GRP PIPES

EBS® GRP

Glass Fiber Reinforced Plastic (GRP) Pipes

Group Companies

EBS®

ECE PIPE SYSTEMS

HIGHER QUALITY IN INFRASTRUCTURE

EBS
ECE PIPE SYSTEMS

Ece Group has 25 years of proven quality and success in the production of concrete and reinforced concrete pipes. Its two established factories are located in Manisa and Adapazarı, Turkey. The company has expanded over the years to produce a variety of Polyethylene Pipes (PE63, PE100, PE80, PE80 Gas, Steel Wire Reinforced Thermoplastic Pipes, Corrugated HDPE Pipes, Metal Reinforced Corrugated HDPE Pipes) and GRP (Glassfiber Reinforced Plastic Pipes) and Pipe Fittings with the EBS (Ece Boru Sistemleri-Ece Pipe Systems) brand name. All of its products are up-to-date and comply with the needs of infrastructure projects according to the latest technological developments.

EBS is located in Manisa, Turkey with a large and modern plant based on high technology. It has a closed area of 7.500 sqm and an open area of 50.000 sqm. In addition to this, there are plans to expand on this and to build new facilities. The company is continually expanding its production capacity and broadening its range of products.

EBS (Ece Boru Sistemleri-Ece Pipe Systems), which is a subsidiary of Ece Group, is the first and only in Turkey with such a wide diversity within its production range. All of EBS products are produced within the scope of TSE (Certificate of Turkish Standards Institude), ISO (International Organization for Standardization) and other related international standards.

EBS (Ece Boru Sistemleri- Ece Pipe Systems) which follows and applies all the new technologies, included and started production of Metal Reinforced Corrugated HDPE 100 Pipes and Steel Wire Reinforced Thermoplastic Pipes to keep up to date in pipe industry.

Group Companies

EBS®
ECE PIPE SYSTEMS

GRP PIPES

Glass Fiber Reinforced Plastic (GRP) Pipes

INDEX

PRODUCT DESCRIPTION

PRODUCTION PROCESS
Continuous Filament Winding Process

NOMINAL DIAMETERS
DN 300 mm - DN2800 mm

PIPE LENGTHS
GRP pipes are manufactured between 6m-12m , may also be manufactured between 0,5m-16m length depending on the desired length according to the project needs.

PRESSURE CATEGORIES
PN 1 bar to PN 40 bar

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

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

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

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

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

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

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

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

QUALITY STANDARDS
GRP pipes are manufactured in accordance with all the national and international standards like TSE, ISO, BS, DIN, ASTM ve AWWA. Other local approvals are also available, dependent on country specific requirements.

PRODUCTION PROCESS

EBS (ECE BORU SİSTEMLERİ - ECE PIPE SYSTEMS), GRP pipes are produced by continuous filament winding process. Major raw materials are ishoptalic, orthoptalic resin, E glass, ECR glass, quartz sand, etc. Production process is fully operated with computer controlled machines which provides standard and repeatable quality in GRP pipes and fittings.

TURKEY	TS4355
USA	AWWA M45 ASTM D 3517 ASTM D 3754 ASTM D 3262
GERMANY	DIN 16 869 (1+2) DIN 16 565 (1)
ENGLAND	BS 5480 (1+2)
ITALY	UNI 9032 UNI 9033
JAPAN	JIS A 5350
SWEDEN	SS 3622 SS 3623
BELGIUM	NBN T 41-101 NBN T 41-102
AUSTRIA	ÖNORM B 5184 ÖNORM B 5182

Manufacturing is in accordance with the national, international standards like TSE, ISO, BS, ASTM, DIN, AWWA etc.

SUPERIORITIES and ADVANTAGES

PRODUCTION and METHODS

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

APPLICATION AREAS

Underground applications, upperground applications, subwater applications, relining

HANDLING and STORAGE

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

LIGHTNESS

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

PIPE LENGTHS

GRP pipes are manufactured between 6m-12m, may be manufactured between 0,5m -16m according to the project needs.

COUPLING

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

FAST MOUNTING

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

CUTTING and FINISHING

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

DESIGN

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

EXTREME PRESSURES

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

SUPERIORITIES and ADVANTAGES

CORROSION RESISTANT

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

HYDRAULIC CONDUCTION

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

QUALITY of FITTINGS

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

RESISTIVITY

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

ELASTICITY

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

DEVIATION IN FITTINGS

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

EXTREMELY SMOOTH BORE

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

ENGINEERING FORMULAS

1. HEAD LOSS

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

1.1 Hazen-Williams equation;

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

Many engineers prefer a simplified version of the Hazen Williams equation.

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

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

Head Loss converted to Pressure Loss;

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

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

1.2 Manning equation;

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

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

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

1.3 Darcy-Weisbach equation;

The primary advantage of this equation is that it is valid for all fluids in both laminar and turbulent flow. "f" coefficient in this equation is characterized with Reynolds number.
If Re≤2000 flow type is "Laminar"
If 2000<Re<4000 flow type is "Transition flow zone"
If Re≥4000 flow type is "Turbulent"

