4-10. Study of Thickness of Sand Blanket

4.10.1 Description

The thickness of the sand blanket was calculated in consideration of contact pressure of construction machine.

Dai Nai sand was selected for the material of sand blanket based on the test result.

4.10.2 Design formula

The calculation method of the sand blanket thickness is used according to Porando & Raysne formula as follows:

$$\frac{K \cdot P}{(B+2 \cdot h \cdot \tan a) \cdot (L+h \cdot \tan a)} < (\gamma \cdot h + C \cot \phi) \cdot \frac{1+\sin \phi}{1-\sin \phi} \cdot e^{\pi \cdot \tan \phi} \cdot C \cdot \tan \phi$$

Where:

Left side of formula is the live load pressure.

Right side of formula is the capacity of the soft ground.

P:	Weight of one vehicle wheel	
K:	Safety factor in construction process	1.1
B, L:	Sizes of vehicle wheel	
a :	Angle of pressure distribution =	30degree
γ:	Dry unit weight of sand blanket=	18.6KN/cm³
h:	Thickness of sand blanket	
C:	Cohesion of soft ground=	7.0kN/m²
ϕ:	Internal friction angle of soft ground=	4.0degree

4.10 3 Determination of sand blanket thickness

Vehicle	B (cm)	L (cm)	P (kN)	h (m)
16 T	20	60	56.0	60
21 T	20	60	73.5	70
30 T	20	60	60.0	65

As for the thickness of sand blanket 70 cm are applied.

4-11. Study of Lateral Movement of Abutment

4.11.1 Description

The lateral movement is the ground deformation the phenomenon that results to level direction by the embankment load.

As for the occurrence mechanism of this phenomenon, there is much problem that is not clarified and the measure method is not established in a present stage.

However, the ground that was consolidated sufficiently with the pre-load or surcharge be that there is little occurrence of this phenomenon is confirmed in the execution of work achievement of Japan.

The abutment is displaced and the expansion spacing of rail joint of an abutment and girder disappear and the bearing and parapet and girder fail is a big problem by lateral movement.

In this Chapter, the determination of the risk of the occurrence of lateral movement is confirmed by using determination formula that is adopted generally in Japan.

4.11.2 Determination of lateral movement

(1) Determination formula

$$I = \mu 1 \times \mu 2 \times \mu 3 \times \gamma (h - hw) / C$$

$$\mu 1 = D/L,\ \mu 2 = \Sigma b / B,\ \mu 3 = D/A\ (=<3.0)$$

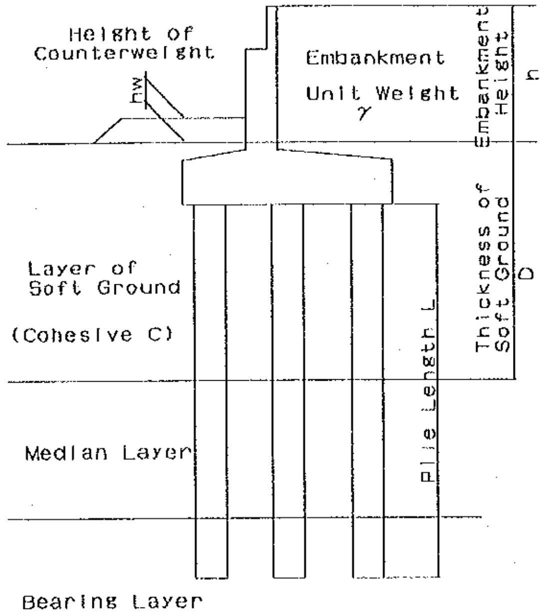
Where

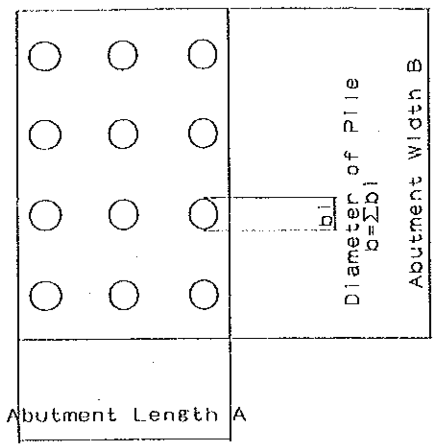
I	:	Later Lateral Movement Determination Index	Non Dimension
γ	:	Unit Weight of Embankment	kN/m^3
h	:	Height of Embankment	m
hw	:	Height of Counterweight	m
C	:	Cohesion of Subsoil	kN/m^2
D	:	Thickness of Soft Ground <3x (h-hw)	m
L	:	Length of Foundation Pile	m
b	:	Diameter of Foundation Pile	m
B	:	Width of Pile Cap	m
A	:	Length of Pile Cap	m

(2) Conclusion

Occurrence probability of the lateral movement occurrence of the abutment will be little. The calculation result is shown to the next page.

Study of Lateral Movement





Determination formula of Japan Road Association

$I = \mu 1 \times \mu 2 \times \mu 3 \times \gamma (h-hw)/C$

$\mu 1 = D/L$, $\mu 2 = \Sigma b/B$, $\mu 3 = D/A (=<3.0)$

I : Lateral movement determination Index

($I < 1.2$; There is little probability of the occurrence of Lateral Movement)

Classification	Bridge Name		Embankment Factor				Thickness of	Soft Ground Factor		Structural Factor						Lateral Movement Determination Index					Remarks
			h(m)	hw(m)	h-hw(m)	γ (kN/m³)	C1Layer	D(m)	C(kN/m²)	A	B	L	n	bi	Σb	μ1	μ2	μ3	I	Judgment	
Vinh Long	Large Tra Va	A1	8.01	3.05	4.96	18.30	26.00	14.90	12.4	9.20	24.10	70.00	6	1.50	9.00	0.21	0.37	1.62	0.94	OK	
		A2	8.33	3.48	4.85	18.30	29.00	14.60	12.4	9.20	24.10	70.00	6	1.50	9.00	0.21	0.37	1.59	0.88	OK	
	Small Tra Va	A1	7.53	2.50	5.03	18.30	25.70	15.10	12.4	8.50	24.10	70.00	5	1.50	7.50	0.22	0.31	1.78	0.89	OK	
		A2	8.75	3.75	5.00	18.30	24.50	15.00	12.4	8.50	24.10	70.00	5	1.50	7.50	0.21	0.31	1.76	0.87	OK	
	Tra On	A1	8.77	3.20	5.57	18.30	36.00	16.70	12.4	9.20	24.10	79.00	6	1.50	9.00	0.21	0.37	1.82	1.18	OK	
		A2	8.58	3.20	5.38	18.30	36.00	16.10	12.4	9.20	24.10	79.00	6	1.50	9.00	0.20	0.37	1.75	1.06	OK	
	Can Tho (Main Bridge)	A1	6.60	2.60	4.00	18.30	29.00	12.00	12.4	7.00	23.10	59.00	6	1.50	9.00	0.20	0.39	1.71	0.80	OK	
Can Tho		A2	5.70	2.55	3.15	18.30	16.00	9.50	15.9	7.00	23.10	62.00	6	1.50	9.00	0.15	0.39	1.36	0.29	OK	
	Cai Tac 1	A1	4.47	0.00	4.47	18.30	26.20	13.40	15.9	7.50	24.10	66.00	6	1.50	9.00	0.20	0.37	1.79	0.70	OK	
		A2	6.88	2.69	4.19	18.30	26.90	12.60	15.9	9.20	24.10	66.00	6	1.50	9.00	0.19	0.37	1.37	0.47	OK	
	Cai Tac 2	A1	6.30	3.00	3.30	18.30	23.30	9.90	15.9	7.00	31.36	55.00	8	1.20	9.60	0.18	0.31	1.41	0.30	OK	
		A2	6.30	3.00	3.30	18.30	23.30	9.90	15.9	7.00	31.45	55.00	8	1.20	9.60	0.18	0.31	1.41	0.30	OK	
	Cai Da	A1	4.65	0.00	4.65	18.30	19.80	14.00	15.0	7.50	25.35	55.00	6	1.50	9.00	0.25	0.36	1.87	0.96	OK	
		A2	4.65	0.00	4.65	18.30	19.80	14.00	14.2	7.50	25.10	55.00	6	1.50	9.00	0.25	0.36	1.87	1.02	OK	
	Ba Mang	A1	4.50	1.76	2.74	18.30	13.60	8.20	14.2	7.50	24.10	40.00	13	0.45	5.85	0.21	0.24	1.09	0.19	OK	
		A2	4.50	1.76	2.74	18.30	13.60	8.20	14.2	7.50	24.10	40.00	13	0.45	5.85	0.21	0.24	1.09	0.19	OK	
	Cai Nai	A1	5.55	2.38	3.17	18.30	12.30	9.50	14.2	7.50	24.10	40.00	13	0.45	5.85	0.24	0.24	1.27	0.30	OK	
		A2	5.67	2.38	3.29	18.30	14.70	9.90	14.2	7.50	24.10	40.00	13	0.45	5.85	0.25	0.24	1.32	0.34	OK	
	Ap My	A1	7.24	2.55	4.69	18.30	12.10	12.10	14.2	7.50	24.10	40.00	15	0.45	6.75	0.30	0.28	1.61	0.83	OK	
		A2	7.24	2.55	4.69	18.30	12.10	12.10	14.2	7.50	24.10	40.00	15	0.45	6.75	0.30	0.28	1.61	0.83	OK	
	Cai Rang	A1	7.64	2.46	5.18	18.30	11.00	11.00	14.2	7.50	24.10	40.00	15	0.45	6.75	0.28	0.28	1.47	0.75	OK	
		A2	7.46	2.46	5.00	18.30	13.00	13.00	14.2	7.50	24.10	40.00	15	0.45	6.75	0.33	0.28	1.73	1.02	OK	
Over Br	NH.54	A1	7.35	2.38	4.97	18.30	36.80	14.90	12.4	9.50	14.00	70.00	4	1.50	6.00	0.21	0.43	1.57	1.05	OK	
		A2	7.35	2.38	4.97	18.30	36.80	14.90	12.4	9.50	14.00	70.00	4	1.50	6.00	0.21	0.43	1.57	1.05	OK	
	NH.91B	A1	8.27	3.43	4.84	18.30	19.80	14.50	15.9	10.50	45.63	57.00	9	1.50	13.50	0.25	0.30	1.38	0.58	OK	
		A2	8.27	3.43	4.84	18.30	19.80	14.50	15.9	10.50	45.68	57.00	9	1.50	13.50	0.25	0.30	1.38	0.58	OK	
Ramp Br	IC NH.91B	A1	4.19	0.00	4.19	18.30	19.80	12.60	15.9	5.40	7.50	40.00	6	0.45	2.70	0.32	0.36	2.17	1.19	OK	
	Rampway D	A2	4.16	0.00	4.16	18.30	19.80	12.50	15.9	5.40	7.50	40.00	6	0.45	2.70	0.31	0.36	2.16	1.16	OK	

4-12. The Plan of Movement Observation and Execution Management

4.12.1 Description

The construction work of the soft ground section should adopt the information processing construction method by movement observation.

The execution management item by the movement observation is shown below.

(1) Control of banking speed.
(2) Stable evaluation of banking.
(3) Prevention of the displacement of the rupture and periphery of banking.
(4) Confirmation of settlement quantity.
(5) Decision in the removal time of surcharge and the pre-load.
(6) Decision of the establishment height of crossing structure.
(7) Prediction of future settlement quantity.

In this chapter, selection of movement observation devices, arrangement of instruments, Execution management method by observation result are entered.

4.12.2 Item of movement observation

(1) Settlement of ground surface and subsoil layer.
(2) Deformation of the surface of the periphery ground by banking.
(3) Horizontal deformation of subsoil.
(4) Fluctuation of pore water pressure of subsoil.
(5) Fluctuation of a groundwater level.

4.12.3 Arrangement of devices for movement observation

Surface Settlement Plate	SSP	Each pre-load, 60m intervals in general section.
Deep Settlement Plate	DSP	Pre-load of high embankment section
Alignment Stakes	AS	Each pre-load, 60m intervals in general section.
Electrical Piezometer	EP	Pre-load of high embankment section
Inclinometer	INC	Pre-load of high embankment section
Observation Well	OW	1 or 2 unit to the each segment section

The detailed establishment position is shown to the Drawings. Also the standard establishment figure is attached in the next pages.

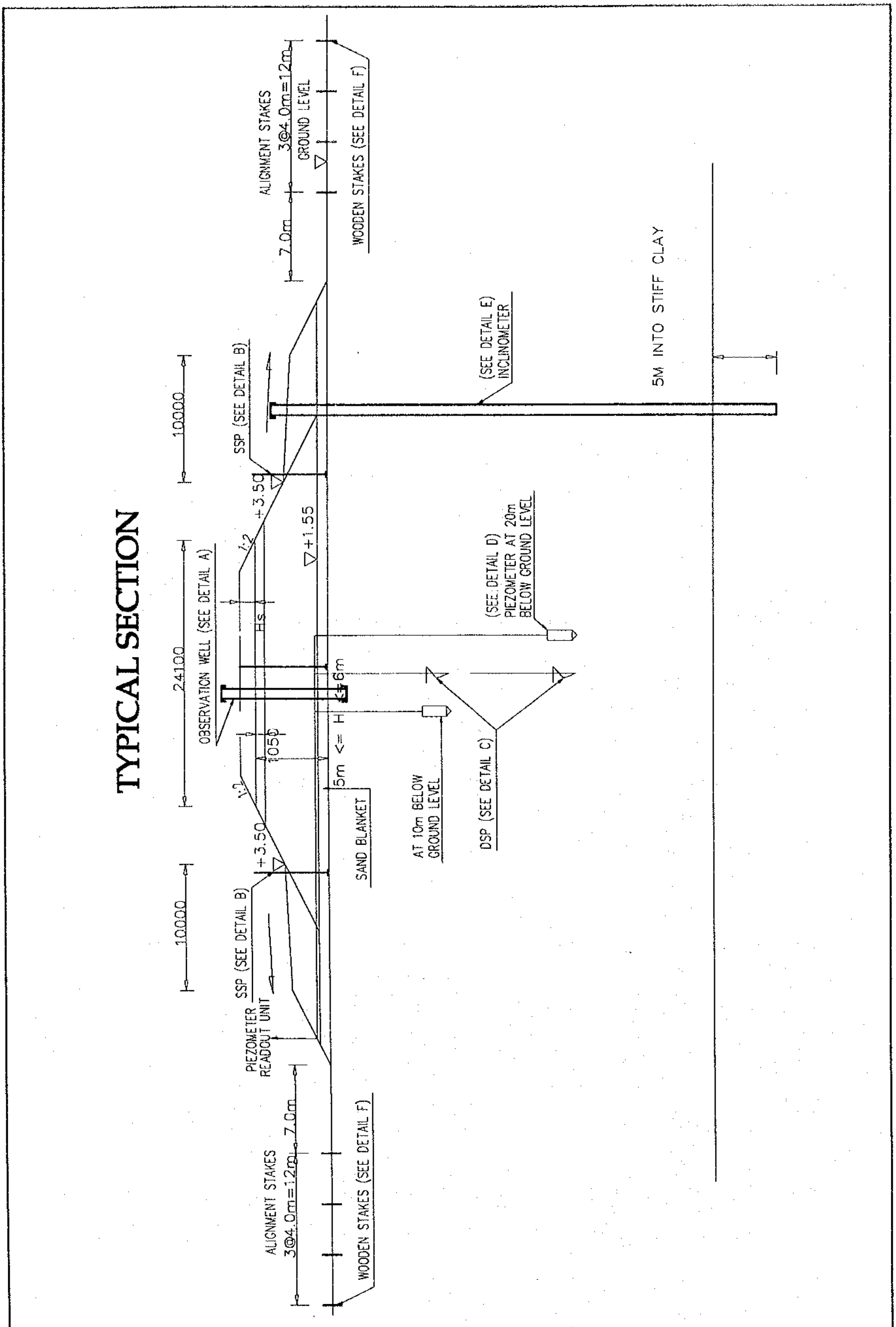
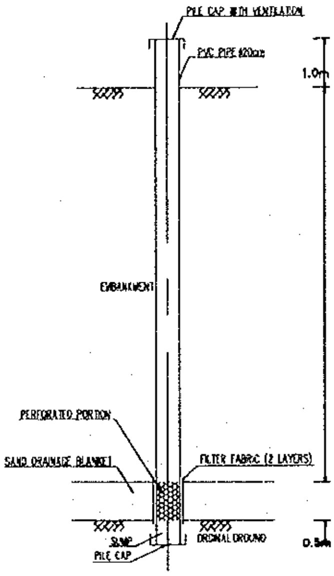
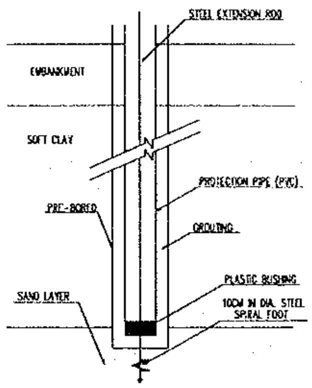


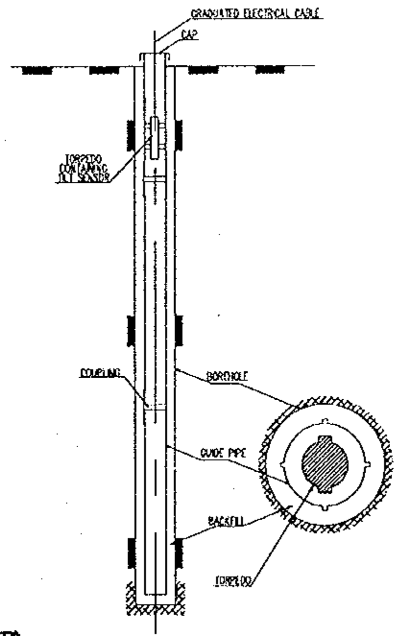
Fig-I-4-9 Details of Moving Observation Devices



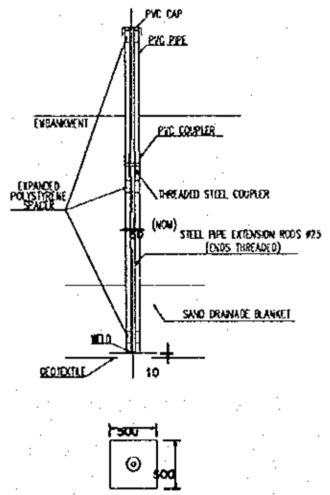
OBSERVATION WELL



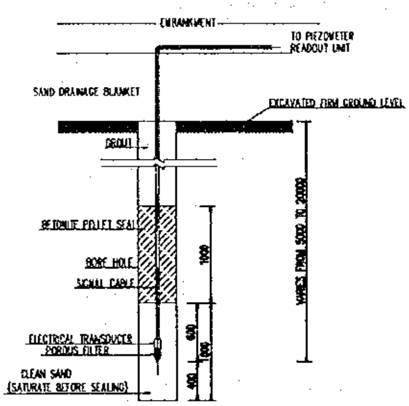
DEEP SETTLEMENT PLATE (DSP)



INCLINOMETER



SURFACE SETTLEMENT PLATE



ELECTRICAL PIEZOMETER

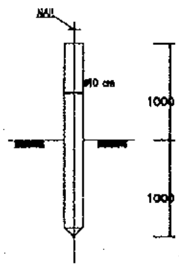


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Fig-I-4-10 Details of Moving Observation Devices

4.12.4 Frequency of observation

Name of Devices	Symbol	Through Banking period	Period from banking completion until pavement construction work start
Surface Settlement Plate	SSP	Measuring/day	Measuring/week
Deep Settlement Plate	DSP	- a a -	- a a -
Alignment Stakes	AS	- a a -	- a a -
Electrical Piezometer	EP	- a a -	- a a -
Inclinometer	INC	- a a -	- a a -
Observation Well	OW	- a a -	- a a -

4.12.5 Application to execution management of the observation result

(1) Application purpose of the observation result

- Measured value of ***SSP*** and ***DSP*** are used to the confirmation of settlement quantity and, the stability control of banking with the measured value of deformation quantity and the confirmation of the progress situation of consolidation.

- Measured value of *AS* and *INC* are used to the stability control of banking with the measured value of settlement.

- Measured value of *EP* and *OW* are used to the confirmation of the progress situation of consolidation and the stability control of banking.

(2) Stability control method of embankment

There are several methods in the stability control method of embankment.
In this paragraph, quantitative stability control methods are chosen to esteem simplicity of the control and shown as below.

