

**WAVISTRONG®**  
INSTALLATION MANUAL





# **Wavistrong<sup>®</sup> Installation Manual**

REP 320/REV 02/0401

Date of issue:  
01-04-2001

Replaces issue:  
01-04-1998



All information was correct at the time of going to press. However, we reserve the right to alter, amend and update any products, systems and services described in this brochure. We accept no responsibility for the interpretations of statements made.

© Copyright by Future Pipe Industries B.V.

No part of this work may be reproduced in any form, by print, photo print, microfilm or any other means without written permission from the publisher.

## Table of Contents

<b>1. Introduction</b>		5
<b>1.2. Systems</b>		5
<b>1.3. Series identification</b>		5
<b>2. Handling of R.T.R.P. material: Transport and storage</b>		6
<b>2.1. Loading</b>		6
<b>2.2. Unloading</b>		7
<b>2.3. Storage of material</b>		8
<b>3. Jointing and preparation methods of Wavistrong</b>		10
<b>3.1. Cutting</b>		10
<b>4. Adhesive bonded joints</b>		11
<b>4.1. Tools for adhesive bonded joints</b>		12
<b>4.2. Machining</b>		12
<b>4.3. Bonding of the joint</b>		12
<b>4.4. Installation time for adhesive bonded joints</b>		14
<b>4.5. Allowable bending radius</b>		14
<b>5. Integral Rubber seal joint (RSJ) and Rubber Seal Lock Joint (RSLJ)</b>		15
<b>5.1. Tools for rubber seal joints</b>		15
<b>5.2. Rubber Seal Joint</b>		15
5.2.1. Rubber Seal Joint (RSJ) with pipe stop		15
5.2.2. Rubber Seal Joint (RSJ) without pipe stop		16
5.2.3. Rubber Seal Lock Joint (RSLJ) with pipe stop		17
5.2.4. Rubber Seal Lock Joint (RSLJ) without pipe stop		18
<b>5.3. Dimensions of rubber ring and locking strip</b>		19
<b>5.4. Installation time for rubber seal joints</b>		21
<b>5.5. Disassembly of rubber seal joints</b>		23
<b>6. Flanged joints</b>		25
<b>6.1. Tools for flanged joints</b>		25
<b>6.2. Flanged joints</b>		25
<b>6.3. Gaskets and maximum torques</b>		27
6.3.1. Torques for assembly of rubber gaskets with steel insert		27
6.3.2. Torques for assembly of rubber gaskets with supporting ring		28
<b>6.4. Assembly and disassembly of flanged equipment</b>		28
<b>6.5. Determination of the bolt lengths</b>		29
<b>7. Butt and wrap joints</b>		30
<b>7.1. Tools for butt and wrap joints</b>		30
<b>7.2. Cutting and shaving</b>		30
<b>7.3. Mixing</b>		30
<b>7.4. Fit layer</b>		30
<b>7.5. Laminating</b>		30
<b>7.6. Curing</b>		31
<b>8. Mechanical couplers</b>		32
<b>8.1. Tools for mechanical couplers</b>		32
<b>8.2. Mechanical couplers</b>		32

<b>9. Installation of underground systems</b>	33
<b>9.1. The trench construction</b>	34
<b>9.2. Pipe assembly</b>	36
<b>9.3. Backfilling</b>	38
9.3.1. Other methods of backfilling	39
9.3.2. Pipe systems to be cast in concrete	39
<b>9.4. Subsidence</b>	40
<b>9.5. Relief plates</b>	41
<b>9.6. Installation of underwater mains</b>	42
<b>9.7. Hydrant connections</b>	44
<b>10. Installation of above ground pipe systems</b>	45
<b>10.1. Supports</b>	45
10.1.1. Protection of the pipe	45
10.1.2. Extra supports	45
<b>10.2. Fixed supports</b>	44
<b>10.3. Pipe clips</b>	46
<b>10.4. Valves</b>	48
<b>10.5. Bellows</b>	50
<b>10.6. Connection to other materials</b>	52
<b>10.7. Algae growth</b>	53
<b>10.8. U.V. resistance</b>	54
<b>10.9. Electrically conductive pipe</b>	55
<b>10.10. Wall penetration and connection to or through walls</b>	56
<b>11. Field test procedure</b>	59
<b>11.1. Filling, saturation and testing</b>	59
<b>11.2. Causes of pressure drop</b>	60
<b>12. Safety precautions</b>	60

## 1. Introduction

This manual is written as a guide for supervisors and field engineers and explains the possibilities of Wavistrong systems. In addition this manual provides guidance on how to avoid and solve problems during installation. Reinforced thermosetting resin pipe (R.T.R.P.) systems offer, by their specific nature, many applications and advantages compared with other materials. In order to utilize all these properties it is essential, for those who use Wavistrong material, carefully to observe these guidelines. Please note that these instructions are for guidance only. Specifications written for a particular project will have priority.

Although the procedures written in this manual are as complete as possible, it is not possible to describe all the different circumstances you may meet. For this reason our experienced supervisors may vary the described procedures in order to achieve an optimum solution, using the latest installation techniques and processing methods.

### 1.2. Systems

Wavistrong pipeline systems are produced from glass fibres, impregnated with an aromatic or cyclo-aliphatic amine hardened epoxy resin.

This thermo hardened resin system offers superior corrosion resistance together with excellent mechanical, physical and thermal properties.

The glass fibre reinforced epoxy pipeline is resistant to the corrosive effect of mixtures with a low concentration of acids, neutral or nearly neutral salts, solvents and caustic substances, under both internal and external pressure.

The cross wound continuous glass fibres of the reinforced (structural) wall of the pipes and the supports are protected on the inside by the resin reinforced liner and on the outside by the resin top coat.

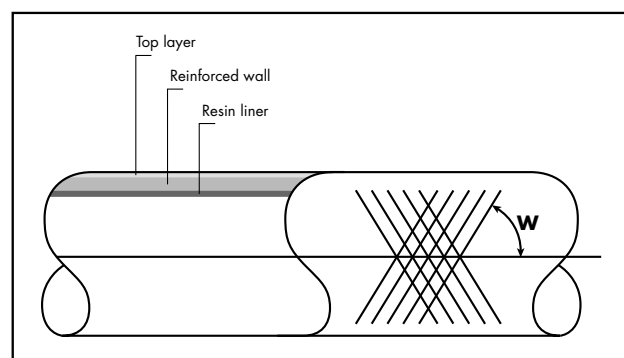


Fig. 1.2.a.

### 1.3. Series identification

The series identification comprises two parts, namely:

#### Type identification

The type of product is identified by three alphabetic letters

1. Type matrix                   **E** stands for epoxy resin,  
  **C** stands for electrically conducting epoxy resin
2. Type of application:       **S** stands for standard,  
  **W** for drinking water
3. Type of joint:                **T** stands for tensile,  
  **N** for non-tensile

#### Pressure class

This number gives the maximum permissible internal pressure (bar) which the product can withstand during a working life of 50 years, with a service (design) factor (Sf) of 0.5, which means a safety factor of 2.

For example: Series **EST 20** means: **E**poxy resin  
  **S**tandard application:  
  **T**ensile resistant joints

Nominal pressure **20** bar.

## 2. Handling of R.T.R.P. material: Transport and storage

### 2.1. Loading

Pipes, fittings and prefabricated parts (spools) have to be transported by suitable trucks. These trucks must have flat floors. Check for and remove any projections or nails etc. before each load. Materials must be secured for example by using wedges and wooden supports. These supports must have a minimum width of 10 cm, avoiding sharp edges. Usually the materials are tied in place, using pliable nylon or canvas slings. Chains or steel cables may **not** be used under any circumstances.



Fig. 2.1.a.

The support distances must not exceed 2.5 m. The width of the supports must be a minimum of 10 cm. When pipes are inserted (one inside the other), the support distance shall not exceed 2 m. Flanges must be secured against sliding. Flanges may only be loaded on their sealing face if they are sufficiently protected against damage.



Fig. 2.1.b.



The best way for fittings to be transported is in crates or onto pallets. Direct contact between products during transport must be avoided.

Pipe ends and machined parts must be protected, for example, by means of straw mats covered by polyethylene sheet or polyethylene netting. Pipes and spools should be lifted by using nylon or canvas hoisting belts with a minimum width of 10 cm and must be lifted at two points, using the largest diameter of the prefabricated part (spool), in such a way that the weight is well-balanced.

Any part of the truck has to be protected by wood or rubber wherever in contact with the products. We recommend the use of trucks which can be loaded from the sides. If pipes are handled by a forklift truck, the forks must be covered with rubber or plastic.

## 2.2. Unloading

The unloading of material is the responsibility of the client, unless agreed otherwise.

Because of the relative lightness of glassfibre reinforced plastics (approximately a quarter compared to steel) handlers may be tempted to handle it roughly, or unload it by letting it drop of its own accord. This may cause serious damage to the material and therefore Wavistrong material should be handled with care.



Fig. 2.2.a.

Do not use chains, steel cables or clamps during lifting. Nylon or canvas hoisting belts with a minimum width of 10 cm must be used. Standard pipe lengths must be picked up at two supporting points. Ensure that hoisting belts are always put round the widest part. We strongly recommend that the pipes are unloaded one at a time when hoisting belts are used. Each consignment is carefully loaded and must be inspected on site in order to ensure that no damage has occurred during transportation. This will avoid disputes with regards to responsibilities.

### 2.3. Storage of material

In order to avoid damage to the stacked pipes, the following rules are important:

- A** Do not lay the pipes directly on the ground, onto rails or concrete floors. Provide a flat surface.



Fig. 2.3.a.

- B** Ensure suitable supports are used for example wooden beams, measuring 10 x 5 cm. To avoid damage to machined pipe ends, stacking should be undertaken with care. The machined ends must be protected for example by polyethylene covered straw mats or polyethylene netting. The socket and spigot ends must not touch each other.
- C** The pipes can be stacked economically by alternating the spigot and the socket, as illustrated below. In order to avoid bending of the pipes, the beams should be laid directly above each other in a vertical line. Supports should be spaced at a max. of 3 metre intervals and about 1 metre from each end. The width of the supports should be at least 10 cm. The maximum allowable stack height is 1.5 metres. However, for diameters of 800 mm and above, a maximum of 2 pipes may be stacked one on top of the other.

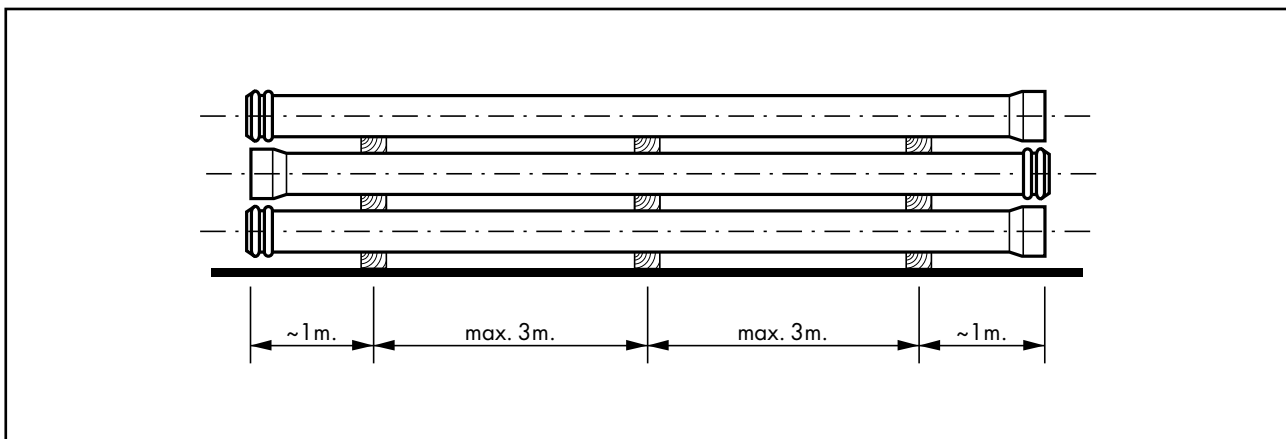


Fig. 2.3.b.

- D** If the product is stacked too high for long storage periods (6-12 months) and subjected to high temperatures, the supports may cause flattening. It is recommended that the product ( in particular machined parts) is stored under tarpaulins or (white) polyethylene sheeting.
- E** Pipe stacks should have side supports or blocks to prevent rolling or slipping of the stack during stormy weather.
- F** Store rubber o-rings, gaskets, plastic locking strips, adhesive kits, resins, hardeners, woven roving and lubricants in its original pack, below 35°C. Keep dry, away from frost, direct sunlight and ozone. Observe the shelf life of the adhesives and resins. It is preferable to order these as required.

- G** Unprotected flange-faces should never be placed directly on the ground or on concrete floors.
- H** If any damage during transportation or installation is noticed such as scratches, cracks or pits, Future Pipe Industries should be contacted for any repair or replacement. Never use any damaged material!
- I** Crystallisation can take place at temperatures lower than 20°C. The resin is then milky in appearance and is congealed. The resin can be made liquid again by re-heating it. A temperature of between 40°-50°C is required for this purpose. Before mixing the resin and hardener for use, the resin must be stirred thoroughly.

### 3. Jointing and preparation methods of Wavistrong

There are several methods available for the installation and adjusting of pipe systems in the field. The following jointing methods are described in chapters 4 to 8.

- A** Adhesive bonded joint
- B** Rubber seal joint
- C** Flanged joint
- D** Lamination joint
- E** Mechanical coupler

In case it is necessary to shorten the pipe length at a certain point in the line, re-jointing can be performed by adhesive bonding or by laminating. The adhesive bonded joint is available up to and including a diameter of 400 mm. Mechanical couplers such as Straub, Viking Johnson, Taylor Kerr and Dresser can be used. However, these mechanical couplers are non-restrained and cannot resist any axial loadings. Additional restraint will be required.

#### 3.1 Cutting

The pipe section to be cut should be marked using a marker pen and a pipe fitter's wrap-around guide. Ensure that the cut end is completely square as the reliability of the joint depends on it. The cutting of glassfibre reinforced epoxy pipes can be done by means of a hacksaw for diameters up to 100 mm. For diameters above 100 mm an (abrasive) cutting disc (diagrit or carborundum) can be used. Do not cut close to the socket end of a rubber seal joint and/or adhesive bonded joint. The cutting distance away from the conical part of the bell end must be equal to, or longer than the length  $L_v$  for laminated joints (see Wavistrong Field Laminate Instructions) and  $SA + 50$  mm for adhesive bonded joints (see Wavistrong Adhesive Instructions).

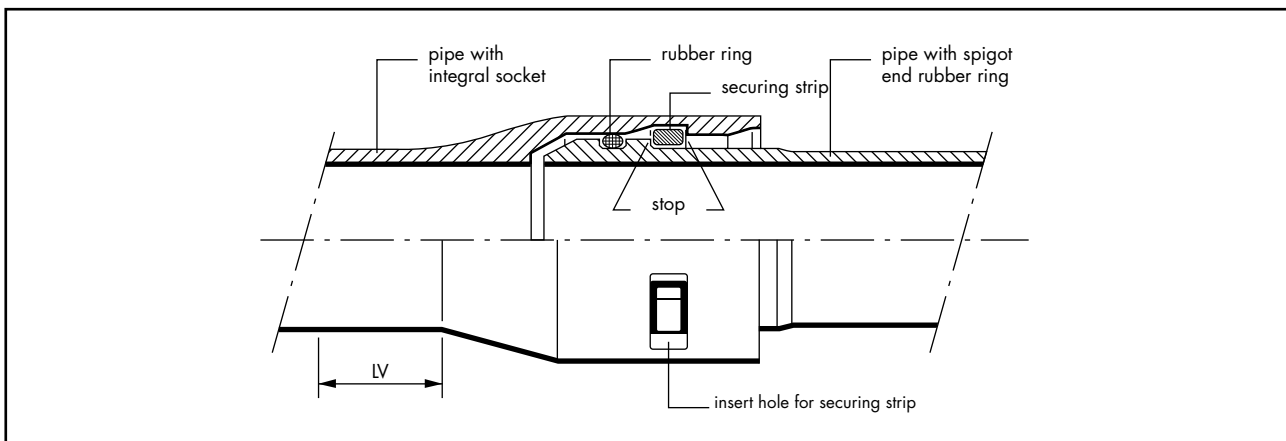


Fig. 3.1.a.

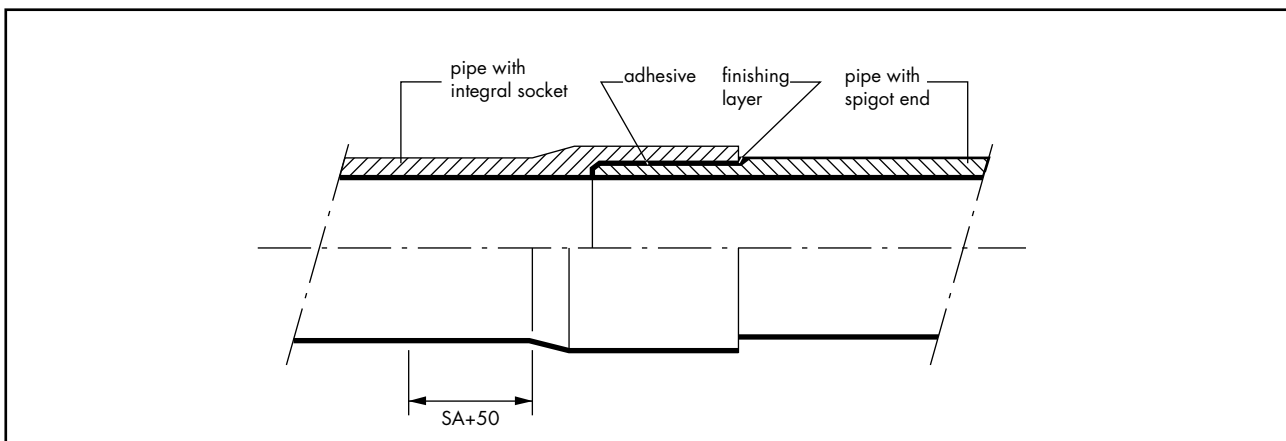


Fig. 3.1.b.

## 4. Adhesive bonded joints

Before adhesive bonding, all safety precautions will need to be checked. Ensure that all necessary tools and materials are available (see chapter 12. and 4.1.).

Adhesive bonded joints can only be made by fully trained and certified personnel.

### 4.1 Tools for adhesive bonded joints

For assembly of adhesive bonded joints the following is needed:

- A** measuring tape + marker pen + pipe fitter's wrap-a-round + measuring gauge
- B** pipe clamp + bench + rubber strip (for use underneath the chain clamp)
- C** angle grinder with diargrit or carborundum cutting disc (grain 24) flapper sander and a sanding bobbin, a handsaw with a 24 teeth/inch blade, jig saw with a 14 teeth/inch blade
- D** shaver
- E** cleaning rag
- F** adhesive, spatula (=rubber scraper plate), emery cloth
- G** heating blanket, hot air gun (paint stripper gun), digital temperature gauge, variable energy control (rheostat), insulation blanket
- H** generator
- I** cleaning fluid/gloves/dust mask/safety glasses.
- J** shelter (depending on the weather conditions)

For adhesive bonding: see instructions included with the cement kit.

For machining: see shaver instructions supplied with the shaver.

#### Note:

Future Pipe Industries supplies two types of adhesive:

- Easyfit Adhesive is suitable for standard EST and for EWT drinking water systems, both suitable for a medium temperature up to 110°C.
- Easyfit Conductive Adhesive is suitable for systems with electrically conducting properties (CST) for medium temperatures up to 110°C.

### 4.2 Machining

After the pipe has been cut to the exact length, the end will have to be machined to the right diameter to ensure a proper joint. The surface has to be cleaned with a clean cloth.

If the surface has been in contact with oil or grease, it should be cleaned with a clean cloth soaked in pure acetone, M.E.K. (methyl ethyl ketone) or M.I.B.K. (methyl isobutyl keton) (free of water). Do not use paint thinners, petrol or alcohol for cleaning. After drying, machining can start. There are 3 shavers available: one for diameters up to 50 mm, one for diameters from 80 mm to 250 mm and one for diameters from 200 mm to 400 mm.

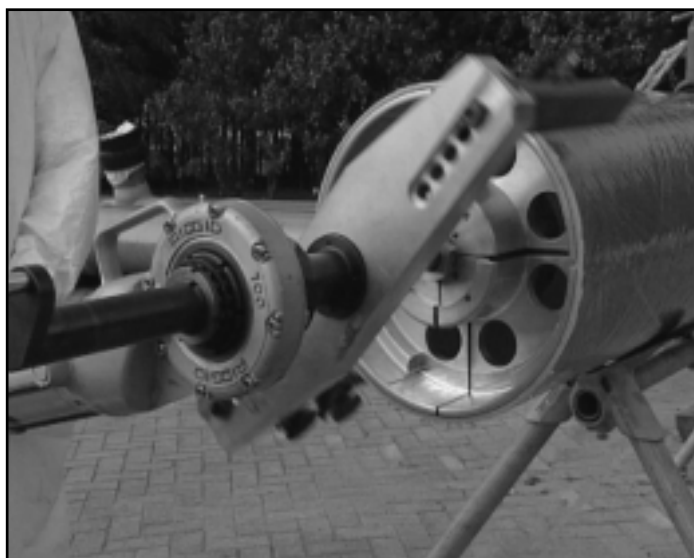


Fig. 4.1.a.

Instructions for the shaver adjustment and machining are provided with the tools.

If a factory made spigot end is not available for adjusting the tool, then the tool can be adjusted so that the machined spigot end jams about 10 mm away from the stop collar in the prepared socket end. This ensures a tight fit. After the adhesive is applied a good bond is guaranteed. Any irregularity in thickness can be determined by measuring the spigot end in several places. On the machined spigot end the max. wall thickness difference allowed is 0.2% of the diameter of the pipe, with a minimum value of 0.3 mm. The spigot dimensions have to be in accordance with the values shown in the bonding instructions packed with the adhesive. Jointing by means of bonding with other RTRP systems from different manufacturers, where the outside diameter is larger than the Wavistrong system, is not allowed. In such cases the joint must be made by laminating.

### 4.3. Bonding of the joint

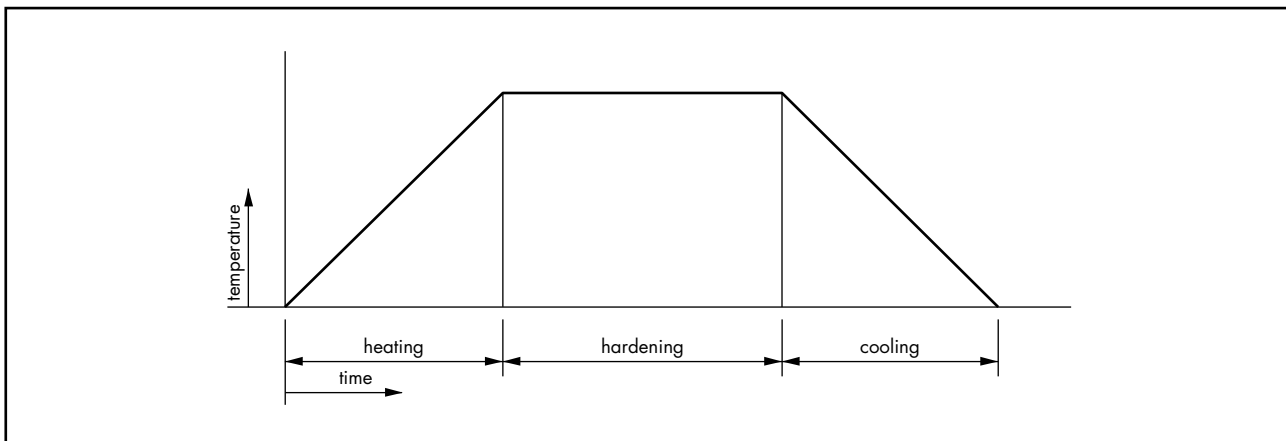


Fig. 4.3.a.

