

ITEM 411

DRILLED SHAFT FOUNDATIONS

- 411.1 Description. This specification shall govern for the construction of foundations consisting of reinforced concrete shafts or columns with or without bell type concrete footings. Concrete shafts shall be placed in drilled excavations when the shafts are without bell type footings and in drilled or underreamed excavations when shafts are with bell type footings. Such foundations shall be constructed in accordance with this specification and in conformance with the details and governing dimensions shown on the plans.
- 411.2 Materials. All concrete materials shall be in accordance with the Item "Structural Concrete" and the requirements herein. Concrete shall be Class A1 or A2, but where casing is used, concrete shall be Class A1. The maximum size coarse aggregate shall be 1 1/2-inches for cased shafts. A retarder or water reducing agent will be required in all concrete when casing is used, or when shafts are placed in water. Reinforcing steel shall conform to the requirements of the Item, "Reinforcing Steel". The size and dimensions shall be as shown on the plans. Welding shall be in accordance with the Item, "Structural Welding".
- 411.3 Construction Methods
- A. Excavation. The plans indicate the expected depths and elevations where satisfactory bearing material will be encountered.
- The contractor shall perform the excavation required for the shafts and bell footings, through whatever materials encountered, to the dimensions and elevations shown on the plans or required by the site conditions. If satisfactory material is not encountered at plan elevation, the bottom of the shaft will be adjusted, or the foundation altered, as determined by the Engineer, to satisfactorily comply with design requirements.
- Shaft alignment shall be within a tolerance of one inch per ten feet of depth.

Where caving conditions and/or excessive groundwater is encountered, no further drilling will be allowed until a construction method is employed which will prevent excessive caving.

Drilling in a mud slurry, as necessary to control ground water and caving until a casing is set, will be permitted. Also drilling with a mud slurry, without the use of a casing, may be allowed with prior approval of the Engineer.

Casing will be required when necessary to prevent caving of material or when necessary to exclude ground water. Casing shall be metal, of ample strength to withstand handling stresses. The pressure of concrete and of the surrounding earth or backfill materials shall be watertight.

When casing is required, the outside diameter of the casing shall not be less than the specified diameter of shaft.

If the elevation of the top of shaft is below ground level at the time of concrete placement, an oversize surface casing from ground elevation to a point below the top of the shaft may be required to control caving of any material into the freshly placed concrete.

When casing is used, it shall be smooth, clean and free of accumulations of hardened concrete.

Under normal operations, the removal of the casing shall not be started, until all concrete placement is completed in the shaft. When unusual conditions warrant, the casing may be pulled in partial stages. A minimum of 6-foot head of concrete shall be maintained at all times above the bottom of the casing to overcome hydrostatic pressure. Casing extraction shall be at a slow, uniform rate with the pull in line with vertical axis of the shaft.

When the plans indicate that skin friction design has been used, any casing used will not be permitted to remain in place unless otherwise noted on the plans or permitted by the Engineer.

Bells shall be excavated to form a bearing area of the size and shape shown on the plans. Bell shapes varying slightly from those shown on the plans are permissible provided the bearing area equals that specified.

Bells may be extracted either by hand or by mechanical methods. Blasting shall not be permitted.

Material excavated from shafts and bells, including drilling mud shall not be used in the backfill around the completed bents or piers and shall be disposed of as directed by the Engineer.

At the time concrete is placed, the excavation shall be free from accumulated seep water. All loose material shall be removed from the bottom of the excavation, prior to placing concrete.

The contractor shall provide suitable access and lighting for proper inspection of the complete excavation and to check the dimensions and alignment of shafts and underreamed excavation.

Any required lighting shall be electric. Any mechanical equipment shall be operated by air or electricity. The use of gasoline driven engines within the excavation, for pumping and drilling, will not be permitted.

When the plans require shafts in abutment bents, the embankment at the bridge ends shall be completed to grade and thoroughly compacted prior to drilling, unless otherwise permitted by the Engineer.

- B. Reinforcing Steel. The cage of reinforcing steel, consisting of longitudinal bars and spiral reinforcement, lateral ties or horizontal bonds shall be completely assembled and placed as a unit immediately prior to concrete placement.

