KRAH USA LLC.
www.krahusa.com PIPES

Structured wall pipe system

Internal Diameter 12-196" with integrated electro fusion bell

Krah smooth and profiled pipes acc. ASTM F-894

Water is of vital importance: Without water no life would exist and our planet would be a huge desert. Plants, animals and humans consist to 50-80 % of water. From polluted water or water scarcity however, they suffer, fall ill or even die. Therefore, our common future is endangered when water is not available in sufficient amount and quality.

Water is a heritage of nature and it belongs to all living beings. The right of access to sufficient and clean water is a universal law and it is therefore anchored in important international treaties. The uneven distribution of rain and water on earth leads to water scarcity in many regions. Today, 2.2 billion people have no secure access to clean drinking water, 4.2 billion people do not dispose or have access to sanitary installations, and 3 billion lack basic landwashing facilities. Thousands of children die every year due to polluted water. Moreover, global climate changes will intensify the water crisis.

All these facts force the world population to react in order to rescue our home planet. To improve this situation and to find solutions, several governmental bodies, engineering and construction companies as well as pipe manufacturers have focused on this world threatening issue.

However, for years tremendous difficulties were observed when selecting the material of construction for infrastructure systems which should be suitable to provide anticipated permanent solutions.

Over the last decades, the inherent weaknesses of concrete, clay, ductile iron, PVC and steel caused tremendous problems in existing sewer pipe systems, as they tend to be brittle or are too sensitive to aggressive chemicals and soil conditions. Failures have become a common occurrence worldwide in sewer and other large-diameter-pipe applications. In addition, they have an unprofitable relationship between cost and benefit.

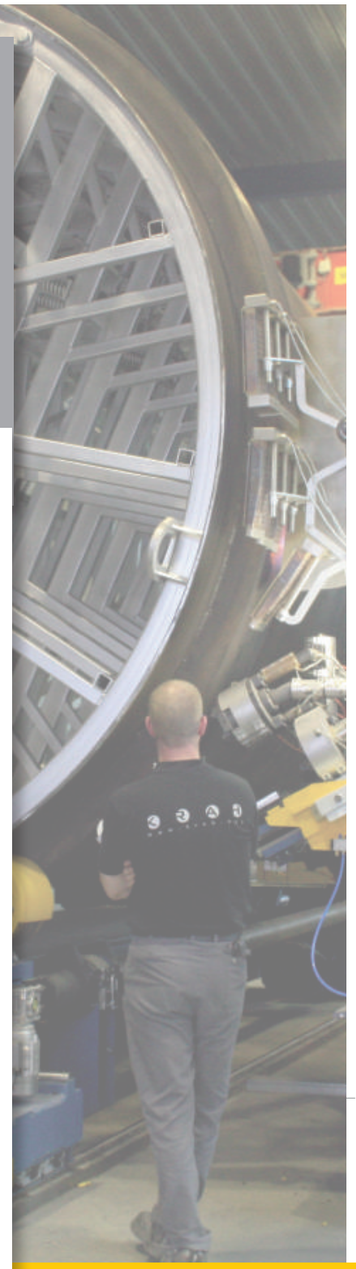
So Krah derived benefit from the fact that the processing of polyolefins is very easy and the plastic materials provide superior properties against adverse effects of the ambient conditions and the chemicals.

In addition to the permanent solution that lasts through generations, the Krah piping system is able to provide everlasting and economical solutions in a wide range of applications, for example drain, storm drain and sewer systems, sea outfalls, 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 of which all features are described in detail in this brochure.

Outfall pipe line DN/ID 2000mm (79")

Sewer pipeline DN/ID 2000mm (79")



Production technology at its highest level

The Krah Group is a German machine manufacturer with over 50 years of experience in the design, development and construction of production plants for large diameter pipes. The machine is equipped with all necessary components to produce pipes and fittings with all different kinds of sizes and stiffnesses as well as the profiles mentioned on the following pages. Even the complete range of diameters can be produced on only one machine by using the production tools in the required diameters.

Basically, Krah pipes are produced in an extrusion process, where a profile is wound around a collapsible steel mandrel. The pipe wall can have a solid-wall or a profiled-wall structure in order to ensure the required stiffness with an efficient weight ratio.

In addition to the extensive pipe range that can be produced, the main features of the machine are a high production output, the simple operation and short change-over times.

Thanks to very close cooperation and a steady information flow with our customers worldwide, we are always up-to-date regarding upcoming demands and changes on the pipe market. This gives us the possibility to develop necessary modifications on our machines in order to respond to the needs of our customers.

Material

Krah Pipes are preferably manufactured with high quality polyethylene resins such as PE4710 and PE100. These high density polyethylene resins are providing excellent properties for the application of water and sewer, as well for the fabrication of tanks for storing liquids and solid materials. The qualified resin for Krah Pipes and fittings is also classified at ASTM D-3350. The classification is considering the characteristics for density, melt index, flexural modulus, tensile strength at yield, slow crack growth resistance and hydrostatic strength. The environmental-friendly polyethylene is resistant to chemicals (detailed information in our brochure "Chemical resistance"). Krah pipes can be produced from the following thermoplastic resins:

- High density polyethylene (PE80, PE100 acc. ISO 12162)
- High density polyethylene (PE3408, PE4710 acc. PPI TR-4)
- Polypropylene-random (PP-R, PP-B)
- Polypropylene-homo (PP-H)
- Flame retardant polypropylene (PP-S)

Please see resin properties in the right table. Other materials can be used after prior acceptance of the producer and a third party for quality control. However, the processed resin should have the indicated specifications.

Pipe diameters

Krah pipes can be produced with inside diameters (ID) from DN/ID 12" to DNI/ID 196". The nominal diameters (DN) coincide with the inside diameter (ID) of the pipe, because in case of any change in the design of the pipe, the wall thickness can be increased or reduced while the inside diameter remains the same. This ensures that the designated hydraulic capacity for the installation is maintained.

