

IMPROFIL

Hydraulic dimensioning of sewage lines

Sinkholes

How can they be prevented?

Reconstruction of filtrate duct for a WWTP in Russia

One night in Pampanga Krah Pipes Manila



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Dear Reader



Mr. Alexander Krah

Yet again I have the pleasure to present another issue of our ImProfil with a few personal lines. Currently everywhere on this planet money is being “produced” – from nothing. And, more importantly, what is it spent for? For example nice airports like the “oh-so-successful” German airport BER Berlin ready to be opened in 2082? A lot of money is used for visible, high class goods, which reflect wealth.

A good example for this paradoxon is Dubai, a city with a lot of nice, expensive and world-record-breaking buildings. Underground however, the drinking water is still partly being transported through outdated pipelines made of asbestos-cement.

A second trend is going to “Stealth Wealth” – hiding your wealth from the society and investing in the future “underground” and unseen – the right term would be “inconspicuous consumption”. Also countries and communities are doing this kind of investment – they invest in their long-term future. So Krah Pipes are the right product at the right time. We are helping the world by providing a good and sustainable solution for water and wastewater problems – and we enjoy doing this, we don’t produce destructive products! Another new trend is sharing instead of owning, how do we try to face this trend? We try

to transfer Know-how at a low price or even for free. Sharing is caring – we will help our customers to grow by on their own – by education. Krah Pipes can proudly present its first App. Enjoy this magazine and if you like to give a feedback, please feel free to contact me at feedback@krah.net.

I would like to point out that there was an error in the last “ImProfil” issue. Our machines are currently running in these Ex-Soviet-Union countries: Russia (Polyplastik Group), Estland (Krah Pipes OÜ), Aserbajdschan (STP) and Ukraine (Instalplast-HV).

But we also got some sad news this month. One of our good business partners and friends passed away – Lee Forbes of Kenneth Forbes Holdings Ltd, United Kingdom. Lee founded the company in 1960 together with his Dad Kenneth. Having worked with plastics his whole life, he decided in 2012 to invest in a Krah Solid One machine, being able to produce plastic tanks and silos. Throughout the Krah Community he was known as very talented and passionate man which also reflected in common projects. Our thoughts are with his family and all those who will miss him as much as we do.



Yours sincerely,

Alexander Krah

CORSYS PLUS pipes used in reconstruction of filtrate mains at Rublevskaya water treatment station

Rublevskaya water treatment station has been operating since pre-revolution times and still remains the main source of potable water for Moscow, Russia's largest metropolis. Today there are plenty of new materials and technologies available for water supply and water disposal which can extend pipeline operating life by up to 50 years or more. Implementation is going slowly, which is why the number of worn networks is still significant. The Rublevskaya water treatment station is no exception. Having reached a certain stage of operation, it needed restoration of its filtrate ducts – underground water mains of rectangular and circular cross-sections made of reinforced concrete. Specialists at Mosvodokanal confirmed the option to use circular cross-section plastic pipes in these conduits and ID 1400 mm and

2000 mm were approved for the various sections. They had to choose pipes and fittings for operating pressures up to 0.15 MPa, and find solutions for the following non-standard tasks:

- Installation of pipes, fittings and branching from inside, because opening of water conduits was only planned at places with bends and in chambers;
- Connection of the new pipeline to the old one;
- Pressure testing of the new pipeline conducted as for a pressure pipeline.

CORSYS PLUS pipes (pressure version) met all the requirements. These pipes fully comply with GOST R 54475 (used for the production of non-pressure pipes). In addition, they also go through an in-house pressure test similar to GOST

18599-2001 for at least 100 hours at a temperature of 20°C. This allows the use of CORSYS PLUS pipes for pressure systems with operating pressures up to 0.6 MPa. The reliability of the CORSYS PLUS pipes connections is ensured by electrofusion using special electric heaters integrated into the sockets of the pipes. This is the only type of connection that meets the requirements for a new pipeline. Application of TRASSA-M fusion units provides automated welding: all parameters for welding are logged in automatically by reading the barcode on the pipe. This minimises the human factor at this crucial stage. The presence of a side connection made of steel along the whole length of the renovated conduits complicated the works, as did the short distance between the conduits, two of which were still in operation. This prevented the builders from expanding the problematic sections by opening the renovated conduit. For these reasons, the welding and connection work was carried out from inside. POLYPLASTIC Group's specialists developed a unique design of connections and installation technology to deal with the issue. To ensure reliable welding of the one and a half metre connections, special pipes with thicker solid wall patches were manufactured. Well-organised first stage construction works with the participation of POLYPLASTIC Group specialists ensured flawless coordination and



Pic. 1: Underground water conduit to be reconstructed



Pic. 2: Welding of CORSYS PLUS DN/ID 2000 mm from inside using two welding units. The pipes are already installed in the renovated conduits.

smooth operation on reconstruction for all three water pipelines. All preparatory works on assembling and welding were conducted by experienced personnel from the construction company, under the supervision of the chief welder. The POLYPLASTIC Training Centre successfully carried out on-site training on installation and quality control for CORSYS PLUS pipes. Constant supervision and the availability of spare installation equipment on site (rented out by POLYPLASTIC) also significantly increased the productivity of the works. During the reconstruction of the first line of water main, this difficult task became a precise operation. Specially designed solutions for PE-Steel transition and the technology of tapping in to the new pipeline were successfully applied and passed a stringent check from technical supervision specialists at the Rublevskaya water treatment station. A special CORSYS PLUS elbow was produced for each individual bend of the conduit. Some of these had bends with a height difference, therefore the elbows were produced to accommodate the bend in two planes. Due to the confined space

available for installation, the sections of elbows needed to be precisely measured and produced accordingly. Welding of the joints was carried out from inside the pipe, even when the elbows were installed using the open method. All the renovated pipelines passed through the hydraulic tests using pneumatic plugs made of special rubber. Acceptance inspection of the joints and tests confirmed the quality of the installation and that the pipeline was leak-tight. At the final stage of installation, the gap between the walls

of concrete reinforced conduits and the renovated pipelines was filled with cement mortar grout. 545 metres of CORSYS PLUS DN/ID 1400 mm and 1,246 metres of DN/ID 2000 mm pipes were used in the project. The implementation of this unique project provided an invaluable experience in trenchless reconstruction of complicated linear facilities, i.e. pressure concrete reinforced rectangular filtrate conduits for Moscow's first water treatment station. Successful results proved the practicality and relevance of CORSYS PLUS pipes for the trenchless reconstruction of pipelines and conduits for various purposes, including highly important, non-standard projects with complicated operational needs.

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Pic. 3: CORSYS PLUS bending connection in open conduit

Hydraulic dimensioning of sewage lines using the example of Jakarta



Pic. 1: Skyline of Jakarta

1. Basis

The development respectively the renovation of waste water discharge system is always associated with high investments and extensive civil engineering works. Beside the purchase costs for the pipelines itself, also high proportionate costs arise for the grounds works and the pipe installation.

Especially in topographical flat Asian metropolitan areas like Jakarta, the pipelines can often only be installed with a low longitudinal slope. Thus, the hydraulic capacity of the pipelines is decisively limited. Increasing the longitudinal slope again means expensive, extensive, technically sophisticated excavation works. In Asia, most sewage and drainage systems are made out of concrete. Those

pipes have a very rough pipe wall and have a lot of connections, due to their production process and quality. By using suitable pipe materials that guarantee smooth walls and need much less pipe connections, the longitudinal slope can be reduced while maintaining the dimension and the hydraulic capacity. Thus, also the costs for excavation and civil works can be reduced considerably. Smooth walls also optimize the discharge conditions and especially avoid depositions during dry weather flow.

2. Dimensioning of the pipeline

The discharge flow condition of open channels respectively free-flow pipelines base on the hydraulic date of Prandtl and Colebrook. The working paper DWA-A110 published by the "Deutsche Vereinigung

für Wasserwirtschaft, Abwasser und Abfall e.V." forms the basis for the hydraulic dimensioning and the proof of performance of sewage lines and channels in Germany.

The discharge capacity and behaviour is depending on the hydraulic cross-section, the longitudinal slope, the inflowing water amount as well a roughness respectively the single losses of the pipe system. The dimensioning and the proof can be carried out according to working paper DWA-A110 by means of overall concept or on an individual basis.

Applying the overall concept, the operational roughness of the complete systems will be determined by fixed values of the application. The individual concept should be applied to prove

the performance of sewage networks considering all loss-causing influences. In doing so, the losses caused by occurring single losses as well the roughness of the pipe wall are determined. Single losses are caused for example by inaccurate positioning, pipe connections, manholes, flow deflections etc.

Picture 2 and 3 show exemplarily the concrete pipes available in Jakarta. The rough surface structure of the inner wall as well as the many pipe connections are clearly visible.

For these low-quality pipes, the wall-roughness of $k = 0,4$ bis $2,0$ mm can be considered. Furthermore, the single losses for the many concrete sockets have a negative influence on the discharge performance and additionally reduce the hydraulic capacity.

It can be assumed that the sockets cannot be carried out water - and pressure-tight and therefore exfiltration or of sewage water into the soil respectively infiltration



Pic. 3: Concrete pipes with high roughness and socket (Source: Krah Pipes GmbH & Co. KG)

of foreign water during high ground water level will occur.

Plastic pipe systems made of PE-HD are an alternative to concrete pipes. Those pipe have, according to the information of the producer, an absolute roughness of $k = 0,0015$ to $0,01$ mm. The pipe connections are hydraulically optimized and can considerably be reduced

compared to concrete pipes, thanks to the longer pipe lengths. The tightness is guaranteed by the possibility to weld the pipe connection.

For both pipe systems the flow rate has been calculated for pipes in diameter DN/ID 2000 mm depending on the wall roughness and for different longitudinal respectively bottom gradient with a flow depth of 1800 mm respectively 90%. In order to simplify the calculation, the influence of the pipe connections and the material-independent single losses were not considered. However, the optimized design and the quantitative reduction of pipe connections of PE lines generally lead to improvement of the flow capacity. For the concrete pipe, according to the available pipes (picture 2 and 3) an absolute roughness of $k=1,0$ mm is considered. The PE pipes will be calculated with a roughness of $k = 0,01$ mm. This complies with the maximum value respectively the worst value according to



Pic. 2: Concrete pipes with many connections (Source: Krah Pipes GmbH & Co. KG)



Pic. 4: PE pipes with smooth inner surface (Source: Krah Pipes GmbH & Co. KG)



Pic. 5: PE pipe inside (Source: Krah Pipes GmbH & Co. KG)

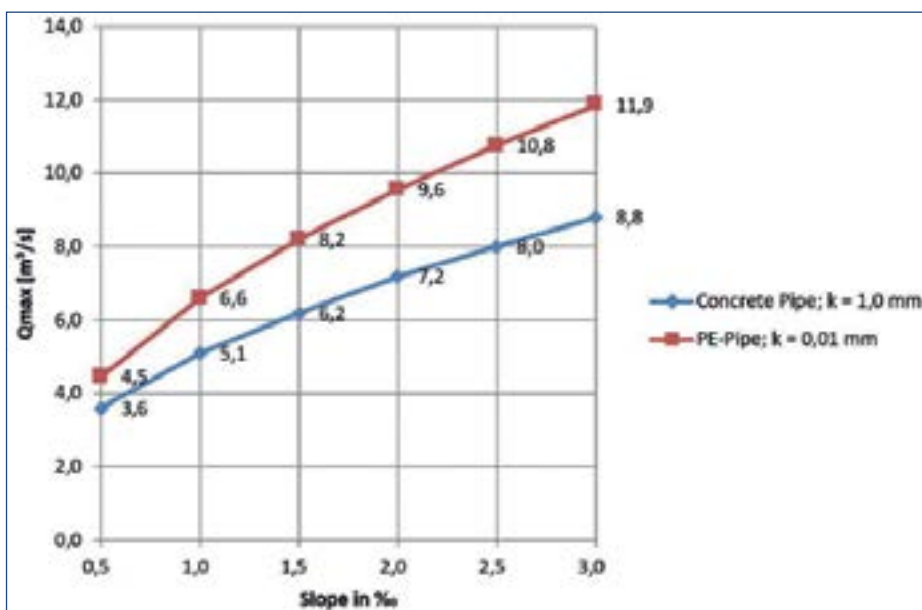
the producer. The calculation is carried out on the basis of the equation of Prandtl-Colebrook. This equation serves to determine the loss amount due to friction. The following diagram shows the calculation results. This shows that by choosing smooth pipes the flow rates increase, considering the same bottom slope. Conversely, this means that when using smooth pipes the bottom slope

transport a higher amount of water compared to the concrete pipes available in the Asian region with a bottom slope of 3,0 ‰. In practice, this means that the depth of the pipe trench can be reduced by around 1,0 m for a pipeline length of 1000 m. Especially in flat cities like Jakarta with a big surface area, collecting pipelines with 10 km are common. The reduction of the bottom slope by 1 ‰

3. Summary

Pipes with a low wall roughness like PE pipes can considerably reduce the total civil works costs and thus the total construction costs, even though they might be more expensive.

