EDITION | **2021**

KELLER INSIGHT

SUSTAINABILITY
Building the foundations for a sustainable future

ALWAYS THERE FOR YOU
Our yards in SEN

DIGITALISATION
The construction industry in the digital world

KELLER

A year of change **or maybe not?**

2021 is drawing to a close, and it is time again to review the year. Once again, many beautiful moments shaped the year – both in private and in the professional environment. We have again summarised those of professional life in our magazine.

I am sure that you will find yourself on some of the pages. In any case, it is a pleasure for us every year to be able to carry out these projects with all of you. And I consciously say "to be able to" because we do not take it for granted, but rather hard-earned mutual respect. We are happy about every completed project – no matter how big or small it is.

Unfortunately, there were also a few losses in our Keller family. Death is a part of life. We had to say goodbye to Mr Peter Stockhammer, our first Austrian managing director. In this way, I wish the bereaved once again a lot of strength in this difficult time.

There were also many natural disasters – from severe floods to severe forest fires. It makes us realise that climate change is right on our doorstep and that we all have to act quickly together. It is never too late.

Such events keep us pausing and thinking about the core things in life. But I always conclude that our company is an important part and fixed point in my life for me and that I can count myself lucky to have been doing what I enjoy for decades.

My motivation? – The team

Even if not everything is running smoothly from time to time, I can always rely on the people around me. After almost two years, we are still concerned with the pandemic. Unfortunately, I have to say, because our usual social behaviour is still affected by this virus. Distance, wearing masks, not shaking hands, etc., has had a massive impact on our daily work life, too. The additional pressure on us from our work life does not make the situation any easier. But it is nice to see that our solidarity, the "Keller spirit", continues to exist.

With these words, I say goodbye for now and wish you all the best for the future. I look forward to carrying out many projects with you again next year.

Yours,
Andreas Körbler

HaloCrete®

Adaptation for petroleum contamination

Special foundation engineering sometimes harbours surprises of a chemical nature. Again and again, apparently harmless projects turn out to involve contaminated soil. Diesel* is a particularly frequent culprit, probably because it is used everywhere.
Jet grouting is a fast answer to these problems.

Katarina Kljajic, Peter Freitag – Keller Grundbau, Vienna

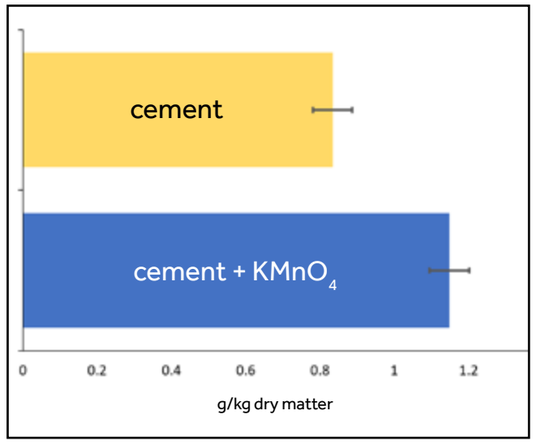
In the past year, Keller had to turn out twice to handle petroleum contamination with this method. One time, diesel had accumulated beneath the tanks of a company filling station over the years and had to be treated. In the other case, a heating oil pipeline developed a leak over the years. This damage was only discovered during construction of a new building and the jet grouting method was used as a timely measure. In both cases, the contaminated soil was successfully secured.

The challenge in these projects was management of the back flow, which had to be examined prior to land-filling, in accordance with current law. This is the focus of a research project that Keller is currently conducting together with the AIT (Austrian Institute of Technology). Following HaloCrete®, which decomposes contaminants in the soil, the aim is to degrade the contaminant through chemical means. The primary goal here is to decontaminate the back flow as much as possible, to enable easier disposal. It uses the proven oxidising agent potassium permanganate ($KMnO_4$).

Another aspect to be examined is the leaching behaviour during hardening of the jet grouting columns. Improvements are sought here, as well.

Laboratory tests to this effect are already in full swing. The oxidation effect on the petroleum-derived hydrocarbons (PDH) in the treated soil is being examined in batch tests. In these tests, contaminated soil is displaced with cement grout and $KMnO_4$ and then tested after eight days of hardening. To do so, the samples have to be carefully prepared and the hydrocarbons must be extracted from the solid material and quantified through gas chromatography (GC). The insights gained here are then applied to the design of further column trials.

GRAPHIC:
Comparison of treated / untreated cores



The objective here is to draw conclusions about the leaching behaviour of fresh jet grouting columns. The assembly is relatively complex. Similar to the tremie method, a plastic pipe is placed in a larger glass cylinder and the pipe is then filled with material. The annulus between pipe and cylinder is filled with sand and the pipe is then withdrawn from the cylinder. This ensures that there is a permeable area around this core. The column is slowly perfused with water from bottom to top. Samples are taken at the upper end of the column and then analysed for their contaminant content. After conclusion of the trial, the cores are removed and handled exactly like the samples from the batch trials.

ASSEMBLED PILLARS:
The Soilcrete® core does not extend to the glass wall, but the violet color due to the $KMnO_4$ is still clearly recognizable. This proves an effect of the measure beyond the treated area.

Initial results show that oxidation can reduce contaminant content in the jet grouting element by 37%. These findings give us reason to hope that the use of a suitable oxidising agent will also enable rehabilitation of the damage itself. This will surely require further examinations, however.

The current tests were completed by the autumn of this year and will be published as part of a master's thesis.

* In chemical terms, diesel is identical to heating oil

A circuitous route to Keller **from biotech to special foundation engineering**

Keller is always on the lookout to recruit and retain young, committed talents. For many years now, these efforts have included hiring seasonal trainees – who are either still in school or have begun university. This has enabled us to recruit highly interesting and interested interns.

In 2021, we made an intentional decision to introduce a different kind of internship and hired Ms Katarina Kljajic to work for us for six months. Katarina came to us via the, FEMtech internship for female students' initiative and is involved in our research project on the further development of the HaloCrete® process.

FEMtech internships for female students aim to attract young female scientists for careers in applied research in the scientific and technical RTI area (research, technology and innovation). The students get to know career entry and advancement paths and gain sound insight into applied research and development. For more information on the program, please refer to the website www.ffg.at/femtech-praktika

It's interesting to see the world (of construction) from the perspective of a young woman who doesn't have the "classic" background you'd expect from a Keller employee.

Who are you?
My name is Katarina Kljajic and I'm 25 years old. I grew up in Upper Austria and now live in Vienna, due to my studies.

What are you studying?
I studied food and biotechnology at BOKU* and have already earned my bachelor's degree. I'm now working on my master's degree in biotechnology.

But food and biotechnology isn't a classic Keller profession...
That's true. I hardly had any skills or even interest in technology until I heard of this field of study through pure coincidence. But now I simply enjoy analysing and understanding technical and chemical connections.

How did you end up at Keller?
Through a circuitous path. The AIT (Austrian Institute of Technology) has participated in the FEMtech programme for many years now. After I finished my bachelor's degree, the time was ripe for me to apply there. Firstly, I had time to do so after my exams, and secondly, I need a balance to my studies – not least due to the pandemic.

Since the AIT has been in contact with Keller for many years based on various research projects, Peter (Peter Freitag – Lead Environmental Geotechnics at Keller Grundbau (editor's note)) had the idea to collaborate in combination with my master's thesis. Since the research project was in my field of interest, it created a win-win situation.

To what extent can these two areas be connected? Biotechnology on one side and contaminated soil on the other?

At first glance, apparently not at all. But if you take a closer look, the methodology of experimental set-up and all the lab tests have a lot in common with biotechnology, primarily the extraction of samples from the soil and the subsequent gas chromatography. From a procedural standpoint, there's no difference between that and my studies. I've already learned many things there and was able to translate them from theory to practice.

What do you think of the programme? It's "only" for women, after all. Isn't that a little discriminatory?
No, not at all. In my opinion, girls are still subject to a role model – whether unconsciously or subconsciously – in which men go into technical careers, while women pursue other professions.

Programmes like this are very good for showing young women that they can work in areas like this. There are no limits, nor should there be any.

There is a lively exchange among the women on the project. The AIT has many interns, which is expanding the network in the technical domain.

How do you feel you are perceived at Keller?
So far, I can only say that everyone has been very nice and lovely. I spend most of my time at the AIT laboratory, but whenever I'm in the Keller offices in Vienna, I'm appreciated and respected by everyone there, even though I'm not an integral part of the team.

I'm very happy with the support I've had on the project and for my master's thesis. It's great and at eye level. I think Peter appreciates me a lot and takes me seriously.

What would you say to other young women in your situation?
You should never let anyone convince you that can't do something or make you underestimate yourself.

You should always be and remain true to yourself, but the most important thing is to learn how to appreciate yourself. Unfortunately, there are still many areas where women have to prove themselves more than men in the same position. Sometimes I think I'd be more likely to be heard as a 25-year-old, 180cm tall man than the 160cm short person I am, but I don't let that deter me. It just motivates me even more to show that we women can achieve everything we strive to.

*The University of Natural Resources and Life Sciences, Vienna

The Federal Ministry Republic of Austria – Climate Action, Environment, Energy, Mobility, Innovation and Technology **supports young women with the FEMtech internships for female students**

FEMtech internships for female students aim to attract young female scientists for careers in applied research in the scientific and technical RTI area (research, technology and innovation). The students get to know career entry and advancement paths and gain sound insight into applied research and development.

The aim of FEMtech internships is to enable female students interested in research to do attractive internships at Austria's innovative companies and non-university research institutions.

Federal Ministry
Republic of Austria
Climate Action, Environment,
Energy, Mobility,
Innovation and Technology

For more information regarding FEMtech and FEMtech internships for female students, visit
femtech.at
ffg.at/femtech-praktika

Building the foundations **for a sustainable future**

Keller's purpose is building the foundations for a sustainable future. We mean that in terms of identifying our key markets and optimising market share, but also very much in terms of having a positive impact on our people, our communities and the world as a whole.
Here, we explore Keller's sustainability priorities and some of the great work that is underway to improve Keller's sustainability.

Luke Deamer – Keller Group, London

Sustainability covers environmental, social and governance. Whilst there are opportunities to improve sustainability across Keller's business, we particularly focus on how we can deliver more sustainable projects for our clients. At Keller, this means we focus on the 4 Ps: planet, people, principles and projects.

Under each of these areas of sustainability, we have a number of initiatives underway. Each of these initiatives aligns with the UN Sustainable Development Goals (SDGs). We use these SDGs because: they are holistic, covering environmental, social and economic sustainability; they are global, with every UN country signing up to meet these goals by 2030; and they are a common language for sustainability, used by many of our clients, investors and trade associations to report on sustainability.

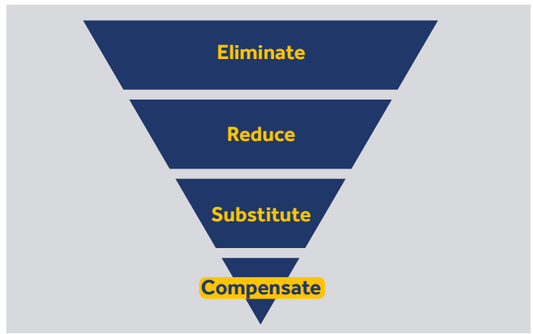
In terms of the planet, Keller realise the need to cut our carbon emissions and help prevent climate change. To drive change in this space, we break down our emissions into three scopes:

Scope 1: Direct emissions from burning fuel on site.
Scope 2: Indirect emissions from the electricity we use.
Scope 3: All other indirect emissions, such as from the materials and business travel.

Last year, Keller produced 176,000 tCO2e last year (scopes 1 & 2). This is the equivalent to around 38,000 cars running for a year or the energy that 20,000 homes use in a year.

This year, we therefore set ambitious but achievable net zero carbon targets. We aim to be net zero emissions for scope 2 (electricity emissions) by 2030, net zero for scope 1 (rig emissions) by 2040 and net zero for non-material scope 3 (business travel, transport and waste) by 2050.

GRAPHIC:
The IEMA* carbon hierarchy which helps us reduce our carbon emissions across our different operations



To help achieve these targets, Keller uses the carbon hierarchy. This means we look to first eliminate emissions completely, such as by using Teams rather than travelling. After this, we look to reduce emissions, focusing on reducing the use of carbon-intensive materials such as cement and steel. From there, we look to substitute materials, using lower carbon materials, before finally we look to compensate through emission offsetting.

