Strategies for Sustainable Design
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Lecture 26
National Building Code 2016 - Part 11 and Energy Conservation Building Code

Hello everyone, in this lecture we will discuss about National Building Code 2016, Part 11 and Energy Conservation Building Code.

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So, this you may be already aware of National Building Code of India. So, a recent edition was launched by Bureau of Indian Standards BIS in two volumes in year 2016.

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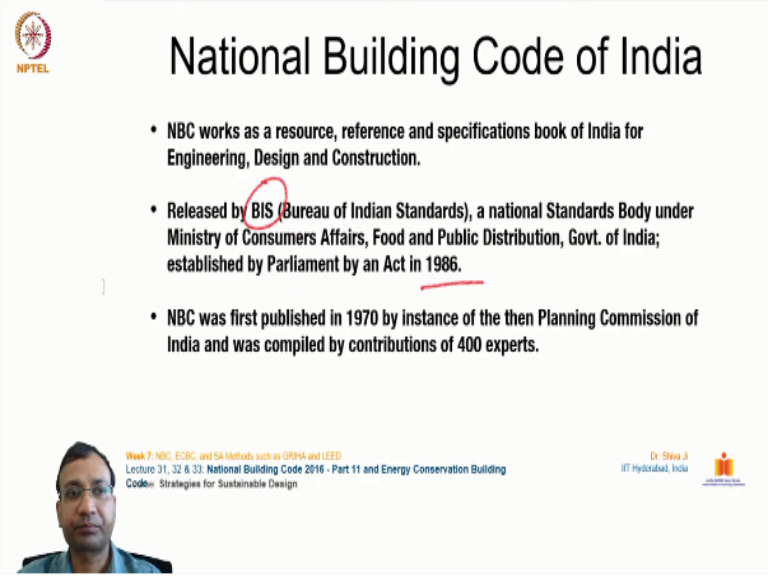

So National Building Code of India it works as a resource reference and a specification book of India for Engineering, Design and Construction, it is released by BIS Bureau of Indian Standards, a national Standards Body under Ministry of Consumer Affairs, Food and Public Distribution, Government of India. This was established by a parliament by an act in 1986. NBC was first published in 1970 by instance of the then Planning Commission of India and was compiled by contributions of over 400 experts.

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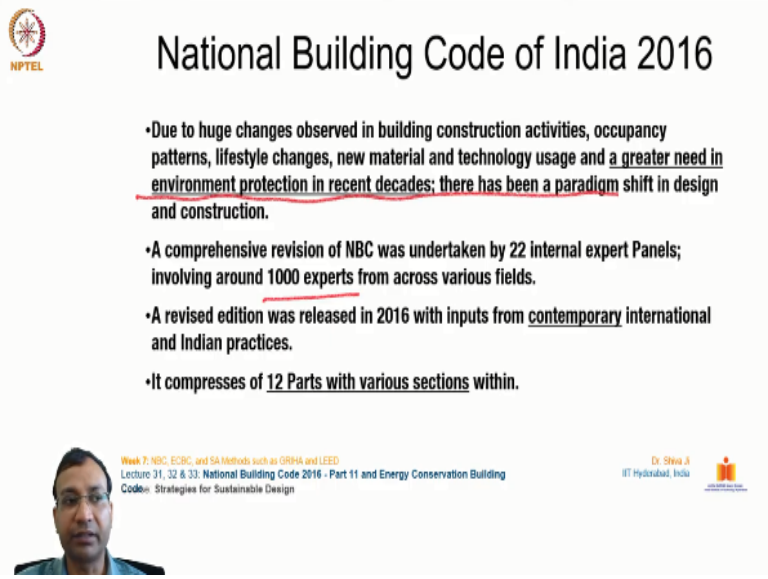

National Building Code of India 2016. Well in the recent times there is a huge change in the growth and development and there is a huge push observed in this sector and the growth is happening very fast. So how this growth can be maintained at a pace which corresponds to the aspects of sustainability? Well, with that need actually this new edition was launched with an additional chapter of additional actually part of part 11, you know which talks about approaches to sustainability.

So due to huge changes observed in building construction activity, occupancy patterns, lifestyle changes, new material and technology uses and a greater need in environment production in the recent decades, there has been a paradigm shift in design and construction.

A comprehensive revision of NBC was undertaken by 22 internal expert panels involving around 1000 experts from across various fields. A revised edition was released in 2016 with inputs from contemporary international and Indian practices. It comprises of 12 parts with various sections within.

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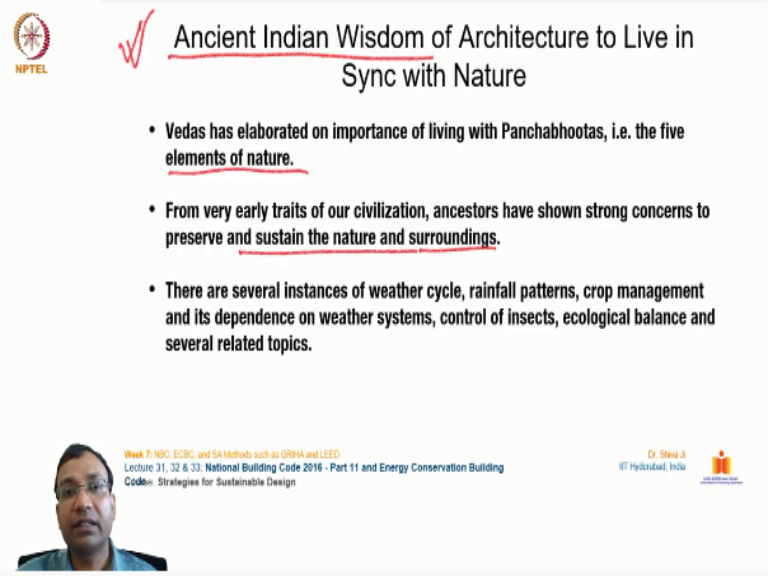

So, how this NBC works? So, there is a wisdom which is taken from the ancient Indian text, which goes like this, so I will elaborate over here, Ancient Indian wisdom of architecture to live in the sync with nature. Well, we have been discussing it like several

times, like how the ancient cultures across the world they have been surviving for like thousands of years without causing any damages to the nature and other like species, other living beings.

The same was actually forward in India also like how our forefathers and ancestor have lived on these lands for a very long time. So is there anything to learn from that, let us have a look at it. Vedas have elaborated on importance of living with *Panchabhootas*, that is five elements of nature.

From very early traits of our civilization ancestor have shown strong concerns to preserve and sustain the nature and surroundings. There are several instances of weather cycle, rainfall patterns, crop management and its dependence on weather system, control of insects, ecological balance and several related topics.

So such actually topics are discussed in these ancient scriptures, scriptures about like annual cycles of climate and weather, how crop cycles are actually arranged accordingly with the cycle of the solar system and well like a movement of earth around the sun, even the control of the insects, ecological like maintaining the balance, even growing crops which could be healthier for a human body in specific months which utilizes actually like a paddy is sown in the months of monsoon, so that it gets ample rainfall and rain water, as the need for the rain, these paddy crop is to consume lot of water and accordingly we can see such actually cycles are actually designed.

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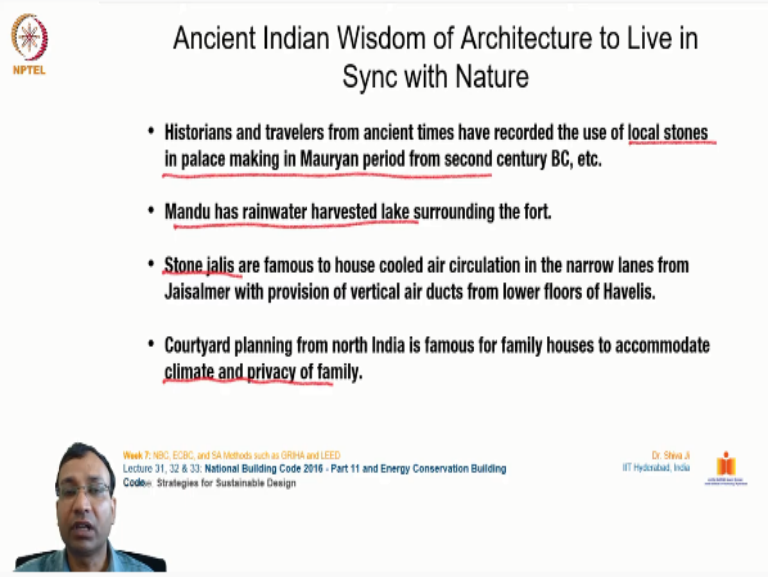

Well historians and travelers from ancient times have recorded the use of local stones in palace making in Mauryan period from second century BC etcetera. Mandu has rain water harvested lakes surrounding the fort, we have seen the pictures of the palaces and forts of Mandu, one of the amazing pieces of architecture from those times. Stone jalis are famous to house cooled air circulation in the narrow lanes from Jaisalmer with provision of vertical air ducts from lower floors of Havelis.

