Course Name: Architectural Approaches to Decarbonization of Buildings

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Lecture 02

Appropriate Planning for Passive Architecture

Hello all. So, in today's class we will continue from what we left in the previous segment. And now we will look at what considerations must you have when you design in a hot dry climate or and a warm humid climate. We will look at that basically. So built form which is designed such that it is self shaded through massing or articulation and resulting in sheltered built forms, and cuts off a large amount of direct solar radiation is most appropriate for hot and dry climate.

In the hot and dry climate, the envelope should be designed so that it remains shaded for greater part of the day. The external walls should be so planned that they shade each other. In the last class we had seen how they can be made to shade each other and this slide is also a reminiscence of where we left. Building block should be arranged as to benefit from mutual shading to minimize solar exposure on the vertical surfaces during summer months and we should look at mutual shading in greater detail.

And we must also consider the height of the context buildings, the distance between the buildings, the latitude and its location. So, the main objectives in terms of form and orientation in hot dry climate are compact and massive design mainly inward facing buildings. What does that mean? In In hot dry climate the buildings must be compact which means the buildings must be placed close to each other. And the buildings must be placed very close to each other. They must be very compact and they should be massive designs.

You should not have very small feeble designs when you try to design in hot dry condition. So, what happens? You can see the streets are very narrow and that is how the design should be. When you have narrow streets and the buildings are placed closer to each other, all the houses will benefit from mutual shading. Mutual shading means one shading the other which is part of the same group. It minimizes surface areas and openings exposed to the east and west sun and orient the building accordingly.

There should be less openings and apertures in the building. That is what it means.

Group buildings close to each other especially east and west wall should be placed close to each other for mutual shading and we should promote access to cooling winds. If there is a wind direction then we must promote this wind because it will get promoted because of the channel effect or tunnel effect. Include small enclosed courtyards with arcades, colonnades for light and air and outside day-to-day activities.

So, if you think the house will get too congested, provide for a small courtyard in the house so that the house is well lit. There is good lighting for the house. Also, this can serve for good ventilation. Then with the help of courtyards you can have adequate lighting and ventilation and you can protect the house from hot and dusty winds. So, this is your approach to the hot and dry climate with respect to orientation and form.

And say, if this is the north then this is how the planning should be for a hot dry climate. Now, let us look at the exact opposite of this which is a warm humid climate. In the warm humid climate, shading of the east and west elevations is difficult because of the low sun and may require special devices whereas the south and north side can easily be protected by an overhanging roof. Thus, the best orientation to minimize solar exposure on vertical surfaces is the longer facades facing north and south. When it comes to wind orientation, if you want to utilize the wind flow, building needs to be oriented at an angle.

Preferably less than 45 degrees to the prevailing wind direction. What does that mean? I will get you to that. So, in a hot or a warm humid climate, wind is an important criterion to enhance indoor performance. So, you should try to orient the wall between at least at 45 degrees, at least at 45 degrees to the prevailing wind direction if you want to catch the breeze.

So, you orient the room at at least 45 degrees, 30 to 45 degrees angle if you want to bank on having to catch the prevailing breeze. Then the other criteria should be where a predominant wind direction can clearly be identified, long side of the building should be arranged across that direction because your main aim is to capture winds in a warm humid climate. In this case, a reasonable compromise should be made based on the detailed analysis of the specific situation. The compromise on how large that opening should be to allow breeze and to prevent solar radiation must be arrived at. You can also look at diverting the wind direction by means of vegetation and structural arrangements.

Such as having shrubs at a particular height or small parapet walls or something like that. As a general rule, with low rise buildings where the walls would not receive much radiation, orientation according to the wind direction is more advisable. So, if you look at the form, the preferences of typologies for multi-storied residential buildings you must try to have the form in such a way that you are able to tap breeze and you are able to cut

off solar radiation or at least have a via media of where you are going to cut solar radiation and bring in breeze. Let us now look at some case studies. Now this is the case study of Dr.

Reddy's lab. Here they have used the orientation. It is at the West Bengal Pollution Control Board building. They had used the orientation as a positive feature to an adverse site. If you look at the master plan, you will find that the western side is this and none of the buildings are directly facing the west. All the buildings are at an angle to the west.

Also you will find that the buildings are mutually shading each other and that is going to help a lot. Because indirect solar radiation is not incident on any of the walls so this site was actually not suitable in that respect but it was a long narrow pla a plot facing the no northwest and southwest and it resulted in useless glare of direct sunlight and excessive heat gain. By using effective design the labs and office spaces are oriented along the north this this part and the south so that they get adequate day lighting, good ventilation and optimal thermal condition. And if you look at the office spaces, you can see the office spaces have windows which are appropriately shaded. You have jolly walls or you have regular windows and the solar radiation, direct solar radiation is completely cut off because this is the western direction.

If you see the western direction you will see that these are all toilets this is the staircase so it's a dead space it's a non-habitable space and a small part of the laboratory alone is exposed otherwise it's a building which is completely insulated. Besides, this part has only incident solar radiation from the west. So next we will look at the silent valley resort located at kalasa with the objective of a sustainable design. The architect had used building form as a major solar passive strategy. The building form adopts a circular form which has a low surface to volume ratio.

This reduces the conduction gains from the building envelope as well as solar gains from the windows which makes the building energy efficient in the warm and humid climate. So, if you look at this building which is a sort of a resort. You can see that the rooms are all circular and along the areas where there is maximum solar heat gains. There is no such one wall where there is direct solar radiation. So, along any wall if there is direct the All the other areas will only get incident solar radiation which is at an angle.

