

Building Materials and Composites

Dr. Sumana Gupta

Department of Architecture and Regional Planning

Indian Institute of Technology, Kharagpur

Lecture No - 21

Introduction to Prefabricated Items

Today we are starting module five and it is on prefabricated construction. Till date whatever we had discussed those were cast in situ concrete construction in module 4. Prior to that in the other modules module one we started with brick, clay materials, clay product, stone and there also we found it is brick by brick laying on site and a structure is coming up so starting from the foundation till most of our constructions are leading to on-site constructions.

We are generally accustomed to such and many of you have witnessed that. Prefabricated construction in the entire discussion, we will see in the entire module the items are not made on-site. (refer time: 01:24)

That means it is made elsewhere. It is made elsewhere and it is brought to site. So, obviously this kind of system will have some good points, some bad points. So, we will have to enter each of them and we have to explore what could be the challenges, what could be the limitations of such system and maybe you are accustomed with the term module. So, you will get prefabricated items that mean you will get units of predefined sizes.

And that gives you indication that your design that means the architectural design, which you are learning maybe most of you, those who are students of this particular stream, that is architecture, you are learning design. And you are given a space and you are given a task, to assemble spaces in such a way that it satisfies your client. So, you will be given a set of functions against which a set of spaces will be generated and you will wish whatever shape you want whatever form you want and you can actually built it up brick by brick.

But the most challenging part of this prefabricated system is, you have to design considering what is in store for you. Otherwise, you can do as you wish but in that case your order should be placed in such a huge quantity that it will, it can be made on factory, you are accustomed with the term mould. So, they can be made out of mould which may be used multiply so many a time that mould can be used and that will eventually what will that do eventually that can bring down the cost.

So, in this particular module instead of getting into the items, we will discuss more on water prefabricated items, what are the advantages of its use and what are the limitations of its use so pre refers to something made before implies a saving on time compared to cast in situ.

(refer time: 04:17)

So what does the time go? Does it mean that whatever the item is it is coming from elsewhere? Yes, it is coming from factory and yes, you have to give that time, that effort, which you had to give it on-site which you had done previously. But it is not as small as brick size, but it will be larger in units. So, you can bring something on-site which is not that small. Again it may be large sized we will see some images later little later and there you have to assemble it.

When you are in cast in situ you were assembling bricks. It was a slow process. Here, you have actually used up your time in the factory and you have brought on-site to assemble. So, the items are made before and assembled on-site. So, when we talk of assembled on-site, here we bring in the details how to assemble it. If it is floor, it will be something, if it is walled, it will be something, if it is beam column, it will be something else.

So, this assembling is very important and the point where it is getting assembled, there should be proper design of it, because one item can actually not or fix get fixed with another item in the process, through the process of assembling. Here in case of cast in situ you had the mortar to join it. Here you will have to apply different techniques this automatically gives you a rapid rate and erection rapid rate of construction and erection on site, so that is again you are saving on time.

Controlled conditions when it is made each of these items were walling for roofing for flooring for beam or column whatever way it is made, it is made in the factory in a controlled condition, whatever be the material. Most of the precast items prefabricated items are of concrete we had extensively learned concrete so in moulds you can actually cast the shape you desire, form you desire and then, you can you have to cure it if it is concrete. Pre-stressed items can be made on factory.

What pre-stressed means? The rods or the reinforcement that is the steel bars which are inside the structure as because these are quite long structures or large structures concrete is good in compression. You have to use steel to take the tension. So, these steel rods can be pre-stressed and can be embedded in the concrete so that can reduce the, reduce the size and number of structural members. That is you can have bigger panel sizes larger panel for walling or for roofing.

And you can see an entire building can be made from precast walls floors foundation columns beams. Other than these, we also we will come to that, we will discuss that little later. (refer time: 08:14)

So now, let us discuss on the advantages. We can start a precast or prefabricated system when there is a large amount of order. Without that the factory cannot survive. You cannot just ask for one residence to be made as prefabricated so that should come into practice. And even I

inform you that building management building Technology Management Center BMTPC is promotion Center technology promotion Center. They have given 16 items which are not all fully prefabricated, but yes some are partially to be done on-site.