So we have seen these like a wind towers where they used to intake of like a outside air, cool it down while passing through that tunnel and then it emerges within the internal quarters of the Haveli of those houses with the touch of those thick walls and even sometimes like a water bodies, water actually kept flowing inside these palaces. Courtyard planning from north India is famous for family house to accommodate climate and privacy or family.

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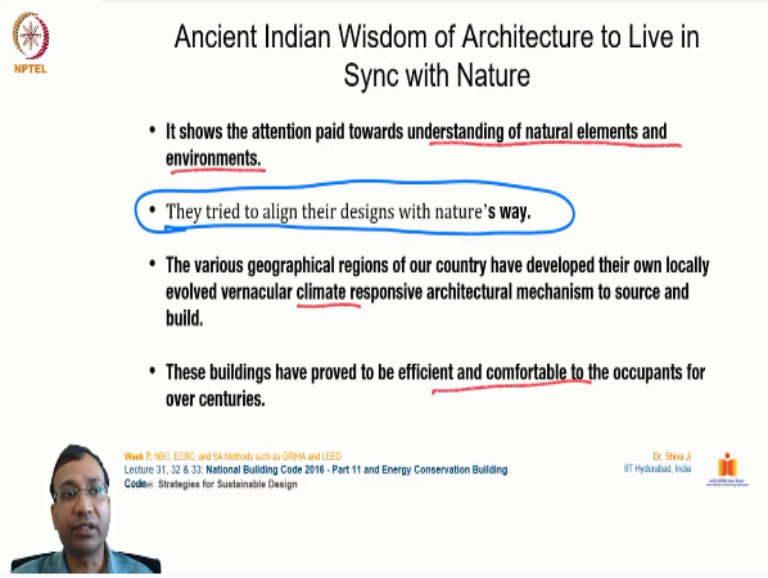

So, it shows the attention was paid towards understanding of natural elements and environments. They tried to align their designs with the nature's way. Well, this is the one just in a nutshell we can say that the ancestors, the forefathers they have actually tried to align their designs with the nature's way.

The various geographical regions of our country have developed their own locally evolved vernacular climate responsive architectural mechanisms to source and build. These buildings have proved to be efficient and comfortable to the occupants for over several centuries.

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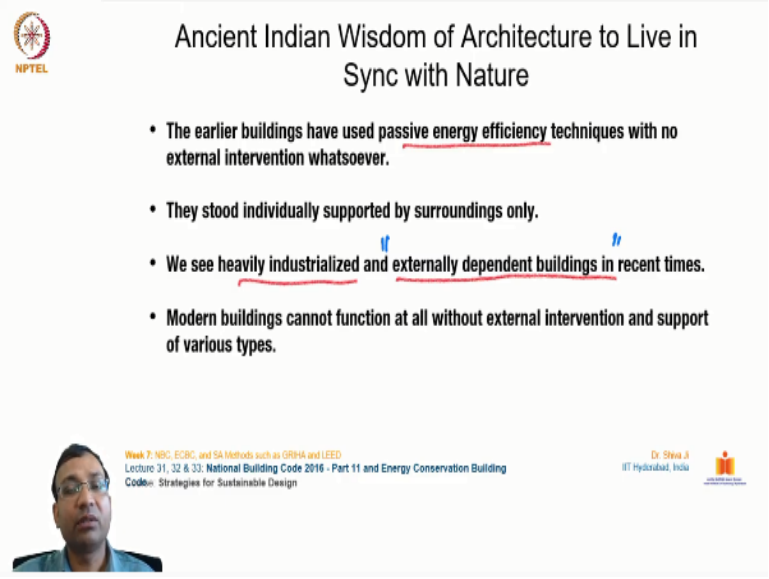

The earlier buildings have used passive energy efficiency techniques with no external intervention whatsoever. They stood individually supported by surroundings only. We see like a heavily industrialized and externally dependent buildings in the recent times, like the buildings which are being erected these days, we have been reiterating it like several times in our previous lectures, we are sourcing materials from across the country in some cases from different parts of the world also. Well, there are several repercussions of it like in the form of indirect emissions, indirect energy consumption and several other like ways.

But in the ancient times the building were completely based on the local resources and local energy and local manpower, so they were not dependent, these buildings used to stand truly alone with the help of the surrounding, with the help of the climate they used to function very efficiently, providing a comfortable quarter inside them. Modern buildings cannot function at all without external intervention and support of various types, the moment we stop the supply of electricity our buildings are completely going to fail to function isn't it the scenario.

Well why to make such buildings which are completely or entirely dependent on external services and inputs. So, this is the motto over here to discuss, why to have such buildings which are externally dependent, why not to make them sustainable, make them stand alone on their own, if they need power why cannot they generate power on their own, if they need other resources why cannot they use the resources from the vicinity only, so that is the concept.

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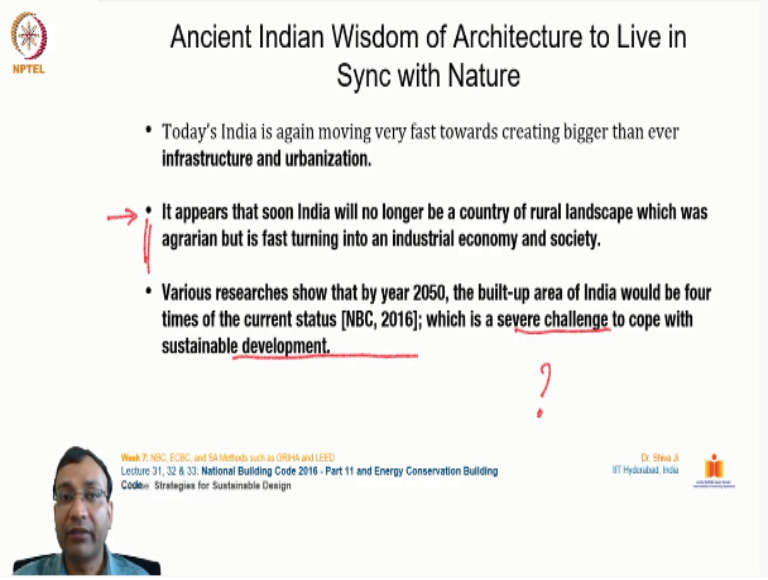

Today's India is again moving very fast towards creating a bigger than ever infrastructure and urbanization. Well, we are seeing and we are witnessing there are several schemes under implementation, they are at a various stage of their implementation and they are promoting a fast growth and development as far as infrastructure and this design and construction sector is concerned. It appears that soon India will no longer be a country of rural landscape which was agrarian but it's fast turning into an industrialized economy and society.

Various researchers have shown that by year 2050 the built-up area of India would be four times of the current status of year 2016, which is a severe challenge to cope with the sustainable development, whether India is going to behave responsibly in this fast based development.

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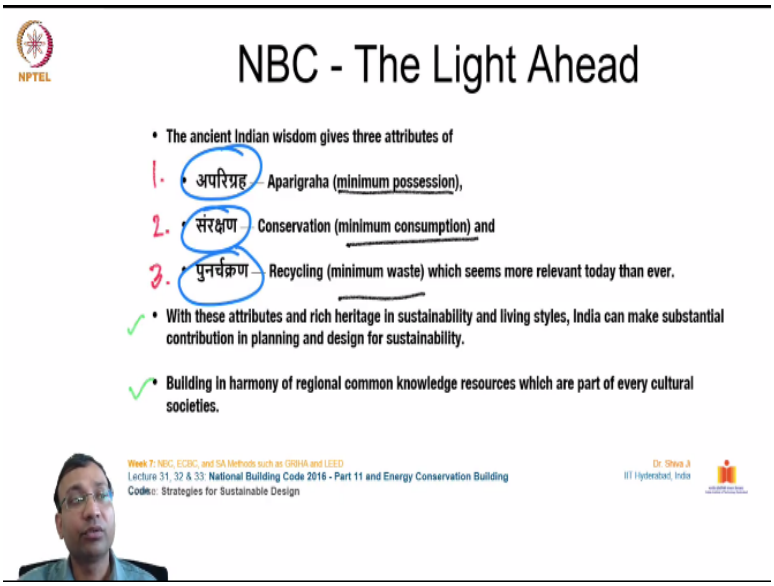

So let us see what is the light ahead, how India has been doing like traditionally from the ancient times. So we can see the Indian, ancient Indian wisdom gives us three important attributes, if we see it here the first one is *Aparigraha*, the second one is *Sanrakshan*, the third one *Punarchakran*. So the first one *Aparigrah* means minimum possession, that means minimum consumerism, minimum resource utilization, minimum resource, taking resources from the surrounding or from anywhere.

So minimizing the need, this is what we have been discussing in our previous lecture for as a strategy how to minimize the waste. So the waste is generated by the mindless consumption of products and artifacts, and even utilizing lots of services which are not that critical to meet needs.

So we have entered into an experiential economy where we have kind of fulfilled our basic needs and we are going beyond that, well that approach is generating a lot of waste, that approach is actually forcing our economy, our industries to produce a lot of stuff which is turning into landfills and the whole place is getting polluted. So, this concept, this wisdom is already given in our Indian text of *Aparigrah* that means minimum possession.

