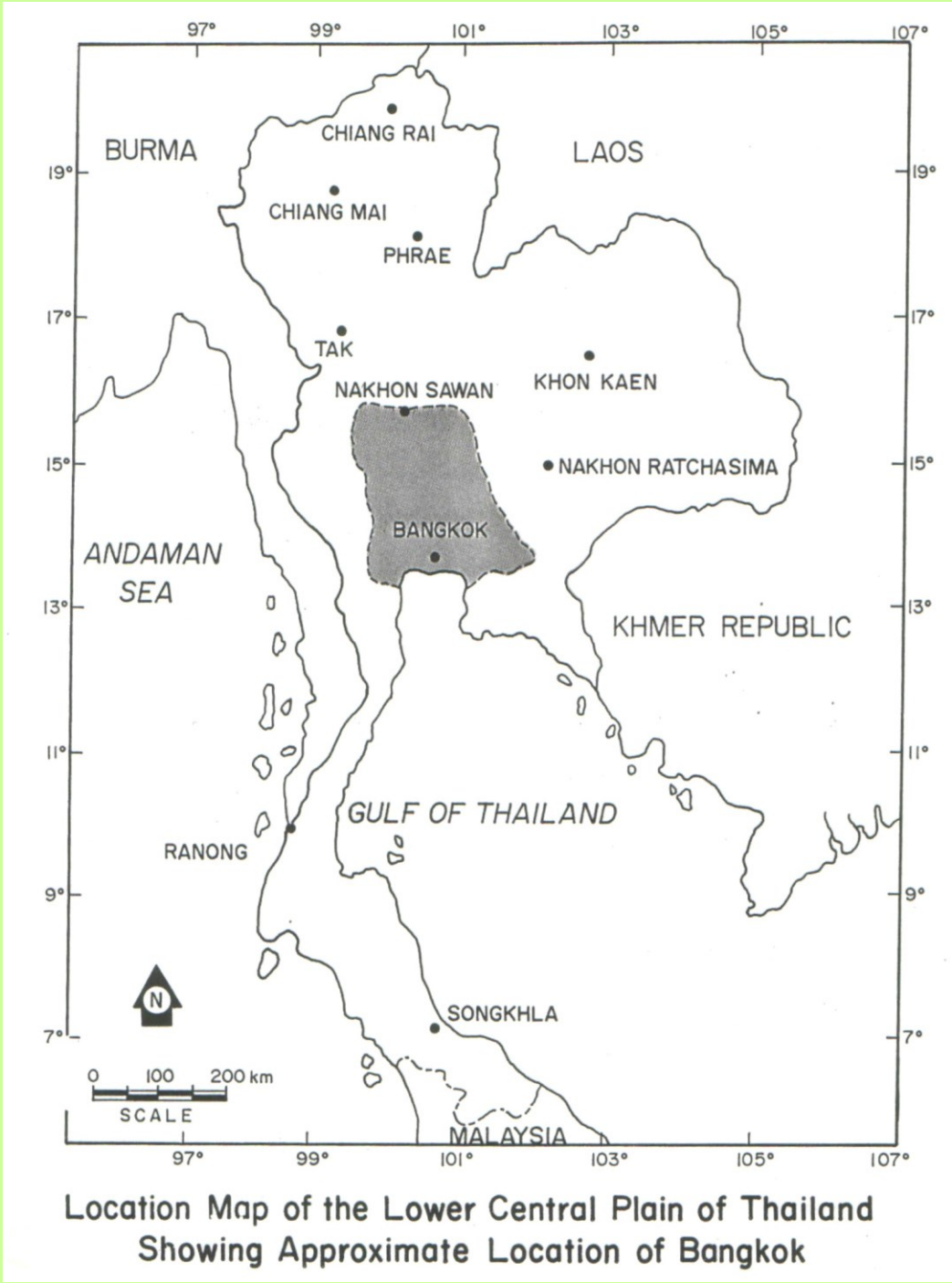
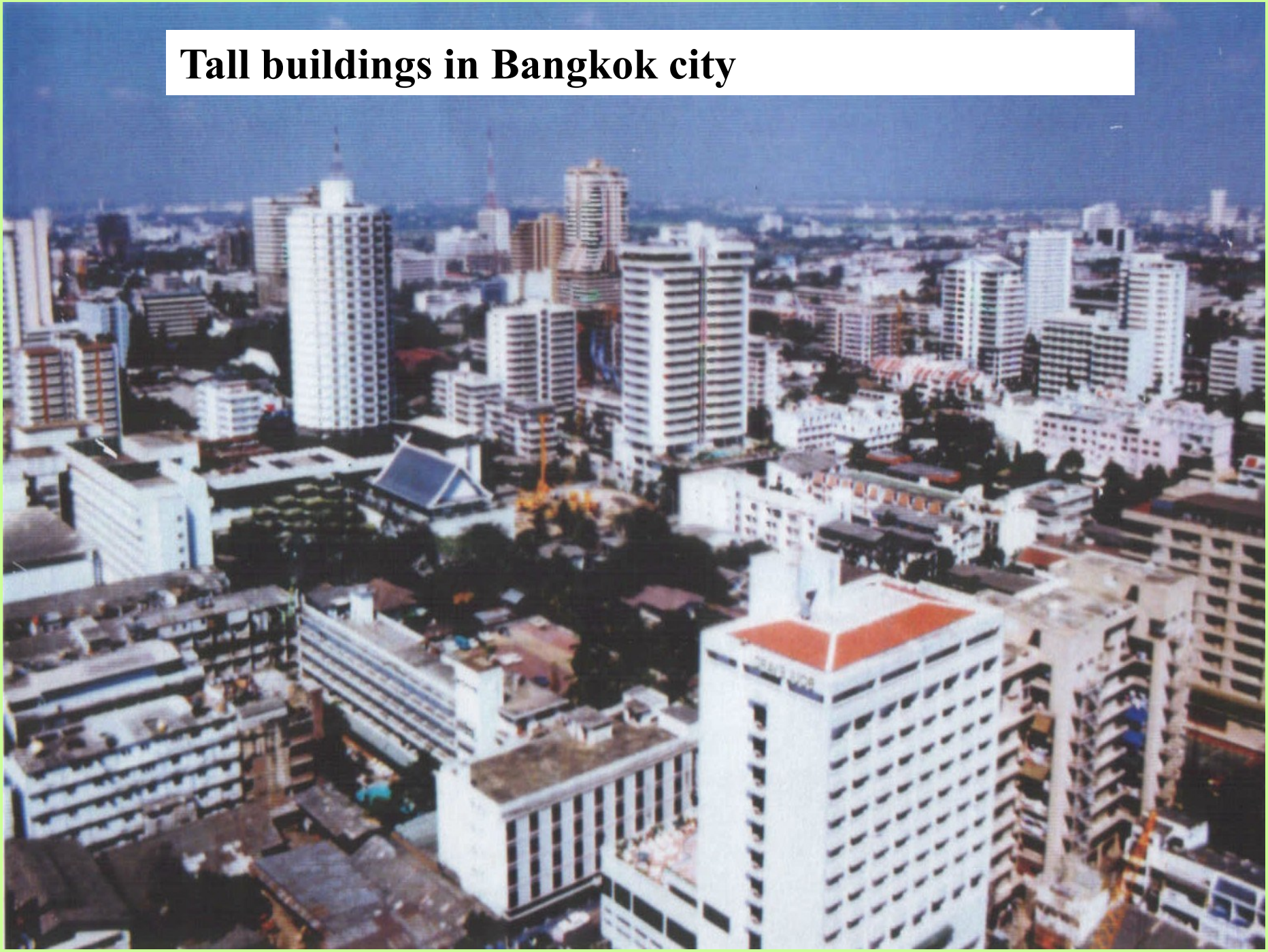
Monday-4

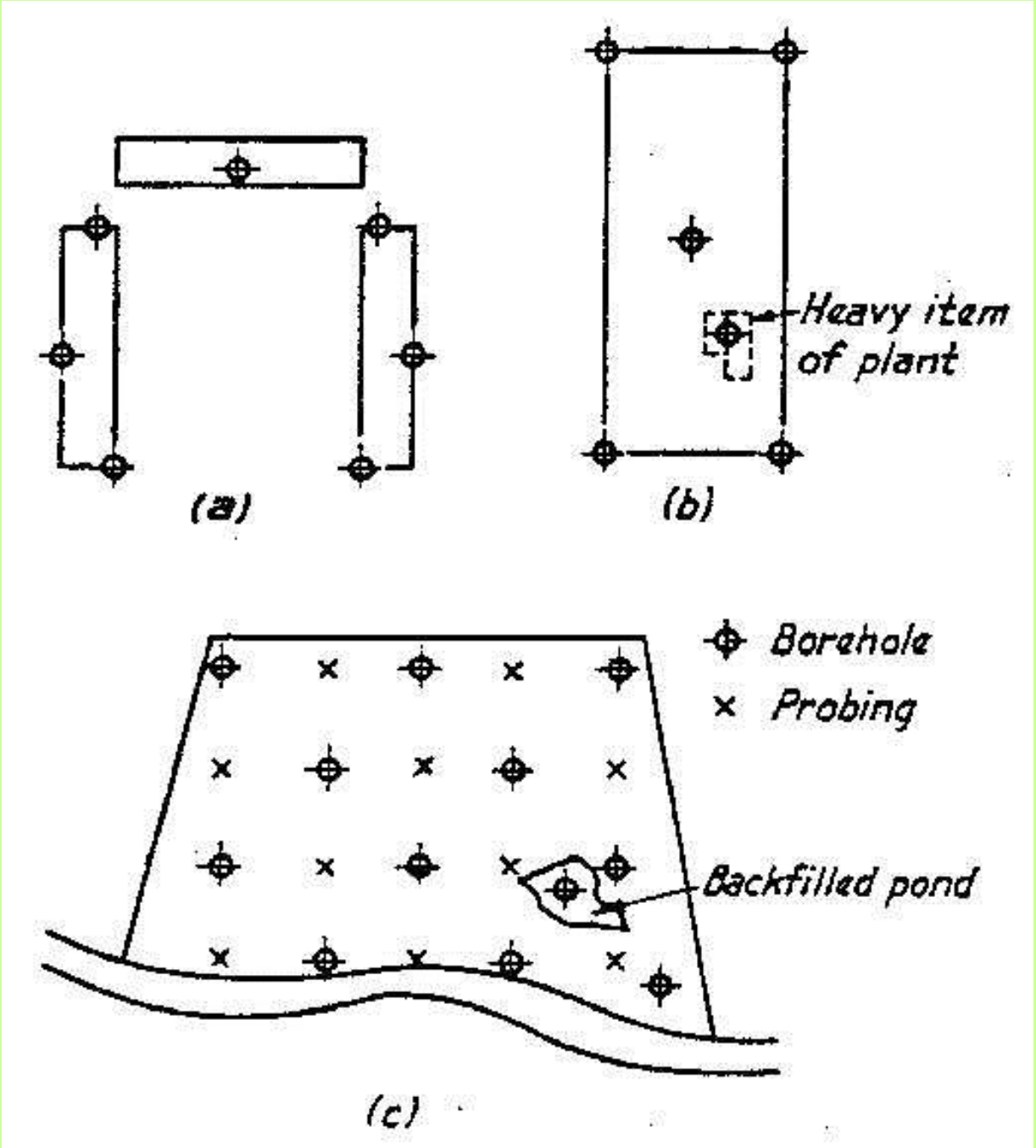
Site Investigation Practice-Case studies



Location Map of the Lower Central Plain of Thailand
Showing Approximate Location of Bangkok

Tall buildings in Bangkok city





Borehole numbers

Borehole layout and in-situ tests

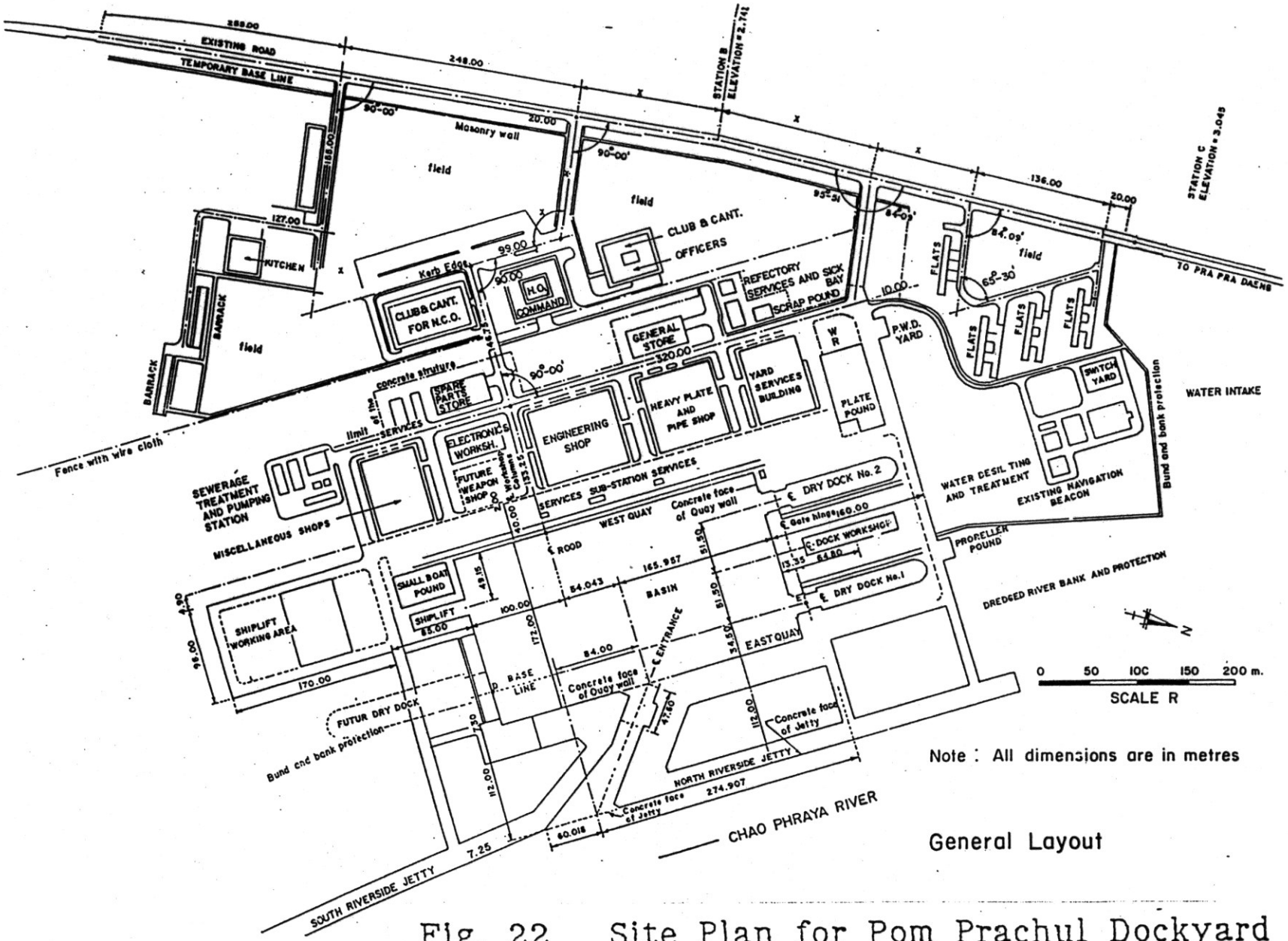
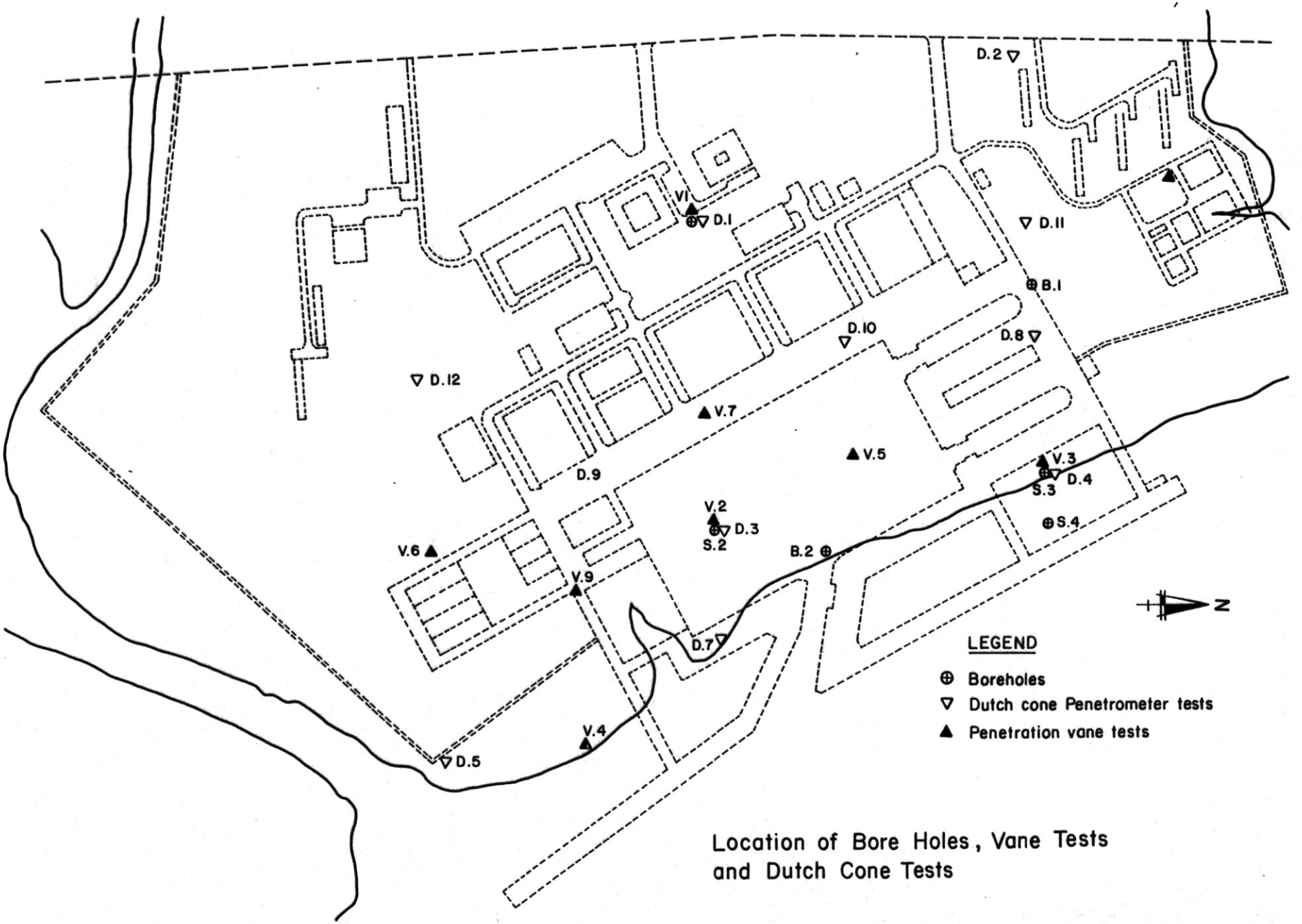


Fig. 22 Site Plan for Pom Prachul Dockyard



Location of Bore Holes, Vane Tests and Dutch Cone Tests

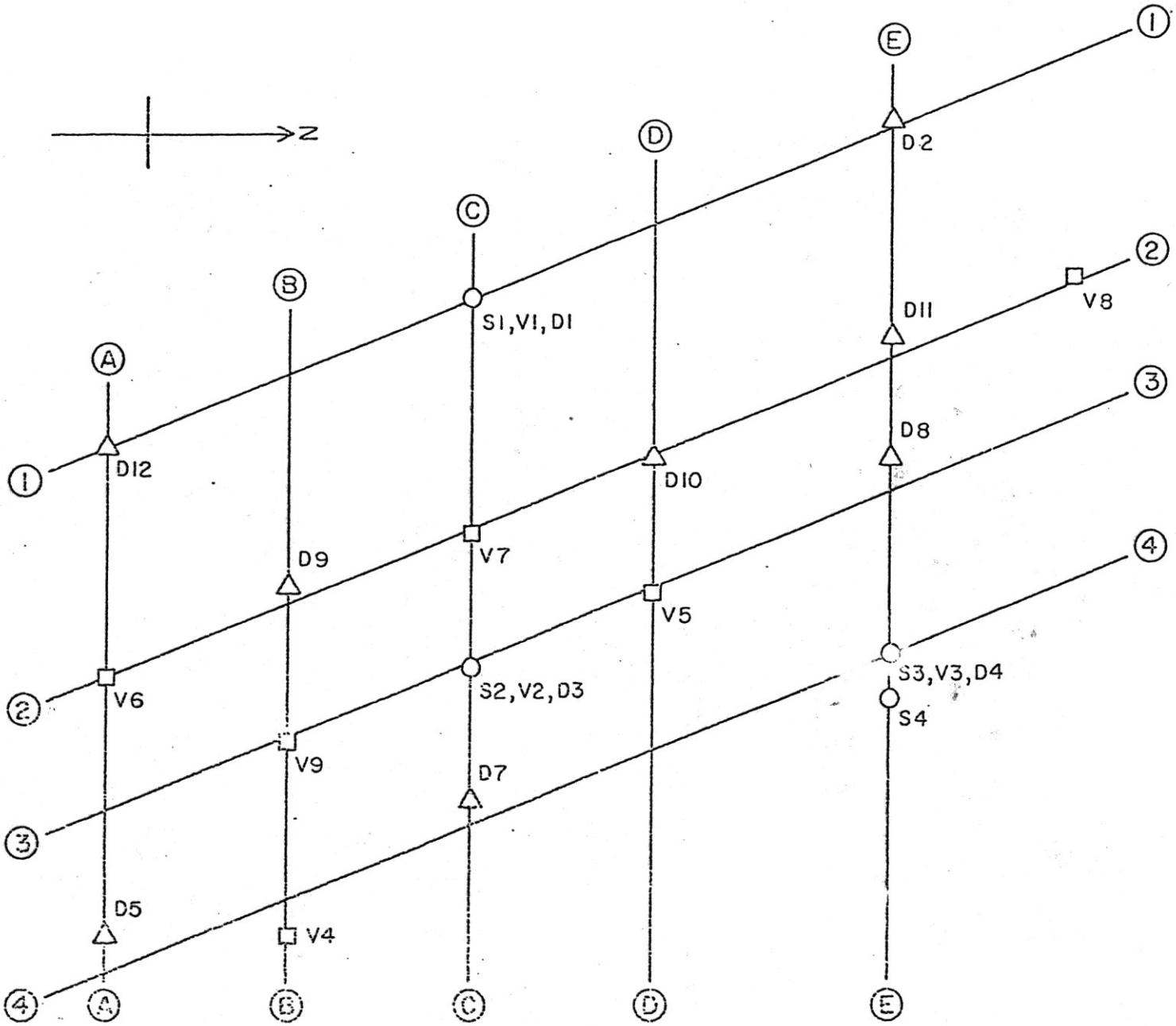
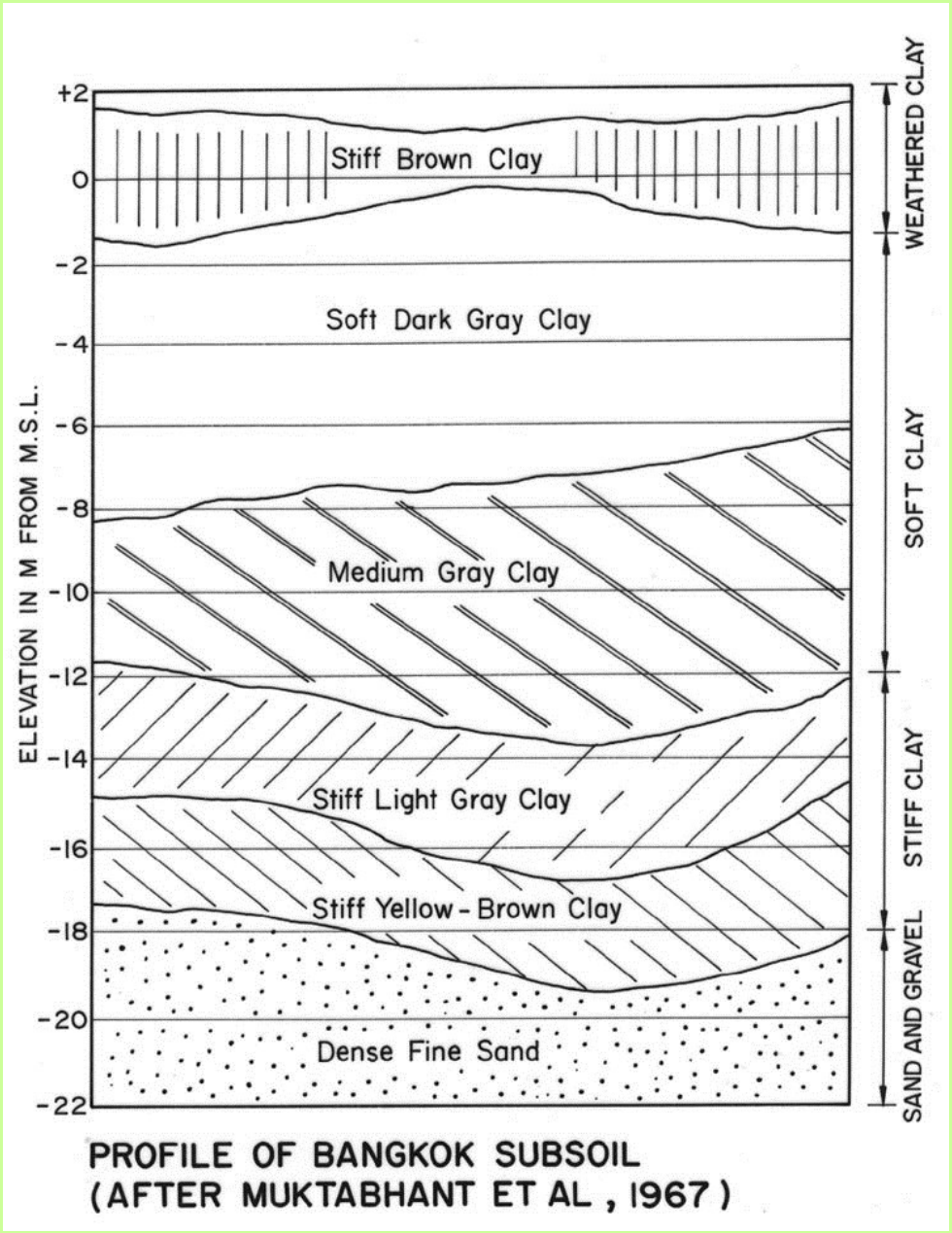


Fig. 5 Locations of Bore Holes, Vane and Dutch Cone Tests



PROFILE OF BANGKOK SUBSOIL
(AFTER MUKTABHANT ET AL , 1967)

