BUILDING ENERGY SYSTEMS AND AUDITING

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Lecture - 21

Lecture 21 : Introduction to Eco-Niwas Samhita 2018

Welcome to the NPTEL course on Building Energy Systems and Auditing. We will be going to start module number 5. Module number 5 is Energy Conservation and Thermal Comfort. Lecture 21 will be delivered on the topic of the Introduction to Eco Nivas Sanghvita. 2018, which is also known as ENS 2018.

So, in this particular lecture, the discussion will be on Econiva Samhita 2018 regarding the building envelope, natural ventilation, and daylighting. So, what we have just now covered in module number 4 regarding the ECBC Energy Conservation Building Code. That code, if you remember, was developed by the Bureau of Energy Efficiency, Government of India, and it basically talks about all types of buildings other than residential buildings. And presently, in 2018, the ECBC residential building was published by the same Bureau of Energy Efficiency, Government of India. The name was given as Eco Niva Samhita 2018, which is the energy conservation code for residential buildings, only for residential buildings, and it has two parts: part one

for the building envelope and part 2 for the overall building. So, part 1 we will discuss in this module, and part 2 we may be discussing in other modules. A brief of that, so let us today in the first part of this lecture or the first part of this particular module, we will see what are the different items provided in this Econiva Samhita 2018 part 1. This is the front page of the left-hand side one is the ECBC 2017 code, and this is 2018 of ENS code, Econiva Sambhita code, the first front page. So, Econiva Sambhita has a mandatory requirement, some of the mandatory requirements, some of the optional requirements are furnished in that particular code. It is basically the code That is going to talk about the minimization of the heat gain through the envelope of the building, particularly for the

residential cases. This also talks about the heat loss for the building in the cold climate. It also imports the design flexibility for the different types of envelope components.

Design flexibility includes the type of wall material you will choose, the type of glazing you have to select for your windows, and also the external shading devices for the windows and the glazings. Of course, this is the last point. If you see, it is mentioned that if the building is over a plot area of more than 500m², then only this particular code is applicable for those kinds of residential buildings. So, in the court, the particular Econiva Samhita, the various chapters have been furnished for different types of recommendations and, in some cases, calculations. We will go through each one of them except the first one today. The RETV, that is the residential envelope transmission value, we will discuss in the next chapter. In the building envelope, in those particular criteria in the Eco-Niwas Samhita, they have excluded the roof, only the four parts, the walls.

It may not be four walls; it may be much more depending upon the shape of the residential building, the shape of the multi-storied residential building. So, that wall part, the facet, the facet part is taken care of. And this particular facet, the nature of the facet, the amount of material, and etcetera is taken care of to calculate the RETV, that is the residential envelope transmission value, transmittance value. This is applicable for different types of climatic zones: the composite climate, the hot and dry climate, the warm and humid climate, and the temperate climate. But as you all know, India has five climatic zones.

So, the cold climatic zone is excluded. It is not mentioned for this particular RETV calculation. But for the cold climatic zone, a separate criterion has been fixed, and we will discuss it today itself. The second one is based only on the roof for the cold climate, I mean, sorry, only for the transmission value for the cold climate, which is known as the U-envelope cold. So, that also can be a checkpoint that has been proposed.

So, these two are basically for the envelope. So, a composite RETV value for those four climatic zones and a typical U envelope value for the cold zone. Next, this particular code also talks about the minimum transmission value of the roof, U roof, for all the climatic zones. They also talk about natural ventilation. In the case of adequate potential amount of natural ventilation and airflow, they have specified a ratio called the minimum openable window to floor area ratio, WFROP.

And this particular fraction or ratio is mentioned for all types of climatic zones. The fourth one is daylight. This particular part 1 code of ENS also talks about the adequate

daylight criteria. In the adequate daylight criteria, they specified a minimum value of VLT, the visible light transmission value for non-opaque building surfaces, such as glazings and windows. So, that has also been specified.

So, if you see in a nutshell, this particular Econiverse Sambita 2018 part 1 talks about so many things. First, the RETV, the residential envelope transmission value, which we have already discussed, covers the maximum value of thermal transmission for the cold climate. The envelope criteria, then specific values for the transmission value for the roof, the openable window to floor area ratio for natural ventilation, and finally the VLT. So, we will go one by one. So, first let us go to the operable window to floor area ratio which this code has mentioned for natural ventilation. Now, here if you see, it is a different ratio which we have actually come across till date, the WWR, that is the window to wall ratio, but here it is not.

