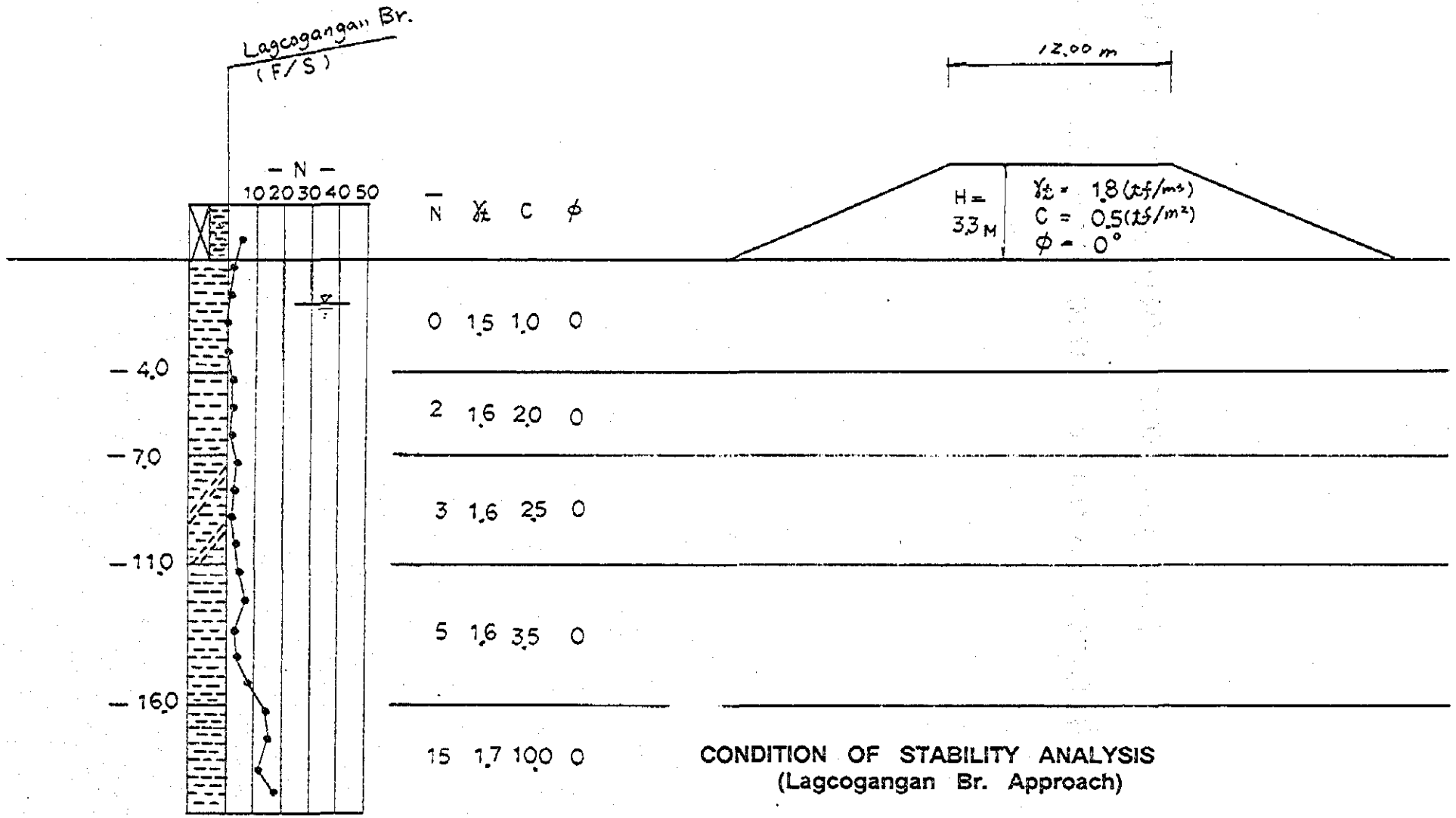
APPENDIX 8.7-1

EMBANKMENT SLOPE STABILITY AND CONSOLIDATION SETTLEMENT ANALYSIS

LAGCOGANGAN BRIDGE APPROACH

SLOPE STABILITY AND SETTLEMENT ANALYSIS



CONDITION OF STABILITY ANALYSIS
(Lagcogangan Br. Approach)

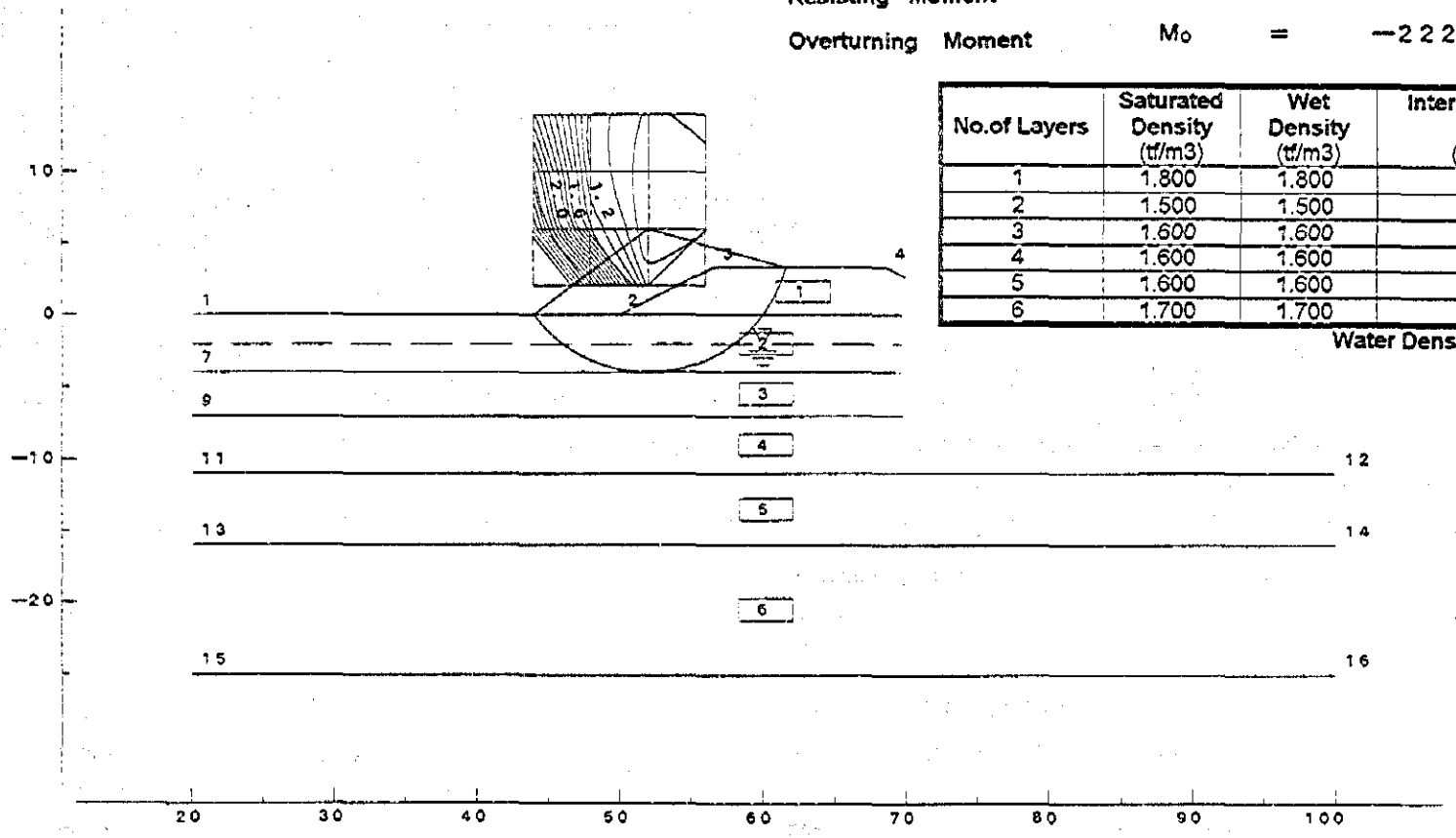
Lagcogangan Br.

Height of Embankment H = 3.30 m

Slope 2:1

Scale 1 / 500

Minimum Safety Factor	$F_{S\,MIN}$	=	0.918
Center of Circle Coordinates	X	=	52.00 (m)
	Y	=	6.00 (m)
Radius	R	=	10.00 (m)
Resisting Moment	M_R	=	203.91 (tf·m)
Overturning Moment	M_O	=	−222.25 (tf·m)



No.of Layers	Saturated Density (tf/m3)	Wet Density (tf/m3)	Internal Friction Angle (degres)	Cohesion (tf/m²)
1	1.800	1.800	0.0	0.50
2	1.500	1.500	0.0	1.00
3	1.600	1.600	0.0	2.00
4	1.600	1.600	0.0	2.50
5	1.600	1.600	0.0	3.50
6	1.700	1.700	0.0	10.50

Water Density = 1.000 (tf/m³)

STABILITY ANALYSIS

App. 8.7-3

Lagcogangan Br.

Height of Embankment H = 3.30 m

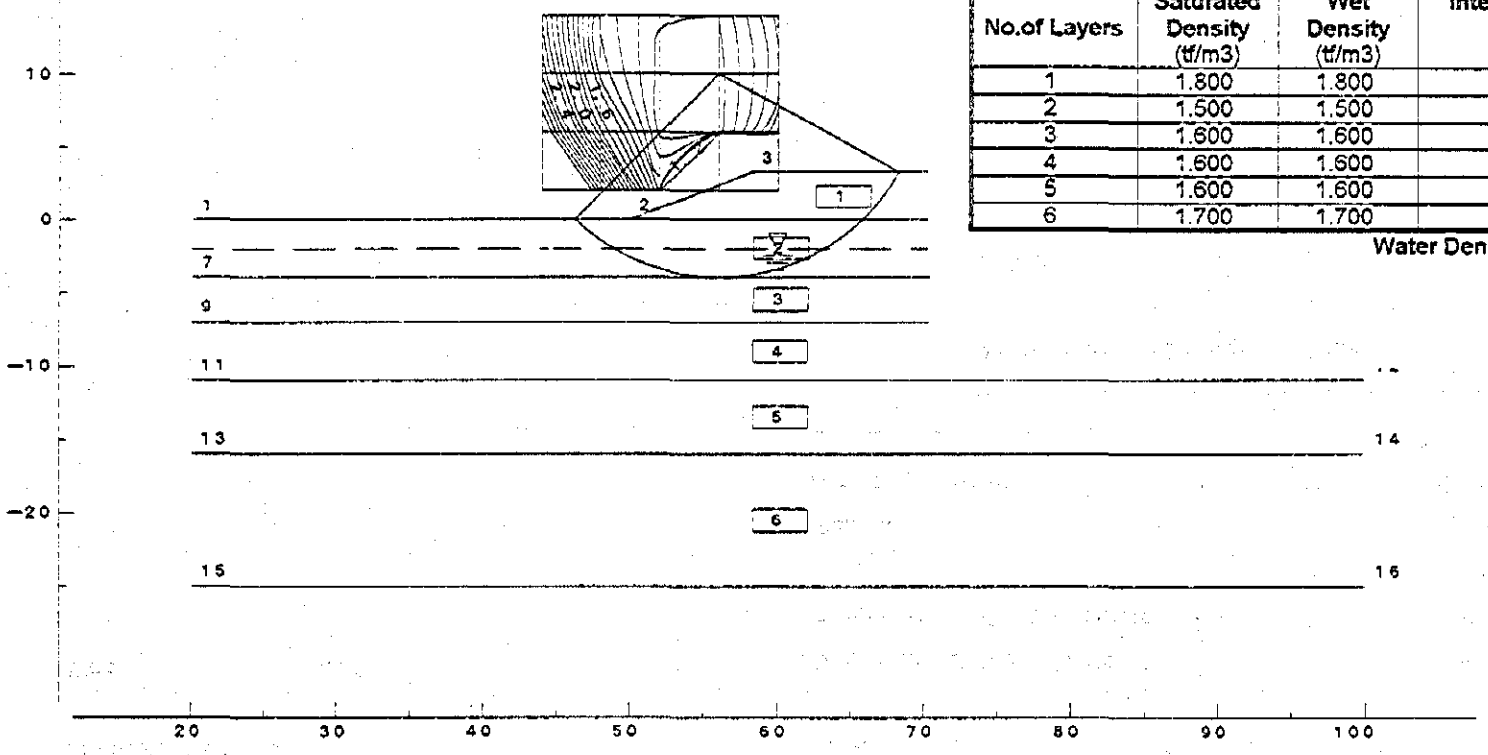
Slope 2.5 : 1

Scale 1 / 500

Minimum Safety Factor	$F_{S\,MIN}$	=	0.965	
Center of Circle Coordinates	X	=	56.00	(m)
	Y	=	10.00	(m)
Radius	R	=	14.00	(m)
Resisting Moment	M_R	=	332.87	(tf·m)
Overturning Moment	Mo	=	−344.98	(tf·m)

No.of Layers	Saturated Density (tf/m3)	Wet Density (tf/m3)	Internal Friction Angle (degres)	Cohesion (tf/m²)
1	1.800	1.800	0.0	0.50
2	1.500	1.500	0.0	1.00
3	1.600	1.600	0.0	2.00
4	1.600	1.600	0.0	2.50
5	1.600	1.600	0.0	3.50
6	1.700	1.700	0.0	10.50

Water Density = 1.000 (tf/m³)



STABILITY ANALYSIS

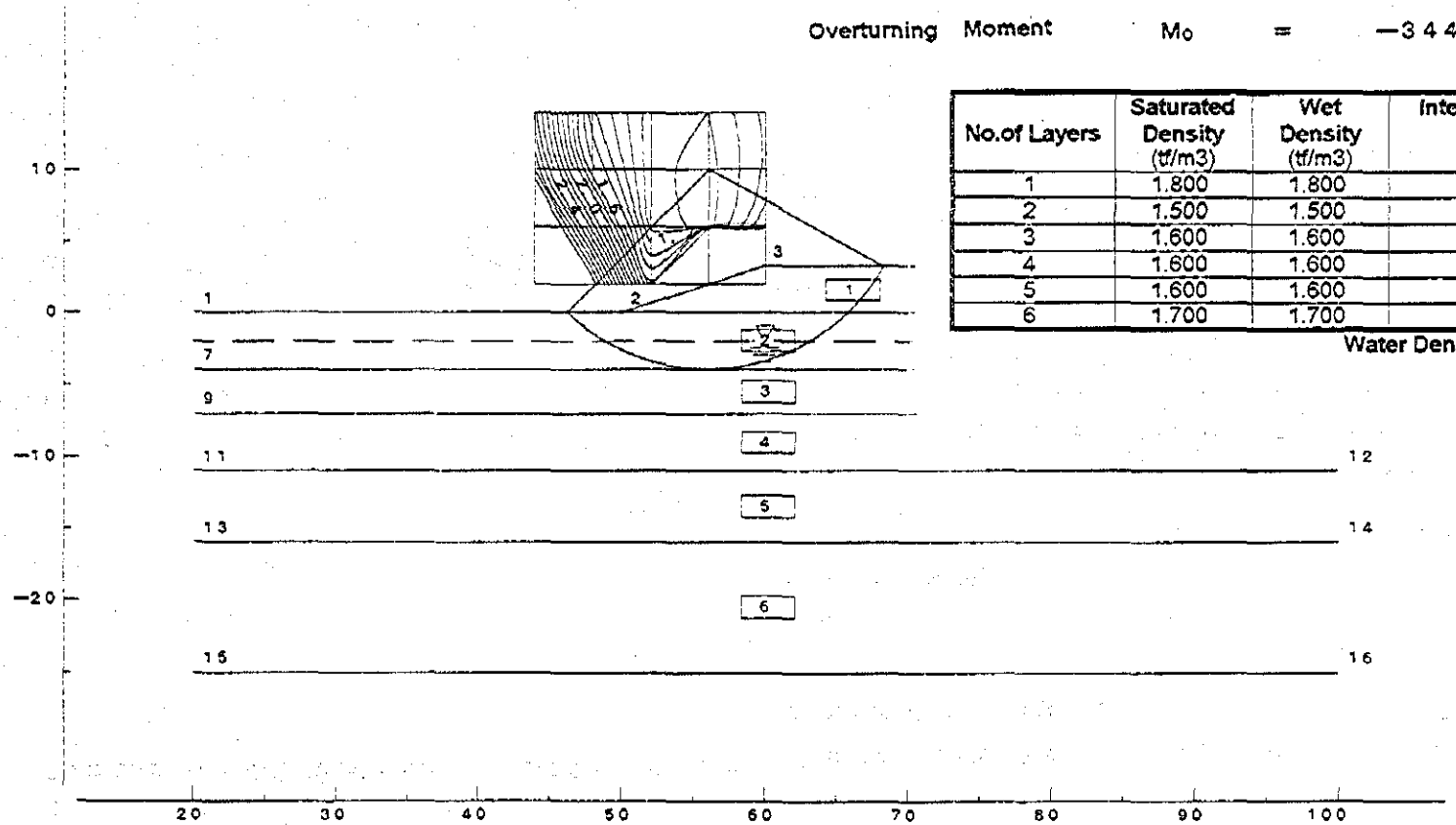
Lagcogangan Br.

Height of Embankment H = 3.30 m

Slope 3 : 1

Scale 1 / 500

Minimum Safety Factor	$F_{S\,MIN}$	=	0.966
Center of Circle Coordinates	X	=	56.00 (m)
	Y	=	10.00 (m)
Radius	R	=	14.00 (m)
Resisting Moment	M_R	=	332.87 (tf·m)
Overturning Moment	M_O	=	−344.73 (tf·m)



No.of Layers	Saturated Density (tf/m3)	Wet Density (tf/m3)	Internal Friction Angle (degres)	Cohesion (tf/m²)
1	1.800	1.800	0.0	0.50
2	1.500	1.500	0.0	1.00
3	1.600	1.600	0.0	2.00
4	1.600	1.600	0.0	2.50
5	1.600	1.600	0.0	3.50
6	1.700	1.700	0.0	10.50

Water Density = 1.000 (tf/m³)

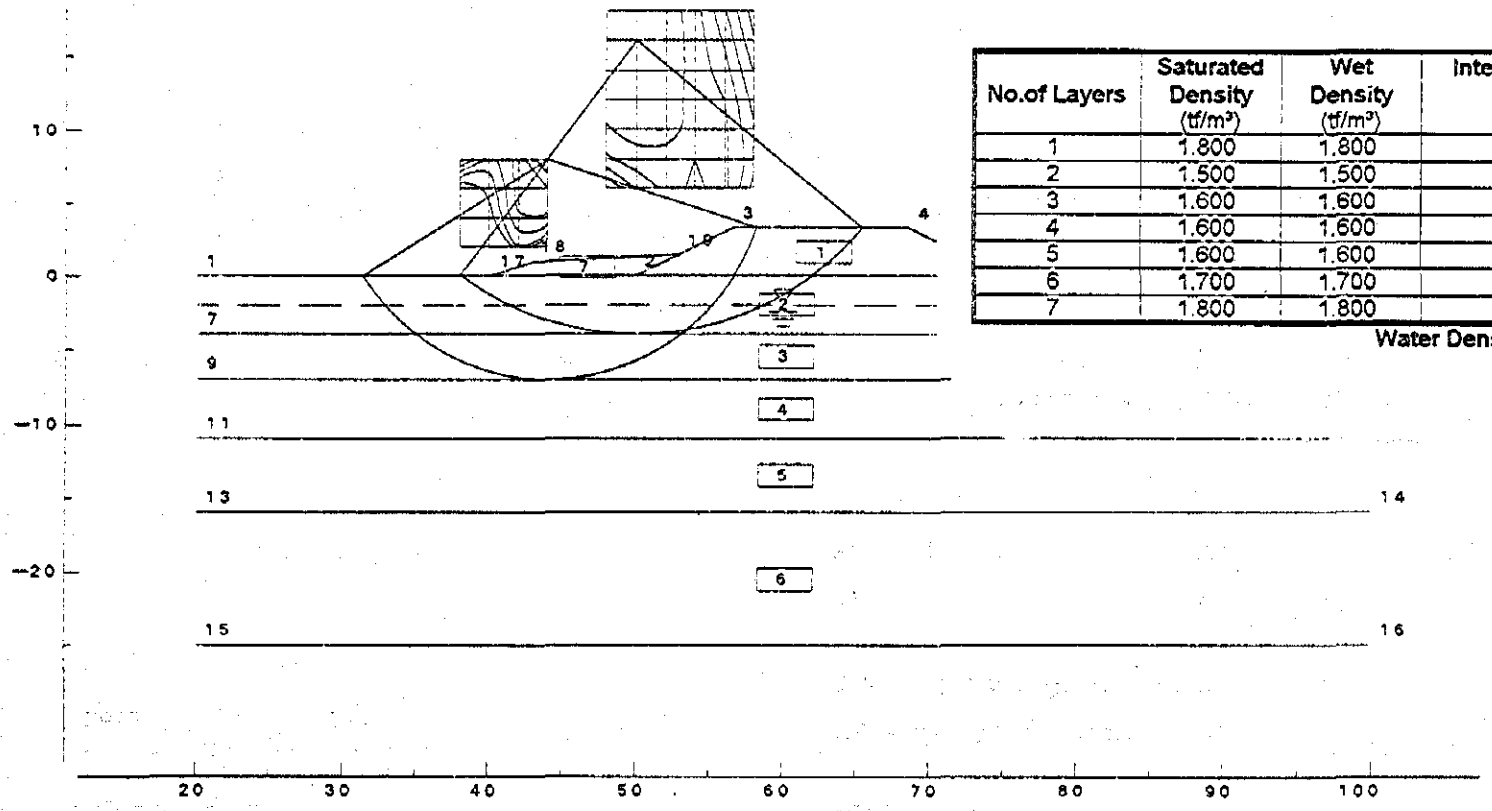
STABILITY ANALYSIS

App. 8.7.5

Lagcogangan Br. Approach
Hight of Embankment H=3.3m
Counter Weight Embankment L=10m,h=1.45m

Scale 1 / 500

Minimum Safety Factor	$F_{S\,MIN}$	=	1.208	
Center of Circle Coordinates	X	=	50.00	(m)
	Y	=	16.00	(m)
Radius	R	=	20.00	(m)
Resisting Moment	M_R	=	562.55	(tf·m)
Overturning Moment	M_O	=	−465.68	(tf·m)

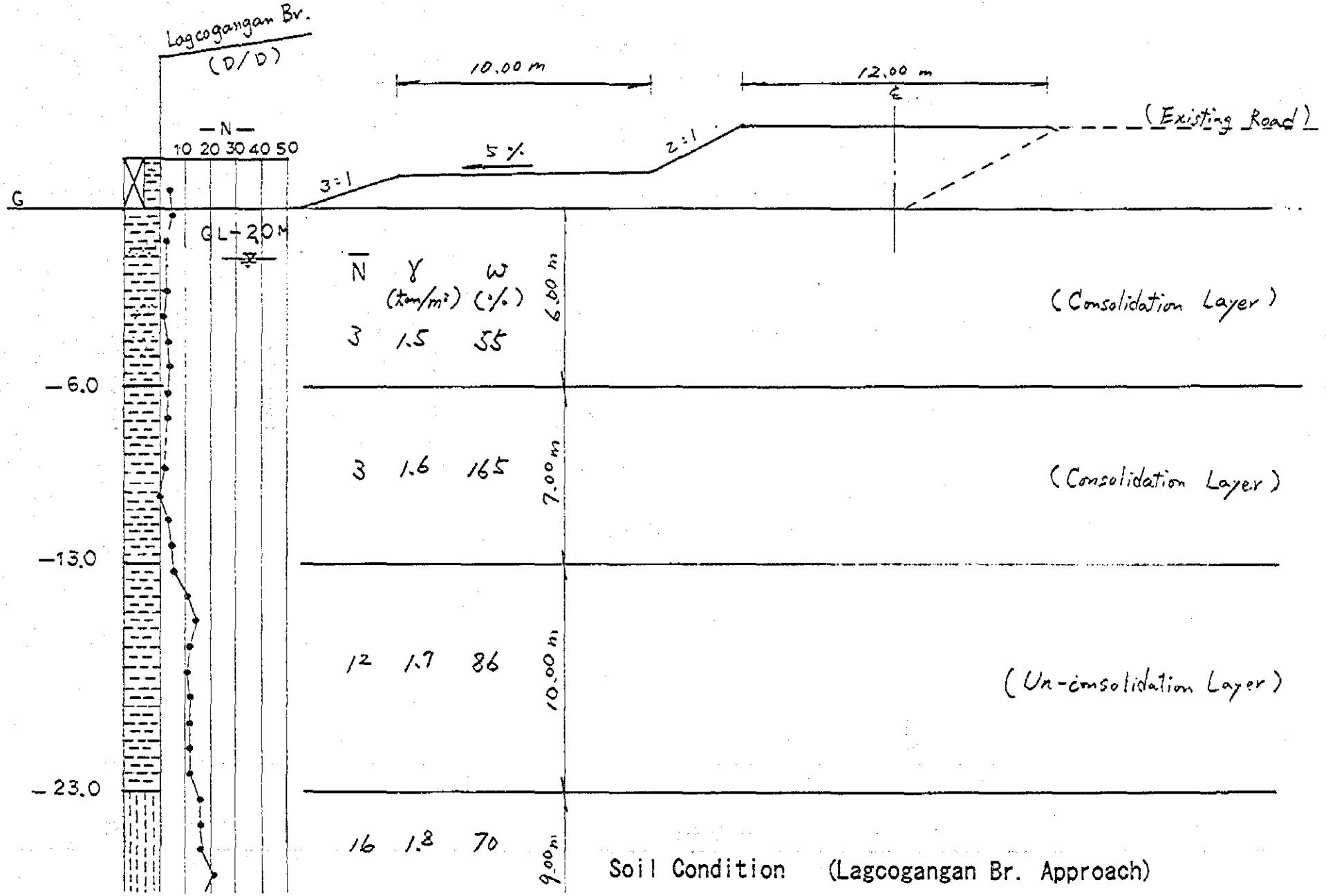


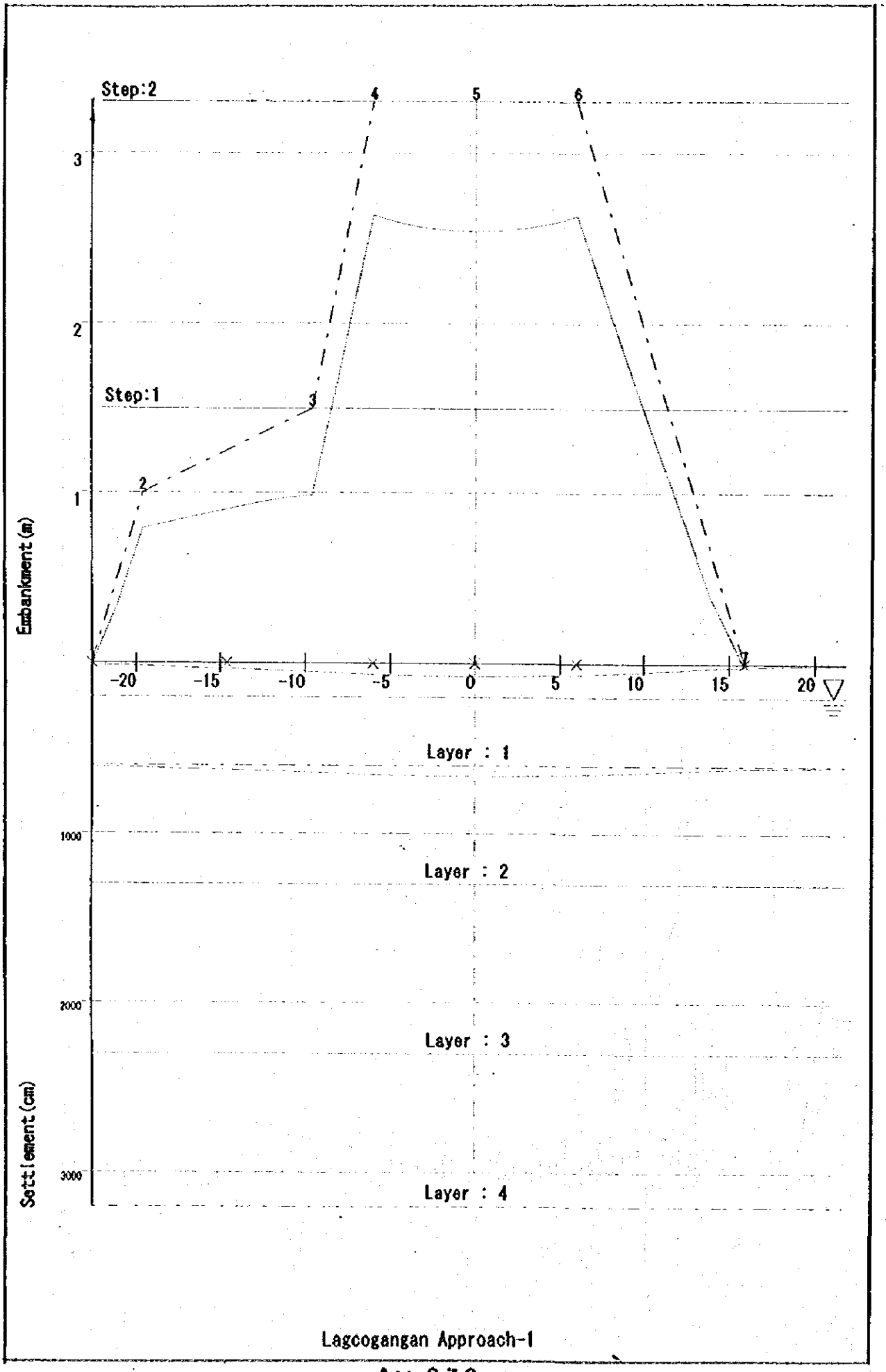
No.of Layers	Saturated Density (tf/m³)	Wet Density (tf/m³)	Internal Friction Angle (degres)	Cohesion (tf/m²)
1	1.800	1.800	0.0	0.50
2	1.500	1.500	0.0	1.00
3	1.600	1.600	0.0	2.00
4	1.600	1.600	0.0	2.50
5	1.600	1.600	0.0	3.50
6	1.700	1.700	0.0	10.00
7	1.800	1.800	0.0	0.50