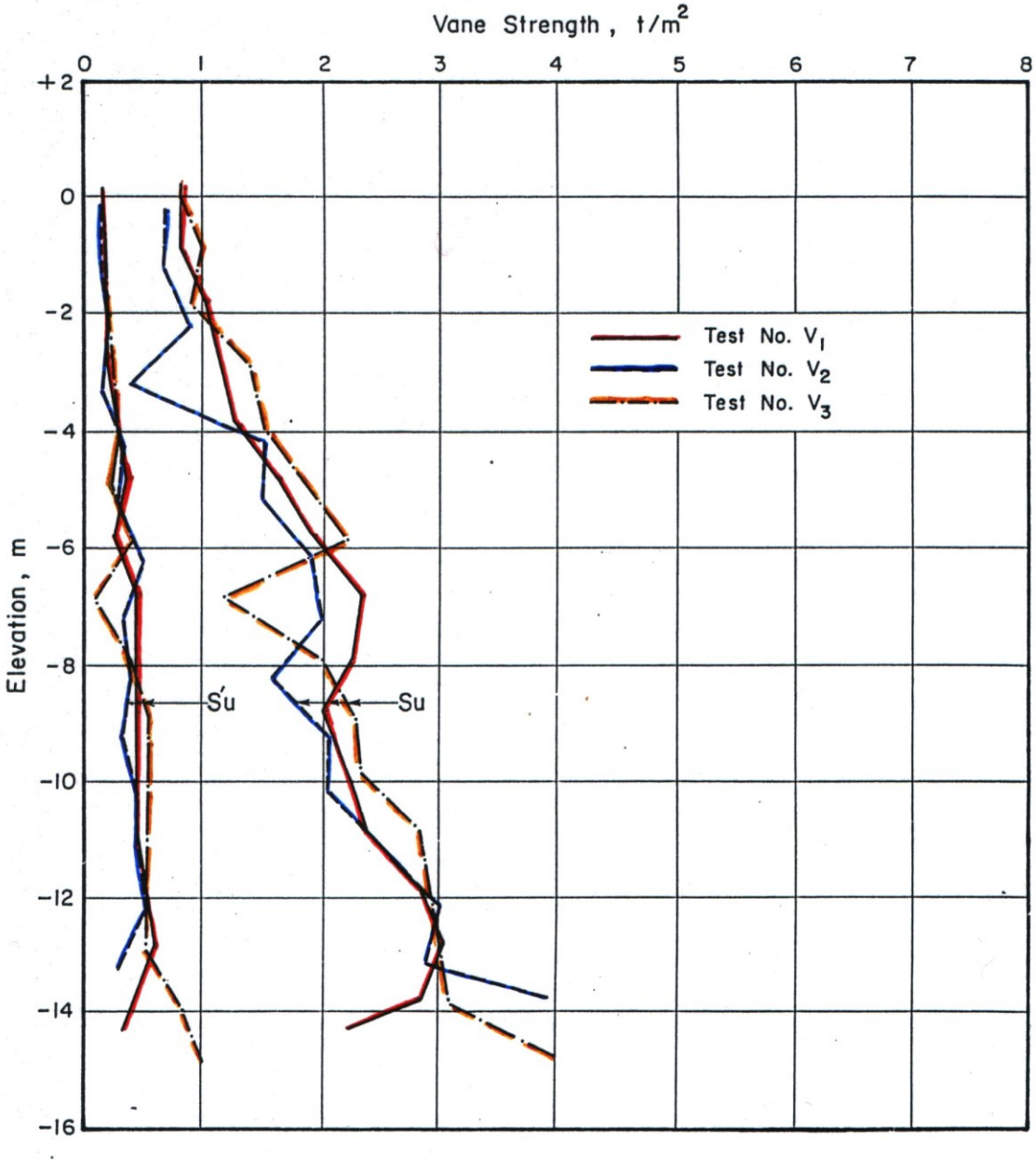
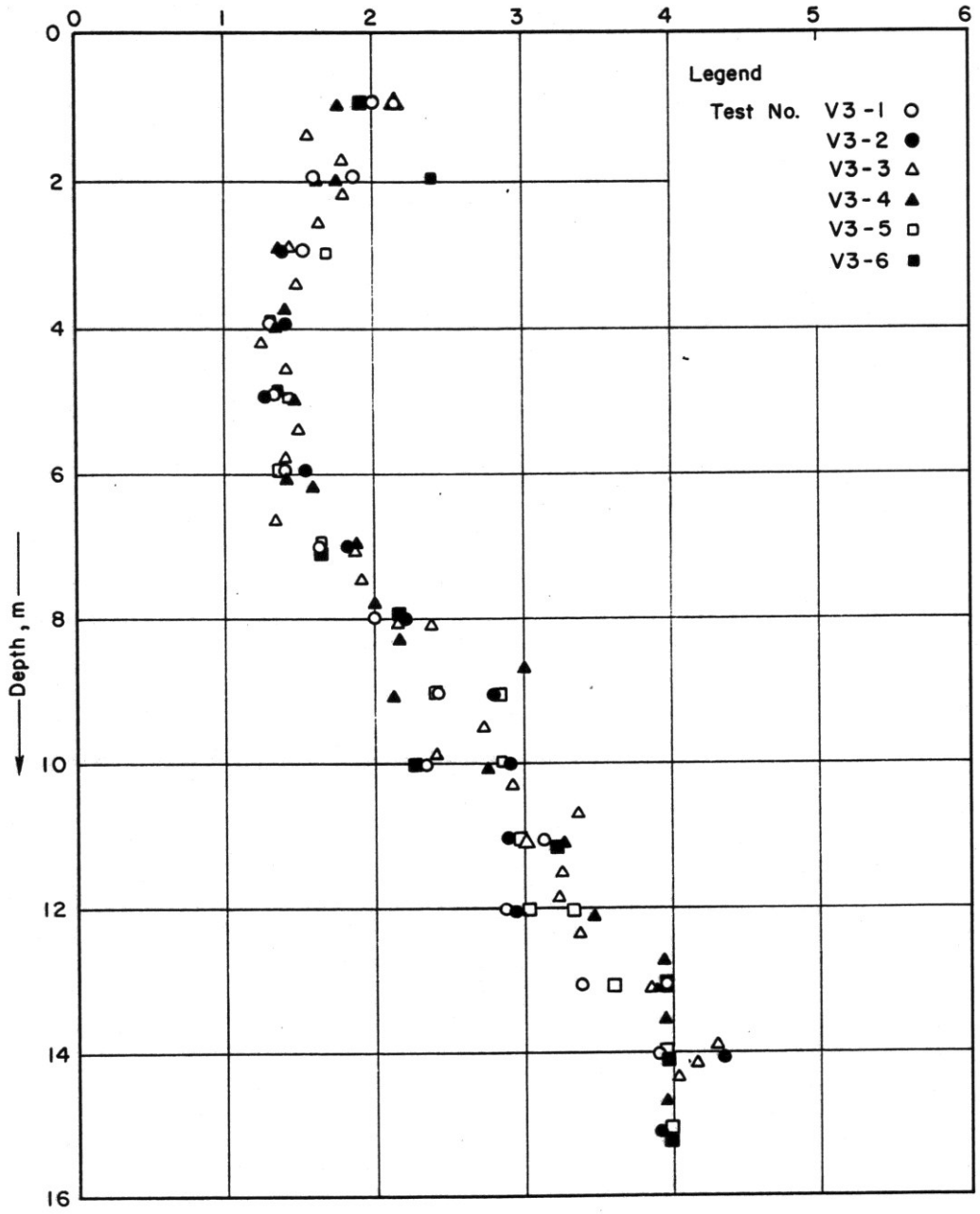


Fig. 7 Vane Strength Profile (Pom Prachul)


0
1
2
3
4
5
6
0
2
4
6
8
10
12
14
16
Depth, m
Legend
Test No. V3-1
V3-2
V3-3
V3-4
V3-5
V3-6
Vane Shear Strength, tons/m² (After AIT 1973 a & b)

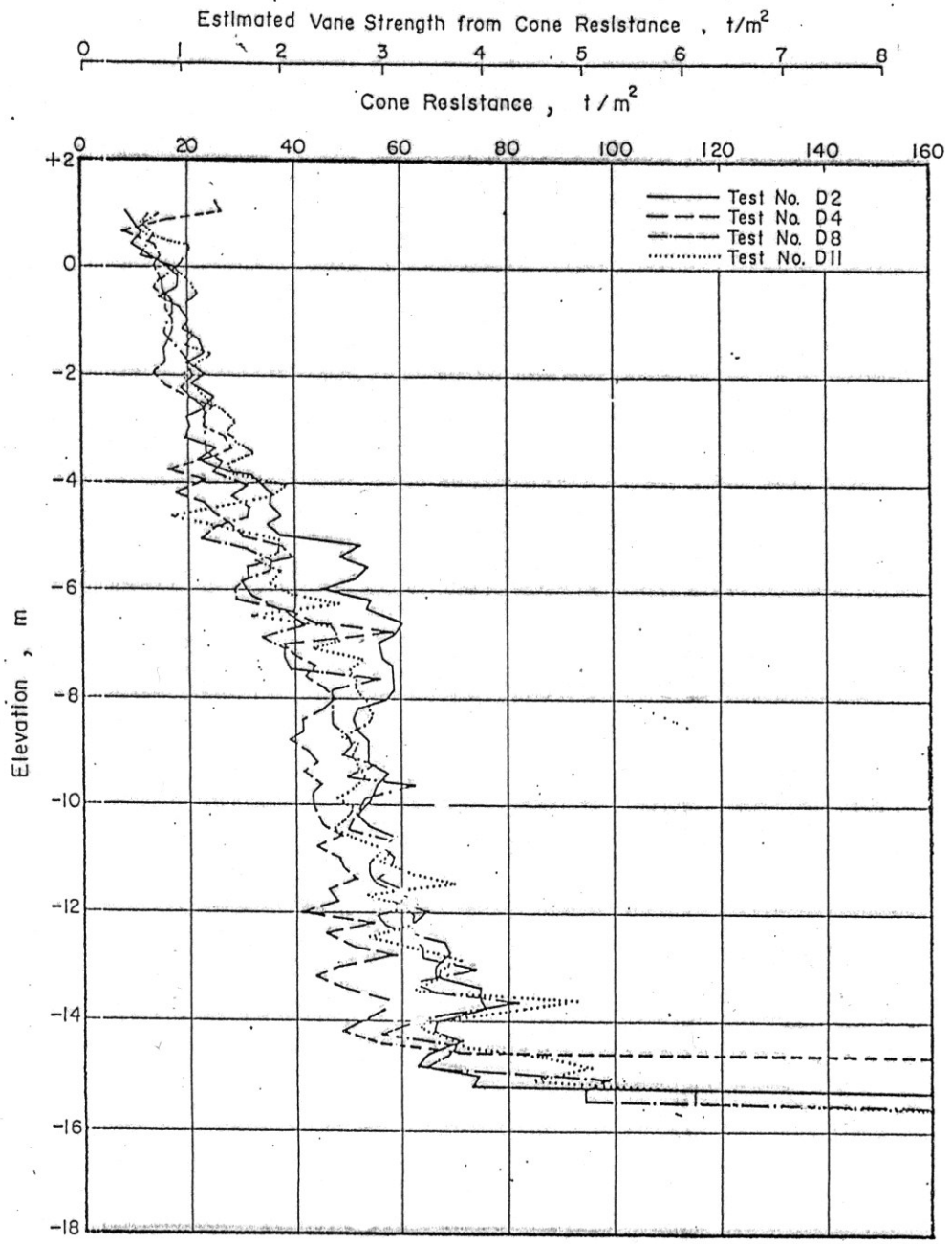


Fig. 50 Grid Line Ⓔ-Ⓔ

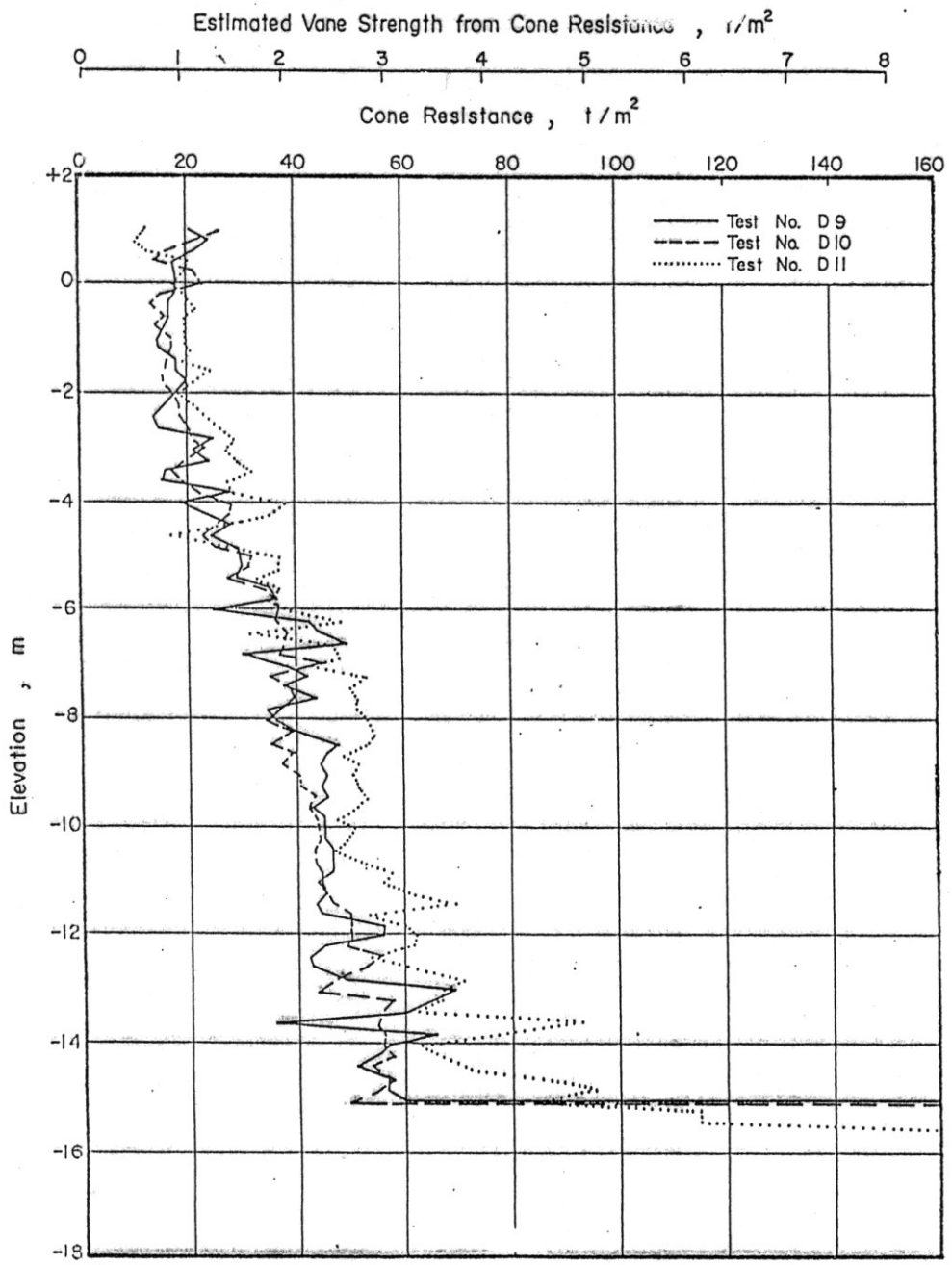


Fig. 40 Grid Line ②-②

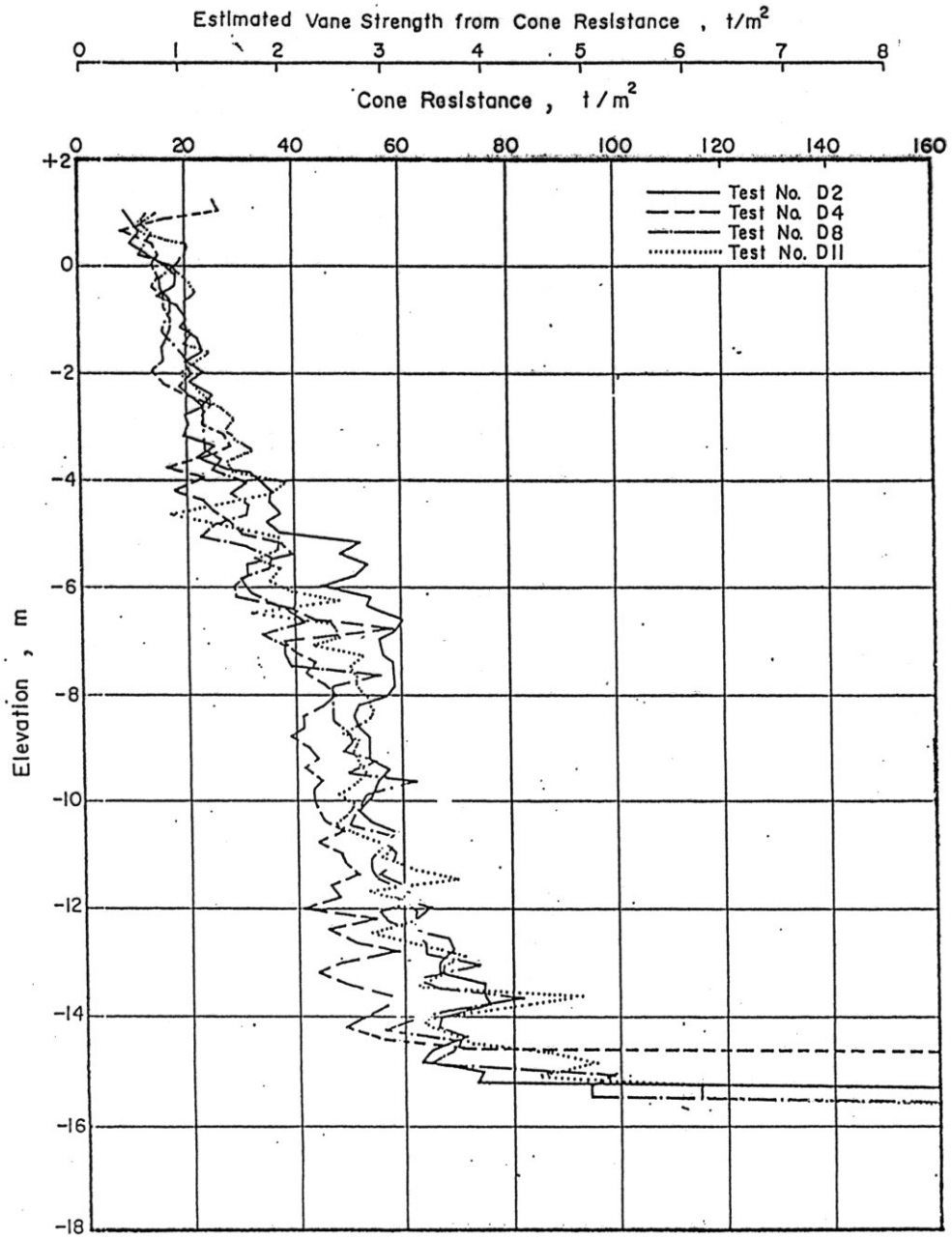


Fig. 50 Grid Line Ⓔ-Ⓔ

ASIAN INSTITUTE OF TECHNOLOGY

LOG BORING NO. 54

PROJECT : RTN Dockyard — DATE COMMENCED Dec. 11, 1974

LOCATION : Pom Prachul — DATE FINISHED Dec. 13, 1974

PA = POWER AUGER
DH = DRIVE HAMMER
WO = WASHING
FT = FISH TAIL

ST = SHELBY TUBE
D = DISTURBED SAMPLE
U_D = UNDISTURBED SAMPLE
SS = SPLIT SPOON

● Standard Penetration ▲
○ △

N, Blows/ft: 10 20 30 40 50

SOIL DESCRIPTION	ELEVATION M
	+5
	0
Dark grey, very soft CLAY with some shell (5.5 – 7.5 m)	-3.05
Olive grey, soft CLAY with some shell	-5
	-10
Olive / brown, stiff to very stiff CLAY with trace of gravel (17.5 m)	-15
Brown, hard CLAY to sandy CLAY	-20
Brown, medium to very dense, fine SAND	-25
	-30
Brown, hard CLAY with trace of gravel	
END OF BORE HOLE	-35

GRAPHIC LOG · SAMPLING METHOD · RECOVERY CM (D / U_D)

FT ST SS

155

Fig. 4

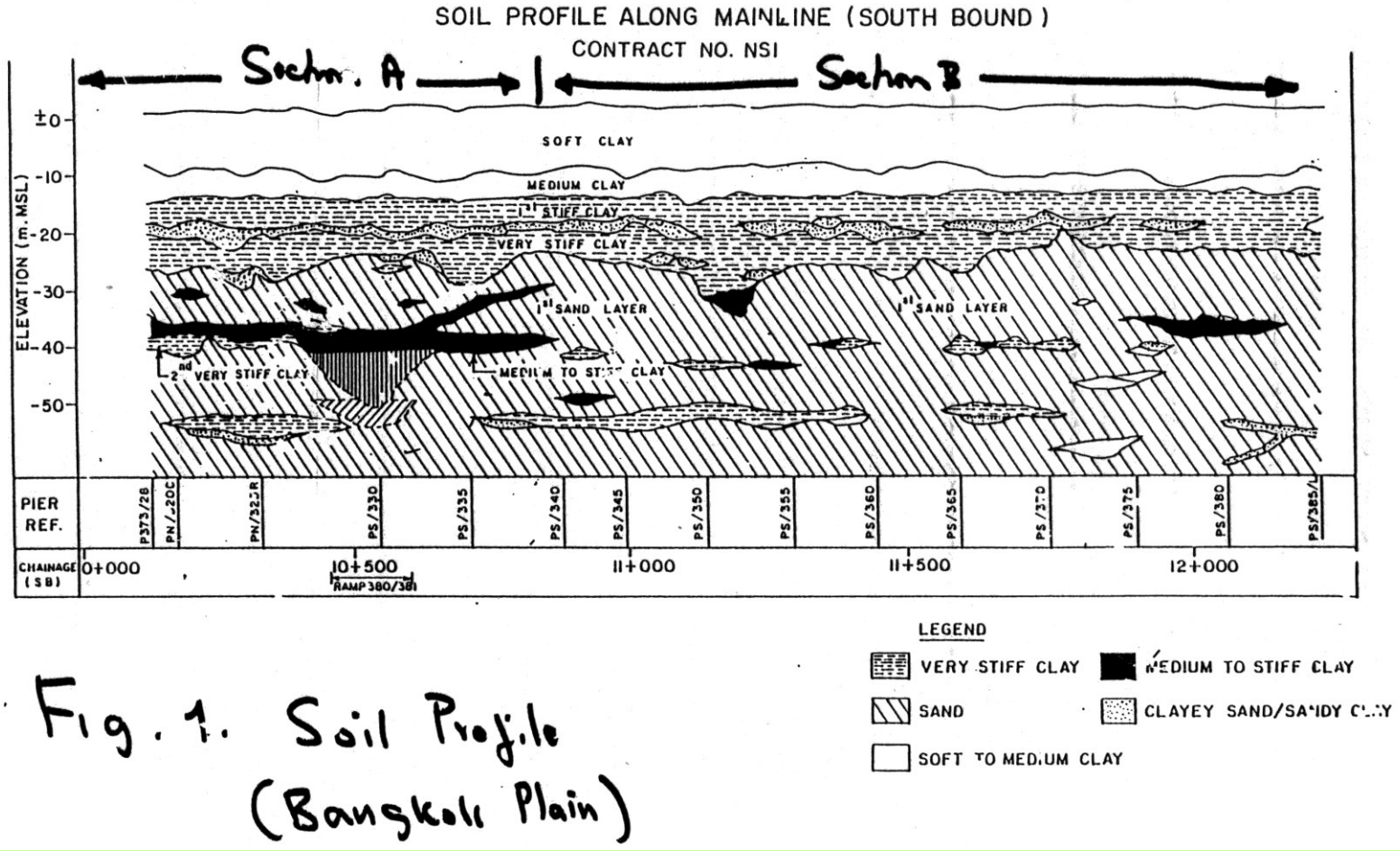
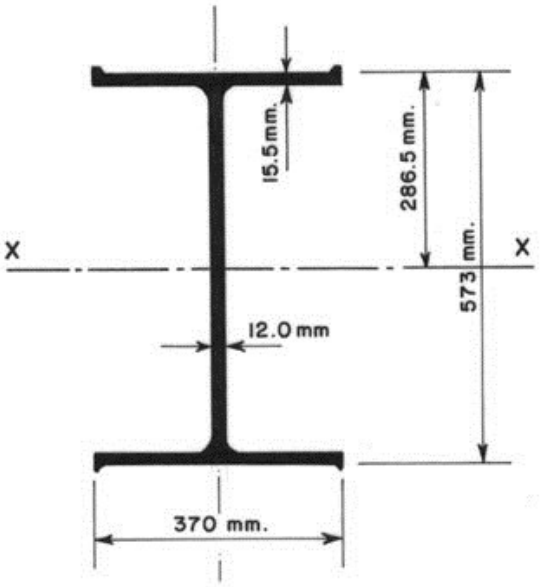
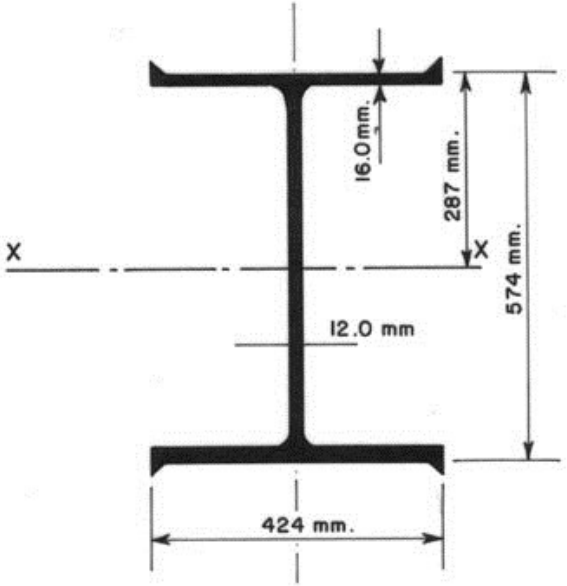


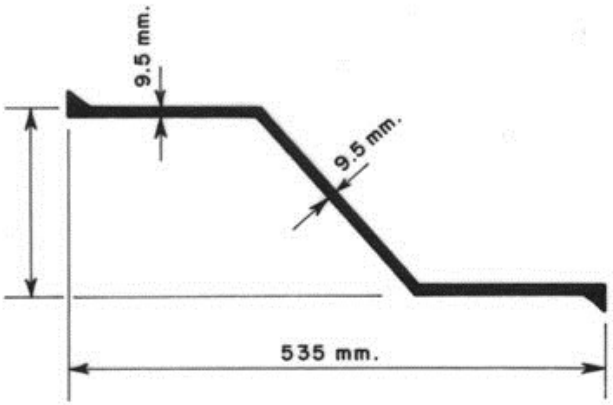
Fig. 1. Soil Profile (Bangkok Plain)



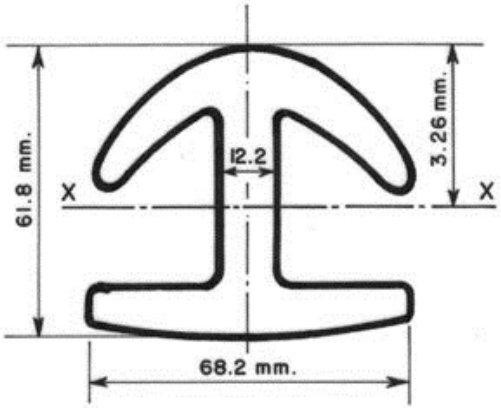
(a) King Pile HZ 600 A



(b) King Pile HZ 600 LS

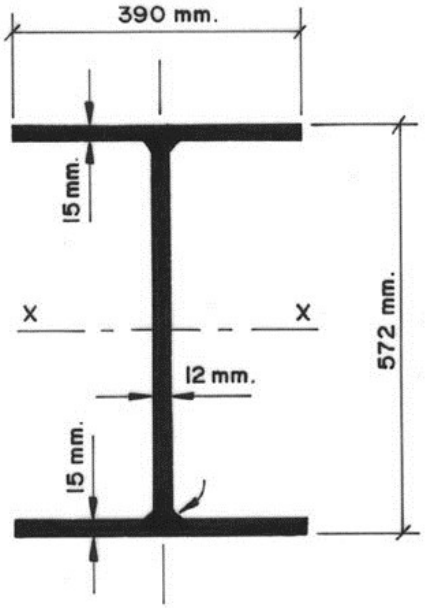


(c) Intermediary Sheet Pile BZ 9.5



(d) Interlocking Section RH 16

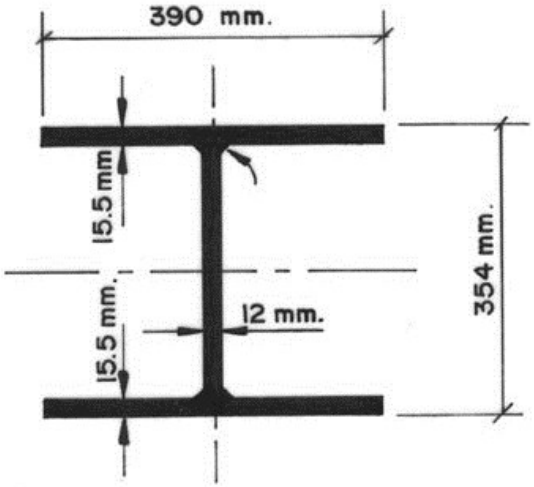
Sheet Pile Section



Sectional Area = 182 cm^2

Perimeter = 263.4 cm.

