Two-Flange Tunnel Liner Plate

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STEEL OR ALUMINUM TUNNEL LINER PLATE SOLUTIONS

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CANADA BEST MANAGED COMPANIES

Two-Flange Tunnel Liner Plate

Two-Flange Tunnel Liner Plate provides optimum stability and protection when constructing new tunnels and relining structures under highways and railroads and relining vertical shafts. It offers the highest continuous ring stiffness and high compression joint strength. Two-Flange Tunnel Liner Plate has an effective stiffness that is more than twice that of the same thickness (gauge) of Four-Flange Liner Plate.

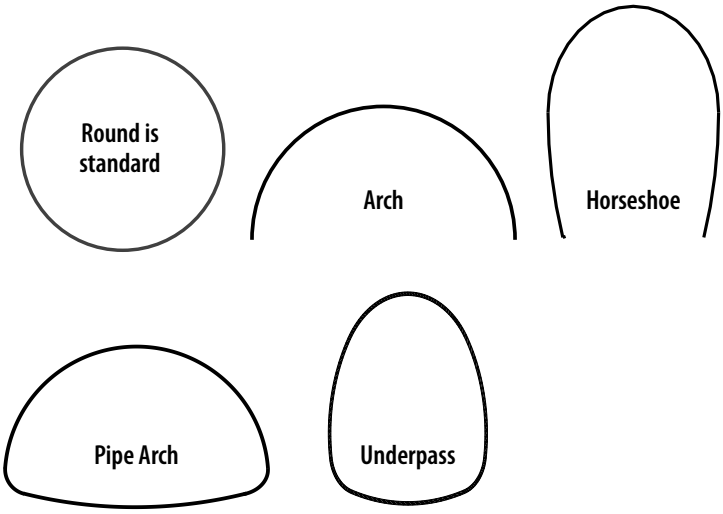
Applications

- Tunnel Lining
- Relining (rehabilitation of failing structures)
- Both Vertical and Horizontal Shafts

Features & Benefits

- Minimizes installation expense
- Optimizes stability in both horizontal and vertical applications
- Excellent in strength and safety

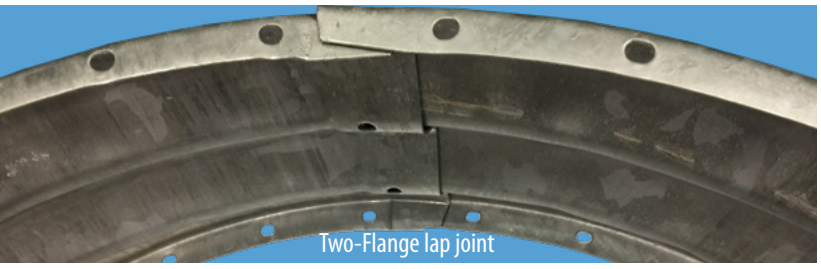
Shapes of Liner Plate



Two-Flange Tunnel Liner Plate

Full depth corrugation with offset end

Full depth corrugation with standard end



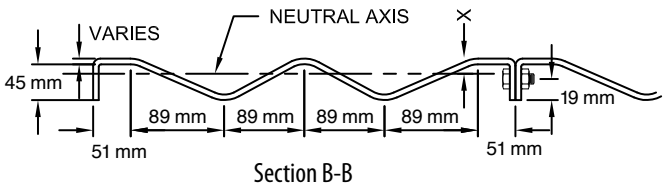
Two-Flange lap joint

Additional Data for Two-Flange Tunnel Liner Plate

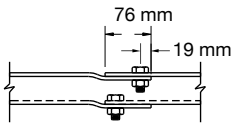
Inside Dimensions

Actual reduction from neutral axis to inside value is less than the theoretical dimensions in Section B-B. To determine inside dimension, average reduction of all thicknesses is 29 mm on radii or 57 mm on diameter.

