Glass in buildings: Design and Application
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Lecture – 15
Modeling the Building Envelope

Hi I am Karthik, I represent ENC sustainability solutions, and we are a sustainability consulting from predominantly into green building consultant, a corporate sustainability reporting and we also do energy audit.

So, welcome you all to the session on Modeling the Building Envelope.

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So, here we are trying to introduce you to energy simulations of buildings, with primary focus on the building envelope say. We will look at the parameters that typically important when we consider modeling building envelopes, and how the how we can alter these parameters during the simulation process, to aid important design decisions. And we will also conclude the session with a case study. Where, we will try to see how we can actually attune or simulate the building by changing various design parameters with respect to the building envelope, which includes the glazing, the wall the roof etcetera which constitute the envelop; and how we can use energy simulation tools and their outputs to aid important design decisions.

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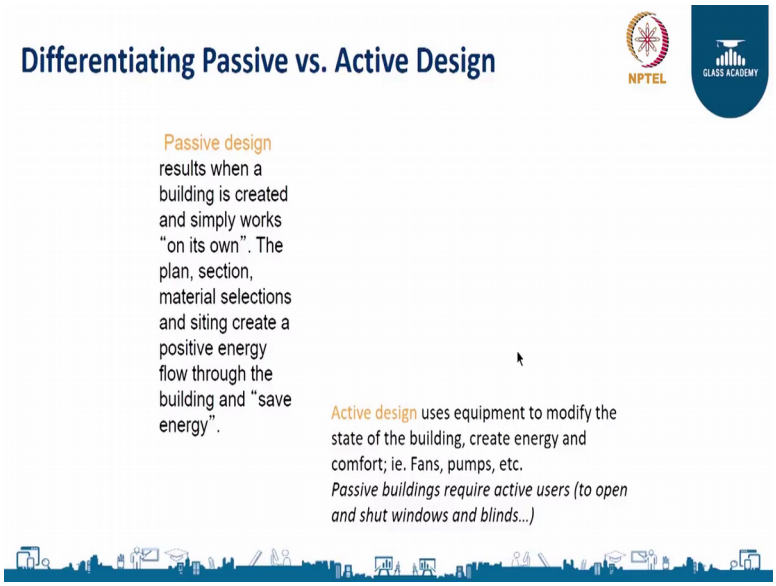

So, to start with let us first try to understand the difference between passive design strategies and active design strategy. Passive design typically involves the elements natural elements, which includes the sky, the earth, the wind patterns, the climate and the choice of materials that we use inside buildings to create the building envelope to create a climate responsive design of the building. So, typically we do not use systems in a passive design strategy, which means you do not use mechanical systems with a powered by electricity.

So, the idea is to basically choose materials, which includes the choice of glass, the choice of the wall material that we intend to be part of the building design to make sure that these elements these materials have properties that actually can influence the amount of heat or light that can actually come inside the building. So, the idea is basically to create a building image, which works on its own without any influence of external systems. As opposed to passive active design which involved the use of systems like fans or any mechanical equipment including chillers, to create thermal comfort power comes inside building.

So, typically this building envelope actually comes on to the passive design strategy, where we are actually trying to choose materials for our envelope to make sure that these materials have the right kind of properties, depending on the location in which we intend to put the building. So, the temperature profile the climate profile of the location of the

building in which the building; where the building is going to be located, will have a an influence on the choice of the material that we need to put in the building.

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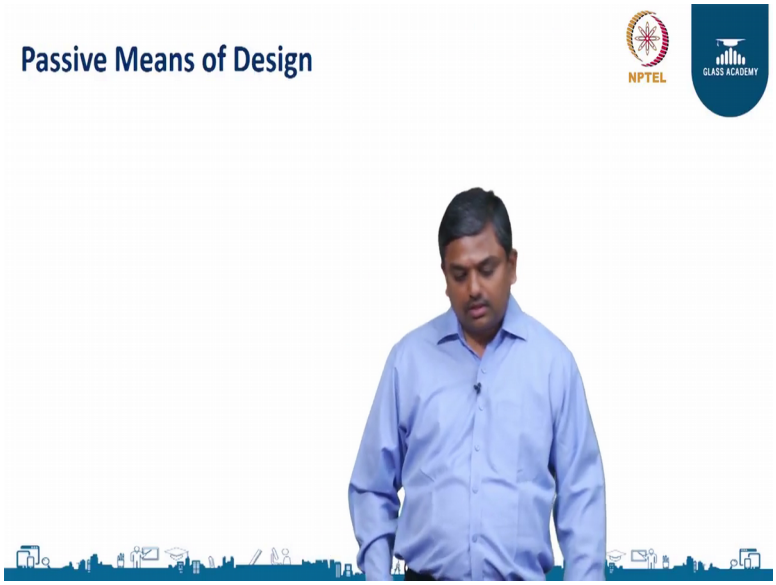

So, the neck the next slide is talking about passive means of design or the strategies that we can use for passive design. Now typically in the winter season we would want to promote solar gain and resist the heat loss from the building, as opposed to summer climate. So, how do we do this with the experiment with the help of materials? So, that is the intent of choosing the right now materials during building design.