Second Conservation, that is conservation, like a minimum consumption, so consuming things in a very little quantity, as much as we need, so preserving the rest. So that means minimizing the consumption. First of all minimizing the possession, then minimizing the consumption. So, if we need something we take only that much, whatever is really needed, we should discard, we should not take at all the resource which is not actually needed by us.

The third one is *Punarchakran*, that is recycling, so that means generating very minimal waste, which seems more relevant than like ever, well traditionally I believe our forefathers they have done a wonderful, they have lived wonderfully but in the recent times we see how much of an impact, we as a community have made on our surroundings. So these are three concepts, these three wisdoms from the ancient texts are like more relevant than ever, going for like a minimum possession, minimum consumption and minimal waste.

With these three attributes and rich heritage and sustainability and living styles, India can make substantial contribution in planning and design for sustainability. Well this is the concept of sustainability, it seems it is not new for us, it is not something new science we are talking about here, we are just trying to… if we are able to even revive our ancient wisdoms that will be good enough, I think that is more than enough for what we are looking through these studies.

Buildings in harmony of regional common knowledge resources which are part of every cultural society. Well, this is also very important, we have been emphasizing on the need of vernacular techniques and designs, how vernacular is very important for the region because vernacular actually is a concept which evolves from the place which is rooted at that particular place, rooted with the culture, rooted with the climate geography, topography, demography. So that has a solution for any kind of requirements which may come up for the community which is a living at any given place.

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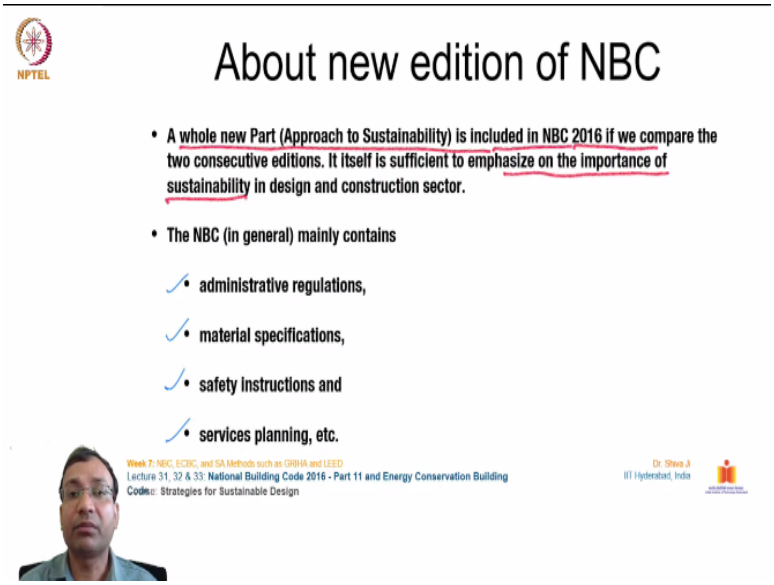

Further we see, so what are the new additions based on these philosophies which were carried out as a new part in the NBC 2016? So we have seen about the kind of challenges we are facing and the kind of strategies which are required to deal with them. So drawing from our contemporary, like case examples and studies in sustainability sciences and drawing from our ancient wisdom, the team has come up with some solutions, some recommendations for creating a new part in itself which is devoted to approaches to sustainability. So we will discuss about the new additions which have happened in the NBC.

A whole new part approach to sustainability is included in NBC 2016. If we compare the two consecutive editions it itself is sufficient to emphasize on the importance of sustainability in design and construction sector. Well, there is a whole thought process which has gone for a while for deciding to introduce this particular part in this NBC as a resource document.

So this document, this book works as a reference and resource book for the practitioners, educators, students, manufacturers, the builders every stakeholder who is anyhow related with this design and construction sector, must refers this book because this book is a constitutionally also in nature and is binding and one must follow the recommendation

and the guidelines given in this book, for any building services, for human comfort designing etcetera.

So NBC in general mainly contains administrative regulations, material specifications, safety instructions and service planning etcetera. So as you can see this is very, very evident that it advises, it lays down a road map, it lays down a layout as how to go for following regulations of a given places, as far as architectural or ergonomics or a human anthropometric data is considered, if it is like a related with the climate, then how to deal with that and if it is related with local administrative rules and regulations and bylaws, then how to go about it. So it lays down such regulations.

On the material specification part, how to use certain materials for a certain requirement in what quantities, what proportions, so that is also given in this book for reference and the safety instructions, while taking precaution, while the design and construction stays is very important, taking safety precautions of the workers who are employed on the site is very important. So those guidelines are also mentioned in this book and of course, the finally the service planning etcetera.

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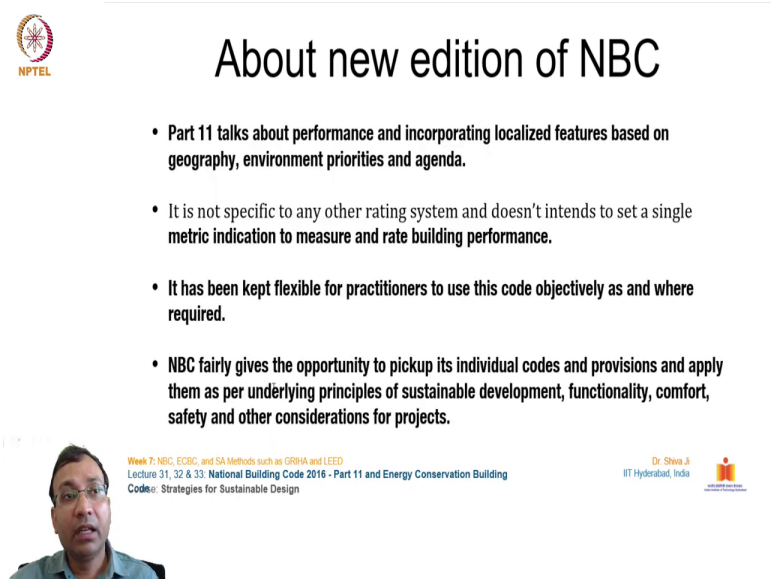

So about the new edition of NBC part 11 talks about performance and incorporating localized features based on based on geography, environment priorities and agenda. It is not specific to any other rating system and does not intend to set a single metric indication to measure and rate building performance. The provisions here are kept flexible for a practitioner to use this code objectively as and where like required, finally like NBC fairly gives the opportunity to pick up its individual codes and provisions and apply them as per underlying principles of sustainable development, functionality, comfort safety and other considerations for the project.

So as you can see this NBC as a overall document, it is a huge compilation of the considerations which could be necessary in any given situation on the construction site. So this provides an extensive and an exhaustive set of considerations and guidelines and regulations which may be required anywhere in any given situation. So a project depending upon its nature and application can choose a number of points which are relevant and necessary for it to follow.

So it is a resource book depending upon need and the provisions which are laid down here can be utilized. NBC is not a rating tool also, so that is why it does not evaluates a building on certain parameters, well that job is left for the rating tools for example, we have GRIHA, LEED etcetera.

So those are specific tools for evaluation but that is why actually NBC is different than any of those tools, those tools evaluate a building on one given parameter or two given parameters but NBC provides an extensive consideration which could be touching a building at any point of time while designing construction, operation and maintenance and human disposal. So that is how this NBC differs with any a rating tool.

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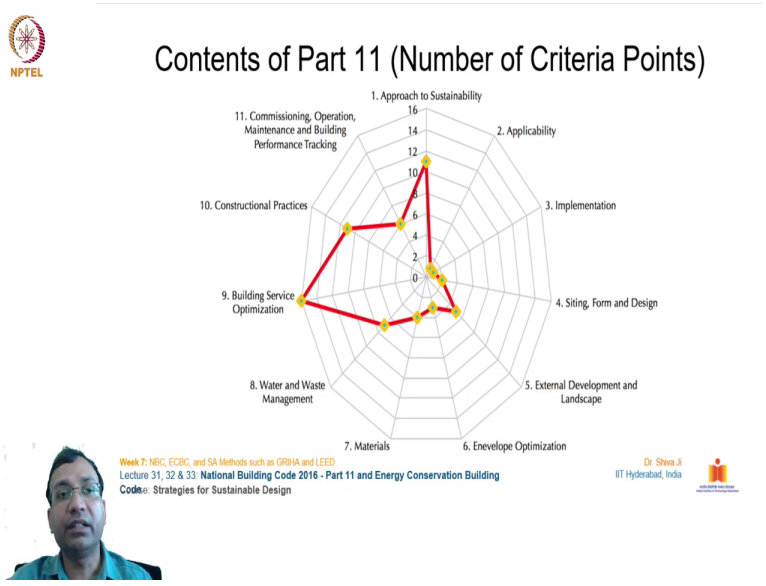

So for the content of part 11 you can see over here it is a diagram which shows the kind of attention, the criteria points given in under these considerations for their evaluation. So approach to sustainability has around 13 points and you can see on the building service optimization it has around 16 points. So this is just a diagram to show how much of a criteria points are distributed in each of these sections.