*IEMA = Institute of Environmental Management & Assessment

Improvement Imperative	Sustainability		
	Enviroment	Social	Governance
Driver	Profitable projects		
	Planet	People	Principles
Global Initiatives	Carbon reduction	Gender DEI Safety	Good governance
Local Initiatives	Resilient cities Resource use and waste Pollution	Race DEI Health and wellbeing Education	Partnerships

Keller therefore offers multiple low carbon solutions. For example, our ground improvement solutions can save up to 90% of the carbon emissions from a conventional concrete foundation. Keller's research & development team have also done some great work developing low carbon grouting materials, such as our new neutrogel solution.

We can also calculate the carbon emissions of any of our solutions using the sector-standard EFFC-DFI carbon calculator. This allows our customers to know their exact emissions, including those from our supply chain.

Keller is also doing a lot of great work with our people. This year, Keller launched new inclusion commitments alongside a new diversity, equity and inclusion (DEI) toolkit. This aims to support our leadership and enable our HR teams to attract and develop the best talent in our sector, regardless of gender, race or any other grouping.

As well as this top-down drive, this year also saw the launch of Keller Women in Construction Europe (KWIC-E). KWIC-E are committed to attracting, inspiring, supporting and developing women at Keller. Composed of champions from across Europe, this group has already started to improve Keller's social sustainability. KWIC-E has both male and female members, reflecting the need to create allies across Keller's business functions.

Additionally, we want to have a positive impact on people beyond our immediate employees. This is why we continue to collaborate with community education projects and rewilding projects across the Keller Group. Our work with trade associations, such as the European Federation of Foundation Contractors (EFFC), has helped highlight sustainability best practices for the whole geotechnical sector. Perhaps most importantly though, we engage with local schools and universities to help create the geotechnical experts of the future.

Overall, sustainability is a key part of our operations at Keller. We offer a range of lower carbon, lower raw material geotechnical solutions. Likewise, we are constantly innovating to reduce our impact on the planet. We continue to push to attract, inspire, support and develop the very best talent in the geotechnical sector. All these initiatives take place within our strong governance framework.

We look forward to collaborating with you in the future and building the foundations for a sustainable future.

*DEI = diversity, equity & inclusion

Söding Competence Centre

More than a mere yard

There have always been several yards and workshops in the SEE business unit – and since the integration of Sweden, Norway and Finland, we now also have a workshop in Lindome, Sweden.

Paul Rott – Keller Grundbau. Söding

The Söding yard has always been a mainstay, and not only for its own BU. With their mechanical engineering expertise, they have repeatedly provided support for the Middle East, Australia and all of Europe. And it wasn't only knowledge that was provided; they also produced and resold a great deal. In recent years, Söding has also developed into a major materials handling hub. Nearly all needs were scheduled, procured, stored and dispatched from here.

Nonetheless, its greatest asset has always been the aforementioned expertise. It has been expanded significantly in recent years. This not only required investments in the location and its expansion; the development of staff has also changed significantly. Just a few years ago, drilling tools were welded in an outdoor area, under a sunshade, by whatever employee currently had time. Today there is a dedicated team with a proper work environment. A hall was purchased, along with a large crane, extraction systems, welding equipment and more. One could say that there is no comparable workshop for large drilling tools on the Austrian market for special foundation engineering. And more than anything else, this statement applies to the motivation and commitment of the staff.

performance at a construction site in Scandinavia isn't the only thing that shines. We gave the same treatment to our "buffalo", a young-at-heart 25-tonne crawler excavator that is used for anchor drilling.

Several years ago, an employee from the anchors' product line was taken on who could no longer work on hard outdoor assignments for health reasons and was therefore assigned to setting up containers. This developed into in-house container production. Paired with the paint shop, it is a commendable project. Over €100,000 have already been invested in new containers through the end of June 2021, a majority of them for Scandinavia, with at least as much being spent on the rehabilitation of old containers.

One larger long-term project is the digitalisation of the warehouse and the associated orders. A first major milestone of it was reached in the end of May: since this point, all material removals are now performed using scanners and when the minimum stock level for an item is reached, a purchase requisition is generated automatically by the SAP system. Digital time recording was introduced in mid-January and has been running smoothly since early February. This has resulted in a marked reduction of the administration effort required in payroll accounting.

Still, the top priority remains employee qualification in the workshop, at the yard and in the warehouse. They are working constantly to develop further and offered training opportunities are gratefully received. We also have to mention the generous capital investments at this juncture: several million euros have been invested in Söding in recent years, to create the perfect conditions for a competence centre. Switzerland and the Czech Republic have also benefited from investments, however. Currently, the main focus is a new location in Sweden. All of this shows extremely high trust in our mechanical engineering, as well as setting the bar high for expectations.

Based on the very positive development in mechanical engineering, we assume that this trend will continue and are excited to see what awaits us in the coming years.

The new hall included taking over a paint shop, which has been shortened somewhat but is still completely sufficient for us. An internal paint option might not be unusual among larger Austrian construction companies, but it certainly is for pure. Electric mixers, diesel and water tanks – and even containers – are regularly removed from circulation and given a fresh coat of paint. This helps create a more attractive picture at construction sites, which we can consider as advertising. After all, even a 25-year-old stirrer can look like new. Small appliances aren't the only things that are repainted – our old KB2 also got a full fresh coat of paint as part of a general overhaul and its

Vienna underground – an overview

Keller supports construction of the new U2 and U5 lines in Vienna

In the course of expanding the public transport network in Vienna, Keller Grundbau will be carrying out regular deep foundation works for expansion of the city's underground in coming years. In the current expansion phase, six new stations, four emergency exits and two tunnel tubes are being built.

Andreas Kalcsics – Keller Grundbau, Vienna

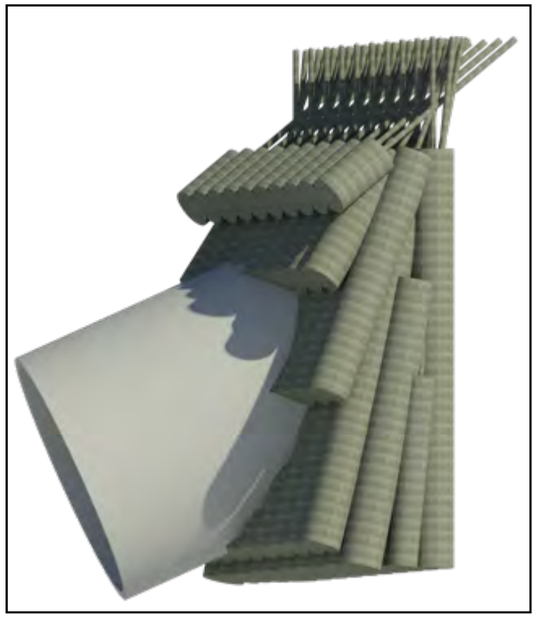
To keep pace with a constantly evolving city and its steadily growing population, Vienna's existing underground network is being extended and expanded. This involves building the new U5 underground line, which will take over the stations Karlsplatz, Museumsquartier, Volkstheater and Rathaus from the current U2 line and be given a new station: Frankhplatz. The U5 will be the first fully automatic line in Vienna.

The U2 line will be extended from the main university campus (Schottentor station) to Matzleinsdorfer Platz. This completely new build consists of four new stations (Neubaugasse, Pilgramgasse, Reinprechtsdorfer Straße and Matzleinsdorfer Platz), three emergency exits and two tunnel tubes for the two tracks.

In total, the two underground lines will require 21 shafts at a depth of around 30 metres. They will be built primarily with discontinuous bored pile walls, using the cut-and-cover method. The concrete between the bored piles will be secured with shotcrete or the jet grouting method, depending on the local geology. The subsequent tunnel construction will be adapted to the geology and the local situations, using the new Austrian tunnel-building method or a tunnel boring machine.

For the construction sections "U2/22 Rathaus" and "U5/2 Frankhplatz", Keller Grundbau has been commissioned as the special foundation engineering firm in the techniques of jet grouting, compensation grouting and shotcrete nail walls. The first execution work started in July 2021 for the U2/22 construction section, with production of the first jet grouting elements. The soil that is rigidified through the jet grouting process serve to minimise subsidence and ensure drilling progress in the areas where tunnel tubes, ventilation shafts and escalator shafts will be built later. Additional jet-grouting blocks fulfil the functions of foundation reinforcement, sealing, reinforcement and excavation pit protection activities. A total of around 10,000m³ of jet-grouted elements are planned for the project.

GRAPHIC:
Example of a jet grouting block



Subsidence compensators are another important measure for the safe, non-intrusive production of the new underground tunnels. This method will safeguard many existing objects during tunnel construction by compensating for building subsidence through regular injections. Around 5,000 metres of sleeve pipes will be bored from shafts below the buildings for this purpose. Precise deformation monitoring of the buildings will provide the basis for offsetting subsidence in a prompt, targeted manner through low-pressure injection.

Shotcrete nail walls with a total area of around 1,200 m² will be produced for the supplementary local excavation pit protection activities.

More information about the project:
u2u5.wien.gv.at
wienerlinien.at/u2xu5

PROJECT INFORMATION

Investor:
AT: Federal state of Lower Austria (Office of the Lower Austrian provincial government – dept. of bridge construction)
SK: Bratislavský samosprávny kraj
Customer:
GLS Bau and Montage GmbH
Geotechnical consultant:
3P Geotechnik
Design:
Mayer Ingenieurleistungen ZT-GmbH; Herrmann & Partner International Engineering ZT GmbH
Quantities:
approx. **350m** bored piles
approx. **45m** ductile piles
Execution period:
March – May 2021

Pedestrian and cyclist bridge over the Morava
between Vysoká pri Morave and Marchegg

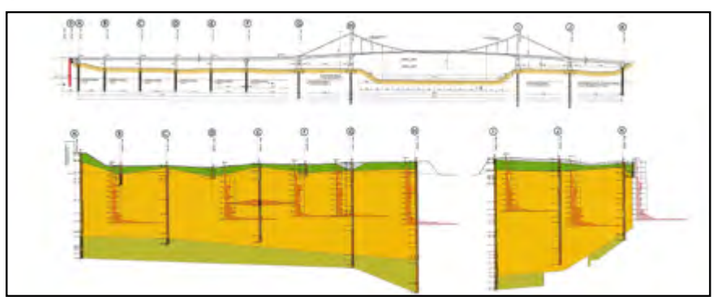
For a cross-border initiative to build a new bridge for pedestrians and cyclists over the Morava River from Marchegg (A) to Vysoká (SK), Keller Grundbau has been commissioned to perform the special foundation engineering work for the necessary deep foundations.

Manuel Glanner – Keller Grundbau, Vienna

Once completed, the new bridge will connect the Kamp-Thaya-Morava route with the international EuroVelo 13 bike path – also known as the "Iron Curtain Trail". The overall bridge structure has a total length of around 260m and consists of one foreland bridge each on the Slovakian and Austrian sides, together with the actual river bridge.

All work has been completed in compliance with all regulations associated with the nature protection areas and flood plains on both sides of the Morava.

GRAPHIC:



In February 2021, Keller Grundbau was commissioned as a contractor to execute cased bored piles with a diameter of 90cm. This involved building foundations for the supports of the two foreland bridges and the river bridge at depths of approximately 16m, in accordance with the geotechnical specifications. In addition to the bored pile foundations, ductile driven piles were also built at the connecting point to the existing flood dam on the Austrian side.

The access roads posed a particular challenge to this bilateral project on a flood plain. Some of them were simple bike paths, which had to be adapted for construction traffic to enable delivery and removal of the drill rigs (BG36) – in compliance with the applicable environmental protection laws.

The special foundation engineering work was finished in May 2021. The overall project is scheduled for completion in the summer of 2022.

Building of Siggerwiesen landfill
550,000m³ of construction waste

The waste disposal firm Salzburger Abfallbeseitigung GmbH is building a landfill for the permanent disposal of 550,000m³ of construction waste at a site near Bergheim. Keller was commissioned to build a double sealing wall system with deep-soil mixing.

Astrid Kaineder / Franz Rathmair – Keller Grundbau, Linz

The landfill site is located at the edge of an industrial building area north-west of Bergheim, near Salzburg, around the Anthering wetlands. In this area, gravel from the Salzach was mined extensively in the 1970s and 1980s and then re-filled with excavated soil.

These recent backfills overlay the thin remaining layer of Salzach gravel, which is followed by still-water sediments (Salzburger lacustrine clay) in depths up to more than 64m.

The planned dumping height of the landfill (up to 25m) on an area of 35,000m², the unfavourable soil conditions and high groundwater levels required extensive preliminary studies of the site's suitability.

These landfill sites require a minimum distance of one metre between the highest expected groundwater level and the landfill rough sub-grade (taking the expected subsidence into account – up to 67cm here). In this construction project, the planned rough grading is located between 402.50 and 404.65m, with a highest groundwater level of approximately 405m.

