

PART 1 - GENERAL

1.1 SECTION
INCLUDES

- .1 Materials and installation for sheet, continuous interlocking flat web and continuous interlocking steel sheet piles driven to form on continuous vertical wall.

1.2 RELATED
SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .3 Section 31 23 33.01 - Excavating, Trenching and Backfilling.
- .4 Section 05 50 00 - Metal Fabrications.
- .5 Section 31 53 16 - Structural Timber.

1.3 MEASUREMENT
PROCEDURES

- .1 Measure supply of steel sheet piling in square metres of piling authorized by Departmental Representative and delivered to site.
 - .1 Calculate area by multiplying lengths of piles by widths.
 - .2 Width of steel sheet pile section is defined as centre to centre distance between pile interlocks measured along a plane parallel to finished wall.
- .2 Measure supply and installation of sheet piling in square metres of piling remaining in place after cut-off.
 - .1 Piling will be measured in plane of bulkhead, calculated by multiplying straight horizontal centre line length of bulkhead measured at top of piles by average vertical length of piles installed and left in work.
- .3 Measure tie rods, nuts, sleeve nuts, turnbuckles, pipe sleeves, bearing plates, washers, transfer bolts, steel wales and other associated hardware supplied and incorporated in Work, as indicated.
- .4 Measure backfill in cubic metres of backfill placed to dimensions as indicated and incorporated in completed work.

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- 1.3 MEASUREMENT PROCEDURES
(Cont'd)
- .5 Mobilization and de-mobilization of equipment for installation of steel sheet piling will be by fixed price.
- 1.4 REFERENCES
- .1 American Society for Testing and Materials International, (ASTM).
.1 ASTM A6/A6M-11, Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
.2 ASTM A307-10, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile.
.3 ASTM A615/A615M-09b, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
.4 ASTM A1011/A1011M-10, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, and Ultra High Strength.
- .2 Canadian Standards Association (CSA International).
.1 CAN/CSA G40.20/G40.21-04(R2009), General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
.2 CSA W47.1-09, Certification of Companies for Fusion Welding of Steel Structures.
- .3 CSA W47.1S1-M1989(1998), Supplement No.1-1989 to W47.1-1983, Certification of Companies for Fusion Welding of Steel Structures.
- .4 CSA W59-M1989(R2001), Welded Steel Construction (Metal Arc Welding) (Metric Version).
- .5 CSA W59S1-M1989(R1998), Supplement No.1-M1989, Steel Fixed Offshore Structures, to W59-M1989, Welded Steel Construction (Metal Arc Welding).
- 1.5 MEASUREMENT FOR PAYMENT
- .1 Sheet Steel Piling: Supply and installation will be measured in m² area of piling remaining in place after cut-off. Piling will be measured in plane of bulkhead, calculated by multiplying straight, horizontal, centre-line length of bulkhead measured at upper end of piles by average vertical length of piles installed and left in work.
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1.5 MEASUREMENT FOR
PAYMENT
(Cont'd)

- .2 Deadman Sheet Steel Pile: Supply and installation will be measured by the m² installed as indicated in the unit price table and the contract drawings.
- .3 Tie Rods: Supply and installation will be measured by the (LM) linear meter installed c/w nuts and washers.
- .4 Sheet Steel Pile Cap: Supply and installation of pile cap as indicated on the drawings will be measured by the (LM) linear meter.
- .5 Splicing plates, sleeve nuts, washers, spacers, channel splice plates, pipe sleeves, bearing plates, machine bolts, and other associated hardware supplied and incorporated in Work, are incidental to the supply and installation of the sheet steel pile.
- .6 Mobilization and de-mobilization of equipment for delivery installation of steel sheet piling will be incidental to the above items and will not be measured separately.

1.6 SUBMITTALS

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit shop drawings for following items:
 - .1 Sheet Steel Piles.
- .3 At least 2 weeks prior to fabrication, submit to Departmental Representative, two copies of steel producer certificates in accordance with ASTM A1011/A1011M, and mill test reports in accordance with CAN/CSA-G40.20/G40.21.
- .4 Provide Departmental Representative with copy of certification for fusion welding in accordance with CSA W47.1 and CSA W47.1S1.

