BAUER
Deep-Soil-Mixing

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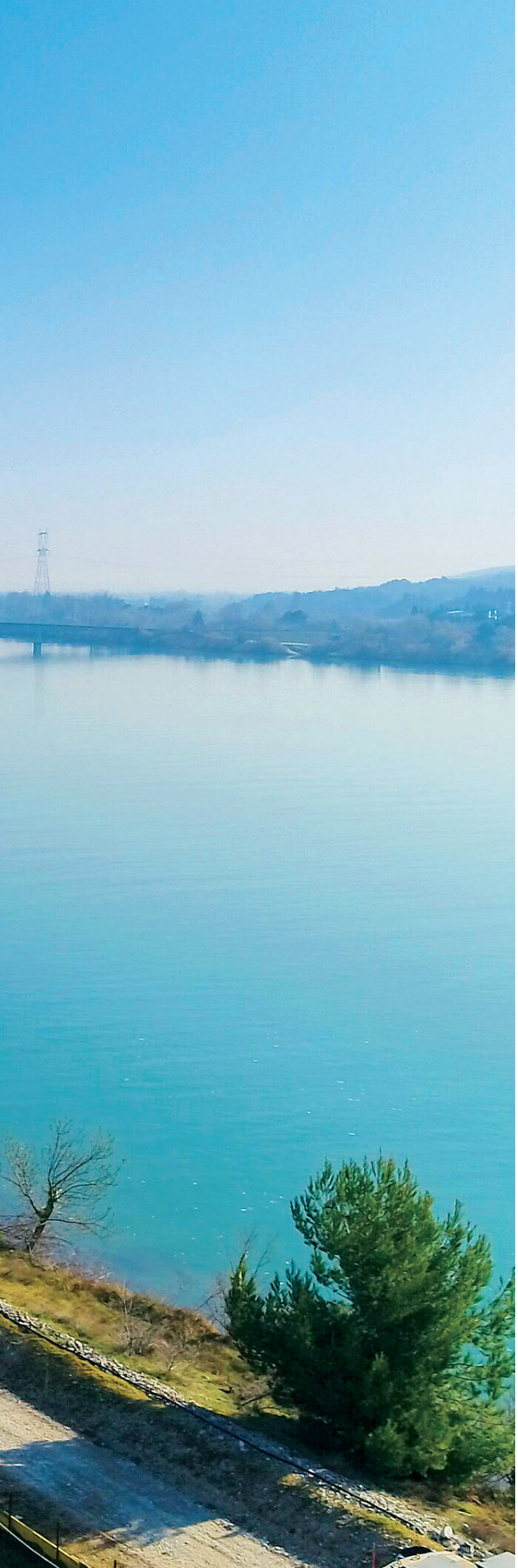


Content

Dike rehabilitation, Aramon, France
A Mixed-in-Place cut-off wall was built to remediate the Rhone River Dike in the Provence. For this purpose, the MIP elements were installed in the existing dike, along a length of 570 m and down to a maximum depth of 20 m. A BAUER BG 40 was used for the works.

Applications

Bauer Deep-Soil-Mixing (DSM) techniques can be applied to a wide range of geotechnical solutions. Instead of excavation and replacement, the soil is mixed with combinations of binders to create a foundation system. Mixing the soils with binders offers environmental and economic advantages and contributes vastly to sustainability.

