

# IMPROFIL

## Restoring the Kidron Wadi

A desert turns back to nature

## Sewage Pipe for Culvert Construction

in German Underground Station

Collecting and supply system  
for potable water

## Krah Virtual Assistance

Machine installation in times of Corona

# Content

1. Thoughts are free - Intro	3
2. Restoring the Kidron Wadi Back to Nature	4
3. Krah Virtual Assistance	8
4. Sewage Pipe for Culvert Construction in German Underground Station	18
5. We cannot repeat it often enough – save money by thinking (SN vs. PN)	25
6. Collecting and supply system with prefabricated constructions for potable water	28
7. Interview with Hawle Kunststoff GmbH	35
8. Krah Pipes bending design	40
9. Short news & Crossword	42

**The magazine for large Plastic Pipe Technology**

No. 23 / 2020

**ISSN 2626-4366**

**Imprint**

Krah Pipes GmbH & Co.KG

Betzdorfer Str. 8

57520 Schutzbach

[www.krah.net](http://www.krah.net)

# Thoughts are free

In the old German folk song "Die Gedanken sind frei" (Thoughts are free) they sing about freedom of thought. This freedom of thought - which for me is a preliminary step to freedom of expression - currently affects us all.

Today, when the "new normal", triggered by Corona, takes away a freedom or normality so dear to people and companies, it is very important that we can still think freely and also want to do so. This is what people are made for - to think and find new ways that were previously "unthinkable", to adapt to new situations - and thus to determine the fate of the company. Out of our boring comfort zone into a new experience. In the words of the British naturalist Charles Darwin (1809-1882) "Survival of the fittest"!



We, as Krah Group, also invest and still concentrate on finding new machine and pipe solutions – not like the ostrich with its head in the sand, waiting for everything to go back to the way it once was – before Corona. Our R&D department has doubled this year and we expect great results in 2021. Besides, we have already virtually assembled and commissioned 3 plants abroad this year. It wasn't easy, but it worked – another positive effect was the environmental factor – it was faster and cheaper than travelling around the globe for several weeks. Our new KRAH-VA (Krah Virtual Assistant) works excellently and efficiently (see article on page 8).

*Pay attention to your thoughts, because they become words.  
Pay attention to your words because they become actions.  
Pay attention to your actions because they become habits.  
Watch your habits because they become your character.  
Watch your character because it becomes your destiny.*

Another British man who lived at the same time as Charles Darwin, Charles Reade (1814-1884) wrote these very wise words. Krah has created a complete sustainability concept in line with the Agenda 2030 and it will be implemented in the next few years without endangering the company's profitability – more like doing one thing without letting the other one go.

In the end, the winner will be our customer and our planet, with thinking and acting for

it as well. We are already facing up to our new normality and are thus thinking and influencing our fate. Let us adapt, let us think - we are looking forward to the future - our thoughts should become actions and these actions should determine the fate of the Krah Group.

I look forward to the future of our ideas and their implementation.

*Alexander Krah*

# Restoring the Kidron Wadi Back to Nature

*"And the king passed through the Kidron Wadi, and all the people passed through to the desert" (Samuel II 15:23)*

The Kidron Wadi is the largest and most impressive of the Judean Desert wadis and passes through a series of ecological strata and unique landscapes, from a Mediterranean urbane region to a unique breathtaking desert region ending at the Dead Sea. The Kidron Wadi is a heritage site for the three monotheistic religions and is rich in cultural assets, natural and landscape values, archeological and pilgrimage sites. Pilgrimage convoys travelled in ancient times from Transjordan to Jerusalem along this wadi's route. Over 70 years, and some say even since

sewage catchment facility in the Hyrcania Valley.

Through the years, various alternative solutions were examined, taking into account geopolitical, heritage, and engineering and regional water balance aspects. About three years ago, Hagihon Company – Jerusalem Water and Wastewater Regional Utility, in partnership with the Israeli Water Authority and various government ministries, determined that the best engineering solution is the implementation of a sewage conveyance

will be dry from sewage and its channel will only flow with storm water during the rainy season.

The plan is to channel the flow of sewage from the wadi into new sewage collection infrastructure with a total length of about 40 km, starting from Jerusalem jurisdiction, passing through the Palestinian Authority (PA) territory, through the Judean Desert and The IDF firing zone, include two new pretreatment plants, and through an infrastructure tunnel winding up in the Og Wastewater Treatment Plant (WWTP) near the Dead Sea. The existing WWTP will be upgraded from handling 24,000 cubic meters of sewage per day to 100,000 cubic meters per day, turning the raw sewage into effluent water in order to irrigate thousands of acres of Israeli and Palestinian agricultural land, such as the famous Medjoul date palms of the Jordan Valley.

Heading the project at Hagihon Company Mr. Dror Cohen-Tarragan, said that "the unique location of the project pushed the engineering team to think outside the box in order to turn the clock back and to bring the Kidron wadi to its natural condition and glory". To achieve those goals, Hagihon Company has partnered with the Israeli Nature and Parks Authority who provides assistance when needed and solutions to problems under their jurisdiction. Cohen-Tarragan further stated that they "walked the pipeline route by foot several times with the different authorities to locate and



*Kidron Wadi*

the Second Temple Era, no treatment or solution has been found for sewage flow in the Kidron Wadi. Tens of millions of cubic meters of raw sewage are channeled into the wadi every year from Jerusalem and from Palestinian villages along the wadi over a course of 15 km, culminating at a

system via the Kidron Wadi.

This plan, costing over 200 million Euros, is one of the biggest, complex, ambitious and challenging engineering and environmental plans ever proposed in Israel. By the end of the project, which is expected mid-2023, the Kidron Wadi

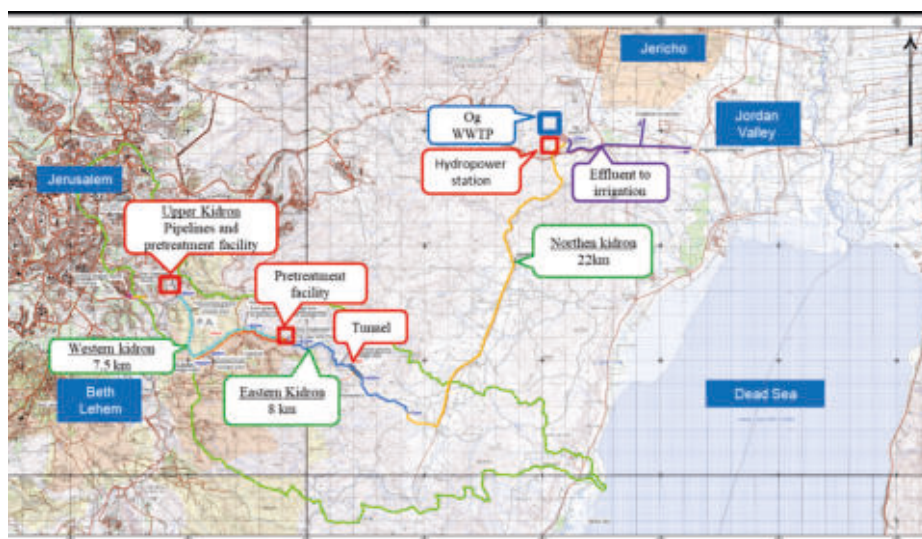
mark all sites to conserve, and adjusted the final route until all parties were in agreement.” The plan is divided into several sections which describe as follow:

in the second section. The request was to have a quick pipeline installation in a narrow construction location. The choice was KRAH pipe, which fitted to several

welding connections as a bend for small angles.

**Second Section: The edge of the border of Jerusalem jurisdiction (Upper Kidron)**

Constructing new sewage pipelines from Jerusalem neighborhoods in the kidron basin and connecting them to a new pretreatment facility in the city border. The pretreatment facility will separate debris and solids with an emphasis on wet wipes that come within the waste water stream and thus, will stop the flow of debris down the wadi. The pretreatment plant will discharge the sewage into a pipeline which will end at the Palestinian Authority border.



**First Section: Jerusalem jurisdiction (Upper Kidron)**

The main goal here is to regulate the sewage and drainage infrastructure, collect all the sewage that reaches the end of the city of Jerusalem jurisdiction. Damaged sewage infrastructure will be repaired and restored, the flow of sewage at the wadi channel will stop and the sewage will be directed to the collection pipeline. A new sewer collector pipeline from MERIKRAH, length of about 2 km with a diameter of 1,000 millimeters in diameter will be laid. Actually the pipeline will be placed twice: the first time is to collect the sewage from the wadi channel into a temporary pipeline in order to dry the construction area for massive road wall construction. The second and final pipeline will convey the sewage to the pretreatment plant describe

other reasons, among them the need for large diameter pipe, light, and with the ability to be in one long unit. The electrofusion welding is giving the pipe the requested sealing at the pipe sections connections. The layout of the pipeline is along the wadi where bends were needed. With KRAH pipe it was able to use the

**Third Section: The Palestinian Authority territory (Western Kidron)**

This section includes installing new pipelines along the wadi for about 7.5 kilometers long, in various diameters in the PA territory. The project was designed



*Temporary pipeline along Kidron Wadi*

in accordance with an agreement reached with the PA, and the sewage system in the PA territory is being coordinated with Hagihon Company and will be laid by the Palestinians. "The people living near the Kidron wadi don't care about politics", Cohen-Tarragan said. "They suffer from the sewage environmental effects, and what they really want is to improve their quality of life. We see the project as an anchor for the whole region, as an environmental improvement and a source for true coexistence".

---

#### Fourth Section: Judea Desert (Eastern kidron)

---

This is the connection point between the western collection pipeline and the eastern collection pipeline. Here Hagihon is constructing second pretreatment facility. The pretreatment plant will take debris and sediments that might enter the western pipeline. From this pretreatment facility until Hyrcania Valley, two parallel sewage pipelines for about



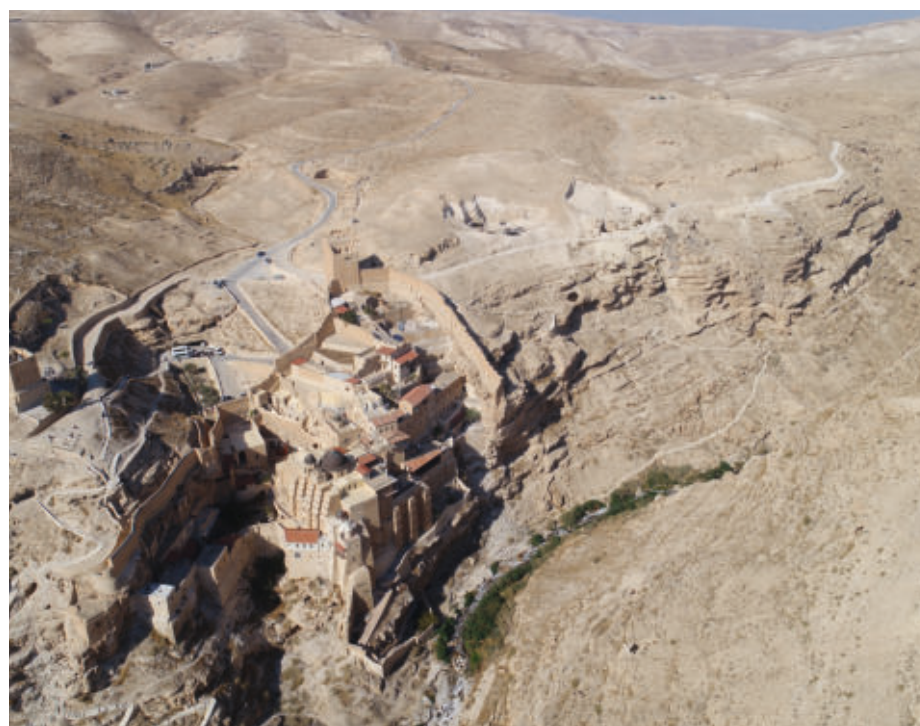
*2nd pretreatment facility*



*Eastern pipelines section*

8 kilometers long with a diameter of 800 millimeters each are being laid. Access to the winding route of the wadi in the Judean Desert is difficult and its channel passes by unique landscapes and unique nature, archeological and heritage sites like the magnificent Marsaba Monastery, built right into the wadi channel. Since the natural flow of water is through the wadi channel, a significant engineering feat was planned in order to respect the Monastery's isolation and solitude and to avoid damaging the unique site.

The route of the pipeline was diverted from the wadi channel into an infrastructure tunnel opposite the Monastery side of the wadi. There, at a depth of about 60 meters under the mountain, the sewage pipelines will be laid. The pipelines route continues across the Judean Desert and will be temporarily discharge in the sewage pretreatment facility in the Hyrcania Valley.



---

#### Fifth Section: Judea Desert (Northern kidron)

---

The last pipeline section is from Hyrcania Valley to Og WWTP with pressurized wastewater pipeline for about 22 kilometers long with a diameter of 1,000 mm will be placed.

---

#### Hydro-electric power (mid-Eastern section and the Northern section)

---

Hagihon Company, using holistic thoughts and methods, decided to use the deep terrain elevation for hydro-electric power. The plan is to produce hydro-electric power, generated by sewage gravity at a head of about 360 meter from the infrastructure tunnel eastern gate down to the WWTP location, for the WWTP's use. Hagihon Company is in the midst of designing this Innovative project starting with engineering feasibility.

---

## Sixth Section: upgrade of OG WWTP

---

This section includes the upgrading of the existing WWTP from handling 24,000 cubic meters per day to 100,000 cubic meters per day of sewage, turning the sewage into effluent water in order to irrigate thousands of acres of Israeli and Palestinian agricultural irrigation, such as the famous date palms of the Jordan Valley.



*The section is currently under advanced construction. In this section there is a use of KRAH pipes for low pressure pipeline section with a total length of about one km with a diameter of 1,000 mm.*

Mr. Cohen-Tarragan hopes that by 2023, the Kidron Wadi will start restoring itself to its natural state, and turn itself back into the environmental, heritage and tourist resource it deserves to be, as the prophet Ezekiel wrote: "And he said to me, "This water is going out to the eastern frontier, and will descend upon the plain, and come to the sea, to the sea that is brought out, and the waters will be healed"" (Ezekiel 47:8).

*Author:*

*Dror Cohen Tarragan, M.Sc. Eng.*

*Head of Kidron Project and Environment  
Hagihon Company Ltd.*



# Performing and surviving in times of crisis

## Installation without being on site - Krah VA

### How Krah is doing the installation and commissioning abroad without being on site – KRAH VA

Today, we live the life of tomorrow. A pandemic has forced the world economic to think in new ways – in high speed. Many companies are facing major problems and do not know how they will continue to operate in the near future. The Krah group is also hit by the new normality and we must perform to survive. We are not located in the world of “new economy” or “finetech” – we are “old economy”, we are machine and pipe producer – so what can we do to perform

(and fulfill our customers’ expectation)? We still can design, manufacture, and deliver our production plants, but how should we keep the relation to our customers and – even more difficult – how should we install, commission and maintain our production plants worldwide, without traveling?

