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SOIL IMPROVEMENT BY GEOPIER® AGGREGATE PIERS

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Abstract: Geopier designs soil reinforcement solutions that provide cost-effective foundation support of commercial, industrial, residential, and transportation-related structures. These turnkey solutions save time and money.

Key words: Soil improvement, aggregate piers, alternative foundation system.

1. GEOPIER RAMMED AGGREGATE PIERS (RAP)

1.1 Process features

Geopier Foundation Company developed Rammed Aggregate Pier® (RAP) Systems as efficient and cost effective intermediate foundation solutions for the support of settlement sensitive structures. These systems have since become effective replacements for massive overexcavation and replacement or deep foundations, including driven piles, drilled shafts or augered cast-in-place piles. Thousands of structures are currently supported by RAP Systems - proven experience that ensures high levels of performance and reliability compared to traditional systems.

The Geopier® process with Rammed Aggregate Piers® is a process of soil improvement. Generally, it is a soil replacement process, which is combined with a displacement process.

The excellent high bearing capacity of each aggregate pier is reached by the means of a patented typically shaped Geopier® tamper and by the compaction of the aggregate in thin lifts.

Fig. 1 Patented bevelled Geopier® tamper

1.2 Technical advantages of the process

- High compaction of the aggregate in the core of the piers by rammed compaction in layers
- Horizontal and vertical compaction as well as lateral displacement of the crushed stone in the surrounding soil by the typically shaped Geopier® tamper
- Low-vibration compaction process by means of vertical force application during installation of piers. The measurements during the construction process showed that the recorded values comply with the boundary values of DIN 4150, T.3 for the line 2 (housing). In particularly sensible areas, special solutions are to be carried out (e.g. plastered piers).

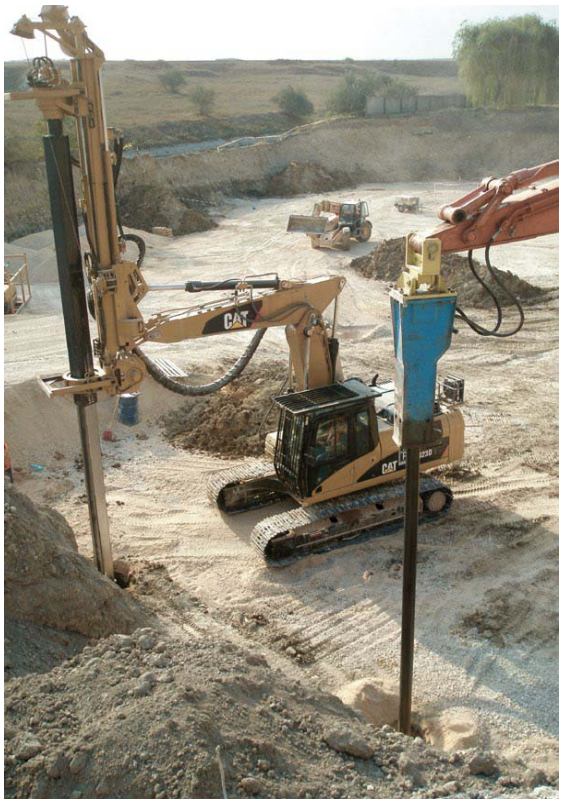


Fig 2 – Typical set of Geopier equipment

1.3 Characteristics of the piers

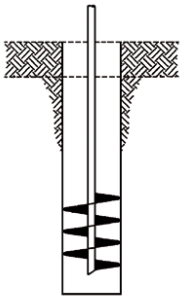
- Very dense core of the piers, high cohesive resistance and low deformation
- Creation of stiff piers with comparatively high bearing capacity of individual pier
- Development of a compacted area around the pier
- Load transfer via mantle friction
- Formation of “floating” piers possible

1.4 High profitability

- Utilization of mineral fill materials favors the consolidation and the reduction of interstitial water pressure. The Geopier® Rammed Aggregate Piers® are faster resilient and the footings can be built faster on top of them.
- Due to the considerable high bearing capacity of the Geopier® Rammed Aggregate Piers®, the amount of aggregate piers can be reduced compared to similar systems.

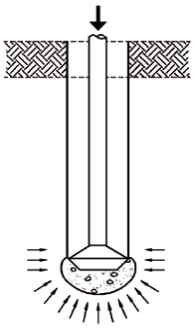
1.5 Installation

A. Boring of the pier shaft in the in-situ soil



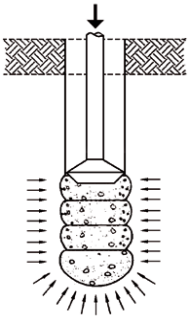
Diameter of the auger: 75 cm
Length of piers up to 7,5 m

B. Production of the bottom bulb with open-graded stone



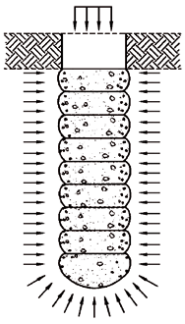
Layer of open-graded stone (e.g. 32/56)
Pressure build-up in combination with vibration

C. Insertion of the aggregate lifts



Layer of open-graded stone (e.g. 32/56)
Pressure build-up in combi-nation
with vibration
Crushed stone fines-chips-gravel
mixture (e.g. 0/32)
Compaction of each aggre-gate lift to a height of approx. 30 cm

D. Compaction of each lift with the Geopier® tamper



Compacted gravel bedding
The piers can get directly overbuilt
Defined lateral excrescence in each
lift due to the typically shaped
Geopier® tamper foot

1.6 Applications

- Industrial and residential buildings
- Bridges and civil engineering
- Warehouses and dispatch halls
- Wind turbines

- Transportation structures
- Slope stabilization
- Embankments
- Uplift and lateral load resistance
- Liquefaction mitigation
- MSE Walls
- Tanks

2. GEOPIER®IMPACT

2.1 Process features

The Impact® System uses vertical displacement Rammed Aggregate Pier® (RAP) elements to reinforce good to poor soils, including loose sands, silts, mixed soil layers, uncontrolled fill and soils below the ground water table.

