Strategies for Sustainable Design
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Lecture 29
Sustainable Building Materials

Hello everyone, in this lecture we will discuss about sustainable building materials. So, as you know this is one of the most important actually chapters most actually important lectures and important why because the building materials actually constitute a major portion of like the sustainability impact because material in itself actually forms the largest bulk among everything and it requires lot of like resources it requires lot of like energy and it creates like a impact during its lifetime at the beginning of the stages of its lifetime in even after like the end of its lifetime lifecycle.

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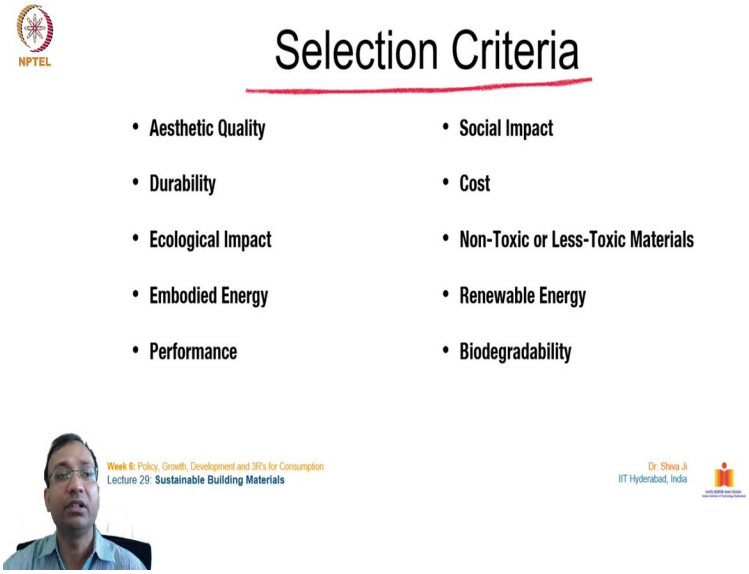

So, let us see like what are the actually tentative like selection criteria's. So, those are like obviously the aesthetic quality one of the important ones but apart from that we are looking for here like durability, ecological impact, embodied energy, performance, social impact, cost, non-toxic or whether like less-toxic materials, are renewable energy we are looking for like biodegradability.

So, these are actually terms, there are actually criteria's which have become very important very crucial in like the sustainability studies and why that we have discussed separately why they are important. So, we will discuss more from the perspective of materials over here.

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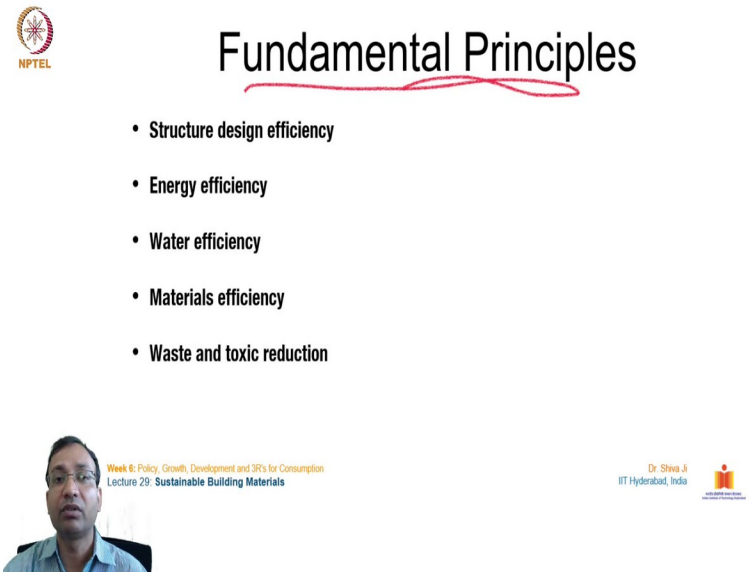

So, the fundamental actually principles which are can be used we can call them like even strategies like these also through which we can actually devise our like guidelines, we can design our accordingly and we can actually fulfill the requirements. So, those could be like a structural design efficiency why structural efficiency is important in order to reduce the actually wastage of material because usually in the lack of like knowledge we may end up spending more where it is not needed or we may maybe we can end up even with the little material where it is like needed.

So, actually thorough and analytical actually study is needed to analyze the structure before going for the construction of it. So, in order to actually optimize the efficiency of the resources, optimize the efficiency of the materials used in the that. So, structural design efficiency is one of the very important ones as far as the building construction is concerned then comes the energy efficiency well of course buildings consume energy throughout their life and mainly during their operation stage the consumption of energy goes like very high.

So, we must actually go for energy efficiency also, water efficiency well water is available in the finite like a quantity. So, as like a natural element this is one of the most-scarce elements, scarce resources in like a today's times in the recent years and we are seen like what are the kind of crises which are happening like in the non-availability of water in the like a summer month and those like other typical months and material efficiency of course we can save on the bulk, we can

save on the manufacturing processes, we can save on the resources itself. So, there are several advantages for actually saving on the materials and of course waste and toxic reduction.

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So, see like how the rating method of GRIHA green rating for integrated habitat assessment recommends sustainable building materials like criteria's in their GRIHA framework. So, the latest GRIHA framework version 2019 has a three actually criterion you can see over here criteria number 19, 20 and 21 which talks specifically with the like material like sustainability of factors.

So, the first one is utilization of alternative materials in the building. So, what it means over here like we should look for actually alternative materials, alternative sustainable materials for like the other like regular materials which are like energy intensive, which are like material intensive, which could be actually toxic in the nature.

So, it talks about you going ahead for like the alternative actually of those sorts of like materials and it gives actually a good weightage of like 5 points over here in its like a framework the second criteria which comes over here is about reduction in the greenhouse gas emissions like parameters through like life cycle assessment.

So, it emphasizes on the like analysis, it is emphasizing on the like environmental impact assessments it emphasizes on the like evaluation before going for the execution of the project. So, this is one of the very important points over here that we have studied in the life cycle

analysis and earlier lecture that we have to be very cautious about the evaluation of the building at the design staff only before going for the final exhibition of it, the last one topic talks about here, about alternative materials for external site development.

