# 4 Planning and design

## 4.1 Relevant standards

Akatherm HDPE is designed for drainage systems inside the building. The planning and design shall comply to:

EN12056 Gravity drainage systems inside buildings

Additionally planning, design, installation and commissioning shall comply to the guidelines as specified in this manual.

**Approvals**
Akatherm HDPE is made in conformity with:

| | |
|---|---|
| EN1519 | Plastics piping systems for soil and waste discharge (low and high temperature) inside buildings- Polyethylene (PE). |
| DIN19535-10 | High-density polyethylene (PE-HD) pipes and fittings for hot water resistant waste and soil discharge systems (HT) inside buildings - Part. 10 Fire behaviour, quality control and installation recommendations |
| DIN19537 | Pipes and fittings of high-density PE for drainage and sewerage. |
| EN12666 | Plastics piping systems for non-pressure underground drainage and sewerage - Polyethylene (PE) - Part 1: Specifications for pipes, fittings and the system. |

Akatherm HDPE is certificated in many countries throughout the world and holds the certifications for pipes and fittings from size d40 to 315 mm (depending on the country).

The ISO equivalent of the EN1519 is ISO8770.

For a full overview of countries and certifications, please check the chapter about approvals, standards and quality.

## 4.2 Conversion tables

Akatherm HDPE is a metric system with diameters compatible to other metric systems like polypropylene based on the EN1451.

Drainage systems with inch dimensions have diameters different compared to the EN1519. Refer to the below conversion table for the relevant equivalent size.

| DN | HDPE | | | ASME B36.10 & B36.19M | | | BS EN 1329 (waste) | | | BS EN 1401 (soil) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | OD [mm] | e [mm] * | ID [mm] | NPS | OD [mm] | OD [inch] | OD [mm] | e [mm] ** | ID [mm] | OD [mm] | e [mm] *** | ID [mm] |
| 6 | | | | ⅛ " | 10,26 | 0,4 | | | | | | |
| 8 | | | | ¼" | 13,72 | 0,5 | | | | | | |
| 10 | | | | ⅜" | 17,15 | 0,7 | | | | | | |
| 15 | | | | ½" | 21,34 | 0,8 | | | | | | |
| 20 | | | | ¾" | 26,67 | 1,1 | | | | | | |
| 25 | | | | 1" | 33,4 | 1,3 | | | | | | |
| 32 | 40,0 | 3,0 | 34,0 | 1¼" | 42,16 | 1,7 | 36,4 | 3,3 | 29,9 | | | |
| 40 | 50,0 | 3,0 | 44,0 | 1½" | 48,26 | 1,9 | 43,0 | 3,3 | 36,5 | | | |
| 50 | 56,0 | 3,0 | 50,0 | 2" | 60,33 | 2,4 | 56,0 | 3,3 | 49,5 | | | |
| 65 | 63,0 | 3,0 | 57,0 | 2½" | 73,03 | 2,9 | | | | | | |
| 80 | 75,0 | 3,0 | 69,0 | 3" | 88,9 | 3,5 | 82,2 | 3,3 | 75,7 | | | |
| 90 | 90,0 | 3,5 | 83,0 | 3½" | 101,6 | 4,0 | | | | | | |
| 100 | 110,0 | 4,2 | 101,6 | 4" | 114,3 | 4,5 | 110,2 | 3,5 | 103,2 | 110,2 | 3,5 | 103,2 |
| 115 | | | | 4½" | 127 | 5,0 | | | | | | |
| 125 | 125,0 | 4,8 | 115,4 | 5" | 141,3 | 5,6 | | | | | | |
| 150 | 160,0 | 6,2 | 147,6 | 6" | 168,28 | 6,6 | 160,2 | 3,5 | 153,2 | 160,2 | 3,5 | 153,2 |
| | | | | 7" | 193,68 | 7,6 | | | | | | |
| 200 | 200,0 | 7,7 | 184,6 | 8" | 219,08 | 8,6 | 200,3 | 4,2 | 191,9 | 200,3 | 4,2 | 191,9 |
| | | | | 9" | 244,48 | 9,6 | | | | | | |
| 250 | 250,0 | 9,6 | 230,8 | 10" | 273,05 | 10,8 | 250,3 | 5,2 | 239,8 | 250,3 | 5,2 | 239,8 |
| 300 | 315,0 | 12,1 | 290,8 | 12" | 323,85 | 12,8 | 315,3 | 6,7 | 302,0 | 315,3 | 6,7 | 302,0 |
| 350 | | | | 14" | 355,6 | 14,0 | | | | | | |
| 400 | | | | 16" | 406,4 | 16,0 | | | | 400,4 | 8,4 | 383,6 |