Considering the same pipe dimensions and hydraulic performance, PE pipelines can be installed with less slope. Hereby, earth works, excavation works, excavation support and water retention measurements can be reduced, especially in topographical areas with few slope. By installing pipelines with less slope, there is potential to save costs and reduce pumping stations, operation points and operational costs.



can be decreased, maintaining the same dimension and hydraulic performance. Picture 5 reveals that smooth PE pipes with a bottom slope of 2,0 ‰ can

thus theoretically means that the trench depth at the performance low point can be reduced by 10 m.

Also the life-cycle has to be taken into account, comparing the concrete pipes available in Jarkarta with modern PE-pipes. The high quality PE pipelines have a lot of financial advantages compared to concrete pipes, taking into account the operation life and the low operational costs, also with regard to further reinvestments and maintenance.

Also the tightness of PE lines is very advantageous. The infiltration of ground- and foreign water can lead to an overload of the system capacity. Also no exfiltration of sewage water to the ground will occur.

Other advantages of using PE pipes are:

- High abrasion resistance
- Responding to dynamic loads (e.g.

earthquakes)

- Corrosion resistance
- Chemical resistance
- Few incrustations and depositions
- Low weight and therefore simplified installation
- Variable pipe lengths
- Welded pipe connections
- Resistant to exfiltration by roots etc.

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Sewage collection tank for a leaking sewer system DN/ID 1600 mm



Pic.1: Sewage collection tank during installation

Around 100 km from Stockholm you will find Västerås, a large city at Lake Mälaren, the third biggest lake in Sweden. Västerås is a big industrial city that was founded over 1000 years ago. In the past year they had some trouble with leakages in the sewer system. High rainfalls had led to full pipes which resulted in an overflow into Lake Mälaren.

Therefore a quick, durable and reliable solution was needed. The engineering company Mälar Energie AB contacted Krah pipes yet again in January 2017 to plan the project for a 950 m³ sewage collection tank of DN/ID 1600 mm with a DN/ID 2000mm manhole. The first pipes were shipped already in October 2017, the project was finished in March this year. The manhole is equipped with a flow regulator 150 l/s from Mosbaek A/S.

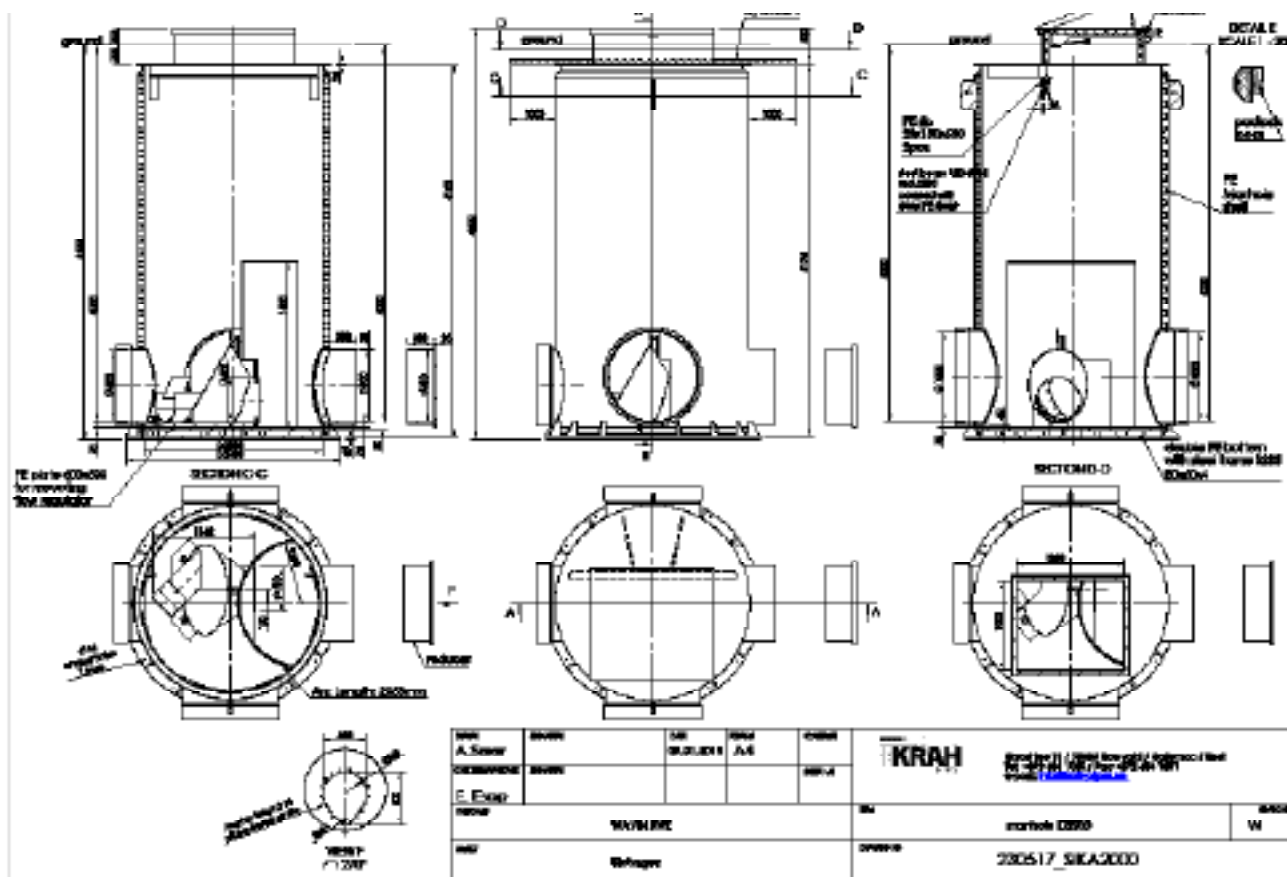
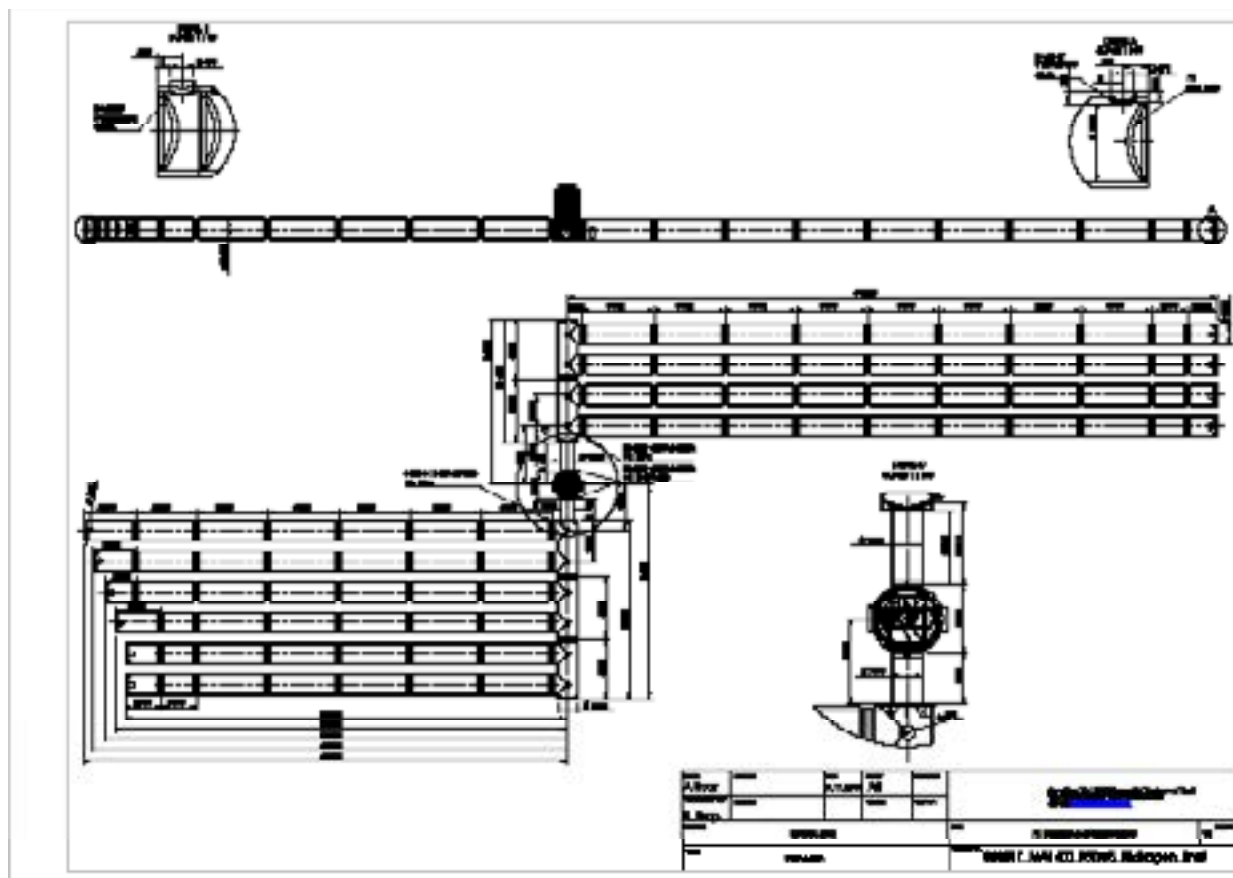
The incoming flow to the manhole is 350 l/s if the incoming pipe is working with full capacity. The pipes were delivered in lengths of 6 Meter including rubber gasket. In a whole, 41 trucks were needed to deliver the whole amount to the construction site.

This was the third magazine of this kind they do in Västerås. It is known as a kommun that only installs plastic pipes. The construction company, Salboheds Construction and Civil Engineering AB, was impressed with the Krah technology: "Fast and easy installation, even with the pipes being so big. The manhole was installed and working in less than two hours. They also did a video inspection of the inner layer after installation and the inner surface was fantastic, bright and smooth. The prefabricated parts were of high quality and fitted perfectly into the system."

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Pic.2: Krah Pipes Manhole



Sinkholes – a matter of water erosion!

