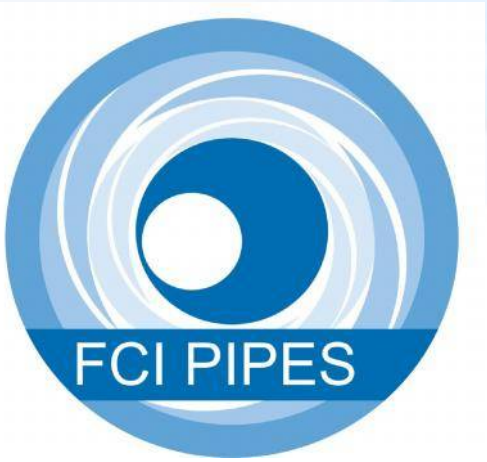
GRP PIPES



Revised Edition 2

INTRODUCTION

FIBRE CRAFT INDUSTRIES is providing fiberglass reinforced plastic molded products since 1985. It is the pioneer setup of its kind for polymeric composites.

Fiberglass based polymeric composites are usually known as FRP or GRP. We are fabricating different type of composite products for industrial, civil and many other engineering applications; waterproof metering cabinets, gratings, fluid storage tanks, Chemical transfer pumps, live line working safety tools, switchgear operating rods, disconnecting sticks, ladders, porta cabins and a vast range of customized products.

FCI produces best quality pipes and allied fittings up to and including **2400 mm** diameter presently. **McCLEAN ANDERSON** is the world leader in Filament Winding technology and ***FCI PIPE*** is fabricated by state of the art **McCLEAN ANDERSON's** Filament Winding equipment. Filament wound pipe provides excellent chemical and mechanical properties and are more durable and long lasting.

Besides, plastic pipes can also be reinforced by fiberglass for transportation of high pressure corrosive fluids that need corrosion barrier other than GRP.

FCI has a comprehensive and competent in-house technical advisory service, which includes on-site installation assistance or only technical services when required.

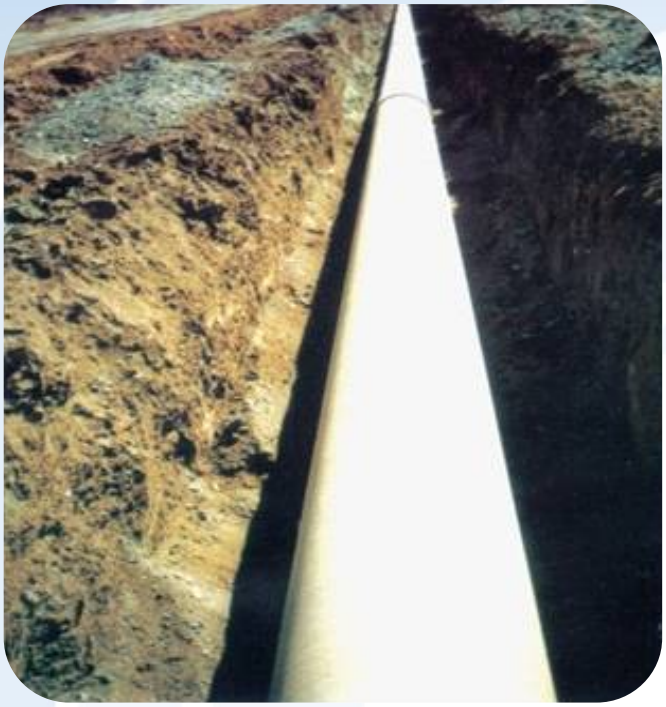
FCI PIPE provides a unique combination of high strength, light weight and corrosion resistance; which has established its use as the most versatile piping system yet produced.

PRELUDE

Before industrialization, human beings were living in real environment friendly atmosphere. Even two decades ago, we were not using as much synthetics in our life as in present age. It has become an essential component of our everyday living. Soaps, Shampoos, different types of detergents, various types of acidic and alkaline toilet cleaners, laundry and household cleaning agents, petrochemicals and solvents are used abundantly in our modern industrialized life style. All of these chemicals have direct or indirect interaction with waterlines either these are for drinking water or for sewerage disposal. All of these chemicals and water itself causes corrosion.

Corrosion is a worldwide problem and it is a major cause of aging to municipal infrastructure. And where an aging infrastructure is not a problem, it is generally because there is no infrastructure, or yet it remains to be constructed in many developing countries. Concrete sewer pipes are rapidly deteriorated by the presence of sulfuric acid in a sanitary sewer system, which is generated through the hydrogen sulfide cycle. It is a natural Phenomenon. Mostly in case of concrete & metallic pipe lines of gravity flow sewers, especially in case of low flow sewers, crown failure is experienced. Where as inbuilt corrosion resistance characteristics of ***FCI PIPE*** **(Fiberglass Reinforced Thermosetting Resin Pipe, GRP or FRP)** prohibit such incidents.

Externally, soil conditions and stray electric currents slowly deteriorate underground metallic pipes. Metallic pipes can corrode when placed on poorly drained soils of low resistivity. The presence of sulfate- reducing bacteria will accelerate this corrosion. These problems can be significantly reduced, if not eliminated, by the careful selection of pipeline's materials. Just think in advance about the consequences of corrosion in the future. Remember, that corrosion is not a reversible process. The remedy to this situation is very simple; select a material immune to galvanic, electrolytic and all sort of chemical corrosion, ***FCI PIPE*** **(Fiberglass Reinforced Thermosetting Resin Pipe, GRP or FRP)** is the ideal choice for water supply system. It's proven resistance to the acidic environment found in a sanitary sewer speaks well for its use in waste water applications as well, in addition to pot water forced mains. GRP Pipe has been the material of choice in developed countries and most of Asian sewers, known to be the most aggressive in the world, since last many decades.



METHOD OF MANUFACTURE

FCI PIPE systems have been tested and approved for the conveyance of raw water meeting many of the world's leading authorities' and testing institutes' criteria, including: international and national standards **1)AWWA, 2)ASTM 3)ISO**

FCI PIPE is filament wound on a fixed length, rotating mandrel. This process of manufacturing enables continuous glass fiber filaments to be placed precisely at the desired angle, forming a double helix pattern, to provide the customer with the exact product for his application. The resin systems used in the process are chosen for the particular application.

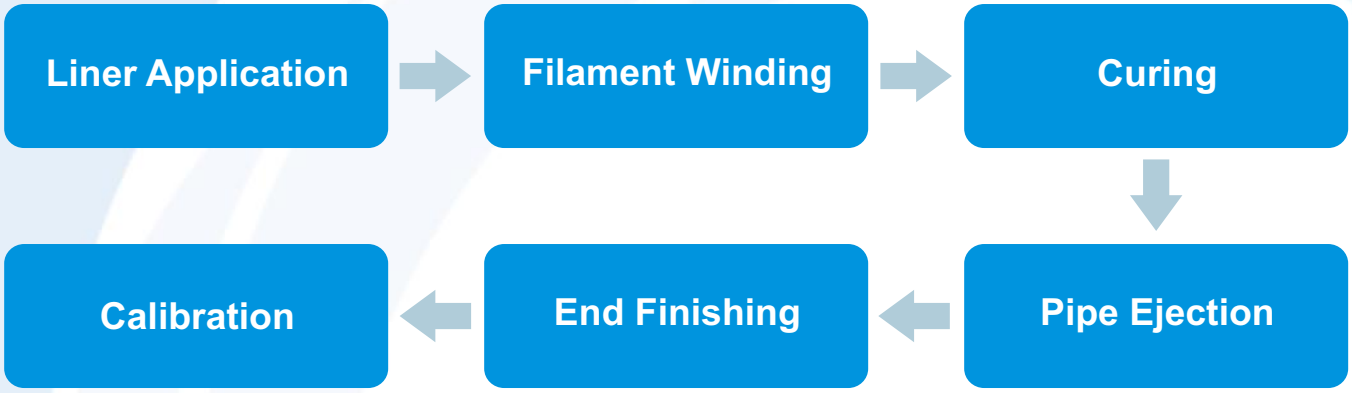
The liner inner of the pipe is applied by hand and allowed to gel, so that it can be inspected before the structural helical winding begins on state of the art computerized filament winding machine. This process ensures the highest quality of the important corrosion resistant liner.

The resulting pipe laminate is allowed to cure fully on the mandrel before being removed and cut to the exact length, to ensure dimensional stability.

Pipe end preparation according to the joint required is carried out and the pipe, now complete is sent to storage.

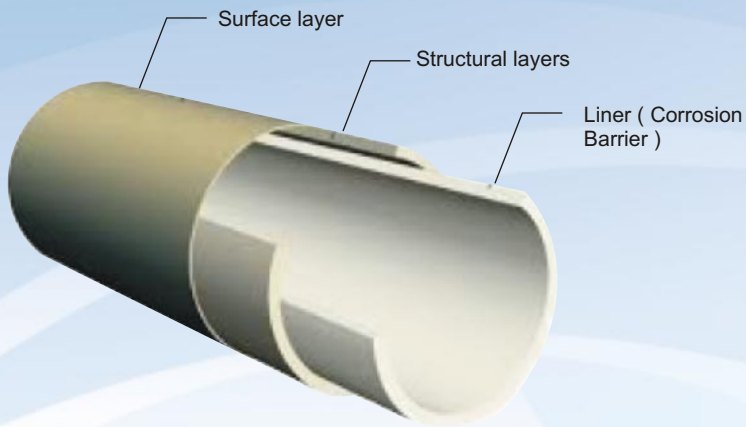
At each stage of the pipe making process, quality control tests are carried out and recorded to ensure that only products that are within the project specifications and matching the highest quality standards are delivered to the customer.

Basic Manufacturing Process



METHOD OF MANUFACTURE

There are three basic layers to any FRP pipe:
1) The internal, or corrosion barrier has a high resin to glass ratio (75-80)% and here the chemical barrier is set up and also the glass smooth internal surface is achieved.
2) The structural layer: Cover upon cover of this continuous filament is laid on top of each other until the required strength of pipe is achieved, standard strengths include gravity pipe, 6 bar, 9 bar and 12 bar pipe, all have corresponding increasing wall thicknesses. Increased pipe strengths can be easily achieved on request.



Internal & External Protective Layer:

The inner and outer layers contain a high concentration of polyester resin that provides a protective layer that has outstanding resistance to chemicals, corrosion and abrasion. Barrier Layer: The Barrier Layer is reinforced polyester resin layer that prevents penetration of materials into the structural layer of the pipe. Structural Layers: The Structural Layers provide hoop strength, axial reinforcement and structural integrity. This consists of Glass Fibres of different types and sizes together with thermosetting resins. Core Layer: The centeral core layer provides strength, reinforcement and stiffness to the product.

FCI takes responsibility, subject to detailed information of the media and soil condition alongwith concentrations were submitted before placing order. As corrosion resistant barrier is applied/selected accordingly.

APPLICABLE CODES AND STANDARDS

Currently, there are several ASTM Product Standards in use which apply to a variety of fiberglass pipe applications. All product standards apply to pipe with diameter ranges of 20mm to 2400mm and require the flexible joints to withstand hydrostatic testing in configurations **(as per ASTM D 4161)** that simulate exaggerated in-use conditions. These standards include many tough qualification and quality control tests, ***FCI PIPE*** is designed to meet all of these ASTM standards.

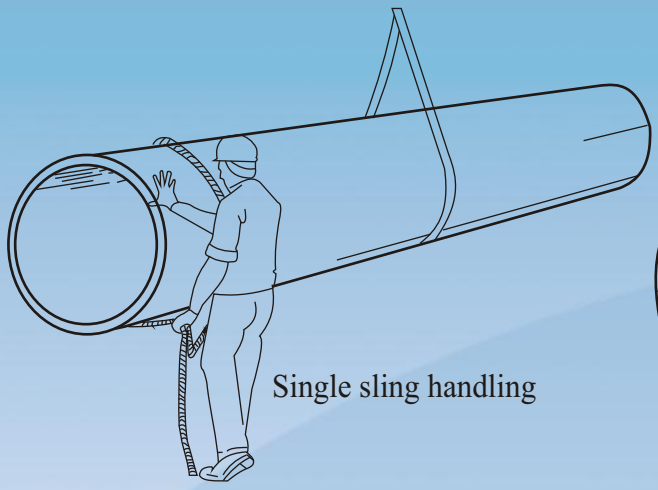
Standard	Main Application
ASTM D-3262	Standard Specification for Fiberglass Sewer Pipe
ASTM D-3517	Standard Specification for Fiberglass Pressure Pipe
ASTM D-3754	Standard Specification for Fiberglass Sewer and Industrial Pressure Pipe
AWWA C-950	Fiberglass Pressure Pipe
AWWA M-45	Fiberglass Pipe Design Manual
BS5480	British Standard Specification for Glass Reinforced Plastic (GRP) pipes, joints and fittings for use for water supply and sewerage.
ASTM D 2412	Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
ASTM D 2992	Standard practice for obtaining hydrostatic or pressure design basis for "Fiberglass" (Glass - Fibe r- Reinforced Thermosetting - Resin) pipe and fittings. (Hydrostatic Design Basis (HDB)
ASTM D 3681	Chemical resistance of "Fiberglass" (Glass - Fiber - Reinforced Thermosetting - Resin) pipe in deflected condition (Strain corrosion performance).
ASTM D 4161	Standard specification for " Fiberglass" (Glass - Fiber - Reinforced Thermosetting - Resin) pipe joint using flexible elastomer seals.
ASTM D 5365	Standard test method for long term ring - bending strain of "Fiberglass" (Glass - Fiber - Reinforced Thermosetting - Resin) pipe.
BS 5480 Appendix L	British standard specification for glass reinforced plastics (GRP) pipes, joints and fittings for use for water supply or sewerage - method for determination of long term specific ring stiffness and creep factor under ring deflection.
ASTM-American Standard for Testing Materials AWWA-American Water Works Association	

AWWA C-950 is one of the most comprehensive product standard in existence for fiberglass pipe. This standard for pressure water applications has stringent requirements for pipe and joints, concentrating on quality control and prototype qualification testing. Like ASTM standards, AWWA is a product performance standard. ***FCI PIPE*** is designed to meet the performance requirements of this standard. AWWA has issued a standards manual M-45, which includes several chapters on the design of GRP pipe buried and aboveground installations.

