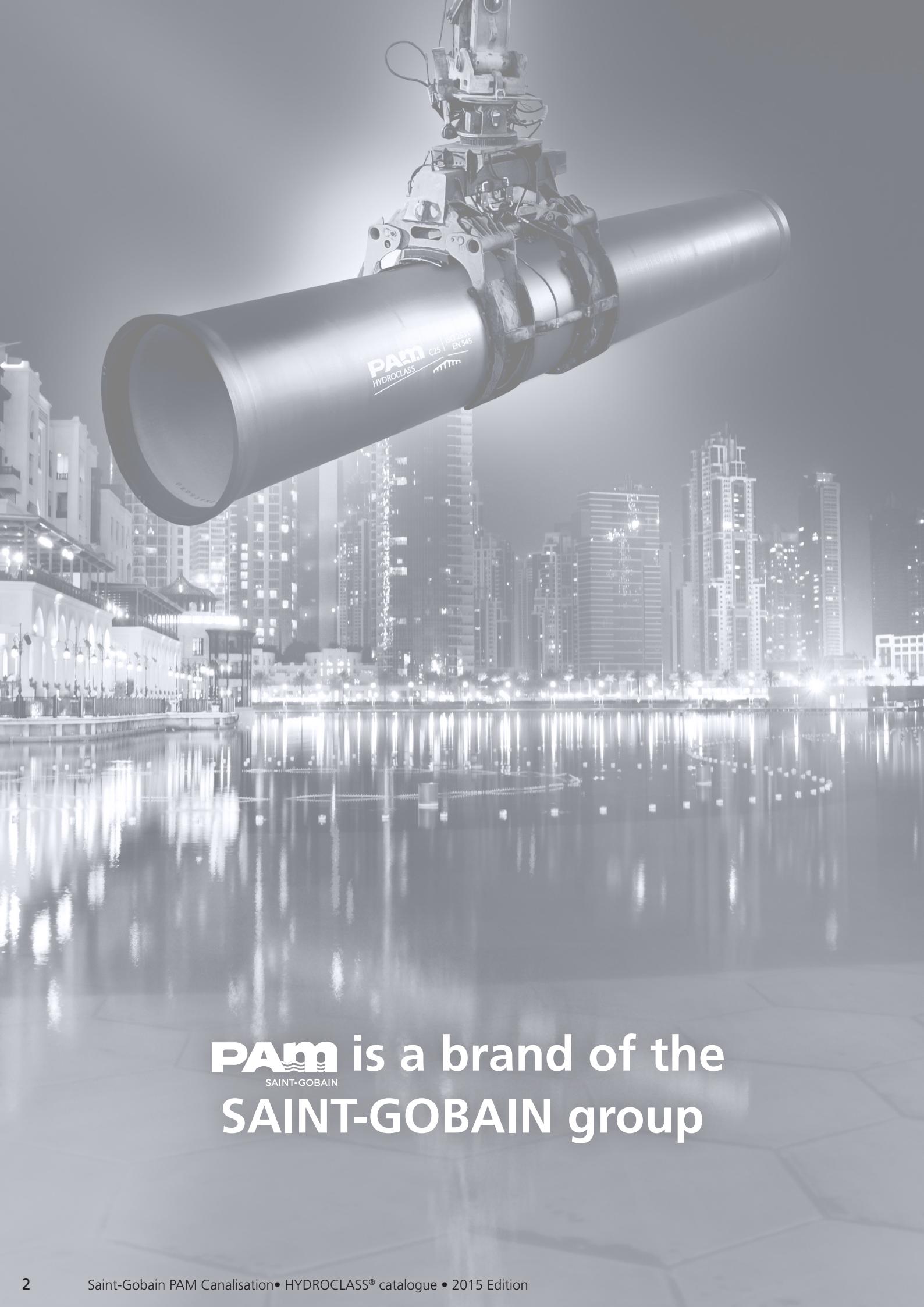




# HydroClass

DN 100 to DN 2000

Water supply and distribution  
Drinking water, irrigation and raw water



**PAM** is a brand of the  
SAINT-GOBAIN group



Saint-Gobain, the worldwide leader in sustainable habitat solutions, designs, manufactures and distributes building materials and high-performance materials, providing solutions to the challenges of growth, energy efficiency and environmental protection.



**64** countries



**180 000** employees



**12** research centres



**4** activities hubs:

Innovative materials (flat glass and high performance materials)

Construction products (comprehensive pipe solutions, plaster products, sound and thermal insulation, wall facings, roofing)

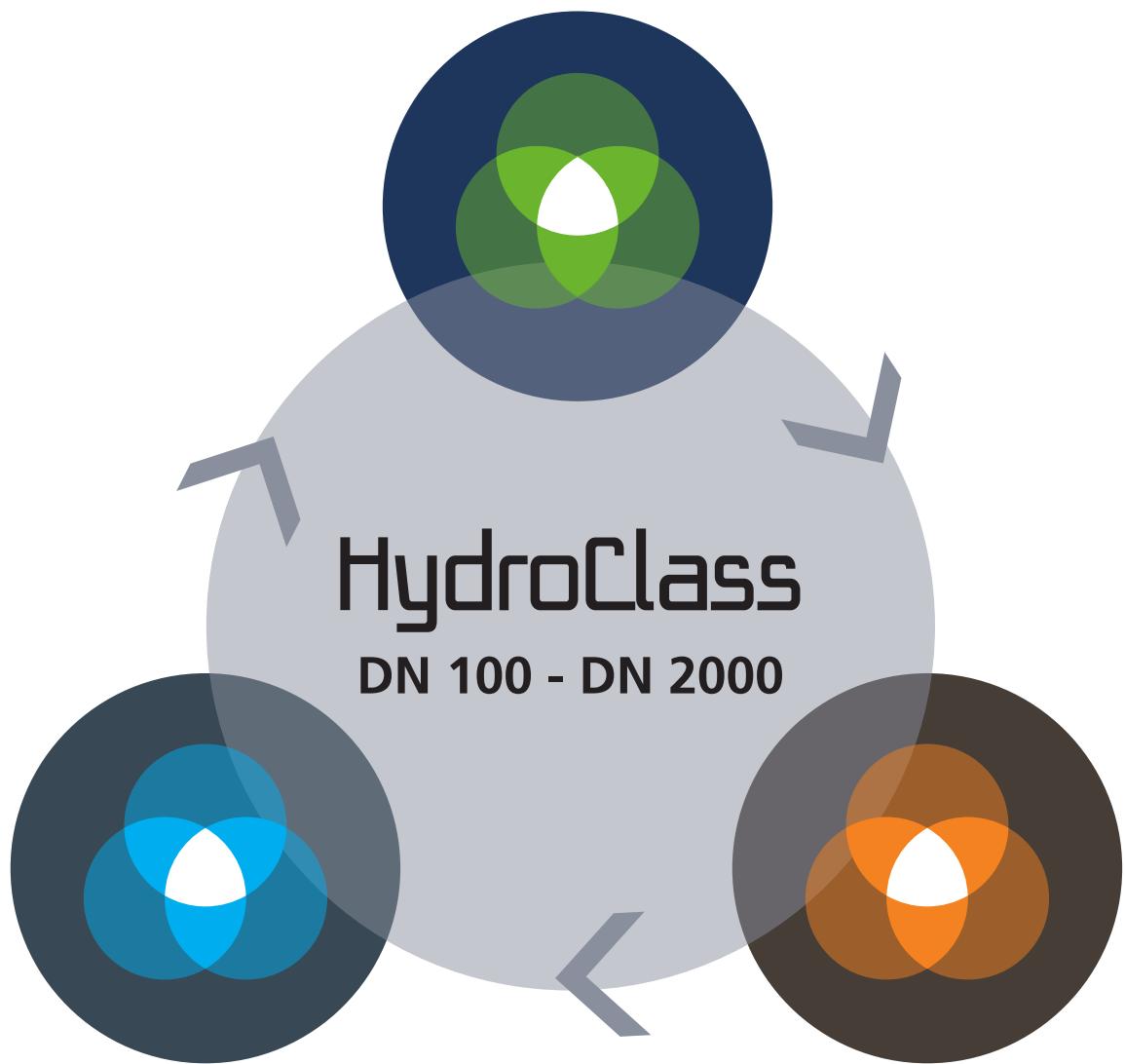
Building distribution (building materials)

Packaging (glass bottles and jars)

**Sustainable habitat solutions are at the heart of Saint-Gobain's strategy.**

Self-cleaning windows, photovoltaic glass, smart insulation systems, water supply systems and building materials distribution, Saint-Gobain is constantly innovating to make living spaces more comfortable, cost-efficient and sustainable worldwide.

**1**  
A  
UNIQUE  
BRAND



**3**  
KEY  
TECHNOLOGIES

**2**  
AN  
IDEAL  
SOLUTION

# HydroClass

## 1. A UNIQUE BRAND

- 1.1 THE REFERENCE
- 1.2 THE PARTNERSHIP
- 1.3 THE ENVIRONMENTAL VALUES

## 2. AN IDEAL SOLUTION

- 2.1 EASE OF DESIGN
- 2.2 RAPID INSTALLATION
- 2.3 RELIABLE OPERATION

## 3. KEY TECHNOLOGIES

- 3.1 DUCTILE CAST IRON
- 3.2 EXTERNAL ZINALIUM®
- 3.3 INTERNAL CEMENT LINING
- 3.4 STANDARD JOINT
- 3.5 STANDARD LOCKED JOINT

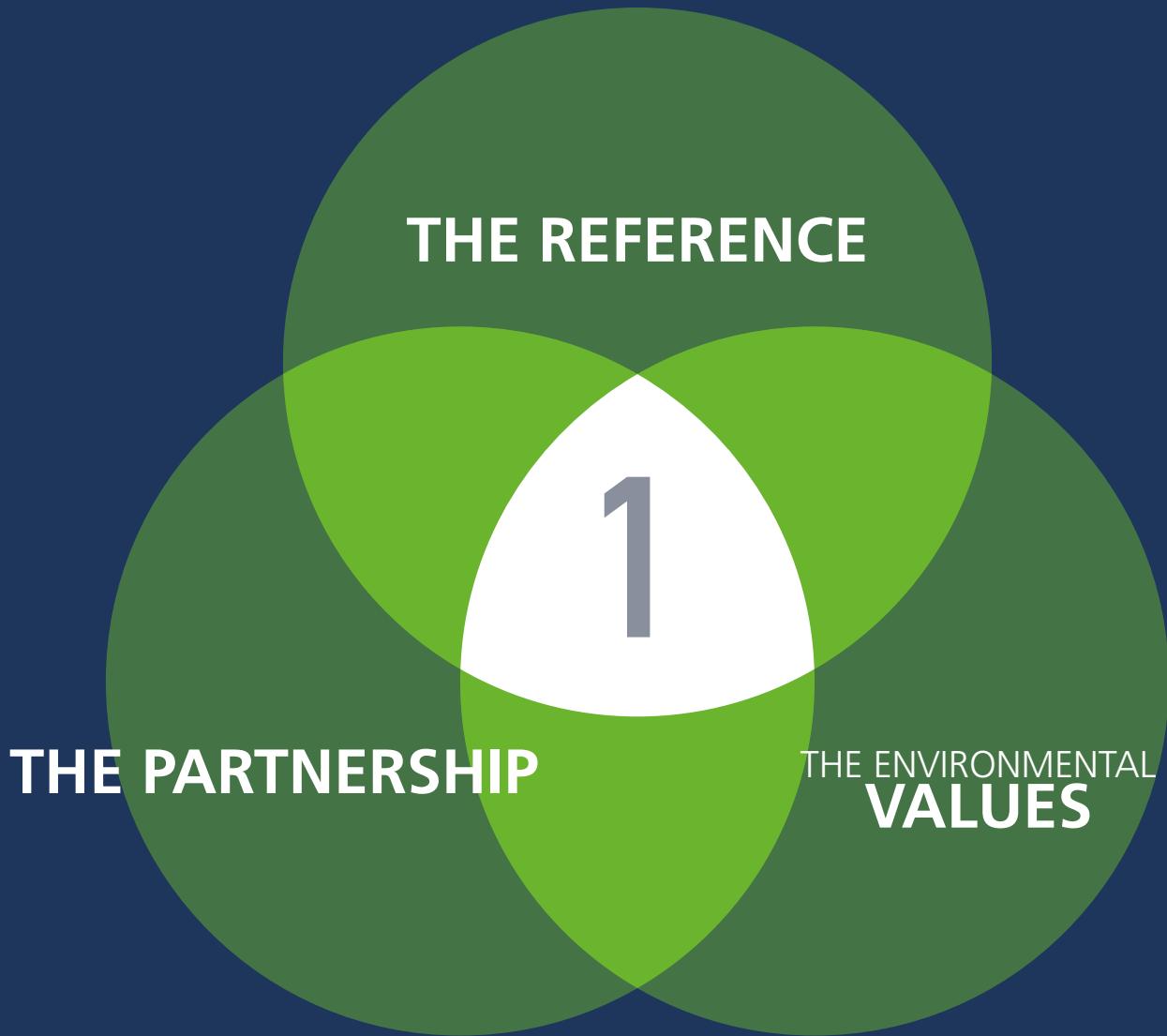
## 4. THE HYDROCLASS RANGE

- 4.1 PIPES DN 100 TO 2000
- 4.2 FITTINGS
- 4.3 JOINTS
- 4.4 TECHNICAL CHARACTERISTICS





## A UNIQUE BRAND





1.1

**160 YEARS OF EXPERIENCE,  
126 COUNTRIES**



# THE REFERENCE

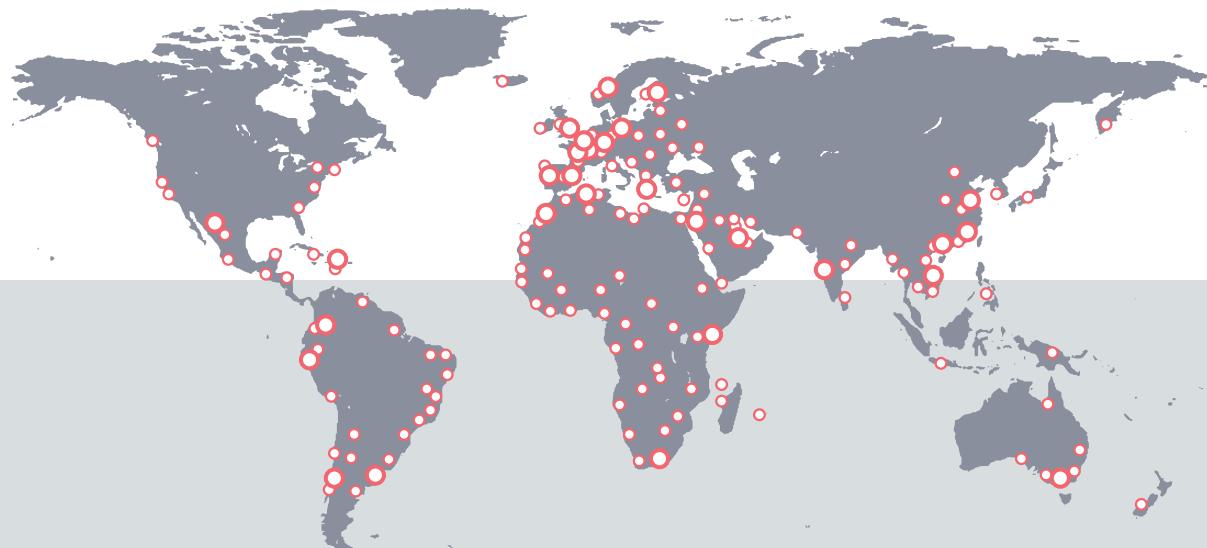
## WORLDWIDE RECOGNISED EXPERTISE

Since 1856, PAM has been designing, producing and marketing a complete set of solutions dedicated to drinking water supply, sanitation and sewage disposal.

