EDITION | 2020

KELLER INSIGHT

KELLER

KELLER SEE BECOMES KELLER SEN
Our Keller family grows. Interesting projects in the far north

HSEQ
Health and safety is our top priority. Progress in this field – made by Keller

160TH ANNIVERSARY
From 1860 until today. Keller's 160th anniversary

EDITORIAL

What we **remember**

Usually it is very easy for me to write the editorial to our Keller Insight magazine. There are always two or three events a year that stay in your memory – that have shaped you – and these are the things you would like to share. And there are some coming up in the next year that you are already looking forward to...

... and then you're faced with a year like 2020!

The 'Covid-19' virus has turned our private and professional lives upside down. At the beginning of the year, none of us expected anything like this. Suddenly we were confronted with the 'new normal'. 'working from home', 'home-schooling', 'keeping distance', 'wear a mask', 'washing and disinfecting hands' were our new reality. But what happens to employees on the construction sites? How can we protect this group that actually keeps our business running? Questions that were answered quickly thanks to a great team, so that we were able to re-start all construction sites across Europe SAFELY after a short interruption in mid/end of March. And the reason that we were able to handle some very interesting projects again in 2020, despite difficult conditions, and put together an interesting magazine for you.

Of course, the coronavirus has kept us busy since March, but there were positive events in the two months before. One of them, which we're delighted to talk about, is that our Keller South East Europe family has grown northwards. Norway, Sweden and Finland are now part of our business unit since January (more on this on pages 6–13). We warmly welcome the new employees and look forward to picking up where we left off in 2021: with a good and equal collaboration.

Welcome – Willkommen – Velkommen – Välkommen – Tervetuloa

Dear business partners, dear friends, I sincerely wish you all the best for the future, whatever it may bring. Let us first reflect on the important things in life – family and health – then manage the business with the mutual trust that we have built up over the past few years.

Stay healthy!

Yours,
Andreas Körbler

MASTHEAD

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We are always there for you – **even in difficult times**

Working from home, keeping your distance and reducing contacts to a minimum are perhaps synonyms for the corona pandemic, which has been shaking the whole world since this year. The pandemic also affected our large Keller family, which is spread all over the world. However, we have never lost sight of our values. Integrity, collaboration and excellence were our priorities despite the pandemic.

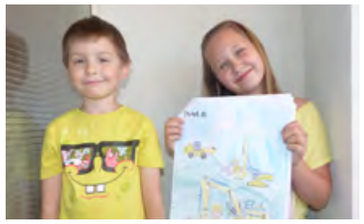
Sophia Anna Holl

It is in the end, when we finally see the outcome. But until now we made it this far without major restrictions to our business. Our conclusion from this year and the raging pandemic is that cohesion and the expanded capabilities of this globally distributed family have made it possible to get here. Countless video conferences that were made from home and that were often interrupted by children, a non-functioning Internet connection or other everyday situations, repeatedly provided a laughing stock or sometimes got on our nerves.

Office work that was done from a tree house, at the dining table with the whole family or on the sofa in front of the TV was part of the everyday work of a Keller employee. The somewhat unusual and different way of dealing with work and the experience that resulted from it required particular commitment from all of our employees.

The work of our company does not only take place in the offices, but rather on the construction sites, which represent the core of the company. Our blue-collar workers have demonstrated maximum performance under difficult conditions, especially this year. The health and safety of our employees is always of the utmost importance, so of course the implementation and compliance with all measures to combat this pandemic were priority in order to make work on the construction sites possible again. So we managed to keep the work you are used to with positive energy.

A very special thank you this year goes to all of our customers and business partners who have placed their trust in this company and were willing to accept special circumstances and thus make a project possible. But also to all employees; be it from the construction site, the office, the yards or from home: without you – Keller's soul – all of that would not have been possible.



Our Keller Insight **magazine becomes interactive**

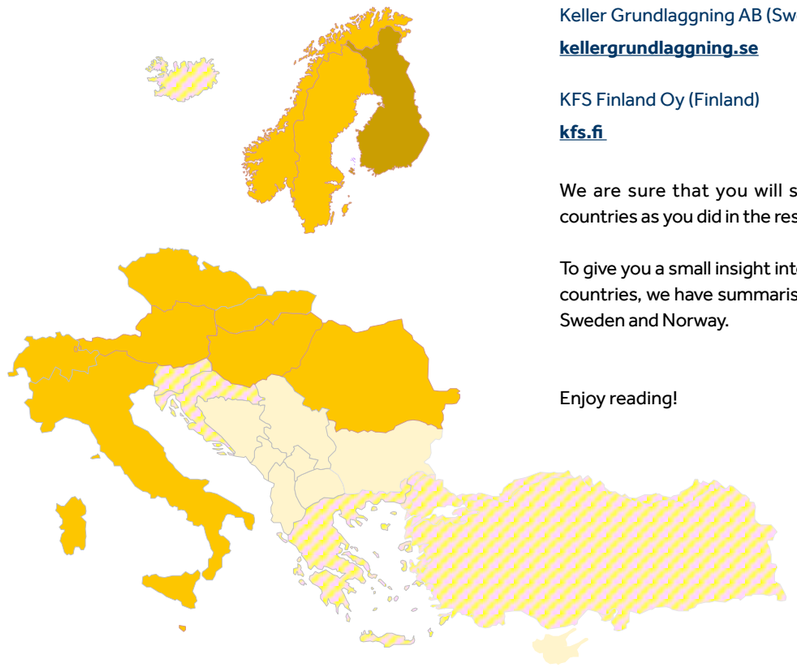
When reading through this year's Keller Insight, you will notice URL or QR codes. Here you will find all the interesting information about our techniques and the described projects.

If you scan the QR codes with your smartphone or tablet, you will be automatically redirected to the YouTube video of the respective project. Of course, you can visit our YouTube channel at youtube.com/c/KellerGroup and find out about our worldwide projects. In this way you automatically get an insight into the practical part of our work.

You can get even more information if you look at the web version of our magazine, which you can view and download from our website www.kellergrundbau.at

Geographical borders are irrelevant to Keller – **Keller SEE becomes Keller SEN**

As you could read in the editorial, the borders of South East Europe in the Keller world now extend to the far north. After we have repeatedly supported our colleagues with staff and equipment in recent years, and as an Austrian company were able to carry out several projects in Iceland, this was now the next step. As a result Norway, Sweden and Finland have been part of our business unit team since January 2020.



This merger has made our multicultural image, which we have always been proud of, even more dynamic. After all, there is nothing better than working with so many people from different countries and cultures.

Another advantage that this expansion of the business unit brought with it is the expansion of our technique portfolio that now includes dry deep soil mixing and sheet piling.

If you want to contact the colleagues in these countries directly, you can find all contact details via the following links:

Keller Geoteknikk (Norway)
keller-geoteknikk.no/en/

Keller Grundlaggning AB (Sweden)
kellergrundlaggning.se

KFS Finland Oy (Finland)
kfs.fi

We are sure that you will show us the same trust in these countries as you did in the rest of Europe.

To give you a small insight into our field of activity in the Nordics countries, we have summarised some interesting projects from Sweden and Norway.

Enjoy reading!

PROJECT INFORMATION

Investor:
KKL-Holding GmbH
Customer:
Kapl Bau GmbH
Geotechnical consultant:
Wsp and Sweco
Design:
Sweco and Keller for temporary sheet piles, WSP for water management

Quantities:
500,000m DDSM columns
9,000m² sheet pile wall with
250 permanent anchors
6,000m uplift anchors
25,000m² temporary sheet pile walls with **3,000** rock dowels

Execution period:
since May 2020 (ongoing)

Årstafältet E01, Stockholm – **Keller lies the foundation for the future**

The Årstafältet project is currently one of the largest urban development projects in Stockholm, Sweden. Six thousand new homes are to be built on this site, along with several preschools, primary schools, and sports halls. It is very important to lay the foundation for the future infrastructure of this large upcoming development project. A recreational park covering over 30 hectares is also to be constructed on this site.

Tünde Lorinczi - Keller Grundlaggning

On this project Keller executed around 500,000m of DDSM columns for soil improvement, 9,000m² of permanent sheet pile with 250 pieces of permanent anchors with a total length of 7,500m for the new dam, over 6,000m of uplift anchors for the dam slab, 25,000m² of temporary sheet wall with over 3,000 rock dowels, welded waling beams and back anchored foot beam. During execution, Keller executed even filter wells for ground watering, infiltration and ground level monitoring pipes.

DDSM works:

Årstafältet lies next to a large underground tunnel. During execution Keller found anchors used for the retaining wall in the ground. These were used during the construction of the tunnel.

Keller with its wide experience in deep soil mixing came to help the client by adjusting its mixing tools and retrieving the old strand and bar anchors from the ground so that the stabilisation and soil improvement process could be executed together with the upcoming piling and sheet wall installation works.

PERMANENT SHEET WALL:
Thick layer of moraine layers, considerably deeper bedrock levels than predicted and remains of wood were found in the area of the former dam which was drained for the execution of the retaining wall of the new dam.

Keller, with its expertise in the area, developed suitable solutions to ensure execution without interruptions and eliminated time loss for the client.

UPLIFT ANCHORS:
The bedrock profile underlying the clay layer posed a challenge as the self-drilling anchors are less stiff in comparison to other drilling techniques for uplift anchors.

With its extensive experience, Keller managed to rapidly and cost effectively meet the client's needs by reducing the effect of the leaning bedrock with pre-injection works.

TEMPORARY SHEET PILE WALL
The Årstafältet project required the excavation of a new canalisation system for the upcoming city development. These pipelines had to be installed up to six metres underneath the existing ground level. The longest pipeline is around 2,300m long passing through the Årstafältet field and embedded in various layer profiles, involving thick clay layers up to 35m and as well shallow bedrock areas where blasting between the sheet piles and foot anchors was necessary.

Keller's design team supplied the client with the design and execution of the temporary structure with the great advantage of in situ adjustments due to the variation of bedrock level above and under final excavation level and its effect on design considerations.

A SMALL JOB **CAN BE BIG TOO**

PROJECT INFORMATION

Investor:
Olav Thon Eiendomsselskap ASA
Customer:
STØ Entreprenør AS
Geotechnical consultant:
ConSisu AS
Design:
ConSisu AS

Quantities:
125m Soilcrete® (Ø1,5 – Ø2,0m)

Execution period:
April 2020

This small job in the street 'Bernt Ankers Gate' was located in the city center of Oslo, Norway. The main part of the project consisted of demolishing and building several new housing complexes around the block. Since one of the existing buildings had historical value and was listed, it couldn't be demolished and had to be fully refurbished while the exterior was kept intact. To use the building for future apartment purposes, the foundations had to be secured. To carry out the project, secure the foundations and stop future settlement, it was decided to underpin the foundations with jet grouting columns down to bedrock.

Andreas Vermedal - Keller Geoteknikk

Keller Geoteknikk AS, the Norwegian branch of Keller, was awarded the jet grouting works. The works consisted of underpinning all load bearing walls with Soilcrete® columns of various diameters and lengths. The biggest challenge in the project was the limited space condition in the basement and in the rig area for our equipment.

The ground conditions
The present soil conditions were very typical for the city of Oslo and over the years Keller have established a good experience in this type of soil. The ground conditions in the area consisted of dry crust clay down to 3–4m depth and then silty clay down to bedrock. The depth to bedrock varied between 20 and 15metres while the water table was registered about 2.4m below the existing terrain.

Solution
The solution for the project was to establish overlapping Soilcrete® columns under all loadbearing walls. To reduce the total length of columns, only every fourth column was installed down to bedrock from underneath the existing foundation. The three columns in between was made like an arch with column lengths of 4m, 2.5m and 4m to distribute loads over to the longer columns and down to bedrock. The columns that went down to bedrock had a diameter of 2.0m while the ones in between had diameters of 1.8 and 1.5m. The compressive strength requirement from the client was 8MPa. The solution also made it possible for the client to lower the basement in the building at a later stage.

Execution
To execute the works within the limited space conditions, a KB1-2 rig was mobilised. The underpinning was done from within the basement of the existing building. The existing foundations was core drilled through to get the centre of the columns as close to the wall as possible to reduce any irregularities. To be able to achieve the diameter of 2m and the strength requirement of 8 MPa, while also keeping the return spoil density down, all columns had to be pre jetted with water. The return spoil from the production was brought directly to landfills by vacuum trucks and trucks with tanks due to the limited space on the site.

The project was successfully finished within the timeframe and the average compressive strength achieved in the columns was around 14 MPa.

Gothenburg's **West Link project**

The West Link project consists of a railway tunnel under Gothenburg city providing commuters with new travel options within Gothenburg as well as in the neighbouring municipalities. The project involves the building of two new stations, in addition to the Central Station in Gothenburg city.

