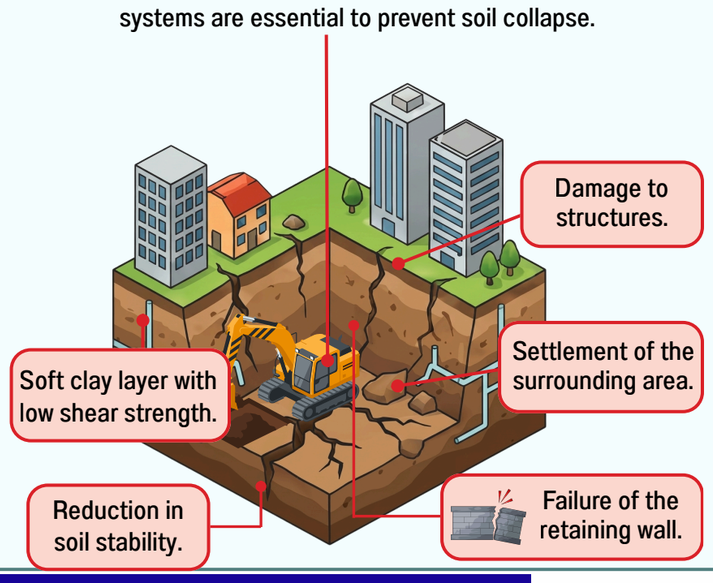
DESIGN OF TEMPORARY BRACING SYSTEMS FOR EARTH RETAINING WALLS

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Problem Statement / Rationale / Motivation

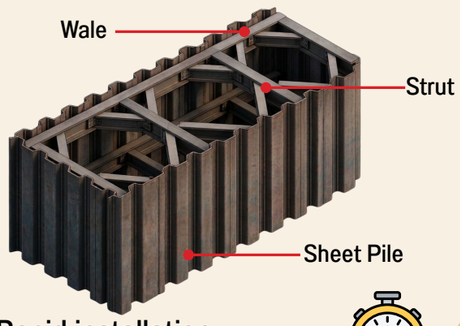
Problem Statement and Rationale

In deep excavation works for foundations or underground structures, temporary earth retaining systems are essential to prevent soil collapse.

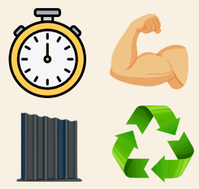


Motivation

Sheet Pile Wall



- Rapid installation and removal
- High strength
- Reusable



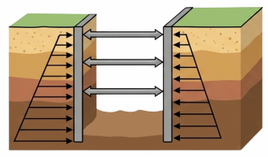
Design Objective

- To analyze and design the structural components of the temporary bracing system to ensure stability and strength in accordance with engineering standards.
- To establish procedures and guidelines for selecting suitable structural sections based on soil pressure conditions at different excavation depths.

Design Specs

- All structural members must pass allowable stress checks (fa < Fa, fb < Fb)
- Stability verified by overturning moment comparison

Design Constraints



- The temporary bracing system was designed for a 4.20 m deep excavation with dimensions of 3.30 × 15.00 m, a groundwater level at 4.00 m below ground surface, and a surcharge load of 2.00 T/m².

Engineering Standards

Engineering Standards

- Rankine Active Earth Pressure (1857)
- AISC Allowable Stress Design (ASD)
- Terzaghi & Peck Apparent Pressure
- Modified Rankine: Model 3

