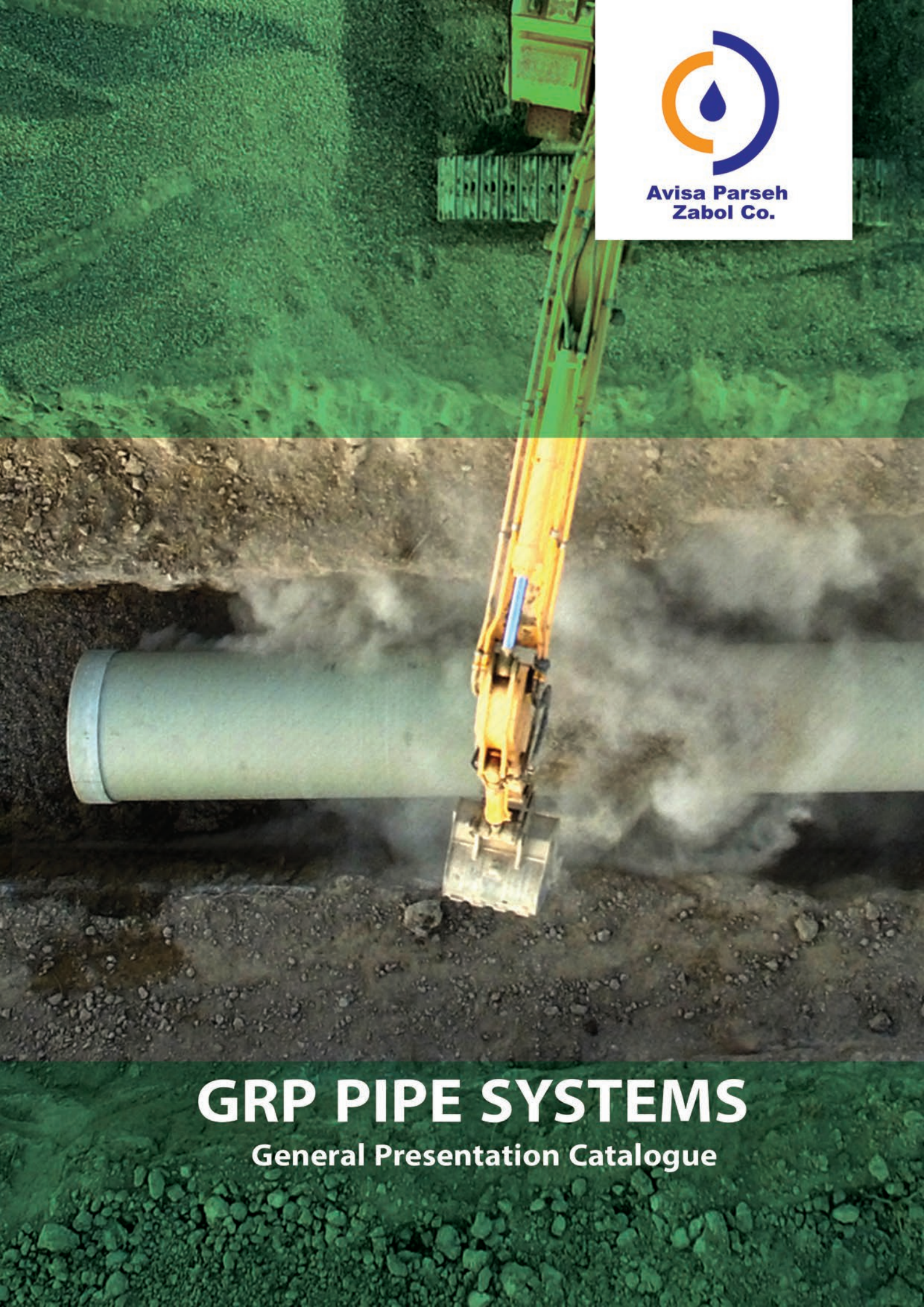
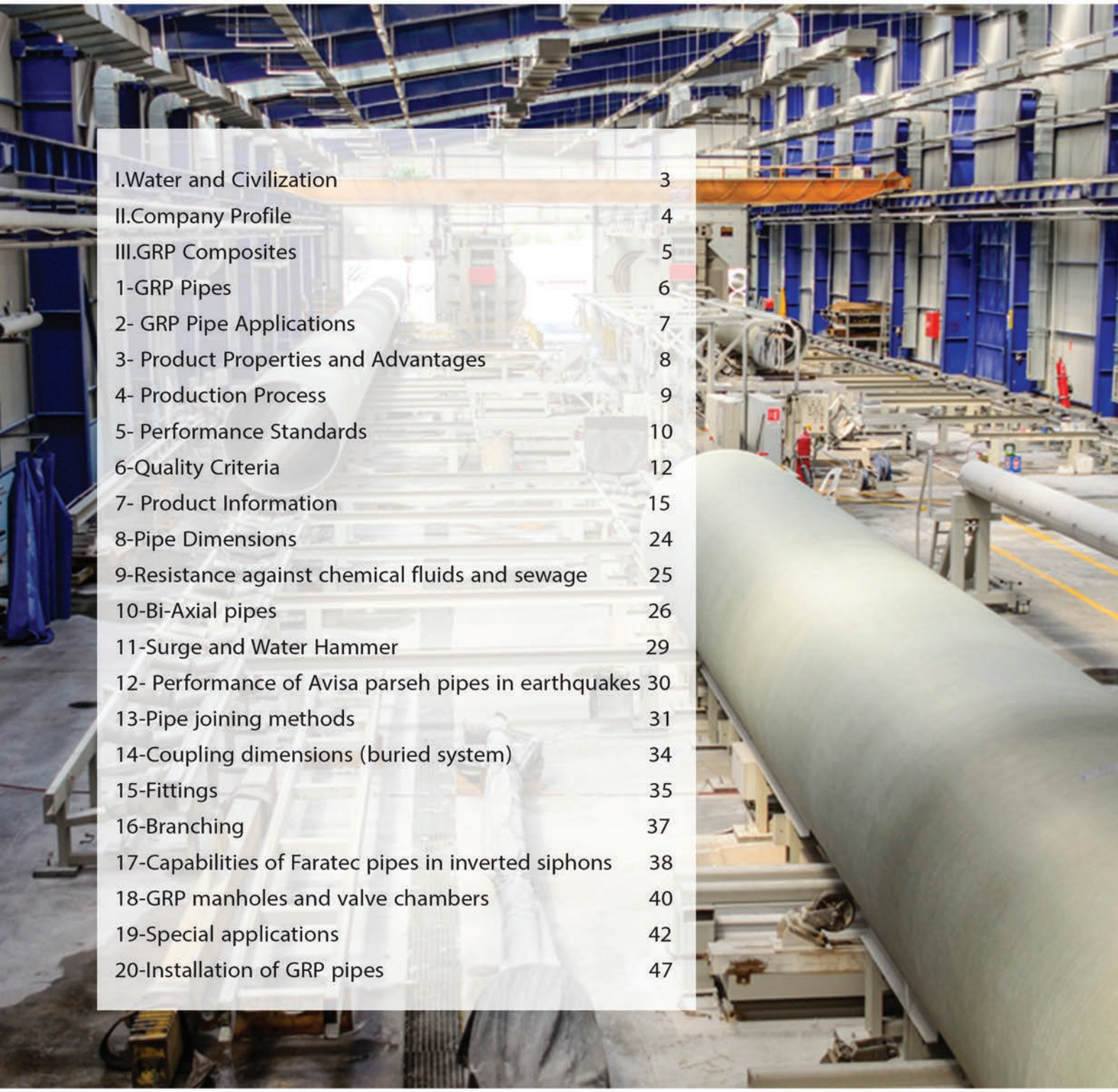


Avisa Parseh
Zabol Co.

GRP PIPE SYSTEMS

General Presentation Catalogue

Avisa Parseh Zabol Co.



Avisa Parseh Zabol Co.

