subor®

GLOBAL SOLUTION PARTNER IN
PIPE SYSTEMS

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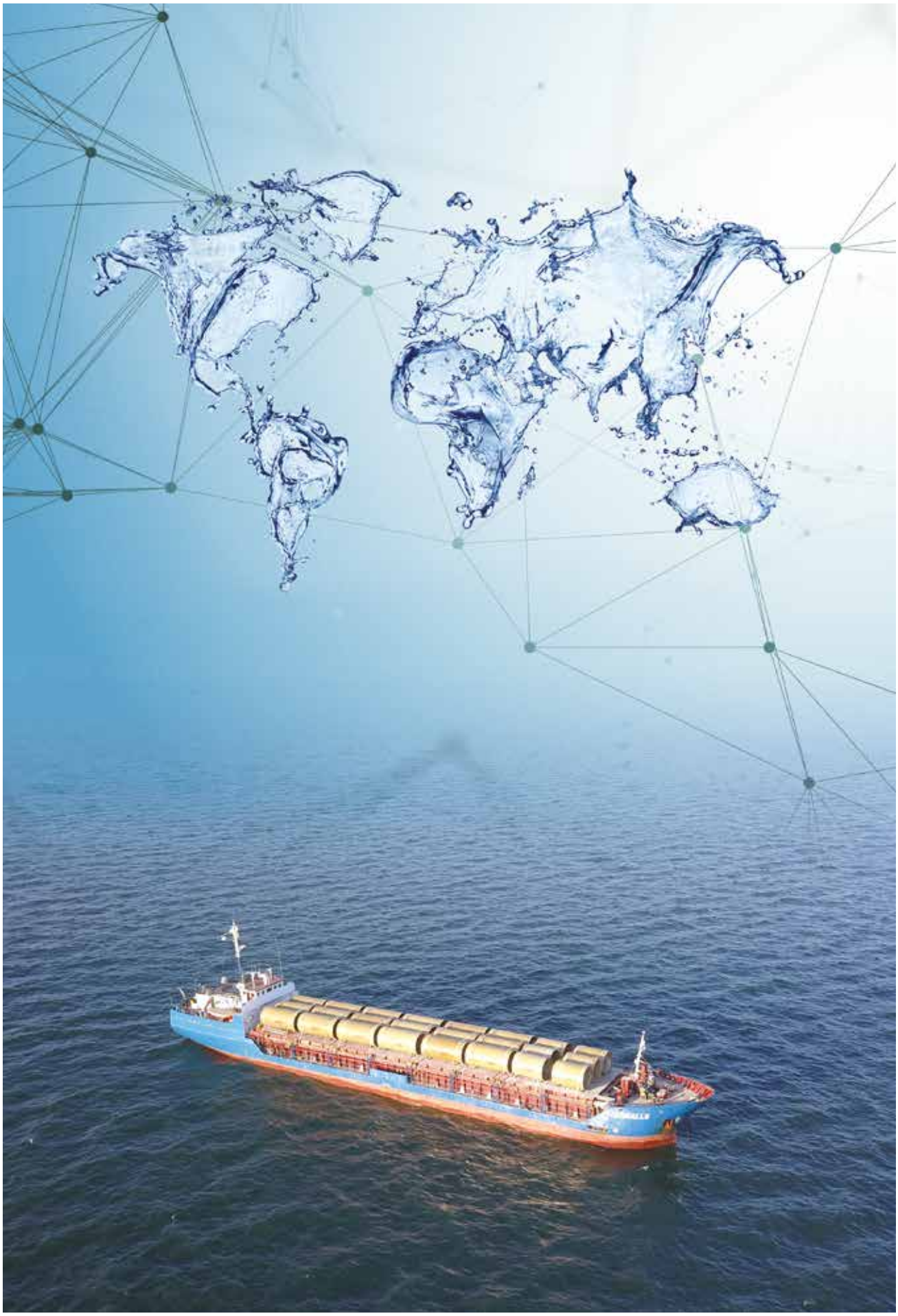


INDEX

ABOUT US

SUBOR is the pioneer company in its territory with the first technological facility founded in 1996 in Turkey to manufacture and sell Glass fiber Reinforced Polyester (GRP) pipes worldwide.

Having the privilege of using the Advanced Continuous Filament Winding Technology over 20 years, SUBOR offers solutions for different infrastructure applications with the help of its wide variety of product and service portfolio.

Depending on the project conditions SUBOR is capable to provide the optimum customized solutions with its fully integrated quality approach to meet the engineering requirements.

Today, SUBOR is amongst the leading GRP pipe manufacturers and has created a reputable brand name in the world through its successful references. SUBOR will continue to improve its global presence by creating value to its partners and to enhance the quality of people's lives.

EXPORT

SUBOR has made a name for itself in the global scale as a result of the breakthroughs performed in GRP pipe sector.

Its capability and power in full integration to the global competitive environment and quality standards with the help of its installed capacity and human resources, SUBOR has proudly waved its flag in many successful projects in 5 continents and 50 countries since its establishment.

Today, with its offices and representatives in different geographies, SUBOR has developed overseas operations as its core tasks and SUBOR aims to further expand its export markets.

Our successful track record and strong experience make us your “GLOBAL SOLUTION PARTNER IN PIPE SYSTEMS.”

WHY SUBOR IS YOUR GLOBAL SOLUTION PARTNER IN PIPE SYSTEMS

PRESENCE IN 5 CONTINENTS

Reliable and long-life piping solutions enable civilizations in different territories to reach **clean water and energy.**

EXPERIENCE

More than **10.000 km** of **SUBOR Pipes** in various applications are serving the development of humankind, **worldwide.**

FIELD SERVICE

By aiming to extend the service life of the pipe system with the correct installation in a cost-effective way, SUBOR is **providing site supervision service all over the world** ensuring the conformity with the technical specifications and standards.

ENGINEERING AND R&D

In order to reach the optimum solution for project needs, **SUBOR's in-house** engineering department delivers the required design works and calculations according to piping principles. With the help of its successful engineering and manufacturing background, **SUBOR is capable to develop researches and innovate new products.**

HIGH PRODUCTION CAPACITY

With an installed manufacturing capacity of over **1.000 km** pipes per year, **SUBOR** is one of the world's leading **GRP pipe producers.**

EFFICIENT USE OF TRANSPORTATION

Wide experience in cost-efficient transportation solutions by means of **truck, container, bulk-shipment, train** and their combinations, together with the lightweight of **GRP pipes** enable the end-user to reach attractive freight charges globally.

WIDE RANGE OF PRODUCTS IN PIPE SYSTEMS

SUBOR provides accurate solutions for a wide variety of projects by manufacturing pipes in a range between **200 mm and 4000 mm** in diameter, up to **40 bar** pressure and **1.000.000 N/m²** stiffness.

ENVIRONMENT FRIENDLY

By aiming to leave a better world to the future, **SUBOR** accepts the principle of respecting the environment and nature in all of its processes within the **awareness of environmental responsibility.**

QUALITY ASSURANCE

SUBOR GRP Pipes are **designed and tested** in compliance with the world's fundamental and acknowledged standards such as **AWWA, ASTM, ISO, EN, DIN, BS.**

PROJECT FINANCE

SUBOR **provides soft loan** by international Export Credit Agencies to projects in order to accelerate the investment return.


GRP
PIPE
TECHNOLOGY

GRP PIPE TECHNOLOGY

A composite material is a combination of two or more materials together in order to create a unique material with superior properties of individual components.

SUBOR GRP Pipes and Fittings are composite materials and have all the superior properties of the technology.

GRP composites are used in more and more applications due to the high strength and low weight in combination with the corrosion resistance.

THE WORLD'S ADVANCED GRP PIPE TECHNOLOGY CONTINUOUS FILAMENT WINDING PROCESS

Continuous Filament Winding Technology is the computer controlled method that involves the winding of the glass fibers around a continuous rotating structure called mandrel. The glass fibers wound around the internal and external resistance layers to ensure the pipe's pressure resistance and rigidity, and the chopped glass fibers used on all layers to ensure axial resistance are bound by the thermoset polymerization reaction of the polyester. The filling material (silica sand) is used on the central layer to enhance the pipe rigidity in a cost effective way.

HOW SUBOR DEFINES SUSTAINABILITY?

SUBOR's approach to a more sustainable business to undertake today's projects with respect to future generations' needs.

Sustainable development must consider the effects it has on the economy, society, and environment as a whole. SUBOR, as a pipe manufacturer calculates the influence of its outputs on these elements at every step of its decision-making process for a sustainable business.

The superior properties of GRP in terms of excellent hydraulic characteristics resulting in higher energy productivity and less pumping energy, high efficient production and transportation methods together with its long life cycle enable SUBOR to offer the utmost quality with better sustainability to the future.

As a result of having very low environmental impact compared to conventional pipe technologies due to its high level of material efficiency, SUBOR GRP products have low carbon footprint and offer the best choice for the environment.

ADVANTAGES

LIGHTWEIGHT

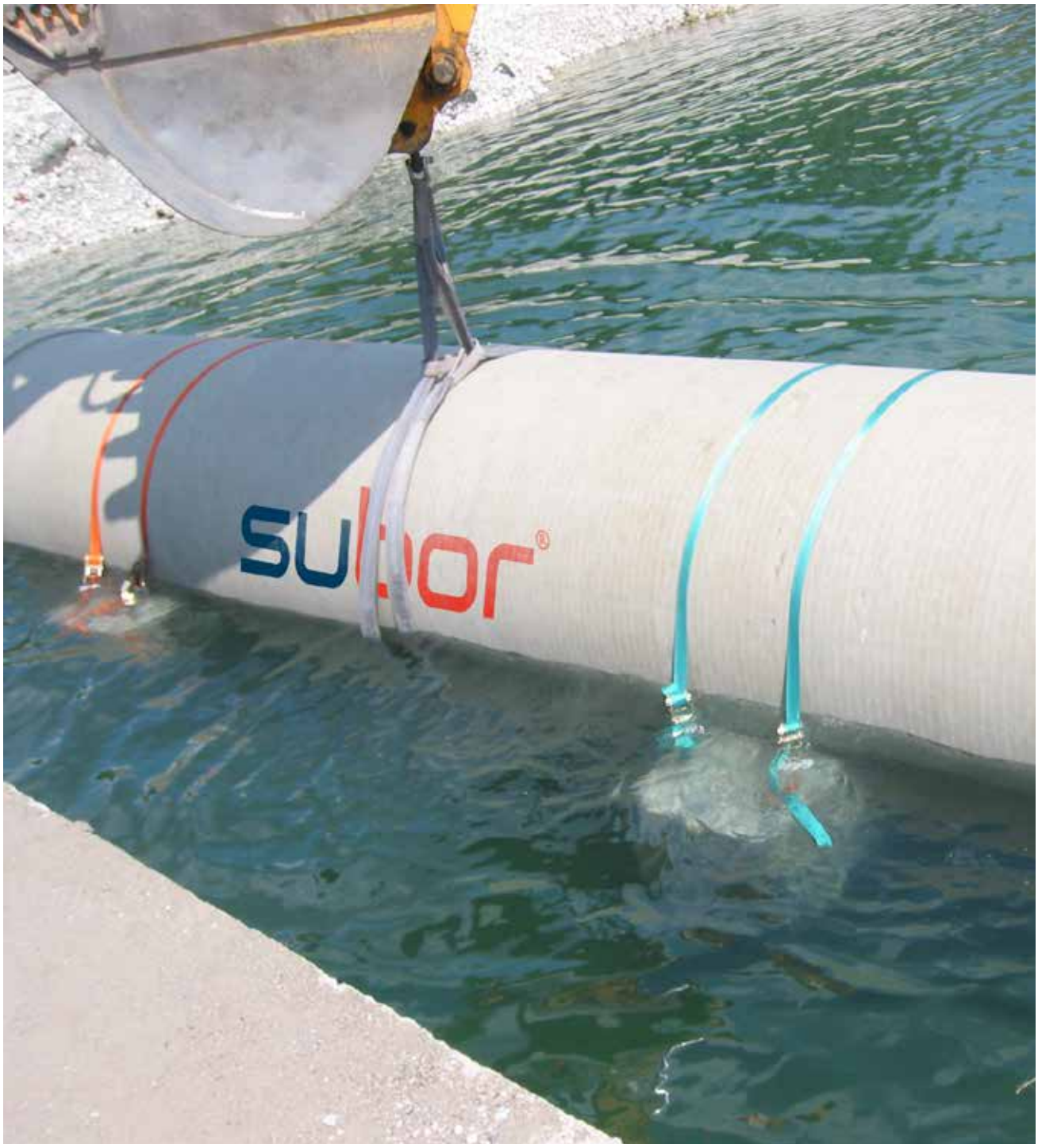
SUBOR GRP Pipes weigh 1/10 of concrete and 1/4 of steel pipes. The lightweight structure not only eliminates the need for expensive handling equipment, but also offers fast and easy installation. The GRP pipes of different diameters are shipped using special packaging as a nested set without detriment to their hydraulic properties and inner surface smoothness. This also provides enormous savings in shipping costs.

SUPERIOR HYDRAULIC PROPERTIES

The hydraulic properties of SUBOR's GRP Pipes provide stability throughout the operating lifespan as courtesy of their smooth interior surface that prevents the formation of lime and sediment. Unlike conventional pipe systems, this property allows the passage of the same flow rate through smaller pipe diameters in the long run. Besides reducing the energy consumption for pumping at the pumping lines with minimum hydraulic loss, this property allows for an increase in energy generation at the power plants.

LONG SERVICE LIFE

SUBOR GRP Pipes are designed according to the results of "Long Term Tests" with respect to the relevant international standards performed at its own accredited laboratories. Hence, SUBOR Pipes preserve their initial performance criteria even after a 50-year service life.



CORROSION RESISTANCE

The composite structure of the SUBOR GRP pipe offers perfect corrosion resistance. The lack of corrosion eliminates the pipes' need of cathodic protection and supplemental coating material, thus eliminating operating difficulties and expenses.

Another important advantage offered by SUBOR's pipe manufacturing technique is the ability to use project specific resins in the inner liner of the pipe against highly corrosive environments or chemical effects.

FAST AND EASY INSTALLATION

With the advantage of using Double Bell Reka Type Coupling, there will be no need for high-qualified workers and welding equipment. As an average, 300 meters of DN1200 mm diameter pipe can be installed by one team in a day.