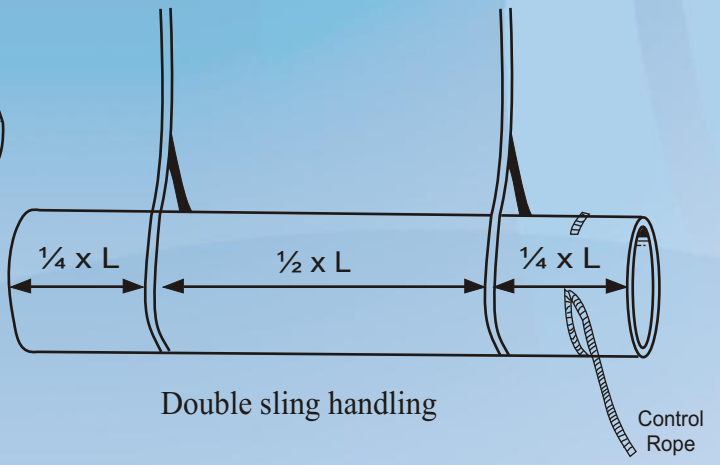
FCI is also a member of AWWA.

HANDLING, STORAGE AND TRANSPORTATION

FCI PIPE is suitable for telescopic handling.
If pipes will be handled by double sling handling method, the distance between the rope and the pipe end should not exceed L' < L/4 ratio.



Single sling handling



Double sling handling

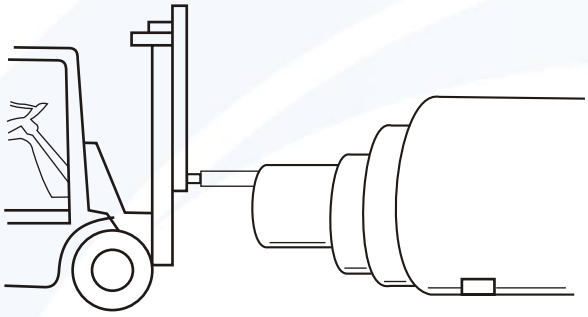
- If the pipes will be handled by single sling method, none of the pipe ends should be dragged on, to ensure safety.
- In horizontal and vertical handling, if pipe falls down on a sharp material, the pipe must be inspected against damages.
- If there is an obligation for nesting the pipes, the distance between the planks should not exceed 6 meters.

Maximum Storage Deflection

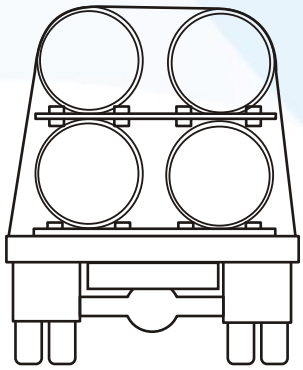
2.5% in SN2500 pipes
2.0% in SN5000 pipes
1.5% in SN10000 pipes

All pipes must be supported on flat timbers, spaced at maximum 4 meters (3 meters for diameter ≤DN250), with a maximum overhang of 2 meters and chocked to maintain stability and separation.

Pipe storage



De-nesting pipes with padded boom on forklift truck



Pipe shipment by truck

Maximum stack height is approximately 2.5 meters. The pipes must be strapped to the vehicle over the support points using pliable straps or rope. Steel cables or chains without adequate padding should never be used to protect the pipe from abrasion. Bulges, flat areas or other abrupt changes of curvature are not permitted. Transport of pipes outside of these limitations may result in damage to the pipes.

QUALITY CONTROL AND TESTING

Raw Materials

Raw materials are procured from certified vendors meeting ***FCI*** quality requirements. In addition, all raw materials are sample tested prior to their use. These tests ensure that ***FCI PIPES*** are manufactured according to the stated specification and top notch quality.

Finished Pipe

Strict quality control checks are made of ***FCI PIPE*** on each and every stage of the manufacturing process. The quality control tests performed on the pipes are:

- Pipe wall thickness
- Pipe length
- Barcol hardness
- Pipe diameter

Physical Properties

Routine tests are performed to evaluate pipe's hoop and axial load capacities. In addition, the construction and composition of pipe are confirmed. The following control checks are performed on a sampling basis:

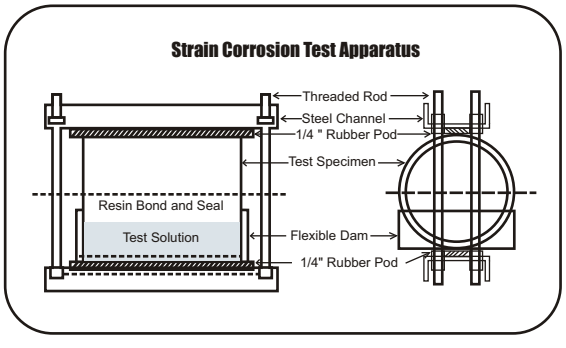
- Deflection without damage or structural failure.
- Axial and circumferential tensile load capacity.
- Pipe Stiffness
- Loss of Ignition (LOI)

A pipe manufactured should comply to the applicable standards and meeting all the minimum performance requirements set by these standards. In most of the cases, the minimum performance requirements fall into both short term and long term requirements. Long term test standards include, initial ring deflection, long term ring bending, long term pressure and strain corrosion capability.

Strain Corrosion Testing

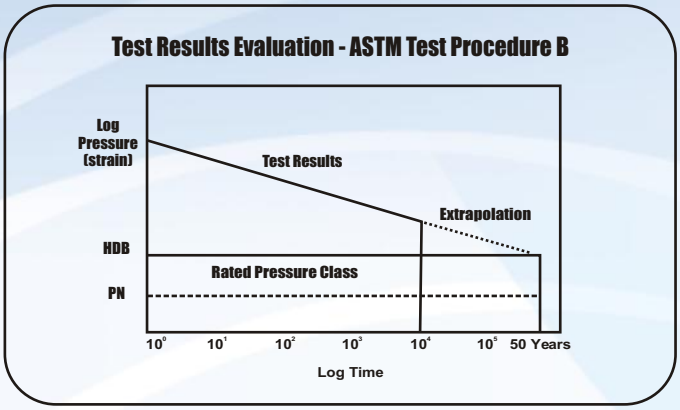
A unique and important performance requirement for ***FCI*** gravity pipe used in sewer applications is the chemical testing of the pipe in a deflected or strained condition. The strain corrosion testing is done in accordance with ASTM D 3681, and requires a minimum of 18 ring samples of the pipe to be deflected to various levels and held constant. These strained rings are then exposed at the invert of the interior surface to 1.0N (5 wt.%) sulphuric acid (shown in the figure below). This is intended to simulate a buried septic sewer condition. This has been shown to be representative of the worst sewer conditions. The time to failure (leakage) for each test sample is observed. The minimum extrapolated failure strain at 50 years, using a least square regression analysis of the failure data must equal the values shown for each stiffness class. The value achieved is then relatable to the pipe design to enable prediction of safe installation limitations for ***FCI PIPE*** used for this type of service. Typically this is 5% in-ground long-term deflection.

Stiffness Class	Scv.Strain (%)
SN 2500	0.49 (t/d)
SN 5000	0.41 (t/d)
SN 10000	0.34 (t/d)



HYDROSTATIC DESIGN BASIS

Formulation of Hydrostatic Design Basis (HDB) is also an important qualification test. This test is carried out in accordance with ASTM D2992 Procedure B and requires hydrostatic pressure testing to failure (leakage) of many pipe samples at a variety of very high constant, pressure levels. As in the previously described Strain Corrosion test, the resulting data is evaluated on a log-log basis for pressure (or hoop tensile strain) vs. Time to failure and then extrapolated to 50 years. The extrapolated failure pressure (strain) at 50 years, referred to as hydrostatic design basis (strain) or HDB, must be at least 1.8 times the rated pressure class (strain at the rated pressure) (see figure below). In other words, the design criteria requires that the average pipe be capable of withstanding a constant pressure of 1.8 times the maximum operating condition for 50 years. Due to combined loading considerations, that is the interaction of internal pressure and external soil loads; the actual long term factor of safety against pressure failure alone is higher than 1.8. This qualification test helps assure the long term performance of the pipe in pressure service.



Initial Ring Deflection

All pipes must meet the initial ring deflection levels of no visual evidence of cracking or crazing (Level A) and no structural damage to the pipe wall (Level B) when vertically deflected between two parallel flat plates or rods.

Deflection Level	Stiffness Class (SN) 2500	5000	10000
A	15%	12%	9%
B	25%	20%	15%

Long Term Ring Bending

A Glass Fiber Reinforced pipe's long term (50 year) ring deflection or ring bending (strain) capability, when exposed to an aqueous environment and under constant load, must meet the level A deflection level specified in the initial ring deflection test. AWWA C950 requires the test to be carried out, with the resulting 50 year predicted value used in the pipe's design. ***FCI PIPE*** is tested using the guidelines of ASTM D5365 "Long-Term Ring Bending Strain of Fiberglass Pipe" and meet both requirements.

Joint Testing

This important qualification test is conducted on joint prototypes for elastomeric gasket sealed couplings. This is a severe test carried out in accordance with ASTM D4161. It incorporates some of the most stringent joint performance requirements in the piping industry for the pipe of any material within the pressure and size ranges of ***FCI PIPE***. ASTM D4161 requires these flexible joints to withstand hydrostatic testing in configurations that simulate every severe in-use conditions. Appropriate test pressures corresponding to in-use severe conditions is applied for ten minutes. Pressures used are twice those rated mid 100kPa (1 bar) is used for gravity flow pipe. Joint configurations include straight alignment, maximum angular rotation and differential shear loading. A partial vacuum test and some cyclical pressure tests are also included.

Stiffness Classes

During the use of pipes for underground applications, deflection can be caused due to the depth of the backfill cover and traffic load, ultimately resulting in pipe failure. In order to avoid this scenario, stiffness tests are performed as per ASTM D 2412.

Stiffness Class	Minimum STIS (EI/D^3) Pa	Minimum Pipe Stiffness (PS) $F/Y = EI/(0.149r^3)$ KPa
SN 2500	2500	124
SN 5000	5000	248
SN 10000	10000	496

Stiffness is selected according to two parameters.

1.Burial conditions; which include native soil, type of backfill and cover depth.

2.Negative pressure; if it exists.

Stiffness Class	N/m^2
SN 2500	2500
SN 5000	5000
SN 10000	10,000

Maximum cover restrictions may be reduced with special installation such as;encasement concrete cover slabs, casting or other provisions to carry the surface load.
Maximum allowable cover depth varies with the type of installation and native soil conditions. Refer to the ***FCI*** technical services team for installation details.

PRESSURE CLASSES

FCI PIPE are supplied in the following pressure classes

FCI GRP pipe is being produced according to the standards of ASTM, ISO in diameter and length. Our pipes are being produced as per international standard for good productivity and quality control and also sellable in overseas market.
FCI GRP pipe is trying to meet requirements of many projects 100% through versatile pipes in terms of various pressure classes (PN) and stiffness classes (SN)

Pressure Class (PN) bar	Pressure Rating bar
Gravity	0.5
3	3.0
6	6.0 (B Class)
9	9.0 (C Class)
12	12.0 (D Class)

Note: Higher rating pipelines are also available on request.

Pressure Class (PN)

The pressure class of GRP pipe is determined as per the AWWA M-45. Fiberglass pipe Design Manual or AWWA C950 Standard. Pressure class stands for physical capability (water pressure) which can endure internal pressure for 50 years.
Pressure class is determined after testing with more than 18 pieces of samples and capability is appraised whether it can endure water pressure for 50 years.
Safety ratio should be over 1.5.