GRP PIPE SYSTEMS

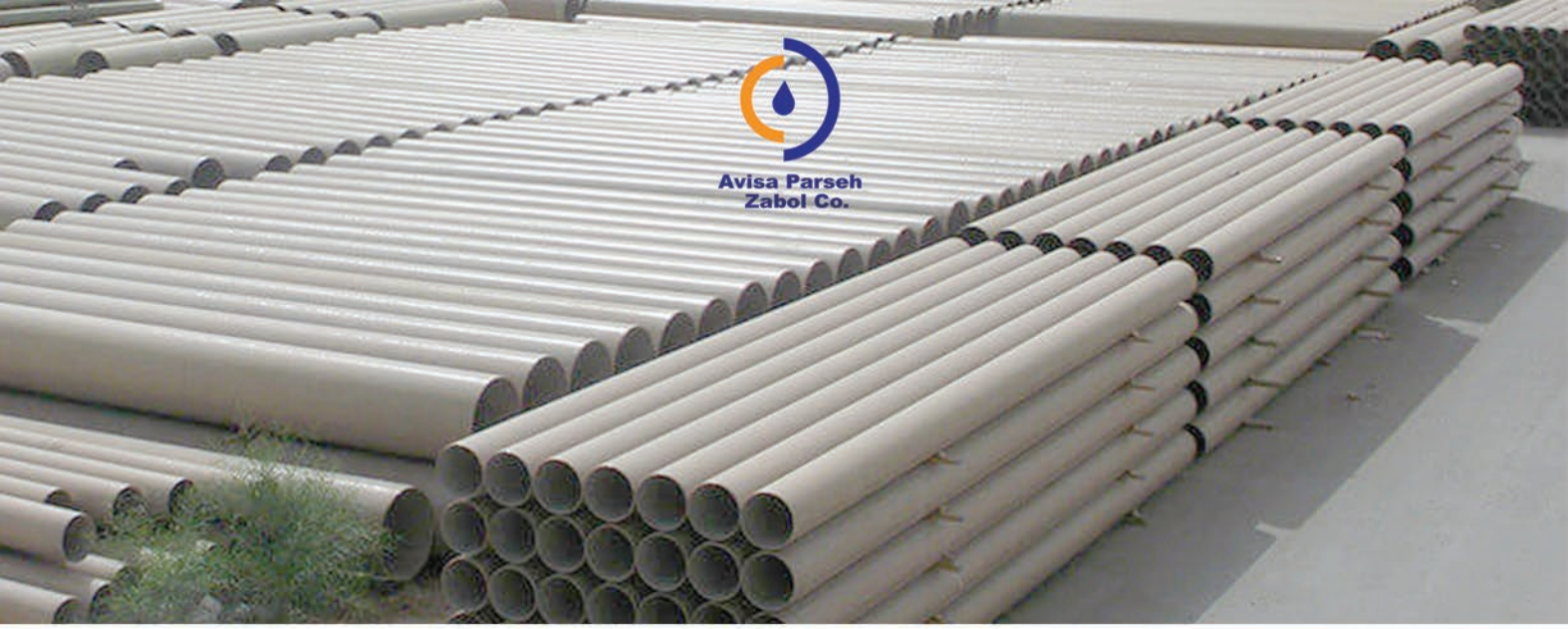

شرکت تولیدی صنعتی
آویسا پارسه زامبل

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 form hunting-gathering to farming and became yet more important with the emergence of cities, industrial towns ,and administrative center. 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 embodies culture and civilization . water is the most important vital item with join culture and civilization as one part, water is the symbol of abundance and purity.

Objective of Avisa parseh is to execute in projects which merge cultures and civilization, to transmit it's culture to regions and integrate to the other cultures.
Our aim is to contribute to be composed of the societies who know the value of water and use the water sources effectively.



II.Company Profile

Avisa Parseh Factory has been builted in 87.500m2 which is 13.200m2 as closed area.
All managerial and production facilities of Avisa Parseh industry and trade Inc.
are located in zabol city .Avisa Parseh has a business cooperation wth Avisa Parseh about pipe system and technologies.

Avisa Parseh follows up domestic and international market as its territorial business partners and representative.

Avisa Parseh Technology center as a standard and accredited test center for GRP products has excellent experience in GRP pipe and composite sector since 1992 for all kind of water transportation including special process applications and petrochemical products transportation. Background of this long termly success is obtained by Avisa Parseh Technology center that precisely performs technology an R&D studies.

Avisa Parseh products meet all requirement of global and local standards like CEN,ISO,TSEAWWA,ASTM,BSI.

Product range of Avisa Parse is as follows.

Diameter: DN 100-3000 mm

Pressure: PN 1-100 bar

Stiffness: SN 2500-25000 Pa

This product range cover standard products according to customer requests and project needs for non-standard application ,special designs are performed by Avisa Parseh on the pressure and stiffness classes mentioned above. All designs are under the guarantee of Avisa Parseh and Avisa Parseh Technology center approval.

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III.GRP Composites

Glass fiber 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 colour),flattened or shaped ,thick or thin. The main principle of GRP can be defined as a composite structure, reinforced by glass fiber and fully combined by resin.

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

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

To sum up it is very common to confront GRP composites at the every field of life.

1-GRP Pipes

It can be noticed easily that world's infrastructure is aged continuously and thousands of kilometers of pipeline need to be rehabilitated .This situation is one of the most major problems that should be considered in priority all over the world.

Investor organization 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 condition 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 in non-GRP products.

2- GRP Pipe Applications

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

-Water transmission and distribution(potable and raw water)
-Sanitary collection systems
-Storm sewers
-Chemical fluids transmission pipelines in different temperatures up to 160 ºC
-Sea water transmission systems
-Irrigation and drainage networks
-Cooling water systems
-Firefighting systems
-Pipe jacking systems
-Petroleum fluids transmission pipelines
-Pipelines transferring petroleum, industrial and chemical sewage
-Hydropower plant projects

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

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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

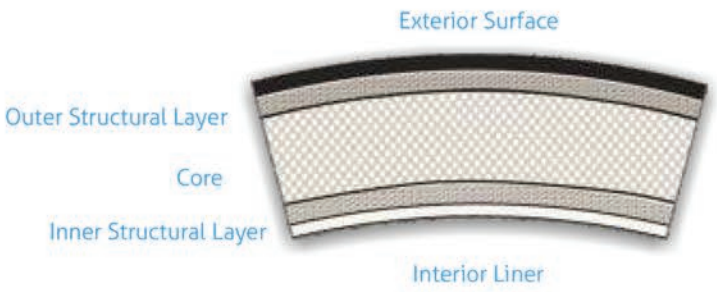
4- Production Process

Avisa Parseh GRP pipes are produced by using continuous advancing mandrel process that represents state-of-the-art in GRP pipe production, product range in 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 and external loads. chop roving 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 that combines all pipe layers and effects chemical life in some special cases , vinyl ester and other resins can be used instead of polyester resins.



5- Performance Standards

Standards developed by ,ISO, ASTM, AWWA,ASME which are the leading standard organization in the world are referred to a variety of GRP pipe applications including conveyance of sanitary sewage ,water and industrial waste .All of the product standards are performance based.
This means that required performance and testing of the pipes are specified based on pipe applications.

5-1-TSE (CEN and TS EN) and ISO Standards

Plastics piping systems for pressure and non-pressure drainage and sewerage-Glass-reinforced thermosetting plastic(GRP) systems	ISO 10467
Petroleum and Natural Gas Industrial –Glass Reinforced Plastic	ISO 14692
Plastics piping systems for pressure and non-pressure water supply	ISO 10639

Pipe type Transmission	Standard
Pressurized or gravity water conveyance systems	TSEN 1796
Pressurized or gravity sewerage and drainage systems	TSEN 14364
Pressurized or gravity water conveyance systems	TSEN 10639
Pressurized or gravity sewerage and drainage systems	TSEN 10467

Note: DNI 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.

5-2 - ASTM (American Society for Testing and Materials)

Abrasion resistance is related to 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, Avisa Parseh GRP pipes have been evaluated by using Darmstadt Rocker Method that is mostly known in the sector. Using gravel, average Abrassion loss of GRP pipes is about 0.34 mm / 100.000 cycles. Results can be varied depending on types of abrasive material used in test.