Name of Method	Data that uses it for stability control
S-δ method	S: Settlement quantity δ: Lateral movement quantity
$\Delta\delta/\Delta t$ method	$\Delta\delta/\Delta t$: Lateral movement quantity per day
S-δ/S method	S: Settlement quantity δ: Lateral movement quantity

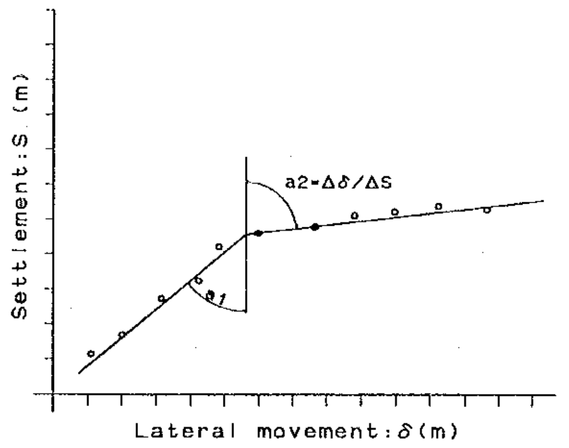
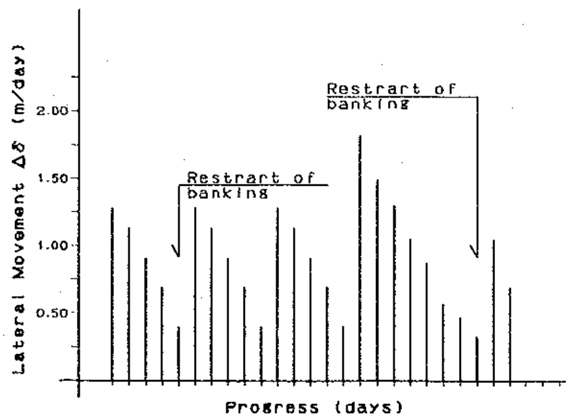
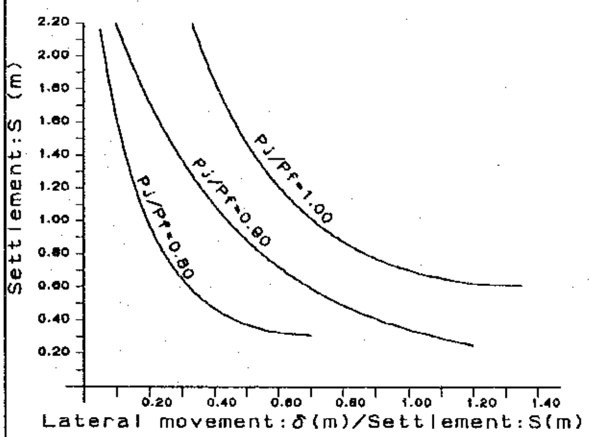
Name of Method	Control chart	Control Limit
S-δ method		a2=> a1+0.5 a2=> 0.7
Δδ / Δt method		Δδ / Δt =>1.5 cm/day
S-δ /S method		(1) δ /S >0.1, pj/pf=>0.95 (2) δ /S >0.8, -1=<a3=<1 (3) δ /S >0.6

Figure I-4-11. Control Chart of Slope Stability

Appendices

Appendix-1: Characteristic Value Subsoil Layer

CAN THO BRIDGE CONSTRUCTION

e - Log P Curves (C1)

Segment	Layer	No	Lab No	Bore No	Depth (m)	Void ratio	P (kPa) 10.0	20.0	50.0	100.0	200.0	400.0	Cc
I	C1-U	1	801	Br-D-1	2.0 - 3.0	1.538	1.480	1.414	1.303	1.175	1.053	0.914	0.462
		2	802	Br-D-1	9.0 - 9.5	1.445	1.417	1.389	1.315	1.198	0.996	0.781	0.714
		5	66	Br-D-2	3.0 - 4.0	1.491	1.413	1.375	1.305	1.226	1.134	1.016	0.392
		6	67	Br-D-2	8.0 - 9.0	1.587	1.565	1.526	1.445	1.337	1.213	1.070	0.475
		12	173	Br-D-3	7.0 - 8.0	2.165	1.995	1.926	1.785	1.609	1.423	1.208	0.714
		15	192	Br-D-4	7.0 - 8.0	1.514	1.479	1.452	1.387	1.288	1.142	0.972	0.565
		18	971	Br-D-5	3.0 - 4.0	1.637	1.568	1.549	1.468	1.384	1.277	1.153	0.412
		19	972	Br-D-5	10.5 - 11.5	1.562	1.543	1.524	1.461	1.347	1.171	0.983	0.625
		25	931	Br-D-6	10.0 - 11.0	1.670	1.655	1.641	1.579	1.476	1.288	1.068	0.731
		28	859	Br-D-7	5.0 - 6.0	1.903	1.862	1.836	1.771	1.695	1.594	1.407	0.621
		29	860	Br-D-7	8.0 - 9.0	1.832	1.811	1.773	1.666	1.529	1.373	1.151	0.737
		31	806	Br-D-8	3.0 - 3.5	1.389	1.350	1.326	1.266	1.190	1.045	0.881	0.545
		32	807	Br-D-8	10.5 - 11.5	1.596	1.580	1.553	1.478	1.388	1.261	1.107	0.512
		34	869	Br-D-9	2.0 - 3.0	1.414	1.396	1.381	1.348	1.315	1.275	1.225	0.166
		35	870	Br-D-9	9.0 - 10.0	1.637	1.624	1.610	1.572	1.524	1.434	1.299	0.448
	Average					**1.625**	**1.583**	**1.552**	**1.477**	**1.379**	**1.245**	**1.082**	**0.541**
	C1-L	3	803	Br-D-1	19.0 - 20.0	1.152	1.123	1.096	1.039	0.966	0.849	0.718	0.435
		7	68	Br-D-2	22.0 - 22.3	1.205	1.163	1.123	1.042	0.962	0.870	0.771	0.329
		13	174	Br-D-3	15.0 - 16.0	1.402	1.337	1.305	1.224	1.142	1.021	0.882	0.462
		14	175	Br-D-3	20.0 - 21.0	1.053	1.019	1.004	0.965	0.903	0.815	0.712	0.342
		20	973	Br-D-5	17.0 - 18.0	1.468	1.454	1.438	1.397	1.325	1.142	0.936	0.684
		24	930	Br-D-6	17.5 - 18.5	1.215	1.202	1.187	1.150	1.101	0.976	0.769	0.688
		30	861	Br-D-7	18.0 - 19.0	1.468	1.449	1.422	1.357	1.284	1.190	1.066	0.412
		33	808	Br-D-8	19.0 - 20.0	1.514	1.499	1.486	1.444	1.380	1.263	1.016	0.821
		36	871	Br-D-9	17.0 - 18.0	1.280	1.253	1.236	1.189	1.120	0.992	0.749	0.807
	Average					**1.306**	**1.278**	**1.255**	**1.201**	**1.131**	**1.013**	**0.847**	**0.553**
III	C1-U	73	749	Br-D-18	8.0 - 9.0	1.862	1.806	1.765	1.663	1.496	1.300	1.086	0.711
		74	750	Br-D-18	13.0 - 14.0	1.872	1.832	1.794	1.682	1.512	1.298	1.052	0.817
		78	742	Br-D-19	4.0 - 4.5	2.092	2.047	2.007	1.891	1.716	1.501	1.266	0.781
		79	747	Br-D-19	12.0 - 13.0	1.491	1.475	1.454	1.398	1.315	1.151	0.973	0.591
		83	836	Br-D-20	9.0 - 10.0	1.700	1.676	1.656	1.591	1.454	1.207	0.939	0.890
		87	847	Br-D-21	11.0 - 12.0	1.423	1.407	1.383	1.315	1.212	1.057	0.877	0.598
	Average					**1.740**	**1.707**	**1.677**	**1.590**	**1.451**	**1.252**	**1.032**	**0.731**
	C1-L	75	751	Br-D-18	18.0 - 19.0	1.381	1.358	1.333	1.266	1.176	1.077	0.963	0.379
		80	744	Br-D-19	19.0 - 20.0	1.269	1.221	1.200	1.149	1.091	1.009	0.913	0.319
		84	837	Br-D-20	19.0 - 20.0	1.102	1.086	1.068	1.021	0.964	0.883	0.794	0.296
		88	848	Br-D-21	19.0 - 20.0	1.426	1.393	1.368	1.320	1.261	1.181	1.063	0.392
	Average					**1.295**	**1.265**	**1.242**	**1.189**	**1.123**	**1.038**	**0.933**	**0.347**
IV	C1	38	342	Br-D-10	6.0 - 7.0	1.956	1.922	1.889	1.798	1.654	1.482	1.281	0.668
		93	372	Br-D-22	3.0 - 4.0	1.956	1.913	1.875	1.751	1.584	1.388	1.190	0.658
		94	373	Br-D-22	8.0 - 9.0	1.547	1.455	1.420	1.342	1.225	1.083	0.938	0.482
		98	26	Br-D-23	6.0 - 7.0	1.360	1.338	1.310	1.249	1.152	0.960	0.756	0.678
		104	305	Br-D-24	4.0 - 5.0	1.765	1.735	1.703	1.616	1.487	1.324	1.145	0.595
		105	306	Br-D-24	11.0 - 12.0	1.557	1.505	1.473	1.398	1.297	1.158	1.007	0.502
		109	52	Br-D-25	9.0 - 10.0	1.538	1.523	1.499	1.435	1.341	1.146	0.928	0.724
		110	53	Br-D-25	12.0 - 13.0	1.538	1.490	1.459	1.397	1.316	1.204	1.085	0.395
		115	259	Br-D-26	3.0 - 4.0	2.241	2.126	2.077	1.941	1.724	1.440	1.152	0.957
		118	985	Br-D-27	4.0 - 4.5	1.381	1.364	1.344	1.299	1.243	1.165	1.061	0.345
		121	8	Br-D-28	8.0 - 9.0	1.528	1.467	1.423	1.340	1.182	1.001	0.796	0.681
		122	9	Br-D-28	12.0 - 13.0	1.319	1.299	1.276	1.225	1.148	1.033	0.909	0.412
		128	354	Br-D-29	5.0 - 6.0	1.423	1.396	1.372	1.301	1.194	1.041	0.871	0.565
	Average					**1.624**	**1.579**	**1.548**	**1.469**	**1.350**	**1.187**	**1.009**	**0.589**

CAN THO BRIDGE CONSTRUCTION

e - Log P Curves (C2)

Segment	Layer	No	Lab No	No Bore.	Depth (m)	Void ratio	P (kPa)							Cc
							10	20	50	100	200	400	800	
I	C2	8	69	Br-D-2	41.0 - 41.5	1.195	1.134	1.103	1.052	0.974	0.889	0.792		0.322
		16	194	Br-D-4	30.5 - 31.0	1.078	1.049	1.036	1.007	0.966	0.904	0.821		0.276
		21	974	Br-D-5	27.5 - 28.0	1.102		1.043	1.013	0.969	0.914	0.843	0.760	0.276
		22	975	Br-D-5	32.0 - 32.5	1.023		0.981	0.954	0.914	0.862	0.801	0.732	0.229
		26	933	Br-D-6	26.5 - 27.0	1.261		1.234	1.206	1.170	1.093	0.946	0.791	0.515
	Average					**1.132**	**1.092**	**1.079**	**1.046**	**0.999**	**0.932**	**0.841**	**0.761**	**0.324**
III	C2	76	752	Br-D-18	39.0 - 39.5	0.784		0.749	0.730	0.704	0.671	0.633	0.578	0.183
		81	746	Br-D-19	30.0 - 30.5	0.739		0.718	0.694	0.667	0.631	0.588	0.536	0.173
		85	838	Br-D-20	28.0 - 28.5	0.839		0.829	0.820	0.794	0.758	0.713	0.654	0.196
		86	839	Br-D-20	40.0 - 40.5	0.870		0.845	0.820	0.789	0.745	0.692	0.623	0.229
		89	849	Br-D-21	24.0 - 24.5	0.890		0.884	0.863	0.820	0.763	0.699	0.622	0.256
		90	850	Br-D-21	34.4 - 34.8	0.745		0.728	0.714	0.690	0.660	0.626	0.585	0.136
		91	851	Br-D-21	41.0 - 41.5	0.971		0.957	0.940	0.919	0.891	0.851	0.784	0.223
	Average					**0.834**		**0.816**	**0.797**	**0.769**	**0.731**	**0.686**	**0.626**	**0.199**
IV	C2	39	346	Br-D-10	33.0 - 33.5	0.812		0.802	0.789	0.777	0.759	0.726	0.665	0.203
		95	375	Br-D-22	16.0 - 16.5	0.815		0.810	0.805	0.793	0.772	0.746	0.705	0.136
		96	377	Br-D-22	34.0 - 34.5	0.655		0.647	0.641	0.631	0.615	0.592	0.559	0.110
		99	27	Br-D-23	10.0 - 11.0	1.345	1.314	1.288	1.223	1.128	1.000	0.860		0.465
		100	29	Br-D-23	18.0 - 18.5	0.675		0.669	0.661	0.650	0.632	0.608	0.569	0.130
		101	30	Br-D-23	27.5 - 28.0	0.703		0.692	0.680	0.657	0.627	0.595	0.548	0.156
		102	31	Br-D-23	37.0 - 37.5	0.606			0.592	0.578	0.559	0.534	0.502	0.153
		106	308	Br-D-24	23.5 - 24.0	0.964		0.953	0.935	0.908	0.868	0.820	0.751	0.229
		111	54	Br-D-25	18.0 - 18.5	0.773		0.763	0.749	0.732	0.703	0.666	0.615	0.169
		112	55	Br-D-25	27.5 - 28.0	0.702		0.685	0.668	0.652	0.626	0.587	0.539	0.159
		113	56	Br-D-25	33.0 - 33.5	0.784		0.763	0.754	0.737	0.717	0.686	0.633	0.176
		116	262	Br-D-26	17.0 - 17.5	0.877		0.866	0.849	0.828	0.799	0.762	0.707	0.183
		117	263	Br-D-26	25.0 - 25.5	0.734		0.724	0.710	0.690	0.659	0.620	0.567	0.176
		119	986	Br-D-27	12.5 - 13.0	0.791		0.777	0.771	0.764	0.749	0.724	0.684	0.133
		123	10	Br-D-28	17.0 - 17.5	0.909		0.896	0.885	0.871	0.844	0.796	0.733	0.209
		124	11	Br-D-28	23.5 - 24.0	0.796		0.775	0.749	0.718	0.675	0.625	0.567	0.193
		125	12	Br-D-28	27.0 - 27.5	0.750		0.743	0.736	0.726	0.708	0.675	0.628	0.156
		126	13	Br-D-28	38.0 - 38.5	0.881		0.853	0.841	0.819	0.792	0.754	0.692	0.206
		129	356	Br-D-29	16.0 - 16.5	0.745		0.738	0.725	0.709	0.685	0.649	0.602	0.156
		130	357	Br-D-29	30.0 - 30.5	0.688		0.669	0.646	0.623	0.589	0.545	0.490	0.183
	Average					**0.794**		**0.779**	**0.765**	**0.747**	**0.720**	**0.681**	**0.628**	**0.177**

CAN THO BRIDGE CONSTRUCTION

Log Cv - Log P Curves (C1)

Segment	Layer	No	Lab No	Bore No	Depth (m)			P (kPa) / Cv (cm2/s)						
								5	15	35	75	150	300	600
I	C1-U	1	801	Br-D-1	2.0	-	3.0	1.525	1.221	1.090	0.948	0.924	0.895	
		2	802	Br-D-1	9.0	-	9.5	1.510	1.452	0.979	0.748	0.527	0.504	
		5	66	Br-D-2	3.0	-	4.0	1.185	1.209	1.343	1.204	1.188	1.129	
		6	67	Br-D-2	8.0	-	9.0	0.781	0.478	0.464	0.451	0.449	0.437	
		12	173	Br-D-3	7.0	-	8.0	0.291	0.274	0.250	0.309	0.440	0.334	
		15	192	Br-D-4	7.0	-	8.0	0.759	0.777	1.195	0.828	0.721	0.667	
		18	971	Br-D-5	3.0	-	4.0	0.929	0.589	0.454	0.449	0.431	0.422	
		19	972	Br-D-5	10.5	-	11.5	0.873	0.881	1.027	0.605	0.600	0.586	
		25	931	Br-D-6	10.0	-	11.0	1.292	1.491	1.364	1.095	0.986	0.951	
		28	859	Br-D-7	5.0	-	6.0	1.420	1.378	1.331	1.273	1.118	0.557	
		29	860	Br-D-7	8.0	-	9.0	1.452	1.160	0.996	0.970	0.956	0.928	
		31	806	Br-D-8	3.0	-	3.5	1.447	1.144	1.101	0.843	0.745	0.718	
		32	807	Br-D-8	10.5	-	11.5	1.091	0.912	0.812	0.623	0.596	0.595	
		34	869	Br-D-9	2.0	-	3.0	1.550	1.585	1.643	1.457	1.419	1.387	
		35	870	Br-D-9	9.0	-	10.0	1.472	1.245	1.188	1.151	0.882	0.833	
	Average		**$cm^2/s \times 10^{-3}$**					**1.172**	**1.053**	**1.016**	**0.864**	**0.799**	**0.730**	
			cm^2/day					**101**	**91**	**88**	**75**	**69**	**63**	
	C1-L	3	803	Br-D-1	19.0	-	20.0	1.856	1.384	1.326	0.852	0.791	0.748	
		7	68	Br-D-2	22.0	-	22.3	0.291	0.334	0.346	0.429	0.415	0.385	
		13	174	Br-D-3	15.0	-	16.0	0.669	0.486	0.440	0.437	0.480	0.439	
		14	175	Br-D-3	20.0	-	21.0	1.096	0.830	0.784	0.773	0.783	0.672	
		20	973	Br-D-5	17.0	-	18.0	1.176	1.021	0.971	0.953	0.407	0.394	
		30	861	Br-D-7	18.0	-	19.0	0.799	0.997	0.964	0.913	0.907	0.891	
		33	808	Br-D-8	19.0	-	20.0	1.287	1.376	1.560	1.371	0.964	0.945	
		36	871	Br-D-9	17.0	-	18.0	1.506	0.781	0.559	0.463	0.374	0.369	
	Average		**$cm^2/s \times 10^{-3}$**					**1.085**	**0.901**	**0.869**	**0.774**	**0.640**	**0.605**	
			cm^2/day					**94**	**78**	**75**	**67**	**55**	**52**	
III	C1-U	73	749	Br-D-18	8.0	-	9.0	0.970	0.646	0.610	0.445	0.422	0.396	
		74	750	Br-D-18	13.0	-	14.0	0.953	0.685	0.582	0.462	0.427	0.398	
		78	742	Br-D-19	4.0	-	4.5	0.840	0.678	0.541	0.499	0.469	0.415	
		79	747	Br-D-19	12.0	-	13.0	0.940	0.712	0.694	0.586	0.478	0.453	
		83	836	Br-D-20	9.0	-	10.0	1.351	1.236	1.060	0.540	0.449	0.418	
		87	847	Br-D-21	11.0	-	12.0	0.722	0.668	0.620	0.395	0.364	0.357	
	Average		**$cm^2/s \times 10^{-3}$**					**0.963**	**0.771**	**0.685**	**0.488**	**0.435**	**0.406**	
			cm^2/day					**83**	**67**	**59**	**42**	**38**	**35**	
	C1-L	75	751	Br-D-18	18.0	-	19.0	0.902	0.706	0.653	0.610	0.588	0.571	
		80	744	Br-D-19	19.0	-	20.0	0.427	0.553	0.669	0.631	0.618	0.606	
		84	837	Br-D-20	19.0	-	20.0	1.087	0.981	0.946	0.851	0.846	0.821	
		88	848	Br-D-21	19.0	-	20.0	0.905	1.095	1.012	1.009	0.795	0.581	
	Average		**$cm^2/s \times 10^{-3}$**					**0.830**	**0.834**	**0.820**	**0.775**	**0.712**	**0.645**	
			cm^2/day					**72**	**72**	**71**	**67**	**61**	**56**	
IV	C1	38	342	Br-D-10	6.0	-	7.0	1.570	1.272	1.107	1.105	1.092	1.051	
		93	372	Br-D-22	3.0	-	4.0	1.191	1.282	0.845	0.408	0.297	0.290	
		94	373	Br-D-22	8.0	-	9.0	1.184	1.043	0.975	0.801	0.745	0.714	
		98	26	Br-D-23	6.0	-	7.0	0.775	0.834	0.962	0.711	0.590	0.559	
		104	305	Br-D-24	4.0	-	5.0	1.080	0.959	0.937	0.722	0.589	0.563	
		105	306	Br-D-24	11.0	-	12.0	0.768	0.725	0.720	0.665	0.537	0.532	
		109	52	Br-D-25	9.0	-	10.0	1.033	1.035	1.184	0.869	0.567	0.555	
		110	53	Br-D-25	12.0	-	13.0	2.027	1.536	1.514	1.356	1.377	1.346	
		115	259	Br-D-26	3.0	-	4.0	0.591	0.441	0.404	0.369	0.423	0.388	
		118	985	Br-D-27	4.0	-	4.5	0.942	1.328	1.283	1.267	1.222	1.212	
		121	8	Br-D-28	8.0	-	9.0	1.130	0.614	0.600	0.525	0.473	0.450	
		122	9	Br-D-28	12.0	-	13.0	0.701	0.629	0.623	0.496	0.473	0.450	
		128	354	Br-D-29	5.0	-	6.0	0.764	0.630	0.617	0.470	0.462	0.451	
	Average		**$cm^2/s \times 10^{-3}$**					**1.058**	**0.948**	**0.905**	**0.751**	**0.681**	**0.659**	
			cm^2/day					**91**	**82**	**78**	**65**	**59**	**57**	