Higher rating pipelines are available on demand. Consult our technical services team for further details.

PRODUCT BENEFITS AND ADVANTAGES

FCI has introduced Glass reinforced pipe in the market which is one of the strongest piping material by weight in use today. These piping products are made by using filament winding . Varying conditions of service has resulted in the use of three major FRP piping: epoxy, polyester, and vinyl ester.

Like most plastic piping systems, FRP is durable, safe and easy to install. In addition, it is very cost competitive when compared to many metal-alloy piping systems. Most FRP piping has both internal and external chemical resistant barriers, mainly laminated to pipes used in corrosive environment.

FRP piping systems has made significant inroads into markets Some of GRP pipes properties are as given.

PROPERTIES	ADVANTAGES
Corrosion resistant materials	● Long effective service life ● No need for linings, coatings, cathodic protection, wraps or other forms of corrosion protection ● Low maintenance costs ● Improved hydraulic characteristics
Light weight (1/4 weight ductile iron and 1/10 weight of concrete)	● Low transport costs (nestable) ● Eliminates need for expensive pipe handling equipment
Length standards Lengths (6 and 12 meters)	● Fewer joints reduce installation time ● More pipe per transport vehicle means lower delivery cost
Extremely smooth bore	● Low friction loss means less pumping energy needed and lower operating costs ● Minimum slime build-up can help lower cleaning costs
Precise FLEX FIT ™ coupling with rubber seal gaskets	● Tight, efficient joints designed to eliminate infiltration and ex-filtration ● Ease of jointing, reducing installation time ● Accommodates small changes in line direction without fittings.
Customised manufacturing	● Custom diameters can be manufactured to provide maximum flow volumes with ease of installation for rehabilitation lining
High technology pipe design	● Lower wave celerity than other piping materials can mean less cost when designing for surge and water hammer pressure.
High technology pipe manufacturing system producing pipe that complies to stringent performance standards (AWWA, ASTM, BS, etc…)	● High and consistent product quality materials can mean less cost when designing for surge and water hammer pressure.
Application in every environment	● Can be installed underground, above ground and also under water. ● FCI Pipe are flexible, successfully qualify for earthquake regions. ● Can be installed inside the existing lines easily for relining.
FCI pipes are environment friendly	● No adverse effect on environment

APPLICATIONS OF FCI PIPE

FCI PIPE (Fiberglass Reinforced Thermosetting Resin pipe) has found multifarious applications in the public health and industrial projects. Some key application areas are:

Water Transmission and Distribution (Potable and Raw Water)

Superior properties, such as corrosion resistance, eliminations of the need for linings, coatings and cathodic protection and perfect hydraulic characteristics of the pipe's inner surface; high strength against pressure and overburden loads; quick and easy installation makes ***FCI PIPE*** ideal for public water transmission, distribution networks and every type of forced mains.

Irrigation

As a result of global warming, efficient and logical use of the world's scarce water resources has become even more important than ever. Particularly, pipe systems are preferred over open ducts for irrigation to prevent loss of water. Superior properties of ***FCI PIPE*** makes it ideal for irrigation. Ease of training of field staff for installation and damage repair makes it most accepted material for irrigation network.

Sanitary Sewerage Collection Systems And Treated Water

FCI PIPE has a high resistance against corrosion caused by sulphuric acid in sanitary sewer systems. As per ASTM procedure, specially selected inner corrosion barrier and smooth surface of ***FCI PIPE*** help minimize the development of deposits and leak-tightness of joints prevent outflow and inflows.

INDUSTRIAL USAGE OF FCI PIPE

FCI PIPE has an inherent high corrosion resistance against most chemicals. ***FCI PIPE*** are used confidently for chemical conveyance lines of industrial plants

FCI PIPES are GRP pipes designed for penstock applications in smaller hydropower projects. It is a high axial strength pipe system and can be used for buried installations as well as above ground installations on supports. It is a UV resistant pipe and light in color for increased heat reflection. It can be used in ambient temperatures from -60C to +50C without any changes in mechanical properties. Dependent on coupling selection, it can be supplied for both restrained and unrestrained systems.

FCI GRP Pipe Systems for submarine applications are higher axial strength pipes suitable for restrained system when required and for the towing forces when pipe strings are assembled on shore and towed to installation location by tugs.

INDUSTRIAL USAGE OF FCI PIPE

Firewater Protection

Scale from internal corrosion of steel piping in a firewater protection system is known to plug nozzles and sprinkler heads. To combat the effects of corrosion and internal scaling, metallic systems require continuous maintenance. Even then, it is questionable how much of a metallic system is in an effective operating condition at a given moment. FRP fire resistant material systems are being developed and should prove to be cost effective in certain fire protection applications.

Pipe use in Cooling Towers

FCI GRP Pipe Systems for cooling water systems and other industrial applications are generally isophthetalic based and requires different reinforcements to build higher axial strength pipes suitable for restrained pipe designs.

Water Distribution

FCI PIPE systems can be used in:

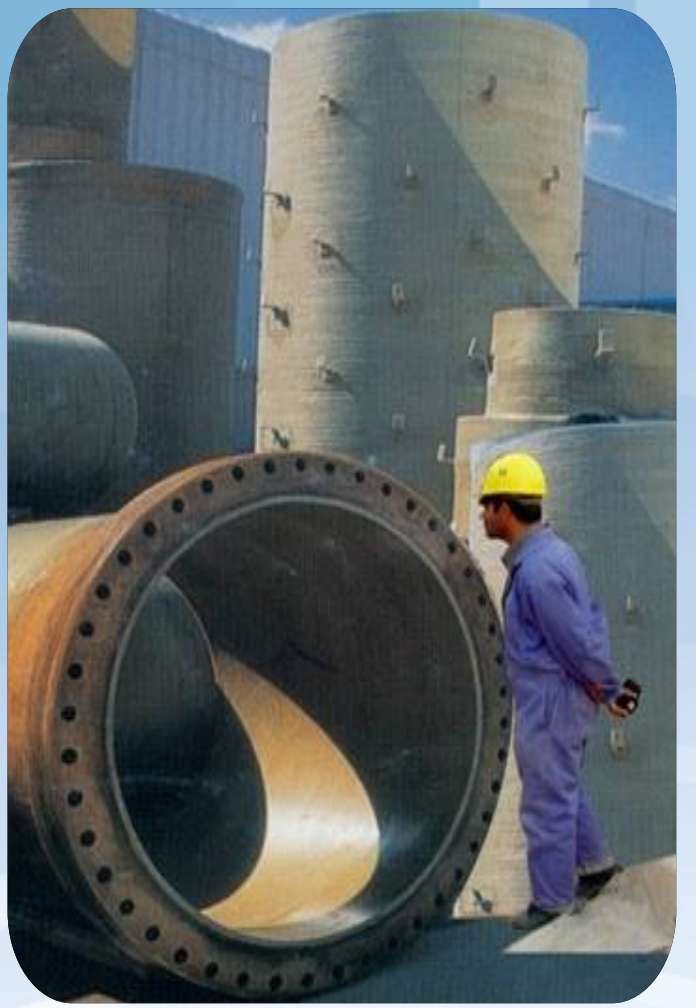
- Cross Country Transmission
- City Distribution
- Urban Development of Potable Water

INDUSTRIAL USAGE OF FCI PIPE

Manhole Liners

FCI Manhole liners are produced by filament winding either as liner tube or as preformed liners of defined length and supplied with integral cover slabs bonded with GRP to the liner tube.

Reducer cover slabs, access shaft tubes, GRP waffles and shuttering, GRP ladders, walkways and handrail systems, GRP lamination to manholes, inspection chambers and other structures are produced as tailor made items in our fabrication division.



Oil Field Tubulars

Bonded or threaded line pipe is frequently used in production lines, gas gathering lines, tank battery hookups and salt water disposal/injection. Standard diameters are available up to 16 inches with pressures to 3500 psi. Threaded tubing and casing are available up to 13-7/8 inches diameter for pressures up to 3000 psi.

- Performance Tested
- Leak-Free Joints
- Low Maintenance

Motor Fuel Underground Piping (GRE,Vinyl ester & customized resins)

FCI fiberglass piping is used for the underground transfer of petroleum products, alcohol and alcohol-blended gasoline motor fuels. This underground piping is available in diameters of 3" to 96"sizes.

FCI GRE PIPES

Production:

The **FCI GRE pipes** and fittings are made of high strength fiberglass (E-glass) and amine cured epoxy resin (Hetron 922). These materials provide the optimal strength in composite pipe system. Computerized Winding machines produce the GRE pipes on a mandrel in a cross section filament winding process. The continuous glass fibers are wound at predetermined helical angle and are reinforced with the epoxy resin. This process, incorporates the most modern equipment with precise control of winding angle through servo motors , upper computer having MM (man, machine interface) data input terminal, ensures a consistent production of the highest quality.

For certain applications, the pipe wall contains an extra liner of 0.5 mm. This optional resin rich liner consists of C-glass (C-veil) and the same resin as used in the pipe wall. Conductive pipes and fittings are available on request for special applications. All pipes are interchangeable with steel pipes. The wide range of fittings provided by FCI ensures that pipe design according to standard procedure is possible. Non standard fitting are also fabricated to meet with special customized requirements.

Benefits:

The product range of **FCI GRE** pipe systems combines many advantages in one product. GRE is a corrosion free material. Coatings (internal or external), chemical inhibitors, cathodic protection and corrosion allowances are not required. The life time of pumps and other inline equipment is extended through the complete absence of rust particles. The low thermal conductivity of GRE ensures low energy losses from the pipe system. In many cases insulation can therefore be avoided.

FCI pipes have a very smooth inside surface resulting in a Hazen William factor of 150. This allows in most cases a smaller pipe diameter for any given volume, which cuts costs of the system. Paraffin, resin and asphalt accumulation in crude oil transmission lines is also reduced, thanks to a very low internal friction. Better wall-thickness/strength ratios are achieved through the high precision Filament Winding Technology used by **FCI**. This results in lower weight per pressure classes. **FCI pipes** can be used for above and underground applications. The life cycle of GRE exceeds stainless steel.

FCI RTRP PIPE

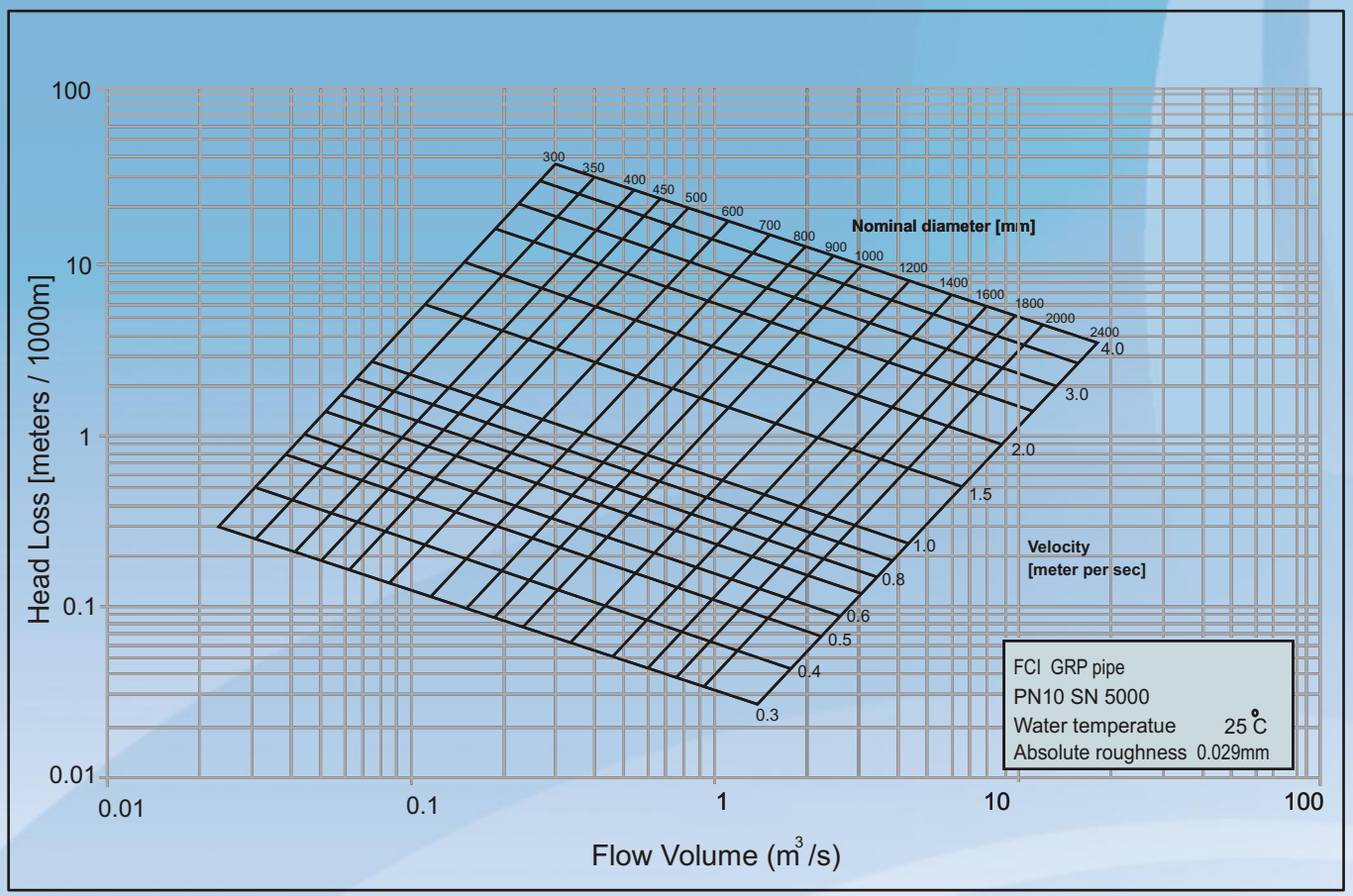
The **FCI RTRP Pipes** (Reinforced Thermosetting Resin Pipes) and fittings are made of high strength fiberglass (E-glass) in the form of Direct Rovings and premium grade Unsaturated polyester Resins (Isophthalic / Orthophthalic Based) or commonly called GP (General purpose) Resin, and High chemical resistant Epoxy Vinyl Ester Hetron 922. These pipes have no filler or pigments except thixotropic agents occasionally. These materials provide the optimal strength in composite pipe system. These are designed for high corrosion resistant and axial strength under severe loads.

