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# **“PRE-STRESSED CONCRETE [BCV703]”**



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## MODULE 2



Losses of Prestressing and Prestressing Systems: Losses— Immediate losses due to Friction and wobble, Elastic shortening Anchorage Slip - Time dependent losses due to Creep, Shrinkage and Relaxation losses - Introduction to Pre-stressing systems – Pre -Tensioning Devices – Post -Tensioning Devices - Anchorage Devices - Mechanical pre-stressing - Chemical Pre-stressing - Electrical Pre-stressing



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# Introduction to Pre-stressing systems



**Pre-stressing** is a technique used in concrete structures to improve their performance by **introducing internal compressive stresses** before they are subjected to external loads. This counteracts the tensile stresses that develop under service conditions, allowing the concrete to perform better in tension.

Pre-stressing eliminates or reduces these cracks by:

- Minimizing or eliminating tensile stresses
- Increasing load-carrying capacity
- Allowing for longer spans and thinner sections
- Improving durability and serviceability



## ❑ Principle of Pre-stressing

- High-strength steel tendons are tensioned.
- This tension is transferred to the concrete (either before or after the concrete is placed).
- The induced **compressive stress** in concrete counteracts tensile stress from service loads.



# Pre-tensioning System



❑ **Definition:** Tendons are tensioned **before** concrete is cast.

❑ **Procedure:**

1. Steel tendons are stretched between end anchors on a casting bed.
2. Concrete is poured and allowed to harden.
3. Once concrete gains strength, the tension is released.
4. The bond between steel and concrete transfers the force.

❑ **Applications:**

- Precast elements like railway sleepers, floor slabs, bridge girders.

❑ **Advantages:**

- Better bond between tendon and concrete.
- Mass production possible.



# Post-tensioning System



❑ **Definition:** Tendons are tensioned **after** concrete has hardened.

❑ **Procedure:**

1. Ducts are placed in the formwork before concrete is cast.
2. After hardening, tendons are inserted into the ducts.
3. Tendons are tensioned using hydraulic jacks.
4. The tension is transferred to the concrete via anchorages.
5. Grout is often injected into ducts to protect tendons.

❑ **Applications:**

- Long-span bridges, slabs, high-rise buildings.

❑ **Advantages:**

- More flexible for in-situ construction.
- Useful for long spans and complex geometry.



## Pre-stressing Systems (Commercial)

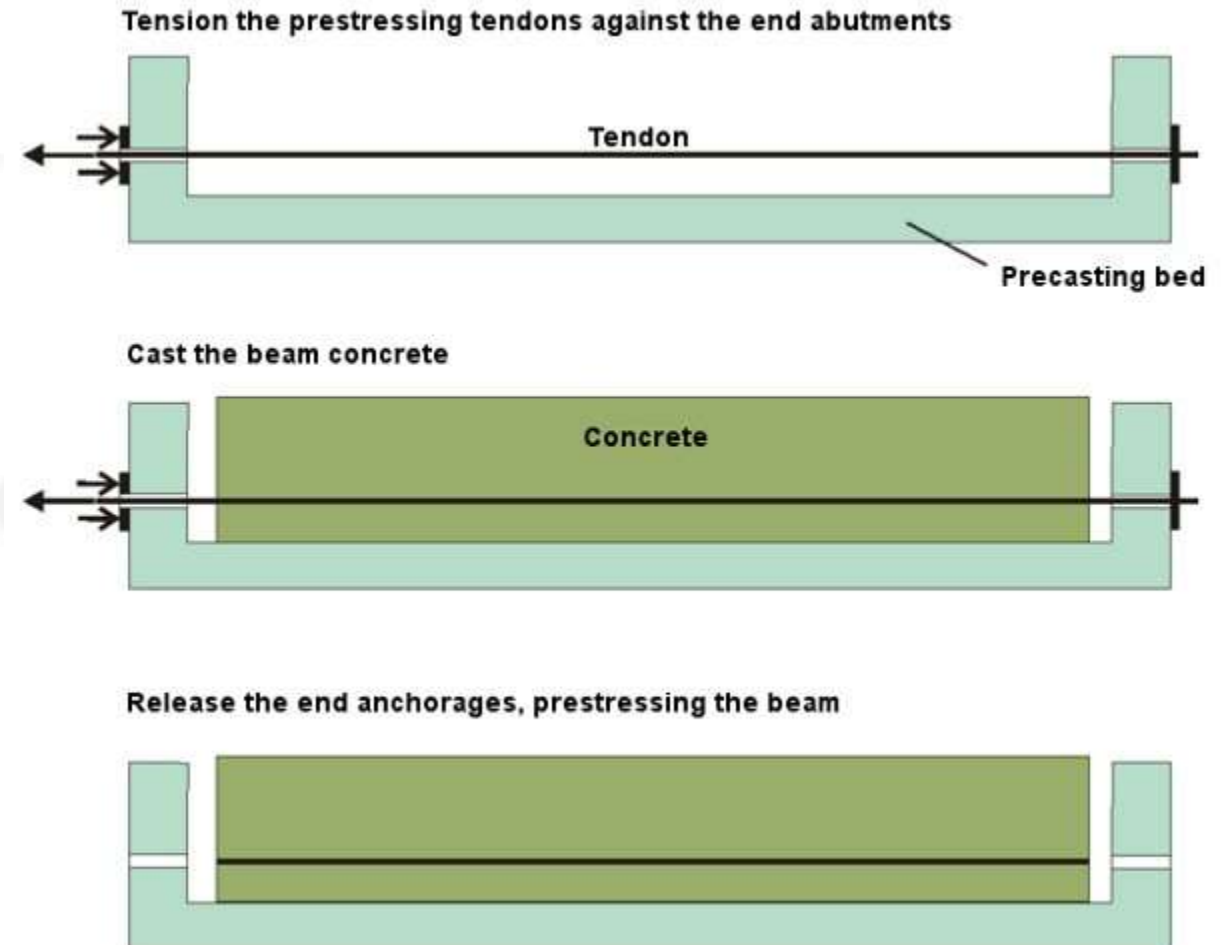
Several commercial systems have been developed for practical application:

| System               | Type            | Features                             |
|----------------------|-----------------|--------------------------------------|
| Freyssinet System    | Post-tensioning | Uses wedge anchors and thick wires   |
| Gifford-Udall System | Post-tensioning | Wire bundles grouted after stressing |
| Magnel-Blaton System | Post-tensioning | Rectangular anchorage blocks         |
| Hoyer System         | Pre-tensioning  | Used in precast factories            |
| Lee-McCall System    | Post-tensioning | Button heads for anchoring wires     |



- **Pre-tensioning devices** are tools or equipment used in **pre-tensioning concrete structures**, especially **pre-stressed concrete (PSC)** elements like beams, slabs, and girders.
- These devices apply tension to the **high-strength steel tendons or wires before** the concrete is cast, ensuring that when the concrete sets and the tension is released, it induces **compressive stress** in the concrete to counteract tensile stresses during service.

- **Prestressing bed:** A long, heavy-duty casting platform where the entire pre-tensioning process is carried out. In a setup known as the Hoyer system or long-line method, multiple concrete members can be cast end-to-end on a single bed.
- **End abutments (bulkheads):** Massive, independently anchored structures located at each end of the prestressing bed. The high-strength steel tendons are anchored and tensioned between these abutments. They must be exceptionally strong to resist the enormous tensile force exerted by the tendons.





- **Molds (shuttering):** Placed within the prestressing bed to form the shape of the concrete member being cast. The tendons run through the mold as the concrete is poured around them.
- **Hydraulic jacks:** These are the devices that apply the tensioning force to the tendons. One or more hydraulic jacks stretch the tendons to the required length and stress level, as measured by calibrated pressure gauges or load cells.
- **Anchoring devices (quick-release grips):** Simple, effective grips that hold the tendons securely against the end abutments while the concrete cures. They are typically based on a wedge and friction principle, such as split-cone wedges with serrated pins.
- **Harping devices:** Optional devices used to profile or bend the tendons into a desired shallow curve, typically for long-span beams. They use hold-down anchors placed along the prestressing bed to create a sag in the tendons before the concrete is cast.