PRODUCTS

PIPES

Thanks to the advantages offered by Continuous Filament Winding Technology, SUBOR is capable of manufacturing according to the technical specifications of each project, with the desired length, pressure and stiffness parameters.

Length: Standard 6 and 12 m. Other tailor-made lengths up to 15 m are available on request.

Diameter (DN): 200 - 4.000 mm

Pressure (PN): 1- 40 bar

Stiffness (SN): Standard 2.500 – 5.000 – 10.000 N/m^2. And other stiffness classes, up to 1.000.000 N/m^2 are available depending on project requirements.

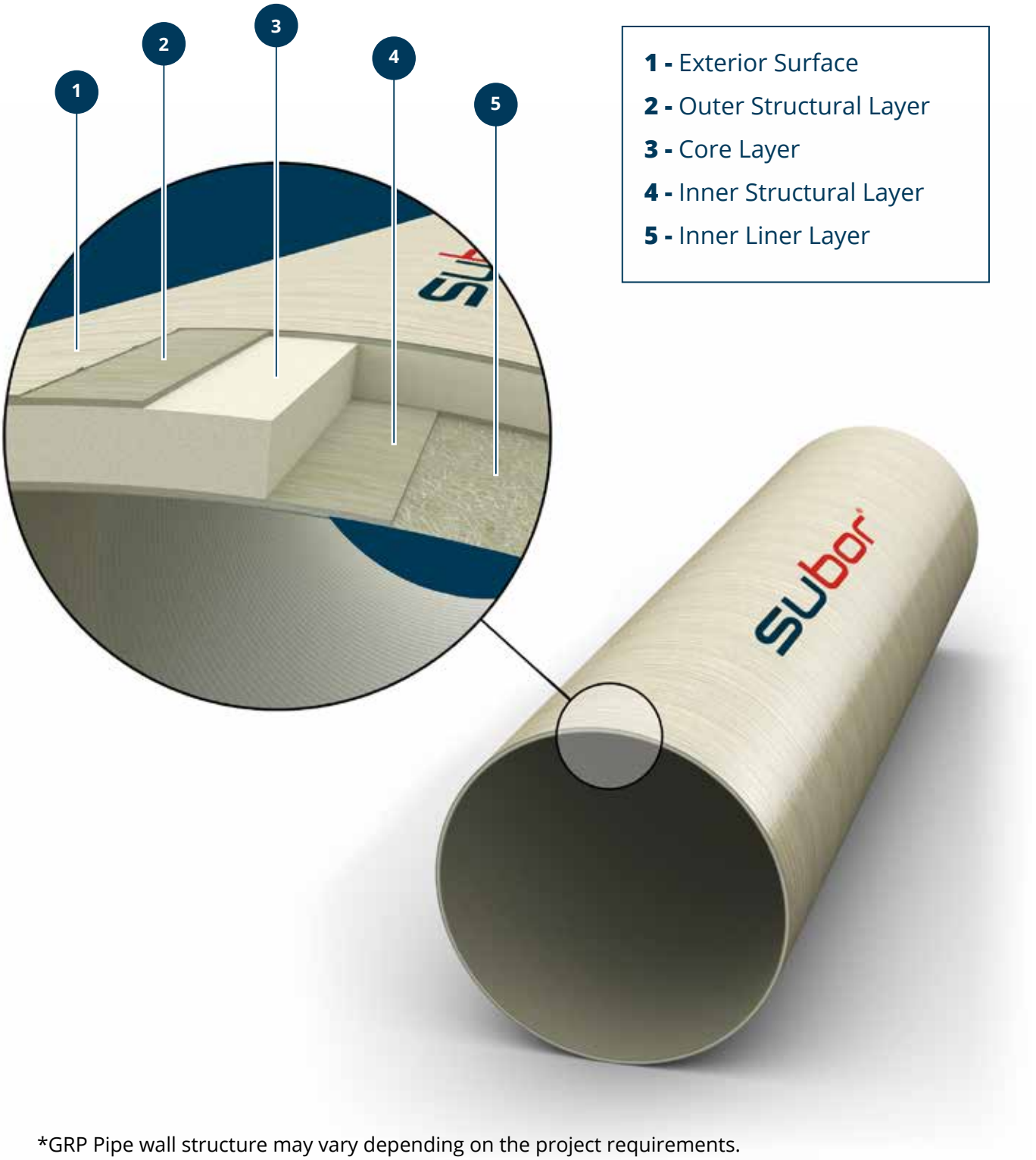
SUBOR GRP pipes are used in below applications

- Drinking water transmission lines and networks
- Irrigation projects transmission and distribution lines
- Waste water transfer, treatment plants and sewer lines
- Storm water lines
- Raw water intake, discharge and cooling water lines of power plants
- Transmission and penstock lines of hydroelectric power plants
- Industrial plants such as desalination, chemical, firefighting systems etc.
- Renovation of current lines by slip-lining
- "Jacking" pipes enabling trenchless installation
- Tank and silo production

Customized products are also available upon request.

WALL STRUCTURE

Using technology developed by material specialists, a very dense laminate is created that maximizes the contribution from three basic raw materials, namely glass fiber, resin and silica sand. Continuous glass fiber roving is providing high circumferential strength against internal pressure, while chopped roving is incorporating for axial reinforcement and outer impacts. A sand fortifier is used to provide increased stiffness with placement near the neutral axis in the pipe wall core.



1 - Exterior Surface
2 - Outer Structural Layer
3 - Core Layer
4 - Inner Structural Layer
5 - Inner Liner Layer

*GRP Pipe wall structure may vary depending on the project requirements.

PRESSURE PIPES

The proven advanced continuous filament winding technology and the benefits of composite materials enable SUBOR to provide solutions for pressure pipe systems up to 40 bars with a cost advantage against conventional materials.

With the benefit of SUBOR GRP Pipes' structure, lower wave celerity than other piping materials can mean less cost when designing for surge and water hammer pressures.

SEWER PIPES

The wide product portfolio of SUBOR is also offering special designed GRP pipe for sewer applications. In order to resist against severe corrosive and aggressive effects and also high water jet cleaning pressure SUBOR Sewer Pipes are manufactured with special inner liner.

BIAXIAL PIPES

SUBOR Biaxial Pipes are designed and produced to resist forces in axial direction as well as circumferential direction in order to eliminate thrust block needs. Loads are transferred from one pipe to the next with restrained joints such as butt-wrap lamination, lock joint or flanges. Stress analysis study which is necessary for biaxial systems can be performed by SUBOR Engineering Team.

JACKING (TRENCHLESS) PIPES

SUBOR is offering an innovative and reliable solution for urban areas by special design jacking pipes. SUBOR Jacking Pipes are used for the construction and renovation of underground pipelines using trenchless methods. High axial compressive strength of jacking pipes provides significant advantages compared to other pipe materials for micro tunneling and slip-lining applications.

SUBOR Jacking Pipes are preferred in the construction of new sewer and pressure pipelines, replacement of old sewers, road culverts in transport engineering and relining using the Micro-tunneling and slip-lining methods.

Depending on the project requirements, SUBOR Jacking Pipes are designed in custom lengths, with different joining types and up to 1.000.000 N/m2 nominal stiffness.

Compared to conventional pipe materials, SUBOR GRP Pipes enable installer to use smaller capacity jacking machines, to minimize the excavation volume, to reduce energy consumption and to increase installation speed.

GRI PIPES

SUBOR provides a safe and more reliable option to engineers and contractors, who need higher resistant pipes for their tough project conditions. The recently developed SUBOR GRI Pipes reach an excellent performance when they are subjected to high abrasion, outer impacts, and highly pressurized water jet cleaning. SUBOR GRI Pipe technology allows to have same connection type and production range with standard pressure pipes.

COUPLINGS

SUBOR GRP Pipes are assembled using the GRP coupling connection system which offers perfect leak tightness. The GRP REKA couplings manufactured with the same technique as the GRP pipes and they are subjected to a hydrostatic pressure test following preparation in the cutting and grooving machine. Tightness of the coupling connections is provided by the gaskets made of elastomeric material. The flexibility of the gaskets allows a certain angular deviation of the couplings, thus preventing direct load on the pipe, which could result from ground subsidence and soil activity such as earthquakes. Compared to its alternatives, SUBOR GRP Couplings offer fast, easy and safe installation in any ground and weather conditions.

Angular deflection for standard SUBOR pressure coupling is given with below table:

Nom. Pipe Diameter (mm)	Nom. Pressure Class (bar)			
	Up to 16	20	25	32
		Max. Angle of Deflection (deg)		
DN ≤ 500	3.0	2.5	2.0	1.5
500 < DN ≤ 900	2.0	1.5	1.3	1.0
900 < DN ≤ 1800	1.0	0.8	0.5	0.5
1800 < DN	0.5	0.4	0.3	NA

Pressure Coupling

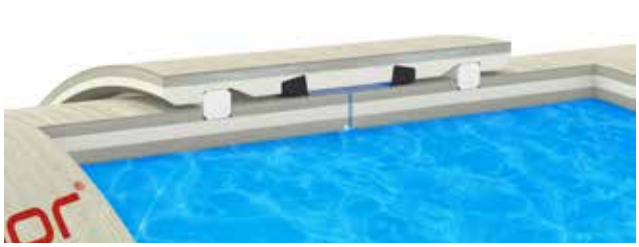
Common applications include irrigation, water supply, pressure sewer and HPP penstocks systems.

DN200 – DN4000 mm diameter range,
up to PN40 bar pressure range

Sewer Coupling

Common applications include sewers and storm water systems

DN200 – DN4000 mm diameter range,
PN1 bar pressure



Biaxial Lock Joint

Common applications include industrial cooling and desalination systems.

DN200 – DN2000 mm diameter range,
up to PN16 bar pressure

Angled Coupling

Cost effective coupling solution for increased angular deflections up to 3 degrees.

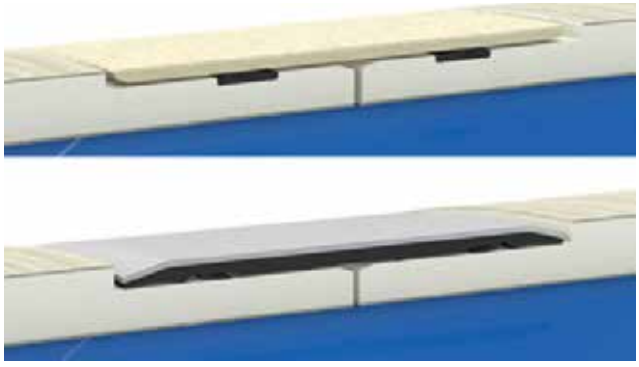
DN600 – DN4000 mm diameter range,
up to PN16 bar pressure rang

SLEEVE COUPLINGS

In jacking applications, the sleeve couplings should have an outside diameter equal to the jacking pipe external diameter. Couplings are available in different types and pressure classes depending on the project conditions. EPDM gaskets are used in sleeve couplings in order to provide sealing at the joints.

Type of Sleeve Couplings:

GRP Non-Pressure Sleeve Coupling
GRP Pressure Sleeve Coupling
Steel Non-Pressure Sleeve Coupling
Steel Pressure Sleeve Coupling




GRP SLEEVE
COUPLING

SUBOR BLUE TAPE COUPLING

To have an easier and faster installation,
just remove the "blue".
In order to prevent EPDM Gaskets from direct UV effect of the sunlight, it is recommended to supply them separately and store in a proper place. SUBOR's new innovative product "BLUE TAPE" offers a perfect solution for the installers and avoids the need for storage place together with long-lasting protection against both UV and environmental effects like dust and dirt.

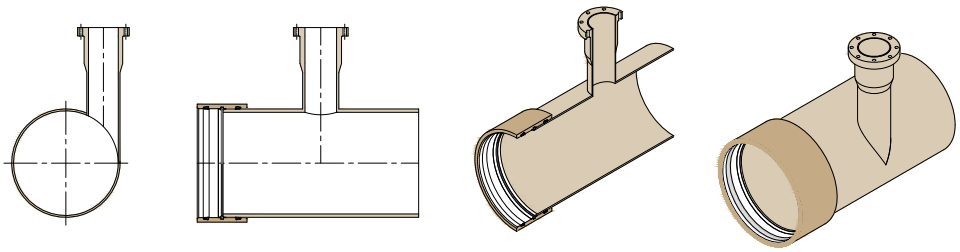
WALL COUPLING

Wall couplings are used when the GRP pipeline penetrates to masonry structures. Couplings can be covered with sand or gravel in order to increase adhesion between GRP and concrete materials. Depending on the project needs, the wall couplings can be supplied up to 3 m length.

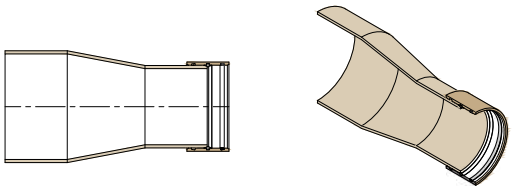
FITTINGS

SUBOR GRP Pipes are also used to fabricate fittings such as elbow, tee, reduction, flange, marine lugs etc. as well as special spools that can be designed on request.
For fitting production, firstly pipes are cut at the desired angles and forms. Then, the cut pipes are attached by connecting glass fiber and polyester resin.
SUBOR offers wide solution opportunities with over 200.000 different types of fitting design.

