

**SECTION 31 66 13
DUCTILE IRON PILES**

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.
- B. Drawings and General Provisions of the Contract, including General and Supplemental Conditions, and Division 1 Specifications, apply to the work in this specification.
- C. Coordination of work between General/Site Contractor and Ductile Iron Pile Contractor affected by work of this Section. Cooperate with trades to assure the steady progress of all work under the contract.

1.2 RELATED DOCUMENTS

- A. Related work specified elsewhere:
 - 1. Section 023000 – SUBSURFACE DATA
 - 2. Section 312300 - EARTHWORK

1.3 DESCRIPTION OF WORK

- A. Work Included: Work to be done under this Section includes providing all labor, materials, supervision, equipment, transportation and services as necessary and incidental to the proper execution of the work as shown on the Drawings and specified herein.
 - 1. The Specialty Contractor shall select, design, furnish and install Ductile Iron Piles to provide support for _____ foundation and slab locations as shown on the Drawings.
 - 2. The design and selected capacity of the Ductile Iron Piles shall be the responsibility of the Specialty Contractor provided the following minimum design guidelines are followed:
 - a. Design is in general accordance with IBC 2009 (or other applicable codes).
 - b. Design relies on subsurface information presented in the project geotechnical report.
 - c. Minimum allowable design capacity of _____ kips per pile,
 - d. Piles achieve acceptable performance as outlined in Article _____ - Load Testing.
 - e. Piles are installed to penetrate the [subsurface conditions] and terminate in the sand strata or deeper as needed to develop the proposed design capacity.
 - f. Design must consider corrosion potential unless grout is used to isolate surface of pile.
 - g. Maximum allowable concrete/grout stress of 33 percent of specified 28-day unconfined compressive strength, up to 1,600 psi.

3. Install one (1) non-production pile for purposes of load testing to demonstrate acceptable performance. In accordance with the requirements of the applicable Building Code, perform a compression (**tension**) pile load test on one of the non-production piles, to a maximum test load of two (2.0) times the design capacity. Testing of the pile load test and production pile installation shall be coordinated with the Engineer's representative.
 4. Prepare and provide submittals as required herein for review by the Owner's Representative.
 5. Furnishing and installing all elements of the load reaction frame, including hold down anchors, reaction frame, and hydraulic jack.
 6. Cut-off of or coordinate with General Contractor for pile stick-ups at design cut-off elevation and legally dispose or recycle pile cut-offs at approved off-site locations.
 7. Coordinate with the General/Site Contractor to provide survey control, site working elevations and layout of design pile locations to complete the work.
- B. Coordinate all handling and disposal of any cuttings or spoils as required to complete the Work described in this Section.
- C. General Contractor is responsible for locating and protecting existing and new utilities, structures, and other facilities and site improvements during all Work. The General Contractor shall coordinate installation of new utilities with Specialty Contractor to avoid interferences with foundation construction.
- D. General Contractor is responsible for excavations required during construction to remove obstructions and allow production piles to be installed. Pile installation shall continue at other nearby locations so as to reasonably continue installation and maintain schedule as the pile location(s) in question is evaluated.
- E. Conduct all Work in accordance with OSHA requirements and other applicable laws and regulations, and with the requirements of all federal, state, county and local agencies and authorities having jurisdiction over the Work.
- F. Obtain, pay for and comply with all required permits, licenses and approvals prior to commencing and during the Work.
- 1.4 QUALITY CONTROL / QUALITY ASSURANCE
- A. The Specialty Contractor shall have a full-time, on-site quality control representative to verify and report all installation procedures and test results. The Specialty Contractor shall immediately report any unusual conditions encountered during installation to the Ductile Iron Pile Designer, the General Contractor and the Quality Assurance representative.

- B. The Owner shall retain an independent engineering testing firm to provide Quality Assurance services in the form of on-site monitoring of Ductile Iron Pile installations. The Quality Assurance representative shall observe installation of non-production load test pile(s) and production piles as well as performance of the load testing. The Quality Assurance representative shall advise the Specialty Designer/Contractor and General Contractor in writing, if at any time, in his opinion, the work is not in substantial conformity with the plans and specifications. The Quality Assurance representative shall at no time direct the Specialty Contractor's work.

1.5 SUBMITTALS

- A. The Specialty Contractor shall submit the information specified herein to the Owner's Representative for review and approval. Unless otherwise specified, submittals shall be made not less than two (2) weeks before the start of work.
- B. All submittals specific to the design shall be prepared and stamped by a Professional Engineer licensed in the State in which the project is constructed.
- C. Submittals shall include the following:
 1. Detailed information on proposed type, design capacity, configuration, dimensions, materials and methods for installing the Ductile Iron Piles.
 2. Experience and qualifications of Specialty Contractor and proposed personnel.
 3. Written statement verifying the Specialty Contractor has successfully completed at least three (3) projects of similar size and complexity in this type of installation. Identify the name of the project, location, design consultant and owner for each project.
 4. Description of the proposed pile installation equipment, materials, and procedures. Include catalog cut sheets of equipment including (but not limited to) hammers, excavators, drills, pumps, and mixing plants.
 5. Detailed design calculations and drawings (the Design Submittal), for review and approval. The information shall include but not be limited to design capacities; spacing; depths; embedment in bearing stratum; locations; soil properties; element installation termination criteria and all other relevant information.
 6. Description of load test location(s), equipment, procedures and load schedule. Provide shop drawings with details of load test setup including test pile, reaction system layout, hydraulic jack, telltales or strain gages, and anticipated subsurface conditions at the test pile location. Provide calibration records for the hydraulic jack to be used, prior to conducting the load test. After test completion, the Specialty Contractor shall furnish a detailed description of the test Pile installation and all test records and data, an analysis of the load test data and recommended design capacity based on the test results.