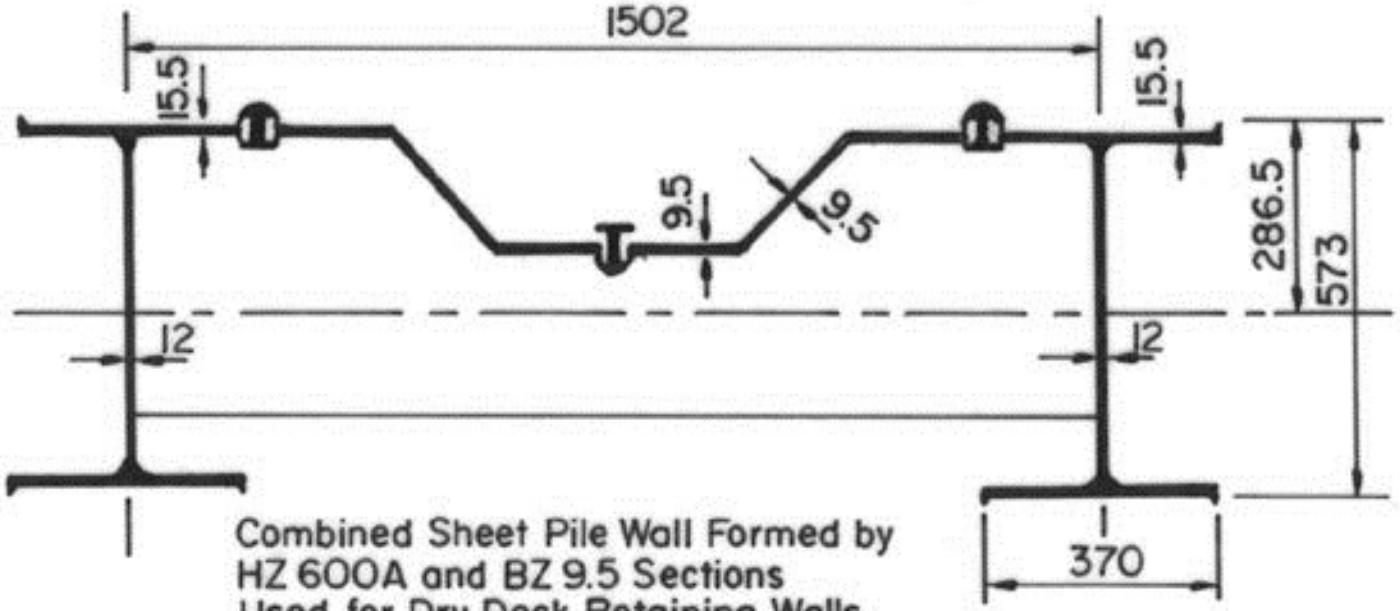
Fig. 3.3 Steel Pile HZ 600 SP



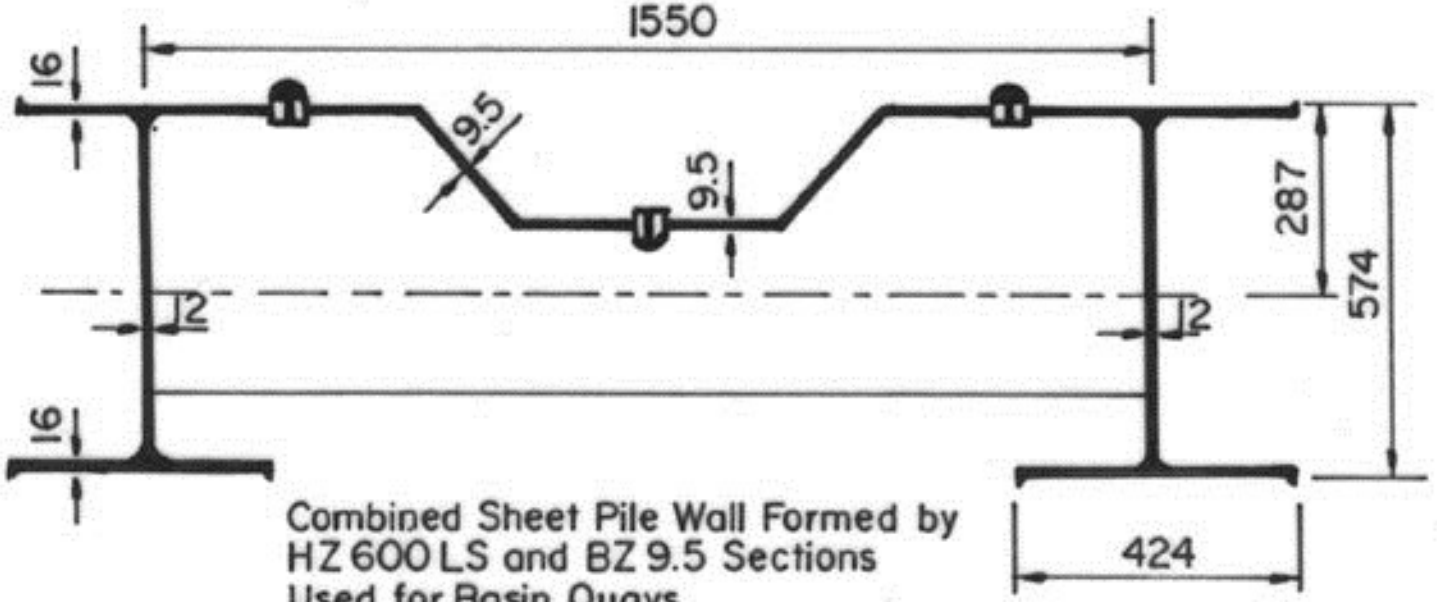
Sectional Area = 160 cm^2

Perimeter = 219.0 cm

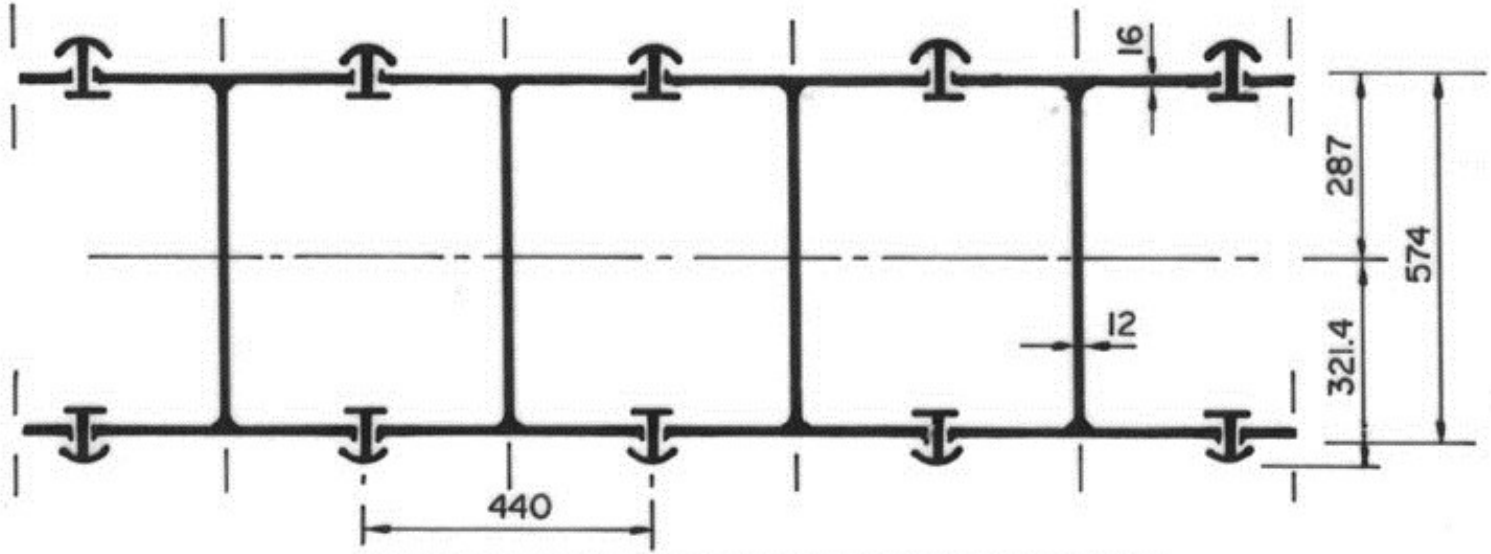
Fig. 3.4 Steel Pile HZ 360 SP



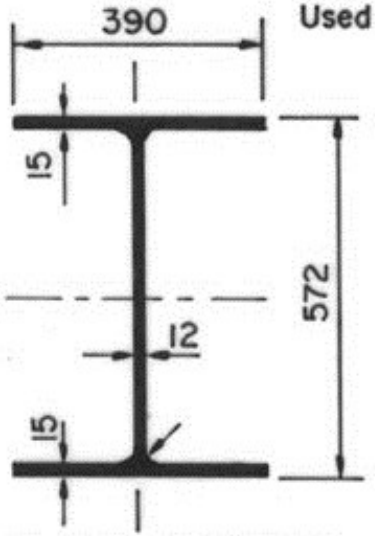
Combined Sheet Pile Wall Formed by
HZ 600A and BZ 9.5 Sections
Used for Dry Dock Retaining Walls
and on riverside of East Quay



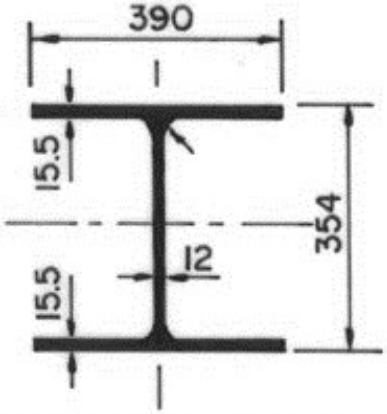
Combined Sheet Pile Wall Formed by
HZ 600 LS and BZ 9.5 Sections
Used for Basin Quays



Box Pile Wall Formed by Double HZ 600 LS Sections
Used for Basin Entrance



Steel Pile HZ 600 SP
Used to secure Basin Entrance
and Dry Dock floors



Steel Pile HZ 360 SP
Used as raking piles to Anchor Beams

Note : All dimensions in millimetres
All piles supplied by Arbed

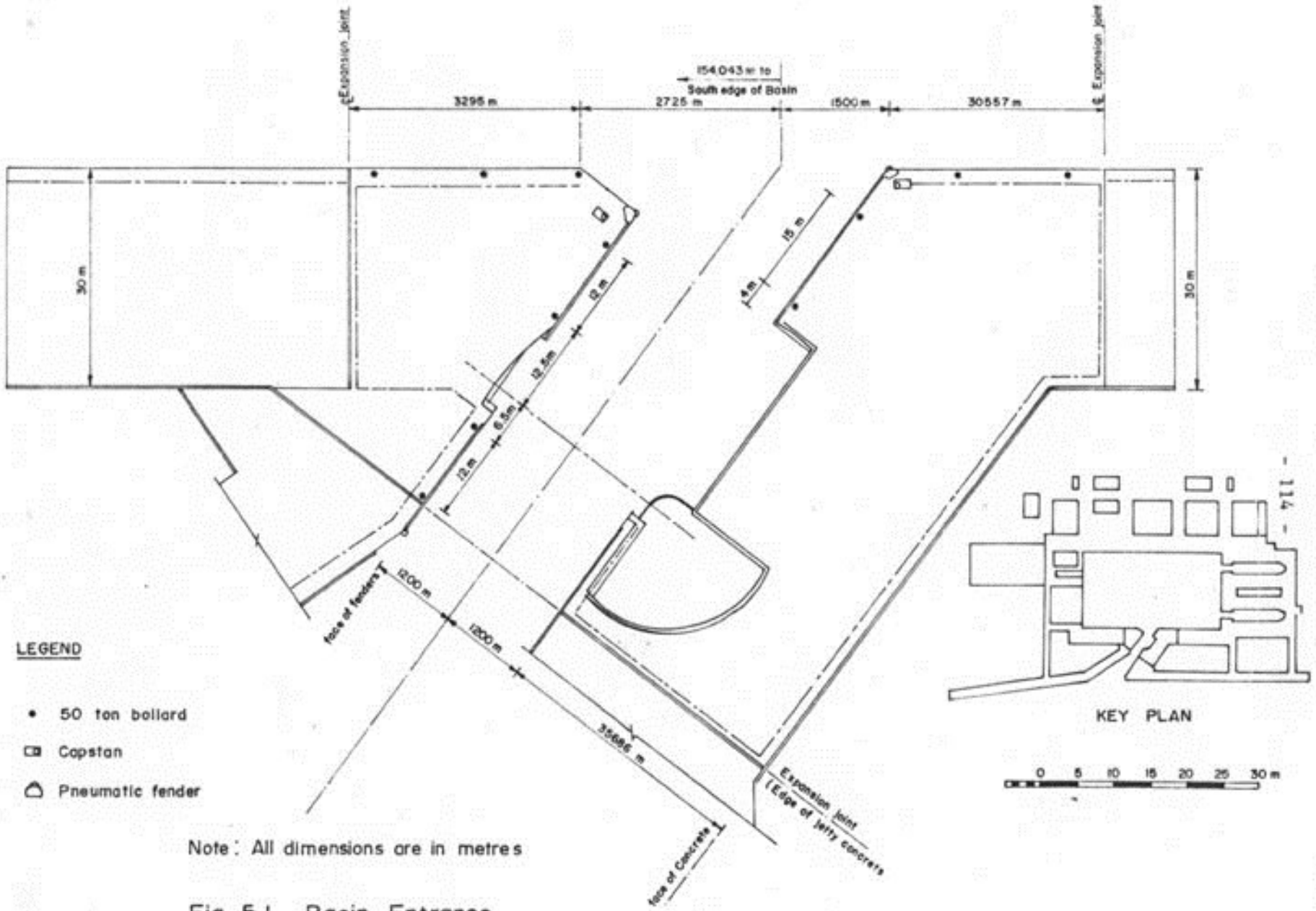


Fig. 5.1 Basin Entrance Layout Plan

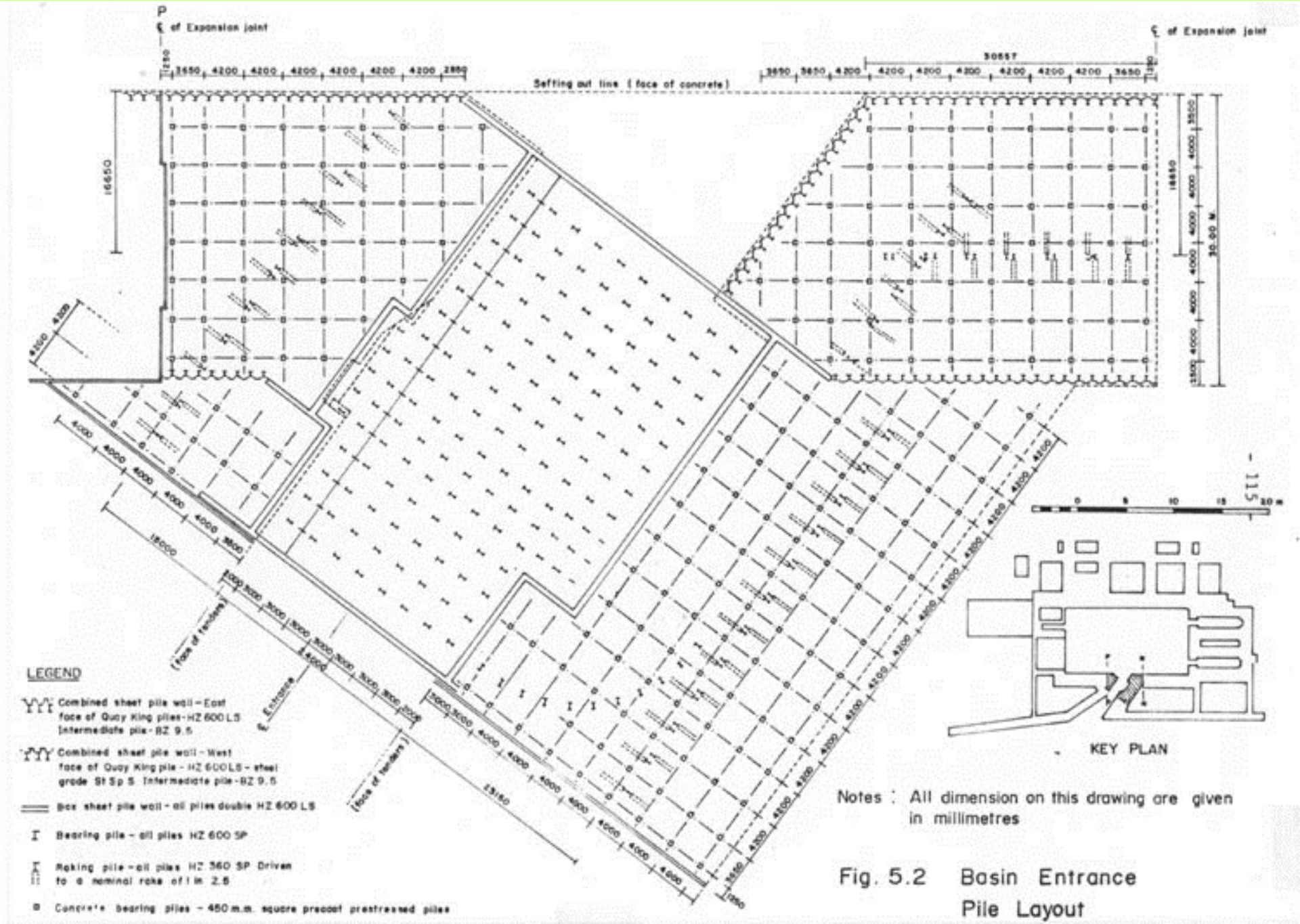
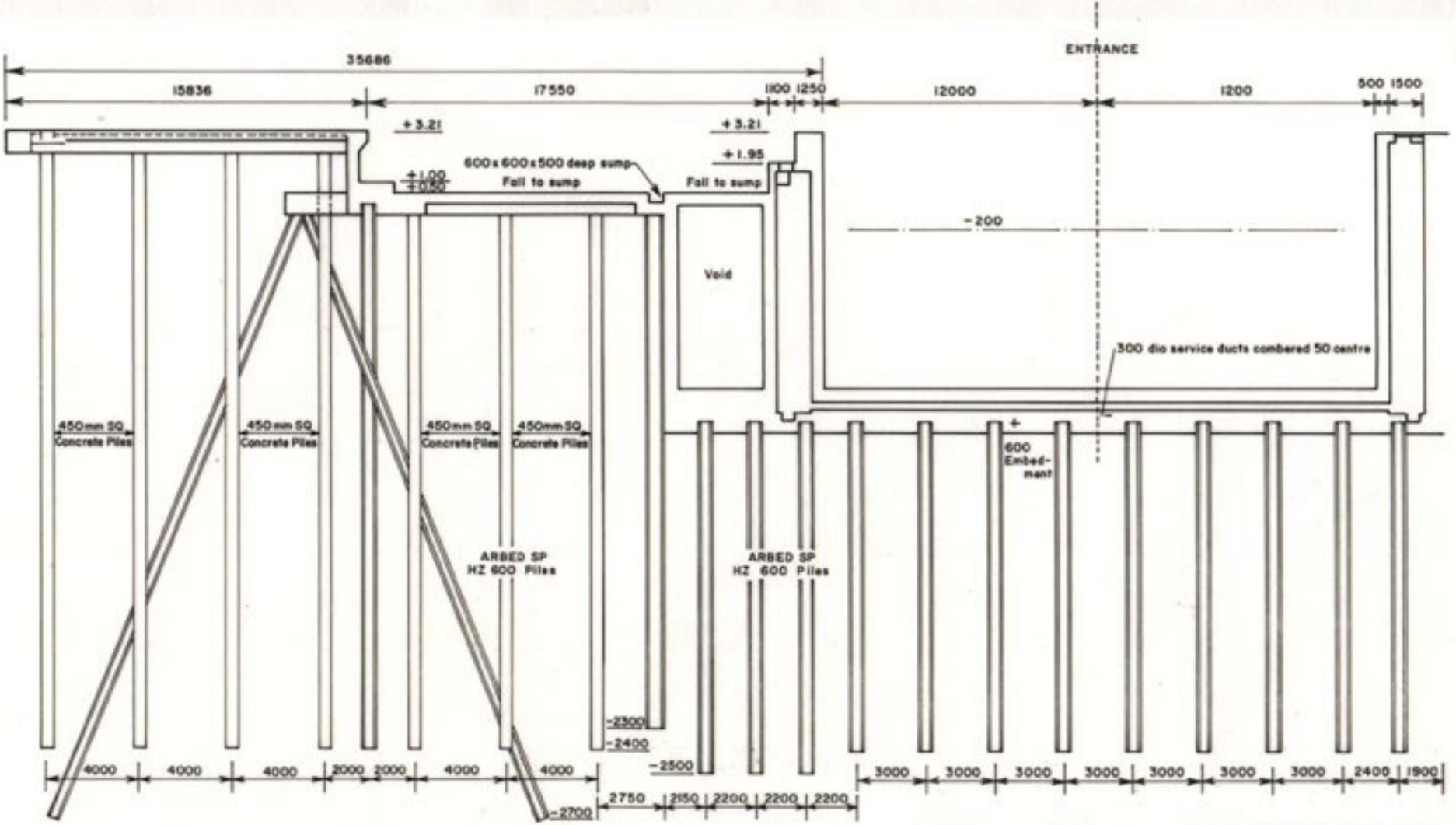


Fig. 5.2 Basin Entrance Pile Layout



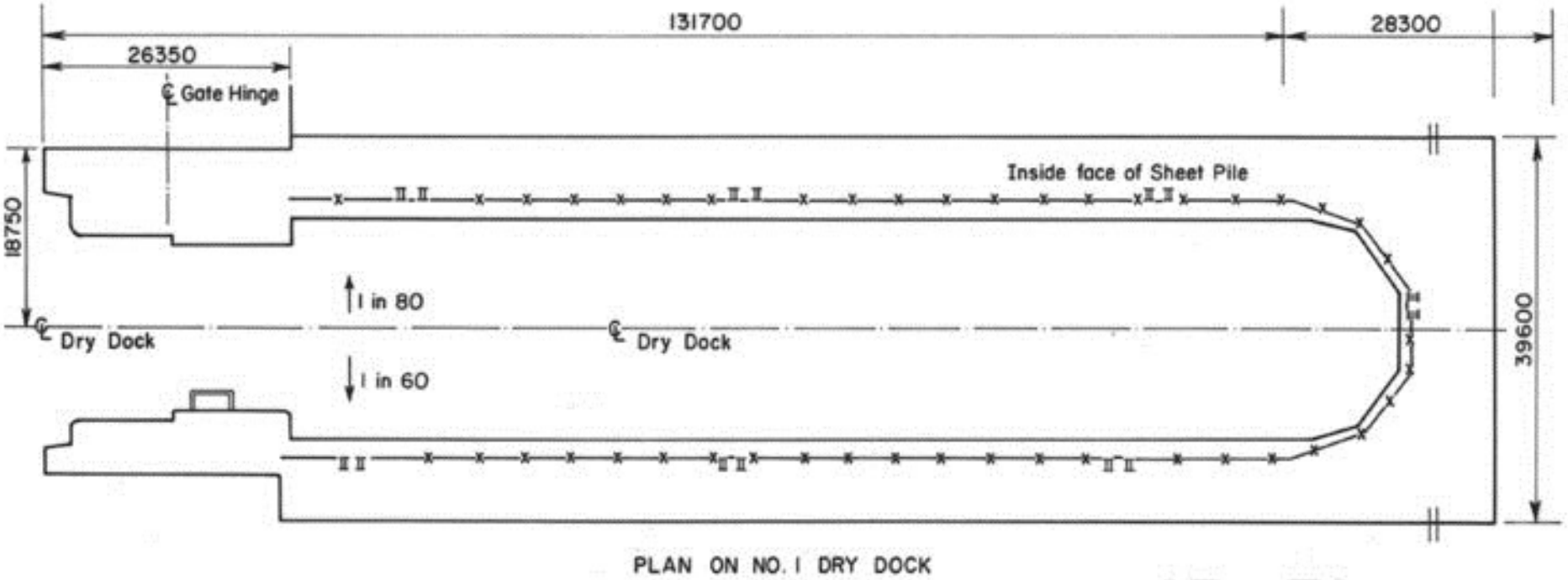
Notes : This figure to be read in conjunction with figure 5.1

All dimensions are in millimetres

All levels are in metres

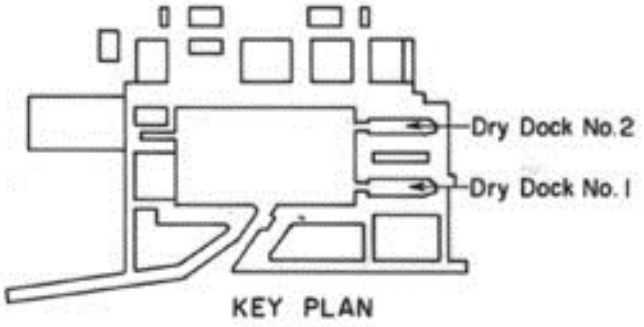
Basin Entrance Main Cross Section (A-A)