Keller Sweden in action
play YouTube video

PROJECT INFORMATION

Investor:
Trafikverket
Customer:
West Link Contractors- WLC JV (Wayss & Freytag and NCC- area E05), AGN JV (Astaldi, Gulermak, NRC-area E03 / E04), NCC (area E02)
Geotechnical consultant:
COWI, Norconsult, Geomind
Design:
Design & Built

Quantities:
approx. **350,000**m³ DDSM
approx. **4,000**m Soilcrete®

Execution period:
since 2018 (ongoing)

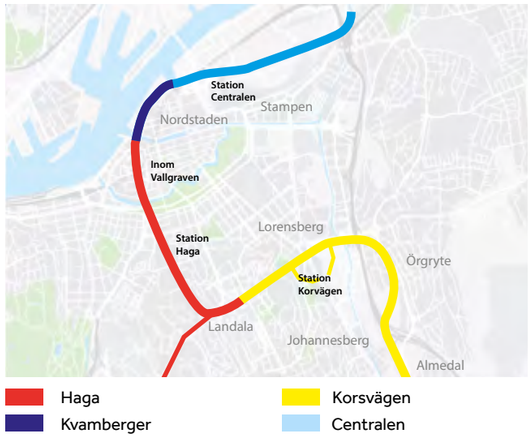
Sami Ullah Raja - Keller Grundlaggning

The first construction phase of the project began in May 2018, and the finalisation of the project is expected for 2026. The total costs are estimated in excess of EUR 2 billion. The project is divided into five sections, each one tendered and awarded individually. Keller is involved in four of these contracts assisting the special foundation works with various geotechnical techniques since the design and planning phase in 2018.

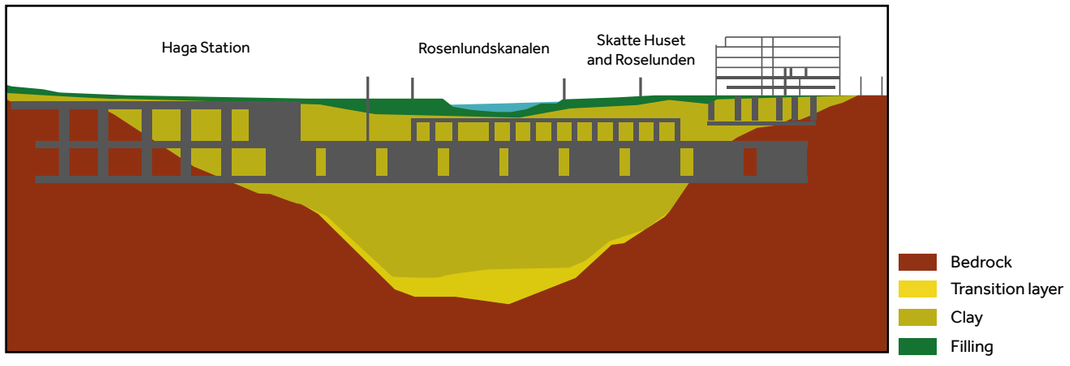
Dry deep soil mixing (DDSM)

Due to the partially very weak soil conditions in Gothenburg (even so called 'quick clay'), the excavation works required soil stabilisation to be executed using lime and cement mixed binder. Keller was awarded DDSM works, at two major parts of the Westlink project- Korsvägen and Kvarnberget – after executing successful test fields for DDSM works in December 2018.

GRAPHIC:
Overview of the West Link Project



GRAPHIC:
Typical soil profile in Gothenburg



The works have demanded intense planning and highly skilled production due to the tight space constraints, central location of the sites and sharing of work area with many other contractors. Day-to-day measures to adjust the production has been necessary due to the close proximity to the existing structures and the risk of settlements this brings.

After Keller's entrance into the project, Keller has continuously capitalised on its strong local presence and adapted its production techniques to various demands regarding column depth, strength and final purpose.

So far Keller has stabilized approx. 130,000m³ of clay in various locations and total value of DDSM works is expected to be around EUR 12 million upon completion.

Jet grouting

To reduce the water ingress and effect of uplift forces during tunnelling works, the design at Liseberg (part of Korsvägen contract) required a combination of a jet grouting slab and uplift anchors. Keller performed an extensive test field for these techniques at the Liseberg in January 2019. Following the test field, Keller was awarded an additional contract for jet grouting plug covering an area of 460m². During the execution of these works, Covid-19 started spreading and added completely new variables to the operations management. Staying true to our number one priority – the health and safety of employees, customers and partners, while minimising the interruptions in its service to the customers – proved to be a challenging but not insurmountable task for Keller.

Considering Keller's performance at Liseberg, Keller was invited to take over the jet grouting works at Service Tunnel 209 and complete almost 95% of unfinished works.

In addition to these big projects, Keller has been actively involved in executing jet grouting for sheet pile sealing, sheet piling and rock dowel installation at smaller sections of the West Link project.

Whilst the project remains under execution in various parts, the successful implementation of various foundation techniques in challenging conditions at the West Link project has demonstrated Keller's strength as a reliable partner for its customers using combination of our global strength and local focus.

Radiumhospitalet – **Keller completes entire excavation pit**

In the heart of Oslo, Sykehusbygg is planning a new hospital for proton therapy which will be adjacent to the already existing hospital for the treatment of cancer patients. The construction of the hospital is projected to be finished at the end of 2023.

Christian Wetzlmaier - Keller Geoteknikk

PROJECT INFORMATION

Investor:
Sykehusbygg HF
Customer:
Hab Construction AS
Geotechnical consultant:
Norconsult AS
Design:
Norconsult AS

Quantities:
1,750m jet-grouting Ø1.00-Ø2.00m
2,600m jet grouting sealing
4,500m injections
360 footbolts Ø100–150mm
60m micropiles Ø273mm x 6.3mm

Execution period:
since May 2020 (ongoing)

Because the planned newly constructed building is adjacent to an already existing building as well as to a public street, an excavation pit for the construction of the building is necessary. In addition, foundation piles up to the rock for the degradation of the loads of the prospective building are to be manufactured.

The works of the excavation pit include soil stabilisation, underpinning measures using jet grouting as well as an excavation enclosure. The latter was designed as a rear-supported sheet pile wall up to the rock by the contracting authority. Geologically notable is especially the rock, which reaches depths of up to about 25m from terrain level. Because of the essential foundation of the sheet pile wall up to the rock, special attention needs to be given to the connection to the rock, because this poses a technical challenge.

That was where Keller started by offering the excavation pit enclosure as an intermittent, anchored bored pile wall with jet grouting sealing in between as an alternative. This does not only obtain an improvement for the connection of the rock, but also enables the gain of a higher flexibility altogether which is not given by the sole sheet pile wall. These synergy effects finally convinced the customer who therefore placed the order on Keller.

Right after the start in May, soil stabilisation (because of sensitive clay layers – quick clay) with the help of two dry mixing rigs began.

At the beginning of June, the bored pile works followed with a bored pile rig weighing 100 tons which produced in the aftermath of the soil stabilisation the intermittent bored pile wall. In mid-June, the jet grouting works in the underpinning area of the existing hospital started. After sufficient advance of the bored piles, the sealing in between the existing piles ensued.

By the middle of July the production of the injection drillings for the filling of the chasms in the rock and the footbolts, which anchor the bored pile in the rock in the foot area, started. Currently, the production is running at full speed and is a daily logistical challenge. Up to now, measured by sales, 40% of the extent of work is finished.

The execution of the temporary strand anchors started in September and subsequently the micropiles for the foundation of the new hospital is planned. The completion – according to the current status – is projected for March 2021.

Working for Keller
since 2015

Facts and figures:
Studies in civil and infrastructure engineering in Cluj-Napoca, Romania and masters in Graz, Austria

Worked on sites in Romania, Finland, Austria and many more

Mind the gap – **A Keller woman travels Europe**

Many people still think that construction is a male-dominated industry, and they're unfortunately right to a point – women are still a minority on construction sites.

As a company which always tries to overcome boundaries and for which 'diversity' isn't only a word but a way of living, we actively encourage women to join our teams on site. And we're glad that we already have many female engineers and site and project managers across the globe.

One of these women is Tünde Lorinczi, who is a Junior Project Manager working for our Swedish branch Keller Grundläggning in Gothenburg. We had the chance to talk to her about her interesting (working) life so far with Keller.

How and where did you hear about Keller?

I studied civil and infrastructure engineering in Cluj-Napoca, Romania and then took a masters in geotechnical engineering, part of which was in Graz, Austria. That's where I first heard about Keller being one of the biggest and most respected companies in its field.

How long have you been working for Keller?

I joined Keller Romania in 2015 as a design engineer and then got the lucky chance to assist on a jet grouting project in Helsinki as a site technician. That was a game changer – I fell in love with project execution and ever since I've been a project engineer working on sites in Hungary, Austria, Finland, Norway and now Sweden, where I'm junior project manager.

What was your experience as a woman in this field? What's your advice to other women?

This is still a profession where women are underrepresented. But I can say I've only ever been trusted and treated with equality here.

My advice for women joining the industry is to remind them that we're just as capable as any man. In my experience, if you set a goal and you're determined, hardworking and persistent, you can achieve anything.

Know yourself. Find your passion and follow it. It's alright to be uncertain sometimes, so ask for advice or take a step back and try another way. But whatever you do, never give up.

Le Grand Paris (LGP)
Huge Metro extension in the French capital

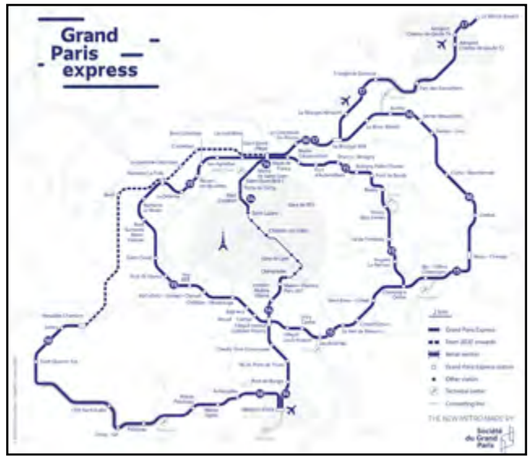
Global strength and local focus (Keller's motto) is in action at Le Grand Paris. Long-standing personal contacts and an exchange of know-how between the business units were the key to success in participating in one of the largest infrastructure projects worldwide. The total length of the underground extension is 200km. These are divided between the extension of the existing line 14 and the new lines 15, 16, 17 and 18 to be built.

Christian Sigmund - Keller Grundbau, Wien

The good cooperation between Keller Grundbau in Austria and Keller France goes back more than ten years now. For this reason, it was not a big surprise when the two companies joined forces in 2017 as part of the planning phase of the LGP project. Keller offered several techniques during planning stages and was ultimately awarded the jet grouting works on line 17-lot 1. Our general contractor on site is a consortium consisting of the companies Demathieu & Bard, Implenia, Pizzaroti and BAM, grouped under the name 'JV Avenir'. The Soilcrete® works in this project serve as a soil improvement between the final tunnels and vertical shafts. The connecting tunnels must be impermeable to water and strong enough to allow safe mining. These so-called 'connection galleries' are located approx. 30m below working level and more precisely 20m below the groundwater level. In addition, the soil tends to liquefy.

The special foundation works are therefore very complex and require the latest jet grouting technology to meet the numerous design requirements. Precise drilling is essential due to the difficult soil conditions. The diameter of the columns is limited to 2m in the prevailing soil conditions – sandy, clayey silts. The drilling depth is 30m. The end position of each individual column must be visualised three-dimensionally in the Revit program. Evidence of the required column diameter had to be provided for 5% of all columns, which Keller does accurately using the internally developed ACI® technology.

OVERVIEW:
Current metro extension in Paris



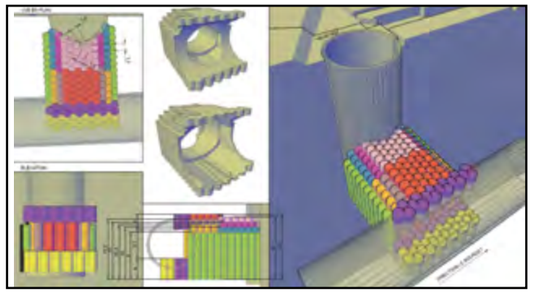
A drainage of the returned spoil was already taken into account in the design phase. As a result of the logistical problems due to the high volume of traffic in Paris and the high price level of the disposal, a chamber filter press was provided for the drainage, whereby the residual moisture of the return could be reduced to approx. 30%.

Further equipment on the construction site was a new high-pressure pumping station and one of our largest drilling rigs, which are manufactured in-house at Keller – a KB6-2 – with which we were able to maintain the high standard that our customers are used to.

The cooperation between Keller France and Austria on this project began in the tendering phase and ended with the deployment of personnel and equipment on site. Sharing experience, know-how and culture (!) was the key to success. During the first tendering phase, several engineers from various Austrian branches worked as part of a large tendering team in our office in Paris. Jet grouting experts were on site for a few weeks to share their experiences with local staff.

After this training program, the enthusiastic team from Keller France was able to carry out this complex project completely independently to a high standard.