*Table 4.1*

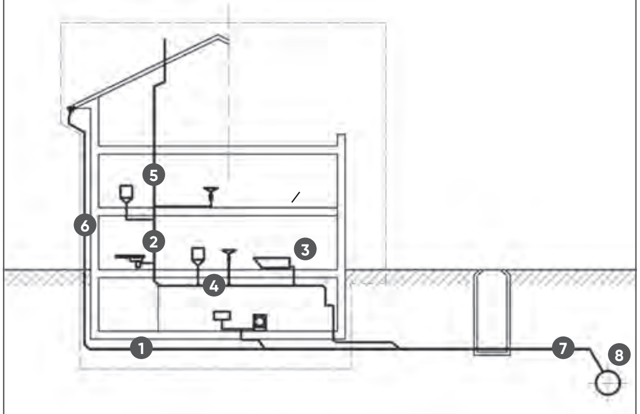
## 4.3 Building drainage principles

These building drainage guidelines are meant for waste water drainage systems which operate under gravity. It is applicable for drainage systems within dwellings, commercial, institutional and industrial buildings that terminate maximally 0,5 m outside the external wall.

**4.3.1 The challenges of drainage system**
Waste water systems are based on the primary pressure relief system in which water and air flow occurs in the same pipe. Waste water and storm water have to be collected separately, or at least until a relief gully has been placed in the rainwater drainage system.

In a waste water drainage system it is important that pipes properly drain empty and that any soil is carried with the flow. By discharges from fixtures, air will be displaced causing over- and underpressure; these have to be minimised so that waste water or sewer gases do not enter the building through the fixtures.

Important as well is to prevent hydraulic closures in the pipe system in which a body of water will limit or fully block air movement thereby causing over- and underpressure.




1 Ground pipe
2 Main stack
3 Branch pipe
4 Connector pipe
5 Ventilation stack
6 Rainwater down pipe
7 Domestic drainage
8 Public sewer

*Illustration 4.1*

Discharge water is introduced in a drainage system by cleaning, washing and drainage of waste. Drainage systems are referred to in different terms like a soil & waste system or a drain-waste-vent (DWV) system.

A soil & waste or drain-waste-vent system removes sewage and grey water from a building and regulates air pressure in the waste system pipes, facilitating flow. The term soil is used for sewage water (black water) that is discharged from toilets and urinals. Waste water is grey water discharge from a shower, bath and kitchen fixtures.

Soil or sewage water is a risk for human health while waste or grey water is not a direct risk. Typically soil & waste water are discharged on the same building drainage pipe system leading to the public sewer.

The building drainage system is an open system that is accessed on many points by fixture discharges that are different in temperature, volume and frequency. Due to hygienic, health and odour reasons each discharge opening must be closed by water traps.

The Akatherm HDPE Soil & Waste system is used to overcome these challenges and create a proper functioning drainage system.

**4.3.2 System configuration**
To prevent the traps from being blown or sucked empty, the under- and overpressure in a drainage system cannot exceed 300 Pa (30mm water column). The air must be able to escape (de-aerate) and enter (aerate) the system and this can be done with several different systems.

