

Building Materials and Composites

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Lecture No - 25

Columns, Foundation, Ferro-Cement

So we are in the last lecture of module 5 which was on prefabricated concrete construction. In the previous lecture we had extensively covered the flooring system where we had also discussed the beam and the flooring system how it is assembled and we had also discussed how the beam is sitting on the column. Now as you all know that the load is finally transferred to the mother earth. So, the load has to be transferred through the column to the ground.

Hence we need to know whether these columns are to be independent single piece or they can also be prefabricated and they finally go and meet into the foundation which can be precast or no? As the answer is yes we can have precast columns being assembled one into the other to form a single connected column. Similarly they can finally go and get set within the foundation and become a single unified structure.

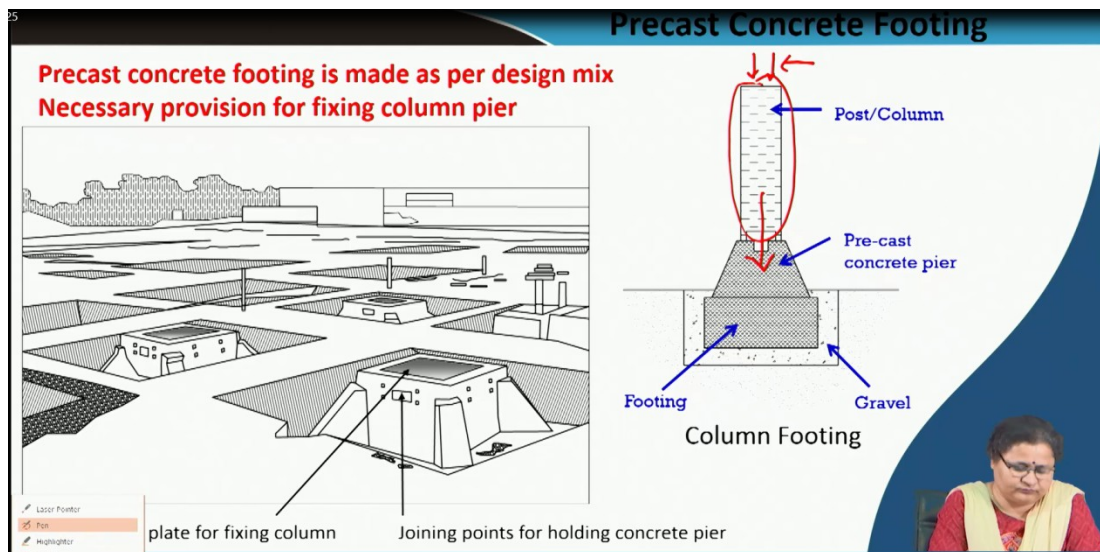
So unless and until the transfer of load is happening we cannot get the assurance of taking such long span structures and even along with it we are taking so much of load so much of large spans. And if any kind of mistake is there the entire system is going to crumble. Again I repeat it is not like cast in situ construction that things are made together in one day's casting and there is continuity.

Here the rods are ending another set of rods are starting so there is no lap no possibility unless and until this joining between the two is very rigid. So we come to in this particular lecture to the columns the foundation and another interesting material which is Ferro-cement which is also a prefabricated material and it is very much contextual to our country context that is developing country context which we are little bit of challenged while using the other precast structures we can always go for Ferro-cement structures.(refer time: 03:28)

So we will go into precast concrete foundation precast concrete column and Ferro-cement precisely. (refer time: 03:35)

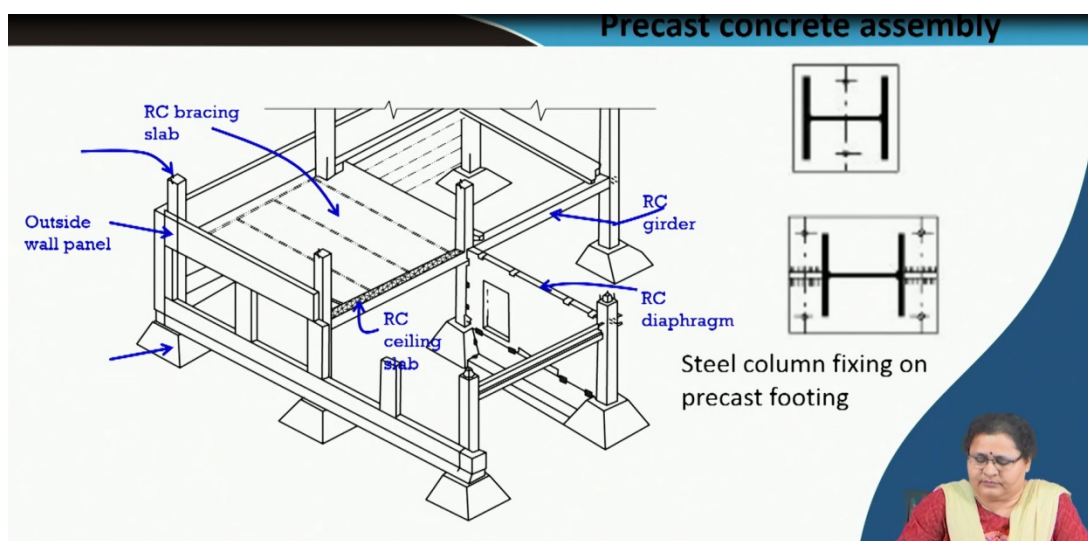
So you see here the precast concrete footing. Here you see a post or a column which is actually subjected to different kinds of loads from the beam it is finally transmitting it to the foundation or the footing. Here you can see on site there are number of footings made