GRAPHIC:
Jet grout column layout of one of the connection galleries



DETAIL:
Jet grouting core drillings

GIWOG **Pichling**

In 'Pichling', a district of Upper Austria's capital Linz, 42 houses with rental apartments will be built on a 98,000m² area over a period of ten years. Grocery stores, doctors and therapists and a kindergarten are also planned.

PROJECT INFORMATION

Investor/Customer:
Gemeinnützige Industrie-Wohnungs-aktiengesellschaft GIWOG
Geotechnical consultant:
Wsp and SwecoOÖ BPS
Design:
CARUS GmbH

Quantities:
approx. **6.500**m vibro compaction

Execution period:
January – October 2020

More info about the project:
giwog.at/projekte/details/linz-pichling-wohnen-beim-see/

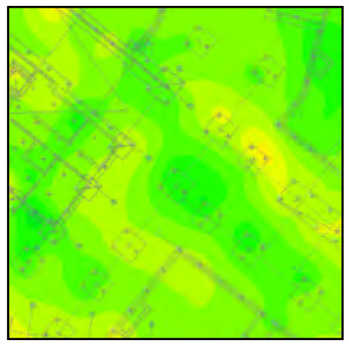
The housing estate is divided into several areas, which are built and managed by various non-profit developers. The 3–4 storey houses are built using the lowest possible energy construction method. (www.giwog.at)

Due to the loose compactness of the sand-gravel mixtures in this area, a ground improvement had to be carried out by means of vibro compaction. This technique leads to an increase in soil compactness into a medium to dense state or to a homogenisation of the subsoil. Through the course of the works, the self-compaction potential of the soil in particular becomes apparent through a lowering of the working platform by up to 70cm.

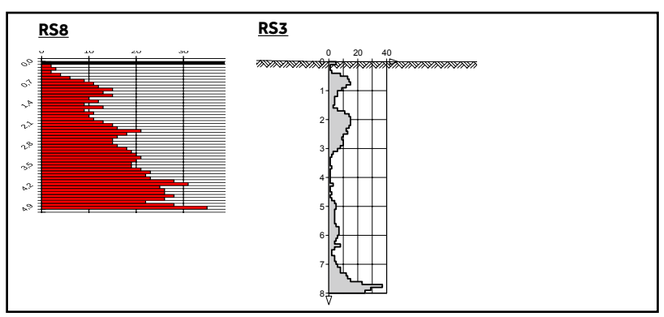
For quality assurance, soundings and evaluations using vibro scan were carried out.

In addition, a test field was created for a diploma thesis at Graz University of Technology. The diploma thesis deals with the changes in tension that arise in the soil when using the vibro compaction technique.

GRAPHIC:
Vibro Scan of GIWOG Pichling



GRAPHIC:
Soil reconnaissance by means of dynamic probing (RS3 before, RS8 after)



Nature conservation concerns us all... **and it requires special foundation works too!**

The Wachau belongs to the NATURA 2000 conservation area, which has committed itself to preserving biological diversity. The EU-funded 'LIFE+ Auenwildnis Wachau' project is currently being implemented in the area.

Markus Zehetner - Keller Grundbau, Wien

Part of this project was to enable the development of the already existing drinking water well of market town Rossatz after the construction of the new Schopperstatt branch, as well as the widening of the existing Danube branch near Rührsdorf. For this purpose, two new bridges are required, founded with bored piles.

In the heart of the Wachau, between Rührsdorf and Rossatz on the right bank of the Danube, nature conservation plays an essential role. Part of the EU-funded LIFE+ project is being implemented in this beautiful meadow landscape. The aim of this project is to ensure the conservation of flora and fauna and their habitats through appropriate measures.

In this project, viadonau – Österreichische Wasserstraßen-Gesellschaft mbh, also paid attention to the fact that on the one hand the preservation of species protection is a priority, on the other hand the needs of the community, neighbours and the population are preserved and both components are always in a balanced status. Therefore a resource-saving and collaborative project development can take place.

Two almost identical concrete girder bridges were built to develop the floodplain areas 'separated' by the side arm. In order to provide the appropriate foundation of both bridges, secant and cased bored piles with a length of 10m were executed. These are intended to transfer the occurring loads of the structure into the load-bearing ground.

In the case of the bridge on the Schopperstatt (Rossatz) branch, the construction of the necessary bored piles was easier, as the new side arm was planned to be excavated at a later point in time.

In the area of the existing side arm near Rührsdorf, the opposite bank could only be reached via the existing bridge to be able to produce the bored piles.

Thanks to the very good cooperation and coordination with our contractor, Schuller Bau & Transport Ges.m.b.H., this 'bottleneck' could also be solved quite easily.

For quality control, the bored piles were checked after an appropriate hardening time with an integrity test using the hammer-blow method ('low-strain method'). This method provides conclusions about the pile length, the concrete quality and the cross-sectional equality.

PROJECT INFORMATION

Investor:
via donau - Österreichische Wasserstraßen-Gesellschaft mbH
Customer:
Schuller Bau- & Transport Ges.m.b.H.
Design:
Schneider Consult ZT G.m.b.H.

Quantities:
360m cased and secant bored piles

Execution period:
February – March 2020

We, as Keller Grundbau, are very pleased that we were given the opportunity to be part of this nature conservation project, as environmental considerations also play an important role in our company.

Handl production hall – **Keller helps to uphold tradition**

In 1902 the grandfather of the current owner, Karl Handl, opened a butcher shop in the middle of Pians in Tyrol. Julius Meinl, known for his exquisite products, was supplied with packaged cold cuts from 1923. In 1970 Karl Handl took over the company. The company headquarters was moved to the outskirts of Pians and in 1990 Handl Tyrol became a well-known brand. In 2012 the company was handed over to the fourth generation, Karl Handl Familien Beteiligungs GmbH, which is managed by Christian and Markus Handl.

Michael Matt - Keller Grundbau, Innsbruck

Markus Handl BeteiligungsgmbH is now building a new production hall at a distance of around 200m from the headquarters on the outskirts of Pians.

On the southern part of the construction site, which lies at approx. 840 m above sea level, we faced an inclination of approx. 44° towards the Sanna, the local stream of the Paznaun valley. Due to repeated backfills and deposits of material of various origins with different installation conditions, the explored soil shows strong inhomogeneities.

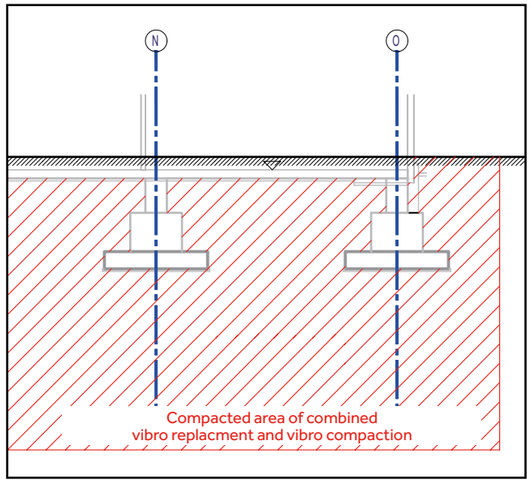
Having theses boundary conditions in mind, it was necessary to improve the soil before the construction of the building could begin. The design showed the necessity of a soil improvement using vibro replacement, so that Keller was awarded the combination of vibro replacement and vibro compaction by the customer Ing. Hans Bodner BaugmbH & Co. KG.

The given value of the bearing pressure resistance on the improved soil layers was given as $q_{f,d}$ = 250kN/m².

Due to the construction process (building retaining walls on the valley side and reinforced earth in advance by the construction company), the compaction works could only be carried out in two construction phases and with structural work already underway.

The logistical challenges were exacerbated during the construction phase by the effects of the Covid-19 pandemic, but it was possible to handle the project satisfactorily in close cooperation with all parties involved and to complete the soil improvement works on time.

GRAPHIC:
Standard section



PROJECT INFORMATION

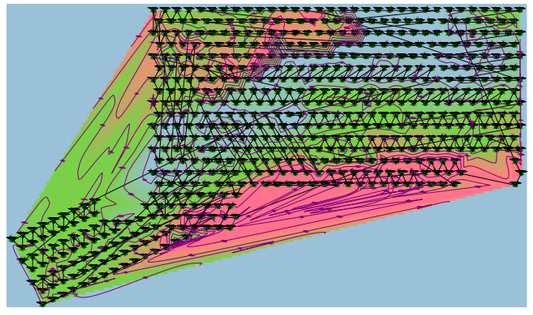
Investor:
Markus Handl Beteiligung GmbH
Customer:
Ing. Hans Bodner Bau Ges.m.b.H. & Co. KG
Geotechnical consultant:
Geotechnik Team GmbH – Techn. Büro für Geotechnik und Wasserbau
Design:
ATP Architekten Ingenieure

Quantities:
approx. **4.000** m² combination vibro compaction and vibro replacement

Execution period:
1st phase: April–May 2020
2nd phase: June–July 2020

Company details Handl:
handltyrol.at

GRAPHIC:
Vibroscan Handl Tirol



Max penetration depth [m]

<	3.60
<	4.20
<	4.80
<	5.40
<	6.00
<	7.20
<	7.20
<	7.80
<	8.40
<	9.00
<	9.60

Revitalisation of the **former main post office in Vienna**

Revitalising historical buildings in inner-city locations, which is difficult and usually involves high investment, has become more and more attractive for the real estate industry in recent years due to the favourable economic conditions.

Andreas Kratochvill – Keller Grundbau, Wien

This project, the former main post office in the first district of Vienna, is a listed building complex from the years 1849–1854. The extensive and existing conserving renovation includes the expansion of the top floor, adapting the use of the standard floors and the ground floor (residential, hotel and commercial), as well as the construction of a new five-storey underground car park under the Dominikanerhof.

Compared to new buildings, historical buildings require a special approach to the planning and implementation of construction work. For example, due to its age, the fabric of this particular building no longer meets today's technical standards and it has already undergone several conversions over the years due to changes of use. A comprehensive inventory is therefore the first basis of increased importance in the project.

PROJECT INFORMATION

Investor:
Postgasse 8 – Entwicklungs OG
Customer:
Hazet Bau GmbH

Quantities:
approx. **8.000** m^3 Soilcrete®
approx. **3.100** m temporary anchors

Execution period:
January – September 2019

Many thanks go to Stefan Kirnbauer and the entire team on the construction site, who made sure that this project could be carried out successfully.

Design requirements and geology

The high building loads and the great excavation depth, supplemented by a groundwater difference of almost five metres, were the most severe challenges in this project.

From a geological point of view, the building is located in the gravel area of the so called Vienna city terrace from the riss glaciation. The original area between the two inner courtyards was situated at a height of about +12m above Vienna level (Wiener Null). Sandy fine to coarse gravel or gravelly sands of the Viennese city terrace were found under a cover layer of heterogeneous embankments. Below that, at a depth of approximately -12.50m W.N. either tertiary fine sands or gray-brown, clayey silts opened up, which from a hydrogeological point of view are known as 'stevedores'. The maximum ground water level was located at +2.00m W.N., taking into account the proximity to the Danube Canal.

Why Soilcrete® (jet grouting)?

The production of bored piles or diaphragm walls was not considered due to the existing possibilities for bringing them into the inner courtyards.

Thus a solution of anchored jet grouting columns was designed. In order to transfer the high loads, several rows of jet grouting columns with different diameters and some head widening were necessary. In addition, jet grouting lamellas with an embedment depth of two metres in the aquifer were produced.

To absorb the horizontal load component from earth and water pressure, the jet grouting walls were installed in the ground using two to three rows of anchors. The lengths of the four-strand temporary anchors were between 13 and 15m with an anchor force (P_d) of around 800kN. Deadman anchors with a length of 20m were installed between the Barbarahof and the Dominikanerhof.

Specific experiences

The optimum choice of the situated jet grouting columns in the plan view and cross section to achieve the required static body and the desired sealing function, required the full range of experience in the field of Soilcrete® production. Adjustments to the manufacturing parameters and additional measures could only be made through the use of the right methods to check the column diameter, such as the Acoustic Column

Inspector® (ACI®) and a continuous 3D verification of the drilling deviations. Depending on the working areas, different and suitable drilling rigs of the best available technology were used to ensure economical production. As a result, dense excavation pit without any water ingress or negative impairment of the existing structure was constructed.

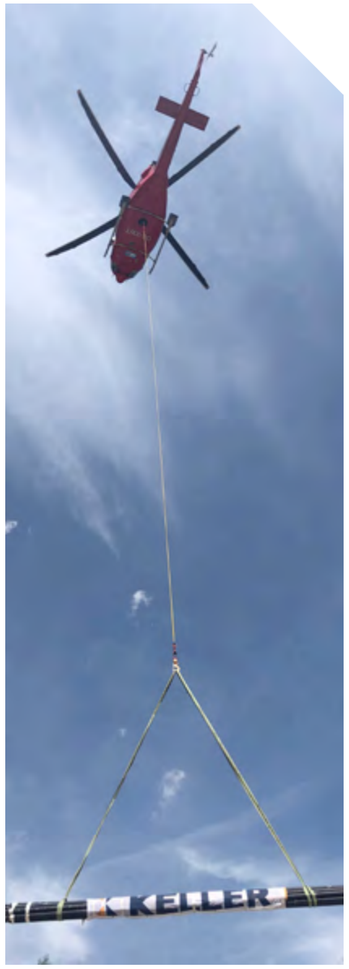
380-kV Salzburg line ‘The first year’

Keller closes the western gap in the Austrian 380-kV ring

With the construction of the 380-kV Salzburg line, the Austrian operator of the supraregional power grid, Austrian Power Grid (APG), is ensuring the security of supply in the Austrian power grid by closing the gap between Salzburg and Kaprun.
This enables the supraregional transport of eco-wind power to the pumped storage power plants located in the Alps.