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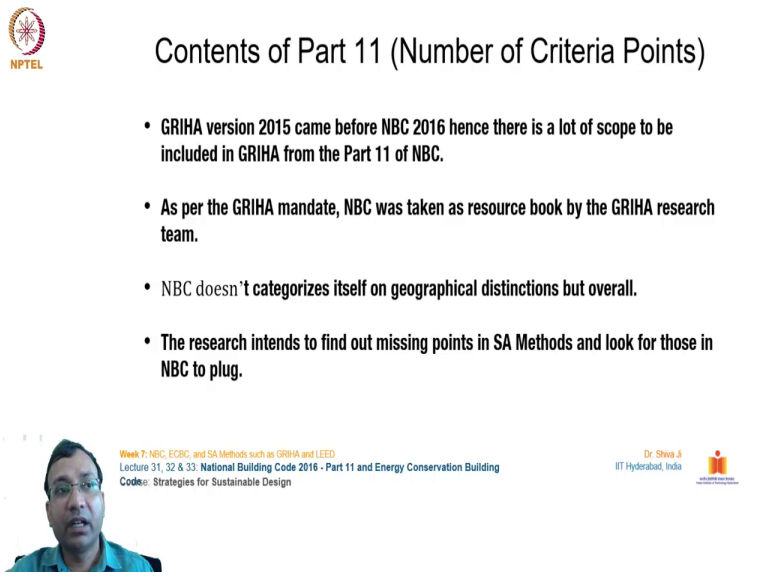

So, GRIHA version 2015 came before NBC 2016 hence there is a lot of scope to be included in GRIHA from part 11 of NBC. Well we know GRIHA is a rating a tool, utilizes NBC it utilizes ECBC for actually drawing considerations and evaluation parameters. So since this NBC has come up in year 2016, so they have released a new version of GRIHA in 2019 which utilizes this document. As per GRIHA mandate, NBC was taken as a resource book by GRIHA research team.

NBC does not recognize itself as a geographical distinction but on an overall sense. The research intends to find out missing points in SA method and look for those in the NBC to plug. So, from here we can find out which are those relevant points, which are those relevant criteria's which are needed for inclusion for fulfilling any certain objective. So for example, if you are framing sustainability assessment method such as GRIHA, LEED etcetera, then we can draw from this latest edition of NBC for appropriate criteria points.

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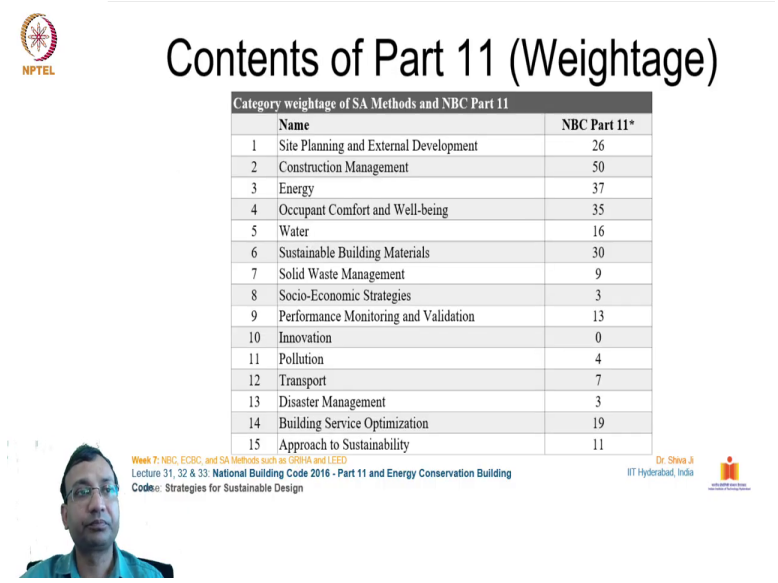

So distribution wise you can see how much of weightage is given in each of these sections.

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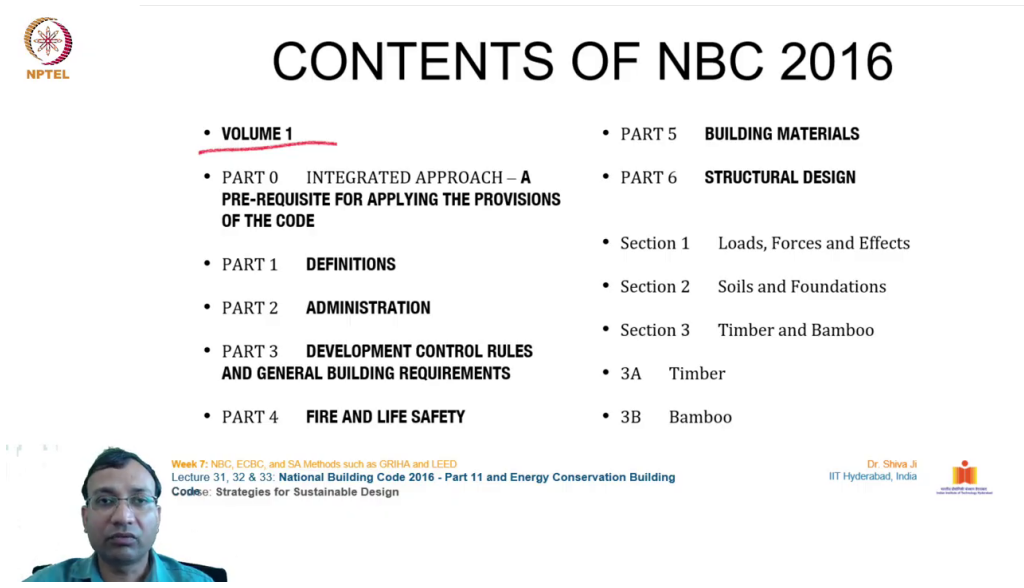

Further I would like to explain about these the contents of NBC 2016. So it has two volumes, in each volume there are a certain number of parts and within those parts there are sections and sub sections, depending upon the strength and depending upon the focus and the weight is needed in those parts.

So the part 0 talks about integrated approach, a prerequisite for applying the provisions of the code, then part 1 starts from here with the definitions, then part 2 talks about administration, part 3 talks about development controls, rules and general building requirements. Part 4 talks about fire and life safety, then part 5 talks about building materials, part 6 talks about structural design.

And under that part there are some sections and subsections, section 1 talks about loads, forces and effects, soils foundation, timber and bamboo.

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Then it has masonry, concrete then plain and reinforced concrete, pre-stressed concrete, steel, prefabrication and system building and mixed composite construction, prefabricated concrete, it has system building and mixed composite construction, it has glass and glazing details.

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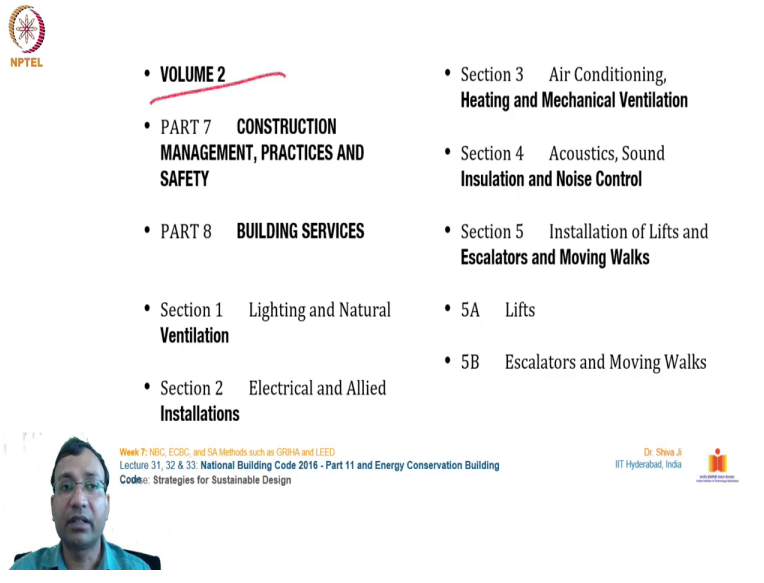

Although, so the that much was covered in the volume 1, volume 2 has a construction management, practices and safety, building services, lighting and natural ventilation, electrical and allied insulations, then it has air conditioning, heating and mechanical ventilation, acoustics, sound insulation and noise control, installation of lifts and escalators and moving walks, lifts, escalators and moving walks.

