Glass in Buildings : Design and Application
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Lecture – 16
Modeling the Building Envelope

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The next parameter is called the Solar Heat Gain Coefficient; it is extremely important to understand this parameter. Because it is a very important property of glass I was just talking about the amount of radiative heat transfer that can actually come through the glass into the building.

So, as part of the radiation that comes out from the glass; it is; it adds a lot of heat into the building. So, to optimize this parameter is extremely important when it comes to heating risks inside buildings and we want to balance the amount of light that comes in with the heat right. So, it ideally we would want more light to come in because we want more of daylight and it is proven that daylight actually includes the productivity of people.

So, the more the daylight the better it is and it also reduces the amount of electric power that you would want to use to power the lighting inside the building. At the same time you do not want a lot of heat to come in to the building when you send when you bring in sunlight.

So, this parameter actually optimizes the two. So, the lower the SHGC the better it is, but unfortunately what happens typically is when you have your low SHGC lower; your visual light transmittance actually goes down right. So, which means you are trying to put some kind of coating or some kind of additive on the glass to make sure that your heat ingress is reduced, at the same time you are trying to also compromise on the amount of light that comes in. So, the idea is to basically create some kind of a balance between the two to optimize the envelope; so, that is important.

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And the next parameter is talking about the U value, the U value is basically the amount of conductive heat transfer that can happen through a particular material right; it is a it is entirely depending on the property of the material. So, if there is a lot of temperature difference between the two sides of a material; the amount of heat would directly dependent on the U value of the material, which means the higher the U value you will have more conductivity which means you will have more heat that will come in. So, the idea is to reduce the U value so that you have lesser heat ingress from the wall or the glass inside the building.

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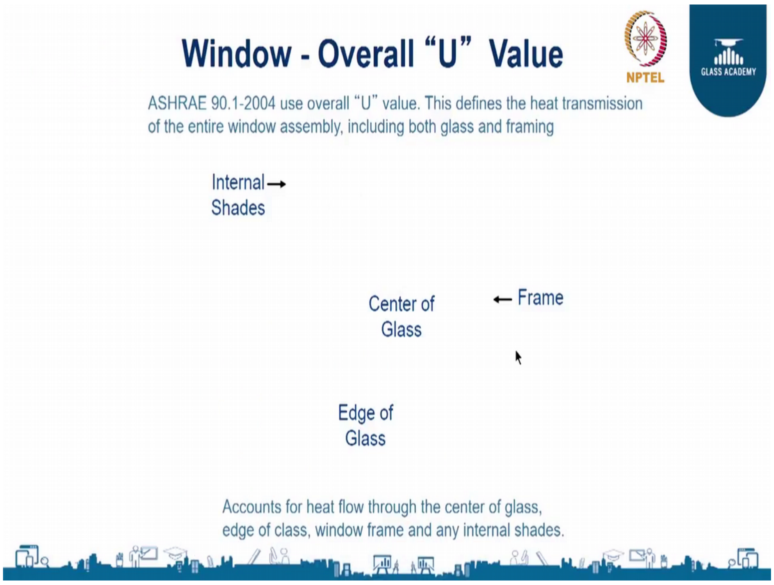

So, it's basically dependent on the temperature gradient between the two sides of the material. So, this is the important parameter when it comes to modeling envelope design. So, typically when we look at the U value; we typically look at the assembly of the envelope and not the individual component. For example, you will have glass and you will have a frame around the glass or you will have some material which will actually be around the glass to kind of create some kind of aesthetic effect or to fix the glass on the envelope.

So, when we do the U value calculation; we actually have to take both the materials together because it is the assembly which matters. But typically the assembly needs to be get and use to be tested in the lab and you get the U value and then use that in your simulations to get a more accurate perspective of how the envelope is going to behave when it comes to conductive heat transfer.

So, here we are trying to see what are the different inputs that go into the tool; the energy simulation tool? So, some of the typical inputs would be the you look at each parameter separately in terms of envelope the roof, the wall, the glass and then you put those properties of different materials in your both the baseline case. Basically most of the codes using which I spoke about the ECVC or ASHRAE 90.1 actually give you a prescriptive U value or SHGC that you should use for a particular envelope; in a particular climate zone that you are going to put the building in.