# Pre-tensioning process using these devices



1. **Anchoring and tensioning:** High-strength steel tendons (strands or wires) are placed and anchored against the end abutments on the prestressing bed.
2. **Stretching:** Hydraulic jacks are used to pull the tendons to the predetermined tensioning force.
3. **Casting:** The concrete is cast into the molds around the tensioned tendons and vibrated to ensure proper consolidation.
4. **Curing:** The concrete is allowed to cure and gain sufficient strength. For mass production, accelerated steam curing may be used to speed up this process.
5. **Transfer of prestress:** Once the concrete reaches the desired strength, the tendons are released from the end abutments. The tendons attempt to shorten back to their original length, but the bond with the concrete prevents this, transferring the tensile force in the steel to a compressive force in the concrete.

# HOYER Long Line System of Pre - Tensioning

- The **Hoyer system**, also known as the long-line method, is a pre-tensioning technique for producing precast, prestressed concrete members on a mass scale.
- It is an efficient and economical method used in factory settings for creating items like railway sleepers, beams, slabs, and poles.

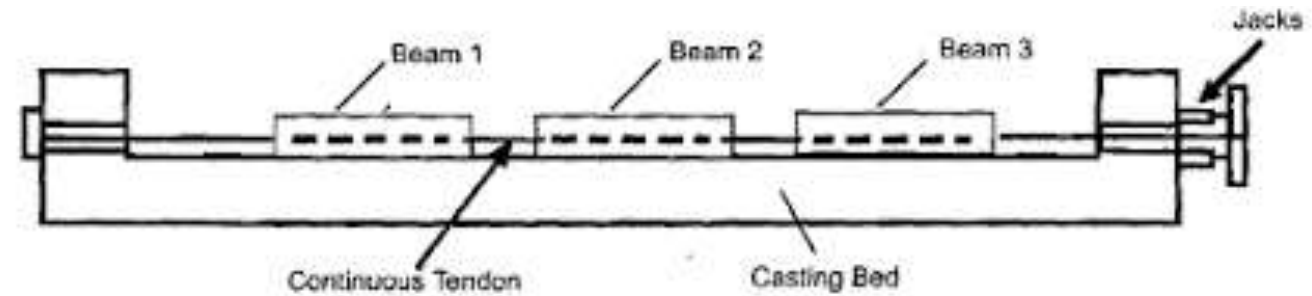
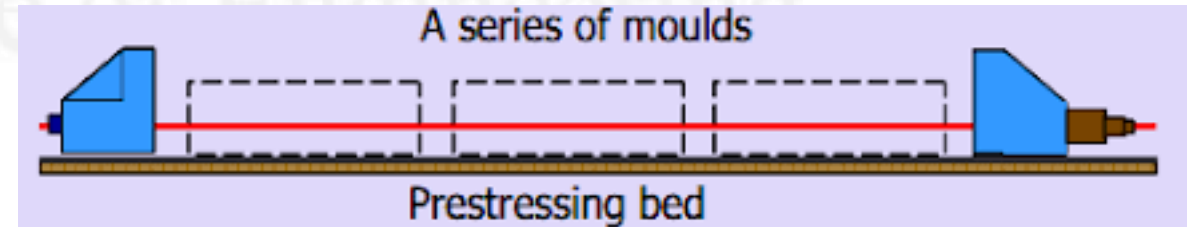


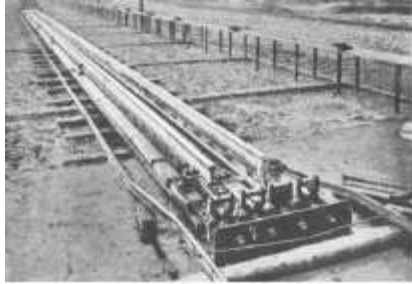
Figure : Hoyer's Long Line System of Pre-tensioning



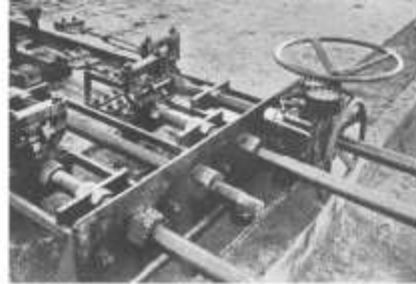


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# HOYER Long Line System of Pre - Tensioning



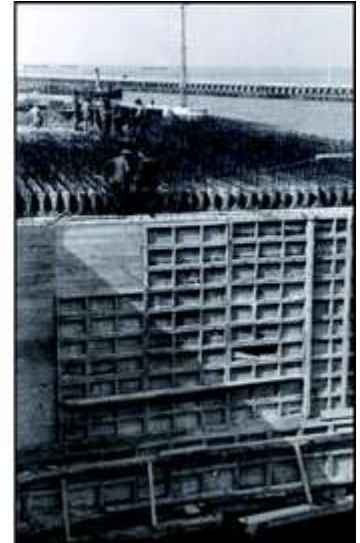
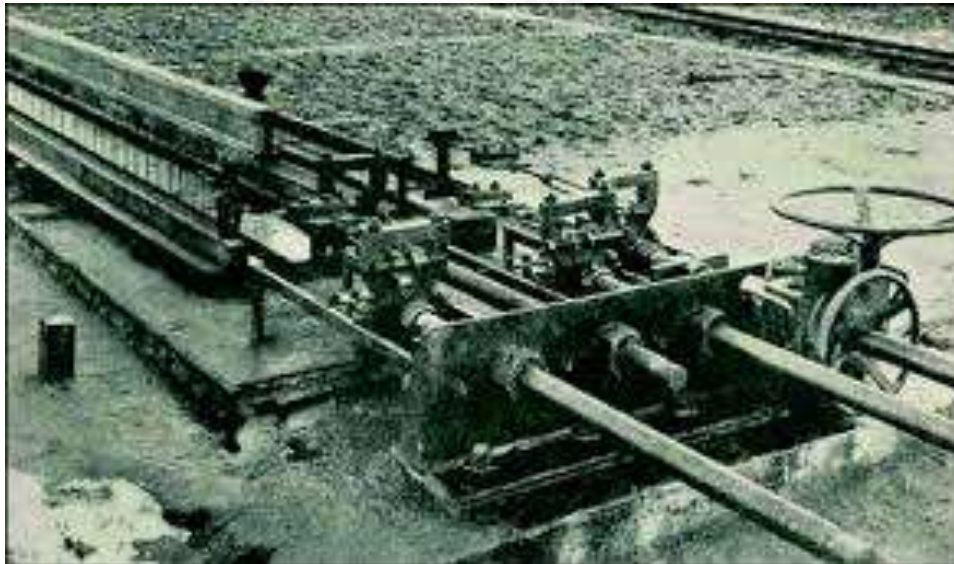
(a) Hoyer's prestressing bed



(b) mechanism for stressing wires



(c) prestressed beams cut to length





- 1. Preparation:** Two massive, heavy-duty end abutments (also known as bulkheads) are constructed at a significant distance from each other, sometimes over 100 meters. These abutments are anchored firmly to the ground to resist the immense forces involved.
- 2. Tendon placement:** High-strength steel tendons (wires or strands) are stretched continuously between the two fixed abutments.
- 3. Tensioning:** Hydraulic jacks are used to pull the tendons to the predetermined, high-tensile stress. The force applied is measured by calibrated gauges to ensure accuracy.
- 4. Moulding:** Formwork or moulds are placed along the prestressing bed, enclosing the tensioned tendons and creating the shape of the individual concrete members.



**5. Casting and curing:** Concrete is poured into the moulds, encasing the tensioned tendons. Once the concrete has gained sufficient strength (which can be accelerated with steam curing), the tensioning force is ready to be transferred.

**6. Transfer of prestress:** The tension is released from the tendons by cutting them at the ends of the cast members. The tendons, attempting to shorten, are bonded to the concrete and transfer their tensile force into a compressive force within each precast member. This creates the internal prestress that strengthens the concrete.

