## Sustainable Architecture Prof. Avlokita Agrawal Department of Architecture and Planning Indian Institute of Technology, Roorkee

## Lecture – 59 Whole Building Performance-IX

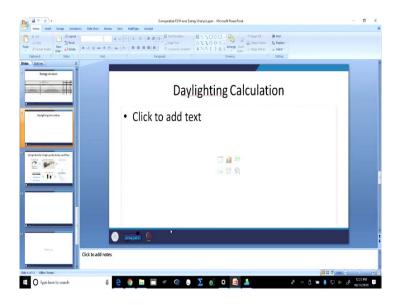
Good morning. Welcome to the second last lecture of this ongoing online course on Sustainable Architecture, where we have been discussing about Whole Building Performance Tool Design Builder. Till yesterday's lecture, we have discussed all related to how to simulate buildings using the tool, how to create building, how to modify them, how to modify the materials, how to modify the geometry, how to modify the different performance parameters which are going to go inside the modelling of the building.

One thing, if you remember which we had left while we were discussing about the daylight in building which is criteria for evaluation in different green building rating programs is the day lighting and building, so how much of the floor area is being day lit adequately. So, one is how much and the other one is adequately. So, we also did manual calculations if you remember. So, we had all the tables, we had the rules, we had the equations which helped us calculate how much of the floor area will be assumed or will be considered as day lit if we calculate it manually.

We also showed in that particular lecture two comparative pictures where one was the manual calculation and the other one was the digital calculation which was using the whole building simulation tool. Now, these tools are also equipped to help us with the day lighting calculations digitally, instead of doing the manually we can do it here. Whole building simulation tools take some other tools for example, design builder takes help of 'Radiance' as a simulation tools for tool for calculating daylight which is what we will show how do we go about it in today's lecture.

So, in today's lecture we are going to discuss about the day lighting calculations using whole building performance tool design builder. Let us switch to the design builder screen now.

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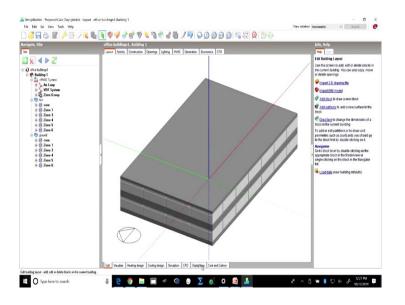


So, today we are going to look at the digital method of day lighting calculation for compliance to green building rating systems. So, as we have already seen that almost all the green building rating programs across the world they place emphasis on allowing daylight to enter the building and in different rating programs different criteria are there.

So, for example, the LEED requires at least 75 percent of the habitated area to be day lit. And day lit also has a range of values, so if we again look at the example from LEED, so we have the day lighting defined using daylight factor, sometimes it is also defined using the luminance, sometimes it is also defined using other terminology which we have seen as part of our lecture on daylight. Most commonly used one is the daylight factor. So, what we have to really do is calculate what is the daylight factor in a room which has windows all around.

So, if you remember we already did the manual calculation using the rules where we calculated how much from the side of the window the light will be available, for how much depth does it penetrate inside the room, if there is a partition then what happens and all of that. Today we are going to look at the digital way of calculating daylight availability in a building. So, we take the same example of as that of the building which we have been considering for calculations.

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Now, the changes that you have to make to the model or not to the model, but to the settings is first of all we go to the activity and in this we say include zone in radians day lighting calculations.

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The moment we do that, the model will be used for calculating day lighting using radians as the engine. So, that is what we need to do in the activity tab and when we go to the construction tab and we select whatever wall we have selected. So, we have already selected this particular template.

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If we go to this template we already have created different layers of this wall. So, this is this was the wall copy of ECBC wall.

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So, what we need to do is we need to change the surface reflectance of all these because when we are talking about day lighting the colour of the internal surfaces, the finish of the internal surfaces, the finish of external surfaces, external ground, roof adjacent building all of that will make a difference.

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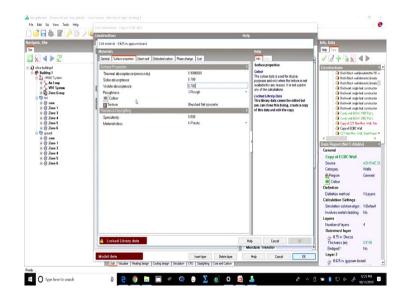
So, what we would do here is we would go to each of these materials.

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So, suppose we have gypsum board inside, we can go to gypsum board and again edit its properties.

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So, for each material we also have the surface properties available and if you look at this is the visible absorptance. So, 1 minus visible absorptance is the reflectance. So, if higher is the absorptance it implies darker is the surface. If we have a lower absorptance which means the reflectance is higher and the surface will be reflecting more of the light. So, depending upon the kind of surface we are going to use and we can also select the roughness, so whether the smoother surface will have higher reflectance which implies that they reflect more light whatever is incident on them.