So, you will have to basically record those parameters as per the code and then you also look at your proposed design which the elements that you are going to put in your design. And start creating some kind of a comparison and see where you try to benchmark your performance based on the baseline. So, that is the idea of documenting and tabulating these different parameters depending on the climate zone of the building.

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So, we do have a lot of software today which is available for energy simulations; this slide is talking about lot of software that we have. And E-Quest is actually a free software which is available and that can be; it is fairly effective and doing lot of energy simulation buildings. And most of the software use the DOE engine as the backend and only the front end is actually kind of variant depending on the kind of UI; the user would be preferring.

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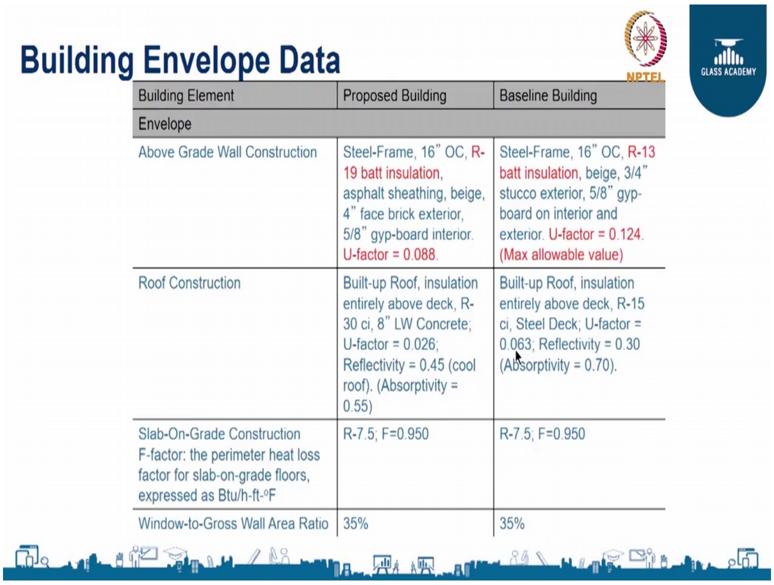

Building Element	Proposed Building	Baseline Building
Envelope		
Above Grade Wall Construction	Steel-Frame, 16" OC, R-19 batt insulation, asphalt sheathing, beige, 4" face brick exterior, 5/8" gyp-board interior. U-factor = 0.088.	Steel-Frame, 16" OC, R-13 batt insulation, beige, 3/4" stucco exterior, 5/8" gyp-board on interior and exterior. U-factor = 0.124. (Max allowable value)
Roof Construction	Built-up Roof, insulation entirely above deck, R-30 ci, 8" LW Concrete; U-factor = 0.026; Reflectivity = 0.45 (cool roof). (Absorptivity = 0.55)	Built-up Roof, insulation entirely above deck, R-15 ci, Steel Deck; U-factor = 0.063; Reflectivity = 0.30 (Absorptivity = 0.70).
Slab-On-Grade Construction F-factor: the perimeter heat loss factor for slab-on-grade floors, expressed as Btu/h-ft-ºF	R-7.5; F=0.950	R-7.5; F=0.950
Window-to-Gross Wall Area Ratio	35%	35%

So, so most of the software typically gives you similar outputs when it comes to simulation results and analysis. As I said earlier the building envelope data we are talking about various aspects of the envelope and what are the different properties of the material that go into the envelop.

So, we will document that for the baseline in the proposed case. So, the proposed case as I said is reflective of the actual building post construction because you are trying to put in the actual elements that you want to put into the design in the proposed case. Whereas, in the baseline case basically it is actually programmed to the code depending on the energy code that you want to adhere to.