KEY PLAN



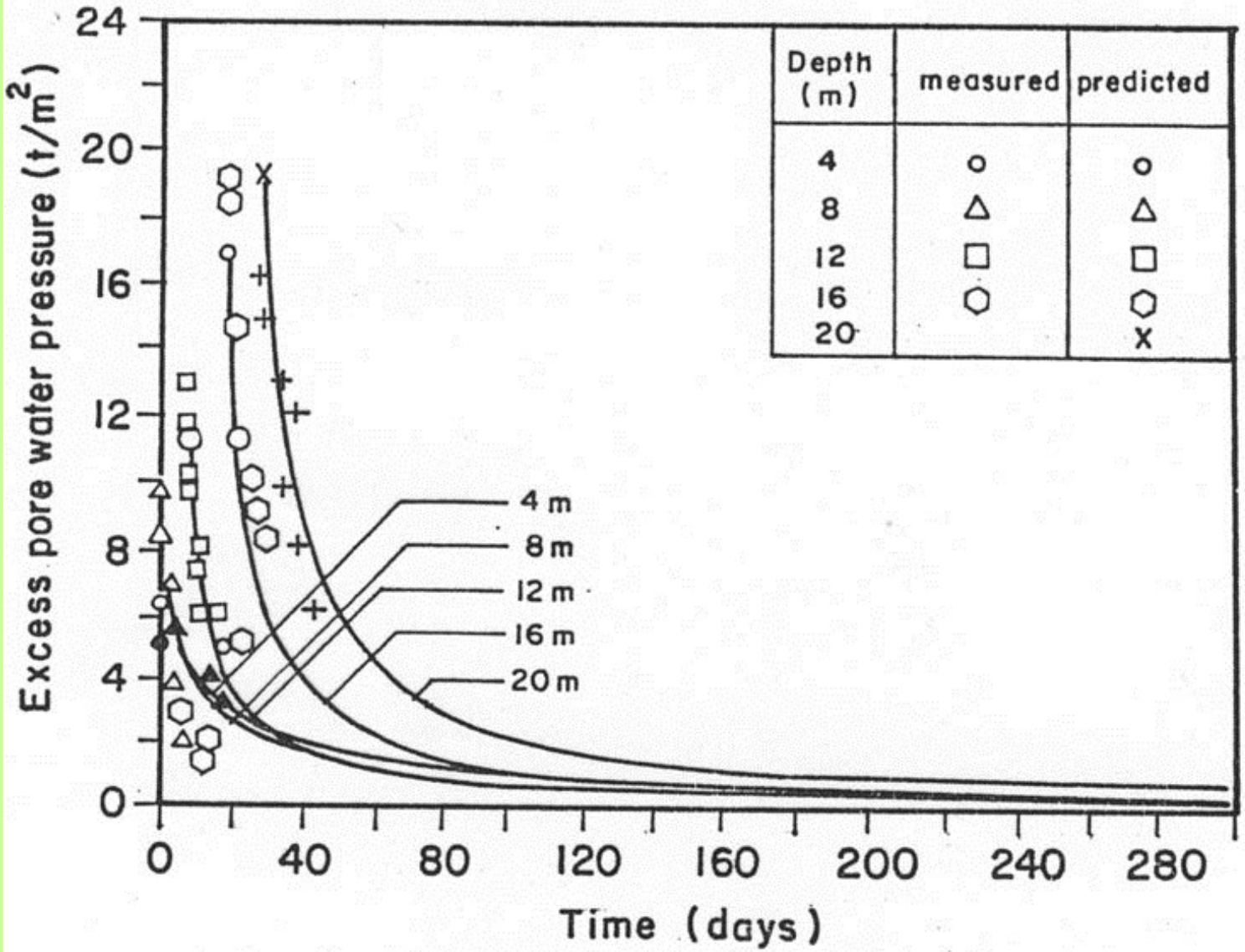
PLAN ON NO. 1 DRY DOCK

Note : All dimensions are in millimetres

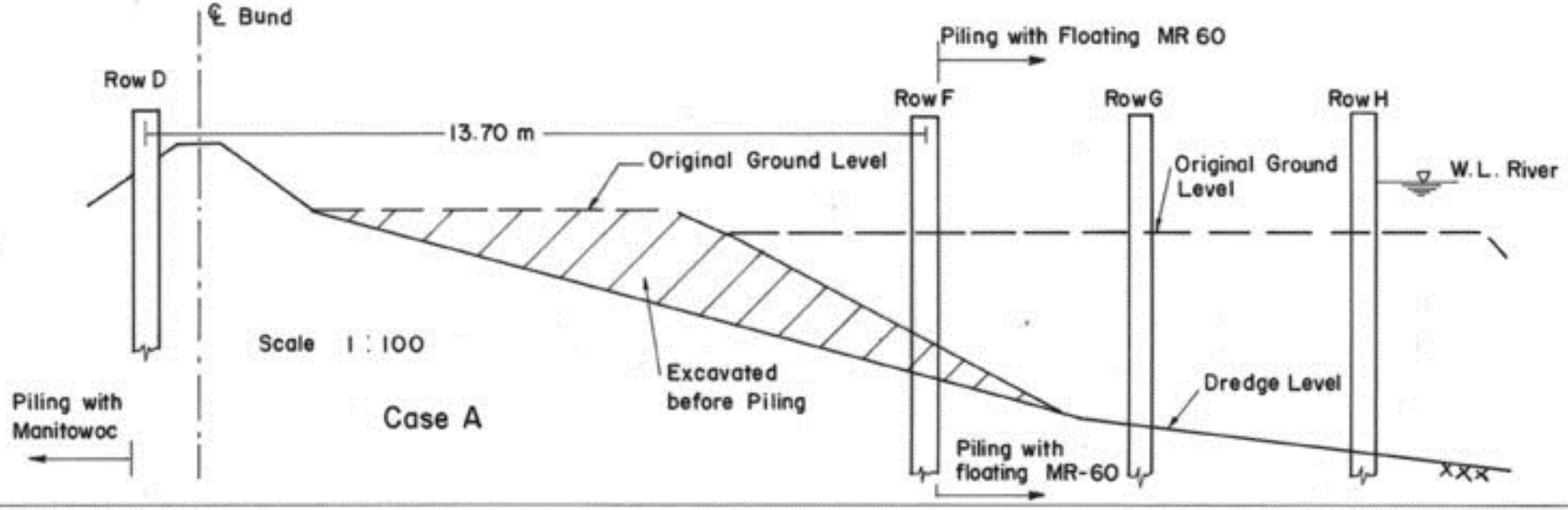


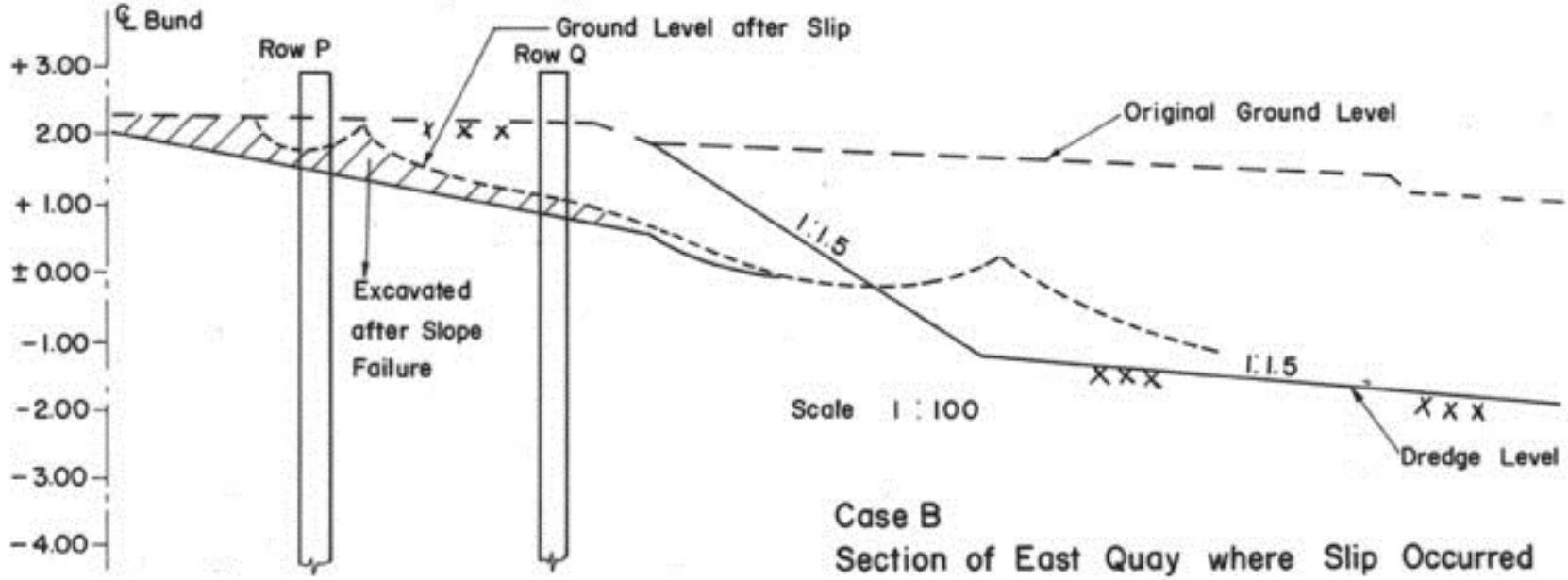
KEY PLAN

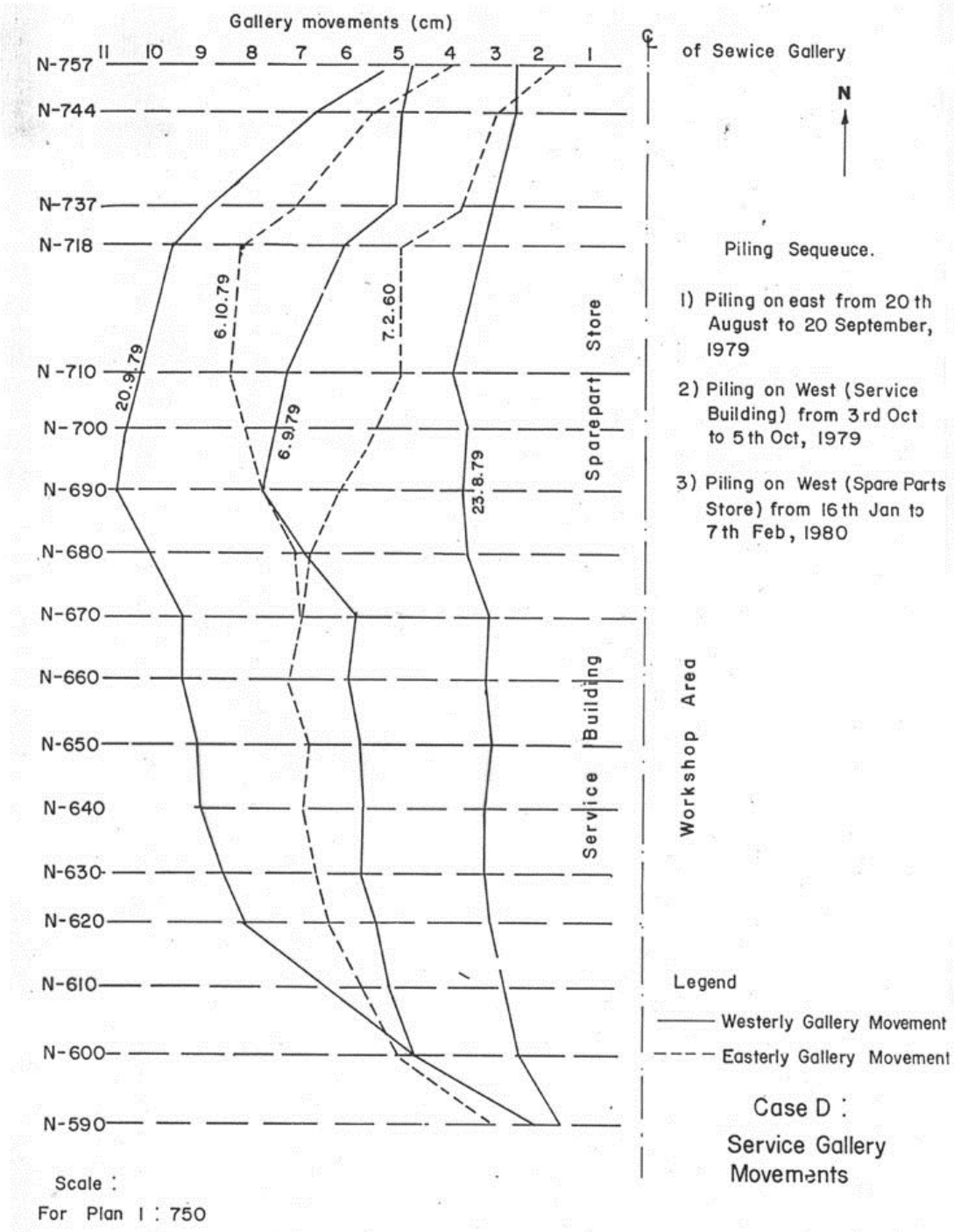
Dry Docks
Layout Plan



Measured and Predicted Excess Pore Water Pressure at Pile Surface


℄ Bund
Row D
13.70 m
Piling with Floating MR 60
Row F
Row G
Row H
Original Ground Level
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


Gallery movements (cm)
11 10 9 8 7 6 5 4 3 2 1
N-757
N-744
N-737
N-718
N-710
N-700
N-690
N-680
N-670
N-660
N-650
N-640
N-630
N-620
N-610
N-600
N-590
20.9.79
6.10.79
6.9.79
7.2.60
23.8.79
Sparepart Store
Service Building
Workshop Area
℄ of Sewice Gallery
N
Piling Sequeuce.
1) Piling on east from 20th August to 20 September, 1979
2) Piling on West (Service Building) from 3rd Oct to 5th Oct, 1979
3) Piling on West (Spare Parts Store) from 16th Jan to 7th Feb, 1980
Legend
Westerly Gallery Movement
Easterly Gallery Movement
Case D :
Service Gallery Movements
Scale :
For Plan 1 : 750

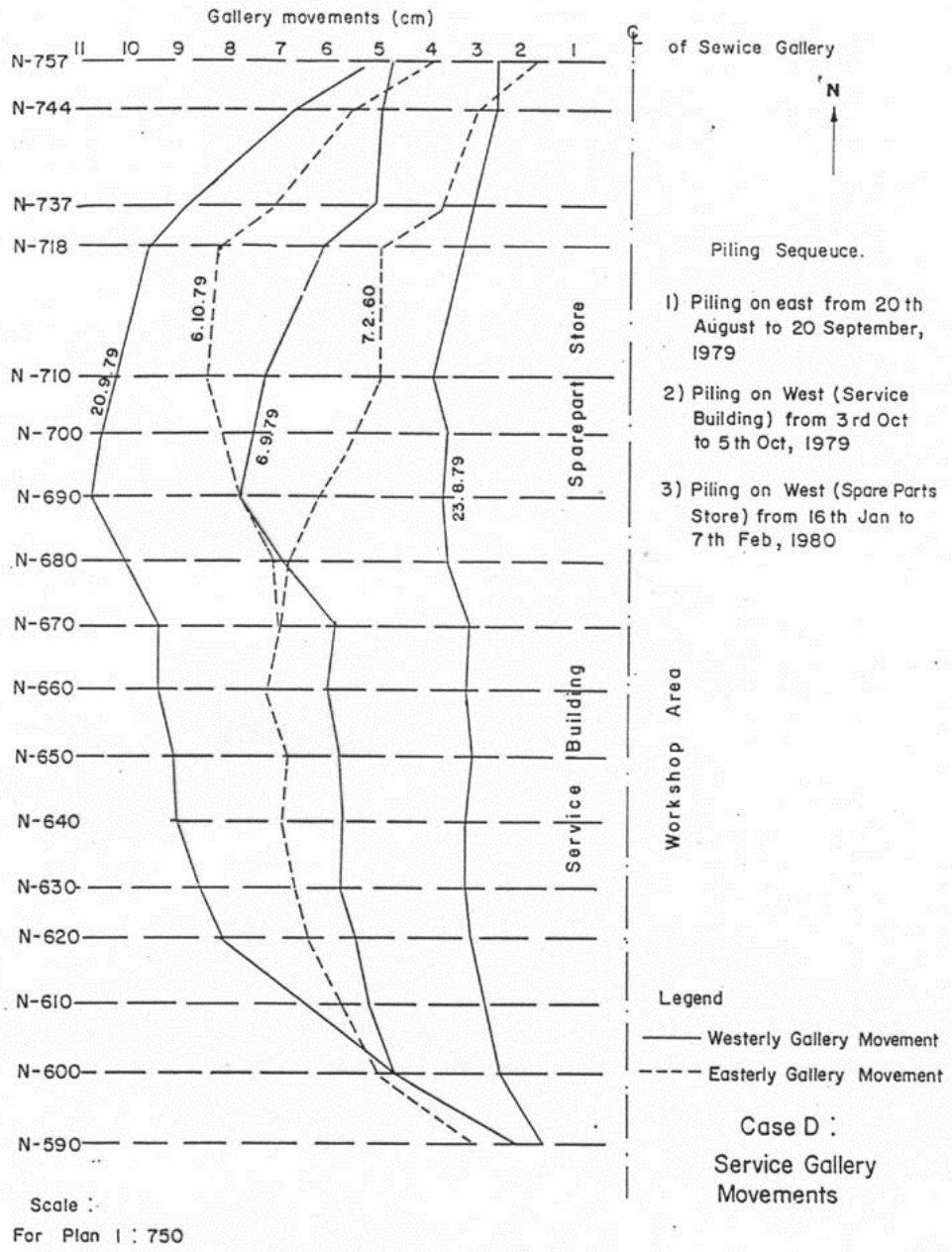
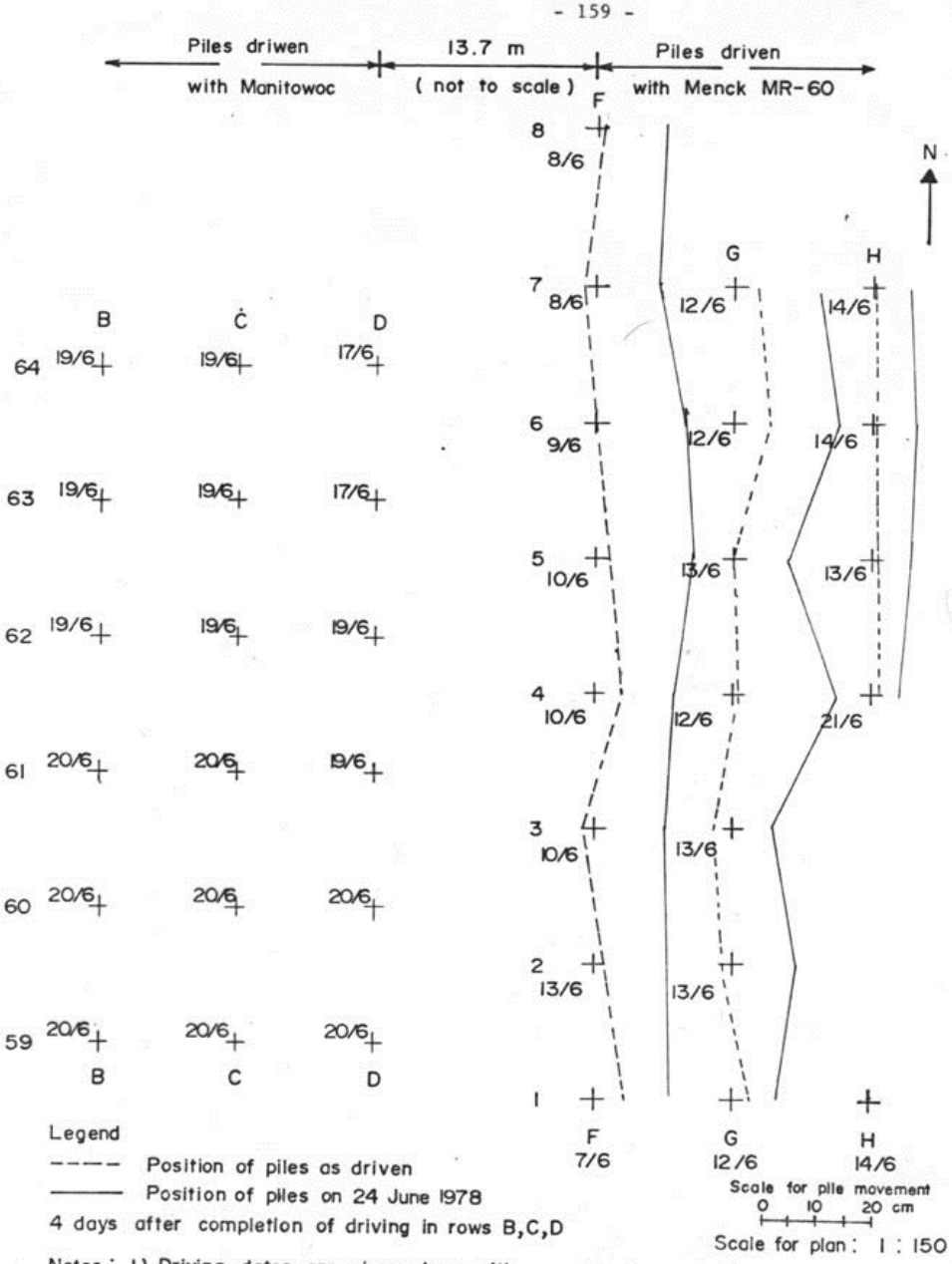
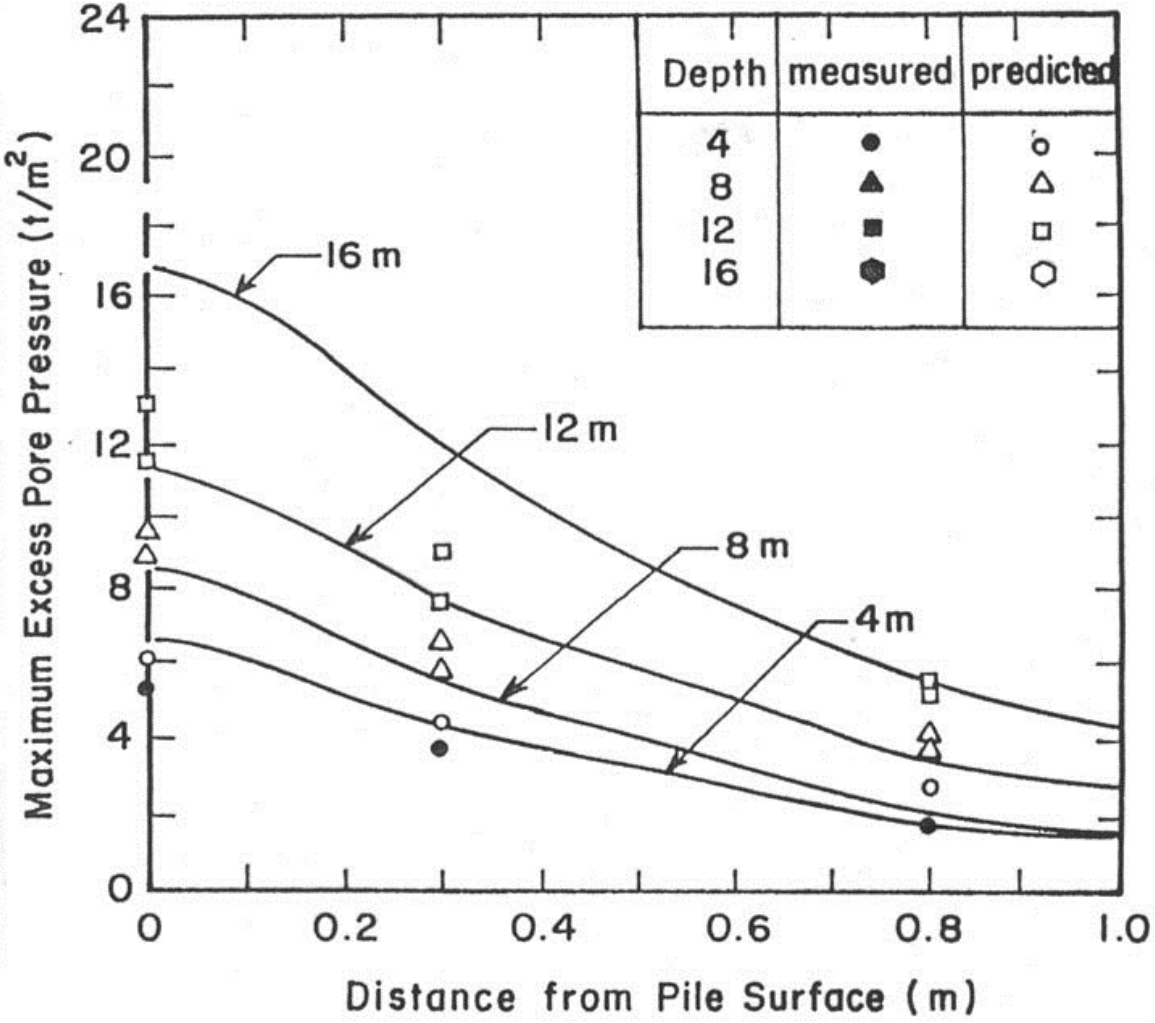


FIG. A.28: Service Gallery Movements



Notes : 1) Driving dates are given along with the piles
2) All piles are 450 m.m. square concrete piles

Fig. 7.3 Case A Movements of Piles in East Quay Area due to Piling in A djacent Area



