BAUER
Soil Improvement

Content

The Island, Dubai, UAE
Vibro compaction of 500,000 m³ of reclaimed carbonate sand.

Applications

Our techniques have been applied in a wide range of sectors such as residential, commercial, industrial, marine and aviation. We take pride that our soil improvement solutions are based on our years of experience, our up-to-date design expertise, and our skilled operations staff.

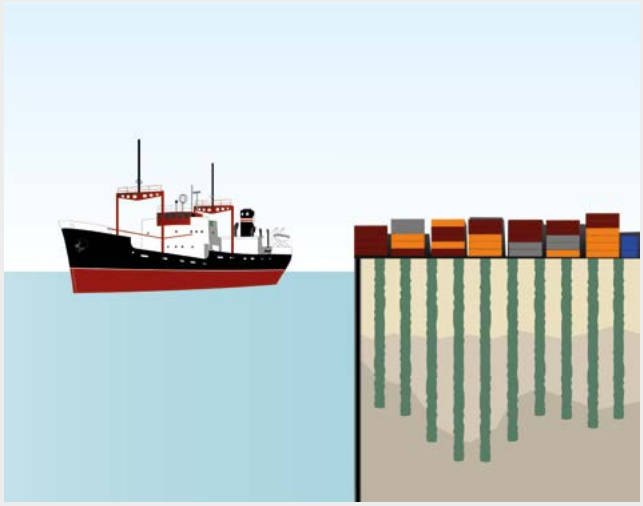
Container Terminal, Moin, Costa Rica
Construction of 180,000 lin. m stone columns with a maximum depth of 24 m.

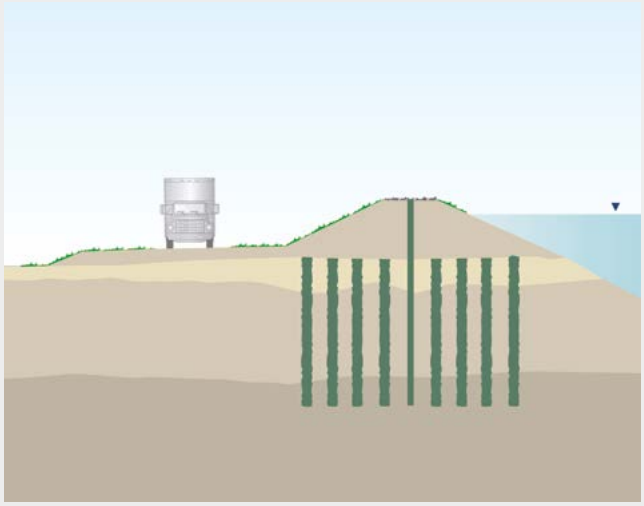
Ports and coastal Infrastructure

The forecasted increase in marine freight has led to the increasing demand for new ports or massive expansion of existing ones. These and other coastal structures like quays and jetties, often require complex geotechnical works, including soil improvement. At Bauer, our soil improvement solutions like vibro replacement, vibro compaction and dynamic compaction have been successfully implemented on coasts as a means of settlement and liquefaction mitigation thus allowing economic development to proceed.

Dams

Whether earth dams, rock fill dams, gravity dams or other dams, Bauer soil improvement offers suitable compaction techniques that aim at preventing piping, provide adequate margins of safety against geotechnical and bearing failure and also mitigate liquefaction risks.



