GRP PIPE SYSTEMS

General Presentation Catalogue

GRANDPIPE

We Join The Cultures By Water

technologized by FARATEC®

GRANDPIPE

GENERAL PRESENTATION CATALOQUE

Technical information given in this catalogue is only for general informing. Granndpipe keeps rights to change technical and design details.

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GRANDPIPE

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The Purest State of Water: **WATER CRISTAL,** under our protection!

technologized by FARATEC®

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I Water and Civilization

Water management has a long history, going back to the attempts in prehistoric times in response to seasonal changes in water availability. Water management was crucial during the transition from hunting-gathering to farming, and became yet more important with the emergence of cities, industrial towns, and administrative centres. Water management has never solely been a matter of technical intervention. It is embedded within a great diversity of cultural, social and political arrangements.

Water emdodies culture and civilization. Water is the most important vital item which togethers cultures and civilizations and joins as one part. Water is the symbol of abundance and purity.

Objective of Grandpipe is to be inside of the projects which act a role to join cultures and civilization, to transmit its selfculture to regions where it reaches and to integrate the other cultures.

By our products, Our aim is to contribute to be composed of the societies who know the value of water and use the water sources effectively.

Therefore, The slogan of Grandpipe is defined ***"We Join The Cultures By Water".***

Suleymaniye Waterway Map

II Company Profile

Grandpipe has been in 87.500 m² which is 13.200 m² as closed area.

All managerial and production facilities of Grandpipe Industry and Trade Inc.are located in Yalova City. Grandpipe has a business cooperation with Faratec about pipe systems and technologies.

Grandpipe follows up domestic and international market by its territorial business partners and representatives.

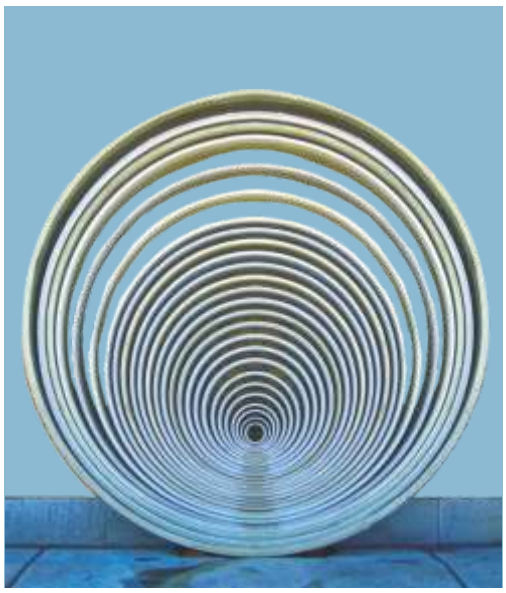
Faratec, has excellent experience in GRP pipe and composite sector since 1992, for all kind of water transportation, special process applications and petrochemical products trasportation. Background of this long termly success is obtained by Faratec Technology Center that precisely performs technology and R & D studies.

Grandpipe products meet all requirements of global and local standards like CEN, ISO, TSE, AWWA, ASTM, BSI .

Product Range of Grandpipe is as follows.

- Diameter : DN 100 – 4000 mm
- Pressure : PN 1 – 40 bar
- Stiffness : SN 1250 – 10000 Pa

This product range covers standard products. According to customer requests and project needs, for non-standard applications, special designs are performed by Grandpipe. On the pressure and stiffness classes mentioned above, all designs are under the guarantee of Grandpipe Approval



III GRP Composites

Glassfiber Reinforced Plastic (GRP) materials are classified as polymer matrix composites. GRP that can be used for several purposes is light, longevous, strong structural composite material. It can be in different appearance (translucent – opaque – fully coloured), flattened or shaped, thick or thin. The main principle of GRP can be defined as a composite structure – reinforced by glassfiber and fully combined by resin.

Accordance with utilisation area, economic factors; other material groups can be included in GRP composite structure together with these two main material groups.

Today, GRP composites are used in several disciplines like aerospace and aeronautical industry, medical, automotive industry, infrastructures.

As summary it is very common to meet with GRP composites at the every field of life.

1 GRP Pipes

When we consider today, easily it can be noticed that world's infrastructure is aged continuously and thousands of kilometers of pipelines need to be rehabilitated. This situation is one of the most priority problems that should be considered, in all over the world.

Investor organizations which serve to humanity at the world are obliged to have right and difficult decisions how to construct new infrastructures, which type of materials they will use not to re-face the same problems met in the past.

Main reason of this problem is corrosion. Internally unprotected concrete sewer pipes are rapidly deteriorated by the presence of sulfuric acid in a sanitary sewer system. Externally, soil conditions and stray electrical currents can deteriorate underground pipes. Metallic pipes can corrode when placed in poorly aerated, poorly drained soils of low resistivity.

These problems can be significantly reduced, even if not eliminated irrevocably, Precautions by corrosion-resistant material systems and corrosion protection systems will be caused to higher pipelines costs.

Corrosion is non-reversible process.

There is one simple way to fully elimination of this problem: GRP PIPE

Amazon Nehri

2 GRP Pipe Applications

Growing awareness of the operational cost savings and superior corrosion resistance is resulted to world wide utilisation area for GRP pipe that emphasized strongestly to related subject. GRP pipes are used wide spread application areas as follows:

- Water transmission and distribution lines (potable water and raw water)
- Sanitary Collection Systems
- Storm Sewer Systems
- Hydroelectric Penstock Lines
- Hydropower Projects
- Sea water intake
- Cooling water lines
- Circulating water, make-up and blow downlines for power plants
- Irrigation and drainage systems
- Fire fighting Lines
- Industrial Applications
- Water reservoir lines and tanks
- Pumping Systems
- Chemical and Petrochemical Industries
- Rehabilitation Projects
- Trenchless System Applications (Pipe Jacking)

Grandpipe GRP pipes delivers long, effective service life with low operating and maintenance costs.

Nile River

Amudarya River

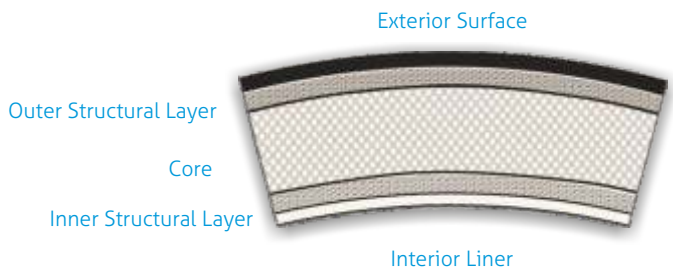
3 Product Properties and Advantages

Properties	Advantages
Corrosion Resistance	⇢ Long and effective service life ⇢ No need for linings, coatings, cathodic protection, wraps or other forms of corrosion problems ⇢ Low maintenance cost ⇢ Hydraulic characteristics long termly constant
Service Life of 50 Years	More economical life at the same performance
Light Weight (At the same performance class, 75 % more light than ductile iron pipes, 90 % more light than concrete pipes)	⇢ Low transport costs (nestable) ⇢ Elimination of need for expensive pipe handling equipments.
Long Standard Lenghts (6 and 12 m are Standard pipe lengths. Pipe length can be provided up to 18 m accordance with customer request)	⇢ Shortened installation time by fewer number of the joints ⇢ Lower delivery cost depending on more number of the pipes for each transport vehicle.
Smooth Inner Surface	⇢ Lower pumping energy need and lower operating costs due to low friction loss. ⇢ Lower cleaning costs due to minimum slime occurance.
Precise Coupling With Elastomeric Gaskets For Underground Applications Adhesive Bonded Couplings For Aboveground Applications	⇢ Tight and efficient joints designed to prevent infiltration and exfiltration. ⇢ Shortened installation time resulted by ease of joining ⇢ Accomodation to small changes in line directions without fittings and differential settlements. ⇢ Thrust Resistant Joints
Flexible Manufacturing Process	Custom diameters can be manufactured to provide maximum flow volumes with ease of installation for special projects like rehabilitation lining projects.
Advanced Technology Pipe Design	Lower wave celerity than other piping materials can mean less cost while designing surge and water hammer pressures.
Producing Pipe In Accordance With Local And International Standards like TSE, ASTM, AWWA, BSI, DIN,CEN etc.	High fixed quality products in a world-wide scale that ensures reliable product performance
Restrained Joining Systems	⇢ No thrust blocks ⇢ Low installation cost

4 Production Process

Grandpipe GRP pipes are produced by using continuous advancing mandrel process that represents state-of-the-art in GRP pipe production. Product range bu this method is 300 – 4000 mm diameter. Main raw materials used in the process: Glass fiber, polyester resin and silica sand. Also surface mat, catalyst, chemical additives and accelerators are included inside of pipe structure.

