Structure, Form, and Architecture: The Synergy

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Lecture – 40
Architecture and Structure: Past, Present, & Future

Hello everyone welcome back again to my online NPTEL course on Structure Form and Architecture: The Synergy. So, we have gone through several lectures several sessions over last few weeks and we have discussed many issues and today we are at the last lecture of this series and this is lecture number 40. And here we will basically discuss not nothing new to it, but what the journey that we have made. So, far what like we have discussed various issues we have discussed on material we have discussed on different techniques, different structural form.

Then we have also seen the change the architectural evolution from the primitive age to the present age. So, with this the name of this session name of this lecture is basically structure and architecture the past the present and the future. So, we will be discussing on that.

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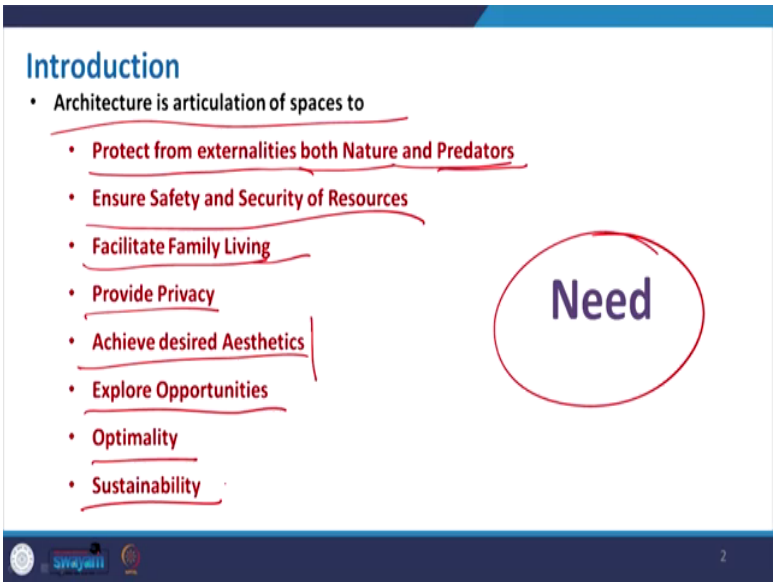

Now, as at the beginning of the lecture probably the first lecture we have discussed various definition of architecture form and structure. Here again just you know get to know about the definition, so there are multiple definitions of architecture given by different architect's famous architects with different personalities. But at the same time if I take something in very short like architecture is basically articulation of spaces with proper application of your science technology and sociology as well.

So, all other aspect will govern the type of outcome that we are expecting as architecture. Now if we just see in this slide architecture is articulation of spaces to there are different purposes. So, let us discuss this one by one. So, protect form externalities both nature and predators and this was the main root cause of making buildings. If you recall if I am sure that

all of us will read in history maybe when we started reading history that time itself like earlier our primitive man.

So, they used to live in the cave, why because that they found is safe to protect themselves from other animals or maybe other natural calamities with a heavy wind flood something like that. But that keep is not considered to be the man made architecture it was not made by that person or the people of that time. Now, gradually over the time because of some changes required in the system, the main they started developing their own houses.

Whether it is pre house or then later on maybe your stone structure stone hinge or maybe in the modern age where we are almost you know virtually touching the sky with the skyscraper. This whole journey there is one single point that actually influenced that is the need. Whenever there is a problem, whenever there is a challenge to the human being they just realized that they need something to do, they need something to improve and then gradually all the innovations that came into picture.

Not in the building sector all the innovations you take, if there is no need there is no invention and then gradually like based on the search based on the experiment based on the failure based on different success. So, now we are in this present age and gradually now the process has not been stopped 1000 and 1000 years that we know from the history of whatever something is documented, that how human there you know building technology that improved today presenting.

But yes to protect from those externalities both natural and from the other predators, that was the threat at that time definitely from other animals and all and that wherever the gigantic size is not like that. Now then men comment over other animals when during that time that was a challenge and then they created that. Now it is also to ensure your CPA and security of resources and this is very important, if you have some resources with you definitely want some place where you can keep it.