7. Cement grout or mortar mix design (if applicable) proposed for this work and strength test data for that mix by an independent testing laboratory certified by the State in which the project is constructed.
8. Daily installation records including:
 - a. Project name and number.
 - b. Name of Specialty Contractor.
 - c. Date and time of installation (driving, grouting, etc).
 - d. Pile numbers, sizes, lengths and locations of piles.
 - e. Type and size of installation equipment (i.e. excavator, hammer, etc)
 - f. Sequences of installation.
 - g. Ground Elevation.
 - h. Cut-off elevation of each pile to the nearest 0.1 foot.
 - i. Volume of grout used and injection pressure (if applicable).
 - j. Reinforcing steel details (bar size, length, etc) (if applicable).
 - k. Rate of penetration (if applicable).
 - l. Depth to encounter start of bond zone (if applicable).
 - m. Bond length (if applicable).
 - n. Time for penetration to bond length (if applicable).
 - o. Verification of set criteria.

1.6 LINES, GRADES AND TOLERANCES

- A. The Specialty Contractor shall coordinate with the General Contractor and Site Contractor to stake the pile locations and establish all elevations required.
- B. Maximum variation of any pile from its indicated location at the cut-off elevation shall not exceed three inches (6") unless approved by the Engineer.
- C. Cut-off elevation shall be within ½-inch of elevation shown on the plans.
- D. See Article [redacted] of this Section for remedial actions for non-conforming piles.

PART 2 - MATERIALS

2.1 MATERIALS

- A. Piling materials shall consist of pre-fabricated Ductile Iron Piles utilizing high strength ductile iron pipes manufactured with a centrifugal-casting process to deliver high impact resistance, ultimate strength and high elastic limit along with high corrosion resistance manufactured by Tiroler Rohre GmbH (TRM) in Austria or another approved manufacturer that provides verification of Ductile Iron Pile material properties and is certified BS EN ISO 9001 compliant. The material must exhibit a yield stress for design of 45 ksi or greater and a modulus of elasticity of 24,000 ksi. Materials used in production piles shall be the same as used in the non-production test piles and those described in the Specialty Contractor submittals.

- B. Grout (if applicable) shall be a mixture of Portland Cement (Type I/II), sand (if applicable) and clean, potable water proportioned and mixed to maintain solids in suspension without appreciable water gain and flowable to provide good bonding in the bearing stratum. Minimum compressive strength as required per the design of the piles but at a minimum of 3,000 psi compressive strength at 28 days. Admixtures shall be used in accordance with manufacturer's recommendations.
- C. Reinforcing Bars (if applicable) shall be a minimum Grade 60 steel, free of rust, grease, oil, dirt or other objectionable material at the time of placement.

PART 3 - EXECUTION

3.1 SEQUENCE OF OPERATIONS AND EQUIPMENT REQUIREMENTS

- A. The Specialty Contractor shall provide the necessary equipment for full-time operation at the site to complete the Work.
- B. The Specialty Contractor shall coordinate his activities with other Work on the site, including activities performed by the Site Contractor.

3.2 EQUIPMENT

- A. Piles shall be installed with approved modern equipment. The proposed pile installation equipment and methods shall be similar as described in the approved Ductile Iron Pile Submittal, subject to approval by the Owner's Representative.

3.3 INSTALLATION

- A. The Specialty Contractor shall furnish and install all Ductile Iron Piles per the project plans and approved Ductile Iron Pile Submittal. In the event of a conflict between the project plans and the approved Ductile Iron Pile submittal, the Specialty Contractor shall not begin construction on any affected items until such conflict has been resolved.
- B. Specialty Contractor shall conduct his work in a manner to insure the safety of persons and property in the vicinity of the work. The Specialty Contractor's personnel shall comply with safety procedures in accordance with OSHA standards and any established project safety plan.
- C. Piles shall be installed using high-frequency impact energy to penetrate the [subsurface conditions] and terminate in the sand strata or deeper as needed to develop the proposed design capacity and described in the Ductile Iron Pile Submittal.
- D. For End-Bearing Ductile Iron Piles, piles shall be installed using high-frequency impact energy to achieve the required driving "set" criteria established with the non-production load test pile that meets the load test acceptance criteria or refusal of the pile. If used, grout and a steel reinforcing bar are then installed in the pipe once reaching the final depth.