So, here we are only talking about the visible properties of the material as far as its reflectance and absorptance are concerned, as far as its texture is concerned and all of that will impart the property, the visible property to the material and these materials will be will automatically be used here and their surface properties will be updated. So, we can make changes in the external surfaces as well as the internal surfaces where the finishes are going to effect the day lighting inside the building.

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Once we have changed that, we can go to the openings and we can also change the glazing type.

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We can check the glazing type here. We have already selected the glazing type when we were changing the type of glass, the glass specifications. Here we can check upon with the light transmission values the VLT values.

Now, if those VLT values would depend upon the type of glass which is being selected for the building for the glass, for the fenestration. Here we can take these values directly from the specifications which we get from the glass or if we have; if we have a requirement we can keep these keep changing these VLT values and see its impact on the daylight. Once we have done that we are ready for simulating daylight performance of this building and so here is a tab where we click which is called a lighting tab.

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And once we do that it will calculate the illuminance and the daylight factor map for this building.

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Here while we are simulating before that we also have to check these properties here, these values here.

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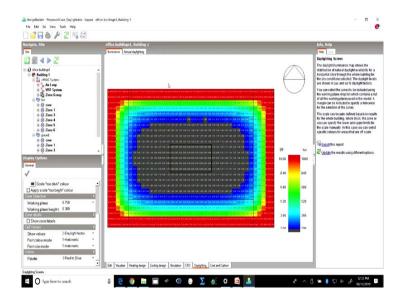
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The simulation type could be for compliance with different rating programs, here we are only taking as general. We can report it in a map type or we can also report it in a grid type. The source could be user defined or building block or zone. Here we keep it user defined for now, and the value source could be daylight factor or illuminance. We can look at both of them. Usually when it simulates it will give us the range of values both in daylight factor as well as illuminance, and they are usually synonymous, not synonymous but they have the same ranges. Higher as the illuminance, higher will be the daylight factor.

If you checking with daylight factor we can also set their low values and high values. So, as per the rating programs the minimum values for daylight factor are usually defined. So, as per LEED the daylight factor has been defined to be a minimum of 2. So, we set the lower value of the allowed factor at 2 and we can fix the higher value the upper value of the daylight factor as well.

So, here again different rating programs have different requirements, so sometimes the higher value is also specified because a daylight factor much higher than a certain value may also result in glare. So, we want to control the daylight factor.

#### (Refer Slide Time: 10:12)



Rest of the areas will be shown as the dark areas. We can also fix the working plane height and we can set the tolerance which we usually keep the same, and here we can also decide to show the values; the values for daylight factor or illuminance on the map itself.

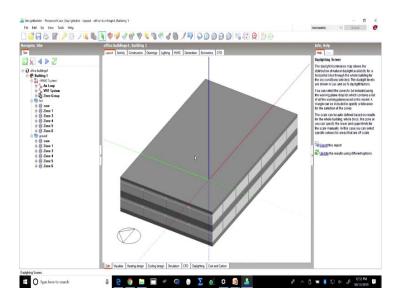
Once we have selected these values and once we have clicked on day lighting we will get a map like this. This is for the entire building taking into account all the zones and if you can see these faint lines here these black lines these are the virtual partitions. So, if you remember while we were creating this building, we had very clearly communicated that virtual partitions are actually non-existent, there are no physical partitions, we are just making these zones to differentiate between the peripheral zones with that of the core zone.

So, if you look at it here we can see that the areas the zones which are shown in red are actually having a daylight factor of close to 10 and as we come down we have some areas on in the corners where we get a daylight factor of 6 to 8, 7 to 8 and then a large area where we have a daylight factor of around 5 to 6 and then 2 to 3 here. And this area which is shown in black has a day light factor of less than 2, which implies that this huge percentage of floor area will not receive sufficient daylight.

So, there is a large percentage of this floor area which is going to remain in adequately lit, it will not have enough light inside. So, we have to, it very clearly tells us that we have to look at the design look at the plan, and here we can very clearly see that the width of the floor plate is much larger than what is required to allow day light penetrate all the way through.

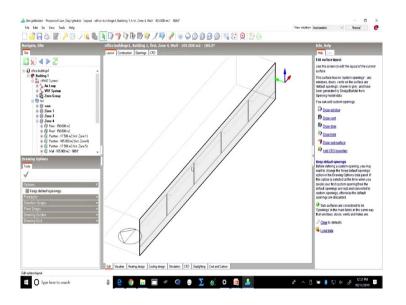
Also another thing which we can see here is that the peripheral areas the areas which are close to the windows they are too bright, they have a very high daylight factor and which as per some of the green building rating programs is not acceptable. So, what we need to look at is the design of the windows, maybe instead of providing 60 percent WWR, we just have greater WWR towards the north and lesser on the sides or maybe we have ventilators and vision glazing separately. So, the upper glazing which is more for the lighting will have clear glass while the one for the vision glazing.