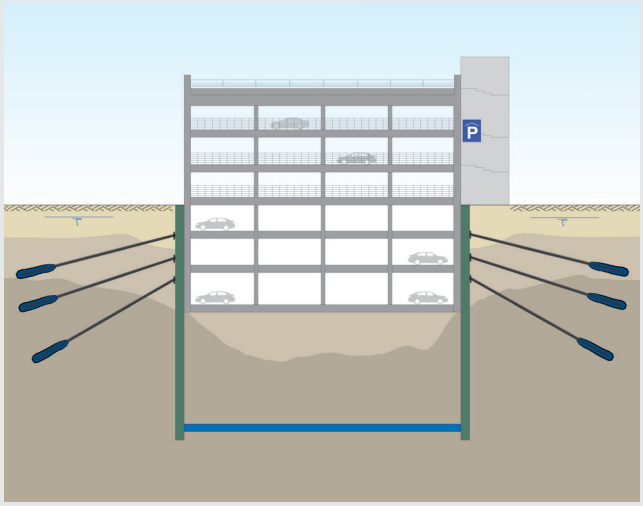
International Airport, Hong Kong, China
In advance of the third runway of the International Airport of Hong Kong, a low-headroom Cutter-Soil-Mixing (CSM) test field was carried out by Bauer to demonstrate the possibility of installing CSM panels offshore in a very constrained environment. 30 ground improvement elements were created by an MC 64 low headroom to an average depth of 20.5 m from seabed level.

Foundations

With Deep-Soil-Mixing, foundations for buildings, tanks, towers and bridges can be produced. The elements can be arranged flexibly based on the structural requirements. Soil volumes can be treated completely or partially as walls, grids or elements. The loads of modern constructions are becoming greater and greater and these structures are increasingly being built on soil with a low weight-bearing capacity.

Structural Walls

Deep-Soil-Mixing can be used to encompass excavation pits and stabilization of open cuts. This can be done with the methods Mixed-in-Place (MIP), Soil-Mixing-Wall and Cutter-Soil-Mixing (CSM). Benefits are the small amount of drill spoil created due to the use of the existing soil as aggregate and the convenience for the residents, due to the reduced need for transport and shorter construction times. In addition, tight retaining structures can be produced close to existing buildings.



Porto Novi Resort Village, Montenegro
On a surface area of approximately 26 ha and along a coastline of about 3.5 km, a five-star hotel development with five building complexes was built on a construction surface of more or less 35,000 m². To fortify the subsoil beneath the building complex, approximately 240,000 m² Mixed-in-Place elements – individual elements as well as walls – were produced to depths of up to 23 m and with a wall thickness of 0.55 m.

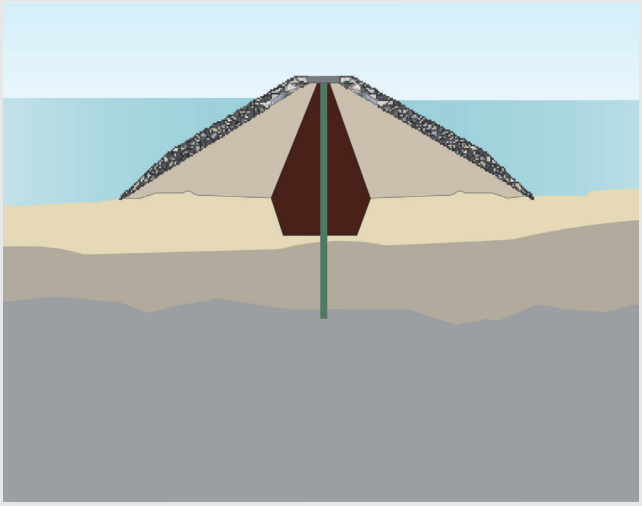
„Dreiländergalerie“, Weil am Rhein, Germany
For the „Dreiländereck“ project Bauer was commissioned to construct an excavation pit. The approximately 10,000 m² excavation pit was encompassed with MIP and pile walls. With a depth of 18 m it was the deepest excavation pit ever created by Bauer Spezialtiefbau using MIP walls.

