References in the world's largest cities

- Black Point power station (Hong Kong)
- Marseilles Canal (France)
- Windhoek water supply (Namibia)
- Ankara and Istanbul water supply (Turkey)
- Laibin Thermal power station (China)
- Cairo ECP pipe factory (Egypt)

66 plants set up in 10 countries
An international group, with over 100 years of experience

- Water supply systems
- Industrial plant pipework
- Sea outfalls
- Sewage pumping mains
- Civil works…

An experience in major development projects

- Rio Sosa Water supply (Spain)
- Saint-Alban nuclear power station (France)
- Pipes for Severnaya power station (Azerbaijan)
- Le Bugey Nuclear Power station (France)
- Folkestone offshore outfall (UK)
What is the BONNA® pipe?

• A steel core made of rolled steel plates welded lengthwise or helically with welded end-rings.
• A steel reinforcement made by helical winding of a steel wire at a constant pitch.
• A double concrete coating placed:
  - either, by centrifugation inside the steel core and by spraying outside the core,
  - or, by casting the external coating and the lining in one single operation with highly compacted concrete.

### Dimensional characteristics

<table>
<thead>
<tr>
<th>Nominal diameter (mm)</th>
<th>250</th>
<th>300</th>
<th>400</th>
<th>500</th>
<th>600</th>
<th>700</th>
<th>800</th>
<th>900</th>
<th>1000</th>
<th>1100</th>
<th>1200</th>
<th>1300</th>
<th>1400</th>
<th>1500</th>
<th>1600</th>
</tr>
</thead>
<tbody>
<tr>
<td>External diameter (mm)</td>
<td>420</td>
<td>420</td>
<td>520</td>
<td>630</td>
<td>730</td>
<td>840</td>
<td>950</td>
<td>1060</td>
<td>1164</td>
<td>1276</td>
<td>1390</td>
<td>1470</td>
<td>1640</td>
<td>1740</td>
<td>1880</td>
</tr>
<tr>
<td>Effective length* (m)</td>
<td>6.07</td>
<td>6.07</td>
<td>6.15</td>
<td>6.15</td>
<td>6.15</td>
<td>6.15</td>
<td>6.15</td>
<td>6.15</td>
<td>6.15</td>
<td>5.03</td>
<td>5.03</td>
<td>5.03</td>
<td>6.15</td>
<td>6.15</td>
<td>6.15</td>
</tr>
<tr>
<td>Weight per meter (t)</td>
<td>0.23</td>
<td>0.17</td>
<td>0.22</td>
<td>0.29</td>
<td>0.35</td>
<td>0.43</td>
<td>0.53</td>
<td>0.63</td>
<td>0.71</td>
<td>0.84</td>
<td>0.99</td>
<td>1.20</td>
<td>1.46</td>
<td>1.56</td>
<td>1.95</td>
</tr>
</tbody>
</table>

*Effective length of pipes with SL ends.

The characteristics above are those of traditional standard BONNA® pipes.
For further information, please refer to SB 21 and to our technical and commercial offers.
The steel-concrete design

The BONNA® concrete pressure pipe design results from the optimum combination of steel and concrete characteristics and performances.

**Optimized materials**

**A welded steel cylinder**

Designed to withstand the maximum working pressure including possible water hammer guarantees absolute and immediate watertightness of the pipeline and contributes to the pipeline load resistance.

**A very smooth concrete inner surface**

With a high cement content giving the pipe an excellent and permanent hydraulic flow coefficient; it protects the steel cylinder from possible corrosion and abrasion phenomena.

**An outer reinforced concrete wall**

Protecting the steel cylinder from external aggressive agents (soil, underground water table, ...) and taking the stresses due to backfill and external dead and live loads.