Water Density = 1.000 (tf/m³)

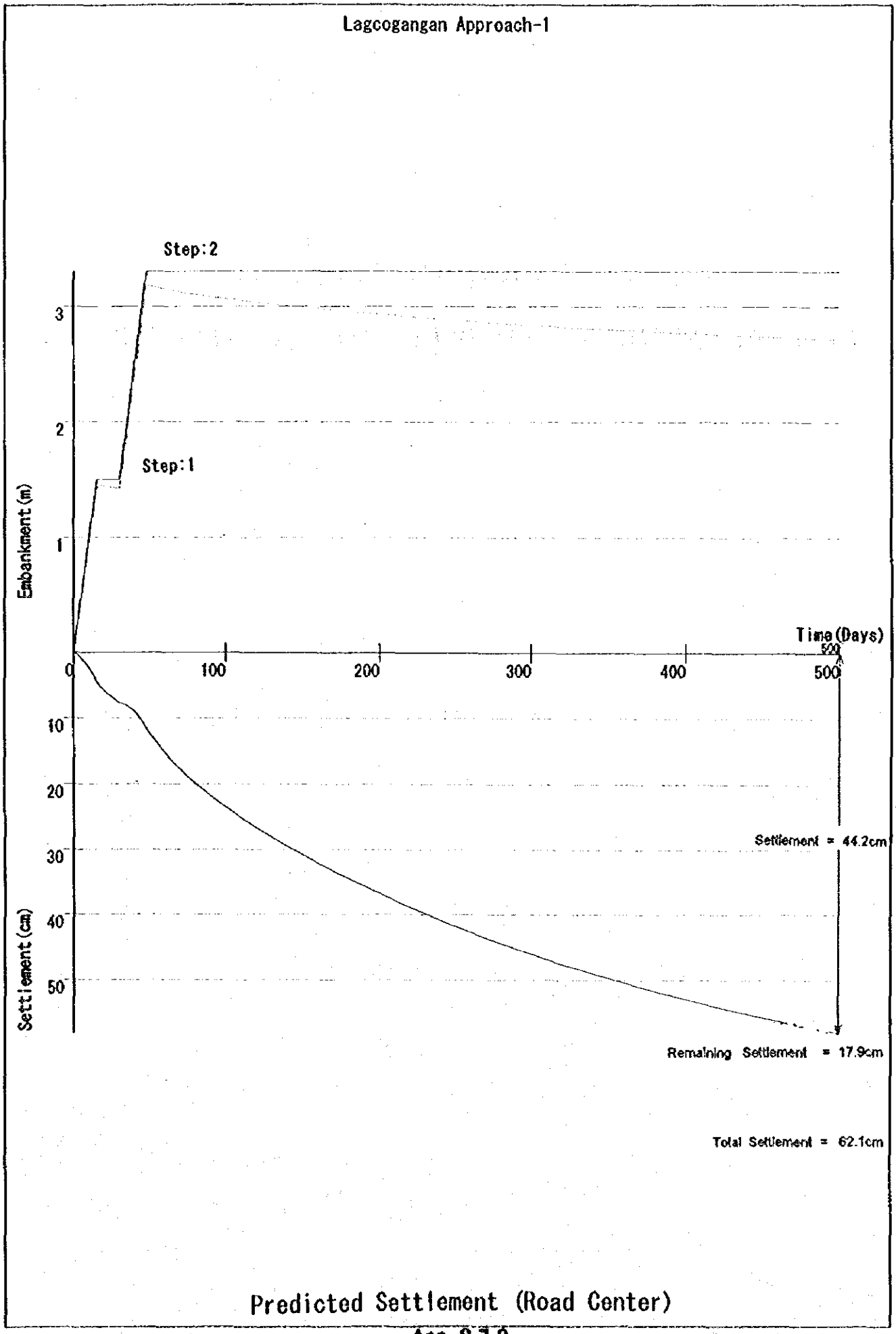
STABILITY ANALYSIS

App. 8.7-6


Lagcogangan Br.
(D/D)
10.00 m
12.00 m
(Existing Road)
— N —
10 20 30 40 50
5 %
3:1
2:1
G
GL+2.0M
N̄ γ (ton/m³) w (%)
3 1.5 55
6.00 m
(Consolidation Layer)
−6.0
3 1.6 165
7.00 m
(Consolidation Layer)
−13.0
12 1.7 86
10.00 m
(Un-consolidation Layer)
−23.0
16 1.8 70
9.00 m
Soil Condition (Lagcogangan Br. Approach)
App. 8.7.7



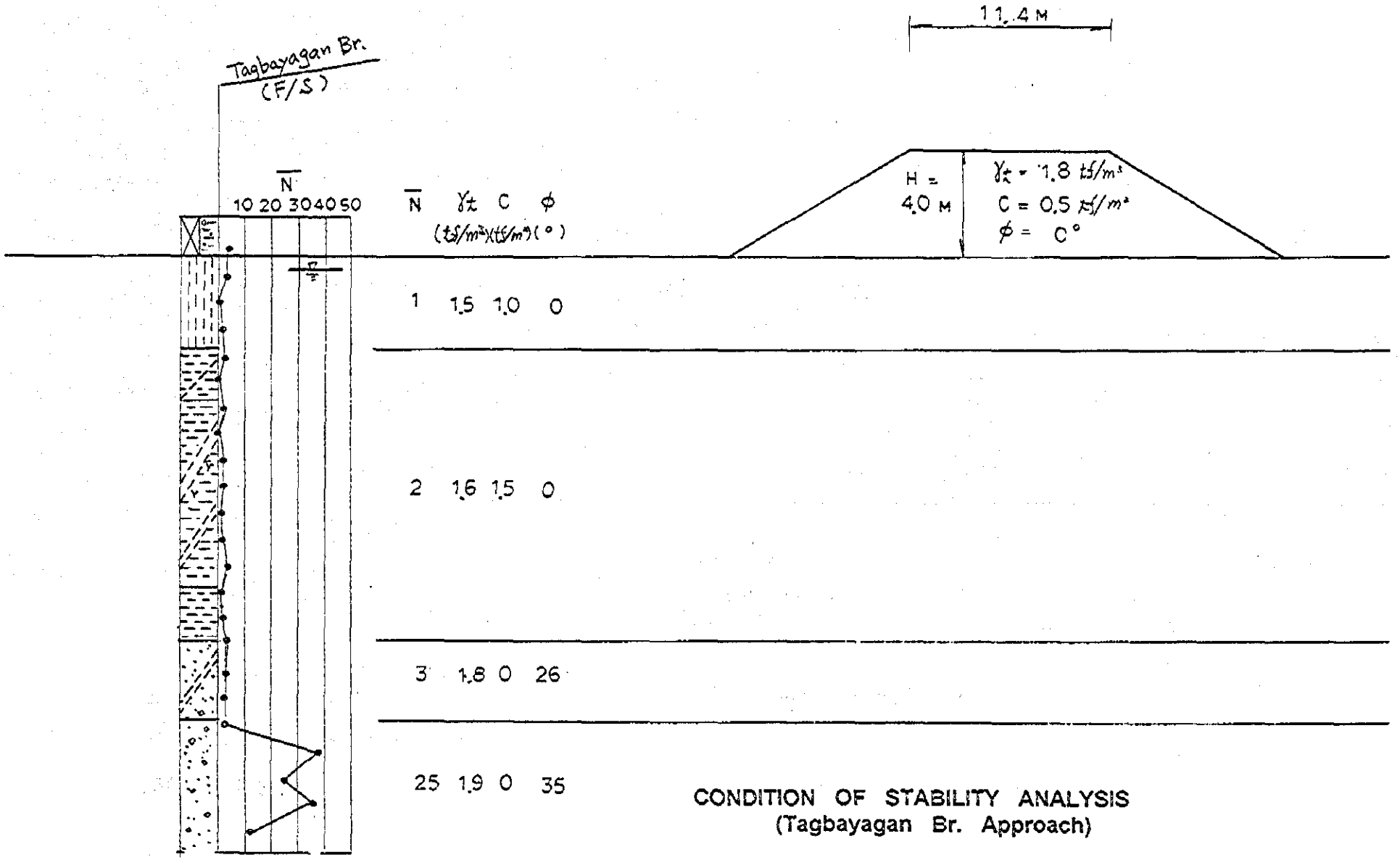
Lagcogangan Approach-1



Predicted Settlement (Road Center)

TAGBAYAGAN BRIDGE APPROACH

SLOPE STABILITY AND SETTLEMENT ANALYSIS



CONDITION OF STABILITY ANALYSIS
(Tagbayagan Br. Approach)

Tagbayagan Br.

Scale ; 1 / 500

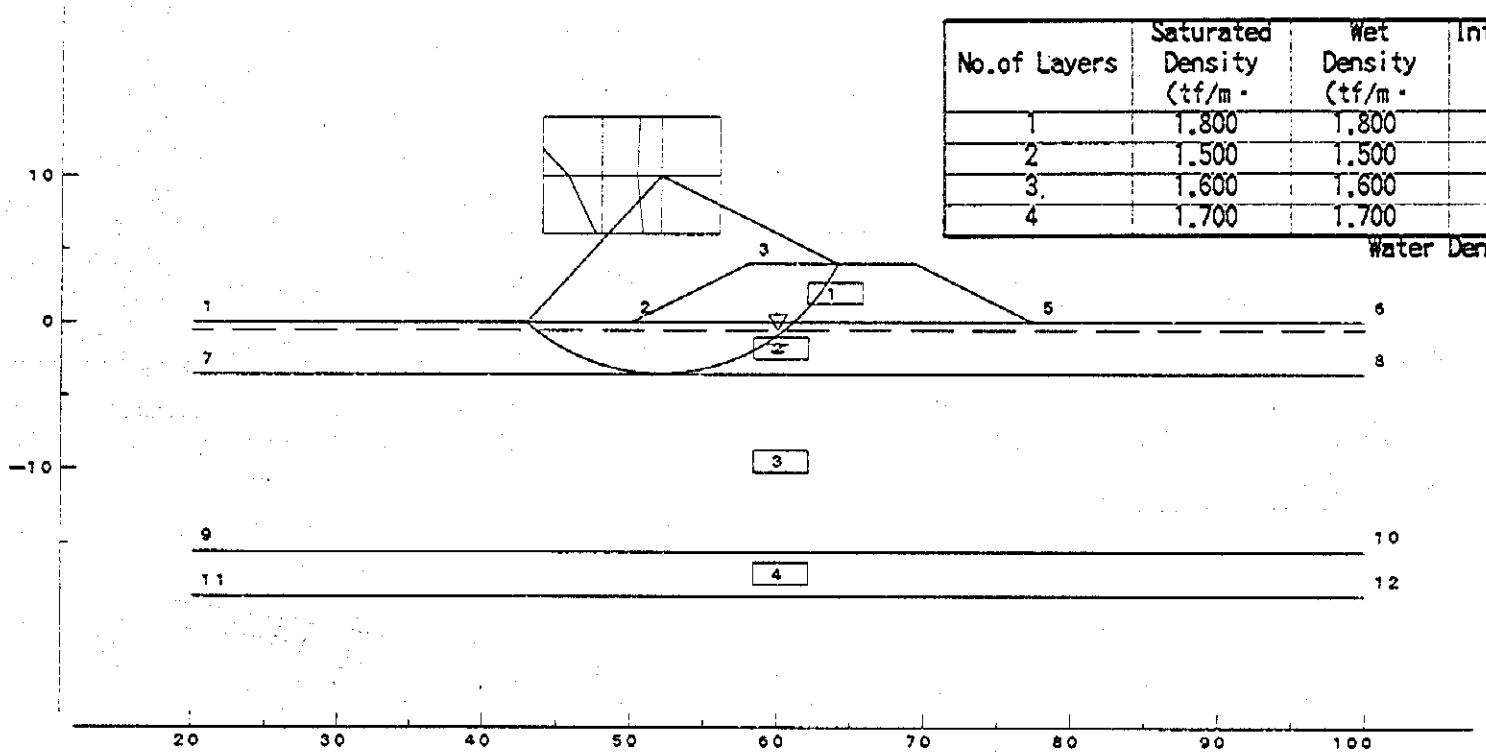
Height of Embankment H = 4.0 m

Slope 2:1

Minimum Safety Factor	Fs_{MIN}	=	0.712
Center of Circle Coordinates	X	=	52.00 (m)
	Y	=	10.00 (m)
Radius	R	=	13.50 (m)
Resisting Moment	M_R	=	275.63 (tf·m)
Overturning Moment	M_O	=	−387.20 (tf·m)

No.of Layers	Saturated Density (tf/m·)	Wet Density (tf/m·)	Internal Friction Angle (degres)	Cohesion (tf/m·)
1	1.800	1.800	0.0	0.50
2	1.500	1.500	0.0	0.90
3	1.600	1.600	0.0	1.20
4	1.700	1.700	0.0	10.00

Water Density = 1.000 (tf/m)



STABILITY ANALYSIS

App. 8.7-12

Tagbayagan Br.

Scale ; 1 / 500

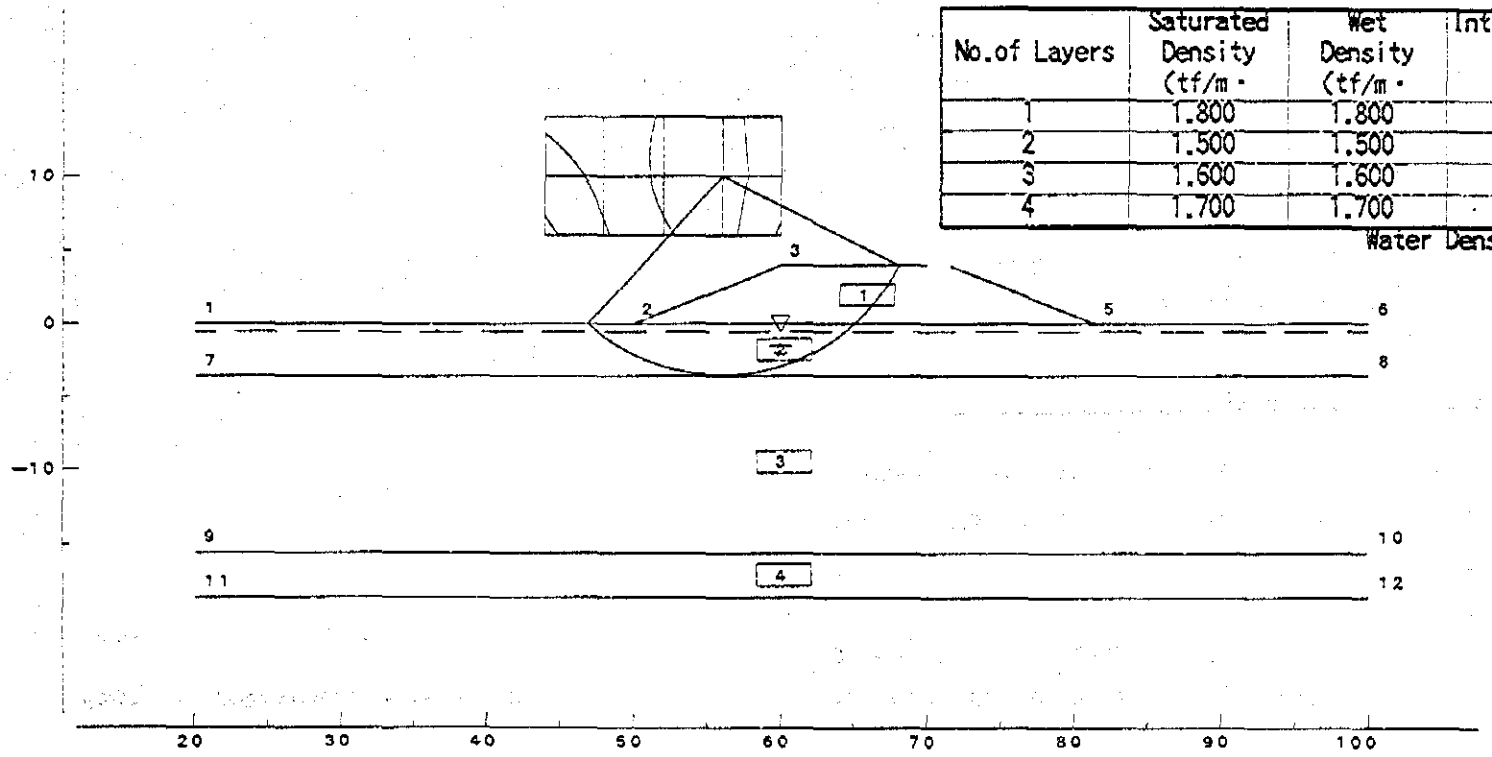
Height of Embankment H = 4.0 m

Slope 2.5 : 1

Minimum Safety Factor	$F_{S\,MIN}$	=	0.712
Center of Circle Coordinates	X	=	56.00 (m)
	Y	=	10.00 (m)
Radius	R	=	13.50 (m)
Resisting Moment	M_R	=	275.63 (tf·m)
Overturning Moment	M_O	=	−387.20 (tf·m)

No.of Layers	Saturated Density (tf/m·)	Wet Density (tf/m·)	Internal Friction Angle (degres)	Cohesion (tf/m·)
1	1.800	1.800	0.0	0.50
2	1.500	1.500	0.0	0.90
3	1.600	1.600	0.0	1.20
4	1.700	1.700	0.0	10.00

Water Density = 1.000 (tf/m)



STABILITY ANALYSIS

Tagbayagan Br.

Scale : 1 / 500

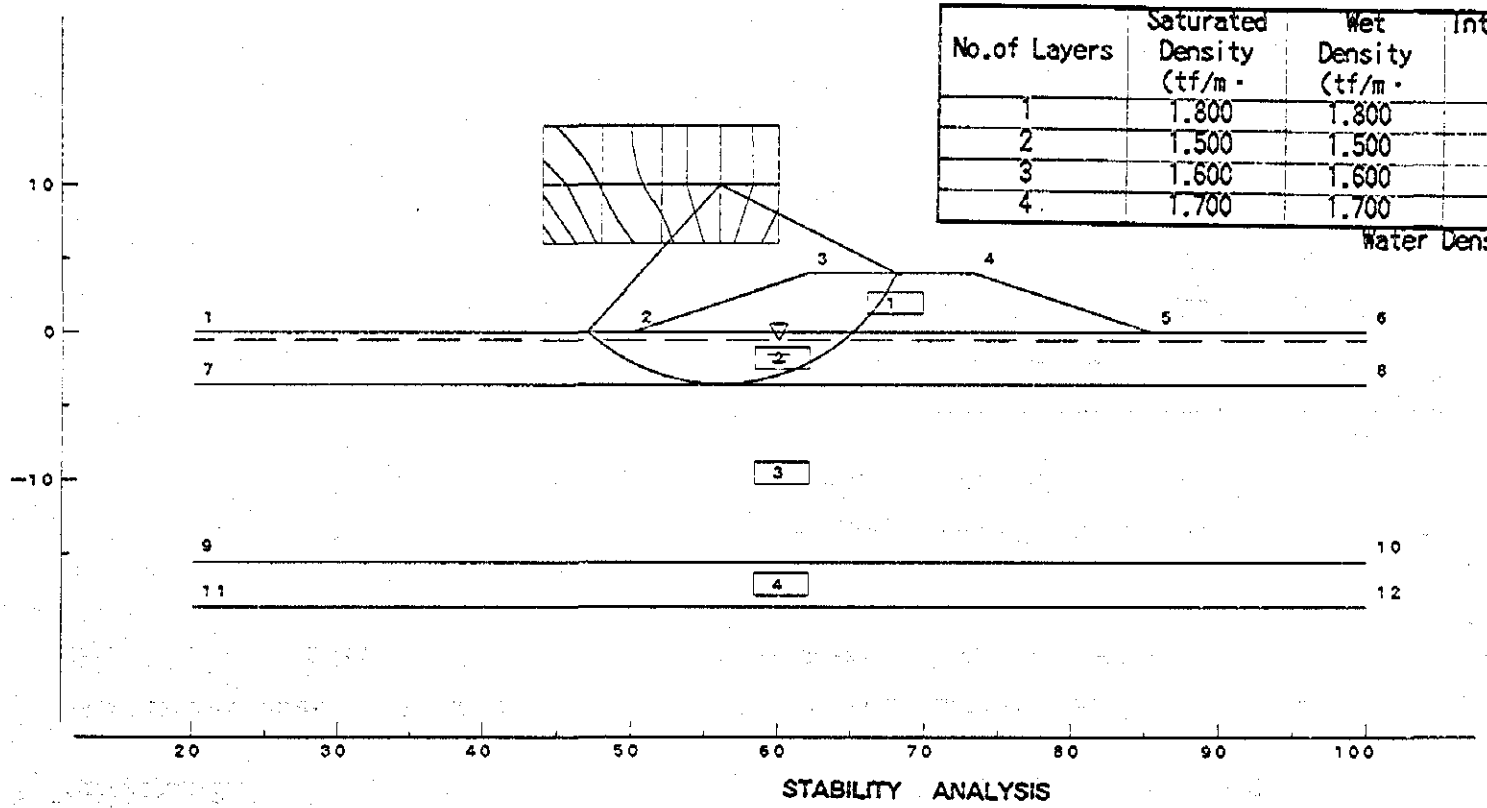
Height of Embankment H = 4.0 m

Slope 3 : 1

Minimum Safety Factor	$F_{S\,MIN}$ =	0.730	
Center of Circle Coordinates	X =	56.00	(m)
	Y =	10.00	(m)
Radius	R =	13.50	(m)
Resisting Moment	M_R =	275.63	(tf·m)
Overturning Moment	M_O =	−377.60	(tf·m)

No.of Layers	Saturated Density (tf/m³)	Wet Density (tf/m³)	Internal Friction Angle (degres)	Cohesion (tf/m²)
1	1.800	1.800	0.0	0.50
2	1.500	1.500	0.0	0.90
3	1.600	1.600	0.0	1.20
4	1.700	1.700	0.0	10.00

Water Density = 1.000 (tf/m³)

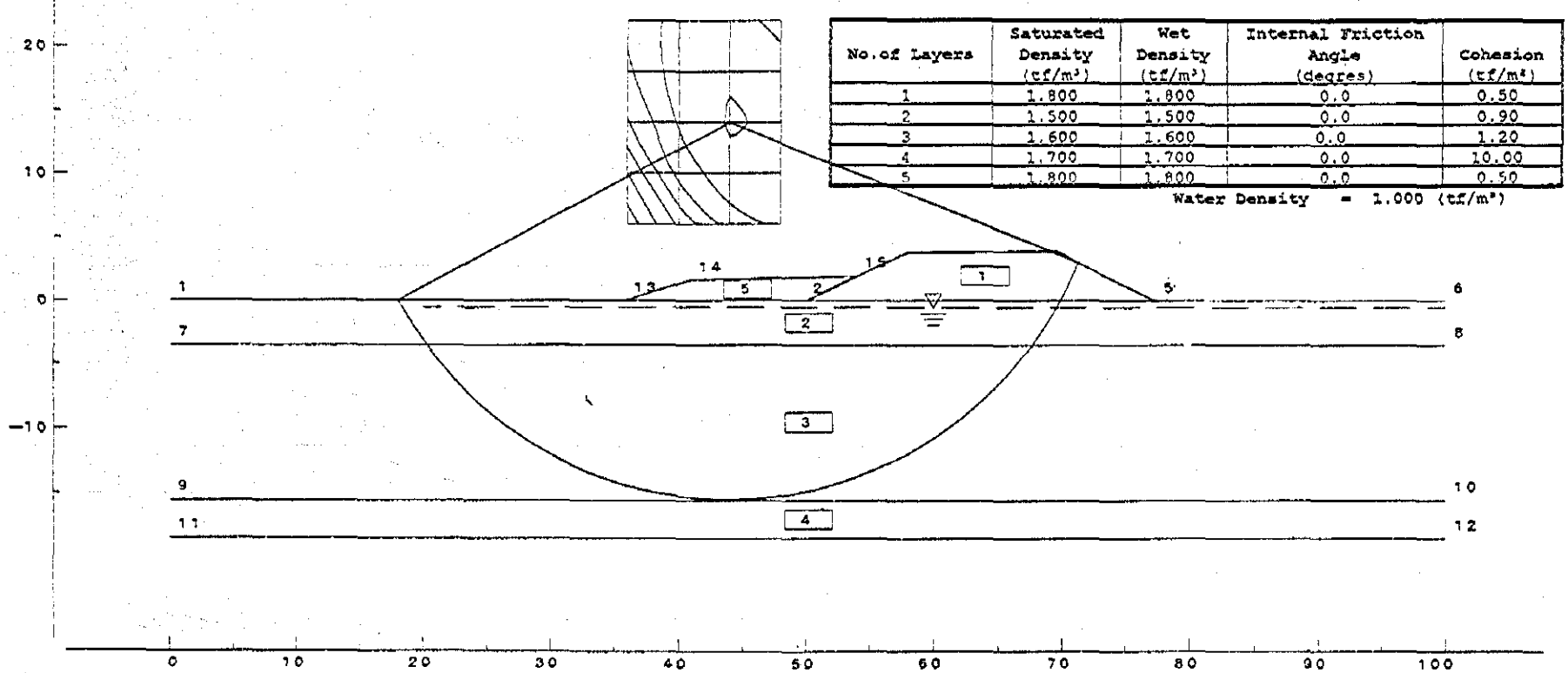


STABILITY ANALYSIS

Tagbayagan Br.
Height of Embankment H = 4.0m
Counter Weight Embankment L = 10.0m, h = 2.0m

