

# KELLER INSIGHT



**WELCOME TO KELLER –**  
Nordwest Fundamentering  
is now part of Keller  
Geoteknikk AS

**ENVIRONMENTAL  
GEOTECHNICS IN UPPER  
AUSTRIA –**  
pollutant immobilisation in  
the soil

**KELLER ACADEMY SEN –**  
Training is our highest  
priority



# “There is no elevator to success. You have to use the stairs”

(Emil Oesch, Swiss author and publisher, 1894-1974)

And these stairs have been generous to us for over fifty years now. Even if there were many ups and downs during these years. But we learn from these and become stronger and can explore new paths.

Because of our exciting projects – large and small ones, on and offshore – we achieve our goals every year.

As the leading special foundation company, we see it as our duty not only to execute successful projects but also to act sustainably and environmentally consciously. This is also reflected in the initiatives we have launched in our business unit.

Despite some challenges this year, there were also a lot of successes that we can be proud of. We completed our projects successfully, made new partnerships and further expanded our presence in the European market. These successes would not have been possible without the commitment and professionalism of all colleagues.

I would therefore like to take this opportunity to express my sincere thanks not only to our business partners but also and especially to our employees. Each and every one of them showed tireless commitment again this year and contributed to ensuring that Keller remains strong and successful.

Even though we sometimes have to struggle with some adversities and times keep challenging us, we always manage to keep going up these stairs.

The coming year will certainly bring new challenges, but I am confident that we will overcome these together with you, dear friends and business partners. All we have to do is roll up our sleeves and do what we do best – carry out specialist foundation projects.



Yours,

Andreas Körbler

## MASTHEAD

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04



**AREAS AND DEPARTMENTS**

Keller Grundläggning has a new address

Söding 3.0 yard – improved energy efficiency

Yellow and blue make green – sustainability at Keller

PPE (personal protective equipment) – it’s not a choice!

Growing in Norway – Keller acquires Nordwest Fundamentering AS in Trondheim, now part of Keller Geoteknikk AS

Sustainable foundation works using vibro techniques

Kwizda high-rack warehouse – optimisation of depth foundation using bi-directional static Pile HAY-Proof-System®

28



**WHAT WE DID IN EUROPE**

Nye Nerlandsøya bru – drilled piles for Nerlandsøya Bridge

Tårn 16 – First construction site ever in Norway, using the “DSM wet” method

Full speed ahead for Sluss och klaffbro, Södertälje kanal

Anchor wall reconstruction in Maribor, Slovenia

Central correctional facilities in Ljubljana, Slovenia

Old becomes new – renovation of a listed building in downtown Budapest

Keller – A reliable partner for tricky hotel projects

Keller Romania aims high – Piling works at ONE LAKE CLUB

Banchina Ponte San Giorgio – looks nice to work near the sea

STEP AS25 Rüthi SG – Oberriet: Rheintal double track expansion

Les Masses – Dent Blanche Resort

Budatin-Brücke, Žilina – Constructing of new railway bridges in Žilina

TITANIUM Brno – Pit walling and pile foundations for new buildings

14



**WHAT WE DID IN AUSTRIA**

Rhesi test field – Alpenrhein flood protection

Tschamlerstrasse 3 – Improvement of an existing foundation in the heart of Innsbruck

Bodner Headquarters – Kufstein soil improvement

KSK – Kardinal Schwarzenberg Clinic Schwarzach im Pongau

Opera for Kids at the Künstlerhaus

Residential high-rise tower DC Flats

Graz University Hospital radiology – excavation pit support and foundation

Environmental geotechnics in Upper Austria – excavation pit support and pollutant immobilisation using jet grouting

54



**WHAT WE DID FOR US**

Keller Academy SEN

HSEQ Day 2023 – How to convey HSEQ topics

Cooperation with school classes – one of the many pillars of ABV

Stars of Styria 2023



# Keller Grundläggning has a new address

Keller Grundläggning has landed in new premises. A total area of 3,500m<sup>2</sup> leaves plenty of room for the entire business to grow continuously in Sweden.

Theresia Bernhardt – Keller Grundläggning, Kungsbacka

► The new properties are easily accessible in the central parts of Kungsbacka, approximately 30 kilometres south of Gothenburg.

During spring, the premises underwent extensive remodelling and reconstruction to adapt to the operations and needs of the company.

“It has been an extensive project, a fantastic fun journey, but not entirely without challenges. With good help from everyone involved, the work has flowed well, and I am satisfied with the final result”, says Frederice Bernhardt, project manager for the relocation.







**WITH THE TRADITIONAL CUT OF THE RED RIBBON**

the new premises were officially opened to the cheering of Keller Grundläggning's staff.

The workshop houses, on an area three times as large as before, can now handle seven machines at once for quick handling and minimised downtime. The premises have been equipped with a lot of new equipment and a 27 metres high, roofed wash hall.

Generous space and bright surfaces characterise the office. The team created space for three larger conference rooms, too, which can be used by all staff for both, conferences and in-house training.

"I hope that, together with my team, I have created a new home for Keller Grundläggning with the best conditions for working and being comfortable in", concludes Frederice Bernhardt.



**LARGER WORKSPACES, UPDATED EQUIPMENT**

and room to maintain structure and order give the workshop fair conditions for an even better job.



**UP TO 4,000 m<sup>3</sup> OF SOIL AND ROCK**

have been blasted away and transported to make room for a functional courtyard and laundry hall.







# Söding 3.0 yard improved energy efficiency

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Keller SEN has seen tremendous growth in recent years. We now serve ten European countries. The yard in Söding needs to be able to keep up, not only in terms of capacity but also in meeting sustainability targets. Energy efficiency considerations are one of our main goals here.

Thomas Kirchmaier / Paul Rott - Keller SEN

# Söding – a brief history:

**1982** Keller Grundbau Austria has its central yard in Unterpremstetten (Styria)

**1992** Relocation to a new storage area in Söding (Styria) with approx. 600m<sup>2</sup> workshop space and an office wing

**2008** After minor adaptations over the last 16 years, a major investment is made to better support the expanded SEE business unit (today: SEN). The factory halls were expanded to the level we know today. In addition, the single-story section is given a second floor to create social rooms for the yard employees.

**2015 /17** Work has started to renew the yard, both by paving the storage areas and by erecting a gantry crane. This allows for the increased demands.

**2019** The business unit continues to grow, and part of WikoTech's premises is purchased. This is accompanied by a revamp of the entire yard. All necessary rooms for our staff are now located in the "WikoTech-Areal", a welding hall with a hall gantry crane is built, the painting plant is adapted to our requirements, and in the old office wing, a link is created on the second floor, connecting the part that is now more than 27 years old with the 2008 expansion.

**2022 /23** A photovoltaic system with 199.5kWp is erected, eight charging stations for EVs are installed, and planning starts for further adaptations to support sustainable working.

## So, where do we go from here? What can we do to continue the story?

► Over the years, deficiencies became apparent, especially in the old office building: drafty windows, high energy costs due to the outdated oil heating system, no wheelchair-accessible equipment in the office, thermal insulation missing from some exterior walls, single glazing in the factory halls, lack of noise insulation when working under the shed roof, and many more.

All these points were no longer compatible with our sustainability ambitions and led us to consider further measures.

To begin with, existing plans were surveyed to enable the preparation of an energy certificate to form the basis for all further considerations. Further steps were then taken, such as:

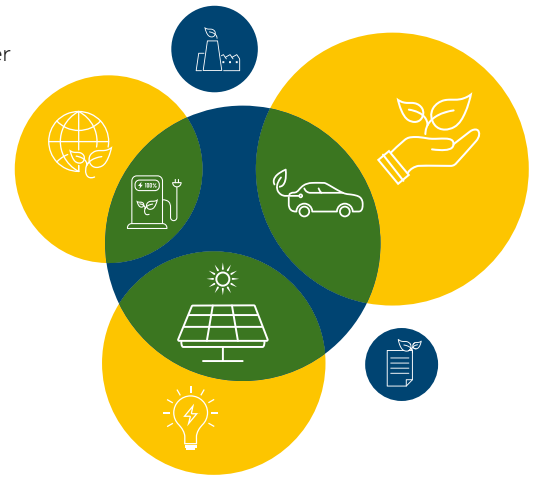
- Replacement of the old heating system
- Expansion of the photovoltaic system in the "WikoTech-Areal", as well as application of thermal insulation and installation of energy-saving windows, including roller shutters
- Adaptation of the office with wheelchair-accessible equipment, to accommodate people with special needs.

***We are striving to implement these sustainable, energy-efficient and necessary measures as soon as possible, to make Keller's buildings as efficient as our construction sites.***





# Yellow and blue make green sustainability at Keller



What began as a vision in 2022 has made progress in 2023, thanks to the help of management and employees. Projects that we considered viable have been started and continued.

Thomas Kirchmaier - Keller SEN



the beginning of the year (see page 55) to instruct and inform all employees about the topics and tasks that sustainable work will impose on us in the future.

In addition, we began initial tests during the year with lower CO<sub>2</sub>e GTL propellants and continued the development of more CO<sub>2</sub>-neutral pile systems (wood/ductile combination pile), as well as research on substitute binders with lower CO<sub>2</sub>e emissions.

## ► ...what happened so far:

**Christmas vouchers:** In the future, we want to support local farmers and small businesses with vouchers for our Austrian employees – a key point for sustainability (SDG 12).

**Electrification of cars in the company fleet:** As of Q1/22, 41% of the registered company cars were already electric; it will reach 47% in 2023. This is clearly an upward trend. About six litres of diesel/100km consumed by a passenger car corresponds to about 59kWh/100 km. In contrast, an average EV consumes about 20kWh/100km.

By using **LED lighting** and switching to green electricity supply in our offices and yards, we have succeeded in reducing CO<sub>2</sub>e emissions by around 26% from 2019 to the end of 2022. In the future, we expect to obtain additional information to find further reduction potential by improving the recording of data on our energy consumption for electricity and heating.

Our 199kWp photovoltaic plant in Söding went into operation in 2023.

Based on electricity consumption from Q1-Q3/2022 as the base value for this year, we have already covered 84.4% of this consumption with photovoltaics. As such, it makes sense to expand a second photovoltaic plant on the site purchased from WikoTech.

For future sustainability reporting, we also need data regarding our grid electricity consumption at construction sites. This data could not be recorded previously, which is why we began using Line-metrics wireless sensors to measure electricity and energy consumption at our construction sites. The advantages of this system are twofold: firstly, recording energy-relevant data with a wide variety of sensors and, subsequently, developing an energy efficiency strategy.

Considerations for more energy-efficient heating systems in our construction containers complement these energy conservation efforts.

After talks with employees, it became clear to us that they only roughly understand sustainability, so we used part of the time at the HSEQ days in Söding at





# PPE (personal protective equipment) it's not a choice!

Our employees' safety is not only a duty, but one of our top priorities as an employer – whether on a construction site, in our workshops, or in warehouses. To achieve this, we provide our employees with PPE of high quality and protection level.

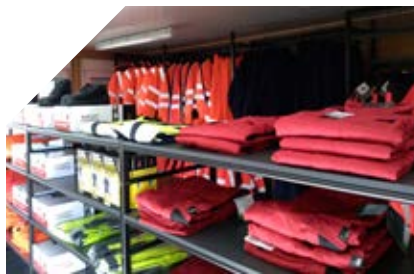
Elke Legenstein / Martina Rückenbaum – Keller SEN



## PPE web shop

In cooperation with Mascot, Keller SEN has established a webshop where employees can order the PPE they need quickly and easily, practically 24/7 – including fits for women.

The respective budget is defined by each person's field of work.



## Rapid response to developments

When a concentration of accidents that could have been prevented by personal protective equipment is spotted, the company acts and responds quickly.

For example, since 1 January 2023, we made it mandatory to wear protective glasses on our construction sites! We also provide our employees with PPE adapted to their personal needs (such as adapted hearing protection, prescription safety glasses, and adapted safety shoes).

## Awareness/communication

We use the standard Group poster on the requirements for safe working to constantly remind construction site employees to use our PPE

We defined the following minimum standards for our construction sites:

- Safety helmet/hard hat
- Safety glasses
- Safety shoes (S3) or boots (S5)
- High-visibility jacket or clothing
- Gloves, when handling materials, tools, and equipment; must be readily available and ready for use at all times.

Training for our employees is also extremely important. Keller SEN also continues to reinforce/educate about PPE internally, where necessary, via our monthly recurring communication feed, Tool Box Talks (TBT). This helps us ensure that all colleagues are up to date on all safety matters – at all times.

## It's not a choice

The following PPE is mandatory





# Growing in Norway

## Keller acquires Northwest Fundamentering AS in Trondheim, now part of Keller Geoteknikk AS

Our acquisition of Northwest Fundamentering (NWF) strengthens our position on the Norwegian coast and brings excellence in driven piles and near-shore projects, further helping us contribute to sustainable infrastructure growth in Norway and beyond.

Muhammed Mesic - Keller SEN /  
John Olav Dybvik - Keller Geoteknikk, Trondheim

► In November 2022, Keller concluded the acquisition of 100% of the shares in NWF, a regional leader in the foundation business based in Trondheim, Norway. This acquisition was a result of not just Keller's strategy to build leading market shares in key markets but particularly of a great fit between Keller's existing presence in Norway and the competence that NWF brings to projects of key importance for Keller's Nordic market footprint. This regards in particular the rapidly growing sector of near-shore foundation engineering. Most importantly, it was the result of a great fit between experienced and enthusiastic teams on both sides.

Founded in 2018 by four colleagues and having 24 employees at the time of acquisition, NWF brings references from having worked on various key projects along the coast (and beyond) for leading Nordic general contractors.

The portfolio of approximately 30 yearly projects includes reference projects from Ålesund in the southwest of Norway and even Oslo to Tromsø, more than 350km above the Arctic Circle. In Karmsund harbour, 813x14 and 914x14mm steel tube piles were laid for a new harbour with a Junttan PMx28 rig, one of Norway's largest. Operating from a sea raft and using hammer weights of five to nine tonnes, this rig can install pile lengths up to 28m. Using a rig of this size has been advantageous, as it ensures a fluid ramming operation without splicing. In Larvik, NWF drove steel piles of up to 70 metres in length. Various near-shore sheet piling projects complete the unique competence portfolio.

A comprehensive integration was carried out in 2023 leading to the merger of NWF into Keller's Norwegian entity, Keller Geoteknikk AS. This gives us more synergies and an even bigger opportunity to contribute to the dramatic ongoing development of infrastructure in all of Norway. John Olav Dybvik leads Keller's Trondheim office and is looking forward to exciting new projects under the flag of the world's largest independent geotechnical contractor.



# Sustainable foundation works using vibro techniques

In addition to their economic efficiency, the ecological sustainability of foundation solutions is increasingly coming to the fore. The well-known vibro techniques, in particular, offer an excellent way to save large quantities of CO<sub>2</sub> emissions.

Vincent Winter - Keller SEN

► The European Climate Law sets emission reduction targets for the coming years, all the way to climate neutrality for the EU by 2050. Sustainability and climate neutrality are also becoming increasingly important in our everyday lives.

Looking at special foundation works and foundation problems in particular, this means that in addition to the economic efficiency of a project, the sustainability factor and the CO<sub>2</sub> emissions as an aspect of it, are becoming increasingly important.

