STEEL H PILES

1. GENERAL

1.1 Work Included

.1 Fabrication, delivery, and installation of steel driven piles.

.2 Pre-boring and filling of pre-boring hole after the pile installation.

.3 Supply and installation of driving shoes.

.4 Splicing and cutting off piles at required elevation.

.5 Fabrication, delivery, and installation of connection plate at top of piles.

.6 Pile Driving Analyzer (PDA) testing: Section 31 09 16.29.

.7 Third Part Vibration Monitoring of existing adjacent buildings.

1.2 Design Standards, Code Requirements

.1 Conform to requirements of CSA S16, CSA-S136, the Canadian Institute of Steel Construction (CISC) "Code of Standard Practice for Buildings" and the Provincial Construction Safety Act.

.2 Use loads, load combinations, and stress levels shown on Drawings and in accordance with the Manitoba Building Code.

.3 Perform all welding in accordance with requirements of CSA W59.

.4 Review the Geotechnical Report prior to submitting Bid for the Work.

1.3 Qualifications

.1 Perform welding in accordance with requirements of CSA W59.

.2 Welding is to be performed by a firm certified by the Canadian Welding Bureau to the requirements of CSA W47.1 in Division 2.

.3 All welders employed to weld load carrying structures in the field are to possess valid "S" Classification Class "O" certificates issued by the Canadian Welding Bureau except for floor and roof hatches.

1.4 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 01 33 00 - Submittal Procedures.

.2 Shop Drawings and Design Briefs are to bear the seal of a Professional Engineer (Construction Contractor’s Engineer), registered in the Province of Manitoba. The Construction Contractor’s Engineer is to have a minimum of ten (10) years experience in the design of specialty items used for driven steel piles. Submit proof of specialty experience to the Contract Administrator prior to submission of Shop Drawings.

.3 Submit Shop Drawings a minimum of four (4) weeks prior to the proposed start date of piling activities. Shop Drawings to indicate the following items:

.1 Copies of Mill Test Certificates showing chemical analysis and physical tests for piling material. Mill Test shall be done by an independent Canadian Testing Company. Piling material without this certificate will be rejected.

.2 Lifting point details and locations.

.3 Storage support point locations.

.4 Pile driving shoe details and connections.

.5 Length of steel piles complete with pile splices.

.6 Steel pile splice and special connections.

.7 Steel plate connection detail at top of piles.

.8 Indicate welded connections using welding symbols in compliance with CISC Welding Standards. Clearly indicate net weld lengths.

.4 Submit a minimum of four (4) weeks prior to the proposed start date of piling activities details of equipment for installation of piles:

.1 Impact hammers: give Manufacturer's name, type, rated energy per blow at normal working rate, mass of striking parts of hammer, mass of driving cap and type and elastic properties of hammer and pile cushions.

.5 Proof of certificate for the welders conducting the work.

.6 Submit a minimum of four (4) weeks prior to the proposed start date of piling activities, details of the pile installation sequencing:

.1 Indicate proposed pile driving equipment locations.

.2 Submit proposed pre-bore length for piles.

.3 Submit proposed piling sequence.

.4 Submit re-tamping sequence for pile groups.

.7 Submit a minimum of four (4) weeks prior to the proposed start date of piling activities, details of the vibration monitoring, including:

.1 Third party vibration monitoring personnel and qualifications.

.2 Vibration Monitoring Plan.

1.5 Site Conditions

.1 Visit site to ascertain special conditions which may affect work.

.2 Review the Geotechnical Report to identify subsurface conditions that may be encountered.

1.6 Delivery and Storage

.1 Minimum size holes are permitted to facilitate handling and lifting to vertical position.

.2 During delivery and storage, support long piles continuously along their lengths.

.3 All foundation units delivered to Site, which do not conform to terms of this Specification may be rejected by the Contract Administrator or his representative.

1.7 Protection

.1 Protect public and construction personnel, adjacent structures and work of other sections from hazards attributable to pile driving operations.

.2 Protect pile surfaces from damage and bent.

1.8 Scheduling

.1 Submit schedule of planned sequence of driving to the Contract Administrator for review, not less than two (2) weeks prior to commencement of pile driving for structure.