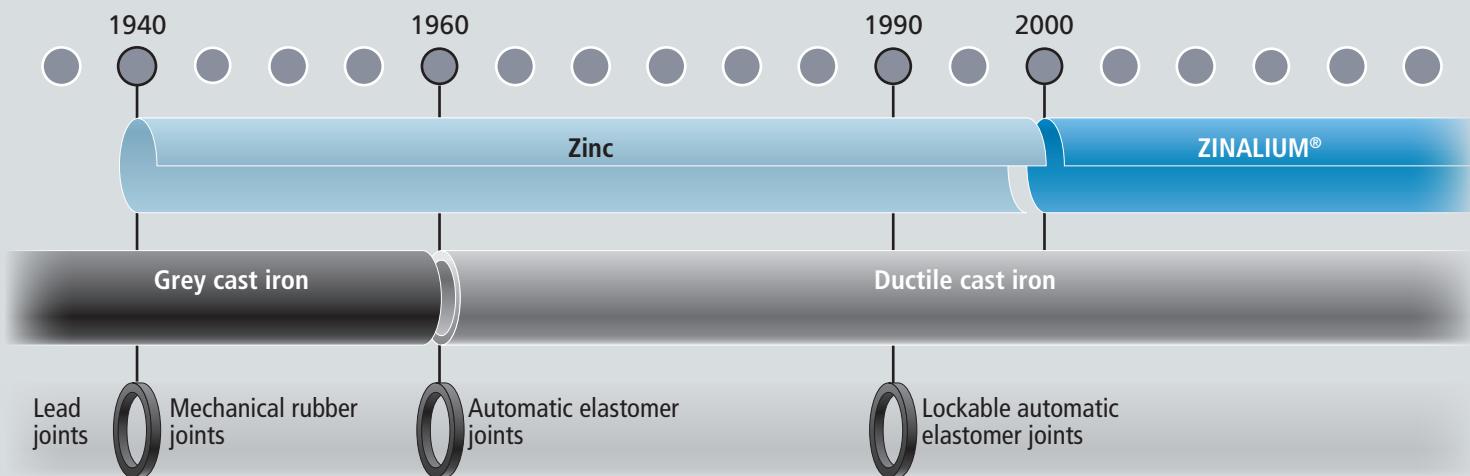


Its reputation in the pipeline profession is based on its know-how, the reliability of its products, as well as on the performance of services rendered to customers.

## 110 CAPITALS AND 40 000 KM OF PIPELINES PER YEAR



## PAM, DRIVER FOR INNOVATION



PAM is continually improving the performance of materials, coatings and junctions. Its engineers and researchers have developed more than 150 inventions that have resulted in 1500 patents to date. Currently, worldwide, 30% of the total business of the company is achieved with products launched less than five years ago.



1.2

**WITH YOU,  
TILL THE END OF THE WORLD**



# THE PARTNERSHIP

## THE EFFECTIVENESS OF A WORLDWIDE NETWORK

PAM has a global network organised for a local service to communities, public and private operators, design offices, installation companies.

PAM is continually striving to share with its customers and its commercial partners the rich experience it draws from its numerous contacts worldwide.

## EVERY STAGE OF THE PROJECT WITH CONFIDENCE

Local PAM teams, backed by their experts in soil and water analysis, hydraulic and civil engineering calculations, are present throughout the project development phase until its final completion.



Soil study and water analysis



Choice of the range of products



Engineering support



Implementation and training



Operation support



► BE A PAM PARTNER

## INTERCONTINENTAL LOGISTICS

PAM operates on large conveyance, irrigation and sanitation systems on smaller regional sites as well as large

scale district sites. The logisticians at PAM are able to manage the entire logistics chain from the factory to the site, charter

trucks and trains, load ships and manage containers, at the lowest costs and under the best safety conditions.





1.3

## WATER, SOIL, FIRE... AND DUCTILE CAST IRON



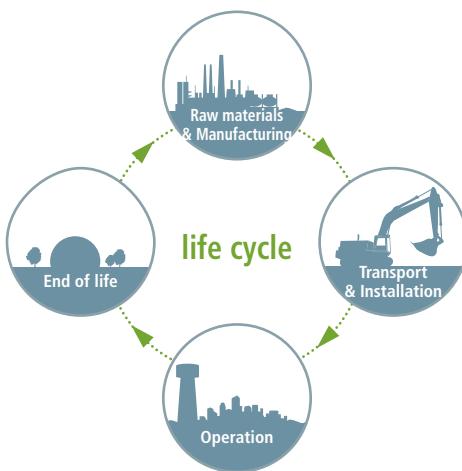
# THE ENVIRONMENTAL VALUES

## THE ECOLOGICAL FOOTPRINT IN A COMPLETELY TRANSPARENT MANNER

The PAM LCA calculator software package is designed to assess the environmental footprint. It analyses the life cycle (LCA) from the manufacturing, transport, installation, operation until recycling.

Complying with the EN 14044 standard, this software package enables to assess on a defined project:

- Emissions of greenhouse gases ( $\text{CO}_2$  equivalent),
- Consumption of fossil fuel (M joule)
- The volume of water taken from nature ( $\text{m}^3$ )



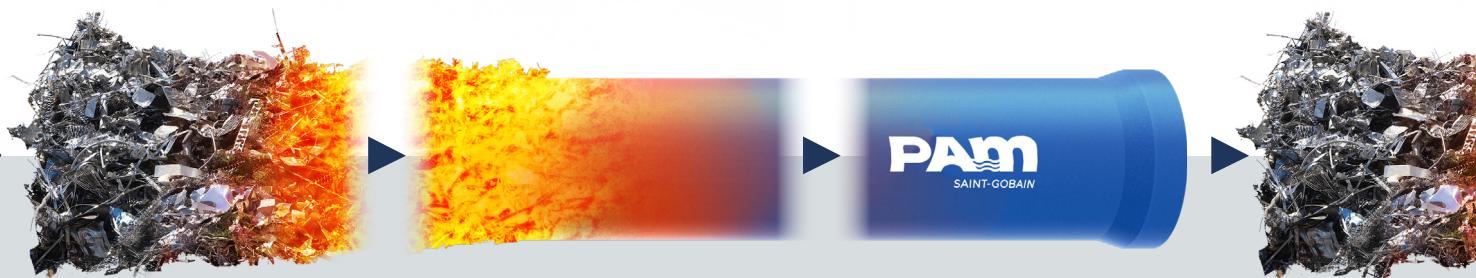
All PAM factories produce under ISO 14001 control, in order to minimise the ecological impacts, to prevent pollution incidents, to control waste management and water consumption.

Thanks to new industrial processes, PAM has reduced its energy requirements by an average of 30% to manufacture a pipe of the same diameter.

*There is more information in the "technical characteristics" chapter with 2 calculation examples.*

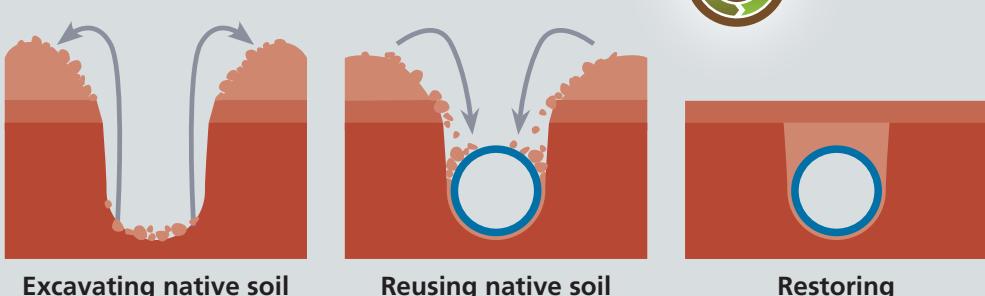


## 100% RECYCLABLE AND INDEFINITELY



The re-use of recycled scrap recovered from iron and steel manufacture is considered inexhaustible. Ductile cast iron, derived largely from scrap, is 100% recyclable and easily, made easier due to the proximity of metal recycles.

## PRESERVED NATURAL SOIL



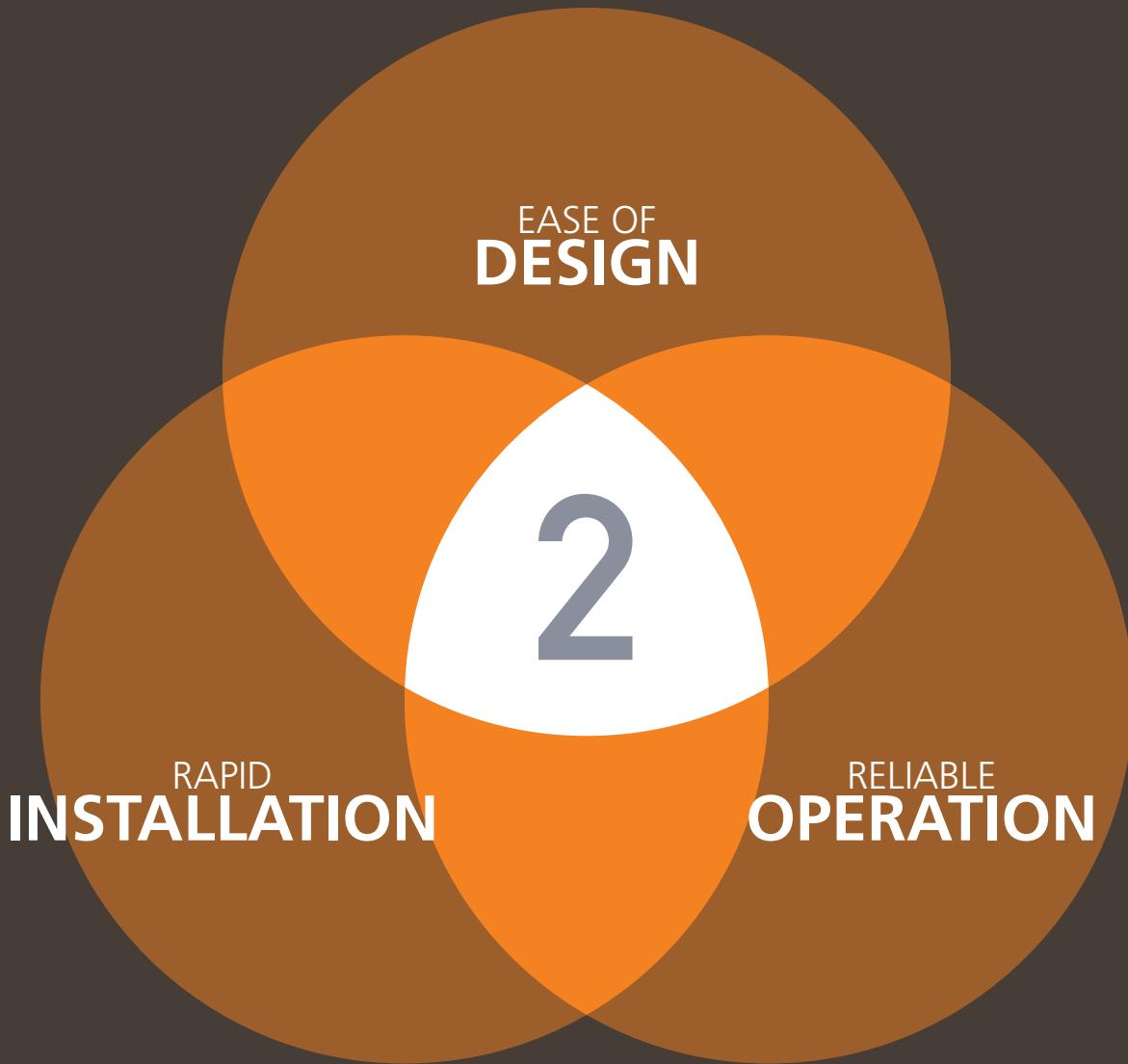
Cast iron pipelines are rigid and robust and do not require excessive compaction rates when they are laid in trenches. They enable to reuse native backfills rather than materials imported from distant