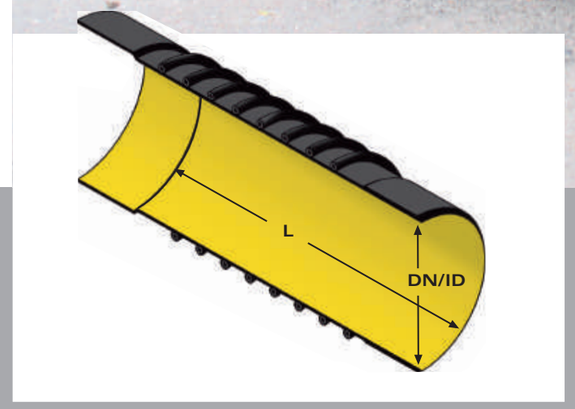
Typical material specification

Property		Standard	Unit	PE 80	PE 100	PP-R
Density		DIN 53479 ISO 1183	g/cm³	0.95	0.96	0.91
melt index MFR 190/5 MFR 190/21.6 MFR 230/5	 Code T Code V 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/mm²	 1.000 170	 1200 170	 750 160
yield stress		DIN 53495	N/mm²	23	25	26
tensile strength		DIN 53495	N/mm²	32	38	15
elongation at break		DIN 53495	%	> 600	> 600	> 50
ball indentation hardness		ISO 2039	N/mm²	42	46	45
coefficient of linear thermal expansion		DIN 53752	1/°C	1.8 x 10⁻⁴	1.8 x 10⁻⁴	1.6 x 10⁻⁴
colour		-	-	black/ yellow	black/ yellow	grey

DN/ID	DN/OD range
300 mm	310 - 460 mm
400 mm	410 – 560 mm
500 mm	510 – 660 mm
600 mm	610 – 760 mm
800 mm	810 – 960 mm
1000 mm	1010 – 1160 mm
1200 mm	1210 – 1360 mm
1400 mm	1410 – 1560 mm
1600 mm	1610 – 1760 mm
1800 mm	1810 – 1960 mm
2000 mm	2010 – 2160 mm
2200 mm	2210 – 2360 mm
2400 mm	2410 – 2560 mm
3000 mm	3010 – 3160 mm

Pipe length

The standard laying length (L) of Krah pipes is twenty feet (6 meters), because in this way they are easy to handle, store and transport. In addition, it is possible to continuously produce any length between 3’ and 20’. 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 can be reduced significantly. Lengths of up to 60 feet consisting of 3 pipe sections are common.

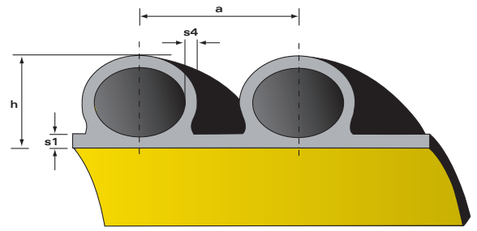


DN/ID = internal diameter [mm] / L = laying length [mm]

Installation of two pre-jointed pipes DN/ID 1600mm (63")

Profiled pipe wall

The great advantage of this development is that a profiled pipe has a very low weight, but at the same time resistant against breaks and cracks. Much less material is needed to produce a pipe with the same statical properties (stiffness) than a solid wall pipe, which means significant savings in material costs. The supportable static load is determined for every profile geometry by the factors flexural modulus [psi] of the respective resin and the moment of inertia of the profile geometry [in.4/in.] referring to the pipe diameter. The resulting parameter is called ring stiffness. By using a profiled 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 safety and durability. The wall thicknesses of our pipes can be adapted in small steps to the respective load.



a = profile distance [mm] s4 = coating thickness [mm]
s1 = waterway thickness [mm] h = profile height [mm]

Fire fighting water tank

Internal pressure

The Krah pipe system can withstand working pressure, depending on the thickness of the waterway wall (s1). Equivalent to PPI chapter 06 the hoop stress formula can be used to calculate the s1 as the minimum wall thickness.

$$p = \frac{2 \cdot HDS}{\left(\frac{ID}{s_1} + 1\right)}$$

p: pressure
HDS: Hydrostatic Design Strength
ID: internal diameter
s1: inner wall

Wall thickness

Both profiled and solid wall pipes with wall thicknesses of up to 12” (300 mm) can be produced. The Krah pipes can be produced with a minimum waterway wall thickness of 0.16 in. (4 mm).
Decisive for the wall thickness design are the project requirements and the required minimum wall thickness according to ASTM F894.

Minimum wall thickness according to EN 13476 table 5

Normal pipe size DN/ID [mm/"]	s1, by PE [mm/"]	s1, by PP [mm/"]
300/12	2,0/0,08	2,0/0,08
400/16	2,5/0,12	2,5/0,12
500/20	2,5/0,12	3,0/0,12
600/24	3,3/0,13	3,5/0,14
800/32	4,5/0,18	4,5/0,18
1000/40	5,0/0,20	5,0/0,20

DN/OD 4000mm (158") solid wall pipe with SDR 11

Co-extrusion

If requested, all pipes can be delivered either with a bright-colored, inspection-friendly and/or an electro-conductive inner surface made by the co-extrusion process.
The co-extrusion ensures an inspection-friendly, bright-colored inner surface and at the same time a long-term UV-resistant outer surface (for example for the outside storage of pipes for a long time).

Norms and standards

The Krah pipe system is designed to meet the requirements of present applicable international norms and standards. The Krah Pipes GmbH & Co. KG is member of the major standardization committees to guarantee that the pipes are corresponding to the standards, but also that the standards are corresponding to the pipes. The Krah pipe conforms to the following international standards:

Subject	Standard
Pipe	DIN 16961, DIN 16917 EN 13476 ISO 21138 ASTM F 894, ASTM F 714 NBR 7373 JIS K 6780
Statical dimensions	ATV A 127 ISO 9969
Hydraulic dimensioning	ATV A110
Pipe installations	EN 1610
Welding	DVS 2207

Installation of a Krah pipe in a very narrow trench

Different co-extrusions – yellow, blue and electro conductive

Pipe properties

Weldability

Due to the thermoplastic resin, the pipes can be welded together which signifies that the whole pipeline builds one homogenous system and is absolutely safe against leakage, infiltrations and exfiltrations.