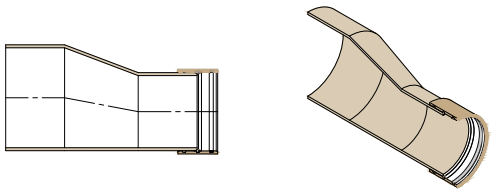
SUBOR FITTING TYPES



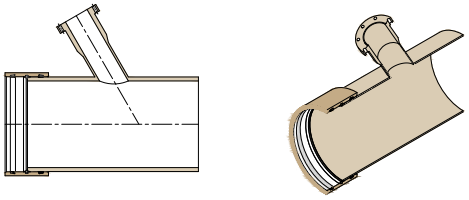
CONCENTRIC & TANGENTIAL TEE



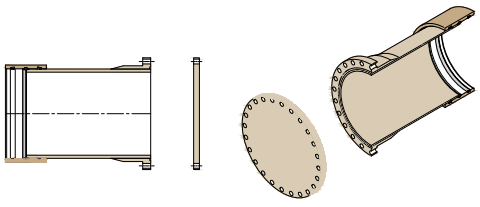
CONCENTRIC REDUCER



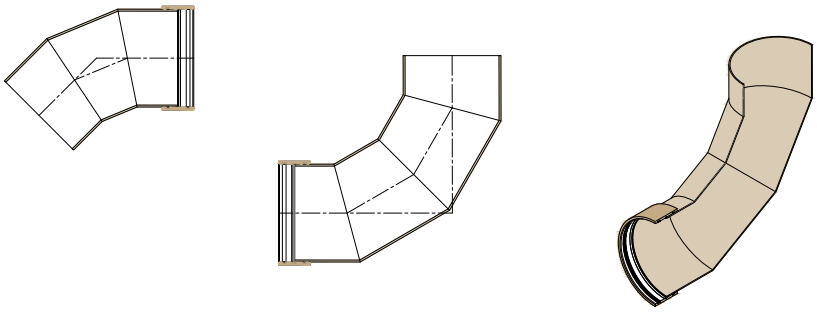
ECCENTRIC REDUCER



WYE



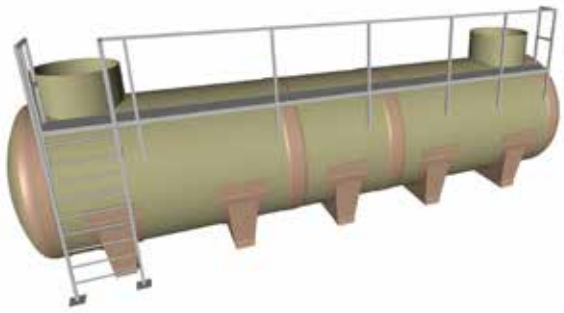
FLANGE & BLIND FLANGE



ELBOWS

SPOOL DESIGN

Another advantage of SUBOR pipes is that they allow production of standard as well as non-standard fittings in a very wide range. Such non-standard pieces (described as “Spool”) are manufactured after the completion of design engineering studies and they are mainly used at power plants and industrial applications.



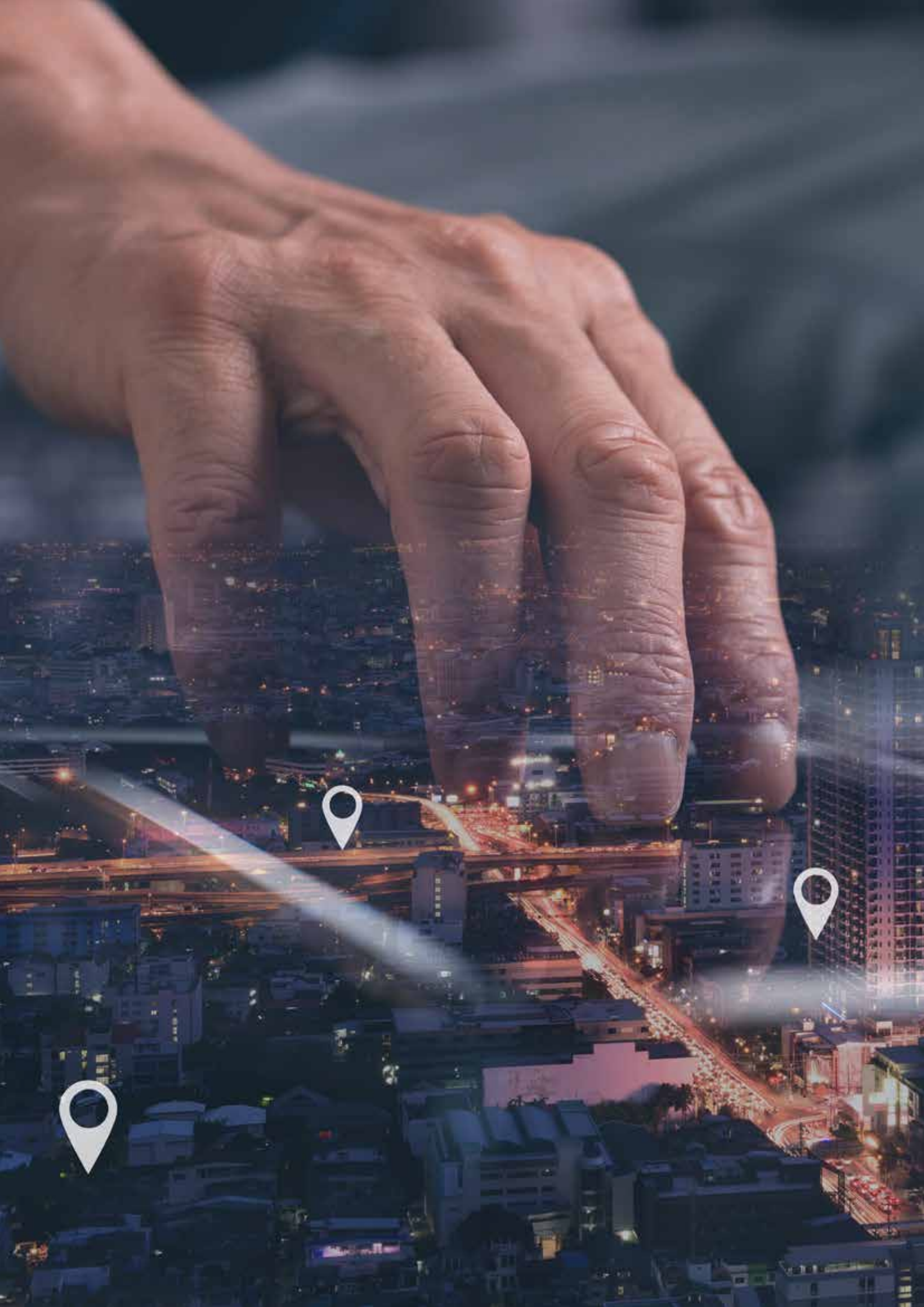
TANK, SILO AND GALLERIES

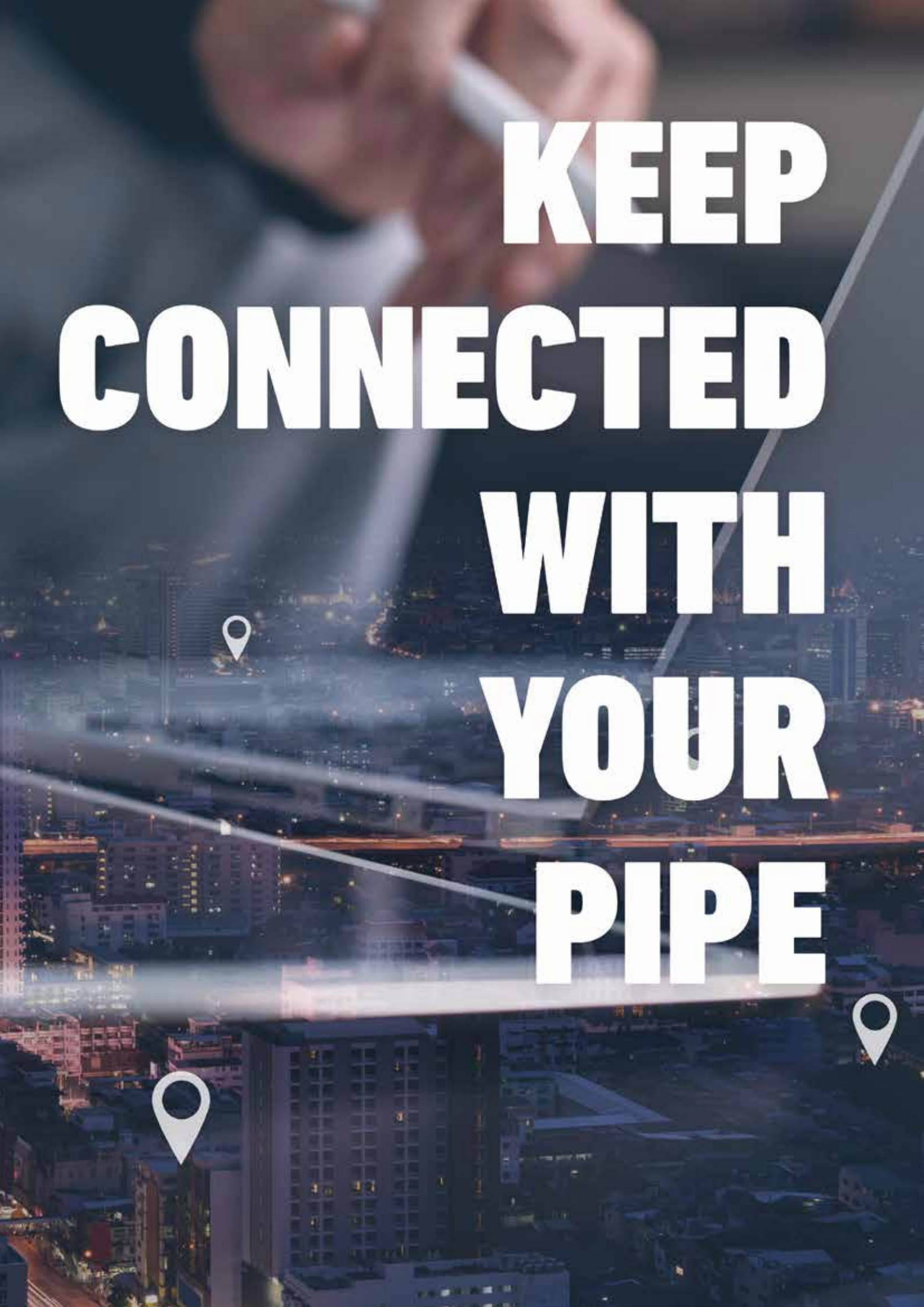
SUBOR Tanks and Silos are designed according to project needs and they can be used for gas, fuel oil, airplane fuel, potable water or waste water, various chemical fluid storing and many other purposes.

Since GRP Material is not affected by corrosion, GRP tanks have a relatively long service life without additional maintenance costs in comparison to other materials.

MANHOLES

Similar to fitting fabrication, manholes are made of SUBOR GRP Pipes. In order to achieve a long service life, high performance and safe service conditions, likewise the whole pipeline system, the GRP pipes are precisely cut and joined with glass fiber and polyester resin. With the benefit of non-corrosive property, light weight, reliability and easy installation advantages; SUBOR manholes are used for ventilation, inspection and maintenance, cleaning and flushing of drains or sewers and pumping stations.



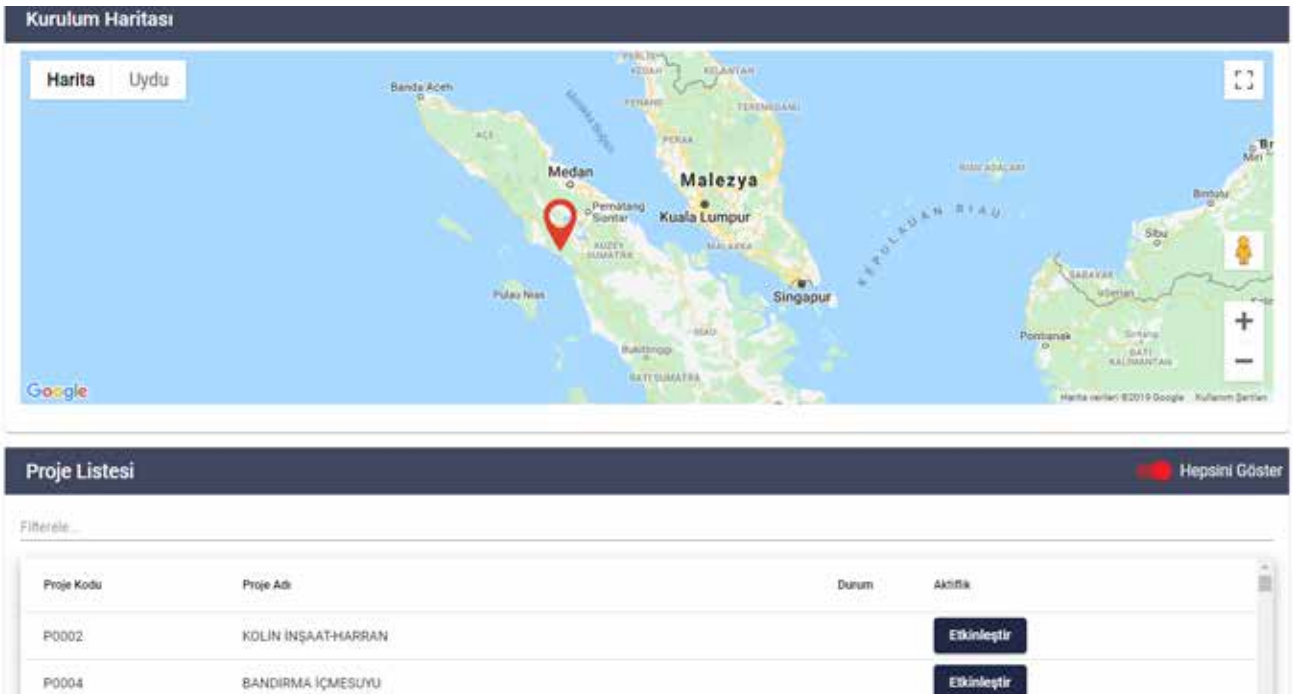

KEEP
CONNECTED
WITH
YOUR
PIPE

KEEP CONNECTED
WITH YOUR PIPE

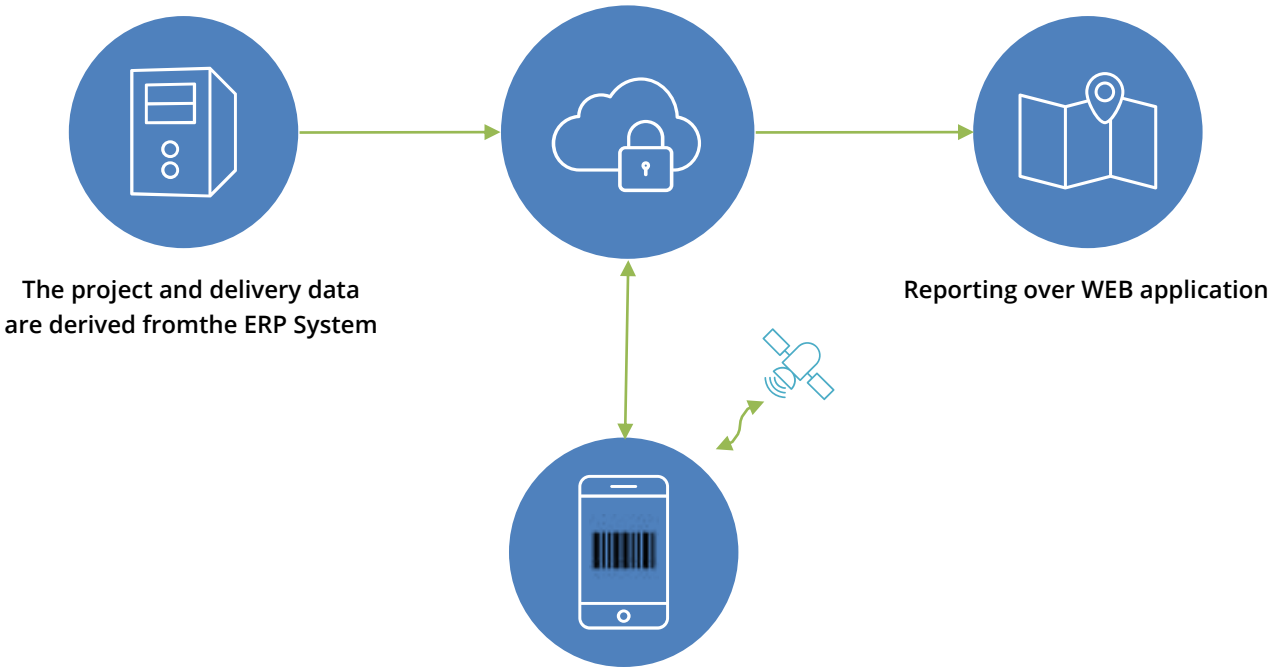
With its innovative engineering approach, SUBOR has successfully developed and launched a unique smart application named as “PIPE MAP”. The application allows you both to store all pipe ID such as DN/PN/SN, geographical coordinates, etc. and to backtrack the history of the pipe starting from raw material supply to installation by using the pipe data.