If you open in like if you stay in an open to sky area so the security level will be less, there will be different threat of you know losing the resources facilitate family living. So, when they used

to make the family then living like in a community. So, they need some kind of settlements that also very much required, like it is not that I roam around here and there. So, definitely with that social community bonding, so that also facilitated by a building provide privacy that is also very important which can be created achieve desired aesthetic.

So, not only making your simple structure, but in order to make it visually pleasing people also they have done with the basic structure it is safe, but definitely people they prefer to make it more beautiful. So, that is something where definitely it is not directly related to the safety or other thing, but yes that the visual pleasure. Say for example, when you make a building, so we all know we test it that if you make your building with the you know this particular reinforced concrete structure and then we just make frame structure than the brick wall that is good enough.

But then if we add plaster is ok, then if you make it just plastering it is ok. But why we go for painting it and different kind of sheet painting putting a some you know kind of artifacts, there who is basically not you know improving the strength of the building it is basically a visual pleaser that one always try to make their building so beautiful that will be appreciated by others.

So, this is another reason that also people they try to innovate something which can add some value. Explore opportunities and this is something where we all can agree like whenever we are doing something and we are repeatedly getting the same thing the same food. Say for example, if we are taking same food each day thrice a day then probably we will get bored, we always try to get something different even the ingredients are same we will try something different or else we just try something totally different from what is available to us and we taste it, if we like if we can take a move.

Say you have practice suppose you are taking a food form a canteen and you like that canteen very much and there is a new canteen come up and then definitely we are going to you know try that canteen and then when you get that food is even better then you will get a shift. So, it is true for any innovation where we keep on investing how we can improve the situation and

there is no end to it and if there is a end virtually, that means there will be no progress after that.

So, that meet is always be there to have the innovation. Optimality is another thing where like how you can optimal the resources the construction in other lectures we have also discussed something on the effectiveness. So, this optimality in design parameters in structural arrangement that is always a challenge and then if you can achieve it that will be good nothing can be better than that. Then the last was is very vital word and now it is like it is being applied everywhere as the sustainability.

So, sustainability concept is something we are definitely, it says that you use the resources in such a manner that will not disturb the future. The future generation can also get something out of that because, whatever we are using to build our environment. So, we are using natural resources directly indirectly and we are also you know damaging the environment, but that will be a threat for the future generation to come.

So, better if we go for at least this you know concept of your built environment or the building, if we can pick up some of the things which will be environmentally safe also economically viable and also socially accepted. So, your economical social and then environmental these three will give sustainable environment and the building can be one of the major factor to that.

This sustainability can be applied in other area as well, but in will stick to the architecture. And we are not going to discuss detail of the sustainable architecture in this lecture because, that is again a full fledged subject that has different part. But in the context of the need of a better articulation better architecture I just mentioned this particular term. Now, we will just go through some of the images.

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So, this lecture purposefully I have not you know put many words many takes to define anything. So, through this picture we will try to understand the journey from like the first house to you know even it is continuing. We do not have any perfect idea that after 50 years or after 100 years what will be the building typology, how building will look like and what would be the material how that will be constructed. But at least with the trained we can guess something that what could be an like what will be the scenario.

So, this is some representative photographs of a cave and that was a natural resources that was a gift we can consider to the human being at that time to get the shelter inside, that which helped them to you know protect themselves from the externalities. Now after that when they started making at their own.

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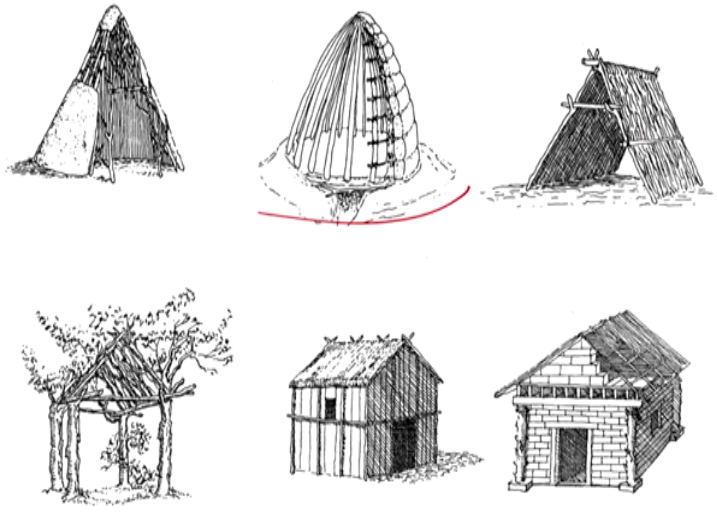

So, they used it is (Refer Time: 12:05) and then the tree houses like they started making their houses with the branch of trees and then also the you know material the agriculture based material or maybe even earlier like in some presentation we have seen that they use the skin of the animal they hunt and then they make the structure at their own. So, these are some of the primitive structure they made and like they use the available material which is easily available they just try to made it.