CAN THO BRIDGE CONSTRUCTION

Log Cv - Log P Curves (C2)

Segment	Layer	No	Lab No	Bore No	Depth (m)	P (kPa) / Cv (cm2/s)						
						5	15	35	75	150	300	600
I	C2	8	69	Br-D-2	41.0 - 41.5	0.703	0.698	0.634	0.644	0.620	0.609	
		16	194	Br-D-4	30.5 - 31.0	1.384	1.136	1.300	1.540	1.501	1.398	
		21	974	Br-D-5	27.5 - 28.0	0.725	0.725	1.345	1.416	1.579	1.723	
		22	975	Br-D-5	32.0 - 32.5	1.493	1.493	1.734	1.871	1.802	1.789	
		26	933	Br-D-6	26.5 - 27.0	2.625	2.911	2.417	1.700	1.695	1.591	
	Average		**$cm^2/sx10^{-3}$**			**1.386**	**1.393**	**1.486**	**1.434**	**1.439**	**1.422**	
			cm^2/day			**120**	**120**	**128**	**124**	**124**	**123**	
III	C2	76	752	Br-D-18	39.0 - 39.5	0.970	0.646	0.618	0.445	0.422	0.396	
		81	746	Br-D-19	30.0 - 30.5	1.225	1.225	1.456	1.342	1.275	1.152	1.071
		85	838	Br-D-20	28.0 - 28.5	0.288	0.288	0.290	0.299	0.321	0.318	0.312
		86	839	Br-D-20	40.0 - 40.5		0.952	1.207	1.403	1.347	1.326	1.195
		89	849	Br-D-21	24.0 - 24.5	0.469	0.469	0.198	0.152	0.138	0.125	0.108
		90	850	Br-D-21	34.4 - 34.8	1.715	1.715	1.868	2.074	1.866	1.826	1.528
		91	851	Br-D-21	41.0 - 41.5	1.163	1.163	1.173	1.318	1.431	1.430	1.232
	Average		**$cm^2/sx10^{-3}$**			**0.972**	**0.923**	**0.973**	**1.005**	**0.971**	**0.939**	**0.908**
			cm^2/day			**84**	**80**	**84**	**87**	**84**	**81**	**78**
IV	C2	39	346	Br-D-10	33.0 - 33.5	3.862	3.862	2.856	2.448	1.382	0.936	
		95	375	Br-D-22	16.0 - 16.5	0.622	0.622	0.598	0.380	0.364	0.454	0.445
		96	377	Br-D-22	34.0 - 34.5	0.440	0.440	0.368	0.301	0.340	0.233	0.218
		99	27	Br-D-23	10.0 - 11.0	0.504	0.558	0.534	0.444	0.432	0.411	
		100	29	Br-D-23	18.0 - 18.5	0.362	0.362	0.234	0.396	0.412	0.343	0.338
		101	30	Br-D-23	27.5 - 28.0	0.811	0.811	1.388	1.746	1.341	1.292	1.282
		102	31	Br-D-23	37.0 - 37.5			1.395	1.613	1.526	1.466	1.169
		106	308	Br-D-24	23.5 - 24.0	0.773	0.773	0.693	0.418	0.397	0.350	0.325
		111	54	Br-D-25	18.0 - 18.5	0.755	0.561	0.510	0.439	0.428	0.419	
		112	55	Br-D-25	27.5 - 28.0	1.712	2.138	2.080	1.811	1.707	1.644	
		113	56	Br-D-25	33.0 - 33.5	1.560	1.847	2.190	2.787	2.213	1.889	
		116	262	Br-D-26	17.0 - 17.5	0.998	0.912	0.935	1.142	1.418	1.184	
		117	263	Br-D-26	25.0 - 25.5	1.790	1.790	1.841	1.897	1.979	1.942	1.906
		119	986	Br-D-27	12.5 - 13.0	1.138	1.138	1.074	0.907	0.883	0.865	0.749
		123	10	Br-D-28	17.0 - 17.5	1.257	1.257	0.618	0.554	0.448	0.379	0.354
		124	11	Br-D-28	23.5 - 24.0	1.134	1.134	1.614	1.471	1.389	1.374	1.360
		125	12	Br-D-28	27.0 - 27.5	0.520	0.520	0.622	0.640	0.464	0.460	0.439
		126	13	Br-D-28	38.0 - 38.5	2.124	2.124	2.861	2.363	2.073	2.017	1.813
		129	356	Br-D-29	16.0 - 16.5	0.628	0.628	0.599	0.490	0.449	0.427	
		130	357	Br-D-29	30.0 - 30.5	0.961	0.961	1.281	1.169	1.084	1.070	1.028
	Average		**$cm^2/sx10^{-3}$**			**1.109**	**1.109**	**1.238**	**1.085**	**0.970**	**0.942**	**0.957**
			cm^2/day			**96**	**96**	**107**	**94**	**84**	**81**	**83**

CAN THO BRIDGE CONSTRUCTION
Unit Weght of C1, C2 Layer

Segment	Layer name	No	Borehole symbol	Laboratory No	Sample depth	Soil Name (ASTM D2487-83)	Water content W	Unit weight g
					m		%	kN/m^3
1	C1 - U	1	Br-D-1	801	2.0 - 3.0	CL : Lean CLAY	53.4	16.00
	C1 - U	2	Br-D-1	802	9.0 - 9.5	CH : Fat CLAY	45.9	15.70
	C1 - U	6	Br-D-2	66	3.0 - 4.0	CL : Sandy CLAY	52.4	16.20
	C1 - U	7	Br-D-2	67	8.0 - 9.0	CH : Fat CLAY	58.5	16.20
	C1 - U	18	Br-D-4	191	1.0 - 2.0	CH : Fat CLAY	56.9	16.20
	C1 - U	23	Br-D-5	971	3.0 - 4.0	CH : Fat CLAY	60.8	16.10
	C1 - U	24	Br-D-5	972	10.5 - 11.5	CH : Fat CLAY	57.1	16.20
	C1 - U	34	Br-D-7	859	5.0 - 6.0	CH : Fat CLAY	68.7	15.40
	C1 - U	35	Br-D-7	860	8.0 - 9.0	CH : Fat CLAY	65.7	15.40
	C1 - U	37	Br-D-8	806	3.0 - 3.5	CL : Sandy CLAY	42.0	15.80
	Average						**56.1**	**15.90**
	C1 - L	3	Br-D-1	803	19.0 - 20.0	CL : Lean CLAY	42.0	17.40
	C1 - L	8	Br-D-2	68	22.0 - 23.0	CL : Lean CLAY	41.4	16.90
	C1 - L	14	Br-D-3	174	15.0 - 16.0	CH : Fat CLAY	51.7	16.70
	C1 - L	15	Br-D-3	175	20.0 - 21.0	CL : Lean CLAY	38.9	17.80
	C1 - L	20	Br-D-4	193	15.0 - 16.0	CH : Fat CLAY	58.7	15.90
	C1 - L	25	Br-D-5	973	17.0 - 18.0	CH : Fat CLAY	52.2	16.30
	C1 - L	31	Br-D-6	932	17.5 - 18.5	CL : Sandy CLAY	39.7	16.60
	C1 - L	36	Br-D-7	861	18.0 - 19.0	CL : Lean CLAY	53.8	16.40
	C1 - L	39	Br-D-8	808	19.0 - 20.0	CH : Fat CLAY	54.4	16.20
	Average						**48.1**	**16.70**
	C2	9	Br-D-2	69	41.0 - 41.5	CH : Fat CLAY	41.9	17.20
	C2	26	Br-D-5	974	27.5 - 28.0	CL : Lean CLAY	37.8	17.30
	C2	27	Br-D-5	975	32.0 - 32.50	CL : Lean CLAY	37.5	17.90
	C2	32	Br-D-6	933	26.5 - 27.0	CL : Lean CLAY	43.2	16.80
	Average						**40.1**	**17.30**
3	C1 - U	111	Br-D-18	749	8.0 - 9.0	CH : Fat CLAY	69.2	15.60
	C1 - U	112	Br-D-18	750	13.0 - 14.0	CH : Fat CLAY	69.5	15.70
	C1 - U	119	Br-D-19	742	4.0 - 5.0	CH : Fat CLAY	77.4	15.20
	C1 - U	120	Br-D-19	747	12.0 - 13.0	CH : Fat CLAY	51.8	16.10
	C1 - U	124	Br-D-20	835	2.0 - 3.0	CH : Fat CLAY	73.8	15.20
	C1 - U	125	Br-D-20	836	9.0 - 10.0	CH : Fat CLAY	58.4	15.50
	C1 - U	129	Br-D-21	846	6.0 - 7.0	CH : Fat CLAY	81.8	15.00
	C1 - U	130	Br-D-21	847	11.0 - 12.0	CL : Lean CLAY	49.3	16.30
	Average						**66.4**	**15.60**
	C1 - L	113	Br-D-18	751	18.0 - 19.0	CL : Lean CLAY	40.3	16.90
	C1 - L	121	Br-D-19	744	19.0 - 20.0	CL : Lean CLAY	44.1	16.80
	C1 - L	126	Br-D-20	837	19.0 - 20.0	CL : Lean CLAY	36.4	17.20
	C1 - L	131	Br-D-21	848	19.0 - 20.0	CH : Fat CLAY	54.2	16.30
	Average						**43.8**	**16.80**
	C2	114	Br-D-18	752	39.0 - 39.5	CL : Lean CLAY	28.8	19.30
	C2	122	Br-D-19	746	30.0 - 31.0	CL : Lean CLAY	26.4	19.50
	C2	127	Br-D-20	838	28.0 - 28.5	CH : Fat CLAY	29.2	18.90
	C2	128	Br-D-20	839	40.0 - 40.50	CL : Lean CLAY	29.5	18.50
	C2	132	Br-D-21	849	24.0 - 24.5	CH : Fat CLAY	30.9	18.60
	C2	134	Br-D-21	851	41.0 - 41.5	CL : Lean CLAY	34.8	18.10
	Average						**29.9**	**18.80**

CAN THO BRIDGE CONSTRUCTION
Unit Weght of C1, C2 Layer

Segment	Layer name	No	Borehole symbol	Laboratory No	Sample depth	Soil Name	Water content	Unit weight
						(ASTM D2487-83)	W	g
					m		%	kN/m3
	C1	137	Br-D-22	372	3.0 - 4.0	MH :Elastic SILT	65.1	14.80
	C1	138	Br-D-22	373	8.0 - 9.0	CH : Fat CLAY	54.6	16.10
	C1	139	Br-D-22	374	12.0 - 13.0	CH : Fat CLAY	63.8	15.90
	C1	145	BR-D-23	26	6.0 - 7.0	CL : Sandy CLAY	42.0	15.90
	C1	155	BR-D-24	305	4.0 - 5.0	CH : Fat CLAY	64.0	15.80
	C1	156	BR-D-24	306	11.0 - 12.0	CL : Lean CLAY	57.1	16.30
	C1	164	Br-D-25	51	4.0 - 5.0	CH : Fat CLAY	74.3	15.20
	C1	172	Br-D-26	259	3.0 - 4.0	CH : Fat CLAY	80.4	14.70
	C1	173	Br-D-26	260	7.0 - 8.0	CH : Fat CLAY	69.9	15.50
	C1	174	Br-D-26	261	11.0 - 12.0	CH : Fat CLAY	77.6	15.20
	C1	177	BR-D-27	985	4.0 - 4.5	CH : Fat CLAY	51.1	16.70
	C1	185	Br-D-28	7	3.0 - 4.0	CH : Fat CLAY	79.2	14.60
	C1	187	Br-D-28	9	12.0 - 13.0	CL : Lean CLAY	46.2	16.70
	C1	194	Br-D-29	354	5.0 - 6.0	CL : Lean CLAY	49.9	16.30
	C1	195	Br-D-29	355	10.0 - 11.0	CH : Fat CLAY	60.2	14.40
	Average						**62.4**	**15.60**
	C2	63	Br-D-13	761	29.0 - 29.5	CL : Lean CLAY	38.7	17.90
	C2	64	Br-D-13	762	44.5 - 45.0	CL : Lean CLAY	34.2	17.90
	C2	47	Br-D-10	344	16.0 - 16.5	CL : Sandy CLAY	26.4	19.10
	C2	48	Br-D-10	346	33.0 - 33.5	CL : Lean CLAY	30.1	19.00
	C2	49	Br-D-10	349	47.0 - 47.5	CL : Lean CLAY	21.6	20.10
	C2	74	Br-D-14	147	16.0 - 16.5	CL : Lean CLAY	28.3	18.70
	C2	75	Br-D-14	148	22.5 - 23.0	CL : Lean CLAY	29.2	0.00
	C2	76	Br-D-14	149	28.0 - 28.5	CL : Lean CLAY	33.0	18.50
	C2	77	Br-D-14	150	40.5 - 41.0	CL : Lean CLAY	22.2	20.30
	C2	87	Br-D-15	239	20.0 - 20.5	CL : Lean CLAY	42.6	17.50
	C2	88	Br-D-15	240	25.0 - 25.5	CH : Fat CLAY.	39.9	17.70
4	C2	89	Br-D-15	241	28.0 - 28.5	CL : Lean CLAY	31.0	18.90
	C2	90	Br-D-15	242	31.5 - 32.0	CL : Lean CLAY	21.6	18.50
	C2	91	Br-D-15	243	40.0 - 40.5	CL : Lean CLAY	34.2	18.40
	C2	99	Br-D-16	367	25.5 - 26.0	MH :Elastic SILT	52.3	16.40
	C2	107	Br-D-17	286	18.0 - 19.0	CL : Lean CLAY	36.7	17.80
	C2	140	Br-D-22	375	16.0 - 16.5	CH : Fat CLAY	27.2	18.80
	C2	142	Br-D-22	377	34.0 - 34.5	ML : SILT	22.9	19.90
	C2	146	BR-D-23	27	10.0 - 11.0	CH : Fat CLAY	48.4	16.40
	C2	147	BR-D-23	28	13.5 - 14.0	CH : Fat CLAY	25.7	19.40
	C2	148	BR-D-23	29	18.0 - 18.5	CL : Lean CLAY	23.2	19.70
	C2	150	BR-D-23	30	27.5 - 28.0	CL : Lean CLAY	25.4	19.40
	C2	157	Br-D-24	307	16.0 - 16.5	CL : Lean CLAY	26.1	19.20
	C2	158	Br-D-24	308	23.5 - 24.0	CH : Fat CLAY	35.7	18.30
	C2	160	Br-D-24	310	30.0 - 30.5	CL : Lean CLAY	26.6	19.50
	C2	161	Br-D-24	311	41.2 - 41.7	CL : Lean CLAY	21.9	19.40
	C2	167	Br-D-25	54	18.0 - 18.5	CL : Lean CLAY	27.4	19.20
	C2	169	Br-D-25	56	33.0 - 33.5	CL : Lean CLAY	28.6	19.30
	C2	170	Br-D-25	57	43.0 - 43.5	CL : Lean CLAY	26.8	19.20
	C2	175	Br-D-26	262	17.0 - 17.5	CH : Fat CLAY	29.3	18.50
	C2	176	Br-D-26	263	25.0 - 25.5	CL : Lean CLAY	24.4	19.30
	C2	178	Br-D-27	986	12.5 - 13.0	CL : Lean CLAY	28.5	19.30
	C2	179	Br-D-27	987	15.0 - 15.5	CH : Fat CLAY	30.2	18.30
	C2	180	Br-D-27	988	19.0 - 19.5	CH : Fat CLAY	34.7	18.10
	C2	181	Br-D-27	989	23.5 - 24.0	CL : Lean CLAY	26.5	19.60
	C2	182	Br-D-27	990	28.0 - 28.5	CL : Sandy CLAY	26.3	18.80
	C2	188	Br-D-28	10	17.0 - 17.5	CH : Fat CLAY	32.3	18.50
	C2	196	Br-D-29	356	16.0 - 16.5	CL : Lean CLAY	26.1	19.40
	C2	197	Br-D-29	357	30.0 - 30.5	CL : Lean CLAY	25.5	19.70
	Average						**28.2**	**19.00**

Segment	Name of Layer	Bor, No.	Depth of Sand Layer m	Remarks	Average of Sand Layer
1	C1-U	Br-D-4	7.5		2
		Br-D-5	4.5		
		Br-D-5	5.5		
		Br-D-5	9.5		
		Br-D-6	5.5		
		Br-D-6	10.5		
		Br-D-7	8.5		
		Br-D-7	10.0		
		Br-D-7	14.0		
		Br-D-8	11.0		
		Br-D-8	14.0		
		Br-D-9	9.5		
		Br-D-9	15.0		
	C1-L	Br-D-4	28.0	Bottom of Layer	1
		Br-D-7	18.5		
		Br-D-7	20.0		
		Br-D-8	17.5		
		Br-D-8	24.0		
		Br-D-8	31.0		
		Br-D-9	17.5		
		Br-D-9	33.5		
	C2	Br-D-1	30.0		2
		Br-D-1	49.0	Bottom of Layer	
		Br-D-5	28.0		
		Br-D-5	49.0		
		Br-D-6	28.5		
		Br-D-6	31.5		
		Br-D-7	38.0		
		Br-D-7	41.4	Thickness =1.1m	
		Br-D-8	37.0		
		Br-D-8	46.5		
		Br-D-9	37.0		
		Br-D-9	43.5		
		Br-D-9	45.0		
		Br-D-9	47.5		
3		Br-D-19	16.0		0
4	C1	Br-D-23	6.5		1
		Br-D-23	9.5		
		Br-D-24	11.5		
		Br-D-24	13.5		
		Br-D-24	15.0		
		Br-D-25	9.5		
		Br-D-25	12.5		
		Br-D-26	13.5		
		Br-D-28	9.5		

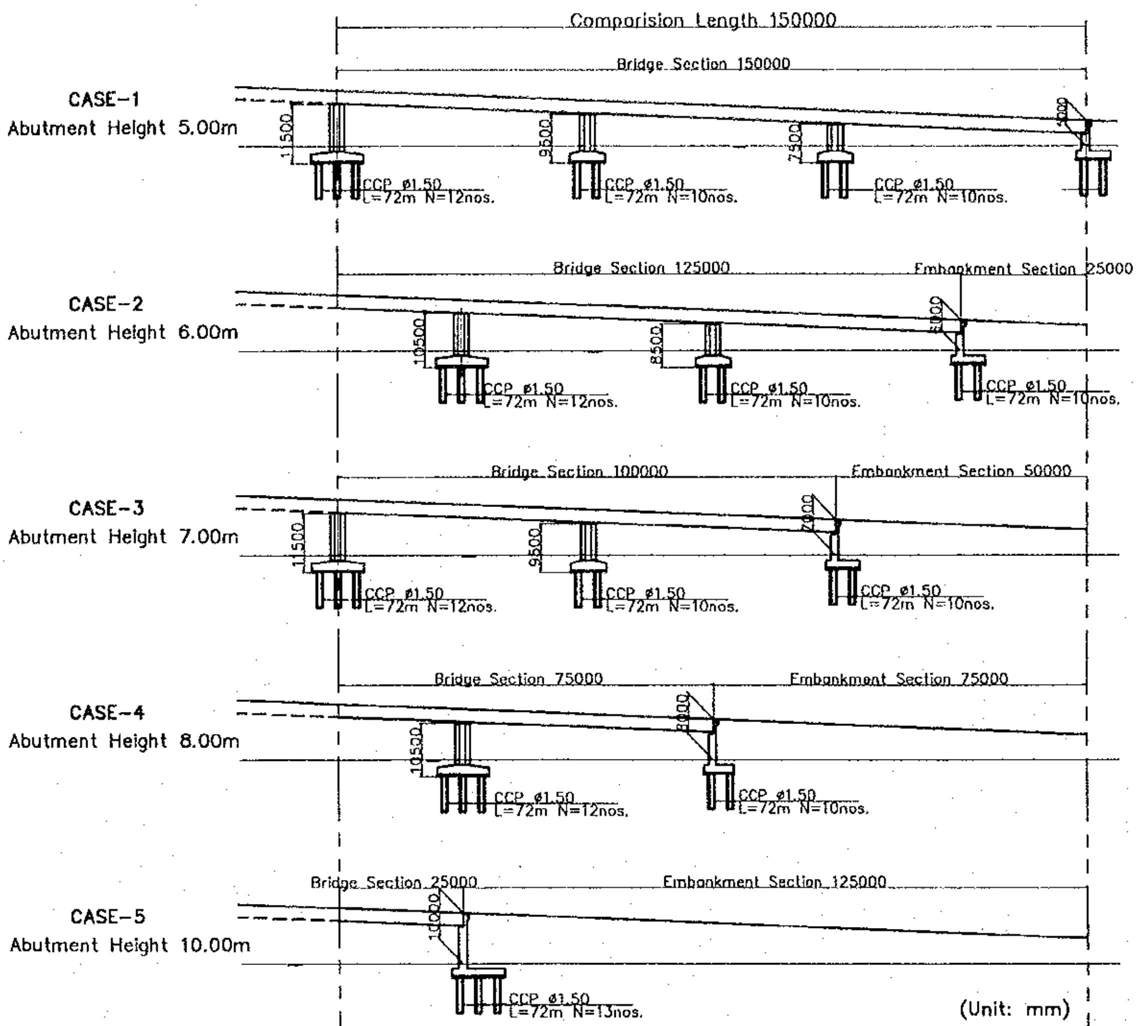
Appendix-2: Cost Comparison of Embankment Height

