HDPE PIPES & FITTINGS.

شركة الصناعات الوطنية لمواد البناء (ش.م.ك.م)

NATIONAL INDUSTRIES COMPANY
For Building Materials (KSCC)

Index

1. Introduction

Ever since the history of civilization is faced with the unreliable infrastructure system within their collective resettlement areas.

The historical process of evolution of the human kind up to the contemporary era has marked various infrastructure systems that have corresponded to a technological development specific to that era. However, tremendous difficulties were observed in selection of the material construction, which was sought to provide anticipated permanent solutions for the system utilized. This had eventually given an impetus for further research and investigations.

The discovery of plastics, which was considered as the biggest invention in the 20th century, together with further development achieved in the plastic technology has resulted with a comprehensive solution of contemporary societies' problems faced in this field, by providing excellent material specifications.

The fact that the processing of the plastic is very easy and the plastic materials provide the superior properties against adverse effect of the ambient and the chemicals; the use of plastics has been eventually spread over many fields of applications, including durable goods.

To this effect, the researchers have considered the ways to make use of the plastics as the materials for the infrastructure system that inherently require great deal of investments. There have been huge technical difficulties encountered in manufacturing of the pipes especially with bigger diameters in conformity with the requirements of infrastructure systems and no satisfactory solution had been established until recently.

National Industries Company one of the major companies owned by "NI Group". The NI Group is a holding company of a diversified group of industrial and financial companies in the Middle East, Europe and North America.

NI Group invests heavily in automation and modern production technology. It develops and uses up to date technology and materials to maintain high quality, cost effective and environmentally sensitive products.

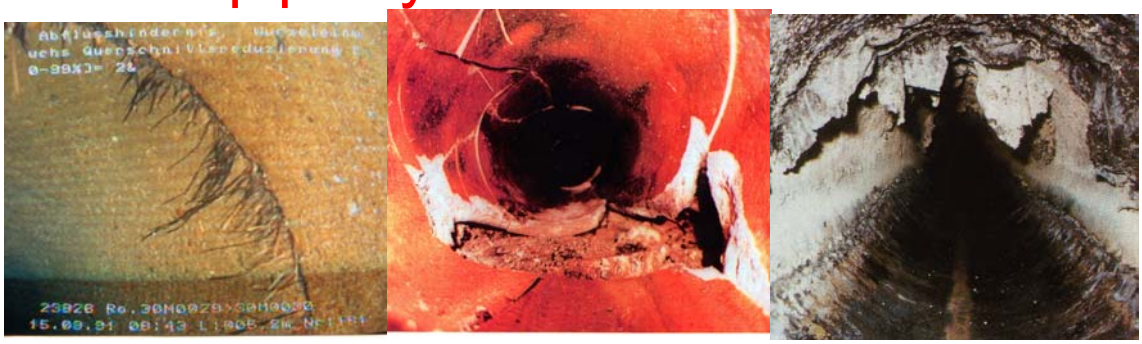
In Kuwait, at "N.I.C." over 1,500 employees operate two major factory complexes, encompassing eleven plants, called Building Material Group. These two major complexes of BMG are Mina Abdullah factory complex and Sulaibiyah Factory complex.

Mina Abdullah factory complex includes "HDPE Pipes Factory", which produces HDPE Pipes, manholes and fittings. The complex also contains a rapidly expanding quarrying plant and one of the largest sand lime bricks in the world. Another factory produces around 70% of Kuwait's gas-aerated concrete blocks "Al Abyad." The complex includes various other plants producing: NIC Plaster, NIC Glue Mortar, NIC Pvc Pipes and Fittings and NIC Ready Mix concrete.

2. HDPE Pipe Factory

"HDPE Pipe" factory was established in 2002 in response to the ever increasing demand in Kuwait and neighboring countries. This factory is considered one of the largest in the Middle East, with an annual production capacity reaching 4,000 metric tones of HDPE pipes and fittings. HDPE pipes ranges from 300 to 4000 mm., and are produced in accordance with international standard including; German (DIN), British (BS), European (ISO), American (ASTM), Saudi Arabia and Kuwaiti standards. HDPE Pipe factory is capable of producing its products to other standards when required by our clients.

3. Krah pipe systems.



For years tremendous difficulties were observed in selection of the material of construction for infrastructural systems, which should be suitable to provide anticipated permanent solutions.

Over twenty years ago, engineers sought to address the inherent weakness of concrete, clay, ductile and steel sewer pipe systems. These and other sewer pipe systems either tend to be brittle or are too sensitive to aggressive chemicals and soil conditions. Failures had become a common occurrence world-wide in sewer and other large-diameter-pipe applications. See the damages of rigid pipes in the pictures above (crack and root intrusion).

So they derived benefit from the fact that the processing of plastic is very easy and the plastic materials provide superior properties against adverse effect of the ambient and the chemicals.

In addition to the permanent solution that lasts through generations, Krah piping systems is able to provide everlasting and economic solutions in wide-ranging fields of applications as for example drain, storm-drain and sewer systems as well as sea outfall, manholes and reservoirs.

In order to meet the requirements of the infrastructure systems, Krah has developed the most robust and advantageous large-bore-pipe systems.

So far tests have shown that the pressure pipes made of HDPE have a lifetime of over 100 years. Moreover the inertness of this material to notches and stress cracking ensures a trouble-free service of the pipe and of course the complete piping system.

4. Pipes made of HDPE or PP.

Polyethylene and polypropylene are thermoplastics with excellent properties for the application of water and sewer as for the fabrication of containers for liquids and solid materials. Polyethylene and polypropylene are resistant to many chemicals and very suitable for conveying and storing various liquids.

Weldability

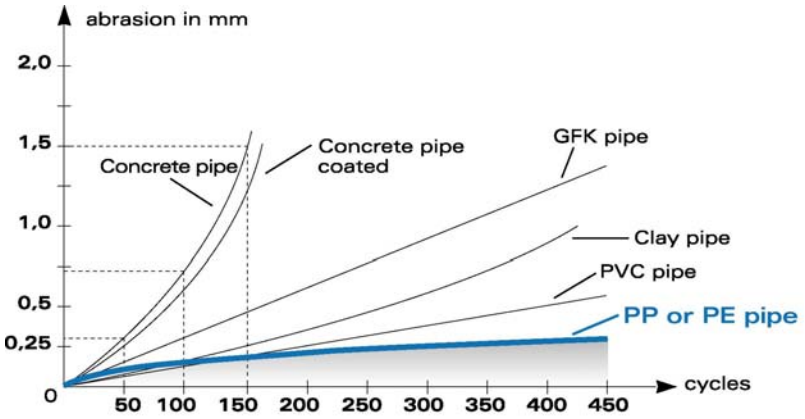
Polyethylene and polypropylene can be welded, i.e. it can be reused continuously. The whole pipeline is a homogenous systems and absolutely safe against wanted or unwanted in- and ex-filtrations.

Good chemical resistance

For buried pipelines the biogeneous sulphuric acid corrosion plays a key role regarding the longevity of the system. The biogenous sulphuric acid corrosion only takes place above the water level and therefore only occurs in partly filled pipes. Krah pipeline systems guarantee optimum security and resistance.

Abrasion proof

Polyethylene and polypropylene pipes are among the most abrasion proof pipes./ This was tested in the so-called Darmsadt procedure and the result are shown in the below diagram and confirms the quality of polyethylene pipes. Tests are performed at the “Süddeutsche Kunststoffzentrum” for its approval.



Abrasion curve of various pipe materials according to the Darmstadt procedure

Impact Resistance

High impact resistance, even at low temperatures, ensures a robust pipe.

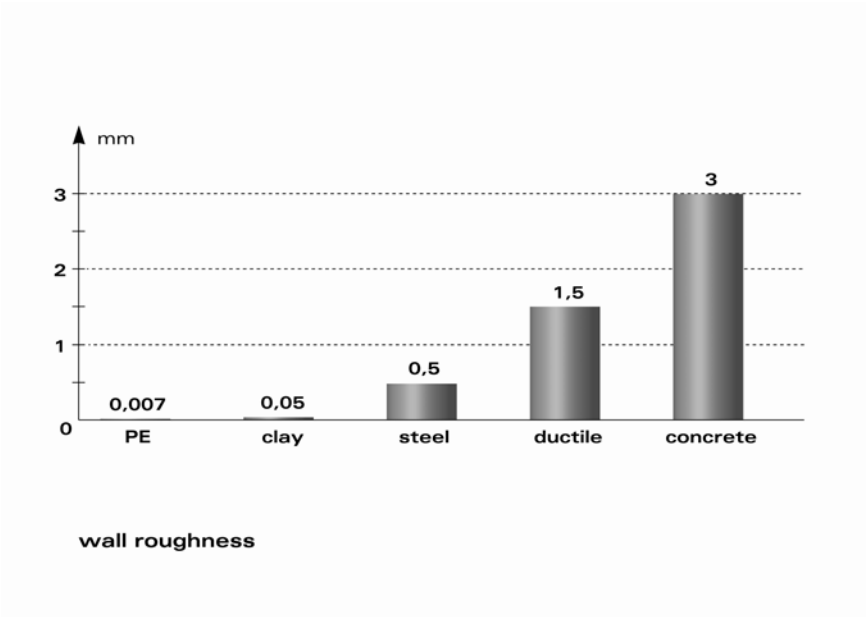
Recycling

Polyethylene and polypropylene materials can be recycled to 100%. They belong to the group thermoplastics. Thermoplastics have the property to be refusible without the structure of the material being modified dramatically. For this reason material of PE and PP can be put back into the production cycle.

Resistant to microorganisms, rodents and termites

The smooth round surface of plastic pipes does not give the teeth of rodents sufficient hold to cause damage. Moreover even in termite-affected countries no damage to PE pipelines by termites has ever been occurred. PE and PP are not a nutrient medium for bacteria, fungi and spores, so that the material is resistant to all forms of microbial attack as well as to both sulphurous acid and sulfates.

Very good hydraulics of the pipes

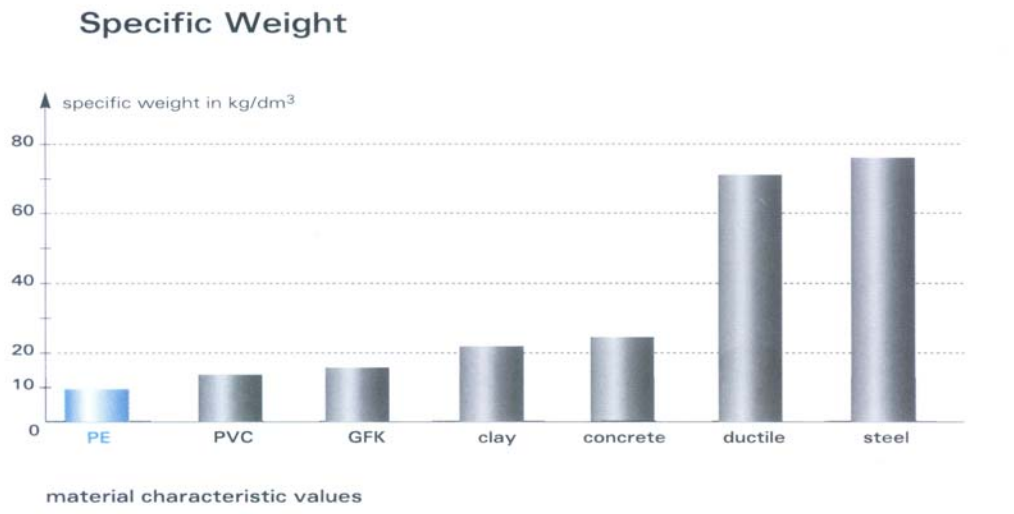


Inner diameter and hydraulic properties of KRAH pipes will remain constant regardless of the wall thickness or the profiles due to the smooth anti adhesive inner pipe surface. The nominal diameter (e.g. DN 500) corresponds to the respective inner diameter according to DIN 16961.

UV-resistance

Black polyethylene pipes are permanently resistance to atmospheric corrosion and UV radiation. Thus the pipes can be used and stored outside without the pipe material being damaged.

