CHAPTER 5: REINFORCED CONCRETE PIPES (CAP AND CAO)

V. Reinforced Concrete Pipes (CAP and CAO)

CAP and CAO pipes are prestressed reinforced concrete pipes:

1. Drinking water supply pipes and sewer pipes offering an alternative for each type of effluent (wastewater, stormwater, industrial water).
2. Prestressed reinforced concrete channels: These channels are used for irrigation in agriculture; they are of parabolic and semi-circular type with male and female socketing.

Figure V.1. CAP and CAO Pipes

IV. 1. Prestressed Reinforced Concrete Pipes with Concrete Hooping (FB)

These pipes are intended for drinking water supply (AEP). Their male and female socketing with a sealing joint is designed for pressures ranging from 2 to 20 bars.
The pipe consists of:

- A primary centrifuged concrete core, with longitudinal prestressing achieved using high-strength serrated steel wires (RC 155-160 kgf/mm²).
- Mechanical hooping with high-strength steel wire, providing radial prestressing to the concrete.
- A coating of high-frequency vibrated concrete that adheres to the primary core and forms a homogeneous prestressed unit.

IV. 2. Prestressed and Ordinary Reinforced Concrete Pipes (CAP-CAO)

Designed for sewer systems (from 500 to 1250 mm), longitudinally prestressed reinforced concrete pipes (CAP) feature a bell (female end) on one side and a spigot (male end) on the other.

They are manufactured in three classes—60A, 90A, and 135A—to adapt to various load conditions. Reinforcement is provided by a cage made of mild steel with sections of 6 ÷ 8 mm, depending on the diameter.

In addition to longitudinal prestressing, these pipes undergo radial prestressing through hooping to withstand service pressures ranging from 3 to 20 bars. A vibrated concrete coating protects the hooping spirals from external corrosion. The resulting pipeline can support backfill heights

of up to 6.00 meters and rolling loads of 30 tons or more. This type of pipe is used at dam outlets for drinking water supply and agricultural irrigation.

V. 3. Manufacturing of Pipes

V. 3.1. Preparation of Reinforcementsμ

The reinforcements for the primary phase consist of mild steel end cages and high-strength longitudinal prestressing wires. All these steel components are prepared using specialized machinery.

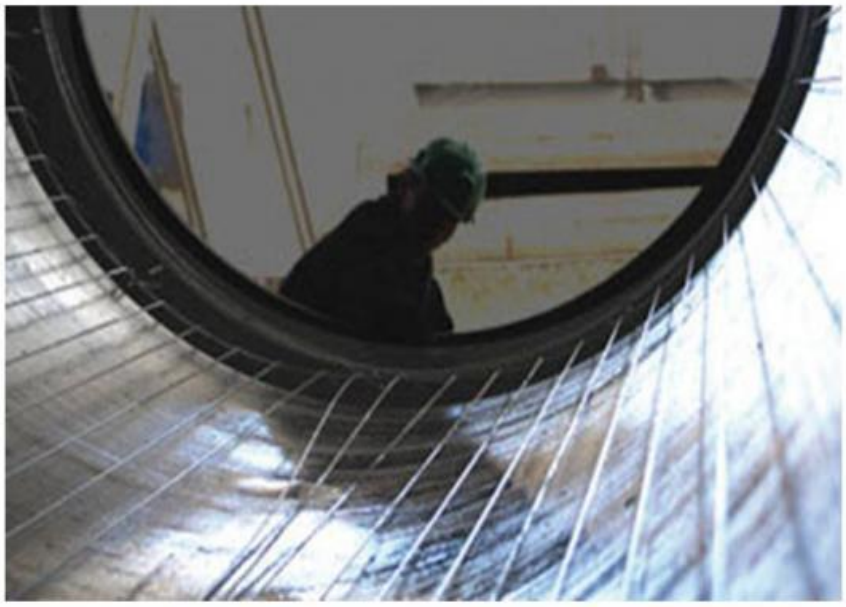

Figure V.2. Preparation of Reinforcements

V. 3.2. Preparation of Molds

After demolding, the mold is cleaned, oiled, and the reinforcement cages and prestressing steel wires are inserted. The end rings are mounted at both ends, and the longitudinal prestressing reinforcement is anchored to the end rings and tensioned using a system that ensures uniform stress distribution.

V. 3.3. Centrifugation

The centrifugation process is equipped with an electronic control system for the concrete pouring speed, which ranges from 6 to 8 m/s during the rotation phase and up to 28 m/s during the centrifugation phase.

