CE 414: Prestressed Concrete
Lecture 3
Pretension and Post-tension

Course Instructor: Saurav Barua

Assistant Professor, Department of Civil Engineering, DIU

Email: saurav.ce@diu.edu.bd

Phone: 01715334075

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Pretensioning

The various stages of the pre-tensioning operation are summarised as follows.

1) Anchoring of tendons against the end abutments
2) Placing of jacks
3) Applying tension to the tendons
4) Casting of concrete
5) Cutting of the tendons.

The stages are shown schematically in the following figures.

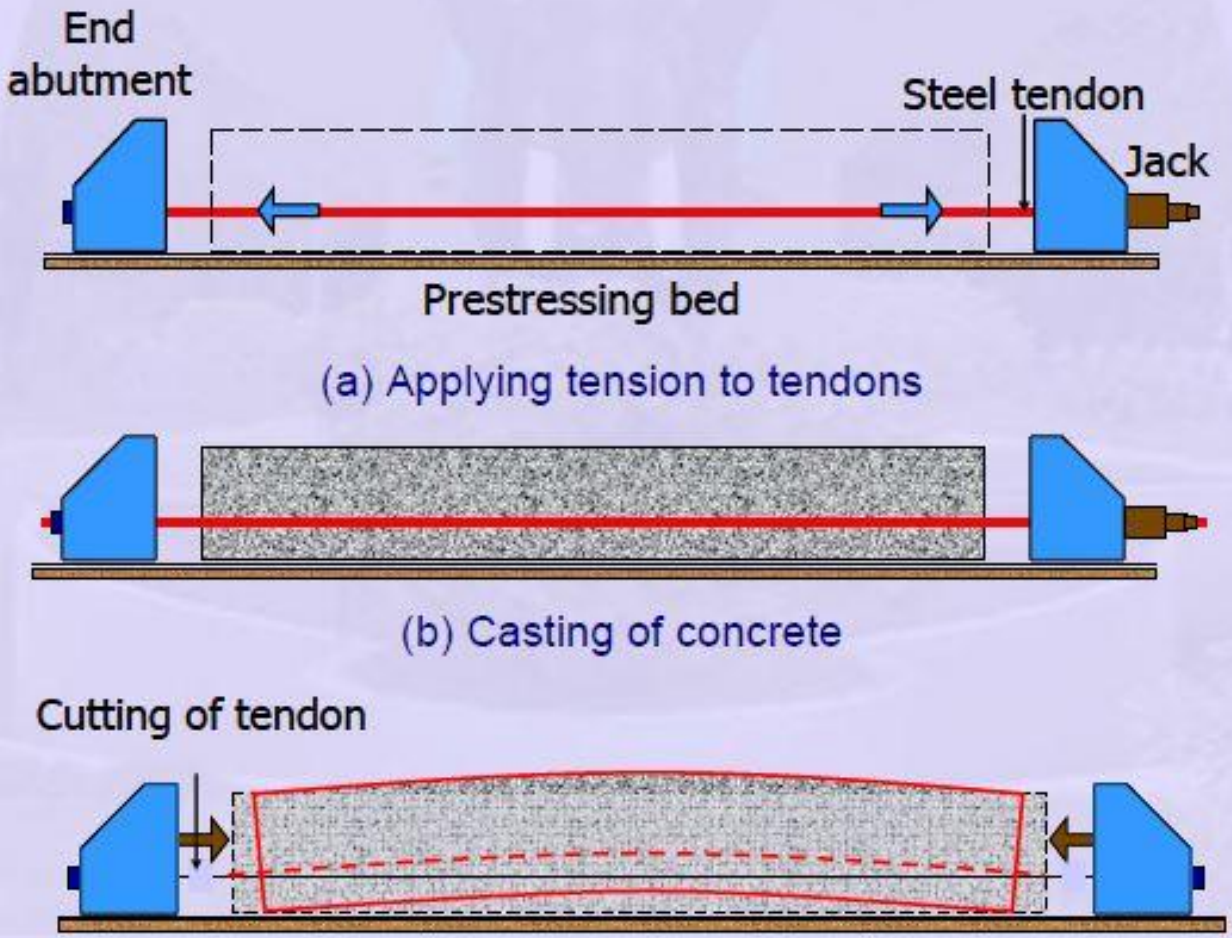

Figure1-3.1 Stages of pre-tensioning

1.3.3 Advantages of Pre-tensioning

The relative advantages of pre-tensioning as compared to post-tensioning are as follows.

