Tuesday 5th December—4,5

Un-supported and Supported Excavations

Un-supported and Supported Excavations

1. **Stability of open excavation in soft clays**
2. **Excavations for a Dry Dock Project**
3. **Basal stability of supported excavations**
4. **Lateral Pressure distribution in braced and unbraced sheet piled walls.**
5. **Stability of slurry trench excavations**
6. **Performance of Deep Excavations**
7. **Ground improvement works in Deep excavations with soft clays**
8. **Use of computer softwares in the analysis of deep excavations**
9. **Concluding remarks**

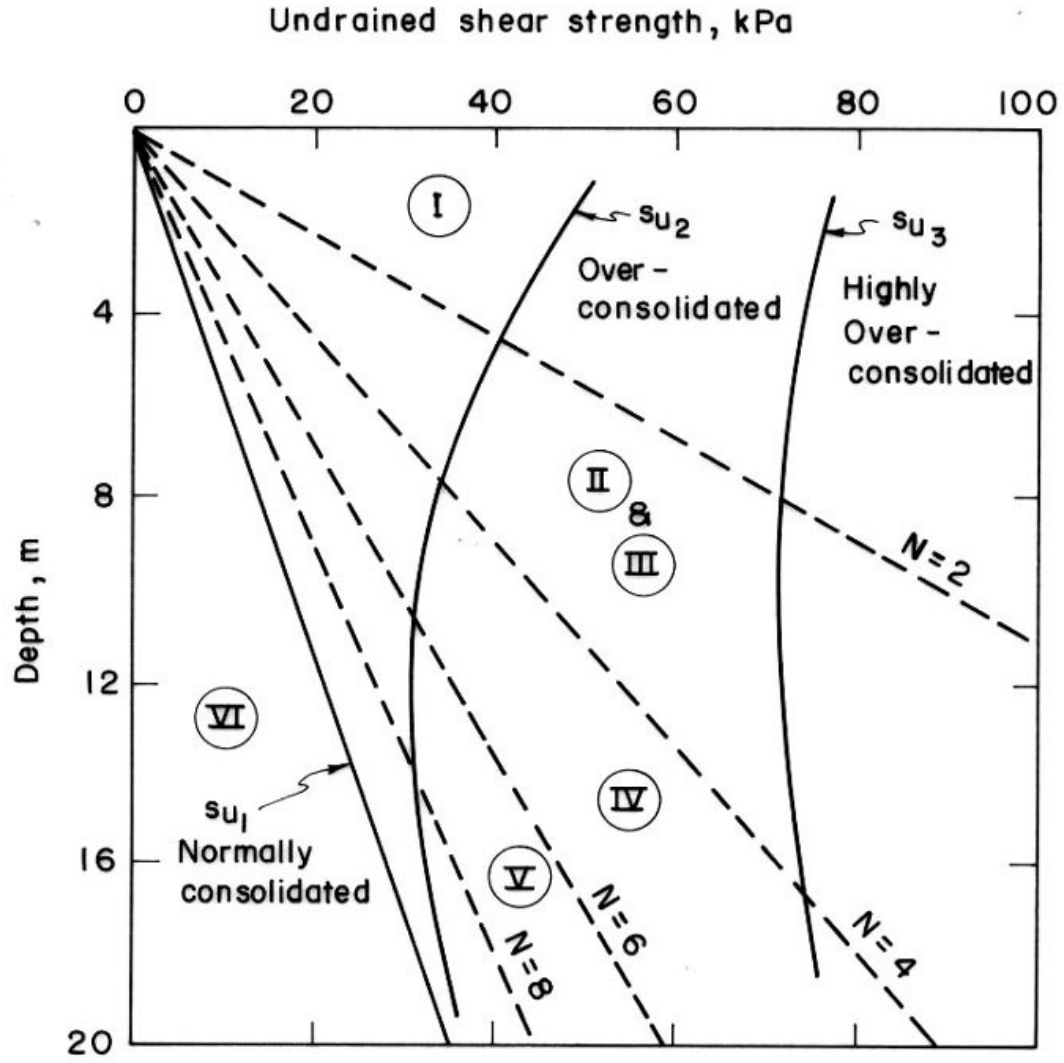


Fig. 2.9 Relationship Between Shear Strength Profiles and Zones of Excavation

Stability of open excavation in soft clays

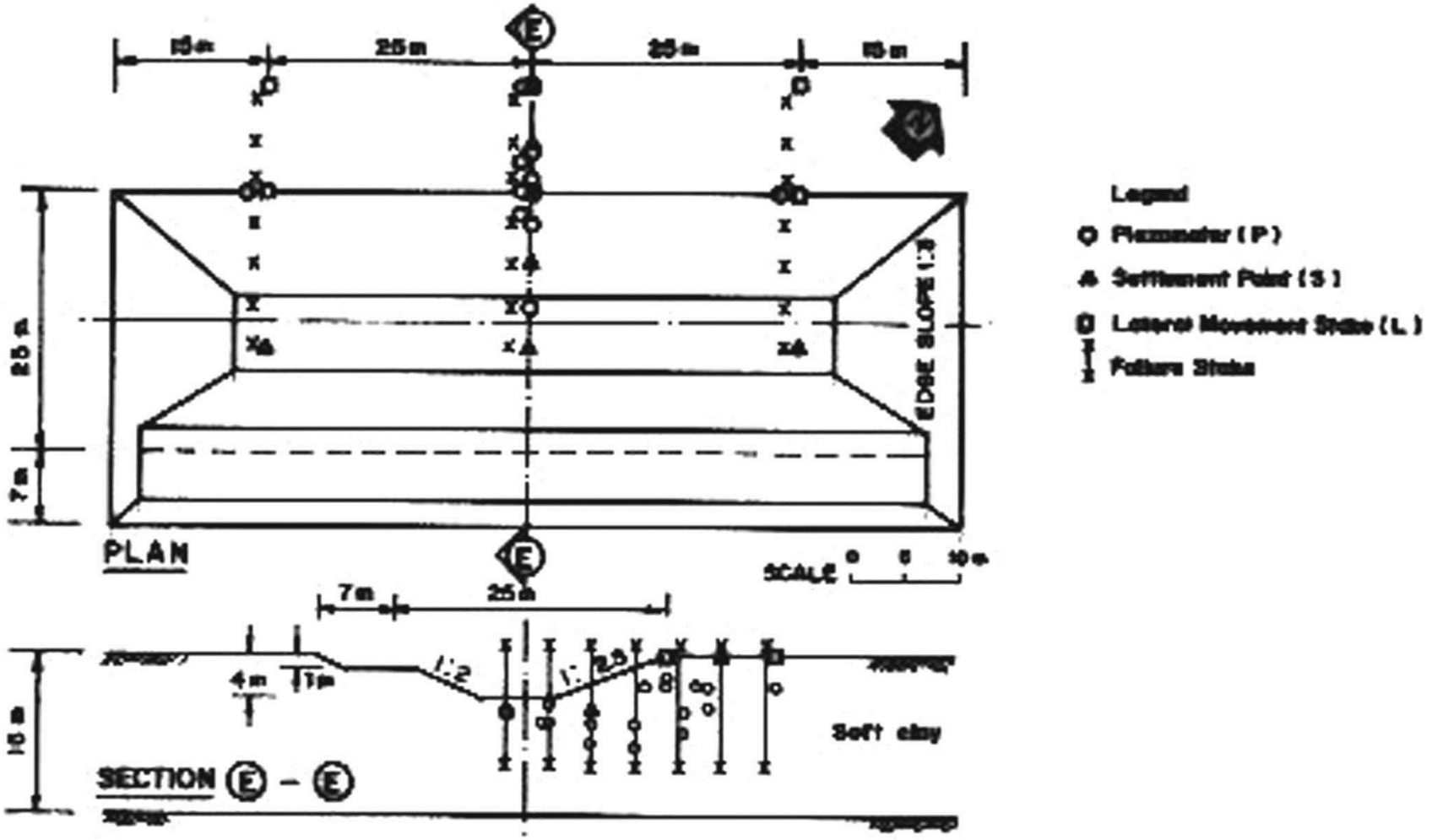
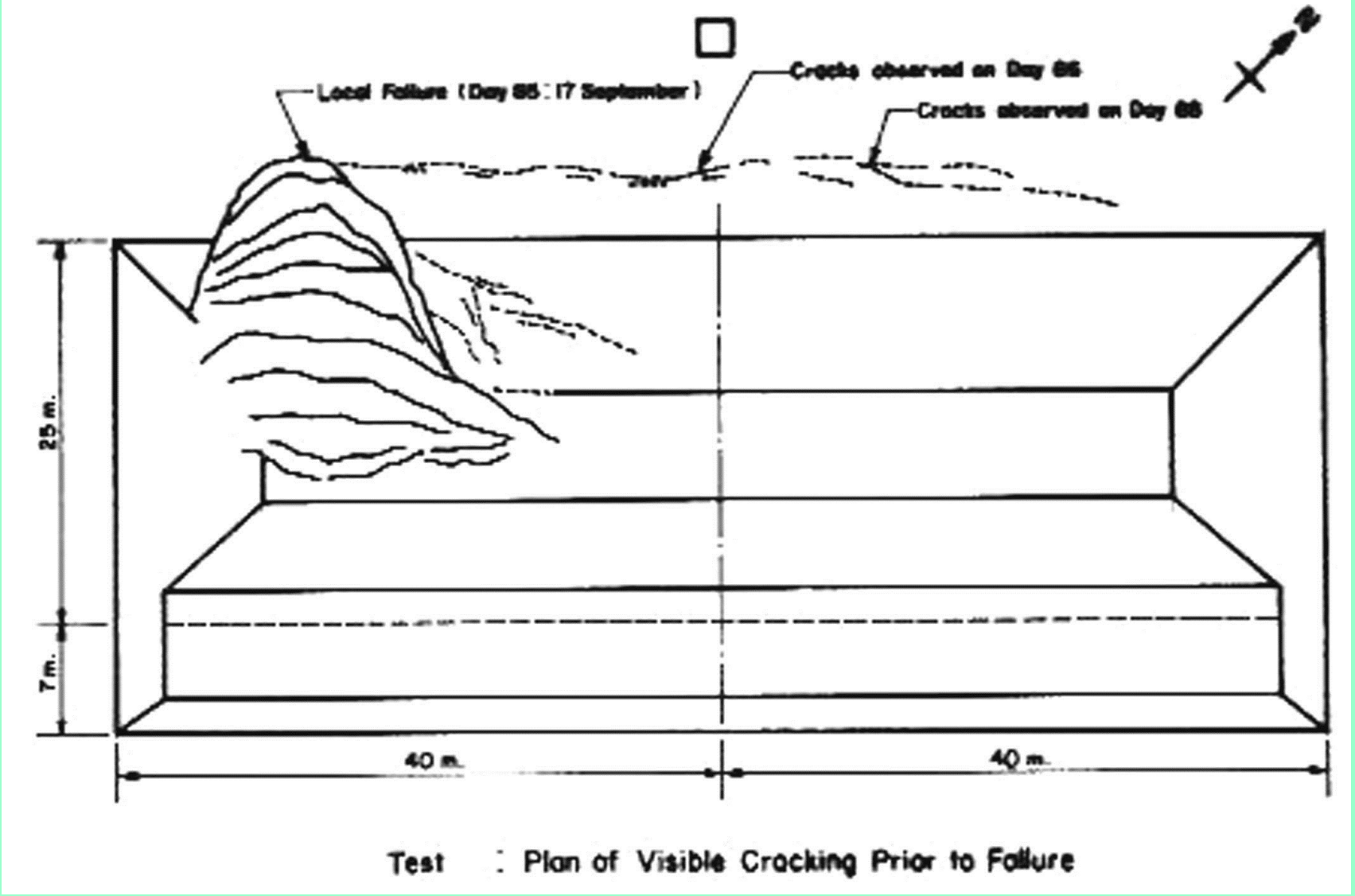
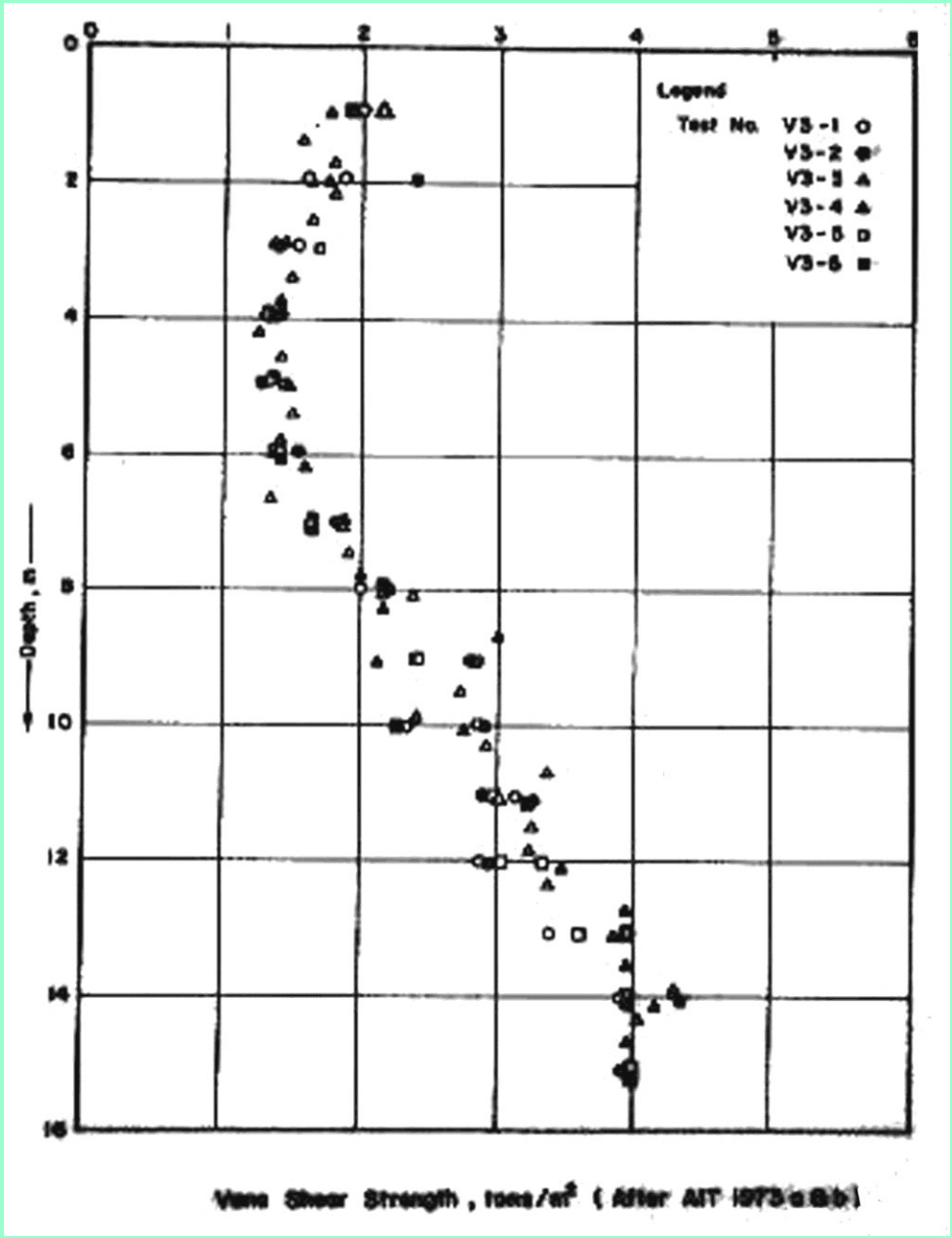


Fig. 14 Full scaled test excavation at Nong Ngoo Hao



Test : Plan of Visible Cracking Prior to Failure


Legend
Test No. VS-1
VS-2
VS-3
VS-4
VS-5
VS-6
Depth, m
0
2
4
6
8
10
12
14
16
0
1
2
3
4
5
6
Vane Shear Strength, tons/m² (After AIT 1973a &b)

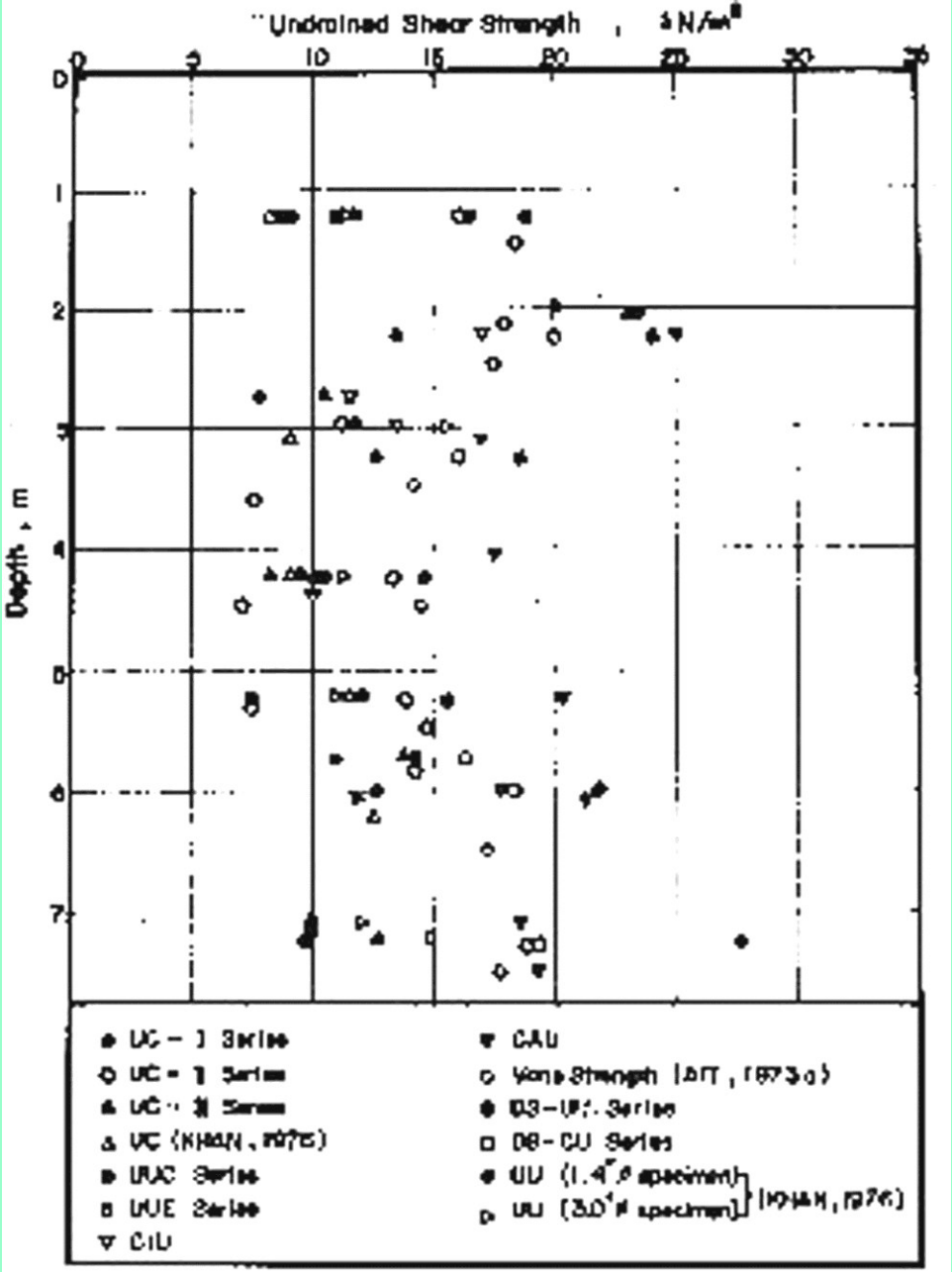
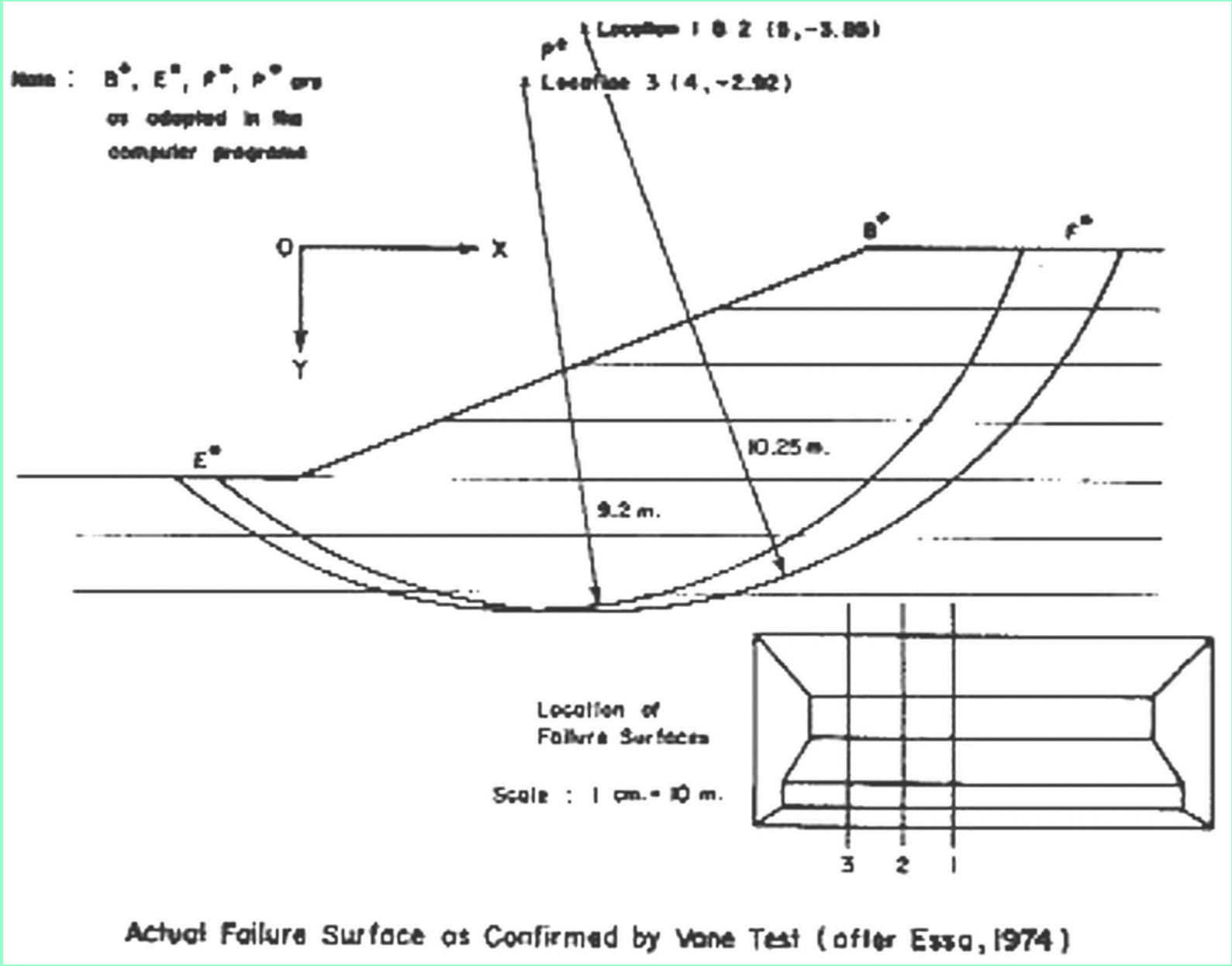


Fig. Undrained Shear Strength from Different Tests as a Function of Depth

Strength Parameters Used in Analysis

Type of Test	Depth , m	$\bar{c}$, ton/m^2	$\bar{\phi}$, degrees
$\overline{CIU}$	0 – 1.80	1.09	12.3
	1.80 – 3.40	1.27	17.5
	3.40 – 5.10	0.40	16.1
	5.10 – 7.35	1.01	10.7
	> 7.35	1.44	13.9
$\overline{CAU}$	0 – 2.00	1.19	18.4
	2.00 – 3.45	1.19	20.0
	3.45 – 6.40	1.71	13.4
	> 6.40	1.06	22.0



Actual Failure Surface as Confirmed by Vane Test (after Esso, 1974)

Excavations for a Dry Dock Project

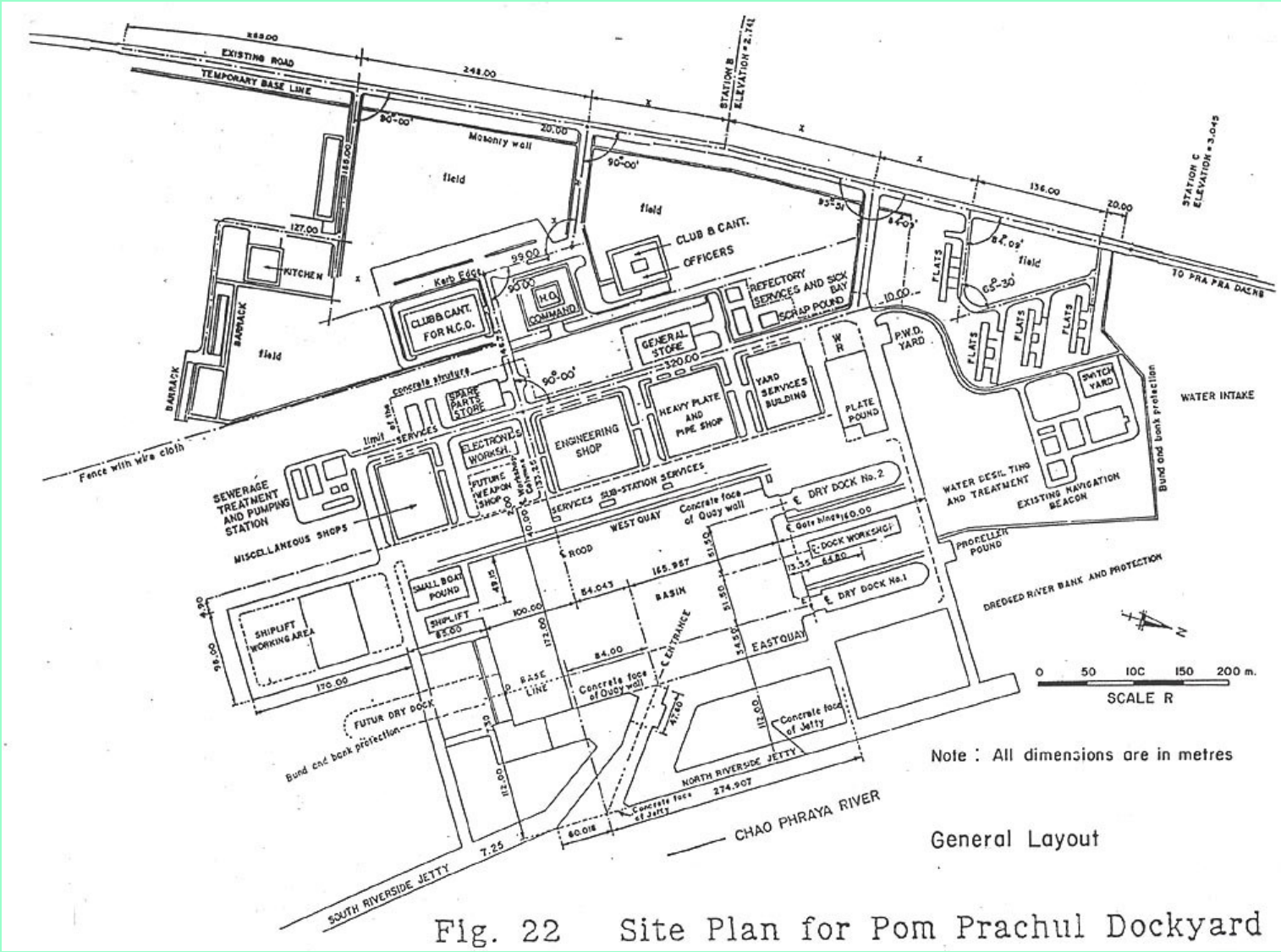
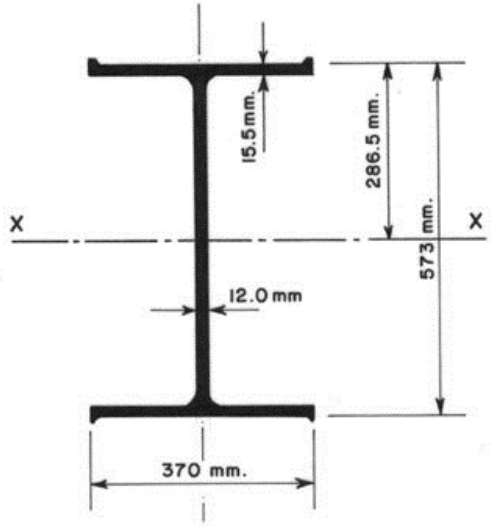
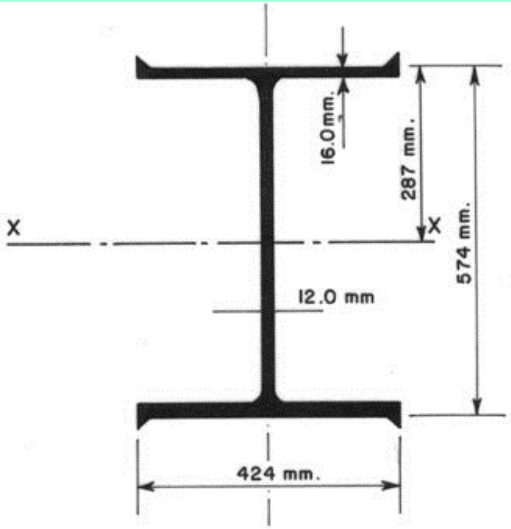


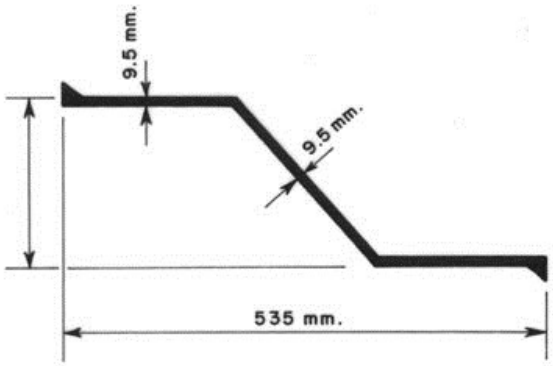
Fig. 22 Site Plan for Pom Prachul Dockyard