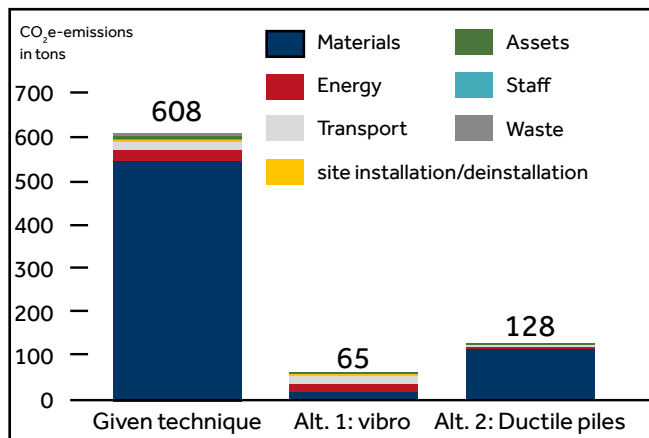
So how can a project's CO<sub>2</sub> emissions be kept as low as possible?

It has been shown that the actual CO<sub>2</sub> emissions can be influenced the most at the beginning of the planning phase.

It starts right from the building design and a good soil investigation, which provides the basis for further planning steps. If the building loads occurring and settlement requirements are known sufficiently, along with the soil parameters, the most technically suitable ones from the portfolio of special foundation solutions can be considered. Thus, the best technique selected from among them in terms of economic efficiency and sustainability.

## GRAPHIC

CO<sub>2</sub> emission calculation for various foundation project options as a component of Keller Grundbau quotations from 2024 onwards



Most CO<sub>2</sub> emissions in construction are caused by the use of cement and steel, so processes that dispense with their use altogether are an option here, of course.

This is the case with the most common vibro techniques. Vibro replacement and vibro compaction use only gravel and sand as construction materials, which are usually available locally at a comparatively short distance from the construction site. This results in further CO<sub>2</sub> reductions, thanks to short transport distances.

Since the beginning of 2023, Keller Grundbau has started logging the CO<sub>2</sub> emissions actually occurring on all construction sites in Austria in a database to target optimisation of CO<sub>2</sub> emissions in the future based on this data.

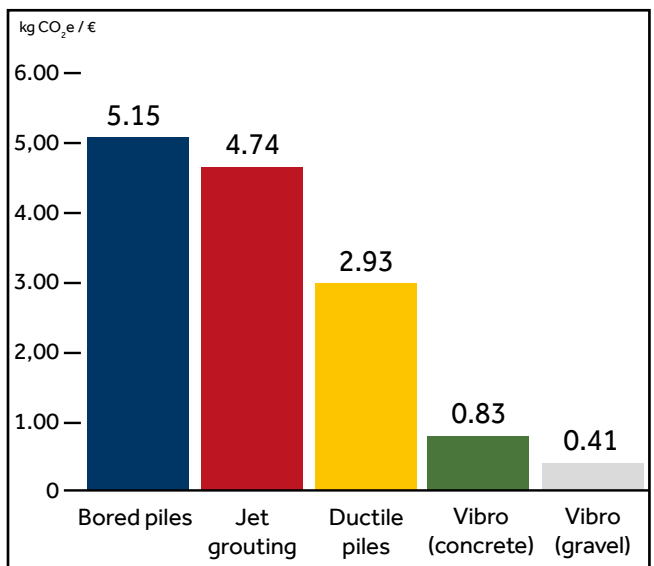
As of mid-2023, the system has been extended to all countries in our South-East Europe & Nordics business unit.

The data obtained shows that the vibro techniques using gravel as the construction material are clearly superior to other foundation techniques that require cement or steel, in terms of CO<sub>2</sub> emissions.

From 2024, a project's calculated CO<sub>2</sub> emissions will also become an integral part of our quotations.

## GRAPHIC

If the CO<sub>2</sub> emissions are related to the respective turnover of the foundation techniques, the vibro techniques result in significantly lower CO<sub>2</sub> emissions than other techniques (analysis of the Keller CO<sub>2</sub> emissions database)



# Kwizda high-rack warehouse optimisation of depth foundation using bi-directional static Pile HAY-Proof-System®

In the spring of 2022, in close cooperation with the project members Kwizda Leasing GmbH (client), Kalczyk & Kreihansel ZT (planning & statics), 3P Geotechnik, and Keller Grundbau, the foundation concept for the new fully automated high-rack warehouse was optimised in the final phase using pile tests on ductile driven piles.

Christoph Januskovecz - Keller Grundbau, Wien



► Kwizda Leasing GmbH built a new high-rack warehouse for the Group's agro division – Kwizda Agro – at the Leobendorf site (Korneuburg district, Lower Austria) from May 2022 through August 2023. Stringent settlement requirements had to be ensured, as the new high-rack warehouse is automated, with autonomous vehicles in the respective building sections. In the spring of 2022, Keller Grundbau was involved in the structural design process to ensure meeting these high demands. In the course of this, we did four test loads with different bond lengths on two test piles and used fibre optic measurement systems. Based on the very significant results and our extensive experience with ductile pile construction, we contributed significantly to the optimisation of the foundation system.

In March 2022, we executed two test piles and one additional exploratory pile at the project site, which were also equipped with fibre optic measurement systems. The trial and exploratory pile installation had two aims: Firstly, to obtain meaningful bearing capacity values (separated according to peak pressure and skin friction), and secondly, to undertake further random exploration of the subsoil, to get an overview of the expected pile-driving times and the actual concrete consumption. Thanks to our many years of experience, it is possible to estimate the overall load-bearing capacities in advance of the execution. So, one test pile was prepared for a maximum test load of 2,000kN and the second for 4,000kN. Following the principles of the Pile HAY-Proof-System®, the applied press force acts on the skin and the tip simultaneously during the static tests. One advantage of this bi-directional test method



**FIBRE-OPTIC SENSOR CABLES (BLUE) IN THE PILE,** along with displacement transducers during the test execution

is that up to 200% evaluation load can be achieved with a 100% applied press load. In other words, total pile-bearing capacity values of up to twice the maximum press load can be determined. This can be seen in the schematic representation of the primary test load. The pile skin acts as an "abutment" for the pressure applied to the pile tip. If there is an early failure of the pile tip, an additional secondary tensile test has to be executed, to determine the failure skin friction values. To achieve this, the compression bar is fixed above ground in a way that the entire compression force is transferred to the pile skin.

The individual resistance components - separately for pile tip pressure and pile skin friction - can be determined in situ for pile tests using Pile HAY-Proof-System®. By recording the two resistance components separately, the total load-bearing capacity of the pile can be calculated by superimposition.





**TEST SETUP READY FOR TESTING**

**TEST PILE PP02 EXPOSED**  
to a depth of approx. 3.2m

The fibre optic measuring systems applied to the test piles in this test field also made it possible to establish a correlation between driving time and bearing capacity in the different soil layers. A detailed pile driving criterion could be derived based on the test results from the Pile HAY-Proof-System® and the fibre optic measurements.

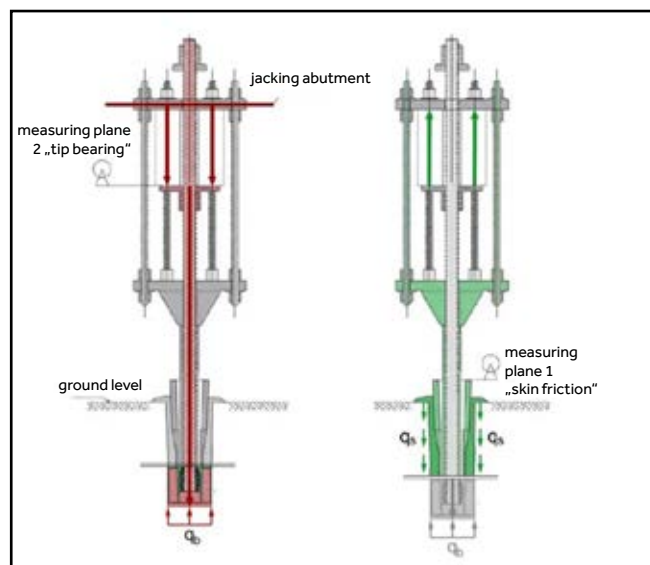
Due to the detailed recording of all production-relevant information for EACH pile (driving time per metre, last heat, amount of grouted concrete per metre, etc.), the different pile loads specified by the structural analysis with the stringent settlement requirements could be transferred into the subsoil safely and economically during the production of the structural piles.

Thus, the ductile pile system allows very efficient adaptation to the subsoil conditions encountered at the construction site. In terms of the Kwizda high-rack warehouse project, the test pile loads carried out ahead of time, and the resulting early integration into the structural design meant that the deep foundation could be adapted to the requirements of the building in the best possible way.

Based on the excellent cooperation between the client, designers, structural engineers, geotechnics, and our company led to the result that the pile foundation could be implemented technically, economically, and in a resource-friendly way while maintaining the highest quality standards in the interest of all parties involved.

**GRAPHIC**

Sketched representation of the force flows during the pile tests





## Rhesi test field

# Alpenrhein flood protection

Flood protection and the ecological condition of the Rhine, will both be improved as part of the upcoming Rhesi project. The project area is located in the Rhine Valley and extends from the mouth of the Ill River to Lake Constance (Rhine km 65.0- Rhine km 91.0). Some flood protection dams are on subsoil susceptible to liquefaction, which can become unstable in the event of strong earthquakes. To better evaluate potential measures against these hazards, three test fields were carried out. Here, Keller Grundbau installed vibro stone columns and vertical drains.

Andreas Neyer - Keller Grundbau, Dornbirn

► Flood events in the Vorarlberg and St. Gallen Rhine Valley can be dated back to the 11<sup>th</sup> century. Extensive regulatory structures were built with the 1892 state treaty, and flood protection has been improving ever since. This work was an important cornerstone for the region's economic upturn. Today, more than 300,000 people live in the Rhine Valley, and many companies have established themselves here. However, this development has significantly increased the potential for damage over the years. The current protection systems are designed to handle severe flooding with a discharge rate of 3,100m<sup>3</sup>/s. The Rhesi flood protection project will expand the discharge capacity to 4,300m<sup>3</sup>/s and include ecological improvements for the Rhine.

The flood protection project is in the approval phase currently, and an extensive soil survey program has already been conducted. The analyses have shown that there are unfavourable soil conditions in some cases, where soil liquefaction in the event of an earthquake cannot be ruled out. These are areas dominated by fine sand, peat, or fine grain, saturated with water. Appropriate improvements must therefore be made to avoid damaging settlements at the dams. In parti-





selected locations to test the vibro replacement, vertical drains and impulse compaction techniques, as well as combinations of these. 3P Geotechnik West ZT GmbH intensively monitored the test fields. Graz University of Technology is also involved with a master's thesis. The locations were determined based on the existing soil investigation.

The tests aim to determine a suitable improvement procedure, including execution details (column grid, depth, material, etc.) that best serves the technical and economic aspects. Different grid spacings and materials were also tested during the trials to keep material consumption as low as possible. In some cases, additional vertical drains were installed (before vibro replacement works) or impulse compaction (after vibro replacement works). An extensive measurement program accompanied the test fields. Core drillings, cone penetration tests, and groundwater level measurements were carried out before the works, to record the subsoil condition before improvement.

The vibro stone columns were executed with the latest generation of the Vibrocat 05, which has a double lock chamber and an automatic replacement system, ensuring very high quality and a constant column diameter during execution. After executing the primary and secondary grids of the vibro stone columns, additional cone penetration tests (outside the columns) were carried out at previously defined points. The interruptions between the primary and secondary grids, due to the required cone penetration tests, called for intensive coordination between the project par-

## PROJECT INFORMATION

**Investor and contractor:**  
Internationale Rheinregulierung

**Geotechnical consultant:**  
3P Geotechnik West ZT GmbH

**Quantities:**  
**2,747m** vibro stone columns  
**1,673m** vertical drains

**Execution period:**  
February–March 2023

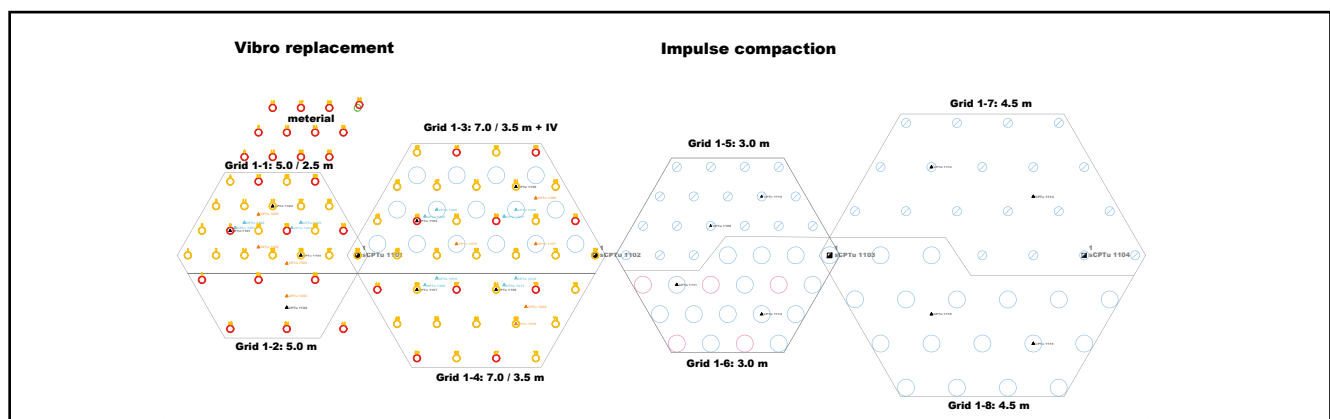
ticipants. The excellent cooperation of all project partners met all these challenges.

Measurements at the test field have not yet been fully completed and are expected to continue until the end of 2023. The results already obtained, are currently being evaluated by 3P Geotechnik and the Graz University of Technology.

cular, the improvements must increase the shear strength in the problem zones mentioned. Doing so requires compaction of soils and/or installation of elements with increased shear strength to sufficient depths. In addition, drainage plays a vital role in the areas at risk (reduction of excess pore water pressure). In the past, vibro replacement has proved to be the most suitable method for improving stability in these soils. Adding vertical drains can also increase this stability.

Soil liquefaction is a complex process that cannot be described with sufficient accuracy through conventional calculation approaches alone. For this reason, trial fields were established in three

### GRAPHIC

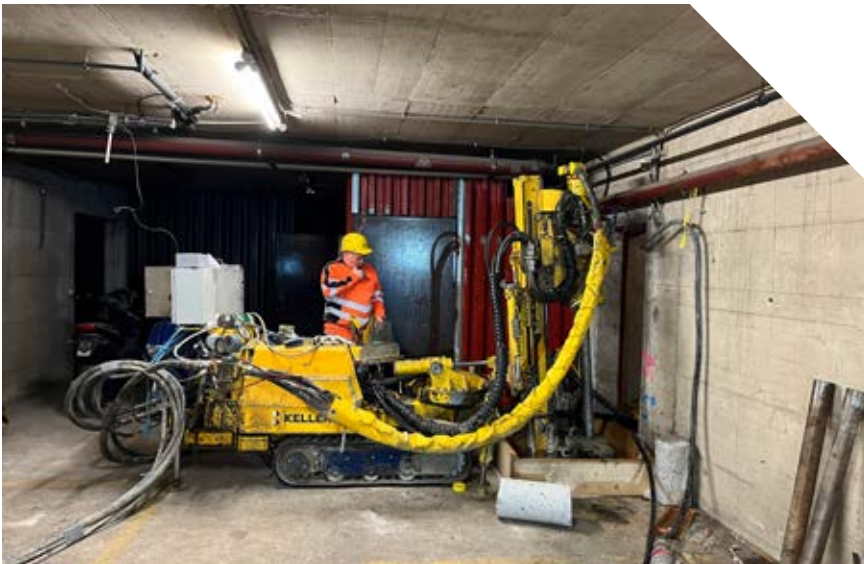


# Tschamlerstrasse 3

## Improvement of an existing foundation in the heart of Innsbruck

Space is limited in densely populated urban areas, as is the case at Tschamlerstrasse 3 in the centre of Innsbruck. The only option is to extend the building upwards. The heavier loads in the building require improvement of the foundations using Soilcrete.

