

CHAPTER II : CAST IRON PIPES

Since the late 19th century, cast iron has undoubtedly been one of the earliest and most widely used materials for pipelines worldwide, particularly for transporting public water supply. Various types of gray cast iron (Figure II.1 a) have been used over time, with pipes produced through casting or centrifugal casting, many of which are still in service (their lifespan can exceed 100 years). Their main drawback lies in their fragility when exposed to ground movements, water hammer, and overloads caused by road traffic in the areas where they are installed. Indeed, in "gray cast iron," carbon is present in the form of flakes, making the material brittle.

Ductile cast iron with spheroidal graphite (Figure II.1 b) represents the modern material; it completely eliminates the flaws of gray cast iron. The graphite particles appear as small spheres, eliminating any risk of crack propagation. The material is no longer brittle but "ductile" and resistant. The crystallization of graphite into spheres is achieved by introducing magnesium into a high-quality base cast iron.

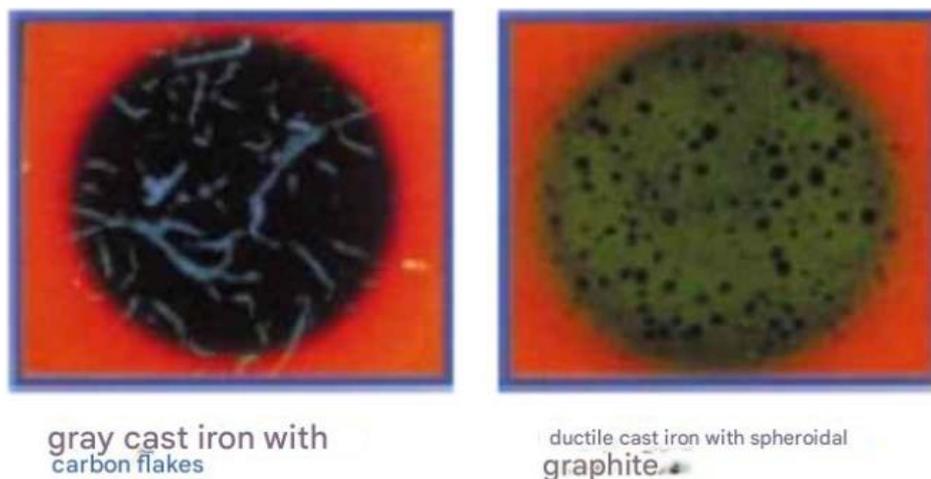


Figure II.1. Different Types of Cast Iron

II.1. Characteristics

Ductile cast iron exhibits the following mechanical properties:

- Elasticity of $R_e \geq 270$ MPa
- Tensile strength of $R_m \geq 420$ MPa
- Excellent impact resistance
- Significant elongation capacity exceeding 10%

The primary European standard for ductile cast iron pipes is EN545.

The EN545 standard defines different types of allowable pressures:

- **PFA (Allowable Operating Pressure):** This is the internal pressure under steady-state conditions. This pressure varies depending on the pipe diameter and the fittings used, ranging from 16 to 64 bars.

- **PMA (Maximum Allowable Pressure):** This is the maximum pressure that can be safely sustained during operation, including water hammer ($= 1.2 \times \text{PFA}$).
- **PEA (Allowable Test Pressure):** This is the maximum hydrostatic pressure that a newly installed component can withstand for a relatively short period:
 - $\text{PEA} = \text{PMA} + 5 \text{ bar}$ in general
 - $\text{PEA} = 1.5 \times \text{PFA}$

Table II.1. Technical Specifications for Cast Iron Pipes

Specification	Belgian or European Standard	International Standard
Requirements	NBN EN 545	ISO 2531
Internal cement mortar coating	NBN EN 545	ISO 4179
External zinc coating for pipes	NBN EN 545	ISO 8179-1
Joint rings	NBN EN 681-1	ISO 4633

The pipes are coated internally with cement mortar applied either by simple spinning or, preferably, by centrifugation. Centrifugation currently allows for a more consistent thickness and a smoother surface. This reduces head losses ($k = 0.03$ in the Colebrook formula) and limits deposits. The cement mortar coating does not act solely as a physical barrier; it also protects the cast iron through a passivation mechanism. The various types of cement swelling caused by water also enable self-repair of any small cracks that may occur during transport, etc. In cases of highly aggressive water, aluminous cement mortar can be used. Fittings and special components are coated with bituminous or epoxy paint.