- Pre-tensioning is suitable for precast members produced in bulk.

- In pre-tensioning large anchorage device is not present.

1.3.4 Disadvantages of Pre-tensioning

The relative disadvantages are as follows.

- A prestressing bed is required for the pre-tensioning operation.
- There is a waiting period in the prestressing bed, before the concrete attains sufficient strength.
- There should be good bond between concrete and steel over the transmission length.

1.3.5 Devices

The essential devices for pre-tensioning are as follows.

- Prestressing bed
- End abutments
- Shuttering / mould
- Jack
- Anchoring device
- Harping device (optional)

Prestressing Bed, End Abutments and Mould

The following figure shows the devices.

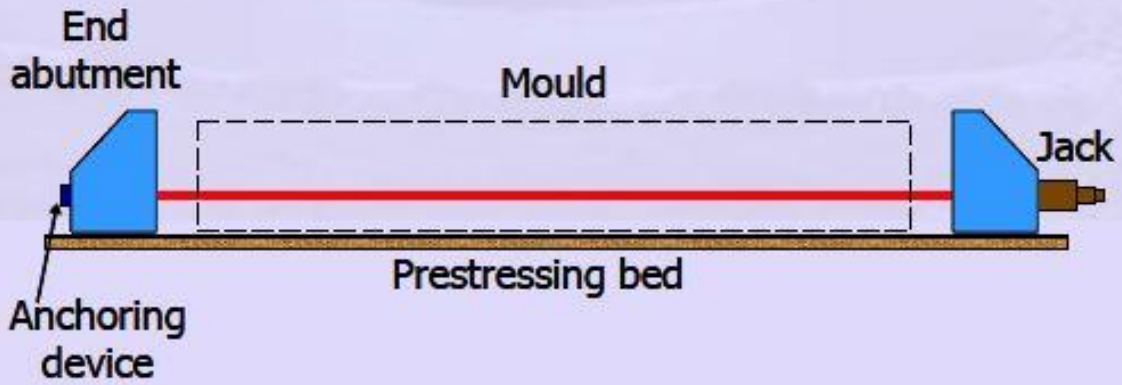

Figure1-3.2 Prestressing bed, end abutment and mould

Jacks

The jacks are used to apply tension to the tendons. Hydraulic jacks are commonly used. These jacks work on oil pressure generated by a pump. The principle behind the design of jacks is Pascal's law. The load applied by a jack is measured by the pressure reading from a gauge attached to the oil inflow or by a separate load cell. The following figure shows a double acting hydraulic jack with a load cell.

Figure 1-3.8 A double acting hydraulic jack with a load cell

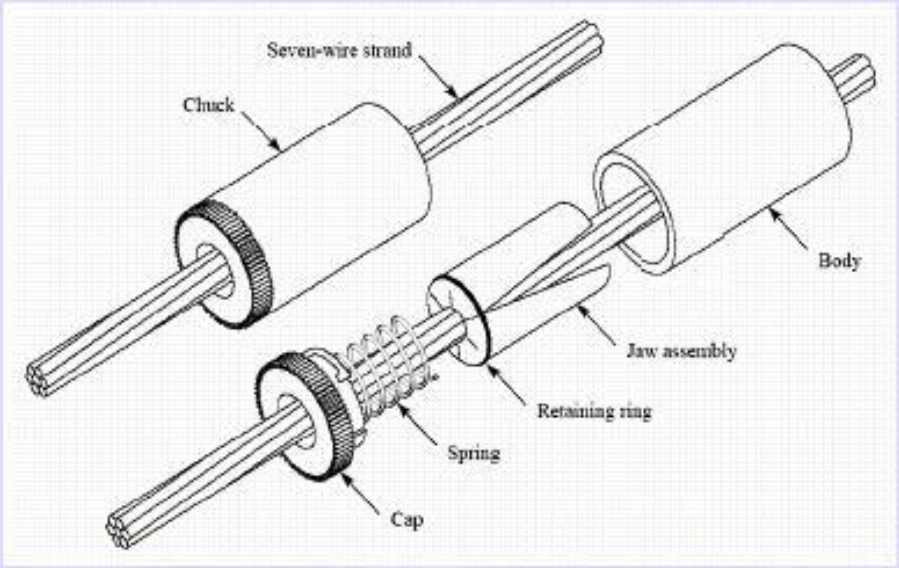

Figure 1-3.9 Chuck assembly for anchoring tendons
(Reference: Lin, T. Y. and Burns, N. H.,
Design of Prestressed Concrete Structures)