Scale : 1 / 500

Minimum Safety Factor	$F_{S\,MIN}$	=	1.293	
Center of Circle Coordinates	X	=	44.00	(m)
	Y	=	14.00	(m)
Radius	R	=	29.50	(m)
Resisting Moment	M_R	=	2871.64	(tf·m)
Overturning Moment	M_O	=	−2220.48	(tf·m)

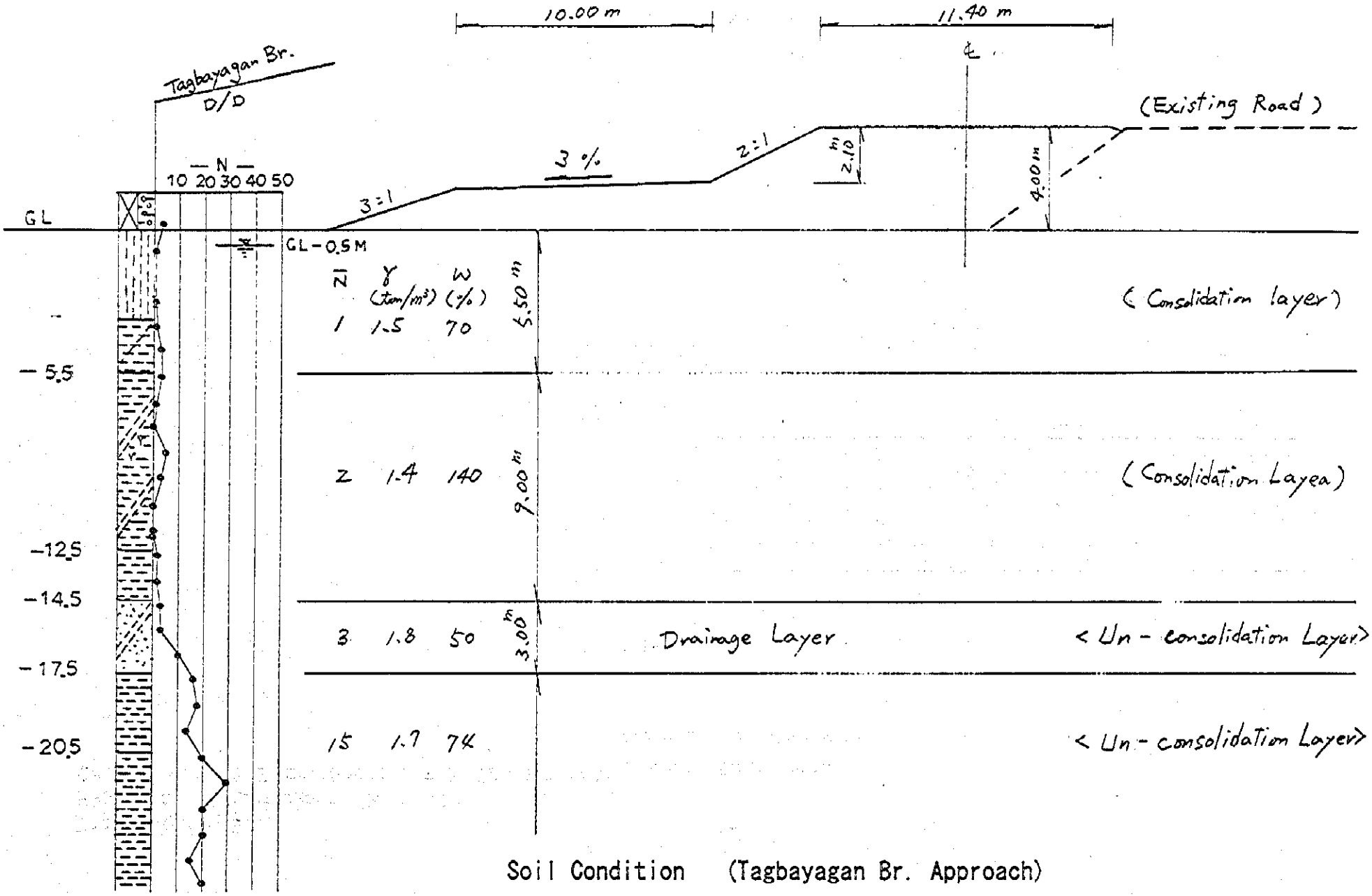


No.of Layers	Saturated Density (tf/m³)	Wet Density (tf/m³)	Internal Friction Angle (degres)	Cohesion (tf/m²)
1	1.800	1.800	0.0	0.50
2	1.500	1.500	0.0	0.90
3	1.600	1.600	0.0	1.20
4	1.700	1.700	0.0	10.00
5	1.800	1.800	0.0	0.50

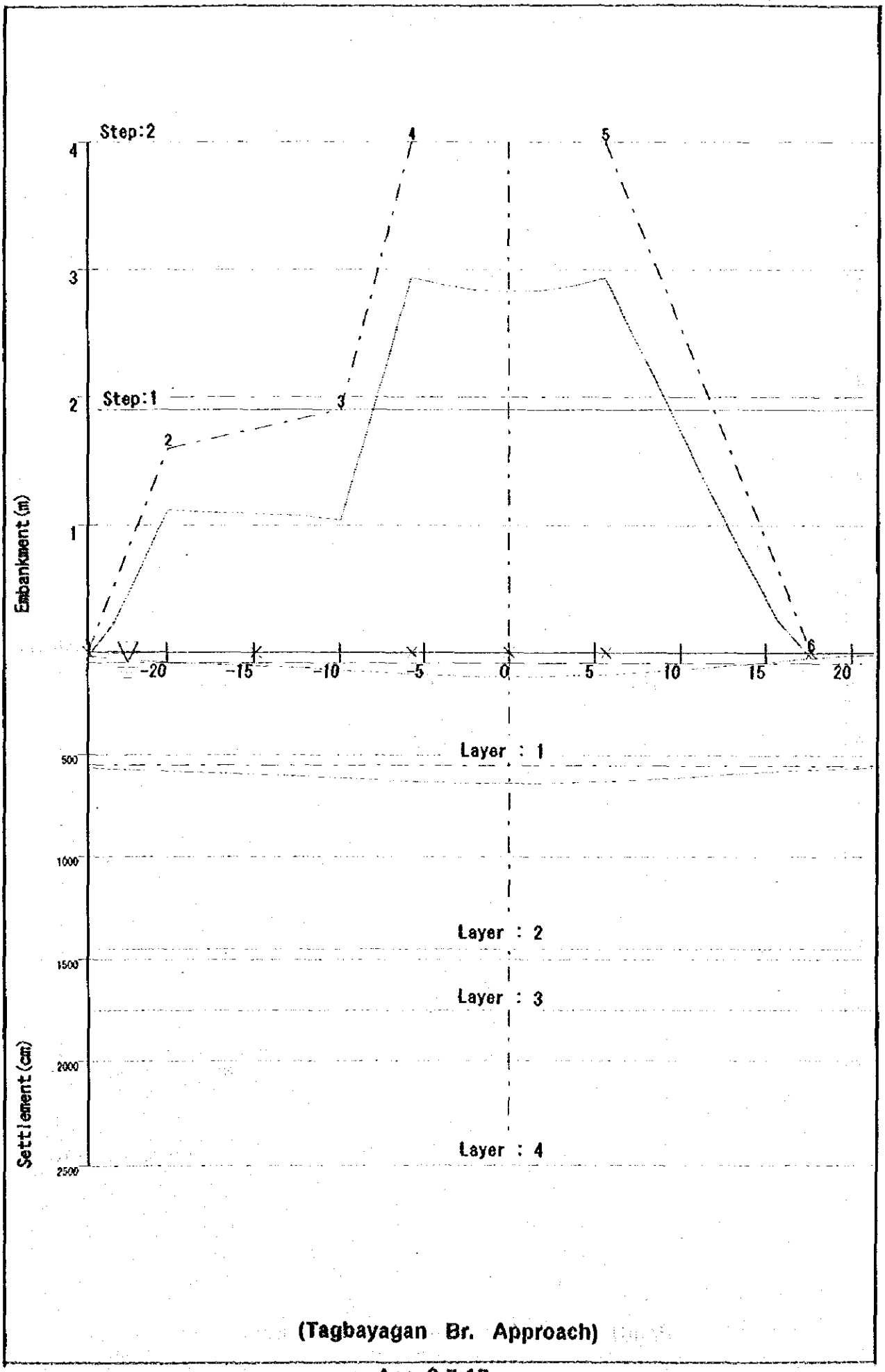
Water Density = 1.000 (tf/m³)

STABILITY ANALYSIS

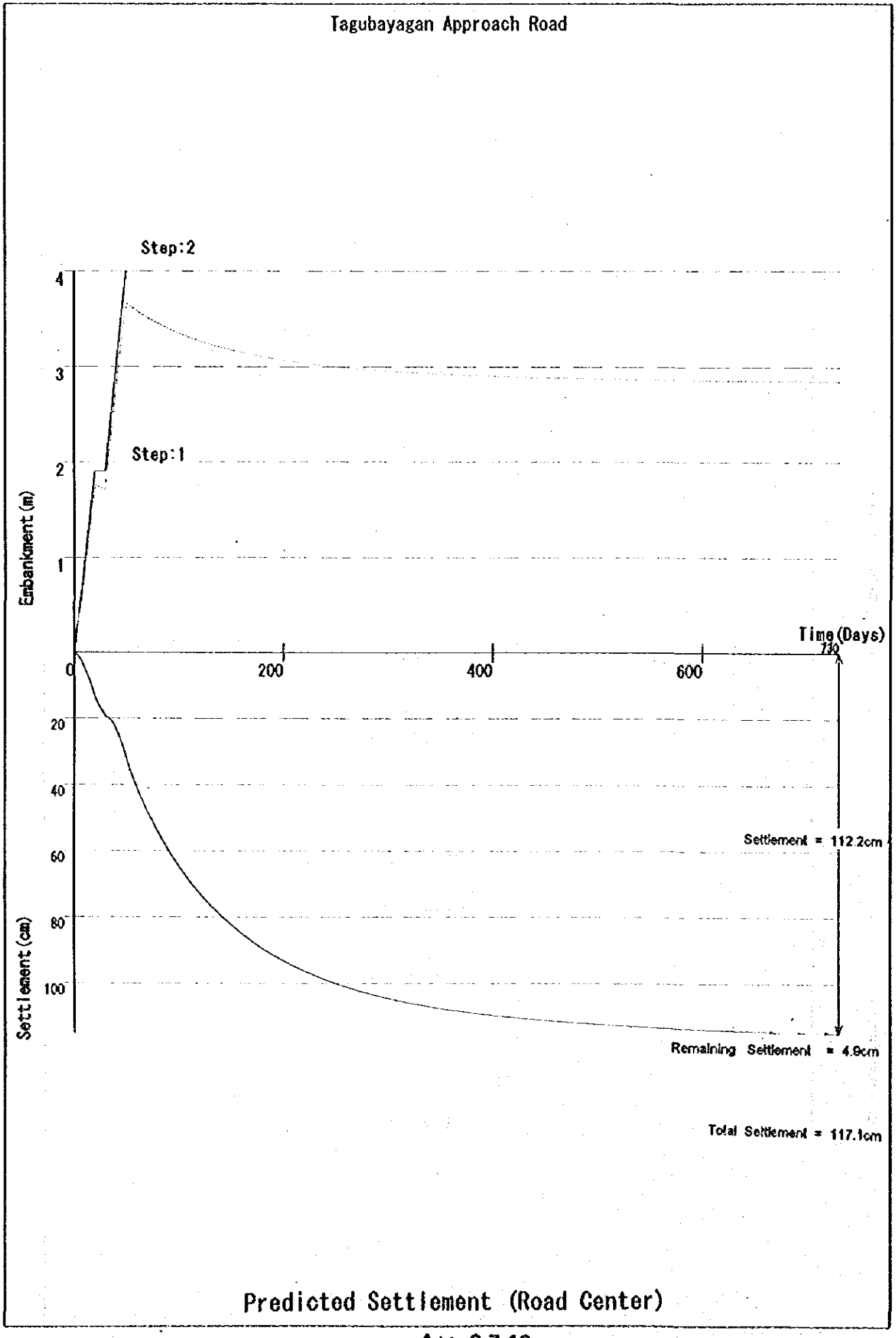
App. 8.7-15



Soil Condition (Tagbayagan Br. Approach)



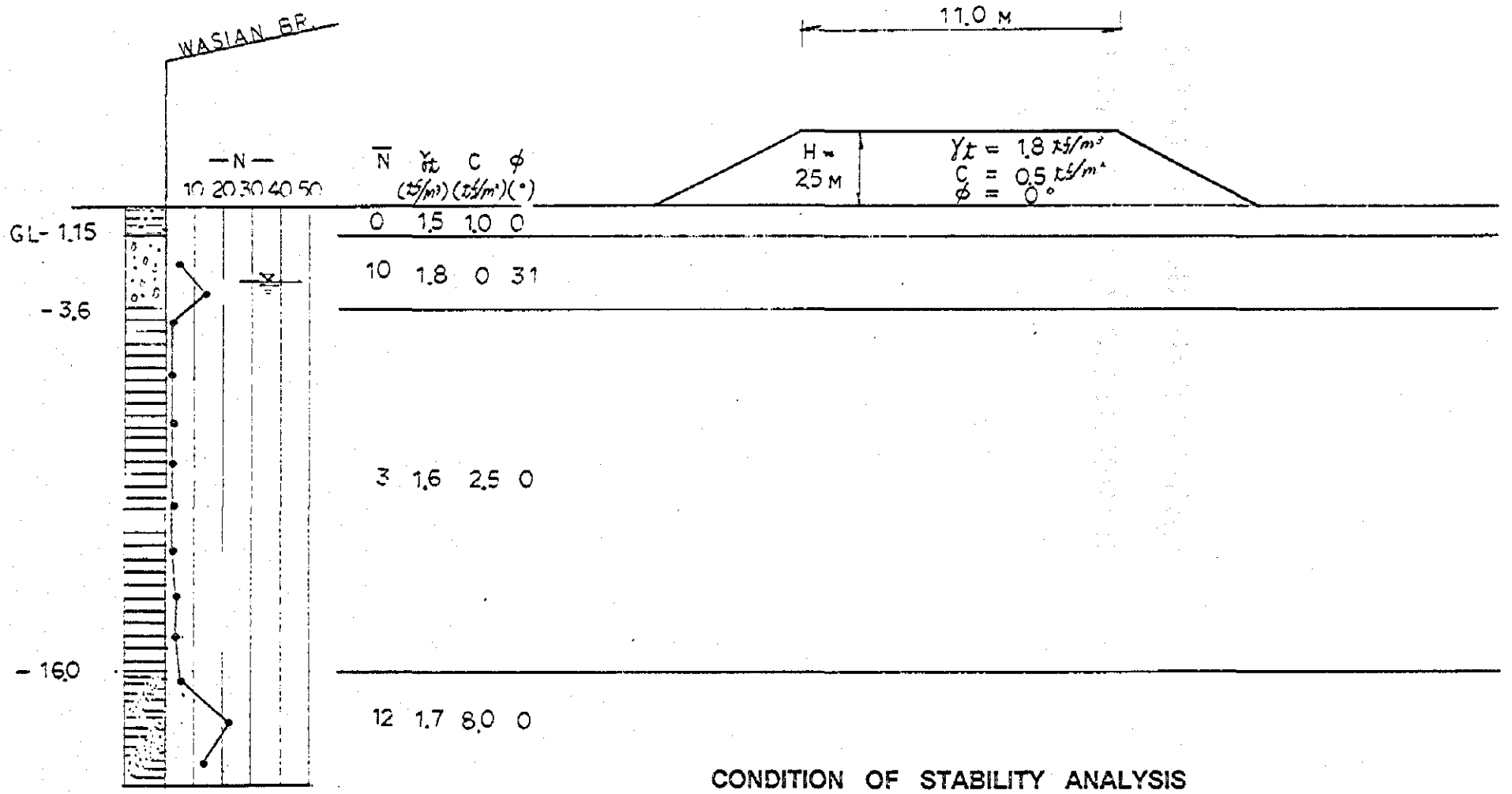
(Tagbayagan Br. Approach)



Predicted Settlement (Road Center)

WASIAN BRIDGE APPROACH

SLOPE STABILITY ANALYSIS



CONDITION OF STABILITY ANALYSIS
(Wasian Br. Approach)

Wasian Br. App.

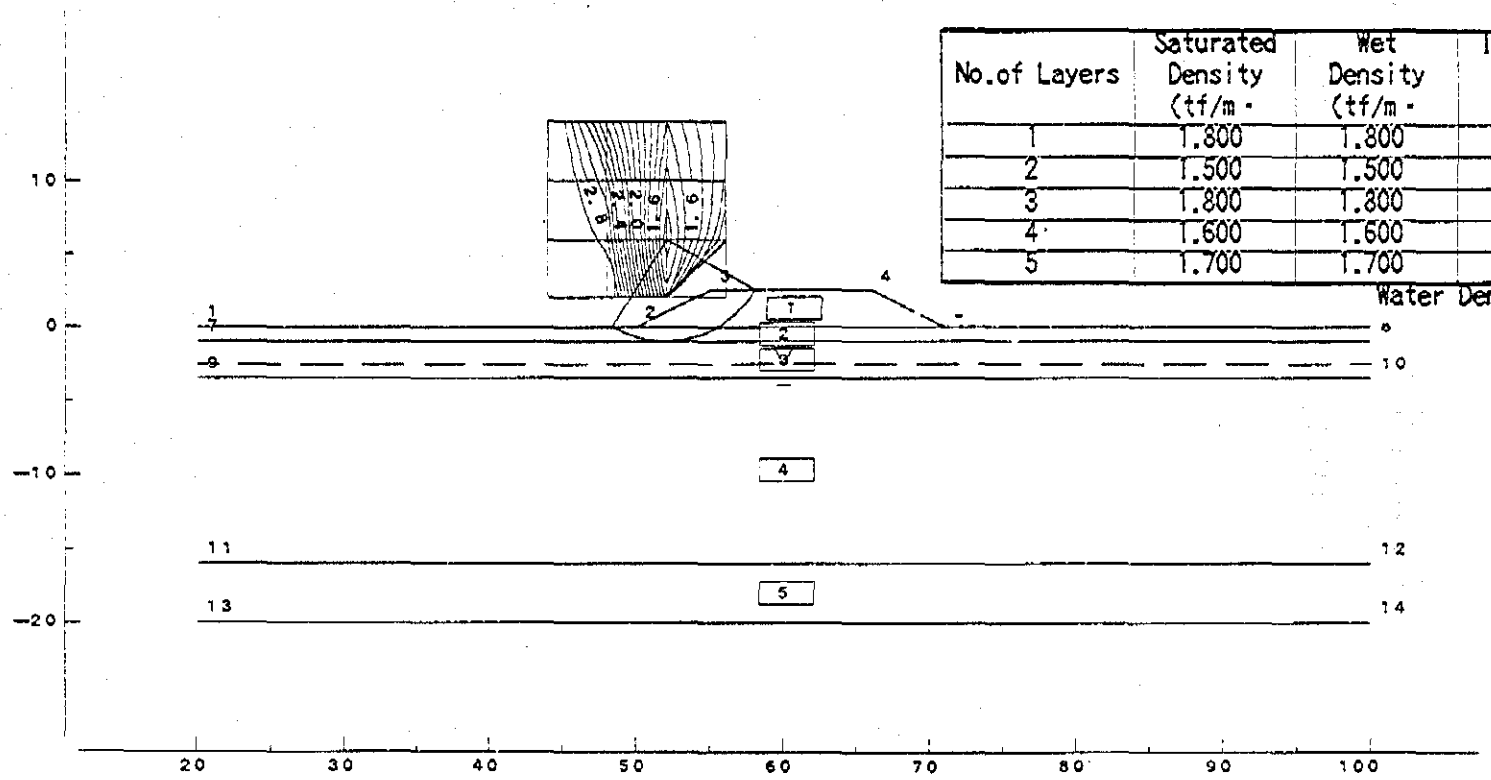
Scale 1 / 500

Hight of Embankment H=2.5m
Slope 2.0:1

Minimum Safety Factor	Fs MIN	=	1.233	
Center of Circle Coordinates	X	=	52.00	(m)
	Y	=	6.00	(m)
Radius	R	=	7.00	(m)
Resisting Moment	MR	=	65.39	(tf·m)
Overturning Moment	Mo	=	−53.03	(tf·m)

No.of Layers	Saturated Density (tf/m·)	Wet Density (tf/m·)	Internal Friction Angle (degres)	Cohesion (tf/m·)
1	1.800	1.800	0.0	0.50
2	1.500	1.500	0.0	1.00
3	1.800	1.800	31.0	0.00
4	1.600	1.600	0.0	2.50
5	1.700	1.700	0.0	8.00

Water Density = 1.000 (tf/m·

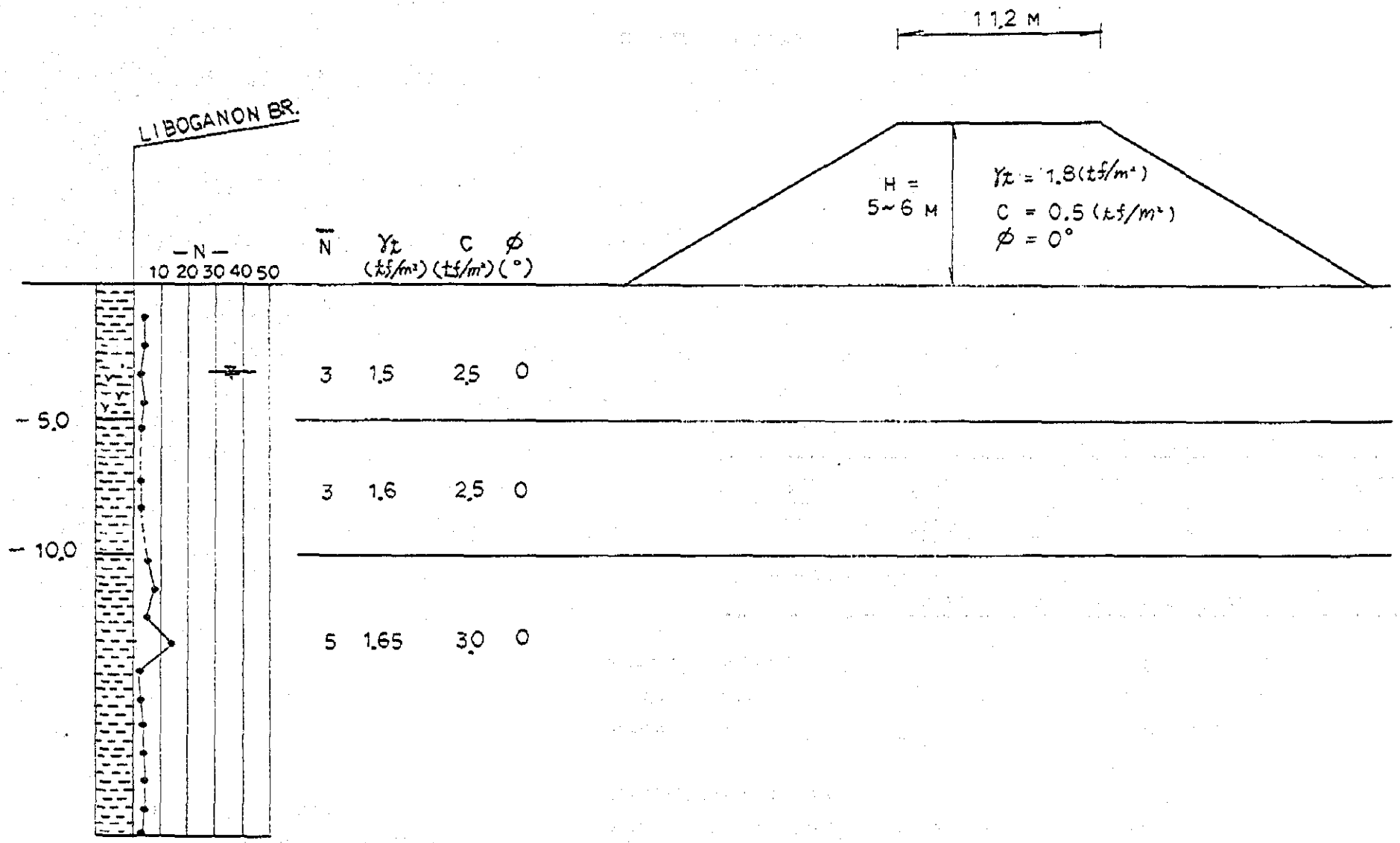


STABILITY ANALYSIS

App. 8.7.21

LIBOGANON BRIDGE APPROACH

SLOPE STABILITY ANALYSIS



CONDITION OF STABILITY ANALYSIS
(Liboganon Br. Approach)