The origin – made by humans and nature



Pic. 1: Sinkhole in the United States, Source: Nationalgeographics, by Octavio Jones

Introduction

Anywhere in our world different kind of erosions happen which form our landscape – on the surface as well the subsurface. The most significant factor of erosion is water (beside wind, landslide and abrasion) which is causing a challenge in engineering problem. The ability of water to move soil and rock depends on several factors. The faster and more turbulent the flows of water, the more erosive characteristics are appearing. Larger particles like gravel are more resistant to erosion than small particles like silt or clay. Finally, rather than physical erosion, some materials dissolve in water, just like sugar or salt. It can be eroded just by dissolving into the ground water from time to time.

Some kinds of soil are more affected than others – i.e. dolomite areas, etc. Most natural sinkholes occur in areas with large deposits of carbonate rocks like lime stone. Over long periods of time, ground water flowing through the subsurface can dissolve the rocks, creating voids and open tunnels. In fact, this is how most

caves are formed – a creative name of sinkholes is also „Internal erosion“. A sinkhole is a feature that occurs suddenly and manifests as a hole in the ground.

The consequences are a catastrophic collapse which may lead to death, injury or heavy structural damages. Many



Pic. 2: Huge sinkhole , Source: Nationalgeographics, by Octavio Jones

photos and videos are collected and published on the internet; - just search for "Sinkholes" and you will be impressed. Sinkholes are usually circular, up to a diameter of 125 meters, with a depth up to 50 meters. Cracks in walls and in the ground of the settlements are often early warning signals of an upcoming sinkhole appearance. As a matter of fact, a sinkhole is a nightmare for every municipality and the damages are huge.

Sinkhole – by nature

A sinkhole is generally what we call a karst terrain. Karst terrains are basically areas that are underlain by soluble rock, rocks that can dissolve like lime stone, gypsum and salt. Rain water naturally is a saline when it gets underground into these rocks. Over long periods of time, hundreds, thousands or tens of thousands of years, the rocks will dissolve and will leave cavities and voids underground. As these voids grow upward, the soil on top can no longer sustain itself, and we get these catastrophic collapses.

Beside the process of creating cavities under the ground and lowering the ground water table which is another reason for sinkholes - cavities exist within the bedrock or the overburden which are in a stable balance. The cavities are accompanied by groundwater. Lowering the water table disturbs the balance and the active erosion under the soil will be accelerated. The process of erosion is gaining an unstoppable process and the collapse will be the final result.



Pic. 3: The failure here was a broken drainage pipe. Source: ABCNews

Sinkhole – human made

But not every sinkhole is formed through natural processes. In fact, many of the most famous sinkholes in recent times have been human-created. Just like a cave dissolved into the bedrock can act like a pipe and allow ground water to carry away the soil – a current pipe can do the same thing and current pipes are limited to areas with specific geology. If you could take a look into the subsurface of any urban area, you will see miles of water, sewer and storm water drainage pipes.

All it takes is a little bit of settlement or shifting to create an opening in one of these pipes and allow internal erosion to start. Other possible reasons of ex-filtration are abrasion, corrosion, pipe aging and wrong installation. During this ex-filtration, water moving through this pipe is able to dislodge the soil and carry it away. On the same leakage infiltrations can happen to speed the time of creating cavities. Notice that there is no signal on the surface that anything is going on below. As more soil is washed away, the

subsurface void grows. Depending on all those soil properties we were talking about earlier, this process can take days to years before anyone notices. Many of our subsurface utilities are placed directly below roadways and the paving often acts as a final bridge above the sinkhole, hiding the void below.

Beside wrong piping systems other human activities can have a great impact on sinkholes like mining, fracking and geothermic works, where cavities are formed or opened – due to their impact on the soil-structure subsurface. But the main origin of sinkholes made by humans is the result of leaking pipelines.

Result:

Sinkholes created by nature cannot be avoided, but man-made sinkholes – result of our fast growing infrastructure - can be avoided by using the right sustainable pipe system. One of the main points for installing new pipelines should be – flexible pipe system – resistance against soil movements – occurred by several impacts, like earthquakes. Modern and



Pic. 4: Repairing a sinkhole sewage line with Krah-Pipes – within 48 hrs.

sustainable flexible pipe solutions (even in large diameters) are available, they are absolutely tight jointed – preferably welded. All components in the pipe system should have the same high quality requirements as the pipe.

Manholes, fittings, etc. Flexible instead of rigid – the Krah pipe system is providing

all features, to be a sustainable solution for infrastructure projects. Not only to repair sinkholes – like the quick repair in Fukumato / Japan, where a sinkhole was repaired with a Krah pipeline – and that only over a weekend!

On the internet many project reports can be found regarding this project.

Conclusion:

Think about the consequences before you act (installing the wrong pipe system)! A right solution is available – Krah Pipes.

Author:

Alexander Krah
Krah Pipes GmbH & Co. KG

14.-18 May 2018



Krah Pipes in Munich - Visit us at IFAT 2018!

The world's leading trade fair for water, sewage, waste and raw materials management will once again take place this year from 14 to 18 May at the Munich Exhibition Centre.

Discover at our booth in hall B3, booth 3.411 all about big pipes.

We would be pleased to welcome you at our booth.

Make an appointment now.



Visiting a Krah Pipes producer in Egypt

Krah Misr, Obour City



Pic. 1: Entrance building of Krah Misr. The total production area has 10.000 m²)

Every now and then Krah Group employees visit different Krah Pipes production plants. In April 2018 Alexander Krah went to visit the factory Krah Misr in Egypt.

Having arrived in Cairo he is warmly welcomed by the owners at the airport. The owners and managing directors are the two brothers Peter and George Yussef Sadek.



Pic. 2: Peter and George Yussef Sadek

The two brothers have been producing Krah Pipes for almost 10 years. Since the political changes in Egypt during these years, the factory was able to produce and sell large pipe systems successfully.

From the airport the group went straight to the production plant, where in a very modern and big office the two brothers held a company presentation. They showed how the company has been growing since 1975 – it was very impressive and inspirational to see how proud the two brothers were of what they

had achieved. The whole production plant is in a very neat and maintained condition and the products (pipes, manholes, fittings and tanks) correspond to the international quality standards. Later this afternoon Alexander had the possibility to talk to Peter privately regarding several topics in a nice club-house.



Pic. 3: Production line KR750 delivered and installed in 2009



Pic. 4: Peter during the interview

1) According to international press we constantly hear that Egypt is booming – especially in the sector of infrastructure. Is that true and what is your main market segment for your products?

Yes, actually it is true – the Egyptian government decided to invest in infrastructure – aiming to provide enough homes for every citizen including the needed infrastructure to increase the life quality of the Egyptians. Today Krah Misr is mainly working on domestic sewage networks. We supply the complete system (pipe, manhole, fittings..) and install it. The market is moving into a positive direction, especially after the economic corrections the government has done in the past.

2) Which difficulties do you have in marketing your products?

The main problem is to change the market mind-set for big pipes. Egypt is more convinced of heavy and rigid pipes and we faced a lot of resistance implementing pipes like DN/ID 2500 mm made out of

Polyethylene – although these kinds of pipes have been used already with big global success.

3) What do you do to change these stubborn mind-sets?

We are constantly working on arranging meetings and seminars for clients, consultants and contractors to present the advantages of the Krah Pipes solutions – including manholes and fittings. And we try to present our success of the latest seven years of carrying out several projects in Egypt.

4) What are your strengths?

We produce and deliver smart solutions that weren't present on the Egyptian market before and we offer a very economic and quick project realization time. In Egypt we have many areas of loose soil, where no other pipe system can solve the problem as good as Krah Pipes. We are very focused on working on extensive engineering before – in the "under design" phase and also in the "under construction" phase.

5) Where do you see successful Egyptian markets in the future?

The trend is going into three major applications: a) large diameter pipelines to serve the new cities, b) desalination plants, due to critical situations with the Ethiopian damm we have to increase our own resources for drinking water other than our famous river NIL. So there is a plan for a large number of desalination plants to convert sea water into drinking water. The third application are sewage treatment plants so the country can use the treated water (sewage) for agricultural purposes.



Pic. 5: The brothers are continuously investing in new upgrades for the machine to have the latest Krah Pipes developments available (such as a new profile)

6) How active are international competitors?

They are trying to get into the Egyptian market but due to support of the government for local producers we can be a successful plant. Especially since we are working with the latest production technology with international know-how in several fields. Our products are minimum the same quality than foreign products at lower prices and the requested quick availability of the products on the market. Furthermore we don't need to face the "still" complicated import procedure and we do all our invoices in Egyptian pounds – which is a big additional advantage.

7) What was your latest great project in Egypt?

Currently we have two big projects running, one of them is situated in the heart of Giza where we installed 10 km of DN/ID 1200 mm and DN/ID 1500 mm pipelines of Krah pipes with many manholes, which decrease the project costs significantly and increase the speed of the project progress due to the quick installment. The second project is in Dumietta, the "furniture city" (a new industrial area for the furniture industry). The difficulty here is a very high ground water table and very loose soil, we are awarded from the Military to realize the complete sewage and storm water system for the complete area – in a very, very tight time schedule: 8 km of pipes (>600 mm) and DN/ID 600 mm manholes within 3 months – all jointed by electrofusion.

8) Last question – just to be curious: Are there any more investments planned?

Yes, for sure! The Egyptian economy is very promising for the next years and we think about investing in Egypt in production equipment and new solutions, to keep our market leading position.

Thank you for the great days and I hope to be seeing you in May at the IFAT 2018 in Munich. Thank you very much for the time spent here and your interest in the Egyptian market, Alexander. I am sure I will see you soon here in Cairo again.

PS: On the next page you will find a project report about the "Damietta Furniture City" Peter Youssef was talking about in the interview.

Author:

Peter Youssef Sadek, Krah Misr
Alexander Krah, Krah Pipes GmbH & Co. KG



Pic. 6: Mr. Peter Youssef Sadek with Mr. Alexander Krah

Sewage and stormwater network for Damietta Furniture City



Pic 1: Overview of "Furniture city"

Network data:	
Network length:	4500 m
Manholes number:	620
House connection:	180 (IC)
Pipe diameters [mm]:	180 - 1000
Installation depth:	until 7 m
Pipe stiffness [SN]:	8 KN/m ²
Manhole stiffness [SN]:	8 KN/m ²

Damietta Furniture City was established with an authorized capital that reaches 5 billion Egyptian Pounds, with a 521 million Egyptian Pound capital value and a 100% Egyptian capital contribution.

An industrial area built on 331 acres, to establish furniture industries of different size and complementary industries and provide the infrastructure, services and facilities needed by those industries.

1500 small and medium workshops of 50 to 150 meters with about 150 large and complete factories, besides the establishment of the furniture technology centre in Damietta.