So, you need a large amount of order to make this system sustainable. If that is done then you can make a saving on cost. So, this cost implies the cost of production, when it is large-scale it becomes industrial and the factory actually survives. So, it must be practiced our age-old system must be practiced, our age-old system must be practiced. But this should also be welcomed but what is the limitation?

We do not have skilled labour because these prefabricated items needs to be assembled properly on-site. And that is why this large-scale production is not becoming very popular in our country. Hence, fast or faster construction methods, this is one of the faster construction methods and that cannot be achieved at all times. So, let us come to the advantages back considering this as because it is happening in a controlled environment within a factory you can actually make it friendly eco-friendly.

So, it is not liberating dust particles and lot of noise etc in the neighbourhood where it is being made. It is all confined to the factory where it is being manufactured and these are ordered in modules generated in modules. And whatever is the leftover as waste can again be recycled in the system so there is no point of wastage and no point of creating pollution to the environment in a residential neighbourhood or maybe it is not creating a noise pollution because this is in a restricted area.

You can reuse each item which you are producing. If this is not fitting into a system or it is not required it can go back you can dismantle a new unit entirely and reuse that in another site. So, you cannot achieve these when it is a cast in situ concrete structure. We had discussed this earlier. So, when you break that concrete structure you do not get anything other than you can recycle some of its coarse aggregate or maybe the some of the reinforcements.

So, here the flexibility is that you can reuse, convert disassemble, move it to another site, large sized units if you have. As I told you, these are much larger than size of brick, it implies that lesser the joints. So if it is a wall panel, if you are trying to make a wall out of your prefabricated panel or precast item, it will have very few joints. Usually they are from floor to floor connecting between the structural systems between two floors.

So, there you will hardly have any joint on the horizontal direction. You will have only joints in the vertical direction. And mostly you see it is a dry construction there is no involvement of water because whatever wet situation was it was all finished in the factory. So, here you are getting a dry item, you are fixing to dry items, five dry items, one after the other. So there is no point of water and you can do it in a waterless manner. (refer time: 13:14)



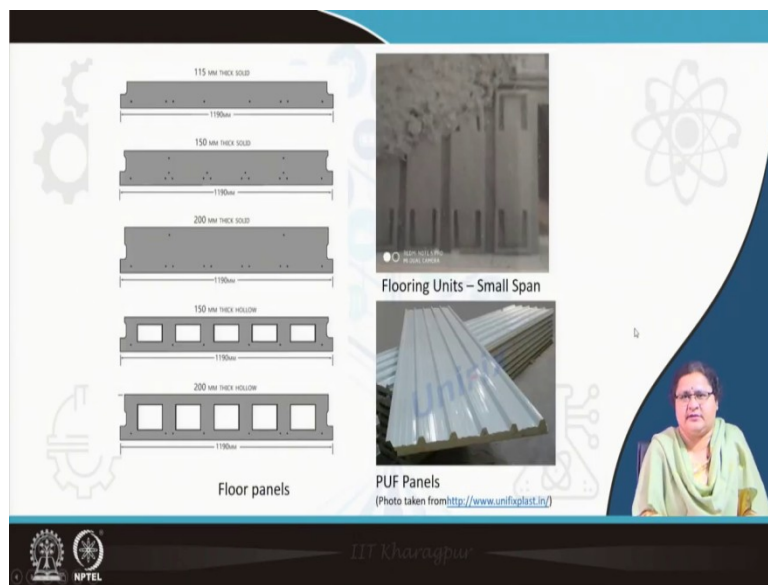
So it is a dry construction entirely. Now, I expose you to some pictures. This hollow block concrete which you see on the first picture here, this resembles more or less brick. But they are larger in size than that of a brick. So, this is cast units special units for when they are connecting one after other they are having you can check here. There are some notches here are some notches. Here is different this is having a flush end.