Pipe type	Code	Standard
Gravity sewer	D3262	ASTM
Pressure pipe	D3517	ASTM
Pressure sewer	D3754	ASTM

5-3-AWWA(American Water Works Association) and ASME(American Society of Mechanical Engineer)

AWWA C950 is one of the most Comprehensive product standards exist for GRP pipes. this standard for pressure water applications has necessitate extensive requirements for pipe and joints, concentrating on quality control and prototype qualification testing. like ASTM standards, this is a product performance standard. Avisa Parseh GRP pipes are designed to meet performance requirements of this standard. AWWA has also a design manual AWWA M45 which includes Several chapters for design of GRP pipes, both for underground and aboveground applications.

Pipe type	Standard
Fiberglass pressurized pipe	AWWA C950
Fiberglass pipes design manual	AWWA M45
Pipes and pipelines	ASME B31.4
Flange drilling	ASME B16.5 (up to 24")
	ASME B16.47 (up to 60")
	AWWA C207 (above 60")
Process piping	ASME B31.3

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6-Quality Criteria

6-1-Raw Material Quality Criteria

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

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

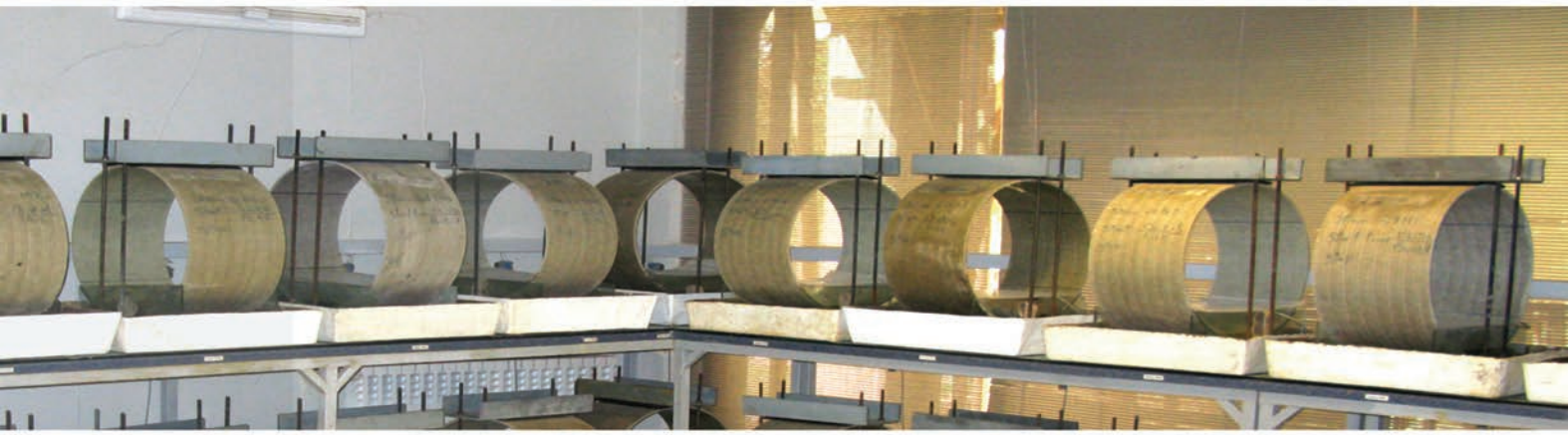
- Visual Inspection
-Barcol Hardness (Barcol: Surface Hardness Unit used for generally GRP composites)
-Diamensional Measurement
-Hydrostatic Leak Tightness Test(Two times of nominal pressure)

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 Avisa Parseh quality criteria. this criteria is determined by referring upper limits of local and international standards. Test results are the main parameters to meet the quality assurance for finished good pipes.



6-4-Qualification tests

Qualification tests are required in accordance with international standards as well as national standard of Iran. These tests are said to be long-term because their duration lasts around 10,000 hours (approximately 1.5 years).
Qualification tests are carried out for three main objectives:

a. Determination of the long-term mechanical properties of the raw materials used in the pipe structure. It should be taken in account that long-term mechanical strength of 50 years is determined by qualification tests.
b. Gaining results for designing GRP pipes with a useful lifespan of 50 years .
C. Performing re-qualification tests to confirm that the raw materials have a consistent formulation and quality (once every 1.5 years)

The most important qualification tests are as follows:

- Hydrostatic design basis
- Long term ring bending , "Strain bending test "
- Long term specific ring stiffness
- Long term strain corrosion

In addition to long-term tests, the following tests are also carried out:

- Resistance to UV rays
- Resistance to abrasion
- Resistance to long-term temperature in high temperatures
- Resistance to fire
- Test of fittings (short-term and long-term)

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7- Product Information

7-1- Diameter Class

Avisa Parseh Pipes can be produced between 100-3000 mm diameter.
Standard diameters are given below(in mm)

Continuous Filament Winding					
300	350	400	450	500	600
700	800	900	1000	1100	1200
1400	1600	1800	2000	2200	2400
2600	2800	3000			

Discontinuous Filament Winding						
25	50	100	150	200	250	300

According to customer request, others intermediate diameters can be produced between 100-3000 mm diameter. please contact Avisa Parseh Marketing Department for more information.

7-2-Pressure Class

Avisa Parseh GRP Pipes have standard pressure class range as shown below.
Other pressure classes can be provided if requested .for non-standard products, please contact Avisa Parseh Marketing Department .

Pressure Class(bar)	6	9	10	12	15	16	20	25	32	50	100
Diameter Upper Limit (mm)	3000	3000	3000	3000	3000	3000	1600	1600	1600	300	200

Pressure ratings of GRP pipes have been established in accordance with design approach outlined in AWWA M45 Fibergladss 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.

Avisa Parseh pipes are manufactured in a wide range of diameters up to 3000 mm (120 inches) and maximum working pressure of 100 bars (1450 PSI). These pipes due to their structure could be designed for a variety of fluids with various pH conditions (acid or alkaline) and have a high resistance to corrosion in chemical environments. Some of the mechanical properties of Avisa Parseh Uni-Axial and Bi-Axial pipes are shown in the table below compared to steel and GRE pipes.

Pipe Type					
Term	Unit	Uni-Axial	Bi-Axial	GRE	Steel***
Max axial tensile	MPa	55.9	115	107.8	207
Max hoop tensile	MPa	342.6	394	264.7	207
Axial modulus of elasticity	GPa	9.4-11.7	10.7	12.7	207
Hoop modulus of elasticity	GPa	9.2-32.9	19.4*	17.6	207
Poisson's ratio	---	0.25	0.3	0.26	0.26
Specific gravity	---	2.0	2.0	1.8	7.8
Hazen-William's C	---	150	150	150	130**

* Average quantity
** New pipe with cement lining. Roughness increases exponentially over time.
*** The range of mechanical strength value is based on AWWA M11. Referring to the API 5L, value of 207 for the metal pipe is the minimum resistance for the pipe made at Grade A.
The values in the table are merely for comparison purposes. Please contact Avisa Parseh Company for precise values if required.

7-3- Hydrostatic Test Pressure

Maximum test pressure in the factory based on pressure classification (AWWA C950, ASTM D3517)	2.0 × PN
Maximum field test pressure	1.5 × (P_w)

7-4-Surage

$P_s + P_w < 1.4 \times PN$	Maximum pressure

7-5-Stiffness Class

Definitions of GRP' Stiffness classes are provided in ISO and AWWA standards based on same principle with different coefficients. mostly used definition " initial specific ring stiffness" included in ISO standard based on the formula EL/D3, in, N/M^2(Pa).
Stiffness 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 soil. The native soil characteristics are rated according to ASTM D1586 standard penetration test.
Avisa Parseh GRP pipes are produced based on following standard stiffness classes.

Reference	Unit	Nominal Pipe Stiffness (SN)					
ISO	Pa	1250	2500	5000	10000	15000	20000
AWWA	kN/m^2	62	124	248	494	744	992

Accordance with customer requests, Avisa Parseh GRP Pipes can be produced more than 10.000 Pa and intermediate stiffness values.