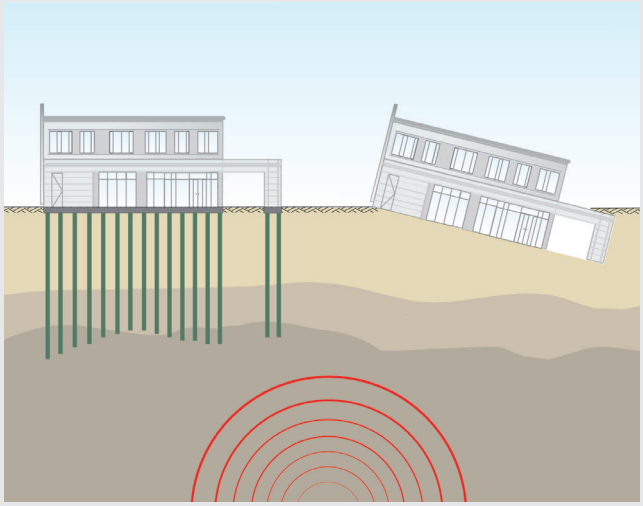
Seepage Control

For the remediation and seepage control of dams and dykes the methods Mixed-in-Place, Soil-Mixing-Wall and Cutter-Soil-Mixing can be used. These walls are generally constructed starting from the crest along the dike axis for the stabilization of river banks and dam rehabilation. The hardened impermeable materials have to be able to withstand erosion and protect the dike against burrowing animals. Reinforcement cages or girders can be installed to resist shear forces and bending moments resulting from earth and water pressure.

Prevention of Soil Liquefaction

In earthquake-affected regions there is often the risk of soil liquefaction, with dramatic consequences. By using the Deep-Soil-Mixing methods, a building affected by soil liquefaction can be supported by the treated soil and protected from collapsing. Liquefaction only occurs in saturated soil, its effects are most commonly observed in low-lying areas near bodies of water such as rivers, lakes, bays, and oceans. The effects of liquefaction may include major sliding of soil toward the body of water.



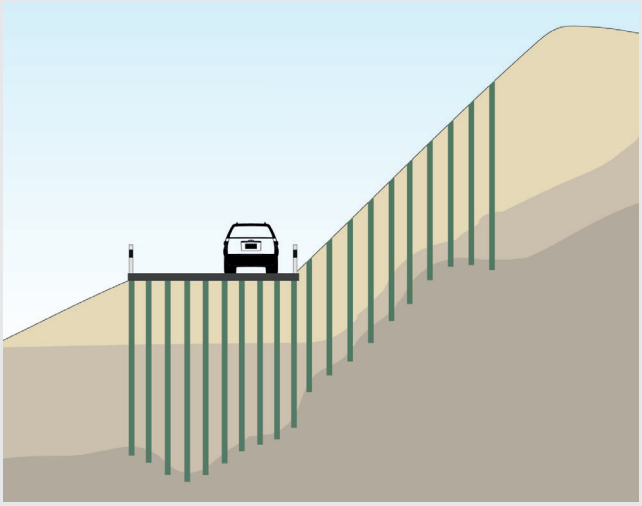


Diavik, Lac de Gras, Canada
The Diavik Diamond Mine is located just off shore of South Island and East Island in Lac de Gras, called the A21 pipe. In order to construct an open pit mine, a 2.2 km perimeter dike was constructed, a cut-off wall was installed through the dike and the water was pumped out. The cut-off wall with 19,000 m² was produced by the CSM-method down to a maximum depth of 25 m.

Cebu Integrated Resort, Cebu Island, Philippines
For the Cebu Integrated Resort a combination of ground improvement techniques was used with 1,624 lin.m of Mixed-in-Place wall. Therefore a BG 14 with double auger was deployed.

Infrastructure

Deep-Soil-Mixing works are often necessary for infrastructure projects including railways, bridge abutments and road embankments. The requirement usually arises due to the need of settlement control within the underlying soil layers and to increase the bearing capacity. Furthermore, DSM techniques are also used as remediation works to curtail the impact of erosion on existing highway infrastructure.



