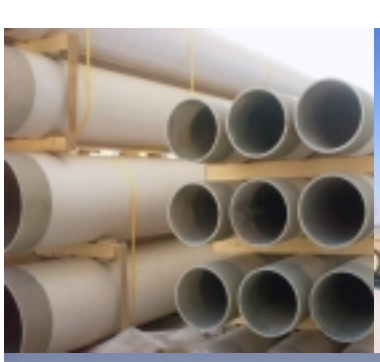
watani Composites




GRP Pipes & Fittings

Product Manual



Pipe Manufacturing Processes Available

- Filament Winding (Continuous Advancing Mandrel)
- Filament Winding (Fixed Mandrel)

Company Profile

Al-Watani Factory For Fiberglass Company was established over 20 years ago in Kuwait and serves the Composite industry locally and its neighboring GCC States. During its early years, it produces GRP moulded products, and a range of fiberglass water storage tanks for household use. Later, it embarked on larger products such as shelters, domes, and other customized items. Today, it manufactures Odour Control Vessels, Water Treatment Equipments and other made-to-order GRP vessels and storage tanks.

In 1998 its Plastic division was started and production of polyethylene tanks were initiated. Capacities of PE water storage tanks ranging from 1000 liters to 10,000 liters became the standard sizes for villas & the industrial sector.

Yet another ambitious endeavour was established in 1999 when the Polymer Concrete Division started operation. It produces a complete range of polymer concrete pipes, fittings, and manholes for the sewer system. Currently, the company is supplying simultaneously a number of projects for the country's sewerage requirements.

The manufacturing facility now covers 100,000 square meters and is fully equipped with state of the art technologies and machineries. The GRP Division is equipped with filament-winding (helical & cross-helical winding patterns-PLC controlled), spray-up, RTM, and hand laminating machines, and is capable of producing large cylinders up to 4250mm diameter with lengths of up to 12 meters. It also manufactures UL-listed GRP underground fuel storage tanks from 4,000 liters to 120,000 liters.

Its new GRP pipe manufacturing plant is about 5,000 square meters and produces pipes of diameters ranging from 300mm to 2600mm at production rate of about 26 meters per hour of high-quality gravity sewer GRP pipes and pressure lines, qualified and tested to international standards.

The company now employs over 800 personnel and is growing to cope up with market demands.

Watani's design philosophy is to provide products with suitable properties and the required margin of safety that will enable the pipe to perform satisfactorily after extended period of operation (more than 50 years) under typical service conditions.

With the GRP Piping Technology from VEM, Watani is looking forward to providing GRP Piping solutions to the various fields:

- Water distribution both civil and industrial
- Sewer Systems both urban and industrial
- Irrigation networks
- Water intakes for cooling water systems
- Waste water outfalls to sea
- Sealines and rivers crossings
- Process lines for industrial plants
- Fire fighting networks
- Corrosive fluids and vent gas stacks
- Well casings and well pump risers
- Penstocks
- Gasoline handling and distribution network
- Flue gas stack

Advantages of Watani GRP Pipe System

Light Weight

- Their lightweight, high-strength ratios require lighter support structures than the heavy metallic systems which enables additional cost savings.
- No need for expensive heavy-duty machineries during installation.

Corrosion-Resistant

- No need for linings or cathodic protection.

Reference Standards

AWWA Manual 45
A Fiberglass Pipe Design Manual for Underground and Aboveground Installation

AWWA C 950
Fiberglass Pressure Pipe

ASTM D 2310
Standard Classification for Machine-Made "Fiberglass" (Glass-Fiber Reinforced Thermosetting-Resin) Pipe.

ASTM D 2996
Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber Reinforced Thermosetting-Resin) Pipe. Applicable to Epoxy, Polyester, and furan resins, in sizes from 1 in. to 16 in. (25mm to 400mm).

ASTM D 3262
Standard Specification for "Fiberglass" (Glass-Fiber Reinforced Thermosetting-Resin) Sewer Pipe. Applicable for pipes 8 in. through 144 in. (200mm through 3,60mm) diameter with or without siliceous sand, and polyester or epoxy resin.

ASTM D 3517
Standard Specification for "Fiberglass" (Glass-Fiber Reinforced Thermosetting-Resin) Pressure Pipe. Applicable for pipes 8 in. through 144 in. (200mm through 3,600 mm) diameter, with or without siliceous sand, and polyester or epoxy resin.

ASTM D 3754
Standard Specification for "Fiberglass" (Glass-Fiber Reinforced Thermosetting-Resin) Sewer and Industrial Pressure Pipe. Applicable for 8 in. through 144 in. (200 mm through 3,600 mm) diameter, with or without siliceous sand, and polyester or epoxy resin.

ASTM D 4161
Standard Specification for "Fiberglass" (Glass-Reinforced Thermosetting-Resin) Pipe Joints using Flexible Elastomeric Seals.

ASTM D 638
Standard Test Method for Tensile Properties of Plastics

ASTM D 1599
Standard Test Method for Short-Term Hydraulic Failure Pressure Pipe, Tubing and Fittings.

ASTM D 2105
Standard Test Method for Longitudinal Tensile Properties of "Fiberglass" (Glass-Fiber Reinforced Thermosetting-Resin) Pipe and Tube.

ASTM D 695
Standard Test Method for Compressive Properties of Rigid Plastics.

ASTM D 790
Standard Test Methods for Flexural Properties of Unreinforced Plastics and Electrical Insulating Materials.

ASTM D 1598
Standard Test Method for Time-To-Failure of Plastic Pipe Under Constant Internal Pressure.

ASTM D 2143
Standard Test Method for Cyclic Pressure Strength of Reinforced Thermosetting Plastic Pipe.