Specific Weight



Properties

The materials from which the Krah pipes are produced features the following properties. Other materials can be used after prior acceptance of the producer and a third party for quality control. The used material should have the following specification:

Material specification					
Property	Standard	Unit	PE 80	PE 100	PP-R
Density	DIN 53479 ISO 1183	g/cm^3	0.95	0.96	0.91
melt index MFR 190/5 Code T MFR 190/21.6 Code V MFR 230/5 Code V	ISO 1133	g/10 min	ca. 0.43 ca. 10 -	0.45 6.6 -	0.50 - 1.25-1.5
tensile modulus Short-time long-time (50 years)	ISO 178	N/mm^2	1 170	1200 170	750 160
yield stress	DIN 53495	N/mm^2	23	25	26
tensile strength	DIN 53495	N/mm^2	32	38	15
Elongation at break	DIN 53495	%	>600	>600	>50
ball indentation hardness	ISO 2039	N/mm^2	42	46	45
coefficient of linear thermal expansion	DIN 53752	1/ºC	1.8 x 10^{-4}	1.8 x 10^{-4}	1.6 x 10^{-4}
colour	-	-	black/yellow	black/yellow	black

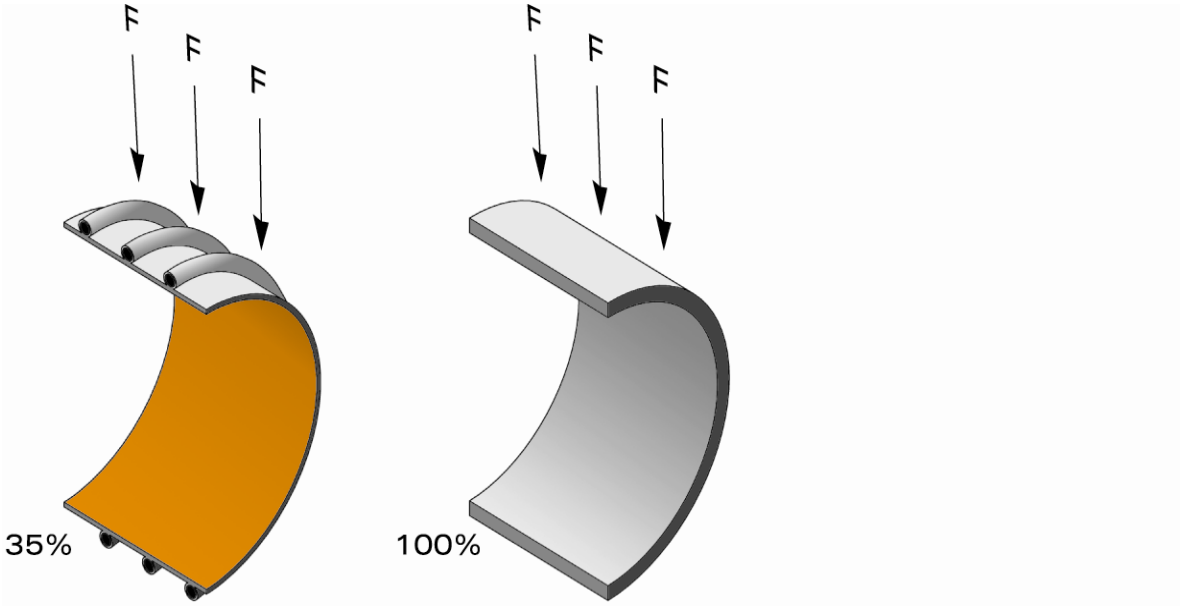
5. Why profiled pipes?

Since the people have begun to found towns and cities, transport facilities for water and sewage water have been needed, Pipes were constructed and gained more and more in importance. With the growing demand and modified requirements again and again the people looked for alternative production methods and materials for the pipes. With the proceeding industrialization also plastic came into question and thus, decades ago, the people started to produce pipes with all kinds of plastic materials and made use of the advantages of this kind of material.

The aim of "NIC HDPE" was to be in the position to offer the customer an ideal solution of a total pipe system, so that they are able to serve the requirements of the projects with the pipes fittings from DN 300 to DN 4000. "NIC HDPE" found solution in profiled pipes and outstanding advantages of Polyethylene and polypropylene. (Refer Sec.4)

The practical experience showed us, that it is necessary to be in the position to offer pipes, which are applicable for all kinds of conditions. Therefore different kinds of pipe wall profiles have been developed, which are combinable with nearly all kinds of diameters. So, "NIC HDPE" is offering profiles VW, PR, SQ and ST. (Refer Sec. 14)

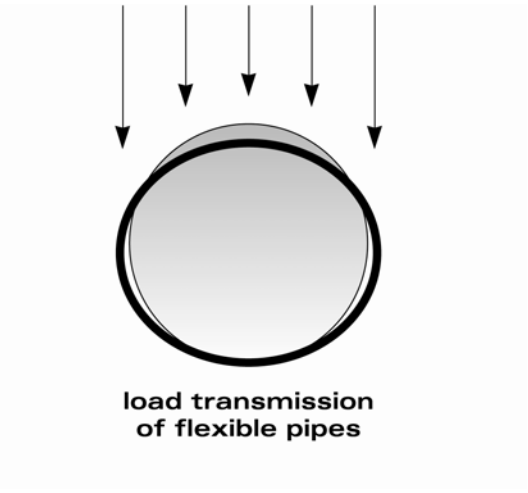
Besides the high flexibility of the KRAH piping systems, these profiled pipes have succeeded to meet the German standards DIN 16961 or DIN 8075 as well as the standards of other countries like the European norm prEN 13476, the Brazilian norms NBR 7373, the Japanese Norm JIS K 6780 and the US Norm ASTM F894.



Weight saving by using profile pipes with the same ring stiffness compared to equivalent solid wall pipes

A nother important point is the design of the pipe wall. In former times very big wall thicknesses for pipes had to be used in order to maintain loads, which influence the pipe. The results were heavy and very expensive pipes although wall thicknesses stipulated in the norms would be sufficient for the actual application of the pipe. In order to solve this problem the profile pipes have been developed. A profile is added to the minimum required basic wall. The profile is connected to this wall. This profile which is calculated by a special software produces a significantly higher moment of inertia and thus the loads can be carried. For comparison, a solid wall pipe of the same material with the respective moment of inertia would weight three times more.

6. Elasticity of HDPE Profiled Pipes.



Pipes made of Polyethylene and Polypropylene has considerable advantages to other pipe materials like concrete, steel, ductile etc. One of these advantages is the high flexibility. Even in areas, which are highly affected by earthquakes, our pipes are hardly damaged in comparison to pipes made of other materials. Despite the flexibility of the Krah pipes they have a great capacity to carry loads, so that they are also suitable for road construction.

In radial direction

Elastic pipes can react to changes in their environment. Due to the deformation performance, the load is distributed to its surrounding and the force acting on the pipe will be diminished. Within a short time there is a balance in the area around the pipeline and the deformation comes to a standstill. Plastic pipes react very flexible to static loads, while the loads do not concentrate themselves on the pipes, but are diverted to the surrounding soil. Flexible pipes still function, when other rigid pipe systems have already broken.

In axial direction

Since the pipelines are profiled on the outside, these profiles can fix the pipes in the soil, There will be no or very few axial extension in the pipeline, Krah pipes are nearly unaffected by temperature variations.

Bending

The maximum bending radius depends on the proportion of the pies wall thickness to the diameter of the pipes. If the proportion is small the maximum bending has to be considered with the relation to the buckling. If the proportion is bigger the maximum bending of the pipe wall has to be considered on a long-term basis. A maximum expansion of 2.5% (ξ) should not be exceeded.

Formula for bending :

$$R_B = \frac{1}{0.28 * s} * \left(\frac{Di + s}{2} \right)^2$$

R_B = bending radius [mm]

s = wall thickness (for profiles the water wall thickness) [mm]

formula for expansion:

$$R_B = \frac{\left(\frac{Di}{2} + s \right) * 100}{\varepsilon}$$

Di = internal diameter [mm]

ε = peripheral strain [%]

7. Delivery Program

"NIC HDPE" Profiled Pipes

Used standards and recommendations:

Pipe:	Din 16961 prEN 13476-1 Or on request ASTM F 894 NBR 7373 JS K 6780
Statical calculations:	ATV A 127 ISO 9969
Hydraulic calculations:	ATV A 110 EN 1610
Laying of pipes	ASTM D 2321
Welding or pipes:	DVS 2207
Internal standard:	KWS

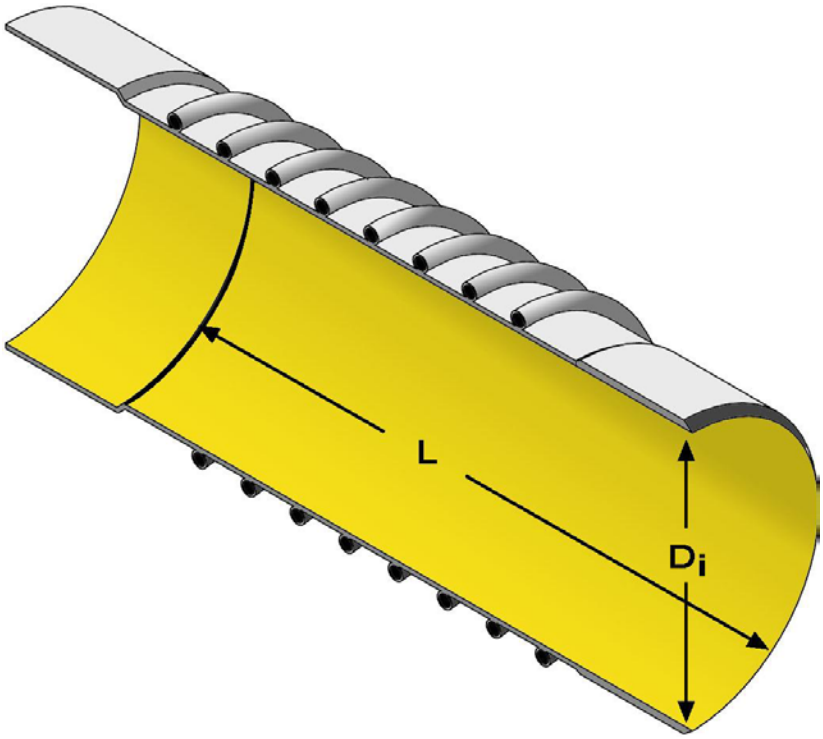
Materials

High density polyethylene (PE80 and PE 100). Polyethylene-random (PP-R), polyethylene-homo (PP-H), polypropylene-flammable (PP-S). Other materials on request.

Pipe lengths

The standard laying length (L) of the Krah pipes is six meters. In addition it is possible to produce continuously any lengths between one and six metes. The longer a pipe is the fewer joints are necessary and this is advantageous for the installation of the pipe. Moreover it is possible to deliver the pipes already jointed, whereby the installation time on site is reduced again. Lengths up to 18 m consisting of 3 pipes sections are common.

Pipe dimensions



Standard and special lengths are produced with internal diameters (D1) from DN 300 to DN 4000 mm, so in case of different wall thicknesses the internal diameter is always the same with the hydraulic capacity.

Di = internal diameter [mm]
L = laying length [mm]

Wall thickness and profile type

Depending on the application, profiled and solid/smooth-wall pipes with wall thickness up to 300 mm can be produced.

Profile and Stiffness

By using a profiled pipe it is possible to use a light pipe for a high static load. The supportable static load is determined for every profile geometry by the factors elastic modulus [N/mm^2] of the respective material and the moment of inertia of the profile geometry [mm4/mm] referring to the pipe diameter. The result is called ring stiffness.

