

Index 455-500 Temporary Cantilever Steel Sheet Pile Walls

Design Criteria

AASHTO LRFD Bridge Standard Specifications; Structures Design Guidelines (SDG); Geotechnical Design Manual (GDM).

General

This Index is intended for use on temporary critical or non-critical steel sheet pile walls and typically included in the Contract Plans where dropoff exist.

Steel sheet pile walls are generally most efficient when the grade separation is greater than 5 feet. For shorter grade separation other wall types or project specific designs are typically more cost-effective.

Design Requirements

It is anticipated that this Index will be primarily used during design by the Engineer of Record. However, for cases where the Contractor determines additional temporary walls are required for construction, this Index may be adopted if the design assumptions outlined herein are confirmed through a geotechnical exploration program.

Use of this Index by the Engineer of Record (EOR):

1. Provide the location and height of temporary walls to the project Geotechnical Engineer with sufficient lead time to ensure that a subsurface exploration that satisfies the requirements of the Geotechnical Design Manual is performed in preparation of the wall recommendations included in the Geotechnical Report.
2. The EOR in coordination with the Geotechnical Engineer shall evaluate the applicability of the Index based on project site soil conditions and design assumptions.

Use of this Index by the Department Approved Specialty Engineer:

1. The Specialty Engineer shall confirm the construction loading, project site soil conditions, and design assumptions are satisfied per this Index and these instructions.
2. Provide signed and sealed shop drawings to the EOR for temporary critical walls demonstrating material grade, section modulus and moment of inertia. The drawing shall include any special details required for conflict avoidance.

When the wall maintains the structural integrity of a utility, the design horizontal deflection criteria shall be based in coordination with the utility owner as indicated in SDG 3.13.3.E. Where the maximum allowable horizontal deflection is less than 1.5 inch, perform a custom design addressing the project specific criteria.

Sacrificial steel thickness of temporary sheet pile sections was not included in the design, therefore this Index is not intended to be used for permanent walls.

Design Assumptions

Soil type: Cohesionless

Angle of internal friction = 30 degrees

Cohesion = 0 psf

Soil-Steel Friction Angle = 15 degrees

Total Soil Unit Weight (Above bottom of excavation) = 115 pcf

Total Soil Unit Weight (Below bottom of excavation) = 105 pcf

The following parameters may be used to evaluate equivalency:

- If the total soil unit weight " γ " above the bottom of excavation exceeds 115 pcf, the product of the coefficient of active earth pressure " K_a " (Coulomb) times γ should not exceed 35 pcf and 16 pcf above and below the phreatic surface, respectively.
- If the total soil unit weight below the bottom of excavation is less than 105 pcf, the product of the coefficient of passive earth pressure " K_p " (Log-spiral) times γ should not be less than 467 and 190 pounds per cubic foot above and below the phreatic surface, respectively.

An average SPT N_{1-60} (corrected for overburden and efficiency) of 8 blows per foot or higher within the sheet pile wall penetration depth.

Soil strata within sheet pile penetration depth does not include very loose sand with SPT N_{60} -values (not corrected for overburden pressure) of 4 blows per foot or less, muck, or other deleterious materials.

When the project Geotechnical Engineer considers soil conditions at the specific site location to be of lesser strength, a custom design of the sheet pile wall will be required.

An unfactored surcharge load of 300 psf was used to model construction equipment and live load behind the wall and extends indefinitely. If construction equipment, or construction practices are expected to generate higher pressures, a redesign is required.

The 225 psf contact pressure modeled for the temporary barrier is based on a type K barrier system.

Groundwater Conditions

Design groundwater depth shall not be lower than the seasonal high groundwater elevation. Higher design groundwater depth shall be incorporated at sites vulnerable to flooding and/or storm events that may pose a more critical development of active pressure due to accumulation of water behind the wall and reduction in passive resistance. In those instances, a custom design addressing this concern may be required to satisfy project specific requirements.

Case 1 in this Index assumes groundwater at the bottom of excavation with a head differential of three feet compared to the water behind the wall. Water was modeled at a higher elevation behind the wall to account for accumulated pressures after storm events or rapid drawdown conditions.

