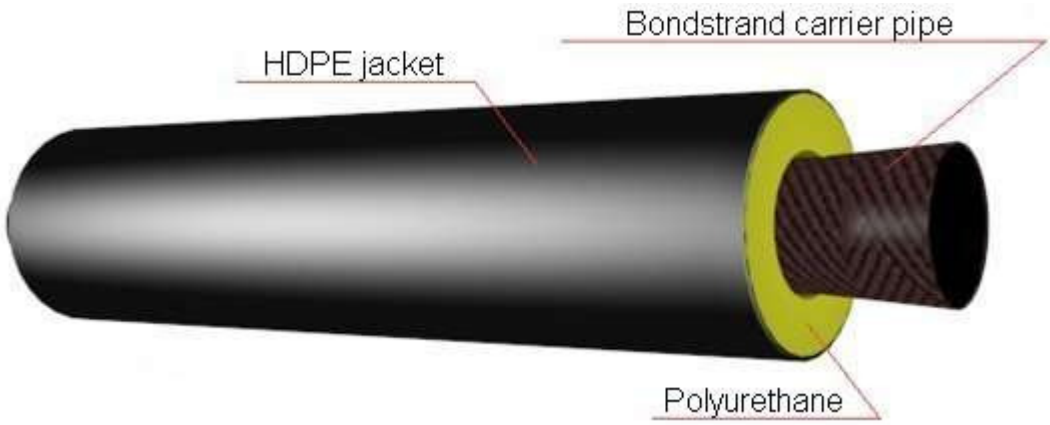
Epocal® insulated pipe description

1 - CONSTITUTION



Epocal®, insulated epoxy resin pipe is composed with :

- Epoxy resin pipe BONDSTRAND® 2000
- HDPE (high density polyethylene) external jacket
- Polyurethane foam - Density : 80 Kg/m^3

2 - ADVANTAGES

Epocal® has a excellent internal and external corrosion resistance for a large range of temperature, and does not require a protective coating. Epocal's unique conception eliminates all maintenance and all cost of cathode protection.

Its low weight ($1/6^{th}$as much as steel, 1.88 g/cm^3 of density) eases its handling and reduces installation costs.

The roughness of Epocal® ($5,3.10^{-6}$ m) does not vary during its lifetime since it is not affected by corrosion. Its very smooth internal coating produces very low headloss, facilitates evacuation, reduces pumping cost and may allow to install, in some case, lower diameter than steel.

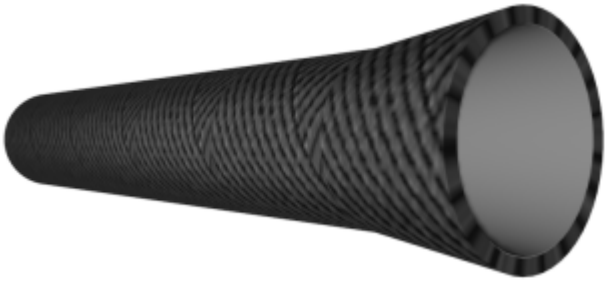
Low thermal conductivity ($1/100^{th}$ of steel) minimizes heat losses.

Withstands full vacuum when properly bedded and backfilled.

Subzero temperatures will not adversaly affect mechanical properties.

Insulated junctions in epoxy foam have the advantage to be perfectly impermeable. These junctions limit polyurethane desaggregation by water in the event of a possible perforation of the HDPE jacket.

3 - CARRIER PIPE



Brand : Bondstrand®
Serie : 2000
Resin : Epoxy
Hardener : MDA

Maximum service conditions :

- Temperature : 250 °F (110°C)
- Pressure :