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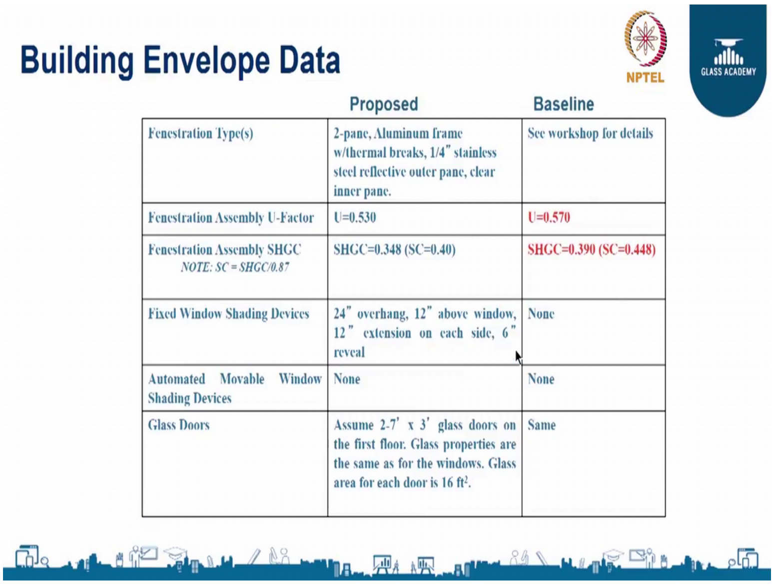

	Proposed	Baseline
Fenestration Type(s)	2-pane, Aluminum frame w/thermal breaks, 1/4" stainless steel reflective outer pane, clear inner pane.	See workshop for details
Fenestration Assembly U-Factor	U=0.530	U=0.570
Fenestration Assembly SHGC *NOTE: SC = SHGC/0.87*	SHGC=0.348 (SC=0.40)	SHGC=0.390 (SC=0.448)
Fixed Window Shading Devices	24" overhang, 12" above window, 12" extension on each side, 6" reveal	None
Automated Movable Window Shading Devices	None	None
Glass Doors	Assume 2-7' x 3' glass doors on the first floor. Glass properties are the same as for the windows. Glass area for each door is 16 ft^2.	Same

So, most of these baseline codes we are talking about a ECVC or Ashrae; we will actually try to limit the window wall ratio to 40 percent. And the idea is basically to reduce the amount of wwr and they do not want you to and they do not enforce the design team to actually go less than 40. You can always have more than 40 percent of glass on the façade, but it makes it all the more difficult for the design team because that will involve lot of cost. So, you are trying to increase amount of glass and it adds to the cost and also it adds to the impact on the energy performance of that particular façade.

So, typically they try to limit it to 40 percent and as a design team; you are free to increase it beyond 40 and try to see how you can accommodate it elsewhere there is a impact on the energy performance. So, typically you will try we will try to document these element; these properties of both the glass and the wall and both the baseline and the proposed case. And you can also model sharing devices as I said earlier in various facades and see how the performance would change.

So, the idea is basically to run the simulations by varying various factors which includes the operations, the usage patterns the clay are the climate zone. You can even look at allocating and building in a different climate zone for that façade; how the variation would be. You can look at people loads, mechanical loads all these loads can be programmed and can change and run various scenarios by varying these parameters and see how the output of your energy performance looks like and take decisions and actually helps a lot in making you take the right decisions in design.

So that is why energies modeling is extremely important to start very at the very early stages of the pre design. So, you get a fairly good picture of how your decision making is actually tied to the actual performance of the building as you start elaborating the design.