Double Railway Track, Kroya, Indonesia
Treatment of the underlying soft saturated clays by means of Deep-Soil-Mixing method in order to improve its bearing capacity and also to limit settlements under the proposed double railway track. A total of 2,803 no. soil cement columns with a diameter of 1 m were constructed.

QA/QC

To ensure the characteristics required of the Deep-Soil-Mixing elements or walls, the construction process is monitored comprehensively. In addition, suitability tests are carried out in advance in the laboratories of BAUER Spezialtiefbau GmbH. The best binder formulation for each application is determined, using soil and groundwater samples taken in situ. Installation volume and composition of the slurry are later adjusted to the local soil conditions during the execution. The drilling rigs are connected to the Internet for exchanging production data with data management software. The drilling rigs are equipped with GPS units for receiving position data. Together with the verticality measurement in the drill string the position of the wall or the individual elements is thus reliably detected. The B-project data management software allows setpoint and actual production data to be automatically collected, processed and analysed. In order to better evaluate the data, various visualization options are available.

INFO

Digital jobsite comprises

- **Building information modeling (BIM)**
- **GPS tracking**
- **Production data monitoring (B-project)**
- **Machine data monitoring (B-Tronic)**
- **Automated data transfer to rig (Data2RIG)**

Production data monitoring
All relevant production data, such as the amount of slurry added or the verticality of the augers, is visualized online for the machine operator and recorded in B-Tronic.

Environment

Reduction of energy consumption on construction sites is an ecologically as well as economically justified objective. A low Product Carbon Footprint through the reduction of diesel consumption and the choice of construction material is a highly motivating factor, contributing to the efficiency of a construction site. Unlike conventional special foundation techniques, the DSM process uses the existing soil, acting as the aggregate. Together with its high productivity, which results in comparatively short execution times, the DSM method is sustainable in terms of the PCF. The assessment of different options for construction methodologies demostrates potential savings of 25 % or even less greenhouse gases using DSM, compared to a diaphragm wall with grab. Furthermore, the use of our methods additionally relieves the environment and residents with regard to traffic frequency and noise.

INFO

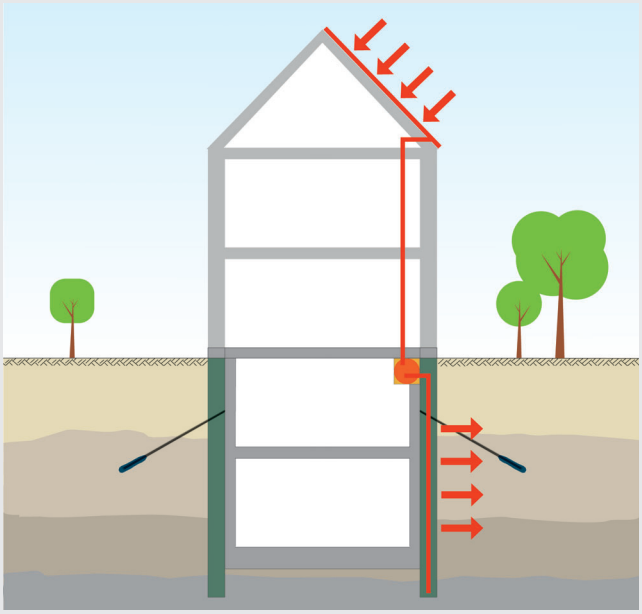
Product Carbon Footprint (PCF)

The Product Carbon Footprint provides the total amount of greenhouse gas emissions (CO_2 footprint) taking into account emission factors from the production of building materials, construction machinery, fuel, on-site power consumption and all transport costs.