Externally, cast iron pipes must be protected by a thin layer of sprayed zinc, with a minimum thickness of 130 g/m^2 . Some suppliers enhance the reliability of their pipes by increasing this layer to 200 g/m^2 . The protection principle is active, relying on the galvanic action of the iron-zinc couple. Passive protection against impacts, etc., is then achieved through a bituminous paint coating.

For corrosive soils, external polyethylene sleeves are commonly used. These sleeves are either pre-installed on the pipes (with risks of damage during transport or handling) or installed on-site (less risk, but a slightly longer installation process). Alternatively, special organic coatings made of polyethylene or polyurethane can be applied in the factory by extrusion, depending on the diameter. In such cases, fittings and components are coated with epoxy.

In cases where there is a risk of freezing, pipes can be insulated in the factory by injecting polyurethane foam between the pipe and a polyethylene sheath.

Pipe lengths are assembled using non-locked joints, locked joints, or flanged joints. Locked joints allow for self-anchoring of the pipelines, eliminating the need for heavy, bulky, and time-consuming concrete anchor blocks. The most commonly used joints are (Figure IV.2):

- **Express joint** (locked or non-locked);
- **Standard joint** (locked or non-locked);
- **Automatic locked joints**;
- **Flanged joint** (fixed or swivel).

Modern joints are locked using elastomer joint rings with metal inserts.

Standard diameters range from 60 to 1,200 mm, with the 80 to 600 mm range being the most commonly used for drinking water networks. However, diameters of up to 2,000 mm can also be supplied. Special components include bends, tees, reducers, straight sleeves, end caps, blank plates, etc.

Ductile cast iron pipes, Zinc + bituminous paint

DN 60 - 2000



Figure II.2. Cast Iron Pipes Protected by a Thin Layer of Zinc

The useful length of the pipes depends on the depth of the socket. Please consult us for exact dimensions. Tolerances: refer to the NBN EN 545 standard.

Classic pipes coated externally with zinc and a layer of bituminous paint have proven their effectiveness over many years. They provide a solution for large diameters. These pipes are primarily used for applications in the drinking water sector.

Table II.2. Technical Specifications for Cast Iron Pipes

DN mm	L m	OF mm	and source mm	Average mass per pipe kg	Average metric mass m
60	6,00	77	6,0	60,1	10,0
80	6,00	98	6,0	78,2	13,0
100	6,00	118	6,1	95,4	15,9
125	6,00	144	6,2	118,0	19,7
150	6,00	170	6,3	145,0	24,2
200	6,00	222	6,4	203,0	33,8
250	6,00	274	6,8	267,0	44,5
300	6,00	326	7,2	337,0	56,2
350	6,00	378	7,7	480,0	80,0
400	6,00	429	8,1	567,0	94,5
450	6,00	480	8,6	671,0	111,8
500	6,00	532	9,0	775,0	129,2
600	6,00	635	9,9	1007,0	167,8
700	7,00*	738	10,8	1515,0	216,4
800	7,00*	842	11,7	1856,0	265,1
900	7,00*	945	12,6	2223,0	317,6
1000	7,00*	1048	13,5	2621,0	374,4
1000	8,27*	1048	13,5	3085,0	373,0
1100	8,27*	1151	14,4	3604,0	435,8
1200	8,26*	1255	15,3	4153,0	502,8
1400	8,19	1462	17,1	5543,0	676,8
1500	8,18	1565	18,0	6236,0	762,3
1600	8,18	1668	18,9	6942,0	848,7
1800	8,17	1875	20,7	8430,0	1031,8
2000	8,13	2082	22,5	10093,0	1241,5

II.2. Coating

II.2.1. External Coating

The zinc coating consists of:

- A layer of metallic zinc with a minimum of 200 g/m² applied by spraying, representing a 50% improvement over the requirements of the NBN EN 545 standard. This provides active protection through the galvanic action of the iron-zinc couple.
- A finishing layer of bituminous paint.

When in contact with the surrounding soil, the zinc slowly transforms into a dense, adherent, impermeable, and continuous protective layer of insoluble zinc salts. The pore-sealing properties promote the formation of a stable and insoluble layer.

On-site measurements can be carried out to determine the appropriate level of protection.

