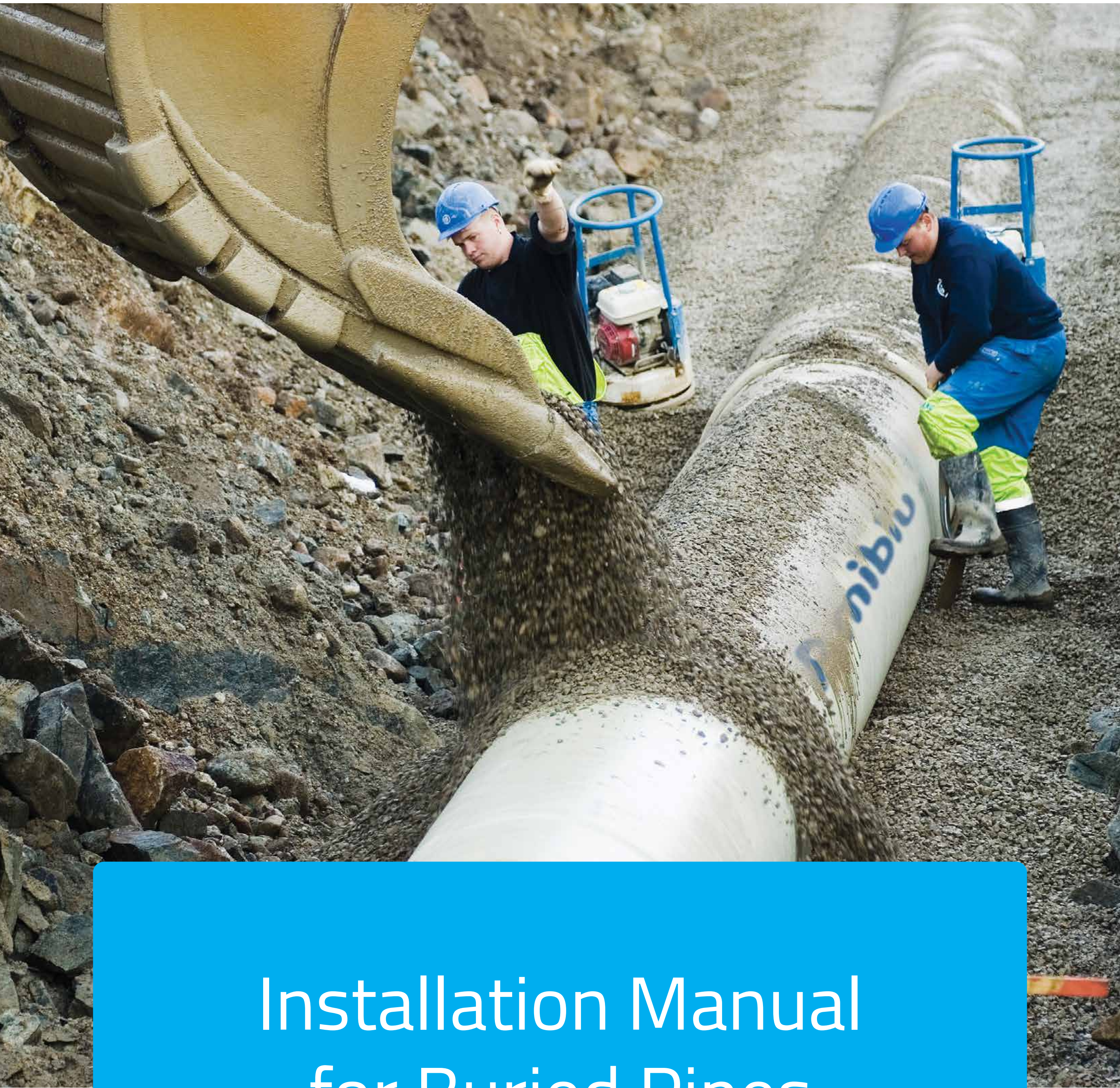
Amiblu

Amiblu Pipe Systems
Engineered for the next generations



Installation Manual for Buried Pipes

FLOWTITE

HOBAS

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1. Introduction

1.1. General information

This manual provides instructions and recommendations for the installation of buried Amiblu pipes and fittings. It is primarily intended for contractors and others who install Amiblu flexible pipes in open trenches. For other products and conditions, see Amiblu's installation manuals for jacking pipes, non-circular pipes, and above-ground pipes.

Although this is not intended to serve as a design manual, it may still prove useful for engineers who design installations according to AWWA M45, Fascicule 70, ATV 127, or other national guidelines for design of buried flexible pipes.

All data and recommendations contained in this manual or provided by Amiblu are general information about Amiblu GRP pipe systems and are not binding for individual projects. Figures are schematic in nature and intended as examples only. The information contained in this document is correct as of the time of publication. All data must be checked and revised as appropriate.

The correct installation of pipes requires individual calculations and comprehensive planning by certified engineers. In addition to the applicable standards and guidelines, the requirements for each installation and the operating conditions for each project shall be evaluated by qualified engineers. Amiblu does not generally verify the installation conditions on-site. As such, this is the responsibility of the contractor or consulting engineer.

This document applies to products made according to EN ISO 23856. For stiffness classes above SN 20000, special requirements may apply.

For the installation of Amiblu GRP pipes, relevant standards and guidelines such as EN 1610 and EN 805 apply. Amiblu offers custom services based on individual advice. For special conditions requiring specific approaches, do not hesitate to contact Amiblu's technical experts.

This installation manual does not replace codes of practice, applicable laws, safety, environmental or other regulations, local regulations, or specifications of the owner.

1.2. Amiblu pipe systems

Amiblu pipes systems are flexible pipe systems that deform under external loads within the scope of their design. The flexibility of Amiblu pipes leads to ideal load distribution on the surrounding bedding and soil, compared to rigid pipes, which have to absorb the full external load. After the natural settling of the backfill material, the pipe/soil system stabilizes, and the deflection remains constant over time.

Amiblu pipe systems are available in two different systems:

1.2.1 Unrestrained (uniaxial loading)

This involves loading conditions where the pipes, joints, and fittings are pressurized, without end-thrust. The joints do not transfer longitudinal (axial) loads, and thrust resistance is controlled by thrust blocks.

1.2.2 Restrained (biaxial loading)

This involves loading conditions where the pipes, joints and fittings are pressurized, with end-thrust. The joints transfer full loads and end-thrust through the pipes directly to the soil.

1.3. Occupational health and safety

From the delivery to the construction site to the commissioning of the pipe system, all legal and operational requirements regarding occupational health and safety, fire protection, and technical safety must be observed independently of this installation manual. All instructions and figures must be checked individually before each application and per the conditions on-site.

Particular attention shall be paid to the fact that the pipes have a very smooth inner and outer surface. Concerning moisture or materials such as oils, grease, etc. that are frequently found on construction sites, special caution is recommended when entering, storing, handling, and transporting the pipes.

Circular products are potentially unstable during storage, handling, and installation. Always ensure appropriate and secure positions (to prevent rolling, turning, falling and sudden movement) for all products during all stages on site.

Follow all local and relevant regulations related to confined space work when entering a pipe or pipeline.

1.4. Weather and temperature

Amiblu glass fiber reinforced plastic (GRP) pipes have been installed and are in service in the harshest climates, from arid deserts to the arctic, with an environmental temperature range of -40 to +50 °C. The pipe materials, as well as the sealing gaskets, are well suited for operation in these varied climates.

Related issues to be considered include:

- Storage of pipes, gaskets, and lubricants
- Lubricant types for different conditions
- Avoid frozen backfill
- Temperature variation between installation and operation
- Assembly force influenced by temperature
- Ice in gaskets and grooves
- Flooding and mud during heavy rain

These issues are addressed in appropriate chapters throughout this document.

2. Transportation and handling of pipes and fittings

2.1. General

Amiblu pipes and fittings are loaded at the factories by trained personnel. The packaging provided is adapted for the intended means of shipping, e.g. road, rail or sea. Nevertheless, each delivery should be checked for deficiencies upon arrival. Particular attention must be paid to damaged pipe ends, strong abrasion, and pressure marks. Any impact loads shall be avoided. The damaged components from these loads must be labelled and stored separately for future repair.

If an initial inspection is not conducted at the time of delivery and damaged pipes are discovered later, future complaints are not permitted and cannot be accepted. Interim transportation on the construction sites shall preferably be in the original packaging.

2.2. Pipe inspection

All pipes should be inspected upon receipt at the job site to ensure that no damage has occurred in transit. Depending on the length of storage, amount of job site handling and other factors that may influence the pipes' condition, it is recommended that the pipe be inspected again just before installation. Conduct the initial inspection upon delivery as follows:

- Make an overall inspection of the load. If the load is intact, ordinary inspection while unloading will normally be sufficient to verify the pipe has arrived without damage.
- If the load has shifted or indicates rough treatment, carefully inspect each pipe section for damage. Generally, an exterior inspection will be sufficient to detect any damage. When pipe size permits, an interior inspection of the pipe surface at the location of an exterior scrape may be helpful to determine if the pipe is damaged.
- Check the quantity of each item against the bill of lading.
- Any discovered defects shall immediately be noted and documented with photographs, in the corresponding freight and shipping documents, and in the presence of the freight forwarder so that they can be taken into consideration in the case of complaints.
- If any imperfections or damage is found, segregate the affected pipes and contact the local Amiblu supplier. Do not use pipes that appear damaged or defective. Both internal and external surfaces shall be free from any irregularities that might impair the ability of the component to conform to its requirements.

Fig. 1: Packaging unit

2.3. Pipe repair

Normally, pipes with minor damage can be repaired quickly and easily at the job site by a qualified individual. However, if in doubt about the condition of a pipe, do not use it.

A field technician from Amiblu can help determine whether repair is required and whether it is possible and practical. Do not attempt to repair a damaged pipe without consulting the local Amiblu supplier first. Repairs must be made by a trained repair technician. Improperly repaired pipes may not perform as intended. Pipe materials that have been processed due to in-house sampling or other reasons may look slightly different from unprocessed materials. However, this will not be considered as a reason for a complaint. If in doubt, contact Amiblu.

2.4. Pipe handling

Safety instructions:

- If a component is supplied with lifting aids, all aids must be used to avoid uneven load distribution.
- Ensure that all pipes are always secured against rolling during all stages of handling on-site.
- Special care should be taken when opening pipe packages.
- Ensure lifting equipment has sufficient capacity for the weight. This may be calculated from the approximate product weights given in the Amiblu Product Guide.
- The lifting devices (e.g., bolts, screws, etc.) must be checked before each use.
- Damaged lifting aids must not be used.
- Impact and excessive bending stresses shall be avoided in the loading of both pipes and fittings.

The pipes are usually delivered in lengths of 3 to 12 m and come with a pre-mounted coupling. When unloading, the packaging units (Fig.1) can be lifted without unpacking. Using slings, a forklift, or wheel loader is suitable to unload. It is advisable to use at least two textile slings. Pay particular attention to prevent the pipe from slipping in the slings (ensuring health and safety at work).

To guarantee safe transport, single pipes are loaded and unloaded according to Fig.2. The limit for the space between the belts and the lifting locations is 0.6 x the total length of the pipe, always taking into account the center point of the pipe as the axis. In certain cases, it may be necessary to transport the pipes with the help of a cross beam inside the pipe. In these cases, the beam shall be padded (cushioned) to prevent mechanical damage to the pipes and couplings.

Do not use hooks, wire rope, chains, or hoisting gear with sharp edges. Do not subject the pipes to point loads (Fig. 3).

Metal tools (forklift forks, etc.) must be padded to prevent pipe damage.

Pipes may be nested (smaller diameter pipes inside of larger sizes) as needed. These pipes generally have special packaging and may require special procedures for unloading, handling, storing and transporting. Special measures, if required, will be carried out by the Amiblu pipe supplier prior to shipment. However, the following general procedures should always be followed in these instances:

- Always lift the nested bundle using at least two flexible slings (Fig. 4).
- Nested pipes are usually best stored in the transport packaging. Stacking of these packages is not advised unless otherwise specified.
- Safe transportation of nested bundles is best achieved in the original transport packaging. Special requirements, if any, for support, configuration, and/or strapping to the vehicle will be specified for each project.
- De-nesting of the internal pipe(s) is best accomplished in a prepared flat area with appropriate equipment. Protected forks will be used to remove pipes one by one and lift them carefully out of the bundle without damaging the other pipes (Fig. 5). When weight, length and equipment limitations preclude the use of this method, procedures for sliding the inside pipe(s) out of the bundle will be recommended for each project.
- Inspect pipe for any damage after de-nesting.

For some components, the center of gravity is not directly in the middle. The position of the lifting slings must be adjusted accordingly (Fig. 6) for these components. In the case of tangential shafts, the lifting gear must have the necessary minimum length to avoid pressure points on the pipe edges.

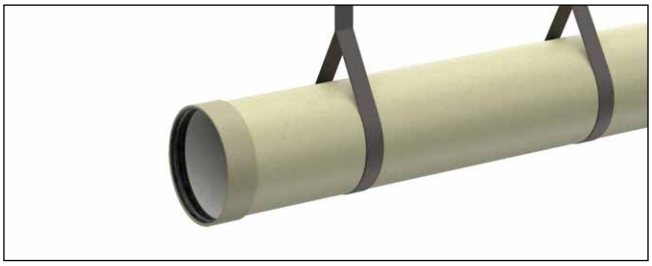

Fig. 2: Loading and unloading of pipes with 2 slings

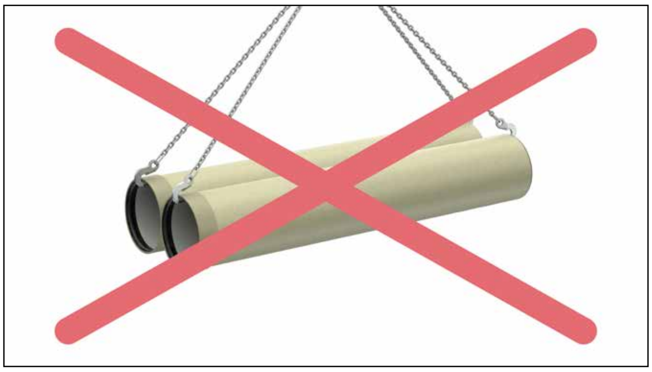

Fig. 3: Hooks and wire ropes must not be used in direct contact with the pipe for transportation

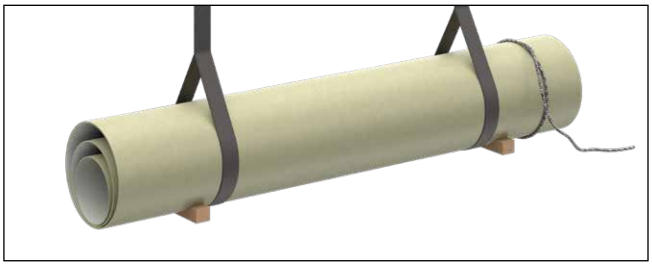

Fig. 4: Lifting of nested pipes

Fig. 5: Denesting of pipes with protected forks

Fig. 6: Handling of GRP fitting

3. Storage

3.1. Pipe storage

The original packaging that comes with each shipment is suitable for both transportation and storage. The pipes should always be stored on an even surface (Fig. 7), free of rocks and other potentially damaging debris. The materials must not be subject to intense heat, flames, solvents, etc. Pipes must also be protected from mechanical damage and point loads (Fig. 8-10).

Pipes shall be protected against vandalism and access by third parties, as well as against damage and displacement. If pipes are subsequently stacked, the acceptable stacking height depends on the soil conditions as well as the loading and safety equipment on site (see Table 1).

Wooden beams must be placed under the bottom layer of pipes to avoid siltation due to rainwater draining and to prevent the pipes from freezing to the ground. Stacking heights above 3 m are not recommended on construction sites to prevent accidents. The pipes must be secured in position with the help of wooden beams and wedges.

Amiblu pipes are usually supplied with a coupling mounted on one pipe end. The inner pipe surface and rubber seals on the couplings must not be subject to UV light for more than 3 months. Furthermore, they must be protected from grease, oils, solvents, and other damaging substances. It is therefore advised to cover the pipe ends if they are stored outdoors over a longer period.

The pipes' outer layer protects the structural layers below from environmental impacts, such as ultraviolet radiation and weathering. In regions subject to higher ultraviolet light exposure, the outer layer can also be adapted to be even more resistant to ultraviolet radiation. Note that weathering over time may cause visual changes without influencing the product properties.

Fig. 7: Proper storage in packaging unit

Fig. 8: Pipes should not rest on stones

Fig. 9: Pipes should not rest on an uneven surface

Fig. 10: Pipes should not be dragged along the ground

3.2. Gaskets, locking rods and lubricant storage

Rubber ring gaskets and locking rods, when shipped separately from the couplings, should be stored in the shade in their original packing and should not be exposed to sunlight except when actively joining pipes. Also, the gaskets must be protected from exposure to petroleum-derivative greases and oils, as well as solvents and other harmful substances.

Gasket lubricant should be stored to prevent contamination. Partially used buckets should be resealed to prevent contamination of the lubricant in any instance. If temperatures during installation are below 5 °C, gaskets and lubricants should be sheltered at a temperature over 5 °C until used. Do not use a frozen lubricant. A special lubricant for lower temperatures than 5 °C as well as for very wet conditions is available upon request.

Nominal Diameter (DN)	200	250	300	400	500	600	700	800	900	1400	≥ 1500
Quantity of layers	8	8	7	6	5	4	3	3	2	2	1

Table 1: Number of pipe layers relative to DN for stacking

4. Installation

4.1. General

A buried pipeline is an engineered structure where the interaction between the pipes, joints, supports, embedment, backfill, and cover form the basis for the system's ultimate stability and reliability. The pipe stiffness and soil consistency together determine system performance, a significant factor in buried installations. Therefore, the quality of the materials and execution of the installation are the most important criteria for the integrity of the finished pipeline structure. Because it is so important, procedures should always be conducted carefully and safely.

4.2. Pipe trench

When designing and excavating pipe trenches and pits, it's recommended to comply with EN 1610. In addition, the requirements of EN 805 can be taken into consideration. It is generally the designer's responsibility to comply with specifications and follow local guidelines. On-site conditions should also be observed. It is important to select a trench width that allows at least the required compaction to be achieved with suitable machinery and installation to be carried out safely and correctly (see EN 1610).

Amiblu can provide structural calculations upon request. Contact Amiblu for any questions about special installation conditions not addressed in this document.

4.3. Soil types

The load-bearing capacity of the native soil must be considered for installation design and when selecting the backfill material.

The primary installation parameters that must be selected according to the site conditions and planned installation are the type of backfill soil immediately around the pipe (pipe zone backfill), degree of compaction, and the characteristics of native soil at the pipe elevation. The initial selection of these parameters may be controlled by prevailing specifications, the project's geotechnical report, manufacturers' recommendations, or experience. A given combination of soil type and degree of compaction will largely determine the values required for design calculations.

Organic materials should be avoided.

It may be necessary to take special action when encountering soils prone to settling or of inadequate load-bearing capacity as settling may cause pipeline disorders. If there is a risk of subsidence particulary in peaty or clayey soils, etc., the exchange of soil or the use of geotextiles, gravel beds, duckboards, etc. is recommended.

Further information can be found in local design guidelines such as AWWA M45, Fascicule F70, ATV-A 127, etc. In this document, no reference is made to specific soil categories, only general description is used.

4.4. Trench bottom and pipe bedding

Terminologies for various trench features are described in Fig. 11.

Load-bearing pipe bedding is an important requirement in order to ensure a long-lasting pipeline that functions properly through its service life. Prepare the trench bottom for the specified gradient and depth of installation, and avoid any loosening of the native soil in the area of the trench bottom.

The bedding should be placed over a firm, stable trench bottom to provide proper support for the pipe barrel (see Fig. 12 & Fig. 13). Bedding layer thickness shall be at least 100 mm (Fig. 11).

Where rock, hardpan, soft, loose, unstable, or highly expansive soils are encountered in the trench bottom, it may be necessary to increase the depth of the bedding layer to achieve uniform longitudinal support (Fig. 11).

It is now becoming common practice to leave the bedding uncompacted for a width of 1/3 of the pipe diameter centered directly under the pipe. This reduces concentrated loads on the invert.

To ensure the pipe barrels are supported smoothly and evenly on the bedding, leave suitable bell holes in the area of the coupling (about 2–3 times the coupling width). Make sure the pipe bedding is aligned between pipes to avoid misalignment.

When making the over-excavation for the couplings in the pipe bed, ensure there is room for joining and checking of the pipe connection (see Fig. 13).

4.5. Placing in the pipe trench

Before lowering the product into the trench, inspect all parts to be installed for damage. For handling guidlines, refer to Chapter 2.

Avoid collisions during movement with trench sheeting, trench supports, already placed products, and any other objects. Do not bring the pipe to grade using mounds of soil or other material along the pipe length. The bedding layer shall be prepared for the intended slope already.

For joining guidelines, refer to Chapter 5.

4.6. Backfilling and compaction of the pipe zone

4.6.1. GENERAL

Immediate backfilling after joining both ends is recommended to prevent two types of hazards: floating of the pipe due to heavy rain and thermal movements due to large temperature fluctuations. Floating of the pipe can cause damage and lead to

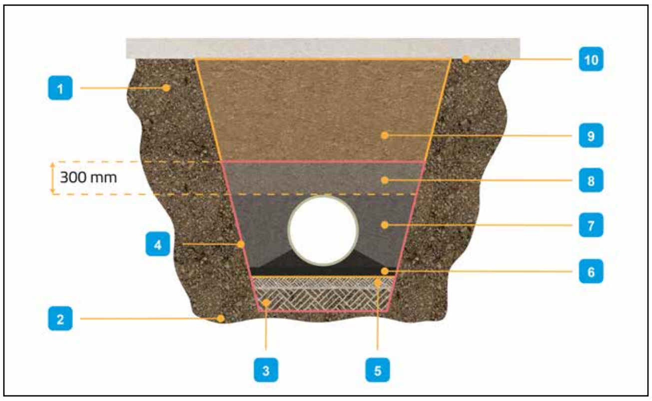

Fig. 11: Pipe trench terminology

1 - Native soil: Natural soil in which a trench is excavated for pipe installation or on which a pipe and embankment are placed
2 - Trench bottom: Native soil below the trench
3 - Foundation (if required)
4 - Pipe zone: All backfill around the pipe including the bedding, haunching, and initial backfill
5 - Bedding: Backfill material placed in the bottom of the trench or on the foundation to provide a uniform material on which to lay the pipe; the bedding may or may not include part of the haunch zone
6 - Haunch zone
7 - Initial backfill: Backfill material placed at the sides of the pipe and up to 300 mm over the top of the pipe including the haunching
8 - Cover layer: The last part of the initial backfill, covering 300 mm above the pipe
9 - Final backfill: Backfill material placed from the top of the initial backfill to the ground surface
10 - Trench width: See Chapter 4.2

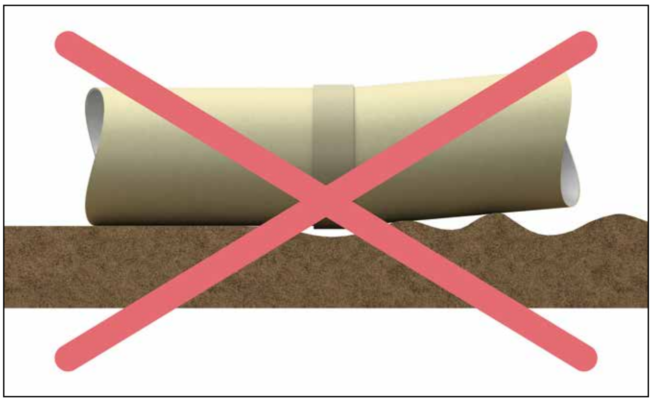

Fig. 12: Improper pipe bedding

unnecessary reinstallation costs, whilst the cumulative effect of thermal expansion and contraction over several lengths can compromise seal integrity.