Johannes Dolzer - Keller Grundbau, Innsbruck



► Construction of new living space is the goal in the existing building at Tschamlerstrasse 3 in the heart of Innsbruck. There are plans to add four new floors to the structure. There are several reasons for this project.

**Lack of space:** Space is limited in densely populated urban areas. Adding new floors to buildings allows for optimising the given area in the existing building without taking up additional.

**Economic efficiency:** Constructing a new building is expensive. Adding on is a cost-effective option to create additional residential or commercial space.

**Environmentally friendly:** Less new construction material is needed when

adding new floors to the existing buildings, resulting in a lower environmental impact than constructing a completely new building. However, adding floors at Tschamlerstrasse 3 will increase loads in the building significantly and, therefore, in the soil, too.



### PROJECT INFORMATION

**Investor/contractor:**

Tscha3 Immobilien OG

**Geotechnical consultant:**

Dipl. Ing. Schaffenrath

**Statics:**

Dipl. Ing. Alfred Brunensteiner ZT-GmbH

**Executed works:**

Foundation reinforcement using Soilcrete

**Execution period:**

March 2023

Since the existing foundations could transfer the additional loads safely, foundation improvement using Soilcrete / jet grouting had to be executed.

Limited space and difficult accessibility to the basement floor of the building were challenging but could be overcome with flying colours.

#### JET GROUTING PLAN

Existing building

- Load-bearing masonry (reinforced concrete/brick)
- Bearer in the basement / reinforced concrete
- Demolition of non load-bearing divider walls
- Escape Room area - stays as is







## PROJECT INFORMATION

### Investor/contractor:

BODNER Gruppe

### Geotechnical consultant:

PGI Kufstein

### Quantities:

**2,800 m<sup>2</sup>** vibro compaction

### Execution period:

January 2023

### RENDERING:

Zechner & Zechner

# Bodner Headquarters Kufstein soil improvement

For constructing the new BODNER Group headquarters in Kufstein, soil improvement using Keller's vibro compaction method was executed as a foundation measure.

Werner Hautz - Keller Grundbau, Innsbruck

► BODNER Group, one of Austria's largest family-run construction companies, is building a new corporate headquarters in Kufstein.

As the soil consisted of loose sand layers with some silty deposits, soil improvement works had to be carried out before the start of construction. Keller's vibro replacement/compaction method is the first choice for such work. The load-bearing capacity is increased significantly by adding appropriate additive mate-

rial, with the effect that the design loads can be transferred without any problems into the ground.

An advantage of this method is that it allows for an almost perfect adaptation to different loads. A narrowed grid is

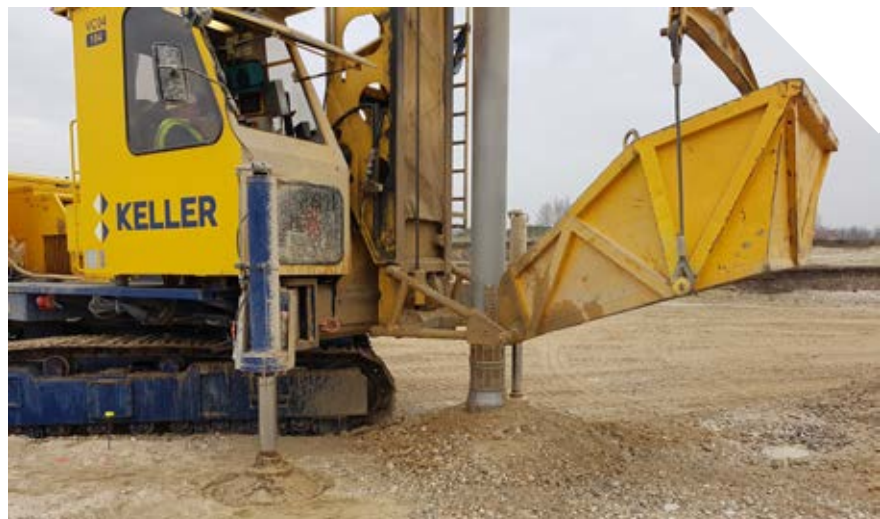
### GRAPHIC

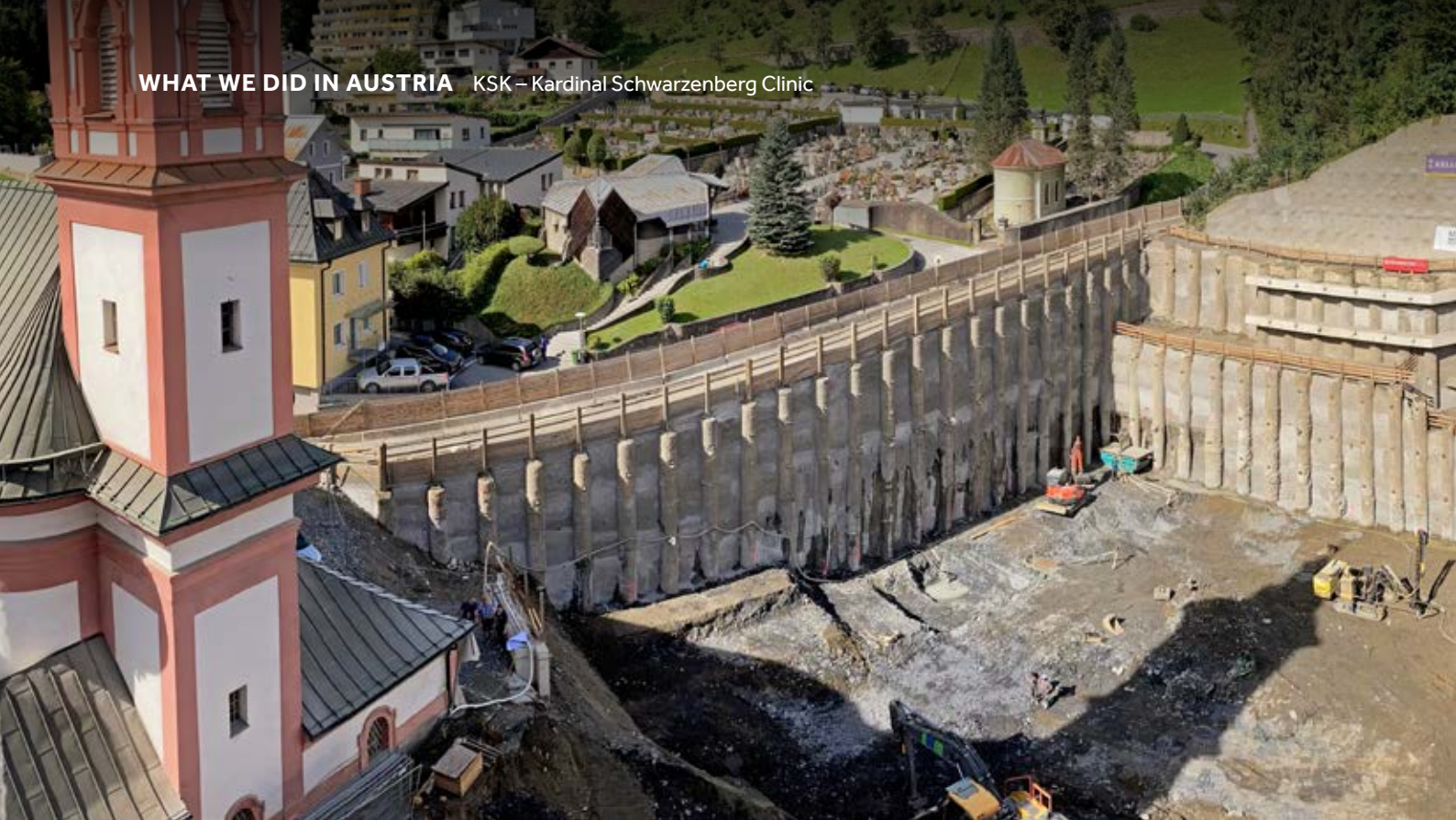


used in areas of heavy-loaded individual foundations, while the grid is widened accordingly in areas with lower loads. This results in cost-efficient homogenisation of the soil conditions in general.

The Vibroscan control system, developed by Keller, displays the recorded compaction effect at each point graphically and serves as an additional quality control.

Work was completed in January, enabling the client to start its building construction work on schedule.





# KSK – Kardinal Schwarzenberg Clinic Schwarzach im Pongau

A modern hospital extension is under construction in the heart of Schwarzach. The limited space and the nature of the terrain made it essential to take appropriate safety measures for the excavation pit. We used techniques such as shotcrete, large-diameter bored piles, and pre-stressed strand anchors on this site.

Kevin Fauland - Keller Grundbau, Salzburg

► Kardinal Schwarzenberg Klinikum GmbH is planning a redesign of its Schwarzach hospital, representing an important development for the medical facilities. Demolition of the current children's hospital and the construction of a modern new building, which will be connected to the existing buildings at the basement level, were key elements of this project.

The inclined slope on which the new building is located was a particularly interesting challenge. This particular topographical location required careful design to ensure the best possible use of the site.

The project's excavation pit support was divided into two main areas: the slope area and the road area.

In the **slope area**, an existing soil nailing wall in the upper part was replaced by a new soil nailing wall. Two offset contiguous bored pile walls were also constructed along the soil nailing wall. These bored pile walls played a crucial role in stabilising the slope and were secured using pre-stressed permanent and temporary strand anchors in up to five anchor rows. While part of the upper bored pile wall will act as a permanent one, the lower one was anchored temporarily.

In the **road area**, the bored pile wall was constructed on a strictly temporary basis and then tied back using pre-stressed temporary strand anchors.

The maximum excavation depth reached about 30 metres at its highest point. The large diameter bored piles were executed up to 18 metres in length, and the strand anchors have a length of up to 26 metres. The earthworks, as well as the shotcrete work, were carried out by our consortium partners, ETM Bau GmbH





## PROJECT INFORMATION

### Investor/contractor:

Kardinal Schwarzenberg Klinikum GmbH

### Geotechnical consultant:

Intergeo Umwelttechnologie und Abfallwirtschaft GmbH

### Statics:

Keller Grundbau Ges.mbH

### Quantities:

approx. **1,300** linear metres of large diameter bored piles

approx. **3,600** linear metres of strand anchor

### Execution period:

March-September 2023

**OVERVIEW OF THE EXCAVATION PIT DURING EXECUTION**



**EXECUTION OF LARGE DIAMETER BORED PILES**

and Greiffenhagen Sprengtechnik GesmbH. Both companies contributed their extensive expertise in their respective fields to ensure efficient and professional execution of these work sections.

Overall, this planned redesign will enable the Kardinal Schwarzenberg Clinic to provide state-of-the-art healthcare and guarantee the viability of the Schwarzach location in the future.

### EXECUTION OF STRAND ANCHORS



# Opera for Kids at the Künstlerhaus

The future “Opera for Kids” is part of the Künstlerhaus, originally called the “French Hall”. It will have a two-storey basement and be converted into an opera for kids. It will later accommodate around 280 spectators, an orchestra pit for 30 musicians and a hinged-cover stage.

Kurt Friedrich - Keller Grundbau, Wien

► Keller’s challenge was to underpin the existing masonry and secure the excavation pit so that two additional basement levels could be built afterwards. The exterior walls were underpinned for this purpose with 70 jet grouting columns, in total, of different diameters and lengths.



The planned location in the first district of Vienna, between the “Albertina Modern” and the underground halls of the Vienna Musikverein, meant that special attention had to be paid to minimising vibrations and noise emissions during construction. This structural task was further complicated by limited wall thicknesses for the jet grouting bodies and varying bottom edges of the existing foundations.

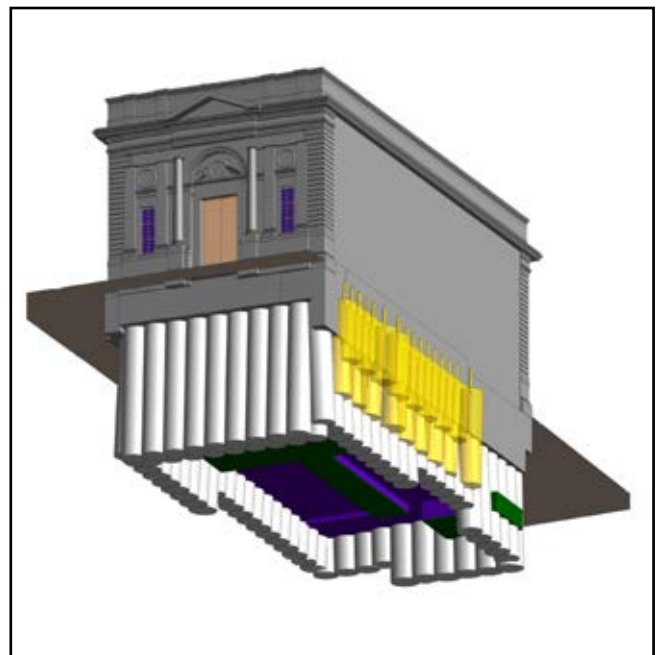
The soil was archaeologically examined before and during our work, as Roman-era stables are expected in the vicinity of the Vienna Ringstrasse. Good relations between those responsible at the music association and the contractor were prerequisite for adapting jet grouting production to the rehearsal schedules of the musicians.

Implementation planning was optimised through extensive preliminary investigations of the existing situation and very project-focused cooperation among the specialist designers aimed at an optimised sequencing of the works. The highly flexible jet grouting process made it possible to implement the construction measure successfully.

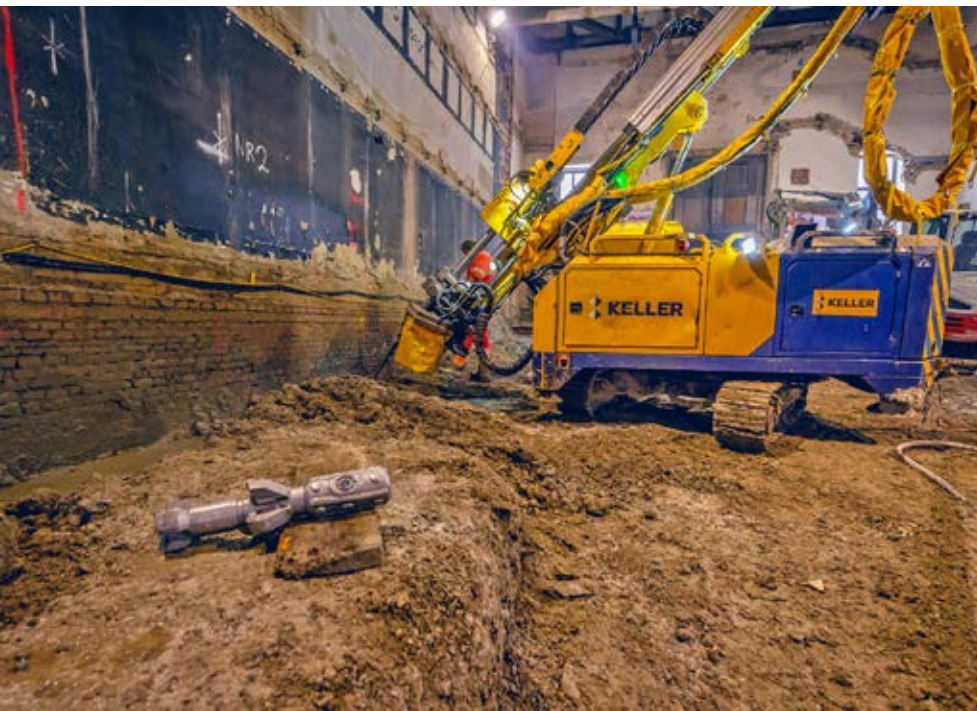
The newly created jet grouting walls were subsequently further sealed by shotcrete to produce a level surface for further conversion measures.