Chemical resistance

For buried pipelines the biogenous sulphuric acid corrosion plays a key role for 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. Thanks to the used resin, Krah pipelines guarantee optimum safety and resistance.

Impact resistance

The high impact resistance, even at low temperatures, ensures a robust pipe, resistant against impacts during transport, installation on the site and during the whole service life conditions.

Recycling

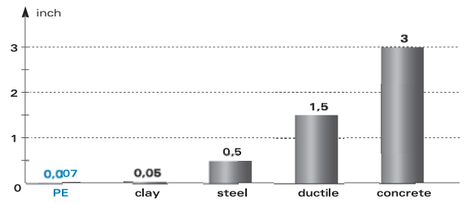
Polyethylene and polypropylene can be recycled to 100%. These resins are reprocessable without the structure of the resin having to be modified dramatically. For this reason all scrap material of polyethylene and polypropylene pipes can be reused in the production cycle.

Resistant to Microorganisms

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 polyethylene pipelines by termites has ever been documented. Polyethylene and Polypropylene are not a nutrient medium for bacteria, fungus and spores, so that the resin is resistant to all forms of microbial attacks as well as to both sulphurous acid and sulfates.

Hydraulics

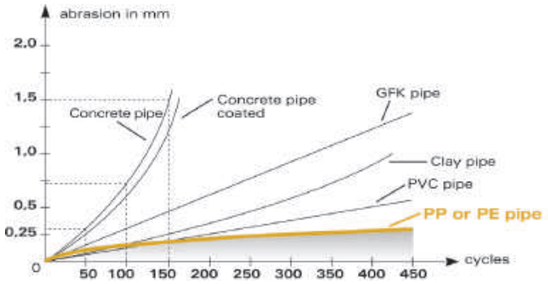
Inside diameter and hydraulic properties of Krah pipes will remain constant regardless of the wall thickness or the profiles due to the smooth anti-adhesive inner pipe surface. The nominal diameter (e.g. DN/ID 24”) corresponds to the respective inside diameter according to ASTM F 894. Compared to other pipe materials like concrete, smaller diameters can be used, which means that costs for material and installation can be reduced considerably.



Wall roughness

Abrasion resistance

Polyethylene and polypropylene pipes provides the best abrasion-resistance. This has been tested in the so-called Darmstadt procedure acc. DIN EN 295-1 and the results are shown in the below diagram and confirm the quality of the Krah pipes. Tests have been performed e.g. at the ”Süddeutsche Kunststoffzentrum” for its approval in Germany.



Abrasion curve of various pipe materials according to the Darmstadt procedure

UV-resistance

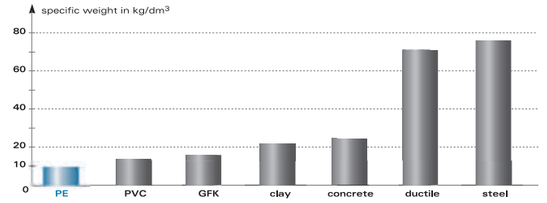
Black polyethylene pipes are permanently resistant to atmospheric corrosion and UV radiation. Due to that the pipes can be used and stored outside without the pipe material being damaged. No aging effect will occur.

Pipe of DN/ID 2000mm (79") installation in a hot enviroment

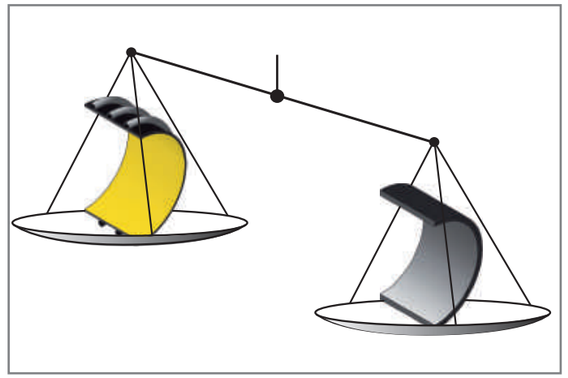
Light weight pipe - Manual unloading of a pipe DN/ID 600mm (24")

Specific light weight

Krah pipes are low weight pipes and therefore easy & quick in installation. This is a significant cost saving factor and eliminates the need for heavy lifting equipment on site.



Material characteristic values



By using profiled pipes we can safe weight up to 65% compared to equivalent solid wall pipes with the same statical capacity.

Deformation resistance

Elastic pipes can react to changes in their environment. Due to the deformation performance, the load is distributed to the surrounding soil and the force impact on the pipe will be reduced. 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 flexibly to static loads, while the loads do not concentrate themselves on the pipe, but are diverted to the surrounding soil. Flexible pipes are still in service, when other rigid pipe systems are already broken. Even in the case of a deformation the system is still absolutely resistant against infiltration and exfiltration. Since the pipes are profiled on the outside, these profiles can fix the pipes in the soil. There will be no or very few axial extensions in the pipeline. Krah pipes are nearly unaffected by temperature variations.

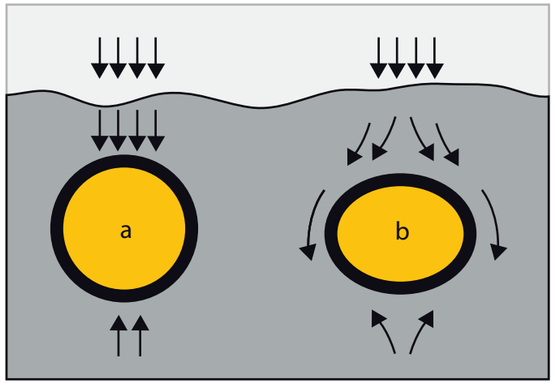
Flexibility

Krah pipes made of Polyethylene and Polypropylene have considerable advantages over other pipe materials like concrete, steel, ductile iron etc. Due to their resin the Krah pipes possess a high elongation at break. This signifies that the pipe can support loads or deformations that were not included in the actual calculation and design of the pipe, such as earthquakes. Krah pipes deform to conform with the movement of the earth without any breaks or cracks, so that the activity of the pipeline is not drastically affected. As soon as the overload and earth movement ends, the pipe will go back to its initial condition and position. Another advantage 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.

