S T A T E **O F** **T E N N E S S E E**

Rev. 8-21-17 January 1, 2015

SPECIAL PROVISION
REGARDING
AGGREGATE FOUNDATION SYSTEMS

626.01 Description – This work shall consist of the design, furnishing of materials and the construction/installation and testing of aggregate foundations, consisting of either stone columns or aggregate piers. The intent of the aggregate foundations specified herein is to provide sufficient soil reinforcement and/or soil densification (i.e. global slope stability, bearing capacity, settlement) within the limits indicated on the contract documents to achieve the degree of improvements required to meet the performance criteria stated in the contract documents.

626.02 Method – Stone columns or aggregate piers shall be designed and constructed for the aggregate foundations based upon the soil information provided in the contract documents, the Contractors expertise, and other factors. The Contractor shall be responsible for all aspects of the design of the aggregate foundation system selected and meeting the performance requirements specified in the contract documents, including any grading deemed necessary by the contractor to prepare the project site for the aggregate foundations.

If the Prime Contractor does not possess the capability or expertise to design and/or install the aggregate foundations, as stated herein, or they select a system that is considered proprietary, they shall make arrangements to contract the services of a licensed Contractor or other qualified personnel, who meet the requirements stated herein, to perform the design and/or installation. All aggregate foundation improvement documents shall be signed and sealed by a Professional Engineer licensed in the State of Tennessee. The procurement of any permits required for the installation of the aggregate foundations, including the disposal of any water or spoils, shall be the sole responsibility of the Contractor.

626.03 Qualifications of Designer/Installer – The Contractor performing the work described herein shall have personnel on-site (engineer, operator, and/or foreman or superintendent) experienced in the aggregate foundations being installed. This work shall be performed under the supervision of the Contractors superintendent, who is knowledgeable and experienced in the method of constructing

aggregate foundations as required by the project. The Contractors equipment shall have the capacity to undertake the work and shall be sufficient to complete the work within the specified contract time.

The Contractor selected for this project shall meet the following criteria:

1. A minimum of five (5) years of experience in the selected aggregate foundation system design and installations.
2. At least one (1) registered Professional Engineer licensed to perform work in the State of Tennessee. The Contractor shall assign an engineer to supervise the work with at least (3) years of experience in the design and installation of the selected aggregate foundations.
3. A superintendent or foreman with a minimum of two (2) years of experience in the supervision of the aggregate foundation. The contractor may not use consultants or manufacturers' representatives in order to meet the requirement of this section.
4. Evidence of successful design and installation of the selected aggregate foundation system, within the United States of America, under similar conditions on at least three (3) projects in the last three (3) years. This documentation shall contain at a minimum: name of client contact, address, and telephone number; location of project; contract value, description of aggregate foundations and use (i.e. slope stability, settlement, bearing capacity, etc.)

626.04 Design Requirements – The Contractor shall be responsible for ensuring that the size, pattern, depth and spacing of the aggregate foundations are adequate to provide the required global slope stability, bearing capacity and/or settlement. The contractor shall be fully responsible for all assumptions, made by the contractor in regard to the aggregate foundation system, the strength of the soil and rock, and all implications that the properties of the soil and rock have on the design, constructability and stability.

The design of the aggregate foundation system shall meet all requirements contained within the contract documents.

626.05 Submittal of Designs and Details– The Contractor shall submit the designs and details (Design Packet) for review and acceptance by the Engineer (Materials and Test Division) no less than sixty (60) calendar days prior to beginning construction of the aggregate foundations.

INITIAL SUBMITTAL

1. Work experience in accordance with required qualifications mentioned in Subsection 625.03 of this Special Provision.
2. The Contractor shall submit one (1) full size plan set and one (1) electronic copy (PDF) of the

design packet to the Engineer as an initial submittal. If clarifications are required, an email with an accompanying electronic file (PDF) will be sent to the Contractor for clarifications within 15 business days after the receipt of the initial submittal.

3. The Contractor will be allowed 5 business days for comments clarification after the initial comments have been received. The Engineer will be allowed 5 business days following the Contractors response to determine if further clarification is needed.
4. The Engineer will not approve the submittal of the design packet but will review the submittal for completeness.
5. The initial submittal shall be signed and sealed by a registered Professional Engineer licensed to perform work in the State of Tennessee.

