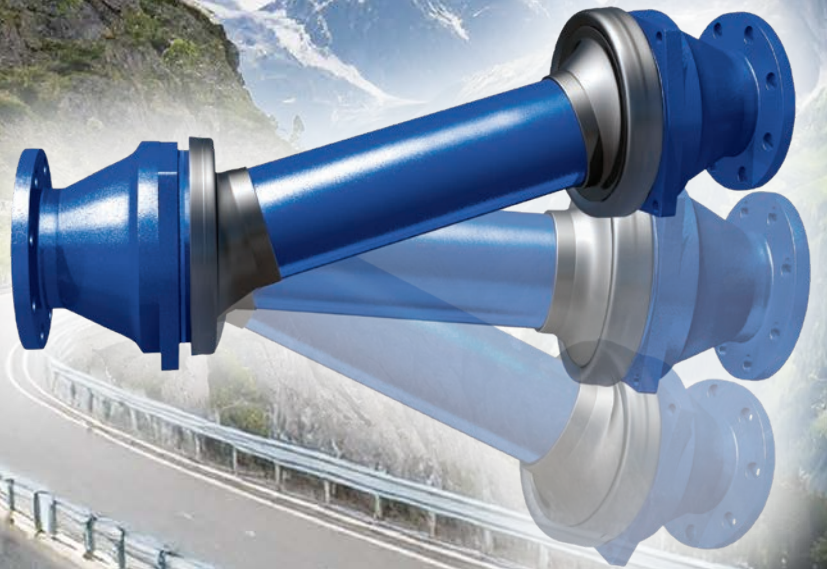


GEOFLEX®

Technology designed for the most stressful conditions.



Solution developed
in compliance
with ISO 16134
Compatible with
PAM pipeline systems

DN 100 to 1800 - PN16



PIPELINE SOLUTIONS FOR THE FUTURE

GEOFLEX®

TECHNOLOGY DESIGNED
FOR THE MOST STRESSFUL
CONDITIONS.

Protection of mains against risks
of dismounting and damages caused
by occasional major or severe
geotechnics events.



A RANGE TO

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PROTECT YOUR NETWORK

GEOFLEX® is a flexible and expandable ductile-iron sliding fitting that has been developed to protect pipelines against the risk of displacement and damage caused by rare but serious ground movements: landslides, subsidence of loose or unstable ground or stresses caused by earthquakes, seismic earth movements, tsunamis, tidal waves etc.

These events can affect the integrity of buildings or key infrastructures such as pipelines which need specific protection, guaranteeing their continual operation, electricity power stations, nuclear reactors, barrages, reservoirs and water towers, important infrastructures such as motorways, tunnels, works of art or TGV type high speed rail links.

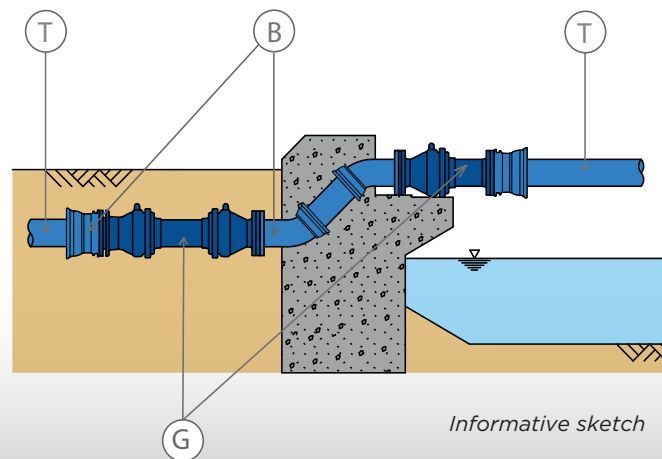
The DN 100 to DN 1800 range can be used for operating pressures of up to 16 bar. GEOFLEX® fittings are available in a range of diameters from DN 100 to DN 1800.

STRONG AND FLEXIBLE

Thanks to its design and extreme flexibility, the ductile iron GEOFLEX® system simultaneously compensates for expansion, contraction, deflection, rotation and angular deflection stresses.

The choice of fitting for a given diameter (DN) depends on the range of potential subsidence to which it may be subjected.

This subsidence is evaluated at the project design stage in terms of geotechnical risks or seismic stresses and the type of ground. Various possible deflection values (h) are available from 100 mm to 600 mm, depending on the range of diameters in question.



Informative sketch

NATURAL® spigot flanged fittings & NATURAL® flanged socket fittings (see (B)) form the irreplaceable interface between NATURAL® type pipes (see (T)) and GEOFLEX® fittings, (see (G)). This specially designed pipe system is homogeneous, high performing and addresses a wide range of needs. GEOFLEX®'s field of application also extends to the whole PAM range of water supply, sewers and fire control mains. Contact us for further information.

AN INNOVATIVE BOLTLESS DESIGN

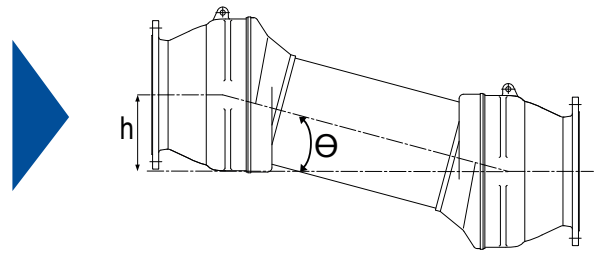
GEOFLEX® uses a unique and innovative assembly technology: it comprises a sliding collar and two articulated flanged ball joints, all assembled in one piece without screws or nuts, which gives it excellent mechanical strength and resistance to displacement. All the components in the range have a guaranteed slip-out resistance $3 DkN$, where D is the diameter, expressed in mm, based on ISO 16134 "Earthquake - and subsidence-resistant design of ductile iron pipelines". This level of performance corresponds to the standard's highest requirement class.

GEOFLEX® fittings, unlike other products in the range (pipes, joints and classical fittings) are designed and tested according to the specific standard ISO 16134 and not according to EN 545:2010.



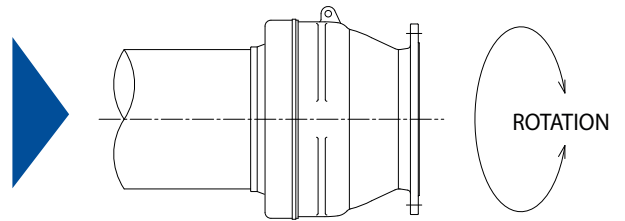
DEFLECTION AND ANGULAR DEFLECTION

Each ball joint offers large angular deflection « Θ » of $\pm 15^\circ$ to $\pm 20^\circ$ (depending on the diameter in question), which corresponds to an overall angular deviation of $\pm 30^\circ$ to $\pm 40^\circ$. With different collar lengths available, GEOFLEX® can offer a deflection capacity (subsidence) “h” of 100 to 600 mm. Wider ranges can be obtained by putting together two fittings consecutively in series.