**Dimensional characteristics**

<table>
<thead>
<tr>
<th>Nominal diameter (mm)</th>
<th>1700</th>
<th>1800</th>
<th>2000</th>
<th>2100</th>
<th>2200</th>
<th>2350</th>
<th>2400</th>
<th>2500</th>
<th>2600</th>
<th>2800</th>
<th>3000</th>
<th>3200</th>
<th>3500</th>
<th>4000</th>
</tr>
</thead>
<tbody>
<tr>
<td>External diameter (mm)</td>
<td>1980</td>
<td>2100</td>
<td>2320</td>
<td>2440</td>
<td>2560</td>
<td>2730</td>
<td>2800</td>
<td>2910</td>
<td>3030</td>
<td>3250</td>
<td>3480</td>
<td>3720</td>
<td>4080</td>
<td>4640</td>
</tr>
<tr>
<td>Effective length* (m)</td>
<td>5,03</td>
<td>5,03</td>
<td>4,50</td>
<td>4,50</td>
<td>4,50</td>
<td>4,00</td>
<td>5,03</td>
<td>4,00</td>
<td>2,91</td>
<td>3,50</td>
<td>3,60</td>
<td>2,91</td>
<td>2,41</td>
<td>2,05</td>
</tr>
<tr>
<td>Weight per meter (t)</td>
<td>2,06</td>
<td>2,34</td>
<td>2,77</td>
<td>3,09</td>
<td>3,43</td>
<td>3,87</td>
<td>4,17</td>
<td>4,44</td>
<td>4,85</td>
<td>5,45</td>
<td>6,23</td>
<td>7,21</td>
<td>8,80</td>
<td>11,07</td>
</tr>
</tbody>
</table>

**Specific cases:** numerous technical adjustments can be made in order to meet the specific needs of a project (settlement compensators, seismic zones...)
The BONNA® pressure pipe is different because of its composite design that makes it possible to meet the three objectives of a pressure pipeline in a full and homogenous way:
- Resistance to external stresses,
- Resistance to pressure and to vacuum conditions,
- Durability.

**Resistance to external stresses**

**Deformation Resistance**

The reinforced concrete provides the pipeline with the transverse rigidity required for resisting backfill loads and live loads.

**Bending strength**

If the pipe is used as a span pipeline, the combined effect of concrete and steel provides it with the required longitudinal rigidity.

**Longitudinal tensile strength**

In case of a pipeline being pulled into place, the steel cylinder tensile strength will be used.

**Longitudinal compressive strength**

In case of installation by jacking or microtunnelling, the external reinforced concrete compressive strength will be used.
Properties and advantages

**Resistance to external stresses**

**Resistance to impact loading**

During and after laying, the pipeline may be submitted to shocks and blows that are likely to damage its coating, and even to destroy its physical integrity. In this case, the best possible protection is secured by the concrete coating.

**Resistance to pressure**

The steel core characteristics are determined so as to resist the maximum working pressure and the factory testing pressure.

The welded joints totally transmit the stresses sustained at changes of direction to the pipeline.

It is thus possible to avoid the use of bulky and costly thrust-blocks at changes of direction.

**Resistance to vacuum conditions**

The pipeline shall withstand full vacuum conditions (water-hammer, empty pipeline, sudden emptying...) thanks to its concrete lining that prevents the buckling of the steel cylinder.
The pipeline watertightness and resistance shall last longer than its depreciation time.

The pipeline shall resist all the phenomena likely to impair its initial capacities and to gradually destroy the performances of its components; these phenomena may be the following ones:

- Corrosion of the metallic components,
- Erosion of the concrete walls,
- Damages due to the weather.

Durability

![Image of waste water delivery pipe at Colombes factory (France)](image)

*Waste water delivery pipe at Colombes factory (France)*

1894 - dia. 1800 mm, pressure : 3.5 bars. This pipeline is still in service.

![Image of sea-water cooling system for refinery - La Mède (France)](image)

*Sea-water cooling system for refinery - La Mède (France)*

![Image of underwater pipeline, dia. 1600 mm - Geneva (Switzerland)](image)

*Underwater pipeline, dia. 1600 mm - Geneva (Switzerland)*
Properties and advantages

Protection against corrosion

The protection of steel by concrete is permanent, does not call for maintenance and causes no pollution (chemical phenomenon of passivation). The balance thus created between concrete and steel is stable and durable.