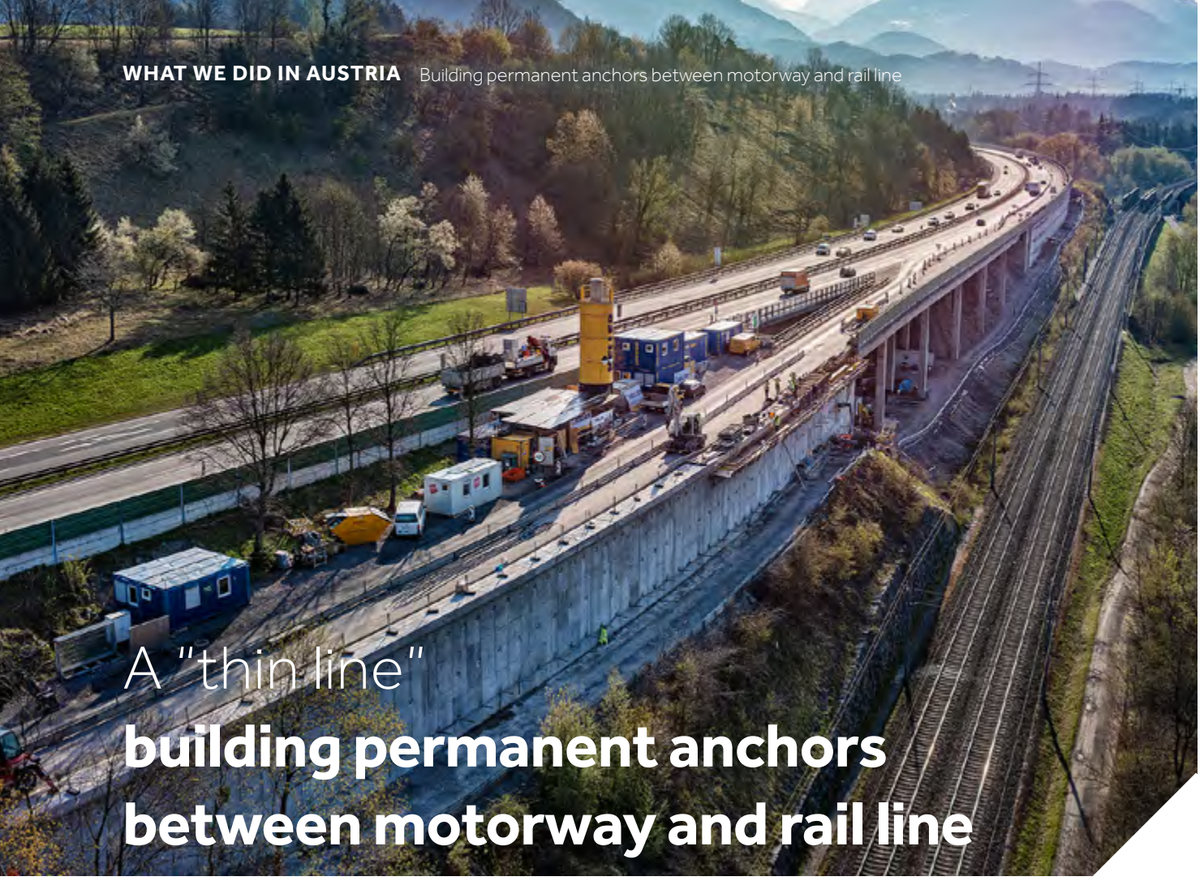
Under this boundary condition, the alternative with full enclosure with a double sealing wall system and dewatering (between the outer/inner sealing walls and within them) to permanently lower the groundwater level in the landfill area. The sealing wall is embedded five metres in the impermeable lacustrine clay and is divided into several sections by transverse diaphragms.

The requirements of the wall elements are defined as permeability of 10^{-8}m/s and unconfined compressive strength between two and five meganewtons per square metre (2-5MN/m²).

In the deep-soil mixing (DSM) process, the remaining soil is mixed with a binding agent suspension using rotating, interlocking mixing arms. The artificial vertical sealing barrier is built by overlapping the individual insertions.

Suitability tests of the soil/binding agent suspension to estimate the achievable material values, as well as extensive quality controls in production (digital recording of the manufacturing process, samples, and so on) guarantee high quality and functionality of this "in situ" deep-soil mixing.

After nearly three months of construction time, the nearly 18,000m² of sealing wall was handed over to our customer.



A "thin line" building permanent anchors between motorway and rail line

In collaboration with the construction firm Tomaselli Gabriel Bau, we were commissioned in the spring of 2020 as a consortium for rehabilitating the retaining walls F5 and F6.

Lukas Waldhart – Keller Grundbau, Dornbirn

The motorway junction AST Feldkirch-Frastanz was built in the 1970s as part of the Amberg Tunnel. After years of heavy traffic, it will be refurbished extensively in the coming years.

The work was divided into several construction sections. The consortium of Tomaselli Gabriel Bau and Keller Grundbau won the commission for the work in the first section. This includes the refurbishment of the existing abutment walls, in the form of building a new facing shell and anchoring the entire abutment walls with permanent strand anchors. The construction site extended over more than 1.5km along the Walgau motorway and the ÖBB rail line.

The building work began in August 2020 with the uncovering of the abutment walls and building of the construction road. Several small shotcrete nail walls had to be constructed for this purpose. Our consortium partner then began building the facing wall, which is 40cm thick and built in several casting sections. Each casting section had an average height of approx. 8-10m and was poured in one go. After the stripping time and hardening of the concrete, the piercing work was begun for the anchors to be built, by means of core drilling. The next step involved producing the permanent anchors used in the construction.

For the drilling work, we leased a Liebherr LB 934 and a drill attachment from Klemm with a double-head rotary motor. The drill had to be adapted to the confined conditions and ensure that the adjacent clearance to the motorway and safety space to the ÖBB line remained free.

The geological conditions we encountered pushed man and machine to their limits. The bond length of the top row of anchors was located in the backfill of the excavated tunnel material. To build the anchors professionally, an average of approx. 2,500l of cement grout was needed for each anchor in the F5 section. The mixing unit had to be adapted to cope with these volumes. In addition, tests were performed on the object anchors, in coordination with everyone involved in the project, to minimise grout consumption.

A variety of aggregates, different grouts and flow packers were used for this.

Anchor work on the abutment walls F6-1 and -2 started in January, to meet the specified construction deadline despite the heavy snow.

PROJECT INFORMATION

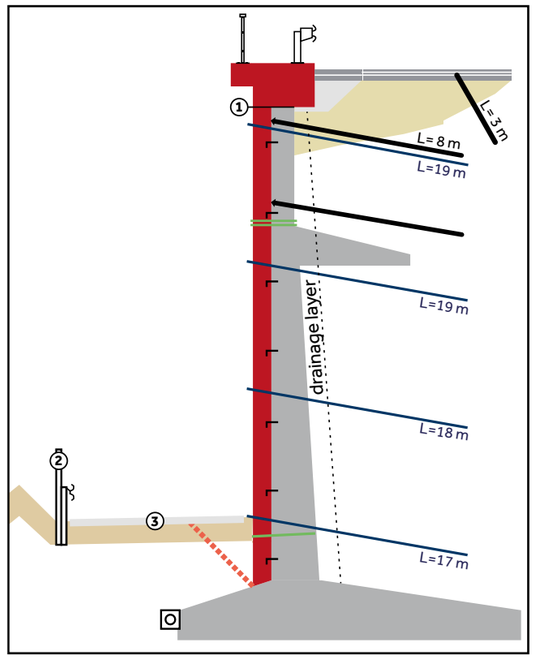
Investor:
Asfinag Bau Mangagement GmbH
Geotechnical consultant:
BGG Consult Dr. Peter Waibel ZT-GmbH
Quantities:
approx. **9,900**m permanent strand anchors
approx. **637**to cement
approx. **100**m² shotcrete nail walls
Execution period:
October 2020 – June 2021

The biggest challenges in these two sections were the extremely confined space conditions that were available to us. The one-way construction road was used for all work and was only around 3.5m wide. As a result, all work steps and processes had to be coordinated closely with our consortium partner, which performed its form and concreting works simultaneously with our anchoring work.

Through the use of a second drill rig (Klemm) and improved soil conditions with regard to consumption, the work proceeded quickly. The original deadline was met despite the vastly increased volume, avoiding contractual penalties.

I wish to thank all the colleagues involved once again for their dedication and commitment.

CROSS SECTION „Q2B"
Retaining structure F6 Part 1 (0+230.00)



Step 1: Construction of facing wall incl. anchors
Step 2: Demolition and rebuilding of the wall head (advantage: 200 gauge can be used longer with a larger width)

- Clean the surface with high-pressure water jets; drill and displace coupler strips (approx. 1.5 piece/m²)
- core drilling DN70 (drainage opening max = 3.0m)
- temporary excavation for the construction of the facing wall
- (1) construction joint incl. waterstop
- (2) anti-fall guard metal beam track with safety fence
- (3) temporary construction road
- Drainage VSR DN 150 filtration body

ÖBB Mürzzuschlag railway station PMZ2

Semmering base tunnel

One of the most important infrastructure projects in the heart of Europe is the nearly 27km long Semmering base tunnel, which crosses below the northern Alps between Gloggnitz in Lower Austria and Mürzzuschlag in Styria.

This tunnel will reduce the load on the historical Semmering railway and reduce travel times. CO2 emissions will also be reduced significantly.

Dominik Binder – Keller Grundbau, Söding

PORTAL: CONSTRUCTION OF BORED PILES

We had already built the shaft construction (overlapping bored pile walls in the upper area) and slope stabilisation (bored piles, shotcrete, permanent anchors) in 2014-2015, in the construction section Fröschnitzgraben Tunnel – SBT 2.1. After its successful completion, we were also engaged to carry out the special foundation engineering work for construction section PM/2 – conversion of Mürzzuschlag Station substructure/structures).

The construction section consists of the following elements:

- Tunnel in cut-and-cover (CAC) method
- Portal structure
- Undercrossing
- Supporting structures

After construction of the slope stabilisation using shotcrete and soil nails in the CAC element, the bored piles with a diameter of 120cm and individual lengths of 16 to 29.5m were sunk in the outcropping rock. The excavation was then performed, with simultaneous gap sealing of the bored pile with shotcrete. The permanent and temporary reinforcements are also being installed. Once the final depth is reached, the base plate and tunnel roof of track 1 will be built and backfilled. In the final state, the slope stabilisation will be taken down in accordance with the terrain modelling.

Once this building section is complete, it will be followed by the portal structure, which consists of the tunnel portal from track 2, a cable collector passage with escape passage and an escape staircase with adjacent operations building. The slope stabilisation required for this consists of a shotcrete nail wall with two anchor levels and extends over a length of around 100m, with a maximum height of some 30m. The connecting bored pile wall in the area of the track 2 tunnel portal will be secured with seven anchor levels and shotcrete between the bored piles. For the escape staircase, the excavation pit is protected by a contiguous, single-anchored bored pile wall.

After the portal structure, the approx. 10m deep excavation pit in the undercrossing will be secured with a shotcrete nail wall, together with a bored pile wall and three-level anchored sheet pile wall along a length of around 180m. Once the protection activities are complete, a box-shaped tunnel profile made of reinforced concrete will be built and backfilled, after which the protection will be partially dismantled. As a result, it will be possible to cross the construction road over the structure, which will serve as an access road to the operations building in its final state.

In turn, as soon as this work is finished, it will be followed by the supporting structures, which consist of contiguous, tangent and secant bored pile walls to the left and right of the rail line, with pile diameters between 90 and 120cm.