ASTM D 2992
Standard Practice for Obtaining Hydrostatic or Pressure Design Basis for "Fiberglass" (Glass-Fiber Reinforced Thermosetting-Resin) Pipe and Fitting.

ASTM D2142
Standard Test Method for Determination of External Loading Characteristic of Plastic Pipe by Parallel-Plate Loading.

Qualification and Quality Control Tests

Strain-Corrosion

The purpose of this test is to simulate the worst service condition of a gravity sewer pipe. The test is conducted by subjecting 18 ring samples of the pipe, then deflected to various levels and held constant. The ends of the ring specimen is sealed such that the test solution of 0.1N sulfuric acid is contained in the deflected specimen. The time-to-failure is measuered for each sample which is evident when the test solution passes through the pipe wall (leakage). The test data is tabulated and a graph is plotted and extrapolated to 50 years using least square regression analysis technique.

This is done by exposing 18 pieces pipe specimens to constant internal hydrostatic pressures at differing pressure levels and measuring the time to failure for each test. To duplicate service conditions, the joints is sealed by an elastomeric seals with GRP coupling. The longitudinal (axial) load is resisted by the test fixtures in a way, that only the circumferential loads are induced into the pipe wall. In actual condition, the longitudinal forces is resisted by a thrust block and the joint is fixed using a coupling with rubber "o" rings. The time-to-failure is determined when the test fluid passes through the pipe

Hydrostatic Design Basis—HDB

The test procedure of ASTM 2992-96 "Obtaining Hydrostatic or Pressure Design Basis for "Fiber Glass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and fittings—Procedure B" is used as guidelines. The test was commisioned by ANYANG FLYING EAGLE GROUP COMPANY LTD. To Horizon Engineering Group Co. LTD. In year 1997. Pipe samples were taken from GRP pipes produced by CONTINUOUS FILAMENT-WINDING process thru VEM technology. Test result is tabulated in Table 1.

Table 1— Pipe Dimensions and Test Results

	Nominal	Average
Nominal Diameter	500	-
Outer Diameter (AWWA)	514	514.12
Nom. Wall Thickness	8.9	8.96
Resistant Wall Thickness	7.5	7.56
Internal Liner Thickness	1.2	-
Outer Liner Thickness	0.20	-
Mean Resistant Diameter	506.10	506.17
Hoop Tensile Modulus	18,000 MPa	

(*) Discontinued

(1) Measured according to ASTM D 3567 average of 5 readings

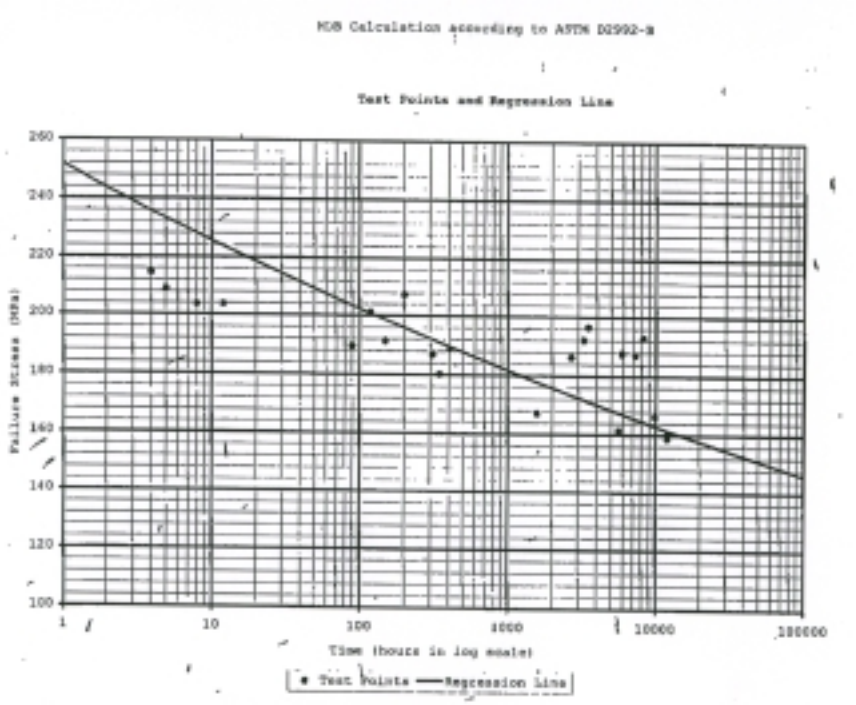
(2) Measured according to ASTM D 3567 average of 4+ readings at each end of the pipe

(3) Calculated on mechanical thickness

Pipe Number	(1) Outer Diameter mm	(2) Wall Tickness mm	Test Pressure bar	Time to Failure h	(3) Hoop Stress MPa	
1	514.49	9.12	65.00	5	208.91	
2	514.94	9.33	65.00	8	203.57	
3	514.95	9.33	65.00	12	203.57	
4	514.03	8.91	65.00	4	214.56	
5	514.79	9.26	60.00	90	189.52	
6	513.25	8.56	60.00	201	207.41	
7	514.61	9.18	60.00	150	191.40	
8	513.77	8.79	60.00	120	201.16	
9	513.51	8.68	55.00	312	187.09	
10	514.16	8.97	55.00	345	180.16	
11	513.35	8.61	55.00	404	188.84	
12	513.53	8.69	55.00	307	186.84	
13	514.41	908	50.00	5600	161.51	
14	513.80	8.81	50.00	1580	167.19	
15	514.53	9.14	50.00	12000	160.30	*
16	513.90	8.85	50.00	9890	166.33	
17	512.93	8.41	45.00	12000	158.78	*
18	513.29	8.58	45.00	12000	155.13	*
19	515.09	9.40	60.00	2680	186.32	
20	514.54	9.15	60.00	3250	192.12	
21	514.96	9.34	60.00	5840	187.68	
22	514.14	8.97	60.00	3500	196.53	
23	514.41	9.09	58.00	7220	187.11	
24	513.88	8.85	58.00	8200	192.93	
25	513.85	8.83	82.00	0.01	273.49	

HDB Calculation according to ASTM D 2992-B

Test Point and Regression Line



● Test Point ▬ Regression Line

Initial Ring Bending

Pipes when subjected to initial ring deflection Level A, shall show no signs of cracking or crazing, and shall show no structural damage to the pipe wall when deflected to Level B.