.2 Do not commence pile driving until authorized to proceed by the Contract Administrator.

1.9 Inspection and Testing

.1 Inspection and Vibration Monitoring of Existing Structures:

.1 The Contractor shall supply and operate enough suitable seismographs to accommodate the vibration monitoring for all structures located within the influenced zone, during pile installation. The Contractor shall monitor vibrations at structures within the 65 m radius of influence identified by the Contract Administrator, for the duration of the pile installation activities. The vibration monitoring equipment shall be capable of recording and reporting peak particle velocity (range of 2.5 to 250 mm/second) and frequency of vibration (range of 2 to 400 Hz in three axes) simultaneously for all structures within the specified radius.

.2 The seismograph equipment shall be made available for inspection and the data able to be downloaded by or provided to the Contract Administrator at any time during the pile installation activities.

.3 The City of Winnipeg shall arrange and complete structural inspections of nearby structures to the site, to the extent the City of Winnipeg will permit, prior to the start of and upon completion of pile installation. The City of Winnipeg shall document the existing conditions with sufficient photographs and produce one site inspection report that covers all structures prior to start of pile installation, and the condition after the pile installation is complete, and make the report available to the Contractor.

.4 The Contractor shall take all precautions to prevent damage to structures and adjacent properties during or as a consequence of pile installation operations. In the event of damage, the Contractor will be held liable, and shall be required to provide appropriate restoration and repairs at his cost, to the satisfaction of the Contract Administrator.

.5 Qualifications of Vibration Monitoring Personnel:

.1 The Contractor's vibration-monitoring personnel shall have the qualifications specified herein. These personnel may be on the staff of the Contractor or may be on the staff of a specialist subcontractor, However, they shall not be employed nor compensated by subcontractors, or by persons or entities hired by subcontractors, who will provide other services or material for the project.

.2 The Contractor's vibration-monitoring personnel shall include a qualified Vibration Instrumentation Engineer (Contractor's Vibration Engineer) who is a registered Professional Engineer in the Province of Manitoba, who has a minimum of a Bachelor of Science degree in civil engineering, and who has at least four (4) years of experience in the installation and use of vibration-monitoring instrumentation and in interpreting instrumentation data. The Contractor's Vibration Engineer shall:

.1 Be on site and supervise the initial installation of each vibration-monitoring instrument.

.2 Supervise interpretation of the vibration-monitoring data.

.6 Vibration Monitoring Plan shall include:

.1 The name of the Firm or Company providing the vibration monitoring services, including vibration monitoring staff qualifications.

.2 Description of the instrumentation, and equipment to be used.

.3 Vibration monitoring equipment laboratory calibration and test equipment certification.

.4 Measurement locations and methods for mounting the vibration sensors.

.5 Procedures for data collection and analysis.

.6 Means and methods of providing warning when the Response Values as specified in the Data Interpretation and Implementing Plans of Action section of this Special Provision are reached.

.7 Generalized plan of action to be implemented in the event any Response Value as specified in in the Data Interpretation and Implementing Plans of Action section of this Section is reached. The generalized plan of action shall be positive measures by the Contractor to control vibrations (e.g. using alternative construction methods).

.8 Submit data and reports as specified in Data Reduction, Processing, Plotting and Reporting section of this specification section.

.7 Pile Installation Plan:

.1 The Contractor shall develop a pile installation plan identifying the equipment to be used to install the piles, the sequence of pile installation, the maximum anticipated vibrations from the pile installation and a defined trigger level. The Contractor shall hire a Geotechnical Engineer (Contractor’s Geotechnical Engineer) registered in

Manitoba to review the pile installation plan and estimate the maximum anticipated vibrations during construction. Pile installation plan should include a proposed action and response plans in case a defined trigger level is exceeded. The Contractor's Geotechnical Engineer shall submit the signed and sealed pile installation plan for review by the Contract Administrator.

.2 The maximum allowable vibration threshold during construction shall be 7.6 mm/second (0.3 inches/second) as per Canadian Highway Bridge Design Code (CAN/CSA-S6-06) latest edition. If at any time during pile installation the vibrations exceed this threshold, the Contractor shall cease pile installation operations, revise and resubmit the pile installation plan to reduce the vibrations below the identified threshold.

