

# Special Specification 4083

## Rammed Aggregate Piers



### 1. DESCRIPTION

Furnish and install rammed aggregate in an excavated hole using special high-energy impact densification equipment. Construct the piers in accordance with these specifications and in accordance with the lines, design, and dimensions as shown on the plans for walls and embankments or as established in writing by the Engineer. This work can be accomplished by one of the following specialty Contractors:

- Peterson Contractors, Inc.  
104 Blackhawk Street  
Reinbeck, Iowa 50669  
(319) 345-2713
- GeoStructures, Inc.  
413 Browning Ct.  
Purcellville, Virginia 20132  
(443) 949-2260
- Farrell Design-Build  
3025 Venture Road  
Placerville, California 95667  
(530) 621-4867

The use of other specialty Contractors or Subcontractors than those listed in the special specification is allowed. However, before being selected for the work, ensure the alternate specialty Contractors or Subcontractors submit documentation to the Engineer for review and approval, demonstrating their experience with rammed aggregate piers, dependability of the equipment and techniques to be used, and the proposed work plan.

Make arrangements with the specialty Contractor for the expertise and services necessary to perform the work under this item.

Key aspects of the work to be performed or furnished by the Contractor include, but are not limited to, the following:

1. Coordinate with relevant utility companies to avoid damage to utilities including, but not limited to, sewer, gas, water, and telecommunication lines.
2. Construct rammed aggregate piers of diameter, spacing, and meeting the design criteria shown in the contract plans and approved shop drawings.
3. Lay out the rammed aggregate piers in accordance with the contract plans and approved shop drawings.
4. Provide appropriate equipment and experienced operators for the installation of the rammed aggregate piers. Experienced operators are defined as operators who have 5 years of method specific experience.
5. Furnish select granular material for the rammed aggregate piers.
6. Conduct testing of the rammed aggregate piers by modulus testing and Standard Penetration Test (SPT) as discussed in Section 4. CONSTRUCTION.

7. Control and dispose of water resulting from rammed aggregate pier construction operations. Comply with all local, state and federal environmental requirements.
8. Furnish and install a granular drainage blanket and separation geotextile as shown in the contract plans.
9. Demobilize the equipment and clean up the site.
10. Installation and Work Plan. Submit construction shop drawings showing rammed aggregate pier locations, depths, and identification numbers. Provide a description of the equipment and detailed construction procedures to be used for constructing the rammed aggregate piers including the plan for disposing of water during construction. Submit the source of the proposed rammed aggregate pier select granular material and the proposed gradation. As part of the installation and work plan, the Contractor/Sub-Contractor shall submit the name of key contact, experience record, and resume of the operators. Related work shall not begin until the submittals have been received, reviewed, and accepted in writing by the Engineer. The Contractor shall allow the Engineer fourteen (14) calendar days to review the submittals after the complete final set has been received. Additional time required due to incomplete or unacceptable submittals shall not be cause for delay or impact costs.

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## 2. MATERIALS

Furnish crushed stone, gravel or recycled concrete for the rammed aggregate piers. Provide crushed stone, gravel or recycled concrete that is clean, hard, and free from organics, trash or other deleterious materials. Use crushed stone, gravel or recycled concrete that conforms to the following limits as determined by Test Method Tex-110-E. This gradation does not apply to stone used to construct the rammed aggregate pier bottom bulb.

Table 1

Sieve Size	Percent Passing
1-1/2 in.	100
1 in.	90 - 100
3/4 in.	20 - 55
1/2 in.	0 - 10
3/8 in.	0 - 5

Variation of the above gradation may be acceptable with prior approval of the Engineer.

Use stone meeting the Tex-410-A, Abrasion, and Tex-411-A, Soundness requirements as stated in Item 421, "Hydraulic Cement Concrete."

Use of open-graded stone, such as ASTM No. 57 stone is acceptable in the bottom bulb of the rammed aggregate pier in order to stabilize the base of the element or if groundwater is encountered in the hole.

Granular Drainage Blanket. Provide material meeting Drainage Aggregate, Item 423 to the thickness shown on the plans.

Separation Geotextile. Provide material meeting TxDOT DMS 6200 Type 2.

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## 3. EQUIPMENT

Provide equipment capable of producing and complying with the following:

- Employ special high-energy impact densification apparatus to densify the rammed aggregate pier elements during installation. Use an apparatus with a breaker and tamper to apply direct downward

impact energy to each lift of aggregate. Apply a minimum tamper energy CMIA rating of 1500 foot-pounds by the energy source.

- Use a beveled tamper to perform densification. Use a tamper foot of at least 25 inches in diameter for a 30-inch diameter pier. Bevel the tamper foot to impart lateral stress into the stone and matrix soil during installation.
- Use 30-inch diameter drilling equipment to drill holes for rammed aggregate piers. Provide drilling equipment capable of drilling through the soils anticipated for this project.

#### 4. CONSTRUCTION

Prior to the installation of production rammed aggregate piers at each wall site and each embankment site where rammed aggregate piers are shown in the plans, install four test piers as directed within the rammed aggregate pier layout pattern shown in the rammed aggregate pier plans. The purpose of these test piers is to establish site-specific installation and construction control procedures to be used in the production work at each site. Test piers shall be located within the area of the deepest rammed aggregate piers at each site, as approved by the Engineer. Perform a modulus test on one of the installed test piers to evaluate the stiffness and verify the design criteria requirements shown on the plans of the rammed aggregate pier. Perform the modulus test in general accordance with ASTM D-1143 and in accordance with Geopier Foundation Company, Inc. modulus test procedures (Fox and Cowell, 1998), or other approved test procedure to verify design criteria requirements.