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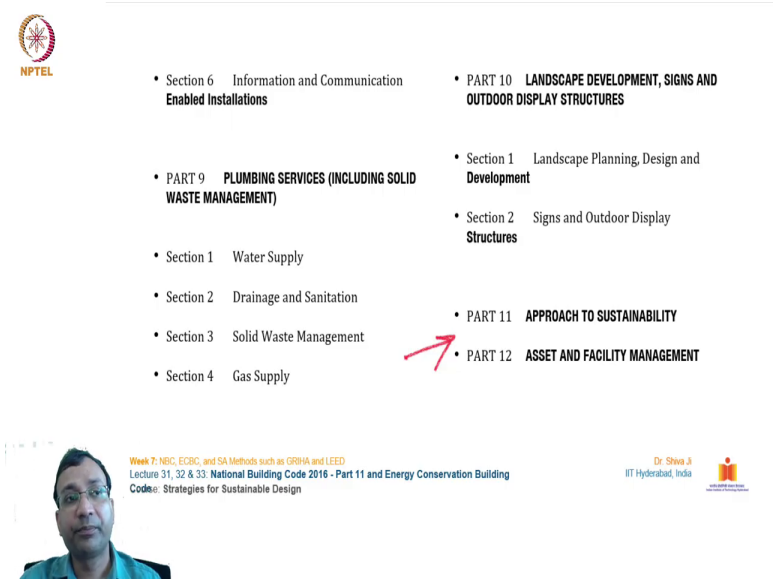

Then it has information and communication, enabled installation, plumbing services including like a solid waste management, water supply, drainage and sanitation, solid waste management, gas supply, it has a landscape development, signs and outdoor display structures, further inside that in the sections it has landscape planning, design and development, sign and outdoor display structures.

Finally, the part 11 comes which is approach to sustainability and the part 12 about asset and facility management, so these are contents of NBC where it has laid down elaborate descriptions and recommendations under these heads and sub heads.

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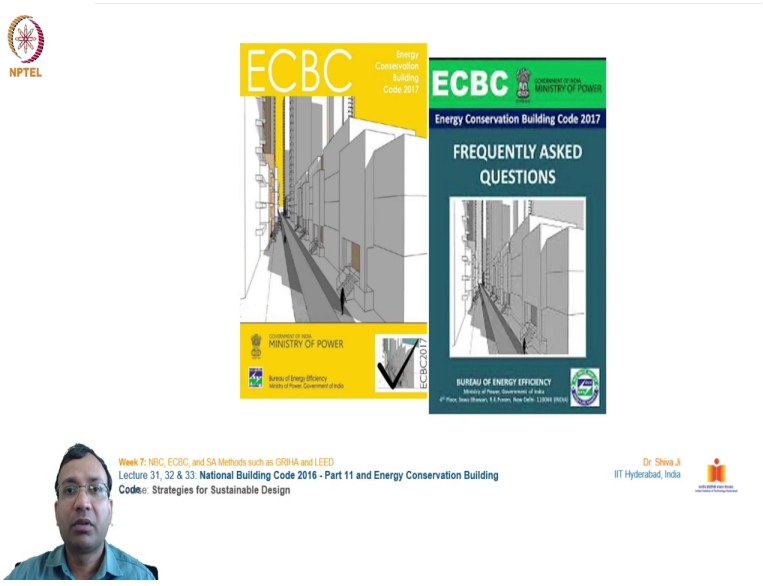

So, now we will discuss about energy conservation building code 2016.

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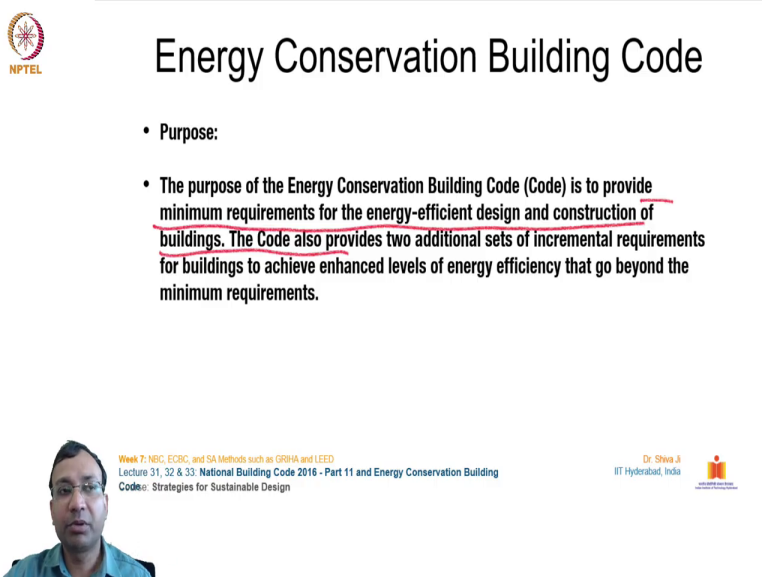

So if you see what is the purpose of this ECBC, Energy Conservation Building Codes, the purpose of the Energy Conservation Building Codes is to provide minimum requirements for the energy efficient design and construction of buildings. The code also provides two additional sets of incremental requirements for buildings to achieve enhanced levels of energy efficiency that go beyond the minimum requirements.

So we can see this gives us a minimum criteria, like how much of energy efficiency should be achieved in any given building, so it talks about the guidelines, it talks about the recommendation, it talks about the other evaluations parameters, so that this purpose can be achieved.

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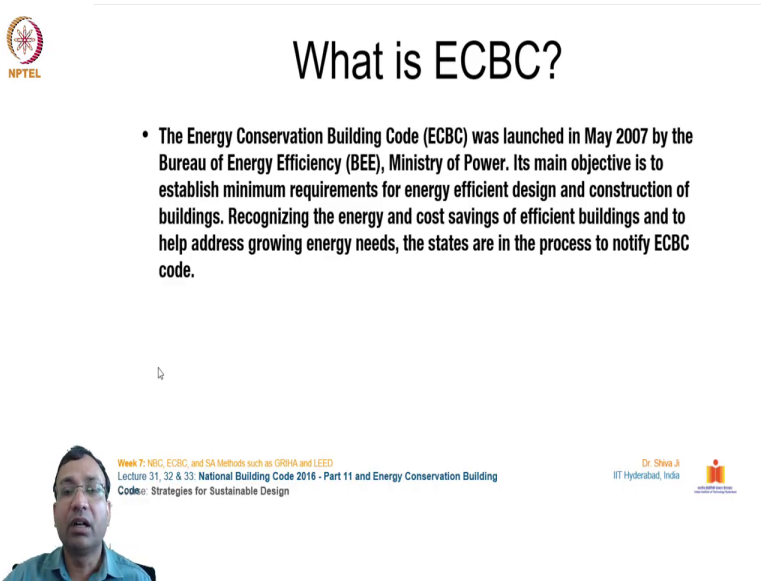

And what is ECBC? The Energy Conservation Building Code was launched in may 2007 by the Bureau of Energy Efficiency BEE, Ministry of Power, its main objective is to establish minimum requirements for energy efficient design and construction of buildings. Recognizing the energy and cost savings of efficient buildings and to help address growing energy needs, the states are in the process to notify ECBC code also.

So as you can see Ministry of Power is the main source for this ECBC codes and in order to go for energy efficiency in buildings and several other appliances, this BEE Bureau of Energy and Energy Efficiency was actually established which recommends, which prepares these guidelines and it implements in the later field. You may have noticed some home appliances also, electrical and electronic appliances also, they are star rated for their energy efficiency, so that is also one of the ways to bringing the products who comply on the energy efficiency parameters.

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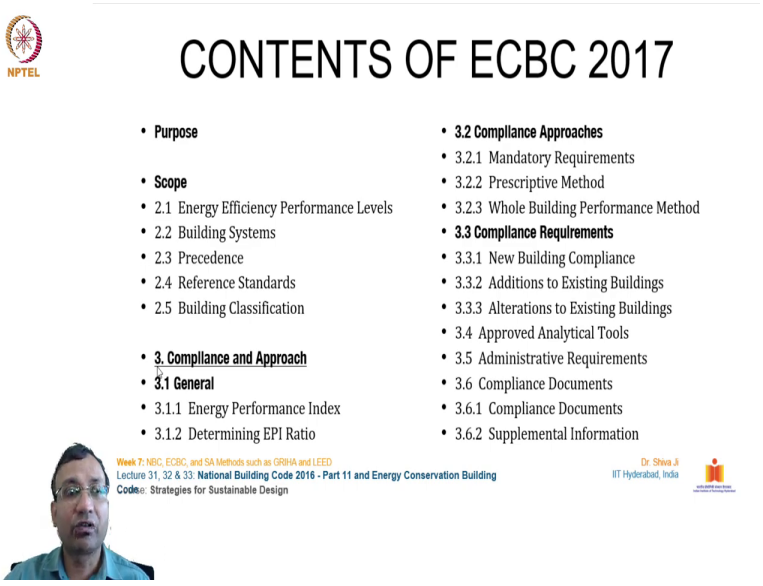

Well, what are the contents of ECBC? We have this slide over here which talks about the contents of ECBC 2017. So starting from purpose to the scope, it goes for energy efficiency performance levels, it talks about building systems, precedence, reference standards, building classification, and in compliance and approach it talks about energy performance index, determining EPI ratio, compliance approaches, mandatory requirements, prescriptive method, whole building performance method.

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There are several documents and recommendations you can see the list is given over here which talks about how to deal, how to design particular component. For example, if you see here in the building envelope chapter, there are mandatory requirements for fenestrations, opaque constructions, daylighting, building envelope ceiling, prescriptive requirements.