**7. Cutting and demolding:** The continuous line of connected concrete is cut into individual members, which are then removed from their moulds.



- **Mass production:** Multiple identical members can be cast in one go, greatly increasing efficiency and output compared to casting members individually.
- **Cost-effectiveness:** Since a single set of tensioning and anchorage operations can produce numerous members, the Hoyer system is highly economical for large-scale production.
- **Reduced need for end anchorages:** Unlike post-tensioning, the Hoyer pre-tensioning process relies on bond strength, so no expensive end anchorages are needed for the finished product.
- **Quality control:** As a factory-based method, the Hoyer system operates in a controlled environment, ensuring high quality and consistent results for every member produced.



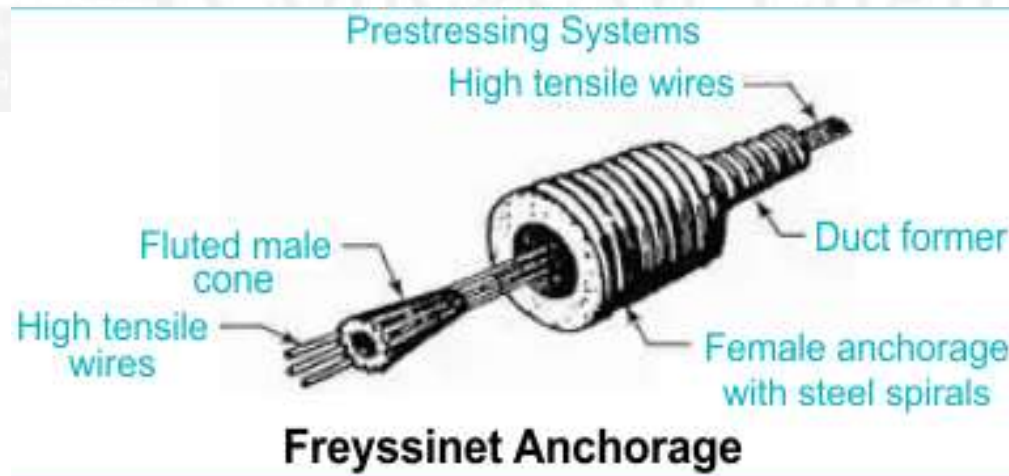
- **Large space required:** The method requires a very long, dedicated prestressing bed, which can only be accommodated in a precast factory setting.
- **Strong abutments:** The end abutments must be extremely robust to withstand the massive prestressing forces, adding to the initial setup cost.
- **Transportation limitations:** The finished precast members must be transported from the factory to the construction site, which can be difficult for large or very heavy elements.



- Post-tensioning devices are specialized mechanical systems used in construction, particularly in post-tensioned concrete structures, to apply a compressive force to the concrete after it has cured. This enhances the strength, durability, and performance of the structure.
- **Types of Post-Tensioning Systems**
  1. **Unbonded System**
    1. Tendons are greased and encased in plastic sheathing.
    2. Tendons remain unbonded to the concrete.
    3. Common in slabs and residential buildings.
  2. **Bonded System**
    1. Tendons run through ducts and are grouted after stressing.
    2. Tendons bond to the concrete after grouting.
    3. Used in bridges, heavy civil structures.

## Freyssinet Post – Tensioning Device

- The **Freyssinet System** is one of the **earliest and most widely used** post-tensioning systems, developed by **Eugène Freyssinet** in the 1930s.
- It played a pivotal role in the development of **prestressed concrete** technology and is still used today, particularly in **bridges, buildings, tanks**, and other large-scale concrete structures.
- It involves tensioning high-strength steel cables after the concrete has cured, providing a long-lasting compressive force that enhances a structure's strength, durability, and load-bearing capacity.





# How the system works



- **Casting the concrete:** Ducts or grooves, often made of metal or high-density polyethylene (HDPE), are placed inside the concrete formwork before casting.
- **Inserting the tendons:** A cable, called a "tendon," consisting of multiple high-strength steel wires or strands bundled around a helical spring, is inserted into the ducts. The spring maintains proper spacing between the wires.
- **Anchoring one end:** A special anchoring device, consisting of a reinforced concrete cylinder with a concentric conical hole, is embedded at each end of the tendon. The wires are secured at one end of the beam using the anchorage.



# How the system works



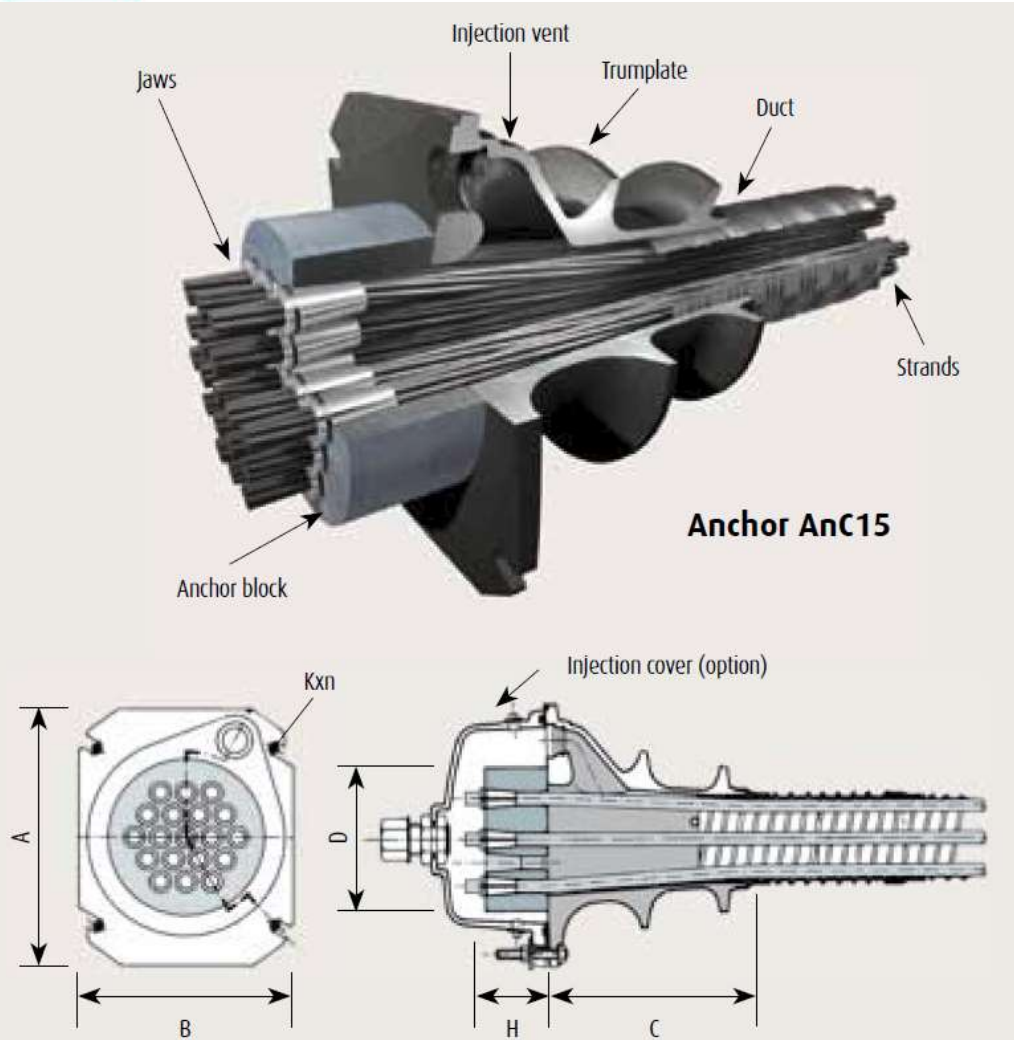
- **Tensioning the wires:** A hydraulic, double-acting jack is used to simultaneously pull all the wires in the cable from the free end.
- **Anchoring the stressed wires:** A conical plug with grooves is then pushed into the concrete cylinder's conical hole. This plug wedges the tensioned wires against the walls of the cylinder, effectively locking in the tension.
- **Grouting the duct:** After tensioning and anchoring, the duct is filled with a cement grout or other protective material to provide permanent corrosion protection for the tendons.



