CNC®

FOUNDATIONS

AGGREGATE PIERS / VSCs

1ST CHOICE™

30+ YEARS SINCE 1987™

GROUND IMPROVEMENT

AGGREGATE PIERS / VSCS

INSTALLATION

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 bore a clear hole in the existing soil down to a pre-determined depth. An open borehole 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 rock. The stone is forced down and laterally into the soil mass.

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

Top Feed Method (above) at Pulliam Square Apartment Complex in Indianapolis, Indiana.

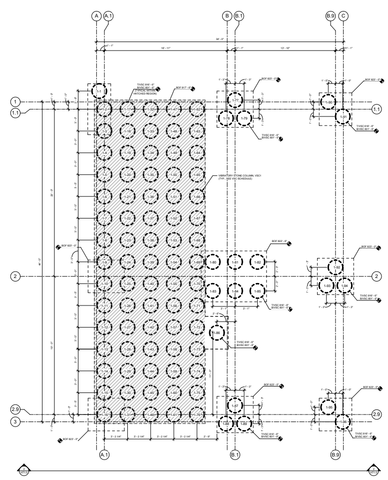
Bottom Feed Method

This method (shown to the right) 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.

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

Aggregate Piers (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 utilized to create a bore 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 rock is built up to the ground surface.

VSCs have successfully been used to increase bearing capacity, reduce settlement, provide slope stabilization, and mitigate liquefaction. They are currently one of the most commonly used ground improvement systems in the world today.

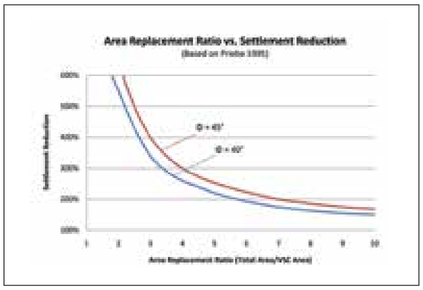


The preliminary layout of Aggregate Piers is shown to the left for the Todd Creek Waste Water Treatment Plant in Kansas City, Missouri.

Above: Our DeepFeed VSC system is a direct-push, bottom feed installation method and allows the vibratory stone columns to be pushed to depths of more than 40 feet. Shown at a mult-family Apartment Building site in St. Paul, MN.

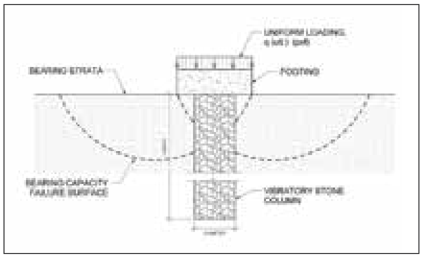
Urea, Ammonia, and Nitrogen Tanks, Fertilizer Plant in Wever, Iowa

APPLICATIONS



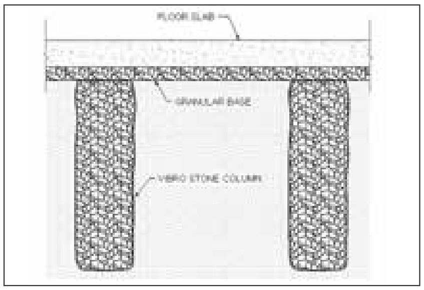
Settlement Control

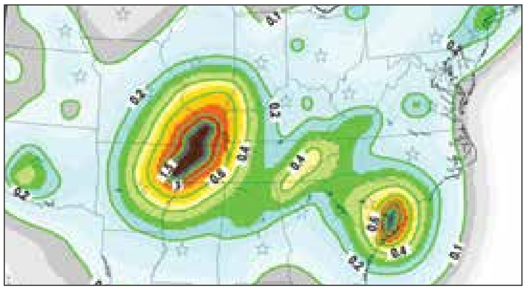
In many cases, design is controlled by the maximum allowable settlements. VSCs decrease the maximum potential settlements by installing a series of very stiff elements (high modulus) in granular soils, directly increasing the stiffness of native soils. The chart to the left depicts the reduction in settlement vs. the replacement ratio, as a function of the internal angle of friction of the VSC. 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.

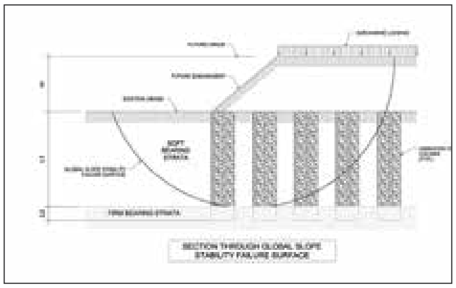


Increased Bearing Capacity

VSCs increase the composite shear resistance of the soil matrix, increasing the allowable design load which can be used in foundation design. Typical bearing capacities for cohesive soils reinforced with VSCs range from 2,000 psf to 5,000 psf. In granular soils typical values range from 3,000 psf to 7,000 psf.