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

Long-Term Ring Bending

This test is outlined in ASTM D5365 "Long-Term Ring Bending Strain of Fiberglass Pipe" requires that the pipe's long-term deflection capability meets the deflection Level A specified in Initial Ring Deflection Test. Watani pipe complies these requirements.

Test on Joints

Watani Pipe have undergone rigorous joint testing for its coupling with rubber "O" rings.

Tests include:

1. Straight-aligned
2. Angular misaligned
3. Differential shear loading

Testing the Raw Materials

Before being used in production, all new products undergo a wide series of tests to ascertain that it posses qualities complying with physico-chemical and mechanical properties.

Resins

The following parameters are checked on each batch of resin employed to make pipes:

- Density at 20˚C (in-house standard)
- Viscosity at 20˚C (Ford Cup No.4 DIN 53211);
- Geltime at 20˚C with a catalyst system which can vary for each type of resin but which remains constant for the same type in various batches (ASTM D 2471-71);
- Styrene content (UNICHIM 79/1969);
- Acid Number (UNICHIM 6/1969);
- Distortion temperature ASTM D 648/72)
- Gardner Colour (ASTM D 1544);
- Volumetric shrinkage—(in-house standard);
- Barcol hardness, on pure resin (ASTM D 2583/67).

Glass

The following parameters are checked on each batch of glass employed in making the pipes:

- Weight per unit of length/width (in-house standard)
- % humidity—once only (in-house standard);
- % size—once only (in-house standard);
- Split disk test—once only (in-house standard)

Catalyst

- Percentage of active oxygen (in-house standard)

Product Technical Data

Nominal Diameter

- Pipes are manufactured in diameters ranging from 300 mm to 2,600 mm.
- Nominal diameters coincide with the internal diameter.
- Any nominal diameter can be manufactured.

Nominal Pressure Classes

- Pressure pipes are classified acording to nominal pressure.
- Nominal pressure classes are: 4, 6, 10, 16, 20, 25 bar.
- Intermediate or higher pressure classes are considered on request or depending on the design conditions.

Specific Pipe Stiffness Classes

- Pipes are also classified according to specific pipe stiffness.
- Specific pipe stiffness classes are: 1250, 2500, 10000 Pa
- Intermediate or higher specific pipe stiffness classes are available on request or depending on the design conditions.

Long-Term design Strengths

The values given in the following tables are as a general guide, due to the almost infinite sort of structures that can be produced:

PROPERTY	UNIT	FW55	CWH	CWL
• Hoop Modulus	N/mm^2	24500	28000	10000
• Hoop Allowable stress	N/mm^2		70	25
(*)	N/mm^2	60		
• Axial Modulus	N/mm^2	12000	8000	8000
• Axial Allowable stress	N/mm^2	30	10	10
• Compressive Strength	N/mm^2	60	40	40
• HDB (strain basis)	%	0.7 for all		
• Strain Corrosion	%	0.9 for all		

FW55 Reciprocal filament-wound—55˚ winding angle
CWH Continuous filament-wound high pressure
CWL Continuous filament-wount low pressure/ gravity

(*) 4:1 safety factor againts elongation at first crack or design strain 0.25%

HYDRAULIC CHARACTERISTIC

Interior surfaces of all pipes and components have a smooth-glass like finish and due to their excellent resistance to corrosion and zero water absorption and to the fact that they are not subject to attacks by micro-organisms, pipes and components do not undergo increases in roughness or reductions of their section caused by deposits over a long period of time.

Therefore, the designer of a piping system has one or more of the following options, in comparison with other traditional materials:

- Smaller the pipe size for equal flow volume
- Reduced horsepower requirement for pump system
- Larger flow volume for equal size and hydraulic head

Maximum Velocity

The suggested maximum fluid velocity for Watani fiberglass pipe and clean fluid is:

$$v = \frac{40}{\sqrt[3]{p}}, \text{ m/s}$$

Where p is fluid density [kg/m³]

This results in a maximum velocity of 4 m/s for clear water at ambient temperature.

Urban sewers and drainage are not considered corrosive or erosive fluid for Watani fiberglass pipe, hence, the maximum velocity of 4 m/s is allowed.

Pressure Loss Calculations

The most commonly used equations for the calculation of pressure losses in fiberglass pipe:

HAZEN-WILLIAM EQUATION

Hazen-William equation has a good applicability for conditions of full turbulent flow:

$$h_m = \left[\frac{1.176 \times v}{C \times R^{0.63}}\right]^{1.852}$$

Where

h_m = friction loss, meters of liquid column per unit length
C = HW friction factor: 145/150 for fiberglass pipe
R = pipe hydraulic radius (D/4), meters
D = inside diameter, m
v = velocity, m/s

The same equation can be used to calculate the velocity, and the flow rate, when the available head is known:

$$v = 0.85 \times C \times R^{0.63} \times h^{0.54}$$

MANNING EQUATION

Manning equation is traditionally used for gravity flow with a free surface (pipe partially full). The Manning roughness coeffecient (n) for fiberglass pipe is 0.009. The basic equation reads:

$$v = \frac{1}{n} \times R^{0.667} \times h^{0.5}$$

And is very similar to the Hazen-William equation (0.85x145=123; 1/0.009=111).