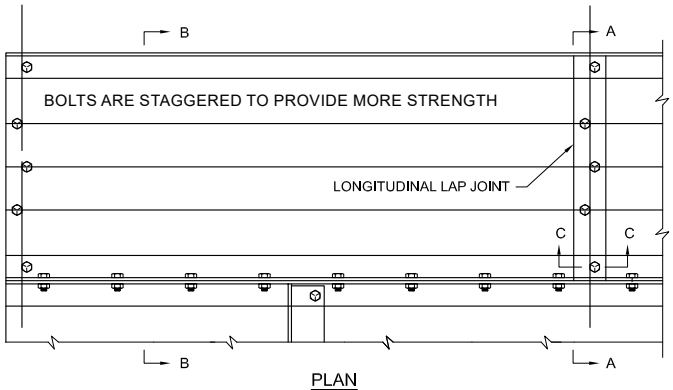
Section A-A



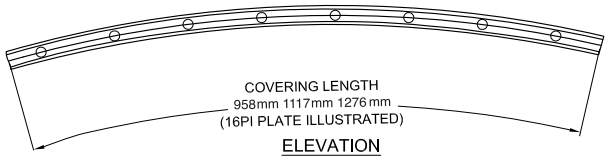
Section B-B



Section C-C



PLAN



ELEVATION

General Considerations

Construction and Design

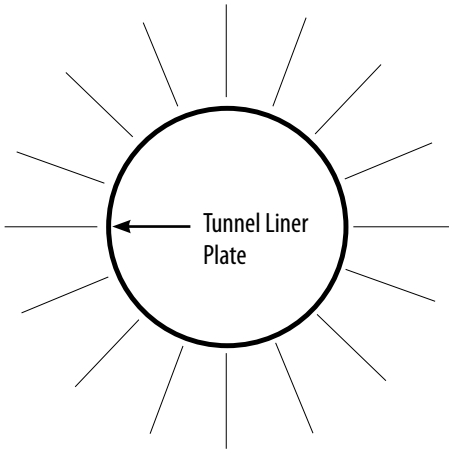
Tunnel loads vary widely in magnitude and classification, depending on the soils encountered and construction practices. Loads encountered during the tunnelling operation are entirely different from those on the finished and grouted tunnel.

Once construction is finished and the tunnel has been grouted, a relatively uniform load distribution develops around the structure. These final loads consist of dead and live loads, if applicable.

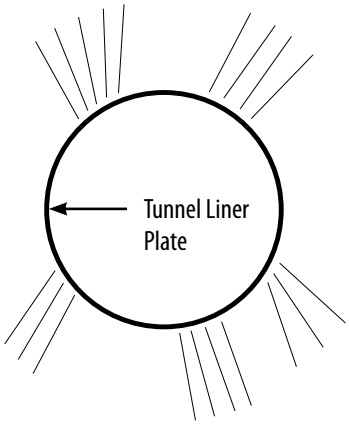
Since loads that develop during construction depend on the tunnelling procedure and soil conditions, they are difficult to predict. The installing contractor often encounters slough-ins, hydrostatic soil pressures and other forms of point loading. Handling these temporary loads, prior to backgrouting, requires proper equipment and good techniques to maintain the correct shape of the tunnel liner.

The designer should be aware that construction loads typically control the design especially in soft ground or hand-mined tunnels.

Contractors and designers utilize effectively designed liner structures with high bending resistance (stiffness) to resist concentrated loads that are common during construction.



Final Load



Construction Load
(often controls)

Material and Coating Considerations

Black Steel: Offers both the lowest cost and high strength. Good for temporary and sacrificial requirements.

Hot-Dip-Galvanized Steel: Longer service life than that of black steel.

Best•Kote® Polymer Coated Steel: +75 year service life in aggressive environmental conditions. Offers superior protection against corrosion, abrasion and inorganic acid, salts or alkali (diluted).

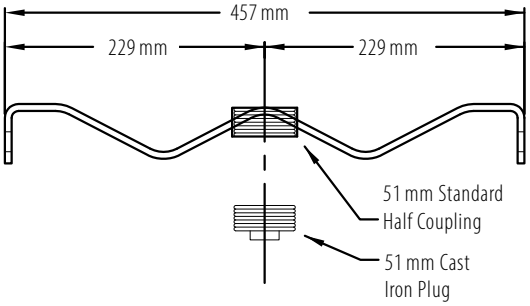
Aluminum: Provides longer service life in certain environmental conditions that would be detrimental to a zinc/galvanic coating. It is a lighter material and is easily carried into the structure. Most often considered for relines.