It is not at a direct angle and hence heat gain inside is minimized. Whereas what is needed most is ventilation and it is a very well ventilated resort. You can see from very well ventilated by means of cross ventilation. That is by virtue of the form it has taken. We will see another case of a building in a composite climate. We will look at the Teri building.

The Teri building is at Gurgaon and it is selected to show how orientation plays an important role in solar architecture. The Teri building was oriented around the east and the west axis so as to have maximum exposure along the north and south. Okay, so the north wall and this is the west wall and this is the most recommended orientation in solar passive architecture. The south orientation receives maximum solar radiation during winters which is preferable as composite climate they receive, they become very cold during winters and at that time solar radiation is very high along the south wall and this is during the winters. Now in composite climate rectangular form is the best with a longer facade oriented towards north and south this is the basics and a compact form with low surface to volume ratios recommended a square plan with a courtyard would be very effective but east and west a orientation must be protected by buffer spaces what we saw 1, 2, 3 either with vegetation or with less number of openings or with having non-habitable spaces.

Let us quickly brush the moderate and cold climate. We will also see an example of a cold climate building in a cold climate. Normally buildings should have inner moderate and cold climates. Buildings should have an elongated shape along with east and west axis. The southern front can easily be designed for proper utilization of the winter sun and for protection against the summer sun.

To achieve a proper sun penetration for natural lighting, solar heat gain and hygiene the depth of the interior should not be excessive appropriate building construction in tropical and subtropical regions for cold climates must ensure orientation slightly east of south That is favoured because exposing the unit to morning and afternoon sun and enabling the building to heat during the day will be beneficial. When we look at wind orientation, buildings should be arranged so that they benefit from summer winds. Because this season is usually humid and a proper cross ventilation is required for cooling and hygienic reasons. Hygienic reasons meaning algal growth and fungal growth has to be curved. Otherwise mould growth can become a big problem.

Shelter should be provided from the winter winds and the buildings are preferably rather compact. However, because of the conflicting climate conditions you have two kinds of a climate condition. Several solutions are possible depending upon local topographical conditions and functional requirements. In upland areas, heating in winter becomes more important than cooling in summer. Hence, rather compact structures with minimal but proper sun oriented exterior surfaces are desirable. Buildings may be latched and grouped close together.

Row houses or adjoining buildings have the advantage of reduced heat loss. Courtyard

buildings with proper wind protection are suitable solution. The houses in say Marfa, it's a village near Nepal with a dry, cold and extremely windy climate is actually a good example of how buildings must be designed in a moderate and cold climate. These buildings are of rectangular form as this is the ideal orientation with their longer axis towards north south direction. Greater the perimeter of area ratio greater is the heat gain in the building.

Unless otherwise you are making an attempt to bring in the heat from outside to inside through certain surfaces. Let us see the orientation of Druk White Lotus School which is again in Ladakh and it's a very cold place. It's in Indian Himalayas and it's extremely cold with snowfall in during a large part of the year. For energy efficiency, the buildings are designed to take maximum advantage of the sun, taking into account the unique solar potential of the high altitude environment. The buildings in the daytime teaching area are turned 30 degrees from the south towards the east to benefit from the morning sun.

All other buildings face south so as to maximize solar benefit throughout the day and store heat in the evening and night time use. So if you look at the orientation here you have two sets of buildings which are distinct and in this you have the school building here and here you have the residential area of the school / classroom area. If you look at the school and classroom area, these are designed to take maximum advantage of the sun. During daytime teaching learning happens here and this is oriented 30 degrees from the south towards the east. Because of this orientation they are able to tap the they are able to know optimize on the unique solar potential of this place so they get the morning Sun because it's a very cold place you must not forget that that it's a very cold place and it is at Ladakh.

So, they get the morning sun to benefit classroom activity. Whereas, in the residential area, The buildings face south so that they maximize on solar benefit through the day and store heat for evening and night time use. Whereas for teaching it is turned at 30 degrees from the south towards the east. So there is a slight angle and here it is directly along the south and here it should ideally be 30 degree to the south. So this is at 30 degrees to south and here it's direct radiation through the day so that heat is stored.

Heat is stored during the day. So, during the day rooms remain warm and rooms remain warm or comfortable comfortable for night. So the Druk school has two strategies 1. One is during daytime when school is functioning they have oriented it to 30 degrees to capture the morning sun which will benefit the classroom activity. 2. Whereas in the residential block they have direct solar radiation making the rooms warm during the day and retaining the warmth at night.

Hence we have seen three different climate types and the strategies for each of these climate types. We have seen the hot dry climate. In the hot dry climate one has to be very careful in having very compact planning. The buildings have to be bulky and large. The spaces around buildings must not be porous.

They must be compact so that there is mutual shading. Also openings must be very less otherwise it will bring in the hot air and it will also bring in the dust sand dust. So hot dry regions normally are very dusty. If you look at warm humid climate The warm humid climate planning and form must be such that the building is insulated from the western sun first and the building must have a provision for cross ventilation. That's very important because it's a very humid and sticky place.

You need to have breeze over your body to feel comfortable. And warm humid place must facilitate that kind of a breeze.

When it comes to cold climates. You have to be very careful. To tap the solar radiation or the heat from the solar radiation and have a building envelope which will store that heat, which can be released at night. If you see the Druk school at Ladakh, they have the classrooms where the morning sun enters and makes the place comfortable and during evenings in the residential area it is oriented in such a way that direct solar radiation falls on the walls, absorbs the heat and keeps the room warm for the night. So, this is the gist of what we saw in this class. We will continue in the next class with another session related to how do we deal with planning and orientation. Thank you.