So, that has got two points dedicated for this one. So, this also talks about the alternative materials for outside the building on the site requirements for example creating boundary walls or maybe creating pavers, creating a landscape, creating other elements on the side. So, those also can be used with locally available material which can be like an alternative to the like a manufactured or fabricated material from the like factories. So, here if you see like the focus is on like a saving on the like impacts, saving on the like other conventional material which are like having like some sort of impact on the ecology. So, this is actually purpose of going for the sustainable building materials in the construction.

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So, how these like alternatives can be actually evolved. So, this is a list of actually those like alternative materials which can be actually used as like a main resource material but they are actually by-product, they are actually waste of like some other actually product. So, we can see like we are all familiar of this fly ash material, red mud, slag, unfired clay bricks and manufactured sand, glass and there are several other list of materials which can be used as and these are actually being adopted in the recent times in the construction industry alternative material.

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So, here if you see in this slide it talks about using mainly the materials which are still available in their natural form condition and which are we can say they are not so highly or a complex processed. So, they can be taken care of while dismantling, disintegrating while disposing them at the end of their life cycle.

So, those could be paper, those could be artificial stones, carbon fibers, translucent concrete, rubber modified asphalt, plastic, recycled bitumen you know silica fumes you know there are several other types of material even husk also of several crops you know and a cloth rayon's and fibers available from discarded government.

So, these could find several applications of it in the whole construction material category when we are talking about well how these can be used. So, this is one very interesting example from India itself here we can see this road constructed the top layer of it this road which you will be constructed using the waste plastic and you can see the holding over here which talks about plastic waste road.

So, there are several advantages this plastic is going to land up in the landfill. So, how this can be put to use somewhere. So, we spoke what is the pollution, pollution is there wrong place our mate when material reaches at the wrong place it becomes polluting thing for that place or obviously. So, why cannot this material which is pollution for the rest of the environment can be put to some use.

So, it has user higher percentage of plastic base and it reduces the need for bitumen by around 10 percent increase the strength and performance of the road reduces the cost to around 5000 per kilometer of single lane road generate jobs for rag pickers, develop technology which is eco-friendly an improvement in fatigue life of road and better resistance toward the rain water and cold weather also better resistance towards rain water and cold weather, cold situations. So, these are some advantages we can have over using conventional bitumen based or tar based road surfaces. So, why not to have such experiments and we can evolve methods and ways to have such constructions in other places also.

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This is one example you can see over here. This is building in Milan which sucks the pollution content of part from the air, from the atmosphere and this is known as smog eating machine small heating building. So, we will look at the details of this building if you see.

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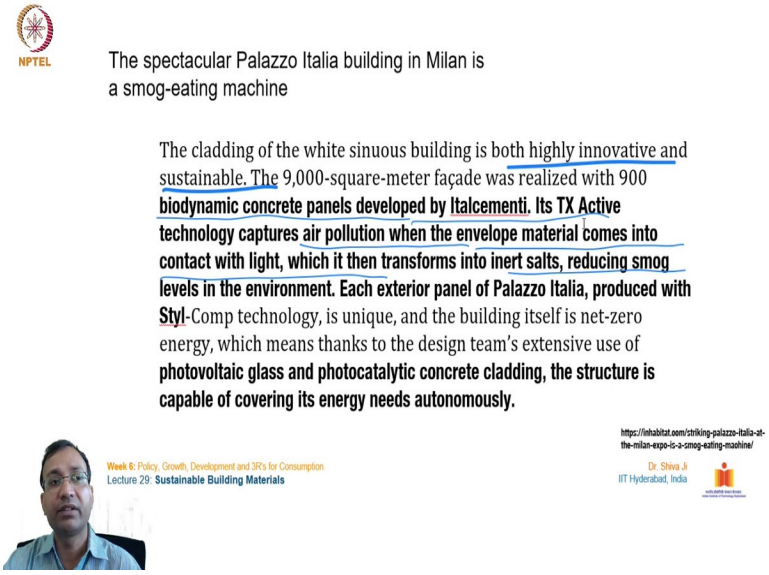

So, the cladding of the white sinus building in both highly innovative and sustainable the 9000 square meter facade was realized with 900 biodynamic concrete panels developed by Italcementi its TX active technology captures air pollution when the envelope material comes into contact with light which it then transforms into insert salts reducing smog levels in the environment each exterior panel of palazzo Italia produced with style comp technology is unique and the building itself is net-zero energy which means thanks to the design team's extensive use of photovoltaic glass and photocatalytic concrete cladding the structure is capable of covering its energy needs autonomously.

So, you can see how the interestingly, how innovatively the technology is used over here first of all to go for the net energy building concept and second to reduce the pollution from the air of the atmosphere. So, this is one of the beautiful examples which I came across to share with you guys how we can put to use several interesting, innovative exercise innovative materials, innovative techniques you know innovative processes to improve all the overall sustainability factor.

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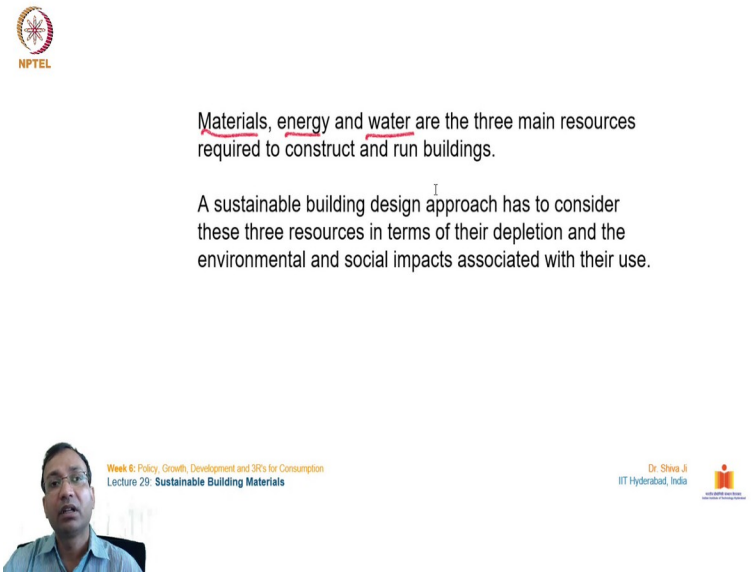

So, if you see over here the major three resources which are required for any building construction is the materials of course energy and water. So, these are the three major resources which we need our sustainable building design approach has to consider these three resources in terms of their depletion and the environmental and social impacts associated with their use. So, we have to take care of these because of these three are very crucial and all of these three like if you see the volume of it. So, they were being the related from the buildings being tilted from the built environment which consumes the largest energy from among all the sectors across the world. So, this is one of the highly potent areas where any sort of intervention is welcome to save either of these three important resources of materials energy and water.