Design Approach / Methodology

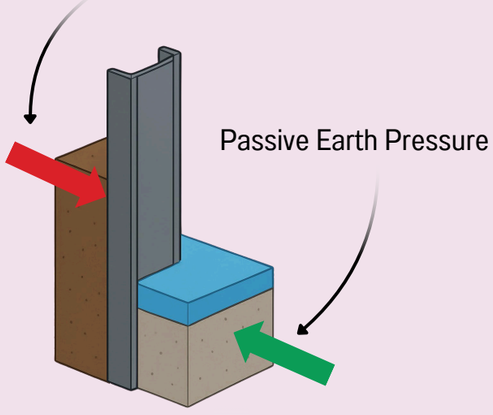
Study of Soil

Soil Data

Z (m)	Unit Weight γ_t (T/m³)	Soil Strength S_u (T/m²)
0.00	0.000	0.000
1.00-2.00	1.000	1.000
3.00	1.400	0.990
4.00-5.00	1.370	0.970
6.00	1.390	0.930
7.00-8.00	1.420	0.850
9.00	1.530	1.210
10.00	1.550	1.370
11.00	1.550	2.140
12.00	1.590	3.070
13.00	1.760	4.000
14.00	1.760	8.000
15.00	1.850	10.000

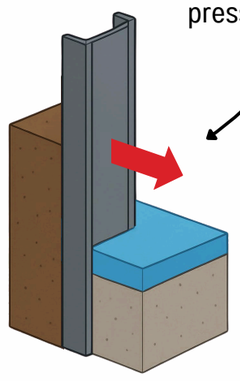
Calculate Earth Pressure

Active Earth Pressure

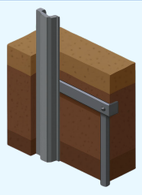


Passive Earth Pressure

Analysis of the resultant force, location of the resultant force, and development of the pressure diagram.

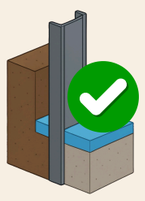


Design of Sheet Pile and Bracing System



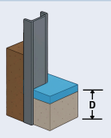
Design of sheet piles and the wale-strut bracing system.

Stability Check



The structural stability was checked by comparing overturning moments with resisting moments.

Calculation of Sheet Pile Embedment Depth



Calculation of sheet pile embedment depth.

Design Deliverables / Results

1 Sheet Pile

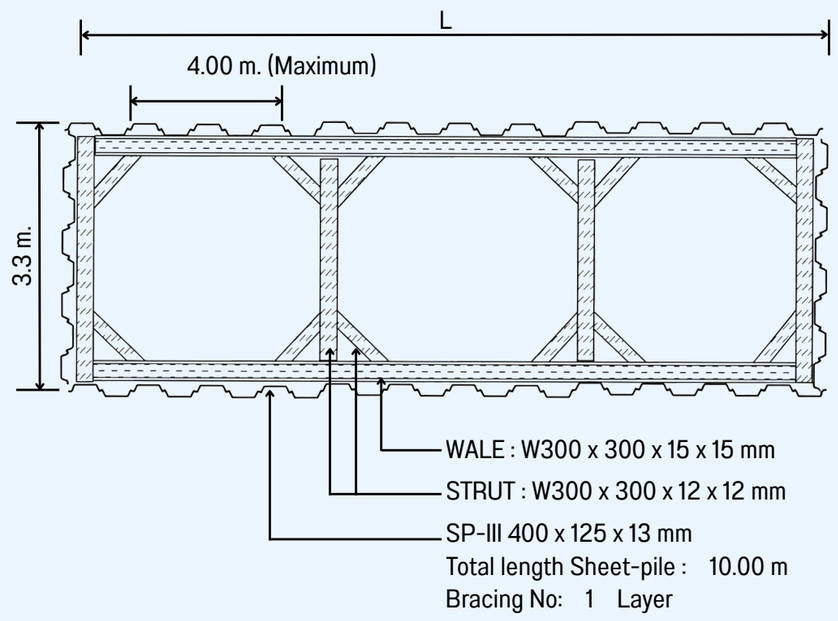
Mmax = 10.56 T-m/m
Selected SP-III : Sx = 1340 cm^3
f_b = M/Sx = 788.06 kg/cm^2
(< 1500 kg/cm^2 **Pass** ✓)
Use **SP-III 400 x 125 x 13 mm**
Length 10.00 m