## GRAPHIC

3D model of the building incl. executed jet grouting columns







## PROJECT INFORMATION

### Investor:

KBBG – Künstlerhaus Besitz- und Betriebsgesellschaft mbH

### Contractor:

STRABAG AG

### Quantities:

**70** pcs. jet grouting columns

**600**m<sup>2</sup> Shotcrete

### Execution period:

February–May 2023

**JET GROUTING WORK INSIDE THE BUILDING**







# Residential high-rise tower DC Flats

A 50m residential high-rise tower with around 350 flats is being built in Donau City (DC), next to the UNO City and the Andromeda Tower. The construction required extensive special foundation works, such as excavation pit support and sealing using the jet grouting technique, as well as a deep foundation using bored piles.

Christoph Nagl - Keller Grundbau, Wien

► A residential high-rise tower is being built on the last vacant lot in Vienna's Donau City, right next to the Andromeda Tower and UNO City and near the Danube Island. The 18 residential floors of the building, which is around 50m high, will provide space for approximately 350 flats with a total area of 16,500m<sup>2</sup>.

Extensive special foundation work was needed ahead of time for the building's construction, involving excavation pit support, sealing, drainage, and deep foundations. Keller Grundbau was assigned to execute the jet grouting work to secure and seal the excavation pit, as well as for the bored piles.

A watertight excavation pit support was essential because the groundwater level is 2m above the planned lowest level of the foundation slab. Jet grouting lamellas, approx. 10m long and up to 3m wide, were executed for waterproofing. The lamellas were embedded at least 3m into the overlying silty, fine-sandy impermeable layer to ensure waterproofing and prevent under-currents. The excavation pit support, directly adjacent to the UNO City retaining wall, also had to be installed using jet grouting. This prevented vibrations on the existing retaining wall. For this purpose, jet grouting columns with diameters of up to 2.50m were executed in the fine sands and gravels.





## PROJECT INFORMATION

<b>Investor:</b> AMISOLA Immobilien AG	<b>Statics:</b> KS Ingenieure
<b>Contractor:</b> STRABAG AG	<b>Executed works:</b> Jet grouting; bored piles
<b>Geotechnical consultant:</b> 3P Geotechnik	<b>Execution period:</b> February–May 2023

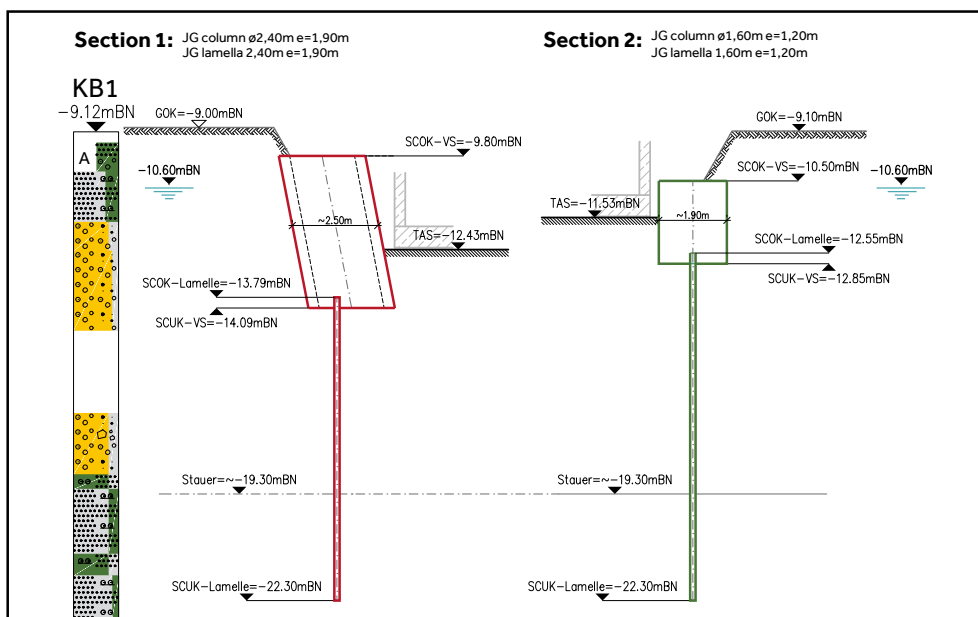
As well as the tight construction time, an additional challenge on the small construction site was that almost all work had to be done more or less simultaneously. Also, many of the bored piles had to be drilled in confined space within a sheet pile box that was only 10m wide.

Due to the height of the structure and the resulting foundation loads, the foundation was built as a combined pile and raft foundation. This foundation method transfers the loads to the ground via both the base plate and the piles.

Bored piles work was also assigned to Keller Grundbau. All in all, around 280 piles with a diameter of 63cm and lengths of up to 21.5m were executed using the continuous flight auger (CFA) technique. One of the reasons for using CFA piles was the tight construction schedule.



### GRAPHIC





# Graz University Hospital radiology – excavation pit support and foundation

Steiermärkische Krankenanstaltengesellschaft mbH (KAGes) is constructing a new building complex for radiology and nuclear medicine on the west side of the Graz University Hospital campus, near the surgical clinics and supply centre. An excavation pit with a depth of up to 10m will be constructed on an area of approx. 5,300m<sup>2</sup> for this purpose.

Peter Schicker - Keller Grundbau, Söding

► For the “New radiology building RK2020” project, Keller Grundbau was awarded by Herzog Bauges.m.b.H & Co.KG to carry out the special foundation works associated with the excavation pit and the foundation.

The design for the excavation pit support shows a single-layer anchored, contiguous bored pile wall with shotcrete infill. Bored piles are also part of the deep foundation of the building com-

plex. A height difference of up to six metres within the excavation means that a nailed shotcrete wall is provided additionally as a securing measure.

Our work started in February 2023 with the execution of 326 bored piles DN63cm with a total length of 4,368 linear metres for the excavation pit support. The individual pile lengths ranged between nine and 16 metres. While the piles were still being under construction, excavation work was carried out in parallel by the construction company, and, as our part, shotcrete work was carried out between the bored piles down to the level of the anchor level. The execution of 236 temporary strand anchors with 3,297 linear metres in total and individual lengths of up to 16m started immediately after the pile completion. For this work, we used a double-head system and cased auger drilling for execution. The loads were applied without any walers, so every pile was anchored, using a special head construction. After the construction work had progressed according to plan, we started with the execution of the approx. 550m<sup>2</sup> shotcrete and soil nailing wall, parallel to the anchors, to secure the 6m drop in height in the excavation pit. The foundation piles were installed immediately after completion of all the anchoring work. 315 CFA piles DN63cm, 3,536 linear metres in total, were executed and distributed over four different elevation levels. The piles were up to 20m long, so a large rig with a Kelly extension had to be used.





## PROJECT INFORMATION

### Investor:

Steiermärkische Krankenanstalten  
Ges m.b.H (KAGes)

### Contractor:

Herzog Bauges.m.b.H & Co. KG

### Geotechnical consultant:

Insitu Geotechnik ZT GmbH

### Statics:

Thomas Lorenz ZT GmbH and Insitu  
Geotechnik ZT GmbH respectively

### Quantities:

approx. **8,400** linear metres  
of bored piles

approx. **3,500** linear metres  
of anchors

approx. **1,000m<sup>2</sup>** shotcrete  
between piles

approx. **550m<sup>2</sup>** nailed shotcrete

### Execution period:

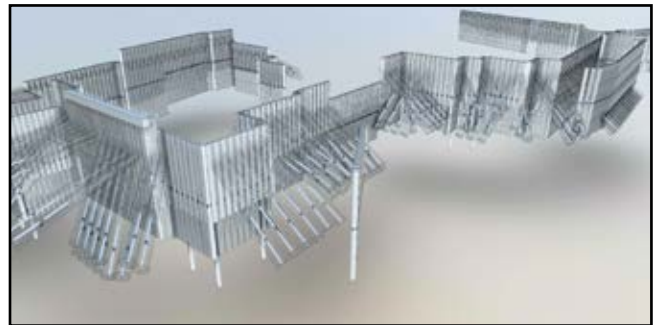
February–August 2023

### CONSTRUCTION OF THE PILES

for securing the excavation pit and the  
foundation using the CFA method

### GRAPHIC

3D model of the excavation pit



During the foundation work, we executed 51 additional piles as excavation pit support to deepen the decaying facility, which was added to the design. A part of this excavation pit support also had to be tied back in a second anchor operation. We completed our work on time by mid-July, except for the remaining pile testing.

We were challenged, especially during anchor production, because of some local conditions and restrictions. On the one hand, we had to adapt the direction of the anchors vertically and horizontally due to the copper beech tree in the Hilmteichstrasse area, protected by nature conservation laws, which meant that the position and direction of all anchors had to be measured precisely due to the narrow spacing between the anchors. On the other hand, some sewer lines are in the area of the main access road, which required exact drilling and frequent relocation.

Despite all these restrictions and the logistically challenging process flow, all the work was completed to the satisfaction of everyone involved in the project.

### ANCHOR PRODUCTION

in confined spaces



# Environmental geotechnics in Upper Austria

## excavation pit support and pollutant immobilisation using jet grouting

Last year, we successfully completed two projects in Upper Austria using jet grouting. One more is expected to join the list by the end of this year.

The subject: pollutant remediation in the soil. We, as Keller, want to contribute significantly to this.

Manuel Senoner - Keller Grundbau, Linz

### ► Remediation at Ennskai, Steyr

Repeated flooding of basements around the town hall in Steyr caused severe fuel oil and heating oil discharge from 1950 onwards. This soil contamination reached the banks of the Enns River around 2016 and resulted in recurring contamination of the river, ultimately resulting in its designation as a contaminated site.

The aim was to separate the oil phase floating on the groundwater along the river from it. Communication between the groundwater and the river, in the area between the aquiclude and the lower edge of the column, had to be ensured.

Jet grouting has the ability to construct a barrier with such geometric accuracy that both requirements could be met. Records obtained from the drilling operation before even starting the jet grouting sequence made it possible to adjust the lower edge of the column to the drilled upper edge of the aquiclude. With the remaining distance between the top of the dam and the bottom of the Soilcrete agreed before the start of work, a jet grouting scum board was constructed that has a retention capacity of approximately 550m<sup>3</sup>. During the subsequent earthworks between the scum board and the river, the oil phase, which had already migrated too far, could be specifically excavated and disposed of properly.

### Remediation of petroleum storage, Linz

Contamination of adjacent soil zones has occurred at a former petroleum storage site in Linz. Reasons for this were determined during sampling operations starting in the year 2000, which served as the basis for the remediation plan.

The groundwater level was approx. 4.0m below the surface due to the proximity of the construction site to the Danube River. The samplings showed contamination down to a depth of approx. 6.5m. To remove this contamination properly, the adjacent existing walls had to be underpinned and the contaminated soil immobilised simultaneously.

Jet grouting was chosen to meet both goals. A Soilcrete lamella wall was executed down to the aquiclude in the non-structurally effective area and below the contaminated soil layers. This sealing measure allowed the groundwater to be lowered to a point where subsequent construction could excavate and dispose of the contamination to the affected depth.

### Remediation at Pettenbach filling station, ongoing project

In 1978, the municipality of Pettenbach was declared a groundwater protection area by decree to protect the groundwater resources of the Pettenbach River. A former gas station located in the centre of the village turned out to be a potentially serious hazard. As a result of leakages from damaged pipes, contaminated zones can still be found in the soil there.

#### HEAVY OIL PHASE

in the area between Soilcrete scum board and Enns, Ennskai







**ENNSKAI CONSTRUCTIONS SITE, STEYR**

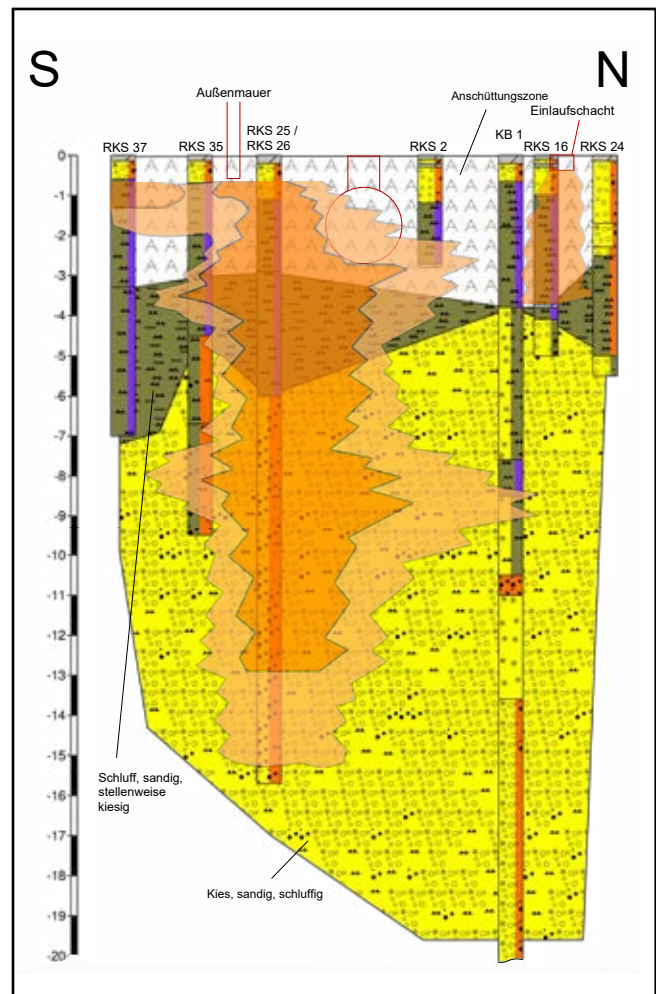


**PETROLEUM CONTAMINATION**  
at the Linz petroleum storage.

The first step during the planned remediation work will be to use the Soilcrete technique to secure the excavation pit, which allows a second step to salvage and dispose of the decommissioned tanks, which have remained in the ground. Accompanied by excavation down to approx. 5.0m below road level, the next step will involve jet grouting to immobilise the soil down to a depth of 15.0m to prevent further contamination of the fuel mixture towards the groundwater. A stationary gauge, already established before the start of the works, will confirm the success of pollutant remediation over the next few years.

**GRAPHIC**

Geological section showing the location of the contaminated soil areas, Pettenbach filling station





# Nye Nerlandsøya bru drilled piles for Nerlandsøya Bridge

Keller Geoteknikk was contracted to execute the geotechnical work for the new Nerlandsøya Bridge. In addition to 54 piles, with a total length of approximately 850m, the work includes installing permanent anchors and executing steel core piles.

Christian Rüdlin - Keller Geoteknikk, Oslo

► The new Nerlandsøya bru construction on the northwest coast of Norway includes a 574m-long bridge and the construction of new roads on both sides. The new bridge will run east of the existing one and is scheduled for completion in March 2025. The existing Nerlandsøya Bridge opened in 1968. The intricate structure of the bridge is striking, typical of the time, but also makes it highly susceptible to corrosion, which is pivotal for the new construction.

The pile work is executed on seven axes, with four axes on land and three on water. For the execution of the steel piles, Keller used a factory-new LRB 355 multipurpose drilling rig. During the tendering process, the drilling method was specified as



**CONCRETING AXIS 4 AND DRILLING WORK ON AXIS 3**

“reverse circulation drilling”. Depending on the pile diameter, Keller used 24” and 36” hammers to drill sufficiently deep into the rock. Drill depth into the load-bearing bedrock varied between two and four metres. Land axes three, four, and five were backfilled artificially and offered only a little space to carry out the piling work. The layout of the pile groups consists of six and twelve 1220x14.2mm piles, respectively. Axes four and five are designed circular with twelve piles each.