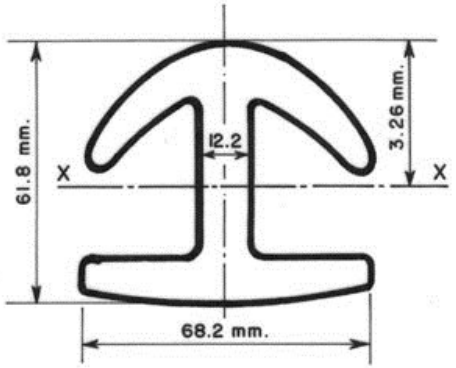
(a) King Pile HZ 600 A



(b) King Pile HZ 600 LS

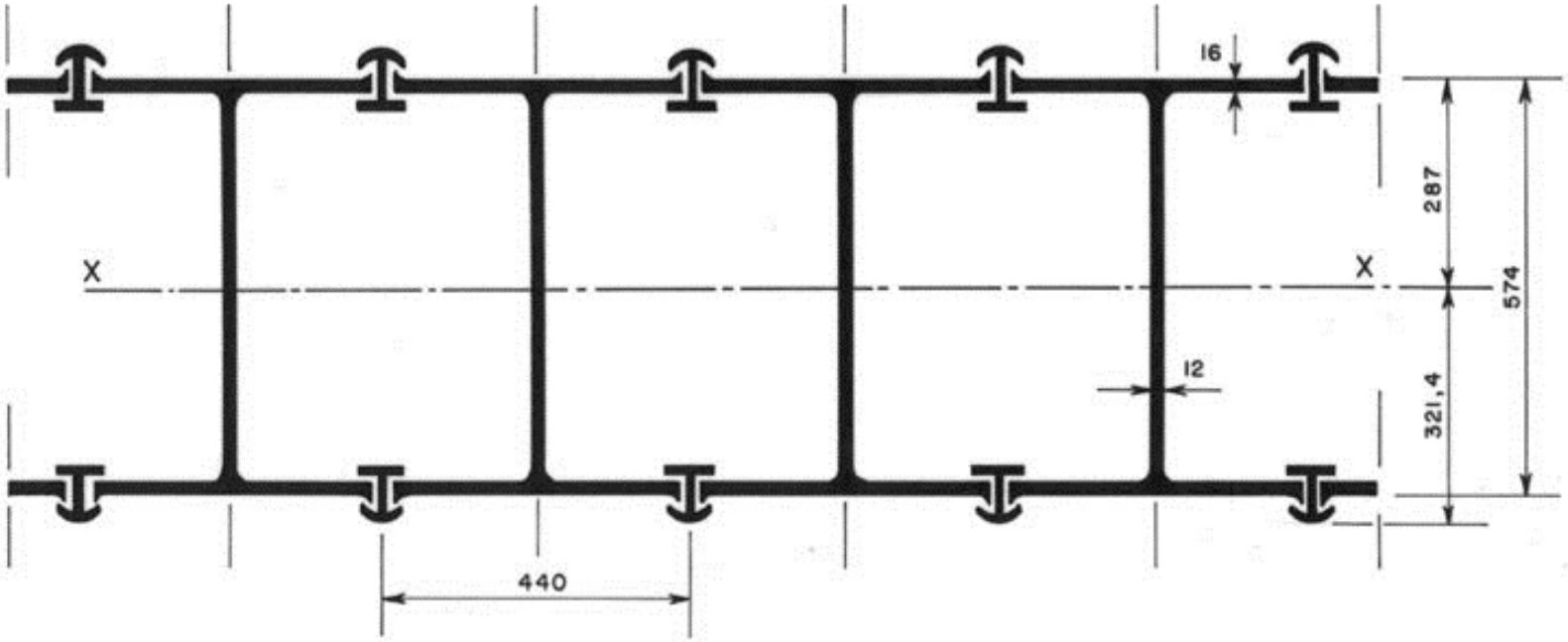


(c) Intermediary Sheet Pile BZ 9.5

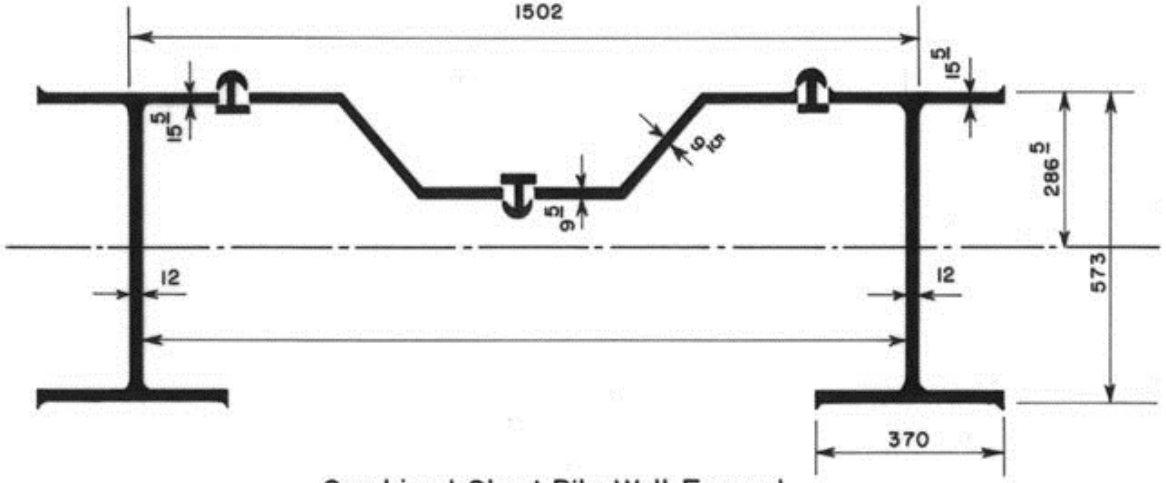


(d) Interlocking Section RH 16

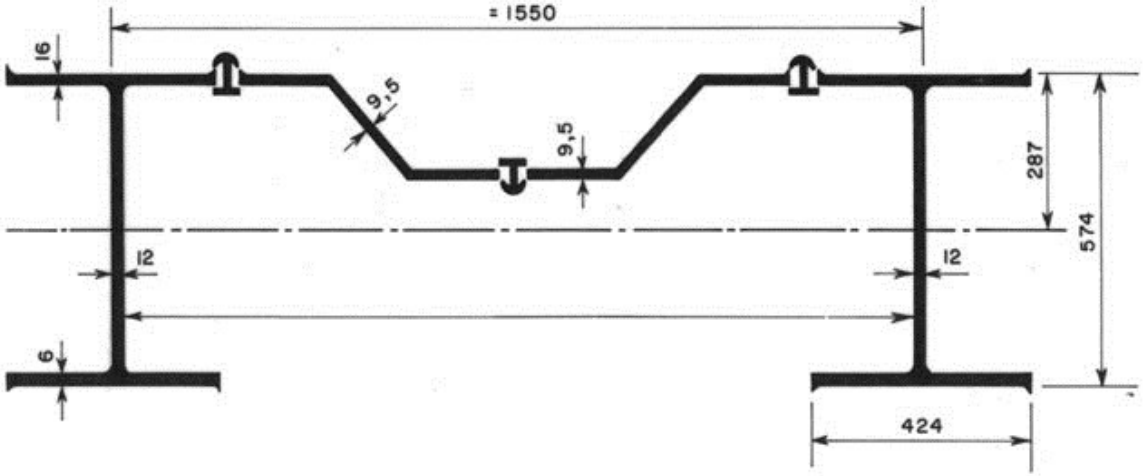
Sheet Pile Section



Box Pile Wall Formed by Double HZ 600 LS Sections

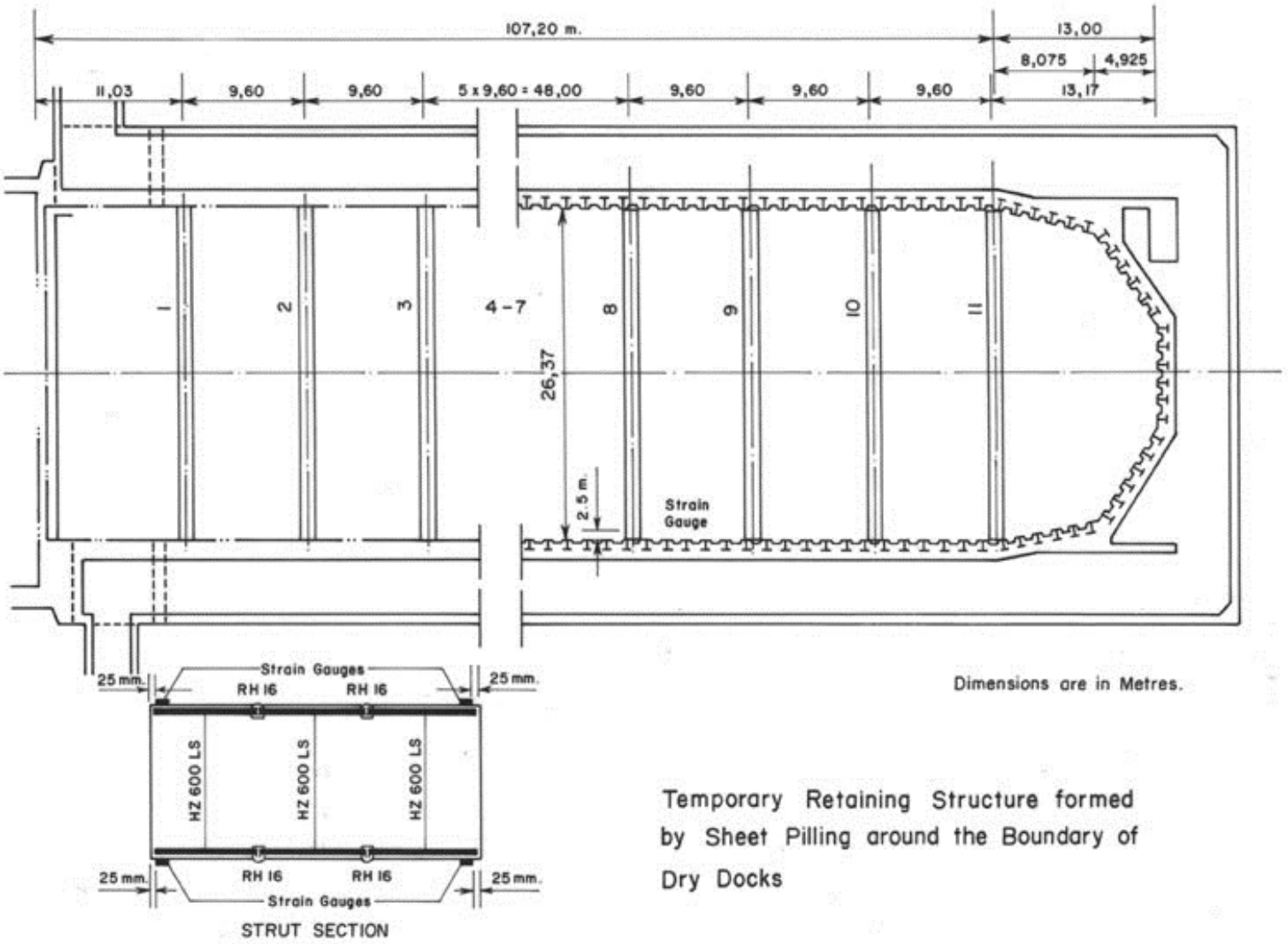


Combined Sheet Pile Wall Formed
by HZ 600 A and BZ 9.5 Sections

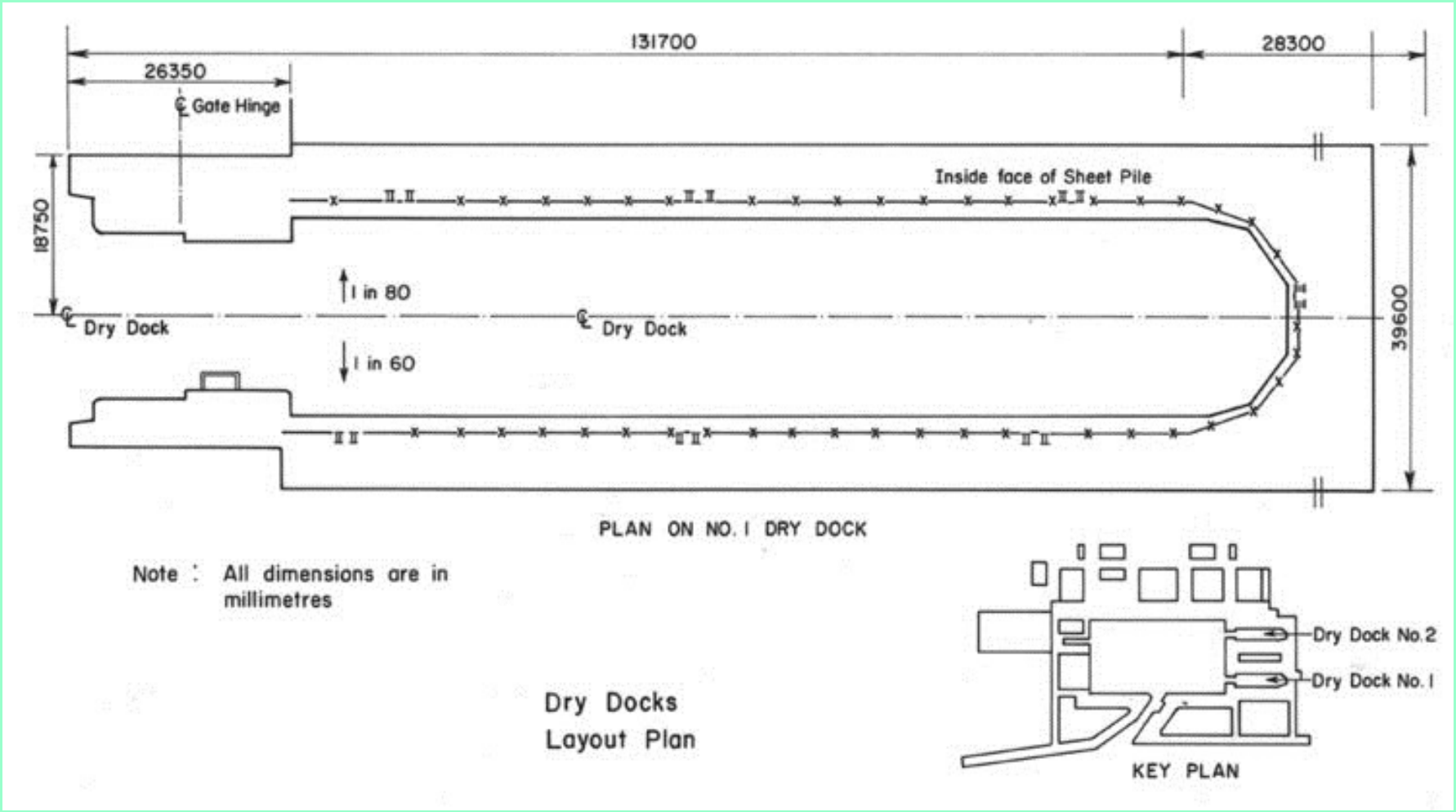


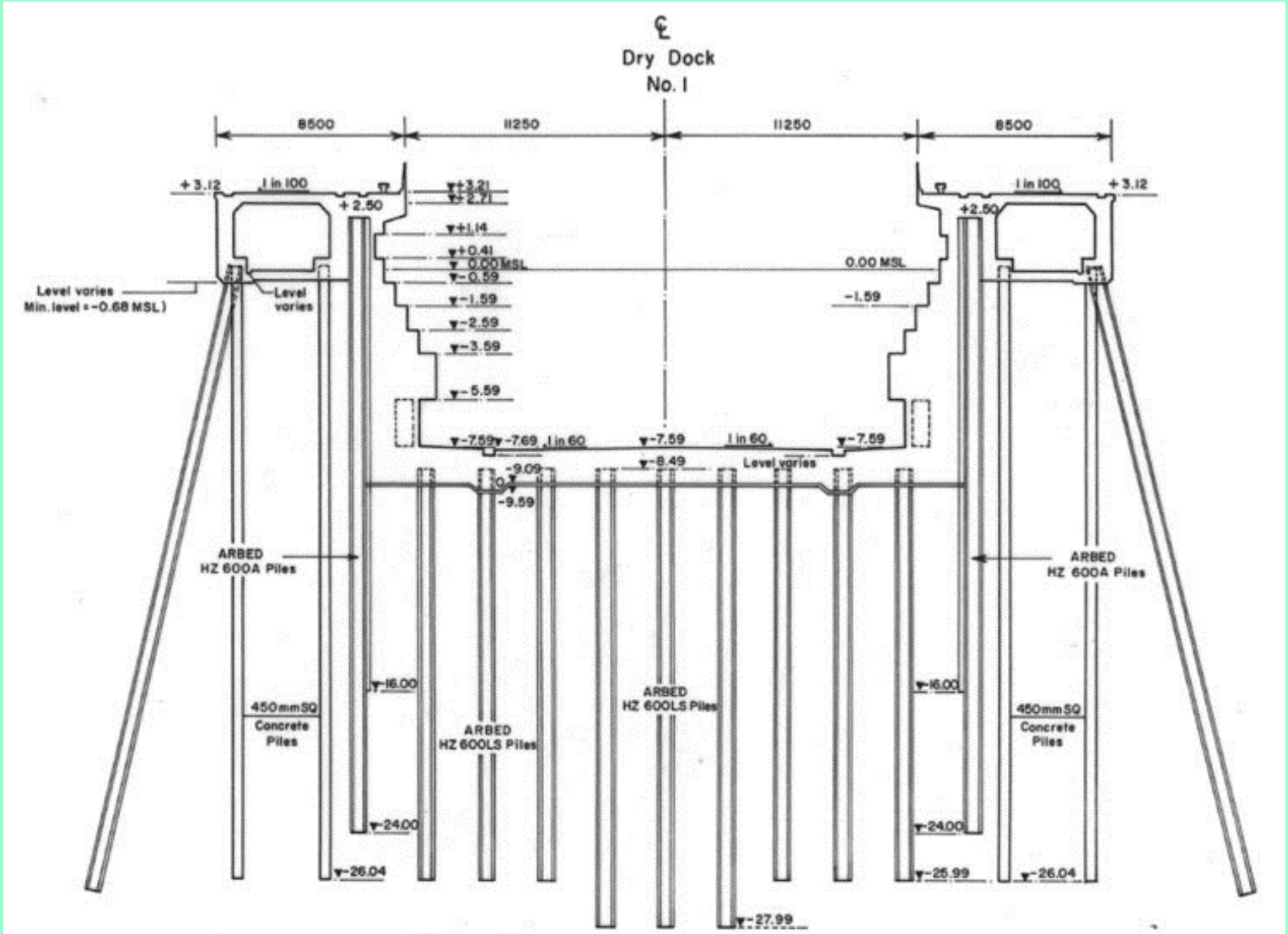
Combined Sheet Pile Wall Formed
by HZ 600 LS and BZ 9.5 Sections

Note : All dimensions are in millimetres.



Temporary Retaining Structure formed by Sheet Pilling around the Boundary of Dry Docks


131700
28300
26350
℄ Gate Hinge
Inside face of Sheet Pile
18750
1 in 80
℄ Dry Dock
℄ Dry Dock
1 in 60
39600
PLAN ON NO. 1 DRY DOCK
Note : All dimensions are in millimetres
Dry Docks
Layout Plan
Dry Dock No. 2
Dry Dock No. 1
KEY PLAN



Notes : All dimensions are in millimetres
All levels are in metres

TYPICAL SECTION
LOOKING TOWARD HEAD OF DOCK

Dry Docks Typical Cross Section

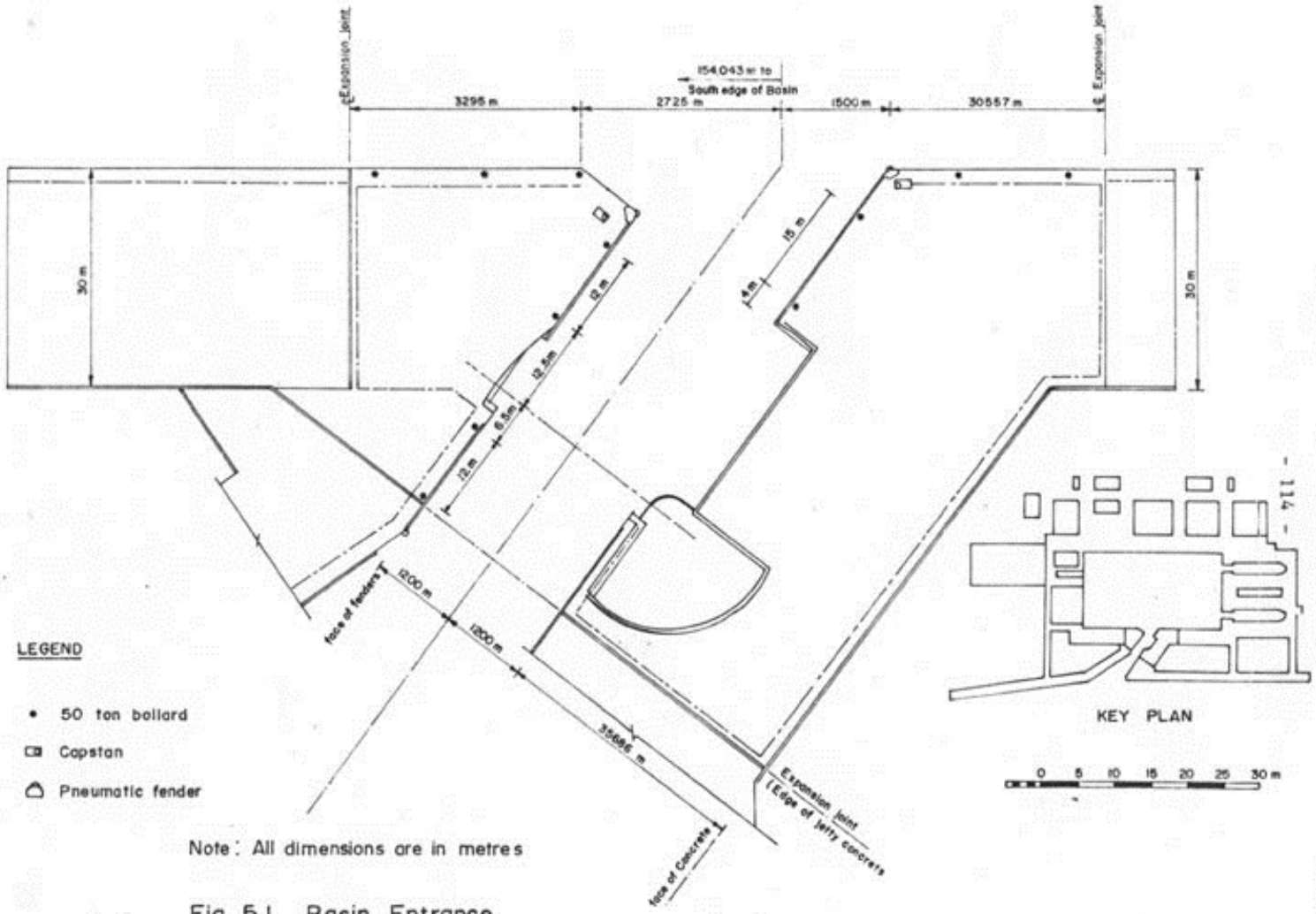


Fig. 5.1 Basin Entrance Layout Plan

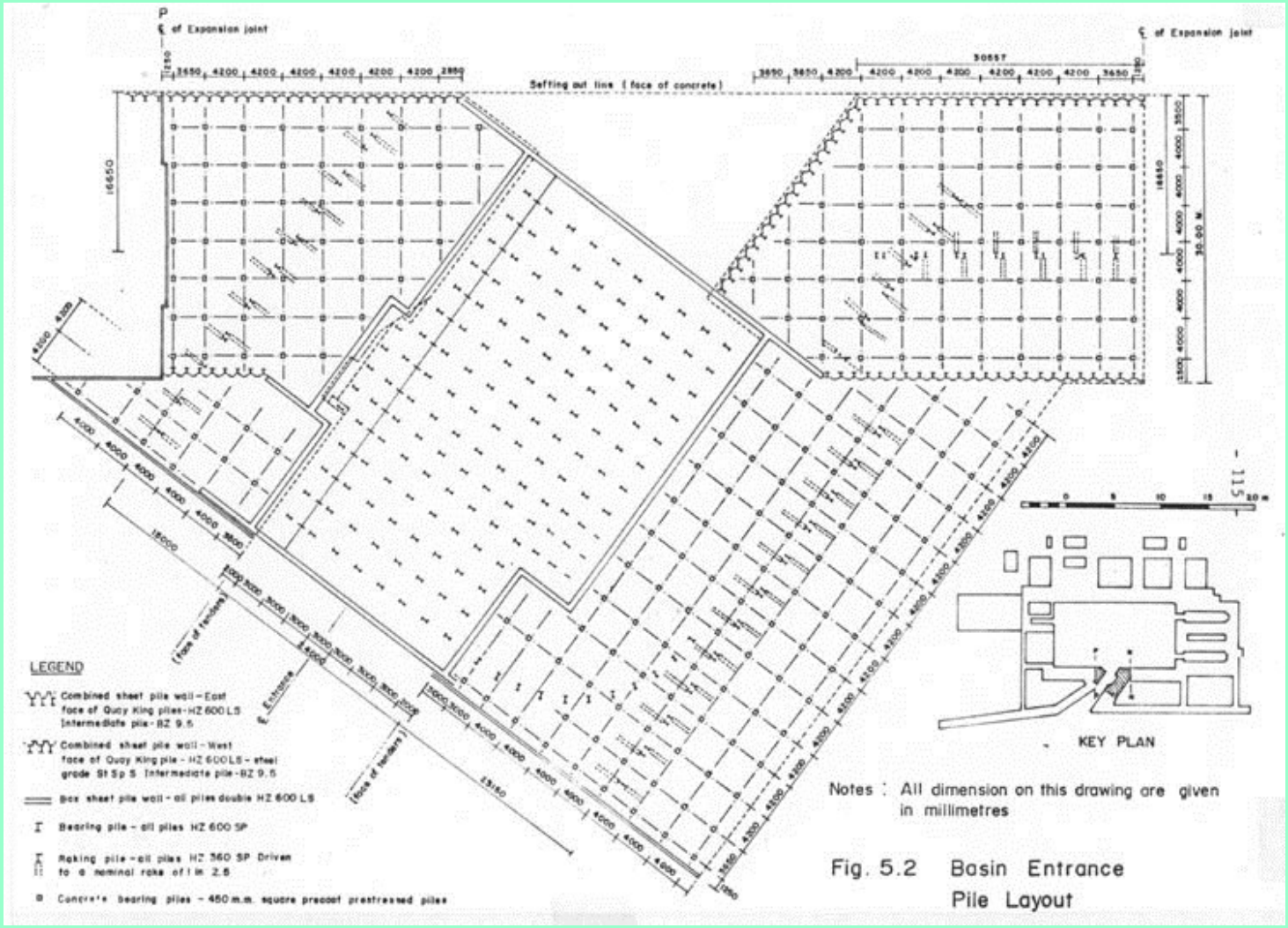
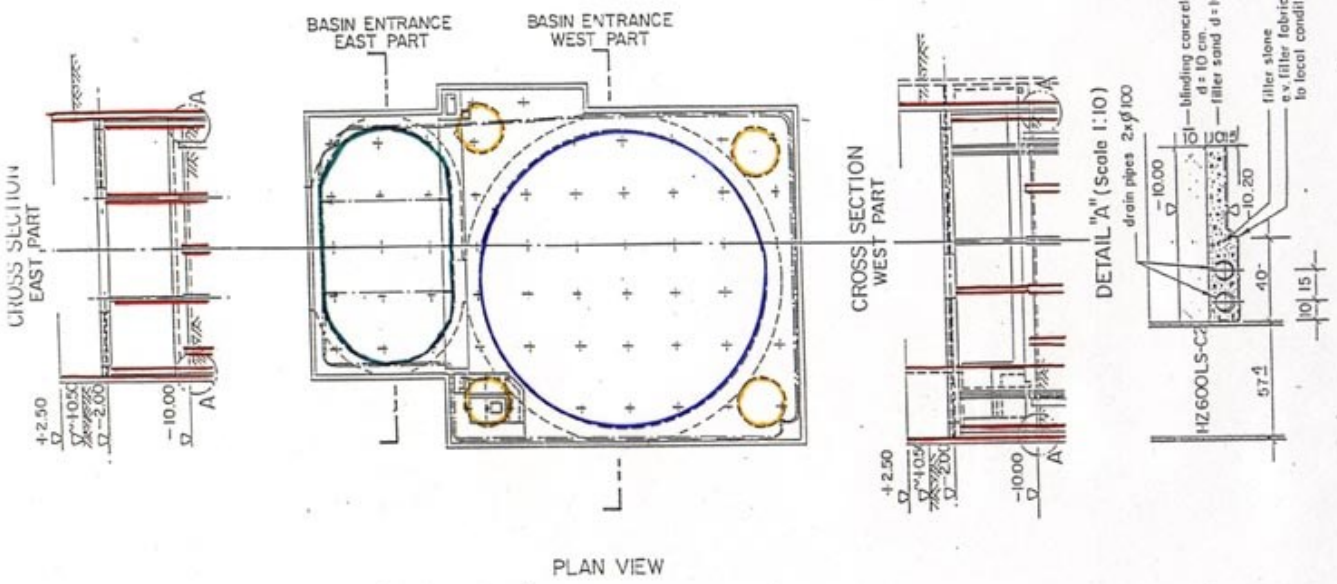


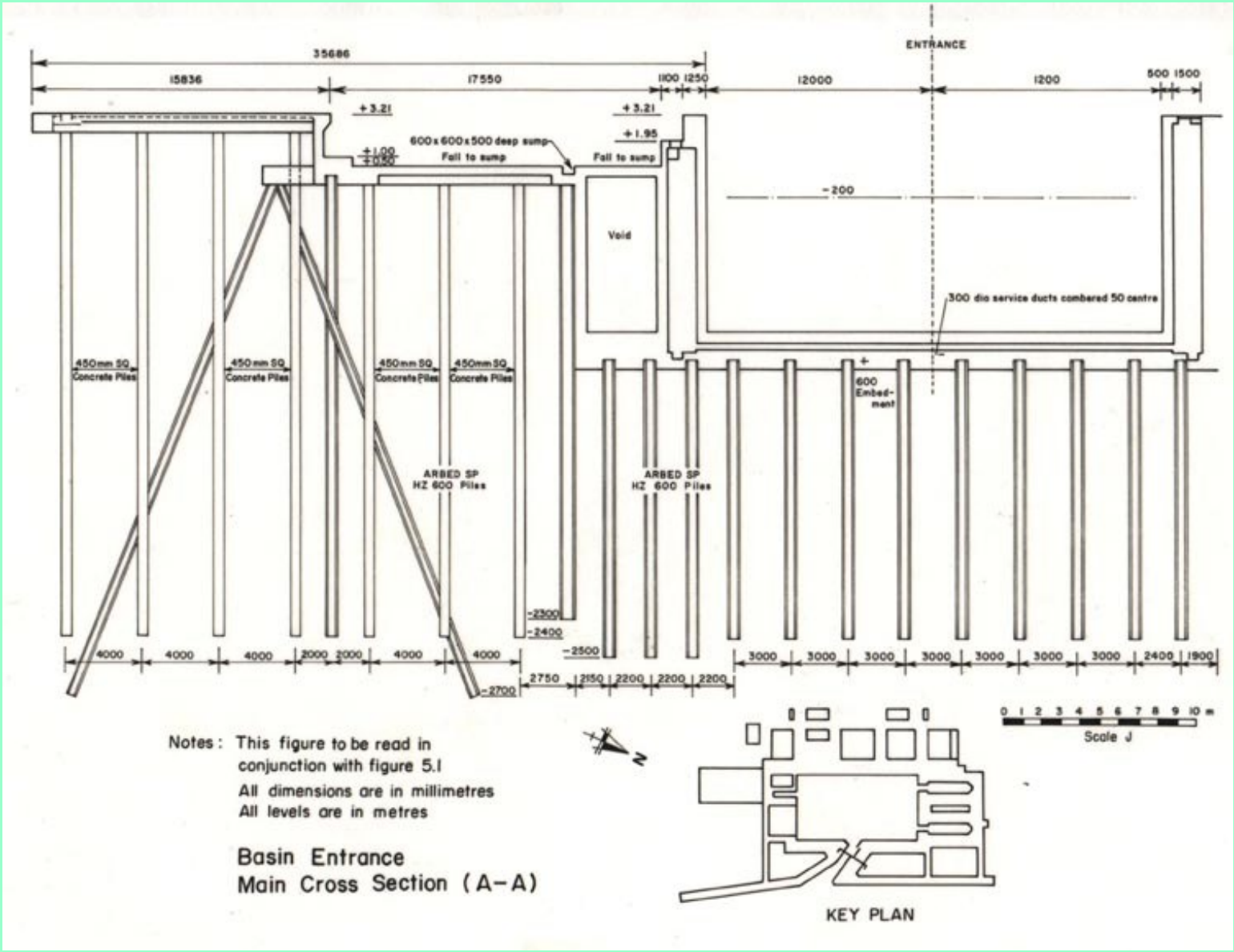
Fig. 5.2 Basin Entrance Pile Layout



Phase 2

1. Excavation to level – 10.20 m.
2. Placing of filter fabric, filter stone drain pipes and sump wells P_1 & P_2, blinding concrete.
3. Casting of reinforced concrete floor slab
4. Placing of concrete parts of entrance gate up to a certain level below the bracing.