The bonding instructions are packed with every adhesive kit.

- The approximate number of joints which can be made with a standard package is as follows:

<b>Table 4.a. Number of joints using standard packagings</b>											
PN (bar)	Internal Diameter (mm)										
	25	40	50	80	100	150	200	250	300	350	400
8-16						2	2	1.5	0.75	0.33	0.25
20-32	20	15	10	6	4	2	1.5	1	0.75	0.33	0.25

Wastage of adhesive can be reduced by good planning and the best use of the adhesive kits. Too much adhesive applied to the socket will reduce the diameter and result in restricted flow. Remove excess adhesive with the aid of the spatula and finish the seam properly and smoothly. This can also be done inside the pipe, for example, by pulling a plug through the pipe. This will prevent problems using foam pigs later.

The temperature of the heating blanket should be at least 90°C for applications of medium below 65°C and 125°C for medium temperatures between 65°C and 90°C for the Easy fit adhesive.

For detailed instructions we refer to the Wavistrong Easy fit Adhesive Instructions, enclosed in the Wavistrong Adhesive set.

Curing time for Easy fit adhesive is one hour (see fig. 4.3.a. page 12) and one hour warming up time. Curing time starts after the surface of the pipe has reached the required temperature underneath the heating blanket. During curing the joint should be insulated for example by using an insulation blanket and seal off the pipe ends to prevent draughts through the pipe.

Because of their configuration, flanged joints and laterals are difficult to cure from the outside by using a heating blanket. They can be cured with the following alternative procedure:

- A** Roll up the heating blanket and place it on the inside of the pipe at the machined end. Fill the space inside the blanket with heat resistant material to ensure that the blanket is pressed against the pipe wall. The electrical cables must not be inside.
- B** Heat the joint on the inside with a hot air gun / paint stripper or infra red device. Control the temperature with a digital temperature gauge. For laterals, the branch and the nearest joint must be cured first. The remaining parts can be cured with a heating blanket.

*Do not move the joint during setting of the adhesive!* This can result in failure of the joint. After the cured joint has cooled down it may be loaded.

**Note** In many cases the number of site joints can be reduced by prefabrication (spoolbuilding) in the factory.

#### 4.4. Installation times of adhesive bonded joints

Approximate times needed to make an adhesive bonded joint are shown in table 4.b. These estimated times are based on uninterrupted work, enough space and an open trench for underground applications the availability of all necessary materials, etc by a two persons installation team.

<b>Table 4.b. Installation times</b>		
ID (mm)	Time for pre-processing (min)	Time for adhesion (min)
25	10	10
40	10	10
50	10	15
80	12	20
100	12	25
150	15	30
200	15	35
250	16	40
300	18	45
350	20	50
400	25	60

#### 4.5. Allowable bending radius

When installing the fully cured adhesive bonded joint system, it is possible to utilize the pipe's flexibility. The permitted bending radii are shown in the Wavistrong Engineering Guide. Bending of the adhesive bonded joint itself must be kept to a minimum.

Adhesive bonded joints must also be laminated when used in expansion loops, unless bending remains within certain limits. If in doubt Future Pipe Industries should be contacted.

## 5. Integral Rubber seal joint (RSJ) and Rubber Seal Lock Joint (RSLJ)

Before assembling the Rubber Seal Joints, all safety precautions will need to be checked. Ensure that all necessary tools and materials are available. See chapter 12 and 5.1.

### 5.1. Tools for rubber seal joints.

#### Rubber Seal Joints

For assembly of rubber seal joints the following is needed:

- A** lubricant for O-ring and locking strip
- B** a rod or stick
- C** 2 pipe clamps
- D** chain tackles (2): up to ID 500 mm pulling force 750 kg.  
ID > 500 mm pulling force 1500 kg.
- E** plastic or wooden mallet to drive the locking strip into the rubber seal lock joint
- F** non fluffy cleaning-rags

### 5.2. Rubber Seal Joint

The following actions must be taken in order to install the rubber seal joint.

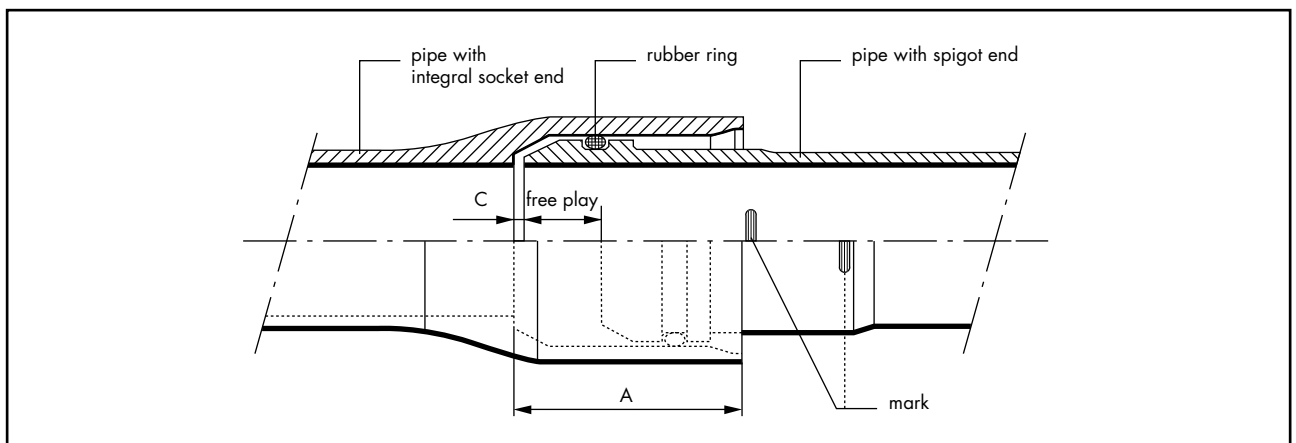


Fig. 5.2.a.

#### 5.2.1. Rubber Seal Joint (RSJ) with pipe stop

- Clean the spigot and socket end thoroughly with a clean cloth before jointing.  
Do not use material like dusters in order to avoid fibres from sticking to the surface of the seal.
- Check both pipe ends for damage.
- Mark the depth of entry on the spigot end.
- The measurement of the mark on the spigot end is as follows:  
depth of the socket end (dimension A) minus end play (dimension C) (see fig.5.2.a. and table 5.c., page 20).
- Position the rubber ring into the groove of the spigot end.
- Use a round tool like a screwdriver underneath the rubber ring and work it around a few times in order to distribute the tension (see fig. 5.2.d., page 17).

### 5.2.2 Rubber Seal Joint (RSJ) without pipe stop

To assemble a rubber ring joint use this manual. For marking the depth of entry on the spigot end use the instruction below. Mark the depth of entry on the spigot end. The measurement of the mark on the spigot end is in table 5.a.

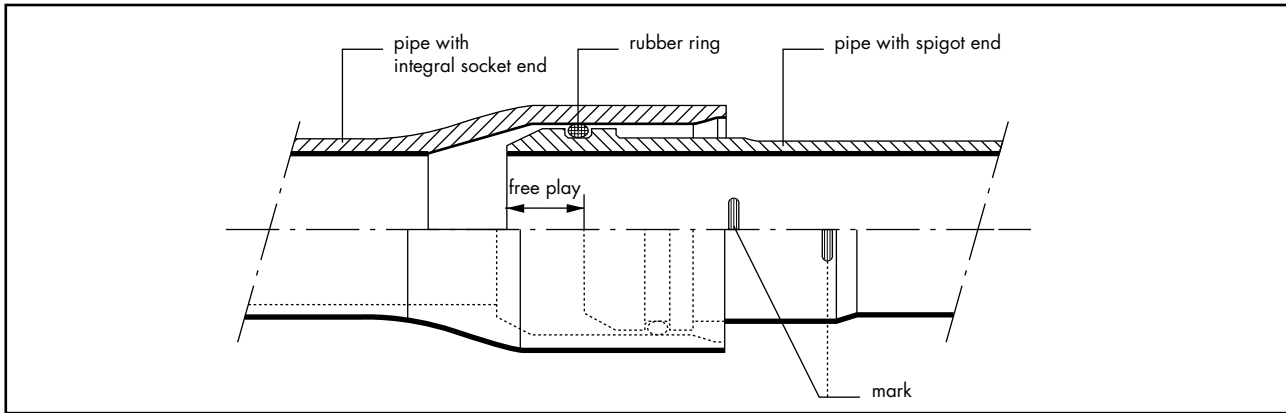


Fig. 5.2.b.

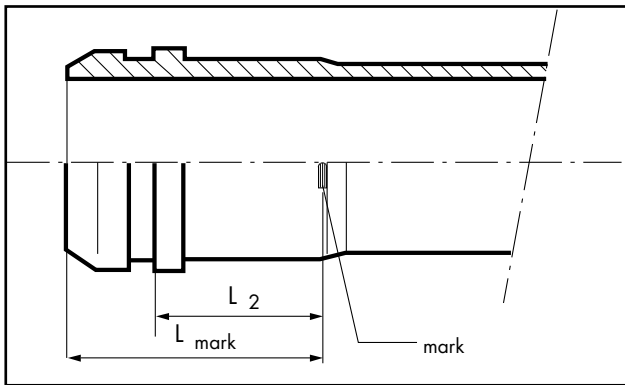


Fig. 5.2.c.

ID (mm)	PN						Angular deflection RSJ
	≤16 bar		20 bar		≥ 25 bar		
	L <sub>mark</sub> (mm)	L <sub>2</sub> (mm)	L <sub>mark</sub> (mm)	L <sub>2</sub> (mm)	L <sub>mark</sub> (mm)	L <sub>2</sub> (mm)	
80					93	62	3°
100					93	62	3°
150					119	78	3°
200			126	86	157	109	3°
250			176	118	220	154	3°
300			181	123	235	164	3°
350	184	127	229	160	229	160	3°
400	197	132	255	178	255	178	3°
450	204	137	266	186	266	186	3°
500	255	164	348	241	348	241	3°
600	268	174	370	256	370	256	2°
700	375	252					2°
750	385	260					2°
800	393	265					2°
900	379	255					2°
1000	394	265					2°
1200	418	281					1°
1400	418	278					1°

Table 5.a.



Fig. 5.2.d.

- Apply Future Pipe Industries lubricant to the rubber ring and the entire inner surface of the socket end.
- Avoid any lubricant under the rubber ring in order to prevent it from slipping out of the groove.  
Do not try to assembly the joint without the use of any lubricant. The standard lubricant can cause filters to block. Future Pipe Industries can supply lubricants which are soluble in water. Soft soap can be used as an alternative for the lubricant.
- Fit the rubber lined clamps on both sides of the joint (fig. 5.2.e.).



Fig. 5.2.e.

- Ensure that the spigot end is positioned right in front of the socket end and that both sections are fully aligned.
- Attach the chain tackles to the clamps on both sides of the parts to be connected and ease the spigot slowly and gradually into the socket until the mark is in line with the front of the socket end.
- If in doubt, check with a thin feeler gauge around the circumference, to confirm that the rubber ring is in the right position in the groove.



Fig. 5.2.f.

**Note:** The above mentioned clamps are available from Future Pipe Industries, but can also be made by the client according to Future Pipe Industries' drawings.

Diameters up to 300 mm can be installed without the use of tackles. The force necessary to make the joint can be done by using a wooden beam as a lever at the end of the pipe.

Do not try to join two pipes at an angle, since it is probable that the rubber ring may slip out of the groove. However, if necessary, only after assembly of the joint a permitted angle may be used (see table 5.c., page 20). Do not use the maximum permitted angle where you anticipate soil settlement.

### 5.2.3. Rubber Seal Lock Joint (RSLJ) with pipe stop

- Position the hole so the locking strip can be inserted easily.
- Follow the assembly instructions for the rubber seal joints (RSJ).
- Attach the chain tackles to the clamps on both sides of the pipe and ease the spigot end slowly and gradually into the socket end until the rear stop of the spigot end is past the hole of the locking strip.
- Apply some lubricant on the first section of the locking strip.
- Insert the locking strip in such a way that the bevelled end rests against the inside of the socket.

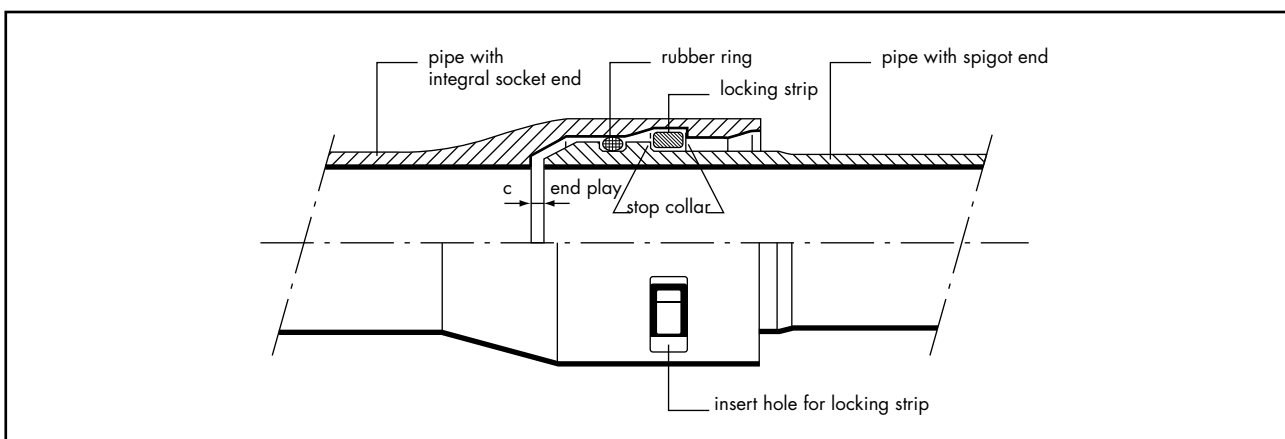


Fig. 5.2.g.

### 5.2.4. Rubber Seal Lock Joint (RSLJ) without pipe stop

To assemble a rubber ring joint use this manual. For marking the depth of entry on the spigot end use the instruction below.

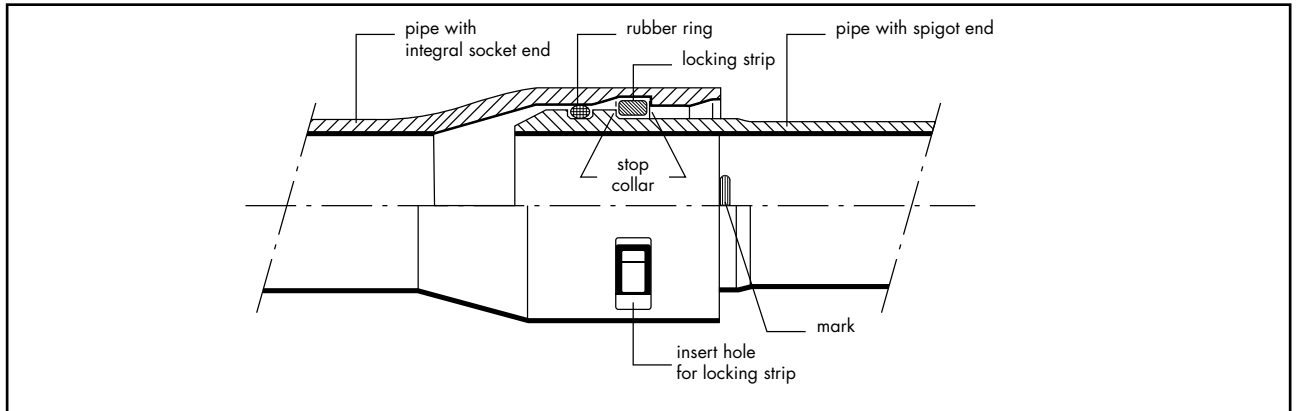


Fig. 5.2.h.

Mark the depth of entry on the spigot end. The measurement of the mark on the spigot end is in table 5.b.

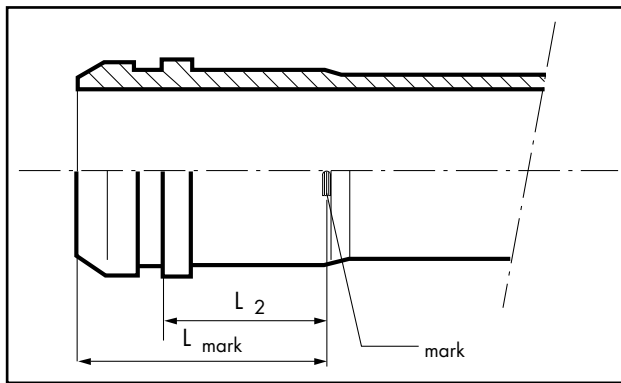
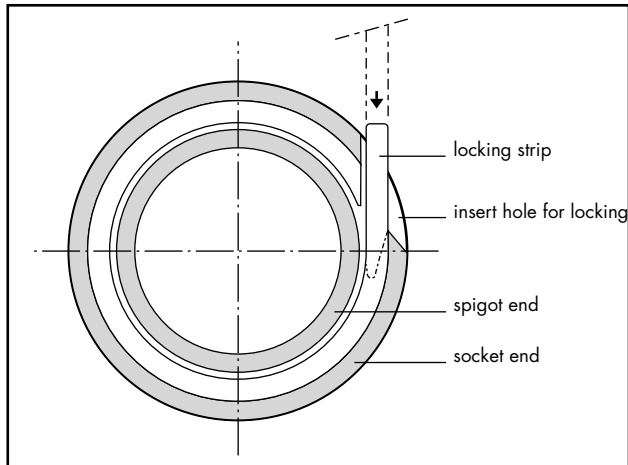


Fig. 5.2.i.

ID (mm)	PN						Angular deflection
	≤16 bar		20 bar		≥ 25 bar		
	Lmark (mm)	L2 (mm)	Lmark (mm)	L2 (mm)	Lmark (mm)	L2 (mm)	<b>RSLJ</b>
80					96	65	1°30
100					96	65	1°30
150			125	84	125	84	1°30
200	134	94	134	94	165	117	1°30
250	185	127	185	127	229	163	1°30
300	191	133	191	133	245	174	1°30
350	195	138	240	171	240	171	1°30
400	210	145	268	191	268	191	1°30
450	218	151	280	200	280	200	1°30
500	271	180	364	257	364	257	1°30
600	287	193	389	275	389	275	1°30
700	391	268					1°
750	402	277					1°
800	411	283					1°
900	400	276					1°
1000	417	288					1°
1200	445	308					1°
1400	450	310					1°

Table 5.b.



- Using a plastic hammer or a piece of wood, tap the locking strip home until it rests against the first part of the strip.
- The end of the locking strip sticks out by approx. 100 mm. This allows disassembly of the newly assembled joint.
- Ensure that the stop of both the socket end and the spigot end are in contact with the locking strip and that the fully extended system is kept in this position.

**Note:** At low temperatures a plastic locking strip may become less flexible. In that case it is advisable to warm the locking strip up to about 20°C.

Fig. 5.2.j.

<b>Tabel 5.c. Admissible angular deflection</b>			
ID (mm)	Play C (mm)	Angular deflection	
		RSLJ	RSJ
80	2.5	1°30	3°
100	3.0	1°30	3°
150	6.0	1°30	3°
200	8.0	1°30	3°
250	9.0	1°30	3°
300	10.0	1°30	3°
350	11.0	1°30	3°
400	13.0	1°30	3°
450	14.0	1°30	3°
500	16.0	1°30	3°
600	19.0	1°30	2°
700	16.0	1°	2°
750	17.0	1°	2°
800	19.0	1°	2°
900	21.0	1°	2°
1000	23.0	1°	2°
1200	27.0	1°	1°

For RSJ systems an additional 'end play' of 30 mm is allowed for diameters up to 300 mm and 50 mm for diameters 350 mm up to 1200 mm. This 'end play' allows for contraction as a result of pressure, temperature changes and soil settlements and therefore should not be used in the installation.

### 5.3. Dimensions of the rubber ring and the locking strip

The commonly used rubber ring is made of NBR (Nitril Butadiene Rubber). Other types of rubber can be supplied depending on the medium and/or the temperature.

The different types of rubber can be recognized by the following codes:

S - styrene butadiene rubber	SBR	colour code	red spot
N - nitrile butadiene rubber	NBR	colour code	yellow spot
E - ethene propene terpolymer	EPDM	colour code	blue spot
F - fluor elastomer	FKM		
H - hydrogenated nitrile butadiene rubber	H-NBR		

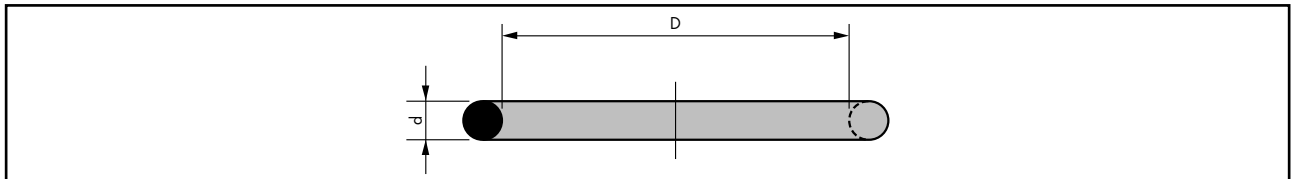


Fig. 5.3.a.

The dimensions d and D are shown on the O-ring as well as the year and month of production

<b>Table 5.d. O-rings dimensions</b>		
ID (mm)	d (mm)	D (mm)
80	7	80
100	7	109
150	10	156
200	10	207
250	14	260
300	14	311
350	14	360
400	17	409
450	17	460
500	22	508
600	22	610
700	26	690
750	26	740
800	26	790
900	26	880
1000	26	980
1200	30	1120

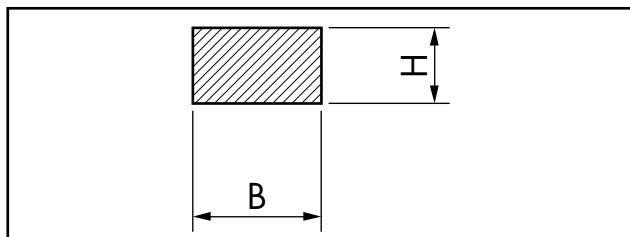


Fig. 5.3.b.

<b>Tabel 5.e. Locking strip dimensions</b>						
ID (mm)	PN (bar)		H (mm)	B (mm)	length (mm)	Pieces
	min.	max.				
80	32	32	8	12	400	1
100	25	32	8	12	400	1
150	20	32	10	14	750	1
200	16	20	10	14	750	1
200	25	32	10	18	800	1
250	12,5	20	16	20	1260	1
250	25	32	16	30	1350	1
300	12,5	20	16	20	1260	1
300	25	32	16	30	1350	1
350	8	16	16	20	1260	1
350	20	25	16	30	1350	1
400	8	16	16	20	1600	1
400	20	25	16	30	1700	1
450	8	16	16	20	1600	1
450	20	25	16	30	1700	1
500	8	16	20	24	2150	1
500	20	25	23	40	2250	1
600	8	16	20	24	2150	1
600	20	25	23	40	2250	1
700	8	16	23	40	2885	1
750	8	16	23	40	2885	1
800	8	16	23	40	2885	1
900	8	12.5	23	40	1765	2
1000	8	12.5	23	40	1765	2
1200	8		34	38	2150	2

#### 5.4. Installation time for the rubber ring joints

Estimated installation times for the rubber ring joints on site are shown in table 5.f. and 5.g.