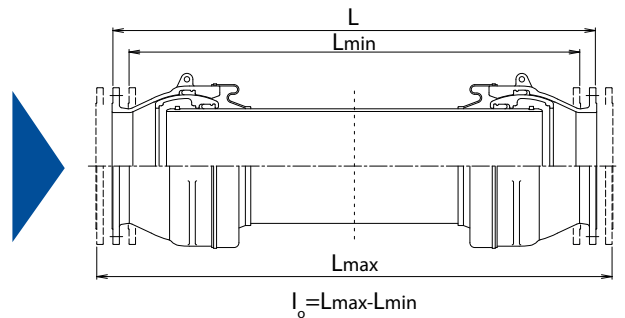
FREEDOM OF ROTATION

In addition to its capacity to absorb axial displacement and deflection, GEOFLEX® is also able to rotate at the ball joints, which helps prevent damage to flanges, valves and other structures that are attached to it.



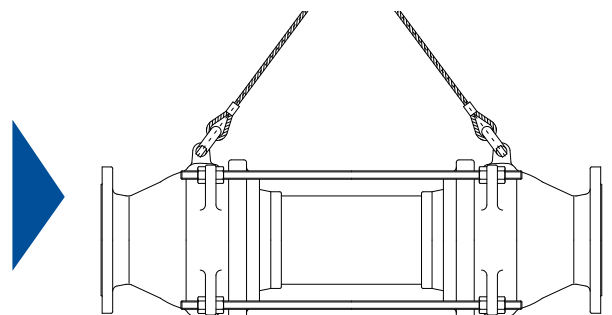
EXPANSION/CONTRACTION CAPACITY

The sliding design of the central collar on each ball joint allows large relative displacement of the flanged ends when contracting or expanding. The total sliding « l_0 » varies from 200 mm (± 100 mm) to 600 mm ($+350$ mm / 250 mm) as the diameter increases up the range.



SIMPLE INSTALLATION

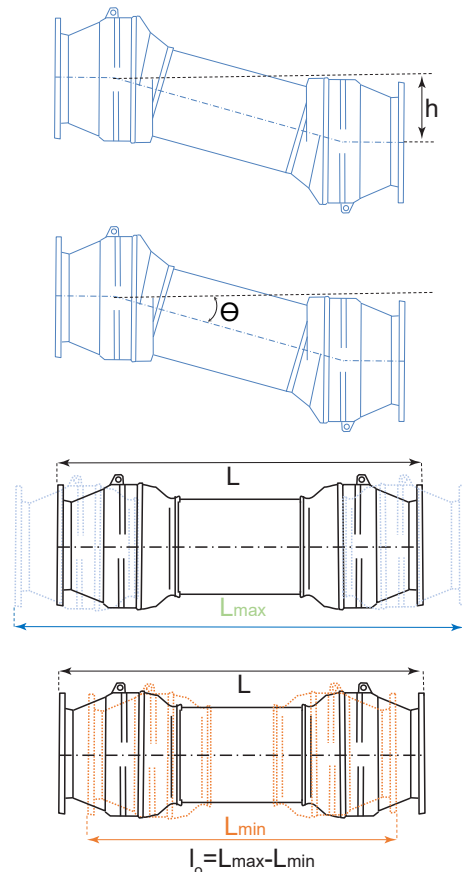
Assembly instructions are supplied with each fitting. GEOFLEX® is shipped with its four rods in place so as to prevent deflection during transport and handling, as well as to keep the overall dimensions of the fitting unchanged.





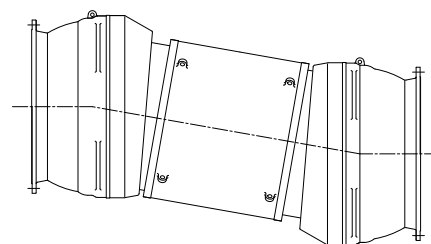
GEOFLEX® DOUBLE BALL JOINT DN 100 TO DN 1000

DN/OD	DEFLECTION	ANGULAR DEFLECTION	EXPANSION/CONTRACTION	SLIP-OUT RESISTANCE
mm	h in mm	°	l_0 in mm	kN
100	100 à 600	+/-38°	100(+/-50)	300
150	100 à 600	+/-36°	160(+/-80)	450
200	100 à 600	+/-34°	160(+/-80)	600
250	100 à 600	+/-32°	160(+/-80)	750
300	100 à 600	+/-30°	200(+/-100)	900
350	100 à 600	+/-30°	200(+/-100)	1050
400	100 à 600	+/-30°	240(+/-120)	1200
450	100 à 600	+/-30°	240(+/-120)	1350
500	100 à 600	+/-30°	300(+/-150)	1500
600	100 à 600	+/-30°	300(+/-150)	1800
700	200 à 600	+/-30°	400(+/-200)	2100
800	200 à 600	+/-30°	400(+/-200)	2400
900	200 à 600	+/-30°	440(+/-220)	2700
1000	200 à 600	+/-30°	440(+/-220)	3000



GEOFLEX® DOUBLE BALL JOINT DN 1100 TO DN 1800

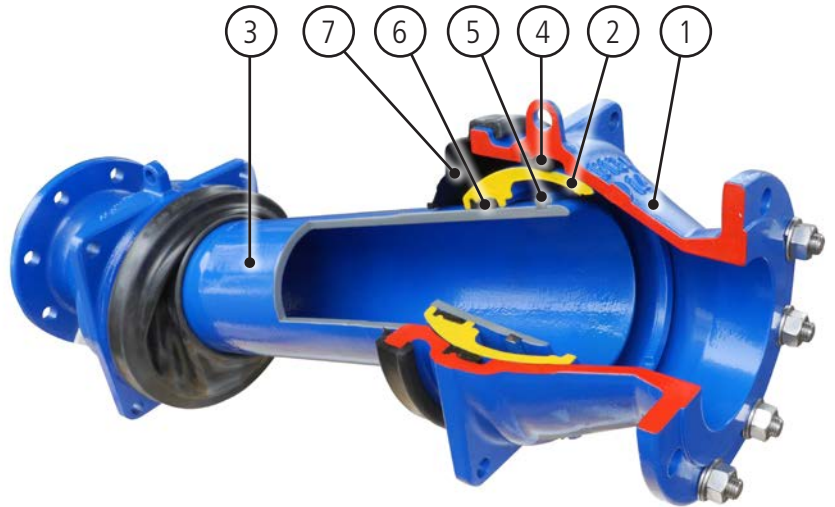
DN/OD	DEFLECTION	ANGULAR DEFLECTION	EXPANSION/CONTRACTION	SLIP-OUT RESISTANCE
mm	h in mm	°	l_0 in mm	kN
1100	400	+/-20°	600(+350/-250)	3300
1200	400	+/-20°	600(+350/-250)	3600
1400	400	+/-20°	600(+350/-250)	4200
1500	400	+/-20°	600(+350/-250)	4500
1600	400	+/-20°	600(+350/-250)	4800
1800	500	+/-20°	600(+350/-250)	5400



