Course Name: Architectural Approaches to Decarbonization of Buildings

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Lecture 4

Recap and Conclusion

So, dear students we have come to the concluding part of this course. Today's class will be a recap and a slight relevance of this course. whatever you have learned in this course what is the relevance of it we will just have a recap and at the end I would be running through the references to give credit to whose ever data I have used. So, in this course what we saw was what is the meaning of greenhouse gas? How it impacts global warming? What can we as architects and designers do to reduce global warming? Now, we can do a lot because the building industry consumes humongous amount of energy from the grid and using simple passive design strategies, using strategies which modify the microclimate with the help of vegetation or water bodies and topography, using renewable building materials and avoiding the use of non-renewable building materials can definitely help us in reducing global warming through reduction in the use of embodied energy and operational energy. We also saw the use of energy efficient alternate building technologies We had a glimpse of efficient utilization of natural resources and raw materials. We saw how earth friendly materials can be used in architecture.

What are the optimal designs and planning practices? What is the significance of recycling of building waste? and the utilization of industrial or mine waste for the manufacturing of building materials? How adopting energy efficient process in manufacturing of building materials help us reduce embodied energy of those building materials? What is the use of renewable energy sources and technologies in reducing operational carbon? Now, why is reduction in energy consumption in buildings so important? As centers of our social and economic lives, buildings are also the source of a great share of our environmental impact. The International Energy Agency, IEA, It estimates that nearly 60% of the world's electricity is consumed in residential and commercial buildings. The building sector is responsible for one-third of the total resource consumption globally. and the Intergovernmental Panel on Climate Change, IPCC, it estimates that by the year 2030, greenhouse gas emissions from buildings will account for over one third of the total emissions.

But the building sector represents a hugely untapped potential for emission reductions. With proven and commercially available technologies, Energy consumption in both new and existing buildings can be cut by at least 30 to even 50% within the lifespan of the building. The United Nations Environmental Programme has stated that no other sector has such a high potential for drastic emission reduction. And that the built environment offers some of the most cost effective and expedient ways to contribute to climate change mitigation. The consumption of energy and emission of carbon in buildings is made up of two types.

One is the embodied energy and another is the operational energy. Now, in India, the real estate and the construction sectors ; they account for about 32% of the total greenhouse gas emissions and these cover both operational and embodied carbon. Currently, Indian buildings account for over one-third of the total annual carbon emissions And these are projected to emit 7 times more carbon by the year 2050 as compared to the year 2005. However, forward-looking -built environment players are increasingly backing the move towards net-zero and ambitious sustainability commitments. India's real carbon saving potential lies in the assets that are yet to be built.

Estimates suggest that about 70% of India's 2030 urban infrastructure is yet to be built, which highlights the need to minimize the associated embodied carbon. Currently, governments and private stakeholders are largely focused on reducing operational carbon emissions, while in comparison, embodied carbon remains more challenging to track. It is also difficult to track those embodied carbon emissions and also to record and report. Across the life cycle of a project, typically 50 to 70% of total embodied carbon is emitted before completion. Of this, 80 to 90% of embodied upfront emissions arise during the manufacturing stage.

while transportation accounts for 7 to 10 percent and the construction stage between 3 to 5 percent. Hence, it is very important for us to reassess the mode of carrying out any of these, whether it is the building material, whether it is the manufacturing process of the building material, the transportation of the building material and how constructions happen. Now, India's stand is in this background. India has pledged in COP26 to achieve net zero emissions by the year 2070. How can we achieve net zero emissions unless we do all that I had stated now? And India's historical cumulative emissions, they amount to less than 4% of the CO_2 emissions of the world.

Yet in absolute terms, India is still emitting a lot of CO_2. So even though the per capita annual emissions, India ranks third globally in the total national emissions. despite having very low per capita annual emission. But the world does not know the statistics. What I

mean by world is the planet and nature does not know these statistics.

The impact of such high global emissions, the impact of such high carbon dioxide emissions even from India is going to affect the earth. by speeding up the global warming. Nearly one third of these sustainable development goals set forth by the United Nations relies on the building and the real estate industries either directly or indirectly. With such a critical role by the building industry to achieve the national sustainability development goals by the year 2030, our government has established many important and notable programs such as the Pradhan Mantri Awas Yojana and the Smart Cities Mission. Hence, a significant quantity of building construction is expected in the upcoming years.

Unless we very consciously apply all that we have discussed, the chances of reduction in carbon emissions is very minimal. the majority of research that is carried out in India is concentrated largely on the carbon footprint and embodied energy of the building construction. This does not account for the additional detrimental environmental externalities like harm to human health, quality of ambient air, quality of water, This makes it impossible to obtain a complete picture of how much the many environmental areas are harmed due to the building development industry. In the next few years, a very important quantity of building construction is anticipated in economically emerging countries such as India. Understanding how these buildings will affect the many environmental domains is the first step towards making sure that new construction is done in a sustainable manner.

