

**AUGER CAST PILES.**  
**(REV 4-25-23)**

Use in conjunction with Dev346ACP and DevMM9.2ACP. DevMM9.2ACP may be viewed at the following URL:

[https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/programmanagement/otherfdotlinks/developmental/files/devmm9-2acp-\(5-16-22\)1ac135e7d84b4d7d970102bc482b3c4a.pdf?sfvrsn=c08a78d0\\_10](https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/programmanagement/otherfdotlinks/developmental/files/devmm9-2acp-(5-16-22)1ac135e7d84b4d7d970102bc482b3c4a.pdf?sfvrsn=c08a78d0_10)

ARTICLES 455-38 through 455-50 are deleted and the following substituted:

**455-38 Description.**

Furnish and install auger cast piles (ACP), also known as augered-cast-in-place (ACIP) piles, used for structural support.

ACP piles are defined as a foundation made by rotating a hollow-stem auger into the ground to the required pile depth with sufficient crowd (downward thrust) to prevent mining of the soil. Portland Cement Grout (Grout) is injected through the auger shaft under continuous positive pressure as the auger is being withdrawn. A full-length reinforcing cage, as specified, is inserted into the column of fluid grout following the completion of grout placement.

**455-39 General Requirements.**

**455-39.1 Personnel Requirements:**

**455-39.1.1 Bridge Foundations:** Provide a foreman in responsible charge for the ACP operations with a minimum of five years of ACP pile experience on multistory buildings or bridges and a minimum of five successful projects using similar or larger pile diameters, penetrations and loads of those indicated in the Plans. The experience shall include subsurface and project conditions similar to those of the current project. In at least two projects the foreman must have used Automated Monitoring Equipment (AME) to monitor tip depths, torque, crowd, auger rotation rate, grouting pressures, and incremental grouting volumes. Experience in foundations for noise walls, sign structures, mast arms or other types of miscellaneous structures shall not count toward this requirement.

Technicians performing the efflux test must take the FDOT on-line Auger Cast Pile course and pass the final examination to be qualified to test for any auger cast pile installations in the field.

**455-39.1.2 Noise Walls and Non-Bridge Structure Foundations:**

Provide a foreman with a minimum of three years of augered cast-in-place pile experience on noise walls, sign structures, mast arms or any other types of miscellaneous structures, on projects using similar or larger pile diameters, penetrations, and load requirements of the requirements of this project. Experience on bridges or multistory buildings may count towards this requirement.

Technicians performing the efflux test must take the FDOT on-line Auger Cast Pile course and pass the final examination to be qualified to test for any auger cast pile installations in the field.

**455-39.2 Contractor's Operations:** For bridge foundations, use only fixed mast rigs or fixed lead rigs. For bridge foundations, unless otherwise stated in the Plans, provide equipment capable of constructing piles supporting bridges to a depth equal to the deepest bridge pile shown in the Plans plus 15 feet. For non-bridge piles, unless otherwise stated in the Plans, provide equipment capable of constructing piles supporting non-bridge structures to a depth equal to the deepest non-bridge pile shown in the Plans plus 5 feet.

Submit an ACP Installation Plan in accordance with 455-47. Demonstrate to the satisfaction of the Engineer, the dependability of the equipment, techniques, and materials by construction of a demonstration pile per pile diameter and per grout mix design prior to the start of load test piles and production piles. Construct demonstration piles at non-production locations selected by the Engineer to the deepest tip elevation for each pile diameter indicated in the Plans. Provide an embedded thermal wire mounted on a center bar, in addition to the reinforcement cage required by the plans, on all demonstration piles and load test piles. Prior to production pile installation, determine the maximum core temperature and time to peak temperature for each project specific grout mix by obtaining temperature measurements at least every 15 minutes during curing of demonstration piles and load test piles.

Demonstration piles may not be used for load tests. Cut off piles installed out of permanent position at an elevation of 2 feet below the ground surface and dispose of the removed portion of the pile.

