

Section 02400

TUNNEL SHAFTS

PART 1 GENERAL

1.01 SUMMARY

This Section includes construction, maintenance, and backfilling requirements of tunnel shafts.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Tunnel shafts, both those shown on Plans and those additional ones needed for Contractor's operations, are incidental to tunnel construction and no separate payment will be made for them. Manholes constructed in tunnel shafts are to be paid separately at contract unit price as specified in Section 02081 – "Cast-in-place Concrete Manholes" or Section 02082 – "Precast Concrete Manholes".
2. Removal and replacement of surface improvements necessary for shaft construction, such as sidewalks, asphaltic or concrete pavement, base and subbase, curbs, curb and gutter, driveways, topsoil, sodding, and hydro-mulch are incidental to tunnel construction and no separate payment will be made for them.

B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for Work in this Section is included in total Stipulated Price.

1.03 REFERENCES (NOT USED)

1.04 SUBMITTALS

A. Conform to requirements of Section 01330 – "Submittal Procedures".

B. Shaft design submittals by Contractor shall be signed and sealed by Professional Engineer registered in State of Texas. If trench box is used in tunnel shaft and such utilization is in a manner other than what is indicated and certified in manufacturers technical data, submit trench box manufacturer certification of proposed usage.

C. Submit shaft construction drawings and seal slabs. Clearly indicate allowable surcharge loads and restrictions on surcharge capacity, including live loads, on shaft construction drawings. Indicate thrust blocks or other reactions required for pipe jacking, when applicable.

1. Location of shafts by station and limits of working sites.
 2. Description of site security arrangements in conformance with Paragraph 3.03.C, Shaft Construction.
 3. Description of method of extending shaft above flood level in conformance with Paragraph 3.03.C, Shaft Construction.
 4. Any geotechnical/boring undertaken by Contractor for whatever purpose connected to Work.
- D. Shaft Monitoring Plan: Submit for review prior to construction, shaft monitoring plan that includes schedule of instrumentation design, layout of instrumentation parts, equipment installation details, manufacturer's catalog literature, and monitoring report forms.
- E. Structures Assessment. Provide preconstruction and post-construction assessment reports for critical structures located within radius of shaft center equal to shaft depth plus shaft radius, measured in plan. Include photographs or video of any existing damage to structures in vicinity of shafts in assessment reports.
- F. Submit shaft surface settlement monitoring plan for review prior to construction. Identify location of settlement monitoring points, reference benchmarks, survey frequency and procedures, and reporting formats on plan.
- G. Submit readings of monitoring plans to Project Manager as soon as readings have been taken.
- H. Submit shaft temporary deck drawings and calculations to Project Manager, signed and sealed by Contractor's Professional Engineer in event that shaft is not needed for immediate construction activity, in conformance with Paragraph 3.03.C, Shaft Construction.
- 1.05 RELATED REQUIREMENTS
- A. Section 01300 – "Submittal Procedures"
 - B. Section 01504 – "Temporary Facilities and Controls"
 - C. Section 01555 – "Traffic Control and Regulation"
 - D. Section 01576 – "Waste Material Disposal"
 - E. Section 01578 – "Control of Ground Water and Surface Water"
 - F. Section 02081 – "Cast-In-Place Concrete Manholes"

