SPECIAL SPECIFICATION

4586
Dynamic Monitoring and Analysis of Driven Piling

1. Description. This item consists of (1) conducting the dynamic pile monitoring during initial pile driving and during pile restrikes and (2) the services of a dynamic testing consultant to provide dynamic analyses using Case Pile Wave Analysis Program (CAPWAP) and Wave Equation analyses programs. The CAPWAP and Wave Equation analyses shall be performed for the purpose of obtaining ultimate pile bearing capacity, pile stresses, pile integrity, and pile driving system efficiency.

The Contractor shall supply all material, equipment, and labor to perform the dynamic monitoring. The Contractor shall obtain the dynamic measurements with the Pile Driving Analyzer (PDA) of monitor piles and furnish the necessary dynamic data to the dynamic testing consultant.

2. Equipment.

A. The Pile Driving Analyzer (PDA) shall be capable of four channels of strain data acquisition and four channels of acceleration data acquisition. The PDA shall conform to the requirement of ASTM D-4945.

B. To prepare the pile for sensor attachment, a drill of sufficient power, operated by either a DC battery or a generator, shall be furnished. A hammer drill is required for preparation of concrete piles.

3. Scope of Work. The Contractor shall furnish equipment, materials, and labor necessary for conducting dynamic pile monitoring and contacting dynamic testing consultant for providing the CAPWAP and Wave Equation analyses.

A. Dynamic Pile Monitoring. This work consists of obtaining dynamic measurements with the Pile Driving Analyzer (PDA) of monitor piles during initial pile driving and during pile restrikes. Dynamic monitoring involves attaching at least two strain transducers and two accelerometers to the 24 inch square pile, and at least four strain transducers and four accelerometers to the 54 and 66 inch cylindrical pile near the pile head during initial driving and during restrike testing. A cable or wireless transmission connects the sensors near the pile head with the Pile Driving Analyzer located a safe distance from the pile, but not more than 330 ft from the pile. The cost of equipment mobilization or any delays due to dynamic pile monitoring shall be subsidiary to pertinent bid items. When dynamic monitoring is specified, the piles shall be lengthened by a distance of 2.5 times the pile diameter to allow access to the top of the pile at the end-of-driving. The additional length on the piles to be monitored is included in the total pile lengths shown in the plans.
During pile driving operations the pile driving stresses induced by the Contractor's hammer shall be monitored with the pile driving analyzer to ensure that the pile is not being damaged. When necessary, the Contractor shall reduce the driving energy transmitted to the pile.

- **Pile Restrike.** Pile restrikes for monitor piles may be performed in accordance with the time intervals specified below unless otherwise shown in the plans. Monitor piles with dynamic monitoring shall have a 1-day restrike after the initial pile installation with the Pile Driving Analyzer monitoring the driving.

- **Field Report.** Within one day of dynamic pile monitoring, the Contractor shall prepare a hand written daily field report summarizing the dynamic monitoring results. As a minimum, the daily reports shall include the calculated driving stresses, transferred energy, and estimated pile capacity at the time of testing. Daily field reports shall be transmitted to the Engineer.

**B. Dynamic Analysis.** The Contractor shall secure the Dynamic Testing Consultant (DTC) to perform either a Case Pile Wave Analysis Program (CAPWAP) analysis or a Wave Equation analysis or a combination of both, for each occurrence of dynamic monitoring. The minimum requirement of the DTC shall be a Master Level PDA tester as certified by the Foundation QA. The Contractor shall furnish the necessary dynamic data obtained from the dynamic monitoring to the consultant who shall use the results from the CAPWAP data to assess pile installation stresses and integrity, as well as to predict the pile’s static bearing capacity and resistance distribution. This information will be used to verify the Pile Driving Analyzer’s Case pile capacity assumptions and to determine the distribution of soil static resistance, quakes, and damping factors required for the wave equation analysis. The dynamic testing consultant shall use the CAPWAP results to establish the relationship between stroke, energy, and blow count in the wave equation. The dynamic testing consultant shall submit two copies of the results to the Department’s Geotechnical Section within 1 week of receiving the data unless otherwise directed by the Engineer. Additional production piles may be monitored if deemed necessary by the Engineer. The cost of additional analyses shall be at the contract unit price for dynamic analysis unless it is determined that the monitoring is necessary because of Contractor error.

**4. Measurement.**

- **A. Dynamic Pile Monitoring.** The number of dynamic monitoring to be paid for will be the number of dynamic monitoring occurrences on monitor piles ordered and completed. Dynamic monitoring during initial pile driving shall be considered as a single monitoring occurrence. Additionally, monitoring during pile restrike shall be considered as a separate monitoring occurrence. Dynamic monitoring occurrences that are necessary because of Contractor error shall not be measured for payment. Quantities of dynamic pile monitoring and dynamic analysis will be shown on the plans.
B. **Dynamic Analysis.** The number of dynamic analysis to be paid for will be the number of dynamic analysis occurrences on test piles or monitor piles. Dynamic analysis occurrences that are necessary because of Contractor error shall not be measured for payment.

5. **Payment.**

A. **Dynamic Pile Monitoring.** Payment for dynamic monitoring will be made at the unit price per each.

B. **Dynamic Analysis.** Payment of the dynamic analysis (CAPWAP or Wave Equation) performed by the dynamic testing consultant will be paid for at the contract unit price for each occurrence of dynamic monitoring.