TYPE AND SPECIFICATIONS OF COMPONENTS

COMPONENT MATERIALS

ITEM	COMPONENT	MATERIAL
1	Flanged housing	Ductile iron
2	Ball joint	Ductile iron
3	Central collar	Ductile iron
4	Housing sealing ring	EPDM
5	Locking ring	Stainless steel
6	Ball-joint sealing ring	EPDM
7	Protective sleeve	EPDM



SPÉCIFICATIONS

COMPONENT	MATERIAL	
Flanged housing	- Housing	Ductile iron FCD 450-10 – ISO 2531
	- Ball joint	Ductile iron FCD 450-10 – ISO 2531
	- Central collar	Ductile iron FCD 450-10 – ISO 2531
Flange	PN 16 – ISO 7005-2 / EN 1092-2	
Inner and outer coating	Blue fusion bonded epoxy powder 250 microns	
Lubricant paste	Silicon grease	
Protective sleeve ⑦	EPDM	
Threaded rods, Reinforced threaded rods, Bolts (rods)	Stainless steel 304	
Protective sleeve (*)	Polyethylene	
Protective sleeve link (*)	Stainless steel	

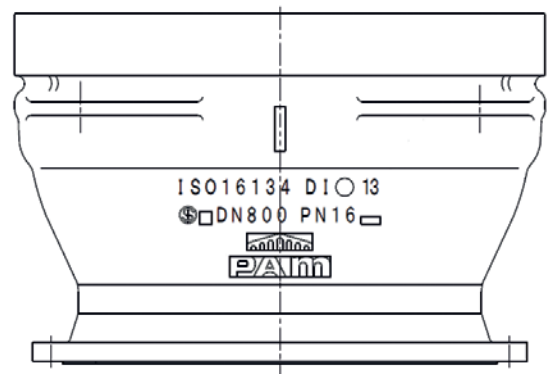
(*) see laying instructions

MARKING

The identification on each GEOFLEX® fitting is accessible by means of a sign located on one of the ends of the fitting. The marking contains the following information :

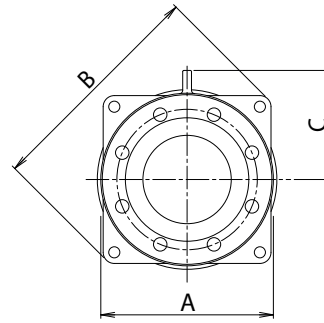
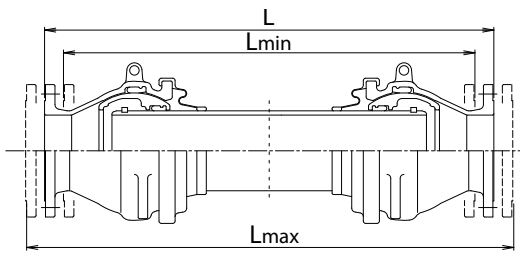
- ISO 1634 : design standard for fittings
- DI : Identifies the material Ductile Iron
- 13 : Year of manufacture
- DN : nominal diameter of GEOFLEX® fitting
- PN 16 : pressure

As well as 2 additional areas, 1 denotes the day of manufacture, the second identifies the control operations.



DIMENSIONS AND MAIN CHARACTERISTICS

GEOFLEX® DOUBLE BALL JOINT DN 100 TO DN 600



(Drawings available in Autocad format on request)

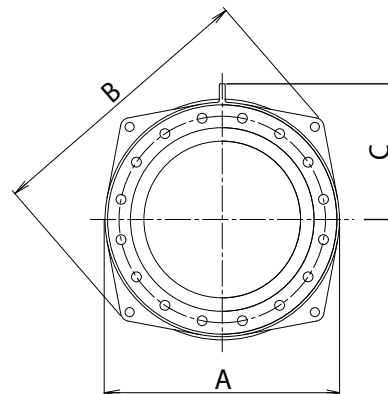
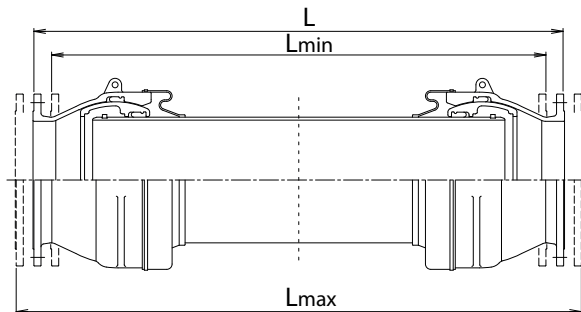
DN mm	DEFLECTION h (mm)	L mm	L MIN mm	L MAX mm	A mm	B mm	C mm	MASS kg	REFERENCE
100	100	630	580	680	247	331	157	53	BBB10GD2ETT
	200	920	870	970				59	BBB10GD2JTT
	300	1210	1160	1260				66	BBB10GD2KTT
	400	1500	1450	1550				72	BBB10GD2LTT
	500	1790	1740	1840				79	BBB10GD2MTT
	600	2620	2570	2670				99	BBB10GD2NTT
150	100	680	600	760	307	390	185	87	BBB15GD2ETT
	200	990	910	1070				98	BBB15GD2JTT
	300	1300	1220	1380				108	BBB15GD2KTT
	400	1610	1530	1690				118	BBB15GD2LTT
	500	1910	1830	1990				128	BBB15GD2MTT
	600	2620	2540	2700				152	BBB15GD2NTT
200	100	790	710	870	367	449	219	126	BBB20GD2ETT
	200	1120	1040	1200				144	BBB20GD2JTT
	300	1450	1370	1530				157	BBB20GD2KTT
	400	1770	1690	1850				171	BBB20GD2LTT
	500	2100	2020	2180				185	BBB20GD2MTT
	600	2730	2650	2810				211	BBB20GD2NTT
250	100	830	750	910	432	516	252	179	BBB25GD2ETT
	200	1180	1100	1260				197	BBB25GD2JTT
	300	1530	1450	1610				217	BBB25GD2KTT
	400	1880	1800	1960				235	BBB25GD2LTT
	500	2230	2150	2310				254	BBB25GD2MTT
	600	2730	2650	2810				281	BBB25GD2NTT
300	100	860	760	960	492	590	280	256	BBB30GD2ETT
	200	1230	1130	1330				282	BBB30GD2JTT
	300	1600	1500	1700				307	BBB30GD2KTT
	400	1970	1870	2070				332	BBB30GD2LTT
	500	2350	2250	2450				357	BBB30GD2MTT
	600	2730	2630	2830				382	BBB30GD2NTT
350	100	1170	1070	1270	545	651	313	360	BBB35GD2ETT
	200	1490	1390	1590				386	BBB35GD2JTT
	300	1860	1760	1960				418	BBB35GD2KTT
	400	2240	2140	2340				452	BBB35GD2LTT
	500	2610	2510	2710				481	BBB35GD2MTT
	600	2980	2880	3080				510	BBB35GD2NTT
400	100	1220	1100	1340	621	711	345	487	BBB40GD2ETT
	200	1500	1380	1620				514	BBB40GD2JTT
	300	1870	1750	1990				550	BBB40GD2KTT
	400	2250	2130	2370				586	BBB40GD2LTT
	500	2620	2500	2740				622	BBB40GD2MTT
	600	2990	2870	3110				658	BBB40GD2NTT
450	100	1260	1140	1380	676	766	372	598	BBB45GD2ETT
	200	1530	1410	1650				629	BBB45GD2JTT
	300	1910	1790	2030				672	BBB45GD2KTT
	400	2280	2160	2400				715	BBB45GD2LTT
	500	2660	2540	2780				757	BBB45GD2MTT
	600	3020	2900	3140				797	BBB45GD2NTT
500	100	1390	1240	1540	748	844	418	781	BBB50GD2ETT
	200	1610	1460	1760				813	BBB50GD2JTT
	300	2000	1850	2150				868	BBB50GD2KTT
	400	2380	2230	2530				923	BBB50GD2LTT
	500	2770	2620	2920				978	BBB50GD2MTT
	600	3120	2970	3270				1028	BBB50GD2NTT
600	100	1530	1380	1680	880	969	476	1104	BBB60GD2ETT
	200	1740	1590	1890				1142	BBB60GD2JTT
	300	2120	1970	2270				1213	BBB60GD2KTT
	400	2510	2360	2660				1284	BBB60GD2LTT
	500	2890	2740	3040				1356	BBB60GD2MTT
	600	3250	3100	3400				1425	BBB60GD2NTT

