DESCRIPTION.
This work shall consist of the Contractor securing and providing the services of an independent Dynamic Monitoring Firm to furnish and operate all equipment necessary to perform dynamic monitoring of the test piles using pile driving analyzer (PDA), and prepare summary reports. Dynamic monitoring shall conform to ASTM D 4945. The Dynamic Monitoring Firm shall have a minimum of ten years’ experience in the use of the test equipment, performance of Wave Equation analysis and performance of Case Pile Wave Program (CAPWAP) analysis described herein, and must be pre-approved by the Engineer. Wave Equation and CAPWAP analyses shall be performed by an approved member of the Dynamic Monitoring Firm with a minimum of seven years’ experience with such analyses. The approved Dynamic Monitoring Firm shall be responsible for conducting the actual tests. Dynamic pile monitoring shall be performed by a member of the Dynamic Monitoring Firm, subject to the approval of the Engineer, with a minimum of ten years’ experience, at test pile locations shown on the Plans or as directed by the Engineer. The Contractor shall submit the qualifications of the Dynamic Monitoring Firm, as well as the proposed personnel for performing the monitoring and analyses, to the Engineer for approval. Dynamic monitoring and CAPWAP analysis shall be overseen by a Licensed Professional Engineer who is registered in the State of New York.

Dynamic pile monitoring involves attaching two waterproof strain transducers and two waterproof accelerometers to the pile approximately 2 to 3 pile diameters below the pile head prior to initial driving. The dynamically monitored piles shall be of sufficient length so those gauges are not driven below the water or ground line. Cables connecting the gauges near the pile head with the PDA located at the ground or water level shall be of sufficient length to reach 50 to 100 feet from the pile.

Dynamic pile monitoring shall be undertaken on all test piles for the full length of driving during both initial driving and restrikes. This monitoring shall be performed to evaluate hammer and drive system performance, to assess pile installation stresses and integrity, and estimate the nominal geotechnical resistance.

MATERIALS. The equipment used shall be suitable for the existing site and subsurface conditions.

CONSTRUCTION DETAILS.

Equipment. The Contractor shall supply a source of electrical power, providing 1,800 watts of 115-volt AC, 60 hertz, at each test location and any shelter from weather, required to protect the test equipment. The dynamic monitoring shall be performed using a GC, GCPC, 8G, or PAK Model Pile Driving Analyzer. All equipment necessary for the dynamic monitoring, such as gauges, cables etc. shall be furnished by the Dynamic Monitoring Firm. Where piles are to be driven underwater, provide dynamic pile monitoring gauges for underwater use. The equipment shall conform to ASTM D 4945 “High Strain Dynamic Testing of Piles.”

All repair or replacement costs, regardless of who performs the actual repair, shall be at no additional cost to the State.
At least 28 days prior to driving the test piles the Contractor shall submit the completed pile and driving equipment data form, BD-138, to the Engineer. The independent testing firm shall use the submitted information to perform initial wave equation analyses and shall prepare a summary report of the wave equation results. The wave equation analyses shall be used to assess the ability of the proposed driving system to install the piles to the specified tip elevations within the allowable driving stresses.

Approval of the proposed driving system by the Engineer shall be based upon the wave equation analyses indicating that the proposed driving system can attain the specified tip elevation and nominal geotechnical resistance shown on the plans without exceeding the allowable driving stress limits specified in the FHWA Manual “Design and Construction of Driven Pile Foundations – Volume I” Chapter 8; Publication No. FHWA-NHI-16-009, September 2016.

The Contractor shall notify the Engineer of the test pile-driving schedule at least 48 hours prior to driving test piles at any location.

The Contractor shall arrange for the appropriate Dynamic Monitoring Firm personnel to be on site at the time of driving.

Dynamic monitoring shall be conducted on test piles for the entire duration of the test pile installation and restrike. Restrikes shall be performed not less than three (3) days following the end of initial driving.

The Dynamic Monitoring Firm shall direct the progress of the testing work and shall obtain and record the test data.

Dynamic measurements resulting from the pile-hammer blows shall be automatically recorded on magnetic tape or computer disks. The independent testing firm shall operate the PDA tape recorder (if applicable) and the digital computer equipment, which analyzes the input data for pile stresses, pile-soil support capacity, and hammer efficiency. For each blow, both the standard Case Method value (RSP) and the maximum Case Method value (RMX) shall be calculated.

Case Pile Wave Program (CAPWAP) analyses of the dynamic pile monitoring data shall be performed on data obtained from the end of initial driving and from the beginning of all restrikes for all test piles. The Engineer may request additional analyses at selected pile penetration depths. The wave equation developed shall be used to evaluate the performance of the pile driving system for all test piles at the specified tip elevation.

Each CAPWAP analysis shall be used to provide a graph showing the bearing capacity versus blow count, pile stress versus blow count; nominal bearing capacity versus elevation and dynamic unit shear friction versus depth; re-evaluation of the soil parameters used in the original wave equation analysis by matching the measured and computed values of forces, velocities and displacements; and static resistance distribution along the length of the pile. All computer printouts and graphs from the CAPWAP analysis shall be submitted to the Engineer within seven days of the completion of the
dynamic tests. The submission shall also include electronic copies of the appropriate files on non-copy protected compact disc in Microsoft Excel® compatible format with no password protection. All hard copies and electronic files of PDA data shall include the correct depth or elevation and the correct blows per foot that match the pile driving record maintained by the Contractor.

During dynamic pile monitoring, the Dynamic Monitoring Firm shall prepare a daily field report summarizing the dynamic monitoring results. As a minimum, each daily field report shall include the calculated driving stresses, transferred energy, and estimated pile capacity at the time of testing. Variations from previous trends in the dynamic test data shall also be noted. Daily field reports shall be e-mailed to the Engineer within 24 hours of each dynamic test.

The Dynamic Monitoring Firm shall prepare a written final report for each test pile that contains a discussion of the pile capacity obtained from the dynamic testing and the method for calculating the pile capacity (RMX and/or RSP). The final report shall also discuss hammer and driving system performance, driving stresses, and pile integrity and shall contain all items outlined in ASTM D 4945 “High Strain Dynamic Testing of Piles”, Section 7 “Report”. This report shall also include the End-of-Driving CAPWAP and the Beginning-of-Restrike CAPWAP. All reports shall be organized and bound in a professional manner and prepared by a Licensed Professional Engineer who is registered in the State of New York. Reports that are unorganized and prepared in a careless manner will be rejected and returned to the Contractor for revision. In addition, the Contractor shall submit an electronic version of all reports in pdf format without copy protection or password.

**METHOD OF MEASUREMENT**

**A. Dynamic Pile Tests.** The quantity of Dynamic Pile Tests to be measured for payment will be the number of pile tests performed. If the pile requires re-driving within 28 hours after the initial test, this shall be considered as one Dynamic Pile Test. If re-driving is more than 28 hours after the initial test, this shall be considered as an additional test.

**BASIS OF PAYMENT**

**A. Dynamic Pile Test.** The cost of furnishing equipment and personnel to perform initial wave equation analyses, perform Dynamic Pile Monitoring, perform CAWAP analysis, and prepare a test report for each test pile, shall be included in the unit price bid.

*Payment will be made under:*

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