II.2. 2. Internal Coating

The internal protection of the pipes consists of cement mortar applied by centrifugation, ensuring:

- Excellent hydraulic flow conditions,
- Maintenance of the quality of the transported drinking water,
- Effective protection of the pipe wall.

Ductile cast iron pipes, zinc + bituminous paint DN 60-2000



Figure II.3. Ductile Cast Iron Pipes, Zinc + Bituminous Paint DN 2000

II.2.3. Available Joints:

- **Non-locked:**
 - DN 60-2000 Standard
 - DN 80-300 Tyton
 - DN 60-600 Standard Vi
- **Locked:**
 - DN 80-300 Tyton Sit or Tyton Sit+
 - DN 350-600 Standard V+
 - DN 350-600 Universal Standard Vi
 - DN 350-1200 Universal Standard Ve
 - DN 350-1200 Standard Ve
 - DN 1400-1800 Pamlock, DN 2000

Table II.3. Types of Automatic Joints and Mechanical Joints

Automatic Joints		
Type	DN	Locking
Standard	60 - 2000	Non-locked
Tyton	80 - 300	Non-locked
Standard Vi	60 - 600	Locked
Tyton Sit, Tyton Sit +	80 - 300	Locked
Standard V+i	350 - 600	Locked
Standard Ve	80 - 1200	Locked
Universal Standard Vi	350 - 600	Locked
Universal Standard Ve	350 - 1200	Locked
Standard Pamlock	≥ 1400	Locked
Mechanical Joints		
Type	DN	Verrouillage
Express	60 -1200	Non-Locked
Express Vi	60 - 300	Locked

Socket joints allow for a certain angular deflection. This deflection not only accommodates ground movements but also provides the possibility of creating large-radius curves in the pipeline without the need for additional fittings.

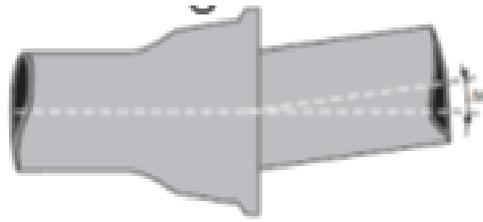


Figure II.4. Angular Deflection of Socket Joints

Table II.4. Types of Joint Assembly

Joint Type	Axial Clearance	Angular Deflection	Axial Force Absorption	Assem- blage	Electrical Insulation
Automatic (e.g., Standard, Tyton)	X	X	0	**	X
Mechanical (e.g., Express)	X	X	0	*	X
Locked, Automatic with Weld Bead (e.g., Standard Ve)	X	X	X	*	-
Locked, Automatic with Inserts (e.g., Standard Vi, Tyton Sit, or Tyton Sit +)	0	X	X	**	X
Locked, Mechanical with Inserts (e.g., Express Vi)	X	X	X	*	X
Fixed or Movable Flange	0	0	X	*	0

- X **Yes**
- * Easy
- 0 **No**
- ** Very Easy
- - **Partial**

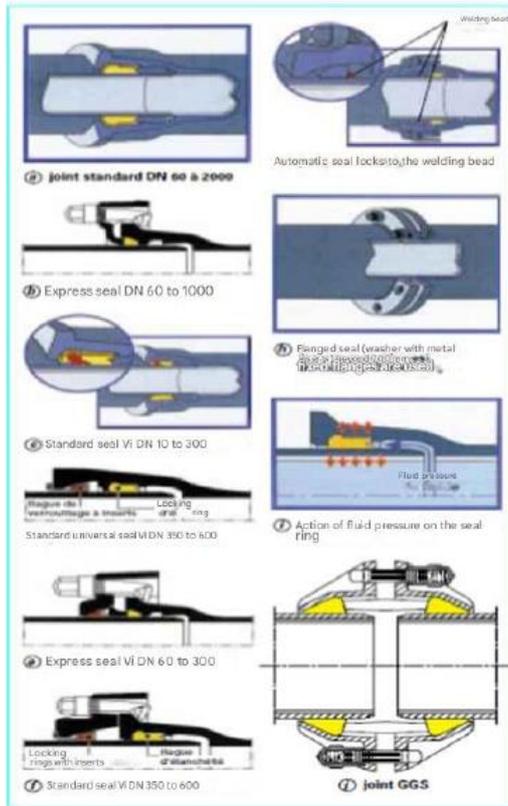


Figure II.5. Joints for Cast Iron Pipelines (Pont-à-Mousson)



Figure II.6. Overview of Different Types of Joints