Course Name: Architectural Approaches to Decarbonization of Buildings

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Lecture 04

Appropriate Planning and openings for Passive Architecture

Well, hello all. In the last class we saw about the planning of buildings -how staggering of buildings help us. How staggering in terms of height, helps in air movement around buildings, the planning that goes into it and how planning the buildings in a non-staggered manner can create wind shadow regions and regions where ventilation is not possible. We also briefly saw how planning of buildings along wind direction against wind direction use of little structures or vegetation to divert the wind will increase ventilation inside the buildings. And now we will continue from the same. In ideal case of fenestration position happens when windows are placed on two external walls with the door on one internal wall. If air is incident on any of the external windows, then the fenestration configuration not only ensures a good distribution of air, but also has a larger outlet area than the inlet area. If the air is incident on any of the other walls, then the door could act as the inlet to the room.

Hence, again the outlet would be larger than the inlet and the configuration would allow good air distribution. The fenestration pattern and configuration involves the area, shape, location and relative position of the windows. This would affect the air movement, daylight and glare indoors. If unshaded, the area would also affect radiative heat gain.

Based on where you want the air to move largely in the room, you must plan the location of inlet and outlet and you must also plan the size of the inlet and outlet. For example, in this picture the inlet is at a higher level and outlet is at a lower level, causing the breeze to blow- which will have a good ventilation for someone working here and it would be a dead ventilative area for anyone working here. When we have inlets at lower level there will be a good indoor environmental quality because this stale air is always taken out. However at working level there would be completely stagnation and no air movement. If you have windows at heights which are above human activity area when the inlet and outlet is such then at the human activity level there will be minimum air movement.

Whereas, if you have the inlet at a lower level and outlet at a lower level, you would get

this breeze. There would be air movement at this level, but there will be minimum air movement at this level. So, it is important to understand air flow patterns with respect to inlet and outlet positions.

Now, you must also understand that physical obstacles in the path of airflow create pressure differences. This causes a new airflow pattern. Air tends to flow from high pressure areas knowing the direction of air movement. The plan form can be determined also as to create high pressure and low pressure areas. So, by virtue of having a perforated base air is channelized to move below and air also slides above.

So, you have high wind speed at ground level whereas in this condition you will have a windy condition at this level, ground level and there will be a wind shadow region here. So, when you have a configuration as such, there will be a small wind deflection this area and the wind would still slide over the building and you would have a wind shadow region. When you have patterns like this which are (we have already discussed this once very briefly), which are unstaggered or parallel rows then you have wind shadow regions. This also causes wind shadow region. Staggering at 45 degree orientation also causes wind shadow region, but it is slightly better off than the parallel row.

Whereas, in this case, when you stagger the block you facilitate the air to move inside the building through the building. So every block gets adequate ventilation. It is seen that it is best to orient a block between 45 to 30 degrees of the primary prevalent wind direction. So, a tilt of 45 to 30 is considered best to enhance indoor air movement inside the building. Now mutual shading of built forms is important but before that a plan form of a building affects the air flow around and through it. How it affects we have already seen. It could either aid or hinder natural ventilation.

The perimeter to area ratio of the building is an important indicator of heat loss and gain. It therefore plays a role in ventilation, heat loss and heat gain. The massing of a building can be designed to provide shading to windows during the hottest parts of the day. This helps prevent excessive solar heat gain reducing the need for air conditioning and improving overall thermal comfort along with improving mutual shading of built forms And also the use of compact forms with low surface area to volume ratio and low perimeter to area ratio can be particularly advantageous in extreme climates. These design strategies contribute to improved energy efficiency, thermal comfort and overall sustainability in harsh environmental conditions.

Now when you have a compact form, the thermal performance of building is influenced by the form and massing. Now you also need to understand that having dense forms having compact forms can in a way help in some climate types for example in hot dry

climates it is needed because compact forms are going to reduce the ingress of solar radiation and it will maximize mutual shading so if you see all these surfaces are shaded either mutually or with the help of vegetation and therefore the harshness of the outdoor will not be felt here because these are closely placed forms. Now narrow streets they keep the building height to street ratio minimal and they can cause mutual shading of the buildings, because of which there is no heat ingress. You should also minimize surface to volume ratio in extreme climate because when you increase compactness by reducing surface area to the same volume you get a better result.