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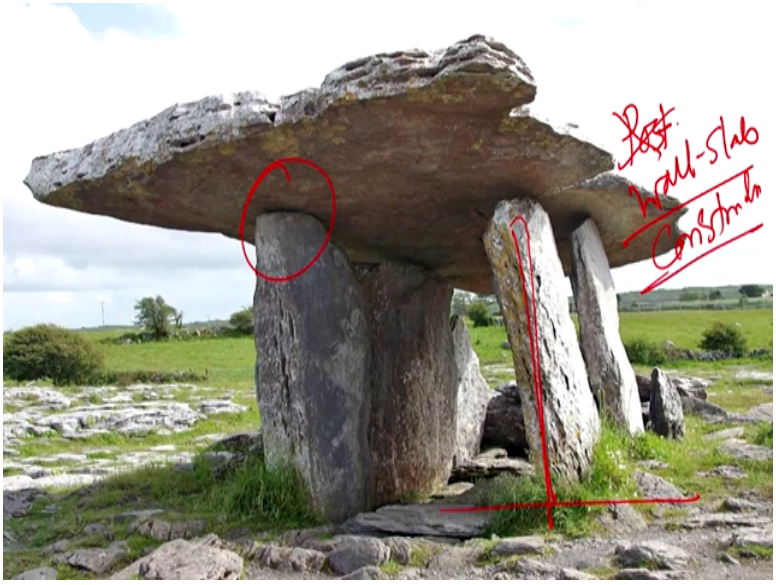

Now, this is the structure which is very important and then it has very much importance to the evolution. So, where the structure is being made with the stone and then this is the first your post not the post is basically rather the wall slab construction.

So, where the stone is being placed, you know in such a situation which is your as a cantilever to the base and then on top of this support at the another slab and that is create some enclosure and there are many examples where this has been used even in the temple even in for small structure. So, this is something very much primitive and that that progress has been started, where the wall slab construction is in the picture.

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Next to that this is again a representative picture we cannot have a real one. But during the time of Neolithic age that time like the where in a position to you know just move from this hunting to they started growing crops and then they started making the buildings next to the riverbank, because a portion they were also engaged in the fishing activity.

And they use very simple structure they use the mud and then they use the you know the timber or the bamboo like material branches and then they use the crops like those straw to make the roof and the plan is very simple that time. So, this is basically the circular plan easy to construct the conical roof at the top, so this is at that time.

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Now, later on then there is a shift from that to the ancient civilizations and then Egyptian civilization is one of the wonders, still we are amazed that how this kind of great pyramid being created that time with a stone one after another. So, perfect arrangement, so that still this is something really we can appreciate. So, they have started making this building, but this is something is not the building to really live it has another value.

So, that there was a belief of life after death and then on that purpose this has been designed and the mummy escaped and then all the belongings is also kept with him after death. Now after that if you see the Greek civilization and all then also like believe in gods and the hierarchy of like to be pleased.

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So, this is the part tenant which is remains of the part tenant that has been placed in front of you. So, again here is the change again. So, earlier in that stone age when we have discussed the wall slab combination, so here it is basically your post beam. Post beam construction where it was realized that you do not need to make very solid wall, instead of that you can use the post or later on is being used as a column column beam structure and that is really giving the satisfactory result. And that has been practice in Greek as well as in Roman when we have seen some structure like pantheon and all.

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Now, this is something in from the room where this multi storey structure being made with this kind of masonry work and use of arches. Now, slowly if you see when this is not very simple architecture or just to have a very rough finish each of the columns look very identical. So that means, the scenes it is basically not the supporting the structure it is now beyond that, in order to make it beautiful attractive in order to present it to other so called like the believe in god and all.