These estimated times are based on

- uninterrupted work
- enough space and an open trench for underground applications, etc.
- an installation crew of 3 persons (two in the trench, one outside)
- excluding the handling of the pipe

<b>Table 5.f. Installation time</b>	
ID (mm)	Time (min.)
80	5
100	5
150	5
200	10
250	15

For diam. > 250 mm it has been taken into account that the pipe will be moved using the excavator.

<b>Table 5.g. Installation time</b>	
ID (mm)	Time for clamping and assembly of the joint (min.)
300	15
350	15
400	15
450	20
500	20
600	20
700	20
750	25
800	25
900	25
1000	30
1200	30

### 5.5. Disassembly of rubber seal joints

In principal it is possible to take rubber seal joints apart within a short period after installation. In practice the joint will be cut out due to the lack of space to pull the spigot out of the socket, unless it is the last installed joint.

The dismantling procedure for a rubber seal lock joint is as follows:

- Push the pipe back into position to free up the locking strip if possible.
- Grip the locking strip with a pair of pliers or a plate clamp.
- Tap the pliers or use a crane to pull the plate clamp to remove the locking strip. (If the locking strip jams, turn the pipe a little while pulling the strip).
- Pull the spigot end out of the socket until the rubber ring is positioned at the insertion hole of the locking strip.
- Pull the rubber ring through this hole, cut the rubber ring and remove the ring completely through the hole.
- Now the joint can be released completely.



Fig. 5.5.a.

## 6. Flanged joints

Before assembling the Flanged Joints, all safety precautions will need to be checked. Ensure that all necessary tools and materials are available. See chapter X. and 6.1.

### 6.1. Tools for flanged joints

Tools necessary for assembly of flanges:

- A** Ring spanner with required bolt head size.
- B** Torque wrench with required socket size.

### 6.2. Flanged joints

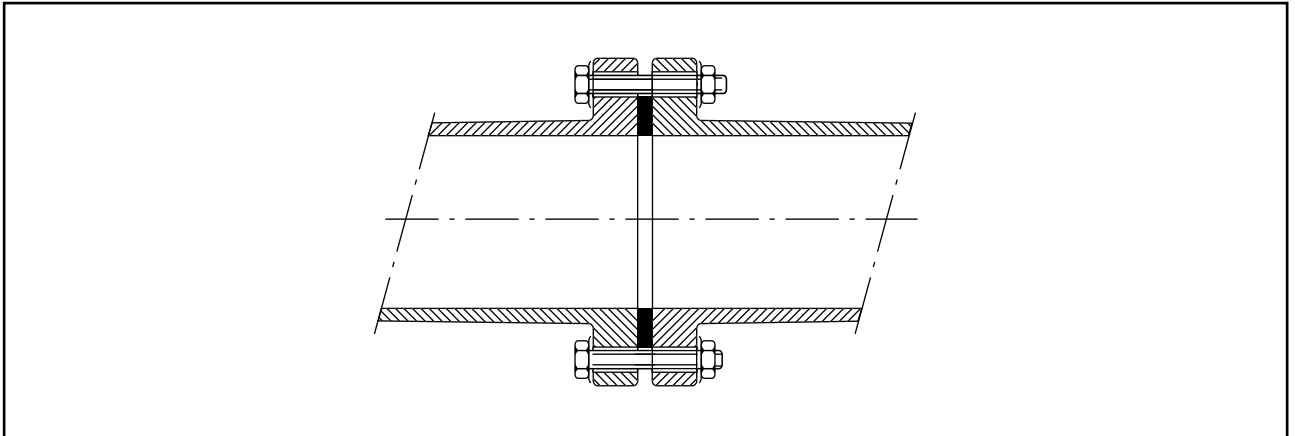


Fig. 6.2.a.

R.T.R.P. flanges are flat faced. These flanges must always be accurately aligned and not subject to any stress. On the R.T.R.P. side of the flanged joint the bolts and nuts must have washers to avoid exceeding the permitted surface pressure. As an alternative, a steel backing ring can be installed. Pipes must not be pulled together by tightening the bolts. If an R.T.R.P. pipeline is connected to a metal pipe, this metal pipe must be anchored to prevent any movement or loads being transmitted to the R.T.R.P. line.

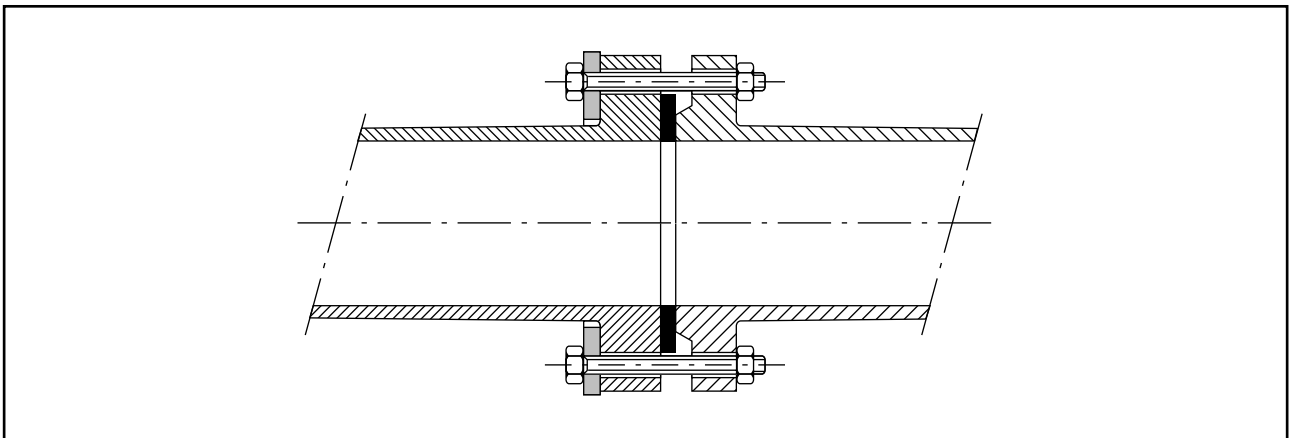


Fig. 6.2.b.

When assembling a wafer-type butterfly valve, the bolts should be tightened first by hand. If leakage occurs during pressure tests, the bolts can be tightened up to the max. values according table 6.a. page 27.

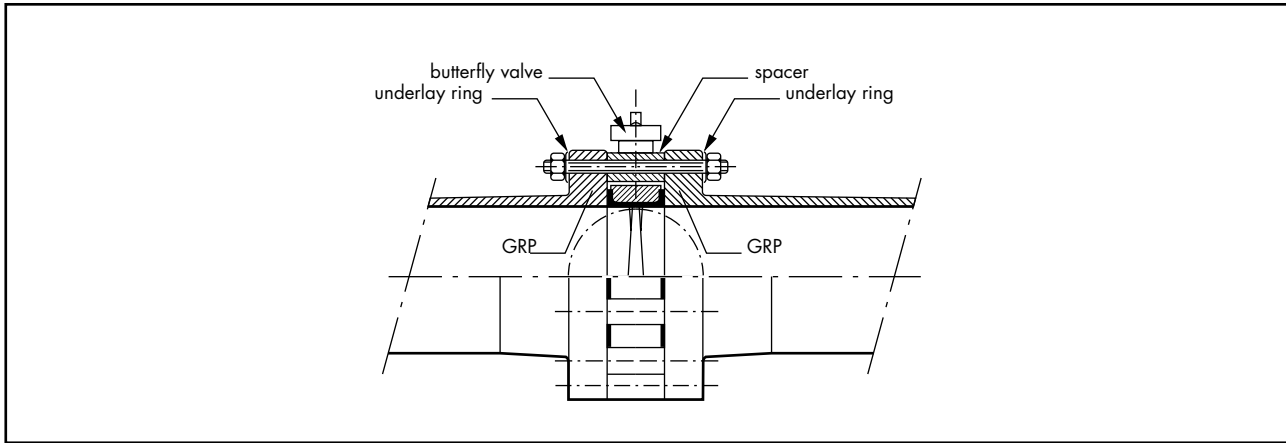


Fig. 6.2.c.

To prevent damage of the flanges when tightening, spacers may be placed between the R.T.R.P. flanges.

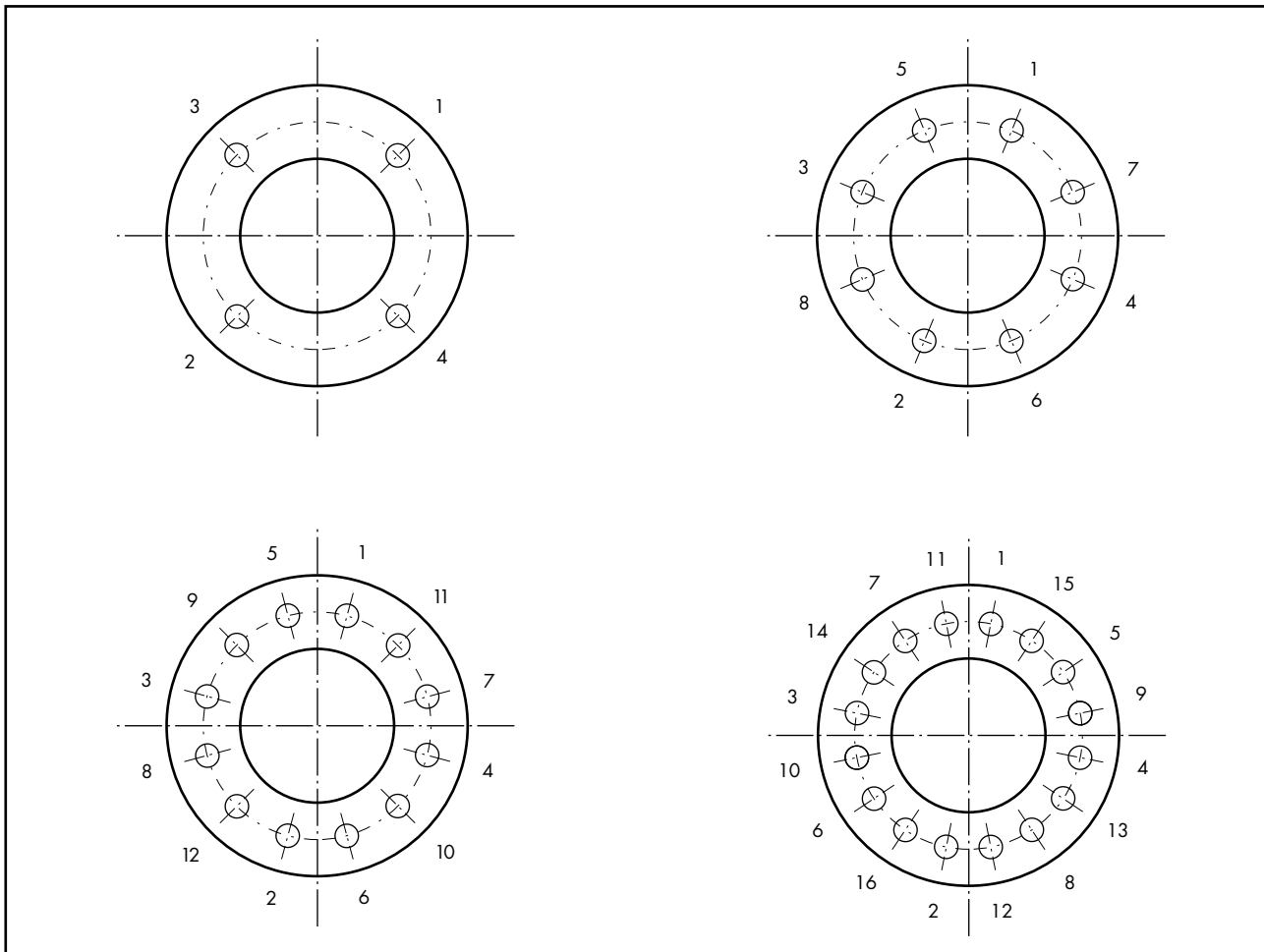


Fig. 6.2.d.

Tightening of the bolts of a flange connections must be done diagonally according to the sequence as shown in figure 6.2.d. Bolts in flanges must be placed on either side of the centre line unless otherwise specified.

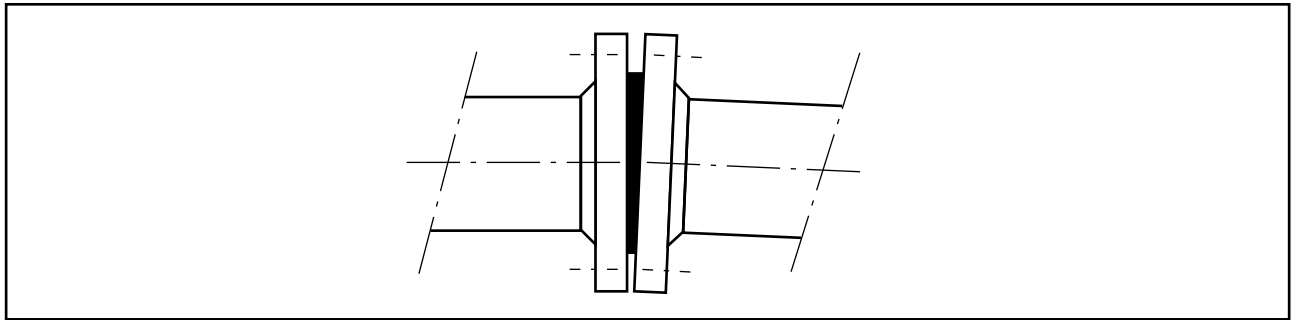


Fig. 6.2.e.

The flange must be connected perpendicular to the axis of the pipe. In practice minor deviations might occur. If this happens, a gasket with an O-ring seal or a profiled gasket with vulcanized steel ring (Kroll & Ziller) should be used. The flange must be installed free of tension.

### 6.3. Gaskets and torques

For R.T.R.P. flanges several gaskets may be used, depending on the diameter, system pressure or specific requirements of the client. To prevent excessive bending on R.T.R.P. flanges the max. bolt torques are specified. In order to determine the right torque value, it is necessary to lubricate the bolt with, for example, molykote.

When assembling Wavistrong flanges, the bolt should be tightened by hand up to 30% of the max. torque value. If leakages occur, increase the torque value up to 60% of the maximum value according to the sequence as showed in fig. 6.2.d. Mentioned torque amounts are maximum values and only valid for ASA and DIN standards as listed in the Wavistrong Product List.

#### 6.3.1. Torques for assembly of rubber gaskets with steel insert

This gasket fits inside the circle of bolts.

##### Rubber profile gasket with steel inlay

- Specification : Depending on medium and temperature.
- Model : Raised face, gasket thickness p=4-10 mm.
- Manufacturer : Kroll & Ziller, Hilden (Germany),
- Type : type G-St-P/S or type G-St-P/K.
- Application : All diameters and pressure classes.

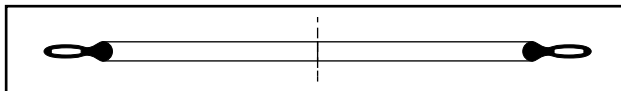


Fig. 6.3.1.a Kroll & Ziller type G- St - P/S

<b>Table 6.a. Flanges</b>		
ID (mm)	Torque (Nm)	
	Max. 16 bar	Max. 32 bar
25 up to 300	50	50
350 up to 600	100	200
700 up to 800	300	
900 up to 1200	400	

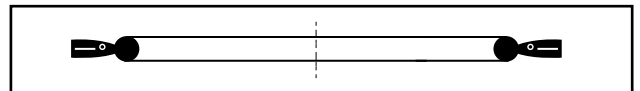


Fig. 6.3.1.b Kroll & Ziller type G- St - P/K

<b>Table 6.b. Push-on flanges</b>		
ID (mm)	Torque (Nm)	
	Max. 16 bar	Max. 32 bar
25 up to 150	50	50
200 up to 300	50	100
350 up to 400	100	200

**Note:** Above mentioned values are also valid for butterfly valves located inside the bolts circle

### 6.3.2. Torques for assembly of rubber profile gaskets with supporting ring.

#### Rubber profile gasket with supporting ring

Specification : Depending on medium and temperature.  
 Model : Raised face, gasket thickness  $p=4,5-6$  mm.  
 Manufacturer: Kroll & Ziller, Hilden (Germany)  
 Type : type G-St-P/KN.  
 Manufacturer: Kempchen, Oberhausen (BRD),  
 Type : type WL.  
 Application : All diameters and pressure classes.



Fig. 6.3.2.a Kempchen type WL

<b>Table 6.c. Flanges</b>		
ID (mm)	Torque (Nm)	
	Max. 16 bar	Max. 32 bar
25 up to 300	50	50
350 up to 600	100	200
700 up to 800	300	
900 up to 1200	400	

<b>Table 6.d. Push-on flanges</b>		
ID (mm)	Torque (Nm)	
	Max. 16 bar	Max. 32 bar
25 up to 150	50	50
200 up to 300	50	100
350 up to 400	100	200

### 6.4. Assembly and disassembly of flanged equipment

Ensure that the joint is fully extended and the stop of both, the socket and the spigot end are in contact with the locking strip. Assembling flanged parts (equipment, valves, adjusting pieces, orifice flanges etc.) one must bear in mind that these parts could also be dismantled. To provide space for disassembly in any installation there must be a rubber seal joint at one side. This allows some displacement in the axial direction using the clearance in the socket.

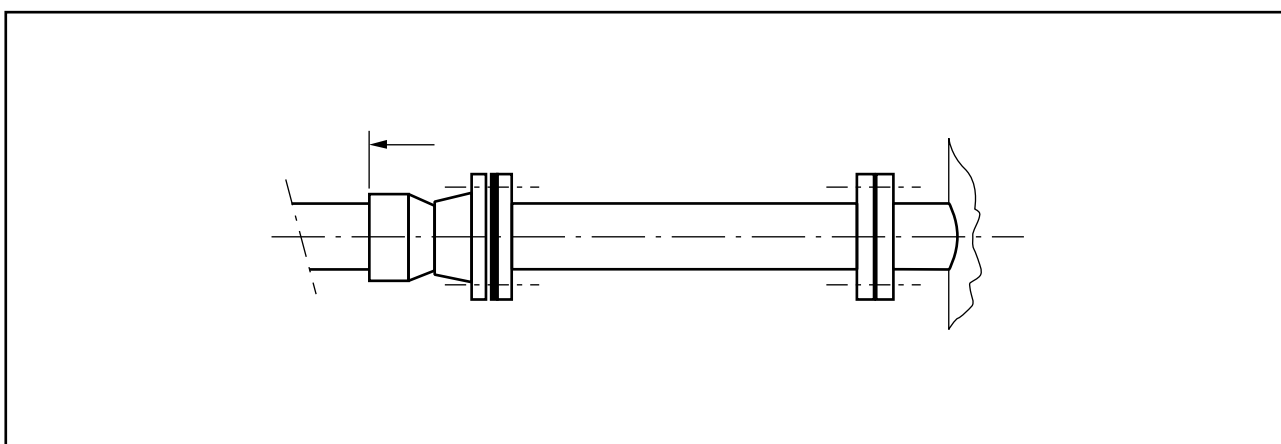


Fig. 6.4.a.

## 6.5. Determination of the bolt lengths

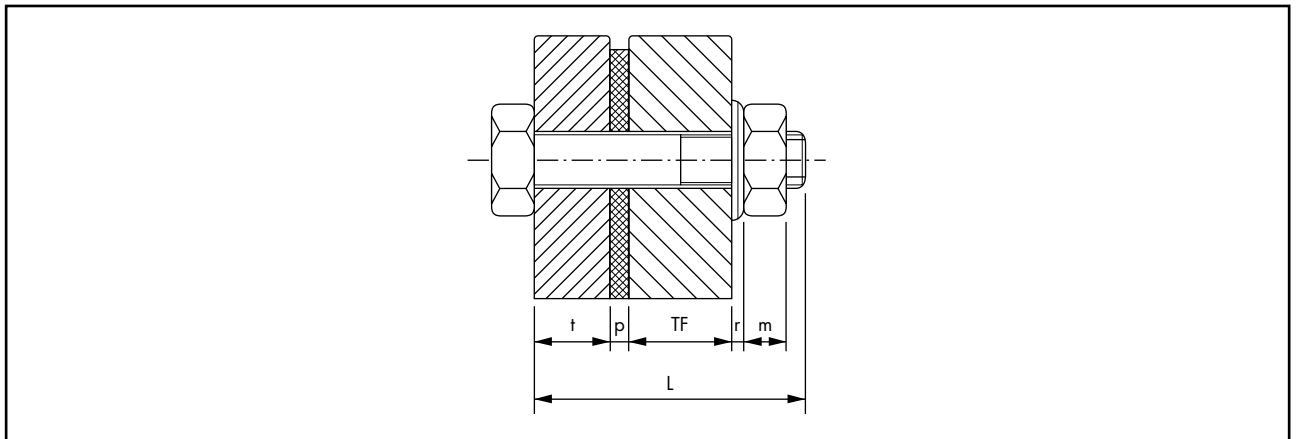


Fig. 6.5.a.

### Type of (flange) connections

There are four different types:

- 1 R.T.R.P. to steel connected with bolt and nut
- 2 R.T.R.P. to R.T.R.P. connected with bolt and nut
- 3 R.T.R.P. to steel connected with stud bolt and two nuts
- 4 R.T.R.P. to R.T.R.P. connected with stud bolt and two nuts

The lengths can be calculated with the following formula:

- 1  $L = T + t + p + r + m + 5$  (case 1)
- 2  $L = 2T + p + 2r + m + 5$  (case 2)
- 3  $L = T + t + p + 2r + 2m + 5$  (case 3)
- 4  $L = 2T + p + 2r + 2m + 5$  (case 4)

### Explanation of symbols:

- T = thickness of R.T.R.P. flange, for various pressure ratings  
t = thickness of the steel flange  
p = thickness of the gasket  
r = thickness of the washer  
m = height of the nut  
5 = allowance in addition to the tolerance of the flange thickness  
(diam. 25 to 300: 0, + 3 mm)  
(diam. 350 to 1200: 0, + 5 mm)

## 7. Butt and wrap joints

Before starting a butt and wrap (lamination) joint, all safety precautions will need to be checked. Ensure that all necessary tools and materials are available. See chapter 12 and 7.1.). A reliable laminated joint can only be made by personnel authorised and trained to do so. For more information, contact Future Pipe Industries.

### 7.1. Tools butt and wrap joints

Lamination joint

For butt and wrap joints the following is needed:

- A** Measuring tape + pipe fitter's wrap-a-round + marker pen
- B** Cleaning-rags
- C** Angle grinder with diargrit or carborundum cutting disc (grain 24), a handsaw 24 teeth/inch, jig saw with a 14 teeth/inch blade
- D** Angle grinder + sanding disc + flexible support disc
- E** Resin, hardener and glass reinforcement + a pair of scissors
- F** Gloves, brushes, rollers, dust masks in quantities as mentioned in the fit and laminating sets, a pair of safety glasses
- G** Shelter (depending on the weather circumstances)
- H** Insulation blanket
- I** Hot air gun (paint stripper gun), digital temperature gauge, gas burner, field oven, heating blanket, variable energy control (rheostat)
- J** Pipe clamp, bench and rubber strips (under chain clamp)
- K** Generator

For the butt and wrap joint procedures see instructions enclosed with the lamination sets. These instructions include; cutting and sanding, mixing, the fit procedure, lamination and curing.