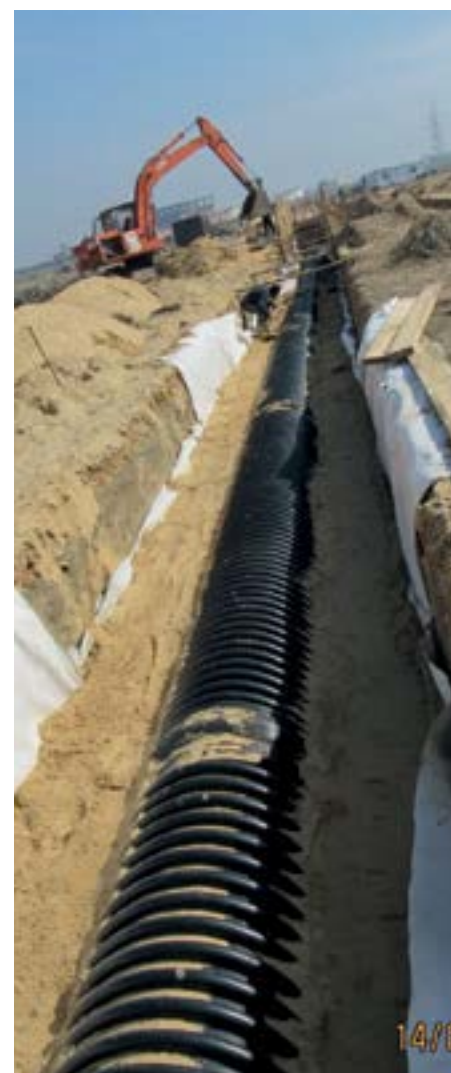
The project also aims to transform Damietta city into an integrated city specialized in the furniture industry by deepening and promoting this industry. For the latest international developments, especially with regard to the design and

development of production lines, as well as the creation of export opportunities to qualify them to compete regionally and internationally, in addition to providing more direct and indirect employment, which is expected to exceed 25,000 employment opportunities.

The complete sewage and stormwater network is made of Krah pipes, made by Krah MISR. All pipes and manholes has to be delivered in approx. 3 month!

A big challenge for installation is the muddy soil. For backfilling well compacted sand is used, separated to native soil by geotextile. Nevertheless a settlement is expected and it is very important to join all pipes and manholes by homogenous welding.

All Krah pipes will be joint by integrated Electrofusion socket. The full pipe string is flexible and move with the soil.



Pic 2: Laying of a Krah structured wall pipe



Pic 3: Krah stormwater manhole installation



Pic 4: Krah sewage manhole installation




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Krah pipes installed in exposed conditions - What has to be considered?

Krah pipes, made of Polyethylene PE100 in typical black colour, provide a perfect weather and UV resistance. If a Polyethylene pipeline is planned for an application in exposed conditions the external loads and influences have to be considered for the design.

Typical applications are:

- Mining industry
- Sewage and water pipelines
- Hydropower plants (headrace, penstock)
- Industrial applications

For exposed installations we mainly differ between industrial pipelines installed in

clamps and free installed pipelines on the ground. In the following abstract we concentrate on free installed pipelines under exposed conditions. Often we receive inquiries regarding the planning of Polyethylene pipes for such exposed conditions. People ask for installation rules and what has to be considered in general.

What are the reasons to install a pipeline exposed on the ground without trench/backfilling and without covering? Often the installation area has very difficult accessibility for vehicles and equipment, either because of natural environment

or infrastructure. Sometimes the soil conditions are very challenging and sometimes it is only because the effort is much less and the pipeline is a temporary solution only. And why are plastic pipes and especially Polyethylene pipes/Krah pipes so popular for exposed installed pipes? The main reason is the unbeatable corrosion and erosion resistance and the durability of high quality Polyethylene materials! Further the homogenous joining procedure by Electrofusion or butt-fusion guarantees a leakage-free pipe system. The flexibility is often another important argument, because the line is following the environment!



Picture 1: Free installed Krah pressure pipe (PE-GF) with partially embankment for mine industry



Picture 2: Krah pressure pipe with clamps and concrete fix points for hydropower plant



Picture 3: Free installed Krah sewer pipe DN/ID 1000 mm with profiled wall for anchorage



Picture 4: Roof installation of Krah pipe ventilation, PE 100, DN/ID 800 - 1400 mm

What are the difficulties, if Polyethylene pipes will be installed in exposed conditions?

UV radiation

Firstly we have to consider, that typical black PE 100 provides already an outstanding UV resistance due to the carbon black content. All the used modern PE 100 raw materials are excellently compounded with all needed stabilizers and ingredients to guarantee a problem-free usage. The carbon black is well distributed in the Polyethylene matrix and absorbs the UV radiation – it is a very effective agent against oxidation and molecule-chain degradation! The minimum content should be more than 2 % – most raw materials guarantee a value of 2,25 % according to ISO 6964, carbon black dispersion ≤ 3 according to ISO 18553.

A typical indicator for the proof of Oxidation stability of black PE 100 is the OIT testing according to DIN EN ISO 728 (OIT = Oxidation Induction Time). For non black Polyethylene other stabilizers e.g. HALS have to be used (HALS = Hindered Amine Light Stabiliser), but then has to be considered that OIT testing is not an adequate testing method.

Temperature

Outside installed pipes are exposed to all weather conditions during the seasons. Polyethylene is generally insensitive to cold weather and provides even at minus temperature a sufficient impact stability. For the design the minimum and the maximum temperatures have to be considered and also the temperature of the transported fluid can have an

effect. By temperature analysis we find the maximum difference of temperature and also the related time period for the change. The shorter the time period, the higher the E-modulus/creep modulus and the higher the occurring forces!

Any temperature change leads to a change of length and so far the pipeline is installed between fix-points, stress will occur by the inhibited temperature change. At free installations, the change in length will be normally compensated by flexible legs or compensators. If stress occurs because of inhibited change in length the stress has to be combined with other stress-factors of inner pressure, bending etc.

Mostly there is not only one solution and the engineers have to find out and to evaluate what is the best choice of installation for installer, contractor, operator and at the end for the owner!

For illustration and clarification a typical load case is calculated in the table on page 22 and the used formulae and the results are explained briefly: From the results in the table we get the information that the axial forces due to temperature change are much lower for profiled pipes in comparison to solid wall pipes. The forces can be handled much easier!

Note: Also internal pressure can have an effect to the length and the forces have to be considered for fix installed pipelines.

$$\sigma_{axp} = \frac{p}{A_{ID}} \cdot A_{ax}$$

Regarding axial buckling stability the roundness of the pipe is very important, because it significantly affects the axial moment of inertia. For this point we have to take into account that solid wall pipes suffer under their high dead weight load, a vertical deformation happens very fast and affects the stability. But Krah pipes with a profiled wall pipe have a low dead weight load in combination with a high stiffness. The result is a very low deformation and minimum reduction of stability.

The axial buckling stability becomes important if the change in length gets inhibited and the pipe is anchored by fix points at both pipe ends. The critical buckling length should be calculated under consideration of adequate safety factor. By using partially embankment or guide bearings it can be ensured that the free, non-guided length will not be exceeded.

To reduce deformation is also very important for the joining technology and efficient installation at site! A Krah pipe with a profiled wall stays round and can be joined easily by integrated Electrofusion-socket or if requested by butt-fusion. But if a standard solid wall pipe gets deformed by dead weight and sun radiation, it becomes very difficult to re-round the pipe for joining and welding!

If other thermoplastic materials or reinforced thermoplastics are used, the linear expansion coefficient is different (see table 2 on page 23).

		Solid Wall	Krah Pipe	Note
Pipe Material		PE 100, black	PE 100, black	MRS 10
Wall structure		Solid Wall	Profiled Wall	Profile type PR75-017.42
		SDR 21	eSDR 21	eSDR means equivalent SDR class
application		sewage pipe		overground installed
inner pressure		gravity		
Outer diameter	OD [mm]	1 200	1 274	
solid wall thickness	e [mm]	57,2	8	
inner diameter	DN/ID [mm]	1 085,6	1 100	
Projected area	A _{pr} [mm ²]	20 5360,2	27 847,1	responsible for transmission of axial forces
Inner area	A _{ip} [mm ²]	925 613	930 332	
Pipe dead weight	G [kg/m]	200	80	Attention for stability of solid wall pipe - deformation by dead weight!
Stiffness	SN [kN/m ²]	11,3	12,2	because the pipe is bedded only with small bedding angle SN 12 is chose to keep the pipe round

Strength [20°C, 12 h]	[N/mm ²]	13,09	13,09	source: standardized creep rupture curves for PE100
E-Modulus [20°C, 3min]	[N/mm ²]	1109	1109	E-Modul short term for standard PE100
Strength [20°C, 50 years]	[N/mm ²]	10	10	source: standardized creep rupture curves for PE100
Strength [20°C, 12 h]	[N/mm ²]	13,09	13,09	source: standardized creep rupture curves for PE100
E-Modulus [20°C, 3min]	[N/mm ²]	1109	1109	E-Modul short term for standard PE100
E-Modulus [20°C, 12 h]	[N/mm ²]	330	310	E-Modul for considered time period, needed for temperature change
expansion coefficient	α [1/K]	0,00010	0,00010	change in length in mm per mm length and per degree Kelvin / Celsius, average value
time period for temperature difference	[h]	12	12	day/night conditions
max. temp. difference during time period	ΔT [K]	20	20	temperature difference in considered time period
average temperature	[°C]	20	20	
Length	L [m]	330	130	

free installed pipeline, free change in length, without fix points				
change in length	ΔL _f [mm]	468	468	$\Delta L = \alpha \cdot L \cdot \Delta T$; due to temperature change
change in length	ΔL _f [%]	0,36	0,36	

Fix installed pipeline, inhibited change in length, anchored by fix points at both pipe ends				
axial stress due to temperature change (12h)	σ _{axT} [N/mm ²]	3,96	3,96	$\sigma_{axT} = \frac{\Delta L}{L} \cdot E$
max. axial forces	F _{axT} [kN]	813,23	110,27	The strength is the same for both pipe systems, but the forces are different due to different axial area. For inhibited change in length the axial forces has to be induced into ground by anchor-blocks. But for profiled pipes often the axial forces gets compensated by friction between profile and ground only!
	F _{axT} [kN]	32,9	11,2	
Critical buckling length	L _b [m]	11,588	11,179	For fix installed pipes only. Euler buckling formula: $L_b = 2 \cdot \sqrt{\frac{EI^2 - E \cdot J_{axT}}{E_{axT}}}$ Considered safety factor for axial buckling SF _{axb} = 2,5

Table 1: Exemplary calculation for change in length and occurring forces

Material	PE100, black	PP-H, grey	PE-GF (MRS20), black
UV resistance	++	o	++
Linear expansion coefficient [1/K]	0,18	0,16	0,05

Table 2: Linear expansion coefficient

Further important things to know regarding exposed pipes:

the pipes can be designed as double wall pipes!

Fire protection:

Polyethylene is a thermoplastic material and by nature flammable, classified acc. to DIN4102 in class B2. But Kraih pipes can be equipped either with non-flammable or with hardly flammable layer (B1) on outer surface! The production procedure of Kraih pipes provide all possibilities to integrate such insensitive layer!

Conclusion:

Kraih pipes are applicable for exposed conditions and provide many advantages against other pipe systems! The smart profile design allows a tailormade design for all internal and external loads, to guarantee a most efficient and durable pipe system!

Author:

Stephan Füllgrabe, Plaspittec GmbH for Kraih Pipes Germany

Unwanted tapping

Avoiding of unwanted tapping is an important point for non buried water pipelines. Kraih pipes can be designed as double wall pipe and the ringspace between inner and outer wall can be monitored by sensors. If someone starts tapping and stealing water, the sensor will give an alarm!

Mechanical damages

Pipes installed outside should have a sufficient protection against mechanical damages. Polyethylene is well-known for high impact resistance even at low temperatures. The profiled wall structure of Kraih pipes is another safety factor to avoid damages. For critical application



Pic. 5: Typical Kraih profile for double wall pipes

Introducing

Jeneleen Lansangan, Krah Pipes Manila Inc.



Pic.1: Ms Jeneleen Lansangan at work

Krah Pipes Manila, Inc. (KPMI) is one of the latest extension and additional part of Krah community in South - East Asia, particularly in the country with 7,107 islands and known as the pearl of the orient, the Philippines.

