B. ARCHITECTURE

CONSTRUCTION TECHNOLOGY (AR6013)

CONTRUCTION SYSTEMS

Lecture – 2

Pre-Stressed Concrete:

So reinforced cement concrete structures are nothing but the structures are structural elements made up of reinforced concrete for the cement concrete structures there is an important concept of Pre Stressed Concrete. So Pre stressed concrete is the method for overcoming concrete's natural weakness in tension like any other material concrete also is a material that has many weaknesses the most significant weakness of all is natural weakness in tension. So when you needed to subject a tension it fails after the certain extent. So pre stressed concrete is done to pre stressing is done to overcome this weakness in tension. It can be used to produce beams, floors or bridges with a longer span than is practical with ordinary reinforced concrete.

So there are two methods of introducing pre stressing to a concrete one is pre tensioning and other one is post tensioning concrete as I said materials like concrete will shrink while curing and it also suffers sectional losses due to creep when subjected to pressure. The amount of shrinkage and creep likely to occur can be controlled by designing the strength and workability of the concrete.

The essence of pre stressed concrete is that once the initial compression has been applied the resulting material has the characteristics of high strength concrete when subject to any subsequent compression forces and of ductile high strength steel when subject to tension forces.

This can result in improved structural capacity and or serviceability compared to conventionally reinforced concrete in many situations.

Tendons

How do we do it we do pre tensioning or post tensioning basically the parts of pre stressing with the help of Tendons, so tendons can be defined as small diameter wires those are (2-7mm) in a plain round, crimped or indented format, these wires may be individual or grouped to form cables.

The two main advantages of strands are

- First of all a large pre stressing force can be provided over a restricted area
- Secondly strand can be supplied in long flexible of being stored on drums thus saving site storage and site fabrication space.

As you can see in the slide here these are the typical tendons formats in this particular figure we can see there are 12 No. 7mm diameter wires that are stressed together and this is you know combined by a binding tape and this is also called parallel lay cable. So all this wire they form a cable structure. Second is a Monostrand Cable in this we are using 15mm diameter stands which are seven in numbers. So these are strongly stressed and they form a single strand and this particular illustration is an illustration of Monogroup Cable. So this is 13 No. 15 mm diameter strands which are stressed together. So this are strands the collection of cables they make tendons so these tendons help as pre tensioning or post tensioning

Pre Tensioned Concrete

Pre-tensioned concrete is a variant of pre stressed concrete where the tendons are tensioned prior to the concrete being cast. The concrete bonds to the tendons as it cures, the following which the end anchoring of the tendons is released and the tendon tension forces are transferred to the concrete as compression by static friction. In this illustration you can see this is the tendons that is joined by two ends the other end we can see a hydraulic jack here which give the tension forces to the tendons. In pre tension concrete what we generally do basic intent is to have the trance put together we apply from one side so this strands are stretched and after that we pier concrete over there, so this is the basic intent of pre tensioned concrete. So you can see here in the illustration as the strands are stretched after that the concrete is discussed around the stressed wires we can put dividing plate or spacer as required, see in this case this is the hydraulic jack to give tension forces to the tendons and the stretch it and this is the anchor in the other end. This is the typical example of how we do pre tensioning,

this is the pre tensioning slab casting picture in this we can see these are the tendons that as stretched at both the ends, once I resficed the other side is pulled and you know it is stretched and properly formed and then after that we pour concrete over it just thus forming a pre tensioned concrete. So now coming to the concept of post tensioned concrete

Post Tensioned Concrete

Post tensioned Concrete is nothing but a variant of Pre tensioned concrete where the tendons are tensioned after the surrounding concrete structures has been cast. The stressing is carried out after the concrete has cured by means of hydraulic jacks operating from one or both ends of the member. In this case we can see this is the concrete element and we see the strand is passing through it, so this strand is put inside this concrete element after the casting and placing of the concrete we put this strands when we tension it either from both sides are from one end we can see the anchorage housed in recess filled with stiff mortar here on this side there is a hydraulic jack and here this is the grout filled duct and this is the pre stressing tendon helical reinforcement. This is the typical example and illustration of how most tensioned concrete structure looks during erection .These are the typical anchorage details for the tendons.

You can see this is the Male cone that is driven into the female cone this are the tensile steel spiral to hole that holds it together. This is the reinforced concrete female cone that is cast into end of concrete member as I already explain in the early slides; this is called the grout hole as shown in the earlier illustrations. This is forge steel anchorage block, this are the holes to support to take the tendons in as I said these are the 7 No holes for strands and jaws, this are the fixing holes, this is the socket for steel duct or also called as sheath, this is the malleable cast iron anchorage and bearing plate cast into end member, this are the grout hole as I explained earlier.