For non-bridge piles, the first production pile may be used as the demonstration pile to prove the acceptability of the means and methods of pile installation.

**455-39.3 Monitoring Equipment:** Use an AME system to monitor the installation of all bridge foundation piles, including demonstration piles, load test piles and production piles. Provide a technician to operate and monitor the AME during pile installation. This technician must have at least two (2) years of experience operating and monitoring AME. An AME system may be used to monitor the installation of noise wall and miscellaneous structure foundation piles at the Contractor's option.

Equip the ACP rig with an AME system to accurately record the measurements listed in 455-44.3. Provide the equipment with a rotational position indicator on the auger head system to measure the inclination of the auger. Provide an electronic position indicator on the crane line or boom holding the auger to measure the depth of the auger injection point below ground. Provide torque cells positioned on the auger head system. Provide electronic flowmeters and electronic pressure transducers placed in the grout pressure line. For bridge piles, provide load cells positioned on the auger head system or on the drill rig hoist winch to monitor crowd.

Prior to each day's drilling operations, provide the baseline torque and crowd pressures, after the hydraulic system is warmed up, to the inspector.

**455-39.4 Priming and Calibration Tests:** When the Contractor's installation procedure includes priming the grout pump, or grouting lines or auger conduit after drilling the hole, perform a priming demonstration to determine the minimum number of pump strokes required to deliver fresh grout throughout the entire system and flow from the grout injection hole at the bottom of the auger. Perform this grout priming

demonstration prior to any calibration test. The Engineer may require additional priming demonstrations when the pump is repaired, a different pump is used, or when the length of the grout lines or hollow auger lengths increase from previous piles for which priming demonstrations were performed.

Calibrate all measuring and recording equipment prior to the construction of demonstration piles and prove that the values indicated by the measuring and recording equipment are within 3% of the values indicated. Calibrations shall be performed in accordance with the equipment manufacturer's recommendations. Recalibrate all measuring and recording equipment when the Engineer determines that drilling and grouting performance has changed. Maintain all measuring and recording equipment in working order throughout the installation of all piles.

Perform a calibration test of the pumping equipment, prior to construction of the demonstration piles, to determine the average volume of grout for every pump stroke, in accordance with FM 5-612. Connect and test any flowmeters to be used in the project, during the pumping equipment calibration tests and demonstrate the volume recorded by the flowmeters are within 3% of the volume of grout measured in the barrel during the calibration tests. Do not use flow meters that do not meet this requirement. Recalibrate the pump prior to beginning the pile installation of every two piers/bents; recalibrate more frequently if the Engineer determines that the grouting performance has changed.

**455-40 Materials.**

Meet the following material requirements:

Structural Portland Cement Grout for Auger Cast Piles.....	Dev346ACP
Reinforcing.....	Section 415

**455-41 Grout Mix.**

Use an approved grout mix produced in accordance with Dev346ACP.

**455-42 Pumping Cement Grout.**

Meet the following requirements:

1. Only use pumping equipment approved by the Engineer in the preparation and handling of the grout. Before using the mixers, remove all oil or other rust inhibitors from the mixing drums, stirring mechanisms, and other portions of the equipment in contact with the grout.
2. If there is a lapse in the operation of grout injection, recirculate the grout through the pump, or through the mixer drum or agitator.
3. The Engineer's approval of grout mixers and all other equipment will be contingent on proper performance during construction of the demonstration pile and subsequent production work.
4. Use a positive displacement piston type grout pump equipped with a pressure gauge, capable of developing displacing pressures at the pump not less than 350 psi. The pump shall be appropriately sized to the pile diameter. Provide a grout pressure gauge in clear view of the equipment operator. Provide a second pressure gauge near the drill rig where it can be observed by the Engineer.
5. Accurately monitor the volume and pressure of the grout flow. Provide a pump stroke counter in good working condition on the grout pump.

#### **455-43 Testing Cement Grout Mix.**

Test ACP grout in accordance with Dev346ACP.

