

**Item No. 420S
Drilled Shaft Foundations**

420S.1 Description

This item shall govern the construction of foundations consisting of "Reinforced Concrete Drilled Shafts" and/or "Non-reinforced Concrete Drilled Shafts", with or without concrete bell footings. Concrete shafts shall be placed in a drilled excavation when the shafts are without bell footings and in a drilled and underreamed excavation when shafts are with bell footings. Foundations shall be constructed in accordance with this item and in conformance with the details and dimensions indicated on the Drawings. Any required test loading of shafts shall be in accordance with standard foundation test loading procedures used by the TXDOT or by other procedures approved by the Engineer or designated representative.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, the inch-pound units are given preference followed by SI units shown within parentheses.

420S.2 Submittals

The submittal requirements of this specification item may include:

- A. The foundation Drawing and drilling/excavation details;
- B. Class A p.c. concrete mix design;
- C. Anchor bolt Drawing and details;
- D. Reinforcing steel details and placement Drawings and
- E. Casing Drawing and details (if required).

420S.3 Materials

All concrete and materials shall conform to Item No. 403S, "Concrete for Structures" and the requirements herein. Concrete shall be Class A. The maximum size coarse aggregate shall be 1-1/2 inches (38 mm) for cased shafts. A retarder or water reducing agent will be required in all concrete when casing is used. Reinforcing steel shall conform to Item No. 406S, "Reinforcing Steel".

420S.4 Construction Methods

(1) Excavation

The Contractor shall perform the excavation required for the shafts and bell footings, through whatever materials encountered, to the dimensions and elevations indicated or required by the site conditions.

Shaft alignment shall be within a tolerance of 1 inch (25 mm) per 10 feet (3 m) of depth.

Bells shall be excavated to form a bearing area of the size and shape indicated. Bell outlines varying slightly from those indicated are permissible provided the bottom bearing area equals that specified.

Bells may be excavated either by hand or by mechanical methods. Blasting will not be used except with written permission of the Engineer or designated representative and shall be controlled to avoid disturbance of the formations below or outside the limits of the proposed shaft.

The plans indicate the expected depths and elevations where satisfactory bearing material will be encountered. This information will be used as a basis for the contract. If satisfactory material is not encountered at plan elevation, the footing may be raised or lowered as determined by the Engineer or designated representative. Alteration of plan depth shall be made to satisfactorily comply with the design requirements. Casing will be required when necessary to prevent caving of the material or when necessary to exclude seepage water. Casing shall be metal of ample strength to withstand handling stresses, the pressure of concrete and of the surrounding earth or backfill materials and shall be watertight. The outside diameter of casing shall not be less than the specified size of shaft; otherwise, the size of casing and the size of drilled excavation in which it is to be placed will be left to the discretion of the Contractor, except as noted below. No extra compensation will be allowed for concrete required to fill an oversize casing or oversize excavation.

Where caving conditions and/or excessive ground water is encountered, no further drilling will be allowed until a construction method is employed which will prevent excessive caving that will make the excavation appreciably larger than the size of casing to be used. Drilling in a mud slurry or other method which will control the size of excavation, will be required.

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

Where casing is not required, any excavation for the bells or shafts beyond the lines indicated shall be filled with Class A concrete at the Contractor's expense. Where casings are used, the Contractor will be permitted to backfill around the upper portions of the casing with pea gravel or other granular material, but space shall be provided to allow for escape of muck, slurry or water displaced by the concrete.

When casing is used, it shall be smooth and well oiled and shall extend approximately to the top of the shaft.

Under normal operations, the removal of the casing shall not be started, until all concrete placement is completed in the shaft. Movement of the casing for short pulls of a few inches, rotating, exerting downward pressure and tapping it to facilitate extraction will be permitted. When unusual conditions warrant, the casing may be pulled in partial stages. A sufficient head of concrete shall be maintained 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 the center of the shaft.

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 (50 mm) or any downward movement thereof not exceeding 6 inches (150 mm) per 20 feet (6 m) of shaft length will be acceptable. Any upward movement of the concrete or 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.

Placing of drilled shaft concrete under water shall not be done without the permission of the Engineer or designated representative. If permission is granted,

the concrete shall be placed conforming to Item No. 410S, "Concrete Structures" and shall be placed with a closed tremie. Provisions shall be made for a sump or other approved method to channel displaced water away from the shaft.

Material excavated from shafts and bells, including drilling mud and not used in the backfill around the completed bents or piers shall be disposed of as directed by the Engineer or designated representative and shall not be placed in the stream or otherwise impair the efficiency or appearance of the structure or other parts of the work.

At the time concrete is placed, the excavation shall be free from accumulated seepage 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 completed excavation, to check the dimensions and alignment of shafts and underreamed excavation.