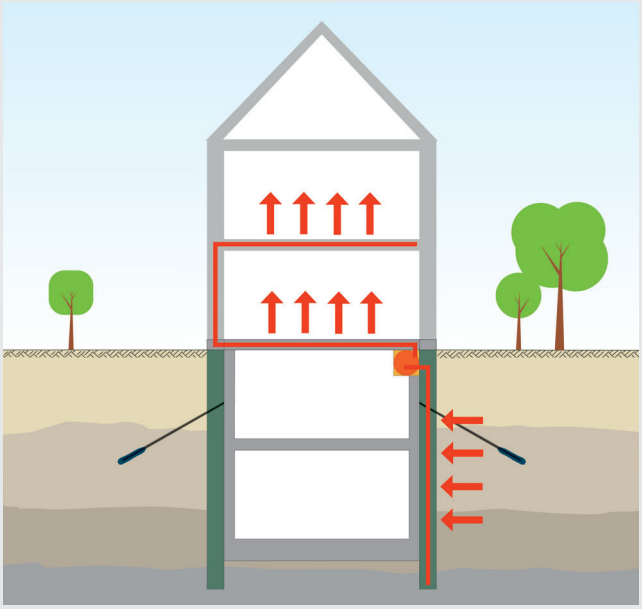
Energy Efficient Power
All of the Bauer Spezialtiefbau drilling rigs are equiped with the energy efficient power package.

Geothermal Energy

The natural resources must carefully be used to achieve targets, particularly when it comes to new construction projects. Solar and geothermal energy can be used in a decentralized manner, i.e. directly where it is generated. The combination of these two renewable energy sources is particularly promising. Since the costs of deep geothermal drilling are very high and there is often insufficient space for surface collectors, it makes sense to geothermally activate the retaining walls that are generally required within cities. Using the thermal roof collectors, energy can be obtained in the summer months, fed into the ground via the installed geothermal probes and stored there. In the winter, this energy is then extracted from the ground again and used to heat the building.



Summer mode



Winter mode

Methods

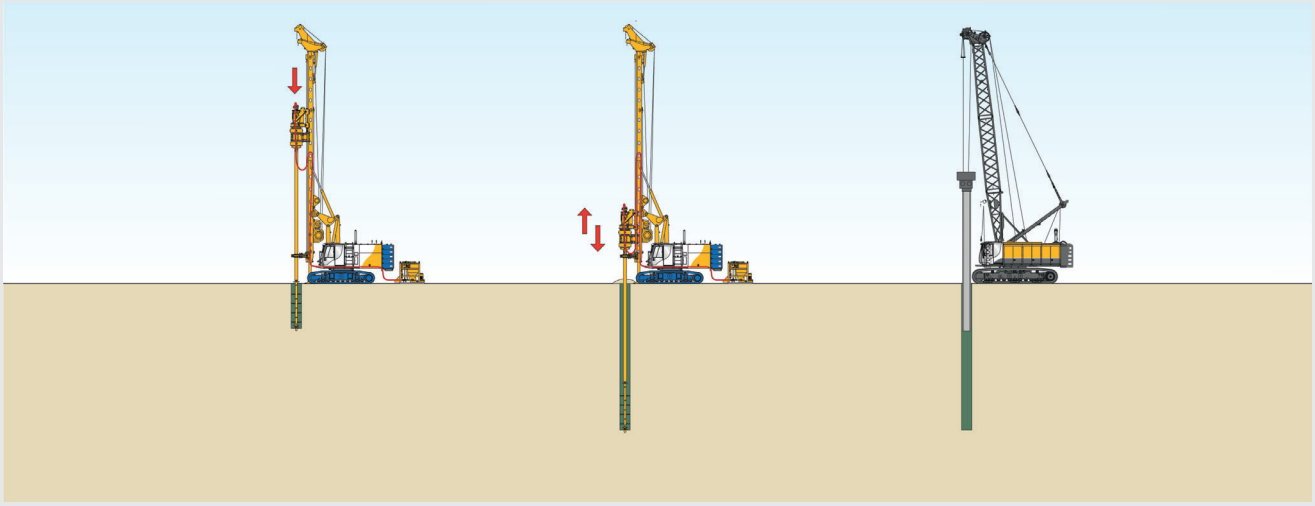
Deep-Soil-Mixing offers a broad spectrum of technologies, which allows us to offer sustainable, in-situ treatments for developments, reducing both the creation of spoils and carbon emissions. The key feature of DSM technologies involves mixing the existing soil in-situ with a binding agent. The experience amassed by our highly qualified team, as well as the continuous development of our drilling and mixing rigs, allows us to select the best possible method, depending on soil condition, depth and application.