A minimum of 0.75 x diameter of earth cover (minimum dry soil bulk density of 19 kN/m³) is required to prevent an empty submerged pipe from floating.

If pipe sections are placed into the trench and backfilling is delayed, each pipe should have the center section backfilled to the crown to minimize movements at the joint.

Partial encasement or concrete haunching requires specific engineering. Contact Amiblu for further information.

4.6.2. MATERIALS FOR INITIAL BACKFILL

In the pipe zone area, good quality of backfilling is essential to provide support. This also largely determines the pipeline's load-bearing capacity. For the backfill of the pipe zone, various materials can be used. This material selection should be made based on local and economic aspects by qualified personnel. Graded material is recommended for the easiest compaction results. The use of crushed rock has also proven to be a cost-effective solution. Clean coarse-grained soils with limited content of fines, sandy or fine-grained soils can also be used as backfill, but these materials require more compaction effort.

Project specifications must be applied in every case, and the selected material must meet the requirements for allowable particle size (see Table 2). Granular backfill soils are the easiest to use and require the least compaction effort to achieve a given level of relative compaction.

Never drop backfill material uncontrolled on the pipe. When backfill material is put around the pipe by excavators, the shovel should be close to the pipe.

It is important to note that processed excavated material or imported backfill may contain oversize particles. The maximum permitted oversize particle shall be less than 2 x allowable particle size, acc. to Table 2. Oversized content share is limited to 10 %.

Do not use any frozen material in the pipe zone. Do not backfill on top of frozen bedding.

For special products like Flowtite Grey, Flowtite Orange, and Hobas PU-Line, other requirements for backfill material within the pipe zone may apply. Contact Amiblu for further guidance if using such products.

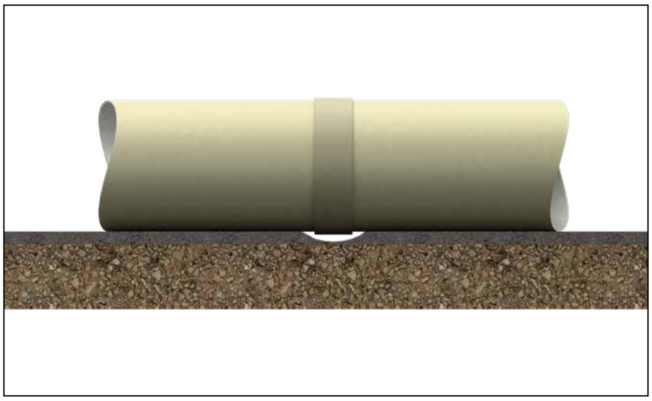

Fig. 13: Pipe laying with bell hole on the appropriate bedding layer

Maximum sieve size (determined by the sieve test)
≤ 16 mm for pipes ≤ DN 400
≤ 32 mm for pipes DN 450 - DN 1200
≤ 40 mm for pipes > DN 1300

Table 2: Requirements for pipe zone backfill material (initial backfill)

4.6.3. HAUNCH ZONE

Backfilling starts with the prepared bedding layer in the trench. Pay particular attention to compacting the backfill under the pipe (Fig. 15). The haunch area must support the pipe throughout its entire length. It must be well compacted and filled with an appropriate backfill material. In addition, using particle sizes less than 25 mm in the haunch area makes it easier to place the material.

The pipe shall rest on the haunch material. Proper haunching is necessary to prevent bulging of the pipe in this area, as well as for providing even support along the pipe length. This prevents longitudinal bending and movements at the joints.

Fig. 14: Improper haunch backfill

4.6.4. INITIAL BACKFILL

The initial backfill shall be compacted properly using suitable machinery (e.g. hand tamper or small pneumatic compactor). When using compacting machines, ensure that the pipes are not damaged during the process. Proceed with care, especially for pipes of smaller diameters. Place and compact the backfilling material on both sides of the pipe up to a height of 300 mm above the crown in layers of 300 mm or less to achieve the required compaction level.

Ensure that the soil and the pipe zone achieve appropriate compaction. Verify that the compaction in the pipe zone is at least of the same level as that of the pipe cover. The degree of compaction at the side of the pipes inside the pipe zone should be at least 90 % standard proctor density or as determined by structural calculations. The initial deflection must be checked as well.

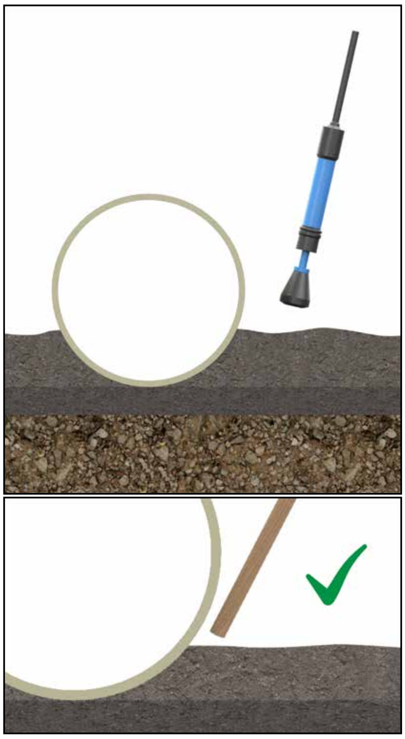

Fig. 15: Proper haunch backfill

Backfilling and compaction work shall be carried out in such a way that pipes and fittings do not move or lift. In the area of the pipe zone, manually compact the material or use light vibrating tampers (max. impact force 0.3 kN) or light plate compactors (max. impact force 1 kN) with appropriate compaction depth.

Properly placed and compacted backfill in the pipe zone should not result in vertical deflection of the pipe when backfilled to the crown. When the backfill has reached the pipe crown, vertical ovalization can be beneficial in case of high cover depths, but it should not exceed 1.5 % of the pipe diameter (vertical ellipse). To achieve the necessary compaction, keep the pipe trench free of water (see Chapter 10.5). Take care that the compaction work during installation does not alter the direction or level of the pipeline. Work involved in installing and removing dewatering systems must be carried out in such a way that the stability of the environment and pipeline is not adversely affected. In the case of groundwater, the use of granular material capable of being compacted for embedment is recommended.

Take appropriate action to prevent bedding or backfilling material from mixing with the native soil. This can include the use of geotextile separation fabrics.

If sheeting or shoring is used, it is recommended to remove this material in layers and compact the backfill material against the trench wall layer by layer. Refer to Chapter 10.6 for additional information.

4.6.5. INSTALLATION TYPES

Two standard backfilling configurations are recommended (Fig. 16 and Fig. 17). The selection between the two types depends on the native soil characteristics, the backfill materials, required depth of burial, site conditions, pipe stiffness and pipe operating conditions.

4.6.5.1. Type 1

The Type 1 configuration is used for applications with regular traffic loading, shallow (less than 1 m) or high (more than 5 m) cover, and negative pressure (vacuum) requirements. For Type 1, initial backfill one material grade compacted to the project specification is used up to 300 mm above the pipe.

4.6.5.2. Type 2 (split pipe zone backfill)

The Type 2 "split" configuration is generally more utilized for applications of lower pressure (PN ≤10 bar), light-duty traffic loading, medium cover (ca. 1 to 5 m), and limited negative pressure (vacuum) requirements. The approach has proven to be economical for projects where native low stiffness soils are not suited for initial backfill.

Backfill material with higher stiffness is used in lower pipe zones up to 60 % of the pipe diameter. These are typically clean coarse-grained soils with limited content of fines. They are easy to work into the haunch area and can be compacted in thicker layers. Such material is typically less sensitive to moisture.

Backfill material with lower stiffness, processed native material, is used in the upper part of the pipe zone. These materials are typically sandy or fine-grained soils that are more economical but may require increased compaction effort.

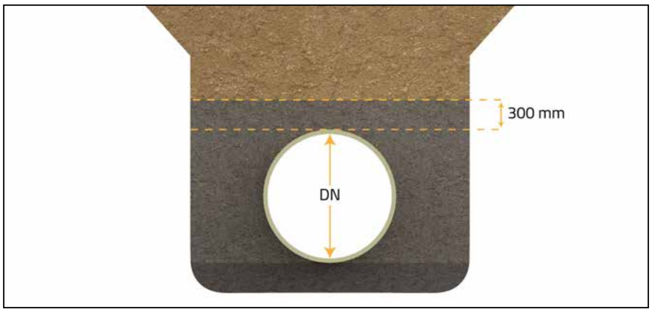

Fig. 16: Installation Type 1

PROCEDURE FOR TYPE 1 INSTALLATION

- Construct the pipe bed following the guidelines of Chapter 4.4.
- Backfill the pipe zone (300 mm) over the pipe crown with the specified backfill material compacted to the required compaction level based on. project specification.
- For low pressure (PN ≤ 1 bar) applications without traffic load, it may not be necessary to compact 300 mm over the pipe crown.

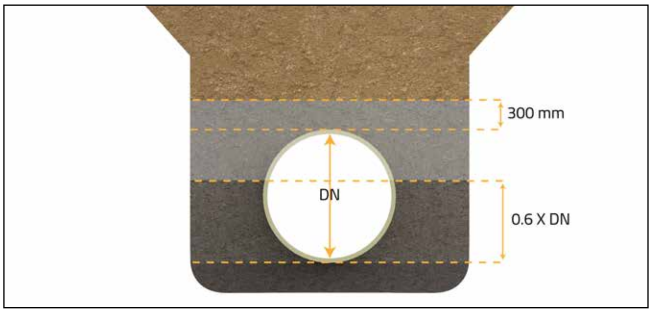

Fig. 17: Installation Type 2

PROCEDURE FOR TYPE 2 INSTALLATION

- Construct the pipe bed following the guidelines of Chapter 4.4.
- Backfill to a level of 60 % of pipe diameter with the specified backfill material compacted to the required compaction level according to project specifications.
- Backfill from 60 % of the diameter to 300 mm over the pipe crown with lower stiffness backfill material, compacted to the required compaction level.
- Backfill configuration Type 2 is not suitable for small diameters or cases with heavy traffic loading.

4.6.6. FINAL BACKFILLING OF THE PIPE TRENCH

Next, the 300 mm cover over the pipe must be compacted. Trench backfill under areas subjected to traffic load is often compacted to minimize road surface settlement (Fig. 18). Table 3 shows the minimum required cover height over the pipe, before certain compaction equipment may be used directly above the pipe.

Care must be taken to avoid excessive compaction above the pipe crown, which may cause bulges or flat areas. However, the material in this area must not be left loose, and the desired specific density should be achieved.

The backfilling above the pipe zone may be achieved using excavated material with a maximum particle size of up to 300 mm, provided there is at least 300 mm of cover over the pipe. Stones exceeding 200 mm should not be dropped from a height greater than 2 m at the 300 mm layer covering the pipe crown.

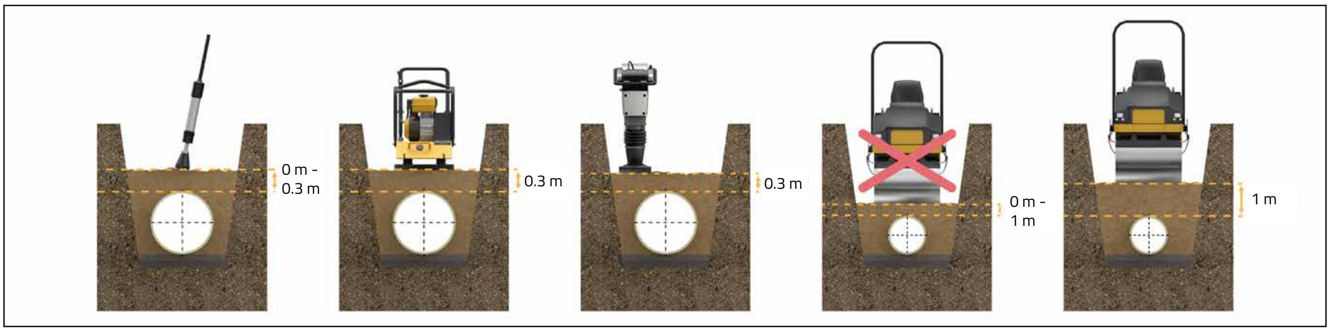

Fig. 18: Minimum height of various compaction equipment.

Equipment	Minimum soil cover over pipe crown before compaction (m)	Equipment	Minimum soil cover over pipe crown before compaction (m)
Foot or hand tamper max. 15 kg	0.2	**Vibrating roller**	
		max. 15 kN/m	0.6
		max. 30 kN/m	1.2
		max. 45 kN/m	1.4
		max. 65 kN/m	1.8
Vibrating rammer max. 70 kg	0.3	**Twin vibrating roller**	
		max. 5 kN/m	0.2
		max. 10 kN/m	0.45
		max. 20 kN/m	0.6
		max. 30 kN/m	0.85
Plate vibrator		**Triple heavy roller (no vibration) max. 50 kN/m**	1
max. 50 kg	0.15		
max. 100 kg	0.15		
max. 200 kg	0.2		
max. 400 kg	0.3		
max. 600 kg	0.5		

Table 3: Minimum cover for compaction above pipe for various types of equipment


Fig. 19: Hand-operated compaction equipment

4.7. Liquid soil and concrete backfilling

The use of liquid soils can be a beneficial method to backfill GRP pipes in cases that involve a high groundwater table, reduced trench width, or situations where installation must be conducted without people in the trench.

Pipe backfilling with liquid soil requires thorough preparation due to buoyancy effects.

Special attention should be paid to:

- Excessive bending loads in longitudinal direction
- Local buckling on shoring points
- Ovalization of the pipe
- Rotation and misalignment of the joints

In addition, the following issues need to be addressed:

- Analysis of the construction and final phase
- Selection of proper pipe support
- Groundwater table
- Securing of the pipeline's position, in particular, to prevent flotation

Liquid soil backfilling is typically done in several stages. The use of non-standard pipe lengths may prove beneficial, depending on the installation techniques used.

When working to prevent pipeline flotation (Fig. 20 and Fig. 21), ensure the work does not lead to excessive deflection and displacement or damage from local supports. The pipe should be supported in such a way that the liquid soil easily flows completely around and fully underneath the pipe.

The supports should ensure acceptable pipe shape (less than 3 % deflection, no bulges or flat areas). For pressure pipes, the deflection should be limited to less than 1 % to avoid high loads on the surrounding liquid soil due to pressure re-rounding of the pipe. Use the methods stated in Chapters 8.2 and 8.4 for proper support.

It is recommended to consult an experienced designer during the preliminary planning stage.

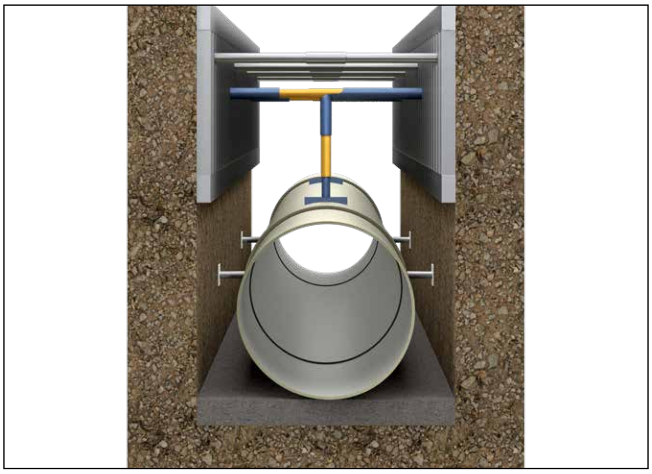

Fig. 20: Typical flotation restraints for installation in liquid soils, front view

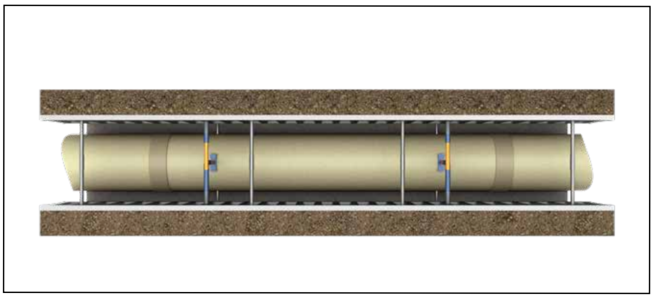

Fig. 21: Typical flotation restraints for installation in liquid soils, top view

$$s = (T_{max} - T_{inst}) \times L \times 30 \times 10^{-6}$$

s - Change in length [mm]

T_{max} - Operational max./min. pipe temperature due to the environment or medium [°C]

T_{inst} - Pipe temperature during installation [°C]

L - Pipe length [mm]

Temperature difference in medium or environment [°C]	Length change of 6 m pipe [mm]	Length change of 12 m pipe [mm]
+/- 20	+/- 3.5	+/- 7
+/- 40	+/- 7	+/- 14
+/- 60	+/- 11	+/- 22

Table 4: Changes in length of pipes as a function of temperature difference

4.8. Temperature effects

If a pipeline is empty and uncovered, e.g. during installation, there is a greater tendency for it to heat up when exposed to sunlight. Pipeline soil cover will prevent this issue.

Amiblu joint systems can experience an acceptable contraction of up to 0.3 % of the nominal pipe length for pressure pipes and 0.2 % for non-pressure pipes. For further details, see Chapter 5.1.

Special attention should be paid to installations where temperatures are more than 20 °C below the service temperature. In such cases, a gap might be planned between stopper and spigot to compensate for the temperature length increase.

When calculating the change in length due to temperature fluctuations, use a thermal expansion coefficient of approx. 30×10^{-6} 1/°C in the longitudinal direction (Table 4).

4.9. Negative operating pressures, vacuum

4.9.1. GENERAL

The maximum allowable negative pressure (vacuum) in the pipe is a function of burial depth, native soil, pipe and backfill soil stiffness, and trench width. To provide proper soil stabilizing support, calculate the minimum burial depth for negative pressure according to applicable standards where vacuum is more than 0.25 bar for SN 2500, 0.5 bar for SN 5000, and full vacuum for SN 10000 pipes.

4.9.2. UNBURIED PIPE SECTIONS

Some sections of a buried pipeline, such as in valve pits or chambers, may be non-soil supported. As the stabilizing support of the soil is not present, the negative pressure capability must be evaluated separately. Table 5 gives the maximum allowable negative pressure for lengths between restraints of 1.5, 3, 6, and 12 meters.

DN	SN 2500				SN 5000				SN 10000			
mm	1.5 m	3 m	6 m	12 m	1.5 m	3 m	6 m	12 m	1.5 m	3m	6m	12 m
100-250	-	-	-	-	-	-	-	-	1	1	1	1
300	0.47	0.29	0.27	0.27	0.78	0.56	0.54	0.54	1	1	1	1
400	0.77	0.31	0.27	0.27	1	0.59	0.54	0.54	1	1	1	1
500	0.83	0.35	0.28	0.27	1	0.64	0.55	0.54	1	1	1	1
600	0.91	0.41	0.28	0.27	1	0.71	0.55	0.54	1	1	1	1
700	1	0.51	0.29	0.27	1	0.84	0.56	0.54	1	1	1	1
800	1	0.66	0.3	0.27	1	1	0.57	0.54	1	1	1	1
900	1	0.79	0.32	0.27	1	1	0.6	0.54	1	1	1	1
1000	1	0.81	0.34	0.27	1	1	0.62	0.54	1	1	1	1
1200	1	0.88	0.4	0.28	1	1	0.7	0.54	1	1	1	1
1400	1	1	0.49	0.28	1	1	0.82	0.55	1	1	1	1
1600	1	1	0.63	0.29	1	1	1	0.57	1	1	1	1
1800	1	1	0.77	0.31	1	1	1	0.59	1	1	1	1
2000	1	1	0.79	0.33	1	1	1	0.61	1	1	1	1
2400	1	1	0.87	0.39	1	1	1	0.69	1	1	1	1
2800	1	1	0.99	0.49	1	1	1	0.81	1	1	1	1
3200	1	1	1	0.62	1	1	1	0.98	1	1	1	1
3600	1	1	1	0.76	1	1	1	1	1	1	1	1
4000	1	1	1	0.78	1	1	1	1	1	1	1	1

Table 5: Maximum allowable negative pressure (bars) for unburied sections. Pipe length between restraints of 1.5 m / 3 m / 6 m / 12 m

Note: The restraints should be stiff enough to keep the pipe round, such as with flanges, concrete encasements, etc.

5. Joint solutions and installation

There are various coupling systems available for Amiblu pipes. Based on your project's requirements, Amiblu will select the best coupling for your scenario.

5.1. Amiblu coupling systems

Amiblu GRP couplings are double bell couplings with various types of gaskets. The gasket should always be cleaned and visually inspected before installation.

Before pressurizing, unburied pipelines or partially covered sections must be properly secured to ensure stability and prevent movement.

5.1.1. SEWER COUPLING / FSC OR ASC (FIG. 22)

This sealing system consists of 2 separate rubber gaskets and is used for gravity applications (PN 1). The gasket is fixed in the FSC coupling for diameters up to DN 1200, and the ASC coupling goes up to DN 960. The gasket position should be checked using a feeler gauge or other appropriate method after assembly.

