7 Fixing system and thermal movement

The Akatherm HDPE pipe system expands and contracts under influence of temperature changes. The pipe system therefor has to be installed to allow for compensation of these changes.

7.1 Choice of pipe installation methods

The choice of the pipe fixing system is essential to correctly install the pipe system. Depending on the temperature of the medium, the ambient temperature and the building constraints multiple options exist:

1. Free moving guide bracket system with axial movement correction by means of:
   - Snap expansion sockets
   - Deflection legs
   - Deflection leg with expansion socket
2. Rigid anchor point bracket system
3. Embedding HDPE in concrete
4. Underground installation of HDPE

7.2 Bracket assembly methods

7.2.1 Guide bracket

The guide bracket is used to support the pipe and to prevent the pipe from buckling sideways in a rigid installation. The pipe can freely move in the bracket.

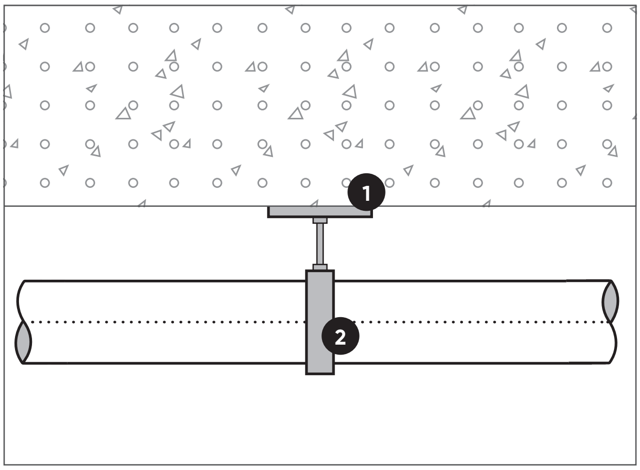


Illustration 7.1 Guide bracket

1. *mounting plate for guide bracket code 7094xx*
2. *guide bracket code 70xx10/70xx80*

7.2.2 Anchor point bracket

This method of bracketing is used for rigid installation. The expansion forces are transferred to the building structure. Within the Akatherm product range there are two options:

Anchor bracket with 2 electrofusion couplers

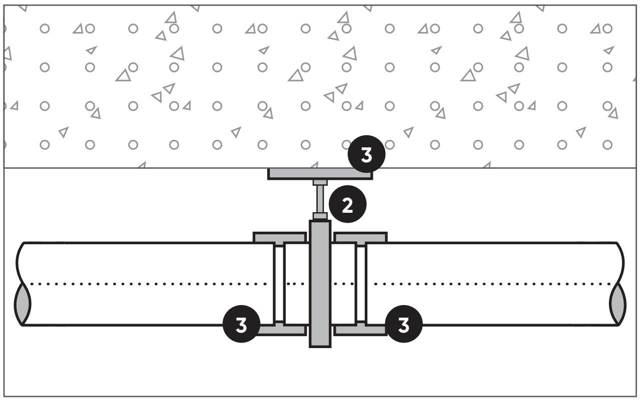


Illustration 7.2 Anchor bracket with electrofusion couplers

1. *electrofusion coupler code 41xx95*
2. *anchor bracket code 70xxxx*
3. *mounting plate for anchor bracket code 7094xx*

Anchor bracket with expansion socket

This method of installation is used for flexible installation where the expansion force is not transferred to the building structure. Only the force caused by the internal resistance of the expansion socket is transferred.

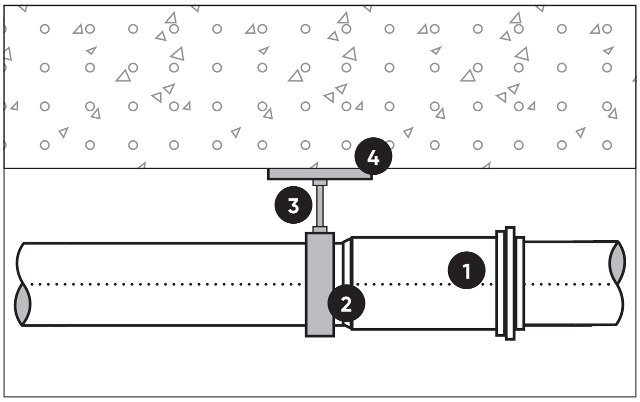


Illustration 7.3

1. *expansion socket code 40xx20/42xx20*
2. *clamp liner code 70xx15*
3. *anchor bracket code 70xxxx*
4. *mounting plate for anchor bracket code 7094xx*

In all previously mentioned setups the anchor bracket must be fixed to the building in such a way that it can resist the forces caused by the expansion or contraction of the pipe. Movement of the pipe bracket has to be limited to a minimum.

Do not use guide brackets (70xx10/70xx80) in an anchor bracket configuration. Anchor brackets are designed so that they can cope with the forces transmitted due to expansion and contraction of the piping system.

7.3 Guide bracket system with expansion sockets

7.3.1 Expansion and contraction calculation

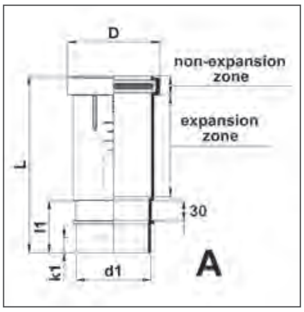
The axial movement is caused by the linear expansion of the pipe. The total expansion Δl triggered by the temperature difference can be calculated using equation 7.1. A visual representation of expansion at specific temperature differences can be found in graphic drawing 7.1.

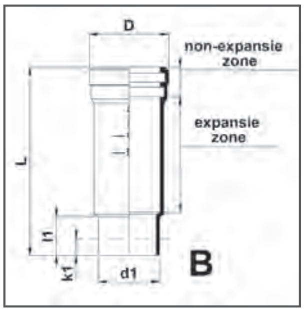
$$\Delta l_t = L_{buis} \cdot \alpha_t \cdot t_{max}$$

Equation 7.1 Length change caused by temperature difference

Δl_t = length change (mm)
L_{pipe} = total length of pipe (m)
αt = linear expansion coefficient (mm / m°K)
t_{max} = temperature difference in °C

