

**SECTION 31 63 26**  
**DRILLED PIERS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

This section specifies excavation and concrete required for construction of foundation piers.

**1.2 DEFINITIONS**

Satisfactory Bearing Material: 3'-0" Minimum into Limestone and is assumed to occur at bottom of pier elevations shown.

**1.3 RELATED WORK**

- A. Materials testing and inspection during construction: Section 01 45 29, TESTING LABORATORY SERVICES.
- B. Safety requirements and blasting operations: Section 00 72 00, GENERAL CONDITIONS, Article, ACCIDENT PREVENTION.
- C. Subsurface Investigation: Section 01 00 00, GENERAL REQUIREMENTS, Article, PHYSICAL DATA
- D. Earth excavation: Section 31 20 00, EARTH MOVING.
- E. Concrete, including materials and mixes: Section 03 30 00, CAST-IN-PLACE CONCRETE.

**1.4 CONTRACT BASIS**

- A. Contract price for piers will be based upon total length for each type of pier shown and number of pier load tests indicated in the Contract Documents. Length of piers will be measured from bottom elevation to top elevation of the pier. The diameter of the pier is defined as the minimum diameter of the shaft.
  - 1. Adjustment of contract price shall be based upon total length of each type of pier placed and not on the length of individual piers. When the total length of each type of completed pier is greater or less than the length shown due to unsuitable soils or design modifications by the PM/COTR, contract price adjustment will be made in accordance with Articles, DIFFERING SITE CONDITIONS, CHANGES and CHANGES-SUPPLEMENT of the GENERAL CONDITIONS as applicable.
  - 2. Contract price and time will be adjusted in accordance with Articles, DIFFERING SITE CONDITIONS, CHANGES and CHANGES-SUPPLEMENT of the GENERAL CONDITIONS as applicable, when artificial materials that are not shown are encountered.

### **1.5 CLASSIFICATION OF EXCAVATION**

#### **A. Soil/Weathered Rock Excavation:**

Soil or weathered rock that can be reasonably excavated with the rock auger, i.e. rock auger advancement greater than 150 mm (6 inches) per 15 minutes (see rock auger refusal, 1.5.C-2, below)

#### **B. Sloping Weathered Rock Excavation:**

Excavation of soil/weathered rock that can typically be excavated with the rock auger, except when the steeply sloping orientation of the stratum causes the rock auger to run askew.

#### **C. Rock Excavation:**

1. Excavation of material that meets the rock auger refusal criteria and requires the rock core barrel or other hard rock excavation techniques for removal.

2. Rock auger refusal is defined as a penetration rate of less than 150 mm (6 inches) in 15 minutes, while operating a pier drilling rig, rated with a torque capacity of at least 110 kN-meters (1,000,000 inch-pounds), applying a continuous down pressure of at least 220 kN (50,000 pounds), equipped with a rock auger that contains conical carbide-tipped ("Kennemetal") teeth.

#### **D. Nominal Soil or Weathered Rock Seams:**

Nominal soil or weathered rock seams below rock auger refusal will be excavated and considered as rock for rock excavation quantities. A nominal soil or weathered rock seam is one which is less than 600 mm (2 feet) thick. Where soil or weathered rock seams or voids of 600 mm (2 feet) or greater are excavated within a mixed rock/soil or rock/weathered rock profile, excavation is classified as soil/weathered rock excavation until rock auger refusal is again established.

### **1.6 MEASUREMENT AND PAYMENT FOR ROCK EXCAVATION**

A. Measurement: Excavation type in units of length shall be considered to change at the upper contact with a different excavation type as defined by section 1.5.

B. Payment: Contract unit rates per length of each type of pier shall be provided for each excavation condition type noted above in Section 1.5. Contract price and time will be adjusted for overruns or underruns in accordance with Articles, DIFFERING SITE CONDITIONS, CHANGES and CHANGES-SUPPLEMENT of the GENERAL CONDITIONS as applicable.

C. Payment for Differing Site Conditions: No payment will be made for any rock excavation beyond pier limits unless additional excavation is

directed by the PM/COTR. When rock excavation, as classified, is encountered, contract price and time will be adjusted in accordance with Articles, DIFFERING SITE CONDITIONS, CHANGES and CHANGES-SUPPLEMENT of the GENERAL CONDITIONS as applicable.

### **1.7 TOLERANCES**

Install piers with not more than the lesser of 1/24th of pier shaft diameter or 75 mm (3 inches) from design center location. Piers shall not be out of plumb more than 25 mm (1 inch) in 3000 mm (10 feet) for the full depth. Cross sections of shafts and bells shall not be less than design dimensions. Batter piers shall be installed a maximum of 2 percent of length from specified inclination.