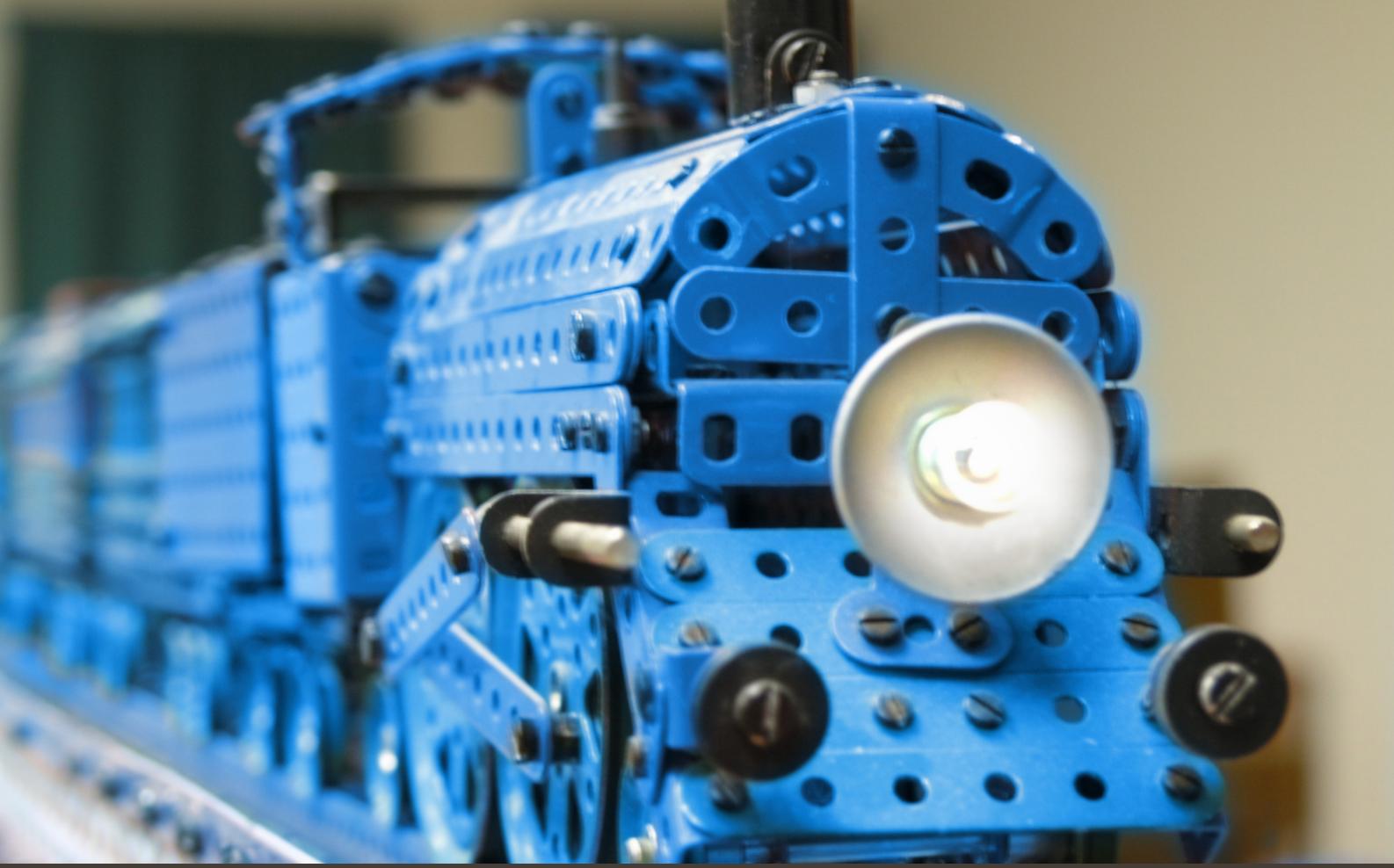
quarries. This good practice participates in the preservation of soil in its natural state while reducing costs and the site's ecological footprint.





# THE IDEAL SOLUTION





## 2.1 INGENIOUS AND SIMPLE



# EASE OF DESIGN

## A COMPLETE AND COORDINATED RANGE

With over 50,000 references, from DN 60 to DN 2000, PAM's fittings offer facilitates the design of networks of all sizes and complexities, in all situations.

With standardised components, to completely compatible assemblies, the PAM catalogue constitutes the perfect design assistance tool for design offices. PAM makes available a library of

PAMCAD digital images, which integrate with software packages intended for designers.

Drawing on its experience and that of its customers, PAM also proposes pre-sized installation solutions, tested and easy to implement.



## CERTIFIED AND BEYOND THE STANDARDS

All PAM products comply with the current European (EN) and international (ISO) standards.

Through the work of the PAM research centre and their knowledge of corrosion phenomena in the soil, the PAM pipelines have the latest coating technologies and often exceed the minimum required by industry standards.

It is also in this centre that the joints are developed and tested in the most extreme conditions.



## BE A PAM DESIGNER

The quality management is a clear and operational concept at PAM, which designs, manufactures and markets its products in accordance with the requirements of the ISO 9001 quality assurance system.

The quality control process is regularly audited by external third party organisations that issue compliance certificates.

*There is more information on the standards and certificates in the "technical characteristics" chapter.*





2.2

TIME IS MONEY

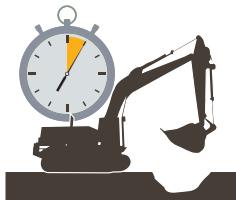


# RAPID INSTALLATION

## ROBUST COMPONENTS

PAM designs efficient and robust parts, compatible with conditions of transportation by truck, train, ship, capable of withstanding stacking up of stocks and rough handling on sites.

## HIGH PRODUCTION RATES



1. Excavating



2. Laying



3. Assembling



4. Filling in

Laying, aligning, fitting! No welding on site, no repairing of the coating, no ultrasonic or X-ray examination... no other material

can match the assembly rate of cast iron pipes with sockets. No immobilisation of specialised equipment, or waiting time for drying or cooling of assemblies. Nothing equals the management flexibility of shutdowns, restarting and progress of the site

with PAM technology.

*More information in the "technical characteristics" chapter on the assembly times.*



**BE A PAM PRO**

installation videos



## ANY TIME, ALL TERRAINS

Deserts or forests, swamps or mountains, sunshine or snow; the products, their protection and their assembly are designed for all climates and all situations.

An excavator for straight lines at high rate, simple hand winches at the bottom of inaccessible trenches! No waiting time, irrespective of the temperature and

humidity level. The short pipe lengths (6m and 8m) facilitate access with equipment of standard size and favourably limit the site's right-of-way strip.





## 2.3 DRINKING WATER, 24/7



# RELIABLE OPERATION

## WATERTIGHTNESS, RELIABILITY, SAFETY

Operators are responsible for regularly providing water in sufficient quality and quantity to consumers. PAM products help them attain their objectives:

- Cast iron is a robust material, which withstands high service pressures and external mechanical accidents. It is impervious to pollution in the soil.
- The joints with flexible sockets ensure watertightness.
- The coatings sustainably protect from external corrosion and preserve the water quality.

## PERENNIAL, UPGRADABLE, EXTENSIBLE SYSTEM

International statistics show that cast iron pipelines have service lives of more than 100 years.

The networks must continually adapt to urban, industrial, agricultural, tourist developments. PAM pipelines are designed with a safety reserve that confidently authorises increases in flow and pressure. They also withstand increases in surface loads (roads, buildings, etc.).

PAM offers a complete solution with pipes, joints and connections that ensure perfect compatibility of installations.



## BE A PAM USER

## INVEST TO SPEND LESS

Investing today in a high-quality pipeline is spending less tomorrow.

The costs of pumping and water losses during the life of a network are considerably greater than the cost of initial purchase.

The PAM TCO calculator software package is designed to assess the total cost of ownership. It highlights the immediate costs of the investor and the deferred costs of the operator. The calculation method takes into account:

- The acquisition costs (pipes, laying, loans, etc.).
- The operating costs (maintenance, water losses, pumping energy)
- The end of life costs (removal, recycling)

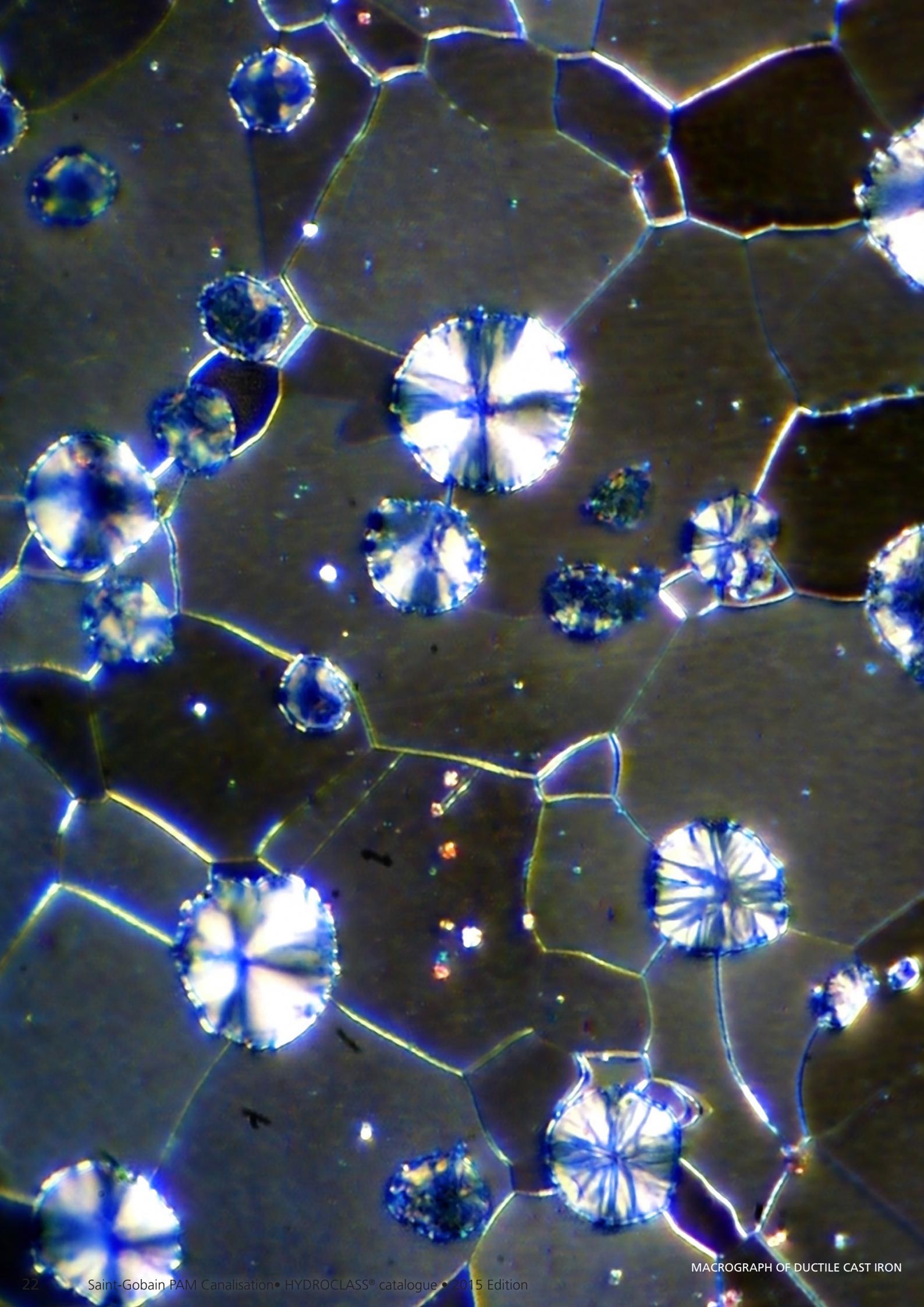
*More information in the "technical characteristics" chapter with 2 calculation examples.*

## WHICH REVEALS THE TCO



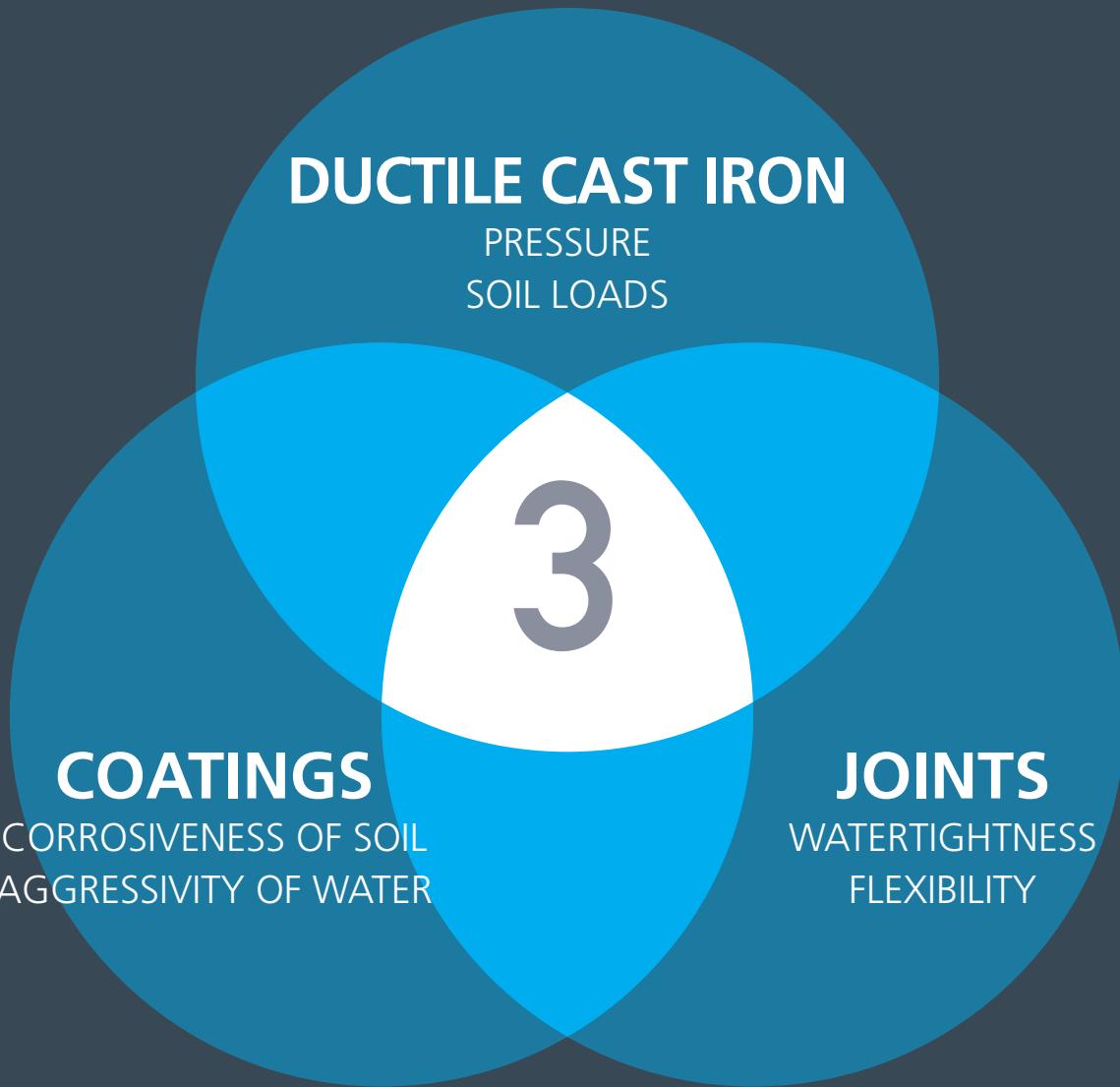
## HYDROCLASS PIPE DN 200 OVER 100 YEARS





MACROGRAPH OF DUCTILE CAST IRON

# KEY TECHNOLOGIES





## 3.1

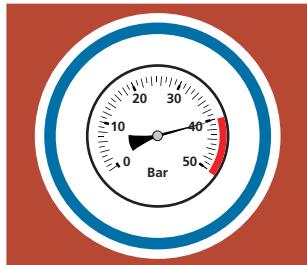
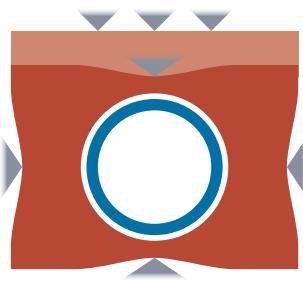
### STRENGTH AT THE CORE OF THE MATERIAL



# DUCTILE CAST IRON

## SOLID UNDER LOADS

In underground conditions, the ductile cast iron pipe has a semi-rigid behaviour: it offers an excellent compromise between mechanical stress in the wall (small DN) and ovality (large DN). It can be laid in high and low height of cover, and easily in soil of low rigidity. The "ground/semi-rigid pipe" system offers optimum mechanical stability over time, without risk of buckling in large DN.