The coupling is designed for a maximum draw of 24 mm.

5.1.2. PRESSURE COUPLING / FPC, REKA (FIG. 23)

This sealing system consists of 2 separate rubber gaskets and is used as a pressure coupling system for pipes up to 12 m in length. The gasket position should be checked using a feeler gauge or other appropriate method after assembly.

The coupling is qualified for a maximum draw of 36 mm.

5.1.3. PRESSURE COUPLING ANGULAR /FPC-A (FIG. 24)

This sealing system consists of 2 separate rubber gaskets. The FPCA coupling is used for larger angular deflections than that shown in Table 6. With this system, angular deflections of up to 3° can be achieved with pipes between 3-12 m in length for all diameters up to PN 16. For DN 600 and larger, 1.5° are required on each side to achieve a total of 3° deflection.

For pipes greater than DN 1200, angular cut pipe spigots are required for joints. If the joint is used in straight alignment, the pipe should not be angular cut. Alignment marks on the pipes should be considered during installation.

The joints should be checked using a feeler gauge or other appropriate method after assembly. The FPCA range is designed for DN 600 to DN 2500. For DN 2600 and larger, the FPC coupling can be used with angular cut pipes.

The coupling is qualified for a maximum draw of 36 mm.

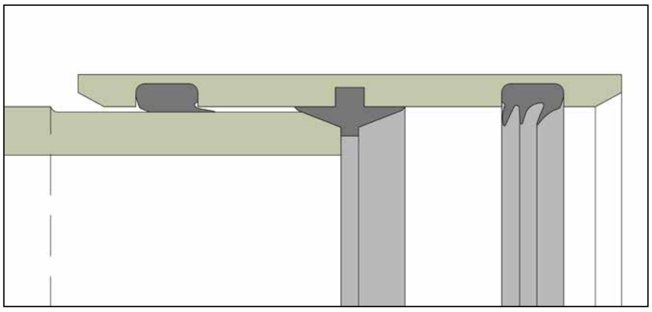

Fig. 22: FSC / ASC coupling

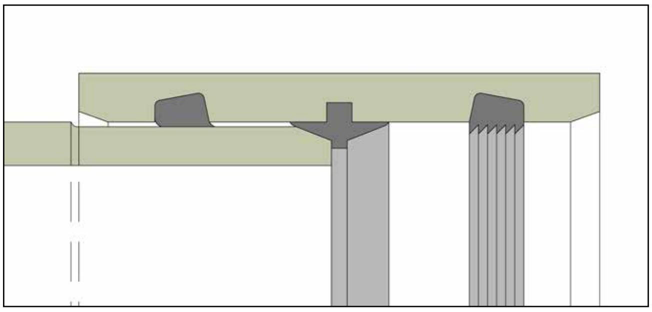

Fig. 23: FPC coupling

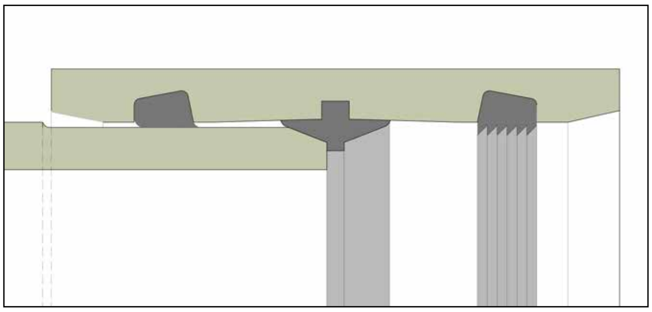

Fig. 24: FPCA coupling

5.1.4. FILAMENT WOUND COUPLING / FWC (FIG. 25)

This sealing system is a full-face rubber profile with 2 sealing lips per spigot. The FWC is a pressure coupling intended for use with pipes up to 6 m in length (also for gravity pipes). The FWC coupling can accommodate an angular deflection as indicated in Annex B. For additional angular deflections, angular cut pipe spigots are required. The allowed deflection is 3° for diameters up to DN 1400, and 2.5° for anything above.

This coupling is qualified for a maximum draw of 18 mm.

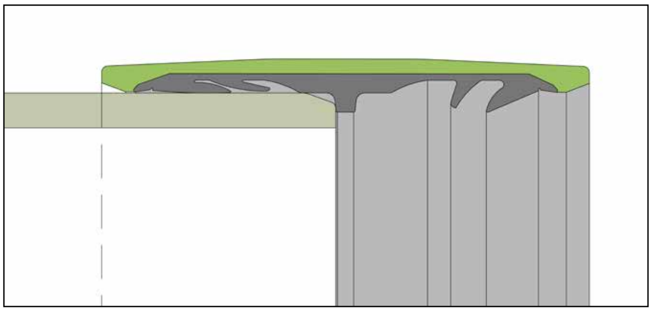

Fig. 25: FWC coupling

5.1.5. LOCKED JOINT COUPLING / FBC (FIG. 26)

This sealing system consists of 2 separate rubber gaskets and 2 locking rods that transfer axial thrust from one pipe section to another. The FBC coupling is a restrained pressure coupling system and can be used for pipes up to 12 m in length. Restrained pipes are locked with a mechanical locker rod. The joint system is available up to a maximum thrust for PN 16 (DN 800) and PN 6 (DN 2000). For fittings with FBC couplings, the laying length and the position of the couplings should be designed in the project.

The FBC coupling is not designed for a draw or angular deflection and should also not be used where bending moments are present.

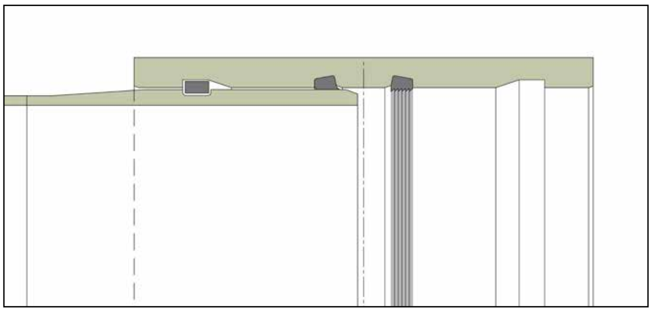

Fig. 26: FBC coupling

5.1.6. FLUSH JOINTS (FIG. 27)

Amiblu has several flush joints available made of stainless steel or GRP with various types of sealing systems. These are mainly used for trenchless applications. Contact Amiblu for further information on this type of connection.

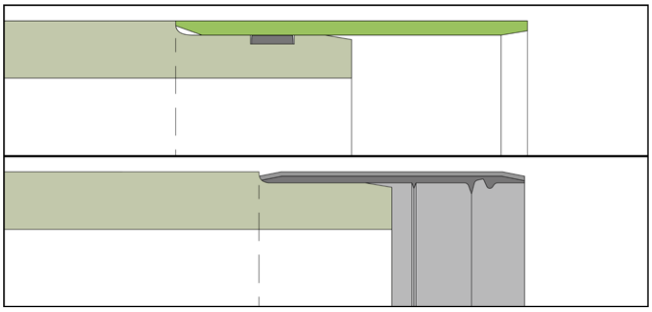

Fig. 27: Flush joints

5.2. Joining of pipes

Amiblu pipes are typically supplied to the construction site with one coupling pre-mounted. Before joining pipes, check that all components such as fitted couplings and gaskets are correctly in place.

5.2.1. MOUNTING STEPS FOR STANDARD JOINTS

5.2.1.1. Pipe placement

Follow Chapter 4.5 for pipe placement.

5.2.1.2. Cleaning the sealing elements

Immediately before joining the pipes, remove any dirt from the surfaces to be joined and in particular the sealing elements in the area of the grooves.

5.2.1.3. Gasket installation (for FPC, FPCA, FBC and ASC)

If the gasket needs to be installed on-site, the following procedure applies: Insert the gasket into the groove leaving loops (typically 2 to 4) of rubber extending out of the groove (see Fig. 28). Do not use any lubricant in the groove or on the gasket at this stage of assembly. Water may be used to moisten the gasket and groove to ease positioning and insertion of the gasket. With uniform pressure, push each loop of the rubber gasket into the gasket groove. When installed, pull carefully in the radial direction around the circumference to distribute compression of the gasket. Check also that both sides of the gasket protrude equally above the top of the groove around the whole circumference. Tapping with a rubber mallet will be helpful to accomplish the above.

5.2.1.4. Applying the lubricant

Next, apply lubricant to the spigot and gasket to minimize the force required for mounting. After lubricating, take care to keep the coupling, gasket and spigots clean. It has been found that placing a cloth or plastic sheet, approximately 1 m^2, under the jointing area will keep the spigot ends and gasket clean. Lubricants suitable for low temperatures are available on request.

Caution: It is very important to use only the correct lubricant. Amiblu provides sufficient lubricant with each delivery of couplings. If for some reason you run out, contact the local Amiblu supplier for additional supply or advice on alternative lubricants. Never use a petroleum-based lubricant. There are various types of lubricants available, see Table 7, for various conditions (warm, cold, wet, etc.).

Table 6 shows the approximate amount of typical lubricant for each gasket/spigot. Different types of lubricants may require greater amounts. Using more lubricant may make installation much easier.

5.2.1.5. Joining the pipes

Align the pipe and the coupling properly before joining. The following steps apply to joining pipes using clamps or slings and come-along jacks. Other techniques may also be used providing the general objectives outlined here are met. In particular, insertion of the pipe spigot ends should be limited to the position mark (home-line), and no damage to the pipe and coupling is permitted. If there is damage to any components, contact Amiblu immidiately. Join the pipes by suitable measures until the coupling is aligned with the home-line or until the spigot touches the center register. For exceptions, see Chapter 4.8. Squeezing of the center register or forcing it underneath the spigot is not permitted.

The pipes can be connected by come-along jacks (see Fig. 29), levers, or an excavator bucket. During installation, it is necessary to protect the pipes from being damaged. Use devices that allow full control of the forces for pipe joining to prevent pipe damage. For even force distribution on the contact area of the pipe or coupling, use appropriate tools. Do not apply point forces therefore, use wooden elements such as battens or beams. If metal equipment must be used, place rubber or wooden sheets between the metal and GRP.

5.2.1.6. Mounting of loose couplings

If the coupling is not pre-mounted, it should be mounted on one of the pipes in a clean, dry place before the two pipes are joined.

This is accomplished by placing a clamp or a sling around the pipe 1 to 2 m from the spigot on to which the coupling will be mounted. Ensure the pipe spigot is resting at least 100 mm above the ground surface to keep away from dirt. Push the coupling onto the pipe spigot end manually and place a 100 x 50 mm timber across the coupling.

Use three come-along jacks distributed around the circumference. Pull the coupling into position, i.e., until the coupling is aligned with the home-line or until the spigot touches the center register (see Fig. 30).

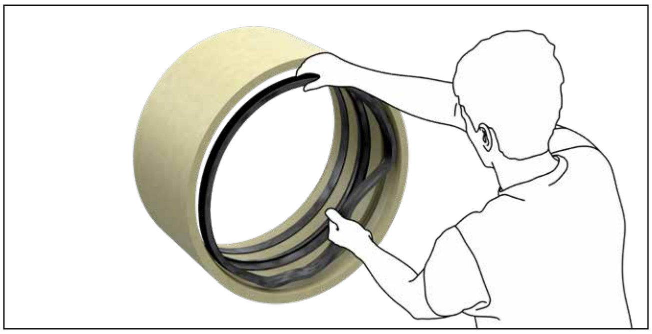

Fig. 28: Installation of the loose gasket

DN [mm]	Lubricant [kg]
100 - 350	0.1
400 - 600	0.2
700 - 900	0.3
1000 - 1200	0.4
1300 - 1500	0.5
1600 - 1800	0.6
1900 - 2100	0.7
2200 - 2400	0.8 - 1.6
2500 - 2700	0.9 - 1.8
2800 - 3000	1.0 - 2.0
3100 - 3300	1.1 - 2.2
3400 - 3500	1.2 - 2.4
3600 - 4000	1.3 - 2.6

Table 6: Approximate amount of lubricant for each gasket/spigot

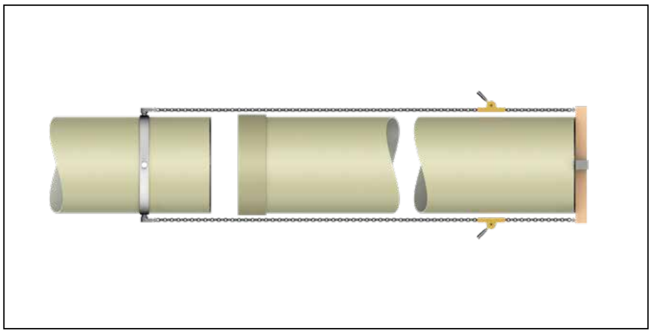

Fig. 29: Pipe assembly with come-along jacks

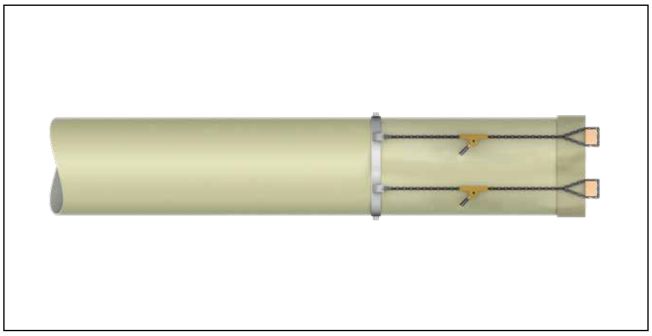

Fig. 30: Mounting of loose coupling to pipes

Name	Temperature range	Application	Diameter Range (DN)	Application Range
Standard	-5°C to +50°C	Standard lubricant	100 - 2000	Small and medium diameters
Standard Potable Water*	-5°C to +50°C	Standard, **Potable water approval**	100 - 4000	Small and medium diameters, **packed with DVGW Approval for potable water**
Potable Water High Performance*	-20°C to +50°C	Large diameter, Pressure Pipes (small DN) up to DN 800, Key-Lock with **potable water approval**	2000 - 4000	High load lubricant for large diameter pipes, locking rod and small diameter pressure pipes **with potable water approval, reduced mounting force**
High Performance	-10°C to +50°C	Large diameter, Pressure Pipes (small DN) up to DN 800, **bad weather conditions, rain, wet surface**	2000 - 4000	High load lubricant for large diameter pipes, locking rod and small diameter pressure pipe, **useful for wet conditions, rain etc., reduced mounting force**
Cold Temperature	-15°C to +50°C	Winter conditions	100 - 2000	Winter lubricant, recommended for small and medium diameters
Extreme Condition	-20°C to +50°C	Extreme conditions, **under water installation, water flow**	100 - 4000	Special lubrication for complicated conditions, not water soluble, vegetable based
* closed packing in potable water quality: Hygienic application required to comply with potable water requirements acc. DVGW, KIWA etc.				

Table 7: Types of lubricant for various conditions

5.2.1.7. Assembly of locked joints (FBC)

The locked joint system is intended for straight installation of pipes and fittings (no planned deflection in joints). The pipe spigot for locked joints has a matching groove (see Fig. 31).

The coupling is installed following the procedure as described above until the coupling matches the home-line, as there is no center register. The pipe is then pulled in position until the groove in the pipe is visible through the opening in the coupling. Generally, an excavator installation is not recommended.

After the coupling is in its final position and before inserting the locking rods, a feeler gauge may be used to ensure the gasket lips are properly oriented. The locking rod is then pushed into position with a hammer or suitable equipment. For large diameter pipes, more than one length of locking rod is needed. The locking rods shall be inserted until they are all around the groove and become visible through the insertion hole.

The pipeline must be backfilled before pressure testing. Note that the FBC coupling is not intended to be fully pressurized without backfill support. During pressurization, there will be movement, which is normal, until the joints are fully loaded.

For cooling water systems and other cases where the service temperature is considerably higher than the installation temperature, see Chapter 4.8.

5.2.1.8. Pipe misalignment

The maximum allowable misalignment of adjacent pipe ends is 5 mm (see Fig. 32). It is recommended to monitor misalignment in particular near thrust blocks, valve chambers, and similar critical structures, as well as at closure or repair locations.

5.2.1.9. Angular deflection (Fig. 33)

There is an allowable angular deflection in service at each coupling (FWC and FPC), as specified in the product standards, and presented in Table 8 and Annex B. These values take into account the combined vertical and horizontal deflection.

This can be utilized to accommodate gradual changes in line direction. The pipes should be joined in straight alignment and thereafter deflected angularly as required. The maximum offset and corresponding radius of curvature are shown in Table 9 and Annex B. For installations requiring larger angles, see Chapter 5.1.

5.2.1.10. Miscellaneous

For FSC, ASC, FPC, and FPCA couplings, a fully exposed central register may be removed or cut out to prevent it from coming loose or falling out.

The pipes can also be mounted with a crowbar up to DN 300, or by an excavator bucket. The spigot ends/coupling are to be protected from any damage or displacement. Do not apply any point loads, and instead use a suitable means for distributing the loads (e.g. wooden beam). If damage does occur, contact Amiblu immediately.

Figure 34 shows the pipe assembly using slings with protection of the spigot end.

Refer to Diagram 1 for the factory measured joining forces. Note that the forces may vary due to on-site conditions. Field experience has shown that a margin of 1.5 times the values shown in Diagram 1 covers most cases.

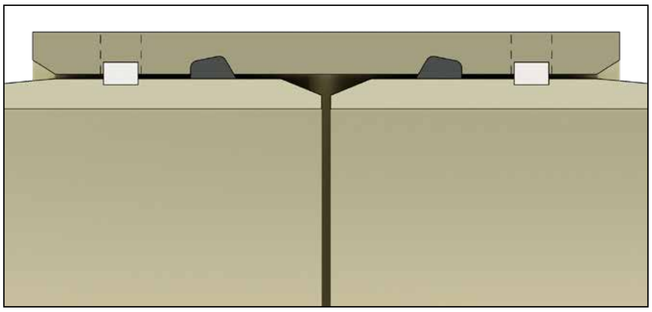

Fig. 31: Flowtite locked joint

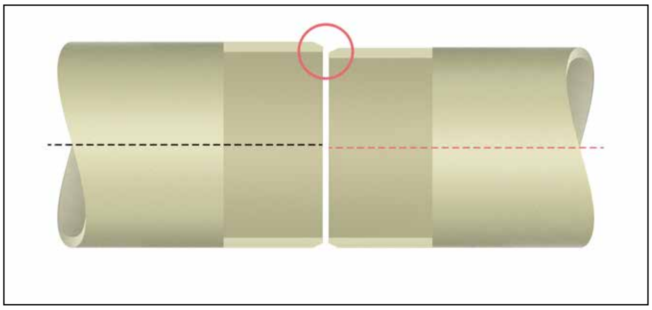

Fig. 32: Pipe misalignment

Amiblu®

Nominal pipe diameter (mm)	Pressure (PN) in bars			
	up to 16	20	25	32
		Max. angle of deflection (°)		
DN ≤ 500	3	2.5	2	1.5
500 < DN ≤ 900	2	1.5	1.3	1
900 < DN ≤ 1800	1	0.8	0.5	0.5
DN > 1800	0.5	0.4	0.3	N/A

Table 8: Max. angular deflection for unrestrained joints based on product standards. See Annex B for more details.

Angle of deflection	Maximum offset (mm) pipe length			Radius of curvature (m) pipe length		
deg	3 m	6 m	12 m	3 m	6 m	12 m
3	157	314	628	57	115	229
2.5	131	262	523	69	138	275
2	105	209	419	86	172	344
1,5	79	157	314	115	229	458
1.3	68	136	272	132	264	529
1	52	105	209	172	344	688
0.8	42	84	168	215	430	859
0.5	26	52	105	344	688	1375

Table 9: Offset and radius of curvature

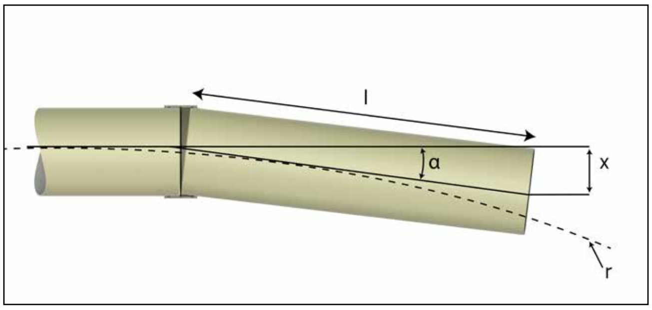

Fig. 33: Coupling, angular joint deflection

l – Pipe length
x – Offset
α - Deflection
r - Radius of curvature

Note: The above is for informational purposes only. The minimum allowable length is a function of nominal pressure and backfill class and compaction, but in general, it should be not less than 3 m.

Angular deflected couplings are stabilized by the stiffness of the soil surrounding the pipe and coupling. Pressure pipes (PN>1) should have angularly rotated joints backfilled to a minimum of 90 % standard proctor compaction.

High pressures require consideration of possible uplift forces at joints both during operation and any field hydrotesting. For operating pressures of 16 bar and greater, the minimum burial depth should be 1.2 meters for pipes of DN 300 mm and larger and 0.8 metres for pipes of DN less than 300 mm.

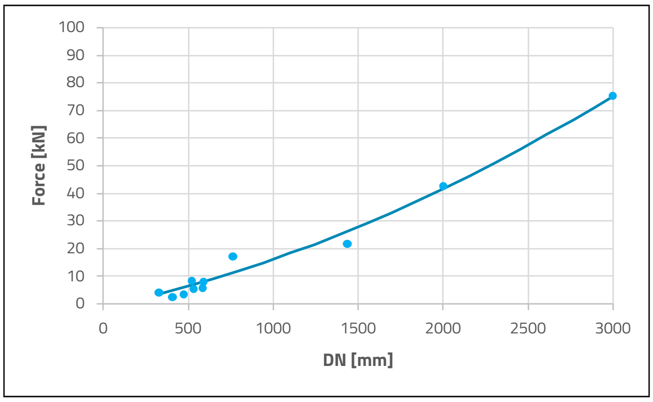

Diagram 1: Factory-set jointing forces with couplings

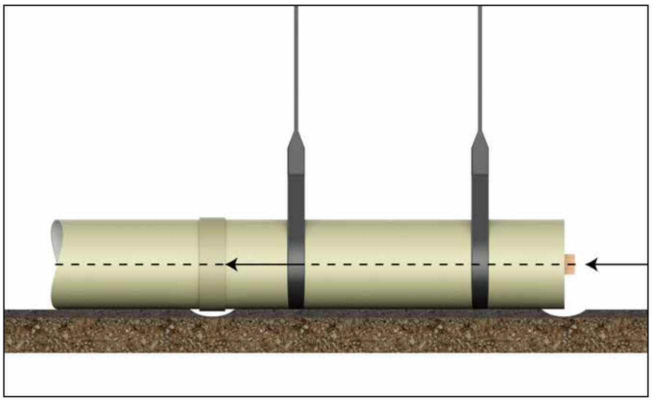
Fig. 34: Pipe joining with suitable equipment (slings not necessarily required)

5.3. Flanged joints

5.3.1. GENERAL

This section contains general information on flange jointing. If more details are required for your installation, consult your local Amiblu supplier.