### **1.8 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Before beginning work, submit a detailed location plan and description of the proposed method of pier installation, all of which shall be subject to the review and approval of the PM/COTR.
- C. Shop Drawings shall comply with ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures". Furnish shop drawings prepared by a Professional Engineer licensed in the State of the project for the detailing, fabricating, bending, and placing of concrete reinforcement.
- D. Reports:
  1. Pier record: Data as specified.
  2. Rock excavation: Data as specified.
  3. Soil Testing Agency Reports shall be issued showing material type and allowable bearing capacity at bottom of shaft within 24 hours after testing//observing each pier.
  4. Certified, "Pier Field Record" for each pier recording actual elevation of bottom, elevation of rock (if applicable), final centerline location of top, variation of shaft from plumb, bell dimension (if applicable), result of all tests and observations performed, material type and actual allowable bearing capacity of bottom, depth of socket into rock, levelness of bottom, seepage of water, still water level (if allowed to flood), elevation (top and bottom) of lining left in place, variation of shaft diameter (from those shown), and evidence of seams, voids or channels below bottom.

- E. Certificates: Contractor's qualifications as specified: Experienced specialty piling subcontractor having a minimum of 5 years successful experience installing Work of the same type required for this project. Employ only skilled tradesmen who are thoroughly experienced with the materials and equipment to be used in the Work.
- F. Independent Testing and Inspection Agency: The Contractor shall retain an Independent Testing and Inspection Agency (Agency) to document, monitor, and observe pier production pier work. This Agency shall submit field reports and test results required for pier load tests, pier installations, and grout testing and inspection. They shall submit a pier installation report for each pier no later than three days after the installation is complete.
- G. Qualification Data: For Installer, Land Surveyor, and Testing and Inspection Agency.
- H. Upon completion of pier installations, the Contractor shall submit five copies of drawings indicating actual in-place pier locations. The Contractor shall pay for all surveying costs. Drawings must be submitted prior to beginning any pier cap or mat installation. One electronic copy of the drawings shall be submitted in AutoCAD DWG format on CD-ROM.
- I. Record drawings at Project closeout according to Division 01 Section "Closeout Procedures."

#### **1.9 QUALITY CONTROL**

- A. Contractor's Quality Control Responsibilities: Contractor is solely responsible for quality control of the Work.
- B. A Quality Control Program shall be submitted by the Contractor at least two weeks prior to the commencement of work. The implementation of a Contractor Quality Control Program does not relieve the Contractor from the responsibility to provide work in accordance with the Contract Documents, applicable codes, regulations, and Governing Authorities.
- C. Contractor's Independent Testing and Inspection Agency (Agency): The Contractor shall retain at his own expense, the services of a qualified Independent Testing and Inspection Agency, licensed in the state of the project, to provide testing and inspection services during the installation of all foundation piling involved in this Work. This firm shall also provide consultation services to the Contractor if problems are encountered during the execution of the Work. The Agency shall be primarily concerned with the testing and construction methods which

will result in finished foundation piling of the required quality and strength. The Agency shall also be concerned with preventing settlement and/or damage to surrounding structures, roads, utilities, embankments, etc., both within the property lines and on adjoining properties during the construction.

- D. The Agency shall be experienced in the testing and installation of pier foundations. It shall have been involved in at least 8 different pier projects in the last 5 years, and shall have experience in recommending, testing, and specifying piers for similar subsurface conditions.
- E. Survey Work: The Contractor shall engage a qualified land surveyor or professional engineer to perform surveys, layouts, and measurements for piers. The surveyor shall record actual measurements of each pier's location, shaft diameter, bottom and top elevations, deviations from specified tolerances, and other specified data.
- F. Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances and regulations of Federal, State and Municipal authorities having jurisdiction. Obtain necessary approvals from all such authorities.

#### **1.10 QUALITY ASSURANCE**

- A. The Owner shall retain the services of a Geotechnical Consultant (Consultant) to provide general observation of all pier operations and to provide technical advice to the Owner with regard to pier operations and performance.
- B. The Consultant shall have been involved in at least 8 different pier installation projects in the last 5 years, and shall have experience in recommending, testing, and specifying piers for similar subsurface conditions.

