SP-150320
(New)

SPECIAL PROVISIONS
FOR
GROUND IMPROVEMENT WITH RIGID INCLUSIONS

Pottawattamie County
IM-NHS-029-3(115)48--03-78

Effective Date
September 19, 2017

THE STANDARD SPECIFICATIONS, SERIES 2015, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SPECIAL PROVISIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

150320.01 DESCRIPTION.

A. Scope of the Work.

The work shall consist of detailing, furnishing, installing, monitoring, and testing of rigid inclusions up to the lines and grades designated on the plans and as specified herein. The installation of the rigid inclusions shall also include the hauling, stockpiling, removal, and disposal of excavation spoils resulting from the installation process of the rigid inclusions. The excavated material is all assumed to be unsuitable and shall either be wasted or used in accordance with the Standard Specifications. The cost of installation of the rigid inclusions shall include the cost of hauling, stockpiling and disposal, of the excavated material.

B. List of Approved Rigid Inclusion Types and Vendor Information.

1. Controlled Modulus Column (CMC) by Menard (Phone: 1 800 326 6015) or their affiliate Nicholson Construction (Phone 1-800-388-2340).

2. Auger Pressure Grouted Displacement Piling (APGD) by Berkel & Company Contractors, Inc. (Phone: 1-913-422-3588).

3. Omega Rotary Torque Displacement Pile (ORTD) by Malcolm Drilling Company (Phone: 1-206-571-9945).

4. Rigid Inclusions (RI) by Hayward Baker (Phone: 1-800-456-6548).

5. Geo-Concrete Columns (GCC) by Tensar- GEOPIER FOUNDATIONS (Phone 1-800-371-7470).

C. References.

The publications listed below form a part of this specification to the extent referenced. The publications are referred to by the basic designation only.

1. **American Society of Testing and Materials (ASTM).**
   - ASTM D1143 / D1143M - 07e1 Standard Test Methods for Deep Foundations Under Static Axial Compressive Load.
   - ASTM C39/C39M-12a Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   - ASTM D4595-11 Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method.
   - ASTM D4751-04 Standard Method for Determining Apparent Opening Size of a Geotextile.
   - ASTM D5261-10 Standard Method for Measuring Mass per Unit Area of Geotextiles
   - ASTM D3080 Standard Test Method for Direct Shear Test of Soils Under Consolidated Drained Conditions.
   - ASTM D4318-05 Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
   - ASTM C136 Test Method for Sieve Analysis of Fine and Coarse Aggregates
   - ASTM D5882 - 07 Standard Test Method for Low Strain Impact Integrity Testing of Deep Foundations

2. **Geosynthetic Research Institute (GRI).**
   - GRI GT7-92 Standard Practice for Determination of Long-Term Design Strength of Geotextiles.

D. Definitions.

Rigid Inclusions: Rigid inclusions may consist of CMC, APGD, RI, GCC, or ORTD. The purpose of the rigid inclusions is to provide ground improvement and support for MSE wall with Light-weight Foam Concrete Fill (LFCF).

Test (Demonstration) Rigid Inclusion: Test (Demonstration) rigid inclusion is a rigid inclusion that is installed at non-production rigid inclusion locations. These test rigid inclusion will be installed as demonstration to verify the installation technique, to assist in selecting location of load tests, develop installation criteria, and identify installation sequence. The rigid inclusions that will be selected for static load tests shall either be installed prior to production of rigid inclusion as verification load test, or during production installation to proof load test the rigid inclusions. Rigid inclusions installed prior to production rigid inclusions are to allow for selection, performance and evaluation of static load tests as well as developing of the installation criteria by the Engineer. For each additional different rig brought to the site, additional demonstration rigid inclusions shall be installed to assess the rig's capabilities.

Working Pad: The working pad shall consist of a 24 inch layer of macadam crushed stone that is placed above the existing ground surface after the top soil is removed. The purpose of the working pad is to provide a stable bearing material for the rigid inclusion installation.

E. Subsurface Conditions.

1. Borings completed within the limits of the project encountered varying thicknesses of soft to medium stiff alluvial silt and clay overlaying medium stiff to stiff clay as shown in the plans.

