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	JOB NO. J2S0787 Livingston County, MO Date Prepared: 2/14/2012

JOB SPECIAL PROVISIONS (BRIDGE)

Job No J2S0787
Route V
Livingston County

JOB SPECIAL PROVISIONS (BRIDGE)

A. DYNAMIC PILE TESTING

1.0 General.

1.1 Scope of Work. Scope of work shall include furnishing all labor, equipment and analysis associated with dynamic testing of driven piles as specified in this special provision.

1.2 Performance and Design Requirements. Performance and design conditions for dynamic testing of driven piles shall be in accordance with [section 4.0](#) of this special provision.

1.3 Approved Manufacturers. For the following hardware and software components, only the listed manufacturer is recognized as providing the level of quality required. If the contractor wants to propose a non-listed manufacturer that is considered to provide an equivalent level of quality, this manufacturer shall be identified and supporting documentation provided. Acceptance of the manufacturer as a substitute will be at the discretion of the engineer.

Component	Product	Manufacturer
Pile Driving Modeling - Wave Equation Software	GRLWEAP	Pile Dynamics, Inc.
Pile Driving Monitoring - Hardware & Software	Pile Driving Analyzer - Model PAK	Pile Dynamics, Inc.
Pile Driving Analysis – Signal Matching Software	CAPWAP	Pile Dynamics, Inc.

1.4 Test Requirements. Dynamic pile testing shall be conducted in accordance with the standard test method indicated below.

Standard Test Method	Designation	Conducted By
High-Strain Dynamic Testing of Piles	ASTM D 4945	Contractor

1.5 Qualifications. The contractor shall perform dynamic pile testing utilizing the services of an independent dynamic pile testing consultant and qualified personnel. An engineer with a minimum of 3 years dynamic pile testing and analysis experience or who has achieved Basic or better certification under the High-Strain Dynamic Pile Testing Examination and Certification process of the Pile Driving Contractors Association and Foundation QA shall perform pile driving monitoring. An engineer with a minimum of 5 years dynamic pile testing and analysis experience or who has achieved Advanced or better certification under the High-Strain Dynamic Pile Testing Examination and Certification process of the Pile Driving Contractors Association and Foundation QA shall perform pile driving modeling and pile driving analyses.

2.0 Execution.

2.1 Pile Driving Modeling. The contractor shall perform preconstruction wave equation analyses and prepare a summary report of the results. The wave equation analyses shall be used to assess the ability of all proposed pile driving systems to install piles to the required capacity and the desired penetration depth within allowable driving stresses. The report shall include a drivability graph relating pile capacity, blow count and driving stresses to depth. The report shall include a bearing graph relating the pile capacity to the pile driving resistance. The bearing graph shall indicate blow count versus capacity and stroke. The report shall also contain a constant capacity analysis or inspectors chart to assist the engineer in determining the required driving resistance at other field observed strokes. The contractor shall perform wave

equation analyses in accordance with [section 4.0](#) of this special provision. Acceptability of the wave equation report and the adequacy of analyses will be determined by the engineer.

2.1.1 Approval by the engineer of the proposed pile driving system will be based upon the wave equation analyses indicating that the proposed system can develop the specified pile capacity at a pile driving rate of 2 to 10 blows per inch at the end of driving, and within allowable driving stresses per *AASHTO LRFD Bridge Construction Specifications*, Section 4.4.1. The contractor shall provide preliminary pile driving criteria based on wave equation analyses and any anticipated capacity changes after driving, set-up or relaxation, subject to revision based upon dynamic pile testing field measurements

2.1.2 If any changes or modifications are made to the approved pile driving system, additional wave equation analyses in accordance with [section 2.1](#) of this special provision shall be required.

2.2 High-Strain Dynamic Pile Testing.

2.2.1 The contractor shall perform dynamic pile testing at the locations and frequency required in accordance with [section 4.0](#) of this special provision.

2.2.2 Dynamic pile testing involves monitoring the response of a pile subjected to heavy impact applied by the pile hammer at the pile head. The testing shall provide information on the driving stresses, pile capacity, structural integrity and hammer efficiency.