## Key components

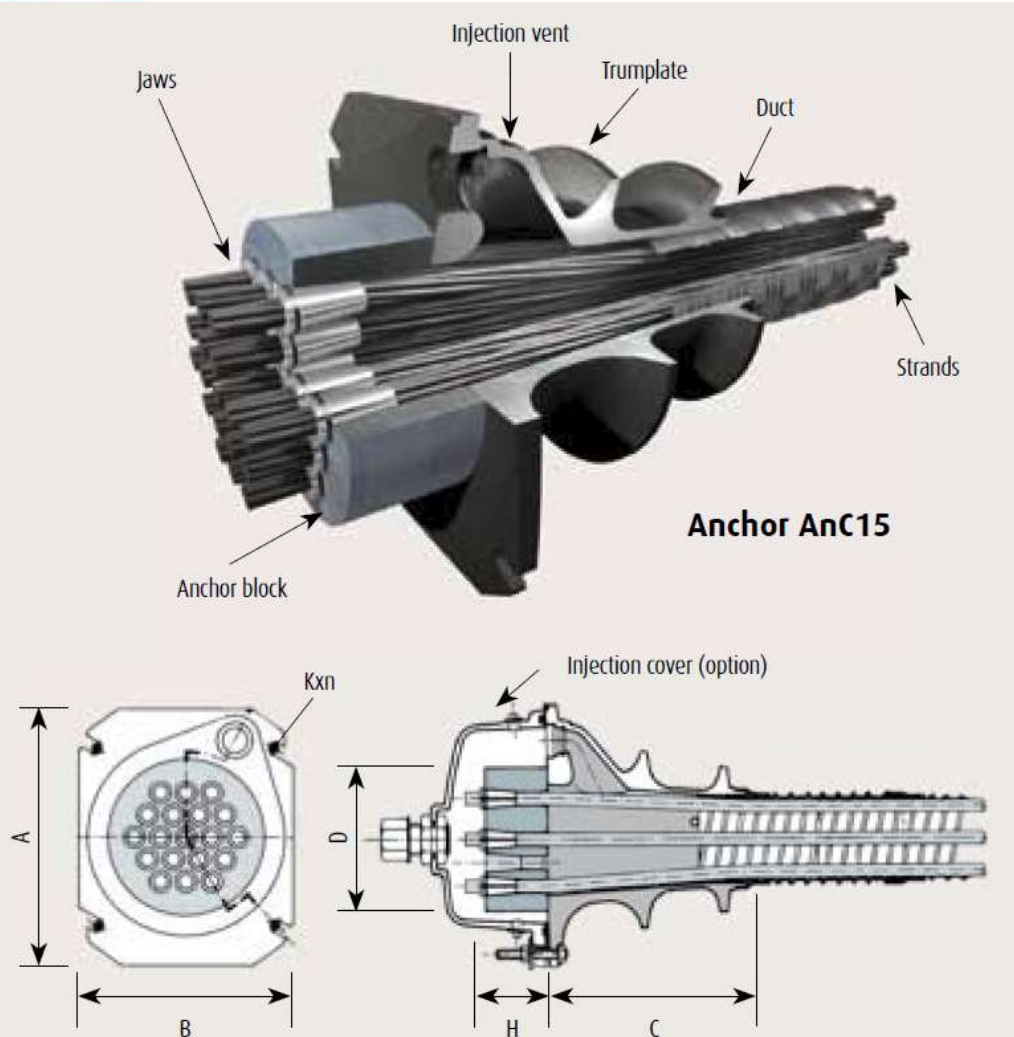
- **Tendon:** A group of high-strength steel wires or strands with a helical spring to maintain spacing.
- **Duct:** A cylindrical sheath of metal or plastic that creates a hollow channel within the concrete for the tendon.
- **Anchorage:** The device, consisting of a concrete cylinder and a conical plug, that grips and holds the stressed wires.
- **Hydraulic jack:** A specialized tool that applies the tensile force to the tendons.
- **Grout:** A cementitious or other protective material injected into the duct to protect the tendons from corrosion and ensure a bond with the concrete.

# Key Components & Configuration



- 1. Trumplate (or Trumpet/Guide):** A cast-iron component embedded into the concrete that serves as a base for load distribution and tendon alignment. It helps guide the tendon and supports the anchorage block.
- 2. Anchorage Block:** This solid block sits atop the trumplate and features conical holes designed to receive the wedges. It securely holds the tendon strands once they are tensioned.
- 3. Wedges (Grips):** Tapered, split (typically into three parts) wedges that grip each strand individually. When pulled into the anchorage block, they lock the strands in place.

# Key Components & Configuration



## 4. Single-Strand System (1F13 / 1F15)

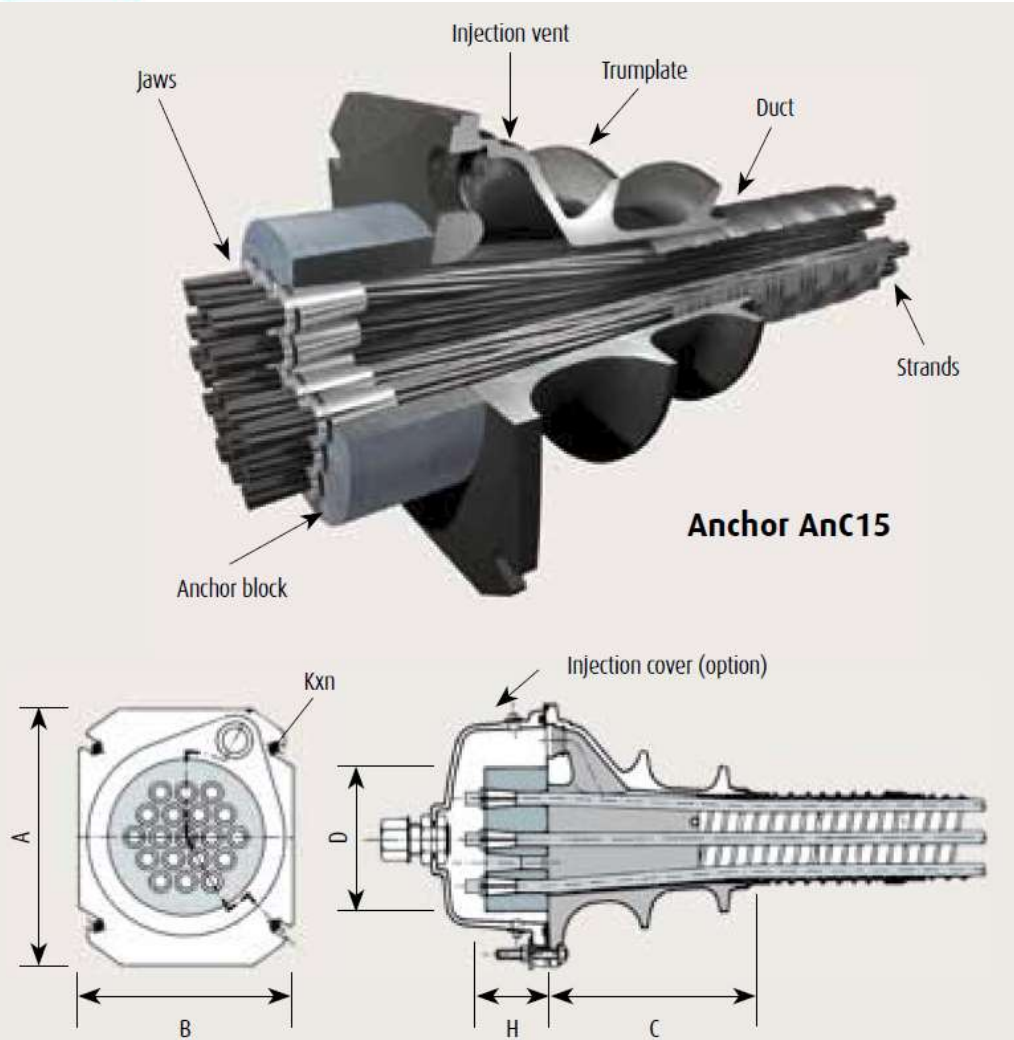
Used primarily for unbonded applications, this setup includes:

- A sheathed, greased strand to prevent bonding with concrete.
- A cast-iron anchorage equipped with wedges.
- A protective plastic tube at the point where the strand exits the anchorage.
- An external cap filled with grease to preserve corrosion protection.