7-6-Flow velocity

The permitted flow velocity in Faratec pipes is 3 m/s which could be increased in the absenceof abrasive materials in the fluid up to 9 m/s. Please contact Avisa Parseh Company for more information.

7-7-Pipe Length

Standard length of Avista Parseh GRP pipes is 12 m for diameters over 300 mm. Smaller diameters are available in 6 meters standard length.
Avisa parseh GRP Pipes can be produced in the range of 0.30-15 m length for diameters over 300 mm.(including intermediate lengths.)

7-8-Poisson's ratio

This coefficient depends on the structure of the pipe. Poisson's ratio in Avisa Parseh pipes for hoop stress and axial strain is between 0.22 and 0.29 and for axial stress and hoop strain is slightly lower than the above.

7-9-Resistance against U.V.

About 5% of sunlight is U.V. ray covering wavelengths of 280 to 400 nm. Solar radiation energy is usually measured with Langley unit (Ly):

The average solar radiation in kilo-Langley (KLy) for different countries is as following table:

$$1\ \text{Ly} = 1\ \frac{Cal}{Cm2}$$

Iran	200	Germany	80
Malaysia	140	England	70
Saudi Arabia	200	Austria	80
Ethiopia	150	Norway	70
France	120	Brazil	120
South Africa	160	Japan	100

Research and experiments show that if the pipes have been selected correctly, the U.V. rays do not have any effect on Avisa Parseh pipes. In general, based on their installation method, pipes are classified into two types of buried and above-ground. In above-ground pipes, chemical U.V. absorber or mechanical U.V. reflective materials are used to prevent damages of U.V. rays. It is recommended to use U.V.-resistant additives if burial pipes are going to be exposed to the sun for more than one year.

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7-10 - Load Capacity

Faratec pipes use the following values for hoop tensile strength and axial tensile strength according to common standards

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

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

7-11- Operating temperature

Avisa Parseh pipes have the ability to be designed for fluid transfer temperatures up to 160 °C. Maximum allowable fluid temperature in standard pipes produced with commonly used polyester resins is 45 °C. For continuous operation at a temperature between 50°C and 60°C it is recommended to consider one higher pressure class; e.g.: use a 10 bar pipe for 6 bars. At higher temperatures other resins with higher thermal resistance and special design are used. Please contact Avisa Parseh Company for more information.

7-12-Thermal expansion coefficient

The thermal coefficient of axial expansion and contraction for Avisa Parseh pipes is as follows:

$$21 \times 10^{-6} cm/cm/^{o}C \qquad 28 \times 10^{-6} cm/cm/^{o}C$$

This coefficient in the longitudinal direction is 1.5 to 2 times the one for steel. However, for under-ground pipes the thermal expansion is eliminated by using couplings. In case of above-ground installation which rigid pipe joints should be implemented, the pipes' longitudinal changes would not be neglected. Hence the stress analysis of piping should be carried out to investigate if using expansion joints or expansion loops are required.

7-13-Hydraulic coefficients

Head loss of pipeline is due to elevation change, flow turbulence (due to a sudden change in cross-sectional direction) and fluid friction with the wall of the pipe. Different methods are used to measure the frictional loss of pressure in Avisa Parseh pipes. Common methods include the equations Manning, Darcy-Weisbach and Hazen-Williams. Following coefficients are used in the corresponding equations for design.

a. In Hazen-Williams equation: the C coefficient is approximately 150 to 165
b. In Manning equation: the roughness coefficient is n=0.009
c. In Darcy-Weisbach equation: the surface roughness value is e=0.00518mm
d. In Colebrook White equation: the coefficient value is k=0.029 mm

One of the advantages of Avisa Parseh pipes in comparison to metal pipes is their low internal roughness. The effects of this advantage on pressurized fluid transfer systems will be as follows:

a. Reducing head loss (HF)
b. Reducing pumping station's electricity costs (CP)
c. Increasing fluid discharge capacity (QF)
d. Decreasing pipe diameter (D)

The mentioned advantages could be verified using hydraulic equations (such as Hazen-Williams). In this regard, the following example is presented about decreasing diameter. In a pressurized system with a constant length and flow conditions (flow and head loss), if the diameter of the steel pipe is 2000 mm, the equivalent diameter is 1800 mm for Avisa Parseh pipes as detailed in following calculation:

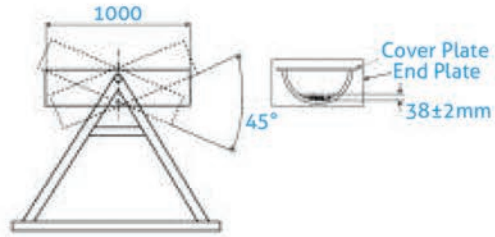
In which:
HF (head loss in mH2O)
L (length of the pipeline in m)
Q (discharge in m3/s)
D (pipe diameter in m)
C (Hazen-Williams coefficient)

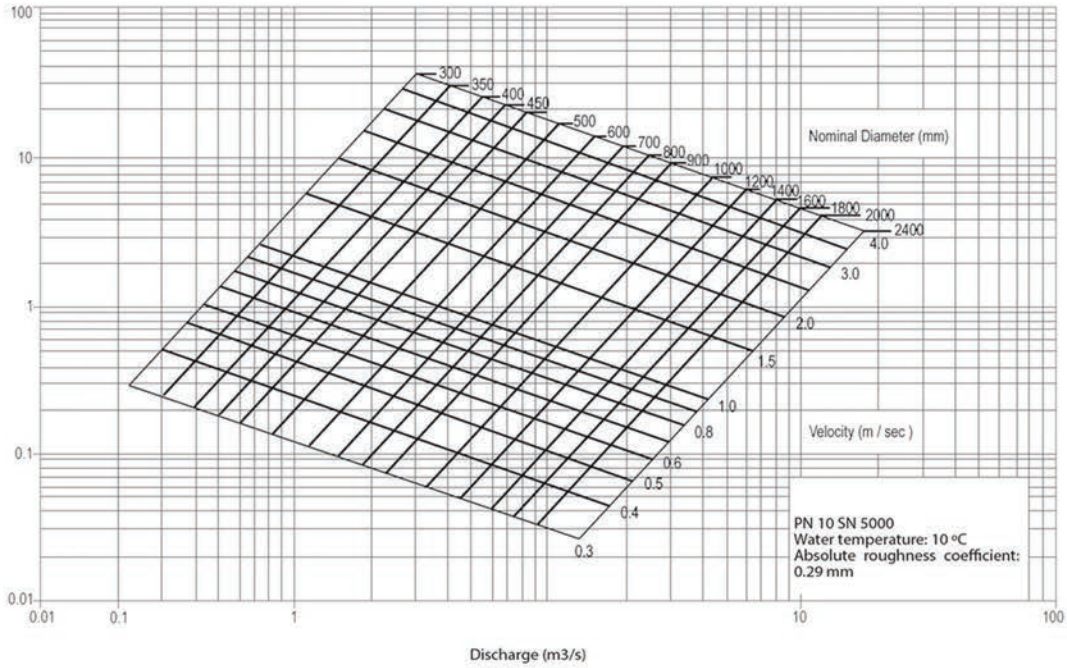
$$HF_{STEEL}=HF_{GRP} \rightarrow \text{(Hazen-Williams equation)}\ HF=\frac{10.68\,Q^{1.852}.L}{C^{1.852}.D^{4.87}} \rightarrow$$

$$\rightarrow \quad (110/150)^{1.852}=(D_{GRP}/D_{STEEL})^{4.87} \rightarrow D_{GRP}=1777mm$$

7-14-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, Avisa Parseh 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.

