CNC®
FOUNDATIONS

AGGREGATE PIERS

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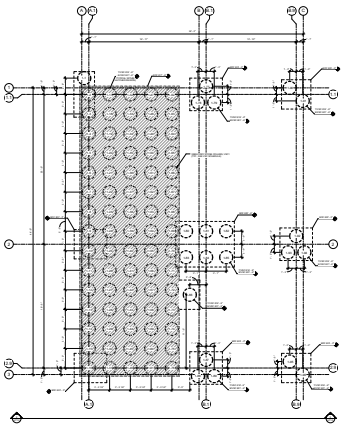
BUILDING AMERICA ... ONE STONE COLUMN AT A TIME.™

INSTALLATION

Aggregate Piers / VSCs are compacted columns of stone that are installed through existing soils to improve the geotechnical properties of the soil matrix.

Sometimes referred to as Vibratory Stone Columns or VSCs, consist of a series of vertical lifts of compacted rock from a pre-determined depth up to the ground surface. They are installed utilizing a specialized vibratory probe called a “vibroflot”. This vibroflot is employed to create a hole down to a specific depth, aggregate is then introduced, and the vibroflot compacts the rock. The aggregate introduction/compaction process repeats until a dense column of aggregate is built up to the ground surface.



The preliminary layout of Aggregate Piers is shown to the left for a Waste Water Treatment Plant in Kansas City.

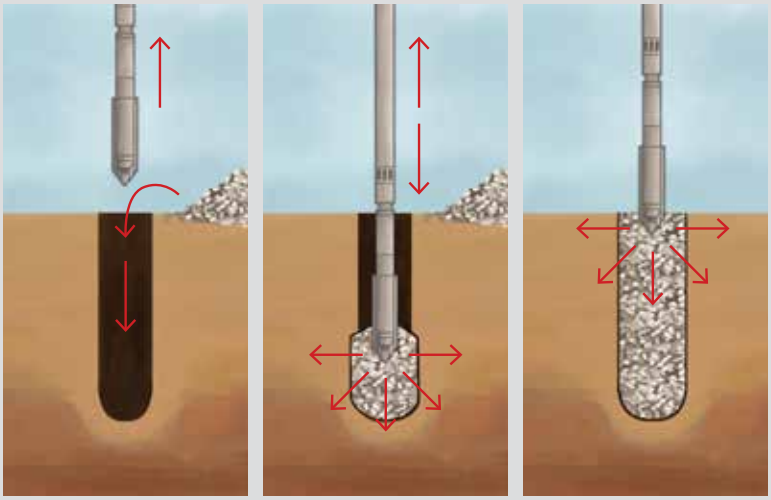
Above: Our DeepFeed Aggregate Pier system is a direct-push, bottom feed installation method and allows the Aggregate Piers to be pushed to depths of more than 40 feet. Shown at a multi-family apartment building site in St. Paul, MN.

Top Feed Method

This method (shown below) is primarily used in cohesive soils capable of staying open throughout the construction process. The vibroflot is used to create an open hole in the existing soil down to a pre-determined depth. This can also be accomplished through predrilling.

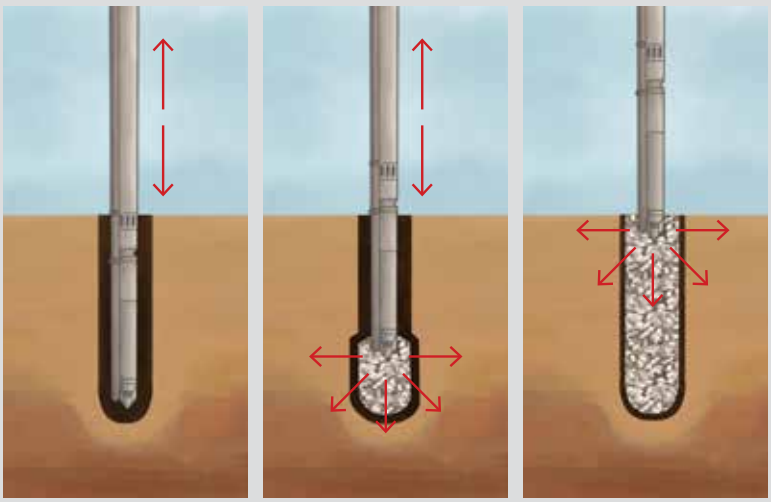
The vibroflot is retracted and a specific quantity of rock is introduced at the ground surface into the open hole. The vibroflot extends down and compacts the aggregate. The aggregate is forced down and out laterally into the soil mass.