(Refer Slide Time: 13:18)



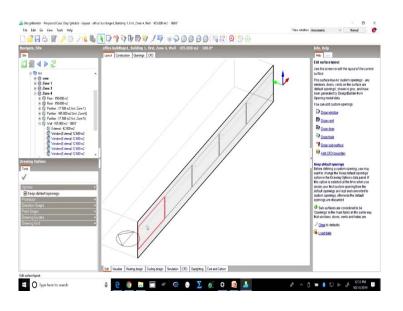
So, instead of having window like this where it is like a single window, we can actually have a different design of the window itself.

## (Refer Slide Time: 13:27)



So, we may actually customize the window we can draw on the wall. So, we can totally design the window as per our requirement.

(Refer Slide Time: 13:46)

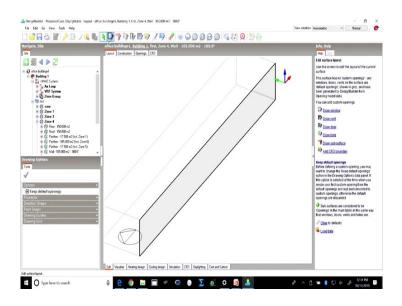


We can remove the windows which are available, customized, we just click on this and we delete. So, we go to the wall and we go to the openings and instead of 60 percent, if we say 0 percent so only on this wall it will change it to 0 percent and here we can now draw the windows.

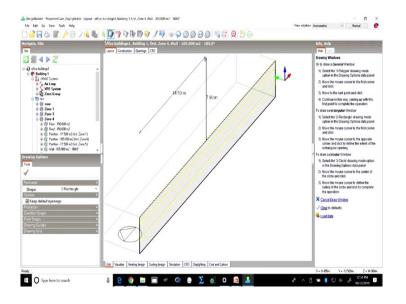
# (Refer Slide Time: 14:01)

rigate, Site	office buildings 1, Building 1, first, Zone 4, Wall - 105.	000 m2 - 180.0*	Info, Data
	Layout Construction Openings CFD		Help Cita
1日 4 2 2	Glaping Template	1	Edit Glazing/Doors/Vents
U office buildings1	Contraction of the second seco	C21. Non-Res. Vertical. Metal haming - All other. Skylight	Use this screen to edit the glazing door, veri and shading details for the current surface
🕐 Bulding 1	Extensi Windows	1	Glazing avroptage
e 🔐 attaic System	(Clazing type	Copy of ECBC Glazing fenes	You can make a generic selection from the
Air Loop	Layout	40% Ventcal Glazing ASHRAE 90.1 Appx G	glazing temptate list at the top of the screen. This loads glazing and trame construction da
· E Zone Group	Dimamions	1	from the selected tomplate into the current
0 🕲 feat	Type	3 Phetenoid height •	surface. You can also open the group heads boxes to access the data directly.
8 () care	Window to wall %	P	
<ul> <li>(i) Zone 1</li> <li>(i) Zone 3</li> </ul>	Window height (m)	tso	Glazing To inspect the obtails of the cumently selecte
e 60 Zone 4	Window spacing (m)	5.00	glazing type, dick on the 'Glazing type' icon.
8 (\$ Floor - 150 000 m2	Sill height (m)	0.90	Alternatively double-click the icon to viewledt the data in a claico
* @ Roof 150.000 m2	Outside reveal depth (m)	0.000	Facade types
B (2) Partion - 17 500 n2 (Int. Zone 1) B (2) Partion - 105 000 n2 (Int. Zone 6)	Frame and Draders		There are a number of standard facade types
* C Patton 17500 n2 (Int. Zone 5)	Shading		None-there is no glazing.
😑 🚱 Wal - 105.000 m2 - 100.01	Artiple Control Windpers		Continuous horizontal - glazing is
- 62 External - 42.000 m2 (1) Vilvedow (External) 12.600 m2	Free Apentine Doors		* generated in a continuous horizontal strip
Window [Lifema] 12 600 m2	Lotis	and the second	using sill height and window to wall %
Window (Eutemai) 12 600 m2			<ul> <li>Fixed height-glazing is generated with a fixed height at the specified sill height, an</li> </ul>
12 600 m2 Window (External) 12 600 m2			width is calculated based on the window
() Window (External) 12.600 m2 () Zone 5			wall % This option uses Window to wall * but prioritises window height
* (i) Zone 5			Preferred height - glacing is generaled
bace 🤨 🖯			using the window height data and the
® (9 cme			window to wait %, but the window height
* (9 Zone 1			may be adjusted to achieve the required window to wall % This option uses windo
* (9 Zone 3 * (9 Zone 4			and sill height but prioritises window to w
* 00 Zore 5			
# (9 Zone 6			<ul> <li>Fired width and height - windows have</li> </ul>
			fixed width and height. This option uses window to wall % but prioritises window
			width and height.
			Fill surface (100%) - the entire surface is
			filled with glading and there is no frame.
			If the glacing does not have a frame, uncheck the Has a frame? box.
	Edit Vauelise Heating design Cooling design Simulation CFD	Internal Constitution	Hade West a new particular methods of West

(Refer Slide Time: 14:12)

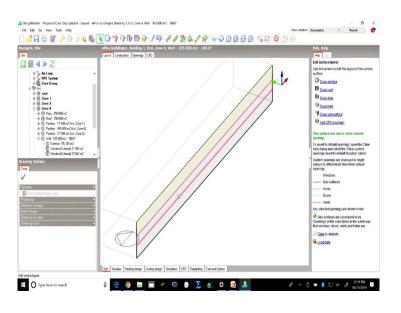


## (Refer Slide Time: 14:14)



So, suppose I want to have a glazing on top and then I want to have a glazing in between and I can also change the specifications of these windows.