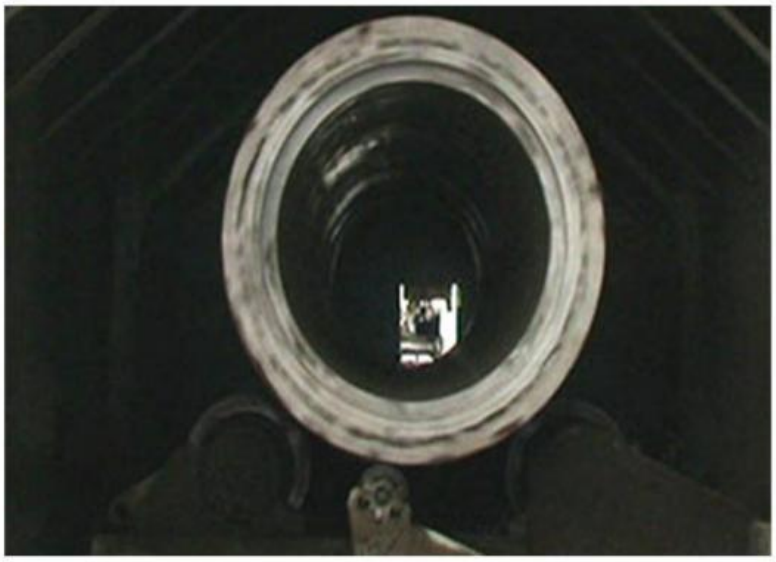

Figure V.3. Centrifugation Phase

V. 3.4. Curing

After the centrifugation phase, the mold is placed in a steam curing chamber with saturated humidity, where the temperature gradually rises to a maximum of 90°C. This temperature is maintained for approximately 4 hours.

Figure V.4. Emergence of the Mold in a Steam Curing Chamber with Saturated Humidity

V. 3.5. Demolding

After curing and achieving the required reference strength, the mold is moved to the demolding area for the extraction of the pipe.

Figure V.5. Pipe Extraction (Demolding Phase)

V. 3.6. Curing

At the end of the primary cycle, all pipes are fully immersed in water in large curing tanks for approximately seven days before being transferred to the secondary phase. This operation, essential for this type of product, provides it with high strength and impermeability qualities.

V. 3.7. Radial Prestressing (Hooping)

Pressure pipes undergo radial prestressing after the core has cured. This process involves wrapping the pipes with high-strength steel wire in the form of evenly spaced spirals. The wire section and the pitch of the spirals are determined based on the pressure and external loads specified by the customer.

Figure V.6. Pipe Hooping

V. 3.8. Hydraulic Testing

All pipes are tested on test benches to ensure compliance with the required specifications. The test bench replicates real working conditions of the pipe, including jointing with other pipes (socketing) and water pressure, while taking into account regulatory safety factors.

Figure V.7. Hydraulic Testing

V. 3.9. Coating

After passing the test bench, compliant pipes undergo coating to protect the hooping

reinforcements from external corrosive actions. Using a vibrating hopper, a layer of fine-grained concrete is applied to the outer surface of the pipe. During this operation, the pipe is rotated at a peripheral speed of 15 to 20 m/min.

Figure V.8. Pipe Coating Using a Vibrating Hopper

V. 3.10. Storage

Storage and handling are carried out using gantry cranes that cover the entire main yard of the factory.

Figure V.9. Storage and Handling of Pipes Using Gantry Cranes

Table V.1. CAP-Type Pipes (Male and Female Socketing) (Class 60 A – 90 A – 135 A)

Diameter (mm)	Length (m)
350	7
400	7
500	7
600	7
700	7
800	7
900	7
950	7
1000	7
1100	7
1200	7
1250	7
1400	7
1500	7
1550	7

Table V.2. CAO-Type Pipes (Plain End) (Class 60 A – 90 A – 135 A)

Diameter (mm)	Length (m)
350	7
400	7
500	7
600	7
700	7
800	7
900	7
950	7
1000	7
1100	7
1200	7
1250	7
1400	7
1500	7
1550	7
1800	7
2000	7

Table V.3. Irrigation Channels

Diameter (mm)	Length (m)
350	7
400	7
500	7
600	7
700	7
800	7
950	7
1000	7
1250	7
1400	7
1550	7
1850	7
2450	7
2850	7