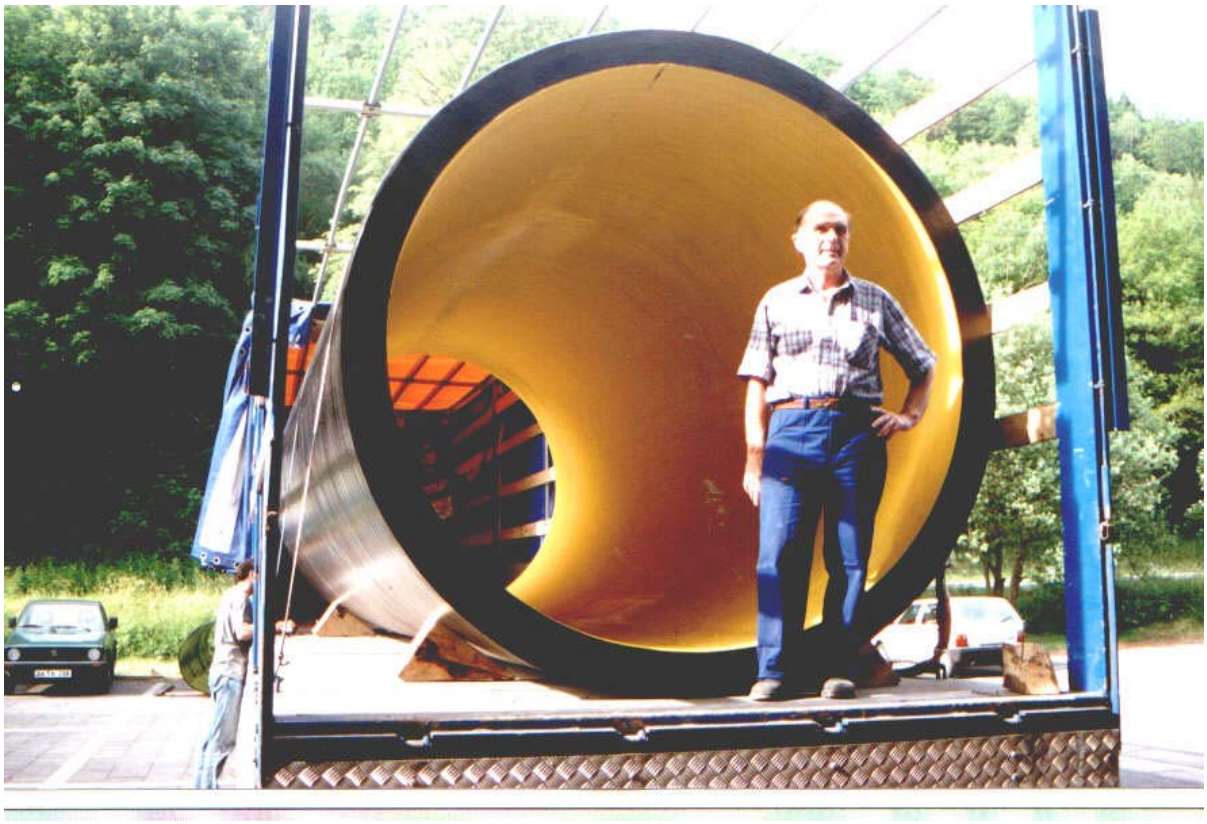
By using a profile design pipe, the weight can be reduced up to 65% compared to a solid wall pipe with the same ring stiffness. Krah pipes offer the best security and durability.

8. NIC HDPE Pipes as per ISO 9969

Nominal Dia. DN mm	Socket inner Dia.	Type SN 2 SN=2kN/m^2	Type SN 4 SN=4kN/m^2	SN=8kN/m^2	SN=16kN/m^2
300	380	PR 21-0.4	PR 21-0.4	PR 21-0.4	PR 34-0.99
400	480	PR 21-0.4	PR 21-0.4		PR 42-1.9
500	580	PR 21-0.4	PR 34-0.99		PR 54-4.5
600	680	PR 34-0.99	PR 34-1.2		PR 54-4.7
700	780	PR 34-0.99	PR 42-1.9		PR 54-8.0
800	880	PR 42-1.9	PR 54-4.5	PR 54-6.6	PR 54-11.39
900	980	PR 42-2.28	PR 54-4.5	PR 54-8.0	PR 54-16.3
1000	1080	PR 42-2.6	PR 54-5.5	PR 54-11.39	**
1200	1280	PR 54-4.5	PR 54-9.6	PR 54-19.8	**
1400	1480	PR 54-7.0	PR 54-16.3	**	**
1600	1680	PR 54-11.36	PR 54-24.25	**	**
1800	1880	PR 54-16.3	SQ1 54-31.5	**	**
2000	2080	PR 54-24.25	SQ1 54-31.5	**	**
2200	**	**	**	**	**
2400	**	**	**	**	**
2600	**	**	**	**	**
2800	**	**	**	**	**
3000	**	**	**	**	**
3200	**	**	**	**	**
3400	**	**	**	**	**
3600	**	**	**	**	**
3800	**	**	**	**	**
4000	**	**	**	**	**

***** stands for special profile shapes on request***

9. Technology at the highest level.



Production Technology

The production of the "NIC HDPE" profiled pipes made on the machines manufactured by Krah AG is designed to meet the requirement of the present local governmental norms and standards. Quality and efficiency are aims, which have been realized.

A great variety of pipe types can be produced. On the following pages various properties and advantages are described. In case of huge projects in large pipe sizes a pipe production on the jobsite is possible. Its mobility is one of the biggest advantages of the Krah production lines.

Co-Extrusion

If requested all "NIC HDPE" profiled pipes can be delivered either with a bright, inspection friendly or an electro-conductive inner surface made by the co-extrusion process. This method ensures an inspection friendly, bright inner surface and the same time a long term UV-resistant outer surface. A pipe production out of grey material cannot fulfil these important properties.

The advantages at a glance :

- Safe and field proven pipe system.
- Safe and easy connection technique (Electro-fusion welding system).
- Good chemical resistant (material polyethylene and polypropylene).
- High mechanical resistance (abrasion and impact resistant, secure against fracture).
- Good Hydraulics (smooth inner surface).
- Flexibility (secure against fracture even in case of earth movement).
- Easy to handle (low weight, easy processing, quick assembly).
- High temperature resistance (application from -40^{0}C, to +80^{0}C).
- Inspection friendly due to light inner surface.
- Earthquake proven.
- UV-resistant.
- Lifetime over 100 years.
- Environmentally friendly.
- Material can be recycled to 100%.
- Resistant to rodents.

10. Technical background.

In order to facilitate the choice of the right pipe some basic formulas are given below. Representatives of "NIC HDPE" will be always ready to assist you in calculations, if required.

Static calculation and determination of the profiles

Normally each individual project is calculated according to the stipulated values of the customer. Generally the following applies:

The more information is available, the more detailed a pipe can be produced according to the requirements. The advantage is that the pipes do not have to be unnecessarily over dimensioned, which otherwise would cause a very high price. Exactly this is the advantage of the "NIC HDPE" profiled piping system: Any customer gets the pipe which is exactly produced according to his requirements. Moreover it is possible to combine different kinds of pipe types. For example it often happens that long pipelines have different requirements for certain sections (e.g. road-crossing). In this case other manufactures take the highest load as yardstick for the whole project while, by using the "NIC HDPE" profiled pipe system the right profile for every action can be defined.

The requested ring stiffness is most crucial for the determination of the right pipe. Another criteria is the minimum wall thickness. Naturally the ring stiffness can be calculated according to all different kinds of norms. Please refer to the following table for two examples.

Ring stiffness	Formula	Explanation
Acc. To DIN 16961	$Rs_{24} = \frac{E_{24} * I_x}{(r+e)^3}[N/mm^2]$	E_{24} = elastic modulus after 24 h [N/mm^2] Ix = moment of inertia [mm^4/mm] R = internal radius (Di / 2) [mm] e = distance of inertia [mm]
Acc. To ISO 9969	$SN = \frac{E_k * I_x}{(Di+e)^3}[N/mm^2]$	E_k = elastic modulus after 1 minute [N/mm^2] Di = internal diameter [mm]

It is very important that the pipe is installed exactly as stipulated in the static calculation. Here the trench depth which has to be given by the customer is particularly significant.

There exist several possibilities to install the pipes that are all described in the norm ATV 127. One of these installation possibilities has to be determined and the later has to be carried out. ATV A 127. One of these installation possibilities has to be determined and later has to be carried out. It is absolutely necessarily to observe the values for the compaction stipulated in the static calculation as this is the basis for the whole static calculation. The recommended or feasible compaction depends, among other things, on the type of soil.

As loads, especially traffic loads, directly affect the manhole, special precautionary measures have to taken. For more about manholes please refer to the pages 27-29. The most significant influencing factors for the static calculation are:

- installation depth
- traffic and area load
- groundwater table
- soil characteristics
- installation conditions

Please also refer to the questionnaire at end of catalogue.

Pipe selection

The following table gives an overview of the standard profiles. For the calculation the following conditions were assumed:
The selection of the profiles in the list is the result of a calculation according to ATV A 127 with a maximal deflection of 6% after 50 years of service.

- a covering of 1000 [mm] up to 5000 [mm]
- normal safety classes
- no ground water
- filling material G1 (non cohesive soil)
- compaction: 97% proctor density
- bedding of the pipe 180°
- pipe made of standard material PE
- 80 (E-modulus, short 800 N/mm^2)

Profile Selection

Diameter in mm	Without traffic load	With traffic load
300	PR 21-0.4	PR 21-0.4
400	PR 21-0.4	PR 21-0.4
500	PR 21-0.4	PR 21-0.4
600	PR 21-0.4	PR 34-1.2
700	PR 21-0.4	PR 34-1.2
800	PR 34-1.2	PR 42-01.9
900	PR 34-1.2	PR 42-02.6
1000	PR 34-1.2	PR 54-04.7
1100	PR 42-02.6	PR 54-05.5
1200	PR 42-02.6	PR 54-06.6
1300	PR 54-04.7	PR 54-08.0
1400	PR 54-04.7	PR 54-08.5
1500	PR 54-05.5	PR 54-10.3
1600	PR 54-06.6	PR 54-11.8
1700	PR 54-07.0	PR 54-12.9
1800	PR 54-08.0	PR 54-14.2
1900	PR 54-10.3	PR 54-16.3
2000	PR 54-10.3	PR 54-19.8
2100	PR 54-11.8	PR 54-19.8
2200	PR 54-14.2	SQ1-34-12
2300	PR 54-16.3	SQ1-34-12
2400	PR 54-19.8	SQ1-34-15
2500	SQ1-34-22	SQ1-34-18
2600	SQ2-34-46	SQ2-34-22
2700	SQ2-34-46	SQ2-34-22
2800	SQ2-34-46	SQ2-34-46
2900	SQ2-34-46	SQ2-34-46
3000	SQ2-34-46	SQ2-34-46
Above 3000	Special shapes as per request.	

11. Hydraulics

Calculation of Flow Rate

To determine the flow rate “Q” for a fully filled pipe in a continuous discharge, the so called “normal discharge” – for public sewer pipes, the ATV A 110 standard and also the European standard DIN EN 752 recommends to use the formula which is related to Prandtl-Colebrook and is called the “general discharge formula”:

$$Q = \frac{\pi * Di^2}{4}\left(-2 * \log\left[\frac{2.51 * v}{Di\sqrt{2gDiJ}} + \frac{k}{3.71 * Di}\right] * \sqrt{2gDiJ}\right)[m^3/s]$$

Q = flow rate [m3/s]
Di = internal diameter [m]
V = kinematic viscosity for sewage [m^2/s]
(acc. To ATV A 110: v = 1.31 x 10^{-6} [m^2/s])
j = energy gradient, at normal discharge [-]
k = hydraulic effective roughness [m]
g = acceleration due to gravity
The values of k is indicated in the table of the ATV A 110 standard as real roughness of 0.25 to 1.50 mm (depending on the kind of pipe). All possible losses are included in the value.

Calculation of partly filled pipes at normal discharge

For the calculation of partly filled pipes at normal discharge there are tables in the ATV Arbeitsblatt A 110 available for the flow speed, calculation with the following formula:

$$v_T / v_v = \left(r_{h,T} / r_{h,v}\right)^{0.625}$$

v = flow speed [m/s]

r_h = hydraulic radius [m], for circular profiles = D/4
V = fully filled value
T = partly filled value

Buckling

Buckling forces (p_b) occurs always, if there exist a great difference between the inside and the outside pressure of a pipe. In order to design the pipes adequately this has to be taken into consideration when carrying out the dimensioning.
The general formula for the buckling capacity of a pipe structure is:

$$P_b = \frac{2 * E}{1 - \nu} * \left(\frac{S_e}{D_m} \right)^3 [MPa]$$

E = modulus of elasticity [N/mm^2]
s_e = equivalent solid wall thickness [mm]
D_m = mean diameter (D_i+s) [mm]
ν = contraction coefficient [-]

The modulus of elasticity (E) is depending on the stress level, the temperature and the loading time. The contraction coefficient (υ) which should be used is 0.4 [-] for polyethylene and o.38 [-] for polypropylene.

Internal pressure

The computation model for calculating the hoop stress σ on the pipe wall induced by an internal pressure pi, is called the ring formula. According to ISO standard 161 part 1, the formula is as follows:

$$\sigma = \frac{p_i * D_e}{2 * s * 10} [N / mm^2]$$

By re-arrangement, the formula can express the wall thickness (s0:

$$S = \frac{Pi * De}{10 * 2 * \sigma + p_i} [mm]$$

$$\sigma_s = \frac{MRS}{C} [N / mm^2]$$

Pi = working pressure [bar]
De = external diameter (Di+2s) [mm]
σ = hoop stress acc. To ISO 161 [N/mm^2]
σs = permissible design stress [N/mm^2]
s = wall thickness, here explicit only the water way wall thickness [mm]
MRS = minimum required strength [N/mm^2]

The permissible design stress is defined by the pipe material lifetime, safety factor and temperature according to DIN 8074, or according to other official test documents.

The standard safety factor for water
C_{min} = 1.25 [-]
c = 1.6 [-]

In reality the MRS of the raw material is higher, depending on the resign supplier.