If the shaft is lengthened and the plans require full depth reinforcement, a minimum of one half of the longitudinal bars required in the upper portion of the shaft shall be extended to the bottom with proper lateral reinforcement. These bars may be lap spliced, or spliced by welding. Any splices required shall be in the lower portion of the shaft.

Where spiral reinforcement is used, it shall be tied or tack welded to the longitudinal bars at a spacing not to exceed 12 inches. Unless otherwise shown, welding will not be permitted within the top 15 feet of the steel cage.

Horizontal steel bends when used, shall be placed and welded as shown on the plans.

The cage shall be supported and/or held down by some positive method to minimize vertical displacement during concrete placement and/or extraction of the casing. The support shall be concentric with the cage to prevent racking and distortion of the steel. An adequate number of the vertical bars shall be supported.

In uncased shafts, concrete spacer blocks, or steel chairs shall be used at sufficient intervals to insure concentric spacing for the entire length of the cage. In cased shafts, concrete spacer blocks may not be used. Metal "chair" type spacers shall be placed at sufficient intervals to insure concentric spacing inside the casing.

The elevation of the top of the steel cage shall be carefully checked before and after casing extraction. Generally, any upward movement of the steel not exceeding 2 inches, or any downward movement not exceeding 6 inches per 20 feet of shaft length will be acceptable. Displacement of the steel beyond the above limits will be cause for rejection.

The minimum length of steel required for lap with column steel shall be maintained. Dowel bars may be used if the proper lap length is provided both into the shaft and into the column.

- C. Concrete. Concrete placement shall be performed in accordance with the provisions of the Item, "Concrete Structures", and in accordance with the requirements herein:

Concrete shall be placed as soon as possible after all excavation is complete and reinforcing steel placed, and shall be of such workability that vibrating or rodding will not be required.

Concrete placing shall be continuous in the shaft, to the construction joint indicated on the plans.

Concrete shall be placed through a suitable tube or tremie, to prevent segregation of materials. The tube or tremie may be made in sections to provide proper discharge and permit raising it as the placement progresses. A non-jointed pipe may be used if sufficient openings of the proper size are provided to allow for the flow of concrete into the shaft.

The elapsed time from the beginning of concrete placement in the cased portion of the shaft, until extraction of the casing is begun, shall not exceed one hour.

Placing of drilled shaft concrete under water may not be done without the permission of the Engineer. If permission is granted, the concrete shall be placed with a closed tremie or may be pumped. Provisions shall be made for a sump, or other approved method, to channel disposed water away from the shaft.

A riser block of equal diameter as the column and of a maximum height of 6 inches may be cast at the top of the completed shaft.

The top surface shall be cured and any construction joint area shall be treated as prescribed in the Item, "Concrete Structures".

No extra compensation will be allowed for the additional concrete required to fill an oversize casing or oversize excavation.

411.4 Measurement & Payment.

- A. Drilled shafts shall be measured by the vertical foot, measured from bottom of footing or shaft to construction joint or bottom of abutment. No separate measurement will be made for the concrete, reinforcing steel or excavation. No measurement or payment will be made for casing left in place or drilling through earth above specified top of shaft elevation, or removing earth above specified top of shaft elevation for convenience of drilling.
- B. Underreamed foundations (bells) shall not be paid for directly, but shall be subsidiary to drilled shaft foundations.

There are line code(s), description(s), and unit(s) for this item.

END OF ITEM 411

SUMMARY SHEET

ITEM 411 – DRILLED SHAFT FOUNDATIONS

Other Specifications Required

Item 420, Concrete Structures  
Item 421, Structural Concrete  
Item 440, Reinforcing Steel  
Item 446, Structural Welding

Reference Standards

None

Description:

Describes installation of drilled shaft footings and underreamed foundations (bells), including excavation, placement and curing of concrete, backfilling, materials and equipment.

Payment:

Drilled shaft footings shall be paid by the vertical foot, however, underreamed foundations shall not be paid directly, but shall be subsidiary to drilled shaft foundations.

DO NOT INCLUDE THIS SHEET IN THE CONTRACT SPECIFICATIONS.