in stock (other references : delivery time is 16 weeks on average). Delivered with nominal length L.

DIMENSIONS AND MAIN CHARACTERISTICS

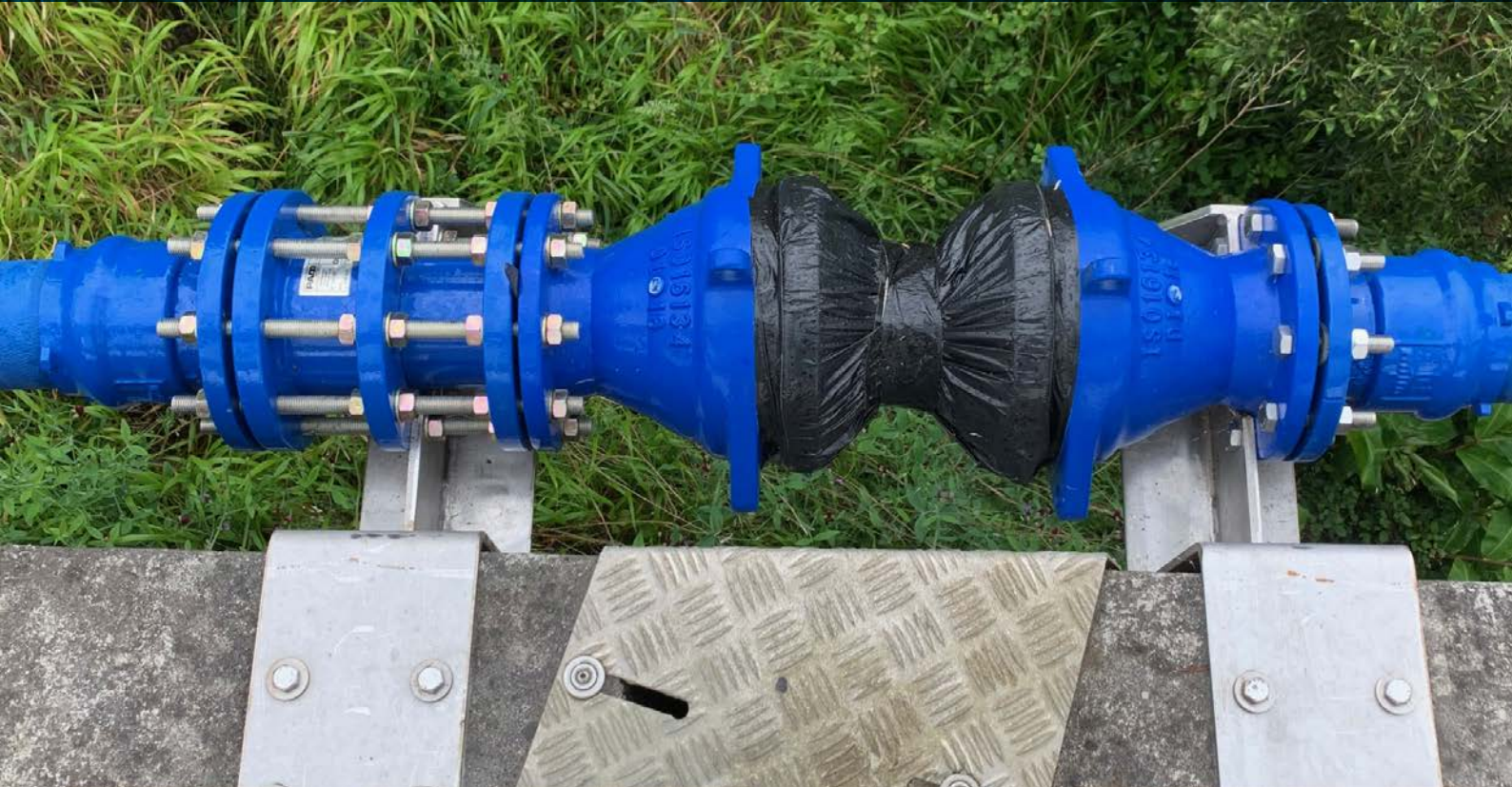
GEOFLEX® DOUBLE BALL JOINT DN 700 TO DN 1000

(Drawings available in Autocad format on request)