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So, what are the environmental impacts of material use if you see during the past 30 years and increase understanding of materials and their characteristics have brought to light other less obvious impacts associated with materials which affect people and environments well beyond the building envelope.

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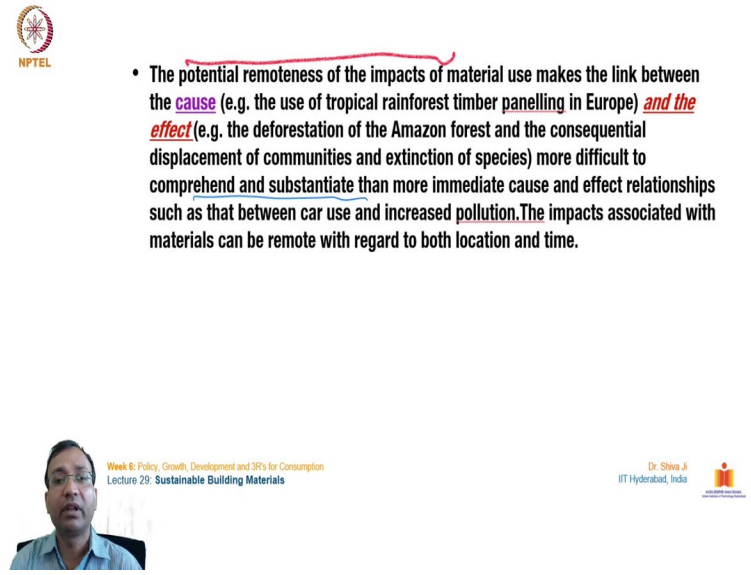

So, the potential remoteness of the impacts of the material use makes the link between the cause and the effect. So, when we talk about house such big impact actually coming in the recent times well there is this cause-and-effect method in place which is working to create imbalances. So, by

the human intervention by the human misadventures in the ecology to destroy forest, to destroy the pure state of water streams rivers, lakes and pollute the airs.

So, these are occurring into other catastrophic events such as drains you know increased temperature wildfires and there are several questions you are already aware of for example if you see over here the use of tropical rainforest timber paneling in the Europe may result into some kind of catastrophic event happening in somewhere else some other country.

So, you may be aware of this butterfly effect. So, the butterfly effect emphasizes the uncertainty and the probability the uncertain probability of catastrophic events which may occur even from slightest of change in the ecological balance. So, this puts up important emphasis over here to control the causes. So, that the effects can be reduced. So, the bad effects can be taken care of.

So, like amazing is failing facing a deforestation in the recent times and there are consequential not just environmental impacts but there are impacts on the society also the people who used to live on these forests who people who used to survive with the help of these forests traditionally they have been living there for hundreds and thousands of years now they are forced to move our or they are forced to take up some other sorts of occupation practices and their livelihood.

So, this is not just the environmental impact such kind of activities had other social as well as economical impacts for the overall well-being of this planet. So, it is very difficult to comprehend and substantiate then more immediate cause and effective relationships such as between car use and the increased pollution. So, well there are some direct cause and effect things also it is mentioned over here, car which emits poisonous and toxic gasses but there are some other subtle and hidden cause and effects phenomena which we are observing we have just explained now this butterfly effect excetra.

So, these are the ones which have very uncertain kind of Lego catastrophic resultants over a long period of time the impacts associated with materials can be remote with regard to both location and time they can happen anywhere. So, for example if there is lot of mining of some metal or some material at one place may result into imbalance in the water level, imbalance in the biodiversity of that area and may result into some kind of other unnatural activity somewhere else. So, that uncertainty is always over there.

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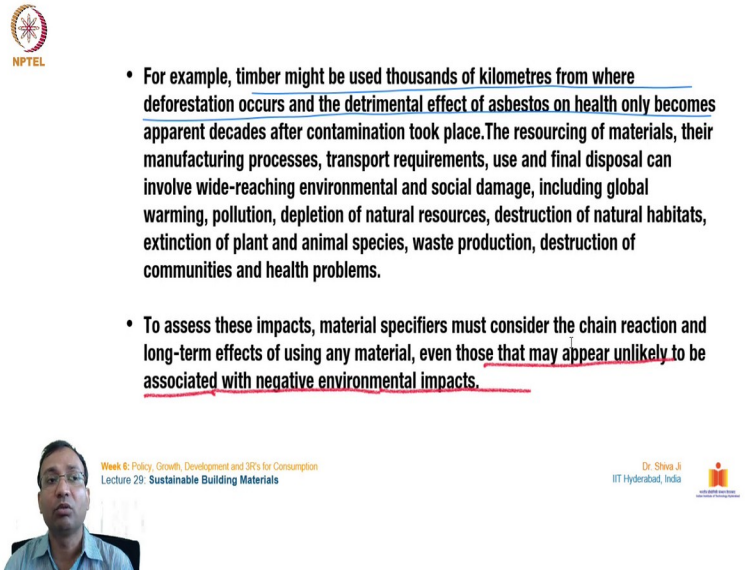

There are some examples of the timber might be used thousands of kilometers from where the deforestation occurs and then the detrimental effect of asbestos on health only becomes apparent decades of the contamination takes place. So, we are all aware of asbestos and some other types of materials which are conventionally have been part of the construction sector they are found to be one of the carcinogens. So, and their impact one feels after longer period of time and that impact becomes irreversible and quite damaging.