For example, in the places of roofing, opaque and external walls, vertical fenestrations, skylights, building envelope trade-off methods, standard building EPF calculations, further like comfort systems and controls it is given for some mandatory requirements for ventilation, minimum space conditioning equipment efficiencies, controls, additional controls for ECBC plus and Super ECBC buildings, additional controls for Super ECBC buildings, piping and duct work, system balancing, condensers and service water heating.

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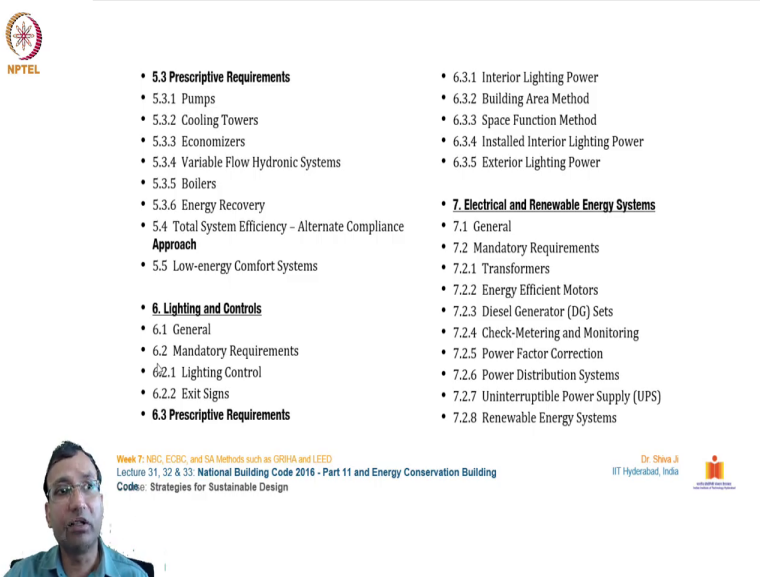

For the prescriptive requirements it speaks about pumps, cooling towers, economizers, variable flow hydronic systems, boilers, energy recovery, total system efficiency, alternate compliance approach and low energy comfort system etcetera. It talks about the lighting and control also for lighting controls for exit signs, some prescriptive requirements it has given for interior lighting power, building area method, space function method, installed interior lighting power, external lighting power etcetera.

And in the further electrical and renewable energy system it talks about transformers, energy efficient motors, diesel generator sets, check metering and monetary, power factor correction, power distribution systems, uninterruptable power supply UPS which we know of, renewable energy system so on.

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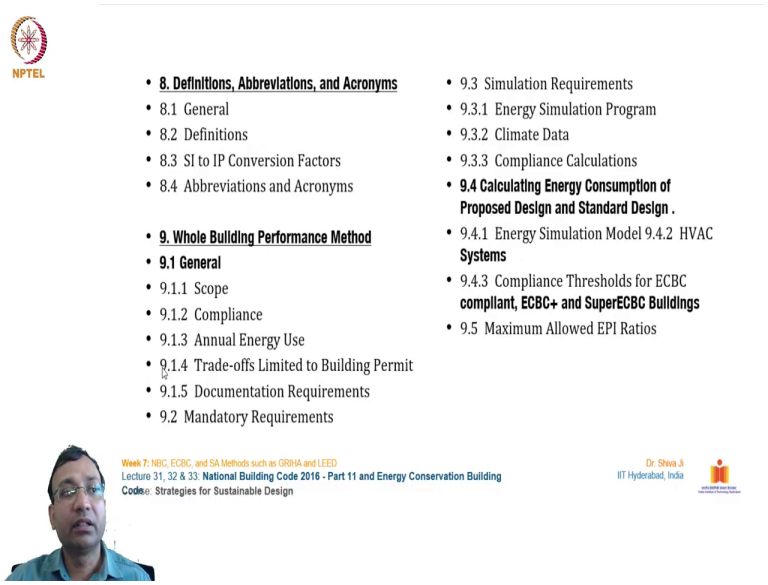

So these are actually various recommendations which ECBC gives for, so that the energy efficiency can be achieved in each and every component of the buildings which are related with the energy efficiency, energy requirements.

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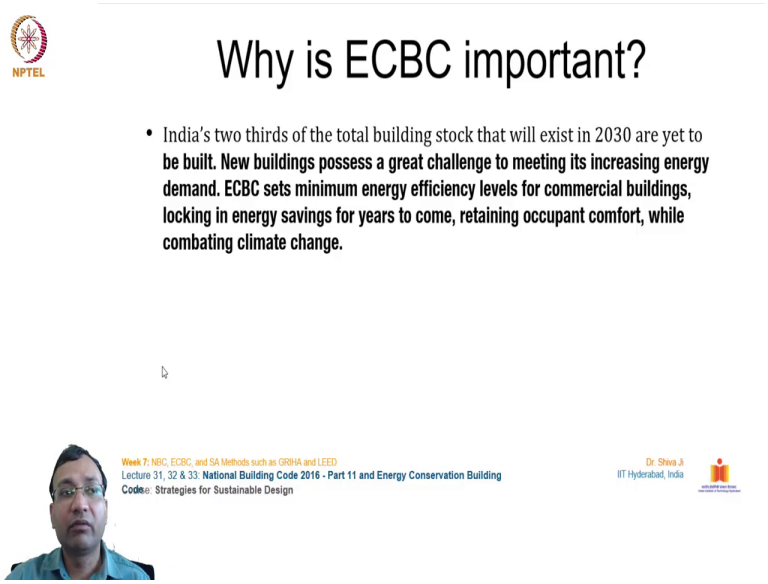

Well, why is it important? India is two thirds of the total building stock that will exist in 2030 are yet to be built, that means a huge construction is coming on our way. New buildings possess a great challenge to meeting its increasing energy demand and we know buildings are the largest consumer of power across the world, almost forty percent of the total energy produced across the world is taken up by the buildings only which is the highest among all sectors, even leaving the industry sector behind.

So, ECBC sets a minimum energy efficiency levels for commercial buildings, locking energy saving for years to come, retaining occupant comfort while combating climate change, so this is why it is important.

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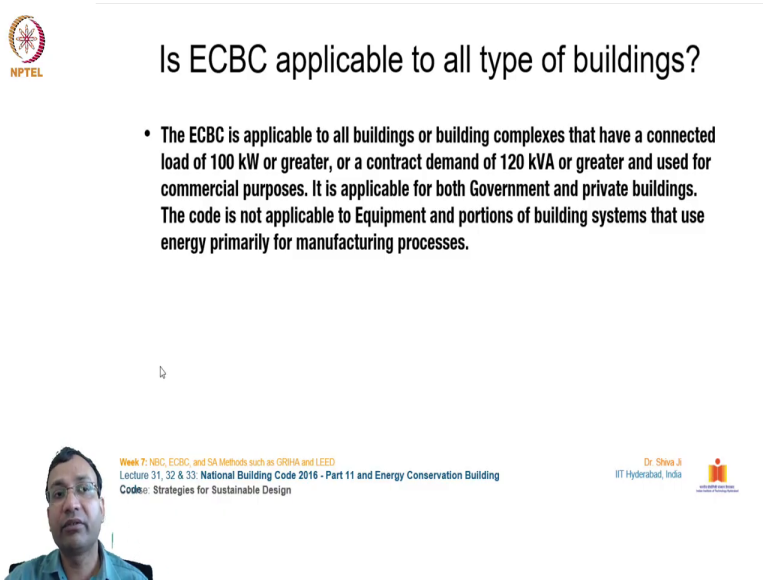

Is it applicable to all the buildings? Well ECBC is applicable to almost all buildings or building complexes that have a connected load of 100 kilowatt or greater, or a contract demand of 120 kVA or greater and used for commercial purposes. So this is where actually ECBC becomes mandatory, it is applicable for both government and private buildings, the code is not applicable to equipment and portions of building systems that use energy primarily for manufacturing processes.

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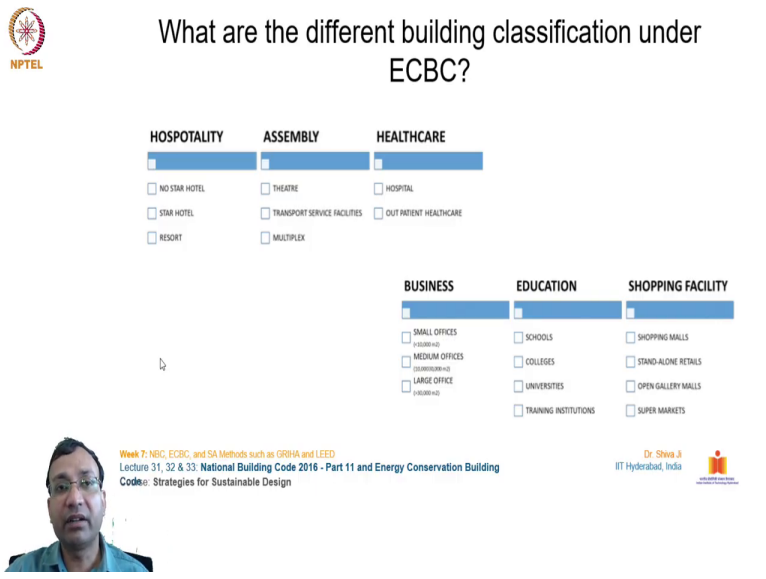

The different types of building classified under ECBC, you can see there are six major hospitality, assembly, healthcare, business, education and shopping facility. Inside that it deals with the star hotels, non-star hotels, resorts, theaters, transport service facilities, multiplexes, hospitals, OPD's, it deals with like small offices, medium, large offices, schools, colleges, universities, institutions etcetera. Shopping malls, stand-alone retails, open gallery malls, supermarkets etcetera. So these are all we can see are the bigger establishments whose power requirements are heavy, so these ECBC norms are mandatory for such facilities.