Floor Slabs

VSCs can be used to reduce both total and differential settlements and provide additional slab support. Stone columns may eliminate the need for thicker, more heavily reinforced slabs, as well as removal and replacement of the underlying marginal native soils below the slab.

Liquefaction Mitigation

VSCs will reduce the potential for liquefaction in silt and sand deposits during dynamic loading and earthquake events. The stone columns will densify the soils, increase the shear strength of the soil matrix, and provide drainage to reduce the amount of pore water pressure developed during a seismic event to mitigate liquefaction.

Global Stabilization

VSCs can provide a cost effective method for the reinforcement of soils underlying embankments to prevent a global stability failure. The illustration depicts a typical slip plane associated with a global stability failure that has been reinforced with VSCs.

Advantages

Aggregate Piers / VSCs are an economic alternative to deep foundation systems. Additionally, there are many benefits to utilizing VSCs for Ground Improvement.

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

Efficient Alternative

- Deep foundations
- Removal and replacement
- Surcharging the site
- Engineered fill
- Pre-loading of building site
- Driven Piles
- Drilled Shafts
- Augercast Piles

Typical Uses

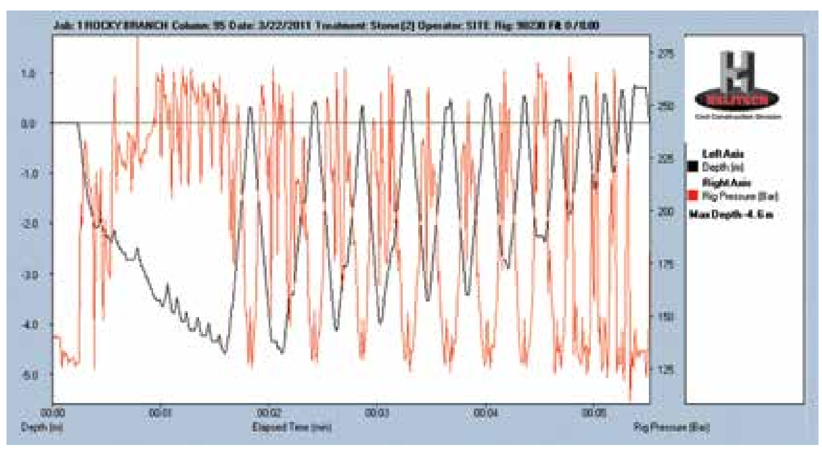
- Multi-story buildings
- Commercial centers
- Industrial facilities
- Liquid Storage Tanks
- Milling facilities
- Wind Towers and Farms
- Pre-Engineered Metal Buildings
- Grain Silos, Bins, and Elevators
- Uplift Resistance

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

Convention Center in Cedar Rapids, Iowa

CNC Foundations utilizes a 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 VSC. Additionally, this data is used to provide accurate records of every stone column that is installed. This installation data can be compared to the load test data verifying the load carrying capability of every VSC installed.



The graph above shows the rig pressure (compaction effort) in red and the probe depth in black over a specific time period.

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

Private Apartment Building, Chicago, Illinois

LOAD TESTING

Full Scale Load Test

This test allows a pre-determined load to be applied directly to the stone column. A series of reaction piles are installed along with load beams to achieve the required load. Depending on the project requirements, this test enables a single VSC to be tested or a series of VSCs to be tested simultaneously. A pre-determined, specified load is applied to the VSC, monitored and documented. Depending on the type of reaction piles installed and the soil type, the reaction piles can often be removed after the load test is completed.

Enclave MSE Wall in Edwardsville, Illinois

Plate Load Test

This test is one of the most common tests performed on VSCs. The VSC rig is utilized to perform an abbreviated load test. Using a hydraulic jack, the load is applied in increments and the deflection is monitored to evaluate workmanship, estimate the modulus, and for comparison to the full scale load test.

Missouri University Chiller Plant in Columbia, Missouri

Tension Test

Uplift anchors, consisting of a steel plate, are installed near the base of the Vibratory Stone Column, with a threaded bar extending up into the foundation. These can be installed and tested in the field to address uplift concerns.