So, each and every material needs to be studied properly and should be understood to have lesser impacts then only should be approved for usage in the design and construction sector and resourcing of the materials their manufacturing processes transport requirements use and final disposition can involve wide reaching environmental and social damage including global warming which is very-very obvious and universal pollution depletion of natural resources destruction of natural habitat extinction of plant and animal species waste production destruction of communities and health problems.

So, these all of the in the recent years all of these have coming to true coming to the places around us whether from wherever we belong to whichever state, whichever country these kind of impacts are touching on each one's life in some way or the other to assess these impacts material specificities must consider the chain reaction and long-term effects of using any material even those that may appear unlikely to be associated with negative environmental impact. So, it is

very important to understand the life cycle analysis of such material which we are using in our industry.

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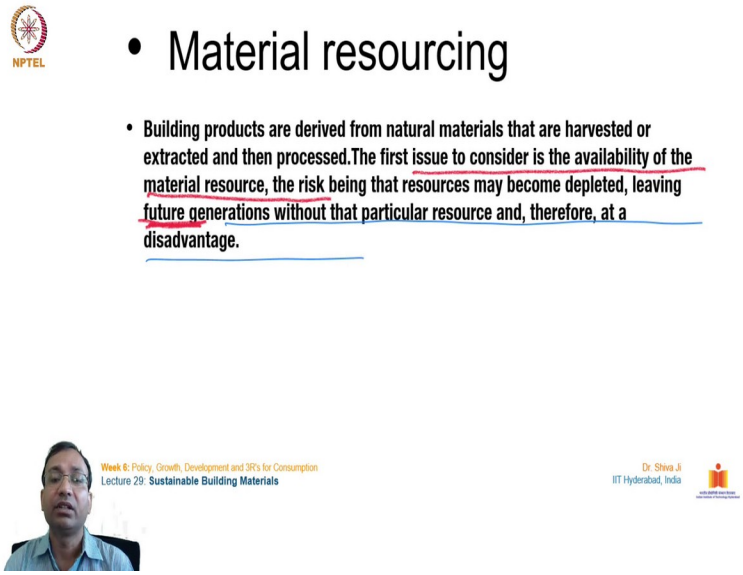

So, material resourcing about this building products are derived from natural materials and that are harvester or extracted and then processed. So, the moment processing the moment this manufacturing gets involved factory-based manufacturing the products these resources they come to possess different kind of our properties also which may affect our life and health and the health of the ecosystem in multiple ways.

So, the first issue to consider is the availability of the material resource the risk being that resources may become depleted this is very obvious fact and leaving future generation without that particular resource and therefore at a disadvantage several such resources are. So, fast harvester they are being extracted from the nature that is speculated that some resources may go completely exhausted from the face of the planet.

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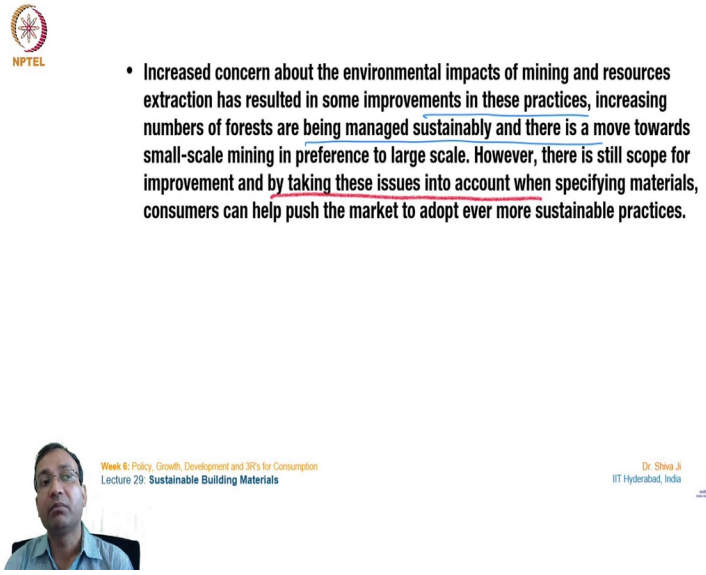

Increased concern about the environmental impacts of mining and resources extraction has resulted in some improvements in these practices increasing number of forests are being managed sustainably and there is move towards small scale mining in preference to large scale however there is still scope for improvement and by taking these issues into account when specifying materials, consumers can help push the market to adopt ever more sustainable practices. So, this awareness very important to spread between the manufacturers, miners, consumers every stakeholder.

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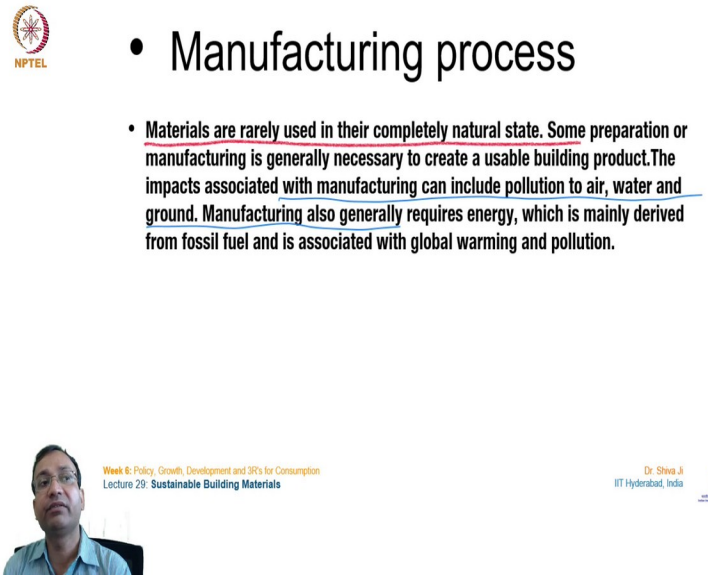

Well what sorts of manufacturing processes we can go for well materials are rarely used in their completely natural state this is what we have seen, this is where all of this new age these manufacturing and fabrication and industrialized way of treating materials has come into the picture some preparation or manufacturing is generally necessary to create a usable brilliant building product.

