Wednesday 6th December--1

Royal Thai Navy Dockyard

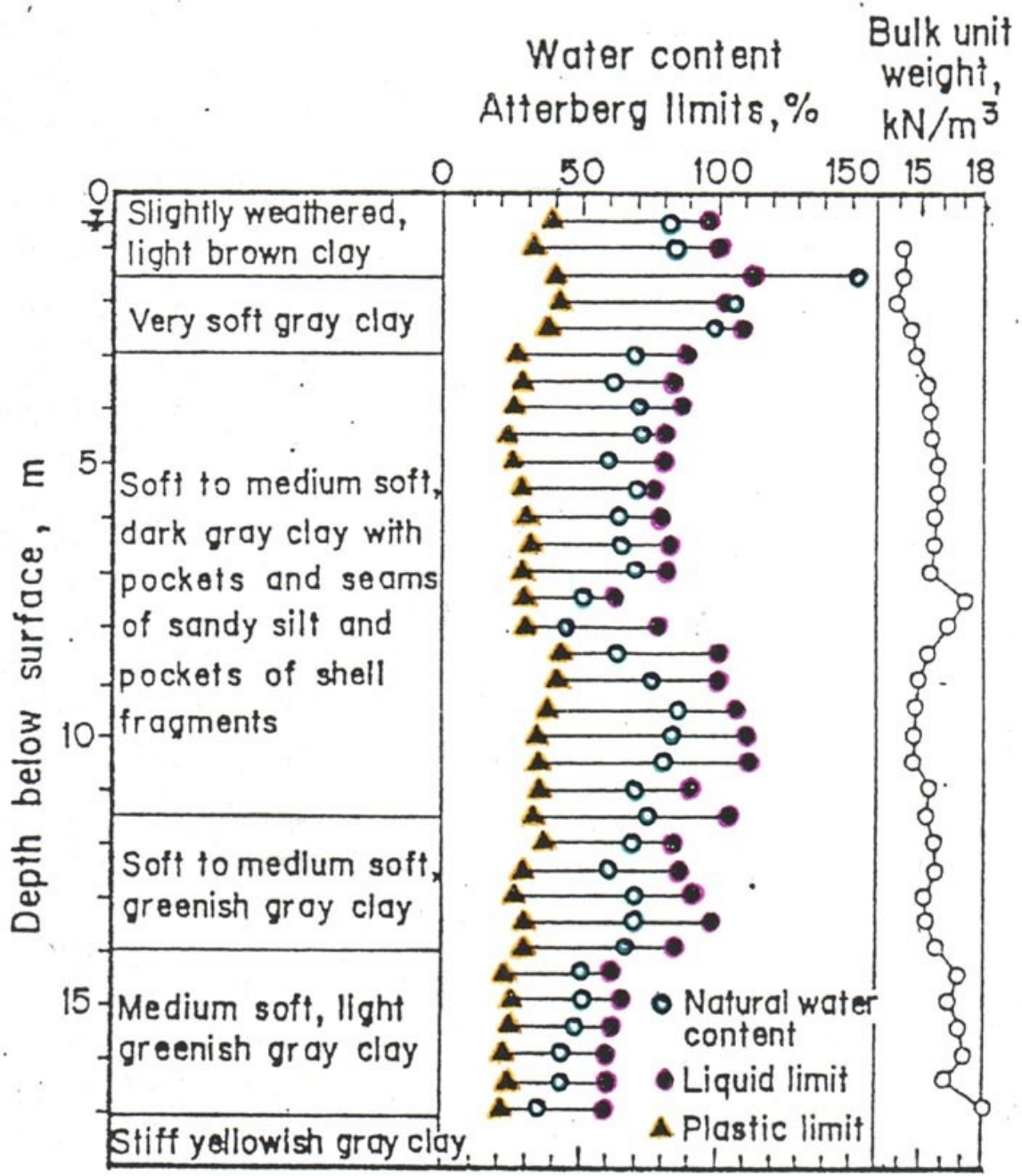
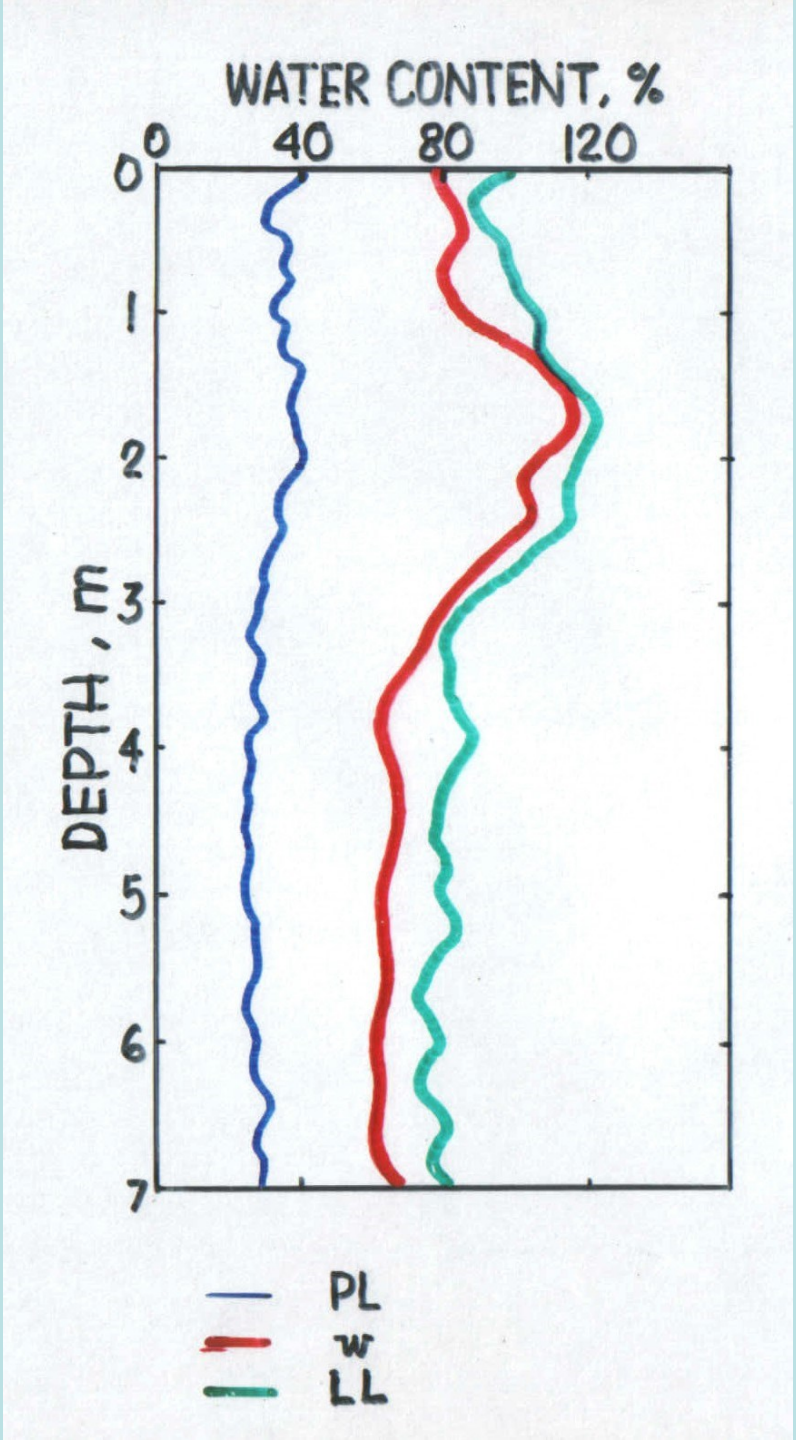
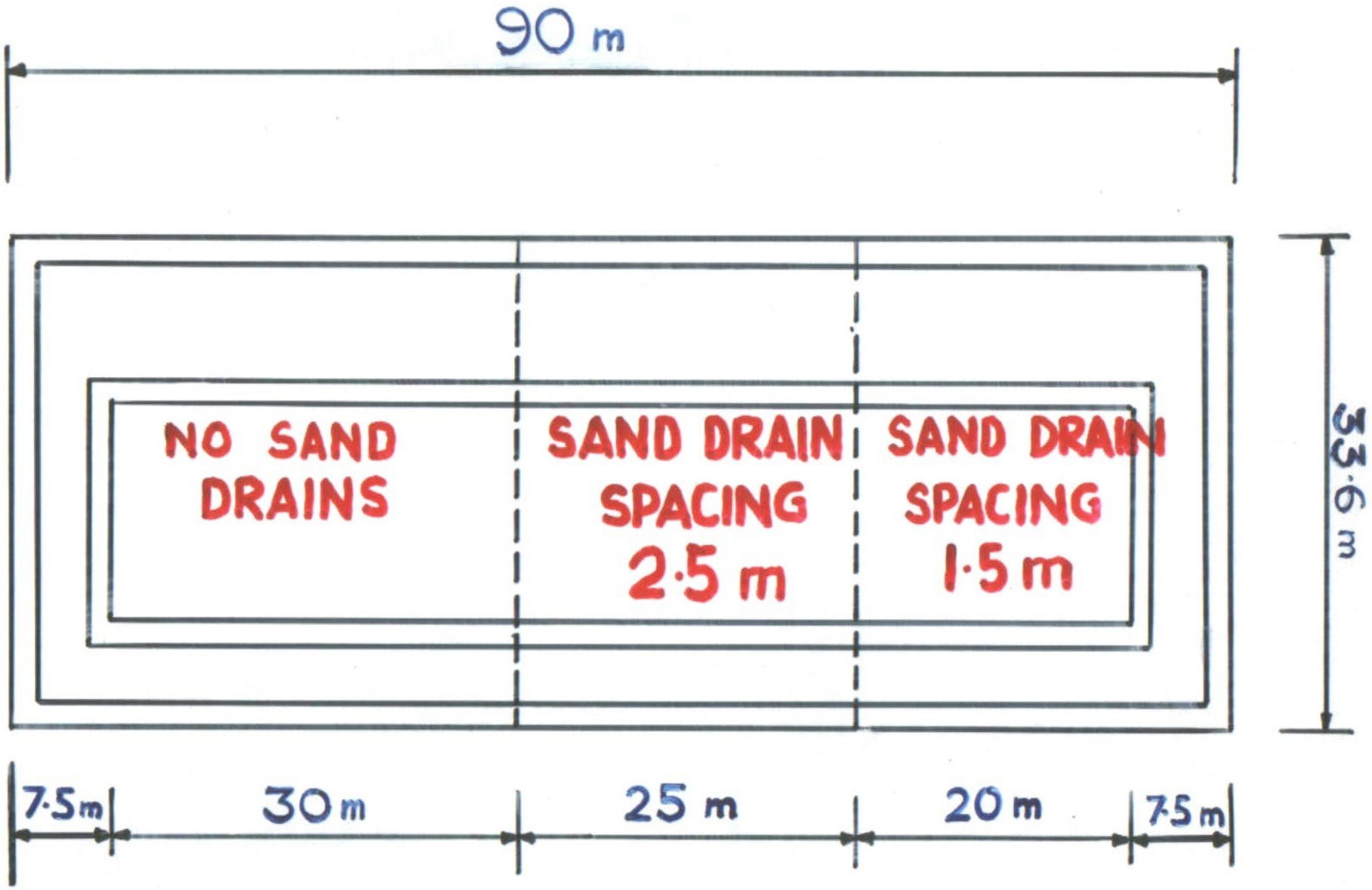
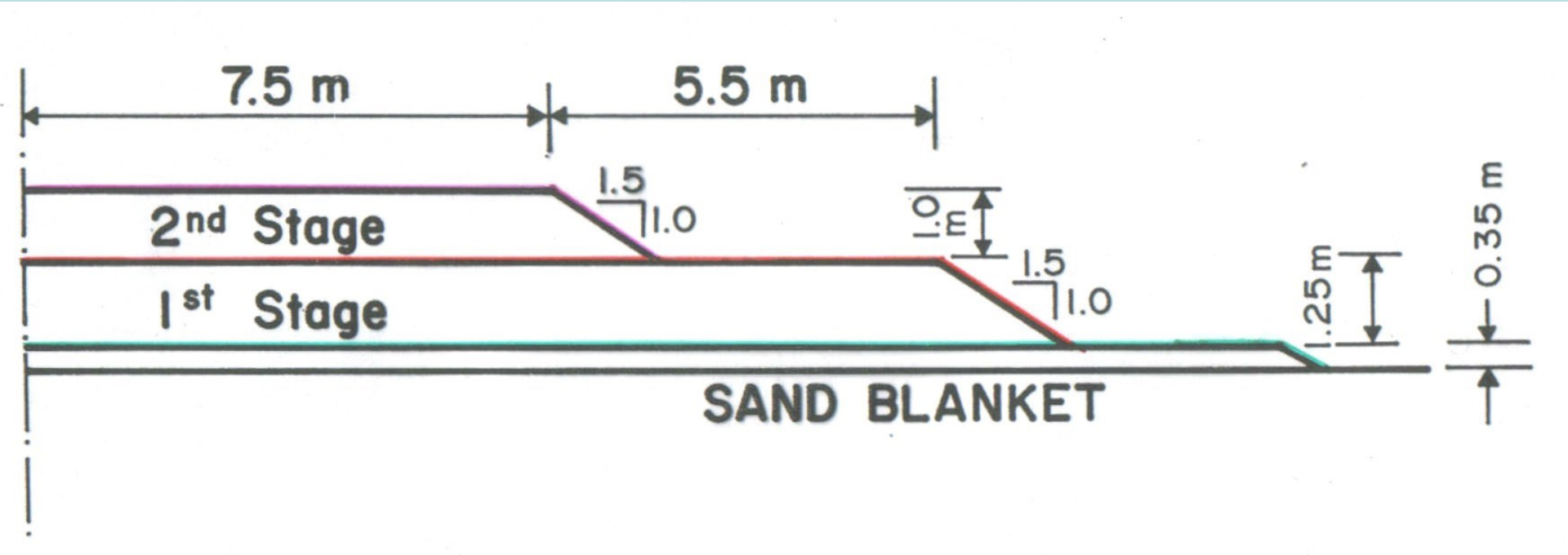
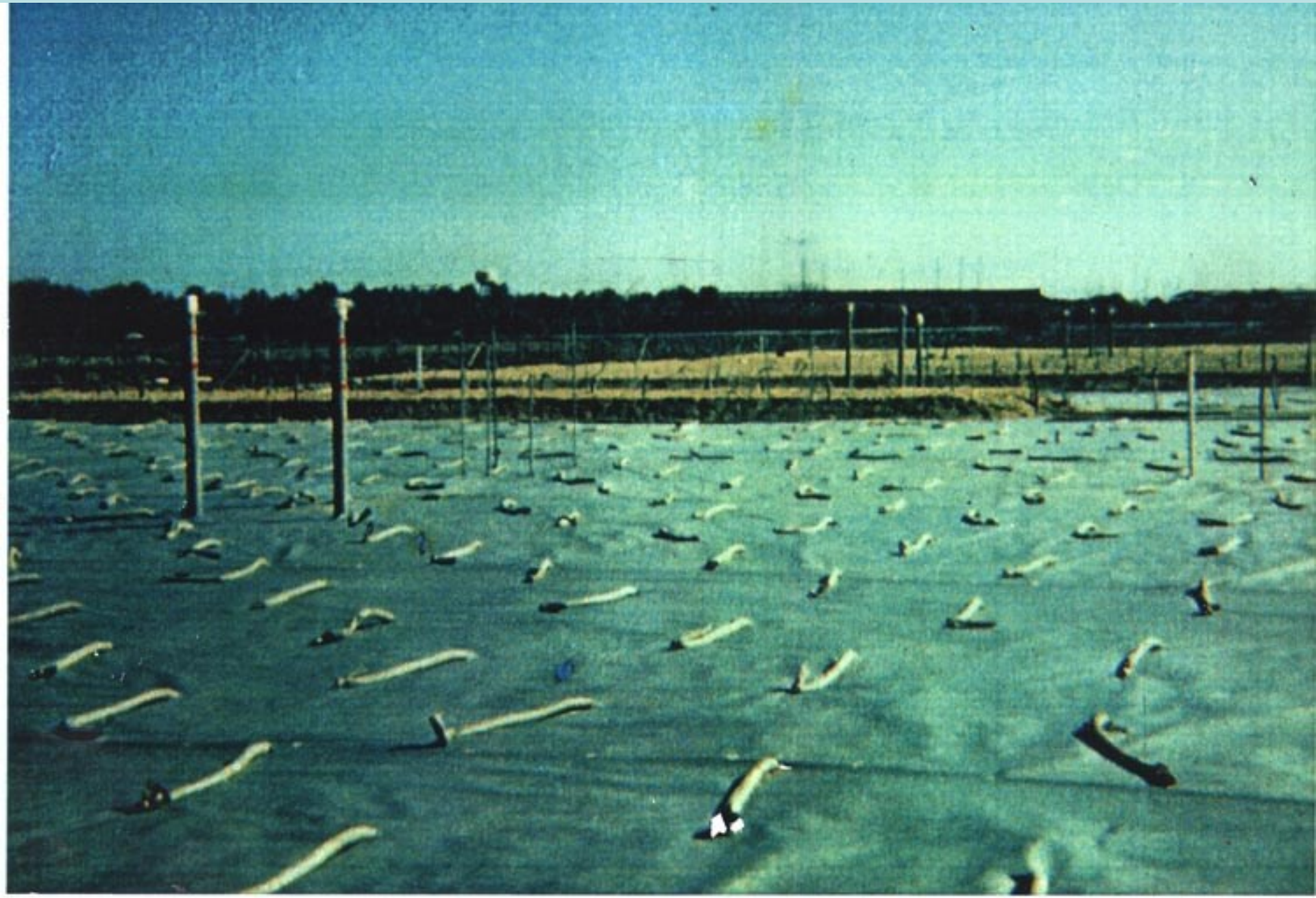


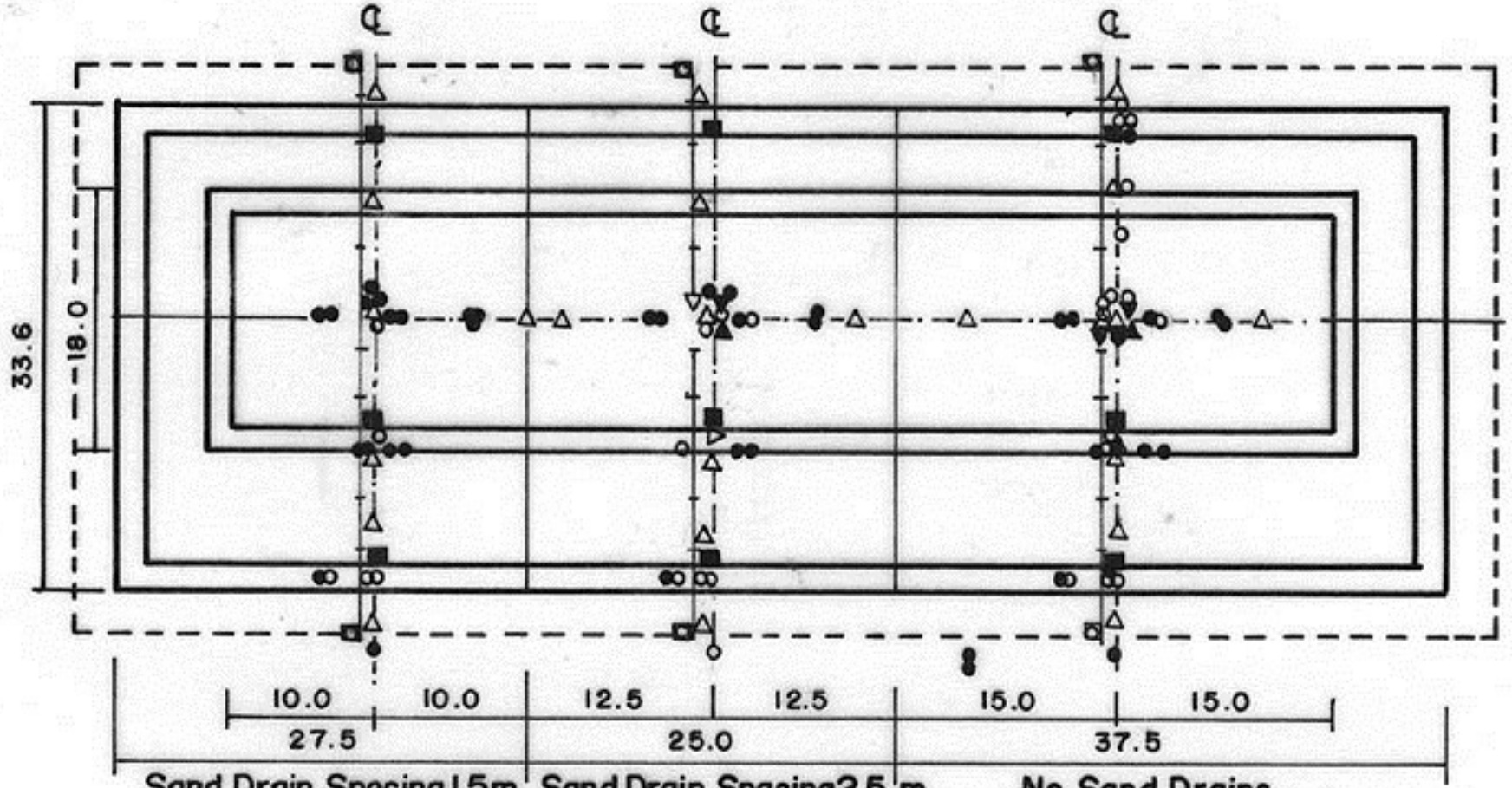
Fig. 4 Soil Profile for Pom Prachul Site