Pipe DN/ID 2400mm (95"), with inspection-friendly inner surface

Deflection is safety

The deflection of flexible pipes is controlled by the settlement of the soil. After settlement, traffic and other loads do not affect the pipe deflection anymore. When pipes are relatively more rigid than the soil, the traffic and other loads have to be carried/resisted by the pipe. Many years of practical experience have shown that flexible pipes (b) can resist traffic and other loads more effective than pipes (a) made of concrete or other rigid material. As shown in the drawing, the flexible pipes elude a selective strain by deflection. By this means the surrounding soil absorbs this strain.



Deflection of flexible pipes compared to flexural resistant pipes

Installation of a sewage line DN/ID 1200mm (47")

Installation of pipes DN/ID 2000mm (79"), with manhole & bench

Installation of a sewage line DN/ID 1400mm (55") with a concrete manhole

Retention tank of a public swinning pool, DN/ID 3000mm (118")

Profiles

Krah pipes are easily adaptable to all different kinds of project requirements. According to different norms and standards, the pipes shall be designed according to ring stiffness classes. The Ring Stiffness Constant (RSC) according to ASTM F894 is, the value obtained by dividing the parallel plate load in pounds per foot of pipe length, by the resulting deflection, in percentages, at 3% deflection. The ring stiffness constant (RSC) that is used in this specification to classify pipe is a measure of the pipe's deformation resistance to diametrical point loading, which is experienced during handling and installation. Therewith the Krah Pipe can be made in all standardized RSC-classes, namely to RSC 40, RSC 63, RSC 100, RSC 160, RSC 250 and RSC 400. Furthermore, due to the tailormade Krah profile design technology, any intermediate RSC value can be manufactured.

Profile type: PR

The main properties of the open profile series PR are the smooth inner and the profiled outer surface. The low weight and the high stiffness are the two significant features. The fields of application for these kinds of profiles are pipeline systems like sewer, drain, storm drain and ventilation.

Installation of pipe with DN/ID 1600mm (63") during low temperature

Profile no.	Ix [mm⁴/mm]	e [mm]	se [mm]
PR 21-000.39	395	6.85	16.80
PR 34-001.23	1229	11.01	24.50
PR 42-001.88	1884	13.14	28.30
PR 42-002.60	2604	14.69	31.50
PR 54-004.39	4386	18.20	37.50
PR 54-004.71	4706	17.62	38.40
PR 54-005.26	5260	20.32	29.80
PR 54-005.66	5561	19.70	40.80
PR 54-006.57	6569	21.54	42.90
PR 54-007.02	7032	21.11	43.80
PR 54-007.98	7983	22.72	45.80
PR 54-008.49	8492	22.41	46.70
PR 54-010.07	10074	23.68	49.40
PR 54-011.77	11774	24.88	52.10
PR 54-012.92	12917	26.14	53.70
PR 54-014.28	14277	26.05	55.50
PR 54-016.32	16321	26.20	58.10
PR 54-019.34	19844	29.97	62.00

List of typical profiles, type PR
Ix = moment of inertia, e = distance of inertia, se = equivalent solid wall thickness

Profile type: CPR

The CPR profile is a closed profile and has a smooth inside and outside surface including an integrated (embedded) profile structure. This profile is the preferred type for Krah manhole shafts and has a very high long-term stiffness. Therefore it is also very suitable for high loads in larger diameters.

Profile type: SP

Should a standard profile not be sufficient due to the effects of all different kinds of loads, the Krah pipe system makes it possible to combine different kinds of profiles in order to achieve the required effects. For example a PR profile can be added to a CPR profile or a solid wall pipe without any problems. With this technique, the following two effects are achieved: Both profiles can be statically added whereby a stronger pipe is produced and a profile will be added to the otherwise smooth surface, which has advantages regarding the anchoring of the pipes in the soil preventing axial deformation.

Profile no.	Ix [mm⁴/mm]	e, se
SQ1	9.400 - 27.000	information on request
SQ2	46.000 - 133.000	information on request
SQ3	164.000 - 300.000	information on request

List of typical profiles, type SQ
Ix = moment of inertia, e = distance of inertia,
se = equivalent solid wall thickness

Installation of pipes DN/ID 1800mm (71") in a mining project for slurry

DN/ID 2200mm (87") pipe installation

Installation of stormwater system DN/ID 1800mm (71")

Solid wall

Solid wall pipes

This pipe type has a smooth inner surface and a slightly uneven outer surface. The pipes are produced homogenously. Moreover, these solid wall pipes are tempered, which means that there are no frozen stresses.

Profile type: VW

The type VW is a homogeneous solid pipe with smooth inside and outside surface. These pipes can be used for internal working pressure. The minimum wall thickness measures 0,2 in. (5 mm) and the maximum wall thickness is 12 in. (300 mm).