In primary ventilated system the downpipe itself is extended and vents through the roof of the building (see illustration 4.1). In a secondary ventilated system a separate vent pipe is build next to the downpipe or each collector pipe is fully vented to the downpipe. Further details are available in the EN12056-2: "Gravity drainage systems inside buildings - Part 2: Sanitary pipework, layout and calculation".

The advice and guidelines in this manual are based on the primary ventilated system.

**4.3.3 Pipe fill rate**
In order to maintain free air movement the pipe system must be designed so that the discharge volume, incline and centreline does not lead to a filling rate higher than 70%. The fill rate is based on a water depth of 0,70 x the pipe centreline and a stabilised flow. A stabilised flow will occur after a certain length after the fixture.

**4.3.4 Pipe slope**
A minimum flow speed is required to properly carry along waste in water preventing blockage. The minimum pipe slope is set at 1:200 (5mm/m). Shorter pipe sections can function on 1:500 provided the calculation has been made and the installation is done very precise. The maximum slope typically used is 1:50 (20mm/m) to prevent water moving too fast thereby creating a hydraulic seal.

**4.3.5 Clean-out openings**
Even in properly designed and installed drainage systems a blockage can occur due to deposits like solidified grease or improper use of the drainage system like food waste or other small objects. Clean-out branches must therefore be placed on key places in the drainage system.

Discharge fixtures and traps should be connected to the pipe system with the option to demount.

A clean out possibility should be placed in a horizontal pipe system when the pipe:

- is longer than 10 m
- has a total direction change greater than 135°

An additional clean out possibility should be placed when the horizontal pipe system is longer than 20 m. The clean out branches should be easy to reach and accessible for a plumbing snake, preferably with the opening on top so the clogged pipe system does not empty when opening the clean out branch. At the transition to the public sewer, a clean out possibility is required.

Downpipes and ventilation shafts on small buildings can be properly cleaned from the roof (if the cover can be removed). On higher buildings a clean out branch should be placed every 3 to 4 floors in the stack.

## 4.4 Thermal movement of HDPE

A physical principal is that all materials expand as the temperature increases. If the temperature drops, the material contracts. Each material has its own unique coefficient of expansion ($\alpha$).

For Akatherm HDPE : $\alpha$ = 0,18 mm/m • K
The equotation for length change is:

$$\Delta L = L \times \alpha \times \Delta T$$

*Equotation 4.1*

$\Delta L$ = length change of pipe system [mm]
L = total pipe length [m]
$\Delta T$ = difference with installation temperature [°C]
$\alpha$ = 0,18 mm/m • °K

**$\Delta T$ 50° = 10 mm/m**

When installed at 30° an Akatherm HDPE pipe of 5m long will behave as following:

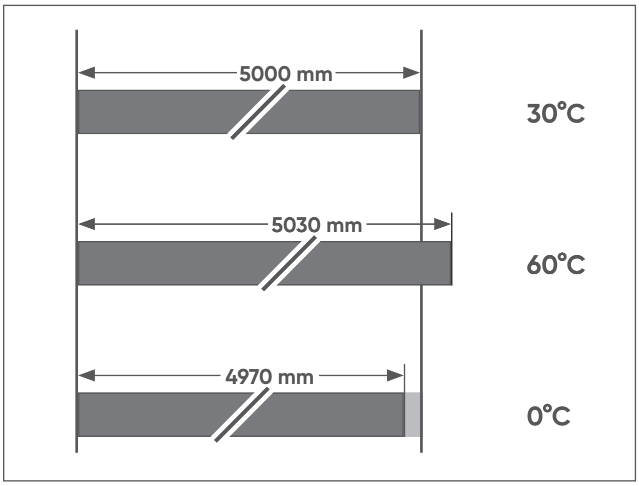



*Illustration 4.2*

In residential applications the maximum wall temperature difference of the connector and collector pipes is 40°C, even during short periods of 80°C to 90°C temperature water discharge.