Unlike the land axes, the execution of axes six, seven, and eight was done from a barge on the water. The layout of these axes consists of eight 1016x12.5mm piles. Working on the barge without an auxiliary boat, with equipment consisting of a





**LRB 355 WITH RC SETUP**

## PROJECT INFORMATION

### Investor:

More og Romsdal fylkeskommune

### Customer:

Metrostav Norge AS

### Geotechnical consultant:

Rambøll

### Quantities:

**54** piles (reverse circulation process)

**800m** permanent anchors

**112m** steel core piles

### Execution period:

January–October 2023

drill rig, crane, cherry picker, auxiliary dredger, generators, and compressors, was a challenge to both the barge setup and the overall work process. For this, we needed excellent coordination with boat owners because of the location of the pile axes near the boat harbour with ongoing boat traffic, as the barge mooring system extended over large portions of the harbour. In addition to the drilling process, the logistics on the water were an enormously important part of the work. We had limited storage capacity on the barge, so the steel pipes were transported to the barge by water on a just-in-time basis. The steel pipes were transported using their buoyancy – so only the ends had to be attached to buoys, and then they were pulled to the barge using a small boat. For reverse circulation drilling, a high amount of backflow must be taken into account. Allowing for a decompaction factor of 1.5, about one cubic metre of backflow plus the volume of pumped water is produced for every metre drilled. The backflow, consisting of water and crushed rock material, was separated as well as possible using two containers so that the remaining material was unloaded on land with a dredger and disposed of afterwards.

The steel pipes used for the project were sourced from Turkey and delivered by road to the construction site in western Norway. The maximum transport length was 13.5m, so the steel pipes had to be cut into pieces and then welded together on-site to the required size. The weather conditions posed a major challenge not only for the welding work. Heavy snow accumulation meant that work had to be stopped regularly, and in some cases, deliveries were even halted. However, the earthquake that severely shook Turkey in February had an even more severe impact on deliveries. As a result, a lack of transport options meant that delivery delays had to be accepted. Even though this resulted in delays in the construction process, we still met the final deadline for the work.

Following the drilling work, we checked the piles for leaks and inspected the pile base using an underwater camera to ensure that it was free of drilling debris and have a clear rock contact.

So, the subsequent reinforcement installation of the prefabricated cages could be carried out without further ado. A 42m concrete pump was used for the concreting work, achieving high concreting output. Concreting in the small boat harbour was also accomplished efficiently using carrier barges and a concrete pump. The core drillings through the core drill pipes installed to the reinforcement cage, verified the transition between concrete and in-situ rock, confirming the excellent concreting result.

The design of axes four and five also included permanent strand anchors centred in the middle of the piles to secure the foundation plate of the bridge piers. Production of the strand anchors began in August, with completion currently forecasted for the end of October 2023\*. Steel pipes for anchor production were installed centrally in the reinforcement cage so that the specified bond length of 15m could then be drilled into the rock. The anchor positioning and the protruding reinforcement of the bridge piers do not allow them to be drilled from the foundation slab. Therefore, an attachable carriage is used on an excavator for the required kinematics. Installation of the 19 strand anchors, 32 and 35m long, is planned using the tower crane installed by our contractor.

The West Coast location, with its very high rainfall and demanding conditions in terms of logistics, presented the team with enormous challenges. Thanks to a strong team performance, we overcame all of them.







# Tårn 16 – First construction site ever in Norway, using the Wet Soil Mixing technique

Keller Geoteknikk implemented the Wet Soil Mixing technique for the first time in Norway in collaboration with the Norwegian Geotechnical Institute (NGI) and Keller Polska.

Osman Besler / Ján Krajčovič - Keller Geoteknikk, Oslo  
Anil Helvacioğlu - Keller Grundläggning, Kungsbacka

► In order to reduce settlements for the foundation of a planned 16-storey residential building in Trondheim, soil improvement has been deemed necessary. For this purpose, the Norwegian Geotechnical Institution (NGI) proposed two alternative design solutions using soil mixing. However, previous experience in the area had shown installation difficulties of Dry Soil Mixing due to soil conditions. Upon joint assessment of the soil conditions and design requirements, parties have considered Wet Soil Mixing as the feasible ground improvement method.

The absence of prior experience with the Wet Soil Mixing technique in the Norwegian clay made it crucial to execute a test field before starting the main work. Keller has assisted NGI with technical and practical input for this planned test field. 16 columns with a diameter of 1.2m have been considered to verify the final execution parameters. Various binder dosages, number of cycles, and withdrawal speeds, among other technical adjustments, have been tested. Finally, 31 test columns were completed to optimise the parameters and obtain a good soil-binder mixture with the required strength.

Keller Geoteknikk performed wet grab sampling and core drillings to evaluate the achievement. Both Keller and the Norwegian University of Science and Technology (NTNU) did quality control tests at both Keller mobile testing containers on-site and the laboratories. This Keller mobile testing container is equipped to provide various quality control tests that enable correct storage, curing and testing of the samples. Immediate obtained results on site have given an advantage for the intensive technical evaluations by the involved parties.

Upon completion of the test field, NGI assessed the final installation parameters. The final design revealed 194 floating columns, with a diameter of 1.2m each and a length of 18.5m. Pre-loading shall be applied before the commencement of the construction works to reduce post-construction settlements. Keller completed the work according to those requirements.



## PROJECT INFORMATION

### Investor:

DNB Eiendom

### Contractor:

Veidekke AS

### Geotechnical consultant / Designer:

Norwegian Geotechnical Institute (NGI)

### Quantities:

**31** test columns Ø1.2m L=18.5m

**194** production columns Ø1.2m  
L=18.5m

### Execution period:

June–July 2023

Furthermore, we installed fibre optic cables at five different design columns. These will provide strain readings during both the pre-loading stage and the service life of the residential building. The final results of the test field are a valuable engineering source to assess the performance of the first constructed Wet Soil Mixing application in Norway and inspiration for further research in this field.

# Full speed ahead for Sluss och klaffbro, Södertälje kanal

The canal lock in Södertälje in Sweden requires rebuilding to accommodate larger ships into Mälaren. Also, the old sluice and bridge construction is past its life expectancy, putting imminent time pressure on the project. Keller is building the foundations for the new bridge, lock gates, and quays. This comes with challenges, such as difficult soil conditions, operating from barges/land, ensuring marine traffic is not impeded, and execution with limited operation and storage space.

Jonathan Greener / Roman Weidacher - Keller Grundläggning, Stockholm



► The construction of the new lock in Södertälje is part of the Mälarpjektet, which has the aim of increasing the safety and accessibility of the waterways through Södertälje canal and Mälaren (Mälaren is a lake extending from the Baltic Sea into the middle of Sweden. It is closed off from the Baltic Sea to keep its higher water level by several locks around the Stockholm region).

Works with the lock started in 2016 by another contractor, but due to complications and difficulties with eg the ground, the contractor and Sjöfartsverket (water authority) parted from each other in late 2019.

Due to the size of the project, its economic importance, and to provide support, Trafikverket (Swedish Transport Authority) took over project supervision for the Södertälje lock project in 2022.

Already for the tender preparation, Peab and Keller had a very tight cooperation, bringing the experience of both companies into the offer. In 2022, Peab was awarded the contract to take over the project on a design and build basis, sub-contracting to

Keller all the geotechnical elements on an execution-only basis. The design approach for the lock gates is different to fit the installations made by the previous contractor. Another change was the main execution methods for piling changed from ramming/vibro to drilled piles.

Keller's scope of work ranges from temporary and permanent installations and includes a great deal of ancillary steel works. The main scope of work includes:

- Foundation piling with drilled steel pipe piles down to rock. Depths reach up to 60m. Therefore, piles have to be extended by butt welding. The most frequent pile type is 323,9x12,5mm.
- Drilled steel pipe pile walls for excavation pits and quay walls in lengths up to 24m. The main quantity consists of pile types 406x12,5mm and 508x14mm.
- Sheet-piling with excavator-mounted Movax and crane-hung Vibro units.
- Anchorage and tie-back rods for excavation pits and quay walls, anchorage inside of foundation piles, and uplift piles for sealing concrete slabs in the excavation pits.
- Welding of pile extensions, strutting/waling beams for anchors and excavation pits.







# Anchor wall reconstruction in Maribor, Slovenia

As a result of the heightened deformations observed in the existing anchor wall along the highway near the city of Maribor and the deteriorated condition of the present geotechnical anchors, it became necessary to undertake anchor refurbishment using longer permanent geotechnical anchors.

Davorin Lesnik – Keller Grundbau, Söding

► Installing the new geotechnical strain anchors necessitated drilling at heights of up to 8.0m, with limited space conditions for execution. Keller's suggested technical support and expertise enhanced the design solution, which enabled the successful execution and deployment of the most advanced geotechnical equipment and procedures on the project.

After winning half of the tender, Keller installed 173 GT anchors, each measuring a length of 45.0m. The execution period was from November 2022 to the end of April 2023. We had the chance to work with DARS d.d, the highway authorities in Slovenia, who financed the project, and Irigo Consulting d.o.o., the prominent geotechnical design company in the region, who conducted the design work. Pomgrad d.d., one of the leading construction companies in Slovenia, acted as the main contractor.

The designers searched for solutions and explored various possibilities to create a geotechnical solution that would be economically efficient, of high quality, and require minimal time for completion. Deformations of the anchor wall required the installation of longer geotechnical anchors on height, where we overcame limited space conditions with special equipment.

These measures enabled the execution of GT anchors at the required up to 10.0m height, as specified in the tender. Additionally, Keller employed a double-drilling L/R rotary head attached to the arm of a Liebherr 932 excavator and



## CONSTRUCTION SITE INSTALLATION FOR GT ANCHORS

on the Anchor Wall Reconstruction project in Maribor, located in close proximity to a heavily trafficked highway.

developed an electric-controlled unwinding device specifically designed for this project to install GT anchors into bored holes at the required height.

To ensure precise drilling, Keller implemented gyroscopic measurement techniques to avoid collisions with existing GT anchors and utilised a horizontal inclinometer measuring device to assess drilling deviations. These were always within the allowed limit of less than 1.5m from the drilling axis. Furthermore, the installed GT anchors can accommodate up to 15cm of movement in the anchor wall.





#### **DRILLING AND INSTALLATION**

of GT anchors at a height of approx. 8.0m.

Efficiency was a key consideration, as Keller successfully executed approx. 8.0km of GT anchors within a timeframe of approx. 5.5 months.

Installing the insulated GT anchors followed the ERM (Electrical Resistance Measurement) requirements and aligned with the standards specified in EN 1537:2000-09-01.

The soil consists of sandwich layers of over-consolidated silt and clay (marlstone or lapor) and sand layers, locally rich with groundwater streams. These were the main concerns on how to choose the proper equipment to maintain the foreseen execution speed with the required quality. For this purpose, drilling rods of 153mm in diameter were used with special drilling bits to allow as minimal deviations as possible and to be able to achieve the designed test forces of the GT anchors, reaching up to 1,562kN.

We implemented extensive external control measures on the project, including monitoring the cement suspension's quality and drilling techniques. Each GT anchor strain was electrically isolated from the base plate by using insulating rings. The electrical resistance between the strands and the substrate was measured using a multimeter, and the anchor's quality was based on the limit value of electrical resistance (ERM). This value should not fall below a particular limit. During the installation of the strand anchors, Keller gave special attention to

maintaining a dry working environment at every stage of the process and the electronic control of drilling and cement grout filling procedures.

This project shows a prime example of how the accumulated technical knowledge developed over decades within the company can be effectively utilised and leveraged for large-scale public projects.

#### **GEOTECHNICAL ANCHORS**

were installed as control anchors in response to deformations observed in the existing anchor wall.





## Central correctional facilities in Ljubljana, Slovenia

Knowledge from challenging international Keller projects is applied to regional projects, leveraging developed geotechnical technologies effectively. The Central Correctional Facilities Project in Ljubljana used site-mixed vibro mortar columns (VMC) for ground improvement in an abandoned quarry filled with construction waste from past decades.

Davorin Lesnik – Keller Grundbau, Söding

► SLP Ljubljana d.o.o., one of the most experienced geotechnical design and supervision companies in the wider region, developed the final ground improvement solution. The development process involved considering suggestions from multiple proposals and expert opinions. The project includes the execution of 2,821 columns with a nominal diameter of 60cm and depths reaching down to 13.0m, covering a total length of 34.6km. Execution of the project occurred from the middle of December 2022 to May 2023, utilising two vibro rigs and one rig for pre-drilling. The Slovenian Ministry of Justice tendered the project, with the leading construction companies in Slovenia, CGP d.d., Kolektor Koling d.o.o., and Pomgrad d.d., acting in a joint venture as main contractors.

The designers searched for solutions to craft a geotechnical solution that would be economically efficient, of high quality, and require minimal time for completion.

To provide a technical and economic advantage over classical geotechnical foundation methods, such as bored or CFA piles, the ground improvement solution implemented in the project addressed several challenges. These included executing the grounding works on an abandoned quarry filled with construction waste, including low-quality excavation soil, concrete blocks, construction steel, wood, bricks, and similar materials. An additional consideration was the potential issue of negative friction on columns due to these artificial refill layers. Furthermore, a robust solution was needed to ensure the stability of unreinforced column elements in the face of potential negative effects of earthquakes, given that Ljubljana is located in a seismic zone with a design earthquake acceleration of  $g=0.275$ . Finally, the project timeline required the installation of 34.6km of vibro mortar columns within approximately four months to enable the smooth commencement of subsequent construction works.

On the project, areas containing concrete boulders and disposed of reinforcement steel presented a significant challenge that necessitated pre-drilling for the VMC columns installation. This challenge resulted in increased wear on the pre-drilling equipment, requiring the





**CENTRAL CORRECTIONAL FACILITIES PROJECT IN LJUBLJANA**  
in the final stage of implementing ground improvement works with VMCs.

The project showcases Keller's geotechnical expertise using innovative techniques. With a clear focus on sustainability, cost-effectiveness, and maintaining stringent quality standards, the geotechnical integrity and performance are assured.

establishment of a specialised maintenance team to manage this negative impact effectively.

To utilise unreinforced VMCs for this project, the technical challenge of addressing the negative effects of earthquakes, which typically necessitate the usage of reinforced concrete grounding elements, had to be overcome. By implementing VMC columns in a saturated grid pattern (commonly with column edge distances of approximately 1.6m), we achieved innovative solutions for ground improvement. One such solution involved the incorporation of a planned load distribution layer of 60cm beneath the concrete base plate. This is used as an effective measure to mitigate potential adverse earthquake effects on the unreinforced vibro mortar columns. Based on numerous analyses, this approach has proven to be a qualitatively optimal and economically viable solution, enabling

further the optimisation of the concrete base plate thickness due to the little column spacing. The initial grounding project in the Ljubljana region, employing this approach, was executed in 2014 and continues to demonstrate excellent results today.

Extensive external control measures were implemented for the project, including monitoring the concrete quality and drilling techniques. In addition, Keller implemented an internal central quality control management system for the executed VMCs. That involved conducting integrity tests, as well as static and dynamic load tests of the constructed columns. The concrete consumption was monitored closely, and other parameters, such as drilling torque and amperage of the vibrator needle, were electronically controlled and recorded using M5, an execution control system developed by Keller.

#### **CORE DRILLING**

from the centre of the VMC (site-mixed vibro mortar column).







## Old becomes new renovation of a listed building in downtown Budapest

Keller Mélyépítő Kft. was awarded at the end of 2022 to perform the required special foundation works for the renovation of the property at Király utca 36., in downtown Budapest. The building is located in Budapest's "party district", popular among the youth, and is one of the most derelict buildings in the district despite of the fact that it is the birthplace of Attila Petschauer, Olympic gold medallist in 1928 and 1932, as well as the residence of several significant Hungarian artists, thus making the building an important historic landmark.