## 5. Multi-Strand (B Range) System

Typically used for bonded or unbonded applications with 3–5 strands (T13 or T15). The unit includes a trumplate, anchorage block, and wedges—often separated for easier installation.

# Key Components & Configuration



## 6. Dead-End Anchorages

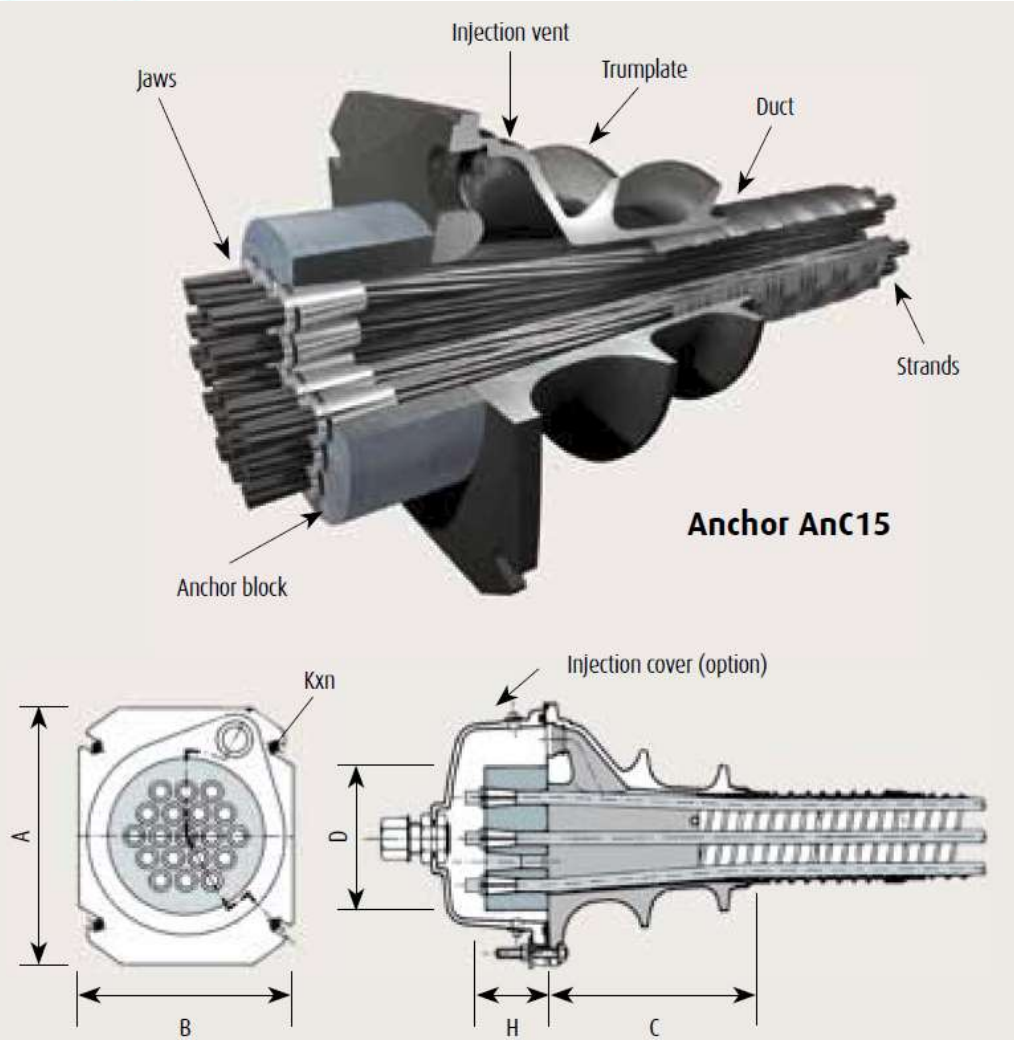
These are specialized anchors deployed when tendon ends become inaccessible after concrete setting. The systems ensure strand retention by options like:

- Blocks with swaged strand ends,
- Steel plates with swaged ends,
- Strand deformation (“onion” shaping).

## 7. Couplers & Segmental Duct Seals

For extending tendons during multi-stage construction, Freyssinet provides couplers—either single-strand or multi-strand types—and the Liaseal system for watertight continuity between segmental bridge ducts.

# Key Components & Configuration



## 8. Protection & Grouting Features

- **Grout Injection & Bonding:** After stressing, cementitious grout is injected to bond tendons and prevent corrosion.
- **Covers & Caps:** Anchor areas may be sealed with concrete or protected using permanent cast-iron/plastic covers, often filled with grease.
- **Advanced Options:** Systems include electrically insulated variants and low-pressure grout injection devices for complex profiles or high vertical tendons.



# Common Applications



- Segmental bridges
- Precast and cast-in-place concrete bridges
- Buildings (especially with large spans)
- Water tanks and silos
- Retaining walls
- Nuclear containment structures
- Foundation slabs and anchorage systems for ground stabilization



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# Advantages of the Freyssinet System



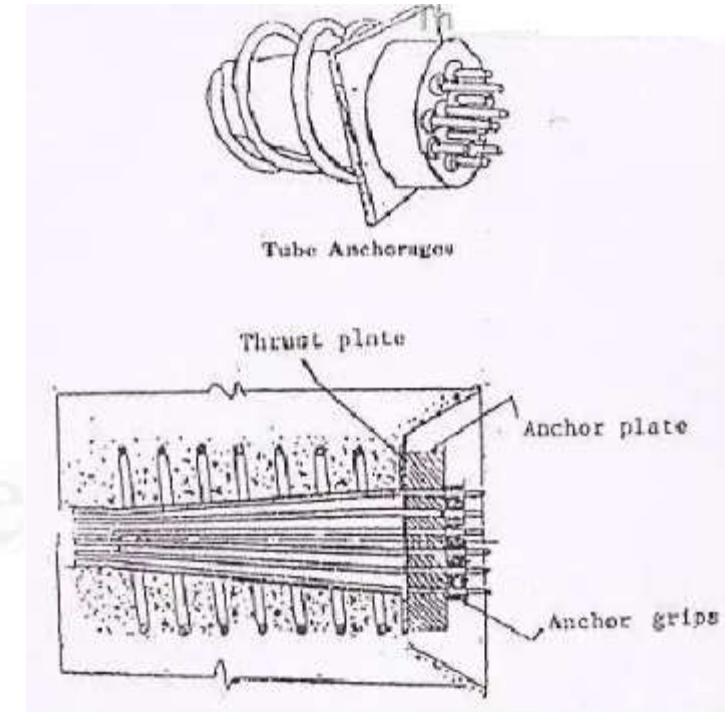
- Proven performance over decades
- High load capacity
- Flexibility in tendon layout and number
- Effective corrosion protection after grouting
- Precision in stressing operations