Infrastructure-Project, South Asia
Soil improvement with Single-Column-Mixing (SCM).
Treatment of 1,096,993 m³ of soil, 2,000 mm
in diameter to a max. depth of 20.5 m.
Seven BAUER BG 28 and one BG 40 were used.


BAUER BG 28
BAUER BG 28

Single-Column-Mixing (SCM)

The Single-Column-Mixing (SCM) method is an economical process for the construction of single load bearing columns, as well as for extensive soil improvement applications. The mixing tool is continously rotated into the ground, while simultaneously adding the required slurry. The speed at which the mixing tool is advanced and the rate at which the slurry is pumped are controlled in such a way that as little excess slurry as possible returns to the surface. After the final depth has been reached, the mixing tool is withdrawn from the ground, while continuing to rotate. Depending on the type of soil, repeated insertion and withdrawal of the mixing tool can improve the mixing result. Depending on structural requirements, reinforcing elements, such as steel stanchion, can be inserted into the column.



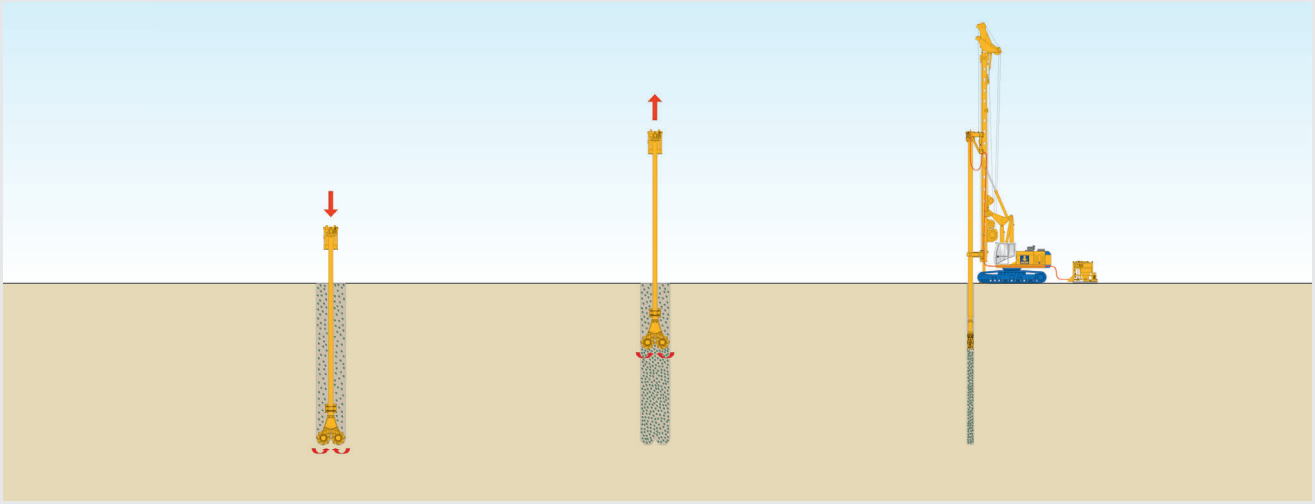
Single column mixing offers a more environmentally friendly, economically flexible and adaptable method than most other ground improvement methods.

Joachim Gaus
Business Division Services
International Projects and Services

Infrastructure-Project, South Asia
Soil improvement with Single-Column-Mixing. Treatment of 1,096,993 m³ of soil, 2,000 mm in diameter to a max. depth of 20.5 m.