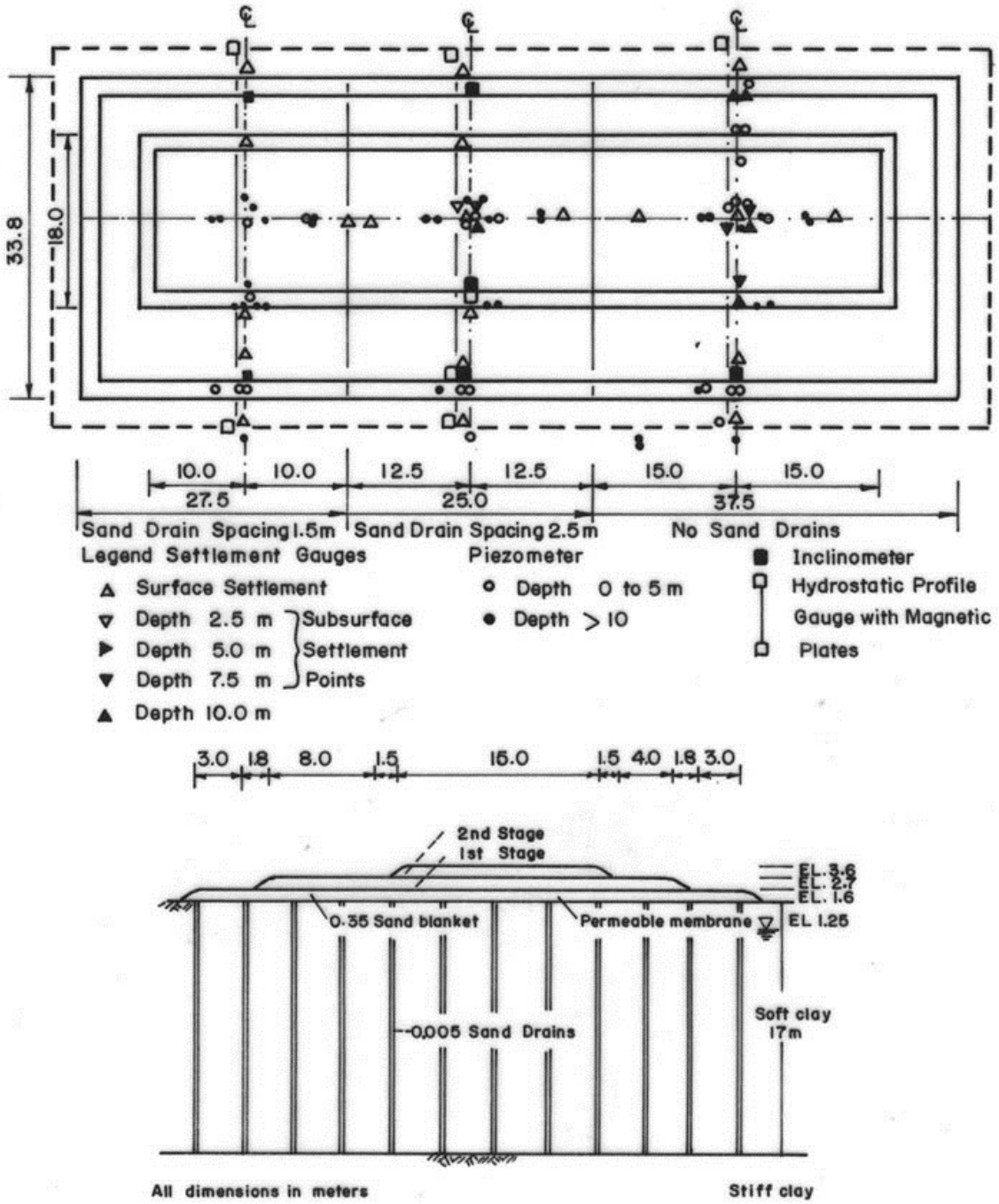

WATER CONTENT, %
0
40
80
120
DEPTH, m
0
1
2
3
4
5
6
7
PL
w
LL

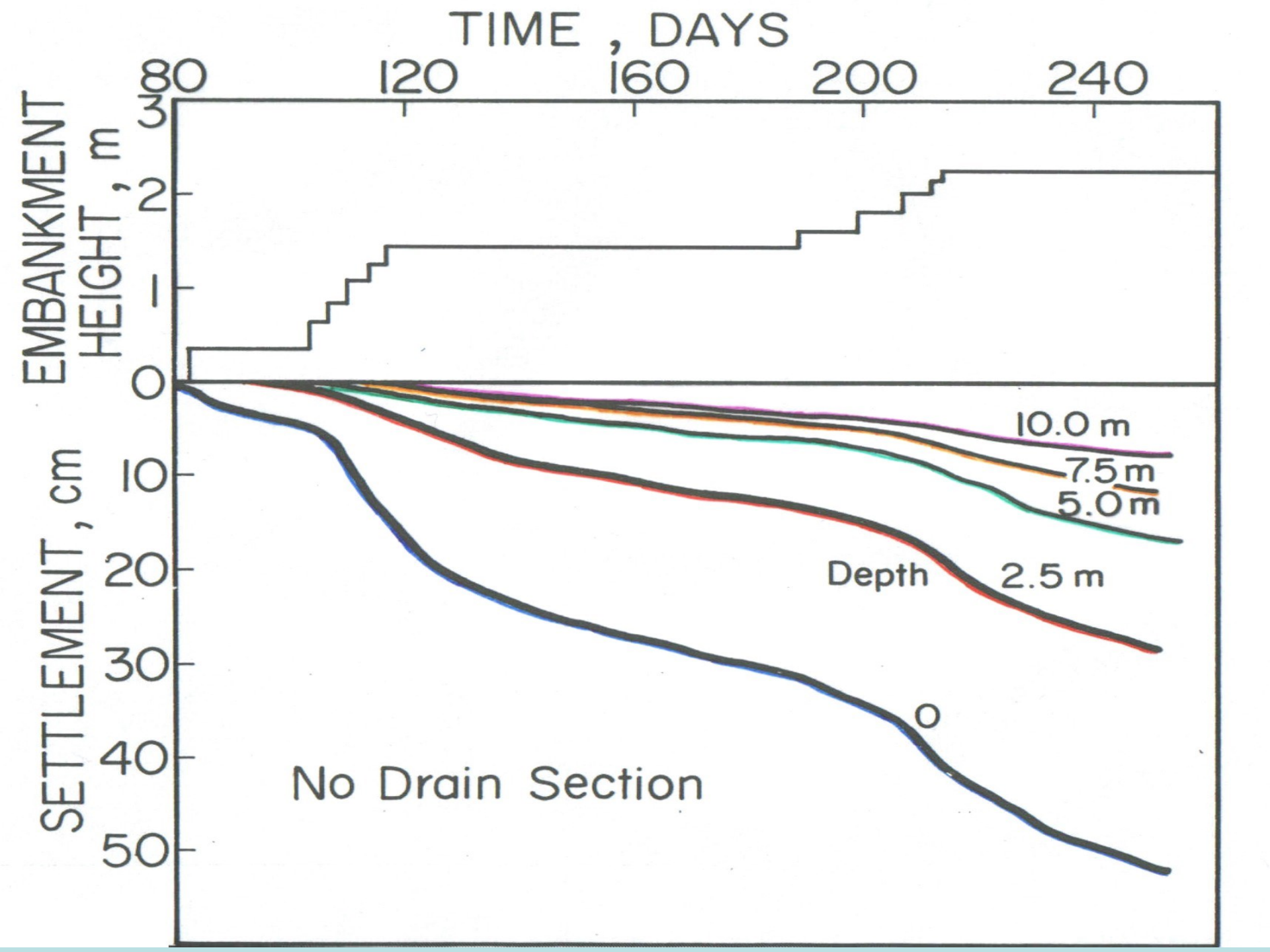

90 m
NO SAND DRAINS
SAND DRAIN SPACING 2·5 m
SAND DRAIN SPACING 1·5 m
33·6 m
7·5m
30 m
25 m
20 m
7·5m
N

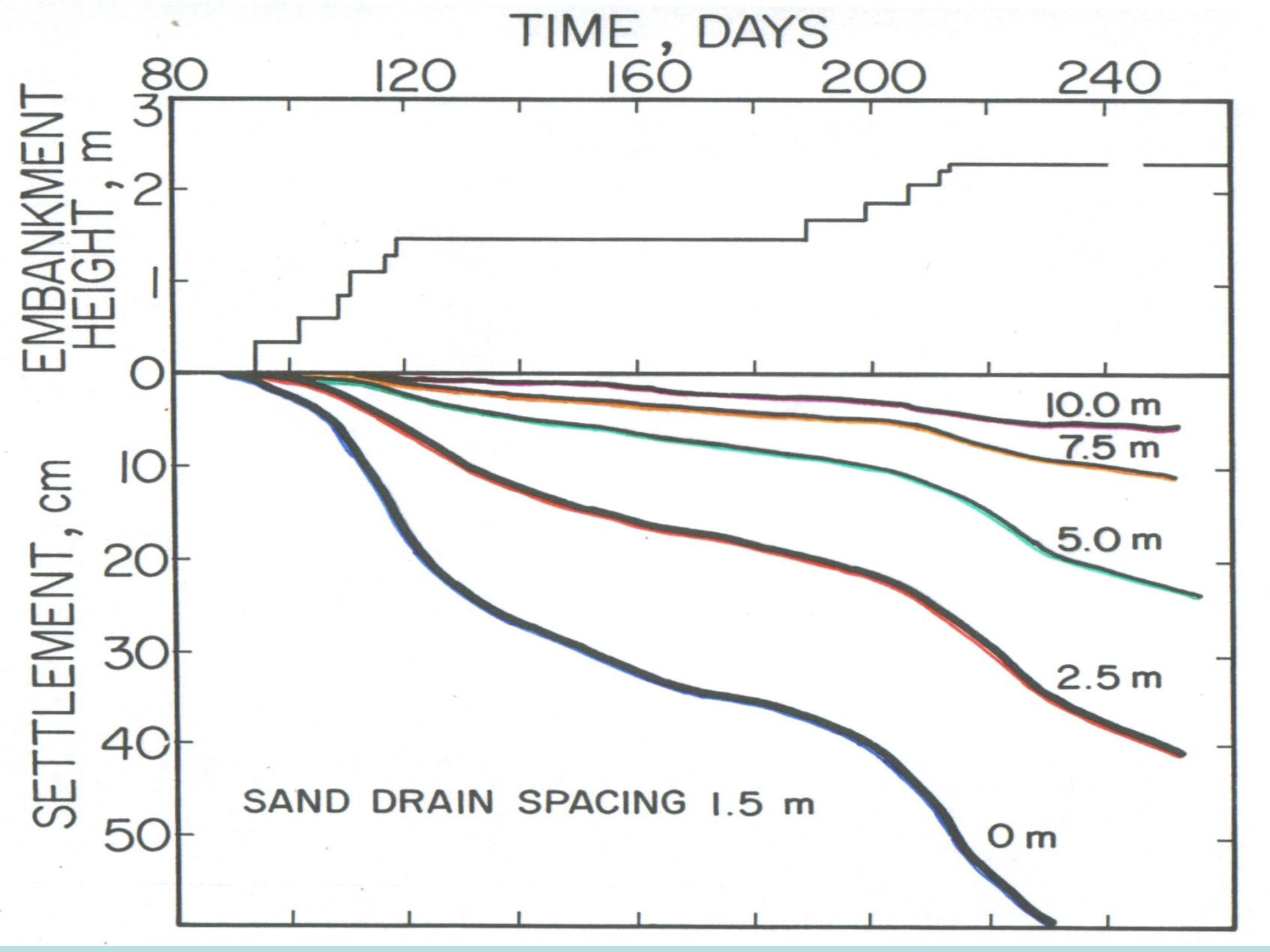

7.5 m
5.5 m
1.5
1.0
2nd Stage
1.0 m
1.5
1.0
1st Stage
1.25m
0.35 m
SAND BLANKET

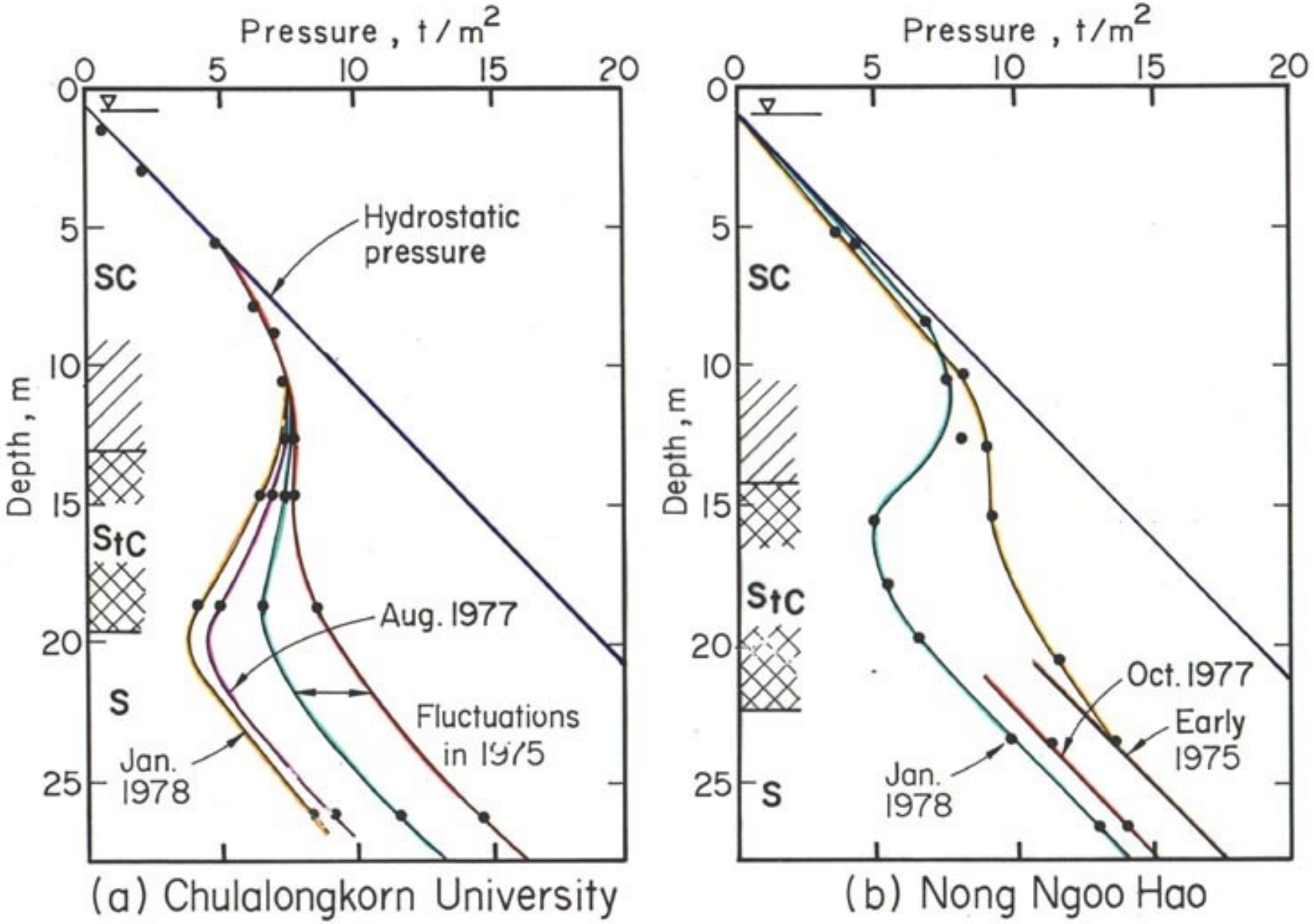



33.6
18.0
10.0
10.0
12.5
12.5
15.0
15.0
27.5
25.0
37.5
Sand Drain Spacing 1.5m
Sand Drain Spacing 2.5 m
No Sand Drains
Legend Settement Gauges
Surface Settlement
Depth 2.5 m
Depth 5.0 m
Depth 7.5 m
Depth 10.0 m
Subsurface Settlement Points
Piezometers
Depth 0 to 5 m
Depth > 5 to 10 m
Depth > 10 m
Inclinometer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

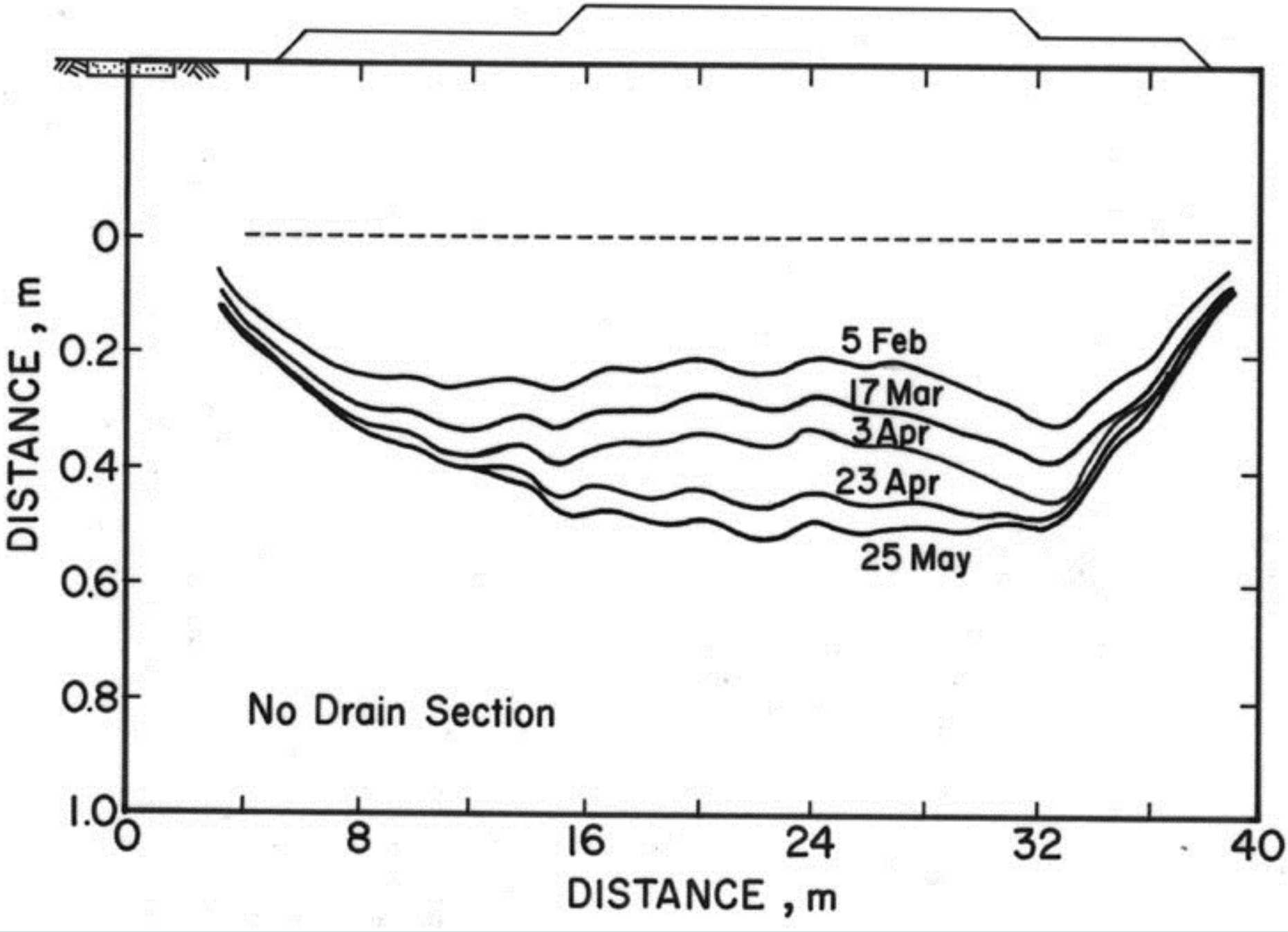

33.8
18.0
10.0
10.0
12.5
12.5
15.0
15.0
27.5
25.0
37.5
Sand Drain Spacing 1.5m
Sand Drain Spacing 2.5m
No Sand Drains
Legend Settlement Gauges
Surface Settlement
Depth 2.5 m
Depth 5.0 m
Depth 7.5 m
Subsurface Settlement Points
Depth 10.0 m
Piezometer
Depth 0 to 5 m
Depth > 10
Inclinometer
Hydrostatic 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

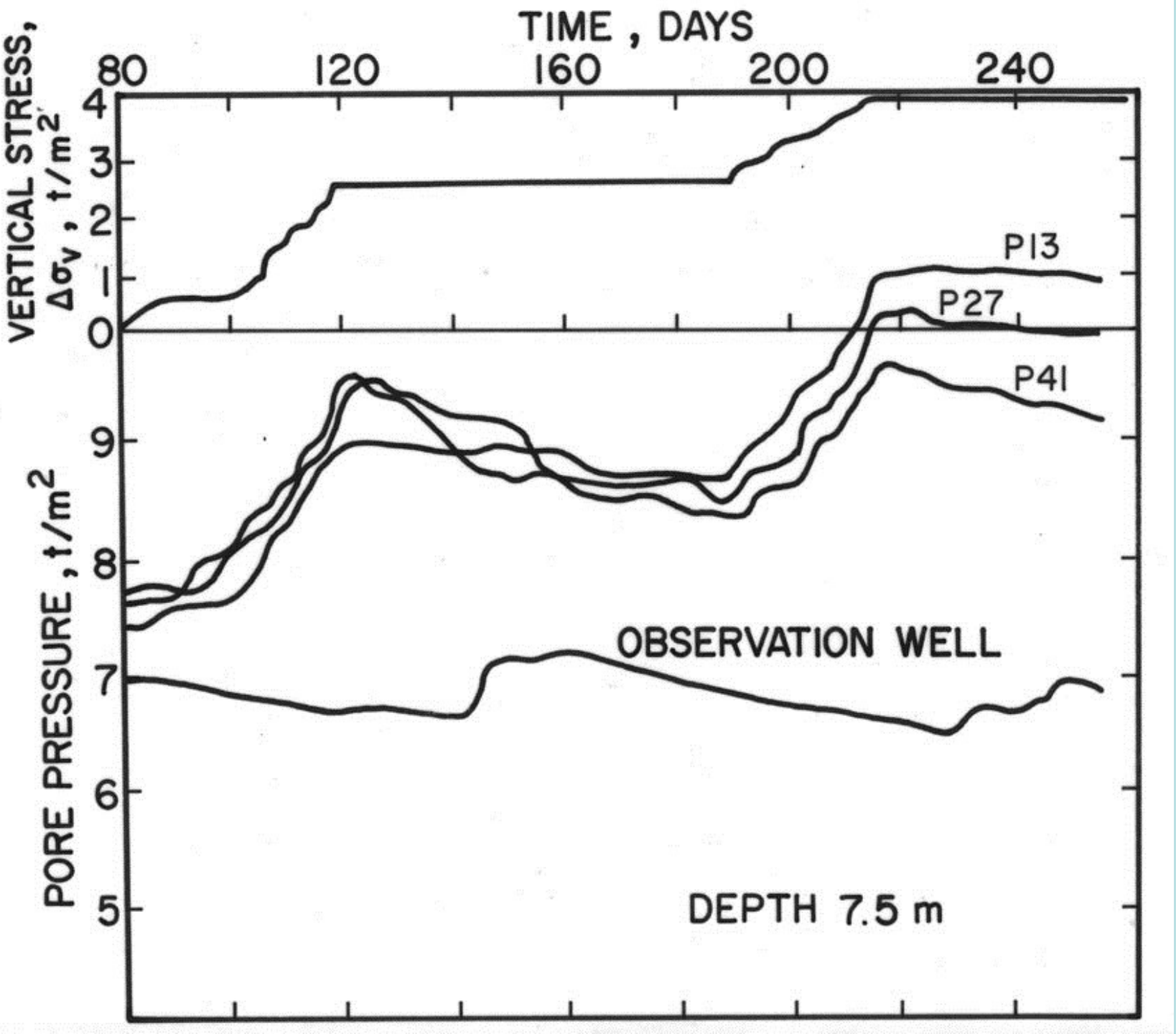

TIME , DAYS
80
120
160
200
240
EMBANKMENT HEIGHT, m
3
2
1
0
SETTLEMENT, cm
10
20
30
40
50
10.0 m
7.5 m
5.0 m
Depth
2.5 m
0
No Drain Section