2.2.3 The contractor shall engage an independent dynamic pile testing consultant and qualified personnel in accordance with [section 1.5](#) of this special provision. Prior to testing, the engineer will review and approve the proposed independent dynamic pile testing consultant, the experience and qualifications of assigned personnel, details of the method of testing, a list of equipment, and the method of analysis of test results. The contractor shall provide all available details of the subsurface conditions, pile dimensions and properties, and pile driving systems to the independent dynamic pile testing consultant.

2.2.4 All field testing and measurements shall be made in the presence of the engineer.

2.3 Field Testing.

2.3.1 Equipment. Dynamic pile testing field measurements shall be carried out using approved equipment, software and recording equipment. The data collected at the end of initial driving and the beginning of restrike shall be analyzed using approved signal matching techniques and software.

2.3.2 Monitoring during driving. During pile driving, piles shall be instrumented and monitored with testing equipment satisfying the requirements of [section 1.3](#) of this special provision.

2.3.2.1 The contractor shall install two sets of strain transducers and accelerometers near the top of each pile to be tested, and shall use a compatible measuring and recording system to record the data during driving.

2.3.2.2 The equipment required to be attached to the pile shall be appropriately positioned and fixed to the approval of the engineer.

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2.3.2.3 The hammer and all site equipment used shall be capable of delivering an impact force sufficient to mobilize the specified pile capacity indicated in [section 4.0](#) of this special provision without damaging the pile.

2.3.2.4 The testing equipment shall monitor pile stresses during driving to prevent pile damage and ensure pile integrity and capacity. If the testing equipment indicates overstressing or damage to the pile, the contractor shall immediately discontinue driving and notify the engineer.

2.3.2.5 If the testing equipment determines that pile stresses during driving exceed acceptable levels, a new pile driving system, modifications to existing system or new pile installation procedures shall be proposed by the contractor. Approval by the engineer of any proposed changes to the pile driving system or pile installation procedures will be based upon the results of additional wave equation analyses in accordance with [section 2.1.2](#) of this special provision.

2.3.3 Preparation of the Pile Head. The preparation of the pile head for the application of dynamic test load shall involve, where appropriate, trimming the head, cleaning, and building up the pile using materials that shall, at the time of testing, safely withstand the impact stresses. The impact surface shall be flat and at right angles to the pile axis.

2.3.4 Dynamic Measurement and Analysis. Monitoring of pile driving shall begin when pile driving begins. The data shall be recorded and processed immediately in the field by the pile driving monitoring equipment and software. Unless monitoring indicates that additional driving will damage the pile, pile driving and monitoring shall continue until both the specified pile tip elevation and the specified pile capacity are reached. For each pile tested, pile driving analysis using signal matching techniques shall be performed for a selected blow at the end of driving to determine the relative capacities from end bearing and skin friction along the pile.

2.3.4.1 Restrike tests shall be performed at the frequency indicated in [section 4.0](#) of this special provision. The time interval between end of initial driving and beginning of restrike shall be in accordance with [section 4.0](#) of this special provision. During restrike, the pile shall be instrumented and monitored similar to during initial driving. For each restrike test, pile driving analysis using signal matching techniques shall be performed for a selected blow from the beginning of restrike to determine the relative capacities from end bearing and skin friction along the pile.

2.3.4.2 The restrike test shall be performed with a warmed up hammer and shall consist of striking the pile for 20 blows or until the pile penetrates an additional 3 inches whichever occurs first unless testing equipment indicates overstressing or damage to the pile. If such overstressing or damage to the pile is indicated, the contractor shall immediately discontinue driving and notify the engineer. In the event initial restrike testing indicates a pile capacity below the specified capacity additional driving may be required as directed by the engineer.

2.3.4.3 The engineer may request use of pile driving monitoring equipment and software on additional piles if inconclusive results are obtained or unusual driving conditions are encountered.

2.3.4.4 Pile bearing capacity and integrity shall be evaluated based on the standard procedure used in practice.

2.3.4.5 Tabular records of the dynamic pile testing field measurements obtained at the end of initial driving and at the beginning of restrike shall be immediately provided to the engineer by the contractor.