Measured and Predicted Excess Pore Water Pressure

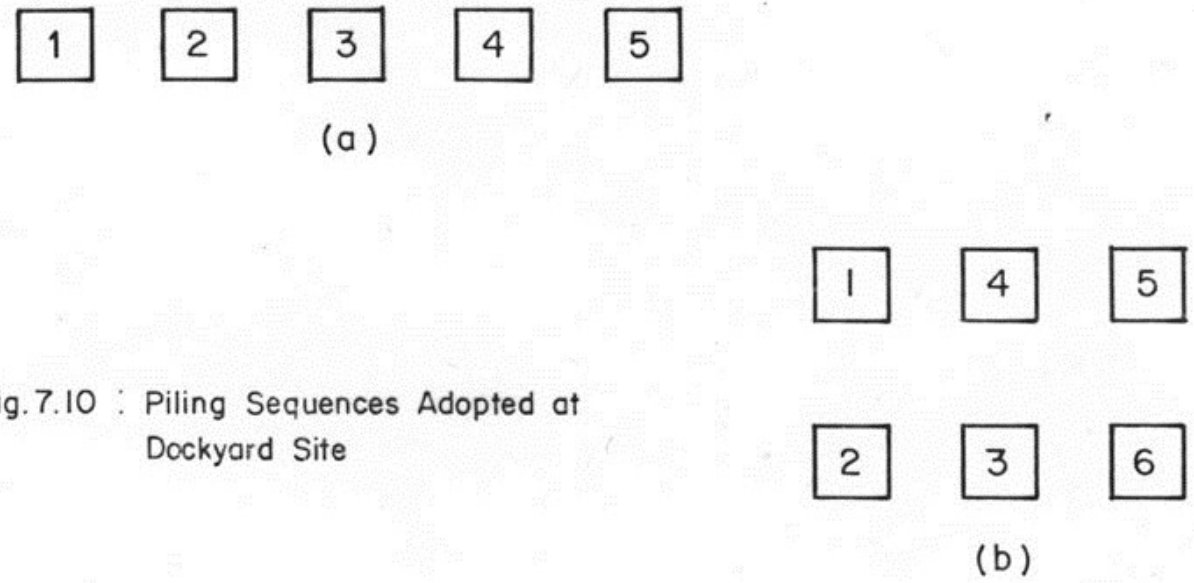


Fig. 7.10 : Piling Sequences Adopted at Dockyard Site

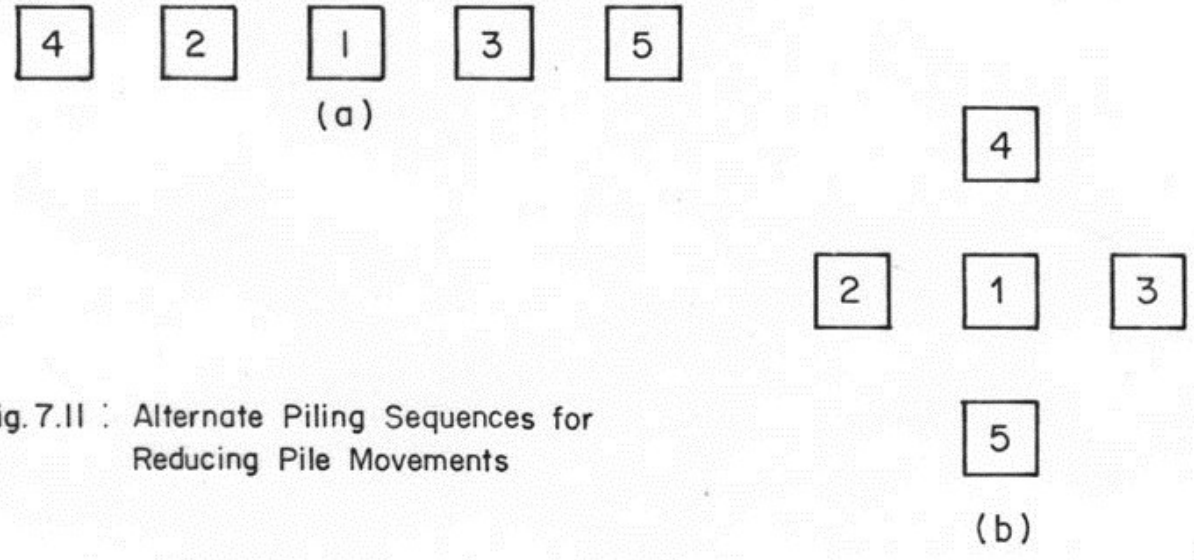


Fig. 7.11 : Alternate Piling Sequences for Reducing Pile Movements

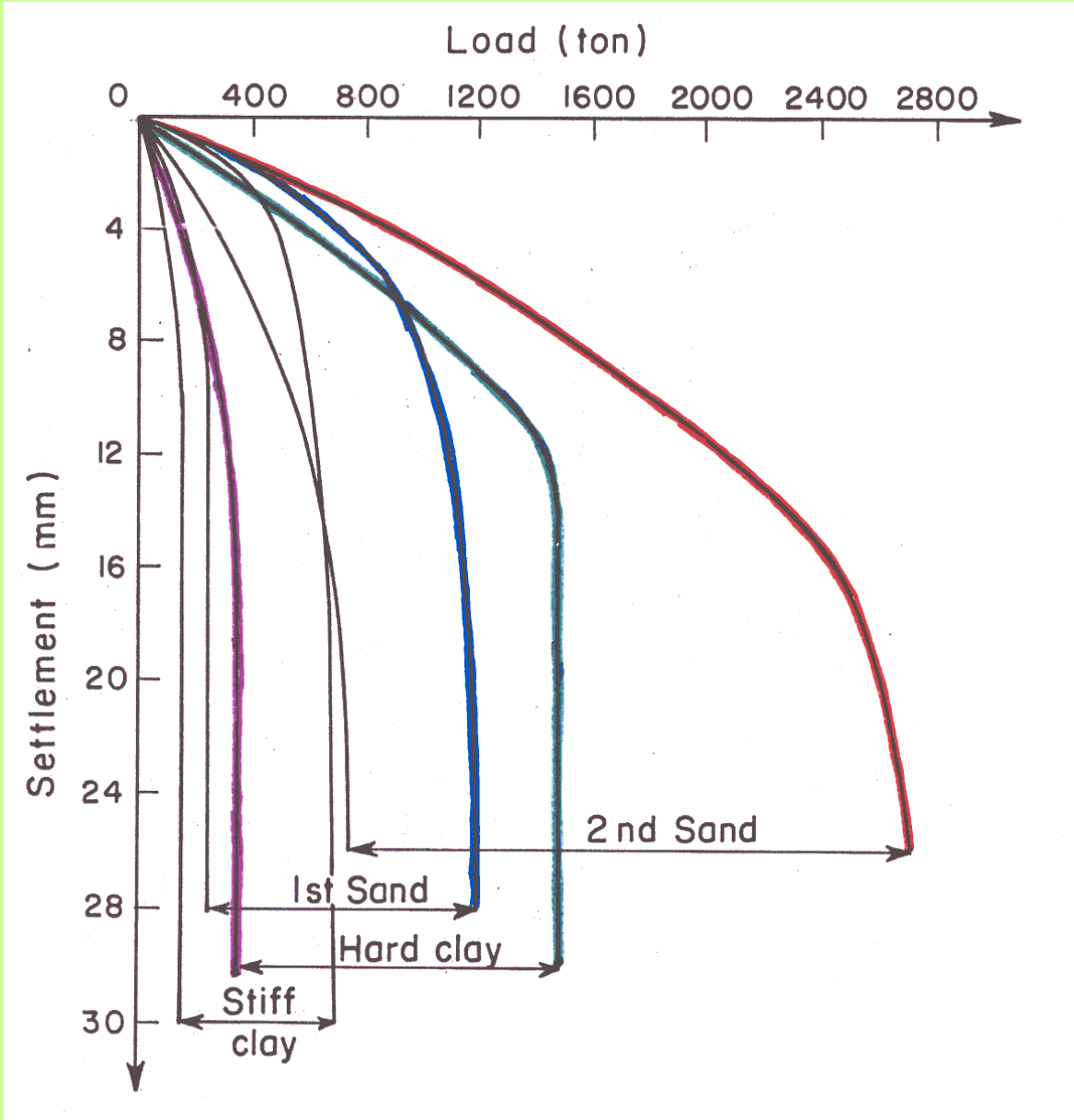
Piling Practice in Sedimentary Soils-- Some Experiences

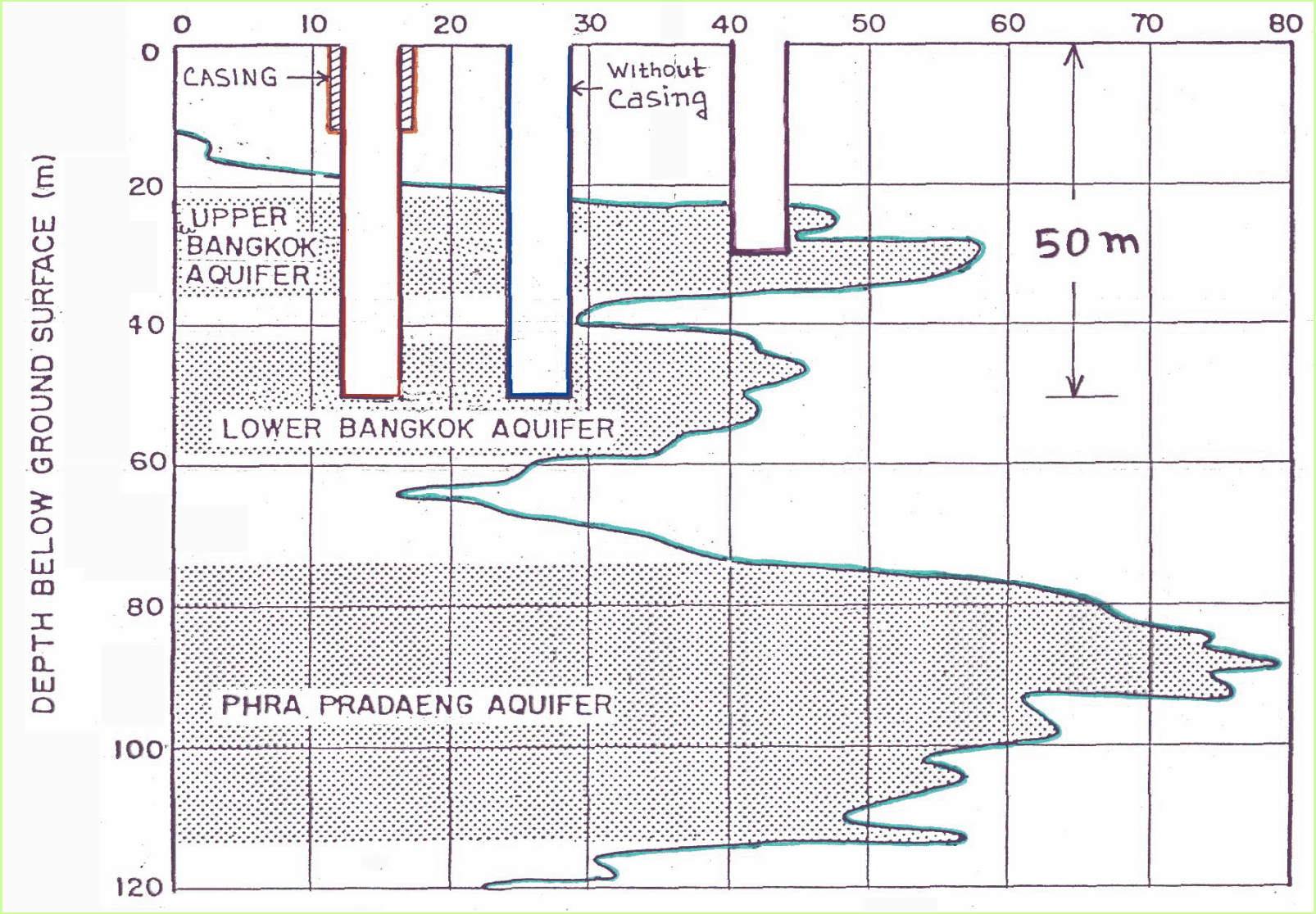
by

A.S.Balasubramaniam
Visiting Professor
Geotechnical and Transportation Engineering Division
School of civil and Environmental Engineering
Nanyang Technological University
Singapore

Higher load capacity with large diameter piles founded in deeper stiff layers

Load capacity of piles founded in different layers



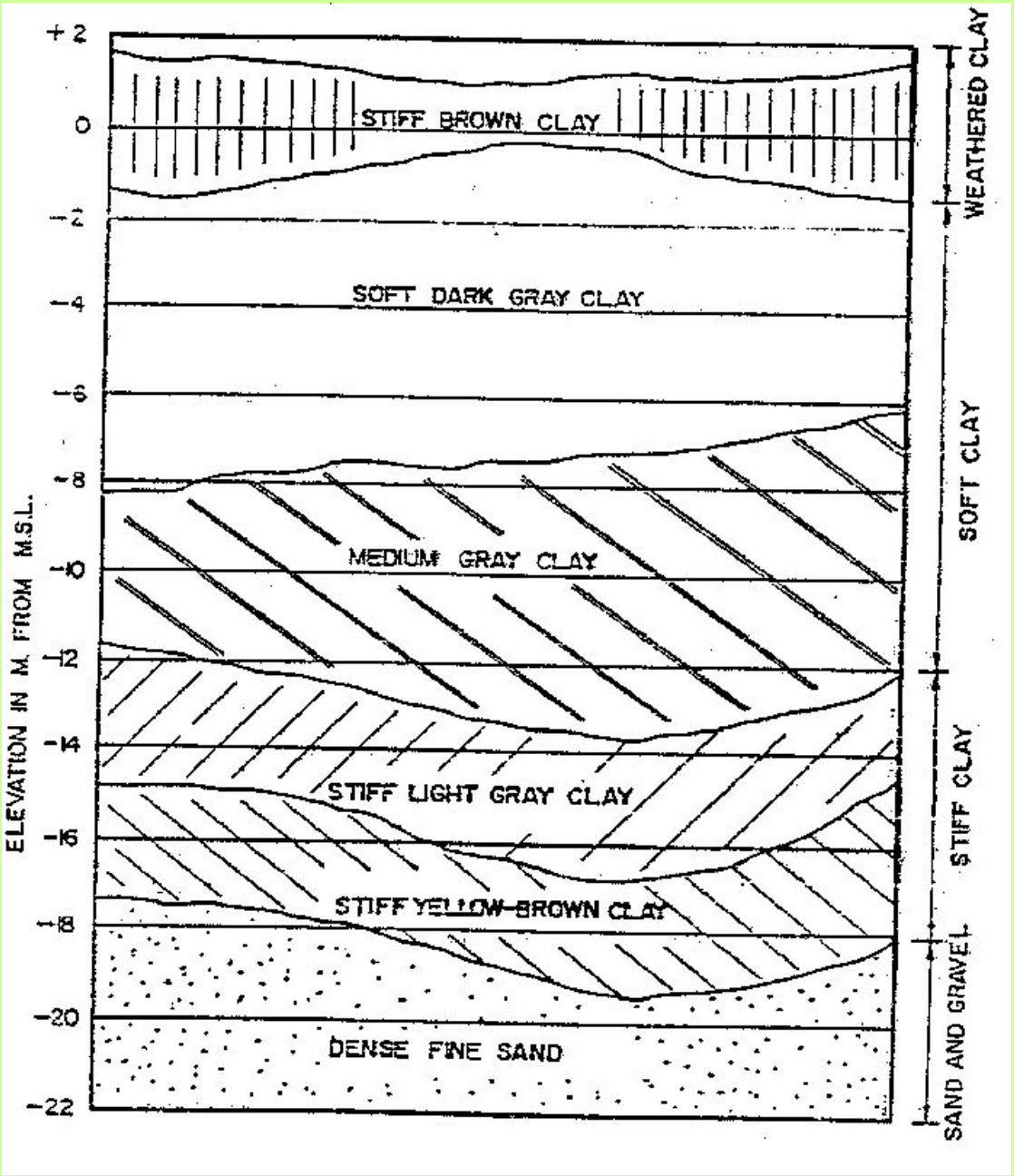


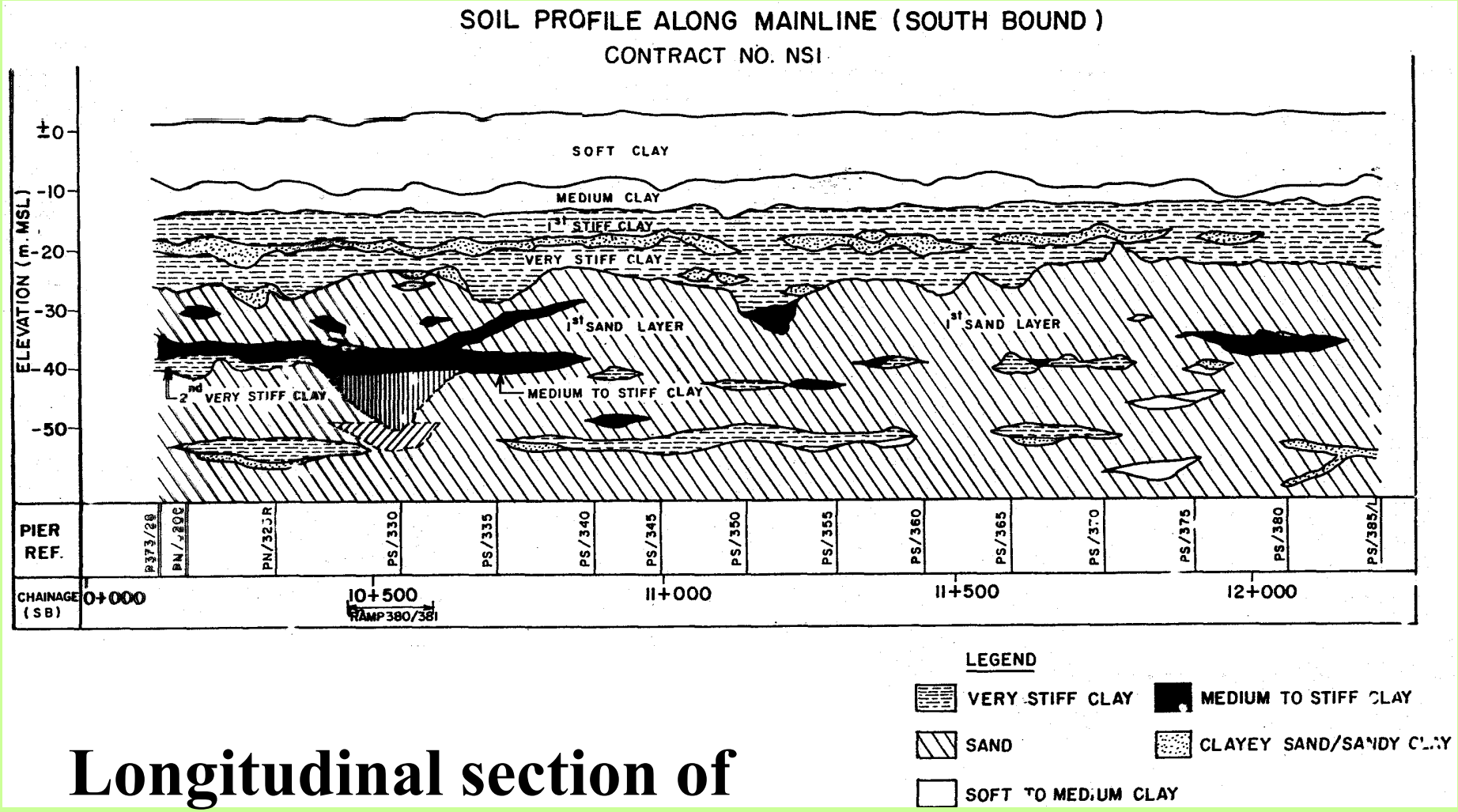
Bored piles founded in second sand layer

Founding level before 1973

1. First stiff clay

2. First sand layer





Longitudinal section of soil profile in the second stage expressway project

Investigator	α				λ	
	Soft Clay	Medium Stiff Clay	Stiff Clay	Sand	Clay	sand
Pham,1972	1.4	1.4	0.7	-	0.33	1.0
Juta-Sirivongse 1972	1.0	1.0	1.0	1.0	0.33	1.0
Chotivittaya-thanin, 1977	1.1	0.7	0.5	0.5	0.33	0.5
Phota-Yanuvat	1.0	0.7	0.5	0.8	0.33	0.5
Chukiat Phota-Yanuvat,1979	1.0	0.7	0.5	0.8	0.33	0.5

Friction and end bearing factors for driven piles to be used with cone penetration test data

Pile Driving Resistance

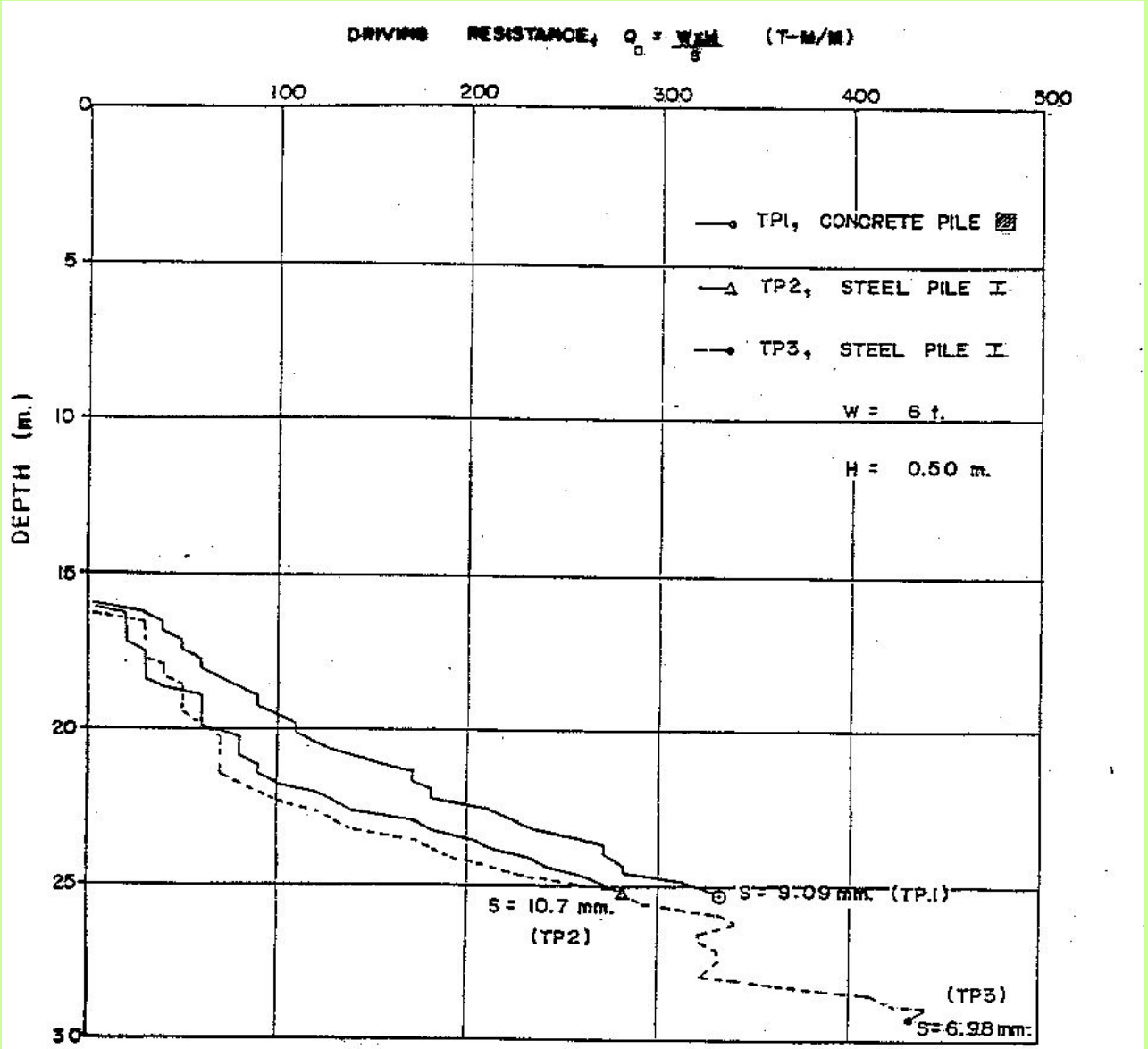
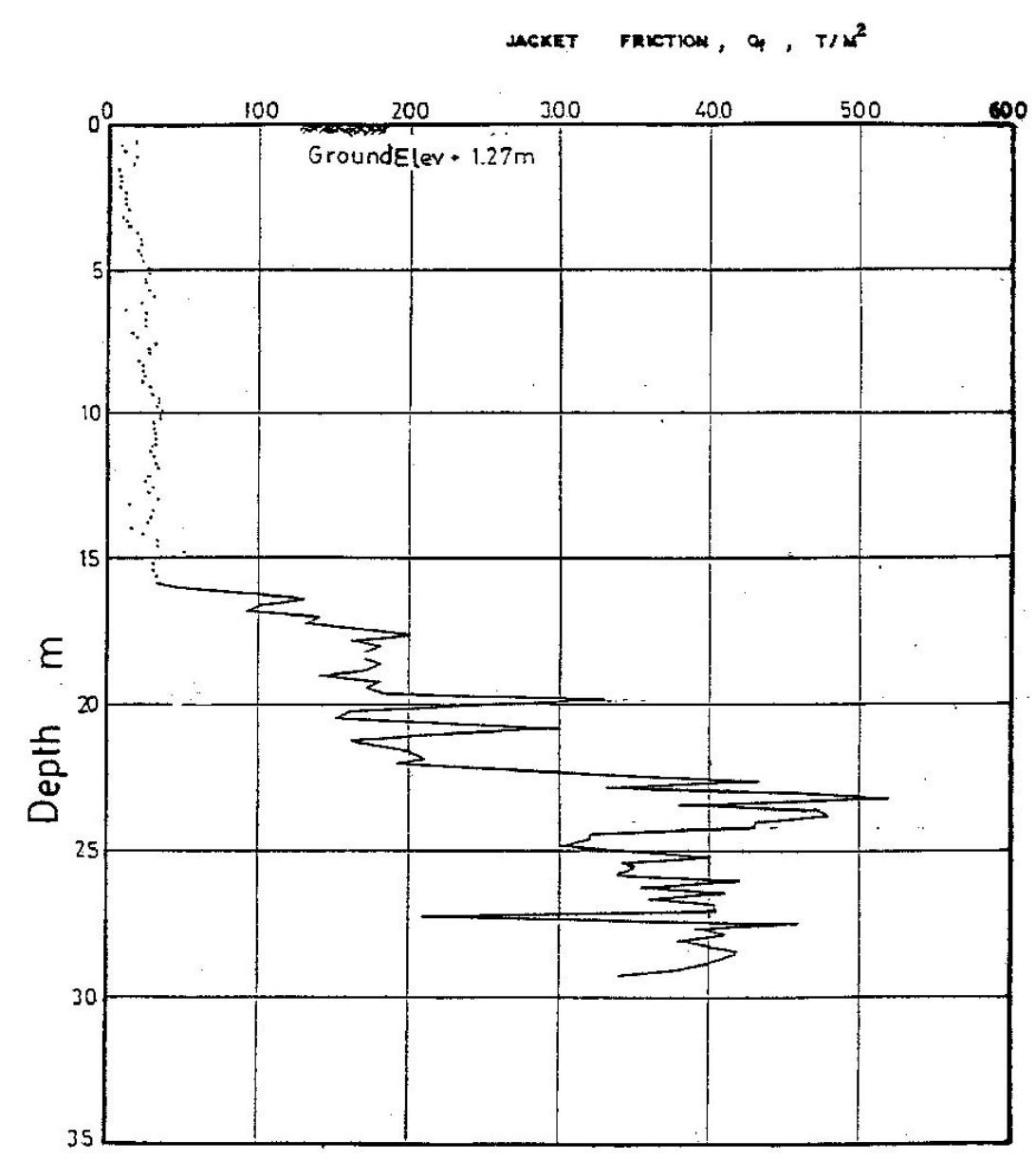