Basin Entrance Sequence of Work for Excavation and Bracing of Pit.

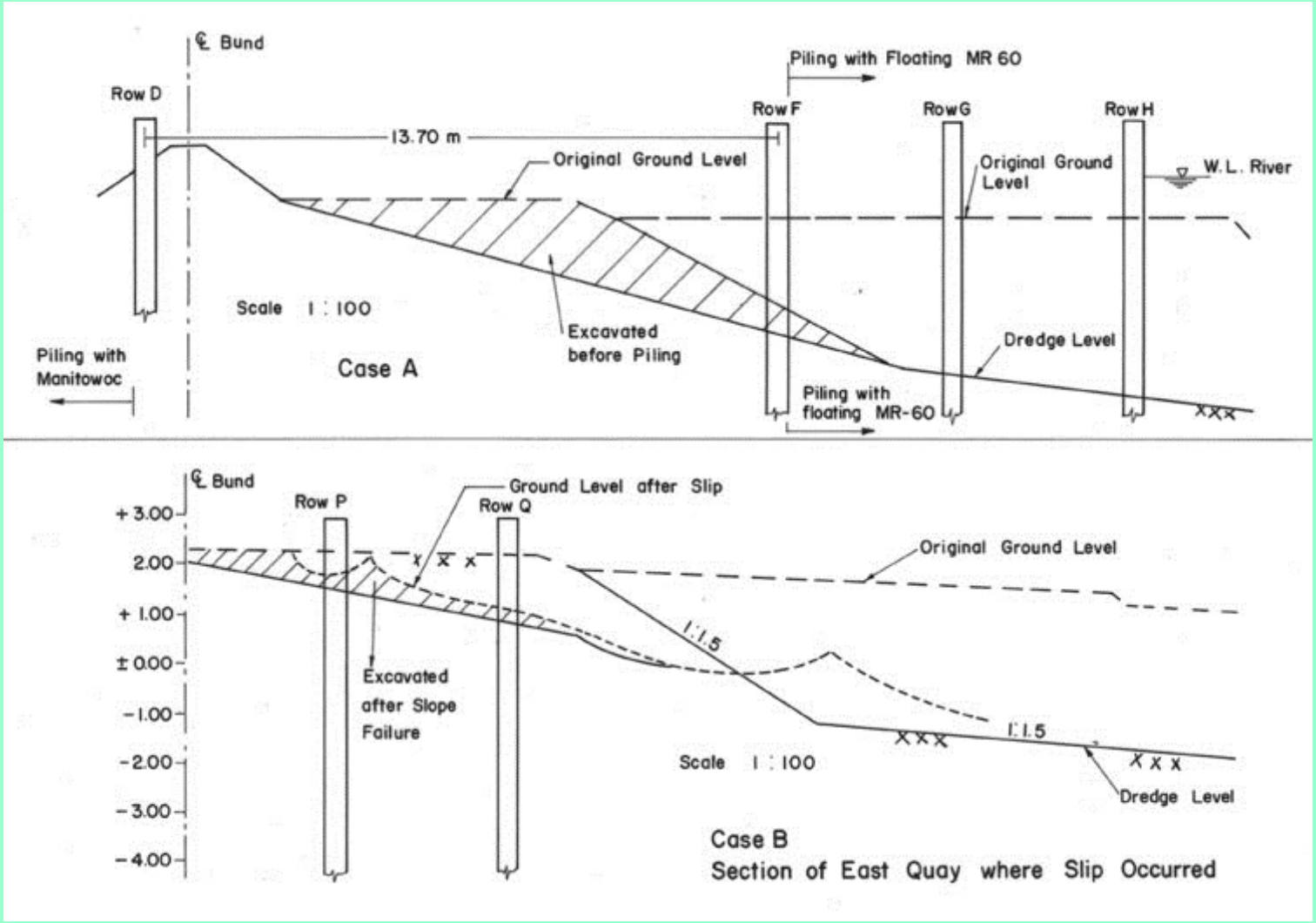


Notes: This figure to be read in conjunction with figure 5.1

All dimensions are in millimetres

All levels are in metres

Basin Entrance
Main Cross Section (A-A)


℄ Bund
Row D
13.70 m
Original Ground Level
Piling with Floating MR 60
Row F
Row G
Row H
Original Ground Level
W.L. River
Scale 1 : 100
Excavated before Piling
Dredge Level
Piling with Manitowoc
Case A
Piling with floating MR-60
℄ Bund
Row P
Row Q
Ground Level after Slip
+ 3.00
2.00
+ 1.00
± 0.00
-1.00
-2.00
-3.00
-4.00
Original Ground Level
1:1.5
Excavated after Slope Failure
1:1.5
Scale 1 : 100
Dredge Level
Case B
Section of East Quay where Slip Occurred

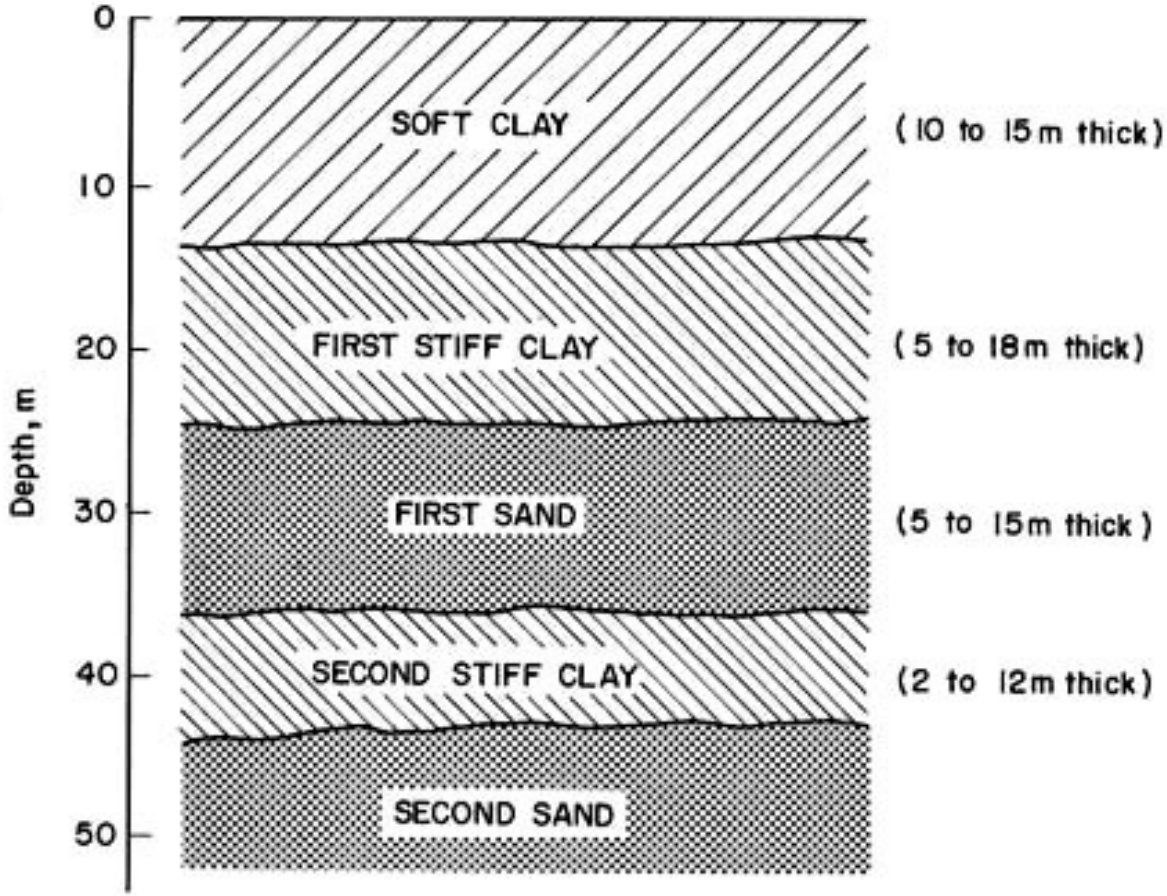
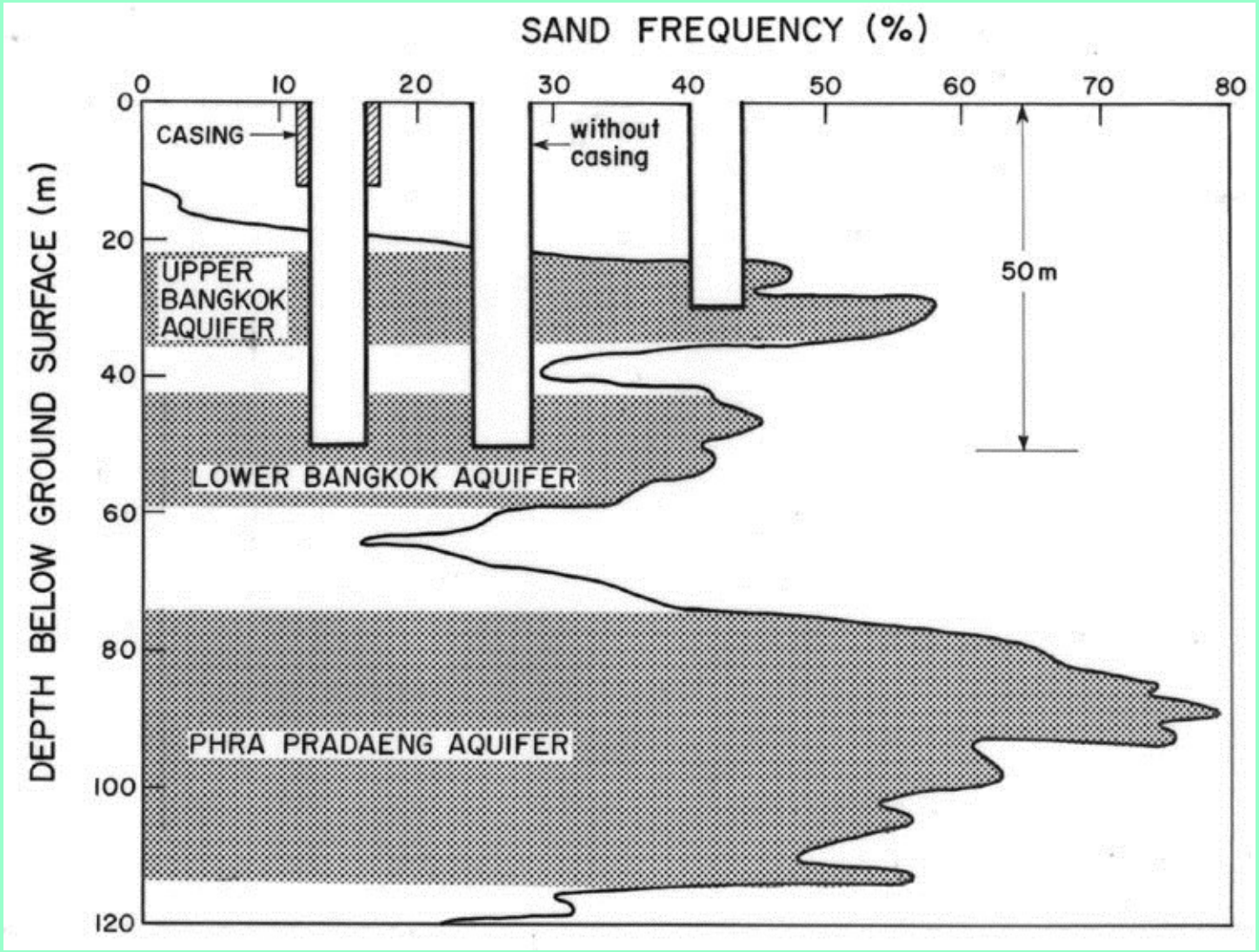
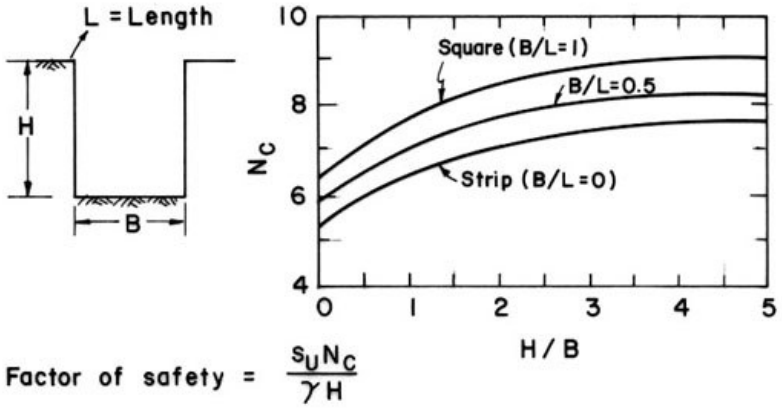


Fig. 2.2 Typical Cross Section of Bangkok Subsoils

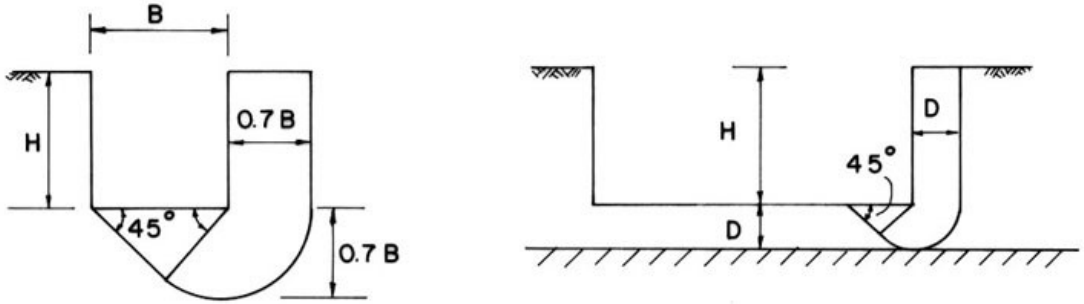

SAND FREQUENCY (%)
0
10
20
30
40
50
60
70
80
DEPTH BELOW GROUND SURFACE (m)
0
20
40
60
80
100
120
CASING
without casing
UPPER BANGKOK AQUIFER
LOWER BANGKOK AQUIFER
PHRA PRADAENG AQUIFER
50 m

Basal stability of supported excavations



Factor of safety = $\frac{s_u N_c}{\gamma H}$

(a)



Factor of Safety = $\frac{s_u N_c}{H(\gamma - s_u/0.7B)}$

Factor of Safety = $\frac{s_u N_c}{H(\gamma - s_u/D)}$

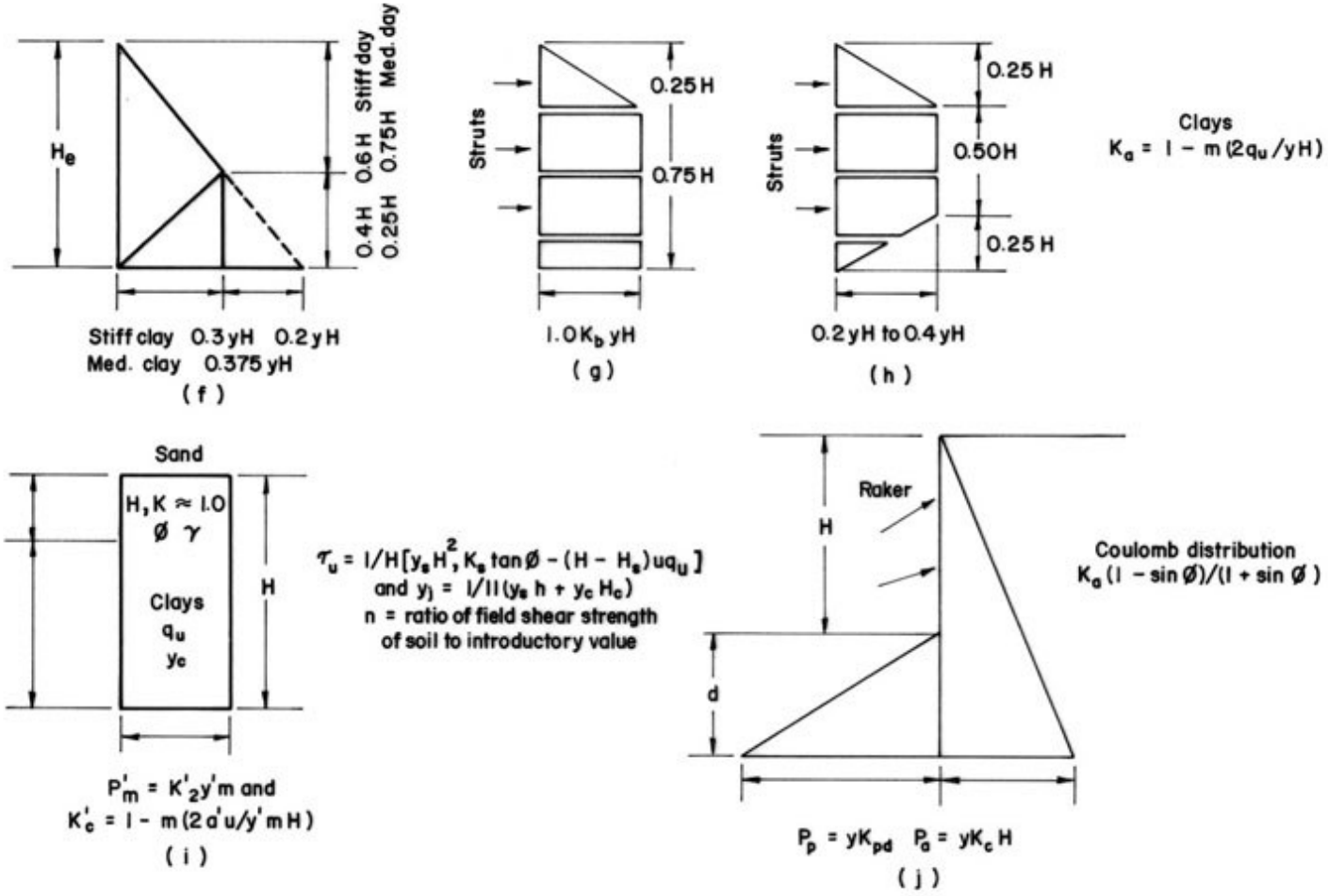
(b)

Fig. 2.12 Methods of Basal Heave Analysis :

a) For Deep Excavations with H/B > 1 (Bjerrum & Eide, 1956)

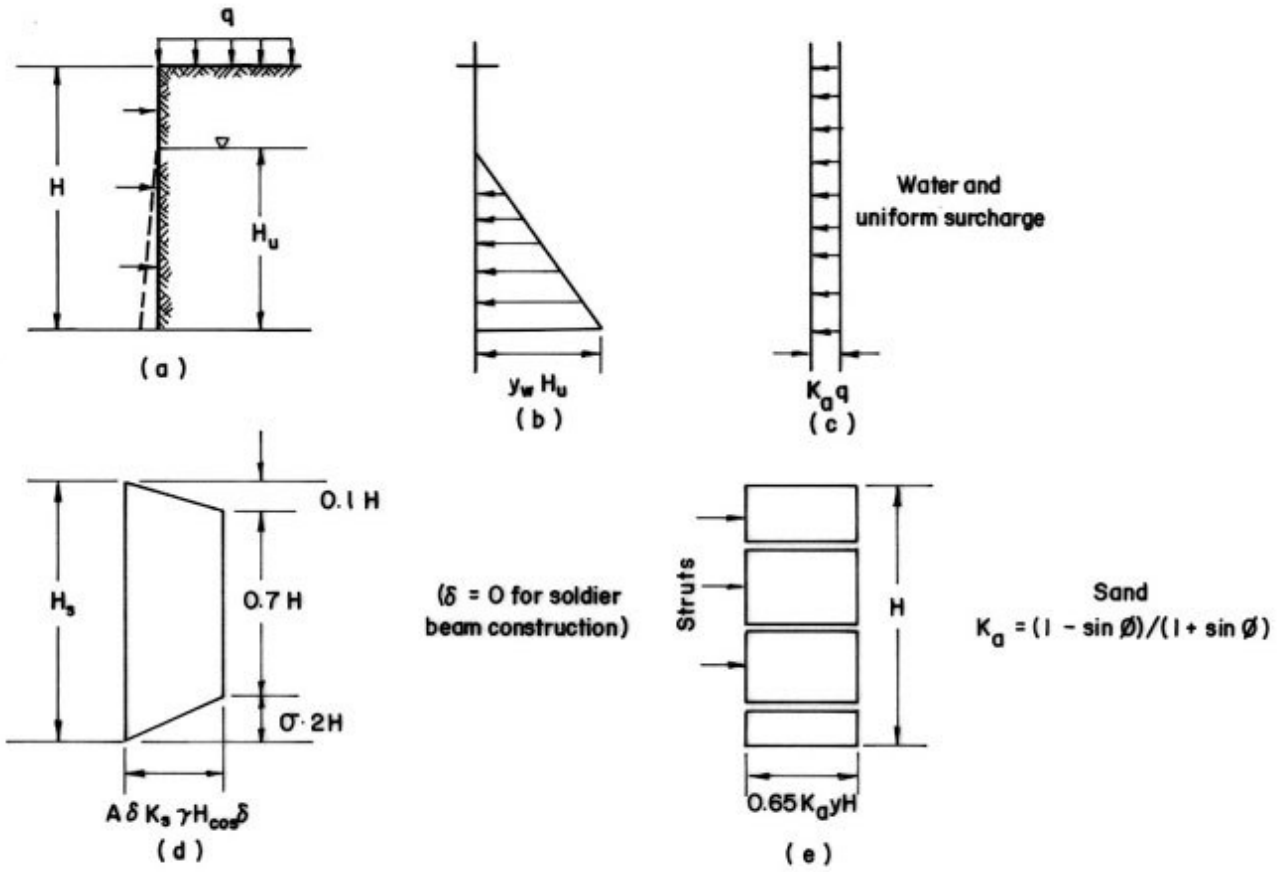
b) For Shallow or Wide Excavations with H/B < 1 (Terzaghi, 1943)

Lateral Pressure distributions in braced and unbraced sheet piled walls.



f) Tschebotarioff (1951)
g) Soft to Medium Clay, Terzaghi and Peck (1967)
h) Stiff Fissured Clay, Terzaghi and Peck (1967)
i) Layered soil,
j) Raker braced

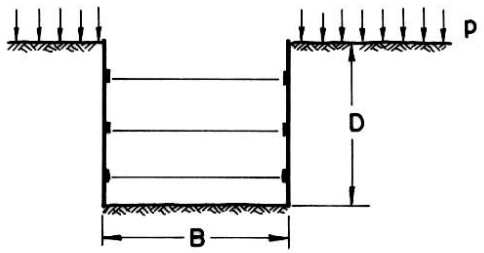
Fig. 2.11 (f-j) Lateral Pressure Distributions for Design of Braced Structures



a) Cross Section, b) Water Pressure
c) Uniform Surcharge, d) Tschebotarioff (1967)
e) Peck (1959),

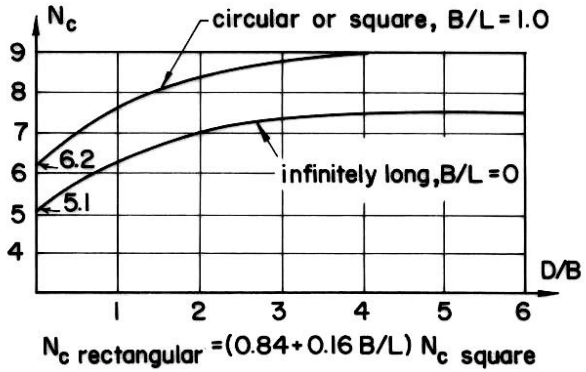
Fig. 2.11 (a-e) Lateral Pressure Distributions for Design of Braced Structures

Stability of strutted excavations in clay

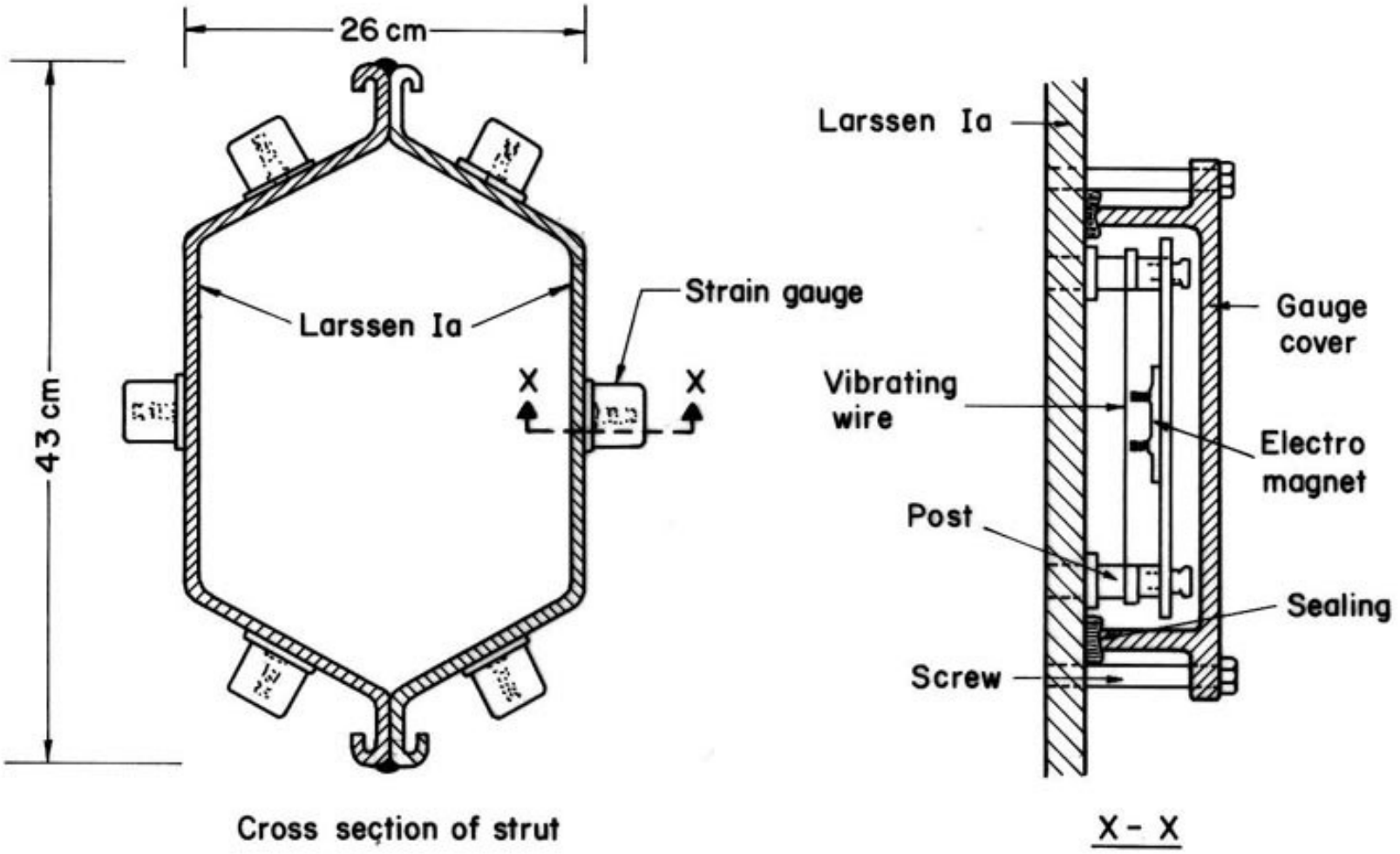


$$F = N_c \frac{s}{\gamma D + p}$$

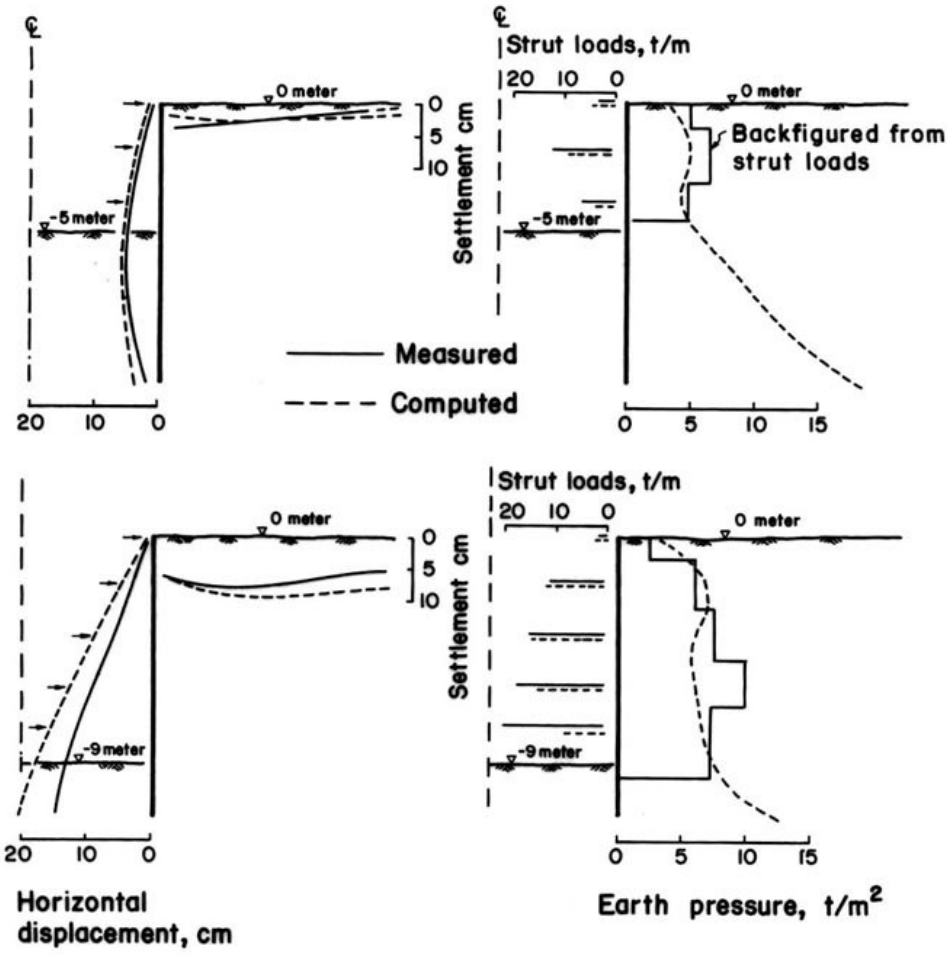
D = depth of excavation
B = width of excavation
L = length of excavation
p = surcharge
s = undrained shear strength of clay
γ = density of clay
N_c = coefficient
F = safety factor