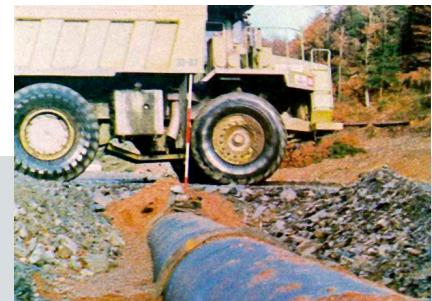
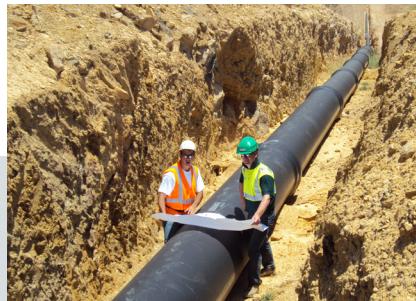
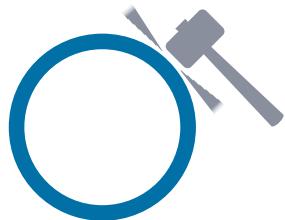


## PRESSURE RESISTANCE

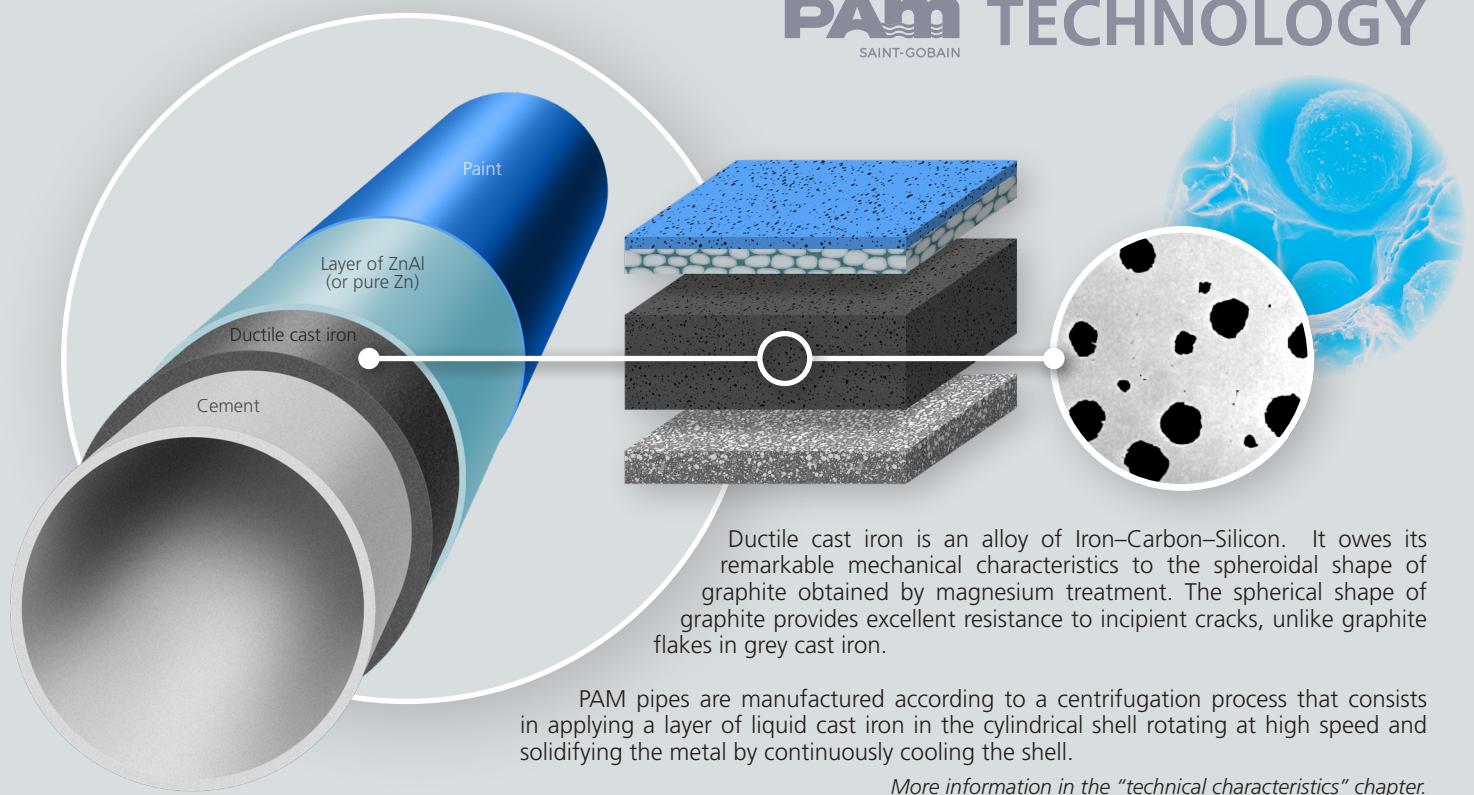
The PAM pipelines are designed to withstand pressures much greater than the values usually encountered on the networks. The wall thickness is calculated with a safety factor of 3 with respect to the maximum operating pressure. This additional safety margin is very useful to the impacts during installation, accidental overpressure and mechanical operating fatigue.

## INSENSITIVE TO IMPACTS

The ductile cast iron structure has a high elastic deformability and a high resistance to crack initiation: it results in excellent impact resistance. The cast iron pipes are perfectly suited to transport conditions over long distances (truck, train or ship), handling conditions on sites and to different types of backfilling. The ductile cast iron pipelines may be laid in very difficult areas: rocky mountain slopes for hydroelectric plants, crossings for cantilever bridges, rockfill for submarine outlets.



## PAM TECHNOLOGY



Ductile cast iron is an alloy of Iron–Carbon–Silicon. It owes its remarkable mechanical characteristics to the spheroidal shape of graphite obtained by magnesium treatment. The spherical shape of graphite provides excellent resistance to incipient cracks, unlike graphite flakes in grey cast iron.

PAM pipes are manufactured according to a centrifugation process that consists in applying a layer of liquid cast iron in the cylindrical shell rotating at high speed and solidifying the metal by continuously cooling the shell.

*More information in the "technical characteristics" chapter.*



**3.2**

**A SERVICE LIFE 3 TIMES  
LONGER WITH ZINALIUM®**



# ZINALIUM®

## THE EXTERNAL COATING

ZINALIUM® is made up of 2 layers:

- A layer of 85-15 Zinc-Aluminium alloy, with at least 400g/m<sup>2</sup>.
- A layer of blue synthetic paint (semi-permeable).

### LONG-TERM PROTECTION

HYDROCLASS® pipes are available with ZINALIUM® or with a pure Zinc coating. As soon as it comes in contact with the soil, a Zinc-based coating generates an overall protective layer that constitutes a real shell for buried ductile cast iron pipelines. Compared with a pure Zinc coating, ZINALIUM® triples the service life of the protective layer.

Moreover, thanks to the electrical rating of its joints, the cast iron pipeline does not require cathodic protection.

### TESTING THE TRANSPORT AND THE SITE

Adhering perfectly to the cast iron surface, the ZnAl 85-15 alloy is also a malleable and deformable metal. The ZINALIUM® coating absorbs transportation or site impacts without breaking.

### SELF-REPAIRABLE

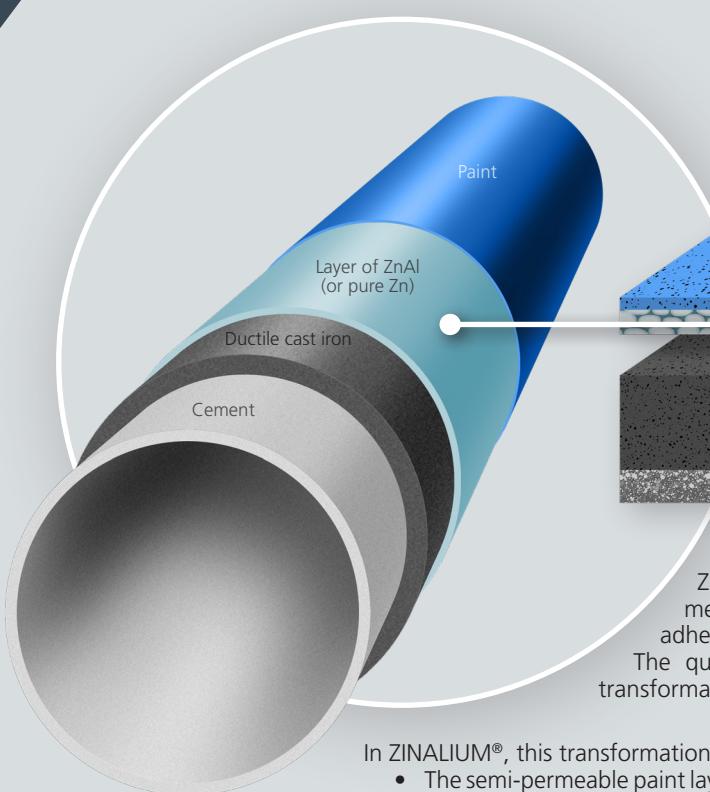
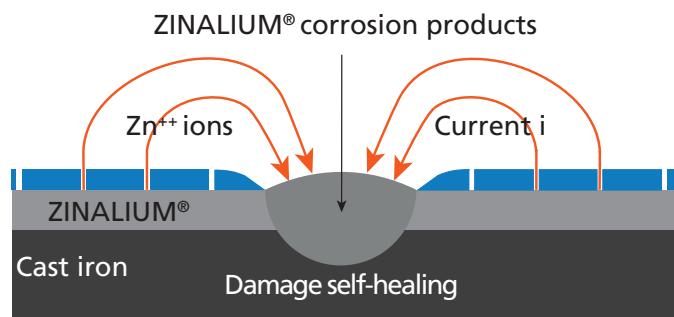
ZINALIUM® restores the continuity of the protective layer at points that have suffered limited damage, by galvanic effect between the exposed cast iron and the Zinc near the damaged area (transport impacts, scraping during backfilling).

### SUITABLE FOR HIGHLY CORROSIVE SOIL

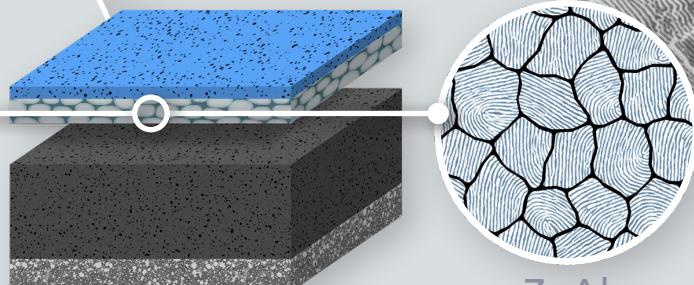
Compared with pure Zinc, ZINALIUM® significantly extends the domain of use (or the service life) in highly corrosive soils as defined in European standard EN 545: 2010 (appendix D.2.2.). PAM teams conduct soil studies upon request.

The sockets and spigot ends of pipes are protected in the factory, so that after assembly of joints no recoating is necessary on site.

*More information in the "technical characteristics" chapter about the domains of use in the soil.*



**PAM TECHNOLOGY**  
SAINT-GOBAIN



ZINALIUM® is an "active" coating: when it is in contact with the ground, the metallic layer of the ZnAl alloy transforms itself into a layer of zinc hydroxide, adherent and stable, which protects the entire surface of the buried pipe. The quality of this overall protective layer is that much better as the transformation of Zinc into Zinc hydroxide is slower.

In ZINALIUM®, this transformation kinetics of Zinc is controlled by 2 elements:

- The semi-permeable paint layer that limits, without prohibiting, the exchanges with the surrounding damp soil;
- The ZnAl 85-15 alloy "traps" the phase rich in Zinc into an aluminium skeleton, slows down the transformation of Zinc into Zinc hydroxide and confines the substances at the core of the metal layer.

ZINALIUM® complies with standards EN 545 and ISO 8179.



## 3.3

### WATER PRESERVED BY MINERALS



# CEMENT MORTAR LINING

## THE INTERNAL COATING

The internal coating is a blast furnace cement mortar; the mixture is prepared with cement, sand and drinking water before being applied by high speed centrifugation, then cured in controlled hygrometry.

### SUITABLE FOR CONTACT WITH DRINKING WATER

The HYDROCLASS® range can be used to canalise all types of drinking water in accordance with European Directive 98/83/EC. The cement coating complies with standards EN 545 and ISO 4179 and with the national sanitary regulations applicable to "materials in contact with drinking water". It is also suitable for channelling certain types of raw water. Contact us for specific applications.

*There is more information on the standards and certificates in the "technical characteristics" chapter.*

### RESISTANT TO SULPHATES

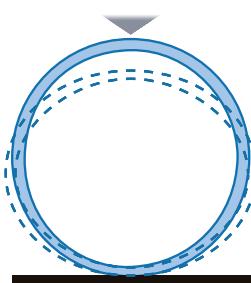
The blast furnace cement coating is classified as "resistant to sulphates" in the EN545 standard. It is suitable for water as defined in table E.1 of appendix E/ EN 545. On request and based on a water sample, the PAM laboratories may verify the compatibility of the cement with the canalised water by using suitable simulation software.

### EXCELLENT HYDRAULICITY

The centrifugation process ensures a perfectly smooth and even cement surface. The Colebrook roughness coefficient of an isolated pipe is  $k = 0.03 \text{ mm}$ .