(Refer Slide Time: 14:26)



So, if I go to openings, I can also change the fenestration type and we can we can select a glass.

# (Refer Slide Time: 14:30)

			A DECISION OF THE OWNER.	
	ayout Openings CFD		Help Deta	
∭ ◀ ▶ 🤃	Glazing Template		V 2 + 4 × 4	. ₽
office buildings1	General State	C21, Non-Res, Vertical, Metal harring - All other, Skylight	Glaring	
Puking 1	Esternel Windows		C C ASHRAE 90 1 2007	
Given     Given     System     System	Octobing type Dimensione	Copy of ECBC Glozing femes	Copy of ECBC Glass	
😸 🖕 VRF System	Outside reveal depth (m)	0.000	C C21 NosRes Stat	Ager with Curb
R 🖸 Zone Group	Frame and Dividers		C21 NonRee Sigh	sight with Curb
# (C) care	Sheding		C21 Non-Res Skill	
8 (9 Zore 1	Airline Contol Windows		C21 NonRes Style	Age willout (
8 (9) Zone 3 ⊖ (0) Zone 4	Free Apenure	•	C21 NonRes Veh	sol Metalita
= 19 Zone 4 = 19 Floor - 150 000 m2			C C21 Non-Ren Veta	ca Netaria Ica Metalia
* (3 Red 150.000 n2			C21 NonRee: Veto	ical Normeta
B S Patton - 17 500 n2 (Int. Zone 1)				splight with Ca
B 02 Patton - 105 000 m2 (int. Zone 6) in - 50 Patton - 17 500 m2 (int. Zone 5)			C Dista Report (Not Editable	
8: 65 Wal - 105 000 m2 - 100 0"			General	0
- 6 External - 55 345 m2			Copy of ECBC Glazing	heave
Window (External) 21.993 m2 Window (External) 27.662 m2				ASHRAE
* (9 Zone 5				ASHRAE
* (j) Zone 6				General
B S gound B C care			Coleur	
* 0 Zone 1			Definition method	
* 🚯 Zane 3				2-Simple
(i) Zone 4 (ii) Zone 5			Calculated Values	
= (3 Zone 5 = (3 Zone 6				0.250
				2,200
			Apply enhanced surface	
			Cest	
				100.000
			Radiance Daylighting	
			Diffusing	No

We can, I can select a glass for the topmost window. So, I can select the glass for the top most window as a clear glass.

(Refer Slide Time: 14:57)

412	Layout Openings CFD			Info, Deta	
				Help Data	
	Glacing Template			V 2 + 4 × ·	€ ▶
ce buildingn1	G Template	C21, Non-Res, Vertical, Me	ral transing - All other, Skylight	Glaring	
Building 1	Clasing Modews	Copy of ECBC Glozing fene		Dets Report (Not Editab	e)
Air Loop		puopy of EUBL Grazing time	•	General	
8 🖕 Wilf System	Select the glazing			Copy of ECBC Glazin	
(8) Eg Zone Group	Copy of ECBC Glacing level		•	Source	ASHRAE
in fill care	C21 NewRes Stylight with Gab Glass - G2-25 d to C21 NewRes Stylight with Gab Glass - G2-25 d to		1	Category	
8 (9 Zone 1	CI NonRes Studyt with Cub Planc - 85/25 of a			Region	General
* (1) Zone 3 - (3) Zone 4	C21 NonRet, Stylight with Cab. Plane - 2053 of			Definition method	
8 fB Flox 150.000 m2	C I Non-Rec Styleft wheat Cub All (5) 25 drie C I Non-Rec Styleft wheat Cub All (5) 25 drie			Defeiños method	2-Simple
# (3 Red 150.000 m2	C 121 Non-Fest Vestical Metal kaning - All other U-1	199(6-81)		Calculated Values	t Grape
<ul> <li>B Patton - 17 500 n2 (Int. Zone 1)</li> <li>C Patton - 105 000 n2 (Int. Zone 6)</li> </ul>	C21 NonRec Vetcat MetalFaming: Cutanivat/S			Total solar transmission	0.250
in 60 Patton - 105 000 in2 (int. Zone 6)	C1 NonFes Vintcal MetaFrance Entered do C21 NonFes Vintcal Noveral France U 1 1990			Lighttensmission	0.781
😑 🚭 Wal - 105 000 m2 - 100 0"	CI Reidenial Skylight with Curb Gillion - 05-25 of			U-Value (Wilm2-K)	2 200
G External - 55.345 m2	<ul> <li>CZ1 Reidental Skylight with Cub Glass - 23/83; dl</li> </ul>	Front, U-1 579 (11 24)		<ul> <li>Apply enhanced surface.</li> <li>Cest</li> </ul>	Tio
Window (External) 21,993 m2 Window (External) 27,662 m2	C 121 Renderind Styledr with Cuch Plante: 02:21 o C 121 Renderind Styledr with Cuch Plante: 23:53 o C 121 Renderind Styledr with Cuch Plante: 23:53 o			Cost per area (GBP/w2)	100 000
* (9 Zone 5	C (21 Readerial Subditional Cash All 05:23 of			Redience Devlighting	
in (j) Zone 6	C21 Reidenal Style Metor Cub Al 25/53 d			Diffusing	No
S gound in fill care	C21 Readenial Verical Metal haveg: All offer U C21 Readenial Verical Metal Foreign Catareval			2012	
* 03 Zone 1			222		
* (9 Zone 3	C21 Rendered Vescal Meta Formy: Enhanced P21 Bandwood Hanned Research Comment Comment	0.00.0011	Y		
8 (9 Zore 4	🗣 😼 📝 🗶 🖉 Sat		Carcel OK		
	the second second				
* (9 Zone 5 * (9 Zone 6					