The impacts associated with manufacturing can include pollution to air, water and ground and so on manufacturing also generally requires energy, which is mainly derived from fossil fuel and is associated with global warming and pollution. So, we can see at any stage of products life cycle there are impacts of some way or the other and in two days' time that the point is highlighted over here in the first line if you see we are not using the materials in there almost natural or near to natural state we are processing them we are turning them into some other type of final product and then we are using and this process itself has become quite detrimental to the ecological balance.

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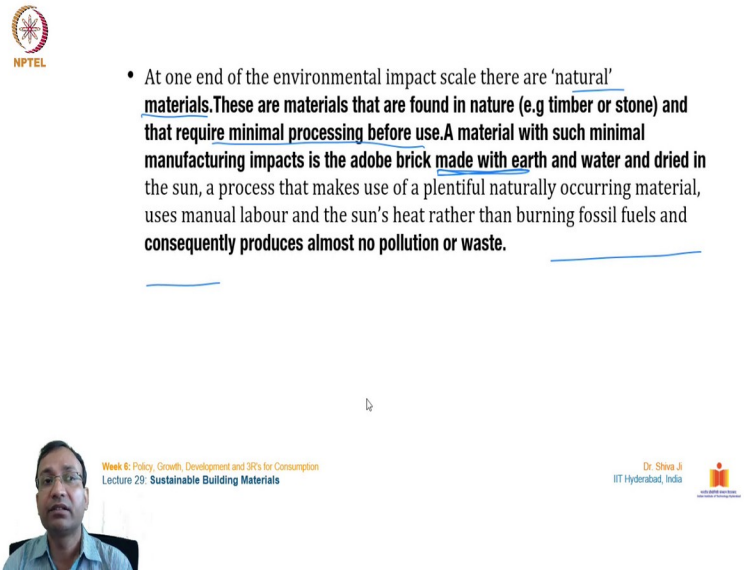

At one end of the environmental impact scale there are natural materials, these are materials that are found in nature example timber or stone and that require minimal processing before use. A material with such minimal manufacturing impacts is the adobe brick made with earth and water and dried in the sun, a process that makes use of a plentiful naturally occurring material, uses

manual labor and the sun's heat rather than burning fossil fuels and consequently produces almost no pollution or waste.

So, we have seen adobe houses. So, adobe houses are the best example of utilizing natural resources without processing them. So, whatever processes are actually adopted those are also very natural. So, the adobe material is taken then it is purified, then it is laid into molds, then it is sun dried, then it is put together with the mud itself and are dried in the sun only. So, it does not use any external or artificial energy it does not utilizes any industrial processing. So, this is one of the best examples of going with the purity of the material which is abundantly available in the nature.

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Well for sustainable material selection there could be some criteria and some strategies minimizing the first of all the need of the material. So, that we can get rid of the processing and every year other consequences which may arise later on. So, building only when it is really necessary building small not very big because with the bigger volume of the building bigger size of the building a huge amount of volume of the material will also be utilized designing for effective use of the materials designed for durability and for reduced maintenance.

Secondly, we can go for this grouping of using existing materials. So, that we can increase the longevity, we can reduce the production of the new material if the old material is good enough to be used in the place of the new materials itself. So, we can go for the reusing the existing

materials we can go for the reusing existing building components we can use recycled materials. So, these are some approaches, some strategies through which we can take up our design exercises there are some other strategies also through which we can design our building such as designed to enable future buildings and materials reuse and recycling.

So, the designing itself should happen in such a way. So, at the end of the life cycle stage the building and its components can go for reusing and recyclability easily they do not should pose complexity, dismantling or taking the components out designed for flexibility and desirability to maximize the building life. So, there should be flexibility given in the building in the design of the building.

So, that it can be used with the multi-purpose application and the adaptation of that building should be kept of flexible. So, that it can be used for a longer period of time and can turn give its return in terms of usability increased, usability design for durability. So, that it can sustain for longer period of time it can keep serving for longer period of time and designing for desirability of course it should be appealing, it should be usable for the user a designing for recycling and to enable biodegrading of the material.

So, the material also should be taken care of in such a way. So, that they can go for the recycling and if not they should be able to degrade on their own naturally without intervention from the several agencies without for the need of again further extension at the end of their life cycle stage.

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Well, there could be some thought processes given for material selection why specifying renewable material with the short generation cycle, regeneration cycles specifying timber from managed and accredited sources only for example like FSC accreditation. Manage forest systems and all the countries of like Canada and New Zealand have this kind of mechanism in place right now. So, we can learn from these places and we can evolve similar practices in our own country as well, we can specify for plentiful resources and avoid scarce resources specifying materials mined, harvested or extracted with.

We can go for minimal impact on the local and global environment, we can go for specifying material associated with low manufacturing pollution specifying materials associated with low levels of CO 2 emissions or the life of the building considering their impact on saving running energy consider manufacturers environmental policies track records and reporting specify materials that do not pollute the indoor air select locally produced materials requiring minimal transport.

So, that we were talking about the other day about indirect emissions. So, indirect emissions for that transportation sector is one of the major contributions for the indirect emissions and one material should not be taken of very far away from the place of its manufacturing or fabrication in order to avoid indirect emissions.