The minimum required strength (MRS)	
	according DIN
8 [N/mm^2] for PE80	8075
11 [N/mm^2] for PE100	8075
12 [N/mm^2] for PP-R	8078
12 [N/mm^2] for PP-H	8078

The values are of 50 years and a temperature of 20ºC. Other lifetime and temperature values on request.

Equivalent standard dimension ratio

To get an equivalent value (eSDR) for "NIC HDPE" pipes, in case that there is no internal pressure, the following formula can be used:

$$SDR = \frac{De}{S}[-] \text{ or } SDR = \frac{Di + 2 * S}{S}[-]$$

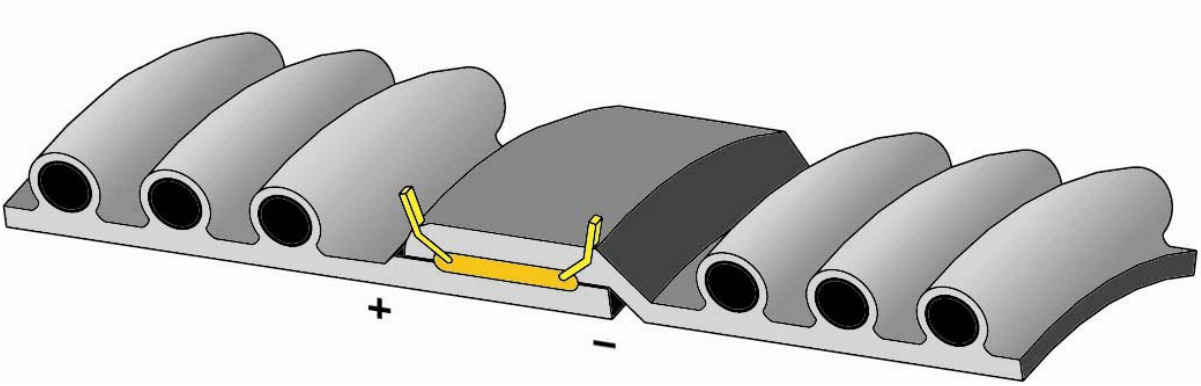
$$I_x = \frac{S^3 * 1}{12.1}[mm^4 / mm] \text{ and } S_e = \sqrt[3]{I_x * 12}[mm]$$

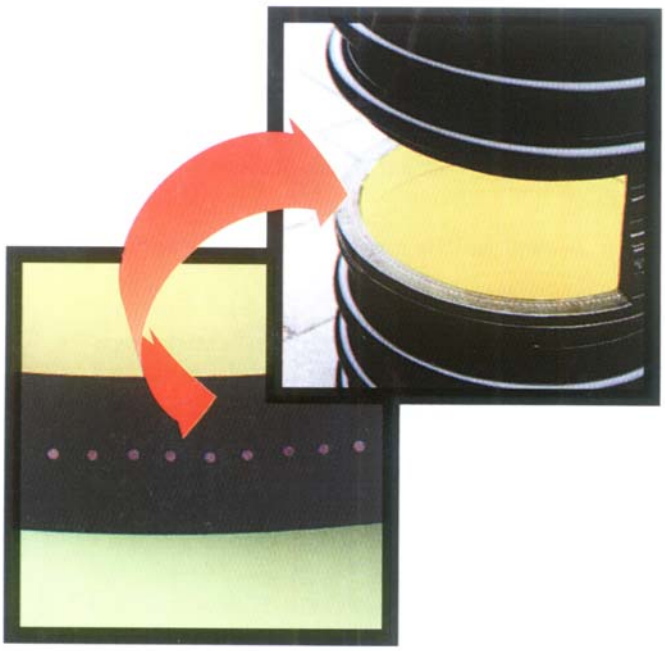
$$eSDR = \frac{Di + 2 * \sqrt[3]{I_x * 12}}{\sqrt[3]{I_x * 12}}[-]$$

12. Jointing Technique

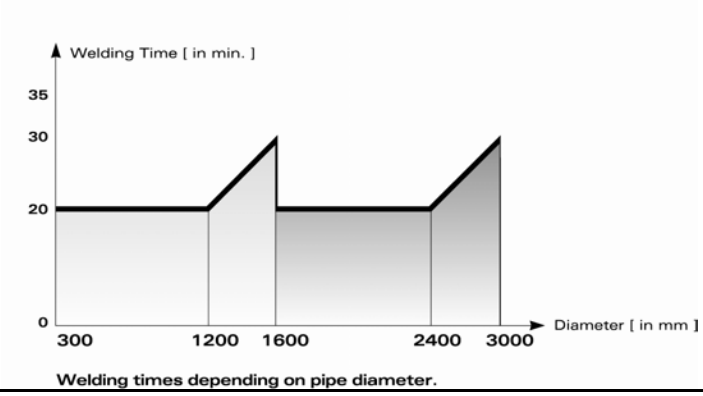
All "NIC HDPE" pipes can be delivered with different joint systems. The pipe ends are equipped accordingly and integrated directly in the pipe.

Integrated Electro-Fusion.





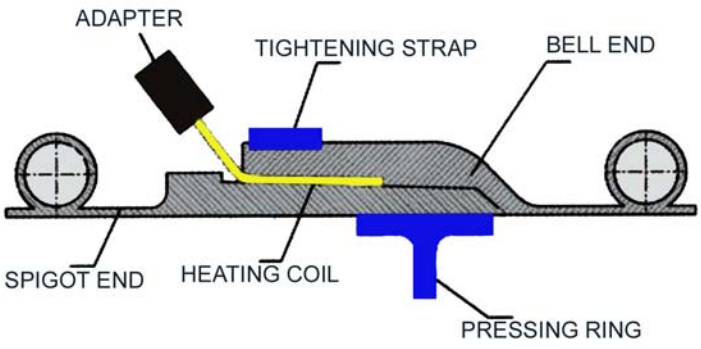
To weld plastic pipes and fittings with the help of Electro-Fusion has been a common method in the market for years. Above all because this joint technique is very favourable, simple and secure.
"NIC HDPE" is using this technique also for big pipes. A welding wire which is included in the socket is heated with the help of a special welding device whereby the two pipe ends (the socket and the spigot) are jointed together.
By this fast jointing technique it is possible to install pipes in such a short period of time which has never been realizable before. Without any problems and with only one welding device it is possible to install a pipeline of 72 mm with a diameter of 1200 mm in 8 hours. The recording which is necessary for the quality assurance is realizable very easy and secure with the help of the welding device from "NIC HDPE"



Welding times depending on pipe diameter.

ELECTRO-FUSION SYSTEM
• The advantage at a glance: • quick welding • welding device at reasonable price • welding possible in narrow trench • welding of bigger pipes possible from inside • quick assembly by using several welding device at the same time • tensile strength • 100% permanent tight joint • printed welding record • it is possible to use the Electro-Fusion welding device again immediately, even the pipe is still cooling

Welding procedure



Generally the Electro-Fusion socket and the spigot are already prepared for the welding. After the basic justification of the pipe the plastic foil, which serves as protection, is removed. Now the welding area is cleaned with a special polyethylene cleaner. The connection of the welding wire should be at the top of the pipes as this facilitates the later welding. Now the spigot can be shifted into the socket. The pipe

is justified, the inside support ring is put into the right position and the outer tensile band is tightened. The welding adapter is screwed on the ends of the welding wire, Now it can be connected to the welding device. On the pipe is a barcode, which includes all necessary information for the welding. With the help of a barcode reader this information is read and welding can be started. After having finished the welding a certain cooling time which depends on several factors, has to be respected. Only after this cooling time the inside support ring and the outer tensile band can be completely detached.

Software

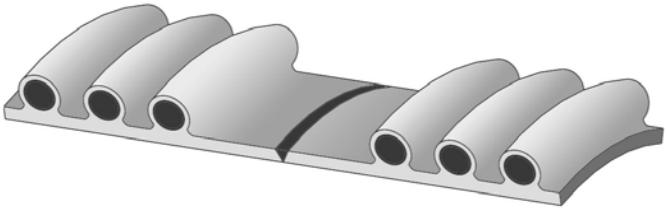
The welding device Tiny Data has the capacity to record any individual welding. These welding records are saved in the device and can be read out by the computer. The software which is needed for this is called “Krahcode”. With this software two things can be done: on the one hand the data of the welding device can be read and administered and on the other hand the barcode for the welding of the pipes can be made.

13. Other jointing possibilities.

In addition to our unique integrated Electro-Fusion jointing technique our pipes can also be produced with the following techniques:

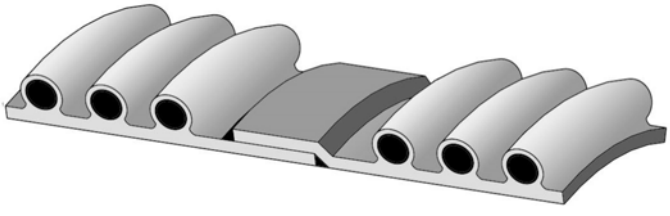
V seam extrusion welding

Pipes and fittings are jointed with the help of a extrusion welding extruder. The outsides of the ends are chamfered. Thus a welding seam is produced which looks like a V. Normally no socket-spigot connection is used. The welding has to be done according to DVS 2207 part 4.



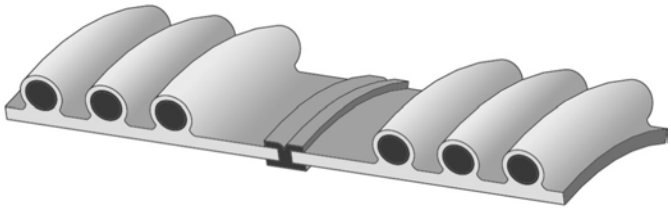
Extrusion welding

The pipe and/or fittings, which shall be connected, are jointed by a socket and spigot joint. Thus the two pipe ends are jointed with a extrusion welding device. The jointing method can be carried out inside or/and outside of the pipe. This jointing is most suitable for low-pressure gravity and manholes. According to DVS 2270 part.



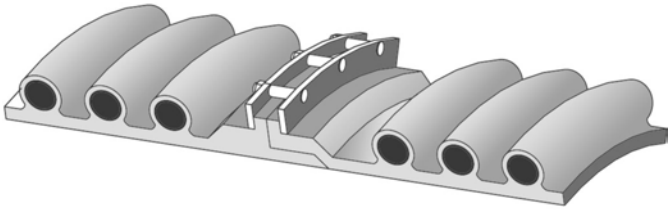
Heat element butt welding

The pipes and fittings are jointed with the help of a heating element butt welding machine. The ends of the pipes and fittings are butt-welded. This kind of jointing methods is only recommended for pies and fittings with a maximum wall thickness of 150 mm and with diameters from 300 mm to 2500 mm. According to DVS 2270 part 1.



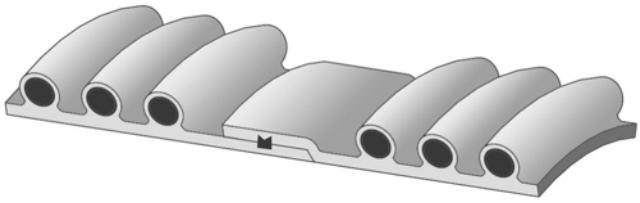
Flange connection

The ends of the pipes and fittings are jointed with the help of steel flange and a rubber gasket. Depending on the type of pipe the flange adapters are completely manufactured with the pipe, or the flanges are available as separate fitting. This kind of jointing method is mostly used for open sea discharge application and for tank connections. The greatest advantage of this connection is the facility of disjointing.



Gasket connection

This connection also uses the socket and spigot jointing including a special rubber sealing which is installed into the spigot end of the pipe or the fittings. This method is also disjointable. The pipe ends has to have the minimum stiffness in the spigot and the socket according to prEN 13476 and should withstand the test according to prEN 1277 and EN 1053.

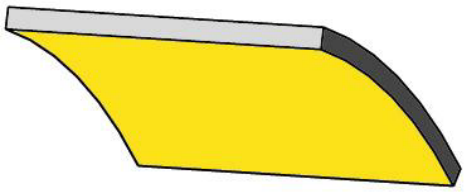


Please note

A complete pipe system is always just as good as its weakest component. The weakest component of the pipe is the joint. Therefore it is important to choose the most suitable and permanent joint. The most preferred joint system is the Electro-Fusion welding. As the whole pipe system becomes a homogenous unit.