UNDERCROSSING:
Construction of shotcrete and soil nails

PROJECT INFORMATION

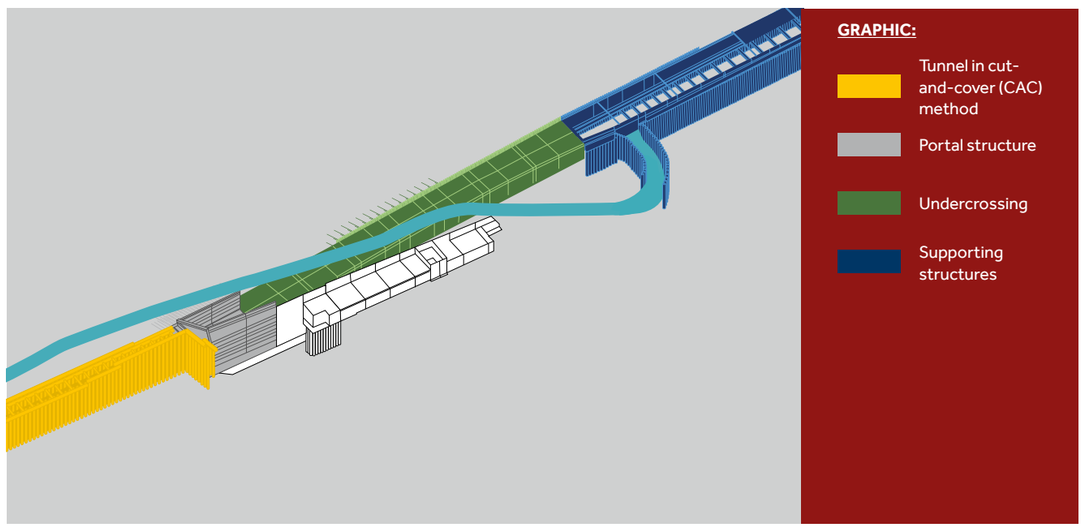
Investor:
ÖBB-Infrastruktur AG
Customer:
Porr Bau GmbH
Geotechnical consultant:
Insitu Geotechnik ZT GmbH
3G Gruppe Geotechnik Graz ZT GmbH

Quantities:
8,400m bored piles
11,500m² shotcrete
26,000m soil nails
8,500m strand anchors

Execution period:
March 2019–August 2021

Thanks to our expertise and the tireless efforts of all our involved colleagues, we were able to successfully deal with the inhomogeneous subsoil – consisting of talus deposits, creek and river deposits, rubble layers and filling in joint faces, crevices and karstic cavities in the carbonate rocks – and keep to the tight schedule.

At the present time, a shotcrete nail wall is currently being built for slope stabilisation in the area of the station.



Tyrol Security Centre

Construction of the Tyrol Security Centre began in the Saggen neighbourhood of Innsbruck in April 2021. In the future, after its completion in 2025, the building will provide new floor space for the state police headquarters, as well as other services of the Austrian Ministry of the Interior.

Devid Wolfsgruber – Keller Grundbau, Innsbruck

Following the demolition of a former nursing home and an existing state police headquarters building in the autumn of 2020, the activities in April of this year involved special foundation engineering work to set up the approximately nine-metre-deep excavation pit for the construction of the two basement levels.

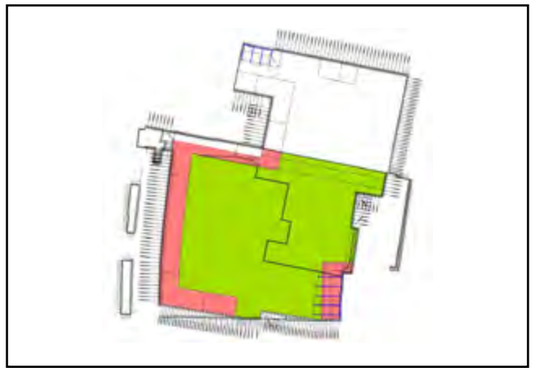
The excavation pit, which is approximately 12,500m² in size, was used as efficiently as possible by the responsible planners, making it possible to build directly attached to the neighbouring existing buildings.

As part of the work, all existing buildings directly adjacent to the construction area were underpinned using the jet grouting process and anchored with strand anchors, to minimise the deformation of the excavation pit structure.

Along Kapuzinergasse, the excavation pit was secured using contiguous bored piles and jet-grouting half-columns between the bored piles.

In addition, for neighbouring buildings whose owners expressly forbade utilisation of their land, bored piles were built adjacently as rigid excavation pit protection elements. Since anchoring these buildings was also ruled out, these bored piles will be braced with steel girders on the excavation pit side after construction of the first basement level is complete.

GRAPHIC:



PROJECT INFORMATION

Investor:
ARE Austrian Real Estate GmbH
Customer:
Ing. Hans Bodner BaugmbH & Co KG
Geotechnical consultant/Design:
ZSZ Ingenieure ZT GmbH
Quantities:
approx. **5,850m³** jet grouting underpinning
approx. **900m** jet grouting gap sealing DN140
approx. **1,250m** bored piles DN60
approx. **5,850m²** vibro compaction
approx. **1,600m²** shotcrete
Execution period:
April–August 2021

To build the two basement levels, the groundwater level had to be lowered by approximately two metres over the entire construction area. To minimise the pumping volume, geotechnical engineers provided for vibro compaction (VC) to reduce the permeability of the soil.

Since the building site lies in the overlap area of the Inn and Sill rivers, this mainly involves rocky, sandy gravel, which is ideally suited for this method. By using the vibro compaction technique, permeability can be reduced by approximately one power of ten, to 10^{-4} m/s. The installation material (0/16 gravel) was provided by a local earthworks company directly at the construction site, by sending the excavated material through a sieving plant concurrently. This made it possible to avoid numerous transports to and from the construction site. The VC was conducted up to the edge of the existing buildings in many areas. To preserve these buildings as much as possible, low-vibration rigs were used in these areas.

To keep with the construction schedule, two rigs were used in parallel for the VC.

Both basement levels of the new building are located in the area affected by the groundwater table. A waterproof concrete tanking ("yellow") is being built as a sealing system. To meet the accuracy requirements for this sealing concept, shotcrete will be applied to create a level excavation pit in all areas where lack of space requires single-skin concreting. Shotcrete will applied with a relatively high level of accuracy, partially on bored piles and partially on milled jet-grouted underpinnings.

In addition, strand anchors will be produced on an ongoing basis during the excavation work, to anchor the bored piles and underpinning elements (built with the jet-grouting method) in one and sometimes two levels.

Due to the strict construction schedule, a jet-grouting rig, a bored pile rig, two vibro rigs, one anchor machine and a jet-grouting unit were all used simultaneously at peak times. As a result, the main part of the special foundation engineering activities could be completed in August.

This is not the end of the special foundation engineering work at the construction site, however: additional work will be performed in the next two years, such as smaller jet-grouting underpinnings and nail walls.

> ***I would like to take this opportunity to thank all the project participants and colleagues for the excellent cooperation.***

K7 Kösslmühle

An exquisite location with extraordinary challenges

In the town centre of Gmunden, Austria, MX Alpha GmbH is building extraordinary flats that include a boathouse. The building directly on the Traunsee lake consists of twelve flats, four penthouse flats and an underground car park. An absolute highlight is concealed in the building's basement: the boathouse, with a direct exit to Traunsee lake that features 23 boat moorings, makes this project unique.

Melanie Zauner – Keller Grundbau, Linz

To construct this building, excavation pit protection was planned in the form of anchored bored pile walls in combination with shotcrete nail walls. The bored pile wall serves as the permanent outer wall with soil contact. A ductile pile foundation was used for the residential building.

The project is located directly on the Traunsee and can be reached over land through a narrow lane (approx. 2m). A shipping pier with a small storage area was built for the project downriver, to supply the construction site.

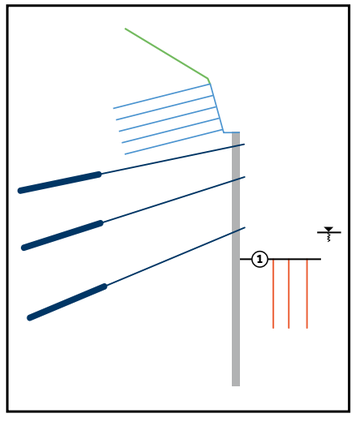
In January 2021, the first rig for the special foundation engineering work was floated in. 15m over the Traunsee, work begun on a shotcrete nail wall to secure the slope. Due to the difficult accessibility, the site equipment had to be transported by ship and remained on the pontoon during construction. To supply the shotcrete material, the ship with the silo had to cast off each time and be brought to the pier downriver.

In early February, the pontoon was put to the test, shipping the 70-tonne BG28 to produce the planned Kelly bored piles. The boring level was around nine metres above Traun level. After just over five weeks, construction of the 880mm piles with lengths of up to 24m was complete. Two of the special challenges for everyone involved in the project were the removal of the drill cuttings and the logistics of the concrete delivery. Concrete delivery was made exclusively using two small mixers, with capacities of 1.5 and 4m³, respectively. The confined space conditions made it impossible to drive directly to the borehole. Instead, the concrete was collected in a pre-mixer and pumped to the borehole via a stationary concrete pump. All the reinforcement cages had to be delivered by ship. Due to the extremely limited storage space at the site, the reinforcement cages had to be delivered in small quantities and could not be stockpiled.

In mid-March, we began building the 600mm Kelly bored piles and accepted delivery of the anchor drilling rig. The 880mm bored piles are anchored permanently at three levels. The 3 to 9 strand anchors are up to 27m long. After each anchor was drilled and installed the anchor grate was built. After an appropriate hardening time, the anchors could be inspected and stressed. Section by section, the anchor horizons were built and the gaps between the bored piles were sealed with shotcrete. Around one hundred pallets of cement had to be transported to the construction site for the anchoring works, because it was not possible to use a silo.

During the excavation works, deformation of the bored piles was measured and checked using four installed inclinometers. A total of 21 load cells have been installed with the anchors for monitoring.

GRAPHIC:



SHIPPING THE BG28

PROJECT INFORMATION

Investor:
MX Alpha GmbH
Customer:
HABAU Hoch–Tiefbaugesellschafts m.b.H.
Geotechnical consultant:
Geotechnik Tauchmann GmbH
Design:
Geotechnik Tauchmann GmbH
Quantities:
approx. **2,470m** permanent strand anchors
approx. **132m** temporary strand anchors
approx. **40m** KELLY piles DN600
approx. **870m** KELLY piles DN880
approx. **290m²** shotcrete nail wall with approx. **1,365m** nails
approx. **280m²** shotcrete between bored piles
approx. **130** ductile piles
Execution period:
January–August 2021

The last anchor was inspected and tightened in mid-July. After final excavation to a depth of approximately 2.5m below the Traun, foundation work could begin in early August. The varying soil conditions and delivery of the concrete posed challenges in the production of the ductile piles. Concrete delivery was also made using a small mixer with a capacity of 1.5m³.

After the ductile piles were completed, the special foundation engineering works were finished in late August.

ANCHORING WORKS

Park de Gasperi **Milano**

After several years of struggling in the Italian market and a Covid-19 year 2020 that hit Italy very hard, Keller Fondazioni managed to sign a €1.3m contract in Milan.

Emanuele Nanni / Stefano Motta – Keller Fondazioni, Verona

This contract contains the construction of a jet grouting sealing slab for an underground parking lot, called 'De Gasperi', as part of the new ENI Branch. ENI is a well-known Italian multinational oil and gas company headquartered in Rome.

As part of the construction of the new ENI branch in Milan, two underground parking lots are planned in total – the 'De Gasperi' and the 'Vannucchi'. Keller was awarded the works to build the jet grouting sealing slab of the 'De Gasperi' car park. The surface of the car park is approximately 5,550m².

An approximately 8,350m³ large and 1.5m thick slab is provided at a depth of 12.5m from the working surface. Tie rod concrete diaphragms, not performed by Keller, are part of the lateral support of the excavation pit. In addition, the project also includes jet grouting columns with a diameter of 2,000mm adjacent to two sides of already former constructed concrete diaphragms. These columns have the function of plugging any faultily executed water-stop joints or badly made concrete diaphragms (non-continuous casting or collapse of material during casting).

Keller won this contract for two main reasons:

- The opportunity to propose to the client a system for monitoring the execution of the works following its quality control protocol developed internally through experience in complex construction sites in Europe (eg Brenner Base Tunnel).

This system makes it possible to verify the executed parameters of each column and return a 3D model of the executed works.

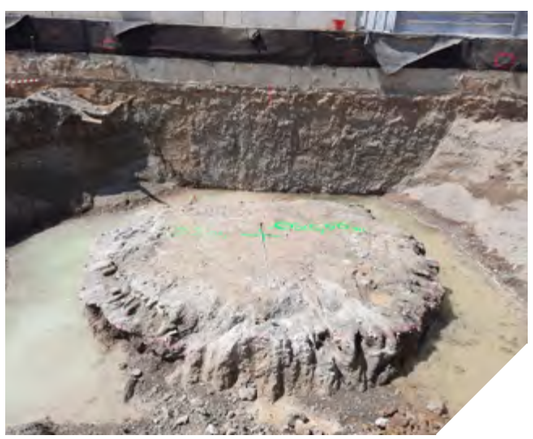
- The ability to demonstrate, with an initial test field and through the results of the performed ACI® tests, the achievement of given diameters (3,500 to 3,600mm) that have allowed the best technical and economic optimisation of the project. And thus improve the execution time significantly, taking the tight schedule of nine months into account.

SOILCRETE SITE PLAN

The soil consists of very open gravels and sand, with dimensions between five and 50mm. These soil conditions are perfect to reach excellent results with the use of our Soilcrete® technology.