### The great Krah-solution

Luckily, the Krah group in Germany has a very good IT-department with very skilled, young and creative people. One week after the management addressed the treat, the first possible solution could be presented – and this solution has inspired us all.

The solution was and still is to change our production line to a kind of “IKEA“-System, together with a virtual communication system. The plan is that machine installations can be carried out without our technicians on site. The mechanics in the respective country are „remote controlled“ by our technicians and with their help they install the machine and put it into operation. Therefore, the customer receives an extensive set containing several cameras, AR-glasses, and much more. The installation and commissioning experts are now working in offices in our headquarter and they are “tele-installing”.

Furthermore with this system it is possible with this system to carry out maintenance work and to eliminate problems and

disturbances, for which otherwise a technician would have to travel to the installation site. This is therefore a long-term solution that can also be used as alternative after the corona pandemic.

### Digitalization requires bandwidth

**Christopher Kirchhöfer**, Head of IT (Pic. 1), sees the main problems in the internet connection: „Digitalization requires bandwidth - for us and for our customers. Internet connection in Germany is often poorer than in other countries in the world (especially in rural areas, where many small and medium-sized businesses are based, and machines and systems are still being built).“ This is also the case with us in Schutzbach, which confronts us with some problems. It is planned to install fiber optic cables in the near future to improve the internet speed enormously.

### How is the setup? Which package are we sending to the client?

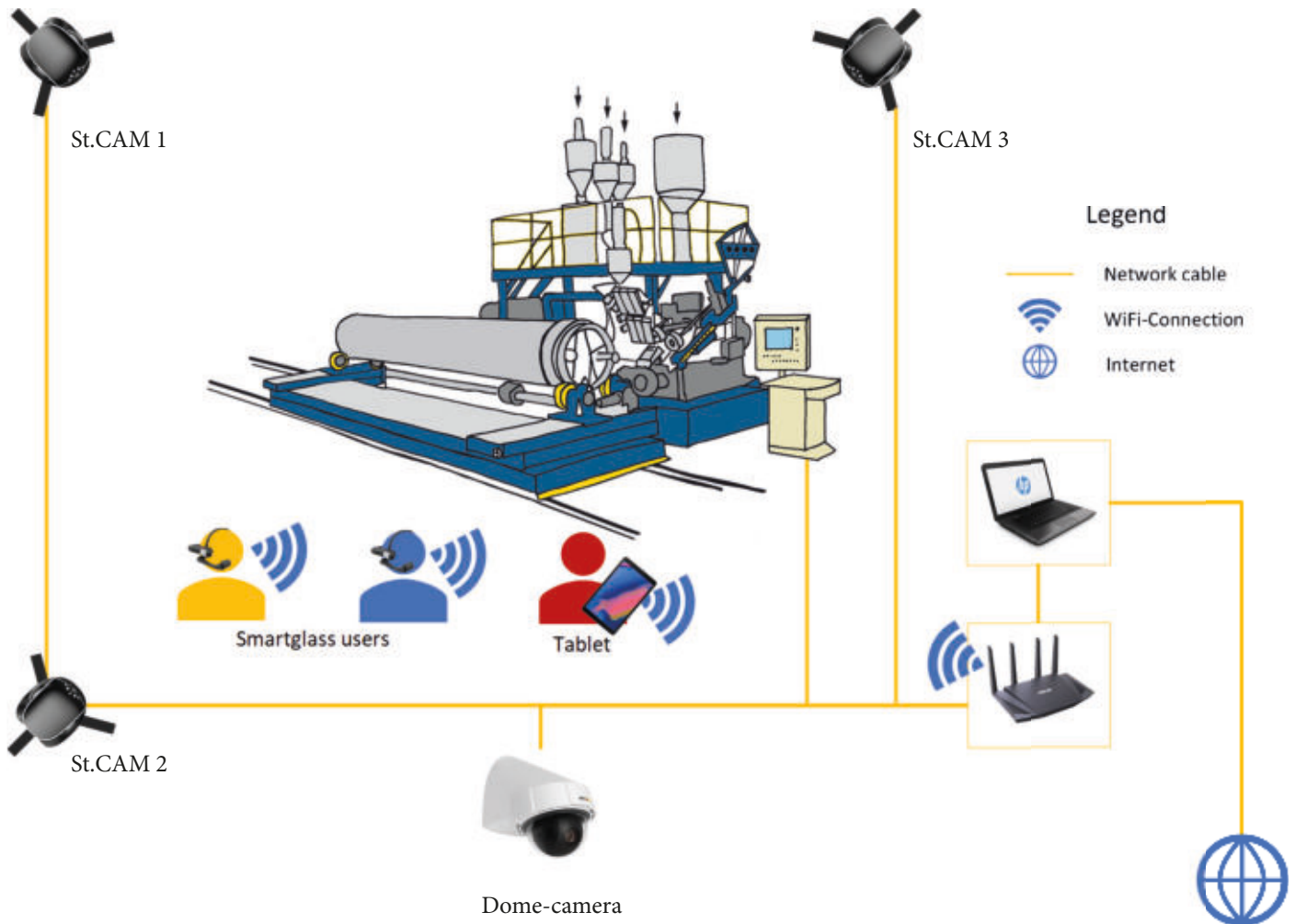
We send our customers everything that is necessary for the visual assistance. Basically, at the customers site, we have a special notebook, connected to the internet. The notebook is controlling 3-4 stationed cams (St. CAM 1-3, see in pic. 3), and 1-2 AR-glasses (Augmented Reality – AR-glasses) plus 1-2 tablets or mobiles.



Pic. 1: Christopher Kirchhöfer is the Head of IT and is responsible for making sure the system runs and that we have a good connection to our customers.



## The principle draft of our visual assistance system



*Drawing 1: The schematic of our system with all cameras and technical equipment*

All these things are of course also sent along, as well as a detailed description of the technology and the structure of the technology.

Besides the main parts described above, this set comes with preconfigured network devices to provide a specific network for these components, so no additional configuration is needed.

The only requirement for this set is electricity and a network cable which

connects our devices to your network in order to gain internet access.

### **The overview with the dome-camera**

In addition, the set contains a dome-camera (see in pic. 2) and different coloured warning vests to easily recognize all actors. The dome-camera is meant to be mount up high to provide a full

overview over the complete factory, not only the installation area but different storage areas as well.

With the help of the dome-camera, we have a total bird-view of the area here in Germany where the line should be installed – this camera can zoom and move. This can also be controlled from here to achieve the perfect viewing angle. Three or more other stationed-cams can show more precisely the



Pic. 2: The dome camera allows a good overview.

ongoing installation, they are mounted on staves and they can be moved easily. The idea is to place the cameras around the installation area to get a good overview of the location so that the installation can be easily monitored. All four cameras show up on a software on the laptop where they can be controlled, so both the onsite workers and our remote operator can see them, which makes communication easier.

We are working with a several eyes concept – many cameras around the machine allow us to see everything important and give us a good overview. We can also access the machine's display from here and access the inside of the control system.

### Tablet for more details

In some situations, the AR-glasses may not be enough, so we also added a

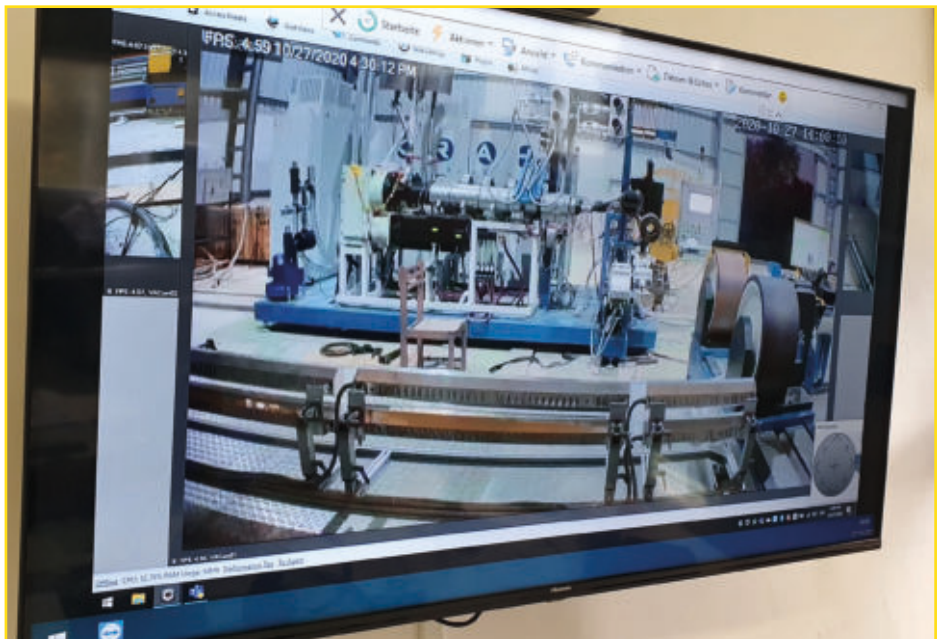
tablet to the package. Workers can use the installed app to show our operator a specific problem in more detail. As with all other devices, our operator can place arrows on the tablet or circle relevant areas to show the onsite worker the relevant details. We can also send videos and pictures from here to the tablet to explain things and make them easier to understand. On the other hand, our customer can also make videos with it to better show us problems.

### AR-glasses to be there live

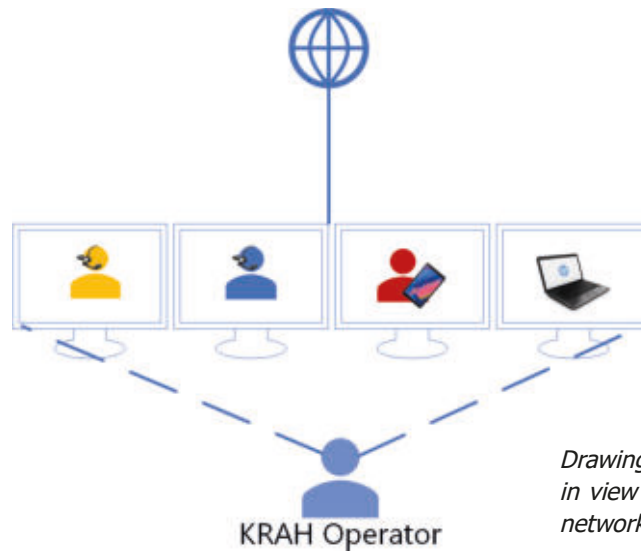
We work with AR-glasses to be there live and see everything happening without delay. AR-glasses are wearable computers that add information to the user's field of vision. They enable augmented reality. The AR-glasses are equipped with a microphone, speakers, a camera, and a screen in front of one



Pic. 3: The stationed cameras are set up a few meters away from the machine to have different perspectives on what is happening.



Pic. 4: Fitting to this you see here the screen of our operator, on which the picture of the camera is shown. There are several stationed cameras to have a good view of what is happening from all sides.



*Drawing 2: Our Krah Operator has everything in view via screens and is connected to the network of our customer*



*Pic. 5: Sandro Vernillo is the main contact person for our customers during installation and commissioning.*



*Pic. 6: He sits in front of 6 screens to have each camera, different displays and more in view. From there, he coordinates the entire setup of the machine and has a perfect overview of the whole process.*

eye. Our operator is able to see through the display what our remote operator sees and can communicate with him through the integrated microphone and speakers. Our operator can also mark "points of interest" on the screen for the worker to see. An AR-glasses for the actual "key-worker" is mounted on the helmet so that you have both hands free to work – safety first.

## The workplace changes in times of Corona

In Germany our "new" department is

handled by **Sandro Vernillo (Pic. 5)**. He is one of the most experienced "technicians" with a lot of experience in many foreign countries. And his working space and condition changed a lot. Before, he flew around the world and now his workplace consists of 6 large screens and many input possibilities (Pic. 6). He has a direct access to all kind of technical drawings and videos about our machine, to support directly and very professional. While he is doing the virtual action, he is creating and designing "gauges" for the next machines – to speed up the installation.

Our aim is to have the same installation speed as before, without having "own" people at site.

Until now, we are doing three installations and commissioning at the same time – in different stages. One customer in India, one in Belarus und one existing in the Philippines. In India and Belarus the machines are already in operation and the first pipes were produced without our technicians on site. Of course not everything went smoothly the first time, but we have now analysed the problems and working on improvements for further installations.

## How do the AR-glasses work?

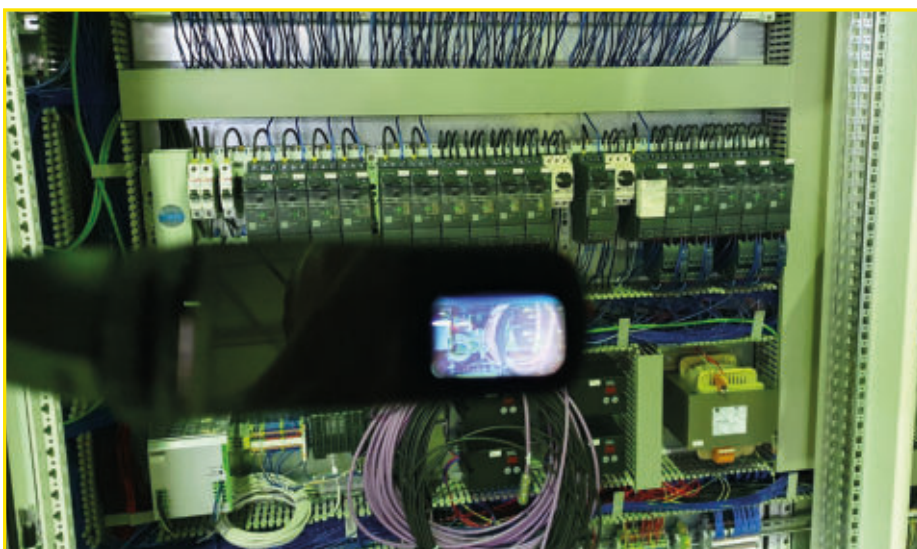
The AR-glasses is integrated in a safety-helmet, so you have both hands free to work (pic. 7). Through the AR-glasses you only can see with one eye. But that works perfect, we tried it often and there were no problems with it (pic. 8). The view through the AR-glasses is projected almost without delay and also with a very good quality onto the screen of our technicians (pic. 9 and 10). So our Krah-Operator can see the same as the technician on site can

see. For example, which cables should be connected. Here you can draw markers on the screen to ask what exactly you need to do (pic. 11), for example, which cables should be connected. In addition, the two parties involved can exchange views on what needs to be done and what the progress is.