Cost Estimate for Study of Abutment Height

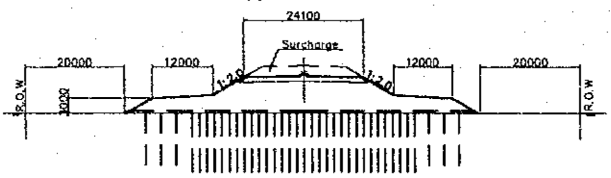
	ITEM	SPECIFICATION		UNIT	UNIT PRICE	Case-1		Case-2		Case-3		Case-4		Case-5		Case-6	
						Abutment Height	= 5 m	Abutment Height	= 6 m	Abutment Height	= 7 m	Abutment Height	= 8 m	Abutment Height	= 9 m	Abutment Height	= 10 m
					US$	QUANTITY	TOTAL COST	QUANTITY	TOTAL COST	QUANTITY	TOTAL COST	QUANTITY	TOTAL COST	QUANTITY	TOTAL COST	QUANTITY	TOTAL COST
1	**Foundation**	CCP Dia.1.5m	L=72m	Pile	18,924	36	**681,264**	32	**605,568**	26	**492,024**	22	**416,328**		**331,170**	13	**246,012**
2	**Substruncure**	Abutment	H=7.5m	Each	48,941	1	48,941										
			H=8.5m	Each	53,854			1	53,854								
			H=9.5m	Each	58,775					1	58,775						
			H=10.5m	Each	63,641							1	63,641				
			H=12.5m	Each	96,602											1	96,602
		Pier	H=7.5m	Each	37,580	1	37,580										
			H=8.5m	Each	39,509			1	39,509								
			H=9.5m	Each	41,437	1	41,437			1	41,437						
			H=10.5m	Each	54,855			1	54,855			1	54,855				
			H=11.5m	Each	56,666	0.5	28,333			0.5	28,333						
		Sub -Total					**156,291**		**148,218**		**128,545**		**118,496**		**107,549**		**96,602**
3	**Superstructure**	PC Box		m	22,258	150	3,338,700	125	2,782,250	100	2,225,800	75	1,669,350			25	556,450
		Pavement		m2	28	3,075	86,100	2,563	71,750	2,050	57,400	1,538	43,050			513	14,350
		Road Miscellaneous		m	106	150	15,900	125	13,250	100	10,600	75	7,950			25	2,650
		Sub -Total					**3,440,700**		**2,867,250**		**2,293,800**		**1,720,350**		**1,146,900**		**573,450**
4	**Earth Work**	PVD		100m	1,223	0	0	448	548,392	929	1,136,329	1,442	1,763,825			2,565	3,137,456
		Embankment		100m3	53	0	0	103	5,466	229	12,160	380	20,156			761	40,355
		Slope Protection		m2	44	0	0	285	12,540	620	27,280	1,005	44,220			1,925	84,700
		Pavement		m2	29	0	0	578	16,762	1,155	33,495	1,733	50,257			2,888	83,752
		Road Miscellaneous		m	106	0	0	25	2,650	50	5,300	75	7,950			125	13,250
		Sub -Total					0		**585,810**		**1,214,565**		**1,886,409**		**2,622,961**		**3,359,513**
5	**Compensation**	For bridge		m2	3.8	7,548	28,682	6,290	23,902	5,032	19,122	3,774	14,341		9,561	1,258	4,780
		For Highway		m2	3.8	1,887	7,171	4,240	16,112	6,693	25,433	9,246	35,135		45,406	14,652	55,678
		Sub -Total					**35,853**		**40,014**		**44,555**		**49,476**		**54,967**		60,458
	Total				US$		**4,314,108**		**4,246,860**		**4,173,489**		**4,191,059**		**4,263,547**		**4,336,035**
					1000US$/m		**28.76**		**28.31**		**27.82**		**27.94**		**28.42**		**28.91**

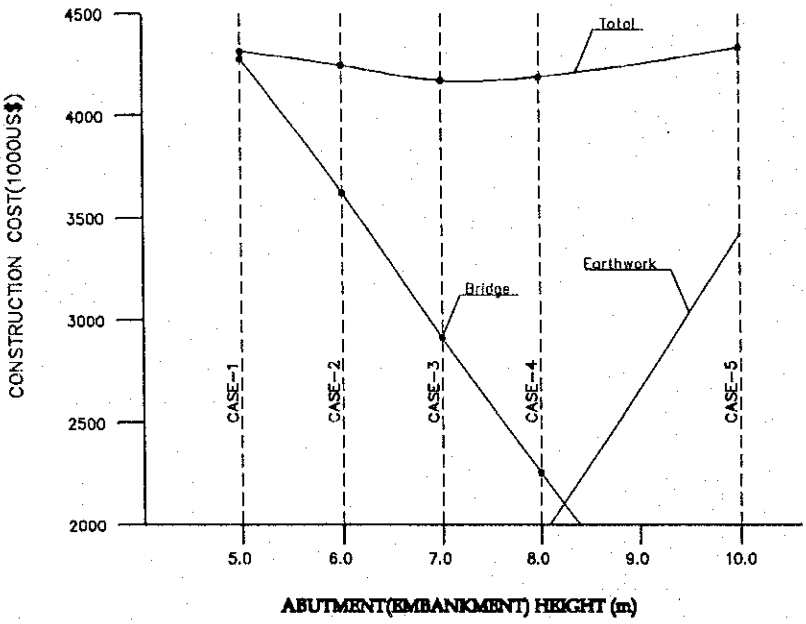
Embankment include Drainage Blanket,Surcharge and Subgrade.

Road Miscellaneous include Concrete Kerb, Median, Railing and Guard Railing.



Approach Road

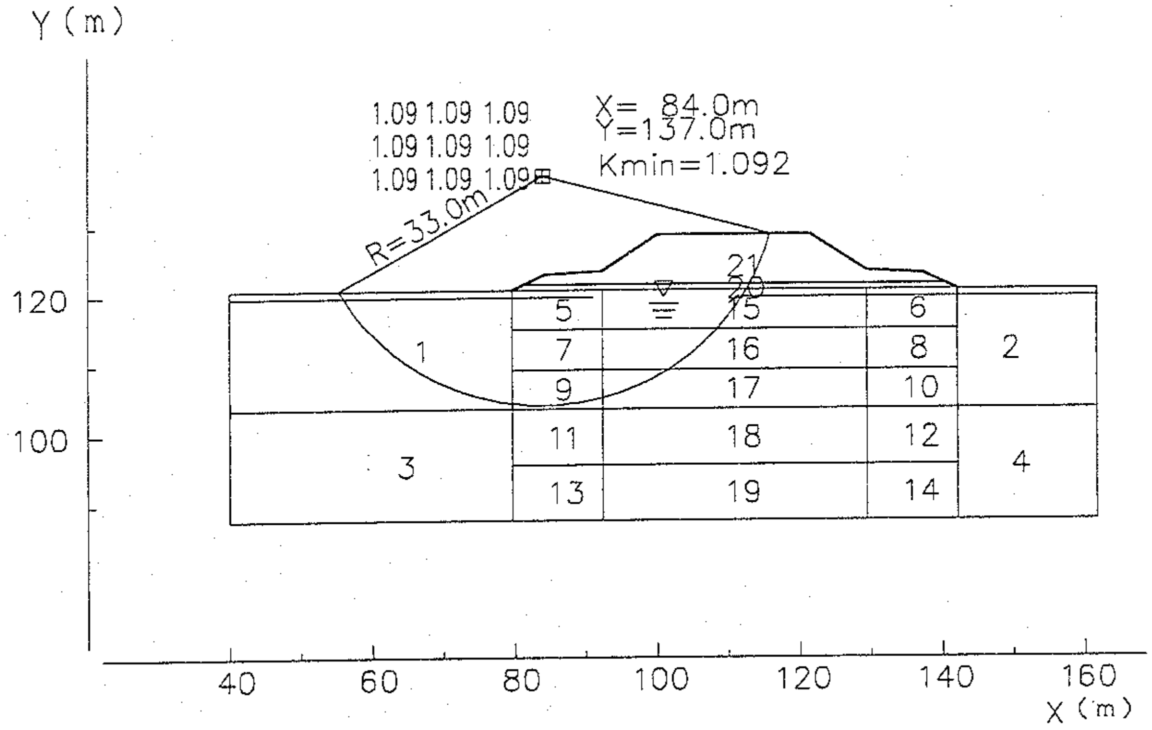




Appendix-3: Study of Counter Berm Form

Style of Counter Berm H=6m B=8m Segment 1

S= 1: 1000

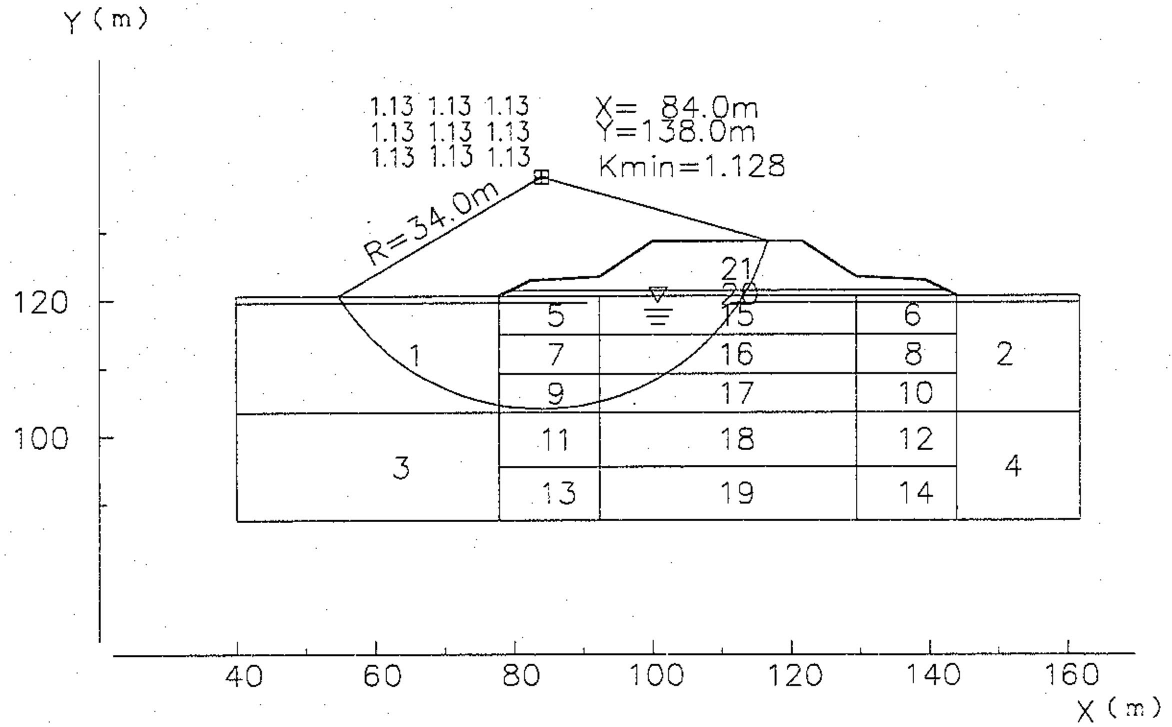


CHARACTERISTIC VALUE

Layer Number	Satureted Density kN/m³	Wet Density kN/m³	Internal Friction Angle	Coheison kN/m²
1	16.90	15.90	4.00	7.0
2	16.90	15.90	4.00	7.0
3	17.70	16.70	6.00	8.0
4	17.70	16.70	6.00	8.0
5	16.90	15.90	4.00	15.0
6	16.90	15.90	4.00	15.0
7	16.90	15.90	4.00	15.0
8	16.90	15.90	4.00	15.0
9	16.90	15.90	4.00	14.0
10	16.90	15.90	4.00	14.0
11	17.70	16.70	6.00	14.0
12	17.70	16.70	6.00	14.0
13	17.70	16.70	6.00	14.0
14	17.70	16.70	6.00	14.0
15	16.90	15.90	4.00	39.0
16	16.90	15.90	4.00	35.0
17	16.90	15.90	4.00	32.0
18	17.70	16.70	6.00	28.0
19	17.70	16.70	6.00	25.0
20	19.60	18.60	30.00	20.0
21	19.30	18.30	30.00	14.0

Style of Counter Berm H=6m B=10m Segment 1

S: = 1:1000

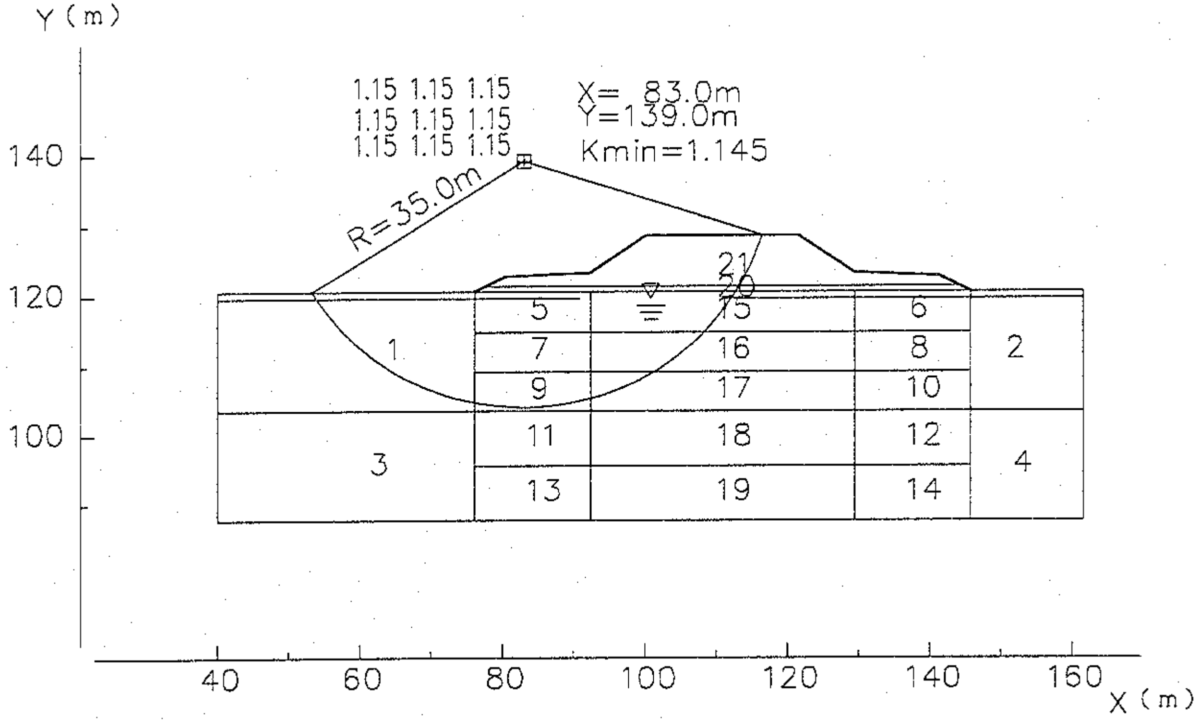


CHARACTERISTIC VALUE

Layer Number	Satureted Density kN/m³	Wet Density kN/m³	Internal Friction Angle	Coheison kN/m²
1	16.90	15.90	4.00	7.0
2	16.90	15.90	4.00	7.0
3	17.70	16.70	6.00	8.0
4	17.70	16.70	6.00	8.0
5	16.90	15.90	4.00	15.0
6	16.90	15.90	4.00	15.0
7	16.90	15.90	4.00	15.0
8	16.90	15.90	4.00	15.0
9	16.90	15.90	4.00	15.0
10	16.90	15.90	4.00	15.0
11	17.70	16.70	6.00	14.0
12	17.70	16.70	6.00	14.0
13	17.70	16.70	6.00	14.0
14	17.70	16.70	6.00	14.0
15	16.90	15.90	4.00	40.0
16	16.90	15.90	4.00	36.0
17	16.90	15.90	4.00	33.0
18	17.70	16.70	6.00	28.0
19	17.70	16.70	6.00	25.0
20	19.60	18.60	30.00	20.0
21	19.30	18.30	30.00	14.0

Style of Counter Berm H=6m B=12m Segment 1

S:1/1000

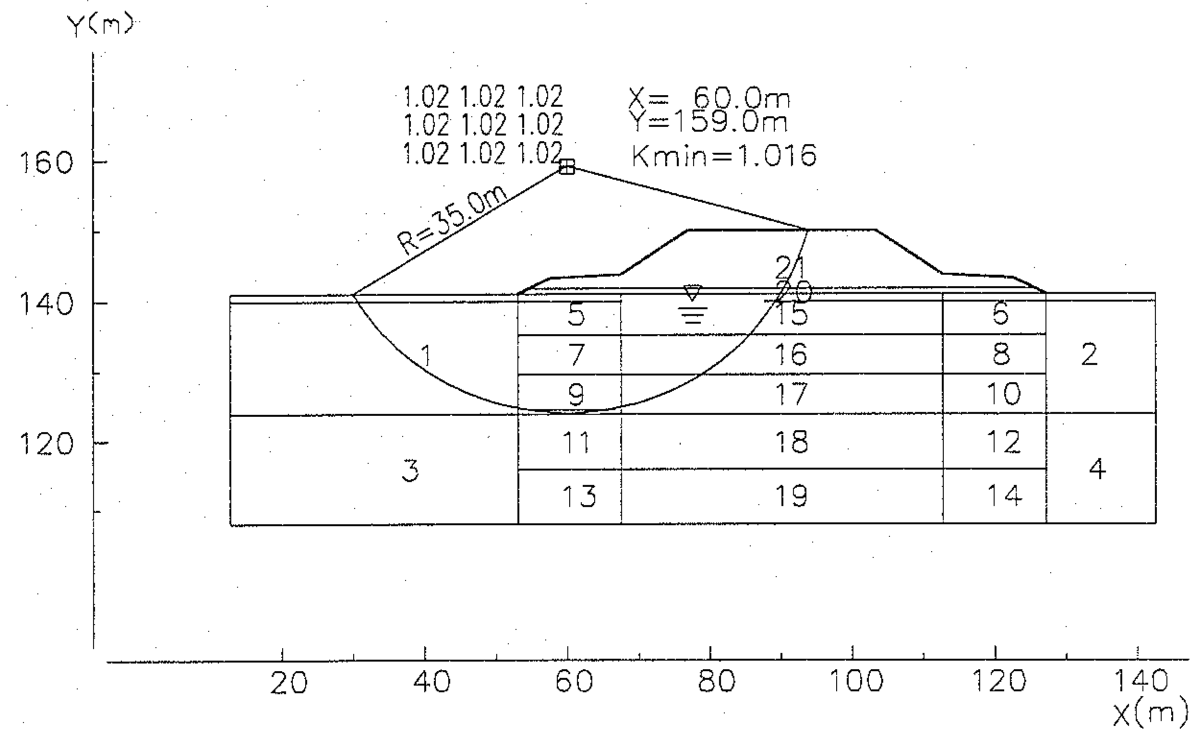


CHARACTERISTIC VALUE

Layer Number	Scturated Density kN/m³	Wet Density kN/m³	Internal Friction Angle	Cohesion kN/m²
1	16.90	15.90	4.00	7.0
2	16.90	15.90	4.00	7.0
3	17.70	16.70	6.00	8.0
4	17.70	16.70	6.00	8.0
5	16.90	15.90	4.00	15.0
6	16.90	15.90	4.00	15.0
7	16.90	15.90	4.00	15.0
8	16.90	15.90	4.00	15.0
9	16.90	15.90	4.00	15.0
10	16.90	15.90	4.00	15.0
11	17.70	16.70	6.00	14.0
12	17.70	16.70	6.00	14.0
13	17.70	16.70	6.00	14.0
14	17.70	16.70	6.00	14.0
15	16.90	15.90	4.00	40.0
16	16.90	15.90	4.00	36.0
17	16.90	15.90	4.00	33.0
18	17.70	16.70	6.00	28.0
19	17.70	16.70	6.00	26.0
20	19.60	18.60	30.00	20.0
21	19.30	18.30	30.00	14.0

