POST TENSIONING / PRE-TENSIONING

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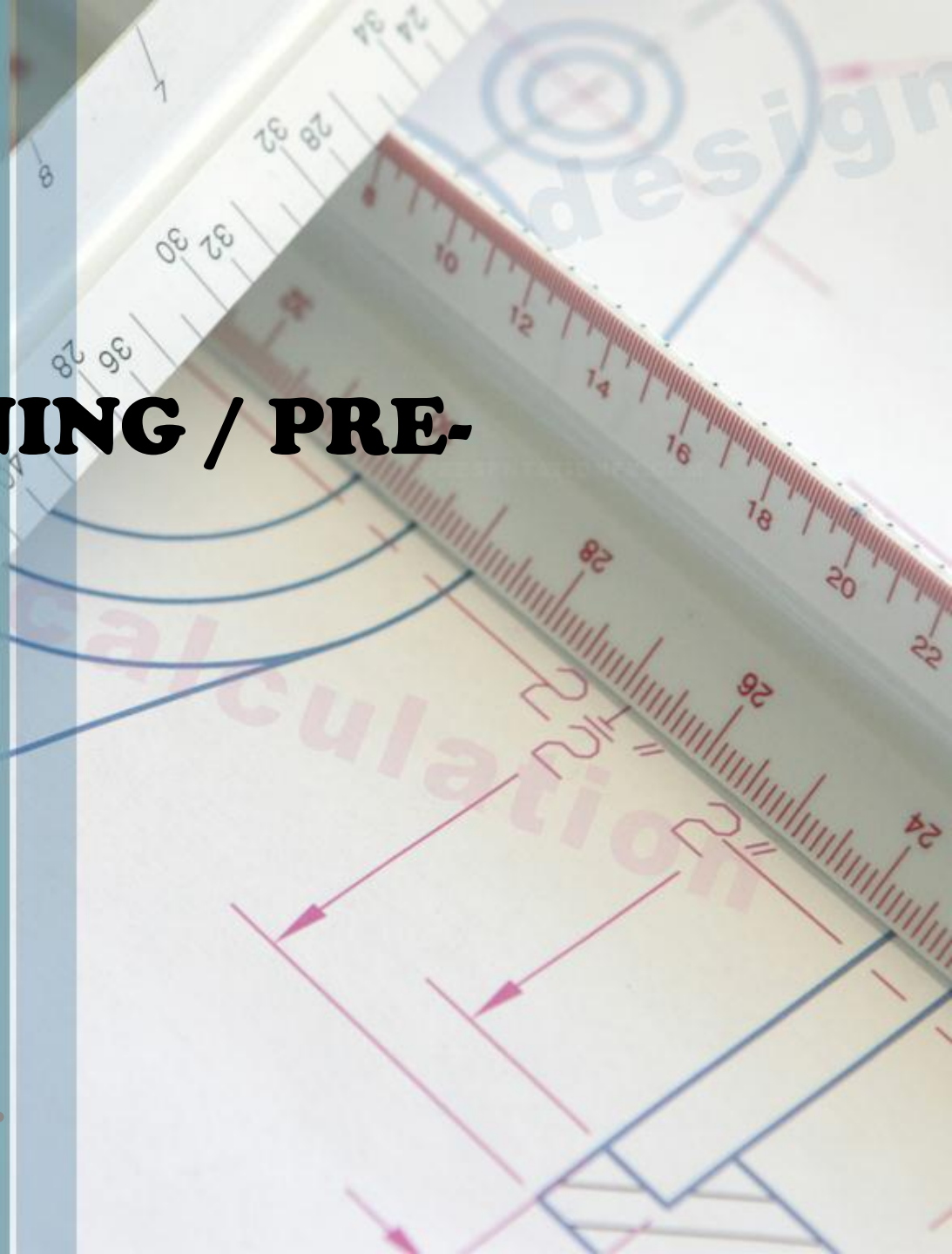

History…

- The first post-tensioning systems consisted of ¼-in.wires bundled in groups of 3 to 12. Eight wire bundles were the most common; the wires were coated and the bundle was spirally wrapped with reinforced craft paper. It was referred to as a "button-headed" system since cold-formed button heads were used to secure the ends of the wires against the anchorage assembly
- By the early 1960s, contractors had started using "strand" tendons. Strand was much easier to install and stress than the button-headed wire systems, and by the mid 1970s, strand was being used for almost all applications except nuclear containment structures.
- Although the first strand systems were paper wrapped, by the early 1970s, most strand systems were using plastic sheathing.

http://www.icri.org/publications/2001/PDFs/julyaug01/CRBJulyAug01_Kelley.pdf

➢Post-Tensioning is best to understand by considering first the main difference between :

REINFORCED CONCRETE
&
PRE-STRESSED CONCRETE

➢both utilize the structural capabilities of steel and concrete. Concrete is very strong in compression, but relatively weak in tension.

Ordinary Reinforced Concrete

- beam supports a load by developing compressive stresses at the top, but since the concrete cannot resist the tension at the bottom, it cracks there.

- Reinforcing steel bars are placed within this tension zone to resist the tension and control the cracking.

Pre-stressed Concrete

- however involves the application of forced or forces tending to bend and compress a concrete structure or structural element in ordered counteractive bending which results from loading.