#### **455-44 Pile Installation.**

**455-44.1 Drilling:** Meet the following requirements:

1. Locate the piles as shown on the drawings.
2. Should soft, compressible muck, organics, clay, or other unsuitable materials (non A-1, A-3, A-2-4 or limestone materials) be encountered, remove the unsuitable material to a maximum depth of 5 feet, and a radial distance around the pile centerline of 2 pile diameters unless otherwise indicated in the Plans. Backfill with clean granular backfill materials (A-1, A-3, A-2-4), placed and compacted in maximum 12-inch lifts to at least 95% of maximum dry density as determined by FM 1-T180. Complete this work to the Engineer's satisfaction prior to ACP construction. Should more than 5 feet depth or excessive quantities of unsuitable material be encountered, immediately advise the Engineer and proceed with the work as directed by the Engineer.
3. Provide continuous auger flighting from the bottom to the top of auger with no gaps or other breaks other than accommodation for partial or full, drilled displacement piles. Ensure the auger flights are uniform in diameter throughout its length, and of the diameter specified for the piles less a maximum of 3%. Provide augers with a distance between flights of approximately half the diameter of the auger.
4. Use augers with the grout injection hole located at the bottom of the auger head below the bar containing the cutting teeth, and with pile auger leads containing a bottom guide.
5. Construct piles of the diameter shown in the plans and to the required lengths or tip elevations specified in the Plans. When plans show estimated pile lengths or tip elevations, construct the piles to the pile tip elevations, rock socket requirements and minimum embedment length into the bearing stratum specified in the authorized pile tip elevations letter.
6. Clearly mark the auger leads to facilitate monitoring of the incremental drilling and grout placement. Provide individual foot marks with 5-foot increments highlighted and clearly visible. Provide a clear reference mark on the moving auger assembly to facilitate accurately monitoring the vertical movement of the auger.
7. Place piles by rotating a continuous flight hollow shaft auger into the ground at a continuous rate that prevents removal of excess soil. Stop advancement after reaching the predetermined depth.
8. Should auger penetration to the required depth prove difficult due to hard materials/refusal, the pile location may be predrilled, upon approval of the Engineer, through the obstruction using appropriate drilling equipment, to a diameter no larger than one half the prescribed finish diameter of the ACP. Commence grouting immediately upon reaching the required tip elevation to minimize ground loss and soil relaxation. Should non-drillable material be encountered preventing placement to the depth required, immediately advise the Engineer and proceed with the work as directed by the Engineer. Refusal is defined as the depth where the penetration of the standard auger equipment is less than 12 inches per minute.
9. Plug the hole in the bottom of the auger prior to advancing into the ground.

**455-44.2 Grouting:** Meet the following requirements during grouting operations

1. Remove the plug within 6 inches of the bottom of the hole by the grout pressure. Pump the grout with sufficient pressure as the auger is withdrawn to completely fill the auger hole, preventing hole collapse and to cause the lateral penetration of the grout into soft or porous zones of the surrounding soil or rock. Prior to commencing withdrawal of the auger, establish, for bridge foundations, an initial head of at least 20 feet of grout or 20 percent the length of the pile (rounded up to the next whole foot) whichever is greater; for non-bridge foundations, establish, an initial head of at least 5 feet of grout or 10 percent the length of the pile (rounded up to the next whole foot) whichever is greater. Establish this head by pumping a volume of grout equivalent to this required initial head times the theoretical cross section of pile. Do not include the volume or strokes required to prime the grout pumping system in the volume required to build this initial head. Maintain this head of grout above the injection point around the perimeter of the auger to displace and remove any loose material from the hole. Maintain positive rotation of the auger at least until placement of the grout.

2. Once the grout head has been established, greatly reduce the speed of rotation of the auger and commence extraction at a rate that allows the requirements of items 3 and 4 to be met. Maintain extraction at a steady rate to prevent a locked-in auger, necking of the pile, or a substantially reduced pile section. Always use this method of placement. Do not depend on the stability of the hole without the earth filled auger.

