

PART 1 - GENERAL

1.1 RELATED  
SECTIONS

- .1 Section 31 09 16.28 - Pile Tests.

1.2 DESCRIPTION

- .1 Design, supply and install micropiles to meet the performance requirements indicated on drawings.
- .2 Select the micropile type, size, size of reinforcement, pile top attachment, installation means and methods, depth of the required grout bond zone and final micropile diameter. The micropile contractor shall design and install micropiles that will develop the load capacities indicated on the contract plans.

1.3 PROTECTION

- .1 Protect public and construction personnel, adjacent structures and work of other Sections from effect of pile installation operations.
- .2 Caution is to be exercised in selecting and constructing micropiles in close proximity to the existing structures on the site.

1.4 REFERENCES

- .1 CSA A23.1-09/A23.2-09, Concrete Materials and Methods of Concrete Construction/Methods of Test for Concrete, Includes Update No.1 (2011).
- .2 CSA A23.3-04(R2010), Design of Concrete Structures.
- .3 CSA A3000-08, Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005), Includes Update No. 1 (2009), Update No. 2 (2010), Update No. 3 (2011).
- .4 CSA G30.18-09, Carbon Steel Bars for Concrete Reinforcement.
- .5 CSA-G40.20-04/G40.21-04(R2009), General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
- .6 CSA S16-09, Design of Steel Structures, Includes Update No.1 (2010).
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1.4 REFERENCES  
(Cont'd)

- .7 CSA W47.1-09, Certification of Companies for Fusion Welding of Steel, Includes Update No.3 (2011).
- .8 CSA W59-03(R2008), Welded Steel Construction (Metal Arc Welding).
- .9 CSA W178.1-08, Certification of Welding Inspection Organizations.
- .10 CSA W178.2-08, Certification of Welding Inspectors.
- .11 ASTM A615/A615M-09b, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
- .12 ASTM A722/A722M-07 Standard Specification for Uncoated High-Strength Steel Bars for Prestressing Concrete.
- .13 ASTM C494/C494M-11, Standard Specification for Chemical Admixtures for Concrete
- .14 ASTM D1143/D1143M-07e1, Standard Test Methods for Deep Foundations Under Static Axial Compressive Load.
- .15 ASTM D3689-07, Standard Test Methods for Deep Foundations Under Static Axial Tensile Load.
- .16 US FHA "Micropile Implementation Manual" June 2000.
- .17 FHWA-SA-97-070 "Micropile Design and Construction Guidelines".

1.4 QUALITY  
ASSURANCE

- .1 The micropile contractor shall be fully experienced in all aspects of micropile design and construction, and shall furnish all necessary plant, materials, skilled labour, and supervision to carry out the contract. The contractor will have successfully completed at least five projects in the previous five years of similar scope and size.
- .2 Requirements of Regulatory Agencies:
  - .1 Conform to the local and provincial regulations, including construction safety regulations.
- .3 Allowable Installation Tolerances:

1.4 QUALITY  
ASSURANCE  
(Cont'd)

- .3 (Cont'd)
  - .1 Plan location at cut-off: 75 mm.
  - .2 Vertical Alignment: Plumb within 2% of total length.
  - .3 Cut-off elevation of top pile: + 25 mm.
  - .4 Centreline of core reinforcing shall not be more than 20 mm from centreline of piling.
  
- .4 Minimum Bond Length:
  - .1 Micropile bond socket in sound rock shall not be less than 1000 mm.
  
- .5 Quality Control
  - .1 Quality control may be performed by an Inspection and Testing Company appointed by the Departmental Representative.
  - .2 Inspection and Testing Company shall be qualified under CSA W178.1.
  - .3 Welding inspectors shall be certified by Canadian Welding Bureau in Category (a) Buildings to CSA W178.2.
  - .4 Inspection service provided by Inspection and Testing Company does not relieve Contractor of sole responsibility for quality control over Work. Performance or non-performance by Inspection and Testing Company, shall not limit, reduce or relieve the Contractor of responsibilities in complying with the requirements of the Specification.
  - .5 Include the cost of pile load tests in the stipulated price (see 3.4 Field Quality Control).
  - .6 Refer to Load Test paragraph in this section for minimum frequency of load tests.
  - .7 The cost of additional inspection and testing, including load testing, because of the failure of Work to meet specified requirements or because of changes to Contract Documents requested by Contractor, shall be at Contractor's expense.
  - .8 Mill Inspection: Inspection shall confirm that materials conform to specified requirements. Mill test reports, correlated to materials, will be accepted in lieu of physical tests.

1.5 SITE CONDITIONS

- .1 Geotechnical investigation has been carried out by DBA Engineering Ltd. Refer to Geotechnical Investigation Report #11-1539-05, dated September 21, 2011.