2. PRODUCTS

2.1 Materials

.1 All materials shall be new.

.2 Structural steel wide flange sections (HP shapes): conforming to CSA G40.20/G40.21, Grade 350W with minimum yield of 350 MPa.

.3 Splice plates: CSA-G40.20/G40.2l, Grade 350 W with minimum yield strength of 350 MPa.

.4 Angles and miscellaneous steel: to CAN/CSA-G40.2l, Grade 300 W with minimum yield strength of 300 MPa.

.5 Bolts, nuts, and washers: conforming to ASTM A325 for steel members.

.6 Welding materials: conforming to CSA W59.

.7 Pile driving shoes: Titus Standard H Pile Points or APF Hard Bite 77600.

2.2 Fabrication

.1 Fabricate structural steel members in accordance with CSA S16 and CSA S136.

.2 Verify all Drawing dimensions prior to commencing fabrication.

.3 Provide connections for pile load capacities including loads related to the installation.

.4 Accurately cut and mill steel pile ends and bearing plates to assure full contact of bearing surfaces prior to welding and attachment of pile driving shoe.

.5 Splices for piles are to be welded.

3. EXECUTION

3.1 Tolerances

.1 Deviation of the pile cut-off elevation; plus or minus 10 mm from indicated elevation.

.2 Deviation of pile centre line indicated on the Drawings, at the pile cut off elevation to the installed location, at the pile cut off elevation to be within a 50 mm diameter circle of the pile centre line indicated on the Drawings. Piles beyond this deviation will be considered as Rejected Piles.

.3 Deviation from vertical; not more than one (1) unit horizontal to 75 units vertical. Piles exceeding this deviation be considered as Rejected Piles.

3.2 Repair and Restoration of Rejected Piles

.1 The Contract Administrator may require one or more of the following remedial measures in case of rejected piles:

.1 Remove rejected pile and replace with a new, and if necessary, a longer pile.

.2 Remove rejected pile and fill hole as directed by the Contract Administrator.

.3 Leave rejected pile in place and cut off as directed by the Contract Administrator.

.4 Leave rejected pile in place, place adjacent pile(s), and modify pile cap as directed by the Contract Administrator.

.2 No extra compensation will be made for items noted in the above clause. The Construction Contractor shall make good all other Work made necessary through the repair and restoration of rejected Piles at no additional cost to the Construction Contract.

.3 Any modification required to the pile cap or beam, due to piles out of tolerance or due to required additional piles to compensate for out of tolerance piles, shall be carried out as directed by the Contract Administrator at the Contractor's own costs.

3.3 Equipment

.1 Hammer:

.1 Hammers with proven performance in local conditions for piles of the same size specified will be accepted for use on this Work. For other hammers the driveability analysis as outlined in the following paragraphs shall be submitted to the Contract Administrator for review prior to driving piles.

.2 Hammers to be selected on basis of driveability analysis using wave equation theory, performed to show that piles can be driven to levels indicated.

.3 The driveability analysis shall include, but not be limited to, the following: hammer, cushion, and capblock details; static soil parameters; quake and damping factors, total soil resistance, blow count, pile stresses, and energy throughput at representative penetrations.

.4 Driveability analysis shall be submitted to the Contract Administrator for review of the hammer or hammers.

.5 When required criteria cannot be achieved with the proposed hammer, use larger hammer and take other measures as required.

.6 Drop hammers are not permitted.

.2 Leads:

.1 Construct pile driver leads to provide free movement of hammer. Hold leads in position at top and bottom, with guys, stiff braces, or other means to ensure support to pile while being driven.

.2 Length: Provide length of leads so that use of a follower is unnecessary.

.3 Swing leads: Not permitted.

.3 Followers: When permitted by the Contract Administrator in writing, provide followers of such size, shape, length, and mass to permit driving pile in desired location to required depth and resistance. Provide followers with socket or hood carefully fitted to top of pile to minimize loss of energy and prevent damage to pile. Drive applicable load test piles using similar follower.

.4 The refusal criteria shall be increased in order to account for additional energy loss through the use of follower and shall be estimated by the Wave analysis.