Grout Options

Grout Coupling with Plug

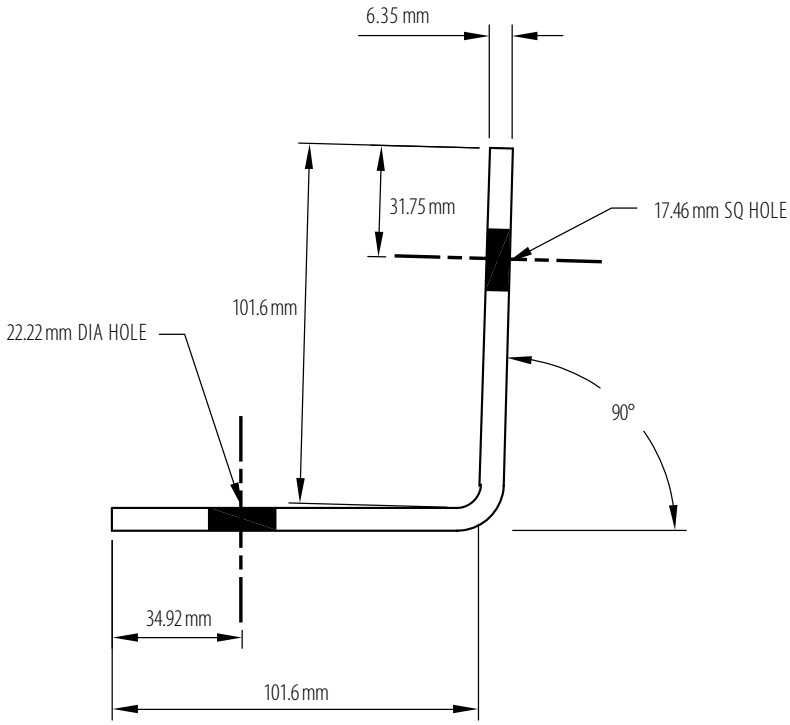
For pressure grouting, liner sections may be supplied with 51 mm standard pipe half couplings welded into a hole in the centre corrugation. Couplings are fitted with threaded plugs. These couplings are used:

- For lighter thicknesses (gauges)
- When required by specification



Base Angle for Arches

Base angles are used to support arch-shaped tunnel liners.



Specification Guidelines

Scope

This specification covers Two-Flange Tunnel Liner Plate, fabricated to permit field assembly of structure. The tunnel structure shall match the neutral axis diameter and/or shape and thickness (gauge) shown on the plans.

Material

Plates shall be accurately curved to suit the tunnel cross section and shall be of uniform fabrication to allow plates of similar curvature to be interchanged. All plates shall be punched for bolting on both the longitudinal and circumferential seams and shall be fabricated so as to permit complete erection from the inside of the tunnel. Circumferential bolt hole spacing will be a multiple of the plate length to allow staggering of the longitudinal seam. Circumferential bolt spacing shall be 159 mm unless unless otherwise specified. All material shall conform to CSA G401.

Grout holes shall be 51 mm in diameter and shall be provided as shown on the shop drawings to permit grouting as the assembly of the Liner Plate proceeds.

STEEL - per ASTM A1011 & A1018

Hot-Dip Galvanized

Material to be galvanized shall be zinc coated in accordance with CSA G401-24.

Material to be coated in accordance with AASHTO M274. Plates shall be of the thicknesses (gauges) shown on the plans and shall be curved to suit the tunnel cross section shown.

Aluminum - per ASTM B746

Aluminum

Material to be fabricated from aluminum plates conforming to the chemical and mechanical properties of the base metal for Alloy 5052-H141 temper. Plates shall be of the thickness (gauge) shown on the plans and shall be curved to suit the tunnel cross section shown.

Bolts and Nuts

Bolts and nuts shall be 16 mm in diameter and length as recommended by the manufacturer. Galvanizing shall conform to ASTM B695, Class 50.

Design

Liner Plate shall be designed per the methodology of AASHTO LRFD Section 12, CHBDC or AREMA.

Installation and Grouting

Liner Plate shall be assembled in accordance with manufacturer's recommendations. Longitudinal seams shall be staggered between rings. After rings have been installed, back grouting to fill any voids should be conducted in a manner to prevent buckling or shifting of the liner ring. The grouting crews should be scheduled as soon as practical behind the assembly operation. Staged grouting in proper lifts is important. Grouting material to be determined by the project specification.

Excavation

Care should be taken during excavation to eliminate voids and maintain maximum plate-to-ground contact. Efficient tunnelling reduces the quantity and frequency of back grouting and helps maintain tunnel shape and proper ring compression of the Liner Plate.