The person who wears the AR-glasses can see these drawings on the screen of the glasses and can do proper work. To explain things in more detail, videos or pictures can also be sent to the tablet to have a larger screen (pic.12).



Pic. 7: The AR-glasses are integrated in a safety helmet.



Pic. 8: The view through the AR-glasses.



Pic. 9: The view is projected onto the screen of our operator.



Pic. 10: Projection onto the monitor of Sandro.



Pic. 11: Our operator can draw in the screen. The one wearing the AR-glasses sees this.



Pic. 12: For more detailed pictures or videos they can use the tablet.

## A typical installation schedule

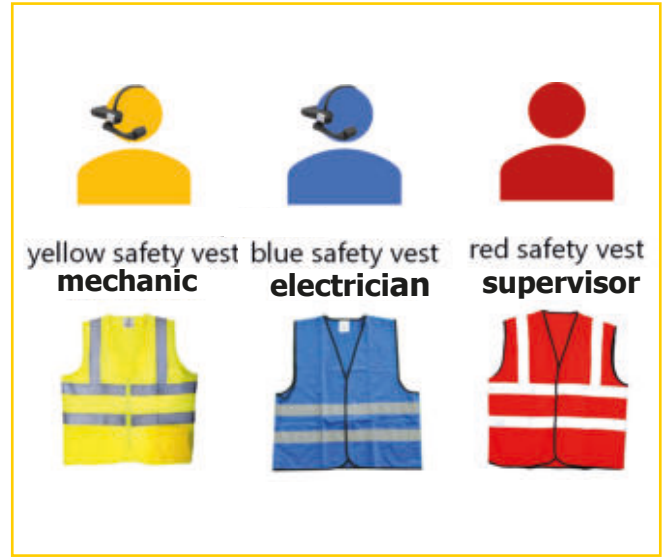
We at Krah have made a plan beforehand, when which step should happen and how the exact process of setting up a machine looks like. The assembly with our employees on site does not necessarily lead to a faster installation time, because a lot of the general setup like well-functioning electricity, gas, water and compressed air on the site are required for this.

**A typical installation schedule should be like that – but will be adjusted after each new installation:**

Day	What tasks need to be done?	Who is required?
Day 1	Installing the camera system (at predetermined positions)	1 (1)
Day 2	Overview, inventory, people, tools, measure the hall area and mark it according to the drawing	2 (2) 2-3 (3)
Day 3	Installing of the rail station (assembly of the individual components)	3-4 (4)
Day 4	Installing of the rail station (drilling and then level out the rail system)	3-4 (4)
Day 5	Platform, cabinet, gas pipe, pressure device / cassette	2-3 (3)
Day 6	Placing the extruder, die head, co-extruder, gravimetric, vacuum pump	2-3 (3)
Day 7	Install the platform, safety ladder, feeding system, heating arm platform, Gas pressure device	2-3 (3)
Day 8	Production station, assemble the individual parts and place them on the rail system	2-3 (3)
Day 9	Burner/ IR-heaters, milling and cooling station, dismantling station, finishing station	2-3 (3)
Day 10-12	Lay the connection cable, connect the suction hoses for the feeders, connect the cables and air connections	2-3 (3)
Day 13	Electrical test run of every component, with no load	1-2 (2) 1 (1)
Day 14	Computer check-up, and first extrusion of material	1-2 (2) 1 (1) 1 (1)
Day 15	Cleaning mandrel, and first pipe extrusion on a mandrel	2-3 (2) 1 (1)
Day 16	Installing completed	
Day 17	Starting of commissioning (production line)	1-2 (2)
Day 18	Pipe production with visual/virtual support – different sizes / different profiles; programming and extrusion	1-2 (2)
Day 19	Pipe production with visual/virtual support – different sizes / different profiles; programming and extrusion	1-2 (2)
Day 20	Pipe production with visual/virtual support – different sizes / different profiles; programming and extrusion	1-2 (2)
Day 21	Quality control	1-2 (3)
Day 22	Electro-fusion jointing	1-2 (2) 1-2 (3) 1-2 (4)

Legend: (1) IT-Personal (2) Machine Operator (3) Quality control (4) Construction support  
 (1) Supervisor (2) Mechanic (3) Electrician (4) Construction support

Now, our customer can produce Krah-Pipes on the newest machine on their own. Depending on the client, he can send back the cam-system, or he can purchase the already-running system for further "maybe-need" maintenance and technical



Pic. 13: With the vests you can see at a glance who is where and make it easier for our technicians to address the right people.

Drawing 3: The different colours of the vests make it easy to see who is who. The mechanic and the electrician wear AR-glasses.

## Coloured vests for quick identification

To make it easy, we are supplying coloured vests, so that we are able to classify employees in terms of qualifications and who is wearing the AR-glasses.

The mechanic wears the yellow vest,

combined with the AR-glasses, the electrician the blue one, also with the AR-glasses and the supervisor wears the red vest.

In addition, it enables us to see better through the camera who is where and where the important contact persons are at every moment.

## Improvement of our new machines

We are gaining our experience and at the same time we are improving our new machines for a quicker and easier installation (like a special plug-and-run system). Occurring problems help us to



Pic. 14: Video tutorials are very important for our customers, as many steps are very complicated and difficult to explain.



Pic. 15: Small videos showing and explaining these procedures make it easier for all those involved. Jochen Blickheuser is responsible for filming and editing videos. In addition, subtitles are usually inserted.

optimize individual work steps for the next time. Therefore we are in contact with our customers every day for hours, discussing problems and trying to find solutions together. It is also important to provide good training for the employees on site, which takes up a lot of time.

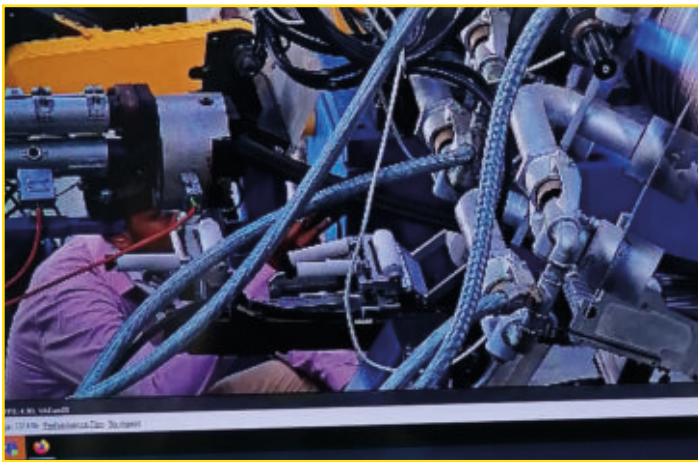
To support our "Krah VA"-department, we invested and established a video-team, to

produce as many as possible "guideline-videos" as possible. A big part of these videos will be available on the second "information-screen" of our newest machines – supplied in the year 2021 (Corona-Version).

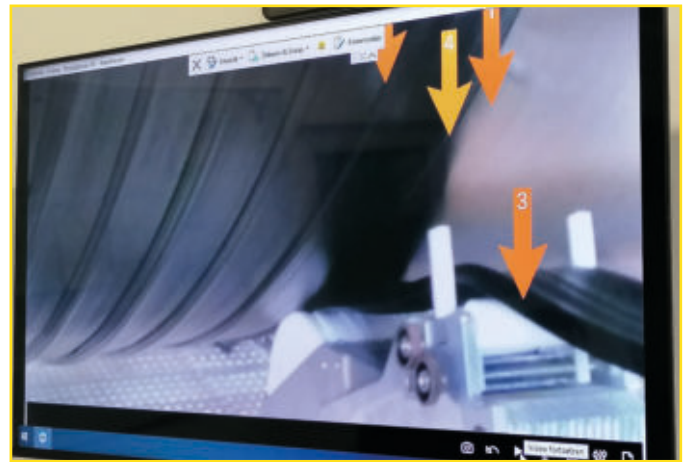
**Jochen Blickheuser** (pic. 15) is the person for this job. He makes a lot of small, self-explaining videos about different wor-

king steps to make it easier for the workers on site. He films our mechanics during the test set-up of the machine here in Schutzbach and adds subtitles if necessary. For each step, which is a little more complicated, there is an additional video.

Because the videos are mostly self-explanatory, different languages are no obstacle and they are understandable for everyone.



Pic. 16: The first pipe in India, what is made with the help of our virtual assistance system. From here in Schutzbach we could follow every single step.



Pic. 17: Markings on the computer enable our local technician with the AR-glasses to see exactly what he has to do. Here the distance between the PE-layers should be changed.

## Electro-fusion welding device Krah E-Box 23 Plus on sale - until December!

- Approved for Krah electro-fusion technology
- Welding range up to DN/ID 4000 mm
- Automatic logging of up to 10000 welding records
- Data input via keyboard or barcode scanner
- Traceability according to ISO 12176-3 / 4
- Data output on USB stick

### Technical data:

Output voltage: 8V - 48V

Output current: max. 130 A

Input voltage: 180-230V

Input frequency: 40Hz-70Hz

Temperature range: -20 ° C to + 60 ° C

Power cable: 5m with EUR plug

Welding cable: 4m with 6mm connector contacts

Weight: 11,5kg

Dimensions: 236 x 295 x 330mm



The Krah E-Box 23 plus is delivered with an user manual, aluminum transport case, Adapter 4.0 mm in pocket, HP terminal adapter for Krah pipes and includes welding extension cable.

## Field reports from our customers



### Pypman Advanced Plastic Technique Pvt. Ltd., India



Pic. 19: Karan Mulchandani, Director (left), and Hemant Ajmera, Managing Director of Pypman Advanced Plastic Technique Pvt. Ltd.

"Due to the unforeseen event of Covid our machine which arrived in March could not be installed. We were frustrated by the situation and waiting for several months for Covid to clear so that our installation could be done. Krah suggested an option of doing the same using Virtual reality and remote assistance. We were concerned on how we would manage this but since there was no options we agreed to the same. Krah put together a package of stationed cameras, a dome-camera, AR-glasses, tablets and a laptop and sent us the same. We installed this and started on the remote installation. Initially, there were a lot of problems of low internet speed, language barrier and other techni-

cal understanding issues.

**We together overcame the same and are proud to state that we successfully installed the machine and took a test run and produced a test pipe.**

The further advantage of doing our own installation was the fact that we have now more intimate knowledge of the machine to do regular maintenance. We now are going through remote training to produce a high quality pipe and we believe that we shall be successful in the same, too."

*Pypman Advanced Plastic Technique Pvt. Ltd.  
Sr. No. 1758, Vathvali, Memdabad  
Vathvali Memdabad, India*



### Krah Pipes Manila, Inc. Philippines



Pic. 20: Sajid Añonuevo, Director of Krah Pipes Manila, Inc.

"The Philippine economy is now facing the biggest challenge ever caused by the overwhelming crisis resulting from the Coronavirus pandemic. Of course, Krah Pipes Manila, Inc. was also affected by the pandemic. Most of our projects have

been put on hold and their implementation schedules have been delayed. The recently delivered new KR800 machine could not be assembled. At that time, the company had no choice but to take and implement emergency measures and take drastic action to prepare for the emergence of a new normality in its operations. When we heard about Krah's new idea to carry out the assembly of our machine virtually, we were a little sceptical at first, but then we were enthusiastic. Because this enables us to start up the machine without the physical presence of the technicians from Germany. In the last few weeks we have learned a lot and are very happy that we have been able to install the KR800 with virtual means. It is important to emphasise that at first we had doubts and uncertainties about the reliability of this virtual installation attempt, but as the cameras arrived and other equip-

ment was installed, we could breathe a sigh of relief and began to trust the system. The technology and the contact with the operator in Schutzbach works very well. We are now sure that everything is possible with the Krah technology. Currently, the installation is running in virtual mode and the result is so far so good. **Our commissioning is in a fortnight and we are very optimistic that our machine of the second line will be fully operational in the first week of December 2020.** We would like to express our sincere thanks to all members of the Krah family who have made this one important step towards achieving our company goals possible."

*Krah Pipes Manila, Inc.  
Blk 4 Lot 1 Main Drive, FCIE Compound,  
Brgy. Langkaan II, Dasmariñas City, Cavite,  
Philippines  
www.krah-pipes.com.ph*





## LLC Stekloplast, Belarus

“At the beginning of the project, the company management assessed the market situation and the offer of proposals from manufacturers of technological solutions and equipment for the production of pipes. As a result, it was decided to introduce a production based on the most modern technologies. Therefore the German company Krah, as the developer of the production technology Solid one+, became a partner. The project was started in 2020. The date clearly shows that the work had to be carried out under very unusual conditions. Special measures had to be taken to set up the machine. Nevertheless, the work went according to plan. The Solid One was delivered in August. The installation and commissioning was carried out online via the

new Krah virtual assistance system. The virtual department of the KrahVA provided great support in this matter. Sandro Vernillo has done everything to make sure that the employees at the production line are doing their job properly. Thus, on October 16th, 2020, despite serious difficulties due to external circumstances, the first pipe could be produced. This is a great event for this year, in which people and companies are going through hard times. Today, Stekloplast is the only company in Belarus that has the Krah technology. The completion of the commissioning works makes the company one of the leading manufacturers of high-tech pipe products and opens the prospect of further movement on the path of innovation.”



*Pic. 21: Denis Losovsky (left) and his father Anatoly Losovsky, Directors of LLC Stekloplast, Belarus.*

*LLC Stekloplast  
Maxim Gorki Str. 121 B  
Hrodna, Belarus  
[www.stekloplast.by](http://www.stekloplast.by)*

“So far we can say that our system works very well. It is a great feeling for me, to see when unexperienced technicians around the world are mounting and commissioning our machines. Most of them never saw our machine installed and producing before. During their work and in their real world, our technicians - from a little village in Germany - can project technical information and drawings in real time in the their AR-glasses and can give instructions in several communication ways – regardless of the time zone and location. Of course, there were some small problems and difficulties in the beginning, but we solved them successfully and learnt a lot. We are proud of our employees and the employees in the respective countries because everyone is facing and handling well new challenges. In Belarus and India, we have already managed to get the machine to produce the first pipes and in Manila we are close to doing so. And more will follow, the next sets are already on their way to our next customer, with whom we will then install their long-awaited machine together. Beside the ugly faces of the actual worldwide Covid situation, I am enjoying the speed of new technology implementation in our company for the wealth of our clients, the environment and for us. Suddenly a company from the “old economy” is deeply implemented in the newest technology. I am proud of our company and our people that we still can perform our duties and thus – hopefully – we will survive this global crisis and we will have a bright and sustainable future.”



