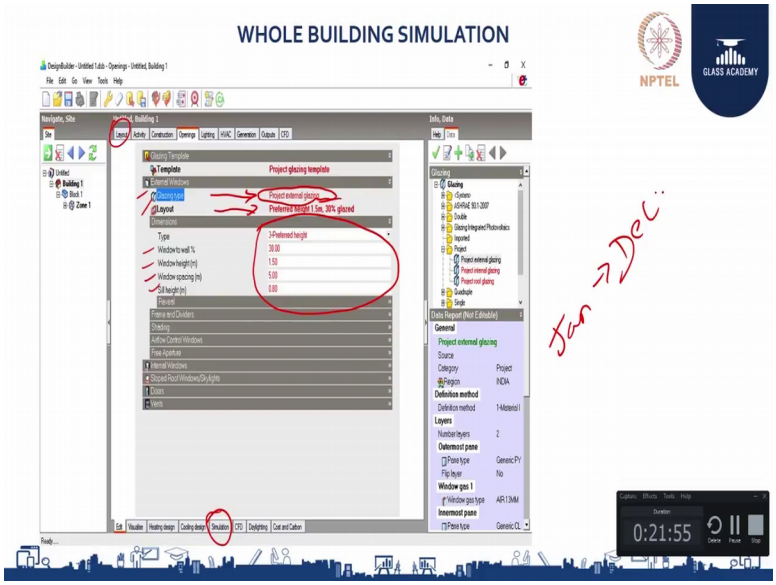

So, there are different types of glass like single glaze, double glaze, laminated glass and then, in the double glaze and single glaze, you can even use your coated glass. So, it can be coated glass or tinted glass etcetera. So, when you go for higher performance, if you go for when you need a higher performance and better energy saving, we usually go for a coated glass which will have a lesser solar factor and lesser U-Value.

So, all those details can be filled in this tab. So, here you can see that there are two methods of entering this. One is using material layers as in you know composition of glass that is going to be used whether the outer pane is going to be coated glass and the inner pane is going to be a clear glass. In a DGO, if you know the exact combination, you can select it over here.

When you click here, you will get a drop down and you can select the type of glass whether it is going to be a particular manufacture's coated glass that will be available here as doc, as a drop down. So, from that you can select the outer glass, what is the air gap whether it is going to be 16 mm or 12 mm or is it going to be air or is it going to be filled with argon gas. So, all that can be selected here and the inner glass whether it is going to be plain 6 mm clear glass or is it going to be some other type of glass, you can select it here. So, that is one method and when you go to calculate it, it will give you the calculated solar factor U-Value and VLT for this particular combination, ok.

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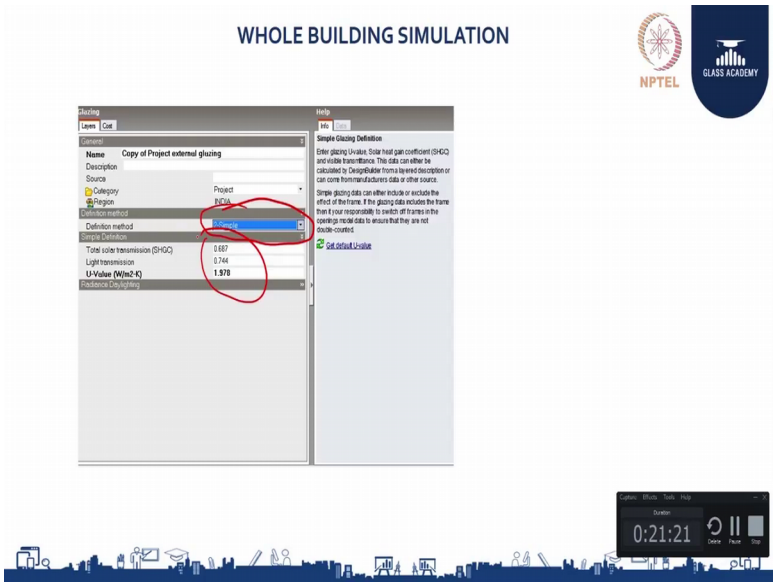

So, next I am going to the second method. Instead of material layers I am selecting simple. So, when I select simple, I can directly enter the solar factor VLT and U-value over here. So, this is more easier in terms of trial and error. So, you want to check what is the suitable range of solar factor or U-Value, you can fill it here and you can finalize to what say to what attain a particular energy consumption.