Style of Counter Berm H=8m B=10m Segment 1

S= 1:1000

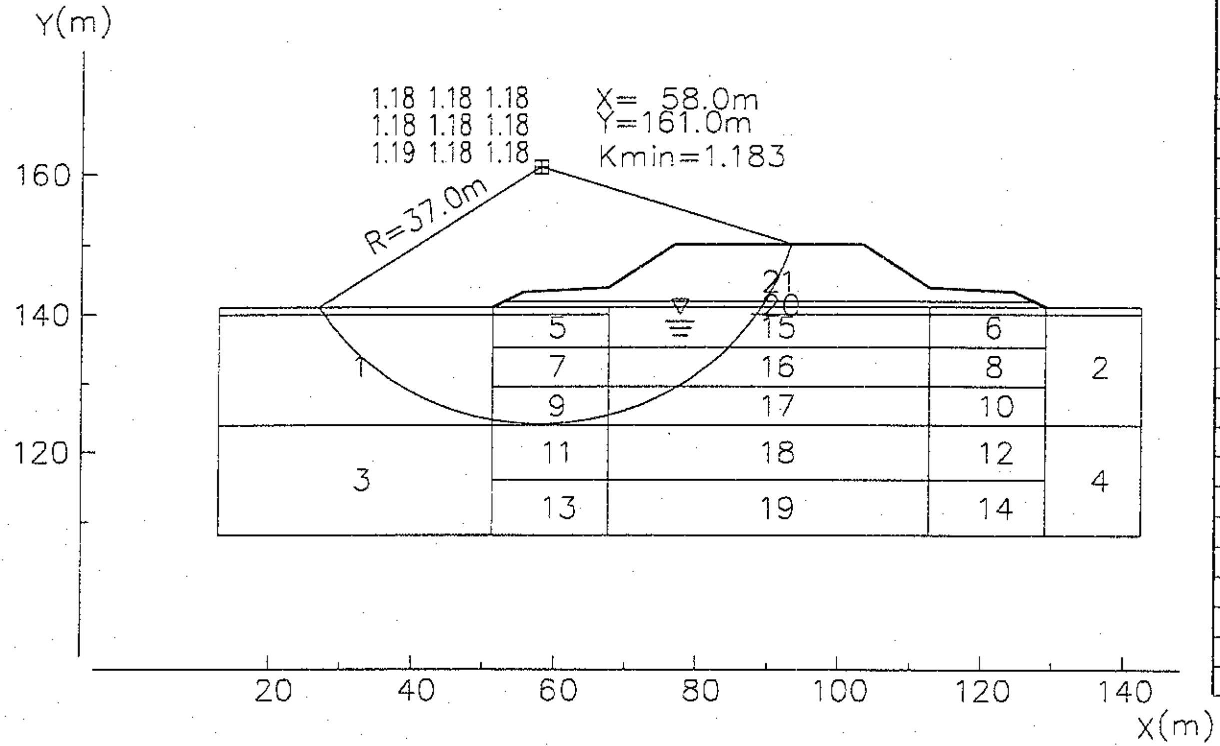


CHARACTERISTIC VALUE

Layer Number	Saturated Density kN/m³	Wet Density kN/m³	Internal Friction Angle	Cohesion kN/m²
1	16.90	15.90	4.00	7.0
2	16.90	15.90	4.00	7.0
3	17.70	16.70	6.00	8.0
4	17.70	16.70	6.00	8.0
5	16.90	15.90	4.00	16.0
6	16.90	15.90	4.00	16.0
7	16.90	15.90	4.00	16.0
8	16.90	15.90	4.00	16.0
9	16.90	15.90	4.00	17.0
10	16.90	15.90	4.00	17.0
11	17.70	16.70	6.00	16.0
12	17.70	16.70	6.00	16.0
13	17.70	16.70	6.00	16.0
14	17.70	16.70	6.00	16.0
15	16.90	15.90	4.00	39.0
16	16.90	15.90	4.00	34.0
17	16.90	15.90	4.00	30.0
18	17.70	16.70	6.00	25.0
19	17.70	16.70	6.00	22.0
20	19.60	18.60	30.00	20.0
21	19.30	18.30	30.00	14.0

Style of Counter Berm H=8m B=12m Segment 1

S= 1:1000

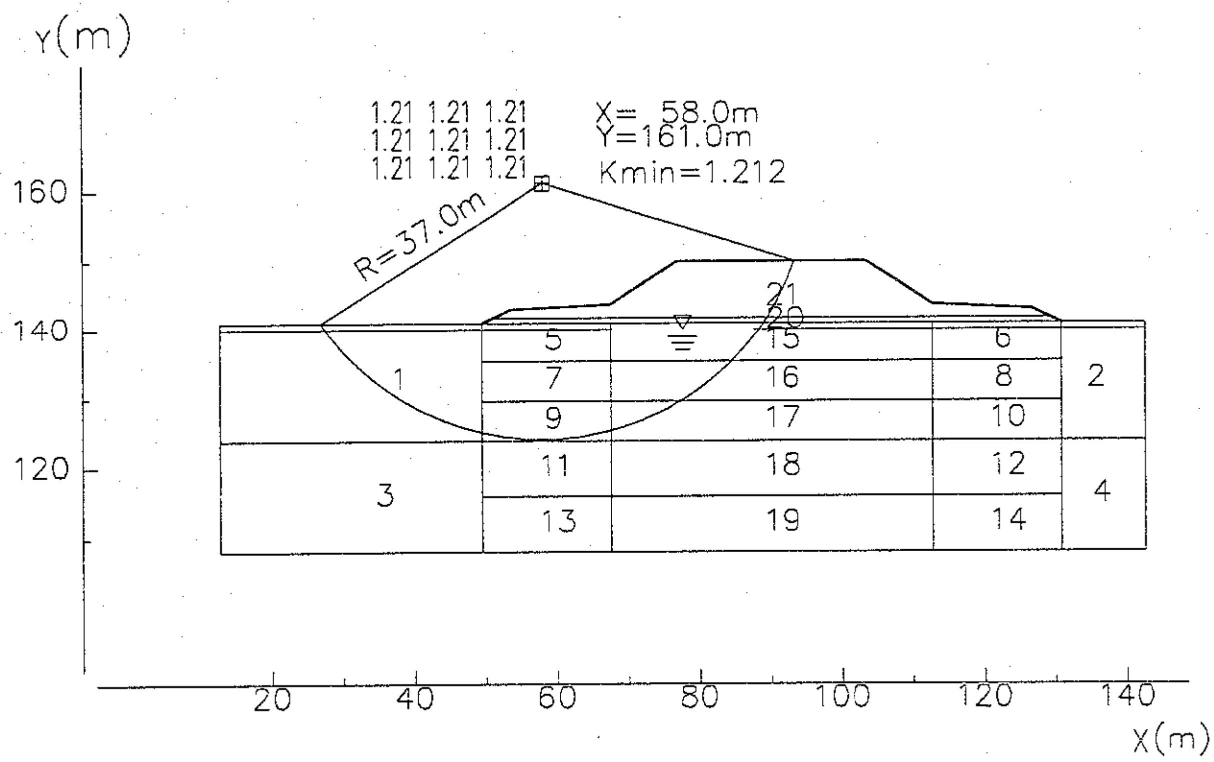


CHARACTERISTIC VALUE

Layer Number	Saturated Density kN/m3	Wet Density kN/m3	Internal Friction Angle	Cohesion kN/m2
1	16.90	15.90	4.00	7.0
2	16.90	15.90	4.00	7.0
3	17.70	16.70	6.00	8.0
4	17.70	16.70	6.00	8.0
5	16.90	15.90	4.00	16.0
6	16.90	15.90	4.00	16.0
7	16.90	15.90	4.00	16.0
8	16.90	15.90	4.00	16.0
9	16.90	15.90	4.00	16.0
10	16.90	15.90	4.00	16.0
11	17.70	16.70	6.00	16.0
12	17.70	16.70	6.00	16.0
13	17.70	16.70	6.00	16.0
14	17.70	16.70	6.00	16.0
15	16.90	15.90	4.00	52.0
16	16.90	15.90	4.00	48.0
17	16.90	15.90	4.00	43.0
18	17.70	16.70	6.00	41.0
19	17.70	16.70	6.00	34.0
20	19.60	18.60	30.00	20.0
21	19.30	18.30	30.00	14.0

Style of Counter Berm H=8m B=14m Segment 1

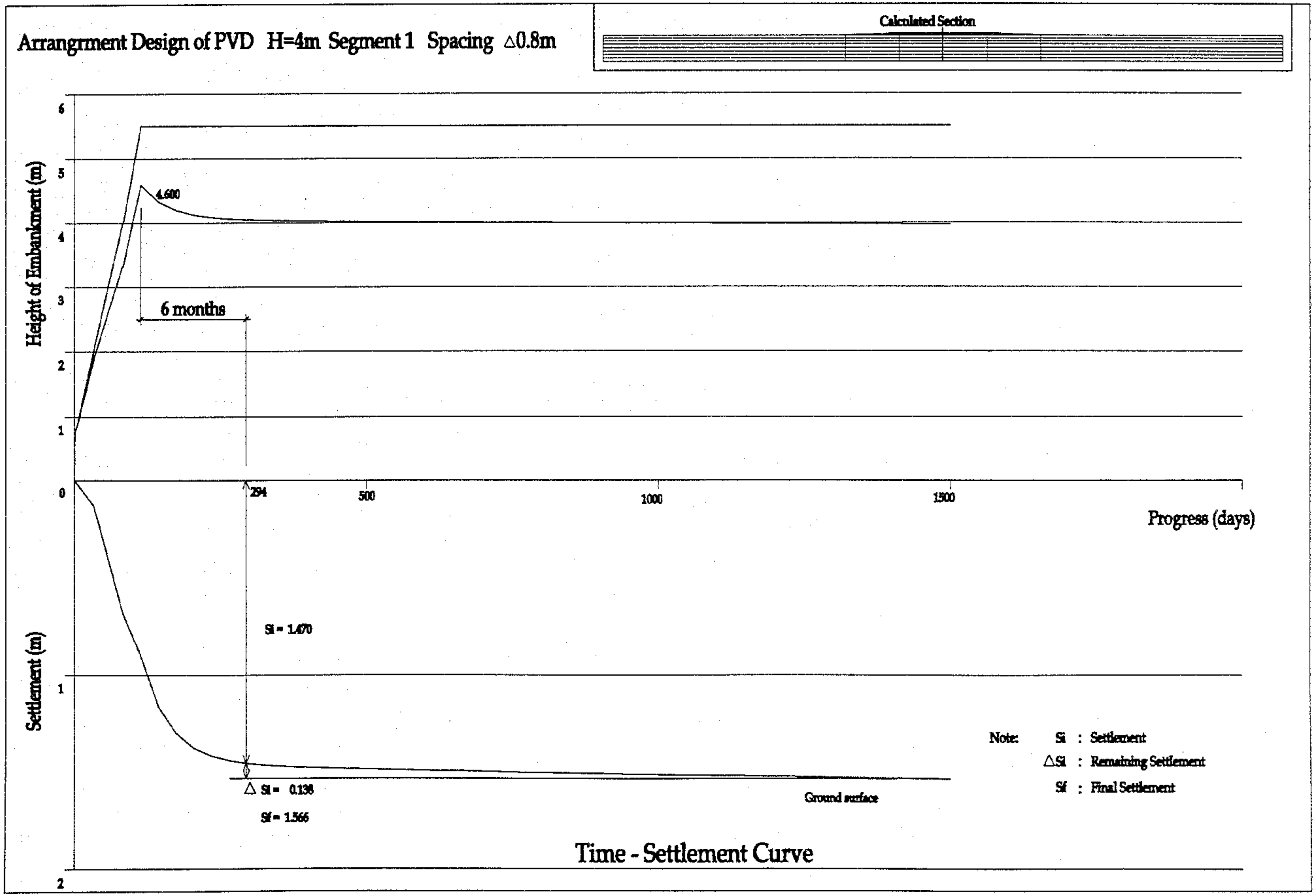
S= 1:1000



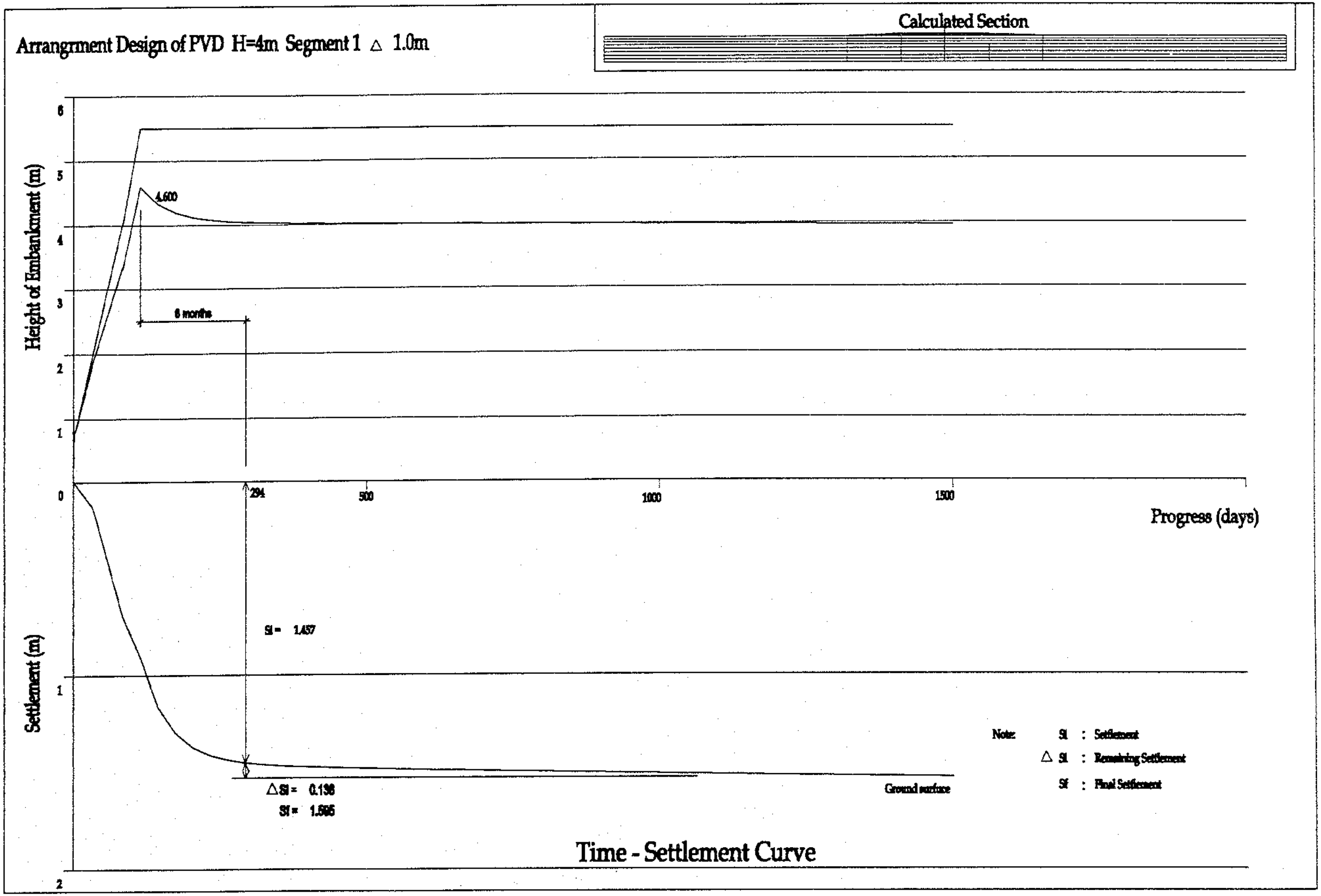
CHARACTERISTIC VALUE

Layer Number	Saturated Density kN/m³	Wet Density kN/m³	Internal Friction Angle	Cohesion kN/m²
1	16.90	15.90	4.00	7.0
2	16.90	15.90	4.00	7.0
3	17.70	16.70	6.00	8.0
4	17.70	16.70	6.00	8.0
5	16.90	15.90	4.00	16.0
6	16.90	15.90	4.00	16.0
7	16.90	15.90	4.00	16.0
8	16.90	15.90	4.00	16.0
9	16.90	15.90	4.00	16.0
10	16.90	15.90	4.00	16.0
11	17.70	16.70	6.00	16.0
12	17.70	16.70	6.00	16.0
13	17.70	16.70	6.00	16.0
14	17.70	16.70	6.00	16.0
15	16.90	15.90	4.00	52.0
16	16.90	15.90	4.00	48.0
17	16.90	15.90	4.00	43.0
18	17.70	16.70	6.00	38.0
19	17.70	16.70	6.00	34.0
20	19.60	18.60	30.00	20.0
21	19.30	18.30	30.00	14.0

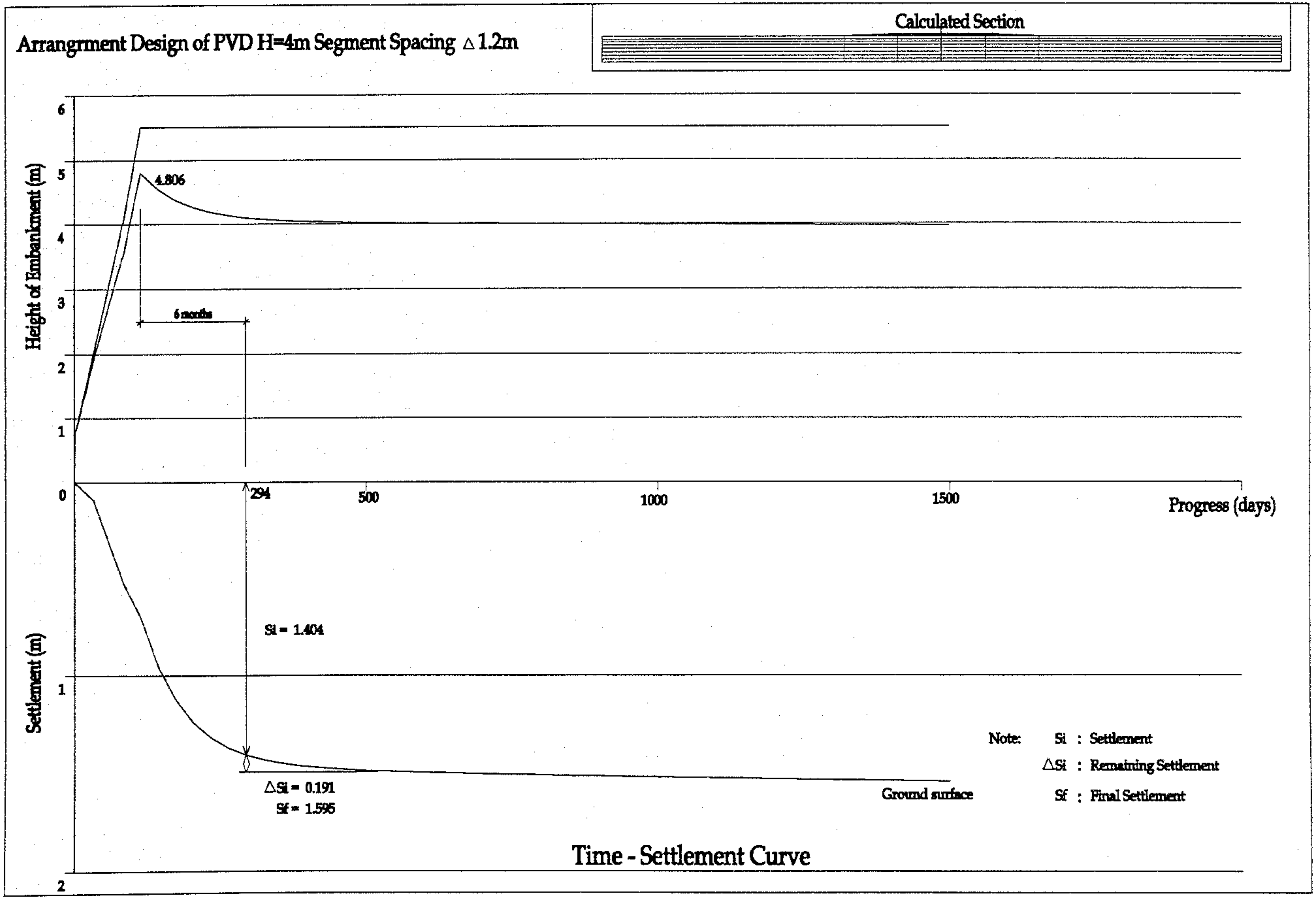
Appendix-4: Study of PVD Arrangement


Arrangrment Design of PVD H=4m Segment 1 Spacing △0.8m
Calculated Section
Height of Embankment (m)
6
5
4
3
2
1
0
4.600
6 months
294
500
1000
1500
Progress (days)
Settlement (m)
1
2
Si = 1.470
△ Si = 0.138
Sf = 1.566
Ground surface
Note: Si : Settlement
△Si : Remaining Settlement
Sf : Final Settlement
Time - Settlement Curve