Direct window to wall ratio. It is the WWRop. Op stands for the openable. So, you may have a window, but if it is not an openable window, if it is a fixed window, or it is a partially fixed window or partially openable window, you have to calculate the amount of openable window and then you have to calculate or recalculate the ratio. It is not the direct, just the gross window area divided by the whole wall area. No, it depends upon the openable window area.

So, in this particular case, the ratio is defined as WFR openable, which is defined as how much is the openable area in the facade, in the envelope, how much openable area is available in your building, in the residential building, divided by the carpet area. Here, if you see in that particular criteria definition, what is the openable window? So, how are you going to calculate or which of the windows or the fenestration will be included in these calculations? If you see, it includes the openable area for all windows and ventilators. So, you can also include the ventilator area.

Opening directly to the external air, external air in the sense that it is directly opening to some external outside. Or it can be open to the balcony. If it is a balcony, it is open to the balcony. A balcony is also almost like a semi-open kind of area which is just next to the building envelope. So, that also will be calculated. That particular window can also be calculated, or if it is a veranda.

So, it is also going to be calculated if it is in the corridor or any kind of a shaft. So, this corridor The corridor is there, the shaft is there, the veranda is there, and the balcony is there, plus the external air. So, all types of windows that open to those areas will be

encountered or will be calculated for the openable area, but the openable areas of the door Some doors may be in your facade, so that door opening directly to the open balcony is also going to be included for the calculation of the openable area. But here I have marked in red color which are exclusions: all the doors opening to the corridor.

If any door is not opening to the outside, I mean to say to the balcony, but it is opening towards the corridor, external door. In the ground floor, external doors in the ground floor, maybe it is in the backyard or maybe in the front door, for example, ground floor entrance door, backyard doors, all doors which are in the ground floor will not be included for the calculation. The reason behind the door which is in the corridor opening is that it is not actually participating directly in the ventilation or That door mostly will be closed because of the entry and exit regulations, so number 1. Number 2, external doors in the ground floor will not be included in the ventilation because those two or three doors which are in the external door, ground floor doors. Which are directly open to the outside, maybe the front or maybe the backyard, so those doors are mostly kept closed, and that is definitely for some kind of regulation, regulating the public entry or whatever.

Those doors are never being used for any kind of ventilation. So, those doors Maybe it is in the surface, it is in the facade, but that will not be going to calculate, will not be included in the calculation of the openable areas also. The carpet area regulations are also important. So, here we have to actually take the net sensible carpet area where we can exclude the area covered by the external wall.

So, only the internal wall areas and the internal carpet areas we have to calculate. The areas under the service shaft, if there is some area, we will not take that one. We will take, we will exclusively omit the balcony area, veranda areas, and the open terrace area. Those we will omit, but definitely we will take the internal partition wall and the dwelling unit area also. So, those we have to actually calculate.

So, based on that the minimum criteria have been fixed. So WFRop, this ratio is prescribed for all the five climatic zones. So, what is the minimum percentage? The minimum requirement is specified over here, and this was adopted from the NBC 2016 directly.

$$WFR_{op} = \frac{A_{openable}}{A_{carpet}}$$

Now, the VLT requirement, VLT we know what is the VLT, the definition of VLT is the visible light transmission. So, some fraction of the wavelength of the light that is 380 to

780 nanometers is going to be transmitted as light, which we require for our daylighting purpose. So, this VLT is actually the percentage, how much fraction is actually going to come inside. So, that we will specify in terms of 0.4, the 0.4 means maybe it is 40% light is passing through. So, for that also we will now calculate the WWR, the window to wall ratio WWR of the building, and we will specify what is the WWR and specifically say about the VLT requirement.

So, this is the VLT requirement for the different WWR, and this particular requirement for WWR is 0, suppose 0 to 0.3. For that, your minimum VLT requirement is 0.27. Suppose your WWR is a little bit higher, suppose it is 0.5 to 0.6, or something like that. The VLT requirement is less. I mean, you can go for 0.13 VLT or so. So, as your WWR is increasing, the amount of the windows is increasing. So, the minimum criteria for the VLT is also going to decrease.