1.7 QUALITY
ASSURANCE

- .1 Inspection and testing of steel sheet piling material will be carried out by testing laboratory designated by Departmental Representative at any time during course of Work.
- .2 Materials inspected or tested by Departmental Representative which fail to meet contract requirements will be rejected.

PART 2 - PRODUCTS

2.1 MATERIALS

- .1 Steel sheet piles: to CAN/CSA-G40.21, including chemical and mechanical requirements grade 350W.
- .2 Continuous interlocking flat web with minimum web thickness 12 mm and minimum mass of 160 kg/m.
- .3 Continuous interlocking Z trough section:
 - .1 Minimum effective section modulus: 2610 cm² per metre of wall.
 - .2 Minimum thickness: 12 mm.
 - .3 Normal width: 673 mm.
 - .4 Normal weight: 109 kg/m.
- .4 Sheet steel piling: to be in accordance with 572 Gr. 42 (CSA G40.21 Gr. 350 W).
- .5 Wharf Steel Sheet Piling/Sheet Pile Deadman Pile: Continuous interlocking Z section with minimum effective section modulus of 2610 cm³ per meter of wall, minimum web thickness of 12 mm. Channel Wall Steel Sheet Piling: Continuous interlocking Z section with minimum effective section modulus of 1630 cm³ per meter of wall.
- .6 Sheet steel closure angle to be 14 mm thick x 400 mm x 400 mm pre-fab galvanized angle necessary to facilitate work and a length of 4.8 metres. Closure angle to be cut off flush with the tops of the new sheet steel piling elevation.
- .7 Sheet steel pile cap to be lengths as specified by sheet pile supplier. Pile cap to be continuous along the top of the new sheet pile. Steel to be min 10 mm thick with 89 mm length. Install as per detail on accompanying drawings.
- .8 Mark each piece of sheet piling legibly by stencilling of die-and-stamping with Heat Number, Manufacturer's Name, and Length and Section Number.
- .9 Do not pre-cut lifting or slinging holes in sheet piles.
- .10 Steel Channels, angles, plates, washer plates in accordance with CAN/CSA-G40.21-M92, grade 300w.

2.1 MATERIALS
(Cont'd)

- .11 Steel tie rods to be in accordance with CAN3-G40.21-M92, grade 300w. Tie rods to be 47.2 mm in diameter with upset screwed ends such that diameter of upset end provides 25% excess root area over gross area of plain tie rod.
- .12 Sleeve nuts and turnbuckles to be a capacity in excess of capable of developing 100% of the ultimate tensile strength of the unspliced bar.
- .13 Pre-assemble, mark, and test tie rod assemblies in shop. Align threaded connection at sleeve nut or turnbuckle to tolerances of $\pm 1/80$ or normal rod diameter with deviation of centre line of 1 in 160).
- .14 Corrosion protection for tie rods: to be shop applied high density polyethylene sheath over a polymerized rubber blended sealant for tie rods. Provide high density polyethylene sheath and rubber blended sealant for use in field for protection of couplers jam nuts and nuts at ends of the tie rods.
- .15 Hexagon nuts, bolts, and washers to be in accordance with ASTM A307.
- .16 Spacer bolts and nuts, 22 mm diameter, in accordance with ASTM A307-89.
- .17 Sheet piling: section modulus of cm^3/m or equivalent as approved by Departmental Representative.
 - .1 Interlocked joint strength indirect tension of not less than kN/m.
 - .2 Minimum thickness of any portion Web Flange of 12.7 mm.
 - .3 Special corners: corners as specified by manufacturer for type of sheet piling supplied.
 - .4 Interlocks: to be such that section of interlock bar of 1 m minimum length will pass along full length of pile without binding.
 - .5 Mark each piece of sheet piling legibly by stencilling or die-and-stamping with following information:
 - .1 Heat Number.
 - .2 Manufacturer's Name.
 - .3 Length and Section Number.
 - .6 Do not precut lifting or slinging holes in sheet piles.