- E. For Friction Ductile Iron Piles, piles shall be installed by driving the ductile iron pile using high-frequency impact energy while continuously pumping grout to fill the annulus created by the proprietary conical grout driving shoe between the pile and the surrounding soil. The pile shall be installed to develop the minimum length and time required to drive the pile the complete bond length in the resisting layer as determined by the non-production test pile that meets the load test acceptance criteria.
- F. Daily installation summary reports shall be provided at the end of each day to the Owner's Representative.

3.4 NON-CONFORMING PILES

- A. Non-conforming piles include piles that are installed out of tolerance, as specified in Article [REDACTED] of this Section, are damaged, the grout tests do not indicated the specified strength had been achieved (if grouted), or the pile is not installed into the required stratum. To mitigate and/or remedy non-conforming piles, the Contractor may be required to provide additional piles or supplement piles to meet the specified requirements at no additional cost to the Owner.

3.5 COMPRESSION LOAD TESTING

A. GENERAL

1. As described in Article 1.4.A.4, the Specialty Contractor shall install a minimum of one (1) non-production piles for purposes of load testing to demonstrate acceptable performance. The pile shall be the same size and type of pile as proposed for the production piles used for the project and installed in the same manner.
2. One (1) of the non-production piles shall be successfully load tested to a maximum compression (or tensile) test load of twice the maximum design capacity. The test shall be performed in general accordance with ASTM D-1143, as specified herein. The maximum test load shall be twice the maximum design load.
3. The Specialty Contractor shall provide all labor, materials and equipment required to set up the load tests, and shall provide personnel at the test(s) during the entire test, to operate the hydraulic jack and all equipment necessary to vary the load increments on the test pile. The Owner's Representative shall be notified of the test schedule to be on-site to observe the test.

B. TEST PROCEDURE

1. The Specialty Contractor is solely responsible for designing and conducting the test(s) in accordance with these specifications.
2. Allow a minimum of three (3) days for the grout to cure (if applicable).

3. Load shall be applied to the test pile by means of a hydraulic jack which reacts against a system of hold down piles, or against a loaded box or test platform, which is supported by cribbing or temporary piles. The load box or platform shall be centered on the test pile and loaded with approved material. The total dead weight or reaction above the jack and the load test support frame shall be capable of safely applying a minimum load of _____ tons.
4. The hydraulic jack shall be of an approved make with a capacity of at least _____ tons and shall be capable of providing enough stroke to load the pile to the maximum testing load without resetting the jack.
5. The top of the test pile shall be level and capped in such a manner as to produce a plane horizontal bearing surface.
6. Gages (micrometer dial indicators), each having a range of two inches and graduated to 0.001 inch divisions shall be used.
7. Micrometer dials shall be mounted to one or more steel reference beams provided by the Specialty Contractor.
8. The load test shall be performed in general accordance with ASTM D-1143-07 except as specified herein.

C. TEST ACCEPTANCE CRITERIA

1. Ductile Iron Piles will be approved for the design load provided that the piles meet one of the following criteria:
 - a. Net settlement of the top of pile, after removal of all load at the completion of the test, does not exceed 0.5 inches, or
 - b. Gross settlement of the pile top at the load corresponding to the design capacity does not exceed the elastic compression of the pile plus 0.15 inches plus one hundredth of the pile tip in width in inches.
2. If the allowable compression load as determined by the load test is less than the required design load, the Contractor shall perform another load test at no additional cost to the Owner.

D. TEST REPORTING

1. The Specialty Contractor shall submit load test report to Owner's Representative for review within five (5) days following completion of each test. Load test reports shall include the following:
 - a. All test pile record information specified in Article _____ of this Section.
 - b. Tabular and graphical summary of the specified load-deformation data.
 - c. Brief memorandum summarizing testing procedure, test results and recommended allowable design load.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. Work under this contract shall be paid as a lump sum based on the specified scope of work and shall include all design, labor, materials, and equipment required to provide and test the Ductile Iron Piles.
- B. Installation of additional piles or piles deeper than the design basis because of unanticipated changes shall be paid on a unit length basis in excess of the design length.
- C. Mobilization and demobilization will be measured as a lump sum per rig. The mobilization/demobilization will be measured as a single, one-time cost on the project. Additional mobilizations/demobilizations shall be paid on a unit basis.
- D. Measurement for payment of static pile load tests required by the Owner's Representative will be per test acceptably performed.
- E. Stand-by time, authorized in advance by the Owner's Representative, due to obstruction removal by others, will be measured on a per-hour basis as the time in excess of 0.5 hour per pile required to remove the obstruction.

4.2 PAYMENT

- A. Specialty Contractor shall provide unit pricing for increased quantity and length of the Ductile Iron Piles.

<u>Item</u>	<u>Unit</u>	<u>Price</u>
Mobilization and Demobilization	Lump sum	\$
Furnishing and Installing Foundation Piles	Linear Foot	\$
Additional Load Tests	Lump sum (per test)	\$