Liboganon Br. Approach

Height of Embankment H = 6.0 m

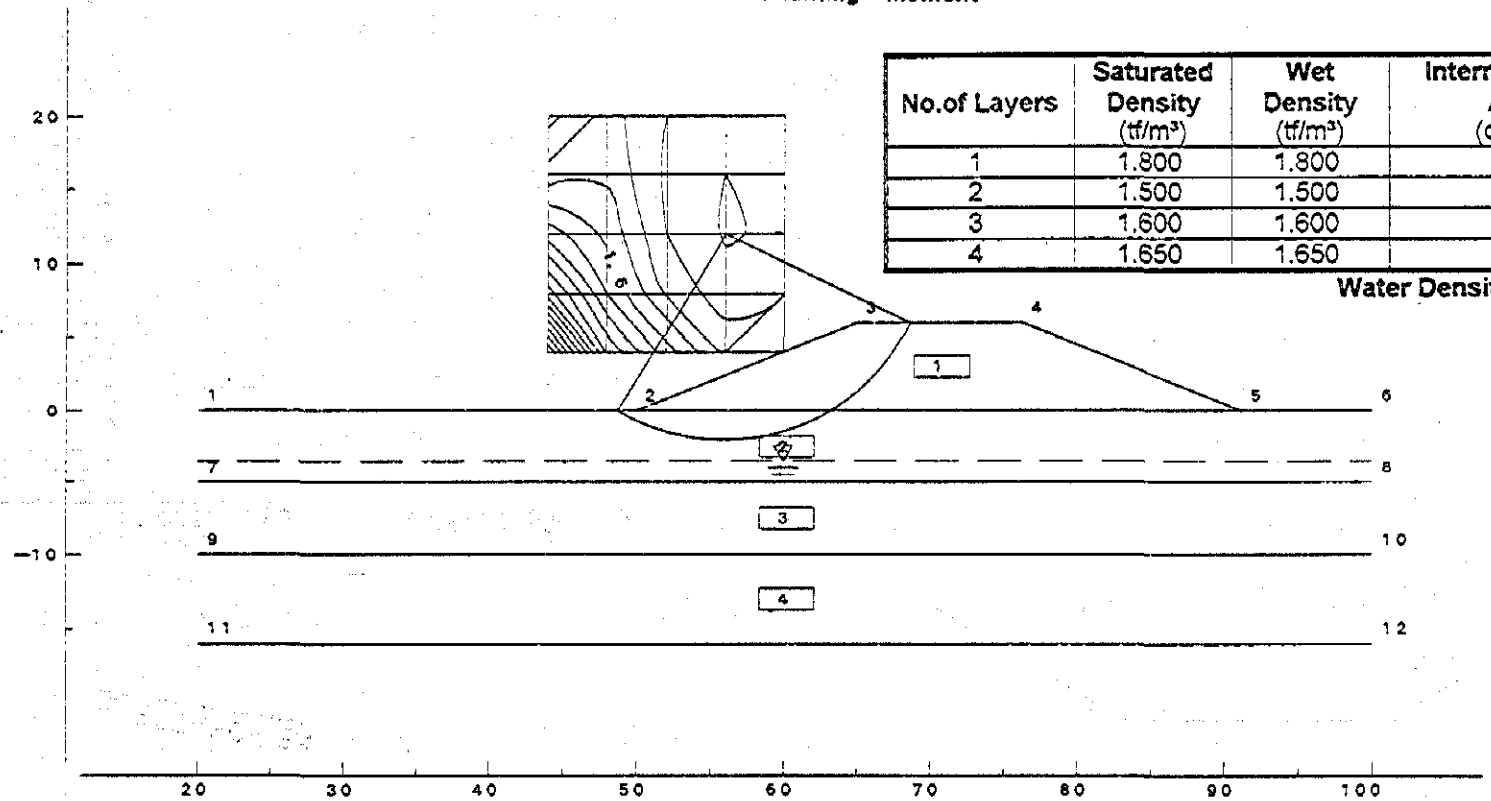
Slope 2.5 : 1

Scale 1 / 500

Minimum Safety Factor	$F_{S\,MIN}$	=	1.203
Center of Circle Coordinates	X	=	56.00 (m)
	Y	=	12.00 (m)
Radius	R	=	14.00 (m)
Resisting Moment	M_R	=	587.59 (tf·m)
Overturning Moment	M_O	=	−491.25 (tf·m)

No.of Layers	Saturated Density (tf/m³)	Wet Density (tf/m³)	Internal Friction Angle (degres)	Cohesion (tf/m²)
1	1.800	1.800	0.0	0.50
2	1.500	1.500	0.0	2.50
3	1.600	1.600	0.0	2.50
4	1.650	1.650	0.0	3.00

Water Density = 1.000 (tf/m³)



STABILITY ANALYSIS

Liboganon Br. Approach

Scale 1 / 500

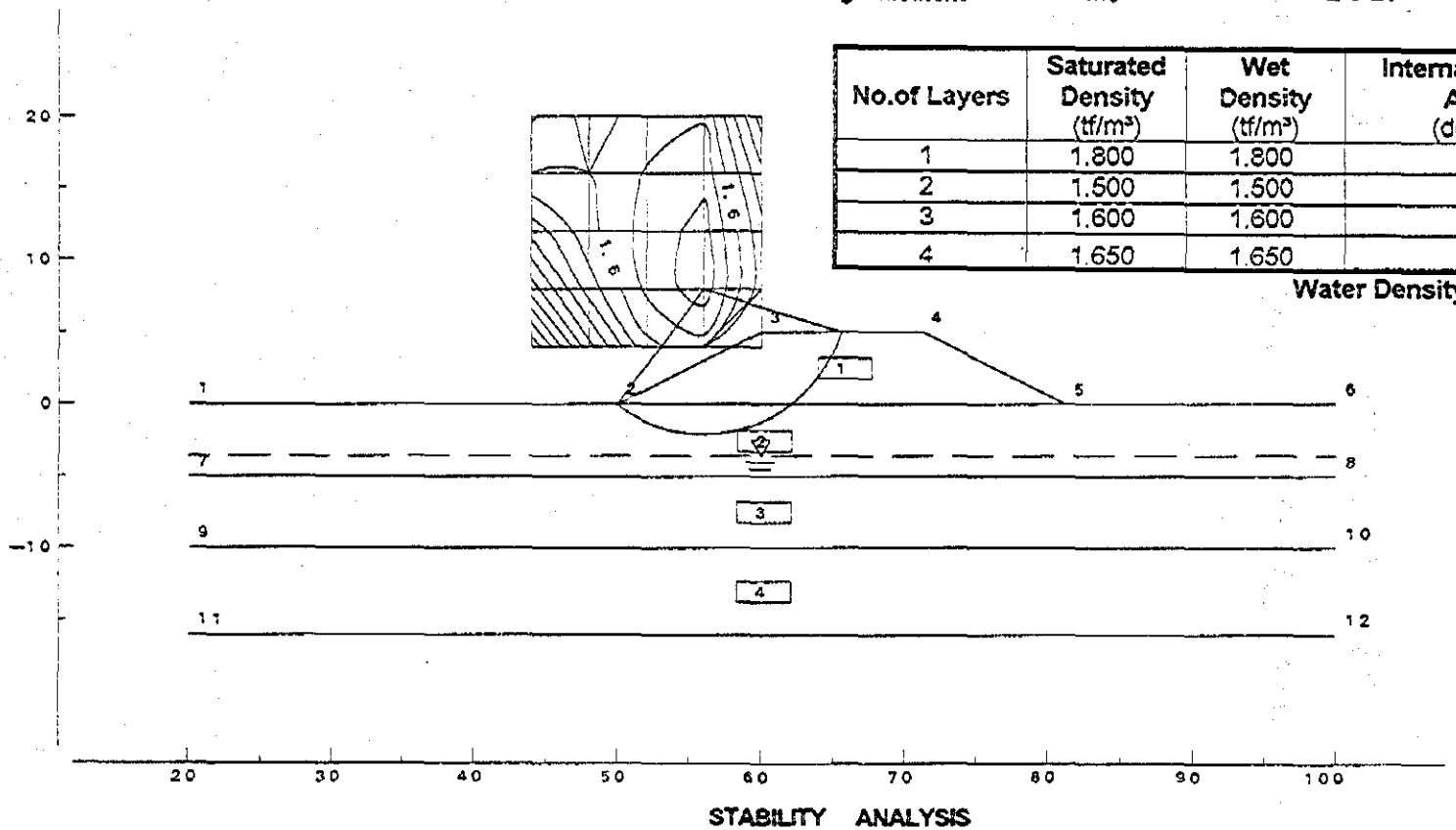
Height of Embankment H = 5.0 m

Slope 2:1

Minimum Safety Factor	$F_{S\,MIN}$	=	1.344
Center of Circle Coordinates	X	=	56.00 (m)
	Y	=	8.00 (m)
Radius	R	=	10.00 (m)
Resisting Moment	M_R	=	352.75 (tf·m)
Overturning Moment	M_O	=	−262.41 (tf·m)

No.of Layers	Saturated Density (tf/m³)	Wet Density (tf/m³)	Internal Friction Angle (degres)	Cohesion (tf/m²)
1	1.800	1.800	0.0	0.50
2	1.500	1.500	0.0	2.50
3	1.600	1.600	0.0	2.50
4	1.650	1.650	0.0	3.00

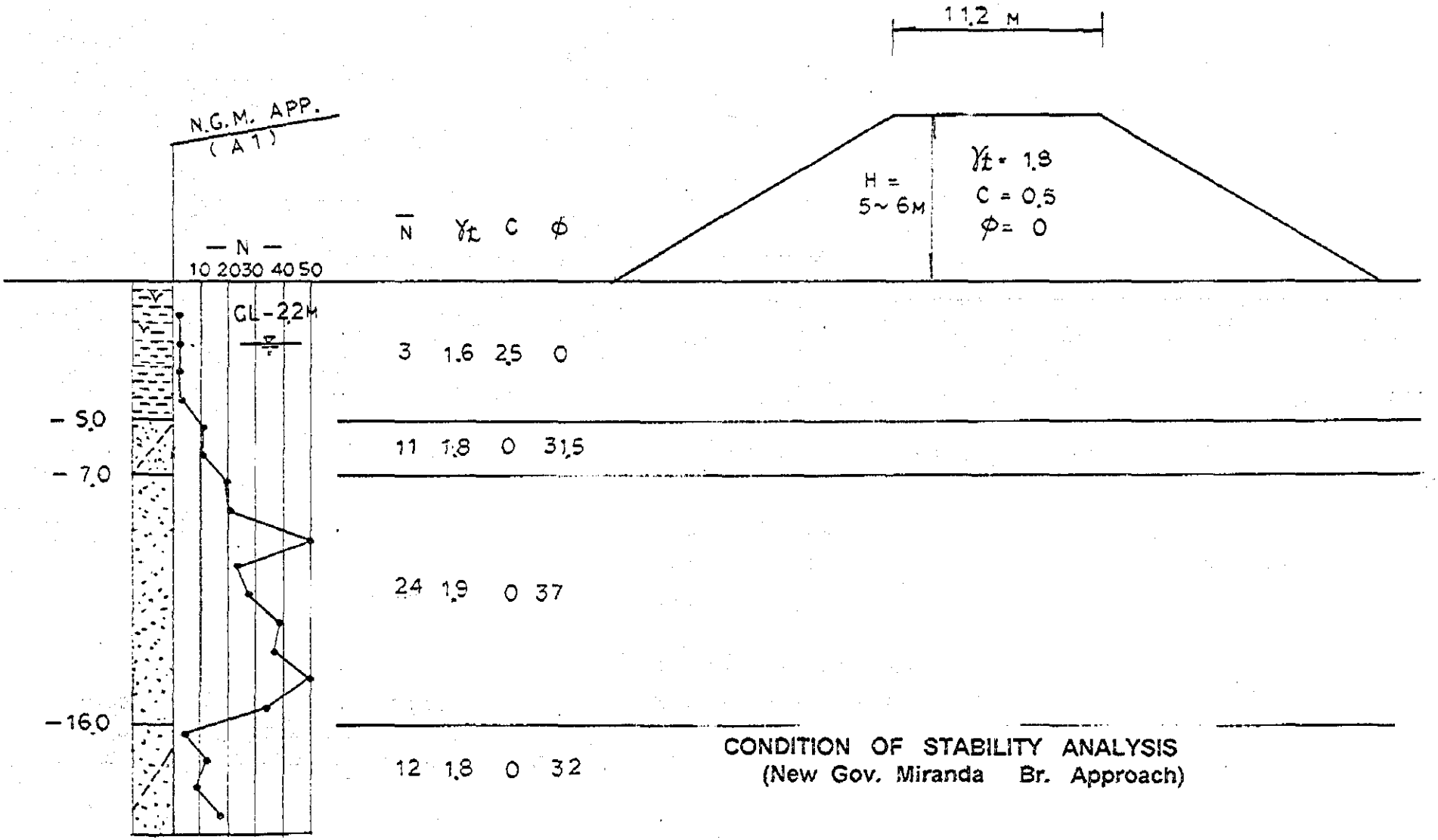
Water Density = 1.000 (tf/m³)



STABILITY ANALYSIS

NEW GOV. MIRANDA BRIDGE APPROACH

SLOPE STABILITY AND SETTLEMENT ANALYSIS



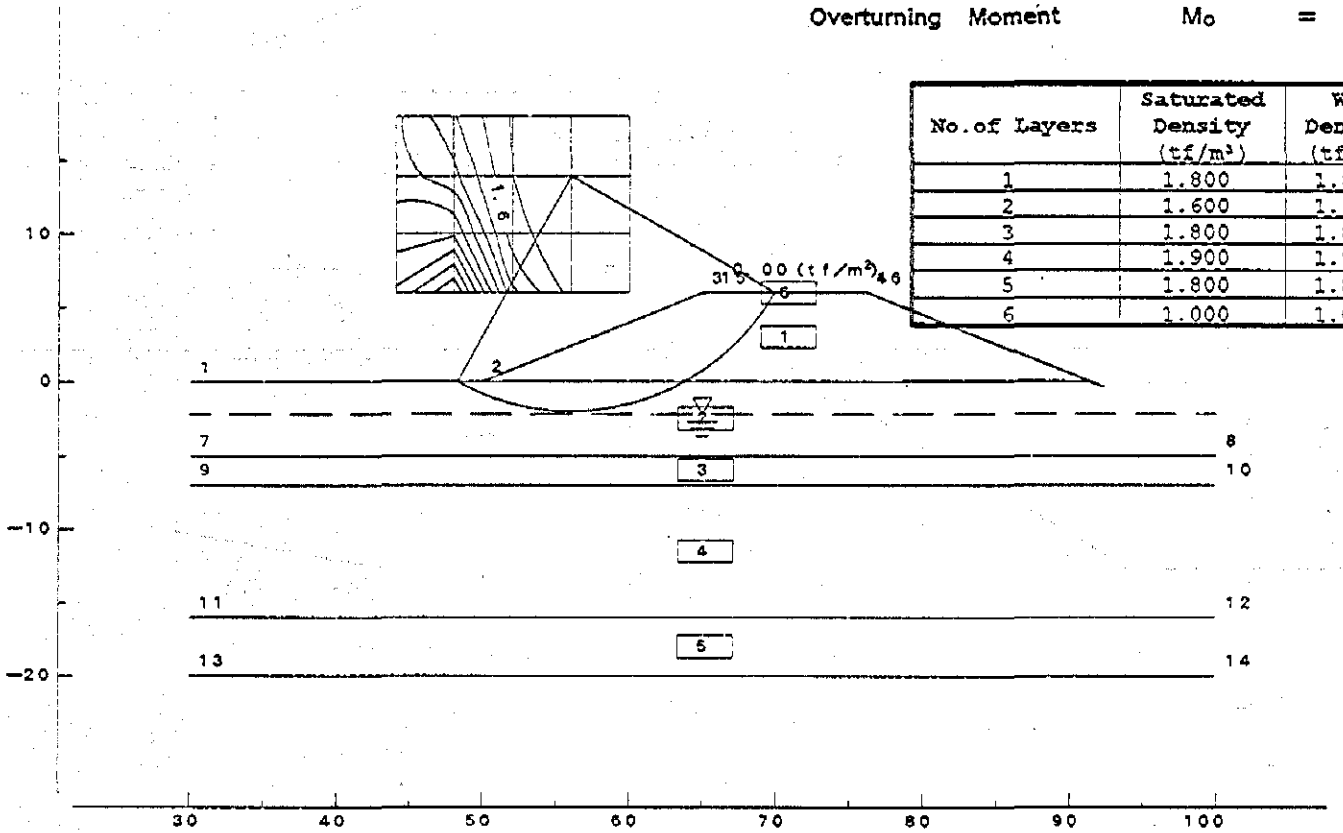
CONDITION OF STABILITY ANALYSIS
(New Gov. Miranda Br. Approach)

App. 8.7.27

New Governor Miranda A1 Side Approach
Height of Embankment H = 6.0m
Slope 2.5 : 1

Scale ; 1 / 500

Minimum Safety Factor	Fs_{MIN}	=	1.204
Center of Circle Coordinates	X	=	56.00 (m)
	Y	=	14.00 (m)
Radius	R	=	16.00 (m)
Resisting Moment	M_R	=	720.02 (tf·m)
Overturning Moment	M_O	=	−597.88 (tf·m)



No.of Layers	Saturated Density (tf/m³)	Wet Density (tf/m³)	Internal Friction Angle (degrees)	Cohesion (tf/m²)
1	1.800	1.800	0.0	0.50
2	1.600	1.600	0.0	2.50
3	1.800	1.800	31.5	0.00
4	1.900	1.900	37.0	0.00
5	1.800	1.800	32.0	0.00
6	1.000	1.000	0.0	0.00

Water Density = 1.000 (tf/m³)

STABILITY ANALYSIS

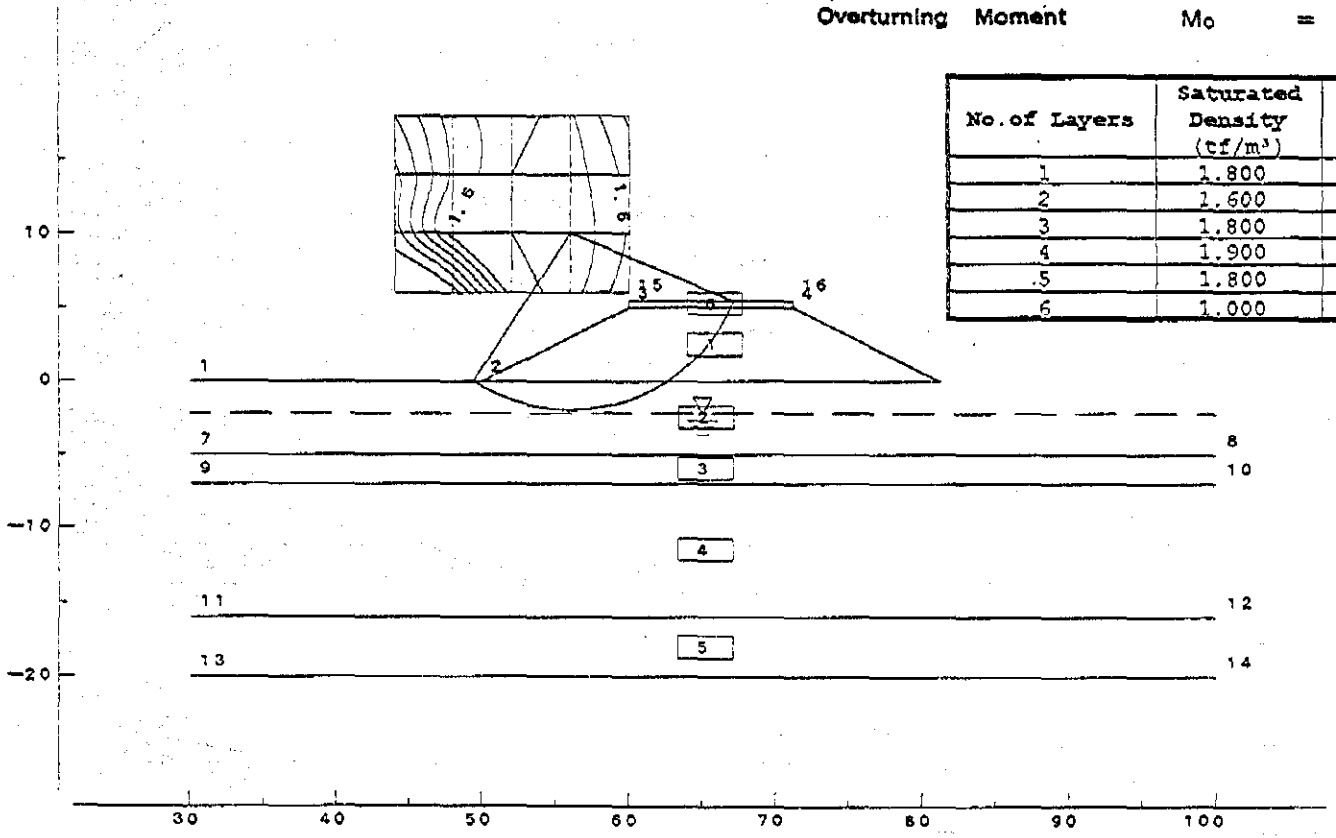
New Governor Miranda　No. 1 Boring Point
Height of Embankment　H = 5.0m
Slope　2 : 1
Load = 0.5 t/m²

Scale　: 1 / 500

Minimum Safety Factor	$F_{S\,MIN}$	=	1.248
Center of Circle Coordinates	X	=	56.00 (m)
	Y	=	10.00 (m)
Radius	R	=	12.00 (m)
Resisting Moment	M_R	=	461.52 (tf·m)
Overturning Moment	M_O	=	−369.74 (tf·m)

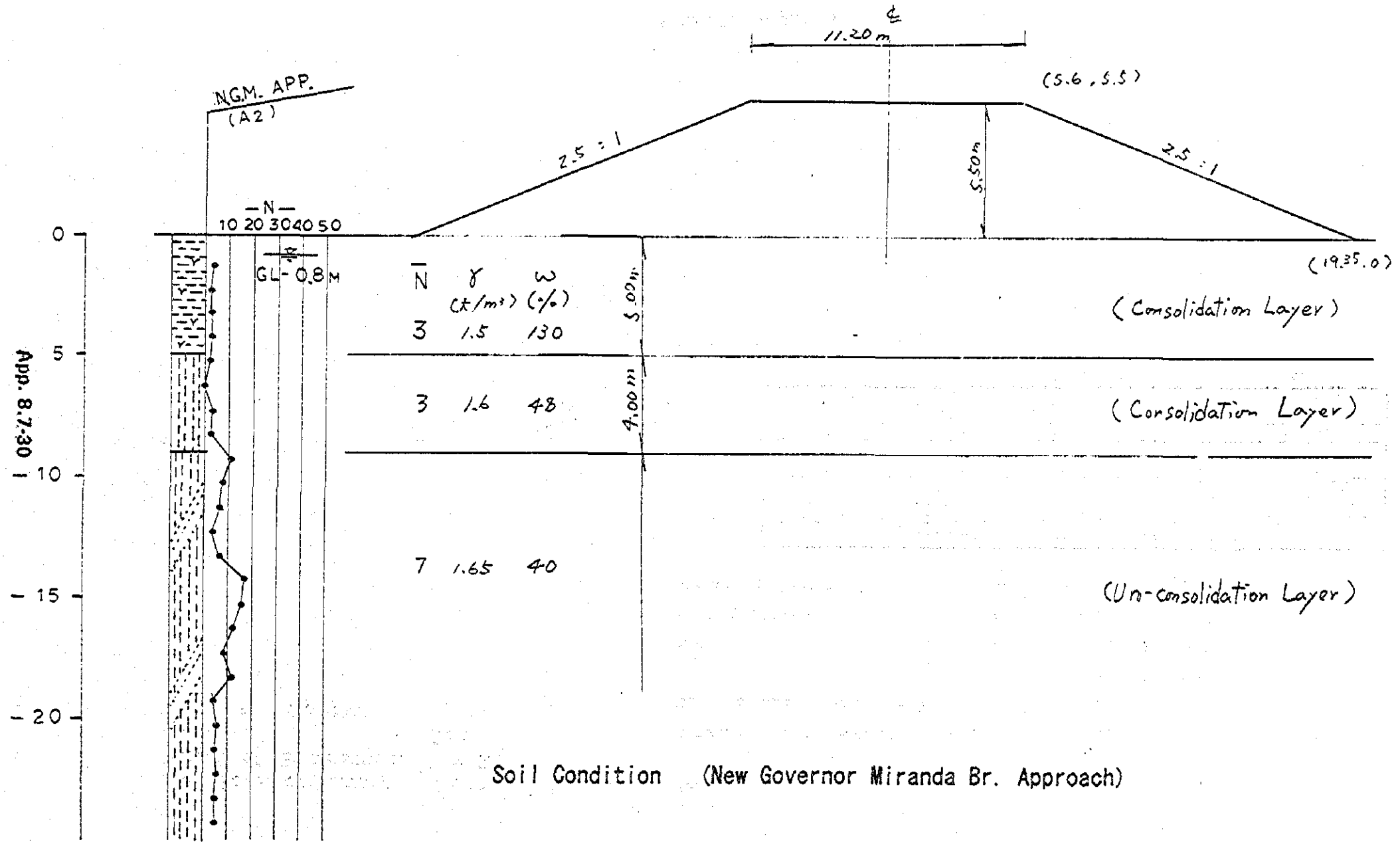
No.of Layers	Saturated Density (tf/m³)	Wet Density (tf/m³)	Internal Friction Angle (degree)	Cohesion (tf/m²)
1	1.800	1.800	0.0	0.50
2	1.600	1.600	0.0	2.50
3	1.800	1.800	31.5	0.00
4	1.900	1.900	37.0	0.00
5	1.800	1.800	32.0	0.00
6	1.000	1.000	0.0	0.00

Water Density = 1.000 (tf/m³)