#### **1.11 APPLICABLE PUBLICATIONS**

- A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only.
- B. American Society for Testing and Materials (ASTM):
  - A36/A36M-08.....Standard Specification for Carbon Structural Steel
  - A283/A283M-03(2007).....Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates

- A615/A615M-09b.....Standard Specification for Deformed and Plain  
Carbon Steel Bars for Concrete Reinforcement
- A929/A929M-01(2007).....Standard Specification for Steel Sheet,  
Metallic Coated by the Hot Dip Process for  
Corrugated Steel Pipe
- A996/A996M-09b.....Standard Specification for Rail Steel and Axle  
Steel Deformed and Bars for Concrete  
Reinforcement
- C33-11a.....Standard Specification for Concrete Aggregates
- C94/C94M-12.....Standard Specification for Ready Mixed Concrete
- C150-C50M-11.....Standard Specification for Portland Cement
- C494/C494M-11.....Standard Specification for Chemical Admixtures  
for Concrete
- C618-12.....Standard Specification for Coal Fly Ash and Raw  
or Calcined Natural Pozzolan for Use in  
Concrete
- C989-C989M-11.....Standard Specification for Slag Cement for Use  
in Concrete and Mortars
- C1017/C1017M-07.....Standard Specification for Chemical Admixtures  
for Use in Producing Flowing Concrete
- D1143-81(1994)e1.....Standard Test Method for Piers Under Static  
Axial Compressive Load
- D3689-90(1995).....Standard Test Method for Individual Piers Under  
Static Axial Tensile Load
- D3966-90(1995).....Standard Test Method for Piers Under Lateral  
Loads
- C. American Concrete Institute (ACI):
- 211.1-91 (2009).....Standard Practice for Selecting Proportions for  
Normal, Heavyweight and Mass Concrete
- 301-10.....Specifications for Structural Concrete
- 315-99.....Details and Detailing of Concrete Reinforcement
- D. American Welding Society (AWS):
- D1.1/D1.DM (2010).....Structural Welding Code - Steel
- D1.4 (1998).....Structural Welding Code - Reinforcing Steel

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. Steel Reinforcement: ASTM A615/A615M, or 996, Grade 60, deformed.
- B. Portland Cement: ASTM C150, Type I or II.
- C. Fly Ash/Slag:
  - 1. Fly Ash Admixture: Not Allowed
- D. Normal-Weight Aggregate: ASTM C33, uniformly graded, 19 mm (3/4-inch) maximum aggregate size.
- E. Water: Potable, complying with ASTM C94/C94M requirements.
- F. Admixtures: Certified by manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material and to be compatible with other admixtures and cementitious materials. Do not use admixtures containing calcium chloride.
  - 1. Water-Reducing Admixture: ASTM C494, Type A.
  - 2. Water-Reducing and Retarding Admixture: ASTM C494, Type D.
  - 3. High-Range, Water-Reducing Admixture: ASTM C494, Type G.
  - 4. Plasticizing and Retarding Admixture: ASTM C1017, Type II.
- G. Steel Casings: All casing shall meet ASTM A283, Grade C; or ASTM A36, carbon-steel plate, with joints full-penetration welded according to AWS D1.1, or ASTM A929/A929M, steel sheet, zinc coated corrugated steel. The Contractor shall design shells to withstand drilling forces and earth pressures and reinforce the bottom cutting edge as required for proper drilling and sealing of the shells into the rock. The cutting edge shall be capable of coring through at least 3000 mm (10 ft) of broken or solid rock. A minimum of 2% out of roundness of the diameter shall be considered in the design of the shell. All seams shall be welded and watertight
- H. Concrete Mix: Prepare design mixes according to ACI 211.1 and ACI 301 for each type and strength of concrete determined by either laboratory trial mix or field test data bases. Use a qualified testing agency for preparing and reporting proposed mix designs for laboratory trial mix basis. Proportion mixes according to ACI 211.1 and ACI 301 to provide normal-weight concrete with the following properties:
  - 1. Compressive Strength (28 Days): 34.5 MPa (5000 psi).
  - 2. Minimum Slump: Capable of maintaining a slump of 125 mm (5 inches) plus or minus 25 mm (1 inch).
  - 3. Do not air entrain concrete for piers
  - 4. Limit water-soluble, chloride-ion content in hardened concrete to 0.15//0.3 percent by weight of cement.

5. Concrete-mix design adjustments may be considered if characteristics of materials, project conditions, weather, test results, or other circumstances warrant. Resubmission and approval of proposed changes to concrete-mix proportions is the responsibility of the Contractor.
- I. Concrete Mixing: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information. Do not add water to concrete mix after mixing, unless a procedure per ACI 301 is submitted to and approved by the PM/COTR. Maintain concrete temperature less than 32 degree Celsius (90 degree Fahrenheit).