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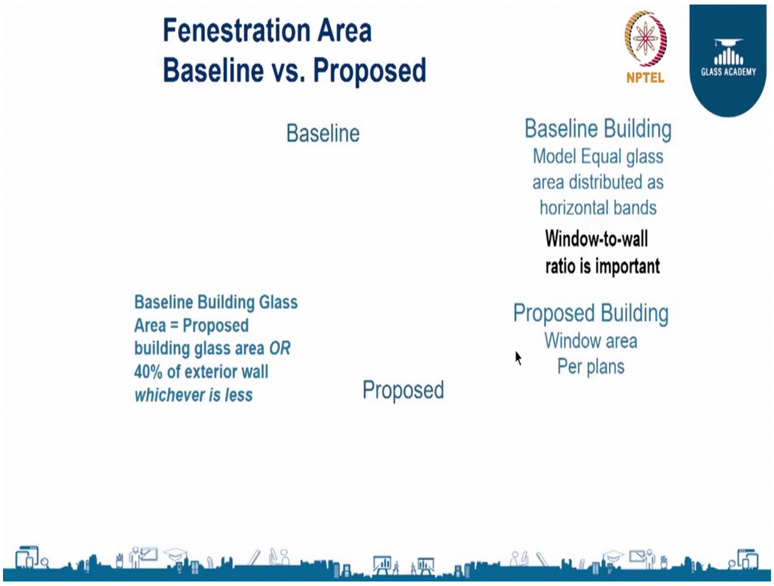

So, as I said earlier most of these codes we will actually try to limit the window wall ratio to 40 percent. And we are free to actually increase it depending on the; baseline code is basically derived from a lot of research and a lot of data from various projects and they keep revising these parameters as and when the building performance changes or; so these codes have various versions. So, depending on the climate zone you are in and the performance of buildings the codes actually get more stringent.

So, today we are talking about ASHRAE 90.1; 2010 and tomorrow it when the next version gets released the code gets more stringent. So, as we start programming to the baseline or simulating the baseline your levels will actually go up and you are trying to actually model to a more stringent code. So, that is important to keep in mind and given the fact that the construction duration actually goes beyond few years right most of the big buildings that you are talking about. So, we have to keep in mind that the code also keeps changing and so, as and when your construction ends your code may be most stringent that is something that important to keep in mind.

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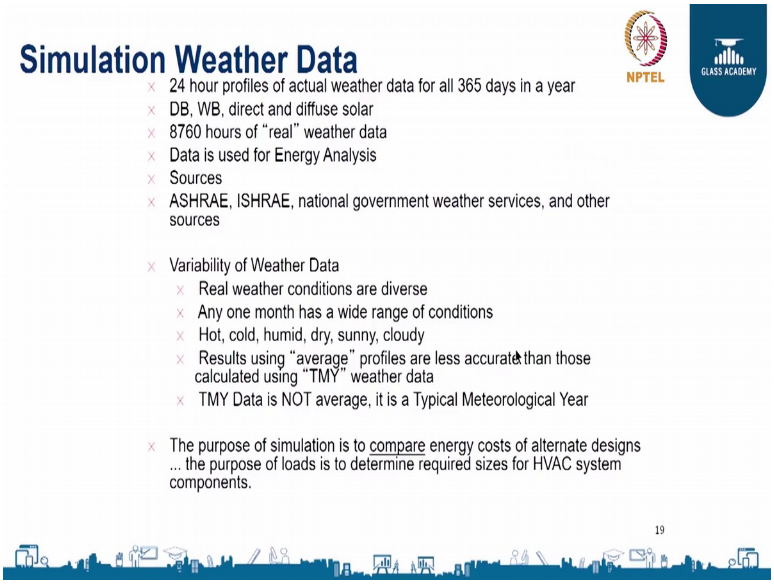

So, today as I said we have a lot of weather data that is available today and many of the organizations like ASHRAE, ISHRAE and other government organizations actually tie up to these or get data from the meteorological institutes of the organizations which are local to that particular geography. And try to generate this weather data an hourly basis which means talking about hourly temperate temperature profiles throughout the year.

So, for the total of 8760 hours in a year, you have complete temperature humidity profiles of that particular location. So, that goes into the simulation software; so which makes it even more detailed in terms of providing energy performance data hourly through the year. So, that makes it even more involved in terms of and more; accurate in terms of providing outputs with respect energy performance.

And most of these data is available free and you can download the other data from most of these websites this includes a meteorological department and the ASHRAE websites and you can get this data available for you, you can use this in your energy model.