Cutter-Soil-Mixing (CSM)

Cutter-Soil-Mixing (CSM) uses the modified trench cutter technique to form rectangular panels of soil mixed ground. The cutterhead is advanced into soft soil or soft rock as the binder slurry is injected. CSM is used mainly for stabilizing soft or loose soils (non cohesive and cohesive), however the machinery used, derived from Bauer's cutter technology, extends the applicability of the method to much harder strata, when compared to other methods of soil mixing. A continuous wall is formed in a series of overlapping primary and secondary panels. Overcutting into fresh adjacent panels is called "fresh-in-fresh method". The cutter technique also allows the "hard-in-hard method", whereby secondary panels are cut into the already hardened primary panels. The system offers a high level of quality control, with the capability of down-the-hole steering, which allows CSM support walls to be, used for deep access shaft and wall constructions.



INFO

Specifics

- **Extended depths can be reached**
- **High productivity**
- **Harder soils can be treated**

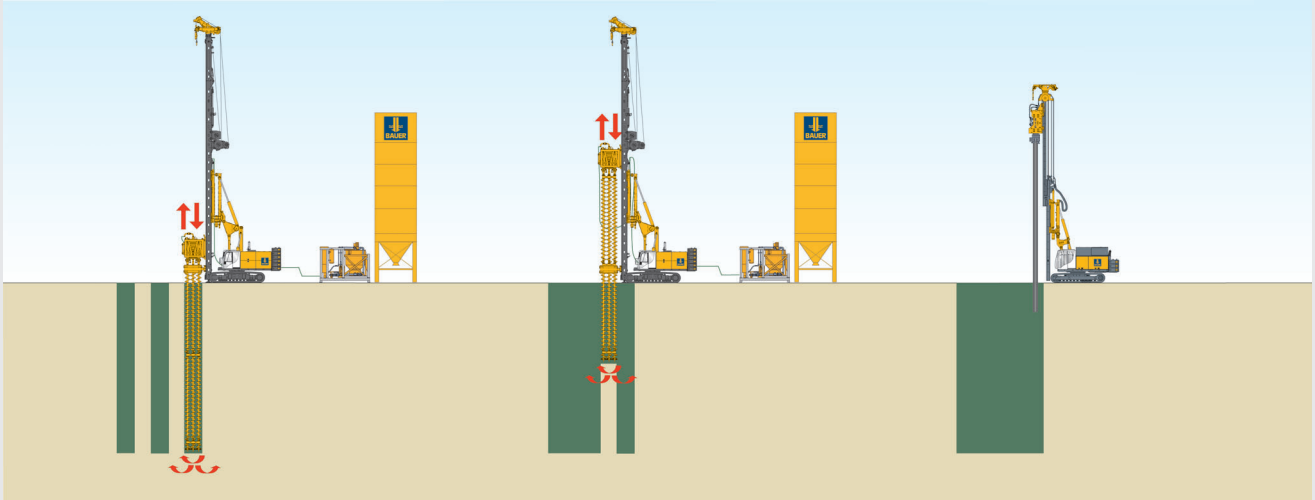
Combinations

In order to cover all variations of geology and to satisfy wide-ranging requirements, an mixing tool combination of Single-Column-Mixing, Mixed-in-Place and Soil-Mixing-Wall is possible.

Herbert Hoover Dike, Florida, USA
Bauer is executing a 13.5 km long cut-off wall to seal the dike section. The dike around the lake Okeechobee is 225 km long and around 24 m deep. Two BCM-5 Cutter Soil Mixers, RG 25 Base Carrier Unit and BG 28 Base Carrier Unit, BG 28, BG 40 were used.