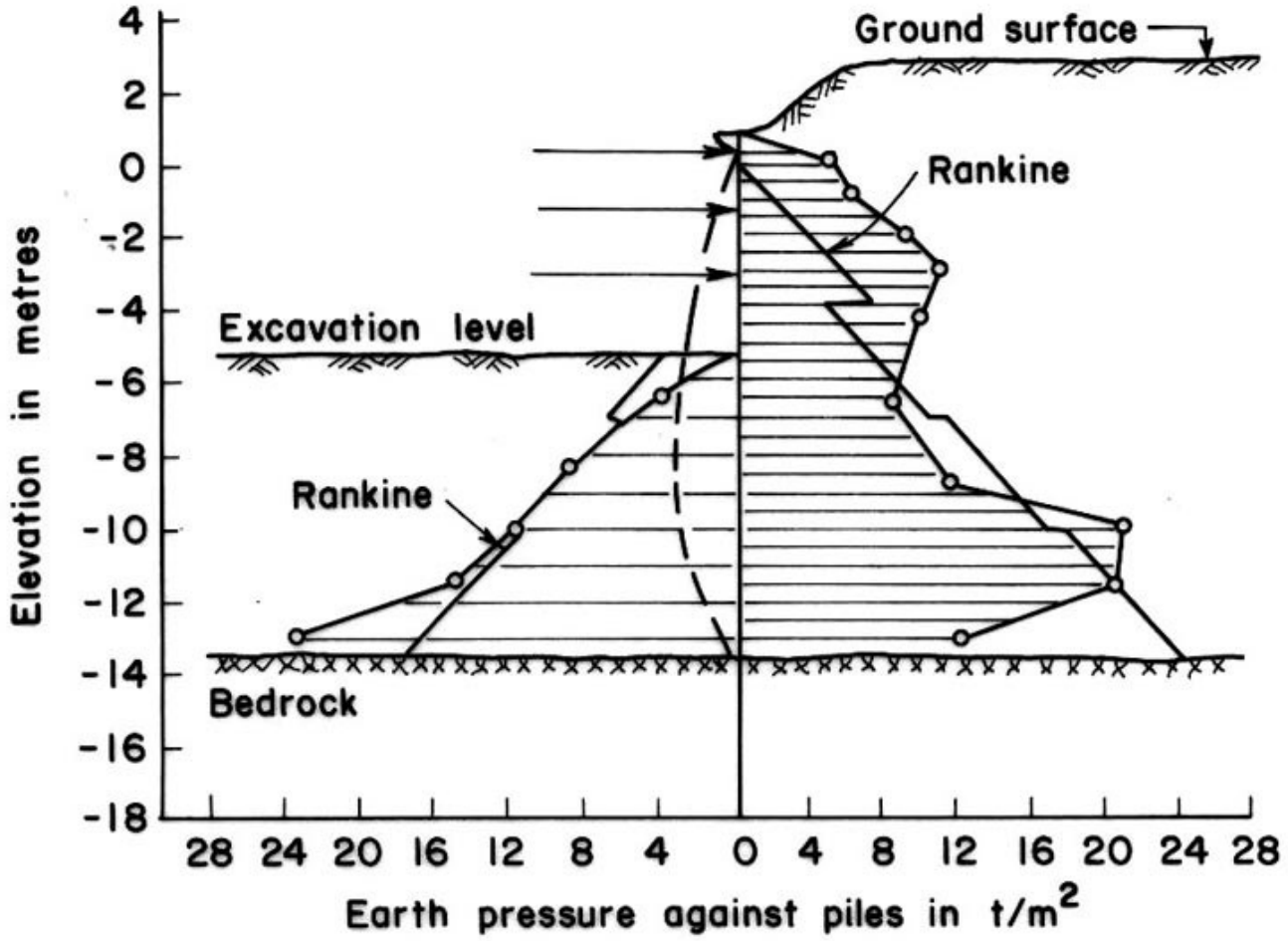
The critical depth of excavations calculated on the basis of the bearing capacity theory. Values of N_c from skempton (1951)



Arrangement and detail of vibrating-wire strain gauges

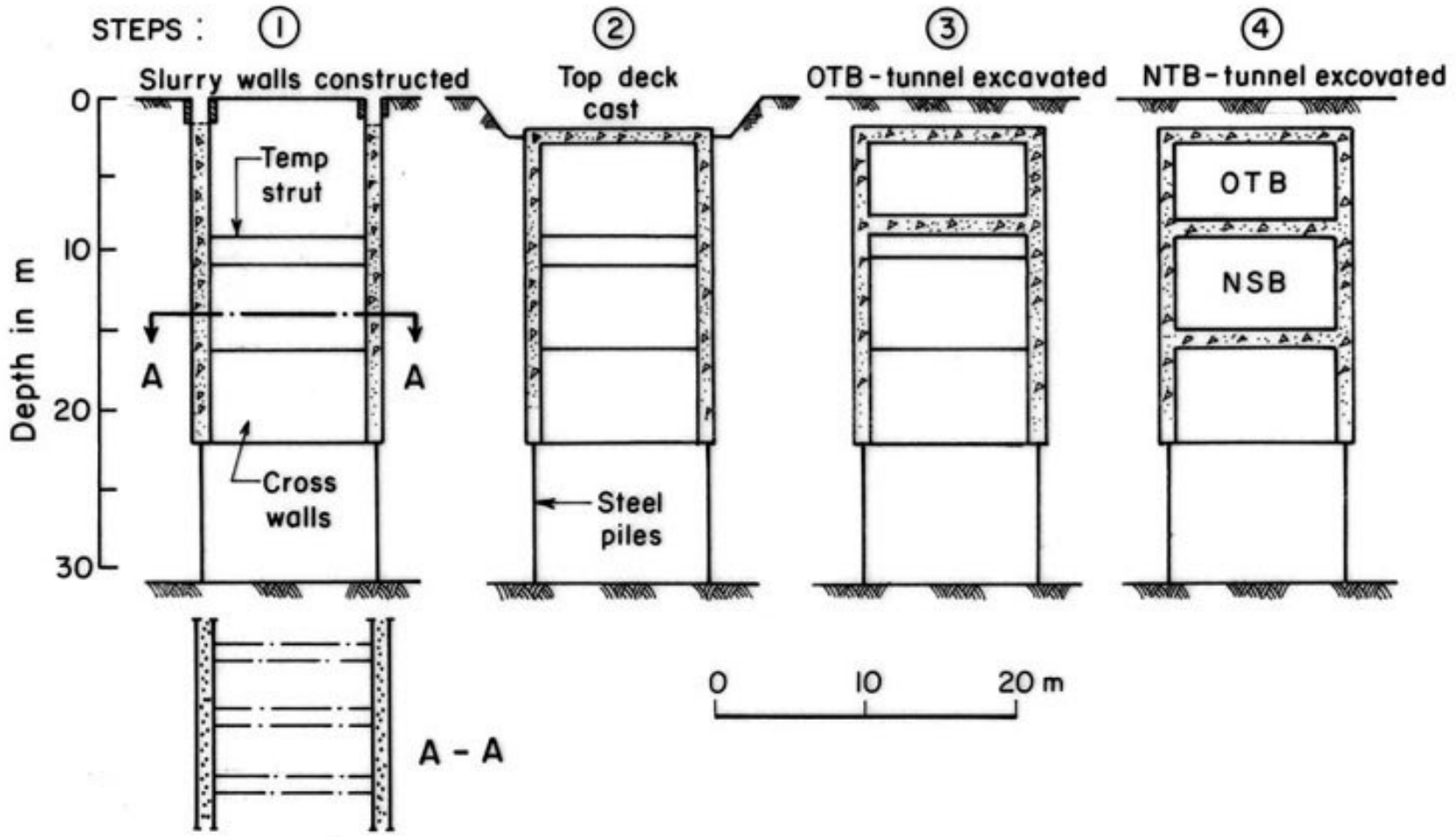


Vaterland 3, Oslo. Comparison between observed deformation and earth pressures and those calculated by the finite element method

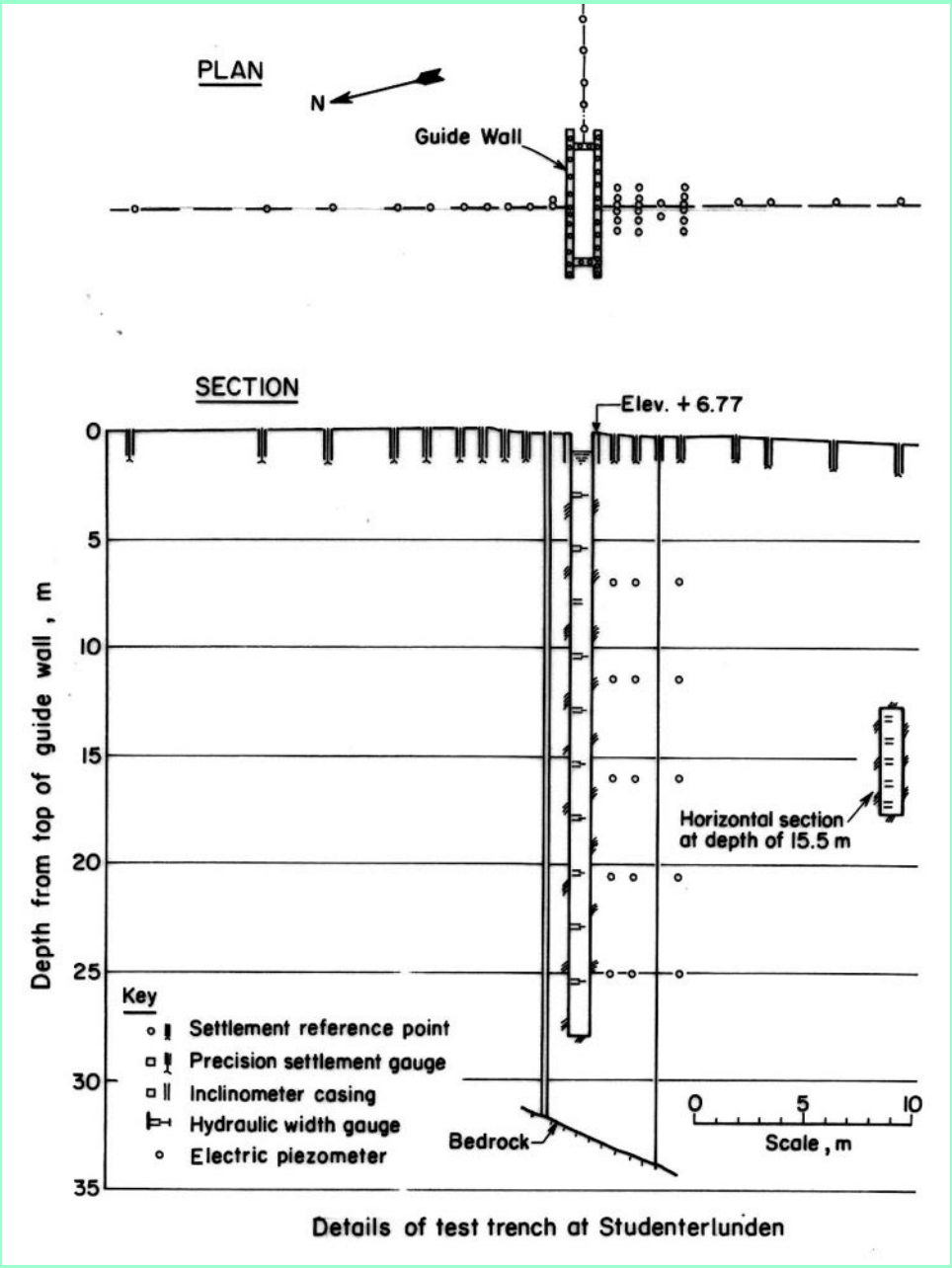


Active and passive earth pressure distribution observed by earth pressure cells in the excavation at Vaterland I for Oslo subway

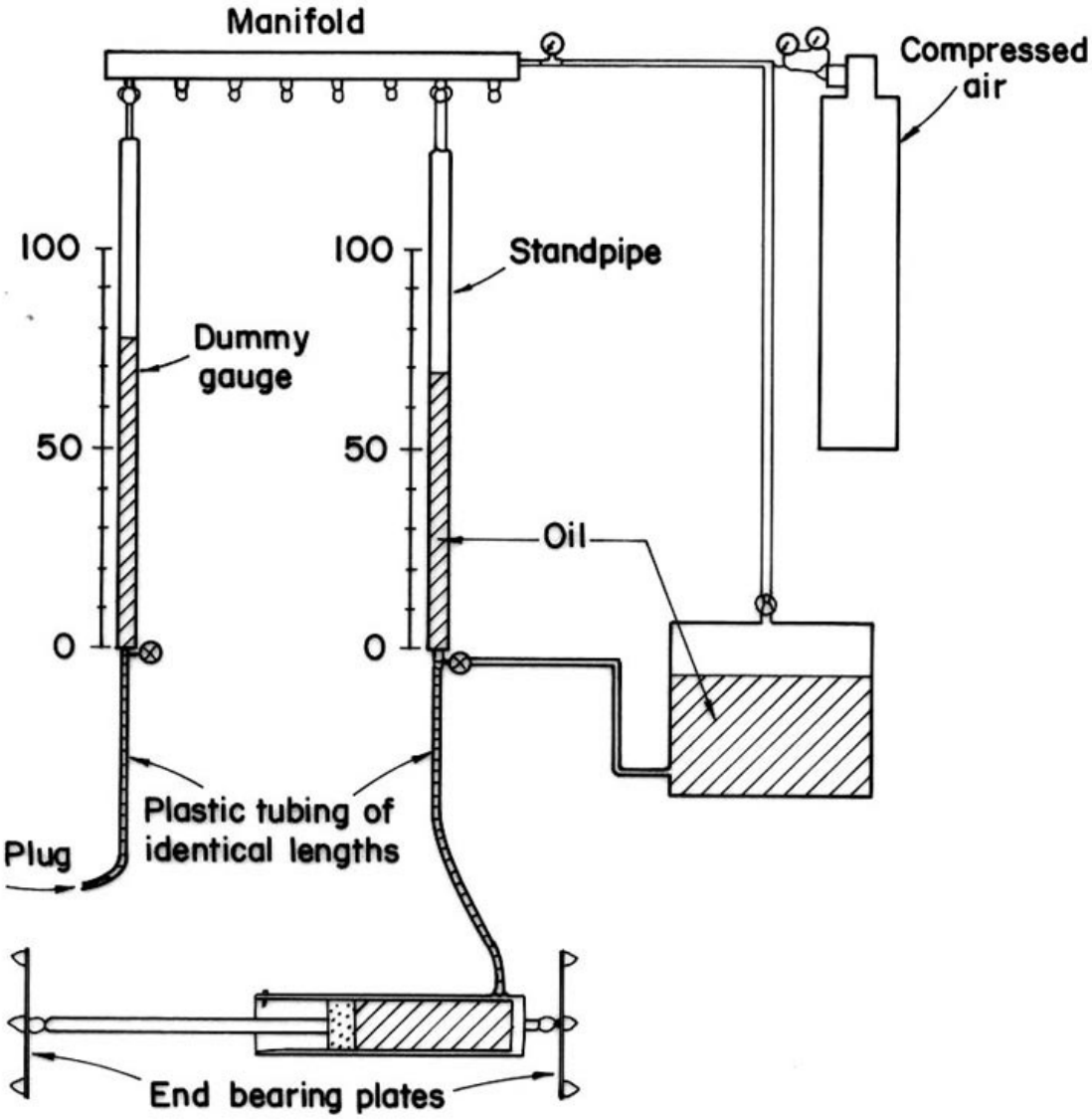
Stability of slurry trench excavations



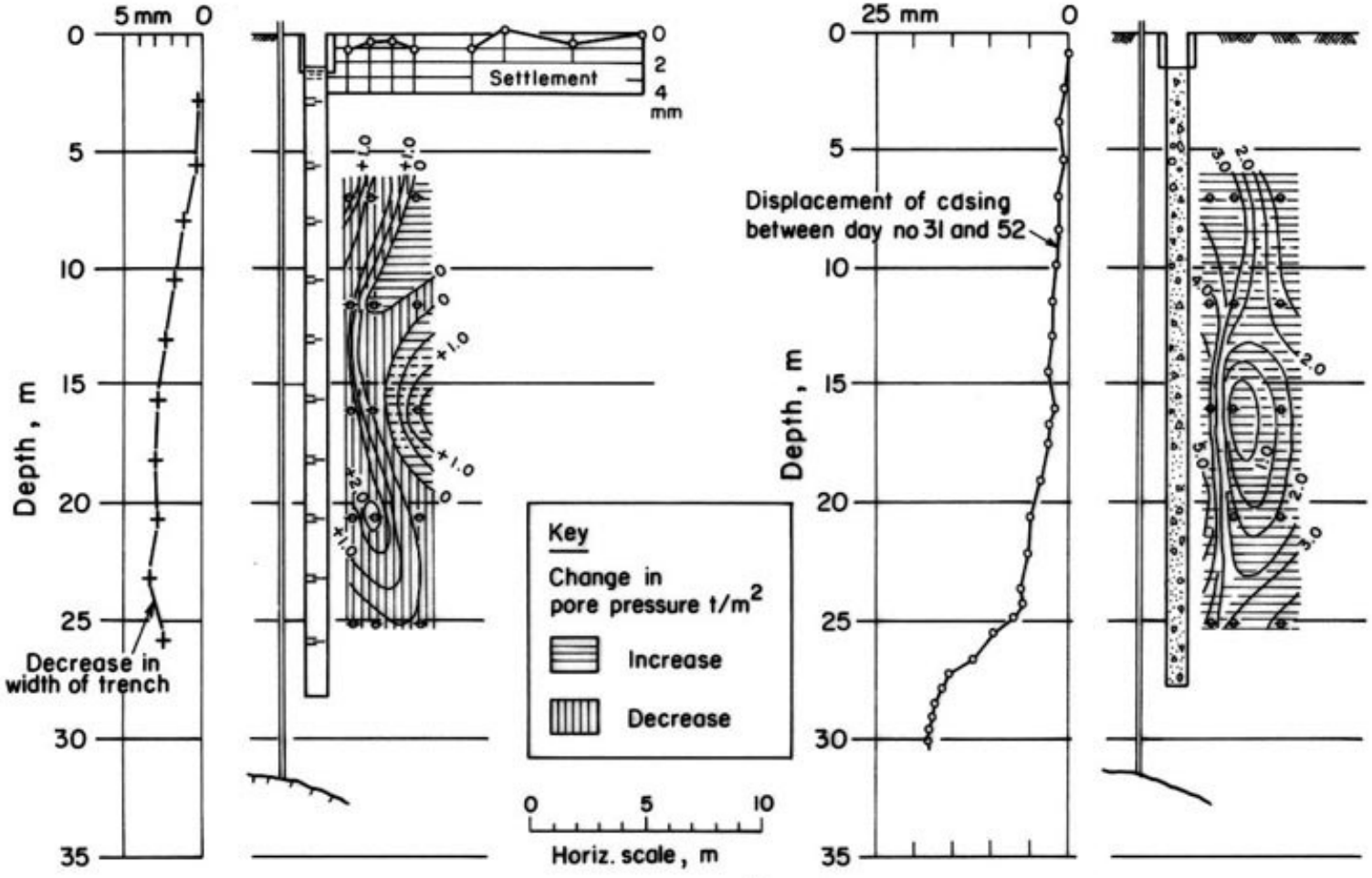
Construction sequence, Studenterlunden.



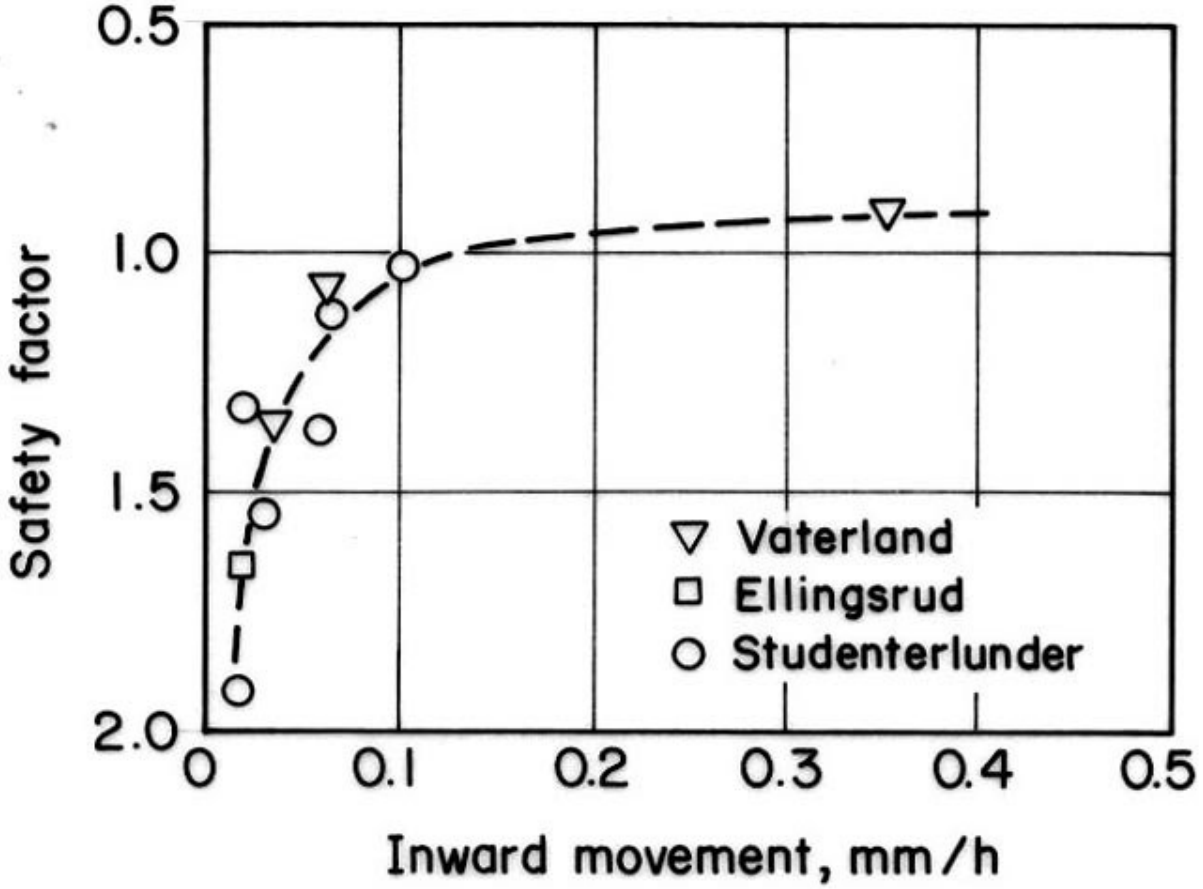
Details of test trench at Studenterlunden



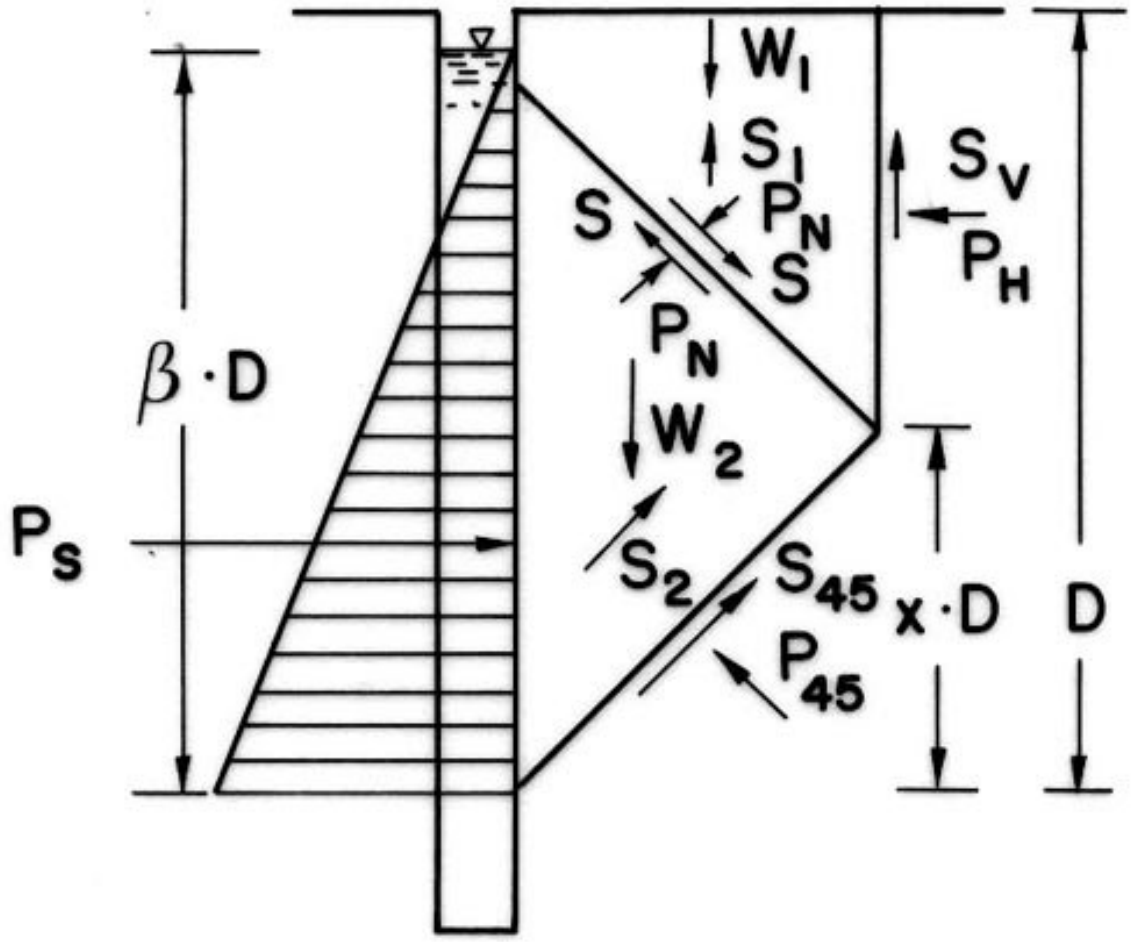
Operating principle of the hydraulic gauges used to measure changes in width of the trench



