Advanced Concrete Technology in Construction Field

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Pre-Tensioning & Post- Tensioning:
Pre-tensioning :

Pre Stress Concrete
Technology :

The recent and emerging technology in construction field is Pre Stress Concrete. It is widely used in foreign countries, the pre stress concrete can be classified into two categories. They are

- Pre-tensioning
- Post-tensioning

Pre-Tensioning & Post- Tensioning:

Pre-tensioning :

The method in which the wires are stretched before concreting is referred to as pretensioning.

The grip of concrete on wires increases slightly when the wires are released from the stretching device due to a slight shortening and swelling of the wires.

Post-tensioning

Cast the concrete in which a sheath or other wrapping is preembeded which allows the wires to move freely during stressing.

Anchor the wires or tendons at the ends of the beam by fixing to an anchor plate, or other devices such as wedging with concrete cones**.**

POST - TENSIONING

WHAT IS POST-TENSIONING?

Post-tensioning- is a method of reinforcing (strengthening) concrete or other materials with high-strength steel strands called tendons.

Post-tensioning allows construction that would otherwise be impossible due to either site constraints or architectural requirements.

Requires specialized knowledge and expertise to fabricate, assemble and install.

After adequate curing of concrete, reinforcing tendons (placed in side the voids of the structure) are tensioned/stretched by jacks on the sides & grouts filled with appropriate mix.

Applications – a) Structural members beams, bridge-deck panels, Roof –Slabs, Concrete Silos Etc.

Types of Post-Tensioning

Bonded post-tensioned concrete: unstressed pre-stressing steel is placed with in the concrete and then tension stressed after concrete has harden to required strength

Un-bonded post-tensioned concrete:

It differs from bonded post- tensioning by providing the pre-stressing steel permanent freedom of movement relative to the concrete.

Prestressing tendons:

Prestressing tendon may be in the form of stands , wires , round bar , or threaded rods.

Classification and types

- Pretensioning v.s. Post-tensioning
- External v.s. Internal
- Linear v.s. circular
- End-anchored v.s. non end- anchored
- Bonded v.s. unbonded tendon
- Precast v.s. cast in-place v.s. composite
- Partial v.s. full prestressing

Prestressing steel Materials

- High strength steel
- Fiber-reinforced composite (glass or carbon fibers)
- RC vs. PPC vs. PC
- Common shapes of prestressing tendons.

Tendons :

Typical stress-strain curves of reinforcing and prestressing steel

Concerns With Pre-tension :

Usually uses a mold which is able to resist the forces within the tendons. Which are more expensive than regular molds.

Exception comes when the sides of the mold our anchored allowing mold to be created between the anchors without supporting stress.

Since it may only tightened once and cannot be retightened the designer must also account for Creep of concrete, elastic shortening of concrete, shrinkage of concrete, relaxation of steel, slip at the anchorage, and friction losses due to intended and unintended (wobble) curvature in the tendons in calculations for the camber of the member in order to have lasting quality of the structure.

Pretension requires for a slightly higher compression rating to cut the steel over post-tensioned .6 instead of .55 of the compressive strength of concrete at the time of initial pre-stress before accounting losses such as creep, relaxation and shrinkage, and redistribution of force effect.

Prestressing Steel

Forms

- Wires
- Strands
- Tendons
- Cables
- Bars

Source of Force

- Mechanical
- Hydraulic
- Electrical
- Chemical

Why Prestressed Concrete?

- Concrete remains un-cracked
- Reduction of steel corrosion
- Increases durability
- Good for pressure vessels
- High span to depth ratio (ex: 45:1 vs. 28:1)
- less dead load
- More economical

CONSTRUCTION Prestress losses :

Prestress force at any time is less than that during jacking.(Jacking means using a mechanical device to raise and support a heavy object)

Sources of prestress loss

Elastic shortning:

Because concrete shortens when the prestressing force is applied to it , the tendon attached to it also shortens, causing stress loss.

Anchorage set :

The wedge in the anchorage may set in slightly to lock the tendon , causing a loss of stress.

Friction :

Friction in the duct of posttensioning system causes stress at the far end to be less than that at the jacking end . Thus , the average stress is less than the jacking stress.

Shrinkage :

Concrete shrinks over time due to loss of water , leading to stress loss on attached tendons.

Creep :

Concrete shortens over time under compressive stress , leading to stress loss on attached tendons.

Steel relaxation :

Steel loses its stress with time due to constant elongation , the larger the stress , the larger the loss.

References

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