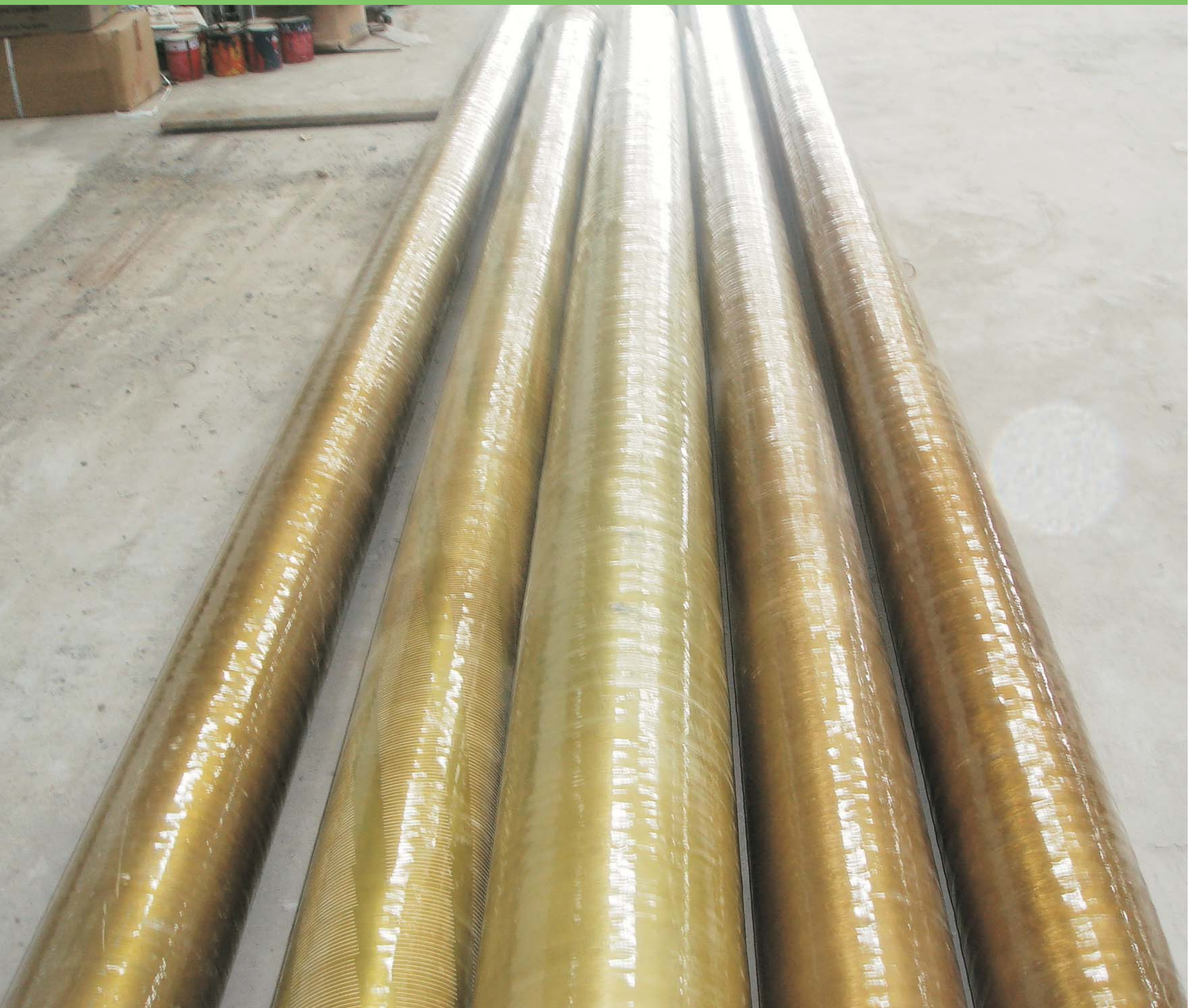
ARC
Insulations & Insulators (P) Ltd.