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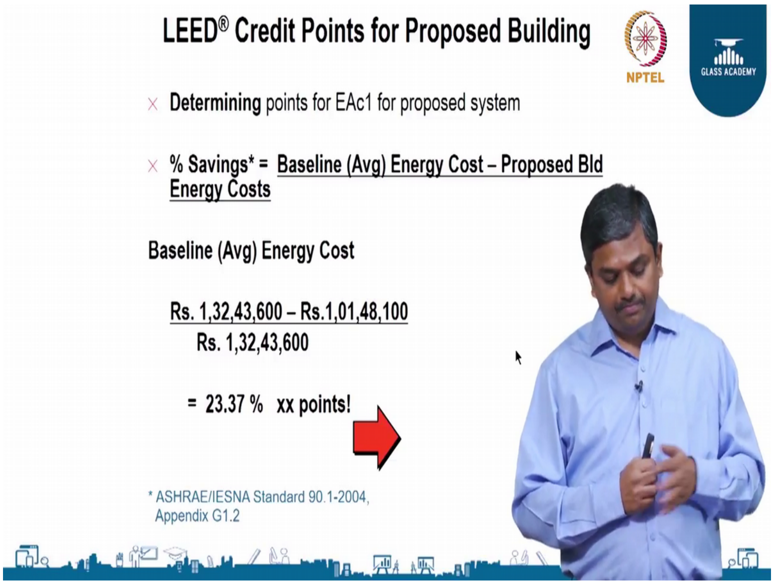

So, typically you are talking about green building rating systems are become very popular today. And they try to arrive at savings based on your baseline versus proposed case energy performance. So, you can actually create the baseline model for your building and the proposed case which is your actual building and see how better you are with respect to the code. So, as your energy savings actually increases; you are rewarded more percentage of points in most of these green building rating systems.

So, the; in fact they give you lot of importance to the energy performance and more points are actually given for better energy performance of buildings.

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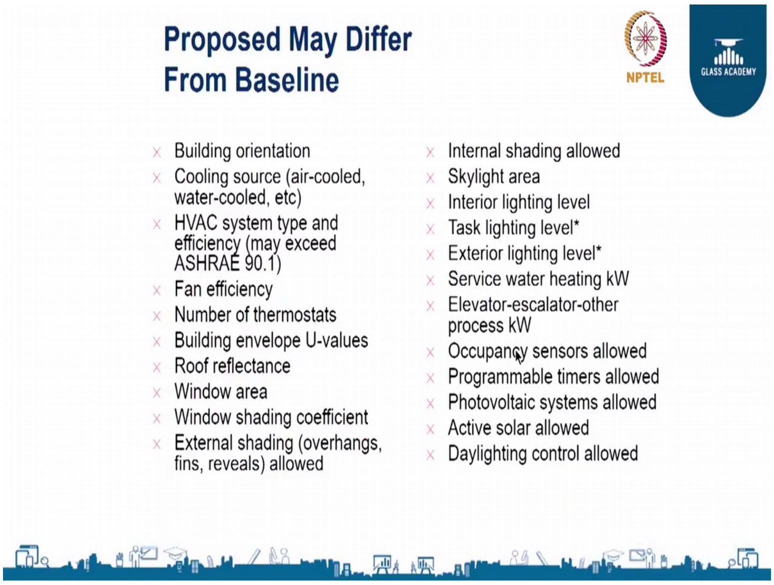

So, here we are talking about different parameters in the proposed case or the purpose case which is actual design of the building which can actually vary compared to the baseline.

So, you can either change these parameters your design team is free to change any of these parameters and that change could either enhance or limit your heat transfer or it can worsen the energy performance or improve the energy performance; so, there is a trade off. So, you can actually do these what if analysis of all these parameters you can keep changing them and see how your energy performance varies.

So, that will give you a fairly good idea on how to go about your design and what to pick and what not to pick. So, you have lot of options you can run with all by changing all these parameters and see how your building is going to perform. So, that gives you a fairly good idea of the energy performance and also you a good idea of how your savings would be compared to the code. So, that also helps you in trying to meet your local code and your approval as well.

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