KEEP CONNECTED WITH YOUR PIPE over years by “PIPE MAP”.

To benefit from this application, please consult SUBOR.



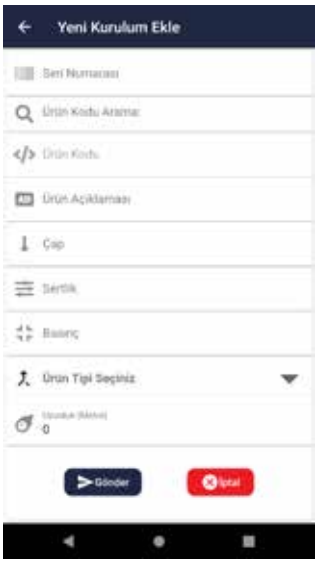
The steps of PIPE MAP application.

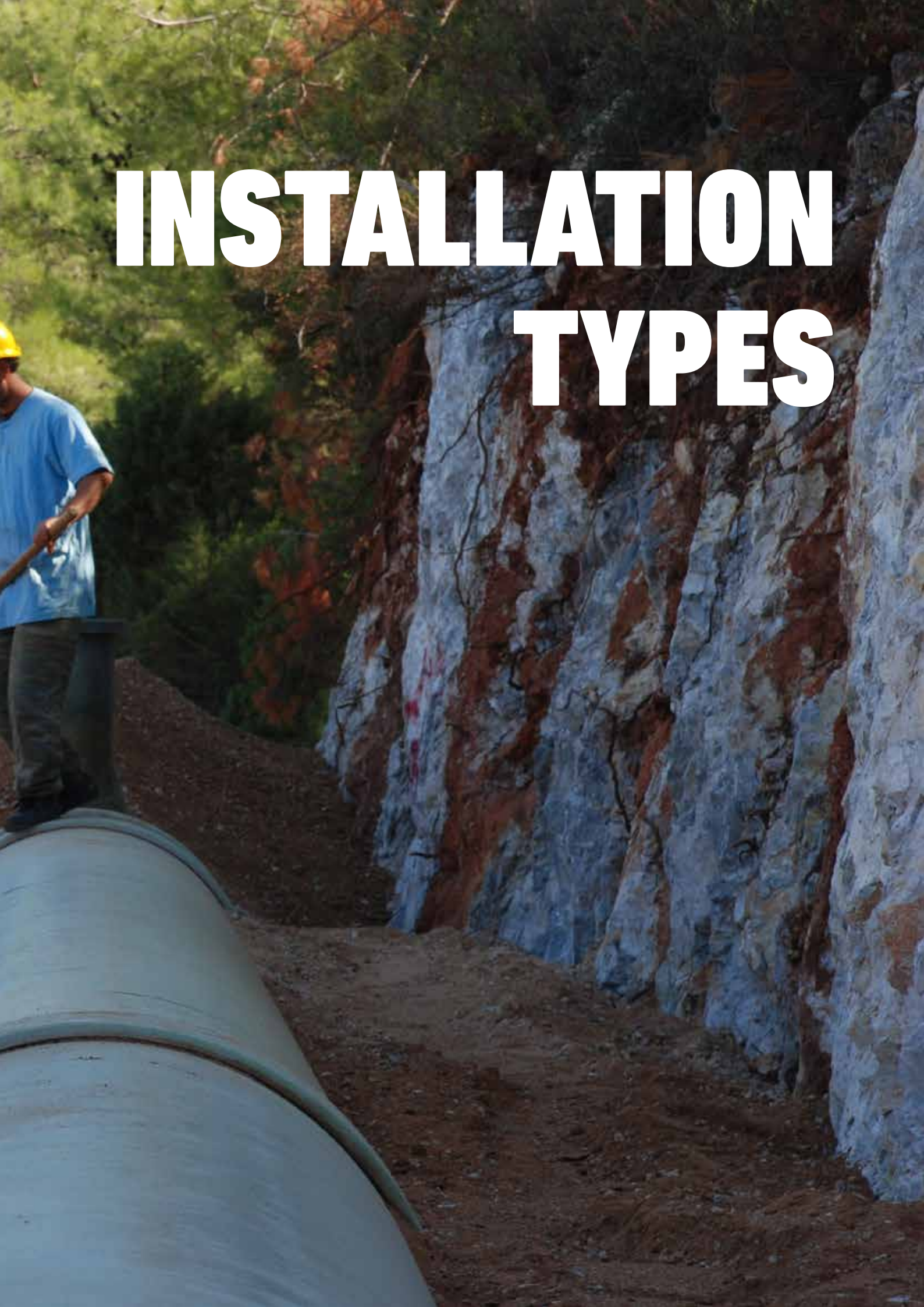


The project and delivery data are derived fromthe ERP System

Reporting over WEB application

Mobile application to be used online/offline at the site





INSTALLATION TYPES

INSTALLATION TYPES

Due to its superior features, SUBOR GRP Pipes offer a wide range of installation possibilities such as underground, aboveground, trenchless and subaqueous.

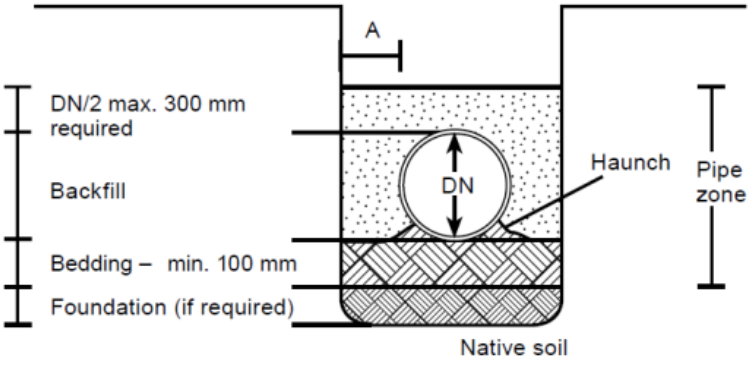
In this section of this manual, main principals of pipe installation methods are presented. For further details and technical support, please get in contact with SUBOR.

BURIED

The structural design procedure for buried fiberglass pipe involves establishing design conditions, selecting pipe classes and corresponding pipe properties, selecting installation parameters, and performing pertinent calculations to ensure that the design requirements are satisfied.

A properly installed SUBOR GRP Pipe can be buried much safer and deeper than a similarly installed rigid pipe because of the flexible pipe/backfill interaction. In order to enhance the interaction and to avoid excessive deflection, external loads acting on the pipeline have to be transferred to the ground. In this context, the selection of correct backfill material incorporated with the pipe rigidity plays a crucial role in the buried systems.

Nominal size (DN)	A (mm)
DN ≤ 400	200
400 < DN ≤ 900	400
900 < DN ≤ 1600	500
1600 < DN ≤ 2400	600
2400 < DN ≤ 4000	900



The following criteria are taken into consideration in buried GRP pipe systems.

Foundation
Material placed and compacted in the bottom of the trench to replace over excavated material and/or to stabilize the trench bottom if unsuitable ground conditions are encountered.

Bedding
Backfill material placed in the bottom of the trench or on the foundation to provide a uniform material on which to lay the pipe.

Backfill
Backfill material placed at the sides of the pipe and up to 300 mm over the top of the pipe. The backfill materials are classified in different groups based on the soil stiffness when compacted and the groups are shown in the table below. If the backfill material is required to be compacted, a surface plate vibrators, vibratory rollers, or internal vibrators shall be used and compaction lift thickness shall not exceed 300 mm.

Soil Classes	Soil Type Description
Class I (SC 1)	Crushed Stone < 15% sand, maximum 25% passing the 9,5 mm sieve and maximum 5% fines
Class II (SC 2)	Clean, course-grained soils SW, SP, GW, GP or any soil beginning with one of these symblos with 12% or less fine
Class III (SC 3)	Clean, course-grained soils with fines GM, GC, SM, SC or any soil beginning with one of these symblos with more than 12% fines Sandy or gravelly fine-grained soils CL, ML (or CL-ML, CL/ML, ML/CL) with more than 30% retained on a No:200 sieve
Classs IV (SC 4)	Fine-grained soils CL, ML (or CL-ML, CL/ML, ML/CL) with 30% or less retained on a No:200 sieve

Soil Stiffness Category	SC1	SC2	SC3	SC4
General recommendations and restrictions	Acceptable and common where no migration is probable or when combined with a geotextile filter media. Suitable for use as a drainage blanket and under drain where adjacent material is suitably graded or when used with a geotextile filter fabric.	Where hydraulic gradient exists, check gradation to minimize migration. Clean groups are suitable for use as a drainage blanket and underdrain. Uniform fine sands (SP) with more than 50% passing a No. 100 sieve (0.006 in.,0.15 mm) behave like silts and sholud be treated as SC3 soils	Do not use where water conditions in trench prevent proper placement and compaction. Not recommended for use pipes with stiffness of 9 psi (62 kPa) or less.	Difficult to archive high soil stiffness. Do not use where water conditions in trench prevent proper placement and compaction. Not recommended for use with pipes with stiffness or 9 psi (62 kPa) or less.

Maximum particle size for pipe embedment

Nominal Diameter mm	Nominal Diameter in.	Maximum Particle Size mm	Maximum Particle Size in.
DN < 450	DN < 18	13	0.50
450 < DN < 600	18 < DN < 24	19	0.75
600 < DN < 900	24 < DN < 36	25	1.00
900 < DN < 1200	36 < DN < 48	32	1.25
1200 < DN	48 < DN	38	1.50

Final Backfill

Backfill material placed from the top of the initial backfill to the ground surface in order to preclude damage to the pipe and disturbance to pipe embedment. Depending on the backfill material type, a cover of at least 0,8 m to 1,2 m shall be considered. If there is a risk of pipe flotation, the burial depth should be at least equal to the pipe diameter.

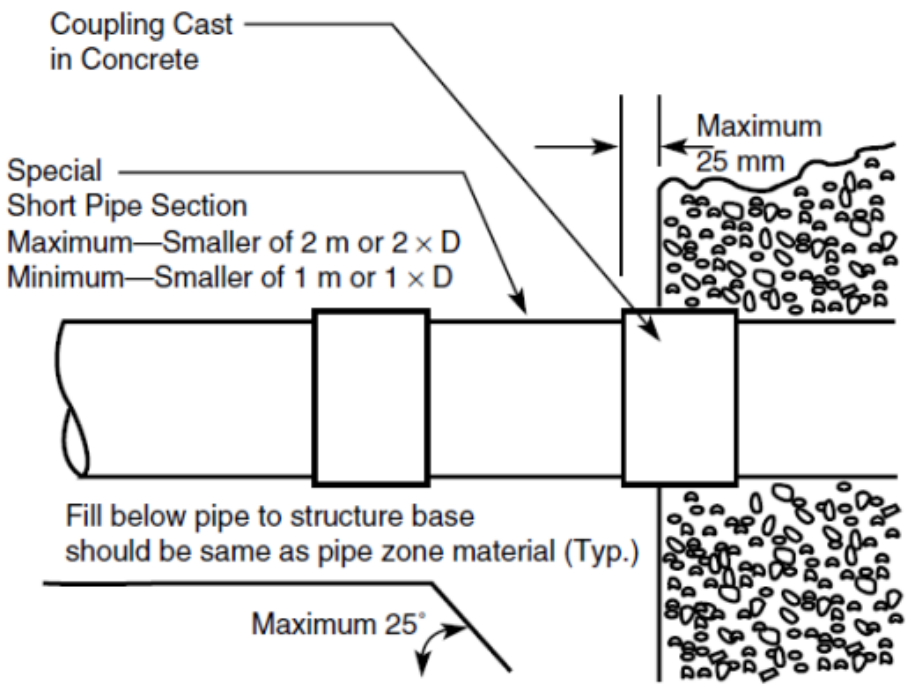
Thrust Block

Unbalanced hydrostatic thrust forces occur at changes in direction when a pipeline is subjected to an internal pressure. In order to avoid coupling separation and damages due to pipeline movements, thrust forces must be adequately restrained by using a thrust block.

NOTE: Biaxial type pipe and fittings are the best solution for projects, where construction of reinforced concrete thrust blocks is not desired or is not possible. In such pipelines the joints of the pipes and fittings are made by restrained joints such as butt-wrap lamination, lock joint or flanges.