To cope with the considerable new construction line length of approx. 130km, this project was divided into a total of six construction areas. Keller Grundbau carries out the special foundation works (bored piles with a diameter of 880mm using the Kelly drilling method and micropiles with double corrosion protection SAS670 DN50) in areas 1 to 3 between Elixhausen and St. Johann im Pongau.

The Salzburg line is by far the most important construction project in the entire Austrian transmission network – not only for the country, but for Salzburg in particular. Around 50% of the electricity for Salzburg is not produced in the federal state and must therefore be transported to the region from the APG high-voltage network. The inner Austrian 380-kV ring, which guarantees the high level of security of supply, will be closed at its most sensitive point.



Exposed pylon locations require a flexible choice of equipment

Due to the dimension of the construction site of area 1 to 3 of – around 65km – and the location of the pylons in the open area, one of the greatest challenges is the choice of the specially suitable drilling rig for each location. Varying excavation geometries, which depend on the type of pylon and the slope of the terrain, require detailed coordination in advance to be able to synchronise each pylon location with the complex construction site process.

The bored piles that were carried out up to this point were managed with a BG20 due to the location and the size of the construction site (access via axis in the terrain up to 400m forest path). The micropile works were carried out with a caterpillar drilling rig and a chain dredger with a mounting carriage. For particularly exposed locations without access, ropeways for the material are built and the micropiles are constructed using a small drilling rig with a max. built-in unit weight less than four tons.

Work carried out in 2020 – the first year of execution – went according to the project requirements, so that the completion of the cable works in the Pass Lueg area can continue as planned in 2021.

PROJECT INFORMATION

Investor:
Austrian Power Grid AG
Customer:
Infra Bau GmbH
Geotechnical consultant:
GWU Geologie-Wasser-Umwelt GmbH
Design:
Mayr Ziviltechniker GmbH

Quantities:
Sum-up of all three areas:
Approx . **1,450**m bored piles DN 880
Approx . **44,500**m micropiles SAS670 DN50

Execution period:
Since spring 2020 (ongoing)

MED CAMPUS Graz – **HBK module 2**

On behalf of the Medical University of Graz, the Bundesimmobiliengesellschaft (BIG) – as owner and developer – is building the 'Med Campus Graz HBK Module 2 East'. When finished, it will include offices, and teaching and research areas for various medical institutes.

Roman Weidacher - Keller Grundbau, Söding

PROJECT INFORMATION

Investor/Customer:
Bundesimmobiliengesellschaft m.b.H.
Geotechnical consultant:
GDP ZT GmbH / Dr. Dipl.-Ing. Walter Prodinger
Design:
Riegler Riewe (Generalplaner)

Quantities:
approx. **6,150**m KELLY piles ø 88cm – pit support
approx. **950**m KELLY piles ø 88cm – foundation piles
approx. **420**m² shotcrete
approx. **12,400**m temporary anchors, 4–6 strands
approx. **140** to steel walers
approx. **70,000**m³ excavation work

Execution period:
April-December 2019

In a joint venture with PORR Bau GmbH, Keller Grundbau was awarded the construction of the pit support including earthworks and the necessary deep foundation measures for this section. The services included the construction of bored piles, temporary anchors, shotcrete and self-drilling hollow bar anchors as well as the excavation.

This construction site is located in an inner-city area on a hillside, which is surrounded by two streets – the Billrothgasse in the north, the Neue Stiftingtalstraße in the south – and by various adjoining structures in the eastern and western part. The challenges began with setting up the construction site and delivering the large drilling rigs for producing the bored pile wall and ended with the excavation work itself. In addition, the storage area on site was very limited, so that an interim storage facility had to be set up not far from the actual construction site.

The excavation pit, with an enclosure length of approx. 340m and a maximum excavation depth of almost 18m, was secured with cased bored piles (Ø 88cm, at a distance of 95cm) with lengths between 16.5 and 28.5m over a length of around 255m. In the remaining area (approx. 85m) there are already existing structures from the Module 1 construction lot with corresponding underground floors. After completion of the bored pile works for securing the excavation pit, a concrete grating was placed over the piles, so that excavation could begin. This took place in parallel with the anchoring works. For this, temporary anchors consisting of four to six strands and lengths between 20 and 35m, were installed. The first anchor row was located in the concrete grating covering the bored piles. All other four to five anchor rows were arranged in the gap area between the bored piles. The load distribution on the bored pile wall was realised with steel walers. The geotechnical monitoring consisted of geodetic measurements, monitoring using inclinometers that were newly installed in the piles and the use of numerous anchor load cells. With all these measures, the very heterogeneous subsoil conditions and above all the tendency of movement of the slope were taken into account.

The progress of the excavation works as well as the anchoring were always carried out in close cooperation with the designers and the on-site construction supervision. Due to the fact that the excavation pit had different foundation levels, berms had to be secured with shotcrete and self-drilling hollow bar anchors. Relief drillings were done from an intermediate level and 93 foundation piles between seven and 20m with a corresponding empty run were constructed.

Despite the very difficult geological and spatial boundary conditions, the work was completed to the full satisfaction of all those involved.

Corrective maintenance of existing retaining walls **across the S6**

As a joint venture with Leithäusl, Keller Grundbau was awarded the corrective maintenance of nine retaining walls and four dewatering wells.

Herbert Siegl - Keller Grundbau, Söding

The renovation measures for the retaining walls included the dismantling of the existing reinforced concrete runner elements and the exposure of the existing anchor heads. These were assessed using endoscopy and the load-bearing capacity of the anchors was determined with lift-off tests. On the basis of these results, the stability of the supporting structures was evaluated and, if necessary, permanent strand anchors up to 70m were installed as a replacement. The existing anchor heads were cleaned, coated in several layers, provided with a new anchor cap and protected against corrosion. The work had to be carried out directly next to the Semmering expressway at a height of up to six metres.

The pipe support was left in the ground and used as a drainage line. The drilling deviation was just a few decimetres at a depth of over 80m.

After that, over thirty horizontal drainage systems in several horizons with lengths of 60m were constructed from the wells to drain the creeping slope. The boreholes were made with water flushing using an in-house developed drilling rig, on which a vibrating hammer was mounted.

ANCHOR DRILLING

PROJECT INFORMATION

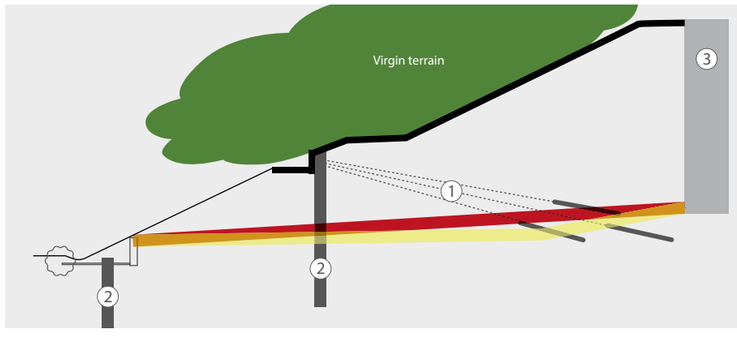
Investor:
Asfinag Baumanagement GmbH
Geotechnical consultant:
approx. **1,300** maintenance of existing anchor heads
approx. **320**mm (4 x 80m) directional drillings for draining the existing wells
approx. **2,000**m drilled horizontal drainage systems – to be installed from the wells
approx. **3,500**m replacement anchors up to a height of 6m and lengths of up to 70m

Execution period:
April–November 2019

DIRECTIONAL DRILLINGS

DRAINAGE DRILLINGS

GRAPHIC
Section of well drainage



S6 SEMMERING EXPRESSWAY

1. existing anchors
2. Bored pile wall; diameter 150cm; distance between the piles 2.5m
3. Existing wells: approx. 6 x 4m; depth: 15–25m
executed directional drillings
Designed controlled drillings

PROJECT INFORMATION

Investor:
GKI GmbH (Tiwag-Tiroler Wasserkraft AG/Engadiger Kraftwerke AG)
Customer:
GKI GmbH
Geotechnical consultant:
Geotechnik Henzinger ZT GmbH
Design:
HBPM Ingenieure GmbH

Quantities:
3,200m bored piles DN1180
3,400m Soilcrete® DN160/220
220m wells
400m strand anchors and micropiles

Execution period:
March-September 2020

Second involvement **at the GKI**

In 2014 the go-ahead was given for the construction of the GKI, the 'joint power station Inn'. The power plant is meant to provide 400GWh hydropower after its eight-year construction phase. The power plant sprawls from the Martina reservoir in the Swiss municipality of Valsot via the Ovella weir on the Austrian-Swiss border up to the powerhouse in Prutz.

Devid Wolfsgruber - Keller Grundbau, Inssbruck

As part of the joint venture 'ST GKI Ovella', Keller was involved in the ground engineering works for the construction of the weir pit from 2016 to 2018. For the support of the 16m deep weir pit bored piles down to 50m were constructed and the spacings were then sealed with jet grouting columns. This pit was then anchored in several strata with strand anchors.

After completion of the concrete construction work on the weir system, the Inn was relocated to create the necessary conditions for the construction of the intake structure and the dopant powerplant and the previous special foundation measures.

The special foundation works for this second construction phase essentially consist of securing the excavation pit and the deep foundation of the structure.

The support for the 10m deep construction pit is made using bored piles with a diameter of 120cm, whereby this is carried out in the upper area, which is directly exposed to the Inn, as a secant pile wall. From a depth of 10m, the primary piles are replaced by jet grouting columns with a diameter of 160cm to a depth of 37m or down to the bedrock.

Bored piles of the same diameter were also planned for the foundation of the structure. Particular attention was paid to embed the piles into the solid rock.
A massive jet grouting block with column diameters of 160 and 220cm was used to transfer the earthquake forces between the structure and the neighbouring rock.

The pile works started in 2019 by a competitor. Due to various problems, these works were briefly entrusted to Keller Grundbau in February of this year, so that the takeover of the work could start in March.

Aware of the complexity and requirements of the upcoming work, the construction site was organised in a very short time, but had to be interrupted for a month in the initial phase due to Covid-19.

Taking the governmental requirements into account, the works were resumed after Easter, so that the construction site could be set up and the piling works could begin.

Despite all the experience gained from the work already carried out on this construction site in previous years, this phase also turned out to be a challenge for our equipment and all people involved from the start.

Two large BG36 type drilling rigs were used for the pile production.

To avoid equipment damage and subsequent downtime, special attention was paid to the condition of the equipment and tools at the start of the construction site. As a result, a large part of the equipment was newly purchased or rented to meet the tight construction time schedule.

As initially expected, the soil conditions were similar to those already found in the first construction phase. By continuously preparing the drilling tools on site, it was possible to counteract excessive wear, especially when digging through the blocks and boulders as well as when embedding into the rock.

Due to the irregular course of the rock, most of the reinforcement cages were adapted on site, resulting in an enormous expenditure of time.

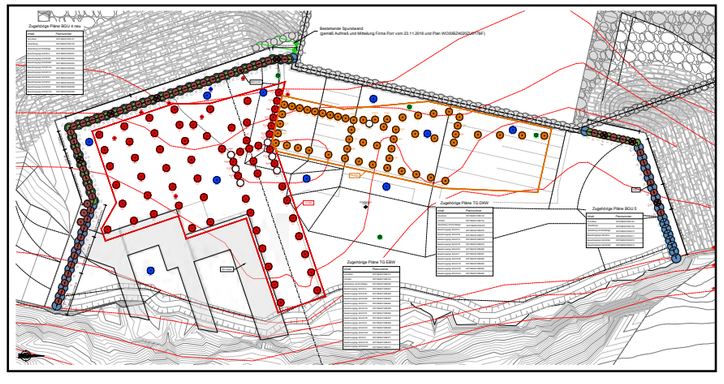
After the jet grouting works started in day and night shifts in June, space on site was reduced even further, bringing with it logistical challenges.

Despite all the challenges, the bored piling and jet grouting works were completed on time in August. The wells for lowering the groundwater table in the excavation pit were built afterward so that the water drainage system is currently being installed to put it into operation in the upcoming weeks.

'At this point we would like to express our sincere thanks to all of the colleagues and third parties involved for their tireless efforts in this project.'