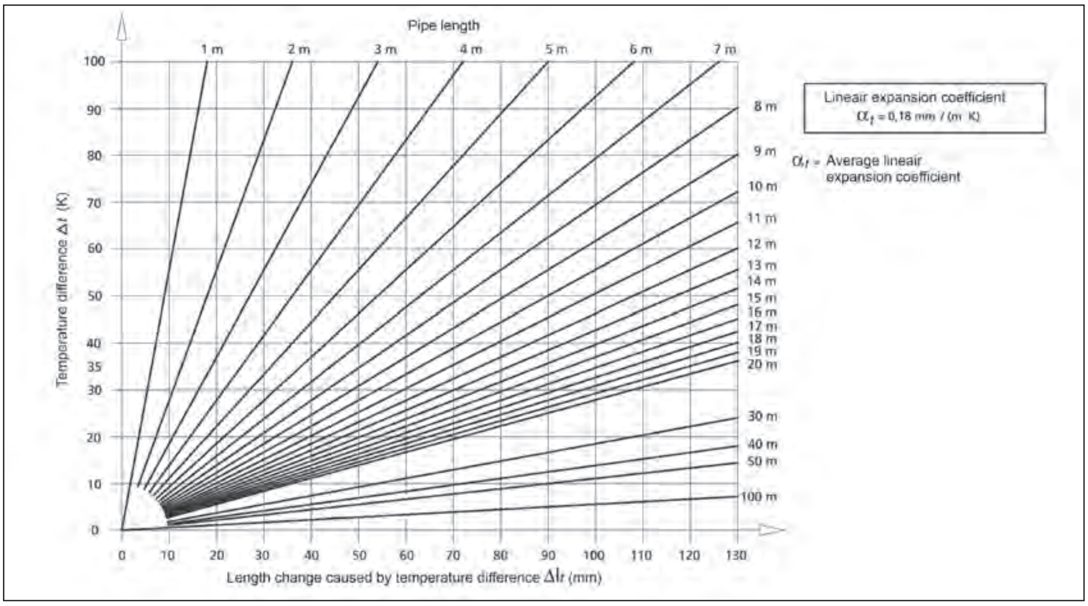
The maximum length change which can be accommodated by the expansion sockets can be found in table 7.1





(mm)	Code	D (mm)	L (mm)	Non- expansion zone (mm)	Expansion zone (mm)	l_1 (mm)	k_1 (mm)	Type
40	400420	56	172	25	109	35	-	B
50	400520	65	172	25	109	35	-	B
56	405620	72	172	25	109	35	-	B
63	400620	80	155	25	114	15	-	B
75	420720	98	255	32	148	72	30	A
90	420920	114	255	32	148	72	30	A
110	421120	135	260	35	145	76	35	A
125	421220	152	260	38	142	76	35	A
160	421620	186	266	41	148	76	35	A
200	402020	240	300	45	200	55	-	B
250	402520	298	325	55	205	62	-	B
315	403120	372	355	55	225	68	-	B

Table 7.1 Length change with expansion sockets



Graphic drawing 7.1 Length change caused by temperature difference

The number of expansion sockets necessary can be calculated using equation 7.1.

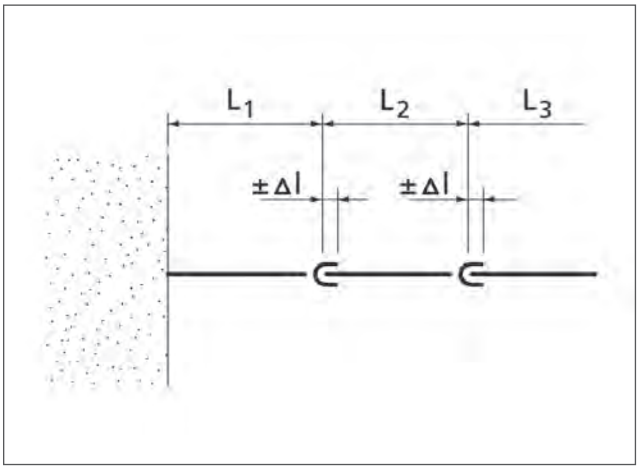


Illustration 7.4 Pipe section with expansion sockets

Example:
Length pipe section ($L_1+L_2+L_3$): 18 m
Installation temperature: 5°C - 278K
Temperature medium: +15°C / +75°C - 288K/348K
Temperature difference: 75-5 = 70°C - 343K
Total expansion: 18 m x 0,18 mm/mK . 70K = 227 mm
Expansion length per expansion socket d110 = 141mm

In a pipe section consisting of 100 mm pipe this results in 227/141 = ~ 1.6 = 2 expansion sockets. Therefore, based upon the calculation only 2 expansion sockets are needed.

With short term temperature differences, for example the emptying of a bathtub, a reduction factor of 0,5 can be applied to the temperature difference. In the example this would result in 0,5 x 227/141 = ~ 0,8 = 1 expansion socket.

7.3.2 Horizontal installation

The bracket directly in front of the expansion socket has a shorter bracket distance (L_A*). This enables a better guidance into the expansion socket (see illustration 7.6). The bracketing distances for this application can be found in table 7.2. The maximum distance between 2 expansion sockets is 5 m.

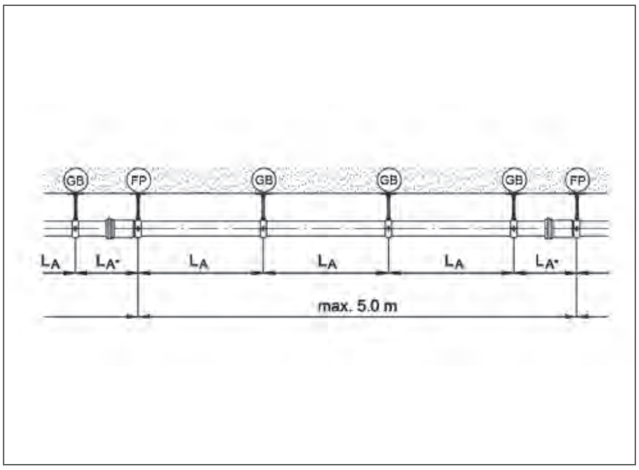


Illustration 7.5 Horizontal installation with expansion sockets without support trays

GB = guide bracket
FP = anchor point
L_A = bracket distance
L_A = bracket distance before expansion socket*

d_1	L_A (m)	L_A* (m)
50	0,8	0,4
56	0,8	0,4
63	0,8	0,4
75	0,8	0,4
90	0,9	0,5
110	1,1	0,6
125	1,3	0,7
160	1,6	0,8
200	2,0	1,0
250	2,0	1,0
315	2,0	1,0
315	2,0	1,0

Table 7.2 Bracket distances horizontal installation with expansion sockets without support trays

7.3.3 Horizontal installation with support tray

In this kind of installation the pipe is extra supported by support trays. The distance between the brackets can be larger than without support trays. The support trays are installed on to the pipe with straps. For distances see table 7.3.