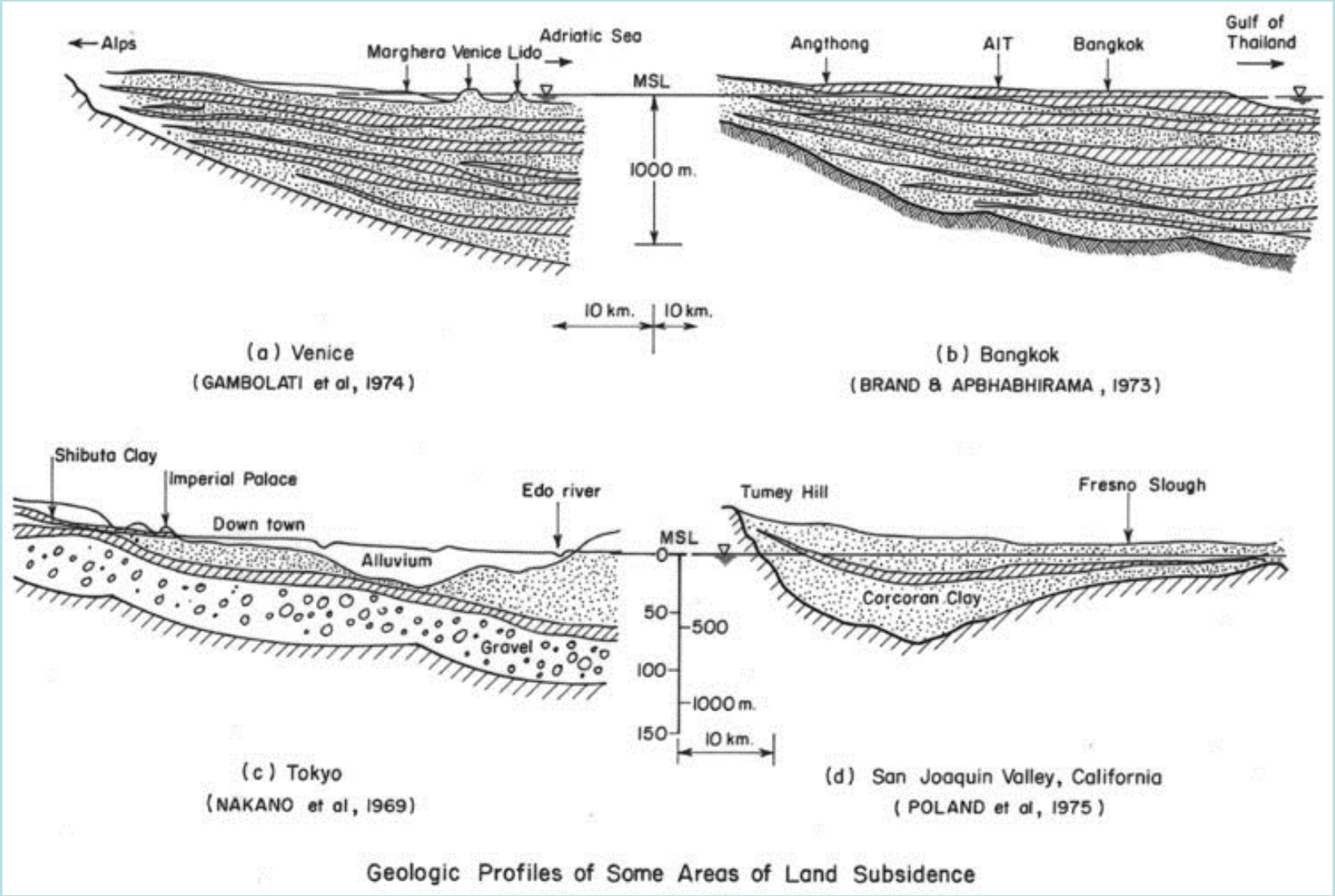

TIME , DAYS
80
120
160
200
240
EMBANKMENT HEIGHT, m
3
2
1
0
SETTLEMENT, cm
10
20
30
40
50
10.0 m
7.5 m
5.0 m
2.5 m
0 m
SAND DRAIN SPACING 1.5 m



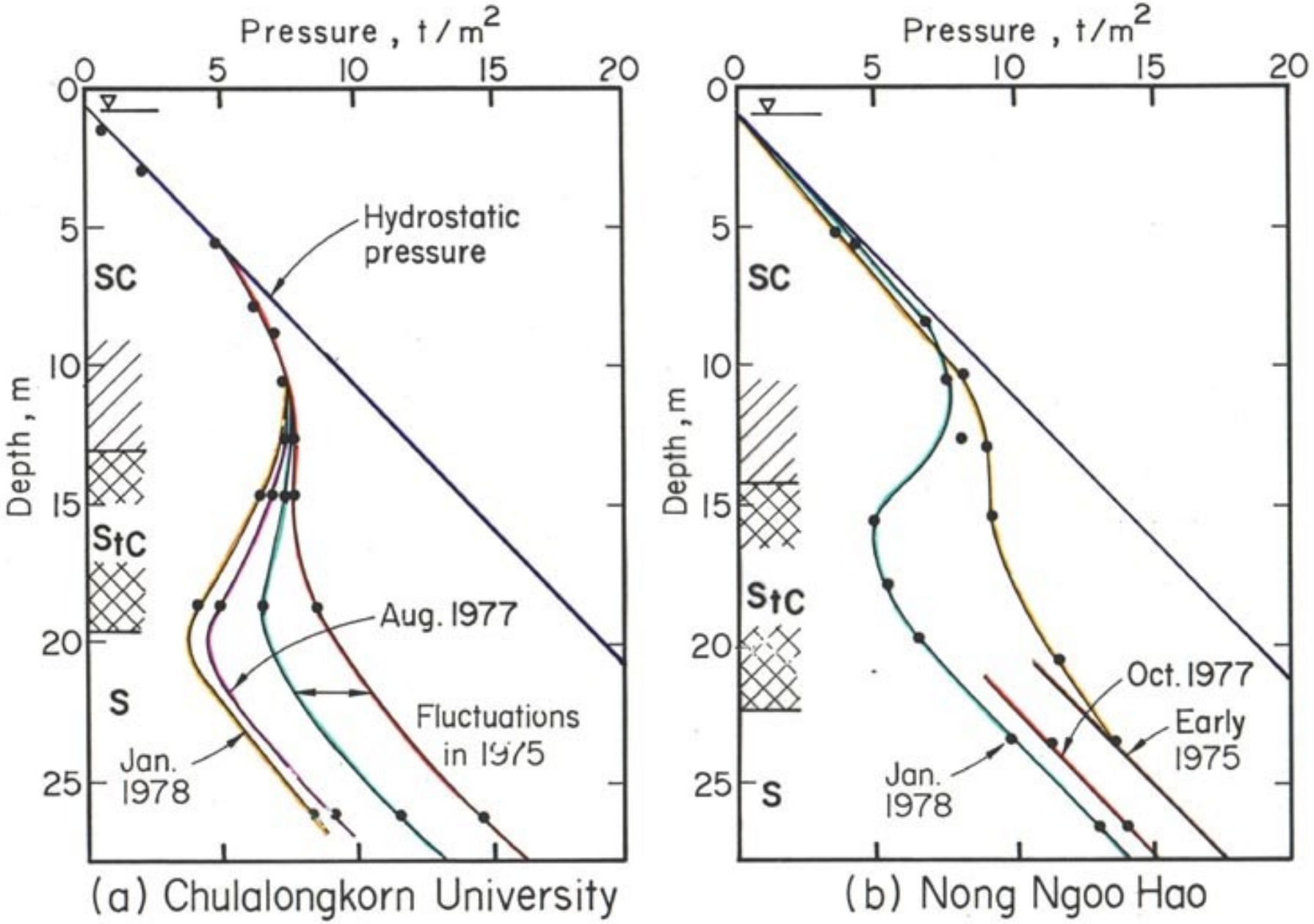
Water Pressure Declines in Surface Clay Layer


0
0.2
0.4
0.6
0.8
1.0
DISTANCE , m
5 Feb
17 Mar
3 Apr
23 Apr
25 May
No Drain Section
0
8
16
24
32
40
DISTANCE , m

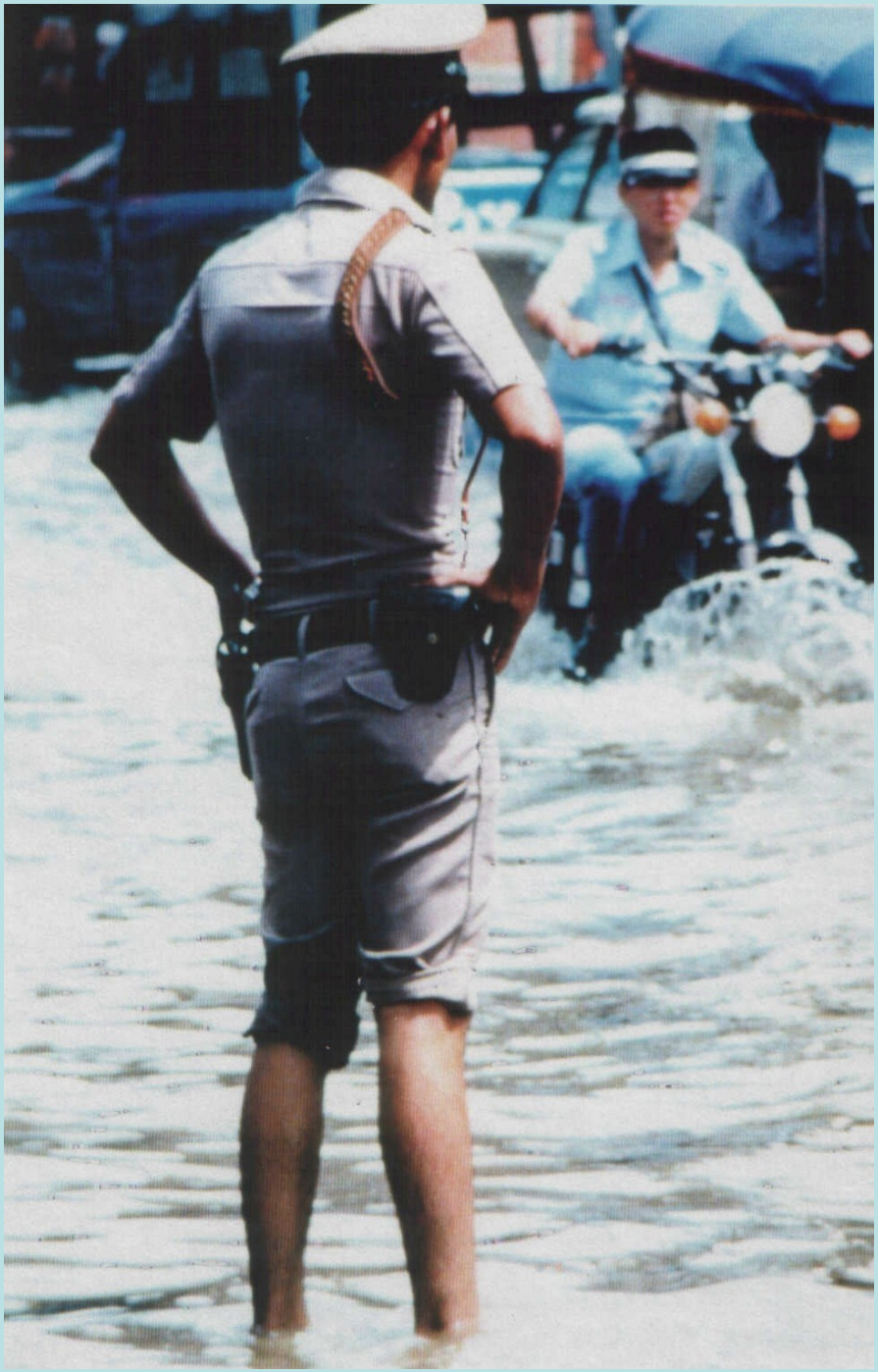

TIME , DAYS
80
120
160
200
240
VERTICAL STRESS, Δσv , t/m2
4
3
2
1
0
P13
P27
P41
PORE PRESSURE , t/m2
9
8
7
6
5
OBSERVATION WELL
DEPTH 7.5 m

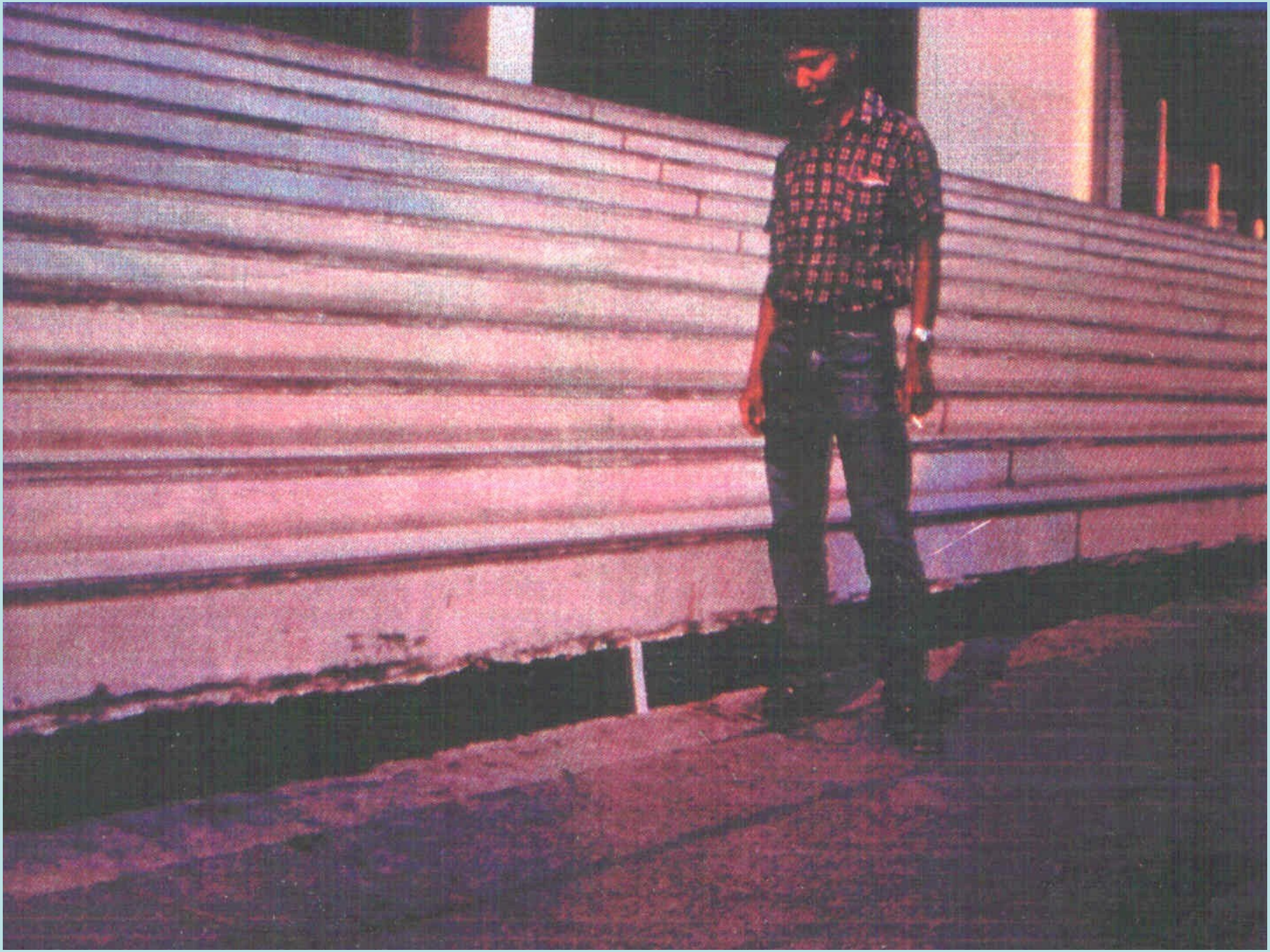


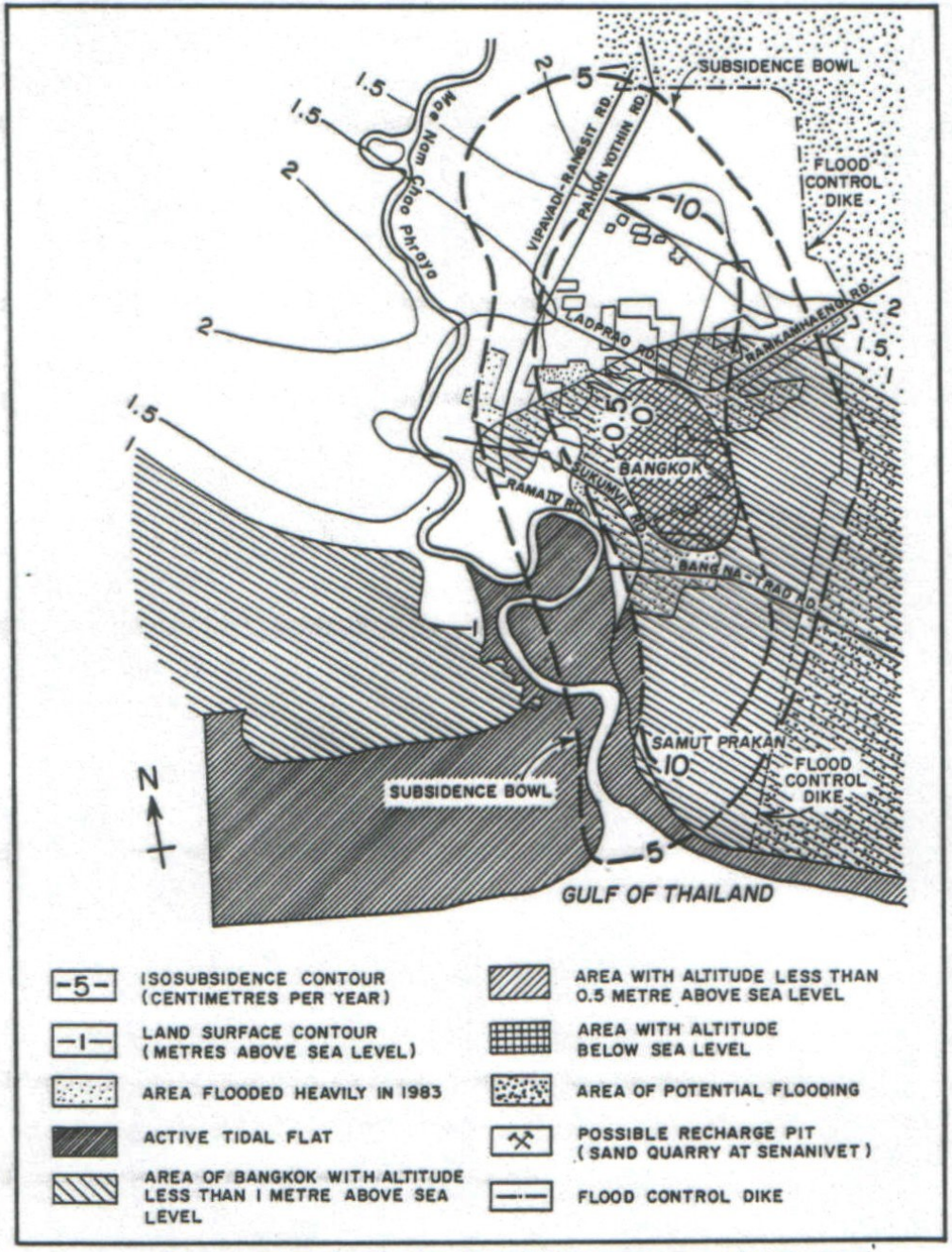
Geologic Profiles of Some Areas of Land Subsidence



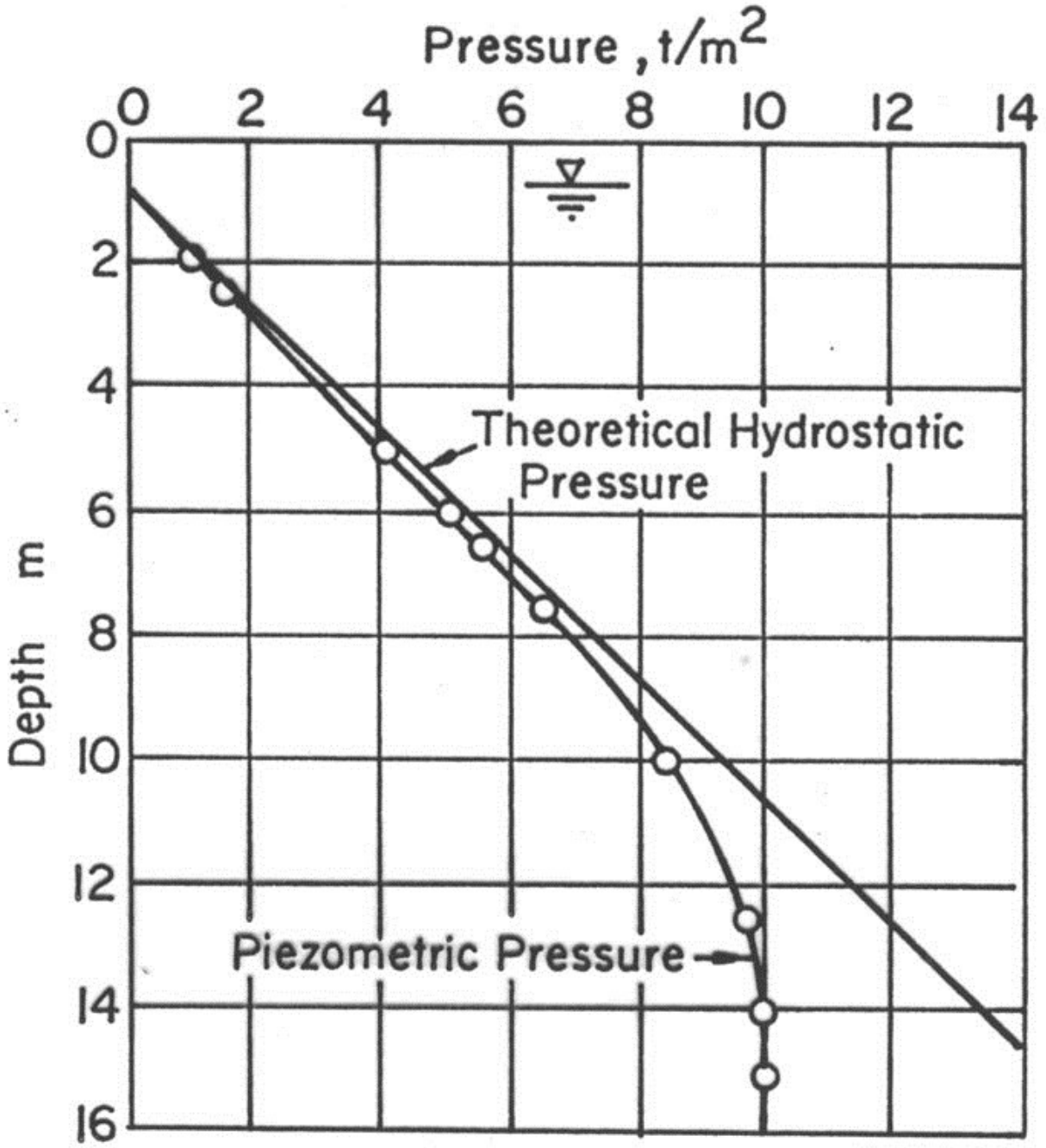
Water Pressure Declines in Surface Clay Layer