Devid Wolfsgruber -
Project Manager Keller Grundbau

GRAPHIC:
Bored piles drawing



PROJECT INFORMATION

Investor:
Municipality of Rapotín
Customer:
OHL ŽS, a.s.
Geotechnical consultant:
Pöyry Environment a.s.
Design:
AQUATIS, a.s.
Quantities:
Sheet pile walls, bored piles, Soilcrete, micropiles, soldier pile walls, anchors
Execution period:
April 2019 – December 2020

PPO Rapotin – **Another flood protection project for Keller**

For years, Keller has been an important partner when it comes to flood protection. We received the request for the project 'Flood protection measures on the Desná' in 2018. In March 2019, OHL ŽS AG commissioned us to carry out the special foundation works. This included bored piles and micropiles as well as sheet piling and Soilcrete®.

Jaroslav Majer - KELLER - speciální zakládání, Brno

So far, the following services have already been performed successfully:

- A bridge as well as several retaining walls were founded using bored piles.
- Micropiles were used to found two pedestrian overpasses
- An excavation pit for the construction of a weir system was secured with sheet piling.
- The Soilcrete® process was used both for sealing and for underpinning individual objects.

Work began in March 2019 immediately after the contract was signed and, as things stand, should be completed by the end of 2020.

All work is carried out in the immediate vicinity of neighbouring properties and existing buildings, often in extremely cramped conditions and restricted access to the construction site. Thanks to the good coordination and communication between our client and all parties involved in the project and also the owners of the adjacent properties and buildings, the work carried out so far was handed over on time and without complaints.

During the drilling works we often encountered layers of soil with dense gravel and blocks. However, due to the large drilling equipment used and the excellent quality drilling tool, these layers could be drilled through without any problems.

Our jet grouting process has also proven to be very effective in this geology and all requirements and specifications were met.

In contrast to the rather problem-free work of the bored piles and jet grouting, ramming the sheet piling turned out to be difficult in these soil conditions. In the short term, this was evident on the one hand in lower production per shift and on the other hand in greater wear and tear on sheet piles and equipment.

Despite these adversities, KELLER – speciální zakládání was able to carry out and hand over all works up to the present time in the usual high quality and to the complete satisfaction of the customer.

PROJECT INFORMATION

Investor:
ȘOIMENI PARC S.A.
Customer:
ȘOIMENI PARC S.A.
Geotechnical consultant:
GEODESIGN S.R.L.
Design:
KELLER GEOTEHNICA S.R.L
Quantities:
approx. **400** Keller ductile piles (KDP)
Execution period:
August–September 2019

Keller ductile piles **foundation for the 'Colina Nouă' residential complex**

The 'Colina Nouă' residential complex, which means 'New Hill', is located east of the village of Babuțiu, about 25km from the city of Cluj-Napoca. The first development phase of the complex will be carried out on an area of approx. 18,000m² and will include 20 single-family houses, which are divided into a ground and first floor. From a structural point of view, all buildings are similar and are constructed of load-bearing masonry.

Radu Cristian Dumitriu, Bianca Scondac
Keller Geotehnica, Bukarest

The soil in this area consists of a 1m thick topsoil layer, followed by very soft mud with a thickness of 4m and an approx. 2m thick layer of sand with loose to medium dense gravel. Underneath is the competent layer of hard marly clay. The ground water table was found at a depth between 0.8cm and 2m. Due to these soil conditions, a direct foundation for the structures was not an option.

After examining several possible geotechnical solutions, in order to safely transfer the loads from the structures to the ground in terms of stability and deformability, the client decided to choose the alternative proposed by Keller – an indirect foundation made of continuous beams and Keller Ductile Piles.

Depending on the specifics of each building, 19 to 21 ductile piles were constructed per house. The load-bearing capacity of the piles was successfully checked on site in two test fields, which were located between the buildings, using static load tests on four piles.

CONSTRUCTION SITE

CONSTRUCTED DUCTILE PILE INCL. PILE HEAD

All works (including the test fields) were carried out in four weeks, with an average performance of 22 piles per shift.

Bratislava,
Cvernovka NaPG-BCT 0

We have a number of long-term projects underway – that we've written about in previous issues – and we like to check in often to see how they're progressing. This year we're taking a closer look at the 'Cvernovka NaPG' project in Bratislava.

Peter Škoda - Keller špeciálne zakladanie, Bratislava

This is the aging cotton mill 'Cvernovka' in the vibrant 'Mlynske nivy' district. The factory, which opened in 1901 during the Austro-Hungarian Empire, was in operation for over 100 years before it was finally shut down in 2004. Now the listed building is being converted into a modern residential and commercial building under the name 'Zwirn'.

For this project, Keller carried out underpinning works, as well as sealing slabs and pit support using Soilcrete®. Here, the new oval shape of the Soilcrete® columns was used.

Closed borders due to the coronavirus pandemic meant we had to develop an online ACI® (Acoustic Column Inspector®) system in a timely manner using existing technology.

Ground conditions

The prevailing soil conditions turned out to be typical for the region in and around Bratislava. There's an approx. 14m thick layer of gravel (quaternary sediments), followed by neogene deposits (sands and clays), in which the boreholes reached a depth of 22.4m. The first two metres are artificial embankments and old concrete structures.

The construction phase

The entire building will serve as a parking garage with four underground levels. The surface will be converted into a park and a new open space.

The oval Soilcrete® columns were designed at three metres long and 1.5m wide. The static model was designed as a 'comb' solution, meaning that some parts of the wall were wider than others. The specified static shape in the design is 3.8m wide. The construction pit is 12.3 m deep in its entirety with an 18m long anchor horizon, whereby the anchor force reaches 1,000kN.

The completed construction pit at the deepest excavation point shows that the pumping rate for the dewatering, was at 17l/s, and therefore lower than the calculated 24l/s.

Three further phases are planned for this project and we will try to support our client YIT here as well. YIT is a global company in which professional work at a very high level, health and safety and sustainability are the highest priorities – a perfect match for Keller's values.

PROJECT INFORMATION

Investor:
YIT Slovakia
Geotechnical consultant/Design:
in-house Keller

Quantities:
160 oval Soilcrete®-columns
79 temporary anchors
64 ension piles with Soilcrete® columns and micropiles
32,000m³ excavation
1,800m² milling work

Execution period:
March – August 2020

Residence Silvy – Sterzing
Pit support, sealing and deep foundation – everything from one source

With the construction project 'Residence Silvy', Mader Immobilien KG is realising a new and modern residential complex in Sterzing, South Tyrol. The multi-family house is located in a residential area close to the centre of Sterzing and comprises seven residential units spread over three floors.

Stefan Nitz - Keller Fondazioni, Brixen

Due to the limited space, a basement for cellars and garages was also planned , which resulted in difficult boundary conditions.

The requirements for the pit support, which were necessary to build the basement, were high due to soil conditions, limited space and groundwater level. Existing neighbouring buildings next to the construction site, which did not allow any deformation of the pit support, were another problem we had to face. So, it was necessary to find a solution that guarantees stability without additional anchoring and simultaneous waterproofing. In the end, we were able to convince all parties that were involved in the project of the advantages of securing the excavation pit using DSM (deep soil mixing). In the implemented solution, the stability of the DSM wall was guaranteed by built-in I-beams. Therefore it was possible to give up the idea of additional anchoring and the excavation of approximately three metres could be carried out independently. For this reason, it was possible to secure the entire excavation pit in just two weeks. Above all, the double advantages using DSM – pit support and sealing – turned out to be a decisive factor for this project.

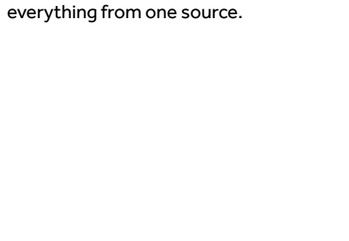
PROJECT INFORMATION

Investor:
Mader Immobilien KG
Customer:
Mader Immobilien KG

Quantities:
DSM (Deep Soil Mixing)
KDP **(Keller ductile piles)**

Execution period:
February 2020 – DSM
May 2020 – KDP

DSM WALL INCL. PILE HEADS



After the excavation and successful lowering of the water level (with a slight delay due to Covid-19), the new residential complex had to be founded on load-bearing soil. This was necessary since the existing soil conditions could not withstand the high loads of the new building. A load-bearing soil was only found at a depth of approx. 18m. Due to the requirements for the load-bearing capacity and the depth of the foundation level, a deep foundation with ductile driven piles was worked out in consultation with all involved parties. The piles were divided according to the vertical loads in the floor plan and flexibly adapted to the existing soil conditions during production.

As this project shows, Keller is once again a competent partner for the implementation of a complete solution. Pit support, sealing and deep foundation – everything from one source.

A new arena for the Lions – **Construction of a Soilcrete® sealing slab**

The ZSC Lions are building a new ice hockey and sports arena for 12,000 fans in Altstetten: the Swiss Life Arena. This arena will be a modern, multifunctional event hall, with steep tiers and a compact cauldron design.

Thomas Kimpritis, Timo Ackermann
Keller-MTS AG, Regensdorf

During the excavation of the construction pit for the arena's refrigerator, it was discovered that the pumping ratio required to lower the groundwater level was significantly higher than expected and therefore the excavation could not be continued as planned.

To address the problem, and allow construction to continue, Keller-MTS was awarded the construction of a low-lying 1.5m thick Soilcrete® sealing slab that reaches a depth of 19m. The heterogeneous soil conditions, with a gravel layer, sandy lake deposits and glacial intercalations consisting of clayey silt with sand, challenged the drilling and jet grouting technology.

During jet grouting works, the existing dewatering process was paused, which caused the groundwater level to rise again to approx. 0.5m below the working platform, bringing it with it an additional challenge for the backflow management and the drilling platform. In addition, bored piles and anchors along the sheet pile walls were already installed which was a further point that had to be taken into account when planning the distribution of columns for the sealing slab.

Due to the very tight construction schedule, it was imperative to produce the Soilcrete® sealing slab with two equipment units. During execution, every borehole and every Soilcrete® column was measured and documented using an inclinometer and plotted in 2D and 3D using the in-house KCI (Keller Column Inspector) program. This ensured that any drilling deviations in the sealing slab could be identified quickly and, if necessary, additional columns could be constructed.

DRILLING HOLE SURVEYING

Even after the first excavation stages, it was clear that the Soilcrete® sealing slab had been successfully built, as expected, and that the requirements were thus fully met.

Keller-MTS - Costruction of a Soilcrete® sealing slab
play YouTube video

OPERATION WITH TWO EQUIPMENT UNITS

PROJECT INFORMATION

Investor:
ZLE Betriebs AG / ZSC Lions, Zürich

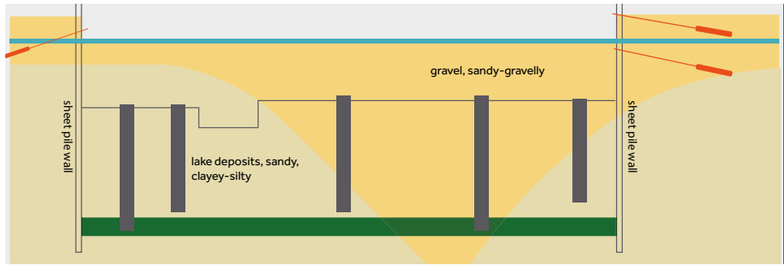
Customer:
HRS Real Estate AG, Zürich

Geotechnical consultant:
Dr. Heinrich Jäckli AG, Zürich

Design:
Dr. Vollenweider AG, Zürich
Ferrari Gartmann AG, Chur
Keller-MTS AG

Quantities:
1,260m² sealing slab
19m depth

Execution period:
November 2019 – January 2020 (8.5 weeks)



SCHEMASCHNITT DICHTSOHLE
- sealing slab
- existing bored piles
- anchors
- artificial filling

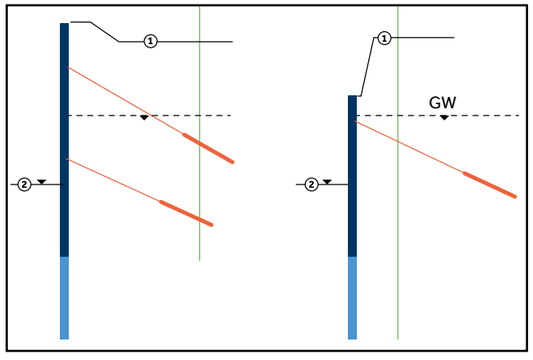
Eurovea 2 – **and it continues...**

Eurovea 1 was a very successful project, which breathed life back into the banks of the Danube in Bratislava. It was the first and so far the last project in Bratislava in which a construction pit with permanent diaphragm walls was carried out using the top-down method. The continuation of this successful project should now take on larger dimensions.

Peter Škoda - Keller špeciálne zakladanie, Bratislava

The entire construction pit will serve as a parking garage with four underground floors. On the banks of the Danube, there will be a public square, and several residential and commercial buildings – one of which will become the tallest building in Slovakia. Eurovea 2 is one of the largest and most important geotechnical projects in Slovakia, the securing of which was originally planned with a permanent diaphragm wall integrated into the neogene sands/sediments.