Composite flanges are typically more flexible compared to metal flanges, with corresponding bolt torque requirements. The recommended bolt torque for GRP flanges as provided in Amiblu Datasheets must not be exceeded.

Composite flanges are available both as a restrained and unrestrained system.

5.3.2. FLANGE TYPES

Amiblu supplies various types of flanges, optimized for their usage and application, as shown below.

5.3.2.1. Loose flanges

These are made of a GRP stub flange and either a GRP, galvanized, or stainless steel backing ring (see Fig. 35).

5.3.2.2. Fixed flanges

The fixed flange consists of a piece of pipe with the same pressure class as the pipeline and a permanently fixed collar (see Fig. 36).

5.3.2.3. Blind flanges

Blind flanges are available as GRP, galvanized, or stainless steel (see Fig. 37).

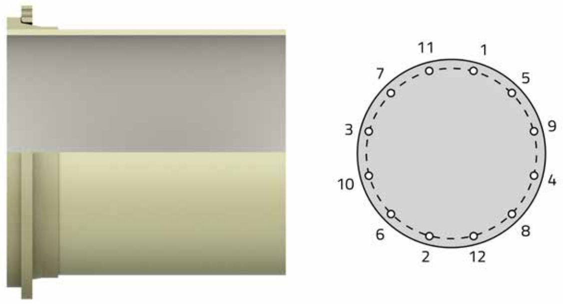

Fig. 35: Loose flange

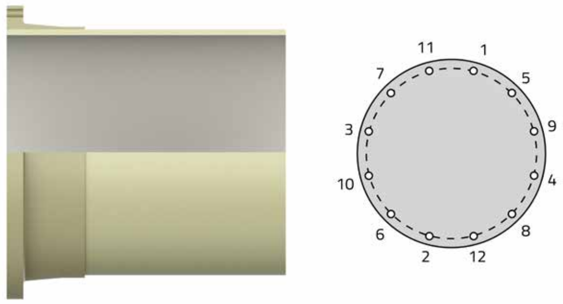

Fig. 36: Fixed flange

Fig. 37: Blind flange

5.3.3. TYPE OF GASKETS

Rubber gaskets are used to seal flange connections and there are various types available. For example, O-ring (Fig. 40), profiled full-face (Fig. 39), and profiled ring gaskets (Fig. 38).

Depending on the type of gasket used, a different tightening torque specification is needed.

A profiled full-face gasket covers the entire face of the flange. Tightening provides support for the entirety of the flange. A profiled ring gasket, on the other hand, is positioned only inside of the bolts. For the O-ring gasket, the flange is equipped with a groove, fitting to the O-ring gasket.

A major advantage of profile gaskets (Fig. 41) is the cross-section with integrated O-ring. This type achives secure sealing with a lower bolt torque.

For assistance with selecting from our different gasket styles and their torque specifications, contact your local Amiblu supplier.

5.3.4. FLANGE INSTALLATION

Bolt torquing should be conducted according to specifications in the technical datasheet for the flange and gasket combination supplied.

Tightening should never be done with flanges under pressure.

Note that the specified tightening torque for gasket or flange should not be exceeded in any situation.

When GRP and metal flanges are connected, the metal flange must be of a flat face type; raised face flanges are not allowed.

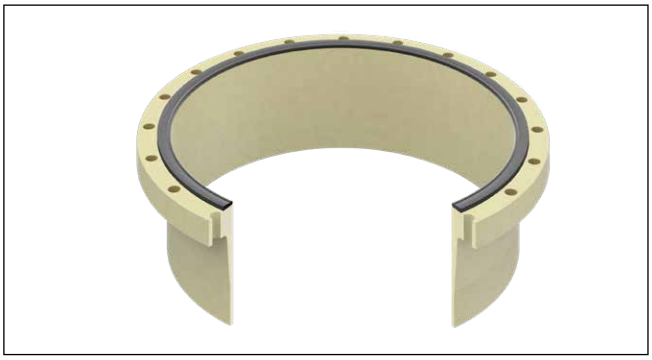

Fig. 38: Profiled ring gasket (considered as raised face condition for torque setting)

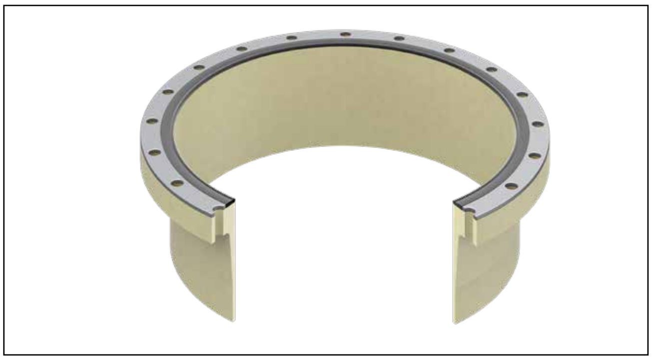

Fig. 39: Profiled full-face gasket with support ring (considered as a full-face condition for torque setting)

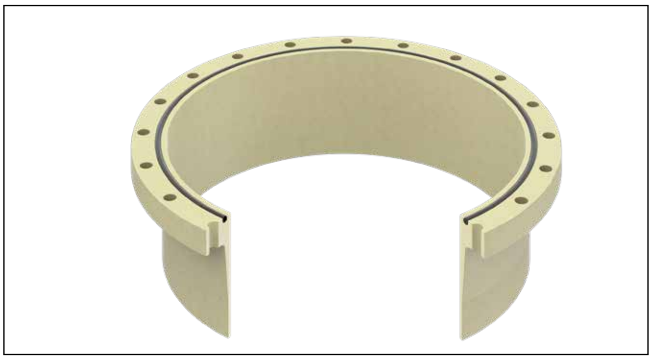

Fig. 40: O-ring gasket (considered as a full-face condition for torque setting)

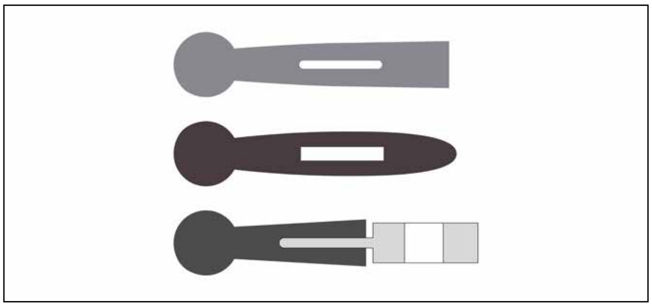

Fig. 41: Cross-sections of typical profiled gaskets

GRP flanges should be joined according to the following procedure (Fig. 42, Fig. 43, and Fig. 44):

- Thoroughly clean the flange face.
- Ensure the sealing gasket is clean and undamaged. Do not use defective gaskets.
- Position the sealing gasket in the flat face or the O-ring in the groove. It is recommended that the gasket be secured with small stripes of tape or adhesive.
- Align flanges to be joined.
- Insert bolts, washers, and nuts. All parts must be clean and lubricated to avoid incorrect tightening. The mating surface between the bolt head/washers and the backing ring plate must be well lubricated to avoid friction.
- Washers must be used on all GRP flanges.
- Using a torque wrench, tighten all bolts following the proper of tightening sequences (Fig. 45). It is important to tighten bolts in several stages according to the specifications for the flange/gasket combination.
- Check bolt torques one hour later and adjust to the specification, if necessary.

5.3.5. BOLTING STANDARDS

Amiblu GRP flanges can be supplied with drilling patterns following most national and international standards.

The engineer needs to ensure that the flanges of one connection are of the same standard. Common available flange standards are:

- EN 1092-1 (former DIN 2501)
- ISO 7005
- ANSI B16.47 Series A
- ANSI B16.5
- AWWA C207 Class D

5.4. Butt-wrap joints

This type of joint is made from glass fiber reinforced plastic

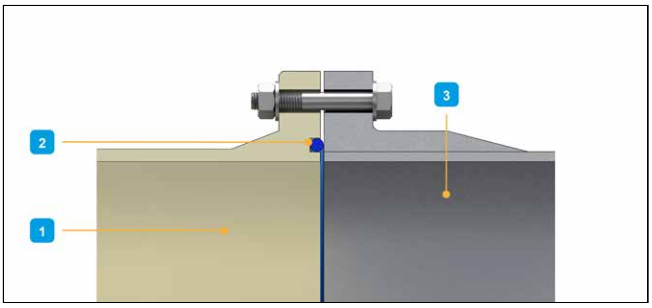

Fig. 43: GRP fixed flange using an O-ring gasket

1 - GRP flange
2 - O-ring gasket
3 - Metal or GRP flange

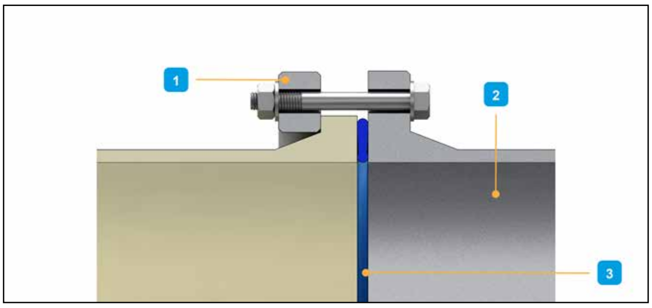

Fig. 44: GRP loose flange with steel backing ring using profiled ring gasket

1 - Steel or GRP backing ring
2 - Steel or GRP flange
3 - Profiled ring gasket

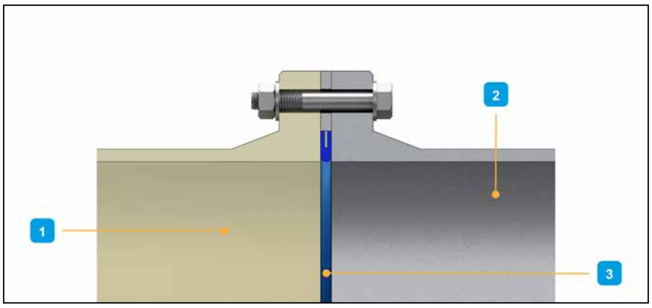

Fig. 42: GRP fixed flange using a full-face gasket

1 - GRP flange
2 - Metal or GRP flange
3 - Full face profiled gasket

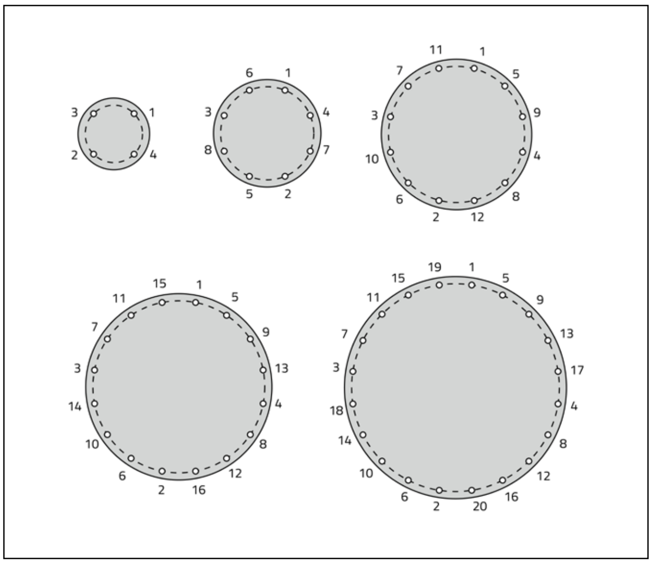

Fig. 45: Tightening sequences

(GRP) on site. It requires qualified designs, clean, controlled conditions, and skilled personnel. Special instructions will be provided when this type of joint is required (see Fig. 46).

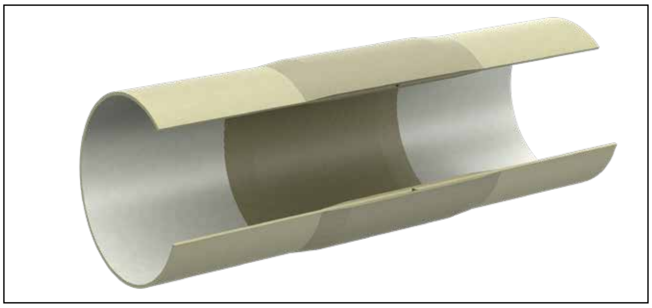

Fig. 46: Butt-wrap joint

5.5. Other joining methods

Couplings described in this chapter can be used for joining Amiblu GRP pipes with different pipe materials, for field closures, or repair. For information about qualified products, contact your local Amiblu supplier.

For installation details, follow the manufacturer's instructions.

5.5.1. SHEAR BANDED COUPLINGS

Shear banded couplings (see Fig. 47) are specifically designed to connect and repair pipes in adopted sewer and drainage applications. The stainless-steel central band protects the joint under shear loads and keeps the joining pipes aligned, helping to prevent pipe displacement. This couplings are typically used in gravity applications. The stainless steel band also helps prevent pipe displacement, and allows for less excavation compared to replacing an entire length of pipe.

Fig. 47: Shear banded coupling

5.5.2. FLEXIBLE MECHANICAL STEEL COUPLING

When connecting Amiblu pipe to other pipe materials with different outside diameters, flexible steel couplings are typically the preferred jointing method (see Fig. 48).

Fig. 48: Flexible steel coupling

These couplings consist of a flexible steel mantle with an interior rubber sealing sleeve.

Three grades are commonly available:

- Coated steel mantle
- Stainless steel mantle
- Hot-dip galvanized steel mantle

With this type of connection, it is important to control the bolting torque of the flexible steel couplings. Do not over-torque as this may over-stress the bolts or the pipe. Follow the coupling manufacturer's recommended assembly instructions, along with Amiblu recommendations.

5.5.3. RIGID MECHANICAL STEEL COUPLING

Rigid mechanical couplings have been used successfully to join pipes of different materials and diameters, as well as to adapt to flange outlets. There is a wide variation in the design of these couplings, including bolt size, number of bolts, and gasket design. Large variations also exist in the diameter tolerance of other materials, which often results in higher bolt torque than necessary to achieve a tight seal on the Amiblu side.
For this type of coupling, the bolt torque to achieve a good seal is controlled by the pipe properties. For instance, the requirements for metal pipes and GRP are different due to

the material elasticity and operational strain. Therefore, rigid mechanical couplings with a dual independent bolting system should be used (Fig. 49). This allows for independent tightening of the two sealing sides.

To achieve a proper seal, steel pipes require a higher bolt torque compared to GRP pipes. Consult your local Amiblu supplier for additional details.

Fig. 49: Dual bolt mechanical coupling

5.6. Corrosion protection

Metal components used in any connection may need to be protected against corrosion according to the manufacturer's specification or applicable standards.

6. Connection to rigid structures

6.1. General

Bending and shear stresses can develop in a pipe that moves in relation to a rigid structure. This may occur when a pipe passes through a wall (e.g., valve chamber or manhole), is encased in concrete (e.g. thrust block), or is flanged to a pump, valve, or other structure. The foundation of the structure should be designed to avoid excessive differential settlements.

Short length pipe (rocker pipe) near the structures is recommended to accommodate differential settlement (see Fig. 50, 51, and 52). Generally, the lengths of rocker pipes should be between 1x DN[m] and 2x DN[m]. For practical purposes, the lengths provided in Table 10 are recommended.

The rocker pipe should be aligned with the structure at the time of installation to provide maximum flexibility for subsequent movements. Multiple short lengths or rocker pipes should not be used, as the short spacing between couplings may result in an unstable condition.

Two options are available. The standard (preferred) method specifies a coupling joint cast into the structure. The alternate method specifies the pipe to be wrapped in rubber to ease the transition.

6.2. Standard method

For the standard solution, a coupling is integrated into the structure at the interface (Fig. 51). The first pipe (rocker pipe) outside the structure has freedom of movement (within the limits of the joint). For PN larger than 16, this standard method should be used, and the length of the rocker pipe should be kept at the maximum indicated in Table 10.

- Caution: Since the coupling cast in concrete is rigid, it is very important to minimize the vertical deflection and deformation of the adjacent pipe.
- Caution: It is recommended to connect the rocker pipe first before concrete encasement. If this is not possible, care must be taken that the coupling is kept round.

6.3. Alternative method

Where the standard method is not possible, wrap a band (or bands) of rubber (Fig. 52 and 53) around the pipe before placement of any concrete such that the rubber slightly protrudes (25 mm) from the concrete. Lay out the pipeline so the first completely exposed coupling joint is located as shown in Fig. 52. For PN larger than 16, this alternate method is not recommended.

DN [mm]	BL [mm][1]
200 - 450	500
500 - 900	1000
1000 - 1400	2000
1500 - 3000	3000
3100 – 4000	6000[2]

[1] Recommended rocker pipe length

[2] For diameters larger than DN 3000, pipes shorter than 6 m are often specified

Table 10: Rocker pipe length

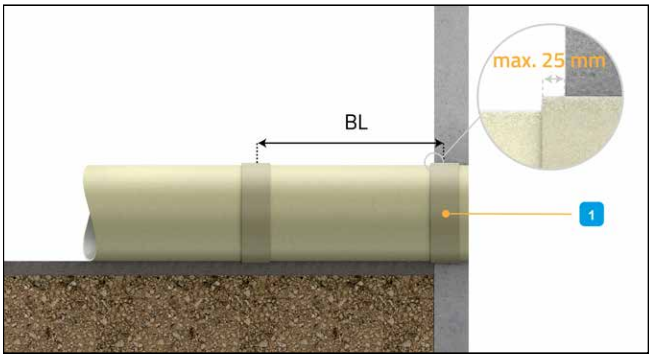

Fig. 50: Connection to buildings with couplings for non-pressure applications

BL - Length rocker pipe (see Table 10)

1 - Coupling

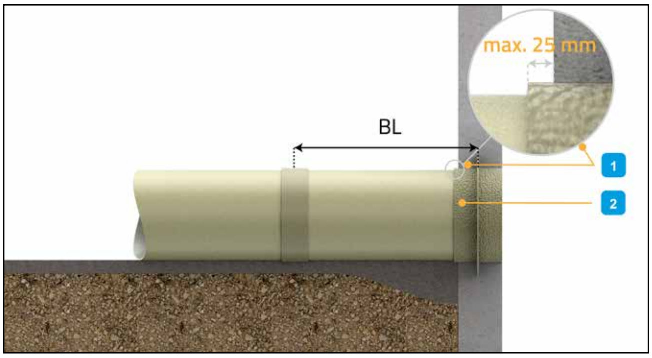

Fig. 51: Connection to buildings with masonry couplings

BL - Length rocker pipe (see Table 10)

1 - Structural adapter

2 - Coupling, optionally sanded outside or with sealing tape (Bitumen)

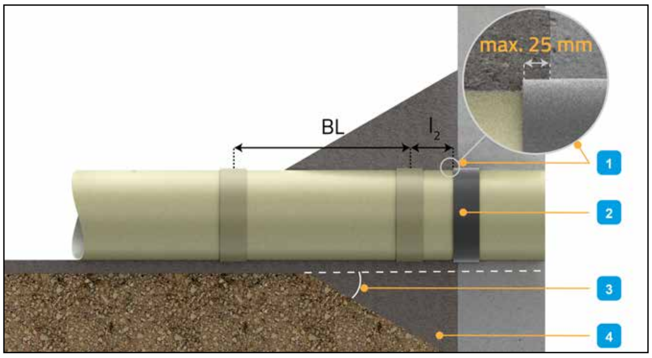

Fig. 52: Alternative connection – rubber wrap around pipe encased in concrete

BL - Length rocker pipe (see Table 10)

l_2 - Max. stub length of the concrete-encased pipe (max. 0.4 m or DN/2000 m; whichever is larger)

1 - Rubber slightly protrudes (max. 25 mm)

2 - Rubber wrap

3 - Max 45° angle

4 - Well compacted pipe zone material (or stabilized) backfill (to min. 95 % SPD)

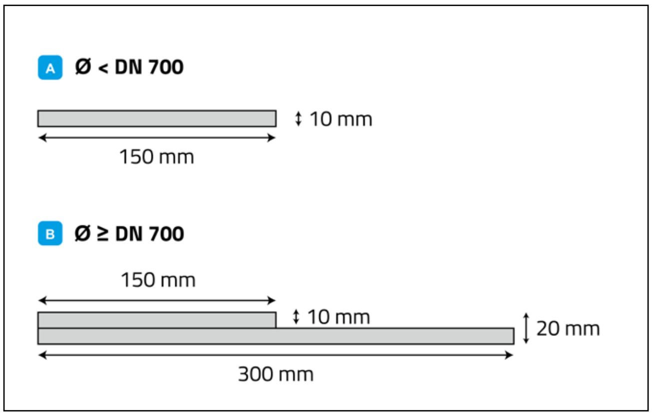

Fig. 53: Rubber wrap configuration – rubber shall have 50-60 shore A hardness

7. Installation of tanks, fittings, and other GRP structures

Installing GRP structures such as tanks, drop structures, combined sewer overflow chambers, and fittings is like laying pipelines. Always ensure that they are well embedded and that the pipe zone is properly compacted, as this work has a direct effect on the pipe/soil system's stability. Such structures may require improved pipe zone conditions to avoid load concentrations due to soil cover and traffic loads. In some cases, a concrete casing may be required.

For the installation of Amiblu GRP manholes, refer to the seperate installation manual for manholes.

For connections to the structures addressed in this chapter, follow the instructions outlined in Chapter 5.

- For GRP structures, special equipment may be required for transport, lifting, and during installation, depending on their size and weight.
- Pay particular attention here to the accident prevention regulations and the equipment's load capacity.
- If the GRP structure is provided with lifting points, they are designed for that purpose. In case of other uses, consult your local Amiblu supplier.
- When installing GRP structures, you want to generally lower them into the pit. Do not push, press, or roll them.

For detailed information about the installation of tanks and special fittings, contact your local Amiblu supplier.