Main principle of continuous advancing mandrel process is to use glass fiber reinforcements in the circumferential direction of pipe. Hoop rovings provide strength to GRP pipe against circumferential and external loads. Chop rovings inside of pipe structure empower the strength against longitudinal loads and multi direction loads. Silica sand used in sandwich structure of pipe is the main parameter to obtain exact pipe stiffness. Polyester resin used as main matrix of pipe is very important raw material that combines all pipe layers and effects chemical life. In some special cases, vinylester and other resins can be used instead of polyester resins.




Mississipi River

Aras River

5 Performance Standards

Standards developed by CEN, ISO, ASTM, AWWA, ASME which are the leading Standard organisation in the world are referred to a variety of GRP pipe applications including conveyance of sanitary sewage, water and industrial waste. A thread common to all of the product standards is that they are all performance based documents. This means that required performance and testing of the pipes is specified based on pipe applications.

5.1 TSE (CEN and TS EN) and ISO Standards

TS EN 1796	Plastic Pipe Systems – Unsaturated Polyester Resin Based – GRP - pressure or non-pressure, potable and usage water.
TS EN 14364	Plastic piping systems for drainage and sewerage with or without pressure. Glass reinforced thermosetting plastics (GRP) based on unsaturated polyester resin (UP). Specifications for pipes, fittings and joints
ISO 10639	Plastics piping systems for pressure and non-pressure water supply - Glass-reinforced thermosetting plastics (GRP) systems based on unsaturated polyester (UP) resin
ISO 10467	Plastic piping systems for pressure and non-pressure drainage and sewerage – Glass-reinforced thermosetting plastics (GRP) systems based on unsaturated polyester (UP) resin.

Note: DIN 16868 and BS 5480 standards were updated by new EN standards mentioned above. These standards and equivalent TS EN standards meet all requirements all previous standards too.

Keban Dam

5.2 ASTM (American Society for Testing and Materials)

Currently, there are several ASTM product standards in use which apply to a variety of GRP pipe applications. These standards include many tough qualification and quality control tests. Grandpipe GRP pipes are designed to meet all of these standards.

ASTM Standards

ASTM D3262	Standard Specification for"Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe
ASTM D3517	Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pressure Pipe
ASTM D3754	Standard Specification for"Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer and Industrial Pressure Pipe

5.3 AWWA (American Water Works Association) and ASME (American Society of Mechanical Engineers)

AWWA C950 is one of the most comprehensive product standards in existence for GRP pipes. This standard for pressure water applications has extensive requirements for pipe and joints, concentrating on quality control and prototype qualification testing. Like ASTM standards, this is a product performance Standard. Grandpipe GRP pipes are designed to meet performance requirements of this Standard. AWWA has also one design manual AWWA M45 which includes several chapters for design of GRP pipes, both for underground and aboveground applications.

AWWA and ASME Standards

ANSI / AWWA C950 Fiberglass Pressure Pipe	**ASME B31** Piping System and Pipeline	**ASME B16.5** Pipe Flanges and Flanged Fittings
AWWA Manual M45 Fiberglass Pipe Design	**ASME B31.3** Process Piping	

Atatürk Dam

6 Quality Criteria

6.1 Raw Material Quality Criteria

Grandpipe determines quality criteria for all raw materials used. Raw materials are delivered with vendor certification demonstrating their compliance with acceptance criteria of Grandpipe. Additionally, all raw materials are tested as sampling base prior to their use. These tests ensure that pipe materials comply with specifications as stated.

Main raw material groups used in GRP pipe production are mentioned below:

- Glass fiber
- Resin
- Catalyst (Hardener)
- Filler (Silica Sand)
- Chemical Additives and Accelerators
- Surface Mats

6.2 Finished Good Quality Criteria (GRP Pipe)

All finished goods (GRP Pipes) are subjected to following control steps:

- Visual Inspection
- Barcol Hardness (Barcol: Surface Hardness Unit used for generally GRP composites)
- Wall Thickness
- Length Measurement
- Diameter Measurement
- Hydrostatic Leak Tightness Test (Two times of nominal pressure)

Ancient Time Water Architecture

On a sampling basis, following control steps are performed:

- Pipe Stiffness
- Inner Surface Control Under The Deflection Load.
- Structural Failure Control Under The Deflection Load.
- Composite Structure Analysis and Design Verification
- Hoop (Circumferential) Tensile Strength
- Axial (Longitudinal) Tensile Strength

6.3 Physical Properties

Control steps based on sampling method define initial physical properties of pipes. Long term performances of the pipes are considered at following articles. These test are performed according to defined Grandpipe quality criteria. This criteria is determined by referring upper limits of local and international standards. Test results are the main parameters to get the quality in assurance for finished good pipes.

6.4 Long Term Performance Criteria

General requirement of whole standards is to obtain minimum performance criteria. In GRP pipe systems, long term performance is the main quality criteria beyond short term or initial performance.All quality criteria of Grandpipe are designed including long term performance. By considering several operating conditions, mostly important items are as follows:

- Long Term Specific Ring Stiffness
- Long Term Ring Bending Strain
- Hydrostatic Design Basis (HDB)
- Long Term Strain Corrosion

In addition to main performance criteris, Grandpipe GRP pipes are tested for:

- Ultraviolet (UV) Resistance
- Abrasion Resistance
- Flow Velocity
- Resistance to Different Operating Temperature
- Fire Resistance

7 Product Information

7.1 Diameter Class

Grandpipe GRP pipes can be produced between 100 – 4000 mm diameter.

Standard diameters are given below (in mm)

Multi-Mandrel System					Advancing Continuous System					
100	150	200	250	300	300	350	400	450	500	600
					700	800	900	1000	1100	1200
					1400	1600	1800	2000	2200	2400
					2600	2800	3000	3200	3400	3600
					3800	4000				

According to customer request, others intermediate diameters can be produced between 100 – 4000 mm diameter. Please contact Grandpipe Marketing Department for more information.

Basilica Cistern

7.2 Pressure Class

Grandpipe GRP pipes have standard pressure class range as shown below. Other pressure classes can be provided if necessary. For non-standard products, please contact Grandpipe Marketing Department.

Pressure Class (bar)	32	25	20	16	15	12	10	9	6
Diameter Upper Limit (mm)	1600	1600	1600	4000	4000	4000	4000	4000	4000

Pressure ratings of GRP pipes have been established in accordance with design approach outlined in AWWA M45 Fiberglass Pipe Design Manual. Pipes are pressure-rated at full operating pressure even buried to the maximum depth recommended.

To ensure the long service life for which our pipes are designed, following capabilities should be noted and observed in service.

7.2.1 Hydrostatic Test Pressure

Maximum Plant Test Pressure (AWWA C950, ASTM D3517)	2.0 x PN (Nominal Pressure)
Maximum Field Test Pressure	1.5 x PN (Nominal Pressure)

(For a safe and proper field test, other structures and equipments at pipelines should be properly selected and installed.)

7.2.2 Surge

Maximum Pressure	1.4 x PN (Nominal Pressure)

Cebecikӧy Aqueduct

7.3 Stiffness Class

Definitions of GRP pipes' stiffness classes are provided in ISO and AWWA standards based on same principle with different coefficients. Mostly used definition is "initial specific ring stiffness" included in ISO standard based on the formula EI/D3 , in , N/m2 (Pa).

Stifness class is selected according to two parameters. These are: (1) burial conditions which include native soil, type of backfill and cover depth and (2) negative pressure. The native soil characteristics are rated according to ASTM D 1586 standard penetration test.

Grandpipe GRP pipes are produced based on following Standard stiffness classes.

References	Unit	Nominal Pipe Stiffness (SN)			
ISO	Pa	1250	2500	5000	10000
AWWA	kPa	62	124	248	496

Accordance with customer requests, Grandpipe GRP pipes can be produced more than 10.000 Pa and intermediate stiffness values.

7.4 Pipe Length

Standard length of Grandpipe GRP pipes is 12 m for diameters over 300 mm. Smaller diameters are available in 6 meters standard length.

Grandpipe GRP pipes can be produced in the range of 0.30 – 18 m length for diameters over 300 mm. (including intermediate lengths.)

Danube River

7.5 Flow Velocity

Maximum recommended flow velocity is 3.0 m/sec. Velocities upto 5.0 m/sec can be used if water is clean and does not contain any abrasive material.

7.6 Poisson's Ratio

Poisson's ratio is influenced by pipe construction. For Grandpipe GRP pipes, ratio for hoop (circumferential) loads and axial response ranges from 0,22 to 0,29. For axial loading and circumferential response Poisson's ratio will be slightly less.

7.7 Resistance to Direct Sunlight (Ultraviolet -UV) Radiation

Sunlight is the main ultraviolet radiation. Tests and researches done by Faratec which is the technology partner of Grandpipe absolutely show that ultraviolet degradation is not considerable issue for long-term service life of GRP pipes produced by using Faratec Technology. Technologic background of Grandpipe is fully capable to do custom-made designs where the customers request extra safety factors.