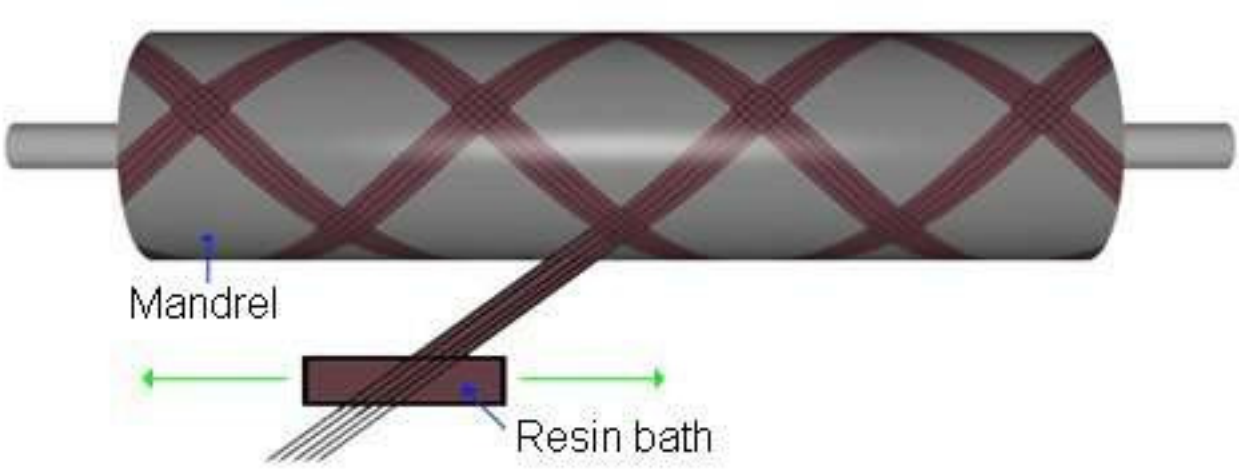
  232 psi (16 bars) from DN 1" to 8"
  175 psi (12 bars) from DN 10" to 16"
  safety factor of 3 to 1

Classification under NF T 57-200 : CVTd DN/A/2C/2A

Classification under ASTM D2310 : RTRP-11FE

3.1 Manufacture process

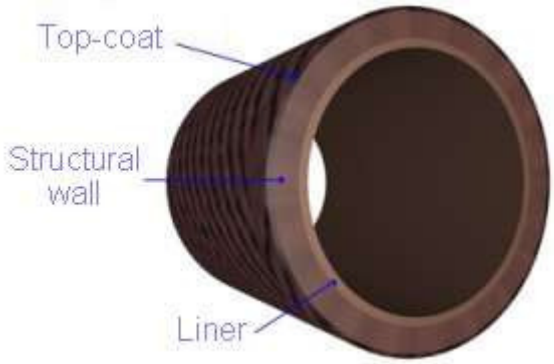
Bondstrand® pipes and fittings are manufactured with continuous glass fibers, wetted with a mixture of epoxy resin and amine hardener, wrapped around a mandrel at an angle of 54°¾.



All fittings (elbows, tees, reducers...) and flanges are manufactured under the same process.

3.2 Constitution

Pipes and fittings are made of 3 distinct layers :



· An anticorrosion internal layer (liner of 0.5 mm) composed of 85% epoxy resin and of 15% C-glass .

· A structural wall : 70% E-fiberglass and 30% epoxy resin.

· An anticorrosion external coating composed of 100% epoxy resin of a width of 0.3 mm.

3.3 Configuration

Pipes are delivered with a cylindricaly shaved male end (spigot) and a conic female end (bell).

Fittings (elbows, tees, reducers...) and flanges have conic female ends.

The assembly is of bonded type, using an epoxy adhesive of same nature than pipe and fittings.

The corresponding cylindro-conical joint is called a Quick-Lock® joint.

Advantages of the Quick-Lock joint :

