

## SECTION 02466

# DRILLED SHAFTS

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Material, equipment, and procedures for constructing drilled shafts.

#### 1.2 RELATED SECTIONS

- A. Section 03055: Portland Cement Concrete.
- B. Section 03211: Reinforcing Steel and Welded Wire.

#### 1.3 REFERENCES Not Used

#### 1.4 DEFINITIONS Not Used

#### 1.5 SUBMITTALS

- A. Submit to Engineer procedure to place concrete under water.

#### 1.6 QUALITY ASSURANCE

- A. If shaft installation is unsatisfactory or the shaft cannot be completed within the required tolerances:
  - 1. Immediately remove the reinforcing steel cage and the concrete.
  - 2. Replace the reinforcing cage and place concrete in a satisfactory manner.
  - 3. Submit proposed remedial action for approval if the reinforcing steel and concrete cannot be removed.
  - 4. Furnish materials and work necessary to correct out-of-tolerance drilled shaft construction at no cost to the Department.

#### 1.7 ACCEPTANCE

- A. Drilled shafts may be accepted at a reduced price when the concrete strength is below that specified.
  - 1. Price adjustment pay factor following Section 03055.
  - 2. The Department applies the pay factor to the measurement of the total length of any shaft containing concrete with strength tests falling below that specified.

## **PART 2 PRODUCTS**

### **2.1 PORTLAND CEMENT CONCRETE**

- A. Class A(AE), unless otherwise specified. Refer to Section 03055.
- B. Modify as follows when placed under water:
  - 1. Use at least seven bags of cement per cubic yard.
  - 2. Provide equipment capable of pumping specified concrete.
  - 3. Use high range water reducers (super plasticizers) per Section 03055.
  - 4. Keep slump between 4 inches and 8 inches when tested at the truck.

### **2.2 REINFORCING STEEL**

- A. Refer to Section 03211.

### **2.3 DRILLING EQUIPMENT**

- A. Capable of:
  - 1. Drilling holes to the required diameter, location, alignment and depth in the type of materials present at the shaft locations.
  - 2. Installing and removing casing.

## **PART 3 EXECUTION**

### **3.1 PREPARATION**

- A. Drilling holes:
  - 1. Drill straight, vertical holes to the tip elevations shown on the plans or as determined by Engineer.
  - 2. Remove all loose material from the bottom of the drilled holes before placing concrete.
  - 3. Do not use water or slurry for drilling operations.
  - 4. Do not begin drilling for a shaft located three diameters center-to-center or closer to an adjacent completed shaft until at least 48 hours after completion of placement of concrete for the completed shaft.
  - 5. Do not begin drilling for a shaft located between three and five diameters center-to-center from an adjacent completed shaft until at least 24 hours after completion of placement of concrete for the completed shaft.

6. No concrete placement time restrictions for shafts five diameters center-to-center or greater apart.
- B. Casing:
1. Furnish and place casing when required to prevent the drilled hole from caving and any time groundwater is encountered. Remove casing as the concrete is placed.
  2. Keep the bottom of the casing between 2 ft and 5 ft below the top of the concrete surface when withdrawing.
  3. Prevent concrete separation when withdrawing the casing.

### **3.2 CONSTRUCTION TOLERANCES**

- A. Install the drilled shaft within 3 inches of the plan position in the horizontal plane at the plan elevation of the top of the shaft.
- B. Install the drilled shaft such that the vertical alignment of the shaft excavation does not vary from the plan alignment by more than 0.25 inches per foot of depth.
- C. Install the drilled shaft such that the top of the reinforcing steel cage is no more than 2 inches above or below the plan elevation.

### **3.3 PLACE REBAR CAGES**

- A. Rigidly brace the reinforcing cage with additional reinforcing steel as needed to retain its configuration during handling and construction. Loose bars will not be permitted. Pick cage in several locations as necessary to maintain cage shape and alignment during placement.

### **3.4 PLACE CONCRETE**

- A. Fill drilled holes within 24 hours after drilling.
- B. Prevent concrete from striking the steel-reinforcing cage during free-fall. Do not allow the free-fall of concrete to exceed 5 ft without the use of a tremie or a flexible metal spout.
- C. Do not vibrate concrete during initial placement. Remove all muck laitance and degraded concrete from the shaft.
- D. Vibrate the concrete during placement for at least the top 10 ft of the shaft.

### 3.5 PLACE CONCRETE UNDER WATER

- A. Submit procedure to Engineer and secure Engineer's written approval to place concrete under water.
- B. Use concrete pumping equipment capable of pumping at least 50 yd<sup>3</sup>/hr against a minimum 20 ft head of concrete measured from the discharge end of the pump hose extension (tremie pipe).
- C. Use a rigid, steel pipe pump hose extension for the tremie pipe with tight couplings straight to within ½ inch in 10 ft.
  - 1. Length of extension must be greater than or equal to the depth of the shaft.
  - 2. Inside diameter must be greater than or equal to the concrete pump discharge hose but not more than ½ of the inside diameter of the reinforcing cage.
- D. Purge the tremie pipe of water.
  - 1. Insert a sturdy plastic ball or equivalent into the top of the pump hose extension before connecting the hose from the concrete pump.
  - 2. The ball must fit snugly into the pump hose extension when the hose is filled. The hose must be strong enough to resist rupture.
  - 3. Prime the hose and pipe with portland cement slurry.
- E. Lower a small diameter pole with an attached flat plate into the hole to determine the top surface of concrete.
  - 1. Mark both pole and pipe so that the length of penetration can be determined immediately.
  - 2. Prevent the end of the pipe from becoming plugged with soil from the bottom of the hole.
- F. Begin pumping the concrete immediately after setting the reinforcing cage and pipe in the hole. Do not begin raising the pipe until the concrete surface is 10 ft above the bottom of the pipe.
- G. Keep the bottom of the tremie pipe at least 5 ft below the top of the concrete until the placement is complete and all muck, laitance, and all unsuitable concrete is removed. Provide a positive hold down if the pipe floats to ensure that the minimum 5 ft penetration is maintained.

### 3.6 FIELD QUALITY CONTROL

- A. If plugging of the pipe, equipment breakdown, or loss of the seal at the end of the pipe occurs:
1. Pull the pipe, reset it 2 ft below the top of the concrete, and purge it.
  2. Lower the pipe to at least 5 ft below the top of the placement, and continue pumping concrete until all degraded concrete has lifted to the top of the shaft.
  3. Remove all muck, laitance and degraded concrete.

END OF SECTION