CERTIFICATION INTERNATIONAL
ISO 9001:2008
Cert No: CI/11769
UKAS QUALITY MANAGEMENT
063

GRP / GRE PIPES & TANKS



Four axis filament winding machine

ARC Insulation & Insulator Pvt. Ltd. started in 2003 with the development and manufacture of a range of GRP pipes which are used in portable drinking water, cooling water systems for power plants, penstock pipes for hydro power plants.

GRP Pipe is the material of choice for handling corrosive fluids and is specially suitable in corrosive conditions, typically cause by corrosive soils, saline water.

Our pipes are engineered and custom fabricated for corrosive environment.

By achieving these parameters, a more reliable and longer pipe life is achieved due to superior properties, higher design factors and higher corrosion resistance.

PRODUCT DESCRIPTION

PRODUCTION PROCESS

Filament winding process

NOMINAL DIAMETERS

DN 50 mm - DN 3500 mm

PIPE LENGTHS

GRP pipes are manufactured between 6m-12m length

PRESSURE CATEGORIES

PN 1 bar to PN 40 bar

STIFFNESS CATEGORIES

GRP pipes are manufactured in SN 2500 N/m2, SN 5000 N/m2, SN 10.000 N/m2, may also be manufactured in the desired values of stiffness according to the project needs.

AREAS OF USE

- Drinking water networks and water distribution pipelines
- Irrigation networks and drainage applications
- Sewerage projects network,collector lines
- Sewerage projects force mains
- Pressure Pipelines for hydroelectric power stations
- Storm water drainage
- Cooling water supply and discharge in power stations
- Pipelines to carry the chemical wastes
- Relining Applications
- Pipelines to remove the industrial wastes
- Pipelines to carry the geothermal water
- Reservoir for chemical plants and drinking water
- Discharge lines of the sea

RAW MATERIALS

Isophtalic, orthophtalic polyester resin, E/ECR fiberglass, quartz sand, catalyst and additives.

Resin: Only qualified resin for the winding process. Usually it is delivered in drums or bulk. The resin is prepared in day tanks at the winder. Normal application temperature is 25oC.

Glass: Glass is specified by tex which is the weight in grams/1000 meters length.

Quartz sand: Sand is added to the core of the pipe and the inner layer of couplings. High silica sand must be within the specifications for approved raw material.

Catalyst: The right amount of catalyst is added to the resin for curing the mix right before application on the mandrel. Only approved catalysts are used in the manufacturing process of the pipes.

Additives: Additives are used as accelerator for the resin and are mixed with it in the day tanks. The addivitives are available in different concentration and may be diluted by the producers in mineral spirit to reach the required concentration needed for the production of the pipes.

QUALITY STANDARDS

GRP pipes are manufactured in accordance with all the national and international standards like IS, ISO, BS, DIN, ASTM ve AWWA. Other local approvals are also available, dependent on country specific requirements. GRP pipes are produced by filament winding process. Major raw materials are ishoptalic, orthoptalic resin, E glass, ECR glass, quartz sand, etc. Production process is fully operated with computer controlled machines which provides standard and repeatable quality in GRP pipes and fittings.

PRODUCTION PROCESS

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Design Codes & Standards :

AWWA C-950	:	For GRP Pressure pipes
ASTM D3517	:	For GRP Pressure pipes
ASTM D2996	:	For filament wound GRP pressure pipes
ASTM D3754	:	For GRP Sewer & industrial pressure pipe
IS 12709	:	For portable drinking water
ASTM D2323-72	:	For installation of buried GRP pipes
ASTM D4161	:	For GRP pipes joints using flexible elastomeric seal
BS 7159-89	:	Design & construction of GRP piping system for industrial plants or sites

SUPERIORITIES and ADVANTAGES

PRODUCTION and METHODS

The production process is fully operated based on computer controlled system to ensure the continuous and repeatable quality. The standards used for the GRP Pipes are, TS 4355 GRP pipes and fittings, AWWA C950 pressure drinking water pipes, ASTM 3517 pressure drinking water pipes, ASTM 3262 gravity sewer pipes, ASTM 3754 pressure sewer pipes, BS 5480 GRP pipes and fittings, DIN16869 GRP pipes and fittings, ISO/DIS 10467.3 waste water pipes, ISO/DIS 10639.3 drinking water pipes, ISO/TR 10465-3 fitting rules.