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

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

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

1.4 Local Head Loss in Fittings;

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

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

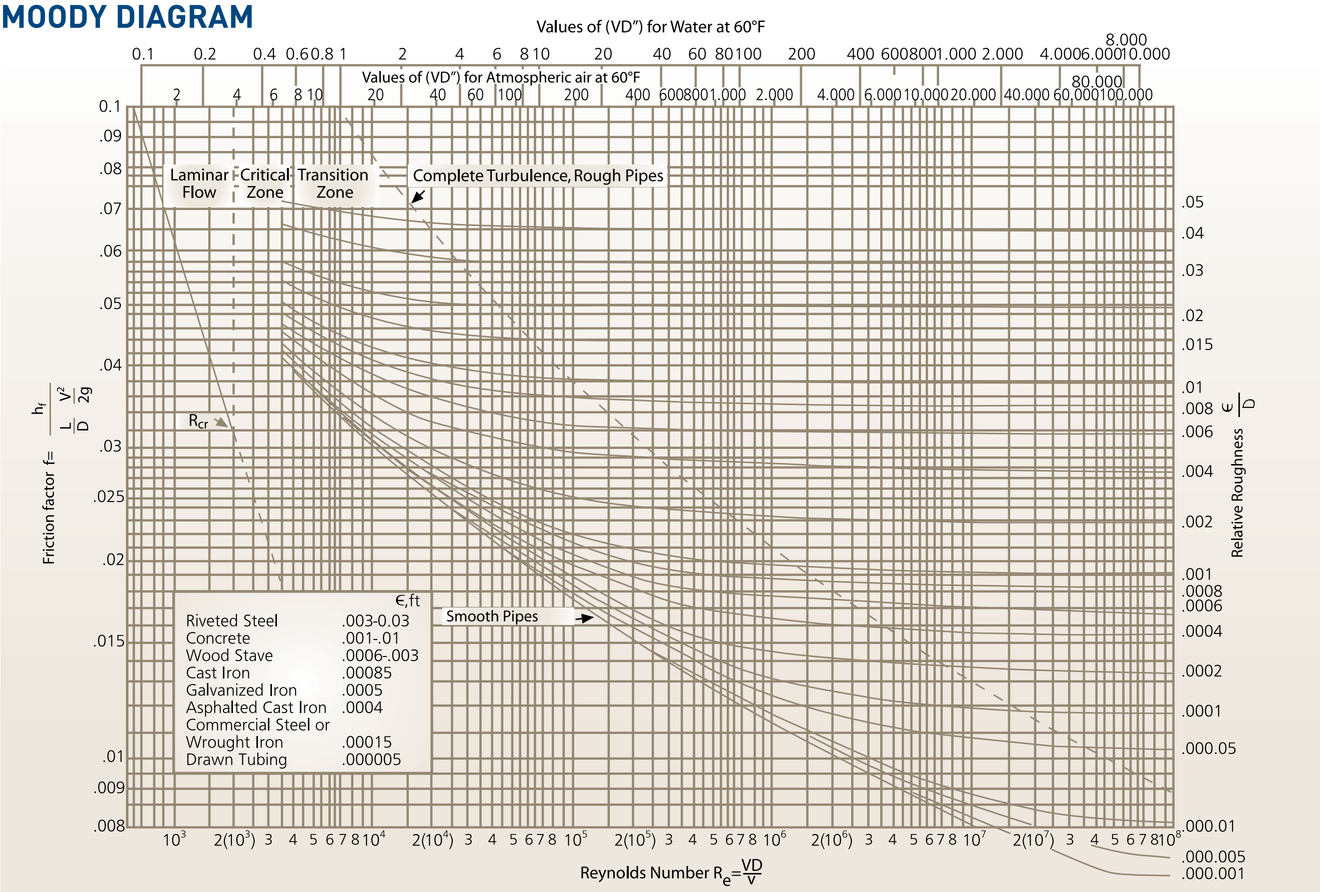
- h_{ff} : head loss (m)

"K" values for some fitting types;

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

ENGINEERING FORMULAS

MOODY DIAGRAM



2. PRESSURE SURGE

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

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

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

$a = 1/[(\rho/g)(1/10^9\,k + d/10^9\,E(t))]^{0,5}$

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

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

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

- Pw : Working pressure
- Ps : Surge pressure

3. RING BENDING

The maximum allowable long-term vertical pipe deflection should not result in a ring-bending strain or stress that exceeds the long term,ring bending capability of the pipe reduced by an appropriate design factor.

For stress basis:

$$\sigma_b = 10^3 D_f E \left(\frac{\Delta y_a}{D}\right)\left(\frac{t_t}{D}\right) \leq 10^3 \frac{S_b E}{FS}$$

For strain basis:

$$\varepsilon_b = D_f \left(\frac{\Delta y_a}{D}\right)\left(\frac{t_t}{D}\right) \leq \frac{S_b}{FS}$$

ENGINEERING FORMULAS

σ_b : maximum ring bending stress due to deflection (MPa)

D_f : Shape factor (dimensionless)
The shape factor relates pipe deflection to bending stress od strain and is a function of pipe stiffness, pipe zone embedment material and compaction, haunching, native soil conditions and level of deflections. Df has a table of values.

E : Modulus of elasticity (GPa)

Δy_a : Maximum allowable long term vertical pipe deflection (mm)

S_b : Long term, ring-bending strain for the pipe (mm/mm)

D : Mean pipe diameter (mm)

FS : Design factor (1,5)

ε_b : maximum ring-bending strain due to deflection (mm/mm)

t_t : Total wall thickness (mm)
$t_t = t + t_L$

Shape factors table

	Pipe-zone embedment material and compaction			
	Gravel		Sand	
Stiffness	Dumbed to Slight	Moderate to High	Dumbed to Slight	Moderate to High
kPa	Shape factor D_f (dimensionless)			
62	5,5	7,0	6,0	8,0
124	4,5	5,5	5,0	6,5
248	3,8	4,5	4,0	5,5
496	3,3	3,8	3,5	4,5

4. WEARING RESISTANCE

The inside surface of **GRP pipes** are resistant to the corrosive liquids inside which prevents the increase of friction losses.

There is no increase of friction losses in **GRP pipes**, depending on the ageing of materials along the 50 years lifetime of design and 100 years lifetime of service.

EBS/GRP pipes provides energy conservation due to sensitivity of 1/100 slickness of pipe walls.

5. DEFLECTION

Buried pipe should be installed in a manner that will ensure that external loads will not cause a long term decrease in the vertical diameter of the pipe exceeding the maximum allowable deflection.

$\Delta y/D \leq \delta d/D \leq \Delta y_a/D$

$\Delta y/D$: Predicted vertical pipe deflection

$\delta d/D$: Permitted vertical pipe deflection

$\Delta y_a/D$: Maximum allowable vertical pipe deflection

$$\frac{\Delta y}{D} = \frac{(D_L W_C + W_L)K_x}{149 \, PS + 61000 \, M_s}$$

D_L: Deflection lag factor to compensate for the time-consolidation rate of the soil (dimensionless)
DL>1,00 is appropriate for long term deflection approximation

W_c : vertical soil load on pipe (N/m²)

$W_c = \gamma_s H$

γ_s : Unitweight of overburden, (N/m³)

H : Burial depth to top of pipe (m)

W_L : Live load on pipe (N/m²)