2. Groundwater at the time of boring drilling was recorded between 2 feet to 20 feet below ground surface, which was performed between 2010 and 2017. It is anticipated that the groundwater level will rise during prolonged periods of precipitation or flooding, and perched groundwater may be present. For the purpose of installation, assume that the ground water is 5 feet below ground and make all necessary preparation to complete the installation under this condition at no additional cost to Iowa DOT

3. Installation of the rigid inclusions to the minimum tip elevation will typically require penetration of the stone working pad. Although it may not be shown on the soil profile, the contractor shall

anticipate that some obstructions such as, rocks, boulders, pavement, wood, debris, gravel, or concrete may still exist below the proposed working pad elevation.

F. Submittals.

1. A certification that states that no techniques that cause vibration to install the element are used in the installation.

2. Shop drawings that include spacing, diameter, installation procedure, sequence of construction with sufficient details including transitions areas, planned cut-off and tip elevations, material, proposed equipment, and mix design.

3. A load testing program to verify the design in accordance with the requirements of this special provision. The load testing program should comply with the following:
- **a.** It shall be performed prior and during production of rigid inclusions.
- **b.** The rigid inclusion production shall only start upon completion of two successful load tests and after the Engineer issues the final tip elevation, and installation criteria of the rigid inclusions.
- **c.** The load test shall be performed on rigid inclusion in accordance with ASTM D1143. Verification rigid inclusion shall be tested to a maximum load equal to 300% of the design load or until failure. The location of the test rigid inclusion will be selected by the Engineer with input from the Contractor and depending on the work and traffic control sequence. The Contractor shall accommodate in his schedule the time required to perform and evaluate the load test, and issue the installation criteria by the Engineer.

4. Design calculations for the load test reaction piles including diameter, type, reinforcement, depth as well as the reaction frame and beams. All details and supporting calculations shall be submitted for review by the Engineer. Design the reaction piles and frame for minimum two times the maximum test load. All shop drawings and supporting calculations shall be signed and sealed by a Professional Engineer registered in the State of Iowa.

5. Calibration records load cells, hydraulic jacks, pumps and pressure gauges should be submitted at least 7 days prior to performing the load testing.

6. A complete load test report should be submitted within 3 days of completion of each test. The Engineer shall evaluate the results of the load tests and issue the final tip elevations and planned spacing for the production rigid inclusions within 14 days from the receipt of the last load test report. Shop drawings and any supporting calculations should be sent to the Engineer at least 15 days prior to start the installation of the production rigid inclusions. Each rigid inclusion shall receive a reference number, which will be indicated on the shop drawings. The shop drawing submittal shall also show cut-off elevations, typical sections, and detail drawings, as required.

7. As-built plans for the installed rigid inclusions based on actual locations and tip elevations. The surveyed locations shall be sealed and signed by a licensed surveyor and tip elevations shall be certified by the Contractor's Professional Engineer registered in the State of Iowa.

8. Rigid inclusion installation records as specified. Installation records shall include all recordable information versus penetration depth, including applied torque, applied static down pressure (crowd pressure), advance rate (penetration speed), grout pressure, and grout volume.

9. A work plan including details of the equipment, sequence of construction, and method of installation should be submitted to the Engineer for review. The submittal should include a detailed quality control plan and explain how the work plan will comply with all the requirements of the project safety plan.

10. Documentation for all imported materials including pertinent laboratory test results prior to arrival on site.

11. Documentation of the Contractor's qualifications shall show that it has been engaged in successful design and installation of deep ground improvements for at least five years, and designed and constructed a minimum of five similar projects with similar scope utilizing the deep ground improvement method proposed for the subject project. A list of previous projects including name, description, amount of rigid inclusions, and contact person with phone number shall be provided. Resumes of the Contractor's site superintendent and/or foreman shall also be provided. Qualifications of the firm that will be performing the pile integrity tests shall also be provided.

G. Design and Performance Criteria.

1. The Contractor shall be responsible for the shop drawings of the deep ground improvement system, with the following constraints:
- **a.** The rigid inclusions may consist of CMC, APGD, RI, GCC, or ORTD. No other substitute shall be accepted. The design shall conform to the requirements summarized in the contract documents.
- **b.** The working pad shall be as shown on the plan documents and as specified herein.