Protection against abrasion and high hydraulic gradient

Because of its high strength and compactness, BONNA® pipe concrete inner wall does not require any specific protection against abrasion caused by the usual carried fluids. Besides, the head-losses inside the pipeline remain low as time goes by. Measurements taken in the inlet pipelines of Saut hydroelectric plant in France confirm the characteristic value, $K$, of 0.0001 m, for the wall roughness. This value that enables one to calculate the headlosses according to Colebrook’s formula, is that of the best inner surface quality of the pipes presently produced (reinforced concrete, cast iron, steel, GRP, PVC, etc.).

Weather resistance

Concrete high thermal inertia makes the pipeline less sensitive to the weather conditions. This effect is enhanced by the high compactness of concrete obtained by high frequency vibration, centrifugation...

The BONNA® pipe can therefore be used in any possible environment:
- Buried conditions
- Aboveground conditions
- Submerged conditions (including sea-water)

Buried pipeline
Water supply pipeline, dia. 800-900 mm - Lubéron (France)

Aboveground pipeline
Rhône Poulenc plant, dia. 1000 mm (France)

Submerged pipeline
Folkestone, dia. 2100 mm - (United Kingdom)
The BONNA® pressure pipe is generally supplied with either one of the two following types of joints to suit any specific conditions.

**ER flexible joint**

![Diagram of ER flexible joint]

**SL welded joint**

![Diagram of SL welded joint]

**Fitting of a flexible sealing gasket:**
It replaces the mortar joint providing the pipeline with a greater deflection capacity and protecting the pipe ends from corrosion risks.

* TANJUNG JATI (Indonesia)

**Mortar jointing**
Black Point (Hong Kong)

**Assembling of two s.c. pipes**
Popka (Indonesia)
Properties and advantages

Inspections and quality

All of our products are subjected to detailed inspection plans that can be consulted on the production site. These plans reproduce the requirements of standards and regulations and can be supplemented by requirements specific to each contract.

Specifications and Quality Assurance

All BONNA® pipes and fittings are designed and manufactured to the European standards EN 639 and 641, and to a Quality Assurance System certified to be in conformity with ISO 9001 version 2000 by an authorized third party.

The inspection plan relates to:

- examining the manufacturing request;
- taking delivery of the raw materials and fittings in compliance with the standards that govern them: sieve analysis;
- inspecting the dimensions of the end joints: diameter, out-of-roundness, etc.;
- inspection of dimensions and of watertightness of the steel cylinders: circumference measurement, squareness, length, weld testing, hydrostatic testing, etc.;
- the inspections of the reinforcements: diameter of the spiral wires and cages, straightness and length of longitudinal wires, visual aspect and quality of welds, etc.;
- quality of the concrete: sieve analysis, water-to-cement ratio, compressive strength, etc.
- concrete casting: thickness, covering over of the reinforcements, visual aspect, etc.;
- finished products: visual and dimensional inspection, pressure testing, joint fitting testing, etc.;
- qualification of staff and of methods: welding, painting and steam curing and operating of the concrete mixing plants, etc.;
- control of inspection, measurement, and testing instruments.

Sieve analysis
Compressive test on a concrete cylinder
Concrete shrinkage measurement

Testing the hardness of the concrete (selerometer)
The services offered by Bonna Sabla

In the early stages of water system design, Bonna Sabla’s design and engineering department helps customers to optimise their system and to create technical documents.

During the performance of the contract, the design and engineering department works out all the technical documents required for the project, in particular:

- the bills of materials and piping arrangement drawings for the pipes and special fittings for manufacturing and for laying,
- detailed drawings of the equipment and/or accessories supplied,
- calculations notes
- the erection manual and instructions on the protection systems to apply on site.

Why trust Bonna Sabla with your water system engineering?

During the system design phase, Bonna Sabla can stand in for you for all the technical aspects involving engineering and design. You specify the specific features and operating conditions of your system, and the design and engineering department brings you its experience, its ability to find innovative solutions and the extreme flexibility of our products to create the design proposal.

The technical data provided by our design and engineering department simplify the laying of your water system on site and optimises your costs by offering the most suitable solutions.

The design and engineering department may consult other Bonna Sabla departments to come up with the most effective solution. The expertise that it can seek in these cases may be in areas as varied as the feasibility analysis of products, the definition or modification of production equipment, handling and implementation operating modes. The concentration of all these skills in a single group guarantees the consistency of the solutions delivered.