- G. Section 02082 – “Precast Concrete Manholes”
 - H. Section 02316 – “Excavation and Backfill for Structures”
 - I. Section 02317 – “Excavation and Backfill for Utilities”
 - J. Section 02321 – “Cement Stabilized Sand”
 - K. Section 02431 – “Tunnel Grout”
- 1.06 QUALITY ASSURANCE (NOT USED)
- 1.07 SYSTEM DESCRIPTION
- A. Performance Requirements
 - 1. Shaft design must include allowance for contractor’s equipment and stored material and spoil stockpile as appropriate. Design must also allow for HS-20 highway loading if located in the vicinity of a paved area and/or allow for Cooper E-80 locomotive loading if located in the vicinity of a railroad.
 - 2. Design shaft to withstand full hydrostatic head without failure.
 - 3. Design shaft located within 50-year flood plain with water retaining liner extending 2 feet above 50-year flood elevation. It is acceptable when liner is stored at site for immediate installation in lieu of it being installed at shaft, provided that shaft liner extends at least 2 feet above existing ground elevation.
 - 4. Design shaft cover for minimum 25 pounds per square foot distributed load plus 300-pound point load.
 - 5. Design steel plate deck, if such is required, for HS-20 loading.
- 1.08 – 1.13 NOT USED
- PART 2 PRODUCTS (NOT USED)
- PART 3 EXECUTION
- 3.01 – 3.02 NOT USED
- 3.03 ERECTION/INSTALLATION APPLICATION AND/OR CONSTRUCTION
- A. Location of Access Shafts

1. Contractor has sole responsibility for selection of shaft sites needed for construction operations unless otherwise indicated on Plans. Location will be subject to approval of the Project Manager.
 2. Locate shafts and associated Work areas to avoid blocking driveways and cross streets, and to minimize disruption to business and commercial interests. Avoid shaft locations near areas identified as residential or potentially contaminated.
 3. Plan shaft locations to minimize interference with storm drainage channels, ditches, water lines, sanitary sewers, storm water sewers or culverts, which, when damaged, could result in ground washout or flooding of shafts and tunnels.
- B. Utility Relocation
1. Relocate utilities as shown on Plans. Utility relocations required by Contractor for shaft construction shall take into account zone of potential settlement in vicinity of shaft.
 2. Obtain approval from Project Manager for permanent relocations prior to relocating.
- C. Shaft Construction
1. Conform to the following for ground support systems:
 - a. Install liner elements, bracing and shoring structural members at locations and in method sequence and tolerances defined on shaft construction drawings as excavation progresses.
 - b. Ensure bracing and shoring are in contact with liner to provide full support as shown in shaft construction drawings. Evaluate and check modifications to liner, bracing, and shoring. Obtain approval from Contractor's Professional Engineer and submit to Project Manager.
 - c. Install seal slab as soon as final depth and stable bottom conditions have been reached and accepted by Project Manager. Construct seal slab capable of withstanding full piezometric pressure, either by pressure relief using under drains, or in case of more permeable ground condition, by use of structural reinforced slab. Construct seal slab in accordance with design provided by Contractor's Professional Engineer.
 - d. Design and construct entire shaft to appropriate factors of safety against yield, deformation, or instability as determined by Contractor's

- Professional Engineer. Shaft must withstand full hydrostatic head without failure.
- e. Special framing, bracing or shoring required around tunnel “eyes” or other penetrations shall be in-place according to shaft construction drawings before liner or any bracing or shoring at penetration is cut or removed.
 - f. Securely breast and shore face of starter or back tunnels to resist both soil and hydrostatic pressure.
 - g. When applicable, pressure grout voids or seepage paths around shafts and adjoining tunnels in accordance with Section 02431- “Tunnel Grout”. Pressure grout bolted steel liner plates as they are installed, unless otherwise approved by Project Manager. Perform secondary or ‘back grouting’ as ground measurement, voids, or deformation of shaft liner are detected.
2. Install suitable thrust or reaction blocks as required for pipe jacking equipment.
 3. Provide drainage from shafts while Work is in progress and until adjacent pipe joints have been sealed and shaft is backfilled. Conform to requirements of Section 01578 – “Control of Ground Water and Surface Water”.
 4. Surface Water Control. Divert surface water runoff and discharge from dewatering system away from shaft. Protect shafts from infiltration or flooding.
 5. Each surface work site is to be surrounded by security fence meeting requirements of Section 01504 – “Temporary Facilities and Controls”, which shall be secure any time site is unattended by Contractor’s personnel.
 6. Protect shaft, when not in use by second security fence at perimeter of shaft, or alternatively by cover designed in accordance with Paragraph 1.07.A, Performance Requirements.
 7. Provide portable concrete traffic barriers at locations where work site is situated adjacent to highway, road, driveway, or parking lot. Angle traffic barriers in direction of lane flow. Do not place perpendicular to on-coming traffic.
 8. Provide and maintain traffic control system in accordance with provision of Section 01555 – “Traffic Control and Regulation”.
 9. Cover shaft which is constructed more than 60 days in advance of its intended use by steel plate deck designed by Contractor’s Professional Engineer, and

