

## ITEM 432

### TUNNEL CONSTRUCTION

- 432.1 Description. This item shall govern for tunnel lines under railroads, state highways, and concrete paved streets or other obstructions indicated. All other street casing shall be made in accordance with the applicable item.
- 432.2 Materials. Steel pipe tunnel liner shall be in accordance with AWWA C200 Grade B, with butt welded joints in accordance with AWWA C200, Section 3. The steel pipe liner shall be 4 inches larger in diameter than the largest diameter of the enclosed pipe. Wall thicknesses shall be in accordance with Table No. 1.

TABLE No. 1

Size	Minimum Thickness
6 inch to 34 inch	1/4 inch
35 inch to 49 inch	3/8 inch

Steel pipe shall be given a factory applied hot coal tar coating inside and out in accordance with AWWA C203.

Tunnel liner plates shall be bituminous coated hot dipped galvanized sectional liner plates in accordance with Table No. 2. Design shall be per AASHTO standards with the following minimum safety factors applied to the design:

TABLE No. 2

Buckling	2
Seam Strength	3
Stiffness	2

Corrugated metal pipe liner shall be bituminous coated hot dipped galvanized metal pipe with an I.D. of 4 1/2 inches plus the O.D. of the bell of the conveyance pipe. Corrugated pipe shall conform to the Item, "Corrugated Metal Pipe" and shall be of the following gauges:

TABLE No. 3

Corrugated Metal Pipe Size with 2-2/3 x 1/2 Corrugations	Minimum Gauge
15 inch diameter and under	16
18 inch to 30 inch diameter	14

30 inch and 36 inch diameter	12
42 inch diameter	10

432.3 Grout Encasement. When conveyance pipe is reinforced concrete steel cylinder pipe, use grout encasement to fill the annular space between the conveyance pipe and tunnel liner. Grout encasement is not necessary on steel conveyance pipe and tunnel liner unless called for elsewhere. Use grout having a 3:1 sand-cement ratio and 100 pounds of bentonite per cubic yard of grout. Seal the ends of the encasement with 2 inch (thickness) creosoted timber.

432.4 Skids. For concrete conveyance pipe inside of smooth steel pipe liner, place additional mortar at the center and quarter points on each length of pipe inside the liner. This additional mortar shall extend approximately 1-inch outside of the diameter of the ball end. Each pad shall be approximately 2-foot long.

For steel, cast iron and asbestos-cement conveyance pipe inside of smooth steel pipe liner. Use PSI Projects pipeline casing insulators and seals or an approved equal. Use Model A61S, A81S, or A12 IS steel insulators and Model S end seals of the proper size to seal ends. For 6, 8, and 10 inch carrier pipe, use Model A61S, 14 gauge, 6 inch width bands; for 24 inch through 36 inch pipe, use Model A12IS, 12 gauge, 12 inch bands. Skids to be steel capped plastic insulators. Place end insulators a maximum of 12 inches from the end of the casing pipe. Intermediate insulated shall be spaced to insure a minimum of two insulators per joint of conveyance pipe.

For corrugated metal pipe liners, use Southern Pine, dense number one structural, or better, SISIE runners. Retaining bands shall be galvanized, heavy duty, box bandings, approximately 7/8 inch wide by 0.028 inch thick. The spacing of bands shall be one per pipe joint of 4 feet maximum. Cut notches at joints of pipe.

432.5 Construction. Install the conveyance pipe in the tunnel liner, where tunnel construction is indicated. Unless otherwise indicated, extend tunnel section 10 feet beyond each side of pavement for highways or road crossings and 10-feet beyond outside ends of ties, for railroads.

Construct the tunnel by machine boring (dry) and jacking metal pipe liner or by tunneling operation in conjunction with the installation of tunnel liner plates. Install to the alignment and grade shown. Diameter of bored or tunneled hole shall be not more than 1 inch greater in diameter than outside diameter of casing pipe.

Shafts will be excavated at points indicated on the plans or where directed by the Engineer, to such depth and location necessary to drive tunnels to the line and grade established by the Engineer. When shaft or shafts have been excavated to proper elevation and shored and braced adequately, the horizontal excavation for tunnel shall be started. Bracing, shoring, sheeting and roofing or metal tunnel linings, if used, shall be installed immediately upon completion of excavation to proper cross-section, and in no circumstances shall the finished section of tunnel precede such installation by more than two feet. Suggested details of timber work for installation in tunnel may be shown on the plans; however, it shall be the Contractor's responsibility to check same to satisfy himself as to the adequacy of design prior to use. Any alternate plan proposed by the Contractor shall be submitted to the Engineer for checking.