3. Grout Return Depth is defined as the depth of the injection point below the ground surface at which grout starts flowing out from the hole. Ensure a minimum grout return depth (MGRD) equal to the initial head provided at each pile, as per item 1 of this subarticle.

4. For bridge foundations, continuously monitor grout volumes and pressures for every 1-foot of grouting, using the AME. In piles for noise walls and miscellaneous structures, verify either by pump stroke count or AME the amount of grout placed. Place a minimum volume of grout in the hole of at least 115% of the column of the auger hole from a depth equal to the required MGRD to the tip of the pile. If less than 115% of the theoretical volume of grout is placed in any 5-foot increment (100% when above the MGRD depth), reinstall the pile by advancing the auger 10 feet below the top of the increment or to the bottom of the pile if less, followed by controlled withdrawal and grout injection, meeting the same 115% criteria for all 5-foot increments. If the total grout volume measured with the AME is over 3% greater than the total grout volume measured with pump stroke counting, use the stroke counting method to determine whether reinstallation of the pile is required and whether the pile is acceptable. Perform recalibration of the flowmeter and pump prior to continuing with the next auger cast pile installation and meet 455-39.4. Replace flowmeter if necessary.

5. Do not include the grout volume used to create the initial head, as part of the grout volume used to satisfy the overgrout requirement of item 4. If the grout does not flow out from the hole when the cutting head is at least equal to the required MGRD below the ground surface, redrill the pile. If grouting is interrupted for any reason or grout pressure loss is observed, reinsert the auger by drilling to at least 15 feet below the tip of the auger when the interruption or pressure loss occurred, and then regrout.

6. Immediately and periodically check the grout level within completed piles for grout settlement. Piles that experience up to 6 inches of grout settlement per 12 hours may be topped with grout provided any deleterious material which may have

accumulated on top of the pile is removed and the grout does not settle below the groundwater level. However, piles that show a drop in grout level more than 6 inches in 12 hours shall be rejected unless successfully tested with Thermal Integrity Testing.

**455-44.3: Automatic Measurements and Recording:** Monitor in real-time and record with the AME all drilling and grouting conditions during the installation of all bridge foundation piles. As a minimum, monitor and concurrently record the following measurements at least once per second during drilling and grouting operations with respect to time and depth of auger tip:

1. auger rotation speed.
2. torque delivered to the auger.
3. crowd force (downward thrust on auger).
4. rate of auger penetration.
5. depth of the auger injection point.
6. rate of auger extraction.
7. volume of grout for each foot of pile.
8. cumulative volume of grout.
9. grout pressure.

Reference and plot all measurements to the depth of the auger injection point. Submit AME records to the Engineer at the end of the day for each pile installed that day including all data from the drilling and grouting phases. The real-time AME information, together with all electronic data, shall be made available to the Engineer in the field in addition to being submitted at the end of day after constructing each pile. Provide electronic data in a format compatible with Microsoft Excel™, and using the column arrangement of the Department Form 700-020-05.

**455-44.4 Reinforcement:** Meet the following requirements:

1. Furnish and install the reinforcing and anchoring bolts as shown in the Contract drawings. Use reinforcement that is without kinks or nonspecified bends, free of mud, oil or other coatings that could adversely affect the bond. Make splices in reinforcement as shown on the Contract drawings, unless otherwise approved by the Engineer.

2. Completely assemble and place as a unit the cage of reinforcing steel. Tie all intersections of reinforcing steel with cross ties or “figure 8” ties. Use double strand ties, ties with larger tie wire, U-bolts, or similar when necessary. Furnish and install the reinforcing steel and anchoring bolts as shown in the Contract drawings. The Engineer will give final approval of the cage construction and placement subject to satisfactory performance in the field.

3. Use wheels or other approved noncorrosive spacing devices within 3 feet of the bottom, within 3 feet of the top, and intervals not exceeding 10 feet along the pile to ensure concentric spacing for the entire length of the cage. For battered piles, intervals between spacing devices shall not exceed 5 feet. Do not use block or wire type spacers. Use a minimum of one spacer per 30 inches of circumference of cage with a minimum of three (3) at each level.