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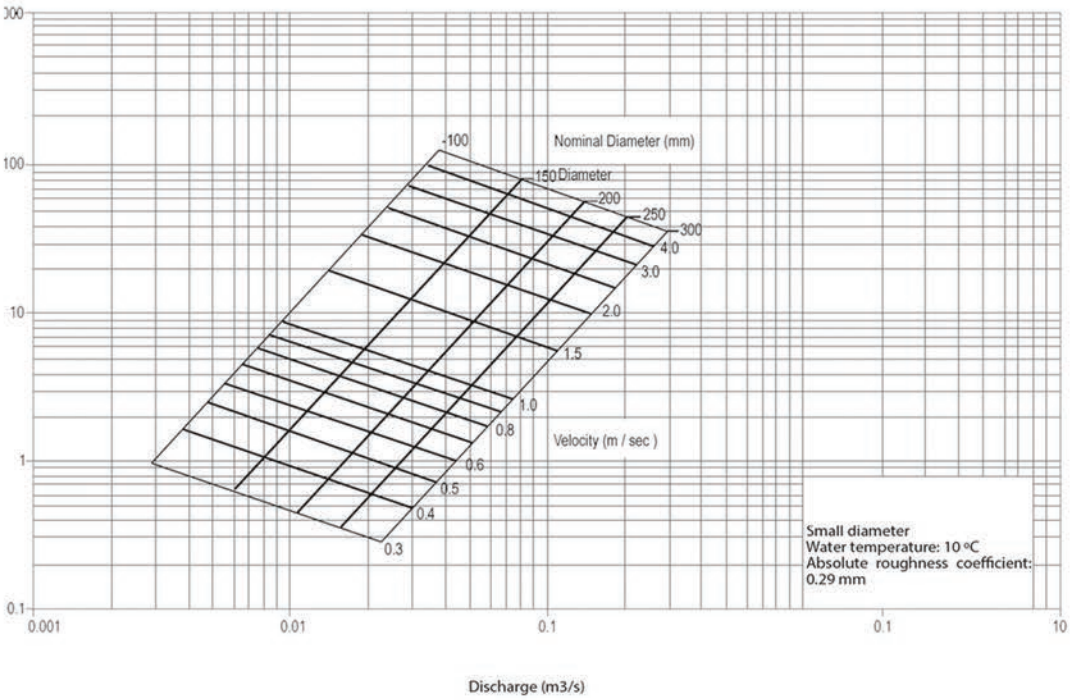
2000
2400
4.0
3.0
2.0
1.5
1.0
0.8
0.6
0.5
0.4
0.3
Nominal Diameter (mm)
Velocity (m / sec)
PN 10 SN 5000
Water temperature: 10 °C
Absolute roughness coefficient:
0.29 mm
Discharge (m3/s)


100
10
1
0.1
0.001
0.01
0.1
0.1
10
100
150
200
250
300
4.0
3.0
2.0
1.5
1.0
0.8
0.6
0.5
0.4
0.3
Nominal Diameter (mm)
Diameter
Velocity (m / sec)
Small diameter
Water temperature: 10 °C
Absolute roughness coefficient:
0.29 mm
Discharge (m3/s)

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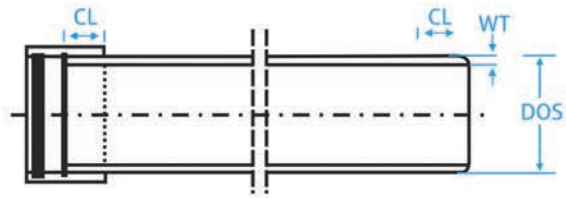
8-Pipe Dimensions



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

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

9-Resistance against chemical fluids and sewage

9-1Resistance against chemical fluids

Long-term tests of 10,000 hours are carried out with various chemical fluids (different types of acids, alkalines , etc. due to ASTM D3681) to obtain a long lifespan of products in chemical conditions. The results of these tests lead to the selection of suitable materials, proper design and useful lifespan of 50 years in different chemical conditions. Consulting Avisa Parseh Company in order to select the correct raw materials is recommended.

9-2 Resistance against sewage

The contents of urban and industrial sewage are not predictable. A wide range of corrosive fluids with different pH (alkalines or acid) such as detergents, disinfectants, drain openers, anti-vermin toxins, along with suspended particles and even sharp objects are also found in sewage. Thus, a pipe used for a sewerage system should not only be resistant to chemicals, but also have a good mechanical strength.
The constant and low roughness of Faratec pipes makes it possible to have milder slopes in gravity sewerage systems and the pipes function optimally over time. Special sewerage Faratec pipes are completely resistant to a variety of chemicals and have constant mechanical properties over their 50-year useful lifespan. Buried metal pipes corrode from the outer side of their wall due to the free electrical charges and corrosive soil around. Unprotected metal pipes are also gradually corroded from inside because of the fluid flow through them.
Unprotected concrete pipelines corrode quickly from the inside due to the presence of acidic environments and corrosive gases from sewage.
It should be noted that because of the chemical properties and quality of the fluid, the type of the GRP product suitable for the users will be recommended and produced by Avisa Parseh Company.

10-Bi-Axial pipes

Bi-Axial pipes can be used in various projects of water supply (drinking or raw water), industrial, oil and gas, etc. Then this generation of pipe is capable of being designed for various industrial applications.

10-1-Mechanical characteristics

The design of the Bi-Axial pipes resulted in pipes with extremely high axial and hoop strengths, therefore these pipes are much more resistant than standard burial pipes. Installing these pipes could be done using different installation methods such as butt-wrap or glued couplings. Some of the mechanical characteristics of the above pipes as well as Butt-Wrap joints are given in the following table:

Biaxial Pipes				Butt-wrap Joints
Physical Prperties	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
ν Poisson 's ratio	0.2	0.25	-	0.3
α Termal coeff liner(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

10-2-Stress analysis considerations

In order to make enough resistance against axial and hoop stresses in above-ground piping, the rigid joint system (like Butt-Wrap or Glued Coupling) is used.
The thermal expansion coefficient of GRP is approximately 2 times the steel but the modulus of elasticity in GRP is less than that of steel, so the stresses decrease to some extent. Expansion Joint or Expansion Loop systems may be used to eliminate the effect of these destroying stresses.
Thrust Blocks or Anchor Blocks are used at elbows in buried pipeline depending on the pipe and project type.
Due to high mechanical strength in Biaxial pipes it might not necessary to use thrust blocks.

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11-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 wich influence water hammer pressure in a pipe system are variation In flluid 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.Avisa parseh 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

12- Performance of Avisa parseh pipes in earthquakes

The effect of earthquake on buried pipelines is divided into two main categories of temporary land deformation due to the release of earthquake waves and permanent land deformation such as liquefaction, lateral extension and landslide. During design and routing of pipelines, geotechnical studies should identify the geological hazards associated with earthquakes, in order to select the most suitable route for pipelines.
The experience of extreme earthquakes in different parts of the world has indicated that composite pipes have the ability to function properly.

This appropriate behavior in the earthquake is due to the following three factors:

1- The considerable flexibility of the fiberglass pipes and the matching of the pipeline with temporary and permanent deformation of the earth during and after the earthquake.

2- High mechanical strength of the fiberglass pipes allows the pipes to tolerate stresses from the surrounding soil.

3- Joints of fiberglass pipes have a good functionality against earthquakes. The common REKA coupling joints with an axial tolerance of at least 0.3% length and a suitable deflection angle, can depreciate a significant portion of the deformations on the pipe. On the other hand, rigid joints such as glued coupling or lamination joints have the ability to attach pipes to create continuous operation in the pipeline and stress is tolerated by the pipe body.

Therefore, Avisa parseh pipes could be designed for a variety of specific conditions.

Country	Name of earthquake	Time	Earthquake magnitude
Iran	Fars-Lar	1996 - 2007	3.0-7.0
Iran	Kermanshah - Sarpol-e-Zahab	Nov. 2017	7.0-7.5
New Zealand	Christchurch	Jun. 2011	6.3
New Zealand	Christchurch	Sep. 2010	7.1
Chili	Conception	Feb. 2010	8.8
Colombia	Armenia	Jan. 1999	6.2
Turkey	Izmir	Oct. 2005	5.9
Turkey	Erzurum	Mar. 2004	5.6
Turkey	Sultandagi-Afyon	Dec. 2000	6.0
Turkey	Izmit (Kocaeli)	Aug. 1999	7.6

Examples of successful performance of composite pipes in large earthquakes in Iran and other parts of the world.