KPMI was listed in the Philippine's directory of corporations last September 2015 and opened its plant doors last May 2017. In between those years, the first ever employee of Krah Pipes Manila joined the team. KPMI's first employee is Miss Jeneleen Lansangan, we like to call her Jen. At the age of 25, she joined KPMI as Mr. Alexander Krah's executive assistant in April 2016. She graduated and passed the

local licensure exam for Civil Engineering and was able to help out in the supervision of KPMI's plant construction which started in October 2015.

She was able to attend various trainings from the very generous and technically equipped seniors from KHB. She was able to train the basics of Krah product and technology from our very own Mr. Alexander Krah, Mr. Jochen Blickheuser and even with Mr. Stephan Füllgrabe.

As the plant operation started during late June 2017, she was assigned to the technical and sales department. Since the KPMI team started, most of the functions were carried out by Mr. Sajid Anonuevo, the president, Mr. Nobu Kotake, Ms. Sheryll and Jen. She was exposed to procurement of raw materials, PE-HD, and communication to suppliers like Bourouge Ltd. and SCG.

Most of the local and various accreditations initiated by KPMI were facilitated by Jen. They are the target clients for KPMI that will pioneer the use of this new and advance technology from Germany.

Through Jen's assistance, KPMI is now an accredited supplier to the Department of Public Works and Highways (DPWH),

Jen's Bio

Date of birth:

22 November 1990

Longest run:

21 km

Highest cliff jump:

45 ft in Cebu

Three things from your bucket list:

1. Skydiving
2. See the Northern lights
3. 300M pesos personal initiated sale for KPMI in 2 years time

Never have I ever...

been out of the country

What do you think of Krah pipes?

Even from the very start, I have known that Krah Pipes in the Philippines are very promising and it will definitely be a solution for our country's various problems in flooding, drainage and sewer systems. I believe that we are not just selling pipes, but a solution. I am proud to be part of this community and to represent it here in the Philippines.



Pic.2: Jen (2nd on the left) with her KPMI colleagues

which is the largest proponent and client on national drainage and sewer systems under the national government. Another is Maynilad Water Services, Inc. which is one of the largest water concessioners in the Philippines. Currently, Jen is assigned to focus on the sales department. She does the product and technology presentation to the different regional offices of DPWH and other private sectors like consultants, contractors and direct consumers. Together with the young and enthusiastic sales team, Mica, Lyntte and Jerrome, Jen is motivated to change the conventional pipe system in the Philippines to the innovative and cost effective KraH pipe technology. Alongside her work, she actively participates in physical activities like mountain climbing and running.

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Jeneleen Lansangan
Krah Pipes Manila, Inc.



Pic.3: Fun photoshoot at the KPMI factory

KRAH PIPES - One night in Pampanga



Pic. 1: The Krah team installing the pipeline

Krah Pipes Manila, Inc. has again made a landmark accomplishment in the installation of a DN/ID 1500mm diameter pipe for its client, SM Telabastagan, Pampanga.

filled making the road ready for the passage of the various vehicles and motorists the following day. The works conducted did not cause disruption and inconvenience to the public.

and finally jointed together down the trench by a backhoe proving that Krah pipes are very easy to handle and lift at project site and very fast to install using the electro-fusion process.

The project which Krah Pipes Manila Inc was able to forge is basically a 24 meter distance of cross drain pipes which ran across a major road, MacArthur Highway considered a very busy road within Fernando City, Pampanga. The 24-meter distance or length is practically 4 pieces of 1500mm diameter Krah Pipes. It was a quick overnight process of installation where the excavation of the trench took only 4 hours and 3 hours for the jointing of 4 pieces of pipes (at 6 meters in length per pipe) and laying them down the trench after which the excavated area was immediately back

The handling was likewise quick and fast for 4 pieces of pipes jointed on ground

This installation works is again another milestone for Krah Pipes Manila, Inc.



Pic. 2: Arrangement of Krah pipes



Pic. 3: The Krahelectrofusion-Boxes



Pic. 4: Lifting Krahelectrofusion pipes with an excavator

Even in the production of the 4 pieces of pipes at 1500mm in diameter was very quick, taking only 7 hours production time.

Krahelectrofusion pipes are really the best fit pipes for this kind of infrastructure works and material requirement compared to the local conventional re-enforced concrete pipes (RC pipes). It is really high time that Krahelectrofusion pipes be highly considered or preferred as the best technology solution for any major infrastructure in the Philippines more specifically for drainage and sewer systems.

With Krahelectrofusion pipes, there is no down time compared to the conventional concrete pipes where excavation must be bigger to allow space for the manual plastering works.

More so, the plastering to join the pipes is only applied to upper portion of the concrete pipes. For Krahelectrofusion pipes, jointing makes the pipes very strong and secure that is no amount of infiltration or leaks. With the conventional concrete pipes,



Pic. 5: Before installation

back filling can only be done when the plastering of the concrete pipes on trenches are cured, meaning sun dried up for about 14-28 days, quite a waste of waiting time and inconvenience.



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Hydraulic calculation of Polyethylene pressure pipes

Krah pipes are often used for pressure applications, whether the requested pipe material is a standard High Density Polyethylene (HDPE) or Polyethylene reinforced with glass fibres (PE-GF). For the flow-characteristic and pressure loss the surface quality is essential, since the surface-roughness affects the friction between fluid and pipe wall. Polyethylene pipes (HDPE and PE-GF) provide in general very low roughness values in comparison to steel or concrete pipes. The low roughness and the kind of waxy surface can also avoid incrustations which is another point to reduce the pressure-loss.

Furthermore also the jointing procedure can be important. Any interruption of the surface generates additional turbulences, which increase the pressure loss. In the pipe design that aspect should be considered. A smooth surface after jointing is very preferable, e.g. by using Electrofusion socket / spigot joints.

Especially in comparison with other pipe materials like concrete or steel the advantages of Polyethylene pipes become clear after calculation. By using Polyethylene pipes very often the necessary pipe diameter can be reduced because of better flow-behaviour and less pressure loss!

1. Pressure loss

The pressure loss in pipe systems is the sum of all pressure losses for any element of the pipe system. All fittings, valves and constructions have an individual pressure loss and even the pipe joint can affect the pressure loss.

$$\Delta p = \Delta p_{\text{pipe}} + \Delta p_{\text{fitting}} + \Delta p_{\text{valve}} + \Delta p_{\text{joint}} + \text{etc.}$$

1.1 Pressure loss of straight pipelines

The pressure loss for pressure pipes can be calculated by using the following Darcy-Weisbach-equation, first time established by Jean François d'Aubuisson de Voisin in the year of 1834. The mean velocity depends on the requested volume-flow and the selected diameter. Usually most pressure pipes are designed

$$\Delta p_{\text{pipe}} = \lambda \times \frac{L}{ID} \times \frac{\rho \times v_m^2}{2} \cdot 10^{-5}$$

$$v_m = \frac{\dot{V} \times 4}{ID^2 \times \pi}$$

Δp_{pipe}	= pressure loss by pipe friction [bar]
λ	= friction coefficient [-]
L	= pipe length [m]
ID	= pipe inner diameter [m]
ρ	= density of fluid [kg/m ³]
v_m	= mean velocity of flow [m/s]
\dot{V}	= volume flow [m ³ /s]

with a velocity between ca. 2-3 m/s, to reduce the pressure loss. The velocity effects the pressure loss a lot, because the velocity is considered squared!

Determination of Friction coefficient

For calculation of the friction coefficient, firstly the Reynolds number has to be calculated. The Reynolds number defines the kind of flow. We differ in general between laminar and turbulent flow. The critical Reynolds number is 2320, below 2320 the flow is considered as not turbulent! Also the hydraulic flow characteristic of the pipe's inner surface has to be considered. We differ between ideal hydraulic smooth and hydraulic rough, in-between a transition area is defined.

Reynolds number

For calculation of the Reynolds number the following formula can be used:

$$Re = \frac{v_m \times ID}{\nu}$$

Re	= Reynolds number
ν	= kinematic viscosity of fluid [m ² /s],

The kinematic viscosity of fluid is specific and changes under temperature. For pure water the following values are measured:

T [°C]	5	10	15	20	25	30
v 10⁻⁶ [m²/s]	1,52	1,31	1,15	1,01	0,90	0,80

Laminar Flow

For laminar flows the friction coefficient can be calculated easily by using the following equation:

$$\lambda = \frac{64}{Re}$$

Unfortunately this is not applicable for typical water and sewage application since the laminar flow happens only at very low and unrealistic velocities.

Turbulent Flow

Turbulent flow is the normal situation for pressure pipes. The pipe roughness and the Reynolds number are decisive as to what formula has to be used for calculation. It has to be considered that the flow is never fully turbulent, because at the pipe inner surface only a very thin laminar layer exists. The higher the velocity, the thinner is the laminar layer. For the pipe roughness (k) it makes no sense to work with measured values at virgin pipes, better is to consider roughness at operation condition. For Polyethylene k = 0,01 mm can be used for calculation. In literature you find for thermoplastic pipes even values of k = 0,01 mm (DVS 2210-1). Generally, we differ between 3 cases with different physical background:

Case 1:

The pipe wall is ideally hydraulically smooth, the roughness k_b = 0 mm. The inner pipe surface is completely covered by a thin laminar flow layer, before the flow becomes turbulent. Then following equation has to be used:

$$\frac{1}{\sqrt{\lambda}} = 2 \lg \left(\frac{Re \times \frac{1}{\sqrt{\lambda}}}{2,51} \right)$$

But because pipes normally have a specific roughness and are not ideally hydraulically smooth the equation above is not applicable for typically pipe application.

Case 2:

The pipe wall provides a specific roughness and a thin laminar flow layer partially covers the roughness. This case is called "transition area" and the following equation has to be used:

$$\frac{1}{\sqrt{\lambda}} = -2 \lg \left(\frac{2,51}{Re \frac{1}{\sqrt{\lambda}}} + \frac{k}{3,71 \times ID} \right)$$

Case 3:

The pipe wall provides a specific roughness and the thin laminar flow layer does not cover the roughness. Then following equation has to be used:

$$\frac{1}{\sqrt{\lambda}} = 2 \lg \times 3,71 \times \frac{k}{ID}$$

Because the handling of the above-mentioned formula is very complex, software solutions or graphical solutions are usually used. An alternative way is a graphical solution by using the Moody diagram, where all different flow- and pipe-characteristics are considered and the friction coefficient can be determined easily.

Moody diagram:

To explain the handling of the Moody diagram at the end of the report two different examples are drawn into the diagram and parallelly calculated by using the relevant equation. Further the pressure loss is calculated.