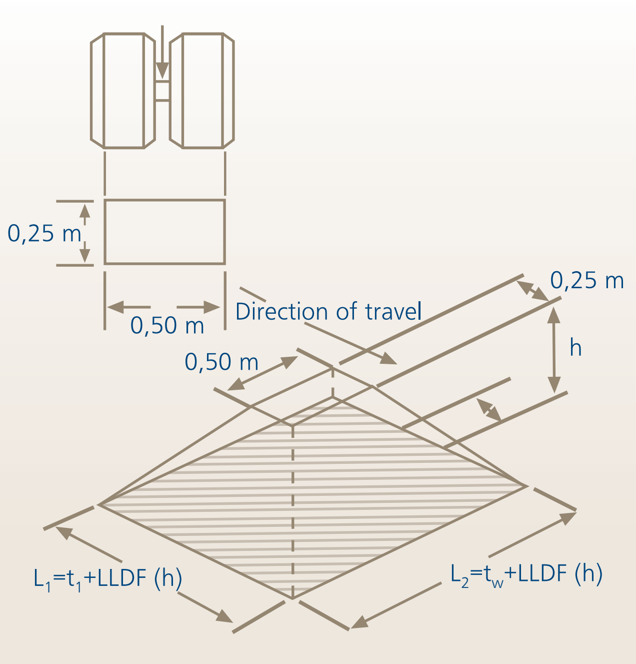
AASHTO HS-20 ve COOPER E-80 LIVE LOADS

HS-20		Cooper E-80	
Depth (m)	W_L (kPa)	Depth (m)	W_L (kPa)
0,6	92	0,9	110
0,8	67	1,2	97
0,9	51	1,5	84
1,2	32	1,8	72
1,5	23	2,1	62
1,8	18	2,4	53
2,4	11	3,0	39
3,0	7,6	3,7	32
3,7	5,5	4,6	23
4,6	4,1	6,1	15
6,1	2,8	7,6	10
8,5	1,4	9,1	7,6
12,2	0,7	12,2	4,1

ENGINEERING FORMULAS

$$W_L = \frac{M_p P I_f}{(L_1)(L_2)}$$

- M_p : Multiple presence factor(1,2)
- P : wheel load magnitude (71300 N for HS-20, 89000 N for HS-25)
- I_f : impact factor
- $I_f = 1 + 0{,}33\,[(2{,}44\text{-h})/2{,}44] \geq 1{,}0$
- h : Depth of cover (m)
- L_1 : Load width parallel to direction of travel (m)
- $L_1 = t_1 + LLDF(h)$
- t_1 : Length of tire footprint (0,25 m)
- LLDF : factor to account for live load distribution with depth of fill, (1.15 for backfills SC1 and SC2, 1.0 for all other backfills)
- L_2 : Load width perpendicular to direction of travel (m)
  $h \leq h_{int}$
- $L_2 = t_w + LLDF(h)$
- t_w : Width of tire footprint (0,5 m)
- h_{int} : Depth at which load from wheels interacts
- $h_{int} = (1{,}83m - t_w) / LLDF$
  h > hint
- $L_2 = [t_w + 1{,}83m + LLDF(h)]/2$
- K_x : bedding coefficient, dimensionless,0,1 for nonuniform pipe beddings 0,083 for uniform pipe beddings



PS: Pipe stiffness (kPa)

The pipe stiffness can be determined by conducting parallel-plate loading tests in accordance with ASTM D2412. During the parallel-plate loading test, deflection due to loads on the top and bottom of the pipe is measured.If DN < 1600 mm, L=300 mm If DN ≥ 1600 mm, L= 1,20 X DN.

$$PS = 1000F / \Delta y_t$$

- F : Load per unit length (N/mm)
- Δy_t : Vertical pipe deflection, mm, when tested by ASTM D2412 with a vertical diameter reduction of 5%

Pipe stiffness may also be determined by the pipe dimensions and material properties.

$$PS = \frac{EIx10^6}{0{,}149\,(r + \Delta y_t/2)^3}$$

- E : Ring flexural modulus (GPa)
- I : Moment of inertia of unit length (mm^4/mm)
  ($I = t_t^3/12$)
  t_t: Total wall thickness
- r : Mean pipe radius (mm)

GRP PIPE STIFFNESS CATEGORIES

ASTM	ISO
9psi-62kPa	1250 Pa
18psi-124kPa	2500 Pa
36psi-248kPa	5000 Pa
72psi-496 kPa	10000 Pa

- M_s : Composite constrained soil modulus (MPa)
- $M_s = S_c\, M_{sb}$
- S_c : Soil support combining factor (dimensionless)
- M_{sb} : Constrained soil modulus of the pipe zone embedment (MPa)
  To use the Sc table, the following values are required;
- M_{sn} : Constrained soil modulus of the native soil at pipe elevation (MPa)
- B_d : Trench width at pipe springline (mm)

ENGINEERING FORMULAS

VALUES FOR THE SOIL SUPPORT COMBINING FACTOR

M_{sn}/M_{sb}	B_d/D 1,25	B_d/D 1,5	B_d/D 1,75	B_d/D 2	B_d/D 2,5	B_d/D 3	B_d/D 4	B_d/D 5
0,005	0,02	0,05	0,08	0,12	0,23	0,43	0,72	1,00
0,01	0,03	0,07	0,11	0,15	0,27	0,47	0,74	1,00
0,02	0,05	0,10	0,15	0,20	0,32	0,52	0,77	1,00
0,05	0,10	0,15	0,20	0,27	0,38	0,58	0,80	1,00
0,1	0,15	0,20	0,27	0,35	0,46	0,65	0,84	1,00
0,2	0,25	0,30	0,38	0,47	0,58	0,75	0,88	1,00
0,4	0,45	0,50	0,56	0,64	0,75	0,85	0,93	1,00
0,6	0,65	0,70	0,75	0,81	0,87	0,94	0,98	1,00
0,8	0,84	0,87	0,90	0,93	0,96	0,98	1,00	1,00
1	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
1,5	1,40	1,30	1,20	1,12	1,06	1,03	1,00	1,00
2	1,70	1,50	1,40	1,30	1,20	1,10	1,05	1,00
3	2,20	1,80	1,65	1,50	1,35	1,20	1,10	1,00
≥5	3,00	2,20	1,90	1,70	1,50	1,30	1,15	1,00

M_{sb} BASED ON SOIL TYPE AND COMPACTION CONDITION

Vertical Stress Level kPa	Depth for soil density 18,8 kN/m³ (m)	SPD100 MPa	SPD95 MPa	SPD90 MPa	SPD85 MPa
		Stiffness Categories 1 and 2 (SC1, SC2)			
6,9	0,4	16,2	13,8	8,8	3,2
34,5	1,8	23,8	17,9	10,3	3,6
69	3,7	29	20,7	11,2	3,9
138	7,3	37,9	23,8	12,4	4,5
276	14,6	51,7	29,3	14,5	5,7
414	22	64,1	34,5	17,2	6,9
		Stiffness Categories 3 (SC3)			
6,9	0,4		9,8	4,6	2,5
34,5	1,8		11,5	5,1	2,7
69	3,7		12,2	5,2	2,8
138	7,3		13	5,4	3
276	14,6		14,4	6,2	3,5
414	22		15,9	7,1	4,1
		Stiffness Categories 4 (SC4)			
6,9	0,4		3,7	1,8	0,9
34,5	1,8		4,3	2,2	1,2
69	3,7		4,8	2,5	1,4
138	7,3		5,1	2,7	1,6
276	14,6		5,6	3,2	2
414	22		6,2	3,6	2,4