.5 Process data reporting shall be provided to the pile driving machine and shall include (at minimum), start time, stop time, total blows, penetration depth, total energy, energy with depth, duration of pile driving, ram weight, depth step and number of blows per minute.

.6 The pile driving hammer shall be equipped with a pile cushion consist of a minimum of 100 mm of compressible material and shall be tightly inside the pile helmet.

3.4 Preparation

.1 Ensure that ground conditions at pile locations are adequate to support pile driving operation. Make provision for access and support of piling equipment during performance of Work.

.2 Pre-boring of holes may be acceptable to facilitate pile alignment control and to penetrate frozen soil. Any void space remaining around the pile after completion of driving shall be filled with sand or other approved material.

.3 Excavate around the top of the pile, at the pile cut off elevation, in order for welding of the pile connection plate to the pile around the full perimeter of the pile.

3.5 Handling

.1 Protect piles from damage due to excessive bending stresses, impact, abrasion, or other causes during handling, storage, and delivery.

.2 Replace damaged piles to satisfaction of the Contract Administrator.

3.6 Splices

.1 Full length piles hall be used where practicable. In exceptional circumstances, splicing of piles may be permitted.

.2 Steel driven piles may be spliced providing the pieces being spliced are not less than 3 m long.

.3 The method of splicing shall be as following and approved Shop Drawings:

.1 Splices are to be equal to the full strength of the pile.

.2 The butting ends of the driven pile and its extension shall be cut square to give reasonable bearing between the matting surfaces.

.3 All butting surfaces shall be one hundred percent (100%) butt welded.

.4 The butting surface of the extension piece shall be bevel cut at 45° to facilitate a full-penetration butt weld. Temporary clamping plates or pre-approved pile splicer may be used as required.

.5 The piles shall not have more than one splice per pile unless otherwise approved.

.6 Material to be welded shall be preheated in accordance with CSA W59.

.7 When the air temperature is below 0°C, all materials to be welded shall be preheated to 100°C for a distance of 80 mm beyond the weld and shall be sheltered from the wind.

.8 When the air temperature is below -18°C, welding will not be permitted unless suitable hoarding is in place.

3.7 Pile Tips

.1 Pile tips shall be fully welded to provide the full strength of the piles.

3.8 Driving of Piles

.1 Steel driven piles are to be driven to achieve refusal as determined by Pile Dynamic Analyzer.

.2 The Contractor will be required to remove any surface and/or shallow depth obstruction(s) to obtain the required penetration of the pile.

.3 For pile installation monitoring purposes, the Contractor shall paint markings on each pile at 250 mm intervals, with a label at each 1000 mm intervals starting from the toe of the pile.

.4 Provide isolated excavation of in-situ soil around the tops of each driven pile to allow appropriate space for welding the underside of the pile weld plate to the top of the steel driven pile.

.5 The Contractor is responsible for the means, methods, and necessary precautions to manage vibration generated during pile driving. This may include modifying the driving sequence or introducing additional requirements to maintain acceptable vibration levels. The Contractor is responsible for all nuisances, noise, damage, and legal claims resulting from noise/vibration generated through piling or construction activities.

.6 Vibration Monitoring of Existing Structures:

.1 The purpose of the vibration monitoring program is to help protect nearby properties from excess vibration during pile installation activities associated with the pile installation work for all structures within 65 m (straight-line distance) from the pile installation activities.

.2 The Contractor shall supply and operate enough suitable seismographs to accommodate the vibration monitoring for all structures located within the influenced zone, during pile installation. The Contractor shall monitor vibrations at structures within the 65 m radius of influence identified by the Contract Administrator, for the duration of the pile installation activities The vibration monitoring equipment shall be capable of recording and reporting peak particle velocity (range of 2.5 to 250 mm/second) and frequency of vibration (range of 2 to 400 Hz in three axes) simultaneously for all structures within the specified radius.

.3 The Contractor shall install seismographs near the closest exterior comer of each structure that is within the specified radius range of the pile installation activities.

.4 The seismograph vibration sensors shall be located at points on the ground between 1 and 2 m from the structure facades unless otherwise directed by the Contract Administrator.