### 7.2. Cutting and sanding

Mark off the pipes to be joined using a pipe fitter's sleeve and felt tipped pen. Saw the pipe (sections) to the right length, with a straight cut perpendicular to the pipe axis. The pipe can be shortened using a diargrit, carborundum slitting disc or with a diamond edged disc. Use a sander (Angle grinder) to remove the top coat of the pipes when cut to the right length, in order to give a clean and rough surface for adhesion. Clean the sanded part with a clean, non fluffy cloth or brush. The pipe sections must now be clean and free of dust (see Wavistrong field laminating instructions).

### 7.3. Mixing

The full contents of the hardener must be added to the container with the resin and carefully mixed. The resin and hardener contain the right mixing ratio.

### 7.4. Fit layer

The functions of the fit layer are, firstly, to ensure proper positioning and, secondly, to create a seal (see fig. 7.4.a.). The fit layer, with its lower viscosity, will not drain from the V-shaped seam.

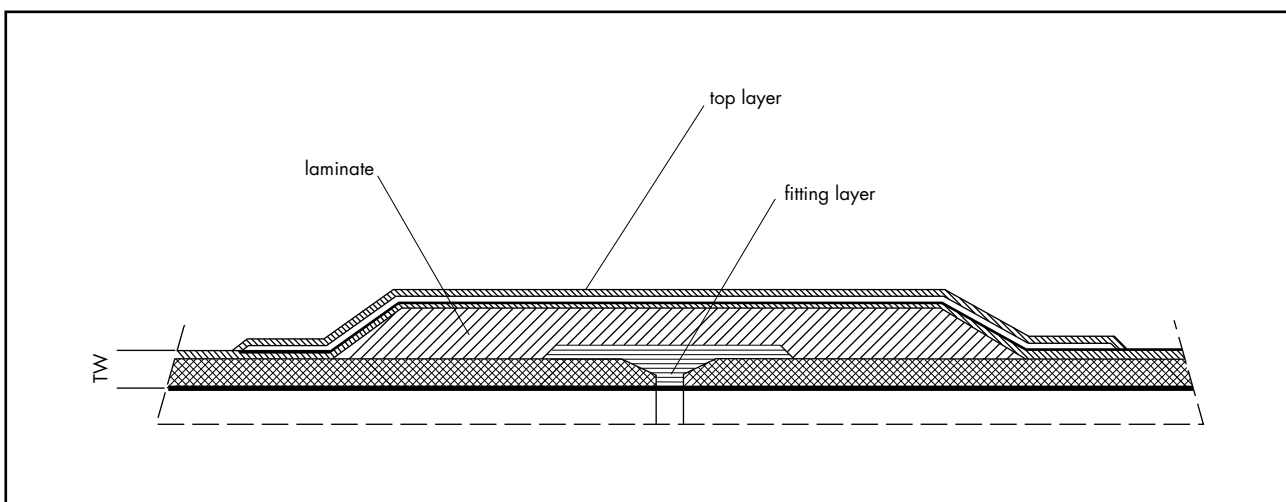


Fig. 7.4.a.

### 7.5. Laminating

Grind the surface (ensure the top coating is removed) and remove the dust using a clean dry cloth or brush to ensure a good adhesion between fit layer and laminate. The work must continue within the hour, otherwise the grinding and cleaning operation will have to be repeated. Ensure that tolerances are not exceeded!

The laminate should be built up following the procedure already mentioned. The woven rovings, the application of resin/hardener mix and the correct sequence of building up the woven rovings must be done according to the instructions on the lamination kit. Remove excess resin using a rubber spatula.

### 7.6. Curing

The lamination will harden at ambient temperatures. This can be speeded up by applying heat using for example, an infra red device or hot air gun. The hardening process needs to be done gradually (see fig. 7.6.a.).

After the lamination is no longer sticky, curing can be continued with the aid of heating blankets, hot air guns or ovens. Heating up to the curing temperature should also be performed gradually. The curing time only starts when the laminate has reached the correct curing temperature.

The joint is ready and can be tested when the laminate is fully cured and has cooled down.

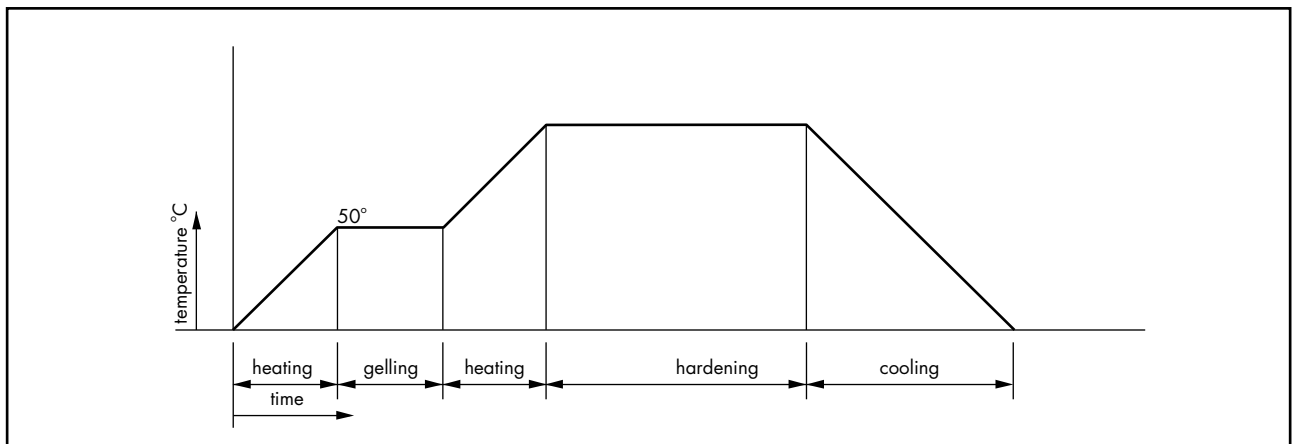


Fig. 7.6.a.

## 8. Mechanical couplers

Before starting the assembly of a mechanical coupler check if all safety precautions have been taken and all necessary tools and materials are available. See chapter 12 and 8.1.

### 8.1. Tools for mechanical couplers

For Straub and Taylor Kerr: - Allen key and torque wrench.

For Dresser, Viking Johnson and Inland couplers: - ring spanner.

Wavistrong pipes have lower torques than steel pipes, depending on the wall thickness.

Contact FPI for more information.

### 8.2. Mechanical couplers

Mechanical couplers, normally used for steel pipes, can also be used: e.g. Straub, Viking Johnson, Dresser, Taylor Kerr. However, restraining couplers should not be used as these may damage the Wavistrong pipes.

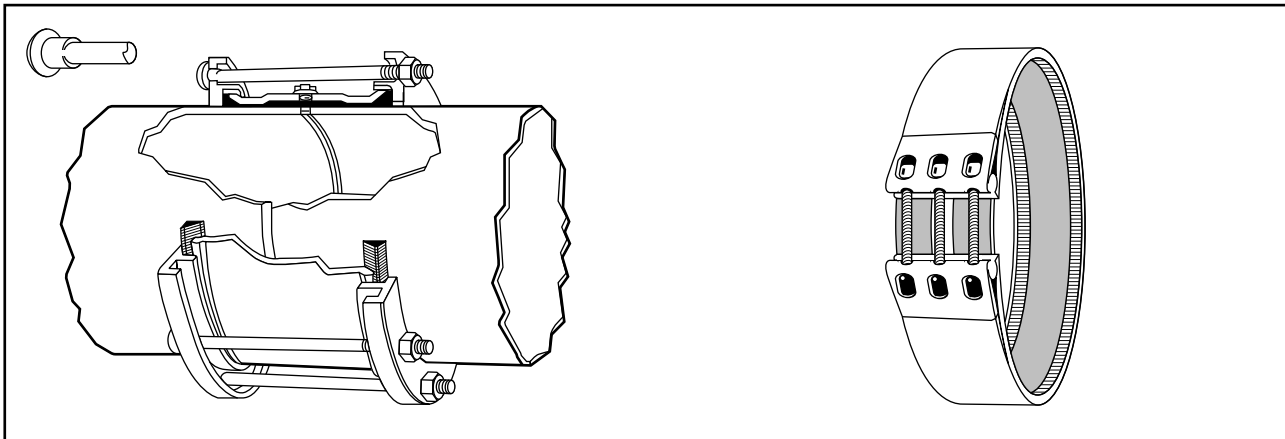


Fig. 8.2.a.

With these couplers connections between R.T.R.P. and other materials can be made. Reducing couplers are available for pipes with different outside diameters. When using these type of couplers, the cut R.T.R.P. pipe ends must be sealed with a resin coating. See lamination instructions. These couplers may also be used for quick repairs of underground pressure systems.

As these couplers do not provide axial restraint, they must not be used within a specific distance of a change of direction as this can cause separation of the joint. One of the factors determining this length is the friction value of the surrounding soil. Adequate fixing of above ground pipe systems is required.

The torques given on the joints do not apply to Wavistrong. For the correct torques, contact Future Pipe Industries.

After installation of Dresser couplers the stopper bolt must be removed and replaced by a plug in order to prevent damage of the pipe wall.

## 9. Installation of underground pipe systems

Wavistrong pipes are flexible in most soils. Special attention needs to be given to the bedding, sidefilling and backfilling of the trench. This provides the necessary support of the pipe. It also prevents distortion and possible damage by the soil and/or traffic. resistance to horizontal movement of the pipe depends on the soiltype, its density and moisture content. The greater the soil resistance, the less the pipe will deform or move.



Fig. 9.a.

### 9.1. The trench construction

The construction of the trench depends on the soil conditions. Generally soil can be classified as stable or unstable. Each type of soil requires a different method of construction.

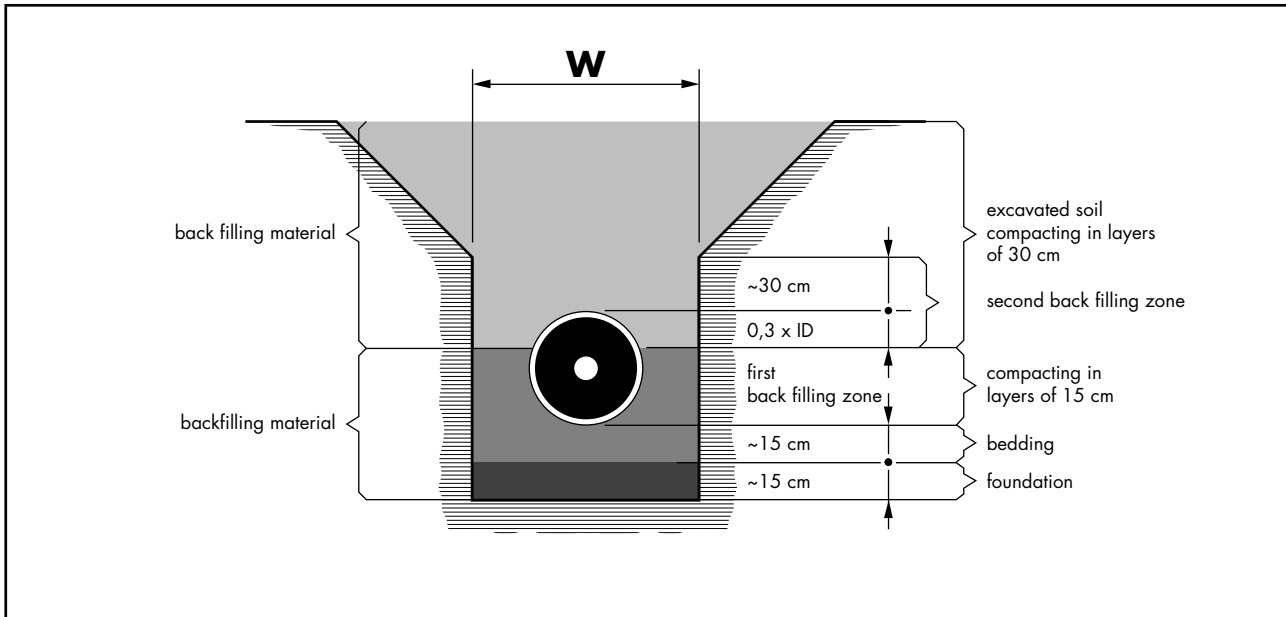


Fig. 9.1.a.

In stable soil (cohesion  $> 0,2 \text{ kg/cm}^2$ ) the walls of the trench can be made as shown in fig. 9.1.a. Such soils, when undisturbed, also provide sufficient support for the backfilling. With unstable soils (cohesion  $< 0,2 \text{ kg/cm}^2$ ) do not dig too long a trench to prevent penetration by ground water or collapse of the trench walls. Generally speaking, two or three pipe lengths will be sufficient depending on the excavator's capacity. The trench must be kept dry during installation e.g. by well drainage or a pumped system. The shape of the trench is shown below.

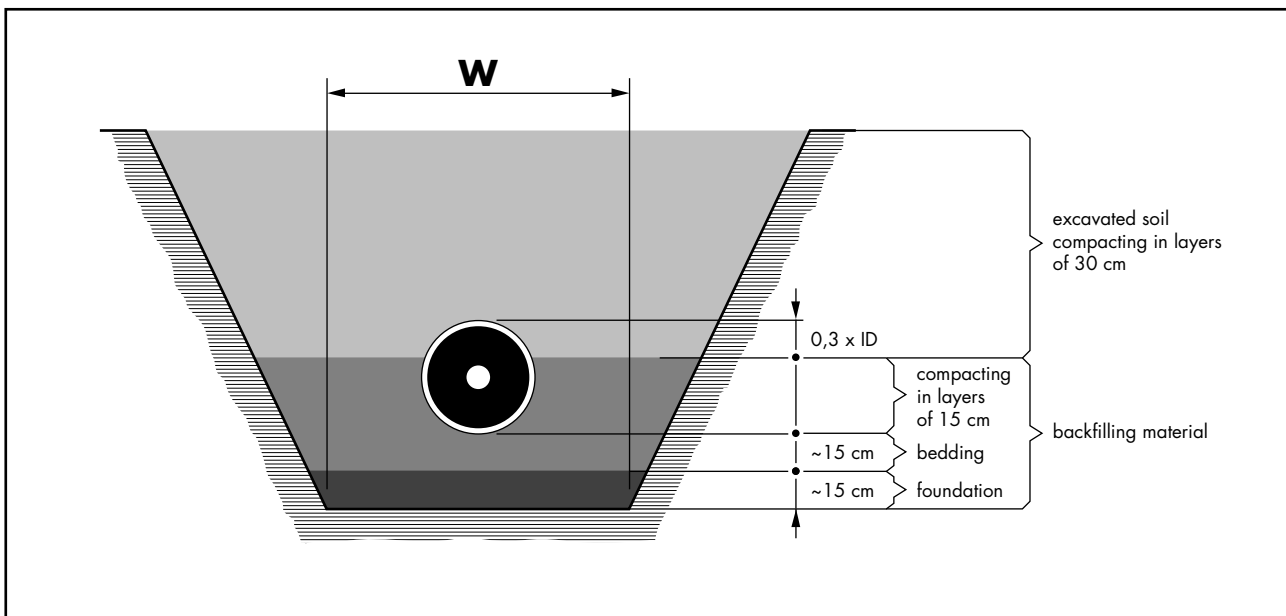


Fig. 9.1.b.

If the trench wall is of a soil type which gives insufficient support, the trench can be widened and backfilled with a high degree of compaction (min. 90% Proctor and 70% relative density). Alternatively, support sheeting may be left in place. The trench floor must be stabilised if it is very soft or uneven is expected.

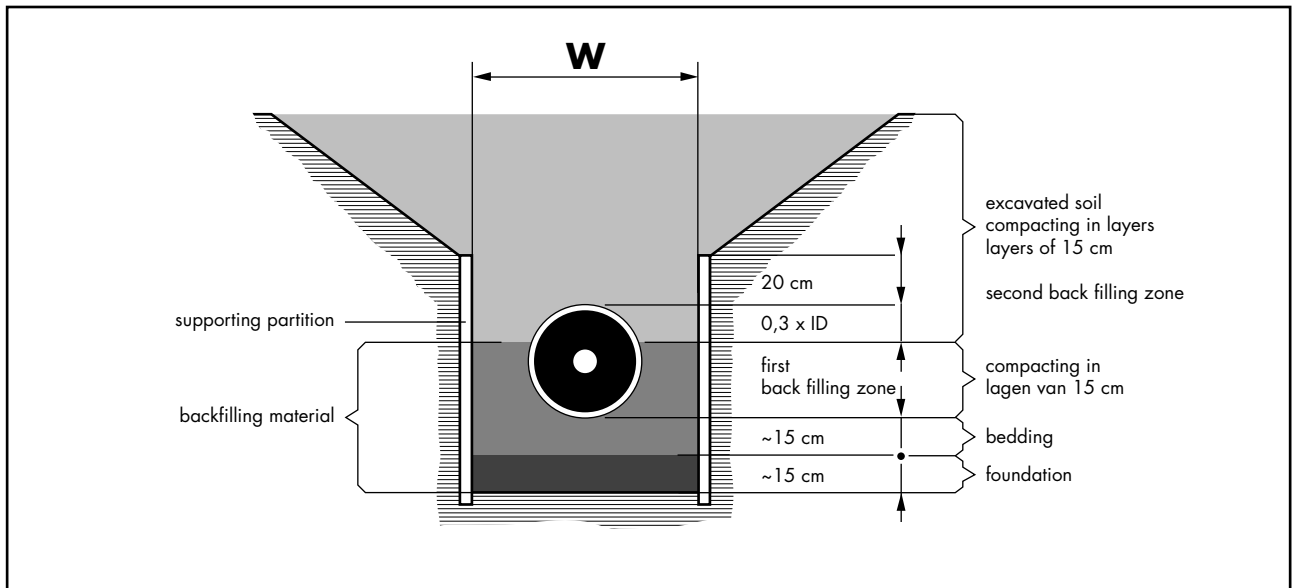


Fig. 9.1.c.

All sharp particles must be removed from the trench floor before pipe installation. A hard uneven trench floor should be loosened to prevent point loading. Alternatively the trench floor can be deepened by about 15 cm below the recommended installation level and this area can be filled with sand or gravel (max. particle size 20 mm) after which it must be compacted to a degree of compaction at least equal to the backfill material. In order to achieve sufficient compaction of the sidefill and to have pressures in the sidefill material well distributed and transmitted to the trench walls, the width of the trench at the crown level of the pipe should be at least:

- for pipes  $\leq 250$  mm :  $W = \text{Diameter of pipe} + 30$  cm
- for pipes  $> 250$  mm :  $W = \text{Diameter of pipe} + 50$  cm

From approximately 30 cm above the crown of the pipe the trench may have any width. Additionally this sub-ditch will lower the load on the pipe. The minimum depth is at least 0.5 m but this depends on pipe class, service conditions, soil conditions and wheelload. The crown of the pipe must be installed below frost level.

## 9.2. Pipe assembly

All pipes should be carefully inspected against damage before installation. Pipes with adhesive bonded joints can be assembled beside the trench and, after curing and cooling of the joint, lowered into the trench. This must be done with reasonable care in order to prevent overstressing of the pipe. Do not move the joint during curing only backfill after the completion of the curing procedure.

Pipes of standard length may be doubled in a spoolshop in order to reduce the installation time. Caution should be taken, because length of 20 metres are difficult to handle and this may result in joint failure. Provide space underneath the joints. Pipes with rubber ring joint should be assembled in the trench. There must be enough space at the joints in order to enable proper alignment of the pipe. The pipes must be laid in the middle of the trench at the required level. After the joint has been made the space below the joint must be carefully backfilled and tamped in order to provide full support of the pipe.

At installation in a trench the allowable angular deflection of the rubber ring joint (see table 5.c., page 20) and the bending radius (see chapter 4.5.) of the adhesive bonded joint may be used to follow the trench. Non restrained joints in pressure systems must not be used within a certain distance (see note) of change of directions like elbows and tees. Use tensile resistant (rubber seal lock or adhesive bonded) joints to prevent separating. Here no angular deflection is permitted when rubber seal lock joints are used. The bending on the adhesive bonded joint must be kept to a minimum. The minimum distance can be carefully calculated and depends on the pressure, soil conditions and compaction.

Should the direction of the pipe required be larger than the permitted angle of deflection a standard or special elbow must be used. When using rubber ring joints in pressure systems, the pipeline must be anchored at the changes of direction. When assembling the Wavistrong rubber seal lock joint be sure that these joints are fully extended. By ensuring this it will prevent any movement in the line and overloading of any elbows and tees when the pipe is pressurized. Any expansion which occurs as a result of the system operating at high temperatures can be accommodated by using this method. Stretching can be done by pressurizing the main (0.8 x working pressure), but it is better to do this mechanically. Check the contact of the locking strip against socket and spigot end by looking through the insert hole of the locking strip. Only after the line is fully extended may branches be installed.

If Wavistrong pipes are installed in a casing the Wavistrong pipe must be provided with spacers to prevent damage during installation. On both sides of the casing rubber ring joints have to be installed to accommodate any further settlement (see chapter 9.4.).

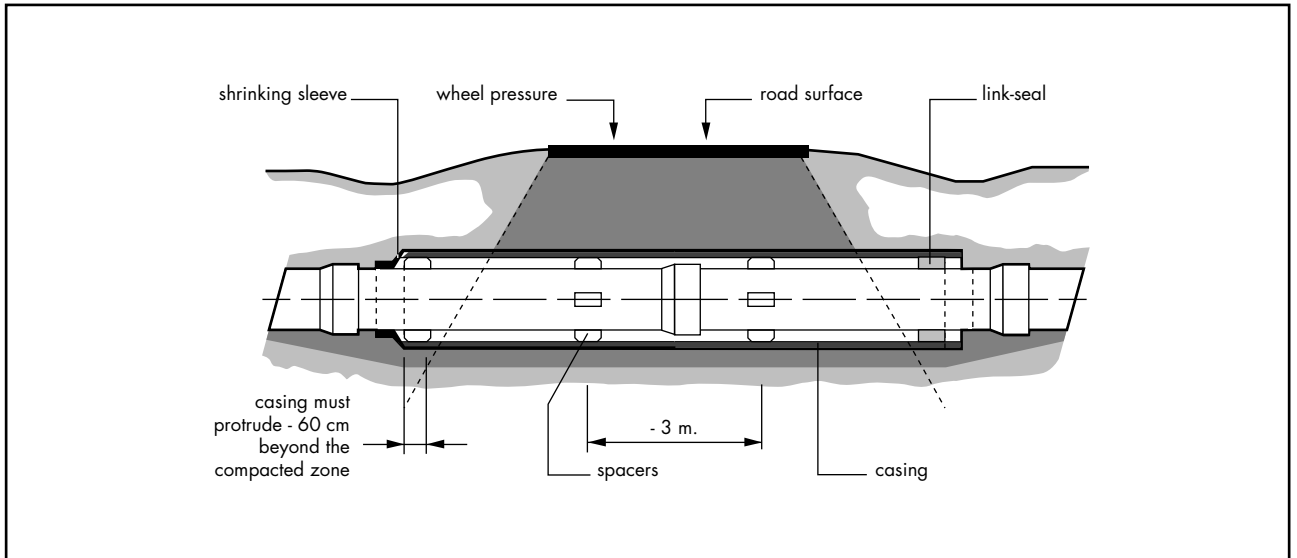


Fig.9.2.a.