In addition to installing four test rammed aggregate piers and performing modulus testing at each site, perform Standard Penetration Tests (SPTs) in the presence of the Engineer through the center of two of the test piers to verify the consistency of density of the pier throughout the entire length. Maximum interval between SPTs is 2.5 feet. Testing of the matrix soil to verify improvement of the matrix soil is not an acceptable quality control method. The Engineer shall approve the initial rammed aggregate piers and results of the modulus testing and SPTs prior to proceeding with the installation of production rammed aggregate piers. The SPT hammer shall have been calibrated in accordance with ASTM D4633 within the past 24 months.

Perform SPT testing on production rammed aggregate piers as quality control and assurance at pier locations and intervals as directed by the Engineer.

Install rammed aggregate piers by first augering to the design depth. If augering results in sidewall instability, temporary casing or biodegradable drilling fluid may be used to maintain stability during the installation process. Densify the bottom of the drilled cavity prior to the placement of the aggregate. If wet, soft or sensitive soils are present at the bottom of the excavation, place open-graded aggregate as described above in Article 2, "Materials", and compact to stabilize the element bottom. Open graded aggregate used to stabilize the element bottom may serve as the initial lift. Add aggregate following the construction of the bottom bulb. Tamp each lift of aggregate for a minimum of 10 seconds. Compact in approximately 12-inch lift thicknesses. Apply downward pressure to the tamper shaft during tamping. Construct rammed aggregate pier to the bottom of granular drainage blanket.

Provide competent and qualified personnel to continuously observe rammed aggregate pier installation and furnish to the Engineer recorded logs of the following data obtained during pier installation:

- Rammed aggregate pier reference number.
- Rammed aggregate pier length and drilled diameter.
- Elevation of top and bottom of each rammed aggregate pier.
- Number of lifts and average lift thickness for each rammed aggregate pier.
- Soil types encountered at the bottom and along the shaft of the rammed aggregate pier.
- Depth to groundwater, if encountered.
- Documentation of any unusual conditions encountered.
- Type and size of densification equipment used.
- Results of SPT testing

In the event that subsurface obstructions are encountered during construction of a rammed aggregate pier that cannot be penetrated with reasonable effort by the drilling equipment, the obstruction may be removed or the rammed aggregate pier may be installed from the obstruction to the bottom of granular drainage blanket as directed. If obstructions are removed utilizing an excavator or other means by the Contractor, this will be considered beyond the scope of work and result in an add-on to the contract price. If the rammed aggregate pier is constructed from the obstruction to the bottom of granular drainage blanket, install a replacement rammed aggregate pier at another location as directed. The cost of the additional rammed aggregate pier is an add-on to the contract price.

Maintain the following tolerances:

Horizontal: Center of the completed rammed aggregate pier shall be within 8 inches of the plan location.

Vertical: Completed rammed aggregate pier shall not deviate more than 2 inches in 10 feet from the vertical as indicated by the tilt of the vibrator.

Diameter: Completed rammed aggregate pier diameter shall not be less than 10 percent below the plan pier diameter, unless excessive ground heave occurs due to the presence of unexpected stiff strata of soil. Such heave will be cause to allow a reduction in the pier diameter requirements as approved by the Engineer.

If any pier falls outside these tolerances, an additional rammed aggregate pier will be required to be installed at the Contractor's expense.

Granular Drainage Blanket and Separation Geotextile. Install the granular drainage blanket and separation geotextile to the limits shown in the plans. Compact the granular drainage blanket to a density of no less than 95 percent of the maximum. Install the separation geotextile in accordance with the manufacturer's recommendations.

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## 5. MEASUREMENT

The accepted quantity of rammed aggregate piers will be measured by the foot of rammed aggregate piers complete in place. Measurement will be from the bottom of each pier to the bottom of the granular drainage blanket. Rammed aggregate piers installed above this elevation will not be measured for payment. If satisfactory founding material is not encountered at plan bottom elevation, adjust the bottom of the pier or alter the foundation, as determined by the Engineer, to satisfactorily comply with design requirements. Measurement will be to the nearest one (1) ft.

Estimated quantity of granular drainage blanket associated with rammed aggregate piers at each site is included in the summary of quantities for contractor's information only. No actual measurement will be made.

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## 6. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided in "Measurement" will be paid for at the unit price bid for "Rammed Aggregate Piers" of the specified diameter. This unit price bid is full compensation for excavating and backfilling rammed aggregate pier holes; for providing records and logs; for conducting modulus tests and SPT tests on rammed aggregate piers; for removing and disposing of any excavated or augered materials from rammed aggregate pier holes, and for providing all labor, backfill stone, tools, equipment, materials, water, power, temporary casing, and incidentals.

Granular Drainage Blanket. All costs associated with and incidental to furnishing, delivering, and placing the granular drainage blanket including the separation geotextile shall be considered subsidiary to bid item

"Rammed Aggregate Piers". No separate payment will be made for granular drainage blanket placed to the lines and thickness shown on the contract plans.