4. Place the reinforcing while the grout is still fluid, and immediately after finishing grouting and clearing it from any contaminating material. Install the reinforcing into the grout by its own weight or manually. Do not use mechanical equipment or tools to impact the reinforcing or to force it into the grout. If the reinforcement does not

achieve the required penetration into the grouted pile, remove the reinforcement, re-drill, and re-grout the pile per Section 455-44.1 and 455-44.2.

5. Wait at least 12 hours after completing grouting of one pile before starting drilling at a pile location within 6 diameters center to center of the completed pile. The Engineer may extend this time to a minimum of 24 hours when excessive grout settlement or integrity problems are observed on recently grouted piles from drilling and installation operations in adjacent locations.

6. Hold the reinforcing in position at the ground surface within the fluid grout column with temporary supports. For bridges, leave any temporary supports in place for a minimum of 24 hours after completion of the pile or until the grout reaches its initial set time in accordance with ASTM C403, whichever is longer. For noise walls and miscellaneous structures, this time requirement may be reduced to 12 hours or until the grout reaches its initial set whichever is longer. Do not place wall panels, footings, or other loads on the piles before the piles are accepted and the grout has set a minimum of seven days or reached the compressive strength shown in the Contract Documents.

#### **455-45 Construction Tolerances.**

Locate piles as shown on the drawings, or as otherwise directed by the Engineer. Locate pile centers to an accuracy of plus or minus 3 inches. Ensure the grout cover beyond the outer layer of reinforcing is at least 4 inches. Ensure that the axial alignment of the auger cast pile does not deviate by more than 1/4 inch per foot from the axial alignment indicated in the Plans. For noise walls, ensure the tolerances of 534-5.1 can be met.

Locate the top of piles for noise wall foundations within plus or minus 3 inches of the plan elevation. Locate the top of piles for bridges and structures other than noise walls within plus 1 inch and minus 3 inches from the plan elevation and unless otherwise indicated in the Plans, the top of the reinforcing steel cage is no more than 6 inches above and no more than 3 inches below plan position.

#### **455-46 Unacceptable Piles.**

Repair or replace unacceptable piles, as directed by the Engineer, at no cost to the Department. Unacceptable piles are piles that fail for any reason, including but not limited to the following:

1. Piles not meeting the required penetration, minimum tip elevations or the required embedment into the bearing stratum, or minimum rock socket lengths.
2. Piles placed out of specified tolerances for position or axial alignment.
3. Piles not meeting the minimum grout cover, diameter or minimum overgrout requirements.
4. Piles with integrity deficiencies, contaminated grout, lack of grout consolidation (honeycombed), or deficient grout strength.
5. Piles with reinforcement, anchor devices or other components cast, or placed into the fluid grout out of position.
6. Piles in which compressive strength tests indicate that the grout compressive strength is more than 500 psi below the specified design strength when the specified design strength is 5,000 psi or less.

7. Piles in which compressive strength tests indicate that the grout compressive strength is less than 90% of the specified design strength when the specified design strength exceeds 5,000 psi.

When the Engineer determines that a pile is unacceptable, the Contractor may propose a foundation redesign to add piles into pile caps or footings, at no expense to the Department. The Contractor's Engineer of Record must perform any redesign, and sign and seal the redesign drawings and calculations. Do not begin any proposed construction until the redesign has been reviewed for acceptability and approved by the Engineer.

#### **455-47 Auger Cast Pile Installation Plan (ACPIP).**

No later than 30 days before auger cast pile construction begins, submit an ACPIP for Engineer's approval. The Engineer will give final approval subject to satisfactory performance in the field. Provide the following detailed information on the plan:

1. Name and experience record of ACP foreman in responsible charge of auger cast pile operations.
2. List and size of the proposed equipment, including cranes, augers, grout pumps, mixing equipment etc. Include the diameter of the hollow stem through which grout will be pumped.
3. Details of grout mixing procedures and proposed calibration procedures.
4. Equipment and procedures for monitoring and recording grout pressures and volumes placed during grouting operations.
5. Details of pile installation methods.
6. Details of reinforcement placement and method of centering in pile, including details of all temporary supports for reinforcement, anchor bolts, precast columns, etc.
7. Required submittals, including shop drawings and approved grout design mixes.
8. Procedures to meet the requirements of Section 108.
9. Evidence of foreman's experience meeting the requirements of 455-39.1. Provide a list of projects performed by the foreman. Include a client contact reference name and contact information for each project listed. Projects that do not meet the requirements of 455-39.1 or that cannot be verified by the Engineer because of insufficient information provided in the ACPIP will not count towards the experience.
10. Evidence that the technicians that will perform the efflux tests meet the requirements of 455-39.1.
11. For bridge foundations, include the following in the ACPIP:
  - a. Name and experience record of the technician(s) in charge of monitoring the AME.
  - b. Equipment and procedures for monitoring and recording auger rotation speed, auger penetration rates, auger depths, and crowd pressures during the drilling process.
  - c. Calibration records for all automated measuring and recording equipment.
  - d. Details of how the grout volumes will be determined, monitored, and documented.

e. Details of any required load tests, including structural elements, reaction foundations, equipment and procedures, and recent calibrations for any jacks or load cells.

f. Proposed Thermal Integrity Testing Specialty Engineer to supervise, perform, log, analyze, and report the test results.

g. Method for measuring the maximum core temperature of the demonstration piles and test piles.

#### **455-48 Inspection and Records.**

Perform the automatic monitoring and recording of the various drilling and grouting parameters. The Engineer will observe the pile installation and complete the ACP Installation record.

#### **455-49 Load Tests and Pilot Holes.**

When pilot holes and/or load tests are performed, the Engineer will use the pilot hole and/or load test results to determine the authorized tip elevations and/or the authorized installation criteria of the auger cast piles. Production auger cast piles shall not begin until pilot hole and/or load test reports are approved by the Engineer. Final authorized tip elevations based on pilot hole results and/or load tests may vary from the tip elevations presented in the Plans. Extend auger cast piles deeper when the Engineer determines the material encountered during drilling is unsuitable or is not the same as anticipated in the design of the auger cast piles. In the absence of suitable strength tests, pilot holes or load tests to evaluate materials excavated, construct the auger cast piles no higher than the tip elevations shown in the Plans.

Perform compression and tensile load tests at the locations indicated in the Plans. Design and install reaction foundations to properly resist a load equal to the maximum test load indicated in the Plans plus 25%. Provide and install internal strain gauges throughout the length of the cage. Unless indicated otherwise in the Plans, provide a minimum of three sister bar strain gauges every five feet along the reinforcing. Provide a readout unit to record the data from all instruments.

**455-49.1 Compression Load Tests:** Perform compression load tests to the load indicated in the Plans and in accordance with ASTM D1143 except use the loading procedures and failure criterion specified in 455-2.2.1. Do not begin static load testing until the grout has attained a compression strength of at least 90% of the specified design strength.

**455-49.2 Tensile Load Tests:** Perform tensile load test to the load indicated in the Plans and in accordance with the scope, preparation and procedures of ASTM D3689. Follow Procedure A: Quick Test, except apply and remove the load at the same increments and decrements specified in 455-2.2.1 and at the same time intervals specified in this subarticle.

The failure load shall be the load that causes a deflection equal to the calculated elastic deflection plus 0.15 inches. Consider the nominal resistance of any pile so tested as either the maximum applied load or the failure load, whichever is smaller.

**455-49.3 Pilot Holes:** When pilot holes are shown in the Plans core a pilot hole, prior to construction of production auger cast piles, in accordance with ASTM D2113 Standard Practice for Diamond Core Drilling for Site Excavation and the Department's Soils & Foundations Handbook using a double or triple wall core barrel through part or

all of the pile, to a depth of 3 times the diameter of the auger cast pile below the tip elevation shown in the Plans. The Engineer may require the Contractor to cut any core to a total depth below the bottom of the auger cast pile of up to 5 times the diameter of the auger cast pile. Submit a complete soil boring log or report of core boring, within 48 hours of completing the pilot hole.

