SHEET PILE WALL ANALYSIS

Project: Sample Project **Number:** SP-2026-013
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1. INPUT PARAMETERS

Parameter	Symbol	Value	Unit
Wall type	*Type*	Cantilever	
Excavation depth	H	3.50	m
Surface surcharge	q	10.0	kPa
Earth pressure theory	*Method*	Rankine	
FOS on passive resistance	FS_p	1.50	
Friction angle (Medium sand)	φ_1	30.0	deg
Cohesion (Medium sand)	c_1	0.0	kPa
Unit weight (Medium sand)	γ_1	18.0	kN/m^3
Thickness (Medium sand)	t_1	5.00	m
Friction angle (Dense sand)	φ_2	33.0	deg
Cohesion (Dense sand)	c_2	0.0	kPa
Unit weight (Dense sand)	γ_2	19.0	kN/m^3
Thickness (Dense sand)	t_2	10.00	m

1. EARTH PRESSURE COEFFICIENTS

Earth pressures computed using Rankine (1857) theory, which assumes a smooth vertical wall and horizontal backfill.

Active Coefficient Ka (φ = 30.0°)

$$Ka = \tan^2(45^\circ - \varphi/2)$$

$$Ka = \tan^2(45^\circ - 15.0^\circ)$$

$Ka = \mathbf{0.3333}$

Rankine (1857); USACE EM 1110-2-2504

Passive Coefficient Kp (φ = 30.0°)

$$Kp = \tan^2(45° + \varphi/2)$$

$$Kp = \tan^2(45° + 15.0°)$$

$Kp = \mathbf{3.0000}$

Rankine (1857); USACE EM 1110-2-2504

Active Coefficient Ka (φ = 33.0°)

$$Ka = \tan^2(45° - \varphi/2)$$

$$Ka = \tan^2(45° - 16.5°)$$

$Ka = \mathbf{0.2948}$

Rankine (1857); USACE EM 1110-2-2504

Passive Coefficient Kp (φ = 33.0°)

$$Kp = \tan^2(45° + \varphi/2)$$

$$Kp = \tan^2(45° + 16.5°)$$

$Kp = \mathbf{3.3921}$

Rankine (1857); USACE EM 1110-2-2504

Soil Layer Summary

Layer	φ (deg)	c (kPa)	γ (kN/m^3)	Ka	Kp
Medium sand	30.0°	0.0	18.0	0.3333	3.0000
Dense sand	33.0°	0.0	19.0	0.2948	3.3921

1. ACTIVE PRESSURE DISTRIBUTION

Active Earth Pressure

$$\sigma_a = Ka \times \sigma'_v - 2c\sqrt{Ka} + Ka \times q$$

$$Appliedateachdepthincrementalongtheretainedside$$

$\sigma_a(z) =$ **(varieswithdepth)**

USACE EM 1110-2-2504, Eq 3-1

Negative active pressures (tension zone) set to zero

1. PASSIVE PRESSURE DISTRIBUTION

Passive Earth Pressure (below excavation)

$$\sigma_p = Kp \times \sigma'_v + 2c\sqrt{Kp}$$

$$Appliedontheexcavationsidebelowdredgeline$$

$\sigma_p(z) =$ **(varieswithdepth)**

USACE EM 1110-2-2504, Eq 3-2

Factored Passive Resistance

$$\sigma_{p,d} = \sigma_p / FS_p$$

$$\sigma_{p,d} = \sigma_p / 1.50$$

$FS_p =$ **1.50**

USACE EM 1110-2-2504, Chapter 4

Factor of safety applied to reduce passive resistance

1. REQUIRED EMBEDMENT DEPTH

Simplified Method: Embedment depth is found by summing moments about the wall base until factored passive moment equals or exceeds active driving moment.