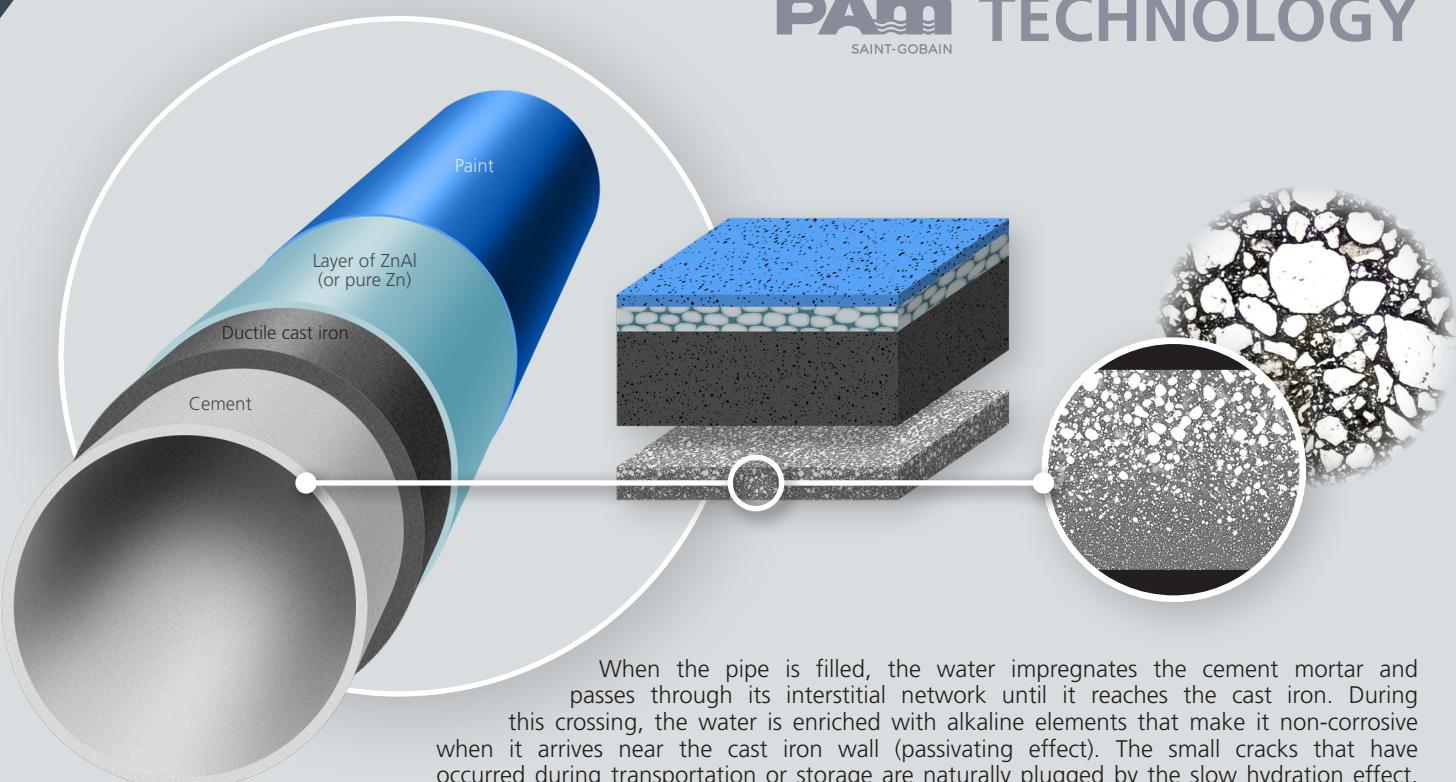
PAM recommends the use of an average value of  $k = 0.1 \text{ mm}$  for sizing networks in order to take into account all the different load losses caused by singular points (tee fittings, elbows, valves, etc.).

### OVALITY



The centrifuged cement mortar is perfectly adherent to the inner wall of the cast iron pipe. This results in an excellent bending and ovality performance and perfect resistance to vacuum (in case of transient negative pressure, for example).

**PAM TECHNOLOGY**  
SAINT-GOBAIN



When the pipe is filled, the water impregnates the cement mortar and passes through its interstitial network until it reaches the cast iron. During this crossing, the water is enriched with alkaline elements that make it non-corrosive when it arrives near the cast iron wall (passivating effect). The small cracks that have occurred during transportation or storage are naturally plugged by the slow hydration effect. PAM applies fresh mortar by high speed centrifugation with vibration. This process produces a compact and homogeneous layer, with a thin and smooth layer of fine particles on the inside, which is favourable for the flow.

*There is more information on contact with water in the "technical characteristics" chapter.*



**3.4**

**THE GREATER THE PRESSURE,  
THE MORE IT IS WATERTIGHT**



# THE STANDARD JOINT

The STANDARD joint has been the preferred assembly system of pipeline contractors for 60 years.

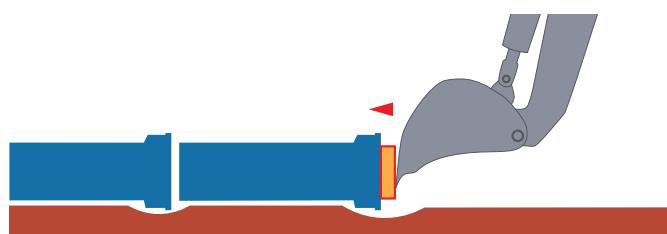
## QUICK AND SELF-SEALING

The watertightness of the STANDARD joint results from the radial compression of the sealing ring (1), by the simple introduction of the spigot ends into the socket. It does not depend on the tightening torque of bolts, or a welding process.

The STANDARD joint is perfectly suitable for installation conditions in trenches or overhead, irrespective of weather conditions.

## WITHOUT WELDING, OR REWORKING

No welding on site, no repair of coatings. As an example, 8 minutes are sufficient to create a watertight junction at 25 bars on a ductile cast iron pipe of DN 1000!



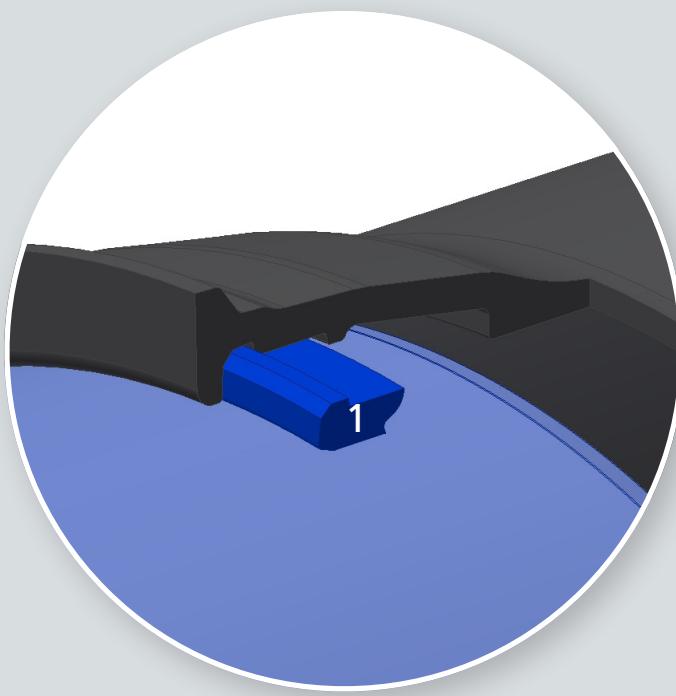
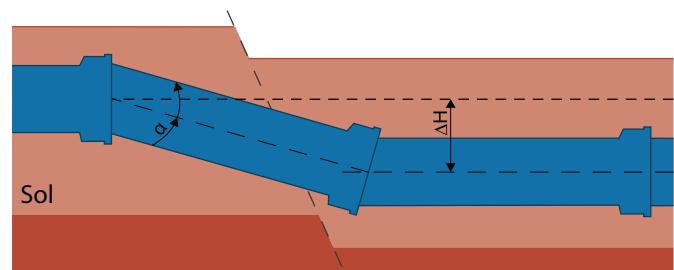
## TESTED UNDER PRESSURE AND NEGATIVE PRESSURE

All PAM joints are qualified under extreme conditions required by the EN 545 standard (pressure, negative pressure, fatigue and water logging from the outside).

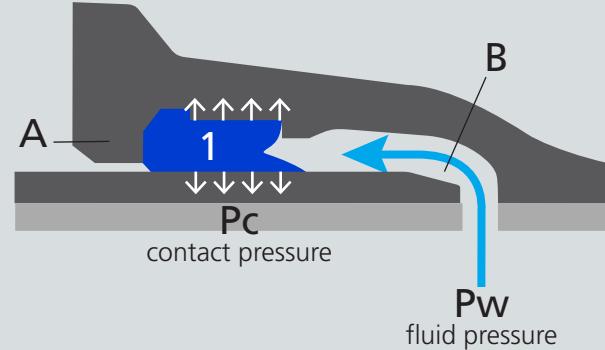
*There is more information on the tests under extreme conditions in the "technical characteristics" chapter.*

## FLEXIBLE

The angular deviation and axial displacement capacity gives the pipeline a chain like behaviour in unstable ground, or simply correct the actual route route depending on obstacles encountered.



**PAM TECHNOLOGY**  
SAINT-GOBAIN



*There is more information about the joint performance levels in the "technical characteristics" chapter.*

The STANDARD joint is self-sealing: the greater the water pressure (Pw), the greater the contact pressure (Pc) between the elastomer ring and the metal. This property is obtained thanks to the shape of the sealing ring (1) and to the physical characteristics of the elastomer. The heel (A) of the socket prevents the expulsion of the joint, and the cavity (B) authorises the angular deviation, even at high pressure.

The sealing ring is a EPDM elastomer. Rigorously selected, it guarantees the maintenance of its physico-chemical characteristics over a very long duration.



## 3.5 **LOCKING IS BETTER THAN WELDING**

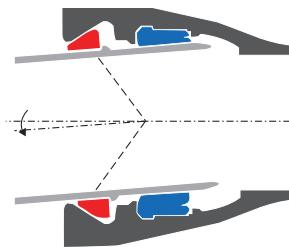


# STANDARD LOCKED JOINT

## HIGH TENSILE STRENGTH

The STANDARD locked joint enables absorption of the axial hydraulic forces while maintaining its angular deviation capacity.

PAM proposes several locking techniques, adapted to different operating pressures and pipeline diameter.



## FAST AND SAFE PROGRESS

The locking eliminates concrete abutments, bulky in urban areas or expensive over large DN. Particularly useful for reducing inconveniences at a site in an urban area, the locking enables the pressure tests on site to be carried out as soon as possible after assembly of pipes and their backfilling. Compared with welding processes (on PE or steel pipes) the locking exempts the contractor from calling certified personnel and immobilising equipment and specialised electrical power sources.

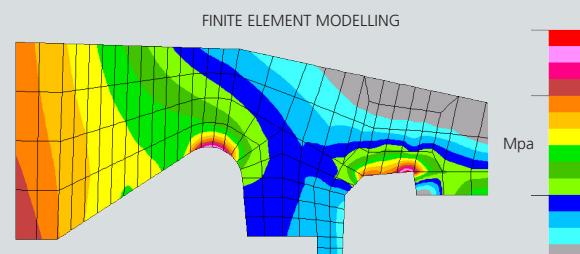
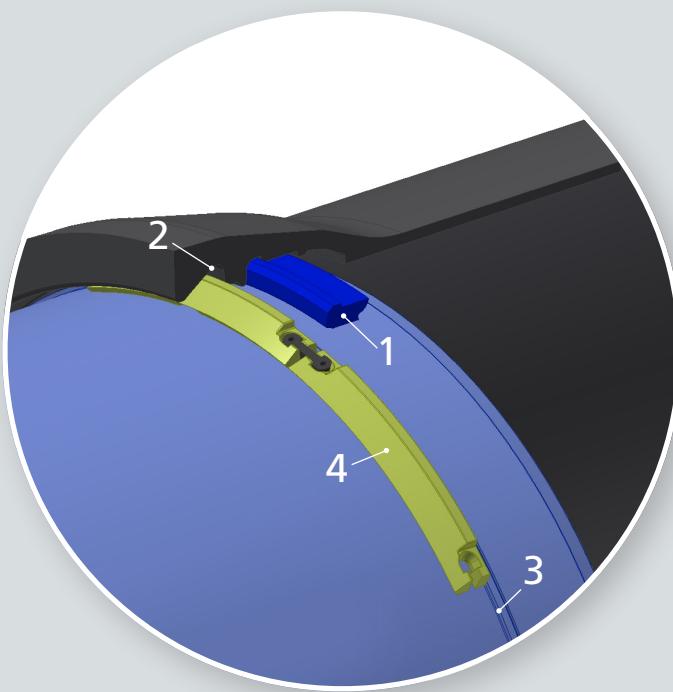
## THE BEST WAY TO PULL A STRING OF PIPES

Locking is the best way to pull a train string in several cases: pulling in a sheath below a roadway, directional drilling without need for trench, installation in high gradient (case of mini hydroelectric generation unit in the mountains), securing in unstable ground, floating pulling before immersion of the pipeline, etc.



## PAM TECHNOLOGY

There are several locking techniques:  
STANDARD Vi or Ve, UNIVERSAL STD Vi or Ve, PAMLOCK.



In the UNI STD Ve locking (opposite), the sealing is ensured by a STANDARD sealing ring (1). The axial hydraulic forces are taken up by a system that includes:

- A UNIVERSAL socket with double chamber (2)
- A weld bead (3) is created in the factory and is situated on the pipe's spigot end.
- A locking ring (4) made up of segments with a spherical external profile, that rests against the weld bead and the socket chamber.

The PAM locks are designed by using finite element calculations, completed by behaviour tests in the most extreme conditions. They support angular deviations and ovality of the pipe without reducing in any way their axial resistance capacities.