FINAL SUBMITTAL

1. Once the Engineer informs the Contractor that the design packet is complete, the Contractor shall submit one (1) full size set and one (1) electronic copy (PDF) of the final approved set of plans.
2. The final submittal shall be signed and sealed by a registered Professional Engineer licensed to perform work in the State of Tennessee.

MINIMUM REQUIREMENTS OF THE SUBMITTAL OF DESIGN CALCULATIONS

1. Configuration of the Design Submittal
    a. The design packet shall contain in the title block the project number, county, foundation locations, initials of the preparer, contract number and page number. An index page shall be included to provide a list of the pages of the submitted design packet.
    b. The design packet shall include an explanation of the symbols on the calculations, a description of the computer program(s) used in the design, and at least one hand calculation documenting the computer program results. The design calculations shall indicate the target minimum replacement ratio and target minimum composite angle of internal friction at each section.
2. Diagrams of Critical Cross Sections
    a. The design packet shall include diagrams of the critical design cross section geometry including soils and rock strata, along with the locations, size and depths of the aggregate foundations.
    b. The design cross sections shall also include the critical slip surface shown where it will result with the minimum factor of safety.

3. Physical Properties of Rock and Soil

    a. The soil and rock properties, including shear strength, friction angle, cohesion and unit weights shall be shown for each soil and rock strata. Geotechnical information is provided in the contract documents.

4. Factor of Safety

    a. The comparison of the calculated factor of safety and the minimum required factor of safety shall be clearly shown in the design packet.

MINIMUM REQUIREMENTS OF THE SUBMITTAL OF AGGREGATE FOUNDATION DETAILS

1. Plan View of the Aggregate Foundations

    a. A plan view of the aggregate foundations shall be submitted. The following details shall be shown in the plan view:

        i. Identification numbers of the aggregate foundations;

        ii. A reference baseline;

        iii. Offset from the construction centerline or baseline to the aggregate foundations;

        iv. Size and alignment of aggregate foundations;

        v. Right-of-way and permanent or temporary construction easement limits, location of all known active and abandoned existing utilities, adjacent structures and other potential interferences;

        vi. The centerline of any drainage structures or drainage pipes located behind, within, or under the foundations.

2. Elevation View of Aggregate Foundations

    a. A drawing of the elevation view of the aggregate foundations shall be submitted. The following details shall be shown in the elevation view:

        i. Identification numbers of the aggregate foundations;

        ii. The elevation at the top and bottom of the aggregate foundations;

        iii. Size and alignment of the aggregate foundations;

        iv. Schematic and elevations of the structure, slope, etc. being supported by the aggregate foundation.

        v. The centerline of any drainage structures or drainage pipes located behind, within, or under the foundations.

626.06 Work Plan – The Contractor shall develop a work plan and submit the plan for review and acceptance to the Engineer no less than sixty (60) days prior to beginning construction of the aggregate foundations. The Contractor shall submit one (1) paper copy set and one (1) electronic copy (PDF) of the Quality Control Plan to the Engineer as an initial submittal. If clarifications are required, an email with an accompanying electronic file (PDF) will be sent to the Contractor for clarifications. Submittal clarifications and responses will follow same process as outlined in Subsection "626.05 Submittal of Designs and Details" The Work Plan shall provide detailed project specific information, including the following:

1. Work experience in accordance with required qualifications mentioned in Subsection 625.03 of this Special Provision, SP626.
2. List and size of all equipment and construction procedures to be used during installation;
3. The source of the proposed aggregate foundation backfill material and the gradation with tolerances the Contractor proposes to use. Upon approval of the backfill source and gradation, the contractor shall maintain this gradation throughout the aggregate foundation installation;
4. Details of the sequence and proposed schedule of aggregate foundation installation, including the anticipated order in which aggregate foundations will be constructed;
5. Details of excavation methods;
6. Designs of temporary embankment slopes and/or shoring deemed necessary by the Contractor;
7. Details on how water and spoils will be handled;
8. Other information shown in the Plans or requested by the Engineer.