PROJECT CASE STUDIES

UAN Tanks in Wever, Iowa

Three UAN (Urea, Ammonia, and Nitrogen) Tanks, 176 feet in diameter, were being constructed in an agricultural area for a new Fertilizer Plant. The tanks were designed for a maximum settlement of two inches at the edge of the tanks. It was estimated that the total settlements on the order of six to eight inches would occur if no ground improvement was performed.

Approximately 6,000 Aggregate Piers / VSCs were to be installed through the upper soft soil stratum to the dense sands approximately 20 feet below sub-grade to meet the project requirements.

Due to a very wet spring season, job site preparation was delayed which initially put the project two weeks behind schedule when CNC Foundations was finally able to proceed. To accommodate the General Contractor and get the project back on schedule, we added a second VSC rig and crew to the site. This allowed us to make up the lost time and get the project back on schedule.

In spite of the initial start date, the entire project was still completed two weeks prior to the original date committed to by the General Contractor.

Cummins Automotive in Seymour, Indiana

Two areas of an 89,354 square foot, two-story building required ground improvement to 4,000 psf within an office area and 5,000 psf within the manufacturing space. Beneath the office area was an organic soil layer issue 20 to 25 feet deep.

For the manufacturing area, CNC Foundations installed approximately 750 Aggregate Piers/VSCs 12 feet deep. For the office space, CNC Foundations installed approximately 200 Vibratory Stone Columns 35 feet deep. Both areas had less than three-fourths an inch of total settlement and less than half an inch of differential settlement.

CNC Foundations validated the design and installation by performing full scale load tests and plate load tests. The project was completed one week ahead of schedule.

Costco in East Peoria, Illinois

A 143,000 square foot retail warehouse for a wholesale store was proposed at a large retail center. The building is a concrete masonry unit, approximately 30 feet high, supported by conventional spread footings. The Geotechnical investigation found the soil to be unsuitable for spread footing construction.

The soils were found to be an existing fill with cobbles and old foundations, and clay from approximately nine to 25 feet, and then clayey sand down to 45 feet.

The Geotechnical Engineering firm recommended one of the following: removing and replacing the soil with compacted fill, preloading the site, augur cast piles, or Aggregate Piers/VSCs. The City of East Peoria found that partnering with CNC Foundations to install Aggregate Piers was the most cost efficient and time saving solution to improve the building pad.

Because of the unsuitable existing fill throughout the project site, CNC Foundations was asked to support the strip footings, columns footings and slabs with Aggregate Piers to keep the total settlement to less than one inch.

CNC Foundations installed over 1,700 Aggregate Piers throughout the job site. The depths of the Aggregate Piers ranged from ten feet deep to support the slabs, to 29 feet deep to support the column footings. Because of the loose sands and fill, CNC Foundations used the bottom feed method for a majority of the job site.

Multiple load tests up to 1.5 percent of the design load were performed and validated CNC Foundations's design. CNC finished the project on time and under budget.

Komatsu in Peoria, Illinois

A proposed new structure consisted of a 400x600 foot warehouse with column supports on a 40x40 foot grid. The new warehouse featured an open bay structure with lightly loaded columns and a floor slab supporting heavily loaded storage racks. Typical column loads being 56 kips, and rack loading on the floor slab in the range of 1,000 psf.

The existing soils consisted of fill material variable in depth across the project site, with a soft alluvial material underneath and extending to depths approximately 35 feet below ground surface.

Due to the variability in strength, depth of the fill materials, low strengths, and high compressibility of the alluvium material, significant differential settlement was expected in the column pads and slab.

A CNC-designed aggregate pier system was selected as the best possible way to minimize differential and long-term settlement.

On-site testing verified design and confirmed minimum differential and long-term settlement.

Courthouse in Hanover, Virginia

A new courthouse complex for Hanover County in Virginia was proposed to be three stories tall and over 115,000 square feet. The unique building plans included a partial basement and prisoner transport tunnel.

The design requirements were 5,000 psf with one inch of total settlement and half an inch of differential settlement. Stone Columns were required to support all column, wall, and retaining wall footings, as well as the elevator pit walls. Additionally, 30 kip uplift anchors were needed for support.

CNC Foundations installed approximately 1,500 Vibratory Stone Columns, with depth ranging from ten to 25 feet. CNC Foundations also installed ten uplift anchors on the building, which were tested the anchors to 32 kips.

The stone column design and installation was validated by performing a full scale load test and three plate load tests. CNC Foundations was able to complete the project a full week ahead of schedule and under budget.

The Ohio State University in Columbus, Ohio

A residential housing design consisting of six new residential buildings was proposed on a site with poor upper soils. Three of the new buildings required a 7000 psf bearing pressure. In order to reach this bearing pressure, CNC Foundations was selected to install an Aggregate Pier/VSC Ground Improvement design.