according to the location of the column. So you can make a concrete structure resembling a footing what we see it is a splayed thing but it has to have a base plate where this column is going to come and sit.



So this concrete pyre is there you can see this post will come and sit on top of this base plate. There are possibilities that you can weld it you can screw it with nut and bolt and such provisions are to be made in advance in the footing. So if you can create this, design this then you can also make a foundation which will take in the load which is transferred to it through the column and this column and this foundation joint is through this base plate where the numbers of screws, nuts and bolts groutings etc. are done to hold this column in position. (Refer time: 05:44)

So once you understood it you see here is the column system coming up. You can see multiple columns in the same site maybe which is having such kind of footing and then there is a connecting beam. There may be floors and outside wall panels set between the two columns again on top of the beam and column system the roofing slab may be the floor slab may be placed. When these can be concrete it could also be steel columns.

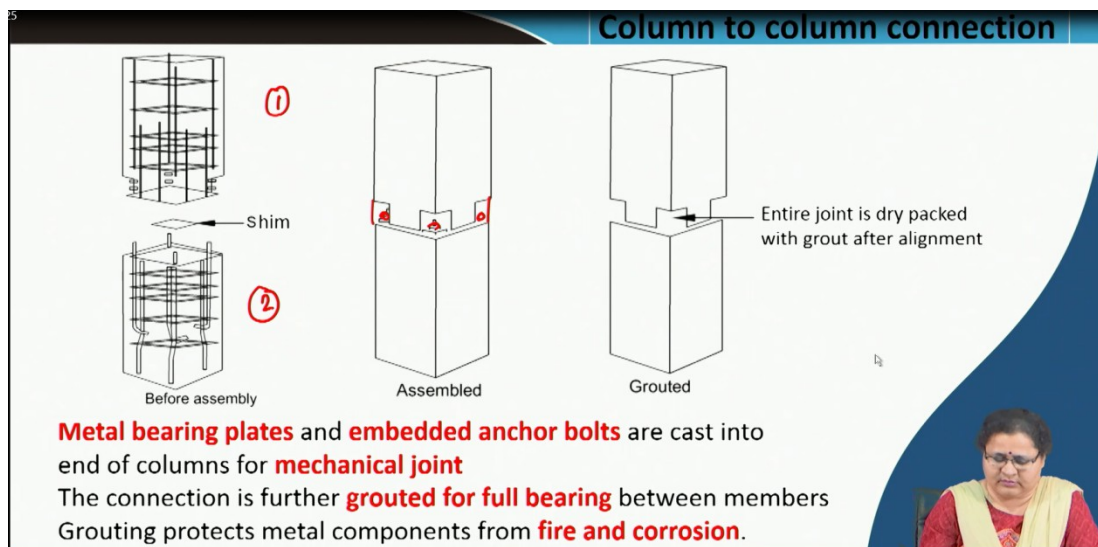


You see this is an I steel section. We will come steel when we will discuss on this these are rolled steel sections which are which can take lot of spans to take lot of load in place of concrete. And see these are the bolts by which they are fixed on the base plate. So this steel column is having this base plate which is sitting on the foundation base plate which we had discussed just before in our previous slide.

So this base plate on this base plate actually this can be fixed. So this is the plan and once it is coming up in section it would not look like a solid rather it will look something like this on top of which you may have a steel section of beam being welded to it by angles set on it. So there may be welding with the beam on top of it. So there may be a steel assembly entirely instead of a concrete assembly.

But finally maybe the roof system the floor system is a precast flooring system. So what are we gaining through it is we are reducing our time of construction. (refer time: 08:53)

Coming to joining two columns when we were talking of steel columns you can actually join two steel columns by means of plates with rivets with welding etc. Here it is case of concrete column where you can see the concrete two columns are being added together. This is before assembly you see one piece, piece one and piece two these are the two items again below it may be piece three. So from ground it can be assembled one on top of the other by means of plates together connected giving a mechanical bond.