So, all these smiles you know minor details to that all this curvature all these you know design in the capital whether it is Doric Corinthian or gothic kind of capital that is really something beautiful. So, many 1000s years back this kind of arrangement is really appreciable. So, there is a move form a simple structure to now ornamenting structure and that journey is started from this Greek and Roman and gradually and then we will follow up it in the byzantine gothic

age. So, this is again a multi storey structure the masonry came into picture and then what I was talking about during the gothic.

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So, this structure like looking into this image. So, definitely the basic requirement to get shelter and all that deviate little bit. Now, is the buildings for the community buildings for the religions and all these worship came into picture, like it is not the own house to just protect myself is basically the belief in some kind of you know superpower and then the community building. Like whether it is making the charge whether it is making some kind of temple and whatever the form they just were looking for.

A then if you see the ornamentation like the archies there are carvings and then the details there is selection of the material like the stone different kind of stone. So, ornamentation of structure was really practiced that time and still they are existing in the world and then

definitely those creations is really appreciable. And along with that what I just forgot to mention then this is basically the scale. So, we need to talk about the scale of architecture this the scale in architecture is basically with respect to the human being.

So, then in earlier cases is all like if you see this pyramid the height of the pyramid and what should be the size of a mummy that is a human height and compared to that this height is something really very big and gigantic. So, gigantic scale and then even here also those columns beams they are also making in gigantic scale. But gradually then the ornamentation and then when the minimalistic form has come afterwards, that we have discussed in some of the lectures of the evolution, evolution of the you know architectural system.

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Then this is something known to us I guess all of as we know this building, again this building is not for you know just to have a regular type building. So, again you can see the scale the

composition the beauty ornamentation is so beautiful. So, this is some type of architecture that has been created, maybe the purpose differs sometimes it is just to leave sometimes it showcase you know some kind of power even the victory tower in India.

So, that sometimes in those kind of structure is made for show case the prosperity of the kingdom king or so that you know the power of the king or the who in the top level of the social hierarchy. So, they are showcasing this kind of elements again the scale is very much gigantic to that. Now, there is a move so I am not here giving work you know chronological order or giving the time series.

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But again the move like this is something in the Sydney opera house the technology being change. Now coming from the traditional your machinery work, load bearing work, now it is transformed to the shell structure. And then we have discussed in detail in the you know in

some in form of some you know lectures like I guess almost three to five lectures on different kind of structural form which is nontraditional to the load bearing or very regular structure, the shell structure, dome structure then you have the space frame structure like that this is something another improvement.

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Now, this is another wonder where the space frame being used as reinforcement and like this structure being maze with the space frame. So, this is a design by architect Zaha Hadid, again this form like it is not regular. Now, it is breaking that particular conventional straightforward orthogonal architecture to this kind of form. Where there is not much ornamentation itself it is showing a ornament it is no additional ornamentation is required this kind of building itself is representing as ornament.

Now coming to that this is another scale and now coming to the residential scale, where it is in human scale. You need some space to live with your family or just live your what we can you can just protect yourself form the other openness.

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So, in that case this is a habitat 67 that was made and where this different cuboid this is very rectilinear shape, that has been arranged in such a manner that all will get the facility to get some kind of view and exposure. So, this is another arrangement where like it is not horizontal is a combination of horizontal and vertical combination that is of the scale. So, far the whatever the pictures we have seen starting from the cave to this.

So, this the journey changes it is various time like the scale change the ornamentation the structural arrangement of the materials, all the components they keep on changing to coming to the you know the present day and it is all because of the need when there was need to make

such gigantic structure that was on the comment of a keying. So, that was made then suddenly this demand for the individual's larger community then this kind of structure being made.

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And then that has something the composition being established and then suddenly like these some requirement is there to go high rise. The reason is the space availability for the metro cities and like where almost like if you consider New York and others cities like in Shanghai.

So, already they have done it before, but now this is in practice in India as well, this is a picture from Kolkata and is the proposed already it is come almost in a batch of completion every it will be used in you know very soon. So, this is basically the 42 and now as per the record this is the tallest building in India which is constructed. Like before that there are were some buildings imperial one and two and Mumbai that was considered to be the tallest, but now this will be the tallest in Kolkata.