626.07 Quality Control Plan – The Contractor shall develop a Quality Control Plan and submit the plan for review and acceptance to the Engineer no less than sixty (60) days prior to beginning construction of the aggregate foundations. The Contractor shall submit one (1) set and one (1) electronic copy (PDF) of Quality Control Plan to the Engineer as an initial submittal. If clarifications are required, an email with an accompanying electronic file (PDF) will be sent to the Contractor for clarifications. Submittal clarifications and responses will follow the same process as outlined in Subsection "626.05 Submittal of Designs and Details" The quality control plan shall include the following:

1. A proposed plan for quality control throughout the installation process;
2. Controls and measurements of the aggregate foundations;
3. A proposed verification program, including proposed independent testing agency to be used;
4. Copies of forms to be used for daily reports, testing reports and other pertinent reports;

5. Copies of testing methods to be used;
6. Copy of written Verification Program.

626.08 Verification Program – A verification plan designed, accomplished and reported by the Contractor is required to measure the quality of the installed aggregate foundations. The proposed verification program is subject to approval by the Engineer. As a minimum, the verification program shall include the following:

1. Proposed means and methods for verification that design and performance criteria, as stated in contract documents, has been satisfied. This may include but shall not be limited to modulus testing on individual elements and/or groups, soil borings, and other methods as required by the aggregate foundation system designer and approved by the Engineer.
2. Quality control program to verify that aggregate foundation elements are installed in accordance with the specifications and requirements as outlined in this Special Provision. The quality control program shall include testing and/or observations by an independent testing agency.
3. Program to monitor performance of the aggregate foundation system during and after construction of the overlying embankment. This procedure may include the installation of instrumentation. Instrumentation installed to monitor performance may also be used to aid in the verification that design and performance criteria have been satisfied.

626.09 Daily Progress Reports and Final Reports – During construction the Contractor shall submit an electronic file (PDF) copy of daily progress reports to the Engineer. Daily reports shall contain (if applicable) but shall not be limited to, element identified by location number, date constructed, drilled diameter, elevation of top and bottom of element, average lift thickness, the type and size of equipment used, description of soil and ground water conditions, quantity of aggregate used per element, results of quality control testing, and other pertinent daily activity information. The Contractor shall immediately report any unusual conditions encountered during aggregate foundation installation to the Engineer.

At the completion of the installation of the aggregate foundations, the Contractor shall submit a final report to the Engineer detailing the equipment and methods used, production rates, the performance of the site during treatment, and that the site meets the established criteria set forth in the contract documents. This report shall include a summary of all verification testing performed.

626.10 Pre Construction Conference – A pre-construction conference shall be held a minimum of 14 calendar days prior to the Contractor beginning any aggregate foundation installation work at the site to

discuss construction procedures, personnel, verification program, quality control and equipment to be used. Those in attendance shall include:

1. The superintendent and/or foreman, on-site supervisors, and the independent testing agency representative.
2. The Engineer, key inspection personnel, and representatives of the Contracting Authority.

If significant changes are made to the Contractors personnel, or significant revisions are made to the Contractors Design Packet and Work Plan, an additional conference shall be held before any additional work is performed.

626.11 Materials – Aggregate foundation backfill materials shall be furnished by the Contractor. Aggregates used for the construction of aggregate foundations shall be relatively clean crushed stone, meeting the requirements of Section 903 of the Tennessee Department of Transportation Standard Specifications for Road and Bridge Construction for abrasion loss and sodium soundness.

Gradations for aggregate foundations shall be Type I, Grade B in accordance with ASTM D1241, ASTM C33 sizes No. 57, No. 67, or shall be a graded aggregate selected by the installer and approved by the Designer and Engineer. For aggregate foundation elements that extend below the water table, the gradation shall be the same as ASTM D1241 Type I, Grade B, except that particles passing the number 40 sieve shall be eliminated. Alternatively, ASTM C33 size No. 57 stone or other stone selected by the installer and approved by the Designer and Engineer. The aggregate shall have been successfully used in the modulus test.

626.12 Installation – The excavation, installation and testing shall be performed in accordance with the requirements shown on the submittals outlined in Subsection “626.05 Submittal of Designs and Details” and “Subsection 626.06 Work Plan”.

1. Excavation and Shoring
    a. The site shall be graded and leveled as needed for proper installation of the aggregate foundation system selected by the Contractor. The Contractor is also responsible for determining the need for and consequently designing any temporary embankment slopes and/or types of temporary shoring used to ensure proper installation. Any designs of temporary embankment slopes and/or types of temporary shoring shall be signed and sealed by a registered Professional Engineer licensed to perform work in the State of Tennessee.