2. The Contractor shall be responsible for the design of the load tests reaction frames and piles.

150320.02 MATERIALS.

A. Working Pad.
The working pad shall be macadam crushed stone with a nominal maximum size of 3 inches. Screen over a 3/4 inch screen. This is identified as Gradation No. 13 of the Aggregate Gradation Table, Article 4109.02 of the Standard Specifications
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B. Grout.
For CMC, APGD, RI, or ORTD, meet the following grout requirements.

1. Portland Cement**:** Shall conform to requirements of Article 4101.01, A of the Standard Specifications
- **a.** Type I or Type II.
- **b.** Cement shall be from an approved source per Materials I.M. 401. If the brand or type of cement is changed during the course of the project, additional grout mix tests shall be conducted to ensure consistency of quality and performance.

2. Fly ash shall meet the requirements of Section 4108 of the Standard Specifications.

3. Sand shall meet the requirements of Section 4110 of the Standard Specifications.

4. Water reducer shall meet the requirements Materials I.M. 403.

5. Fluidifier.
- **a. Water Reducing Agent.**
  - Specrete-IP Incorporated; Intrusion-Aid SCX.
  - Specrete-IP Incorporated; Intrusion-Aid FG.
  - Grace Concrete Products; WRDA 35.
  - Grace Concrete Products; ZYLA 640.
- **b. Retardant.**
  - Specrete-IP Incorporated; Flo-Aid XR.
  - Grace Concrete Products; Recover.

6. Water shall conform to requirements of Section 4102 of the Standard Specifications.

7. **Grout Mix.**
   - **a.** Proportion by weight to produce a grout capable of being satisfactorily pumped and of penetrating and filling all voids.
   - **b.** Minimum Compressive Strength:
     - 2000 psi at 7 days as required prior to pile integrity testing.
     - 4000 psi at 28 days
   - **c.** Minimum Flow Cone Rate: 10 seconds to 25 seconds with modified 3/4 inch opening flow cone, ASTM C939.
   - **d.** The grout mix shall be designed utilizing fluidifiers as needed to maintain the range of acceptable fluid consistency (flow cone rate) for a period of at least 2 hours.

8. A ready mix truck shall be supplied from an approved ready mix plant with certified plant inspection according to Articles 2001.20 and 2001.21 of the Standard Specifications and Materials I.M. 528. An Iowa DOT ticket per Materials I.M. 528 shall be prepared and provided to the Engineer.

C. Concrete for GCC Construction.

1. All materials, proportioning, air entraining, mixing, slump, and transporting of PCC shall be according to Section 2403 of the Standard Specifications, except as modified herein.

2. Water/cement ratio: not to exceed 0.45.

3. Use Class D PCC mixture with a slump of 6 inches ±1.5 inches.

4. Portland cement: meet the requirements of ASTM C 150 Type I / II and Section 4101 of the Standard Specifications.

5. Fly Ash shall meet requirements of Section 4108 of the Standard Specifications.

6. Sand shall meet the requirements of Section 4110 of the Standard Specifications.

7. Water Reducer shall meet the requirements of Materials I.M. 403.

8. Air entrainment: apply Section 2403 of the Standard Specifications.

9. Retarder is required according to Materials I.M. 403 to maintain workable concrete.

10. Do not use GGBFS.

11. **Minimum Compressive Strength.**
    - 4000 psi at 28 days.
    - 2000 psi at 7 days as required prior to pile integrity testing.

12. A ready mix truck shall be supplied from an approved ready mix plant with certified plant inspection according to Articles 2001.20 and 2001.21 of the Standard Specifications and Materials I.M. 528. An Iowa DOT ticket per Materials I.M. 528 shall be prepared and provided to the Engineer.

150320.03 CONSTRUCTION.

A. Safety Requirements.

Complete all work in accordance with the Project Safety Plan. The Contractor shall be responsible for ensuring that all conditions of these requirements are met to the satisfaction of the Engineer.

B. Equipment.

1. Utilize machines or combinations of machines and equipment that are in good working condition, safe to operate, cause no vibration, and will produce the results specified herein.

