Course Name: Bioclimatic Architecture: Futureproofing with Simple and Advanced Passive Strategies

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Lecture 02

Strategies for Bioclimatic Architecture

Hello students. So, last class we saw an introduction of what is bioclimatic architecture. We saw the history of bioclimatic architecture, how the word got derived right from prehistoric times until and where it positions itself today with respect to sustainable architecture as a very commonly used term and regenerative architecture, which is again not even a futuristic concept. Today already some buildings are getting designed as regenerative. Today we will look at the strategies for bioclimatic architecture. So, we will look about what is bioclimatic architecture? So in this presentation on bioclimatic architecture, we will be discussing an innovative and forward-thinking approach to sustainable building design that places a strong emphasis on environmental harmony and energy efficiency.

So during this session, we will delve deep into the following pivotal aspects. Strategies for bioclimatic architecture, advantages of bioclimatic architecture. Now a quick recap on what is bioclimatic architecture. Bioclimatic means considering how climate affects living things.

Bioclimatic architecture looks at the weather where a building will be or where the building will be located using different factors to make the most of nature while causing less harm to the environment. It aims to keep people comfortable without using too much energy or materials. So it's all about being eco-friendly. As climate change accelerates, the escalating global temperatures necessitate heightened cooling requirements to maintain occupants' thermal well-being. In response, the adaptation of passive design strategies in architecture, known as bioclimatic architecture, is tailored to local climate, and it emerges as a crucial solution.

These strategies aim to minimize reliance on active cooling and various methods that can be used, because of which we will not be dependent on electricity-generated ways of cooling a building, mitigate conventional heating demands, and guarantee optimal thermal

comfort. Thus, the relevance and significance of bioclimatic architecture has never been more pronounced than how it is today. This image gives you a glimpse of three ways of heating a building. We will be looking at these methods in detail, but just to tell you how we are using nature as a means to tap whatever we want in order to make the indoors comfortable. In this case, if we try to tap the heat from outside in order to make the indoors comfortable, then how can we do that? The first picture, this diagram I will just number these.

The first, second and third diagram. the first diagram or this image it shows direct gain method. So this is like when the sun shines straight into a room through the windows. So it warms up the room directly. It's like when you feel warmer standing in the sunlight.

the second picture is called as the indirect gain so instead of sunbeams coming right inside the building, this indirect gain is when the sunlight warms up a particular surface, say, a wall or something. There are some things we will see later during the course so it's like a Sunny sidewalk which warms your feet even after you step off it. The third is the trombe wall. So this happens when the warmth is trapped, saved and kept inside the building. And then, when you want, you will use it.

So it is like putting on a cozy sweater or something like that to keep warm. It stops the heat from escaping outside. Now in this slide, we will look at the listed elements, which will help us in understanding the elements of bioclimatic architecture. Soil- now buildings designed with this approach often integrate into the ground to tap into the soil's ability to moderate temperature changes. This technique, sometimes called melting into the landscape, utilizes the soil's heat retention properties to regulate indoor temperature effectively.

Geothermal energy is a renewable resource. It complements this strategy by harnessing the earth's natural warmth, making it an ideal solution for sustainable heating and cooling. The second one is orientation. So, combining thoughtful orientation with shading elements like blinds or vegetation, or some kind of shading device, they enable precise management of indoor temperatures throughout the day and across the seasons. This approach optimizes comfort while minimizing the need for artificial heating or cooling, ultimately reducing energy consumption and promoting sustainability.

The third one is insulation in buildings. So insulation is typically installed within floors or walls, ceilings, and roofs to minimize heat loss during colder months and heat gain during warmer months. This helps to improve energy efficiency, reduce heating and cooling costs and enhances overall comfort for occupants. Insulation materials can vary widely ranging from traditional options like fiberglass, cellulose and foam board to more innovative

alternatives such as recycled denim or cork or spray foam. Then third is ventilation.

Now ventilation we have three types of ventilation. First is the natural ventilation. So this type of ventilation relies on natural forces like wind and temperature differences to circulate air. It is like opening windows to let in the breeze. The second is mechanical ventilation.

So, in mechanical ventilation, fans or other systems that use energy and machinery are used to actively move air in and out of the building. It is like turning on a fan to keep the air flowing. Then third is the hybrid ventilation. Hybrid ventilation combines elements of both the natural and mechanical systems. It's like using windows for fresh air most of the time, but having fans kick in when there is a need for extra airflow.

Now, these are very, very briefly and loosely coined elements that I'm telling you. and you will understand the context as we move further into the class. So, here what we saw first is soil. So, what we were trying to see in this soil is that how soil can be used to insulate a building. Second is orientation.