Connection to Rigid Structures

While connecting GRP pipes to rigid structures, short pipes (rocker pipes) shall be used to minimize the bending and shear stress acting on the pipe due to the excessive settlement difference between pipe systems and rigid structure. The short pipes shall be installed in straight alignment and the surrounding soil shall be compacted properly and with extra care.



ABOVE GROUND

Because of excellent resistance against the impact of UV lights, SUBOR GRP Pipes ensure reliable solution for aboveground installations.

Depending on the specific project requirements, different design provisions and supporting methods may be applicable for aboveground applications. For appropriate design parameters, please consult with your piping engineer and SUBOR.

SUBAQUEOUS

Superior features such as high corrosion resistance, low maintenance cost, long service life, economic installation and easy handling make SUBOR GRP Pipe a unique choice in subaqueous installations. Marine harness lugs are applied on pipe surface adjacent to couplings and they are used to keep the pipe springs together during the installation works. The marine lugs also help divers during loading, transferring, and sinking operations and also to assist with the jointing operation under water.

TRENCHLESS

The innovative GRP pipe systems of SUBOR include ideal solutions in areas such as crossings and culverts under the roads and buildings and also renovation of existing pipelines.

• Microtunneling / Jacking Installation

In accordance with the capacity of Tunnel Boring Machine (TBM), SUBOR is capable to offer customized jacking pipes, which maximize the performance of the pipe system while easing the jacking operation.

• Slip-lining

As a result of the advance manufacturing technology and use of composite materials, SUBOR GRP pipes offer excellent hydraulic properties, chemical resistance and long service life for the replacement and rehabilitation of existing lines.

QUALITY AND STANDARDS

QUALITY AND STANDARDS

SUBOR's approach to the quality concept is not limited to the production process and its product. SUBOR's management conception in all activities is an insight that considers the satisfaction of all stakeholders, especially the customers and it adopts occupational health and safety as the fundamental policy.
Having established its management system upon such foundations, SUBOR has obtained certificates for ISO 9001 Quality, ISO 14001 Environment, and OHSAS 18001 Occupational Health and Safety Management Systems.

SUBOR manufacturing process has been designed to meet the requirements of the most fundamental and extensive international standards of the industry as given below:

AWWA C-950	Fiberglass Pressure Pipe
ASTM D 3754	Standard Specification for Sewer and Industrial Pressure Pipe
ASTM D 3517	Standard Specification for GRP Pressure Pipe
ASTM D 3262	Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe
ISO 10639	Plastics piping systems for pressure and non-pressure water supply — Glass-reinforced thermosetting plastics (GRP) systems based on unsaturated polyester (UP) resin
ISO 10467	Plastics piping systems for pressure and non-pressure drainage and sewerage — Glass-reinforced thermosetting plastics (GRP) systems based on unsaturated polyester (UP) resin
ISO 25780	Plastics piping systems for pressure and non-pressure water supply, irrigation, drainage or sewerage — Glass-reinforced thermosetting plastics (GRP) systems based on unsaturated polyester (UP) resin — Pipes with flexible joints intended to be installed using jacking techniques
EN 1796	Plastics piping systems for water supply with or without pressure - Glass-reinforced thermosetting plastics (GRP) based on unsaturated polyester resin (UP)
EN 14364	Plastics piping systems for drainage and sewerage with or without pressure - Glass-reinforced thermosetting plastics (GRP) based on unsaturated polyester resin (UP) - Specifications for pipes, fittings and joints
DIN 16868	Glass fibre reinforced unsaturated polyester resin (UP-GF) pipes

All relevant tests as required in the scopes of international standards as listed above are performed in SUBOR's laboratories, which are accredited with regards to conformity to ISO 17025: General Requirements for the Competence of Testing and Calibration laboratories.

PRODUCTION CONTROL TESTS

Tests are performed in order to inspect and measure performance of the product. The results of tests are recorded and they can be accessed easily. The conducted tests cover the entire process; from the entrance of raw materials to the shipment of the final products.

Raw materials are delivered with supplier certification demonstrating their compliance with SUBOR quality requirements; in addition, raw material samples are subjected to incoming control tests in SUBOR laboratories prior to their use.

All pipes are subjected to the following control checks in SUBOR laboratories and on production lines during production.

- Visual Inspection
- Barcol Hardness
- Dimensional Checks (Pipe Length, Diameter, Wall Thickness)
- Hydrostatic Leak Tightness Test (for pressure pipes)

On a sampling basis, the following control checks are performed.

- Determination of Pipe Stiffness
- Deflection without damage or structural failure
- Axial Tensile Strength Tests
- Circumferential Tensile Strength Tests
- Composition Test

QUALIFICATION TESTS

In addition to in-process product and performance tests, SUBOR also performs short and long term tests in order to determine qualification, pipe design criteria and monitor the long term material condition. The long term monitoring is carried out for more than 10.000 hours in the "SUBOR Long Term Test Laboratory" and aim at reviewing the performance of pipes over 50 years.

SUBOR performs the following tests:

- Strain Corrosion Testing
- Hydrostatic Design Basis (HDB)
- Long Term Ring Bending Strain
- Long Term Specific Ring Stiffness
- Abrasion Resistance
- Joint Qualification Tests
- Water Jetting Resistance Testing

STRAIN CORROSION TEST

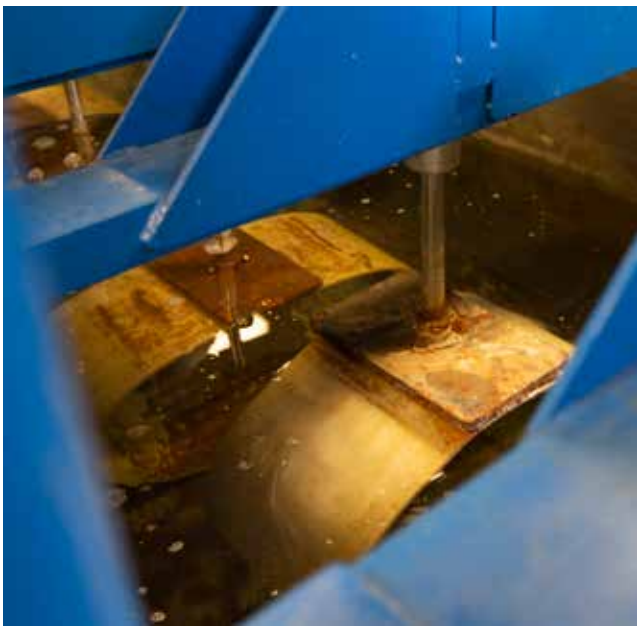
The method evaluates the effect of a chemical environment on the pipe when in a deflected condition. It has been found that the effects of chemical environments can be accelerated by strain induced by deflection. This test is performed by applying sulphuric acid solution in accordance with ASTM D 3681 standard.

HYDROSTATIC DESIGN BASIS (HDB)

This practice is useful for establishing the hoop stress or internal pressure versus time-to-failure relationships, under selected internal and external environments which simulate actual anticipated product end-use conditions, from which a design basis for specific piping products and materials can be obtained. This test is applied in accordance with ASTM D 2992 standard.

LONG TERM RING BENDING STRAIN TEST

Long term ring bending strain test method determines the long-term ring-bending strain of pipe when deflected under constant load and immersed in a chemical environment. It has been found that effects of chemical environments can be accelerated by strain induced by deflection. This test is applied in accordance with ASTM D 5365 standard.



LONG TERM SPECIFIC RING STIFFNESS

The test is applied for determining the ring creep properties for glass-reinforced thermosetting plastics (GRP) pipes. Properties include the wet creep factor and the long-term specific creep stiffness. This test is applied in accordance with ISO 10468 standard.

ABRASION RESISTANCE

The method for this test has been released by Darmstadt University. The test is carried out by adding a gravel mixture with water inside the pipe sample and cycling it within certain times to determine abrasion level of liner layer of pipe.

JOINT QUALIFICATION TESTS

Various joint qualification tests are applied according to international standards such as EN 1119 and ASTM D 4161, to find out the performance of the joint.

WATER JETTING RESISTANCE TESTING

During the service life, the sewer lines need to be cleaned with high pressurized water. Therefore the pipe has to have strength against high pressurized water jetting cleaning applications. This test is applied in accordance with DIN 19523 standard.

ENGINEERING SERVICES

ENGINEERING SERVICES

SUBOR provides engineering support to the customers before and after the procurement phase to ensure correct and efficient use of the products and technology offered with its in-house expert engineers by looking out for their maximum benefit.

SUBOR also examines the suitability of the projects designed by engineers for GRP Pipes.

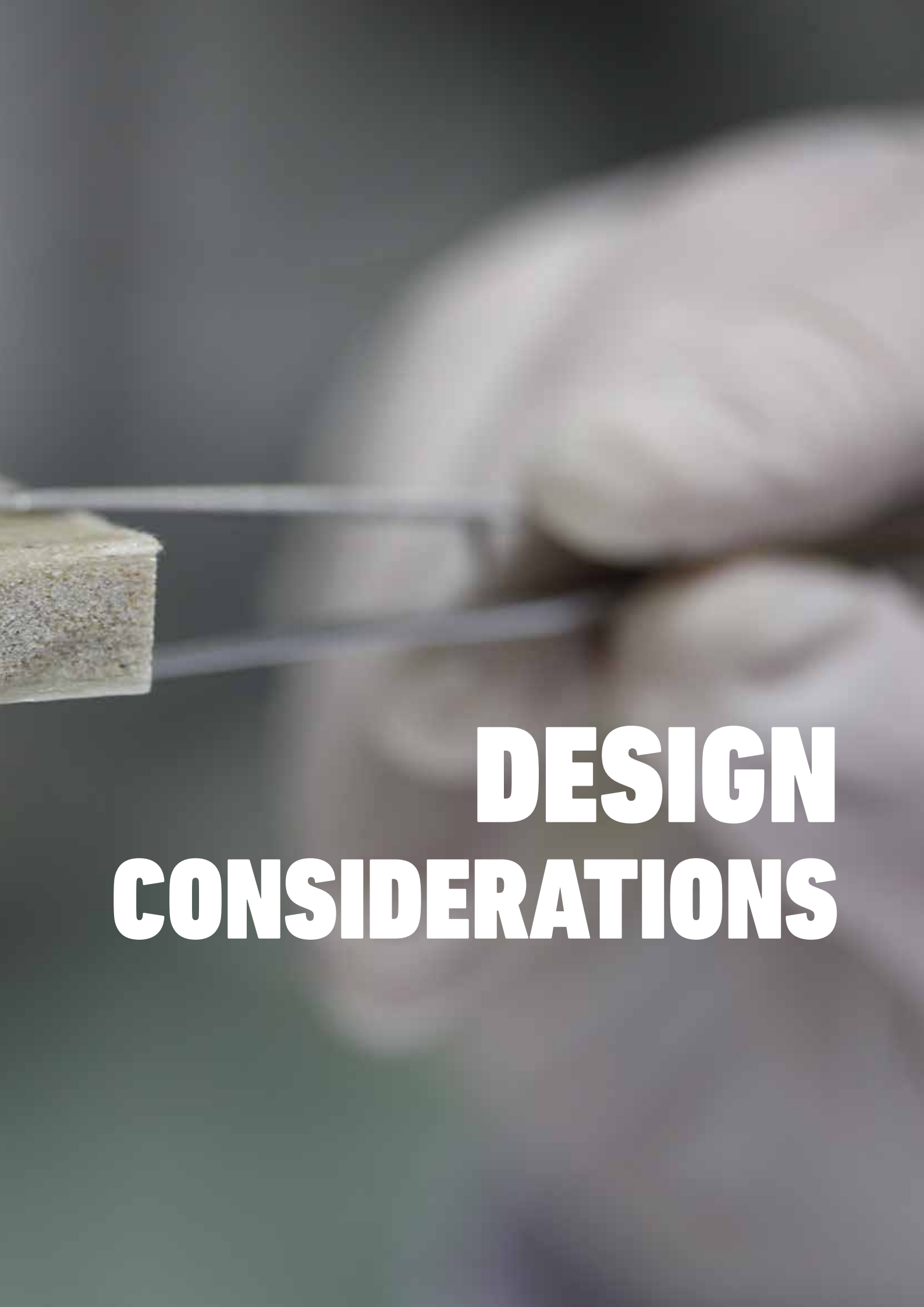
In-house engineering offered by SUBOR:

- Buried pipe design
- Hydraulic calculations
- Stress and Flexibility Analysis of pipelines and stress isometric drawings
- Engineering drawings
  - Piping layout and isometric drawings
  - GRP component shop drawings
  - Conceptual support and clamp drawings
  - Connection detail with different materials
- Calculation of pipe anchoring and support requirements
- Calculation of concrete thrust blocks
- GRP tank, silo, manhole and spool design

SITE SUPERVISION

SUBOR provides technical support at every stage of project implementation starting from design to the finalization. Assisting to the proper pipe installation process, our "Field Engineering" department provides supervisory services and technical support during the implementation of project.

Our aim is to ensure the installation in conformance with the procedures and technical specifications of GRP pipes. By means of those services provided by SUBOR Field Engineering Team, the service life of pipes is extended safely in a cost effective way.



DESIGN CONSIDERATIONS

DESIGN CONSIDERATIONS

ROUGHNESS

Pipe roughness is the main parameter for hydraulic analysis.
Coefficient for different calculation methodologies are given below.

Flow Coefficients

- Manning – n = 0,009
- Hazen-Williams – C = 150
- Colebrook-White – k = 0,029

FLOW VELOCITY

For standard fluid conveyance the flow velocity is suggested as 3 m/sec. Maximum velocity is recommended as 5 m/sec. For higher flow velocities, SUBOR is capable to design special products depending on the fluid properties.

WATER HAMMER

Under the similar operating conditions, the water hammer pressure of SUBOR GRP Pipe is expected roughly 50% of that for steel and ductile iron pipes. SUBOR GRP Pipe has a surge pressure allowance of 40% of the nominal pressure. The formula to calculate pressure variation is given below:

$$\Delta H = \frac{(w \times \Delta V)}{g}$$

ΔH = change in pressure (meters)
w = surge wave celerity (meters/sec)
Δv = change in liquid velocity (meters/sec)
g = acceleration due to gravity (meters/sec²)

Surge wave celerity (w in m/sec) values of SUBOR GRP Pipes are shown in the below table.