2.1 MATERIALS
(Cont'd)

- .18 Structural steel for wales, bearing plates, wales splices, capping channels, support angles and miscellaneous steel: to CAN/CSA-G40.21, Grade 300W.
- .19 Tie rods, sleeve nuts and turnbuckles:
 - .1 Tie rods: to ASTM A615, Grade 300W.
 - .2 Tie rods: to continuously threaded bar with single double corrosion protection.
 - .3 Sleeve nuts, and connector sleeves: to have load capacity in excess of capacity of tie rod.
 - .4 Preassemble, mark and test tie rod assemblies in shop. Align threaded connection to following tolerances at sleeve nut or connector sleeve: 1/80 of normal rod diameter, deviation of centre line, 1 in 160.
- .20 Nuts and bolts: hexagon nuts, bolts, and washers: to ASTM A307.
- .21 Backfill material: to Section 31 23 33.01 - Excavating, Trenching and Backfilling.

2.2 BUBBLE CURTAIN

- .1 This work shall consist of furnishing, installing, operating, monitoring, maintaining and removing a confined air bubble curtain system to alternate under water noise and to keep fish from the area where pile driving is being completed.
- .2 The contractor is to submit within two weeks of contract award an air bubble curtain system that will be used for review and approval. The submittal will consist of an air compressor(s) providing oil-free compressed air in sufficient volume and pressure. Supply lines to deliver the air, distribution manifolds or headers, gauges, perforated pipes and frames if required with the design. Provide details of the anchoring components including weights and restraints. Details of the manufacturer's recommendations for installation of flow meters in conditions of high flows and low flow water.

2.2 BUBBLE CURTAIN
(Cont'd)

- .3 The design, installation, maintenance, monitoring, operation and removal of the bubble curtain system shall take into account the site conditions and the requirements of pile installation. Factors to be taken into account include: anchoring, moving, and dismantling the system; configuration of river bed; water velocity; water-surface conditions; air and water temperatures; and positioning of pile and pile-driving equipment relative to the bubble curtain system. Water velocity at the site is expected to vary in direction due to changes in tidal flow.
- .4 The contractor shall make provisions for the engineer to inspect the bubble curtain system for proper operation before each deployment and as necessary during deployment. Proper operation during deployment will be determined by observation of the gauges in the bubble curtain system, and by other methods developed by the engineer.
- .5 The approved attenuator system's containment vessel shall be constructed from smooth inside bore poly-pipe or equivalent.
- .6 Perforated pipes in any layer shall be arranged in a geometric pattern, which shall allow for the pile driving operation to be completely enclosed by bubbles for the full depth of the water column and for a radial dimension of no more than 900 mm as measured from the outside surface of the pile.
- .7 The layer of perforated aeration pipes (bubble rings) shall be designed to ensure close proximity with the river bottom without sinking into the silts. Containment vessel and bubble rings shall be working in unison to keep rings at river bottom not in it. This can be best accomplished by attaching the ring to the bottom of the containment vessel (200 mm from bottom) and lowering containment vessel to the river bottom then allowing the weight of the containment vessel to push into the silts approximately 150 mm leaving the bubble ring within 150 mm of the silt line. The containment vessel must then be tied off at this elevation and not allowed to descend into the river bottom further as the pile is driven, which will naturally occur if it is not restrained.