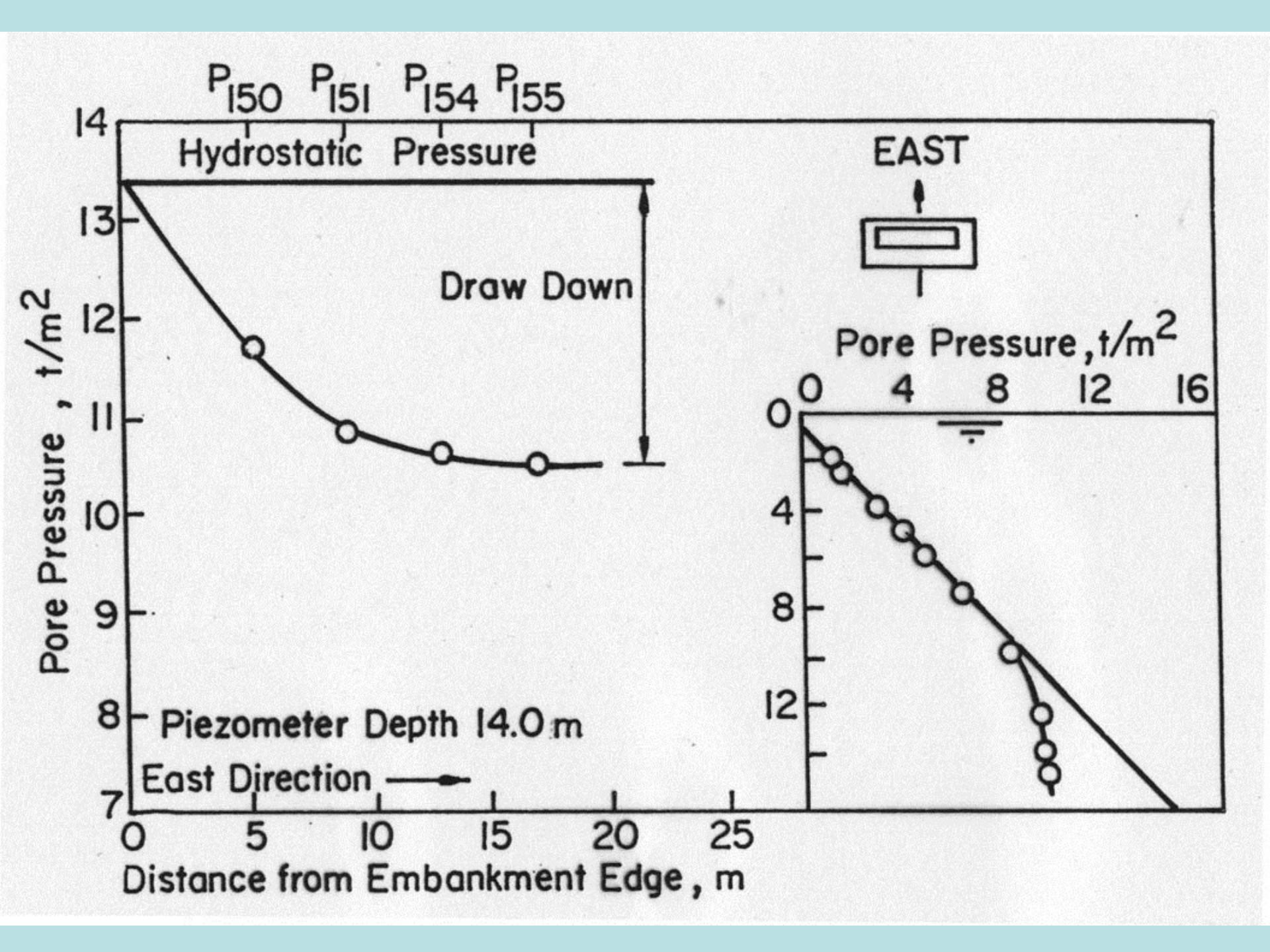




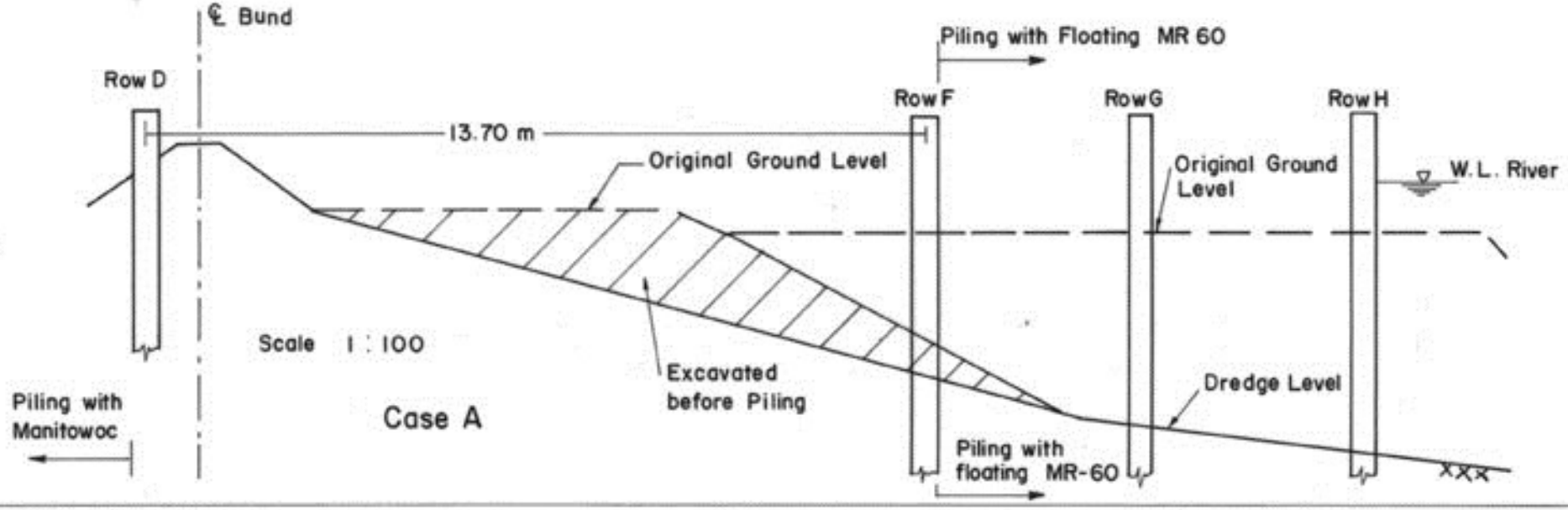


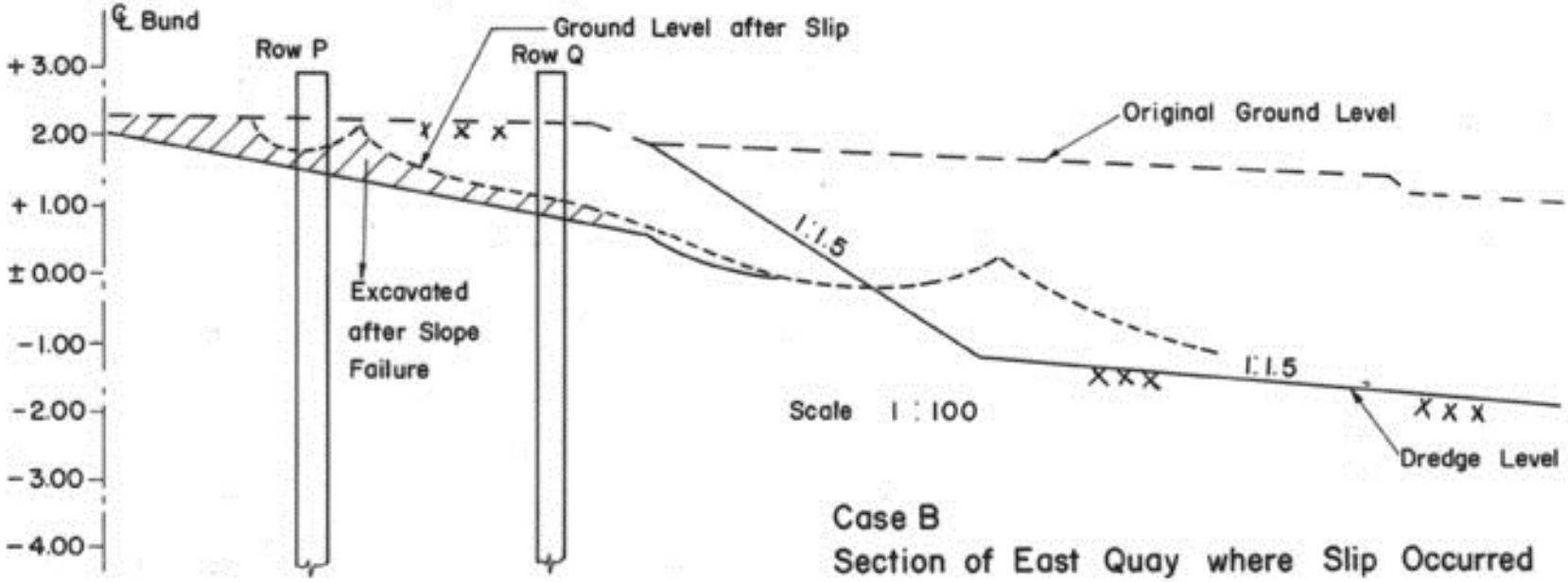
Sources : Prinya Nutalaya (AIT), Dept. Mineral Resources, Japan International Cooperation Agency (JICA)

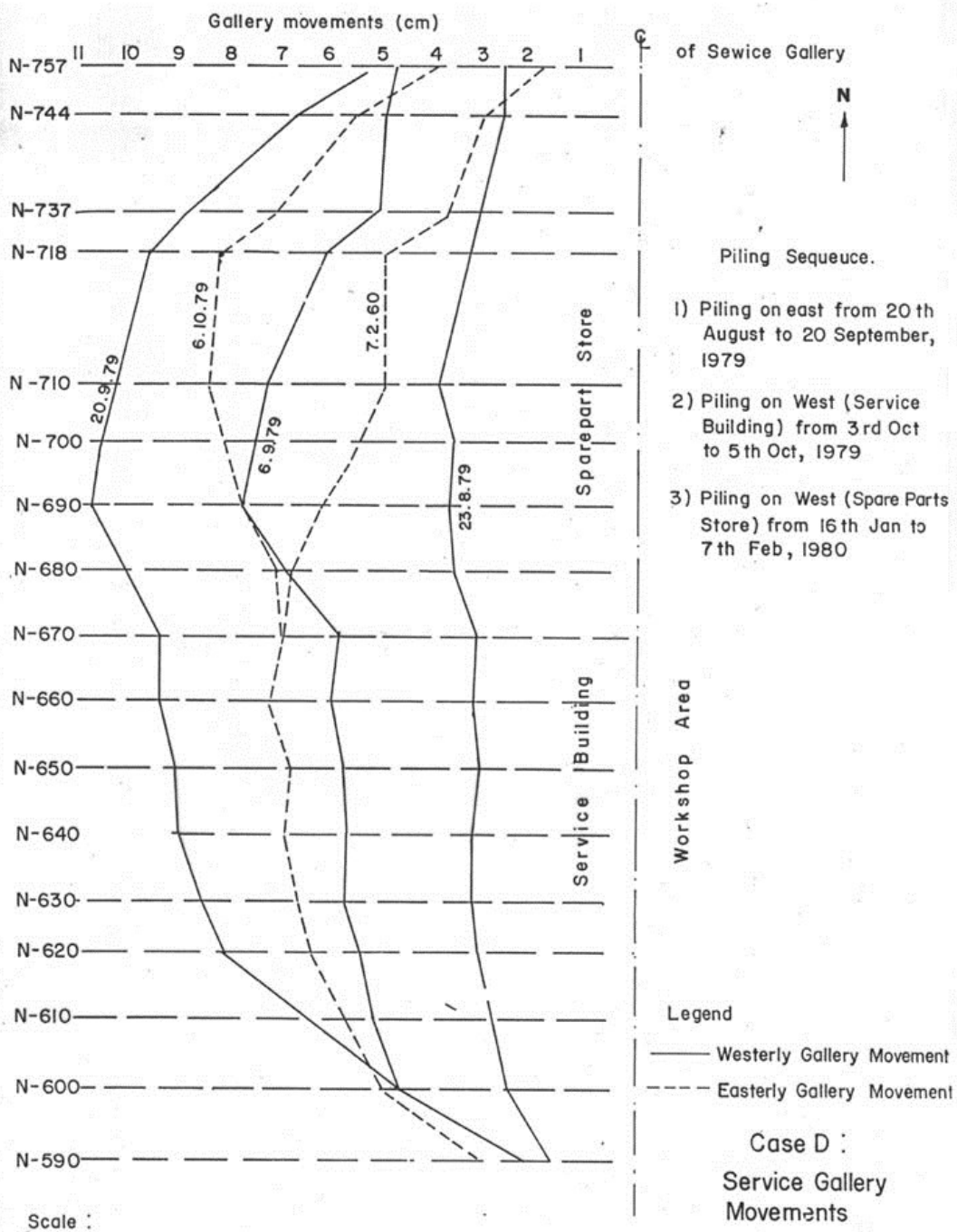

Pressure , t/m2
0
2
4
6
8
10
12
14
Depth m
0
2
4
6
8
10
12
14
16
Theoretical Hydrostatic Pressure
Piezometric Pressure


P150 P151 P154 P155
Hydrostatic Pressure
Draw Down
EAST
Pore Pressure, t/m2
0 4 8 12 16
Pore Pressure, t/m2
14 13 12 11 10 9 8 7
Piezometer Depth 14.0 m
East Direction
0 5 10 15 20 25
Distance from Embankment Edge, m

Piles


℄ Bund
Row D
Piling with Floating MR 60
Row F
Row G
Row H
13.70 m
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
7.2.60
6.9.79
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