In case of flow with a free surface the hydraulic radius is:

$$R = \frac{A}{W_p}$$

Where

A = cross-sectional area of the liquid section, m^2

W_p = wetted perimeter of the pipe, m

DARCY-WEISBACH EQUATION

Darcy-Weisbach equation with colebrook friction factor is the most universal since it is valid for any diameter, velocity and fluid, both in turbulent and laminar flow.

$$h = \frac{f.v^2}{2.g.D}$$

Where

f = Colebrook friction
g = gravitational constant

The friction factor depends on the Reynolds number R_e and on the roughness of the internal pipe surface, measured as a length (E).

The Reynolds number is:

$$R_e = \frac{v.D}{\ddot{u}}$$

Where $\ddot{u}$ is the kinematic viscosity $[m^2/s]$, depending on the fluid and on the temperature.

For $R_e > 4000$ (in most cases) the Colebrook friction factor is:

$$\frac{1}{\sqrt{f}} = -2 \log \left[\frac{E}{3.71.D} + \frac{2.51}{R_e \sqrt{f}} \right]$$

The value of absolute roughness (E) of the interior surface of RTRP pipe is estimated at 5 $\ddot{u}$m. For the use in Darcy-Weisbach formula with Colebrook coeffecient a value of 50/100$\ddot{u}$m can be used epending on the type of joint and on the distance between them.

Head Loss in Fittings

Head loss in fitting can be calculated in equivalent length of pipe that is added to the straight run of pipe or using loss coeffecient (K factors) like for other piping materials.

$$H_f = K \frac{v^2}{2g}$$

Typical K factors for fiberglass fittings are given in the following table:

Type of Fitting	K Factor
45˚ elbow, std.(R=1.5D)	0.3
45˚ elbow, 1 miter	0.5
90˚ elbow, std.(R=1.5D)	0.5
90˚ elbow, 3 miters	0.6
90˚ elbow, 2 miters	0.8
90˚ elbow, 1 miter	0.9
180˚ return bend, std.	1.8
Tee, straight flow	0.4
Tee, flow branch	1.4
Tee, flow from branch	1.7
Reducer, single size reduction	0.7
Reducer, double size reduction	3.3

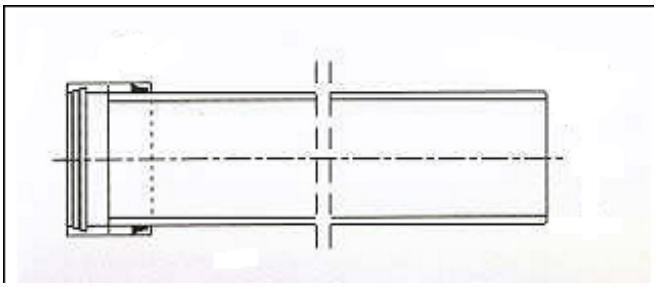
Water Hammer

The magnitude of water hammer is a function of

- The fluid properties i.e. the bulk modulus of compressibility of the fluid
- The change in flow velocity
- The modulus of elasticity of the pipe material
- The thickness to diameter ratio of the pipe

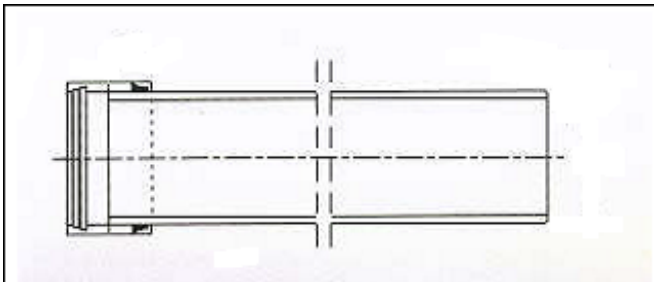
The relatively low modulus of elasticity of fiberglass pipe contributes to a self-dampening as the pressure wave travels through the piping system.

Pipe Dimensions



THICKNESS & WEIGHT OF PIPE AT 2,500 STIS

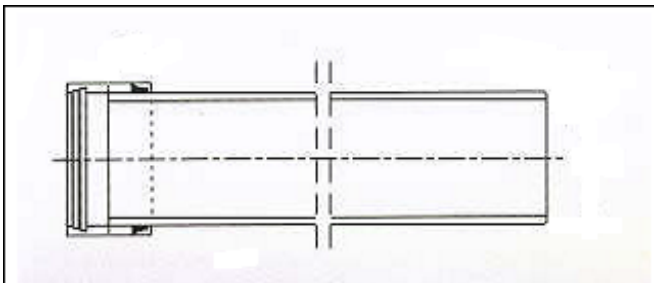
DN (mm)	OD (min)	OD (max)	3 BAR (mm)	6 BAR (mm)	10 BAR (mm)	12 BAR (mm)	16 BAR (mm)	20 BAR (mm)	25 BAR (mm)	32 BAR (mm)	WEIGHT (kg/m)
300	352.2	352.7	-	-	-	-	-	-	-	-	15.46
350	378	379	4.72	4.72	4.55	4.47		4.44	-	-	11.50
400	412	413	5.14	5.14	4.92	4.82	4.74	4.77	-	-	13.76
450	463	464	5.78	5.78	5.45	5.32	5.27	5.25	-	-	17.59
500	514	515	6.44	6.44	5.95	5.82	5.76	5.73	-	-	21.95
600	616	617	7.84	7.84	6.97	6.82	6.72	6.68	-	-	32.05
700	718	719	9.02	9.02	8.01	7.85	7.68	7.63	-	-	43.20
800	820	821	10.08	10.08	9.07	8.85	8.64	8.57	-	-	56.05
900	922	923	11.26	11.26	10.11	9.83	9.59	9.52	-	-	70.71
1000	1024	1025	12.46	12.46	11.14	10.83	10.54	10.46	-	-	87.15
1100	1126	1127	13.66	13.66	12.16	11.81	11.50	11.40	-	-	105.27
1200	1228	1229	14.78	14.78	13.18	12.80	12.45	12.35	-	-	124.46
1300	1330	1331	15.98	15.98	14.20	13.80	13.40	13.29	-	-	146.05
1400	1432	1433	17.12	17.12	15.23	14.77	14.36	14.23	-	-	168.64
1500	1534	1535	18.20	18.20	16.22	15.75	15.31	-	-	-	192.34
1600	1636	1637	19.43	19.43	17.28	16.74	16.26	-	-	-	219.26
1700	1738	1739	20.76	20.76	18.29	17.72	17.21	-	-	-	249.15
1800	1840	1841	21.91	21.91	19.31	18.71	18.17	-	-	-	278.73
1900	1942	1943	23.03	23.03	20.31	19.71	19.12	-	-	-	309.35
2000	2044	2045	24.21	24.21	21.36	20.69	20.06	-	-	-	342.54
2100	2146	2147	25.37	25.37	22.38	21.68	21.02	-	-	-	377.20
2200	2248	2249	26.54	26.54	23.39	22.65	21.97	-	-	-	413.43
2300	2350	2351	27.70	27.70	24.43	23.65	22.92	-	-	-	451.42
2400	2452	2453	28.86	28.86	25.42	24.63	23.87	-	-	-	491.09
2500	2554	2555	29.97	29.97	26.46	25.61	24.82	-	-	-	531.21