And you can see that earlier tallest that how it is suppressing and then a days to come it will be something like that which will solve that need of the living space. And then this is basically the high rise structure high rise residential or mixed use towers which will have. So, in some presentation you have discussed the you know some buildings like the Shanghai tower, whether it is considered to be city within city all the facilities shopping's that is already being planned in the same building.

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So, similar to that this is again that was from India and this is the world like still like still before the kingdom tower. So, this is basically the considered to be the tallest tower like building in the world. So, this is basically the Burj Khalifa and again if you consider the structural system. So, definitely changes with the height we have seen in the recent lecture that how the evolution of the high rise building that develops.

Like starting form a small to three storey building to the you know hundred storey, two hundred storey building how it is being made and different structural form, how the tube structure, how like your different shear wall different advanced structure tube in tube structure. Then the outrigger exterior structure interior structures those are the system are developed to just get this kind of result, which will actually be safe from all this you know lateral load due to the heavy wind pressure at different height or maybe to save to be safe from the seismic activity.

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Now, this is something again you can see the composition where it is being taken from the Dubai and the construction is now going on all high rise development. So, where you can see that scale here it is not basically gigantic because this may consists of different flows, but the overall skyline has changed. And this is this has happened not just for like to make something

very much high to just get some kind of you know appreciation or to get declared that tallest building.

To solve the purpose within a limited area with the compact area how you can serve maximum population. So, that is something that is engineering that innovation that helped to make this kind of building so high rise.

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This is another example and this is from your New York. So, you can see that overall urbanization, if you see that all buildings they are almost multi story building and that was the need within the stipulated area it is all compacted and definitely we should even go in future like this is already being developed. Now, there will be increase in population and there is no such land.

So, either we have to go for some alternative to make some structure, using the underwater structures some part of the world we do have this or maybe some engineering by which we can you know solve the purpose of the people. This is from again Shanghai.

(Refer Slide Time: 29:10)

So, this is a Shanghai tower I just mentioned earlier and then if you see that skyline and you see that human scale. So, the skyline itself is basically showing some wonders and this all architecture. Again if you consider the height of the pyramid and all they will some match with this right, but now the purpose it can cater huge number of population.

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So, the purpose has changed for going high rise. But at the same time when you talk about the high rise building very much advanced structure. But there are other factors as will were like a particular building to be made for showing the culture the typology of the building, like some this is some example I have picked up from Japan. So, Japanese temple is something like this where you think for take any temples from the southern part of India. So, you will get a different kind of form.

So, then probably your orthogonal or that kind of you know tube structure will not work. So, this ornamentation still has some value where this form itself giving the typology. So, looking at this we can see that this is basically a Japanese architecture or this is Mughal architecture. So, this building typology is also to be carried out. Now so far whatever we have seen and also this is something definitely aspiring inspiring and very high class.

Now this is something where also it is a slum development and this is from the Dharavi in Mumbai. So, here also the space is essential constraint, but then also the affordability plays a crucial role.

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So, this entire area where it is horizontally spreaded and the life is really very much suffering. So, if you search about that there are many documentary there are different videos as well, so where you can see the conditions of the life. So, what exactly have the progress we have made to give the built environment, is now we have to think on it, so how to do it how to improve it.

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Now, in this case this is something where again is something futuristic, where the city like all this park that is moved up. So, these are some hypothetical, so that can be developed where this can be made at some upper level and then this is something where like your habitat 67. So, this kind of development of houses can be made.

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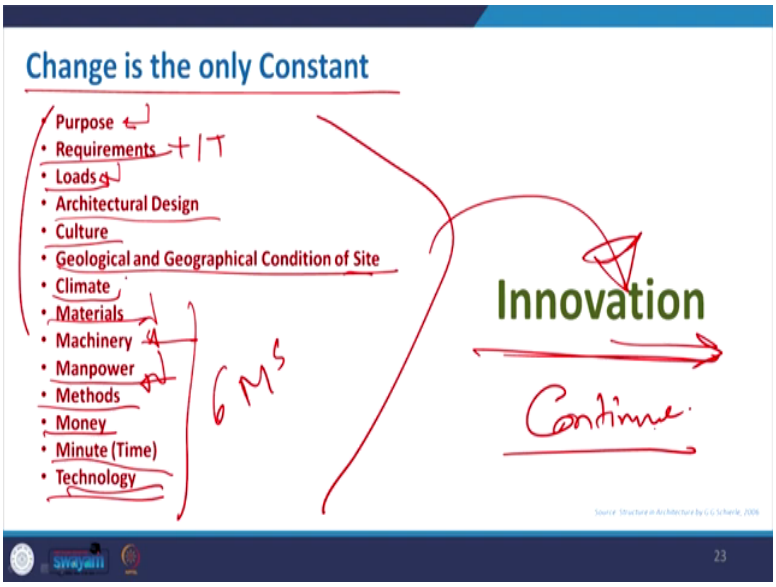