Harping Devices

The tendons are frequently bent, except in cases of slabs-on-grade, poles, piles et
The tendons are bent (harped) in between the supports with a shallow sag as show
below.

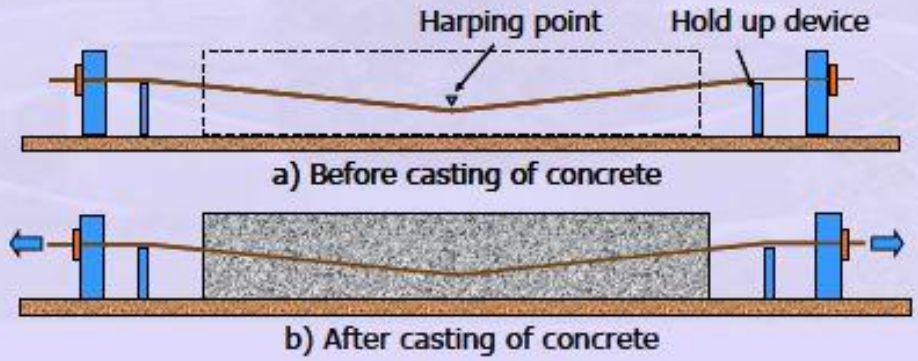

Figure 1-3.10 Harping of tendons

(a) Travelling pre-tensioning stress bench

(n) Storage and dispatching of sleepers

Figure 1-3.12 Manufacturing of pre-tensioned railway sleepers

Post-tensioning

1.4.2 Stages of Post-tensioning

In post-tensioning systems, the ducts for the tendons (or strands) are placed along with the reinforcement before the casting of concrete. The tendons are placed in the ducts after the casting of concrete. The duct prevents contact between concrete and the tendons during the tensioning operation.

Unlike pre-tensioning, the tendons are pulled with the reaction acting against the hardened concrete.

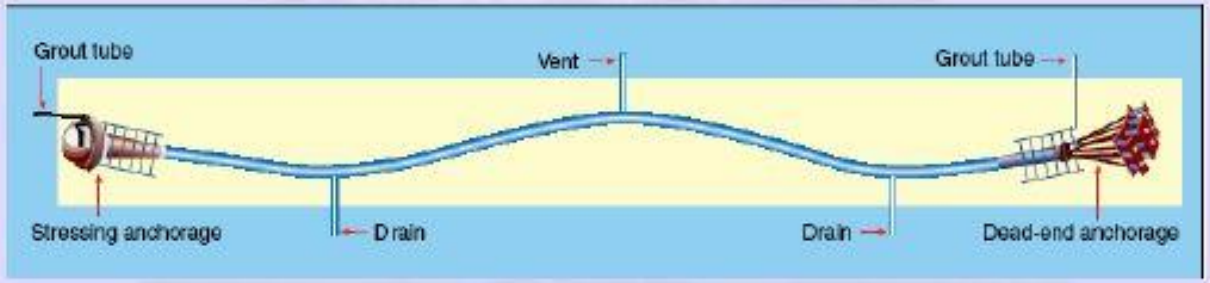

Figure 1-4.1 Post-tensioning (Reference: VSL International Ltd.)

Among the following figures, the first photograph shows the placement of ducts in a box girder of a simply supported bridge. The second photograph shows the end of the box girder after the post-tensioning of some tendons.

Figure 1-4.2 Post-tensioning ducts in a box girder

(Courtesy: Cochin Port Trust, Kerala)

The various stages of the post-tensioning operation are summarised as follows.

1) Casting of concrete.
2) Placement of the tendons.
3) Placement of the anchorage block and jack.
4) Applying tension to the tendons.
5) Seating of the wedges.
6) Cutting of the tendons.