SPD: Standard proctor density (%)

VALUES FOR THE CONSTRAINED MODULUS OF THE NATIVE SOIL AT PIPE ZONE ELEVATION

Native In Situ Soils				
Granular		Cohesive		
Blows (0,3m)	Description	q_u(kPa)	Description	M_{sn}(MPa)
>0-1	very, very loose	0-13	very, very soft	0,34
1-2	very loose	13-25	very soft	1,4
2-4		25-50	soft	4,8
4-8	loose	50-100	medium	10,3
8-15	slightly compact	100-200	stiff	20,7
15-30	compact	200-400	very stiff	34,5
30-50	dense	400-600	hard	69,0
>50	very dense	>600	very hard	138,0

SOIL STIFFNESS CATEGORIES

Soil Stiffness Category	Unified Soil Classification System Soil Groups
SC1	**Crushed rock:** ≤15% sand, maximum 25% passing the 3/8-in. sieve and maximum 5% passing No. 200 sieve
SC2	**Clean, coarse-grained soils:** SW, SP, GW, GP or any soil beginning with one of these symbols with 12% or less passing No. 200 sieve
SC3	**Coarse-grained soils with fines:** GM, GC, SM, SC or any soil beginning with one of these symbols with more than 12% fines **Sandy or gravelly fine-grained soils:** CL, ML (or CL-ML, CL/ML, ML/CL) with more than 30% retained on a No. 200 sieve
SC4	**Fine-grained soils:** CL, ML (or CL-ML, CL/ML, ML/CL) with 30% or less retained on a No. 200 sieve
SC5	**Highly plastic and organic soils:** MH, CH, OL, OH, PT

ENGINEERING FORMULAS

6. COMBINED LOADING

The maximum stress or strain resulting from the combined effects of the internal pressure and deflection should meet the equations as follows:

For stress basis;

$$\frac{\sigma_{pr}}{HDB} \le \frac{1-\left(\frac{\sigma_b r_c}{S_b E \times 10^3}\right)}{FS_{pr}}$$

$$\frac{\sigma_b r_c}{S_b E \times 10^3} \le \frac{1-\left(\frac{\sigma_{pr}}{HDB}\right)}{FS_b}$$

For strain basis;

$$\frac{\varepsilon_{pr}}{HDB} \le \frac{1-\left(\frac{\varepsilon_b r_c}{S_b}\right)}{FS_{pr}}$$

$$\frac{\varepsilon_b r_c}{S_b} \le \frac{1-\left(\frac{\varepsilon_{pr}}{HDB}\right)}{FS_b}$$

FS_{pr} : Pressure design factor (1,8)
FS_b : Bending design factor (1,5)
σ_{pr} : Working stress due to internal pressure (MPa)
$\sigma_{pr} = P_w D / 2t$
P_w : Working pressure (kPa)
D : Diameter (mm)
t : Thickness (mm)
σ_b : Bending stress due to the maximum permitted deflection (MPa)
$\sigma_b = D_f\, E\, (\delta d/D)\, (t_t/D)$
r_c : Rerounding coefficient, (dimensionless)
$P_w \le 3000 kPa \Rightarrow r_c = 1 - Pw/3000$
ε_{pr} : Working strain due to internal pressure (mm/mm)
$\varepsilon_{pr} = P_w D/2\, tE_H$
ε_b : Bending strain due to maximum permitted deflection (mm/mm)
$\varepsilon_b = D_f\, (\delta d/D)\, (t_t/D)$
δd : maximum permitted long-term installed deflection (mm)

7. BUCKLING

The summation of appropriate external loads should be equal to or less than the allowable buckling pressure.

$$q_a = \frac{(1{,}2C_n)\,(EI)^{0{,}33}\,(\varphi_s 10^6 M_s k_\upsilon)^{0{,}67} R_h}{(FS)r}$$

q_a : Allowable buckling pressure (kPa)
FS : Design factor (2,5)
C_n : Scalar calibration factor to account for some nonlinear effects (0,55)
φ_s : Factor to account for variability in stiffness of compacted soil; suggested value is 0,9
k_υ : Modulus correction factor for Poisson's ratio, v, of the soil
k_υ = (1+v) (1-2v)/ (1-v); in the absence of specific information. (it is common to assume v=0,3 giving k_υ=0,74)
R_h : Correction factor for depth of fill 11,4 / (11 + D /1000h)
h : Height of ground surface above top of pipe (m)

An alternate form of buckling;

$$q_a = \left(\frac{1}{FS}\right) [1{,}2\, C_n\, (0{,}149\, PS)^{0{,}33}]\, (\varphi_s 10^6 M_s k_\upsilon)^{0{,}67} R_h$$

Satisfaction of the buckling requirement is assured for typical pipe installations by using the following equation:

$$[\gamma_w h_w + R_w (W_c)] \times 10^{-3} + P_v \le q_a$$

γ_w : Specific weight of water (9800N/m³)
P_v : Internal vacuum pressure, (kPa)
R_w : Water buoyancy factor
R_w = 1-0,33(h_w/h)[0 ≤ h_w ≤ h]

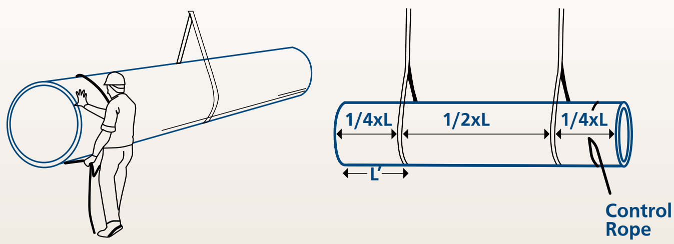
If live loads are considered, satisfaction of the buckling requirement is ensured by;

$$(\gamma_w h_w + R_w (W_c) + W_L) \times 10^{-3} \le q_a$$

HANDLING, STORAGE and TRANSPORT

- GRP pipes are suitable for the telescobic handling.
- Pipes are transported with the fittings attached on them which avoids extra cost of transport and also fastens the mounting process.

- If the pipes will be handled by double sling handling method, the distance between the rope and the pipe end should not exceed L’ < L/4 ratio.