So, what we advise is that, as per the code, they advise the WWR less than 0.15, and a minimum VLT should be around 40%. So, here they say it is fine. It is this bracketed term of 0 to 0.3, but if it is less than, if it is less than less than 0.15, that means 15% or so. Some of the buildings we provide less than 15% window. In that case, the VLT should be around 40% or so, a very huge amount of the VLT value they advise, not prescribe. The WWR in the residential building may not exceed 40%.

So, 0.4 should not exceed 40%. That is also a kind of advice, but that will actually increase the heat gain and that will actually affect the RETV value. Since WWR is now calculated in a slightly different way as specified by this ENS 2018. This WWR again is not the clear WWR which we actually measure by just the window dimension or window area divided by the whole surface area of the perimeter surface area. It is the area of the non-opaque area. So, as we all know, a window will have some portion opaque part and some portion non-opaque part.

The glass portions are the non-opaque part, and the other portions, which are supposed to be the frame, are maybe a metallic frame, iron, maybe aluminum, or maybe a wooden frame that is the non-opaque part. So, in this calculation of the WWR, it has to take only the non-opaque part. That means, this is glass. How much is the glass?

How much area is the glass? The whole area is not glass at all. There are some frames, mullions, and all those things. So, those have to be deducted. And in the case of the other one, I mean, I just forgot to say, in the case of the openable, the calculations also have to consider the type of the window. Is it a casement kind of window? Then more area is

openable. If it is a sliding window, then maybe not more area, meaning 50% of the area is openable.

So, there is a table there, and we will discuss how to calculate that. Now, let me calculate these two ratios and try to see what the criteria are. So, suppose these are the window dimensions, the type of the window, and how much is the glass dimension within the window. The doors are also there, and the ventilators are also there. So, those are listed for a particular building in a particular location. So, there are three types of windows: W1, W2, and W3.

The first one is the casement window, which opens like this, and there are two panels maybe. The width and height are 1.1 to 1.2 meters. There is a sliding window with two panes. So, there are two panes of a sliding window to slide one. So, one part is always going to block the other.

So, you would not get a 100% opening. So, that window's dimensions are also there: 1.5 meters by 1.2 meters. And W3 is a sliding pane; there are 3 panes, so maybe it can move, so at least a 60% to 70% opening can be achieved because if you slide all 3 to one side, you may not get a 100% opening. So, I have used these 3 types of windows. The D1, D2, D3 are the three types of doors, with different dimensions of course, but those are all wooden doors, and the V1 is a ventilator, which is also a casement kind of ventilator.

All those dimensions are also there: 0.6 x 0.9 meters. So, I can easily calculate how much the area is. And also, corresponding to all the doors and windows, I have mentioned how much the glass area is because of the visibility and the non-opaque character. So, suppose the first one, the casement window, is the first window, W1, with an overall opening area of 1.2 meters x 1.2 meters. But, the width of the glass is 1.1 meters.

So, that means 10 centimeters is less with respect to the overall window dimension. Similarly, the height is also 1.1. So, it is a little less, 10 centimeters less with respect to the overall height. So, that means, if I know this particular dimension and multiply them with each other, I will get to know how much is the opaque, sorry, non-opaque area. You see in the D1, D2, D3, as they are wooden doors, so the glass area is zero. It is fully opaque, so it is not going to give you any kind of light transmission or so. And the last column, what I have written over here, is the number of fenestrations in the building. You know, so that I have mentioned, W1, there are three such windows in the envelope, W2, there are two such types, W3 also has three such types.

The door, so out of the doors, D1, there are two doors actually, one is in the balcony and one is the back door of the ground. W2, there is no door in the balcony, no door wherever, it is maybe inside, and W3, there is a door which is one in the ground floor, maybe it is the entrance door, and the ventilators, or three ventilators, are in the perimeter or the envelope. The external envelope I am talking about. The carpet area of the building is supposed to be 122m², and the envelope area of the building is 95. So, based on that, we can calculate the openable area.

Now, see, I have introduced another column. So, just multiply the first two numbers of the width and the height, I get all those values. So, this is the absolute area of the window. Or the doors, or maybe the ventilators. Now, this yellow color, this particular column.

So, I know that not all doors can be taken into account. So, windows cannot be taken into account. So, all the areas should also be taken into account from the casement or sliding point of view. So, it is also given in table number 5 of the Econiva Samhita that if it is a casement window, 90% of the openable area can be calculated because both panes are going to open, whereas if it is a sliding window with two panes, then 50% of the area because it is going to shift, and 50% of the area will always be open, 50% always closed, so you can only get 50% of the area for natural ventilation.