APPLICATION AREAS

Underground applications, upperground applications, subwater applications, relining

HANDLING and STORAGE

The ability of telescobic loading provides savings in handling and storage.

LIGHTNESS

GRP pipes are in the 1/4 weight of ductile iron, steel pipes and 1/10 weight of concrete pipes. GRP pipes eliminates need for expensive pipe handling equipment.

PIPE LENGTHS

GRP pipes are manufactured between 6m-12m

COUPLING

Sleeve couplings combined with gaskets provides 100% tightness . (Mechanic Couplings , Flanged couplings, couplings with other type of pipes, couplings with parts like valves and etc.)

FAST MOUNTING

Mounting is fast and reliable with EPDM gaskets. GRP pipes make handling and mounting easier than any other types.

CUTTING and FINISHING

Adjustments of pipes on site with easy cutting and finishing according to the desired lengths.

DESIGN

Design alternatives on the basis of chemical materials to be carried, stiffness values, temperature of fluids and fitting types.

EXTREME PRESSURES

Elastic pipe walls substantially absorb the peak pressures which is known as water hammer.

CORROSION RESISTANT

GRP pipes do not require for linings, coatings, cathodic protection, wraps or other forms of corrosion protection. Maintenance cost is low. Hydraulic characteristics essentially constant over time.

HYDRAULIC CONDUCTION

Smooth inside walls of GRP pipes provides savings from pipe diameters and from electrical energy consumptions in pumping lines.(Colebrook White k=0,001 Hazen Williams c=155 Manning n=0,008)

QUALITY of FITTINGS

Fittings have the same characteristics of GRP pipes as they are produced from the same materials.

RESISTIVITY

GRP pipes do not conduct electricity and are not affected from induction flows.

ELASTICITY

The elastic characteristic of GRP pipes enables the accomodation to earth movements. For this reason GRP pipes are preferred in seismic zones. Elasticity also reduces the quantities of bends used in the project.

DEVIATION IN FITTINGS

The tolerance of deviation in the fittings decrease the bends required in the projects. The tolerable degrees are; 3o for DN300-500 mm, 2o for DN600-900 mm, 1o for DN1000-1800 mm and 0,5o for DN>1800 mm

EXTREMELY SMOOTH BORE

Low friction loss means less pumping energy needed and lower operating costs.

ENGINEERING FORMULAS

1. HEAD LOSS

The Hazen Williams, Manning and Darcy-;Weisbach methods are prevalently used to determine the local and continuous pressure loss.

1.1 Hazen-Williams equation;

Hazen Williams equation is applicable to water pipes under conditions of full turbulent flow. Although not as technically correct as other methods for all velocities the Hazen Williams equation has gained wide acceptance in the water and wastewater applications. Many engineers prefer a simplified version of the Hazen Williams equation.

$h_f = [3{,}35 \times 10^6 Q/(Cd^{2{,}63})]^{1{,}852}$

- h_f : Friction factor, m of water /100 m
- Q : Flow rate (L / sec)
- C : Hazen Williams roughness coefficient, (dimensionless)
  Typical value for fiberglass pipe= 150
- d : Pipe inside diameter, mm

Head Loss converted to Pressure Loss;

$p = [(h_f/100)\ L\ (SG)]$

- p : Pressure loss, tone/m² (1 tone/ m²= 9,81 kPA)
- L : Line length (m)
- SG : Specific gravity, dimensionless, (1 for water)

1.2 Manning equation;

The manning equation typically solves gravity flow problems where the pipe is only partially full and is under the influence of an elevation head only.