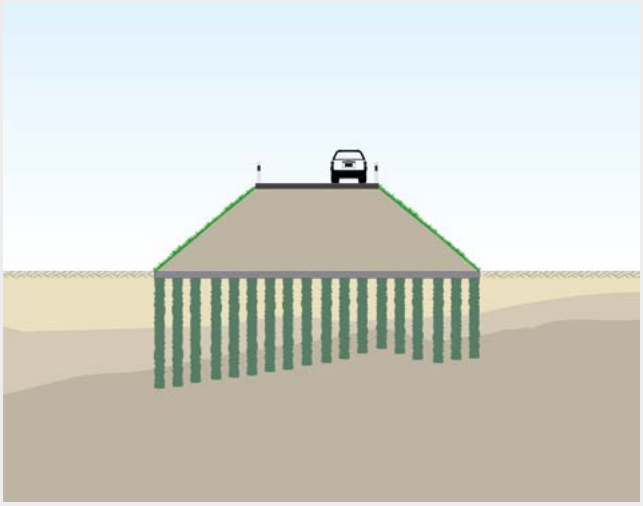


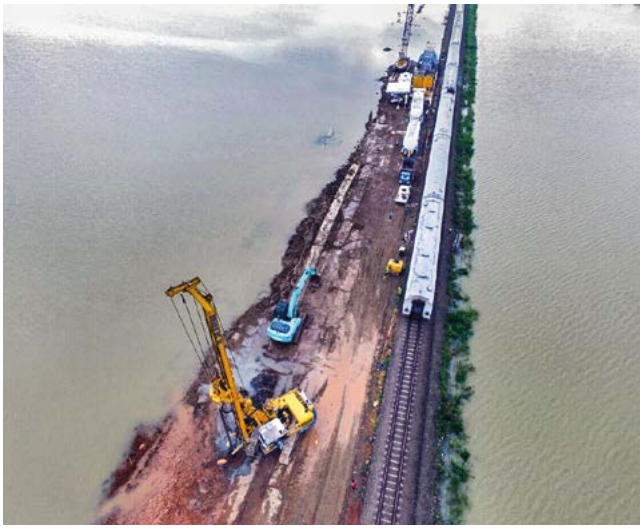
Container Terminal, Moin, Costa Rica
The treatment of the dredged fill executed with vibro replacement by means of stone columns. More than 180,000 lin. m stone columns were constructed with the wet top feed method to a maximum depth of 24 m. A further 380,000 m² were treated by means of surface compaction and 330,000 m³ using Mixed-in-Place (MIP) method.

Peribonka Hydroelectric Development, Canada
In addition to the Cut-Off wall construction, Bauer provided a complete construction package comprising soil improvement of the in-situ alluvial materials and the placed man-made fills approx 85,000 m² by means of vibro compaction down to depths of 35 m.

Transport Infrastructure

Soil improvement works are often necessary for highway infrastructure projects including railways, bridges, bridge abutments, road embankments etc. The requirement usually arises due to the need to control differential settlement within the underlying soil layers, increase bearing capacity and also to mitigate the impact of liquefaction on the structures in earthquake prone regions. Furthermore, Soil improvement techniques are also used as remediation works to curtail the impact of erosion on existing highway infrastructure.





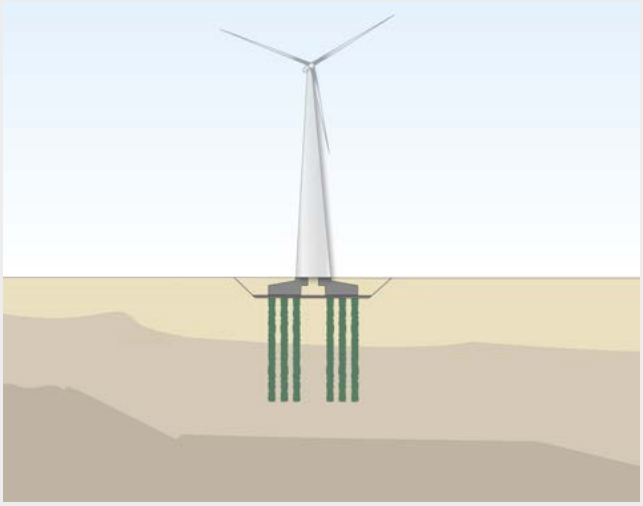
Double Railway Track, Kroya, Indonesia
Treatment of the underlying soft saturated clays by means of deep soil mixing method in order to improve its bearing capacity and also to limit settlements under the proposed double railway track. A total of 2,803 no. soil cement columns with diameter of 1 m were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

Buildings

Prior to the construction of residential and commercial buildings, it may be necessary to perform specialist soil improvement works in the proposed work area, with a view to improve or modify the ground shear strength, stiffness, permeability and also to reduce the risk of liquefaction in areas of seismic activity. Common stabilization techniques that have been successfully implemented include: rigid inclusions, the vibro methods and surface compaction methods such as dynamic compaction and replacement.

Oil & Gas, Renewable Energy

Bauer has been able to deliver soil improvement solutions for wind turbines, power stations and renewable energy plants. Due to Bauer in house design and construction expertise considerable savings were gained by the client whilst achieving the design goals of stringent settlement control and liquefaction mitigation. Our experience in the Oil and Gas sector is worthy of note, having been involved in many projects both upstream and downstream across the globe.



Ocean Reef Island II, Punta Pacifica, Panama
Bauer soil improvement solution was implemented for the Ocean Reef artificial islands I & II, comprising mostly luxurious residential buildings. For this new reclamation Bauer undertook vibro compaction. This luxury development of residential buildings had stringent settlement control.

Punta Catalina, Dominican Republic
Punta Catalina is a new coal-fired power station, built about 40 km from the capital city of Santo Domingo to improve the electrical power supply of the island nation. The scope of works executed by Bauer included 210,000 lin. m stone columns with pre-drilling to a depth of up to 20 m and with a diameter of 1 m.

Green Port, Hull, United Kingdom
Improvement works carried out on fill and underlying soft, compressible alluvial soil, in order to control settlement and improve bearing pressure in an area of approximately 30,000 m². A total of 27,642 lin. m stone columns using the vibro replacement method were installed.

Industrial Park, Slovakia
Bauer BF13 Dry Bottom Feed Rigs were used to treat over 300,000 m² for the new car manufacturing plant in Slovakia.

INFO

Bauer soil improvement is available for these applications:

- **Ports and coastal Infrastructure**
- **Dams**
- **Transport Infrastructure**
- **Residential and commercial Buildings**
- **Oil & Gas, Power Stations and Renewable Energy**

Petrochemical Complex, Philippines
The extension of the petrochemical complex in Batangas, Philippines required soil improvement works by means of Bauer FDPs. A total of 4,652 lin. m Bauer FDPs to 15 m depths were executed at this project.