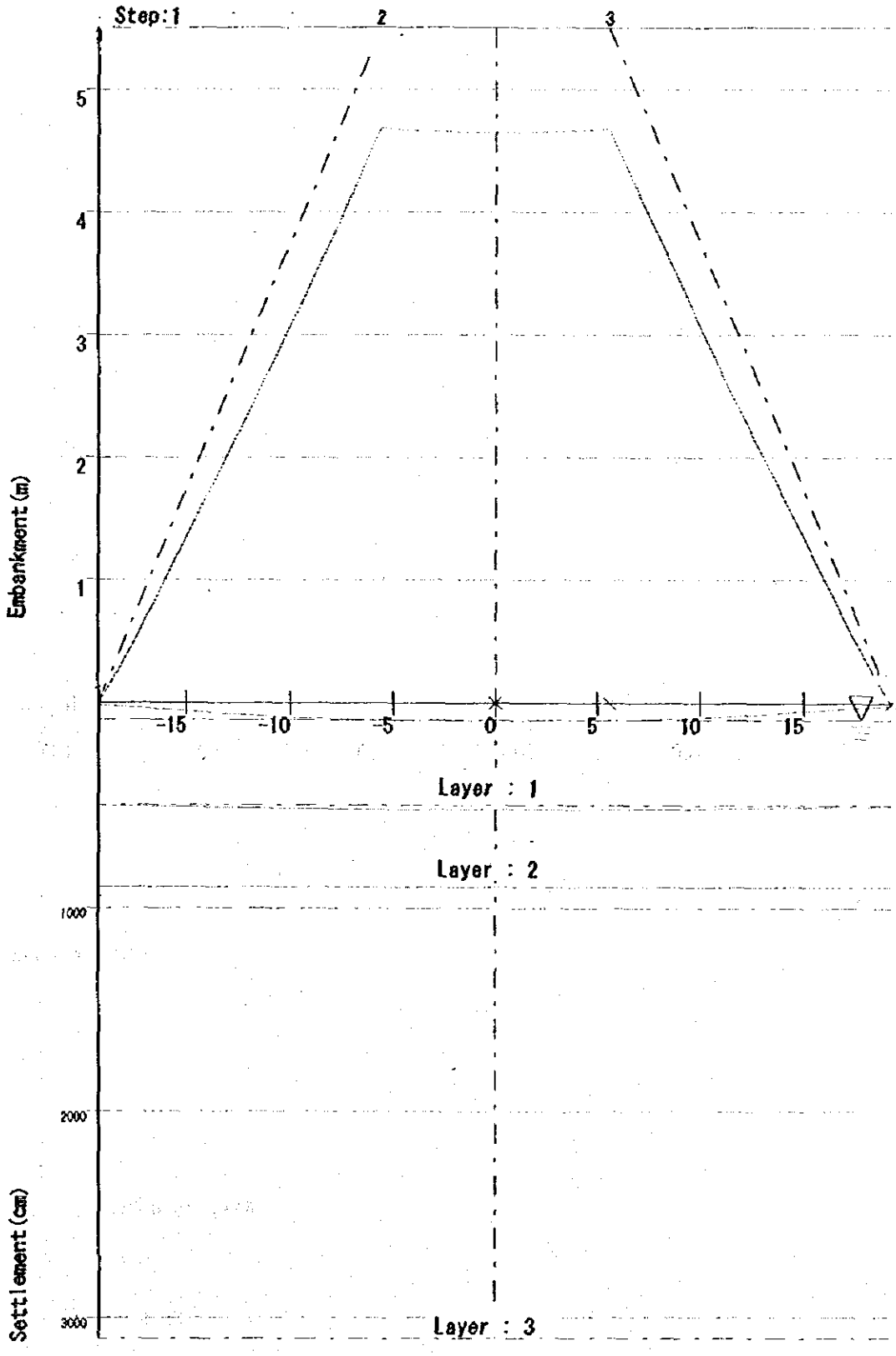


STABILITY ANALYSIS

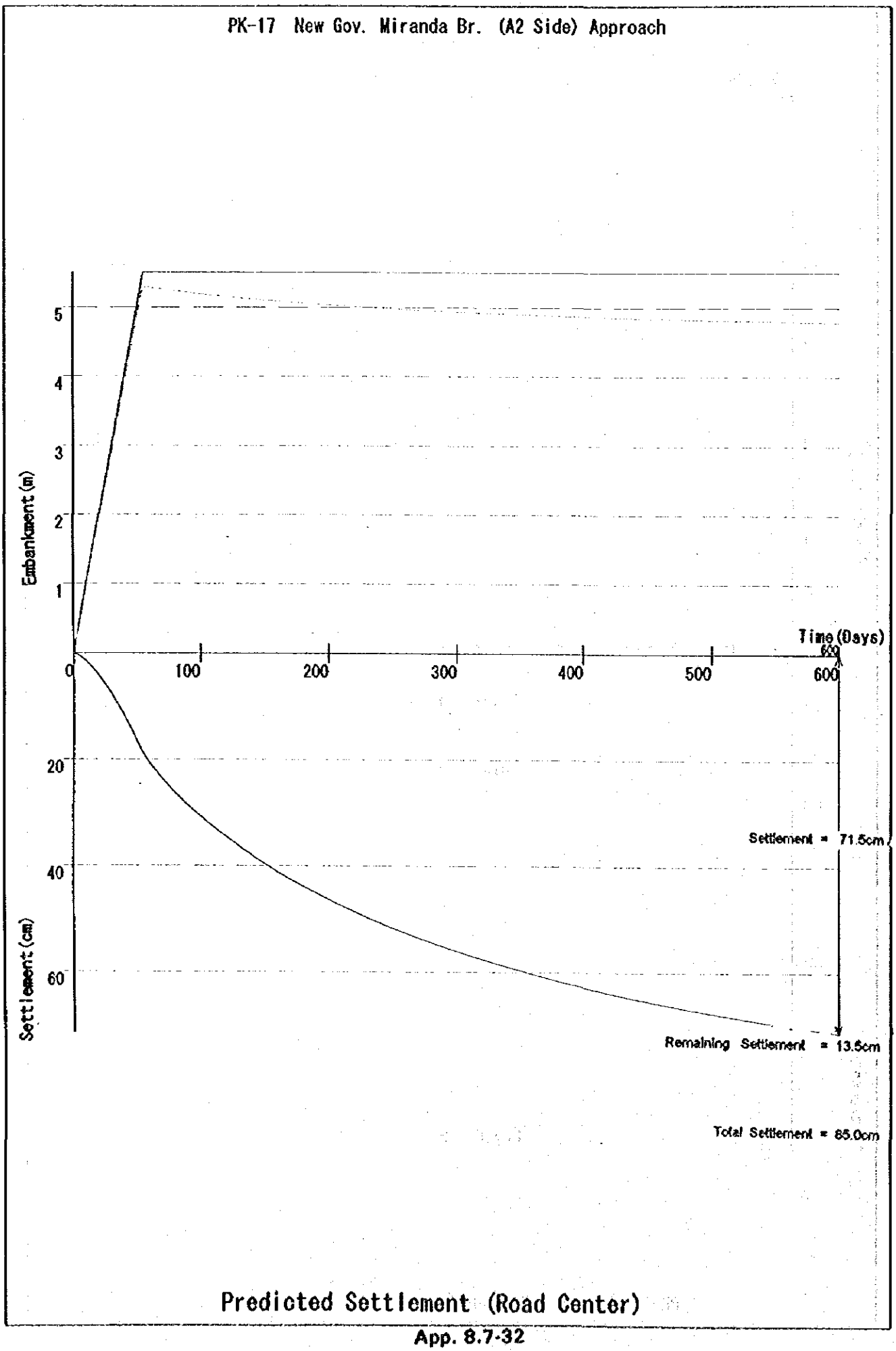
App. 8.7.29



Soil Condition (New Governor Miranda Br. Approach)



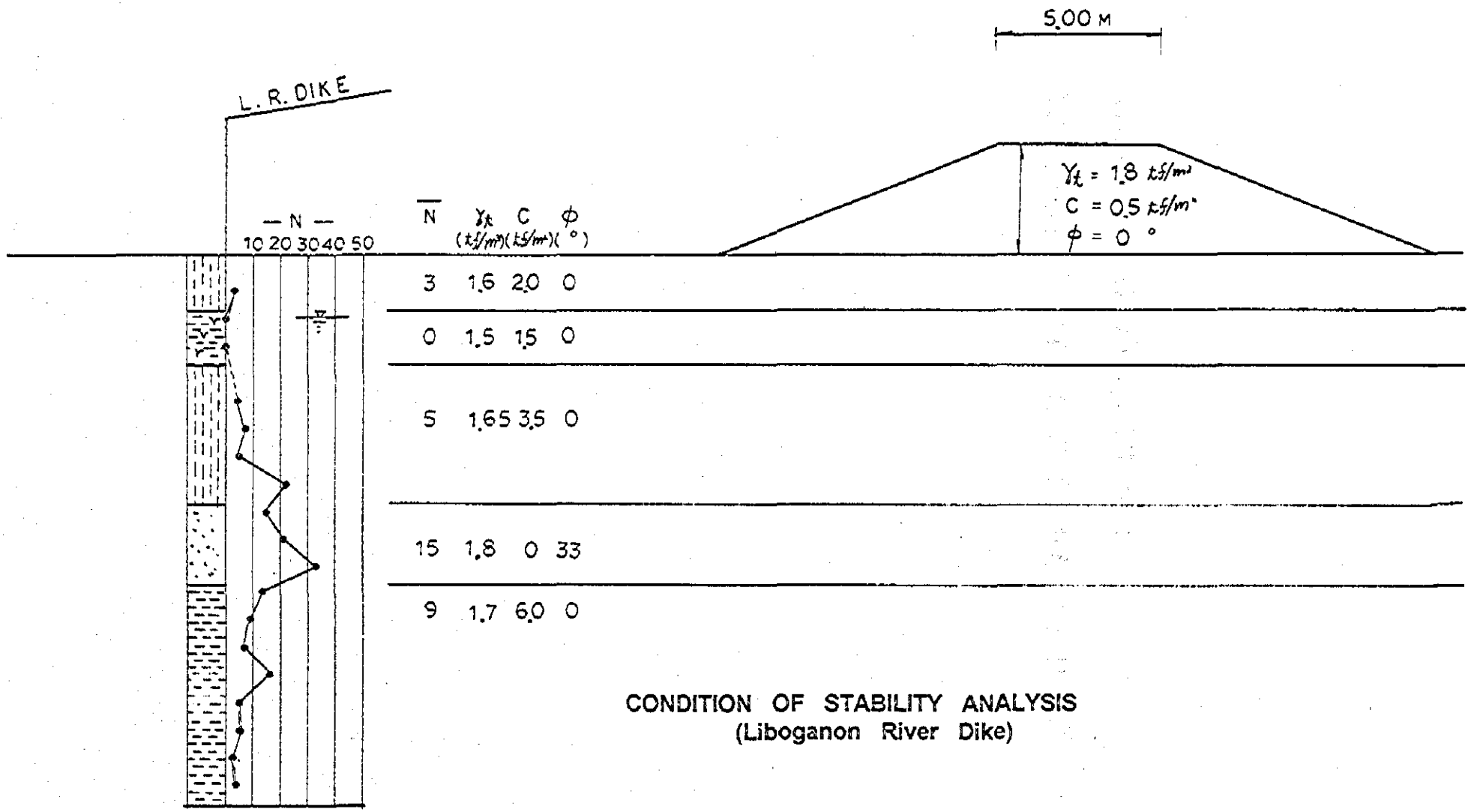
PK-17 New Gov. Miranda Br. (A2 Side) Approach



Predicted Settlement (Road Center)

LIBOGANON RIVER DIKE

SLOPE STABILITY AND SETTLEMENT ANALYSIS

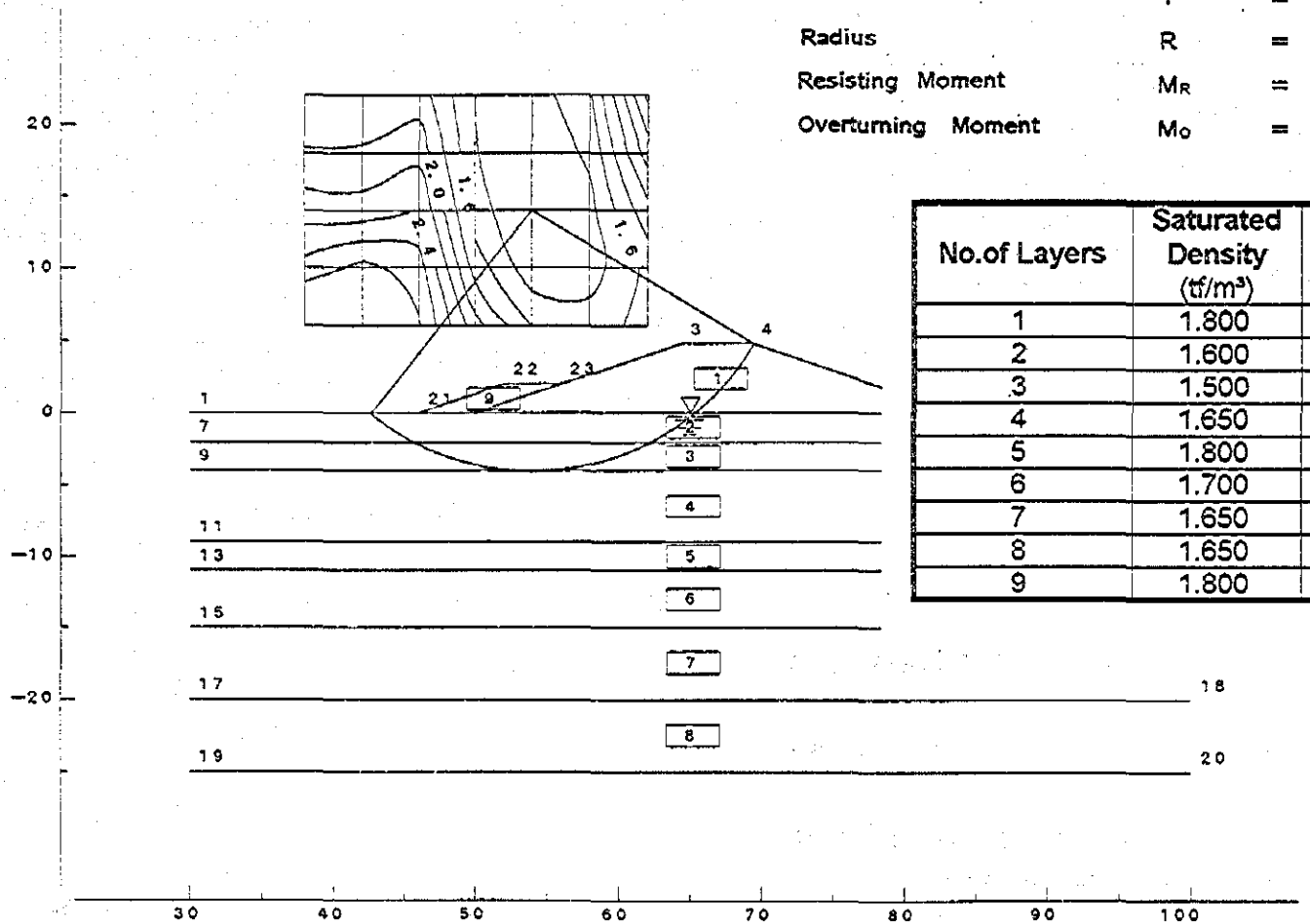


CONDITION OF STABILITY ANALYSIS
(Liboganon River Dike)

Liboganon River East Dike
Height of Embankment H = 4.30m
Counter Weight Embankment L = 4.0m, h = 2.0m

Scale 1 / 500

Minimum Safety Factor	$F_{S\,MIN}$	=	1.210
Center of Circle Coordinates	X	=	54.00 (m)
	Y	=	14.00 (m)
Radius	R	=	18.00 (m)
Resisting Moment	M_R	=	783.78 (tf·m)
Overturning Moment	M_O	=	−647.83 (tf·m)



No.of Layers	Saturated Density (tf/m³)	Wet Density (tf/m³)	Internal Friction Angle (degres)	Cohesion (tf/m²)
1	1.800	1.800	0.0	0.50
2	1.600	1.600	0.0	2.00
3	1.500	1.500	0.0	1.50
4	1.650	1.650	0.0	3.50
5	1.800	1.800	33.00	0.00
6	1.700	1.700	0.0	6.00
7	1.650	1.650	0.0	3.50
8	1.650	1.650	0.0	10.00
9	1.800	1.800	0.0	0.50

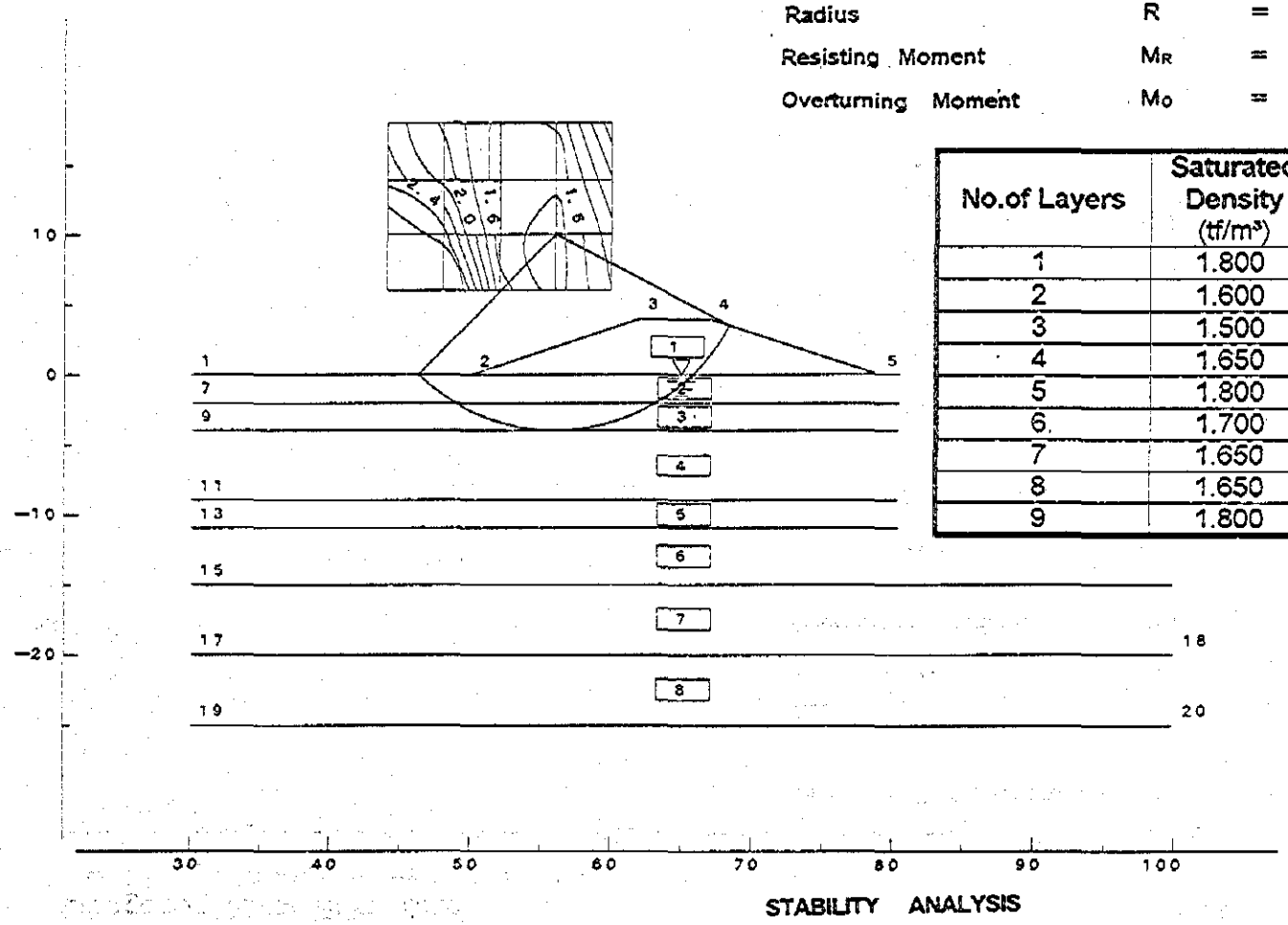
Water Density = 1.000 (tf/m³)

STABILITY ANALYSIS

Liboganon River East Dike
Height of Embankment H = 4.0m
Slope 3 : 1

Scale 1 / 500

Minimum Safety Factor	$F_{S\,MIN}$	=	1.308
Center of Circle Coordinates	X	=	56.00 (m)
	Y	=	10.00 (m)
Radius	R	=	14.00 (m)
Resisting Moment	M_R	=	547.48 (tf·m)
Overturning Moment	Mo	=	−418.68 (tf·m)

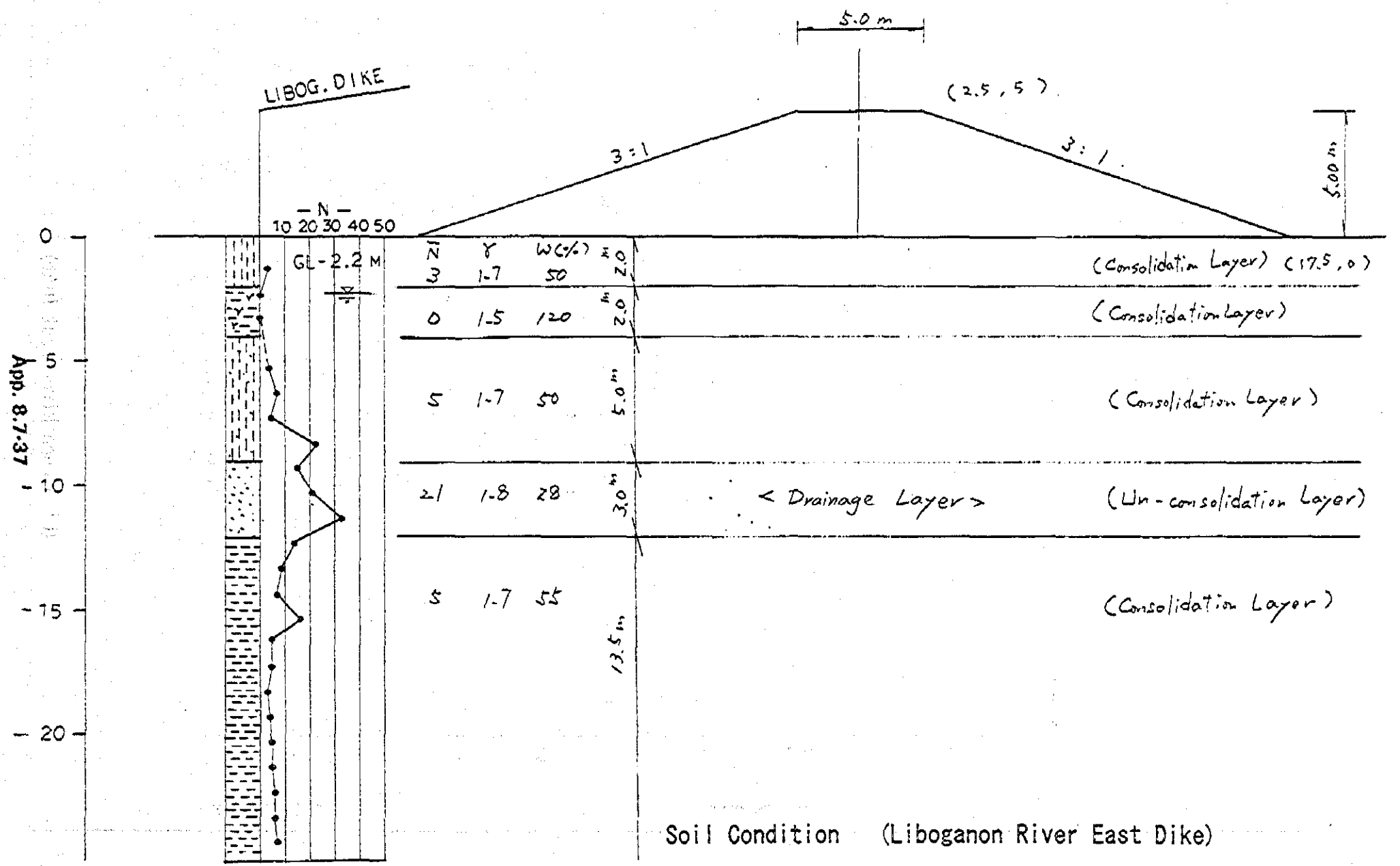


STABILITY ANALYSIS

No.of Layers	Saturated Density (tf/m³)	Wet Density (tf/m³)	Internal Friction Angle (degres)	Cohesion (tf/m²)
1	1.800	1.800	0.0	0.50
2	1.600	1.600	0.0	2.00
3	1.500	1.500	0.0	1.50
4	1.650	1.650	0.0	3.50
5	1.800	1.800	33.00	0.00
6	1.700	1.700	0.0	6.00
7	1.650	1.650	0.0	3.50
8	1.650	1.650	0.0	10.00
9	1.800	1.800	0.0	0.50

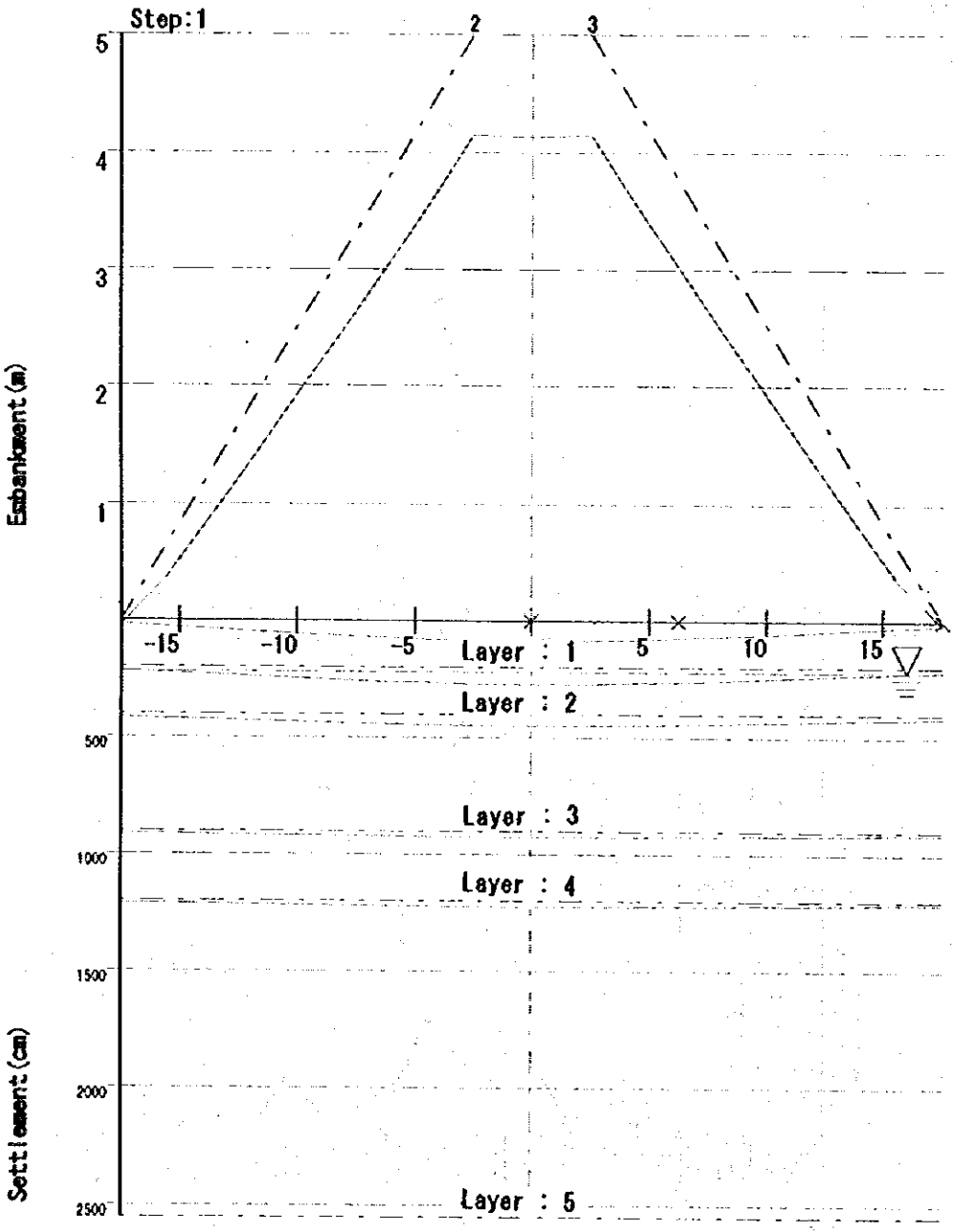
Water Density = 1.000 (tf/m³)