GRAFIK:
Section



As a subcontractor of Bauer Spezialtiefbau, Keller was awarded the contract for this project after submitting an alternative offer. We were able to show again that we react flexibly and deliver the best solution for every project. As a general contractor, Bauer carried out the CFA piles (continuous flight auger) for the contiguous pile wall and the anchors that were situated below the ground water table. They were also responsible for the drainage system. Keller was commissioned to carry out the gap sealing between the piles using Soilcrete® half-columns and to build the sealing wall downto a depth of 30m. To obtain a surface as flat as possible for a one-sided timbering, the Soilcrete® columns were milled off to the level of the piles.

Soil conditions

The soil conditions in this area are typical for Bratislava. The 50m deep core drillings showed an approx. 14m thick layer of gravel (quaternary sediments) and underlying neogene deposits (sands with pressed water lenses).

Execution of works

Our scope of work consisted of sealing the gaps between the 880mm CFA piles placed every 2m down to a depth of 22m. We decided to use Soilcrete® half-columns with a diameter of 2m. The gap between each pile was only 1.1m. Under the piles we continued with a Soilcrete® sealing wall using half-columns as well, this time with a diameter of 2.5m. Designed depth for that sealing wall was 30m under the ground level.

For capacity reasons caused by the Covid-19 crisis, we were asked to drill the temporary anchors in 12m depth which means that they had to be constructed 6m below the ground water level.

Drilling anchors below the water table creates major challenges in terms of drilling technology on the one hand and the way in which the anchors are installed on the other.

Due to the coronavirus restrictions, it was not possible for us in this situation to share internal knowledge by sending the specialists directly to the site. Our advantage at this point, however, was that we had trained our local staff very well in the various techniques over the past years, so that the correct method was found with the help of video calls and the right equipment (Eurodrill). In this way, we were able to construct the 19m long anchors under the difficult conditions without facing any further problems.

The pumping rate of 133l/s of water for almost 27.000m² was below the calculated rate and shows that the chosen solution was successful.

PROJECT INFORMATION

Investor:
J&T Real Estate
Customer:
Bauer Spezialtiefbau
Geotechnical consultant/Design:
Geotechnik SK

Quantities:
approx. **530** Soilcrete® half columns
approx. **7.000**m² milling work

Execution period:
May 2019 – July 2020

PROJECT INFORMATION

Investor:
NIF Nemzeti Infrastruktúra Fejlesztö Zártkörüen Müködö Részvénytársaság
Customer:
STRABAG Àltalános Èpitö Kft
Geotechnical consultant/Design:
TPA HU Kft
Planer:
IMLAB Mérnökiroda Kft

Quantities:
approx. 80,000m vibro replacement
approx. 385,000m vertical drains

Execution period:
since March 2019 (ongoing)

M76 motorway – **installation of vibro replacement piles and vertical drains**

In western Hungary, a four-lane expressway is being built parallel to an existing main road. The construction work began in autumn 2018 with the removal of the topsoil and is set to be completed in January 2022. The approx. 70km long new expressway serves to improve the connection between Zalaegerszeg and Budapest.

Robert Holczer - Keller Mélyépítő, Budapest

Zalaegerszeg is a city in south-west Hungary, where a test track for autonomously controlled vehicles has been built. The expressway runs in an approx. 8km long section through a marshland to the western end of Lake Balaton.

Strabag received the contract from the Hungarian motorway administration as general contractor and awarded Keller Mélyépítő the soil improvement and vertical drain works on the bridge abutments in the marshland with a volume of approx. 80,000m of vibro replacement and approx. 385,000m of vertical drains. The vibro columns have a planned depth from five to approx. 9.5m and a diameter of 80cm. The calculated length of the vertical drain is between 12 and 20m. The foundation works began in March 2019 and are expected to be completed in spring 2021.

The first part of the compaction works was carried out in 2019, mainly below the new route near an interchange. Once this part has been handed over, the remaining sections will be established and completed in 2020 and 2021, respectively.

When old becomes new – **The viaduct IV21 of the high-speed line Milan-Verona**

The planned fly-over is part of the project for a new high-speed line connecting Milan with Verona. This new viaduct is located in the immediate vicinity of Lake Garda, between Desenzano del Garda and Sirmione. It will replace the existing 'Montonale Basso' fly-over, which crosses the A4 motorway but is unsuitable for the new railway line.

Alessandro Monteferrante
Keller Fondazioni, Verona

PROJECT INFORMATION

Investor:
R.F.I. Rete Ferroviaria Italiana
Customer:
Consorzio Cepav Due
Geotechnical consultant/Design:
CeAS
Design:
CeAS

Quantities:
28.800m vibro replacement

Execution period:
June-August 2020

The geotechnical reports showed that very loose, sandy silt deposits with lenses made of dense sand are dominant near the surface. Further analyses confirmed the risk of liquefaction and thus the need for geotechnical solutions to minimise the risk.

An external geotechnical consultant, CeAS, developed the final design for the general contractor Cepav Due (the consortium responsible for building the entire railway, consisting of Saipem, Impresa Pizzarotti and ICM) and chose the vibro replacement technique as the best solution below the new northern and southern road embankments that are built for the new fly-over.

The project involves the execution of a total of 2,800 columns with a minimum diameter of 60cm. These were split into approx. 1,600 columns on the south side, which reached a depth of 12m, and approx. 1,200 columns on the north side with a depth of 8m. The total length of the constructed columns corresponds to approx. 28,800m, which were carried out with two VC04 rigs and two CAT914 wheel loaders. The execution time was approx. 2.5 months with an average performance of more than 350m per shift and rig.

The IV21 project is one of the best examples in Italy that speaks in favour of our vibro techniques as a solution to minimise the hazards caused by liquefaction. In this extremely important and still ongoing railway project, we were given a great opportunity to demonstrate our know-how and our strong organisation – not least thanks to a perfect team on site.

Štěchovice – **reconstruction of a road and bridges**

Due to increasing traffic and risk of floods, the Central Bohemian Region has is reconstructing the road II/102 between the cities Štěchovice and Prague.

Jiří Čech - KELLER - speciální zakládání, Prag

The project involves the reconstruction of a six-kilometre-long section of the road and three bridges leading along the Vltava river. We were awarded the contract in a joint venture with Strabag a.s. and special foundation works began in May 2019.

Two rows of micropiles 6.5 and 7.0m long have been installed below the road. The new bridges will be built on micropile foundations along with micro rider bracing and vibrated sheet pile wall securing the excavation. All micropiles were originally reinforced with steel pipes, which we changed to GEWI type bars with a diameter of 40mm SAS 550. This change significantly fastened the construction process.

The first complication appeared early on: it was impossible to fill the boreholes with cement suspension. Drilling took place in the rubble of crumbling rock containing fragments (20–150mm), from which the fine-grained component had been removed by erosion. Due to the very high permeability, it was out of the question to carry out the classic production of micropiles. After an extensive series of trials, we managed to find a solution in the form of a special fine concrete mixture. To allow these changes, we had to perform load tests on non-system elements, which confirmed that our proposed solution met all the requirements of the project.

Keller has good results on this site. Currently, all works are being carried out according to the requirements and time schedule of the projects, mainly thanks to the change of the reinforcing element and finding an effective method of execution,. The construction is on track and will continue this way for the next two years.

PROJECT INFORMATION

Investor:
Středočeský kraj (Central Bohemian Region)
Customer:
JV KELLER-STRABAG
Design:
ML s.r.o.

Quantities:
38,7km micropiles
920m² vibrated sheet pile wall
150m² micro rider bracing

Execution period:
since May 2019 (ongoing)

Keller returns to Iceland **with innovative approach and new technique**

Drive on the main road from Iceland's international airport toward the capital city of Reykjavík today and you can't miss the distinctive yellow of Keller's equipment at our South-East Europe & Nordics (SEN) Business Unit's fourth and newest project on this windswept island in the North Atlantic.

Muhamed Mesic - Keller Grundbau, Wien

Located in Iceland's capital region – where two thirds of the country's population live – Keller is working on a Multiuse Sports Hall in Garðabær which will accommodate a full-size football field, allowing for year-round play in Iceland's changeable weather. With a big surge in sports interest sparked by recent successes of Icelandic teams, Keller is happy to contribute to this important investment.

Between 2017 and 2019, Keller Grundbau executed three very successful ductile pile and micropile projects in the same region, and the first enquiry came in April 2019 from a reference for one of these – through Keller's legal department!

The project client, ÍAV hf., is one of Iceland's largest general contractors. This time, however, the significant presence of organic material in the soil required optimisation of the geotechnical design. Keller worked closely with Verkís, the engineering designer of the project, and our client, to help ensure the best technical and economical solution. While Iceland is generally known for its good basalt and rock soils, the site lies in an area of a former creek bed with a 5–10m peat layer sprinkled with irregular blocks.

The solution was to supplement the intended ductile pile and micropile foundation works (approx. 4,000m of ductile piles and approx. 4,700m of tension bars) with dry deep soil mixing (approx. 1,900 piles with a total length of more than 15,000m). Dry Deep Soil Mixing (DDSM) was used to stabilise the soil showing a water content of 400% to avoid buckling and negative skin friction for the ductile piles.

In an innovative approach, a KB7 rig was successfully used for the DDSM works. KB7 is a reliable rig for jet grouting, but due to the present work load in Scandinavia a new setup was required for the work in Iceland. Therefore the team decided to use and adjust a KB7 which turned out to be perfect for the job based on the production rates achieved.

Despite the challenges of travelling to and working in Iceland during the COVID-19 pandemic – with severely reduced flight connections and quarantine regulations in place – Keller SEN was once again able to rely on its strength as one of Keller's most international business units. The on-site team from Austria, Greece, Italy and Sweden, was seamlessly able to find a common language when it came to working together. Keller was also able to rely on a strong network of local partners in Iceland.

Execution began in mid-August and ran until the end of October 2020. The sports hall itself, a steelwork frame building covered with metal insulated prefabricated walls and grass turf roof, is expected to be completed next year. Apart from the sports hall itself, the project also provides for the rerouting of the existing road.

This project marks not just the affirmation of ductile piles as a key technology in the Icelandic market, but also the successful introduction of dry deep soil mixing and innovative execution of this technology with a KB7 rig.

PROJECT INFORMATION

Investor:
B&L Real Estate GmbH
Customer:
B&L Real Estate GmbH
Quantities:
10,000m secant pile wall (diameter 0.88m)
8,000m prestressed anchors
1,000m foundation piles (diameter 1.50m – lengths up to 30m)
9,000m micropiles
125,000m³ excavation Dewatering
Soundings of warfare material
Execution period:
1st March 2019 until expected March 2021

Hafenpark Quartier Frankfurt am Main – **A complete solution for a construction pit**

Directly on the Main, next to the headquarters of the European Central Bank, B&L Group from Hamburg developed the 'Hafenquartier' in Frankfurt. In the 'Honsell triangle', around 600 apartments, offices, a hotel and a boarding house will be built over the next few years.

www.kellergrundbau.de

In November 2018, Keller Grundbau (Germany) received the order to build the construction pit South as a complete solution including implementation planning. The works began at the beginning of 2019 and included the construction of a pit support using a partly anchored secant pile wall. In both the western and southern part of the construction site, a 20m wide area is interrupted by sheet pile walls. After the buoyancy control has been achieved by the building shell and the backfilling of the working space, these are pulled back to establish permanent permeability.

To carry out the complete excavation down to depths of 10m, a water drainage system consisting of wells and relief boreholes had to be built and operated until buoyancy security was guaranteed. Further foundation work that was part of our contract portfolio included 125,000m³ of excavation material, micropiles against buoyancy, foundation piles and investigations using extensive geotechnical and geodetic measuring technology.

After completion of the pit, support works in April 2019 using secant bored pile wall and the sheet pile outlets, the drainage system was put into operation and the groundwater inside the construction pit was lowered as planned. During the subsequent excavation of the construction pit, the micro and foundation piles as well as the first – and in some areas the second – anchor row was created.

Since the construction site was identified as a potential suspected ordnance site, the excavated soil was constantly monitored by a licensed pyrotechnician. This was particularly important when we came across a 500kg WWII bomb. The works were immediately interrupted, the construction site cleared and observed by the police until it was defused.

As soon as the danger was over, the works could safely be resumed and in October 2019 the first part for the building shell was handed over to the customer. The remaining works were carried out until the end of March and the entire excavation pit was finally handed over.

Hafenparkquartier project in Frankfurt
play YouTube video

Dos Bocas **Refinery in Mexico**

Our colleagues from IberAm have carried out a dynamic compaction project at the New Dos Bocas Refinery in Mexico. The site is the largest dynamic compaction project carried out to date by Keller.

www.keller.com.es

Although this site was very large, stratigraphy was mostly homogeneous. It consisted of a layer of loose sand 8 to 12m thick, susceptible to liquefy. Dynamic compaction was considered with the goal to achieve soil improvement for a depth between 8 and 12m, the first 2–3m comprised by reclaimed fill and the rest by compactable native soil. The reclaimed fill contained mostly sand with 20% of fines dredged from the nearby sea bed.