restore surface to permit full traffic flow during time shaft is not in use. Remove from site other material and equipment used by Contractor including portable concrete traffic barriers, traffic control system, fencing and reinstall at time shaft is re-opened for use.

10. Construct suitable guardrail barrier around periphery of shaft, meeting applicable safety standards. Properly maintain barrier throughout period shaft remains open. Repair broken boards, supports, and structural members. Provide ladder with safety cage when required by OSHA in each shaft. In addition, provide full cover or other security barrier for each access shaft in which there is no construction activity or which is unattended by Contractor's personnel.
11. Size of Shafts: Make size adequate for construction of permanent structures indicated on Plans and to provide adequate room to meet operational requirements for tunnel construction and backfill.

D. Backfill

1. Provide cement-stabilized sand to minimum depth of 10 feet above crown of pipe, but where shaft is located in paved area, cement-stabilized sand shall be used to within one foot of pavement subgrade elevation. Provide cement-stabilized sand in accordance with Section 02321 – "Cement-stabilized Sand". Compact cement-stabilized sand in accordance with Section 02317 – "Excavation and Backfill for Utilities". In locations where backfill is not subject to traffic loading, depth above initial cement-stabilized sand may be backfilled with select backfill in accordance with Section 02316 – "Excavation and Backfill of Structures". When insufficient work space exists, Grout manhole or structure annular space in accordance with Section 02431 – "Tunnel Grout".
2. Remove shaft liner above level of 8 feet below ground surface, unless otherwise indicated on Plans. Maintain sufficient ground support to meet excavation safety requirements while removing shaft structure.

E. Monitoring

1. Monitoring Instrumentation. Instrumentation specified and readings shall be accessible at all times to Project Manager.
 - a. Install and maintain instrumentation system to monitor and detect movement of ground surface and adjacent structures. Establish vertical survey control points at distance from construction area that avoids disturbance due to ground settlement.

- b. Project Manager may through independent contractor or consultant, install instrumentation in, on, near, or adjacent to construction work. Provide access to Work for such independent installations.
 - c. Install instruments in accordance with Plans and manufacturer's recommendations.
2. Surface Settlement Monitoring
- a. Establish monitoring points on all critical structures.
 - b. Record location of settlement monitoring points with respect to construction baselines and elevations. Record elevations to an accuracy of 0.01 feet for each monitoring point location. Establish monitoring points at locations and by methods that protect them from damage by construction operations, tampering, or other external influences.
 - c. Monitoring points to measure ground elevation are required at distance of 10 feet and 20 feet from perimeter of shaft on each of four radial lines, at 90 degrees to each other.
 - d. Railroads. Monitor ground settlement of track subbase at centerline of each track when within zone of potential settlement.
3. Reading Frequency and Reporting. Submit to Project Manager, records of readings from various instruments and survey points.
- a. Record all shaft monitoring readings at least once per week starting prior to shaft construction and continuing until shaft has been backfilled and until no more detectable movement occurs.
 - b. Immediately report to Project Manager any movement, cracking, or settlement which is detected.
 - c. Following substantial completion but prior to final completion, make final survey of all shaft related monitoring points.

F. Disposal of Excess Material

Remove spoil in accordance with Section 01576 – “Waste Material Disposal”.

3.04 – 3.10 NOT USED

END OF SECTION