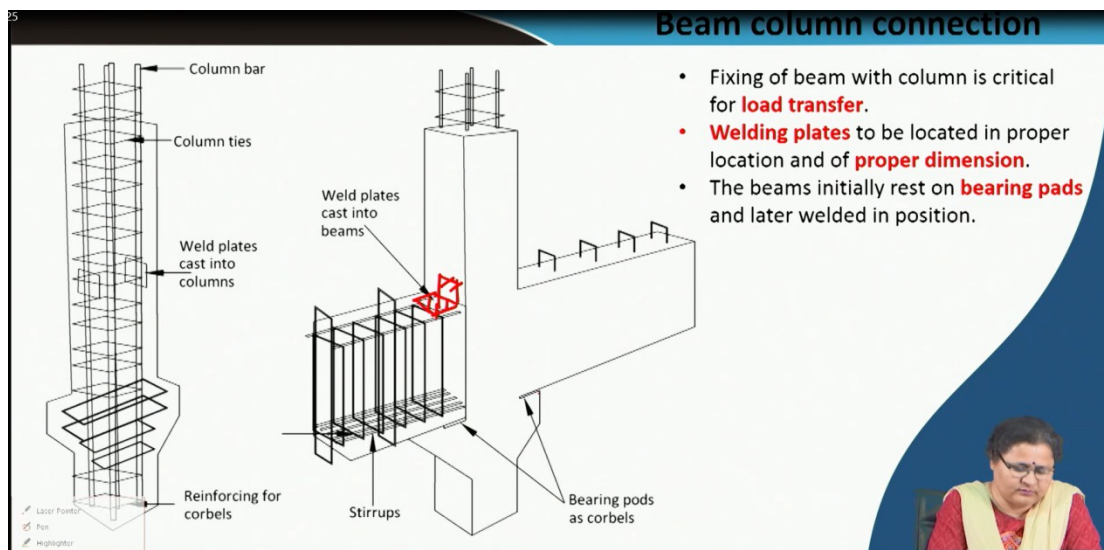


So metal bearing plates are embedded and embedded anchor bolts are cast into the end of the column for giving mechanical joint. And then you see in the second picture so these are the bolts these are the nut bolts here and after which these edges are grouted these edges are actually filled in by grouts. So once this this plate shim is connecting the two through this base plate now these nuts and bolts are tightened up and then they are packed with their proper alignment.

Actually these grouting or the filling protects the steel whichever is seen from fire and corrosion. So this fire may weaken it, corrosion may eat it away, wither it away because no

one can access these portions many a time maintenance is very important. So you are sealing or plugging these points and not allowing fire or air or moisture to react with these nuts and bolts so that there is no kind of mechanical failure. So the joint between the two columns is also very important. (refer time: 11:33)

As we had discussed the beam and the column connection, we had shown the beam and the slab connection where we also discussed that these welding plate is left in the column this angle is coming out free onto which the plate of the beam is being screwed, bolted. Unless this is done there is no rigidity between the rigid connections between the two members. So you can check here in the column where it is going to receive the beam this bearing pods are created.



Since these bearing pods are being created are left and with the dimension known to the fabricator that this kind of beam will be received they are keeping position of this weld plate provision of this weld plate. So unless and until these dimensions are worked out precisely one cannot leave this plate for welding purpose. So this is very important for the load transfer welding plates are to be located in proper location and these bearing pads are to be there for the beam to rest on the column.

So once this is done the joint becomes rigid and then the sharing or the transfer of the load becomes easier. So I think with all these we could cover the precast items all together with its structural system that is the beam columns connection and transferring the load to the foundation. So all these mechanical joints are to be done according to the specifications specified in the codes and hence we can get a proper stable system. (refer time: 14:15)

With these we now move to the other interesting material which is Ferro cement. As we had seen the concrete machinery units which are made of definite sizes and which are largely used now in India that is developing country context. This is another material which is very low cost cheap and also a precast item this is called Ferro cement where it is a construction


element may be beam may be slab may be dome any shape you can think of you can make it with this item which is Ferro cement.

It is a system where steel bars are first placed and then it is wound that is it is covered by chicken wire mesh. Chicken wire mesh as you have seen may be fencing you can see chicken wire mesh they are made of 0.4 centimeter diameter mesh. So these wire mesh may be hexagonal wire mesh or maybe rectangular wire mesh as you can see in this picture.


You can see the wire mesh so this steel reinforcement of the desired shape is first place, see this mason is first placing the main rods on top of which he has wound this chicken wire mesh and then what has he done he has kept it on ground and he has actually pushed in mortar inside it. So once that is done he is getting shapes of rectangle with some thickness all around as you can see in the picture here.