The process repeats until the open hole is transformed into a continuous compacted column of aggregate.

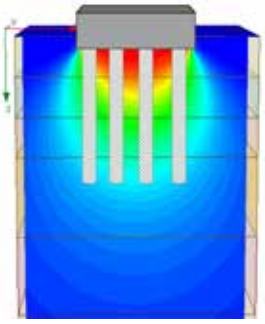


Bottom Feed Method

This method is utilized in collapsible soils, such as sands and silts where a pre-bored hole would not stay open. The vibroflot penetrates down to a pre-determined depth. Once there, aggregate is introduced at that depth through a feeder tube, which is connected to the vibroflot assembly. The aggregate is compacted in a series of vertical lifts from the base of the hole up to the ground surface.

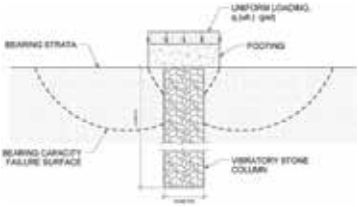


APPLICATIONS



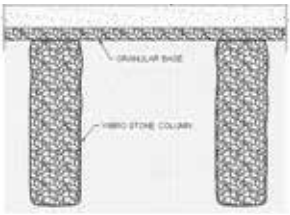
Settlement Control

In many cases, design is controlled by the maximum allowable settlements. Aggregate Piers decrease the maximum potential settlements by installing a series of very stiff elements (high modulus) in granular soils, directly increasing the stiffness of native soils. The stone columns also provide a drainage path allowing pore water pressures generated by the applied loads to dissipate more rapidly, reducing the time rate of settlement and accelerating the construction process.



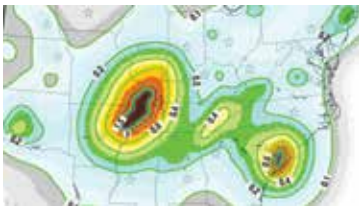
Increased Bearing Capacity

Aggregate Piers increase the composite shear resistance of the soil matrix, increasing the allowable design load which can be used in supporting a foundation. Typical bearing capacities for cohesive soils reinforced with Aggregate Piers range from 1,500 psf to 6,000 psf. In granular soils typical values range from 1,500 psf to 8,000 psf.



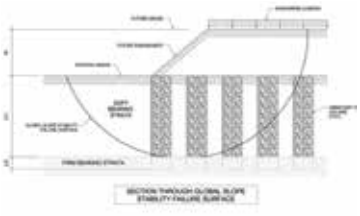
Floor Slabs

Aggregate Piers can be used to reduce both total and differential settlements. They can also be used to mitigate the risks associated with undocumented fill and marginal soil deposits eliminating the need for expensive over-excavation options below the slab.



Liquefaction Mitigation

Aggregate Piers will reduce the potential for liquefaction in silt and sand deposits during dynamic loading that occur during earthquake events. The aggregate pier installation process will densify the soils, provide drainage to reduce pore water pressure, and reinforce the soil matrix reducing the soils potential for liquefaction and minimizing the total settlement potential.



Global Stabilization

Aggregate Piers can provide a cost effective method for the reinforcement of soils underlying embankment and MSE walls to prevent a global stability failure.

FOUNDATION STABILIZATION

Washington, D.C.
Commercial Mixed-Use Building

OVERVIEW A commercial mixed-use building in downtown Washington, D.C., needed Aggregate Piers to stabilize its foundation. The project had several challenges, including the presence of an adjacent tieback wall underlying the proposed Aggregate Pier improvement area.

The 25-foot tieback wall necessitated quick-reaction adjustments in the Aggregate Pier layout in the overlapping area to prevent damage to the tiebacks, which could have been catastrophic to the shoring wall. A buried storage tank's position also threatened to slow down the project.