Tigris River

7.8 Load Capacity (Strength) Values

For design purposes the following values can be used for hoop tensile and axial tensile load capacity.

Hoop (Circumferential) Load Capacity (Strength), in N/mm of Circumference

DN	4	6	10	12,5	16	20	25	32
100	80	120	200	250	319	400	500	640
150	121	180	300	375	478	600	750	960
200	160	240	400	500	639	800	1000	1280
250	201	300	500	625	798	1000	1250	1601
300	240	360	600	750	957	1200	1500	1920
350	281	420	700	875	1117	1400	1750	2240
375	300	450	750	937	1197	1500	1876	2400
400	320	480	800	1000	1276	1600	2000	2560
450	361	540	900	1125	1436	1800	2250	2880
500	400	600	1000	1250	1595	2000	2500	3200
550	441	660	1100	1375	1755	2200	2750	3520
600	480	720	1200	1500	1915	2400	3000	3840
700	560	840	1400	1750	2234	2800	3500	4480
750	601	900	1500	1875	2393	3000	3750	4801
800	641	960	1600	2000	2553	3200	4000	5120
850	681	1020	1700	2125	2712	3400	4250	5440
900	720	1080	1800	2250	2871	3600	4500	5760
1000	800	1200	2000	2500	3191	4000	5000	6400
1100	880	1320	2200	2750	3510	4400	5500	7040
1150	921	1380	2300	2875	3669	4600	5750	7360
1200	960	1440	2400	3000	3829	4800	6000	7680
1300	1040	1560	2600	3250	4148	5200	6500	8320
1400	1120	1680	2800	3500	4467	5600	7000	8960
1500	1200	1800	3000	3750	4786	6000	7500	9600
1600	1280	1920	3200	4000	5105	6400	8000	10240
1700	1360	2040	3400	4250	5425	6800	8500	10880
1800	1440	2160	3600	4500	5743	7200	9000	11520
1900	1520	2280	3800	4750	6062	7600	9500	12160
2000	1600	2400	4000	5000	6381	8000	10000	12800
2100	1680	2520	4200	5250	6701	8400	10500	13440
2200	1760	2640	4400	5500	7020	8800	11000	14080
2300	1840	2760	4600	5750	7338	9200	11500	14720
2400	1920	2880	4800	6000	7658	9600	12000	15360
2500	2000	3000	5000	6250	7977	10000	12500	16000
2600	2080	3120	5200	6500	8296	10400	13000	16640
2700	2160	3240	5400	6750	8615	10800	13500	17280
2800	2240	3360	5600	7000	8934	11200	14000	17920
2900	2320	3480	5800	7250	9253	11600	14500	18560
3000	2400	3608	6000	7500	9572	12000	15000	19200
3100	2480	3726	6200	7750	9891	12400	15500	19840
3200	2560	3844	6400	8000	10210	12800	16000	20480
3300	2640	3962	6600	8250	10529	13200	16500	21120
3400	2720	4080	6800	8500	10848	13600	17000	21760
3500	2800	4200	7000	8750	11168	14000	17500	22400
3600	2880	4320	7200	9000	11487	14400	18000	23040
3700	2960	4440	7400	9250	11806	14800	18500	23680
3800	3040	4560	7600	9500	12125	15200	19000	24320
3900	3120	4680	7800	9750	12444	15600	19500	24960
4000	3200	4800	8000	10000	12763	16000	20000	25600

Axial (Longitudinal) Load Capacity (Strength), in N/mm of Length

DN	4	6	10	12,5	16	20	25	32
100	70	75	80	85	90	100	110	125
125	75	80	90	95	100	110	120	135
150	80	85	100	105	110	120	130	145
200	85	95	110	115	120	135	150	155
250	90	105	125	130	135	155	170	190
300	95	110	140	145	155	175	200	220
400	105	130	165	175	190	215	250	285
500	115	145	190	205	225	255	300	345
600	130	160	220	235	255	295	350	415
700	140	175	250	265	290	335	400	475
800	155	190	280	300	325	380	450	545
900	165	205	310	330	360	420	505	620
1000	180	225	340	365	395	465	555	685
1200	205	255	380	415	465	540	645	790
1400	230	290	420	460	530	620	745	915
1600	255	320	460	520	600	700	845	1040
1800	280	350	500	570	670	785	940	1160
2000	305	385	540	625	740	865	1040	1285
2200	335	415	575	675	810	945	1140	1410
2400	360	450	620	730	880	1025	1240	1530
2600	385	480	665	785	945	1110	1335	1655
2800	410	515	710	840	1015	1190	1435	1780
3000	435	545	755	890	1080	1270	1535	1900
3200	460	575	805	950	1150	1350	1630	2025
3400	490	610	850	1005	1220	1430	1730	2150
3600	520	645	895	1060	1290	1515	1830	2250
3800	550	680	940	1115	1355	1595	1930	2400
4000	580	715	985	1170	1425	1675	2025	2520

Note: This table is prepared by referring ISO and EN standards.

Note: This table is prepared by referring AWWA and ASTM standards.

Yenisey River

7.9 Temperature Consideration

Maximum permitted temperature of fluent without pressure derating is 45 °C. Grandpipe recommends that pressure rating should be dropped one class where operating temperatures are set between from 46 °C upto 60 °C (For example, a PN16 pipe with pressure rating of 16 bar would be used as a PN 10 rated product). Temperature resistance of GRP pipes can increase upto 100 °C by using appropriate types of resins.

7.10 Thermal Expansion

Thermal coefficient of axial expansion and contraction for Grandpipe GRP pipes is 24 – 30 * 10-6 cm/cm/°C.

7.11 Flow Coefficients

Based on the tests carried out, Colebrook – White Coefficient can be taken as 0.029. This corresponds to a Hazen – Williams Flow Coefficient approximately C = 150 – 165 and a Mannings Roughness Coefficient of n=0.009 and a Surface Roughness Number of 0.00518 in Darcy-Weisbach Equation.








GRANDPIPE GRP PIPE SYSTEMS





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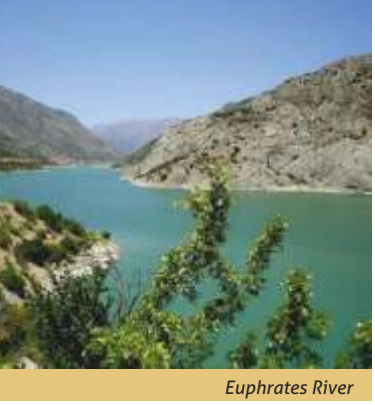


Euphrates River

7.12 Hydrolic Properties

Due to special flow coefficients, GRP pipes have some specific charateristics:

- Extremely smooth internal surface of GRP pipes decrease flow resistance and therefore required energy and cost of pumping are reduced.
- Due to corrosion resistance of GRP pipes, pipe quality doesn't differ throughout time. Unlike concrete and steel pipes, flow coefficients of GRP pipes don't change during their service life.
- For a specific discharge, an smaller diamater pipe can be chosen in comparison with other type of pipes.

Example: We will see that instead of using 2000 mm steel pipe, we can transfer same amount of fluid at a same head-loss through a 1800 mm GRP pipe.

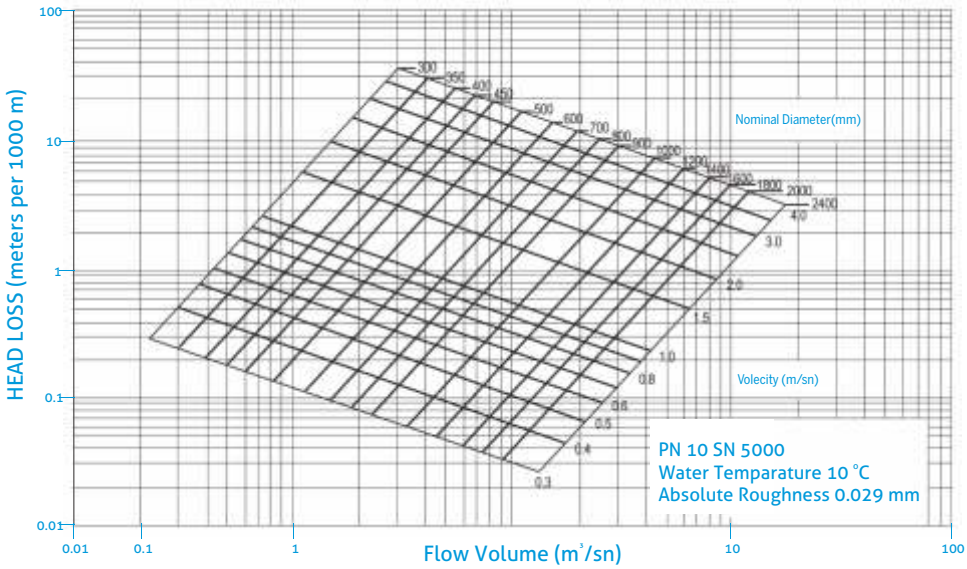
$$\text{Hazen Williams Equation: } HF = \frac{10.68 \times Q^{1.852} \times L}{C^{1.852} \times D^{4.87}}$$