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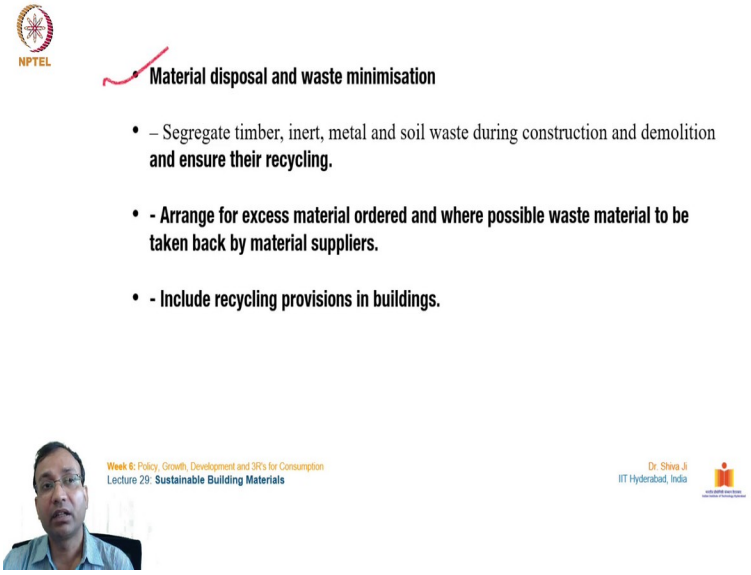

So, this is what is talking about over in this particular slide material disposal and waste minimization. So, about this thought if we see segregating the components of the building and converting them into inert materials. So, that they can go with any other component any other material also. So, segregating timber, inert, metal and soil waste during construction and demolition and ensure they are recycling arranging for excess materials ordered and where possible waste materials to be taken back by the material suppliers including recycling provisions in the building.

So, if you see this second point it talks about creating mechanism where the surplus material where the waste if it can be taken by the supplier from manufacturing agency. So, that they can take it into their raw material and they can again make it illegal and convert them it into usable product. So, this we saw yesterday in the previous one of the previous lectures where that carpet manufacturing company was usually utilizing the 100 percent of its material and for reuse and for recycling and they are working for creating almost nil waste from their manufacturing facility. So, this kind of efforts are loadable and these are the critical strategies which are required in today's context.

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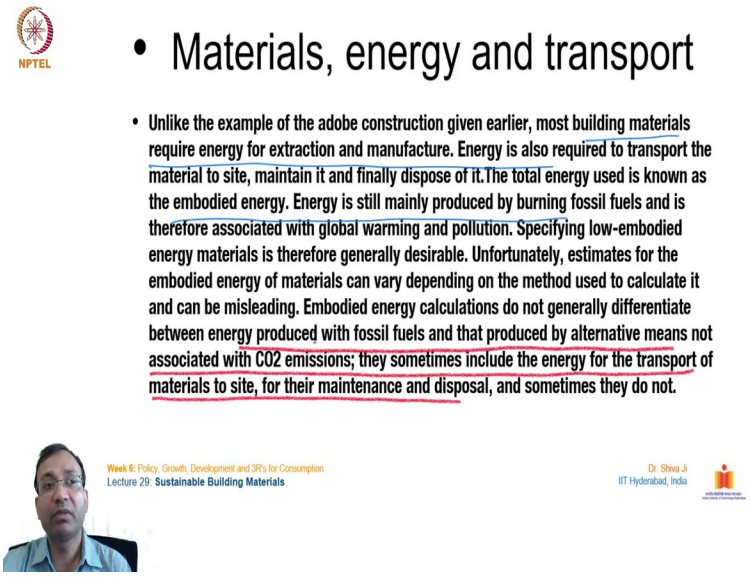

So, material energy and transport on this thing if you see there are some concerns on these factors also. So, unlike the example of adobe construction given earlier most building materials require energy for extinction and manufacturing energy is also required for transporting material to the site maintaining it finally disposing of it the total energy used is known as the embodied energy you have already known this fact embodied energy is the energy which is required for sourcing, for manufacturing transporting and finishing that product.

So, that all of these stages if you combine. So, the energy required at all of these stages combined in combined manner is called as the embodied energy. So, by reducing energy like expenses on each of these stages we can overall in the sense we can reduce the embodied energy of any product.

So, the total energy used is not the number of energy is still mainly produced by burning fossil fuels and is therefore associated with global warming and pollution specifying low embodied energy materials is therefore generally desirable unfortunately estimates for the embodied energy of materials can vary depending upon the method used to calculate it and can be misleading modern energy calculations do not generally differentiate between energy produced with the fossil fuels and that produced by alternative means not associated with CO 2 emissions they sometimes include the energy for the transport of material to site for their maintenance and disposal and sometimes they do not well.

So, we have to be cautious while calculating embodied energy this is what being talked about over here does not considers whether the energy used in this by manufacturing of this product whether it was source from non-renewable sources or renewable resources or whether it has included some energy which was used while transporting it back for the recycling knowledge.

So, these are minor details which they can take care of but it requires attention case to case basis but in an overall sense energy is energy and whether it is coming from like non-renewable resource or a renewable resource as long as it is consumed by that particular product and its manufacturing it constitutes it gets added in the embodied energy of that product.

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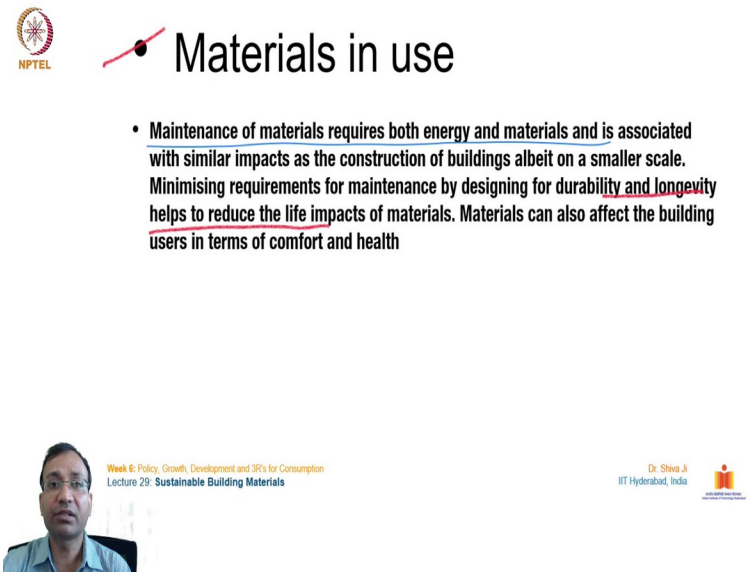

About material in use maintenance of materials requires both energy and materials and is associated with similar impacts as the construction of buildings albeit on a smaller scale. Minimizing requirements for maintenance by designing for durability and longevity helps to reduce the life impacts of materials. Materials can also affect the building users in terms of comfort and health.