Depending on the actual GRP structure involved, it may be difficult to apply the forces required for joining. If so, you can generally work with installation aids to enable fittings to be joined in a controlled way. Winches or jacks have proved useful in the field (see Fig. 54).

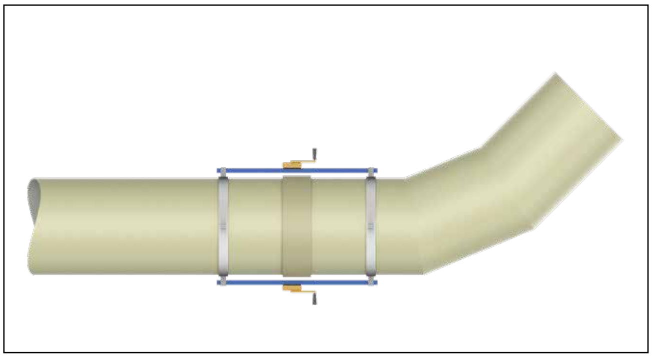

Fig. 54: Joining of fittings with mechanical equipment

8. Concrete and grout encasement

8.1. General

When pipes (or fittings) must be encased, such as for thrust blocks or to carry unusual loads, the following additions to the installation procedures must be observed.

8.2. Pipe anchoring

During the pouring of the concrete, the empty pipe or fitting will experience uplift (flotation) forces. The pipe must be restrained against movement caused by such forces. The method of securing the pipe must be appropriate for the product installed (see also Chapter 4.7).

This is normally accomplished by strapping over the pipe to a base slab or other anchor(s).

Straps should be made from a flat material of minimum width 10 % of DN, but never smaller than 25 mm. They should also be strong enough to withstand flotation uplift forces, with two straps, or more per pipe and with the maximum spacing between straps as shown in Table 11.

The straps should be tightened to prevent pipe uplift, but should not be tightened so much that additional pipe deflection results (see Fig. 55 and Fig. 56).

Tees and elbows require at least a 3-strap fixing. To prevent lateral movement, cross strapping is recommended.
Pipes should also be strapped adjacent to joints to avoid misalignment.

The strap width and spacing is based on the specifications for maximum concrete pouring in this manual. For project specific conditions consult your local Amiblu supplier.

DN [mm]	Maximum strap spacing [m]	Maximum strap spacing PN 1 [m]
< 200	1.5	1
200 - 350	2	1.5
400 - 550	3	2
600 - 960	4	3
≥ 1000	6	4

Table 11: Maximum strap spacing for pipe anchoring

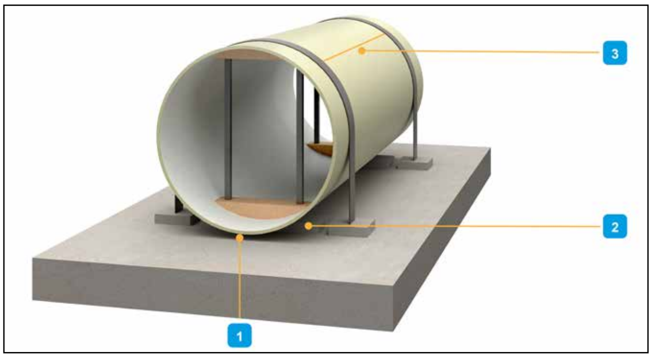

Fig. 55: Pipe anchoring—maximum spacing of straps. See Table 11

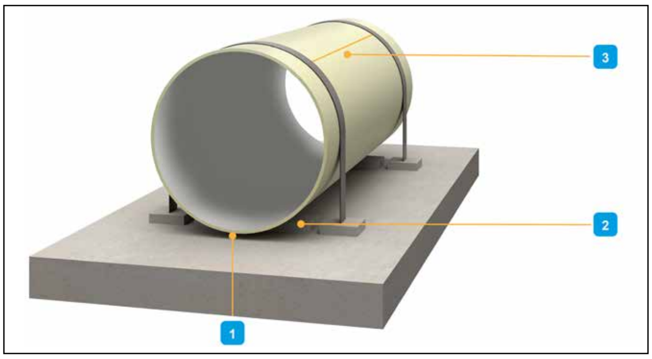

Fig. 56: Pipe anchoring without internal support—maximum spacing of straps. See Table 11

1 - Clearance
2 - External support
3- Max. strap spacing

Note: The need for anchoring and supporting the pipes during the concrete pouring can be reduced by actively controlling and limiting the buoyancy exerted on the pipes; e.g. filling the pipe with water (consider the liquid density of the encasement material).

8.3. Concrete pouring

The concrete must be placed in stages to allow sufficient time between layers for the cement to set and no longer exert buoyant forces. The maximum lift heights, as a function of stiffness class, are as shown in Table 12. The pipe should be supported in such a way that the concrete can easily flow completely around and fully underneath the pipe with ease.

The maximum lift is the maximum depth of concrete that can be poured at one time for a given nominal stiffness class.

SN Maximum lift	Maximum lift heights [m] [1]
2500	Larger of 0.3 m or DN/4
5000	Larger of 0.45 m or DN/3
10000	Larger of 0.6 m or DN/2
[1] Assuming density of concrete as 24 kN/m³	

Table 12: Maximum concrete pour lifts with pipe anchoring acc. to Chapter 8.2

8.4. Temporary pipe support during concrete encasement

If the maximum pour lifts in Table 12 are utilized, then for diameters larger than 1500, the pipe shall be supported internally as shown in Fig. 55 and Fig. 57 to prevent excessive deflection. The internal supports shall have large, shaped contact surfaces to avoid stress concentrations in the pipe and should be collocated with the anchoring straps, see Fig. 55.

Supports (see Fig. 57) need to be designed properly for the expected forces. Also, the supports should result in an acceptable pipe shape (less than 3 % deflection and no bulges or flat areas).

For pressure pipes, the deflection should be limited to less than 1 % to avoid high loads on the surrounding concrete due to pressure re-rounding of the pipe.

SN	Maximum grouting pressure [bar]
2500	0.35
5000	0.70
10000	1.4

Table 13: Maximum grouting pressure (pipe invert) without internal supports

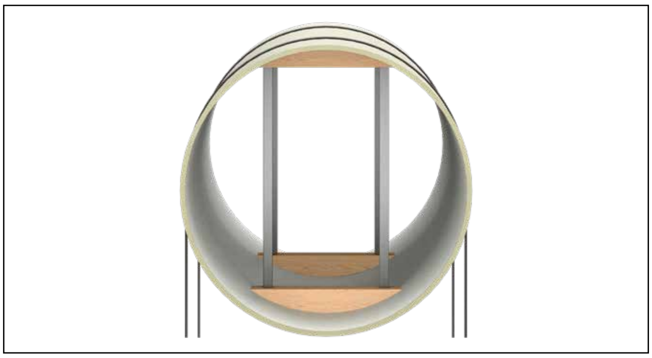

Fig. 57: Internal pipe support

8.5. Casings (Tunnels)

When a standard pipe (unequal exterior flush) is installed in a casing, the following precautions should be observed:

- Pipes may be placed into the casing by pulling (drawing) or pushing (jacking). Consult your local Amiblu supplier for the calculation of the maximum insertion length/force.
- For easy insertion and for protection from sliding damage, the pipes should be equipped with plastic spacers, steel sleeves, or wooden skids. These must provide sufficient height to permit clearance between the coupling joints and the casing wall.
- Installation into the casing is made considerably easier by using lubricant between the skids and the casing wall. However do not use a petroleum based lubricant as it may cause harm to some gaskets.
- The annular space between the casing and pipe may be filled with sand, gravel, or cement grout.

Care must be taken not to overstress or collapse the pipe during this step, particularly when grouting. The maximum grouting pressure is given in Table 13.

9. Thrust restraints

9.1. General

When the pipeline is pressurized, unbalanced thrust forces occur at bends, reducers, tees, wyes, bulk- heads and other changes in line direction. There must be reinforcement against these forces to prevent joint separation. Usually, this is best economically accomplished by using thrust blocks or by direct bearing and friction between pipe and soil.

The weight of the thrust restraints should be well-founded and achieve a similar settlement as the pipeline. Weight loads must not act as a shear force on the pipeline. Connections with rocker pipes have proven to be a good technical solution. Refer to Chapter 6 for more information.

Determination of need and design, as well as the level of steel reinforcement of concrete structures, is the responsibility of the owner's engineer. Amiblu fittings are designed to withstand the full internal pressure, while the concrete structure shall support its shape and transfer the thrust force.

As the expansion of the pressurized fittings is typically greater than the tensile strength that the concrete would carry, steel reinforcement to control crack widths should be considered.

9.2. Thrust blocks

Thrust restraints are typically not required when the line pressure does not exceed 1 bar (100 kPa).

Thrust blocks must limit the displacement of the fitting relative to the adjacent pipe to preserve the leak tightness of the Amiblu coupling joint. The resulting angular deflection shall be less than the values indicated in Table 8.

For operating pressures above 10 bar (PN>10), the block must surround the fitting. For lower pressures, special fittings can be supplied that allow for partial embedding. Consult your local Amiblu supplier.

The block should be placed either against undisturbed earth or backfilled with pipe zone materials selected and compacted as appropriate to meet the original native soil's strength and stiffness.

Concentric manways (blind flange tees), drains and air vents, which do not generate unbalanced thrust in operation, do not require encasement but do require thrust resistant branches and fittings. The thrust block shapes shown in Fig. 58 are merely illustrative. The exact shape will be dependent on design and project requirements. Refer to Chapter 8 for concrete encasements.

9.3. Direct bury

The direct transfer of thrust through friction and bearing is accomplished using restraint joints and special pipes that transfer axial thrust. The accompanying fittings are designed for direct bury. A friction factor of 0.25 - 0.5 for Amiblu GRP pipes and non-cohesive soils was measured. When determining the required anchor length of the pipe connecting to the fittings, apply an appropriate safety concept. There are national standards for calculation of the anchor length, contact your local Amiblu supplier for guidance.

A direct bury of unrestrained fittings is possible in specific project conditions. Contact Amiblu for design support.

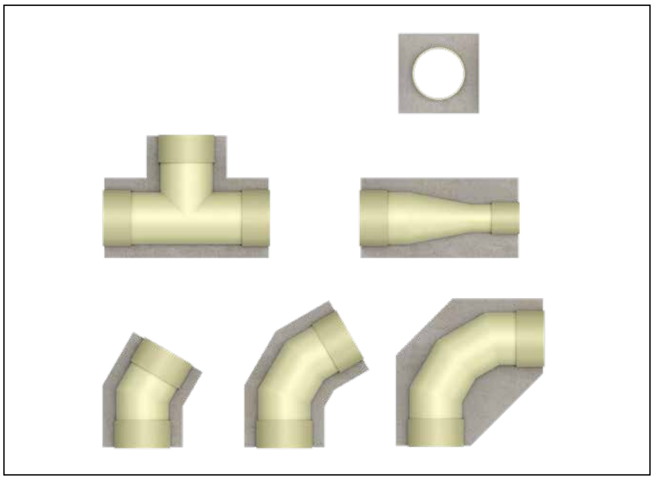

Fig. 58: Thrust blocks (examples)

10. Other installation procedures and considerations

10.1. Multiple pipelines

If planning multiple pipelines, proceed as described in Chapter 4 and select the distance between them "C", based on the requirements for the largest diameter pipe.

For trenches with man access, follow relevant health and safety rules. The distance between pipes shall be selected to ensure proper haunching and backfilling of the pipe zone.

In case of installation in liquid soil or concrete pouring, the minimum spacing (see Fig. 59) between the pipelines is 0.15 m.

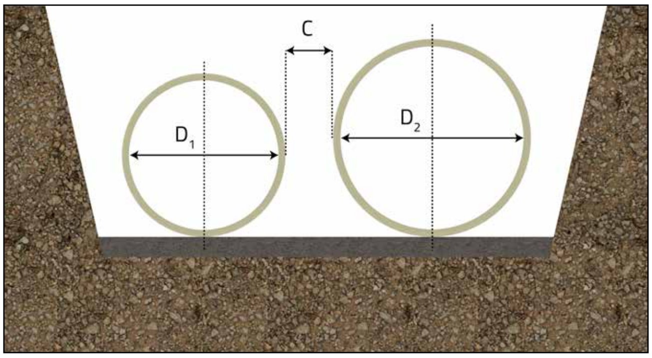

Fig. 59: Minimum spacing (C) between pipelines

C - Horizontal distance between pipes

10.2. Crossovers

When two pipes cross, such that one passes over the other, vertical spacing between pipes and installation of the bottom pipe should be as shown in Fig. 60. In some cases, it is necessary to lay a pipe under an existing line. Extra care should be taken not to damage the existing pipe. It should be protected by temporarily fastening it to a steel beam crossing the trench during construction. It is also advisable to wrap the pipe to protect it from impact damage.

When the new pipe is laid, clean coarse-grained soils with limited content of fines, sandy or fine-grained soils should be used as backfill. They should be compacted to a minimum of 90 % SPD completely around both pipes, plus 300 mm above the crown of the upper pipe. This backfill should extend at least twice the diameter into each trench (see Fig. 60).

Placing rocker pipes on each side of this installation should be considered.

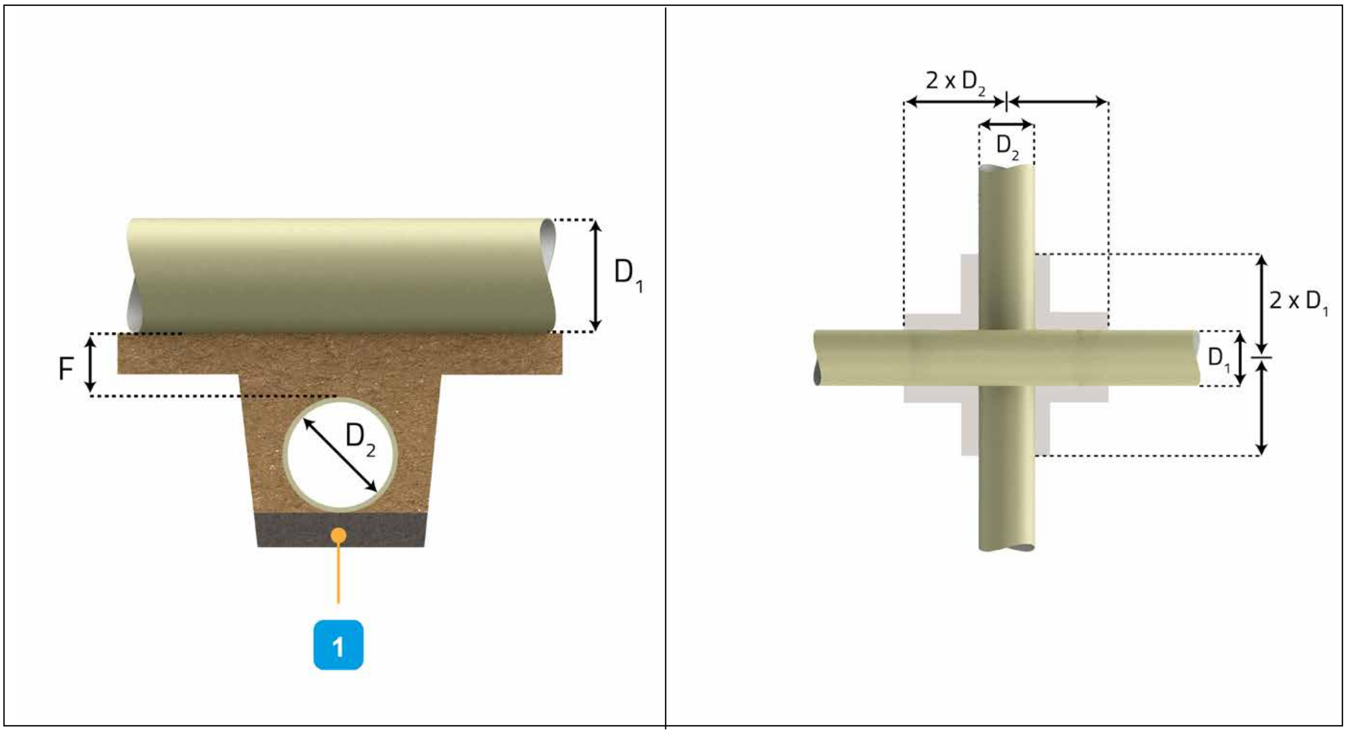

Fig. 60: Crossing of other pipelines

1 - Bedding
F - Vertical distance between pipes

Depth of cover over upper pipe:		
Up to 4 meters:	Over 4 meters:	Never less than 150 mm.
$F \geq \frac{D_1 + D_2}{6}$	$F \geq \frac{D_1 + D_2}{4}$	
Clean coarse-grained soils with limited content of fines, sandy or fine-grained soils.		

10.3. Installation with steep gradients

10.3.1. GENERAL

- The angle at which slopes can become unstable depends on the quality of the soil. The risk of unstable conditions increases dramatically with slope angle.
- Pipes should not be installed on slopes or in areas where slope instability is suspected, unless supporting conditions have been verified by a proper geotechnical investigation.

10.3.2. BURIED INSTALLATION

Before pipes are installed underground on slopes where instability is suspected, it is recommended that a geotechnical engineer be consulted.

The surface of the completed trench must be recontoured to eliminate depressions and preclude the formation of puddles of water. The collection of water on a slope reduces slope stability and may contribute to internal slide and shear conditions.
In thrust direction, the soil capacity to compensate for unbalanced thrust forces must be checked both for angular deflected joints and thrust blocks.

Amiblu pipes can be installed on slopes provided the following minimum conditions are achieved:

- The long-term stability of the installation is ensured through a proper geotechnical design.
- For slopes where instability is suspected, use either crushed rock or cement stabilized backfill in the pipe zone as backfill material.
- Installation should always proceed from the low point and progress up the slope. Each pipe should be properly backfilled to grade before the next pipe is placed in the trench.
- The surface over the completed pipe trench must be protected against erosion from flowing water.
- Pipes are installed in straight alignment (plus or minus 0.2 degrees) with a minimum gap between pipe spigots.
- Absolute long-term movement of the backfill in the axial direction of the pipe must be less than 20 mm.
- The installation must be properly drained to avoid washout of materials and thus ensure adequate soil shear strength.
- The stability of individual pipes is monitored throughout construction and the first phase of operation. This can be done by controlling the gap between pipe spigots. For engineering support, contact your local Amiblu supplier.

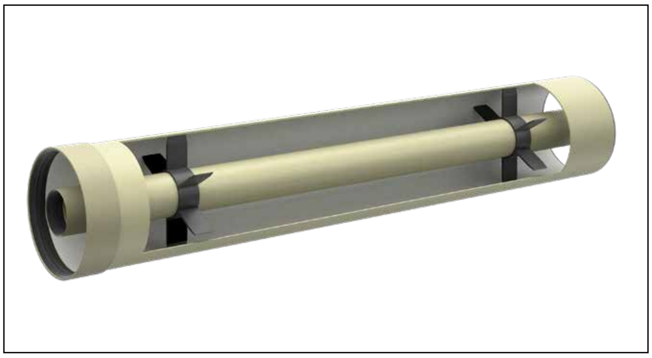

Fig. 61: Pipe in pipe system with casing pipe and spacers

10.3.3. ABOVE-GROUND INSTALLATION

The preferred method of installing pipes on steep slopes is above ground. This is because above-ground structures, such as pipe supports are more easily defined, the quality of installation is easier to monitor, and settlement easier to detect.
Reach out to your local Amiblu supplier for more information on above-ground installation.

10.4. Double pipes

Amiblu double pipe systems are frequently used in potable water protection zones. Pipe-in-pipe is normally pre-assembled before being supplied to the construction site. The distance between spacers should follow the Amiblu above-ground installation manual.
The double pipe system consists of a carrier pipe for media transport and a host pipe for protection (see Fig. 61).

10.4.1. INSTALLATION

Spacers with runners keep the carrier pipe in place. To maintain the pipeline's structural stability, at least two spacers are required per 6 m pipe. As various spacer models have different ratings and applications can vary, more spacers may be necessary. The process for laying double pipes is the same as for standard pipes. The only difference when joining them is that you are to start with the carrier pipe and check it before joining the casing pipe.

10.4.2. PRESSURE AND LEAK TESTING

When leak testing double pipes, note the following special features. If only the carrier pipe is to be tested, proceed as described in Chapter 11.

Given the forces acting during changes in direction, special precautions have to be taken for pressure tests.

Consult Amiblu about such projects.

If the annular space between host and carrier pipe is tested without filling the carrier pipe (counter pressure), consider the allowable buckling pressure of the carrier pipe.

One possible procedure is to test the carrier pipe first, and then the carrier pipe and casing space at the same time. This ensures that the pressure is the same both in the carrier pipe and the casing space.

10.5. Pipe installation in an area with a high groundwater table

To guarantee a safe structure in the long term, the soil and groundwater conditions must be examined. When the groundwater table is above the trench bottom, the water level must be lowered to at least the trench bottom (preferably about 200 mm below) before the preparation of the bed. Different techniques may be used depending on the nature of the native material. For sandy or silty soils, a system of well-points to a header pipe and a pump is recommended.

The spacing between individual well-points and the depth at which they will be driven depends on the groundwater table and the permeability of the soil. It is important to use a filter around the suction point (coarse sand or gravel) to prevent clogging of the well-points by fine-grained native material.

Consider the use of an appropriate soil filter or a geotextile filter fabric along the boundary of incompatible materials to avoid migration and act against buoyancy.

When the native material consists of clay or bedrock, well-points will not work. Dewatering is more difficult to achieve in this case. The use of sumps and pumps is therefore recommended. If the water cannot be maintained below the top of the bedding, sub-drains must be provided.

The sub-drains should be made using single-size aggregate (20 to 25 mm) embedded in a filter cloth. The depth of the sub-drain under the bed depends on the amount of water in the trench.

If the groundwater can still not be maintained below the bed, filter cloth should be used to surround the bed (and if necessary, the pipe zone area as well) to prevent contamination by the native material. Gravel or crushed stone should be used for bed and backfill. The following cautions should be noted when dewatering:

- Avoid pumping long distances through the backfill materials or native soils, since the loss of support to previously installed pipes due to removal of materials or migration of soil may occur.
- Do not turn off the dewatering system until sufficient cover depth has been reached to prevent pipe flotation.

10.6. Use of trench supports

The use of trench supports is a common procedure during the installation of pipes. This is part of the project design and must follow health and safety regulations. Considerations are needed when temporary sheeting is removed.