REQUIREMENTS AND CHALLENGES We worked with the General Contractors and Subcontractors to navigate the tieback wall issue so the columns didn't harm it. When we discovered the storage tank, we worked elsewhere on the site and allowed another team to dig it out. No time was lost after the tank was discovered and removed from the site.

SOLUTIONS AND RESULTS Our team was able to complete the stone column installation smoothly and stayed within the project's budget and timeline. The general contractor would recommend CNC Foundations, and looks forward to our next project together.

LIQUEFACTION

Southern California | Logistics Center

OVERVIEW The project was built on a site where the soils consisted of a mix of loose sands and soft clays extending to a depth of approximately 20 feet, with relatively dense soils below. Due to the high risk of seismic activity, the site's sandy soils were very susceptible to liquefaction.

Liquefaction is a term used to describe the loss of strength of a granular soil with vibrations typically associated with earthquakes. It can cause large settlements and building failures, unless the proper ground improvement measures are taken.

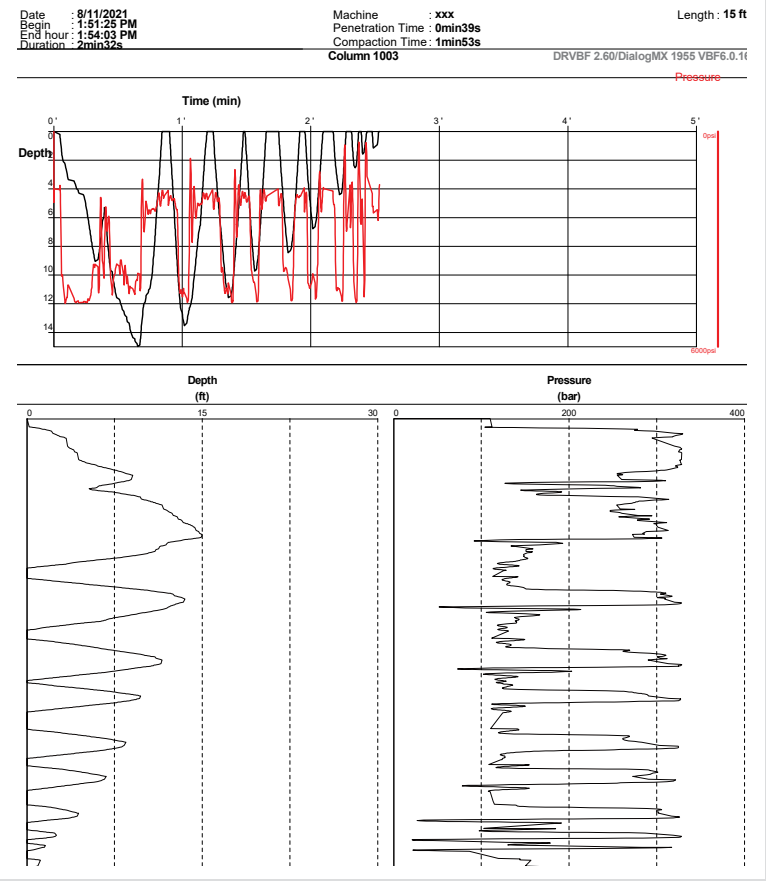
CNC Foundations installed Aggregate Piers to densify the loose soils, reduce the risk of liquefaction, and limit the extent of the damage that an earthquake could cause to the eventual structure.

SOLUTIONS AND RESULTS Aggregate Piers were chosen for their quick and efficient installation along with their flexibility to meet a variety of different needs. A portion of the site required predrilling the Aggregate Pier locations, as well as utilizing multiple installation methods to complete the project.

In addition to the liquefaction concerns, we provided an increased bearing capacity allowing for a more economical shallow foundation system to be used.

CNC Foundations utilizes full-time, state-of-the-art computer monitoring systems during Aggregate Pier installation.

This allows the operator to monitor the installation depth and compaction effort in real time, immediately identifying changes in site conditions and ensuring a consistent, uniform system of Aggregate Piers across the site. Additionally, data is used to provide accurate records of every Aggregate Pier that is installed. This installation data can be compared to the load test data verifying the capability of every Aggregate Pier installed.