### **PART 3 - EXECUTION**

#### **3.1 GENERAL**

- A. Size: Minimum sizes and types of piers are shown. Proposal to use piers of sizes and types different from those shown may be accepted if submitted in writing to PM/COTR for approval and provided the following conditions are met:
  1. Least dimension of pier is equal to or greater than least dimension shown.
  2. Entire pier receives full lateral support from surrounding material.
- B. Changes: Requests for change in size or type of pier from those shown shall be accompanied by calculations and other documentation necessary to show that proposed changes will meet load requirements. Do not proceed with changes before receiving written approval from PM/COTR.
- C. Temporary Steel Casings: Install casings for protection of workers and inspection personnel, for prevention of cave-ins or displacement of earth walls, and for retention of ground water.
- D. Defective Casings: Do not install buckled, distorted or otherwise damaged casings. Replace casings damaged or disturbed during construction, casings that are not mud-tight or otherwise not in accordance with drawings or specifications, at no additional cost to the Government.
- E. Survey: Registered Professional Land Surveyor or Registered Civil Engineer, specified in Section 01 00 00, GENERAL REQUIREMENTS, shall establish lines and levels and stake pier locations.

**3.2 EXCAVATION**

- A. Excavation and construction methods shall result in minimum disturbance of surrounding material and full lateral support of piers by surrounding material.
- B. Remove boulders and rock in piers such as rock seams underlain with soil seams, sloping rock or rock otherwise unsatisfactory for bearing.
- C. If materials with satisfactory bearing strength occur at elevations higher or lower than those shown, place bottom of piers at higher or lower elevations, subject to approval of PM/COTR.
- D. Excavate piers to dimensions and required bearing strata or elevations shown on contract drawings. Maintain sidewall stability during drilling. Excavate holes for closely spaced piers, and those occurring in fragile strata, only after adjacent holes are filled with concrete and allowed to set. The excavation shall be accomplished by hand or machine excavation as required. Pier drilling equipment shall have the minimum torque capacity and downward force capacity for the contract site conditions. Bottoms of piers shall be cleaned of loose or soft materials and leveled. If bottoms are sloping rock, excavate to a level plane or step with maximum step height less than 1/4 the width or diameter of the bearing area. All material removed from the pier holes shall be removed from the ground around the casing before concrete placement is started and shall be disposed of by the Contractor off site in areas submitted to and approved by the Engineer.
- E. Excavations for utilities, support of excavations, or other purposes shall be kept a minimum distance of two shaft diameters away from the outer edge of the pier.

**3.3 PLACING CONCRETE**

- A. Before placing concrete, the tip of the pier shall be observed and approved by a qualified testing agency registered and licensed in the state. The testing agency shall be retained by the Contractor and approved by the PM/COTR. The shaft shall be inspected, cleared of mud, water, loose material and debris.
- B. Place concrete using a down pipe to direct flow of concrete. Except in presence of water, concrete may fall freely up to a maximum height of 9.14 meters (30 feet) provided the concrete does not hit the sides of the pier. Use tremie pipe or pump if distance is greater than 9.14 meters (30 feet).

- C. Withdraw casings, as concrete is deposited, maintaining top surface of concrete constantly at least 1800 mm (6 feet) above lower end of casings. Place concrete to form a monolithic cylindrical shaft having full lateral support from surrounding undisturbed materials. Strike finished top surface of concrete to true plane at required elevation.
- D. Concrete placement in each pier shall be one continuous operation. If placing operation has to be stopped, leave surface approximately level. If concrete has hardened, clean surface and slush with a 1 to 1 cement-sand grout before placing operation is resumed. Concrete pours shall not begin within one hour of darkness. In the event that this type of continuous sequential operation cannot be performed, the Contractor shall submit for approval by the PM/COTR a method of securing the open excavation. The Contractor shall not leave excavations open overnight without receiving prior written approval from the PM/COTR.
- E. When water is present, control water level to within 50 mm (2 inches) of bottom of the pier by pumping. If impossible or impractical to control water, secure written permission from PM/COTR to place concrete through water by means of a watertight tremie.
  - 1. When placing concrete under water, discharge end of tremie shall be submerged in fresh concrete and shaft of tremie maintained full of concrete to point above water level.
  - 2. Increase cement content of concrete required to be placed in water by one sack per cubic yard of concrete.

#### **3.4 PIER RECORD**

- A. For each pier placed and before superstructure framing is placed, submit to PM/COTR for approval a certified report recording following information prepared by Registered Professional Land Surveyor or Registered Civil Engineer.
- B. Pier number, length, and bearing material.
- C. Location.
- D. Concrete and steel reinforcement properties.
- E. Plumbness.
- F. Dates:
  - 1. Excavation completed.
  - 2. Concrete placed.
- G. Diameters:
  - 1. Top of shaft.

2. Bottom of shaft.

3. Bell.

H. Elevations:

1. Top of ground.

2. Top of concrete.

3. Top of rock.

4. Bottom of pier.

**3.5 CLEAN UP:**

A. All debris from excavation of objectionable material, removal of obstructions, and any material not to remain as part of the construction are to be removed and disposed of by the Contractor in a legal manner at no additional cost to the Owner.

B. The site shall be cleaned at frequent intervals and no material shall be stored on the site in a manner, which would obstruct the easy access of equipment and personnel.

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