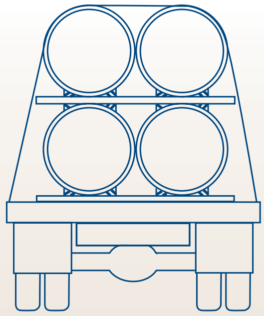


Single sling method   Double sling method

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

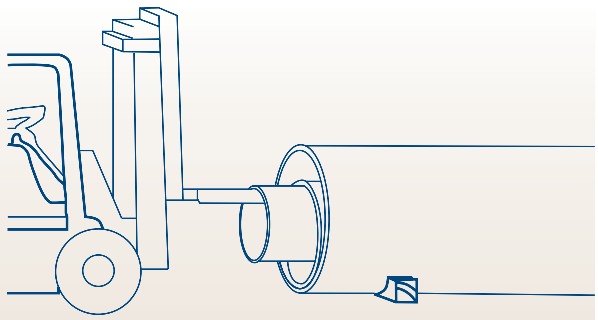
Maximum Storage Deflection:
%2,5 in SN2500 pipes
%2,0 in SN5000 pipes
%1,5 in SN10000 pipes

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



Transporting pipe

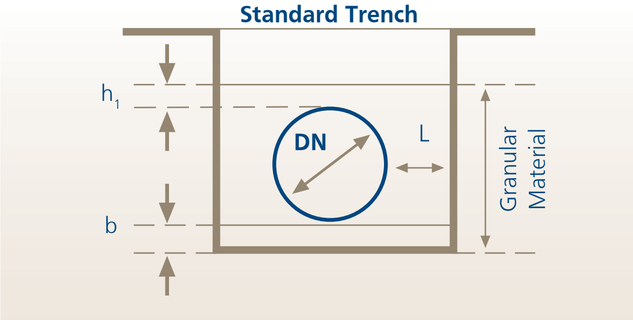
- Maximum stack height is approximately 2.5 meters. The pipes should be strapped to the vehicle over the support points using pliable straps or rope. Steel cables or chains without adequate padding should never be used to protect the pipe from abrasion. Bulges, flat areas or other abrupt changes of curvature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



De-nesting with padded boom on forklift truck

PIPE TRENCH

Standard type of trench prepared for mounting the GRP pipes is illustrated shematically below. GRP pipes are manufactured in SN2500, 5000 and 10000 N/m^2 stiffness categories and offer alternative types for mounting depending on the loads. (live loads, backfill loads, etc) In general the bedding material is preferred to be the same material being used for the initial backfill.



h_1= D/2 (max.300 mm), b= D/4 (min. 150 mm)

PARTICLE SIZE

DN (mm)	a (mm)
<300	10
300-600	15
700-1000	20
>1000	30

CUSHION LAYER

DN	b (mm)
300	75
350-500	100
600-2500	150

WORK AREA

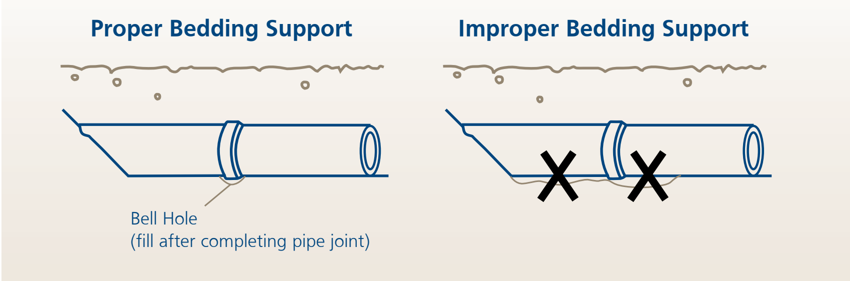
DN (mm)	L (mm)
200-350	150
400-500	200
600-900	300
1000-1600	450
1800-2600	600

If the soil removed from the trench will be used as backfill material in pipezone, the particle size allowed should not exceed two times the standard values

PIPE ZONE BACKFILL MATERIAL (ASTM D2487)

GRAVEL	GW, GP, GW-GC GW, GM, GP-GC GP-GM
FINE SAND	SW, SP, SW-SC SW-SM, SP-SC SP-SM
SAND	SW, SP, SW-SC SW-SM, SP-SC SP-SM, SM*, SC* GM*, GC*

The initial deflection limit of GRP pipes installed underground is, %3 for pressure pipes DN≥300 mm and %6 for gravity pipes DN≥300 mm



Water Control:

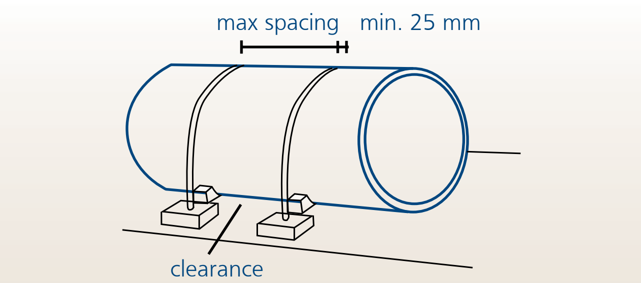
It is always good practice to remove water from a trench before laying and backfilling pipe. Well points, deep wells, geotextiles, perforated underdrains or stone blankets of sufficient thickness should be used to remove and control water in trench. Groundwater should be below the bottom of the cut at all times to prevent the washout from behind sheeting or sloughing of exposed trench walls. To preclude loss of soil support, dewatering methods should be employed for minimizing the removal of fines and the creation of voids within in situ materials. Suitable graded materials should be used for foundation layers to transport running water to sump pits or other drains.

Concrete encasement and Floatation

The concrete must be poured in stages allowing sufficient time between layers for the cement to set and no longer exert buoyant forces. The maximum lift heights are shown in the table below.

SN	MAXIMUM LIFT
2500	Larger of 0.3 m or DN/4
5000	Larger of 0.45 m or DN/3
10000	Larger of 0.6 m or DN/2

During pouring the concrete, or in order to prevent floatation, the pipe must be restrained against movement. This is usually done by strapping over the pipe to a base slab or other anchors. The straps are flat with a minimum of 25 mm width and strong enough to withstand the floatation forces.

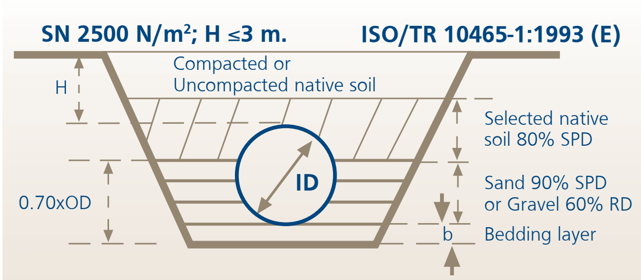


The buoyancy must be checked in cases of low coverage and high groundwater levels or in flood plains.