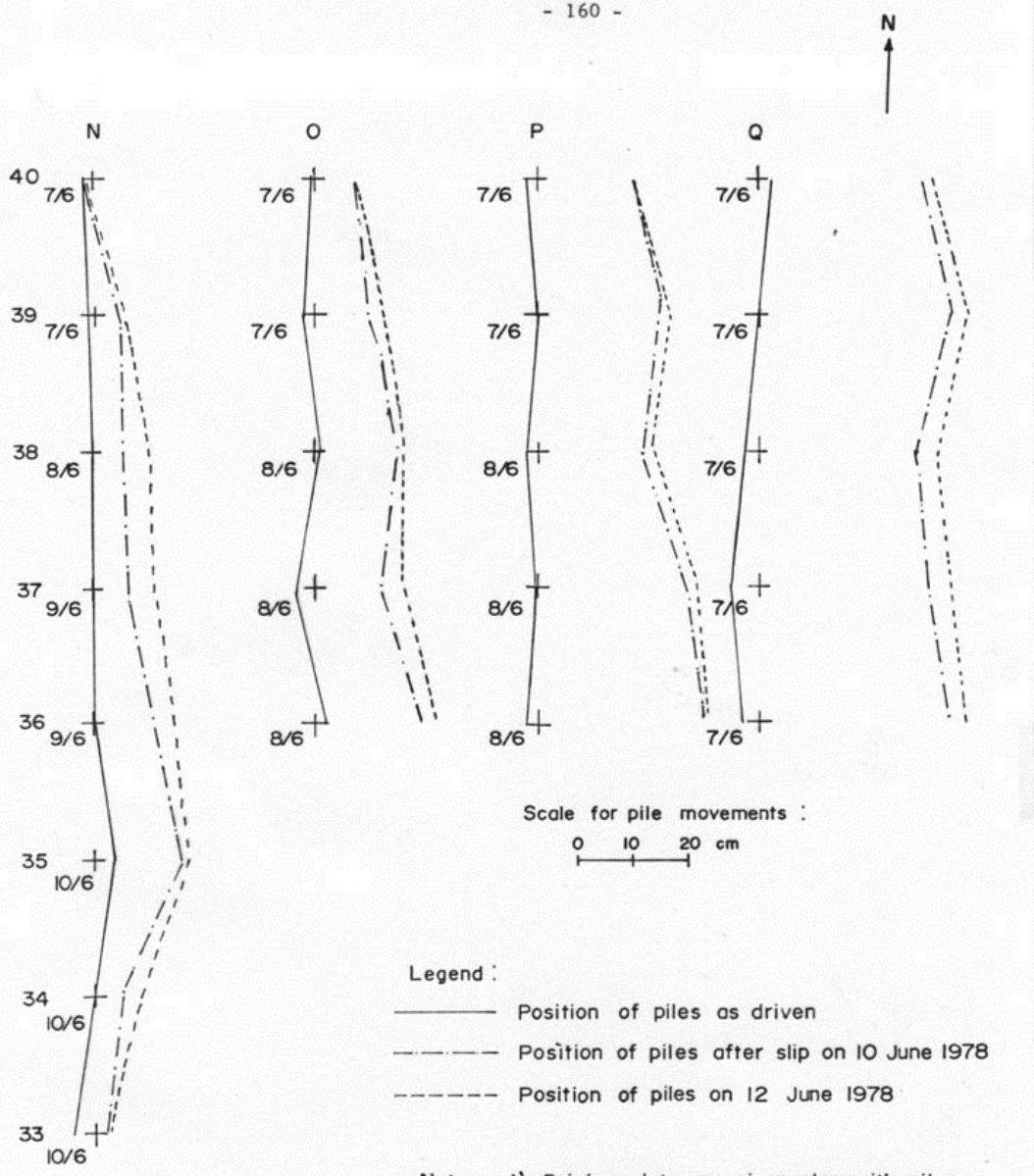


Fig. 7.4 Case B
Movements due to Slip in East Quay Area

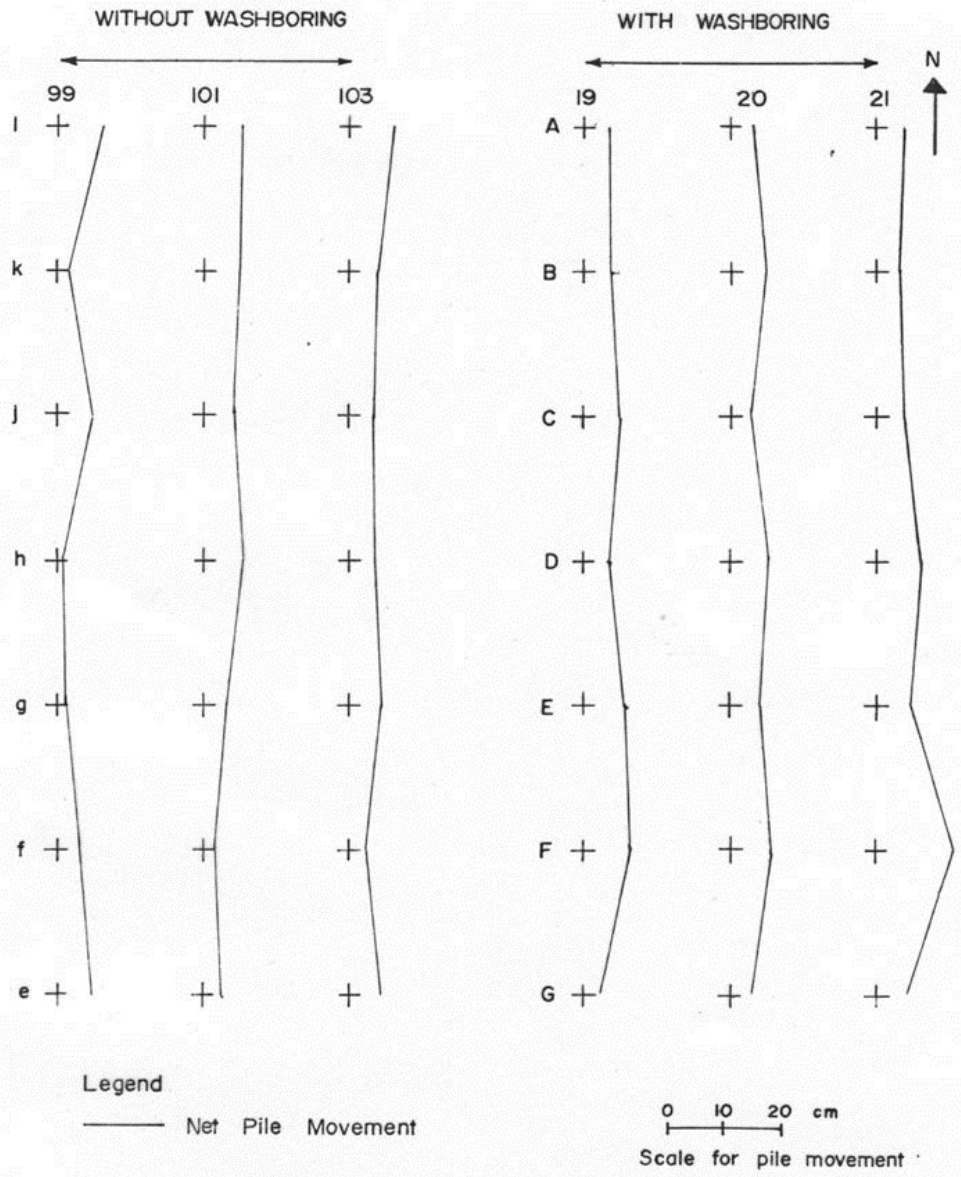
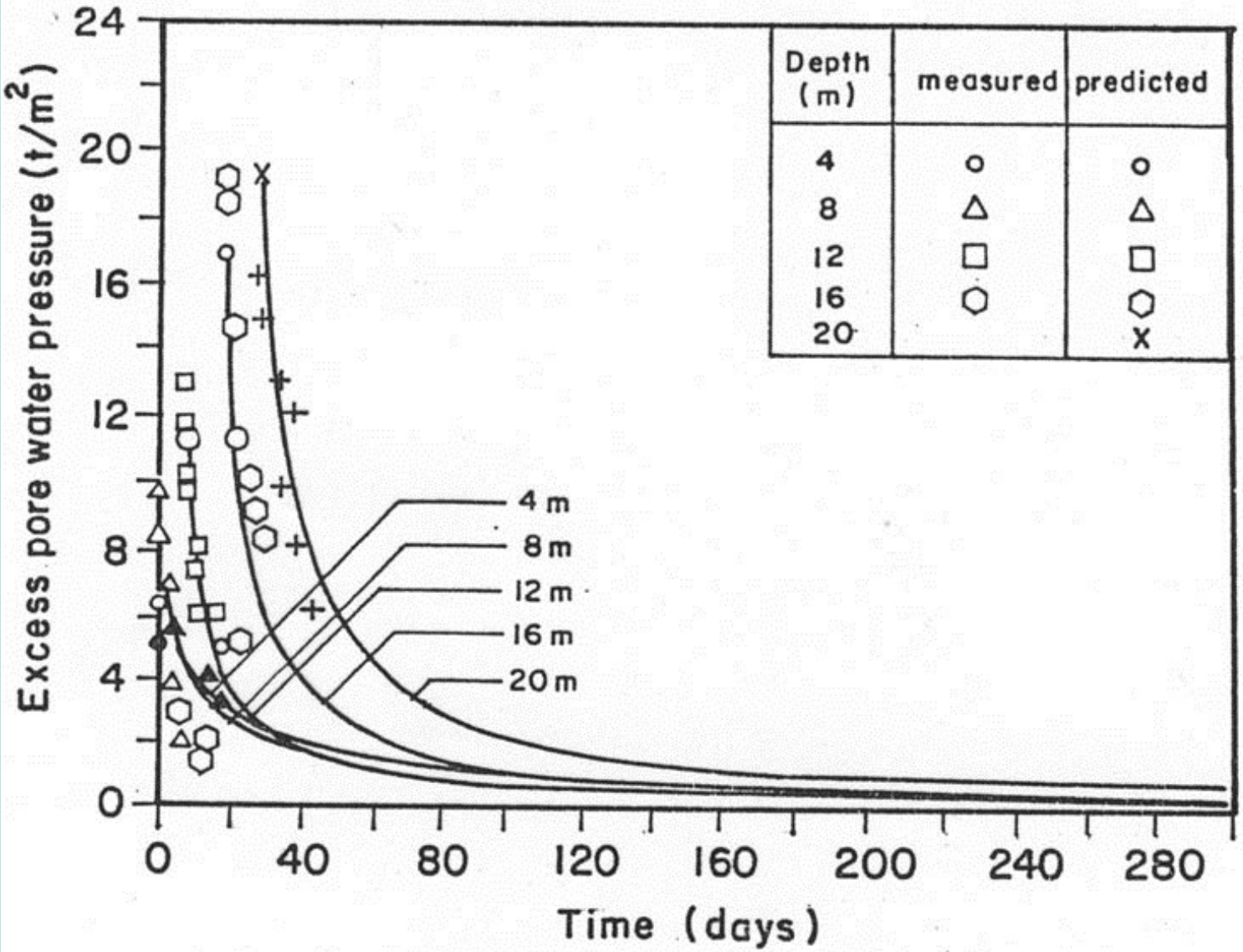
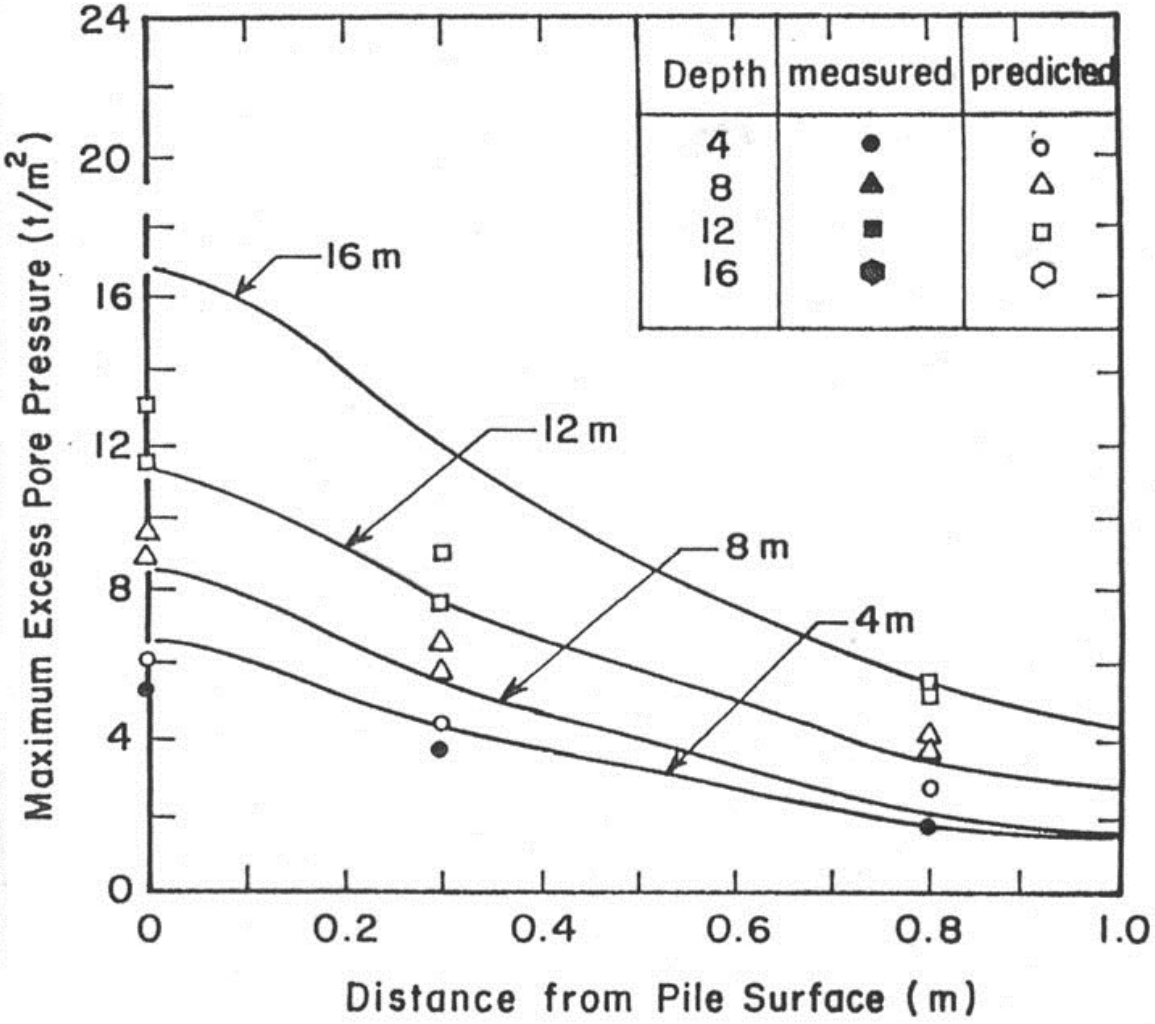


Fig. 7.12 Comparison of Pile Movements With and Without Washboring



Measured and Predicted Excess Pore Water Pressure at Pile Surface



Measured and Predicted Excess Pore Water Pressure

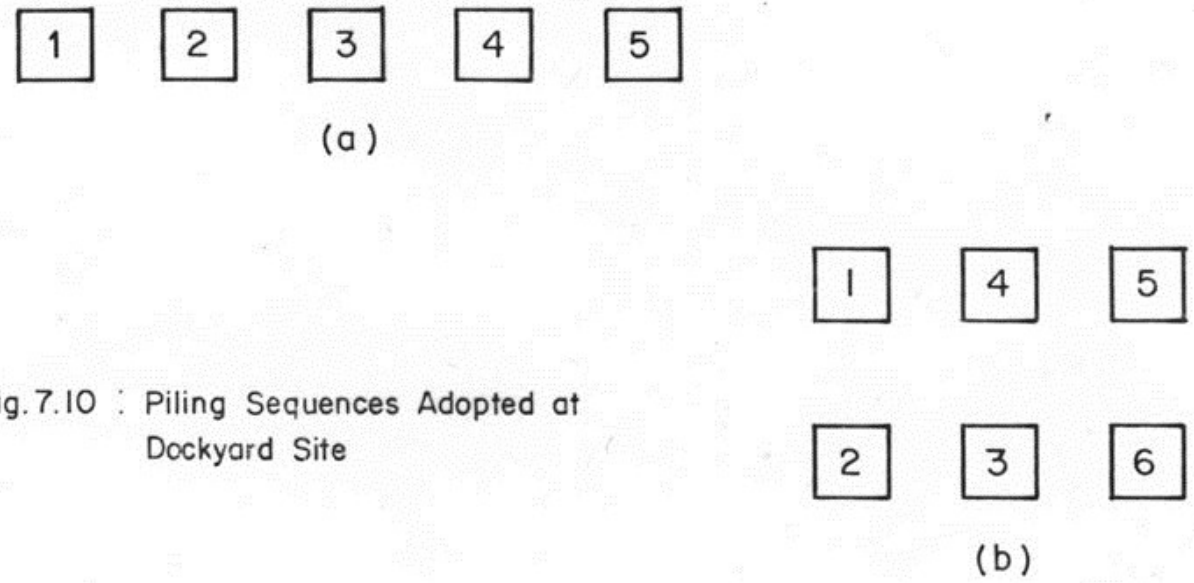


Fig. 7.10 : Piling Sequences Adopted at Dockyard Site

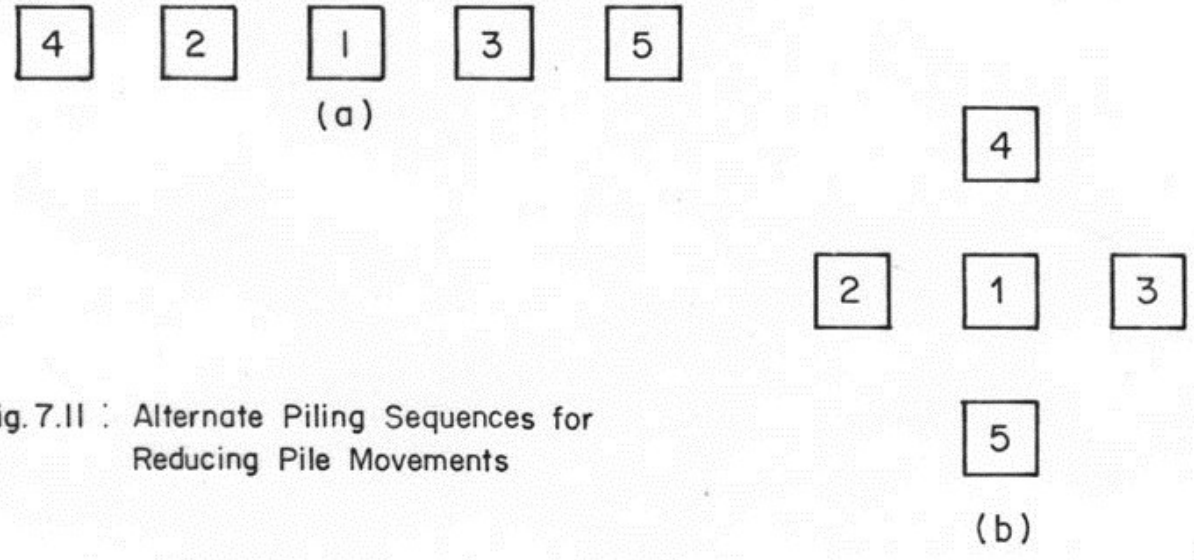


Fig. 7.11 : Alternate Piling Sequences for Reducing Pile Movements

Vacuum Drains

Sand Drains

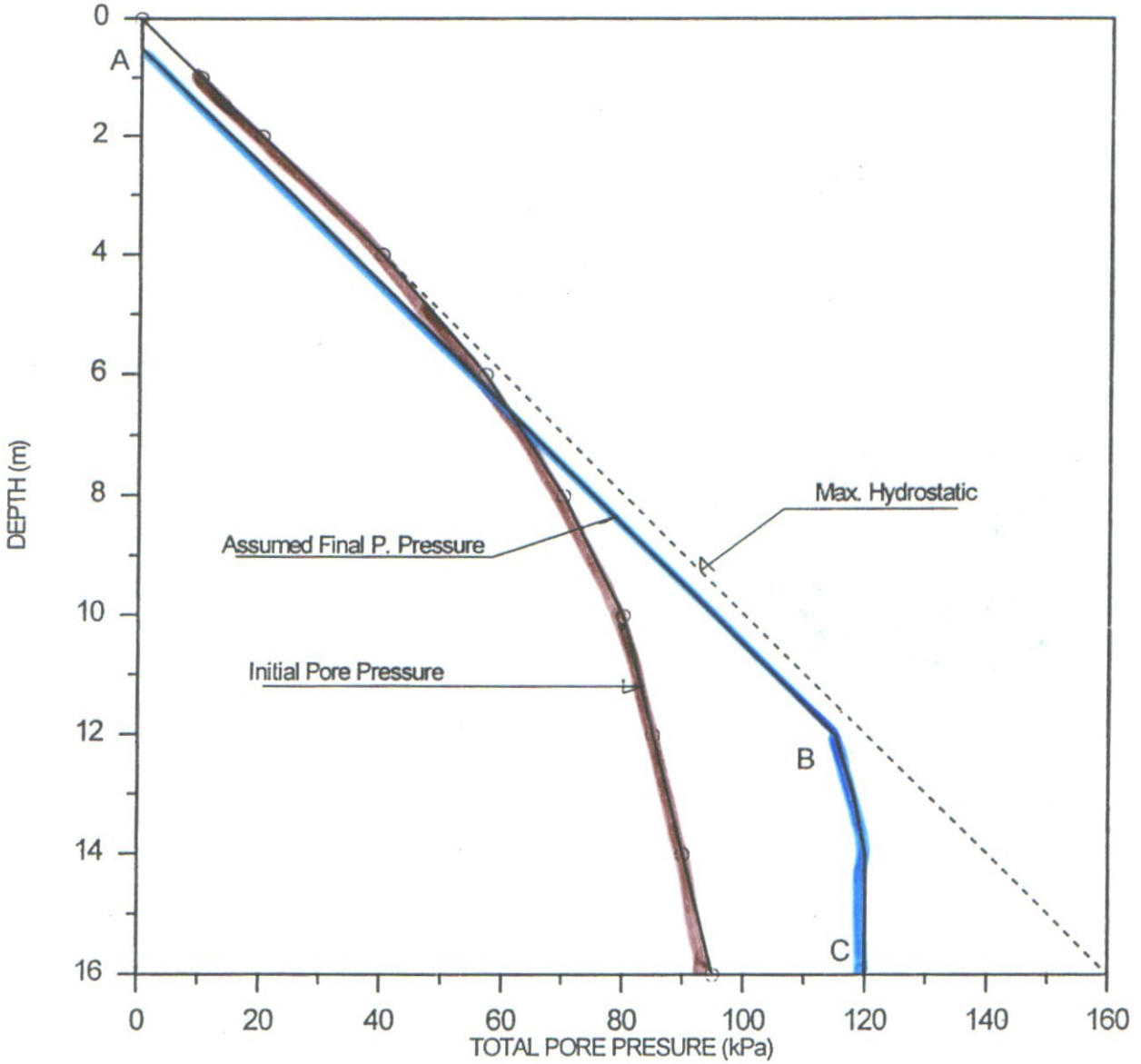
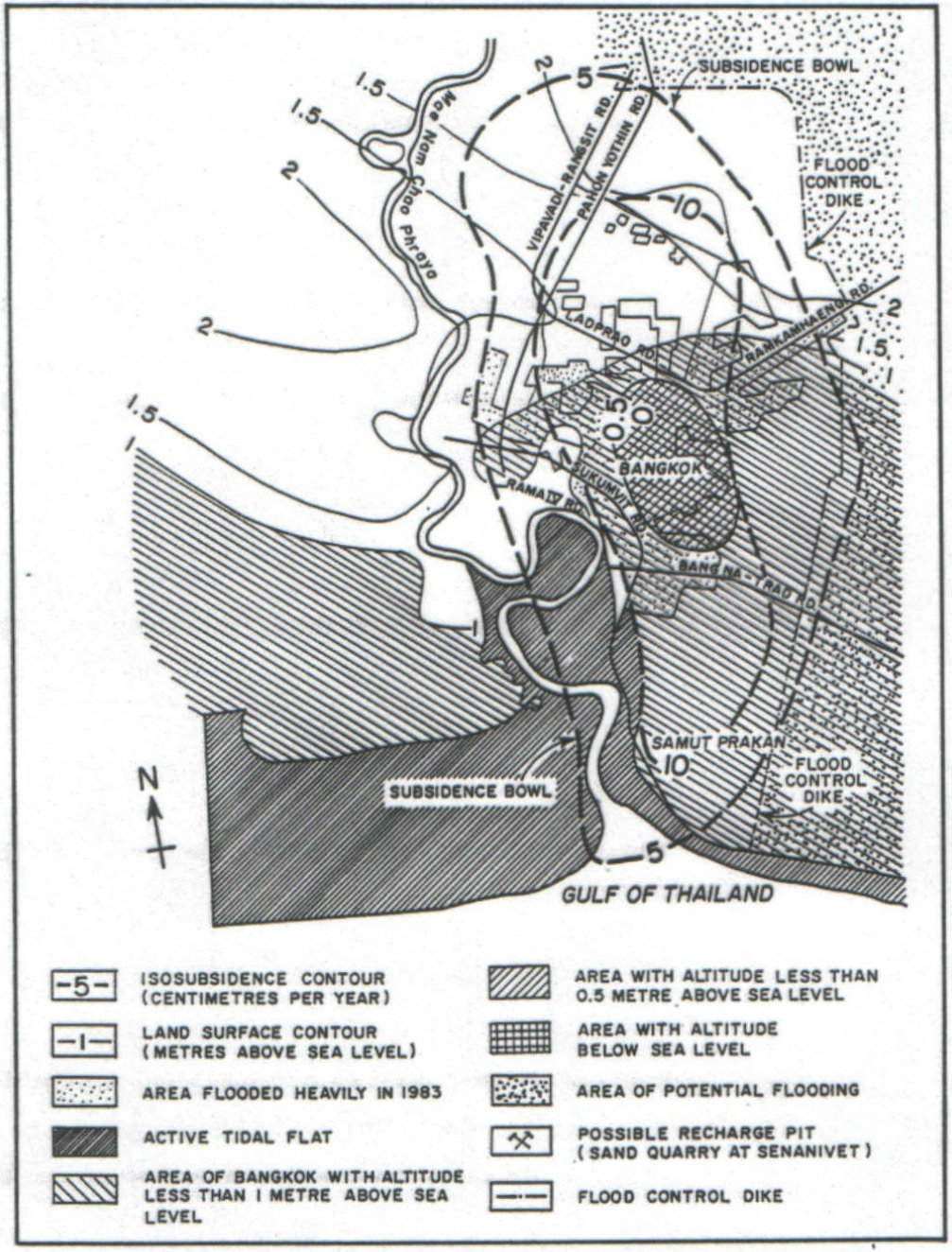
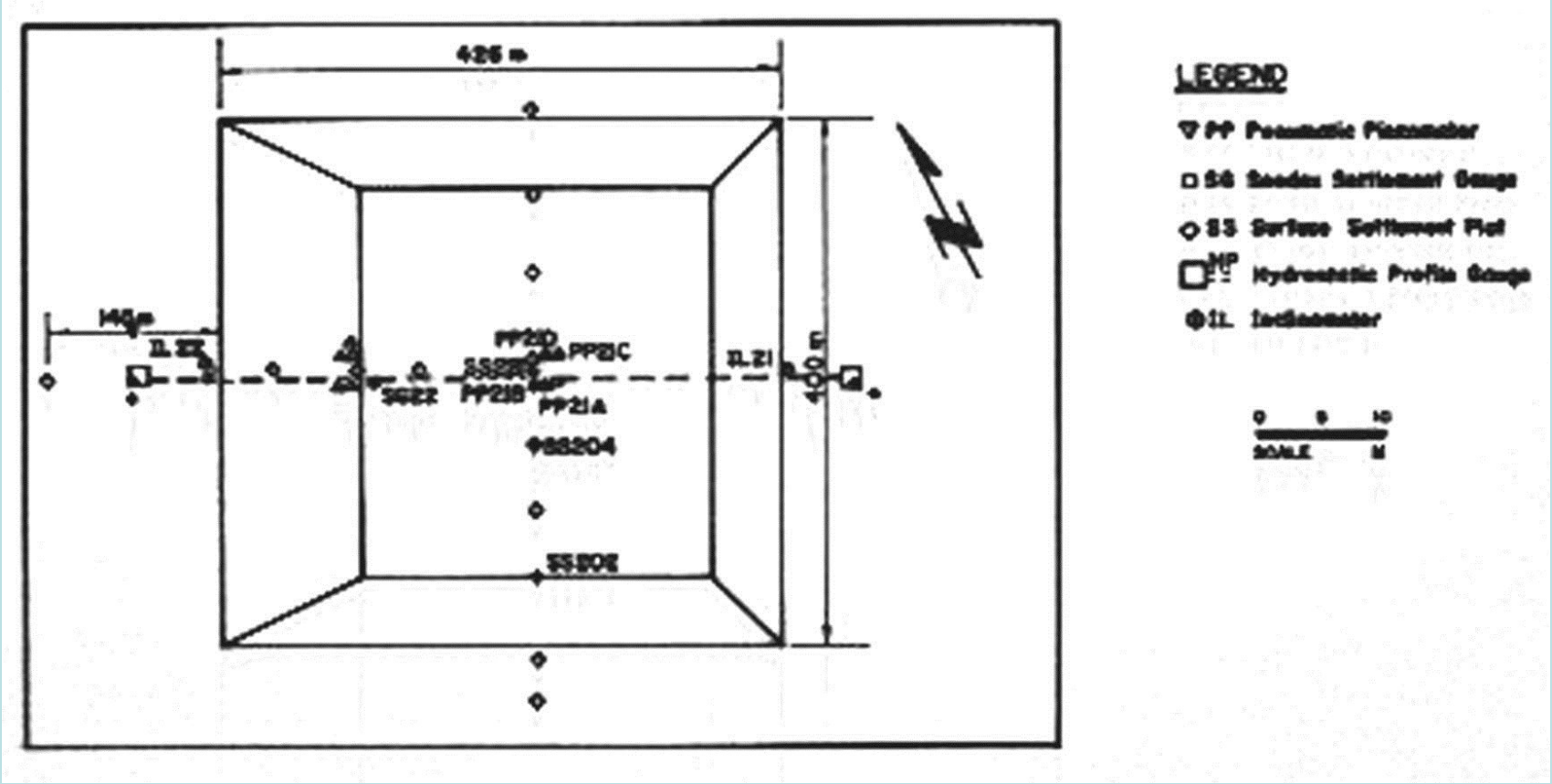
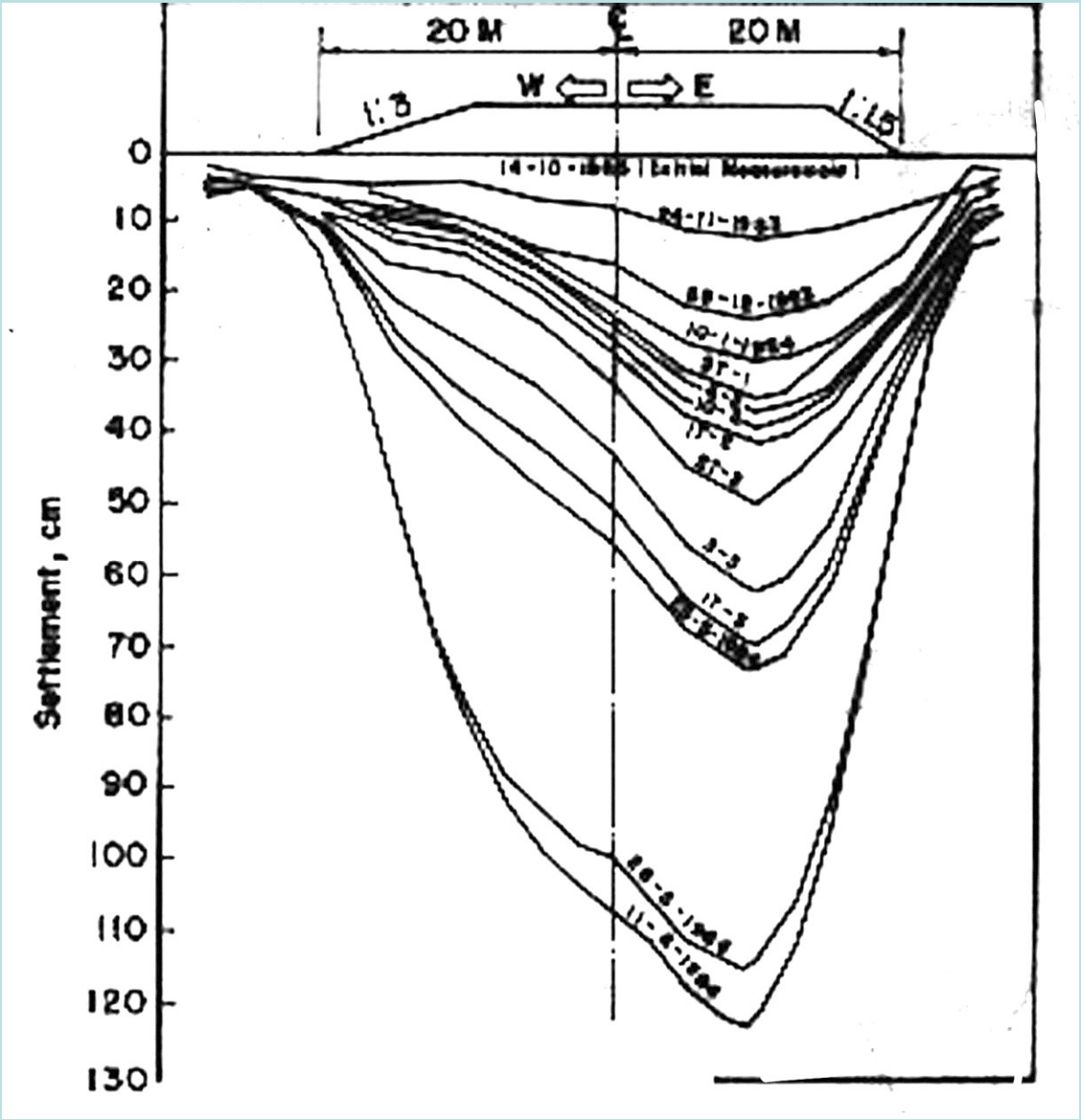