So, instead of ECBC fenestration I can just take it to be a simple clear glass.

## (Refer Slide Time: 15:00)

Layout Opennps Cr0	1	Meb (244)	
			< ▶
Clannel Windows Clannel Windows (Classing type) Select the glacing	C21. Non-Res. Vertical Metal haming - All other. Skylight Copy of ECBC Glasing Innes	Glazing Data Report (Not Edital General Copy of ECBC Glazin	
B C Cystem     Cy		Source Category Pagion Colcur Definition method	ASHRAE 9 ASHRAE 9 General
a gi southe souther south		Calculated Values Total solar treasmission Light treasmission U-Value (WIm245) Apply enhanced surface Cest	0.781 2.200
🔶 🔓 😰 Øsər	Cancel (K.		
	Charlow State Forchter garant Statester	Officiency bits         Dogs of ECRC Consequences           Construction         State           State         State	Chrome type         Roopy of ECRC Gatery times         Concent           Concent of grands         Concy of ECRC Gatery times         Concy of ECRC Gatery times           Index States         States         States         Concy of ECRC Gatery times           Index States         States         Concy of ECRC Gatery times         Concy of ECRC Gatery times           Index States         States         Concy of ECRC Gatery times         Concy of ECRC Gatery times           Index States         States         Concy of ECRC Gatery times         Concy of ECRC Gatery times           Index States         States         Concy of ECRC Gatery times         Concy of ECRC Gatery times           Index States         States         Concy of ECRC Gatery times         Concy of ECRC Gatery times           Index States         States         Concy of ECRC Gatery times         Concy of ECRC Gatery times           Index States         States         Concy of ECRC Gatery times         Concy of ECRC Gatery times           Index States         States         States         Concy of ECRC Gatery times           Index States         States         Concy of ECRC Gatery times         Concerts           Index States         States         Concerts         Concerts         Concerts           Index States         States         Concert

And I take it to be say single clear 6 mm.

(Refer Slide Time: 15:05)

The bulleton 1 Device of the second	Al Devrop (30)	C21. Non-Res. Vertical. Meta Copy of ECBC Glassing lenes	-	Help Star Classing Date Report (Not Edinable General Copy of ECDC Glassing	9)
tifet buldings1	Conception Conceptions Concept	The second s	-	Glazing Data Report (Not Editabl General	0)
Pulding 1       Solution       Matter       Matter       VIII System       Solution	Council Windows Classing type riect the glasing Single	The second s	-	Dats Report (Not Editable General	
Summer C System     Summer C System     Summer C System     Summer C System     Summer C Summer	Closing type electing glacing	Copy of ECBC Glazing lines	-	General	
© VIII System 5 ≈ © Zone Gasup 8 ⊗ Shat ≈ © cone	🔁 Single				
in ∰ Zone Gosup ⊖ Shat ⊛ © fore					feners
⊖ ♥ fest ⊛ (1) core				Source	ASHRAE
				Category	ASHRAE S
	Grand Set Brander Jam     Grand Set Brander Jam			Region	General
* (i) Zone 3	C Sg(D) Jun		1	Coleur	
⊖ (3) Zone 4 ⇒ (5) Floor - 150 000 m <sup>2</sup>	C Sd O ten			Definition method	2-Simple
# (2 Red 150.000 m2	- O Sal Oi Leviton 3en - O Sal Oi Leviton 5en			Calculated Values	c-ombia
8 🚱 Patton - 17 500 n2 (Int. Zone 1)	- 🕼 Sal Elec Abs Bleached form				0.250
Patton - 105 000 m2 (int. Zone 6) R-52 Patton - 17 500 m2 (int. Zone 5)	C Syl Elec Abs Colored Gerer C Syl Elec Ret Bleached Gerer			Lighttransmission	0.781
B 65 Wal - 105 000 m2 - 100.0"	SgiElec Rel Colored from			U-Value (W/m2-K) Apply enhanced surface	2.200
External - 95:345 m2 Window (External) 21:993 m2	D Sel Green Jran			<ul> <li>Appy enhanced surface.</li> <li>Cest</li> </ul>	TED
Window (Litema) 27.662 m2	C Syl Green feas C Syl Green Jam			Costper area (GBP/w2)	100.000
* (9 Zone 5	0 Sel Grey from			Rediance Daylighting	
* (i) Zone 6	(j) Syllof (n2+2)(0; 3mm) (j) Syllof (n2+2)(0; 6mm)			Diffusing	No
* () care	5 st Lot in2+4) Ck 3mm				
* (3) Zone 1 * (3) Zone 3	SdRelAH O 6em				
* fil Zone 4	4 4 8 8 Sot		Carcel OK		
* (0 Zone 5			1010		
* (3 Zone 6					