Example A:

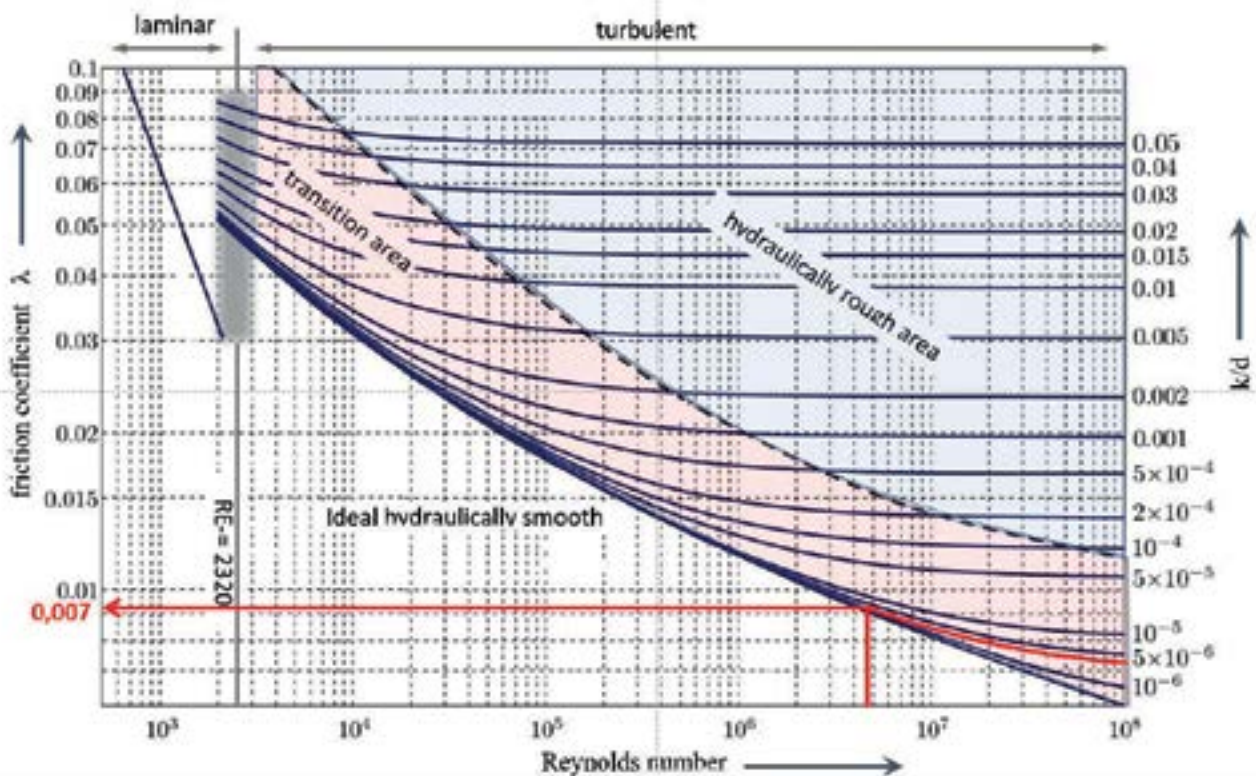
Volume flow	12	m ³ /s
Inner diameter	2500	mm
Inner diameter	2,5	m
Velocity	2,4	m/s
Kinematic viscosity	1,31 x 10 ⁻⁶	m ² /s
Roughness (operation condition)	0,01	mm
Pipeline length	1000	m

$$Re = \frac{v_m \times ID}{\nu} = \frac{2,4 \frac{m}{s} \times 2,5 m}{1,31 \times 10^{-6} \frac{m^2}{s}} = 4\,665\,305$$

$$\frac{k}{d} = \frac{k_b}{ID} = \frac{0,1mm}{2000mm} = 2 \times 10^{-6}$$

Intersection of both lines Re and k_b/ID is in transition area !

Result for lamda by Moody diagram and software => λ = 0,007063.



Pressure loss

$$\Delta p = \lambda \times \frac{L}{ID} \times \frac{\rho \times v_m^2}{2} \times 10^{-5}$$

$$\Delta p = 0,007063 \times \frac{1000m}{2,5 m} \times \frac{1000 \frac{kg}{m^3} \times 2,4^2 \frac{m^2}{s^2}}{2} \times 10^{-5}$$

$$\Delta p = 0,0814 \text{ bar}$$

Example B:

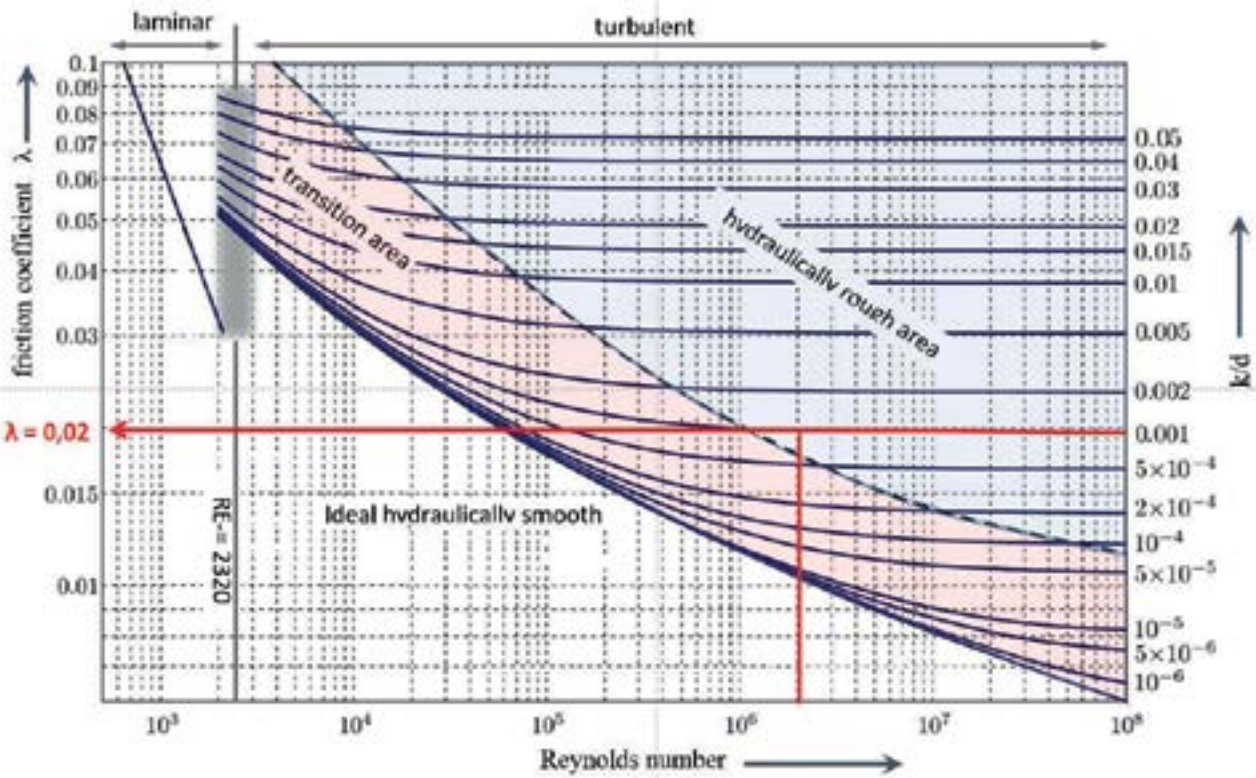
Volume flow	2,1	m ³ /s
Inner diameter	1000	mm
Inner diameter	1	m
Velocity	2,7	m/s
Kinematic viscosity	1,31 x 10 ⁻⁶	m ² /s
Roughness operation condition	1	mm
Pipeline length	1000	m

$$Re = \frac{v_m \times ID}{\nu} = \frac{2,7 \frac{m}{s} \times 1m}{1,31 \times 10^{-6} \frac{m^2}{s}} = 2\,041\,071$$

$$\frac{k}{d} = \frac{k_b}{ID} = \frac{0,1mm}{1000mm} = 0,001$$

Intersection of both lines Re and k_b/ID is in a hydraulically rough area!

Result for λ by Moody diagram and software $\Rightarrow \lambda = 0,01963 \approx 0,02$



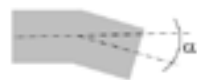
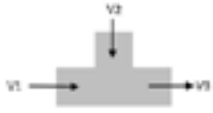
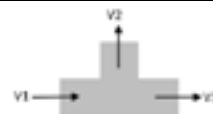
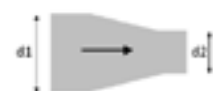
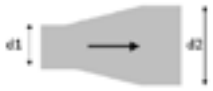


Pressure loss

$$\Delta p = \lambda \times \frac{L}{ID} \times \frac{\rho \times v_m^2}{2} \times 10^{-5}$$

$$\Delta p = 0,02 \times \frac{1000m}{1m} \times \frac{1000 \frac{kg}{m^3} \times 2,7^2 \frac{m^2}{s^2}}{2} \times 10^{-5}$$

$$\Delta p = 0,729 \text{ bar}$$

Kind of fitting	Reference values	Resistance coefficient ζ [-]	Sketch
90° Bend	R = 1,0 x d R = 1,5 x d R = 2,0 x d R = 4,0 x d	0,51 0,41 0,34 0,23	
45° Bend	R = 1,0 x d R = 1,5 x d R = 2,0 x d R = 4,0 x d	0,34 0,27 0,20 0,15	
Elbow	$\alpha = 45^\circ$ $\alpha = 30^\circ$ $\alpha = 20^\circ$ $\alpha = 15^\circ$ $\alpha = 10^\circ$	0,30 0,14 0,05 0,05 0,04	
T-Branch	V2/ V3 = 0,0 V2/ V3 = 0,2 V2/ V3 = 0,4 V2/ V3 = 0,6 V2/ V3 = 0,8 V2/ V3 = 1,0	ζ V2 ζ V1 -1,20 0,06 -0,40 0,20 0,10 0,30 0,50 0,40 0,70 0,50 0,90 0,60	
	V2/ V1 = 0,0 V2/ V1 = 0,2 V2/ V1 = 0,4 V2/ V1 = 0,6 V2/ V1 = 0,8 V2/ V1 = 1,0	ξ V2 ξ V3 0,97 0,10 0,90 -0,10 0,90 -0,05 0,97 0,10 1,10 0,20 1,30 0,35	
Reducer ζ valid for $\lambda=0,025$	angle d2/d1 =1,2 d2/d1 =1,4 d2/d1 =1,6 d2/d1 =1,8 d2/d1 =2,0	ζ 8° ζ 8° ζ 20° 0,046 0,023 0,01 0,067 0,033 0,013 0,076 0,038 0,015 0,031 0,041 0,016 0,034 0,042 0,017	
Reducer ζ valid for $\lambda=0,025$	angle d2/d1 =1,2 d2/d1 =1,4 d2/d1 =1,6 d2/d1 =1,8 d2/d1 =2,0	ζ 4-8° ζ 16° ζ 24° 0,10 0,15 0,20 0,20 0,30 0,50 0,50 0,80 1,50 1,20 1,80 3,00 1,90 3,10 5,30	
<p>Note: R = Radius V1,2,3 = Volume flow n = number of fitting</p> <p>equation for fittings: $\Delta p_{fitting} = n \times \zeta \times \frac{\rho \times v_m^2}{2} 10^{-5}$</p>			

Pressure loss of fittings

The pressure loss of fittings is another important point, that can be calculated if all fitting are known. Each fitting has a specific and individual resistance coefficient and pressure loss. The resistance coefficient depends mainly on shape and figure of the fitting and the flow direction. In the literature values for different fittings are described. For thermoplastic fittings the DVS code 2210 is recommended using.

Conclusion:

Polyethylene pipes provides very low roughness values and this effects the flow resistance and pressure loss significantly. Further incrustations can be reduced. Less pressure loss means either the pipe diameter can be reduced or the necessary energy to convey the required volume flow gets reduced! These are important arguments for both designer and operator.

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Ashkelon Wastewater Pipeline Project



Pic. 1: Engineer Mr. David Yaloz at construction site

Israel is known as the land of the Bible, but it is actually much more than that. Israel is a modern, developed country located along the Mediterranean Sea.

Due to the long, hot and dry summers with very short rainy winters, water becomes one of the most important issues in the country. Therefore, as one of the most arid environments on earth, the available water system has to be handled and developed very carefully.