Measured movement and changes in pore pressure



Relationship between observed creep rate and calculated safety factor



Stability analysis

$x \leq 0.5$ and

$\beta < 2x$ or

$\beta \sim 2x$

Performance of Deep Excavations

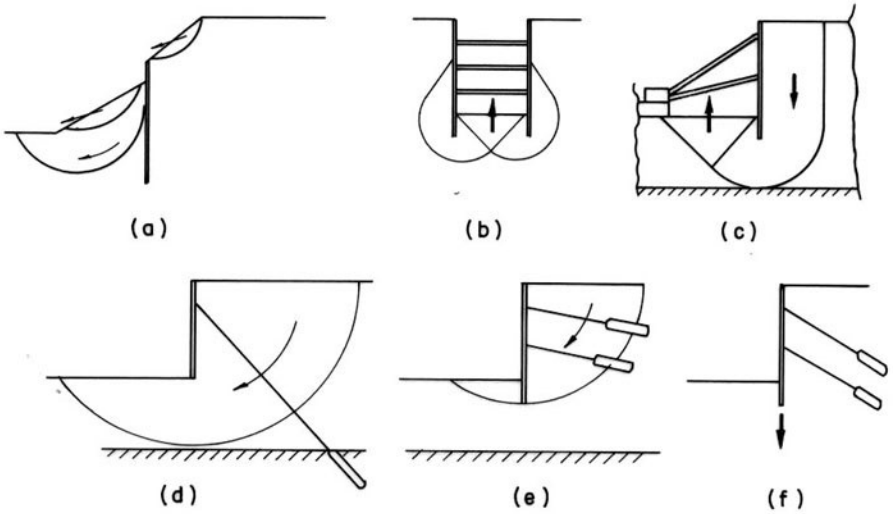


Fig. 2.7 Modes of Instability for Supported Excavations in Soft Clay

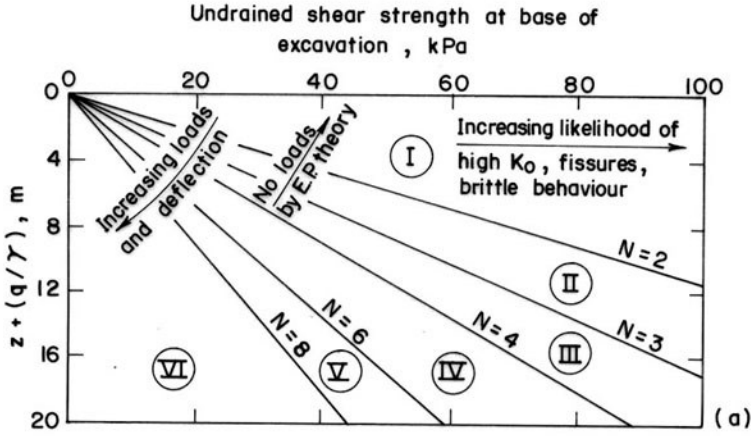


Fig. 2.8 Classification charts for Excavations

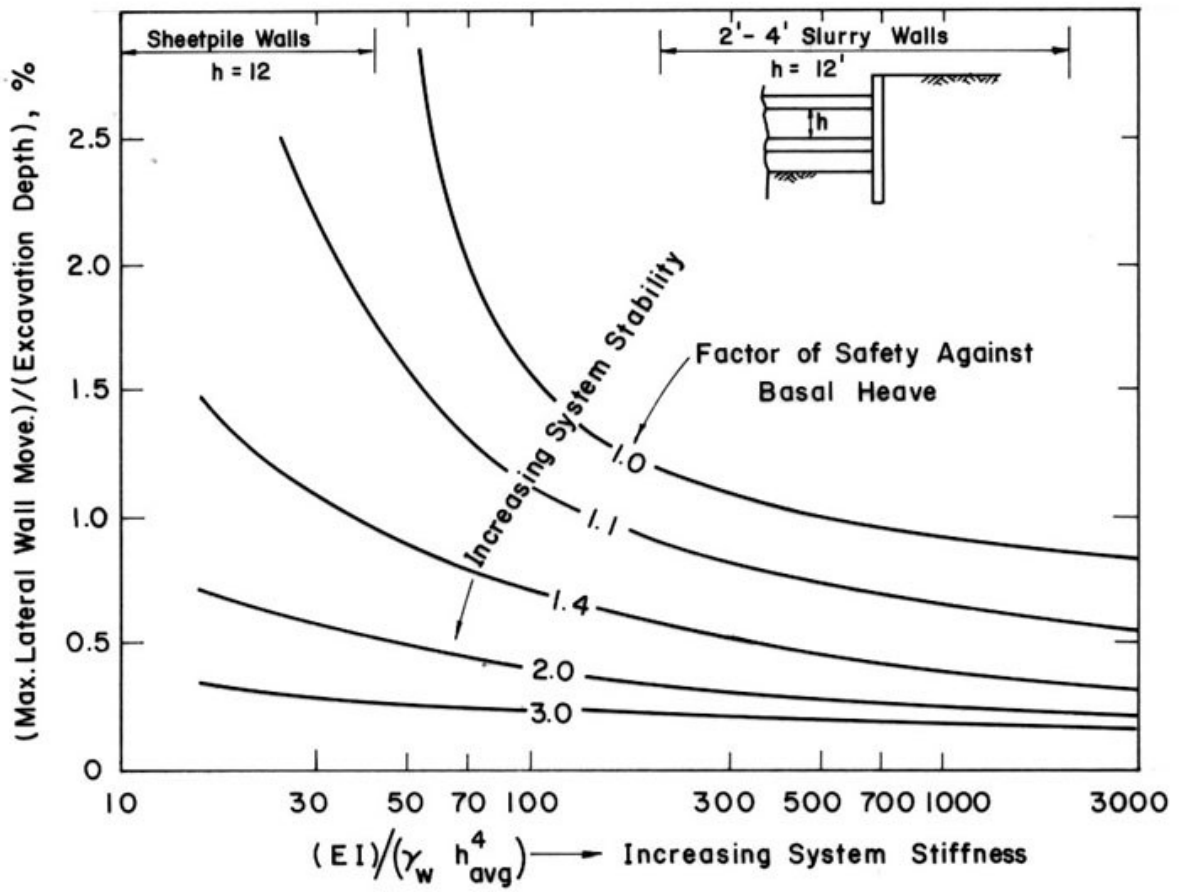
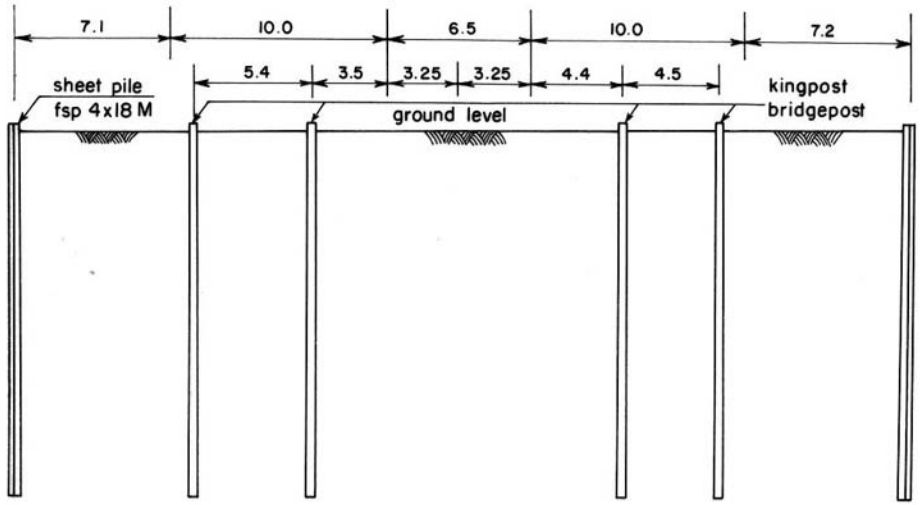


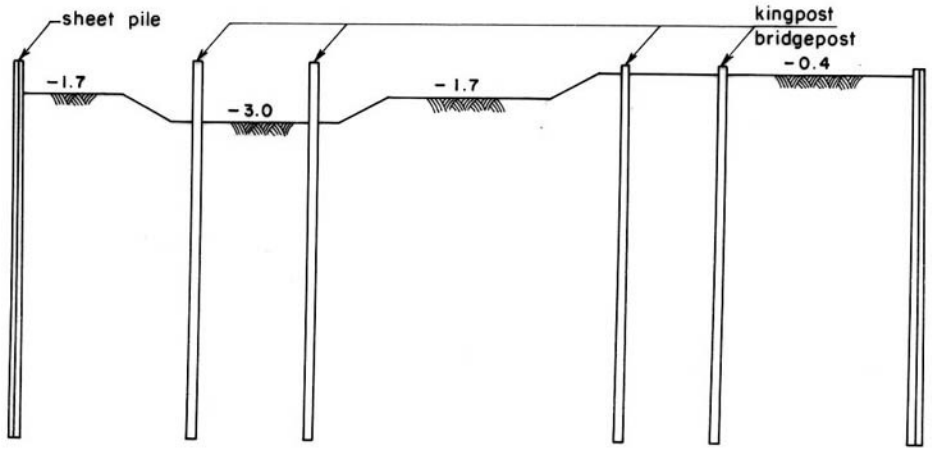
Fig. 2.17 Theoretical Relationship Between Maximum Lateral Wall Movement, Factor of Safety Against Basal Heave and System Stiffness


KOBE
KX078

PHAHOLYOTHIN PLACE
SEQUENCE OF WORK

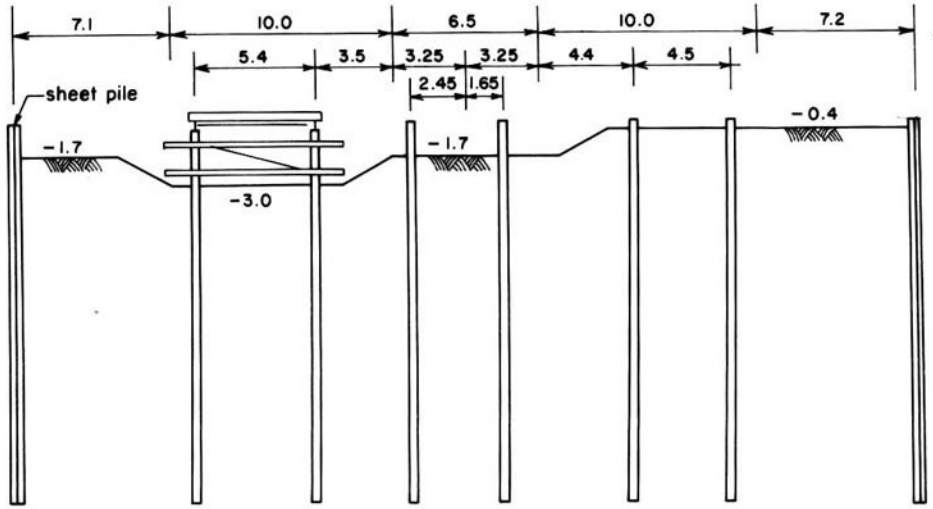


(a) Step 1 : Install Sheet Pile and Kingpost

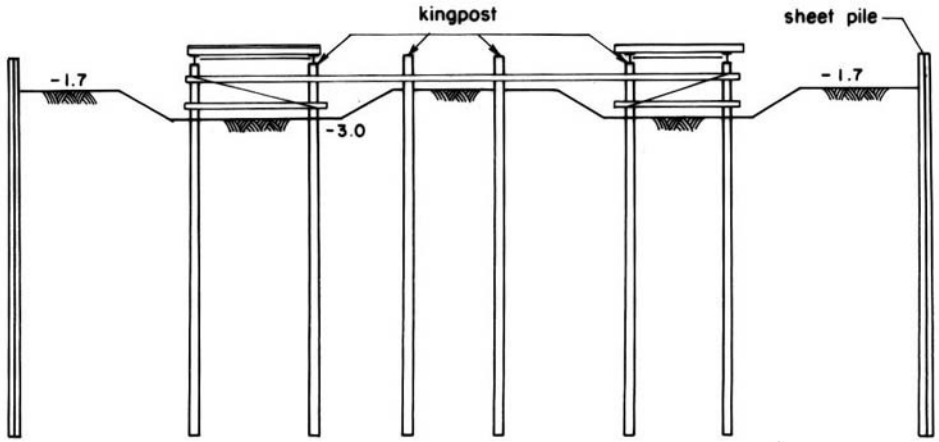


(b) Step 2 : First Stage Excavation

PHAHOLYOTHIN PLACE
SEQUENCE OF WORK

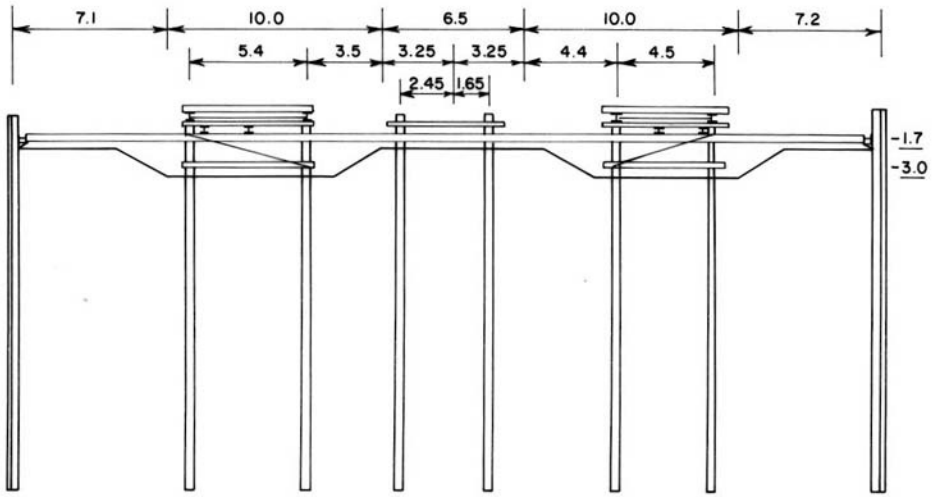


(c) Step 3 : Construct Bridge

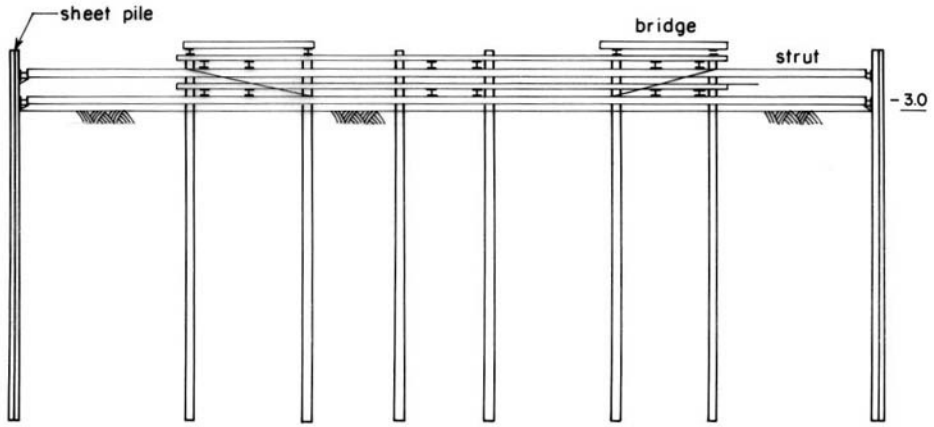


(d) Step 4 : Second Stage Excavation (-3.0m)

PHAHOLYOTHIN PLACE
SEQUENCE OF WORK

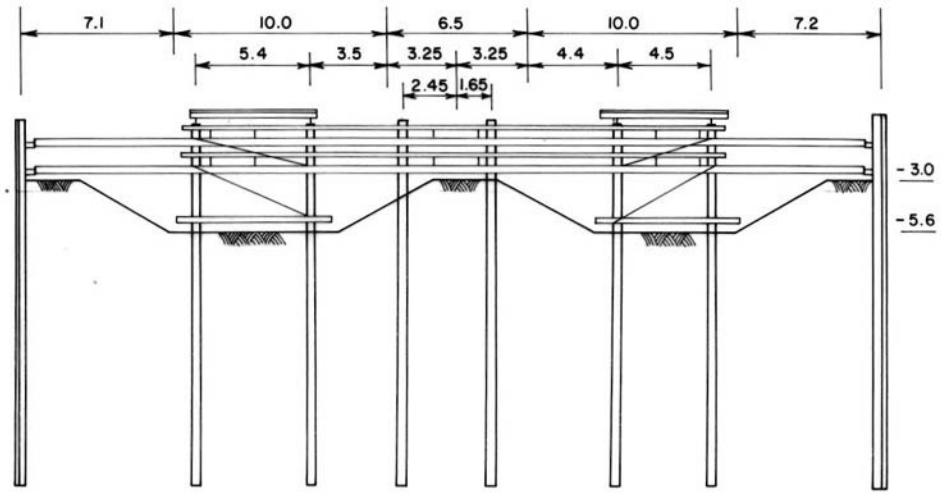


(e) Step 5 : Install First Level of Struts

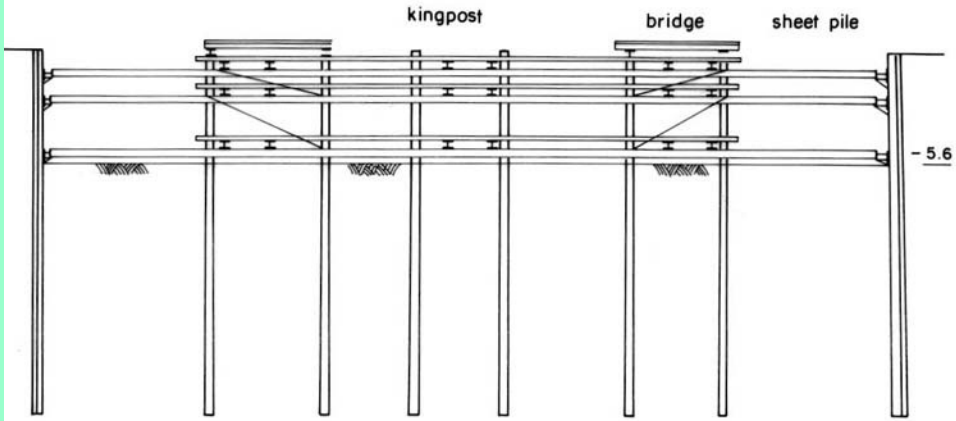


(f) Step 6 : Install Second Level of Struts

PHAHOLYOTHIN PLACE
SEQUENCE OF WORK

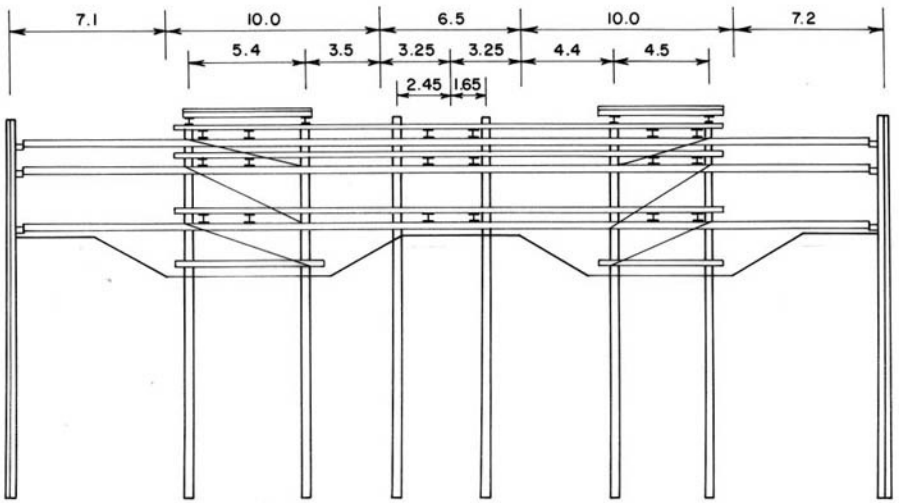


(g) Step 7 : Third Stage Excavation (-5.6 m)

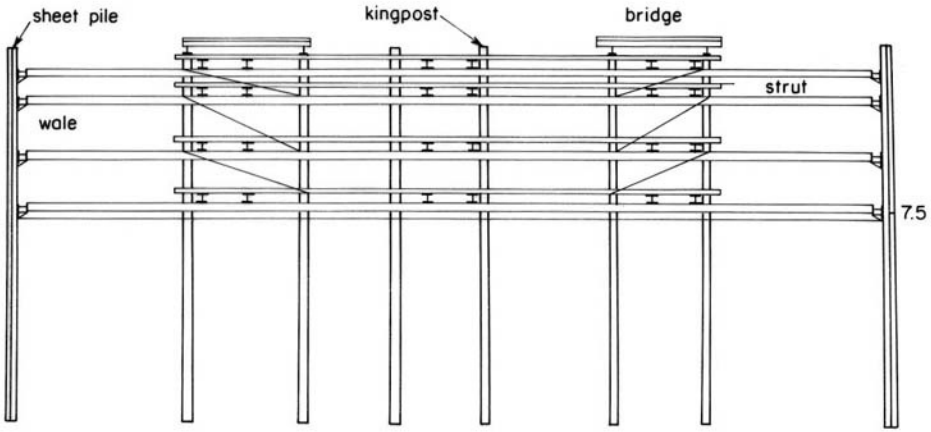


(h) Step 8 : Install Third Level of Struts

PHAHOLYOTHIN PLACE
SEQUENCE OF WORK

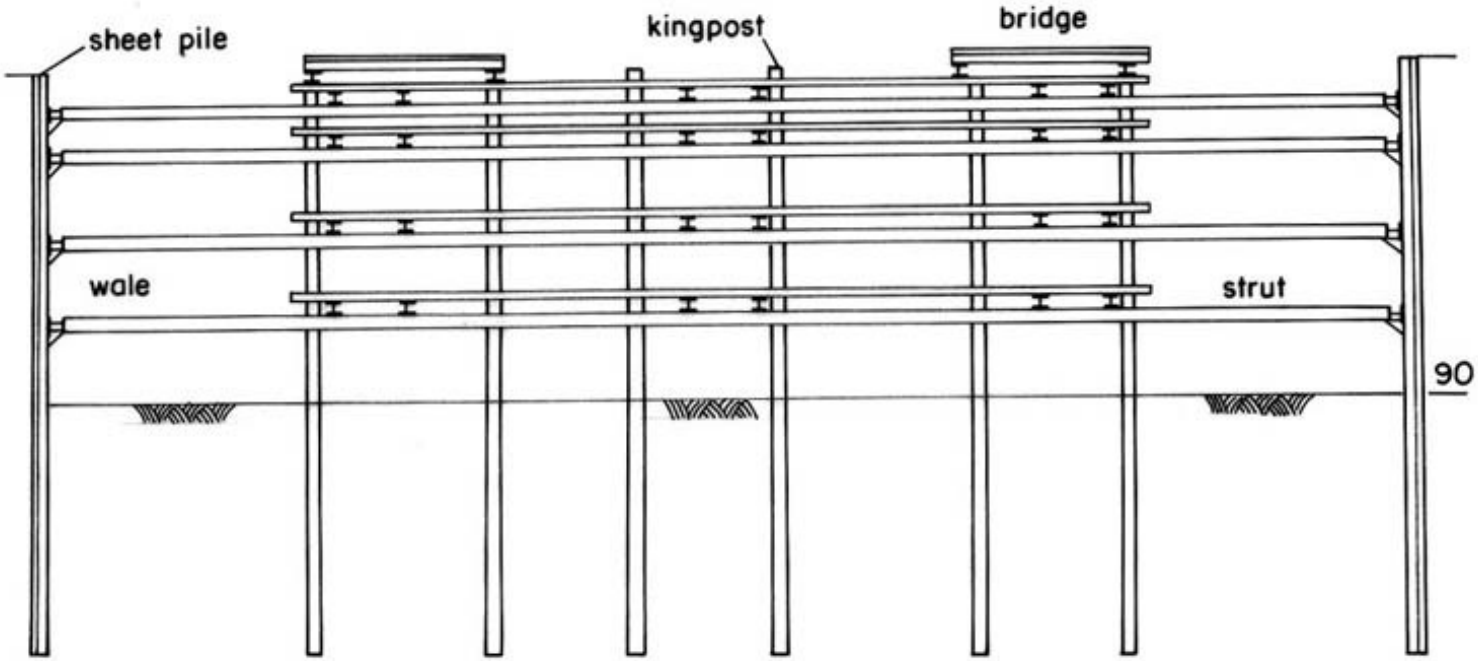


(i) Step 9 : Fourth Stage Excavation



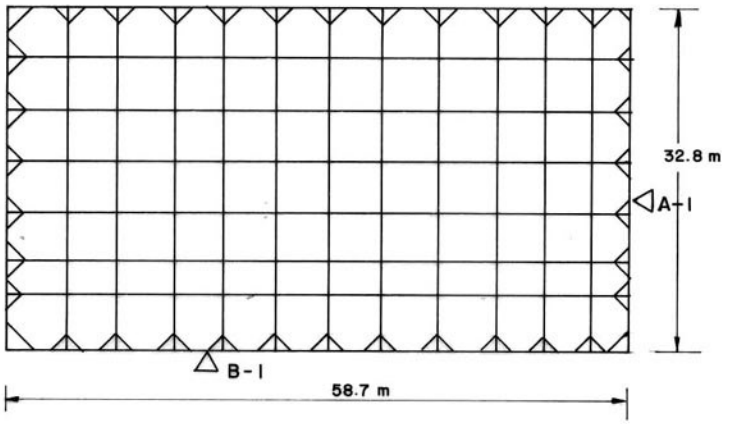
(j) Step 10 : Install Fourth Level of Struts

PHAHOLYOTHIN PLACE
SEQUENCE OF WORK



(k) Step II : Final Stage of Excavation

Fig. 3.1 (a–k) Sequence of Work in Sheet Piled Wall Excavation



Plan View Scale 1:500 △ Inclinometer

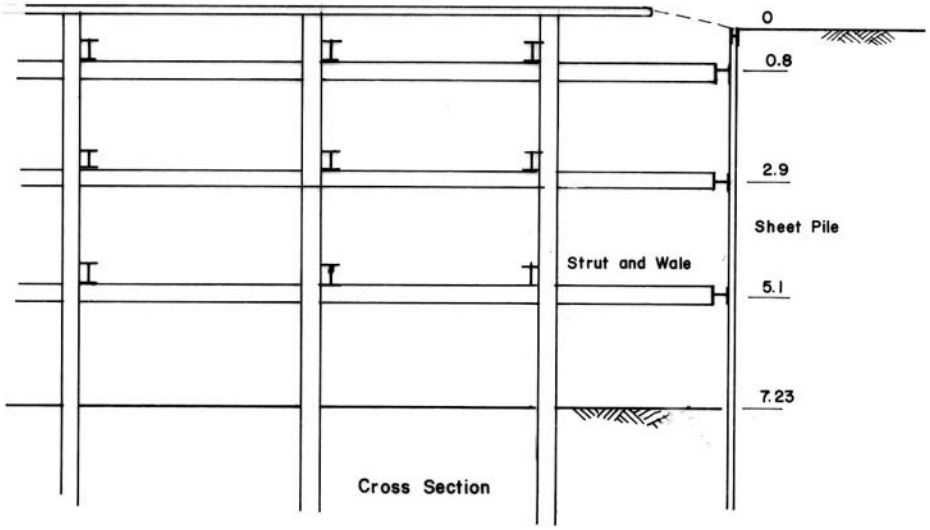


Fig. 4.28 Plan View and Cross Section Siam Motor Machine Site

Dimensions in m

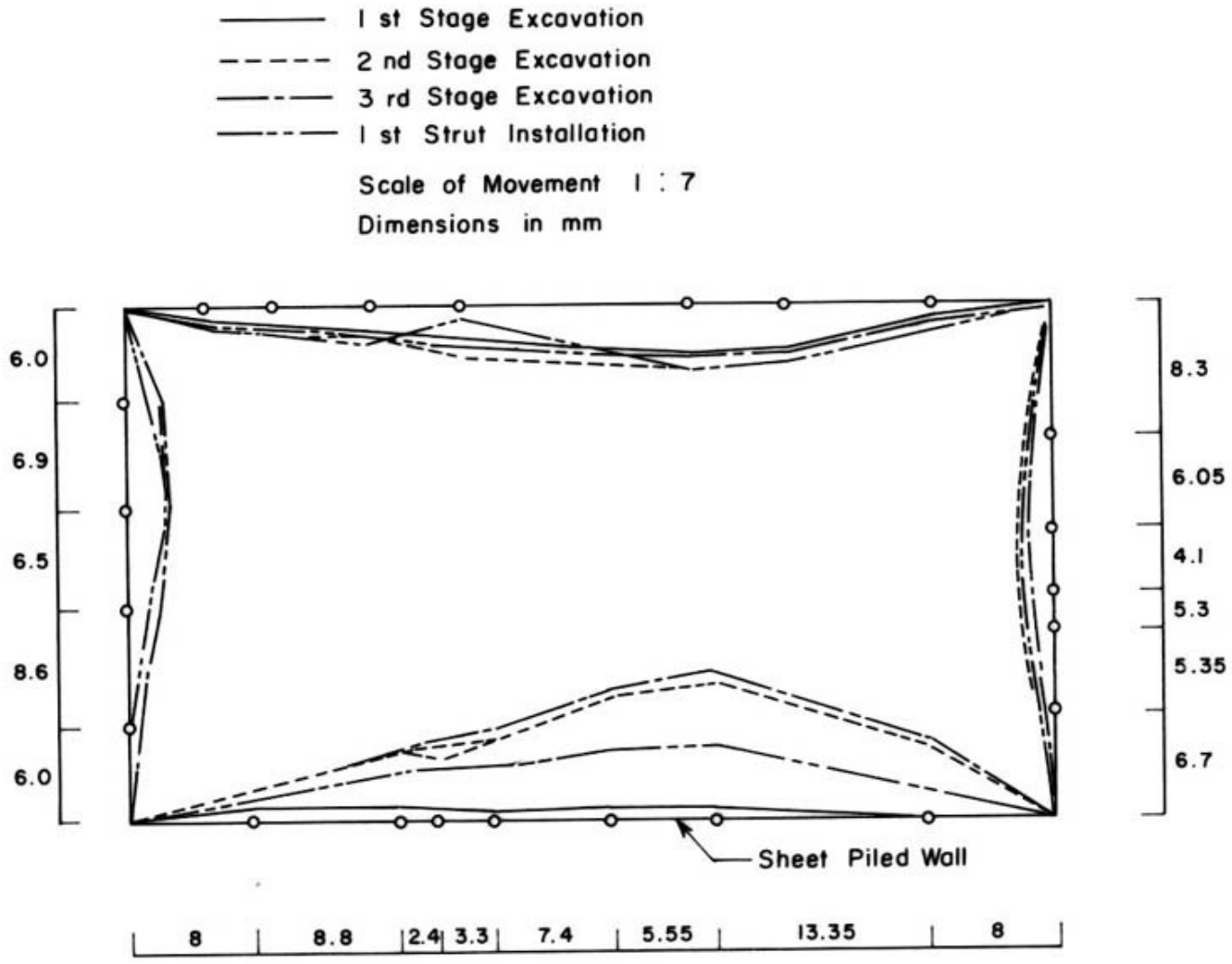


Fig. 4.29 Sheet Piled Wall Movements (Siam Motor Machine Site)