PK – 17



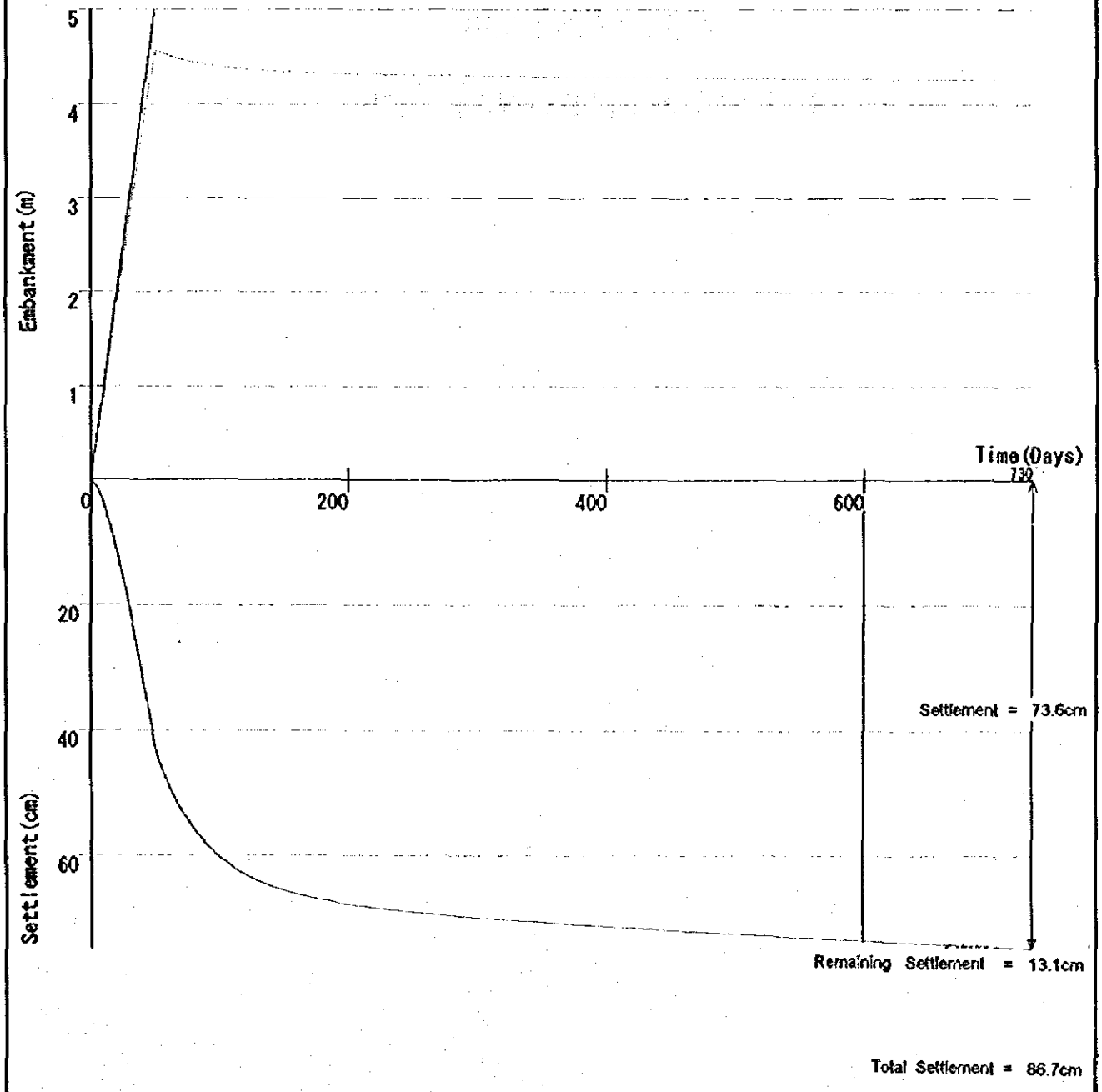
Soil Condition (Liboganon River East Dike)

App. 8.7-37



(Liboganon River East Dike)

PK-17 (Liboganon River East Dike)



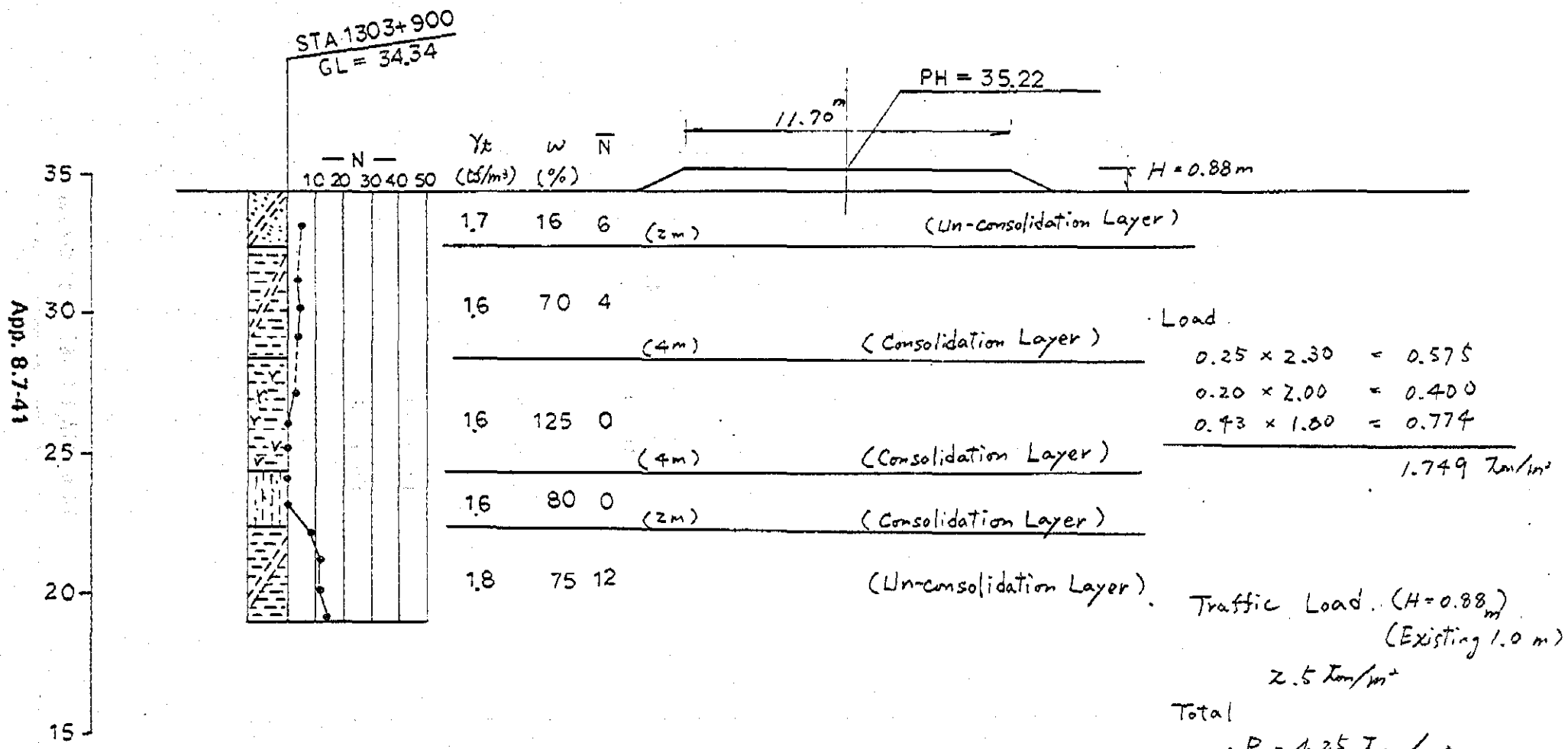
Predicted Settlement (Road Center)

STA. 1303+900

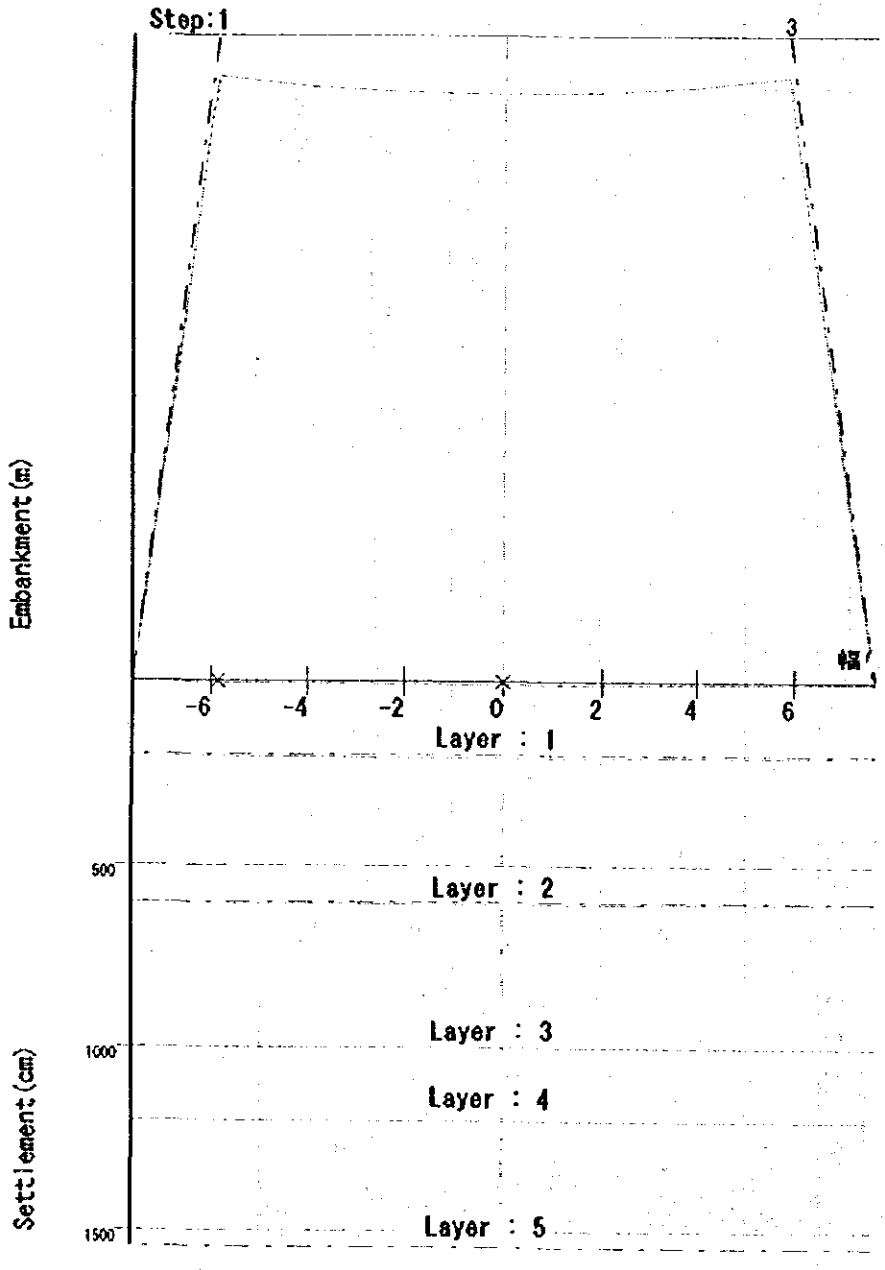
SETTLEMENT ANALYSIS

PK – 8

PCC TYPE-1(25)

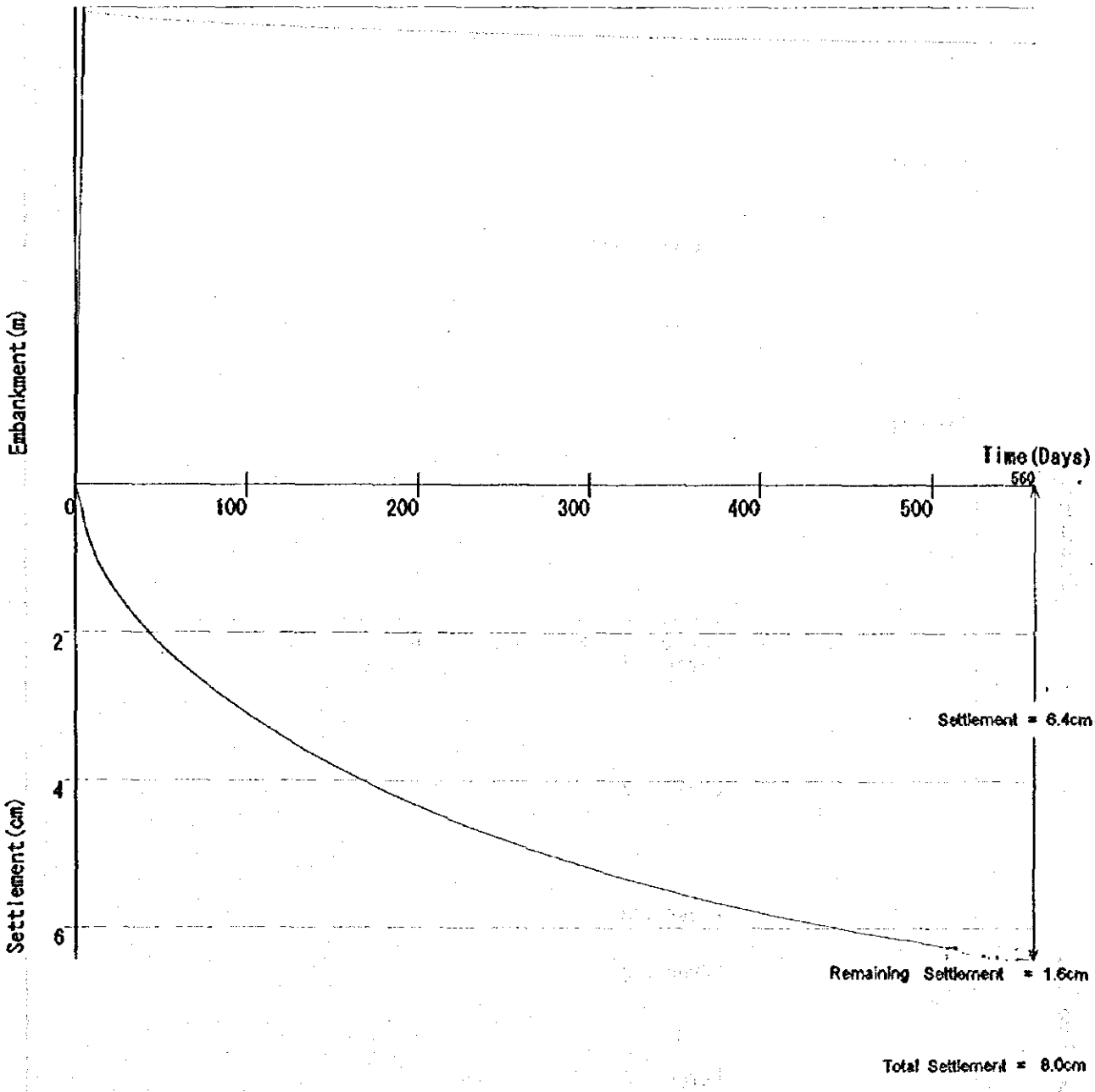


Soil Condition (STA. 1303+900 Soft Ground)

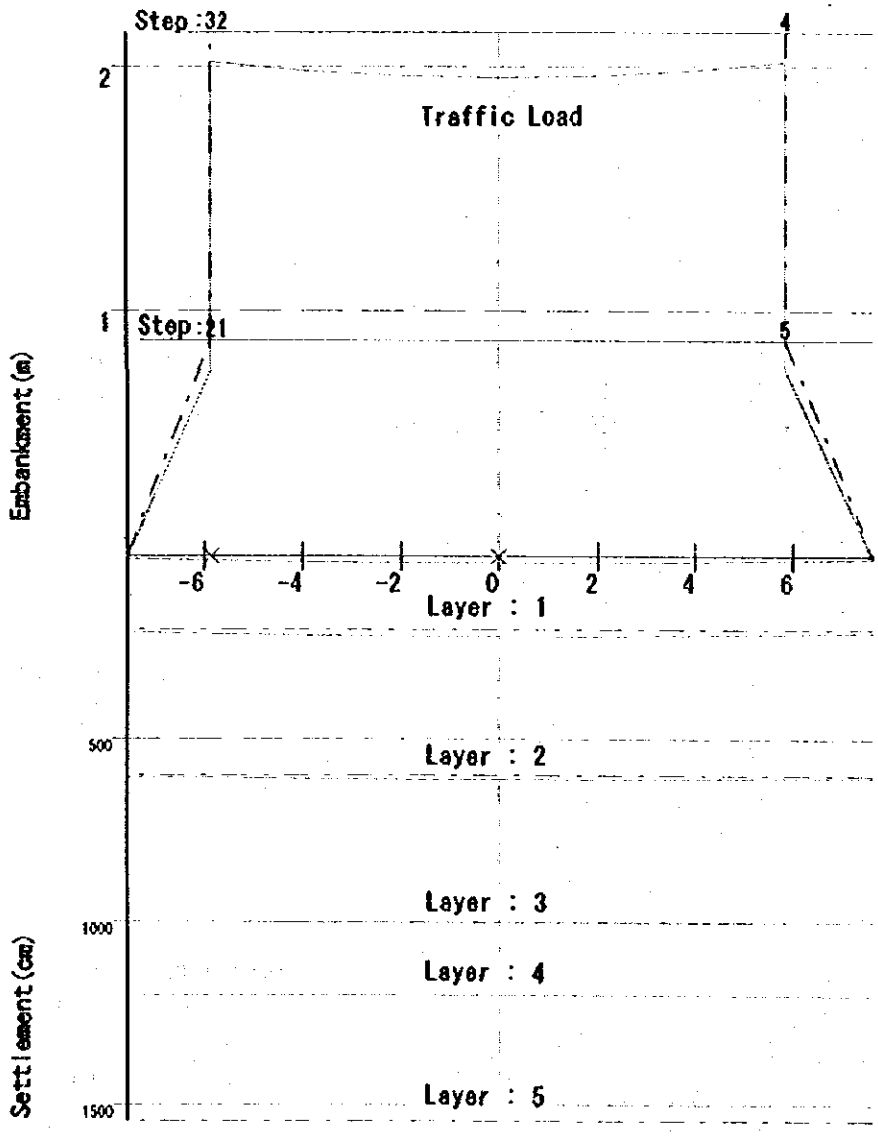


PK-8 STA. 1303+900 Soft Ground

PK-8 STA. 1303+900 Soft Ground

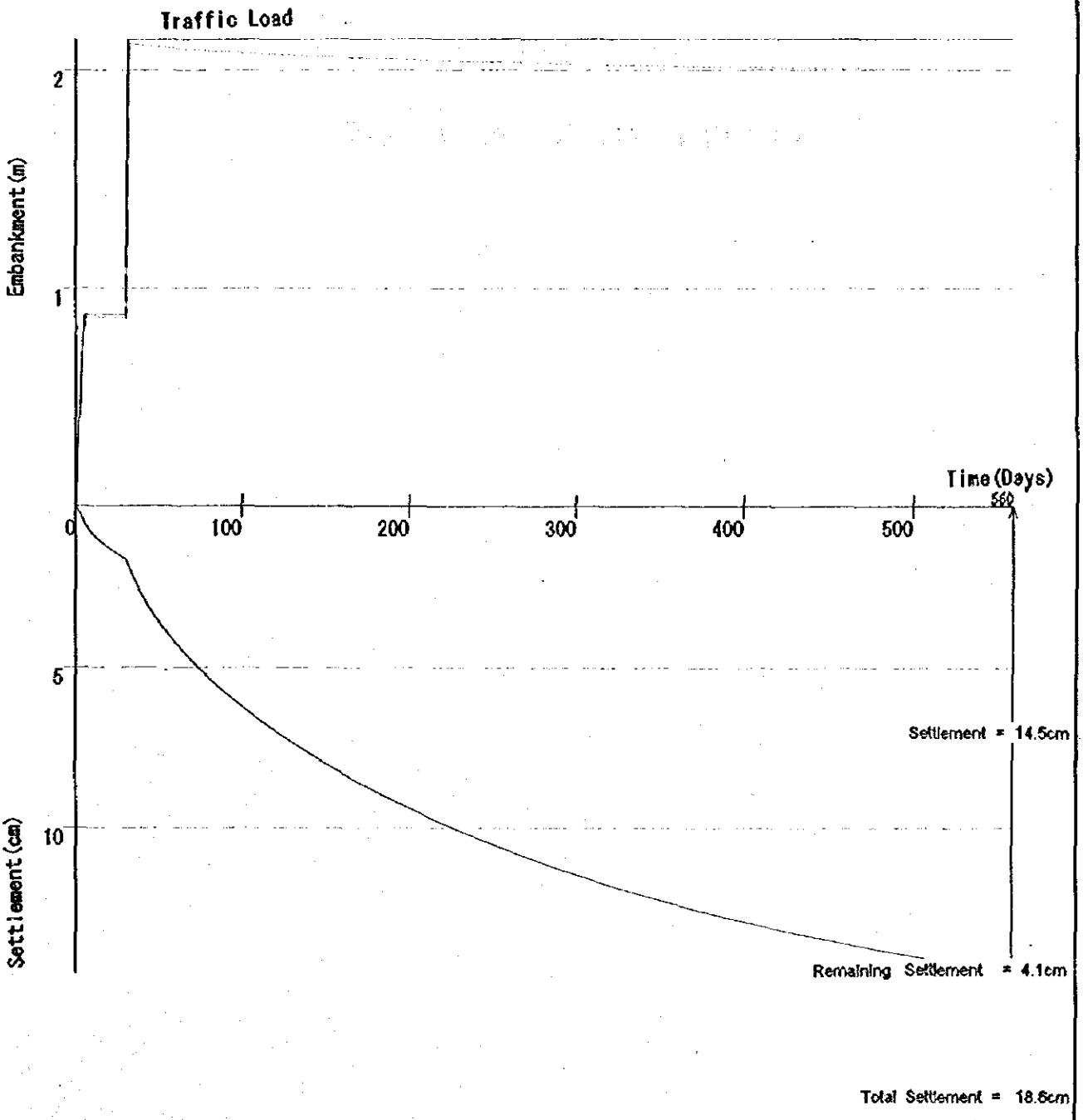


Predicted Settlement (Road Center)



PK-8 STA. 1303+900 Soft Ground

PK-8 STA. 1303+900 Soft Ground

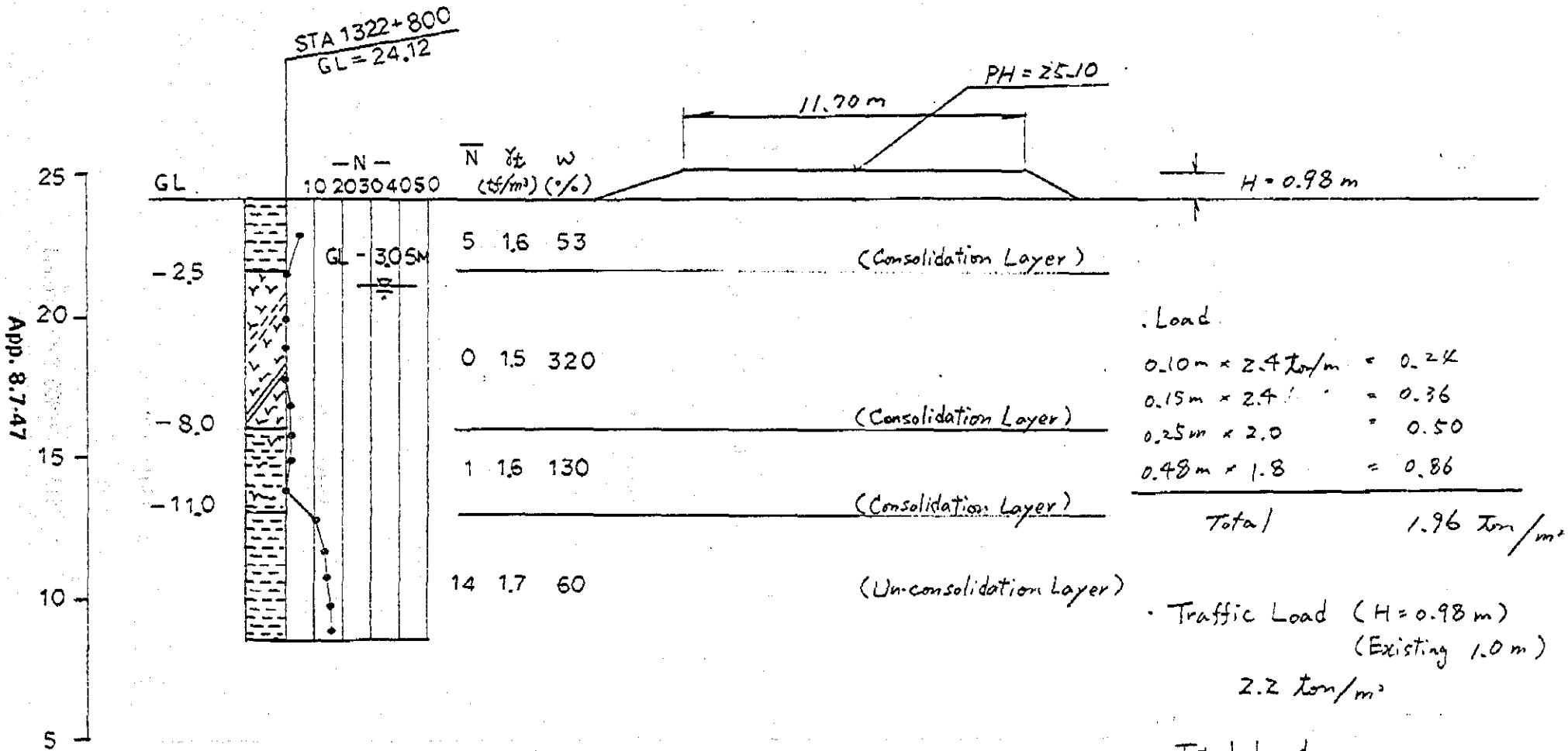


Predicted Settlement (Road Center)