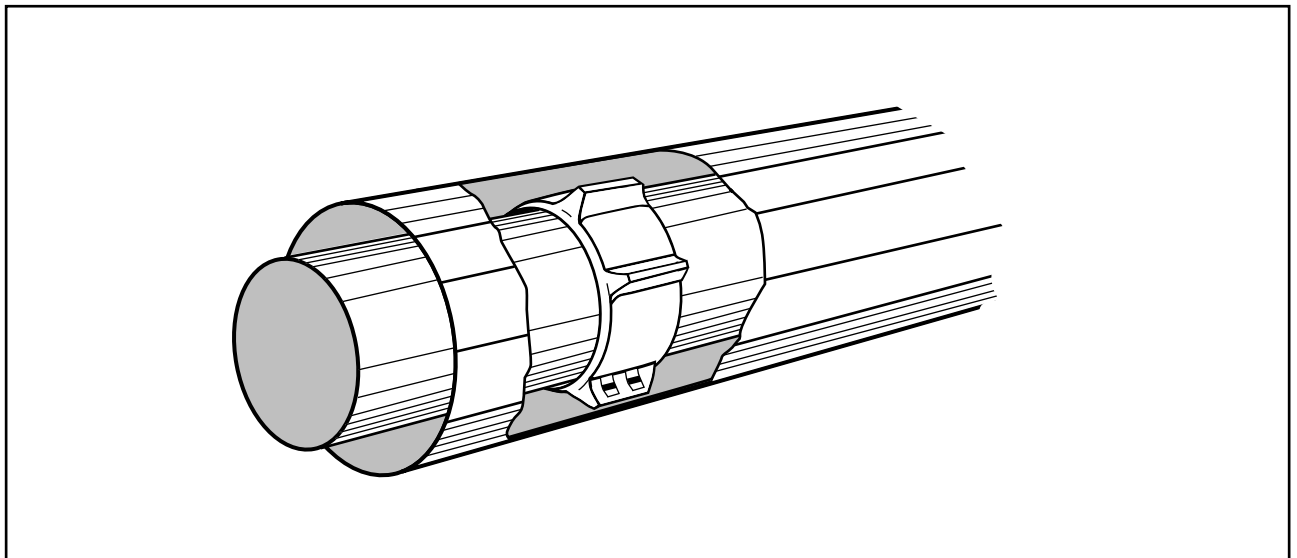


Fig.9.2.b.

### 9.3. Backfilling

Before backfilling all temporary levelling pegs must be removed. Remove any support sheeting over at least one pipe length. The selected backfill material must be compacted in layers of 15 cm taking into account that the pipe must not be displaced. This compaction can be done manually as well as mechanically. Avoid any contact between tools and pipe. When the compacted area has reached a level of 30% of the diameter below the crown of the pipe, one can fill and compact the remaining backfill up to the crown of the pipe in layers of 30 cm. After compacting these layers, the procedure can be continued by putting a minimum layer of 30 cm over the pipe. This layer may only be tamped on both sides of the pipe and never across the pipe. This can be done e.g. by using a Wacker 100 vibrating plate with an impact force of 3000 N.



Fig. 9.3.a.

The trench can now be completely backfilled with excavated original soil in layers of 30 cm. Each layer must be carefully compacted to a minimum of 85% (standard) Proctor density. Do not use heavy pneumatic hammers or vibrating equipment until a level of about 50 cm over the crown of the pipe is reached. After this a vibrating drum with an impact force of 20 kN may be used. If the excavated material can be easily compacted, this may be used as backfill material. Cohesive material like clay may not be used as sidefill material. In such cases special material must be used. Be sure that any sidefill material that will soften or break when saturated with water is not used. If gravel is used for backfilling the maximum particle size must be 20 mm.

#### Specification backfill material

For classification of the different soils and for values of modulus of soil reaction ( $E'$ ) see ANSI / AWWA C950-88 or ASTM D 3839 (Standard Practice for Installation of "Fiberglass" Pipe).

### 9.3.1. Other methods of back filling

Use of the saturation method does not give any better results than the method already described. If the saturation method is used the compaction may be disturbed. Ensure the pipe does not float and the sides are not eroded during water injection. Do not backfill if the ground is already saturated. This method may only be used for free draining soils or when the drainage pumps are kept running and the pipe system is completely filled with water.

### 9.3.2. Pipe systems to be cast in concrete

Do not pour concrete directly onto the pipe. Compacting in the surrounding area of Wavistrong pipes is not allowed. The vibrating needle must be kept at least 30 cm from the pipe. Prior to casting, the pipe system must be pressure tested (see chapter 11). In order to prevent the pipe from floating concrete cradles provided with steel clamps and rubber lining can be used (see fig. 9.3.b.). Support distance has to be calculated. Consult Future Pipe Industries. Buckling of the pipe during casting can be prevented by pressurizing the system. This also reduces the bending caused by the buoyancy of the pipe. Please note that as the concrete sets there will be shrinkage and this will increase the pressure in the system. Ensure the permitted pressure is not exceeded by the use of pressure relief valves.

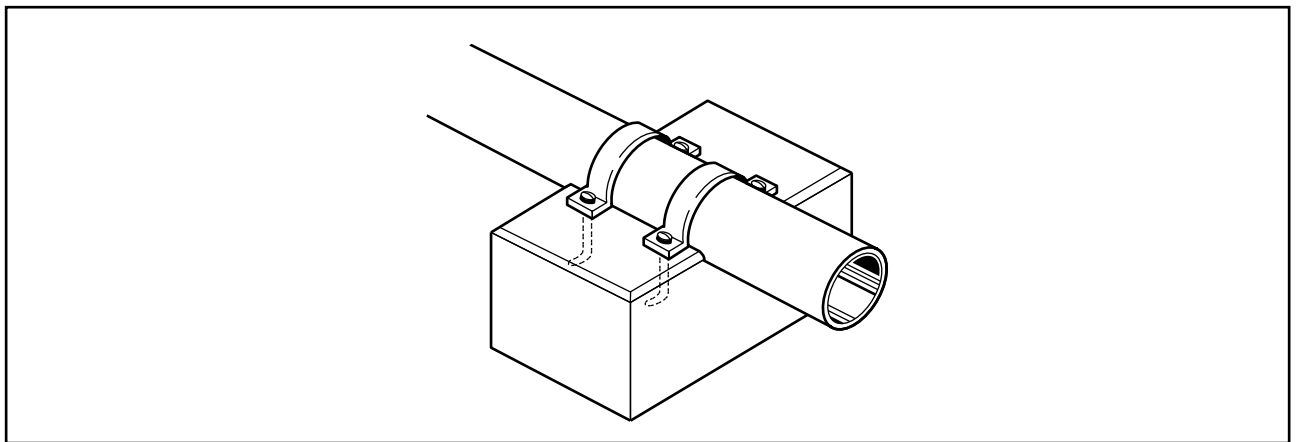


Fig. 9.3.b.

### 9.4. Subsidence

In order to allow for subsidence flexible rubber seal joints can be used (RSJ, RSLJ). There would be no sense in using one joint in a pipe section (e.g. between two manholes), as these joints only allow angular deflection and no lateral displacement. So they always have to be installed in pairs to create a rocker pipe. In this a way that one will be placed at the beginning and the other at the end of the area where settlement will occur. The rocker pipe will then act as a hinge.

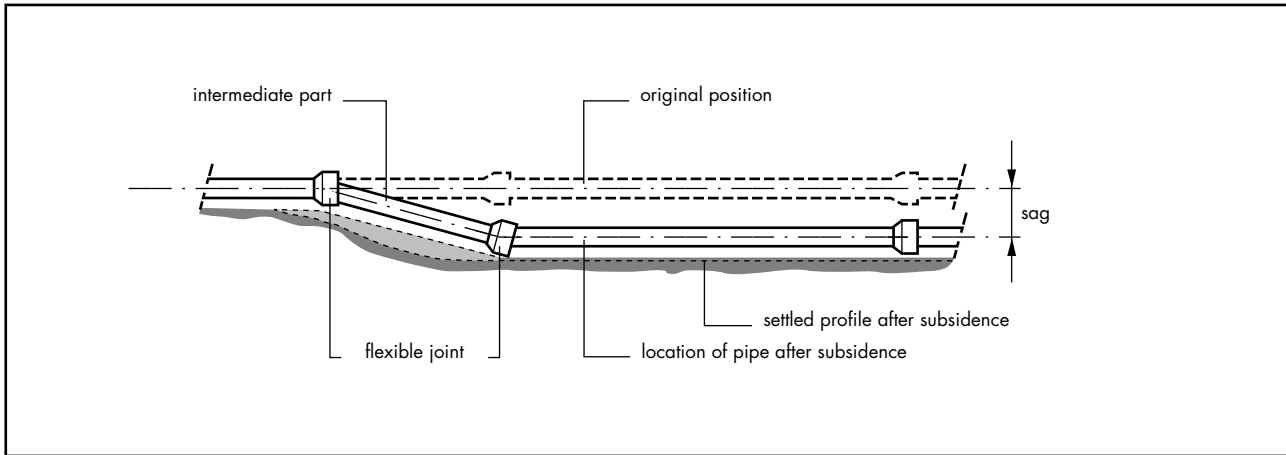


Fig. 9.4.a.

The longer the rocker pipe, the bigger the difference in subsidence that can be accommodated. However, this will also increase the loads on the joints. This can be avoided by using more rocker pipes.

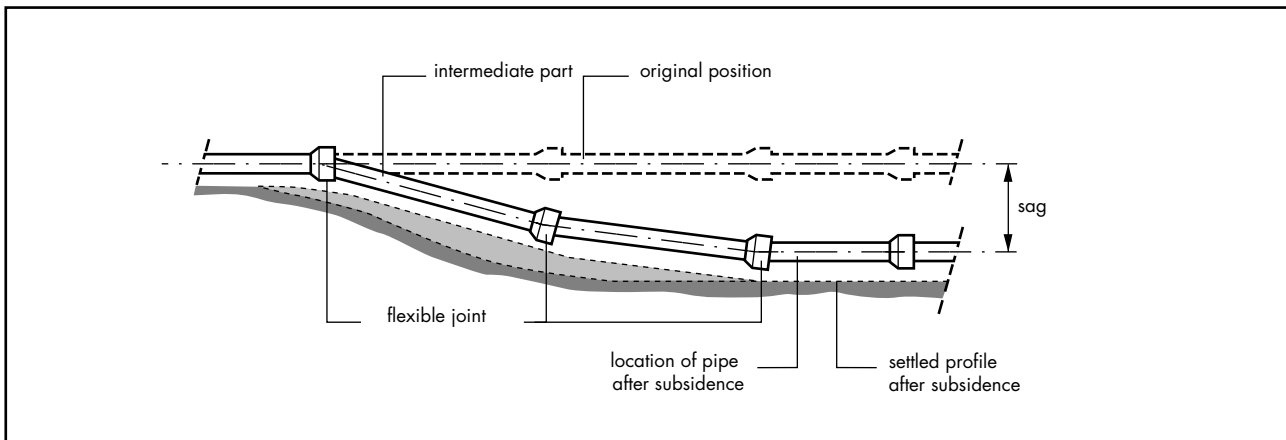


Fig. 9.4.b.

Depending on the soil condition and foundation of the buildings, pumping stations, under piled manholes, etc. to which the pipes are connected a minimum of 4 flexible couplers (RSJ) should be used between 2 manholes. This accommodates possible settlement of the manholes. The branch connection of the manhole (provided with socket or spigot end) should also be of a limited length to avoid excessive bending. Otherwise this may result in a break in the pipe or the branch connection. The length of these connections is  $1 \times ID$  with a minimum length of 0.5 m.

### 9.5. Relief plates

Where pipes are installed close to the surface or where weight of the soil exceeds the permitted wall stress level relief plates can be used. The relief plates may only be used if:

- A** The ground consists of sand to a considerable depth.
- B** The trench is to be filled with sand and very well compacted.

These plates should have a rebate equal to the diameter of the pipe 5-10 cm deep. This rebate must be kept free from soil during installation for example by means of synthetic foam. The dimensions of the relief plate must be chosen so that the load-bearing capacity of the foundation is not exceeded. Select the correct size of the relief plate so that the load bearing capacity of the foundation is not exceeded. The distance between the relief plate and crown of the pipe may be maximum  $0.5 \times ID$ .

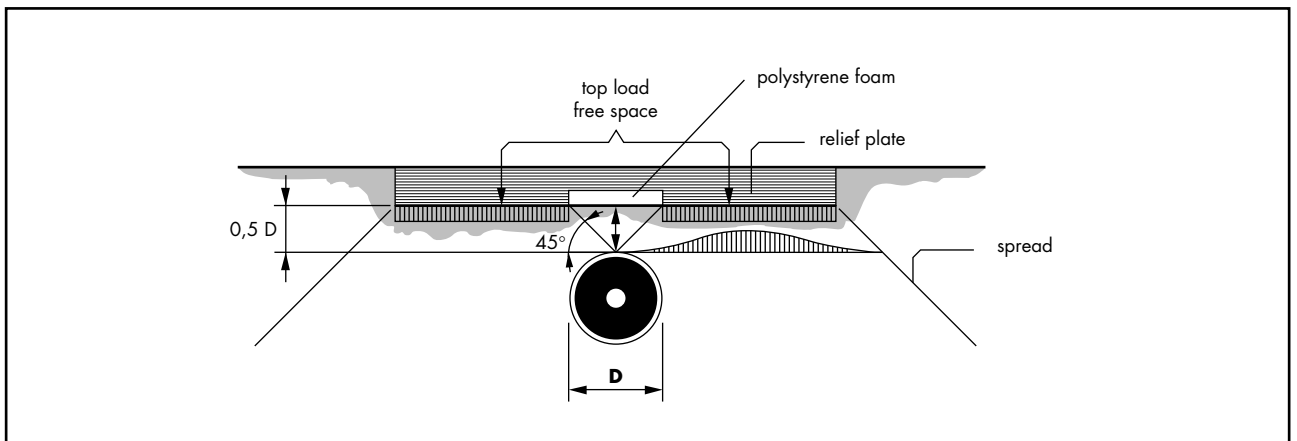


Fig. 9.5.a.

The plate must not be installed too high because the spread of the load will cause increased pressure on the pipe as in fig.9.5.b. Positioning the relief plate within the recommended distance, i.e.  $\leq 0.5 \times ID$ , provides better side support.

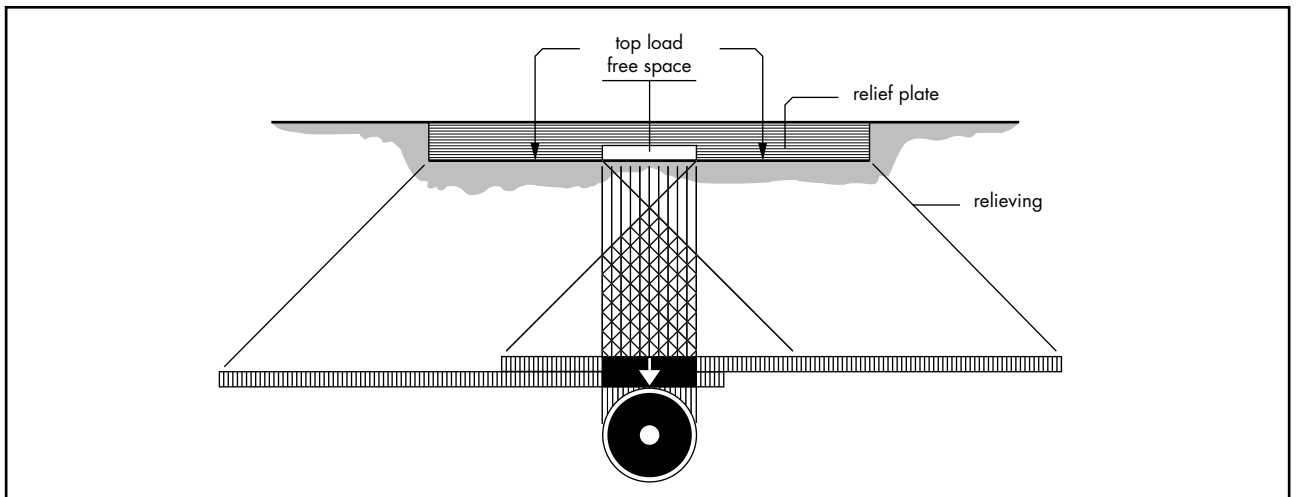


Fig. 9.5.b.

### 9.6. Installation of underwater mains

Installation of underwater mains can be carried out in several ways. The common method is to assemble the pipe on the bank of the canal or river. The ends are sealed and the system is pulled into the water. It will stay a float. The pipe is then carefully filled and sunk into its final position.



Fig. 9.6.a.

The pipe can also be lowered using a floating gantry crane or other lifting equipment; care should be taken to provide sufficient support as mentioned in the Wavistrong Engineering Guide.



Fig. 9.6.b.

Using this method of installation rubber seal lock joints can only be used if they are injected with resin.

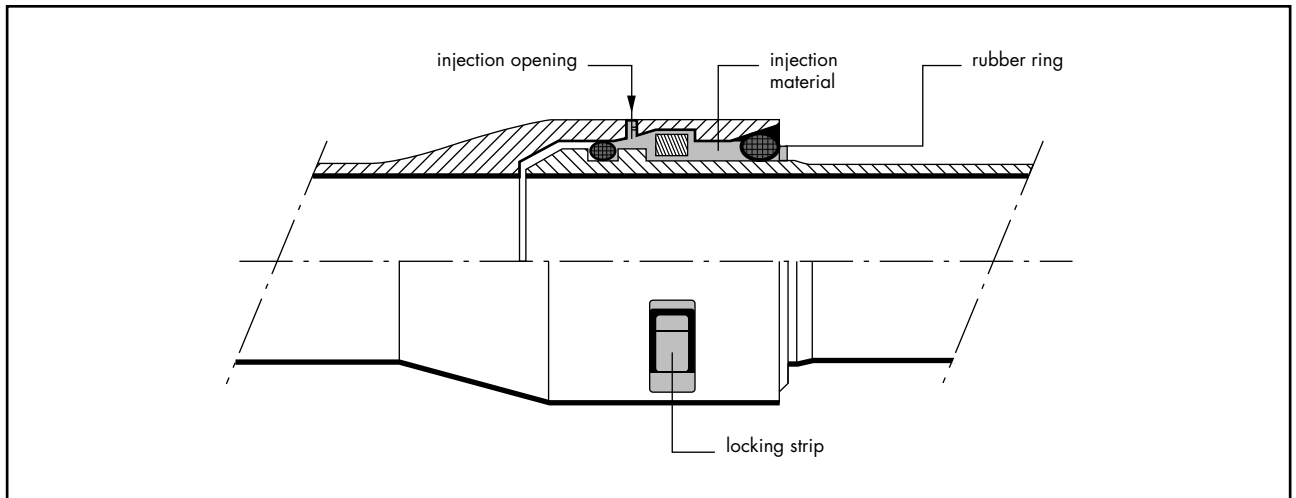


Fig. 9.6.c.

For installation of underwater pipes using a cofferdam, flexible joints can of course be used because this is similar to land installation. The underwater pipe must be covered to prevent damage for example by a ship's anchors.

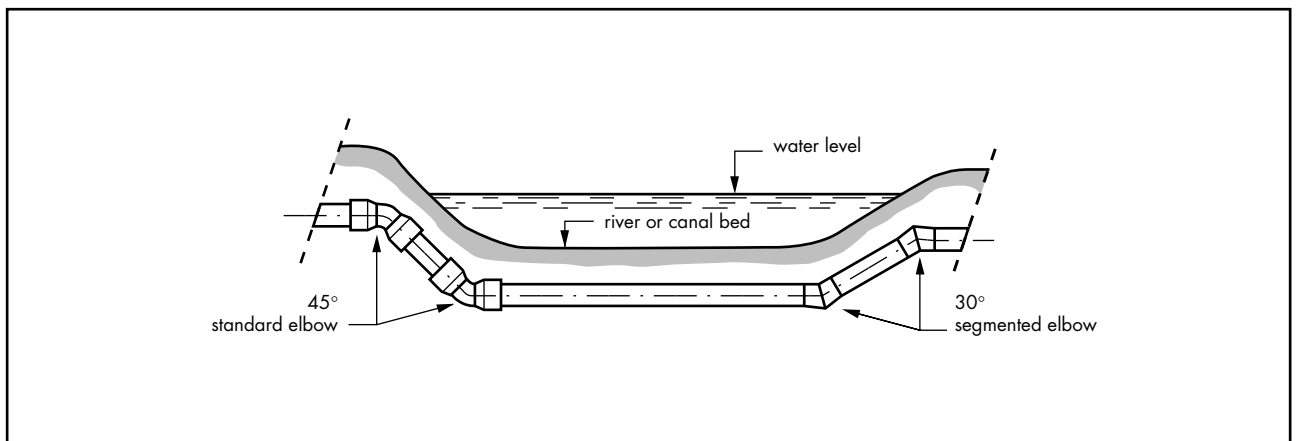


Fig. 9.6.d.

For diameters up to 400 mm standard radius elbows can be used. For non standard elbows and larger diameters, mitred elbows of any required angle can be supplied.

### 9.7. Hydrant connections

Future pipe industries has developed an RTRP elbow support for hydrants. Fig. 9.7.a. below shows the preferred layout to allow maximum system flexibility.

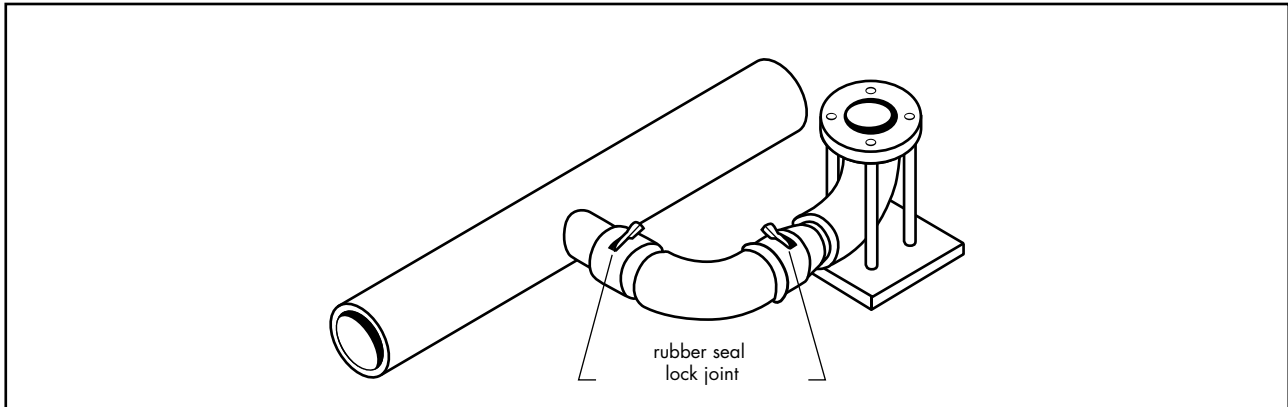


Fig. 9.7.a.

The following design restricts flexibility.