$Q = (K/n)\ (S)^{0{,}5}\ (R_H)^{2/3}\ A$

- n : Roughness coeefficient
  (0,009 for typical fiberglass pipe)
- K : Coefficient (K=1,0m)
- S : Hydraulic slope, S=(H1-H2)/L
- H_1 : Upstream elevation (m)
- H_2 : Downstream elevation (m)
- L : Length of pipe section (m)
- A : Cross sectional area (m²)
- R_H : hydraulic radius (m), (A/Wp)
- Wp : wetted perimeter of pipe (m)

1.3 Darcy-Weisbach equation;

The primary advantage of this equation is that it is valid for all fluids in both laminar and turbulent flow. "f" coefficient in this equation is characterized with Reynolds number.

If Re.2000 flow type is "Laminar"
If 2000<Re<4000 flow type is "Transition flow zone"
If Re.4000 flow type is "Turbulent"

$h_f = (f/D)\ (V^2/2g)\ L$

- f : Darcy-weisbach friction factor, (dimensionless)
- D : Pipe inside diameter (m)
- h_f : Friction factor (m)
- g : Gravitational constant (9,81 m/s²)
- L : Length of pipe section (m)
- V : Fluid velocity (m/sec)

If $Re \leq 2000$; $f_l = 64/Re$
If $Re \geq 4000$; f coefficient is,
$f_t = [1{,}8 x Log\ (Re/7)]^{-2}$ (%1 imperfection)

1.4 Local Head Loss in Fittings;

Head loss in fittings is expressed as the equivalent length of pipe, that is added to the straight run of pipe. When tabular data are not available or when additional accuracy is necessary, head loss in fittings can be determined using loss coefficients "k" for each type of fitting.

$h_{ff} = K\ (V^2/2g)$

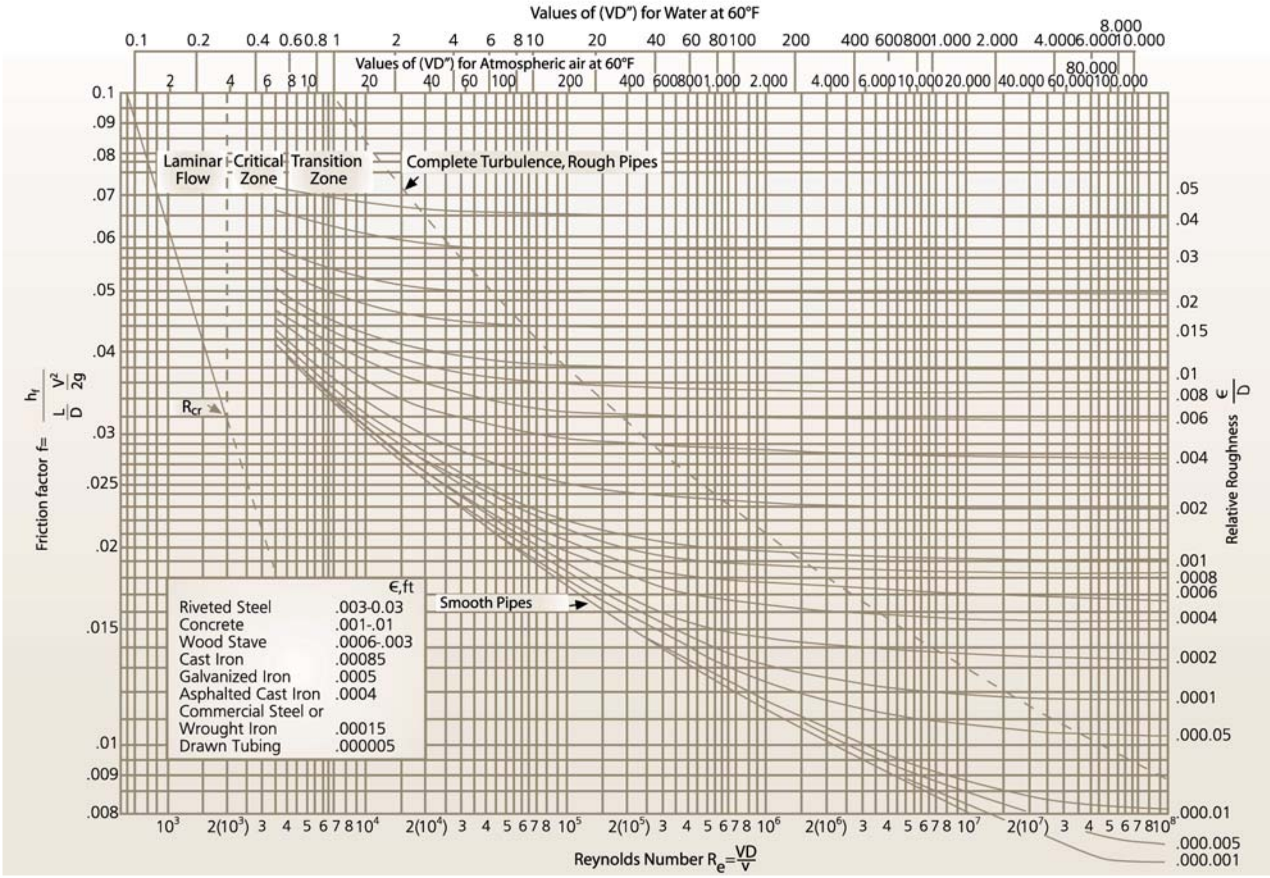
- h_{ff} : head loss (m)