14. HDPE Pipe Profile

VW

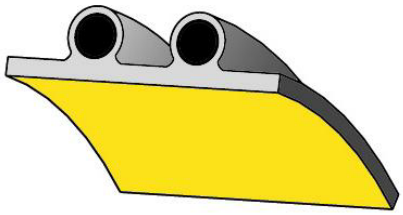


CHARACTERISTICS:

- ✓ *Smooth inner and outer surface for a good hydraulic, bright colour on request*
- ✓ *Flexible and impact resistant*
- ✓ *homogenous*
- ✓ *inside pressure resistant*

The type VW is a homogenous solid pipe with smooth inside and outside surface. These kinds of pipes can also have a socket and spigot with all kind of different jointing techniques. In addition, these pipes can be used for internal pressure.

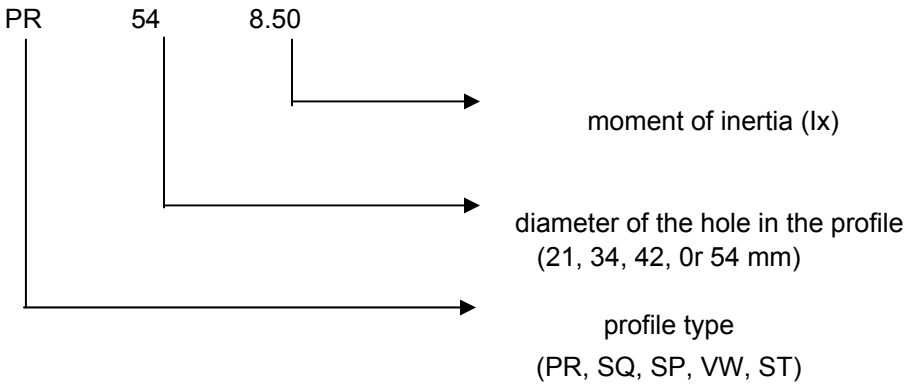
PR



CHARACTERISTICS:

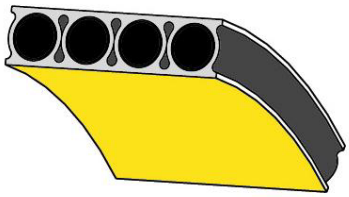
- ✓ *Smooth inner surface for a good hydraulic, bright colours upon request.*
- ✓ *Outside profile for high ring stiffness and good anchorage in the soil.*
- ✓ *Flexible and impact resistant.*

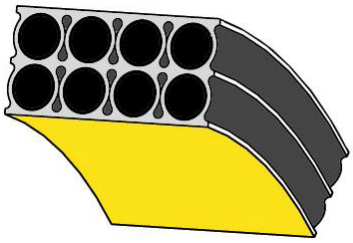
This profile type is manufactured in the winding process. The main properties of this profile is the smooth inside and, of course, the profiled outside. The low weight and the high stiffness are significant. The fields of application for this kind of profiles are several pipeline systems, like for example sewer, drain, storm drain and ventilation.

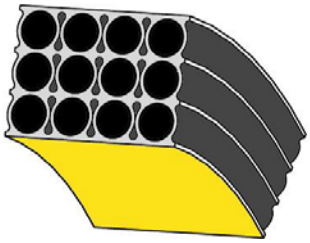


WALL CONSTRUCTION FOR CLOSED PROFILE

(Single and Multilayer Wall)







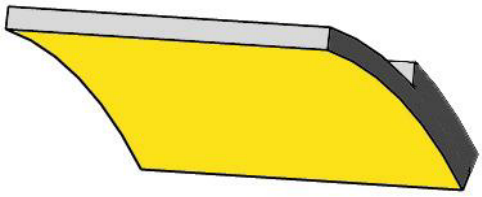
SQ1 ***SQ2*** ***SQ3***

CHARACTERISTICS:

This profile is developed to fabricate shafts and special constructions. The pipe wall is smooth both inside and outside and therefore very suitable for standing objects such as shafts. This profile is in particular suitable forland-fills, because the coefficient of friction is low at the outside surface.
Upon request, the inside surface can be made in a bright colour or electro-conductive.

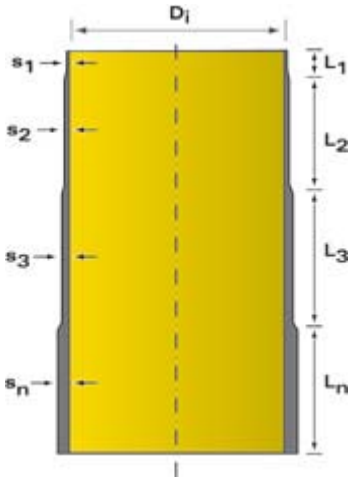
In individual cases the static calculation must be adapted to fit the side requirements and conditions; such as ground water or special loads (trains etc.) The guidelines for this calculation are described in ATV 127 or finite element (FEM) calculation.
We have available software to do these calculations.

ST



CHARACTERISTICS:

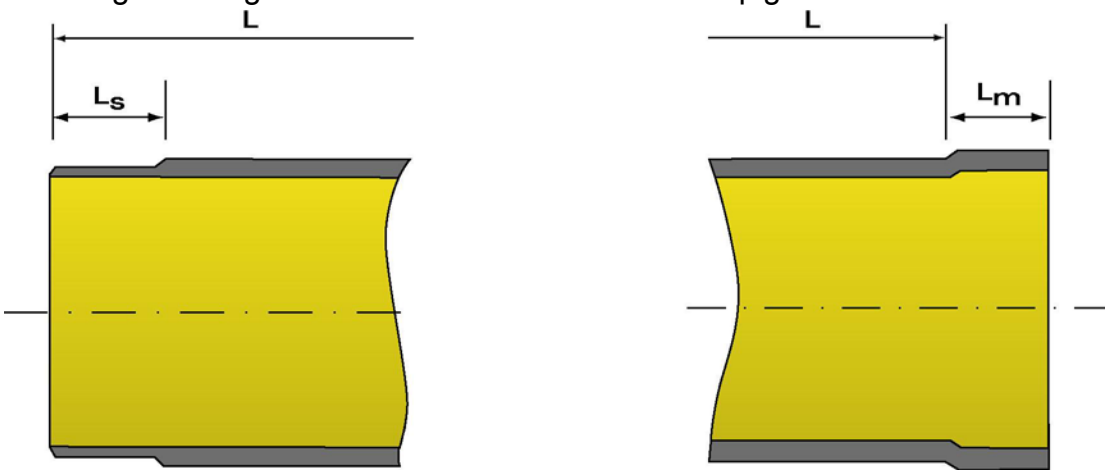
- ✓ *Smooth inner and outer surface for a good hydraulic, bright colour on request*
- ✓ *Flexible and impact resistant*
- ✓ *homogenous*
- ✓ *inside pressure resistant*



Pipes with the profile type ST are specially made for vertical tanks, where different wall thickness in one pipe are required to save material. The calculation method is according to DVS 2205

15. Fittings.

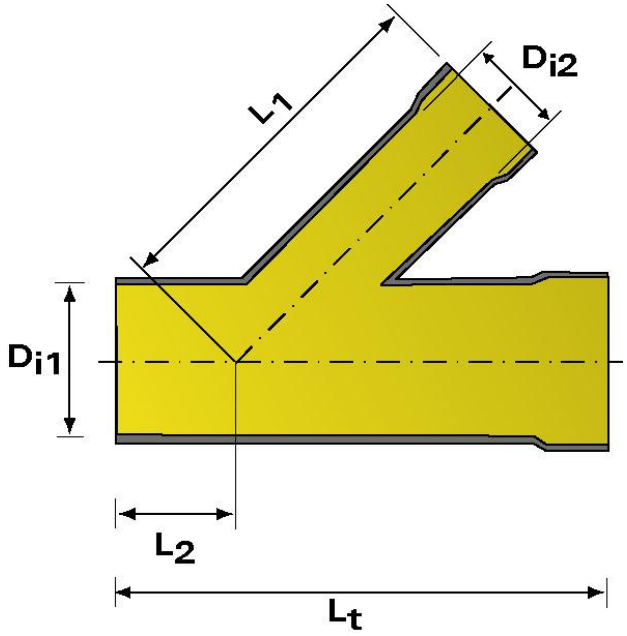
All fitting are fabricated from pipes of the type VW or SQ. Generally the fittings are designed corresponding to the required stiffness and in consideration of the welding factors. Every fitting can have any kind of pipe end and any jointing techniques including the integrated Electro-Fusion socket and spigot.



All pipe end dimensions fulfill the requirement of the prEN 14376 standard, like minimum lengths and stiffness. The standard spigot length (Ls) is 140 mm and the standard socket length (Lm) is 140 mm.

Branches

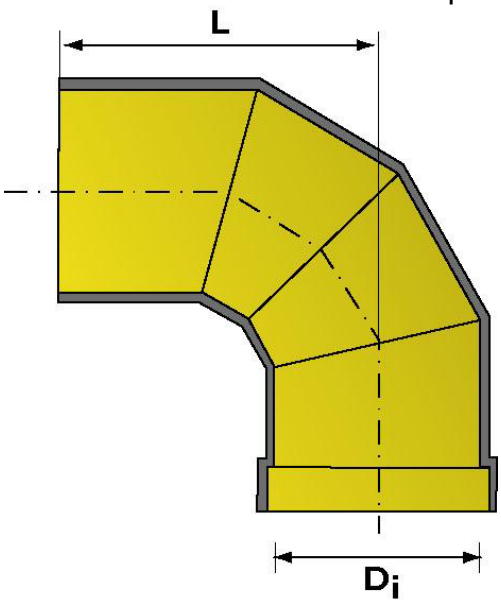
Branches can be manufactured and delivered in every type and form. The angle can be adapted individually from 30º to 90º as well as the ends and the respective segment lengths.



Tee dimensions as per standard DIN 16961				
D_{i1} [mm]	D_{i2} [mm]	L_t [mm]	L_1 [mm]	L_2 [mm]
300	100/150/200/250	1100	350	750
400	100/150/200/250/300	1300	400	900
500	100/150/200/250/300	1400	400	1000
600	100/150/200/250/300	1650	450	1200
700	100/150/200/250/300	1900	500	1400
800	100/150/200/250/300	1900	500	1400
900	100/150/200/250/300	2000	500	1600
1000	100/150/200/250/300	2000	500	1600
1100	100/150/200/250/300	2100	500	1600
1200	100/150/200/250/300	2100	500	1800
1300	100/150/200/250/300			
1400	100/150/200/250/300			
1500	100/150/200/250/300			
1600	100/150/200/250/300			
1800	100/150/200/250/300			
2000	100/150/200/250/300			
2000 - 4000	Special construction as per design dimensions			

Bends

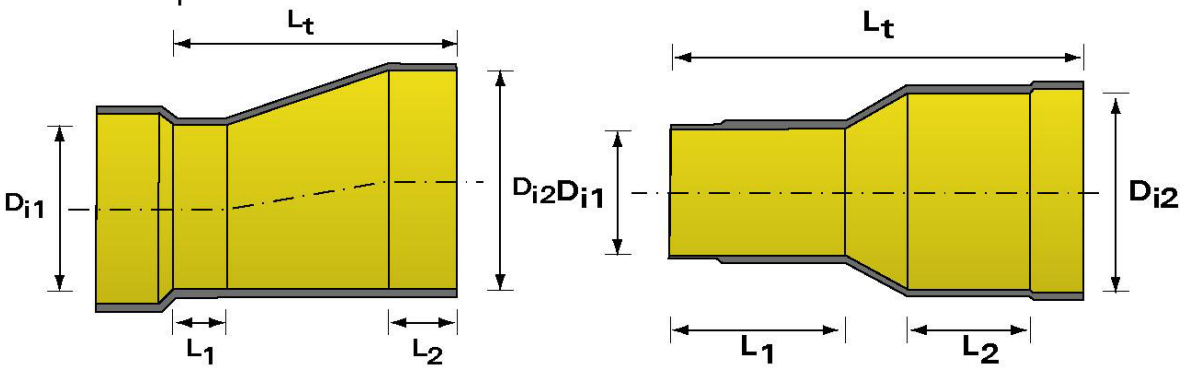
Bends can be manufactured and segmented in different angles and the related radius of the bend to pipe diameter can be selected independently.