2.3.5 Results.

2.3.5.1 Preliminary Reports. The contractor shall prepare a preliminary report for each pile tested for review by the engineer. Each report shall contain tabular as well as graphical presentation of the dynamic test results versus depth. Each report shall also indicate the pile driving criteria for the additional piles to be installed at the substructure unit of the pile tested. Each preliminary report shall include the following:

- (a) The maximum force applied to the pile head.
- (b) The maximum pile head velocity.
- (c) The maximum energy imparted to the pile.
- (d) The assumed soil damping factor and wave speed.
- (e) Static capacity estimate.
- (f) The maximum compressive and tensile forces in the pile .
- (g) Pile integrity.
- (h) Blows per inch.
- (i) Stroke.
- (j) Summary results of pile driving analysis from selected blow analyzed using signal matching techniques and software.

2.3.5.2 Summary Report. The contractor shall prepare a summary report of all piles tested for review by the engineer. The report shall include the results of hammer performance, pile driving stresses, and pile capacity during initial driving and restrike for all piles tested. The report shall also include the following:

- (a) Date of testing and date of pile installation.
- (b) Pile identification number and location.
- (c) All information given in preliminary reports as follows:
 - (1) Length of pile below commencing surface.
 - (2) Total length of pile, including projection above commencing surface at time of test.
 - (3) Length of pile from instrumentation position to tip.
- (d) Hammer type, drop, and other relevant details.
- (e) Blow selected for signal matching analysis.

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- (f) Maximum compressive and tensile stresses, stroke, and capacity versus penetration depth.
- (g) Temporary compression.
- (h) Pile integrity and location of damage, if any.
- (i) Force/velocity versus time trace.
- (j) Force/velocity match curve.
- (k) Resistance distribution along the pile.
- (l) Detailed graphical and tabular results from blow analyzed using signal matching techniques and software.

3.0 Schedule of Contract Submittals.

Item Number	Submittal Item	Type	Calendar Days	Event/Date	Liquidated Damages Apply
1	Proposed independent dynamic pile testing consultant, and a listing of assigned personnel and their experience and qualifications.	DOCS	45 Before	Start of Pile Driving Monitoring	No
2	Details of the components, method of testing, pile driving equipment and materials to be used, and the results of wave equations analyses.	DOCS	15 Before	Start of Pile Driving Monitoring	No
3	Two copies of each Preliminary Report as defined in section 2.3.5.1 of this special provision	DOCS	3 After	Completion of Each Field Test	No
4	Four copies of the Summary Report as defined in section 2.3.5.2 of this special provision	DOCS	7 After	Completion of All Field Tests	No

4.0 High-Strain Dynamic Pile Testing Specification.

Item	Requirement
Wave Equation Analysis	Minimum of 1 and sufficient additional analyses as needed to define performance for all combinations of piles, driving systems and subsurface conditions anticipated.
Dynamic Testing Pile Capacity	Nominal Axial Pile Compressive Resistance or 2.25 times the Design Bearing shown on the plans or as required by engineer

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Item	Requirement
End of Initial Driving Test Frequency	Minimum of 1 production pile for each substructure
Restrike Test Frequency	Minimum of 1 production pile for each substructure
Time Interval between End of Initial Driving and Restrike	Minimum of 7 days or as required by the engineer
Pile Driving Analyses using Signal Matching Techniques	For each End of Initial Driving Test and each Restrike Test

5.0 Method of Measurement. Dynamic pile testing and dynamic pile restrike testing will be measured per each.

6.0 Basis of Payment. Payment for the above described work, including all material, equipment, tools, labor and any other incidental work necessary to complete this item, will be considered completely covered by the contract unit price for “Dynamic Pile Testing” and “Dynamic Pile Restrike Testing”.

