Course Name: Building Materials as a Cornerstone to Sustainability

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Lecture 03

Construction and Demolition waste

Hello everybody. So, we are in our ongoing process of understanding how alternate building materials can help us in lowering the embodied carbon emissions and move towards a greener planet. Today we will look at construction and demolition waste and its incorporation into architecture. We will look at what is construction and demolition waste also called as C and D waste, the world scenario, the Indian scenario and how we could manage this waste. Now, what are construction and demolition waste materials? C and D materials (Construction and Demolition waste materials) encompass the byproducts of constructing new buildings and civil engineering structures as well as the materials resulting from the renovation or demolition including deconstruction of existing buildings and civil engineering structures. This category extends to various civil engineering projects such as streets, highways, bridges, utility plants, piers and dams.

Typically, C and D materials include bulky and weighty substances like concrete, wood derived from the buildings, asphalt from the roads and roofing shingles, gypsum which is a primary component of drywall. Metals, bricks, glass, plastics, salvaged building components such as doors, windows and plumbing fixtures as well as natural materials like trees, stumps, earth and rocks from the site clearing activities. The diversity of these materials underscores the comprehensive nature of C and D waste and emphasizes the need for effective waste management strategies in construction and demolition practices. It is a challenging task no doubt to handle C and D waste because it is bulky, heavy and inert and also it is a mixture of various materials of different characteristics.

It is also difficult to choose any suitable disposal method. For example, it cannot be incinerated due to its high density and inertness. With the advent of sustainable practices in the construction industry, C&D waste generation and handling issues have been in focus to achieve the sustainable goals of our common future. We need to reduce, reuse and recycle that is follow the three R's philosophy and it will be highly useful in handling the C and D waste. Though recycling has already been taken place at the time of Second World War, when Germany reused most of the demolished concrete for construction

purposes, yet many countries, especially India, are not fully aware of the potential of three arts.

And hence, we still find landfilling as the only method for C&D waste handling. The better practice to handle C&D waste is to minimize generation of C and D waste, but sometimes it is unavoidable due to various issues such as change orders of demolition requirements for redevelopment. Now, if you look at this figure, you can notice that a variety of materials form C and D waste. These are aggregates, cement. These are aggregates, cement aggregates, concrete, and bricks.

You have stone, gypsum, wood, glass, ferrous and non-ferrous metals, aluminum, iron rods, plastic, broken asphalt, railway ballast, paper, cardboard, asbestos sheets, excavated soil, gravel, rock, trees and so on and so forth. So, all these combined together form C and D waste. So, these C and D waste can be manmade, it can be generated as a manmade source because of virtue of either retrofitting a building or demolishing a building or it could be from a nature made source such as a disaster like an earthquake or floods or hurricanes. Now by the 2030, the world is expected to generate 2.59 billion tons of solid waste annually.

By 2050, this amount is expected to rise further to 3.4 billion tons. Globally, about 37% of waste is disposed of in some type of landfill. 33% is openly dumped and 19% undergoes material recovery through recycling and composting, while 11% is treated through modern incineration. Just to give you a perspective, in the United States, it is estimated that 600 million US short tons, about 544 million tons of C and D debris were generated in the United States in 2018.

This is more than twice the amount of generated municipal solid waste. In 2018, 76% of all CND waste was recovered or recycled. Demolition represents more than 90% of total CND debris, while construction represents less than 10%. Just over 455 million US short tons which are about 413 million tons of C and D debris were directed to next use and just under 145 million short tons or 132 million tons were sent to landfill. If you look at the composition of C and D debris, you can see that about 67.

5% of the debris comprises of concrete. A largest chunk of debris is concrete. While asphalt concrete is about 17.8 percent, wood products constitute 6.8 percent and the rest of the things are in the range of between 2 to 2.

5 which are asphalt shingles, brick and clay tiles, drywall and plasters, steel constitutes less than 1 percent of the C&D debris out of the 600 million tons. So, in the Indian scenario, we can see that in India's rapidly urbanizing landscape, the construction sector

is a significant contributor to local air pollution and toxic exposure. This sector's frenetic pace amplifies the material and energy intensity of the built environment locking in substantial carbon. While responsible construction is imperative for reducing environmental impact, effective waste recovery is crucial to lowering material intensity and substituting virgin materials curbing environmental degradation. Waste management from construction and demolition is integral to pollution control effects in the 131 non-attainment city under the National Clean Air Program.

These cities aim to reduce particulate pollution and achieve cleaner air by 2024 and 2026 with detailed action plans and monitoring in the place. Swachh Bharat Mission 2.0 and Swachh Survey Action complement these effects by supporting waste management and ranking cities based on their waste management practices. Both clean air and waste management programs receive dedicated funding, including a corpus in the 15th Finance Commission targeting a 5% annual reduction in particulate pollution until 2024. This grant is performance linked and dispersed based on the identified cohort of major cities.

These comprehensive initiatives align with national goals for sustainable urban development and environmental well-being. The Asian Institute of Technology in Thailand conducted a survey on construction and demolition waste management across Asian countries in May 2008. The report covers nations like Bhutan, Japan, Hong Kong, China, Thailand and India. The survey assessed the status of construction and demolition waste to be having in the order of ranking. China recorded the maximum amount of waste among these countries with approximately 48 percent of C and D waste.