FIG. F.3 DRIVING RESISTANCE V.S. DEPTH OF TEST PILES AT POM PRACHUL

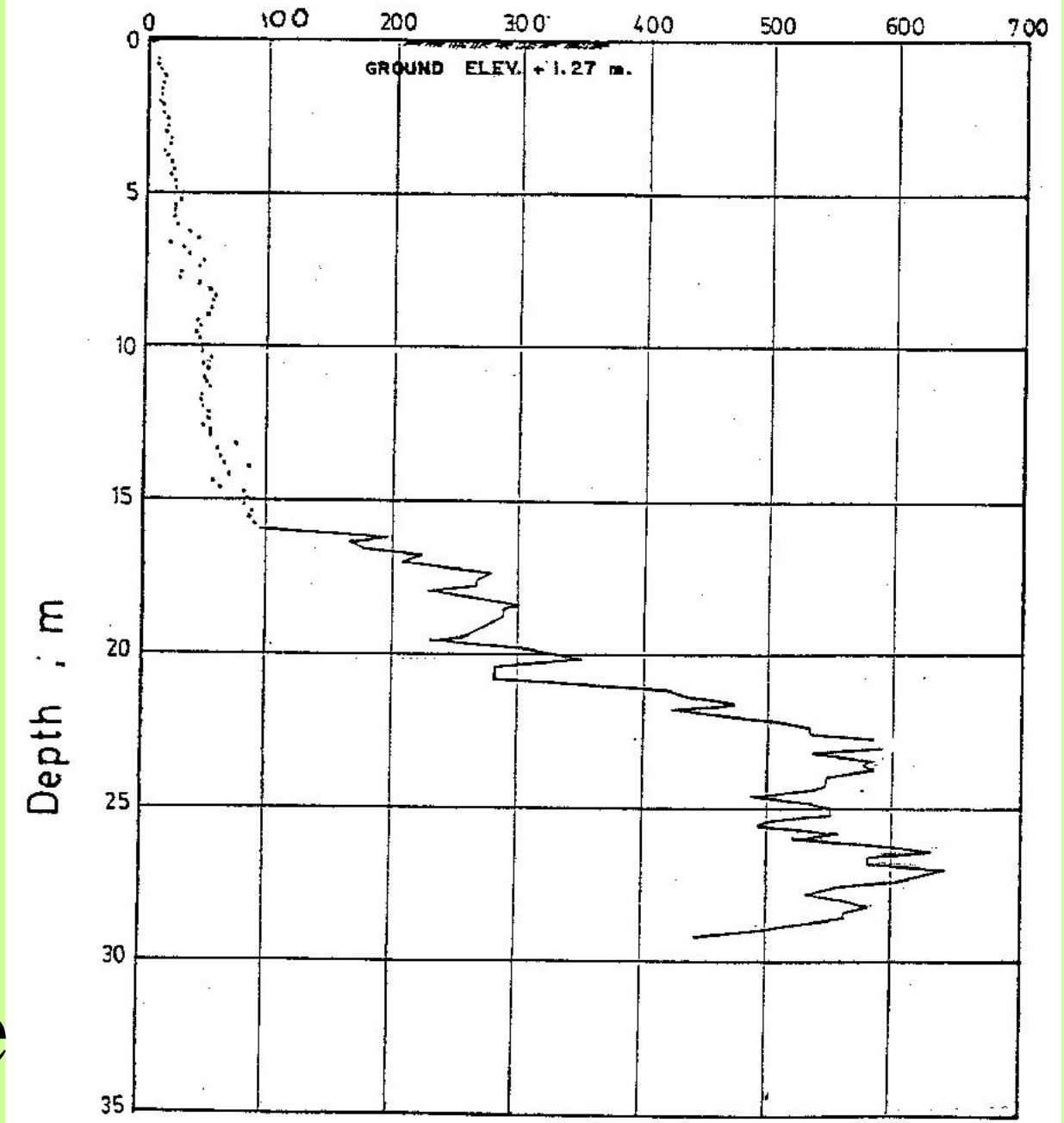
(TP1, TP2, TP3)

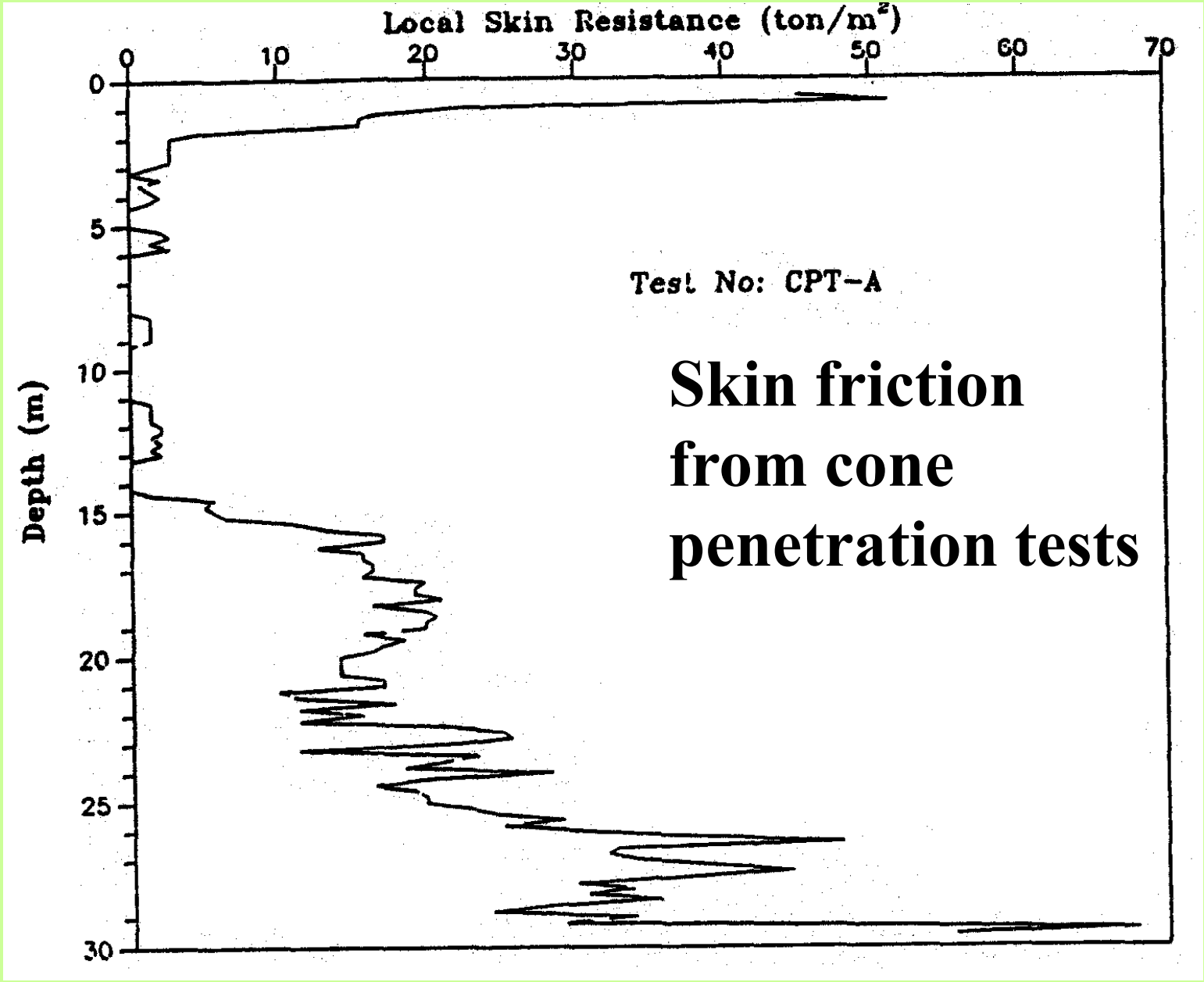
Jacket friction in Cone penetration test



Cone Resistance

Cone resistance in t/m^2




Local Skin Resistance (ton/m²)
0
10
20
30
40
50
60
70
Depth (m)
0
5
10
15
20
25
30
Test No: CPT-A
Skin friction from cone penetration tests

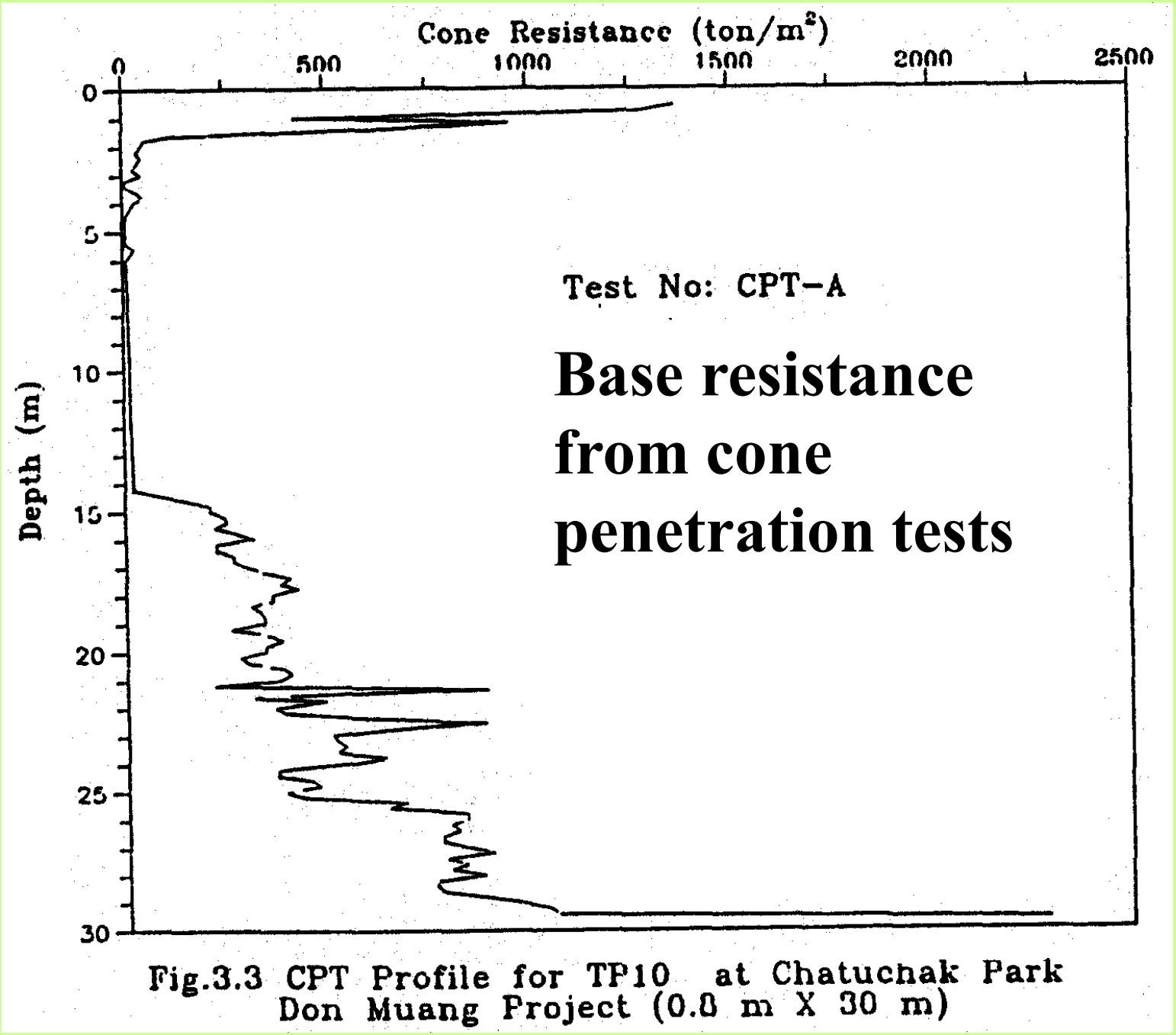
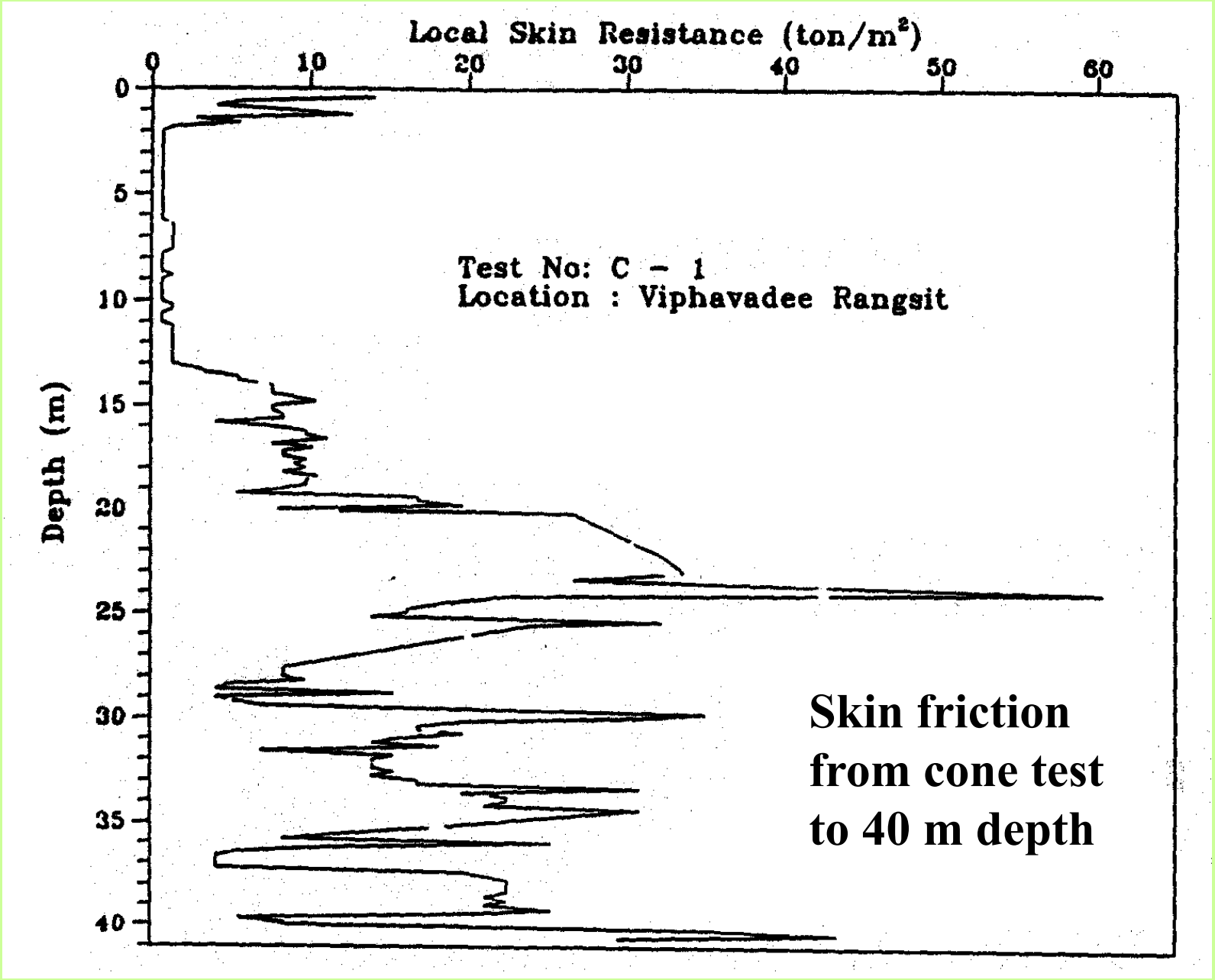


Fig.3.3 CPT Profile for TP10 at Chatuchak Park Don Muang Project (0.8 m X 30 m)


Local Skin Resistance (ton/m²)
0
10
20
30
40
50
60
Depth (m)
0
5
10
15
20
25
30
35
40
Test No: C – 1
Location : Viphavadee Rangsit
Skin friction
from cone test
to 40 m depth

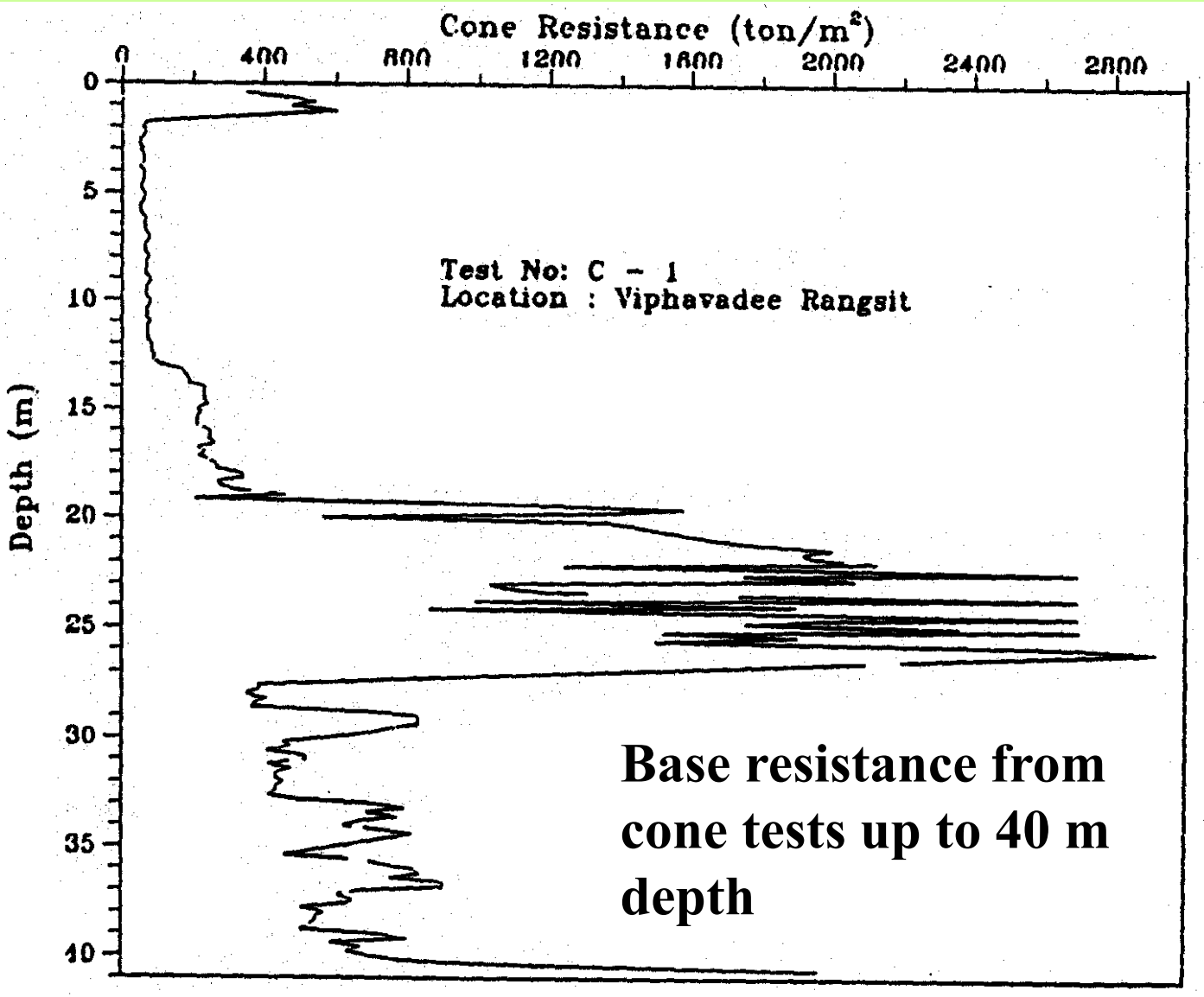
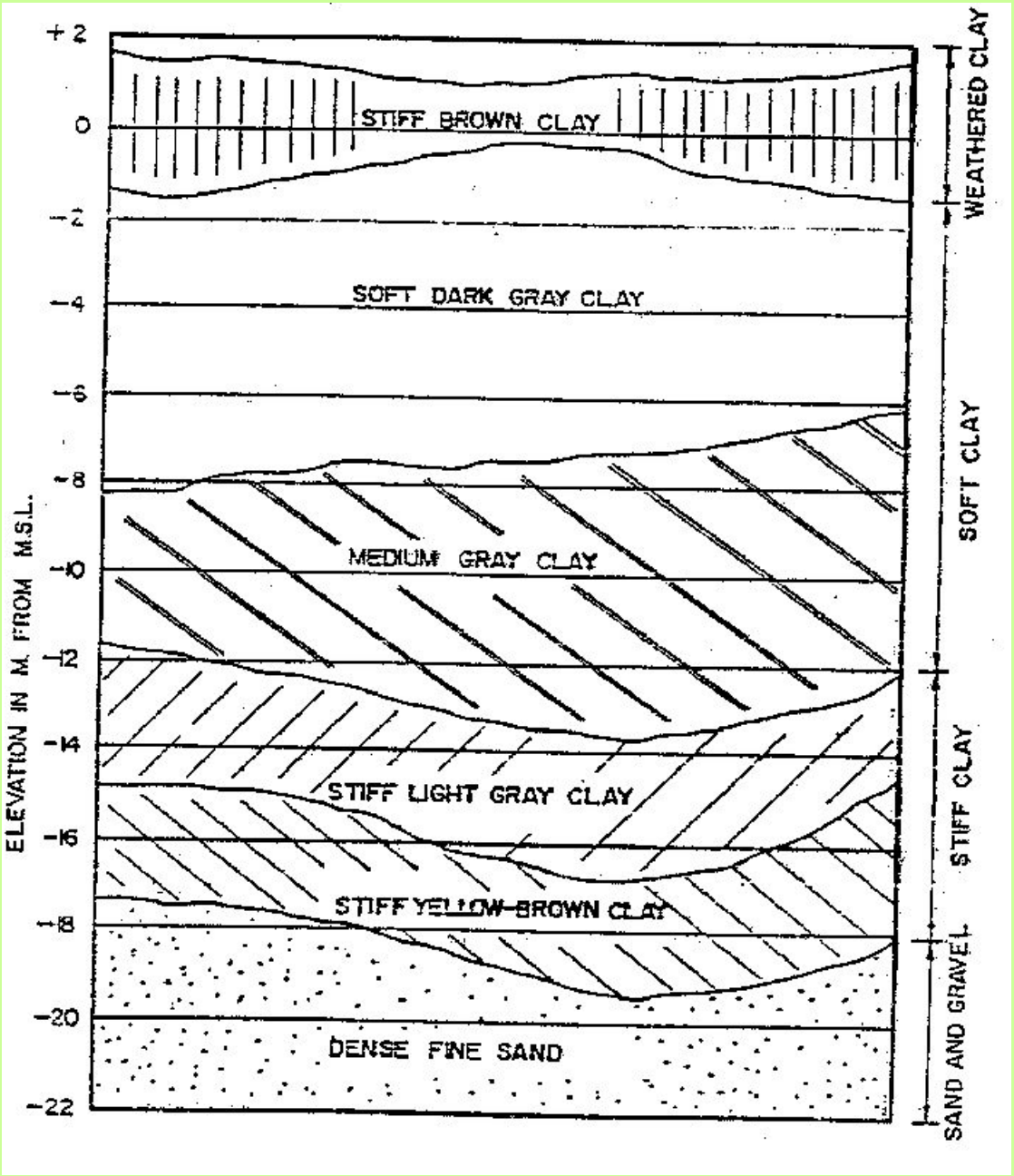


Fig. 3.5 CPT Profile for pile at 16+035
Don Muang Project (0.8 m X 37.5 & 24.6 m)

Founding level before 1973

1. First stiff clay

2. First sand layer

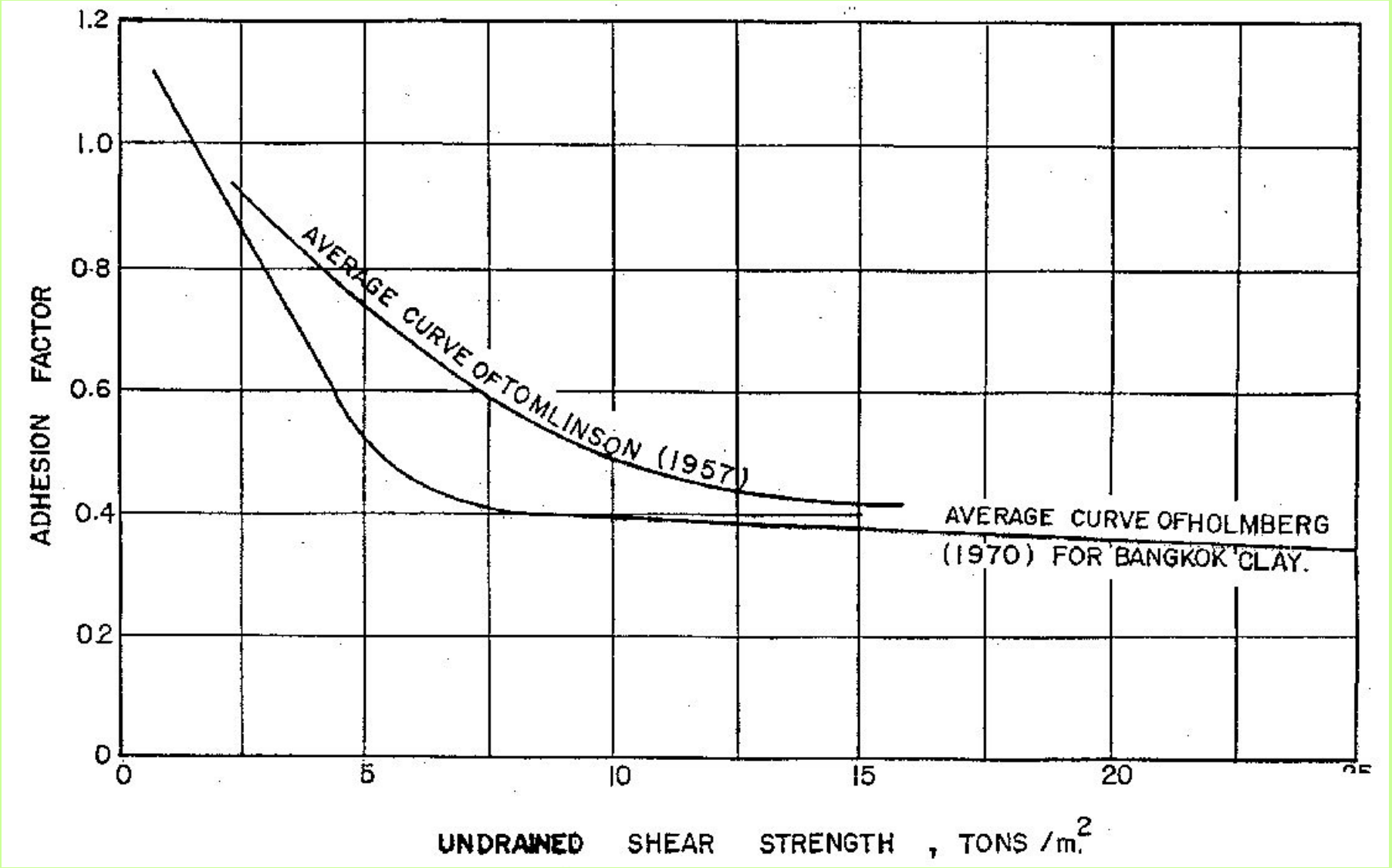


* **Cone resistance**

* **Driving Resistance**

* **Ultimate Load measured**

PILE	Depth of Pile Tip (m)	Average cone Resistance q_c;(t/m^2)	Driving Resistance Qo;(t-m/m)	Measured Ultimate Pile Loads Qu;(tons)
TP1	25.26	545	330	210
TP2	25.32	525	280	165
TP3	29.33	518	430	210
TP17	27.55	780	840	360
TP18	26.95	689	1,110	360
TP19	27.05	615	1,050	360
TP20	22.40	430	117	90
TP21	28.025	402	385	180
TP22	18.50	415	183	78
TP23	20.50	535	293	82.5
TP29	20.70	366	66	67
TP30	25.00	759	1,250	270
TP31	22.30	403	350	143
TP32	18.20	265	260	71
TP33	18.30	275	280	86
TP34	18.40	260	240	67
TP35	24.40	403	470	122