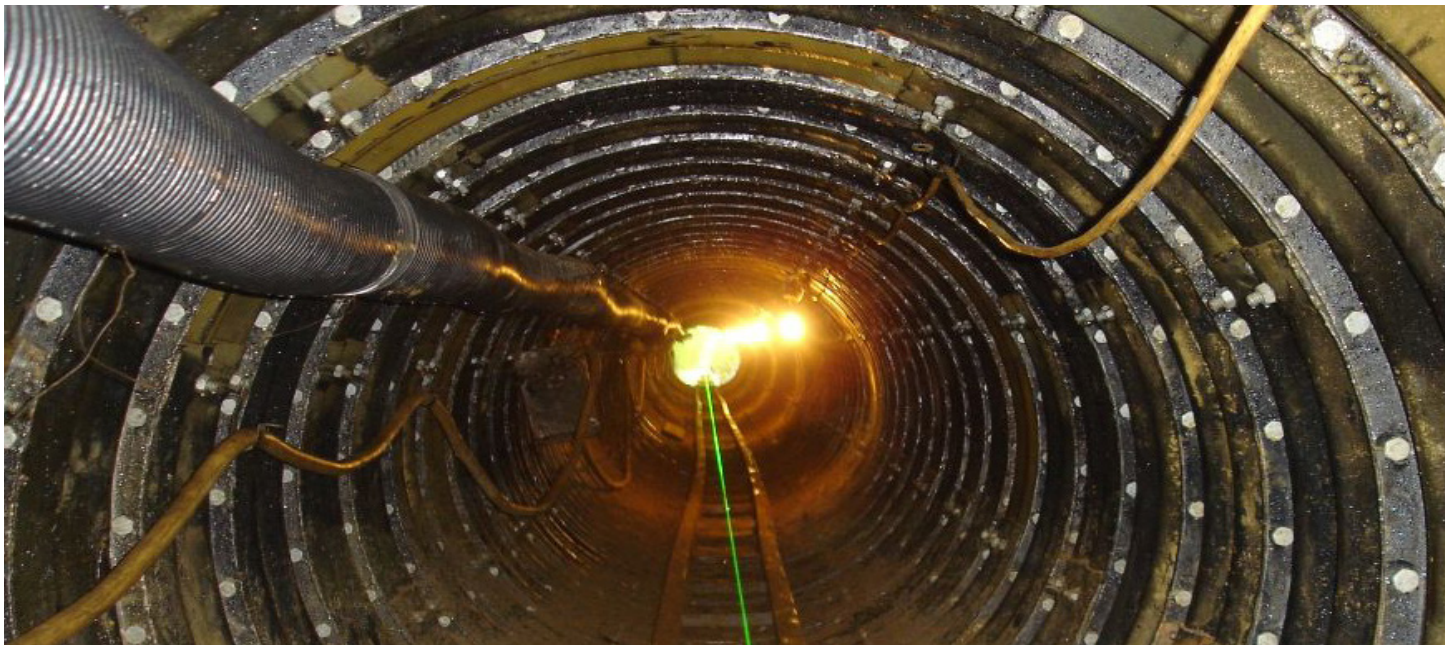
In unstable soils, it is important that tunnel headings be continuously protected against any loss of ground materials. Breast boards, shields and soil solidification have been successful in controlling tunnel headings under unstable conditions. Use of any one of a combination of these methods may be necessary for the proper and safe advancement of the tunnel. The contractor shall be responsible for the safety of their employees and agents. Adequate safety measure is the contractor's responsibility and shall be given to all personnel employed by their firm.

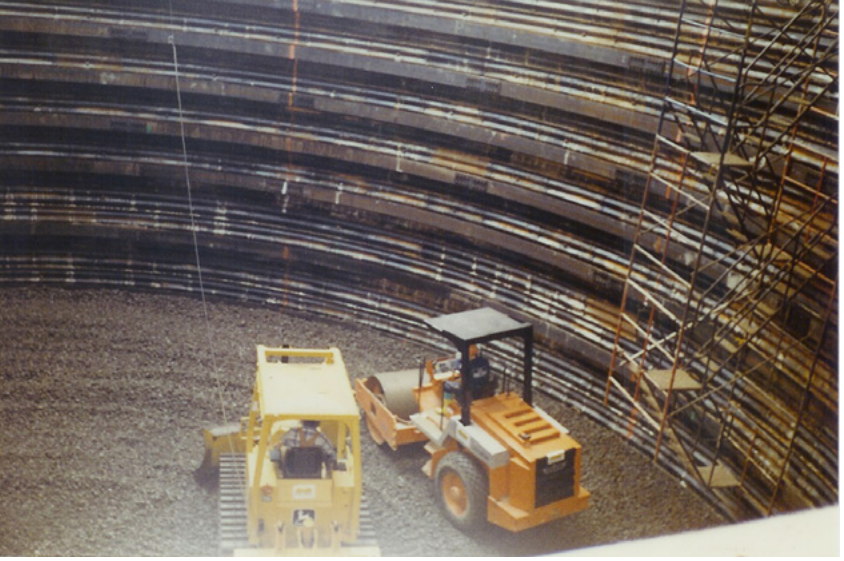
Stiffness

Wherever the soil becomes unstable, the loads on the tunnel tend to increase. Maximum ring stiffness under these conditions becomes of prime importance.