The comparison of Pre Stressed Concrete with Reinforced Concrete

So when comparing pre-stressed concrete with conventional reinforced concrete structure the main advantage and disadvantage can be enumerated but in the final analysis each structure and or component must be decided on its own merit.

The Main advantages

1. It makes full use of the inherent compressive strength of concrete
2. It makes full use of the special alloy steels used to form the pre-stressing tendons
3. It eliminates tension cracks thus reducing the risk of corrosion of steel components
4. It reduces shear stresses
5. For any given span and loading condition a component with a smaller cross section can be used thus giving a reduction in weight
6. Individual precast concrete units can be joined together to form a composite member

The Main Disadvantages are

1. High degree of control over materials, design and quality of workmanship is required for to a great deal.
2. The special alloy steels are dearer than most traditional steels used in reinforce concrete.
3. Extra cost of special equipment required to carry out the pre-stressing activities
4. Cost of extra safety requirements needed whilst stressing tendons.

As a general comparison between the two structural options under consideration it is usually found that

1. Up to 6m span traditional reinforced concrete is the most economic method.
2. But for spans between 6m and 9m the two cost options are somewhat comparable
3. But for spans over 9m pre-stressed concrete is more economical than reinforced concrete because the span is to high it always better for the application of pre-stressed concrete

It should be noted that generally columns and walls do not need pre-stressing but in tall columns and high retaining walls where the bending stresses are high. Pre-stressing techniques can sometimes be economically applied.

Precast Concrete:

Precast concrete is the construction product produced by Casting concrete in a reusable mold or formed which is in cured and controlled environment,

This structures which are cured in a controlled environment and molded to particular shape or then transported to the construction site and lifted it into the place. In contrast standard concrete is port into side specific forms and cure on side. So the basic idea is that there is an assembly line and there are molds and we are pouring concrete into the molds Curing the some other locations transporting the particular form of concrete to the site and lifting an placing it up as required and why do we used precast concrete. First of all precast concrete structure are very comfortable the material has intrinsic properties of thermal inertial allowing a more constant temperature both in cold and hot regions and also acoustic insulation. So we can actually controlled how much it will expand and contract as per the location and structure is getting built to

Secondly the precast concrete is safe not only the structural stability maintains for longer periods, but concrete construction prevents the spread of the fire from one building to another. It is sufficiently strong to resist impacts, blasts and natural catastrophes like earthquakes, tornadoes and floods.

Precast Concrete is Versatile

Factory production allows a wide choice of surface finishing, colour range and special shapes. Precast concrete has another advantage: its mouldability which entails designers to copy classical details like keystones and capitals or match the finish of materials like weathered stones. The precast concrete industry can source a wide range of aggregates locally and offer a tremendous variety of colours and visual effects. So the precast concrete is very useful for designers so we can use the surfaces we want we can use the textures we want we can use the color we want and we can use we can have applications at various locations, not only a structural member but also a finishing material

Precast Concrete is Healthy

In today's case Indoor air quality is a concern for all of us, precast concrete is stable throughout its life and does not need chemical treatment to protect it against rot and insect attack, this means that there are no emissions in the internal environment at all.

Precast Concrete is optimized

Advanced technologies used in the precasting plants create an improved quality product that is reduced tolerances thinner sections engineered solutions compared with cast-on-site concrete. What happens is that side when we do cast-on-site construction in most of the cases due to workmanship errors we do not get finished edges. So we do application of precast concrete. Precast concrete are product can be corrected to even plus minus 0.00. so additionally this quality can be checked before unit is inserted to the structure or site works. So we can check the tolerance of the particular product and then we apply you know wherever the use the application is required. So precast concrete is useful for that plus also precast concrete comes undergoes there are quality checking before it reaches the site so its also bone to use precast concrete for various application.

Precast Concrete is Durable

We all know that concrete last for years. Egyptians and Chinese people used in ancient form of concrete of buildings and structures that still exists today. Concrete is used where the structural stability has to be maintained for long periods. Effective design detailing helps to lengthen the life of a concrete building; precast manufacturers can offer guidance on designing for durability

Precast Concrete is Ecological

Precast Concrete is made up of natural raw materials that are stones, gravels, sand, cement etc. which are locally available almost everywhere and in an enormous quantity Precast Concrete minimizes the whole life cycle impact on the environment when compared with other construction because Precast concrete units can entirely be re-used or recycled.

Precast Concrete is Fast

The top floor of the skyscraper for example can be cast in the factory when the foundations are not able started. In the typical construction of the skyscraper to go for a foundation to the top floor will take ages whereas in precast construction what we do is when the foundation is still on site we can cast the floor in some factory and we can bring it to the site and then we can place it as in where we want. But the project requires for the model construction prefers an in time delivery as I was say on site construction

using precast concrete not only faster but also safer as secure working platforms are quickly established.