So here there is no notch so when you are starting or beginning your construction, you can start with this when you are using these ends you can interlock it. So, we will go into little detail in our next lecture maybe. But these are the first precast units; masonry units are called concrete masonry units. What you see here picture below it is concrete wall panel which I am talking. Now you see here there is a series of panels kept of different sizes kept.

Some may be floor to floor some may be for the plinths and you can see some details they are not clean items, you can see some cuts. There may be some notches and those are for fixing. And you can understand from this size and also from this picture they are not humanly possible to lift it to position. See on this picture a person is working on it trying to fix it. So, this unit has to be manoeuvred by a machine to come and get fixed here.

So this unit is coming directly at this point and this person has to be skilled enough to manoeuvre that to its exact position which was quite unlike in case of a cast in situ construction. What more you notice is the opening that may receive a window. But that is not that cannot be done by the way of assembling bricks and creating an opening. It has to be done pre before so the design of the entire thing has to be done prior.

So, your door location, window location, opening location, every detail should be given to the factory and there should be enough of such order to for to satisfy the economics of the entire thing. Here you see some more patterned items. These are paving blocks; these are also precast concrete units. So, in our basket we have so many things. (refer time: 16:27)



We come to the roofing part. In this picture, you see there are number of sections. We will elaborate on these later. Some are hollow. These are hollow, actually the blank spaces are hollow some may be solid and some dots you can notice. These are all reinforcement showing the marks off it is a schematic picture you can see some units assembled one after the other in this picture showing floor flooring unit small span.

And you see on top of it is being covered with some material to make the floor flat. In this case the flooring unit in as you see, as a section, is flat. Here you see there are lots of notches. So on top of it there is a concrete, concrete filled in to make the floor flat or usable. These are for small spans. These are for, these units are for large span, these are for small span. By this time, you are almost thinking that everything is of concrete, yes, it is mostly concrete.

But we also have panels prefabricated tunnels with as you see in this picture which is PUFF panels, polyurethane foam panels. There is a metal sheet on top of it these are also walling panels. So, there are various kinds of prefabricated items of which or mostly with which are made of concrete. They are durable they are giving you a challenge with time, fast speedier construction. (refer time: 18:23)

And the limitation is you have to go with a pre-set dimension. So, you have to go for modular construction, repeating sections, items, shapes, forms, so that makes it industrial, that makes it possible for a factory to make large number of units. Otherwise if you keep on changing your design, if you keep on changing the module, you will keep on changing your order and that may not be possible for the factory to supply.

Challenges to overcome are the joints and connections especially for these prefabricated systems it is not like joining with mortar. There is thermal and acoustical behaviour which may be a limitation you may have problems in fixing the plumbing and electrical services. So you have to plan for that because not all panels will be carriers of electrical lines or maybe fixing the plumbing lines.

So, you have to be very much particular because without services a building cannot survive. So these are to be pre-planned provisions are to be made and that becomes a challenge where is it can be used? As I showed you some small-scale roofing systems, small-scale wall panels

can be small-scale building you can be applied in small scale buildings like mass housing. You have few floors of same plan moving up, you can actually use it.

Or else large-scale long span buildings commercial buildings, industrial buildings, you can create large spaces, large office buildings, large floor spaces. And they are inside you make compartments and use it. So, the building is a large-scale building, long span building, you can use pre-stressed panels and you can make a prefabricated or precast system developed for that. (refer time: 20:54)

Other limitations are: when it is a concrete item, it is whatever thin it be, it is very heavy. It has to be transported to site very precisely, very carefully, so that the corners, ends, edges, do not fall out because they actually form the connections with the next item or the next panel. So, these members are to be transported very carefully heavy cranes are required with skilled operators to install the parts.

So without a proper mechanism, you cannot actually operate the entire system and that requires skill, which is lacking in our country context. So, we need not only we can propose a system but we have to look into the education part, looking look into the technical part, how this can be installed in a better way. Very small margins of error are allowed so because it is very precise, you have to have units one after the other very particularly you have to be very close or closely packed you do not have provision to put some mortar inside and fill in the gap.