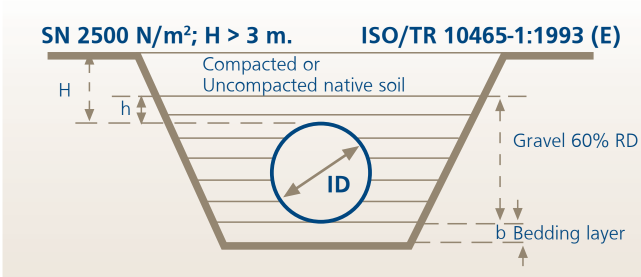
DN	MAXIMUM SPACING (m)
<200	1.5
200-400	2.5
500-600	4.0
700-900	5.0
≥1000	6.0

DN	h MIN (m) for SECURITY S=1.1
100	0.07
300	0.20
600	0.37
1000	0.62
2000	1.25
2400	1.5

TRENCH SECTIONS



SPD: Standard Proctor Density
RD: Relative Density
Granular Materials are filled to the 70% of pipe outside diameter.



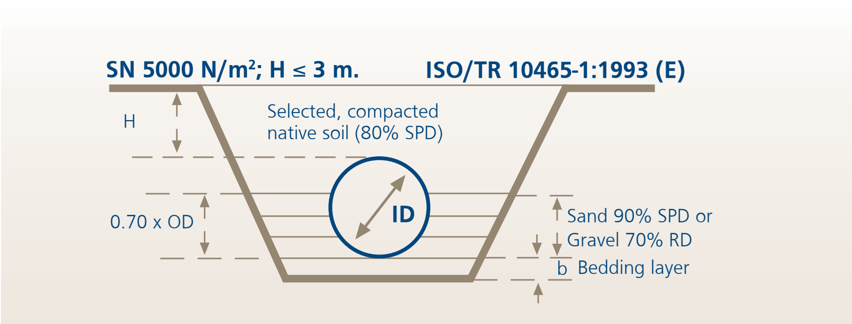
Granular materials are filled from the crown upto the h distance. (h) is min. 100 mm, max.300 mm.

Limits of Deflection in Installed GRP Pipes

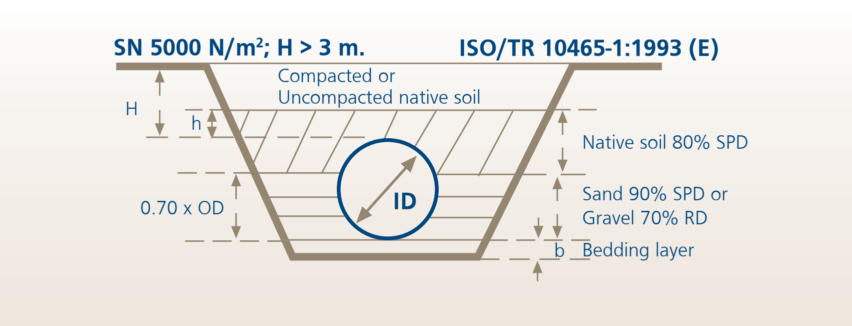
Deflection (%)	Soil classification				
	1	2	3	4	5
DN≥300 mm (initial)	4	3,5	3	2,5	2
DN<300 mm (initial)	2,5	2,5	2	1,5	1,5
Long Term	6	6	6	6	6

Soil Groups	1	2	3	4	5
Fine-Grained Soils	very hard	hard	medium	soft	very soft
Coarse-Grained Soils	very dense	dense	medium	loose	very loose

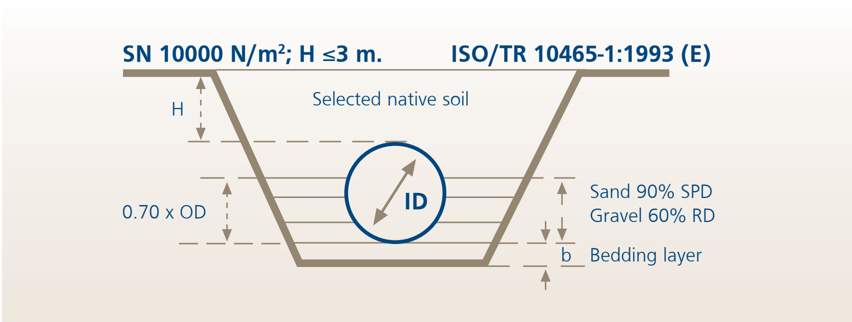
TRENCH SECTIONS



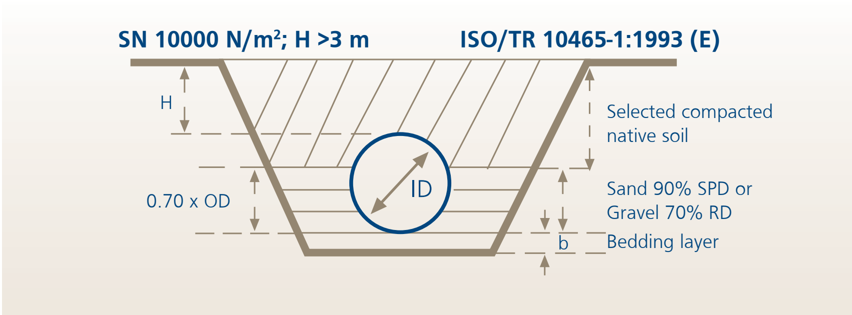
Granular materials are filled upto the 70% of pipe outside diameter.



Granular materials are filled upto the 70% of pipe outside diameter then selected, native soil is compacted upto (h) distance. (h) distance is min.100 mm max. 300 mm.

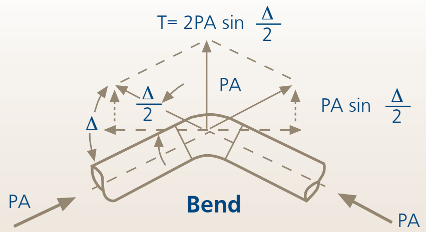


Granular materials are filled to the 70% of pipe outside diameter.



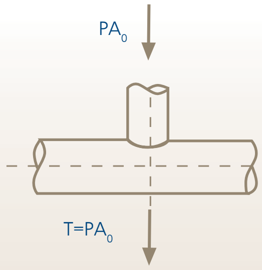
Granular materials are filled to the 70% of pipe outside diameter.