The design and engineering department also provides a very responsive “after sales” service by coming up with solutions that are always adapted to the changing needs of your water system.

Skills at the service of the customer

Bonna Sabla’s design and engineering department has a thorough knowledge of its products, from their geometrical and mechanical characteristics to their manufacturing requirements and specific constraints.

It has worked on a wide variety of specific cases and problems in the water system business, and with the in-depth experience that acquired from them, it is able to place its expertise at the service of your project:

- Pipe laying methodology
- Mastery of product characteristics
- Manufacturing know-how
- Incorporation of engineering constraints (road traffic load, overpressure, earthquakes, etc.).
- Analysis and incorporation of information relevant to design calculations.
- Optimisation and adaptation of special fittings to the systems
- Design of connections that are suited to almost all cases
- Working with the customer to find the most suitable solutions to problems encountered throughout the construction.
- For special types of laying: customized laying engineering and methodologies (span pipes, underwater laying, pipejacking, etc.)
- Monitoring and supervision of the laying site
- Expertise of water systems.
Plant engineering

Bonna Sabla’s contribution to the design of plants and manufacturing machines

When the project calls for it, we can put our experience at your service to design production equipment, machines or event plants for manufacturing pressure pipes.

Our plant engineering offering comprises the design of the entire project: plant and workshop layout, standard and specific machines and equipment, handling equipment, utilities and civil engineering.

During the commissioning of the plant and, if necessary, during the operating phase, we can provide you with full support by training your production staff and assisting your operators.

Why trust Bonna Sabla with the engineering for your plant?

Our objective is to bring our clients and partners all our expertise accumulated over more than a century to ensure that the end products are perfectly in line with our quality and durability requirements which underpin our reputation.

With a view to maintain this level of quality which is our best retort against competition, the standard machines recommended and the specific ones that we supply are particularly adapted to the manufacture of our products and to project requirements.

The machines designed by our design and engineering department are the fruit of our hands-on manufacturing experience. They take into account the justified changes in our clients’ expectations not only with respect to technical performance, but also to changes in legal requirements on such points as safety and environmental impact.

The moulding equipment is designed to enable easy maintenance and servicing through the choice of replacement parts that can be found all over the world.

A wide offering to suit all needs

Each project is accompanied by an elaborate analysis that will determine the proposal made to you. Some of the criteria taken into account by our experts in planning the project are:

- Market studies in the water transport sector: existing segments and foreseeable changes in market trends, competition and potential local partnerships;
- The analysis of any existing infrastructures whether they are production-related (land, plants) or related to the distribution of products (railway network, waterways, etc.);
- Local resources: quality and localisation of raw material deposits, labour quality and cost, local industrial fabric for possible subcontracting contracts, etc.
- Specific local characteristics such as the climate, connection to the various site utilities (electricity, water supply, drainage, etc.).

The nature and scope of plant engineering may greatly vary from one project to another. They may take the following forms:

- Layout of a plant on an undeveloped site
- Appraisal of old plants in view of modernisation or bringing into compliance with standards
- Appraisal of existing plants in view of the extension of the product range to include pressure pipes
- Adaptation of machines in view of the manufacturing of project-specific products

In each case, our design and engineering team draws up an optimised and appropriate proposal.
BONNA® steel cylinder fittings of any configuration can be produced to suit the specific needs of a project. The in-house project design department provides: design calculations, reinforcement drawings, definition of fittings characteristics however complex they may be pipework drawings (connecting flanges, anchoring pieces, settlement compensators,..)
Industrial projects

- Skikda Power Station - dia. 2000 mm (Algeria)
- Dunkirk Power Station DK6 – dia. 2200 mm (France)
- Phuny 2.2 Power Station – dia. 1800 mm (Vietnam)
- Panglima Power Station – dia. 2200 mm (Malaysia)
- Pre-assembly of the sections
- Panglima Power Station (Malaysia)
- Tanjung Jati Power Station - dia. 3500 mm (Indonesia)
- Brindisi Power Station – dia. 2200 mm (Italy)
The BONNA® pipe
thermal and nuclear power stations

Barking Reach thermal power station, dia. 2200/2400 mm (United Kingdom)

Rades thermal power station, dia. 1600 to 2000 mm (Tunisia)