For downpipes and ground pipes the maximum wall temperature difference is 20°C.

In general for a long-lasting discharge of high volume hot water the maximum wall temperature difference is 60°C.

Please note that this is the temperature difference over the complete circumference of the pipe, the variation in the discharge temperature can be a lot higher.

## 4.5 Transitions to other materials

### 4.5.1 Transition to PVC, PP Silent and PP-HT

Transitions to metric PVC, PP Silent and PP-HT pipe systems can be made using a rubber ring joint or by screw couplers.

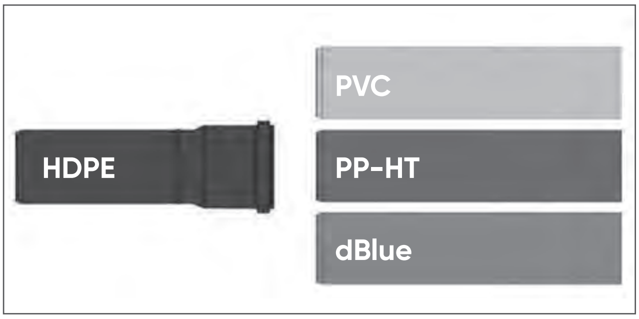



*Illustration 4.3*

Refer to the table below for the type of fittings, the dimensions and article numbers.

| Fitting type | Diameter range (mm) | Akatherm Code |
|---|---|---|
| Plug-in socket | 40-160 | 42xx50 |
| Snap socket | 40-200 | 40xx10 |
| Expansion socket | 40-315 | 4xxx20 |
| Screw coupler | 40-110 | 43xx30 |

*Table 4.2*

### 4.5.2 Transition to metal thread

The transition from Akatherm HDPE to metal thread requires screw thread adaptors available in the Akatherm range.

The adaptors are available with inside and outside thread in HDPE connection diameters 40, 50 and 63 mm. The adaptors have a cylindrical thread dimensioned according to DIN-ISO 288-1 with threads in ½", ¾", 1", 1 ¼", 1 ½" and 2".

Refer to the product tables for a complete overview of article numbers and available combinations.

### 4.5.5 Transition plumbing fixture fittings

Connections from plumbing fixture drainage fittings are typically with other materials. Connections to Akatherm HDPE are possible using adaptor fittings with rubber nipple, available from the Akatherm HDPE range.

*Illustration 4.4*

Akatherm HDPE has a straight connection socket and a connection bend. Refer to the table below for the possible transitions available both straight and as a bend (32 mm not available for the bend).

| Diameter (mm) | Connection range |
|---|---|
| 32 | 1 ¼" and 1 ½" |
| 40 | 1 ¼" and 1 ½" |
| 50 | 1 ¼", 1 ½" and 2" |
| 56 | 1 ¼", 1 ½" and 2" |

*Table 4.3*

The socket and bend do not contain a rubber ring. The rubber ring can be ordered separately.

### 4.5.6 Transition to other materials

Pipe connection with non-standard diameters can be connected to Akatherm HDPE using the Akatherm contraction sockets.

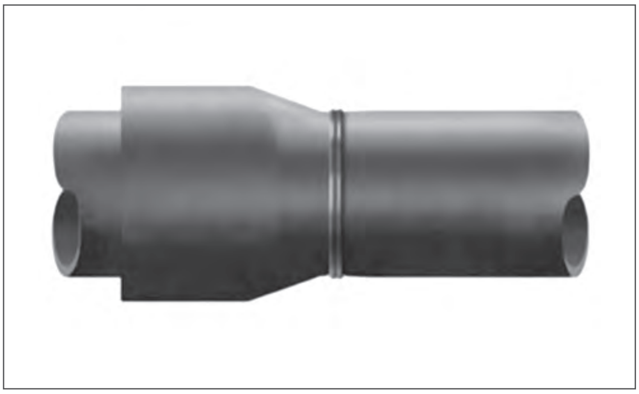


*Illustration 4.5*

The contraction sockets have a variable connection diameter which shrinks and forms to the inserted pipe by applying heat. The connection is made watertight with a rubber ring and are available according to the table below