THRUST BLOCKS

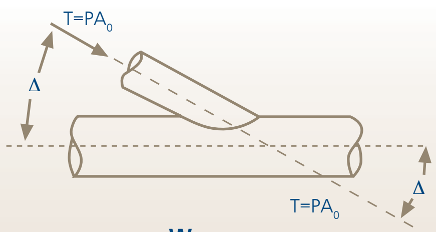


Bend

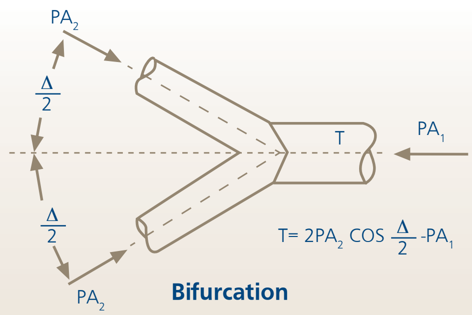
Dead end



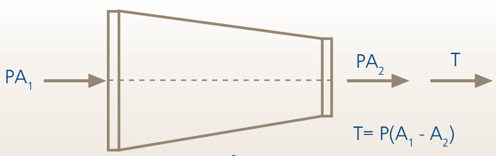
Tee



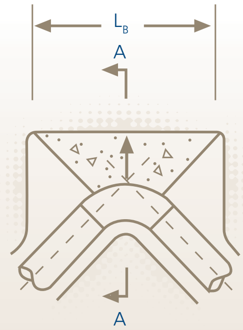
Wye



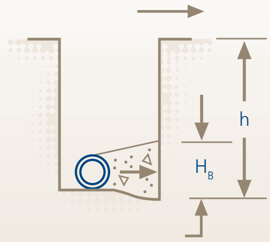
Bifurcation



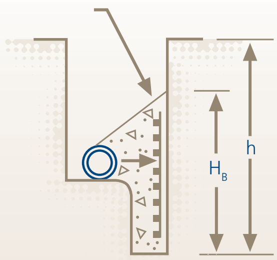
Reducer



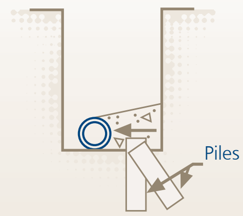
Plan view



Section A-A



Alternate Section A-A



Alternate Section A-A

Concrete thrust blocks increase the ability of fittings to resist movement by increasing the bearing area and the dead weight of the fitting. The block size can be calculated as follows:

$$L_b \times H_b = (T \times FS)/1000\ \sigma$$
$$T = 2000\ P \times A \times \sin(\Delta/2)$$

$L_b \times H_b$ = Area of bearing surface of thrust block (m^2)
T = Thrust force (N)
σ = Bearing strength of soil (kPa)
FS = Design factor (1,5)
P = Internal pressure (kPa)
A = Crosssectional area of pipe joint (m^2)
$A = (\pi/4)\ (D_j/1000)^2$
D_j = Joint diameter (mm)
Δ = Bend angle, (degrees)

FIELD HYDRO-TESTING

It is advised not to exceed pipe testing with installation by more than approximately 1000 meters

1. Prior to the test the following should be checked:
- Initial pipe deflection within the acceptable limit
- Joints assembled correctly
- System restrained in place
- Flange bolts are torqued per instructions
- Backfilling completed
- Valves and pumps anchored
- Backfill and compaction near structures and at closure pieces has been properly carried out.

2. The line should be filled with water- The valves and vents should be opened, so that all air is expelled from the line during filling and pressure surges should be avoided"

3. The line should be pressurized slowly. Considerable energy is stored in a pipeline under pressure and this power should be respected.

4. It should be ensured that the gauge location will read the highest line pressure or adjust accordingly. Locations lower in the line will have higher pressure due to additional head.

5. It should be ensured that test pressure does not exceed 1,5 x PN. Normally the field test pressure is either a multiple of the operating pressure or the operating pressure plus a small incremental amount. However in no case should the maximum field test pressure exceed 1,5xPN."

6. If after a brief period for stabilization the line does not hold constant pressure it should be ensured that thermal effect (a temperature change), system expansion or entrapped air is not the cause. If the pipe is determined to be leaking and the location is not readily apparent, the following methods may aid discovery of the problem source:"
- Checking flange and valve areas
- Checking line tap locations
- Using sonic detection equipment.
- Testing the line in smaller segments to isolate the leak.

An alternate leak test for gravity pipe (PN 1 bar) systems may be conducted with air pressure instead of water. In addition to routine care, normal precautions and typical procedures used in this work, the following suggestions and criteria should be noted:

1. As with the hydrotest, the line should be tested in small segments, usually the pipe contained between adjacent manholes."

2. It should be ensured that the pipeline and all materials, stubs, accesses, drops, etc. are adequately capped or plugged and braced against the internal pressure."

3. The system should be pressurized to 0,24 bar and must be regulated to prevent over pressurisation. (maximum 0,35 bar)"

4. The air temperature should be allowed to stabilize for several minutes while maintaining the pressure at 0,24 bar."

5. During this stabilization period, all plugged and capped outlets should be checked with a soap solution to detect leakage. If leakage is found at any connection, system pressure should be released, leaky caps or plugs should be sealed and the procedure at Step 3 should be repeated."

6 . After the stabilization period, the air pressure should be adjusted to 0,24 bar and the air supply should be disconnected or shut off."

7 . The pipe system passes this test if the pressure drop is 0,035 bar or less during the time periods mentioned in the table below."

8. Should the section of line under test fail the air test acceptance requirements, the pneumatic plugs can be coupled fairly close together and moved up or down the line, repeating the air test at each location, until the leak is found . This leak location method is very accurate, pinpointing the location of the leak to within one or two meters. Consequently, the area that must be excavated to make repairs is minimized, resulting in lower repair costs and considerable saved time."

Caution: Considerable energy is stored in a pipeline under pressure. This is particularly true when air (Even at low pressures) is the test medium. Should take great care to be sure that the pipeline is adequately restrained at changes in line direction and should follow manufacturers safety precautions for devices such as pneumatic plugs.

Note: This test will determine the rate at which air under pressure escapes from an isolated section of the pipeline. It is suited to determining the presence or absence of pipe damage and/or improperly assembled joints.