*Dipl.-Kfm. Alexander Krah*

# Welded PE Sewage Pipe up to DN/ID3500 for Stuttgart Underground Station

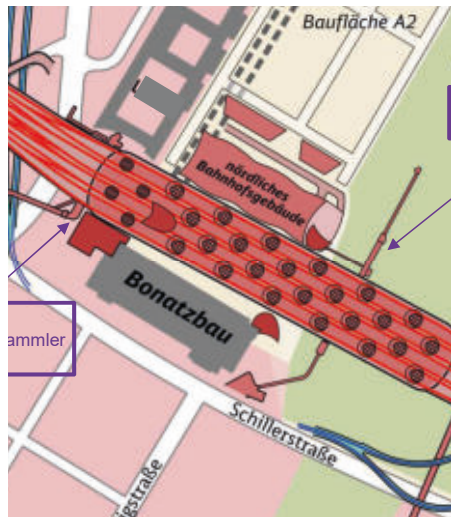
As part of the century project "Stuttgart 21" extensive infrastructure measures must be carried out in the region of the new underground station of the state capital of Baden-Württemberg. This includes the relocation of several large waste water collectors that are "in the way" of the new station. The existing sewers will be laid (culverted) under the future underground station at several points – pipes and components made of PE100 from Frank GmbH will be used for this project. In several locations the existing sewers are placed (culverted) under the future underground station - for this purpose, PE100 pipes and components by FRANK are used.

## Overview of the Building Project

The terminus station, also known as "Bonatz-Bau", was opened in 1922. Over the past centuries the infrastructure around the station has developed, so that for the new construction of the underground station many existing lines need to be severed and re-laid. Picture 1 shows the location of the underground station compared to the terminus station and the course of the large sewage culverts.

## Definition and Operating Principle of a "Culvert"

Wikipedia [2] states that the operating principle of a sewage culvert (see Picture 2) as follows: "A culvert is a pressure pipe to pass under a road, a tunnel,



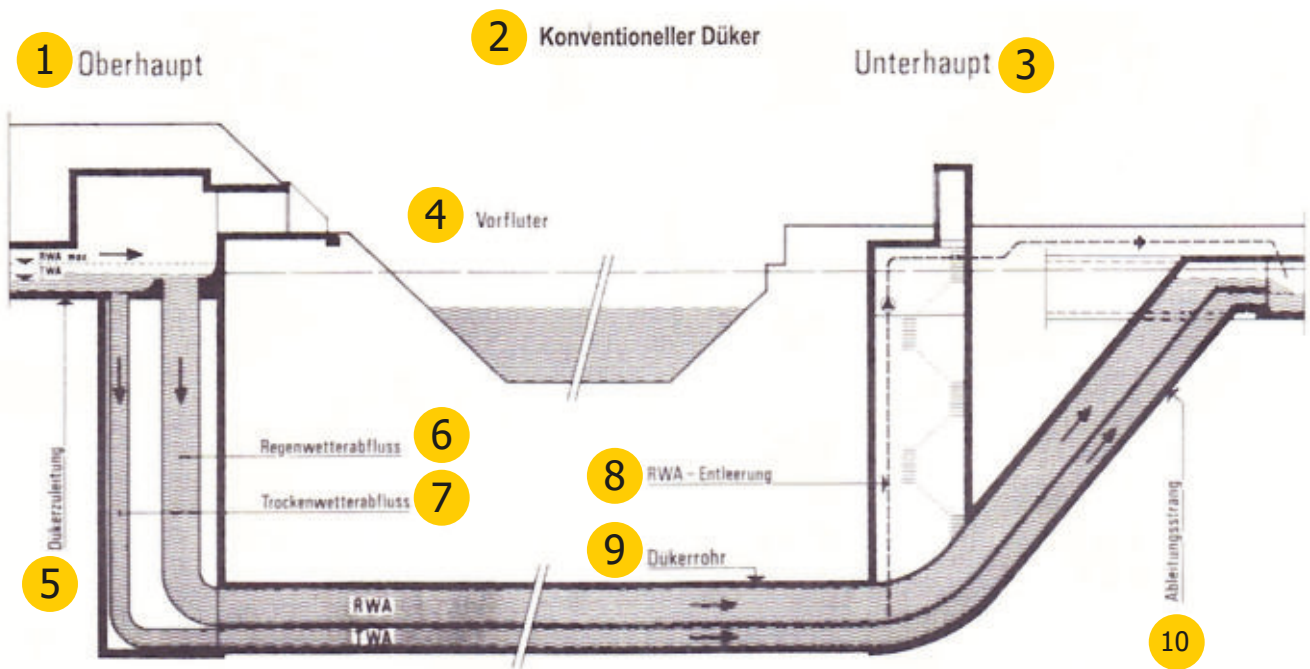
a river or railway tracks etc. The pipe can, for example be a gas, sewage or drinking water pipeline or a groundwater or oil pipeline. In the culvert the liquid overcomes a barrier without pumps having to be used. This is done by using the principle of the communicating pipes, according to which liquids in interconnected pipes always tend to the same level. If now liquid keeps on flowing in on one side, it reaches the same level of height on the other side and can be

forwarded almost without any loss of height." Since the existing collectors (main collector west and Nesenbach) drain in free fall, the fill level in the sewer always corresponds to the current flow rate. In case of low discharge (dry weather -  $Q_{TW}$ ) the filling of the sewer falls back into the dry weather channel. Here, a relatively high flow velocity is generated with a reduced cross-section to prevent deposits. In a culvert, the system of the weather channel no longer works as the culvert would first fill up with water completely before a drain is possible on the other side at the lower gates. This would lead to an extremely slow flow speed, a high dwell time and to depositions within the culvert line. Thus, the side streams are separated in the upper gates – namely in  $Q_{TW}$  – here, the culvert is always filled as well as in  $Q_{krit}$  and  $Q_{max}$ .  $Q_{krit}$  and  $Q_{max}$  are only flooded when the respective maximum drains are reached. In case of heavy rain all three cross sections of the culvert line are filled. In the lower gates the side streams are led back together again – the further sewage transport is carried out as gravity line.

## Introduction of the Subprojects – Material Selection

### Main Collector West (Picture 3)

The existing cross section of the collector around the "Kurt-Georg-Kiesinger-Platz" is a circular tubing channel DN3700 with dry weather channel ( $Q_{max} \sim 65000$  l/s),



- |                          |                           |
|--------------------------|---------------------------|
| 1 = Upper gates          | 6 = Rain weather drainage |
| 2 = Conventional culvert | 7 = Dry weather drainage  |
| 3 = Lower head           | 8 = RWA discharge         |
| 4 = Receiving water      | 9 = Culvert pipe          |
| 5 = Culvert pipeline     | 10 = Drainage line        |

that was made in closed construction. In the upper gates of the culvert the separation of the side streams is carried out in

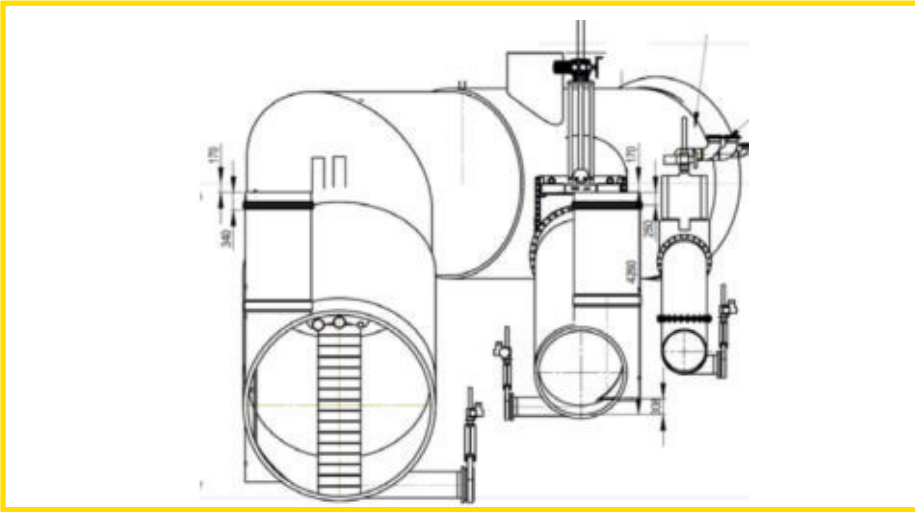
- $Q_{TW}$  ca. 400 l/s -> culvert DN800 PE100 pipe -> always in operation, always filled
- $Q_{krit}$  ca. 3600 l/s -> culvert DN1600 PE100 pipe -> emptied
- $Q_{max}$  ca. 47000 l/s -> culvert DN3500 PE100 pipe -> emptied

#### **Culvert Nesenbach (Picture 4)**

Here, the existing cross section is a typical tunnel vault with dry weather channel – in the upper gates of the culvert a separation of the side streams happens as follows:

- $Q_{TW}$  ca. 1500 l/s -> culvert DN1000 – PE100 pipe
- $Q_{krit}$  ca. 10000 l/s -> culvert DN2400 – PE100 pipe
- $Q_{max}$  ca. 100m<sup>3</sup> /s -> culvert rectangular duct 7,00 m x 3,60 m -cast-in-place concrete

According to Wikipedia [4] “The Nesenbach is a tributary stream of the Neckar with a length of around 13 km. The Nesenbach has “cut through” the basin in which Baden-Wurtemberg’s capital Stuttgart has developed. The small stream used to cross the city from southwest to northeast but has now been replaced along its entire length by the main collector of the same name in Stuttgart’s combined sewer system. [...] As the Nesenbach became more and more polluted over time, it was



increasingly vaulted and completely dug in. Today it is the most important main collector in Stuttgart's sewage system and serves as a sewage and rainwater canal for the entire southern part of the city. It no longer flows into the Neckar near Berg but is fed into the Mühlhausen sewage treatment plant. [...]"

**Material selection**

The original planning provided for reinforced concrete pipes with PE liners as pipe material, the culvert "Cannstatter Straße" was then the first culvert structure at the new station with a nominal width of DN/ID2000 to be designed in this way. During the implementation planning it was determined that the handling of reinforced concrete pipes >DN/ID2000 is not possible in the wide, deep excavation

trenches. Furthermore, a solution ..for the large pipe fittings up to DN/ID3500 was needed.

The advantages of the lightweight, flexible pipe material PE100 and the availability of wound sewer pipes made of PE100 up to a nominal width of DN/ID3500 then led to the redesign of the subprojects culvert Nesenbach and main collector West.

**Pipe Materials and Pipe Production**

The production of the wound PE100 sewage pipes DN/ID800 – DN/ID3500 with integrated E-fusion socket (up to DN/ID2400) as well as manholes and components took place at the Frank Kunststofftechnik GmbH in Wölfersheim. As pipe material PE100 Borsafe HE3490-LS was used. Here are some selected

material characteristics:

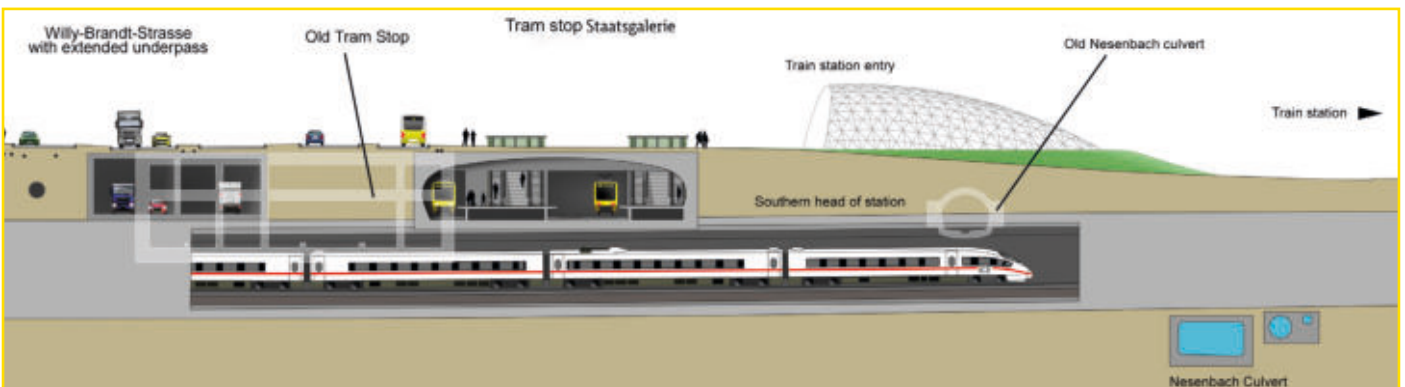
Density:	940 kg/m <sup>3</sup> acc. to ISO 1183
Poisson's ratio:	0,38
Short-time E modulus:	1203 N/mm <sup>2</sup>
Long-time E-modulus:	193 N/mm <sup>2</sup>
Short-time tensile strength:	29,90 N/mm <sup>2</sup>
Long-time tensile strength:	18,90 N/mm <sup>2</sup>

Polyethylene (PE100) is a thermoplastic which has, next to a low, specific weight, an extraordinary workability, weldability and flexibility. PE is especially resistant against aggressive media (acids and lies). Furthermore, the molecular construction of the material, which is made of carbon hydrogen, enables a material recycling.

Polyethylene can be recycled up to 100%. In DIN 8074 "Polyethylene (PE) – Pipes PE80, PE100 – Dimensions" and DIN 8075 "Polyethylene (PE) pipes – PE80, PE100 – General quality requirements, testing" the following statement regarding long-term strength has been made: "The operating time previously estimated at 50 years can be extended to at least 100 years due to many years of testing and experience for PE pipes at application temperatures of 20°."

**Production of Spiral Wound Pipes**

In a molten state, the moulding compound



is spirally wound onto a metal mandrel in form of a continuous overlapping strip (Picture 5). A second, functional and/or inspection-friendly inner layer can be applied via a co-extruder. A metal mandrel, which determines the inside diameter of the pipe, serves as calibration. The pipes are slowly cooled by a blower. In this way, residual stresses caused by volume shrinkage and the production process can be reduced. Different wall thicknesses and profile geometries can be achieved by winding the moulding compound in several layers and varying the amount of material applied (Picture 6). PKS® sewer pipes are available in the nominal sizes DN 300 to DN 3500. The basic wall thickness is determined in accordance with the minimum requirements of DIN EN 13476-3 or operational requirements. Production and quality assurance are carried out within the framework of the general building approval Z-40.26-359.



### Welding Connections

In the PKS® pipe system (profiled sewer pipe system) the single pipes, manholes and accessories are welded according to the standard with an integrated heating socket (E-fusion), this connection technology is available up to DN/ID 2400. During production socket and spigot are attached to the pipe. When the installation is carried out on site, the spigot is put into the socket and welded together (Picture 7).

The welding parameters are transferred to the welding device using a barcode. The welding device automatically records the welding process.