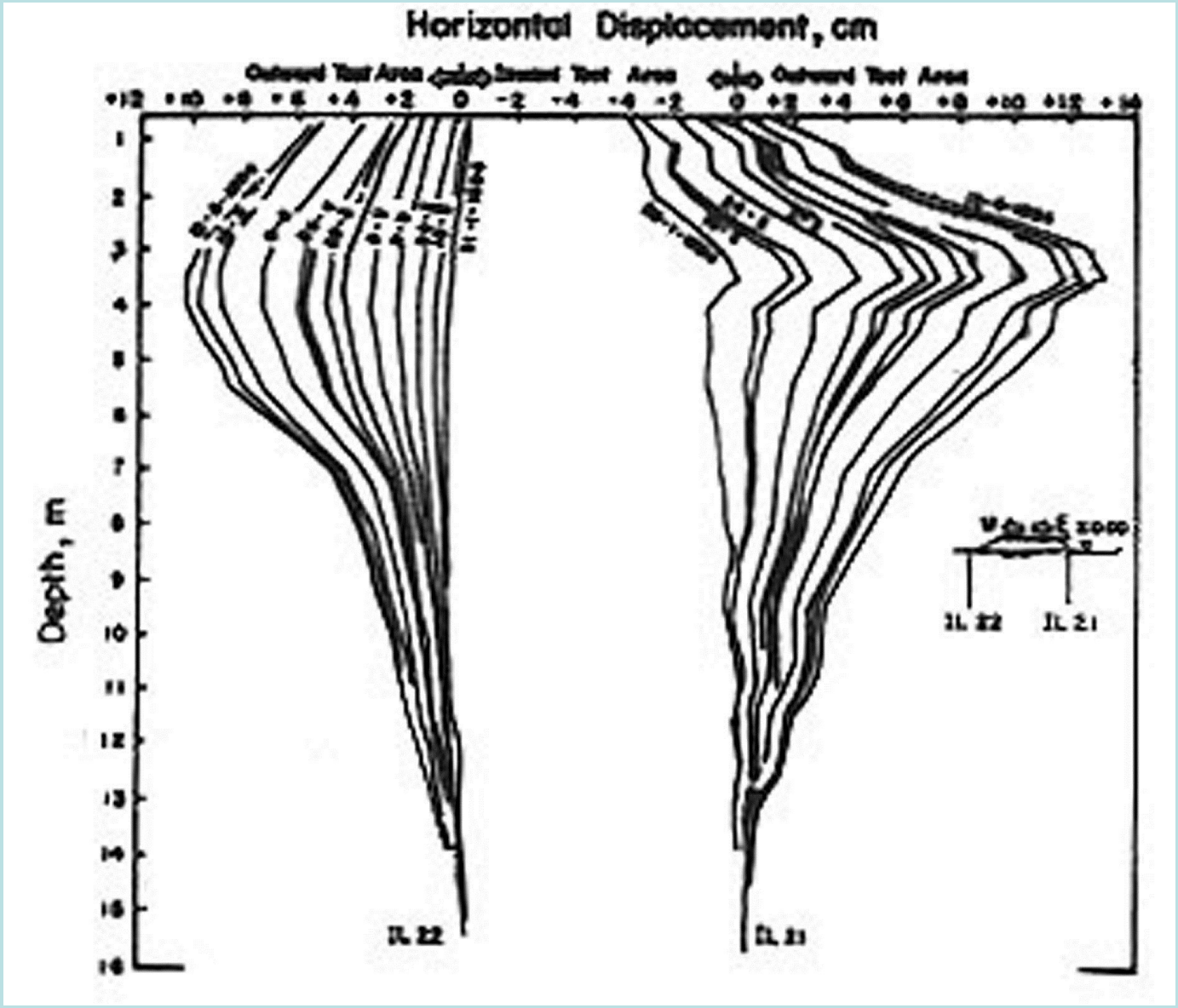
Fig. 6.26: Piezometric Drawdowns (Initial and Assumed Final Values)



Sources : Prinya Nutalaya (AIT), Dept. Mineral Resources, Japan International Cooperation Agency (JICA)


425 m
140 m
IL 22
IL 21
PP21D
PP21C
PP21B
PP21A
SS22
SS204
SS20E
LEGEND
PP Pneumatic Piezometer
SG Soeaton Settlement Gauge
SS Surface Settlement Plat
HP Hydrostatic Profile Gauge
IL Inclinometer
0 5 10
SCALE M


20 M
20 M
W
E
1:3
1:1.5
0
10
20
30
40
50
60
70
80
90
100
110
120
130
Settlement, cm


Horizontal Displacement, cm
Outward Test Area
Inward Test Area
Outward Test Area
+12 +10 +8 +6 +4 +2 0 -2 -4 -6 -2 0 +2 +4 +6 +8 +10 +12 +14
Depth, m
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
IL 22
IL 21
IL 22
IL 21

Wednesday, 6th December-- 3

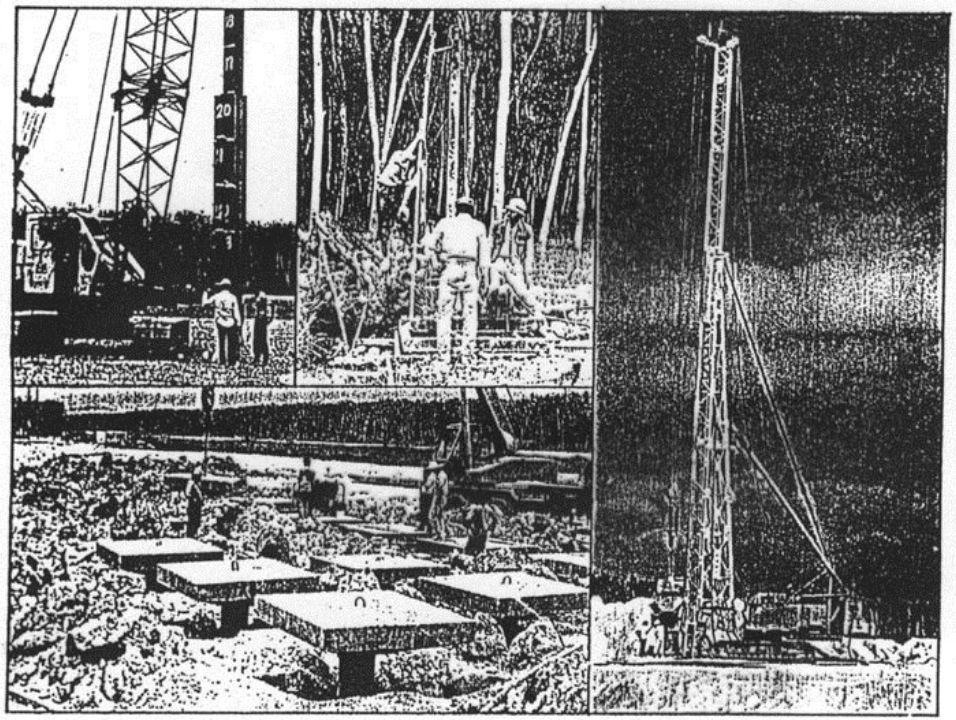
Ground Improvement Case Studies in Muar Flats Site, Malaysia

LEMBAGA LEBUHRAYA MALAYSIA

International Symposium On

TRIAL EMBANKMENTS ON MALAYSIAN MARINE CLAYS

KUALA LUMPUR *NOV. 6–8, 1989*



PREDICTION AND PERFORMANCE

FINAL BULLETIN

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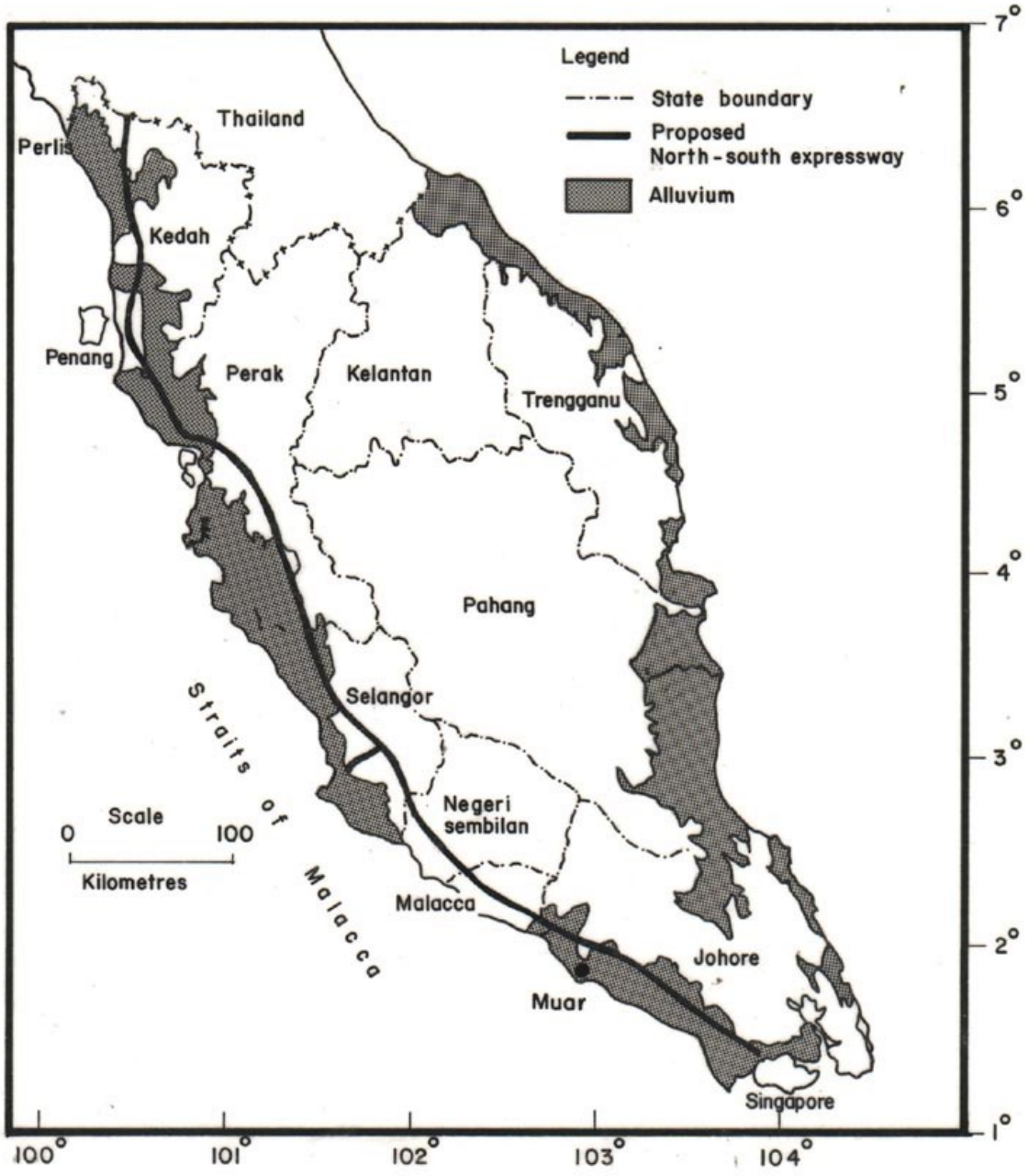
THE INSTITUTION OF ENGINEERS MALAYSIA

SOUTHEAST ASIAN GEOTECHNICAL SOCIETY

Official Airline

malaysia



River and Coastal Alluvium of Peninsular Malaysia

SECTION	TREATMENT METHOD
3/1	ELECTRO-CHEMICAL INJECTION (3m)
3/2	3m CONTROL
6/1	ELECTRO-CHEMICAL INJECTION (6m)
6/2	WELL-POINT PRELOADING
6/3	ELECTRO-OSMOSIS
6/4	PRESTRESSED SPUN PILES
6/5	SAND COMPACTION PILES
6/6	6m CONTROL
6/7	VACUUM PRELOADING AND VERTICAL DRAINS
6/8	PRELOADING, GEOREINFORCEMENT AND VERTICAL DRAINS (6m)
6/9	PRELOADING AND VERTICAL DRAINS
3/3	SAND SANDWICH
3/4	PRELOADING; GEOREINFORCEMENT AND VERTICAL DRAINS (3m)
	EMBANKMENT BUILT TO FAILURE

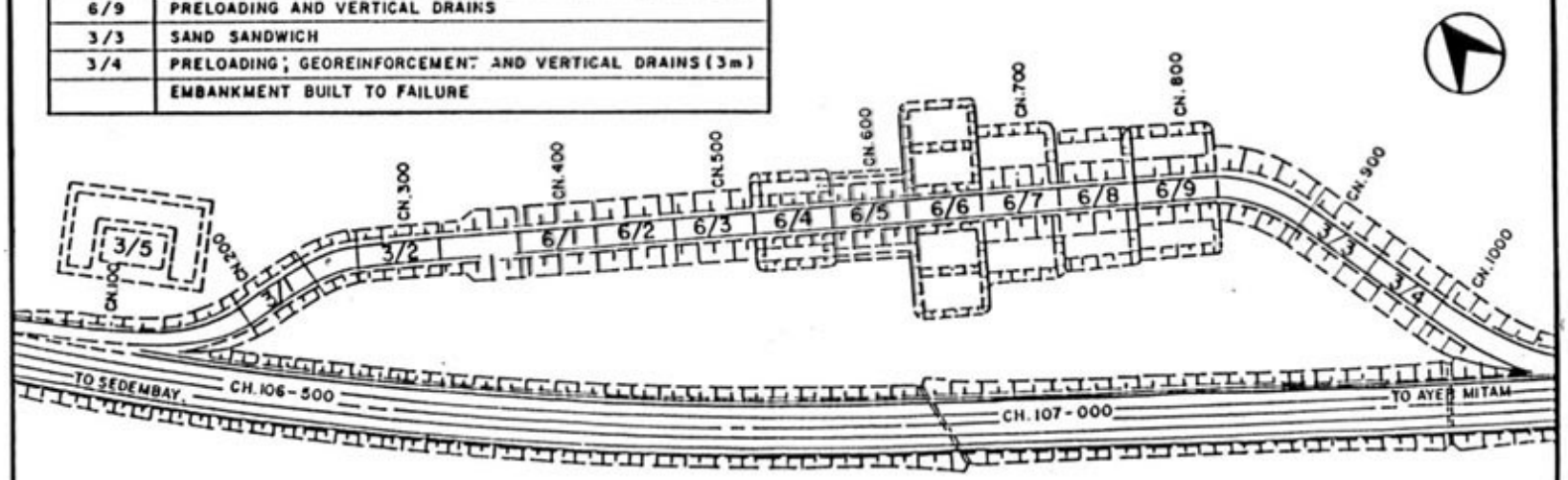
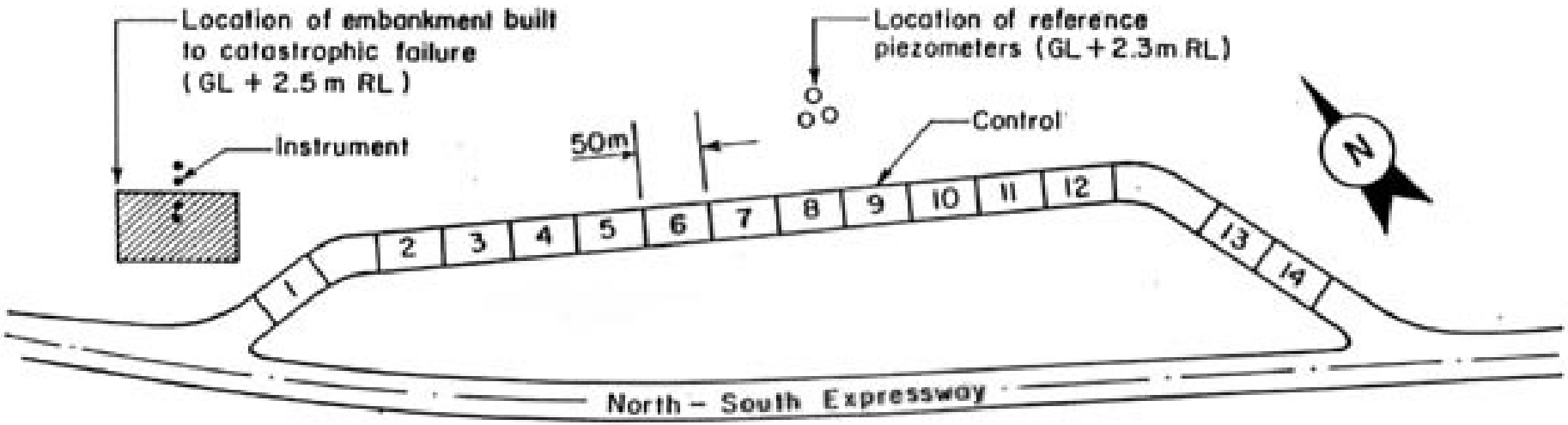


FIG. A.48 : Layout of Trial Embankments

LEMBAGA LEBUHRAYA MALAYSIA
TRIAL EMBANKMENTS



Method of Ground Improvement :

- Electro - osmosis (6)
- Chemical Injection (1 & 4)
- Sand Sandwich (13)
- Preloading & Drains (11, 12 & 14)
- Micro Piles (3)
- Vacuum Preloading (10)
- Sand Compaction Piles (8)
- Well-point Preloading (5)
- Prestressed Spun Piles (7)