*There is more information about the joint performance levels and the choice of locking techniques in the "technical characteristics" chapter.*



**PAM**  
SAINT-GOBAIN



# THE HYDROCLASS RANGE

## 4

- 4.1 PIPES DN 100 TO 2000
- 4.2 FITTINGS
- 4.3 JOINTS
- 4.4 TECHNICAL CHARACTERISTICS

# 4.1 PIPES

DN 100 TO 2000



PFA: Permissible operating pressure under EN 545 and ISO 2531

HYDROCLASS® pipes				Unlocked				Locked				Coatings		
DN	Lu	Class	Mass (1)	STD	STD Vi	STD Ve	Class	Mass (2)	UNI STD Vi	UNI STD Ve	PK	INT	EXT	
mm	m	(*)	kg/m	PFA bar	PFA bar	PFA bar	kg/m	kg/m	PFA bar	PFA bar	PFA bar	CHF	Zn	ZnAl
100	6.00	C40	14.7	40	16									
150	6.00	C40	22.2	40	16									
200	6.00	C40	30.2	40	16									
250	6.00	C40	42.2	40	16									
300	6.00	C40	55.5	40	16	30 <sub>nc</sub>								
350	6.00	C30	67.9	30	16	27 <sub>nc</sub>	C40	83.5						
400	6.00	C30	79.4	30	16	25	C40	98.2	20 <sub>nc</sub>	35 <sub>nc</sub>				
450	6.00	C30	93.7	30	13 <sub>nc</sub>	23	C40	117.3	16 <sub>nc</sub>	32 <sub>nc</sub>				
500	6.00	C30	111.1	30	11	22	C40	139.2	16 <sub>nc</sub>	30 <sub>nc</sub>				
600	6.00	C30	150.6	30	10	20	C40	187.8	16 <sub>nc</sub>	30 <sub>nc</sub>				
700	6.00	C25	186.2	25		20	C30	227.0		27 <sub>nc</sub>				
800	6.00	C25	229.0	25		16/20 <sub>nc</sub>	C30	278.0		25 <sub>nc</sub>				
900	6.00	C25	276.2	25		16/20 <sub>nc</sub>	C30	348.7		25 <sub>nc</sub>				
1000	6.00	C25	330.6	25		16/20 <sub>nc</sub>	C30	554.1		25 <sub>nc</sub>				
1100	8.19	C25	395.4	25		16/20 <sub>nc</sub>								nc
1200	8.19	C25	461.6	25		16/20 <sub>nc</sub>	C30	521.6		25 <sub>nc</sub>				nc
1400	8.17	C25	632.4	25			C25	632.4		16 <sub>nc</sub>	25 <sub>nc</sub>			nc
1500	8.16	C25	720.3	25			C25	780.6			25 <sub>nc</sub>			nc
1600	8.16	C25	806.1	25			C25	872.8			25 <sub>nc</sub>			nc
1800	8.15	C25	995.1	25			C25	1064.7			16 <sub>nc</sub>			nc
2000	8.13	C25	1210.0	25			C25	1306.7			16 <sub>nc</sub>			nc

(1) Weight calculated with STD socket

(2) Weight calculated with UNI STD socket

Lu: unit length

(\*): Other pipe classes available

- C25 DN 350 to 600 on request
- C20 DN 700 to 2000 on request
- All upper classes on request

Coatings:

Internal coating: CHF blast furnace cement mortar

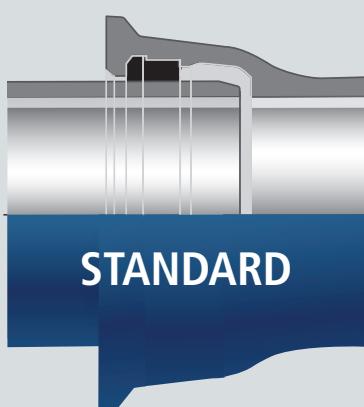
External coating: pure zinc 200 g/m<sup>2</sup> + blue synthetic paint

External coating: Zinalium alloy 400 g/m<sup>2</sup> + blue synthetic paint

STD: STANDARD joint  
 STD Vi: STANDARD Vi joint  
 STD Ve: STANDARD Ve joint  
 UNI STD Vi: UNIVERSAL STANDARD Vi joint  
 UNI STD Ve: UNIVERSAL STANDARD Ve joint  
 PK: PAMLOCK joint

nc: Contact us

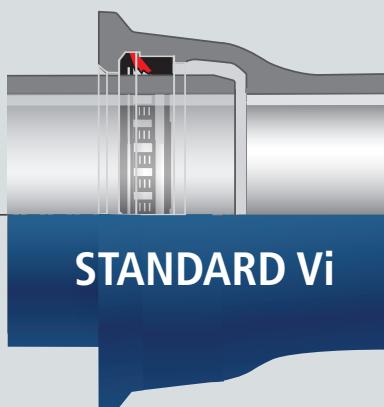
# JUNCTIONS AND LOCKINGS



**STANDARD**

**DN 100-2000**

Self-sealing,  
not locked  
QUICK FOR ALL DN!

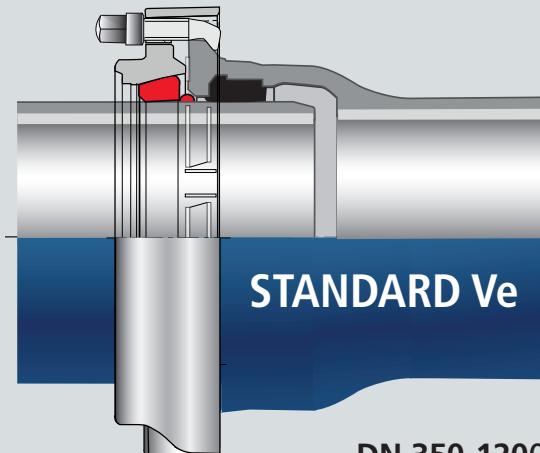


**STANDARD Vi**

**DN 100-600**

Seal ring equipped with  
locking inserts

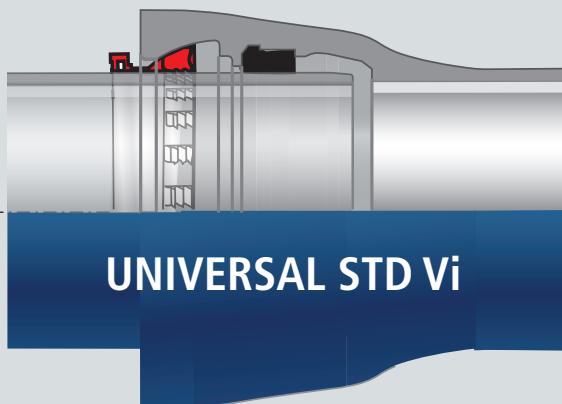
LAST MINUTE INSTALLATION!



**STANDARD Ve**

**DN 350-1200**

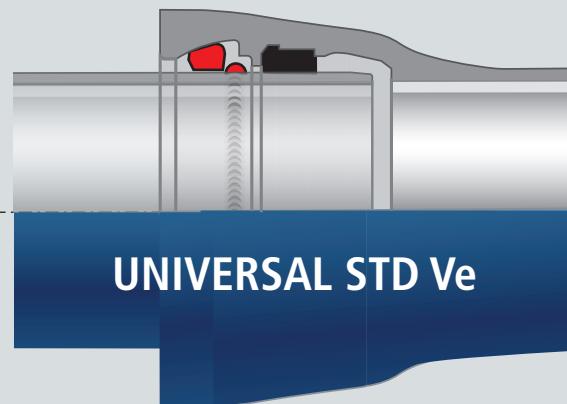
Locking with ring in abutment on the weld bead  
maintained by a removable mounting flange  
FOR STANDARD JOINT WITH FLANGE RING!



**UNIVERSAL STD Vi**

**DN 400-600**

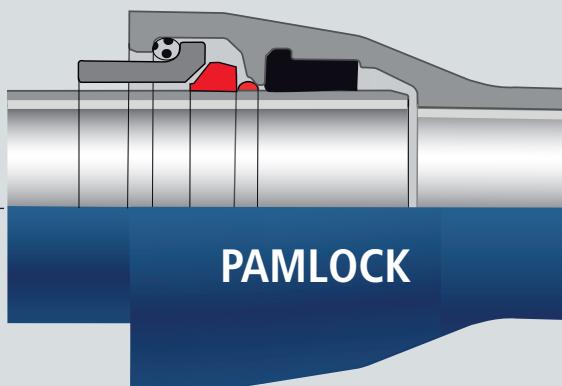
Locking with insert rings housed in a chamber  
adjoining the sealing chamber  
**WITHOUT WELD BEAD!**



**UNIVERSAL STD Ve**

**DN 400-1400**

Locking with ring and weld bead housed in a chamber  
adjoining the sealing chamber  
**HIGH PRESSURE, WITHOUT ANY BOLTS!**



**PAMLOCK**

**DN 1400-2000**

Locking with cooling jig, ring and weld bead housed in  
a chamber adjoining the sealing chamber  
**HIGH PRESSURE IN LARGE DN!**

VIDEOS OF ASSEMBLIES

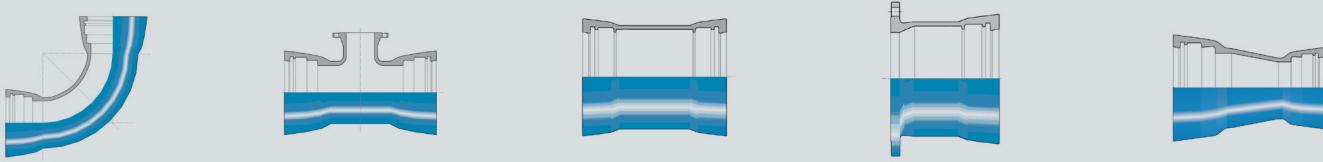


CHOICE OF LOCKING TECHNIQUES

*There is more information  
in the "technical characteristics" chapter.*

# 4.2 SOCKET FITTINGS

# FITTINGS



DN	Double socket bend				Collar	Flange Spigot	Flange Socket	Double socket taper												Coating				
	11°	22.5°	45°	90°				80	100	150	200	250	300	350	400	450	500	600	700	800	900	1000		
100							***	***																
150							***	***																
200							***	***																
250							***	***																
300							***	***																
350							***	***																
400							***	***																
450							***	***																
500							***	***																
600							***	***																
700							***	***																
800	**	**	**	**			**	**																
1000	**	**	**	**			**	**																
1200	**	**	**	**			**	**																
1400	**	**	**	**			**	**																
1600	**	**	**	**			**	**																
1800	*	*	*	*			*	*																
2000	*	*	*	*			*	*																

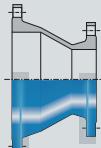
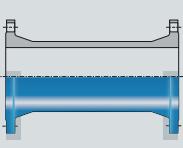
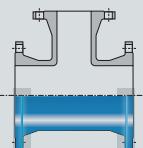
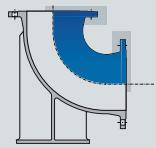
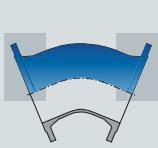
DN	All socket tee												Double socket tee with flange branch												Coating										
	80	100	150	200	250	300	350	400	450	500	600	700	800	900	1000	1200	80	100	150	200	250	300	350	400	450	500	600	700	800	900	1000	1200			
100	***	***															***	***																	
150	***	***															***	***																	
200	***	***															***	***	***																
250	***	***															***	***	***	***															
300	***	***															***	***	***	***	***														
350	***	***															***	***	***	***	***	***													
400	***	***															***	***	***	***	***	***	***												
450	***	***															***	***	***	***	***	***	***	***											
500	***	***															***	***	***	***	***	***	***	***	***										
600	***	***															***	***	***	***	***	***	***	***	***										
700	***	***															***	***	***	***	***	***	***	***	***										
800	***	***															***	***	***	***	***	***	***	***	***										
1000	***	***															***	***	***	***	***	***	***	***	***	***	nc	***	***	***	***	***	***	***	***
1200	***	***															***	***	***	***	***	***	***	***	***	***	nc	***	***	***	***	***	***	***	***
1400	***	***															***	***	***	***	***	***	***	***	***	***	nc	***	***	***	***	***	***	***	***
1600	***	***															***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***
1800	***	***															***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***
2000	***	***															***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***



Flanged pipes and anchoring liners with custom lengths are available on request.  
Contact us for all DN 900, 1100 and 1500 fittings.

# 4.2 FLANGE FITTINGS

# FITTINGS



DN	Double flange bend				Duckfoot bend	Flange Spigot	Double flange taper										Coating	
	11°	22.5°	45°	90°			Double flange taper											
	50	65	80	100	150	200	250	300	350	400	450	500	600	700	800	900	1000	
80	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	
100	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	
150	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	
200	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	
250	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	
300	***	***	***	***	***	0	***	***	***	***	***	***	***	***	***	***	***	
350	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	
400	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	
450	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	
500	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	
600	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	
700	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	
800	0	0	**	**	**	***	***	***	***	***	***	***	***	***	***	***	***	
1000	**	**	**	**	**	***	***	***	***	***	***	***	***	***	***	***	***	
1200	**	**	**	**	**	***	***	***	***	***	***	***	***	***	***	***	***	
1400	**	**	**	**	**	***	***	***	***	***	***	***	***	***	***	***	***	
1600	**	**	**	**	**	***	***	***	***	***	***	***	***	***	***	***	***	
1800															*			
2000															*			

DN	All flanged tee												Coating				
	80	100	150	200	250	300	350	400	450	500	600	700	800	900	1000	1200	
80	***																
100	***	***															
150	***	***	***														
200	***	***	***	***													
250	***	***	***	***	***												
300						***	***	***	***	***							
350							***	***	***	***	***						
400								***	***	***	***						
450									***	***	***						
500										***	***						
600											***						
700												***	***	***	***	***	
800												0	***	***	***	***	
1000												0	***	0	***	***	
1200												0	***	0	***	***	
1400												0	***	0	***	***	
1600												0	***	0	***	***	
1800																	
2000																	

Joints:

- TYT joint
- STD joint
- EXP joint (Express)
- Fixed flange gasket

\* Available in PN10

\*\* Available in PN10 and 16

\*\*\* Available in PN10, 16 and 25

o Available in PN16 only

nc: Contact us

Locking STD Ve

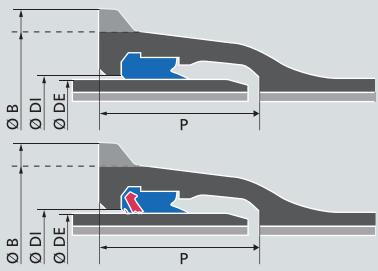
Coatings:

internal/external coating: epoxy 250 microns blue

internal/external coating: polyurethane 1 mm white

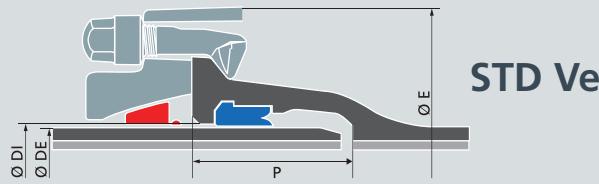
# 4.3 JOINTS

# FOR SOCKETS



STD

STD Vi

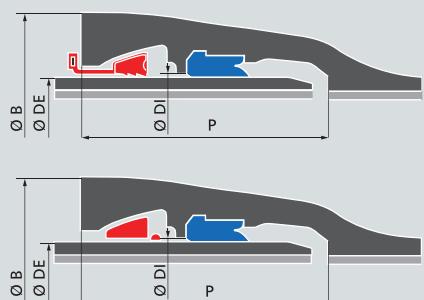


STD Ve

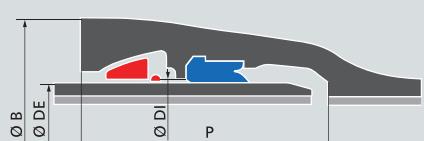
DN mm	Ø DE mm	Ø DI mm	P mm	Ø B mm
100	118	121	94.5	170
150	170	173	100.5	224
200	222	225	106.5	277
250	274	277	105.5	334
300	326	329	107.5	393
350	378	381	110.5	464
400	429	432	112.5	516
450	480	483	115.5	574.2
500	532	535	117.5	629
600	635	638	132.5	738.5
700	738	741	192	863
800	842	845	197	974
900	945	948	200	1082
1000	1048	1051	203	1191
1100	1152	1155	225	1300
1200	1255	1258	235	1412
1400	1462	1465	245	1592
1500	1565	1568	265	1710
1600	1668	1671	265	1816
1800	1875	1878	275	2032
2000	2082	2085	290	2259