2. Utilize equipment that is capable of advancing the rigid inclusion through the subsurface materials efficiently to meet the project schedule.

3. The equipment shall be of sufficient size and capacity, and capable of installing rigid inclusions to the minimum depths shown in the plans or that required by the design, whichever is deeper.

4. The equipment shall be capable of installing rigid inclusions in the presence of very dense granular soils and/or obstructions, where encountered.

5. The rigid inclusion equipment must be equipped with installation monitoring capabilities including, as minimum, the following: (a) applied torque (b) applied static down pressure (crowd), (c) advance rate (penetration speed), (d) grout pressure, and (e) grout volume.

C. Site Preparation.

1. Inspect the site prior to the start of operations to verify the depth ground improvements can be constructed using the proposed equipment.

2. Excavation for the working pad shall not begin until the results of the load testing program on rigid inclusions has been submitted and approved by the Engineer.

3. The final excavation for the working pad shall be made using an excavator equipped with a smooth-edged bucket to minimize disturbance of the in-situ soils. The prepared subgrade shall consist of in-situ soils compacted to moisture content within ±2% of optimum moisture content. If compaction is not practical due to natural water contents far above optimum and/or wet weather conditions, the in-situ soils shall be over excavated to a depth of 12 inches and replaced with compacted granular fill. Any organic or otherwise unsuitable soils shall be removed and replaced with compacted granular fill.

D. Working Pad Construction.

1. Prior to construction of the working pad, topsoil and other unsuitable materials shall be removed as specified in Article 150320.03, C, 3.

2. Construct the working pad which consists of at least 2 feet of Macadam Crushed Stone and proof roll it.

3. Any rutting of the working pad that occurs during installation of the rigid inclusions should be measured and the Engineer notified. If practical, when rutting occurs, reroute construction traffic to avoid further damage to the underlying in-situ soils, or remove and replace the rutted material with compacted granular fill.

E. Rigid Inclusion Construction.

1. Provide adequate number of drilling rigs to meet the project schedule considering all facets of the project.

2. Evaluate the site and subsurface conditions and assess any need for working platforms. Such platforms, preparatory work, and material needed is considered part of the means and methods and no additional payment or time will be granted toward such work.

3. Install a total of ten demonstration rigid inclusions at non-production locations throughout the site(s). Install three demonstration rigid inclusions in each of the ground improvement Area 2 and 5 as defined in the plans. Install four demonstration rigid inclusions in ground improvement Area 6 as defined in the plans. Demonstration rigid inclusions are necessary to assess any variation in soil conditions and select the locations of the rigid inclusions that will be load tested and to be used in the development of the production rigid inclusion installation criteria. These demonstration rigid inclusions shall be installed before the load tests and before installation of production rigid inclusions. The demonstration rigid inclusion shall be paid at the same unit rate as the production rigid inclusion and no separate mobilization or additional cost shall be borne by Iowa DOT.

4. Perform a total of three verification load tests prior to the start of rigid inclusion production. One verification load test shall be performed at each of the three ground improvement areas where rigid inclusions are proposed. The load test results will be signed and sealed by the Contractor's Professional Engineer and submitted to the Engineer. No payment shall be made for load tests which were unsatisfactorily performed as determined by the Contractor and/or the Engineer.

5. Layout and Tolerances.
- **a.** Surveying: Prior to installation of the rigid inclusions, each rigid inclusion location shall be surveyed by a licensed surveyor. Provide all survey layouts, maintain utility clearances and provide any required coordination with the Engineer and any other local, state, and federal agencies having jurisdiction, prior to the start of construction. The location of each rigid inclusion shall be marked using a numbered utility flag.
- **b.** Plan position: The center of the completed rigid inclusion shall be within 3 inches of the plan location.
- **c.** Verticality: The axis of the completed rigid inclusion shall not deviate more than 2% from vertical. The verticality of the mast of the rig shall be checked by the operator before start of the installation for each rigid inclusion. The operator shall indicate on the daily drilling log for each rigid inclusion that verticality was within tolerance by checking the appropriate box on the installation log.
- **d.** Diameter: The completed rigid inclusion diameter shall not deviate more than 10% from the plan diameter.