"K" values for some fitting types;

Fitting Type	K- Value
11,25° bend-single miter	0.09
15° bend-single miter	0.20
22,50° bend-single miter	0.12
30° bend-single miter	0.29
45° bend-single miter	0.50
90° bend-single miter	1.40
180° U part	1.30
Tee, flow from branch	1.70
Reducer, single size reduction	0.70
Reducer, double size reduction	3.30

ENGINEERING FORMULAS

MOODY DIAGRAM



2. PRESSURE SURGE

Pressure surge, also known commonly as water hammer, results from an abrupt change of fluid velocity within the system. The magnitude of pressue surge is a function of the fluid properties and velocity, the modulus of elasticity and wall thickness of the pipe material, the length of the line, and the speed at which the momentum of the fluid changes. The relatively high compliance of fiberglass pipe contributes to a self-damping effect as the pressure wave travels through the piping system.

$Ps = a\ (SG)\ \Delta V$

- Ps : Pressure surge deviation from normal (kPa)
- SG : Fluid specific gravity, (dimensionless), (1 for water)
- ΔV : Change in flow velocity (m/sec)
- a : Wave velocity, (m/sec)

$a = 1/[(\rho/g)(1/10^9\ k + d/10^9\ E(t)]^{0.5}$

- ρ : Fluid density (kg/m^3)
- g : Gravitational constant (9,81 m/sec^2)
- k : Bulk modulus of compressibility of liquid (Gpa)
- d : Pipe inside diameter (mm)
- E : Modulus of elasticity (GPa)
- t : Pipe wall thickness (mm)

The pressure class Pc must be greater than or equal to the sum of the working pressure Pw and surge pressure Ps divided by 1,4.