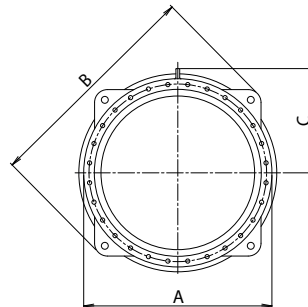
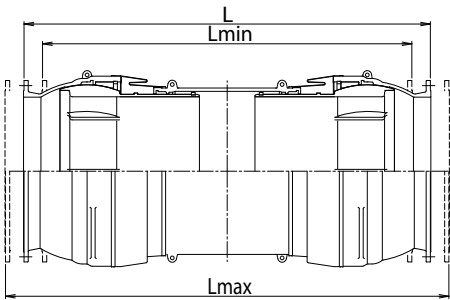
DN mm	DEFLECTION h (mm)	L mm	L MIN mm	L MAX mm	A mm	B mm	C mm	MASS kg	REFERENCE
700	200	1850	1650	2050	996	1108	535	1429	BBB70GD2JTT
	300	2220	2020	2420				1513	BBB70GD2KTT
	400	2590	2390	2790				1598	BBB70GD2LTT
	500	2970	2770	3170				1682	BBB70GD2MTT
	600	3340	3140	3540				1764	BBB70GD2NTT
800	200	2050	1850	2250	1110	1238	609	2000	BBB80GD2JTT
	300	2320	2120	2520				2075	BBB80GD2KTT
	400	2700	2500	2900				2204	BBB80GD2LTT
	500	3070	2870	3270				2282	BBB80GD2MTT
	600	3440	3240	3640				2360	BBB80GD2NTT
900	200	2160	1940	2380	1259	1402	686	2878	BBB90GD2JTT
	300	2540	2320	2760				3006	BBB90GD2KTT
	400	2930	2710	3150				3134	BBB90GD2LTT
	500	3320	3100	3540				3263	BBB90GD2MTT
	600	3610	3390	3830				3359	BBB90GD2NTT
1000	200	2230	2010	2450	1363	1496	738	3425	BBC10GD2JTT
	300	2610	2390	2830				3585	BBC10GD2KTT
	400	3000	2780	3220				3727	BBC10GD2LTT
	500	3390	3170	3610				3878	BBC10GD2MTT
	600	3680	3460	3900				3990	BBC10GD2NTT

Delivered with nominal length L.



GEOFLEX® DOUBLE BALL JOINT DN 1100 TO DN 1800

(Drawings available in Autocad format on request)



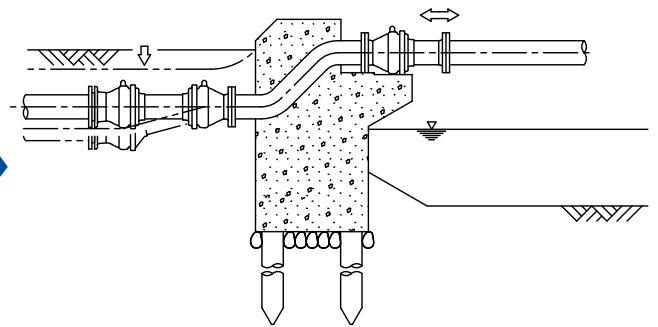
DN	DEFLECTION	L	L MIN	L MAX	A	B	C	MASS	REFERENCE
mm	h (mm)	mm	mm	mm	mm	mm	mm	kg	
1100	400	3190	2940	3540	1390	1540	748	4490	BBC11GD2LTT
1200	400	3340	3090	3690	1550	1700	837	5640	BBC12GD2LTT
1400	400	3440	3190	3790	1713	1863	935	7250	BBC14GD2LTT
1500	400	3490	3240	3840	1820	2020	986	8110	BBC15GD2LTT
1600	400	3870	3620	4220	1930	2187	1106	9870	BBC16GD2LTT
1800	500	3890	3640	4240	2256	2415	1235	13930	BBC18GD2MTT

Delivered with nominal length L.

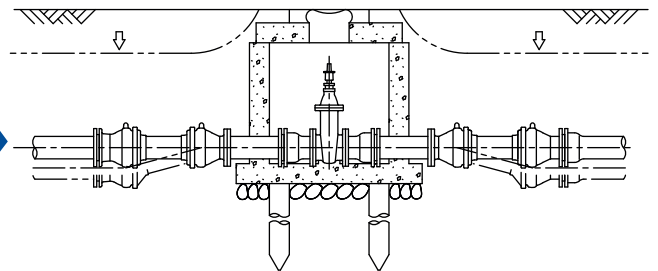
CONSTRUCTION APPLICATIONS, EXAMPLES

Following the recommendations of geotechnical studies ensures the durability of networks. Potential ground movement identified over the long term can cause pipelines to be displaced by dozens of centimetres. GEOFLEX® offers adaptation ranges to ground movements of up to 60 cm while maintaining its flow and sealing properties.

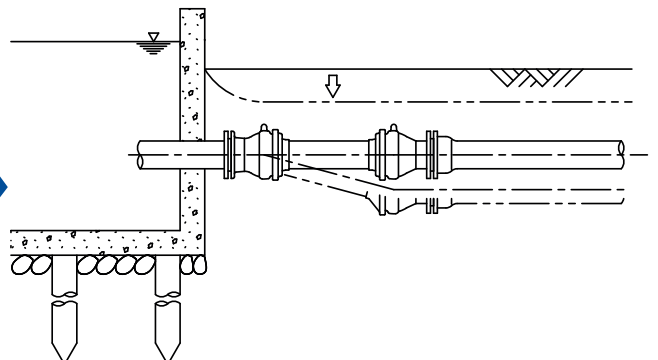
Laid at the inlet/outlet of an aqueduct



Laid at inlet/outlet of valve chambers



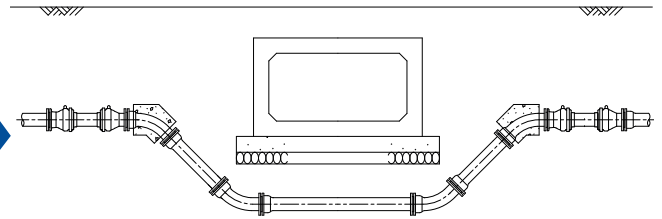
Laid at edge of structures



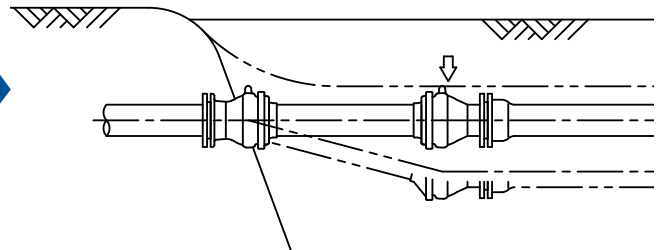
ADAPTED TO EVERY SITUATION



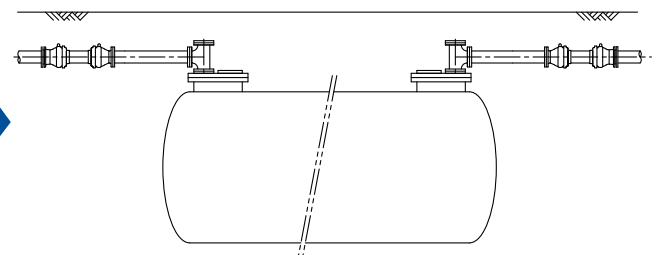
Crossing beneath a channel/box culvert



Laid at edge of unstable ground (liquefaction)