So, if you look at the types of heat transfer that we all know is basically conduction convection and radiation. So, most of these modes of heat transfer actually are dependent on the material, that is exposed to a temperature difference which includes the solar heat exposure or the various factors, that influence ambient temperature of space where the building is supposed to be located. So, we actually the idea of passive design is basically to choose those kinds of materials which can either enhance or limit the amount of heat transfer for achieving the right kind of climate control and provide the right kind of thermal comfort cookie fence inside the building.

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So, the next slide is talking about the stepped approach to energy management of sustainability in buildings a very important approach and possibly the most important style of this presentation. Here we are talking about a three tier approach towards energy management. The bottom tier is talking about how we can achieve climate responsive design by just looking at the location, the sighting and the orientation of the building.

So, that is very critical when it comes to energy management. So, the next tier actually adds the passive and active passive heating and cooling strategies to this tier; then this strategy will not work if bottom tier is not appropriate. So, it is entirely dependent on how we locate and sight the building and of course, the bottom two tiers are much larger than the top tier, the top tier is talking about adding mechanical systems on top of the passive design strategies that we have tried to incorporate to achieve thermal comfort.

So, the idea is basically to keep the top tier as small as possible or as thin as possible compared to the bottom two tiers. So, we want to exhaust all the passive design strategies, before we even look at mechanical systems for achieving thermal comfort. So, now, off light lot of these green building rating systems which include lead or GRIHA; what IGBC green rating system actually emphasize a lot on the building envelop.

In fact, there are requirements or own commissioning of building envelopes today, which have been introduced in rating systems were actually third party people actually commissioning agents, actually come and verify the building envelop, and test the

building envelop, and certify them, to ensure that the properties that have been committed by the manufacturer are actually in the site.

So, it is gaining a lot of importance and envelop is actually very important in terms of achieving building performance optimization.

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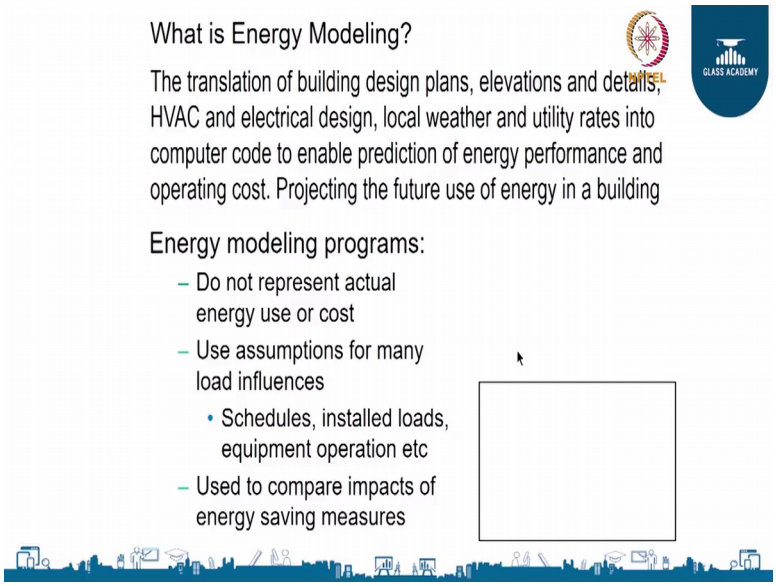

So, now let us look at what is energy modeling. So, energy modeling is typically we are trying to build the computer, and then build on a computer the building virtually and try to take the building through the various weather changes throughout the year of that particular building. So, how the building actually is able to perform, when there are budget changes that we see in the particular location.

So, what we do is we basically create this model on a computer and we start feeding in all the different materials that we intend to put on different facades of the building, which includes the wall, the glass, specs of the glass and so on. And as we talked about the three tiers we actually go through putting all the elements of the three tiers, which we spoke about in the computer and make sure that we have all the materials captured in the computer. And on top of that we put the people right because people also contribute to loads. So, you have heat loads coming from people, you have heat loads coming from the mechanical systems, lighting. So, all those inputs actually go on top of the passive design strategies that you have tended to propose in the design.