\* STD Vi joint not available for these DNs

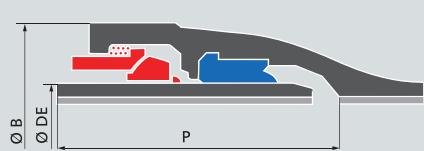
DN mm	Ø DE mm	Ø DI mm	P mm	Ø E mm
350	378	381	110.5	570
400	429	432	112.5	618
450	478.6	483	115.5	671
500	532	535	117.5	734
600	635	638	132.5	840
700	738	741	192	958
800	842	845	197	1100
900	945	948	200	1218
1000	1048	1051	203	1306
1100	1152	1155	225	1417
1200	1255	1258	235	1547



UNI STD Vi



UNI STD Ve



PAMLOCK

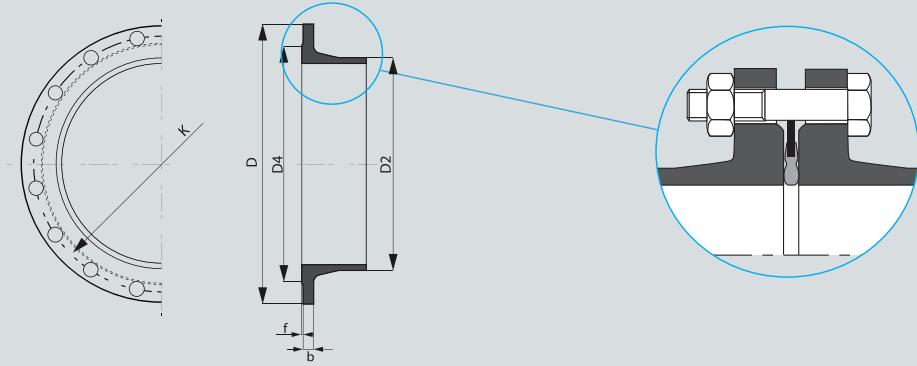
DN mm	Ø DE mm	Ø DI mm	P mm	Ø B mm
400	427.4	431.9	176	510
450	478.6	483.0	190	570
500	530.5	535.0	200	625
600	633.3	638.2	209	740
700	736.6	741.7	250	855
800	840.4	845.8	261	980
900	943.2	948.9	280	1087
1000	1046.0	1052.0	279	1191
1200	1252.3	1260.0	279	1415
1400	1458.9	1468.5	330	1640

\*\* UNI STD Vi joint not available for these DNs

DN mm	Ø DE mm	Ø DI mm	P mm	Ø B mm
1400	1458.9	1467.9	300	1620.1
1500	1561.7	1571.1	315	1757.3
1600	1664.5	1674.2	325	1868.0
1800	1871.6	1881.5	350	2075.3
2000	2077.7	2088.8	394	2307.0

# 4.3 JOINTS

# FOR FLANGES



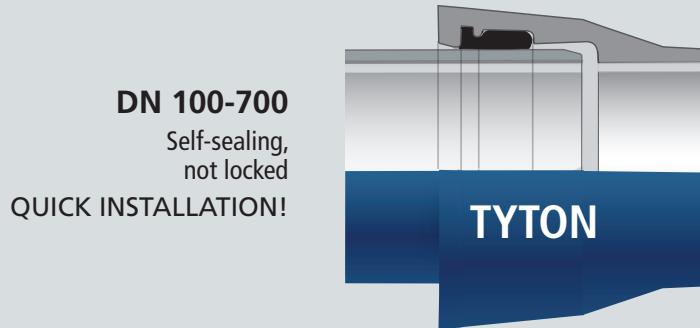
PN10							PN 16				PN 25			
DN mm	D mm	D2 mm	D4 mm	K mm	b mm	f mm	D4 mm	K mm	b mm	f mm	D4 mm	K mm	b mm	f mm
80	200	98	132	160	16	3	132	160	16	3	132	160	16	3
100	220	118	156	180	16	3	156	180	16	3	156	190	16	3
125	250	144	184	210	16	3	184	210	16	3	184	220	16	3
150	285	170	211	240	16	3	211	240	16	3	211	250	17	3
200	340	222	266	295	17	3	266	295	17	3	274	310	19	3
250	400	274	319	350	19	3	319	355	19	3	330	370	21.5	3
300	455	326	370	400	20.5	4	370	410	20.5	4	389	430	23.5	4
350	505	378	429	460	20.5	4	429	470	22.5	4	448	490	26	4
400	565	429	480	515	20.5	4	480	525	24	4	503	550	28	4
450	615	480	530	565	21.5	4	548	585	26	4	548	600	30.5	4
500	670	532	582	620	22.5	4	609	650	27.5	4	609	660	32.5	4
600	780	635	682	725	25	4	720	770	31	4	720	770	37	4
700	895	738	794	840	27.5	5	794	840	34.5	5				
800	1015	842	901	950	30	5	901	950	38	5				
900	1115	945	1001	1050	32.5	5	1001	1050	41.5	5				
1000	1230	1048	1112	1160	35	5	1112	1170	45	5				
1100	1340	1152	1218	1270	37.5	5	1218	1270	48.5	5				
1200	1455	1255	1328	1380	40	5	1328	1390	52	5				
1400	1675	1462	1530	1590	41	5	1530	1590	55	5				
1500	1785	1565	1640	1700	42.5	5	1640	1710	57.5	5				
1600	1915	1668	1750	1820	44	5	1750	1820	60	5				
1800	2115	1875	1950	2020	47	5								
2000	2325	2082	2150	2230	50	5								

PN 40: contact us

Contact us

## 4.3 JOINTS

## OF TYTON TYPE ON FITTINGS



DN mm	Lu m	Class	TYT PFA bar
100	6.00	C40	64
150	6.00	C40	62
200	6.00	C40	50
250	6.00	C40	43
300	6.00	C40	40
350	6.00	C30	30
400	6.00	C30	30
450	6.00	C30	30
500	6.00	C30	30
600	6.00	C30	30
700	6.96	C25	25

**TYT**

DN mm	Ø DE mm	Ø DI mm	P mm	Ø B mm
100	118	121	88	163
150	170	173	94	217
200	222	225	100	278
250	274	277	105	336
300	326	329	110	393
350	378	381	110	448
400	429	432	110	500
450	480	483	120	540
500	532	535	120	604
600	635	638	120	713
700	738	741	150	824



## 4.4 TECHNICAL CHARACTERISTICS

STANDARDS AND CERTIFICATES

PAM DUCTILE CAST IRON

PAM COATINGS

PAM JOINTS

TCO-LCA ASSESSMENTS



## 4.4.1 STANDARDS AND CERTIFICATES

The components in the HYDROCLASS® range comply with the following standards.  
Compliance certificates are supplied on request.

Environment and Quality Standards:	EN standards	ISO standards
Environmental management systems	EN ISO 14001	ISO 14001
Quality management systems	EN ISO 9001	ISO 9001
Water supply Requirements for networks outside buildings	EN 805	
Product Standards	EN	ISO
Technical specifications of ductile cast iron pipelines	EN 545	ISO 2531
Internal cement mortar coating	EN 545	ISO 4179
Zinc exterior coating	EN 545	ISO 8179
Reinforced epoxy coating of fittings	EN 14901	
Polyurethane coating on fittings	EN 15655	
Polyethylene sleeve	EN 545	ISO 8180
Sealing rings. Specifications of materials	EN 681.1	ISO 4633
Flange dimensions	EN 1092 - 2	ISO 7005 - 2
Implementation standards:	EN	ISO
Calculation methods for laying buried pipelines	EN 545	ISO 10803
Pressurisation test on site	EN 805	ISO 10802
Standards compliance certificates:	Prepared by:	
Compliance with standard ISO 14 0001	Veritas	
Compliance with the ISO 9001 standard	Veritas	
Compliance with the EN 545 standard	Veritas	
Compliance of the HYDROCLASS® range with the ISO 2531 standard	Veritas	
Compliance with the 8179 standard	Veritas	
Compliance with standard 14 901	Veritas	
Compliance with the 681-1 standard	Veritas	
Assembly performance certificates:	Prepared by:	
Standard EN 545 test on STD joint	Veritas	
Standard EN545 test on STD Vi joint	Veritas	
Standard EN545 test on STD Ve joint	Veritas	
Standard EN545 test on UNI STD Ve joint	Veritas	
Standard EN545 test on UNI STD Vi joint	Veritas	
Certificates of qualification in contact with drinking water:	Prepared by:	
HYDROCLASS® range	ACS Veritas	
Epoxy Coating	WRAS	
Cement coating	WRAS	
Lubricating paste	WQC	

## 4.4.2 PAM DUCTILE CAST IRON

### ■ MECHANICAL CHARACTERISTICS

Elastic limit (*), Rp 0.2	300 MPa
Tensile strength, Rm	420 MPa
Elongation at break, A	10% for DN 60 to 1000, 7% for DN 1100 to 2000
Elastic modulus	$1.7 \times 10^5$ N/mm <sup>3</sup>
Thermal expansion coefficient	$1.1 \times 10^{-2}$ mm/m °C
Density	7.05 g/cm <sup>3</sup>

(\*) 270 MPa when A >= 12 % for DN 40 to 1 000 or A >= 10 % for DN > 1 000

DUCTILE CAST IRON: GRAPHITE NODULE UNDER AN ELECTRON MICROSCOPE

## 4.4.3 PAM COATINGS

### ■ ZINC AND ZINALIUM® PAM COATINGS: USE UNDERGROUND

	Traditional Zinc	ZINALIUM®
<b>Performance in the soil:</b>	Pure Zinc 200g/m <sup>2</sup> + bituminous varnish	ZinAlu alloy 400g/m <sup>2</sup> + synthetic paint
Resistivity greater than (see EN 545:2010 D.2.1 standard) : - 2500 ohm.cm below water table - 750 ohm.cm outside water table	X	X
Resistivity greater than (see EN 545:2010 D.2.2 standard): 500 ohm.cm below water table		X
Regeneration of the protection on coating damage	X	X

### Field of use according to the EN 545 standard

#### Basic coating with pure Zinc

The ductile cast iron pipes coated with a pure zinc metal layer of minimum 200g/m<sup>2</sup> and a layer of bituminous varnish can be buried in contact with a large number of soils, which may be identified by in situ soil studies, except for \*\*:

- soil with low resistivity, of less than 1 500 Ω.cm above the water table or less than 2 500 Ω.cm below;
- mixed soil, i.e. constituted by two or more types of soil;
- soil with a pH less than 6 and a large acidity reserve;
- soil containing waste, ash, slag or contaminated by certain industrial waste or effluents.

#### Coating with Zinc and Aluminium alloy

The ductile cast iron pipes with a zinc and aluminium alloy coating of minimum 400 g/m<sup>2</sup> mini with a top coat can be buried in contact with most soils, except for \*\*:

- peat and acid soil;
- soil containing waste, ash, slag or contaminated by certain industrial waste or effluents;
- soil situated below the marine water table with a resistivity less than 500 Ω.cm.

(\*\*) In this soil identified by on site studies, and in the event of stray currents, it is recommended to use an additional protection (such as polyethylene sleeving) or other types of suitable external coatings (see EN 545 / D.1, D.2.2 and D.2.3).

## ■ ELECTRIC LINES AND CATHODIC PROTECTION

### Proximity of electric lines:

"The rubber-gasketed joints offer electrical resistance that is sufficient for DI pipelines to be considered electrically discontinuous. In effect, the rubber-gasketed joint segment the pipe and prevent magnetic induction from being a problem. Also, in most cases, DI pipelines are installed bare and are therefore essentially grounded for their entire length, which further prevents magnetic induction on the pipelines"

Source: *Effect of overhead AC power lines paralleling DI pipelines 1996 ( R.W. Bonds / DIPRA Research )*

### Cathodic protection:

Unlike electrically continuous welded metal tubes, cathodic protection is not necessary on ductile cast iron pipelines assembled with elastomer sealing rings and protected with anti-corrosion coatings adapted to the terrain traversed.

## ■ CEMENT MORTAR: CONTACT WITH WATER

The internal coating of Hydroclass pipes is a blast furnace cement mortar. The latter is part of the class of cement resistant to sulphates, whose field of use is defined by standard EN 545 / Appendix E.

### Field of use of cement according to EN 545

Characteristics of water	Blast furnace cement		
	Portland Cement	Sulphate-resistant cement	High alumina cement
Minimum pH value	6	5.5	4
Maximum (mg/l) :			
aggressive CO <sub>2</sub> content	7	15	Not limited
Sulphates (SO <sub>4</sub> )	400	3000	Not limited
Magnesium (Mg <sup>++</sup> )	100	500	Not limited
Ammonium (NH <sub>4</sub> <sup>+</sup> )	30	30	Not limited

## ■ CEMENT MORTAR: THICKNESSES

DN	Coating thickness according to EN 545	
	Nominal value in mm	Nominal deviation* in mm
40 to 300	4	- 1.5
350 to 600	5	- 2.0
700 to 1,200	6	- 2.5
1,400 to 2,000	9	- 3.0

\* Only the lower deviation is given

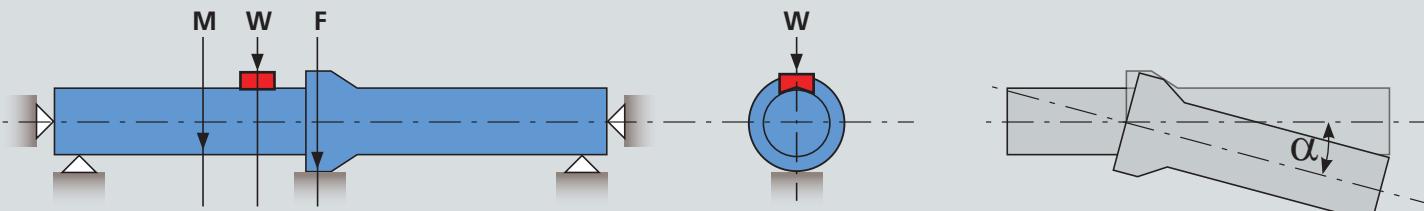
## 4.4.4 PAM JOINTS

### ■ ANGULAR DEVIATION FOR PAM JOINTS

DN	Min required under ISO 2531 on unlocked joints	Maximum angular deviation $\alpha$ permissible on PAM joints						
		Unlocked		Locked				
		STD	TYT	STD Vi	STD Ve	UNI STD Vi	UNI STD Ve	PAMLOCK
100	3.5	5	5	5				
150		5	5	5				
200		5	4	4				
250		5	4	4				
300		5	4	3	4			
350	2.5	4	3	3	3			
400		4	3	2	3	3	3	
450		4	3	2	3	3	3	
500		4	3	2	3	2	2	
600		4	3	2	3	2	2	
700	1.5	4	2		2		2	
800		4			2		2	
900		4			1.5		1.5	
1000		4			1.5		1.2	
1100	1.5	4			1.5			
1200		4			1.5		1.1	
1400		3					1.1	1
1500		3						1
1600		3						1
1800		2.5						0.8
2000		2						0.8

### ■ TESTS IN EXTREME CONDITIONS

All PAM joints are qualified under extreme pressure and angular deviation conditions recommended by the EN 545 standard.