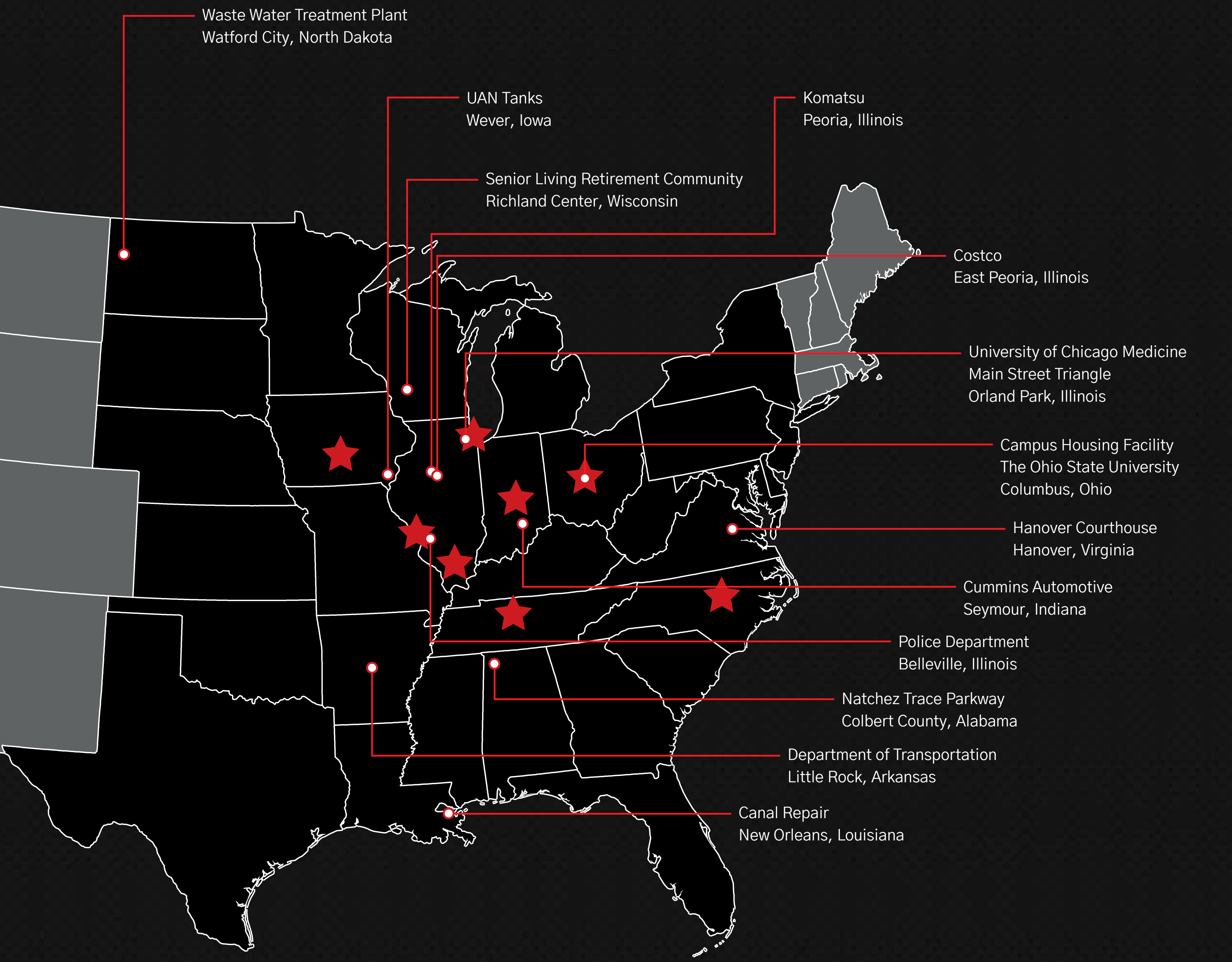
In addition to the poor soils, there were many project challenges, including a shale shelf that ran through site from two to ten feet below bottom of footing.

Access was limited not only due to the tight urban setting, but there were four additional buildings being constructed simultaneously alongside CNC's job site. This affected the daily delivery of rock for the aggregate columns.

CNC Foundations worked to install approximately 1,000 Aggregate Piers to meet the design requirements of 7000 psf with less than one inch of total settlement, and less than a half an inch of differential settlement. CNC Foundations validated the design and installation by performing full scale load tests and plate load tests.

Additional project profiles

For additional information and project profiles, visit our case study page on our website at cncoundations.com/case-studies/



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