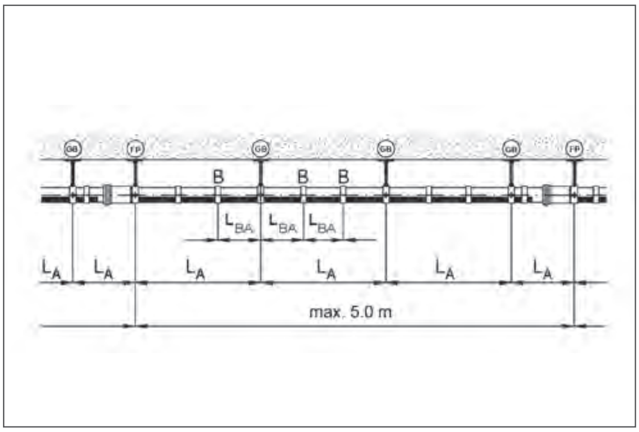


Illustration 7.6 Bracket distances horizontal installation with expansion sockets without support trays

GB = guide bracket
FP = anchor point
B = tray band
L_A = bracket distance
L_A = bracket distance before expansion socket*
L_{BA} = spacing for straps

d_1	L_A (m)	L_A* (m)	L_{BA} (m)
50	1,0	0,5	0,5
56	1,0	0,5	0,5
63	1,0	0,5	0,5
75	1,2	0,6	0,5
90	1,4	0,7	0,5
110	1,7	0,9	0,5
125	1,9	1,0	0,5
160	2,4	1,2	0,5
200	3,0	1,5	0,5
250	3,0	1,5	0,5
315	3,0	1,5	0,5

Table 7.3 Bracket distances horizontal installation with expansion sockets and support trays

7.3.4 Vertical installation

The bracketing distance for vertical installation is in general 1,5 times the distance of the horizontal bracketing. There is no separate bracket distance for immediately in front of the expansion socket because there is no sagging of the pipe and the insertion is always in line.

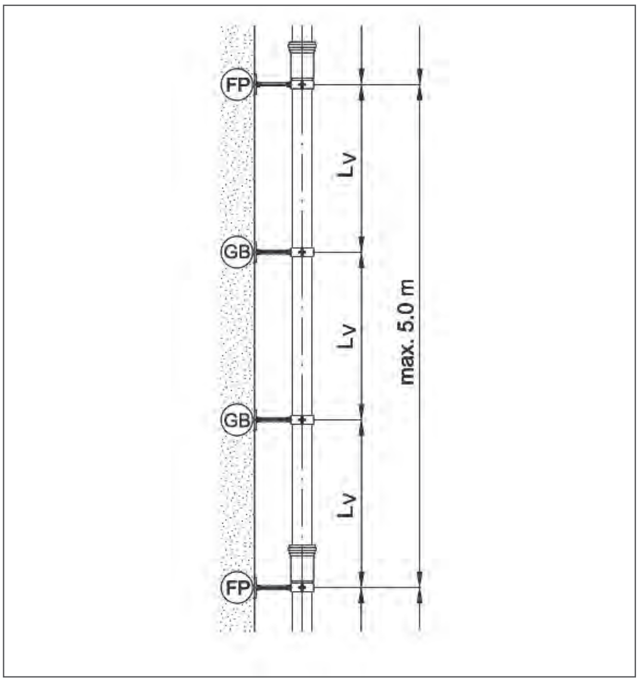


Illustration 7.7 Vertical installation

GB = guide bracket
FP = anchor point
LV = bracket distance

d_1	L_V (m)
50	1,0
56	1,0
63	1,0
75	1,2
90	1,4
110	1,7
125	1,9
160	2,4
200	3,0
250	3,0
315	3,0

Table 7.4 Bracket distances vertical installation from wall to wall

In the table 7.5 the diameters of the connecting pipe are listed per pipe dimension and the distance from the wall/floor. The threaded rod diameter as given in the table has to be respected to prevent pipe movement.

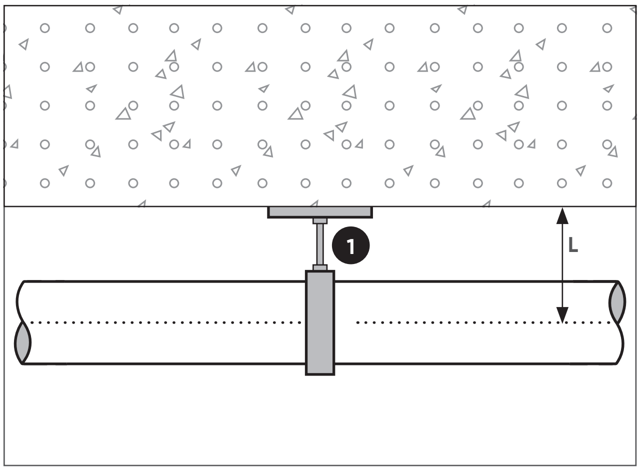


Illustration 7.8

1. diameter of the connecting rod

> In all cases, brackets have to be connected to the pipe in accordance with the installation instructions. Movement of the bracket itself, opposed to the longitudinal movement of the pipe system is to be minimized.

	Bracketing using expansion sockets - diameter of the connecting rod																							
Pipe diameter (mm)	**40**		**50**		**56**		**63**		**75**		**90**		**110**		**125**		**160**		**200**		**250**		**315**	
	Guide	**Fixed**	**Guide**	**Fixed**	**Guide**	**Fixed**	**Guide**	**Fixed**	**Guide**	**Fixed**	**Guide**	**Fixed**	**Guide**	**Fixed**	**Guide**	**Fixed**	**Guide**	**Fixed**	**Guide**	**Fixed**	**Guide**	**Fixed**	**Guide**	**Fixed**
Distance to wall/floor L (mm) **100**	M10	½″	M10	½″	M10	½″	M10	½″	M10	½″	M10	½″	M10	½″	M10	½″	M10	½″						
200	M10	½″	M10	½″	M10	½″	M10	½″	M10	½″	M10	½″	M10	½″	M10	½″	M10	½″	1″	1″	1″	1″	1″	1 ¼″
300	M10	½″	M10	½″	M10	½″	M10	½″	M10	½″	M10	½″	M10	½″	½″	¾″	½″	¾″	1″	1″	1″	1 ¼″	1″	2″
400	M10	½″	M10	½″	M10	½″	M10	½″	M10	½″	M10	½″	½″	¾″	½″	¾″	½″	1″	1″	1 ¼″	1″	1 ¼″	1″	2″
500	½″	½″	½″	½″	½″	½″	½″	½″	½″	¾″	½″	¾″	½″	¾″	½″	1″	½″	1″	1″	1 ¼″	1″	1 ¼″	1″	2″
600	½″	½″	½″	½″	½″	½″	½″	½″	½″	¾″	½″	¾″	½″	¾″	½″	1″	½″	1 ¼″	1″	1 ¼″	1″	2″	1″	2″