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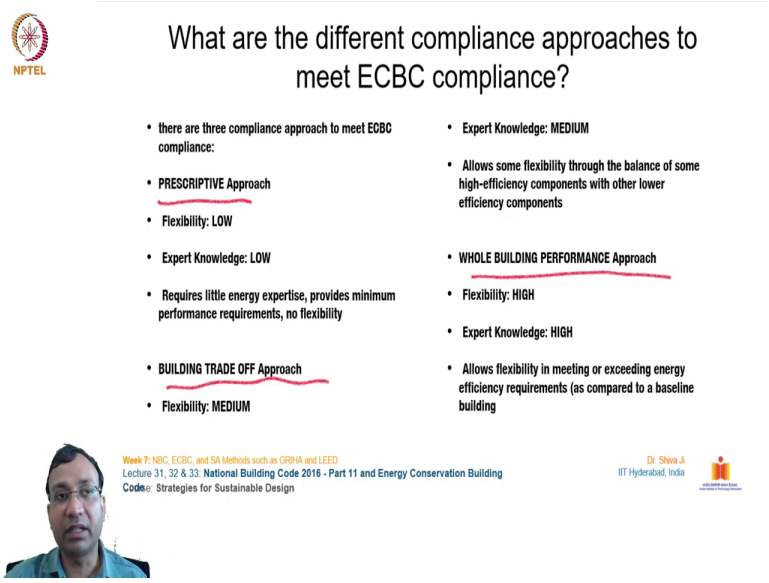

Well what are the different compliance approaches to meet ECBC compliance? Well there are three type, three compliance approaches to meet ECBC compliance. The prescriptive, building trade-off and a whole building performance approach. So we will see one by one. In the prescriptive approach it has flexibility, keeping it low, expert knowledge keeping it low and requires little energy expertise, provides minimum performance requirement, no flexibility. So this is actually the simplest one over here.

And the second one if you see, the flexibility is kept at the medium level, expert knowledge at the medium level and it allows some flexibility through the balance of some high efficiency components with other lower efficiency component. Finally, the third one, whole building performance approach, the flexibility level here is very high

and expert knowledge high allows flexibility in meeting or exceeding energy efficiency requirements as compared to a baseline building.

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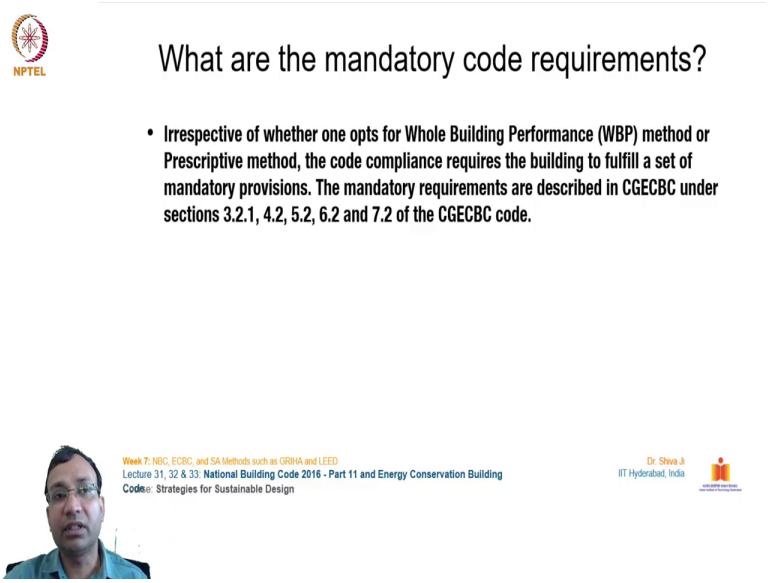

Well, what are the mandatory code requirements? Respective of whether one opts for a whole building performance method or prescriptive method, the code compliances require the building to fulfill a set of mandatory provisions, the mandatory requirements are described in CGECBC under sections 3.2.1, 4.2, 5.2, 6.2 and 7.2 CGECBC code.

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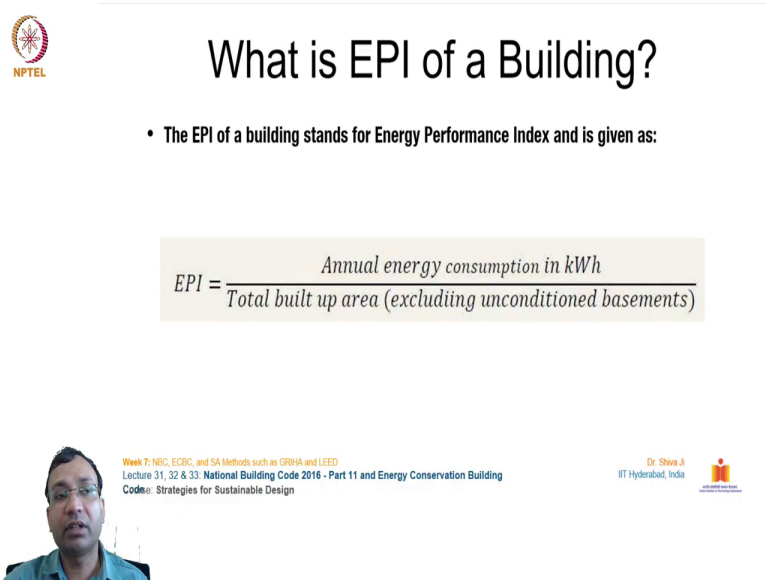

Well, what is the EPI of a building? This is one of the important things I wanted to elaborate over here. the EPI of a building stands for Energy Performance Index which can be given as under, a EPI is equal to annual energy consumption in kilowatt hour kWh divided by total built up area, excluding the unconditioned basement. So unconditioned spaces like a basement etcetera, so this is where the performance index of building is evaluated on the energy parameter, so that is known as EPI.

So, how much of the area it is consuming divided by the total built up area, whatever is the built of area of that building, so per square meter for example, how much of energy is being consumed on an annual basis, so that a number is known as EPI. Why this is important? Because there are certain slabs given for optimal uses of, optimal consumption of power in the buildings, it is divided based on the different the types of the building also, whether it is a retail, hospitality, educational etcetera. So, a building must come closer to that to attain the efficiency on energy consumption part.

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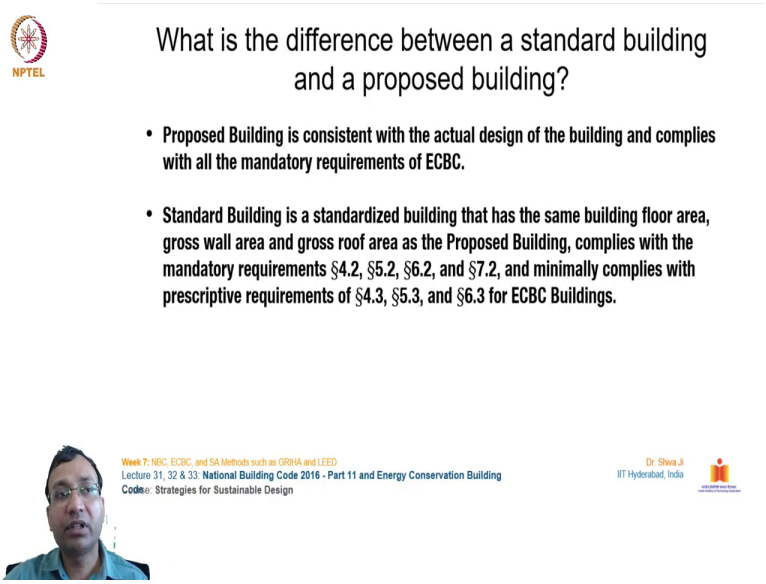