STA. 1322+800

SETTLEMENT ANALYSIS

PK - 9



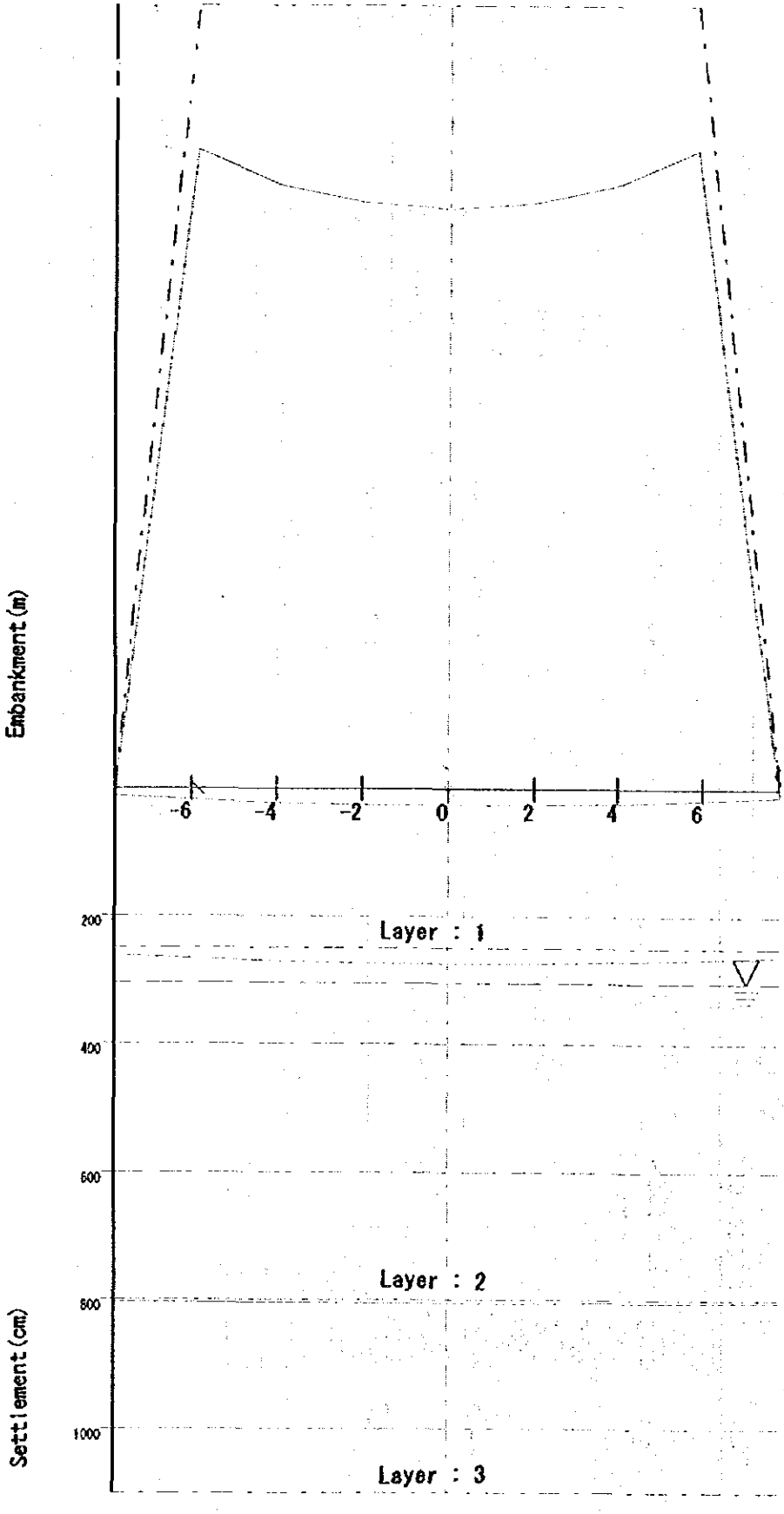
. Load

0.10m × 2.4 ton/m	=	0.24
0.15m × 2.4 "	=	0.36
0.25m × 2.0	=	0.50
0.48m × 1.8	=	0.86
Total		1.96 ton/m²

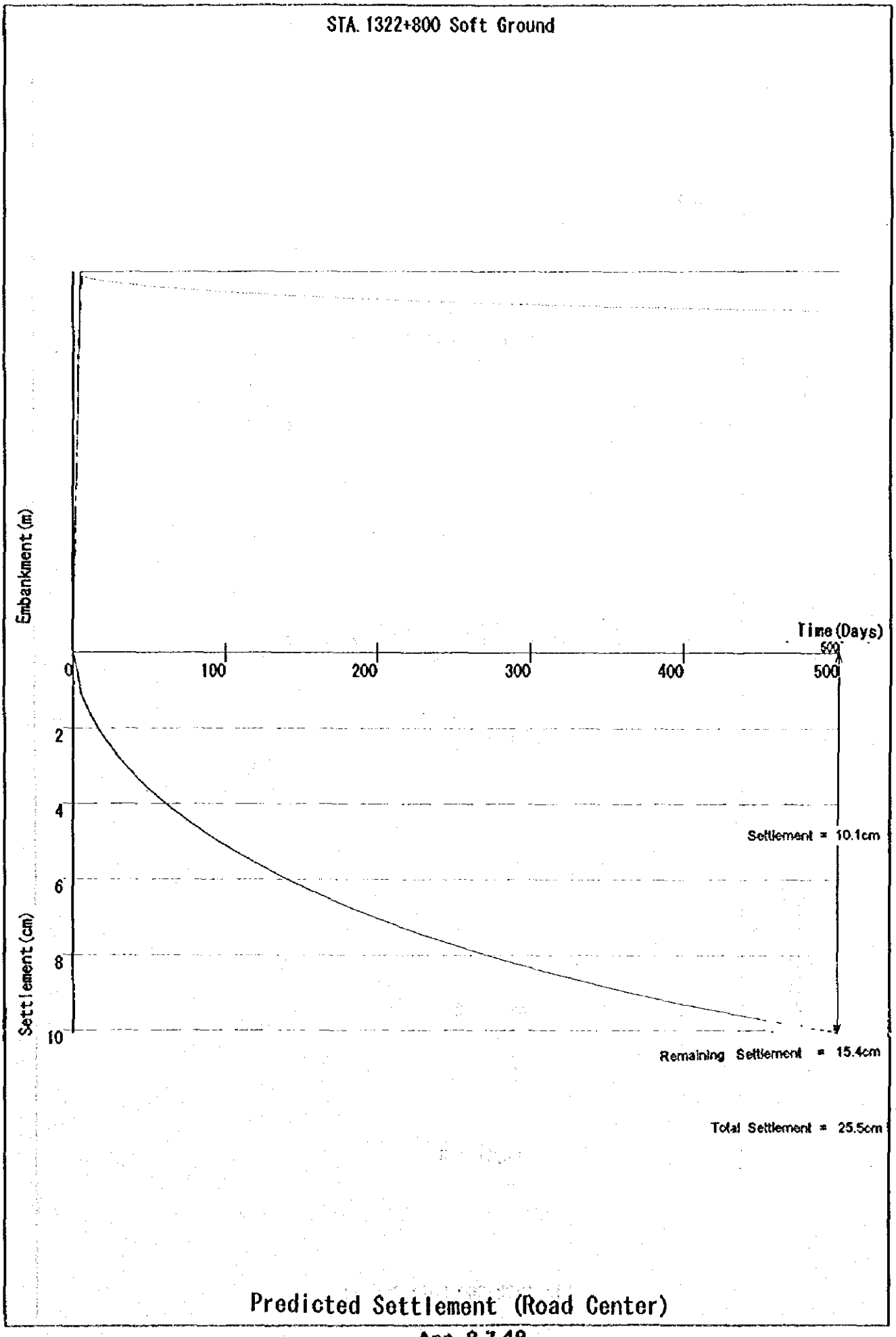
· Traffic Load (H = 0.98 m)
(Existing 1.0 m)
2.2 ton/m²

Total Load
ΔP = 4.16 ton/m²

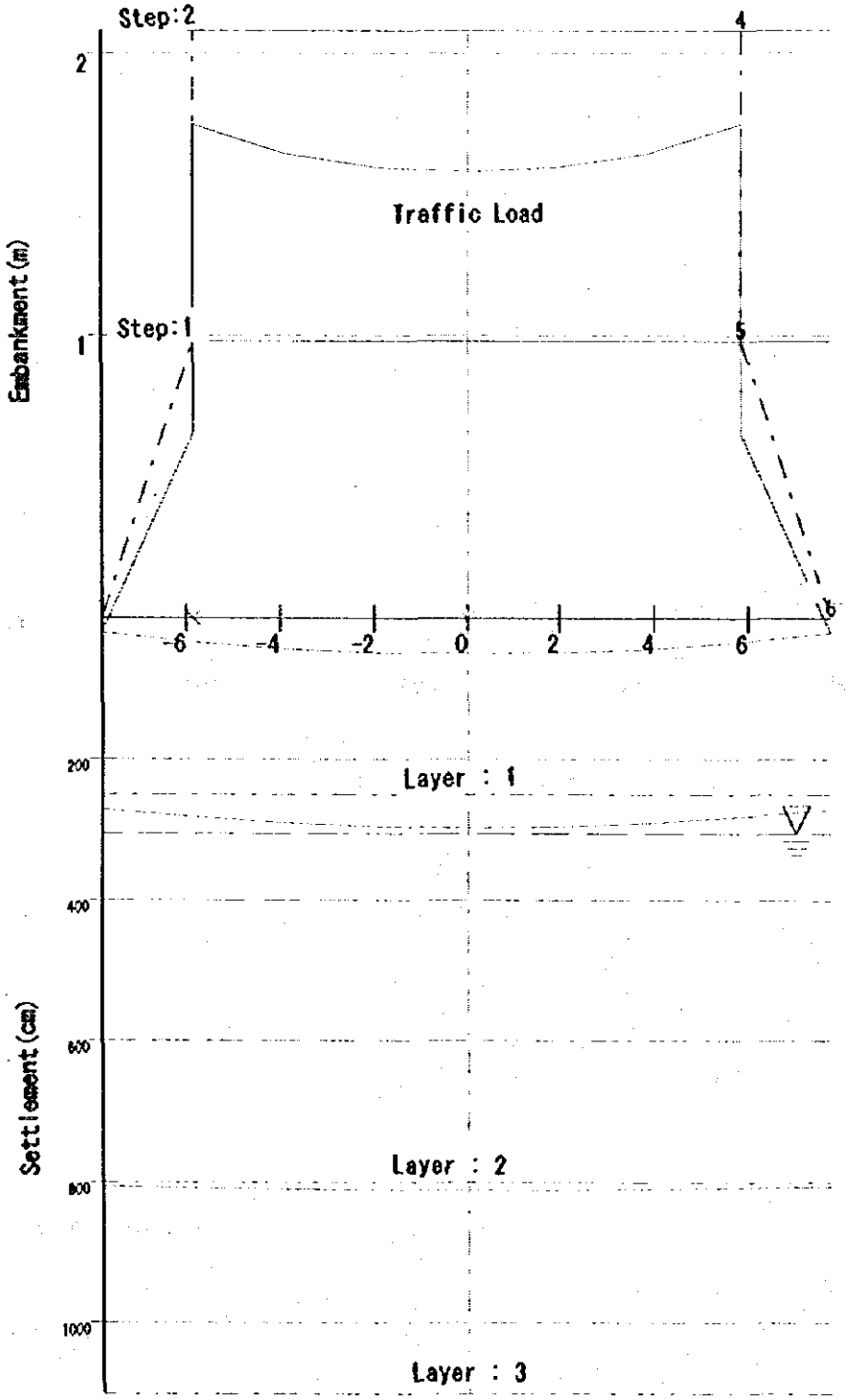
Soil Condition (STA. 1322+800 Soft Ground)



STA. 1322+800 Soft Ground

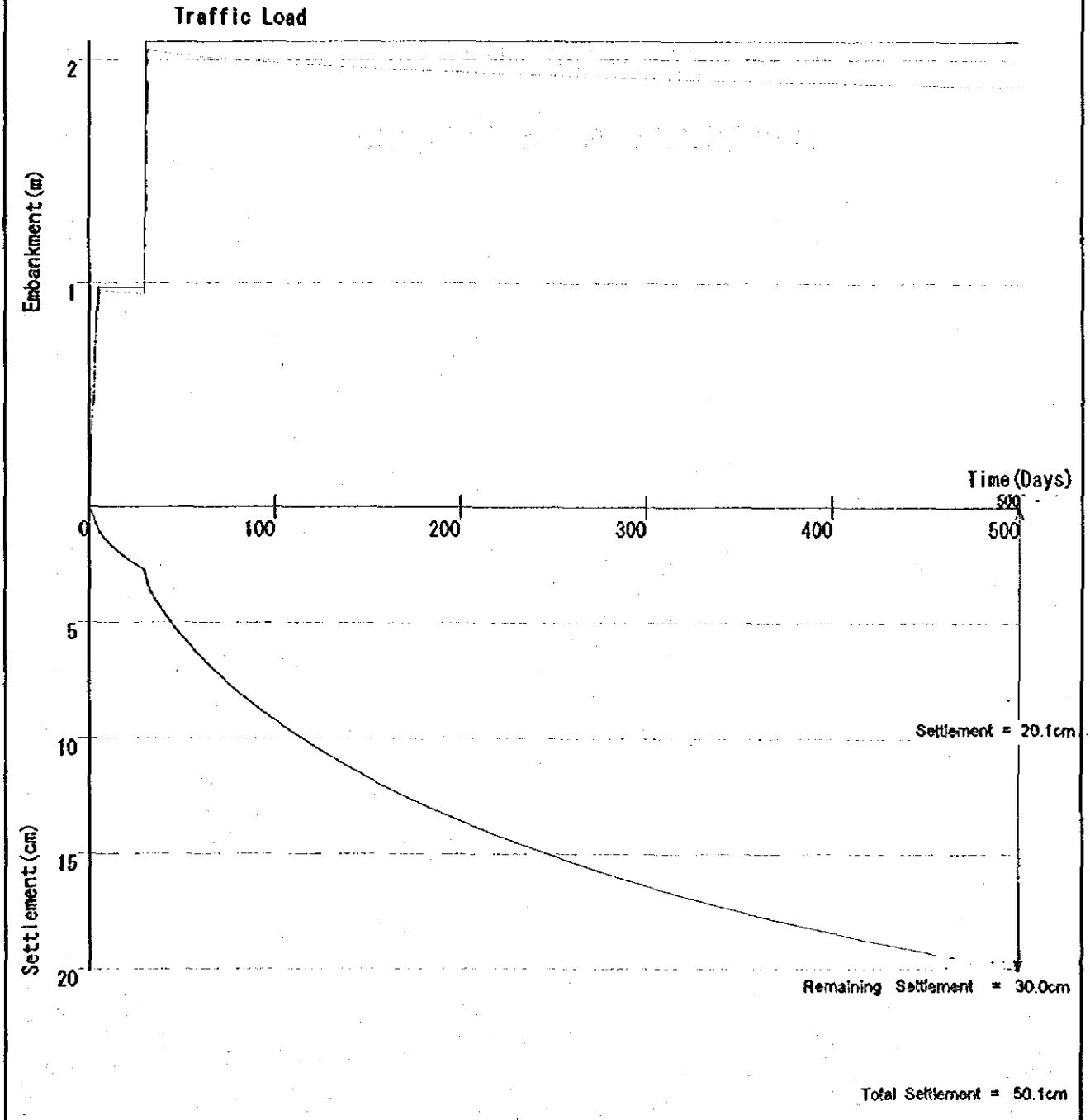


Predicted Settlement (Road Center)



STA. 1322+800 Soft Ground

STA. 1322+800 Soft Ground



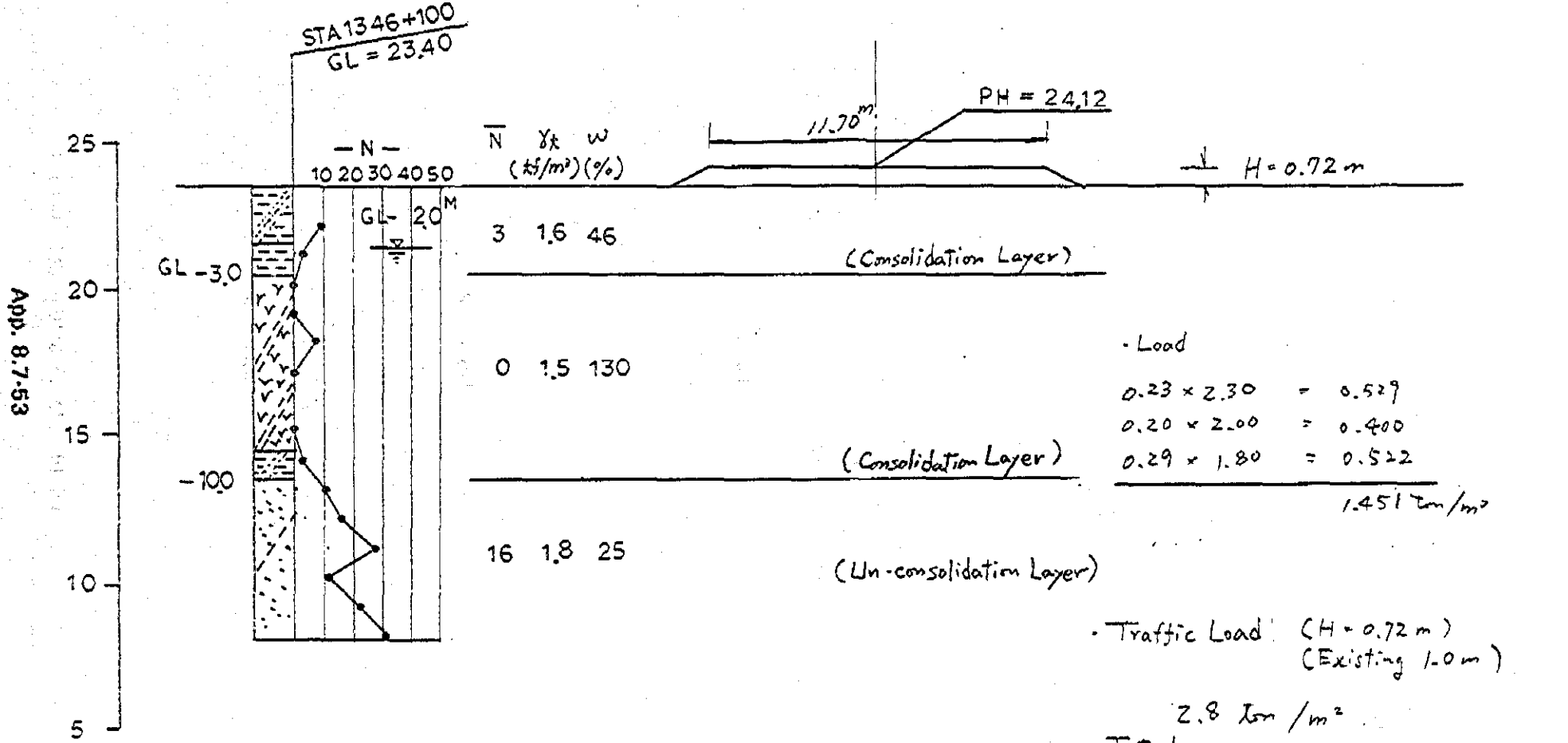
Predicted Settlement (Road Center)

STA. 1346+100

SETTLEMENT ANALYSIS

PK – 10

PCC TYPE – 5(25)



App. 8.7-53

- Load

0.23 × 2.30 = 0.529
0.20 × 2.00 = 0.400
0.29 × 1.80 = 0.522

1.451 Ton/m²

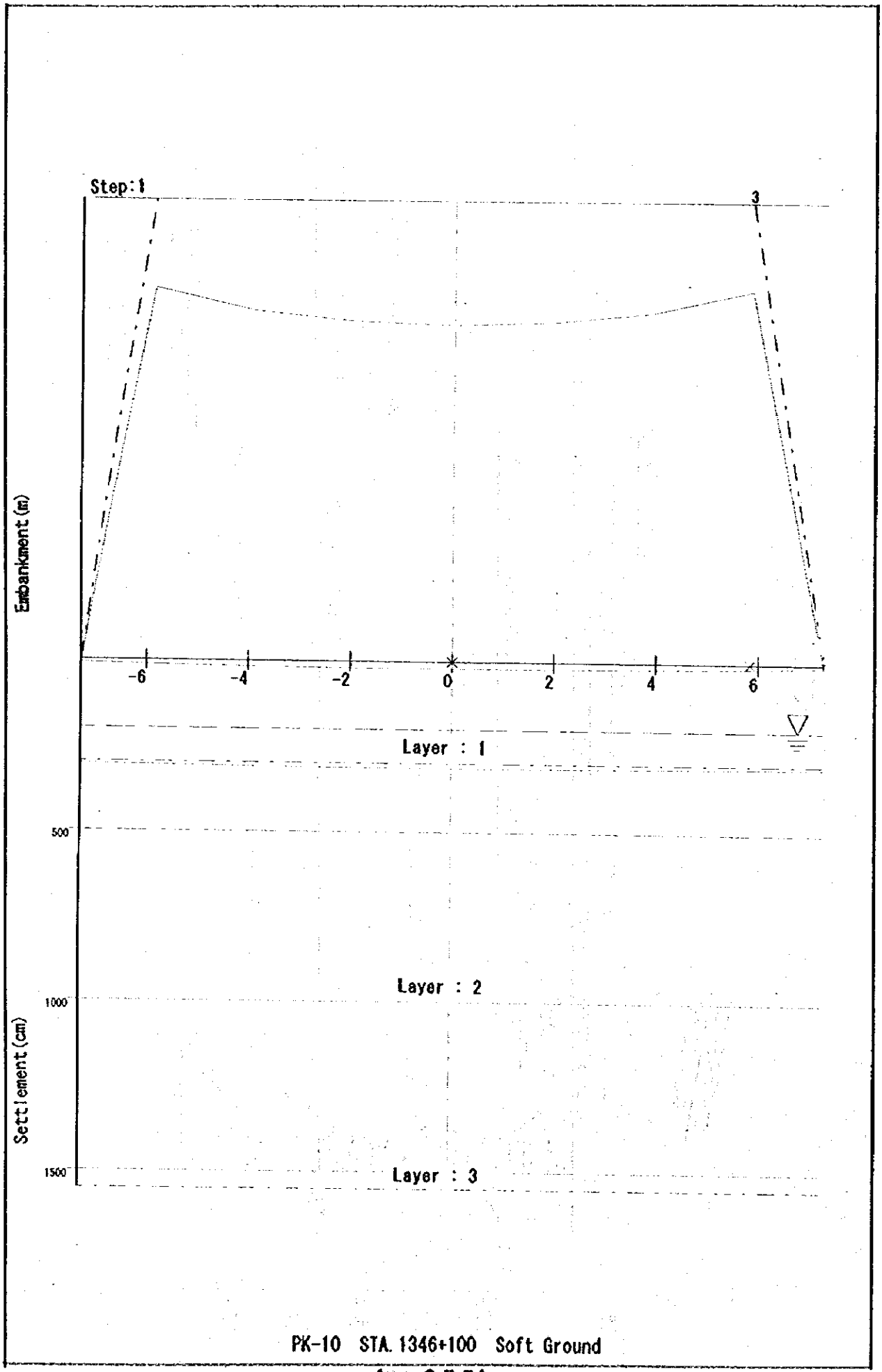
- Traffic Load (H = 0.72 m)
(Existing 1.0 m)

2.8 Ton/m²

- Total

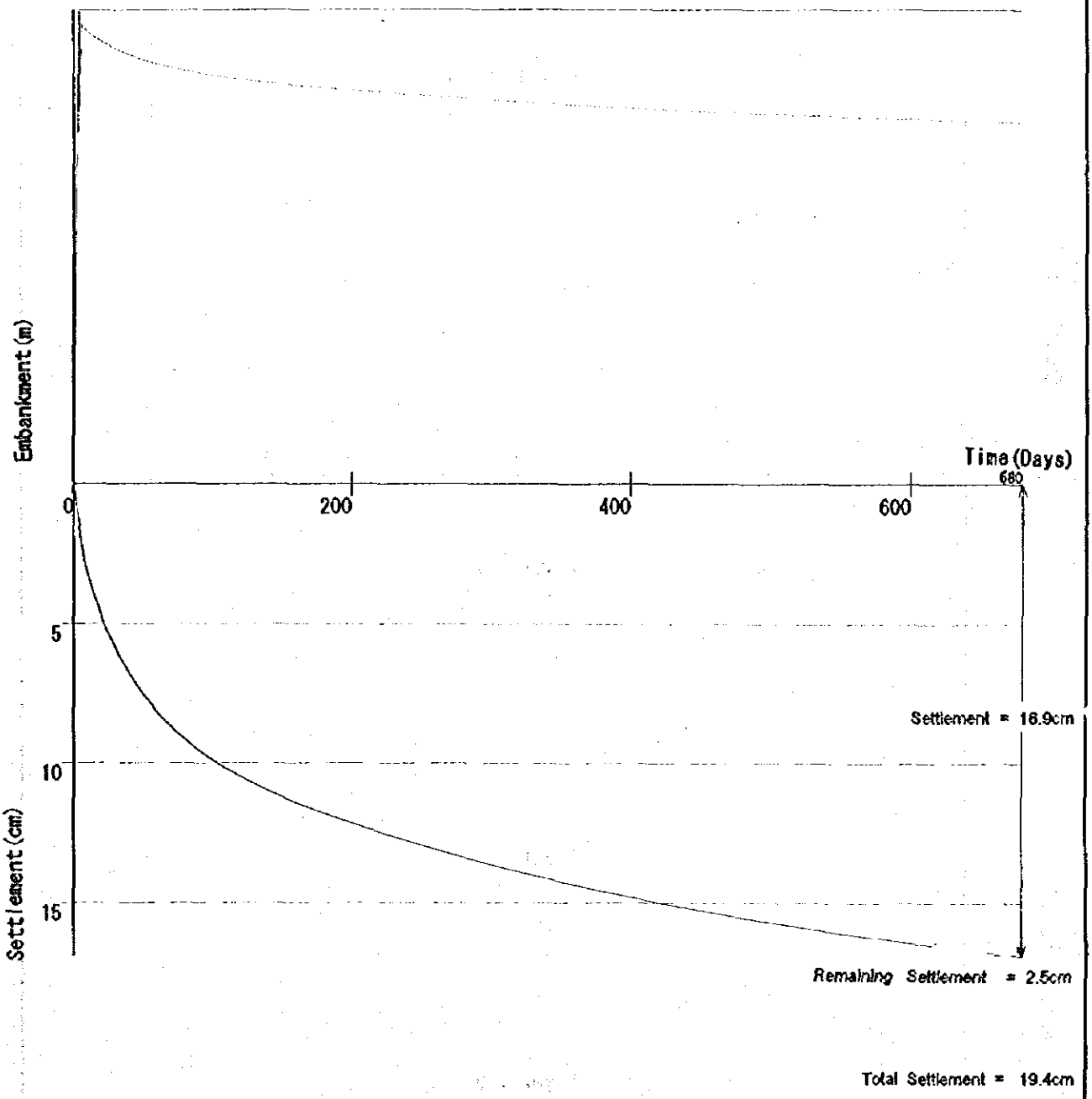
$\Delta P = 1.45 + 2.80 = 4.25$ Ton/m²

Soil Condition (STA. 1346+100 Soft Ground)