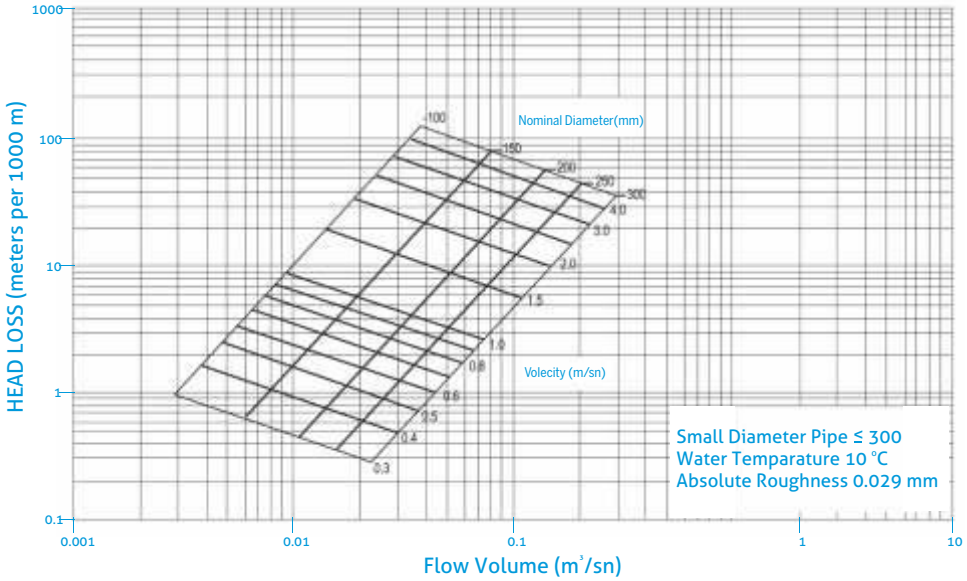
HF (head loss in meter water)
Q (discharge in cubic meter)
L (length of pipe line)
C (roughness coefficient)
D (pipe diameter in meter)

C (steel) = 110
C (GRP) = 150

Q (steel) = Q (GRP)
L (steel) = L (GRP)
HF (steel) = HF (GRP)
D (steel) = 2000 mm

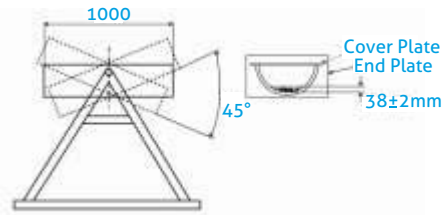
Yangtze River





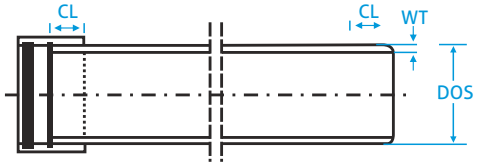
7.13 Abrassion Resistance

Abrasion resistance is related with effects of sand or similar granular materials which there are possibly interior surface of the pipe. Although there is no widely-used standard test procedure or ranking method, Grandpipe GRP pipes have been evaluated by using Darmstadt Rocker Method that is mostly known in sector. Using gravel, average abrassion loss of GRP pipes is 0.34 mm / 100.000 cycles. Results can be varied depending on type of abrasive material used in test.



Kızılırmak

7.14 Pipe Dimensions



SN 2500						
DN	DOS max	WT (Wall Thickness) (mm)				Weight kg/m
		PN6	PN10	PN16	PN20	
300	311	4,1	3,9	3,8	3,8	8
350	362	4,7	4,6	4,4	4,4	10,6
400	413	5,1	4,9	4,8	4,7	12,5
450	464	5,8	5,4	5,3	5,2	15,7
500	515	6,4	5,9	5,8	5,7	19,2
600	617	7,8	7	6,7	6,7	27
700	719	8,9	8	7,7	7,6	37
800	821	10,1	9,1	8,6	8,6	48
900	923	11,3	10,1	9,6	9,5	60
1000	1025	12,5	11,1	10,5	10,5	74
1100	1127	13,7	12,2	11,5	11,4	89
1200	1229	14,8	13,2	12,5	12,3	106
1300	1331	16	14,2	13,4	13,3	124
1400	1433	17,1	15,2	14,4	14,2	144
1500	1535	18,2	16,2	15,3	15,1	164
1600	1637	19,4	17,3	16,3	15,9	187
1700	1739	20,8	18,3	17,2		210
1800	1841	21,9	19,3	18,2		235
1900	1943	23	20,3	19,1		261
2000	2045	24,2	21,4	20,1		290
2100	2147	25,4	22,4	21		319
2200	2249	26,5	23,4	22		349
2300	2351	27,7	24,4	22,9		382
2400	2453	28,9	25,4	23,9		415
2500	2555	30	26,5	24,9		450
2600	2657	31,2	27,5	25,9		486
2700	2759	32,5	28,5	26,8		523
2800	2861	33,7	29,5	27,6		553
2900	2963	35	30,5	28,6		604
3000	3065	35,9	31,5	29,7		654
3100	3167	36	31,7	29,9		665
3200	3269	37,1	32,6	30,8		710
3300	3371	38,3	33,6	31,8		790
3400	3473	39,4	34,6	32,7		800
3500	3575	40,5	35,5	33,6		845
3600	3677	41,6	36,6	34,6		895
3700	3779	42,8	37,5	35,5		945
3800	3881	43,9	38,5	36,5		995
3900	3983	45,1	39,5	37,4		1045
4000	4085	46,2	40,5	38,3		1100

SN 5000							
DN	DOS max	WT (Wall Thickness) (mm)					Weight kg/m
		PN6	PN10	PN16	PN20	PN25	
300	311	5,1	5,1	4,8	4,7	4,7	10,3
350	362	5,9	5,8	5,4	5,4	5,4	13,8
400	413	6,6	6,2	5,8	5,8	5,8	16,2
450	464	7,3	6,9	5,8	5,8	5,8	21
500	515	8,1	7,6	7,1	7	7	25
600	617	9,6	8,9	8,4	8,2	8,2	36
700	719	11,1	10,3	9,6	9,3	9,3	49
800	821	12,5	11,6	10,9	10,5	10,5	63
900	923	14	13,2	12,1	11,8	11,8	80
1000	1025	15,4	14,5	13,3	12,9	12,9	99
1100	1127	16,9	15,9	14,6	14,2	14,2	119
1200	1229	18,3	17,3	15,8	15,3	15,3	141
1300	1331	19,9	18,6	17	16,5	16,5	165
1400	1433	21,4	20	18,3	17,8	17,8	191
1500	1535	22,9	21,3	19,5	19	18,5	219
1600	1637	24,3	22,7	20,7	19,9	19,7	249
1700	1739	25,8	24,1	22			281
1800	1841	27,3	25,4	23,2			314
1900	1943	28,7	26,8	24,4			350
2000	2045	30,1	28,2	25,6			388
2100	2147	31,6	29,5	26,9			427
2200	2249	33,1	32,9	28,1			468
2300	2351	34,5	32,3	29,3			512
2400	2453	36	33,7	30,6			557
2500	2555	37,5	35	31,8			604
2600	2657	38,7	36,5	33			657
2700	2759	41,2	38	34,5			708
2800	2861	41,9	39	35,5			760
2900	2963	44,1	40,5	37			814
3000	3065	44,8	41,5	38			871
3100	3167	45,1	41,6	38,2			885
3200	3269	46,5	42,9	39,4			940
3300	3371	47,9	44,3	40,6			1000
3400	3473	49,3	45,6	41,8			1065
3500	3575	50,8	46,9	43,0			1125
3600	3677	52,2	48,2	44,2			1190
3700	3779	53,7	49,6	45,4			1260
3800	3881	55,1	50,9	46,6			1325
3900	3983	56,5	52,2	47,8			1400
4000	4085	57,9	53,5	49,0			1470