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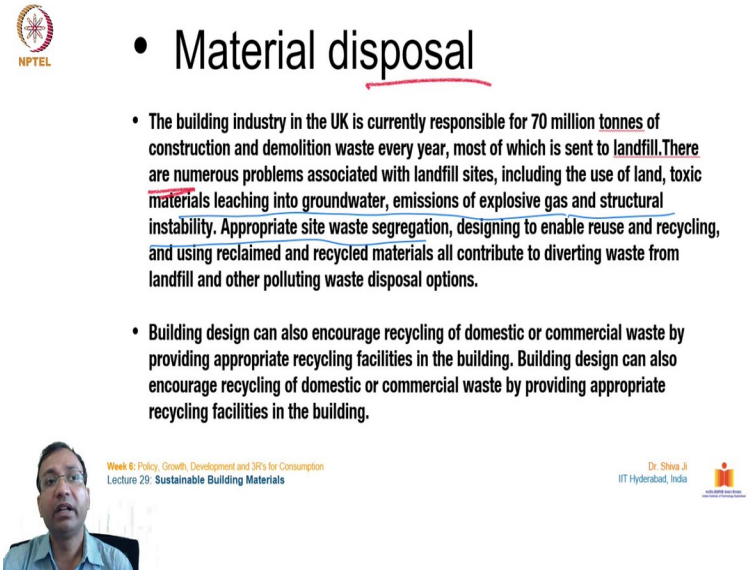

Material about materials disposal the building industry in the UK is currently responsible for 70 million tons of construction and demolition waste every year, most of which is sent to landfill. There are numerous problems associated with landfill sites, including the use of land, toxic materials leaching into groundwater, emissions of explosive gases sometimes emission explosions also happen on these locations and structural instability of course.

Appropriate site waste segregation, designing to enable reuse and recycling and using reclaimed and recycled materials all contribute to diverting waste from landfill and other polluting waste disposal options. Building design can also encourage recycling of domestic or commercial waste by providing appropriate recycling facilities in the building itself.

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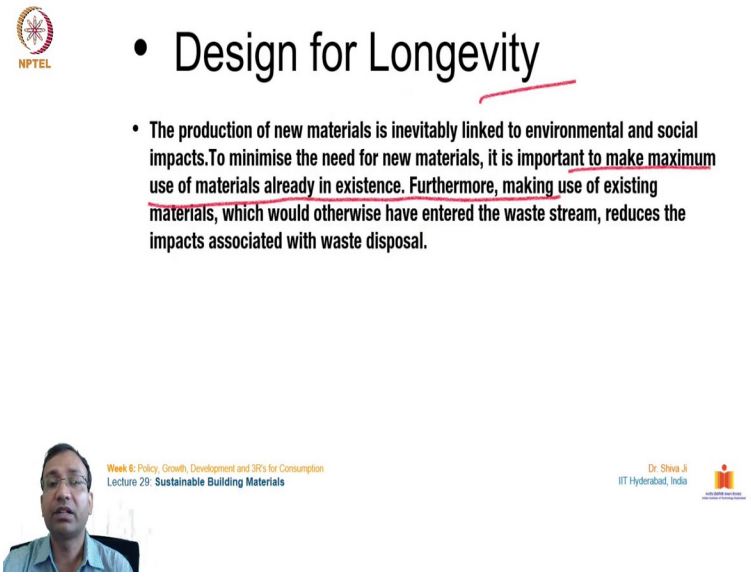

Well, another strategy over here is for design for longevity. Well, what is longevity, longevity means if we can expand life's span of any product. So, if you are expanding the life span of any product for example twice. So, that directly means we are saving at least production of another unit of that same material by extending the life span of the first material in its place.

So, by using the material for our twice office life span we can at least save on the one unit of that material is simple as that. So, the production of new materials is inevitably linked to environmental and social impacts. To minimize the need for new materials, it is important to make maximum use of materials already in existence. Furthermore, making use of existing materials, which would otherwise have entered the waste stream, reduces the impacts associated with waste disposal. So, there are only benefits there is no harm of using this strategy design of longevity.

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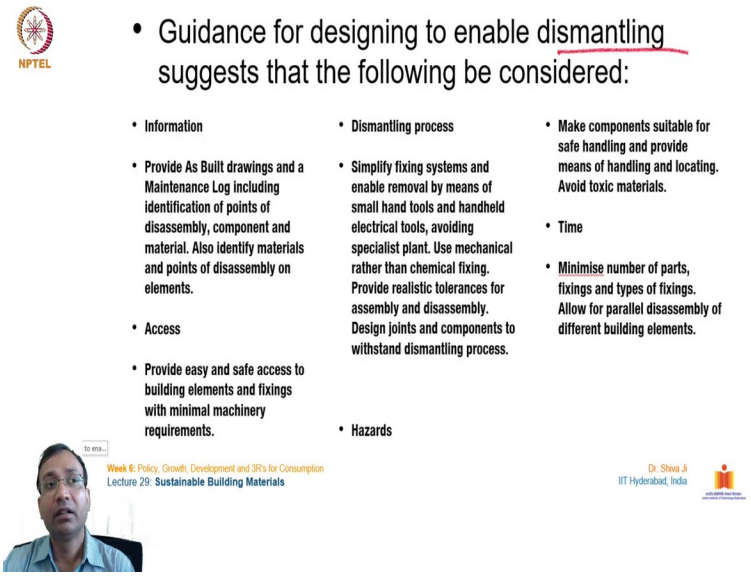

Further, some guidance for designing to enable dismantling. So, this is also one of the very important stages where once the product life cycle is over for any product. So, it goes for some sort of dismantling, some sort of degradation, decomposition or some kind of disposal. So, at that time the material or that component should be able to be get disassemble properly. So, that it can be disposed of the different materials can be disposed of in a responsible way. So, for example some things which are necessary to be aware of at the beginning only information.