| Diameter (mm) | Connection diameter $d_x$ (mm) | Akatherm Code |
|---|---|---|
| 40 | 41-44 | 550401 |
| 40 | 57-64 | 550402 |
| 50 | 57-64 | 550503 |
| 50 | 67-74 | 550504 |
| 56 | 62-69 | 555601 |
| 63 | 62-69 | 550601 |
| 63 | 75-79 | 550603 |
| 75 | 80-84 | 550701 |
| 75 | 90-94 | 550702 |
| 90 | 94-98 | 550902 |
| 110 | 102-111 | 551102 |
| 110 | 110-120 | 551103 |
| 110 | 115-136 | 551104 |
| 125 | 120-140 | 551201 |
| 125 | 135-155 | 551202 |
| 160 | 155-165 | 551602 |
| 160 | 160-180 | 551604 |
| 200 | 185-207 | 552001 |
| 250 | 236-260 | 552501 |

*Table 4.4*

## 4.6 Condensation

Condensation occurs when the water vapour carried in the air is deposited on a 'colder' surface. Air at a given temperature can contain only a certain amount of water vapour. If the air temperature drops when in contact with the colder pipe system, the excess amount of water vapour will then condense.

The temperature of the air at which air is saturated with water vapour is called the 'dew point'. Condensation occurs when pipework has a temperature under the dew point of the surrounding air. Condensation depends on a number of factors:
- Room temperature
- Relative humidity of the air
- Temperature of the pipe surface

Akatherm HDPE has a relatively good thermal coefficient and no condensation will occur during short periods of rain. To know exactly when and how to insulate a h-x (Mollier) diagram and a detailed calculation has to be used.

Pipe systems which are likely to be insulated against condensation are installed in:
- Wall cavities
- Concealed ceilings
- Concrete
- Pipes in poorly conditioned industrial buildings
- Pipes in food and paper applications

Usually, there is no need to insulate pipes in a properly conditioned industrial building that has sufficient air circulation due to heaters and fans.

When using Akatherm HDPE for storm water drainage, the relatively cold rainwater can cause dew condensation quicker than in soil & waste applications.

> When insulating the pipe system use diffusion-proof closed cell insulation material. Open cell insulation has to have an impermeable outer layer.

The entire pipe network must be insulated and an insulated pipe system must always be a closed circuit. Always ensure to:
- Close all openings, cuts and transitions with sealing material
- Encasing the bracket fully and seal the transition

## 4.7 Noise attenuation

Noise is all around us all the time. In modern urbanised life there are few places left to enjoy the comfort of silence. In many building constructions like multi-storey apartment blocks, hospitals or luxurious spas, the sound of the sanitary and drainage systems have become a significant source of noise. Modern standards require the noise to stay within acceptable limits for everyday use.

Every object in motion makes noise transmitting its vibrations to the surrounding air as pressure waves. There are two types of noise in soil & waste systems:

**Air-borne noise**
This is sound that travels through the air from its source. The source causes the air to vibrate. Air-borne noise can pass through structures and is reduced by using absorbent materials.

**Structure-borne noise**
This is sound that first occurs through a solid structure generated from a vibrating source or impact event. The vibrations pass through the structure and reach the human ear as air-borne noise at different locations within the building. The building structure acts as an acoustic bridge. Structure-borne noise is reduced by using soft material to acoustically uncouple the vibrating source or impact event.