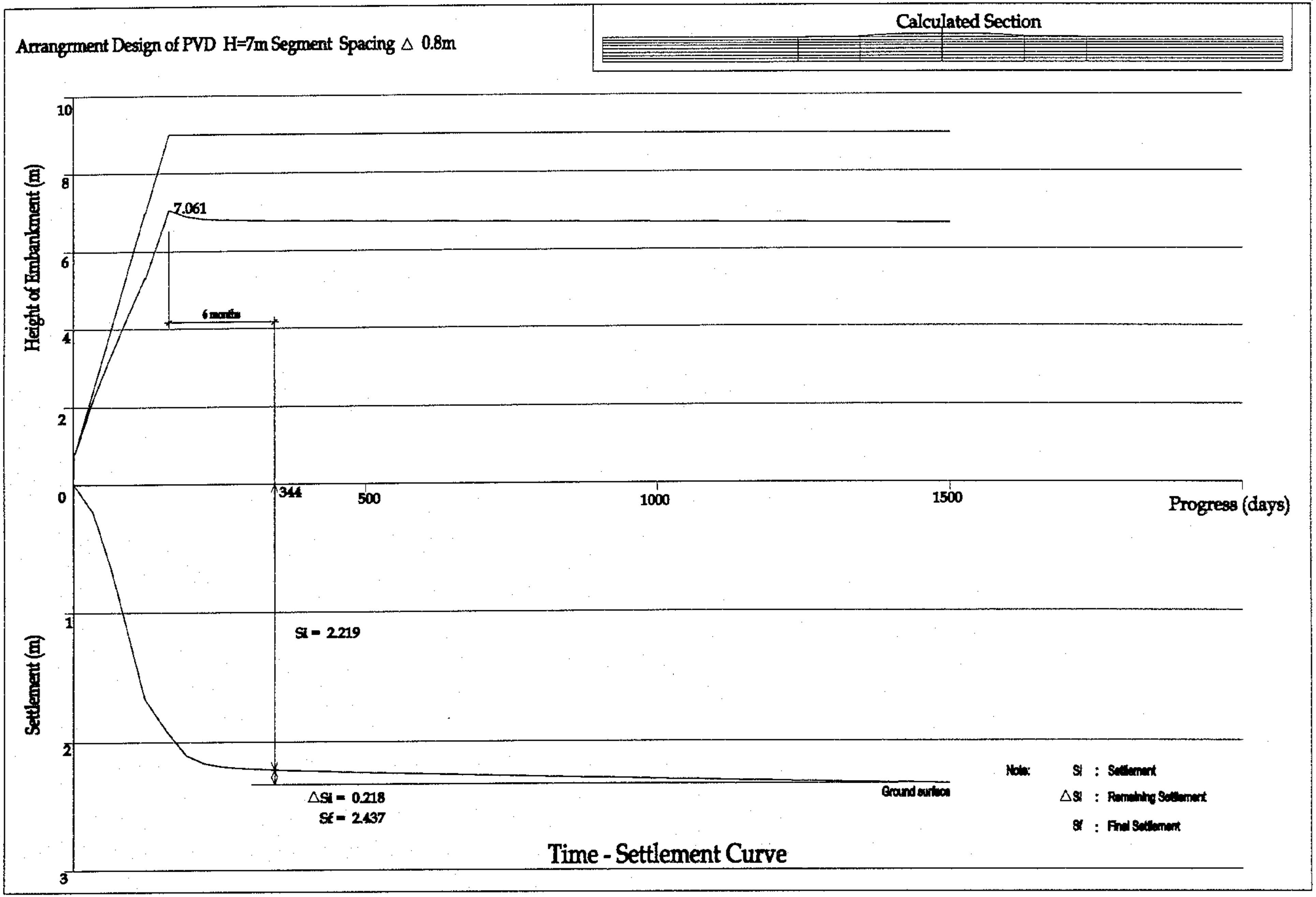
Arrangment Design of PVD H=4m Segment 1 △ 1.0m



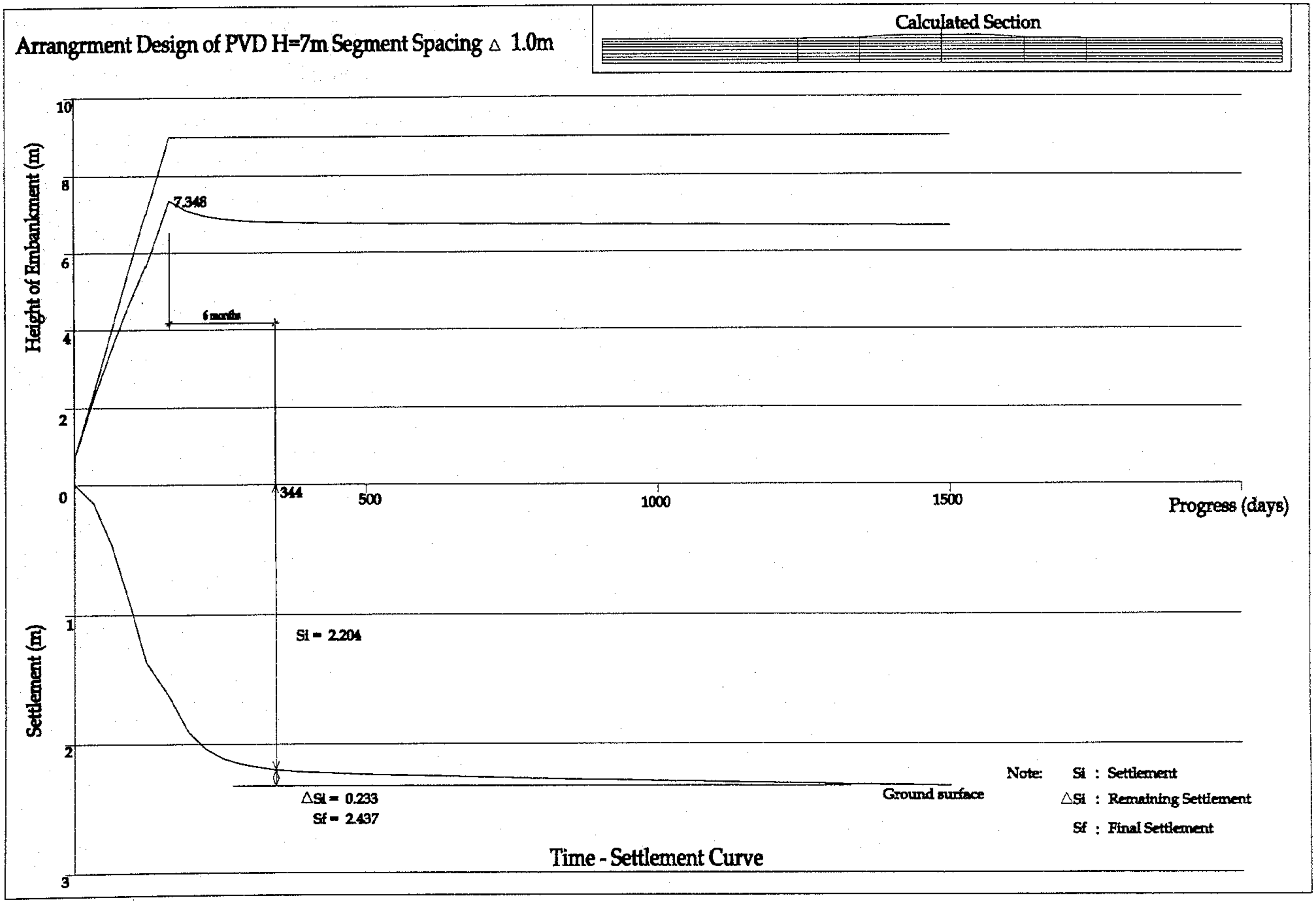
Time - Settlement Curve

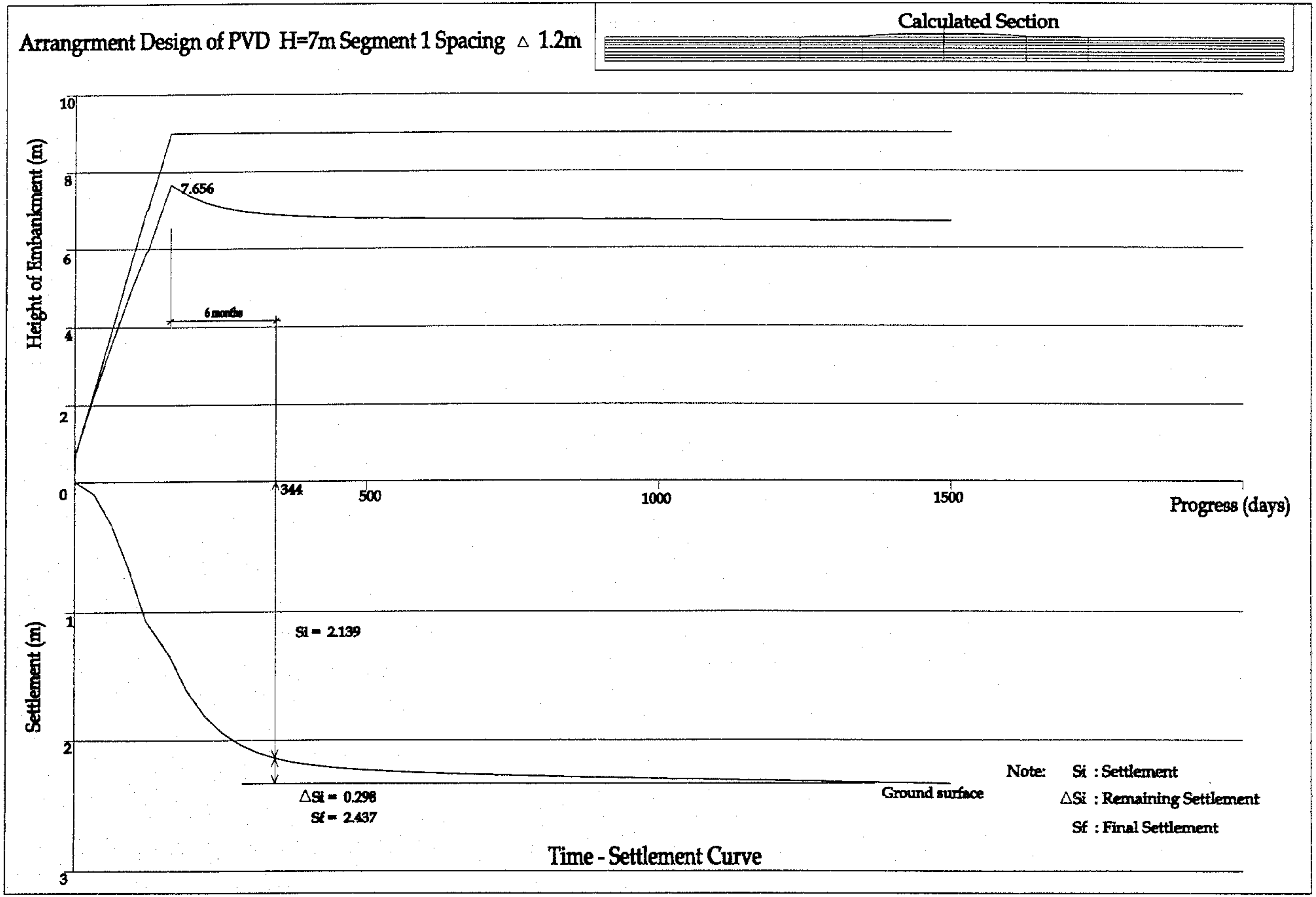

Arrangrment Design of PVD H=4m Segment Spacing △ 1.2m
Calculated Section
Height of Embankment (m)
6
5
4
3
2
1
0
4.806
6 months
294
500
1000
1500
Progress (days)
Settlement (m)
1
2
Si = 1.404
△Si = 0.191
Sf = 1.595
Ground surface
Note: Si : Settlement
△Si : Remaining Settlement
Sf : Final Settlement
Time - Settlement Curve

Arrangrment Design of PVD H=7m Segment Spacing △ 0.8m

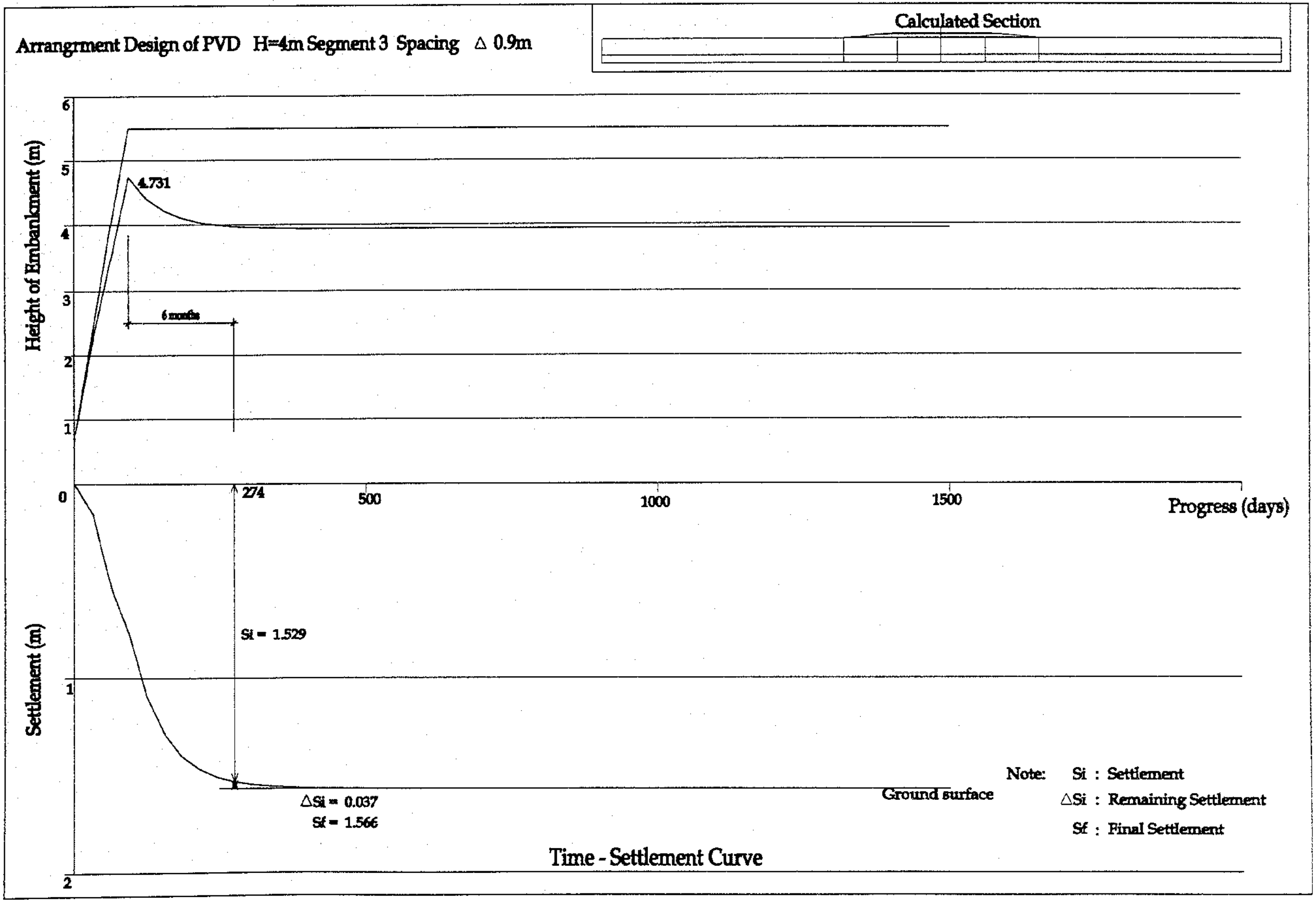


Time - Settlement Curve

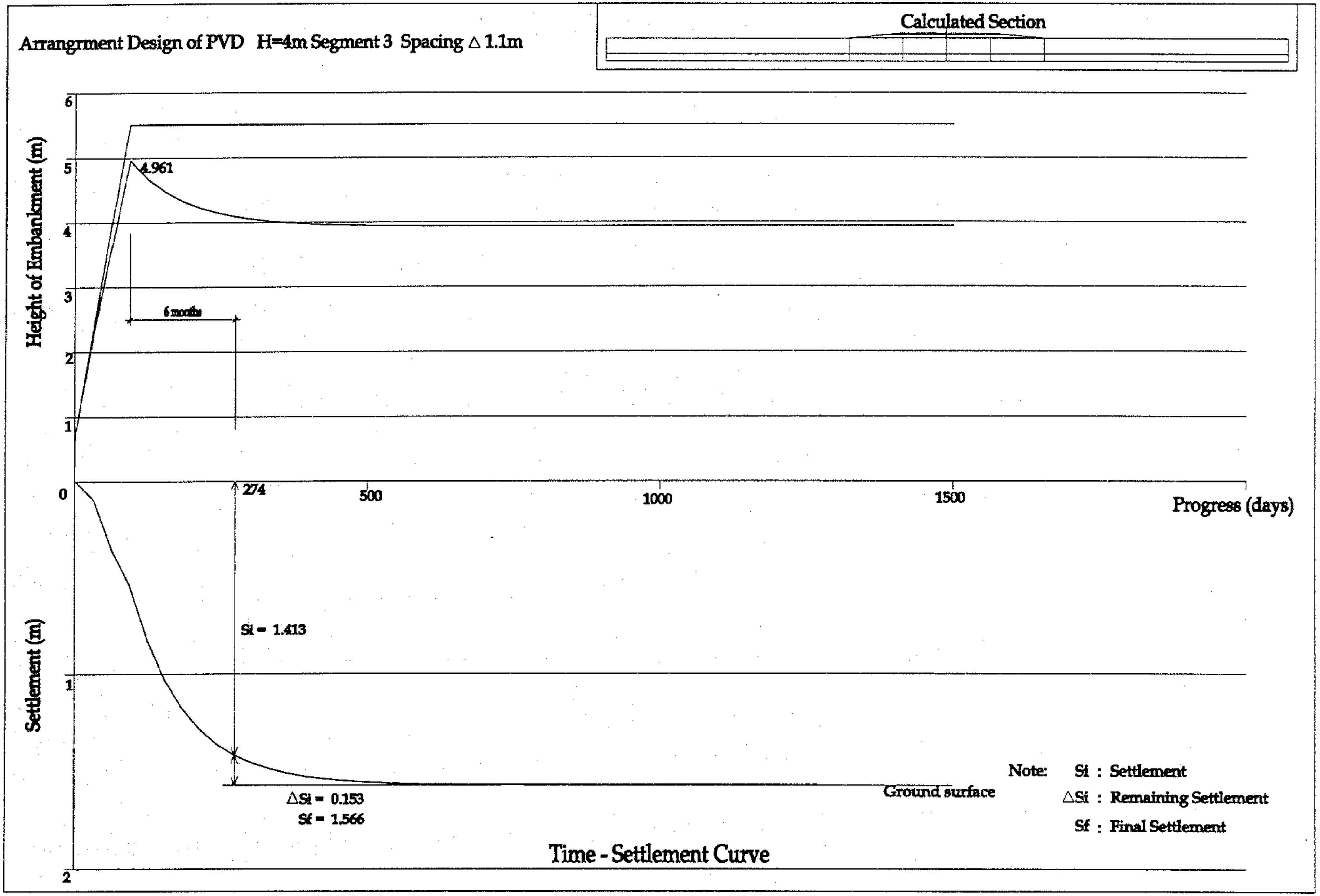

Arrangrment Design of PVD H=7m Segment Spacing △ 1.0m
Calculated Section
Height of Embankment (m)
10
8
6
4
2
0
7.348
6 months
344
500
1000
1500
Progress (days)
Settlement (m)
1
2
3
Si = 2.204
△Si = 0.233
Sf = 2.437
Ground surface
Note: Si : Settlement
△Si : Remaining Settlement
Sf : Final Settlement
Time - Settlement Curve

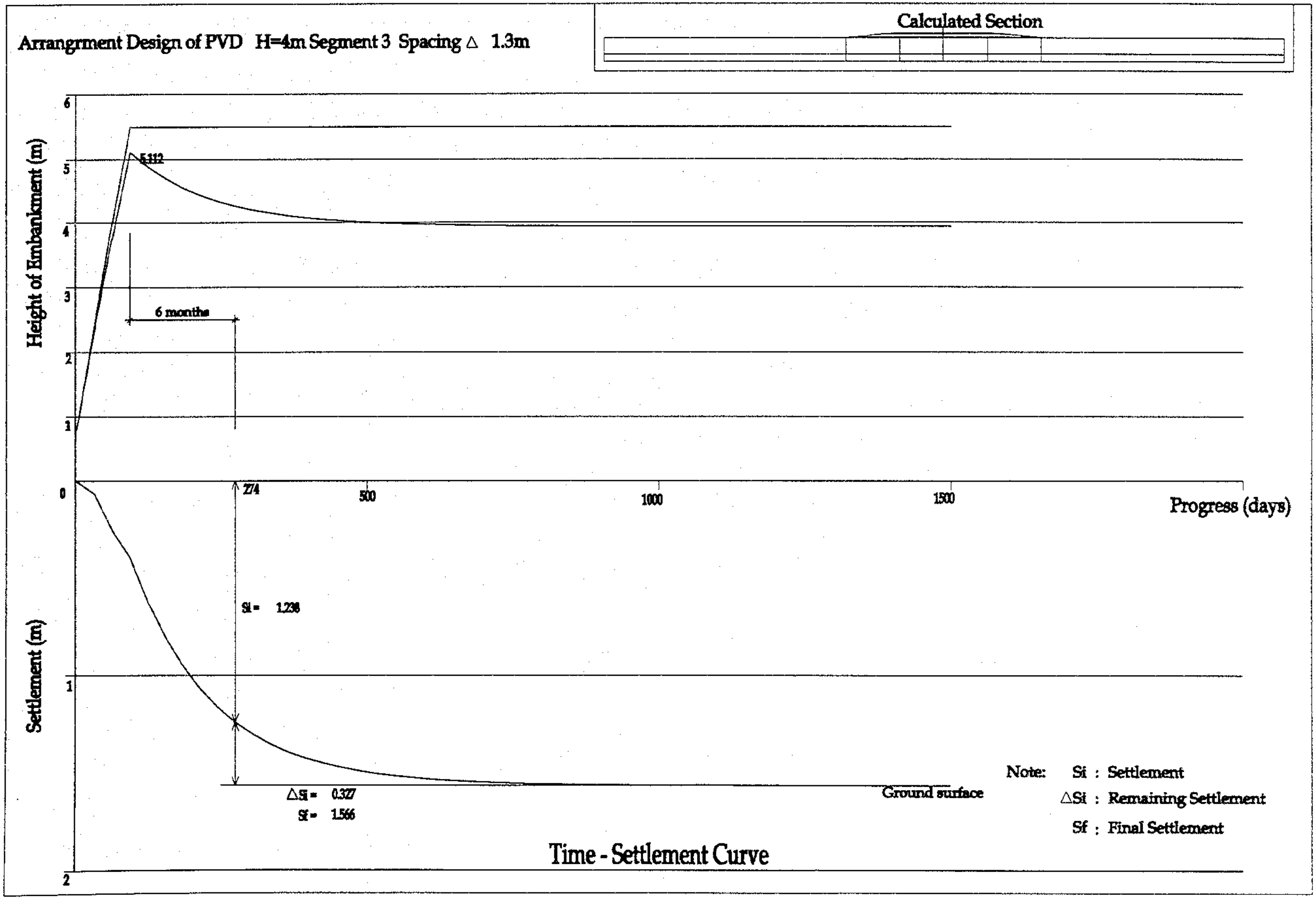

Arrangrment Design of PVD H=7m Segment 1 Spacing △ 1.2m
Calculated Section
Height of Embankment (m)
10
8
6
4
2
0
7.656
6 months
344
500
1000
1500
Progress (days)
Settlement (m)
1
2
3
Si = 2.139
ΔSi = 0.298
Sf = 2.437
Ground surface
Note: Si : Settlement
ΔSi : Remaining Settlement
Sf : Final Settlement
Time - Settlement Curve