The performed inclinometric measurements confirmed the minimum deviations during drilling, with an average deviation of approximately 1.1%.

FIELD TEST (SINGULAR COLUMN DIAMETER 550 CM)



In accordance with our internal experts, we used a Triplex system, with an additional pump during drilling and the DS-NG monitor. All this made it possible to achieve these high performances.

- Initial project: Jet grouting columns diameter 1,500mm with approximately 4,200 columns
- Keller initial proposal: Jet grouting columns diameter 2,000mm with approximately 2,900 columns (about 190 shifts)
- Keller alternative solution after the trial test: Jet grouting columns diameter 3,600mm with approximately 875 columns (about 54 shifts)

Our alternative solution, provided after the test field, allowed the customer to meet the contractual deadlines for the underground car park. The reduction of time, together with a better logistics organisation, has created the best possible synergy with our customers. In this way, we have managed to coordinate all activities on-site, without any production stops, especially by considering the limited space.

PROJECT INFORMATION

Investor:
DEA CAPITAL REAL ESTATE SGR SPA

Customer:
I.T.I. IMPRESA GENERALE SPA

Geotechnical consultant:
Dott.sa. Paola Baronci

Planer:
ATIproject S.r.l.

Quantities:
Jet Grouting slap:
approx. **5,550m²/ 8,320m³**

Execution period:
May–August 2021

Reinforcement **of Etsch embankment**

The project included the reinforcement of an existing embankment along the Etsch River (section from km 124.9 to km 126.03) with the building of a waterproof curtain using DSM (deep-soil mixing) technology. The new sealing was built on the right bank of the Etsch over a length of 1,150m and a height of eight metres around the existing embankment to secure and stabilise it.

Stefan Nitz – Keller Fondazioni, Brixen

Flooding due to extreme precipitation is a constant issue that regularly puts the population along the Etsch on tenterhooks. To minimise the risk for the local population and continually improve flood protection for the important, well-functioning infrastructure, the Agency for Civil Protection – Check Dam Department – executes new projects every year.

For the project "Reinforcement of the right-side Etsch embankment" in the section between Kurtinig a.d.W. and Salurn (section from km 124.9 to km 126.03), Keller Fondazioni won the official bid tender. The works are intended to seal the existing embankment along the Etsch and stabilise it for future high water. The measure became necessary because recent floods revealed several imperfections that posed a risk to the residential area behind it, as well as to the adjacent A22 motorway.

The requirements for the curtain that were defined in the technical tender were very demanding and the customer – a public entity – was also interesting. The sealed core had to have a minimum thickness of 55cm over the entire depth of eight metres and a system permeability less than or equal to 10E-8 m/s, which proved to be technically challenging. The customer carried out an extensive ground survey ahead of time. With this geological information, we were able to plan the construction effectively ahead of time, because the soil involved is the most important factor in the definition of the building parameters (pulling speeds, rotating speeds, and so on) and in the choice of the grout composition. In this case, we decided to build a DSM wall with a water, cement and bentonite suspension. Thanks to projects we had already carried out nearby and the experience we gained from them, we were able to assess the tender requirements well ahead of time and incorporate them in our pricing.

efre·fesr Südtirol · Alto Adige
EUROPEAN UNION
AUTONOME PROVINZ BOZEN SÜDTIROL
PROVINCIA AUTONOMA DI BOLZANO ALTO ADIGE
AGENTUR FÜR BEVÖLKERUNGSSCHUTZ - BOZEN
AGENZIA PER LA PROTEZIONE CIVILE - BOLZANO

After a very hard winter, we were ultimately able to start the works in February 2021. It should be noted that the works were carried out in collaboration between Keller Fondazioni and the Agency for Civil Protection – Check Dam Department. The individual processes were planned together ahead of time and implemented at the site during construction. The logistics proved to be one of the greatest challenges, because all rigs and machinery had to be delivered over narrow access roads or over the existing embankment.

The heart of this embankment construction site was the site installation, including the corresponding logistics for delivery and removal of the rigs and materials. The size of the installation area was severely limited due to the local conditions (with the Etsch River on the left and the motorway on the right). Nonetheless, we were able to identify an optimal position for the construction site and serve the entire site from a single point. As a consequence, we had to use hoses to supply the rigs with grout, at times over more than one kilometre.

The curtain was built using a well-organised line construction site:
the first work step involved removing around one metre from the existing embankment. This created a stable working platform for us, enabling us to work safely with rigs weighing up to 70t. This was followed by building a guide trench in the head area of the embankment and realisation of the DSM wall with triple paddles. The Agency for Civil Protection – Check Dam Department – then installed a plastic sheet pile with a length of around one metre in the fresh grout of the DSM wall. This measure made it possible to extend the sealing of the DSM curtain up to the original embankment height. This was necessary because the embankment which was removed ahead of time was restored to its original height and sealed accordingly. The sequence of steps described above was carried out for each section, linearly, along the entire length of the construction site. The collaboration between the involved enterprises (Keller Fondazioni with the Agency for Civil Protection – Check Dam Department) and the well-planned process flow on the line construction site were decisive factors for the smooth, safe, ongoing activities at the construction site.

In accordance with our current standards, the ongoing quality control played a key role – not least because of the high demands defined by the customer. In addition to continuous recording of the construction parameters (depth of the DSM wall, grout volume, rotational speed, and so on), the ongoing quality control of this DSM construction site included periodic unconfined compressive strength tests and verification of the thickness of the DSM wall. As a result, the customer not only had ongoing checks of the works performed, but also full documentation of the completed structure, for subsequent safeguarding and stabilisation.

Multifunctional complex Prievozská
Nové Apollo

Sheeting and sealing of the construction pit by jet grouting and foundations on Soilcrete® columns.

Michal Durmek / Peter Cápay
Keller špeciálne zakladanie, Bratislava

Construction site:

The construction is located in Bratislava district II, between Prievozská, Mlynské Nivy and Turčianska streets. The construction pit protection project was exceptional, because together with the demolition of the previous BC Apollo building, special foundation works were carried out in order to deepen the new construction pit so that one additional underground floor could be added. The new construction pit is in the same position as the construction pit of the removed BC Apollo building. For the design of a new construction pit to accommodate three underground floors, the original two underground floors construction pit support was reused as much as possible, which was designed.

The aim of the solution used was to enable construction of a stable and dry construction pit using the original and a new sheet pile construction for the purpose of building a new construction of the 3rd underground floor.

Geology:

The foundation conditions were evaluated on the basis of a geological survey carried out for the original BC Apollo building. The surface layer has a variable thickness, from 0.5 to 4.9m (clay, mortar, slag, glass, bricks, pieces of concrete, etc.). Below this surface layer are the quaternary fluvial sediments of the Danube River, represented by sandy clay and silty sand. The thickness of this strata complex is 0.3 to 1.5m, or it is completely missing in places. Below that is a gravel-sand layer. It is a highly permeable aquifer layer. The depth of this layer was verified by a single borehole to be at 13.2m below the ground (122.95m above sea level).

Below the layer of gravel are Neogene sediments of clay. From the experience gained during construction of the surrounding buildings, it is clear that this is a continuous layer, which in our design of the construction pit protection forms a natural seal of its bottom. The bottom of the sealing underground wall was sunk into this layer.

The groundwater level is at approx. 131.5m above sea level, and depends on the water level in the Danube River.

Construction:

As part of the NOVÉ APOLLO multifunctional complex project, Keller had the task of making a construction pit measuring approx. 151.5 by 112m, with a depth of approximately 10.4m, which will ensure the stability of its side walls during construction work within the pit, both above and below the groundwater level. It must seal below the level of the groundwater level and make it possible to reduce the groundwater level to below the foundation joint. It was therefore necessary to provide sheeting above the groundwater level and sheeting and sealing below it.

For the foundations of individual buildings, it was necessary to prepare an economically and technically suitable type of foundation in combination with a base plate.

Securing of the construction pit

After removal of the original BC Apollo and excavation of the backfill to a depth of -3.5m from the ground floor level, the entire original structure of soil nails and shotcrete was exposed. The condition of the shotcrete and soil nails was poor and it was necessary to add two new levels of soil nails and repair the shotcrete on the entire area of the pre-excavation.

Description of jet grouting columns implementation

Jet grouting full and half-columns were made along the entire perimeter of the construction pit behind the original sheet pile wall. A special drilling rig made columns from a working platform of -4.00m before the construction pit could be dug out. The stability of the sheet pile wall was ensured by temporary anchors in order to prevent the movement of the surrounding buildings and endangering their stability.

Foundation

The design of the building's foundation included improvement of the subsoil layers below it using columns of Soilcrete® and construction of a monolithic foundation slab. This type of foundation on subsoil improved by Soilcrete® columns ensures the transfer of loads from the building to the subsoil and helps to increase the shear strength of the ground slab.

The Soilcrete® technology was chosen due to the construction site's geological and technical conditions. After hardens, it reliably transfers loads from the superstructure to the sub-foundation.

VIEWS:
of the existing wall made of shotcrete before and after stabilization

JET GROUTING

Part of the ground slab had to be anchored with tension piles. Micropiles with high-strength steel reinforcement were chosen as the tensile elements, while their bond lengths were improved by Soilcrete®. The length of these micropiles depends on the type of geology and the size of the load on them.

Constructing the foundations

The depth of the Soilcrete® columns was at a height of about -7.10, i.e. about 2.1m below the groundwater level. The Soilcrete® columns were completed with an overlap of about 0.5m above the level of the third underground floor. The extra length was framed and milled after digging the construction pit to the level of the foundation joint.

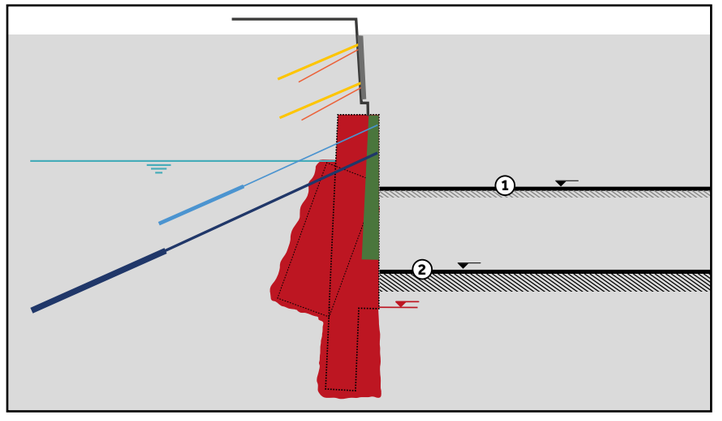
Tensile micropiles for anchoring the foundation slab were constructed from the level of the foundation joint (or from the level of the base concrete) using a special drilling equipment with a small diameter drilling tool. A central threaded SAS bar reinforcement was installed in the boreholes and covered by cement grout, and subsequently an anchor head consisting of an anchor plate and nuts was mounted on its protruding end.

Conclusion

The resulting solution of securing the construction pit using Soilcrete®, ground anchors, shotcrete and grouted soil nails met the requirements for temporary structures, which provided the required function of ensuring the stability of the excavation wall above and below groundwater level and enabled the construction of basement structures of the building.

The sub-foundation of the building, improved by Soilcrete® columns and tensile micropiles, meets the requirements for safe foundation of the building on its foundation slab.

VIEWS:
Construction pit support



new soil nails
existing soil nails
strengthened shotcrete incl. nails (new)
① deepest excavation (old)
② deepest excavation (new)
new anchors
old anchors
Stabilisation by jet grouting and new lowering
existing pit support

AFI Thámova Praha

Pit support and deep foundation for a new building

As part of construction of the AFI Thámova multifunctional building in Prague, it was necessary to secure the construction pit and provide deep foundation for completing the new building. The size of the construction pit was approximately 70m x 35m, the maximum depth level of the final excavation is approximately 10.7m below the existing terrain (or 5.5m below the groundwater level). The deep foundation was built on large-diameter piles and micropiles.

Přemysl Havlík, KELLER – speciální zakládání, Prague

EXCAVATION OF THE PIT

The 'AFI Thámova' building is located in the centre of the capital city of Prague. It was built in the Karlín neighbourhood, which historically contained industrial buildings as well as a port. As time passed, the port was removed and the industrial buildings gradually disappeared from this location. Over the past 20 years, new administrative and residential buildings were built in the area. Keller took part in many of such projects. One of these projects is the 'AFI Thámova' Multifunctional Building , which was built in place of the former Kotlárna building and is located on the corner of Thámova and Pernerova streets.

The location's geographical composition is typical for the given area. There are various backfills in the surface layers on the site, which were deposited on compacted layers of boulders and loose soil sand and gravel, which are up to 12m thick below the existing terrain. The bedrock is made up of layers of variously eroded clay-dust shale (R6 to R4). The groundwater level is approximately 5.5m below the existing terrain in an area of highly permeable terraced sediments (gravel).