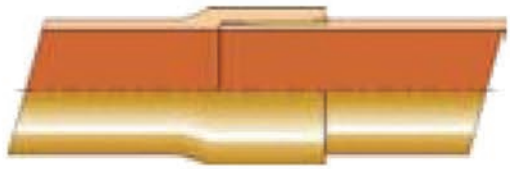
13-Pipe joining methods

13-1-Bell and Spigot joint

This joining method is typically used for pipe diameters less than 300 mm (12 inches).
The pipes in this method have an enlarged diameter part (bell) at one end. After the application of resin around the spigot end (the thinner part of the pipe) of a pipe, it is slid into the bell end of the other pipe. This joint will be rigid as soon as the resin dries.

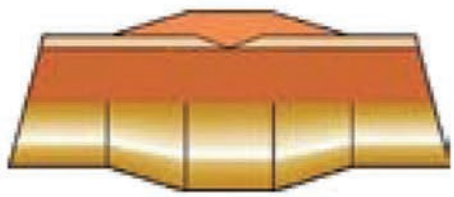
13-2-Adhesive bonded double bell coupling

This type is a rigid joint made with the help of an intermediate piece called the adapter. This joining method is usually used in above-ground piping, especially in oil platforms.



13-2-Butt-Wrap or Lay-Up joint

This joint is made using different types of fiberglass and resin layers. The length and thickness of the joint are determined based on the diameter and working pressure of the pipe. This type of connection requires trained personnel and appropriate conditions. The manufacturer wil provide relevant services as needed.

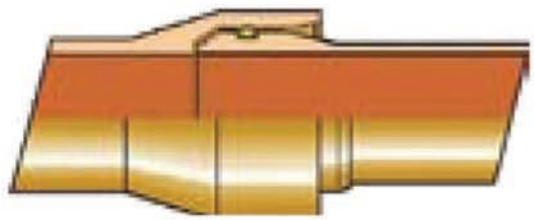


13-4-Adhesive bonded coupling (four-gasket glued coupling)

Rigid couplings with epoxy glue are provided in this method to be used in buried or above-ground pipelines. This type of joint is used when it is necessary to provide resistance in the axial direction of the pipe. Sealing with two gaskets and epoxy adhesives is performed in these couplings .
In addition, the epoxy adhesive between the pipe and the coupling causes the coupling to be rigid, and as a result the joint is quite resistant to the stresses along the pipeline.

13-5-Reka coupling

Reka couplings are the most common joints, especially for buried pipelines. The pipes are generally connected by a two-gasket GRP coupler. Pipes and couplings can be provided separately, but usually a coupling is installed at one end of the pipe in the factory. The couplings are sealed with two gaskets, and a gasket or separate pieces of gaskets in the middle of the coupling prevents the head-to-head collisions, called Stopper.
Gaskets are placed in the grooves that are carefully cut and are resistant to more than 75 years application. All dimensions of the couplings of this company are specified in the table below.



13-6-Angular deflection of the joints

Coupling joints are subject to several tests according to ASTM D 4161 and ISO DIS 8639 standards. Faratec pipes at each (coupling) joint can have angular deflections up to the values given in the following table:

Nom. Pipe Diameter (mm)	Angle of Deflection (deg)	Offset (mm) Pipe length			Radius of curvature(m) Pipe length		
		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

If the nominal pressure of the pipes is more than 16 bars, the maximum deflection angle is obtained from the following table:

Nom. Pipe Diameter (mm)	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

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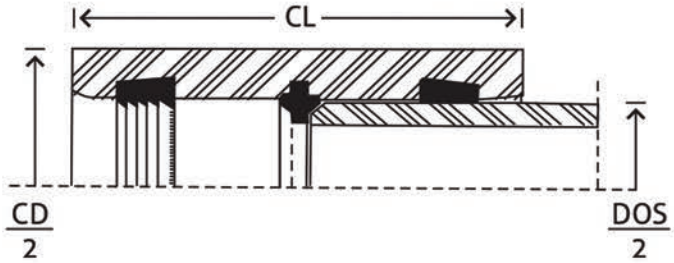
14-Coupling dimensions (buried system)



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

14-1-GRP Flanges

It is possible to connect GRP pipes to other kind of pipes by buttwrap , adaptor , flanges and etc. For connecting to steel pipes GRP flange holes would be compatible to steel flange holes. It would be possible to use different standards for flange drilling like (AWWA, EN, ANSI, ASME, DIN, SSI, etc.).

15-Fittings

All GRP fittings, such as elbows at various angles, tees, flanges, nozzles, etc. are produced in standard sizes. They could be also produced in sizes other than Faratec standards on request. Samples of the manufacturer's fittings are displayed in the next page.
It is possible to provide fittings up to a diameter of 900 mm. Please contact the company for more information about integrated or mitered fittings.

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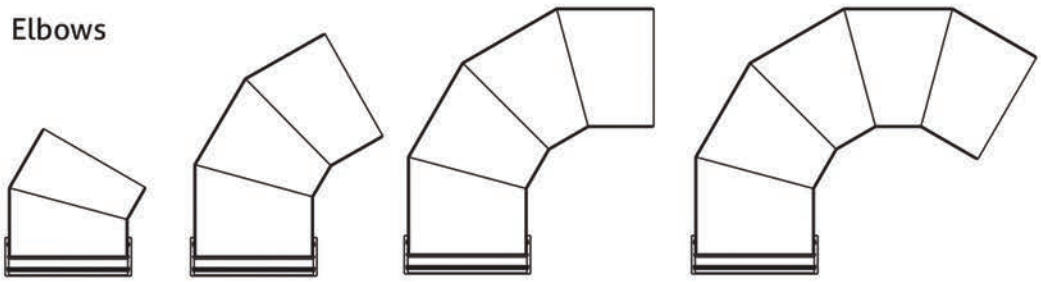
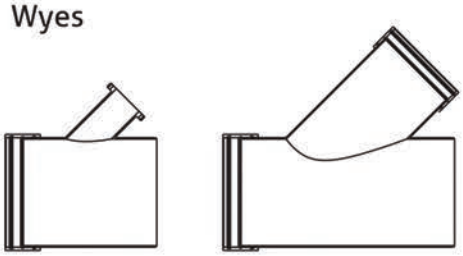
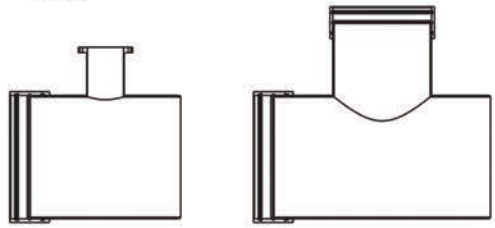
Elbows



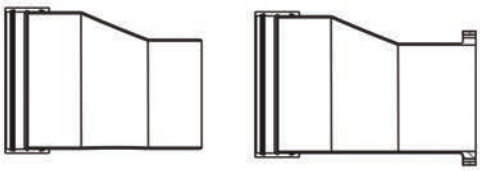
Wyes



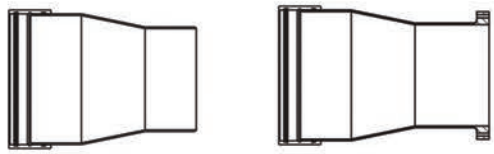
Tees



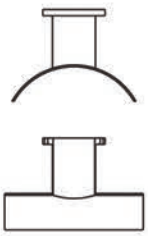
Eccentric Reducer



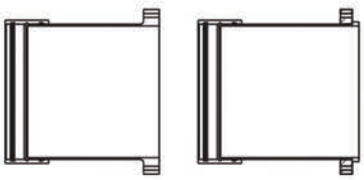
Concentric Reducer



Saddle



Flanges



16-Branching

The most important issue in installing a pipeline network is the ability to branch out the main pipe. Branching methods are as follows:

a- Branch saddle

Branching of Avisa Parseh pipes is very easy in this method. The gaskets and fittings of this saddle branch are designed to be sealed completely.

b- Mechanical coupling

c- Branching by lay-up joints

(e.g. connecting a flange and a valve to the pipe)

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17-Capabilities of Faratec pipes in inverted siphons

Avisa Parseh GRP pipes, due to their various technical and economic advantages, including strong structure, light weight and especially high corrosion resistance, smooth inner surface and very high mechanical strength, long lifespan, easy and fast installation are worthy of consideration as a superior pipe generation in comparison with other pipes. Especially, because of their economical price which makes them considerable options of inverted siphons.