Layout of Trial Embankments

-Electro-osmosis

-Chemical injection

-Sand sandwich

-Pre-loading with drains

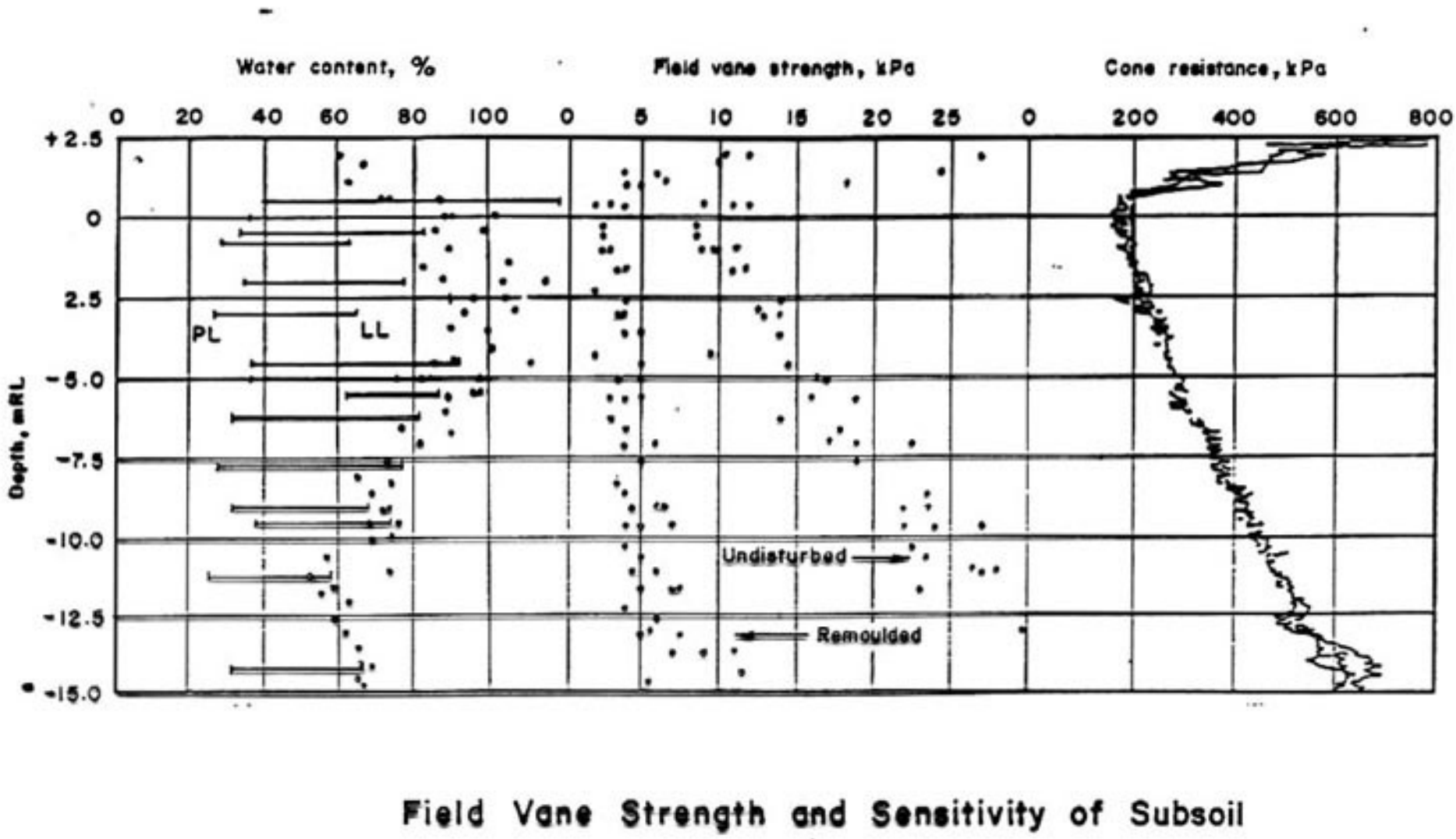
-Micropiles

-Vacuum pre-loading

-Sand compaction piles

-Well point pumping

-Pre-stressed spun piles



Field Vane Strength and Sensitivity of Subsoil

+2.5 mRL		Liquid Limit ω_L (%)	Plastic Limit ω_p (%)	Natural Water Content ω_n (%)	Plasticity Index	Grain Size (%)			$\frac{C_c}{1+e_o}$	$\frac{C}{1+e_o}$	Preconsolidation Pressure P_c (KPa)
						Clay	Silt	Sand			
+0.5	Weathered Crust	108	55	70		42	57	1	.24	.04	110
	Very Soft Silty Clay with Decated Leaves and Roots	90	40	100	50	48	52	0	.48	.04	40
-5.5											
	Soft Silty Clay with Traces of Shell Fragments Occasionally Sand Lenses	80	30	60	50	40	60	0	.31	.04	60
-15.3											
-15.9	Peaty Soil										
	Sandy silt / clay with Organic Matters					22	43	35			
-19.9											
	Dense Medium to Coarse Sand with Gravels SPT N = 21 to 37										

Description of Soil Profile and Index Properties Used in the Analysis

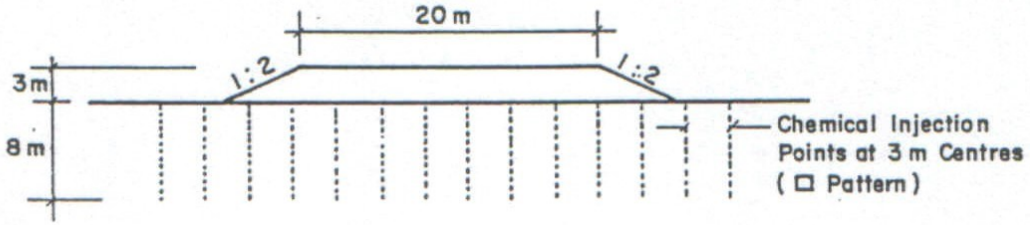


Fig. I.2 (a) Scheme 3/1 - Electro-chemical Injection (3 m)

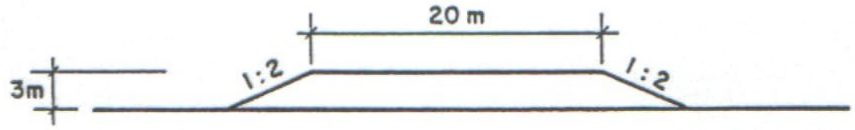


Fig. I.2 (b) Scheme 3/2 - Control Embankment (3m)

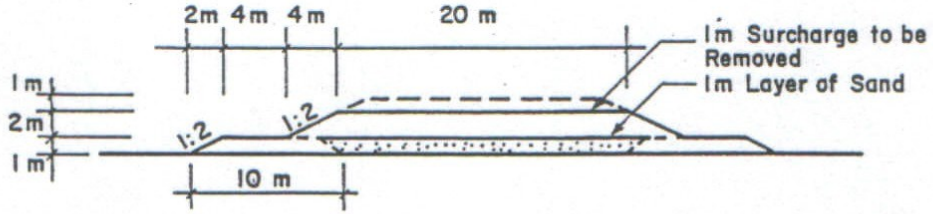


Fig. I.2 (c) Scheme 3/3 – Sand Sandwich (3 m)

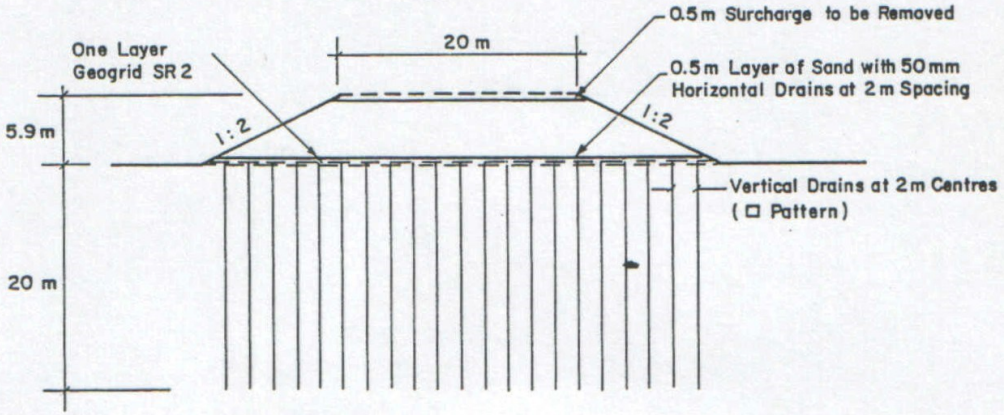


Fig. I.2 (d) Scheme 3/4 - Preloading Geogrid Reinforcement and Prefabricated Vertical Drains (3m)

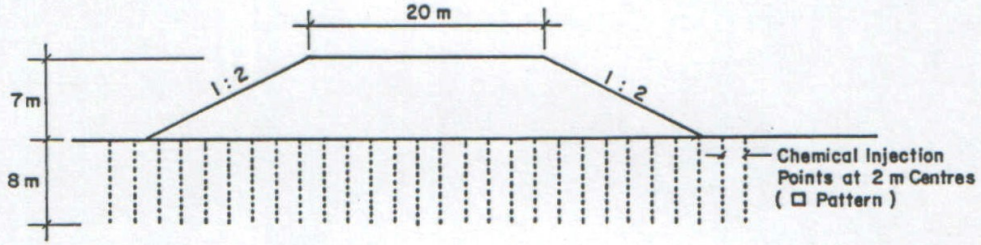


Fig. I.2 (e) Scheme 6/1 - Electro-chemical Injection (6m)

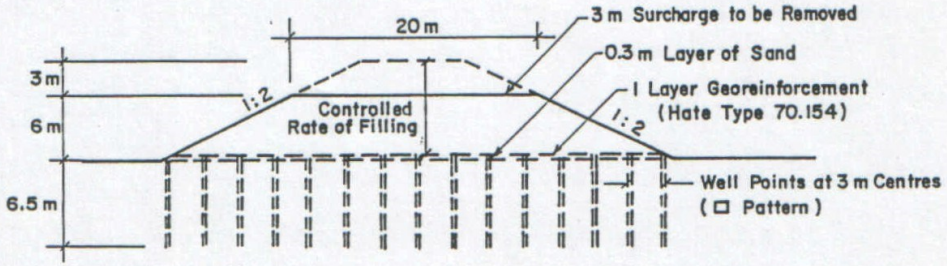


Fig. I.2 (f) Scheme 6/2 - Well-point Preloading (6m)

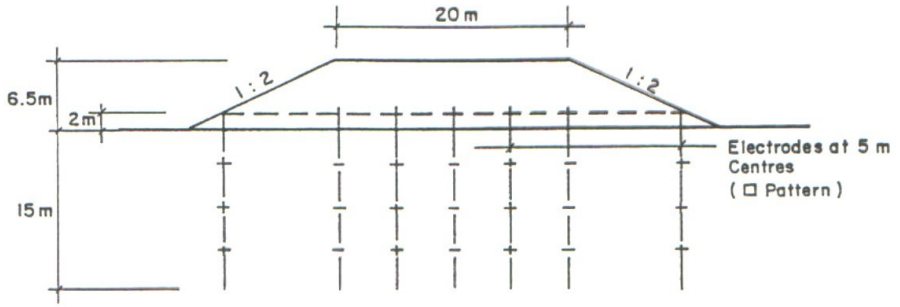


Fig.1.2(g) Scheme 6/3 - Electro-Osmosis (6 m)

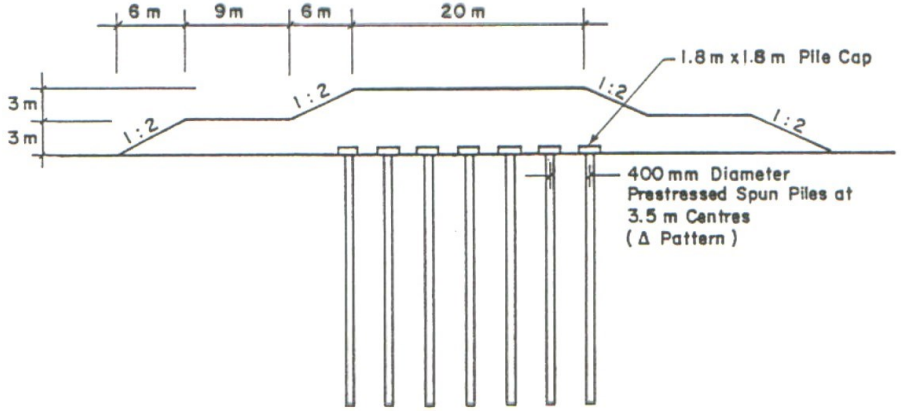


Fig.1.2(h) Scheme 6/4 - Prestressed Spun Piles (6m)

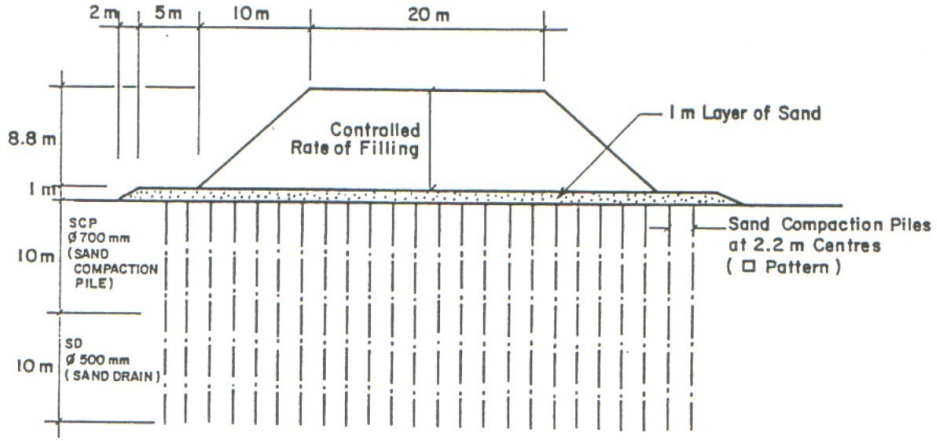


Fig.1.2(i) Scheme 6/5 - Sand Compaction Piles (6m)

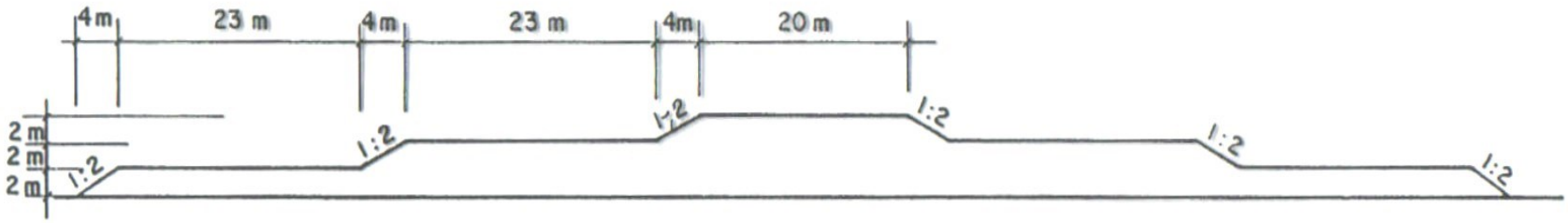


Fig. I.2 (J) Scheme 6/6 - Control Embankment (6m)

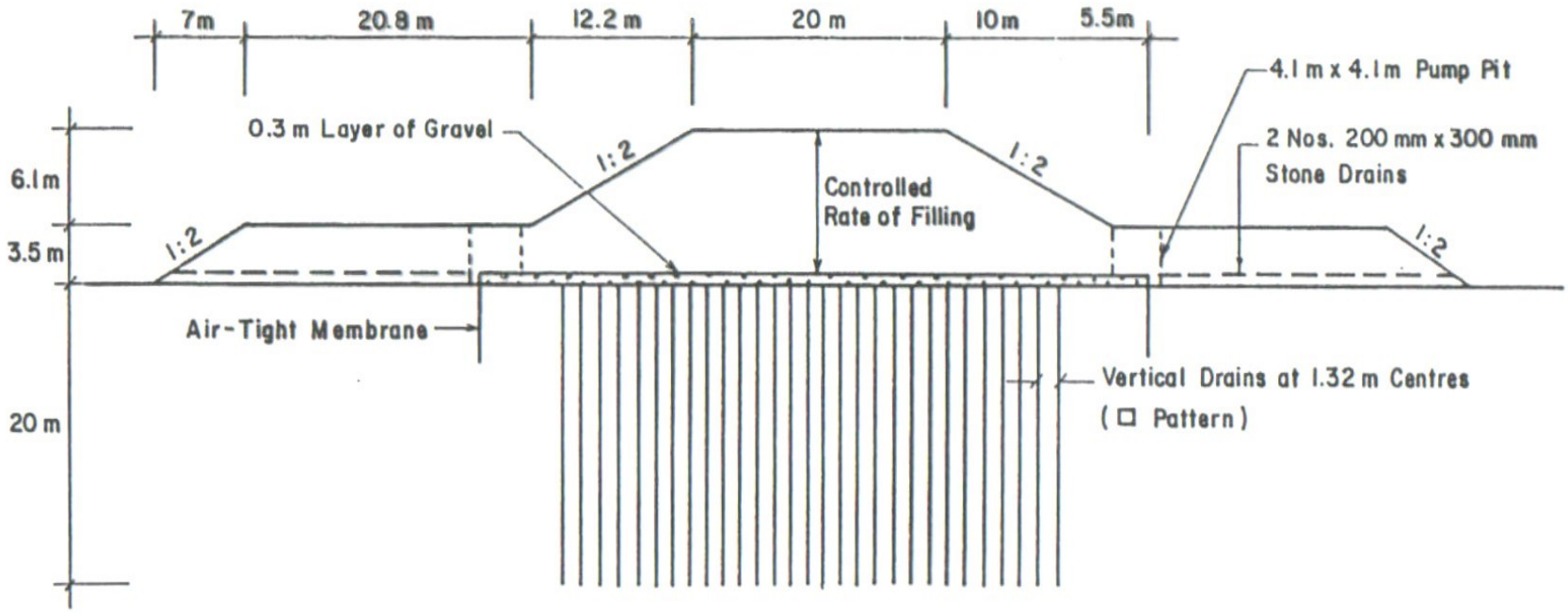


Fig. I.2 (k) Scheme 6/7 - Vacuum Preloading and Prefabricated Vertical Drains (6m)

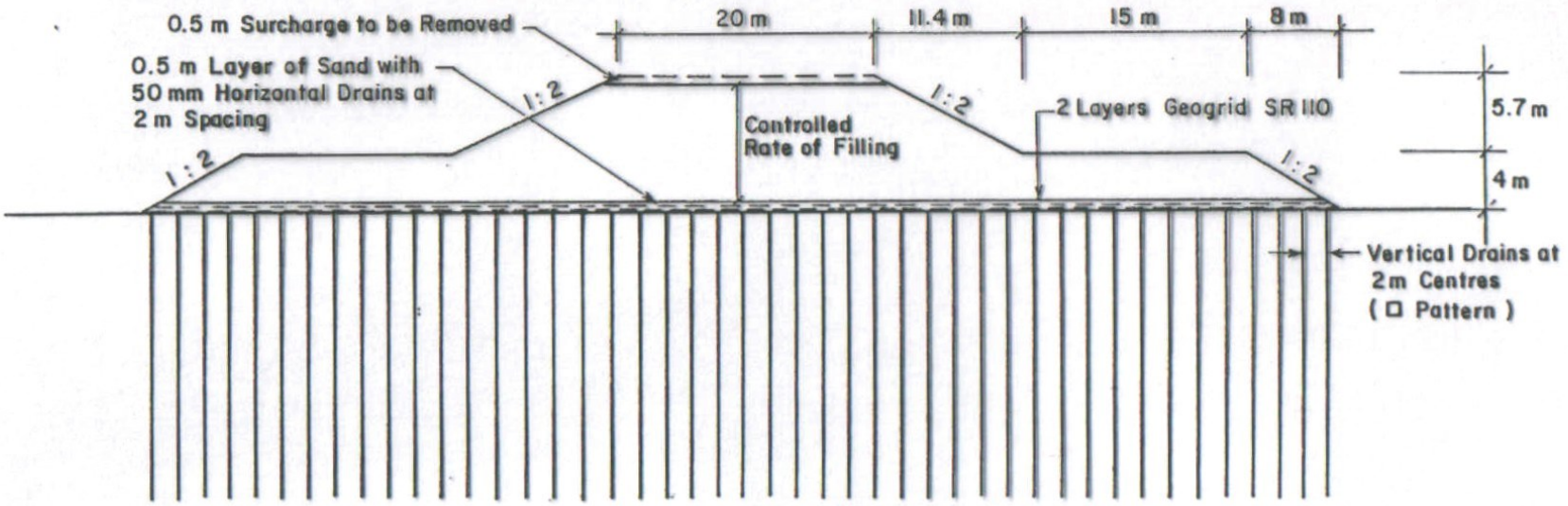


Fig. I.2(*l*) Scheme 6/8 - Preloading, Geogrid Reinforcement and Prefabricated Vertical Drains (6m)