So, providing as built drawings and a maintenance log including identification a point apply disassembly, components and material also identify materials and points of disassembly on elements. So, how that product, how the components of that product are going to be disassembled. So, this information should be given beforehand for the dismantling about access provide easy and safe access to building elements and fixings with minimal machinery requirements.

So, that they can be carried out without much hindrance dismantling process, simplify fixing systems enabling removal by means of small hand tools and handheld electrical tools, avoiding specialist plant, use mechanical rather than chemical fixing provide realistic tolerances for assembly and disassembly, designing joints and components to withstand dismantling process.

Further coming down to the hazard because one of the after effects of this dismantling and disposal stage. So, how does the hazards can be reduced at this stage. So, make components

suitable for safe handling and provide means of handling and locating avoid toxic materials also because this could be harmful for the people who are involved this work. For time factor minimizing the number of parts, fixings and types of fixings, allow for parallel disassembly of different building elements. So, that there is flexibility in terms of another uses in terms of dismantling in terms of recycling excetra.

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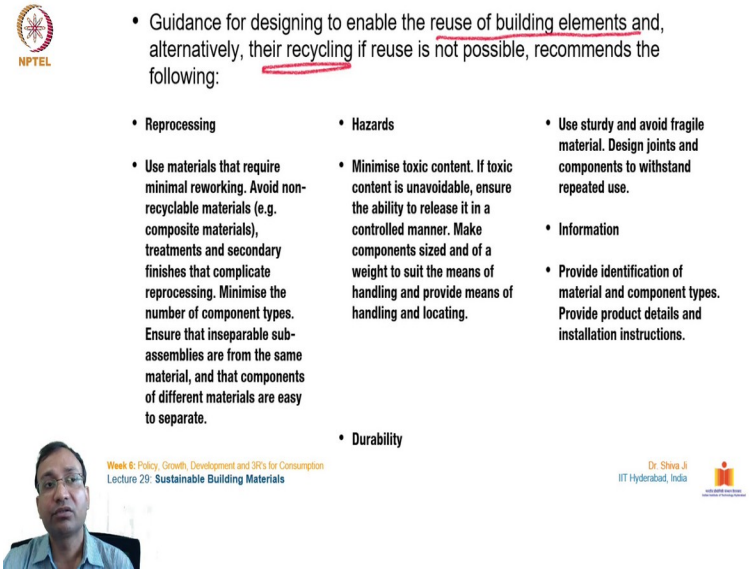

Finally, guidance for designing to enable the reuse of building elements and alternatively their recycling if reuse is not possible recommends these are following points. For example, reprocessing. So, use materials that require minimal reworking, avoid non-recyclable materials such as composite materials they are very difficult to get recycled treatments and secondary finishes that complicate reprocessing services such as powder coating such as lamination. So, these are appealing and aesthetical treatments and finishing for several types of products but in turn they end up complicating that product for it is disassembly and recycling.

So, minimize number of component types ensure that inseparable sub-assemblies are from the same material, and that components of different materials are easy to separate. For hazards, minimize toxic content if toxic content is unavoidable ensure the ability to release it in a controlled manner make components sized and of a weight to suit the means of handling and provide means of handling and provide means of handling and locating it.

About durability use sturdy and avoid fragile materials. Design joints and components to withstand repeated use. So, that there is no wear and tear. So, often and one can see on the maintenance and operations part of the life stage of that product. About information, provide identification of material and component types provide product details and installation instructions. So, the information has to be complete from end to end to enable as a successful and unhindered operation as well as a successful and complete recycling and disposal of the building material.

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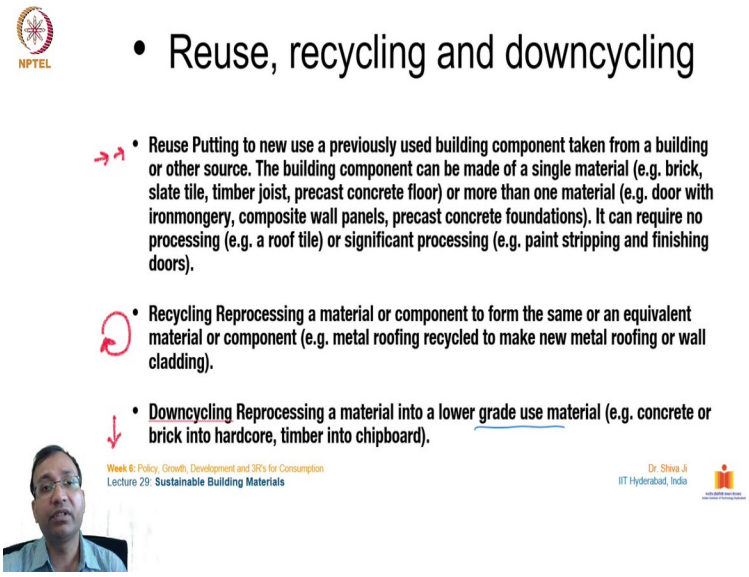

So, that is intent of this lecture over here. So, we can talk about final some approaches to a dispose of these materials into by utilizing reusing them by recycling them or even down cycling them. So, reuse putting to new use a previously used building component taken from a building or other source, the building component can be made of a single material such as brick, slate tile, timber joist, precast concrete floor excetra are more than one material such as door with ironmongery, composite wall panels, precast foundations. So, it can require no processing or for example roof tile also or significant processing like paint stripping and finishing doors excetra.

Second, recycling. So, reprocessing a material or component to form the same or an equivalent material or component such as metal roofing recycled to make new metal roofing or wall cladding excetra. So, they can go for recycling or reusing them then lastly down cycling

reprocessing a material into a lower grade use material such as concrete or brick into hardcore timber or timber into chipboard.

So, these materials can be actually down cycled it can be become inferior but still can be used into some other sorts of usages and applications. So, that is the down cycle. So, these are strategies which are very important as far as sustainable building construction materials are concerns and that is why we have discussed over here and with this I would like to come to end of this lecture. Thank you all.