Next was Japan with 1%. In comparison to that India had only 4% whereas the countries which had more generated more CND wastes were apart from China, Hong Kong, South Korea and Taiwan. These countries generated more CND waste than India did. Also, if you look at the waste metric tons per day, we can see that Mumbai generates the most of C&D waste. Next to it is Bhopal and followed by Ahmedabad, Bengaluru, Hyderabad and Delhi.

Pune is also similar to Delhi. So, these comprehensive initiatives must align with our national goals for sustainable urban development and environmental well-being. Let us now look at waste in India and its composition. The composition of construction waste varies based on the structure type. For flyovers or bridge structures, it typically comprises of concrete and steel.

In contrast, residential structures exhibit diverse composition including concrete, steel, wood, tiles, paints, plastic, glass, etc. If you look at the quantity of typical composition of C and D waste, you can see that of all the three types, three bodies that did the survey,

soil, sand and gravel ranks highest. While concrete comes next followed by metals. Wood, bitumen and others rank least. Let us now look at the environmental benefits of C and D waste.

So, first is carbon emissions. Construction demolition waste contributes to carbon dioxide emissions impacting global warming. The landfill gets overloaded because C&D accounts for a significant portion of landfill waste leading to space scarcity. Besides, the landfill that happens normally is over areas which are not inhabited by people. Eventually, it is the water bodies and areas outside of cities that face the brunt of this landfill.

If these are marshland and water bodies, then it means that the city's marshland and water bodies would also get depleted and eventually the land gets reclaimed. All this causes a big environmental risk when it rains because the city does not have any source to store its water. Resource depletion is another important environmental implication. The extraction and processing of new materials add to resource depletion. Instead, if we could find ways to reuse the C and D waste, then this resource depletion can be prevented.

Sustainability wise, it causes reduced environmental impact when we reuse and recycle these products. This is also directly related to cost savings because lower material costs and waste disposal expenses occur. It can also give us an opportunity for creative and unique designs using repurposed materials. Let us see some of these - what all materials can be made or got from construction and demolition waste.

So, the first is aggregates. Now the construction and demolition waste aggregates have been recycled and produced in many countries. The aggregate preparation is done by first is breaking the construction and demolition waste. For which we need a very powerful crusher. These crushers they vary in size based on the capacity and the strength.

So there are many crushers. Then these are put through vibrating screens to segregate rock, gravel and sand sizing. Once this is done, then crushing and screening happens and the process gets repeated until you get this aggregate size that is required by you. The products that go into this the construction and demolition waste that go into the crusher are concrete, concrete products, mortar, and concrete brick. Sometimes this gets mixed with natural stone and recycle aggregate which is clean without mortar. Also some bituminous material or floating stone could also get mixed with this.

So, then these are then later sieved with screen for appropriate sizes of either fine aggregates or coarse aggregates. Now, what materials can be reused? The main advantage of material reuse is the reduction in resource and energy consumption that results from a

decrease in the manufacture of new materials. Typically construction and demolition materials and applications that are reused are these. First is objects that are simple to remove such as fixtures, doors, hardwares and appliances. These can be saved for donation to be used in the reconstruction process or for other purposes.

To avoid cutting full length lumber, wood cut-offs can be used for blocking, lintels and cripples. On-site chipping of scrap wood allows it to be used as ground cover or mulch. In moderation, depapered and ground gypsum can be applied as a soil supplement. On-site recycling is possible for masonry, concrete and brick for use as driveway bedding, fill and sub-base material. You can use extra insulation from outer walls to reduce noise in internal walls.

Remixable paint can be used as a primer layer for other projects or in garages or storage places. Returned packaging materials can be reused by vendors. So, from this we can see what all are the materials that can be reused and need not go through the process of getting changed to aggregates or any other material. Let us look at recycling and repurposing the construction and demolition waste. Asphalt, concrete and rubble are often recycled into aggregate or new asphalt and concrete products.

Wood can be recycled into engineered wood. Products like furniture as well as mulch, compost and other products. Metals including steel, copper and brass are also valuable commodities to recycle. These can be added to aggregates in road laying, refills in buildings and as aggregates to concrete. Here you can see eco-friendly tiles made from recycled glass which contributes to sustainable built environment.

Concrete debris is transformed into durable and visually appealing brick pavers for outdoor spaces. Hence, from this you can learn and summarize that Construction and demolition waste is getting generated in a huge quantity in the world as well as in India. It becomes necessary for us to salvage products from these C&D wastes. We have seen what products can be salvaged from these C and D waste. These include metals, these include timber products, these include masonry, concrete, brick to be separated and used either as filling material for the same project. Or these can be taken away and sourced to be converted into some other material.

Mostly it becomes an aggregate. If we do not recycle, then all these materials go to the landfill and land gets filled wherever there is a depression. Having a depression means it is a likely place to store water. Hence, by disposing of the C & D waste in landfills, we are reclaiming the land for further development. But at the same time, the city loses its water body either in the form of lake, pond or a marshland. All of this is harmful to the environment because it shows lack of respect to the lung space in the city.

Hence, the best way to handle C and D waste is to salvage as many things as possible for recycling and the remaining thing which comes out or the remains which are left behind can be converted into aggregates with the help of crushing, sieving, again sorting, crushing and sieving. And these aggregates can be mixed during the construction process to get new products. So, today we stop with this class. In which we have learnt the importance of handling construction and demolition waste considering the humongous quantity of construction and demolition waste that is generated by the building industry. We will meet again in the next class with another interesting topic.