SN 10000

DN	DOS max	WT (Wall Thickness) (mm)						Weight kg/m
		PN6	PN10	PN16	PN20	PN25	PN32	
100	107	3,5	3,5	3,5	3,5			2,0
150	157,6	3,8	3,8	3,8	3,8			3,3
200	209,8	4,9	4,9	4,9	4,9			5,8
250	262	6,0	6,0	6,0	6,0			8,9
300	311	6,2	6,2	6	5,8	5,7	5,7	12,7
350	362	7,2	7,2	6,8	6,7	6,6	6,5	17,4
400	413	7,8	7,8	7,4	7,2	7,1	7	21
450	464	8,8	8,8	8,2	8	7,9	7,8	26
500	515	9,8	9,8	9	8,8	8,6	8,5	33
600	617	11,7	11,7	10,7	10,4	10,2	10	48
700	719	13,7	13,7	12,3	11,9	11,7	11,5	65
800	821	15,5	15,5	14	13,5	13,2	13	85
900	923	17,3	17,3	15,6	15,1	14,7	14,5	107
1000	1025	19,2	19,2	17,2	16,6	16,2	16	132
1100	1127	21,2	21,2	18,9	18,2	17,7	17,5	160
1200	1229	23	23	20,5	19,7	19,3	19	190
1300	1331	24,8	24,8	22,1	21,3	21,8	20,4	223
1400	1433	26,7	26,7	23,7	22,9	22,3	21,9	258
1500	1535	28,4	28,4	25,4	23,9	23,8	23,1	295
1600	1637	30,3	30,3	27	25,4	24,8	24,5	336
1700	1739	31	32,1	28,6				378
1800	1841	34	34	30,3				423

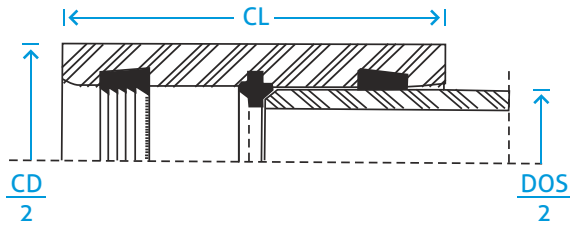
DN	DOS max	WT (Wall Thickness) (mm)						Weight kg/m
		PN6	PN10	PN16	PN20	PN25	PN32	
1900	1943	35,8	35,8	31,9				472
2000	2045	37,6	37,6	33,5				521
2100	2147	39,5	39,5	35,1				574
2200	2249	42,7	42,7	38				630
2300	2351	44,6	44,6	39,7				688
2400	2453	46,5	46,5	41,4				748
2500	2555	47,2	47,7	41,7				822
2600	2657	47,9	49,5	43,3				888
2700	2759	50,8	51,3	44,9				955
2800	2861	51,3	53,1	46,5				1025
2900	2963	54,5	55	48,2				1102
3000	3065	55,1	55,8	49,7				1176
3100	3167	56,4	56,0	49,8				1200
3200	3269	58,2	57,7	51,4				1275
3300	3371	60,0	59,5	53,0				1355
3400	3473	61,8	61,3	54,5				1440
3500	3575	63,6	63,1	56,1				1525
3600	3677	65,4	64,9	57,7				1615
3700	3779	67,2	66,7	59,3				1705
3800	3881	69,0	68,4	60,9				1800
3900	3983	70,7	70,2	62,4				1895
4000	4085	72,5	72,0	64,0				1995

Note: Values given below at tables are determined based on the standard production criteria of Grandpipe. According to raw material diversification, these values can be changed.

8 Pipe Joining Methods

8.1 GRP Couplings

GRP pipes are typically joined by using GRP double-bell couplings. Pipes and couplings can be delivered to site seperately or pipes can be delivered as one-end coupling mounted. Elastomeric gaskets are used on GRP couplings for sealing. Gaskets are placed in precision-machined grooves in each end of the coupling. Gaskets have proven life more 75 years.



İznik Lake

Underground coupling dimensions

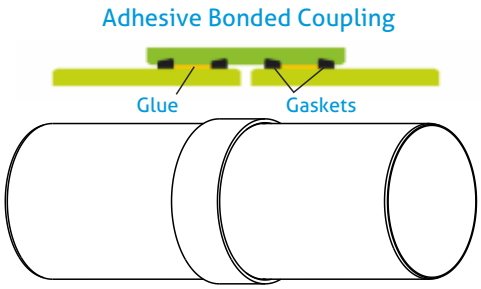
DN	DOS Max (mm)	Coupling IDMin (mm)	CD (mm)						CL (mm)
			PN6	PN10	PN16	PN20	PN25	PN32	
100	107	107,5	107	107	107	107	107	107	150
150	157,6	158,1	157,6	157,6	157,6	157,6	157,6	157,6	150
200	209,8	210,3	209,8	209,8	209,8	209,8	209,8	209,8	175
250	262	262,5	262	262	262	262	262	262	175
300	311	312,5	351,1	352,7	354,3	356,4	360,7	367,5	270
350	362	363,5	403,3	404,9	406,7	407,6	412,7	447,9	270
400	413	414,5	454,1	456,1	458,1	462,4	463,7	468,7	270
450	464	465,5	504,9	506,5	508,7	513	513,9	519,3	270
500	515	516,5	555,7	557,7	559,3	563,4	564,3	571,1	270
600	617	618,5	664,1	665,9	668,1	673,2	675,9	683,7	330
700	719	720,5	765,9	768,3	772,5	778,2	781,1	792,1	330
800	821	822,5	867,7	871,7	876,7	882,8	883,7	896,9	330
900	923	924,5	970,7	975,1	980,9	984,8	988,7	1001,7	330
1000	1025	1026,5	1073,5	1078,5	1084,7	1089,2	1098,1	1106,5	330
1100	1127	1128,5	1176,3	1181,5	1183	1193,4	1208	1211,7	330
1200	1229	1230,5	1278,9	1284,5	1289,9	1299,4	1315,3	1316,7	330
1300	1331	1332,5	1381,3	1387,3	1393,3	1407,4	1421,1	1422,1	330
1400	1433	1434,5	1483,9	1490,1	1497,5	1515,6	1527,1	1527,1	330
1500	1535	1536,5	1586,3	1592,9	1602,7	1621,2	1632,9	1646	330
1600	1637	1638,5	1688,7	1695,5	1707,3	1722,3	1739,1	1750	330
1700	1739	1740,5	1791,1	1798,3	1812,1				330
1800	1841	1842,5	1893,5	1900,9	1916,1				330
1900	1943	1944,5	1995,9	2003,3	2020				330
2000	2045	2046,5	2098,3	2105,9	2123,5				330
2100	2147	2148,5	2200,5	2208,9	2226,9				330
2200	2249	2250,5	2302,9	2311,9	2330,3				330
2300	2351	2352,5	2405,3	2414,7	2433,3				330
2400	2453	2454,5	2507,5	2517,9	2536,3				330
2500	2555	2556,5	2559,7	2620,9	2639,3				330
2600	2657	2658,5	2690	2695					360
2700	2759	2760,5	2792,5	2797,8					360
2800	2861	2862,5	2895	2900					360
2900	2963	2964,5	2997,5	3002,2					360
3000	3065	3066,5	3099,5	3104,4					360
3100	3167	3168,5	3246,5	3253,5	3274,3				400
3200	3269	3270,5	3348,7	3356,1	3377,7				400
3300	3371	3372,5	3451,1	3458,5	3481,5				400
3400	3473	3474,5	3553,3	3560,9	3589,1				400
3500	3575	3576,5	3655,5	3663,3	3692,7				400
3600	3677	3678,5	3757,9	3765,5	3796,7				400
3700	3779	3780,5	3860,3	3867,9	3900,9				400
3800	3881	3882,5	3962,7	3970,3	4004,7				400
3900	3983	3984,5	4065,1	4072,5	4106,9				400
4000	4085	4086,5	4167,7	4174,7	4213,3				400

Note: Values given below at tables are determined based on the standard production criteria of Grandpipe. According to raw material diversification, these values can be changed.

Idil (Volga) River

8.2 GRP Combicouplings

Restrained coupling made from GRP material is used to join pipes where is needed to resist axial thrust forces. In this coupling type, sealing is performed by two gaskets and epoxy adhesive glue for each pipe end. Adhesively bonded area by using epoxy glue between pipe and coupling obtains very strong joint which will be fully resisted against pipeline tensile forces.

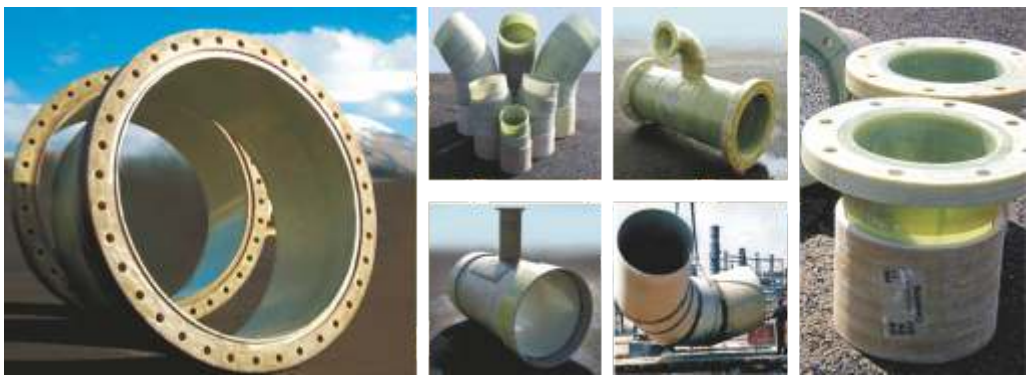


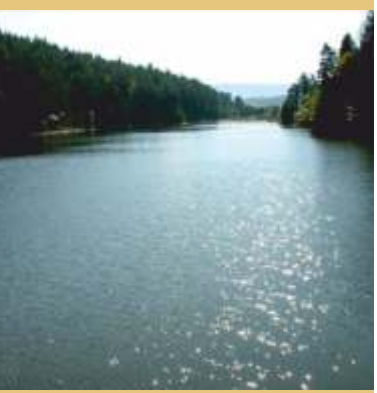
8.3 GRP Flanges

In special conditions, pipes can be joined with GRP flanges. For joining two GRP flanges over 300 mm diameter, one flange with gasket groove is enough to sealing. Standard bolt dimensions are based on ISO 7005 standard related with flange manufacturing. Flanges with other bolt dimensions can be manufactured according to CEN, AWWA, ANSI, ASME, DIN or JIS etc if required.