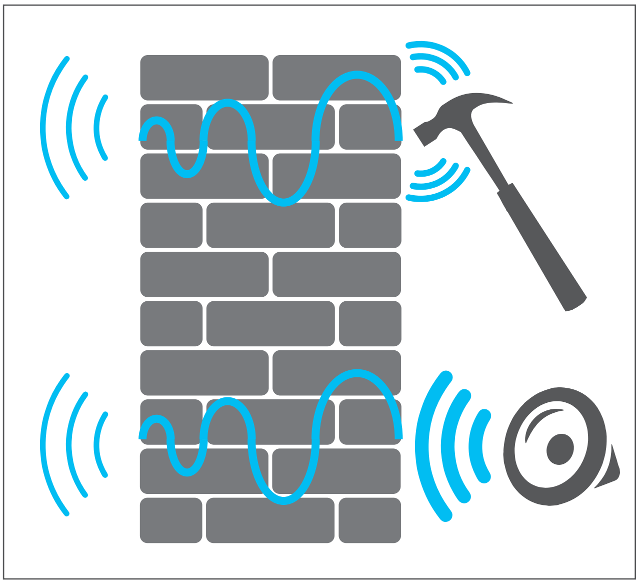


*Illustration 4.6*

The noise level resulting from internal sewers depends on factors as:
- type of (drain) pipe
- type of bracketing used
- insulation
- fall height
- drainage capacity and diameter

**Acceptable noise level**
The acceptable noise level that a human being can be exposed to while performing everyday activities and relaxing is described as 'the threshold noise level value'. According to the valid regulations, there are two categories of noise tests:

The table below presents several examples of the acceptable sound level in rooms designed for everyday stay.

| Type of room | Acceptable average noise level day | Acceptable average noise level night |
|---|---|---|
| Rooms designed for mental activities that require intense concentration | 30 db | - |
| Rooms in 3-star or below 3-star hotels | 40 dB | 30 dB |
| Accommodation in residential buildings, boarding schools, children's homes, old people's homes, 4 and more star hotels | 35 dB | 25 dB |
| Rooms in intensive Medical Care Units | 25 dB | 25 dB |
| Patient's rooms in hospitals and sanatoriums except rooms in Intensive Care Units | 30 dB | 25 dB |
| Kitchens and sanitary rooms in flats | 40 dB | 40 dB |

*Table 4.5*

**Measures against noise**
Design and construction measures can limit the noise levels in a drainage pipe system:
- Avoid drainage pipes installed close to habitable areas
- In non-residential construction drainage pipes installed close to storage rooms, toilets and pantries have the preference over offices and meeting rooms
- In no case should pipe work be installed directly in living areas
- A rubber lined bracket will prevent a noise bridge to the wall. A pipe system should never directly contact the building structure.
- Install the pipe system to a heavy wall (> 220 kg/m$^3$)
- A heavy comparting wall will limit airborne noise
- Don't install the pipe system to the pre-wall but to the construction wall
- All wall and ceiling penetrations must be filled using an acoustic and moisture insulation
- A pipe system running through a concealed ceiling can be insulated at bends and branches
- Encasing the pipes in concrete at diameter of no more than 69 mm. A concrete cover of approximately 50 mm thick reduces the potential noise level by about 30 dB(A).
- Insulate the shaft wall in multi-storied residential buildings

A well designed and properly aerated pipe system will reduce the noise transmission levels:
- Use gradual bends for direction changes
- At the transition from downpipe to horizontal pipe use 2 x 45° bends with a 250 mm pipe section in between
- Design and dimension drainage pipes to have enough capacity for both the drainage water and the air
- Use a side connection to branch into a horizontal pipe section. If a top connection can't be avoided use a 45° branch.

## 4.8 Trace heating

Animal and vegetable-based oil and grease discharged by commercial kitchens are separated from the waste water by grease separators. Akatherm HDPE is very well suited to connect the discharge fixtures to the grease separator. When the pipe system has enough length, the grease can accumulate and lead to serious blockage of the pipe system. The use of trace heating and additional insulation may be required to reduce heat loss. The trace heating element should not exceed 45°C.

## 4.9 Embedding HDPE in concrete

The Akatherm HDPE system is suited to be embedded in concrete. Before pouring the concrete all welds need to be cooled down and it is preferable to check the pipe system for leakage. To prevent the pipes from floating upwards the systems needs to be properly bracketed to keep it in place.