Due to the groundwater level height, the contract specified a technically waterproof construction pit that would use the investor's land plot to the maximum, as well as a deep foundation for the new building.

Securing of the construction pit was designed as a combination of several techniques. The section of the construction pit that was directly next to the existing buildings was made with jet grouting columns with a diameter of 1.6m, supplemented by columns with a diameter of 1.0m to 1.4m. The jet grouting serves both to directly support the existing buildings and as a seal and sheeting structure of the construction pit. The jet grouting columns are therefore embedded in their lower part into layers of impermeable clay shale. The stability of this sheet pile structure was ensured using 2 to 5 temporary 0.62" diameter strand anchors at either one or two anchor levels. During the excavation work, the visible surface of the jet grouting body was levelled used a rotary cutter, and subsequently covered by a layer of shotcrete to remove any unevenness. A pile wall was then built in the second section adjacent to the pavement or the part of the new building which will not have underground floors. The 88mm diameter piles were provided at 1.8m apart and were anchored into layers of impermeable clay shale. To ensure the tightness of the sheet pile structure, 1.6m diameter jet grouted columns were added between the individual piles, from the groundwater level to the bedrock level, into which they were embedded. A layer of shotcrete reinforced with a steel mesh was applied to the visible surface of the sealed pile wall. The stability of the sheet pile structure was ensured using four temporary 0.62m diameter strand ground anchors, which were fitted through core holes in each pile. Thus, the resulting sheet pile structure served as a single sided formwork and was only temporarily used during the construction of the new building, in which all the new loads were then taken over by the new reinforced concrete structure.

UNDERPINNING OF THE EXISTING STRUCTURES

PROJECT INFORMATION

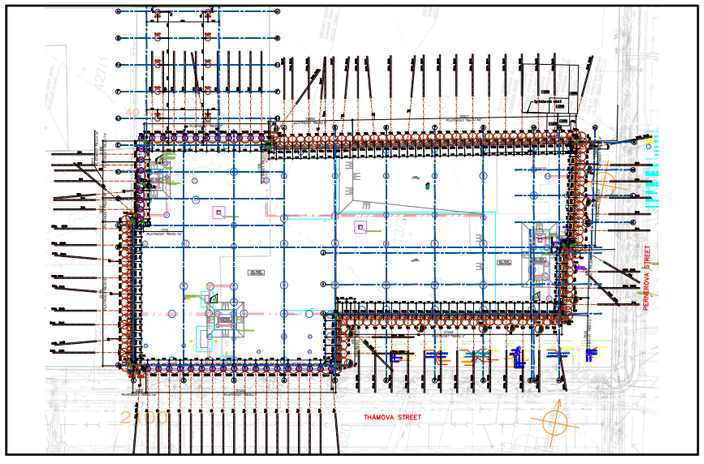
Investor:
AFI EUROPE Czech Republic s.r.o.
Customer:
IMOS Brno a.s.
Design:
KELLER-speciální zakládání, spol. s r.o.
Quantities:
approx. **2,750m** jet grouting (Soilcrete-D)
approx. **1,800m** bored piles
approx. **2,050m** temporary strand anchors
approx. **90m** micropiles „GEWI"-type
approx. **1,735m²** shotcrete
Execution period:
May 2020–February 2021

The deep foundation for the new building and cranes was made using 600, 900 and 1,200mm diameter bored piles. The length of these piles ranged from 6 to 16m. The base of every pile reaches the bedrock level. The length and diameter of the piles were chosen depending on the load supported by them from the upper structure of the building under construction, with a maximum allowed subsidence of up to 12mm. A total of 112 piles with a total length of 1,122m were used. The piles were made from a working platform above the groundwater level and the depths of the boreholes for individual piles was up to 6m. In the final stage, the pile heads were aligned with the level of the upper surface of the base concrete and the tensile piles were connected to the foundation slab reinforcement. The project also included a refurbishment of a part of the existing building, where it was necessary to provide additional foundation. To this end, nine "GEWI"-type 50mm diameter micropiles, made of SAS550/620 steel, with a total length of 88m, were included under the existing building. Reinforced concrete bases were then cast onto these micropiles.

The final structures of the new building were designed using a waterproof concrete tanking, and as part of the protection of the structure against stray current corrosion, selected reinforcement cages were connected to the base plate reinforcement by grounding strips.

The entire construction was completed in the required time and its quality corresponds to both the client's and investor's requirements, thanks to the cooperation of the client's construction management, designers, and the building site manager responsible for securing the construction pit.

GRAPHIC



Moson lock – **continuation of the project**

We like to introduce you to projects that run for many years and/or in which we are involved in their various phases. This year, we'd like to show you the continuation of the Moson lock project, in which we had the opportunity to assist with the first part of the construction in 2019. The second part followed in 2021.

Robert Holczer – Keller Melyepitö, Budapest

Near Győr in western Hungary, the city is building a lock in a tributary of the Danube as part of an environmental rehabilitation project. The structure will serve to regulate the water level, thus guaranteeing a continual supply of water in the tributary. The public tender was for a design-and-build task. A bidding consortium consisting of Keller Melyepitö Kft and Swietelsky Magyarország Kft won the contract for the excavation works, which were divided into two sections due to the size of the construction project. A sealing slab was constructed for the first section in 2019 and now, two years later, the artificially backfilled embankment was given a lip seal ring. Building the approximately 8,000m² excavation pit was the greatest challenge in the project, since it is located primarily on a flood plain. Our partner Swietelsky Magyarország Kft built the diaphragm wall for the excavation pit bracing, with a thickness of up to 80cm and the anchors required for structural reasons.

Due to the expected difference in the groundwater table of up to seven metres, a Soilcrete® sealing slab was also built as a horizontal seal. Starting in April 2019, Keller began building a deep-set Soilcrete® sealing slab with an area of around 8,000m², divided into cassettes, and a thickness of 2.5m. The Soilcrete® works were completed successfully in December 2019, with an extremely low residual water volume of around 50l/24h for each cassette.

Once the construction of the lock's steel and reinforced concrete structure had advanced enough that the surrounding dam body could be finished, we continued our Soilcrete® work in the summer of 2021. The task here was to limit the water permeability of the dam body to a certain amount. We planned to do this with Soilcrete® or jet-grouted lamellas. The section to be treated has a length of around 990m; the drilling depth is up to 20m in places. The necessary bores are sunk from the dam crest level. To meet the high level of position accuracy needed for the individual bores, measurements were taken regularly during drilling. The Keller Column Inspector (KCI) software, which we developed in-house, was used to analyse the bore hole paths. This enables an immediate response to any deviations by building additional columns, but this was hardly necessary on the project thanks to the strict construction monitoring.

The construction site logistics were subject to particularly high demands here: firstly, all the supplies had to be transported over long construction roads in the floodplain area, and secondly, the site installation had to be set up at a level that was at least safe from high water. Even though high water occasionally caused restrictions and interruptions to the works, we were still able to meet all the deadlines.

Parameters of Soilcrete lamellas:

- **Thickness:** 40cm in average
- **k-values to be achieved:** 10^{-8}m/s
- **compression strength:** 0.3-0.5MPa

V-Zug: New Zephyr East building **excavation pit support**

The long-established company for home appliances has commissioned another new building at its factory site in Zug, Switzerland. The construction field is surrounded by existing production buildings on Oberallmendstrasse. Building this solid construction requires extensive excavation pit support and sealing work with the Soilcrete® jet-grouting process.

Keller-MTS AG, Regensdorf

PROJECT INFORMATION

Investor:
V-Zug Infra AG, Zug
Customer:
H. Hürlimann AG
Geotechnical consultant:
Dr. von Moos, Zürich
Design:
Bänziger Partner AG
Keller-MTS AG
Quantities:
2,200m Soilcrete® – underpinning columns and sealing lamellas
Execution period:
June–July 2021 (4 weeks)

The new build of Zephyr East is located between several existing company buildings of different ages. The planned excavation pit runs north and south, directly adjacent to the façades of the existing buildings.

A variety of installation systems are being used to protect the excavation pit and seal off the groundwater. To restore the flow capacity of the subsoil for groundwater after the construction works, an anchored sheet pile is being built on the lee side of the buildings and will be removed once the basement levels are complete.

The existing buildings, with their basement floors at different depths, have different foundations, which will be underpinned and sealed down to the aquicludes for space reasons. To do so, a two-row, full-column solution with the jet grouting method has been planned in addition to the sheet pile.

The tendered jet grouting works provide the flexibility needed to react to unexpected situations. This process makes it possible to implement low-subsidence underpinning and build a deep-soil sealing element in a single step. Since the works can be performed from the top edge, synergies can be captured at the boring level and the high groundwater level does not require any additional measures to build the excavation pit protection.

During the submission phase, Keller-MTS AG was able to optimise the Soilcrete® jet grouting cubage for the project. Thanks to the use of powerful high-pressure pumps, the latest rig software and the in-house building of the largest Soilcrete® drilling rig, nothing stood in the way of building the deep-soil sealing lamellas.

Adjustment of the geometry of the sealing element made it possible to reduce the metres drilled and material requirements significantly. Since the lamella elements were structured with a larger diameter, only every second bore of the underpinning columns had to be sunk down to the aquicludes. This reduced both the construction and the costs for the customer.

During production, the different column diameters and lamella geometry were inspected layer-dependently and over the entire drilling depth.

The ACI® method, developed by Keller, was used for this: the Acoustic Column Inspector® (ACI®) records the acoustic signals that the jet stream emits upon contact with previously installed gauge rods. As a result, proof of the minimal geometrical contour dimension can be confirmed and the construction parameters and adapted to optimise resource utilisation.

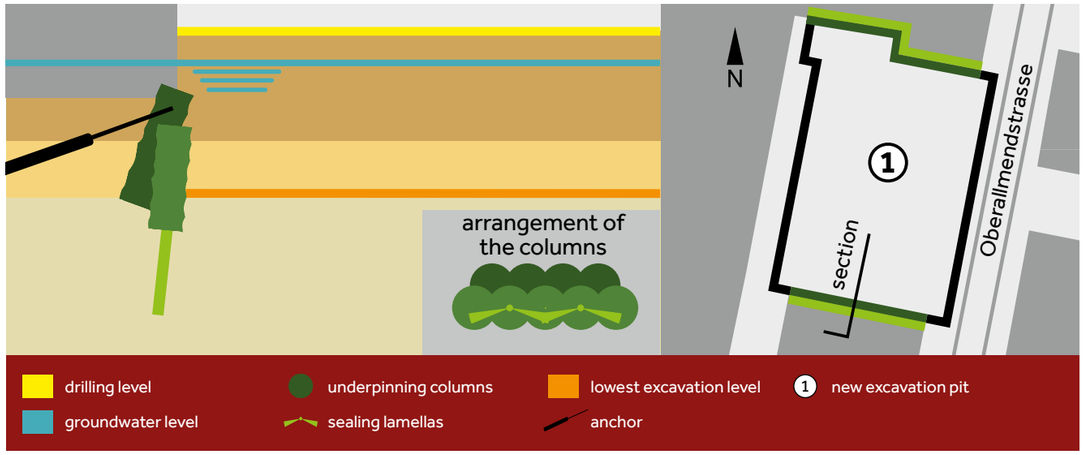
SEALED CONNECTION OF THE SHEET PILE WALL CONSTRUCTION TO THE SOILCRETE® CUBATURE

Execution planning and the underpinning statics were part of our offered services and were carried out by our technical office in coordination with the project planning engineers. The efficient, lively exchange between the planning department and the construction site was a key factor in the successful completion of the project. Unexpected situations during the construction period were tackled dynamically and the execution plans could be adjusted without interrupting production.

The extensive use of the construction perimeter by the sheet pile and pile construction carried out in parallel required intensive the coordination of the all special foundation engineering work.

Keller-MTS AG was able to produce nearly 2,200 linear metres of Soilcrete® elements within four weeks. The diameters of the full columns varied from 1.30 to 1.50m and the two-sided lamellas reached a total diameter of 2.80m.

GUIDE TUBES UP TO THE PRE-CORED foundation projections of the basement.



MOSS SMS 2a

Our story in Norway began with the Follline Project ... now, we are back at SMS2a...

Osman Besler – Keller Geoteknikk, Oslo

Reaching the end of the Folloline project with accomplished references after five successful years in Norway, Keller steps into another part of the Intercity project – SMS2a. The Sandbukta-Moss-Såstad (SMS) project is a part of the Intercity development project, which is part of the largest transport project in Norway, consisting of 270km of new double-track rail.