# Gifford-Udall Post-tensioning System

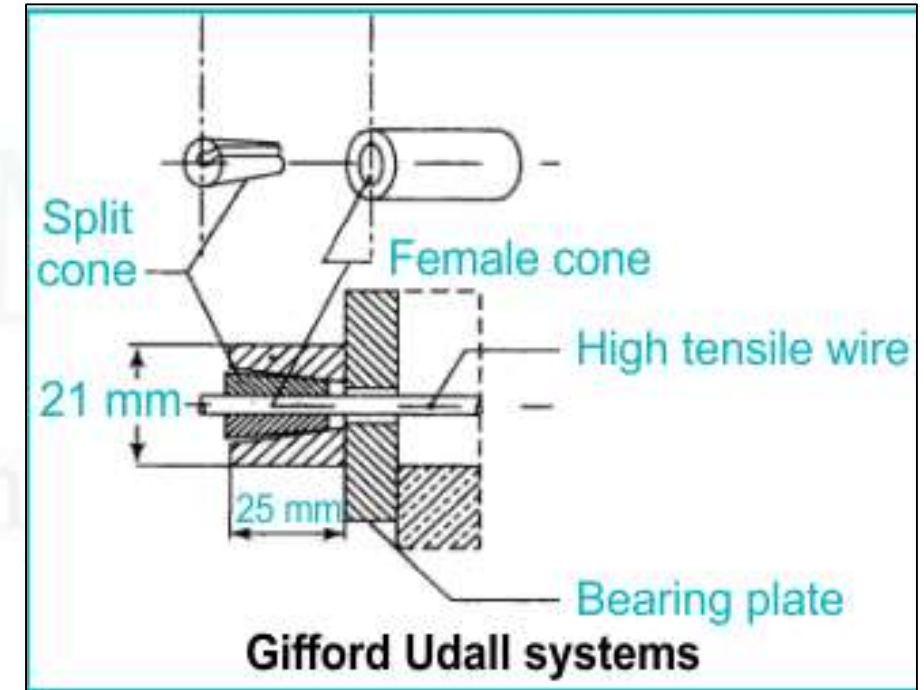


- The **Gifford-Udall Post-tensioning System** is an early and historically significant method of **post-tensioning concrete**, developed in the UK during the mid-20th century by engineers **Guy Gifford** and **George Udall**.
- This system was one of the pioneering commercial methods used to introduce post-tensioning techniques in structural concrete.
- Unlike systems that stress multiple wires at once, the Gifford-Udall system stresses and anchors each individual wire using a small, double-acting jack and special wedge grips. This flexibility allows for the formation of cables with any desired number of wires.



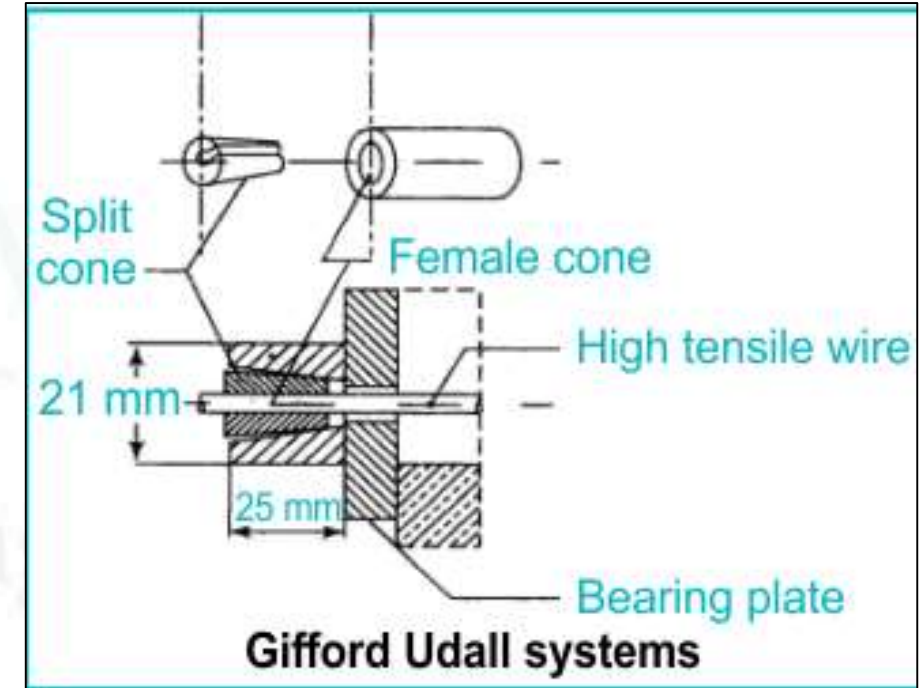
## Components

- **High-strength steel wires:** The individual wires are typically 5 mm or 7 mm in diameter.
- **Udall grips:** These are small, two-piece split conical wedges used to anchor the wires. The serrated grips fit into the tapered holes of the bearing plate, securing the tensioned wires.
- **Bearing plate:** This can be a square or circular plate with tapered holes that accommodate the individual anchor wedges. It transfers the prestressing force to the concrete.



## Components

- **Thrust ring:** In the "tube anchorage" variation, the bearing plate rests against a thrust ring that is cast into the concrete.
- **Double-acting jack:** This specialized hydraulic jack is used to independently stress each wire.
- **Helical spring/helix:** A helical wire arrangement or helix is used to maintain spacing between the wires inside the duct and to encircle the duct end.



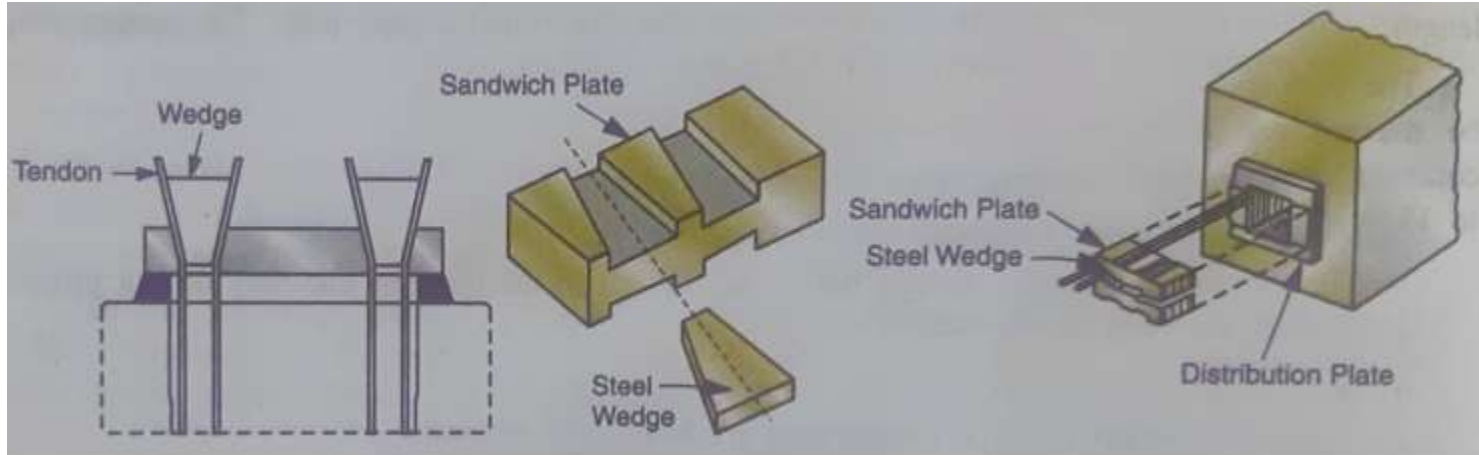


# Process



1. **Duct preparation:** A duct is placed in the formwork according to the engineered profile, typically using a fabricated steel tube or helix unit that also serves as part of the anchorage.
2. **Wire placement:** Individual high-strength steel wires are inserted into the duct.
3. **Anchorage installation:** A bearing plate with tapered holes is installed at each end of the member.
4. **Stressing:** After the concrete has cured, a double-acting jack is used to independently pull and tension each wire. The "Udall grips" (split cone wedges) are inserted into the tapered hole to lock the tensioned wire in place.
5. **Grouting:** Grout can be injected into the duct through a grout entry hole in the bearing plate to protect the wires and bond them to the concrete.

# Magnet Blaton Post-tensioning System



- The **Magnet-Blaton system** is a **bonded post-tensioning method** developed in the early 20th century by the Belgian engineer **Victor Magnel** and the French company **Blaton**.
- It was one of the pioneering techniques for prestressing concrete and remains a foundational system in the evolution of post-tensioning technology.
- The Magnet Blaton system is a method of post-tensioning concrete, where high-tensile steel wires are tensioned and anchored after the concrete has been cast and hardened.



# Key components and working principle



Unlike the Freyssinet system, where all wires are stretched at once, the Magnel Blaton method tensions pairs of wires sequentially.