Cylindrical metal linings, either tunnel liner plates fabricated in place in the tunnel or corrugated culvert pipe, jacked ahead as the tunnel excavation proceeds, will, unless otherwise specified, be approved for use in lieu of timber linings. Liner Plates or culvert pipes shall have sufficient strength to provide safe support for all earth and other loads likely to be encountered and shall be equal in every respect to the strength of timber or other supports and linings that may be shown on the plans.

The inside diameter of tunnels for pipe sewers shall be ample to permit proper access for making up the joints. The inside diameter of tunnels for monolithic sewers shall be sufficient to provide for the inside diameter of the sewer plus twice the minimum thicknesses plus any additional diameter necessary to secure minimum wall thickness when forms cannot be placed in the exact center of the tunnel.

Where the length of tunnel is in excess of ten feet, the Contractor shall be required to bore holes from the surface to and through the roof of tunnel for depositing concrete. These holes shall be of such numbers and spaced as directed by the Engineer, and under no condition shall spacing of holes exceed ten feet. Tremies will be used for depositing concrete at these intermediate points along the sewer tunnel. Where monolithic sewer is required, inside forms shall be carefully placed to true line and grade as established by the Engineer, and shall be securely blocked in place to prevent floating or misalignment during the concreting operation. The consistency of concrete placed in the sewer tunnel shall be carefully controlled to insure flow to all parts of sewer barrel without pocketing or honey-combing. Concrete shall be thoroughly vibrated to insure monolithic construction.

In lieu of placing concrete through holes bored from the surface the Contractor will be permitted to place grout by means of suitable pumping equipment, in tunnels containing pipe sewers. Such methods shall not be used for construction of monolithic sewers.

The shafts and tunnel shall be maintained in a dry condition during the excavation period, and shall continue to be kept in a dewatered state until

after concrete has attained its final set. This shall be accomplished by pumping, bailing, or by well-point installation at the Contractor's own expense. Where precast concrete pipe is placed under this specification it shall be encased in concrete in concrete.

Where the plans call for cast iron or other pipe in a bored hole the work shall be done as follows: when only one length of pipe is to be installed so that the pipe bell or other joint will not enter the bore, the inside diameter of the bored hole shall not exceed the outside diameter of the pipe by more than one inch. Where pipe bells or other types of joints must enter the bore, the inside diameter of the bored hole shall not exceed the outside diameter of the pipe bell or other type of joint by more than one inch. Leaded joints to be installed in bored holes shall be caulked with extra care with the maximum amount of lead and fully protected against any bending action.

On gravity lines where leakage tests are not made the Engineer may require that the pipe be plugged and filled with water to reveal any leakage. The tunnel shall be checked by the Engineer before the cast iron pipe is placed therein. If the tunnel at any point is more than 0.15 feet above grade, or more than 1/4 the inside diameter of the pipe below grade the hole shall be rebored or otherwise modified as directed by the Engineer to come within these tolerances.

To install the conveyance pipe, make up joints as specified in the applicable items of the technical specifications and in open trench. Place insulators and skids as specified above. Where wood runners are indicated, attach runners to the conveyance pipe. Skid the conveyance pipe into the tunnel liner. Provide blocking on top of conveyance pipes requiring grout encasement to prevent vertical displacement due to buoyance. Place grout encasement by pumping.

432.6 Method of Measurement. Conduit installed in tunnels in accordance with these specifications shall be measured by the **linear foot**, between the faces of shafts or portals at the ends of tunnels. When cast iron pipe is used, no additional payment will be made for cast iron pipe projecting outside of the ends of tunnels, or for concrete collars joining same to concrete pipe.

432.7 Payment. Pipe in tunnel, measured as set out above and accepted by the Engineer, shall be paid for at the unit price bid by the Contractor of "Pipe Tunnel Construction" of the size indicated on the proposal sheet, which price shall be full compensation for furnishing all tools, equipment, labor and materials; all excavation, disposal of excess excavation; all shoring, bracing, sheeting and linear; all pumping, bailing and operations used in dewatering; placing all forms, mixing and placing concrete, furnishing and placing tunnel liner, furnishing and placing conduit, all backfilling and other incidentals necessary to furnish the complete installation in the tunnel.

END OF ITEM 432