#### **455-50 Authorized Pile Tip Elevations.**

The tip elevation indicated in the Plans is an estimation that may change for the final construction based on the pilot holes information or the load test results. Within five working days after performing all pilot holes, completing all load tests, and receiving all load test reports, the Engineer will issue a letter with an itemized list of authorized pile tip elevations. This letter may also specify a minimum rock socket requirement. During the drilling operations, the Engineer may require a deeper pile tip than the authorized tip elevation to meet a required socket elevation or for any other reason.

#### **455-51 Non-Destructive Integrity Testing.**

**455-51.1 Thermal Integrity Testing for ACP (TITACP) Procedure:** Engage a qualified Specialty Engineer and personnel for TITACP in accordance with 455-17.6 Thermal Integrity Testing for Drilled Shafts (TITDS) to perform Thermal Integrity Testing in accordance with ASTM D7949 Method B (wires) and 455-17.6.1.1, except that a minimum of 4 equally spaced wires must be used on the reinforcement cage of each pile, and as indicated otherwise herein. When approved by the Engineer, thermal probes (Method A) may be substituted for thermal wires (Method B) in accordance with 455-16.4 and 455-17.6.1. Provide all necessary assistance to the Specialty Engineer to satisfactorily perform the testing.

Test all demonstration piles, all load test piles and all production piles with wires at the time of peak temperature. For demonstration piles and load test piles, determine the core center temperature and the temperatures at the reinforcement using the center wire and wires at the reinforcement respectively.

For each grout mix design and each pile size, determine the Average Delta Temperature between the core temperature and the rebar temperature as follows:

$$\text{Average Delta Temperature} = \text{Average Center Temp.} - \text{Average Rebar Temp.}$$

Where:

Average Center Temperature is the average temperature throughout the full depth of the wire measured by the center wire.

Average Cage Rebar Temperature is the average temperature at the rebar cage computed by averaging all cage wire temperatures throughout the full depth of the wires on the rebar cage.

If the radial position of wire changes due to cage configuration changes, then compute the average cage temperature for each region with the same cage configuration. Compute Average Delta Temperatures for each cage configuration in the pile.

Determine the core temperature of the production piles at each depth by adding the Average Delta Temperature computed for each mix grout and pile size, to the

temperatures measured at each depth and wire location. The core temperature at any depth determined this way shall not exceed 160°F.

**455-51.2 Thermal Integrity Testing Access Tubes:** For piles to be used in the foundation of bridges and tested with thermal probes, provide 4 Thermal Integrity Testing Access Tubes attached to the reinforcing cage of all auger cast piles in accordance with 455-16.4 except that the entire length of each access tube may be NPS 1-1/2 or 2-inch diameter Schedule 40 or Schedule 80 PVC pipe, and the tubes must be filled with water and recapped prior to or immediately after inserting the reinforcing cage into the grouted pile.

Unless indicated otherwise in the Plans, neither thermal wires nor access tubes are needed for piles supporting miscellaneous structures and noise walls.

**455-51.3 Thermal Integrity Testing Reports:** Submit Thermal Integrity Testing reports meeting the requirements of 455-17.6.1.3, together with all electronic data, within 48 hours of testing to the Engineer. Replace all references to shafts in 455-17.6.1.3 with piles. When Method B (wires) is used, include a graph of measured temperatures versus time in the report.

**455-51.4 Engineer Testing:** The Engineer may perform independent testing using thermal integrity or other means on selected piles.

#### **455-52 Method of Measurement.**

**455-52.1 Auger Cast Pile:** For ACP supporting bridge structures and other structures identified in the Plans, the quantity to be paid for will be at the Contract unit price per foot between the authorized tip elevation and the accepted as-built pile top elevations for all piles completed and accepted. If, during the drilling of a particular pile, the Engineer requires a pile tip deeper than the authorized pile tip, the quantity to be paid will be computed between this final deeper tip elevation and the accepted as-built pile top elevation.