$Pc \geq (Pw+Ps)/1,4$ (AWWA M45)

- Pw : Working pressure
- Ps : Surge pressure

ENGINEERING FORMULAS

Hoop tensile load capacity (N/mm)

DN	PN1	PN6	PN10	PN16	PN20	PN25	PN32
80	N/A	89	178	238	269	N/A	N/A
100	N/A	119	238	318	358	N/A	N/A
150	N/A	178	357	477	538	N/A	N/A
200	N/A	238	476	636	717	N/A	N/A
250	N/A	297	595	795	896	N/A	N/A
300	N/A	357	714	950	1076	N/A	N/A
350	70	420	400	1120	1400	1750	2240
400	80	480	800	1280	1600	2000	2560
450	90	540	900	1440	1800	2250	2880
500	100	600	1000	1600	2000	2500	3200
600	120	720	1200	1920	2400	3000	3840
700	140	840	1400	2240	2800	3500	4480
800	160	960	1600	2560	3200	4000	5120
900	180	7080	1800	2880	3600	4500	5760
1000	200	1200	2000	3200	4000	5000	6400
1200	240	1440	2400	3840	4800	6000	7680
1400	280	1680	2800	4480	5600	7000	8960
1600	320	1920	3200	5120	N/A	N/A	N/A
1800	360	2160	3600	5760	N/A	N/A	N/A
2000	400	2400	4000	6400	N/A	N/A	N/A
2400	480	2880	4800	7680	N/A	N/A	N/A
2500	500	3000	5000	8000	N/A	N/A	N/A

Axial Tensile Load Capacity (N/mm)

DN	PN1	PN6	PN10	PN16	PN20	PN25	PN32
80	N/A	89	178	238	269	N/A	N/A
100	N/A	119	238	318	358	N/A	N/A
150	N/A	178	357	477	538	N/A	N/A
200	N/A	238	476	636	717	N/A	N/A
250	N/A	297	595	795	896	N/A	N/A
300	N/A	357	714	950	1076	N/A	N/A
350	70	420	400	1120	1400	1750	2240
400	80	480	800	1280	1600	2000	2560
450	90	540	900	1440	1800	2250	2880
500	100	600	1000	1600	2000	2500	3200
600	120	720	1200	1920	2400	3000	3840
700	140	840	1400	2240	2800	3500	4480
800	160	960	1600	2560	3200	4000	5120
900	180	7080	1800	2880	3600	4500	5760
1000	200	1200	2000	3200	4000	5000	6400
1200	240	1440	2400	3840	4800	6000	7680
1400	280	1680	2800	4480	5600	7000	8960
1600	320	1920	3200	5120	N/A	N/A	N/A
1800	360	2160	3600	5760	N/A	N/A	N/A
2000	400	2400	4000	6400	N/A	N/A	N/A
2400	480	2880	4800	7680	N/A	N/A	N/A
2500	500	3000	5000	8000	N/A	N/A	NA

FILAMENT WINDING PIPE IN PROCESS

PROPERTIES OF PIPES

The following figures refer to laminated obtained by the filament winding process with a winding angle of 55 degrees. The winding angle can be varied to increase properties in the axial or circumferential directions.

Design Basis Properties

Property	Test method	Pipe N/sq. mm
Ultimate hoop stress	ASTM D1599	250
Hydrostatic design basis, 10^5 hours	ASTM D2992 Method B	172
Hydrostatic design stress, 10^5 hours	ASTM D2992 Method b	86

Mechanical Properties

Property	Test Method	Pipe N/mm²	FittingN/mm²
Allowable axial tensile stress	ASTM D1599	30	25
Axial Tensile modulus	ASTM D1599	13000	10000
Allowable hoop tensile stress	ASTM D1599	55	25
Hoop tensile modulus	ASTM D1599	23000	10000

Other Physical Properties

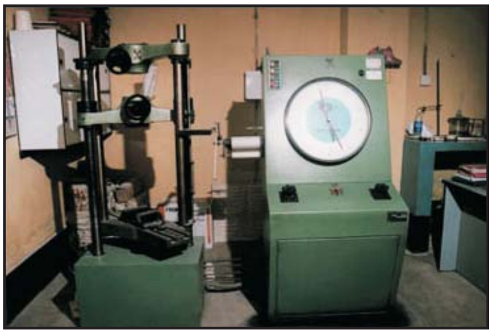
Property	Pipe	Fitting
Coeff. Of linear thermal expansion, 1/ °C	1.8* 10 ^-5	3.0* 10^ -5
Specify gravity, kg/cu. M.	1850	1650
Glass / resin ratio (by weight), %	About 60	About 40

