Course Name: Architectural Approaches to Decarbonization of Buildings

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Lecture 03

Appropriate Openings for reduced Operational Energy - Part 1

Hello all. So, in the last class we had seen how planning is used as a passive strategy in order to have comfortable indoors and therefore how we can consider planning as a strategy towards a carbon neutral architectural design. This time in this class we will see how openings are a passive strategy and how we can use openings as a passive strategy to create comfortable indoor environment. So what are openings? So any building envelope is a boundary between inside and outside. It has protective and regulatory functions and it allows for exchange of climatic elements between the indoor and outdoor. So there is exchange of solar radiation and heat specifically between the indoor and outdoor by virtue of an opening.

There is also exchange of air causing good ventilative conditions and hence the opening serves as a void and as a relationship between outside and inside to a building. At the same time, there is also a direct exchange of climatic elements or weather elements from outside to inside in the form of solar radiation and wind or breeze as we may call it. This occurs mainly through the openings. And normally we understand opening as a window or a door and sometimes as a ventilator.

And it is an element offering a controlled connection between inside and outside. We have the ability to operate a window and therefore, there is a controlled connection. We can close the window when we do not want it. We can open the window when we want the outside weather elements to come in. Now openings play a very crucial role in achieving many passive design strategies in a sustainable building.

They help to improve the energy efficiency and also in reducing the operational energy of the building. How does it do that? Buildings which have openings provide ventilation. By virtue of ventilation what do we mean? Buildings provide and the sorry openings provide an opportunity for outside weather elements to be brought in and what does that mean? It means that there is a reduction or there is a substantial improvement in indoor air quality because the stale air from inside moves out and fresh air from outside comes in

and therefore the indoor air quality becomes much better. If the indoor air quality has to be controlled in any other way then it becomes mechanized. Sometimes we can use air conditioners or air purifiers.

Both are dependent on the grid electricity and therefore both will use of either one of them will increase the operational energy. If you do not want to do that, then to improve indoor air quality we must have openings which facilitate ventilation. Now the second thing that openings can do is bring in daylight. So daylight is brought in.

Now natural daylight has its own advantages which we will see in forthcoming classes. Now what does, what are the benefits? By bringing in natural daylight the operational energy is reduced because the use or reliance on artificial lighting system is reduced or completely can be avoided and hence it is directly benefiting the operational energy use. And it is a vicious cycle we have already seen that operational energy and greenhouse gas emissions they are all directly related. Then in places which need to be made warm we can use solar heating or what happens is you can close the windows if the place is very hot and hence it offers you an opportunity to insulate or isolate yourself from the heat outside by closing the windows.

The openings also provide us with an opportunity of natural cooling. What happens? You need to have cooler inside Cooler insides, reduced temperatures insides. Keep the window open. It will bring in natural cooling. This, see this is, these things may look like basics but it becomes important when you start reading about or when you take up courses on active, simple passive and advanced passive systems where nocturnal ventilative cooling is based on this, what shall I say, this is the basic for it.

And so if you want the indoors to be cool then you use windows to bring in the cool air inside especially during night. And by virtue of being able to make the indoors cool or indoors warm as the case may be as the case you may want to be we are able to regulate the indoor temperature. All of this eventually adds up to a reduction in operational energy. There are other functions of opening, and what are those functions? So creating a connection with the outdoors- It has been known that psychologically, it is always more pleasant to connect ourselves with nature rather than sitting in a completely enclosed room.

So you have the psychological benefits. You have the psychological benefits of creating a connection with the outdoors by yourself and enhancing the well-being of occupants, which is again a psychological benefit, and it is also found to increase productivity, which has been proven in cases or instances where biomimicry is used as a principle of design, where it is found that connections between indoors and outdoors increase

productivity. Now, what all does ventilation does? Ventilation is the flow of fresh air through an enclosed space. It is the essential process of replacing stale air with fresh air. Without proper ventilation, buildings become susceptible to stagnant air where bacteria and carbon make the indoor air more polluted than the air outside.

Hence, natural ventilation using prevailing wind is the easiest, cheapest, most inexpensive form of ventilation. Placement of the building as well as the openings with respect to the wind direction is very important and crucial to creating pressure differences and getting fresh air into the buildings naturally. You can see this picture is about We have already seen this. We can use it as a pressure. That it is about the movement of air around the buildings.

And movement of air around the buildings is directly related to movement of air within the buildings. So, you can see when you have buildings placed in parallel rows. Then the breeze moves along the direction and it is so openings or breeze movement is directly related to planning which we have seen in the last couple of classes so this is in combination with planning At 45 degree orientation, it is a slightly better situation. Whereas, if you have buildings which are oriented towards the wind direction and which are staggered, then there is an opportunity for the breeze to even flow through the buildings. And in this manner, planning and breeze movement are related.

Now, the size and placement of the inlet and outlet also plays a part in proper circulation of fresh air throughout the building. Size and position should be determined based on the climate, desired indoor wind velocity and wind direction. If openings are placed across each other then a pathway is created for the wind to flow through the building and that is called as cross ventilation. So, if you have here we are talking of position of openings. And what happens when you have a single opening? When you have a single opening, the breeze that enters inside gets fizzled out and less of breeze goes out.