Moment Equilibrium about Base

$$\Sigma M_{passive} \geq \Sigma M_{active} (about wall base)$$

$$Iterative solution with numerical integration$$

$D_{calc} = \mathbf{4.50}$ m

USACE EM 1110-2-2504, Chapter 4

Embedment at moment balance before safety factor increase

Design Embedment Depth

$$D_{design} = 1.20 \times D_{calc} (USACE 20$$

$$D_{design} = 1.20 \times 4.50$$

$D_{design} = \mathbf{5.40}$ m

USACE EM 1110-2-2504

20% increase per USACE guidance for simplified method

Total Wall Length

$$L = H + D_{design}$$

$$L = 3.50 + 5.40$$

$L = \mathbf{8.90}$ m

1. MAXIMUM BENDING MOMENT

Maximum Bending Moment

$$M_{\max} occurs where shear V = 0 (net pressure sign change)$$

$$Computed by numerical integration of net pressure diagram$$

$M_{\max} = 267.7$ kN·m/m

USACE EM 1110-2-2504

Depth of Maximum Moment

$$zatV = 0$$

$z_{Mmax} = 8.89$ m

Depth from top of wall

1. RESULTS SUMMARY

Design Summary

Quantity	Value	Unit
Excavation depth (H)	3.50	m
Required embedment	5.40	m
Total wall length	8.90	m
FOS on passive	1.50	
Maximum moment	267.7	kN·m/m
Depth of max moment	8.89	m

1. FIGURES

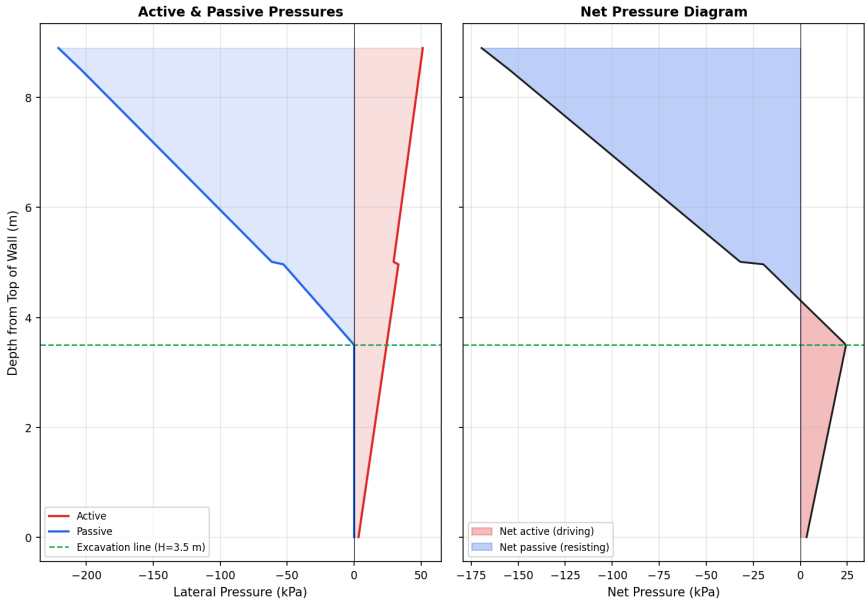

Figure 1: *

Figure 1: Active and passive earth pressure distributions along the wall (H = 3.50 m, D = 5.40 m).