Table 7.5

Guide = guide bracket
Fixed = expansion socket

7.4 Guide bracket system with deflection leg

7.4.1 Deflection leg calculation

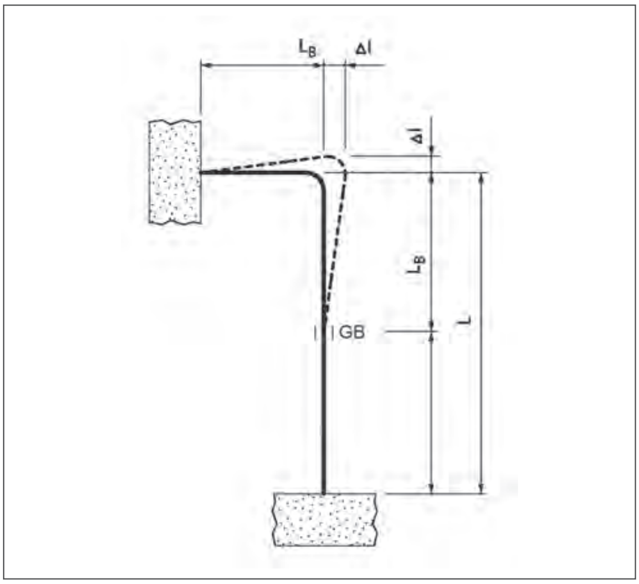


Illustration 7.9 Installation with deflection leg

L_B = length deflection leg
L = pipe length
GB = guide bracket
Δl = length change

For calculating the length of the deflection leg, the equation 7.2 can be used.

$$L_B = 10 \times \sqrt{\Delta l \times d_{1,2}}$$

Equation 7.2 Computing the length of deflection leg

L_B = Length of deflection leg (mm)
d_1 = Diameter pipe (mm)
Δl = Length change caused by expansion (mm)

First the length change Δl has to be determined at a temperature difference $\Delta_{t\ max}$ (see paragraph 7.3.1).

Remark:
If the calculated deflection leg is shorter than the available length there will be no extra load on the pipe system.

! If this is not the case, an additional expansion socket needs to be installed (see paragraph 7.4.2).

Fixing system

Check: Allowed $L_A \leq L_{B1} + L_{B2}$

Equation 7.3

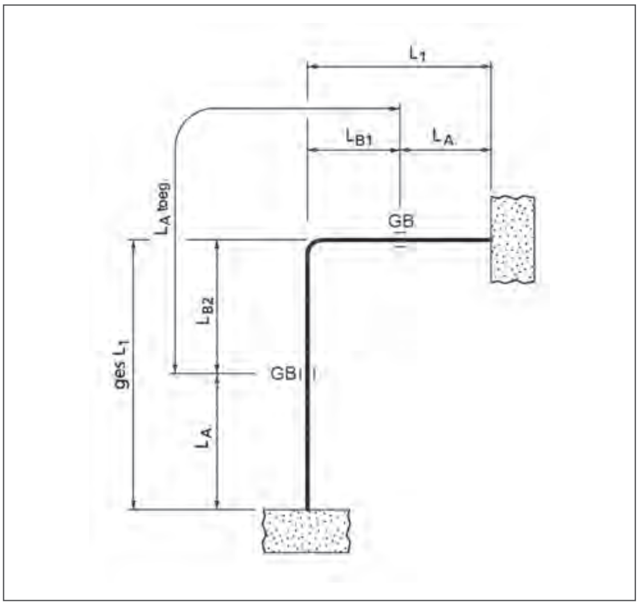


Illustration 7.10 Check fixing system

L_1 = pipe length
L_A = bracket distance
L_{B1}/L_{B2} = length deflection leg
ges L_1 = total length L_1
$L_{A\ toeg.}$ = allowed bracket distance
GB = guide bracket

When the distance between both guide brackets is larger than the allowed bracket distance L_A, the deflection leg needs additional support to prevent sagging. This extra bracket should not hinder the working of the deflection leg. This can be done by a pendulum bracket. Bracket distance L_A can be found in table 7.6.

d_1	L_A (m)
50	0,8
56	0,8
63	0,8
75	0,8
90	0,9
110	1,1
125	1,3
160	1,6
200	2,0
250	2,0
315	2,0

Table 7.6 Bracket distances horizontal installation with anchor brackets

Anchor bracket with double-flange bushing

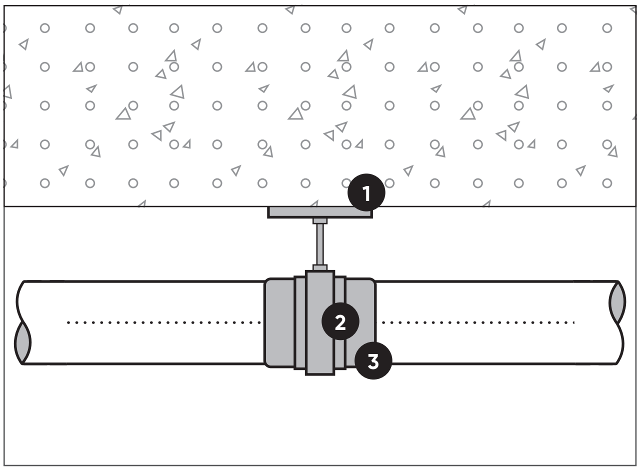


Illustration 7.11

1. *mounting plate for anchor bracket code 7094xx*
2. *anchor bracket code 70xxxx*
3. *double-flange bushing code 43xx15*

Anchor bracket with expansion socket

This method of installation is used for flexible installation where the expansion force is not transferred to the building structure. Only the force caused by the internal resistance of the expansion socket is transferred.