Adhesion factor α

Vane strength used

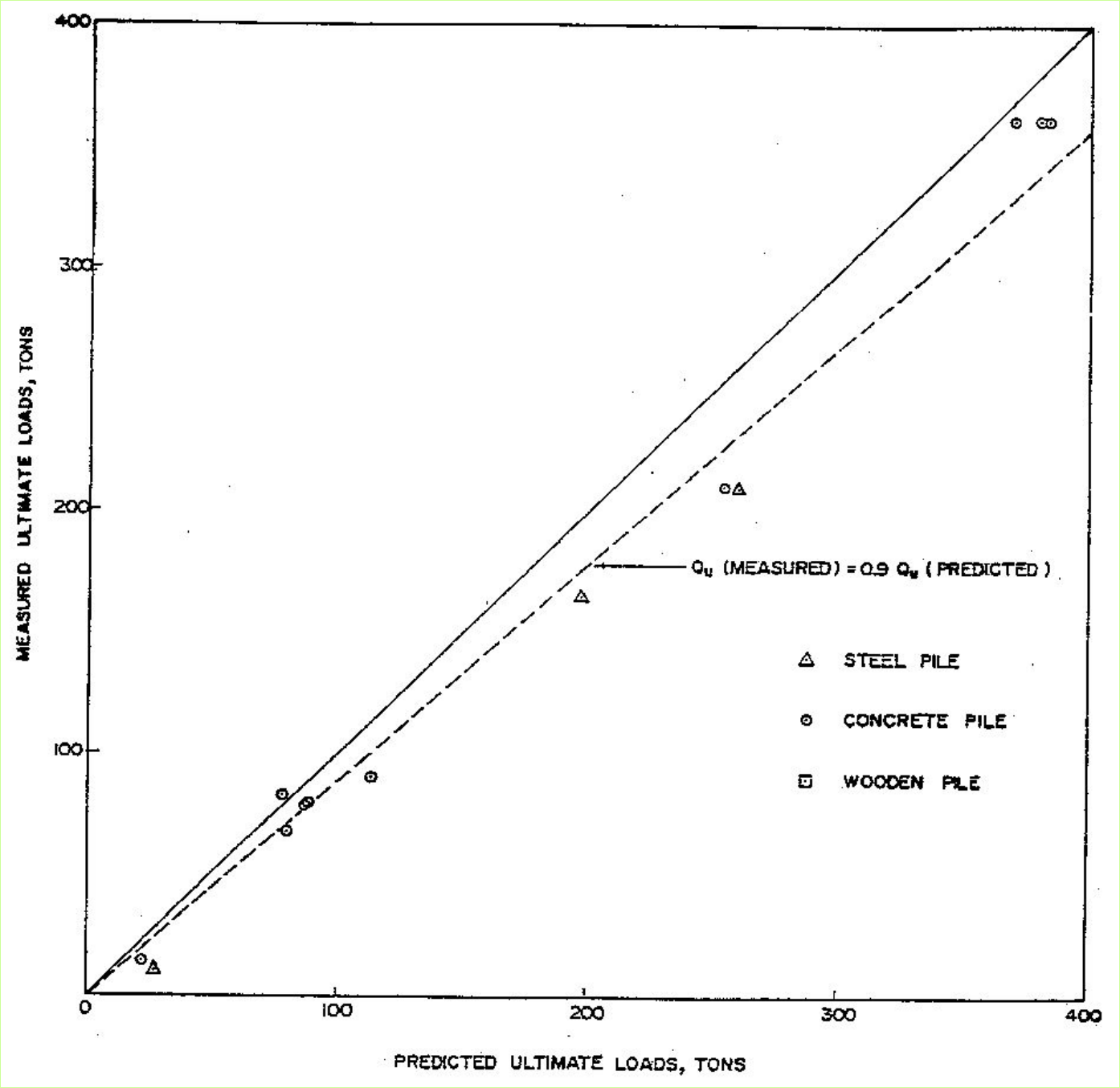
α Method short piles

PILE	Ap (m^2)	C (t/m^2) Vane	Nc	Qp (t)	P (m)	Embedded length (m)	α	Su (t/m^2)	Qs (t)	Qu (t)	Qu Load Tests (t)
TP4	-	-	-	-	1.445	5.33	1.0	1.20	9.2	9.2	4.7
TP5	-	-	-	-	1.445	11.3	0.97	1.73	27.4	27.4	10.3
TP6	0.018	2.65	10	0.47	0.471	6.0	0.88	2.42	6.0	6.47	3.5
TP7	0.018	2.65	10	0.47	0.471	6.0	0.88	2.42	6.0	6.47	3.5
TP8	0.108	2.65	10	0.47	0.471	6.0	0.88	2.42	6.0	6.47	4.5
TP9	0.018	2.65	10	0.47	0.471	6.0	0.88	2.42	6.0	6.47	4.5
TP10	0.018	2.65	10	0.47	0.471	6.0	0.88	2.42	6.0	6.47	4.5
TP11	0.019	2.60	10	0.49	0.497	4.0	0.89	2.31	4.1	5.59	2.24
TP12	0.018	2.60	10	0.49	0.471	4.0	0.89	2.31	3.9	4.39	2.10
TP13	0.019	2.60	10	0.48	0.497	4.0	0.89	2.31	4.1	4.59	2.16
TP14	0.018	2.60	10	0.49	0.471	4.0	0.89	2.31	3.9	4.39	2.10
TP15	0.022	2.65	10	0.58	0.523	7.5	0.85	2.56	8.5	9.08	6.5
TP16	0.022	2.65	10	0.58	0.523	6.0	0.88	2.42	6.7	7.28	5.5
TP24	0.0193	2.0	10	0.40	0.472	9.9	1.0	1.30	9.3	9.70	9.0
TP25	0.0324	2.0	10	0.65	0.92	9.6	1.0	1.25	11.0	11.65	9.0
TP26	0.0324	3.9	10	1.26	0.92	10.6	0.87	2.46	20.9	22.16	14.3
TP27	0.0225	2.2	10	0.50	0.70	12.65	0.95	1.95	16.4	16.90	12.0
TP28	0.0324	2.15	10	0.70	0.85	10.7	0.96	1.90	16.6	17.30	12.0

PILE	Depth of Pile Tip (m)	BASE				SHAFT																		Qu (t)	Qu (t) Load Tests
		Ap (m^2)	N_c	C (t/m^2)	Qp (t)	p (m)	Soft Clay				Medium Stiff Clay				Stiff Clay				Sand					Total Qs (t)		
							Su (t/m^2)	α	L (m)	Qs (t)	Su (t/m^2)	α	L (m)	Qs (t)	Su (t/m^2)	α	L (m)	Qs (t)	K	Avg.$\bar{\sigma}_v$ (t/m^2)	δ (deg)	L (m)	Qs (t)			
TP1	25.26	.2025	10	38	77	1.80	1.6	0.98	8.6	24.8	3.0	0.80	7.5	33.2	20.9	0.35	9.16	120.6	-	-	-	-	-	178	256	210
TP2	25.32	.133	10	38	51	1.46	1.6	0.98	8.6	20.1	3.0	0.80	7.5	27	20.9	0.35	9.22	98.5	-	-	-	-	-	146	197	165
TP3	29.33	.133	10	42	56	1.46	1.6	0.98	8.6	20.1	3.0	0.80	7.5	27	24.0	0.34	13.2	157.3	-	-	-	-	-	204	260	210
TP21	20.025	.0676	10	18.6	12.5	1.36	2.1	0.92	13.6	36	5.5	0.48	3.0	11	15.5	0.39	3.43	28	-	-	-	-	-	76	88	80
TP22	18.50	.0676	10	16.8	11.4	1.29	3.2	0.76	10	31	4.5	0.57	5.0	17	16.8	0.37	3.5	28	-	-	-	-	-	76	87	78
TP23	20.50	.0676	10	18.4	12.4	1.29	1.25	1.0	13	21	5.4	0.49	4.0	14	18.4	0.37	3.5	31	-	-	-	-	-	66	78	82.5
TP29	20.70	.0676	10	15.0	10.0	1.21	2.4	0.87	13	33	5.0	0.53	4.5	14	15.0	0.38	3.2	22	-	-	-	-	-	69	79	67
			$\bar{\sigma}_v$ (t/m^2)	ϕ (deg)	Nq																					
TP17	27.55	.157	23.0	34	46	162	1.885	2.16	0.9	11.0	40.	.8	0.54	4.0	19.5	15.8	0.38	10.2	115	1.0	22.0	25.5	2.35	46	221	383	360
TP18	26.95	.157	11.5	34	46	159	1.885	2.16	0.91	11.0	40.8	4.8	0.54	4.0	19.5	15.8	0.38	10.2	115	1.0	22.0	25.5	1.75	35	210	369	360
TP19	27.05	.157	19.0	36	56	167	1.885	2.6	0.85	11.5	48	6.1	0.53	4.5	7.6	10.2	0.40	8.2	63	1.0	16.5	27.0	5.85	93	212	379	360
TP20	22.40	.0404	15.5	35	43	27	1.19	2.7	0.84	15.0	41	-	-	-	-	7.1	0.42	3.8	14	1.0	14.5	26.3	3.6	31	86	113	90

Total stress method-- long piles

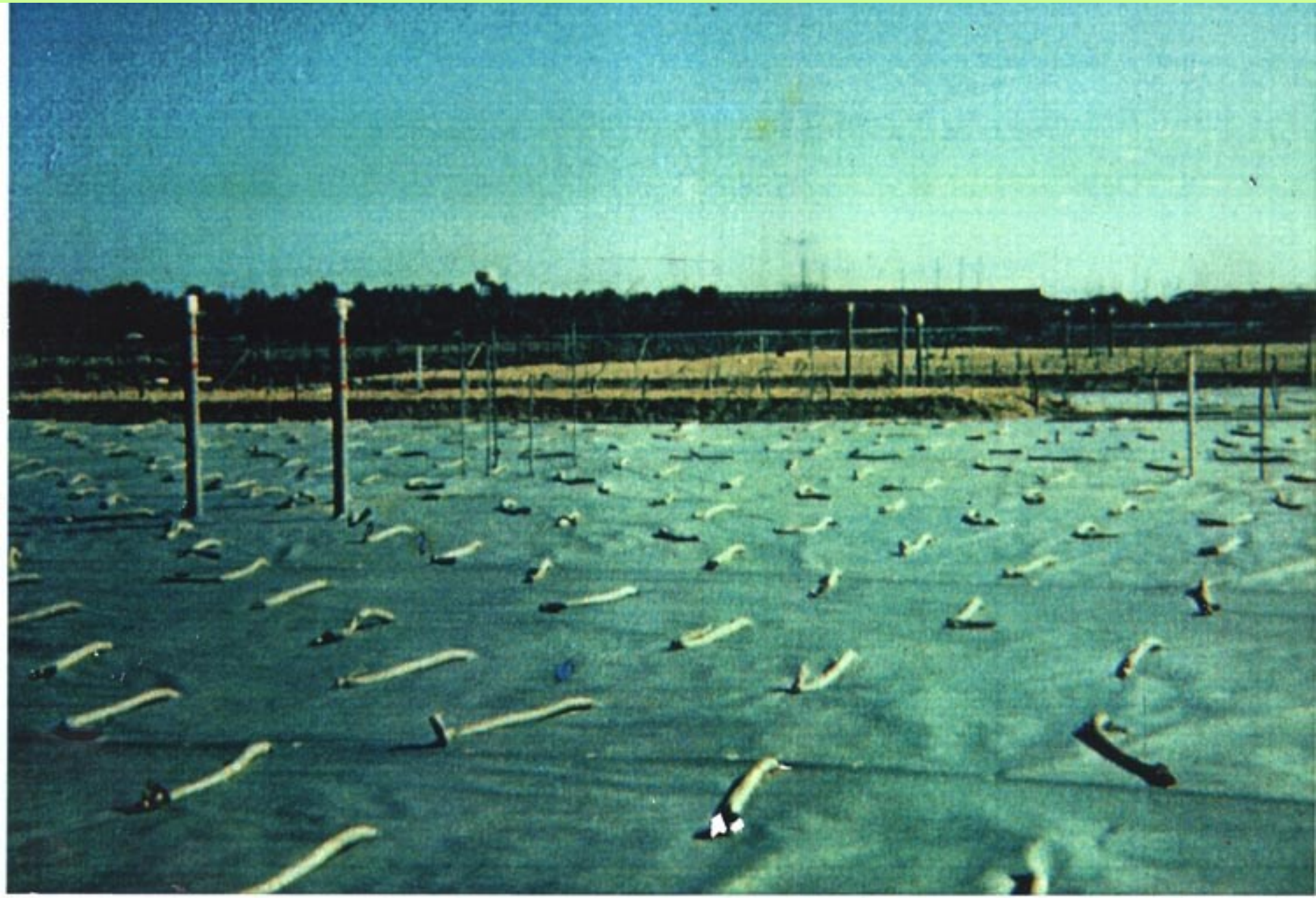
Total stress method long piles

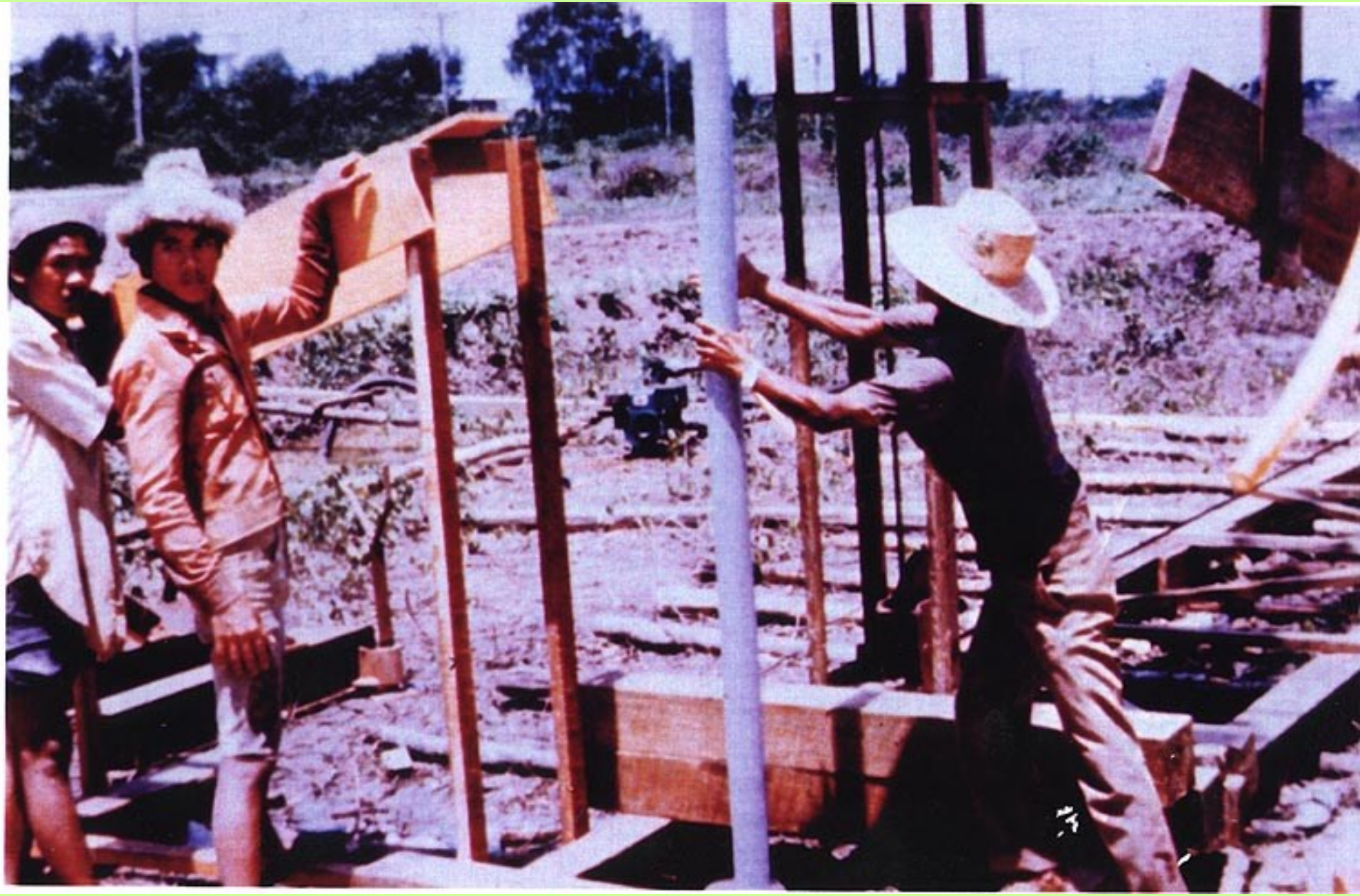


PILE	Depth of Pile Tip (m)	BASE				SHAFT																Weight of Pile (t)	Qu (t)	Qu Load Test (t)
		Ap (m^2)	q_c (t/m^2)	λ	Q_p (t)	P (m)	Soft Clay				Medium Stiff Clay				Stiff Clay				Sand				Qs (t)			
							L (m)	q_{TF} (t/m)	α	Qs (t)	L (m)	q_{TF} (t/m)	α	Qs (t)	L (m)	q_{TF} (t/m)	α	Qs (t)	L (m)	q_{TF} t/m)	α	Qs (t)				
TP1	25.26	.2025	545	0.33	36.4	1.80	8.6	10	1.0	18	7.5	15	0.7	18.9	9.16	164	0.5	147.6	-	-	-	-	184.5	12.64	208	210
TP2	25.32	.133	525	0.33	23.0	1.46	8.6	11	1.0	16	7.5	20.5	0.7	21	9.22	144	0.5	105	-	-	-	-	142	3.36	162	165
TP3	29.33	.133	518	0.33	22.7	1.46	8.6	11	1.0	16	7.5	17	0.7	17.4	13.2	242	0.5	176.6	-	-	-	-	210	3.87	229	210
TP21	20.025	.0676	402	0.33	8.9	1.36	13.5	19.5	1.0	26.5	3.0	14.5	0.7	13.8	3.43	50	0.5	34	-	-	-	-	74.3	2.42	81	80
TP22	18.50	.0676	415	0.33	9.3	1.29	10	16	1.0	20.6	5.0	18	0.7	16.3	3.5	52	0.5	33.5	-	-	-	-	70.4	2.09	78	78
TP23	20.50	.0676	535	0.33	11.9	1.29	13	15	1.0	19.4	4.0	9	0.7	8.1	3.5	71	0.5	45.8	-	-	-	-	73.3	2.09	83	82.5
TP29	20.70	.0676	366	0.33	8.2	1.21	13	18	1.0	21.8	4.5	32	0.7	27.1	3.2	26	0.5	15.7	-	-	-	-	64.6	2.61	70	67
TP17	27.55	.157	780	0.5	61	1.885	11	16	1.0	30.1	4.0	9	0.7	11.9	10.2	159	0.5	150	2.35	72	0.8	108.6	300.6	10.55	351	360
TP18	26.95	.157	689	0.5	54	1.885	11	12	1.0	22.6	4.0	31	0.7	40.9	10.2	190	0.5	179	1.75	53	0.8	80	322.5	10.92	366	360
TP19	27.05	.157	615	0.5	48	1.885	11.5	15	1.0	28.3	1.5	2.5	0.7	3.3	8.2	100.5	0.5	94.7	5.85	132	0.8	199	325.3	10.92	362	360
TP20	22.40	.0404	430	0.5	8.7	1.19	15	24.5	1.0	29.2	-	-	-	-	3.8	90.5	0.5	18.1	3.6	40	0.8	38.1	85.4	2.04	92	90