**Pressure and heat during pouring**
When a pipe system is vertically installed into concrete the liquid concrete will cause outer pressure, possibly exceeding the maximum ring stiffness depending on the height of the installation.

To increase the maximum installation height the pipe can be filled with water (and closed) to compensate for the outer pressure. Refer to the table below for the maximum allowed height depending also on the wall thickness of the pipes and fittings (at 30°C).

| Diameter (mm) | Wall thickness (mm) | Allowed height (m) Empty | Allowed height (m) Filled with water |
|---|---|---|---|
| 40 | 3,0 | 26,0 | 45,0 |
| 50 | 3,0 | 14,0 | 24,0 |
| 56 | 3,0 | 7,0 | 12,0 |
| 63 | 3,0 | 7,0 | 12,0 |
| 75 | 3,0 | 3,8 | 6,5 |
| 90 | 3,5 | 3,8 | 6,5 |
| 110 | 4,2 | 3,8 | 6,5 |
| 125 | 4,8 | 3,8 | 6,5 |
| 160 | 6,2 | 3,8 | 6,5 |
| 200 | 6,2 | 2,0 | 3,5 |
| 250 | 7,7 | 2,0 | 3,5 |
| 315 | 9,7 | 2,0 | 3,5 |
| 200 | 7,7 | 3,8 | 6,5 |
| 250 | 9,6 | 3,8 | 6,5 |
| 315 | 12,1 | 3,8 | 6,5 |

*Table 4.6*

! Quick drying concrete will undergo an exothermic reaction which releases heat during its process. The heat will soften the HDPE pipe and influence the maximum allowed pressure. Adequate protection must be provided to the Akatherm HDPE system like filling the system with water.

**Expansion and contraction compensation**

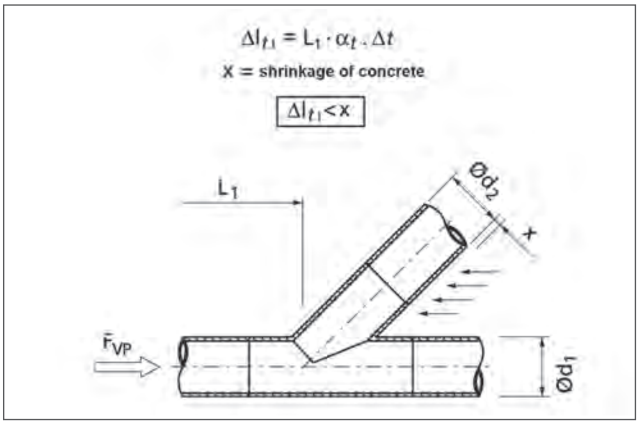



*Illustration 4.7 HDPE expansion forces in concrete*

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 subdued to the expansion force. The concrete acts as a rigid system and the expansion and possible deformation of the fittings therefore has to be counteracted like in any HDPE installation.

When the length change of the HDPE is smaller than the shrinkage of the concrete no special precautions have to be taken however this is very rarely the case.

All 45° and 88,5° branches are subdued to the expansion force (FVP) which can be counteracted by installing an electrofusion coupler. The electrofusion coupler acts as an anchor point preventing the additional load to be transferred to the branch (see illustration 4.8).

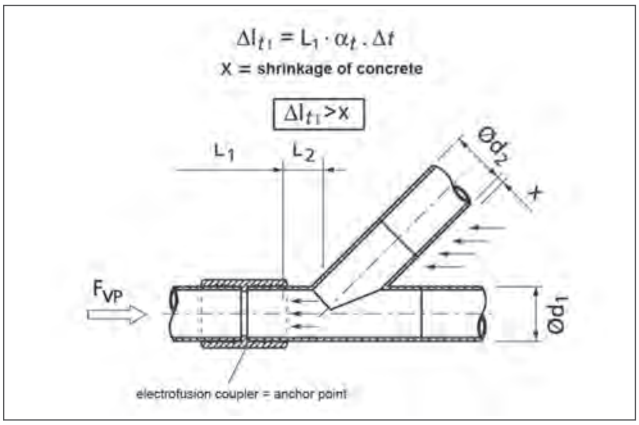



*Illustration 4.8 Anchor point with an electrofusion coupler*

As an alternative (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 m pipe (see illustration 4.9).