With the increase in population over the last decade and anticipated population growth in the coming years, Norway is making significant investments in the country's infrastructure. The Intercity development project consists of 270km of new double-track rail, capable of train speeds reaching 250km/h. The SMS project, being another part of the Intercity development in addition to the Folloline project, includes ten kilometres of new double-track situated on the Østfold Line, near the city of Moss.

The project, with three open stretches and two tunnels, is divided into six sub-sections: Circle K, Kransen, Station, Carlberg, Larkollveien and Dilling. Throughout the project, we will execute our techniques of DDSM, JG, micropiles, piles, anchors, diaphragm walls (D-wall) and sheet pile walls. A dynamic project with difficult ground conditions and multiple techniques requires the know-how of a geotechnical contractor who can provide a wide range of capabilities. Therefore, MossIA, a joint venture between Implenia Norge AS and Acciona Acciona Construcción S.A., chose Keller Geoteknikk as the main subcontractor for this task, in consideration of our extensive experience with quick clay during the tendering stage.

Keller Geoteknikk is awarded to perform 55,000m jet grouting, 1,400,000m DDSM and injection works. Moreover, Keller is the preferred subcontractor for any geotechnical work. So far, Keller has produced around 500,000m DDSM (Ø600mm-Ø800mm) and 20,000m JG (Ø 1.2m-Ø 1.6m).

CIRCLE K:

In the Circle K section of the tunnel, unconsolidated soils are close (up to 1.3m) to the tunnel crown at a depth of 27m, creating stability issues for the advancement of the tunnel. Due to the risk of subsidence resulting from groundwater level drawdown, as well as the presence of buildings founded on deposits of compressible soils in the area, ground improvement consisting of JG (Ø1.6m, min UCS:2 MPa) is executed to reinforce the soil above the tunnel. The critical requirement is the overlap of the JG columns and connection to the bedrock. We perform part of the works within the station, with a maximum working height of four metres. Therefore, a KB0-5 is needed, and approximately 25% of the columns are installed at a batter to account for the various obstructions. The Gyro/Aligner system provides the inclination and azimuth in real time, reducing setup for the operators and ensuring proper execution.

TOOLBOX MEETINGS
by following Covid measures

DDSM (DRY DEEP SOIL MIXING) WORKS

KRANSEN:

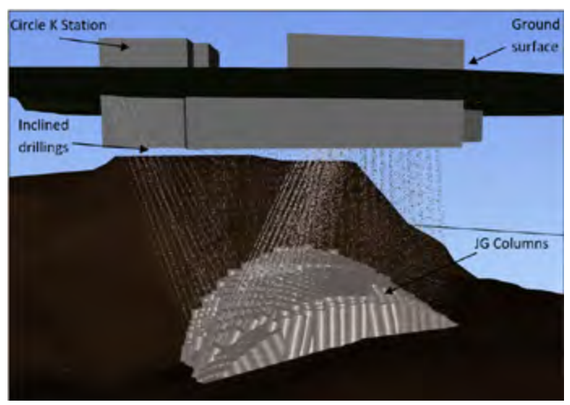
A 420m cut-and-cover tunnel starting at the Kransen portal will connect to the new station. The necessary 40m wide, up to 32m deep open excavation pit will be supported by D-walls and sheet piles that will be secured with lateral struts and anchors. To facilitate the excavation to these depths, soil improvement through DDSM and JG will serve various objectives, first and foremost being the improvement of the quick clay.

The DDSM is designed with an 80% replacement ratio and a design strength of 150kPa. The presence of dense gravels, along with cobble and boulders, causes difficulties with installing DDSM in certain areas, requiring the alternative stabilisation method of JG designed with a minimum compressive strength target of 3.5MPa, and an E-Modulus of 500MPa. The necessary column overlaps, which ensure full load transfer as excavation progresses, required precise inclinometer measurements of each column and the implementation of 3D BIM modelling by the Keller team to evaluate missing overlap and the necessity of additional columns.

The production of backflow per JG rig reaches approximately 250m³ a day, which means that the limited working area in the city centre requires the use of backflow treatment plants providing waste reduction of up to 40%.

The arduous ground conditions, logistical challenges with teams in different work areas and the environmental regulations positioned Keller to provide the client with the confidence that the project will be executed according to their standards. During peak operation, Keller will have up to eight rigs running simultaneously, with more than 50 persons on site. Despite the Covid-19 pandemic exerting additional challenges due to travel and local restrictions, causing a financial burden, Keller has provided the highest efficiency and HSEQ standards throughout the execution so far.

CIRCLE K STATION:
- Ground surface
- jet grouting columns
- inclined drillings



PROJECT INFORMATION

Investor:
Bane Nor
Customer:
MossIA
Design:
NGI
Quantities:
Execution / Drilling
1,400,000m DDSM
1,600,000m DDSM
55,000m DSV
Injection works
Execution period:
2019–expected 2025

OVERVIEW OF SMS2A PROJECT

One project **several techniques (Arbetstunnel Hagalund, Solna)**

Stockholm is growing and so is the Metro. SLL Förvaltningen för utbyggnad Tunnelbana has decided to build several new metro lines and stations.

Fredrik Brauer – Keller Grundläggning, Stockholm

The part of the metro project that we are working on is called the 'yellow line – Hagalund Solna Arbet tunnel'. We work as a subcontractor of Implenia Sverige AB and carry out the excavation support and water sealing for the access road to the tunnel entrance. The design comes directly from the client SLL, who created it in WSP.

Anders Johansson (site manager) planned and executed the project with help from Henrik Landergren (project engineer) to get the various sheet piles and pipes in the correct position.

The project started with six test DDSM columns with different mixing and lifting speeds. Fourteen days later, we tested them.

Pipes (ø140mm) were welded onto the sheet piles for rock dowels and jet grouting. Some of the sheet piles had three pipes installed.

Because of the weight and length of the sheet piles (longest VL604 19.2m), we installed all of them using our Movax and a free-hanging vibro on a mobile crane.

Next, we drilled for the rock dowels and started the execution of DDSM columns. Always with the given design specifications in mind.

After the DDSM work, the jet grouting team arrived and did six test columns. After choosing the correct parameters, we started execution. The rig that drilled the rock dowels installed the pipes (ø170mm) for the drilled pipe wall.

The welders attached the beams for the first level and welded them, along with plates and struts. The anchoring rig arrived so that we were able to start drilling. During drilling, we faced some challenges because of the inclination of the bedrock. To overcome them, we had to change the angle for the beams and anchors from 45° to 60°. We continued to stress and lock the anchors and then insulated the struts to minimise the effect of different temperatures from the weather.

> ***"A fun and interesting project for us, since the project included all the techniques/product lines we have in Sweden."***

Implenia excavated down to level two, and we installed the second level of beams and drilled the anchors. After one week, we could finally stress and lock the last row of anchors. Implenia was then able to start their excavation for the access road descending the construction tunnel's mouth.

The biggest challenge was the different sheet pile sorts and lengths, with various pipes involved. And to install them in the correct position. In addition, the sloping bedrock surface made the drilling of the inclined anchors difficult. Furthermore, we had to arrange careful planning of storage and preparation of sheet piles, coordination with the client and planning of areas to be affected.

To ensure accurate drilling, we did inclinometer measurements to detect possible incorrect anchors due to the sloping bedrock.

It has been a fun and impressive project so far, and I would like to thank everyone who is a part of it.

We are building another metro project in Stockholm. We hope that it will not be the last and that we will win more projects in 2021 and 2022.

GRAFIK
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PROJECT INFORMATION

Investor:
Region Stockholms förvaltning för utbyggd tunnelbana
Customer:
Implenia Sverige AB
Geotechnical consultant:
WSP
Design:
WSP
Quantities:
approx. **1,700**m² sheet piles
approx. **14**m² soldier pile wall
approx. **130** rock dowels
approx. **410** DDSM columns
approx. **200** jet grouting columns
approx. **290** drilled pipes
Beams
Injection works
Execution period:
April 2020 – March 2021

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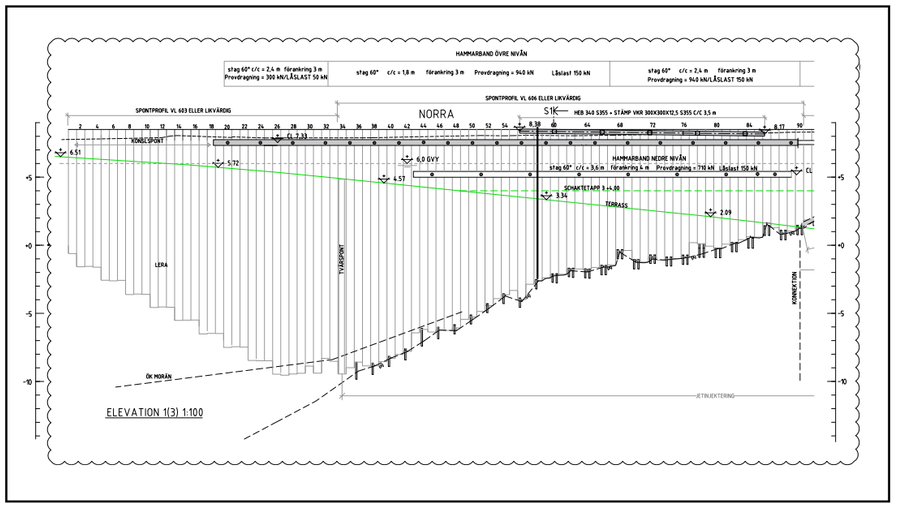


One Cotroceni Park I

In the downtown of Bucharest, One United Properties began the construction of development comprising office and residential buildings. The first stage of the project consists of three office buildings with a total footprint of 11,700 sqm. The buildings have a height regime 3U+GF+9/11S and are built on the same raft foundation. Keller Romania was awarded the design & build contract for the foundation solution.

Bianca Scondac – Keller Geotehnica, Bucharest

EXECUTION OF CFA PILES

The soil investigation showed a typical layering for the area, namely non-homogenous anthropic fill, firm to stiff silty clay, followed by medium dense to dense sand, locally with clay lenses. The ground level on-site was varying in a 9m range, and the groundwater was encountered right above the sand layer.

The challenge was keeping the settlements of the buildings under 3 cm, in the context of varying soil conditions and building heights on the same raft, as well as high seismic loads on an L- shaped foundation without seismic joints.

The foundation solution proposed by Keller and accepted by the Client comprised approx. 960 CFA foundation piles with lengths ranging between 13 and 15m, reinforced with cages between 9 and 12m. The piles are connected to the raft foundation and embedded in the medium dense to dense sand layer.

Five static compression tests on trial piles were made to confirm the presumed bearing capacity and showed favourable results.

The achieved productivity was around 240m/shift.

The sharing of information between site and office worked quite well despite the Covid-19 crisis. Keller handed over all works without significant issues. Thus, the special foundation works contract for the second stage of the development comprising eight residential buildings was awarded again to Keller Romania.

Keller at a glance

1860 founded

9.000 employees

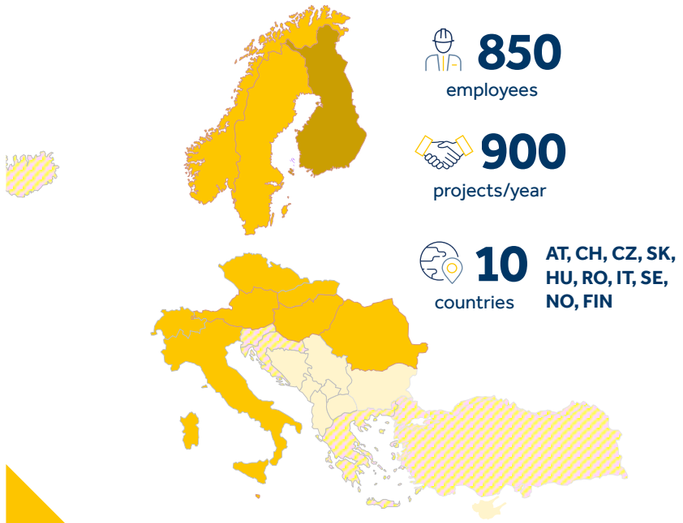
20+ acquisitions since 2000

5 continents

6.000 projects/year

21 Business units

Who we are in SEN



850 employees

900 projects/year

10 countries

AT, CH, CZ, SK, HU, RO, IT, SE, NO, FIN

- Vibro
- Soilcrete® – Jet grouting
- Anchors, micropiles, injections
- Bored piles
- Ductile piles
- Sheet piles
- DDSM

What we do

We offer solutions to a wide variety of geotechnical challenges across the construction sector

Digitalisation at Keller SEN

Digitalisation of the construction sector is moving more slowly than in many other industries. Yet the construction firms aren't idle; there is no shortage of ideas or specific projects. Keller has already developed and implemented several new tools and digital work processes, while others are currently under development. The following article gives you brief insights into selected aspects of digitalisation at Keller.