And finally, we of course, add the mechanical systems, which include the chillers and other swag systems that we want to put in the building. And then what we do is we use a very very intense of weather data that is available today. From most of these organizations include ASHRAE ISHRAE and we feed the weather data hourly weather data of that particular location into the software and then what this does is, actually produces it actually helps you to predict the energy performance of the building given all these inputs for 8760 hours throughout the year right.

So, we are basically trying to simulate hourly simulation of energy performance of building throughout the year. So, that makes it very powerful and you can actually play around with lot of these parameters, to find out how the building is going to behave if you change for example, a particular glass in the particular façade, or if you add some shading devices in a particular façade, or if you want to change the operational profile of the building, the schedules of the building, the number of people inside the building.

So, all these factors can actually be programmed and you can do a lot of these walkthrough scenarios around these parameters, and actually arrived at very prudent design decisions. So, which is very important for us to make our detailed design much more effective and make the building more optimized in terms of energy performance.

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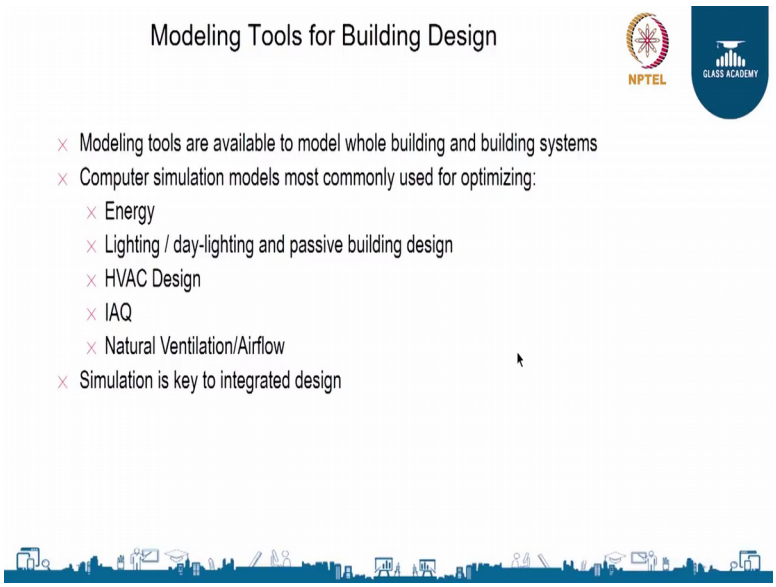

So, modeling tools today are very powerful and with the advancement of lot of technology we have a lot of these software, which are available which can actually

model the energy performance. Apart from energy performance you can also model the day lighting, HVSC, the indoor air quality, natural ventilation, the amount of airflow and so on.

So, these tools actually are very useful during the design process or the early stages of design, when you want to finalize on what kinds of materials that you would want to use or what kind of systems for the active design part if you want to use; in terms of achieving the right kind of airflow or right kind of the thermal comfort that you want to provide for your occupants. So, it becomes a key element of the integrated design, which we are talking about today in most of these building life cycles.

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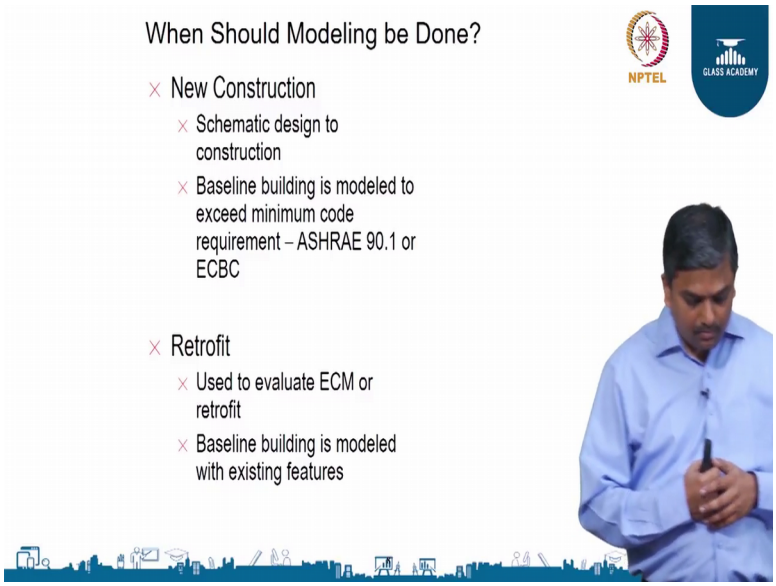

So, the next slide include when do we want to do this modeling. So, energy modeling typically is done for new buildings, in the very from the very early stages of design, which is from the early design or the pre design stage followed by the schematic design and the detailed design as we go around, as we start elaborating the design. We can use these tools to actually find out how the building is going to perform as we elaborate the design based on various factors that come into play, they include the materials, the kind of people the occupants the schedule the operational efficiencies the diversities all those things can be actually programmed, and actually helps you to actually arrive at very fairly accurate energy performance of the building.