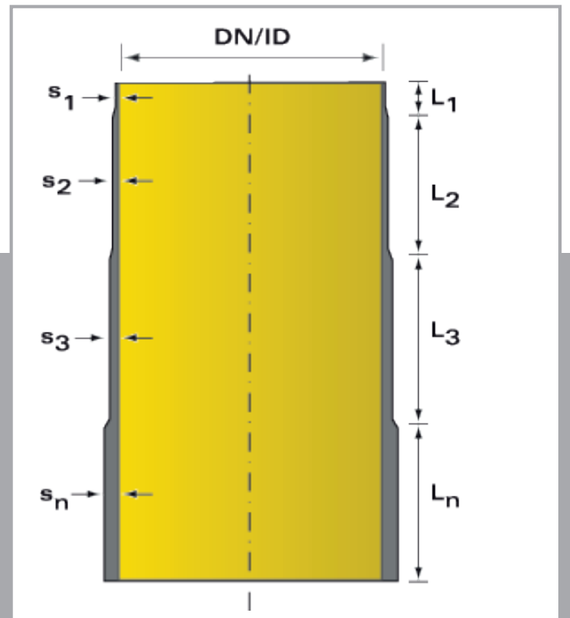
S / DN/ID	5	6	7	8	9	10	11	12	13	14	15	18	20	25	30	35	40
	[kg/m]																
300	4.6	5.5	6.5	7.4	8.4	9.3	10.3	11.3	12.3	13.3	14.2	17.3	19.3	24.5	29.9	35.4	41.0
400	6.1	7.3	8.6	9.8	11.1	12.4	13.6	14.9	16.2	17.5	18.8	22.7	25.3	32.0	38.9	45.9	53.1
500	7.6	9.2	10.7	12.3	13.8	15.4	17.0	18.5	20.1	21.7	23.3	28.1	31.4	39.6	48.0	56.5	65.1
600	9.1	11.0	12.8	14.7	16.5	18.4	20.3	22.1	24.0	25.9	27.8	33.5	37.4	47.1	57.0	67.0	77.2
700	10.6	12.8	14.9	17.1	19.2	21.4	23.6	25.8	28.0	30.1	32.3	39.0	43.4	54.7	66.0	77.6	89.3
800	12.1	14.6	17.0	19.5	22.0	24.4	26.9	29.4	31.9	34.4	36.9	44.4	49.5	62.2	75.1	88.1	101.3
900	13.6	16.4	19.1	21.9	24.7	27.4	30.2	33.0	35.8	38.6	41.4	49.8	55.5	69.7	84.1	98.7	113.4
1000	15.2	18.2	21.3	24.3	27.4	30.5	33.5	36.6	39.7	42.8	45.9	55.3	61.5	77.3	93.2	109.2	125.5
1100	16.7	20.0	23.4	26.7	30.1	33.5	36.9	40.2	43.6	47.0	50.4	60.7	67.6	84.8	102.2	119.8	137.5
1200	18.2	21.8	25.5	29.1	32.8	36.5	40.2	43.9	47.5	51.3	55.0	66.1	73.6	92.4	111.3	130.4	149.6
1300	19.7	23.6	27.6	31.6	35.5	39.5	43.5	47.5	51.5	55.5	59.5	71.5	79.6	99.9	120.3	140.9	161.6
1400	21.2	25.4	29.7	34.0	38.2	42.5	46.8	51.1	55.4	59.7	64.0	77.0	85.6	107.4	129.4	151.5	173.7
1500	22.7	27.3	31.8	36.4	41.0	45.5	50.1	54.7	59.3	63.9	68.5	82.4	91.7	115.0	138.4	162.0	185.8
1600	24.2	29.1	33.9	38.8	43.7	48.6	53.4	58.3	63.2	68.1	73.1	87.8	97.7	122.5	147.5	172.6	197.8
1700	25.7	30.9	36.0	41.2	46.4	51.6	56.8	62.0	67.1	72.4	77.6	93.3	103.7	130.1	156.5	183.1	209.9
1800	27.2	32.7	38.1	43.6	49.1	54.6	60.1	65.6	71.1	76.6	82.1	98.7	109.8	137.6	165.6	193.7	222.0
1900	28.7	34.5	40.3	46.0	51.8	57.6	63.4	69.2	75.0	80.8	86.6	104.1	115.8	145.1	174.6	204.2	234.0
2000	30.2	36.3	42.4	48.4	54.5	60.6	66.7	72.8	78.9	85.0	91.2	109.5	121.8	152.7	183.7	214.8	246
2100	31.7	38.1	44.5	50.9	57.2	63.6	70.0	76.4	82.8	89.3	95.7	115.0	127.9	160.2	192.7	225.4	258
2200	33.2	39.9	46.6	53.3	60.0	66.7	73.3	80.1	86.8	93.5	100.2	120.4	133.9	167.8	201.8	235.9	270.1
2300	34.8	41.7	48.7	55.7	62.7	69.7	76.7	83.7	90.7	97.7	104.7	125.8	139.9	175.3	210.8	246.5	282.3
2400	36.3	43.5	50.8	58.1	65.4	72.7	80.0	87.3	94.6	101.9	109.2	131.3	146.0	182.8	219.9	257.0	294.3
2500	37.8	45.3	52.9	60.5	68.1	75.7	83.3	90.9	98.5	106.1	113.8	136.7	152.0	190.4	228.9	267.6	306.4
2600	39.3	47.2	55.0	62.9	70.8	78.7	86.6	94.5	102.4	110.4	118.3	142.1	158.0	197.9	237.9	278.1	318.5
2700	40.8	49.0	57.1	65.3	73.5	81.7	89.9	98.1	106.4	114.6	122.8	147.5	164.1	202.5	247.0	288.7	330.5
2800	42.3	50.8	59.3	67.7	76.2	84.7	93.3	101.8	110.3	118.8	127.3	153.0	170.1	213.0	256.0	299.2	342.6
2900	43.8	52.6	61.4	70.2	79.0	87.8	96.6	105.4	114.2	123.0	131.9	158.4	176.1	220.5	265.1	309.8	354.7
3000	45.3	54.4	63.5	72.6	81.7	90.8	99.9	109.0	118.1	127.3	136.4	163.8	182.2	228.1	274.1	320.4	366.7

Weight of pipes, type VW
s = solid wall thickness in [mm]. Other dimensions and materials on request. Weights without socket and spigot.

Profile type: ST

Pipes with the profile type ST are especially made for vertical tanks, where different wall thicknesses are required in one pipe to save material.