Other groundwater table cases in this Index include design groundwater level at specified depths below the bottom of excavation. For the cases where the design groundwater depth does not perfectly match any of the groundwater table cases in this Index, it is recommended that a groundwater depth shallower than the design groundwater depth be used. Alternatively, the required minimum sheet pile properties and embedment depths may be linearly interpolated between different groundwater depths.

Engineering Analysis

The following analysis approach was adopted:

Active Earth Pressure: Coulomb

Passive Earth Pressure: Log Spiral

Surcharge loads, including live load and self-weight of concrete barrier, are incorporated in the analyses using the trial wedge method.

For sheet pile deflection analyses, the point of first zero deflection was assumed to be at 50% of the wall embedment depth. This is defined as the location where the sheet pile horizontal deflection crosses the zero line below bottom of excavation. The depth to the anticipated point of first zero deflection was selected based on the deformation characteristics obtained by the p-y method of analyses.

Limiting Lateral Deflection

The moment of inertia requirements included in the drawings correspond to the limiting lateral deflection for the following two cases.

Table 1. Limiting Horizontal Deflection for Critical Walls

Service Condition	Limiting Deflection (inches)
The supported paved roadway will not be paved or resurfaced after the wall deflects.	1.5
The supported paved roadway will be paved or resurfaced after the wall deflects, or the supported roadway is unpaved.	3.0

Refer to SDG 3.13.3 for additional requirements when utilities are present, and to SDG Figure 3.13.3-1 for the definition of critical wall.

The requirements for a maximum deflection of 3.0 inches can be adopted for non-critical temporary steel sheet pile walls, unless a more stringent design is required for the project (e.g., adjacent utilities or sensitive structures).

Load and Resistance Factors

Embedment:

Load Factors = 1.0 (Lateral Earth Pressure, Live Load, and Barrier Wall)

Resistance Factor (passive) = 0.75

Added 20% embedment depth per AASHTO.

Section Modulus:

Load Factor = 1.5 (Earth Horizontal)

Load Factor = 1.75 (Live Load)

Load Factor = 1.25 (Barrier Wall self-weight)

Resistance Factor = 0.75

Deflection:

Load Factors = 1.0 (Lateral Earth Pressure, Live Load, and Barrier Wall)

Resistance Factor = 1.0

Plan Content Requirements

In the Structures Plans:

Complete the “TEMPORARY CANTILEVER STEEL SHEET PILE WALL DATA TABLE” and include it in the Plans. Include the wall location, required section modulus and moment of inertia, tip and top elevation, soil and water elevation in front and behind the wall, and the design live load. A sample table is shown below.

TEMPORARY CANTILEVER STEEL SHEET PILE WALL DATA TABLE												Table Date 01/01/27	
CONSTRUCTION INFORMATION								DESIGN PARAMETERS					
WALL LOCATION			MINIMUM PLASTIC SECTION MODULUS * (in ³ /ft)		MINIMUM MOMENT OF INERTIA (in ³ /ft)	MINIMUM TIP ELEVATION (ft)	TOP ELEVATION (ft)	SOIL ELEVATION (ft)		WATER ELEVATION (ft)		DESIGN LIVE LOAD (psf)	
WALL No.	STATION		OFFSET (ft)	A328 Fy = 39 (ksi)				A572 Fy = 50 (ksi)	FRONT OF WALL ** (ft)	BACK OF WALL (ft)	FRONT OF WALL (ft)		BACK OF WALL (ft)
	BEGIN	END											

* MINIMUM PLASTIC SECTION MODULUS IS BASED ON HOT ROLLED SECTIONS. FOR COLD ROLLED SECTIONS, INCREASE BY 20%

** MINIMUM (LOWER) OF EXCAVATION OR SCOUR DEPTH

Payment

Item number	Item Description	Unit Measure
455-133-22	STEEL SHEETPIILING, TEMPORARY, CRITICAL, CANTILEVER	SF

Payment for Contractor to perform geotechnical borings, laboratory testing, and preparing signed and sealed Report of Core Boring sheets and test reports shall be included in the unit bid price of the bid items listed above, where applicable.