Course Name: Architectural Approaches to Decarbonization of Buildings

Professor: Dr. Iyer Vijayalaxmi Kasinath

Department of Architecture,

School of Planning and Architecture, Vijayawada

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Lecture 02

Role of Landscape and water in Passive Design - Part 1

Hello students, last class we saw the significance of openings and all the aspects regarding openings we have touched upon already. In this class, we will look at the relevance of vegetation in trying to achieve carbon neutral architectural design through passive design strategies. So, in the course of these class, we will look at the role of landscaping in carbon neutral architectural design with respect to climate, The role of water body in carbon neutral architectural design with respect to the climate, varying climate types. Plant carbon sequestration. Climate positive design. What should be the strategies for design? What are the strategies for installation? The strategies for management.

and a pathfinder tool example. Let us start with trying to understand the role of landscaping in carbon neutral architectural design. In architectural design, plants are often underestimated for their functional benefits in influencing a building's heating, cooling and lighting. Beyond aesthetics, they act as seasonal windbreaks, shading devices, coolers and light filters.

Proper landscaping reduces erosion, noise, dust and enhances oxygen. Deciduous plants provide effective shading while evergreens protect against winter winds contributing to decreasing heating and cooling costs. It also helps integrate nature into design and promotes ecological sustainability and human well-being. In architectural design, the appearance of a building significantly influences its heating, cooling and lighting. Plants play a crucial role in enhancing these aspects, often undervalued for their functional benefits.

What I meant to say was- the role of plants is very crucial, not only in how a building appears, but also in how a building functions. If you look at the pictures of the works of architect Alvar Aalto, They would always be framed with the pine trees. The overall landscape and the building as a part of the landscape was a very important way for Alvar Aalto to perceive his buildings. So how a building looks and functions, plants have an

important role. Plants can also act as seasonal windbreaks, shading devices, evaporative coolers and light filters.

Properly positioned plants can reduce erosion, noise, dust, carbon dioxide levels and enhance oxygen. Deciduous plants offer effective shading. while evergreen ones are suitable for protection against the winter winds. Thoughtful landscaping, accounting for plant species, growth rates and positioning can substantially decrease building heating and cooling costs. Integrating nature into design contributes to ecological sustainability and human well-being.

When we look at landscape techniques, the design cases presented in the below, they demonstrate landscaping strategies for effective solar, thermal and wind control tailored to specific climate types. These are derived from principles found in various sources And these solutions offer general guidelines that can serve as references for similar applications in diverse contexts. Let us now move on. If we look at the strategies for landscaping in various climate types, Let us look at the temperate climate. The temperate climate's effective strategies for optimizing comfort and energy efficiency includes maximizing winter sun exposure, providing summer shade, blocking cold winds, insulating with evergreen shrubs, strategic windbreak placement, employing overhead trellis and opting for light colored paving to minimize heat absorption and maintain cooler temperatures in the outdoors.

So, these strategies would include maximizing winter sun with high canopy deciduous trees on east and the west side. So, there is a need to have low branching evergreen trees to protect from cold winds. Then for summer shading using full canopies of deciduous trees to shield from high summer sun, having evergreen shrubs. So we must have very low deciduous trees or low deciduous trees on the south. High canopy deciduous trees must block the east and west sun.

But because they are deciduous, they should allow summer air flow underneath like this. The tree must be such that it should allow breeze underneath. Importance for evergreen shrubs along the north and strategically place windbreaks on north within four times their height for optical optimal effectiveness using overhead trellis with deciduous vines on the southern façade can give summer shade so having trellis on the south with Deciduous vines will help protect from the summer sun. Opt for light colored outdoor paving to minimize heat absorption and maintain cooler temperature. These will be the basics to follow in the temperate climate.

Now we move on to the hot and humid climate strategies. In hot and humid climate, key strategies include selecting plants for low angle winter sun penetration and summer

shade, avoiding dampness by placing planting beds strategically, and considering forestation on the northern front for solar protection. We must utilize wide trellis with vines, high canopy deciduous trees and maintain building vegetation, distance for comfort and air flow. We must implement wind channeling for optimal air movement. Throughout the year, prioritize shade with plants suitable for hot humid conditions.

Not all plants can survive the climate. We must choose plants allowing low angle winter sun penetration while offering summer shade. Again, we must ensure that there is deciduous vines on trellis along the south while evergreen shrubs and low branching evergreen trees should be along the north. High canopy trees should block east and west sun but same east and west sun, but they must also permit movement of breeze. Similarly, we can have deciduous vine trellis along the north direction too.

There should be deciduous shrubs along the south in order to channelize wind flow. So, depending upon the wind direction we must have deciduous shrubs normally along the around 13 degrees latitude south and southeast is a prominent direction for breeze. Let us now address the hot and dry climate conditions. In addressing hot and dry climates, strategies focus on maximizing shade for comfort using high canopy deciduous trees strategically and monitoring tree roots to prevent damage. Additional tactics include combating solar heating and on the southern side, reducing heat gain with climbing vines and enhancing cooling with water features.

We need to minimize paved surfaces. Prioritize maximum shade during late morning and late afternoon for optimal comfort. Have the building designed in such a way that it provides shading from the trees during late afternoon and evening. Utilize high canopy deciduous trees on the east and west side to enhance shading effectiveness. So, we must use deciduous trees on the east And also on the west to shade the building.