Arrangrment Design of PVD H=4m Segment 3 Spacing △ 0.9m

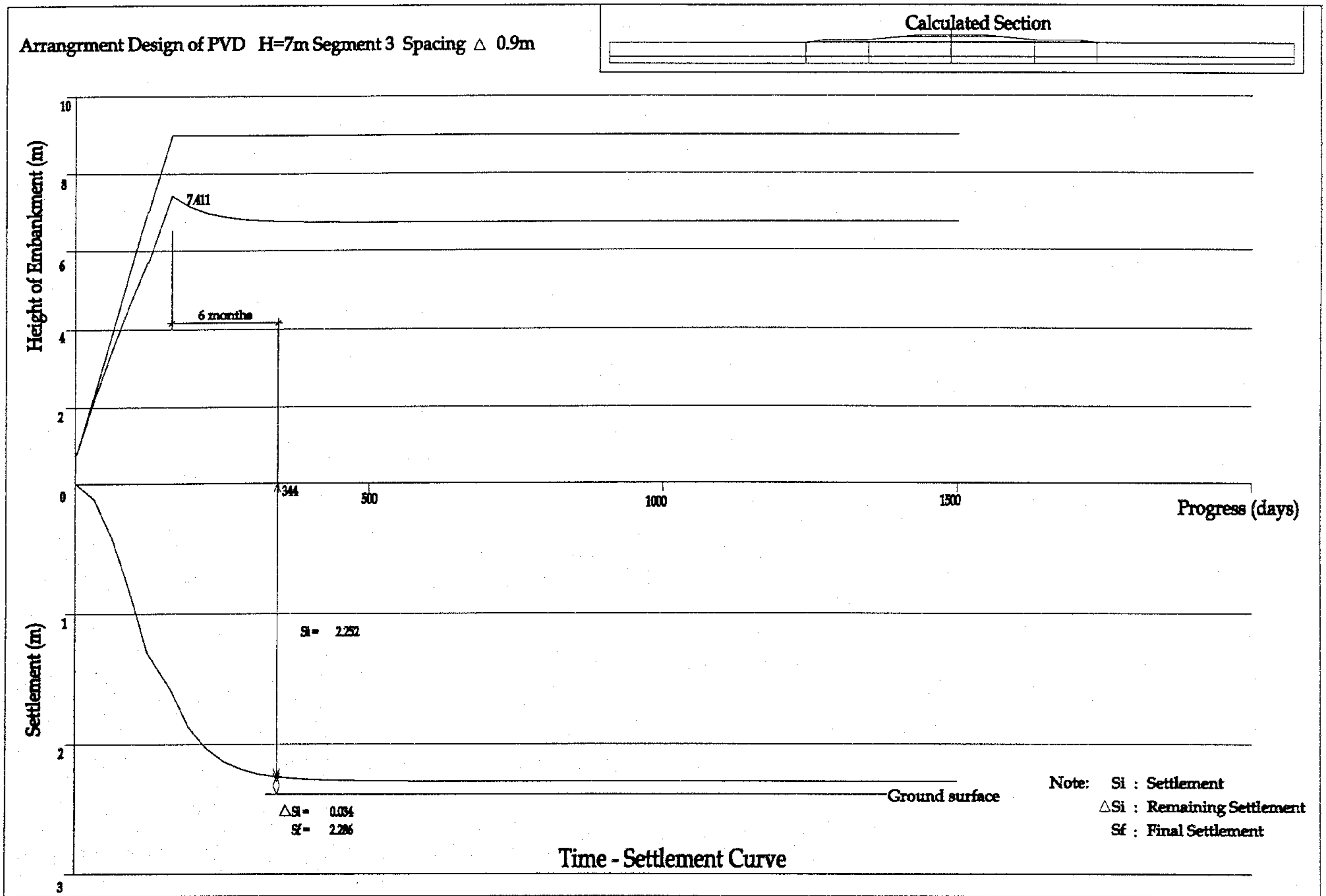


Time - Settlement Curve

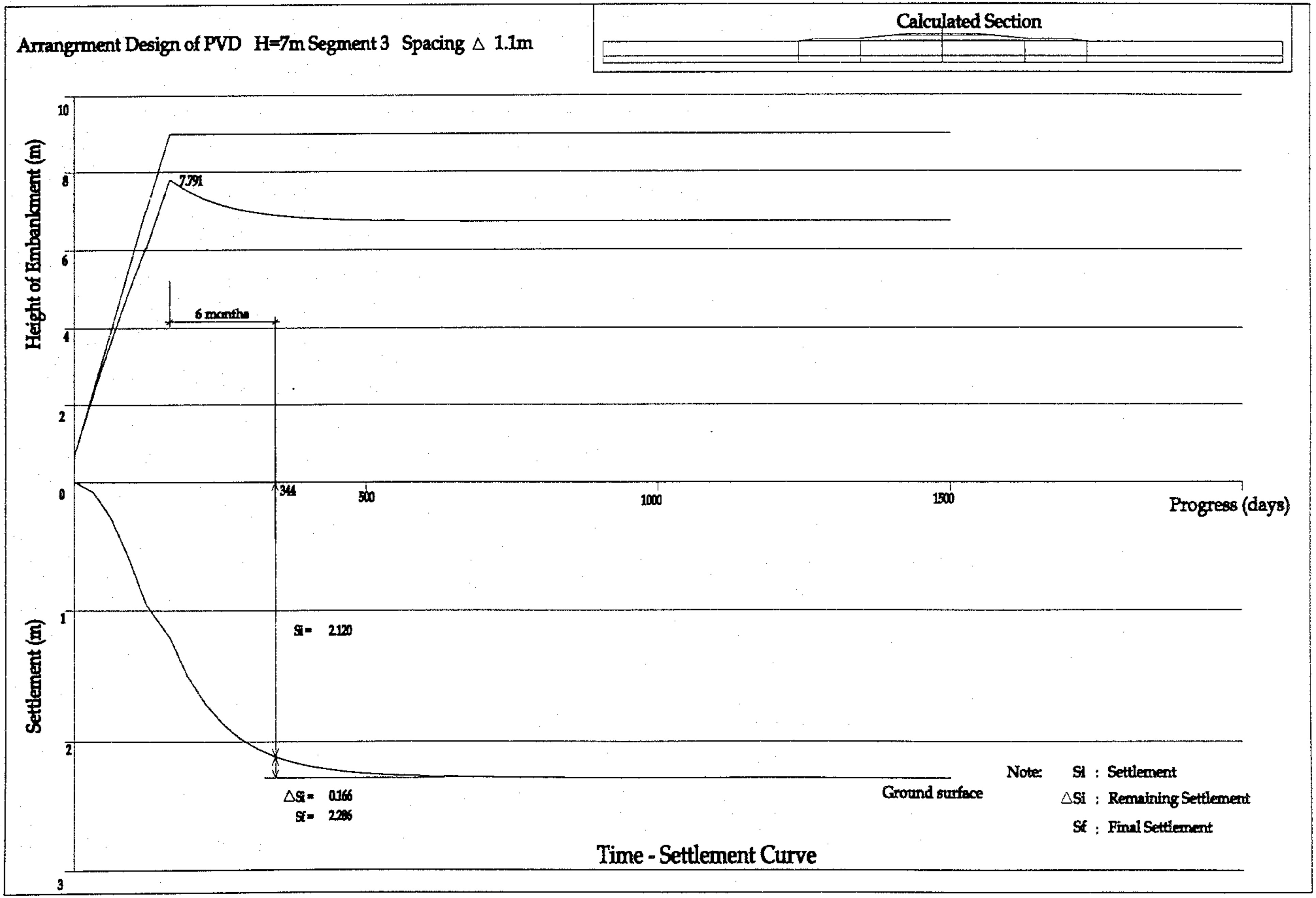

Arrangrment Design of PVD H=4m Segment 3 Spacing △ 1.1m
Calculated Section
Height of Embankment (m)
6
5
4
3
2
1
0
4.961
6 months
274
500
1000
1500
Progress (days)
Settlement (m)
1
2
Si = 1.413
ΔSi = 0.153
Sf = 1.566
Ground surface
Note: Si : Settlement
ΔSi : Remaining Settlement
Sf : Final Settlement
Time - Settlement Curve


Arrangment Design of PVD H=4m Segment 3 Spacing △ 1.3m
Calculated Section
Height of Embankment (m)
6
5
4
3
2
1
0
5.112
6 months
274
500
1000
1500
Progress (days)
Settlement (m)
1
2
Si = 1.238
ΔSi = 0.327
Sf = 1.566
Ground surface
Note: Si : Settlement
ΔSi : Remaining Settlement
Sf ; Final Settlement
Time - Settlement Curve

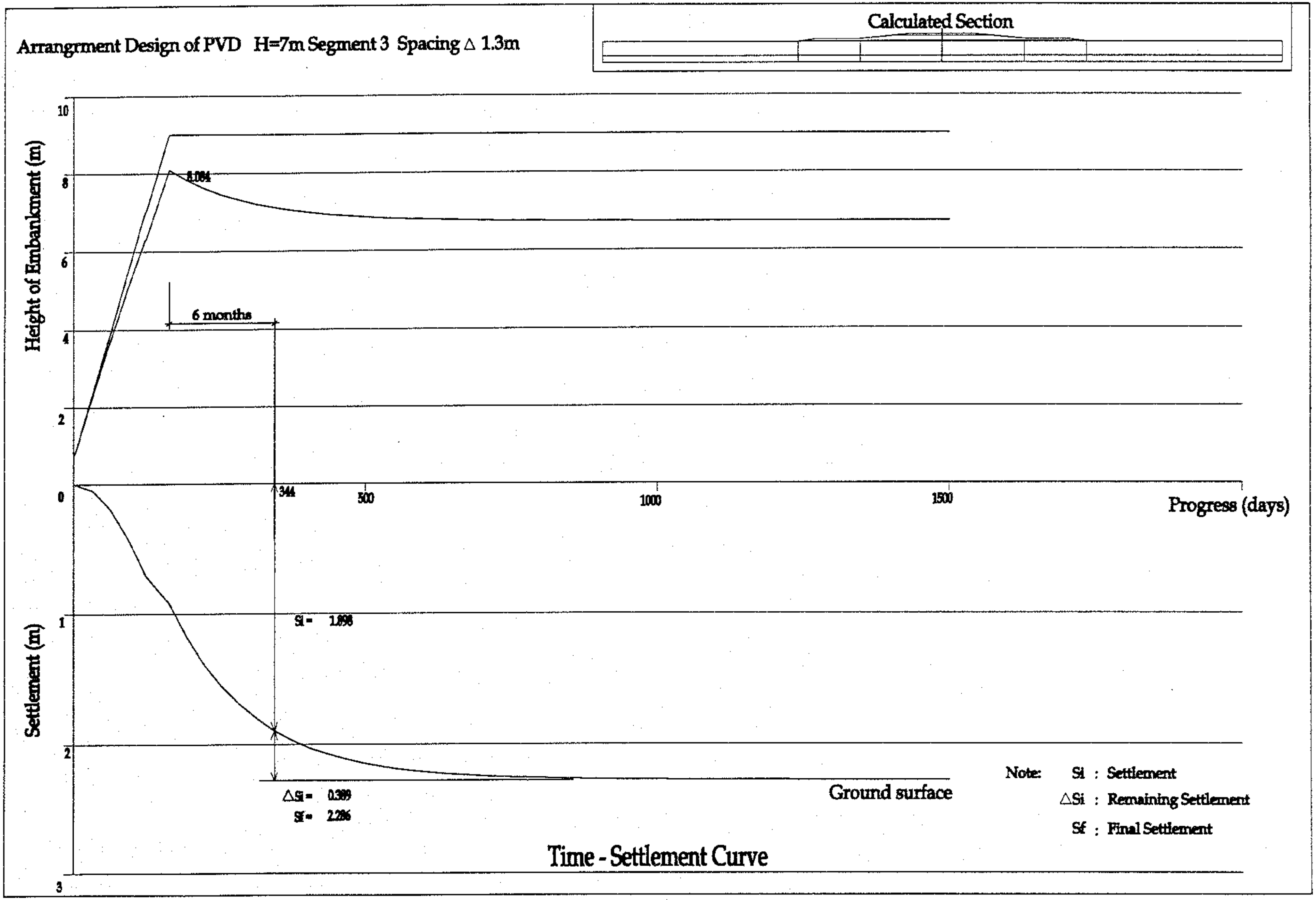
Arrangrment Design of PVD H=7m Segment 3 Spacing △ 0.9m

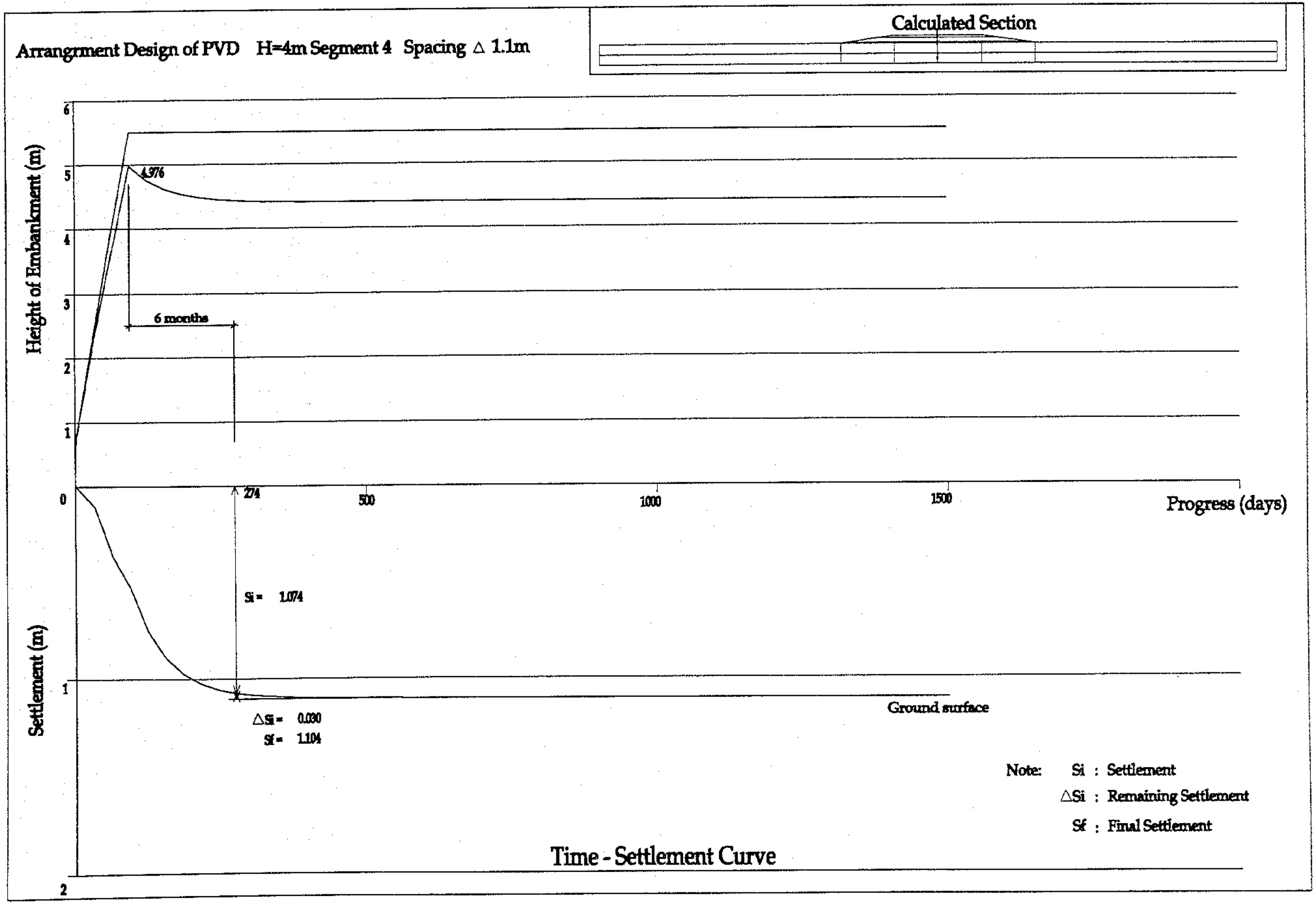


Time - Settlement Curve

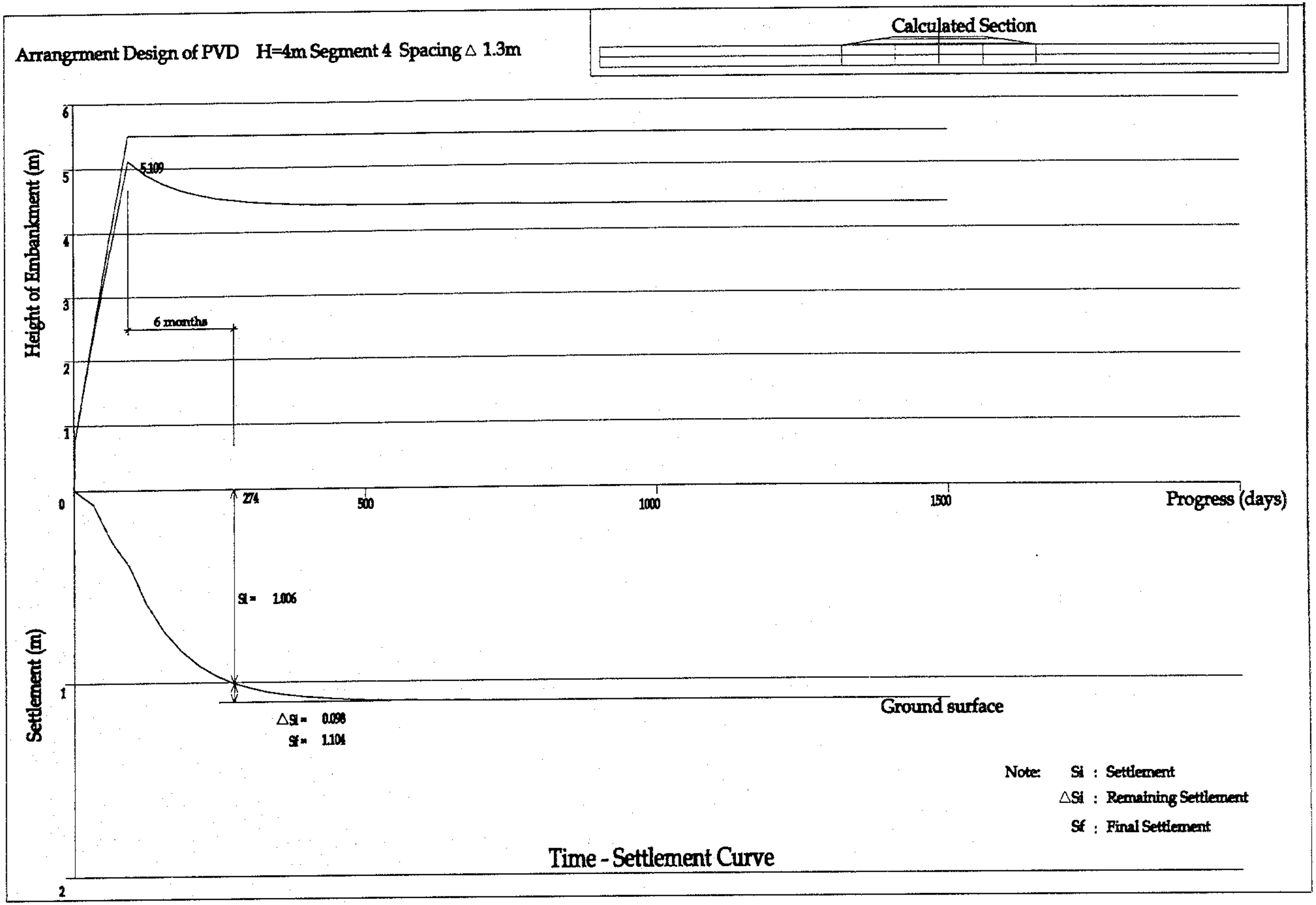


Arrangment Design of PVD H=7m Segment 3 Spacing △ 1.1m
Calculated Section
Height of Embankment (m)
10
8
6
4
2
0
7.791
6 months
344
500
1000
1500
Progress (days)
Settlement (m)
1
2
3
Si = 2.120
△Si = 0.166
Sf = 2.286
Ground surface
Note: Si : Settlement
△Si : Remaining Settlement
Sf : Final Settlement
Time - Settlement Curve