- Centering of the spigot allows a uniform distribution of adhesive on the circumference of the joint.
- The bell stop allows exact cutting and shaving lengths.
- Blocking of the pipe for operation of polymerization.
- Evacuating the excess of adhesive toward the outside, therefore avoiding any formation of an adhesive rim inside, which would reduce pipe section.
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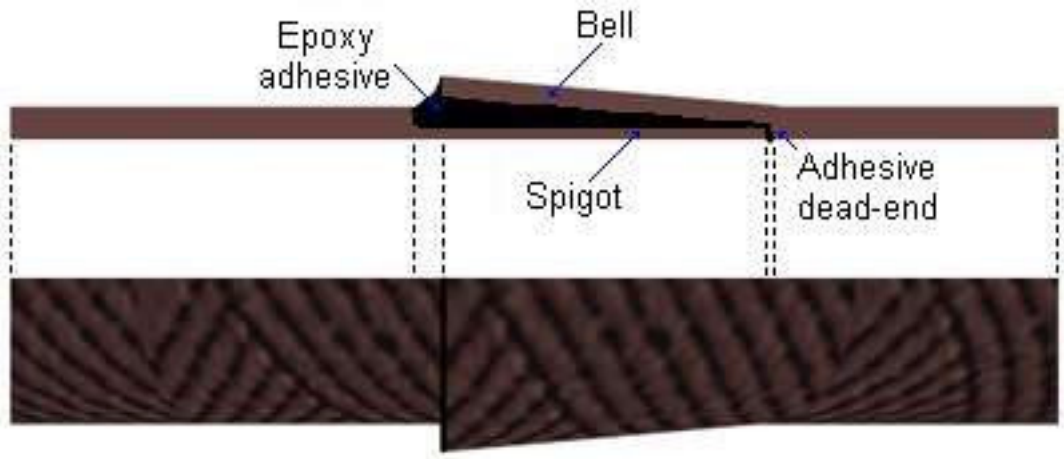


3.4 Dimensions

Nominal Diameter		Int Diam	Minimum Thickness	Length	Weigth
"	mm	mm	mm	m	kg/m
1	25	27.1	3.5	5.50	0.6
1½	40	42.1	3.5	5.50	0.9
2	50	53.2	3.6	6.15	1.2
3	80	81.8	3.6	6.15	1.8
4	100	105.2	4.6	6.15	2.9
5	125	131.9	4.6	6.15	3.6
6	150	159.2	4.6	6.15	4.3
8	200	208.8	5.1	6.10	6.4
10	250	262.9	5.1	6.10	8.1
12	300	313.7	5.1	6.10	9.6
14	350	344.4	5.3	6.05	11.0
16	400	393.7	6.0	6.05	14.1

3.5 Performances

Nominal Diameter		Continuous service pressure rating (bar) *				External pressure **
"	mm	at 175°F	at 225°F	at 250°F	at 275°F	bar
1	25	119.6	119.6	83.3	59.8	630.0
1½	40	80.7	80.7	56.2	40.3	167.0
2	50	67.1	67.1	46.7	33.5	94.0
3	80	44.7	44.7	31.2	22.4	25.0
4	100	46.1	46.1	32.1	23.0	27.0
5	125	37.1	37.1	25.8	18.6	12.0
6	150	31.0	31.0	21.6	15.5	7.9
8	200	26.6	26.6	18.5	13.3	4.9
10	250	21.2	21.2	14.8	10.6	2.5
12	300	17.9	17.9	12.4	8.9	1.5
14	350	17.0	17.0	11.8	8.5	1.2
16	400	17.0	17.0	11.9	8.5	1.2

** Datas from long term tests from TÜV in 1989 following tests and procedures from the French norm NF T 57-206 and for an hydrostatique design basis (HDB) static of 124 N/mm^2.*
*** Pressure at 21°C, reduce linearly to 90% at 66°C, 80% at 93°C, 65% at 121°C.*

3.6 Physical properties

Maximum thermal conductivity : 0,33 W/mK.
Linear thermal expansion : 18.10^{-6} mm/mm/°C.
Flow coefficient : 150 (Hazen-Williams).
Absolute roughness : 5,3.10^{-6} m (for Darcy-Weisbach formulae and Moody diagram).
Density : 1,8 g/cm^3.

3.7 Pipe mechanical properties

Property	Temp = 21°C	Temp = 93°C	Method
Circumferential : - Tensile strength at weeping - Tensile modulus - Poisson's ratio	 165 N/mm^2 25 200 N/mm^2 0.56	 - 22 100 N/mm^2 0.70	 ASTM D1599 Ameron Ameron
Longitudinal : - Tensile strength - Tensile modulus - Poisson's ratio	 58.6 N/mm^2 11 000 N/mm^2 0.37	 47.6 N/mm^2 8 500 N/mm^2 0.41	 ASTM D2105 ASTM D2105 ASTM D2105
Beam : - Apparent elastic modulus	 11 700 N/mm^2	 6 900 N/mm^2	 ASTM D2925
Hydrostatic design basis (cyclic)	6.10^3 psi * 41.4 N/mm^2	- -	ASTM D2992 Proc. A
Hydrostatic design basis (static)	18.10^3 psi * 124 N/mm^2	- -	ASTM D2992 Proc. B