So, typically these simulations may not give you the exact absolute value of the energy that will be consumed by the building per say, because a lot of assumptions that you actually make during design. But actually where they become extremely important this to analyze the incremental benefits of design alternatives, that you want to propose. So, what if I change a certain particular material in a facade to something else or if adds a particular device or a shading device for example. So, how you are building is going to change incrementally, whether it is going to be worse or better in terms of energy performance. So, these incremental benefits can actually be programmed fairly accurately using modeling tools. So, that makes it very effective when making prudent design decisions.

A place where most of those energy modeling is very underutilized is in existing buildings. If you are able to create a building energy model for an existing building, and calibrate it to the actual energy performance based on utility bills. Then what you get is actually a computer model which actually reflects the actual performance of the building and what this helps in, is when we start doing energy audits of existing buildings, we come up with a lot of energy conservation measures. So, we can actually do put these energy conservation measures into the model, and see actually how these ECMs are going to perform in real time right.

So, it will give you a fairly accurate analysis of the implementation of implementation impact of that ECM on that actual model, on the in the software and you can use that to find out which ECMs would be more effective in an operational scenario. So, it becomes very interesting and a lot of buildings today which are existing. Actually look at energy modeling tools to evaluate building performance building operations.

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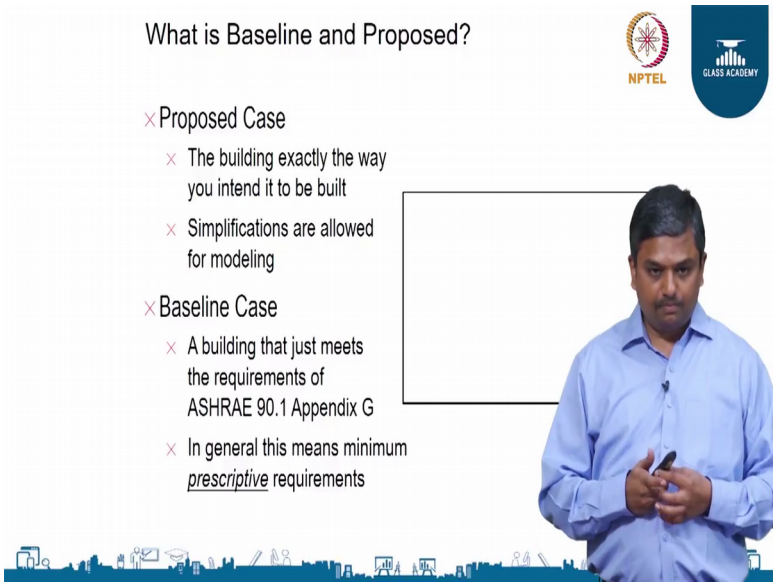

So, typically no energy simulation, we do something called as a baseline case and proposed case. So, the baseline case is basically you are trying to model the building to a particular code which is basically the energy code, it could be ASHRAE 90.1 or it could be ECVC or various codes which actually try to establish the minimum prescriptive requirements for a building. So, its driven by a lot of factors includes policy, the government and so on. So, once you design a building for a particular baseline, you are trying to compare or benchmark the performance of the bare minimum performance requirement of a building.

And then on top of that you start putting in your design parameters. So, proposed case is basically what you intend to build right. So, you have lot of plans on putting various things in your design. So, what you do is you put that onto the model and start seeing how your building is going to perform in real time and start comparing it with the baseline. So, whether you are better than the baseline, where better than the energy code or you are worse than energy code, but typically we would want to be better than the baseline case.

So, the idea is basically to benchmark your building again something which is common in a particular climate zone so, that you can start comparing your performance with somebody else. So, if two people start comparing the same baseline, then there is some in. So, you can start comparing the pa energy performance of two different buildings. If

your baselines are different there is no way you can compare the two performances. So, that is the idea of creating a baseline.

Most of the building codes today would want you to meet at least the code minimum for you to get your approvals. So, in which case you will have to do a baseline model and then try to see how your performance is with respect to the model, the baseline model. So, that gives you some kind of a way to check whether you are better than the code or worse than the code. So, that is important.

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So, let us look at some parameters which actually influence the building envelope when it comes to energy modeling. The first parameter is called the window wall ratio and it is talking about the amount of glazing that you have on a particular façade, compared to the total surface area of that facade. So, the more the WWR we are talking about more glazing that is there on the façade, which means more glass. So, how would that impact your energy performance? So, that is the idea of creating how WWR influences your envelope design.

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