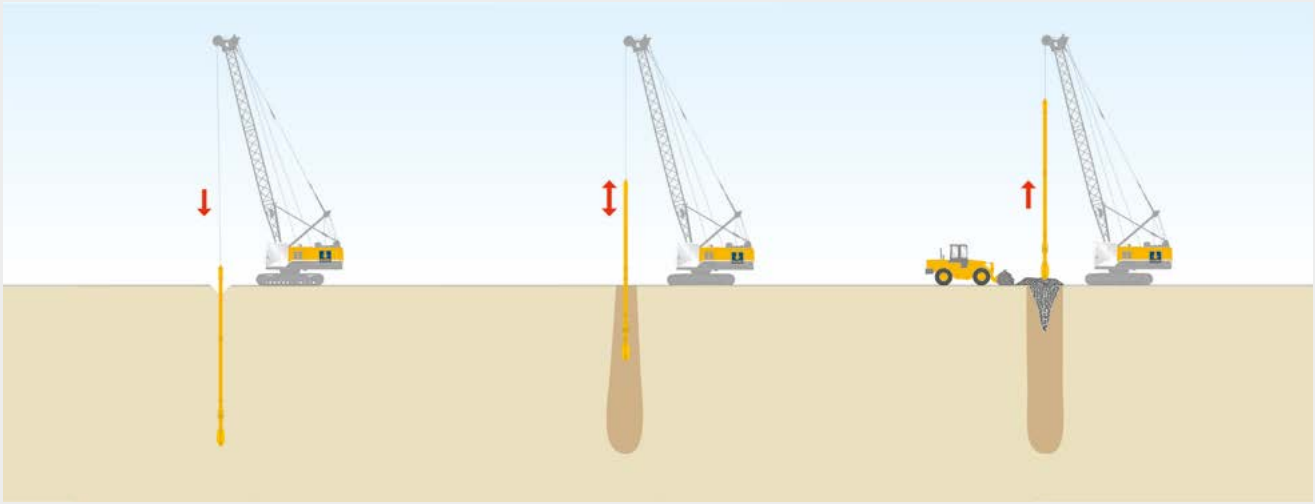
Methods

Globally and regionally we offer a broad spectrum of soil improvement and traditional piling technology. This situation allows us to offer sustainable, in-situ treatments for developments, reducing the creation of spoil and reducing carbon emissions. Bauer has a cost effective, environmentally friendly solution for all your construction needs.

Ocean Reef Island II, Punta Pacifica, Panama
More than 11,000 vibro compaction points with an average compaction depth of 15 m were required to treat the reclaimed marine sands.

Vibro Compaction

This compaction method is most suitable for loose, medium to coarse-grained non-cohesive soils, with the compaction achieved by means of deep vibration using vibroflots. Cohesive soils consisting of silt and clay material do not respond to vibratory compaction. This deep compaction method serves to improve the mechanical properties of soils; the relative density of the soil could be increased up to around 80%. Furthermore, it offers an effective means of limiting settlements and mitigating the risk of liquefaction in areas of seismic activity. The compaction process involves the floatation and subsequent compaction of the soil in the vicinity of the vibroflots by means of the horizontal vibration emitted from the vibroflots. The upper metres of the subsoil may need supplemental surface compaction treatments to achieve certain specifications in addition to the vibro comapction; this is of course included in our service as required.