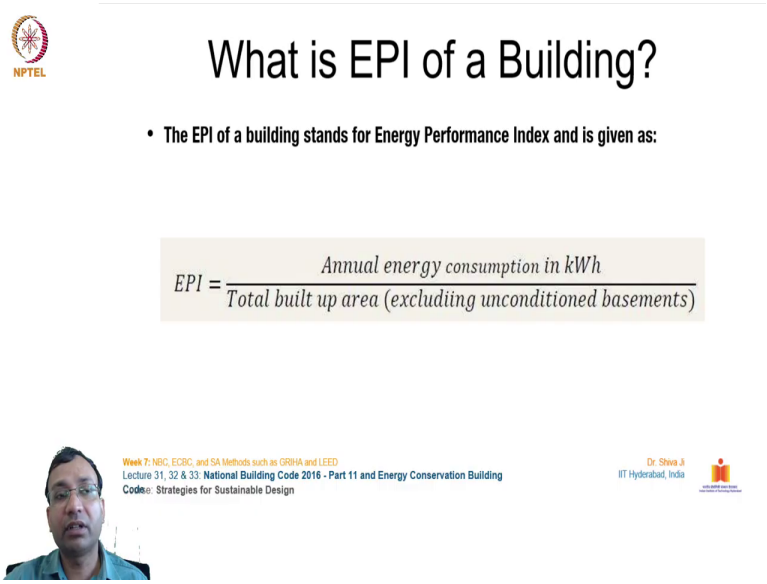

Well, let us see there is another combination coming up, so this is EPI ratio, so what is EPI ratio, for understanding that we must understand how to derive this. So let us see this slide what is the difference between a standard building and a proposed building? A proposed building is the consistent with the actual design of the building and complies with all mandatory requirements of ECBC and what is a standard building? So, standard building is a standardized building that has the same building floor area, a gross wall area and gross roof area as the proposed building complies with the mandatory requirements

section 4.2, 5.2, 6.2 and 7.2 and minimally complies with prescriptive requirements of section 4.3, 5.3 and 6.3 ECBC buildings.

So based on this if you see what is the EPI ratio, so the EPI ratio is the ratio of the EPI of the proposed building to the EPI of the standard building, simply. So, EPI ratio is the EPI of proposed building divided by EPI of standard building. So standard building is the standard you can say as a base case, so how well is the performance of your proposed building, so that is checked with this base case and you get the EPI ratio.

So this is a EPI ratio, so this will define how much deviation, the proposed building, the design building has compared to the base case, the standard building. So this is where if the ratio is 1 or if it is closer to 1, it will be taken as an optimum case.

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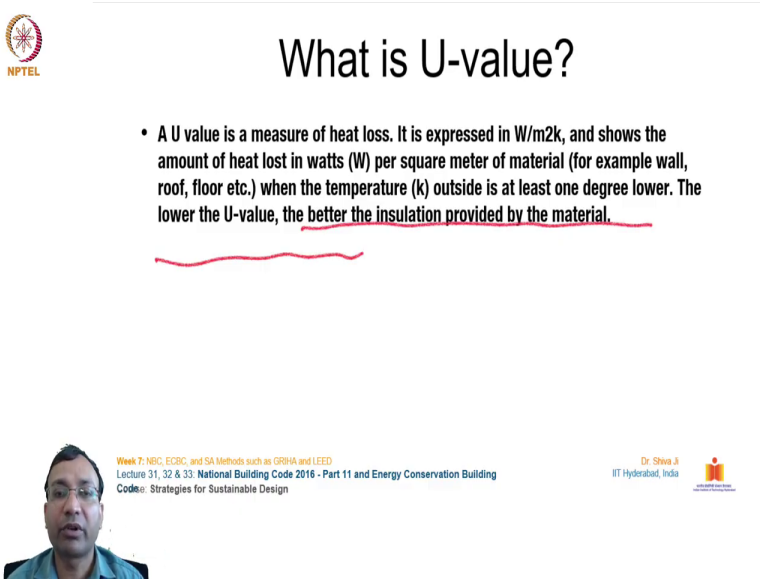

Well, important thing over here what is the U value? A U value is a measure of a heat loss, it is expressed in watt per meter square Kelvin and shows the amount of heat loss in watts per square meter of material, for example, wall, roof, floor etcetera. When the temperature k outside is at least one degree lower, the lower the U value the better the insulation provided by the material. So actually U value it provides the thermal abilities. So how efficient the material is to reduce or minimize the heat loss, so we use this U value to calculate the property of such materials, so that efficient material can be utilized.

For example, where there is air conditioning or there is a huge temperature gap between inside to outside, so an efficient U value will give us, it will protect us from the heat loss, from the energy loss.

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Where can I find construction material properties? Well for your calculations purpose this is advised you can find construction material properties from the suppliers first of all or the test certificates. So, most of the companies they have been asked and recommended to provide specification data related regarding their product, so they usually provide a manual or a booklet or maybe a one-page document where they talk about these specifications of their product.

For example, a U-value etcetera, so that the information is handy while you are undertaking the design process. Secondly, if they are not available with the manufacturer, vendor or supplier you can refer the appendix of ECBC for the default values of certain standard materials which are commonly used in the market. So from here you can collect the data, you can get the data and you can conduct your calculations in your project.

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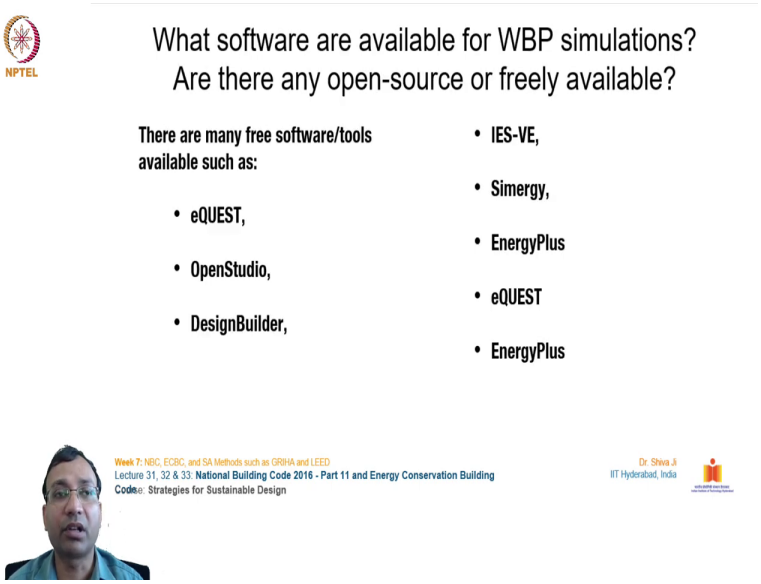

Well, the software important for WBP whole building performance calculations and simulation etcetera. So these are some open source or freely available software, listed by ECBC which you can take note of or take a screenshot of this slide and you can look for these software if you are looking for creating simulations, if you are looking for calculating the value or WBP of your designs, so these are eQUEST, OpenStudio, DesignBuilder, IES-VE, Simergy, EnergyPlus, eQUEST and EnergyPlus. So these are some software, some open source and free software which you can use for your calculation purposes.

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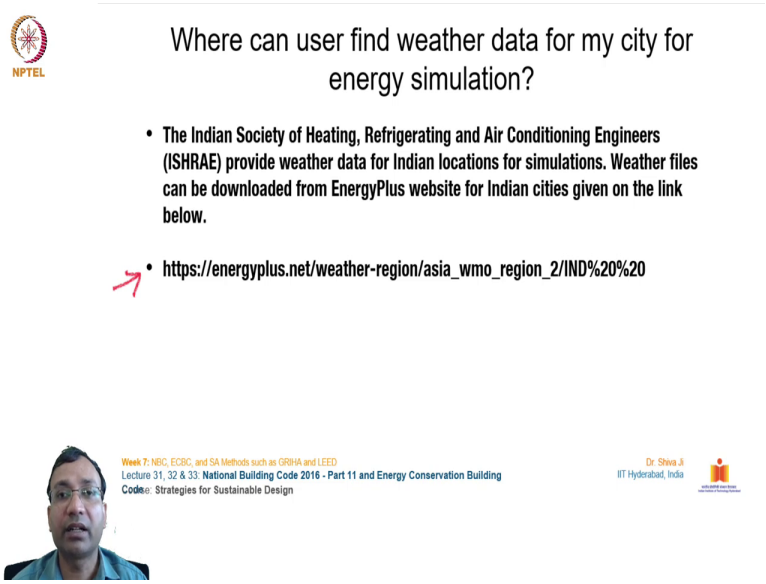

Well, what about the weather data and all? So this is also one of the important data sets, which are needed for undertaking such analysis and studies. So Indian Society of Heating, Refrigeration and Air Conditioning Engineers, ISHRAE provides weather data for Indian locations for simulations.

Whether files can be downloaded from EnergyPlus website for Indian cities given on the link below. So, this is the link below, you can go to this link and you can gather weather related information of the Indian given cities, from wherever your locator or your project is located, you can download this data, you can feed into the software and that software will generate a simulated environment, where that actually places.

So by placing your building and design in that simulated atmosphere you can calculate the further calculations, so this will be helpful for your project for calculating the EPI or EPI ratio of your projects. So, this is how you can make use of this ECBC recommended materials, ECBC recommended provisions and NBC provisions also. So it is very important for you as an architect, designer or engineer to practice in India. So you must actually consider NBC and ECBC norms and recommendations for your designs. Thank you very much.