On this basis, the Water Authority approached the engineer Mr. David Yaloz with the task of finding the most suitable piping system to enlarge and replace an existing wastewater system in the town of Ashkelon. The existing pipeline is constructed from a 48" asbestos cement pipe. The new 3.6 km pipeline will replace the existing pipe and a further 3.6 km pipe will be laid after the existing pipe

is decommissioned to provide additional capacity and flexibility for this expanding town. The Israeli pipe market offers many different pipe materials i.e concrete, HDPE, PP, steel, and PVC etc. for a sewer pipeline project like this.

Existing specifications and data sheets of various pipe manufacturers were compared with the project requirements until the most efficient piping system was identified. Furthermore the project required that the pipes should be in accordance with applicable international standards.

The pipeline will be installed at a depth of up to 6 meters. Groundwater levels could be higher than the level of the pipe therefore the piping system must be leak-tight. The customer requires a long service life without any leaks or failures. If the pipe system leaks, infiltration and

exfiltration can cause damage to the piping system and the environment. In this case infiltration was the main concern of the customer which could occur due to defective pipe joints or broken pipes.

Considering these issues, High Density Polyethylene (HDPE) became the best choice for the engineer and the customer. The material is flexible, impact resistant, has excellent hydraulic, abrasion and corrosion resistance and is much lighter when compared to traditional rigid pipe materials. The physical properties and material characteristics fit in perfectly with the requirements of the customer. Therefore the decision was made to use DN/ID 1500 mm sized High Density Polyethylene pipe and according to the soil conditions the required ring stiffness was determined as SN8 according ISO9969. A further question and the most important issue was to clarify which type

of jointing will prevent any pipe failures or disconnection. Traditional rubber ring sealing is leak-tight when installed correctly, but due to soil movement the pipe can be disconnected and it does not create a homogenous piping system.

As the most experienced pipe manufacturer in Israel, Plassim recommended the use of HDPE Krah Pipe with integrated electro-fusion joints according to the DVS2207 standard. The electro-fusion socket is one of the most efficient techniques for jointing of large bore pipes from polyethylene. This type of connection is rightly considered to create an absolutely leak-tight joint which assures a completely homogenous piping system with a long service life of at least 100 years.

A further issue was to define the right "HDPE" material. HDPE has many grades which can also include undefined types



Pic. 2: Tightness test on a Krah pipe

of recycled material. Poor quality material can cause poor quality fusion therefore we recommended using PE100 virgin material. This was not specified in the tender but provides superior fusion quality and added value to the customer. The installation of the first Krah Pipes began in March in Ashkelon together with Krah's application engineer from Germany Eng. Mr Jochen Blickheuser. The leak-

tightness of each of the fused joints was tested according to DIN EN 1610 using a special test rig prior to backfilling the pipes. The project is still ongoing with great success.

Plassim is proud to manufacture and deliver the superior leak-free Krah piping system especially due to the importance of water and sewage conveyance in our arid country.



Pic. 3: Electrofusion joint carried out on a Krah pipe



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Mr. Eng. Gadi Yahav
Plassim Infrastructures Ltd.

Laguna Krah Heroes

A Krah Manila Basketball Team



Pic. 1: Laguna Krah Pipes team during a match

LAGUNA KRAH HEROES, is new expansion team that recently joined the MAHARLIKA PILIPINAS BASKETBALL LEAGUE. Laguna Krah Heroes is team formed for Laguna province with Biñan City as the LGU Partner spearheaded by the most sports enthusiast, Vice Mayor Gel Alonte of Biñan City in Laguna.

The Maharlika Pilipinas Basketball League (MPBL) is a regional men's professional basketball league in the Philippines. It is founded by no other than the World Boxing Champion, now a senator in the Philippines, Senator Manny Pacquiao. The League was founded in August 29, 2107 and started the founding league with Bulacan Kuyas Team emerging as the Champion last year.

In January 25, 2018, the League kicked off its first formal Inaugural MPBL CUP, The Anta Raja Cup where 10 Teams

had participated and just recently, last April 17, 2018, Batangas Athletics Team was the Champion and known to be the Team to beat in the League. The MPBL features both Regional Commercial and Barangay-Level League with teams on the commercial side to have a Home-locality. The League is initially organized in Luzon with plans to expand to include teams

in the Visayas and Mindanao. MPBL plans to conduct the next conference Season which will be patterned after the NATIONAL BASKETBALL ASSOCIATION (NBA) with additional expansion team including those from the Visayas and Mindanao Regions wherein the Teams will be divided into Northern and Southern Divisions. The two winning team from



Pic. 2: Giving their best to win the match



Pic. 3: Senator and World Boxing Champion Mr. Manny Pacquiao

the two divisions will face off the National Championships and the winner will bring home a 10-million worth of trophy and ball rings to be given for the members of the Champion Team. The tournament will be inaugurated to coincide with the 120th year of Philippine Independence since its declaration on June 12, 1898 in Kawit, Cavite. Senator Manny Pacquiao is duly supported with very able ex-professional basketball players from the Philippine Basketball Association (PBA). The Chief Operating Officer or COO is former PBA Player, Zaldy Realubit and the MPBL Commissioner is also a former PBA Star Player, Kenneth Duremdes. The games

are aired on national television live every Tuesday, Thursday and Saturday thru the ABS-CBN Sports Channel 23 S+A and can also be watched by audiences from the other parts of the world thru the Filipino Channel. MPBL is a novel project of Senator Manny Pacquiao that aims to give GRASS ROOTS ATHLETES who are still young and have the capacity, skills, power and passion in Basketball but never been given the chance to play in bigger leagues, never been drafted and tapped to showcase their skills and pursue their Basketball Dreams.

With MPBL, these Athletes will now have

the chance and opportunity by joining with the expansion teams for MPBL like Laguna Krah Heroes. Laguna Krah Heroes Team aims to really put up a strong and formidable Team in the League. After the Franchise Agreement was signed on April 5, 2018, immediately the Coaching Staff formed went on conducting try outs in the various localities in the Province to scout for good, strong, power players who are determined to take this rare opportunity in their lives to be a part of the MPBL Expansion Team. The Coaching Staff formed also went thru a thorough selection. The faith of the Team in the upcoming Conference Season is a big challenge to the Coaching Group particularly on Alex Angeles, the Head Coach to train the players selected and lead the Team to the Championship this coming Second Conference Season of the MPBL.

A message of HOPE, COMMITMENT, AN OPPORTUNITY that comes only once in the lives of the players who came to participate in the Tryout with perseverance and patience in the 2-week



Pic. 4: Mr. Sajid Anonuevo motivating his team

try out and selection for 3 hours a day. Author:
Mr. Sajid R. Anonuevo, one of the two Krah Pipes Manila, Inc.
owners of the Laguna Krah Heroes gave Philippines
a brief inspirational message to all the
selected players.



Pic. 5: Ms. Tess Alforque giving a speech



Pic. 6: Instructing the team for the game



Pic. 7: Coaching staff of the team



Placing new pipeline in Estonia with Krah Pipes

Powerful tool for take-away Krah Pipes App

To improve the know-how transfer from us to our customer we choose the way of a free app, so after half a year of further developments, we are proud to present our latest improved Krah-Pipe Calculation App. The app can run without an internet connection, so you are free to use it nearly everywhere.

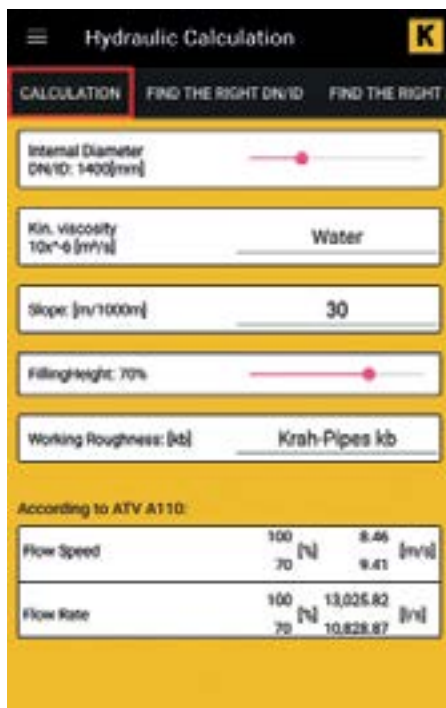
A small tool, but a lot of functions:

1. The first main part of the App is handling the field of hydraulic calculations:

- This feature enables you to calculate the flow speed and flow rate (according to ATV A110) just by entering your diameter, slope and filling height and rather choose your Kinetic viscosity and working roughness from a list or entry a free chosen value.

- If you already got a flow rate and a filling height but need a diameter you can calculate this by tapping on "FIND THE RIGHT DN/ID" on the tab bar on the top of the page.

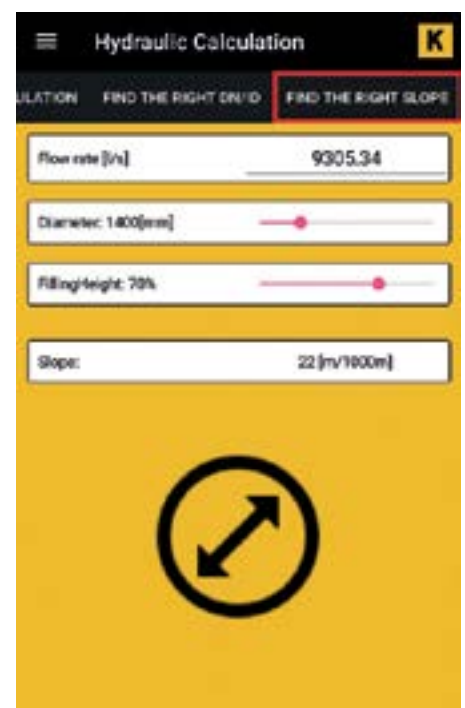
- Last but not least you can even calculate the right slope for your flow rate, diameter and filling height.



Pic. 1: Calculating flow speed and rate



Pic. 2: Determining your internal diameter



Pic. 3: Calculating the slope

2. The second part is handling the field of "Storm water retention":

- This feature is made for dimensioning storm water retention regarding to diameter, length and volume at different filling heights.

- On the "REQUIRED VOLUME" tab you are able to enter the volume you need and you will get a table with diameters between 300 mm and 2000 mm and 3 different filling heights showing you which length you will need.

- On the "AVAILABLE LENGTH" tab you are able to enter your given length to calculate a table with diameters from 300 mm to 2000 mm and 3 different filling heights (full filling, 2/3 filling and 7/8 filling) showing you what volume you will need.

3. The third part is "Electrofusion":

- Here we got 2 different categories.

- First of all, the Krah welding instruction which is explaining step by step how to weld.

- The second part is a page where you can choose a diameter to get the right barcode for your Krah E-Box.

4. The fourth part is the pressure pipe calculation:

- This feature provides you with the possibility to calculate the needed wall thickness for your specific working pressure and even shows you the SDR (standard dimension ratio), weight and the stiffness of your pipe.

- On the "KRAH PIPES" tab you are able

to calculate the SDR (standard dimension ratio), the wall thickness, the weight and the stiffness (according to ISO 9969) for your KRAH pipe with given diameter and working pressure (according to DIN 16961).

- On the "REQUIRED VOLUME" tab you are able to choose a SDR (standard dimension ratio) to get a table which shows you the internal diameter, the wall thickness and the weight (according to ISO 4427) for outside diameters between 315 mm and 2400 mm.