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

In order that the Engineer or designated representative may judge the adequacy of a proposed foundation, the Contractor, if requested, shall make soundings or take cores at the Contractor's expense to determine the character of the supporting materials. The depth of such soundings or cores will not be required to exceed 5 feet (1.5 m) below the proposed footing grade. It is the intent of this provision that soundings shall be made or cores taken at the time the excavation in each foundation is approximately complete.

When shafts in abutment bents are indicated, the embankment at the bridge ends shall be completed to grade and thoroughly compacted prior to drilling.

(2) Reinforcing Steel

The cage of reinforcing steel, consisting of longitudinal bars and spiral reinforcement, lateral ties or horizontal bands, 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 1/2 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, spliced by welding or unspliced bars of the proper length. 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 (300 mm). Unless otherwise indicated welding will not be permitted within the top 15 feet (4.5 m) of the steel cage.

Horizontal steel bands shall be placed and welded as indicated.

The cage shall be supported from the top by some positive method, to minimize its slumping downward 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. A minimum of 1/2 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 shall not be used. Metal "chair" type spacers or bent pieces of steel bars shall be placed at sufficient intervals around the steel cage to insure concentric spacing inside the casing.

(3) Concrete

The work shall be performed conforming to Item No. 410S, "Concrete Structures", details indicated and 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. Reinforcing steel and concrete shall be placed during the same work day that the drilled shaft is excavated. Drilled shafts that cannot be completed the same work day as they are excavated shall be backfilled that same day with material removed from the excavation, subject to the approval of the Engineer or designated representative.

Concrete placing shall be continuous in the shaft to the construction joint indicated. The height of free fall of concrete shall be limited to 3 to 4 feet (900 to 1,200 mm), preventing segregation.

Concrete shall be placed through a suitable tube or tremie to prevent segregation of materials. The tube or tremie shall 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 1 hour.

Where a cap or tie beam is required to be placed monolithically with the shaft, a time interval will be allowed for placing the required form and reinforcing after casing removal.

A riser block of equal diameter as the column and of a maximum height of 6 inches (150 mm) 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 Item No. 410S, "Concrete Structures".

420S.5 Test Holes

When indicated or when ordered by the Engineer or designated representative in writing, test holes will be required to establish elevations for "belling", to determine elevation of ground water or other soil characteristics.

The diameter and depth of test hole or holes shall be as indicated or as directed by the Engineer or designated representative.

420S.6 Test Bells

When indicated or when ordered by the Engineer or designated representative in writing, the reaming of bells on specified test holes will be required to establish the feasibility of belling in a specific soil strata.

The diameter and shape of the test bell shall be as indicated or as approved by the Engineer or designated representative in writing.

420S.7 Measurement

Acceptable drilled shafts (of the specified diameter), complete in place, will be measured by the linear foot. Shafts for interior bents and piers will be measured from a point approximately 6 inches (150 mm) below the ground elevation at the center of shaft unless specific elevations or dimensions are indicated or unless the Engineer or designated representative directs otherwise to meet unusual conditions. (The bent height indicated is for estimating purposes only and does not control the top of shaft measurement.) For grade separations and railroad underpasses, the ground elevation used will be the completed subgrade section under the structure. At stream crossings and at railroad overpasses, the existing ground elevation at the time drilling begins will be used. For abutment bents and retaining walls, the length of shaft shall be measured from the bottom of footing or cap elevation. For sign structures and illumination towers, the elevation of top of shaft will be shown either as a dimension above ground or as a dimension to the bottom of footing.

Drilled shafts used with commercial designs of overhead sign bridges will not be measured for payment but will be included in the unit price bid for the item of construction in which this item is used.

The quantity for acceptable bell footings placed will be measured by the cubic yard, computed by using dimensions and shape indicated or as revised in diameter by the Engineer or designated representative. The bell shall consist of the volume outside the plan or authorized dimensions of the shaft, which will extend to the bottom of the bell for the purpose of measurement.

Test holes of the specified diameter will be measured from the elevation of the ground at the time drilling begins, by the linear foot of acceptable test hole drilled.

Test bells will be measured by the cubic yard of material excavated, computed from the dimensions indicated or those authorized by the Engineer or designated representative in writing.

420S.8 Payment

Drilled shafts will be paid for at the unit price bid per linear foot of "Drilled Shaft" or "Drilled Shaft (Non-reinforced)", of the specified diameter, subject to the following limitations for overruns authorized by the Engineer or designated representative.