**455-52.2 Thermal Integrity Testing:** The quantity of the Thermal Integrity tests to be paid for will be the number of auger cast piles tested with this method and accepted based on the results of the test. No payment will be made for any integrity testing performed to evaluate the acceptability of piles as part of an EAR. No payment will be made for any integrity testing performed by the Engineer.

**455-52.3 Test Loads (Compression):** The quantity to be paid for will be the number of auger cast piles tested in accordance with 455-49.1.

**455-52.4 Test Loads (Tensile):** The quantity to be paid for will be the number of auger cast piles tested in accordance with 455-49.2.

#### **455-53 Basis of Payment.**

**455-53.1 Auger Grouted Piles for Tangent and Secant Walls Only:** Price and payment will be full compensation for all labor, materials, including grout, reinforcement, and incidentals for construction of auger cast piles, of the sizes and depths indicates on the Contract drawings or otherwise required under this Contract. Price and payment will also include the removal and proper disposal off site of all spoil from the auger operation and all excess grout displaced from the auger hole, unless otherwise approved by the Engineer. Work to remove and replace unsuitable materials, when necessary, as specified in 455-44 will be considered Unforeseeable Work. Payment will be made under item 455-112.

**455-53.2 Auger Cast Piles for Bridges:** Price and payment will be full compensation for all labor, materials, including grout, reinforcement, wires, and access tubes for TIPACP testing, drilling, and incidentals for construction of auger cast piles for bridge structures, of the sizes and depths indicated on the Contract drawings or otherwise required under this Contract. Price and payment will also include the removal and proper disposal off site of all spoil from the auger operation and all excess grout displaced from the auger hole, unless otherwise approved by the Engineer. Work to remove and replace unsuitable material, when necessary, as specified in 455-44 will be considered Unforeseeable Work.

**455-53.3 Auger Cast Piles for other Structures:** No separate payment will be made for ACP for privacy walls, noise walls, signs, lighting, mast arms and any other miscellaneous structure. The cost of ACP for these structures is included in the cost of the structure.

**455-53.4 Load Test Auger Cast Piles:** Price and payment will be full compensation for all labor, materials, including grout, reinforcement, access tubes for TIPACP testing, drilling, and incidentals for construction of load test piles of the sizes and depths indicated on the Contract drawings or otherwise required under this Contract. Price and payment will also include the removal and proper disposal off site of all spoil from the auger operation and all excess grout displaced from the auger hole, unless otherwise approved by the Engineer. Work to remove and replace unsuitable material when necessary as specified in 455-44 will be considered Unforeseeable Work.

**455-53.5 Demonstration Piles:** No separate payment will be made for demonstration piles. All cost of demonstration piles will be included in the cost of Auger Grouted Piles.

**455-53.6 Thermal Integrity Testing:** Price and payment will include all costs related to the performance of the Thermal Integrity Testing including any incidentals.

**455-53.7 Pilot Holes:** Price and payment will be in accordance with 455-24.5.

**455-53.8 Static Load Tests (Compression):** Price and payment will be full compensation for all labor, materials, and incidentals for the execution of compression tests, including instrumentation and professional services to prepare the report.

**455-53.9 Static Load Tests (Tensile):** Price and payment will be full compensation for all labor, materials, and incidentals for the execution of tensile tests, including instrumentation and professional services to prepare the report.

**455-53.10 Payment Items:** Payment will be made under:

- |                   |   |
|-------------------|---|
| Item No. 455-112- | Auger Grouted Piles - per foot.                           |
| Item No. 455-113- | Auger Cast Piles for Bridges - per foot.                  |
| Item No. 455-148- | Thermal Integrity Testing for Auger Grouted Piles - each. |
| Item No. 455-119- | Static Load Test (Compression) - each.                    |
| Item No. 455-119- | Static Load Test (Tensile) - each.                        |
| Item No. 455-111- | Core/Pilot Hole - per foot.                               |