1.6 SUBMITTALS

- .1 Construction Submittals
- .1 Submit in accordance with Section 01 33 00.
  - .2 The Contractor shall prepare and submit to the Departmental Representative for review and approval, working drawings and relevant structural design calculations for the micropile system or systems intended for use. All design submittals shall be sealed by a Registered Professional Engineer, currently licensed in the Province of Ontario.
  - .3 The Contractor shall submit a detailed description of the construction procedures proposed for use to the Departmental Representative for review.
  - .4 The Working Drawings shall include micropile installation details giving:
    - .1 Micropile number, location and pattern.
    - .2 Micropile design load.
    - .3 Type and size of reinforcing steel.
    - .4 Type and casing size.
    - .5 Grouted drill hole diameter.
    - .6 Minimum total bond length.
    - .7 Casing socket length.
    - .8 Overburden/ free length.
    - .9 Batter angle if applicable.
    - .10 Bar transfer length if applicable.
    - .11 Total micropile length.
    - .12 Grouting volumes and maximum pressures.
    - .13 Micropile top attachment.
    - .14 Micropile cut-off elevation.
  - .5 The Contractor shall submit shop drawings for all structural steel, including the micropile components, corrosion protection system, pile top attachment and bond length details to the Departmental Representative for review.
  - .6 Submit source of materials and mill test reports.
  - .7 The Contractor shall submit the grout mix designs, including details of all materials to be incorporated, and the procedure for mixing and placing the grout to the Departmental Representative for review.
  - .8 The Contractor shall submit detailed plans for the method proposed for testing the micropiles to the Departmental Representative for review and acceptance prior to beginning load tests. This shall include all necessary drawings and details to clearly describe the test method and equipment proposed.

1.6 SUBMITTALS  
(Cont'd)

- .1 (Cont'd)
  - .9 The Contractor shall submit to the Departmental Representative calibration reports for each test jack, pressure gauge, and master pressure gauge to be used. The calibration tests shall have been performed by an independent testing laboratory and tests shall have been performed within one year of the date submitted. Testing shall not commence until the consultant has reviewed the jack, pressure gauge and master pressure gauge calculations.
  - .10 Work shall not begin until the appropriate submittals have been received and reviewed in writing by the Departmental Representative.
- .2 Inspection Reports
  - .1 Inspections and Testing Company shall submit written reports of inspection and tests.
  - .2 Include in each report a plan locating each pile and identifying each pile which fails to satisfy specified tolerances.
  - .3 Micropile test records, analysis and details.
  - .4 Distribute reports as follows:
    - .1 Three (3) copies to Departmental Representative.
    - .2 One (1) copy to Contractor.

1.7 UNIT PRICES

- .1 Unit prices requested as part of Bids, shall represent complete cost of piles installed in place, including concrete fill, splices, dowels, and preparation and submittal of shop drawings.
- .2 Piling costs will be adjusted by unit price indicated in Bid, by measuring total installed length of piles.
- .3 Base Bid on number of piles and sound rock elevation shown in contract documentation: contract drawings and the geotechnical report.
- .4 Length of piles installed will be established by Departmental Representative from piling records.
- .5 Unit of measurement for piles will be per metre, measured from sound rock elevation to cut-off elevation of pile. Select length into the rock is not considered in this measurement.

1.7 UNIT PRICES  
(Cont'd)

- .6 Pile lengths extending above the cut-off elevation indicated on drawings shall be considered as normal waste and shall not be included in measured installed length.
- .7 No compensation will be made for boulders or other obstructions encountered during installation of piles.
- .8 Piles not meeting requirements of Contract Documents will not be included in measured installed length.

PART 2 - PRODUCTS

2.1 MATERIALS

- .1 Admixtures:
  - .1 Admixtures shall conform to the requirements of ASTM C494/C494M. Admixtures which control bleed, improve flowability, reduce water content, and retard set may be used in the grout subject to review and acceptance of the Departmental Representative. Expansive admixtures shall only be added to the grout used for filling sealed encapsulations. Accelerators will not be permitted. Admixtures shall be compatible with the grout and mixed in accordance with the manufacturer's recommendations. The use will only be permitted after appropriate field tests on fluid and set grout properties. Admixtures with chlorides shall not be permitted.
- .2 Cementing Materials:
  - .1 Cementing materials shall conform to the requirements of CSA A3000. If the brand or type of cement is changed during a project, additional mix tests shall be conducted to ensure consistency of quality and performance in situ.
- .3 Bar Reinforcement:
  - .1 Reinforcing shall be deformed bars in accordance with CSA G30.18 or ASTM A722/A722M.
  - .2 For cases of tensile loading, bar couplers, if required, shall develop the ultimate tensile stress of the bar, without any evidence of failure. For compressive loading, the coupler shall be compatible with efficient load transfer and overall reinforcement performance requirements.