8.4 Lay-up Joints

This joint is made from glassfiber reinforcements and polyester resin. It is typically used in situations where pipe joint is required to transmit axial forces from internal pressure or as a repair method. The length and thickness of lay-up depends on diameter and pressure. This type of joint requires clean, controlled conditions and skillled – trained personel. Grandpipe provides special instructions when this type of joint is required.





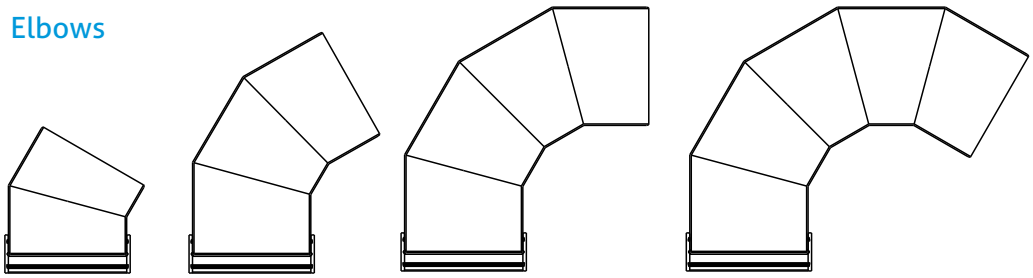
Sakarya River

9 Fittings

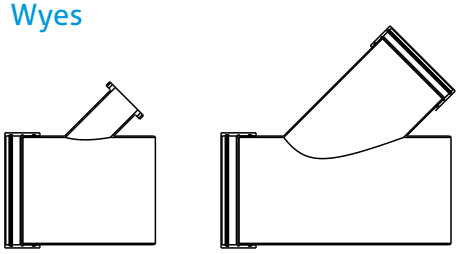
Grandpipe utilizes standardized manufacturing methods for GRP fittings which have similar techniques with GRP pipe production. Grandpipe GRP fittings techniques allow to manufacture a wide range of fittings in both standard and non-standard dimensions.

Fittings upto DN 900 mm diameter can be manufactured by mould winding technique.

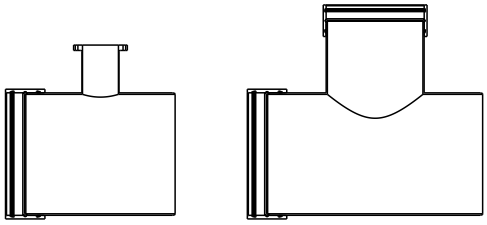
Elbows



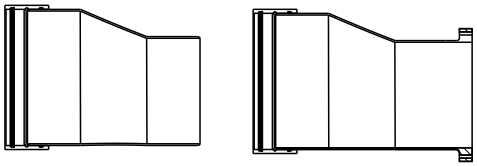
Wyes



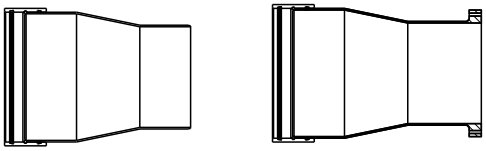
Tees



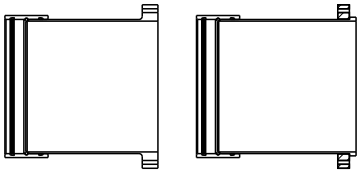
Eccentric Reducer



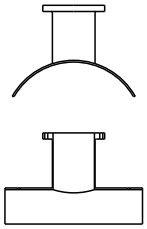
Concentric Reducer



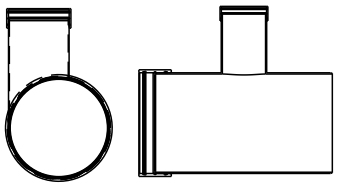
Flanges



Saddle



T Eccentric



10 Biaxial Pipes

10.1 Physical Properties

Raw materials, production techniques and properties of biaxial pipes could be different from underground pipes based on pipe applications. Biaxial pipes are made to resist forces in axial direction as well as circumferential direction. Therefore they are much stronger than pipes for underground purposes. Some physical characteristics of these pipes are mentioned below.

Biaxial pipes can be connected with eachother by using combicouplings, by using restrained couplings or by butt-wrap joints.

Grandpipe Biaxial Pipes			Butt-Wrap Joints	
Physical Properties	**Hoop**	**Axial**	**Hoop**	**Axial**
E_T ,tensile modulus (GPa)	20.0	13.1	-	10.3
E_T,flexural modulus(GPa)	18.6	12	-	10.3
$\sigma_{T_{ULT}}$ ultimate tensil stress (MPa)	380	158	-	138
υ,Poisson's ratio	0.2	0.25	-	0.3
α Termal coeff linear (cm/cm/°C)	9.0	12.6	-	27
G ,shear modulus (GPa)	3.3	3.3	-	3.1
τ_{ULT} ultimate shear stress (MPa)	46.9	19.	-	138
Tensile allowable stress (MPa)	62.0	26.4	23	23
Flexural allowable stress (MPa)	62.0	26.4	23	23
Shear allowable stress (MPa)	7.8	7.8	5.7	5.7

Çark (1901)

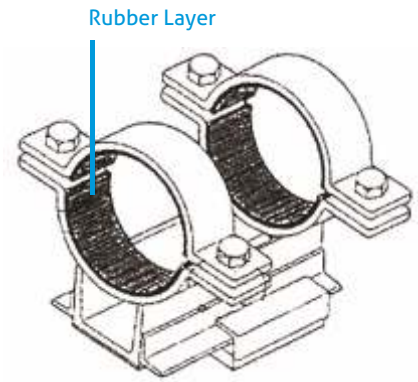
Water Mill

10.2 Stress Analysis Considerations

In most of aboveground biaxial pipe installations, joints are monoblock bound together to resist tensile forces acting on each pipe due to internal pressure. In these cases, thermal stresses are more effective than stresses related to weight and pressure. Thermal expansion coefficient of GRP pipes is nearly two times of steel pipes. But modulus of elasticity of GRP is less than steel. Thus, thermal load would be reduced. For compensating thermal expansion, Usage of expansion joints or expansion loops may be necessary.

10.3 Supports

Aboveground biaxial GRP pipes have their special supports. Spacing between supports can be calculated by flexibility analysis. Here, shape of typical support is presented.



Note: Picture above shows special design vinylester basis GRP pipes for aboveground application in a oil refinary

Lake Garda

11 Installation of GRP Pipes

11.1 Pipe Classification

Selection of Grandpipe GRP pipes is based on stiffness and pressure class requirements.

	ISO	ASTM
SN	N/m²	kN/m²
2500	2500	124
5000	5000	248
10000	10000	496

Stiffness of GRANDPIPE GRP pipes is selected from one of three stiffness classes listed below. Stiffness class represents pipe's minimum initial specific stiffness as EI/D^3 in N/m^2 (Pa).

Stiffness is defined according to two parameters. These are: (1) burial conditions, which include native soil, type of backfill and cover depth and (2) negative pressure, if it exist. Native soil characteristics are rated according to ASTM D1586 standard penetration test. Some typical soil blow count values relative to soil types and density are given following table.

			Non-Cohesive Soils		Cohesive Soils	
Native Soil Group	Blow Counts	E'n Value (MPa)	Description	Friction Angle (Degrees)	Description	Unconfined Comp. Strenght (kPa)
1	>15	34.5	Compact	33	Very Stiff	192-384
2	8-15	20.7	Slightly Compact	30	Stiff	96-92
3	4-8	10.3	Loose	29	Medium	4-96
4	2-4	4.8	Very Loose	28	Soft	24-48
5	1-2	1.4	Very Loose	24	Very Soft	12-24
6	0-1	0.34	Very, Very Loose	26	Very, Very Soft	0-12

Van Lake

A wide range of backfill soil types are offered in tables to allow each installation to be customized providing the most economical installation. In many instances, native trench soils can be used as pipe zone backfill. Maximum allowable cover depths for threee different stiffness classes in six native soils groups are illustrated in following table - assuming standard trench construction, an allowable long term deflection 5 % (DN 300 – 4000 mm) – 4 % (DN 100 – 250 mm), with consideration of traffic loads.