Now, this is very catchy part in this slide and this is one of the important slide that we need to understand that change is the only constant. The statement is very much famous and exactly, this is something we need to if we do not change then probably we will be losing something, we cannot really sustain with that. So, for that what change we require the purpose, the purpose has changed and that we have seen from those examples, earlier the sometimes the purpose may be only to showcase the power of the king, that is why so gigantic structure is made invested.

So, much of capital to that, whereas the common people they need was not that much highlighted. But now the purpose is to serve if we consider this slum and all though this is something where the affordability is concerned. But definitely we should go for some low cost effective solutions for them, so that they can also enjoy the built environment the requirements

has changed. Earlier the requirement was different nowadays with the different gadgets and all.

So, we need some buildings where it will be very smart building where based on your you know instruction that building will perform accordingly. So, this application of IT information technology has come into this and there are other requirements. The loads this is something was there is present also and it will be, but then to tackle these loads different technology different construction technology different arrangement of structure is has been developed and then you know this is taking into consideration.

The architectural design has changed whether like whether it was of the minimalistic form or maybe it is of making something very broad that has changed. Culture this culture plays crucial role to make the form and structure and that we have seen in case of the temple or in case of your pyramid and then maybe the you know Taj Mahal and then so on.

The geological and geographical condition of the site, again it has changed a lot like from the primitive ways there was some age of dinosaurs and then there is a sudden change multiple major earthquakes tsunami the natural attack. So, the world has changed and then geographical condition and keep on changing, the temperature of the art is changing day by day the global warming has you know started affecting. So, with that geological geographer condition of the site changes accordingly, the selection of the building typology that have also changed. Now, the climate this is another impact that already I have talked about the climate has changed.

So, for that accordingly how you make your building climate responsive, how you really tackle that issue the high tornado or maybe the high heat in case of in summer situation in Dubai that we have discussed in some other lectures. Then where like the fashion should be designed in such a manner that which will protect from this. The material improvement is like each minute there is some improvement in that with earlier there was no availability of concrete.

So, people they started making it with the mud and then gradually they started with the lime and then the machinery work and then the concrete and then the steel and then the composite

and then nano carbon. So, keep on keep on increasing the number of options and then there is a particular you know requirement to select the material. The machinery has changed different crane different robots now being used as already I have mentioned earlier in this like the 3D painters and then automated you know mode automation to the construction.

So, that the building can have the minimal error and then that will have also the quality control and also it can be a speedy construction. The manpower again there also the it is automation like the portion that people can really you know that robot can help that. But at the same time the manpower also includes it is not about the labor, as I mentioned earlier that it is also includes the intellectuals who are making this innovation.

And also this is very vital for like we are very much helpful to those scientists to those engineers who develop alternative materials and just improve that scenario which will actually tackle all these issues. Then the methods is the similar thing how you construct then the money is again a very much critical issue, where the affordability can make wherever there is some you know developed situation develop economy.

So, we can have that impact on the overall urban settlement and the building as well. The time and the technology they that also like this is basically the 6 Ms that we talked about that also change. That time like earlier a building requires a 6 month of time for one or two storey building and now with a prefabrication with the modern techniques within a week or within a months, a multi storey building is formed and is ready for the use.

So, this is the improvement that already you have made and we are in a process to even go beyond that. Taking the application of IT defend you know artificial intelligence minimizing the risk of any other issue and then it is can all come through the innovation. So, we need innovation we first require a need. So, need is the seed and then that will actually instigate the innovation.