DN	300	400	450	800	≥900
SN 2500					
PN6	420	380	370	350	340
PN10	440	430	430	420	410
PN16	510	500	500	490	480
PN20	560	540	540	530	520
PN25	590	580	580	570	560
SN 5000					
PN6	430	410	400	380	380
PN10	440	430	430	420	410
PN16	520	500	510	490	490
PN20	550	540	540	530	520
PN25	590	580	580	570	560
SN 10000					
PN6	480	460	450	430	420
PN10	480	460	450	430	420
PN16	520	510	520	500	490
PN20	550	550	540	530	520
PN25	580	580	580	570	570
PN32	630	630	620	620	620

NEGATIVE PRESSURE (VACUUM)

If vacuum or negative pressure is expected in pipelines, it is recommended to use higher stiffness class GRP pipes. For buried installation, stiffness of pipes shall be minimum SN5000 and the burial depth shall be not less than 1,0 meter in case negative pressure exceeds 0,5 bar.

AMBIENT CONDITIONS

Since SUBOR GRP Pipes are not affected by UV lights and cold weather conditions, their mechanical properties remain the same over time; therefore, there is no need of protective measures.

OPERATING TEMPERATURE

Due to its nature, an operating temperature above 35°C will cause change in the mechanical properties of the resin. In such case, the pipe pressure class shall be selected according to the sustained operating temperature.

TEMPERATURE	PRESSURE DERATING [PN = Pipe PN / (1 - %Ratio)]	RESIN SELECTION
35°C and Below	No pressure derating is required.	Resin selection should be in accordance to the fluid contents.
36 °C to 50 °C	Below Derating Ratios to be applied on pipe pressure class	Resin selection should be in accordance to the fluid contents.
36 to 40 °C 41 to 45 °C 46 to 50 °C	30 % 40 % 50 %	
Above 50 °C	50 %	Vinylester resin has to be used for entire pipe structure

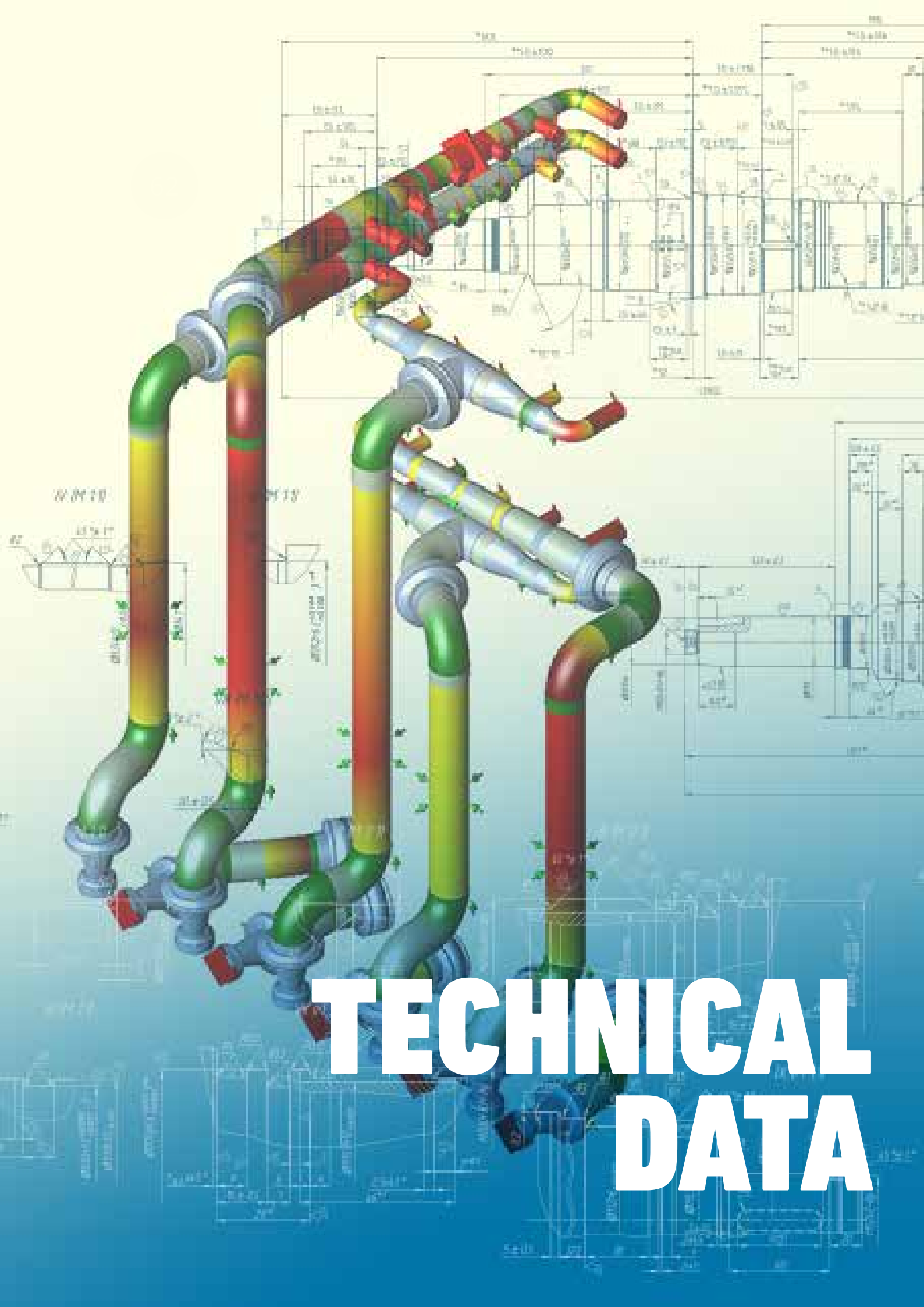
Please contact SUBOR for further technical advice.

THERMAL COEFFICIENT

The thermal coefficient of axial expansion and contraction for SUBOR Pipe is 24 to 30x10^{-6} mm/mm/°C.

ABRASION RESISTANCE

The average abrasion loss of SUBOR standard GRP pipe is 0.34 mm at 100.000 cycles according to Darmstadt Test method. However, the improved SUBOR GRI Pipes have 0,118 mm average abrasion after 100.000 cycles.



TECHNICAL DATA

subor®

SUBOR PIPE DIMENSIONS

PRESSURE CLASS			PN6						PN10					
STIFFNESS CLASS			SN2500 N/m²		SN5000 N/m²		SN10000 N/m²		SN2500 N/m²		SN5000 N/m²		SN10000 N/m²	
DN (mm)	Inch	OD_{max} (mm)	ID_{min} (mm)	W_{min} (kg/m)	ID_{min} (mm)	W_{min} (kg/m)	ID_{min} (mm)	W_{min} (kg/pm)	ID_{min} (mm)	W_{min} (kg/m)	ID_{min} (mm)	W_{min} (kg/m)	ID_{min} (mm)	W_{min} (kg/m)
250	10″	272,5					258,9	11,0					258,7	11,0
300	12″	324,9	314,8	7,7	312,8	9,8	310,7	11,9	314,9	7,5	312,8	9,7	310,7	11,9
350	14″	376,8	365,4	10,5	363,0	13,4	360,6	16,2	365,8	10,0	363,3	13,0	360,6	16,2
400	16″	427,7	415,1	13,6	412,3	17,4	409,6	21,0	415,6	12,8	412,9	16,5	409,6	21,0
450	18″	478,6	464,7	17,3	461,5	22,0	458,6	26,5	465,5	15,9	462,4	20,6	458,6	26,5
500	20″	530,5	515,2	21,5	511,8	27,3	508,5	32,7	516,3	19,4	512,9	25,2	508,5	32,7
600	24″	617,4	599,9	29,4	596,1	36,8	592,0	44,8	601,5	26,1	597,5	33,9	592,0	44,8
700	28″	719,4	699,6	39,7	695,2	49,7	690,0	61,3	701,4	35,2	696,8	45,9	690,0	61,3
800	32″	821,4	799,2	51,5	794,3	64,3	788,3	79,8	801,3	45,8	796,1	59,3	788,3	79,8
900	36″	923,4	898,9	64,9	893,4	81,0	886,8	100,3	901,2	57,6	895,1	75,7	886,8	100,3
1000	40″	1025,4	998,5	80,0	992,5	99,3	984,9	124,0	1001,1	70,7	994,3	93,1	984,9	124,0
1100	44″	1127,4	1098,1	96,6	1091,6	120,0	1083,1	150,1	1101,1	85,1	1093,6	112,2	1083,1	150,1
1200	48″	1229,4	1197,8	114,2	1190,8	141,9	1181,5	177,8	1201,0	100,8	1192,8	133,3	1181,5	177,8
1300	52″	1331,4	1297,4	134,0	1289,6	167,3	1279,8	208,5	1301,0	117,8	1292,1	155,9	1279,8	208,5
1400	56″	1433,4	1397,2	154,8	1388,7	193,4	1378,1	241,2	1400,9	136,3	1391,5	180,1	1378,1	241,2
1500	60″	1535,4	1497,0	176,6	1487,6	222,2	1476,5	275,8	1501,0	155,7	1490,7	206,4	1476,5	275,8
1600	64″	1637,4	1596,5	201,2	1586,8	251,9	1574,7	314,2	1600,8	77,2	1589,9	234,7	1574,7	314,2
1700	68″	1739,4	1695,9	228,6	1685,8	284,4	1673,2	353,6	1700,8	199,5	1689,2	264,4	1673,2	353,6
1800	72″	1841,4	1795,6	255,8	1784,8	318,5	1771,4	396,3	1800,8	223,2	1788,5	296,0	1771,4	396,3
1900	76″	1943,4	1895,3	283,9	1884,0	354,0	1869,7	441,3	1900,8	247,9	1887,8	329,4	1869,7	441,3
2000	80″	2045,4	1995,0	314,4	1983,1	391,3	1968,2	487,6	2000,7	274,7	1987,0	364,6	1968,2	487,6
2100	84″	2147,4	2094,7	346,2	2082,2	431,3	2066,5	537,5	2100,6	302,3	2086,3	401,4	2066,5	537,5
2200	88″	2249,4	2194,3	379,4	2181,2	473,1	2164,8	589,5	2200,6	331,3	2185,6	440,2	2164,8	589,5
2300	92″	2351,4	2294,0	414,3	2280,4	515,9	2263,2	643,2	2300,5	362,0	2284,8	481,4	2263,2	643,2
2400	96″	2453,4	2393,7	450,7	2379,5	561,3	2361,6	699,4	2400,6	393,2	2384,1	523,4	2361,6	699,4
2500	100″	2555,4	2493,5	487,6	2478,4	609,7	2459,8	759,6	2500,5	426,6	2483,3	567,6	2459,8	759,6
2600	104″	2657,4	2593,0	528,0	2577,5	658,7	2558,1	821,4	2600,4	460,8	2582,7	613,0	2558,1	821,4
2700	108″	2759,4	2692,7	569,0	2676,7	708,9	2656,5	885,0	2700,4	496,4	2681,9	660,8	2656,5	885,0
2800	112″	2861,4	2792,5	610,4	2775,7	762,7	2754,8	951,8	2800,4	533,7	2781,1	710,7	2754,8	951,8
2900	116″	2963,4	2892,1	654,7	2874,7	818,3	2853,3	1018,8	2900,3	571,9	2880,5	761,5	2853,3	1018,8
3000	120″	3065,4	2991,7	701,3	2973,9	874,6	2951,5	1090,9	3000,3	611,9	2979,8	814,4	2951,5	1090,9
3100	124″	3167,4	3091,5	746,4	3073,0	932,9	3049,9	1163,8	3100,3	652,0	3078,9	870,3	3049,9	1163,8
3200	128″	3269,4	3191,2	795,7	3172,1	993,6	3148,1	1240,4	3200,2	694,7	3178,2	926,5	3148,1	1240,4
3300	132″	3371,4	3290,8	846,6	3271,1	1056,9	3248,0	1303,8	3300,2	738,7	3277,5	985,3	3248,0	1303,8
3400	136″	3473,4	3390,5	897,4	3370,1	1122,0	3347,9	1367,2	3400,1	784,0	3376,8	1044,5	3347,9	1367,2
3500	140″	3575,4	3490,1	951,1	3469,3	1187,2	3450,0	1408,1	3500,1	829,9	3476,0	1107,7	3450,0	1408,1
3600	144″	3677,4	3589,8	1006,2	3568,5	1254,5	3551,7	1449,0	3600,0	878,2	3575,3	1171,1	3551,7	1449,0
3700	148″	3779,4	3689,4	1062,4	3667,4	1327,1	3650,4	1530,9	3700,0	926,9	3674,5	1237,0	3650,4	1530,9
3800	152″	3881,4	3789,3	1118,2	3766,5	1399,2	3749,0	1612,8	3799,9	977,5	3773,8	1304,5	3749,0	1612,8
3900	156″	3983,4	3888,8	1178,8	3865,6	1472,6	3853,9	1613,7	3899,9	1029,4	3873,1	1373,5	3853,9	1613,7
4000	160″	4085,4	3988,4	1240,6	3964,7	1548,9	3958,8	1614,6	3999,9	1081,6	3972,4	1443,9	3958,8	1610,8