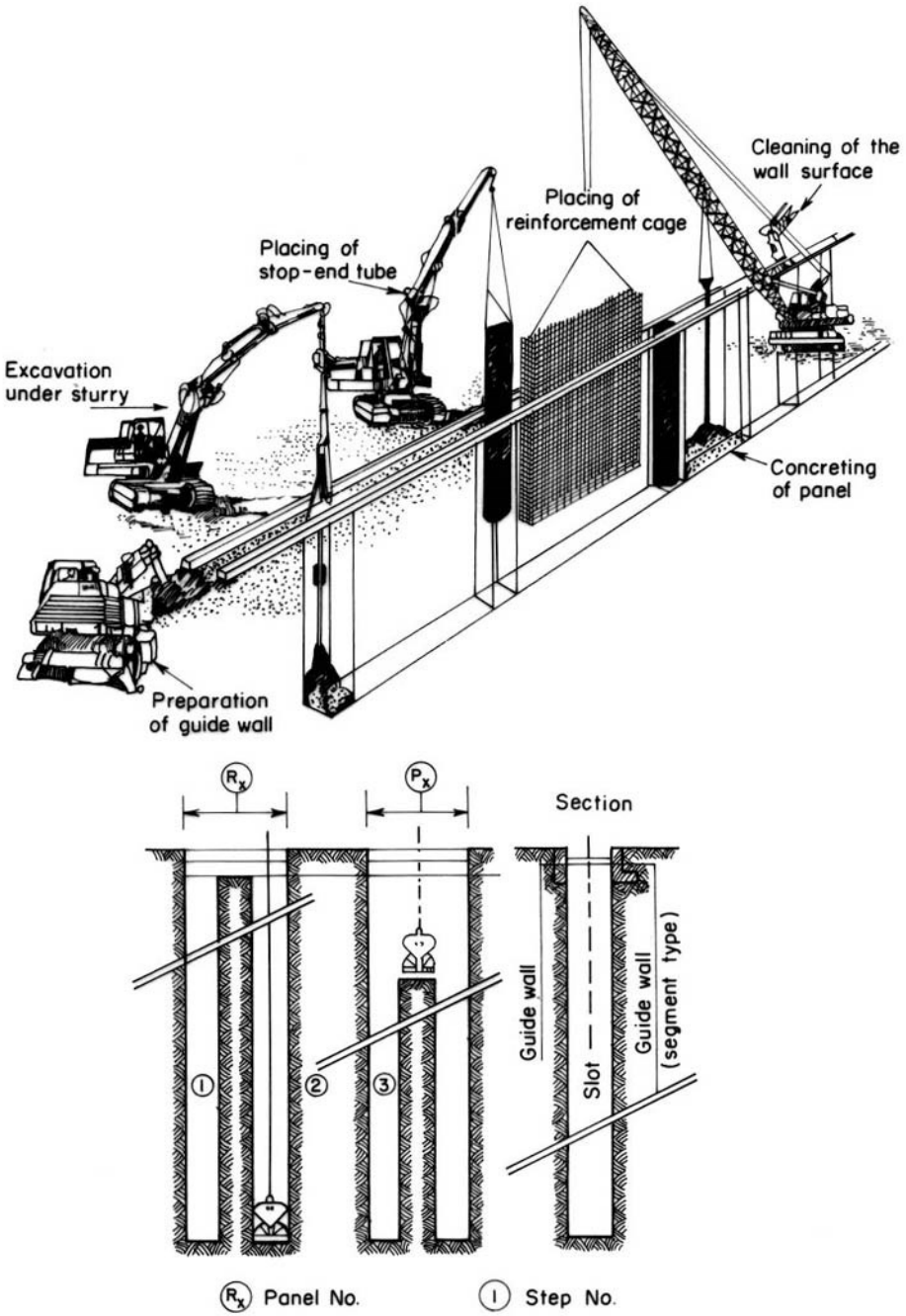


Fig. 2.27 Diaphragm Wall Construction

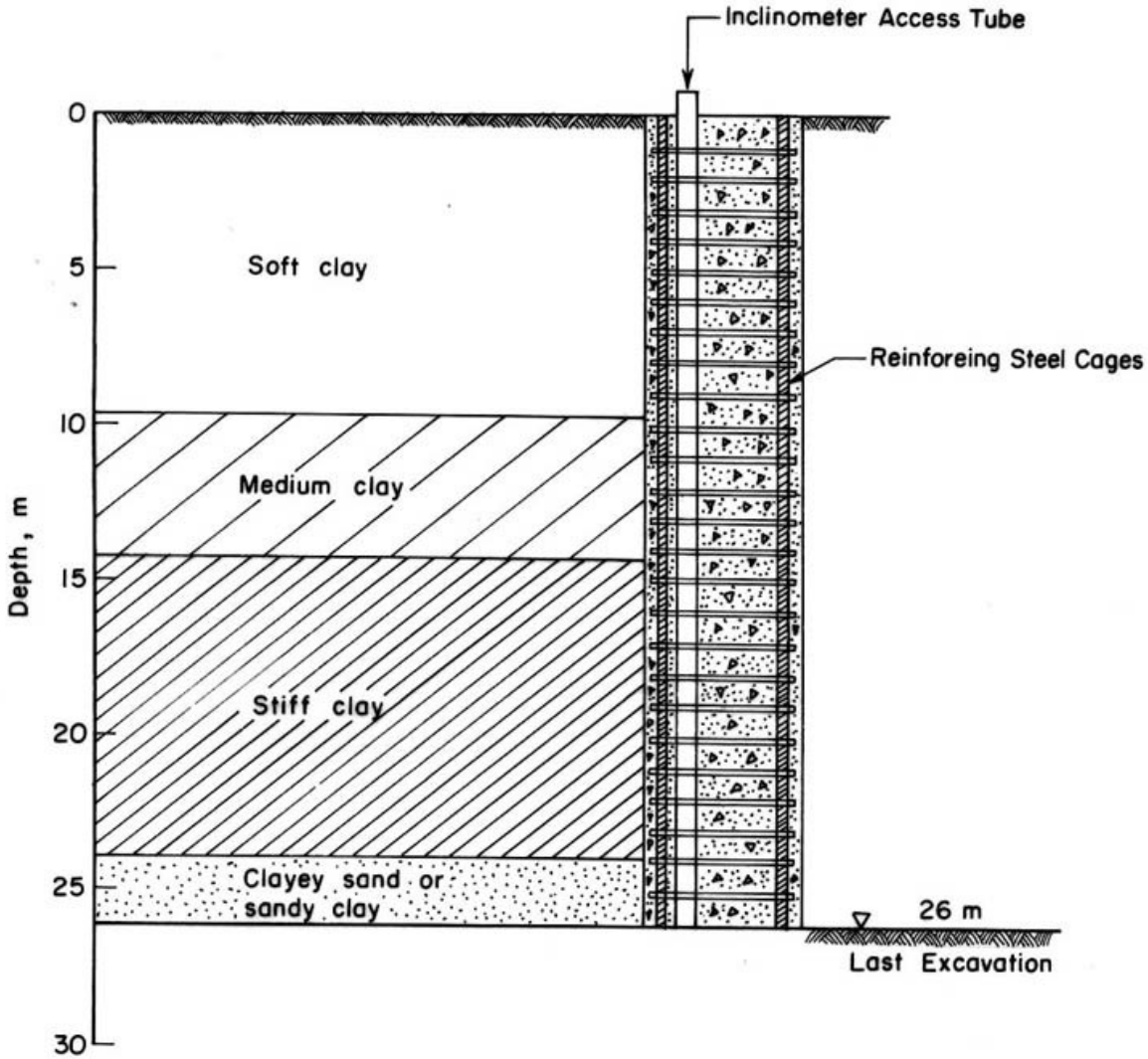


Fig. 3.7 Details of Inclinometer Casing Installation
(Internation Trade Center)

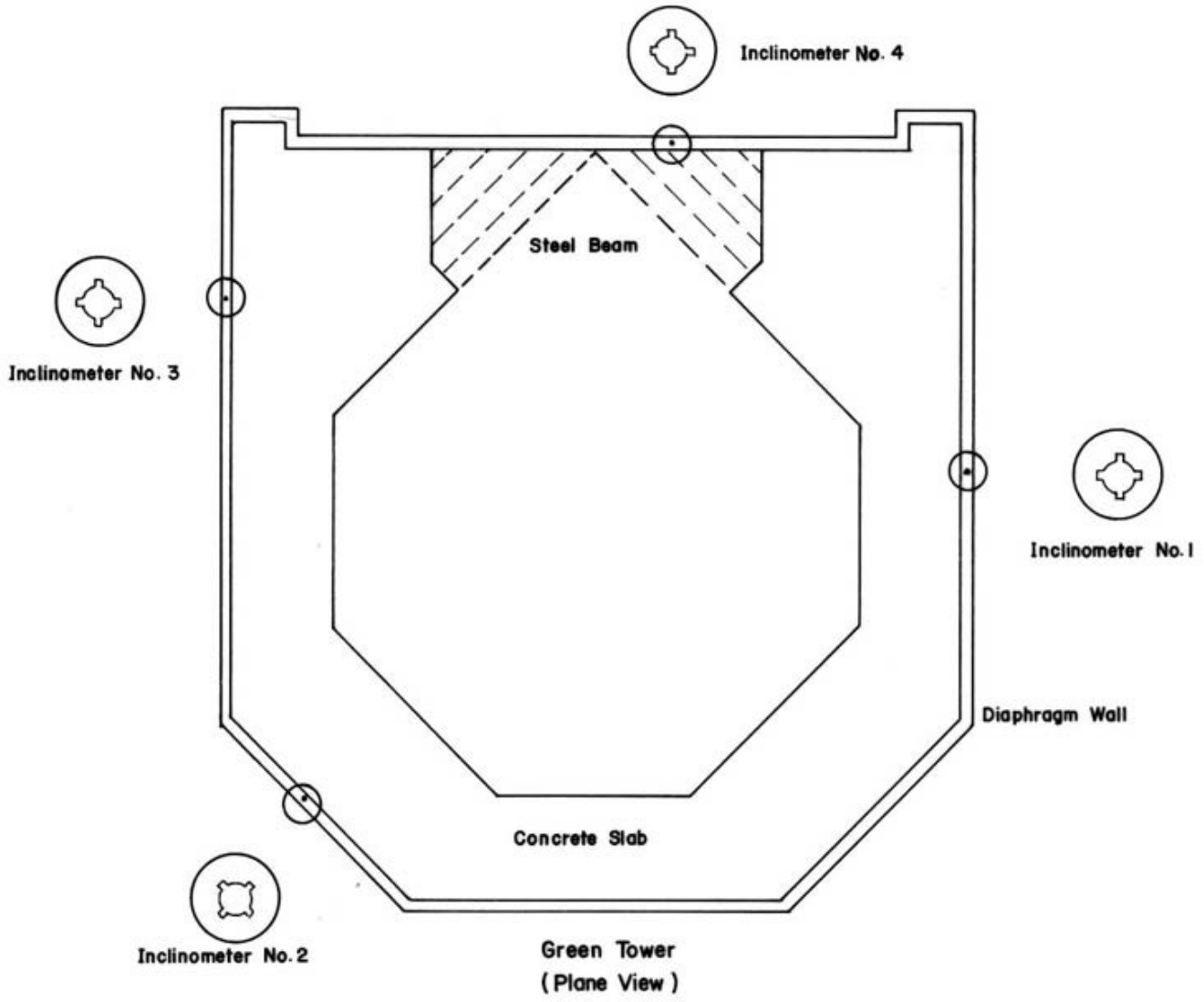
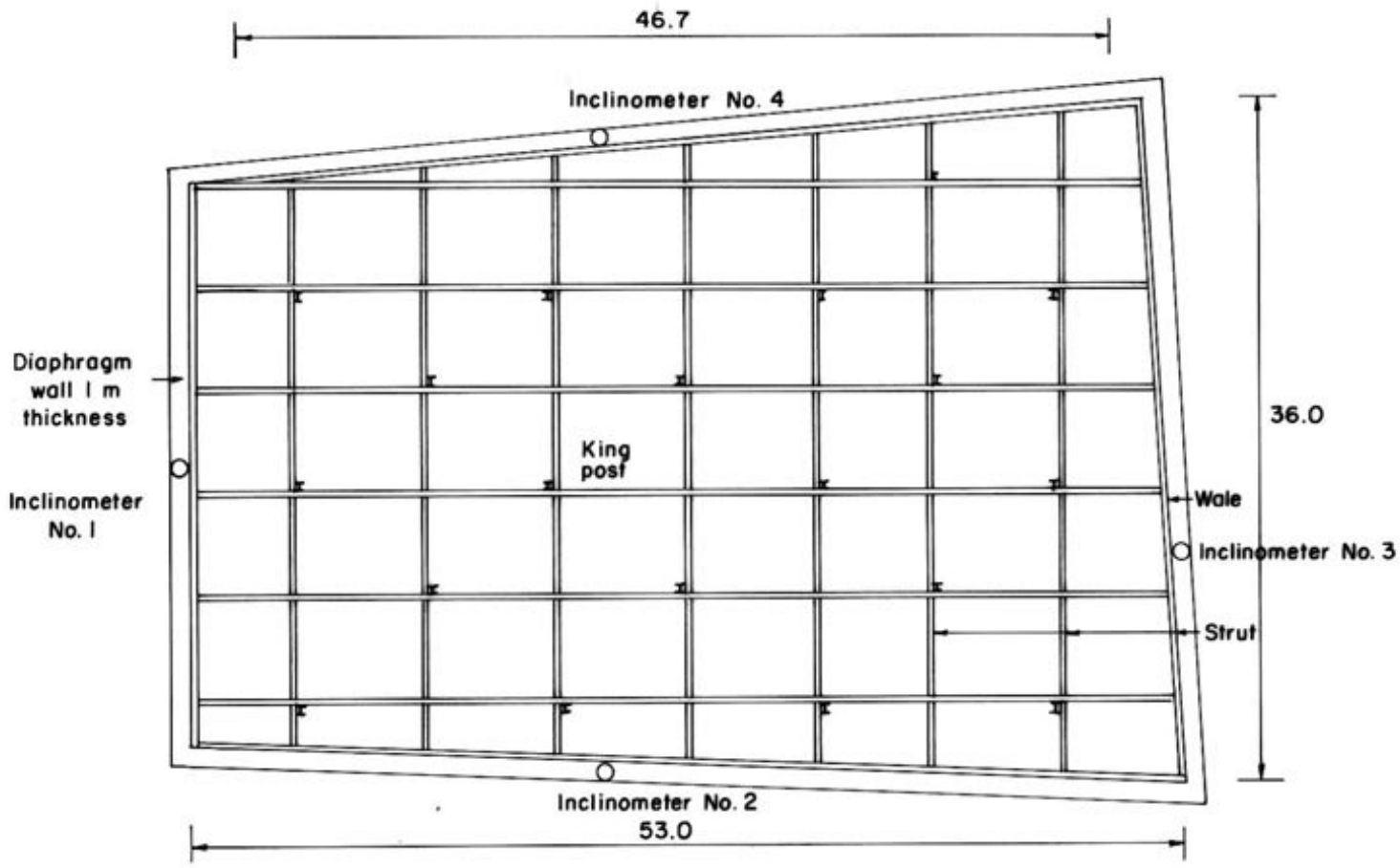


Fig. 4.48 Inclinometer Locations (Green Tower Site)



Braced Excavation (Oriflame Project)

Dimensions in m

Fig. 4.39 Inclinometer Locations. (In Oriflame Project)

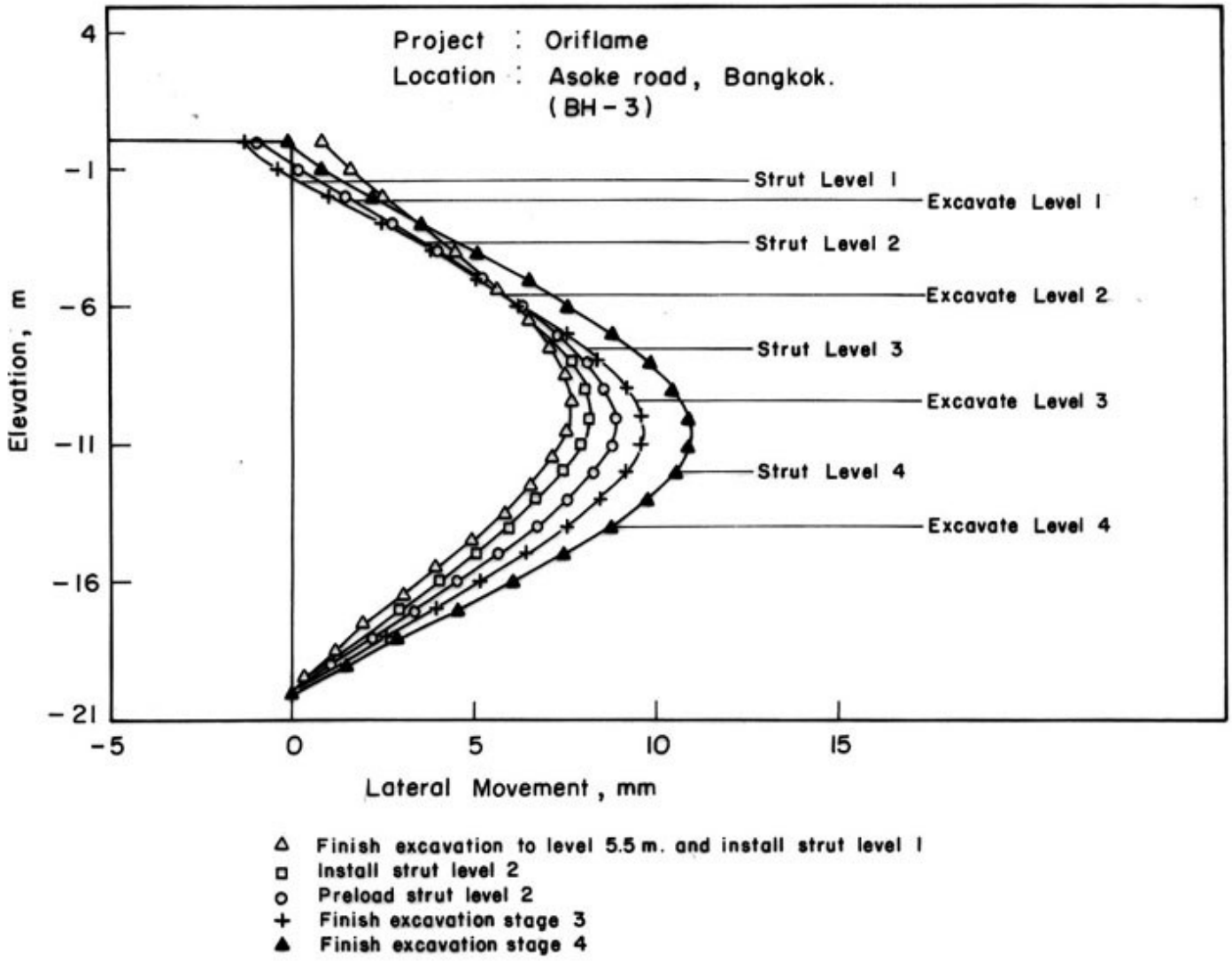


Fig. 4.42 Inclinometer Measurements (Oriflame Project , Inlinometer No. 3)

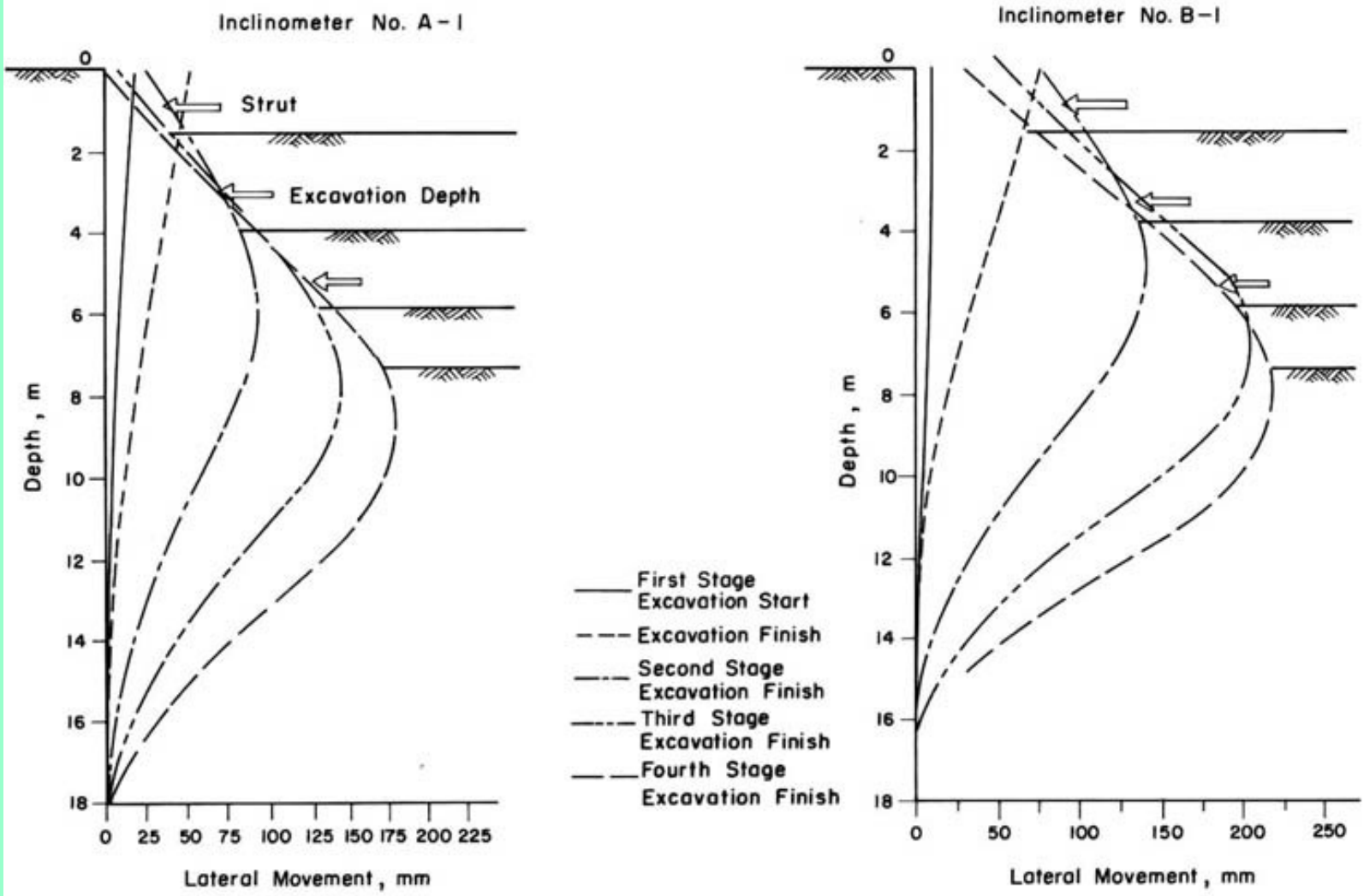


Fig. 4.30 Lateral Movements (Siam Motor Machine Site)

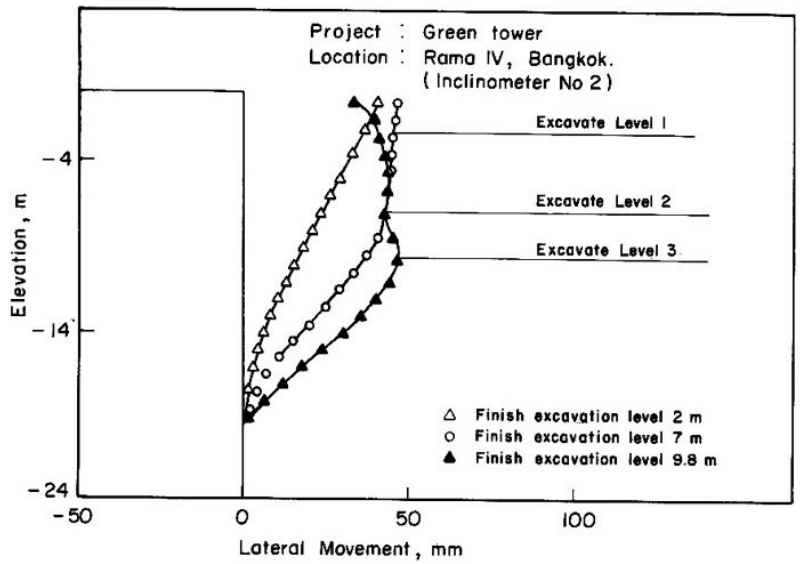


Fig. 4.49 Inclinometer Measurements (Green Tower)

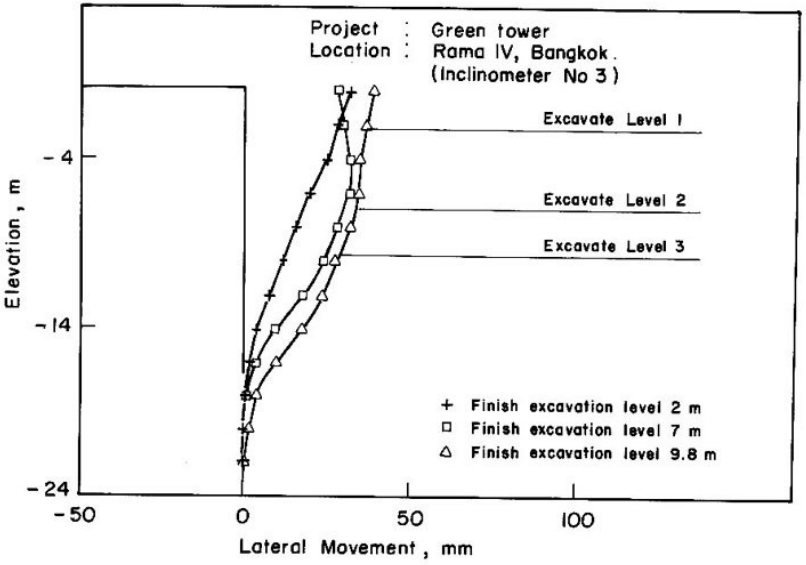


Fig. 4.50 Inclinometer Measurements (Green Tower)

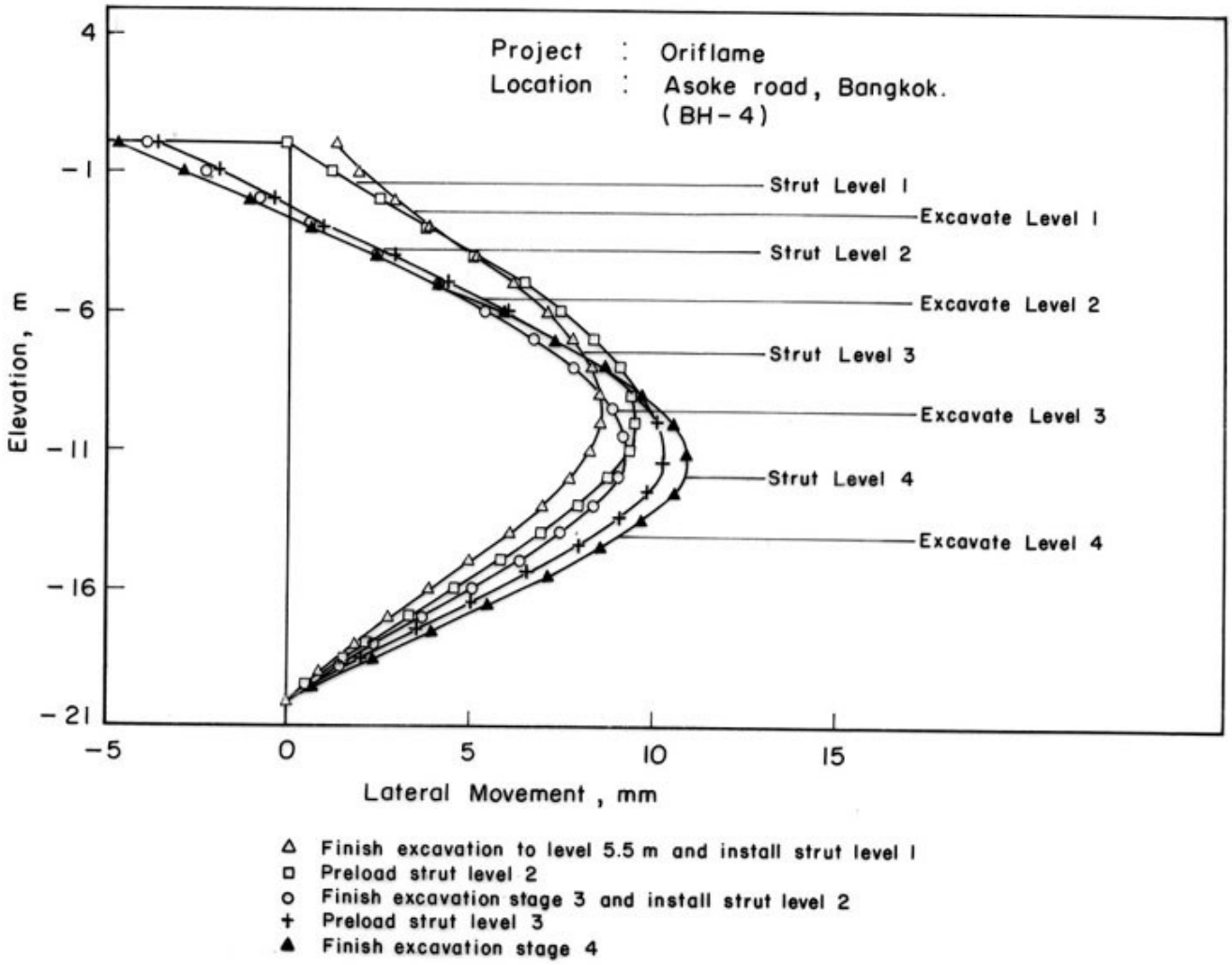


Fig. 4.43 Inclinometer Measurements (Oriflame Project, Inlinometer No. 4)

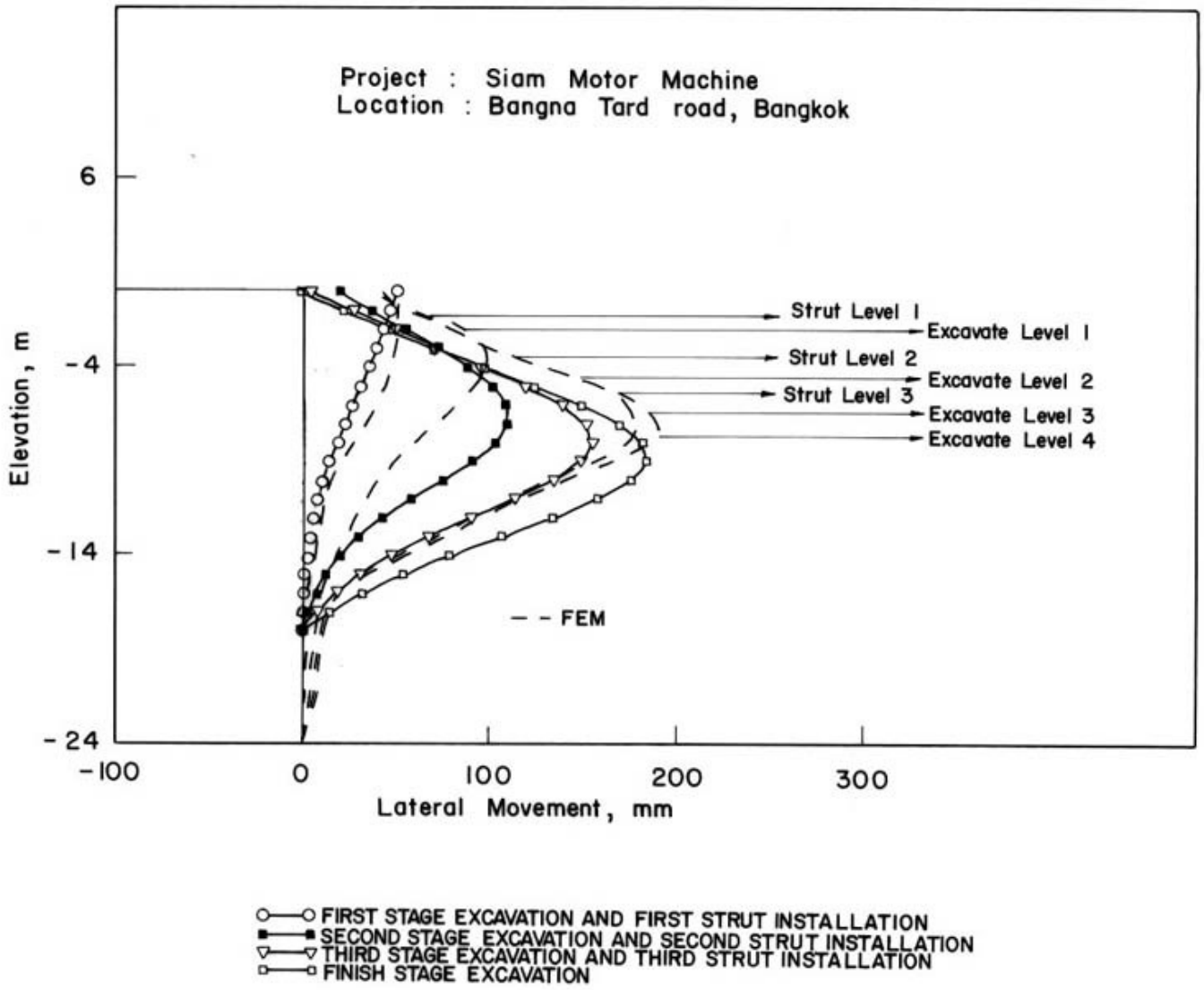


Fig. 4.58 Lateral Movement Comparison Between Actual and Computed Values (Siam Motor Machine Site)