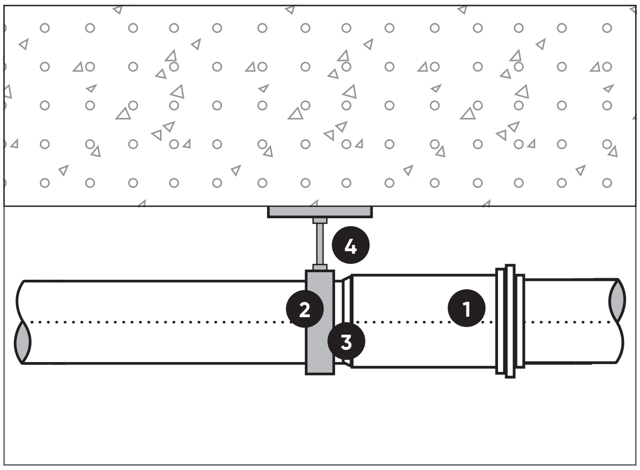


Illustration 7.12

1. *expansion socket code 40xx20/42xx20*
2. *clamp liner code 70xx15*
3. *anchor bracket code 70xxxx*
4. *mounting plate for anchor bracket code 7094xx*

> ! In all previously mentioned mentioned setups the anchor bracket must be fixed to the building in such a way that it can resist the forces caused by the expansion or contraction of the pipe. Movement of the pipe bracket has to be limited to a minimum.

> ! Do not use guide brackets (70xx10/70xx80) in an anchor bracket configuration. Anchor brackets are designed so that they can cope with the forces transmitted due to expansion and contraction of the piping system.

	Bracket system using expansion legs - diameter of the connecting rod																							
Pipe diameter (mm)	40		50		56		63		75		90		110		125		160		200		250		315	
Distance to wall/floor L (mm)	Guide	Fixed	Guide	Fixed	Guide	Fixed	Guide	Fixed	Guide	Fixed	Guide	Fixed	Guide	Fixed	Guide	Fixed	Guide	Fixed	Guide	Fixed	Guide	Fixed	Guide	Fixed
100	M10	¾"	M10	1"	M10	1"	M10	1"	M10	1¼"	M10	1¼"	M10	1½"	M10	2"								
200	M10	1¼"	M10	1½"	M10	1½"	M10	1½"	M10	1½"	M10	2"	M10		M10		M10		1"		1"		1"	
300	M10	1¼"	M10	2"	M10	2"	M10	2"	M10	2"	M10		M10		½"		½"		1"		1"		1"	
400	M10	1½"	M10	2"	M10	2"	M10	2"	M10	2"	M10		½"		½"		½"		1"		1"		1"	
500	½"	2"	½"	2"	½"	2"	½"		½"		½"		½"		½"		½"		1"		1"		1"	
600	½"	2"	½"	2"	½"		½"		½"		½"		½"		½"		½"		1"		1"		1"	

Table 7.7

Guide = guide bracket
Fixed = expansion socket

7.4.2 Deflection leg calculation with expansion socket

When possible a combination of a deflection leg with expansion sockets is recommended. It uses the advantages of both systems and saves expansion sockets. In illustration 7.14 you will find an example.

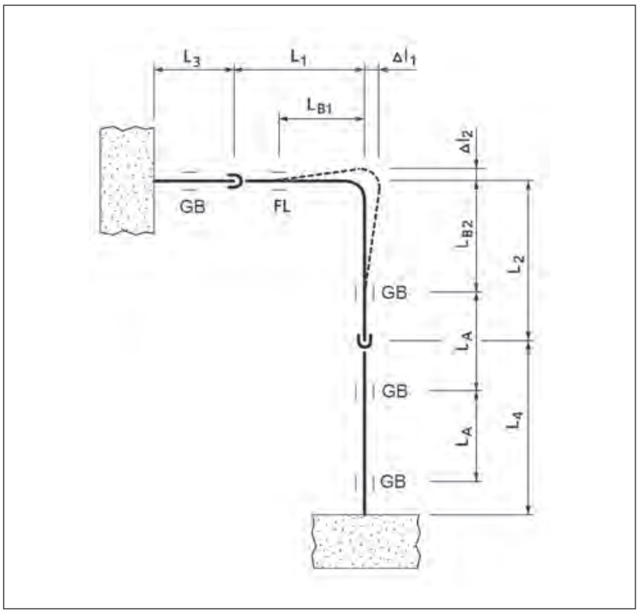


Illustration 7.13 Installation with deflection leg and expansion sockets

$L_1/L_2/L_3/L_4$ = pipe length
L_A = bracket distance
L_{B1}/L_{B2} = length deflection leg
$\Delta l_1/\Delta l_2$ = length change
GB = guide bracket
FL = guide bracket

Operating temperature: +15°C/+75°C
Pipe lengths $L_1 - L_4 \leq 5$ m

The expansion sockets take up the expansion of pipe sections L_3 and L_4. Several guide brackets have to be installed. The deflection leg L_{B1} and L_{B2} compensates the length change of L_1 and L_2 from pipe section L_1 and L_2. When the expansion is more than can be compensated in one expansion socket a number of expansion sockets with anchor brackets need to be used. Guide bracket FL prevents lateral kinks.

7.5 Anchor point bracket system

7.5.1 Bracket distance at different temperatures

The bracket distances for Akatherm HDPE depend on the working temperature and the weight of the pipe including the medium. When the pipe is fully filled, other bracket distances are applicable (see table 7.8).

7.5.2 Horizontal installation

> Because the pipe generates different forces with different dimensions, the anchor brackets have to be placed at dimension changes, branches and on the beginning and end of a pipe section.

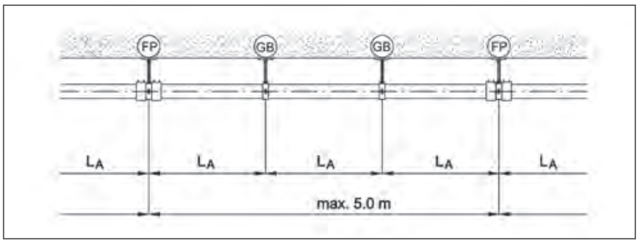


Illustration 7.14 Horizontal installation with anchor points

GB = guide bracket
FP = anchor point
L_A = bracket distance

d_1	L_A (m)
50	0,8
56	0,8
63	0,8
75	0,8
90	0,9
110	1,1
125	1,3
160	1,6
200	2,0
250	2,0
315	2,0

Table 7.8 Bracket distances horizontal installation with anchor brackets

7.5.3 Horizontal installation with anchor points and support trays

Because the pipe generates different forces with different dimensions, the anchor brackets have to be placed at dimension changes, branches and on the beginning and end of a pipe section.