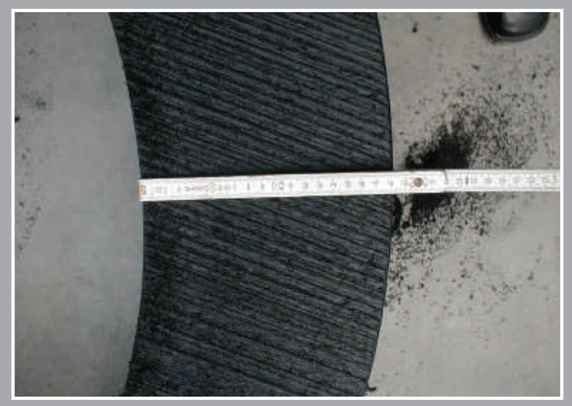
The calculation method is according to the German standard DVS 2205.



Sketch of a stepped vertical storage tank
S1 = wall thickness of the step
L1 = length of the step

stepped pipes	minimum	maximum
nominal diameter (DN/ID)	300 [mm]	5000 [mm]
number of steps (n)	two	six
length of step (L_n)	200 [mm]	pipe length
wall thickness of step (S_n)	5 [mm]	300 [mm] for PE 150 [mm] for PP
step distance	5 [mm]	

Technical data of stepped pipes



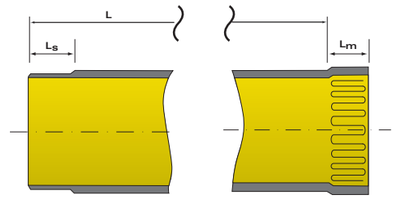
Solid wall polyethylen pipe, s = 180mm (7")

Industrial storage system „silos“

Different types of pipes

Fittings

The Krah pipe can be provided in the complete range of diameters and stiffness classes but also fittings, manholes and other components are deliverable to accomplish the mission of a homogenous and reliable pipe system.



All fittings are fabricated from pipes of the type VW (solid wall) or CPR (closed profile). Generally, the fittings are designed corresponding to the required stiffnesses and in consideration of the welding factors. Every fitting can have any kind of pipe end and can be assembled with the existing pipe system with any applicable jointing technique.

All pipe end dimensions are in correspondence with international standards (ASTM F 894, EN 13476, ISO 21138), like the minimum lengths and stiffnesses. The standard spigot length (Ls) is 140mm (5,5") and the standard bell length (Lm) is 140mm (5,5").
All fittings are fabricated out of Krah pipes with required stiffness and wall structure.

Branches

Branches can be manufactured and delivered in every type and form. The angle can be adapted individually from 15° to 90° as well as the ends and the respective segment lengths.

bend

branch

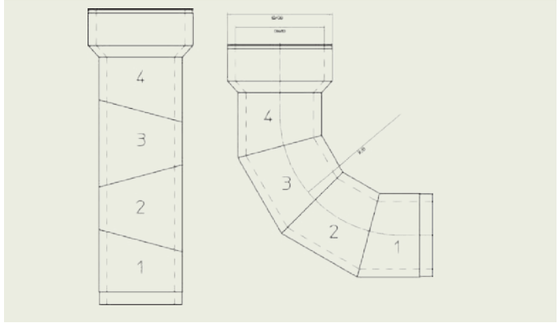
Bends

Bends can be manufactured and segmented in different angles and the related radius of the bend to the pipe diameter can be selected independently.
In the table the standard bend angles are mentioned, according to DIN 16961 – any other dimensions are possible. In principle, any angle can be manufactured.

α	Number of segments
15°	2
30°	2
45°	3
60°	3
75°	4
90°	4

Reducers

Reducers can be made both centrically and eccentrically so that they will meet all the technical requirements. Reducers made out of Krah pipes can be manufactured tailormade in requested angles and diameter differences.



Division and new arrangement of the pipe segments to create a 90° angle

House connections

House connections and other outlets until OD 18 in. (450 mm) can be installed by using the Krah HAS system. This technology ensures a proper welding joint between main pipe and outlet, no matter which structure (profiled-wall or solid-wall) is used. For transition to other pipe materials adequate fittings are applicable.

Puddle flanges

InIn order to connect Krah pipes leakfree to concrete walls, e.g. at water treatment plants or concrete shafts/manholes, Krah puddle flanges are the solution. The puddle flange fitting can be installed into the concrete wall also with an integrated electrofusion bell.

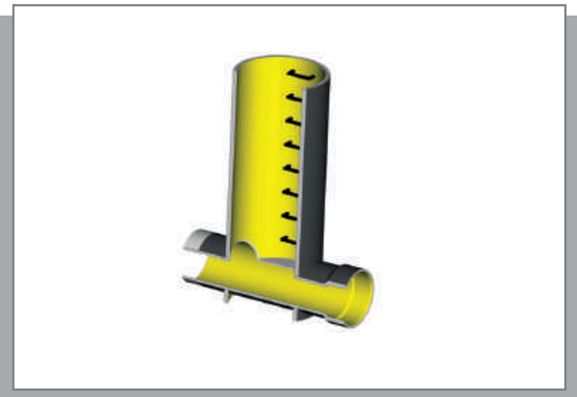
House connection

Manholes

To inspect and to maintain pipe systems regularly, manholes are needed in the system. Manholes are mainly installed at the positions of bends, reducers or branches. The used resin is the same resin as used for the pipes and are connected to the system with similar jointing techniques. Krah manholes are designed according to internationally accepted standards for all internal and external loads (soil, traffic, subsurface loads, groundwater etc.). The shaft is produced according to ASTM F 894 and for design and static calculation ASTM F1759, EN 13598 and the German ATV A 127 are applicable.
The significant advantage is that a homogenous system of the same resin is produced. It is preferred to use Krah structured wall types like CPR and VW for the production of manholes, as the soil can densify better at the smooth outer surface of the pipe and can settle without problems. The recommended type of a Krah manhole depends on the connected pipe dimension and the quantity of inlets and outlets. There are two types of manholes: “centric manholes” and “tangential manholes”. The usages of both types depends on application, customer requirements and local conditions, but typically centric manholes are used for smaller pipe dimensions (e.g. from ID 12 in. up to ID 32 in.) and tangential manholes are used for larger pipe dimensions (ID 32 in. up to ID 196 in.). If requested, other shaft materials and components can be integrated in the riser. In case of areas with high water table, the Krah manholes are secured against buoyancy. The connection to top slab or hatches can be executed by telescopic design to ensure perfect levelling even in anticipated soil settlement. The main advantages of the Krah manhole are sustainability, flexibility, light weight, the inspection friendly and self-cleaning surface and durability. The excellent corrosion resistance and homogenous jointing method ensures 100-year service time.