- The forced applied is the tensioning or stretching of the steel component which usually in the form of high tensile strands, wires or bars.

Types of Pre-Stressed Concrete:

Pretension
&
Post Tension

- These two differ in the method of stressing the elements. A description of the construction sequences will help bring out this difference.

Pretension - Pre-stressed Concrete

- the beams or elements are constructed on a stressing bed and stranded cable is placed between two buttresses anchored to a stressing bed which holds the force in the stretched cables.

- After stretching the steel with hydraulic jacks, concrete is placed in forms around the cables and allowed to harden. When the concrete reaches sufficient strength, the pre-stress forced is transferred to the concrete by bond when the steel strand at the ends of the beam is cut loose from buttresses.

Post-tensioned pre-stressed concrete

- so called tendons (wire strand or cable) are placed in the forms at the proper location. These tendons are covered with a multi layer heavy paper wrapping.
- Concrete is then placed in the forms around the tendons and allowed to harden to the required strength (usually 5 to 7 days).
- After the concrete has hardened, the pre-stressing steel which is separated from the concrete by paper, plastic or metal sheathing is stressed or stretched by a hydraulic jack which pushes directly against anchorage embedded in the hardened concrete .

- The force in the stretched steel is then permanently transferred to the concrete through the anchorage devices at the end of the concrete casting.
- The use of curved tendons will help carry some of the shear in a member. In addition pre-compression in concrete tends to reduce diagonal tension. Thus it is possible to use a smaller section in post-tensioned concrete to carry the same amount of external shear in a beam.
- Pre-tensioned pre-stressed concrete is usually fabricated away from the job site in a pre-stressing plant, whereas in post-tensioned pre-stressed concrete the application of stressing forces to the structure is done at the job-site.

Advantages of Pre-stressed Concrete or Post-tensioned Pre-stressed Concrete

- Serviceability
- Safety
- Economics

Serviceability:

- Post-tensioned concrete design is more suitable for structures of long span and those carrying heavy loads principally because of the higher strengths of materials employed. Members are more slender and hence more adaptable to artistic treatment. They yield more clearance where it is needed. They do not crack under working loads, and whatever cracks may be developed under overloads will be closed as soon as the load is removed, owing to the cambering effect of pre-stress

- This becomes an important consideration for such structures as long cantilevers. Under live loads the def section is also smaller because of the effectiveness of the entire un-cracked concrete section.

Safety:

- It is difficult to say that one type of structure is safer than another. The safety depends more on its design and construction than on its type. However, certain inherent safety features in pre-stressed concrete may be mentioned. There is partial testing of both the steel and the concrete during post-tensioning operation.
- For many structures during post- tensioning, both the steel and concrete are subjected to the highest stresses that will exist in them during their life of service. Hence if materials can stand post-tensioning, they are likely to posses sufficient strengths for service loads.

- When properly designed by present conventional methods, post-tensioned concrete structures have overload capacities similar to and perhaps slightly higher than those of reinforced concrete. For the usual designs, they deflect appreciably before ultimate failure thus giving ample warning before impending collapse.

- The ability to resist shock and impact loads and repeated working loads, has been shown to be as good in post-tensioned as in reinforced concrete. The resistance to corrosion is better than that of reinforced concrete for the same amount of cover owing to the non existence of cracks.

Economics:

- From an economic point of view it is at once evident that smaller quantities of materials, both steel and concrete, are required to carry the same loads since the materials are of higher strength.
- There is also a definite savings stirrups, since shear in post-tensioned concrete is reduced in the inclination of the tendons, and the diagonal tension is further minimized bathe presence of pre-stress. The reduced weight of members will help in economizing the cost of structures', the smaller dead load and section of member will result in saving materials and labor from other pollution of the structure such as the foundation columns shear skills, etc.

Advantages of Post-Tensioned Construction are as Follows:

1. Where columns are vertical members and are not too far apart, post-tensioned flat-plate slab is possible thus eliminating need for ceilings.

2. No joints can be seen as it is monolithic structure.

3. Concrete topping is not required and therefore resulting in another considerable cost-savings.

4. There is no camber or deflection in a post- tensioned member at service load.

5. Construction is much faster than any other system of construction because form work can be removed after stressing usually after 7 days

6. Cranes and other heavy equipment are not necessary.

7. Waterproofing is not required for a two way post- tensioned slab.

8. Construction can be stopped at any floor which is automatically waterproofed when tendons are placed in both directions. Thus there is no additional expense for the next phase of construction.

9. It is cast-in-place solid monolithic construction completely safe and resistant to earthquakes.

10. Where limited height is required, more floors can be constructed because of shallower beams and slabs.

11. Many other advantages accrue to the owner architect or engineer such as design flexibility, reduced building height, and better aesthetic features.

STEP-BY-STEP PROCEDURE

1. Rolls of post-tensioning cables

2. Pulling anchors for post-tensioning cables

3. Pulling anchors for post-tensioning cables

4. Pulling anchors for post-tensioning cables

5. Post-tensioning cables stripped for placement in pulling anchors

6. Positioned post-tensioning cables

7. Post-tensioning cable ends extending from freshly poured concrete

8. Post-tensioning cable ends extending from concrete slab