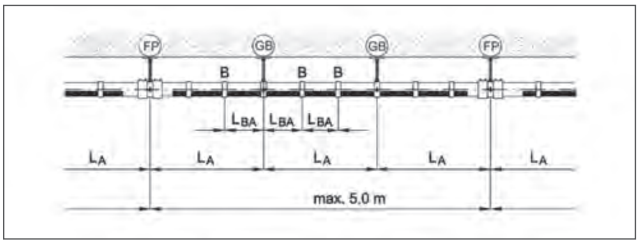


Illustration 7.15 Horizontal installation with anchor points and support trays

GB = guide bracket
FP = anchor point
L_A = bracket distance
L_{BA} = spacing for straps

d_1	L_A (m)	L_{BA} (m)
50	1,0	0,5
56	1,0	0,5
63	1,0	0,5
75	1,2	0,5
90	1,4	0,5
110	1,7	0,5
125	1,9	0,5
160	2,4	0,5
200	3,0	0,5
250	3,0	0,5
315	3,0	0,5
315	3,0	0,5

Table 7.9 Bracket distances horizontal installation with anchor brackets and support trays

7.5.4 Vertical installation

The bracketing distance for vertical installation is in general 1,5 times the distance of the horizontal bracketing.

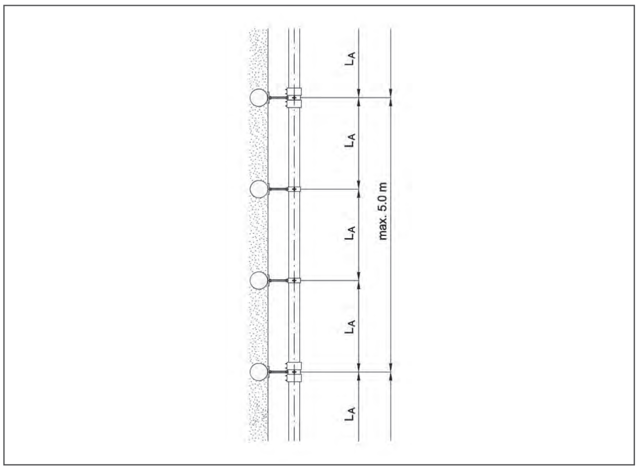


Illustration 7.16 Vertical installation with anchor points

GB = guide bracket
FP = anchor point
L_A = bracket distance

d_1	L_A (m)
50	1,0
56	1,0
63	1,0
75	1,2
90	1,4
110	1,7
125	1,9
160	2,4
200	3,0
250	3,0
315	3,0

Table 7.10 Bracket distances vertical installation with anchor brackets

7.5.5 Distance of the bracket to the wall or ceiling
In table 7.5 the diameters of the connecting pipe are listed per pipe dimension and distance from the wall/floor (see illustration 7.18).

> ! When the pipe is larger than 160 mm, a special construction is needed and has to be dimensioned.

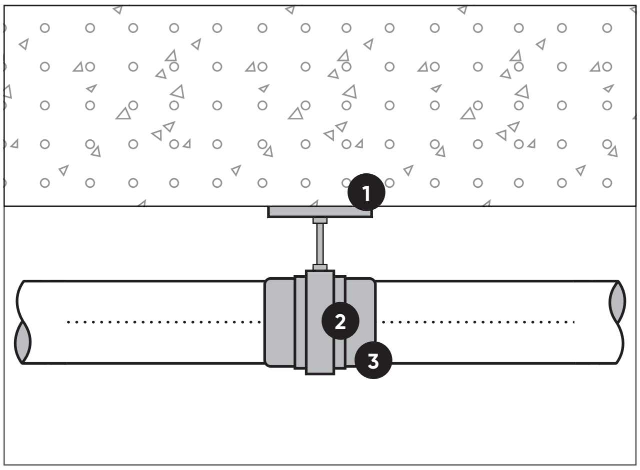


Illustration 7.17 1 = diameter of the connecting tube

1. *Mounting plate for anchor bracket code 7094xx*
2. *Anchor bracket code 70xxxx*
3. *Double-flange bushing code 43xx15*

> ! In all previously mentioned mentioned setups the anchor bracket must be fixed to the building in such a way that it can resist the forces caused by the expansion or contraction of the pipe. Movement of the pipe bracket has to be limited to a minimum.

> ! Do not use guide brackets (70xx10/70xx80) in an anchor bracket configuration. Anchor brackets are designed so that they can cope with the forces transmitted due to expansion and contraction of the piping system.

7.6 Embedding HDPE in concrete

7.6.1 installation guidelines before pouring concrete
High-density polyethylene (HDPE) is well suited to be embedded in concrete. Depending on the installation circumstances and material used, certain installation practices are to be applied.

Several precautions have to be taken for the pipe system to withstand the forces resulting from expansion and shrinkage of the concrete:

- Outer pressure on the piping system due to the liquid concrete being poured may cause the pipe system to be deformed. To prevent this ensure that the pipe system is compeletly filled with water.
- When quick-drying concrete is used, the exothermic reaction (a chemical reaction that is accompanied by the release of heat) may cause the maximum allowed temperature of HDPE to be exceeded. This may degrade the material and lower the threshold for the maximum allowed negative pressure. In this case, ensuring the pipe system is filled with water and thus creating an uncompressible closed system is critical.
- The pipe system has to be secured against movement before pouring the concrete.

7.6.2 Expansion and contraction compensation
Because HDPE and hardened concrete do not adhere, the pipe system embedded in concrete can move freely when expanding under influence of temperature changes. All fittings installed in the pipe system act as an anchor point and are subjected to expansion forces. The concrete acts as a rigid system and the expansion and possible deformation of the fittings has to be counteracted like in any HDPE installation.

Embedding HDPE in concrete
All 45° and 88,5° branches are subjected to expansion forces which can be counteracted by installing an electrocution coupler (see illustration 7.18).

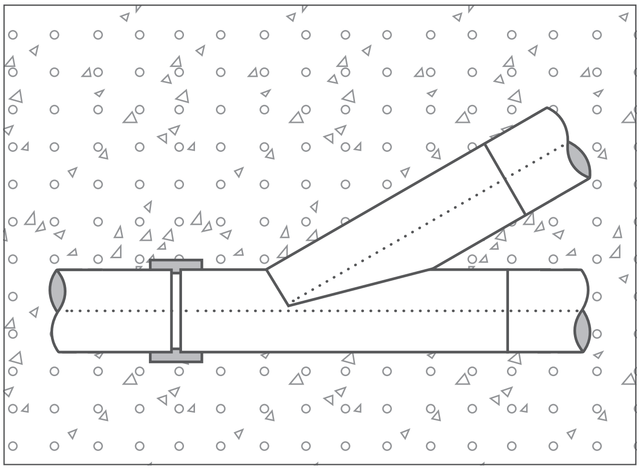


Illustration 7.18 Anchor point with an electrofusion coupler

If contraction of pipe has to be compensated (snap) expansion sockets can be used. The (snap) expansion sockets act as an anchor point on one side and absorb the expansion on the other side of the socket. The snap-expansion socket can accommodate the expansion and contraction of a 5 meter pipe.