So, what are the outputs? So, I have done all this, fed all the data etcetera. So, next what will I do, I will go to simulation and select how many months I want to run, say from January to December or you want a monthly consumption, weekly consumption. So, all that can be selected there and when you click simulation, you get a detailed output as to what is the solar gains, what is the energy consumption from due to the chiller and what is the energy consumption due to the lighting.

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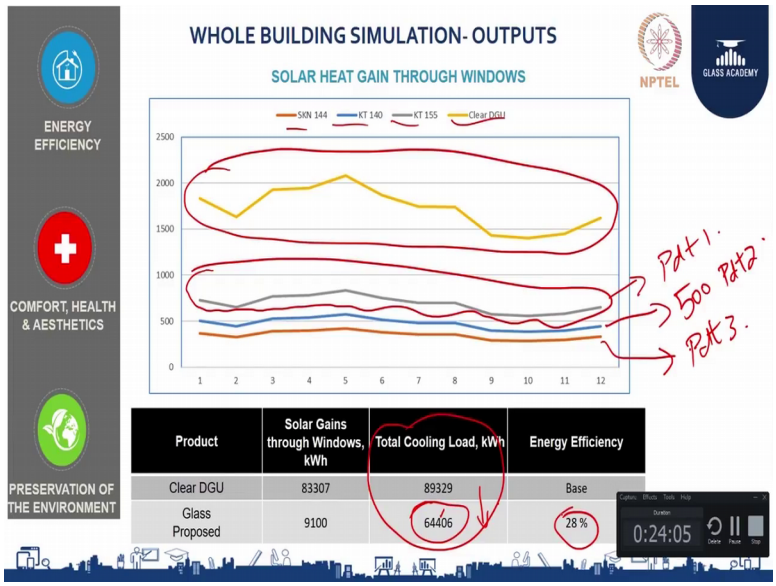

So, all those details will be the output of this simulation and two outputs that will be quite important for your understanding will be the solar gains and your energy consumption.

So, this solar gains through the windows you can see that here this is the case study with different products. So, case 1 we have plotted for clear DGU for particular building. These are the proposed glasses, 3 proposed glasses you can see that solar gain of clear glasses somewhere around 1500 to 2000 kilo watt hours. It goes down to somewhere between 750 when I use this particular product 1, ok. When I use the 2nd product it goes down to as slow as 500, when I use the 3rd product which is the 3rd option for the windows. I can see that it is going as low as 450 somewhere close to 450.

So, this is one understanding that you can get as to how much solar gains you can cut by selecting a proper glass and one more output that you can get is here energy consumption. So, over here is particular case study, where your clear glass which I have taken as a base case is consuming 89,000 megawatt hour of energy, 89 megawatt hour of energy. So, from there when we use a particular glass with the particular solar factor and U-Value which is less, say I have used the double silvered product. So, in that case it goes down to as slow as 64 megawatt hour. So, this will account to around 28 percent energy savings in this particular model and this will directly account to savings in electricity bill.

So, that is something that we need to consider in your design. So, where will all this be useful? So, for example, you understood that particular product is saving so much of energy, a particular product is saving so much of heat gain. So, these are some of the outputs that are requirements in a green building.