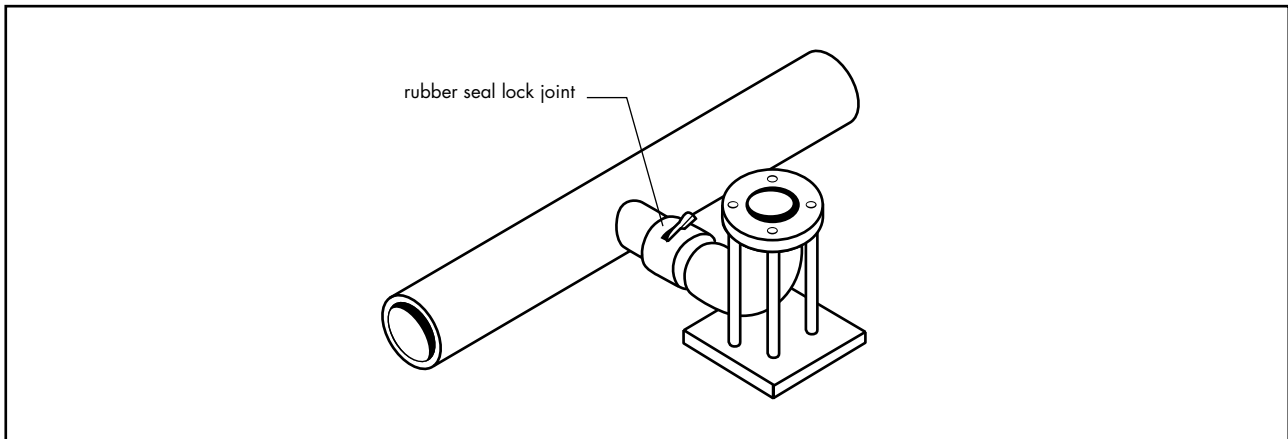


Fig. 9.7.b.

If there is insufficient space in the trench the hydrant must be installed on top of the pipeline. It can be done as follows.

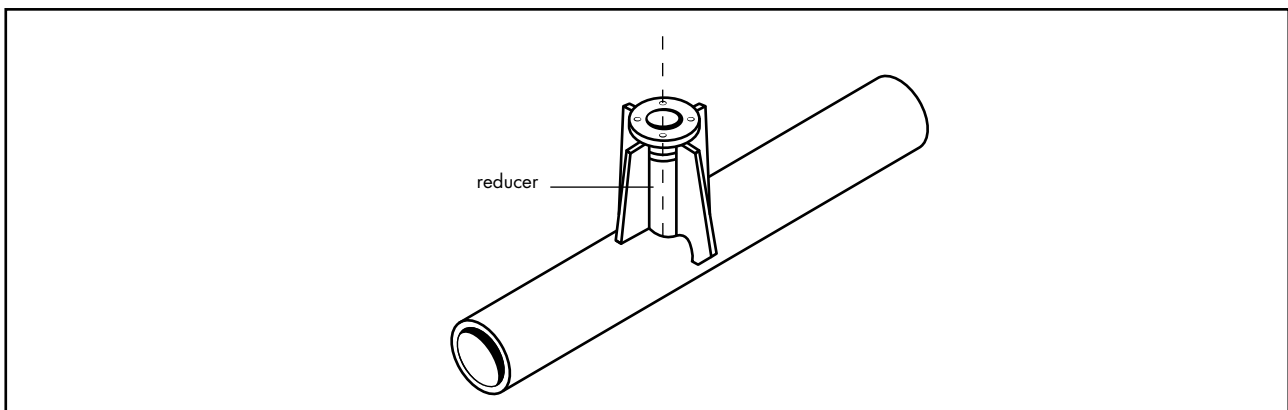


Fig. 9.7.c.

Forces on the hydrant can cause branch connections to break. The hydrant must be supported for example by a concrete block. It is important that in freezing conditions the hydrant connection must remain flexible. Therefore the preferred layout should be as in fig 9.7.a. to 9.7.c.

## 10. Installation of above ground pipe systems

Above ground pipe systems can roughly be divided into two categories:

- a. lines which are laid directly on the ground.
- b. lines which are installed on pipe bridges.

In either case the required precautionary measures must be taken to insure the optimum performance of the pipe system. For support distances see the Wavistrong Engineering Guide.

### 10.1. Supports

#### 10.1.1. Protection of the pipe

In order to avoid pipe damage by stones and other sharp objects it is advisable to support the pipe, for example by means of wooden or concrete sleepers. Using these kinds of support, it is necessary to bond a 180° saddle to the bottom of the pipe at the support locations, in order to protect the pipe against damage caused by possible pipe movements. The length of this saddle with respect to the width of the support must be 50 mm longer than the calculated displacement of the pipe. The support width itself must be at least 100 mm. The jointing systems are the same as those used in underground installations. To avoid sideways displacements a metal clamp is sufficient. The construction of fixed points is described in chapter 10.2.



Fig. 10.1.a.

#### 10.1.2. Extra supports

To avoid overloading caused by heavy valves, these must be supported separately. When connecting to tanks and pumps, additional forces and movements caused by pumps and tanks fluctuations must be eliminated. It could be necessary to include an expansion loop to absorb these movements. If adhesive bonded joints have been used in expansion loops these joints must be laminated. Overhead installation on pipe bridges requires compliance with the rules which are also applicable in the previous case of installation on wooden or concrete sleepers. The construction of fixed points is described in chapter 10.2.

## 10.2. Fixed support points

Fixed points in R.T.R.P. systems may never be constructed by clamping with pipe clips. This could result in deformations and excessive wall stresses. The pipe must be allowed to expand within its clip. The pipes at fixed points must have additional laminates or bonded collars on both sides of the clip (see fig. 10.2.a.).

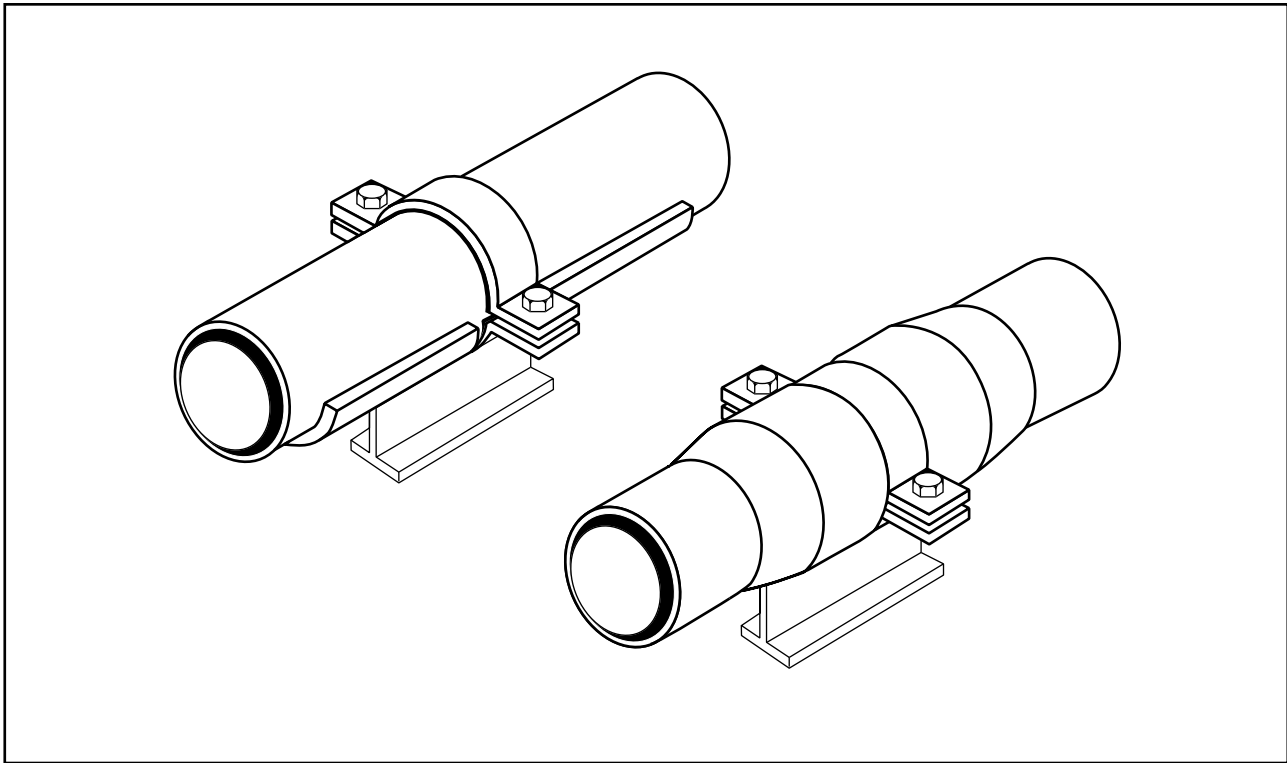


Fig. 10.2.a.

Choose fixed points so that the loads are balanced. For vertical pipe sections the socket configuration of adhesive bonded joints can be used as the fixed point. As a result of pumps and tanks fluctuation, branch connections may need rubber seal joints so that these can follow the movements of the main line.

Vertical pipe sections with rubber seal joints, in areas where the temperature can drop below zero degrees centigrade, should be positioned so that no water will remain in between the socket and spigot parts. For instance by assembling the socket ends downwards. Otherwise the remaining water could cause frost damage.

When using rubber seal lock joints, at least one support per pipe is required. In general the maximum distance  $L$  of the support to the joint for diameter up to 200 mm is 1.2 m and for diameter 250 mm through 1200 mm is 2 m. In case there are more supports on a standard length required, one pipe clip should be fixed, the others sliding in order to allow for movement. One of the advantages of a rubber seal system is that the free play in the joints allow for movements caused by temperature fluctuations.

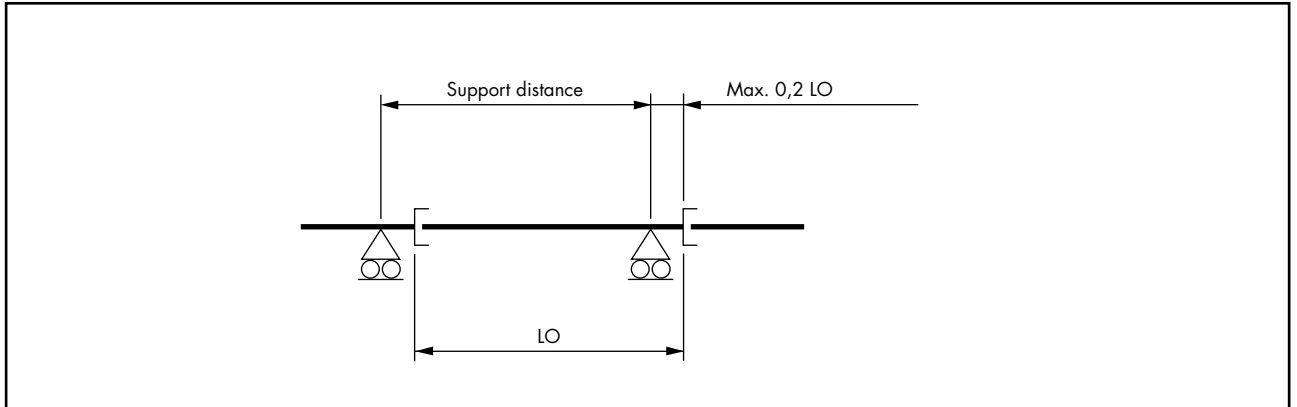


Fig. 10.2.b.

When using non locked rubber seal joints or mechanical couplers, pipelines must be anchored at each change in pipe direction, to prevent the pipes coming apart. Sideways movement is prevented by clamping. Where mechanical couplers are fitted, sideways movement can be avoided by scuring the coupler itself.



Fig. 10.2.c.



Fig. 10.2.d.

**Please note that rubber seal lock joints must be fully extended.** This means that the locking strip is pinched between the stop in the socket and the stop in the spigot end. This prevents movement of pipe sections and overloading at bends and tees. Mechanical stretching is preferable; the results can be seen by inspection of the position of the locking strip through the insert hole. Extending can also be done by pressurizing the main line (0.8 x working pressure). Take care that the pipe sections are not pushed off their supports. In order to prevent this the lower part of the clip should be tightened temporarily and the upper part of the clip should be loosened. Relocate any moved pipe clips in their original position. After fully extending, the branch pipe sections can be installed.

### 10.3. Pipe clips

To support Wavistrong pipes several types of pipe clips may be used. As point loads on Wavistrong pipes are to be avoided, flat clips instead of u-bolts (see fig. 10.3.a. up to 10.3.e.) must be used.

The inside should be covered with a rubber or cork-rubber layer in order to minimize abrasion, caused by pipe vibrations or movements.

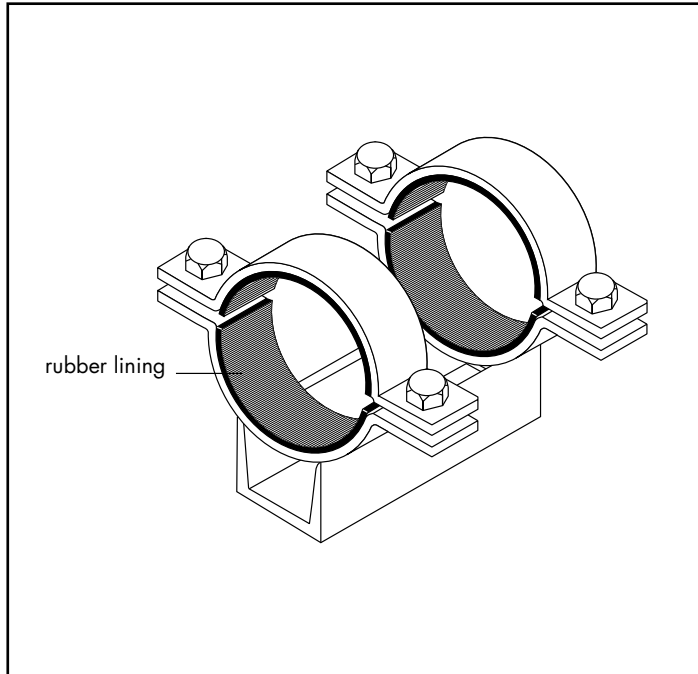


Fig. 10.3.a.

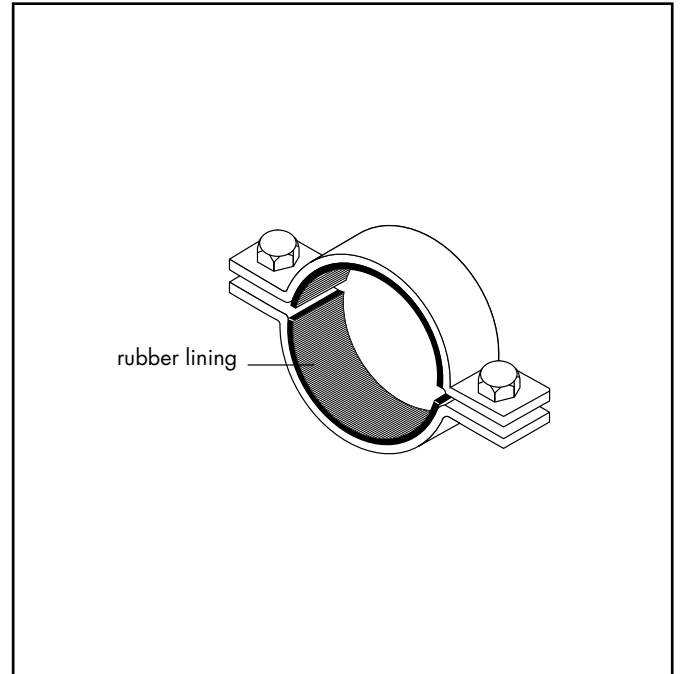


Fig. 10.3.b.

Clips which allow axial movement of pipes must be provided with a PTFE, PE or PA sliding layer. This sliding layer can be placed inside the clip or between the clip and the supporting beam. When the clip has to accommodate movement in more than one direction (expansion loop), a slide plate under the clip is needed to create a floating support.

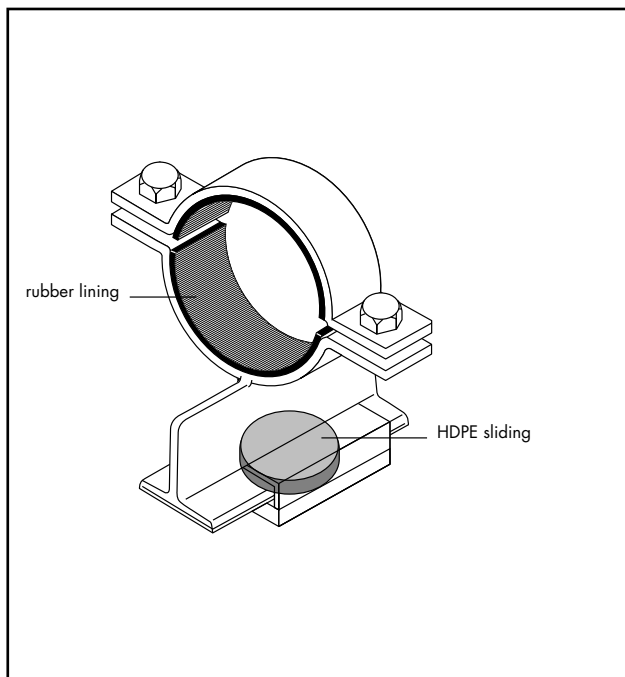


Fig. 10.3.c.

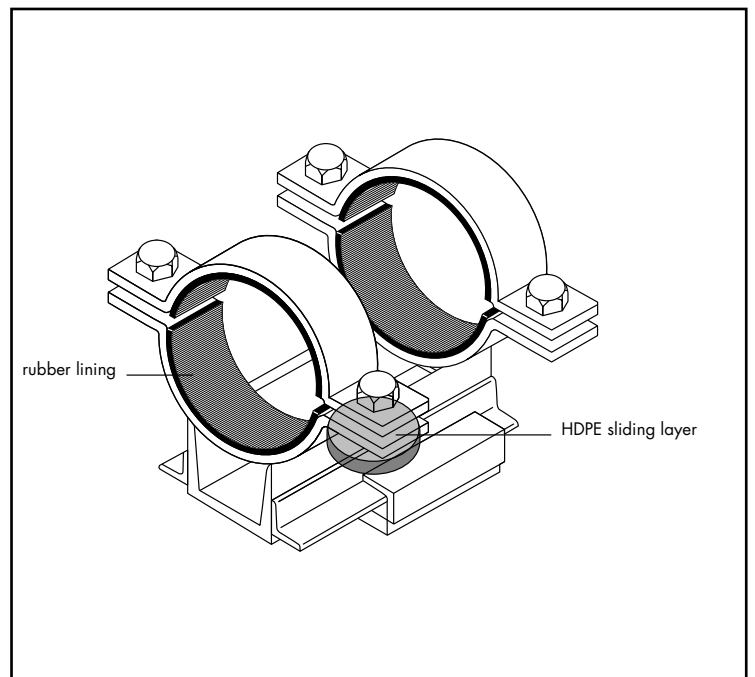


Fig. 10.3.d.

The choice of a certain clip design depends on: the lay-out for the system, the width of the bearing surface, the expected amount of movement as a result of change of temperature and inside pressure.

For the different dimensions of pipe clips see table 10.a.

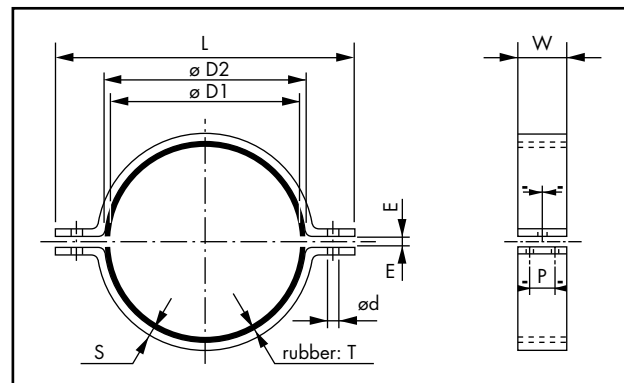


Fig. 10.3.e.

<b>Table 10.a. Dimensions of brackets</b>										
ID	D1	D2	d	A	L	E	steel bracket WxS	rubber inlay WxT	bolt(s) HEX nut(s) rings	number holes per bracket
25	33	39	12	40	110	7	30 x 5	30 x 3	M10 x 35	2
40	48	54	12	47	124	7	30 x 5	30 x 3	M10 x 35	2
50	58	66	14	57	150	9	40 x 6	40 x 4	M12 x 40	2
80	89	97	14	72	180	9	40 x 6	40 x 4	M12 x 40	2
100	109	119	18	92	232	11	50 x 8	50 x 5	M16 x 50	2
150	160	170	18	117	282	11	50 x 8	50 x 5	M16 x 50	2
200	212	222	18	148	344	11	50 x 8	50 x 5	M16 x 50	2
250	265	277	23	171	390	14	60 x 8	60 x 6	M20 x 55	2
300	317	329	23	203	466	14	60 x 8	60 x 6	M20 x 55	2
350	369	381	23	229	518	14	60 x 8	60 x 6	M20 x 55	2
400	421	433	27	263	598	18	70 x 10	70 x 6	M24 x 70	2
450	473	485	27	289	650	18	70 x 10	70 x 6	M24 x 70	2
500	525	537	27	315	702	18	70 x 10	70 x 6	M24 x 70	2
600	629	641	33	381	852	25	90 x 15	90 x 6	M30 x 90	2
700	723	735	33	428	946	25	90 x 15	90 x 6	M30 x 90	2
750	775	787	33	454	998	25	90 x 15	90 x 6	M30 x 90	2
800	826	838	33	479	1048	25	90 x 15	90 x 6	M30 x 90	2
900	924	936	33	533	1156	25	150 x 20	140 x 6	M30 x 100	4
1000	1026	1038	33	584	1258	25	150 x 20	140 x 6	M30 x 100	4
1200	1225	1237	33	684	1458	25	150 x 20	140 x 6	M30 x 100	4

### 10.4. Valves

To avoid Wavistrong pipes being overstressed by bending, valves, butterfly valves or other heavy accessories must be supported separately. This can be done by direct support of the valve or indirectly by means of the flange bolts.

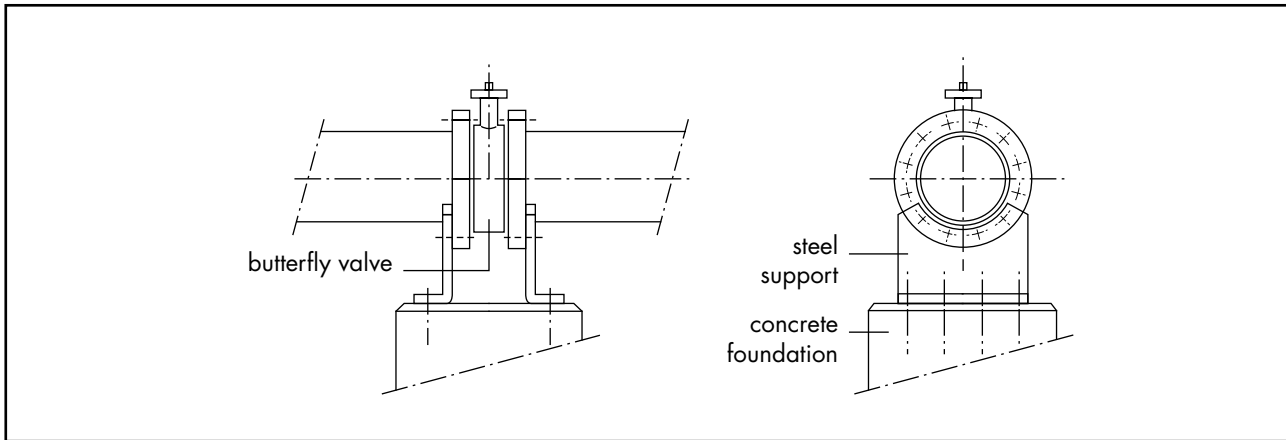


Fig. 10.4.a.