1. **Casting:** Concrete is first cast with a duct or sheath placed in the formwork, through which the steel wires will later pass.
2. **Anchorage:** After the concrete reaches sufficient strength, the high-tensile steel wires (typically 5–8 mm in diameter) are fed through the duct. The anchorage consists of several parts at each end of the member:
  - Sandwich plates: Metallic plates with tapered, wedge-shaped grooves on their faces that hold up to eight wires.
  - Flat wedges: Grooved flat wedges are driven into the plate grooves to secure the wires.
  - Distribution plate: A bearing plate that distributes the prestressing force from the sandwich plates to the concrete.



# Key components and working principle



3. **Tensioning:** A special hydraulic jack pulls two wires at a time until the desired tension is achieved.
4. **Anchoring:** The two wires are then anchored by driving the grooved wedges between them and the sandwich plate. This process is repeated for each pair of wires until the entire cable is tensioned.
5. **Grouting:** Once the tensioning is complete, the ducts are typically grouted with a cement paste to protect the steel from corrosion and create a bonded tendon.



# DIFFERENCES



| Aspect               | Freyssinet System                                                                       | Gifford-Udall System                                                         | Magnel-Blaton System                                              |
|----------------------|-----------------------------------------------------------------------------------------|------------------------------------------------------------------------------|-------------------------------------------------------------------|
| Origin               | Developed by Eugène Freyssinet (France, 1928)                                           | Developed by Gifford & Udall (UK, 1950s)                                     | Developed by Victor Magnel & Blaton (Belgium/France, 1920s-30s)   |
| Tendon Type          | High tensile steel wires or strands                                                     | High tensile steel wires or strands                                          | Flat rectangular steel bars                                       |
| Duct/Sheath          | Metallic or plastic ducts                                                               | Metallic ducts                                                               | Metallic ducts                                                    |
| Prestressing Type    | Initially unbonded, later evolved to bonded post-tensioning                             | Bonded post-tensioning                                                       | Bonded post-tensioning                                            |
| Anchorage System     | Wedge-type anchorage with special anchor plates                                         | Wedge-type anchorage                                                         | Special wedge anchors for flat bars                               |
| Grouting             | Grouted to protect tendons and bond them in later versions                              | Grouted after tensioning                                                     | Grouted after tensioning                                          |
| Key Innovation       | Introduced the concept of prestressing by post-tensioning with high tensile steel wires | Adapted and commercialized post-tensioning in UK, focused on wedge anchorage | First to develop bonded post-tensioning using grout and flat bars |
| Typical Applications | Bridges, buildings, water tanks, large concrete members                                 | Bridges, buildings, water tanks                                              | Bridges, slabs, beams, water-retaining structures                 |
| Advantages           | High strength, reliable anchorage, adaptable to complex shapes                          | Simple wedge anchorage, relatively easy to install                           | Bonded system improves durability and load transfer               |
| Limitations          | Early versions were unbonded (less corrosion protection), required skilled labor        | Older system, less common today, potential grouting issues                   | Flat bars less flexible, more complex anchorage                   |



# Anchorage Devices



- Anchorage devices are the **end hardware components** used to transfer and maintain prestressing forces from **tendons (wires/strands/bars)** into the **concrete**.
- Anchorage devices are critical components in prestressed concrete that secure the tensioned steel tendons and transfer the prestressing force to the concrete member.
- Since prestressing steel carries very high tensile forces, safe and efficient anchorage is crucial.
- The type of anchorage used depends on whether the prestressing is done before (pre-tensioning) or after (post-tensioning) the concrete is cast.

# For Wires and Strands

## 1. Wedge Anchorage

- Uses **conical wedges** to grip the strand.
- Widely used in modern systems (e.g., Freyssinet, CCL, VSL).
- Consists of:
  - **Anchor Head** (steel plate with conical holes)
  - **Wedges** (split steel pieces that grip strand when pulled)
  - **Bearing Plate** (transfers force to concrete)



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## 2. Button Head Anchorage (older system)

- Wire ends are upset into button heads and anchored in a steel plate.
- Rarely used now.



# For Bars

## 1. Threaded Anchorage

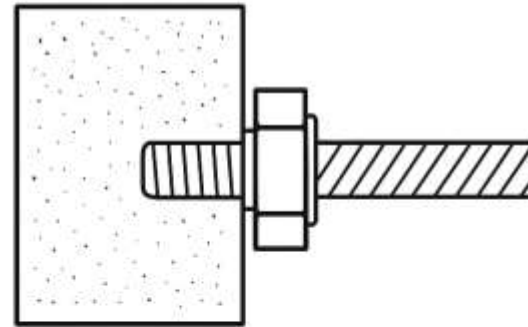
- Bars are threaded at ends, and nuts/plates anchor them.

## 2. Coupler System

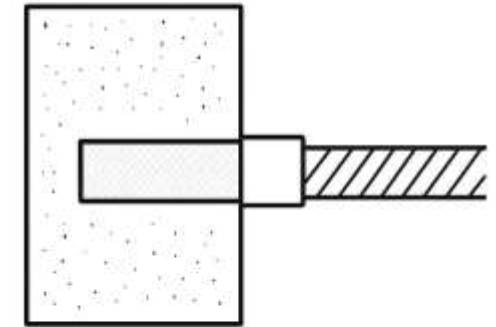
- Used when prestressing bars are extended.

## ANCHORAGE DEVICES

THREADED ANCHORAGE



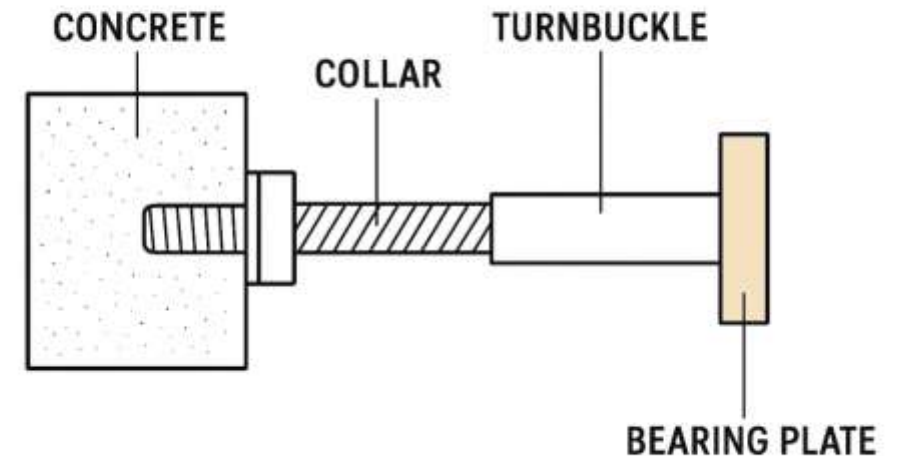
COUPLER SYSTEM



## Mechanical Pre-stressing

- In prestressed concrete, the prestressing force can be generated through various means. The primary methods based on the source of the force are mechanical, electrical, and chemical prestressing.
- Mechanical prestressing involves the use of mechanical devices to tension the high-strength steel tendons. The most common method involves a hydraulic jack, though other mechanical systems exist.

### MECHANICAL PRESTRESSING





# Types of Mechanical Pre-stressing Systems



## 1. Turnbuckle System

1. Uses a **turnbuckle (threaded sleeve)** between two tendons/bars.
2. By rotating the sleeve, the tendon is stretched.

## 2. Screw Jack System

1. Uses threaded bars and nuts.
2. Tightening the nuts stretches the tendon.

## 3. Leverage System

1. Uses **levers and fulcrums** to magnify applied force and stretch tendons.

## 4. Rack & Pinion / Gear System

1. Uses gear arrangements to mechanically stretch tendons.



## ❑ Components

- **Tendon/Bar** → High strength steel bar or wire.
- **Collar/Nut** → Provides grip to the tendon.
- **Turnbuckle / Screw Jack / Lever** → Mechanical device for tensioning.
- **Bearing Plate** → Transfers stress to the concrete.
- **Concrete Member** → Receives compressive prestress.