** At 66°C.*

Nominal diameter		Stiffness Factor*	Pipe Stiffness*	Tangentiel initial stiffness	Beam moment of inertia**
"	mm	N.m	N/mm^2	N/m^2	10^6 mm^4
1	25	98	182	4 811 000	0.037
1½	40	215	119	1 477 000	0.110
2	50	70	20.0	777 000	0.250
3	80	70	5.93	227 000	0.828
4	100	154	6.14	221 000	2.21
5	125	145	3.10	57 500	4.3
6	150	154	1.86	67 000	7.3
8	200	214	1.17	41 000	18.89
10	250	214	0.59	21 000	37.10
12	300	214	0.35	13 000	62.39
14	350	254	0.32	11 000	86.27
16	400	371	0.31	11 000	145.55

** ASTM D2412.*
*** Use these values for calculating permissible spans.*

4 - INSULATED PIPE

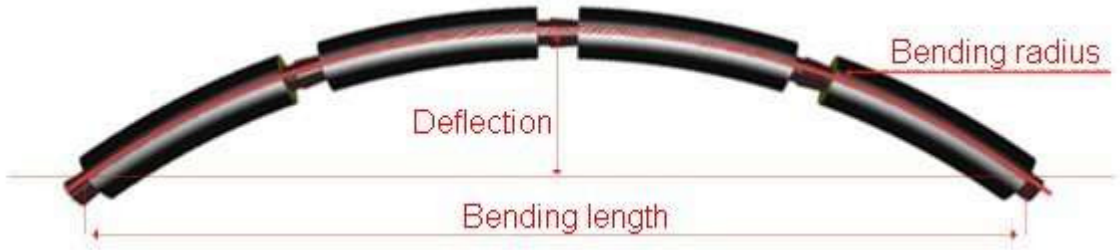
4.1 Insulation

Injection of a rigid polyurethane foam with closed cells at a density of 80 kg/m^3 under a protective external jacket in high density polyethylene (HDPE).
Thermal conductivity : 0,027 W/mK.

4.2 Insulation dimensions

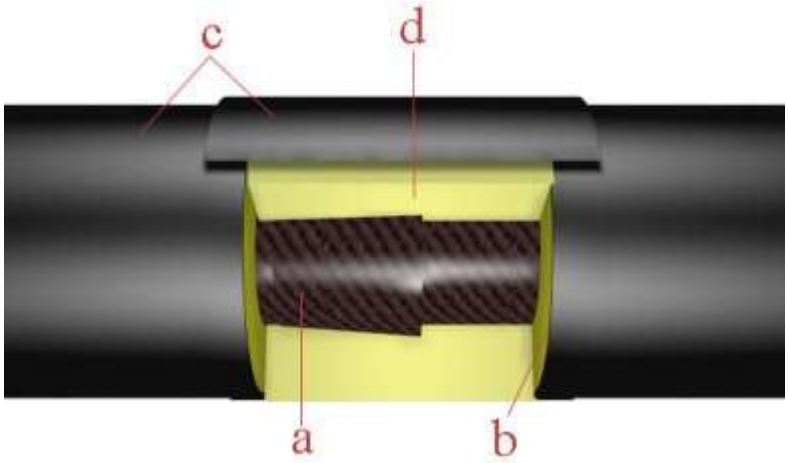
Nominal Diameter		Ext Diam	Thickness	Length	Weigth
"	mm	mm	mm	m	Kg/ml
1	25	90	28	5.30	1.5
1½	40	110	31	5.30	2.2
2	50	125	32	5.90	2.7
3	80	140	26	5.90	3.8
4	100	180	33	5.90	5.5
5	125	225	42	5.90	7.8
6	150	250	41	5.90	9.1
8	200	315	48	5.90	12.9
10	250	355	41	5.90	16.8
12	300	400	38	5.90	18.5
14	350	450	48	5.80	25.9
16	400	500	47	5.80	35.8