Bend dimensions as per standard DIN 16961						
Number of Segments, L, [mm]						
D_i [mm]	2	2	3	3	4	4
	α =15°	α =30°	α =45°	α =60°	α =75°	α =90°
300	100	190	230	280	330	410
	160		270	330	410	510
	70	236	310	390	490	600
	180	270	350	450	560	700
	200	300	400	510	550	820
	210	320	430	560	720	900
	220	340	470	620	790	1000
	240	380	520	680	870	1100
	250	400	560	750	950	1200
	270	430	600	800	1020	1300
	300	460	640	860	1100	1400
	330	490	680	920	1180	1500
	360	520	720		1260	1600
	390	650	760	1040	340	1700
	420	580	800	1100	420	1800
20 00	Special construction as per design dimensions					

Reductions

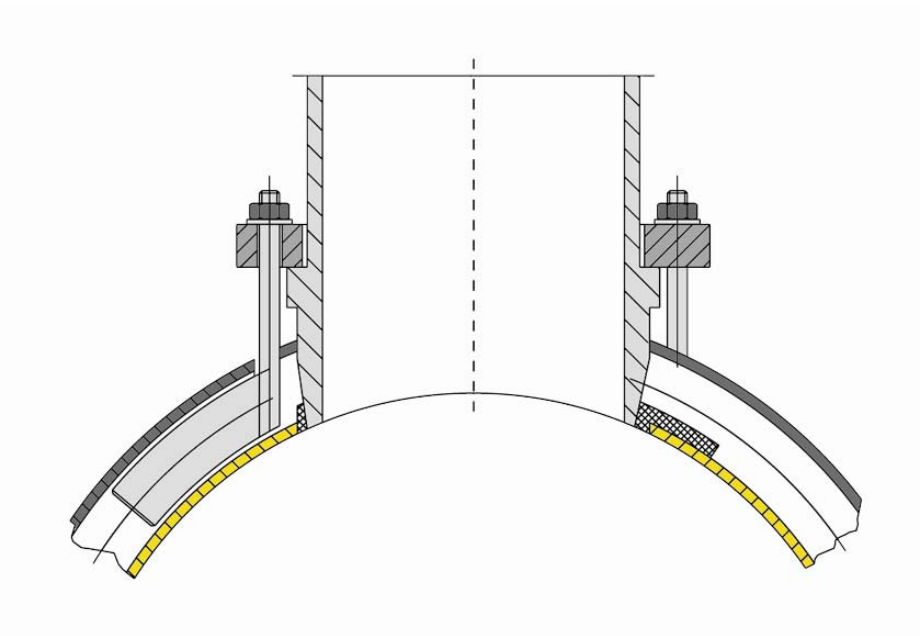
Reduction can be mane both centric and eccentric so that the reduction will always meet the requirements.



Reduction dimensions as per standard DIN 16961				
D_{i2}	D_{i2}	L_t	L_1	L_2
[mm]	[mm]	[mm]	[mm]	[mm]
300	400	1200	500	500
	500	1300	500	500
400		1400	500	500
	600		500	500
	600	150	500	500
	700	1500	500	50
600	700	16	500	500
	800	16	500	500
	800	17	500	500
	900	17	500	500
	900	18	500	500
	1000	18	500	500
900-4000	0-3600	Spe onstructi per des ension		

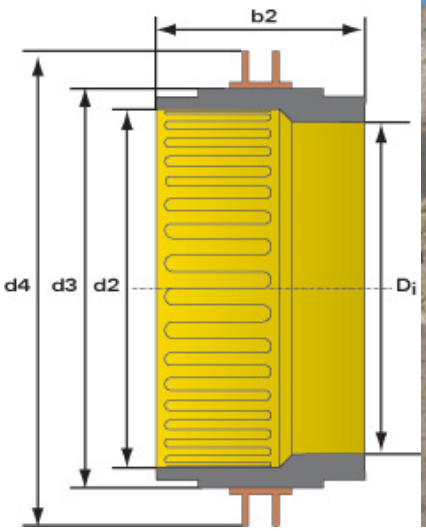
16. Special Constructions.

House connections



House connection can be installed at any time using our transition sleeves. The house connection can be built onto the profile pipe at any place and in any weather. All usual dimensions for house connections lines are available. The assembly can be carried out by experts onsite. The standard outer diameters are 160 mm and 200 mm.
Following any other kind of pipe systems as, for example, corrugated, clay, and PVC pipes can be jointed.

Puddle flanges

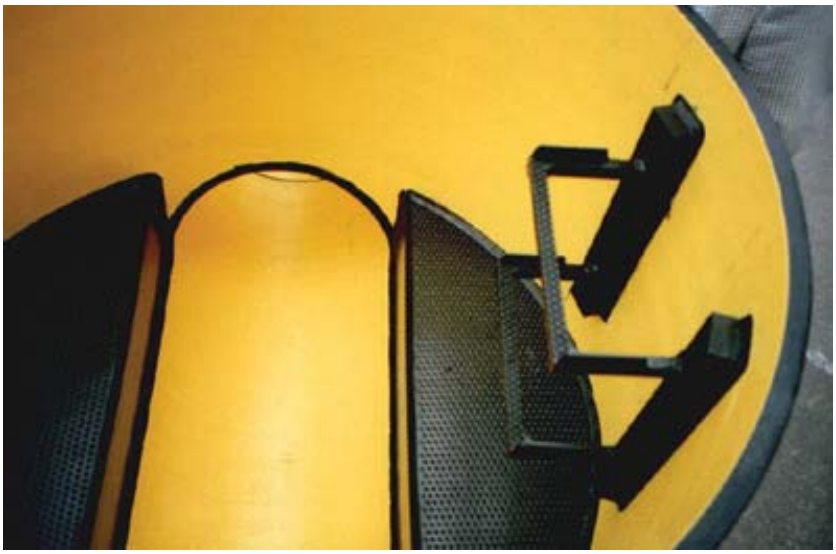


In order to lead Krah pipes through wall, e.g. in sewage plants or concrete shafts, we recommend our puddle flanges which can be flush mounted in concrete. The tightness is secured by a ring made of EPDM.

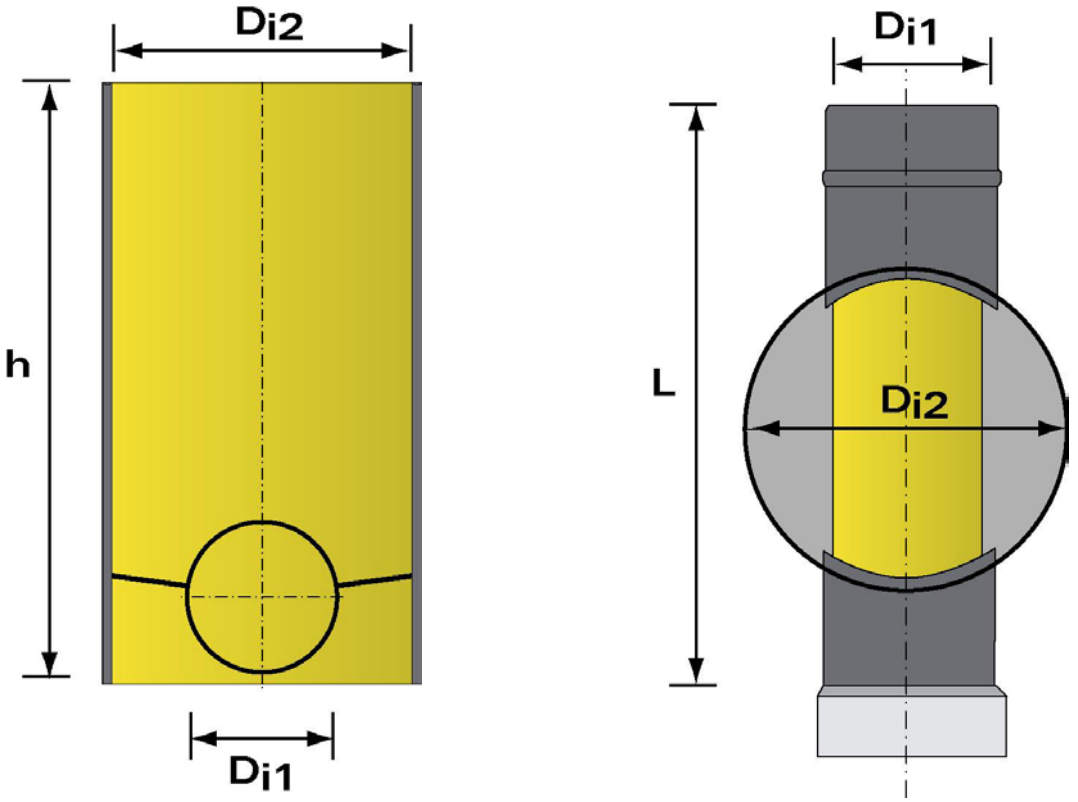
Puddle flange dimension								
	Type KPF 1		Type KPF 2 and KPF 2a					
Di	d1	b1	d2	d3	d4	b2	b3	b4
[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
300	-	-	336	442	517	200	130	140
400	-	-	436	542	617	200	130	140
500	-	-	536	642	717	200	130	140
600	-	-	636	742	817	200	130	140
700	770	160	736	842	917	200	130	140
800	870	160	836	942	1017	300	130	140
900	970	160	936	1056	1131	300	130	140
1000	1070	160	1036	1156	1231	300	130	140
1100	1170	160	1136	1256	1331	300	130	140
1200	1270	160	1236	1356	1431	300	130	140
1300	1370	160	-	-	-	-	-	-
1400	1470	160	-	-	-	-	-	-
	1570	160	-	-	-	-	-	-
1600	1670	160	-	-	-	-	-	-
	1770	160	-	-	-	-	-	-
1800	1870	160	-	-	-	-	-	-
1900	1970	160	-	-	-	-	-	-
2000	2070	160	-	-	-	-	-	-

17. Manholes.

To offer the possibility to control and maintain pipe systems regularly, manholes are integrated in the system. These are mainly installed at the positions of bends, reduction or branches. The manholes are made of the same material as the pipes and also connected to the system with similar jointing techniques. The special advantage is that a homogeneous system of the same material is produced. With preference, profile types like SQ and VW are used for the production of the manholes, as the soil can densify better at the smooth outside of the pipe and settle without problems.



Standard manhole

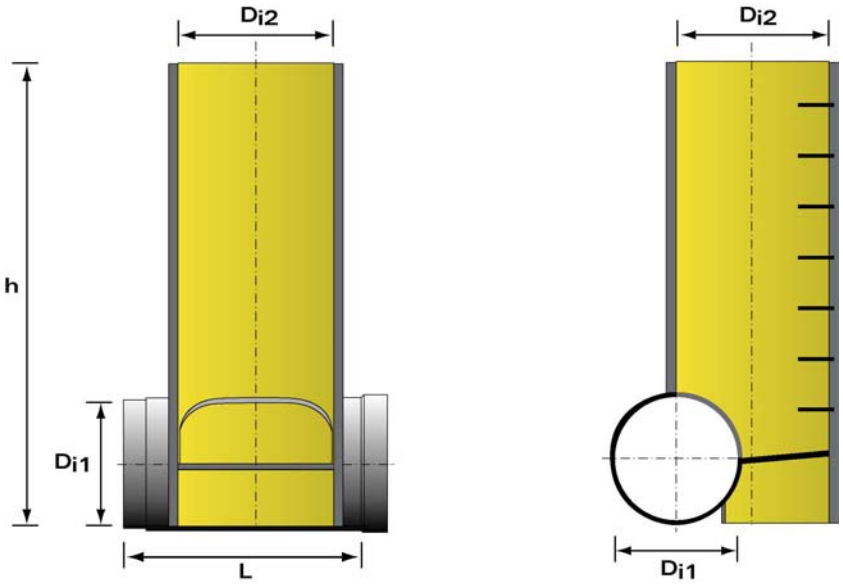


This kind of manhole is situated centrically above the pipe. Because of static and safety reason this type is only recommended if the diameter of the pipe is smaller or equal to the diameter of the manhole. Normally the diameters DN 800 of ND 1000 are used for this kind of manhole.

Usually the lower part of the manhole is completely fabricated out of polyethylene or polypropylene according to the statical requirements. The upper part is a concrete or reinforced concrete ring according to DIN 4034. Even very complex constructions according to the engineer's requirements are possible. The main advantage is the sustainable, flexible lightweight, inspection friendly, self-cleaning and durable construction.

Manholes design			
pipe diameter (D_{i1})	manhole diameter (D_{i2})	height (h)	length (L)
[mm]	[mm]	[mm]	[mm]
300	800, 1000	min 1000, max 6000	2000
400	800, 1000	min 1000, max 6000	2000
500	800, 1000	min 1000, max 6000	2000
600	800, 1000	min 1000, max 6000	2000
700	800, 1000	min 1000, max 6000	2000
800	1000	min 1000, max 6000	2000
900	1000	min 1000, max 6000	2000

Tangential manholes



This manhole is situated tangentially to the pipe. That means displaced from the middle. That is the reason why by using this kind of manholes with the standard diameter of DN 1000 it can be also used by pipe with bigger diameters.