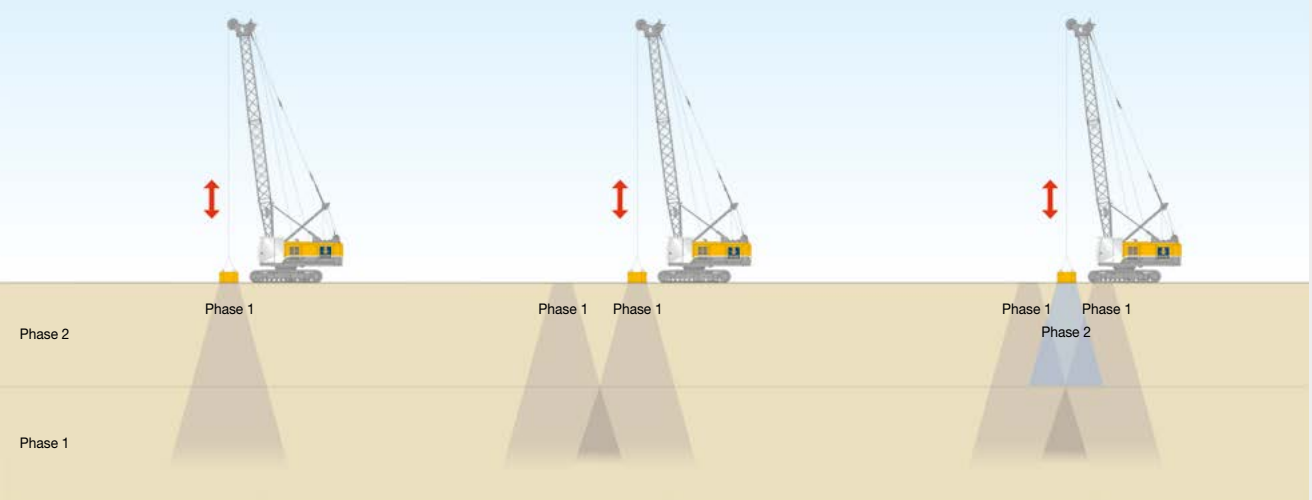
INFO

For large depths and clean sands vibro compaction is the most cost effective method, whereas for lesser depths (< 8 m) dynamic compaction methods are excellent. As the fines contents of the soils increase, then we must look at soft and rigid inclusions (stone columns, full displacement columns, or soil mixing) all depending on the soils, the loads and the timescales.

The Island, Dubai, UAE
Vibro compaction of 500,000 m³ of fill to an average depth of 16 m. Full-scale zone load tests and CPTs were also executed to verify the settlement requirements of this treatment of reclaimed carbonate sands.

Dynamic Compaction and Replacement

Dynamic compaction (DC) involves the use of high-energy heavy tamping passes to improve the packing density of loose, coarse-grained soils. The engineering properties of a wide range of soils can be substantially improved using this method. The treatment is achieved by a combination of the weight, drop height, grid pattern, number of passes, position of the ground water table and the underlying soil properties. The kinetic energy emitted on impact compacts the soil via forced re-packing of the grains. With dynamic replacement, the dynamic compaction method is applied in highly compressible, cohesive soils to reinforce the weak layers by the addition of imported granular material that are driven into the soils by the means of the specially designed pounder, creating in effect a large diameter stone pillar.



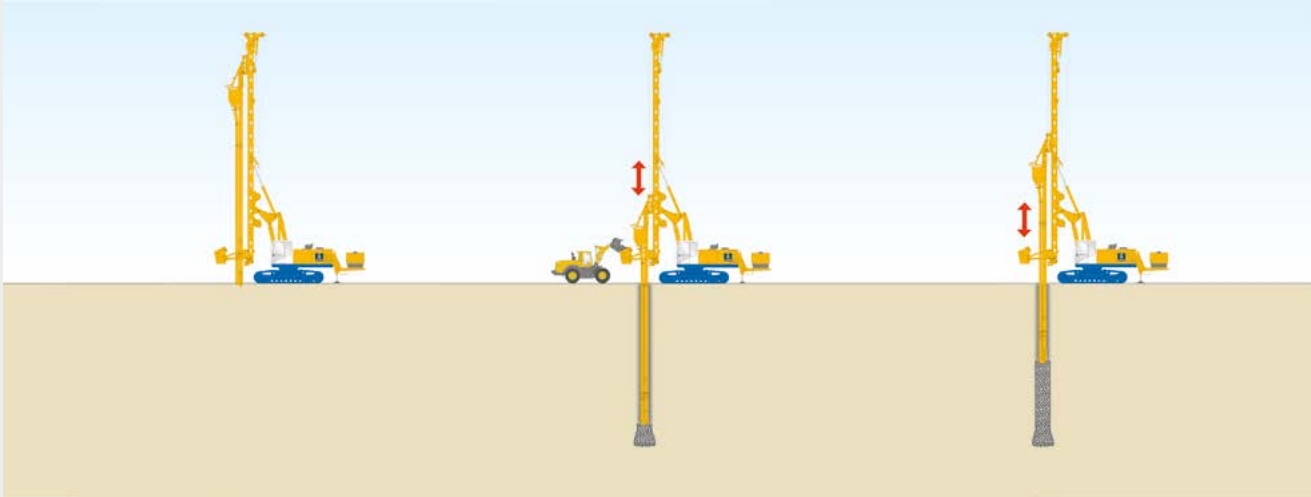
Dynamic compaction is a great technique for compacting large areas of sandy soils, even pockets of silts. It is quick and allows flexibility in the choice and location of the foundations.

Jason Redgers
Soil Improvement Director

Dubai Creek Harbour, Dubai, UAE
Approximately 530,000 m² of a combination of dynamic compaction and vibrocompaction works performed.

Vibro Replacement / Stone Columns

This method of deep vibration treatment offers the advantage of being applicable to a wide range of soils, from loose granular soils to soft cohesive deposits. Within Bauer, we offer both the wet top feed and the dry bottom feed methods of installation. Generally, both methods involve the introduction of backfill material into a void in the ground made by penetrating the vibroflot to the design depth as needed to meet the specification requirements. In the case of the wet top feed method, the void or annulus is maintained by means of water flushing. The backfill material is then compacted in increments by successive withdrawal and re-penetration of the vibroflot to form a continuous column throughout the treated soil layers. In the dry method (as shown below) only air is used.