.5 The seismograph vibration sensors shall be firmly mounted on a surface slab of concrete or asphalt or firmly set in undisturbed soil.

.6 The seismograph equipment shall be made available for inspection and the data able to be downloaded by or provided to Contract Administrator at any time during the pile installation.

.7 Installation of Seismographs:

.1 The Contractor's instrumentation personnel shall conduct regular maintenance of seismograph installations.

.2 All seismographs shall have been calibrated by the manufacturer or certified calibration laboratory within one year of their use on site. A current certificate of calibration shall be submitted to the Contract Administrator with the Contractor's data.

.8 Vibration Monitoring of Existing Structures Data Collection:

.1 The Contractor shall collect seismograph data prior to any vibration-producing pile installation activities to document background vibrations at each monitoring location. This monitoring shall consist of a continuous recording of the maximum single-component peak particle velocities for one-minute intervals, which shall be stored in the device memory or printed on a strip chart. The background monitoring shall be performed for a minimum of two (2) non-consecutive workdays, spanning the hours during which pile installation activities will take place.

.2 The Contractor shall monitor vibration during pile installation construction activities as determined by the Contract Administrator. This monitoring shall consist of a continuous recording of the maximum single-component peak particle velocities for one-minute intervals, which shall be stored in the device memory or printed on a strip chart. During the monitoring, the Contractor shall document all events that are responsible for the measured vibration levels, and submit the documentation to the Contract Administrator

with the data as specified in the Data Reduction, Processing, Plotting and Reporting section of this Special Provision.

.3 All vibration monitoring data shall be recorded contemporaneously and plotted continuously on a graph by the data acquisition equipment, Each graph shall show time-domain wave traces (particle velocity versus lime) for each transducer with the same vertical and horizontal axes scale.

.4 The Contractor shall notify the Contract Administrator at least twenty-four (24) hours prior to starting new pile-installation tasks, and shall have the seismographs in place and functioning properly prior to any such activity within 65 m of the monitoring locations. No significant pile installation activity shall occur within this zone unless the monitoring equipment is functioning properly.

.5 The equipment shall be set up in a manner such that an immediate warning is given when the peak particle velocity in any direction exceeds the Response Values specified in the Data Interpretation and Implementing Plans of Action section of this Special Provision. The warning emitted by the vibration-monitoring equipment shall be instantaneously transmitted to the responsible person designated by the Contractor, by means of warning lights, audible sounds or electronic transmission. The Contractor shall then immediately notify the Contract Administrator regarding the exceedance warning.

.9 Vibration Monitoring of Existing Structures Data Reduction, Processing, Plotting and Reporting:

.1 Raw data shall be made available to the Contract Administrator on a daily basis.

.2 Within ten (10) Business Days after the completion of the background vibration monitoring, the Contractor shall submit to the Contract Administrator a hard copy report documenting the results at each of the monitoring locations,

.3 During pile installation, activities, the Contractor shall provide weekly, hard copy reports summarizing any vibration monitoring data collected at the specified vibration-monitoring locations. The reports for each week shall be submitted on or before the end of the following week.

.4 All reports shall be signed by the approved Vibration instrumentation Contract Administrator, and shall include the following:

.1 Project identification, including Project Name and assigned Structure address as shown on the project plans.

.2 Location of the monitoring equipment, including address of adjacent building(s).

.3 Location of vibration sources (e.g. pile installation equipment, etc.)

.4 Summary tables indicating the date, time and magnitude and frequency of maximum single-component peak particle velocity measured during each one-hour interval of the monitoring period.

.5 Field data forms (pile installation vibration monitoring),

.6 Appendix graphs of the strip charts (if any) printed during the monitoring periods.

.7 In addition to the hard copy data specified herein, the Contractor shall provide data on 120 mm-diameter computer diskettes (CDs) with each report. Electronic data files for all instrument data shall be provided in dBASE IV (DBF) format.

.10 Vibration Monitoring of Existing Structures Damage to Instrumentation:

.1 The Contractor shall protect all instruments and appurtenant fixtures, leads, connections, and other components of vibration-monitoring systems from damage due to construction operations, weather, traffic, and vandalism.