> When rubber ring connections are used assure that the rubber ring cannot be contaminated with concrete mix water. To do so use plastic film or insulating tape.

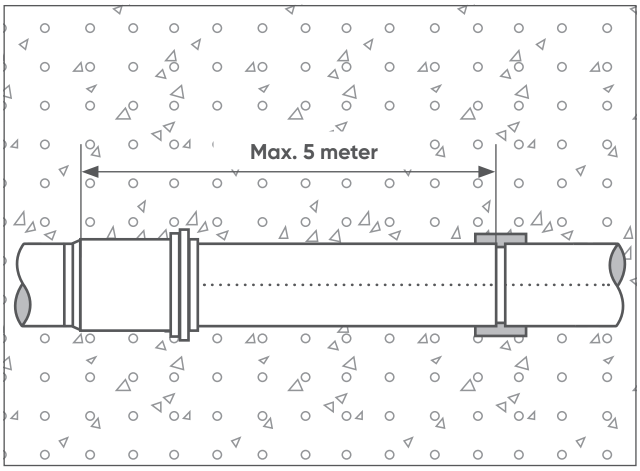


Illustration 7.19 Expansion socket in concrete

Embedding insulated HDPE in concrete
In case HDPE is embedded into concrete using thermal or acoustic insulation the system needs to be protected from expansion forces and slippage inside the concrete and insulation material. In order to do this the following configuration has to be considered:

1. Pipe (with insulation material)
2. Electrofusion socket
3. Pipe bracket
4. Threaded rod (½")

The pipe and electrofusion socket are to be insulated first. After insulating the pipe bracket is to be placed and fastened in between the electrofusion sockets. The threaded rod can be used to increase the anchoring.

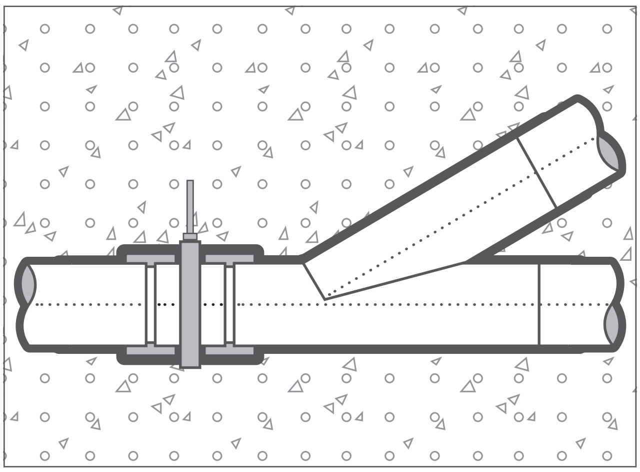


Illustration 7.20 Insulated HDPE in concrete

7.7 Underground installation of HDPE

The properties of Akatherm HDPE make the system ideal for use in underground pipelines:

- Akatherm HDPE is a fully closed pipe system. When the installation instructions are properly applied (chemical) soil and waste has no way of entering the environment.
- The system is suitable to be installed in a wide temperature range. It is possible to install Akatherm HDPE in cold climates (-40°C).
- The flexibility of the pipe system makes it especially suitable for underground installations in which small ground movements may take place.

The stability of the Akatherm HDPE pipe system allows it to withstand pressures exposed to the pipe system when laid at substantial depth. Various factors such as depth, groundwater level, trench width, embedding, the density of the soil and traffic load have to be considered.

7.7.1 Loads
The load capacity of underground plastic pipes is determined by a combination of factors. The vertical load by the soil directly above the pipe causes the pipe to be compressed in turn this will cause the sides of the pipe to be pressed outward against the surrounding soil. The resulting pressure, the axial compression exercised on the pipe by the surrounding soil prevents a larger deformation of the pipe. The construction of the trench, the type of bedding used and the backfilling of the trench are, to a large extent, decisive factors determining the total support function of the trench and thus, the maximum load capacity of the underground plastic pipe.

> Bends in the pipe system may cause soil load to be concentrated in specific points. When designing the system ensure that the load is evenly divided over the entire length of pipe.

> Traffic loads may cause increased pressure on the piping system. Ensure that loads are evenly distributed.

> Underground pipes can be subject to external overpressure, especially in areas with high groundwater levels.

Pipe systems subject to additional external pressure must be tested for the ability to withstand denting.

7.7.2 Construction and installation of underground pipe systems
To assure that soil and traffic loads are evenly distrusted it is important to take care of proper construction of the pipe trench. To do so a trench base, pipe embedding layer and protective layer have to be created.

> It is the responsibility of the purchaser, specifier or installer to install the pipe system taking into account particular requirements and any relevant national regulations and installation practices or codes.

> Akatherm HDPE has been designed according to EN1519 which limits underground use of pipes and fittings.

Trench base (bedding) - zone 1
The state and form of the trench base must match the mechanical properties of the HDPE pipe.

The existing or newly constructed support layer must consist of stone-free sand that has been slightly compressed using a suitable piece of equipment. The pipe must be laid in such a way that a stable surface with at least a 90° arc of enclosure is created in order to prevent sagging or intermittent loads.

The trench in which the pipe is laid must be sufficiently wide in order to keep the final soil pressure as low as possible. The space between pipe and trench wall must be at least ⌀ + 20 mm.