Setting up the standard test according to EN 545

Performance	Test pressure	Stresses on joint	Acceptance criteria
Pressure tightness (operating and overpressure)	Positive internal P		1.5 PFA +5 bar
Negative pressure tightness (accidental negative pressure)	Negative internal P	Maximum deviation $\alpha$ Shearing force W Duration 2 hours	-0.9 bar (cavitation)
Performance in fatigue (proximity of pumps)	Cyclical internal P		PMA +/- 5b 24000 cycles
Tightness to water penetration from the outside (empty pipe)	Positive external P		2 bar (20 m of water)

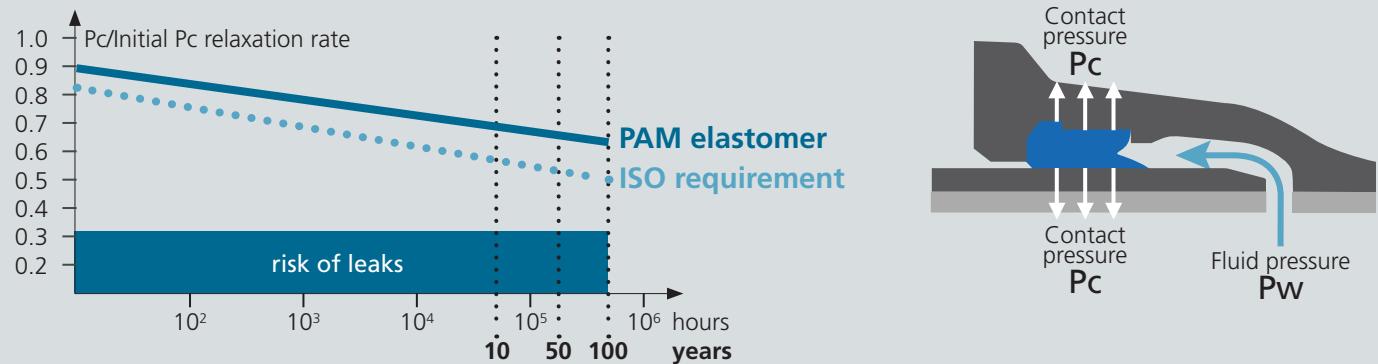
## ■ CHOICE OF LOCKING TECHNIQUES

Contact PAM to determine the pipe lengths to be locked (at singular points, on slopes, etc.) and calculate the number of locked joint pipes required.

Typology	DN range	Pressure range	Locking techniques	Advantages
Connected water network Urban distribution	100 - 300	16 bar	STD Vi	Last minute installation without welding
Water pipes Supply to towns	400 - 1000	average pressure high pressure	STD Vi, UNI STD Vi STD Ve, UNI STD Ve	Mechanical, powerful with or without bolt
Water transportation Large DN and long distances	1200 - 2000	16 - 25 bar	UNI STD Ve, PAMLOCK	No specialised equipment, quick to lay, ideal in difficult access

## ■ PERFORMANCE OF THE PAM ELASTOMER

Long-term behaviour of the PAM elastomer



The relaxation rate under stress (Pc/Initial Pc) indicates the capacity of the EPDM elastomer to withstand pressure. The graph below shows that the elastomer ring is capable of fulfilling its sealing function during the entire service life of the pipeline.

## ■ ASSEMBLY TIMES

DN	minutes per joint	
	With power shovel	With cable and hand winch
300	4	7
400	4	8
600	5	10
800	6	14
1000	8	16
1200	12	18
1400	12	20
1600	12	20
1800	12	20

Note: The values above are proposed for information for normal laying conditions. They are not contractual in nature. It is the qualified installer's responsibility to adapt them in function of his exact knowledge of site access and execution conditions

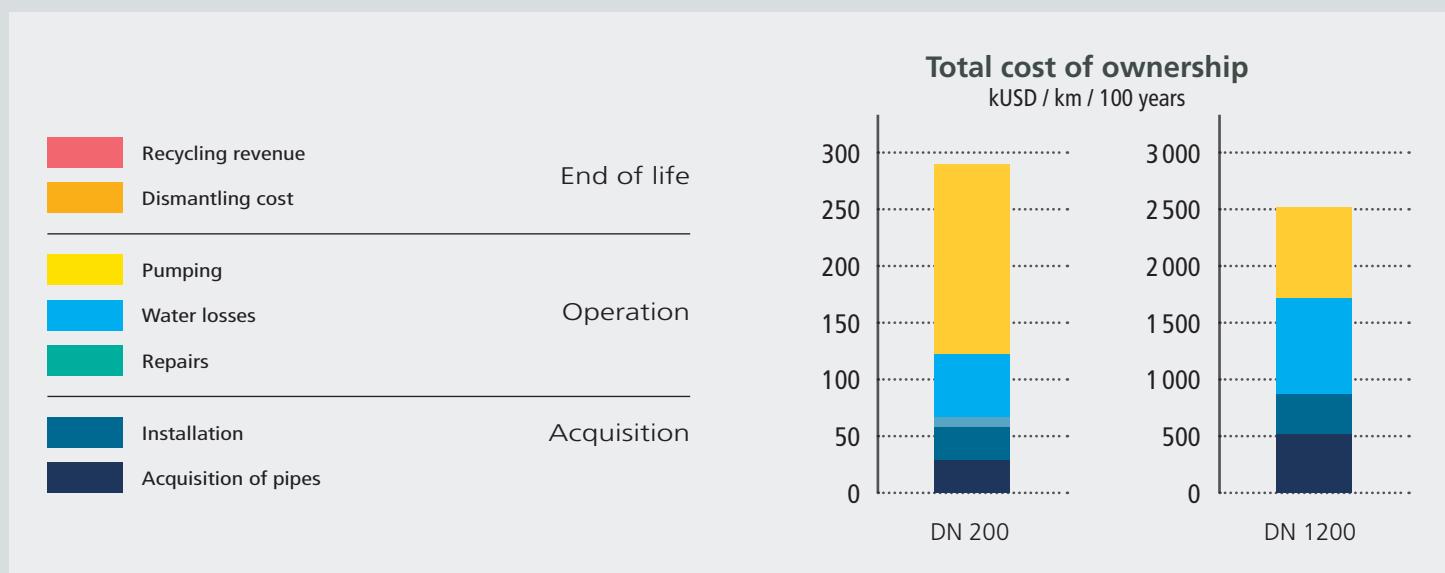
## 4.4.5 EXAMPLES OF TCO-LCA ASSESSMENT

Hypotheses of calculations performed with LCA-TCO PAM calculator:

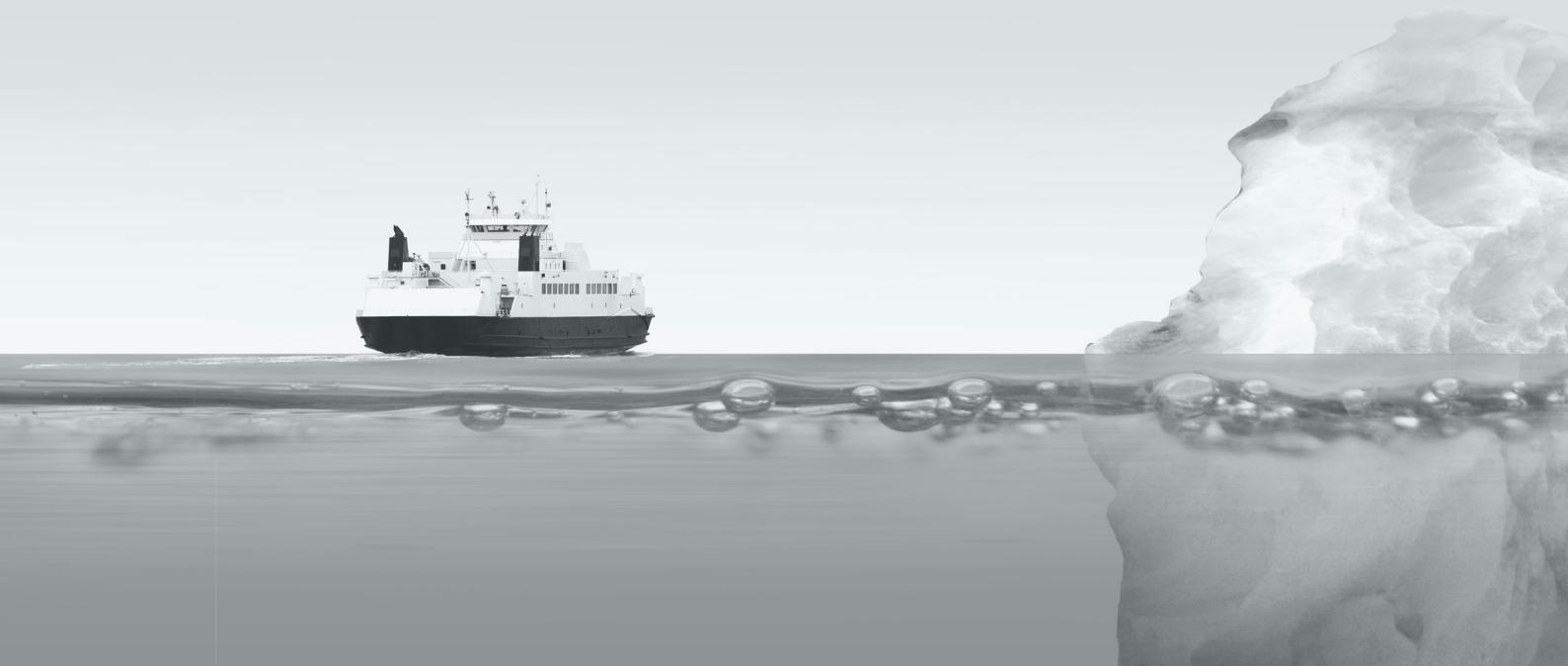
- For **HYDROCLASS®** pipes DN 200 and 1200
- Laid in trenches under standard conditions
- Transported over 13000 km by ship
- Technico-economic data of the year 2014 for Asia/Middle East areas
- Service life 100 years

The values below, based on hypothetical cases and average data, are proposed for information. They are not contractual in nature.

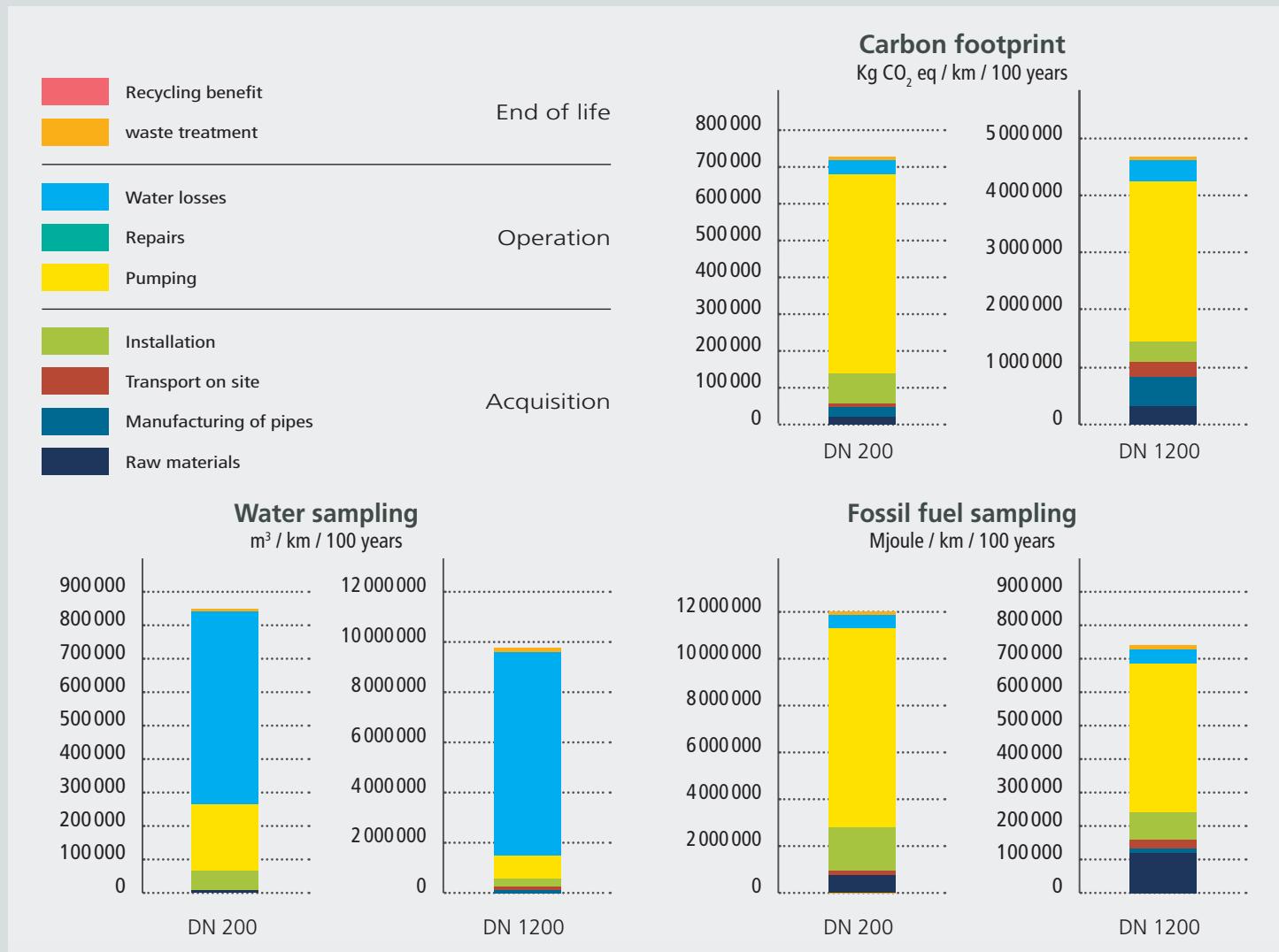
### ■ TCO ANALYSIS (TOTAL COST OF OWNERSHIP)



Contact PAM to assess your project.



## LCA ANALYSIS (LIFE CYCLE)



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