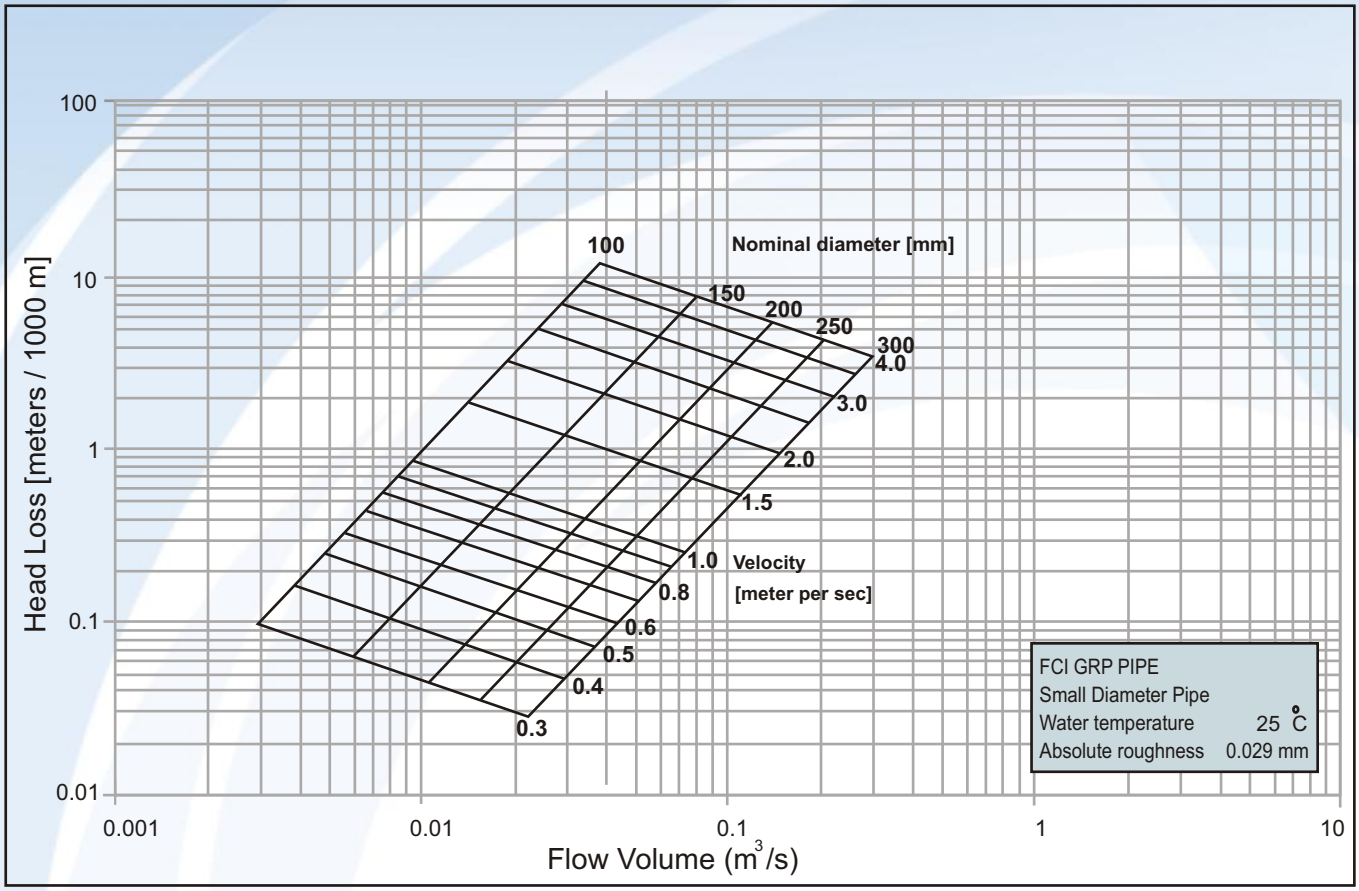
FCI RTRP Pipes are manufactures using the continuous mandrel process which represents the state of the art in RTRP pipe production. This process allows the use of continuous glass fiber reinforcements in the circumferential direction. For a pressure pipe or buried conduit the principle stress is in the circumferential direction, thus incorporating continuous reinforcement in this direction yields a higher performance product at lower cost.

FCI has supplied such RTRP pipes for multiple projects which are under continuous operation since last many years.

TYPICAL FIBERGLASS PIPE APPLICATIONS BY INDUSTRY

Applications	INDUSTRY								
	Chemical Process	Petro chemical	Marine Offshore	Pharma ceutical	Food Processing	Power Plants	Pulp and Paper	Waste Water Treatment	Mining and Metal Refining
Aeration								✔	
Brine Slurry	✔								
Bottom Ash						✔			
Chemical Feed	✔	✔			✔	✔	✔	✔	✔
Column Piping			✔						
Condensate Return	✔	✔	✔	✔	✔	✔	✔		
Conduit		✔			✔	✔	✔		
Cooling Water	✔	✔		✔	✔	✔			
Disposal Wells	✔	✔	✔					✔	✔
DownHole Tubing & Casing		✔	✔					✔	
Effluent Drains	✔	✔	✔	✔	✔	✔	✔	✔	✔
Fire Mains		✔	✔			✔	✔		✔
Flue Gases Desulphurization						✔			
Guttering and Downpouts	✔				✔	✔	✔		
Oily Water		✔	✔						✔
Scrubber Headers	✔	✔				✔			
Sea Water		✔	✔			✔			
Slurry	✔					✔			
Vents	✔	✔	✔	✔	✔		✔	✔	✔
Water	✔	✔	✔	✔	✔	✔	✔		✔
Waste Treatment	✔		✔	✔	✔	✔	✔	✔	✔
Buried Gasoline		✔							


Head Loss [meters / 1000m]
Flow Volume (m3/s)
Nominal diameter [mm]
300
350
400
450
500
600
700
800
900
1000
1200
1400
1600
1800
2000
2400
Velocity
[meter per sec]
4.0
3.0
2.0
1.5
1.0
0.8
0.6
0.5
0.4
0.3
FCI GRP pipe
PN10 SN 5000
Water temperatue 25 °C
Absolute roughness 0.029mm


Head Loss [meters / 1000 m]
Flow Volume (m3/s)
Nominal diameter [mm]
100
150
200
250
300
Velocity
[meter per sec]
4.0
3.0
2.0
1.5
1.0
0.8
0.6
0.5
0.4
0.3
FCI GRP PIPE
Small Diameter Pipe
Water temperature 25 °C
Absolute roughness 0.029 mm

Typical Mechanical Prperties of the Structural Wall of FCI PIPE

Property	Test Method	Units	Value
Density	ASTM D2584	Kg/m^3	1580-1850
Hoop Tensile Strength	BS5480 : 1990 @ 25°C	N/mm^2	350-490
Axial Tensile Strength	BS5480 : 1990 @ 25°C	N/mm^2	148-169
Compressive Strength	ASTM D695	N/mm^2	208-364
Coefficient of Thermal Expansion		mm/mm/ $Cx10^{-6}$	24-30

When pipes are used for underground applications, the load application on the pipe due to the depth of cover backfill & traffic load etc, could cause the deflection of the pipe, ultimately resulting in pipe failure. So to avoid these failure, stiffness tests are performed as per ASTM D2412.

A specific stiffness class corresponds the specific cover of back fill, so stiffness class should be choosed carefully according to the required cover backfill, to avoid pipe failure.

Stiffness class	Maximum Cover in m (related with soil nature)
2500	8
5000	12
10000	16

Stiffness class selection for a particular project is depending on customers' requirement; the engineer in charge can advise it keeping in view the site requirements, like traffic load and native soil. Our technical division is also available for recommendations.

The stiffness selected should be the higher of that determined to suit negative pressure and burial conditions

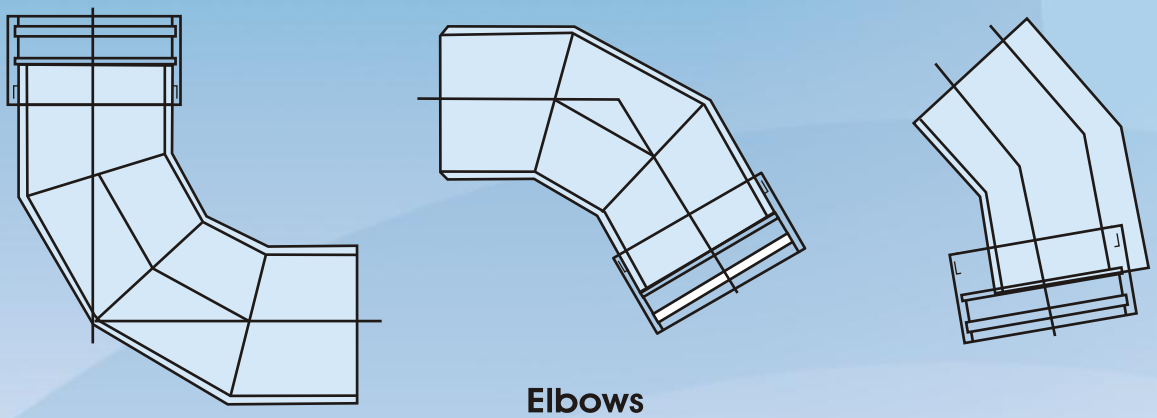
Nominal Diameter DN

FCI PIPE is manufactured in the following diameters. Special application diameters are also available upon request, as specified by ASTM D3754, ASTM D3262 and ASTM D3517.

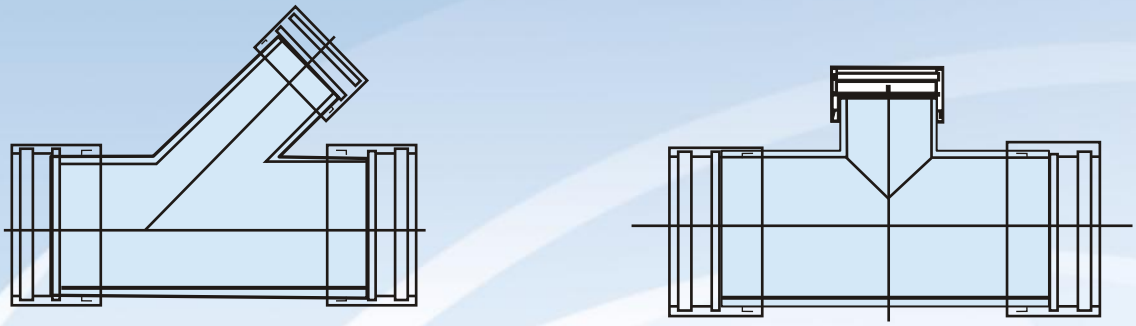
Nominal Diameter - DN (mm)					
100	300	600	1000	1500	2400
150	350	700	1200	1600	
200	400	800	1300	1800	
250	500	900	1400	2000	

FITTINGS & PIPELINE ACCESSORIES

FCI is producing stub mitred fabricated fittings using the same materials that are used to produce ***FCI GRP Pipe***. One of the benefits of ***FCI PIPE*** is the ability to fabricate a wide assortment of fittings, standard as well as non-standard. GRP molded fittings are fabricated for certain specific requirements. The following tables shows the standard dimensions of standard fittings with different ends configuration.