INFO

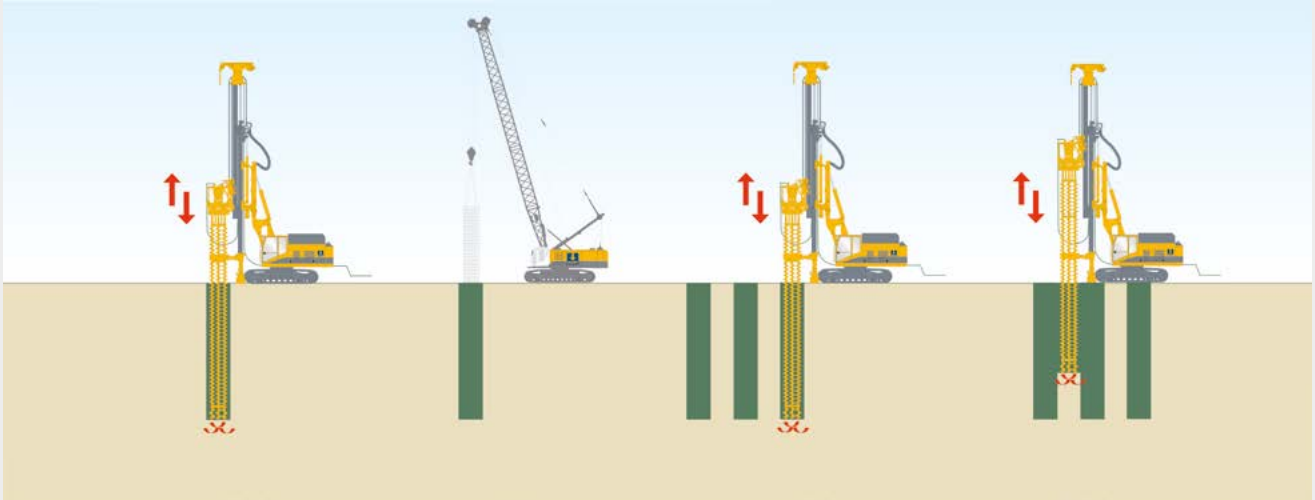
Vibro replacement is suitable for:

- **Clays**
- **Silts**
- **Silts/clays/sand mixes**
- **Improvement of bearing capacity**
- **Reduction of Settlements**
- **Mitigiation of liquefaction**

Punta Catalina, Dominican Republic
The scope of works executed by Bauer included 210,000 lin. m stone columns with pre-drilling to a depth of 20 m and with a diameter of 1 m.

Soil Mixing

The soil mixing methods are suitable for both cohesive and non-cohesive soils, which may be used as a soil improvement method in addition to applications in cut-off-walls, groundwater or pollution control, and remediation of dykes and dams. This method has also been successfully used to secure terraces in the ground and excavation pits. The method involves the breaking up of the surrounding soil with a single or triple auger, turning over and filling of the pores with binder agent slurry. The individual insertions are combined to walls using the pilgrim step method. The auger dimensions ultimately determine the size of the insertion. In some cases, reinforcement can be added into the fresh mix for structural strengthening. The method offers an efficient, cost-effective and environmentally friendly ground stabilisation alternative.



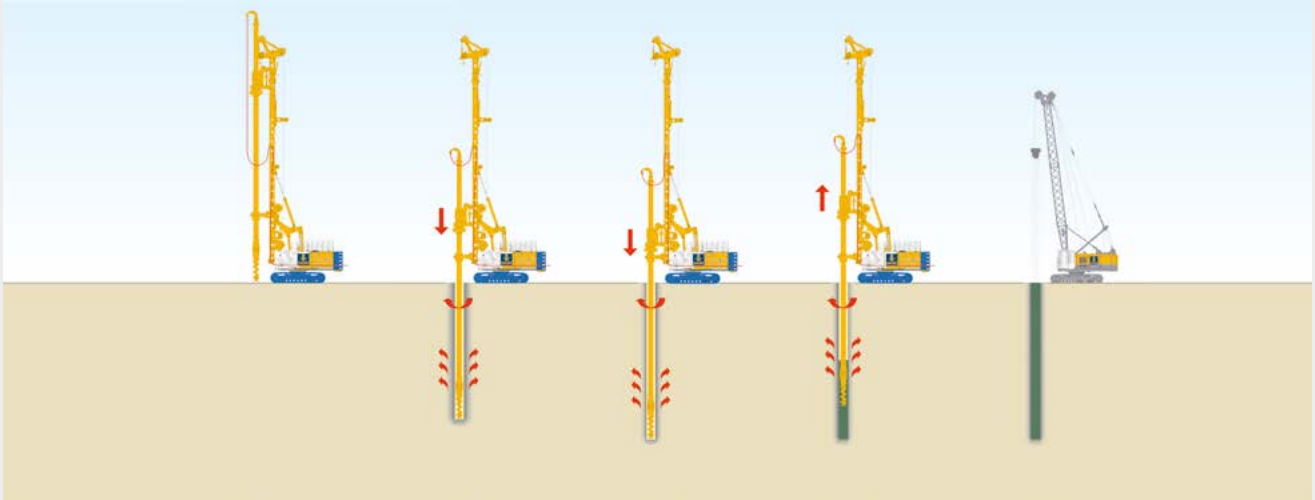
INFO

The Mixed-in-Place method is a resource-efficient, environmentally compatible and productive construction method. The MIP drilling rigs manufactured by Bauer can be deployed in the most confined urban construction sites as well as in the largest dams and dykes.