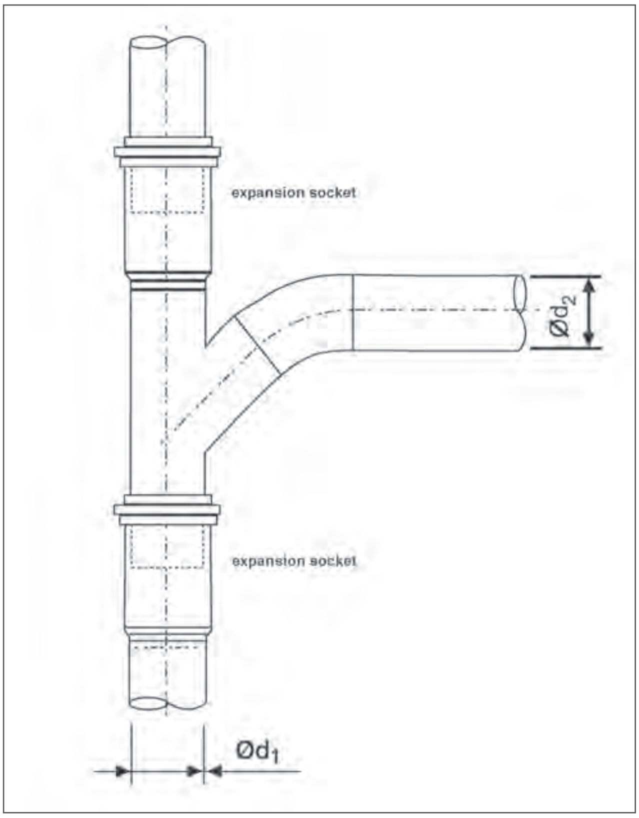



*Illustration 4.9 Anchor point with (snap) expansion sockets*

When the length of the branch is more than 2 m special precautions have to be taken as well. A fitting installed in a ceiling penetration acts as an anchor point as well. In case branches are used in a ceiling it is recommended to use an electrofusion coupler.

## 4.10 Installation underground

Due to specific properties such as flexibility and resistance to cold temperature (freezing), HDPE pipe systems are ideal for use in underground pipe lines. Buried pipes are exposed to various loads. The stability of Akatherm HDPE makes it possible to bury the pipes at substantial depth. The suitability depends on such factors as depth, groundwater level, density of the soil and traffic load.

**Soil and traffic loads**
The load capacity of underground plastic pipes is based on changes in the pipe and movement of the ground. The soil load causes the top of the pipe to deflect downward. The sides of pipe are correspondingly pressed outward against the surrounding soil. The reaction pressure, the lateral force exercised on the pipe, prevents a larger cross-sectional deformation (support function). 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 load capacity of an underground plastic pipe. The load needs to be evenly distributed over the entire pipe line. For this reason, the trench must be created in such a manner that bends in a longitudinal direction and loads at specific points are avoided. It is assumed that the increased pressure resulting from traffic loads caused by road or rail traffic are surface loads evenly distributed over the pipe sectional plane.

**Groundwater**
Underground pipes can be subject to external overpressure, especially in areas with high groundwater levels. In addition, a pipe enclosed in concrete is exposed to external pressure, though just for a short period. Underground pipe systems subject to additional external pressure must be tested for the ability to withstand dinting. The effective load due to external pressure will agree with the related hydrostatic pressure on the pipe axis.

For special circumstances contact our Technical Support department.