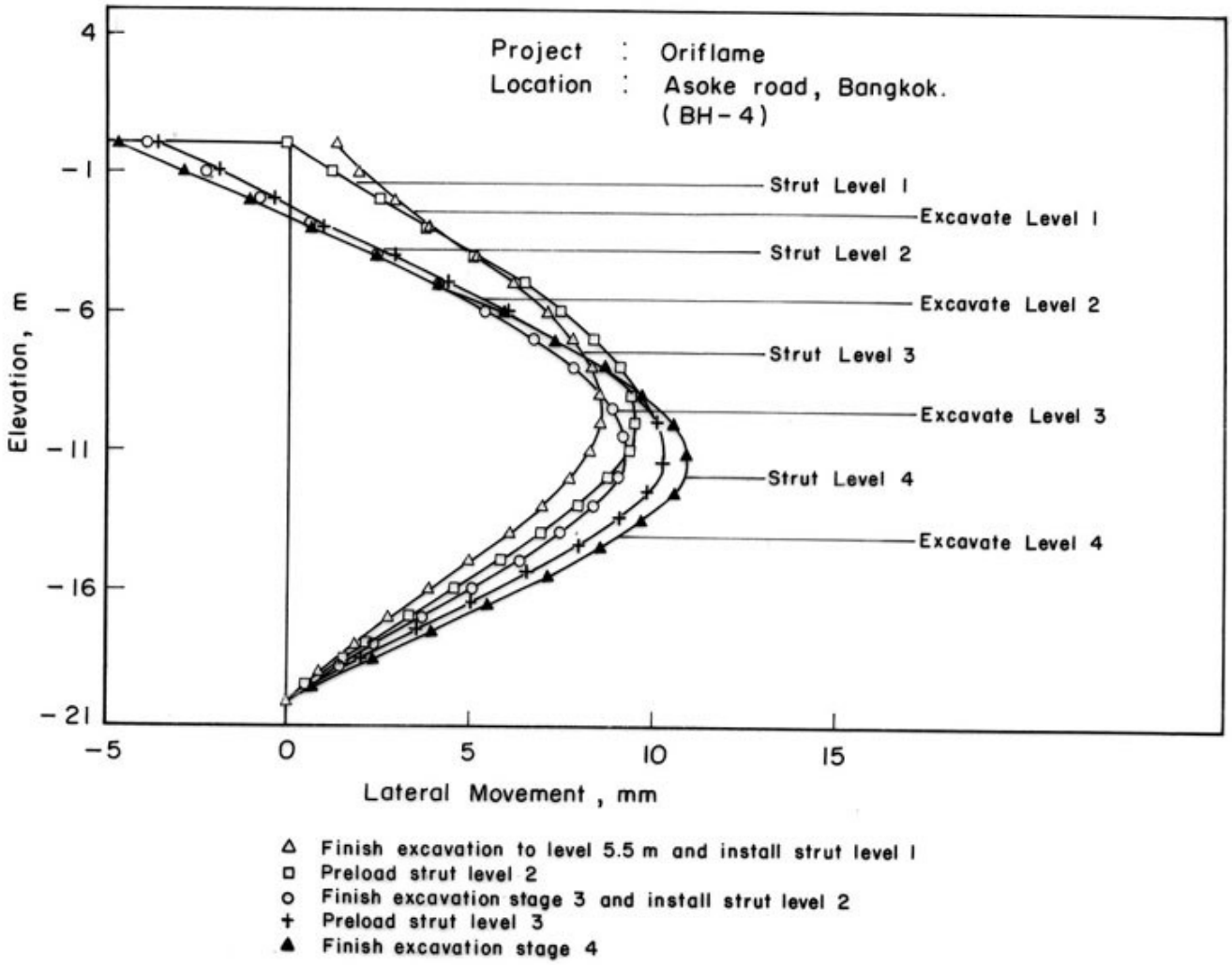


Fig. 4.43 Inclinometer Measurements (Oriflame Project, Inlinometer No. 4)

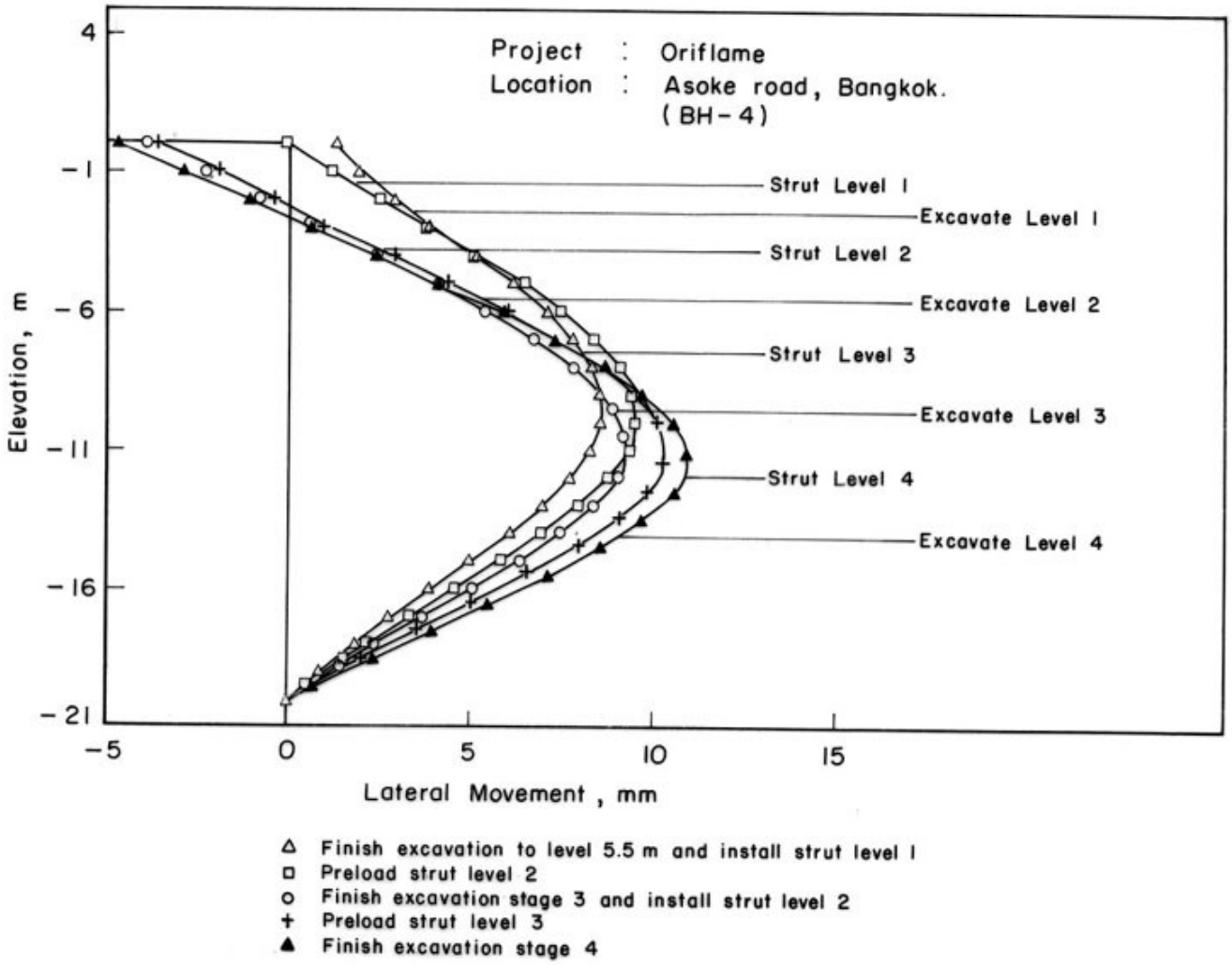


Fig. 4.43 Inclinometer Measurements (Oriflame Project, Inlinometer No. 4)

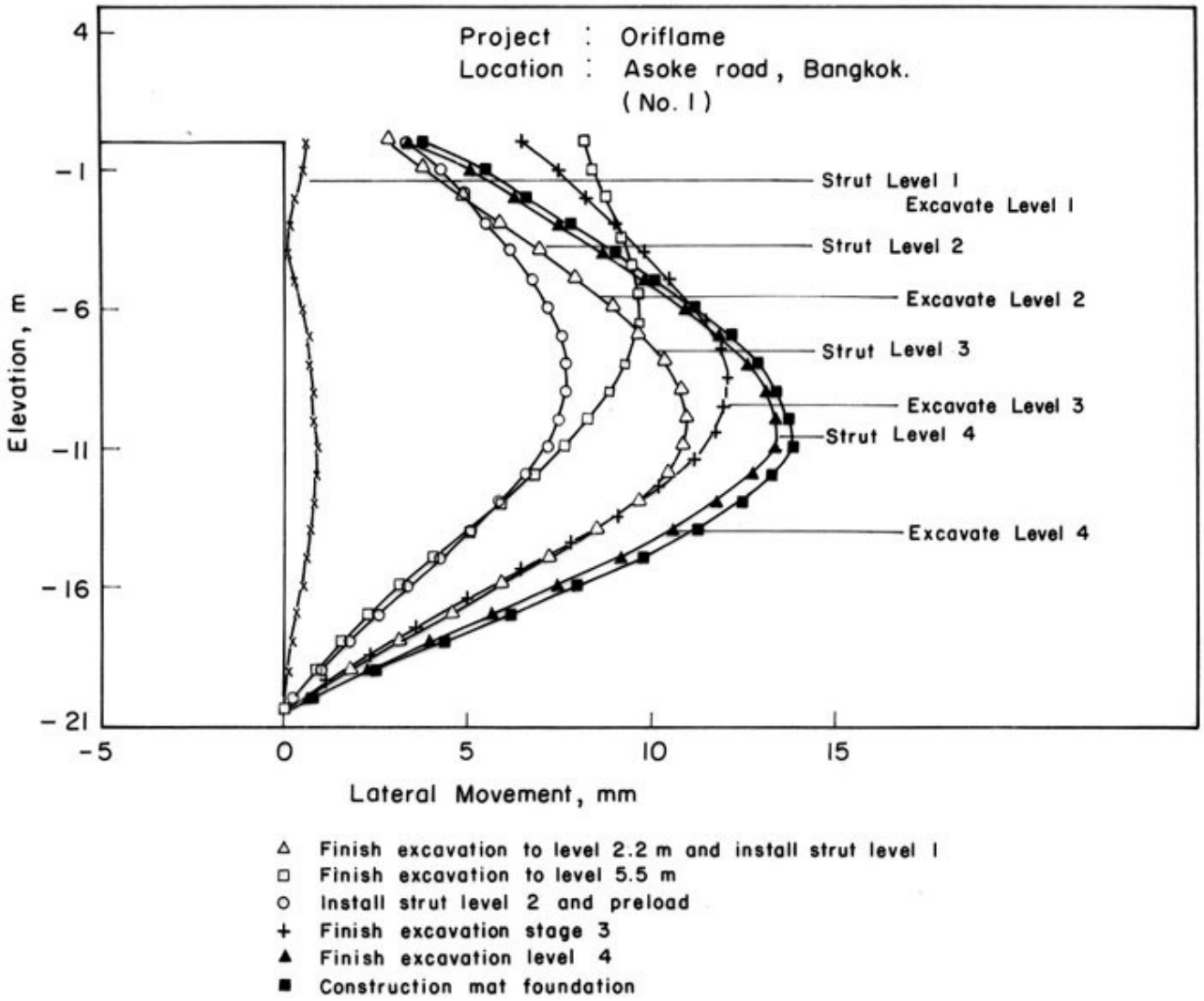


Fig. 4.40 Inclinometer Measurements (Oriflame Project, Inlinometer No. 1)

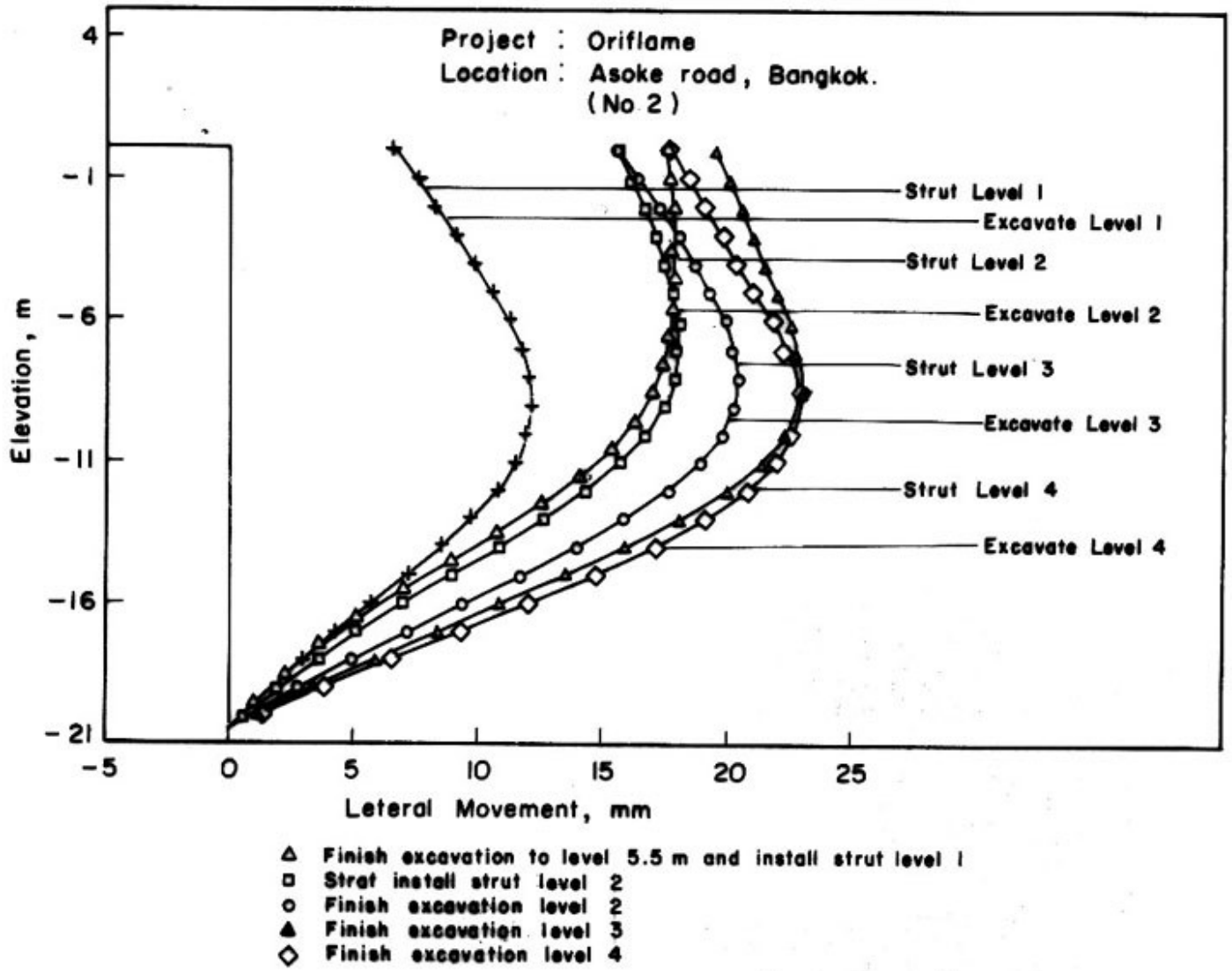


Fig. 4.41 Inclinometer Measurements (Oriflam Project, Inlinometer No.2)

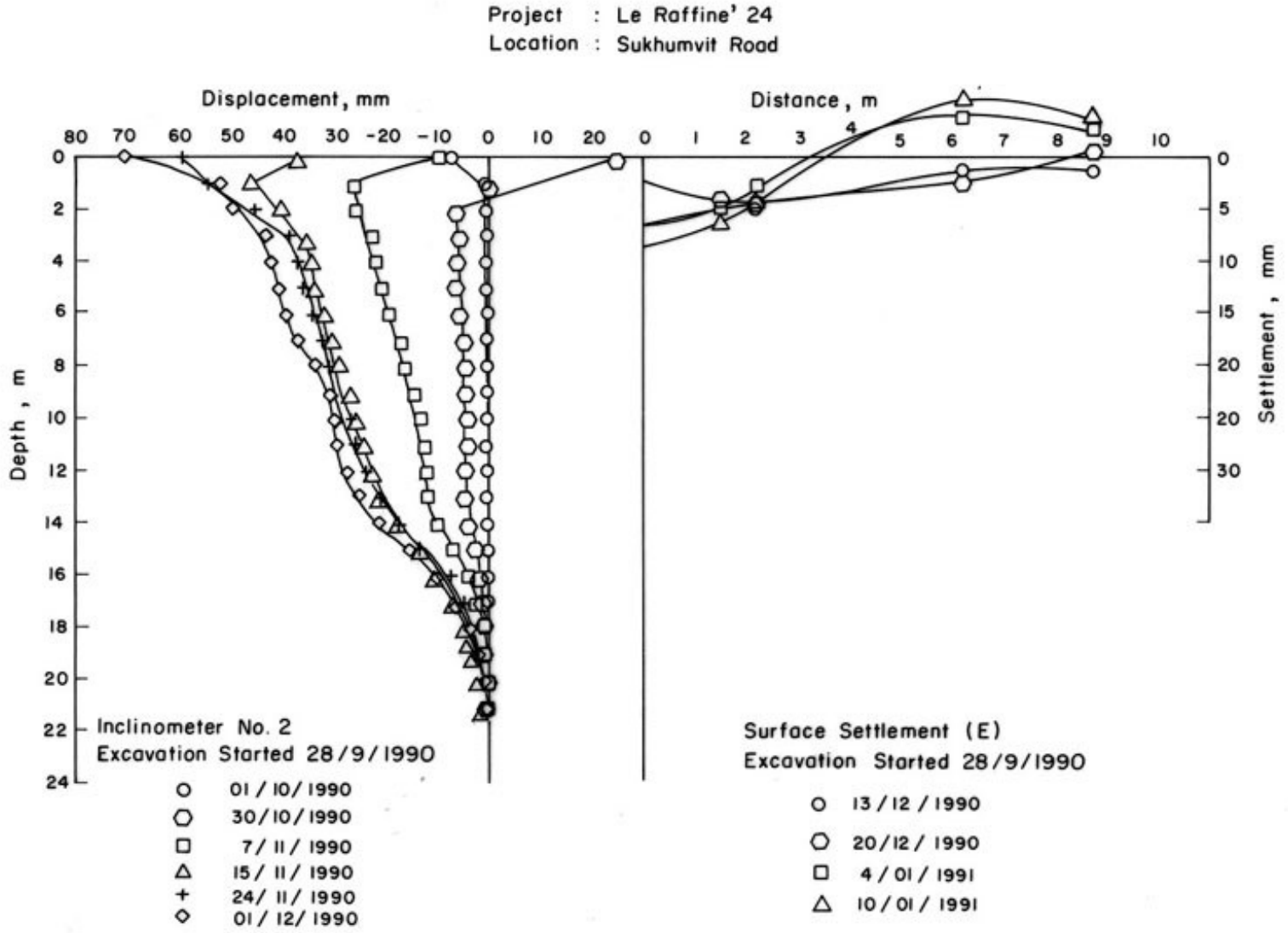


Fig. 4.37 Surface Settlements and Lateral Movements
(Le Raffine' 24 Site)

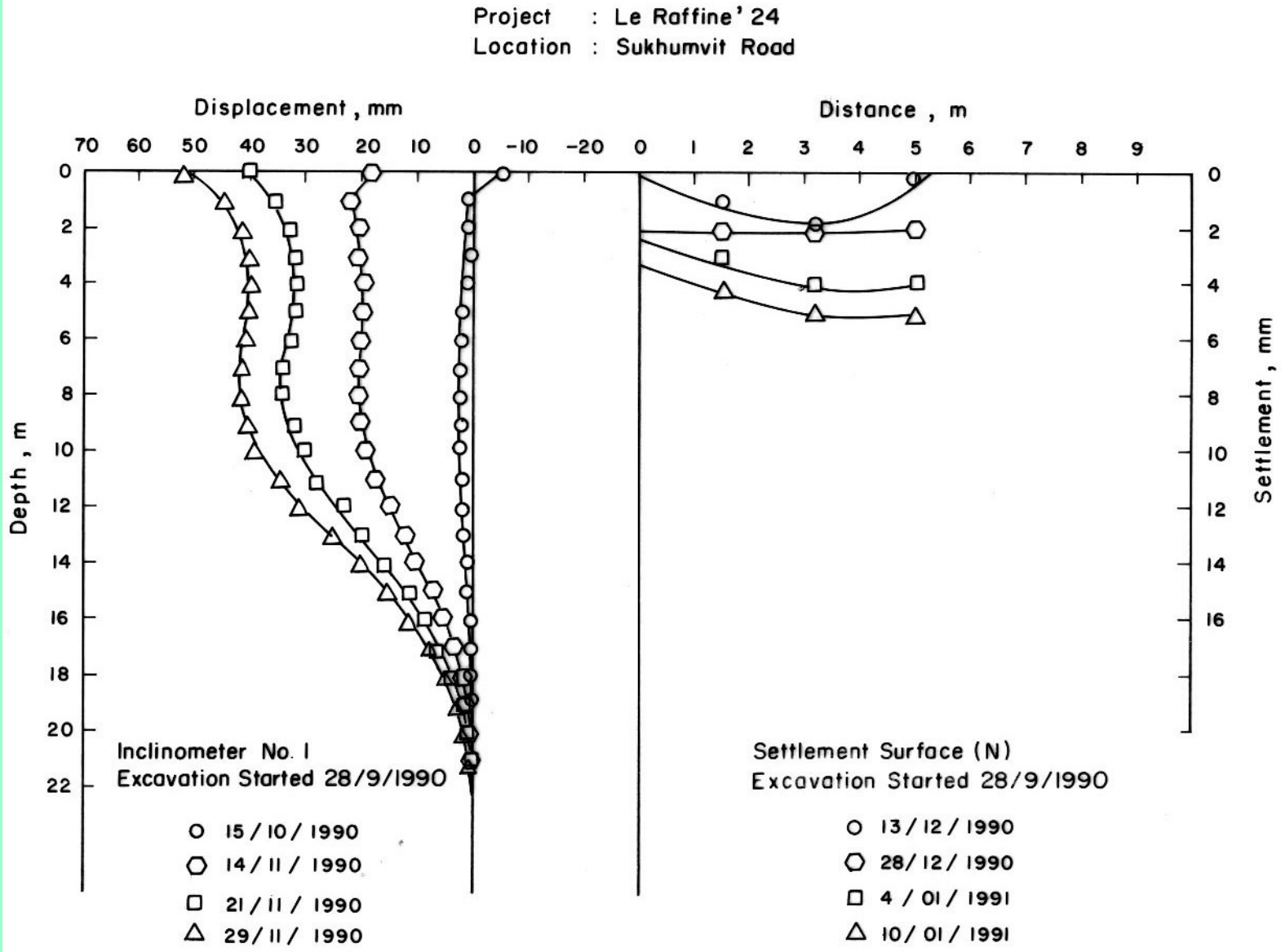


Fig. 4.36 Surface Settlements and Lateral Movements
(Le Raffine' 24 Site)

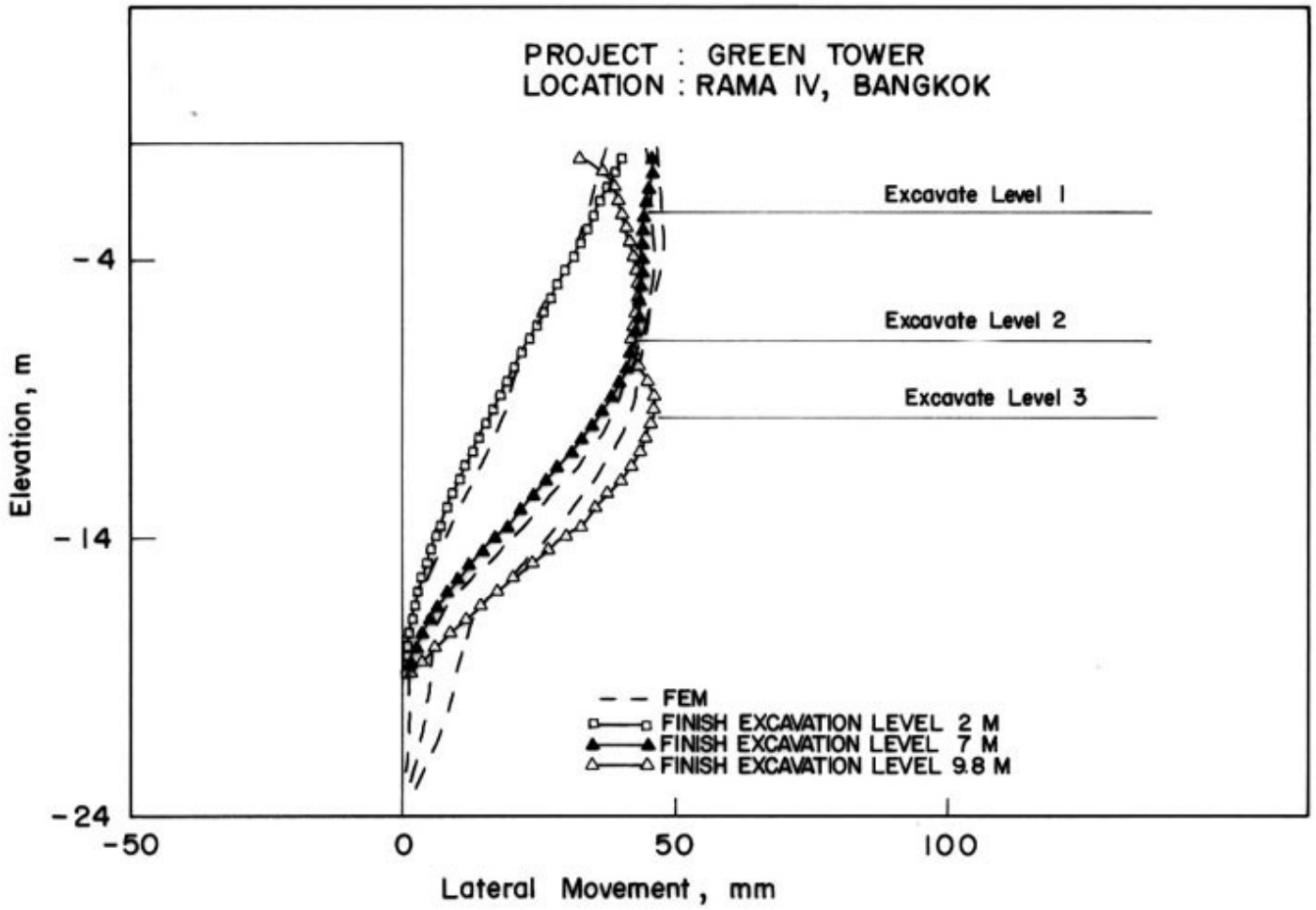


Fig. 4.61 Lateral Movements, Comparison Between Actual and Computed Value (Green Tower Site)

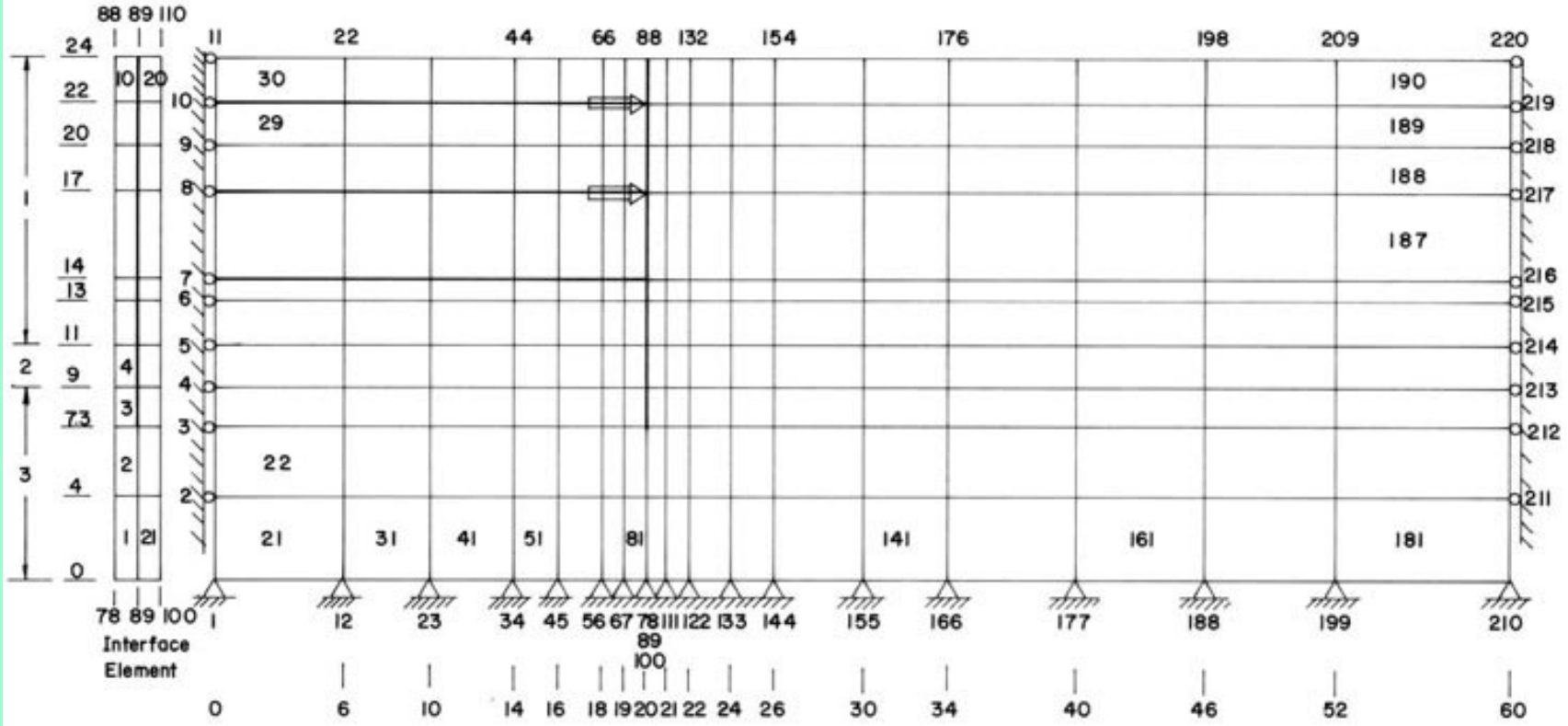


Fig. 4.54 Finite Element Mesh for Diaphragm Wall Excavation
(Green Tower)