If a Wavistrong flange is connected to a steel flange, the support should preferably be situated at the side of the steel flange. This is also applicable for underground applications. Pipe sections should not become overloaded by the weight of the accessories, for example by soil settlement. One suggestion would be concrete supports provided with steel connections, able to carry the full load of the valve. Also bending and torque forces caused by opening and closing of valves should be absorbed. Hand operated butterfly valves can be supported or mounted in a manhole as follows:

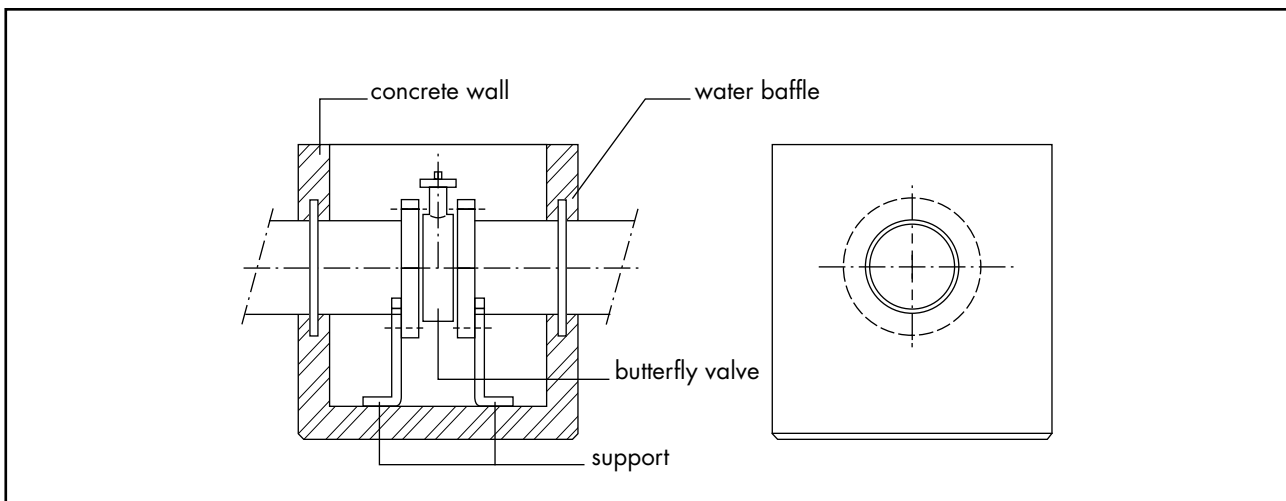


Fig. 10.4.b.

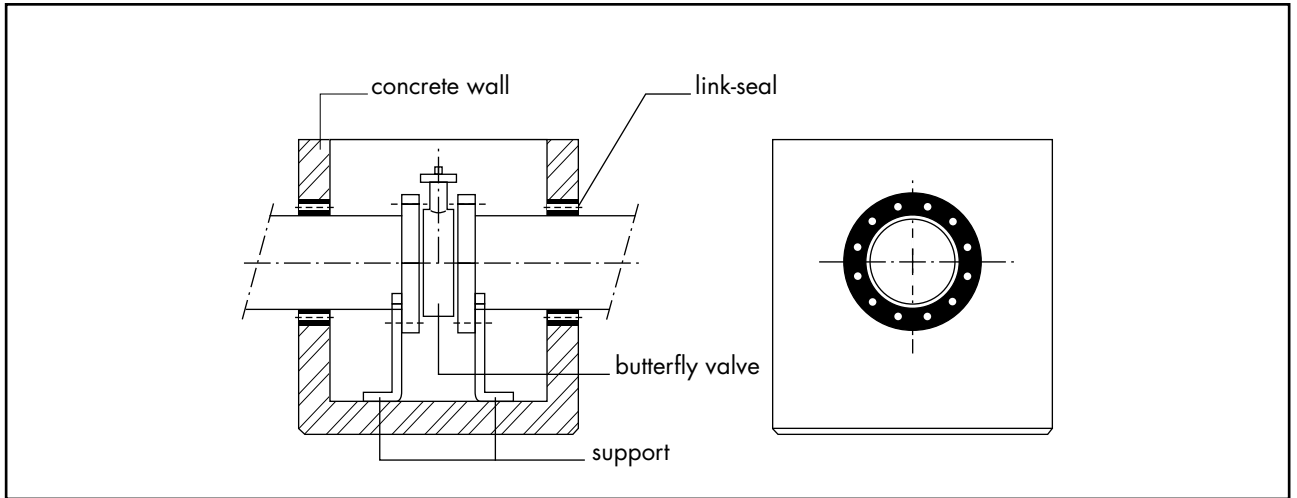


Fig. 10.4.c.

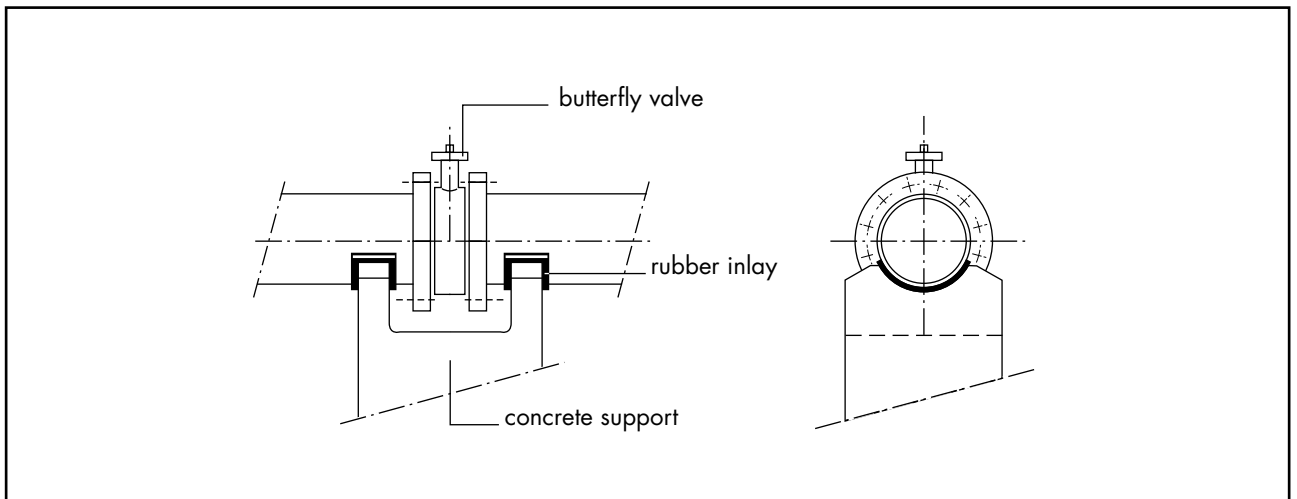


Fig. 10.4.d.

### 10.5. Bellows

Low amplitude vibrations will have little effect on Wavistrong pipes, because these will be absorbed due to the low E-modulus material. To eliminate high amplitude vibrations caused by e.g. pumps and to eliminate soil settlements or expansion of tanks to which Wavistrong pipes are connected, bellows can be employed. Where relatively stiff adhesive bonded joints are employed, again bellows can absorb the pipe movements due to alternating pressures and temperatures. In many cases it will be possible to connect a bellow directly to the vibrating item by means of flanged joints. Immediately next to this bellow the pipe section must be supported separately to absorb the pipe loads.

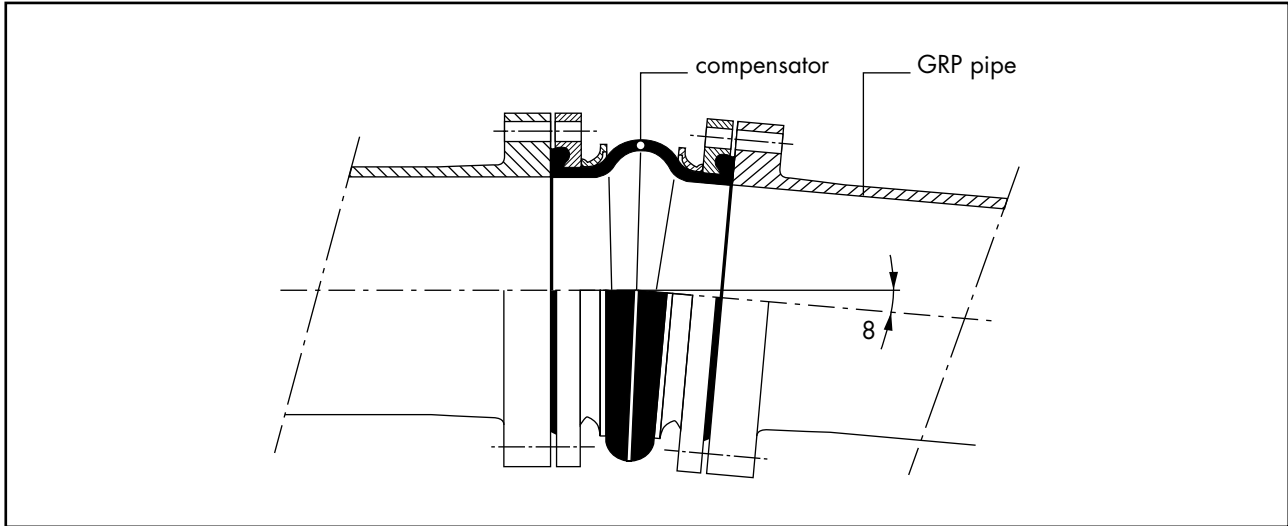


Fig. 10.5.a.

Bellows can also be employed to facilitate removal of pipe sections, valves, orifice flanges or gaskets for repair purposes. The flexibility of the bellow allows a play of some 10 to 20 mm so that it is possible to disconnect and connect flanged parts easily.

Often a rubber seal (lock) joint can be installed instead of the bellow.

### 10.6. Connection to other materials

The most appropriate way to connect objects of different materials is the flanged joint, with the mechanical coupler as an alternative. For installation reference is made to chapter 8, mechanical couplers.

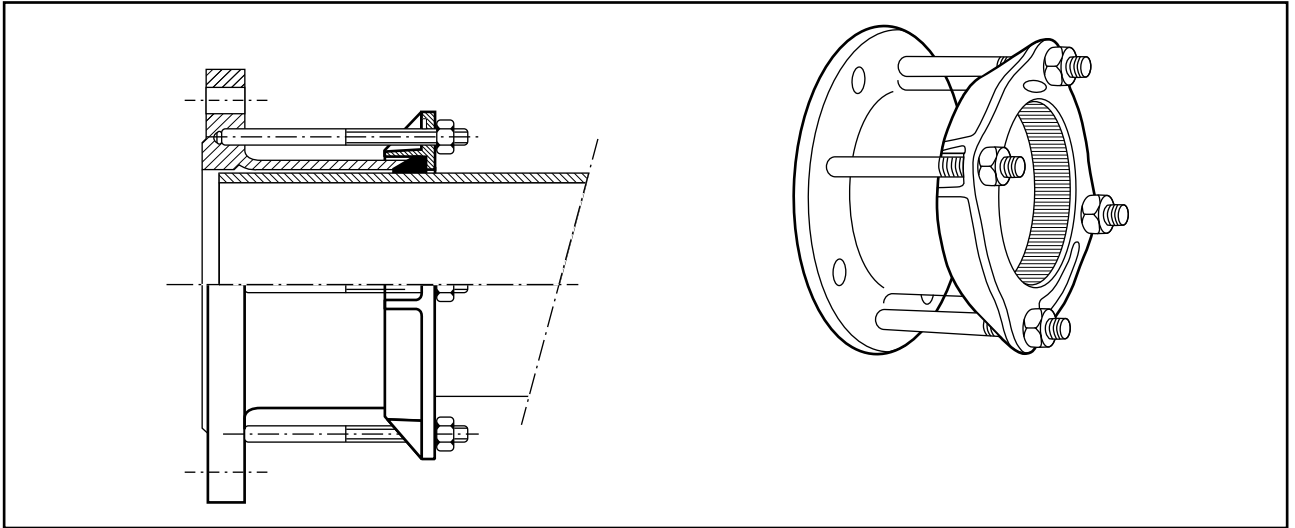


Fig. 10.6.a.

Flange drillings are available according to almost every existing standard. These flanged connections can be made using our standard program. Also non standard items can be manufactured on request for example saddles for main lines > 300 mm. The only restriction is that the branch has a diameter within our standard range.

When a flanged R.T.R.P. pipe section is connected to a metal pipe section, this metal part must be anchored so that no contraction or expansion forces will be transmitted to the R.T.R.P. pipe section.

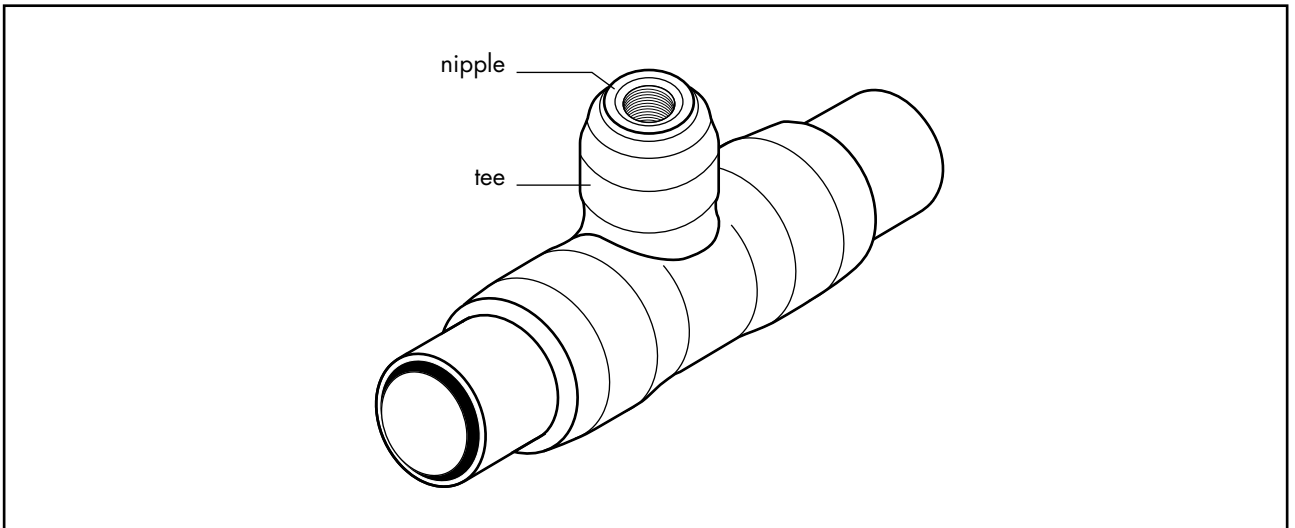


Fig. 10.6.b.

Threaded nipple connections are standard available up to 1", the type of thread is to be selected. This nipple connection may be manufactured in 3 different ways for example by a saddle provided with thread bonded to the pipe, or by assembling a nipple into a laminate layer applied to the pipe or by assembling a nipple into a tee. The last two mentioned methods are preferred. Saddles with branches of diameter 80 mm and above must be laminated after the adhesive bonding has been cured.

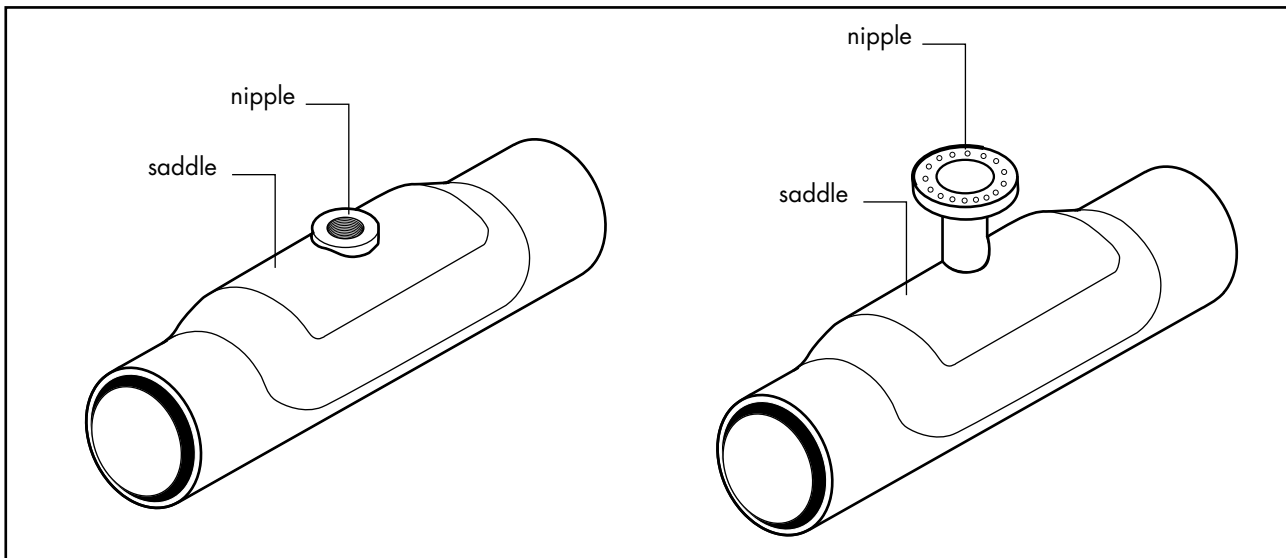


Fig. 10.6.c.

When assembling saddles with flanges or nipples, the following rules have to be observed:

- A** Remove the topcoat of the pipe with a sanding disk, over an area equal to that of the saddle or laminate.
- B** Locate the saddle and mark the hole to be drilled.
- C** Remove the saddle and drill the hole with a hollow diamond drill or a hollow saw.
- D** Be sure that the surface is free of grease and dirt. Abrade both the inner surface of the saddle as well as the outer surface of the pipe, with the abrasive paper packed with the adhesive kit. After sanding make sure that saddle and pipe still fit accurately.
- E** Mix resin and hardener according to the instructions (packed with the adhesive) and apply the mixture to the sanded surfaces. Make sure that saddle as well as pipe are pre-heated (30° à 35°C.). Make sure adhesive is applied also on the edge of the drilled hole.
- F** Relocate the saddle and fix it with clamps or clamping strips, taking into account that the pipe will not be deformed.
- G** Cure the adhesive according to instructions with the aid of a heating blanket at which the joint should be insulated.

In order to avoid leakage, take care when mounting measuring or regulating equipment, that the nipple is by no means rotated in relation to the saddle, support or laminate layer.

### 10.7. Algae growth

To prevent growth of algae caused by the translucency of Wavistrong, the following solutions are advised:

- A** Pipes supplied with a black liner on the inside.
- B** Pipe supplied standard with a dark undercoating with a black polyurethane coating on top.
  - The best adhesion for the coating is achieved if the top coat of the pipe is roughened by blasting. If this is not possible for whatever reason, the pipe can be cleaned using thinner.
  - Now coat with an epoxy (dark) base coat.
  - Now apply 2 layers of polyurethane top coat (black). Check chapter 10.8 for painting instructions.
- C** Injection with chlorine gas (C12) concentration < 20 p.p.m.

### 10.8. UV resistance

The topcoat of Wavistrong pipes and fittings consists of a resin rich layer with a thickness of 0.3 mm. This layer offers sufficient protection against U.V. radiation. It is known that epoxy resin will be attacked in the long run due to weather exposure, which results in chalking of the topcoat. This chalky layer forms a protection against further attack of the topcoat. Should excessive chalking occur after several years of operation, a protective polyurethane paint coating can easily be applied.

The painting procedure is as follows:

- Clean the surface using thinner (e.g. Redox 0256)  
Apply one coat of epoxy undercoat (e.g. Redox EP 3200, rust brown or beige colour).  
The following layer can be applied after 8 hours' drying time at 20°C or 4 hours at 40°C.  
Theoretic cover 5.5 m<sup>2</sup>/l at a thickness of 100 µm (micron).
- Apply a top coat (e.g. Redox PUR 3355 polyurethane HB, white or other RAL colour).  
The following layer can be applied after 8 hours' drying time at 20°C or 3 hours at 40°C.  
Theoretic cover 4.8 m<sup>2</sup>/l at a thickness of 100 µm (micron).

If painting of a recently installed pipe is required, the surface of the pipe should be roughened in order to get a proper adhesion.

### 10.9. Electrically conductive pipe

When using electrically conductive R.T.R.P. pipe (series CS) the supports of the pipe fulfil two functions namely supporting and earthing of the pipe system. Static electricity originates e.g. by friction of transported media against the pipe wall. This is conducted away by anti-static (conductive) pipes. If the specially conductive adhesive Easy fit conductive is used, no interruption in conducting properties will occur. In the case of rubber seal joints or mechanical couplers, special measures have to be taken to ensure continuity of conductivity.

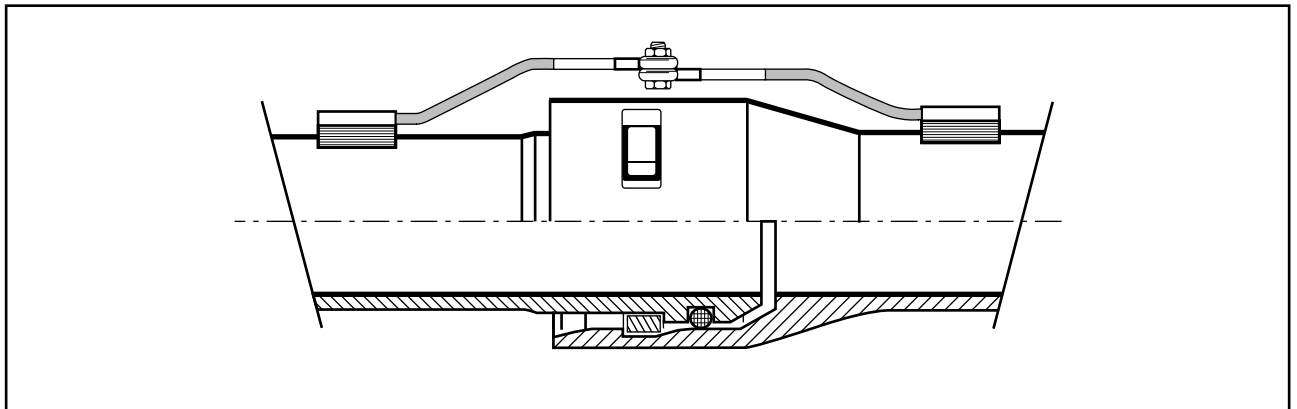


Fig. 10.9.a.

Saddles in which cables are inserted will be applied onto the pipe wall some 0.5 meter from the pipe spigot and bell ends. By these cables conduction of electricity over the joint will be ensured. Where the pipe is to be earthened by the pipe supports these have to be provided with a layer of electrically conductive rubber. In case of using a non-conductive mechanical coupler this coupler must be earthened.

The conductivity is measured using a Megger with a reach of 0-2000 M Ohm, maximum 30 mA and a measuring accuracy of ± 10%.

This method applies a potential difference of maximum 1500 Volt to the product to be tested and the subsequent resistance is measured. This test can also be used after the product has been exposed to a variety of chemical environments, in order to determine the possible effect on the electrical properties of the product.

The resin outer layer may be removed to gain good contact with the conducting element.

A conducting medium (salt water on the contacts, for example) is also allowed.

The resistance measured must be at least 10 M Ohm. For more information, contact Future Pipe Industries.

### 10.10. Pipe connections through (concrete) walls.

Several alternatives are available for R.T.R.P. pipe connections through (concrete) walls.