So, I started the lecture with the need and then I am almost in a you know in the end of this presentation, where I said innovation and this is basically it is continuing. So, this is continuing

still we get innovation we always make betterment in our building structure and form the selection.

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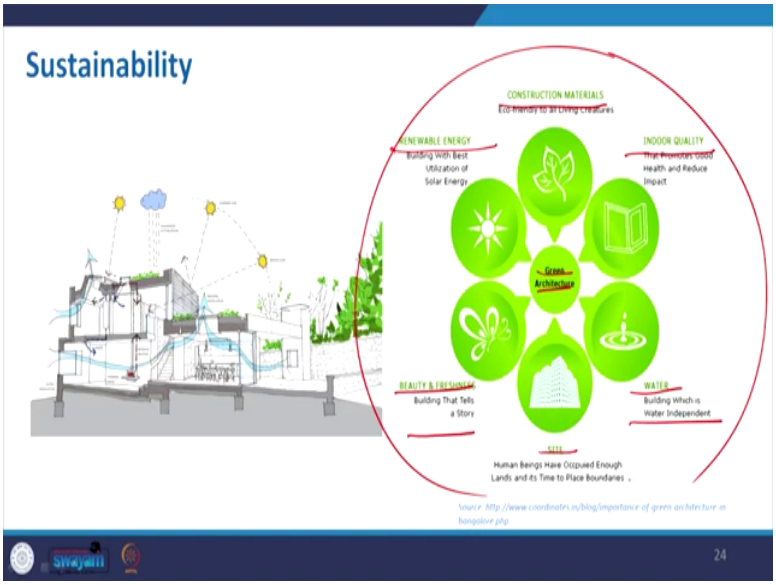

So, this is very useful and then definitely I just simply mentioned this slide, this is the sustainability where like whatever we make whatever the technology we use with the material we use we should think for making the yield environment sustainable, that is also referred to the green architecture or green development.

So, it has some component where the construction material should be eco friendly, will have very minimal effect or no effect to the environment. The indoor quality where basically you can make it with the health and other thing with the day lighting and ventilation. Then the water is very much precious resource for us and for that the you know proper use the building,

water independent building and you know that can actually optimize the use of water is desired in the site wherever you make your site.

Then basically it should evolve with the side and then the proper maintenance, it should not disturb the ecology of this. And then the beauty and freshness that is again another view that with all these you should not really make something very boring people will not add up. So, there will be no compromise on the structural point of view, even you can do excellence on the aesthetic and then the renewable energy. Because not only the energy that we are talking about to like switching on the AC on all.

Even during the procurement of the building materials there is energy involved the transportation also energy involved, then the during construction energy involved. When there are some energy which also lead to the embedded energy of the material and the research is also going on to just minimize, to have some materials will have this kind of minimization in the energy sector. So, with all these parameters if we can make something really a green architecture or sustainable architecture that will be really helpful for the future.

So, the practice is already been done there are different agencies like Riha, even the leads in the international scale. So, who are making some rating and there are more, even this subject is very interesting and definitely either you have gone through this subject or maybe in future in your curriculum you will get it there are materials available on sustainability.

But this is a full fledged subject, I cannot really cover all of them into this I just highlighted this part, where the importance of sustainable architecture for the future generation is very vital and we can contribute in many ways of taking the parameters as well. Where this particular roof gardening is being concerned where the ventilation cooling heating the passive solar application. So, this all can help to make a building sustainable.

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So, here you can see that along with this greenery and all this is vertical, but again it is giving some good result.

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Now, this is basically the concluding slide for this particular lecture, as well as for the entire course. As I mentioned that this is the last lecture of this particular course and this picture is self explanatory, so where we started earlier with the stone hinge and then now that this is the marina bay sands hotel.

So, it is almost look like, maybe the structural system structural arrangement material use the scale that differs. But basically again in this case we have discussed earlier that this is also constructing of the slab like structure, where your building is having some inclined. So, if you see from this section, so you have this kind of two slab and then these three buildings is holding another you know slab on top of it. So, this is the evolution and it is continued.

So, this is very important to understand for us, whatever we know whatever the information we know today it will be obsolete or it will be back dated tomorrow. So, always our the target

should know to get updated with the new technology, new materials, new examples which is being practice which has been researched and tasted to adopt it.