2.1 MATERIALS  
(Cont'd)

- .4 Plates and Shapes:
  - .1 Structural steel plates and shapes for pile top attachments shall conform to CSA G40.20/G40.21.
- .5 Centralizers:
  - .1 Centralizers shall be fabricated from plastic, steel or material that is non-detrimental to the reinforcing steel. Wood shall not be used.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 The micropile installation technique shall be such that it is consistent with the geotechnical, logistical, environmental, and load carrying conditions of the project. The micropile contractor shall select the drilling method and the grouting procedures used for the installation of the micropiles, subject to the approval of the Departmental Representative.
- .2 The drilling equipment and methods shall be suitable for drilling through the conditions to be encountered and restraints of existing structures with minimal disturbance to these conditions or any overlying or adjacent structure or service. The borehole must be open to the defined nominal diameter, full length, prior to placing grout and reinforcement.
- .3 All installation techniques shall be determined and scheduled such that there will be no adverse effect on the achieved final set of adjacent piles.
- .4 Centralizers shall be provided at 3 m center maximum spacing on central reinforcement. The uppermost centralizer shall be located a maximum of 1.5 m from the top of the micropile, for micropile with continuous central bar, or at the bar end if central bar is not continuous through whole micropile length. Centralizers shall permit the free flow of grout without misalignment of the reinforcement.

3.1 INSTALLATION  
(Cont'd)

- .5 The central reinforcement steel with centralizers, shall be lowered into the stabilized drill holes to the desired depth without difficulty. Partially inserted reinforcing bars shall not be driven or forced into the hole such that there will be no interconnection or damage to piles in which the grout has not achieved final set.
- .6 Damaged or Defective Piles:  
.1 Replace piles which do not meet requirements of Drawings and Specifications at no cost to the Departmental Representative.  
.2 Leave rejected pile in place and install adjacent pile or piles as directed by the Departmental Representative.  
.3 No compensation will be made for removing and replacing or other work necessary due to rejection of defective piles.  
.4 Related expenses, such as pile cap redesign, shall be paid by Contractor.

3.2 GROUTING

- .1 The Contractor shall provide systems and equipment to measure the grout quality, quantity and pumping pressure during the grouting operations. This information is to be measured and recorded.
- .2 After drilling, the hole shall be finished with water and/or air to remove drill cuttings, and/or other loose debris. The Contractor shall provide a stable, homogenous, neat cement grout or a sand cement grout with a minimum 28 day unconfirmed compressive strength of 30 MPa. The grout shall not contain lumps or any other evidence of poor or incomplete mixing. Admixtures, if used, shall be mixed in accordance with manufacturer's recommendations. The pump shall be equipped with a pressure gauge to monitor grout pressures. The pressures gauge shall be capable of measuring pressures of at least 1 MPa or twice the actual grout pressure used by the Contractor, whichever is greater. The grouting equipment shall be sized to enable the grout to be pumped in one continuous operations. The grout shall be kept in constant agitation prior to pumping.

3.2 GROUTING  
(Cont'd)

- .3 The grout shall be injected from the lowest point of the drill hole (by tremie methods) until clean, pure grout flows from the top of the micropile. The tremie grout may be pumped through grout tubes, hollow stem augers, or drill rods. Subsequent to tremie grouting, all grouting operations, associated with, for example, extraction of drill casing and pressure grouting, must ensure complete continuity of the grout column. The use of compressed air to directly pressurize the fluid grout is not permissible. The grout pressures and grout takes shall be controlled to prevent excessive heave in cohesive soils or fracturing of soil or rock formations. The entire pile shall be grouted to the design cut-off level.
- .4 Grout within the micropiles shall be allowed to attain the minimum design strength prior to being loaded.

3.3 PILE SPLICES

- .1 Pile splices shall be constructed to develop the required design strength of the pile section.
- .2 Lengths of casing and reinforcing steel to be spliced shall be secured in proper alignment and in such a manner that no eccentricity between the axes of the two lengths spliced or angle between the results.

3.4 FIELD QUALITY CONTROL

- .1 Inspection and Testing Company appointed as specified for Quality Control elsewhere in this Section, may perform sampling, inspection and testing of concrete and detailed inspection of piling operations including the following:
- .1 Monitor and record pile installation procedures.
  - .2 Record installed pile lengths.
  - .3 Confirm installed pile tolerances.
  - .4 Monitor and analyze results of pile testing.
  - .5 Confirm concrete strength in accordance with Section 03 30 00.
- .2 Load Test:
- .1 One pre-construction compression test (to minimum 250% of working load) for every 100 piles installed.
  - .2 5% of remaining piles in tension.