6. Rejection: Rigid inclusions improperly located or installed beyond the maximum allowable tolerances or reported to be defective as a result of pile integrity testing, shall be abandoned and replaced with new rigid inclusions unless the Contractor and the Contractor's designer propose a remedial measure which is acceptable to the Engineer, either of which will be done at no additional cost to the Iowa DOT.

7. Schedule: Mobilize and maintain sufficient equipment, materials, and personnel to complete the work in accordance with project milestones and shall coordinate operations with all other aspects of the project.

8. Installation Sequence: Install the rigid inclusions in accordance with the sequence detailed in the approved work plan. If adjacent rigid inclusions are observed to be influenced by the installation of a neighboring rigid inclusion, the installation sequence shall be modified to prevent disturbance of already constructed rigid inclusions. Any required modifications to the sequence, or mitigation of rigid inclusions deemed unusable due to disturbance, shall be completed at no additional cost to the Iowa DOT or extension in the project schedule.
Rigid inclusion spacing and length as noted in the contract plans will be optimized based on the static load tests. Any required modification to the sequence based on the optimization shall be completed at no additional cost to the Iowa DOT or extension in the project schedule.

9. Depth: Install the rigid inclusions to the minimum tip elevation, or deeper as required to found the rigid inclusions on a suitable bearing stratum, as determined by the Engineer.

10. Obstructions: Subsurface obstructions may include but are not limited to boulders, timbers, concrete, bricks, utility lines, foundations, slabs, etc. that prevent rigid inclusions to be installed to the required depth. In the event that obstructions are encountered during installation of a rigid inclusion that cannot be penetrated with reasonable effort, one or more of the following procedures will be used:

- Position the element a short distance not more 1.5 feet away from the original position.
- Pre-drill the obstruction.
- Install additional elements to bridge over the obstruction.

Any change made to the design or rigid inclusion layout because of obstructions shall be approved by the Engineer. An as-built submittal should be provided to the Engineer no later than 7 calendar days after the modification has been performed on site. This submittal shall be signed and sealed by the Registered Professional Engineer responsible to the Contractor. All elements that are abandoned due to obstructions or equipment malfunction shall be completely backfilled with grout.

The Contractor shall be paid for the abandoned rigid inclusion elements per the contracted price per foot of rigid inclusions. No additional compensation or time for any items related to obstructions shall be awarded for delays, or mobilization to the relocated position of the rigid inclusion.

11. Cut-off Elevation: Cutoff the rigid inclusions 6 to 12 inches below the top elevation of the working pad, or slightly higher to allow any required trimming or removal of low strength material at the top of the rigid inclusion.

12. Ground Heave: Up to 2.0 feet of heave of the working pad is expected due to rigid inclusion installation. The rigid inclusions may need to be cut down prior to construction of the MSE wall leveling pad. Any cut to the rigid inclusion shall be performed using methods that do not crack or damage the rigid inclusion. Such work is considered incidental and shall be performed at no additional cost to the Iowa DOT.

13. Axial load test on selected rigid inclusions shall be performed after the design strength has been achieved. The working pad should be excavated to the original ground surface at the test location. Perform the excavation, load test setup, load testing, and backfill the excavation, in a single shift. The load test loading schedule given below shall be followed

a. Apply the load in increments of approximately 20% of the design load up to 150% of the design load.

b. Maintain the applied load at each increment for 5 minutes during loading and unloading except at 100% and 150% of design load. Record the deformation and strain 2 minutes after applying the test load and just prior to applying the next load increment.

c. At 100% and 150% of the design load, hold the load for at least 10 minutes. Deformation readings shall be recorded at 1, 2, 4, 6, and 10 minutes. If the average deformation between 1 and 10 minutes increases by more than 0.04 inches, hold the load for 60 minutes and record the deformation every 10 minutes.

d. After completing the required hold time at 150% of the design load, unload the pile in increments of 25% of the design load until the alignment load is reached.

e. Then, continue testing by reloading the test pile at increments equal to 25% of the design load until plunging failure occurs or a maximum load of 300% of the design load is reached, whichever occurs first. During the reload cycle, hold each load increment for 2.5 minutes.

f. After reaching the maximum test load, unload in increments of 50% of the design load until the alignment load is reached.