### Static Calculation of the Pipes

Generally, the static calculation of buried sewer pipes is carried out in accordance with ATV-DWA A 127. For the preselection of a suitable pipe, this calculation method was also used. Much more precise and illustrating the installation conditions better is a calculation using Finite Elements (FE). With this method the installation conditions and the pipes are divided into small elements (finite elements). This results in a very precise calculation. As the culvert pipes were completely encased in concrete, the groundwater level and inner pressure values were decisive for the calculation. For flexible pipe materials

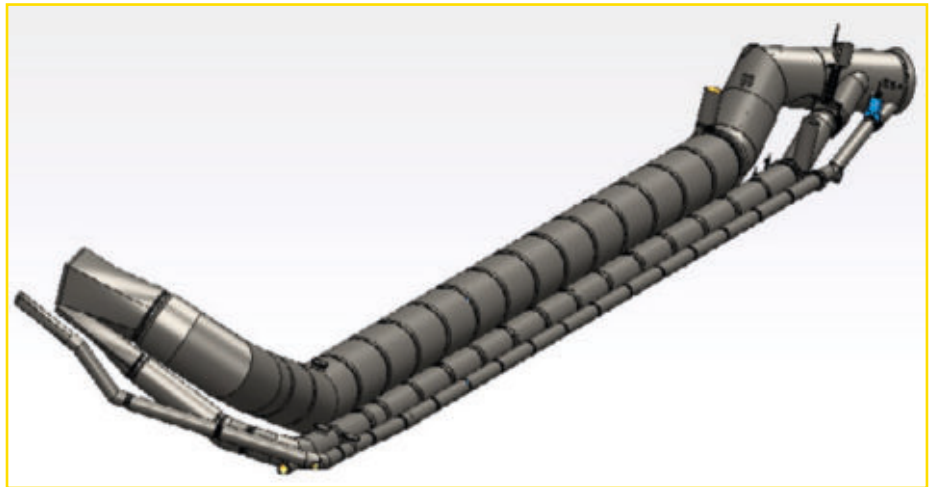
three checks always have to be performed - deformation, stability and stress check (Picture 8). An essential condition of the contracting authorities was that the evidence of a service life of 100 years could be given.

### Details Main Collector West

After the basic decision for the pipe material PE100 and the static calculation had been made, the work planning of the culvert sections was carried out in 3D. The individual parts for the production drawings were taken from the overview design (Picture 9). First, component 1.1 was installed in the lower head to be able to connect the necessary bypass for the duration of the construction period. Since component 1.1 (Picture 10) could not be assembled in one piece, production in the factory was divided into two parts. After delivery in Stuttgart, the homogeneous joining was carried out by hot gas extrusion welding. An essential aspect in the selection of the pipe material was the weight and thus the possible handling of the pipes and components in the deep and wide excavation pits. The concrete pipes up to DN3500 included in the original planning could only have been moved with a very large mobile crane. However, there was no space available on the narrow inner-city construction site for a corresponding mobile crane. The PE100 pipes could be completely moved and installed using the existing tower crane.

The weight of the individual pipes DN3500 with a length of 5.50 m was approx. 5 tons. As the transports were only allowed to be carried out in times of low

traffic volume within the scope of the "traffic law exemption permit", the pipes were also unloaded and brought into the excavation pit during the night (Picture 11). A further advantage of the pipes and components made of PE100 is the high degree of prefabrication, which made it possible to prepare complex components and pipe fittings in the workshop. For example, DN3500 pipe bends (Picture 12) and access shafts could be prefabricated, delivered and installed.



Stairways (Picture 13), which were necessary to comply with accident prevention regulations, could also be prepared accordingly in the inclined and ascending sections from the head and to the lower head. For the operator of the culvert structures, the "Stuttgarter Stadtentwässerung", a uniform, bright, inspection-friendly inner layer of the pipes and components was very important. This was made possible by the coextrusion process used to manufacture the pipes. The transitions from rectangle to round (Picture 14) in the head could be realized with unwinding made of PE sheet material.

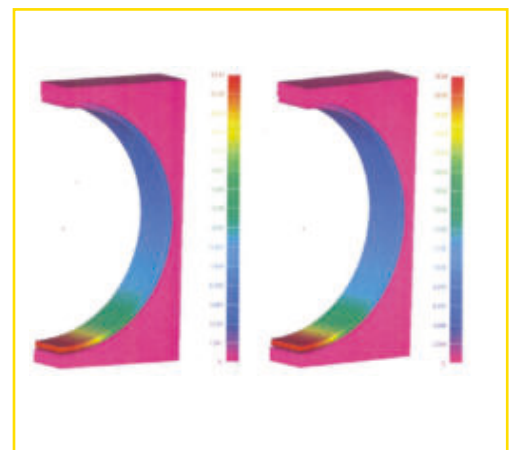
#### Details Culvert Nesenbach

For the Nesenbach culvert, the main cross-section ( $Q_{max}$ ) must be designed as an in-situ concrete rectangular channel, as no precast elements could be used for the dimension (7.00 m x 3.60 m). For the two "small" pipes DN2400 ( $Q_{krit}$ ) and DN1000 ( $Q_{tw}$ ) the same construction method was used as for the main collector West. The pipes and components made of PE100 were constructed as far as possible in the same way as the main collector west.

There, the installation in the very deep excavation trench (20 m) was also carried out with a tower crane. The individual pipes DN1000 and DN2400 were welded using the integrated electrofusion socket. The tightness test was then carried out directly with a socket testing device (Picture 15).

The method "L" from DIN EN 1610 "Testing of individual joints" was used. This ensured that only "tight" pipe connections were encased in concrete. The lowest point of the Nesenbach culvert is the pump house. As with the main collector west, the pipe cross-sections  $Q_{krit}$  and  $Q_{max}$  are emptied after filling (after a rain event) to prevent rotting and odour.

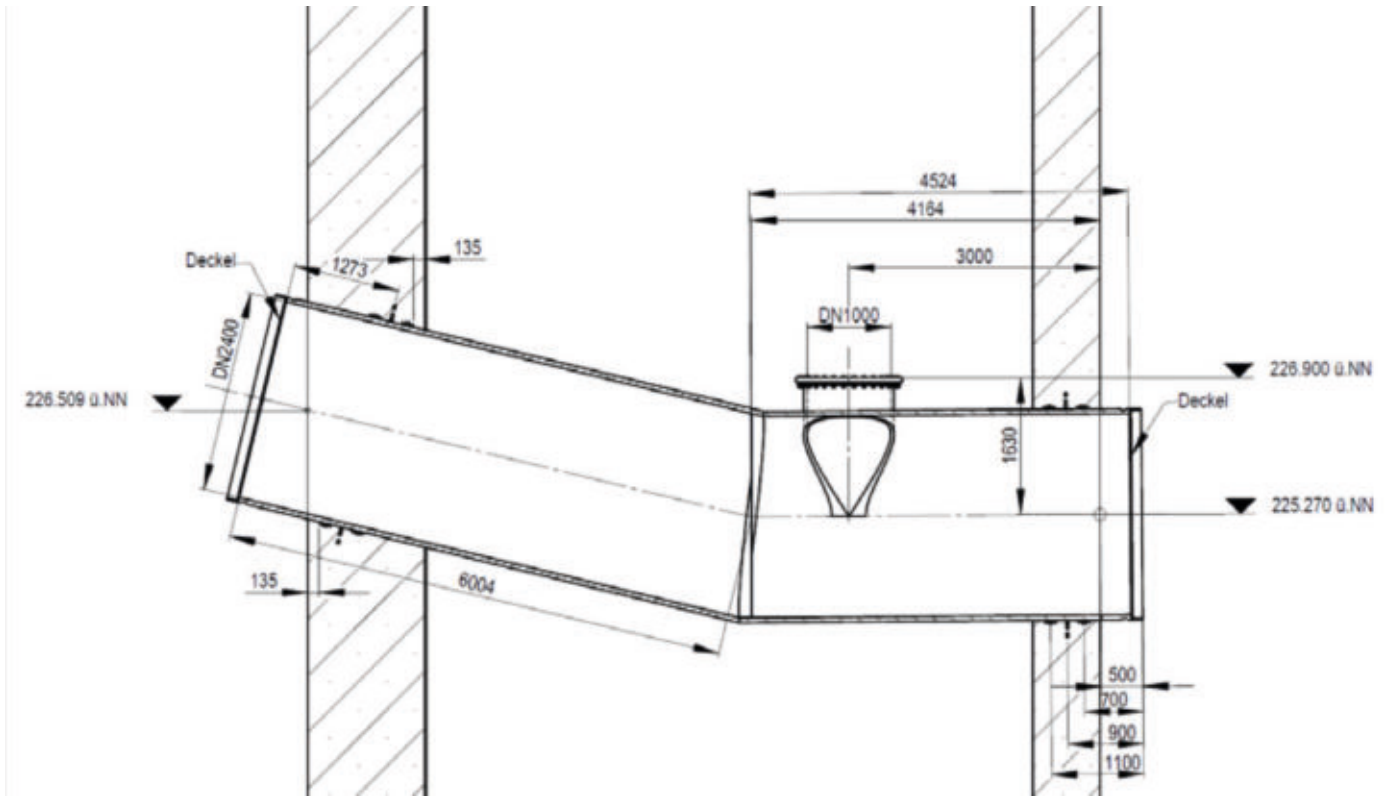
To be able to construct the underground building in advance, "insert parts" (Picture 16) had to be delivered long before the actual pipe sections to be set in concrete. The pipe sections "Crossing" and "Climbing" were then connected to these inserts after the construction of the excavation pits.



#### Conclusion

(August 2018) - main collector West in operation - culvert Nesenbach under construction)

- Feasibility produced by PE100 as pipe material
- High degree of prefabrication
- Easy handling with tower crane due to low weight
- Permanently tight due to welded joints
- Adjustment work on site possible
- Flexible material compensates for settlement differences
- Guaranteed long service life – design period --> 100 years



### Literature / Sources

- [1] <http://www.bahnprojekt-stuttgart-ulm.de>
- [2] <https://wikipedia.org/wiki/D%C3%BCcker>
- [3] <https://link.springer.com>
- [4] <https://de.wikipedia.org/wiki/Nesenbach>
- [5] DIN EN 8074/8075 "Rohre aus Polyethylen PE) – PE80, PE100" (2011-12)
- [6] <https://www.bahnprojekt-stuttgart-ulm.de> | Foto: Achim Birnbaum, Stuttgart

Autor:

Jochen Obermayer

FRANK GmbH, Mörfelden-Walldorf

Tel +49 6105 4085178

j.obermayer@frank-gmbh.de

- Picture 1: Overview underground station and location of sewage culvert [1]*
- Picture 2: Operating principle sewage culvert [3]*
- Picture 3: Location of culvert pipes – view of lower gates at main collector west*
- Picture 4: Location of the old Nesenbach line and the new culvert [1]*
- Picture 5: Production of a spiral pipe at FRANK Kunststofftechnik GmbH*
- Picture 6: Wall construction of hollow chamber profile*
- Picture 7: Electro-fusion welding until DN2400*
- Picture 8: Graphical representation of deformation analysis in FE statics*
- Picture 9: 3D construction main collector west DN800, DN1600 and DN3500*
- Picture 10: Production of component 1 – branch lower gate DN3500 with connection bypass*
- Picture 11: Unloading and lifting of pipes DN3500 with tower crane*
- Picture 12 + 13: Installation floor arch DN3500 / inside staircase and access shaft*
- Picture 14: Dimension transition rectangle to circular profile DN3500 – segment bottom*
- Picture 15: Installation pipes  $Q_{krit}$  DN2400 – socket testing device in operation*
- Picture 16: Insert  $Q_{krit}$  – DN2400 inside pump house with pressure tight access*

# UPLOAD YOUR KRAH PIPE PROJECT!

Be a part of our new online community and send us pictures and information from your favourite applications using our pipes, so we can create a huge new references brochure, showing a wide variety of application possibilities and experience exchange.

**Everyone participating will be named in the brochure.**

### Conditions:

- **The project mustn't be older than 5 years**
- **Pictures must be in high resolution**
- **You should be a Krah pipe producer or part of the Krah Community**





# We cannot repeat it often enough – save money by thinking



## Costs optimized pipe due to the distinction of working pressure and pipe stability, while designing

Imagine: Tuesday morning at the technical department of Krah in Germany. A customer from South-East Asia is calling and asking for a pipe with 10 bar working pressure, because a big tender is new in the market DN 2000 and 10 bar, total length 3 km, application "closing an open channel".

So, should we really suggest a solid wall pipe SDR17, for a pipe DN/ID2000 – or will make it sense to ask questions and think? Our aim is it to get the tender and to reduce the investment for the client, because usually it is tax-payers money in infrastructure projects.

### *1<sup>st</sup> Question: "What is the requested inside diameter of the pipe?"*

Sometimes the pipe is described with inside dimensions and sometimes with outside dimensions, depending on the referred standard. For example, if the tender for a PE-Pipe is according to DIN8074, the corresponding Krah pipe would be DN/ID1800, because DN2000/SDR17 will have a hydraulic inner diameter of 1765 mm.

Due to the information that the application is "closing an open channel, for transport of raw water" you could ask the

### *2<sup>nd</sup> Question: "What is the filling level of the pipe?" or "Is the pipe fully filled?"*

Usually the answer is: "no" or "could be, when a valve is closed". At this moment you know, that the 10bar requirement is because of the installation conditions and not because of a real inside working pressure.

### *3<sup>rd</sup> Question: "What is at the ends of the pipe (pumps, lake, river, plant etc.)?"*

The reply is important for better understanding what internal pressure could be theoretical there and what is necessary for operation.

### *4<sup>th</sup> Question: "How the pipe is installed (exposed, buried)?" and if buried: "What is the soil quality*

(backfilling, proctor density etc)?"

That and also information about additional loads are crucial for the needed stiffness and stability of the pipe.

So, finally we have an idea of the needed structural load capacity of the pipe. Assumed the customer is telling us, that the pipe is connecting a municipality with a sewage treatment plant and there is no integrated pump and no significant geodetic height difference (remember the pipe is replacing an open channel). It become very clear that the original reason for choosing PN 10 classification was not the internal pressure, but the external load capacity of a PN 10 wall thickness.

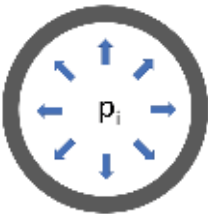
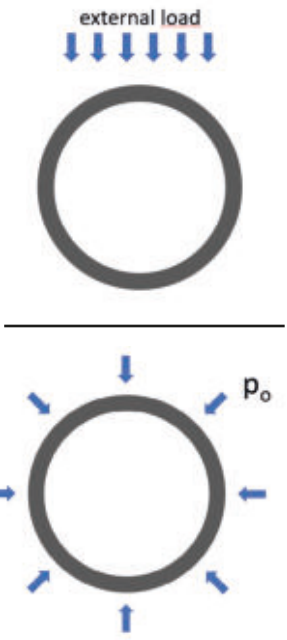
So, what is the external load capacity of PN 10 pipes and how it is related to stiffness classes?