4.3 Bending radius



Nominal Diameter		Deflection for a 30m bending length	Bending radius
"	mm	m	m
1	25	5.5	23
1½	40	3.4	35
2	50	2.8	42
3	80	1.9	60
4	100	1.5	75
5	125	1.2	93
6	150	1.0	110
8	200	0.8	142
10	250	0.66	172
12	300	0.54	210
14	350	0.46	247
16	400	0.38	300

4.4 Insulated junctions between pipes



a : carrier pipe
b : polyurethane 80 Kg/m^3
c : external jacket and sliding muff in HDPE
d : EPOXY foam

Obtained by pouring in a sleeve of an Epoxy resin composed of 3 elements :
resin + hardener + foaming agent.

4.5 Insulation protection

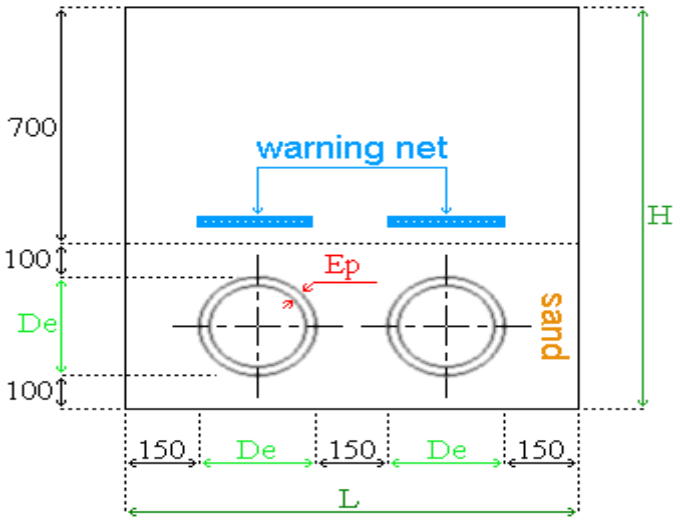
Insulation extremeties of pipes going inside buildings or valves chambers are protected by end-cap in heat-shrinkable reticulated polyethylene (DHEC).

4.6 Physical properties

Thermal conductivity : 0,036 W/mK.
Density : 1,88 g/cm^3.

5 - Buried installation

5.1 Trench dimensions



Nominal Diameter		De	L	H
"	mm	mm	mm	mm
1	25	90	630	990
1½	40	110	670	1 010
2	50	125	700	1 025
3	80	140	730	1 040
4	100	180	810	1 080
5	125	225	900	1 125
6	150	250	950	1 150
8	200	315	1 080	1 215
10	250	355	1 160	1 255
12	300	400	1 250	1 300
14	350	450	1 350	1 350
16	400	500	1 450	1 400

5.2 Bottom of trench, Aggradation

The bottom of the trench will be graded and the sand bed rammed in order to ensure uniform, horizontal and continuous canalizations.

At each canalization direction changes, the bottom of the trench must be digged before installation of pipe, in order to ensure a strong seating of anchor-blocks on the ground. At these locations, the generated cavities will not be filled with sand.

After pipe installation, hydraulic tests of the canalizations and installation of insulated junctions, the aggradation of the trench will be performed according the following :

- Fine sand up to 10 centimeters above the superior of Epocal®, spaces between pipes and sides of the trench will be fulfilled with a particular attention,
- Installation of a warner net 20 centimeters above Epocal®,
- After removing stones and rubbish, the extracted soil during the canalization digging is used to fill up the trench, by compacting successive layers of 30 centimeters heigth.

5.3 Thrust block (for hot water)

Refer to our dimensionnal standard calculated for maximum pressure and service temperature for standard fittings.

5.4 Penetration in building

In all cases, the HDPE jacket will cross the walls, and stop at 5 to 10 centimeters from the inside side of the walls of building or of valve room.

5.5 Fixed steel flange

Steel flanges in contact with Bondstrand® flanges must be anchored so as to create a fixed point, in order to avoid transfering stress from steel to Bondstrand®.

5.6 Evacuation of water in trench

The bottom of trench must be dry, in order to place the pipe on a perfectly compacted fine sand.

If installation is in a phreatic water area, the straight lengths of pipes need to be ballasted by concrete weights, to avoid that the installation curves and comes up to surface again on account of thrust of water.