Tangential manhole

The tangential manholes are used for larger pipe dimensions (e.g. from DN/ID 40 in. up to DN/ID 196 in.). The manhole shaft is positioned eccentrically on the pipe. The accessibility for maintenance and inspection is considered in the design. The big advantage of this solution is easy handling at site and the low space demand. The installation effort of a Krah tangential manhole is not much more than that of a simple pipe - that saves a lot of time and money.



Centric manhole

The centric manholes are used for smaller pipe dimensions (e.g. from DN/ID 12 in. Up to DN/ID 32 in.). The manhole shaft is positioned centrically on the pipe. The benching, channel and bottom plate can be designed according to designer specifications.

Electro-Fusion joint DN/ID 1800mm (71")

Storm drainage line with integrated manhole

Butt-welding of pipes DN/ID 1800mm (71")

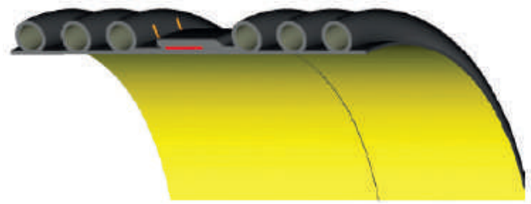
DN/ID 1000mm (40") segmented 90° bend

Jointing technology

All Krah pipes are produced with an integrated socket and spigot, which are adaptable to the following kinds of jointing techniques:

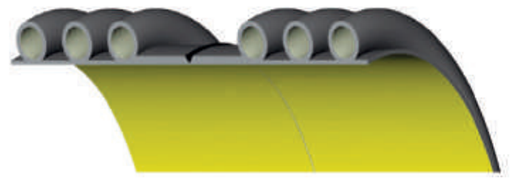
Electro fusion joint

This is the most preferred jointing system, as the whole pipe system becomes a homogenous unit. A welding wire which is integrated into the socket or spigot is heated with the help of a special welding device whereby the two pipe ends (socket and spigot) are jointed together. The electro-fusion jointing technique is a very favourable, simple and safe method to install pipes in even very narrow trenches in a short time. For further information please refer to our special brochure "E-fusion".



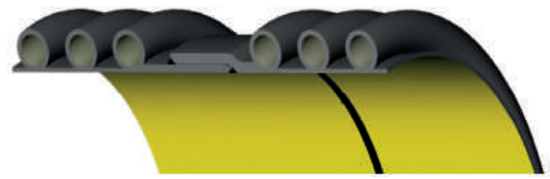
V seam extrusion welding

The pipes and fittings are jointed with the help of an extrusion welding extruder. The outside of each end is milled off forming a welding seam which looks like a "V". Normally no socket-spigot connection is used. The welding has to be done according to DVS 2207 part 4.



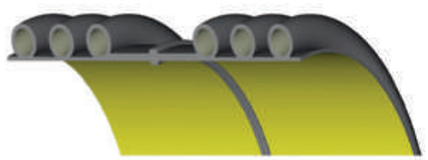
Extrusion welding

The pipes and/or fittings which are to be connected are jointed by a socket and spigot joint. Similar to a V-seam connection, the two pipe ends are connected with the help of an extrusion welding device. The jointing can be carried out inside and/or outside of the pipe. This jointing is most suitable for low-pressure gravity pipes and manholes. The welding has to be done according to DVS 2207 part 4.



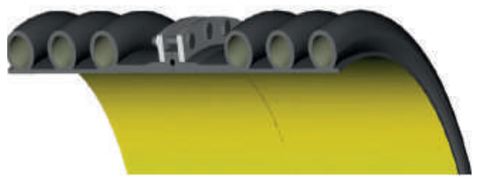
Heat element butt fusion

The pipes and fittings are jointed with the help of a heating element butt fusion machine. The ends of the pipes and fittings are butt-fused. This kind of jointing method is only recommended for pipes and fittings with a maximum wall thickness of 5,9 in. (150 mm) and with diameters from DN/ID 12 in. (300 mm) to DN/ID 118 in. (3000 mm). The welding has to be done according to DVS 2207 part 1 or equivalent welding standard.



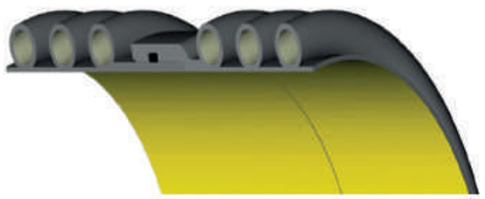
Flange connection

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



Gasket connection

The Krah rubber sealing system consist of a solid plain bell and spigot, with integrated EPDM gaskets. The special double gasket design of Krah provides maximum safety for leak-free joints. Gaskets can be an alternative solution if detachable connection or a temporary joint is requested.



Applications

Due to the versatility of Krah pipes, with all their different kinds of profiles, they are applicable in all kinds of application fields:

Sewer systems

Sewer systems made of profiled Krah pipes have been used for more than 50 years in all areas of local and industrial drainage. The Krah Pipes GmbH & Co. KG offers a modern sewer pipe program with manholes, fittings, and safe jointing systems for the planning of sewer treatment plants.