Precast Concrete is Affordable

Precast concrete combines the excellent quality of factory production with a relatively inexpensive material. The costs of repair and maintain a concrete structures are highly limited. There is therefore no need to compromise on quality to reduce costs, simply choose the best way to use locally available resources.

Precast concrete is also Sustainable

Sustainable means a "3-win" situation for the three pillars of our society. People, profit and planet. If only one of these elements is "negative", the solution can't be considered sustainable. Here in this illustration this i bring to you examples of precast concrete. In this figure you can see as the section of the staircase which is completely precast in a factory brought to site and assemble. You see this is the picture on the right hand side of a factory which does precast modules for constructions. So this are precast modules with holes or insertions which are brought to site and inserted wherever is required. It's a male female joint concept so we can bring this we can transport these modules to site and fit to the applicable spaces as in when required.

Prefabrication System:

Prefabrication system is the practice of assembling components of the structure in a factory or other manufacturing site and transporting complete assemblies or sub-assemblies to the construction site where the structure is to be located, I just spoke about precast concrete. Prefabrication system is the extension of precast concrete what we do is what we explain about the precast concrete system. Prefabrication is extensive combination of those e precast elements. For example the summary of the entire prefabrication thing definition is for example if I have to make a house What I do is in a factory or warehouse I assemble the entire may be half full or a twenty five percent of a house including staircases that mean include walls that may include doors, that may include floor slabs, that may include roof slabs and then transport the entire unit to the site and fixed as per the site condition.

The Salient Features of such construction techniques:

- The assembly of buildings or their components at a location can be done other than the building site.
- This method controls construction costs by reducing on time, wages, and materials
- Prefabricated units may include doors, stairs, window, walls , wall panels, floor panels, roof trusses, room-sized components and eve entire buildings
- The term is used to distinguish this process from the more conventional construction practice of transporting the basic material to the construction site where all assembly is carried out

Advantages of Prefabrication system:

- We get a high quality product without any error
- We get related savings, we get considerable savings related to labor costs
- We get savings in time
- We have in overall efficiency which I s greatly increased
- Mass Production easier and quick
- Protected and controlled production environment
- Potential for lower production costs and other cost savings
- Independence of climatic conditions
- The disruption of traffic is avoided
- And it also ensures high degree of safety

Disadvantages of Prefabrication system

- We have to carefully handled the prefabrication components such as concrete panels, steel or glass panels when we have to transport from the factory or the warehouse to the side.
- Attention has to be paid to the strength and corrosion resistance of the joining of prefabricated sections to avoid failure of the joint. Not only that the joints once placed at the certain point we have also ensure the water tight. So all this requires a lot of attention and detail.
- The leaks can form at joints in prefabricated components.
- Transportation costs may be higher for a voluminous prefabricated sections than for the materials of which they are made for example concrete is concrete might be easier to transport other than joint sections for say a gutter, NRC gutter and huge gutter for a bridge

- Large prefabricated sections require heavy duty cranes as I just explain and precision measurements and handling to place in position because nowadays in fact we even use GPS system to construct the metro lines, the metro gadders, and the bridges so we require the high degree of precision to prefabricate such members of concrete.

Here I bring you few illustrations of prefabrication system. In this left picture you can see this wall getting built for a building and this element is prefabricated element. So this are like modules you know the module contains three units you can see here it's an RC wall which also include three division three windows and including Malians and glasses etc. So each of these components is manufactured at site or manufactured in the factory or fabricated at the factory and is brought into site and assembled. In the right illustration you can see an entire part of a floor getting prefabricated at a site brought to site by a heavy duty vehicle and lifted by a heavy duty crane and put into place.

Modularity:

The concept of Modularity,

What are Modular Buildings?

Modular Buildings and Modular homes are sectional prefabricated buildings or houses that consist of multiple sections called modules. "Modular" is a method of construction differing from other methods of building like the conventional ones

Modular components are typically constructed indoors on assembly line. Modules construction may take as little as ten days but more often one to three months. Completed modules are transported to the building site and assembled by a crane placement of the modules may take from several hours to several days. As I explained prefabrication system modularity is just an extension of the prefabricated system. In modular buildings what we do for example an entire floor or an entire building is prefabricated at site brought to site and then it is constructed, it is placed into position. In this illustrations you can see a floor is getting constructed at the site or staircases getting done all the walls are getting erected at site, so this is the example of perfect modularity or perfect floor along with its components or constructed in warehouse which will be further shift to the site and will be lifted by heavy duty crane to its particular position. In this illustration you

can see we are constructing a roof in modules so this is the roof peace which is set in place so which will be further take into side and fixed it appropriate location when we are doing modular buildings construction is just the reputation of modules. So this modules are fixed prefabricated we have certain set of dimension in construction what we do have a reputation of this for example the module dimension has square feet area of X say at the site we will have for example a multiple of 2X, 4X so it’s always a repetition of this modules.