THICKNESS & WEIGHT OF PIPE AT 5,000 STIS

DN (mm)	OD (min)	OD (max)	3 BAR (mm)	6 BAR (mm)	10 BAR (mm)	12 BAR (mm)	16 BAR (mm)	20 BAR (mm)	25 BAR (mm)	32 BAR (mm)	WEIGHT (kg/m)
300	325.2	325.7	-	-	-	-	-	-	-	-	15.46
350	378	379	5.93	5.93	5.78	5.60	5.41	5.35	-	-	14.75
400	412	413	6.49	6.49	6.19	6.02	5.83	5.81	-	-	17.69
450	463	464	7.29	7.29	6.94	6.70	6.46	6.42	-	-	22.50
500	514	515	8.11	8.11	7.62	7.33	7.14	7.02	-	-	27.95
600	616	617	9.63	9.63	8.94	8.63	8.38	8.23	-	-	40.08
700	718	719	11.12	11.12	10.32	10.03	9.63	9.43	-	-	54.17
800	820	821	12.54	12.54	11.64	11.35	10.86	10.64	-	-	70.08
900	922	923	14.01	14.01	13.16	12.63	12.09	11.84	-	-	88.26
1000	1024	1025	15.44	15.44	14.53	13.95	13.33	13.04	-	-	108.20
1100	1126	1127	16.92	16.92	15.89	15.27	14.55	14.25	-	-	130.71
1200	1228	1229	18.32	18.32	17.28	16.56	15.78	15.45	-	-	154.55
1300	1330	1331	19.92	19.92	18.63	17.86	17.02	16.65	-	-	182.27
1400	1432	1433	21.36	21.36	19.97	19.17	18.26	17.85	-	-	210.66
1500	1534	1535	22.88	22.88	21.35	20.45	19.48	-	-	-	242.13
1600	1636	1637	24.30	24.30	22.74	21.74	20.71	-	-	-	274.47
1700	1738	1739	25.80	25.80	24.09	23.05	21.95	-	-	-	309.86
1800	1840	1841	27.28	27.28	25.45	24.38	23.17	-	-	-	347.05
1900	1942	1943	28.71	28.71	26.82	25.66	24.40	-		-	385.71
2000	2044	2045	30.14	30.14	28.18	26.97	25.65	-	-	-	426.38
2100	2146	2147	31.62	31.62	29.53	28.26	26.87	-	-	-	469.96
2200	2248	2249	33.10	33.10	30.90	29.57	28.10	-	-	-	515.52
2300	2350	2351	34.51	34.51	32.31	30.84	29.33	-	-	-	562.12
2400	2452	2453	35.97	35.97	33.66	32.19	30.57	-	-	-	611.55
2500	2554	2555	37.49	37.49	35.03	33.46	31.79	-	*	-	664.33

Pipe Dimensions



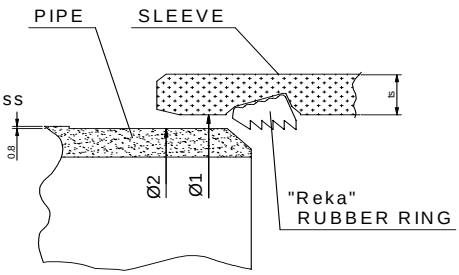
THICKNESS & WEIGHT OF PIPE AT 10,000 STIS