## ❑ ADVANTAGES

- Simple system, no need for hydraulic pumps.
- Suitable for short span members and precast factories.
- Low initial investment compared to hydraulic jacks.

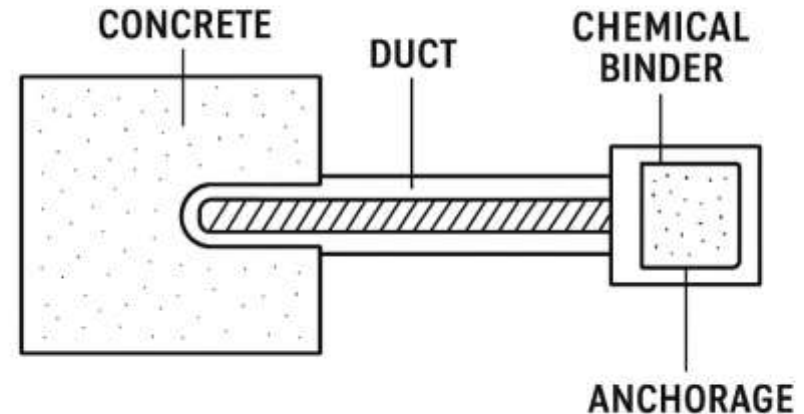
## ❑ LIMITATIONS

- Not suitable for very high prestressing forces (modern structures need higher capacity).
- Time-consuming and labor-intensive.
- Limited accuracy in controlling prestress compared to hydraulic methods.
- Rarely used in large-scale projects today, but still found in small precast units (railway sleepers, poles, pipes).

# Chemical Pre-stressing

- Chemical pre-stressing is a **method of inducing prestress** in concrete using the **expansion property of cement** and special admixtures (expansive cements).
- Instead of applying tension mechanically (jacks) or thermally (heating tendons), **expansion of concrete itself** develops tensile stress in the reinforcement, which in turn applies **compressive stress** to concrete.

## CHEMICAL PRE-STRESSING





## ❑ Principle

1. **Expansive cement** is used in the mix (containing admixtures like calcium sulfoaluminate).
2. After hydration, the cement undergoes **controlled expansion**.
3. The embedded reinforcement (steel) **restrains this expansion**, and as a result:
  - The steel goes into **tension**.
  - The concrete goes into **compression** (prestressed).

## ❑ Materials Used

- High-strength steel reinforcement (bars/wires).
- Expansive cement types (e.g., sulfoaluminate cement).
- Chemical admixtures: calcium chloride, gypsum, aluminates, etc.

## ❑ Process

1. Concrete is prepared using expansive cement.
2. Steel reinforcement is embedded in concrete (no external stressing equipment needed).
3. During hydration → **concrete expands**.
4. The steel reinforcement resists this expansion → develops tensile stress.
5. The **prestressing force** is thus locked into the member.



## ❑ Advantages

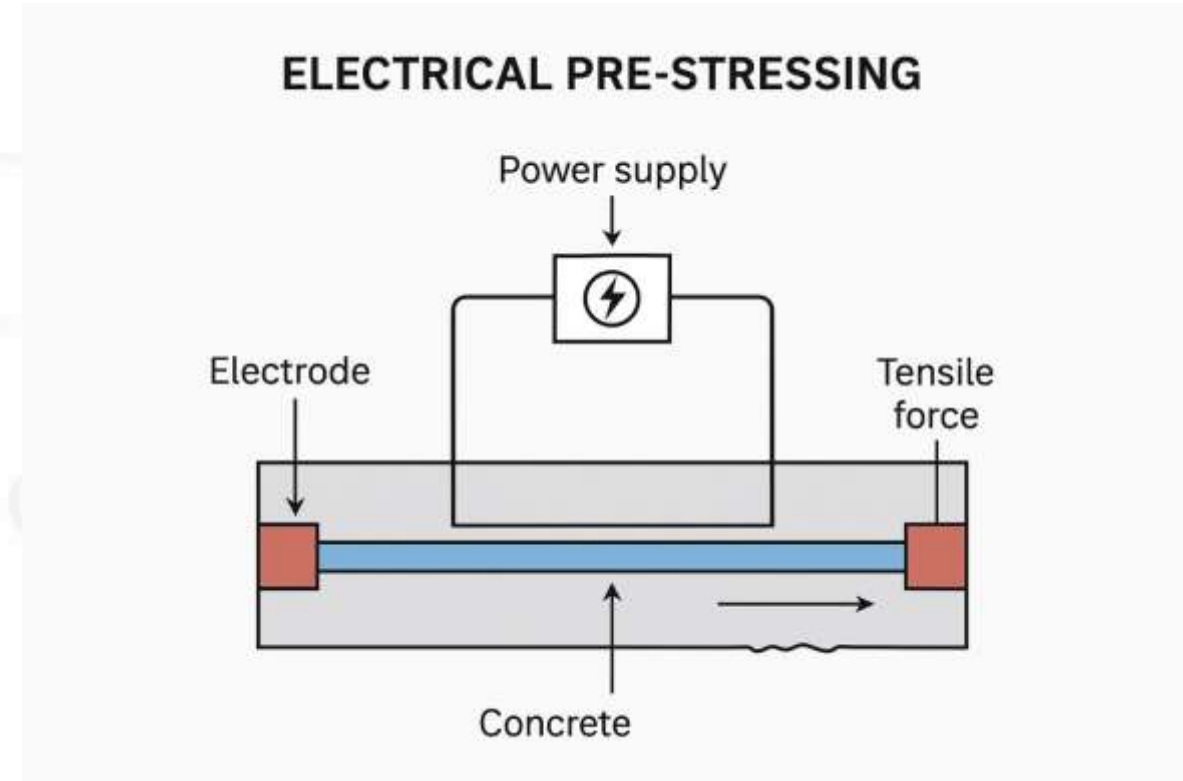
- No need for external stressing devices (jacks, wedges).
- Simple and economical for factory-made elements.
- Useful for thin sections like slabs, pipes, and tanks.
- Reduces shrinkage cracks due to counter-compression.

## ❑ Limitations

- Prestress level is relatively low (compared to mechanical/hydraulic methods).
- Prestress depends on cement properties → variation in performance.
- Not suitable for heavily loaded structural members.
- Requires special cement which may not be locally available everywhere.

# Electrical Pre-stressing

- Electrical pre-stressing is a method of inducing prestress by heating steel tendons electrically before anchoring them in concrete.
  - Current is passed through the steel tendons → they expand due to heat.
  - While in the expanded state, the tendons are anchored to the concrete.
  - As the steel cools → it contracts, inducing tensile stress in the steel and compressive stress in the concrete.





## ❑ Equipment Used

- **Power supply (transformer/rectifier)** – for controlled heating.
- **Electrodes** – connected at tendon ends.
- **Anchorage system** – wedges, plates, or collars to hold tendons.

## ❑ Principle

- Based on the thermal expansion and contraction of steel.
- Heating → elongation.
- Cooling → contraction → induces prestress.



## ❑ Process

- Tendons (high-strength wires/bars) are placed in ducts inside the concrete member.
- A low-voltage, high-current supply is passed through the tendons → heating them.
- Tendons expand and elongate.
- Ends are anchored against the concrete while hot.
- When the steel cools → it shortens → prestress is induced.



## ❑ Advantages

- Simple and fast method (no hydraulic jacks needed).
- Useful for mass production of precast elements (like poles, sleepers, pipes).
- Reduces labor as stressing and anchoring are automatic during cooling.

## ❑ Limitations

- Requires continuous electric power supply.
- Heating may cause oxidation/scaling of steel surface.
- Difficult to control uniform heating for long tendons.
- Limited to small/medium-size members; not practical for long-span bridges.



# VTU Questions



1. List and explain the various losses in pre-stressed concrete.
2. Define Anchorage. Explain with sketch Freyssinet system of Post-tensioning.
3. Explain with as neat sketch Hoyer's long line systems of Pre-tensioning.
4. Explain Post-tensioning anchorage devices and explain any one in details.