Peter Kovacs - Keller Mélyépítő, Budapest

► After more than ten years of abandonment and dilapidation, the reconstruction, expansion, and complete renovation of the three-floor apartment building, enjoying heritage protection since 1998, finally started last year and is progressing nicely.

The three-storey 180-year-old antique building with its historic past was built in the Classic style. It will be reborn as a 60-room hotel and a 204-bed hostel, retaining its protected façade, dating from 1846-1847. The street front area will be completely rebuilt, and an entirely new courtyard area will be constructed.

Using the jet grouting technique that has worked generously in similar underground engineering projects, Keller Mélyépítő Kft. underpinned the old foundations that were in poor condition and used the same technique for creating foundations for novel building areas. This ground improvement technique is widely accepted and effective in downtown reconstruction works, as has proven to be effective in repairing the foundations of buildings of this age and condition, increasing their load-bearing capacity significantly.





## PROJECT INFORMATION

### Investor:

Projekt Builder Kft.

### Design:

István Józsa

### Quantities:

approx. **1,200m** jet grouting columns  
(236 pieces)

### Execution period:

November 2022 – February 2023

Less the technological challenge and the complexity of the task were worthy of mention in this project since jet columns with a 120cm diameter were executed down to the load-bearing soil layer at a depth of -7.0m. The procedure is routine in downtown Budapest. Instead, the conditions that had to be ensured in the narrow streets of downtown Budapest were a challenge for the successful implementation of the project. The most challenging was supplying the construction site and carrying out the preparatory works. The building is located in the heart of Budapest on a narrow one-way street, where transporting the Keller jet grouting equipment and the construction materials, especially the large quantities of cement, was an enormous logistical challenge. The area for setting up the construction site was narrow, with a street front only 15 metres long and three metres wide, separated in the middle by the only gate leading to the internal yard, which had to be left accessible for transport. The jet grouting equipment and the amount of space they require are large. However, most tasks can be performed with suitable planning and a rational machinery composition. We used a space-efficient CUBE TW5020 jet grouting unit and carefully planned logistics to complete the task successfully and satisfy the customer.

Thanks to the good relationship built up with the customer, we have since been awarded for performing the neighbouring building's jet grouting base slab sinking works, which promises to be an even larger task with even more significant technological challenges. We trust that our professional work will bring even more recognition to the Keller name in the Hungarian special foundation market.





**HOTEL EXTENSION UNDER HISTORICAL WALLS**

Hotel Imm Sterzing

## Keller – A reliable partner for tricky hotel projects

Each hotel project has its specialities. Every hotel is unique in itself and has its history. This uniqueness especially comes to the fore in hotel modifications, upgrades or expansions. So, each project is different and unique, both in design and execution.

But there is one thing all projects have in common: a tight program since the start and opening date are both fixed. When schedules are limited, it is essential to introduce an excellent sequencing plan in advance. So, to ensure that no compromises on quality are allowed on the construction site, to keep costs under control, and above all, to guarantee safety on the construction site.

Stefan Nitz / Matthäus Plaikner - Keller Fondazioni, Brixen

### ► Hotel expansion under historic walls

The Hotel Lamm is in the historic centre of the small Fugger town of Sterzing. For the underground extension of the hotel, an amalgamation with an adjacent property, which included a listed barn, was planned.

The biggest challenge here was to preserve the existing building structure. To meet this challenge and to ensure full utilisation of the potential underground cubage, we chose underpinning using the Soilcrete® technique.

Before the special foundation work, the entire roof truss and wooden superstructure were removed down to the to-be-preserved walls. This removal made it possible to work without height restrictions.

The whole building was secured by the jet grouting technique, using the so-called back-step method to minimise structural movement and preserve the old brick walls as much as possible.

From a technical point of view, it should be emphasised how Keller reacted to the





**HOTEL EXTENSION – UNDERPINNING WITH JET GROUTING**  
Hotel Alpenrose – Wengen

actual geological conditions: when the first columns were exposed, an extensive silty, fine sand layer was discovered, where gravel layers had been expected. We changed the execution parameters immediately, and with additional pre-cutting and some post-execution measures, we ensured the required quality of the columns.

### **Underpinning with jet grouting enabled hotel extension**

The Moling family owns the Hotel Alpenrose, a traditional hotel in the centre of Wengen (Alta Badia). Last year, the hotelier family decided to expand the current hotel while maintaining the existing building. Because of the narrow, steep terrain, the expansion building had to be directly in front of the existing building. This required a massive underpinning of the existing structure. The schedule was tight, and the building had to be safely preserved, so the designers decided to use underpinning with jet grouting.

Keller was involved in an early design phase to contribute its experience in implementing such challenging projects. Keller had gained experience from several projects in the surrounding area already, and this knowledge came in very handy. The active cooperation between the client, the designers (G22 Projects GmbH and I&M Ingenieure), and the construction companies was the key to smooth progress with all the works.

Thanks to Keller's early involvement in the project, we could plan the work efficiently, execute it successfully, and complete it on time.

### **“Top-down” hotel expansion**

The traditional Hotel Huber in Vals has already seen several extensions, upgrades and modifications during its longtime existence. But through all this time, the oldest, central part of the basement, had never been updated completely, only the areas around it. This steady growth over the years led to the situation that the kitchen inside the hotel complex became too small. But the needed enlargement could only be done “top-down”. That means from the existing level down.

Therefore, Keller underpinned the existing structure with jet grouting bodies. At the same time, additional columns were constructed, which subsequently acted as supports for the new ceiling that could be installed in a very short time. The requirement was that work in the existing building had to be carried out independently of the new basement.

The smallest drilling rig from Keller, the KB1-2, was suitable for working in areas with limited height. The rig also has an electric engine, which did not generate any exhaust fumes at the work site. The adjacent basements and the existing buildings had to be treated sensi-

tively due to their use, age, and design, so they were permanently monitored during the construction of the underpinning columns.

The cooperation between the client, the architect, the structural engineer, and the contractors was excellent, making it possible to plan the strictly scheduled processes well and to implement them according to plan. Keller's small and manoeuvrable jet grouting equipment excelled here.

***The projects listed here are just a few examples of the many hotel projects that have now been completed in South Tyrol. In this context, Keller has an outstanding reputation as a reliable expert partner for planning and on-time implementation.***

### **“TOP-DOWN” HOTEL EXPANSION**

Hotel Huber – Vals





# Keller Romania aims high

## Piling works at ONE LAKE CLUB

The residential project "One Lake Club" near Lake Tei in Bucharest consists of five towers - 14 storeys each, plus two undergrounds for parking area. In order to meet the requirements and take the position and the heights of the future buildings into consideration, Keller Romania designed an excavation pit and a foundation system with CFA piles.

Stefan Guran - Keller Geotehnica, Bucharest

► "One United Properties" is building an apartment complex on the North side of Bucharest, near the shore of Lake Tei. This complex consists of five towers over 50 metres height above the ground. These towers share the same infrastructure. It consists of two basements for parking places and storage boxes constructed on the entire 13,000m<sup>2</sup> of the project.

The existing soil can be described as silty clay with medium consistency (soft in some areas) up to 9.0m depth and then as sandwich layers of sand medium dense and sandy silty clay stiff down to 40m depth. The underground water level is roughly 2.0m under the surface, related to the natural terrain level, strongly influenced by the water level from the lake.

Due to the fact that at the foundation level, the ground was not suitable to sustain the new building in allowable settlements, it was necessary to execute soil improvement works below the construction to limit the settlements to a maximum of 5cm. Keller Romania was responsible for the special foundation





**PHOTO DURING THE FOUNDATION PILES EXECUTION**

works, consisting of the design, the execution of soil improvement under the new buildings, the dewatering system, and the excavation works:

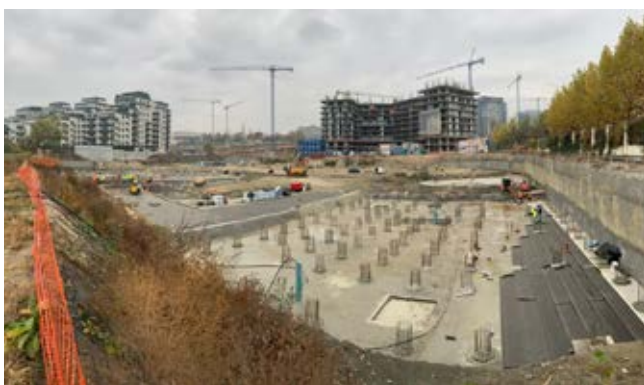
The excavation pit consists of a retaining pile wall in the areas with vicinity, near the property limit, and slope excavations in the rest of the project - in total, 272 retaining piles with 800/600 mm diameter.

The excavation depth was approximately 6.0m related to the natural ground level. The entire excavation was roughly 12,000m<sup>2</sup>, with about 95,000m<sup>3</sup> of excavated soil.

Dewatering works to lower the underground water under the foundation level, so the works execution is in dry conditions. The future infrastructure will be approximately 4.0m below the groundwater. The dewatering system consisted of 18 connected wells to lower the water level. The design capacity of the dewatering system was approx. 15l/s, but it was redesigned for approx. 40l/s.

Foundation piles were drilled under the entire area to reduce the settlements. A total of 455 piles, with a diameter of 800mm, were executed below the buildings (90 piles under each tower) and 190 piles with diameters of 600/800mm underneath the

**LAYOUT OF THE FOUNDATION PILES**



**PROJECT INFORMATION**

**Investor:**  
ONE UNITED PROPERTIES

**Client:**  
ONE LAKE CLUB

**Design:**  
Keller Geotechnica

**Quantities:**  
**Retaining wall:**  
CFA secant piles D=800/600mm -  
2,593m - 272 pcs.

**Foundation:**  
CFA piles D=800/600 mm -  
12,936m - 645 pcs.

**Dewatering system:**  
18 wells - 40l/s

**Execution period:**  
January–June 2022

Dewatering system still in function

basement outside the area of the towers. The length of the piles under the buildings varies between 20 and 22m, with the base in the sand layer. For the basement outside the towers, the length of the piles varies between 12 and 14m, with their basis in the clay layer.

The connection of the entire structure with the piles is through a main raft foundation with variable thickness between 0.50 (basement outside the towers) and 1.40m (underneath the buildings). The technique used to drill the piles was a continuous flight auger (CFA), which has the advantage of high productivity (approximately 250 linear meters/day on this site).

In order to check the bearing capacity of the foundation piles obtained through the design, we executed load pile tests on-site on additional piles. The maximum axial load applied during the tests was 440 tons. The mean value of the settlement measured at the maximum load was 18mm, which fulfils the settlement requirements.

We finished our work at the end of June 2022, and the client was able to start building above the surface. At the present time, the building construction is almost finished and completed up to the 7<sup>th</sup> floor. The current survey of the buildings shows settlements of only a few millimetres.

***We wish our client a good construction process till the end of the project and are happy that we were a part of it.***



## Banchina Ponte San Giorgio looks nice to work near the sea

After several years, Keller Fondazioni has returned to operate in Liguria. The occasion was a major public tender in a JV with a local partner. The final client is the Port System Authority of the Western Ligurian Sea, which manages the development plan for the ports of Genoa, Savona and Vado Ligure. These together constitute the most important commercial port hub in Italy.

Emanuele Nanni / Stefano Motta - Keller Fondazioni, Verona

► “Terminal Rinfuse Genova” operates a series of docks located in the heart of Genoa port, which serve as the gateway for a range of bulk products (coal, de-icing salt, silica sand, cement, fertilizer, minerals) stored on the docks and then reloaded onto rail cars or vehicles and destined for Italian industry.

The sites, currently underway in the ports of Genoa and Savona-Vado, involve an investment of more than 2.5 billion Euros, all from European funds.

**The port of Genoa is currently the first port in Italy in terms of cargo handling and the 5<sup>th</sup> Gateway in Europe and in this scena-**

**rio, the Port System Authority is planning the necessary interventions to confirm and develop a strategic productive fulcrum representative of an adequately performing port in the EU panorama, says Francesca Arena, project manager for the investor.**

The specific project within the “Termina Rinfuse Genova” on the “Banchina Ponte San Giorgio” is part of the larger project dedicated to the historic and passenger port of Genoa and aims to deepen the seabed by an additional two metres to allow the docking of large ships on the quayside as well as accommodate future generation ships and acquire new commercial traffic.

**The requirements in the shipping sector in recent years have shown the increasing trend towards “naval gigantism” with the consequent need for port facilities suitable for the latest generation of cargo ships being attractive for development traffic, adds Ms. Arena.**

In January 2022, Keller won the public tender in a JV with Injec-tosond Italia Srl of Genoa, mainly due to the high technical score awarded by the Commission, which considered the high technologies, both executive and control, during the execution of the work.

As mentioned above, to proceed with the deepening of the seabed for dredging, the project included the construction of a consolidated soil block with jet grouting columns over the entire height of the dock to perform a massive consolidation of soil having the scope of reducing the thrusts behind the dock.

**In 1990, at the foot of the dock, a consolidation by jet grouting with anchors was already carried out to adapt it (built with**



*boulders) to the ship draughts of those years, which are now largely outdated, necessarily requiring a performance upgrade of the primary infrastructure.*

The length of the consolidated dock is about 450 metres. Consolidation was carried out along the entire length and width of about 5.5 metres and an average drilling depth of about 21 metres for about 50,000 cubic metres of consolidated soil. We reached the maximum drilling depth of about 28 metres in the area at the head of the dock. The diameter of the columns was 2.0 metres, with an empty drilling of about 2.0 metres from the working platform.

The cement mixture plant was designed with an additional one to ensure continuity during the grouting phases, increasing the production performance and ensuring higher daily production. As stated in the tender phase, it was possible to demonstrate, both with the preliminary trial test and through the results of the ACI® tests performed, the achievement of the design diameters by optimising the initially planned 1.5 to 2.0m. This change led to a significant improvement in the timing schedule, which was very tight.

Of course, the choice of diameter was also based on the characteristics of the in-situ soil and the to-be-achieved grid to meet the design volume.

For the first about 15 metres the soil consists of blocks, stones, gravel and fine fill material, while the part below is composed of weakly silty sandy material. With these soil conditions, parameters were calibrated differently for the different layers to achieve the best results using our Soilcrete technique.

- After the preliminary test, it was possible to achieve this high performance in terms of optimisation:
- Initial design: jet grouting diameter 1.5m with approx. 1,215 columns
- Keller alternative solution after preliminary test: jet grouting diameter 2.0m with approx. 701 columns.

Keller's alternative solution allowed the client to meet and improve the contractual schedule time for dock consolidation. The time reduction combined with a better logistic organization created the best synergy with our client while respecting

## PROJECT INFORMATION

**Investor & Contractor:**  
Autorità di Sistema Portuale del Mar Ligure Occidentale

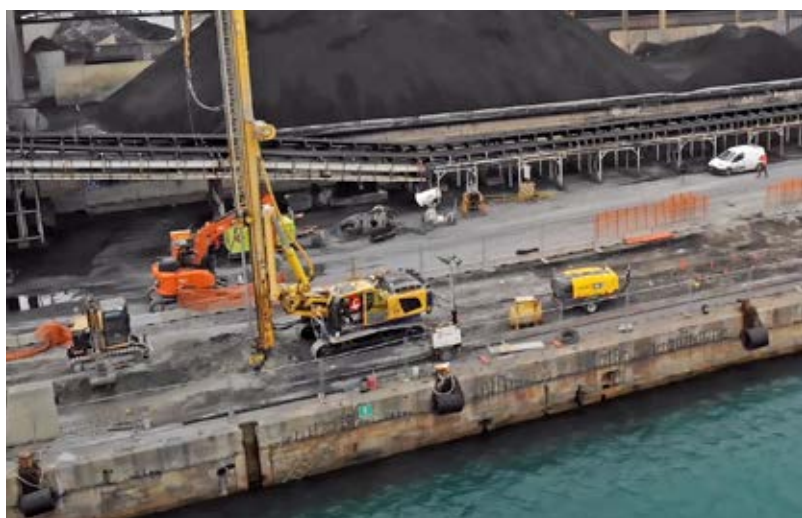
**Design & Geotechnical consultant:**  
SGAI s.r.l. di E.Forlani & C.