Due to which there isn't much encouragement for more air flow to come in through that single opening. Whereas if you have two openings on the same wall due to pressure differences breeze flows in and goes out leaving out a non-ventilated space nearby. If you have openings with wings again it directs these wings help in directing the breeze inside in directing the wind inside. So it helps facilitate and directs the wind inside and the wind goes out. When you have again you have an issue of having a small dead space which is where people will not able to feel the wind movement.

And if you have it on either sides of the room, then wind movement can happen in a much better way, again leaving a small void. And if you have it on openings on either side, then again this is called as cross ventilation. This is also called as cross ventilation.

But having this also creates some dead spaces which will not have significant feel of a breeze movement. So, the best strategy would be to have a situation where the openings are at an angle.

So, what happens is breeze flows across this room and if you have this all the more better there is Cross ventilation in every sense of the word and most of the room becomes very well ventilated which is the best case scenario. So, what is it that you should not do and what is it that you should do? Try to avoid placing windows directly across each other. Because doing this will not facilitate breeze movement in these two areas of the room. Try to avoid having windows too close to each other on the perpendicular walls. Much larger space remains unventilated or perception of ventilation is very less.

Stale air is removed from all of these situations but people will not be able to perceive the air movement. Having too many openings also not a great idea. It's not a bad idea but what happens is you still have areas where you will not be able to perceive breeze movement and try to avoid having openings in areas where there is an internal obstacle because the wind velocity fizzles out by the time it comes on to this side. What is it you must do or what is the best case scenario? The best case scenario is to have windows on if you have to have perpendicular walls then you have windows size of the window and position of the window is very crucial here should have substantially large windows placed perpendicular and at the same time located farther away from each other unlike this window it should be located farther away so that we give an opportunity for the wind to blow across the room. This is another very good scenario where you have breeze flowing in all across the room covering maximum area.

Having openings along three walls. Again ensures very good ventilation because breeze can flow from one place to another and ventilate the entire room. If at all there is a no the partition or the blockage cannot be avoided ensure that it is placed not closer to the inlet window. So, if it is not placed to the inlet window this element will be used more for diverting the breeze. So, this is a more wind diverting element rather than this being a wind blocking element.

So, these are the don'ts and dos of how windows should be located on walls. We will also look at what is the best case scenario, which is a good scenario, which is a poor scenario and what are the situations we must avoid. Now, if you have wings, these are called as wings. These wings can be used for, so using wings for diverting the flow of breeze is a very good option if you have window only on one side. So, if the aperture is only on the same wall on one wall we must use wings for diverting and that diverts the breeze causing a positive pressure and the breeze goes out the other opening and this wing helps in diverting the breeze to go in the other direction.

What can be another good solution but not the best solution is having a single wing. When you have aperture on the same wall then if there is a possibility of not having two wings you could have at least one wing which will divert the breeze causing a positive pressure along the inlet side and a negative pressure on the outlet side. This is a very poor design because what is happening is, when the wings are located in this manner; it is actually deflecting the breeze away rather than directing the breeze inside. So, the breeze is not getting directed inside whereas the breeze is getting deflected inside. So, facilitate the wind to go inside and come out.

And this makes having the wing along the windward region along the windward side makes it a very poor design and for that same reason This is also a very poor design because having a wing along the breeze direction is actually diverting the breeze away and it is not encouraging the breeze to enter the room. And hence even in this case wing is along the windward side. Making it a very very poor strategy of ventilation. Let us look at case scenarios where the apertures are on the adjacent side. So, you have an aperture on one side but you also have a wing wall this side which is directing the breeze to come in and you also have a wing wall on the outlet side which is diverting the breeze to go out and this becomes the best case scenario.

And if you see a slightly better case because of the location of the windows -only that location of the window- only that difference makes a particular situation from best to good. If you see here, the wing of the inlet and the wing of the outlet are placed close to each other. So, if the inlet and the outlets are placed close to each other then Ventilation will happen but a larger part of the room will not have the effect of ventilation. They will not be able to reap the benefit of that ventilation which is a poor case scenario. Poor case scenario is this where the wind is getting deflected due to this wing wall.

The wing wall is actually not encouraging the wind to get inside. And it is a same condition even here where the wind wall is deflecting. So, wing wall is deflecting the wind away from the aperture or away from the window or fenestration or aperture or however you may call it. Let us look at the change in location of the wing wall. Now, here you have a situation where the wind is along this direction and the wing wall is actually encouraging breeze movement.

And this wing wall is helping in deflecting the breeze outside. Due to the position, most of the room gets covered in ventilation. When you have apertures which are closer to each other, but along adjacent walls and you have wing walls which deflect and encourage breeze movement it is a good strategy but the disadvantage is the large amount of room where you cannot feel the impact of ventilation. This is a poor case scenario

where your wing wall is actually deflecting the wing away from the room and it is not encouraging the breeze to get inside but it is encouraging the breeze to move out and similar is a wing wall which is actually not allowing the breeze to get in.

So, in this class we have seen the significance of location of windows and the role of wing walls in enhancing indoor ventilation. So, how indoor ventilation is enhanced due to location of windows and use of wing walls. So, in this class we saw what is ventilation, we saw the significance of ventilation, we also saw how ventilation is important and crucial in reducing operational energy because having openings enhances ventilation. And our reliance on active means of ventilation such as fans and air conditioners get reduced. And this encourages us to have lower operational energy.

We will stop this class today and we will continue to learn about the significance of openings in passive design as having passive design is an important criteria for reduction in operational energy. So, we will meet next class with a continuing topic. Thank you.