So, this implies that I have if we look at the properties here of the glass, it has a light transmission value of 88 percent and while if I go back and if I look at the other window, this window I might want to have glass which does not have a VLT as high as that.

# (Refer Slide Time: 15:10)

igate, Site	office buildings 1, Building 1, first, Zone 4, Wall · 105.0	00 m2 - 180.0°, Window (External) 21.993 m2	Info, Data	
	Layout Openings CFD		Help Data	
	😡 Giaong Tempiate	1	✓ 2 + 3 1 <	
g stice buildings1	General de la complete	C21, Non-Res. Vertical, Metal haming - All other, Skylight	Glaring	
🖯 🥐 Bulding 1	Externel Wridows		Data Report (Not Editable	a)
🗟 🚰 dWAC System	(Claring type	Sgl Cir finim	General	
🛪 🖕 VIIF System	Dimensions	0.000	Sgl Cir 6mm	
🕫 🔁 Zone Group	Outside reveal depth (m)	2000	Source	EnergyPlus
C S feat	Sheding		Category	Single
* (i) Zone 1	Article Control Windows		Region	General
* (9 Zone 3	Free Apenue		Colcur	
⊖ Ø Zone 4	Babara anno 1		Definition method	
8-03 Floor - 150 000 m2 9-03 Floor - 150 000 m2			Definition method	1-Material la
# 02 Patton - 17 500 n2 (Int. Zone 1)			Loyers	1
B (g) Patton - 105 000 m2 (inst. Zone 6)			Numberleyers	1
Father - 17 500 e2 (Int. Zone 5)	1		Outermost pane	Generic CLE
- 60 External - 55 305 m2		Þ	Pane type Filo lever	No
Window (External) 21.993 m2	1	-	Outside Surface	140
() Window (Estemai) 27 662 m2			Fix convective heal trans.	Ma
* (3) Zone 5 * (3) Zone 6			Inside Surface	140
B gourd			Fix convective heat trans	No
* () care			Calculated Values	
® (§) Zone 1			Total solar transmission	0.810
* (3) Zone 3 * (3) Zone 4			Direct soler transmission	
· (i) Zone 5			Lighttrensmission	0.861
🛞 🚯 Zone 6			U-value (ISO 10292/ EN U-Value (Wim243)	6121
			Apply enhanced surface	
				140
			Cest Costperaise (GBP/w2)	100.000
			Cest	

So, suppose I am taking a double glass and I take a double, if I take a double grey and I select the properties 6; 13, 6.

(Refer Slide Time: 15:40)