SUBOR PIPE DIMENSIONS

PRESSURE CLASS			PN16						PN20					
STIFFNESS CLASS			SN2500 N/m²		SN5000 N/m²		SN10000 N/m²		SN2500 N/m²		SN5000 N/m²		SN10000 N/m²	
DN (mm)	Inch	OD_{max} (mm)	ID_{min} (mm)	W_{min} (kg/m)	ID_{min} (mm)	W_{min} (kg/m)	ID_{min} (mm)	W_{min} (kg/pm)	ID_{min} (mm)	W_{min} (kg/m)	ID_{min} (mm)	W_{min} (kg/m)	ID_{min} (mm)	W_{min} (kg/m)
250	10″	272,5					258,7	11,0						
300	12″	324,9	315,1	7,2	313,4	9,0	311,0	11,5	316,1	7,2	314,5	9,9	312,3	11,2
350	14″	376,8	366,0	9,6	364,0	12,0	361,2	15,4	367,0	9,6	365,2	11,8	362,6	14,9
400	16″	427,7	416,0	12,2	413,7	15,3	410,5	19,7	416,9	12,2	414,7	15,2	411,8	19,2
450	18″	478,6	465,8	15,3	463,4	19,0	460,1	24,0	466,8	15,1	464,4	18,8	461,1	23,9
500	20″	530,5	516,7	18,6	513,8	23,5	510,0	30,0	517,8	18,3	515,1	22,9	511,4	29,2
600	24″	617,4	602,0	24,8	598,6	31,4	593,9	40,7	603,0	24,5	599,9	30,7	595,7	39,1
700	28″	719,4	702,0	33,2	698,1	42,3	692,7	54,9	703,1	32,8	699,5	41,2	694,5	52,8
800	32″	821,4	802,1	42,9	797,7	54,7	791,5	71,0	803,3	42,4	799,1	53,3	793,4	68,3
900	36″	923,4	902,2	53,8	897,2	68,8	890,2	89,6	903,4	53,1	898,7	67,0	892,3	86,0
1000	40″	1025,4	1002,3	65,9	996,7	84,4	988,9	110,1	1003,5	65,0	998,3	82,1	991,2	105,6
1100	44″	1127,4	1102,4	79,3	1096,3	101,6	1087,7	132,7	1103,6	78,1	1097,9	98,9	1090,1	127,3
1200	48″	1229,4	1202,5	93,9	1195,8	120,3	1186,4	157,5	1203,7	92,5	1197,5	117,1	1189,0	150,8
1300	52″	1331,4	1302,6	109,7	1295,4	140,7	1285,2	184,0	1303,8	108,0	1297,1	136,9	1287,8	176,6
1400	56″	1433,4	1402,7	126,7	1394,9	162,8	1383,9	213,3	1403,9	124,7	1396,7	158,3	1386,7	204,5
1500	60″	1535,4	1502,8	145,0	1494,4	186,3	1482,7	244,4	1504,1	142,6	1496,3	181,1	1485,6	234,1
1600	64″	1637,4	1602,9	164,5	1594,0	211,5	1581,4	277,5	1604,2	161,8	1595,9	205,6	1584,4	265,9
1700	68″	1739,4	1703,0	185,1	1693,5	238,4	1680,2	312,7	1704,3	182,1	1695,5	231,5	1683,3	299,6
1800	72″	1841,4	1803,1	207,1	1793,1	266,6	1778,9	350,4	1804,4	203,7	1795,1	259,0	1782,2	335,4
1900	76″	1943,4	1903,2	230,2	1892,6	296,5	1877,7	389,5	1904,5	226,4	1894,7	288,2	1881,1	373,1
2000	80″	2045,4	2003,3	254,5	1992,1	328,3	1976,4	431,2	2004,6	250,4	1994,3	318,7	1980,0	412,8
2100	84″	2147,4	2103,4	280,2	2091,7	361,3	2075,2	474,9	2104,8	275,5	2093,9	350,8	2078,9	454,7
2200	88″	2249,4	2203,5	307,0	2191,2	396,1	2173,9	520,7	2204,9	301,9	2193,5	385,8	2177,8	498,3
2300	92″	2351,4	2303,6	335,0	2290,7	432,4	2272,6	569,0	2305,0	329,6	2293,1	419,8	2276,6	544,3
2400	96″	2453,4	2403,7	364,3	2390,3	470,5	2371,4	619,0	2405,1	358,2	2392,7	456,0	2375,5	592,0
2500	100″	2555,4	2503,8	394,7	2489,8	509,8	2470,1	671,4	2505,2	388,9	2492,3	495,0	2474,4	643,1
2600	104″	2657,4	2603,8	426,6	2589,3	551,2	2568,9	725,1	2605,3	419,3	2591,9	535,6	2573,3	693,7
2700	108″	2759,4	2704,0	459,3	2688,9	594,0	2667,6	782,1	2705,5	451,5	2691,5	576,1	2672,1	747,9
2800	112″	2861,4	2804,0	493,7	2788,4	638,3	2766,4	840,1	2805,6	485,2	2791,1	619,3	2771,0	804,0
2900	116″	2963,4	2904,1	528,6	2888,0	683,8	2865,1	901,2	2905,7	520,0	2890,7	663,7	2869,9	861,8
3000	120″	3065,4	3004,2	565,7	2987,5	732,6	2963,9	964,8	3005,8	556,8	2990,3	709,8	2968,8	921,9
3100	124″	3167,4	3104,3	605,4	3087,0	780,7	3062,7	1028,1						
3200	128″	3269,4	3204,4	642,5	3186,6	831,3	3161,4	1095,5						
3300	132″	3371,4	3304,5	682,8	3286,1	883,5	3260,1	1164,3						
3400	136″	3473,4	3404,6	724,3	3385,6	937,5	3358,9	1235,8						
3500	140″	3575,4	3504,7	767,1	3485,2	995,1	3457,6	1310,3						
3600	144″	3677,4	3604,8	811,1	3584,7	1049,8	3556,3	1380,8						
3700	148″	3779,4	3704,9	856,3	3684,2	1109,9	3655,1	1458,5						
3800	152″	3881,4	3805,0	902,7	3783,8	1168,9	3753,8	1536,2						
3900	156″	3983,4												
4000	160″	4085,4												

subor®

SUBOR PIPE DIMENSIONS									
PRESSURE CLASS			PN25				PN32	
STIFFNESS CLASS			SN5000 N/m²		SN10000 N/m²		SN10000 N/m²	
DN (mm)	Inch	OD_{max} (mm)	ID_{min} (mm)	W_{min} (kg/m)	ID_{min} (mm)	W_{min} (kg/m)	ID_{min} (mm)	W_{min} (kg/pm)
250	10″	272,5						
300	12″	324,9	314,5	8,9	312,5	11,0	312,5	10,9
350	14″	376,8	365,1	11,8	362,7	14,7	362,9	14,5
400	16″	427,7	414,8	15,0	412,1	18,8	412,3	18,4
450	18″	478,6	464,5	18,5	461,5	23,3	461,7	22,8
500	20″	530,5	515,2	22,6	511,8	28,4	512,0	27,9
600	24″	617,4	600,1	30,2	596,1	38,1	596,4	37,3
700	28″	719,4	699,7	40,6	695,1	51,3	695,4	50,2
800	32″	821,4	799,3	52,4	794,0	66,4	794,4	65,0
900	36″	923,4	899,0	65,8	893,0	83,5	893,4	81,7
1000	40″	1025,4	998,6	80,8	992,0	102,5	992,4	100,3
1100	44″	1127,4	1098,2	97,2	1090,9	123,5	1091,5	120,8
1200	48″	1229,4	1197,8	115,0	1189,9	146,5	1190,5	143,2
1300	52″	1331,4	1297,5	134,5	1288,9	171,2	1289,5	167,5
1400	56″	1433,4	1397,1	155,5	1387,8	198,1	1388,5	193,7
1500	60″	1535,4	1496,7	178,0	1486,8	226,9	1487,5	221,8
1600	64″	1637,4	1596,4	202,0	1585,8	257,6	1586,6	251,4
1700	68″	1739,4	1696,0	227,4	1684,7	290,3	1685,6	284,2
1800	72″	1841,4	1795,6	254,9	1783,7	324,9	1784,6	317,5
1900	76″	1943,4	1895,2	283,7	1882,7	361,4		
2000	80″	2045,4	1994,9	313,0	1981,6	400,9		
2100	84″	2147,4	2094,5	344,5	2080,6	440,6		
2200	88″	2249,4	2194,1	377,5	2179,6	483,6		
2300	92″	2351,4	2293,8	412,1	2278,5	527,4		
2400	96″	2453,4	2351,6	470,7	2377,5	573,7		
2500	100″	2555,4						
2600	104″	2657,4						
2700	108″	2759,4						
2800	112″	2861,4						
2900	116″	2963,4						
3000	120″	3065,4						
3100	124″	3167,4						
3200	128″	3269,4						
3300	132″	3371,4						
3400	136″	3473,4						
3500	140″	3575,4						
3600	144″	3677,4						
3700	148″	3779,4						
3800	152″	3881,4						
3900	156″	3983,4						
4000	160″	4085,4						

SUBOR DOUBLE BELL REKA PRESSURE COUPLING DIMENSIONS

PRESSURE CLASS				PN6		PN10		PN16		PN20		PN25		PN32	
DN (mm)	DN Inch	ID min	Length (mm)	OD nom (mm)	W min (kg/pcs)	OD nom (mm)	W min (kg/pcs)	OD nom (mm)	W min (kg/pcs)	OD nom (mm)	W min (kg/pcs)	OD nom (mm)	W min (kg/pcs)	OD nom (mm)	W min (kg/pcs)
300	12"	326,0	270,0	366,0	10,9	366,9	11,1	368,1	11,5	368,6	11,7	369,2	11,7	375,9	13,7
350	14"	377,9	270,0	417,8	12,4	418,9	12,8	420,3	13,3	420,3	13,3	421,6	13,6	428,4	16,0
400	16"	428,8	270,0	468,6	14,0	469,9	14,5	472,4	15,6	471,6	15,2	472,6	15,6	479,6	18,2
450	18"	479,7	270,0	519,1	15,6	520,7	16,3	522,7	17,1	522,9	17,1	524,0	17,5	531,2	20,6
500	20"	531,6	270,0	570,9	17,2	572,5	17,9	574,3	18,7	575,6	19,4	576,9	20,0	582,9	22,7
600	24"	618,5	330,0	664,2	28,6	665,7	29,6	668,0	31,0	670,2	32,5	673,1	34,3	680,2	39,0
700	28"	720,5	330,0	765,8	32,8	768,1	34,5	772,5	37,8	773,0	38,0	776,0	40,1	785,4	47,4
800	32"	822,5	330,0	867,6	37,1	871,7	40,6	876,7	44,9	877,5	45,2	881,4	48,5	896,5	61,6
900	36"	924,5	330,0	970,6	42,5	975,1	46,8	978,2	49,1	980,7	51,1	986,5	56,6	1002,9	72,7
1000	40"	1026,5	330,0	1073,5	48,1	1078,3	53,1	1081,9	56,1	1084,8	58,8	1097,1	72,0	1113,4	89,6
1100	44"	1128,5	330,0	1176,2	53,5	1181,4	59,5	1185,6	63,4	1190,2	68,4	1205,6	86,5	1221,5	105,4
1200	48"	1230,5	330,0	1278,8	58,9	1284,3	66,0	1289,1	70,9	1297,8	81,6	1312,4	100,2	1328,1	120,6
1300	52"	1332,5	330,0	1381,3	64,5	1387,2	72,4	1392,6	78,6	1404,1	93,9	1418,3	113,6	1433,7	135,1
1400	56"	1434,5	330,0	1483,7	69,9	1490,0	78,8	1497,4	88,6	1509,5	106,1	1523,5	126,7	1538,5	149,3
1500	60"	1536,5	330,0	1586,2	75,4	1592,8	85,5	1602,8	100,1	1614,4	118,0	1628,1	139,8	1642,8	163,3
1600	64"	1638,5	330,0	1688,6	81,2	1695,5	92,3	1707,6	111,3	1718,9	129,8	1732,4	152,5	1746,6	176,8
1700	68"	1740,5	330,0	1791,0	86,9	1798,2	99,3	1812,0	122,3	1823,0	141,4	1836,3	165,2	1850,2	190,3
1800	72"	1842,5	330,0	1893,4	92,7	1900,9	106,2	1916,0	133,1	1926,9	153,1	1939,7	177,5		
1900	76"	1944,5	330,0	1995,8	98,4	2004,4	114,9	2019,8	144,1	2030,5	164,5	2042,9	189,4		
2000	80"	2046,5	330,0	2098,2	104,3	2108,0	124,2	2123,4	154,8	2134,0	176,2	2146,0	201,2		
2100	84"	2148,5	330,0	2200,6	110,4	2211,5	133,6	2226,8	165,4	2237,3	187,4	2248,8	212,7		
2200	88"	2250,5	330,0	2303,0	116,5	2314,8	142,6	2330,1	176,1	2340,5	199,1	2351,6	224,5		
2300	92"	2352,5	330,0	2405,4	122,5	2418,0	151,7	2433,2	186,5	2443,5	210,4	2454,3	236,1		
2400	96"	2454,5	330,0	2507,8	128,7	2521,1	161,1	2536,3	197,1	2546,5	221,7	2556,9	247,7		
2500	100"	2556,5	330,0	2610,1	135,1	2624,1	170,2	2639,3	207,7	2649,0	232,2				
2600	104"	2660,5	360,0	2729,9	199,5	2740,6	230,6	2753,7	265,5	2766,9	302,7				
2700	108"	2762,5	360,0	2832,6	209,0	2843,2	241,4	2856,4	277,4	2871,1	320,8				
2800	112"	2864,5	360,0	2935,2	218,8	2945,8	252,0	2959,1	289,9	2975,4	339,6				
2900	116"	2966,5	360,0	3037,8	228,5	3048,4	262,7	3061,5	301,4	3079,6	358,8				
3000	120"	3068,5	360,0	3140,4	238,2	3150,9	273,2	3163,8	312,3	3183,9	378,8				
3100	124"	3170,5	380,0	3242,5	259,7	3253,1	298,5	3268,3	349,7						
3200	128"	3272,5	380,0	3345,0	270,2	3355,6	310,2	3372,0	367,4						
3300	132"	3374,5	380,0	3447,5	280,1	3458,1	321,7	3475,8	385,7						
3400	136"	3476,5	380,0	3550,0	290,8	3560,6	333,2	3579,6	408,8						
3500	140"	3578,5	380,0	3652,5	300,9	3663,1	344,6	3683,4	428,1						
3600	144"	3680,5	380,0	3755,0	311,9	3765,5	356,5								
3700	148"	3782,5	380,0	3857,4	322,2	3868,0	368,0								
3800	152"	3884,5	380,0	3959,8	332,6	3970,4	379,7								
3900	156"	3986,5	380,0	4062,2	342,9	4072,8	391,4								
4000	160"	4088,5	380,0	4164,6	353,5	4175,2	403,2								

