Course Name: Building Materials as a Cornerstone to Sustainability

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Lecture 01

Introduction to Advanced Building Materials

Dear students, we have so far seen traditional building materials that are made of natural building materials like mud, bamboo, straw, and so on. We have seen alternate building materials that were trying to integrate the traditional building materials with modern building materials. Then we saw innovative building materials that had geopolymers, concrete, the use of mycelium bricks, and so on. Today, we will have a small introduction about advanced building materials because the series today will start on advanced building materials. So, what are advanced building materials? Advanced building materials are materials that have very high efficiency in their performance, and they also have very high efficiency even in terms of strength as compared to the traditional building materials. Use of various resources, such as packaging material, the raw material for which is again from the trees.

The maintenance and life cycle have again resulted in energy consumption, carbon dioxide emissions, resource use and replacement, wear and tear, chemical contamination, and water pollution. Demolition has led to chemical contamination, toxicity, and environmental poisons through land, also affecting the water aquifer. Reciting the waste has resulted in landfill decomposition, groundwater contamination, and methane gas production. In order to deal with all these environmental impacts, we need to think and reconsider the use of any other building materials than what we have been conventionally using.

In this context, we have seen traditional building materials, advanced building materials, and innovative building materials. Today, we will see advanced building materials. So, why advanced building materials? We have already seen and discussed a lot. That the most important environmental threat associated with the production is not so much the depletion of non-renewable raw materials, but instead the environmental impacts caused by its extraction. New advanced materials offer opportunities to change how we construct and retrofit buildings.

They give added value in terms of increased performance and functionality. Reduction of carbon footprint for construction materials can start at the production stage itself, where energy efficient processes can be developed and waste or recycled materials can be employed. New materials can also help address the new challenges of durability in a changing climate. Technology continues to create new building materials with exceptional properties. Composite materials are made by combining different types of building materials.

These materials combine organic and inorganic components. One material acts as a type of adhesive that binds the other components together. Advanced building materials include photovoltaics, nanotechnology and use of innovative technology Here let us look at how we can classify advanced building materials. These can be classified by type. So, the advanced building materials market can be segmented on the basis of type of building material, the material itself, and the application.

Based on the type, the market is bifurcated into green materials and technically advanced materials. Based on material, the market is divided into advanced building materials such as cross-laminated timber, structural insulated panels, sealants, and others. In terms of applications, based on application the market is divided into building construction and infrastructure development. What are the demand trends for advanced building materials? So, the increase in construction activities in developing nations has resulted in the need for advanced building materials. The increase in global construction activities, especially in the developing nations, has emerged as a pivotal driver for the global cement market.

Developing countries are experiencing rapid urbanization and infrastructure development, leading to a surge in demand for cement as a fundamental construction material. This growth can be attributed to several key factors. Firstly, population growth and urbanization are reshaping the landscape of developing nations. As more people migrate from rural areas to cities, the demand for housing, commercial buildings, and infrastructure projects such as roads and bridges is on the rise. This urbanization trend is particularly pronounced in countries like India, China, Brazil, and various African nations.

Consequently, cement consumption has surged to meet of these expanding urban population. Secondly, government initiatives and investment in infrastructure development, they play a significant role in propelling construction activities. Many developing countries are actively pursuing infrastructure projects to boost their economic growth and improve living standards. Advanced building materials are also high performance materials. They are innovative in the sense that they possess superior strength, durability and other desirable properties compared to traditional construction

materials or conventional construction materials like concrete or steel.

These materials are specifically designed to enhance the performance, sustainability, and resilience of modern construction projects. The future outlook of the advanced construction materials market appears promising. The growing demand for sustainable and eco-friendly construction materials is one of the key factors driving market growth. With the increasing focus on environmental conservation, advanced materials such as self-healing concrete or green roof concrete or green roof systems and recyclable materials are gaining traction amongst builders and contractors. If we look at the global advanced building materials market, it can be seen that that as compared to the year 2018, as compared to the year 2018 there is a exponential rise in the demand for advanced building materials.

And this growth trajectory is bound to continue. Yet, even if we consider a very conservative rate of growth of demand for advanced building materials, you can see that there is still a demand, even if we predict the demand to be linear. Hence, the advanced building material market, which was valued at 54 billion dollars in the year 2021, is projected to grow to at least 57 billion dollars in the year 2022. Now, India is a fast-developing country with demand for more buildings and hence, in India, this growth is bound to be much or this demand is bound to be So, out of these advanced building materials, if we look at green materials as against technically advanced materials,. The advanced building material market is categorized into green markets and technically advanced materials.