DN (mm)	OD (min)	OD (max)	3 BAR (mm)	6 BAR (mm)	10 BAR (mm)	12 BAR (mm)	16 BAR (mm)	20 BAR (mm)	25 BAR (mm)	32 BAR (mm)	WEIGHT (kg/m)
300	325.2	325.7	7.60	7.60	7.60	7.60	7.60	-	-	-	15.46
350	378	379	7.16	7.16	7.16	7.16	6.81	-	-	-	17.88
400	412	413	7.84	7.84	7.84	7.80	7.36	-	-	-	21.47
450	463	464	8.78	8.78	8.78	8.67	8.18	-	-	-	27.17
500	514	515	9.78	9.78	9.78	9.55	9.02	-	-	-	33.78
600	616	617	11.71	11.71	11.71	10.83	10.73	-	-	-	48.82
700	718	719	13.68	13.68	13.68	13.02	12.34	-	-	-	66.83
800	820	821	15.53	15.53	15.53	14.89	13.95	-	-	-	86.90
900	922	923	17.32	17.32	17.32	16.64	15.61	-	-	-	109.24
1000	1024	1025	19.25	19.25	19.25	18.43	17.23	-	-	-	135.04
1100	1126	1127	21.15	21.15	21.15	20.18	18.86	-	-	-	163.49
1200	1228	1229	22.95	22.95	22.95	21.89	20.49	-	-	-	193.72
1300	1330	1331	24.82	24.82	24.82	23.67	22.08	-	-	-	227.15
1400	1432	1433	26.65	26.65	26.65	25.41	23.74	-	-	-	262.86
1500	1534	1535	28.43	28.43	28.43	27.21	25.37	-	-	-	300.52
1600	1636	1637	30.33	30.33	30.33	28.91	26.99	-	-	-	342.32
1700	1738	1739	32.12	32.12	32.12	30.71	28.61	-	-	-	385.24
1800	1840	1841	33.99	33.99	33.99	32.47	30.26	-	-	-	431.84
1900	1942	1943	35.83	35.83	35.83	34.22	31.86	-	-	-	480.87
2000	2044	2045	37.60	37.60	37.60	35.97	33.49	-	-	-	531.21
2100	2146	2147	39.46	39.46	39.46	37.71	35.11	-	-	-	585.60
2200	2248	2249	41.30	41.30	41.30	39.43	36.74	-	-	-	642.25
2300	2350	2351	43.10	43.10	43.10	41.22	38.39	-	-	-	700.82
2400	2452	2453	44.90	44.90	44.90	42.99	40.01	-	-	-	762.00
2500	2554	2555	46.79	46.79	46.79	44.72	41.64	-	-	-	827.58

Coupling Dimensions

DIMENSIONS

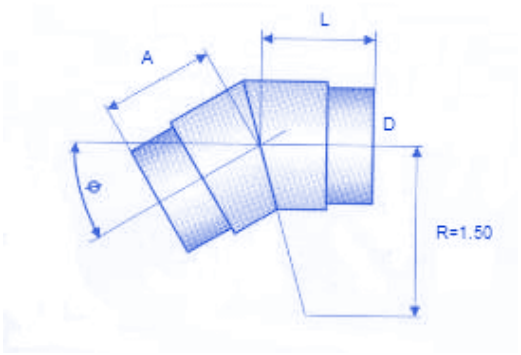
Ø1 = Sleeve ID
Ø2 = Spigot OD
ts = Spigot thickness



SECTION DETAILS OF PIPE WITH INSTALLED COUPLING WITH RUBBER RING

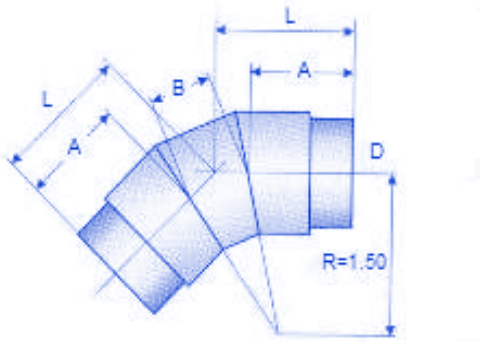
DN	SPIGOT OD (mm)	SLEEVE ID (mm)	t0 (mm)	PN 6 BAR		PN 10 BAR		PN 16 BAR		PN 25 BAR	
				t1 (mm)	ts (mm)	t1 (mm)	ts (mm)	t1 (mm)	ts (mm)	t1 (mm)	ts (mm)
250	259	263.2	14.1	-	-	2.0	16.1	2.0	16.1	3.3	17.4
300	310	314.2	14.1	-	-	2.0	16.1	2.0	16.1	4.5	18.6
350	361	365.2	14.1	-	-	2.0	16.1	2.6	16.7	5.6	19.7
400	412	416.2	14.1	-	-	2.0	16.1	3.3	17.4	6.8	20.9
450	462	465.0	17.1	-	-	2.0	19.1	3.4	20.5	7.3	24.4
500	514	517.0	17.1	-	-	2.0	19.1	4.2	21.3	8.5	25.6
600	616	619.0	17.1	-	-	2.2	19.3	5.6	22.7	10.8	27.9
700	718	721.0	17.1	2.0	19.1	3.1	20.2	7.1	24.2	13.1	30.2
800	820	823.0	17.1	2.0	19.1	4.1	21.2	8.6	25.7	15.5	32.6
900	922	925.0	17.1	2.0	19.1	5.0	22.1	10.1	27.2	17.8	34.9
1000	1024	1027.0	17.1	2.1	19.2	5.9	23.0	11.6	28.7	20.2	37.3
1100	1126	1129.0	17.1	2.7	19.8	6.8	23.9	13.1	30.2	22.5	39.6
1200	1228	1231.0	17.1	3.2	20.3	7.8	24.9	14.6	31.7	24.9	42.0
1300	1330	1333.0	17.1	3.8	20.9	8.7	25.8	16.1	33.2	-	-
1400	1432	1435.0	17.1	4.3	21.4	9.7	26.8	17.6	34.7	-	-
1500	1534	1539.8	19.1	4.5	23.6	10.2	29.3	18.8	37.9	-	-
1600	1636	1641.8	19.1	5.1	24.2	11.2	30.3	20.3	39.4	-	-
1700	1738	1743.8	19.1	5.6	24.7	12.1	31.2	21.8	40.9	-	-
1800	1840	1845.8	19.1	6.2	25.3	13.0	32.1	23.3	42.4	-	-
1900	1942	1947.8	19.1	6.8	25.9	14.0	33.1	24.8	43.9	-	-
2000	2044	2049.8	19.1	7.3	26.4	14.9	34.0	26.3	45.4	-	-
2100	2146	2151.8	19.1	7.9	27.0	15.9	35.0	27.8	46.9	-	-
2200	2248	2253.8	19.1	8.4	27.5	16.8	35.9	29.3	48.4	-	-
2300	2350	2355.8	19.1	9.0	28.1	17.7	36.8	30.8	49.9	-	-
2400	2452	2457.8	19.1	10.4	29.5	20.0	39.1	34.5	53.6	-	-
2500	2554	2559.8	19.1	11.9	31.0	22.6	41.7	38.6	57.7	-	-
2600	2656	2661.8	19.1	12.6	31.7	23.6	42.7	40.3	59.4	-	