Outfall pipelines

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 Krah pipes offer considerable advantages, such as the elasticity of the pipeline and therefore optimum adaptation to the area, low weight, safe and strong jointing technology, seawater resistance and pipe stiffness adapted specifically to the respective requirements because the appropriate profiles are selected for every individual project.

Tanks and containers

Profiled or solid wall pipes made of polyethylene or polypropylene are well suited for the manufacture of horizontal and vertical tanks. For other special constructions like chimneys, compost plants, and wash towers Krah pipes offer advantages in terms of variety, precision, quality, and expandability.

Reservoirs, storm water tanks

Within a sewage system, and particularly in mixed water systems, reservoirs can store rainwater for delayed release to the sewage plant in order to avoid overload. As reservoir systems are usually built-in subsequently, they must be assembled in a very short time. Since Krah reservoirs are prefabricated, this condition is fulfilled perfectly. Krah pipes offer considerable advantages:

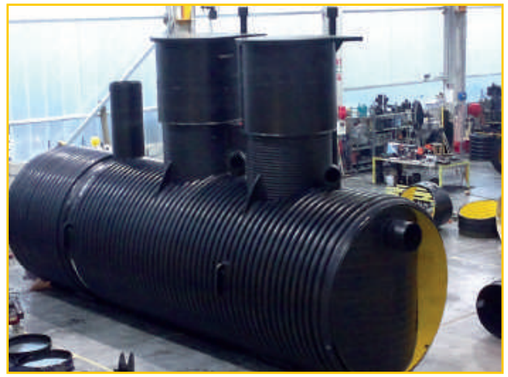
- the compact construction allows short building times
- 100% tight joints between the various elements due to the electro fusion process
- smooth inner surfaces which prevent incrustations
- the pipe’s self cleaning ability

Relining

The reconstruction of damaged sewer pipes by means of relining, „pipe in pipe method”, becomes more and more important. Krah pipes are very suitable for the relining process. Specific pipe stiffnesses can be calculated for all loads. Also in the area of short pipe relining, Krah pipes offer smart solutions. The welding or Krah click-in joint can be carried out inside the shaft. Pipe lengths are available in length of 32 in. (800 mm) to 236 in. (6 m).

Krah pipes are able to reestablish the static carrying capacity of the sewer without the need of digging. In order to insert longer stretches, pipe lengths of up to 18m (709") can be pre-fabricated. With DN/ID 32 in. (800 mm) and larger pipes, it is also possible to insert the pipe one by one into the existing sewer network and weld from the inside of the pipe.

Preparing an outfall pipeline string DN/ID 3000mm (118")



Special storage tank with pumping manholes

Installation of two pipe strings DN/ID 1200mm (47") and DN/ID 1400mm (55")

Heavy wall billets

Landfill shafts

Open storage of pipes DN/ID 1600mm (63")

Transportation of a drinking water tank DN/ID 2000mm (79")

Shafts for landfill

Easy handling of a watertank DN/ID 1800mm (71")

DN/ID 1200mm (47") relining of a concrete pipe

Landfill

Krah is a competent partner for system components for drainage and de-gassing of landfill sites. Many landfill sites have been successfully equipped with profiled drain pipes and manholes. Krah's developments have set new standards for soil and ground water protection. Drain shafts with control systems are available in diameters of up to DN/ID 196 in. (5000 mm).

Special applications

In addition to the common areas of application Krah pipes are also suitable for special projects like underground shelters, tunnels, geothermal equipment etc. Krah pipes are also used as ventilation pipes for industrial applicationsparticularly for the chemical and biological industry. The corrosion resistance of the thermoplastics ventilation systems is necessary for a maintenance-free and long service life.

Industrial applications

Pipeline systems which are installed for industrial applications have high technical requirements.
Typical challenges for such pipelines are handling and conveying of hazardous media and their chemical impact and changing operation conditions. For all that, Krah pipes are using superior thermoplastic resins, which provide excellent properties to meet customer expectations.

Checking of the wall thickness

The advantages at a glance

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

Time Saving
Up to 30 % savings when laying the light and flexible pipes with lengths of 6 m (236").

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

Hydraulics
Due to the very good hydraulic 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.

Lengths
The standard length of 6 m (236") reduces the amount of joints.

Integrated E-fusion
Every pipe can have an integrated electro fusion.

Temperature resistance
Due to the machining the application of the pipes range from -40 °C to +80 °C.

Environmental friendly
All materials can easily be recycled and lead back into the production cycle.

Flexibility
The pipes are secure against fracture, even in case of earth movement

Easy handling
Due to the low weight and the quick assembly, the pipes are very easy to handle.

Quality Control

Total quality management

The quality of the pipes and the pipe products are the main criteria for all developments of the Krah pipe producing companies using the Krah technology. As the international requirements vary because of the different norms and standards, there exists a number of test procedures for quality assurance.

The entire production process is integrated into an extensive "Total Quality Management System". There are two main fields, one is the internal quality control and the other is the external (third-party) quality control. Generally, the internal quality control is divided into three different steps:

• Before production control

The resins and any other input are tested for melt flow rate, moisture, density and color. Usually any new batch of resin is tested before it is stored. Every test is documented, analysed and filed.

• During production control

During 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 production, the final product is tested and compared with the requirements of the customer and the relevant standards. In order to guarantee the required statical characteristics, pipe samples are tested frequently according to ASTM F894 for their strength, stiffness and flexibility.

Marking

Depending on the used pipe standard, the requested marking can vary, but usually the content of the marking (complete or crypted) is as follows: Number of the standard, stiffness class, diameter series DN/ID, resin, melt flow rate, name of manufacturer, date of production.

Quality certificates

In general, the whole production is constantly supervised by an internal and a third party inspection. The implemented quality control system fulfils the local requirements and is getting improved continuously. For the manufactured pipes and fittings quality certificates according to customer requests can be issued.

Get more information from your local Krah Pipe producer:

KRAH USA LLC

3840 NW BUS EVANS Rd.
Prineville OR 97754