Alexander Zöhrer – Keller Grundbau, Söding

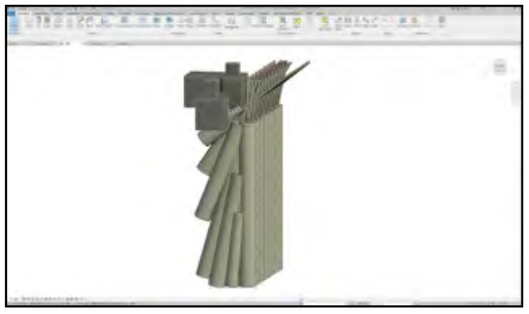
Keller Grundbau laid the foundation for a digital project management system more than ten years ago. The original system, called "Workplace", which was largely developed in-house, was already capable of modelling the important project phases and also enabled digital handling of the associated approval processes in addition to digital storage of the most important project documentation. Its successor, "Keller Dynamics", was implemented several years ago on the basis of Microsoft Dynamics, represents a new, cross-business area platform. In combination with SAP, conventionally executed processes are now being analysed and optimised – and then digitalised – on an ongoing basis. This involves typical project management processes, such as risk assessments, credit checks and the corresponding approval runs. Many commercial processes, such as invoice verification and approval, have also been digitalised. The optimised processes have not only improved efficiency, but also reduced paper consumption noticeably. The use of other Microsoft applications, such as OneDrive, OneNote and Teams, gives every employee permanent access to the relevant data. This cloud-based system was a decisive factor in making it possible to work from home nearly without any restrictions, even during the coronavirus lockdowns.

As a result of increasing use of the BIM method, particularly for larger construction projects, special foundation engineering works are also being planned in the form of 3D models (figure: BIM). To this end, Keller has created a proprietary construction element library, which can be used to model all construction activities down to the very last detail. In parallel, CAD engineers have been retrained as modellers through internal and external courses (including the "buildingSmart" certificate). And it isn't just the planning processes: new tools are also changing conventional production methods at the construction sites. Keller Site Data Manager (KSDM) is a database-centric quality management tool for the automated comparison of design data and as-built data. Any deviations are identified reliably during production, enabling construction managers to react quickly. Automated record-keeping and centralised data collection are other benefits of this tool (figure: KCI underground).

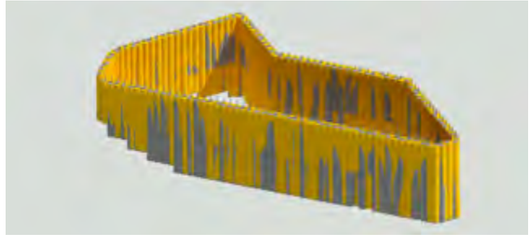
3D SCAN:
of a slope, stabilised with shotcrete and soil nails

Another tool was developed specifically to check the produced geometries. Keller Column Inspector (KCI) is used where never particularly high demands are defined for the location or sequence of columns, piles or anchors (such as sealing bottoms, excavation pits below groundwater level and the like). The self-programmed add-on for Revit utilises different data sources (incline and GPS measurements, process data and so on) to generate 3D models of the built geometry. This makes it possible to identify critical bore deviations and carry out all necessary additional activities (figure: KCI Design AsBuilt).

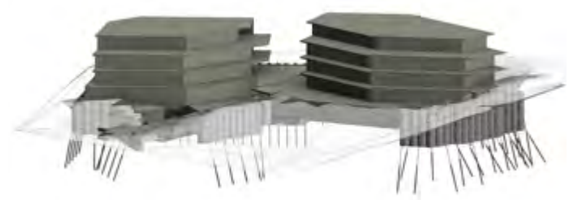
KCI UNDERGROUND:
3D design of a complex excavation pit with jet grouting columns



KCI DESIGN AS-BUILT:
Pit support with jet grouting columns; the set position (grey) is overlapped by the real position (yellow), to visualise the drilling and position deviation



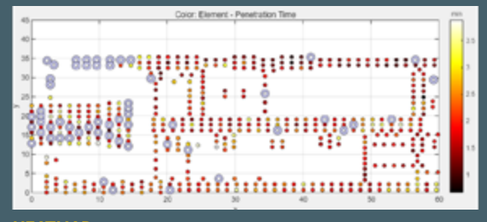
BIM MODEL



Another tool is currently in development, which will improve quality controls for all vibro and jet-grouting methods for the site manager. For its input, it will use the process data which are recorded by data loggers on all building rigs during production and transmitted to a database in the cloud. In collaboration with the University of Leoben, Chair for Automation, we are developing an application that combines the classic, rule-based approaches to data analytics with new machine learning methods. The algorithm can detect all process phases automatically, calculates a variety of KPIs and identifies outliers. The clear visualisations (figure: PPI 1+2) enable quality control experts to identify deviations quickly and reliably, as well as initiate changes when necessary.

The aforementioned system for recording production data is also being revised at the present time. The new KDAQ (Keller Data Acquisition) system not only uses modern technology for the database and user interface; in the future, it will also be capable of recording and analysing data from all construction rigs and for all building methods. KDAQ also makes it possible to send key planning information directly to the construction rig, and thus into the rig operator's field of vision. As a result, the construction works can be executed based on the latest digital planning documentation.

EXAMPLE FOR THE VISUALISATION OF A KPI
in a plane representation; you can see the higher concentration of outliers in the left area of the construction site



HEATMAP
for the simultaneous visualisation of a large number of KPIs

Ductile pile technology is also a focus of digitalisation. In addition to digital recording of the installed volumes, this also involves exact recording of the depths and corresponding driving times. All other parameters that influence the production of driven piles (such as hydraulic pressure, oil flow, impact frequency, nitrogen pressure) are also recorded. This is done using either data loggers and the corresponding sensors that are mounted on the excavator or mobile tablet PCs. In both cases, programs developed in-house ensure that the data are recorded and processed correctly. The creation of driving logs and daily reports has also been largely automated.

The use of 3D scanners is a valuable addition for quality assurance. Future construction sites can be recorded in detail and to scale as early as the project phase. The recorded scatter plots, the summarised results of the individual scanning processes, can be used as the basis for the further 3D planning. 3D scans can also be a helpful tool for simple documentation, either during construction or after building is complete. Lengths, areas and volumes can also be calculated reliably. The settlement volumes can even be calculated transparently for geometrically irregular structures, such as shotcrete walls (figure: 3D scan). The analysis programs also support more complex use cases, such as determining the planarity of an excavation pit wall, the check of actual positions compared to target positions and the measurement of deformations.

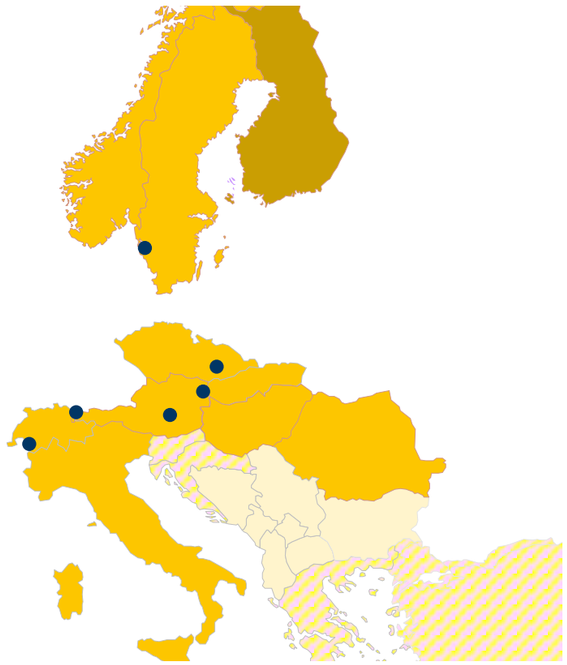
The increasing use of BIM in planning, combined with modern systems on the construction rigs, is a powerful driver for the digitalisation of construction sites. Smartphones, tablet PCs and laptops make it possible for these new tools to support builders, especially rig operators, directly during production.

Despite the euphoria associated with the many possibilities, every new digitalisation project still requires a critical review as to whether it will actually deliver significant improvement to respective work processes. After all, not everything that is technically possible is sensible.

Our yards in SEN

Our yards are the mainstay of all construction sites that we support throughout SEN. With the nearly 900 construction sites that our business unit carries out each year, exact planning and pan-European coverage are existential. With them, we guarantee on-time delivery of all rigs and short travel routes.

Paul Rott – Keller Grundbau, Söding



The locations of all of our storage facilities have been selected strategically, to enable us to work efficiently. In addition to covering the countries where they are located, we always try to support and supply construction sites in other countries that might be closer to these locations.

In total, we have six yards in five countries (Austria, the Czech Republic, Slovakia, Sweden and Switzerland). In total, we have six yards in five countries (Austria, the Czech Republic, Slovakia, Sweden and Switzerland). In this issue, we'd like to give you an overview of how we operate in this area and always strive to process your project inquiries as quickly as possible and provide the necessary rigs and machinery.

SÖDING — AUSTRIA

Storage location manager:
Hr. Friedrich Lasnik
Countries covered:
All of SEN
Site area incl. buildings:
17,000m²

VĚŽKY — CZECH REPUBLIC

Storage location manager:
Mr Luboš Krejčiřík
Countries covered:
Czech Republic
Site area incl. buildings:
10,000m²

SAMORIN — SLOVAKIA

Storage location manager:
Mr Vladimír Ďurej
Countries covered:
Slovakia, Austria
Standortfläche inkl. Gebäude:
7,000m²

LINDOME — SCHWEDEN

Storage location manager:
Mr Michael Johansson
Countries covered:
Sweden, Norway
Standortfläche inkl. Gebäude:
5,450m²

VÉTROZ — SWITZERLAND

Storage location manager:
tbd
Countries covered:
Switzerland
Site area incl. buildings:
2,200m²

DORNBIRN — AUSTRIA

Storage location manager:
Hr. Roland Berthold
Countries covered:
Vorarlberg
Site area incl. buildings:
1,200m²

Deep soil stabilisation
Alternative use cases

The expansion of deep soil stabilisation offers many synergies, fast construction processes and economical solutions. This proven method is also opening up new possibilities in the field of environmental geotechnics.

Vincent Winter – Keller Grundbau, Vienna

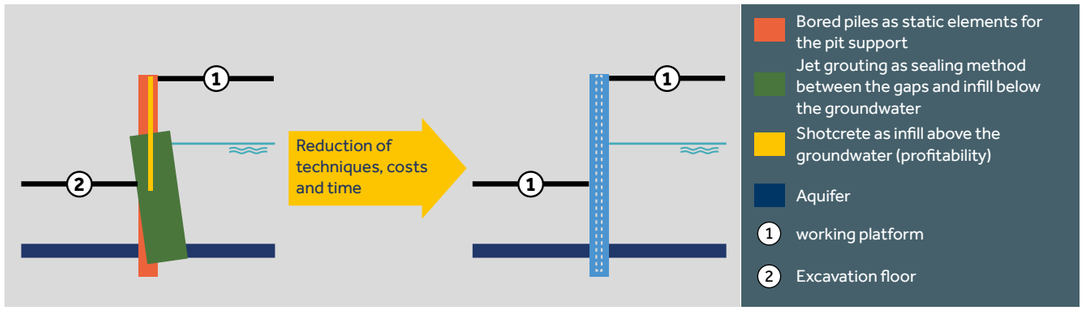
For many years, deep soil stabilisation (DSS) was used largely to seal dams and dikes for flood protection. This method also has many other uses, however. Excavation pit support that is effective statically and also seals the pit against water entry, as well as foundations via DSS, are becoming increasingly important. Why is this the case?

Whereas solutions for protecting conventional, inner-city excavation pits are always associated with multiple disciplines, such as contiguous bored pile walls with shotcrete infill, DSS makes it possible to do so in a single operation, with just one site installation. If the excavation pit support also required sealing against groundwater entry, the jet grouting method had to be used to seal the gaps between the piles in the groundwater area. For economic reasons, the jet grouting infill often continued above the groundwater level. With deep soil stabilisation, these three techniques can be replaced by one, enabling the entire excavation pit protection to be produced more quickly and more economically in just one operation.

If the building also requires a foundation, this can also be executed directly with the DSS and combined with the excavation pit support.

DSS is increasingly becoming the preferred method for contaminated soils as well. Flexible adjustments to grout composition make it possible to chemically remove contamination or immobilise it, while only creating minimal amounts of waste.

CONSTRUCTION OF A WATERTIGHT PIT SUPPORT



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