Dutch cone test used in pile capacity determination

Sand Drain





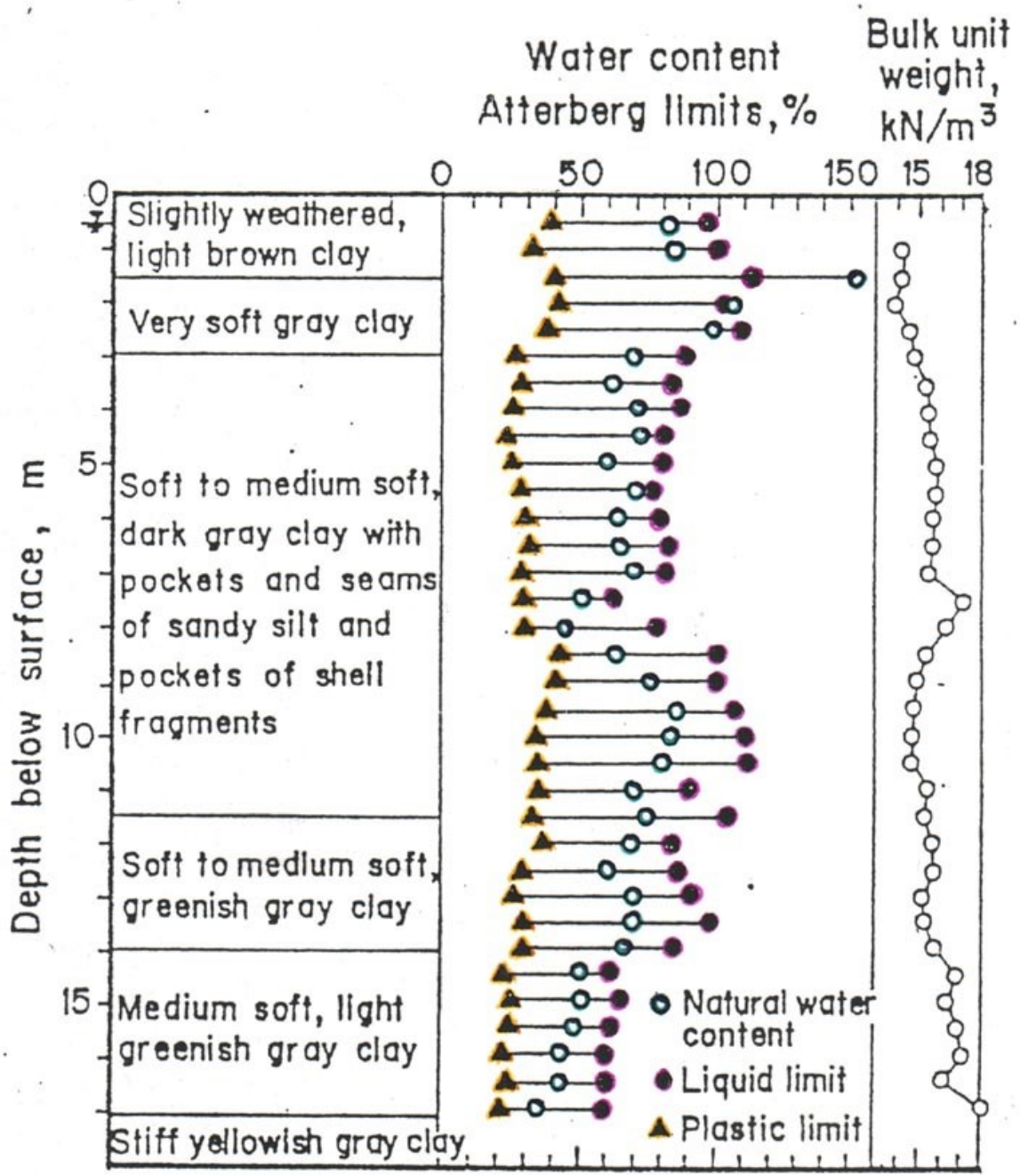
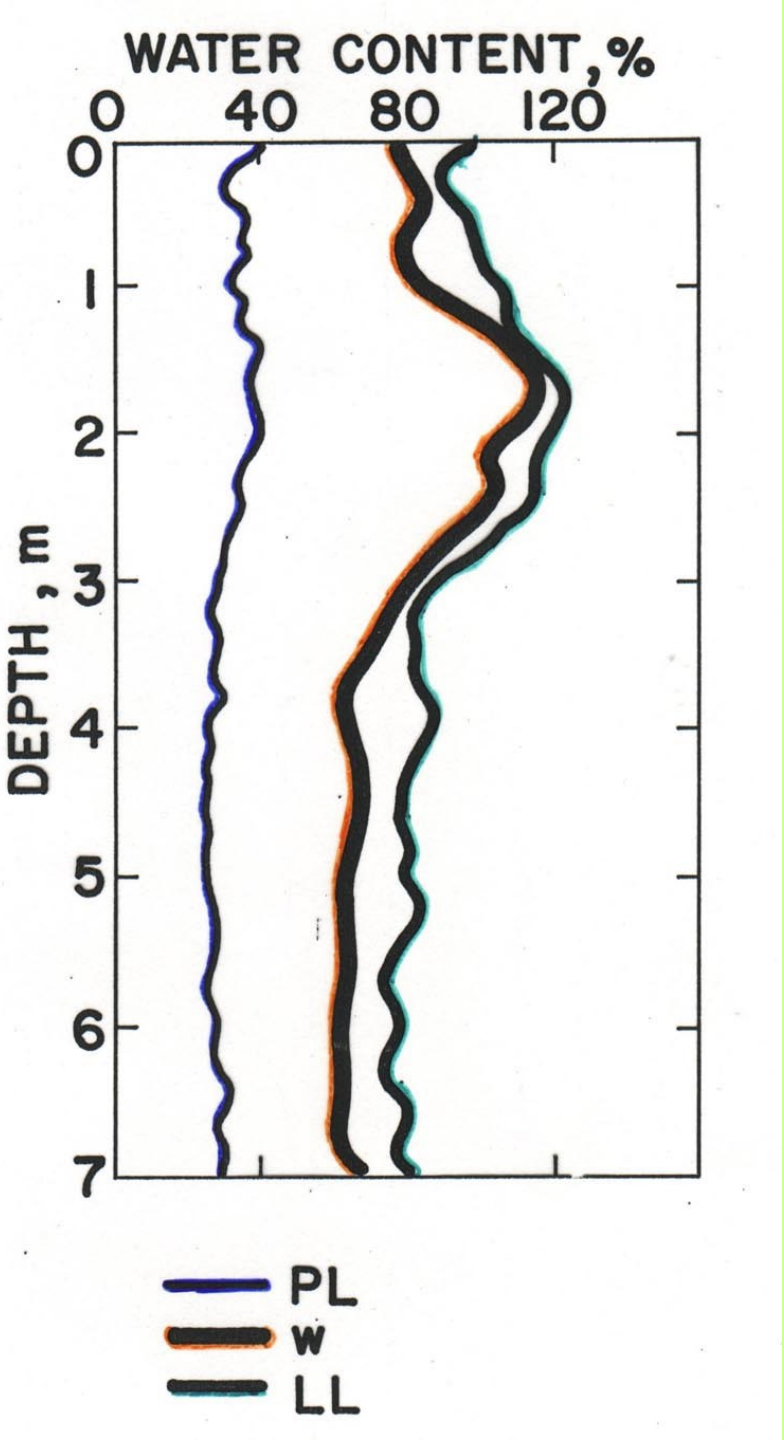
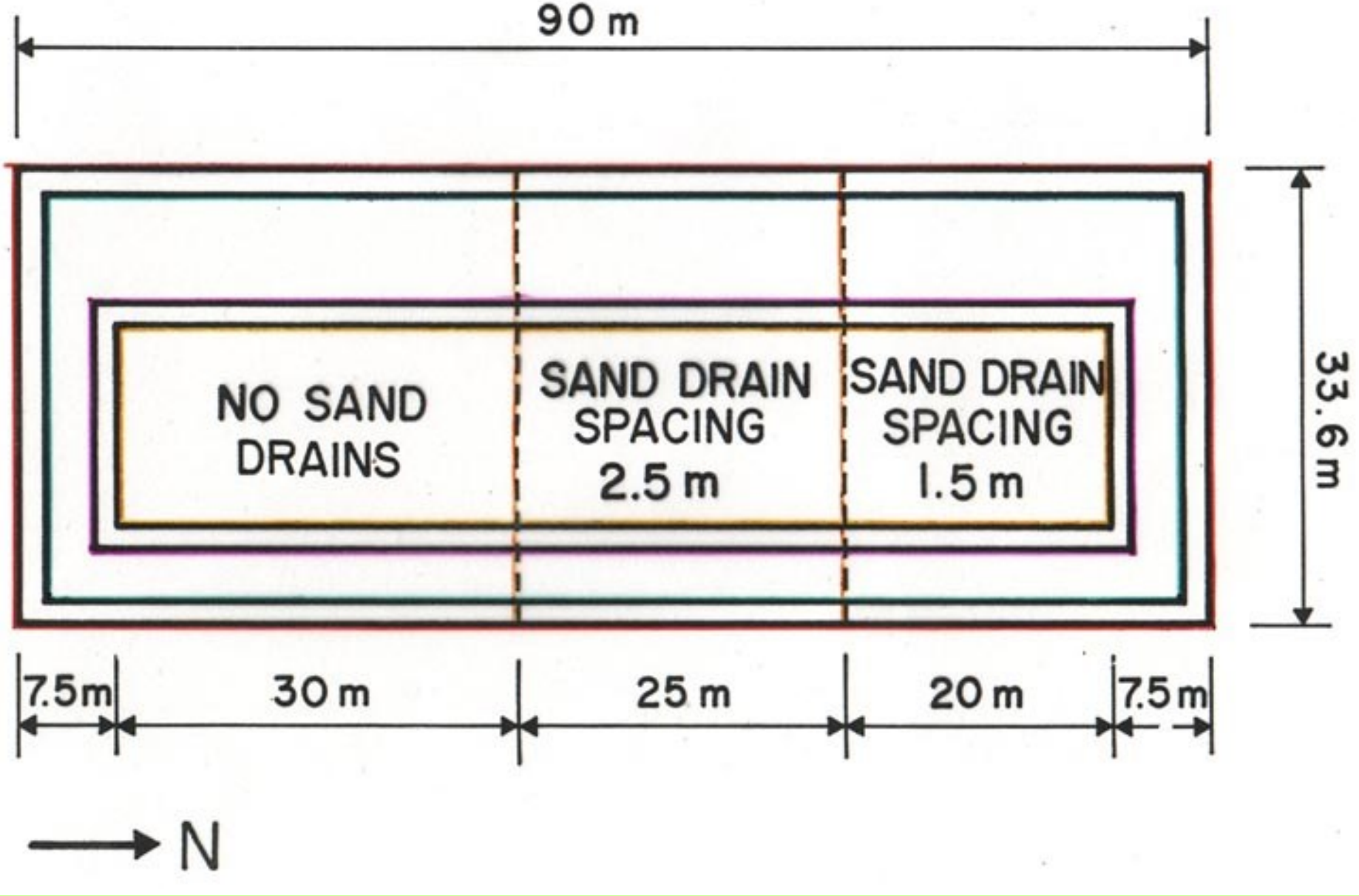
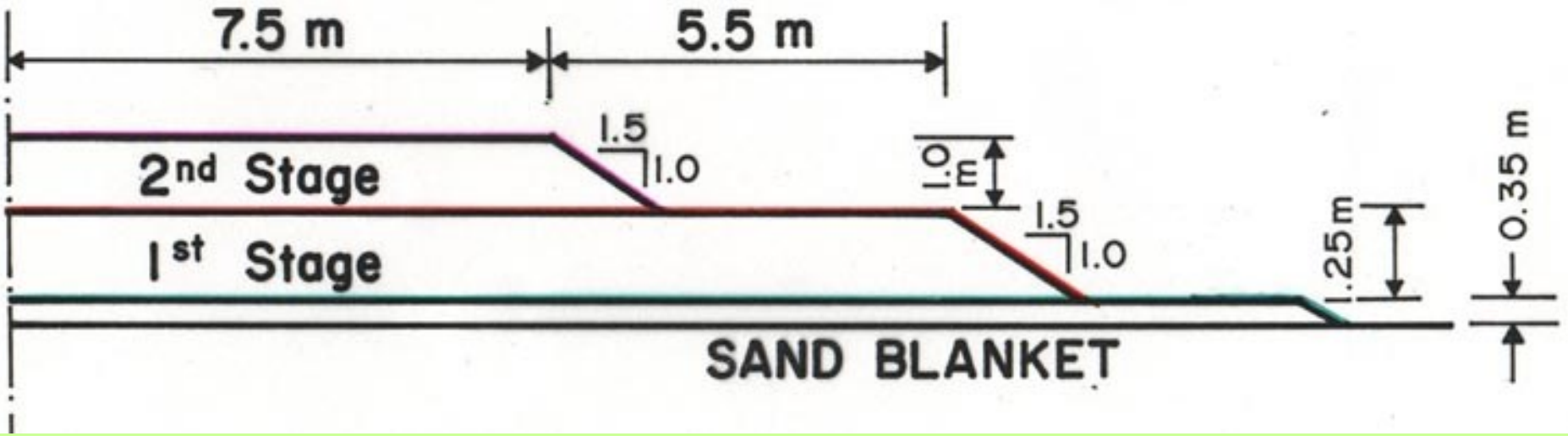
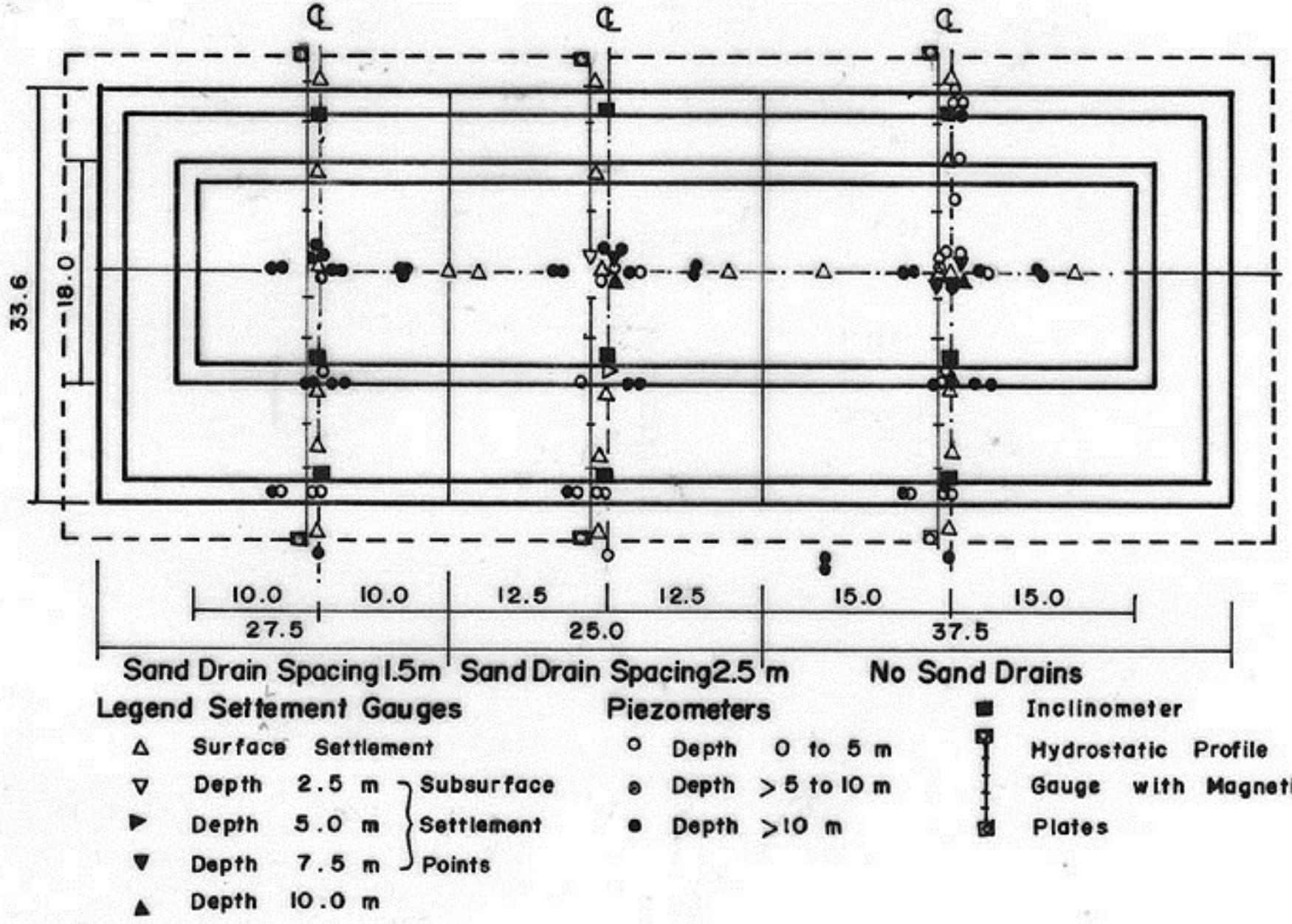


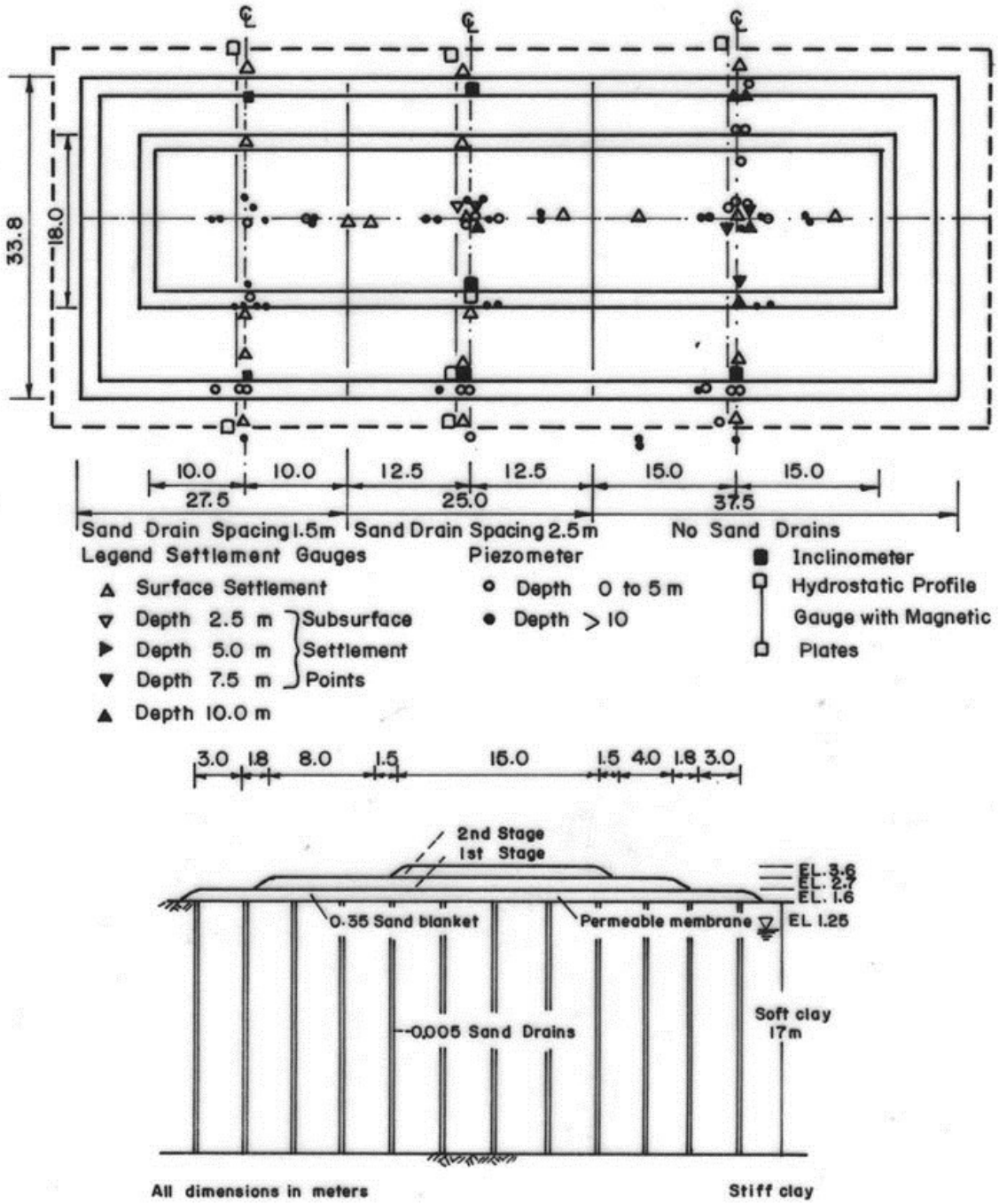
Fig. 4 Soil Profile for Pom Prachul Site

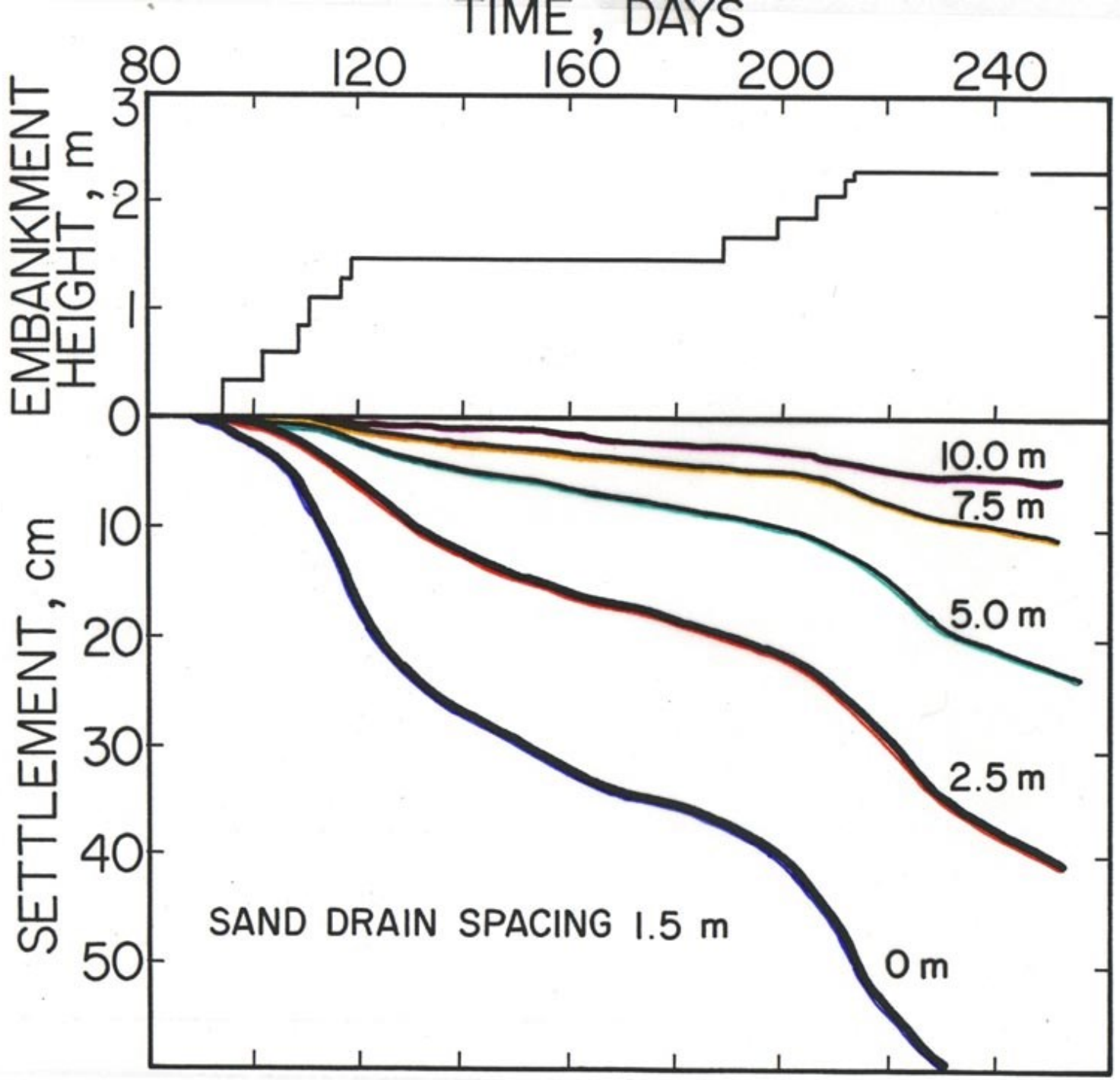

WATER CONTENT, %
0
40
80
120
DEPTH, m
0
1
2
3
4
5
6
7
PL
w
LL

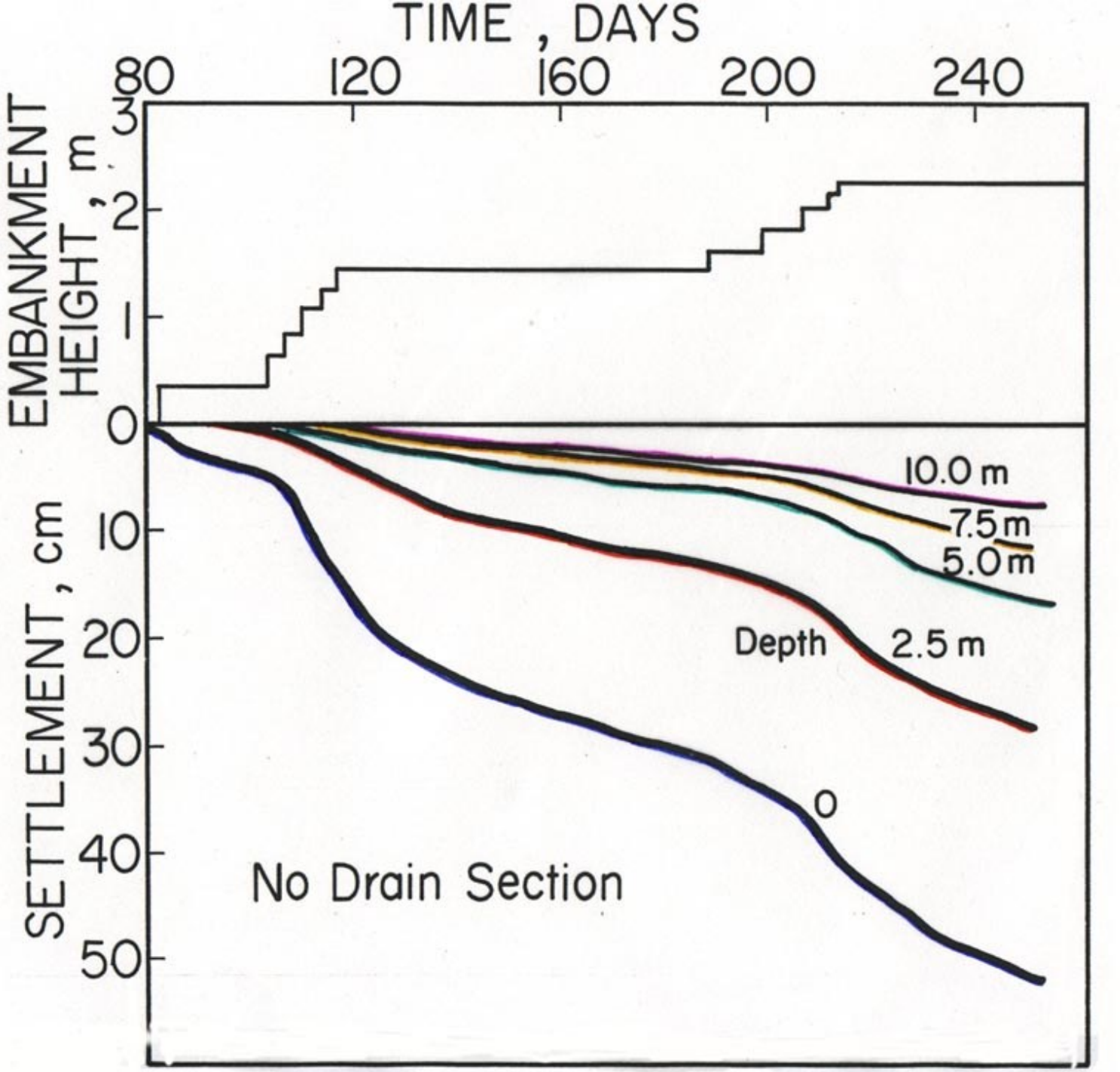

90 m
NO SAND DRAINS
SAND DRAIN SPACING 2.5 m
SAND DRAIN SPACING 1.5 m
33.6 m
7.5m
30 m
25 m
20 m
7.5m
N

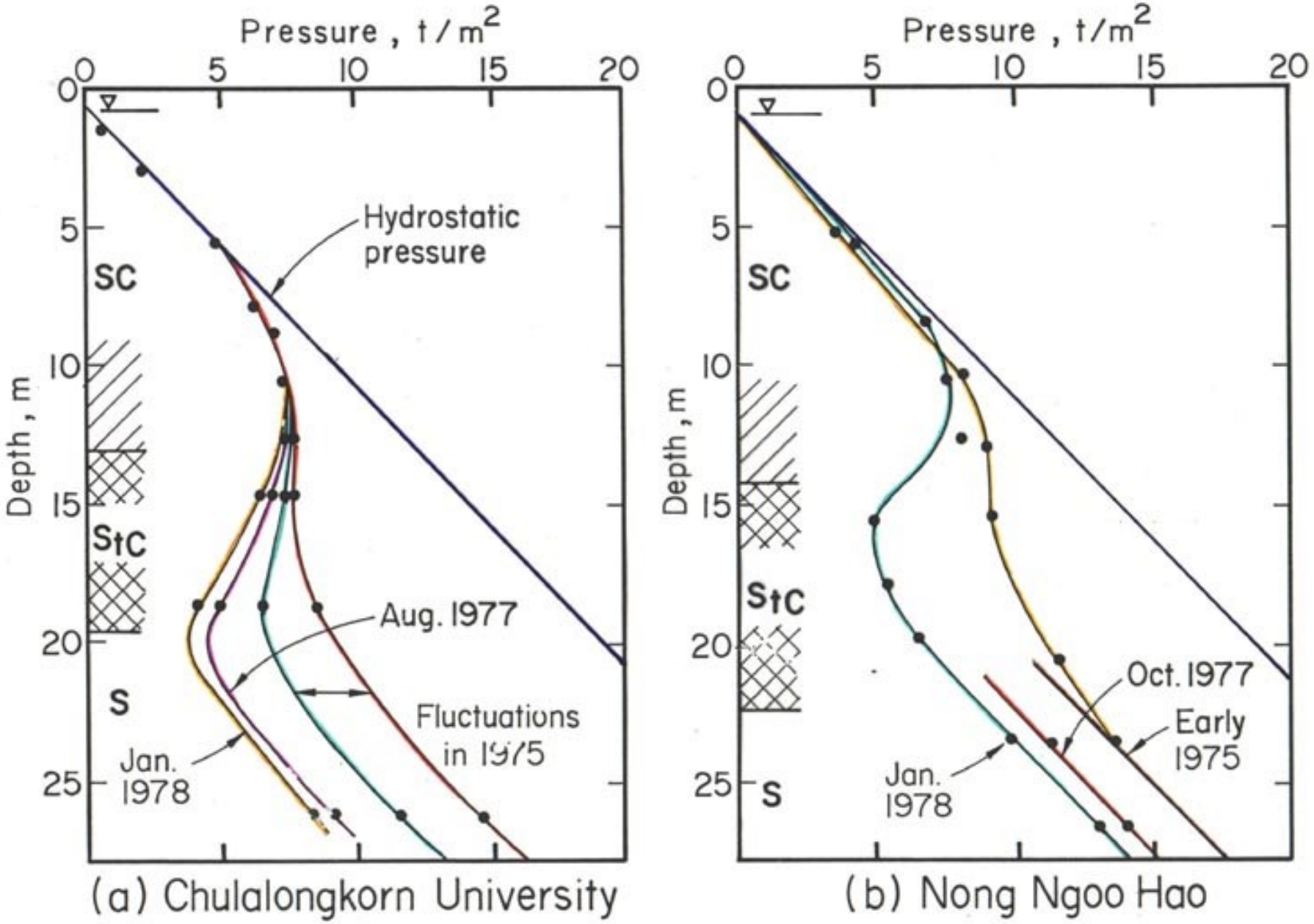

7.5 m
5.5 m
1.5
1.0
2nd Stage
1.0 m
1.5
1.0
1st Stage
1.25 m
0.35 m
SAND BLANKET


33.6
18.0
10.0
10.0
12.5
12.5
15.0
15.0
27.5
25.0
37.5
Sand Drain Spacing 1.5m
Sand Drain Spacing 2.5 m
No Sand Drains
Legend Settement Gauges
Surface Settlement
Depth 2.5 m
Depth 5.0 m
Depth 7.5 m
Depth 10.0 m
Subsurface Settlement Points
Piezometers
Depth 0 to 5 m
Depth > 5 to 10 m
Depth > 10 m
Inclinometer
Hydrostatic Profile
Gauge with Magnetic Plates


33.8
18.0
10.0
10.0
12.5
12.5
15.0
15.0
27.5
25.0
37.5
Sand Drain Spacing 1.5m
Sand Drain Spacing 2.5m
No Sand Drains
Legend Settlement Gauges
Surface Settlement
Depth 2.5 m
Depth 5.0 m
Depth 7.5 m
Subsurface Settlement Points
Depth 10.0 m
Piezometer
Depth 0 to 5 m
Depth > 10
Inclinometer
Hydrostatic Profile Gauge with Magnetic Plates
3.0
1.8
8.0
1.5
15.0
1.5
4.0
1.8
3.0
2nd Stage
1st Stage
EL. 3.6
EL. 2.7
EL. 1.6
0.35 Sand blanket
Permeable membrane
EL. 1.25
0.005 Sand Drains
Soft clay
17m
All dimensions in meters
Stiff clay


TIME, DAYS
80
120
160
200
240
EMBANKMENT HEIGHT, m
0
1
2
3
SETTLEMENT, cm
0
10
20
30
40
50
10.0 m
7.5 m
5.0 m
2.5 m
0 m
SAND DRAIN SPACING 1.5 m


TIME , DAYS
80
120
160
200
240
EMBANKMENT HEIGHT, m
3
2
1
0
SETTLEMENT, cm
10
20
30
40
50
10.0 m
7.5m
5.0m
Depth
2.5 m
0
No Drain Section



Water Pressure Declines in Surface Clay Layer