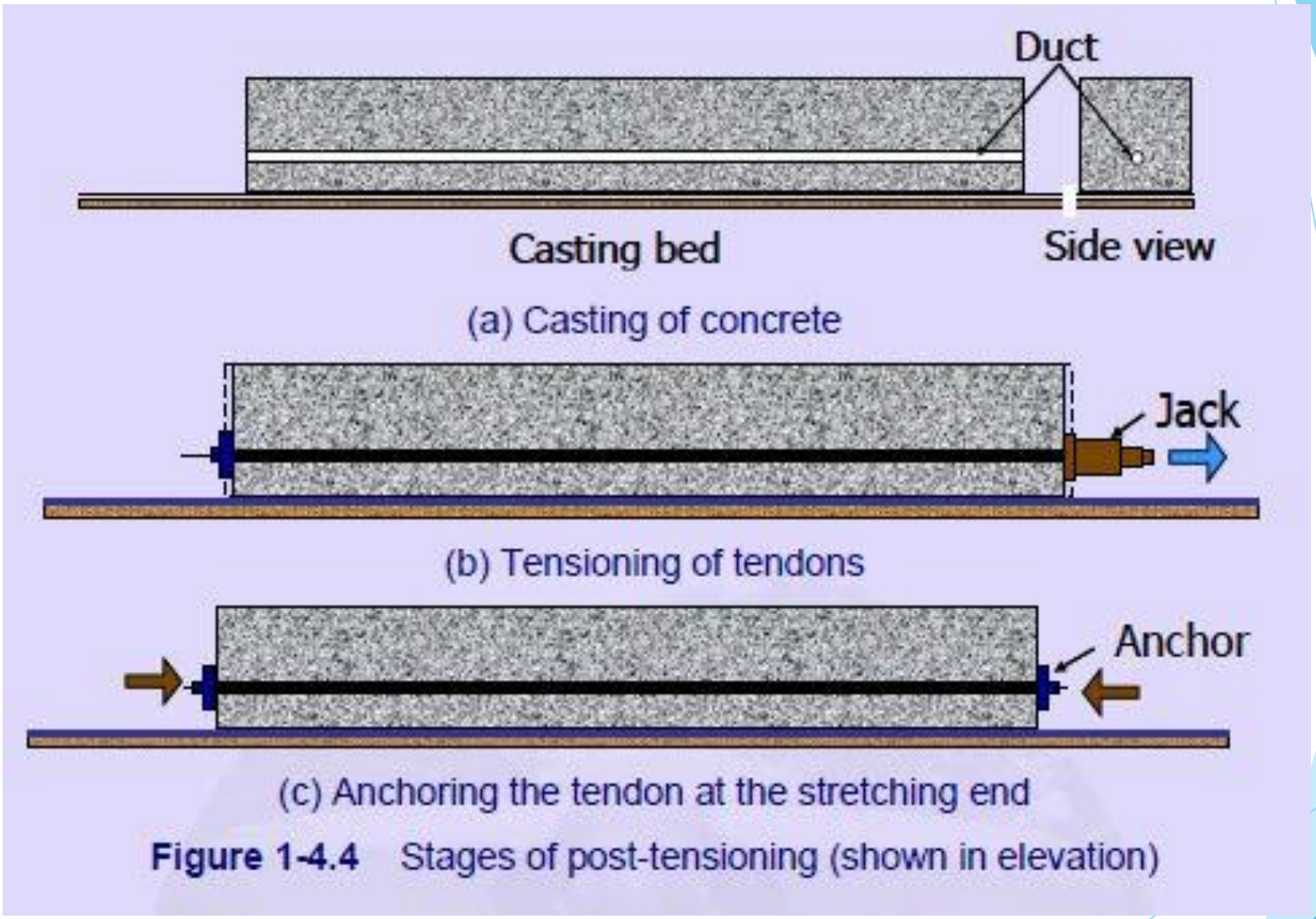

Figure 1-4.4 Stages of post-tensioning (shown in elevation)

1.4.3 Advantages of Post-tensioning

The relative advantages of post-tensioning as compared to pre-tensioning are as follows.