B. STATIC LOAD TEST

1.0 Description. This project will be part of a Missouri University of Science and Technology (MST) study on friction pile capacity. A static load test shall be performed on a sacrificial pile. The static load test will be performed by MST and high-strain dynamic testing will be performed by Geotechnology, Inc using a pile driving analyzer (PDA). This test will be performed during normal construction activities except as specified in this job special provision. The load test is expected to last no more than 3 days unless restrike testing is required by MST. The contractor will not be responsible for conducting any testing on the test pile. The contractor will be responsible for the dynamic testing on the piles used in the new bridge construction.

2.0 Construction Requirements. The contractor shall allow MST the opportunity to be present during the installation of the test pile and the construction of the load frame.

2.1 Pile Construction Requirements. The contractor shall be responsible for supplying and driving the test pile and the anchor piles as shown on the plans. Geotechnology, Inc. will use a PDA to monitor the test pile during driving at no cost to the contractor. Restrike testing of the test pile may be required as determined by MST. The contractor will be required to do anything needed to assist Geotechnology, Inc. with the test setup. Piles shall be driven to a nominal compressive resistance no greater than 250 kips with a terminal driving resistance between 25 and 100 blows per foot, which may be used to size the hammer for driving. In no case should the hammer for the test pile be larger than the hammer for the bridge pile. The test and anchor piles will have a maximum length of 35 feet. The actual embedment length will be specified by MST at the time of driving. Pile construction shall be in accordance with [Sec 702](#) except as noted in this special provision. The general location of the test pile will be at the _____ corner of the bridge and as specified by MST at the time of driving. No water jetting will be allowed during installation of the test and anchor piles. **Five feet of prebore shall be required for the test pile.** Pile cut-off elevations will be as directed by MST. Piles shall be concrete filled for static testing without steel reinforcement. Pile placement tolerances for driving may be more restrictive than allowed by [Sec 702](#).

2.2 Load Frame Construction. The contractor shall supply the materials and construct the load frame in accordance with the plans and [Sec 712](#) and [1080](#). Shop drawings will not be

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required for this portion of the work but questions regarding fabrication should be brought to the attention of MST. The contractor has the option of providing an equivalent W-shape beam as a substitute for the W24x84 beam as approved by the engineer.

2.3 Cooperation of Work. The contractor shall notify the engineer at least 4 weeks prior to driving of the test and anchor piles. The contractor shall work in cooperation with MST and Geotechnology, Inc. to complete the static pile load test. This may include, but is not limited to, use of the crane to move and set heavy equipment, miscellaneous welding and pauses in pile driving while instrumentation for the pile test is read accurately. No payment will be made for any inconvenience or time delays caused by this testing. The contract completion date will not be adjusted to compensate for any delays caused by this testing.

2.4 Removal and Storage of Load Frame. Upon completion of the load test, the contractor shall carefully disassemble the load frame so that no damage is done to the load frame members. After the load frame is disassembled, the contractor shall deliver the load frame members to the MoDOT storage lot on Route AA in Miner, Missouri. The contractor shall give the engineer 2 days notice prior to moving the load frame so that MoDOT can have the proper equipment on sight to unload the load frame. The parts of the load frame that need to be delivered are the load beam and channels.

2.5 Removal of Piles. Upon completion of the load test, the test and anchor piles shall be cut off 2 feet below the streambed or ground line and backfilled as approved by the engineer.

3.0 MST Self Insurance. MST is self insured and as such will be responsible for any negligence by their own employees including those activities associated with the Static Load Test.

4.0 Method of Measurement.

4.1 Test and Anchor Piles. No measurement will be made.

4.2 Load Frame. No measurement will be made.

5.0 Basis of Payment.

5.1 Test and Anchor Piles. Payment for materials, equipment and labor necessary to drive and cut-off the test and anchor piles will be considered completely covered by the contract lump sum price for "Static Load Test". The contractor will be paid for the full 175 feet of test and anchor pile regardless of how much is driven and cut-off.

5.2 Load Frame. Payment for the materials, equipment and labor necessary to construct, disassemble and delivery of the load frame will be considered completely covered by the contract lump sum price for "Static Load Test".

C. CANADIAN PACIFIC RAILROAD REQUIREMENTS

Insert RR JSP from Missy Wilbers when available