**The answer is simple: PE 100, PN 10 is equivalent to SN 20 !** Any PN can be translated to SN by considering the typical mechanical characteristic of Polyethylene\*

PE 100				
SDR	17	21	26	33
PN [bar]	10	8	6	5
SN [kN/m <sup>2</sup> ]	20	10	5,3	2,5

\* flexural modulus of 1000 MPa

Honestly, very often we get the reply, that there would be no difference between internal and external capacity and people insist in PN 10. Very clear that people who insist in PN 10 are not aware that the load direction is decisive for the static design and ignoring that is wasting a lot of money.

<p><b>Internal pressure / Working pressure</b></p> $e = \frac{p_i \cdot ID}{20 \cdot \sigma_s \cdot p_i}$ <p><i>e</i> = wall thickness [mm]  <i>p<sub>i</sub></i> = internal pressure [bar]  <i>ID</i> = internal diameter [mm]  <i>σ<sub>all</sub></i> = design stress [MPa]</p>	
<p>Typical stress-related safety factor = 1,25 has to be considered for calculation of allowed outer pressure</p>	
<p><b>External load / Working pressure</b></p> <p>Stiffness formula:</p> $SN = \frac{e^3 \cdot E}{12 \cdot D_n^3}$ <p>Outer pressure formula:</p> $P_o = \frac{20 \cdot E \cdot e^3}{(1 - \mu^2) \cdot D_n^3}$ <p><i>E</i> = flexural modulus [N/mm<sup>2</sup>]  <i>p<sub>o</sub></i> = outer pressure [bar]  <i>D<sub>n</sub></i> = diameter at neutral axes [mm]  <i>μ</i> = poisson ratio [-]; for polyethylene = 0,4  <i>σ<sub>all</sub></i> = design stress [MPa]  <i>SN</i> = stiffness classes [kN/m<sup>2</sup>]</p>	
<p>Typical stability-related safety factor = 2,0 has to be considered for calculation of allowed outer pressure</p>	

The difference in internal and external load design is briefly described in the table above. Back to the first questions, what should we quote? If we quoted standard PE100 pipes DN/OD 2000, with SDR 17, length 3km – the total weight is 2408 tons. Jointed by butt-welding (Cost of one machine approx.. 100.000 EURO, speed of one joint 8 hrs – outside the trench. If we quote Krah-Pipe with same stiffness/external load capacity, with PN 1 or PN 1,5 internal pressure load capacity, same length of 3km – the total weight is 1220 tons. Jointed by integrated electro-

fusion (Cost of one machine approx.. 5.000 EURO, speed of one joint 30 min. – inside the trench).

**Material Saving = 1188 ton = approx. 1,2 Billion \$**

**These Material savings of 50% for profiled pipes with same SDR is valid for all SDR classes !**

Saving material means:

- Saving costs for the client (and more projects can be realized with the same budget)

## Did you know..?

- Saving installation time means saving costs again, and a quicker realisation of the project

Also: The described case is a true story and finally the necessary pipe stiffness was SN 7.2, calculated and verified by third party. That means the saving was not 50%, it was almost 70% !

So, think! Save money and protect the environment.

Author: Dipl.-Kfm. Alexander Krah,  
Krah Group

*Simplified for Polyethylene we can use the ratio between short and longterm flexural modulus of "5.5 : 1" and receive by inserting the typical stiffness formula into the external load formula following the simple relation.*

$$p_o = 0,052 \cdot SN$$



# Collecting and supply system with prefabricated constructions for potable water

## Introduction

High safety requirements in terms of hygiene and security of supply are the most important aspects in the planning and construction of drinking water supply networks. Therefore, it is necessary to use all available resources as far as possible. Local resources should be available for the local residents inside their region.

A proper transportation of potable water by appropriate equipment is essential. During the configuration of a supply system, special attention must be paid to the efficiency of the pumps, to the inner pipe diameter and to the proper selection of pipe material. But it is just as important

to consider all constructions of potable water systems. They must correspond to the rest of the supply system in terms of functional reliability, safety requirements and durability.

Prefabricated constructions out of HDPE are used in drinking water supply systems for over 50 years. They are characterized by

- Low weight to reduce the transport costs and make the installation easy
- High strength to withstand all internal and external loads
- High flexibility to allow a wide range of variety of styles and shapes
- Short time for the installation on site

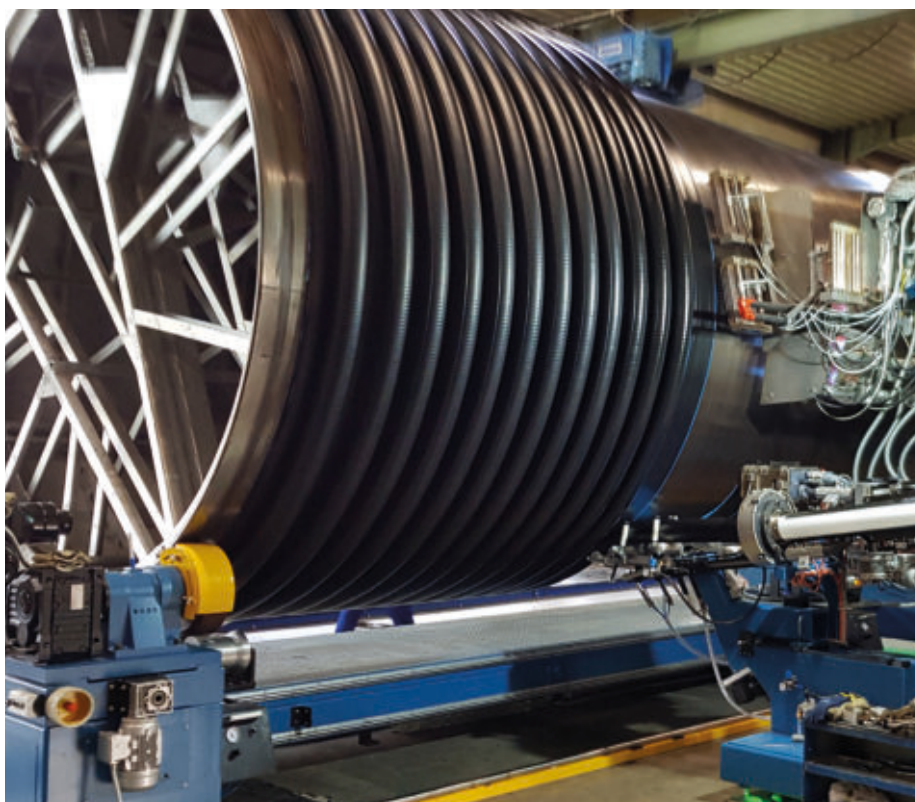
- Low maintenance based on the smooth interiors resist growth of algae and bacteria and is easy to clean
- Highest standards in hygiene
- High level of safety
- Guaranteed reliability
- Economic efficiency

They have been developed for sparsely populated areas (e.g. mountains) where central drinking water supply is not economically feasible.

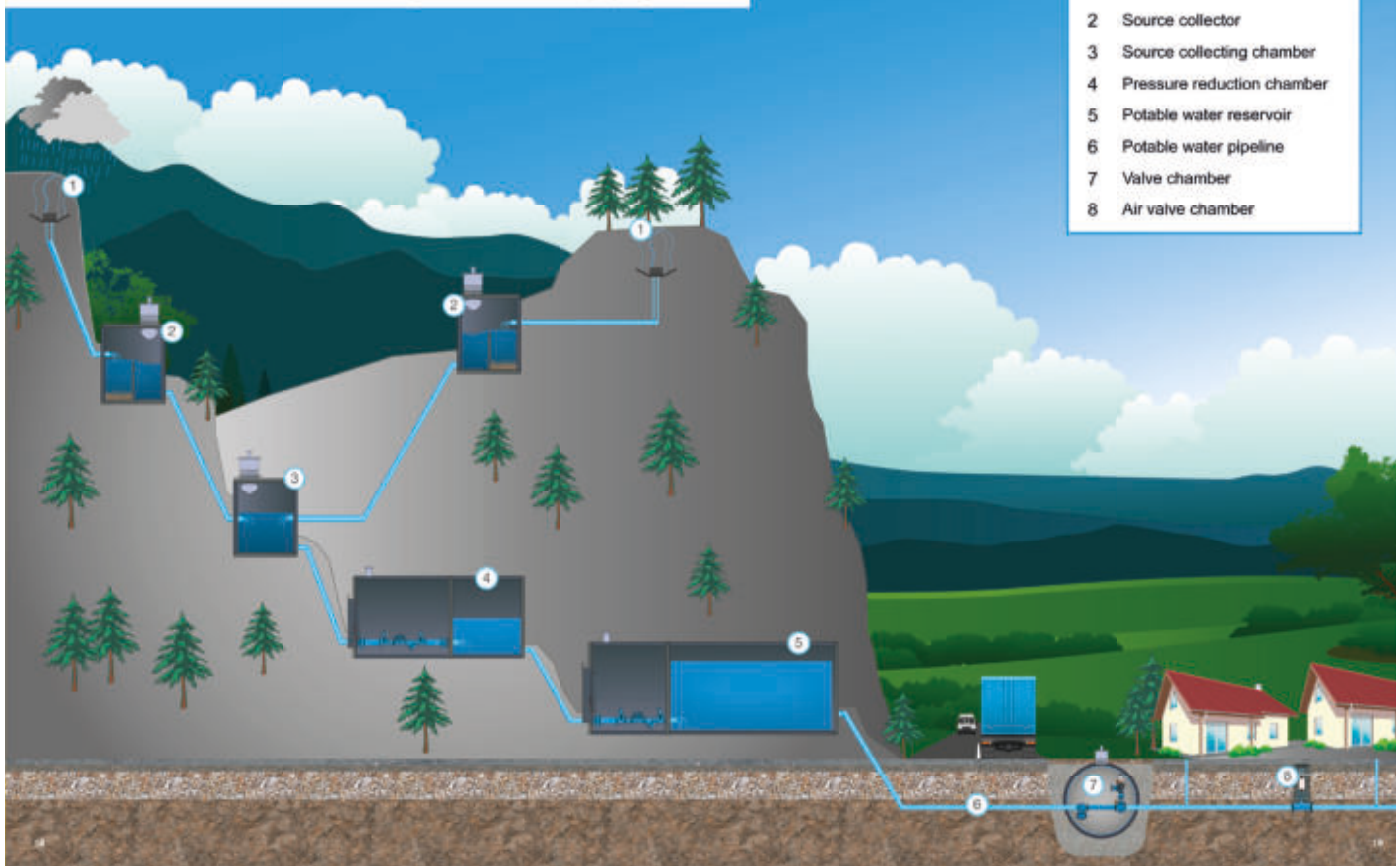
But a clear separation between a central and a decentralized drinking water supply is disappearing. Drinking water is a precious good. Where drinking water can be obtained from springs or wells, it is used to supply the people. A supply system consists of pressure pipes, manholes and reservoirs. The complete system has to be tight, fast to install, easy to operate and should have a possibly long lifetime and must meet all hygienic requirements.

The great advantages of the prefabricated constructions that were learned to appreciate in the mountains also help in densely built-up areas. Now, they are used regardless of the population density in the drinking water systems.

The basement for all constructions is usually a spirally wound polyethylene pipe with a double walled structure. This double wall contains an internal solid wall layer, a reinforcing profile and a final external solid wall layer. These kinds of pipes provide



## Structure of a drinking water supply



- |   |                            |
|---|----------------------------|
| 1 | Source intake              |
| 2 | Source collector           |
| 3 | Source collecting chamber  |
| 4 | Pressure reduction chamber |
| 5 | Potable water reservoir    |
| 6 | Potable water pipeline     |
| 7 | Valve chamber              |
| 8 | Air valve chamber          |

low weight, high ring stiffness and low costs. They can be designed in a way that they withstand all internal and external loads. Together with the characteristics of the material, it is ideal for manufacturing collecting shafts and water reservoirs. The following report shows that structural double-walled pipes are a very attractive option for the fabrication of storage tanks and collecting shafts regarding costs and safety during installation and usage.

### Situation in the drinking water supply area

The following figure shows a scheme of

drinking water supply area. The water from different sources is collected and transported through pipes to the collecting shafts. Here, a quality and quantity control can be made. After this, the water is forwarded to a storage tank. The storage tank is used as a buffer; if necessary, the water can be treated here additionally. At last supply to the consumer can be carried out.

The following constructions are required for a safe drinking water supply:

- Source collection chambers
- Well shafts

- Transport Pipes
- Drinking water reservoirs
- Valve Chambers
- Firefighting Tanks

### Requirements for constructions

The constructions must complete the supply system of pressure water pipes. Moreover, they must fulfil the requirements of safety and reliability. They are meant to collect and store potable water. At the same time the tanks and shafts must leave room for the measuring and controlling technology such as for pumps to pass on drinking water. However, the

design should enable for easy inspection and maintenance as well.

Further requirements are:

- Short installation time
- Little maintenance
- High level of safety
- Guaranteed reliability
- Economic efficiency

To fulfil all these requirements prefabricated constructions are used. The basis is always a structured double wall pipe that is made out of polyethylene.

### Choice of material - Polyethylene

Polyethylene has proven itself successfully for potable water applications for a long time. For more than 50 years it has been used for water supply systems as well as for collecting systems. Its neutral properties towards taste are constantly given. It has also been tested successfully for use of food storage. It is tasteless and resistant to corrosion. Pipes and other semi-finished products made from polyethylene provide a smooth and pore-less textured surface. These characteristics reduce the maintenance work and simplify the cleaning procedure. Because of the mentioned advantages it makes sense to design the complete drinking water construction out of this material as well. The welding of all inlets and outlets create a complete plastic system, which guarantees tightness and safety.

### Large diameter HDPE pipes with structured walls

The polyethylene pipes with structured

walls have been originally designed for gravity lines. They provide low weight, high ring stiffness and low costs. The wall structure is a combination of a solid liner and a reinforcing profile. The pipes are produced and controlled according to the international standards DIN 16961, EN 13476 and ISO 9969. The pipes are helically wound on a steel-mandrel. The mandrel ensures the inner diameter of the pipe. All pipes can be delivered from ID 300 to ID 3500. The winding technology allows an individual and customized design of the pipes for each project to fulfil all requirements regarding internal and external loads like inner pressure, soil- and traffic loads. Thus, any ring stiffness can be achieved and pipes for high loaded drain systems and manholes, even in large diameters, can be manufactured. All pipes that are used for drinking water supply have a blue inner surface.