GRP Fittings



30° Elbow, 1-miter

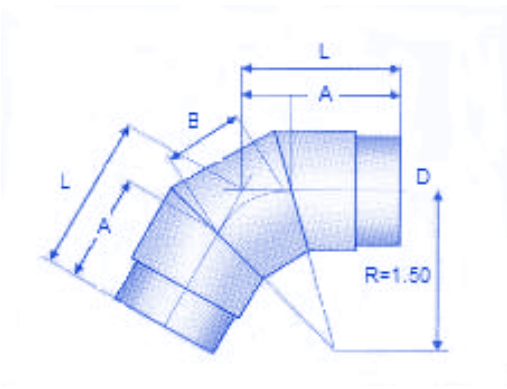
D (mm)	A (mm)	L (mm)
300	350	350
350	350	350
400	400	400
450	400	400
500	450	450
600	500	500
700	550	550
800	600	600
900	650	650
1000	650	650
1100	650	650
1200	700	700
1300	750	750
1400	800	800
1500	900	900
1600	950	950
1700	1000	1000
1800	1050	1050
1900	1150	1150
2000	1200	1200
2100	1250	1250
2200	1300	1300
2300	1350	1350
2400	1450	1450
2500	1500	1500



45° Elbow, 2-miter

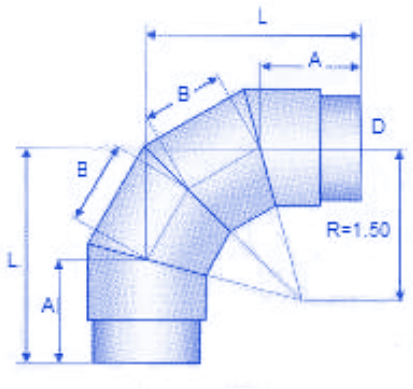
D (mm)	A (mm)	B (mm)	L (mm)
300	400	179	497
350	400	209	513
400	400	239	529
450	400	269	546
500	450	299	612
600	500	358	694
700	550	418	776
800	600	478	859
900	650	537	941
1000	700	597	1023
1100	750	657	1106
1200	800	716	1188
1300	850	776	1270
1400	900	836	1352
1500	950	895	1434
1600	1000	955	1517
1700	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
2500	1500	1492	2308

GRP Fittings



60˚ Elbow, 2-miter

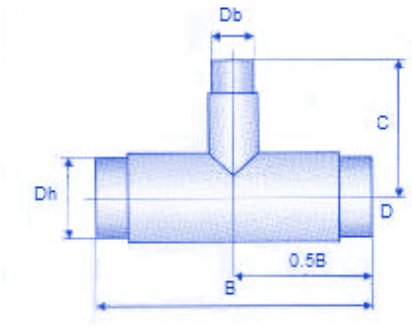
D (mm)	A (mm)	B (mm)	L (mm)
300	400	242	540
350	400	281	562
400	400	322	586
450	400	362	609
500	450	402	682
600	500	482	778
700	550	563	875
800	600	643	971
900	650	724	1068
1000	700	804	1164
1100	750	884	1260
1200	800	965	1357
1300	900	1045	1503
1400	1000	1126	1650
1500	1100	1206	1796
1600	1200	1286	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
2500	2000	2010	3160



90˚ Elbow, 3-miter

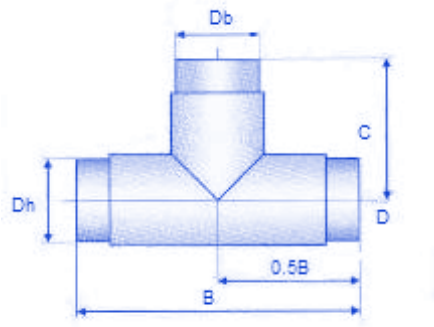
D (mm)	A (mm)	B (mm)	L (mm)
300	400	242	731
350	400	281	784
400	400	322	840
450	400	362	895
500	450	402	999
600	500	480	1158
700	550	563	1319
800	600	643	1478
900	650	724	1639
1000	700	804	1798
1100	750	884	1958
1200	800	965	2118
1300	900	1045	2328
1400	1000	1126	2538
1500	1100	1206	2747
1600	1200	1286	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
2500	2000	2010	4746

GRP Fittings



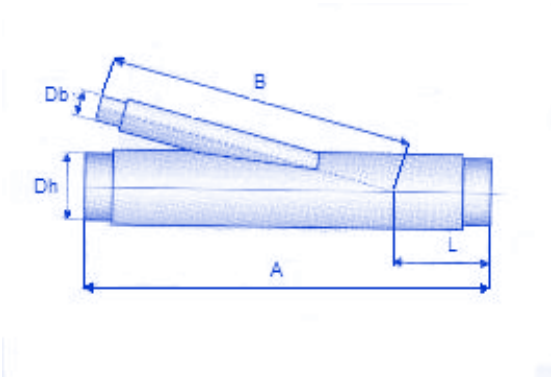
90° Tee, $D_b < 0.5D_h$

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
2500	3800	2510



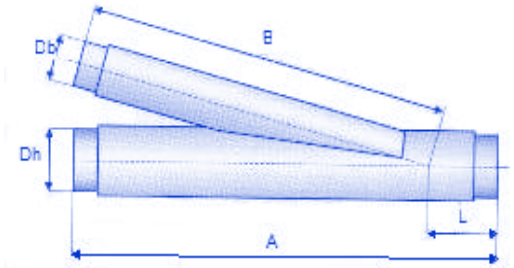
90° Tee, $D_b > 0.5D_h$

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	4300	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
2500	6550	3275