Laid at the inlet/outlet of a tank



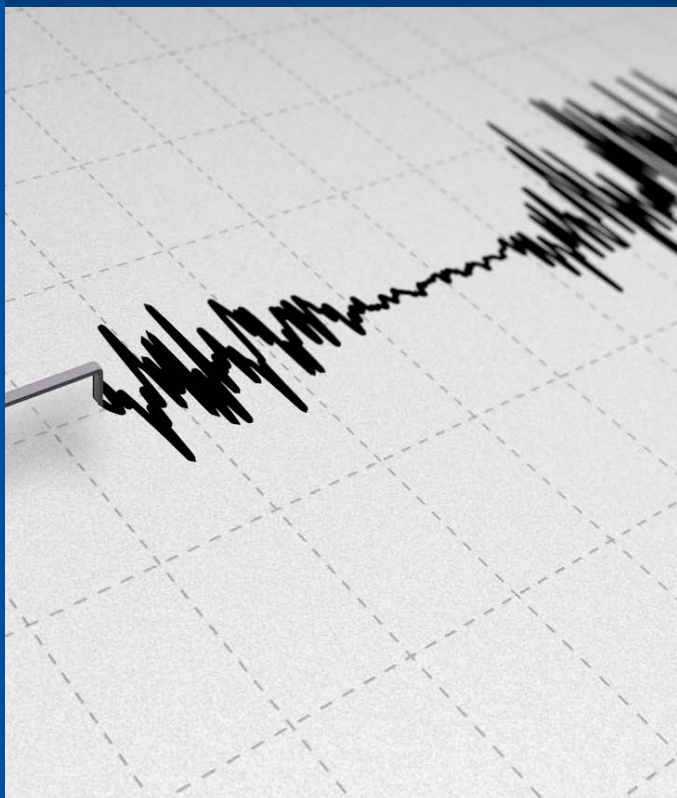
PERFORMANCES TESTS RESISTANCE TO EARTHQUAKES

ISO 16134 REQUIREMENTS:

“Earthquake- and subsidence-resistant design of ductile iron pipelines”

SCOPE:

ISO 16134 specifies the design of earthquake and subsidence-resistant ductile iron pipelines suitable for use in areas where seismic activity and land subsidence can be expected. It provides a means of determining and checking the resistance of buried pipelines and also gives example of calculations. It is applicable to ductile iron pipes and fittings with joints that have expansion/contraction and deflection capabilities, used in pipelines buried underground.



EARTHQUAKE RESISTANCE CALCULATIONS AND SAFETY CHECKING

When checking the resistance of pipelines to the effects of earthquakes, a calculation must be made for the condition in which the nominal load (dead load and payload) is combined with the effects of the stress caused by the earthquake.

The stress level of the pipe or fitting and the displacement caused (deflection/angular deflection; expansion/contraction) are calculated by the response displacement method. Earthquake resistance is checked by comparing these values to their respective permissible limits.

CLASSIFICATION OF PIPELINE COMPONENTS:

The three basic criteria for checking the earthquake resistance of pipelines are divided into three or four performance levels:

PARAMETER	CLASS	COMPONENT PERFORMANCE
Expansion/contraction capacity	S-1	± 1% or more of the length of the pipe or fitting
	S-2	± 0.5% to ± 1% of the length of the pipe or fitting
	S-3	Less than ± 0.5% of the length of the pipe or fitting
Slip-out resistance	A	3 DkN or more
	B	1.5 DkN to less than 3 DkN
	C	0.75 DkN to less than 1.5 DkN
	D	Less than 0.75 DkN
Angular deflection of the joint	M-1	± 15° or more
	M-2	± 7.5° to less than 15°
	M-3	Less than ± 7.5°

All fittings in the GEOFLEX® range offer the highest safety level for all three performance criteria for mechanical resistance to earthquakes:

- Expansion/contraction capacity: Class S-1 greater or equal to +/-1% of the length
- Resistance to displacement: Class A: 3 DkN or more
- Angular deflection of the joint: Class M-1: +/- 15° or more

DEFLECTION SEALING TEST

OBJECTIVE:

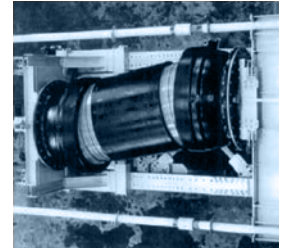
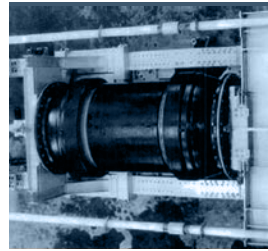
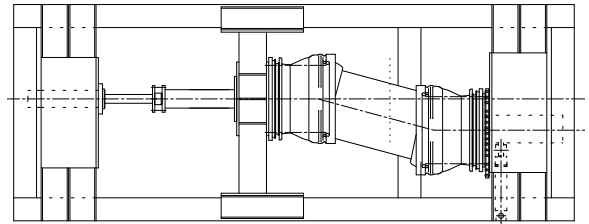
To test the sealing and integrity of GEOFLEX® when subjected to internal hydraulic pressure in misaligned position.

TEST PROCEDURE:

To test the sealing and integrity of GEOFLEX® when subjected to internal hydraulic pressure in misaligned position.

Place GEOFLEX® in a horizontal, aligned position on the test bed. Pressurise the system in accordance with the recommended operating conditions.

Misalign GEOFLEX® by a value identical to that of its intended application (misalignment: h). Check that there is no water leakage nor any other failure during the test period.



CYCLICAL "EXPANSION/CONTRACTION" SEALING TESTS"

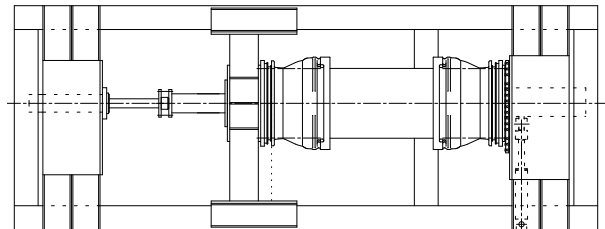
OBJECTIVE:

To test the sealing and integrity of GEOFLEX® when subjected to internal hydraulic pressure in a cyclical expansion-contraction test.