**Quantities:**  
Total JG columns length: 14,438m  
Total empty drill: 1,402m  
Total columns: 701

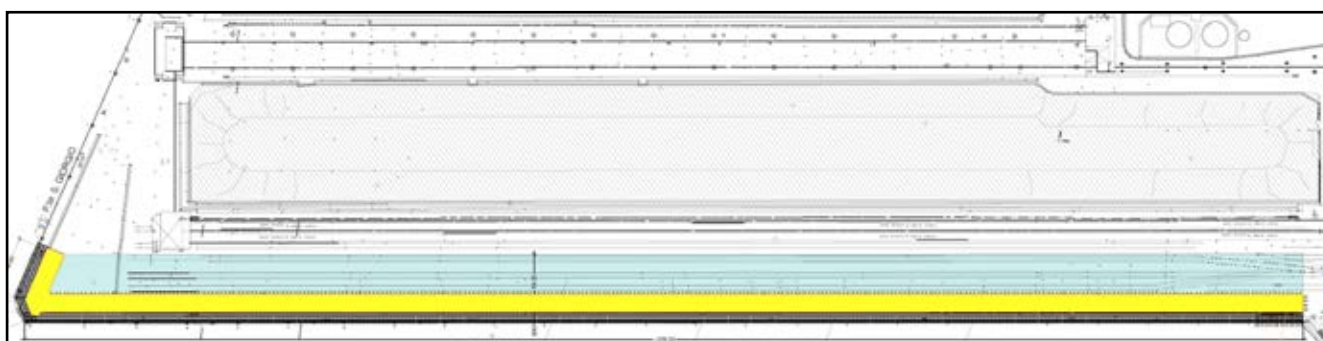
**Execution period:**  
August 2022–  
January 2023

an important contractual constraint - which is, to always allow ships up to 200 metres in length to dock at the quay at any time, even during the consolidation phases.

All this is done by coordinating all activities on site, with no interruption in production, especially considering the limited space available for site logistics, **thanks to the minimisation of interference between port activities and the site activities achieved by implementing the organization of work proposed in the tender phase and assessed by the Commission with the maximum score.**



## GRAPHIC



# STEP AS25 Rüthi SG – Oberriet: Rheintal double track expansion

The STEP AS 2025 project included a capacity expansion of the SBB Rüthi SG – Oberriet line, enabling a half-hourly train service between St. Gallen and Sargans. The double-track extension between the centre of Oberriet and Oberriet North toward Altstätten, along with a crossing station in the neighbouring community of Rüthi, was carried out during a total shutdown of rail traffic.

Gramos Muja - Keller-MTS, Regensdorf

► The project is a first for railroad construction in Switzerland in many aspects. Previously, it had been rather unusual to carry out construction work on rail tracks during a total shutdown. The scope of the work and the impact of the construction activity in the pronounced peat areas entailed a ten-month period of intensive construction phases, during which the existing rail facilities were dismantled completely, including embankment structures.

Ground improvement was the foundation method for the new railroad embankments and structures due to the very soft and settlement-prone local soil conditions. This soil improvement was designed as a combined system of vibro concrete columns and a geogrid-reinforced embankment. The combined load-bearing system reduces the settlement of the new structures in the long term and thus has a positive effect on the effort involved in railroad maintenance. An increase in the maximum speed of rail traffic is therefore possible.

The client had already contracted a test field to Keller-MTS in 2020. At this point, the focus was on environmental impact assessments and higher-level feasibility verification as well as possible requirements for the project design and tender phase.

ARGE PLUS realised the construction project for the Swiss Federal Railways as the general contractor and assigned Keller-MTS in spring 2022 to carry out all the soil improvement work as a subcontractor.



Our services included the execution of detailed and extensive tests to confirm the selected technique, the execution parameters, and the construction phases, as well as establishing and defining the control and monitoring program to ensure quality during execution. The test fields, spread over the entire project location, provided essential insights into the locally prevailing hydrogeological conditions and formed the basis for realising the soil improvement.

The final execution technique was a modified vibro concrete column with a circular tip of 50cm. Depending on the given soil parameters, the pile-like ground improvement elements were executed using the full displacement method, with appropriate overlay. Due to the effects of rail traffic and the potential uplift of the columns during execution, DN 26mm reinforcement bars were placed into the rigid elements.

## **Oberriet**

Soil improvement in the Oberriet area extended over two kilometres, most of which was two-track. The load-bearing Rhine gravels were found at depths of 4.5 to 14 metres. The higher-situated and pronounced saturated peat layers required a stable working platform for logistics and construction work.

In some areas, fill thicknesses of up to one metre and open drainage measures were required. These were essential for a successful execution during the very intensive construction phase, with extreme weather phenomena from heavy rain to extremely hot days between March and June 2023. With up to six Keller vibrocats working simultaneously and the earthworks and route work being in place, coordination of all the construction phases and findings of the carried-out tests was essential.





## PROJECT INFORMATION

### Investor:

Swiss Federal Railways (SBB)

### Contractor:

ARGE PLUS consortium  
(Implenia, Käppeli, Zindl)

### Project designer:

Locher Ingenieure

### Design/statics:

AFRY Schweiz

### Executed works:

Vibro concrete columns  
Vertical drains

### Execution period:

Test fields:  
August–November 2022  
Main works:  
March–June 2023

## Rüthi

This section around the new crossing station proved to be a particular challenge. Soil in Rüthi consists of soft and saturated peat and clay layers - all with different sand content. Right in the beginning, the stiffer sand layers, 12m below the future railroad embankment, were identified as the foundation horizon. The low water permeability of the fine-grained soil layers and the pronounced soil displacement caused by the execution process of the narrow grid of the vibro concrete columns resulted in a local increase of excess pore water pressures in the embedded sand lenses.

In the test fields, it could be observed that the pore water pressures were reduced by the fresh concrete columns. Thus, a bond of the reinforcement steel could not be guaranteed due to the lack of cement paste. The risk of damage could be avoided through the construction aid measure of vertical drains to reduce pressure.

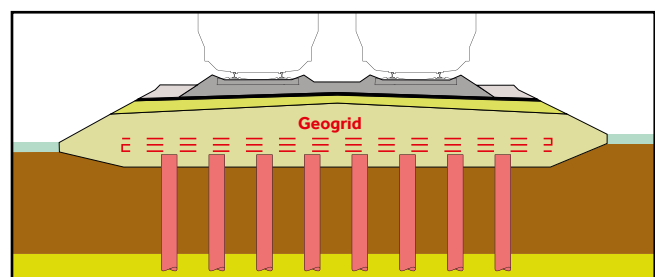
Preventing a permanent vertical connection between surface water and groundwater was part of the environmental specifications for this project. This required an innovative approach. As a result, biodegradable vertical drains made of corn starch (PLA) were used for the first time in Switzerland. This product degrades naturally in just a few years.

### Facts and figures

- Executing the subsoil improvement with vibro concrete columns required an extraordinary use of resources during the short construction period.
- Six parallel Keller equipment units and more than 30 skilled workers were needed to execute almost 15,000 columns with a total length of 155,000 linear metres within just three months.
- The daily delivery of up to 1,000m<sup>3</sup> of fresh concrete was a major logistical challenge.
- Column construction in this project alone required an impressive 40,000m<sup>3</sup> of concrete.
- Keller was able to make a significant contribution to the complex work on this project, thanks to our internal expertise and experience in the areas of, design, equipment engineering, monitoring, and execution.



### GRAPHIC



- Vibro concrete columns
- Load-bearing layer
- Soft layer
- Embankment





## Les Masses Dent Blanche Resort

The “Dent Blanche Resort” right next to the ski lifts of the well-known 4 Vallées area, needed a special solution for securing the excavation pit. The resort, with a view of the imposing Grande Dixence dam, was located on a steep terrain with complex geology.

Keller’s experienced team in Vétroz designed an excavation pit support system for this project in combination with micropiles using an innovative, eccentric drilling system.

Otman Elammari - Keller-MTS, Vétroz

► The construction schedule was tight, so up to twelve employees and three drilling rigs (one Comacchio MC 15 and two Casagrande C6-XP) were in operation at times to keep it on schedule.

Micropiles were used as an additional static element due to the very high and steep excavation pit support and to reduce deformations. ROR steel hollow sections were carefully placed into the ground using an innovative, eccentric drilling system. Each micropile was composed of different steel pipes, graduated in length that both served as casing during drilling and remained in the ground as a static element after removing the inner rods. After successful drilling, the cavity was immediately grouted and the outer casing of the steel pipe coated with a cement slurry. All in all, approximately 900 linear metres of drilling for micropiles was completed successfully. These micropiles form the





The securing measures were supported by reinforcing mats with a total mass of about 33 tonnes. These reinforcement mats strengthened the structure of the shotcrete and added to the robustness of the excavation pit support.

Overall, a wide combination of different techniques was used on the "Dent Blanche Resort" construction site to overcome the challenges of stabilising the slope and excavation. Precision drilling and the use of micropiles, soil nails, shotcrete, and reinforcing mesh were essential to ensure not only technical stability but also long-term safety and a harmonious co-existence with the surroundings.

## PROJECT INFORMATION

### Investor/contractor:

Dent Blanche Resort SA

### Statics:

BEG SA – Géologie & Environnement

### Executed works

Micropiles

Soil nails

Shotcrete

### Execution period:

May–October 2023

stable base frame of the soil nailing wall, on which the slope stabilisation and the excavation pit support are constructed.

Soil nails, placed between the micropiles, acted as an additional, invisible safety factor. These nails are 6.0 to 18.0m long. In total, over 9,000 linear metres with a borehole diameter of 120mm were drilled.

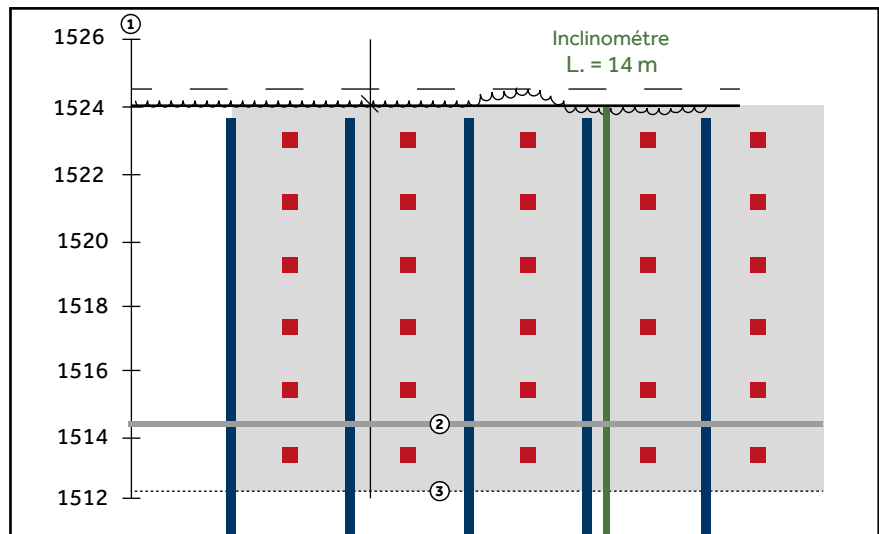
These soil nails played an important role in temporarily securing the excavation pit and were part of a complex system that ensured stability during construction.

Together with other elements, such as shotcrete, they formed a robust excavation pit support that allowed the resort structure to be integrated seamlessly into the surrounding natural environment. The shotcrete was applied and compacted pneumatically with an impressive total volume of 1,600m<sup>3</sup>.

The carefully applied dry-mix process was used afterwards, to seal and stabilise freestanding, vertical, or sloped surfaces as the resort gradually took shape.



### GRAPHIC



① Altitude above sea level

② ca. rock surface

■ Micropiles ROR 152.4 / 10

■ Soil nails L = 6.0 to 18.0 m





# Budatín-Brücke, Žilina

## Constructing of new railway bridges in Žilina

The railway infrastructure in and around Žilina has been modernised extensively in recent years. This includes the overall reconstruction of two railway bridges that span the river close to Budatín Castle. These bridges are approximately 110m long and are supported by two common concrete pillars, surrounded by the current of the Váh River. As part of the overhaul, the overall redevelopment of existing structures was proposed – a new support structure on each side of the bridge and new pillars in the river bed.

Michal Durmek / Peter Cápaj / Daniela Piliarová - Keller špeciálne zakladanie, Bratislava

► The scope of our participation in this project included providing pit walling and waterproofing in the four construction pits that were dug to build two new bridge pillars in the river and two bridge supports at the end. The project design also considered the foundation of all the new structures using micropiles.

The geology at the site is favourable as far as special foundations are concerned - the river bed comprises a roughly 2m thick layer of gravel (G3 class), with eroded marl below it (R6 – R5).

The projected timeline for special foundation work (in several phases) was specified for January 2023 until February 2025. The project respected the need to keep one of the bridges open for trains in both directions during the entire construction period. The works specified for the first phase of construction comprised: dismantling one of the steel bridges, digging the construction pit for a new bridge pillar, installing micropiles as the pillar foundation, demolishing and removing one-half of the bridge support structure and founding the new support

on micropiles. Once the new pillar, and the new bridge support, are completed, this procedure will be repeated on the other side of the river. After completion of both new pillars and support structures, a new steel bridge will be constructed on them to take over rail traffic in both directions, and the second part of the bridge will be closed, removed and reconstructed using the same procedures.

Keller won the contract for this project by, among other things, optimising the technical solution. The original design of micropiles under both pillars was substituted by improving the subsoil using Soilcrete. The method for digging the two deep construction pits under the groundwater level was specified in the design documentation: the foundation joint was lifted 4.5m above the level suggested in the original proposal (i.e. above the groundwater level), eliminating the need for pit walling while the micropiles for support were lengthened from 7 to 12m.

The resulting volume of contracted work consisted of approximately 1,600m Soilcrete (pit walling and soil improvement), 4,500m of micropiles (foundations for the supports) and 1,100m of temporary strand anchors (pit walling).





**DIGGING OF THE CONSTRUCTION PIT**  
for the P1 pillar. You can clearly see the difference between the individual geological layers.

Construction work for the reconstruction of the railway bridges was launched in the autumn of 2022. Between November 2022 and January 2023, a working platform was constructed in the river, consisting of an aggregate mount supported on its sides by a sheet pile underground wall. Next, one of the railway bridges was dismantled and removed. This work was carried out by STRABAG s.r.o. as part of the first stage of the new bridge.

In February 2023, work started from the working platform on securing the construction pit for concreting the "P1" pillar using jet grouting. To reinforce the pit walls, 2-metre diameter vertical columns were proposed (first line) and additional inclined columns (rear), also with a 2-metre diameter. To improve the

other three sides of the construction pit. Despite the highly extensive geological survey conducted in this area, we were surprised to find boulders measuring up to 1m during the jet grouting process. These were approximately 4m under the top of the working platform and were not described in any previous geological survey. To be able to drill through these boulders using the KB0-4 drilling rig, we had to extend the duration of this construction phase by more than two weeks (the original schedule specified five weeks of work). Individual drills were 11m in length.