Electrical Conductivity

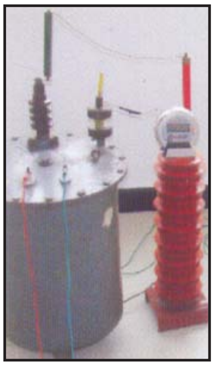
Standard Piping 10^9 M Ohm/m

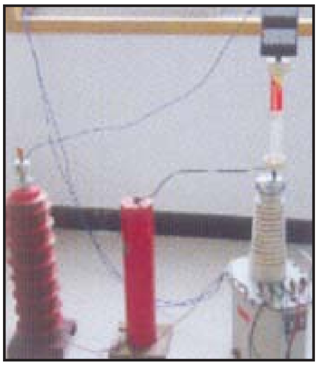
Conductive Piping < 1 M Ohm/m

TESTING EQUIPMENTS



Universal Testing Machine 60 tonnes for testing of hoop tensile and axile tensile of pipes





HIgh Voltage Machine 100 kV

Hydro tester 250 tonnes

Pipe extractor machine

Pipe end callibration machine

Comparison of Technical Features between Glass Fibre Reinforced Pipe(GRP) & Ductile Iron Pipe(DI)

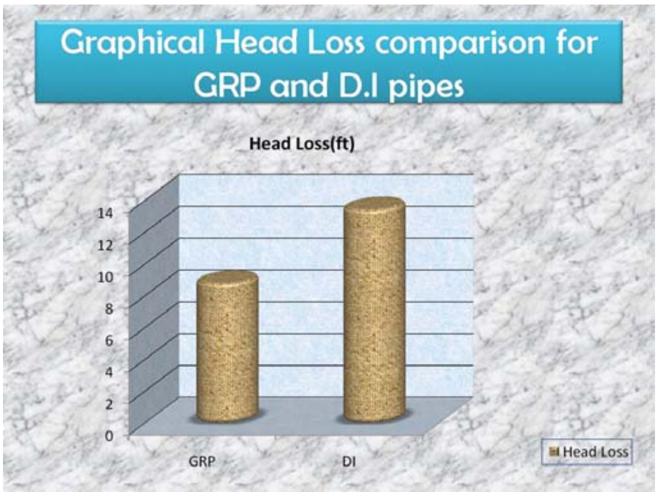
Sl no	Description	DI pipe	GRP pipe
1	Corrosion resistance	Very poor corrosion resistance. Hence coating, Cathodic protection required.	Excellent corrosion resistance. No wrapping or coating is required.
2	Cost	-	15% lower than DI pipe.
3	Installation Cost	Heavy duty tools, Fork lift, Crane required due to heavy weight. Hence installation cost is very high.	Light duty tools are required due to light weight hence lot of cost saving.
4	Maintenance	Periodical maintenance is required.	Less maintenance.
5	life	Due to corrosion the life of the pipe is maximum 15 years.	GRP pipes are designed for minimum 50 years of life.
6	Underground Application	The life of the underground DI pipe is reduced due to organic matters present in the soil.	GRP pipe are not attacked by the organic matters present in the soil.

Sl no	Description	DI pipe	GRP pipe
7	Process parameter for manufacturing	Only one type for all applications.	Varies from case to case. Properties can be fixed depending upon the applications.
8	Weight	Heavy	Very light. Nearly 1/4th of DI pipe.
9	Handling	Difficult, due to heavy weight	Handling is very easy since very light in weight.
10	Specific gravity	7.05	1.8 – 1.9
11	Hazen William's coefficient	120	150. Hence lesser head loss.25% lesser diameter pipe can maintain the same flow.
12	Wall thickness	For particular pressure rating, wall thickness is higher than GRP.	Lesser wall thickness due to proper fibre orientation.