How properly orienting a building can help us tap the resources of the sun or cut the sun when you do not want the indoors to be heated. Third, we talked of insulation, which is more like a barrier for heat and sound. And fourth we talked of is ventilation and ventilation; we said is of three types of ventilation. One is natural ventilation, another is mechanical and third a combination of both, which is hybrid. Now let us look at what is passive building design and how we can have heat protection, heat rejection and heat gain from the sun.

So, passive building design calls for protecting the building from heat, making the heat to come inside. And third is rejecting the heat- don't want the heat. So, heat protection can happen by insulating the building. So, you can use various insulations, like what we saw in the previous slide—recycled denim, cork, or glass wool. We can have insulated windows, double-glazed windows maybe.

Third is by infiltration and fourth is by solar control. We can also have direct heat gain from the sun which can be direct as we saw in the previous slide or last two slides back. Solar buffer spaces and third is the indirect heat gain. How do we reject or prevent heat? Heat rejection or we can even call it as prevention. This can happen by ventilating the building, by evaporative cooling, ground cooling, using geothermal or deep lake or ocean cooling and by radiative cooling.

Now, let us look at heat protection. If you want to protect the building and insulate the

building, then what all will you use? You can use organic insulation, mineral insulation, oil-derived insulation, or some other innovative and advanced insulation. Insulated windows can comprise of insulated panes and insulated frames. In order to have a solar control, you can have permanent shading features like long cantilevers or you can have fixed shading devices like vertical fins. You can have movable or adaptable adaptive shading devices, which we call dynamic shading devices, and you can have solar control glazing.

When it comes to heat gain from the sun, direct solar gain we already saw. It is more like allowing the sun to get into the building. This refers to direct solar gain So, the sun just enters the building. If we want solar buffer spaces, then we can have winter gardens or we can have a double facade. Indirect heat gain: we can have trombe wall.

Or we can have attached sun space. None of these are exhaustive. These are all only indicative. There are many other methods also.

But the list becomes too long. So this is indicative. Then, when it comes to ventilation, we can have comfort ventilation, which is more like cross ventilation when the ambient air temperature is comfortable. Or we can have nocturnal ventilation. Then we can have evaporative or adiabatic cooling which can be through direct means or indirect means. So, these are the various ways in which we can design buildings passively.

Now, in our next slide, we will see the simple and advanced passive techniques that we can use for designing a building. Now, if we look at simple passive techniques, what are simple passive techniques? Simple passive techniques are techniques that do not require the use of any special contraption or devices to capture, store, release heat energy, or any other form of energy. What are the ways of making a building with simple passive techniques? First is layout. How do we layout the building, or how do we orient the building? So, orientation is important.

Next is spacing between buildings. So, how dense is the building? Is it compact? Or are the buildings placed far apart? Third is air movement. Fourth is by using opening size and appropriately positioning the openings. By protecting the openings, how do you protect the openings? Various ways are there. We can have sun shades, we can have vertical fins, we can have egg-grade jaalis, we can have chhajas, long cantilevers and so on. Then walling material, roofing material, protection from rain and protection from storm water.

So, in order to make the building comfortable for the user by using any of these techniques, we do not use any special contraption or special spaces or special technology. And therefore, we will look at what are advanced passive techniques. So, advanced passive

techniques are techniques that require specific design or contraption to capture, store and release energy. Under this, we will see passive cooling.

So, I will call this as 1 and 2. So, 2A is passive cooling technique. So, what are the various passive cooling techniques? We have the natural night ventilation, earth to air exchangers, evaporative cooling, PDEC passive downdraft evaporative cooling, radiant cooling, green roof, wind tower, double skin facade and double roof. For passive heating we can use which I call as 2B. We can use the trombe wall, solarium, water wall, phase change materials, earth air exchanger, thermal siphoning, and earth air tunnels. Now, do not be carried away or disturbed by the terminologies.

We will be looking at each of these techniques in detail in the forthcoming classes. Now, how does passive cooling or passive heating actually work? So, there are actually two approaches in bioclimatic architecture: analytical bioclimatic design and symptomatic bioclimatic design. Now, the analytical bioclimatic design involves studying the local climate, recognizing its bioclimatic features, and devising appropriate strategies accordingly. On the other hand, symptomatic bioclimatic design involves examining traditional buildings that have successfully integrated bioclimatic solutions and applying similar techniques to new constructions. So, in the realm of bioclimatic design strategies, often revolved around passive heating, which includes methods for retaining the admitted heat.

So, first, you have to admit the heat and then retain it, and also passive cooling, which involves excluding and dissipating the heat. Now this picture shows the summary of the methods that can be used for passive heating and passive cooling. If we look at passive heating, how is heat retention happening and how is heat admission happening? Heat admission happens by direct and indirect heat gain. by having orientation and space zoning and third is by convective heat exchange. How do you retain the heat that is already admitted? That happens because of thermal insulation, building massing, orientation and space zoning, convective heat exchange and thermal mass.