- Post-tensioning is suitable for heavy cast-in-place members.
- The waiting period in the casting bed is less.
- The transfer of prestress is independent of transmission length.

1.4.4 Disadvantage of Post-tensioning

The relative disadvantage of post-tensioning as compared to pre-tensioning is the requirement of anchorage device and grouting equipment.

1.4.5 Devices

The essential devices for post-tensioning are as follows.

1) Casting bed
2) Mould/Shuttering
3) Ducts
4) Anchoring devices
5) Jacks
6) Couplers (optional)
7) Grouting equipment (optional).

Casting Bed, Mould and Ducts

The following figure shows the devices.

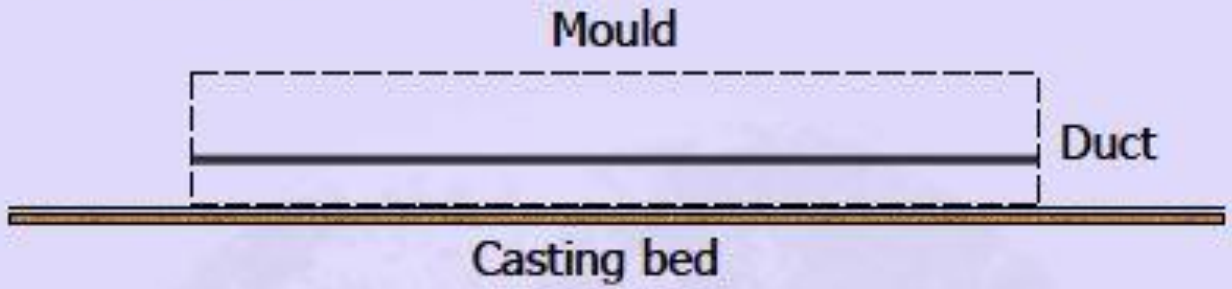

Figure 1-4.5 Casting bed, mould and duct

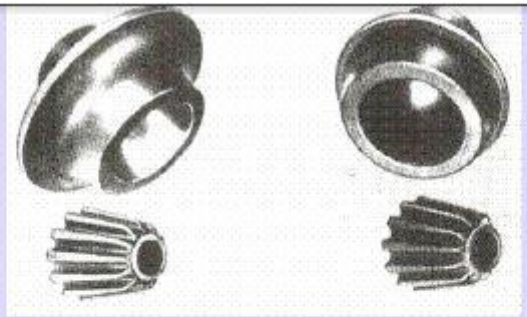

Figure 1-4.6 Freyssinet "T" system anchorage cones

(Reference: Lin, T. Y. and Burns, N. H., *Design of Prestressed Concrete Structures*)

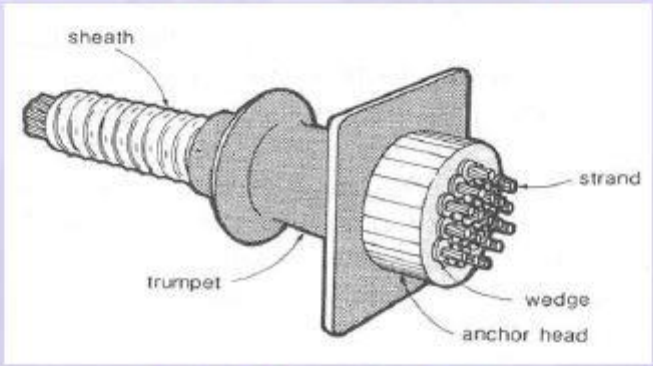

Figure 1-4.7 Anchoring devices

(Reference: Collins, M. P. and Mitchell, D., *Prestressed Concrete Structures*)

Figure 1-4.8 Anchoring devices (Reference: VSL International Ltd)

(a) Fabrication of reinforcement

(b) Placement of tendons

Wires

A prestressing wire is a single unit made of steel. The nominal diameters of the wires are 2.5, 3.0, 4.0, 5.0, 7.0 and 8.0 mm. The different types of wires are as follows.

1) Plain wire: No indentations on the surface.
2) Indented wire: There are circular or elliptical indentations on the surface.

Strands

A few wires are spun together in a helical form to form a prestressing strand. The different types of strands are as follows.