2.2 Advantages of the Impact® System

Rammed. Vertically ramming thin lifts of aggregate is the key to providing strength and stiffness.

Strength. Vertical impact ramming results in high density and high strength RAP elements that provide superior support capacity.

Stiffness. Vertical impact ramming results in high pier stiffness that provides excellent settlement control.

Proven. Thousands of structures are currently supported – proven experience that ensures high levels of performance and reliability.

Economical. Often results in 20% to 50% savings compared to traditional deep foundation alternatives.

Fast. Rapid installation process means shorter construction schedules.

2.3 Characteristics of the piers

- Very dense core of the piers, high cohesive resistance and low deformation
- Creation of stiff piers with comparatively high bearing capacity of individual pier
- Development of a compacted area around the pier
- Load transfer via mantle friction
- Formation of “floating” piers possible

2.4 High profitability

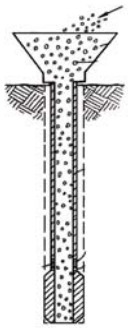
- Utilization of mineral fill materials favors the consolidation and the reduction of pore water pressure. The Geopier® Impact® Rammed Aggregate Piers® are faster resilient and the footings can be built faster on top of them.
- Due to the considerably high bearing capacity of the Geopier® Impact® Rammed Aggregate Piers®, the amount of aggregate piers can be reduced compared to similar systems.
- Dewatering costs may often not apply unlike other procedures.

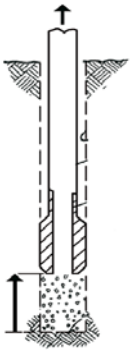
2.5 The Construction Process

The unique installation process displaces soil during installation and utilizes vertical impact ramming energy to construct RAP elements, which exhibit unsurpassed strength and stiffness. RAP solutions are designed to provide total and differential settlement control and increase bearing support to meet project requirements.

1. The cavity is created to full depth by driving a specially designed mandrel and tamper foot using a large static force augmented by dynamic vertical impact energy. Tamper foot diameters vary from 12 to 16 inches

and depths normally range from about seven to 35 feet, depending on design requirements, longer depths are possible. This method eliminates spoils as all penetrated soils are displaced laterally. A sacrificial cap prevents soil from entering the tamper foot and mandrel.

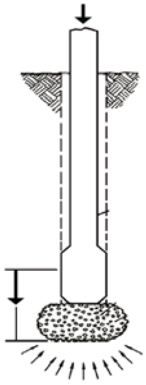


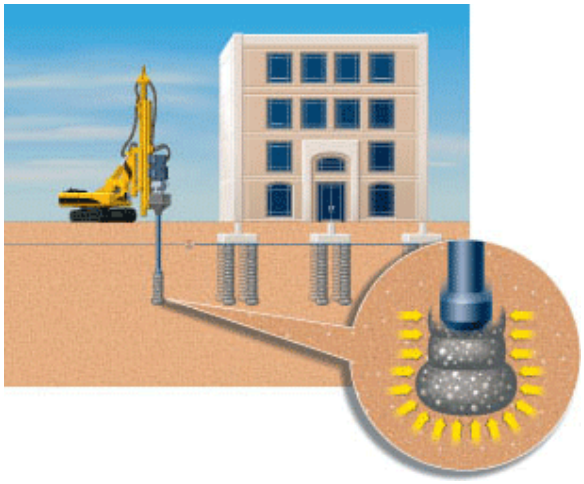


2. After driving to design depth, the hollow mandrel serves as a conduit for the placement of aggregate. The aggregate is placed inside the mandrel and the mandrel is lifted, leaving the sacrifical cap at the bottom of the pier. The tamper foot is lifted approximately three feet and then driven back down two feet, forming a one-foot thick compacted lift.

Compaction is achieved through static force and dynamic impact energy from the hammer. The hammer densifies aggregate vertically and the beveled tamper foot forces aggregate laterally into cavity sidewalls. This results in excellent coupling with surrounding soils and reliable settlement control with superior strength and stiffness.

3. Following installation, RAP elements reinforce slopes and embankments, support shallow foundations, floor slabs and tank pads. The footing stresses are attracted to the stiff RAP elements, resulting in engineered settlement control.





1.6 Applications

Rammed Aggregate Pier® (RAP) Systems were developed to be efficient and cost effective intermediate foundation solutions for the support of settlement sensitive structures. These systems have since become effective replacements for massive overexcavation and replacement or deep foundations, including driven piles, drilled shafts or augered cast-in-place piles.

Our engineers work directly with the project team to develop project-specific solutions for many applications, including:

- Foundation Support
- Wind turbines
- MSE Walls and Embankment Support
- Slope Stabilization
- Floor Slab Support
- Tank Support
- Liquefaction Mitigation
- Uplift and Lateral Load Resistance

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