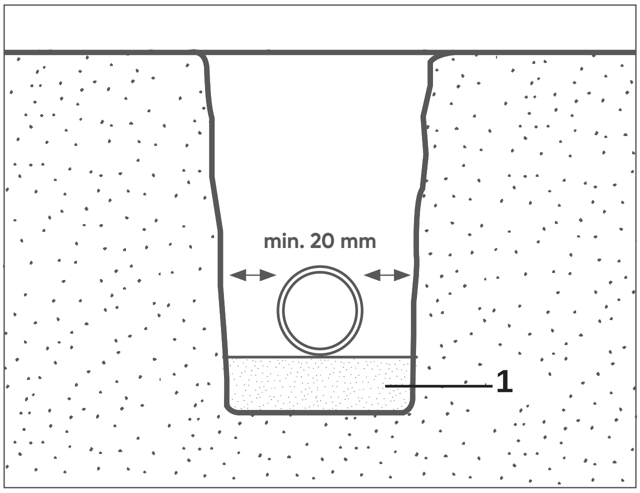


Illustration 7.21

The height of zone 1 depends on the soil conditions and the nominal pipe width, the heights for Akatherm HDPE are provided in table 7.20.

d	Normal soil	Rocky or thick soil
75	108 mm	158 mm
90	109 mm	159 mm
110	111 mm	161 mm
125	113 mm	163 mm
160	116 mm	166 mm
200	120 mm	170 mm
250	125 mm	175 mm
315	132 mm	182 mm

Table 7.11 Zone 1 height

Embedding of the pipe (consolidation) - zone 2
The fill for the pipe system embedding must consist of stone-free sand or similar material: the fill must ensure optimal compacting of the ground. The embedding is, to a large extent, a decisive factor in distributing the soil pressure and load, as well as providing lateral soil pressure on the pipe with the resulting pipe support effect.

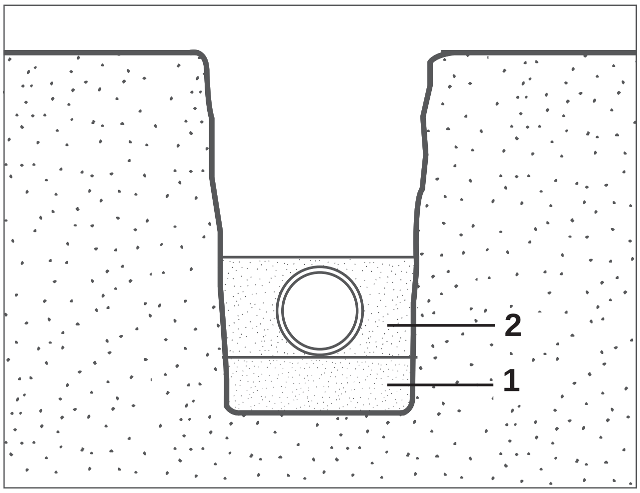


Illustration 7.22

The height of zone 2 must extend to at least 150 mm above the pipe. This must also be at least 100 mm above any pipe fittings.

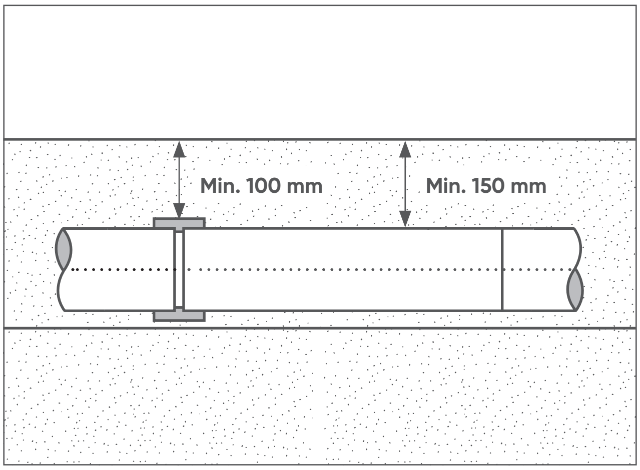


Illustration 7.23

Filling of trench (protective layer) - zone 3

The trench is backfilled in layers and compacted with care. Types of soil and materials which may cause dents are not permissible to be used to backfill the trench (e.g. ash, waste, stones). The protective layer consists of the following 2 sublayers:

- Protective layer (P): Consists of a layer of minimally 300 mm made of the same material as zone 2. The material must be stone-free sand or similar material. It is not allowed to use heavy compacting equipment on this layer
- Ground layer (G): Layer to fill the rest of the trench of at least 500 mm. Small stones are allowable. Depending on local regulations this layer may be compacted using heavy compacting equipment.

> ! It is important to immediately press the sand and fill the trench after laying the pipe. Not doing so may uncover the pipe.

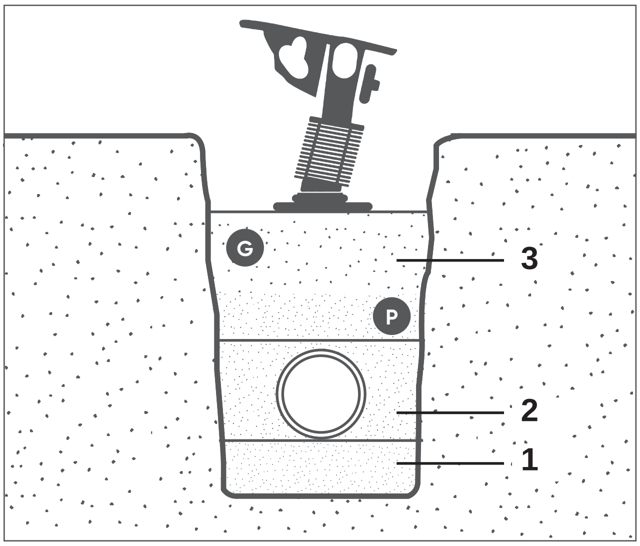


Illustration 7.24

Due to risk of the waste water freezing, the pipes must be laid at a frost-free depth.

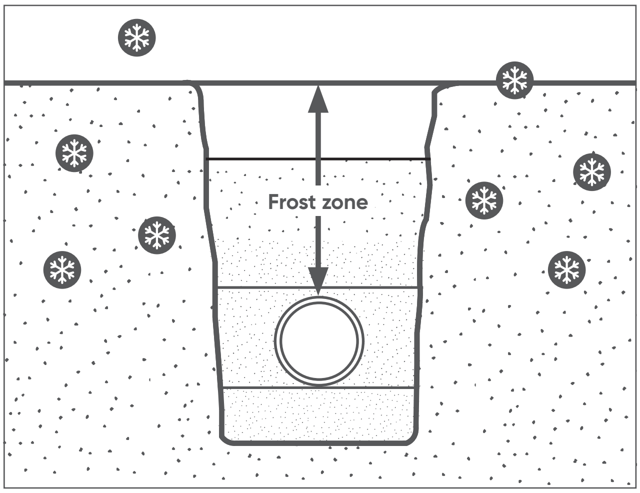


Illustration 7.25

> ! For determining the depth of the frost zone consult local regulations.