In brief, ground improvement through dynamic compaction was carried out using heavy pounders dropped from a height to rearrange the grains into a more compacted stage.

The works were performed using nine crawler cranes with sufficient capacity to work with a minimum compaction pounder of 25t and a minimum fall height of 20m. Cranes were equipped with a so called "free fall device" that allows dropping the tamper from the working height. Ancillary equipment included shovel loaders for filling the compaction craters and dozers for leveling the ground after all compaction phases.

The initial main challenge for Keller was to complete the whole job – about 2.5 million squre metres of dynamic compaction 8 to 12m deep, with nine rigs working in shifts 24/7 – over a during seven-month period (October 2019 – April 2020). The work was performed using nine cranes with between 120 and 140 ton capacity (Liebherr 889 and 895), and only one of them was located in Mexico, another one was shipped from Spain and the remaining seven from the port of Jebel Ali in Dubai directly to Dos Bocas port on one single ship.

We overcame the lack of experience in this technique, both in Mexico and in our BU, by the continuous involvement in this project of the Keller ME Business Unit and the support of our colleagues from EMEA and other parts of the Keller group.

The site had over 170,000 man-hours of work and 0 accidents for a total of 118 workers. That is what we are proud of.

Renewable energy with **Keller's help in France**

As the energy transition progresses, with the aim of having 100% renewable energy by the end of the century, EDF LUMINUS is building a wind farm consisting of 13 turbines in Villers le Bouillet.

www.keller-france.com

The project concerns the construction of a wind farm with a total capacity of 26 MW. Several solutions for deep foundations and soil reinforcement under the bases have been recommended by the geotechnical report.

The execution schedule required the construction of 13 wind farms in four months. To meet these deadlines, our work had to be completed in two months, requiring the simultaneous implementation of three units.

The land consists of a silty surface layer, then a sandy or even clayey silty layer up to 7m deep, alternating yellow and brown sand up to 13.5m deep, and finally a chalky and/or marly substratum.

In addition, one of the characteristics of this operation is the presence of karstic anomalies under two wind turbines.

To optimise work taking place, and as an alternative to the simple drilled piles and rigid inclusion provided for in the basic description, Keller proposed:

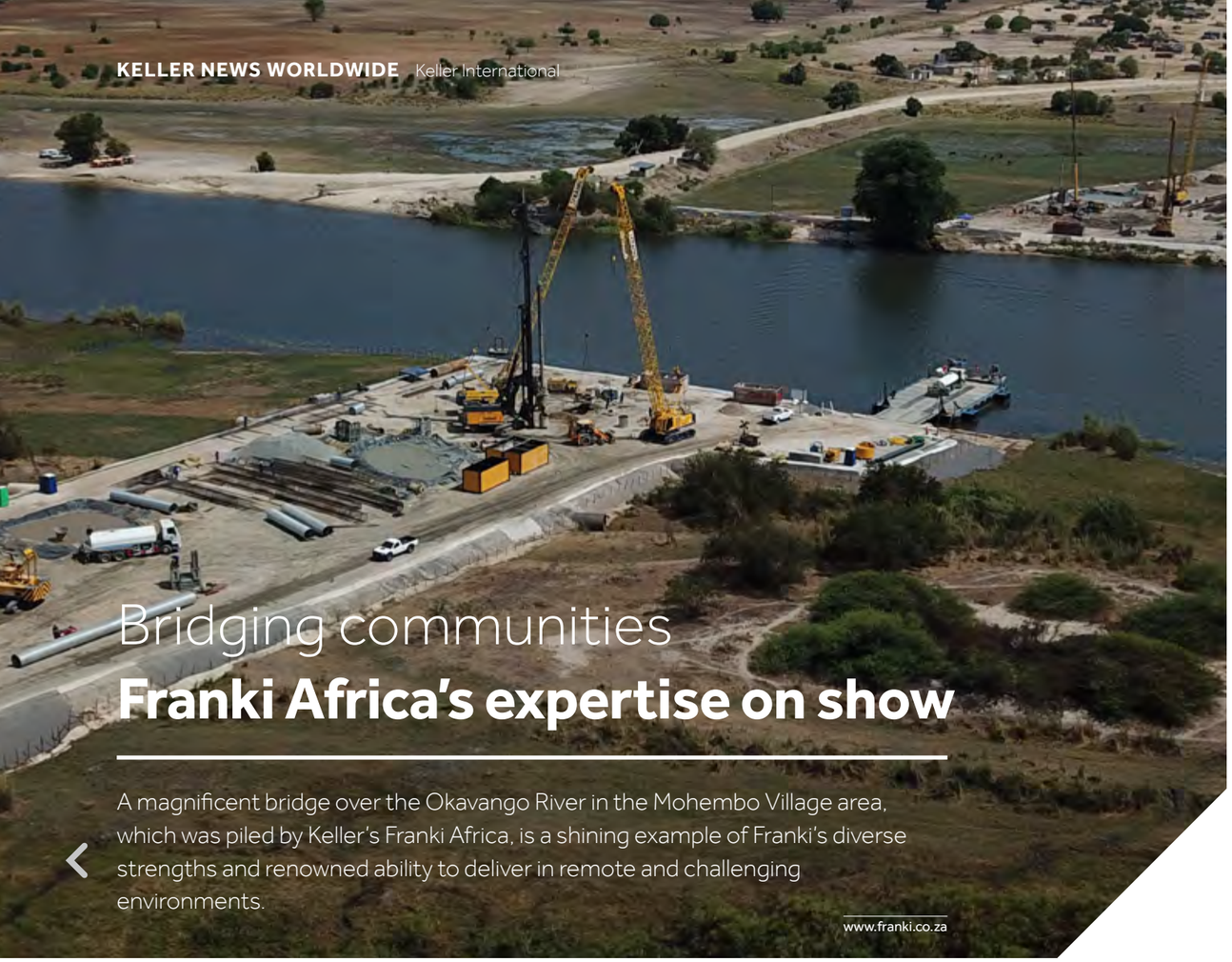
The installation of 820mm diameter CFA piles reinforced ranging from 10 to 19m for four turbines, with the reinforcements dimensioned based on cyclic and dynamic stresses and steel fatigue.

Also, soil reinforcement by CMM® for the eight others avoids the constraints related to the regrading of the rigid inclusions provided at the base; the rigid part of these is drilled with a hollow auger with a diameter of 420mm and are anchored by 1.2m in the compact formations.

The combination of an 80cm gravel head with these rigid concrete parts makes it possible to dispense with the need for regrading.

In addition, for two turbines treated with CMM®, injections of up to 60ml were carried out in order to treat karstic anomalies.

Keller's involvement in this technical and innovative project was successful: the technical objectives and ambitious schedule were achieved.



Bridging communities
Franki Africa's expertise on show

A magnificent bridge over the Okavango River in the Mohembo Village area, which was piled by Keller's Franki Africa, is a shining example of Franki's diverse strengths and renowned ability to deliver in remote and challenging environments.

www.franki.co.za

The bridge, which connects villages on the east of the river with the rest of the country, straddles the Mohembo East (Kauxwi) Ferry landing site with the Mohembo West (Shakawe) Ferry landing site.

The 1.2km bridge, which consists of two towers for the Cable Stayed portion and 18 piers, required 189 no. 1200 diameter, permanently cased auger piles at an average of 35m below platform level. Some of the piles required were installed to a depth of 50m.

In terms of the ground conditions, the top 12m consisted of alluvial deposits underlain by soft rock, schists and gneisses – metamorphic rock developed from basement granites. A thorough geotechnical investigation, including the drilling of over 100 boreholes and the completion of more than 700 rock-strength tests, was carried out by Botswana Roads Authority.

The nature of the site and the surrounding area, including roads and general access, was extremely challenging especially for bringing in the specialised equipment required to do the job which included a Liebherr 355 – one of the largest augering machines in Africa – two Casagrande B180s, a Bauer BG 28 and two Liebherr 845 service cranes. The Liebherr 355 was doing rigid inclusions at Clairwood Logistics Park in Durban and had to be converted to an auger configuration before transporting it to Mohembo, 1500km away. This trip took 14 days!

As the geotechnical work took place on both sides of the river, it was a challenge to get the plant across the river. Our client provided us with a 150t pontoon for the job.

We look forward to seeing this bridge completed. The design shows that it will be a magnificent structure with both towers literally towering over the landscape in the shape of elephant tusks.

Keller serves Middle East
to fulfill its drinking needs

Scarcity of drinking water is a major issue in today's world which is increasing at a rapid pace and is a strain, particularly for countries in Asia and Middle East with their harsh, arid environment. Currently, about 1% of the world's population living in coastal areas is dependent on desalination plants and 40% of this demand comes from the Middle East.

www.kellerme.com

Desalinating seawater is an expensive proposition as it requires significant energy input. The Middle Eastern countries that still have adequate wealth and abundant reserves of fossil fuel and gas are regularly launching new desalination and power plant projects with latest technologies that are more efficient and cost effective. The high demand for desalinated water in the Middle East region is required for potable, industrial and irrigation use.

Keller's presence in the Middle East dates back to the 1970s. Since then Keller has been involved in power and desalination plant projects in Saudi Arabia, Bahrain, United Arab Emirates, Oman, Qatar and Egypt.

Keller is proud to have been involved in the construction of the world's largest desalination plants built in the Middle East region. As these plants are located on the coastal planes, the ground is originally low lying and therefore prevalent with Sabkha deposits. The Sabkhas are mixed soils that have high fines content and are saline. For the construction works, the land is reclaimed to 3.0 to 4.0m above MSL, creating ideal conditions for applying ground improvement solutions.

Keller's innovative and value engineered designs were successfully applied at the world's four largest desalination plants as listed in the table below. The majority of them are in Saudi Arabia, which remains the largest producer of desalinated water in the world.

RANK	COUNTRY	DESALINATION PLANT	DESAL CAPACITY [M3/DAY]	POWER OUTPUT [MW]	KELLER'S SOLUTION
1	Saudi Arabia	RAS AL KHAIR, Integrated Power & Desal. Plant	1,025,000	2,650	Stone Columns (top-feed)
2	Saudi Arabia	TAWEELAH IWP -largest RO Plant	909,200		Stone Columns (top & bottom feed
3	Saudi Arabia	SHUAIBA 3 IWPP MSF technology	880,000	900	Stone Columns (top)
4	UAE	UAQ 150 MIGD, IWP RO Plant (under construction)	681,900		Stone Columns (top)

Tens of kilometres of piles and columns – **geotechnics without risk at the construction site in Police**

One of the largest investments in the Polish industry is underway in Police: the construction of an integrated chemical complex of 'Polimery Police'. After completion, Poland will be one of the leading polypropylene producers in Europe. The complex will include large objects, whose safe foundation in various ground conditions requires the application of special geotechnical solutions.

www.keller.com.pl
www.geo-instruments.pl

The required works are carried out in two zones. The first one covers the area directly on the premises of Grupa Azoty's Zaklady Chemicze in Police, where the main installation for polymer production is planned. The second one is the port part, where a quay and tanks for semi-finished products will be built (two with a volume of 20,000m³ and one of 12,000m³). Additionally, a flyover will be built, connecting the designed facilities in both zones.

The investment in Police required the foundation of several facilities with different techniques and load capacity/subsidence. Therefore, the geotechnical design required a flexible approach and very broad knowledge and experience. Thanks to the cooperation between Keller and Hyundai designers, the highest quality 'tailor-made' solutions were created.

In total, the projects involves about 20km of hybrid columns for the foundation of the main tanks, over 12km of CFA reinforced concrete piles for the port section and for one facility on the site, 55km of DSM columns to reinforce the ground for the main installation and finally almost 2km of micropiles to build the flyover that connects both zones.

In addition to the geotechnical works, a very detailed column and pile testing plan has been prepared for this site, which included column group loads, pile continuity tests, compression test loads on individual columns and piles, horizontal and pull-out test loads on piles. Keller was able to carry out these tests by our own instrumentation and monitoring company - GEO-Instruments Polska.

This site will require the use of several thousand tons of cement and over 10,000m³ of concrete. Only for the construction of the DSM columns, several dozen tons of cement is delivered daily to the construction site. Transport and logistics on site are crucial for meeting the given production goals and time schedule.

The works were carried out without any problems and in compliance with all health and safety standards. The geotechnical works finished in June and the emerging Polimery Police complex, worth about 1.5bn, is to be commissioned in 2022.

Making history with **Miami's Signature Bridge**

Keller is taking a lead role on the first Florida Department of Transport (FDOT) project for half a century to use auger cast piles.

www.keller-na.com
www.geo-instruments.com

With its six enormous, fountain-like arches, the $800 million, 1,000ft-long Signature Bridge will be an eye-catching addition to the Miami Skyline. It will also be the defining centrepiece of a transformed area of the city, featuring plazas, gardens and 30 acres of urban parkland. When early tests showed that the FDOT's preferred foundation method of precast piles wouldn't have enough load capacity, and drilled shafts would take too long, they needed a new solution.