Like the standard manhole, the lower part of the manhole is completely fabricated out of polyethylene or polypropylene according to the statical requirements. The upper part is a concrete or reinforced concrete ring according to the DIN 4034. Even very complex constructions according to the engineer's requirements are possible. The main advantage of the tangential manhole is the sustainable, flexible, light weight, inspection friendly, self-cleaning, durable and a very cheap construction.

Tangential Manholes			
pipe diameter (D_{i1}) [mm]	(D_{i2}) [mm]	height (h) [mm]	length (L) [mm]
1000 to 4000	10	min 1	2000

Special manholes

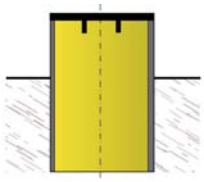
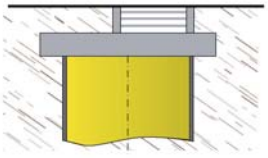
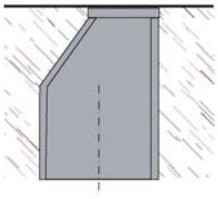
If required a manhole made of concrete can be produced with the inlet and outlet which are designed to connect to the Krah pipe system.

Cover of manholes


For the cover of the manholes there exist all different kinds of possibilities. Especially the application case and the loads are major criteria for the correct choice of the cover.

Regularly the manholes are installed in such a way that the top edge is justified to the earth's surface or the street. In this case the cover has to be designed in a way that the direct load conditions, e.g. crossing vehicles, can be carried and forwarded The most frequently used system is the concrete plate above the manhole which lies on a ring anchor. The advantage is that the rising loads are not forwarded to the manhole but through the ring anchor to the surrounding earth.
Also the PE cone, which was especially developed for PE and PP manholes, has similar properties like the above-described cover.
These covers are especially suitable for the installation in roads, as the cover is integrated into the asphalt and flexibly connected with the manhole (telescopic). Thus covers moves with the asphalt in case that the road settles and the manhole is always even.

Moreover it is possible to choose between the following covers:

18. Transport, Handling, Storage

Transport

The transport of Krah pipes is very easy as they are very good to move due to the low weight. It only has ensured, that the pipe cannot move and that they are stored in the right way, in special cases, e.g. if the pipes are shipped in containers, it is recommendable to adapt the total length of the pipe to the shipping conditions in order to use the space efficiently.

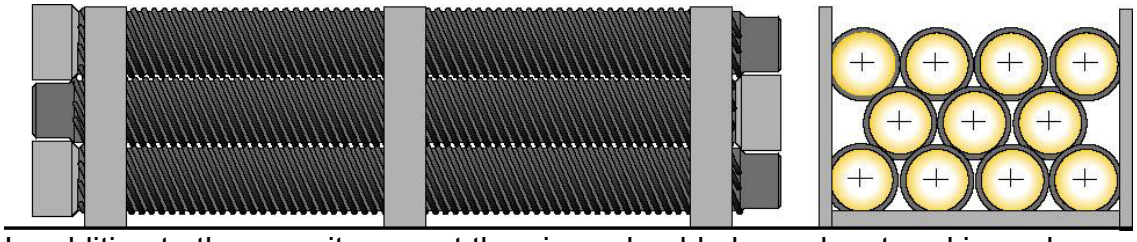
Handling

Forklifts with a rod of 5 meters are very suitable for the handling of the pipes in the production facilities. On site no additional heavy devices are needed. Normally the pipes can be unloaded and transported to the trench by an excavator, which anyway is present on site.

Storage

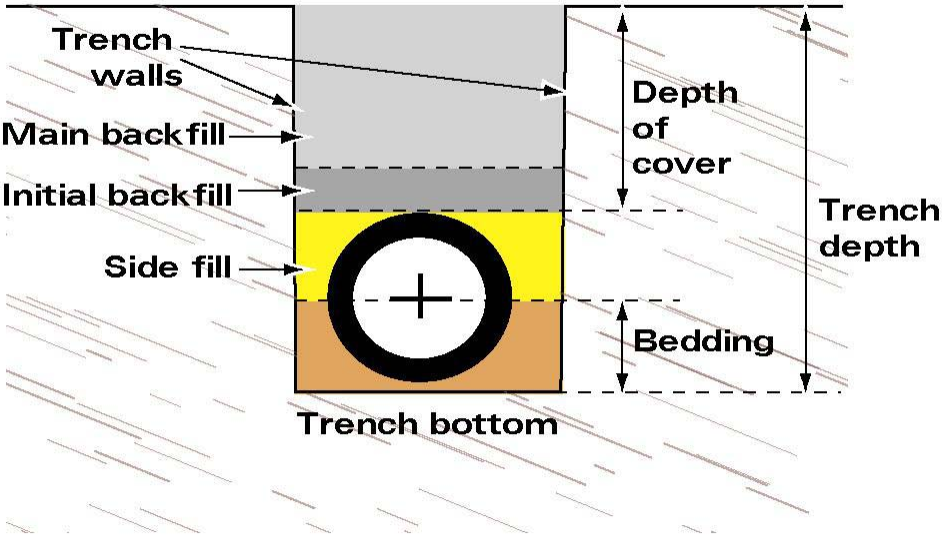

For the storage of the pipes and fittings it is absolutely necessary that they are stored on a even ground. Free of stones and sharp-edged objects, so that point-loads are avoided. Further it is important to make sure that the sockets of the upper layer are not contacting the sockets of the lower layer. This means, the pipe of each layer has to be rotated 180°.

In any case the pipes have to be protected against rolling, especially if the pipes are stored in several layers above each other. A maximum height of 4 meters should not be exceeded.



In addition to the security aspect the pipes should always be stored in such a way that they do not deform. Generally there should be three wood bearing support to guarantee a good load distribution.

19. Installation



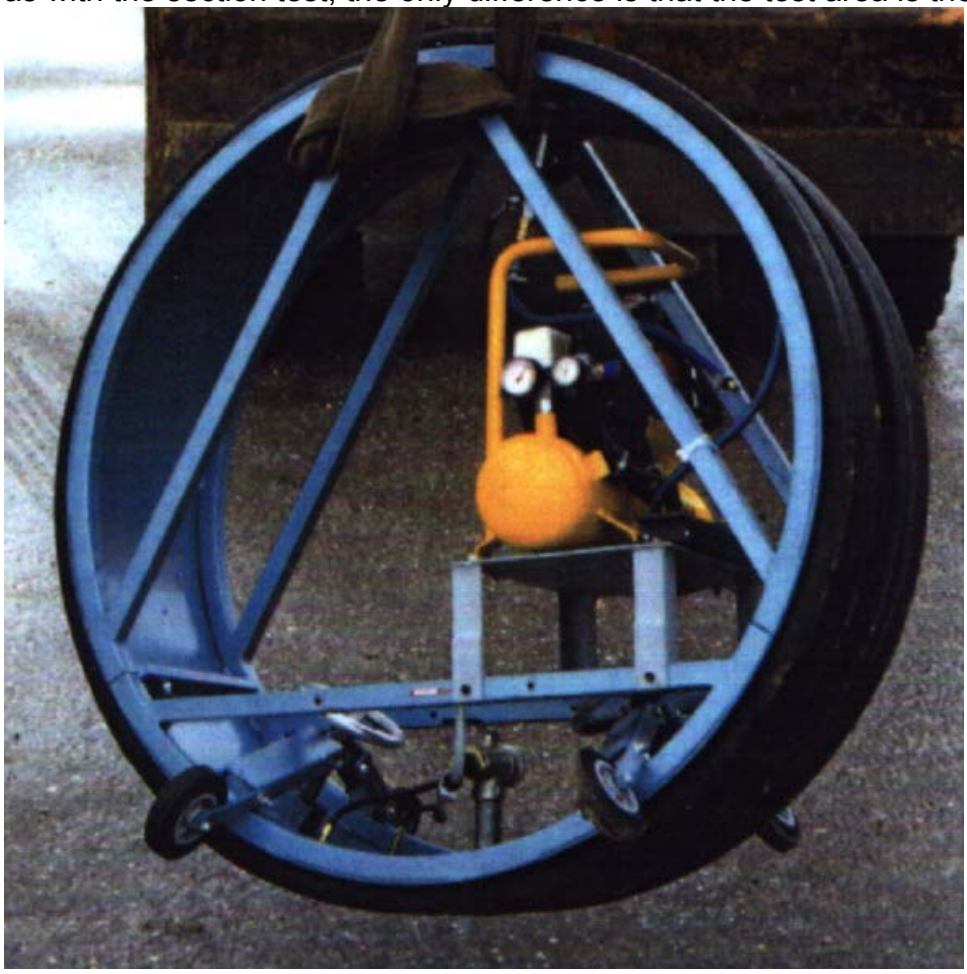
The installation of NIC HDPE pipes is very easy. After the trench has been prepared in the same way as for all other pipes, the "NIC HDPE" pipe is laid down and aligned. The individual pipe parts are jointed with the different kinds of jointing techniques.
The backlifting has to be carried out according to the requirements of the statical calculations.
In general, the installation is carried out according to EN 1610.

20. Leakage test

According to the requirements pipe systems have to be tested for leakage. There exists different kind of test procedures.

The first alternative is the section test, where the total pipe sections (between two manholes) are tested in all. Air hoses are blown and they lock the pipes at both ends. Then water, with a certain nominal pressure is pumped into the tightened section. This overpressure is tested after a certain period of time, which gives information about the leakage of the section.

The other alternative is the jointing test (only possible with diameters bigger than 600 mm), where only the pipe joints are tested as it is assumed that the pipes themselves are tight. A leakage-testing device is used but the principle is the same as with the section test, the only difference is that the test area is the joint.



21. Total Quality Management.

As the international requirements vary because of the different norms and standards, there exist a multiplicity of test procedures for the quality assurance. The whole production process is included in an extensive Total-Quality-Management-System.

Generally it is divided in three different steps:

Before production control

The raw materials and any other input are tested before production, for example the melting flow ratio, moisture and colour. Usually any new delivery of material is tested before it is stored. Every test is documented, analyzed and filed.

During production control

During the production the individual working steps are continuously supervised and documented. Moreover the most important dimensions are measured and if necessary, corrected.

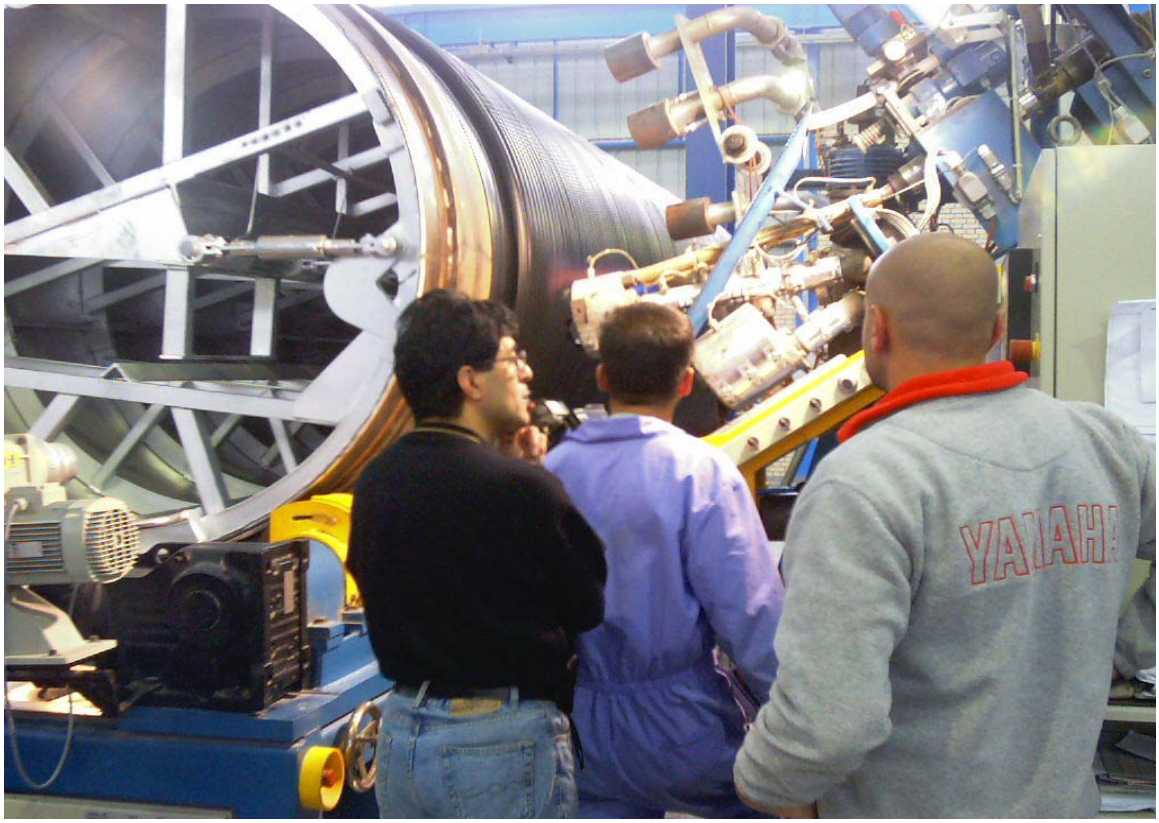
After production control

After the production, the final product is tested and compared to the requirements of the customer. The final minute is written and the documentation is finished.