TEST PROCEDURE:

Place GEOFLEX® in a horizontal, aligned position on the test bed. Pressurise the system in accordance with the recommended operating conditions.

Apply a cyclical reciprocating expansion/contraction movement for a total travel value identical to that of the intended application of GEOFLEX®.



SLIP-OUT RESISTANCE TEST

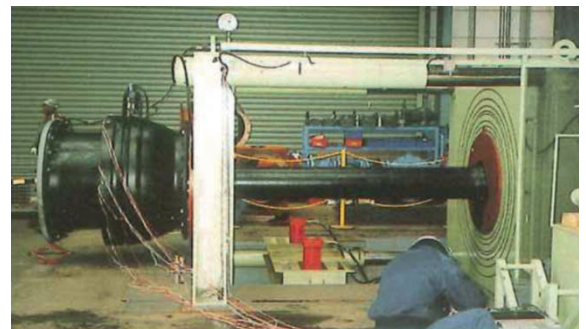
OBJECTIVE:

To test that the resistance of GEOFLEX® to slip-out is compliant.

TEST PROCEDURE:

Place GEOFLEX® in a horizontal, aligned position on the test bed. Gradually apply tensile stress until it reaches the equivalent of $3 D^{(1)}$ in kN.

⁽¹⁾ D expressed in mm



PLANT PERFORMANCE TESTS

RESISTANCE TO EARTHQUAKES

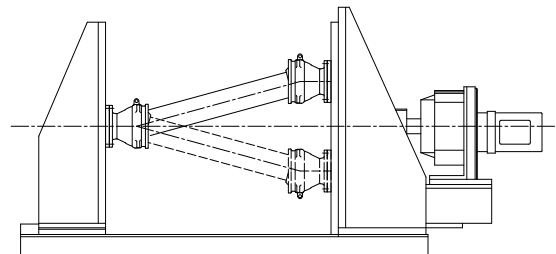
The performance tests carried out on a test bed or a laboratory designed for simulating seismic earth movements, reveal no deformity, fault or damage sustained to the products in the GEOFLEX® range.



COMBINED DEFLECTION AND EXPANSION/CONTRACTION SEALING TEST

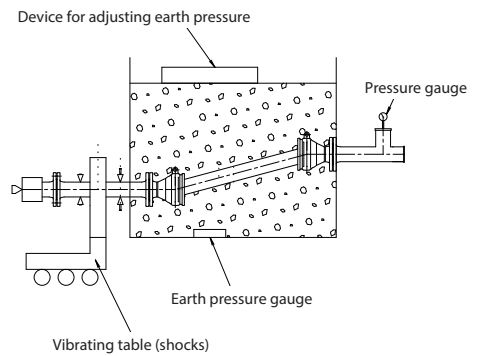
ROTATION SEALING TEST

These 2 tests allow to check the sealing and integrity of GEOFLEX® when subjected to internal hydraulic pressure in a cyclical movement test combined simultaneously, either with deflection and expansion/ contraction, or with rotation.

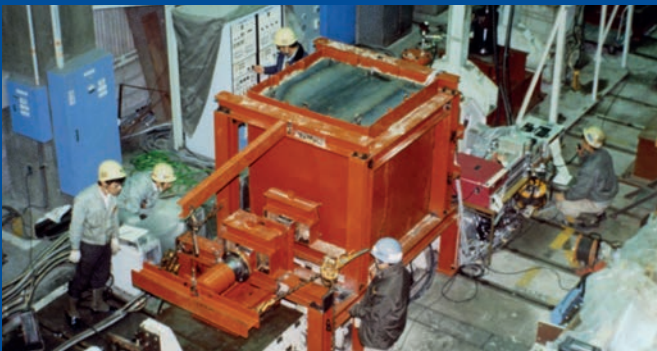


TESTING GEOFLEX®'S RESISTANCE TO SEISMIC STRESS

These tests are performed in an earthquake simulation chamber in order to assess the tightness and the resistance of a buried GEOFLEX® when it is submitted to an internal hydraulic pressure up to 0.75 MPa and to 17000 cyclic movements with a maximal acceleration up to 14.5 m/s².



Test bed designed to recreate seismic earth movements: GEOFLEX® DN 150 - Deflection 200mm



INSTRUCTIONS FOR LAYING AND INSTALLATION

Whilst handling GEOFLEX® fittings the same precautions and procedures must be followed as when handling other PAM product: pipes, fittings and accessories.

SAFETY PRECAUTIONS:

- Use appropriate power lifting device
- Maneuver the fitting gently without balancing it
- Avoid impacts and sudden movements whilst unloading

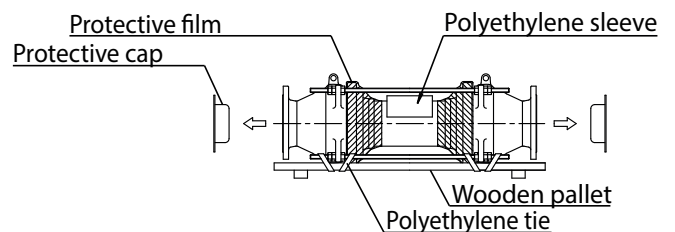


SAFETY RECOMMENDATIONS

Warning. Accident prevention measures

1. Use a hoist sling and shackles that are fixed on both sides to lift GEOFLEX®.
2. Lift GEOFLEX® using a sling with a 30° angle.
3. Only use the hooks for handling.

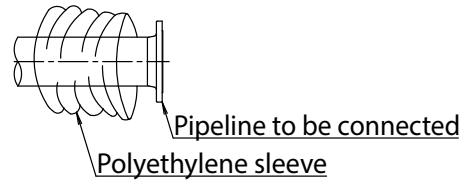
Step 1 Removing packaging



Remove the GEOFLEX® packaging materials, taking care not to damage the inner or outer coatings.

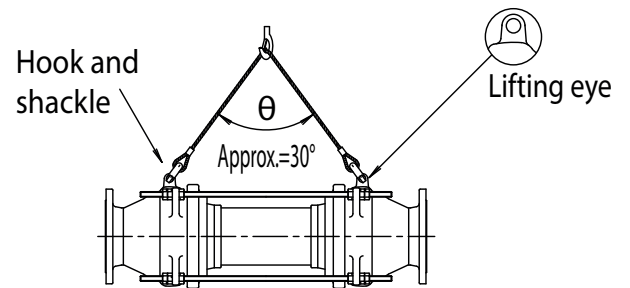
INSTRUCTIONS FOR LAYING AND INSTALLATION

Step 2 Inserting polyethylene sleeve (included)



Unfold the PE sleeve and place it on the end of one of the two pipes to be connected to GEOFLEX®.