17-1-GRP inverted siphons

Enough hydraulic head should be supplied in upstream of an inverted siphon to gain suitable efficiency. This upstream head should compensate the losses from inlet and outlet reducers, elbows and the main conduit. Therefore, it is necessary to use pipes with less losses in the design phase. One solution in this condition is to use pipes with smoother and more persistent inner surface so that the roughness of the pipe wouldn't change along service lifespan because of the effects of corrosion or mechanical and chemical factors. The use of GRP pipes and conduits is recommended for this purpose. By applying this change in selecting the type of pipe, the Manning roughness coefficient decreases to 0.009.

The short term advantages of GRP pipes for inverted siphons are:
slight weigh, low price of purchase, transformation and installation.

The long term advantages of GRP pipes for inverted siphons are:
minimum 50-year useful lifespan, constant roughness coefficient along lifespan of the pipes, no need to protection methods like inner and outer coating or cathodic protection. The use of GRP pipes in comparison with other types of pipes minimizes corrosion effects and provides structural health during operation.

GRP pipes reduce the cost of the project significantly and have the following advantages:

- Reducing hydraulic loss by reducing Manning's roughness coefficient

- Minimizing the likelihood of an undesirable hydraulic jump in inlet of the siphon

- Reducing cost, risk and duration of installation

- Ease of installation of GRP pipes compared to other types of pipes

- Ability to use anti-abrasion additives in the structure of the GRP pipes to minimize the effects of abrasion caused by the entry of sediment into the siphon conduit

- Cleaning and draining sediments from the inverted siphon will be facilitated due to easy branching and installing drain valves

It should be mentioned that the Avisa Parseh Technology Center has recommended the use of flexible
adhesive mastic (Polyeutex) on couplings in special projects. By injecting this adhesive, in addition to eliminating the possibility of leakage, the flexibility of connection at the couplings remains intact. In other words, the seam between the pipe and the coupling from the inside is filled with elastic mastic and the water leakage is completely ruled out.
Additionally, the injection of this type of adhesive at the junction of the siphon conduit to the inlet and outlet concrete reducers will also fully seal the gaps, so the concern of water leakage at these points will be resolved.

18-GRP manholes and valve chambers

Due to high technology products Avisa Parseh have increased the lifespan of the projects as well as decreasing the installation duration and costs by means of producing GRP manholes and valve chambers. This type of product, in combination with GRP pipelines, is an integrated and almost maintenance-free system that can guarantee the quality and life of the pipelines. Valve chambers are designed as parts of pipelines that work either as pressurized or gravity systems for the following purposes:

- Installation and maintenance of the valves
- Accommodating the facilities of chemical injection to fluids
- Accessing and visiting the transmission pipeline, facilities and fittings
- Draining the pipeline
- Cleaning the pipeline
- Changing the conditions of the fluid
- Possibility to inspect inside the pipelines
- The rapid discharge of fluid from the pipeline at certain times
- Ease of installation and repair of valves

Advantages of using GRP manholes and valve chambers	
Corrosion resistant	- Durable and stable - Safe and reliable - No need for repair and maintenance - Resistance to internal and external corrosion - Convenient installation
Light weight	- High maneuverability at production time - Loading, transporting and unloading by lighter and more affordable machines - Faster and easier installation at the site
Easy installation	- Time saving - Less excavation - No need for a specific foundation - Adding quick and easy new parts and joints to manholes using standard devices
Reliable	- A completely independent and integrated structure - Stable - No changes in dimensions
Integrated wall	- Preventing internal leakage - Resistance to external leakage

Technically, when the GRP pipe is considered for vertical usage (like manholes and valve chambers), the external force from the soil implemented on the pipe in hoop direction is practically less. As a result, the stiffness of the pipe is reduced, which is a criterion for resistance to deflection.

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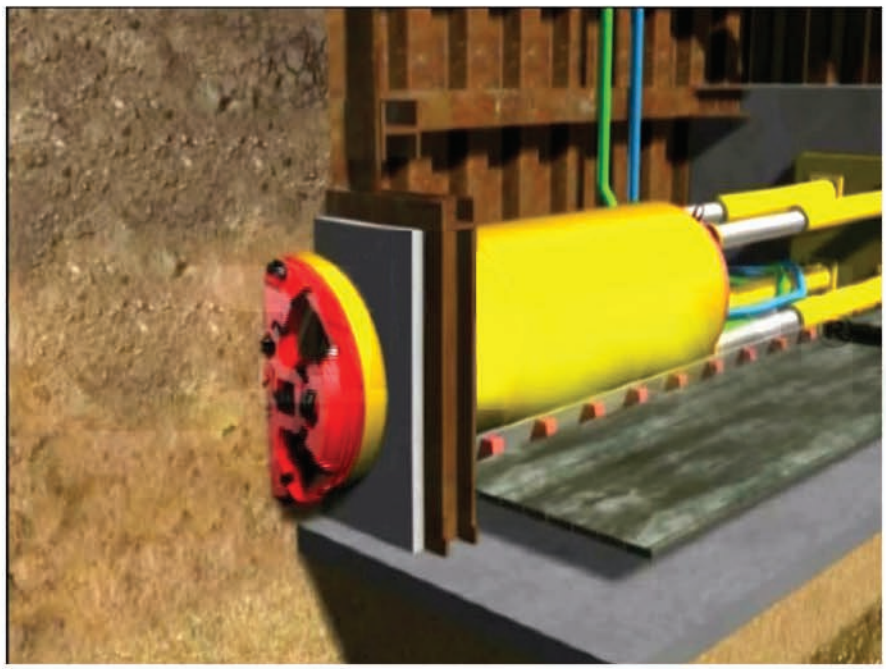
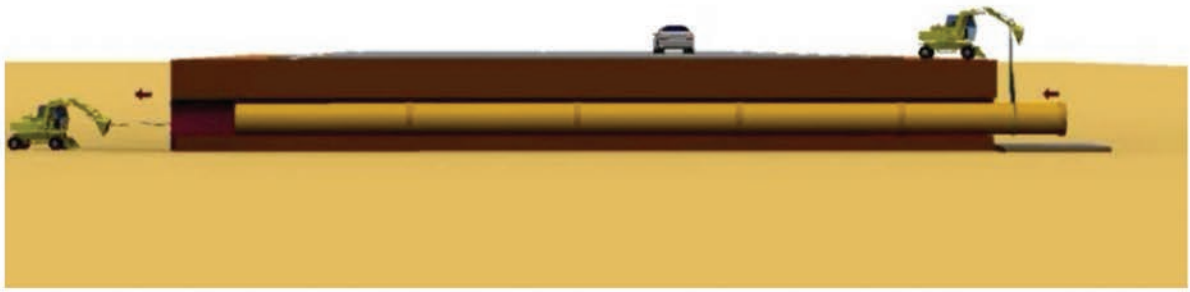
19-Special applications

19-1-Pipe Jacking

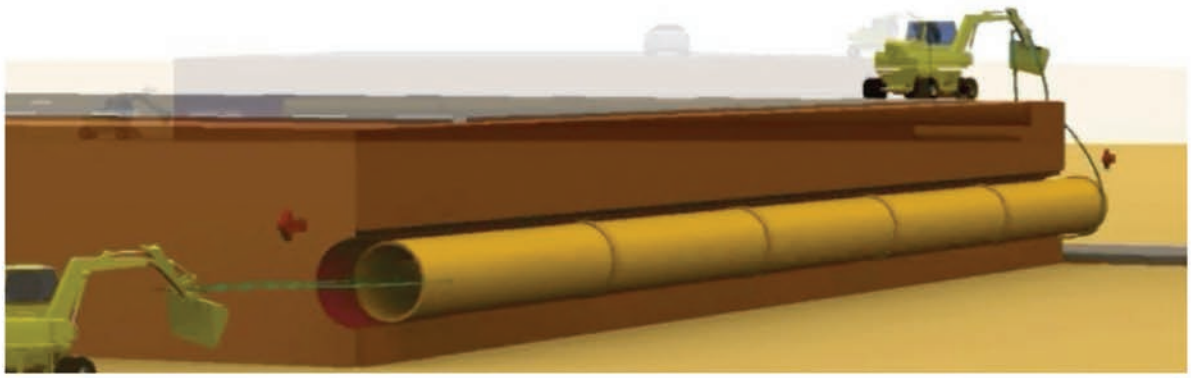
If the open trench system for installing the pipeline is not applicable, the pipe jacking system could be used. Avisa Parseh jacking pipe products can be manufactured to be used in pressurized systems too. According to the customer's requirements and the pipeline system for different projects, a new pipe jacking product is designed. Please contact the company for more complementary information.