In order to guarantee that the static theoretic values are conforming to the reality, pipes are continuously taken out of production and they are tested with the help of ring stiffness according to DIN 16961 or ISO 9969.

Quality certificates and external quality control

In general the whole production is constantly supervised by a third party inspection, like Kuwait University, KISR, etc. All quality procedures and management confirms to requirement of ISO 9001 : 2000. The quality control exceeds by far the ISO 9001 certifications because in our case the quality of the final product is tested. As result we are in the position to issue quality certificates for every delivery of pipes from the most simple quality certificate 2.2 to the first class certificate 3.1b according to EN 10204.



22. Advantages at glance.

.

Durability

Low investment costs and a service life over 100 years reduce the operating costs.

Time saving

Up to 30% saving when laying the light and flexible pipes with lengths of 6 m.

Maintenance

The smooth inner surface reduces the maintenance and cleaning costs considerably.

Hydraulics

Due to very good hydraulics properties, smaller pipe diameters can be used compared to current traditional pipe materials.

Tightness

100% tight joints. No infiltration or exfiltration, no root penetration due to welded system.

Length

The standard lengths of 6 m reduced the amount of joints.

23. Other Applications.

Water outlets / discharge

Water outlets are used for the discharge of liquid and gaseous substances at the base of rivers and the sea. For the construction and operation of such pipelines "NIC HDPE" pipes offer considerable advantages, such as the elasticity of the pipeline and therefore optimum adaptation to the area, low weight, secure and strong jointing technology, seawater resistance and pipe stiffness exactly adapted to the respective requirements because the appropriate profiles are selected for every individual project

Reservoirs, storm water tanks

Within a sewage system, especially mixed water systems, reservoirs can store rainwater for delaying release to the sewage plant. This will avoid overload. As reservoir systems are usually built in subsequently, they must be assembled in a very short time. Since the "NIC HDPE" reservoir are prefabricated, this condition is fulfilled perfectly. "NIC HDPE" tanks offer considerable advantages:

- smooth inner surface which prevent incrustations
- the pipe's self cleaning ability

Relining

The reconstruction of damaged sewer pipes by means of relining. “pipe in pipe method,” becomes more and more important. "NIC HDPE" pipes are very suitable for the relining process. Specific pipe stiffness can be calculated for all loads. Also in the areas of short pipe relining, "NIC HDPE" pipes offer competent solutions. The welding can be carried out inside the shaft. Pipe lengths are available from 1 m to 6 m. "NIC HDPE" pipes are able to re-establish the static carrying capacity of the sewer without the need of digging. In order to insert longer stretches, pipe lengths of up to 18 m can be pre-fabricated by welding. With pipes DN 800 and larger, it is also possible to insert the pipe one by one into the existing sewer and weld from the inside of the pipe.

Sewer Systems

Sewer systems made of profiled pipes, same as "NIC HDPE" have been used for more than 40 years in all areas of local and industrial drainage, through out world. The "NIC HDPE" offers a modern sewer pipe program with manholes, fittings, and safe pipe joint systems for the planning of sewer treatment plants.

Tanks and Containers

Profiled or solid pipes made of polyethylene or polypropylene are well suited for the manufacture of horizontal and vertical tanks.
For other special construction like chimneys, compost plants and wash towers "NIC HDPE" pipes offer all advantages regarding variety, precision, quality, and expandability.

Special tunnels & Ventilations.

In addition to the common areas of application "NIC HDPE" pipes are also suitable for special projects like tunnels etc. "NIC HDPE" pipes are also used as ventilating pipes. The advantages over the traditional ventilating pipes which are made of sheet steel, is that there occur no corrosion which is especially important for the chemical and biological industry.

STATICAL QUESTIONNAIRE FOR BURRIED PIPES

BASIC DESIGN

Raw Material: ❑ PEHD ❑ PP ❑ other: _____

Internal Diameter: _____ [mm]

INSTALLATION

Cover Condition

❑ A1 ❑ A2 ❑ A3 ❑ A4 ❑ standard

Bedding Condition

❑ B1 ❑ B2 ❑ B3 ❑ B4 ❑ standard

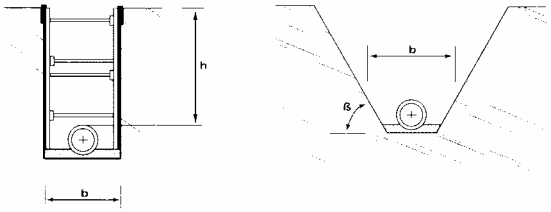
The cover condition defines the method from the pipe crown to the ground surface. The bedding condition describes the method in the pipe zone (trench bottom up to pipe crown). As the same method is usually used for pipe installation over the entire depth, installation and cover conditi-ons are often assumed to be the same.

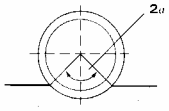
Trench Condition

Covering height (h): _____ [mm]

Trench width: _____ [mm]

Slope angle (ß): _____ [°]



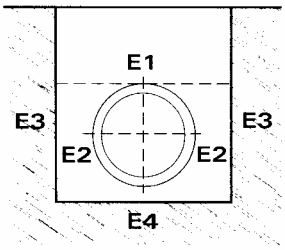
Angle 

❑ 60° ❑ 90°

❑ 120° ❑ 180°

Bedding form: ❑ loose ❑ tight

SOIL CONDITIONS



E1: above pipe crown

E2: at the side of the pipe

E3: beneath thrench / line zone

E4: below the pipe

E1: above pipe crown

Soil group: ❑ G1 - loose (sand, gravel) ❑ G2 - lightly bonded (sand, graval)

❑ G3 - mixed soil (bonding, muddly) ❑ G4 - clay, wet clay

proctor density (DPr): _____ [%]

E-modulus: _____ [N/mm²]

❑ standard

E2: at the side of the pipe

Soil group: ❑ G1 - loose (sand, gravel) ❑ G2 - lightly bonded (sand, graval)

❑ G3 - mixed soil (bonding, muddly) ❑ G4 - clay, wet clay

proctor density (DPr): _____ [%]

E-modulus: _____ [N/mm²]

❑ standard

STATICAL QUESTIONNAIRE FOR BURRIED PIPES

E3: beneath thrench / line zone

Soil group: ❑ G1 - loose (sand, gravel) ❑ G2 - lightly bonded (sand, graval)

❑ G3 - mixed soil (bonding, muddly) ❑ G4 - clay, wet clay

proctor density (DPr): _____ [%]

E-modulus: _____ [N/mm²]

❑ from table 8 of ATV-A 127

E4: below the pipe

Soil group: ❑ E4 = 10 x E1

❑ G1 - loose (sand, gravel) ❑ G2 - lightly bonded (sand, graval)

❑ G3 - mixed soil (bonding, muddly) ❑ G4 - clay, wet clay

proctor density (DPr): _____ [%]

E-modulus: _____ [N/mm²]

❑ from table 8 of ATV-A 127

LOADS

Soil density: _____ [kN/m³]

Additional surface load: _____ [N/mm²]

Maximum groundwater level: _____ [mm]

Minimum groundwater level: _____ [mm]

Internal pressure: _____ [bar]

❑ Water filling (e.g.damming channel)

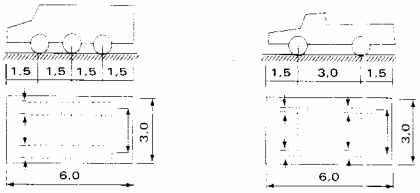
Traffic load:

❑ no traffic

❑ HCC 60, [60 N/mm²]

❑ HCC 30, [30 N/mm²]

❑ HGV12, [12 N/mm²]



❑ free entry of traffic load

on crown level: _____ [N/mm²]

SAFETY CLASSES

ATV-DVWK-A 127 differentiates between "Safety class A" and "Safety class B", "Safety class B" can only be used in special cases if the following conditions apply:

· No risk to groundwater

· Little interference with use

· Failure will only have minimal economic impact

Safety class A (regular case) (> 2.5)

admissible deformation:

❑ 2% (railway)

Safety class B (special case) (> 2)

❑ 6% (regular)

❑ 9% (justified exceptions)

STATICAL QUESTIONNAIRE FOR MANHOLES

BASIC DESIGN

Material: ❑ PEHD ❑ PP

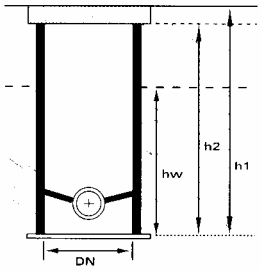
❑ other: _____

Internal Diameter (DN): _____ [mm]

Installation depth (h): _____ [mm]

Length of shaft pipe (h2): _____ [mm]

Height of groundwater (hw): _____ [mm]



BEDDING / SOIL

Bedding

soil group: ❑ G1 - loose (sand, gravel) ❑ G2 - lightly bonded (sand, graval)

proctor density: _____ [%]

known E-modulus: _____ [N/mm²]

Existing Soil

soil group: ❑ G1 - loose (sand, gravel) ❑ G2 - lightly bonded (sand, graval)

❑ G3 - mixed land bonding, muddly ❑ G4 - clay, wet clay

proctor density: _____ [%]

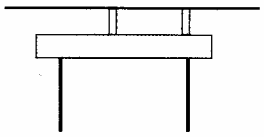
known E-modulus: _____ [N/mm²]

COVER

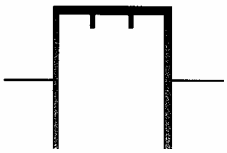
Cover construction type

❑ without cover

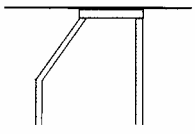
❑ lean on cover



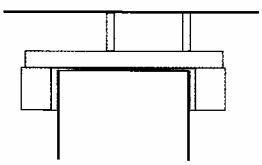
❑ with a flat roof made of the manhole material



❑ standard concrete cone



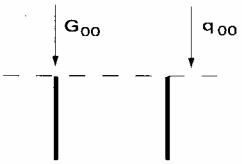
❑ separately supported cover



❑ direct indication of loading

G_{00}: _____ [N/mm²]

q_{00}: _____ [N/mm²]



STATICAL QUESTIONNAIRE FOR MANHOLES

LOADS

Details on traffic load

Traffic load on cover

❑ no traffic load ❑ HCC 60 [60 N/mm²] ❑ HCC 30 [30 N/mm²] ❑ HGV 12 [12 N/mm²]

free entry: _____ [N/mm²]

impact coefficient: _____ [1]

Traffic load beside shaft cover

❑ no traffic load ❑ HCC 60 [60 N/mm²] ❑ HCCS 30 [30 N/mm²] ❑ HGV 12 [12 N/mm²]

free entry: _____ [N/mm²]

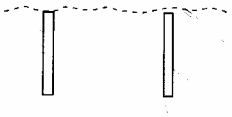
impact coefficient: _____ [1]

Soil density: _____ [kN/m³]

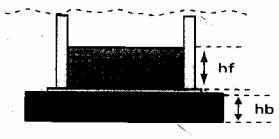
FOUNDATION

Foundation construction type

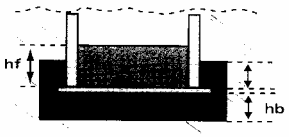
❑ without foundation plate



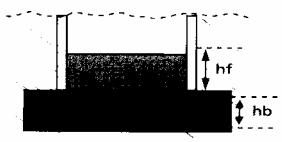
❑ simple plate foundation



❑ with concrete ring



❑ with solid casing



Details on foundation construction

Thickness of concrete foundation plate (hb): _____ [mm]

Diameter of concrete foundation plate: _____ [mm]

Quality of concrete for foundation plate: _____ [B25]

Height of concrete ring: _____ [mm]

Concrete filling (hf): _____ [mm]

CONNECTION PIECE

	diameter	wall thickness	position	height
1. conn.:	_____ [mm]	_____ [mm]	_____ [°]	_____ [mm]
2. conn.:	_____ [mm]	_____ [mm]	_____ [°]	_____ [mm]
3. conn.:	_____ [mm]	_____ [mm]	_____ [°]	_____ [mm]
4. conn.:	_____ [mm]	_____ [mm]	_____ [°]	_____ [mm]