TABLE 2 - Ultimate Longitudinal Seam Strength for Two-Flange Tunnel Liner Plate (kN/m)						
STEEL						
Specified Thickness	2.8 mm	3.5 mm	4.2 mm	4.6 mm	5.3 mm	6.1 mm
Strength kN/m	438.0	686.3	803.1	905.3	1270.4	1343.4
ALUMINUM						
Specified Thickness	3.2 mm	3.8 mm	4.5 mm	5.1 mm	5.7 mm	6.4 mm
Strength kN/m	511.0	657.1	730.1	876.1	1022.1	1080.5

Note: In 2.0 mm through 4.6 mm thickness structures, longitudinal bolts are ASTM A 307, Grade A, 16 mm diameter by 32 mm long. For a thickness greater than 4.6 mm, the bolts are ASTM A449 Type 1, 16 mm diameter by 38 mm long.





Steel Vertical Shafts

Vertical Shafts are often required as access means for horizontal tunnelling and relines. These shafts may vary in diameter from 1.8 m to over 21 m and depths well over 30 m.

Optimizing Shaft Design

In each case, maintaining shaft integrity requires a dependable support system. Various methods are used for vertical shaft lining: sheet piling, unbraced timber, ring beams and timber lagging, concrete and stacked trench boxes.

Liner Plate Systems

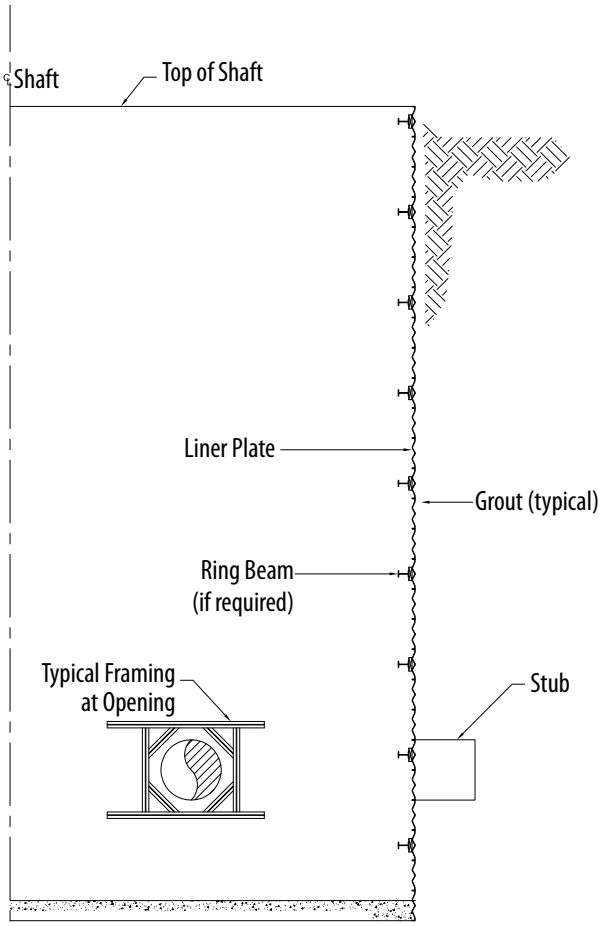
Two-Flange Tunnel Liner Plate is used in vertical shafts when the top-down installation is preferred. A net laying depth of 457 mm permits advancing the shaft in 457 mm increments. Bolts and nuts for Two-Flange Tunnel Liner Plate are easily installed from within the structure and rings of Liner Plate can be quickly installed and backgrouted.

Two-Flange Tunnel Liner Plate is the stiffest plate available and, unlike other shaft liner systems, often does not require the use of permanent ring-beam stiffeners.