The graph above shows the rig pressure (compaction effort) in red and the probe depth in black over a specific time period, and is part of our Closeout Document given to our clients at the end of each project.

Shown to the left is the on-board computer monitoring system.

ADVANTAGES

Aggregate Piers / VSCs are an economic alternative to deep foundation systems.

Additionally, there are many benefits to utilizing Aggregate Piers for Ground Improvement.

- Quick and efficient installation
- High production
- Generates minimal spoils
- Suitable for most soil types
- Significantly increases bearing capacity
- Quality control through use of a computer monitoring system

Efficient Alternative To:

- Deep foundations
- Removal and Replacement (Over Excavation)
- Surcharging the site
- Helical Piles
- Driven Piles
- Drilled Shafts
- Augercast Piles

Typical Uses

- Multi-story buildings
- Commercial centers
- Industrial facilities
- Liquid Storage Tanks
- Milling facilities
- Wind Towers and Farms
- Pre-Engineered Metal Buildings
- Grain Silos, Bins, and Elevators

Additionally, CNC Foundations can install vertical steel reinforcements to provide uplift resistance alongside standard Aggregate Pier installation. Uplift resistance can be achieved between 15k to 60k per Aggregate Pier, depending on the soil conditions.

FOUNDATION SUPPORT

South Texas | Wind Farm

OVERVIEW Wind turbines are mounted to towers and the tower height makes them susceptible to the force of the same winds powering the turbines. Towers will tip in the wind and the foundation must resist this force to stop the tower from rocking. The foundation must also stand up to elements such as earthquakes and other natural factors.

REQUIREMENTS AND CHALLENGES The large overturning moments caused by the wind can lead to differential settlement problems in soft soil and they require additional foundation support. That is where our services with Aggregate Piers make their impact. Our certified operators installed Aggregate Piers through soft clay and loose sand up to 18 feet below the bottom of the base at 13 turbine locations. The purpose of the Aggregate Piers was to control total settlement of the wind turbines and minimize differential settlements expected from the large overturning movements so the turbines can perform as planned.

Due to the depth of wind turbine foundations, we developed a specific load testing process to measure the modulus of the Aggregate Pier within the zone of soil below the final turbine foundation bearing elevation. This custom procedure consists of installing a sacrificial test outside the turbine footprint and a concrete-filled sonotube shaft to the bottom of foundation elevation. This enables the Aggregate Piers to be tested at the final elevation to provide the best representation of their long-term performance.

SOLUTIONS AND RESULTS CNC Foundations developed a detailed testing Quality Assurance/Control plan to ensure the full-scale modulus test at each turbine installed and the piers performed consistently. This sequence not only qualifies our design, but is performed to keep the project on schedule and includes the Closeout Document Process. As part of CNC Foundations' quality control plan is the reassurance from our closeout document process to provide the client with the Aggregate Pier logs, test results, and as-built drawings within 48 hours of completing each turbine.

HEAVY FOUNDATIONS

Wisconsin | Food Manufacturing Facility

OVERVIEW Our client was a food manufacturing facility in Wisconsin. The project required the ground be improved to allowable bearing pressure of 10,000 pounds per square foot (PSF) to support the building size and all the manufacturing equipment inside. This project had a tight timeline and a highly structured 10-week build schedule for ground improvement Additionally, the project came with difficult soil conditions and rigid oversight. CNC Foundations needed to navigate these challenges to complete the project on time and within budget.

REQUIREMENTS AND CHALLENGES We used Aggregate Piers to provide heavy foundation support. Our team installed the Aggregate Piers 30+ feet deep to limit total differential settlement to less than a half inch. CNC Foundations worked through winter weather December until February. Three crews and rigs were utilized to meet the project's schedule.

SOLUTIONS AND RESULTS We completed the project two and a half weeks ahead of schedule, subsequently we have done multiple projects across the country for this client. The general contractor was very happy with the results and reached out to compliment our on site team and our project management processes.

LOAD TESTING

Full Scale Load Test

Full scale testing consists of applying a pre-determined load directly to the aggregate pier. Either the installation rig or a specified series of reaction piles are installed along with a load beam to achieve the required reaction. The pre-determined (specified) load is incrementally applied to the aggregate pier with the deflection monitored and documented to verify the design pier stiffnesses in the field. CNC Foundations typically tests to 1.5 to 2 times design load.