After a bad experience with auger cast piles about 50 years ago, the FDOT was reluctant to use them. However, Keller's successful use of auger cast piles for around 90 percent of high-rise towers in the area, achieving several world records along the way, helped convince the consulting engineers to meet with Keller and develop an auger cast pile design solution. That solution was then presented by Keller to FDOT and the general contractor (Archer Western-de Moya joint venture), who green-lit the project.

After an intense negotiation, Keller was awarded the contract and started on site in September 2019, carrying out a rigorous regime of test piles, with support from affiliate GEO-Instruments.

The project is progressing well. Over the next couple of years, Keller will work in phases to install more than 2,000 auger cast piles, with diameters of 30 and 36 inches, to depths of 134ft.

Health & Safety **in daily use**

In the past we've faced dangerous situations with splintered parts while working with hardened hammers. Sharp-edged shards of metal have loosened from the tool or work-piece and endangered our employees. Wear and tear of the equipment also occurs more quickly due to the hard surface.

To stop this from happening, we started a test phase with alternatives that we could find on the market. From ‚A' as per aluminium, over various PVC and soft-head hammers, till ‚Z' as per Zinc. But nothing was satisfying enough to use it in our everyday working life. Either the power of impact was missing, or the centre of gravity, or the hammer geometry didn't meet our requirements.

All the above led to a suggestion as part of our continuous improvement process from two resourceful employees that work in our yard in Söding, near Graz (AT): spheroidised annealing of the hammers.

On testing, we quickly realised that softer hammers would be the solution to the problem. But unfortunately, unhardened hammers are not common on the European market. Most manufacturers/vendors produces and import their hardened hammers from China.

After a long search we found a reliable local partner in the company 'Krenhof AG' from Styria. This company supported us both technically and during the implementation phase.

> ***This means we can rely on 300 years of experience in forging high-quality hammers Made in Austria.***

In close cooperation with Mr. Roland Meitz, Krenhof's environmental and sustainability manager, we created a profile of requirements that was discussed locally with metallurgist Mr. Reinisch.

And what happens to the old, hardened ones?

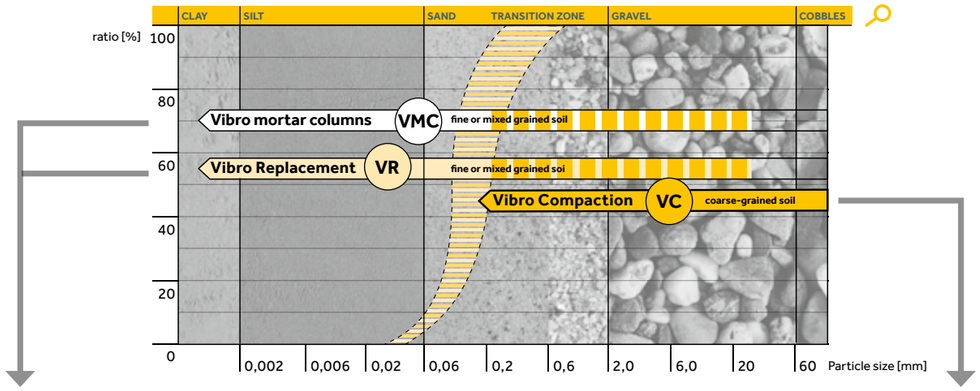
As part of a trainee programme/project where new employees learn the theory of the behaviour of steel types, spheroidised annealing and hardening, they also have the chance to spheroidise anneal the old hammers to reach a similar surface hardness to new unhardened Keller hammers. This means an interesting and practice-oriented skill is then passed on to the next generation of Keller employees.

The outcome: various types of unhardened, forged hammers in Keller yellow, branded with our logo

Sledge hammers and stone mallets from 3 to 6kg as well as egg dollies in sizes of 1.5 and 2kg

Design aid for vibro techniques

The soil determines the technique

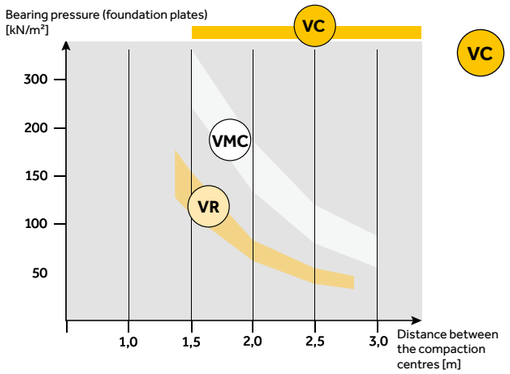


Characteristic bearing pressure under foundation plates / column forces / execution grid

Minimum distance of 1.4 to 1.5m between the column centres, so that the penetration of the vibrator is not affected by the precompaction of already installed columns and to ensure reaching the bearable soil layer.

VMC **VIBRO MORTAR COLUMNS**

- **Char. bearing pressure up to 350kN/m² possible**
- approx. 500–750kN characteristic column force
- The greater the density and thickness of the bearing soil layer into which the vibro concrete columns are embedded, the higher the assigned load per element can be.
- The spacing of the vibro concrete columns depends on the load



VC **VIBRO COMPACTION**

- **possible up to 600kN/m²**
- The spacing of the vibro compaction columns depends on:
  - the density of the existing soil
  - the settlement requirements
  - the used depth vibrator

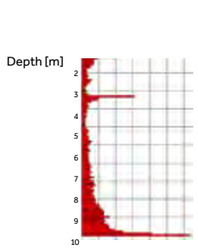
The grid is ideally determined after consultation with the executing company or after a test field.

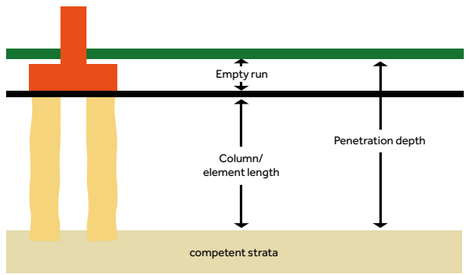
- Usually, grids are between 2.0 and 6.5m²/VC-point.
- The distance between the VC-points is chosen so that the given compaction requirements are met even in the most adverse point between the executed points.

VR **VIBRO REPLACEMENT**

- **Char. bearing pressure up to 180kN/m² possible**
- approx. 250–350kN characteristic column force (incl. surrounding soil)
- The greater the density/stiffness of the soil layers, the higher the assigned load per element can be.
- Max. 2.0–2.5m distance between the column centres in order not to lose the interdependent supporting effect of the columns to reducesettlements.
- The spacing of the vibro replacement columns depends on the load

Determination of the column/element length

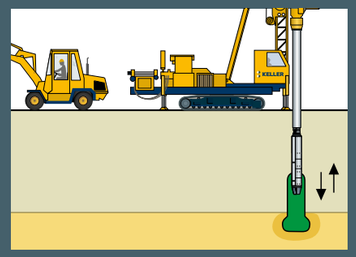
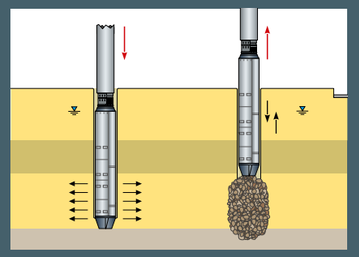
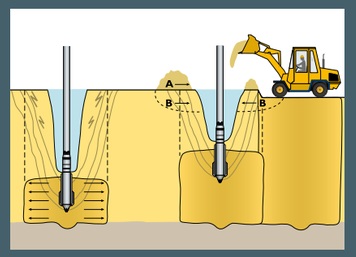




Working platform

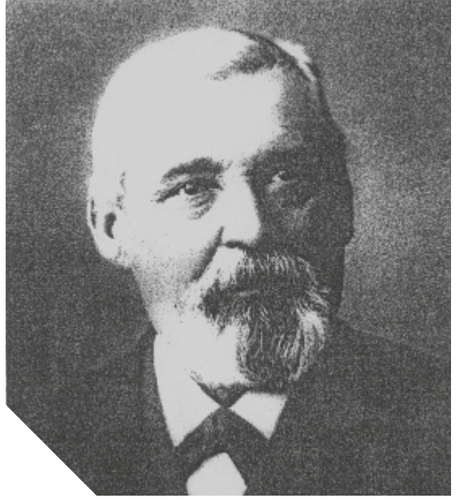
Footing bottom edge

Bearable soil horizon at N10 = approx. 15–20 (DPH15) with sufficiant thickness

VMC VIBRO MORTAR COLUMNS	VR VIBRO REPLACEMENT	VC VIBRO COMPACTION
		
Combination between ground improvement and pile-like elements	Improvement by installing vibro replacement columns with high stiffness into the low-stiffed soil	The result of the vibro compaction is a compacted and homogenised soil below structural load areas
Calculation: • The design of these pile-like elements is not to be done according to ÖNORM B 1997-1-3 pile foundation (see chapter 6.2) • Due to the production with a displacement method, the external load-bearing capacity can be calculated with increased skin friction and peak pressure values of ÖNORM B1997-1-3, Annex C. Increase approx. 15–40% based on the improvement of the surrounding soil and the pre-loading of the column base by the activating force of the rig during installation. • The internal loadbearing capacity is determined based on the compaction strength of the used material and the cross-section area to be created. • Proof of service limit state (settlements) using a modified Priebe method or the Load-Transfer-Method	• Design as a shallow foundation according to ÖNORM B 4435 with increased soil parameters after improvement • Proof of service limit state (settlements) using the Priebe method	• Design as a shallow foundation according to ÖNORM B 4435 with increased soil parameters after improvement
Height of the working platform • Working platform on the top edge of the mortar column or slightly above, to be able to cut the columns in fresh condition to the design level • Single and stripe footings have to be excavated immediatly in fresh mortar condition after the execution of the columns (the same day)	**2 possible options:** 1. Working platform on the top edge of the column or slightly above. After the foundation has been excavated, the column heads have to be recompacted by a roller. 2. Working platform 0.5–1.0m above the top edge of the column or higher. There is no need to recompact the column heads as long as there is no loosening during the excavation of the foundation.	**2 possible options:** 1. Working platform on the top edge of the vibro compaction or slightly above. After the foundation has been excavated, the column heads have to be recompacted by a roller 2. Working platform 0.5–1.0m above the top edge of the vibro compaction and higher. There is no need to recompact the column heads as long as there is no loosening during the excavation of the foundation.
Quality control • Production protocols (depth, Ampere) • In the case of existing, fine-grained soils, no increase of soil density can be expected when probing between the vibro mortar columns. • Compressive strength of the used material • Possibly a large-scale load test on a single column (expensive)	• Production protocols (depth, Ampere) • In the case of existing, fine-grained soils, no increase of soil density can be expected when probing between the vibro columns. • Possibly a large-scale load test (expensive)	• Production protocols (depth, Ampere) • Dynamic probing before and after vibro compaction. In non-cohesive soils, an increase of the soil density can be reached after improvement.

Time flies...

Keller celebrates its 160th anniversary!



160 years ago, Johann Keller founded his company for well and pumping construction and laid the foundation for our global Keller group.

When Johann Keller founded the company in 1860, he was already setting an example for today's success at that time by purposefully adapting the company to the requirements of the industrial age. While wells were asked for in the middle of the 19th century, the development of the infrastructure in Alsace-Lorraine required new approaches. The first reconnaissance drilling in the Rhine and the foundation of bridge abutments in the river around 1880 marked the rise to one of the most innovative companies of the time. It's hard to believe, but many of today's global players were not yet founded. Many other powerful companies have come and gone over time.

'Old experiences - new ways' was the motto at the centenary in 1960, with which the enormous competence and handling experience with complex construction tasks was shown at the time. As today, the 'Keller' brand is a term for innovation, inventiveness and technical competence in the international professional world.

In the ups and downs of the company's history over 160 years, it is difficult to do justice to all events, but from today's perspective, the management buyout in 1990 with the subsequent IPO of Keller Group plc. in London (1994) was a special milestone.

What has remained is the same ambition and drive to break new ground every day and expand what is technically 'feasible', as Johann Keller already demonstrated. Today there is no continent in which Keller is not operating, and with numerous acquisitions we are represented in almost all markets with the locally necessary techniques.

Our anniversary does coincide with one of the most serious crises in recent history, but Keller has proven for over 160 years that it will be stronger than before. For years now, we are happy to work with our customers on new markets and to face the local challenges of construction tasks. We can promise you today that this will not change in the future and that we will always look back on 'Keller-Hannes'' values that we all stick together when things are 'getting serious'. As it has been for 160 years now!

We are sure that, despite all challenges of the current crisis, Keller is perfectly prepared to cope with the construction tasks of current and future customers for the benefit of them and our employees and to celebrate the next anniversary.

JOHANN KELLER G.m.b.H. gegründet 1860

Spezialtiefbau GKN KELLER

KELLER

1860 KELLER 150 2010

KELLER

160 years KELLER

global strength and local focus