GRAVITY SEWER PIPE & COUPLING DIMENSIONS

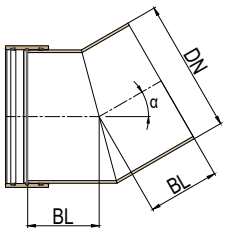
PRESSURE CLASS / STIFFNESS CLASS		GRAVITY SEWER PIPE						GRAVITY SEWER COUPLING			
		SN2500 N/m²		SN5000 N/m²		SN10000 N/m²					
DN (mm)	DN inch	OD max (mm)	ID min (mm)	W min (kg/m)	ID min (mm)	W min (kg/m)	ID min (mm)	W min (kg/m)	OD nom (mm)	Length (mm)	ID min (mm)	W min (kg/pcs)
250	10″	272,3					258,5	11,1	304,0	175,0	275,1	4,1
300	12″	324,9	313,6	9,9	311,5	12,3	308,4	15,8	356,1	240,0	327,5	6,9
350	14″	376,8	364,2	13,2	361,7	16,5	358,1	21,3	417,8	240,0	379,4	8,0
400	16″	427,7	413,7	17,0	410,9	21,3	407,2	26,9	458,9	240,0	430,3	9,0
450	18″	478,6	463,4	21,3	460,2	26,9	456,0	33,8	509,8	240,0	481,2	10,0
500	20″	530,5	513,9	26,4	510,6	32,6	505,9	41,5	561,7	240,0	533,1	11,0
600	24″	617,4	598,5	36,0	594,6	44,5	589,2	56,2	649,2	240,0	620,0	13,1
700	28″	719,4	698,0	48,4	693,3	60,4	686,8	76,8	752,4	240,0	722,0	15,9
800	32″	821,4	797,4	63,3	792,2	78,1	784,2	101,3	855,4	240,0	824,0	18,7
900	36″	923,4	896,6	80,2	891,2	97,8	881,7	129,5	958,2	240,0	926,0	21,5
1000	40″	1025,4	996,3	97,8	990,0	120,1	981,6	151,5	1060,8	240,0	1028,0	24,2
1100	44″	1127,4	1095,9	117,1	1088,5	146,4	1079,6	182,4	1163,2	240,0	1130,0	26,9
1200	48″	1229,4	1195,0	140,2	1187,4	174,7	1177,6	215,9	1278,8	270,0	1230,5	48,2
1300	52″	1331,4	1294,2	164,9	1285,9	205,3	1275,8	252,0	1381,3	270,0	1332,5	52,8
1400	56″	1433,4	1393,8	191,8	1384,9	236,9	1373,7	292,2	1483,7	270,0	1434,5	57,2
1500	60″	1535,4	1493,3	219,4	1483,7	270,6	1471,7	334,8	1586,2	270,0	1536,5	61,7
1600	64″	1637,4	1592,6	250,0	1582,4	308,3	1569,8	379,5	1688,6	270,0	1638,5	66,5
1700	68″	1739,4	1692,0	281,2	1680,9	348,6	1667,7	428,3	1791,0	270,0	1740,5	71,1
1800	72″	1841,4	1791,4	315,2	1779,8	389,5	1765,7	479,2	1893,4	270,0	1842,5	75,8
1900	76″	1943,4	1890,9	349,1	1878,7	432,6	1863,6	533,9	1995,8	270,0	1944,5	80,5
2000	80″	2045,4	1990,2	388,1	1977,6	477,6	1961,6	591,1	2098,2	270,0	2046,5	85,4
2100	84″	2147,4	2089,6	426,8	2076,4	526,3	2059,6	650,6	2200,6	270,0	2148,5	90,3
2200	88″	2249,4	2189,1	467,4	2175,2	576,5	2157,7	713,0	2303,0	270,0	2250,5	95,3
2300	92″	2351,4	2288,3	511,7	2273,8	631,2	2255,5	780,3	2405,4	270,0	2352,5	100,2
2400	96″	2453,4	2387,9	555,5	2372,7	685,7	2353,7	846,7	2507,8	270,0	2454,5	105,3
2500	100″	2555,4	2487,4	600,8	2471,1	746,6	2451,8	918,2	2610,1	270,0	2556,5	110,5
2600	104″	2657,4	2586,6	651,2	2569,9	806,5	2549,4	995,3	2729,9	300,0	2660,5	166,2
2700	108″	2759,4	2686,2	700,7	2668,8	868,0	2647,4	1072,1	2832,6	300,0	2762,5	174,1
2800	112″	2861,4	2785,3	755,1	2767,6	932,3	2745,4	1152,9	2935,2	300,0	2864,5	182,3
2900	116″	2963,4	2884,8	808,6	2866,5	997,9	2847,4	1192,6	3037,8	300,0	2966,5	190,4
3000	120″	3065,4	2984,4	863,1	2965,4	1065,5	2949,4	1232,3	3140,4	300,0	3068,5	198,5

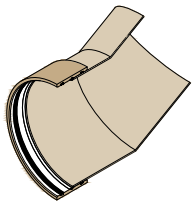
*Please get in contact with SUBOR for other diameter pipes' dimensions.

SUBOR STANDARD ELBOW DIMENSIONS

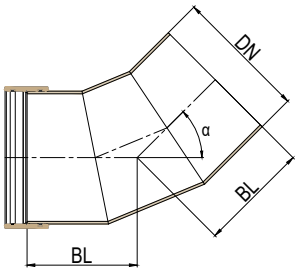
NO.OF MITERS		1				2		3
ELBOW DEGREE *		11.25°	15°	22.5°	30°	45°	60°	90°
DN mm	inch	BL						
100	4″	250	250	250	250	250	300	350
125	5″	250	250	250	250	300	300	400
150	6″	250	250	250	250	300	300	400
200	8″	250	250	250	300	350	400	500
250	10″	250	300	300	300	400	450	600
300	12″	350	350	400	400	500	550	750
350	14″	400	400	400	450	550	600	800
400	16″	450	450	450	450	600	650	900
450	18″	450	450	500	500	600	700	1000
500	20″	450	450	500	500	650	750	1050
600	24″	400	400	450	450	600	700	1100
700	28″	400	400	450	450	650	800	1200
800	32″	450	450	450	500	700	850	1350
900	36″	450	450	500	550	800	950	1500
1000	40″	450	500	500	550	850	1000	1650
1100	44″	450	500	550	600	900	1100	1800
1200	48″	500	550	600	600	950	1200	1950
1300	52″	500	600	650	700	1050	1300	2100
1400	56″	600	600	650	700	1100	1350	2250
1500	60″	600	650	700	750	1200	1450	2400
1600	64″	650	700	750	800	1250	1550	2550
1700	68″	650	700	800	800	1300	1600	2700
1800	72″	650	750	800	850	1350	1700	2850
1900	76″	700	750	800	850	1400	1750	2950
2000	80″	700	750	800	900	1450	1800	3100
2100	84″	700	750	800	900	1500	1850	3200
2200	88″	700	750	800	900	1550	1950	3350
2300	92″	700	750	800	950	1550	2000	3450
2400	96″	700	750	800	1000	1550	2100	3600
2500	100″	700	750	800	1000	1600	2200	3750
2600	104″	700	800	900	1000	1700	2200	3800
2700	108″	800	800	900	1000	1800	2200	4000
2800	112″	800	800	900	1000	1800	2300	4100
2900	116″	800	800	900	1000	1900	2400	4200
3000	120″	800	800	900	1100	1900	2400	4300
3100	124″	800	800	1000	1100	2000	2500	4500
3200	128″	800	900	1000	1100	2000	2600	4600
3300	132″	800	900	1000	1100	2100	2600	4700
3400	136″	800	900	1000	1100	2100	2700	4900
3500	140″	800	900	1000	1100	2200	2800	5000
3600	144″	900	900	1000	1200	2200	2800	5100
3700	148″	900	900	1100	1200	2300	2900	5200
3800	152″	900	900	1100	1200	2300	3000	5400
3900	156″	900	1000	1100	1200	2400	3000	5500
4000	160″	900	1000	1100	1300	2400	3100	5600

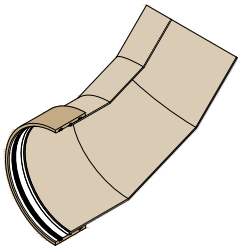
ONE MITER 0-30º



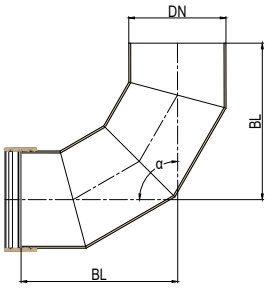


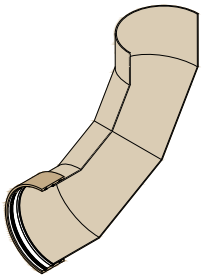
TWO MITER 30-60º





THREE MITER 60-90º





CHEMICAL RESISTANCE TABLE	Standard Resin	Vinyl Ester Only
Acetic Acid < 20%		X
Adipic Acid		X
Alum (Aluminum Potassium Sulfate)	X	
Aluminum Chloride, Aqueous	X	
Ammonia, Aqueous < 20%		X
Ammonium Chloride, Aqueous (40°C)		
Ammonium Nitrate, Aqueous (40°C)	X	
Ammonium Phosphate-Monobasic, Aqueous	X	
Ammonium Sulfate, Aqueous	X	
Aniline Hydrochloride		X
Barium Carbonate		X
Barium Chloride		X
Barium Sulfate		X
Beet Sugar Liquor		X
Benzene Sulfonic Acid (10%) *		X
Benzoic Acid *		X
Black Liquor (Paper)		X
Borax (40°C)	X	
Boric Acid		X
Bromine, Aqueous (5%) *		X
Butyric Acid < 25% (40°C)*		X
Calcium Bisulfide *	X	
Calcium Carbonate	X	
Calcium Chlorate, Aqueous (40°C)	X	
Calcium Chloride (Saturated) (40°C)	X	
Calcium Hydroxide, 100%		X
Calcium Hypochlorite *		X
Calcium Nitrate (40°C)	X	
Calcium Sulfate NL AOC	X	
Cane Sugar Liquor		X
Carbon Dioxide, Aqueous	X	
Casein	X	
Caustic Potash (KOH) (40°C)		X
Chlorine, Dry Gas *		X

CHEMICAL RESISTANCE TABLE	Standard Resin	Vinyl Ester Only
CHLORINE, WATER *		X
CHLORINE, WET GAS *		X
CITRIC ACID, AQUEOUS		X
COPPER ACETATE, AQUEOUS (40°C)	X	
COPPER NITRATE, AQUEOUS (40°C)	X	
COPPER SULFATE, AQUEOUS (40°C)	X	
CRUDE OIL (SOUR) (30°C) *	X	
CRUDE OIL (SWEET) (30°C) *	X	
CRUDE OIL, SALT WATER (25°C) *		X
CYCLOHEXANE (40°C) *		X
CYCLOHEXANOL (30°C) *		X
FUEL OIL (25°C) *	X	
GASOLINE, ETHYL *		X
GLYCERINE		X
GREEN LIQUOR, PAPER		X
HEXANE *		X
HYDROCHLORIC ACID, UP TO 15%	X	
KEROSENE *		X
LACTIC ACID, 10% (30°C)	X	
LEAD ACETATE, AQUEOUS (25°C)	X	
LEAD NITRATE, AQUEOUS (25°C)	X	
LINSEED OIL *	X	
LITHIUM BROMIDE, AQUEOUS (40°C) *	X	
LITHIUM CHLORIDE, AQUEOUS (40°C) *	X	
MAGNESIUM BICARBONATE, AQUEOUS (30°C) *	X	
MAGNESIUM CARBONATE (40°C) *	X	X
MAGNESIUM SULFATE	X	
MAGNESIUM CHLORIDE, AQUEOUS (25°C) *	X	
MANGANESE CHLORIDE, AQUEOUS (40°C) *	X	
MANGANESE SULFATE, AQUEOUS (40°C) *	X	
MINERAL OIL *	X	
N-HEPTANE (25°C) *	X	
NAPHTHALENE (30°C) *	X	
NAPTHA *		X

CHEMICAL RESISTANCE TABLE	Standard Resin	Vinyl Ester Only
Oleic Acid (40°C)	X	
Oxalic Acid, Aqueous		X
Paraffin (30°C) *	X	
Perchloric Acid (25°C)		X
Petroleum, Refined & Sour *		X
Phosphoric Acid		X
Potassium Nitrate, Aqueous (40°C)	X	
Potassium Sulfate (40°C)	X	
Propylene Glycol (30°C)	X	
Sea Water (40°C)	X	
Sewage (50°C)	X	
Silicone Oil (40°C)	X	
Silver Nitrate, Aqueous (40°C)	X	
Sodium Hydroxide 10%		X
Sodium Mono-Phosphate		X
Sodium Nitrate, Aqueous (40°C)	X	
Sodium Nitrite, Aqueous (40°C)*	X	
Sodium Silicate		X
Sodium Sulfide		X
Sodium Tetraborate		X
Stannous Chloride, Aqueous (40°C)	X	
Stearic Acid, Aqueous (40°C)*	X	
Sulfuric Acid, < 25% (25°C)*	X	
Tannic Acid, Aqueous (35°C)	X	
Tartaric Acid (30°C)	X	
Triethylamine (40°C) *		X
Turpentine *		X
Urea, Aqueous (30°C) *	X	
Vinegar (25°C)	X	
Water, Distilled (40°C)	X	
Water, Sea (40°C)	X	
Water, Tap (40°C)	X	
Zinc Chloride, Aqueous (40°C)	X	

*Please get in contact with SUBOR for further clarification about resin type selection by taking into account the operational conditions in the project.

"The data presented in the Technical Data section of this brochure is not binding SUBOR and have to be individually checked prior to use. SUBOR does not accept any responsibility for the typing errors in publishing this brochure."

SUBOR Milestones

1996 SUBOR was established as an equal partnership between Yapı Merkezi and Owens Corning

1997 The first production line developed by Flowtite Technology was launched in Sakarya Plant

1998 The second production line developed by Flowtite Technology was installed in Sakarya Plant

1999 ISO9001 certificate has been approved

2000 SUBOR GAP Plant was set up in Şanlıurfa with one Flowtite Technology winder

2001 The partnership structure has changed and SUBOR became an equal partnership between Yapı Merkezi and Amiantit Groups

2008 The new fitting facility was built in Sakarya Plant

2009 The third production line developed by Flowtite Technology capable to produce up to 4 meters diameter was launched in Sakarya Plant

2010 The laboratories have been internationally accredited by TURKAK

2019 Yapı Merkezi became the mother company by increasing its shares to %80 and SUBOR continues the production with its own superior technology

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