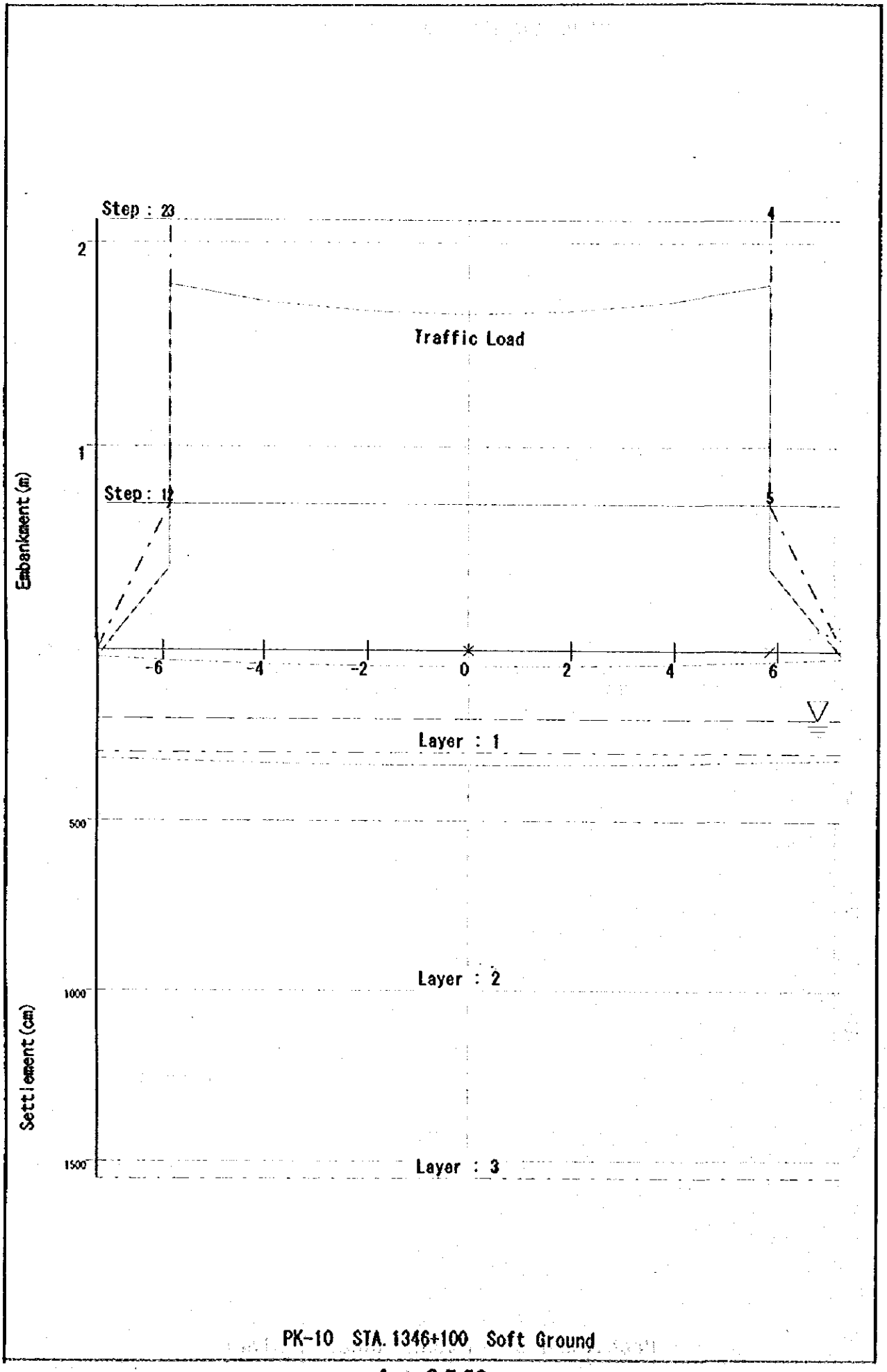


PK-10 STA.1346+100 Soft Ground

PK-10 STA. 1346+100 Soft Ground

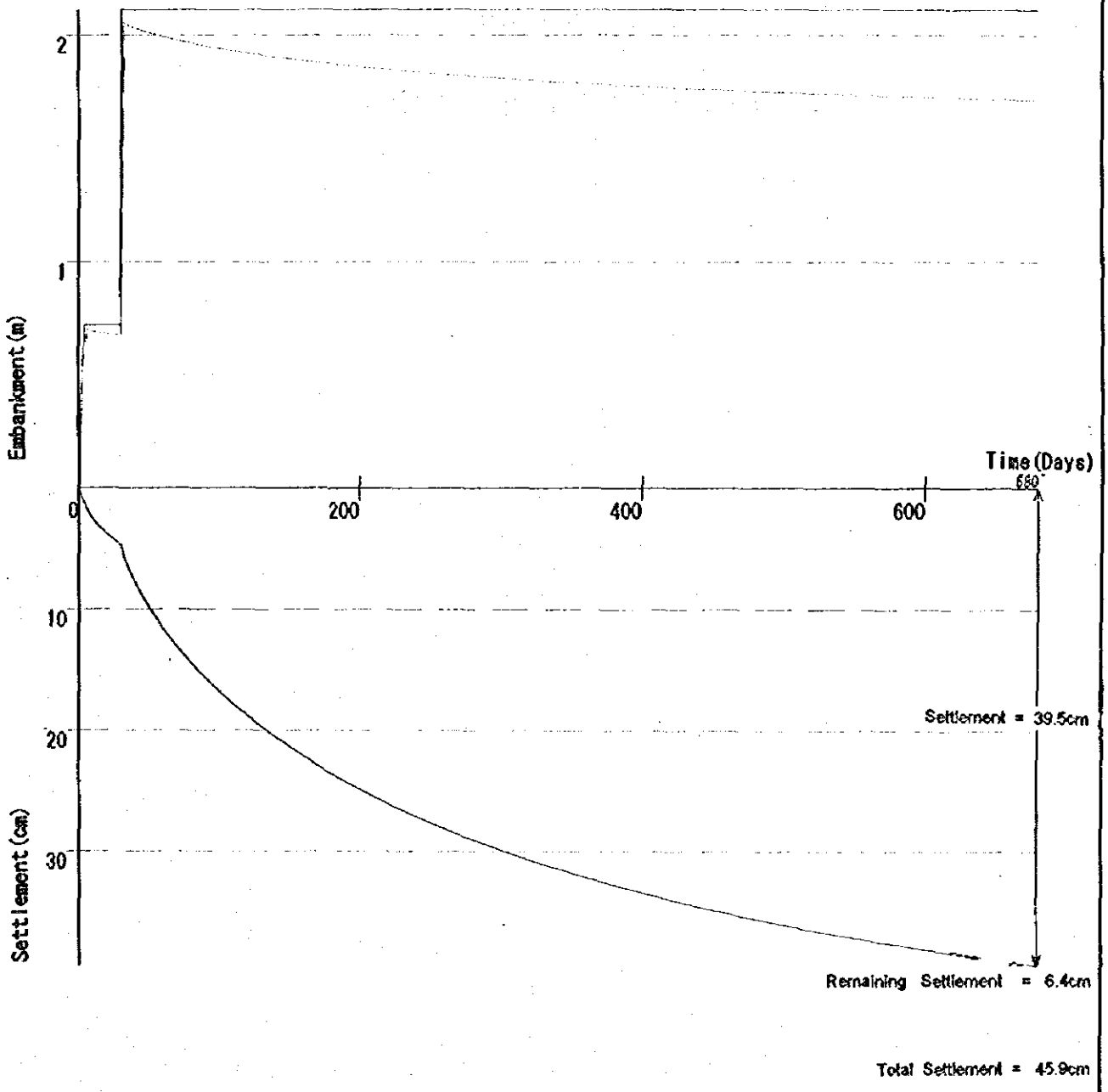


Predicted Settlement (Road Center)



PK-10 STA. 1346+100 Soft Ground

PK-10 STA. 1346+100 Soft Ground



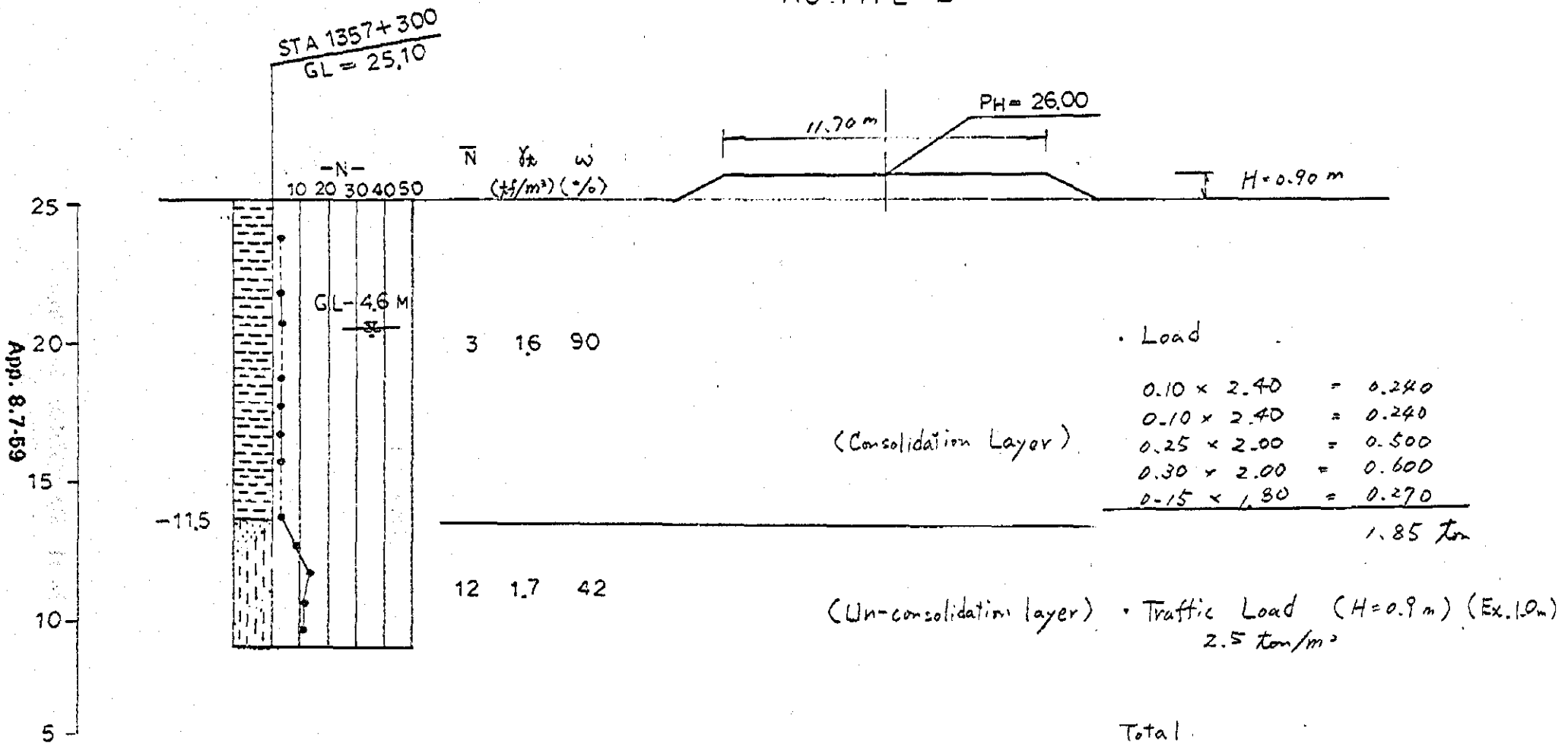
Predicted Settlement (Road Center)

STA. 1357+300

SETTLEMENT ANALYSIS

PK - 11

AC TYPE - 2(10)



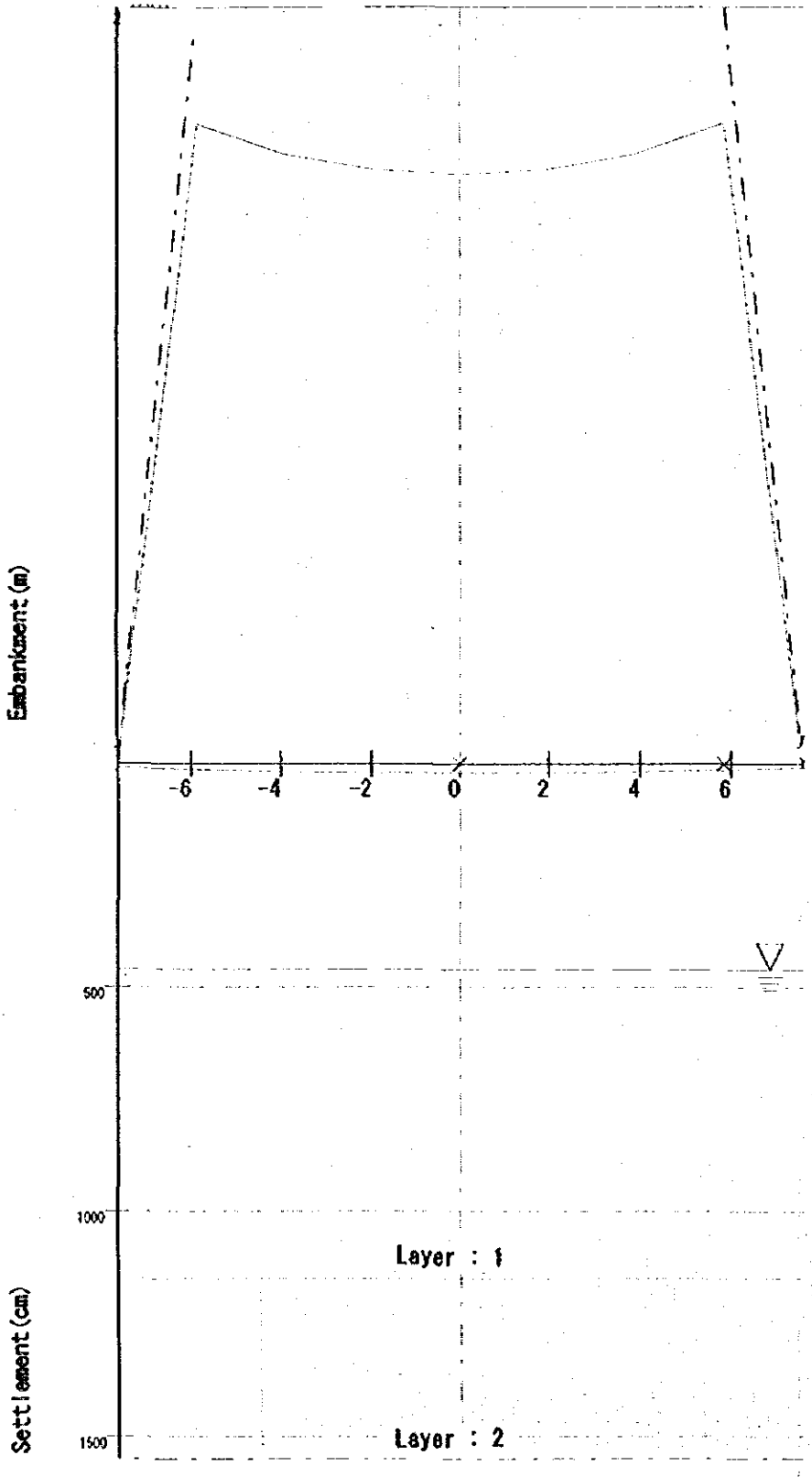
· Load

0.10 × 2.40	=	0.240
0.10 × 2.40	=	0.240
0.25 × 2.00	=	0.500
0.30 × 2.00	=	0.600
0.15 × 1.80	=	0.270
		1.85 ton

· Traffic Load (H = 0.9 m) (Ex. 1.0m)
2.5 ton/m²

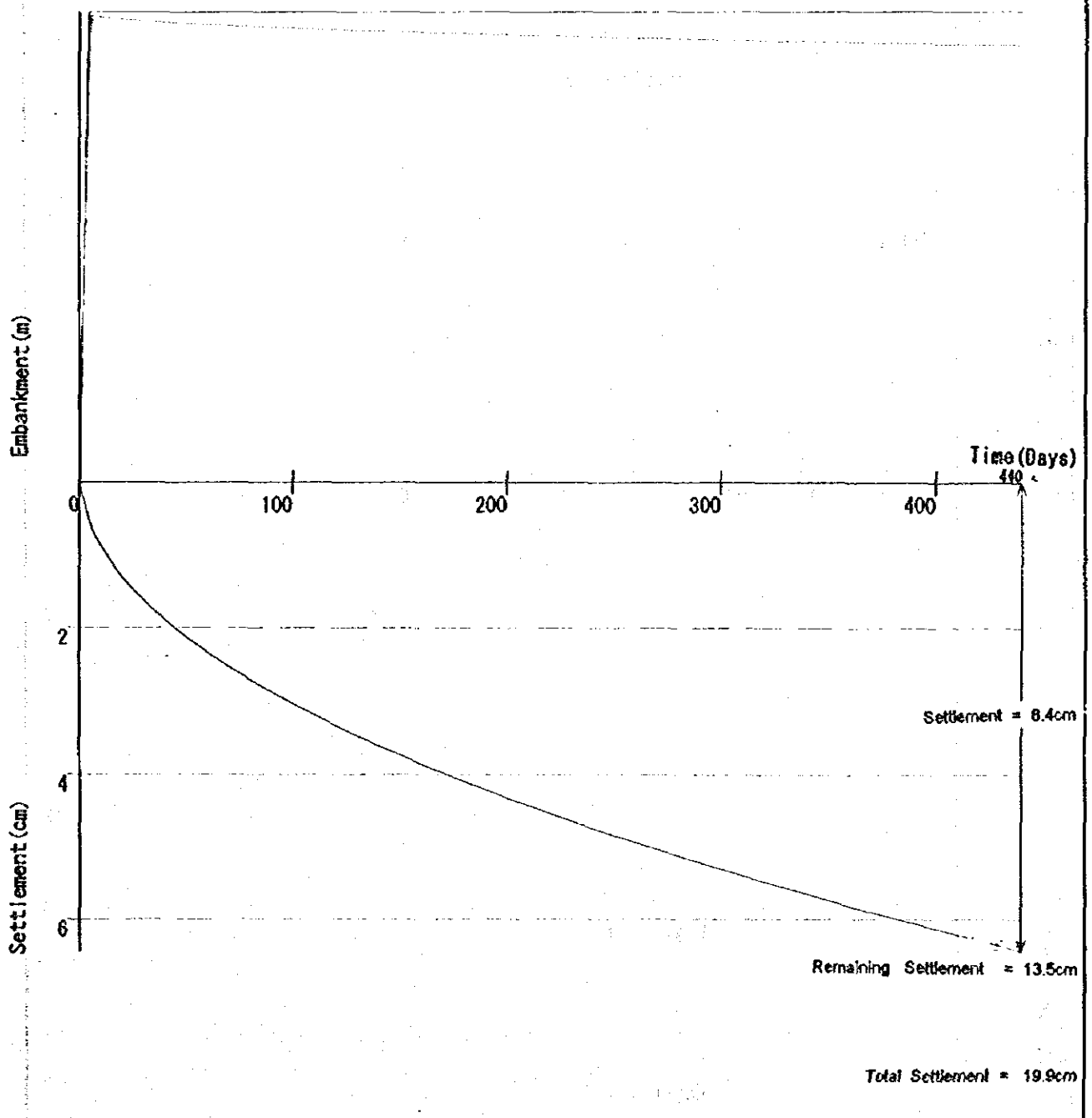
Total
$\Delta P = 1.85 + 2.5 = 4.4$ ton/m²

Soil Condition (STA. 1357+300 Soft Ground)

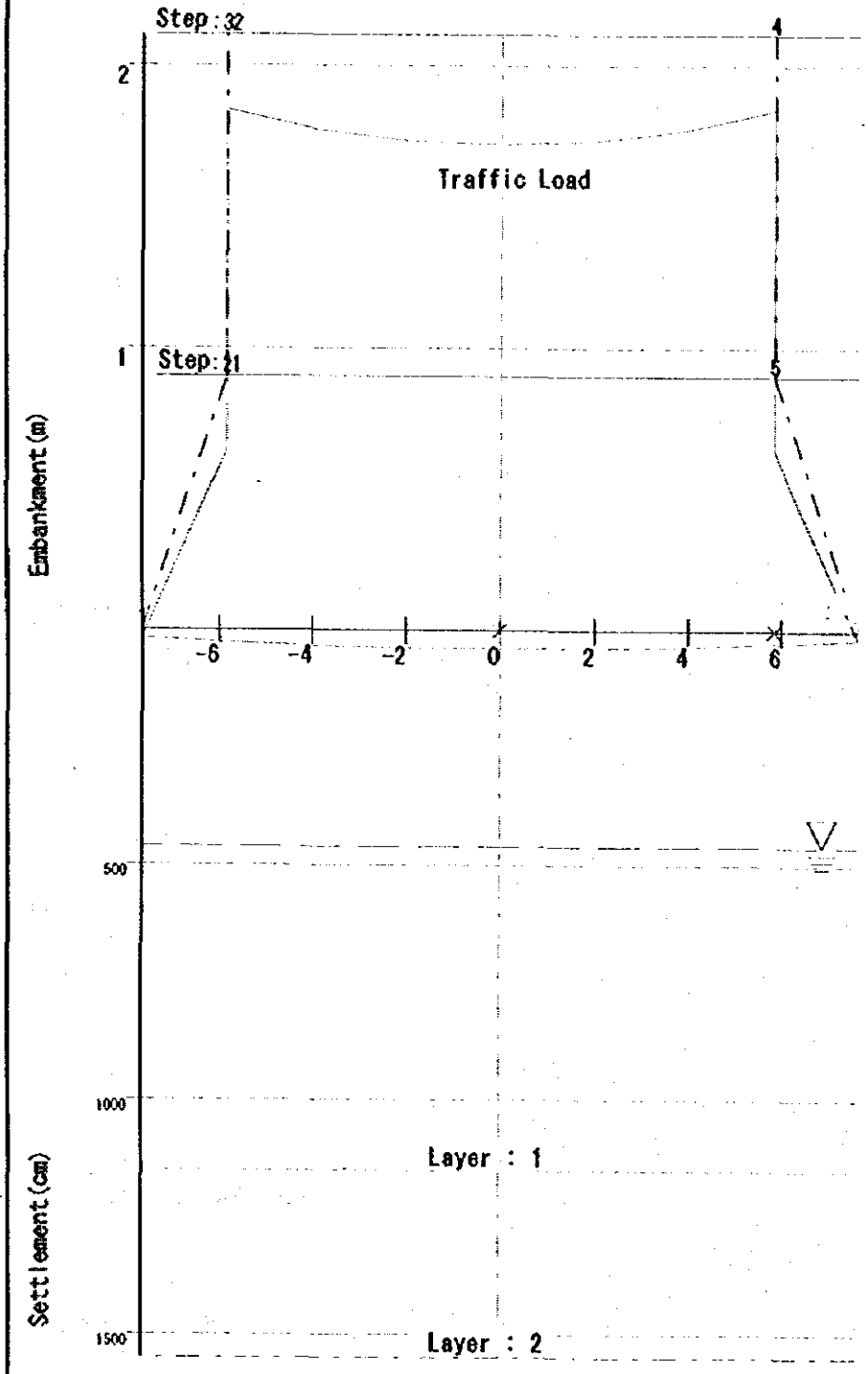


PK-11 STA. 1357+300 Soft Ground

PK-11 STA. 1357+300 Soft Ground

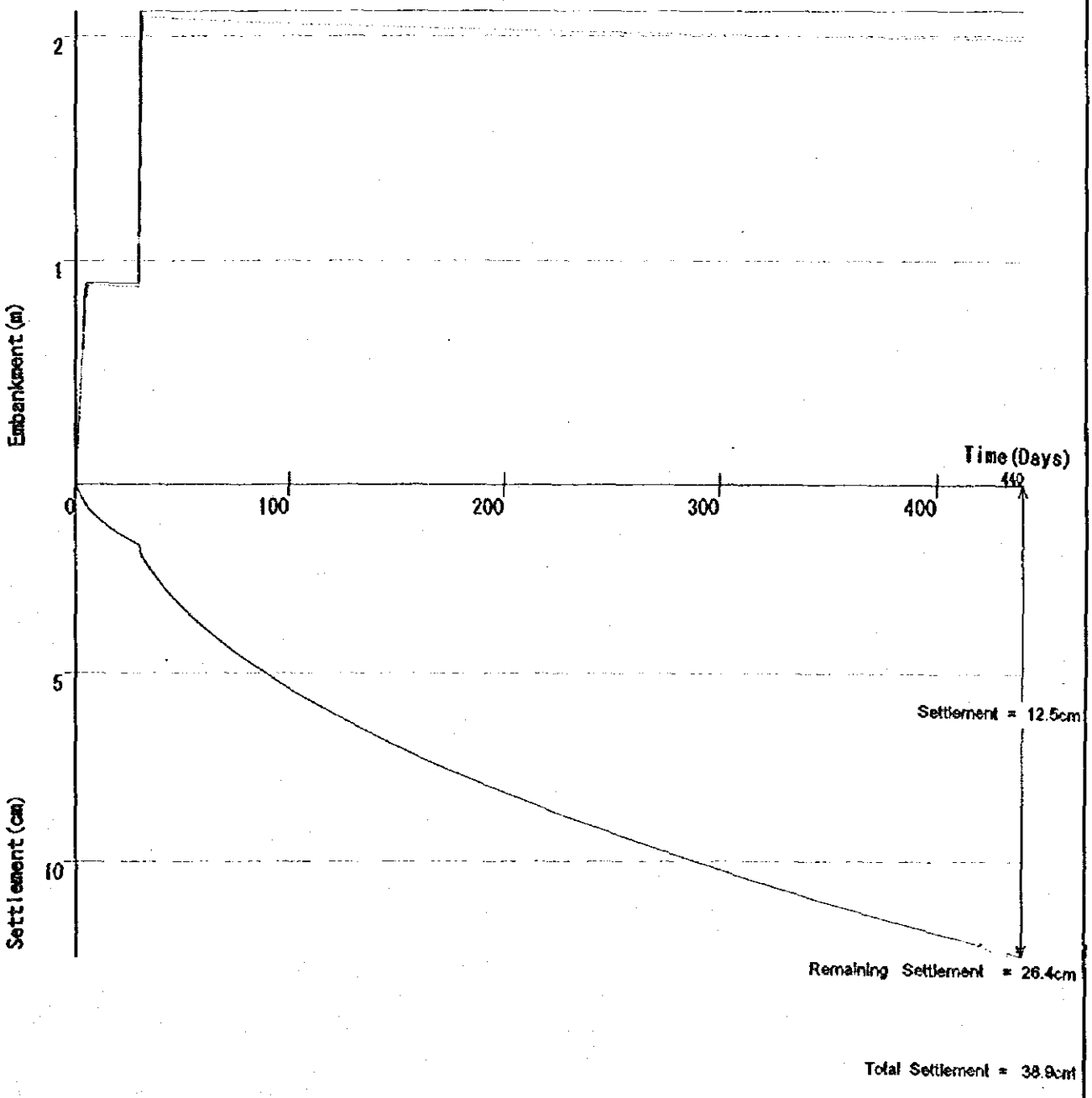


Predicted Settlement (Road Center)



PK-11 STA. 1357+300 Soft Ground

PK-11 STA. 1357+300 Soft Ground



Predicted Settlement (Road Center)