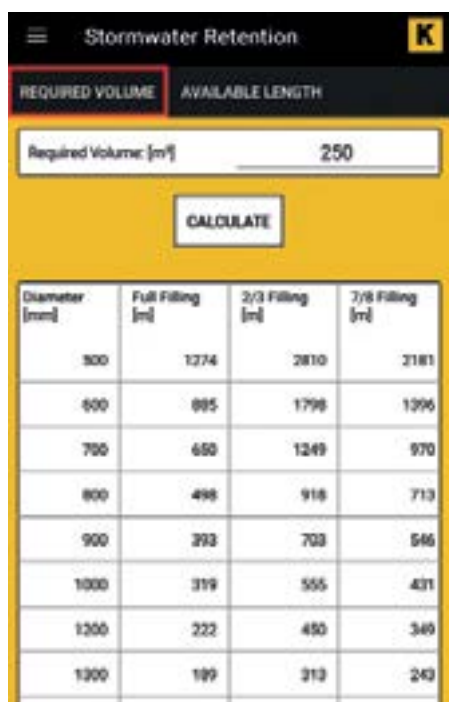
Last but not least there is our newest feature the "Quick Structural Calculation"

- Based on many structural calculations, we setup this part to choose the right profile number of Krah-pipes to meet several conditions. Based on ATV127A and AWWA M55.

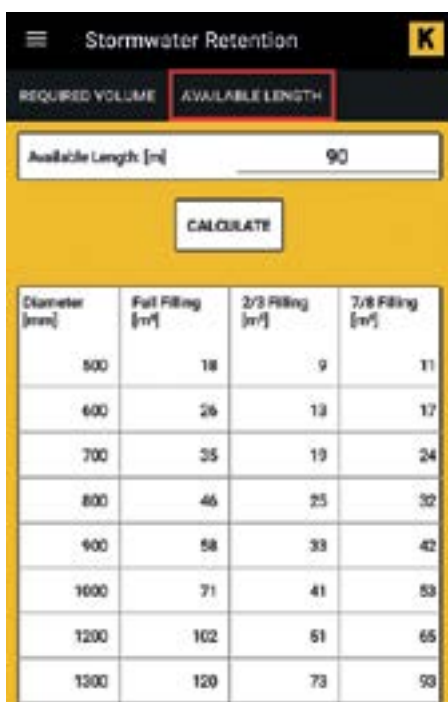
- A feature to do a quick static check with a small selection of our favorite KRAH-Profile numbers.

- Just enter the internal diameter, the trench depth, the groundwater level and if there is going to be traffic load to receive the trench width and a KRAH-Profile number out of a list of our favorite profiles in return.

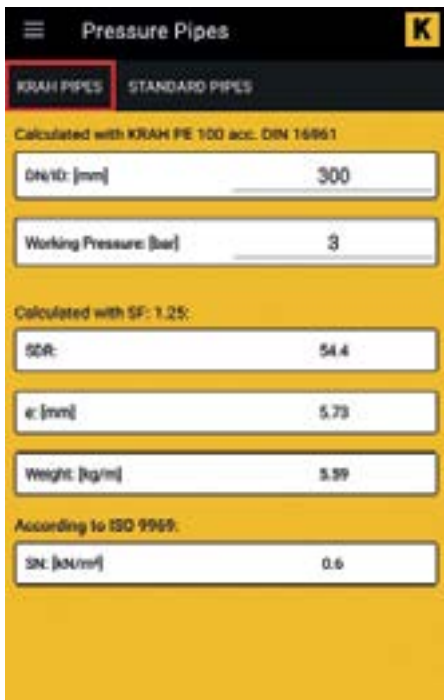
The app is currently available for Android and we plan to release an iPhone version very soon. We work every day to enhance our app for you.



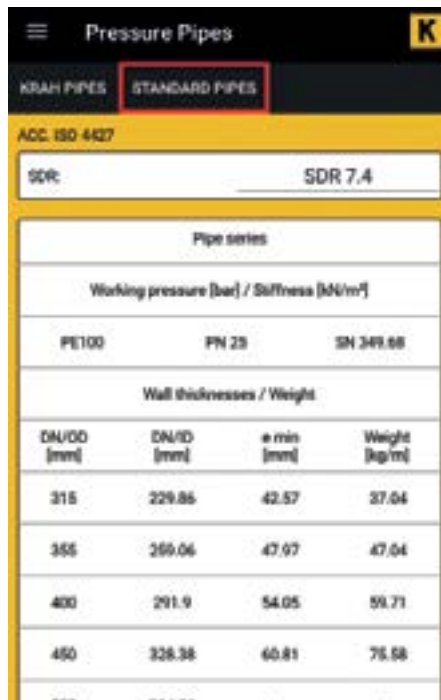
Pic. 4: Dimensioning the required volume



Pic. 5: Dimensioning the available length



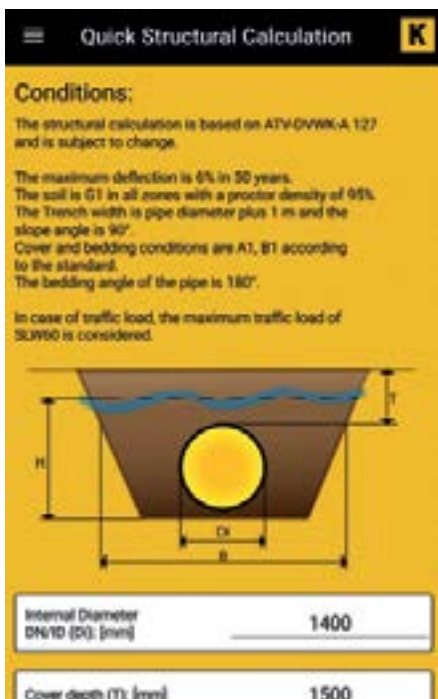
Pic. 6: Dimensioning a pressure pipe



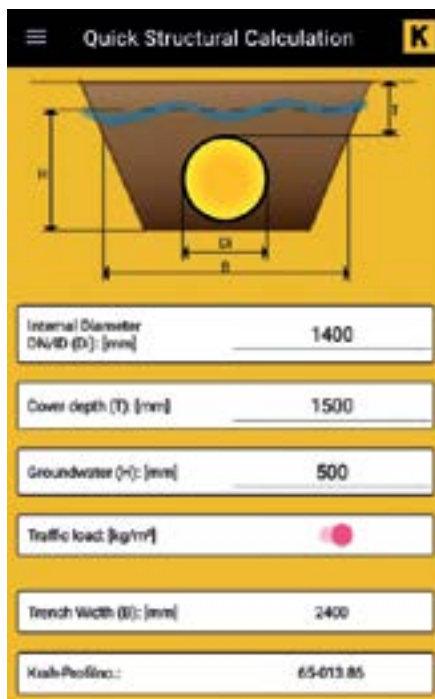
Pic. 7: Dimensioning a standard pipe

So, if you miss any features or would like to give us feedback, please feel free to contact us at app@krah.net or rate our App on the Google Play Store. If we have aroused your interest, just try it and use

the following link:
<https://play.google.com/store/apps/details?id=com.Krahpipes.Pipecalculation>
 Alternatively go to the Google Play Store and search for KRAH.



Pic. 8: Quick structural calculation



Pic. 9: Quick structural calculation

Author:
 App-Developer Felix Bay, KAT GmbH



FAQ

This is the third part of our "Frequently asked questions" section. In every issue we will answer some of the most asked questions we get from potential customers and interested parties about the Krah Technology. Also, please feel free to send us some new ideas for our FAQ at improfil@krah.net, we will try to publish as many as we can.

Can Krah pipes be used for outfall and intake pipelines?

Yes, Krah pipes are 100% applicable for marine applications and have a multitude of successfully reference projects worldwide. Both Krah profiled wall pipes and Krah solid wall pipes can be used for outfall and intake pipelines. However, the profiled wall in combination with the Krah Electrofusion technology is mostly used.

Notice: *The Krah marine pipe profile provides a higher stiffness and buckling stability than normal solid walls. And also an axial strength is excellently given by using this special Krah profile!*

How is the chemical resistance of Krah pipes against acid and lyes?

Krah pipes and Polyethylene products in general have been successfully used for decades in the chemical industry for transport of chemicals as well as for storage tanks.

Notice: *Polyethylene has a very good chemical resistance against most of acids and lyes!*

Will Krah pipes float in the water?

Yes, Krah pipes are made of Polyethylene and Polypropylene, and due to being slightly less dense than water, they will float even when they are full of water. For underwater anchored pipeline installations, it is important to specify the proper weights and distance of the weights. Whenever possible, an underwater pipeline should be installed in a trench with a protective crushed rock cover.

Notice: *Krah can support you with designing marine pipes!*

What is the maximum recommended flow velocity for possible fluids going through Krah pipes?

In a pumped system the maximum operating velocity is limited by the surge pressure capacity of the Krah pipe. If surge is not a consideration, water flow velocities exceeding 7,5 meter per second may be acceptable. This number can also be used as a maximum for gravity applications.

Will sunlight adversely affect Krah pipes?

Sunlight is not a concern if black PEHD material is used. Carbon black, utilized for black compounds, is the most effective ultraviolet stabilizer. Therefore, black is the recommended pipe colour for an exposed long-term service or storage. Krah pipes, made of a black PE pipe compound will provide decades of outdoor use!

Some applications require explosion protection, especially in explosive gas atmosphere – how can Krah pipes avoid a static charge?

Krah pipes can be made of electrical conductive Polyethylene for an anti-static behaviour. Mostly it is sufficient to produce the coextruded inner or outer layer with electrical conductive Polyethylene!

Are Krah pipes applicable for landfill technology?

Yes, Krah pipes provide a perfect chemical resistance against almost all hazardous media you will find in landfill application. Krah pipes are used for leachate drainage pipes, telescopic shafts for manholes, gas collectors etc.

Is thermal expansion and contraction of Krah pipes a problem?

No. All pipes expand and contract with change of temperature. The key is the management of the resultant thermal strain. As with all materials, expansion and contraction must be taken into consideration when designing a HDPE piping system. However, for above ground applications thermal effects must be considered - the unrestrained coefficient of thermal expansion for HDPE pipe is 0,18 mm per meter and degree temperature change (mm/mK).

Notice: Buried pipelines usually do not move due to soil friction, especially in the case of a Krah profiled wall structure!

Can Krah pipes also be used as tank shell for vertical installation?

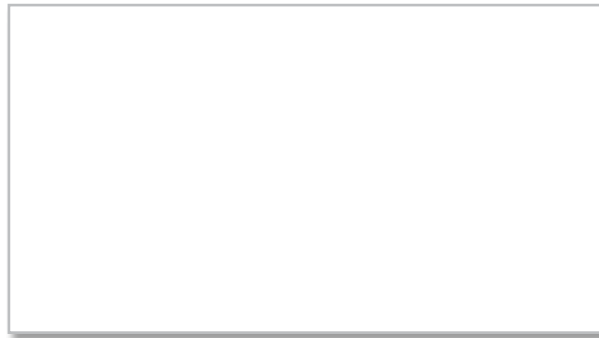
Yes, we make a difference between vertical and horizontal tank applications. Vertical tanks are mostly used for an industrial application as like a storage tank for water or chemicals. For the design we provide the static software "PROFITank" which considers all load case scenarios (wind, sun, earthquake etc.). Horizontal tanks, made of Krah pipes are either buried in the ground or installed on saddles!

Systematic drainage is important to avoid flooding and soil stabilization! How can Krah pipes be used for drainage?

Krah Pipes for drainage application have already been used for decades. According to project requirements either slots or holes are implemented in the wall structure between the profiles. The holes/slots can be implemented at fully or partially circumference and can be covered by Geotextile ex work. Krah drainage pipes and manholes are available in all stiffness classes from DN/ID 300 until DN/ID 5000 mm.



Get more information here:
www.krah-pipes.de



IMPROFIL