Tanjung Jati thermal power station, dia. 3500 mm (Indonesia)

Haïfu thermal power station, dia. 2400 mm (Taiwan)

Koeberg nuclear power station, dia. 3000 mm (South Africa)

Discharge into the Garonne river. Golfech nuclear power station, dia. 3200 mm (France)

Tobruk II electric power station and desalination plant (Libya)

Misurata electric power station and desalination plant, dia. 1400 to 1600 mm (Libya)

desalination plants,...
for industrial sites

chemical, petrochemical plants,...
The Bonna pipe

Water supply, irrigation, sewerage

Paramo Bajo irrigation pipeline, dia. 3000 mm (Spain)

Lauris Water supply dia. 900 mm (France)

Aubonne force main dia. 2000 mm.
Hydroelectric plant (Switzerland)

Firefighting system dia. 400 mm.
Geneva Oil port (Switzerland)
When it is not possible to instal the BONNA® pipe in an open trench (crossing under roads, railways, large depths,...) two techniques can be used.

**Pipe jacking**

This technique makes it possible to instal pipes with diameters up to 4000 mm underground. It consists in driving the pipe into the ground by means of jacks. As heading proceeds, the soil is excavated from inside and upstream the string of pipes. Excavating is performed by drilling machines or by full-face shields.

**Microtunnelling**

The microtunnelling technique adjusted to difficult environments consists in boring the ground horizontally by using a remote controlled machine from the surface. This technique can be applied to small bore non man-entry pipes.

At the rear of the microtunnelling machine, a string of pipes is pushed ahead in the same way as in pipejacking.

BONNA has thus adjusted its 400 to 1200 mm dia. range to withstand the microtunnelling machine thrust forces. ER flexible type of joints and SL welded type of joints are used, depending on the diameter and the site conditions.
Whether used as a sea-water intake or as an offshore outfall, the BONNA® pressure pipe keeps its major assets.

**Pressure watertightness**

- of the steel components (systematic tests throughout the manufacturing stage).
- of connecting joints (SL, ER joints...).

**Durability in any kind of water**

(including sea-water)

- Thanks to the natural protection provided by concrete against steel corrosion.
- There is no need for maintenance inspection.

*Folkestone subsea outfall, dia. 1800 mm (United Kingdom)*

*Positioning and sinking of one pipeline section
Sea-water intake, dia. 2100 mm, for Balikpapan Refinery (Indonesia)*
Mechanical strength

- Adjusted to the site conditions: in case of pipes working as span pipes, (even under backfill, or possible rockfill)
- Resistance to impact loads (anchors...)
- Stability with regard to swell and currents and capacity to sustain possible mechanical bending stresses.
- Maximum safety with regard to floating risks: thanks to its reinforced concrete structure, the BONNA® pipe is weightcoated.
Easy and economical installation underwater

Various laying methods are possible: bottom tow or float and lower.
- ER joints for easier connections.
- Minimum digging operations in the sea bottom: no specific compacting or backfilling are required.

Installation by bottom tow

- Onshore assembling of pipes into strings by means of SL welded joints.
- Continuous towing of the pipeline sections.
- Jointing of pipeline sections together by means of SL welded joints.

Installation by float and lower, then jointing of sections together underwater

- Onshore assembling of pipes into strings by means of SL welded joints.
- Floating of sections to their sinking position.
- Sinking of sections.
- Jointing of sections underwater by means of ER joints.
- Fitting by means of hydraulic jacks.
- Operations performed by divers.
Underwater projects

Jointing of sections underwater

Assembling by hydraulic jacks

Fitting of sections together
"E" - "R" type fitted joint

Anchoring box

Internal diameter

Hydraulic jack

"E" type anchoring

Protective placing before anchoring the pipe

External diameter

"R" type end-ring

Elastomer gasket

Protective padding

Final stage with tie-rods

Fitting of sections together
"E" - "R" type fitted joint

Tie-rod

Anchoring box

Internal diameter

External diameter

Floating of sections to their sinking position
Malaga offshore outfall dia. 1600 mm (Spain)

Lowering of sections
Folkestone offshore outfall dia. 2100 mm (United Kingdom)