And these trees should be high canopy trees. We must monitor tree roots closely to prevent potential foundation damage near buildings because due to dearth of water, the roots tend to move towards any crevices in search of water. Compact solar heating on the southern side with additional shade trees or trellis structure. We must have trellis structure, adequate shading along with the deciduous vine. Reduce heat gain on the east and west side by employing climbing vines on vertical structure.

So, the east and west walls can have a climbing vine. enhance cooling with water features using channelized wind across water bodies for added effect place a water body so that the dry breeze gets humidified and brings in cool air minimize paved surfaces lower heat absorption and considered vegetative ground cover try to have as much as grass as possible as against pavements because pavements tend to radiate heat. Grass or

any ground cover keeps the ground cool. Opt for light colored surface materials in paved areas to mitigate heat related issues. Let us look at the strategies in very cold climate.

In extremely cold climates, effective strategies include creating windbreaks with low shrubs in the south and using deciduous trees in southeast and southwest directions. Building earthen berms on northern sites, planting dense evergreen rows and utilizing earth sheltering contribute to winter wind control and insulation. Selecting deciduous shrubs and trees for summer shading and high canopy deciduous trees for winter warmth and summer shade optimizes environmental conditions. Additionally, integrating a sunken reflective terrace on the southern side captures low winter sun, thus enhancing warmth reflection. So, it is important to use dense windbreaks with evergreen shrubs on the north, east and west front.

So, we need to have no, dense windbreaks on north, east and west sides. We must build an earthen berm on the north and northwest sides, planting dense evergreen rows with winter wind control. So, it is important to have windbreak of very low deciduous shrubs along the south side. And there must be absence of trees. We can use very high canopy deciduous trees along the south or southeast and northwest, low branching evergreen trees along the north and windbreak snow trap of evergreen shrubs along the north.

So, integrating all of this will help in very cold climate places. Let us now look at the role of water body in carbon neutral architecture. So in this lecture on carbon neutral architectural design, we explore the pivotal role of water bodies in mitigating climate impact. Evaporative cooling effective in hot dry climate utilizes water to reduce indoor temperatures. Proximity to water bodies optimizes the cooling process, contributing to enhanced thermal comfort in traditional and contemporary building practices, particularly beneficial in warm, humid climates.

Integrating water features holistically improves both aesthetics and functionality, fostering sustainable and comfortable living spaces. Evaporative cooling effective in hot dry climates reduces indoor air temperature by harnessing sensible heat to facilitate water evaporation. Proximity to water bodies enhances the cooling impact. Operating adiabatically without heat exchange. This method optimizes interaction between water and air creating a cooler environment within buildings.

So if you look at traditional building practices, traditional buildings have always employed various evaporative cooling techniques. Examples include water features like pools, fountains which are integrated into courtyards or building interiors. The effectiveness in warm humid climate looks at cooling through water bodies as particularly effective in certain conditions. It provides a practical and efficient means to

improve thermal comfort, but not during days when it is intensely humid. When the air is already laden with humidity to about 98 or 99%, more of water body will be an ineffective mechanism.

If we look at holistically contributing to an improved sense of comfort in the built environment, blending aesthetics with functionality, considering that water bodies have been a very important part of the Indian culture. We can create a sustainable and comfortable living space by integrating water bodies. One needs to be very careful on where we locate the water bodies for which climate type. It is one of the most effective means to enhance indoor thermal comfort in hot humid climates, not so much in warm humid climate. If you look at how water bodies were being used, we can look at the Amber Palace in Jaipur where the water fountain was used.

Sprinkled water causes adiabatic cooling to all the structures around it. There has been a trellis which provided shading from the vegetation in the interior courtyard. The entire interior courtyard had plants which reduced the heat due to reflection and the buildings were made up of light coloured sandstone. The surfaces were reflective because they were light in colour. And the water body in the interior courtyard served to cool the air that would eventually enter the rooms around.

We would continue with the other issues. Evaporative cooling aligns with landscape design utilizing greenery and water features to regulate temperature. It reflects sustainable practices seen in traditional architecture like water features in Indian palaces demonstrating an environmentally conscious approach. Research suggests significant cooling effects through water surface interaction and traditional Iranian spring house. Integration with landscape design results in evaporative cooling aligning itself to the greenery and landscape elements such as the water features and the soft landscape and it plays a crucial role in temperature regulation.

The sustainable and traditional practices are reflected with the use of water bodies with fountains in palaces across India. It demonstrates an environmentally conscious approach to cooling in building design. It has been well documented and also well known about how water bodies have been used in their significance-cultural significance in Indian architecture. Let us look at the application of water body adjacent to a building. When there is a water body adjacent to a building, the water droplets evaporate from the water body and the evaporative cooling air which passes over it enters the building And this cool air cools the building and exits as a warm air.

The various reasons or strategies of how cool air descends and warm air rises and the circulation effect that we had already studied must be clubbed with this understanding

and then we should finally realize the significance of water bodies and vegetation separately and in combination to create a thermally comfortable indoors. So, it becomes important to understand that vegetation and water body assist in indoor thermal performance resulting in reduced use of operational energy and hence reduced use of greenhouse, reduced emission of greenhouse gases. We will stop this class at this stage and we will continue in the next class with the same theme. Thank you.