Diameter (mm)	Time (min.)	Diameter (mm)	Time (min.)
100	2.50	1000	25.00
150	3.75	1100	27.50
200	5.00	1200	30.00
250	6.25	1300	32.50
300	7.75	1400	35.00
350	8.75	1500	37.50
400	10.00	1600	40.00
500	12.50	1800	45.00
600	15.00	2000	50.00
700	17.50	2200	55.00
800	20.00	2400	60.00
900	22.50		

Test time-field air test

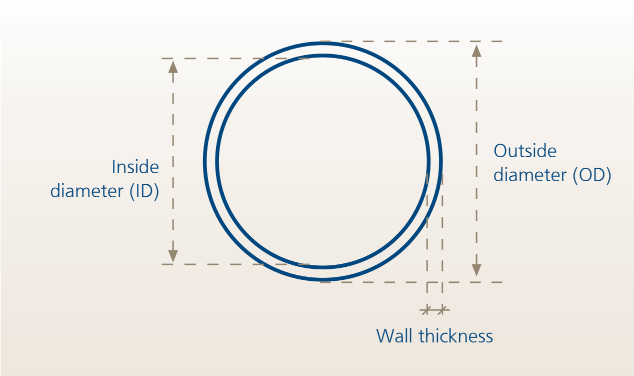
DIMENSIONS

Pipe

DN Nominal Diameter (mm)	**OD** PN6 Outside Diameter (mm)	**OD** PN10 Outside Diameter (mm)	**OD** PN16 Outside Diameter (mm)	**OD** PN25 Outside Diameter (mm)	**OD** PN32 Outside Diameter (mm)
300	310	310	310	310	310
350	361	361	361	361	361
400	412	412	412	412	412
450	463	463	463	463	463
500	514	514	514	514	514
600	616	616	616	616	616
700	718	718	718	718	718
800	820	820	820	820	820
900	924	924	924	924	924
1000	1026	1026	1026	1026	
1200	1229	1229	1229	1229	
1400	1434	1434	1434		
1600	1638	1638	1638		
1800	1842	1842	1842		
2000	2046	2046	2046		
2200	2250	2250	2250		
2400	2453	2453	2453		
2600	2658	2658			
2800	2861	2861			

Coupling

DN Nominal Diameter (mm)	**ID** Inside Diameter (mm)	**Width**
300	313	250 mm.
350	364	250 mm.
400	415	250 mm.
450	465	250 mm.
500	517	250 mm.
600	619	250 mm.
700	721	250 mm.
800	823	300 mm.
900	927	300 mm.
1000	1028	300 mm.
1200	1232	300 mm.
1400	1436	300 mm.
1600	1640	300 mm.
1800	1844	300 mm.
2000	2048	300 mm.
2200	2252	300 mm.
2400	2456	300 mm.
2600	2660	300 mm.
2800	2865	300 mm.



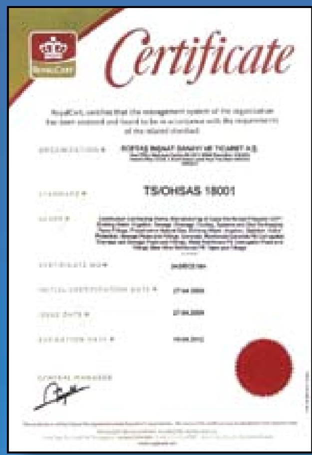
CHEMICAL RESISTANCE

Chemicals	Resistance	Chemicals	Chemicals
Ethyl alcohol	x	Magnesium chloride	x
Isopropyl alcohol	x	Magnesium sulfate	x
Alumina	x	Mercury	x
Aluminium chloride	x	Mercuric chloride	x
Aluminium fluoride	x	Ferro chloride	x
Barium chloride	x	Ferro nitrate	x
Calcium nitrate	x	Ferro sulfate	x
Ammonium chloride	x	Flobonic acid	x
Ammonium nitrate	x	Fluosilic acid	x
Ammonium phosphate	x	Formic acid	x
Ammonium sulfate	x	Stearic acid	x
Acidferic chloride	x	Sodium bisulphate	x
Acidferic nitrate	x	Sodium bromide	x
Acidferic sulfate	x	Sodium chloride	x
Barium sulfate	x	Sodium nitrate	x
Sodium sulfate	x	Sodium nitrite	x
Copper nitrate	x	Sulphuric acid	x
Brine	x	Vinegar	x
Glucose	x	Glycerin	x
Aluminium nitrate	x	Potassium nitrate	x
Potassium sulfate	x	Nickel chloride	x
Carbon dioxide	x	Nickel nitrate	x
Carbon monoxide	x	Nickel sulfate	x
Copper chloride	x	Phosphoric acid	x
Potassium bicarbonate	x	Malt	x
Potassium chloride	x	Calcium chloride	x
Calcium sulphate	x	Crude Oil	x
Copper sulfate	x	Ethylene glycol	x
Liquid hydrogen sulfide	x		

x: Resistant


Certificate
ISO 9001:2000


Certificate
ISO 14001:2004


Certificate
TS/OHSAS 18001


TÜRK STANDARDLARI ENSTİTÜSÜ
TÜRK STANDARDLARINA UYGUNLUK BELGESİ
TURKISH STANDARDS INSTITUTION
CERTIFICATE OF CONFORMITY TO TURKISH STANDARDS


TÜRK STANDARDLARI ENSTİTÜSÜ
TÜRK STANDARDLARINA UYGUNLUK BELGESİ
TURKISH STANDARDS INSTITUTION
CERTIFICATE OF CONFORMITY TO TURKISH STANDARDS


TÜRK STANDARDLARI ENSTİTÜSÜ
TÜRK STANDARDLARINA UYGUNLUK BELGESİ
TURKISH STANDARDS INSTITUTION
CERTIFICATE OF CONFORMITY TO TURKISH STANDARDS


TÜRK STANDARDLARI ENSTİTÜSÜ
TÜRK STANDARDLARINA UYGUNLUK BELGESİ
TURKISH STANDARDS INSTITUTION
CERTIFICATE OF CONFORMITY TO TURKISH STANDARDS


ДОДАТОК


СЕРТИФІКАТ ВІДПОВІДНОСТІ


ООО «ПАЙПХОЛДИНГ» PIPEHOLDING Ltd.

HEAD OFFICE

Meşrutiyet Caddesi No: 28/11 06640
Bakanlıklar / ANKARA
Tel: +90 (312) 418 92 16 Fax: +90 (312) 425 24 07

İSTANBUL OFFICE

36. Ada Ata 2/2 Blok D:89 Ataşehir
İSTANBUL, TÜRKİYE
Tel: +90 (216) 456 96 62-63 Fax: +90 (216) 456 96 48

FACTORY

3. Organize Sanayi karşısı, Mercan Mevkii,
Gürle Yolu Üzeri 45020 MANİSA
Tel: +90 (236) 213 07 87 Fax: +90 (236) 213 07 86

www.ebsboru.com | ecetasas@ecegrup.com.tr

Group Companies