You can also minimize P by A ratio in extreme climates The perimeter to area ratio is also an important criteria and you need to minimize it in the hot conditions because more the perimeter, more the exposure to solar radiation. The diagram just disappeared because of the way I press the pen. So, more the perimeter, more the opportunity for solar radiation to strike - whether it is mutually shaded or not shaded and hence, P by A or perimeter by area ratio is important when you evolve a form and also in the planning. You should also understand when you are designing in a climate where the western sun is very harsh, which is largely the tropical belt, then placing service areas such as toilets, staircases, lifts, lobbies, Sometimes kitchens on the east and west facing wall can act as buffer zones against direct sunlight and heat gain. These areas often non-habitable spaces can act as a thermal buffer and it helps to insulate the more occupable spaces from excessive heat.

Additionally, this design strategy allows these service areas to benefit from day lighting reducing the need for artificial lighting. Window sizing and placement is an important criterion because window sizing and placement have their crucial consideration for optimizing natural light and minimizing heat gain. Designing windows according to prevailing climate condition involves understanding the path of the sun and the intensity of sunlight during different seasons. Ideally, windows should be larger on the north and south walls to allow for even diffused day lighting without excessive heat gain or glare. If you look at the wall to window ratio, the wall to window ratio is an important factor in energy efficiency.

Limiting the wall to window ratio to not exceed 40% helps to strike a balance between maximizing daylighting and minimizing heat gain. This ratio ensures that the building envelope remains well insulated and doesn't compromise on energy performance. So, window sizing must be done with the consideration of prevailing climatic conditions and the placement preferably on north and south wall should not exceed 40% while on the west wall it should be as minimum as possible. So, here you can see along the west the building is completely insulated and buffered with the help of a staircase and a small lobby. So, these spaces do not experience direct incident solar radiation of the western

sun which is very harsh in the tropics.

The east side can also be buffered with certain spaces like kitchens or store rooms or something like that and then the entire area is sandwiched between two spaces which are buffered. The window to wall ratio is an indication here. You can see that 30% seems to be nominal. Visually when we see 30% seems to be a normal percentage as compared to 50% or 100% to window to wall ratio area of openings. Right, now we need to look at where compact development must be encouraged and where it must not be encouraged.

So, compact development must be encouraged in all hot dry climates. And it aims to create urban spaces where residential, commercial and recreational areas are closely situated like a mixed use development. It can also help in reducing the need for extensive transport and promote walkability. So, zoning regulations play a crucial role in guiding the layouts and the planning of the buildings in neighborhoods and regulations that prioritize energy efficiency consider factors such as solar orientation, shading and wind exposure to optimize the use of natural resources. When you have to optimize building orientation, zoning regulations can encourage or require buildings to be oriented in ways that maximize exposure to sunlight for passive solar heating during winter if need be while minimizing heat gain in hot climates.

They also aid in being no shading and wind control because regulations may guide the placement of buildings to create shading and wind control strategies. For example, taller buildings may be strategically located to provide shade to lower structures reducing the cooling load. While green space preservation regulates to promote the preservation of green spaces and open areas which contribute to improved microclimate, air quality and overall urban aesthetics. You also must have energy efficient infrastructure with guidelines to promote the use of this infrastructure such as smart street lighting, green roofs and energy efficient building materials. The compact development must encourage to reduce the need for transportation and promote walkability.

Zoning for energy efficiency must be implemented such that it promotes energy efficient building layouts considering factors such as shading and wind exposure. If you look at this small sample layout, this layout is not too dense but it is not too loose also and a layout of this compactness will do good as there will be adequate breeze in between the houses it does not seem suitable for hot dry climate because it is not too compact and not too dense And this kind of a layout must focus more on overall sustainability in terms of trying to give green space conservation and transportation, that too green transportation as well as increasing walkability within this setup. So, increasing/ encouraging this walkability will be an added advantage, because it will have reduced transportation needs. By having no amenities within walkable distance and workplaces in close

proximity and so on and so forth.

So direct energy efficiency through use of energy inside a building is one aspect. But energy efficiency overall by also considering transport and other facilities is also something which should not be neglected by architects and planners. Since we are dealing with planning as a topic you must take care of this aspect too. When you plan the planning must be, it must resonate with the climate. In a warm, humid or hot, humid climate, planning must not be compact.

In a hot, dry climate, planning must be compact. Planning of a settlement should be such that it should incorporate green spaces which also act as lung spaces. Besides amenities must be placed in such a way that people do not have to walk for long hours to reach for basics. So basic amenity must be within walkable distance. So these are the things one must take care during planning.

So for now, we will wind up this class as we have seen what planning does in terms of having a staggered layout, in terms of having a parallel layout, the impact it has on the breeze within the building and inside the building. Where must we give appropriate apertures? And how do we look at basic thumb rules of planning and zoning for a small settlement? We will continue with this topic in our forthcoming next class also. Until then, see you.