Below are some necessary considerations when temporary trench support is removed:

- Care must be taken to ensure proper support between native soil and backfill.
- Removing the sheeting in steps with backfill compaction in the pipe zone against the native soil will provide the best support to the pipe, thus filling the voids that frequently occur behind sheet piling.
  Removal of the sheets after the pipe-zone backfill has been placed and compacted will cause the backfill to lose support which in turn reduces the support for the pipe, especially when voids form behind the sheeting.
  To minimize this loss of support the sheeting should be vibrated during removal. Use only granular backfill between the temporary sheeting and the native soil, compacted to the required density to ensue sufficient final pipe support.
- Verify sure that there are no voids or lack of backfill between the outside of the sheeting and the native soil up to at least above the pipe zone.
- In the case of backfilling with liquid soil, the sheeting should be removed while the backfill is still in liquid status.

Considerations when using permanent sheeting:

- In the case of soft soils, it may be decided to use permanent sheeting for the pipe zone where sheet removal with compaction against native soil is not possible.
- Use sheeting of sufficient length to properly distribute the pipes lateral loads, at least in the pipe zone.
- The quality of the sheeting should be such that it lasts for the design life of the pipe. Backfill procedures are the same as for standard installations.

10.7. Trench construction in rocks

Installation in rock creates a stiff and firm foundation for a pipeline. Where the rock ends and the pipe passes into a soil trench area (or reverse), create a smooth transition with rocker pipes (see Chapter 6.1), as shown in Fig. 62. Alternatively, the use of cement stabilised backfill for the foundation and bedding of a pipe passing through a rock-soil transition would negate the need to locate a coupling at this transition. Trench construction should be conducted according to the method applicable for the native soil conditions.

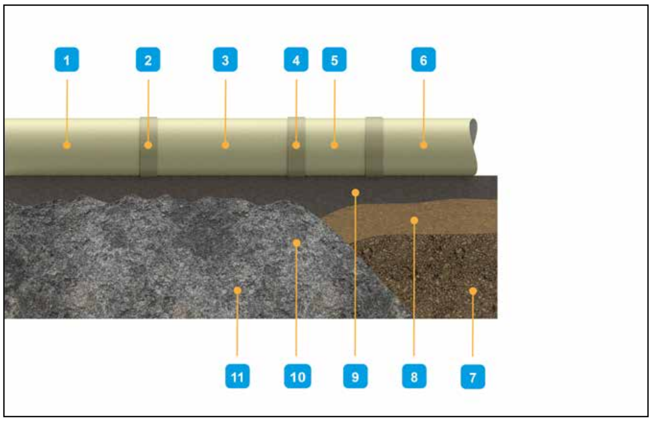

Fig. 62: Method of trench construction and pipe layout at a rock-soil transition[1]

1 - Standard pipe section
2 - Coupling
3 - Make-up section
4 - Coupling adjacent to rocker pipe
5 - Rocker pipe
6 - Standard pipe
7 - Native soil
8 - Foundation (if required)
9 - Bed
10 - Drop-off point
11 - Rock

[1] Also used at abrupt changes in foundation conditions.

11. Leak-tightness testing

11.1. General

Amiblu GRP gravity pipe systems (PN 1) shall be tested for leak tightness in accordance with EN 1610 for pipelines with test pressure up to 0.5 bar. Pressure pipelines are tested according to EN 805. It is recommended to follow installation progress with frequent leak tightness testing for sections of a project.

This chapter describes general recommendations for leak tightness testing for further details and instructions, contact your local Amiblu supplier.

It is generally good construction practice to not exceed pipe testing with installation by more than approximately 1000 m to properly assess the quality of work.

The allowable test pressure for Amiblu GRP pipes and joints is 1.5 x PN. For system testing, including fittings, manholes, and valves, project conditions may need to be considered.

In cases where the test pressure exceeds 1 bar, refer to Chapter 9.

Unburied pipelines or partially covered sections must be stabilised and prevented from moving with suitable measures.

It is recommended to fill the pipeline slowly, without pressurizing, from the lowest elevation. Large enough air vents should enable contained air to escape the pipeline (see Diagrams 2 and 3).

Whenever ther is air within the test section, ensure special safety requirements and consider risks associated with air compressibility.

11.2. Leak-tightness testing with water acc. to EN 1610

Method "W" (testing with water) according to EN 1610 is recommended for conduction tightness tests on manholes and other GRP structures. The described test procedure is based on the test method "W". Individual pipe joints, pipeline sections, or whole pipelines can be tested. Follow the procedures outlined in EN 1610 and use equipment similar to Fig. 63, or suitable pressure gauges, for testing. PN1 products shall be tested at a max. of 0.5 bar. Contact Amiblu if higher test pressure is planned. These pressures should be applied at the lowest point of the tested section.

Refer to EN 1610 for the allowable make-up water per meter.

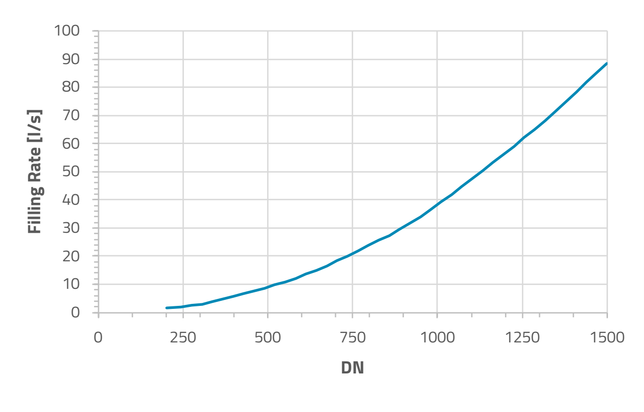

Diagram 2: Recommended filling rate DN 200-1500

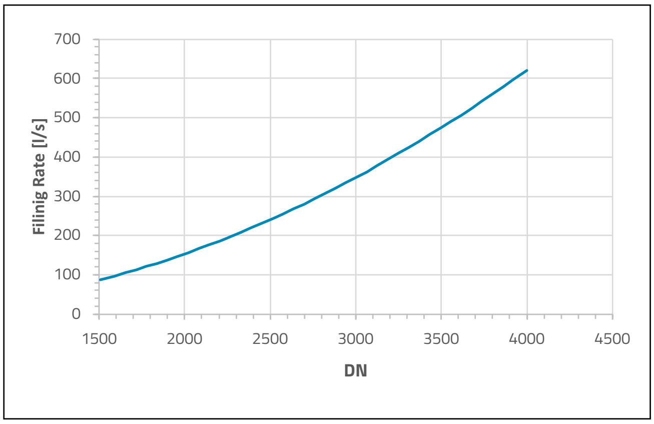

Diagram 3: Recommended filling rate DN 1500-4000

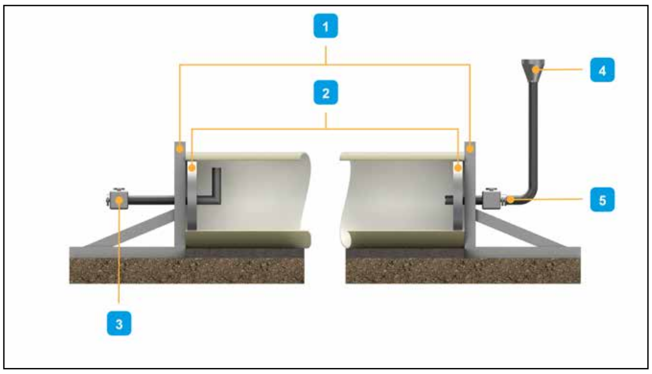

Fig. 63: Temporary valve for leak test of pipe sections

1 - Bracing for pressure test plate and pipeline
2 - Pressure test plate
3 - Vent connection
4 - Funnel for gravity filling
5 - Venting nozzle

11.3. Leak-tightness testing with air acc. to EN 1610

This test procedure is based on the test method "L" in EN 1610, which uses air rather that water. Individual pipe joints, pipeline sections or whole pipelines can be tested. Follow the procedures outlined in EN 1610.

Refer to Table 14 for proper test duration for pipelines without manholes and inspection chambers, taking the pipe diameters and test methods in EN 1610 (LA; LB; LC; LD) into consideration. The test procedure shall be selected according to the owner's or the designer's requirements.

Caution: Considerable energy is stored in a pipeline under pressure. This is particularly true when air (even at low pressures) is the test medium. Take great care to ensure the pipeline is adequately restrained at the fittings in an unbalanced thrust situation. Follow manufacturers' safety precautions for devices such as pneumatic plugs.

Test method	p_0	Δp	t (minutes)						
	mbar (kPa)		DN 100	DN 200	DN 300	DN 400	DN 600	DN 800	DN 1000
LA	10 (1)	2.5 (0.25)	5	5	7	10	14	19	24
LB	50 (5)	10 (1)	4	4	6	7	11	15	19
LC	100 (10)	15 (1.5)	3	3	4	5	8	11	14
LD	200 (20)	15 (1.5)	1.5	1.5	2	2.5	4	5	7
K_p-value			0.058	0.058	0.04	0.03	0.02	0.015	0.012

Table 14: Testing with air - duration of test depending on test method and diameter (source EN 1610)

The relationship between test time and allowable pressure drop is as follows:

$$t = \frac{1}{K_p} \cdot \ln \frac{p_0}{p_0 - \Delta p}$$

Kp=12/DN, with a maximum of 0.058, where t is rounded to the nearest half minute for t - 5 min and the nearest whole minute for t > 5 min

t - Test duration

p_0 - Test pressure above atmospheric

Δp - Allowable pressure drop

11.4. Tightness testing of pressure pipelines acc. to EN 805

This test procedure is based on the test method "pressure loss" in EN 805. Individual pipe joints, pipeline sections, or whole pipelines can be tested using this method. Follow the procedure described in EN 805. Below is a summary of that information.

11.4.1. PREPARATION

Before testing, inspect the completed installation to verify that all work has been finished properly. The following items are of critical importance:

- Joints assembled correctly.
- System restraints (i.e., thrust blocks and other anchors) in place and properly cured.
- Flange bolting torqued per instructions.
- Backfilling completed as described in see Chapter 4.6.
- Axially restrained systems achieve minimum cover for the securing pipe length on all restrained points.
- Valves and pumps anchored.
- Backfill and compaction near structures and at closure pieces properly carried out.
- In case of different product pressure classes used, ensure max. allowed test pressure for each class. Take note of PN changes.

Use equipment similar to Fig. 63, or suitable pressure gauges for testing. Pressure products shall be tested according to EN 805 at a max. of 1.5 x PN up to PN 10 and PN plus 5 bar for anything greater. These pressures should be applied at the lowest point of the tested section.

We recommend performing these 3 test steps as described in EN 805:

- Preliminary test
- Pressure drop test
- Main pressure test

11.4.2. PRELIMINARY TEST

The preliminary test serves to halt the change in volume in the pressure pipeline dependent on the internal pressure, time, and temperature to such an extent that the subsequent main test can give a clear indication of the test section's tightness.

Gradually increase the internal pressure of the filled pipeline at least until ti reaches the operating pressure. Be sure to not exceed system testing pressure.

Maintain the preliminary test pressure (operational pressure) for 6 hours. If pressure drops are observed, depressurize the pipeline, and evaluate the root cause.

System Test Pressure (STP)	Maximum Design Pressure (MDP)	
	MDP ≤ 10 ba	MDP > 10 bar
	1.5 x MDP	MDP + 5 bar
Low point in test section	< 1.5 MDP	< 1.5 MDP
High point in test section	> 1.1 MDP	z> 10 bar

Table 15: System test pressure acc. to EN 805 without water hammer calculation.

11.4.3. PRESSURE DROP TEST

The pressure drop test enables the assessment of the remaining volume of air in the pipeline. Air in the pipeline reduces the accuracy of a pressure test with water. To determine the air remaining in the pipeline, a pressure drop test is recommended. Follow the procedure provided in EN 805.

To calculate the required parameters found EN 805, contact Amiblu for product properties. The pipe wall E-Modulus for Amiblu GRP pipes varies with diameter, pressure and stiffness class.

11.4.4. MAIN PRESSURE TEST

Complete all preparations, clarify safety requirements and complete the preliminary and pressure drop test before starting the main pressure test.

All components of the pipeline (e.g. pipe, fittings, valves, thrust blocks, and restraints), including equipment to close the test section, must be designed for the test pressure with sufficient safety.

Increase the pressure uniformly to the system test pressure (STP). The test pressure should be achieved in the lowest point of the test section and should not be lower than 1.1 times the maximum design pressure (MDP) in any case at the highest point. Observe temperature effects when evaluating the test. If pressure drops are observed, depressurize the pipeline and evaluate the root cause.

For pressure pipelines with a design pressure higher than 10 bar (MDP), the EN 805 system test pressure (STP) is recommended with design pressure +5 bar. This seeks to avoid costly thrust restraints, overdesigned equipment / accessories, or other engineering details in the pipeline for pressure testing only.

11.5. Joint test

If not specified differently, joint test of couplings may be considered (see Fig. 64). On accessible pipelines, it can be econominal to immediately check each joint during installation.

When selecting the joint tester, it is important to consider the inside diameter tolerances for the planned equipment, as well as pipe deflection in the buried condition.

As mentioned, in the field it has proven practical and economical to conduct the test immediately after joining the pipes and moving the machine along as installation progresses.

Note that portable hydraulic field joint test equipment can be specially ordered and supplied for diameters of 800 mm and above.

This equipment can be used to internally test selected pipe joints. It is required that each pipe adjacent to the joint under test be backfilled sufficiently to prevent pipe movement during testing.

For additional details, contact your local Amiblu supplier.

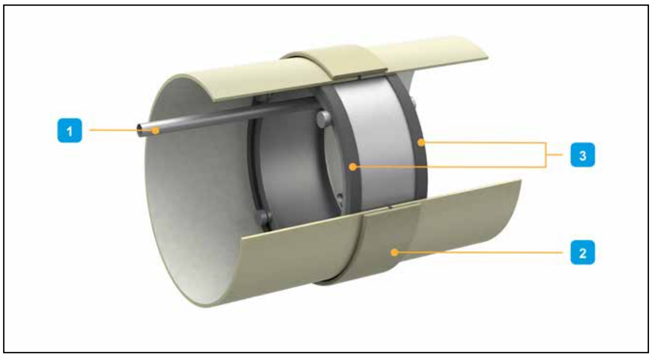

Fig. 64: Joint pressure test unit

1 - Filling hose
2 - Coupling
3 - Rubber sealing

Note: This equipment is designed to allow a test of the joint to verify that joint has been assembled properly with gaskets in their proper positions.

12. Field adjustments

Below are some notes and precautions to keep in mind when conducting field adjustments:

- Secure pipes and fittings to prevent them from rolling or moving. Remove any dirt from surfaces.
- Support the pipe or fitting, enabling the cut to be made in one operation without interruption. Support and hold the cutaway piece at the same level as the pipe to prevent a breakaway.
- Measure and cleary mark the cutting line.
- Cut using preferably a slotted diamond tool, typical tools for concrete or stones are suitable while those for steel do not work well. Avoid excessive force to achieve faster cutting.
- Break the sharp edge on the inside of the pipe with a grinding disk.
- Chamfer the cut edge on the outside of the pipe according to Table 16 and round the edges with a diamond grinding disk (Fig. 65).
  In general, cut edges do not require protection unless the pipes have been ordered with special protection.
- Wear appropriate personal protection equipment when cutting and grinding GRP.

For field adjustment of Flowtite pipes, it is recommmended to use pipes labeled "adjustment pipe". Pipes marked as such do not need further treatment of the pipe spigot.

Flowtite pipes not marked as adjustment pipes must be ground to the spigot diameter d_{PS} with minimum length L_{PS} according to Table 17. Tools for calibration are available upon request. For further details, contact Amiblu.

Note: No additional treatment of the spigot diameter is required for Hobas pipes.

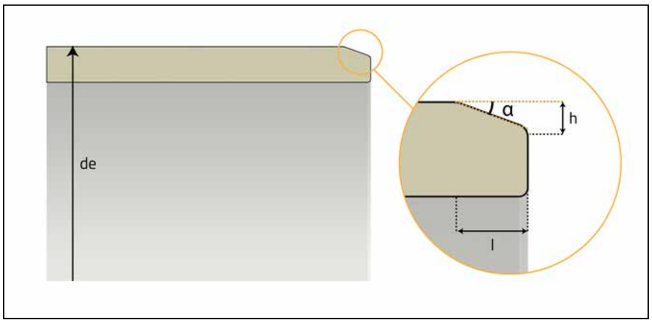

Fig. 65: Required chamfering of the pipe spigot

l – Length
h – Height
α – Chamfer angle
de – Outside diameter

Diameter [mm]	Angle α [°]	Max. Length [mm]	Min. remaining wall thickness [mm]
200	20	4	2
250	20	6	2
300	20	6	2
350	20	8	2
400	20	10	2
500	20	14	2
600	20	17	2
700-4000	20	20	

Table 16: Dimensions of chamfering of the pipe spigot dependent on the pipe diameter

DN	Spigot diameter Flowtite	Spigot length	DN	Spigot diameter Flowtite	Spigot length
	d_{PS} [mm]	L_{PS} [mm]		d_{PS} [mm]	L_{PS} [mm]
300	324 -0.5/+0.5	130	2100	2146.5 -0.5/+0.5	160
350	375.9 -0.5/+0.5	130	2200	2248.5 -0.5/+0.5	160
400	426.8 -0.5/+0.5	130	2300	2350.5 -0.5/+0.5	160
450	477.7 -0.5/+0.5	130	2400	2452.5 -0.5/+0.5	160
500	529.6 -0.5/+0.5	130	2500	2554.5 -0.5/+0.5	175
600	616.5 -0.5/+0.5	160	2600	2656.5 -0.5/+0.5	175
700	718.5 -0.5/+0.5	160	2700	2758.5 -0.5/+0.5	175
800	820.5 -0.5/+0.5	160	2800	2860.5 -0.5/+0.5	175
900	922.5 -0.5/+0.5	160	2900	2962.5 -0.5/+0.5	175
1000	1024.5 -0.5/+0.5	160	3000	3064.5 -0.5/+0.5	175
1100	1126.5 -0.5/+0.5	160	3100	3166.5 -0.5/+0.5	185
1200	1228.5 -0.5/+0.5	160	3200	3268.5 -0.5/+0.5	185
1300	1330.5 -0.5/+0.5	160	3300	3370.5 -0.5/+0.5	185
1400	1432.5 -0.5/+0.5	160	3400	3472.5 -0.5/+0.5	185
1500	1534.5 -0.5/+0.5	160	3500	3574.5 -0.5/+0.5	185
1600	1636.5 -0.5/+0.5	160	3600	3676.5 -0.5/+0.5	185
1700	1738.5 -0.5/+0.5	160	3700	3778.5 -0.5/+0.5	185
1800	1840.5 -0.5/+0.5	160	3800	3880.5 -0.5/+0.5	185
1900	1942.5 -0.5/+0.5	160	3900	3982.5 -0.5/+0.5	185
2000	2044.5 -0.5/+0.5	160	4000	4084.5 -0.5/+0.5	185

Table 17: Spigot dimensions of Flowtite pipes PN 1 – PN 16

13. Site work and repairs

13.1. General

If irregularities are noticed during unloading, storage, or handling on-site, thoroughly investigate before installation in the pipe trench and its backfilling.

If damage is found to such an extent that it requires repairing, follow the procedure below. Consult Amiblu if in any doubt about the extent of the damage or suitable repair options.

13.2. Assessing damage

13.2.1. OUTER SURFACE

Slight scratches, scraping, or scuff marks on the external protective layer of GRP pipes are acceptable and do not generally have any impact on the component's service life. Damages deeper than 1 mm and/or broken glass fibers require review. Consult your local Amiblu supplier for support.

13.2.2. INNER SURFACE

Slight scratches, scraping, or scuff marks on the internal protective layer of GRP pipes are acceptable and do not generally have any impact on the component's service life. Damage where the wall structure is broken and glass fibers are exposed require review.

If there are cracks and mechanical damage, consult Amiblu.

13.3. Field closures

The minimum length of the closure pipe should be 1 m. In addition, the closure pipe should not be adjacent to a rocker pipe; i.e., the short length is meant to provide flexibility adjacent to rigid connections (see Fig. 66). Measure the distance between the pipe ends where you want to set in the closure pipe. The closure pipe should be 10-20 mm shorter than the measured length. The narrower the gap the easier it will be to make the closure.

The compaction of the backfill around a field closure pipe is very important and should be no less than 90 % SPD. The closure area is often over excavated for ease of access. This is recommended to prevent excessive movement and joint rotations.

Flowtite couplings and ASC couplings can be used for field closures and repairs. To move the coupling, the central register needs to be taken out.

For other joining methods as mentioned in Chapter 5.5, the installation procedures for the coupling used must be followed.

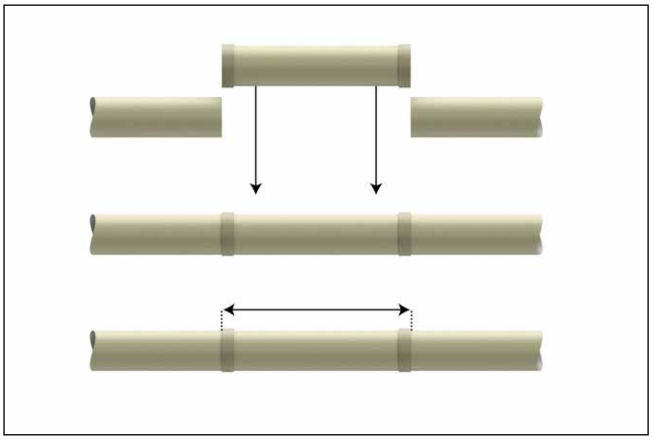

Fig. 66: Field closure section assembly

13.4. Flexible repair couplings

If the damaged area of the pipe is very small, a repair coupling can be mounted for non-pressure applications. The type of coupling used depends on the actual damage and the application for the pipeline. Before mounting the repair coupling, clean the damaged area.

The coupling can then be opened, placed around the damaged area, and tightened. Note the instructions provided by the repair coupling manufacturer.

For pressure applications, consult your local Amiblu supplier.

13.5. Internal repair couplings

Internal elastomeric repair sleeves are used to repair joints and localized damage. They are available in numerous sizes and variations - they can be used to seal joints and local damages on all diameters which are internally accessible. The type of sleeves used depends on the actual damage and the operating conditions for the pipeline.