If we look at exclusion of heat, when you want cooling, then what do you do? You exclude the heat from entering. That can happen through thermal insulation, shading, orientation and space zoning. The dissipation can occur through evaporative heat exchange, building massing, radiative heat exchange, convective heat exchange, and thermal mass. So, this is how the strategy of admitting the heat and storing the heat can work.

So, simple passive strategies if we take. So, strategies that I will keep on repeating this for quite some time because it is very important that this gets fixated in your mind. So, simple passive strategies are strategies that do not require any contraption to capture, store and

dissipate heat in the cold climate. So, these strategies do not require any contraption to make the inside cool. So, what are these simple passive strategies? So, simple passive strategies, appropriate building orientation, appropriate building organization, spatial layout and density, using correct opening size, having appropriate volume of spaces, Having good opening details, having opening orientation along the correct side, weather protection, water as an element that can be used and building materials, correct choice of building materials. Now passive design strategies are features that rely on the form and design of a building to channelize available natural resources.

So what are the available natural resources? The sun and the wind is given and by using this you must ensure thermal comfort. These climate-specific, naturally available entities can be employed to design energy-efficient buildings. Now, what are the advantages of bioclimatic architecture? Now, first is reduced energy consumption. Bioclimatic architecture significantly reduces energy consumption by leveraging natural resources and passive design strategies. Techniques such as orientation, insulation, and shading minimize the need for mechanical heating, cooling and lighting systems, resulting in lower energy usage and reduced carbon emissions.

The second is lowering utility bills. So bioclimatic buildings translate reduced energy consumption into lower utility bills for the occupants. So it gives you an economic advantage. By relying on natural resources for heating, cooling and lighting, occupants enjoy substantial cost savings over time, making bioclimatic architecture a financially viable choice. Third is less dependence on fossil fuels. This is very important in today's context, where the world and our country India today, is trying to run a race to reduce greenhouse gas emissions.

So, having less dependence on fossil fuels is not going to hurt. Bioclimatic architecture decreases the dependence on fossil fuels by utilizing renewable energy sources like solar and wind power. This shift reduces greenhouse gas emissions, mitigating climate change while promoting sustainability and environmental responsibility. Fourth is optimal thermal comfort. Bioclimatic buildings prioritize thermal comfort through passive energy strategies like insulation and natural ventilation.

By maintaining stable indoor temperatures all through the year, these buildings eliminate the need for excessive heating or cooling and also ensure comfortable indoor living. So, the advantages of bioclimatic architecture are first is reduced energy consumption. This becomes very important in the light of the fact that 25 to 50 percent of the energy used by buildings. 72% is through electric consumption leading to 38% carbon dioxide emissions by buildings. 14 percent of water, potable water is consumed by buildings.

How much ever we try to recycle, 30 percent of the waste output is contributed by buildings and 40 percent of raw material use is by buildings globally. And therefore, it becomes very important in today's time and date that we follow the principles of bioclimatic architecture which aims to reduce the electricity use thereby also reducing GHG, greenhouse gas emissions. Now, what are the further advantages of using this bioclimatic architecture? First is improved air quality. So, bioclimatic architecture enhances indoor air quality through natural ventilation strategies, reducing pollutants and promoting a healthier living environment for occupants, particularly those with respiratory conditions and allergies.

Here if you look at this picture. This picture talks of various forms of buildings and how energy use intensity varies with the changing form of the building. The first form uses 44 percent energy, the second one 45, third is 46, Fourth gets reduced 43, fifth is again 44 and sixth is 43. So, by appropriate using of appropriate building form and orientation we can reduce energy electrical energy consumption. This causes reduced environmental impact. The bioclimatic buildings minimize environmental impact by optimizing natural resources and minimizing energy consumption.

This sustainable approach contributes to a significant reduction in greenhouse gas emissions and promotes environmental stewardship. It also gives us cost savings. Bioclimatic architecture offers cost savings in construction and maintenance by prioritizing energy efficiency and reducing reliance on mechanical systems. Other advantages are natural lighting and views. Bioclimatic buildings prioritize natural lighting and views, enhancing occupant well-being and productivity.

They also promote social interaction. So, bioclimatic buildings promote social interactions and community engagement through shared spaces and amenities. Thus, we can see that bioclimatic architecture offers us several advantages. We will stop this class with this slide today, and we will continue the next class. In this class, we saw what are the passive cooling systems, what are the passive heating systems, how, what are the systems through which heat is trapped, what are the systems through which heat is disseminated, and also the same thing we saw for passive cooling. In the next class, we will continue with another interesting topic on Bioclimatic Architecture.