- (1) Payment for individual completed shaft lengths up to and including 5 feet (1.5 m) in excess of the maximum plan length shaft, as defined herein, will be made at the unit price bid per linear foot of the specified diameter of "Drilled Shaft".
- (2) Payment for that portion of individual completed shaft length in excess of 5 feet (1.5 m) and up to and including 15 feet (4.5 m) more than the maximum plan length shaft, as defined herein, will be made at a unit price equal to 115 percent of the unit price bid per linear foot of the specified diameter of "Drilled Shaft".
- (3) Payment for that portion of individual completed shaft length in excess of 15 feet (4.5 m) and up to and including, 25 feet (7.5 m) more than the maximum plan length shaft, as defined herein, will be made at a unit price equal to 125 percent of the unit price bid per linear foot of the specified diameter of "Drilled Shaft".
- (4) Payment for that portion of individual completed shaft length, over 25 feet (7.5 m) in excess of the maximum plan length shaft, as defined herein, will be made at a unit price equal to 150 percent of the unit price bid per linear foot of the specified diameter of "Drilled Shaft".

- (5) For extra depth drilling at interior bents and piers, the maximum plan length shaft shall be the maximum length shaft, regardless of diameter, for any interior pier or bent of any bridge included in the contract.
- (6) For extra depth drilling for abutment bents and retaining walls, the maximum plan length shaft shall be the maximum length shaft, regardless of diameter, for any abutment bent of any bridge or of any retaining wall included in the contract.
 - (7) For extra depth drilling for sign structures, the maximum plan length shaft shall be the maximum length shaft, regardless of diameter, for any sign structures included in the contract.
 - (8) For extra depth drilling for illumination towers, the maximum plan length shaft shall be the maximum length shaft, regardless of diameter, for any illumination tower included in the contract.

The 20 percent limitation referred to in the "General Conditions", Section 11.6.5, will not apply to overruns due to extra depth of drilled shafts.

Bell footings, constructed to the specified dimensions or to the altered dimensions authorized by the Engineer or designated representative, will be paid for at the contract unit price bid per cubic yard for "Bell Footings". Authorized increase in bell footing diameter beyond 3 times the specified shaft diameter, unless indicated, shall be considered as beyond the scope and intent of these specifications. Payment for such increased bell footing quantity shall conform to the "General Conditions":

Test holes, of the specified diameter, when included in the contract as a bid item, will be paid for at the contract unit price bid per linear foot for "Test Hole".

Test bells of the diameter and shape specified, when included in the contract as a bid item or authorized by the Engineer or designated representative, will be paid for at the contract unit price bid per cubic yard of "Test Bells".

The foregoing unit prices shall be full compensation for making all excavations, for drilling all test holes and test bells, for doing any necessary pumping; for furnishing, placing and removing any required casings, for furnishing and placing all concrete and reinforcing steel, for all backfilling and for furnishing all tools, labor, equipment and incidentals necessary to complete the work. When the bottom of any drilled shaft is ordered to be placed at an elevation below plan grade and a splice of reinforcement is required, no payment will be made for the extra reinforcement required, but it shall be included in the unit price bid for the item of construction in which this item is used. No extra payment will be made for casings left in place.

No partial estimates will be allowed for "Bell Footing" or for "Drilled Shaft" until the concrete has been placed, except that partial payments will be made for reinforcing steel materials delivered on the job conforming to the "General Conditions".

Payment will be made under one of the following:

Pay Item No. 420S-A:	Drilled Shaft, ___ Dia. -	Per Linear Foot.
Pay Item No. 420S -B:	Drilled Shaft, Non-reinforced, ___ Dia. -	Per Linear Foot.
Pay Item No. 420S -C:	Bell Footings -	Per Cubic Yard.
Pay Item No. 420S -TB:	Test Bells, ___ Dia. -	Per Cubic Yard.
Pay Item No. 420S -TH:	Test Holes, ___ Dia. -	Per Linear Foot.

End

SPECIFIC Cross Reference Materials
Standard Specification Item No. 420S, " Drilled Shaft Foundations"

City of Austin Standard Specifications

Designation	Description
Item No. 403S	Concrete for Structures
Item No. 406S	Reinforcing Steel
Item No. 410S	Concrete Structures

RELATED Cross Reference Materials
Standard Specification Item No. 420S, " Drilled Shaft Foundations"

City of Austin Standard Specifications

Designation	Description
Item No. 104S	Removing Portland Cement Concrete
Item No. 111S	Excavation
Item No. 130S	Borrow
Item No. 132S	Embankment
Item No. 201S	Subgrade Preparation
Item No. 401S	Structural Excavation and Backfill

Texas Department of Transportation: Standard Specifications for Construction,
Maintenance of Highways, Streets and Bridges

Designation	Description
Item No. 420	Concrete Structures
Item No. 421	Portland Cement Concrete
Item No. 440	Reinforcing Steel
Item No. 449	Anchor Bolts
Item No. 618	Conduit