Elbows

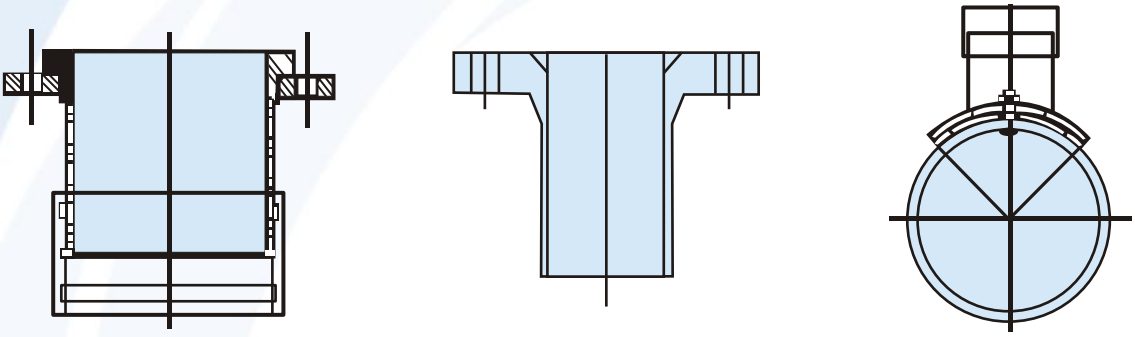


Wyes

Tees

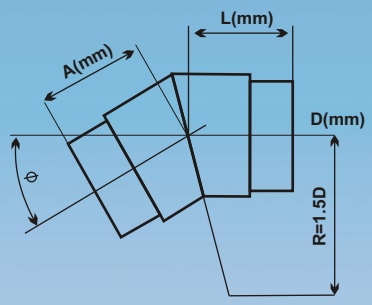
Eccentric Reducers

Concentric Reducers

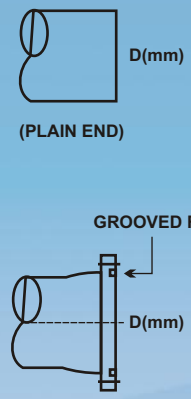


Flanges

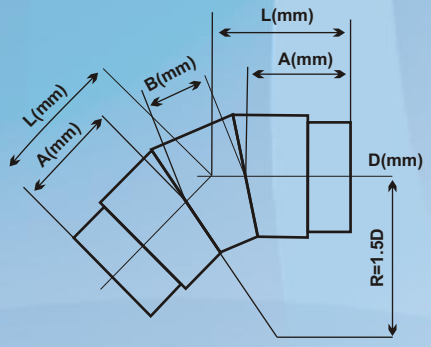
Saddles



ONE MITER- 0° < ϕ < 30° ELBOW
(SPIGOT ENDS)



(FLANGE END)



TWO MITER- 45° ELBOW
(SPIGOT ENDS)

30 DEGREE ELBOW

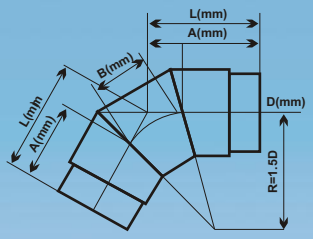
Nominal Diameter D (mm)	A (mm)	L (mm)
80	400	400
100	400	400
150	400	400
200	400	400
250	400	400
300	400	400
350	350	350
400	400	400
450	400	400
500	450	450
600	500	500
700	550	550
800	600	600
900	650	650
1000	650	650
1100	650	650
1200	700	700
1300	750	750
1400	800	800
1500	900	900
1600	950	950
1700	1000	1000
1800	1050	1050
1900	1150	1150
2000	1200	1200
2100	1250	1250
2200	1300	1300
2300	1350	1350
2400	1450	1400

Note: All small diameters from 80mm to 300mm flanges will be flat faces.

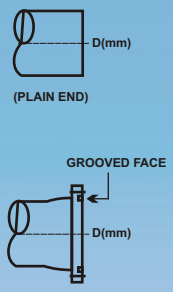
45 DEGREE ELBOW

Nominal Diameter D (mm)	A (mm)	B (mm)	L (mm)
80	400	48	426
100	400	60	432
150	400	90	449
200	400	120	465
250	400	149	481
300	400	179	497
350	400	209	513
400	400	239	529
450	400	269	546
500	450	299	612
600	500	358	694
700	550	418	776
800	600	478	859
900	650	537	941
1000	700	597	1023
1100	750	657	1106
1200	800	716	1188
1300	850	776	1270
1400	900	836	1352
1500	950	895	1434
1600	1000	955	1517
1700	1050	1015	1599
1800	1100	1074	1681
1900	1200	1134	1814
2000	1250	1194	1896
2100	1300	1253	1978
2200	1350	1313	2061
2300	1400	1373	2143
2400	1450	1432	2225

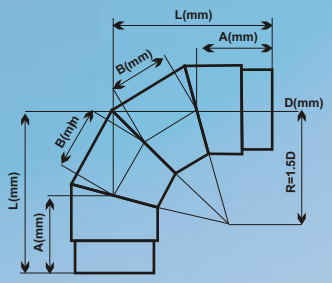
Customized diameters above DN 2400 are available on demand.



TWO MITER - 60° ELBOW
(SPIGOT ENDS)



(FLANGE END)



THREE MITER - 90° ELBOW
(SPIGOT ENDS)

60 DEGREE ELBOW

Nominal Diameter D (mm)	A (mm)	B (mm)	L (mm)
80	400	65	438
100	400	81	447
150	400	121	470
200	400	161	493
250	400	201	516
300	400	242	540
350	400	281	562
400	400	322	586
450	400	362	609
500	450	402	682
600	500	482	778
700	550	563	875
800	600	643	971
900	650	724	1068
1000	700	804	1164
1100	750	884	1260
1200	800	965	1357
1300	900	1045	1503
1400	1000	1126	1650
1500	1100	1206	1796
1600	1200	1286	1943
1700	1300	1367	2089
1800	1400	1447	2235
1900	1500	1527	2382
2000	1600	1608	2528
2100	1650	1688	2625
2200	1750	1769	2771
2300	1850	1849	2918
2400	1900	1929	3014

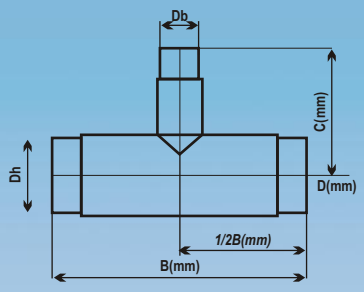
Note: All small diameters from 80mm to 300mm flanges will be flat faces.

90 DEGREE ELBOW

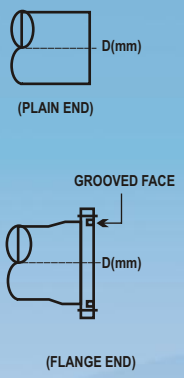
Nominal Diameter D (mm)	A (mm)	B (mm)	L (mm)
80	400	65	489
100	400	81	511
150	400	121	565
200	400	161	620
250	400	201	675
300	400	242	731
350	400	281	784
400	400	322	840
450	400	362	895
500	450	402	999
600	500	480	1158
700	550	563	1319
800	600	643	1478
900	650	724	1639
1000	700	804	1798
1100	750	884	1958
1200	800	965	2118
1300	900	1045	2328
1400	1000	1126	2538
1500	1100	1206	2747
1600	1200	1286	2957
1700	1300	1367	3167
1800	1400	1447	3377
1900	1500	1527	3586
2000	1600	1608	3797
2100	1650	1688	3956
2200	1750	1769	4167
2300	1850	1849	4376
2400	1900	1929	4535

Customized diameters above DN 2400 are available on demand.

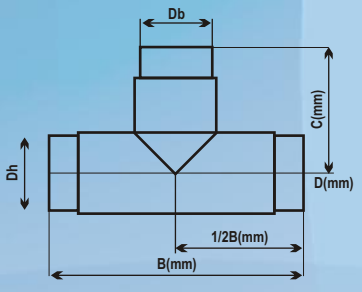
Standard Tee Dimensions table for diameters of branch less than one half the diameter of header (Db < 1/2 Dh)



90° TEE (SPIGOT ENDS)



Standard Tee Dimensions table for diameters of branch greater than one half the diameter of header (Db > 1/2 Dh)



90° TEE (SPIGOT ENDS)

90° TEE ($D_b < 1/2\ D_h$)

Nominal Diameter D (mm)	B (mm)	C (mm)
350	1000	560
400	1000	570
450	1050	650
500	1080	670
600	1220	760
700	1350	850
800	1480	940
900	1650	1030
1000	1750	1130
1100	1880	1220
1200	2020	1310
1300	2150	1402
1400	2300	1490
1500	2420	1590
1600	2550	1680
1700	2700	1770
1800	2850	1860
1900	3000	1950
2000	3100	2050
2100	3210	2140
2200	3400	2230
2300	3500	2320
2400	3750	2420

Note: All small diameters from 80mm to 300mm flanges will be flat faces.

Customized diameters above DN 2400 are available on demand.

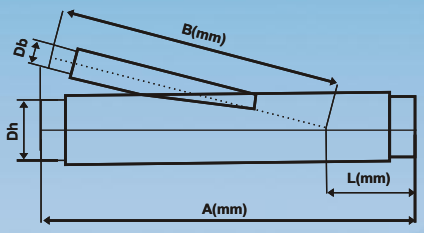
90° TEE ($D_b > 1/2\ D_h$)

Nominal Diameter D (mm)	B (mm)	C (mm)
350	1300	650
400	1400	700
450	1500	750
500	1600	800
600	1800	900
700	2050	1025
800	2300	1150
900	2550	1275
1000	2800	1400
1100	3050	1525
1200	3300	1650
1300	3550	1775
1400	3800	1900
1500	4050	2025
1600	1300	2150
1700	4550	2275
1800	4800	2400
1900	5050	2525
2000	5300	2650
2100	5550	2775
2200	5800	2900
2300	6050	3025
2400	6300	3150

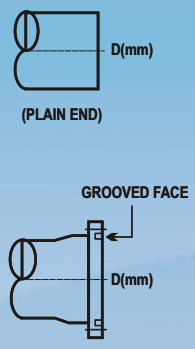
90° TEE

Nominal Diameter D (mm)	B (mm)	C (mm)
80 X 80	500	800
100 X 100	500	900
150 X 150	500	1100
200 X 200	600	1200
250 X 250	625	1250
300 X 300	650	1300

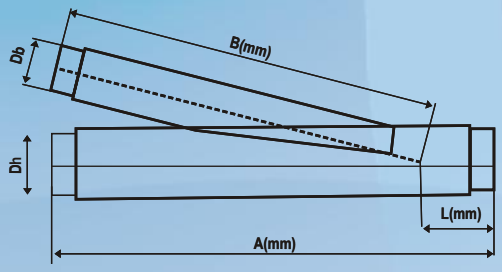
Standard Wye Dimensions for diameters of branch less than half the diameter of header (Db < 1/2 Dh)



15° WYE (SPIGOT ENDS)



Standard Wye Dimensions for diameters of branch greater than half the diameter of header (Db > 1/2 Dh)



15° WYE (SPIGOT ENDS)

15° WYE (D_b < 1/2 D_h)

Nominal Diameter D(mm)	A (mm)	B (mm)	L (mm)
80	1500	1200	300
100	1600	1300	300
150	1700	1350	350
200	1700	1400	350
250	1800	1450	400
300	1900	1500	400
350	2200	1700	500
400	2500	1900	600
450	2800	2100	700
500	3100	2300	800
600	2550	3650	900
700	4000	3000	1000
800	4500	3400	1100
900	4900	3800	1200
1000	5100	4200	1300
1100	5700	4550	1400
1200	6200	4950	1500
1300	6700	5300	1600
1400	7200	5500	1700
1500	7700	5800	1800
1600	8350	6000	1900
1700	8850	6300	2000
1800	9300	6700	2100
1900	9800	7100	2200
2000	10300	7300	2300
2100	10750	8000	2400
2200	11250	8300	2500
2300	11700	8500	2600
2400	12200	8700	2700

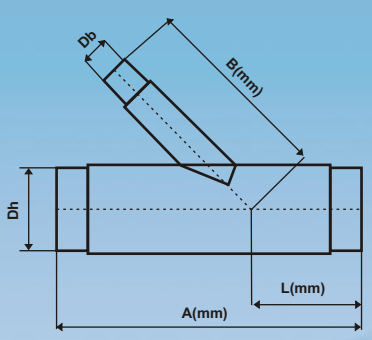
Note: All small diameters from 80mm to 300mm flanges will be flat faces

15° WYE (D_b >1/2 D_h)

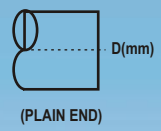
Nominal Diameter D(mm)	A (mm)	B (mm)	L (mm)
80	2100	900	240
100	2200	1000	280
150	2400	1100	300
200	2600	1300	330
250	2800	1500	350
300	2900	1700	400
350	3200	2700	500
400	3500	2900	600
450	3800	3100	700
500	4100	3300	800
600	4550	3650	900
700	5000	4000	1000
800	5500	4400	1100
900	6000	4800	1200
1000	6500	5200	1300
1100	6950	5550	1400
1200	7450	5950	1500
1300	7900	6300	1600
1400	8400	6700	1700
1500	8900	7100	1800
1600	9350	7450	1900
1700	9850	8580	2000
1800	10300	9200	2100
1900	10800	9600	2200
2000	11300	10000	2300
2100	11750	10350	2400
2200	12250	10750	2500
2300	12700	11100	2600
2400	13200	11500	2700

Customized diameters above DN 2400 are available on demand.