For pipes, tanks and shafts which are buried and which have to withstand heavy soil or traffic load, the ring stiffness is one of the most important design factors. The ring stiffness  $S_R$  [ $\text{kN/m}^2$ ] is defined as the capability of the pipe to withstand the external pressure or forces. It depends on the moment of inertia of the wall, on the mean radius and the modulus of elasticity.

$$S_R = \frac{E_c \cdot I}{r_m^3}$$

$E_c$  [ $\text{Nmm}^2$ ] = Modulus of elasticity

$I$  [ $\text{mm}^4/\text{mm}$ ] = Moment of inertia of the wall

$r_m$  [ $\text{mm}$ ] = Mean radius

One of the major advantages of these pipes is the high ring stiffness at low weight. A comparison to solid wall pipes with same stiffness makes it obvious. A typical pipe that is used as a storage tank with a diameter of 3000 mm is a combination of a solid inner liner with a reinforcing profile and a final external layer. This pipe has a long time ring stiffness of  $S_{50\text{years}} = 3.1 \text{ kN/m}^2$ . To achieve the same ring stiffness with a solid wall pipe a wall thickness of  $s = 89 \text{ mm}$  is necessary. Whereas the structural double-walled pipe has a weight of 359 kg/m, a solid wall pipe has a weight of more than 828 kg/m.



The total weight of a complete prefabricated collecting shaft ID 3000 mm is about 1200 kg. A comparison with rigid concrete material makes the advantage in terms of weight even more obvious: a concrete construction would have a weight of about 18.000 kg (18 tons).

### Factory control and assurance of quality

The whole production process is monitored by a quality management system. Which includes the internal quality control and the external (third-party) quality control.

The internal quality control is divided into three phases.

### *Phase one - intake control*

When purchasing the raw material, the manufacturer's test report must routinely be requested. On receipt, an intake control regarding melting index and density is carried out. After the material has passed the intake control, a test-pipe is produced to verify its technical properties. Melting index and density are once more tested at this stage. Furthermore, the durability of the material under short term tension is tested, a bending test is carried out and the heat resistance is examined. After this intensive procedure, the material is preliminary approved for production.

### *Phase two – during production control*

During the production the complete production process including the production parameters and all working steps and must be continuously supervised and documented. So, corrections can be made immediately. The most important dimensions are measured continuously.

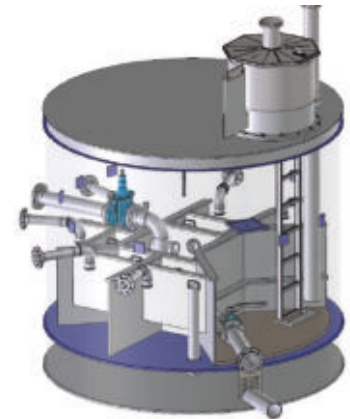
### *Phase three – finished product control*

After the production, the final product (pipe, fitting, manhole) is tested and compared with the requirements. This is the final control of all products where all parameters like surface, dimensions, material, colour and marking are checked. The results of the internal control testing shall be recorded, and, as far as possible, statistically evaluated. Records are kept for at least five years, and submitted to the inspection body on request. If the product passes all tests a quality certificate according to DIN EN 10204 can be made. The external quality control should take place twice a year. Of course The frequency of all tests must be agreed in accordance

with the external quality control party – which can be "TÜV Rheinland GmbH". All checked samples shall be considered representative for the whole production. Raw material tests should be carried out before adding the product to the production cycle. Undamaged / non affected samples can be sold afterwards. Those tests made in Production Plants are exceeding the requirements of the international standards like DIN16961, DIN EN 13476, ISO 9969, DVGW W300, etc.

### **Collecting shafts**

The collecting shaft serves as a control station where quality and quantity of the water can be checked before it flows into the reservoir or continues to the transport lines. Every collecting shaft has to be divided in a dry chamber and one or several wet chambers. The entrance is always located in the dry chamber, which serves as a base for maintenance and service work. The different water chambers are arranged in such a way, that each spring is directed into a separate intake chamber which is



also divided into an intake area and a settlement area which are separated by a scum board. Thereby it is possible to treat them individually. At the same time some particles like sand can settle down. The standard production has an inside diameter of ID 1200 up to ID 3500 mm. All pipe constructions consist of the structural double wall. They have a side entrance ore a shaft lid and can be delivered with a conical entrance. Whereas constructions with DN 1200 include only one intake, constructions with DN 3500 can include up to six intakes. A special drainage facilitates the cleaning. The water flow of each spring can be measured by installing



a rectangular or a triangular-notch thin plate wire.

### Drinking water reservoirs

Drinking water reservoirs are used as buffer for fresh water. Thus, variations in consumption can be well- balanced. The size of the reservoir has to be chosen in relation to the amount of fresh water supply, so that a sufficient supply of drinking water can be guaranteed at all times. The water reservoirs consist of an operating room and two or more storage chambers. These chambers are accessible from the operating room via a stainless-steel safety door which is located in the separating wall. The operating room includes all necessary valves and measuring equipment.

Through sight glasses, the internally illuminated storage tank can be visually inspected at any time. Each water reservoir has also an intake, an overflow, an extraction, and an outlet.

The standard constructions are produced with an inside diameter from ID 2000 up to ID 3600 mm. They are constructed with structural double wall pipes. The front and end walls are made of reinforced PE plates. The entrance is exclusively located in the dry chamber. Exceptions to this rule are storage tanks for fire-fighting purposes. They are constructed without a dry chamber. The storage volume can be freely chosen. Usually the storage tanks have a volume of 5 m<sup>3</sup> to 800 m<sup>3</sup>.

### Valve chambers

Valve chambers are required to separate pipes, ventilate the supply lines, reduce pressure or measure the water quantities. So that a safe drinking water supply is guaranteed.

### Design and installation

Flexible plastic pipes provide a higher durability than conventional rigid pipes. In the case of a buried rigid pipe, it is the pipe alone that constitutes the structure and is subjected to the full load, whereas in the case of a flexible pipe, it is the interaction procedure between the pipe and the surrounding soil that constitutes the structure [1]. The pipe always carries







the loads together with the surrounding soil. A correct design of plastics pipes and shafts requires consideration of the actual situation at site regarding the product itself, the soil conditions, the installation procedure and the different types of loading.

The pipe design method considers the following values:

- Information about construction site, pipe line zone and the main filling. It can have different modulus of deformation and Proctor density of compaction.
- Information about external loads
- Installation including the trench excavation
- Height of ground water level
- Working conditions, such as outside temperature or operating pressure

The installation of the pipes is as important as the accurate calculation beforehand. Pipes and shafts perform only as well as they are installed. A proper soil investigation and a definition of the backfill parameters are necessary for the pipe design. It is commonly known that the deflection of all flexible pipes and their

capability to withstand the external loads are strongly influenced by the installation conditions. Because of the interaction between the pipe and the surrounding soil, the installation should be done properly. The embedment is the most important part of the soil- pipe structure. Regarding the compaction around the pipes, tanks or shafts, it is necessary, that the backfilling material is easily and homogeneously compactable. The backfilling material should be noncohesive soil and free of big stones. The compaction of the soil should be homogeneously and evenly distributed with the result that deflection is limited. The installation time of the constructions should be as short as possible and include:

- Supply of all materials
- the excavation
- If necessary; wrecking of existing constructions
- Preparing the bedding
- Installation of the construction
- Connecting the service pipes
- Backfilling
- Surface reinstatement

Our Experience has shown, that depending

on the constructions, the installation time can vary between one and nine days. Such a short installation time can be realized due to the high degree of prefabrication in the factory. The constructions are supplied ready for operation. Only the connection of the service pipes must be done on site.

The following pictures show the installation of a collecting shaft. The transport is done by a small truck. After preparation of the excavation and the foundation, the shaft is positioned and the service pipes are connected. A minimum working space of 0.5 m shall be provided for correct backfilling. No grain size should come below 32 mm. The material is to be filled equally in layers of 20 - 40 cm thickness and must be carefully compacted. If necessary, an extra inlet or outlet can be made at any time during the installation. After this the old shaft can be wrecked. The last step of the installation is the reinstatement of the surface after the completion of the backfill.

The following pictures show a water reservoir during transport, the installation and after the reinstatement of the surface.



After the trench excavation, the bedding must be prepared. The bedding must ensure an even pressure distribution under the pipe in the surrounding area. According to EN 1610 the bedding type 1 should be suitable. The thickness of the lower bedding shall not be less than 150 mm. After that the compaction of side fill and main backfill can start. The initial backfill directly above the tank should be compacted by hand or light compaction equipment. The side fill and the main backfill are usually compacted

with a medium weight vibration stamper. All remarks about the material, layer thickness and working space are valid for the storage tanks as well. Because of their low weight, easy handling and the fact that all constructions were prefabricated, both introduced constructions have been completely installed an extremely short time and in accordance to all hygienic requirements.

#### Conclusion

The structural HDPE pipe is the most

important component of constructions like collecting shafts, water reservoirs and valve chambers. It has been shown, that a fast and cost-effective installation of an absolute tight, safe and reliable drinking water supply system can be realised. As the pipes are designed individually for each project, a highly loaded system even in large diameters can be produced.

Author

Andreas Wittner, Hawle Kunststoff GmbH

**TIRED AND UNCONCENTRATED AT WORK? FEELING LIKE YOU NEED TO GO BACK TO BED? ONLY CHOCOLATE FROM BLACK OPS COFFEE CAN HELP! ENERGY FOR BODY AND SOUL IN A NATURAL WAY. BEST COCOA FROM ECUADOR. WITH AT LEAST 70% COCOA AND OUR PROVEN BLACK OPS COFFEE!**

**CHECK OUT [WWW.BLACK-OPS-COFFEE.COM](http://WWW.BLACK-OPS-COFFEE.COM) FOR YOUR DOSE OF ENERGY!**

**BLACK OPS COFFEE**

**NEW!**

PARISCHOKOLADE  
MILK CHOCOLATE  
DARK CHOCOLATE

# Hawle´s credo: Overtaking instead of catching up

## - an interview with the management

November 2020, in Wiehl at the headquarters of Hawle Kunststoff GmbH.

**Alexander Krah visits the oldest and at the same time the newest customer in Germany, Hawle Kunststoff GmbH, formerly Bauku GmbH. This summer, the Krah Group delivered the latest production plant of the type KR800-MAX and successfully put it into operation under Corona conditions - with full physical effort. During the company visit, there was a spontaneous opportunity to motivate the two managing directors for an interview.**

***Hello, Mr Bonimeier (B) and Mr Wagner (W). Thank you for taking the time to have a chat with us. How are you doing today on this beautiful day in the Rhineland - as a true Bavarian?***

W: Every time we drive up here we ask ourselves why we are even driving up here (both laugh). At the very beginning, when we were here for the first time, we said that nobody wants to hang dead over the fence here (German idiom for "There's not much going on there") - that's what they say in Bavaria. But now we really like coming up here – over time we have learned to like the area.

***People coming from the region of the Rhine are known to have a cheerful nature, do you notice it here as a Bavarian or is it simply ignored?***



From the left: Gerd Bonimeier, Alexander Krah and Rupert Wagner.

B: Well, basically yes, but you have to admit that in the beginning there was the problem that people here didn't really understand what we Bavarians are like – they didn't really get our way of humour.



Rupert Wagner, Managing Director of Hawle Kunststoff GmbH.

***And what about the beer, do you like it compared to Bavarian Oktoberfest beer?***

W: It is a bit thin, but it tastes good.

B: Well, let's put it this way: The glass size is definitely a big difference: In Bavaria you can only get such small glasses in the pharmacy (laughs).

***What exactly do you two do at Hawle?***

B: Roughly speaking, we are both Managing Directors of Hawle Kunststoff GmbH, but we have to dig a bit deeper in this respect. We started the whole subject a few years ago within the sister company "Hawle Armaturen GmbH", because historically there is a company - that was active in this field, but only processed the pipe - and Hawle now attaches great importance to its own, deep value creation and would like to

manufacture the products itself, and so the decision was made that we said - OK, we are now making our own profile pipe. And with Bauku GmbH, we then took this step. As we both were the only ones who dealt with this topic at that time, it was obvious that we would take care of it and so one thing led to another. Additionally, of course, we wanted to transfer this attitude of the Hawle brand, this „spirit“, to here, and so we were of the opinion that this could only be done if we sent someone to take care of it and not just lay hands on it and wait.

**What does Hawle Armaturen GmbH actually do?**

W: Hawle Armaturen actually is a manufacturer of heavy-duty fittings, i.e. hydrants, gate valves and control valves. More than 90% are produced for water supply, which means that everything Hawle produces is buried. You can actually only see it when a hydrant is in a field somewhere. Otherwise we are invisible and everyone assumes that when the tap



*Gerd Bonimeier, managing director of Hawle Kunststoff GmbH.*

is opened, water of sufficient quality and quantity will come. Hawle always hangs somewhere in between, not only with the fittings, but also with the fittings shaft or the pipe.

**In 2015 you (Hawle) took over the insolvent Bauku GmbH winding pipe manufacturer. Why would a well-known German fittings manufacturer take over a company that deals with large pipe systems, of all companies?**

B: Well, figuratively speaking and in simple terms, we see the pipe as packaging, and we can now see very clearly where our fittings are installed. Because now we don't just deliver it via dealers, but we more or less manufacture the entire system ourselves and the customer installs the complete unit. This also makes it more visible to us where the products are actually going - where are we strong, where are we weak, where can we take even stronger action?

W: This „shell“ used to be made mainly of concrete, GRP, Frank pipes or additionally purchased Krah pipes, and we wanted to have an influence there, and we have influenced the market in a way that this valve well market made of polyethylene is becoming more and more attractive. Now we are also involving many small apparatus manufacturers, who in turn buy our pipe - so now we build the „shell“ ourselves.

B: It is also important to us that the ideas and the implementation often come from the customer - this is not always something we think up, the development and progress in the manhole itself is actually the customer's requirement that makes us creative. And of course, the material also brings with it a number of advantages.

**So our pipe production plant is now a machine that produces packaging material (Krah laughs). The Bauku**

**GmbH was an old company and the name Bauku was quite well-known on the market. Why didn't you keep the name, but started again with Hawle plastic - isn't that unusual?**

B: This is actually due to the fact that we did not know that Bauku GmbH existed until the 2014 fair. Until then, we had only perceived the company Frank GmbH and Henze GmbH as a manufacturer of sectional tubes. With the brand or the name Hawle, we have a very good stand on the market and therefore naturally want to sell under this/our brand name. We wanted to start with Bauku GmbH's products and, if necessary, to expand into new areas - such as fire water tanks. Until then this was not a field of business for the Hawle company and we took it on board with Bauku GmbH - which opened our eyes - and fire water tanks are of course now a big issue for us.