Tension Test

Uplift anchors consist of steel reinforcement within an aggregate pier or concrete column and extended up into the foundation. These are installed in the field to address uplift requirements. Similar to the load testing, these anchors will be tension tested in the field to verify the anchors load carrying capacity.

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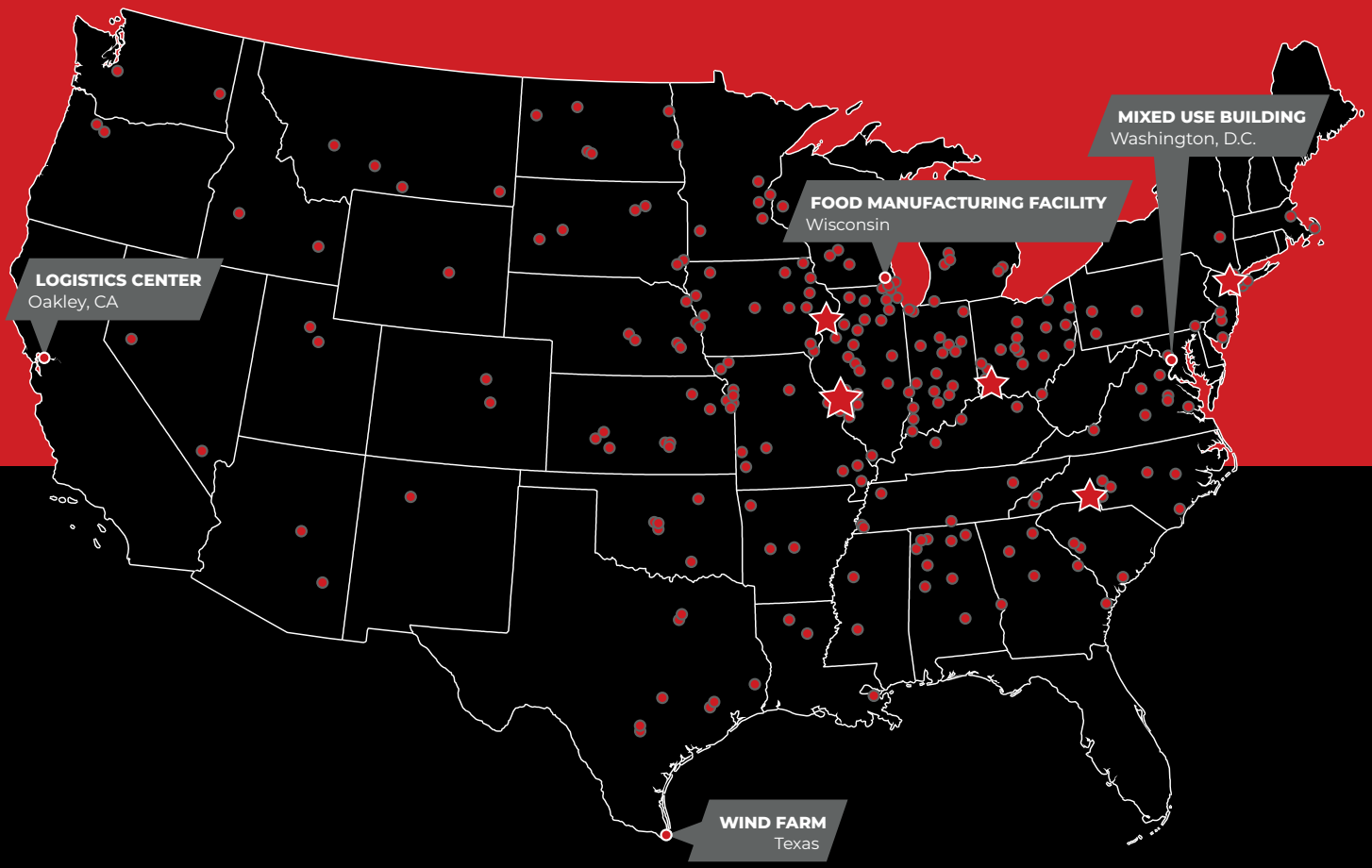

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