Standard Wye Dimensions for diameters of branch less than half the diameter of header (Db < 1/2 Dh)



45° & 60° WYE (SPIGOT ENDS)



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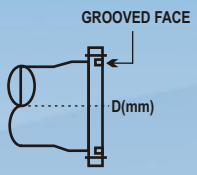
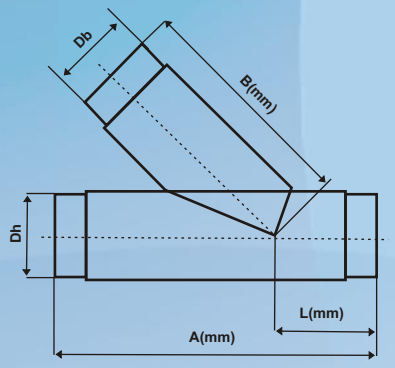


(FLANGE END)

Standard Wye Dimensions for diameters of branch greater than half the diameter of header (Db > 1/2 Dh)



45° & 60° WYE (SPIGOT ENDS)

45° & 60° WYE (D_b < 1/2 D_h)

Nominal Diameter D(mm)	A (mm)	B (mm)	L (mm)
80	600	480	240
100	700	530	250
150	750	600	250
200	800	700	280
250	850	800	300
300	900	900	300
350	1300	850	450
400	1550	1000	550
450	1700	1100	600
500	1800	1150	650
600	2050	1300	750
700	2350	1500	850
800	3650	1700	950
900	3950	1900	1050
1000	3250	2100	1150
1100	3550	2300	1250
1200	3850	2500	1350
1300	4150	2700	1450
1400	4450	2900	1550
1500	4750	3100	1650
1600	5050	3300	1750
1700	5350	3500	1850
1800	5650	3700	1950
1900	5950	3900	2050
2000	6250	4100	2150
2100	6550	4300	2250
2200	6850	4500	2350
2300	7150	4700	2450
2400	7450	4900	2350

Note: All small diameters from 80mm to 300mm flanges will be flat faces

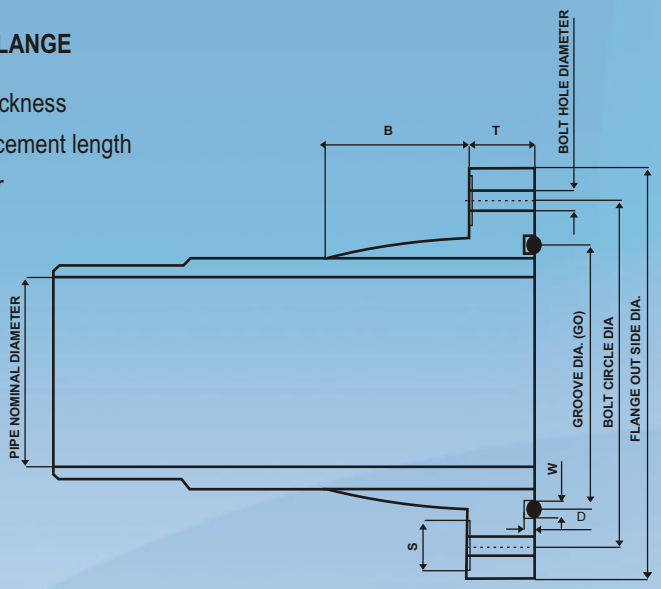
45° & 60° WYE (D_b > 1/2 D_h)

Nominal Diameter D(mm)	A (mm)	B (mm)	L (mm)
80	850	500	300
100	900	600	300
150	900	700	350
200	950	800	350
250	1000	900	350
300	1000	1000	400
350	1000	800	300
400	1250	850	400
450	1500	900	500
500	1600	950	550
600	1750	1100	600
700	2050	1300	700
800	2350	1400	800
900	2550	1600	850
1000	2660	1700	900
1100	2950	1800	950
1200	3250	2000	1050
1300	3550	2200	1150
1400	3760	2400	1200
1500	3950	2600	1250
1600	4100	2700	1300
1700	4300	2800	1350
1800	4600	2900	1450
1900	4800	3000	1500
2000	5000	3100	1550
2100	5300	3200	1650
2200	5500	3300	1700
2300	5700	3400	1750
2400	5850	3600	1800

Customized diameters above DN 2400 are available on demand.

CONTACT MOULDED FLANGE

T = effective flange thickness
B = flange hub reinforcement length
S = spot face diameter
GD = groove diameter
D = depth of groove
W = width of groove

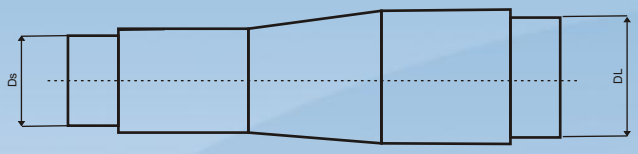


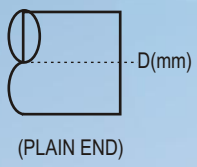
Standard Flange Dimension Complying with AWWA-ANSI B 16.1

Nominal Diameter		Flange Thickness	Flange OD 'FOD'	GROOVE DIAMETER	DRILLING STADARD					
					AWWA Class 'D'			ANSI B 16.1 Class 125		
(mm)	(inch)	T (mm) +10	+10-0	GD(MM)	No.of Bolts	Bolt Hole Dia.+ 1.5	Bolt Circle Dia.	No.of Bolts	Bolt Hole Dia.+ 1.5	Bolt Circle Dia.
80	3	24	200	107	8	18	160	8	18	160
100	4	24	220	130	8	18	180	8	18	180
150	6	28	285	184	8	22	240	8	22	240
200	8	30	340	230	8	22	295	8	22	295
250	10	42	395	280	12	22	350	12	22	350
300	12	42	445	345	12	22	400	12	22	400
350	14	45	537	399.3	12	31.6	476.3	12	31.6	476.3
400	16	47	601	434.3	16	34.8	539.8	16	31.6	539.8
450	18	52	645	485.3	16	34.8	577.9	16	34.8	577.9
500	20	53	703	536.3	20	34.8	635	20	34.8	635
600	24	57	823	638.3	20	37.8	749.3	20	37.8	749.3
700	28	66	937	743.9	28	37.8	863.6	-	-	-
800	32	72	1064	845.9	28	44.1	977.9	-	-	-
900	36	78	1172	947.9	32	44.1	1085.9	32	44.1	1085.9
1000	40	83	1287	1049.9	36	44.1	1200.2	-	-	-
1100	44	93	1401	1155.8	40	44.1	1314.5	-	-	-
1200	48	98	1509	1257.8	44	44.1	1422.4	44	44.1	1422.4
1300	52	104	1636	1359.8	44	50.5	1536.7	-	-	-
1500	60	115	1858	1563.8	52	50.5	1759	52	50.5	1758.9
1700	66	130	2030	1771.7	52	50.5	1930.4	-	-	-
1800	72	136	2194	1873.7	60	50.5	2095.5	60	50.5	2095.5
2000	78	147	2373	2077.7	64	56.8	2260.6	-	-	-
2100	84	155	2537	2182.3	64	56.8	2425.7	64	56.8	2425.7
2300	90	167	2715	2386.3	68	63.3	2590.8	-	-	-
2400	96	174	2880	2488.3	68	63.3	2755.9	68	63.3	2755.9

Note:Bolt hole Diameter in FRP flanges is larger than standard steel flanges ,where as the bolt diameter remains same as that of standard.
Customized diameters above DN 2400 are available on demand.

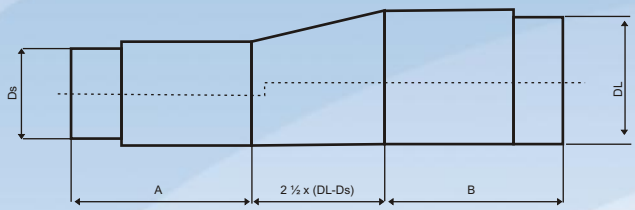
FOR SMALL PIPE DIAMETER
< OR = 300
CONCENTRIC REDUCER (SPIGOT ENDS)

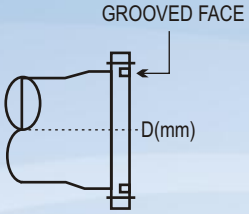




(PLAIN END)

ECCENTRIC REDUCER (SPIGOT ENDS)

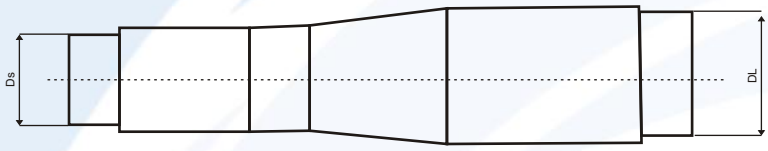


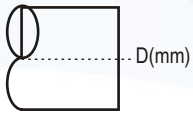


(FLANGE END)

A= 500mm or Ds. whichever is greater
B= 500mm or DL. whichever is greater

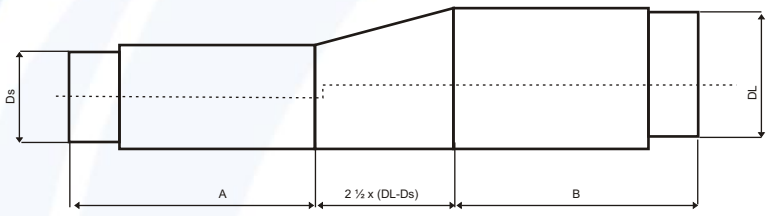
FOR LARGE PIPE DIAMETER
> OR = 350
CONCENTRIC REDUCER (SPIGOT ENDS)

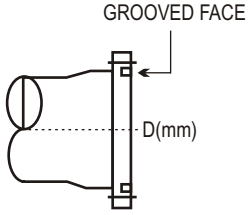




(PLAIN END)

ECCENTRIC REDUCER (SPIGOT ENDS)



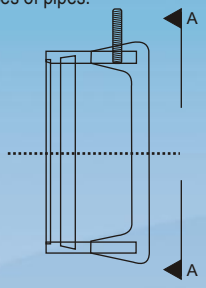


(FLANGE END)

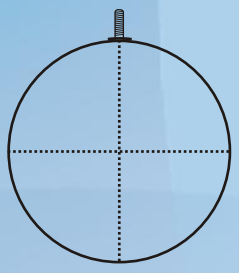
A= 500mm or Ds. whichever is greater
B= 500mm or DL. whichever is greater

END CAP

- End Caps are used to close the end of the line for testing purposes.
- They are available in all FCI pipe sizes.
- End caps should be restrained to eliminate axial forces of pipes.



END CAP WITH STEEL THREADED NOZZLE

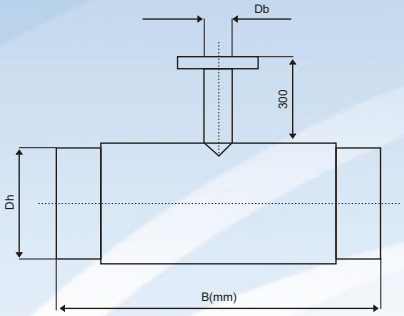


END VIEW - AA

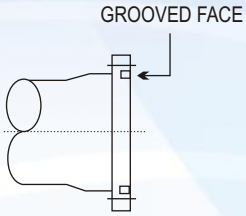
FLANGED NOZZLES

- Flanged nozzles are available in diameters range 100mm,150mm,200mm,250mm & other sizes on order..
- Flanged nozzles are drilled to ANSI B 16.5. 150lb. OR as required.
- Pipe Header diameter could vary from 300mm to 3000mm.