2 Strut

Design Strut L = 3.30 m
Pmax = 59.73 T
Selected W300 x 300x 12 x 12 mm
(A =107.7 cm2, rx = 12.5 cm, Sx = 1150 cm^3)
KL/r = 26.4, Fa = 1404.62 kg/cm^2
fa = 554.60 kg/cm^2 (fa < Fa Pass ✓)
Use **W300 x 300x 12 x 12 mm**

3 Wale

Design Wale L = 4.00 m
Max Force = 9.05 T/m, Mmax = 18.10 T-m, Vmax = 18.10 T
Selected W300 x 300 x 15 x 15 mm (A = 134.8 cm2, rx = 12.6 cm, Sx = 1440 cm^3)
KL/r = 31.75, Fa = 1379.47 kg/cm^2, fa = 134.27 kg/cm^2 (fa < Fa Pass ✓)
Fb = 1500 kg/cm^2, fb = 1256.94 kg/cm^2 (fb < Fb Pass ✓)
fa/Fa + fb/Fb = 0.94 (< 1.00 Pass ✓)
Use **W300 x 300 x 15 x 15 mm**



BOQ / Cost Estimation

BILL OF QUANTITIES

Project: Temporary bracing system for earth retaining wall, excavation 4.20 m deep

No.	Description	Qty	Unit	Material (THB/unit)	Labour (THB/unit)	Amount (THB)
1. Preparation and earthwork						
1.1	Mobilisation and demobilisation of heavy machinery	1.00	job	0.00	100,000.00	100,000.00
1.2	Excavation 4.20 m deep and off-site disposal	207.90	m³	0.00	300.00	62,370.00
1.3	Lean concrete levelling at pit base, 10 cm	4.95	m³	2,400.00	0.00	11,880.00
2. Steel sheet pile wall						
2.1	Rent of sheet pile SP-III, 10.00 m long (54.90 t, 3 months)	164.70	t-month	0.00	1,300.00	214,110.00
2.2	Driving and extraction of sheet piles with vibro hammer	366.00	m²	0.00	250.00	91,500.00
2.3	Transport of sheet piles in and out (trailer, lump sum)	1.00	trip	0.00	30,000.00	30,000.00
3. Internal bracing						
3.1	Rent of wales WF 300 × 300 × 15 × 15 mm (3.88 t, 3 months)	11.64	t-month	0.00	1,500.00	17,460.00
3.2	Rent of struts WF 300 × 300 × 12 × 12 mm (1.96 t, 3 months)	5.88	t-month	0.00	1,500.00	8,820.00
3.3	Labour: cut, weld, install and remove bracing	5.84	t	0.00	6,000.00	35,040.00
				Direct cost (materials + labour)		571,180.00
				Overhead and profit	10%	57,118.00
				VAT	7%	43,980.86
				GRAND TOTAL		**672,278.86**

Conclusions and Recommendations

For the 4.20 m deep excavation in soft clay (Rankine active pressure), the design uses SP-III sheet piles 400 × 125 × 13 mm, 10.00 m long, with one bracing level of W300 × 300 × 15 × 15 mm wales and W300 × 300 × 12 × 12 mm struts. All members pass the allowable stress checks and the system is stable.

Acknowledgement

This engineering design report (Capstone Project) was successfully completed with the support and assistance of many people. The authors would like to express their sincere gratitude to Sada Engineering Co., Ltd., Asst. Prof. Treerapot Siripirote, Ph.D., and Asst. Prof. Piyanuch Jaikaew, Ph.D.

Reference

- Wanchai Teparaksa (2008). Design of Steel Sheet Pile Bracing Systems. Lecture Notes, Chulalongkorn University.
- Piya Rattanasuwan. (2015). Design of Sheet Pile Retaining Systems for Excavation Works. Lecture Notes. Bangkok: Royal River Hotel.

Key Courses Used In The Project

- **Soil Mechanics:** soil properties and Rankine earth pressure (Ka = 0.49).
- **Foundation Engineering:** embedment depth and stability check.
- **Steel and Timber Design:** sizing the sheet pile, wale and strut.
- **Structural Analysis:** earth pressure loads, bending moments and reactions.
- **Engineering Drawing:** plan, section and detail drawings.