2.2 BUBBLE CURTAIN
(Cont'd)

- .8 The system shall provide a bubble flux of 2 cubic meter per minute per 1.0 meter of pipe in each layer (ring). Air holes shall be 1.6 mm in diameter and shall be spaced approximately 19 mm apart. Air holes shall be placed along the pipe to provide uniform bubble flux.
- .9 Meters shall be provided in accordance with the following:
- .1 Pressure meters shall be installed at all inlets to aeration pipelines and at points of lowest pressure in each branch of the aeration pipeline.
- .2 Flow meters shall be installed in the main line at each compressor and at each branch of the aeration pipelines at each inlet. In applications where the feedline from the compressor is continuous from the compressor to the aeration pipe inlet the flow meter at the compressor can be eliminated.
- .3 Flow meters shall be installed according to the manufacturer's recommendation based on either laminar flow or non-laminar flow, whichever applies.
- .10 The contractor shall perform a performance test of the bubble curtain, prior to any pile driving operations, in order to confirm the calculated pressures and flow rates at each manifold ring.
- .11 Gauges shall be installed above the water line and shall be easily accessible to the Department Representative. Air pressure and air flow meters and gauges shall be calibrated and approved by the Departmental Representative prior to use in the attenuator system. Meters shall be accurate to within 2 percent.
- .12 The contractor shall monitor the condition of the attenuator system and prepare inspection reports daily during pile installation operations.
- .13 The contractor's design, installation, maintenance, monitoring, operation and removal of the attenuator system shall take into account the site conditions and the requirements of pile installation. Factors to be taken into account include anchoring, moving, and dismantling the system; configuration of slough bottom; water velocity; water-surface conditions; air and water temperatures; and positioning of pile and pile-driving equipment relative to the bubble curtain system.

- 2.2 BUBBLE CURTAIN
(Cont'd)
- .14 Water velocity at the site is expected to vary from zero to 2 feet/second and vary in direction due to changes in tidal flow. The design of the bubble curtain shall ensure that the system extends from slough bottom to at least 5-feet above the water surface during maximum water-current conditions and accommodates tidal changes.
- .15 The contractor shall completely remove the attenuator system at the completion of the project and the system will remain the property of the contractor.

PART 3 - EXECUTION

- 3.1 INSTALLATION
- .1 Do welding in accordance with CSA W59 except where specified otherwise.
- .2 Do not begin pile installation until required quality control tests have been completed and test results approved by Departmental Representative.
- .3 Submit full details of method and sequence of installation of piling to Departmental Representative for approval prior to start of pile installation work. Details must include templates, bracing, setting and driving sequence and number of piles in panels for driving.
- .4 When installing sheet piles in bulkhead wall, use procedure as follows:
- .1 Provide temporary templates or bracing to hold piles in alignment during setting and driving.
- .2 Drive piles two at a time. Drive first double pile to full depth, then place panel of five to eight double sheet piles in templates and secure last (end) double pile in location to prevent spreading of piles in panel.
- .3 Drive end double pile in panel sufficiently deep into ground to ensure that it will remain plumb, then, drive remaining double piles in panel to full depth beginning with double pile next to end double pile and finishing with double pile next to double pile first driven.

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- 3.1 INSTALLATION .4 (Cont'd)
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- .4 After one panel has been driven, place and drive succeeding panels in similar manner. Complete driving of end double pile of first panel after double piles of second panel have been driven.
- .5 When installation is complete, face of wall at top of sheet piles to be within 75 mm of location as indicated and deviation from vertical not to exceed 1 in 100.
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- 3.2 OBSTRUCTIONS .1 If obstruction encountered during driving, leave obstructed pile and proceed to drive remaining piles. Return and attempt to complete driving of obstructed pile later.
- .2 Advise Departmental Representative immediately if impossible to drive pile to full penetration, and obtain direction from Departmental Representative on further steps required to complete Work.
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- 3.3 HOLES .1 Patch holes in sheet pile wall, except where permanent holes are indicated.
- .1 Use 12 mm thick plate of material equal to that of piling to patch holes and overlap not less than hole diameter.
- .2 Weld to develop full strength of plate.
- .2 Drill any required holes in piling. Do not use flame cutting without permission of Departmental Representative.
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- 3.4 CUTTING .1 When flame cutting tops of piles, and flame cutting holes in piles approved by Departmental Representative], use following procedure:
- .1 When air temperature is above 0 degrees C, no pre-heat is necessary.
- .2 When air temperature is below 0 degrees C, pre-heat until steel 25 mm on each side of line of cut has reached a temperature very warm to hand (approximately 35 degrees C).
- .3 Use torch guiding device to ensure smooth round holes or straight edges.
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3.9 CLEANING
(Cont'd)

- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.