Green building materials are non-toxic, environmentally friendly, and green, leading to improved occupancy health, lowered energy costs, and reduced energy consumption. Green materials are expected to exhibit very high levels of environmental response in a very positive manner. Technically advanced are modern techniques and practices that include the most recent advancements in materials technology, design procedures, quantity surveying, structural analysis, and design. Now, these are all covered under this segment. Technically advanced is expected to exhibit the largest share in the type segment in the advanced building materials market during this forecast period.

Hence, we can see that there is a rise in the requirement of both the green materials as well as the technically advanced materials. There is a requirement in the next decade from 2021 to 2031. Now, by materials, if we look at them, we have seen the classification of advanced building materials. Now, if we look at materials, the advanced building materials market is classified into advanced cement and concrete, cross-laminated timber, structural insulated panels, sealants, and so on, among others. The advanced cement and concrete offer properties such as high-strength concrete, high-performance concrete,

ultra-high-performance concrete, stamped concrete, and self-consolidated concrete.

Cross-laminated timber is a type of prefabricated engineering lumber that consists of layers of cross-stacked timber joined by structural adhesives on the wider side and sometimes even the shorter side. Structural insulation panels, or SIPs, are high-performance building systems for residential and light commercial use. The panels consist of an insulating foam core sandwiched between two structural faces, usually like an oriented standard board. Sealants are the materials which are used to block the passage of fluids through openings in walls, corner passages in a constructed building or infrastructure. It is a type of mechanical seal.

The other segment in advanced building material includes advanced, say, firefighting-based materials or advanced paints, advanced waterproofing solutions, and many others, which we will be seeing in the forthcoming classes. Sealants are expected to exhibit a very high demand. Advanced cement and concrete is expected to again exhibit the largest share of material segment in the advanced building materials market in the at least next decade. So, here we can see the demand in advanced cement and concrete, in cross-laminated timber structural insulated panels in sealant, and others. So, overall, during this decade, when we look at material-wise segregation, we see that there is heavy demand in the next decade for advanced cement concrete, cross-laminated timber structural insulated panels, sealants, and others.

If we look at material with regard to material type, again you can clearly see how there is an exponential demand. in the requirement of advanced cement and concrete, cross-laminated timber, structural insulated panels, sealants, and others in the period between 2021 and 2030. So, one decade is going to create a demand for advanced building materials Let us look at the purpose of using advanced building materials. The purpose of using advanced building materials in residential construction or even in any other construction is to create more durable, energy-efficient, safe, and sustainable buildings. Advanced building materials such as insulated concrete, forms, energy-efficient windows, ceilings, and engineered lumber offer enhanced structural strength and resistance to weather.

Seismic activity and other hazards are also safeguarded if we use advanced materials. Now, also advanced building materials are highly versatile and can be applied in various ways in commercial construction. One of the significant applications is in the creation of sustainable and energy-efficient buildings. Advanced construction materials such as green insulation, energy-efficient windows, and renewable energy systems can help reduce energy consumption, thus lowering the carbon footprint of a building. Hence, the rising demand for various advanced building materials in industries positively impacts

the market growth.

Let us look at the examples and benefits. Now, this category which includes ultra high strength concrete, this offers higher strength and rapid setting. Self-healing concrete offers improved insulation Quick setting sealants offer enhanced water resistance. The 3D printed concrete based on the additive can offer fire resistance. Enhanced fire resistant solutions can offer ease of application.

for every advanced building material there is a very strong basis and strong benefit that it is likely to offer. Let us look at in terms of application. By application the advanced building materials market is divided into building construction and infrastructure. Now, building construction application requires advanced building material in technologically advanced and it specially made to support the construction of robust and long standing buildings. These materials are used in the construction of all kinds of buildings such as industrial, residential and commercial.

They are composed of concrete admixtures, polymer composites, adhesives and sealants which help in enhancing the structural integrity of the building. The infrastructure segment in application is the collection of facilities and systems that serve a country. This includes the services and facilities required for the economy, households and businesses to function. Infrastructure is expected to exhibit the largest share in application segment in advanced building materials market during the forecast period. Finally, we looked at The advanced building materials market which is expected to grow at 46.

8% by the year 2031 and the global advanced building materials market which was valued at 56 billion in 2021 and is projected to reach 111 billion by 2031. So, advanced building materials can be defined as materials that are more sustainable and have superior technical properties than conventional building materials. So, with this we will come to an end of this segment. which was an introduction on advanced building materials, and we saw after classification what these green materials are in terms of materials, in terms of buildings and infrastructure. We will look at yet another interesting topic in the next class.