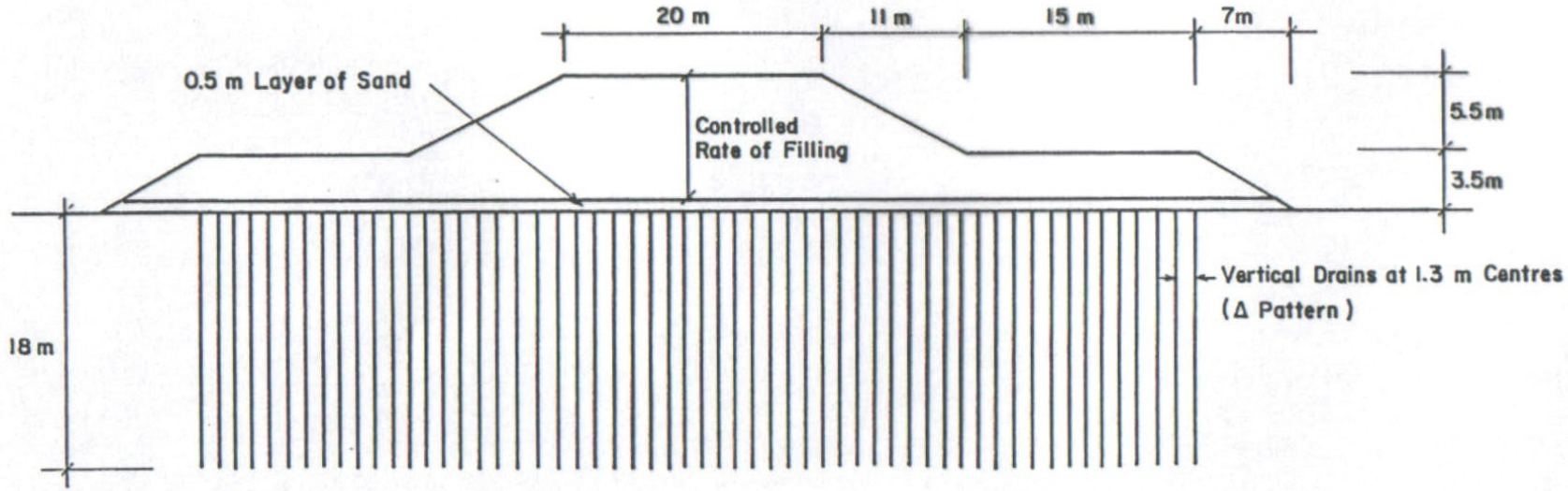
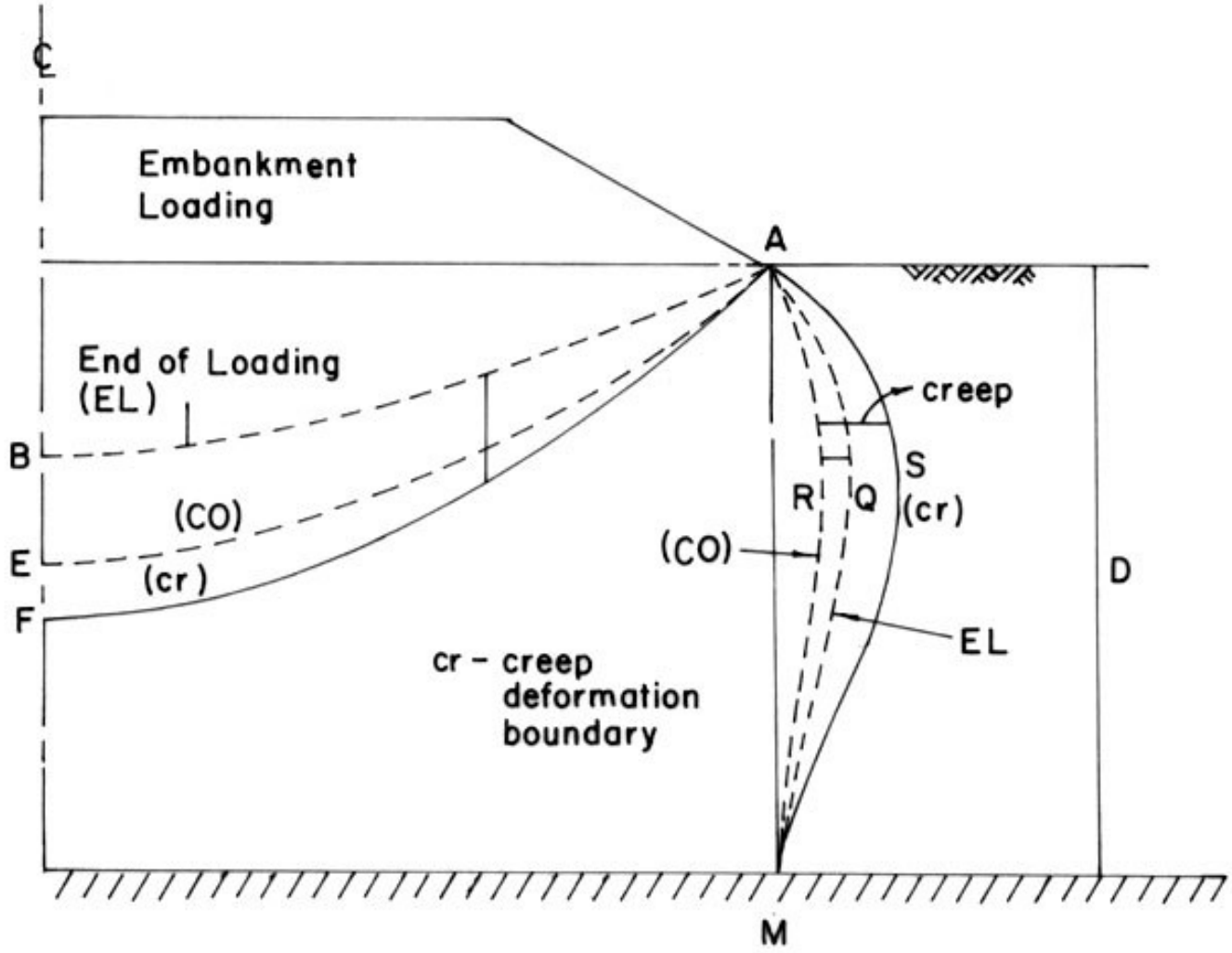


Fig. I.2 (m) Scheme 6/9 - Preloading and Prefabricated Vertical Drains (6m)



Embankment Foundation (Sub-soil) Deformation Pattern During Consolidation.

Soil Constants

$$M, \quad \kappa, \quad \lambda$$

$$\bar{\phi}, \quad C_s, \quad C_c$$

SOIL PARAMETERS

For 3m high embankments

	κ	λ	M
Weathered Crust	0.05	0.13	1.19
Upper Clay	0.05	0.13	1.19
Lower Clay	0.08	0.11	1.07

For 6m high embankments

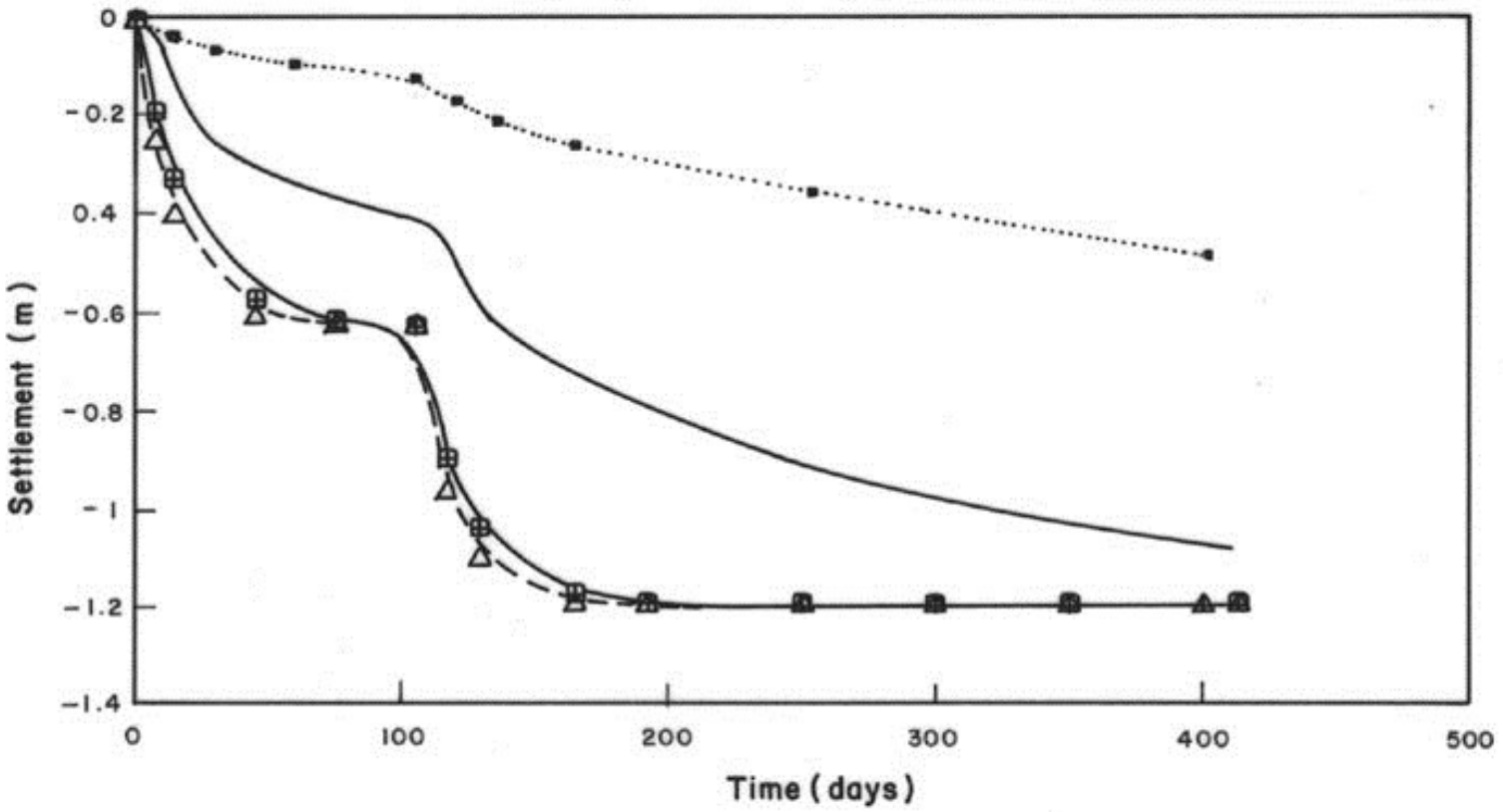
	κ	λ	M
Weathered Crust	0.05	0.60	1.19
Upper Clay	0.05	0.61	1.19
Lower Clay	0.04	0.09	1.07

TABLE 1. Variation of Strength and Consolidation Parameters

Depth (m) (1)	E_u (kPa) (2)	c' (kPa) (3)	ϕ' (degrees) (4)	$c_v \times 10^{-4}$ (cm²/s) (5)	$c_h \times 10^{-4}$ (cm²/s) (6)
0–2	25,500	8	12.5	7.5	10.0
2–5	6,600	14	14	30.0	40.0
5–8	8,933	22	7	15.0	23.5
8–11	9,120	9	20	13.0	15.0
11–14	6,593	16	17	16.0	22.0
14–18	5,884	14	21.5	5.5	8.5

TABLE 2. Modified Cam-Clay Parameters Required for Numerical Analysis (CRISP)

Depth (m) (1)	κ (2)	λ (3)	e_α (4)	M (5)	ν (6)	K_w ($\times 10^4$) (7)	γ_t (kN/m^3) (8)	k_h (m/s) (9)	k_v (m/s) (10)
0–1.75	0.06	0.16	3.10	1.19	0.29	4.4	16.5	6.4×10^{-9}	3.0×10^{-9}
1.75–5.50	0.06	0.16	3.10	1.19	0.31	1.1	15.0	5.2×10^{-9}	2.7×10^{-9}
5.50–8.0	0.05	0.13	3.06	1.12	0.29	2.4	15.5	3.1×10^{-9}	1.4×10^{-9}
8.0–18.0	0.035	0.09	1.61	1.07	0.26	22.7	16.0	1.3×10^{-9}	0.6×10^{-9}



——— Extrapolated consolidation settlement from the field measurements

..... Calculated consolidation settlement if no vertical drains exist

Consolidation settlement from Barron's theory

—△— perfect drain case

—+— Drain with smear

—□— Drain with smear and well resistance

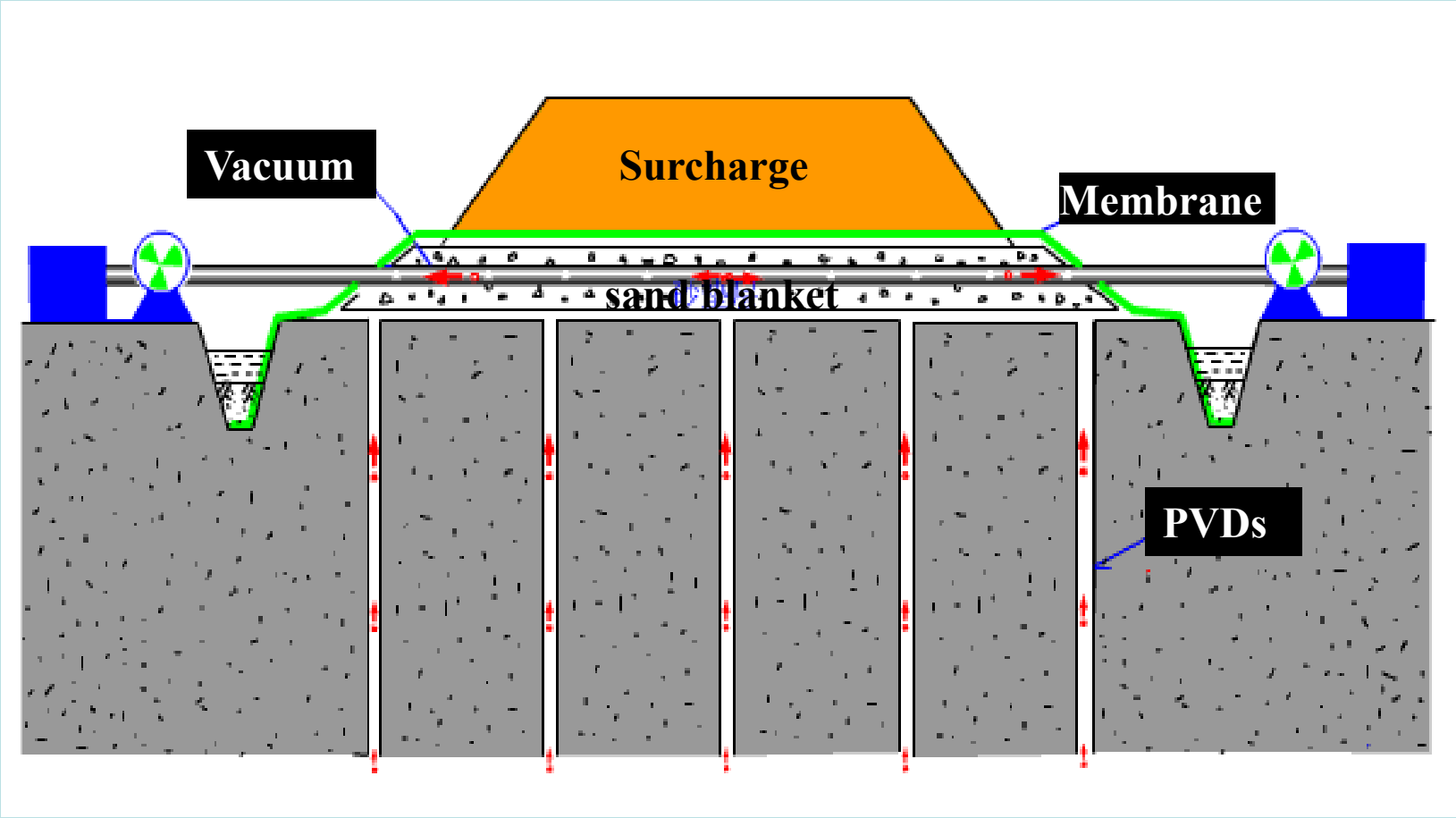
Comparison of Consolidation Settlement at ground surface, along the center line of the Embankment with Vertical Drains

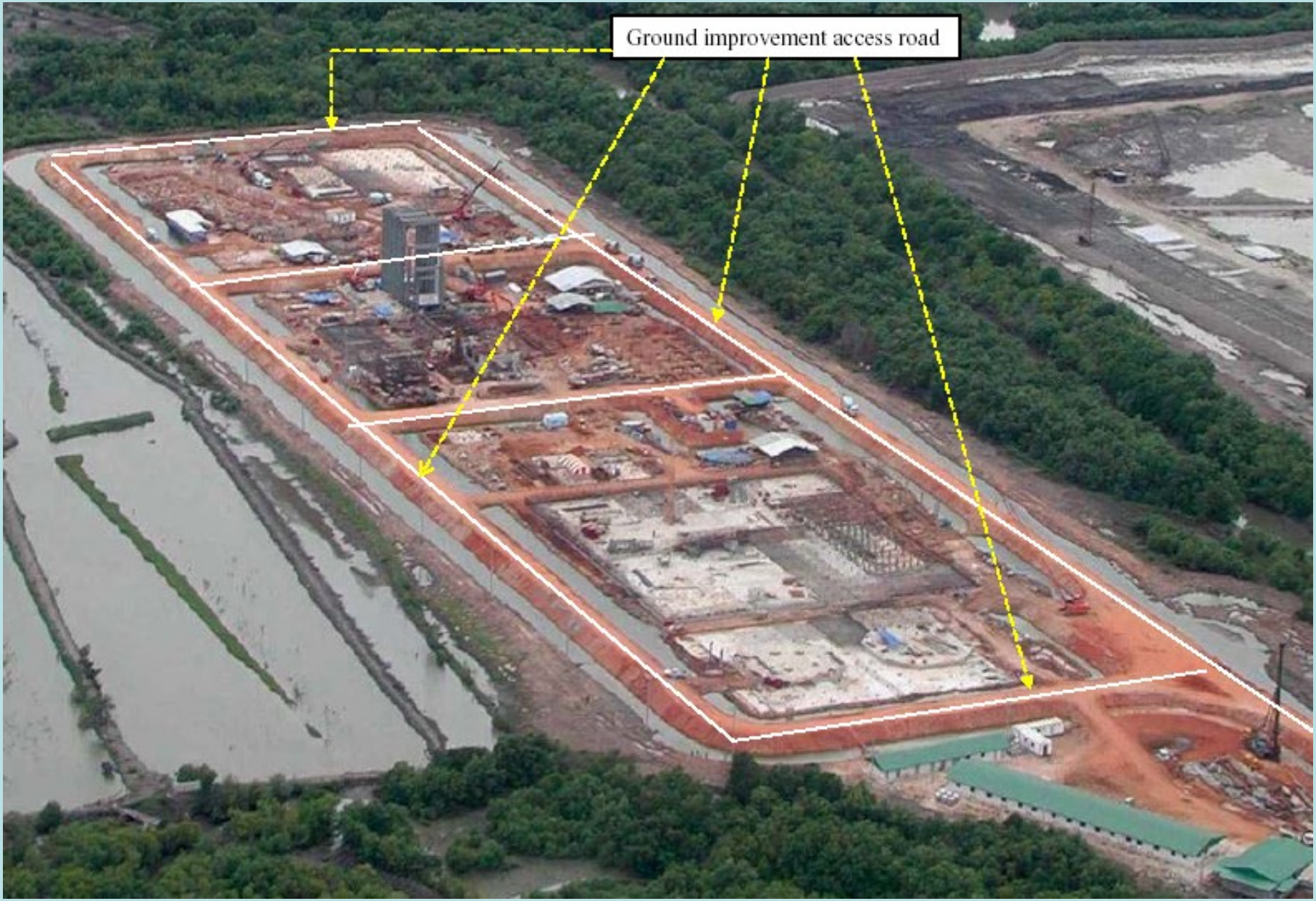
Vacuum consolidation

at

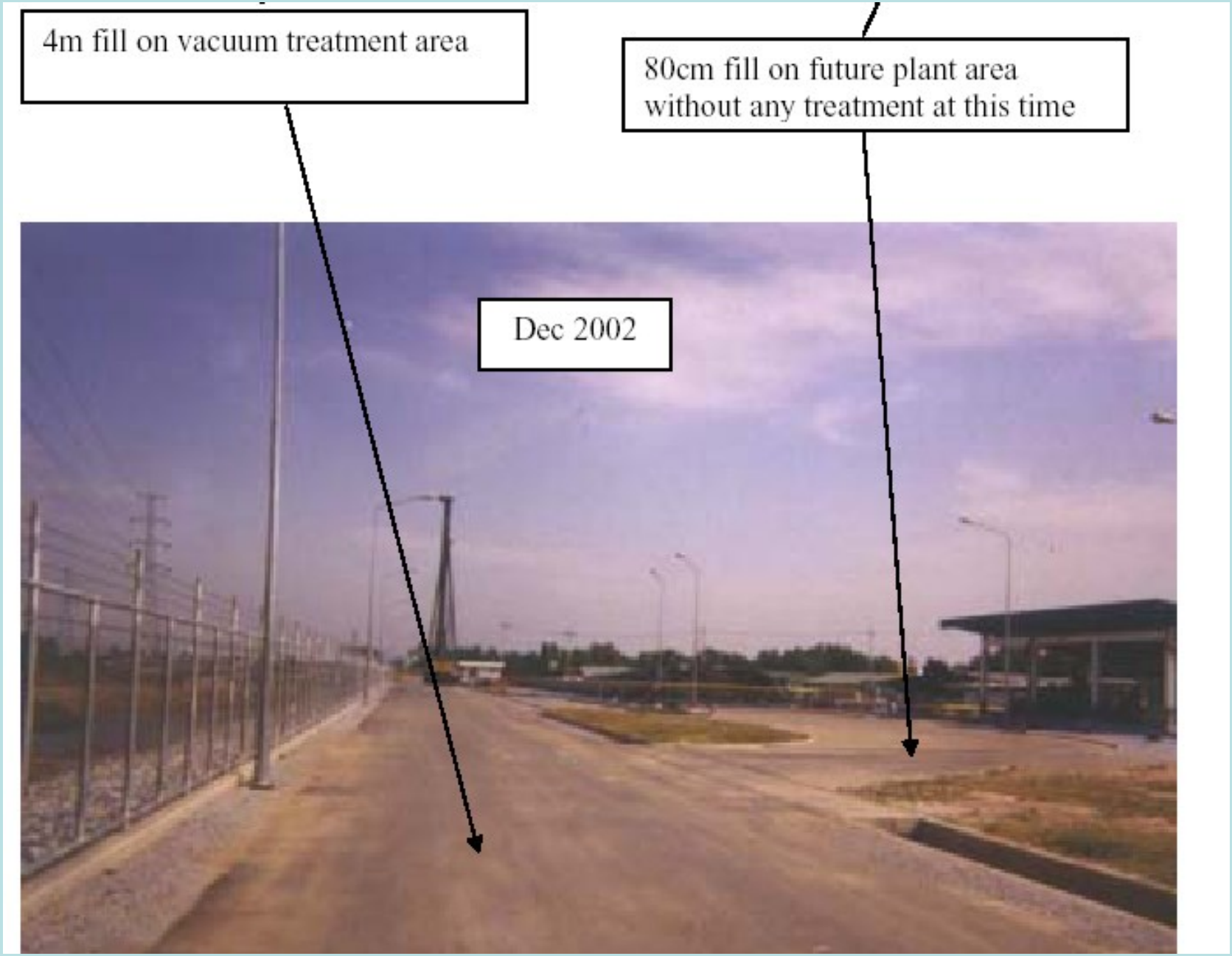
Bangpo Thermal Power Plant-- Bangkok

Principle




Ground improvement access road


~ Mid 2001
4m fill on vacuum treatment area
80cm fill on future plant area
without any treatment at this time


4m fill on vacuum treatment area
80cm fill on future plant area
without any treatment at this time
Dec 2002


Non-Treatment Area
Treatment Area = 12 m width

Non-Treatment Building Area

Differential settlement between piled and non-piled areas on non-treatment plant area