14. Disposal of Excavation Spoils: Stockpile all spoil material, including any topsoil and spoils generated by rigid inclusion installation, at the locations designated on the soil erosion plan. Handling and disposal of spoils shall be performed at no additional cost to the Iowa DOT.

F. Contractor Quality Control.

The following describes the minimum inspection and testing required in the Contractor's Quality Control (CQC) Plan and Program for the work of this section and is for CQC only. The implementation of the Contractor Quality Control Program does not relieve the Contractor from the responsibility to provide the work in accordance with the contract documents, applicable codes, regulations, and governing authorities.

1. Supervision, inspection, and records.

a. The Contractor shall have an on-site field engineer to manage all of the QC activities on the project including pile integrity testing, grout sampling (if applicable), and other testing. These tests should be performed as defined in the Design Submittal and approved by the Engineer. Load tests, production rigid inclusions, subgrade preparation, and working pad shall be done under the direct supervision of a professional geotechnical engineer registered in the State of Iowa from the Contractor's side. The geotechnical engineer shall have supervised a minimum of five similar deep ground improvement projects.

b. An accurate installation record shall be kept for all rigid inclusions. The record shall indicate the location, length, cut-off elevation, date and time of construction, applied torque, applied static down pressure (crowd pressure), advance rate (penetration speed), grout pressure, and any other pertinent installation details as indicated in the Design Submittal and approved by the Engineer. Any unusual conditions encountered during installation should be immediately reported to the Engineer and any corrective measures recorded. Daily records shall be signed by the Contractor' superintendent and by the inspector. A complete tabulation of all records pertaining the approved rigid inclusions installation shall be certified by the Contractor's engineer and shall be delivered to the Engineer no later than 14 days after the completion of the rigid inclusion work. All testing and inspection documents certifying that the rigid inclusions and working pad were installed based on the construction and installation criteria shall be reviewed and approved by the Contractor's engineer.

c. Pertinent installation data as defined in the Design Submittal and approved by the Engineer should be provided on a daily basis. These documents shall be prepared continuously as the production progresses and shall be submitted to the Engineer no later than one working day after the installation of a rigid inclusion. The Contractor has to ensure that the Engineer has complete access at all times to the data for the rigid inclusion installation, as required.

2. Working Pad.

a. Perform proof-rolling of the top of the working pad prior to and following completion of the rigid inclusion installation. The proof-rolling shall cover the entire work area, and the wheel pass spacing shall be equal to the axle length of the dump truck. All required testing will be completed to the satisfaction of the Engineer at no additional cost to the Iowa DOT.

b. Following installation and curing of the rigid inclusions, proof-roll the working pad using a fully loaded dump truck. Where deflections more than 1/4 inch are observed, remove the working pad, over excavate 12 inches per Article 150320.03, C, 3, and reconstruct the working pad. The excavation shall not damage the rigid inclusions.

3. Concrete and Grout.

Conduct strength testing of the concrete in accordance with ASTM C 39 and Articles 2001.20 & 2001.21 of the Standard Specifications and Materials I.M. 528. For concrete testing, cured cylinders measuring 3 inches in diameter by 6 inches high are required. For testing grout, 2-inch cubes are used. For the cylinders and molds, molds and a curing environment conforming to the requirements of ASTM C 39 should be provided. At a minimum, prepare a set of four test cylinders or cubes for each 50 cubic yards of concrete or grout placed or a minimum of two sets of four cylinders or cubes per day (whichever is greater). One cylinder or cube from each set shall be tested for strength at 1, 2, 7, and 28 days. Certified strength test results should be provided to the Engineer for acceptance.