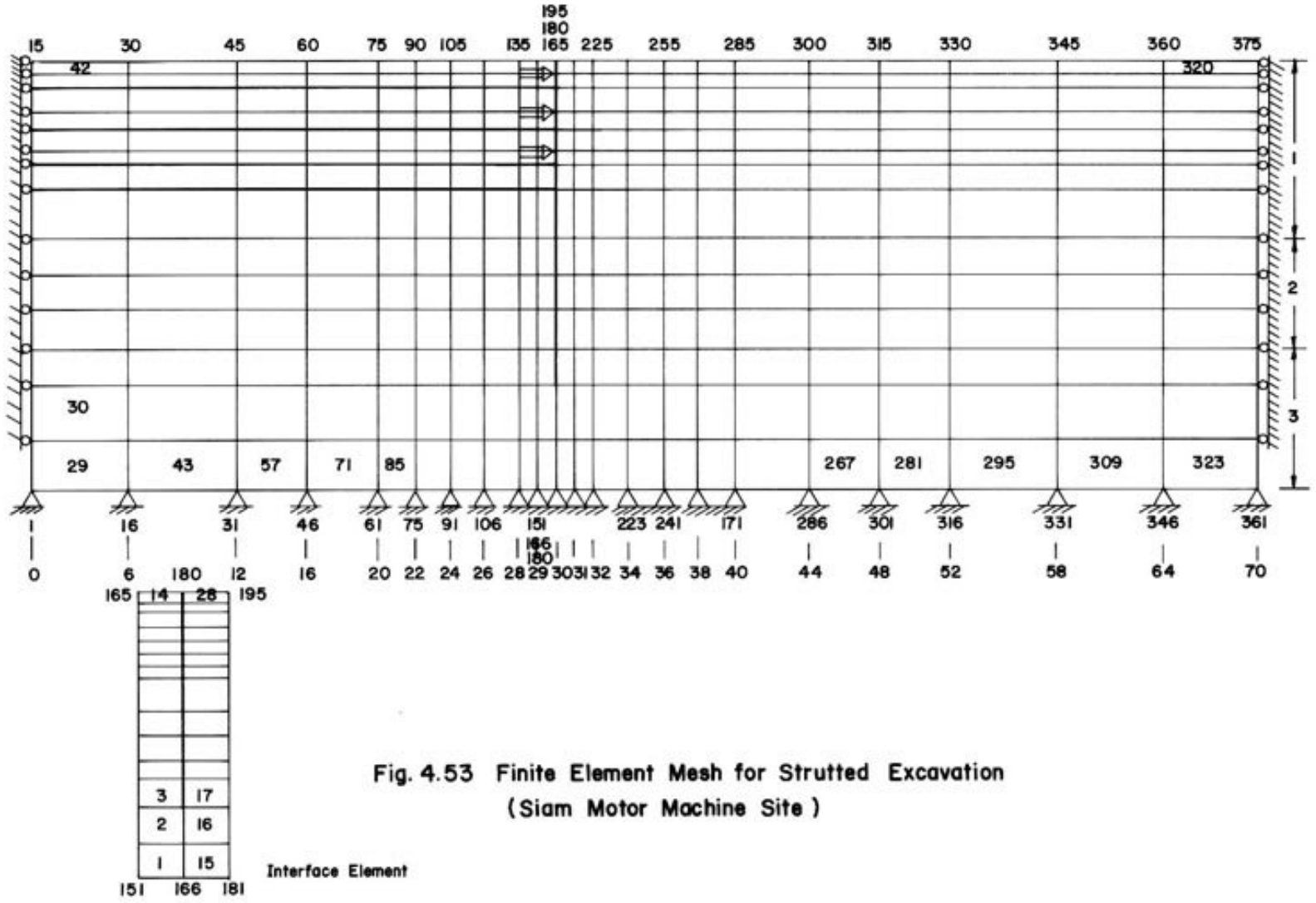


Fig. 4.53 Finite Element Mesh for Strutted Excavation
(Siam Motor Machine Site)

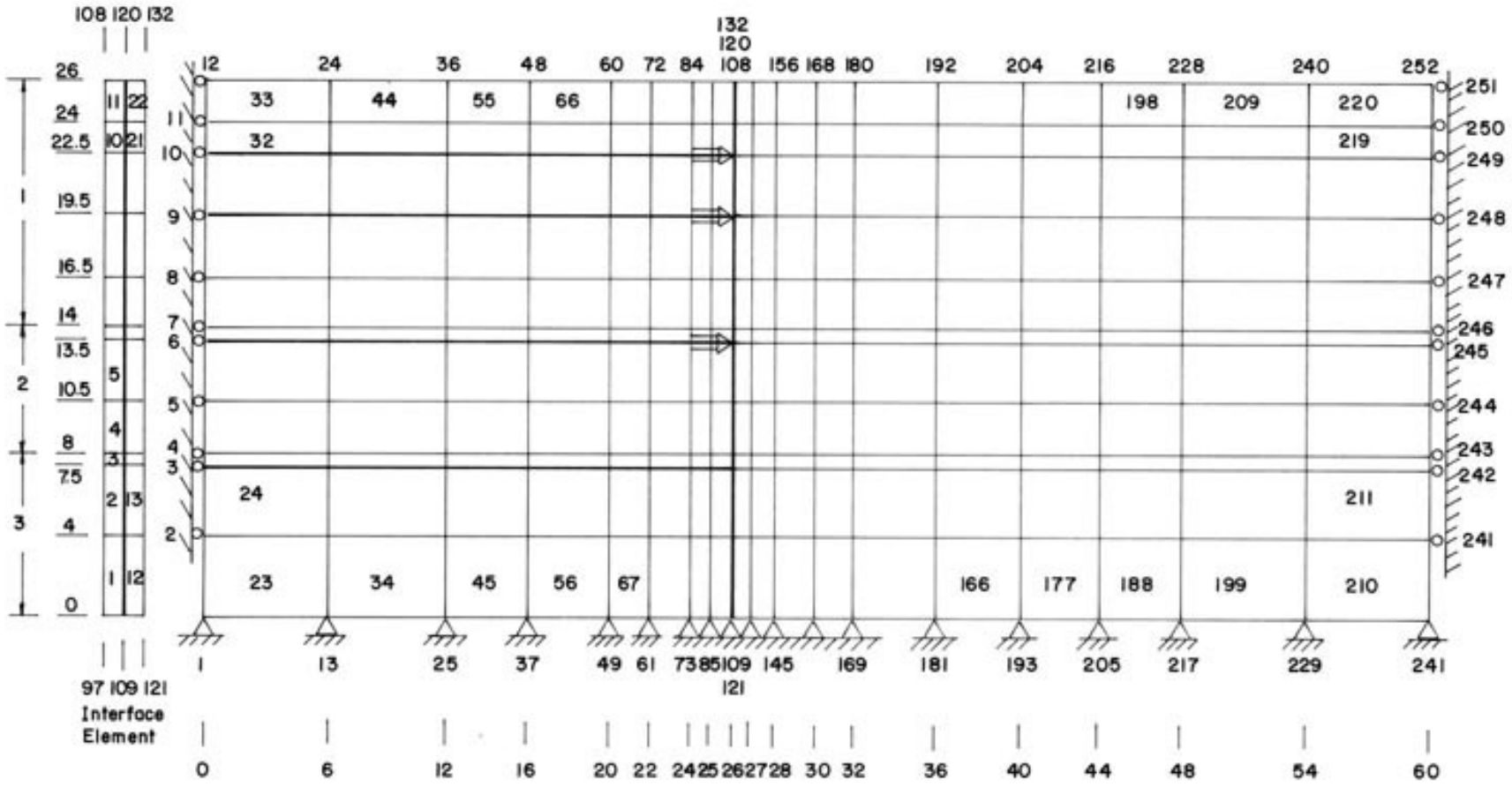
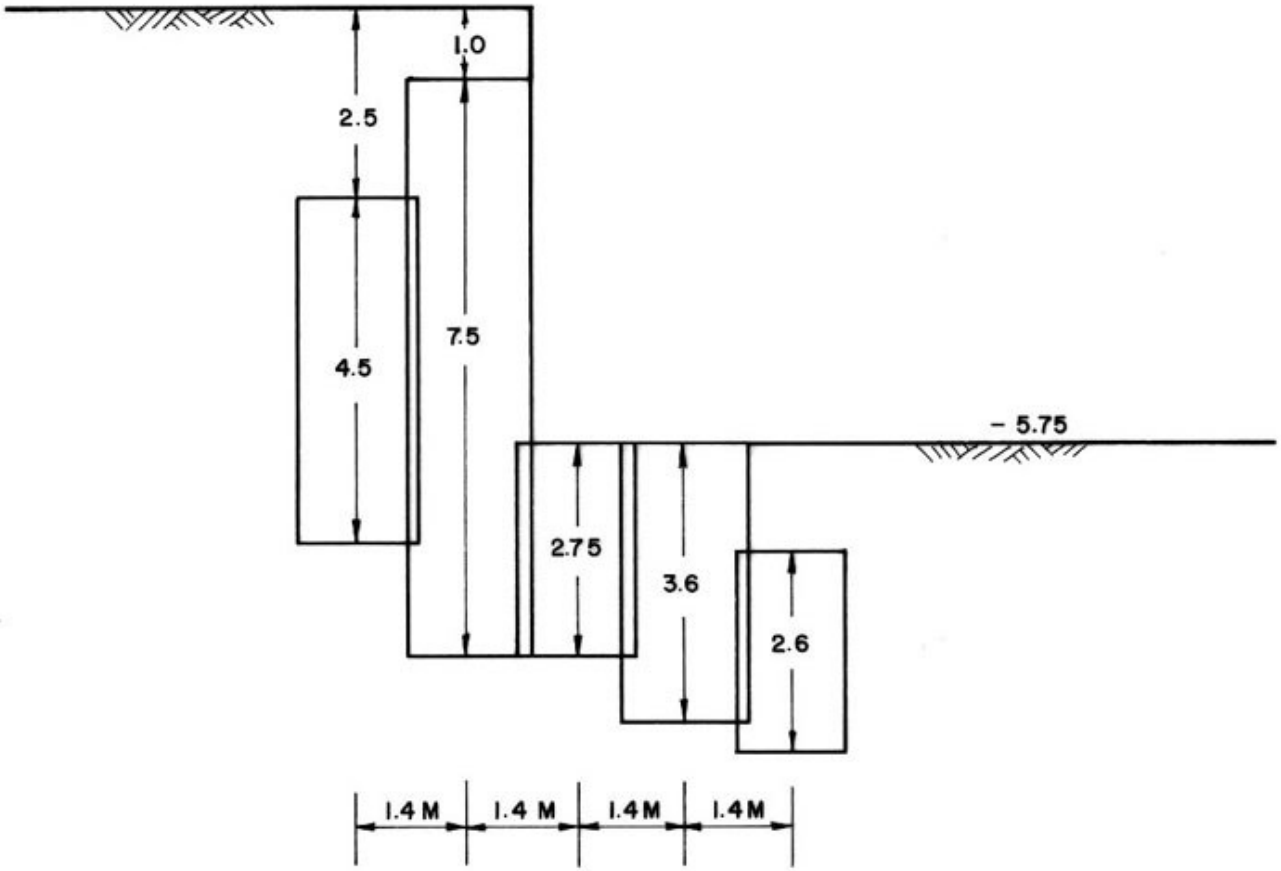


Fig. 4.55 Finite Element Mesh for Diaphragm Wall Excavation
(International Trade Center)

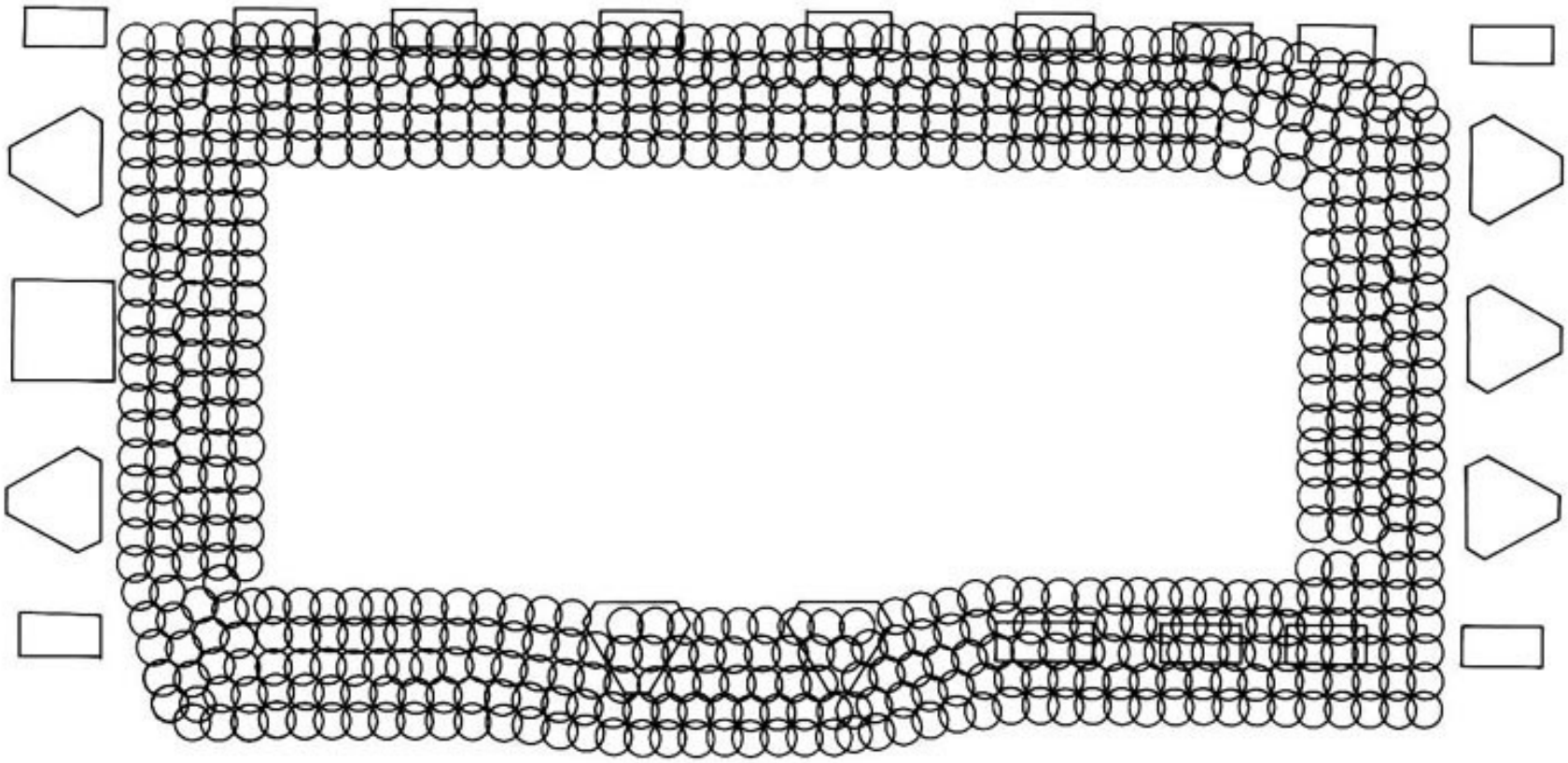


Cross Section of Jet Grouted Piled Excavation

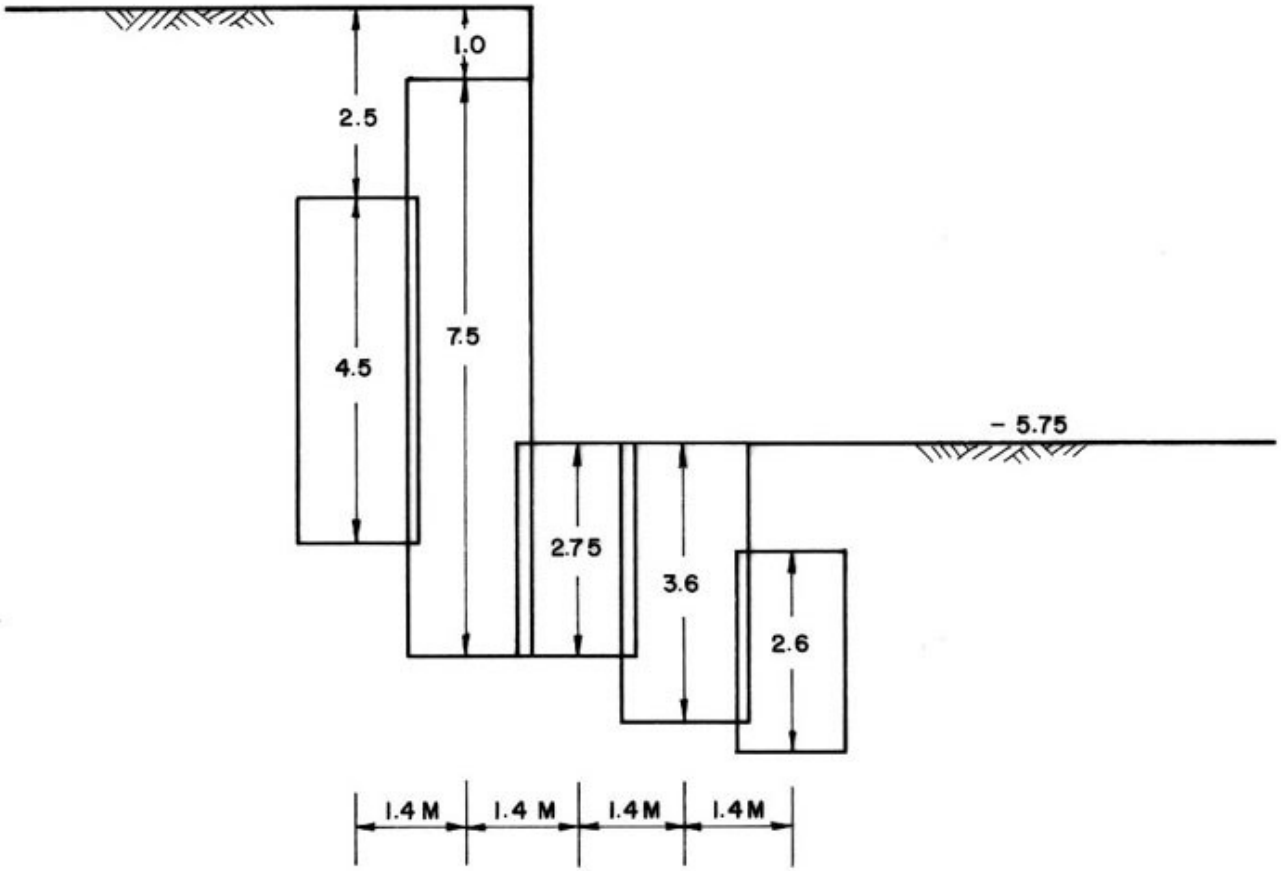
Scale 1: 100

(S & M Tower and Le Raffine' 24)

Dimensions in m



S & M Tower
(Plan View)
Jet Grouted Piles



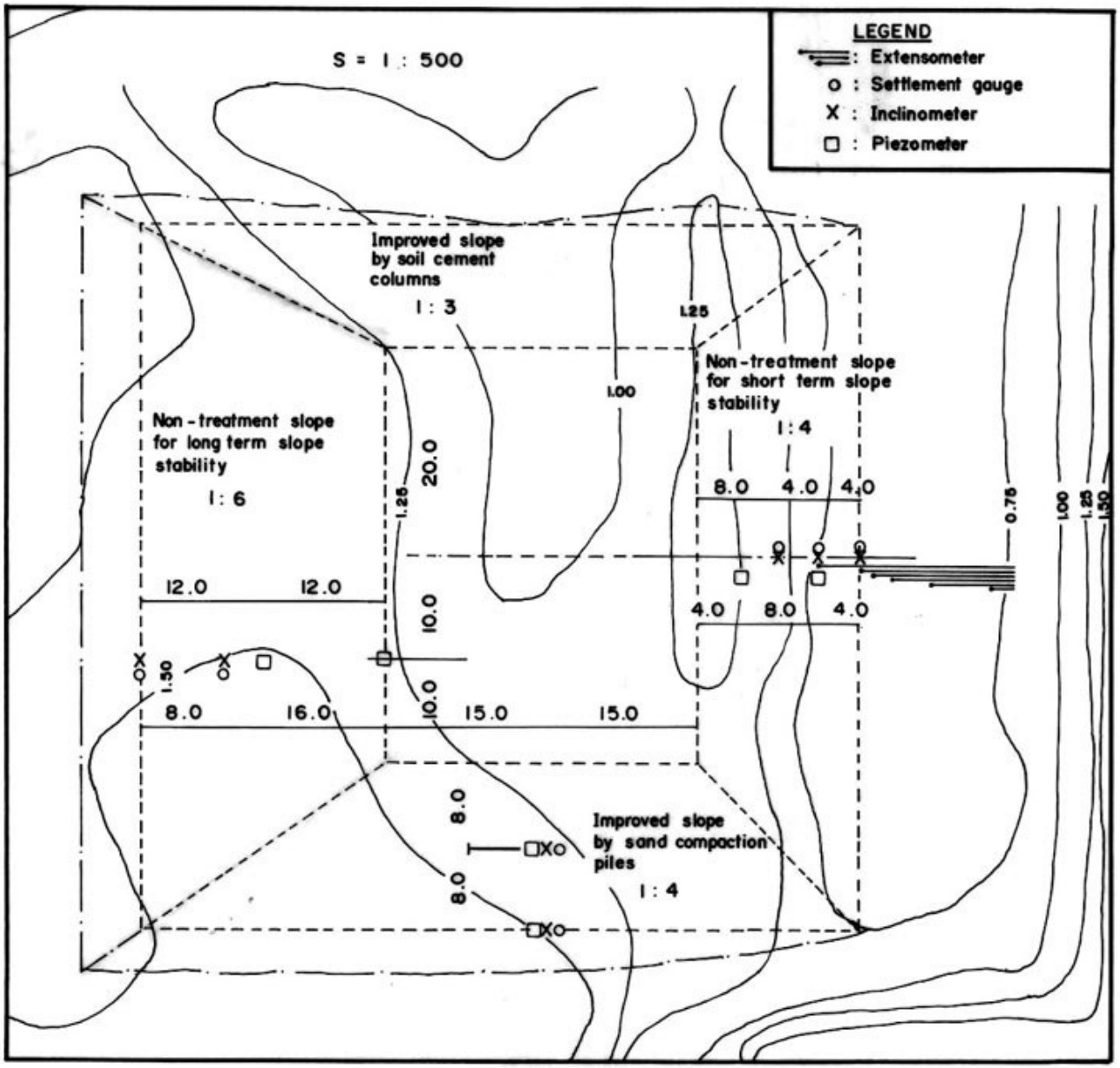
Cross Section of Jet Grouted Piled Excavation

Scale 1: 100

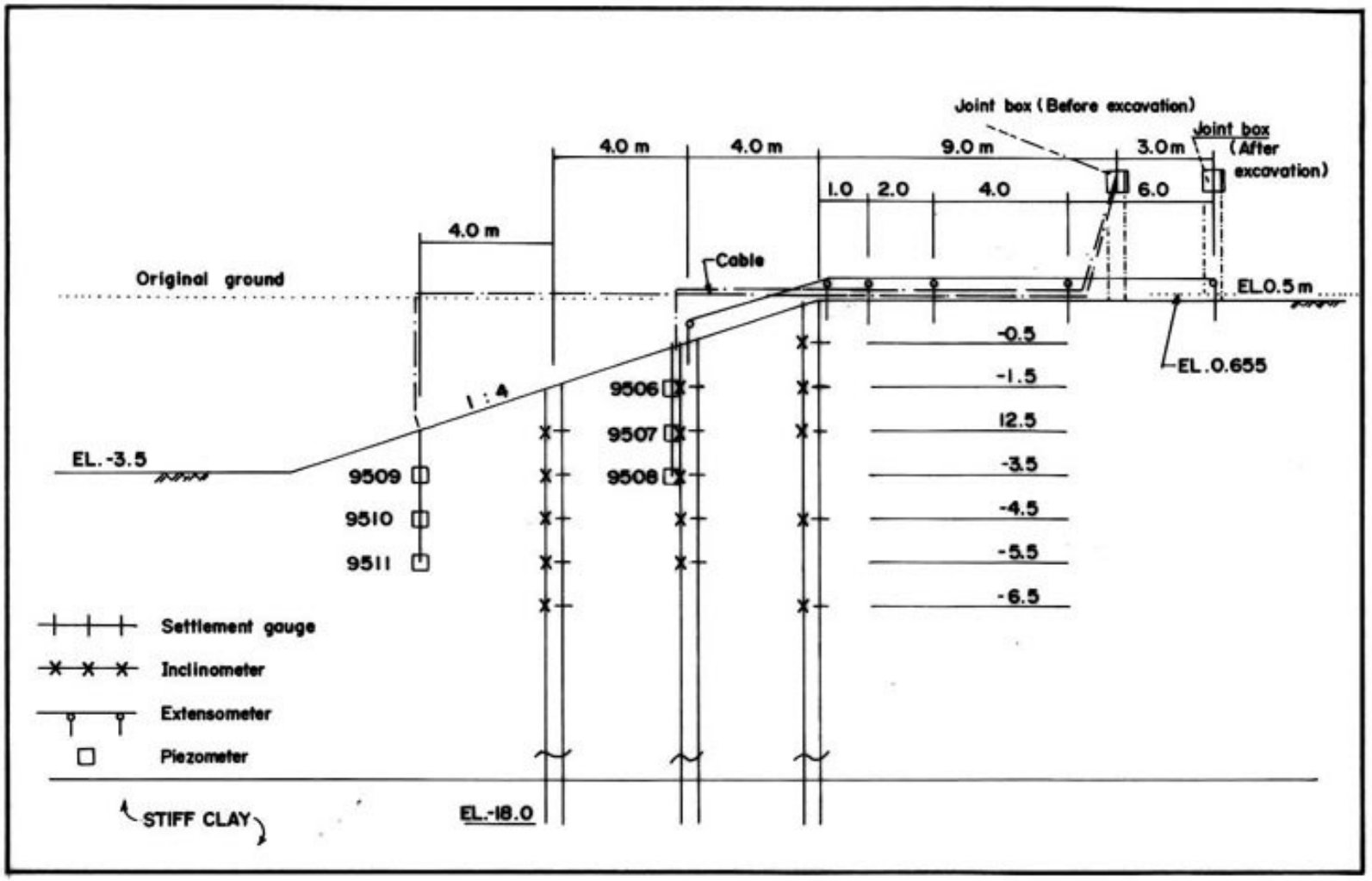
(S & M Tower and Le Raffine' 24)

Dimensions in m

Ground improvement works in Deep excavations with soft clays

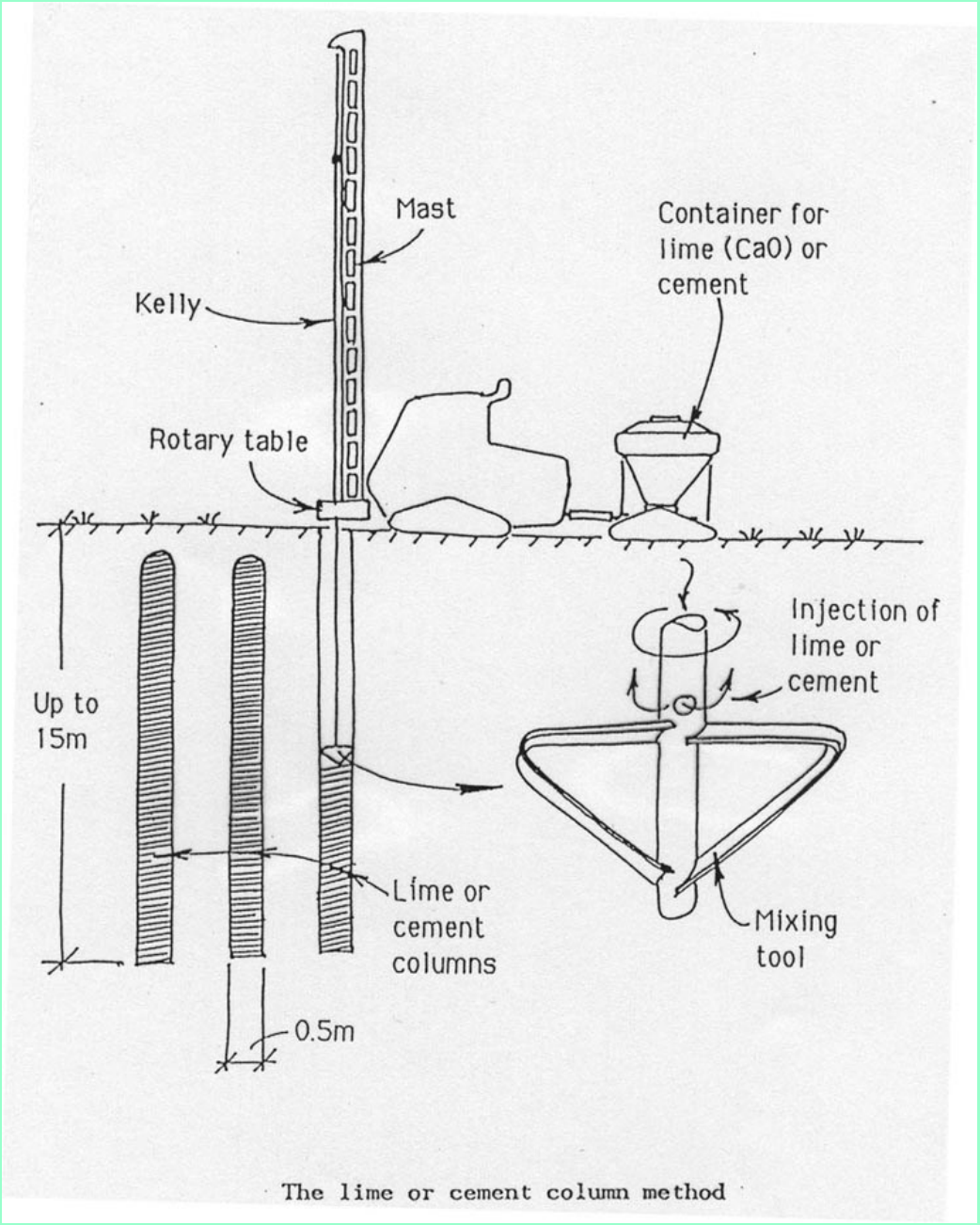


GENERAL PLAN OF MONITORING SYSTEM BY EQUIPMENT



NON-TREATMENT SLOPE FOR SHORT TERH SLOPE STABILITY

(SLOPE GRADIENT = 1 : 4)



The lime or cement column method

Concluding remarks

1. Effective stress analysis be performed for the stability of open excavations in soft clays.

2 Bjerrum's simplified approach is adequate for the basal stability of supported excavations.

3 Lateral pressure distributions in sheet piled walls depend on their flexibilty and deformation pattern.

4 Deformation based design of retaining structures demand sophisticated numerical analysis and appropriate geotechnical parameters.

5. Instrumentation and proper monitoring of stresses and movements can enhance the observational approach in design and construction.