So you have to be very the dimensions etc and fitting and fixing is become is becoming crucial. Connections may be difficult. You have beam column system they are connecting each other because that will lead the connection will lead to the load sharing, transferring the load. So, these are the limitations. Design flexibility as I have already told you cannot think beyond certain fixed dimensions or multiple of certain dimensions.

And everything has to be prefixed; everything has to be designed so the flexibility in design gets a challenge. So, you have to follow given dimensions and finally it will become a prototype. Economies of scales is required for set up and run as I have already told factories cannot survive with very few such orders. It should be practiced in our country which is practiced in other Western countries where they have skilled labour they have mechanisms to use it the cranes the movers and there is lack of labour.

Here in our country context, labour may be available cheap, but it is unskilled too. So, to bring this system in prominence into prominence you have to look for training these labourers who are unskilled to at least semi-skilled, to skilled labourers who can operate such kind of systems the cranes etc and these are very much, very much you are having a risk if you are not skilled or trained in this particular profession.

Repetition of form affects building design. We, as architects, we have to take this as a limitation. But yes, within these limitations, we also need to know these items, so that we can actually make a make use of it and make a faster movement towards fulfilling our aims like

housing for all etc. Skilled workmanship is required as I have already told so all this becomes a limitation for our country context at times. (refer time: 24:55)

Now, coming to the general observation, it is particularly the openings. I told you, you have to finalize beforehand. You have to give it during fabrication and you have to know which place it will come. So, proper understanding of how to organize the assistance into becoming a building built form is to be known. Doors windows other openings should be marked. Coming to the services as I told you the MEP the mechanical electrical and plumbing all services have to be designed beforehand as it would not be possible to create openings in future.

Say in floor there should be proper holes to receive the pipes on wall there should be proper holes to receive the outlets overflow pipes. So, you will have a wait area. So you are you are actually having design very prototype what one particular bay other can be dedicated for the waterlines other areas will remain dry lines dry where electrical and mechanical lines will be very important.

So, rain water pipes etc are to be planned, Water inlet, outlet from washrooms, from kitchen, if you are having for a residence are to be planned. So, pre-planning and also the future provision are to be kept in mind before entering into such material design such materials. So, as an architect, you need to keep in mind that what kind of construction system you are going to face and then only you can pre-plan the entire design plan accordingly. Even staircases can come as a precast item.

So, the entire folds of the staircase the risers and the treads can come precast to site. So, there you have to remember how many treads and how you have to calculate what is the dimension and have to keep that space enough, so that it goes and gets assembled with the beam column system, then only you can achieve speedy construction. (refer time: 27:34)

So, if we come to what are they made of usually they are made of concrete good compressive strength, it lacks tension and shear strength which can be provided by reinforcing it. Earlier, in during the Romans, we had seen it used for aqueducts, culverts, tunnels presently also these areas are covered in buildings, in regular households, we have we see shelf precast manhole covers where precast.

We have the opportunity to use pre-stressed concrete pre-stress steel inside these precast items. So pre-stressed as I told you when the reinforcement is embedded with tension in the rods. So, this is not possible when it is a cast in situ construction when it is a cast in situ construction you cannot pre-stress the rods. In a precast system you can actually pre-stress the rods and pour in the concrete. So, then that becomes much effective in taking strength and larger spans can be achieved.

Thinner slabs lighter in weight can be achieved by pre-stressed mechanisms. Otherwise, you can always go for the non-prestressed structures So, what are we going to cover in this particular module. (refer time: 28:59)

From next module onwards, we will try to cover hollow block concrete, wall panels, one is single thickness one is double thickness, paving units, flooring units for small span flooring units for large span, beams, columns and Foundation, Ferro-cement roofing channels and also we will touch upon the poly urethane forms panels which is not made of concrete. So, with this we end this module this lecture and we will move to lecture 2 in the next day, thank you.