The stage of material manufacture has the largest impact on a building's overall environmental footprint. The choice of building materials at this stage becomes very important. And therefore we need the support of the clients, the architects and designers and the civil engineers to pitch in and welcome renewable and earth friendly building materials. Material transportation that also consumes a lot of embodied energy. One needs to therefore focus more on locally available building materials and also look at earth friendly transportation methods to the construction site.

The elements causing high impacts the building materials which are very high in embodied energy are cement, steel, glass, aluminum, brick and plastic. These are the widely used building materials today. As architects and designers you need to rethink the usage of high quantum of these building materials. Since buildings in India account for 35% of all energy generated, the first environmental effect category which is the energy use. This relates to the nation's sustainable development goal number 7 which is improvement in energy efficiency.

The second impact category which is global warming potential measures how human

caused greenhouse gas emissions affect the atmosphere's ability to absorb heat radiation or radiative forcing. This raises earth's temperature which has a negative impact on the ecosystem health as well as the human health. Massive volumes of greenhouse gas emissions occur during the production and processing of building materials such as steel, concrete, glass, cement, bricks, etc. and during construction operations using of the inappropriate fuel. This must be taken into consideration when one chooses a building material.

This metric is crucial for monitoring the nation's advancement towards Sustainable Global Development Goal No. 13 or Climate Action. The employment of standard production procedures for brick, cement, steel, aluminium and natural aggregates results in substantial environmental consequences when carrying out reinforced cement concrete, aluminium and brick. We have seen how the use of different fuels to burn or fire the brick alters its embodied energy. Setting aside the relative effects of various materials and life cycle stages, it is evident and pertinent that the building construction has a significant overall impact.

There is substantial proof that using green concrete made from industrial waste like fly ash or steel slag and foundry sand instead of conventional concrete for building projects can save 20-30% of the energy used. It is possible to decrease energy use and to reduce carbon emissions, reduce air acidification and particulate matter emissions by 70 to 90 percent by using locally and naturally occurring cob earthen material such as clay, sand, straw, and the other renewable materials that we have seen during the course of the study. Instead of using conventionally processed high energy intensive building materials such as concrete masonry, one can really look at the alternate building materials. When compared to traditional concrete, carbon emissions can be reduced by employing concrete constructed from recycled concrete, industrial or agricultural byproducts, recycled crushed clay brick aggregate and cement. Replacing these materials with rice husk ash, palm oil fuel ash and palm oil clinker powder.

The use of diesel during material transportation to the site and for operating various machinery during on-site building construction is the single biggest contributor to the life cycle impact, apart from building materials. In order to do this, some of the possibilities that needs to be investigated in the future include the use of alternative greener fuels like ethanol, more efficient heavy-duty vehicles, battery-based truck and logistical efficiency. So, what we have seen during the course of this class, during each of these classes that we have taken, it all amounts to that the architects, designers, civil engineers and clients have a huge role in reducing greenhouse gas emissions, and global warming. This can be done through first understanding whether there is need to scale up the project or to downscale the project. The architect plays a crucial role in counseling the client to have a

scaled down, build less approach.

Even when one has to build, try to look at the options that you have in terms of building materials and construction technology. Try to go for renewable building materials. Try to go for locally sourced building materials. Adapt all simple passive techniques try to adapt advanced passive techniques. I have not covered advanced passive techniques in this course and I have only hinted upon simple passive techniques in this course.

These two could form part of another course where in detail simple passive techniques and advanced passive techniques can be taught to students. All aiming towards reduction in embodied energy and operational energy. Also try to design building envelope which are sensitive to climate. We have hinted upon low energy envelopes. Day lighting consumes a large part of energy.

Try to avoid artificial lighting and replace artificial lighting with natural daylight. This can be done by appropriate design. If artificial lighting is needed, one should go in for energy saving fixtures. Overall, look at the building in a holistic manner. Such that the embodied carbon and operational carbon emissions are very less.

Because that is the way forward for decarbonization of buildings in India. I conclude my lecture series with this class. I hope you all have learned the basics of what should be done, what is in your control to reduce embodied and operational carbon and embodied and operational energy to decarbonize buildings because it is India's commitment to go carbon neutral and net zero. I thank each and every one of you who have taken up this course. I only wish that you follow these basic principles and thumb rules that we have discussed in this course.

I wish you all the very best. As a future of this country, it is your responsibility to be more sensitive for the damage that has already been done. Thank you one and all and I wish you all the best. Thank you.