(PLAIN END)



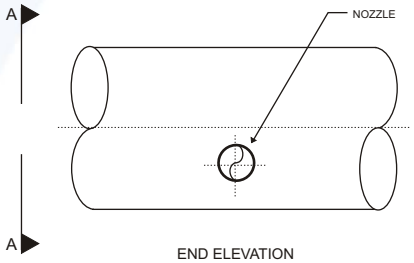
(SPIGOT ENDS)



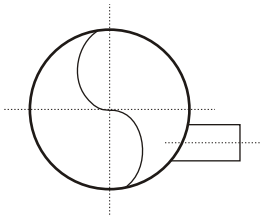
(FLANGE END)

ECCENTRIC TEES

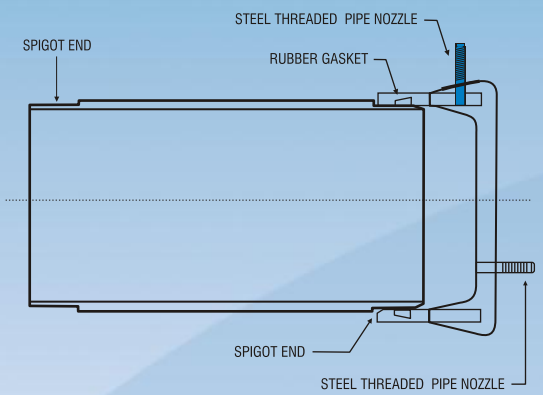
- Eccentric Tees can be manufactured upon request.
  The overall dimensions should be as per customer requirement .
  It can be , Plain end, Spigot end, or Flanged end
- Flanged Eccentric tees can be fabricted as per required drilling.

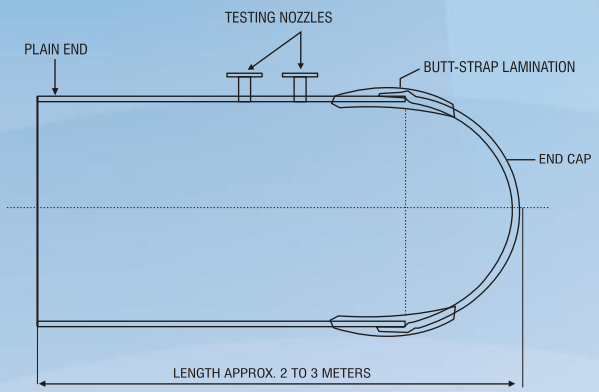


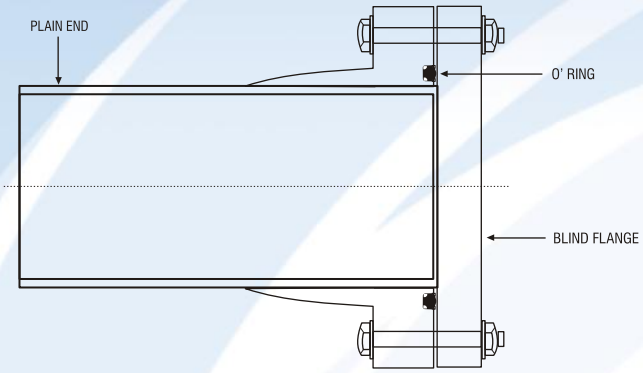
END ELEVATION

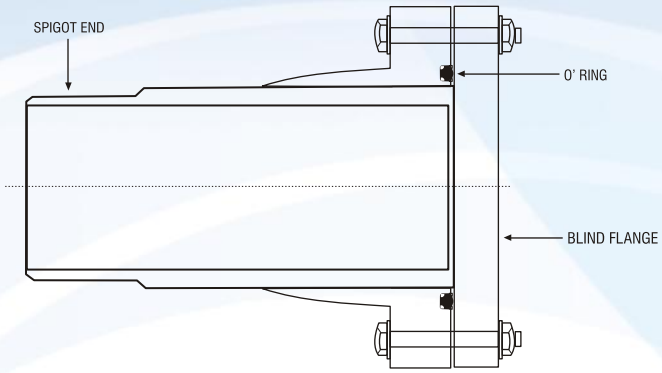


END VIEW-AA


STEEL THREADED PIPE NOZZLE
SPIGOT END
RUBBER GASKET
SPIGOT END
STEEL THREADED PIPE NOZZLE


TESTING NOZZLES
PLAIN END
BUTT-STRAP LAMINATION
END CAP
LENGTH APPROX. 2 TO 3 METERS


PLAIN END
O' RING
BLIND FLANGE


SPIGOT END
O' RING
BLIND FLANGE

JOINTING SYSTEM OF PIPES AND FITTINGS

Generally there are two types of joints:

- Restrained
- Non-Restrained

Restrained	Non-Restrained
• Flanged Joint	• Bell and Spigot
• Butt and Strap Joint	• Double Bell Spigot Mechanical Coupling
• Rubber Seal Locked Joint	
• Adhesive	

Adhesive Joint

Pipes are produced with integral spigot and socket ends. Ends are slightly tapered. The inside of the socket matches with the outside of the machined spigot. The two components of the adhesive, namely, epoxy resin and hardener are supplied in appropriate sized cans in correct mixing ratio. The joint is done by coating the surface with adhesive, assembly and elevated temperature curing using a heat source.

Flanged Joint

Flanged joints are used to enable connections and for assembling and disassembling of process lines. ***FCI PIPES*** & FITTINGS are supplied with flanges, drilled in accordance with ANSI, DIN or any other specification recommended by the customer. Special requirements can be met on demand.

Butt and Wrap Joint

In general, these joints will only be used for diameters over 400 mm. The Butt and Wrap consists of plain ended pipes and fittings, prepared (outer surface abraded), aligned and laminated with reinforcing glass fibers and appropriate thermosetting resin. Joints are prepared by over-laminating with alternate layers of chopped strand mat and woven roving glass fiber and resin. Butt and Wrap joints needs good craftsmanship and specially trained personnel to make on-site.

Bell and Spigot Joint

The socket end of this joint is an integral filament wound part of the pipe. The spigot end is a machined part on which O-ring seal in positioned on the spigot end. The flexible joint allows for axial movement of the spigot in the socket and some permissible angular deflection. The O-ring seal is an elastomeric gasket, which is the sole element of the joint to provide water tightness.

GENERAL INSTALLATION PROCEDURE

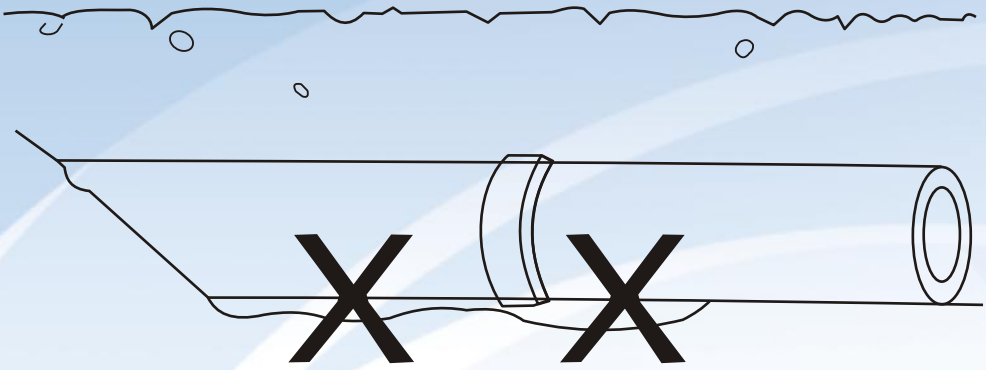
Long life and good performance characteristics of FCI PIPE can only be achieved by proper handling and installation of the pipe. It is important for the owner, engineer and contractor to understand that Fiberglass Reinforced Thermosetting Resin (FRP/GRP) pipe is designed to utilize the bedding and pipe zone backfill support that will result from recommended installation procedures. It has been found through considerable practice and experience that properly compacted granular materials are ideal for backfilling FRP/GRP pipe. A high performance "Pipe Soil System" is formed together by the pipe and the embedment material. For further information on installation instructions, refer to the *FCI PIPE* installation manual. This is only a general overview of the installation procedure and does not intend to replace any procedures that must be followed during installation for any project.

Trenching

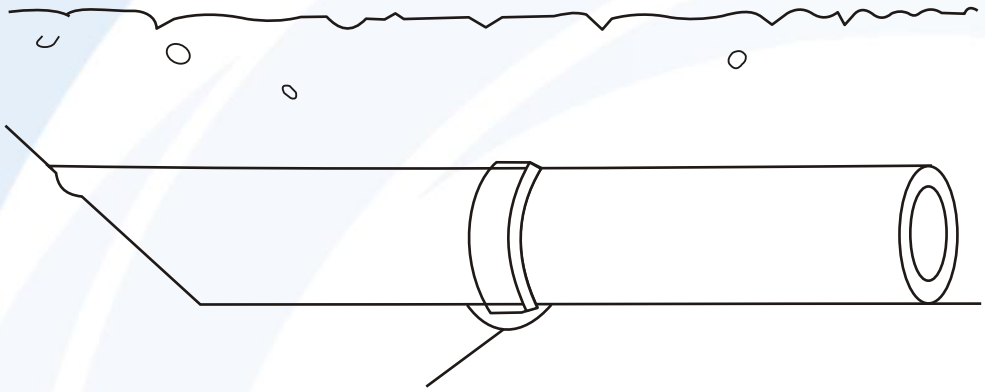
Details of standard trench installations are shown on the next page. The trench must always be wide enough to permit placement and compaction of the pipe zone backfill materials and provide proper pipe support. The depth of cover charts presented in the brochure are based on an assumed trench width of 1.75 times the pipe's nominal diameter. Widths down to 1.5 times DN may be achievable, however the burial limits will be affected.

Bedding

The trench bed, of suitable material, should provide uniform and continuous support for the pipe. The trench bedding material should be of uniform composition to provide continuous support to the pipe during initial installation. No sharp or oversize material must be used in the bedding.



Wrong : Improper Bedding Support



(fill after completing pipe joint)

Right : Proper Bedding Support

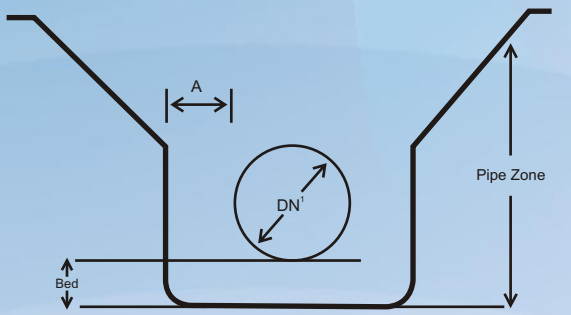
Backfill Materials

To ensure a satisfactory pipe-soil system, correct backfill material must be used. Most coarse grained soils are acceptable bedding and pipe zone backfill material. Where the instructions permit the use of native soil as backfill, care should be taken to ensure that the material does not include rocks, soil dumps, debris, frozen or organic material.

Standard Trench Details

Minimum Width of Trench

Dimension "A" is a minimum of 0.75 * DN/2 and shall not be less than 150.



1. Where rock, hard pan, soft, loose, unstable or highly expansive soils are encountered in the trench. It may be necessary to increase the depth of the bedding layer to achieve adequate longitudinal support.
2. Dimension "A" must allow for adequate space to operate compaction equipment and ensure proper placement of backfill in the haunch region. This may require a wider trench than the minimum specified above, particularly for smaller diameters.

Checking the Installed Pipe

Maximum vertical diametrical deflection must be checked for each pipe after installation.

Installed Diametrical Deflection

The typical maximum allowable vertical diametrical deflection shall be;

Maximum Initial Deflection	
DN > 300	DN ≤ 300
3%	2.5%

The maximum allowable long-term diametrical deflection shall be 5% for diameters 300 mm and higher, and 4% for smaller diameters. These values will apply to all stiffness classes.

Bulges, flat areas or other abrupt changes of pipe wall curvature are not permitted. Pipe installed outside of these limitations may not perform as intended.

Please consult FCI installation manual

FIELD HYDRO TESTING OF FCI PIPE

UNDER GROUND PIPING SYSTEM-COUPLING JOINTS

Field hydro test could be conducted in segments or as complete piping system.

Segment Hydro testing:

Distances of 500 mtrs to 1 KM (min length) will be decided by FCI installation engineer according to site conditions to test the installed piping system in segments. A clearance (undisturbed original soil) of 10 meters minimum shall be maintained between the segments which will take care of end thrust to be transmitted through end caps. In this gap will be later installed as Make-Up pipe piece with double spigot calibrated piece to facilitate the jointing on existing segment.

Fixing Test Plugs

- Using Blind Caps: Make sure Blind end cap is MS/GRP coupling with one end closed through lamination, while the other end is with groove for rubber gasket to work as sealing the end. MS end caps having one end machined same as dia of spigot OD can also work.
- Fix the end cap on the last pipe end to be tested after placing the rubber gasket into end cap groove. Join with the spigot pipe end through pullers/ come-along jacks. Necessary openings could be provided to the end caps for ventilation/pressure gauge. Pressure gauges can be fixed on these opening (there is a screw type connection). After segment test, these end caps could be removed through pullers & upon rubber gasket replacement, could be reused for other segments.
- Hydro test using flange & blind flange, Flange will be of GRP & Blind flange can be metallic. Adequate concrete block supports shall be provided to the end cap to prevent the pipe movement during hydro test.After removal of the end caps after the hydro-test, there will no movement of the pipe.
- Make sure that the test method statement is available with full understanding of implementation to the testing team. Fixing ventilation at highest points, minimum two pressure gauges and filling points with valves or all the ventilation, fill points with valves can be fabricated on end cap.
- Drawings and end cap can be supplied by **FCI.**

  The values and reading at the pressure shall be calculated taking into account the static head between the lowest pipe invert level along the complete line and the level of the pressure gauge. All flanges are tightened to the specified torque bolt sequence.