Porto Novi Resort Village, Montenegro
123,000 m² Mixed-in-Place elements consisting of single MIP elements for soil improvement and deep foundations, continuous MIP walls for soil improvement and reinforced MIP walls for securing the sea banks.

Rigid Inclusion by the Bauer Full Displacement System

This Rigid Inclusion or Full Displacement Column system creates a known modulus column that in conjunction with the load transfer platform (LTP) provides a safe, fast and economical solution for medium loaded structures on soft soils. They are mainly used to mitigate settlement and improve bearing capacity of the underlying soil layers. The displacement system improves the ground and eliminates spoil arising at the surface thus adding extra benefits in reduced spoil management, again saving costs. There is no physical connection between the Rigid Inclusion and the foundation system as the foundations are supported on the LTP. The installation equipment consists of a drill rod system, which has an auger as a started, followed by the displacement body and the extension casing. The system can also be used for Full Displacement Piles (FDP) in which reinforcement is added to create the FDP, as the situation dictates based on loading requirements and the soils.

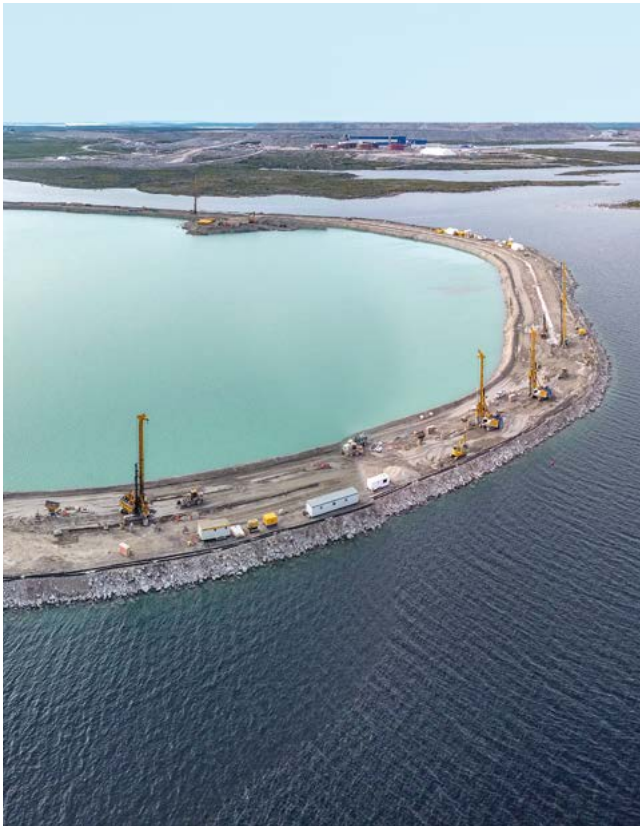


"Full Displacement Columns have proven to be a popular option for road and rail embankments as well as for tank farms, where control of differential settlement is vital."

Jason Redgers
Soil Improvement Director

Sewage treatment plant, Biha, Bosnia
The deep foundation of the sewage treatment plant (various buildings and tanks) comprised 681 reinforced Bauer FDPs. The rigid inclusions were executed to depths of 20 m.

Petrochemical Complex, Philippines
Bauer performed the design and construction of 4,652 lin. m Bauer FDC. The rigid inclusions were executed to depths of 15 m.



Diavik Diamond Mine, Yellowknife, Canada
In addition to the cut-off wall and soil mixing scope, vibro compaction was executed ahead of the Cut-off wall works to depths of 23 m.

INFO

This methods are used for Bauer soil improvement:

- **Vibro Compaction**
- **Dynamic Compaction and Replacement**
- **Vibro Replacement / Stone Columns**
- **Soil Mixing**
- **Rigid Inclusion by the Bauer Full Displacement System for FDC or FDP**

Road Remediation, Plzen, Czech Republic
The leader mounted bottom feed method was used to install approximately 3,500 lin. m of stone columns as remediation works on a road that had excessively settled.

Projects

With over 50 subsidiaries and branch offices around the world, our regional networks, coupled with our expertise and passion provide a platform and flexibility for a world-wide reach.

Palm Jumeirah, Dubai, UAE
Densification of reclaimed carbonate sands by means of vibro compaction for depths between 12 m to 18 m, to achieve bearing capacity improvement, settlement control and liquefaction mitigation.