13.6. Site lamination

Only qualified personnel shall conduct site lamination. Proof of such qualifications are often required by local authorities or associations. Amiblu laminators all have the necessary qualifications and experience to carry out laminating work on the construction site. Contact Amiblu if such services are needed.

Amiblu employs skilled engineers to design such laminates to ensure compliance with strength requirements for the pipeline. Contact Amiblu for details.

13.7. Removing a pipe coupling

To disassemble joints, it is required to use a suitable fixture (see Fig. 67). After disassembly, coupling, pipe, and gaskets shall be checked for damage. Any damaged part should be replaced or repaired as needed. Ensure the force applied to remove the coupling is controlled to prevent subjecting the pipe material to excessive stress.

In case of old installed connections, or if no suitable equipment is available, you can cut the coupling with a saw and replace it. When doing this, ensure that the pipe surface is not damaged. Another option is to swivel the pipe out.

13.8. On-site pipeline connection for gravity pipelines

There are two common options for connecting pipelines to Amiblu pipes on site:

- Glued and bolted saddles
- Connection saddles from other manufacturers

13.8.1. GLUED AND BOLTED SADDLES

Amiblu supplies glued and bolted saddles (see Fig. 68) for connecting sewers on site. Where saddles are glued, the outlet is generally at an angle of 45° or 90°. Saddles for a flush fit on the inside of the pipe can also be manufactured upon request. Dimensions may vary according to national legislation. These saddles can be connected to other materials, e.g., vitrified clay and PVC.

A glued saddle is a prefabricated part used to connect the sewer to the required point in the pipeline. Use a circular saw (with a carbide-tipped or diamond blade, not a metal blade) or drill to cut out the pipe area required for the connection.

No gluing is required for the Amiblu bolted saddle. It is connected to the main pipe by bolting onto a plate and using a full-face gasket to seal it on the inside.

13.8.2. CONNECTION SADDLES FROM OTHER MANUFACTURERS

Various manufacturers supply mechanical connections for thin-walled pipes that are inserted into the drilled hole in the Amiblu pipe and sealed with a bolted connection. Contact the saddle supplier for installation instructions and other information.

13.8.3. ASSEMBLY OF BOLTED SADDLES (SEE FIG. 69)

- Mark where the saddle is placed for drilling.
- Cut the hole with a suitable core drill. The size of the hole (-0/+5 mm) depends on the outside diameter of the pipe to be joined.
- Place the saddle over the core hole and mark the holes to be drilled for the bolted connection.
- After removing the saddle, drill two holes.
- Insert the rubber gasket supplied on the underside of the saddle. If profiled gaskets are supplied, the lips should be visible.
- Place the saddle and join it to the pipe with the bolts and sleeves on them, inserting them from the inside to the outside. Tighten the bolts with a washer.

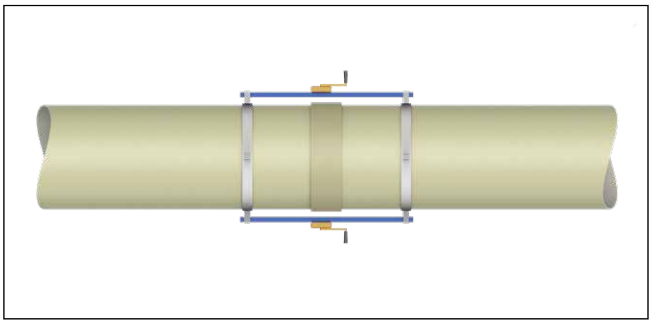

Fig. 67: Example of an installation aid for the dismantling of pipes

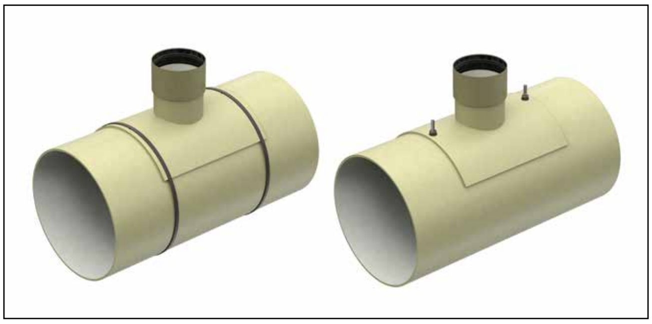

Fig. 68: Glued saddle (left) and bolted saddle (right)

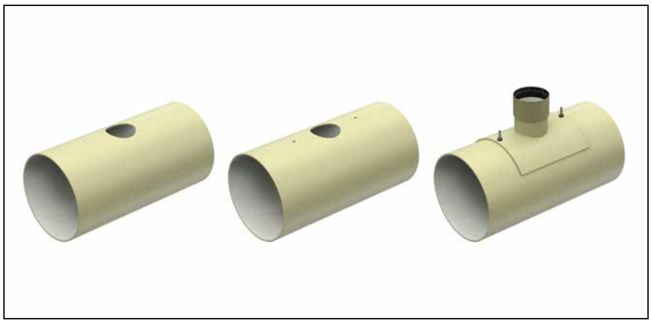

Fig. 69: Assembly of bolted saddles

13.8.4. ASSEMBLY OF GLUED SADDLES (SEE FIG. 70)

- Remove any dirt from the pipe's outer surfaces and ensure the surface to be glued is dry and free from debris.
- Determine the area to be cut out and glued, and mark with a felt pen.
- Use a circular saw (with a carbide-tipped or diamond blade, not a metal blade) to cut along the marking or make a hole with a core drill, depending on the type of saddle, and check the dimensions.
- Roughen and clean the surfaces to be glued. Apply the glue evenly to the surfaces. Seal the one component glue immediately after use to allow for reuse.
- Place and secure the saddle in position (e.g., with a strap) until the glue has completely cured.

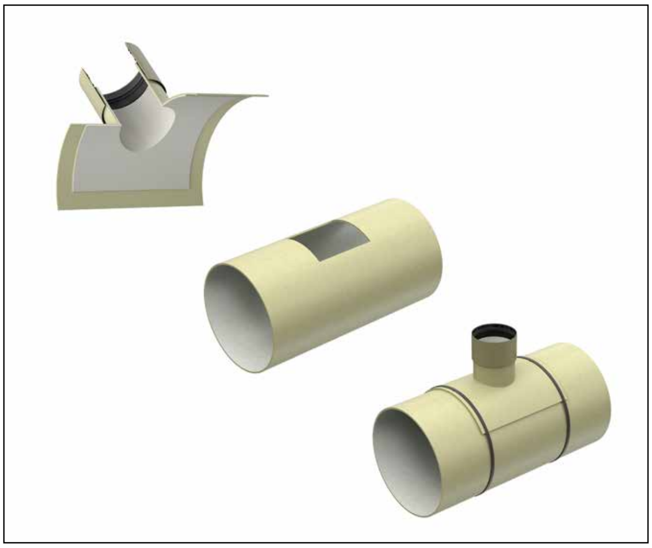

Fig. 70: Assembly of glued saddles

13.9. On-site pipeline connection for pressure pipelines (see Fig. 71)

In some circumstances, it may be necessary to tap into pressure pipelines in service, either by hot tapping (pressurized pipes) or cold tapping (depressurized pipes). This procedure requires special techniques, equipment, tools, and expertise. Tapping into Amiblu pipes is possible, depending on conditions such as the type of pipe, pressure level, temperature, and installation conditions. Consult Amiblu for further information and detailed methodology before executing.

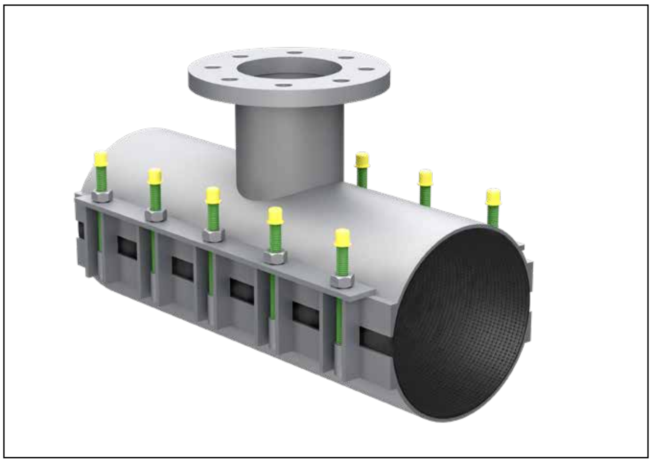

Fig. 71: Tapping clamp

14. Installation inspection recommendations

14.1. General

This section provides inspection recommendations to ensure a proper, high-quality pipeline installation and reliable operation.

This includes checking the following items:

- Vertical pipe deflection
- Offset of pipe spigots at joints
- Gab between spigots

Before backfilling, visually check the pipeline from the outside for signs of damage. If damage is found, document it and, depending on the severity, contact Amiblu for guidance.

In addition to an external inspection, it is recommended to inspect the pipeline, and particularly the joints, from the inside after completing the backfilling.

14.2. Pipe deflection

It is recommended to conduct deflection measurements on installed pipes to verify proper pipeline installations.
Ensuring that the initial deflection requirements have been met is easy to do shortly after completing the installation (typically within 24 hours after reaching maximum cover).
The vertical deflection of a pipe is calculated as follows:

$$\%\ \text{Deflection} = \frac{\text{Actual I.D.} - \text{Installed Vertical I.D.}}{\text{Actual I.D.}} \times 100$$

The expected initial pipe deflection after backfilling to grade level is less than 2 % for most installations. A recommended method to check the installation is to compare the measured and computed deflections in project design. Reference values for deflection can be taken from Table 18 or the structural analysis of the pipeline.

Bulges, flat areas, or other abrupt changes in pipe wall curvature are not permitted. Different deflections between adjacent pipes must be avoided. This is important as pipes installed with larger initial deflections may not perform as intended.

The nominal inner diameter (actual ID) of a pipe design used in a project may be taken from provided technical data sheets or calculated based on the following equation for a pipe not yet installed on site:

$$\text{Actual I.D.} = \frac{\text{Vertical I.D.} + \text{Horizontal I.D.}}{2}$$

The pipe used should be laying loose on a reasonable plain surface.

	Maximum initial deflection of the diameter [%]
Larger diameter (≥ 300)	3
Smaller diameter (≤ 250)	2.5

Table 18: Maximum allowable pipe initial vertical deflection of pipe

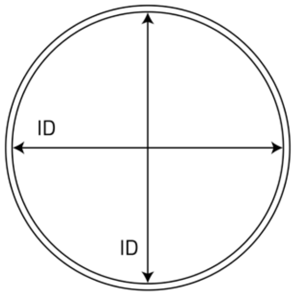

Fig. 72: Estimate inner pipe diameter from field measurement

14.3. Correcting over-deflected pipes

Pipes installed with initial deflections exceeding the reference values should be corrected to ensure the intended performance of the pipeline. Excessive deflections may negatively impact the pipe's performance, operation, and longevity.

14.3.1. PROCEDURE

For a pipe deflected up to 8 % of diameter:

- Excavate down to the haunch area. Excavation just above and at the sides of the pipe should be done utilizing hand tools to avoid impacting the pipe with heavy equipment (Fig. 73).
- Inspect the pipe for damage. A damaged pipe should be repaired or replaced appropriately.
- Re-compact haunch backfill. Ensure that it is not contaminated with unacceptable backfill material.
- Re-backfill the pipe zone in lifts with the appropriate material, compacting each layer to the required relative compaction density.
- Backfill to grade and check the pipe deflections to verify they have not exceeded the reference values.

Pipes that show more than 8 % deflection should be replaced completely.

Caution: Do not attempt to jack or wedge an installed over-deflected pipe into a round condition. This may cause damage to the pipe.

If excavating multiple pipes, care must be taken not to mound the cover from one pipe over the adjacent one. The extra cover and reduction of side support could magnify the over-deflection.

For details on joint requirements, see Chapter 5.

Experience has shown that removal of the final layer above the pipe can be done by suction and flushing vehicles.

14.4. Gap between spigots

Identify the gap between both spigots to check whether the angular deflection of the pipeline is within the tolerances relative to the pipe diameter. For acceptable values of gaps, see Annex B.

A proper installation would show full contact between both pipe spigots and the central register of the coupling without compressing it.

Be sure to have a sufficient gap between spigots where the operating temperature is well above the installation temperature to accomodate material expansion. (For example, cooling water pipelines, see Chapter 4.8).

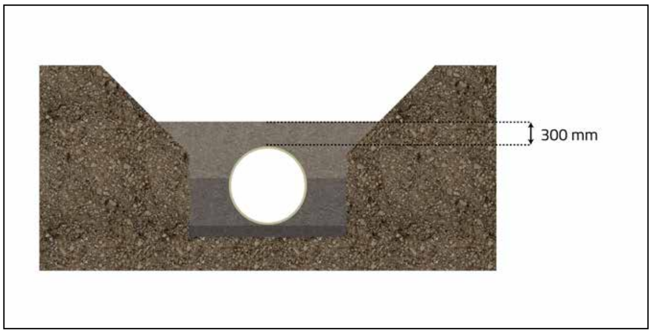

Fig. 73: Excavating over-deflected pipe

Amiblu

15. Cleaning pipelines

15.1. General

Sewer pipes may need to be cleaned occasionally to ensure longevity and optimal performance. The smooth inner surface of Amiblu pipes largely prevents the buildup of sand and sludge, making cleaning easy.

15.2. Mechanical cleaning

For cleaning, simple brushes or special devices such as pigging systems, propelled through the pipes mechanically with compressed air or water, are recommended. Special pigs for GRP pipes are available on the market and provide the best option. These devices can be produced based on the pigs' size relative to the pipe inside diameter. Models range from brushes with plastic bristles to complex tools with integral spray nozzles for pipelines.

The use of chain spinners, metal bristles or other such devices is not permitted.

15.3. Cleaning by flushing at normal pressure

The most economical method of cleaning pipes is flushing, which increases the hydraulic shear stress, thus scouring and washing out deposited sediment.

15.3.1. CLEANING BY HIGH-PRESSURE WATER JETTING

When pressure cleaning pipelines with water (see Fig. 74), take due care to prevent damage to the inner surface of the pipes. Always use methods that do not damage the pipe wall mechanically. Take special care to choose the appropriate nozzle (Fig. 75). Select the nozzles so that there can be no sudden impact of the nozzle against the pipe wall. Amiblu can provide guidance if needed.

15.3.2. CLEANING OF AMIBLU SEWER AND PRESSURE-SEWER PIPES

Amiblu sewer pipes generally meet the requirements of water jet cleaning according to DIN 19523:

- The maximum allowable pressure at the nozzle is 120 bars[1]. Due to the smooth interior surface of the GRP pipe, adequate cleaning and removal of blockages can normally be achieved below this pressure.
- Nozzles with jet holes around the circumference are preferred. Nozzles with cleaning chains or wires, as well as rotating, aggressive or other damaging nozzles are not permitted.
- The water discharge angle should not be greater than α = 30°. An angle smaller than α = 20° is usually sufficient for a GRP pipe, as the smooth surface of the material inhibits adhesion and only washing of the interior is required.
  The number of jet holes should be 6 to 8, and the hole size must be at least 2.4 mm.
- The external surface of the nozzle shall be smooth.
- The forward and backward speed of the nozzle shall be limited to 30 m/min. Avoid stopping the nozzle during the cleaning procedure. Uncontrolled movement of the nozzle is not allowed. When inserting the nozzle into the pipe, care should be taken to prevent the device from hitting the pipe wall.
- Jetting/swabbing sleds with several runners give a greater distance between the nozzle and the pipe wall, resulting in a less aggressive cleaning (Fig. 76).

To improve cleaning results, increase the amount of water used and not the pressure applied. Hence, it is recommended to increase the size and the number of inserts in the nozzles.

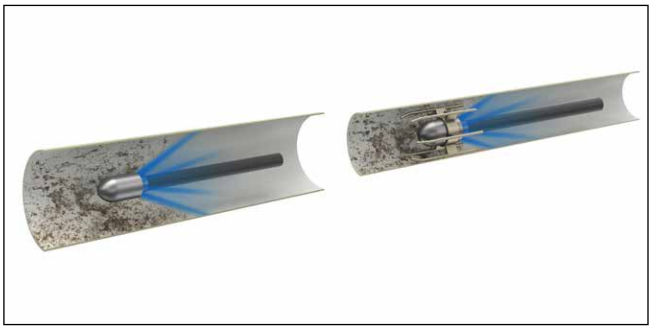

Fig. 74: Cleaning with high-pressure water jetting

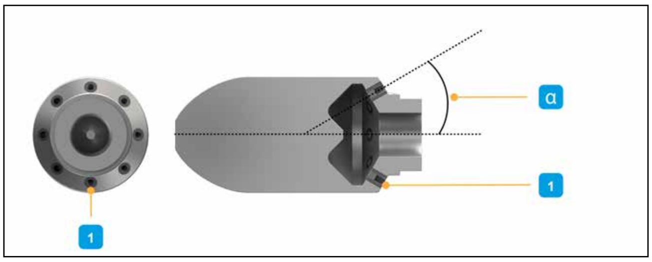

Fig. 75: Nozzle for high-pressure cleaning

1 – Insert for water jetting
α – Angle of water jet to pipe wall

[1] Cleaning can be conducted with a jet-power density of 330 W/mm². Experience has shown that if one uses the setup nozzle and jet holes with a flow rate of 300 l/min, a pressure of 120 bars will occur.

15.3.3. CLEANING OF FLOWTITE PRESSURE PIPES

These guidelines are to be used when Flowtite pressure pipes are used in sewer applications.

- The maximum allowable pressure at the nozzle is 80 bars[1]. Due to the smooth interior surface of the GRP pipe, adequate cleaning and removal of blockages can normally be achieved below this pressure.
- Nozzles with jet holes around the circumference are preferred. Nozzles with cleaning chains or wires, as well as rotating, aggressive, or damaging nozzles are to be avoided.
- The water discharge angle must be between 6° and 15° relative to the pipe axis.
- The number of jet holes should be 6 to 8 or more and the size of each hole must be at least 2.4 mm.
- The external surface of the nozzle shall be smooth.
- The forward and backward speed of the nozzle shall be limited to 30 m/min. Uncontrolled movement of the nozzle is not permitted. When inserting the nozzle into the pipe, care should be taken to prevent it from hitting the pipe wall.
- Jetting/swabbing sleds with several runners that give a greater distance between the nozzle and the pipe wall are required (see Fig. 76).
- The use of equipment or pressures that do not meet the above criteria could cause damage to the installed pipe and must be avoided.

For further questions, contact your local Amiblu supplier.

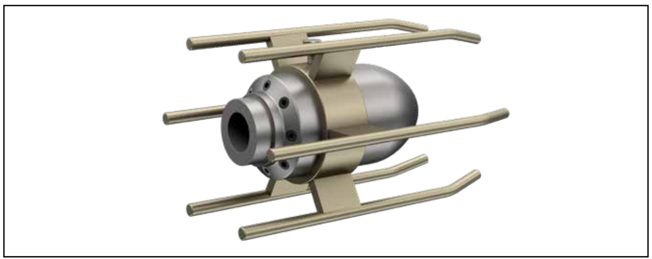

Fig. 76: Cleaning nozzle with swabbing sleds

Note: Flowtite pipes smaller than DN 300 shall be cleaned as pressure pipes.

[1] Cleaning can only be conducted with a jet-power density of 330 W/mm². Experience has shown that if one uses the setup nozzle and jet holes with a flow rate of 300 l/min, a pressure of 80 bars will occur.

Annex A - Relevant standards

Below is a list of relevant standards and the various aspects they cover. The standards and regulations provided here are purely for informational purpose and must be evaluated individually for every case and project.

Product Standards	
EN ISO 23856	Plastics piping systems for pressure and non-pressure water supply, drainage or sewerage –Glass-reinforced thermosetting plastics (GRP) systems based on unsaturated polyester (UP) resin.
ISO 25780	Plastics piping systems for pressure and non-pressure water supply, irrigation, drainage or sewerage – Glass-reinforced thermosetting plastics (GRP) systems based on unsaturated polyester (UP) resin – Pipes with flexible joints intended to be installed using jacking techniques.
EN 15383	Plastics piping systems for drainage and sewerage. Glass-reinforced thermo- setting plastics (GRP) based on polyester resin (UP). Manholes and inspection chambers.
ISO 16611	Plastics piping systems for drainage and sewerage without pressure - Non-circular pipes and joints made of glass-reinforced thermosetting plastics (GRP) based on unsaturated polyester resins (UP) - Dimensions, requirements and tests.
European Standards for Installation and Testing	
EN 805	Water supply – requirements for systems and components outside buildings.
EN 1610	Construction and testing of drains and sewers.

Annex B - Allowable deflection in Amiblu joints

This table provides the allowable angular deflection and corresponding radius of curvature for FPC and FWC up to PN 16. For special diameters provided here, contact your local supplier.

The allowable angular deflection values presented here are valid for pipes installed all the way to the central register of the coupling without squeezing the rubber. In all cases, the designer shall consider lower angular deflections to account for installation variations and joint movement.

See also Chapter 5.2 for information on joining pipes with relation to angular deflection.

EN ISO			Min. radius of curvature		
			3	6	12
DN	rqmt.	Allowable angle	m	m	m
100	3	3	57	115	229
125	3	3	57	115	229
150	3	3	57	115	229
200	3	3	57	115	229
250	3	3	57	115	229
300	3	3	57	115	229
350	3	3	57	115	229
400	3	3	57	115	229
450	3	3	57	115	229
500	3	3	57	115	229
600	2	3	57	115	229
650	2	3	57	115	229
700	2	2.6	66	132	264
750	2	2.6	66	132	264
800	2	2.2	78	156	313
860	2	2.2	78	156	313
900	2	2	86	172	344
960	2	2	86	172	344
1000	1	1.8	95	191	382
1100	1	1.5	115	229	458
1200	1	1.4	123	246	491
1280	1	1.3	132	264	491
1300	1	1.3	132	264	529

EN ISO			Min. radius of curvature		
			3	6	12
DN	rqmt.	Allowable angle	m	m	m
1400	1	1.2	143	286	573
1500	1	1.2	143	286	573
1600	1	1.1	156	313	625
1700	1	1.1	156	313	625
1720	1	1	172	344	688
1780	1	1	172	344	688
1800	1	1	172	344	688
1900	0.5	0.9	191	382	764
2000	0.5	0.9	191	382	764
2100	0.5	0.9	191	382	764
2160	0.5	0.8	215	430	859
2200	0.5	0.8	215	430	859
2300	0.5	0.8	215	430	859
2400	0.5	0.7	246	491	982
2500	0.5	0.7	246	491	982
2600	0.5	0.7	246	491	982
2700	0.5	0.7	246	491	982
2800	0.5	0.6	286	573	1146
2900	0.5	0.6	286	573	1146
3000	0.5	0.6	286	573	1146
3100	0.5	0.5	344	688	1375
3200	0.5	0.5	344	688	1375

Annex C -
Valves and chambers

General

For practical purposes, it is necessary to position in-line valves along most pressurised pipelines. Isolating a portion of the supply or distribution system, air and vacuum relief valves at high points for the controlled release of accumulated air, or introduction of air to avoid under pressure, drainage or clean-out can be accommodated using Amiblu pipes.