626.13 Tolerances – Aggregate foundations shall be installed so that each completed element will be

continuous throughout its length. Aggregate foundations shall be installed in a sequence that will minimize ground heave. Any heaving shall be re-compacted or excavated as directed by the Engineer, and be considered incidental to aggregate foundation installation.

1. The center of the completed element shall be within 6 inches of the required horizontal location as shown on the approved details.
2. The completed element shall be out of plumb no more than 2 inches horizontal for every 10 feet vertical of depth as shown on the approved details.
3. The diameter of the completed element shall not be less than 10% of the required diameter as shown on the approved details
4. The centerline of the top of the ground improvement provided by the completed element shall be within 6 inches of the required elevation.

If the aggregate foundation elements are determined to be out of one of more of these tolerances, installation of an additional element may be required at the Contractors expense. The Engineer may require additional aggregate foundation elements to be installed at the Contractors expense if the average effective diameter of any group of 40 consecutively installed elements is less than the plan diameter as shown on the approved design and details.

626.14 Modulus Testing – Testing to evaluate performance values selected for design will be provided by the Contractor. A telltale shall be installed at the bottom of the test foundation so that the deflection at the bottom of the element can be measured. The modulus test shall be conducted at a location where the bottom of the element terminates in soil. ASTM D1143 general test procedures shall be used to establish load increments, load increment duration, and load decrements. Performance will be deemed acceptable when the deflection at the bottom of the element does not exceed 20% of the deflection at the top of the element.

1. The minimum number of modulus tests required will be presented in the contract documents, if not specified in the contract documents a minimum of one modulus test shall be required.
2. The location(s) of the modulus test(s) shall be determined by the Engineer.
3. A seating load of approximately 5% to 9% of the design load shall be applied prior to application of load increments and prior to the measurement of deflection.
4. With the exception of the load increment representing approximately 115% of the design maximum foundation stress, all load increments shall be held for a minimum of 15 minutes and a maximum of 1 hour, and until the rate of deflection reduces to 0.01 inches per hour or less.
5. The load increment that represents approximately 115% of the design maximum on the foundation shall be held for a minimum of 15 minutes, a maximum of 4 hours and until the rate

of deflection reduces to 0.01 inches per hour or less.

6. The modulus testing shall be performed as described in the design packet.

626.15 SPT Verification Testing – Testing to evaluate performance values selected for design will be provided by the Contractor. SPT verification testing parameters will be given in the contract documents. The SPT verification testing shall be conducted in compliance with the following criteria;

1. Testing at each SPT location shall be performed at 2.5 ft. intervals through the entire depth of the improved soil zone.
2. The normalized SPT blow count shall be equal to the sum of the hammer blows required to drive the sample from 6 to 18 inches below the cleanout depth adjusted to an overburden pressure of 1 tsf and for a hammer efficiency of 60%.
3. SPT testing shall be conducted in accordance with ASTM D1586.
4. SPT testing shall be conducted at midpoint locations between the column patterns.
5. Failure to satisfy the minimum normalized SPT blow count criterion given in the contract documents shall require the installation of additional aggregate columns at the Contractors expense. The Engineer may elect to perform additional SPT verification testing.

626.16 Rejection of Aggregate Foundation Elements – If an aggregate foundation element is installed in an incorrect location or does not satisfy the specified tolerances, the Contractor shall install an additional element near the rejected element at a location approved and agreed upon by both the Designer and the Engineer. Alternate remedial procedures will be accepted only if they are approved by the Engineer. Unless the rejection is caused by an obstruction, refusal in rock, dense soil or errors in the project drawings, the cost of all labor and materials required for the additional element shall be the responsibility of the Contractor.

626.17 Method of Measurement – Aggregate Foundation Improvements will be measured as Lump Sum.

626.18 Basis of Payment – The Contractor will be paid the contract Lump Sum price for the aggregate foundation improvements. This payment shall be full compensation for all submittals, labor, equipment, tools, materials, material tests, field tests, verification program, and incidentals necessary to acceptably construct the foundations.

Payment will be made under Item Number:

- 626-01.01 Aggregate Foundation Improvements – Lump Sum