BAUER

Container Terminal Extension, Freetown, Sierra Leone

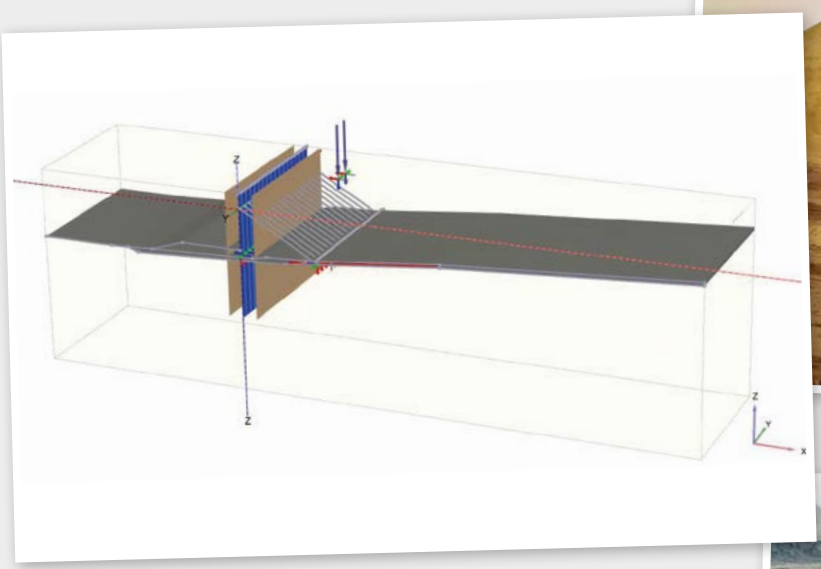
Bauer was commissioned by Eiffage Génie Civil and BellSea Ltd. to carry out soil improvement works by means of vibro compaction and surface compaction of the reclaimed marine sand. Given the stringent timeline, two compaction systems were implemented. The first comprised vibroflots in tandem suspended from a crawler crane, to treat depths beyond 7 m to a maximum depth of 24 m, while the second method consisted of a single vibroflot mounted to an excavator. The latter method was used to treat areas with depths less than 7 m. A total of 543,000 m^3 were compacted by vibro compaction. Subsequently, surface compaction was performed on a total area of 51,030 m^2 to treat the upper layers for enhanced specification requirements. With the presence of several anchors and tiebacks to support the existing harbour combi-walls in the reclamation area, Bauer performed a 3D verification of the influence of vibro compaction on anchored quay walls prior to commencement of our works.

Tandem unit being setup prior to calibration and trials.

With the tandem system, there is the potential to match and even exceed the performance of two single rigs working, at significantly lower costs.

Ikenna Osayi
Soil Improvement Specialist

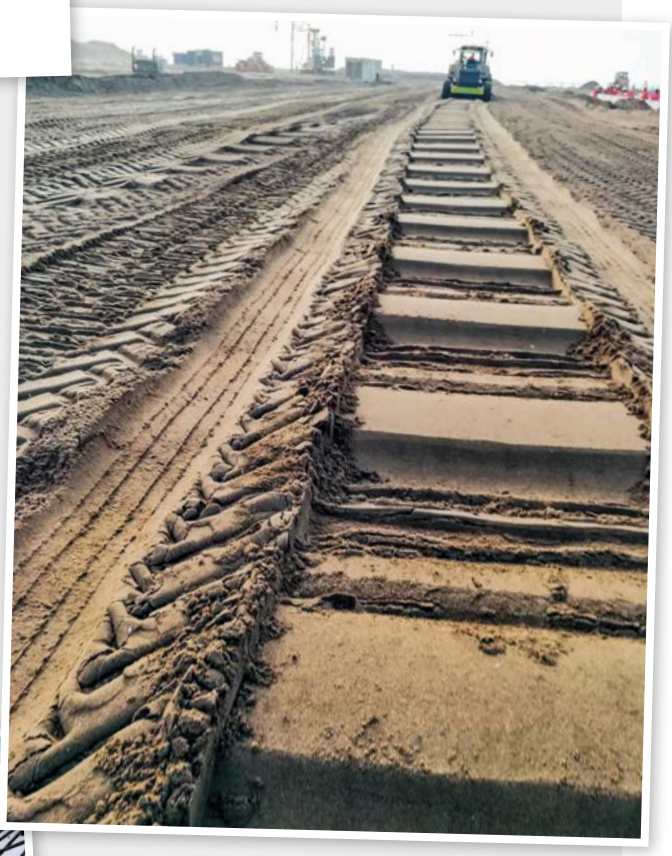
With the stitcher system a compaction to 7 m depths was done.



Structure model for the second section using PLAXIS 3D – Inclined anchors.