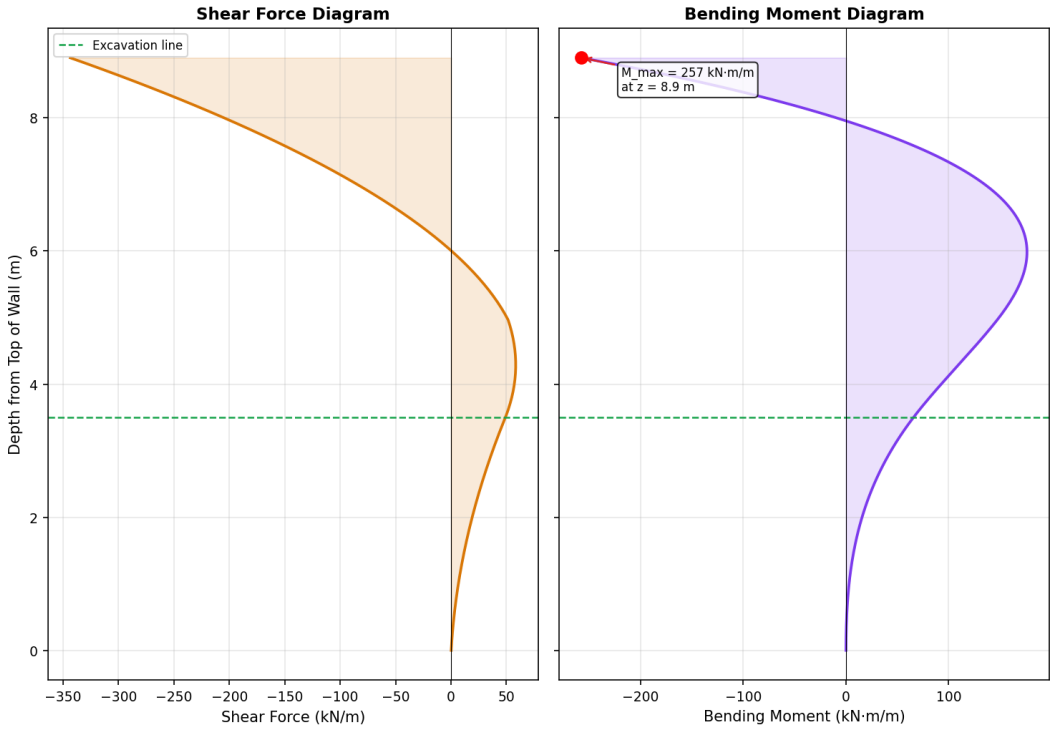

Figure 2: *

Figure 2: Shear force and bending moment along the wall. M_max = 267.7 kN·m/m at depth 8.89 m.

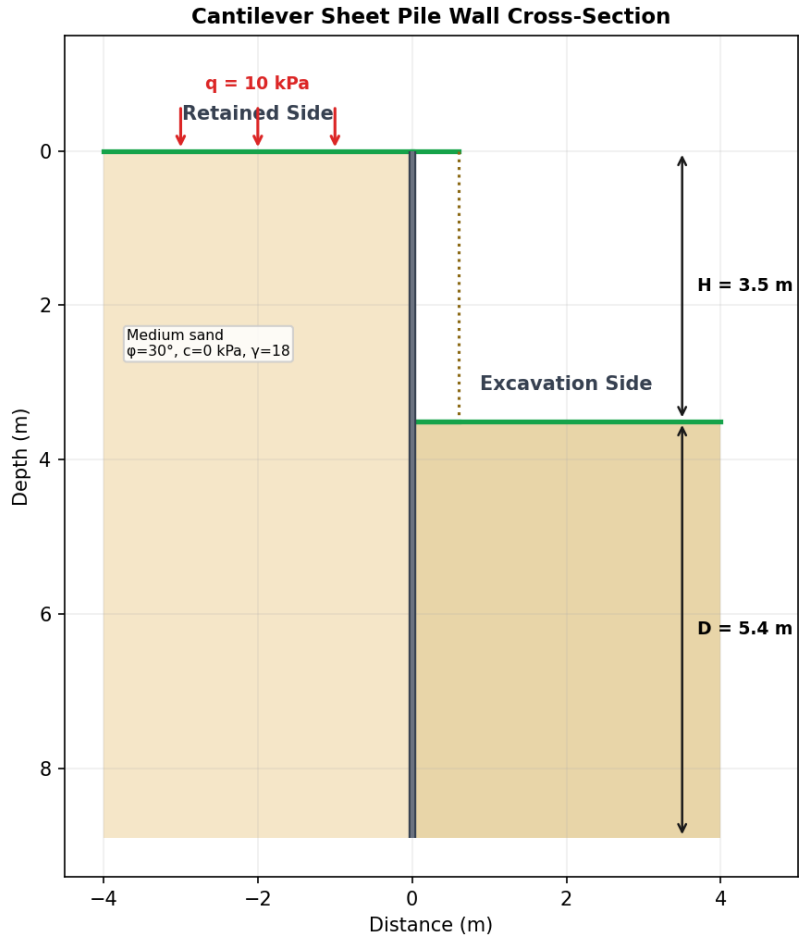

Figure 3: *

Figure 3: Sheet pile wall geometry showing excavation depth, embedment, and key dimensions.

1. REFERENCES

1. USACE EM 1110-2-2504: Design of Sheet Pile Walls.
2. USS Steel Sheet Piling Design Manual.
3. Dawkins, W.P. (1991). CWALSHT — Computerized Analysis of Sheet Pile Walls by Classical Methods. USACE ITL.
4. Rankine, W.J.M. (1857). "On the Stability of Loose Earth." Philosophical Transactions of the Royal Society of London, Vol. 147.
5. Coulomb, C.A. (1776). "Essai sur une Application des Regles de Maximis et Minimis." Memoires de Mathematique et de Physique, Vol. 7.
6. Das, B.M. "Principles of Foundation Engineering", Chapter 9.