In all cases, the final responsibility for the design of the piping systems belongs to the design engineer.

However, Amiblu technology engineers have observed many different methods of incorporating these appurtenances into a pipeline using Amiblu pipe and are able to provide recommendations or guidance. This annex is devoted to offering the design engineer or contractor some recommendations on accommodating valves and chambers in a pressure Amiblu pipeline.

Anchoring in-line valves

Amiblu pipes are designed to handle nominal axial loads, but they are not designed to accommodate thrust and shear loads that may result from the inclusion of valves in the piping system.

Weights and loads from valves must be restrained. For unrestrained pipelines, pressure thrust and valve weight must be secured by a thrust block. In the case of restrained pipelines, the weight of the valve should not rest on the pipeline. Several methods for anchoring valves are described. The best method will be dependent on the specific operating conditions for each system.

Generally, the best method is dependent on the pipe diameter and operating pressure. There are two basic considerations for in-line valves: directly accessible (installed in chambers) or not accessible (directly buried). Generally, smaller diameter valves are directly buried without the use of concrete chambers for easy access.

Direct bury

TYPE 1:

The cheapest and easiest way to install a small diameter valve is to directly bury it, encapsulated it in its concrete thrust block (see Fig. 77).

This method can be used with larger valves, with the only limit being a reasonable thrust block design. The reinforced concrete thrust block must be properly designed to resist thrust from a closed valve with movement limited to the leak tightness of the joint.

The following guidelines should be observed in designing a Type 1 arrangement:

- The size of the thrust block is based on the local soil stiffness, backfill material, and installation conditions. Limit lateral movement as much as possible to preserve joint's performance against leakage.
- The flanged stubs should be no more than 1000 mm in length, with an Amiblu coupling on the outside leg connecting the stub to a rocker pipe (Fig. 77).

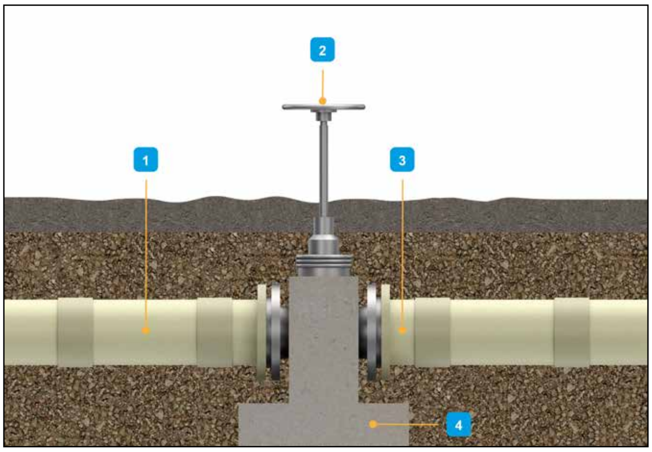

Fig. 77: Type 1—Valve encased in thrust block

1 - Rocker pipe
2 - Valve
3 - GRP flange
4 - Concrete encasement

TYPE 2

The anchoring method for Type 2 is similar to that of Type 1, except that the valve body can be accessed (see Fig. 78). While enabling a relatively simple installation, the valve may be available for service. The limit of use is dependent on the strength of the stub of steel or ductile iron pipe and the attached anchoring collar. For small thrust loads, only one side of the valve needs to be anchored.

The following guidelines should be observed in designing the Type 2 arrangement:

- The size of the thrust block is based on the local soil stiffness, backfill material, and installation conditions. Limit lateral movement to preserve the leak tightness of the joint.
- The flanged stubs should be no more than 1000 mm in length. The stub, with the flange or anchor collar, connects to the Amiblu rocker pipe using a standard Amiblu coupling.
- If steel or ductile iron stubs are used, it is recommended to use flexible steel couplings or transition (dual bolting) mechanical couplings.

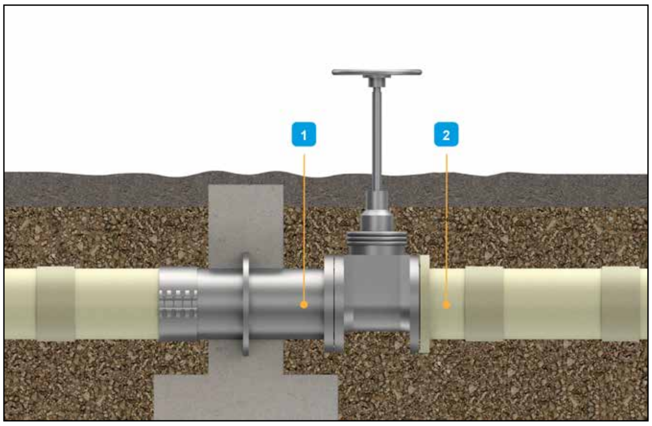

Fig. 78: Type 2—Thrust block adjacent to the valve

1 - Steel flange with trust ring
2 - GRP flange

Chambers

TYPE 3

This method can be used for all cases except for larger, high pressure valves. The use limit is dependent on the ability to place the structural support system into the valve chamber. The support system must be designed to accept the total axial thrust without overstressing the valve flanges or the reinforced concrete valve chamber walls. The valve chamber acts as the thrust block and must be designed as such. The thrust restraint is placed on the compression side of the valve to transfer the thrust directly to the chamber wall. The other end of the pipe system is relatively free to move axially. This allows for movement due to temperature changes and Poisson's effect.

The assumption inherent in Fig. 79 is that the thrust acts only in one direction. However, consideration must be given to the possibility of back pressure on a closed valve, which could create a thrust load in the opposite direction. To accommodate this possibility, the structural support system can be designed to handle the load in either direction. The associated details are to be developed at the discretion of the design engineer.

The following guidelines should be observed in designing a Type 3 arrangement:

- Thrust and shear from the valve are to be supported through a steel frame support system.
- Standard Amiblu pipes have either a rubber wrap or coupling at the concrete wall penetration to reduce local stresses caused by the constraint of free radial displacement during pressurization.

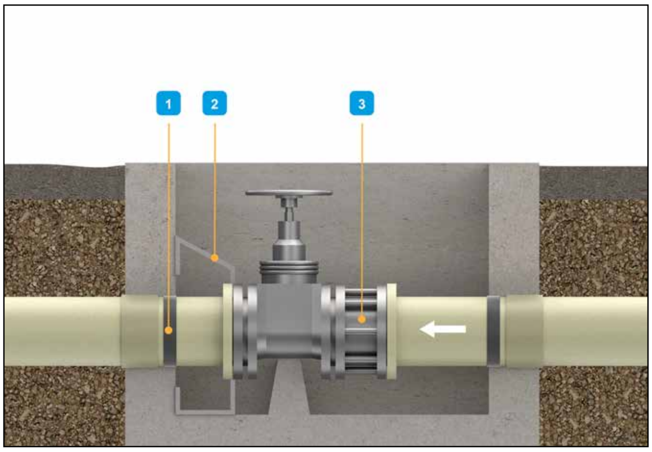

Fig. 79: Type 3—Thrust block adjacent to the valve

1 - Rubber wrap
2 - Steel support structure
3 - Dismantling coupling

- The valve chamber must be designed to accept the full axial thrust and vertical weight of the valve. Local reinforcements of the valve chamber foundation and walls will be required to accept the axial forces at the attachment points.
- The valve chamber is to be designed as a thrust block to resist axial thrust. The backfill selection, placement, and compaction must be sufficient to resist settlement and lateral forces created by the valve closure. Limit lateral movement to preserve the leak tightness of the joints.
- There must be a rocker pipe placed outside the valve chamber according to standard installation practices (see Chapter 6).
- The thrust is taken via compression of the structural support system. No axial load is transmitted to the pipe.
- Use cement-stabilized backfill, or gravel compacted to a minimum 95 % relative compaction, to fill the void beneath the pipe exiting the valve chamber structure (see Fig. 52).

TYPE 4

This anchoring method (Fig. 80) may be used for any application. Its only limitation in use is the size of the valve chamber. The valve chamber is to be designed as the thrust block. When the dimensions of the required thrust block face are larger than the physical dimensions of the valve chamber, extend the dimensions of the downstream side of the valve chamber to meet the thrust block requirements.

Here, the thrust restraint flange is placed on the compression side of the valve to transfer the thrust directly to the chamber wall, which acts as a thrust block. The other end of the pipe system is relatively free to move axially to allow movement due to temperature changes and Poisson's effect.

The following guidelines should be observed in designing a Type 4 arrangement:

- The weight of the valve is to be supported from the base of the valve chamber. The thrust from a closed valve is to be taken by a steel puddle flange anchored into the valve chamber wall by a welded flange on the compression side of the valve.
- A flexible steel coupling or a transition mechanical coupling is to provide a transition between the steel pipe stub and a standard Amiblu rocker pipe outside the valve chamber.
- The other pipe leg is free to move axially through the sealing gasket in the valve.
- The size of the thrust block is based on the local soil stiffness, backfill material, and installation conditions. Limit lateral movement to preserve the leak tightness of the joint.
- There must be a rocker pipe placed outside the valve chamber according to standard installation practices (see Chapter 6).
- Use cement-stabilised backfill, or gravel compacted to a minimum 95 % relative compaction, to fill the void beneath the pipes exiting the valve chamber structure (see Fig. 52).

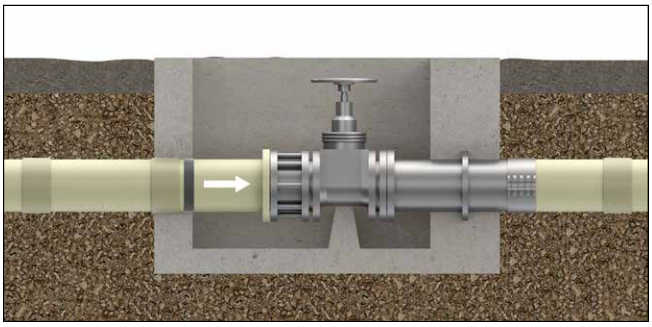

Fig. 80: Type 4 – Anchoring with steel puddle flange

Air and vacuum valves

It is common practice to place air or combination air/vacuum relief valves at high points in a long transmission line. The valves should be designed to slowly release any accumulated air in the high point of a line that might limit or block the flow.

Likewise, vacuum relief valves limit the amount of negative pressure a pipeline might experience by opening when pressure is sensed by the valve. The detailed design and sizing of these valves are beyond the scope of this installation guide. However, generic guidelines are offered here related to the general layout of fittings and structures to accommodate these off-line valves.

There are two ways that air/vacuum relief valves can be accommodated in an Amiblu system. The most common method is to mount the valve directly on the vertical flange nozzle. Alternatively, for heavy valves, a tangential nozzle can also be designed to accommodate the assembly. Details for all possible arrangements are presented next.

SMALL AIR/VACUUM VALVES

The simplest way to accommodate small air/vacuum valves is to mount the valve directly on top of a vertical flanged nozzle rising from the main below. Typically, a concrete chamber houses the valve, providing safe and easy passage of air through the valve assembly. When designing and constructing the valve chamber directly over the pipe, it is important to ensure that the weight of the concrete chamber is not directly transferred to the vertical nozzle and thuereby to the Amiblu pipe below.
This can be avoided by using a vertical opening in the base of the chamber that is larger than the outside diameter of the Amiblu riser nozzle.

Fig. 81, Fig. 82, and Fig. 83 provide general illustrations of these desired features.

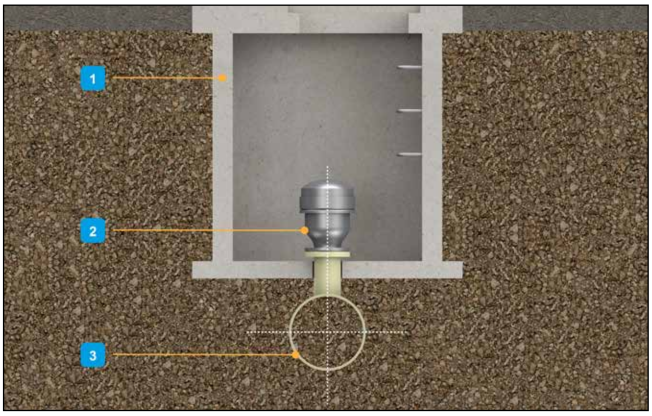

Fig. 81: Accommodating a small diameter air/vacuum valve

1 - Concrete chamber
2 - Air vent valve
3 - GRP flanged T-piece

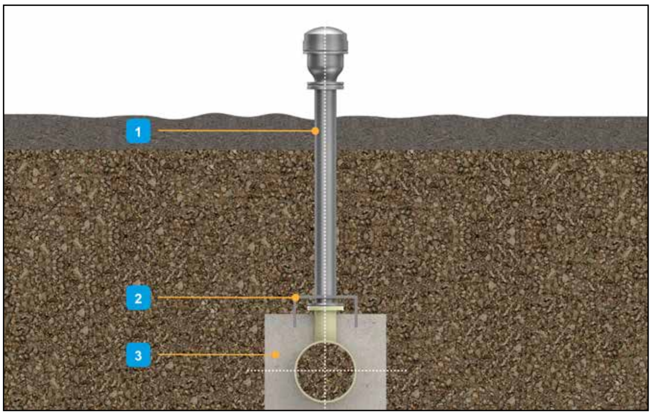

Fig. 82: Support block for large burial depths

1 - Air vent valve
2 - Steel support
3 - Thrust block

Note: In cases where the weight of the valve is greater than the expected thrust, consult Amiblu. The installed valve must not create lateral loads on the branch pipe.

An alternative method involves bearing the weight not directly on the riser, but with a tangential nozzle leading to the valve installed in an adjacent chamber (see Fig. 84).

The tangential nozzle can be parallel to the horizontal axis or at a slight vertical angle (< 22.5°) with an elbow.

In general, if the tangential branch pipe's diameter (chord length) is more than 50 % of the diameter of the header pipe, a thrust block is required (refer to Chapter 9).

LARGE AIR/VACUUM RELIEF VALVES (> 100 MM)

In the case of larger air/vacuum relief valves, the preferred method of installing these heavier valves is to provide a GRP flanged tee with a large branch DN ≥ 600, to accommodate the high axial load. This valve is attached to a steel blind flange connected to the GRP branch.

Nozzles

Nozzles are tee branches meeting following criteria:

- Nozzle diameter ≤ 300mm.
- Header diameter ≥ 3 times nozzle diameter

Note: In general, it is not necessary to encase nozzle connections in concrete. For exceptions, see the preceeding section on Air/ Vacuum Valves.

Wash-out and scour valves

The process for accommodating wash-out valves and scour valves is similar to the methods used for large diameter air valves, with the primary difference being that the branch is tangential to the invert of the pipe.

If the chord length of the intersection between the branch and the header pipes is more than 50 % of the diameter of the header pipe, then a thrust block is required (Chapter 9.2).

Fig. 85 provides some typical arrangements for accommodating these types of appurtenances in an Amiblu pressure pipeline. It is important to note that all valves must be properly supported.

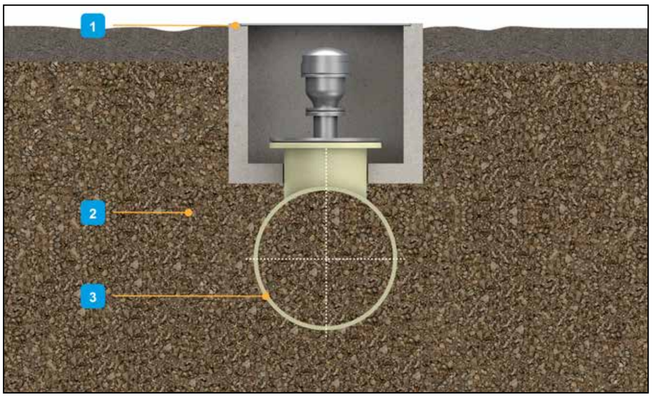

Fig. 83: General illustration of a large air/vacuum valve with Amiblu pipe

1 - Cover and frame with looking bar
2 - Cement-stabilzed backfill or gravel at 95 % relative compaction
3 - GRP flanged T-piece, branche DN ≥ 600

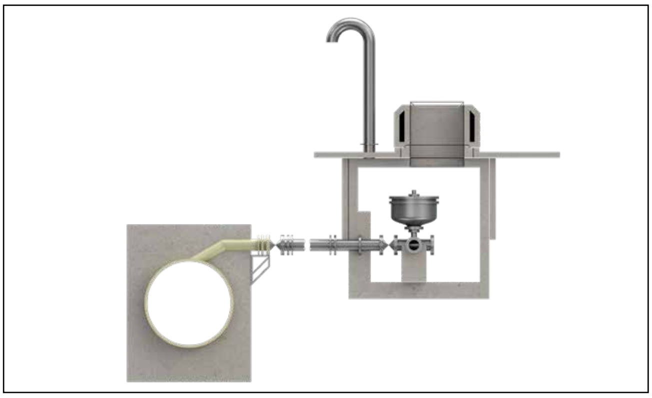

Fig. 84: Alternative method to accommodate large air/vacuum valve with Amiblu pipe

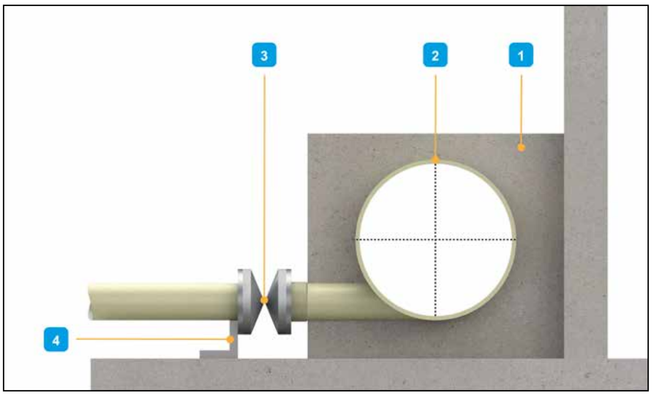

Fig. 85: Accommodating wash out– and scour valves

1 - Thrust block
2 - GRP tangential flanged T-Piece
3 - Valve
4 - Steel support for valve

Annex D - Disclaimer for manual / Copyright

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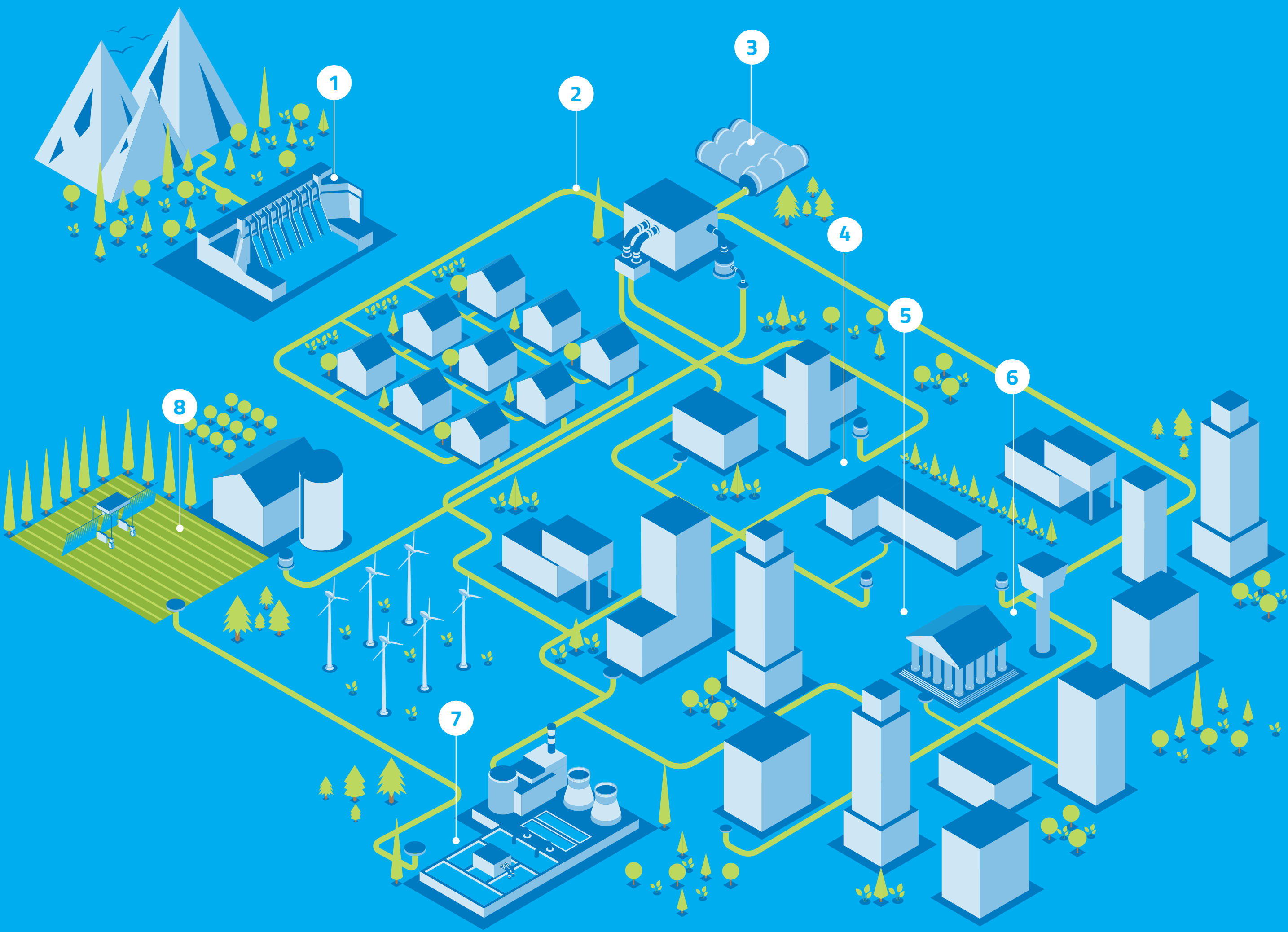

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