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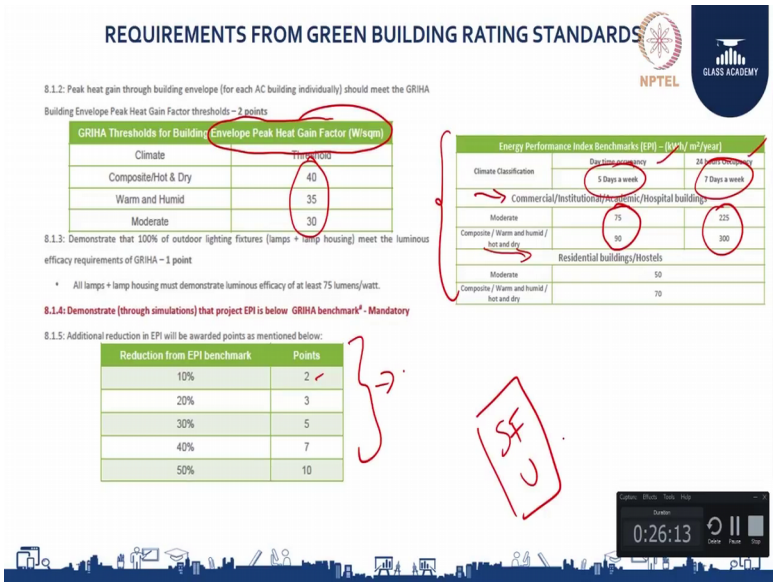

For example, this is a typical requirement from a green building rating standard. So, this is from GRIHA. So, you can see that one of the requirement says that your peak heat gain factor in your envelope should be within this say 40 watts per square meter, 35 watts per square meter, 30 watts per square meter. So, this has to be satisfied for getting a point or getting the rating.

So, next is your Energy Performance Index. So, this is nothing, but how much energy is consumed per square meter of your building floor area for a particular year. So, this will give you an idea of how much energy the entire building is consuming in a year. So, they have given some threshold depending upon the type of the building say commercial or institutional or academic and another typology is your residential building and also, depending upon whether it is going to be 5 days a week or 7 days a week, day time occupancy and 24 hour occupancy. Based on these criteria, this is the base EPI that GRIHA has given. So, your design should have lesser than this. When you design the building, it should have a lesser than this and then only it can get the rating.

So, this is a type of requirement that is given in GRIHA. So, you can see that when we achieve an EPI which is 10 percent lesser than the benchmark given, then we get 2 points. So, based on this points your building gets rated as 1 star, 2 star etcetera. So, these are not, this is just one criteria as energy efficiency, there are multiple criteria's in the green building rated systems. So, what we can understand from here is, this EPI that they have given to understand that we need to do the simulation and by different glasses, you can see how much is EPI you get for the particular building and then, based on that you can take a decision on what should be the solar factor range and what should be the U-Value range for your glass, when keeping all the other factors as constant. So, with that we come to the end of whole building simulation. Next we go to the next topic.

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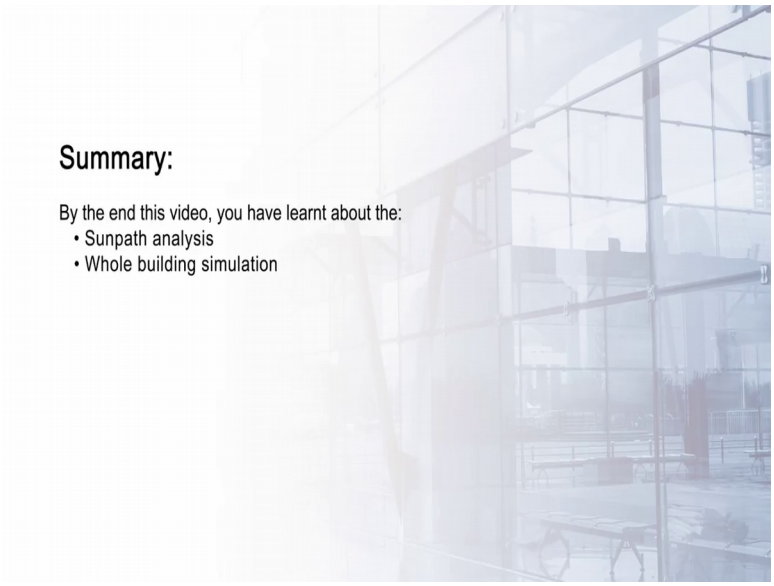

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