ate, Sité		15.000 m2 - 180.0°, Window (External) 27.662 m2		Info, Deta	
	Layout Openings CFD			Heb Date	
∰ ◀ ▶ 🤃	Claring Template			V 2+ 4x 4	
slice buildings1	Genelate Generation	C21. Non-Res. Vertical. Metal harring - All other. S	aylight	Glaring	
Pulding 1	Estimal Windows			Data Report (Not Editabl	ə) ·
GIVAC System	Claring type	Copy at ECBC Glazing fenes		General	
* Wilf System	Select the glazing			Obl Green 6mm/6mm	Ne
· C Zone Group	0 0bi Elec Ret Bleached feav Seen Ar		~	Source	EnergyP
C State	0 0bl Elec Ref Colored Been/13een.Ar			Category	Double
* GI Zone 1	0 BM Elec Ref Colored Error/Tom-Arg DM Elec Ref Colored Error/Tom Arg			Region	General
* 63 Zone 3	ON Green In Your As		-	Coleur	
0 O Zone 4	0 Bbl Green Jam/13vm.Ar			Definition method	
<ul> <li>B Flox - 150 000 m2</li> <li>B Real - 150 000 m2</li> </ul>	0 0bl Green Janv'l Janu Jep			Definition method	1-Materia
# 52 Patton - 17 500 n2 (int. Zone 1)	0 bb Green fann 1 Jam Je 0 bb Green fann 7 Jam Jep			Loyers	
# 65 Parton - 105 000 m2 (inst. Zone 6)	(i) Did Green Conv. Swin. Ap			Numberlayers	2
Patton - 17 500 n2 (Inst. Zone 5)	014 Gray Jonn/Thorn Are			Outermost pane	
⊖ 6 Wal 105 000 m2 - 100 0°	🖉 Obl Grey Joss/1 Joss Aug			Pane type	Generic
- 65 External - 95 3/5 m2	Bbl Grey Jow/Sem Ar			Fliplayer	140
Window [Literal] 27 582 m2	0 Ul Gray form/Them Air			Window gas 1	
· () Zone 5	C DM Gray form/form for			("Window gos type	AREMM
* 🚯 Zone 6	0 0M LoE Je2+ 1J Dr Jons/TJnes Ar			Innermost pane	
S S pound R S care	eArwET/veeE to JI -5 at 3o1 kB 💭			Pone type	Generic
· (i) Zone 1	0 0biteE (e2= 1) Or 3nn/Sees Ar 0 0biteE (e2= 1) Or 6nn/Tans Ar			Flip layer	No
* (3 Zone 3	Bill of the second second second second		v	Outside Surface	
· [] Zone 4	🔹 🗣 🐼 🐼 🖾 Sat	Cancel	CK.	Fix convective heat trans.	No
O Zone 5				Inside Surface	
8 (9) Zone 6				Fix convective heat trans.	No
				Calculated Values	
					0.490
				Light transmission	0.564
				U-velue (ISO 10292/ EN _	
				U-Value (Wim2-K)	3157
				Apply enhanced surface.	No
				Cost	
	In the second se	and the second se		Costperarea (GBP/m2)	160.000
	Edit Vaualise Heating design Cooking design Simulation (	CFD Daylighting Cost and Carbon		comber med (oper twe)	100.00

And if I check the light transmission it is around 66 percent and I select it ok.

# (Refer Slide Time: 15:58)

	1990 - 1991 - 1992 - 19		Jafo, Deta	
	Layout Openings CFD		Help Cuta	
14 ♦ 2	Glazing Template	1	V 2 + 2 1	
stice buildings1	Template	C21, Non-Res, Vertical, Metal haming - All other, Skylight	Glazing	2
Building 1     Building 1     Building 1     Building 1	Cating type	Obl Green Emm/13mm Air	Dets Report (Not Editab	(0)
🛞 🆕 Air Loop	Duranuora	Die Green enny sinn Au	General	-
🛞 🍆 Wilf System 🗷 🕼 Zone Gasup	Outside reveal depth (m)	0.000	Dbl Green 6mm/13mm Source	EnergyPI
H Kg Zone Group	Frame and Dividers		Category	Double
· () care	Shading		Region	General
8 (9 Zone 1 8 (9 Zone 3	Antion Control Windows		Coleur	
E Q Zone 4	Free Apenure	-	Definition method	
⊕ (∰ Floor 150.000 m2			Definition method	1-Materia
⊕ ( <sup>1</sup> / <sub>2</sub> ) Rool - 150:000 m2 ⊕ ( <sup>1</sup> / <sub>2</sub> ) Partition - 17:500 m2 (first, Zone 1)			Loyers	
⊕ 6 Patton - 105 000 w2 (int. Zone 6)			Numberleyers	2
⊛ 62 Patton - 17 500 m2 (Init. Zone 5) ⊕ 62 Wall - 105 000 m2 - 180 0*	0		Ovtermost pane	Generic
(§ External - 55 3/5 m2			* Flo lever	No
Window (External) 21 993 m2			Window gas 1	100
() Window (External) 27.662 m2 () Zone 5			T Window gas type	ARIM
* (3 Zone 6			Innermost pene	
⊖ Spound ⊛ (C) care			Pone type	Generic
* (3 Zone 1			Flip layer	No
* () Zone 3			Outside Surfece Fix convective heat tans	
© (3) Zone 4 = (3) Zone 5			Inside Surface	160
* (3) Zone 6			For convective heat trans	No
			Colculated Volues	
			Total solar transmission	
			Direct solar transmission	0.379
			Light transmission U-value (ISO 10292/ EN	
			U-Value (W/m2-K)	2.708
			Apply enhanced surface	No
			Cest	160 000
	Edit Visualise Heating design Cooling design Simulation CFD	Davidters Cett and Cation	Costperarea (GBP/w2)	160.000

We can go back and we can simulate it again.

(Refer Slide Time: 16:07)

1 🚰 🖶 💩 🎤 🖓 📲 🚇		
vigate, Site	office buildings 1, Building 1	Info, Help
14	Burnance Annual daylgting	Heb Cara
3∰∢⊳2	🖓 Updan data	No results are available as the calculation has not run yet
2) Sinch Margol ⇒ 2) Sinch Margol ⇒ 20 Sinch System ⇒ 24 Sinch System ⇒ 24 Sinch System ⇒ 25 Sinch Sin	e 6)	22 <u>upper</u> the constants
iday Options well i imulation type 1-General inportype 1-Map of	-	
Source 4-User Defined Value source 1-Doylight facto Low vehice 2		
tigh value 10 Apply scale "too dark" colour Scale "too dark" colour Apply scale "too bright" colour		
Working plane 0.750		
Off 0 states hand and and and	Edit Vaualse Heating design Cooling design Simulation CFD Daylighting Cost and Carbon	

So, we simulate the building again for its day lighting and we can see the changes that it brings along with it.