4. Rigid Inclusions.

a. Pile Integrity Testing: Pile Integrity Testing (PIT) shall be performed on all the inclusions used for load test and approximately 5% of the rigid inclusions. The PIT shall be performed in accordance with ASTM D5882. The production elements selected for the PIT shall be at the discretion of the Engineer based on daily records indicate likelihood of anomalies in the inclusions.

b. The PIT shall be performed by a firm qualified to do such testing. Documentation of the firm's qualifications shall show that it has successfully performed PIT testing for at least 5 years, and for a minimum of five similar projects. A list of previous projects including name, description, number of tests performed, and contact person with phone number shall be provided.

c. The firm performing PIT will be responsible for testing and assessing the integrity and condition of the pile, including but not limited to significant reductions in pile cross-sectional area (necking) or pile material strength/stiffness above the pile toe. In addition, the firm performing PIT shall confirm the pile lengths where clear pile toe reflection is obtained or state to which pile length the test appears to be conclusive.

d. The PIT submittal shall include:

- A record of each rigid inclusions tested.
- Low-Strain Dynamic Testing (LSDT) Report: In accordance with referenced standard for test performed.
- Submit report to the Engineer within 48 hours of test completion.
- Installation Record.
- Pile Length.
- Unusual occurrence(s) during installation.
- A report with complete interpretation of PIT results.

5. Strain Gauges.

a. The test rigid inclusion shall be instrumented with five levels of strain gauges. The strain gauges shall be Geokon model 4911, 4911A or approved equivalent. The strain gauges shall be compatible with a real time monitoring system. The test rigid inclusions shall include a rebar to facilitate installation of the strain gauges. The test rigid inclusion may include, to the contractor's choice, a lightly reinforcement cage for the top five feet of the rigid inclusion to avoid any risk while transmitting the load effectively into the rigid inclusion. Strain gauges elevations can be assumed preliminarily at the soil layering breakdown, 2 feet below to top of RI and 2 feet above RI tip elevation. Strain Gauges final elevations shall be adjusted by the Engineer on site based on the confirmation borings and length of the rigid inclusion.

b. Take initial readings 24 hours after completing installation and testing of each strain gauge. During the load test, the strain gauges shall be monitored prior to construction of production rigid inclusions. After monitoring the strain gauges during load tests, the strain gauges cables or wires shall be routed through a buried schedule 80 PVC pipe and shall be connected to the real time monitoring system to be monitored during placement of embankment as defined in the Special Provisions for Instrumentation. Strain gauges shall be compatible with the real time monitoring system. Readings shall be taken daily and made available online to the engineer. Any strain gauge that malfunctions or becomes inoperable during the load test shall be replaced and the load test shall be redone by the contractor at no additional cost to the Iowa DOT.

c. After the load tests, the strain gauges will continue to be monitored as defined in the Special Provision for Instrumentation and Monitoring. A minimum of two readings every 24 hours shall be taken using real time automated monitoring system for each strain gauge.

d. Additional special provisions for instrumentation related to the grading works are included in the contract documents.

150320.04 METHOD OF MEASUREMENT.

A. Rigid Inclusions
Measurement for Rigid Inclusions, in linear feet, will be measured from the cut-off elevation to tip elevation of installed rigid inclusions and rounded to the nearest foot.

B. Rigid Inclusions Working Pad (Macadam Stone)
Measurement for Rigid Inclusions Working Pad (Macadam Stone), in cubic yard, will be the quantity shown in the plans.

C. Load Test
Each performed Load Test will be counted.

150320.05 BASIS OF PAYMENT.

A. Rigid Inclusions.

1. Payment for Rigid Inclusions will be at the contract unit price per liner foot.

2. Payment is full compensation for:
- Furnishing and installing demonstration and production rigid inclusions.
- Performing design.
- Performing site preparation.
- Handling and disposal of cuttings.
- Performing any associated inspection and laboratory testing.
- Performing PIT for demonstration and production rigid inclusions.

B. Rigid Inclusions Working Pad (Macadam Stone).

1. Payment for Rigid Inclusions Working Pad (Macadam Stone) will be at the contract unit price per cubic yard.

2. Payment is full compensation for furnishing and installing working pad, and performing inspection and laboratory testing.

C. Load Test.

1. Payment will be at the contract unit price per each load test.

2. Payment is full compensation for furnishing and installing the rigid inclusion test element with strain gauges for static load test, all components for load application mechanism/reaction frame, all components for measuring load magnitude and rigid inclusion displacement, performing PIT testing on the rigid inclusion test element and assessing the results, performing load test, providing all associated supervision and inspection, record data and provide load test results report. Monitoring of strain gauges after completion of load test will be compensated under Special Provision Instrumentation and Monitoring.