HYDRO TESTING METHOD

- Hydro Testing method is as follows,
- Thoroughly clean the flange face and the O-ring groove.
- Ensure the sealing gasket is clean and undamaged.
- Position sealing gasket in groove.
- Align flanges to be joined. Insert bolts, washers and nuts. All hardware must be clean and lubricated to avoid incorrect tightening.Washers must be used on all GRP flanges.
- Tighten all bolts by a torque wrench, following standard flange bolt tightening sequences.

WATER FILLING AND PRESSURIZING THE SYSTEM

- Repeat this procedure, raising the bolt torque until the flanges touch at their inside edges. Do not exceed this torque.Doing so may cause permanent damage to GRP flanges.
- It shall be confirmed that all the vent points are fully opened to atmosphere, prior to filling water.
- Introduce water filling through temporary hosing and pump at lowest point.
  Pump capacity shall be chosen according to the pipe diameter and system's linear length.
  (Pumps having capacity of 100 m^3/h are mostly used for large diameter pipes).
- The sign of complete water filling is when the water starts coming through higher point ventilation valves.
- Stop water pumps at this stage and check the flanges, valves and connected accessories for any weepage / leakage while keeping the vents open.

Pressurizing

- Start pressurizing the system through pump. Once the water starts coming out through the vent opening, close the valves at low elevation. Later on, the vents at the higher elevation should also be closed after the water starts coming.
- The pressure increment shall be maintained at approximately 0.5 bar / 10 minutes at this stage. When the pressure reaches to 2 bar, the pumps shall be stopped.
- Keep this stoppage for 15-20 minutes. During this time, following checks shall be made:
- Pressure at each test gauge shall be checked and recorded on inspection sheet.
- Watch the pressure at the water feed point for any decrease in pressure.
- Walk through along with the underground lines to observe any traces of wet soil. Check the coupling joints if exposed.
- The inspection sheet shall be maintained for observations and findings. Anything unusual shall be immediately reported to the engineer Incharge.
- Unless there are no findings which prevent the test from continuing, the system shall be further pressurized.
- Connect the hose with the pressure pump and start pressurizing the line. At this stage, open the vent slightly. Valve should be fixed at a higher elevation to ensure that no entrapped air is present.
- Upon confirmation of water coming out of the vent, valve shall be closed. The system is now totally closed and under pressure.
- Continue the pressure pump until it reaches to 5.0 bar. During this operation the pump shall be continuously attended for pressure control.
- Stop the pressure pump until it reaches 5.0 bar and let it stabilize.
- There could be a drop in pressure due to thermal expansion, which could be resolved by restarting the pump or keep it as it is and record it on the inspection sheet.
- Keep this stoppage for about 30 minutes. During this period, repeat the same sequence of inspection as described earlier. **The test pressure should not exceed 1.25 times the maximum rated operating pressure**. The test pressure shall be maintained for a minimum period of time
- It is recommended to maintain the test hold time to a maximum of 15 minutes after pressure stabilization.
- Fill up the inspection sheets accordingly.
  The test shall be considered **"PASS"** if no sign of leakage is observed.
  The inspection sheet (s) shall be signed by the concerned authorities.

ENVIRONMENTAL GUIDE

Using this environmental guide:

All materials listed in "green" can be used with our current standard pipe resin systems as well as vinyl ester lined pipes. All materials listed in "blue" are in addition to the "green" materials that can be used in pipes that use a vinyl ester resin liner. All materials listed in "red" are not recommended and may not work in any type of FCI pipe system.

	Standard Pipe Resin or Vinyl Ester	Vinyl Ester only	NR
Acetic Acid		x	
Adipic Acid		x	
Alum (Aluminum Potassium Sulfate)	x		
Aluminum Chloride, Aqueous	x		
Ammonia, Aqueous, 20%		x	
Ammonium Chloride, Aqueous (40° C)	x		
Ammonium Fluoride			x
Ammonium Nitrate, Aqueous (40° C)	x		
Ammonium Phosphate Monobasic, Aqueous	x		
Ammonium Sulfate, Aqueous	x		
Aniline Hydrochloride		x	
Antimony Trichloride			x
Barium Carbonate		x	
Barium Chloride		x	
Barium Sulfate		x	
Beet Sugar Liqour		x	
Benzene Sulfonic Acid (10%)		x	
Benzoic Acid		x	
Black Liqour (Paper)		x	
Bleach			x
Borax		x	
Boric Acid		x	
Bromine, Aqueous 5%		x	
Butyric Acid, <25% (40° C)		x	
Calcium Bisulfide	x		
Calcium Carbonate	x		
Calcium Chloride (Saturated)	x		
Calcium Hydroxide, 100%	x		
Calcium Hypochlorite		x	
Calcium Nitrate (40°C)		x	
Calcium Sulfate NL AOC	x		
Cane Sugar Liqours		x	
Carbon Dioxide, Aqueous	x		
Carbon Tetrachloride			x
Casein	x		
Caustic Potash (KOH)			x
Chlorine, Dry Gas		x	

	Standard Pipe Resin or Vinyl Ester	Vinyl Ester only	NR
Chlorine,Water		x	
Chlorine, Wet Gas		x	
Chlorocetic Acid			x
Citric Acid, Aqueous (40° C)			x
Copper Acetate, Aqueous (40° C)	x		
Copper Chloride, Aqueous	x		
Copper Cyanide (30°C)	x		
Copper Nitrate, Aqueous (40° C)	x		
Copper Sulfate, Aqueous (40° C)	x		
Crude Oil (Sour)		x	
Crude Oil (Sweet)		x	
Crude Oil, Salt Water (25° C)		x	
Cyclohexane			x
Cyclohexanol			x
Dibutyl Sebacate	x		
Dibutylphthalate	x		
Diesel Fuel	x		
Dioctyl Phthalate	x		
Ethylene Glycol	x		
Ferric Chloride, Aqueous	x		
Ferric Nitrate, Aqueous	x		
Ferric Sulfate, Aqueous	x		
Ferrous Sulfate, Aqueous	x		
Formaldehyde			x
Fuel Oil	x		
Gas, Natural , Methane			x
Gasoline Ethyl		x	
Glycerine		x	
Green Liqour, Paper			x
Hexane		x	
Hydrobromic Acid			x
Hydrochloric Acid, up to 15%	x		
Hydroflouric Acid			x
Hydrogen Sulfide, Dry		x	
Kerosine (Jet Fuel (all grades)		x	
Lactic Acid, 10%	x		
Lactic Acid, 80% (25° C)	x		

ENVIRONMENTAL GUIDE

Using this environmental guide:

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	Standard Pipe Resin or Vinyl Ester	Vinyl Ester only	NR
Lauric Acid	x		
Lauryl Chloride		x	
Lauryl Sulfate	x		
Lead Acetate, Aqueous	x		
Lead Nitrate	x		
Lead Sulfate	x		
Linseed Oil	x		
Lithium Bromide, Aqueous (40°C)	x		
Lithium Chloride, Aqueous (40°C)	x		
Magnesium Bicarbonate, Aqueous (40°C)	x		
Magnesium Carbonate (40°C)	x		
Magnesium Chloride, Aqueous (25°C)	x		
Magnesium Nitrate, Aqueous (40°C)	x		
Magnesium Sulfate	x		
Magnesium Chloride, Aqueous (40°C)	x		
Manganese Sulfate, Aqueous (40°C)	x		
Mercuric Chloride, Aqueous	x		
Mercurous Chloride, Aqueous	x		
Mineral Oils	x		
n-Haptane		x	
Naphthalene		x	
Naptha		x	
Nickel Chloride, Aqueous (25°C)	x		
Nickel Nitrate, Aqueous (40°C)	x		
Nickel Sulfate, Aqueous (40°C)	x		
Nitric Acid			x
Oleic Acid	x		
Oxalic Acid, Aqueous	x		
Ozone, Gas			x
Paraffin	x		
Pentane			x
Perchloric Acid		x	
Petroleum, Refined & Sour		x	
Phosphoric Acid		x	
Phosphoric Acid (40°C)	x		
Phthalic Acid (25°C)		x	
Potassium Permanganate, 25%		x	
Potassium Bicarbonate	x		
Potassium Bromide, Aqueous (40°C)	x		
Potassium Chloride, Aqueous	x		
Potassium Dichromate, Aqueous	x		
Potassium Ferrocyanide (30°C)	x		
Potassium Ferrocyanide, Aqueous (30°C)	x		
Potassium Nitrate, Aqueous	x		
Potassium Sulfate (40°C)	x		
Propylene Glycol (25°C)	x		

	Standard Pipe Resin or Vinyl Ester	Vinyl Ester only	NR
Sea Water	x		
Sewage (50°C)	x		
Silicone Oil	x		
Silver Nitrate, Aqueous	x		
Sodium Bromide, Aqueous	x		
Sodium Chloride, Aqueous	x		
Sodium Dichromate		x	
Sodium Dihydrogen Phosphate	x		
Sodium Ferrocyanide	x		
Sodium Hydroxide 10%		x	
Sodium Mono-Phosphate	x		
Sodium Nitrate, Aqueous	x		
Sodium Nitrite , Aqueous	x		
Sodium Silicate		x	
Sodium Sulfate, Aqueous	x		
Sodium Sulfide		x	
Sodium Tetraborate		x	
Stannic Chloride, Aqueous	x		
Stannous Chloride, Aqueous	x		
Stearic Acid	x		
Sulfur			x
Sulfuric Acid, 25% (40°C)		x	
Tannic Acic, Aqueous	x		
Tartaric Acid		x	
Toluene Sulfonic Acid		x	
Tributyl Phosphate			x
Triethanolamine			x
Triethylamine			x
Turpentine			x
Urea (Aqueous)		x	
Vinegar		x	
Water, Distilled		x	
Water, Sea	x		
Water, Tap	x		
Zinc Chloride, Aqueous	x		
Zinc Nitrate, Aqueous	x		
Zinc Sulfate, Aqueous	x		
Zinc Sulfite, Aqueous (40°C)	x		

NOTE:

This guide is intended to serve as a basic guide when considering FCI PIPE. Final determination of the suitability of a particular resin system for given environment is the responsibility of the customer. This list is based on information supplied by resin manufacturers who provide FCI producers with their material. Thus, this guide provides only general information and does not imply approval of any application as FCI has no control of the conditions of usage nor any means of identifying environments to which the pipe may unintentionally have been exposed.

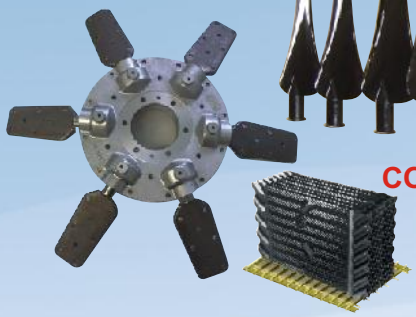
OUR PRODUCT LINE

FCI COOLING TOWERS

COOLING TOWER
FAN BLADES

COOLING TOWER
FAN BLADES

PVC FILL MATERIAL



PVC FILL MATERIAL

FCI IS PIONEER IN FILAMENT WOUND CHEMICAL STORAGE TANKS

Filament Wound
Chemical Storage Tanks

We have no size limitations; as we operate the world,s best computer controlled USA made McClean Anderson filament winding machine & technology.

OUR PRODUCT LINE

FCI BOATS

FCI marine
www.fcimarine.com

Rescue Boat (RB 19)

DY 11

Unsinkable Speed Boat (DY 19)

General Purpose Boat (RQ 29)

Sports / Fishing Boat (SP 21)

Multipurpose Boat (TN 19)

Reservoir Survey Boat (RS 31)

OUR PRODUCT LINE

FCI CHEMICAL TRANSFER PUMPS & PORTA CABINS

Chemical Transfer Pumps

Pit Pump

FRP Porta Cabin

Toll Plaza/Hut/Security Post/Bullet proof security post

OUR PRODUCT LINE

FCI LADDERS

Reach the Height

Extendable
Heavy Duty
Ladder
EXT-20 to 70 ft

A Frame
Both Side Steps
Heavy Duty Ladder

A Frame
Medium Duty
Ladder
AM-6

A Frame
Heavy Duty
Ladder
AH-6

A Frame Platform
Medium Duty Ladder
APM-7