## (Refer Slide Time: 16:10)

wigate, Site	Edit Calculation Options		1	Info, Help
14	Calculation Options		Help	Heb Data
	General		the Care	No results are available as the calculation h not run yet
a) office buildings 1	Calculation Description	1	Daylighting Calculation Options	Hitter Pt
🖻 🅐 Building 1			Select the parameters for the daylighting calculation.	Update the calculations
e Citwic System	Celculation Options		The maximum grid size will significantly affect the time taken for the calculations	1.000
Air Loop	Simulation type	1-General ·	The margin defines the zone perimeter area that is not	
E Zone Group	Detailtemplate	4-Good •	od included in the calculations and average daylight factor	
⊖ ∰ fea ≋ ∰ care ≋ Ø Zone	Working plane height (m)	6.7500		
	Margin (m)	6 3 6 9		
* (3 Zone 1 * (3 Zone 3	Ground plane extension (m)	10.0		
B ( Zone 4	Sv	1		
8 f3 Floor 150 000 m2	Skymethod	1-Stenderd sky •		
* @ Root 150.000 m2	Skymodel	E-CE overcest day (specify illum .		
<ul> <li>B Patton - 17 500 n2 (Init. Zone 1)</li> <li>B Patton - 105 000 n2 (Init. Zone 6)</li> </ul>	Zenth (luminonce (lui)	10000		
# 01 Patton - 17 500 e2 (tot. Zone 5)	Ged	<b>b</b> 1	*	
😑 🚱 Vial - 105 000 m2 - 100 01	<ul> <li>Min Grid Size (m)</li> </ul>	0.100		
splay Options	Max Grid Size (m)	1.000		,
ered	Advatced Options			
	Ambient baunces	4		1
/	Ambient accuracy	0.22		
tw 3	Ambient resolution	512		
Simulation type 1-General •	Ambient divisions	1024		
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This is what we can do, if you want to check different options for the daylight calculations and every time we can see whether more and more area is being adequately lit, day lit or not.

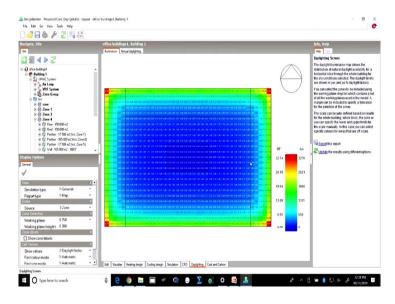
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We can also select if you want to go for the compliance we can go with either of these options and it will automatically tell it will generate a report in the format which is desired for LEED or BREEAM or Green Star and tell us whether this particular building plan and the open the fenestration design complies with the criteria, compliance criteria

given in these rating systems or not and we can see the changes. So, we this is very good to be used at a very initial stage of design; at a very initial stage of design where we are still working on the on finalizing the design of fenestration which orientation should I provide fenestration on.

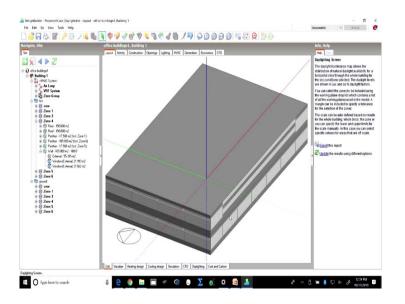
So, if I know clearly the fundamentals that, not as the side where I want to provide with fenestration, but I was not very clear whether I have to provide for a clear glass or I can provide for a tinted glass or I should provide for a low-e glass. This is an interesting way to look at this. So, we will simultaneously be looking at the day lighting calculations and also the energy implications of that.



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So, if we compare the values which we had earlier we would see that the values for the southern side has they have become more uniform, and similar thing we can do if you want to change the fenestration design and the glazing specifications for all the windows in this particular building. And we can keep experimenting and comparing the different options that we can possibly have through design as well as specifications.

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So, this is what we would do while we are doing daylighting simulations. We can work with the design of windows, we can work with the specifications, we can work with the shading devices, we can work with orientation of the windows and literally all the parameters concerning the fenestration.

So, this was all for today's lecture. And with this we have already completed almost everything about the whole building simulation and the various purposes for which whole building simulation is used in green building certification and for green building rating programs compliance.

In the last lecture, on whole building simulation we would be looking at some easy options of generating the base case models and using them for compliance. Here what I have been discussing so far was where you want to improve upon your design. So, besides the compliance, the tool, the whole building simulation tools helps us in designing better buildings. If we have already designed, if we have already completed the design of the building these tools also help us in proving the compliance which is what we will see in the last lecture of this course which is unsustainable architecture in tomorrow's lecture.

Thank you for being with us today. See you again tomorrow. Bye-bye.