	SN 2500						SN 5000						SN 10000					
Native Soil Group	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
Backfill Soil Modulus (MPa)																		
20.7	23.0	18.0	11.0	7.0	-	-	23.0	18.0	12.0	7.0	3.0	-	24.0	19.0	12.0	8.0	3.5	-
13.8	18.0	15.0	10.0	6.0	-	-	18.0	15.0	10.0	6.5	2.4	-	19.0	16.0	11.0	7.0	3.5	-
10.3	15.0	13.0	9.0	5.5	-	-	15.0	13.0	9.0	6.0	2.4	-	15.0	13.0	10.0	6.5	3.0	-
6.9	11.0	10.0	7.5	5.0	-	-	11.0	10.0	8.0	5.0	-	-	12.0	10.0	8.5	5.5	3.0	-
4.8	8.5	7.5	6.0	4.0	-	-	8.5	7.5	6.5	4.5	-	-	9.5	8.5	7.0	5.0	2.5	-
3.4	6.0	5.5	5.0	3.5	-	-	6.0	6.0	5.0	4.0	-	-	7.0	6.5	5.5	4.5	-	-
2.1	3.5	3.5	3.5	-	-	-	4.0	4.0	3.5	3.2	-	-	4.5	4.5	4.0	3.5	-	-
1.4	-	-	-	-	-	-	2.4	2.4	2.2	-	-	-	3.0	3.0	3.0	2.8	-	-

The second parameter for pipe stiffness class selection is negative pressure. If it exists, following tables show which stiffness to select for various amounts of negative pressure and burial depths for average native and backfill soil conditions.

Stiffness selected should be higher than determined value to suit negative pressure and burial

Native Soil Group 3 (E'n=10.3 MPa)
Backfill Type Cat 90% SPD (E'b=14Mpa)
Water Table Below Pipe Standard Trench Installation

Vac (bar)	SN2500	SN5000	SN10000
-0.25	10.0	10.0	11.0
-0.50	8.5	10.0	11.0
-0.75	6.5	10.0	11.0
-1.00	4.0	10.0	11.0

For Saturated Soil Condition

Vac (bar)	SN2500	SN5000	SN10000
-0.25	5.5	5.5	6.0
-0.50	0.4	5.5	6.0
-0.75	1.8	5.5	6.0
-1.00	NA	4.0	6.0

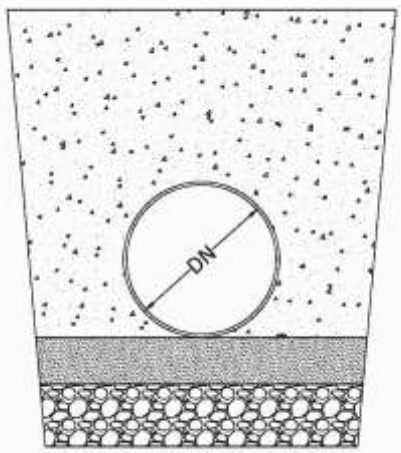
Long life and good performance of Grandpipe GRP pipes can only be achieved by proper handling and installation of the pipes. For owners, engineers and contractors, it's important that GRP pipes can be obtained excellent performance when recommended installation procedures are applied by using suitable bedding and pipe backfill support. Engineers have found through considerable experience that compacted granular materials are ideal for backfilling GRP pipes. Together pipe and embedment material form a high performance pipe-soil system. For complete installation instructions, consult to Grandpipe Field Department.

Pipeline Installation on The Grand River (1886)

11.2 Installation Types

Following illustrations show two Standard installation types commonly used with GRP pipes.

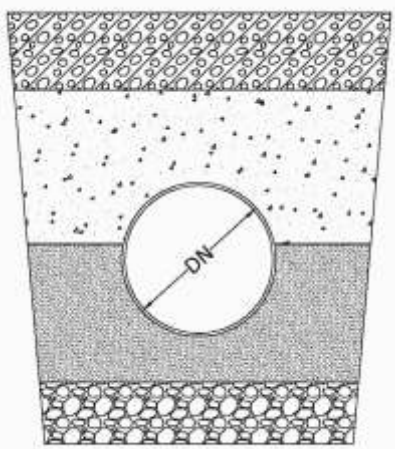
11.2.1 Installation Type 1



- Carefully constructed bed
- Backfill pipe zone to 300 mm over pipe crown with specified backfill material compacted to required relative compaction level.

Note: For non-pressure applications, requirement to compact 300 mm over pipe crown is not applied.

11.2.2 Installation Type 2

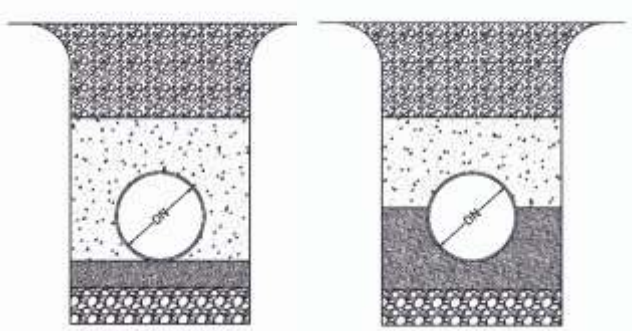


- Backfill to a level of 60 % pipe diameter with specified backfill material compacted to required relative compaction level.
- Backfill from 60 % of diameter to 300 mm over pipe crown with a relative compaction necessary to achieve a minimum soil modulus of 1.4 MPa.

Note 1: Installation type 2 is not applicable to small diameters.

Note 2: Installation type 2 is not suitable for high traffic load conditions.

Alternative installations to accommodate a specific field condition include wider trenches, sheet piles, soil stabilization, geotextiles etc. Grandpipe installation instructions for buried pipe should be consulted for additional details.



Istanbul Aqueducts

Grandpipe GRP pipes can be installed in a number of different situations including aboveground, sub-aqueous, trenchless and sloped applications. These applications can require more initial planning and more care than standard buried pipe installation. Please contact Grandpipe for further

11.3 Trenching

Trench must always be wide enough to permit placement and compaction of pipe zone backfill materials and provide proper pipe support. Depths of cover charts presented in this brochure are based on an assumed trench width 1.75 times the pipe's nominal diameter. Widths down to 1.5 times DN may be achievable, however burial limits will be affected. In extraordinary conditions, please consult to Grandpipe Expert Team.

11.4 Bedding

Trench bed, of suitable material, should provide uniform and continuous support for pipe.

Caspian Sea(Eastern Coast)

11.5 Backfill Materials

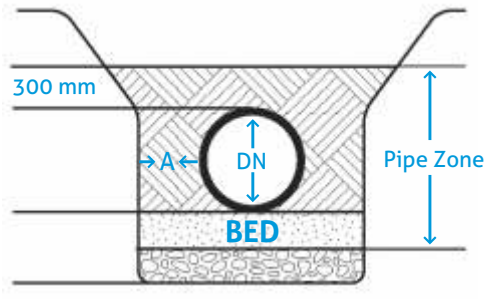
To ensure a satisfactory pipe-soil system, correct backfill material must be used. Most coarse grained soils (as classified by Unified Soils Classification System) are acceptable bedding and pipe zone backfill material. Where the instructions permit the use native soil as backfill, care organic material. Following table identifies acceptable backfill soils:

Backfill Material	Description	Unified Soil Classification Designation
A	Crushed stone and gravel <12% fines	GW, GP, GW-GM, GP-GM
B	Gravel with sand, sand, <12% fines	GW-GC, GP-GC, SW, SP, SW-SM, SP-SM, SW-SC, SP-SC
C	Silty gravel and sand, 12-35% fines, LL<40%	GM, GC, GM-GC, SM, SC, SM-SC
D	Silty, clayey sand, 35-50% fines, LL<40%	GM, GC, GM-GC, SM, SC, SM-SC
E	Sandy, clayey silt, 50-70% fines, LL<40%	CL-ML
F	Low plasticity fine-grained soils, LL<40%	CL-ML

11.6 Standard Trench Details

A typical trench detail for GRP pipe can be as following figure:

Dimension A is a minimum 0.75 DN / 2.



- Where rock, hard pan, soft, loose, unstable or highly expansive soils are encountered in trench bottom, it may be necessary to increase depth of bedding layer to achieve adequate longitudinal support.
- Dimension A must allow for adequate space to operate compaction equipment and ensure proper placement of backfill in haunch region. This may require a wide trench than minimum specified above (Particularly for smaller diameters).

11.7 Checking Installed Pipe

After installation of each pipe, maximum diametrical vertical deflection must be checked. For Grandpipe GRP pipes, this procedure is fast and easy.