Step 3 Handling GEOFLEX®

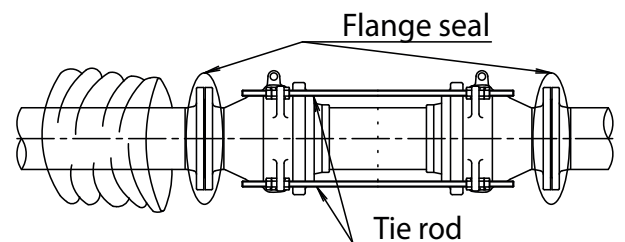
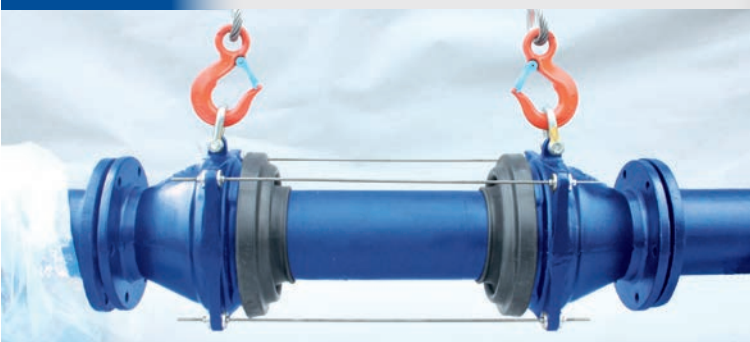


Suspend GEOFLEX® horizontally using a sling and place in the trench.

1. Use a sling fitted with cargo hooks.
2. Insert the hooks into the shackles, which have been screwed to the two lifting eyes beforehand.

Do not suspend GEOFLEX® with a sling using the tie rods.

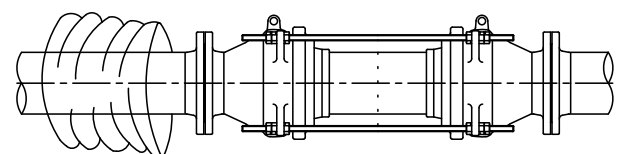
Step 4 Installing GEOFLEX®



The rods are used to prevent GEOFLEX® from moving as a result of end thrust. Consequently, DO NOT remove the rods after installation. Do not use the rods to adjust the fittings in final position.

Install GEOFLEX® on the site where the pipes concerned are being laid.

Step 5.1 Connecting the ends of GEOFLEX®



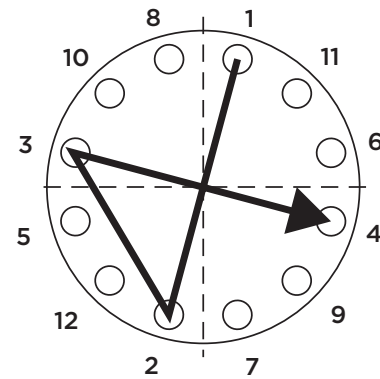
Clean the surface of the flange, nuts, bolts and joint to prevent foreign bodies from entering the different parts of the installation.

INSTRUCTIONS FOR LAYING AND INSTALLATION

FOR UNDERGROUND INSTALLATION

The wrapping of the polyethylene sleeve must be done with care in order to protect the fitting. The sleeving not only protects the fitting from aggressive soils but also reduces the effect of mechanical stresses during minor ground movements and keeps the GEOFLEX® fitting intact and retaining its functional capabilities during more serious ground movements.

Step 5.2 Installing the seal and tightening the nuts and bolts



TIGHTENING TORQUE OF NUTS AND BOLTS

DN	TIGHTENING TORQUE Nm
150	6
200	6
250	8
300	8
350	8
400	12
450	12
500	15
600	18
700	18
800	30
900	30
1000	40

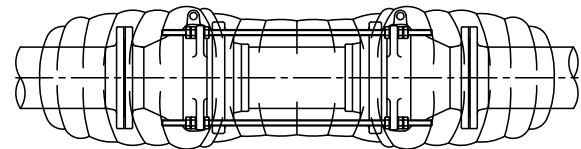
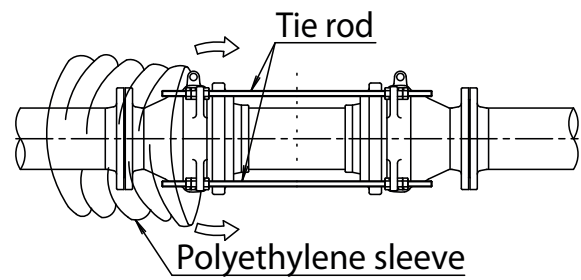
After placing the seal between the flanges, carefully tighten the nuts and bolts. Keep in mind the position of the seal and the flange holes. See the drawing above for the tightening sequence of the nuts and bolts. The table below gives the tightening torque. The seal must be compressed evenly around its entire perimeter.



Step 6 Installing the polyethylene sleeve

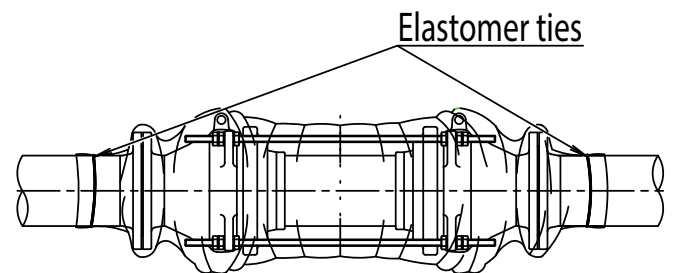


Install the polyethylene sleeve with the rods.



Slide the polyethylene sleeve that was positioned in step 2 along the GEOFLEX® fitting so that it partially covers the end of the next joint.

Step 7 Installing the elastomer ties

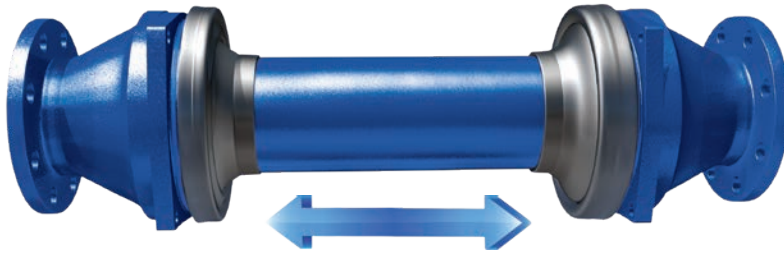


Secure the polyethylene sleeve with the elastomer ties provided. Once this operation is finished, installation is complete.

GEOFLEX®

Technology designed for the most stressful conditions.

EXPANDABLE AND CONTRACTABLE FITTINGS



DEFLECTION OF FITTINGS



ROTATIONAL DEVIATION OF FITTINGS



Video clip of GEOFLEX® available on:



PamlineTV
(YouTube)
or
www.pamline.fr



Also download your GEOFLEX® brochure on PAM e-catalogues website.



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