- A** A RTRP pipe piece provided with a puddle flange (10.10.1)
- B** A Link-Seal (10.10.2)
- C** Casting and sandcoated RTRP pipe into the concrete wall (10.10.3)
- D** A rolling ring (10.10.4)
- E** A special shaped sealing (10.10.5)
- F** No connection of the pipe to the (concrete) wall. (10.10.6)

#### 10.10.1.

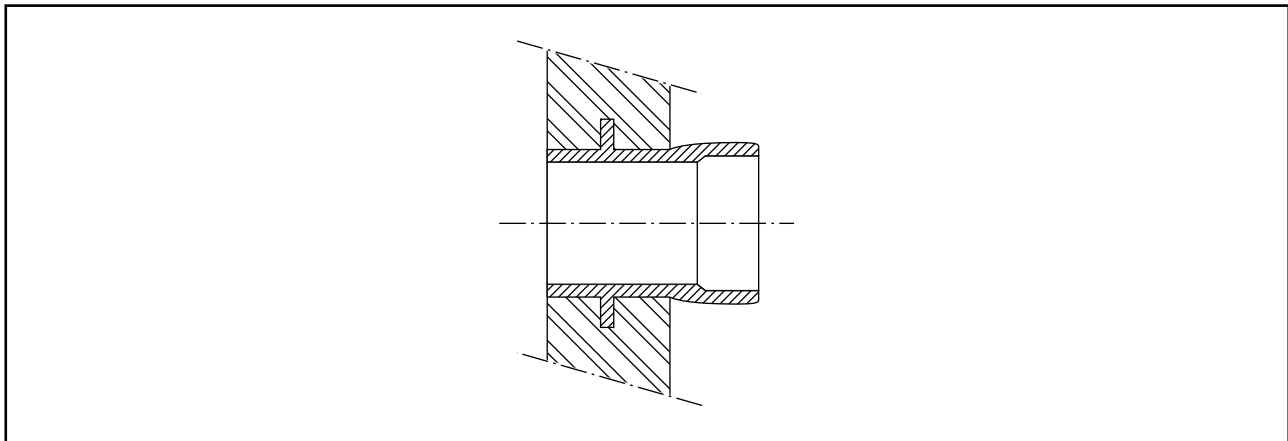


Fig. 10.10.1.a.

The puddle flange which is already in the factory connected to the pipe body, consists of a ring with a thickness of approximately 30 mm and a diameter of 80 mm greater than the diameter of the pipe to be installed. This puddle flange is connected to the pipe part by means of a lamination and placed into a recess in the wall, after which it is fixed with concrete or mortar.

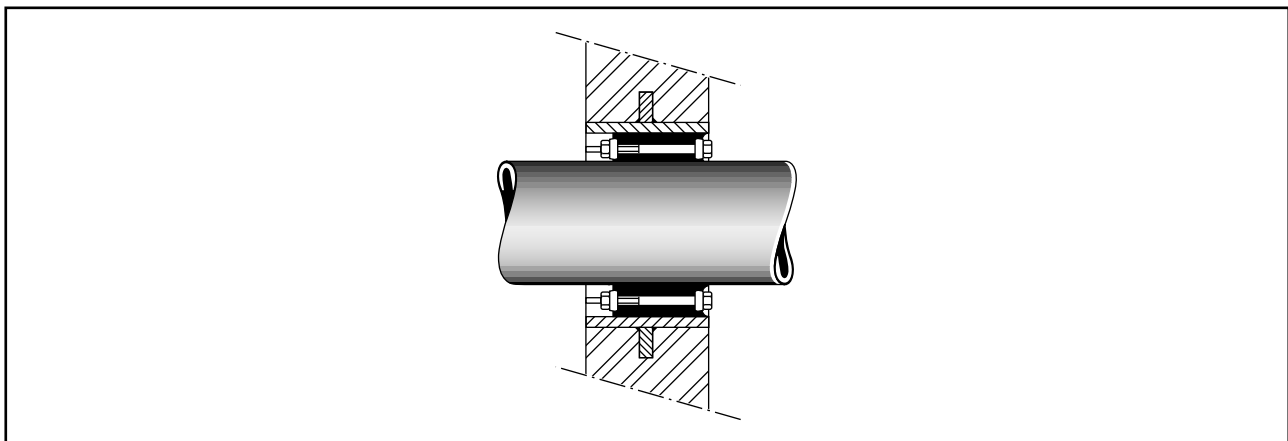


Fig. 10.10.2.a.

#### 10.10.2.

Link-Seals consist of several linked rubber parts shaped to fit the circular space between the R.T.R.P. pipe and the inside of an insert in the wall. The rubber parts are interconnected by steel bolts, to form a rubber chain. Under each bolthead and nut, pressure rings are placed.

After assembly of the R.T.R.P. pipe with the rubber "chain" into the circular wall insert, the rubber is compressed by tightening of the bolts, thus ensuring a complete watertight construction. Link-Seals are available in various materials. The rubber elements are made of EPDM, silicone or nitrile rubber. Bolts are of stainless steel 18-8, or zinc or cadmium plated or phosphorated steel. The pressure rings are made of acetal polymer. As an additional advantage constructions with Link-Seals allow the R.T.R.P. pipe a certain angular deflection and movement in an eccentric direction. A sufficiently smooth surface of the hole inside the concrete wall can be obtained in various ways:

- By fixing a steel pipe piece with waterseal before pouring mortar.
  - By drilling a hole in the wall with a crown drill with diamond inlays.
  - By fixing a removable plastic casing pipe piece before pouring mortar.
- After removal of the casing pipe piece, the quality of the whole surface has to be checked.

### 10.10.3.

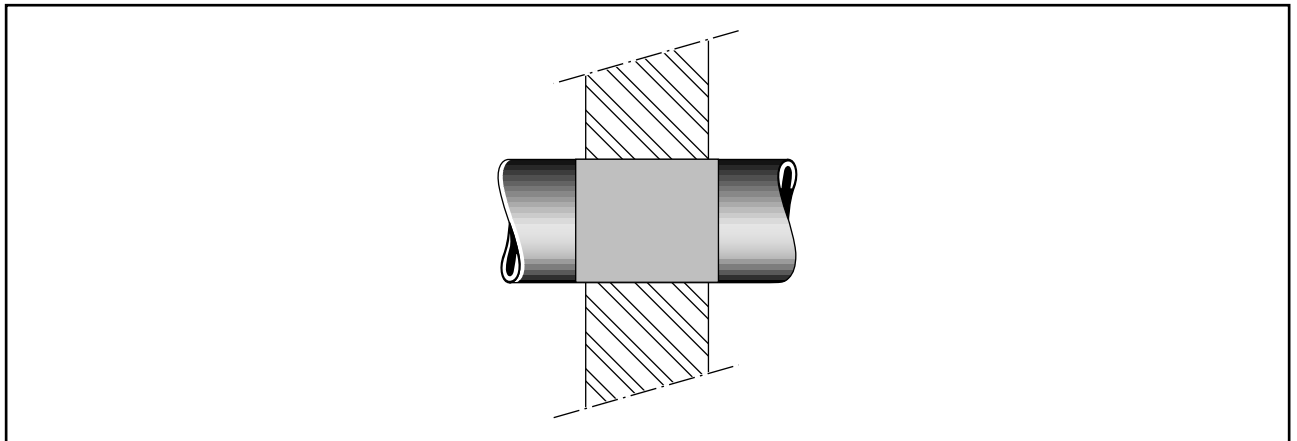


Fig. 10.10.3.a.

Sandcoating of R.T.R.P. pipe must be carried out as follows: Sand the pipe at the spot where it fits in the wall, over a length at least equal to the wall thickness. Apply a mixture of resin and hardener equal to that used for bonding or laminating Wavistrong pipes with the aid of a brush, a roller or a spatula to the sanded surface. Pour sharp sand over the prepared surface and allow the resin mixture to cure. Through this sandcoating an excellent adherence between concrete and R.T.R.P. is obtained.

### 10.10.4.

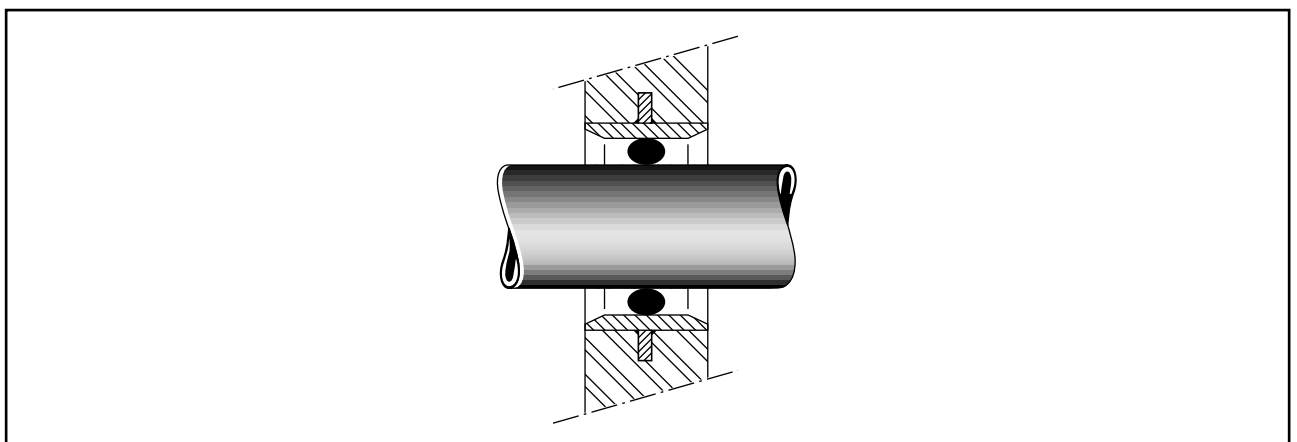


Fig. 10.10.4.a.

Using the rolling ring construction pipes going onto the wall should be provided with a guide-way in order to allow the ring to roll between pipe and wallcasting. The diameter of the guide-way should be a minimum of: the outer diameter of the pipe + 2x diameter of the O-ring.

**10.10.5.**

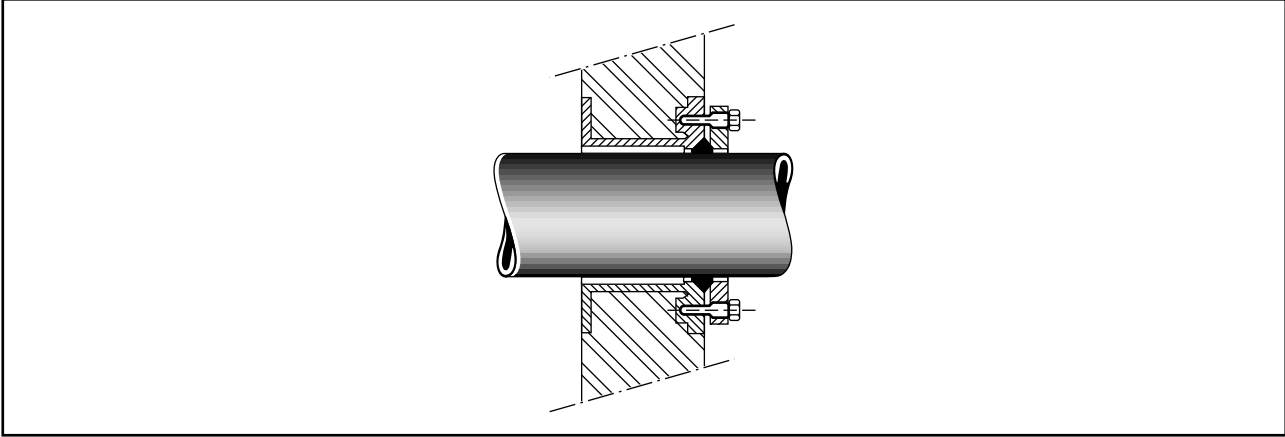


Fig. 10.10.5.a.

The wall penetration consists of a steel pipe provided with flanges. One of these flanges is profiled to fit the shape of the sealing element. By tightening the nuts the seal will be pressed in the wedge-shaped space between flange and pipe, thus creating an excellent seal.

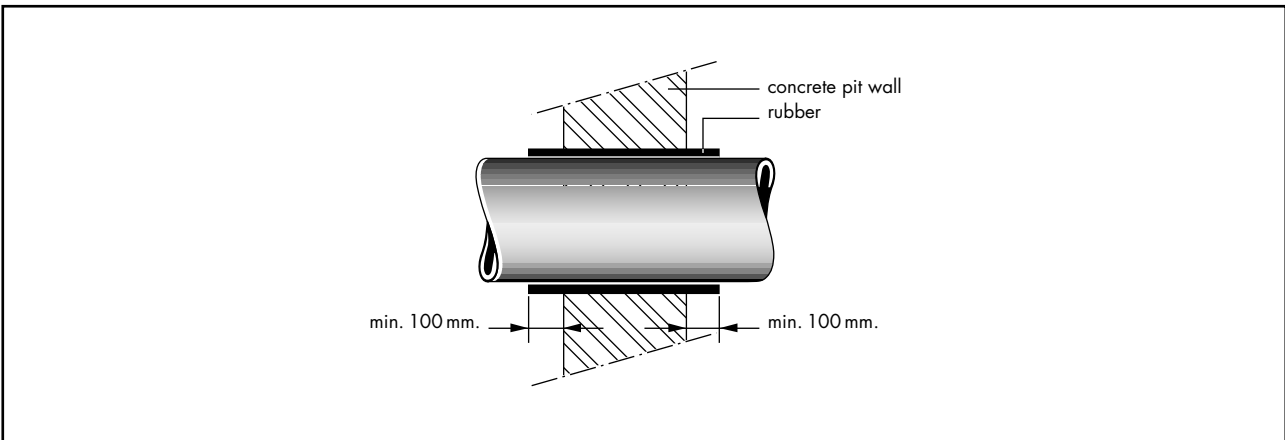


Fig. 10.10.6.a.

**10.10.6.**

When a pipe has to pass through a wall, the outside of the pipe must be protected by a flexible material (a rubber layer, with a minimum thickness of 5 mm) protruding some 100 mm outside the wall at each side. In order to allow for setting of the adjoining pipe sections, flexible couplings must be installed on both sides of the wall. Joints must not be located at a distance of more than 1 x ID outside the wall, with a maximum of 0.5 m.

## 11. Field test procedure

Before the installed pipe system can be used, the system needs to be tested to ensure that all the joints function correctly. The test equipment must be suited to the diameter and pressure, and be able to reach the required test pressure. If the pipe system ends with a flange, a steel blind flange, which has connections for filling and air release, can easily be connected. The pressure gauge must be connected between the valve and the system in order to indicate the pressure after the valve is closed. Due to the head of water, the pressure gauge should be located at the lowest point. The pressure gauge should have a full scale reading of about twice the test pressure.

If the system has not been designed to withstand any negative pressures and this occurs during testing, the system needs to be protected by an air release valve. Trapped air can be released using a vent at the highest point in the system.

### 11.1. Filling, stabilizing and testing

Fill with water at the lowest point in the line using a small diameter branch connection and vent the trapped air at the highest point(s). Long straight sections may be vented using an inflatable ball or foam pig to expel any air and impurities.

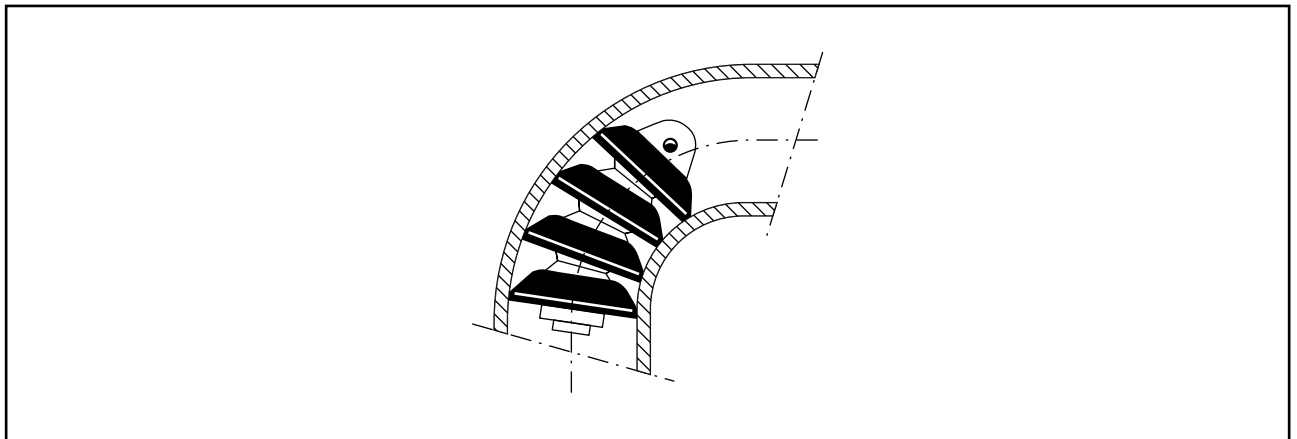


Fig. 11.1.a.

After filling, the line must be pressurized gradually at 0.8 times working pressure dependent on the system and must be maintained for 24 hours allowing the pipe system to set. After the system is stabilized, the pressure must be raised gradually to 1.5 times working pressure and maintained for 4 hours.

After 4 hours the pressure may have dropped by 0.5 bar for diam. ( 500 mm and 0.3 bar for diam. ( 450 mm per 1000 metre length. The test pressure and its tolerance should be determined in advance.

It is preferable to test the line in sections, for example the length of one day installation, which will be shut off by a temporary flanged joint and a ball. The blind flange should be provided with an air release valve. After testing the section, the ball needs to be pushed back about 2 metres using air via the air release valve. The excess water needs to be released by opening the valve at the start of the line. After the ball has been secured by inflating it, the temporary flange connection can be removed and assembly can continue.

The advantage of this method is that the line does not need to be re-filled every time.

During the test of underground systems, the trench must be partially backfilled and compacted, but the joints should be left exposed. Temporary anchors at directional changes should be applied.

Any leak which occurs caused by wrong assembly of the joints can be easily detected. Extreme movements can be prevented by partly filling and compacting the trench.

Depressurization of the system must be done carefully to avoid negative pressures. Bear in mind that temperature changes during day and night will affect the pressure in a closed system. A drop in pressure during the night does not indicate a leak. When testing a system the ambient temperature should be measured.

The low weight, the flexibility and elasticity of R.T.R.P. create different conditions compared with steel. If during testing a joint should fail, the system will whip, due to the sudden release of pressure and stored energy. There is also a risk of injury to personnel.

Testing with air or gas is extremely dangerous and should be avoided. Systems must never be tested with flammable fluids or gases!

Future Pipe Industries does not take any responsibility for any damage resulting from the use of these methods. For safety precautions see chapter 12.

### **11.2. Causes of pressure drop**

The following causes may affect pressure and can be used as a check list.

- A** Temperature change, by day as well as by night
- B** Leakage of valves, fittings, hydrants, etc.
- C** Leakage of gaskets
- D** Dirt at sealing ring
- E** Wrong installation of O-ring (slip ring)
- F** Pipes or fittings insufficiently blocked in the trench resulting in displacement
- G** Air lock
- H** Leaking test equipment
- I** Stabilizing time too short (24 h)
- J** Leaking joint (adhesive bonded, rubber seal or laminated joint)
- K** Leakage in fittings
- L** Leakage of the pipe as result of damage (cracks)
- M** Settlement of the pipe system

## 12. Safety precautions

The following safety precautions should be observed when using RTRP products.

When cutting or grinding RTRP materials the following personal protection is necessary to prevent dust irritating the skin:

- A** A dust mask covering nose and mouth
- B** A pair of safety glasses
- C** Gloves and overalls.

Using resin and hardener of adhesives or lamination sets, the following R and S code number are applicable:

Easy Fit	Hardener	R 34, 43, 50/53	S 26, 36/37/39, 45, 60, 61
Easy Fit	Resin	R 36/38, 43, 51/53	S 24, 26, 28, 37/39, 61
Easy Fit conductive	Hardener	R 34, 43, 50/53	S 26, 36/37/39, 45, 60, 61
Easy Fit conductive	Resin	R 36/38, 43, 51/53	S 24, 26, 28, 37/39, 61
Wavistrong laminating sets:			
Euredur 278	Hardener	R 36/38, 43	S 24, 37/39
Euredur 43	Hardener	R 20/21, 43	S 26, 36/37/39, 45
Epikote 828	Resin	R 36/38, 43, 51/53	S 24, 26, 28, 37/39, 61

Nature of the special risks attaching the dangerous substances (R-numbers):

- R 20 Harmful upon inhalation.
- R 21 Harmful in contact with skin.
- R 22 Harmful if swallowed.
- R 36/38 Irritating to eyes and skin.
- R 37 Irritating to respiratory system.
- R 40 Permanent damage cannot be precluded.
- R 43 Can cause over-sensitivity upon skin contact.
- R 45 Can cause cancer.
- R 50/53 Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
- R 51/53 Poisonous for organisms in water, can have long-term damaging effect on the aquatic environment.

Safety advice concerning dangerous substances (S-numbers):

- S 23 Do not inhale the vapour.
- S 24 Avoid skin contact.
- S 25 Avoid contact with eyes.
- S 26 In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
- S 28 Upon contact with skin, wash immediately with plenty of water and soap.
- S 36 Wear suitable protective clothing.
- S 36/37/39 Wear suitable protective clothing, gloves and eye/face protection.
- S 37/39 Wear suitable gloves and eye/face protection.
- S 45 In the case of an accident or feeling unwell, seek medical advice immediately (show this label if possible).
- S 60 This material and its container must be disposed of as hazardous waste.
- S 61 Avoid dumping in the environment. Ask for the special instructions/safety chart.

In case of irritation of the respiratory system care should be taken that satisfactory ventilation is provided.

If a system is pressure tested, adequate safety precautions will have to be taken as a "safe test pressure" does not exist. Any pressure in itself is dangerous.

The test equipment must be operated by experienced personnel. Personnel not involved in the test or inspection, should not be allowed in the immediate area. Only one person should be in charge, and everyone else must follow his/her instructions. Do not change anything to the pipe system when it is under pressure. Leaking joints may only be repaired after the pressure has been fully released.

The test equipment must be installed at a sufficient distance (several metres) from the connection to the pipe system. If welding needs to take place, the R.T.R.P. material must be protected from welding sparks.

Depressurization of the system must be done carefully to avoid negative pressures. Bear in mind that temperature changes during day and night will affect the pressure in a closed system. A drop in pressure during the night does not indicate a leak. When testing a system the ambient temperature should be measured.

The low weight, the flexibility and elasticity of R.T.R.P. create different conditions compared with steel. If during testing a joint should fail, the system will whip, due to the sudden release of pressure and stored energy. There is also a risk of injury to personnel.

Testing with air or gas is extremely dangerous and should be avoided. Systems must never be tested with flammable fluids or gases!

Future Pipe Industries does not take any responsibility for any damage resulting from the use of these methods. For safety precautions see chapter 12.

### **11.2. Causes of pressure drop**

The following causes may affect pressure and can be used as a check list.

- A** Temperature change, by day as well as by night
- B** Leakage of valves, fittings, hydrants, etc.
- C** Leakage of gaskets
- D** Dirt at sealing ring
- E** Wrong installation of O-ring (slip ring)
- F** Pipes or fittings insufficiently blocked in the trench resulting in displacement
- G** Air lock
- H** Leaking test equipment
- I** Stabilizing time too short (24 h)
- J** Leaking joint (adhesive bonded, rubber seal or laminated joint)
- K** Leakage in fittings
- L** Leakage of the pipe as result of damage (cracks)
- M** Settlement of the pipe system