It will take time, but definitely it will be the future, where we can talk about the materials the prefabrication whether we talk about the technology energy optimization application of IT to your building design, everything will play around and also like even going for the alternative materials, how to reuse minimize the waste making material out of the waste material.

So, there are plenty of area where we can contribute to make a better sustainable built environment and that actually will be the true you know follow up for you know the architecture and structure, their relation from the past the present and the future. And if we can practice that will be justice to this particular you know learning and then at the end what I just want to give you all a very huge thank for your patience to you know attend this particular to join these particular course and to get different you know idea with the discussion and all. And for that I give you a big thank to all of you who have you know gone through this who joined this.

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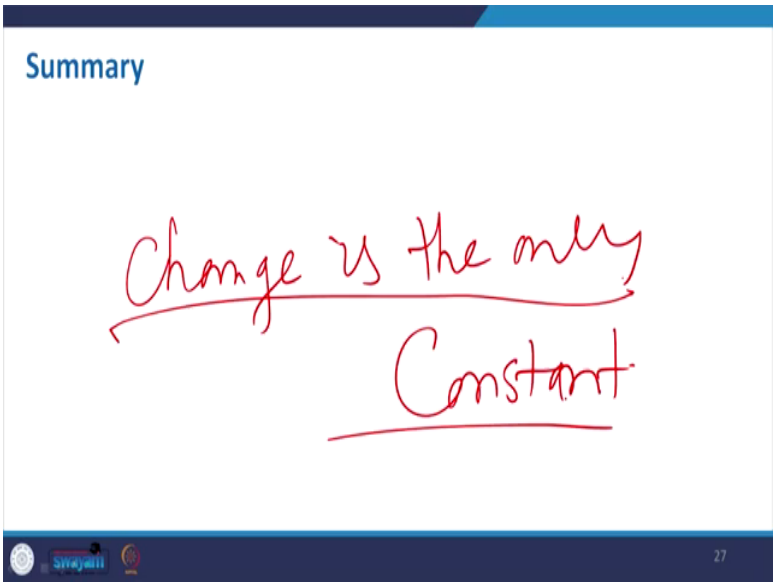

And here also the key point that I just repeat that is your again the change is the only constant. So, this is the line that here like in other lectures I summarized something that what we have learned, but here is the key point that we should take the change is the only constant and that is the reason that form the cave architecture to now Burj Khalifa.

So, this is the journey and how the multi dimensional improvement that happened over the period and it is continuing. Taking the concept of sustainability adopting new technologies materials and definitely whatever is good for the society for the human being, with that I complete this particular course.

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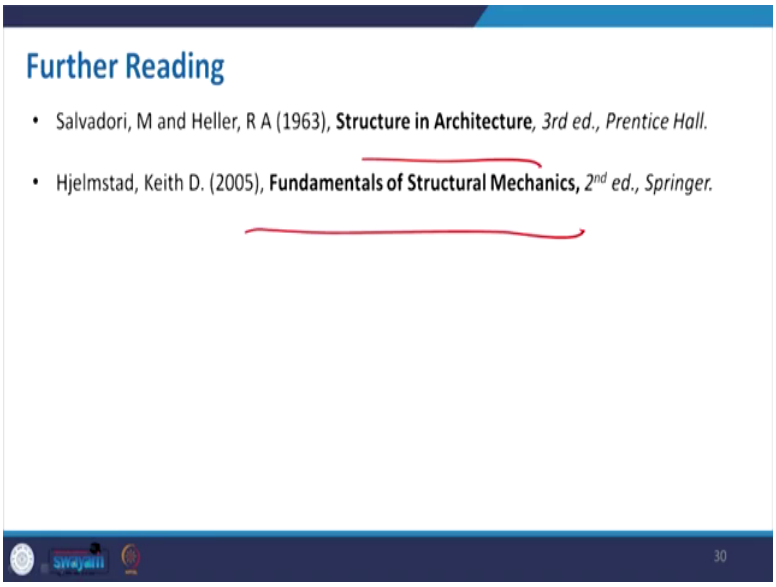

These are very few reading materials and then already that is being there in for all the slide. So, thank you very much for attending this course.

Thank you.