Ferro cement

A construction element made of **steel bars**, tightly fitted with **chicken wire mesh** wound over the reinforcement bars and filled with mortar pressed into it.




6mm ϕ
0.4 mm ϕ mesh



Thickness varies from 25 mm to 30 mm with a maximum of 50 mm.

It was developed by Architect **P.L. Nervi** in 1941 for disaster shelter.



So this is not fabricated in the factory but he is making it here and then how is he using it we will come to see. Now what is the thickness you can observe some 30 to 35 millimetre maybe here how big are the units say some three feet by three feet this may be little smaller three feet by two feet. So depending on where you are using you are making first the dimension that is the schedule as we prepared the door window schedule.

So here this schedule has been made and they have been cast accordingly with chicken wire mesh wound over very thin reinforcement rods may be 6 millimeter diameter. This is 0.4 millimeter only so this mesh is 0.4 millimeter these rods are 6 millimeter dia and once these are cast these become your construction unit. This was first developed by architect P.L. Nervi in 1941 for disaster shelters and cyclone shelters.

What is the benefit? this can sway big being light in weight they can sway being less in weight they can absorb the earthquakes and you can go for low cost construction. (refer time: 19:10)

Now what is the mix it is cement sand mix in the proportion of one is to two or one is to two point five depending on the coarseness of sand you can also add coarse aggregate to it. Those will be usually six millimetre stone chips water cement ratio should be strictly between; 0.35 to 0.4 that is water cement ratio should be very controlled to get good quality Ferro cement. And concrete is manually pressed or by help of vibrators pressed.

As you can see the chicken wire mesh would not allow masons to reach inside this is to avoid voids because this is very thin sheet going to give you a shelter as a permanent solution. Admixtures are added to reduce weight so you can add admixtures to it these are all discussed earlier plasticizers may help in easy movement. However once it is made you can cover any dimension any coverage any shape only the internal reinforcement are to be checked considering which is the direction of tension whether it is subjected to tension or compression.

So once the rods are spread inside and it is coated with the chicken wire mesh there is very less chance of the mortar along with coarse aggregate to come out and it can act as a unified structure. Hussein Doshi gufa in Ahmedabad is completely made of Ferro cement you can always see the images which I could not produce it here but you can always see it, it is a domical structure it is a very interesting shape which has been made out of it.

However the Ferro cement that is one such structure but Ferro cement is extensively used in cyclone prone areas in disaster shelters in India. Water tanks are made with Ferro cement because it can take a circular shape and it is joint-less so chances of leakage is very minimum. (refer time: 21:57)

Coming to the advantages of it, being lightweight, it is economical, it can take earthquake up to for 7.2 in the Richter scale, it can sway up to four feet, it can be used as a walling unit, roofing unit combined. You do not require skill labour which is a challenge in our country. It does not crack easily because of the chicken wire mesh so it does not disintegrate quickly. Complex shapes for giving architectural expressions.

You can always adapt Ferro cement and you can use it for low cost constructions also. Auroville art centre experience has lot of experimentation with Ferro cement, they have designed the vault, the roofing system, the wall roofing system where ferro cement walls are used as a roofing purpose. And these Ferro cement roofing the vaults are being used in structures all around in Auroville- Auroville earth center

So experiments are on at the same time practices are also to be there to popularize a material. (refer time: 23:31)

Here you see those units which were made by the mason who are sitting, is building his own rural house getting the technology from our institute. So you see these all units are made one after the other and this is being placed within a frame where you can see the beam is here another beam was here and he is actually filling it with means of these panels and this is becoming a faster method of construction.

Ferro cement



Pre cast ferro-cement panel



Pre cast ferro-cement roofing
(under construction)



This is the roofing where you see the chicken wire mesh you can see and the roof is being cast here directly not like the vault system but it is cast here directly. However you can cast it below and place it on top of the roof that could also be done. (refer time: 24:37)

So we can conclude or conclude that these precast structures can reduce time of construction but involves skill and mechanized method. In our country context it is not so easy to adapt even till date. Yes this is a dry method of construction which is a very positive side of it though your units are all coming being made to site where you are using the water. So it is a controlled environment hence the desired quality is always attained.

Provision of expansion has to be kept particularly on the walling system where you neither can join them completely nor you can leave gaps. So sealing has to be very properly done which in case of the flooring system is not that much challenged. However, to get a finished surface motor is being used to connect all the units. Beam column slab connections are very critical for transfer of load.

Ferro cement is another method which is a low technology to make precast building units. However this Ferro-cement use is not that popularized and is not that much in use on a regular basis though it can be taken up and it can be made more popular. So with these we end this module five on pre pre-fabricated construction system particularly we covered the concrete elements but we also have foam steel embedded puff panel system etc. which initially was thought of to be put into this module but due to lack of time we will discuss it in some other module, Thank you for now.