Eğirdir Lake

11.8 Installed Diametrical Deflection

Maximum allowable initial diametrical deflection (typically vertical) shall be as folloews:

Maximum Initial Deflection	
DN ≤ 250	DN ≥ 300
%2,5	%3

Maximum allowable long-term diametrical deflection shall be 5 % for diameters 300 mm and larger 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.

11.9 Traffic Load

All backfill to grade should be compacted when continuous traffic loads are present. Minimum cover restrictions may be reduced with special installations such as concrete encasement, concrete cover slabs, casing etc.

Traffic (Wheel) Load			
Minimum Burial Depth	Force (lbs)	Force (Kn)	Load Type
1.0	16000	72	AASHTOH20(C)
1.5	20000	90	BS 153HA(C)
1.0	9000	40	ATV LKW12(C)
1.0	110000	50	ATV SLW(C)
1.5	22000	100	ATV SLW 60(C)
3.0	Railroad	-	Cooper E80

Based a minimum pipe zone backfill soil modulus 6,9 MPa.

11.10 High Pressure

High pressure more than 16 bar may require deeper burial depth to prevent uplift and movement. Pipes - DN 300 and larger - should have a minimum burial depth of 1.2 meters, and 0.8 meters for smaller diameters.

11.11 High Water Table

A minimum of 0.75 diameter of earth cover (minimum dry soil bulk density of 1900 kg/m3) is required to prevent an empty submerged pipe from floating. Alternatively, the installation may proceed by anchoring pipes. If anchoring is proposed, restraining straps must be a flat material – minimum 25 mm wide, placed at maximum 4 meter intervals – Please advise Grandpipe for details on anchoring and minimum cover depth with anchors.

Neretva River

11.12 Joint Angular Deflection

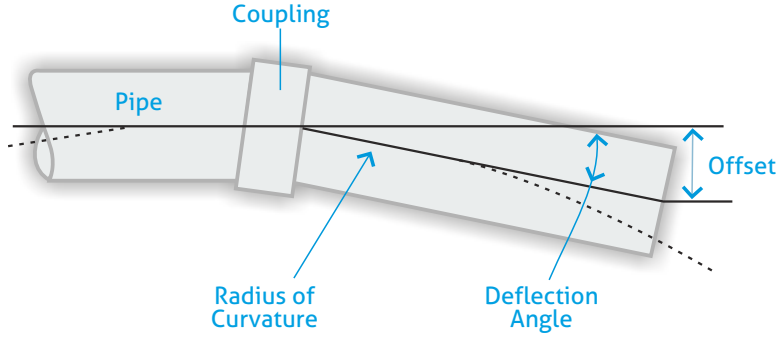
Coupling joints are extensively tested and qualified in accordance with ASTM D4161 and ISO 8639. Maximum angular deflection for each coupling joint – measured as change in adjacent pipe center lines – must not exceed the values given in table below.

Pipes must be joined in straight alignment but not all the way to home line and thereafter deflected angularly as required.

Nom. Pipe Diameter	Nom. Angle of Deflection	Nom. Offset (mm) Pipe Length			Nom. Radius of Curvature (m) Pipe Length		
(mm)	(deg)	3 (m)	6 (m)	12 (m)	3 (m)	6 (m)	12 (m)
DN≤500	3	157	314	628	57	115	229
500< DN≤900	2	107	209	419	86	172	344
900<DN<1800	1	52	105	209	172	344	688
DN<1800	0.5	26	52	78	344	688	1376

When GRP pipe system will be operated at pressures exceeding 16 bar, allowable angular joint deflection should be reduced to levels noted in following table.

Nom. Pipe Diameter (mm)	Nom. Angle of Deflection (Deg)		
	20(bar)	25(bar)	32(bar)
DN<500	2.5	2.0	1.5
500< DN<900	1.5	1.3	1.0
900<DN<1800	0.8	0.5	0.5



Yeşilırmak

11.13 Surge and Water Hammer

Water hammer or pressure surge is sudden rise or fall in pressure causes by an abrupt change in fluid velocity with in pipe system. Usual cause of these flow changes is the rapid closing or opening of valves or sudden starting or stopping of pumps such as during a power failure. Most important factors which influence water hammer pressure in a pipe system are variation in fluid velocity, rate of change of the velocity (valve closing time), compressability of the fluid, stiffness of the pipe in hoop direction and physical lay-out of the pipe system.

Where similar conditions are considered for GRP, steel and ductile iron pipes, water hammer pressure assumed for GRP pipes is approximately 50 % less than the others. Grandpipe GRP pipes have surge pressure allowance of 40 % of nominal pressure.

An approximate relationship for maximum pressure variation at a given point in a straight pipeline with negligible friction loss can be calculated from the formula.

$$\Delta H = (W.\Delta V)/g$$

ΔH = change in pressure (meter)
W = surge wave celerity (meter/sec)
ΔV = change in liquid velocity (meter/sec)
g = acceleration due to gravity (meter/sec)

Surge wave celerity for Grandpipe CTP Pipes (m/sn)

SN 2500			
DN	300-400	450-800	900-2500
PN6	365	350	340
PN10	435	420	405
PN16	500	490	480

SN 10000			
DN	300-400	450-800	900-2500
PN6	420	415	410
PN10	435	425	415
PN16	500	495	485
PN25	580	570	560
PN32	620	615	615

SN 5000			
DN	300-400	450-800	900-2500
PN6	405	380	370
PN10	435	420	410
PN16	505	495	485
PN25	575	570	560

SN 10000					
DN	100	125	150	200	250
PN6	580	560	540	520	500
PN10	590	570	560	540	520
PN16	640	620	610	600	590

Büyük Menderes Delta

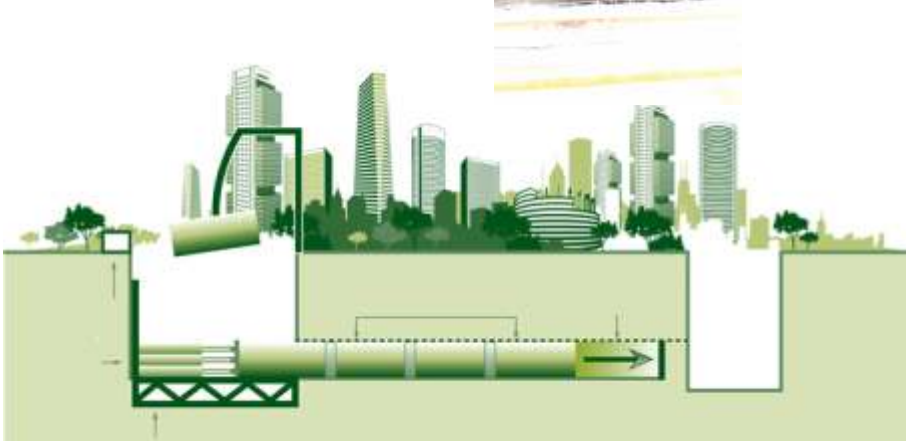
12 Special Applications

12.1 Trenchless System Applications (Pipe Jacking, Rehabilitation)

In metropolitan cities and regions where there are heavy traffic, intense people movements etc., installation of pipes by excavation method causes extreme social and economical losses. Also, interruption of traffic on the crowded roads creates great problems. In this case, trenchless systems are preferred.

Rehabilitation of old pipelines is considered as a concept trenchless system applications.

Grandpipe produces GRP pipes for trenchless system applications by its own technological background. Technical properties and wall thicknesses of these pipes are variable based on the project needs. For custom-made solutions according to project requirements, please contact Grandpipe Marketing Team.



GRP pipe application for trenchless infrastructure systems

Meriç River

12.2 Industrial Applications

Grandpipe has a special product range for petrochemical and chemical industries. In these applications where are performed by special type of glassfibers and vinylester (VE) and epoxy basis resins, long-life operating conditions without problem occurance are easily provided.

GRP Fire Resistance Test For Petrochemical Industry

12.3 Geothermal Applications

Grandpipe is also solution partner for transportation of higher temperature fluids by its technological background. By considering of operating conditions and parameters, Turnkey System Production can be done.

Please do not hesitate to contact Grandpipe Marketing Team for any subject about special applications.

GRANDPIPE

GRP PIPE SYSTEMS

The Gateway To The New Age Of Infrastructure

FARATEC® Group Certificates

ROYALCERT ISO 9001:2008

ROYALCERT ISO 14001

ROYALCERT OHSAS 18001:2007

TSE TS EN 1796

TSE TS EN 14364

TÜV INDUSTRIE SERVICE GmbH,
Institute For Plastics
Test Certificate for DIN 16868 Part 1-2
(ASTM D3567, ASTM D2412, ISO 1167)

SGS INSPECTION REPORT
FIRE REQUIREMENTS
IMO A.753 (18) AND ASTM F1173

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