**We/I as Krah (on the family and on the company side) were for years closely connected with Bauku GmbH and the founding family - until one day a dispute arose between us - but that is another story. We are therefore even more pleased to have once again delivered and installed a machine to Wiehl-Drabenderhöhe - this means that Hawle-Kunststoff GmbH is also at the cutting edge of production technology for large wound pipes. How is the production going?**

W: We had the constellation that the old managing director of Bauku GmbH operated a mechanical engineering company (to produce winding machines), also with the participation of Hawle



Deutschland Beteiligungs GmbH. In this respect it was of course a huge step for us not to buy from our own company, but to go to the Krah company and buy there the latest state of the art. It also took us years before we were able to implement this in the company, but we are now more than satisfied with this decision and also with the technology, and they are absolutely competitive.

**What were the biggest challenges in the beginning when „converting“ the „old“ company into a „new“ one?**

B: The employees of Bauku GmbH had to go through quite a lot towards the end and in the beginning it was of course the case that two young guys from Bavaria were not taken seriously. More or less according to the motto, here comes the next one and let's see how it ends. At the same time the question arose whether we could use what we have here for ourselves. It took a long time to find out what the Bauku GmbH covers - from the technology, and how to bring it up

to the high standard we had as Hawle. And taking every single one with us was a bit difficult. Rupert Wagner always has a good example: If you bring a cow into the barn the same way for 30 years, it's unlikely that she would like to go another way. And that was a bit of a challenge to get that into people's heads, that you just have to look outside the box sometimes.

**Did you imagine the pipe system business as it is now?**

W: Well, actually everything went very quickly. The Bauku GmbH company was insolvent, then the Hawle company came into play and a few months later it was clear that the Hawle company would buy the Bauku GmbH company. That means we didn't have much time to think - what was actually bought, and what kind of problems are brought on board. The problems came up after the decision was made, and then had to be tackled bit by bit: The building is very old, the employees were dismissed according to a social plan, which means that the average age of the





workforce at the start of production was 55 years, one of them has pain in the shoulder, the other problems with the heart, the third one has a sore knee, so it was incredibly difficult to bring this „spirit“ back into the company – like a new beginning.

***In which market segments and regions do you see your target markets?***

B: We sell through different locations, with our sister companies, with Etertub in Switzerland, Liot in Austria and ushere in Germany. If you draw a radius of 500 km around these companies, we already cover a lot. We already see ourselves as Central European, or have the possibilities to deliver there and we do so. We are very active in Luxembourg, and occasionally in other countries, but Germany, Austria and Italy are the main markets for us. Very clear market segments are, of course, the supply of drinking water - where Hawle comes from, where we

are strongly involved - and, of course, the disposal of waste water. Gradually, we are also getting more and more involved in these projects, which involve major measures: sewer pipes, damming systems and so on.

***If you could turn back time: would you do it again like this - take over Bauku GmbH?***

W: We would definitely buy Bauku GmbH again. The most important capital were the employees who were already there. They were longtime employees, some of them had been with the company for 20 or 30 years, and this experience, or to create it anew, is incredibly difficult. With all the problems we had in the beginning, it has paid off in any case to take over Bauku GmbH.

***Have other acquisitions been made or are there any pending in the plastics sector?***

W: Last year, we added a further

company in Eastern Germany in the field of pipeline construction, in Reichenbach in the Vogtland region, where we now have 14 pipeline constructors, who are again exerting a targeted influence to ensure that the Hawle fittings are installed in the pipe space and not in a third-party or competing product.

B: Of course, it also makes us incredibly flexible in the way we work. The distribution in Germany shortens distances considerably and we can cover everything with our own staff.

***What does the future of Hawle-Kunststoff look like? - Where is the Hawle journey going; what are the expectations for the following „post-Corona years“?***

B: What we have in mind is quite clear: we have a foundry, the fittings factory Hawle Armaturen, Hawle Kunststoff and Hawle Service, and we want to play this trump card with customers. If we are smart, we can do a deal with a project



Alexander Krah, CEO of the Krah Group

several times, and that is exactly what we want to sell to the customer – since it's a lot worth for the customer of course. We want to attract to us those who no longer have the manpower to cover all this. And in the end, we want to look after them from start to finish. There is no one else in Germany who can cover this range from A to Z.

**What do you see as the biggest challenge in the coming years?**

W: That we network and link the various locations sensibly.

**And how do you do that? Is digitalisation also an issue at Hawle?**

W: Of course, it is also an issue at Hawle, but it is also important to have the right people in the right places.

**How many more of you are there at Hawle?**

W: We have plant managers and production managers at every location - and the wheels are increasingly turning. The better these intermesh, the more powerful we are. Now we want to do more and more in the area of service as well, which means offering the customer a service right up to the commissioning of the control valve that no one else in Germany can offer at the moment - and I think we are very well positioned for the future.

**Is it easy to manage a business from Bavaria? How often do you travel to Wiehl?**

B: Regularly. Partly weekly, but due to Corona, we currently have larger gaps and are sometimes not there for several weeks, but basically, we are always



there. Depending on what's on the agenda, one of us is always on site.

**Last question: Judging by your hands, you are both married, can you imagine moving to the Rhineland with your families?**

(both laugh) W: That's not an issue for us! We are both very attached to our homeland. The Bavarian is basically rooted in his roots as far as associations and family are concerned.

W: I have three small children at home, so it would be incredibly difficult for me

to leave home.

**I thank you both very much for the nice conversation and wish you much success and joy with the new machine!**

*Author: Jenny, Krah Group*

*Hawle Kunststoff GmbH  
Industriegelände 9  
51674 Wiehl  
Germany*

*info@hawle-kunststoff.de  
www.hawle-kunststoff.de*

# Krah Pipes bending design



For the design of pipes, the flexibility and bending characteristics are an important factor, in terms of consideration for the correct installation of the pipe system. For buried pipe applications, the “field-bending” can help to reduce the quantity of needed bends and elbows. The allowed minimum bending radius depends on the pipe wall structure, jointing method, environmental conditions (temperature, sun radiation) and duration of the bending process. For marine application, the bending process is a must for the sinking

process and one of the decisive advantage of thermoplastics in comparison to rigid pipe materials.

## Determination of bending radius

For determination of the bending radius the strain of the outer fiber and the buckling resistance of the pipe have to be considered separately. For the design all elements of the pipe string, incl. jointing, have to be verified for the bending process. The permitted strain of outer fiber mainly depends on the load period, but typical

for Polyethylene and Polypropylene is to define a strain-limit for bending of 2,5% (adequate safety included).

$$R_{\epsilon} = \frac{OD \cdot 100}{2 \cdot \epsilon}$$

OD = Outer diameter [mm], for profiled pipes with inner wall only:  $OD = ID + 2 \cdot e_1$   
 $\epsilon$  = Strain of outer fiber [%]  
 $R_{\epsilon}$  = bending radius, strain related [mm]



The bending radius to avoid buckling depends on pipe stiffness and wall structure and is for solid wall pipes and closed profile pipes (CPR) calculated as follows:

$$R_B = \frac{(ID + e_{equ})^2}{4 \cdot 0,28 \cdot e_{equ} \cdot S_{FF}}$$

ID = Inner diameter [mm]

$e_{equ}$  = equivalent wall thickness, for solid wall pipes: wall thickness

$S_{FF}$  = Spiral factor [-], for solid wall = 1, for profiled wall ca. 0,8

$R_b$  = Minimum bending radius, buckling related [mm]

The spiral factor SFF considers the helical profile around the pipe and the distance between the profiles. It should be noted that all equations assume a circular round pipe without ovality, what is especially important for more heavy solid wall pipes with higher weight/stiffness-ratio. In case an additional safety factor can be considered.

**The minimum bending radius  $R_{min}$  must be bigger than  $R_b$  and  $R_e$  !**

The final determination depends further on material characteristic (flexural modulus, creep-factor etc.), the environmental conditions (temperature, sun radiation, wind etc.) and how the bending load is

Profiled wall pipes								
SN	1	2	4	8	12	16	24	32
eSDR	15	36	28	23	20	18	16	15
R/D	50	40	30	30	25	25	25	25

Solid wall pipes								
SDR	41	33	26	21	17	13	11	9
R/D	50	40	30	25	25	25	25	25

applied. But the above-mentioned values of a bending radius are typical.

The relation between eSDR respectively SDR and SN values can be described as follows:

$$eSDR = \frac{1}{\sqrt[3]{\frac{12 \cdot SN}{1000 \cdot E}}}$$

eSDR = equivalent SDR class for profiled pipes

E = short term flexural modulus [N/mm<sup>2</sup>]

SN = stiffness value/class acc. to ISO 9969 [kN/m<sup>2</sup>]

Author: Dipl.-Ing. Stephan Füllgrabe,  
Krah Pipes GmbH & Co. KG

**FOLLOW US ON  
SOCIAL MEDIA!**



**@DERKRAH**



**@KRAHPIPES**



**@KRAH**

## KRAH'S SHORT NEWS



ocial Media has become the most important way of spreading news these days. Regardless of the topic, wether business news, sports news, celebrity news or economical trends, everything gets published via the internet and reaches people the quickest. We have been hopping on the train and can look back on a few years of Social Media presence, continuously growing followers and reach.

We are featured on Instagram (@DERKRAH) and LinkedIn (@KRAHPIPES), the last being more of a business platform to interact and get in contact with new potential customers and partners. On Instagram, we show a bit of the "background action" - who even is Krah? (without forgetting our product of course). Over the past few years we have developed a steady platform to talk about our technology, solve problems, show examples and interact with customers.

Our private LinkedIn group "Krah Community Worldwide" offers a great way of communicating with customers, exchanging experience with different applications in different situations and even solving problems through guidance and professional help of other members.



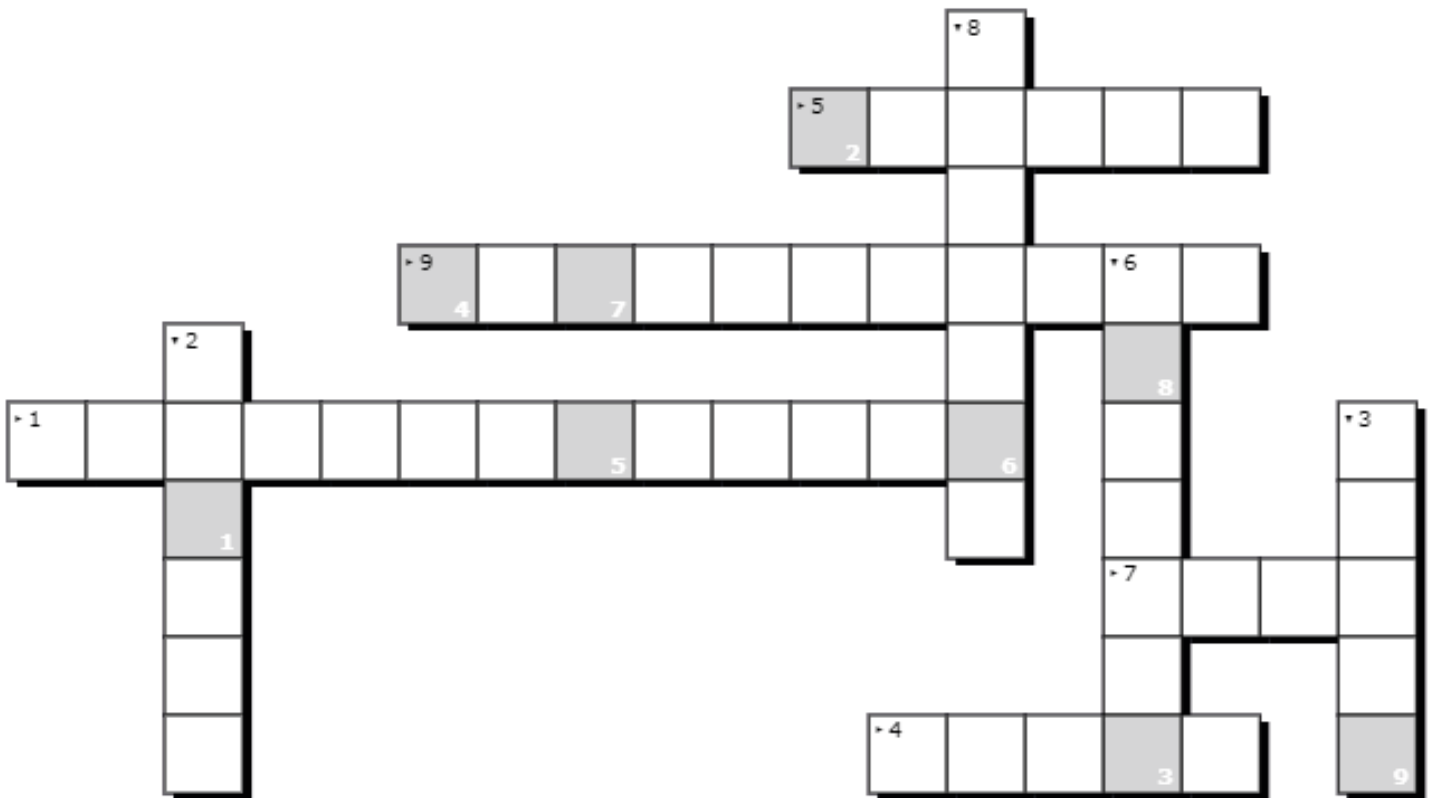
### Special application: Krah pipes used as high seats for hunters

With the beginning of autumn, the hunting season in Germany starts as well. Alexander Krah is a hunter himself, being responsible for a big district around the company. This season, something is new: Many hunters around have decided to switch the usual, wooden high seats for Krah pipes. Obviously, wooden material has to be exchanged every few years. It is constantly exposed to heavy rain, wind, sometimes heavy snow loads, sunshine and other. Therefore, the change to high seats made of Krah pipes made perfect sense to Alexander's hunting colleagues. They will serve as observation point, giving shelter to bad weather and a long service lifetime at the same time. The hunting culture is especially present in our area and is a long-known tradition. Even more successful that our pipes now serve as new, very important accessoire.

*Find more special applications like fish farms, flower pots, swimming pools etc. in previous ImProfil issues.*

# KRAH'S SHORT NEWS

Since our last crossword in ImProfil issue #22 was so popular, we have decided to create yet another one. Should you be able to find the solution, please send it to [marketing@krah.net](mailto:marketing@krah.net) and you will get a special Krah package.. Have fun!



- |   |  |
|---|--|
| <ol style="list-style-type: none"> <li>1. What is the easiest way to connect two pipes?</li> <li>2. What is Mickey? A... program</li> <li>3. Which fiber is used to reinforce Krah pipes?</li> <li>4. What is the tank machine of Krah called? .. one</li> <li>5. Krah pipes are regularly installed in a...</li> </ol> | <ol style="list-style-type: none"> <li>6. What is an unusual application of Krah pipes developed by Dainippon? ... shelters</li> <li>7. What is the abbreviation for American Water Works Association?</li> <li>8. What is the most Southern country to work with Krah pipes?</li> <li>9. What is one of the main advantages of Krah pipes?</li> </ol> |
|---|--|

# **IMPROFIL**