In the case of three panes, you have to use 67% of the area for ventilation because one-third of the area is always going to be blocked by another pane. So, if you need ventilation, you can only get 67% of the area. So, based on that, I have calculated the fractions. You see the casement area, there are 3 numbers I have multiplied by 3, 1.44 into 3, but only 90% I have taken. So, my total overall area for the casement window, 3 casement windows, is 3.888m², right?

For the sliding, I have one window of size 1.8, and there are two such windows I have multiplied by that and also taken 50% of that because 50% openable percentage is prescribed for the two-pane sliding window. Similarly, for the three-pane window, I have multiplied by 3 because there are three such windows, but I have taken the 0.67 fraction of that for my final calculation. So, it is 4.3416m². See, I have taken one door; here you see there are two doors, one is D1, which is a balcony door, and one is the back door. So, the back door I cannot take as per the definitions because it is the ground floor back door, and it may not be used for ventilation.

So, on one balcony door, I have to take. So, the only one door instead of the two I have taken. And the fraction is 0.9 because it is also a kind of a casement type. So, that particular area I have taken. D2 is a wooden door, so it is nil, so no area is taken. D3 is again a wooden door, one of the front doors, so it is also not calculated in my calculation. So, these two are not taken. V1 is the casement window; the one window's area is 0.5. 3, and this is 3 multiplied by that, and as it is a casement type, so 90% area is taken. So, the total openable area is 13.1886m², and this is the total area: 13.1886m².

My carpet area is 122m². So, the ratio I have found is my WFRop. The window to the openable floor area ratio. So, 10.8. Now, let us verify with that what is the minimum criteria.

If I see the minimum criteria, I have not told in which zone this building is. So, if you see, this particular criterion is not going to comply for the composite zone, not going to comply for the warm and humid zone, and even not for the temperate zone. The percentage is 10.8, 0.8 slightly higher than 10. So, it is going to comply for the hot and dry climate, which has a minimum prescribed value of 10. So, it is slightly higher, and of course, it is going to comply for the cold zone, which is prescribed as 8.33, but all other zones are not because it is more than 10.8.

So, I think it is clear to you how to calculate those very systematically. You have to calculate those. Next, let us see the calculation for the glass areas also. So, the same table, but we have calculated how much the glass area is, similarly, if you know. So, the casement has a glass area of 1.21m² for each one of them.

So, there are 3. So, multiply by 3, and directly I got those values for the 3 windows. So, here it is not openable. It is all about how much the glass area is because it is for the light. Even if it is open or closed, the light can come through the VLT criteria, but there should be 0 for my doors because those are all wooden doors. So, there is no question of any kind of light transmission.

Of course, there is some light transmission possible in the case of the ventilators. So, the total area is about 12.97, and our perimeter envelope area is 95m². So, based on that, the non-OPEC area is 12.97, and the perimeter envelope area is 95m². So, the ratio, the WWR, is 0.134, and 0.134 I can get the minimum value.

So, that will be around 0.27, but it is better if I go with 0.4. So, that was not prescribed, but actually talked about. So, the VLT requirement as per this particular table is 0.27.

Next, the transmission value for the roof. So, in the case of the roof, we have to find out what is the average, weighted average, the U roof.

So, different parts of the U value of the roof and different corresponding areas have to be multiplied, added together, and divided by the whole area of the roof, and we have to find out. That particular average value for all the climatic zones should be less than or equal to 1.2 W/m²K. So, this is the criteria for the roof as a whole. For all the climatic zones, that is one of the cases, and the last one is the thermal transmission value for the cold climatic zone, except for the roof. So, for the cold climatic zone, the envelope component, we have to take the conduction component.

So, the U value component of the the wall, the opaque windows, sorry, the non-opaque windows, doors, windows, whatever is there. So, we can use this equation. So, again, we have to take the corresponding U value and the area of the different sectors of the envelope and multiply them together, add them together, and then divide by the envelope values, and we can find out that, and in the climate, it was mentioned that if this value, the final value, should be less than 1.8 or a maximum of 1.8.

So, that was the criteria for the roof, sorry, for the cold climate envelope factor. So, in this particular lecture, we have taken care of the Eco-Niwas Samhita 2018 guidelines, each one of those, the criteria for the building envelope, criteria for the roof, criteria for the natural ventilation and daylight. Thank you very much.