Mixed-in-Place (MIP)

The Mixed-in-Place method is suitable for both cohesive and non-cohesive soils. A triple auger is used to break up the soil and work in the binder slurry. The triple auger is drilled down to the final depth, with slurry being added. During the subsequent homogenization process, the direction of rotation of the individual augers is varied so that a vertical material flow over certain depth is produced in the trench. This vertical material flow is only made possible through the use of augers with counter clockwise rotating flights, which ensures the homogeneity of the slurry-soil mixture and thus of the finished wall. As required and needed suitable reinforcement can be added into the fresh mix for structural strengthening.



With the Mixed-in-Place method we can offer our clients technically advanced, customized and cost-effective soil improvement and foundation solutions.

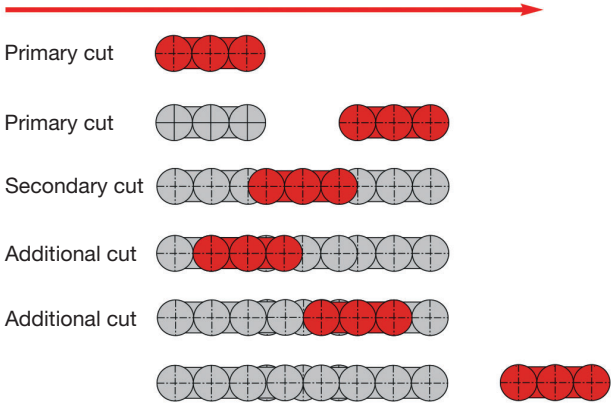
Dr. Philipp Schober
Design Manager

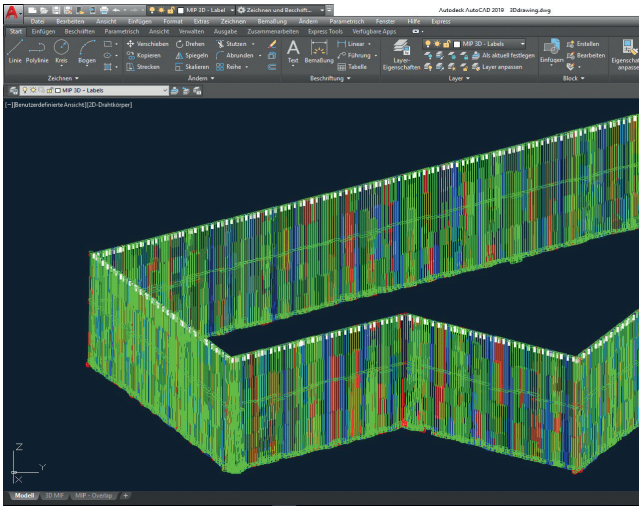
Railway embankment renovation, Vilseck, Germany
As a part of a full closure of the railway line, around 42,000 m² of Mixed-in-Place panels were produced, as 2,700 individual elements in six weeks and at three different railway embankments. The work was carried out using an RTG RG 27 S, an RG 25 S, two RG 19 T and a BAUER BG 24.

Work procedure

To ensure that a solid, seamless and continuous wall is produced, MIP walls are constructed by the double pilgrim step method. This construction method is characterized by additional processing of the overlapping areas, comprising primary and secondary cuts, providing redundancy for overlap.

“Double pilgrim step” production sequence:





As-Built Generator (ABG)

The position and verticality of MIP injection sites can be recorded and visualized using the Bauer As-Built Generator (ABG). These representations serves the planning basis also avilable in 3D.

Soil-Mixing-Wall

The SMW procedure is simillar to the MIP construction process, but the used tools are different.

Revit 3D construction simulator

The structured models created by Revit provide an ideal base for visualizations. Surfaces suitable for the type of material are rendered on the construction models, i.e. material surfaces, light and shadows are added, creating an even better impression of individual objects.

INFO

Soil-Mixing-Wall (SMW)

When compared to the MIP method, the SMW method mixes the existing soil horizontally instead of vertically. This is due to the fact that the MIP is equipped with continuous augers, whereas the SMW has mixing paddles in the lower part.

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