19-2-Pipe Jacking with Pipe Slip method

The experiences of operators in different parts of the world have shown that the erosion of concrete or metal pipes is unavoidable. In addition, because of their less fluid flow capacity, the overall diameter of these pipes is more than GRP pipes. So, an affordable solution was found to revive old networks by placing new, corrosion-resistant GRP pipes inside the old network. This process is called Rehabilitation of pipeline.
The important issue in jacking pipes is the exact diameter of the pipes and their strength. According to what mentioned above, GRP jacking pipes have been used in Europe for many years as an ideal product. The process of manufacturing Avisa Parseh GRP pipes, allows the manufacturer to fully control their internal and external diameter. This is the reason; Avisa Parseh pipes are ideal choices for pipe jacking. Avisa Parseh jacking pipes have been used in several pipeline projects in Iran.
Another application of GRP is the coating of other pipes with GRP sheets. By applying this coating, the inner surface of the pipe will act as a GRP pipe, which means, a lower roughness and a fully corrosion resistant surface. The implementation of this cover requires its own special tools and technology existing in Avisa Parseh Company.



19-3-Industrial applications

Other special products could be designed and manufactured to be used in various industries including the chemical industry for the transfer of various types of chemical fluids at different temperatures, fire resistant systems, abrasion resistant systems, etc. Please consult Avisa Parseh Company if more information is needed.

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20-Installation of GRP pipes

20-1-Pipe classification

Selection of Avisa Parseh GRP pipes is based on stiffness and pressure class requirement.

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

Stiffness of Avisa Parseh GRP pipes is selected from one of three stiffness classes listed below. Stiffness class represents pipes's minimum initial specific stiffness as EL/D3 in N/m2 (Pa).

Stiffness is defined according to two parameters. These are: (1) burial conditions, which include native soil, type of back-fill 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

A wide range of backfill soil types are offered in tables bellow 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 three 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- 3000 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 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 Avisa Parseh 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 recommend 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 Avisa Parseh Field Department.

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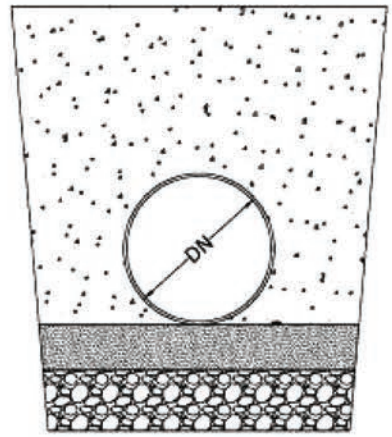
20-2-Installation Types

Following illustration show two standard installation types commonly used with GRP pipes.

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.

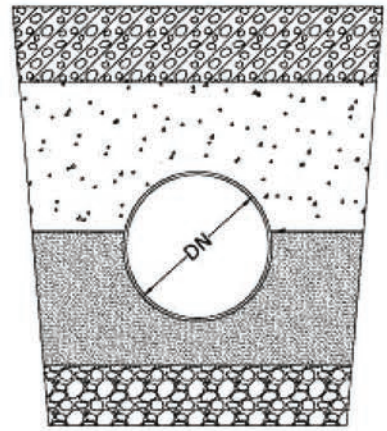
Note:for on-pressure applications,requirement to compact 300 mm over pipe is not applied.



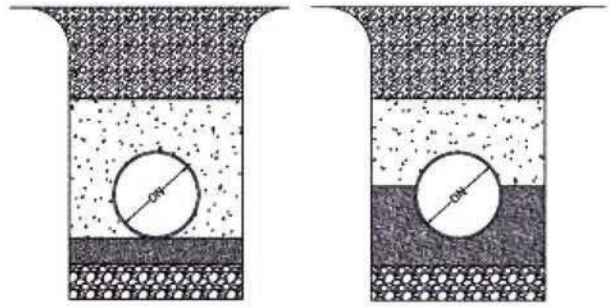
Installation Type 2

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 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. Avisa parseh installation instructions for buried pipe should be consulted for additional details.



Avisa parseh 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 installations. Please contact Avisa parseh for further.

20-3-Trenching

Trench must always be wide enough to permit placement and compaction of pipe zone backfill materials and provide proper pipe support. Depth 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 limitswill be affected. In extraordinary conditions, please consult to Avisa parseh Expert Team.

20-4-Bedding

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

20-5-Backfill Materials

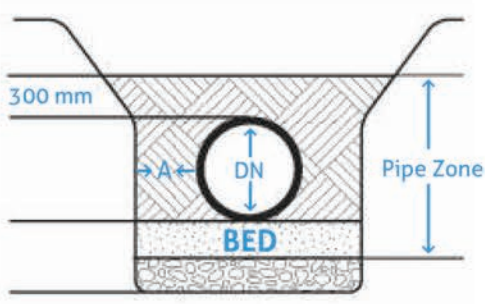
To ensure a satisfactory pipe-soil system. Correct backfill material must be used. Most coarse grained soils (as classified by Unified Soils Classification System) are acceptable bedding and pipe zone backfill material.Where the instructions permit the use native soil as backfill, care organic material.Following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

20-6-Standard Trench Details

Atypical trench detail for GRP pipe can be as following figure:

Where rock, hard pan ,soft, loose,unstable or highly expansive soils are encountered in trench botoom, 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 spacified above(Particularly for smaller diameters).

20-7-Checking Installed pipe

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

20-8-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 300mm 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.

20-9-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.

20-10-High Pressure

High pressure more than 16 bar may require deeper burial depth to prevent uplift and movement. Pipes-DN300 and larger- should have a minimum burial depth of 1.2 meters,and 0.8 meters for smaller diameters.

20-11-High Water Table

A minimum of 0.75 diameter ofearth cover (minimum dry soil bulk density of 1900 kg/m3)is required of prevent an empty submerged pipe from floating.Alternatively,the installation may proced 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 Avisa parseh for details on anchoring and minimum cover depth with anchors.

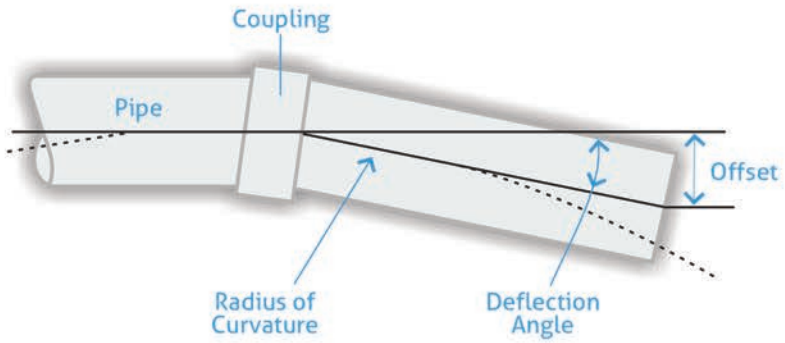
20-12-Joint Angular Deflection

Coupling joints are extensively tested and qualified in accordance with ASTM D4161 and ISO8639. 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 jointed in straight aligment but not all the way to home line andthereafter deflected angularly as required.

Nom. Pipe Diameter	Angle of Deflection	Offset (mm) Pipe Length			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)	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



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