INFO

- **The influence of vibro compaction on already existing anchors and wall structures was analysed using PLAXIS 3D.**
- **Pressure sensors were also installed close to a chosen wall section, to monitor the build-up of pore water pressure during compaction in its vicinity.**

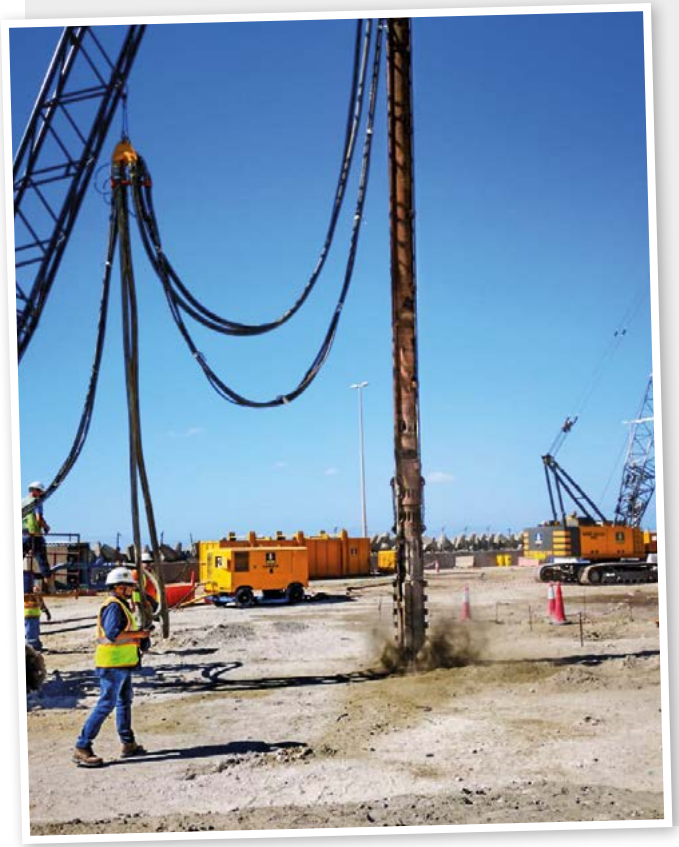


Surface compaction being undertaken post Soil Improvement by a 25 kJ High Energy Impaction Compaction system.

Tandem unit being setup for compaction to 24 m depths.

Layyah combined cycle power plant, Sharjah, UAE

The Layyah combined cycle power plant is an excellent Bauer Project. The client initially wanted compaction for the upper layers, but whilst working with Bauer specialists saw that deep treatment of the soils for liquefaction mitigation was needed. This treatment was an extra to the piling works already awarded to Bauer on the project. Up to 300,000 m³ of sand treated with the Bauer TR75 vibroflot for the government of Sharjah, UAE in conjunction with over 2,200 nos. piles (0.6 m to 1.0 m diameter) up to 22 m depth.



Penetration stage: the vibroflot can be seen penetrating the in-situ soil by a combination of its weight, vibration and air and water jetting.

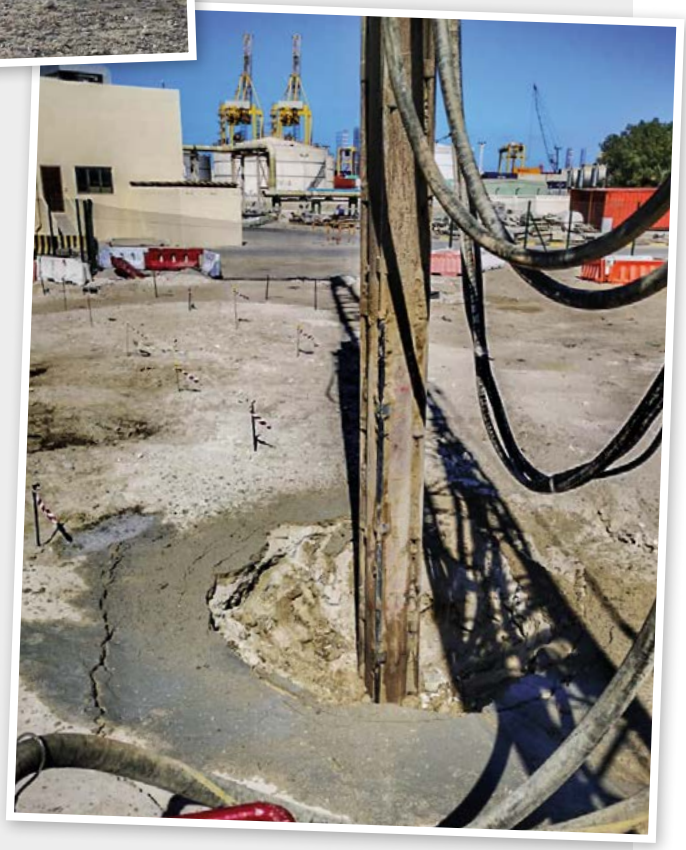
INFO

- **Client: Sharjah Electricity and Water Authority (SEWA)**
- **Employer: JV Elsewedy Power & MHPS**
- **Scope: 250,000 m³ vibro compaction, 45 nos CPTs**
- **Duration: 1 month**

Compaction stage aided by air and water flushing.

INFO

- **Up to 15 m depth**
- **Reclaimed sands from the Persian Gulf**
- **Working close to existing pipelines**
- **Measurement of vibration levels**
- **Combined team works**



Compaction stage with formation of settlement cracks arising due to the compaction effort.

Completion stage, with the crater being filled with suitable material.

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