After the jet grouting was completed and the construction pit excavated to the anchor level, 32 temporary 17m long strand anchors were installed. Once they were prestressed, the construction pit was dug down to its final depth of 8.8m without any significant water leakage through the pit walls. The construction pit was then handed over to our client.

Our work on this project continued by providing 81 12m long micropiles (GEWI system, 57.5mm, DCP) for the foundation of the new bridge support. After doing that successfully, we handed over the site to STRABAG and expect the work to continue (to the same extent, i.e. Soilcrete + piles + micropiles) on the other side of the river between September and November 2023\*.

## PROJECT INFORMATION

### Investor:

Železničná spoločnosť Slovensko, a.s.

### Contractor:

STRABAG s.r.o.

### Design:

KELLER speciální zakládání, spol. s r.o.

### Quantities:

**1,600m** Soilcrete Duplex

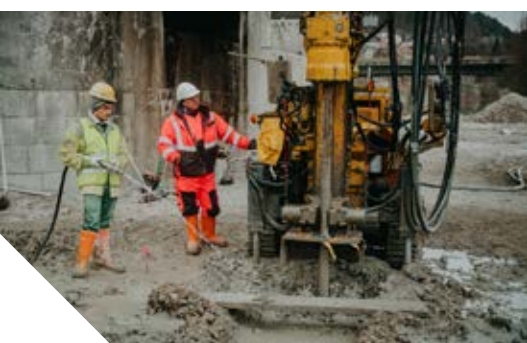
**4,500m** micropiles

**1,100m** of anchors

### Execution period:

January 2023 –

approx. February 2025

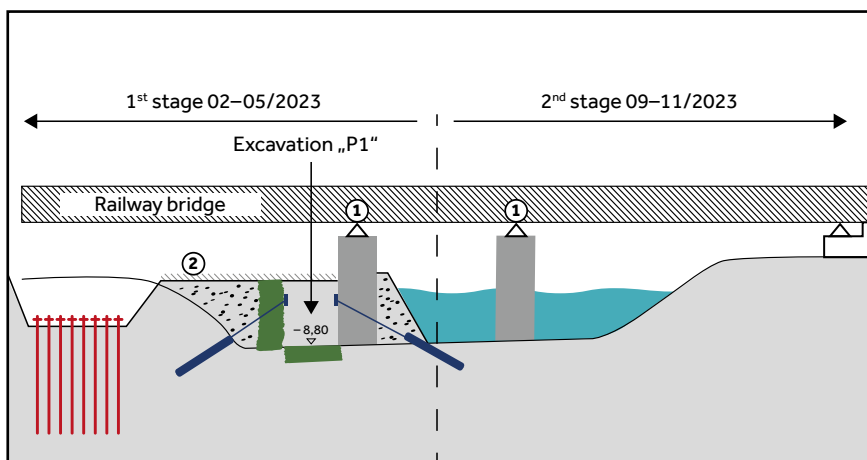


**BY USING THE KB0-4**  
drilling rig with a short relay, this enabled us to work even under the remaining bridge structure.

soil, columns under the construction pit were designed to improve the properties of the eroded mica. The interesting thing about this construction pit is the use of the original bridge pillar as a pit wall from one side, with the creation of pit walls using jet grouting from the

### GRAPHIC

Longitudinal section 1<sup>st</sup> stage



- ① old pillars
- Micropiles
- Soilcrete

- Strand anchors
- Váh River
- ② working platform = ± 0,000

# TITANIUM Brno

## Pit walling and pile foundations for new buildings

KELLER-speciální zakládání has been a success in the Czech market for 30 years. Its activities include being one of the leading providers of securing construction pits and foundations for new buildings in Brno. We work almost exclusively using our own design solutions and have worked with basically all special foundation techniques.

Petr Svoboda – KELLER - speciální zakládání, Brno

► Since 2008, the TITANIUM modern multi-functional facility has gradually been built up on brownfield land near the main railway station in Brno.

Together with the neighbouring IN SADY and CENTROPOLIS projects, which are also still being built, it occupies a trapezoid-shaped area measuring along Nové Sady street of 210m in length and 110m/50m in width.

Keller has been present since the beginning of the entire project in 2008 when we founded the first (main) part of the facility using the Deep Soil Mixing method. At that time, this was a unique way in the Czech Republic of taking advantage of suitable geotechnical conditions. The current building has two 7-storey high-rise sections with a single underground floor covering the entire footprint, which has a massive foundation plate above the groundwater level. Despite increased load in structural columns, it was possible, using groups of up to nine DSM columns, to transfer these loads to the load-bearing gravel subsoil. Unfortunately, after the underground floor was finished, the main contractor went bankrupt, meaning it took over three years for the construction to restart. The final building settling, measured after completion of the entire building, was in mere millimetres, as predicted.

In 2019, the second phase of this project started when work started on TITANIUM II. This part extends the site to the south but has ten above-ground floors across the entire floor plan. The new part has a single underground floor, connected to

TITANIUM I. For the second phase, there were requirements for rapid construction, with the same level of connection to the existing building on all floors. Plus, the loads in the structural columns of TITANIUM II were significantly higher. For these reasons, we opted to establish the foundation with bored piles of up to 1,200mm in diameter and up to 25m in length. The main reason for this comprised concerns about the slower settlement of the DSM elements in the new structure after its completion and the need to ensure level connections between both buildings. Subsequent phases of the project went swiftly.

In 2021, the site was extended further to the south by the IN SADY project, which has a different investor and contains only apartments. From the perspective of special foundations, the main change was a requirement to have two underground floors. For the pit walls of the construction pit, which was up to 8m deep, we considered several options, but in the end, we used an anchored sheet pile wall (with pre-drilled holes). These walls were anchored to the neogenic bedrock, which gave us confidence for excellent underground water tightness from approximately 3m below the terrain. In the section along the TITANIUM II building, a pile wall with jet grouting was provided as casing and sealing when its foundations were constructed. The tie-in to the sheet pile wall was also prepared in advance. The anchors for the pit walls and the foundation piles were to be drilled from the lower levels of the pit. Unfortunately, during pre-drilling for the sheet piles and for the necessary pumping of underground water out of the pit, it turned out that the sheet piles were not anchored into impermeable clay subsoil, which







## PROJECT INFORMATION

### Investor:

JRA Istate + IN SADY  
+ Property Brno

### Contractor:

JRA Istate + GEMO Olomouc

### Geotechnical consultant:

BALUNgeo + IGM Brno

### Design:

KELLER-speciální zakládání, spol. s r.o.

### Quantities:

**2,930m<sup>2</sup>** Sheet pile walls

**800m<sup>2</sup>** Jet grouted walls

**5,870m** Bored piles

### Execution period:

2019–2023

contradicted the information from the client's geo-engineering survey. For this reason, we suggested sealing the base of the sheet pile wall with jet grouting lamellas, and in order not to slow down the progress of work, large-diameter reinforced bored piles were drilled from a level just above the groundwater level, i.e. with an extra drilling length of about 5m.

The last phase of the project - its extension to the north - was started in the autumn of 2022. The TITANIUM I building is being connected to TITANIUM X, whose construction is linked to another building by another developer, called CENTROPOLIS. TITANIUM X has a similar above-ground structure and functionality (offices) as the existing TITANIUM I. On the other hand, CENTROPOLIS will contain only apartments. However, both these buildings are being built using a single construction pit, with a technical concept similar to that of the IN SADY pit. It is approximately 7.5 to 8.5m deep, following the requirement to have two underground floors. Geotechnical and dimensional conditions led us and the investor to design pit walls and sealing for the pit on three sides using sheet pile walls. The wall adjacent to TITANIUM I was supported and sealed by jet grouting columns. From the existing terrain, the pit was first excavated just above the underground water level. From there, sheet piles approximately 10m in length were inserted, after pre-drilling in the centre of the wall using the CFA system. These drills reached the required depth and/or impermeable neogenic clay bedrock of solid consistency. In this area, we used a Hitachi belt carrier and a MOVAX vibrator to ram the sheet piles. The jet grouting was also anchored into the clay, and both types of



pit wall, or sealing, were anchored by strand anchors at one or two levels. Unlike the pit in the IN SADY phase, this pit was sealed properly, and there was no need to alter the sheeting in any way. The drilling of reinforced bored piles up to 25m long was the final part of the successful participation of Keller in this new building project in Brno.

# Keller Academy SEN

Keller is known for training its people. In our Business Unit, this is done primarily through our internal Keller Academy SEN, since 2007, with the instruction language alternating between English and German.

Andreas Kolenc / Alexander Zöhrer - Keller SEN



**SOME OF OUR PARTICIPANTS**  
during the 2023 Keller Academy SEN

► The initial idea in 2006 was to use the Keller Academy both as an internal continuing education program in geotechnical engineering, construction methods, structural engineering, risk management, and client relationship management and as an “in-house” assessment centre for potential future colleagues. Furthermore, the Keller Academy offers people the opportunity to network beyond their own region, nationally or internationally, and learn from each other.

The first Keller Academy was held in Italy in 2007, as there were five candidates at that time for new positions in the local company. Assessment was the clear focus of this first Keller Academy. The candidates experienced presentations and tests by 12 internal lecturers over the course of 50 days. Four candidates were hired at the end of this Keller Academy by Keller Fondazioni.

Since 2008, Keller SEE (today: SEN) has organised two-week programs for new colleagues in construction management and engineering once or twice a year in Söding, to which colleagues from other business units are also invited, subject to capacity.

The Keller Academy of 2023 took place from 27 February to 10 March and involved 13 participants from six regions. All content was presented by internal lecturers. Along with presentations and exercises in the seminars, there were visits to the workshop and yard, as well as a visit to a construction site, to emphasise practical relevance.

In addition to learning theory and practice, there was also plenty of time and many opportunities in the evenings and weekends during these two weeks for participants and lecturers to exchange ideas at a personal level.

This format of comprehensive, internal training has proven very successful. The next Keller Academy will be in English, probably in February/March 2024.



**OUR FIRST KELLER ACADEMY IN ITALY (2007)**



# HSEQ Day 2023

## How to convey HSEQ topics

At Keller, we firmly believe that no one should come to any harm by the work we do or the services we provide and that everyone who works for or with us should go home safe. Based on these principles, we tried to find more engaging, efficient and compact training methods.

So, the idea of an HSEQ training day was born and held in 2023 for the first time to provide various statutory face-to-face training courses for Austrian-based blue-collar workers at our branch in Söding (Austria).

Elke Legenstein / Martina Rückenbaum – Keller SEN

► The idea of the first HSEQ day for blue-collar workers arose from input that we received from them and/or their line managers directly. Especially during the Covid-19 pandemic, it was not possible to do any training. In addition, we had many new entries and had to find a suitable way of bringing them all together and transferring the knowledge. To emphasise training, we separated it by product lines and held it on different dates, intending to work with smaller groups.

It was the first time we had conducted training in this manner, so we focused on topics most relevant to our construction sites. These included:

- Annual basic training according to Austrian law (§154 BauV, §7 and §14 of the PSA-V), incl. compliance training
- Self-propelled work equipment (for product line "anchors, micropiles & grouting techniques": incl. loading crane up to 5 tons)
- Sustainability
- PPE against falls from a height (by an external trainer)

Besides these internal HSEQ topics, we also wanted to communicate any other substantial and statutory training (e.g. our annual compliance training).

What made these training days special, was that we were able to reach so many colleagues in person. And they all had the opportunity to voice their problems, concerns, and issues directly during the training. All this led to lively discussions and a constructive exchange of experiences. It was very important to reassure the participants that they did not have to fear any consequences for expressing their opinions bluntly.

The employees contributed their personal experiences and practical examples to the respective topic blocks. The most important thing, and what we benefit from most of all as a company, is that we can avoid (tragic) accidents during construction. Dealing with unknown parameters is part of our day-to-day business. By training our people properly, we can make them aware of as many as possible.

But not only safety is important to us, but our good reputation, too. We are all part of our communities, and ESG and sustainability get into the focus more and more. Our corporate motto, "building the foundations for a sustainable future", is at the heart of everything we do - and with this kind of training, we increase awareness of them among all our employees.



In this way, we continue building the trust among us that Keller South-East Europe/Nordics (SEN) cares deeply about HSEQ matters with a focus on HSEQ and sustainability. Furthermore, the aim of this day was also to show transparency of actions in terms of health/safety and sustainability. As a consequence, we all get a better understanding of the employees for this on both sides - construction sites and HSEQ department. But above all, the social aspect of this event should not be forgotten.

With a thriving participation rate of 91% of workers trained, we have set the best possible HSEQ standards for the remainder of 2023.

Once more, it became clear that such critical topics have to be submitted face-to-face, and we are happy that we had this chance after a long time. The feedback we received from all participants was consistently positive. We take this as a go for our second HSEQ day in 2024 and look forward to a successful workshop.

# Cooperation with school classes one of the many pillars of ABV

The equipment and yard team in Söding is actively participating in a wide variety of events inside and outside of schools. But we also collaborate with great success with institutions such as the Styrian Economic Community (STVG), the Rural Education Institute (LFI), and [Lehrlingswelten.at](http://Lehrlingswelten.at).

Paul Rott - Keller SEN



**VISIT OF THE VOITSBERG MIDDLE SCHOOL**

► It all started in 2017 when Keller joined the Voitsberg Training Association (ABV). One of the ABV's core pillars is its close cooperation with the schools in the district. The main focus is on third-year middle-school students when they are 13-14 years old. Students gradually begin to focus on their further education or career choices in this grade and complete their first teaser days in a range of companies.

Together with the general career preparation program, we organise an annual Career Experience Day in Technology (CEDT). Up to three school classes visit our company on different days, where we introduce them to the technical professions and opportunities and the working environment, too. In the process, the students learn through play metalworking, including welding, with soft soldering and lasering also forming part of their challenges. An absolute must for the boys is operating our construction machines, which they really enjoy.

But, we must say that it is so encouraging that more and more girls enjoy technical professions. All in all, the CEDT has been a source of many applications for apprenticeships, and we have already been able to hire some of these appli-

cants as construction equipment technicians or metal technician apprentices. We are especially looking forward to welcoming our second female apprentice, eager to become a welder.

Meanwhile, we have also established participants at "Job Out of the Box" in cooperation with the STVG and Köflach Middle School (4<sup>th</sup> school year). This year, we also participated in "Creative



**METALWORKING**  
during the 2023 CEDT



**DRIVING THE EXCAVATOR**  
is an experience for all age groups

Apprentice Worlds" and "Girls Day" and are really looking forward to participating again next year.

Keller's profile in the Voitsberg district has increased massively in recent years. We also welcomed a Higher Federal College for Economic Professions (HLW) senior class and an excursion of teachers and professors from the Voitsberg Business School (HAK).





VISIT OF THE KÖFLACH MIDDLE SCHOOL



Finally, after a five-year break, we also want to mention a visit by a kindergarten to us. On a free Friday, we gave them a short tour followed by snacks and, for sure, some serious excavator driving!

# Stars of Styria 2023

Our apprentices are our future. We are more than happy when they become "stars".

Paul Rott - Keller SEN

Matthias Schörgi was awarded the "Star of Styria" by the Economic Chamber of Styria in 2023. This award is given to apprentices who pass their final apprenticeship examination with excellent results.

Matthias started his apprenticeship as a mechatronics technician with us in 2017, following a trial day, and has integrated very well over the entire period as he developed further. He completed every single year of his vocational school with honours. He also passed his general career preparation training with very good results.

We would like to thank him as well as his instructor Karl Grabler, for the commitment and the good teamwork they have

demonstrated. Matthias and his work ethics is for sure a great incentive for all our colleagues in training.



global strength and local focus

 [linkedin.com/company/keller](https://www.linkedin.com/company/keller)

 [youtube.com/c/KellerGroup](https://www.youtube.com/c/KellerGroup)

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