.2 If an instrument is damaged or inoperative, the Contractors instrumentation personnel shall repair or replace the damaged or inoperative instrument within seventy-two (72) hours at no additional cost. The Contractor shall notify the Contract Administrator at least twenty-four (24) hours prior to repairing or replacing a damaged or inoperative instrument. The Contract Administrator will be the sole judge of whether repair or replacement is required.

.11 Vibration Monitoring of Existing Structures Disclosure of Data:

.1 The Contractor shall not disclose any instrumentation data to third parties and shall not publish data without prior written consent of the City.

.12 Vibration Monitoring of Existing Structures Data Interpretation and Implementing Plans of Action:

.1 The Contractor shall interpret the data collected, including making correlations between seismograph data and specific pile installation activities. The data shall be evaluated to determine whether the measured vibrations can be reasonably attributed to pile installation activities.

.2 The Response Values for vibration include a trigger value of 6.3 mm per second (0.25 inches per second) and a Limiting Value of 7.6 mm per second (0.3 inches per second). The actions associated with these Response Values are defined below. Plans for such actions are referred to herein as Plans of Action, and actual actions to be implemented are referred to herein as Response Actions. Response Values are subject to adjustment by the Contract Administrator as indicated by prevailing conditions or circumstances.

.1 If a trigger Value is reached, the Contractor shall:

.1 Immediately notify the Contract Administrator.

.2 Meet with the Contract Administrator to discuss the need for Response Action(s).

.3 If directed by the Contract Administrator during the above meeting that a Response Action is needed, submit within twenty-four (24) hours a detailed specific plan of action based as appropriate on the generalized Plan of Action submitted previously as part of the Vibration Monitoring Plan specified in the Submittals section of this Special Provision.

3.9 Field Quality Control

.1 Pile Driving Analyzer:

.1 Refer to Section 31.09.16.29.

.2 Testing agency appointed and paid by Contractor shall use Pile Driving Analyzer and Wave Equation Analysis to confirm driving criteria. Included are: hammer size and variation in impact, suitability of driving cap and cushions, and penetration resistance relative to set for initial driving and re-striking.

.1 Confirm criteria during pile installation by using Pile Driving Analyzer and Wave Equation Analysis on minimum of 10% of piles per substructure unit. Contract Administrator to select piles.

.2 Do additional PDA tests on any piles damaged, out of plumb an excessive amount or reaching premature refusal. No additional payment will be made for these additional testing required.

.3 Work to be performed by geotechnical engineer registered or licensed in Province of Manitoba.

.3 Prepare piles to be instrumented by drilling and tapping holes for installation of strain transducers and accelerometers, as directed by the Contract Administrator.

.4 Provide assistance, as required, in instrumentation process during initial set-up and during test.

.1 Such assistance shall include: attaching of test equipment leads to transducers and accelerometers when pile is positioned in leads prior to driving, replacing of transducers and accelerometers, if required, during driving.

.5 Make allowance for probable interruption in driving for:

.1 Changing/modifying hammer, cap, cushions, or other equipment.

.2 Replacing/adjusting of transducers and accelerometers.

.3 Assessing of monitored results.

.6 Replace/adjust hammer and modify cap, cushions, and other equipment, as directed by the Contract Administrator.

.7 Confirm that final set has been achieved, when instructed by re-striking instrumented piles.

.8 Measurement:

.1 Maintain accurate records of driving for each pile, including:

.1 Type and make of hammer, stroke or related energy.

.2 Other driving equipment including water jet, driving cap, cushion.

.3 Pile size and length, location of pile in pile group, location or designation of pile group.

.4 Sequence of driving piles in group.

.5 Number of blows per 0.25 m for entire length of pile and number of blows per set criteria determined by Pile Driving Analyzer and Wave Equation Analysis.

.6 Final tip and cut-off elevations.

.7 Other pertinent information such as interruption of continuous driving, pile damage.

.8 Record elevation taken on adjacent piles during before and after driving of each pile.

.2 All measurements, observations and calculations associated with pile driving analyzer and wave equation analysis.

.3 Provide the Contract Administrator with three (3) copies of records.

END OF SECTION