15° Wye ($D_s < 0.5D_h$)

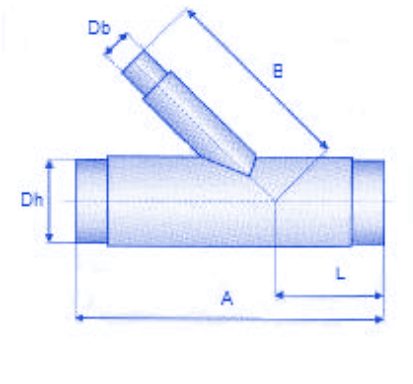
D (mm)	A (mm)	B (mm)	L (mm)
300	1900	1500	400
350	2200	1700	500
400	2500	1900	600
450	2800	2100	700
500	3100	2300	800
600	3550	3650	900
700	4000	3000	1000
800	4500	3400	1100
900	4900	3800	1200
1000	5100	4200	1300
1100	5700	4550	1400
1200	6200	4950	1500
1300	6700	5300	1600
1400	7200	5500	1700
1500	7700	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
2500	12650	8900	2800



15° Wye ($D_s > 0.5D_h$)

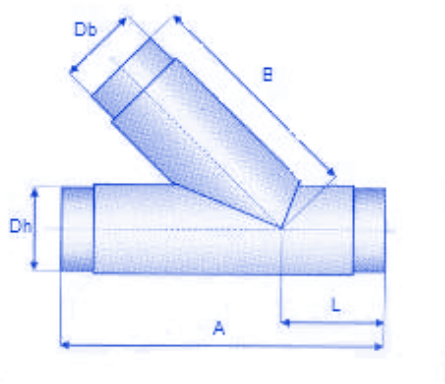
D (mm)	A (mm)	B (mm)	L (mm)
300	2900	1700	400
350	3200	2700	500
400	3500	2900	600
450	3800	3100	700
500	4100	3300	800
600	4550	3650	900
700	5000	4000	1000
800	5500	4400	1100
900	6000	4800	1200
1000	6500	5200	1300
1100	6950	5550	1400
1200	7450	5950	1500
1300	7900	6300	1600
1400	8400	6700	1700
1500	8900	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
2500	13650	11850	2800

GRP Fittings



45° and 60° Wye, ($D_b < 0.5D_h$)

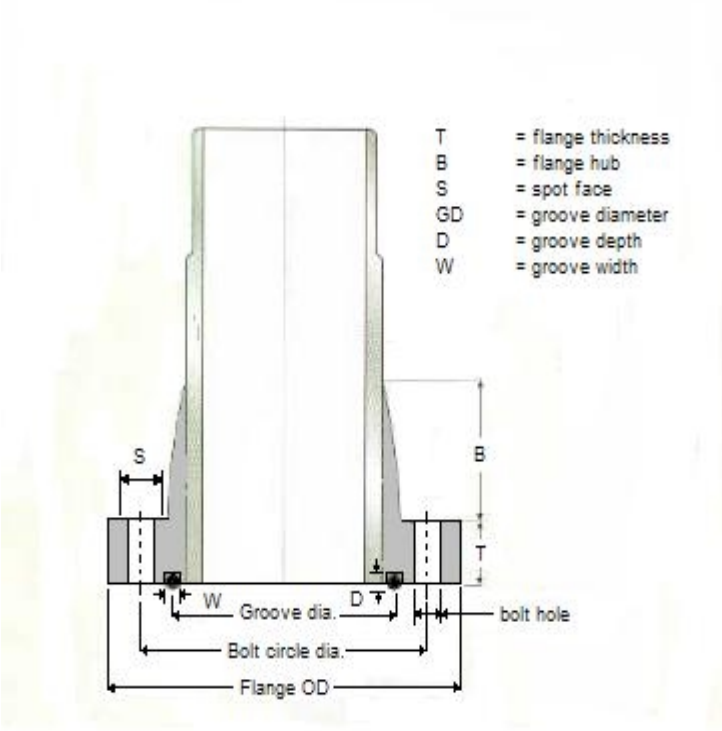
D (mm)	A (mm)	B (mm)	L (mm)
350	1300	850	450
400	1550	1000	550
450	1700	1100	600
500	1800	1150	650
600	2050	1300	750
700	2350	1500	850
800	3650	1700	950
900	3950	1900	1050
1000	3250	2100	1150
1100	3550	2300	1250
1200	3850	2500	1350
1300	4150	2700	1450
1400	4450	2900	1550
1500	4750	3100	1650
1600	5050	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
2500	7750	5100	2650



45° and 60° Wye, ($D_b > 0.5D_h$)

D (mm)	A (mm)	B (mm)	L (mm)
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
2500	6100	3700	1850

GRP Fittings



FLANGE DIMENSIONS

DN		Flange Thickness	Flange OD	Groove Diameter	DRILLING STANDARD					
					AWWA Class D			ANSI B16.1 Class 125		
mm	inch	T, mm +10	+10-0	mm	No. of bolts	Bolt holes Dia +1.5	BCD	No. of bolts	Bolt holes Dia. +1.5	BCD
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	635.0	20	34.8	635.0
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	1155	1858	1563.8	52	50.5	1759.0	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