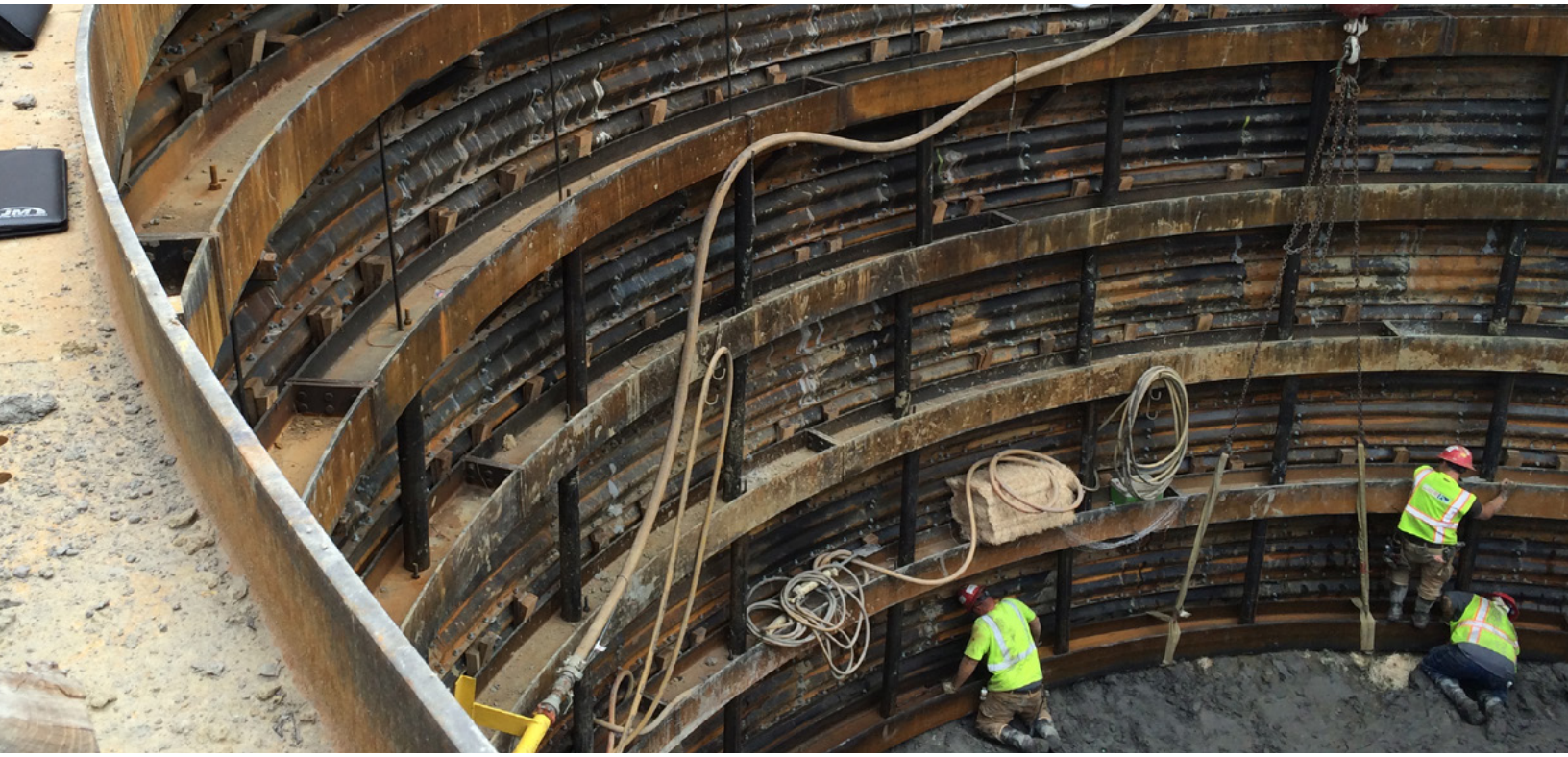
The Liner Plate system, available in in a variety of finishes, provides strength and safety. Often, the Liner Plate may be dismantled and reused.

Two-Flange Tunnel Liner Plate is much stiffer than Four-Flange Liner Plate. Commonly required diameters for Two-Flange Liner Plate will not require Ring-Beam bracing, whereas Four-Flange designs would more than likely require them.

If adjacent structures are sensitive to pile driving, a starter shaft using Two-Flange Tunnel Liner Plate can be used. Once the shaft reaches sufficient depth, pile driving can be commenced and disturbance to nearby foundations, railroads or other structures is minimized or eliminated.



Typical structure cross-section



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AIL-1227 01/2025

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