Head Loss Comparison For D.I & GRP

Pipe Material	C Factor	Flow Rate (gpm)	Inside Diameter (inch)	Velocity Of Flow(fps)	Head Loss(ft)
1) GRP	150	4000	24	2.8	8.78
2) DI	120	4000	24	2.8	13.41

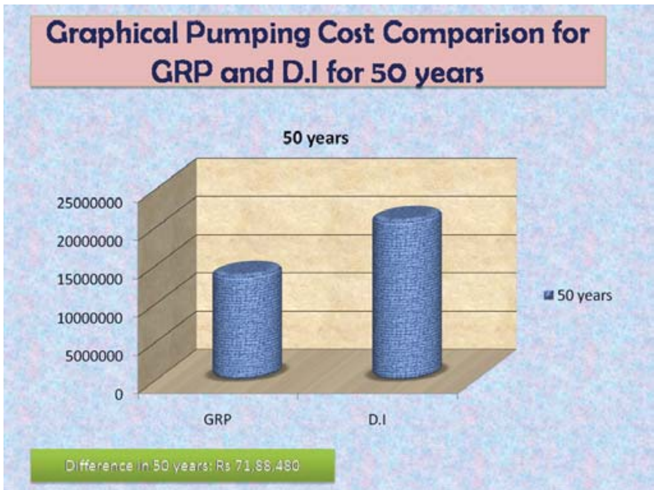
NOTE:
Taking an example of a 24 inch internal diameter water transmission pipeline, that is 10,000 feet long with water flowing at 4000 gpm. We can see the relative effects of C factor. The results are shown in the above tables.



Pumping Cost comparison for GRP and D.I

Pipe Material	Pumping cost/hour (Rs)	Pumping cost/day (Rs)	Pumping cost/month (Rs)	Pumping cost/year (Rs)	Pumping cost for 50 years design life(Rs)
1) GRP	31.50	756.00	22,680.00	2,72,160.00	1,36,08,000
2) DI	48.14	1155.36	34,660.80	4,15,929.60	2,07,96,480

NOTE:
If we take an example of a 24 inch internal diameter water transmission pipeline that is 10,000 feet long with water flowing at 4000 gpm with a velocity of 2.8(fps) considering the total efficiency of pump 90% and motor 70%. We can see the relative cost of pumping between the two types. The results are shown in the above tables considering Rs.3/KWH unit power cost.

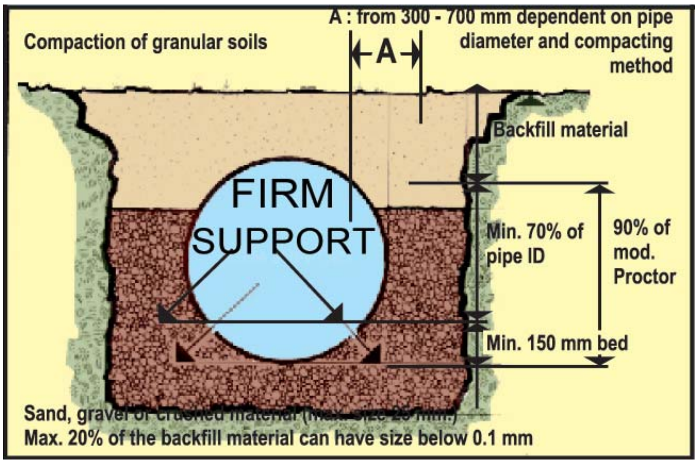


END FITTINGS OF PIPES



Various endfittings such as TEE, Elbows, Reducers and Couplings are supplied as per the specs of the pipes

INSTALLATION DETAILS BURIED PIPINGS



TANKS


The tanks are supplied in vertical and horizontal type upto 4 m dia
Typical uses are in chemical industries, oil and Gas industries, water storage, water effluent treatment plant

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