1) Two-wire strand: Two wires are spun together to form the strand.
2) Three-wire strand: Three wires are spun together to form the strand.
3) Seven-wire strand: In this type of strand, six wires are spun around a central wire. The central wire is larger than the other wires.

Tendons

A group of strands or wires are placed together to form a prestressing tendon. The tendons are used in post-tensioned members. The following figure shows the cross section of a typical tendon. The strands are placed in a duct which may be filled with grout after the post-tensioning operation is completed (Figure 1-7.1).

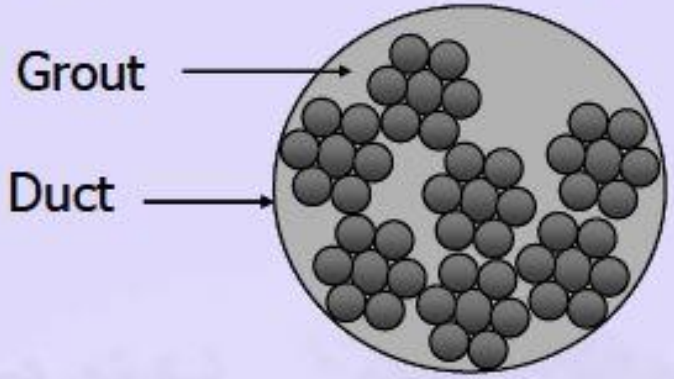

Figure 1-7.1 Cross-section of a typical tendon

Cables

A group of tendons form a prestressing cable. The cables are used in bridges.

Bars

A tendon can be made up of a single steel bar. The diameter of a bar is much larger than that of a wire. Bars are available in the following sizes: 10, 12, 16, 20, 22, 25, 28 and 32 mm.

The following figure shows the different forms of prestressing steel.

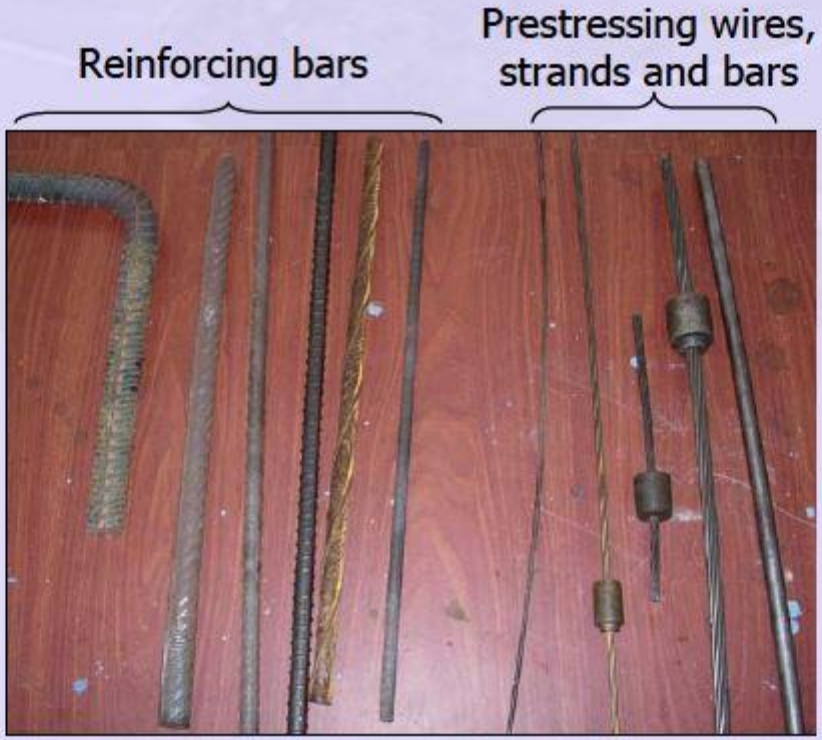

Figure 1-7.2 Forms of reinforcing and prestressing steel

1.7.3 Properties of Prestressing Steel

The steel in prestressed applications has to be of good quality. It requires the following attributes.

1) High strength
2) Adequate ductility
3) Bendability, which is required at the harping points and near the anchorage
4) High bond, required for pre-tensioned members
5) Low relaxation to reduce losses
6) Minimum corrosion.