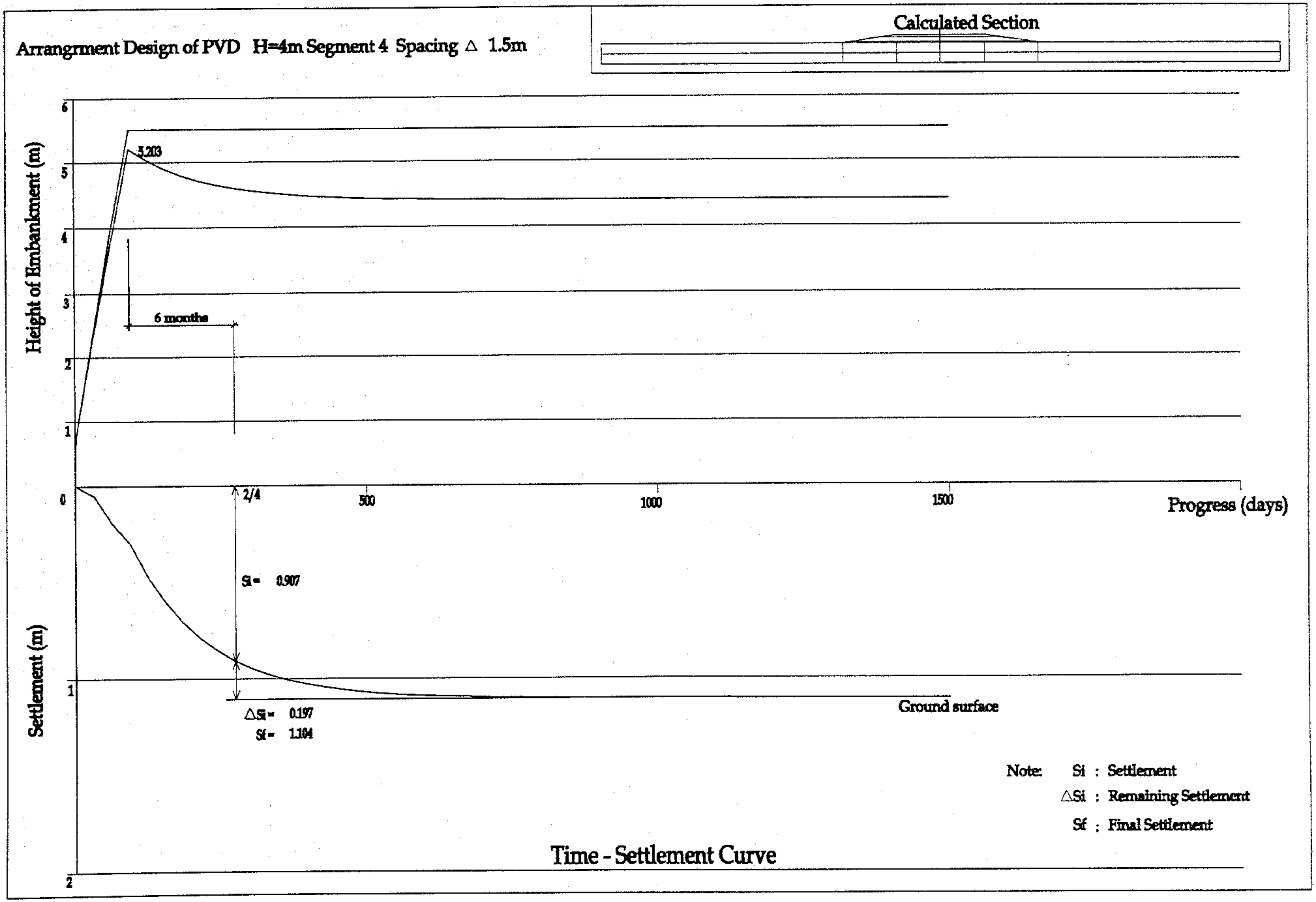

Arrangrment Design of PVD H=7m Segment 3 Spacing △ 1.3m
Calculated Section
Height of Embankment (m)
10
8
6
4
2
0
8.084
6 months
344
500
1000
1500
Progress (days)
Settlement (m)
1
2
3
Si = 1.898
△Si = 0.389
Sf = 2.286
Ground surface
Note: Si : Settlement
△Si : Remaining Settlement
Sf : Final Settlement
Time - Settlement Curve

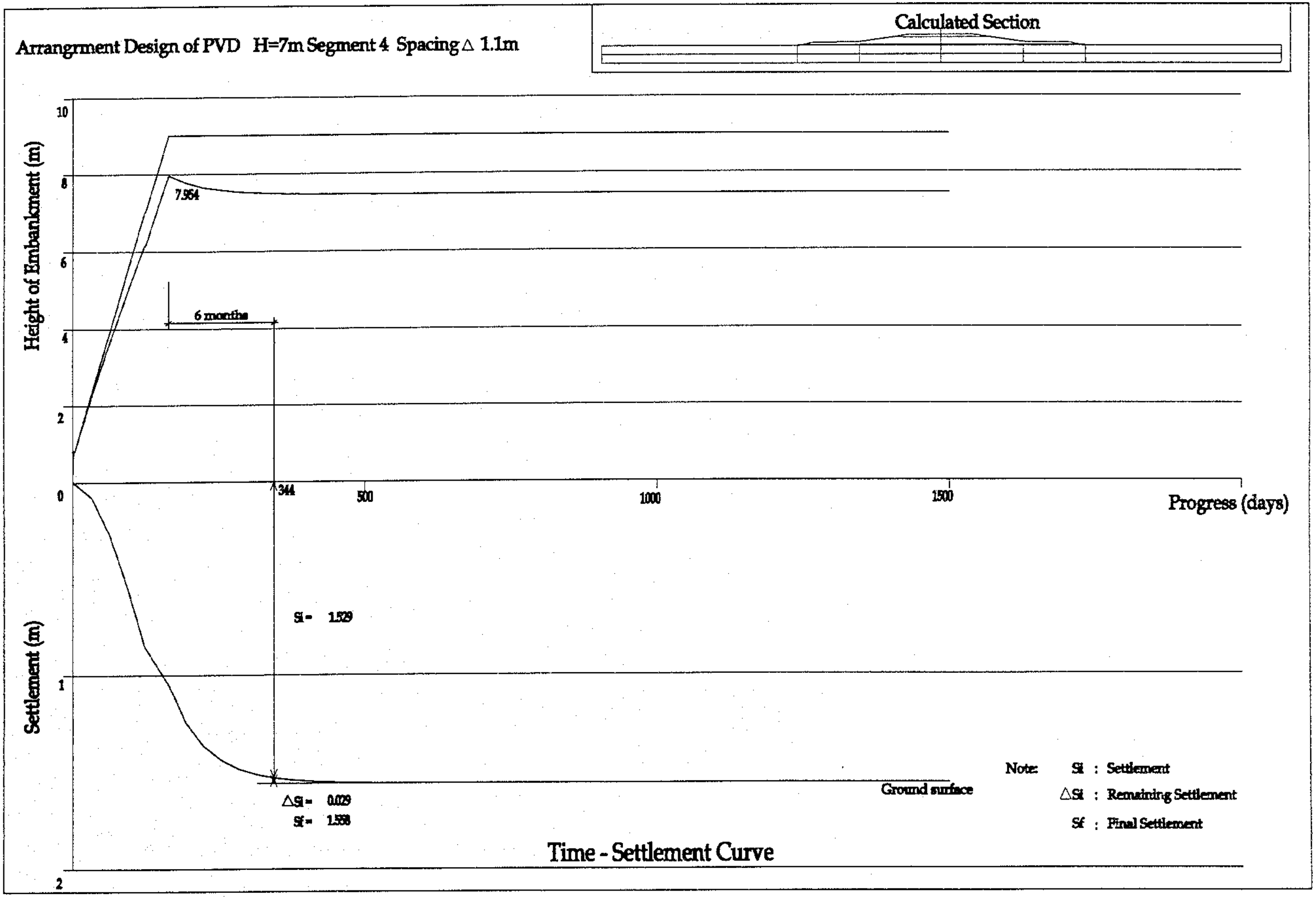

Arrangrment Design of PVD H=4m Segment 4 Spacing △ 1.1m
Calculated Section
Height of Embankment (m)
6
5
4
3
2
1
0
4.976
6 months
274
500
1000
1500
Progress (days)
Si = 1.074
Settlement (m)
1
2
△Si = 0.030
Sf = 1.104
Ground surface
Note: Si : Settlement
△Si : Remaining Settlement
Sf : Final Settlement
Time - Settlement Curve

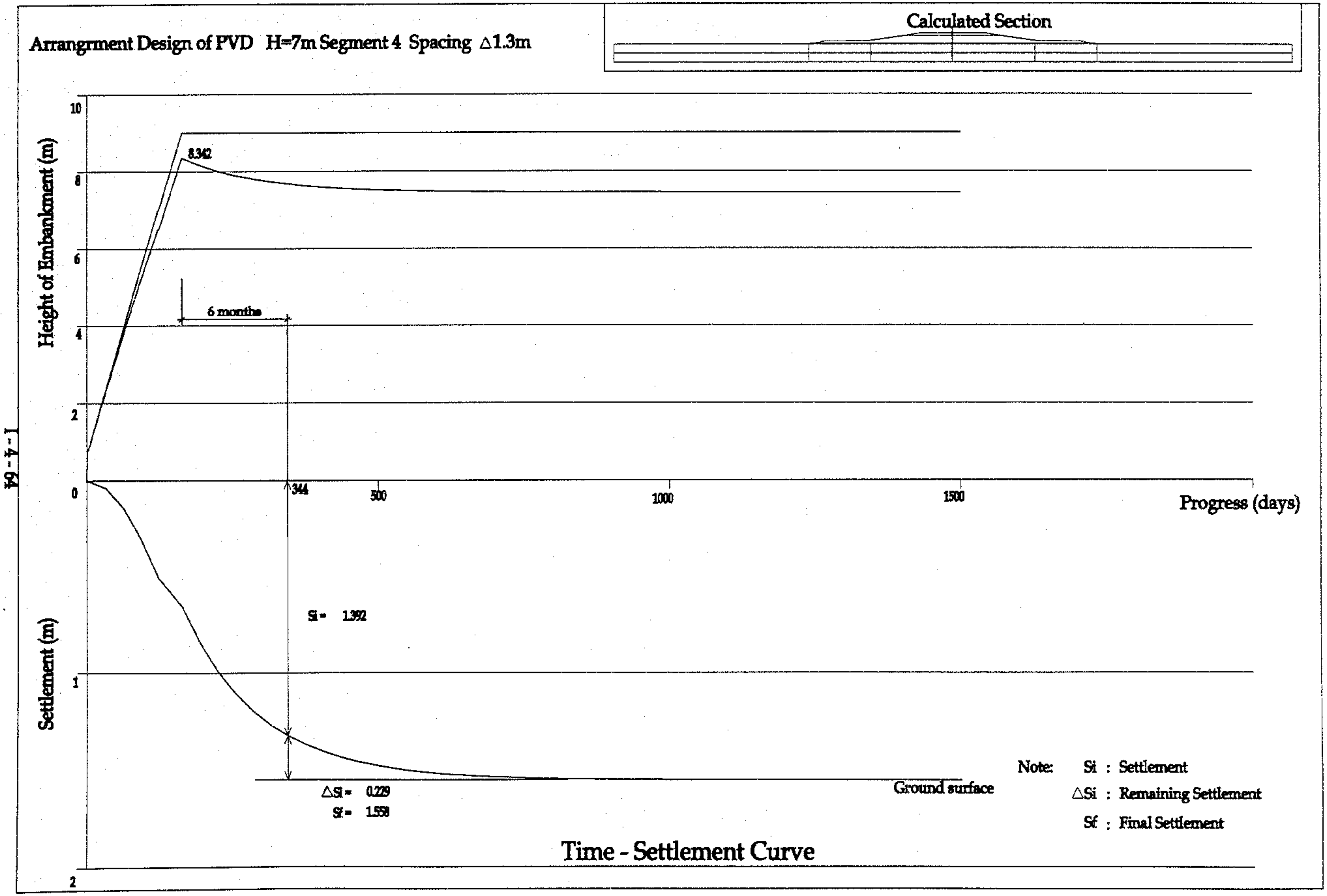
Arrangrment Design of PVD H=4m Segment 4 Spacing △ 1.3m

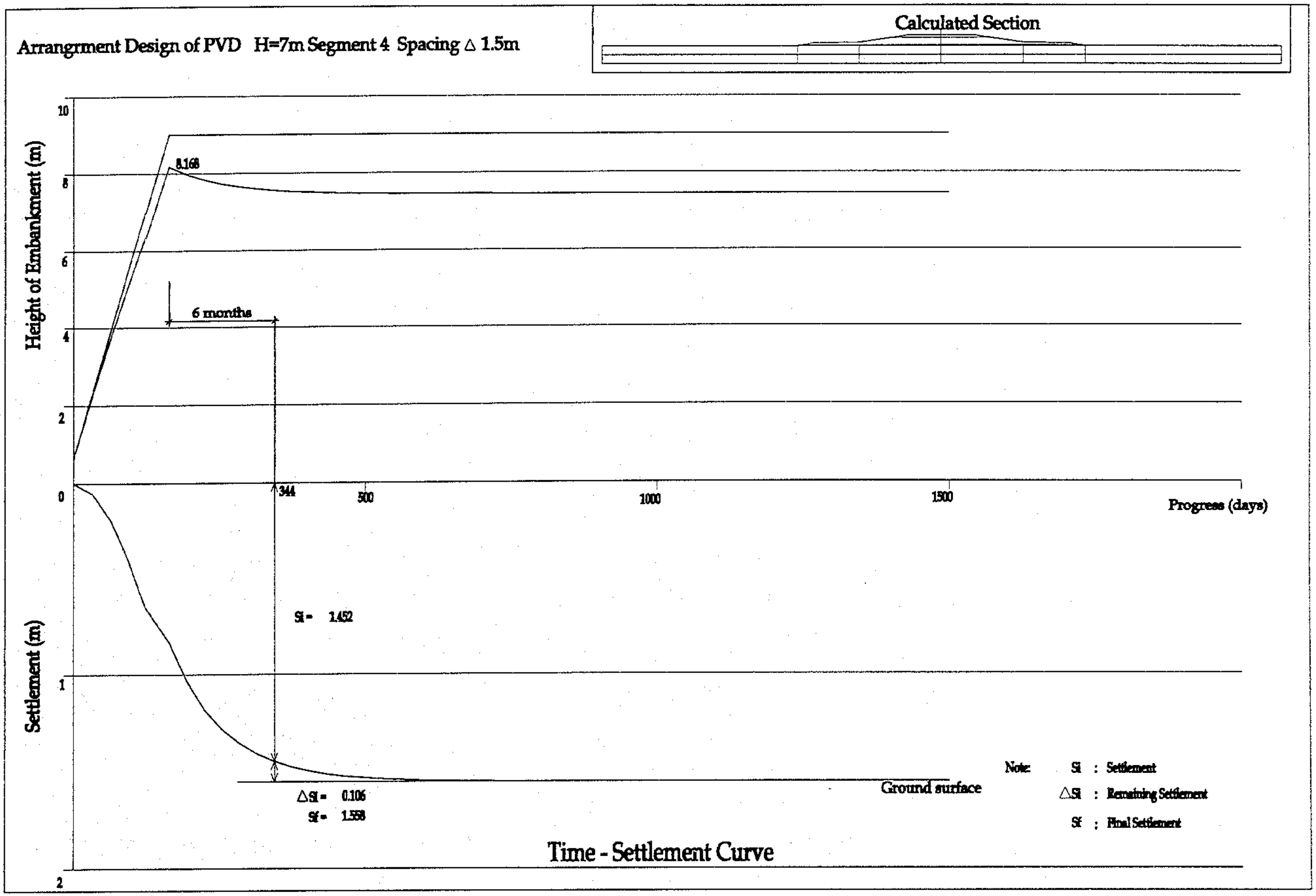


Time - Settlement Curve


Arrangment Design of PVD H=4m Segment 4 Spacing △ 1.5m
Calculated Section
Height of Embankment (m)
Settlement (m)
6
5
4
3
2
1
0
1
2
5.203
6 months
2/4
500
1000
1500
Progress (days)
Si = 0.907
△Si = 0.197
Sf = 1.104
Ground surface
Note: Si : Settlement
△Si : Remaining Settlement
Sf : Final Settlement
Time - Settlement Curve


Arrangrment Design of PVD H=7m Segment 4 Spacing △ 1.1m
Calculated Section
Height of Embankment (m)
10
8
6
4
2
0
7.564
6 months
344
500
1000
1500
Progress (days)
Settlement (m)
1
2
Si = 1.529
△Si = 0.029
Sf = 1.558
Ground surface
Note: Si : Settlement
△Si : Remaining Settlement
Sf : Final Settlement
Time - Settlement Curve


Arrangment Design of PVD H=7m Segment 4 Spacing △1.3m
Calculated Section
Height of Embankment (m)
10
8
6
4
2
0
8.342
6 months
344
500
1000
1500
Progress (days)
Settlement (m)
1
2
Si = 1.392
△Si = 0.229
Sf = 1.558
Ground surface
Note: Si : Settlement
△Si : Remaining Settlement
Sf : Final Settlement
Time - Settlement Curve

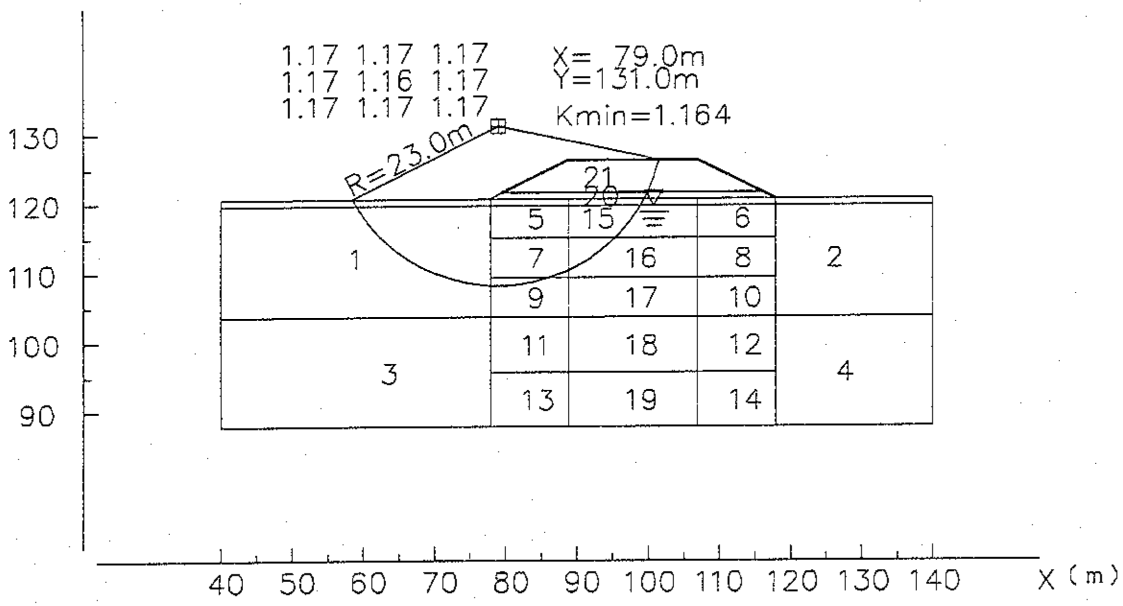


Arrangment Design of PVD H=7m Segment 4 Spacing △ 1.5m
Calculated Section
Height of Embankment (m)
10
8
6
4
2
0
8.168
6 months
344
500
1000
1500
Progress (days)
Settlement (m)
1
2
Si = 1.452
ΔSi = 0.106
Sf = 1.558
Ground surface
Note: Si : Settlement
ΔSi : Remaining Settlement
Sf : Final Settlement
Time - Settlement Curve

Appendix-5: Study of Slope Stability

SLOPE STABILITY SEGMENT 1 H=4m

S = 1:1000

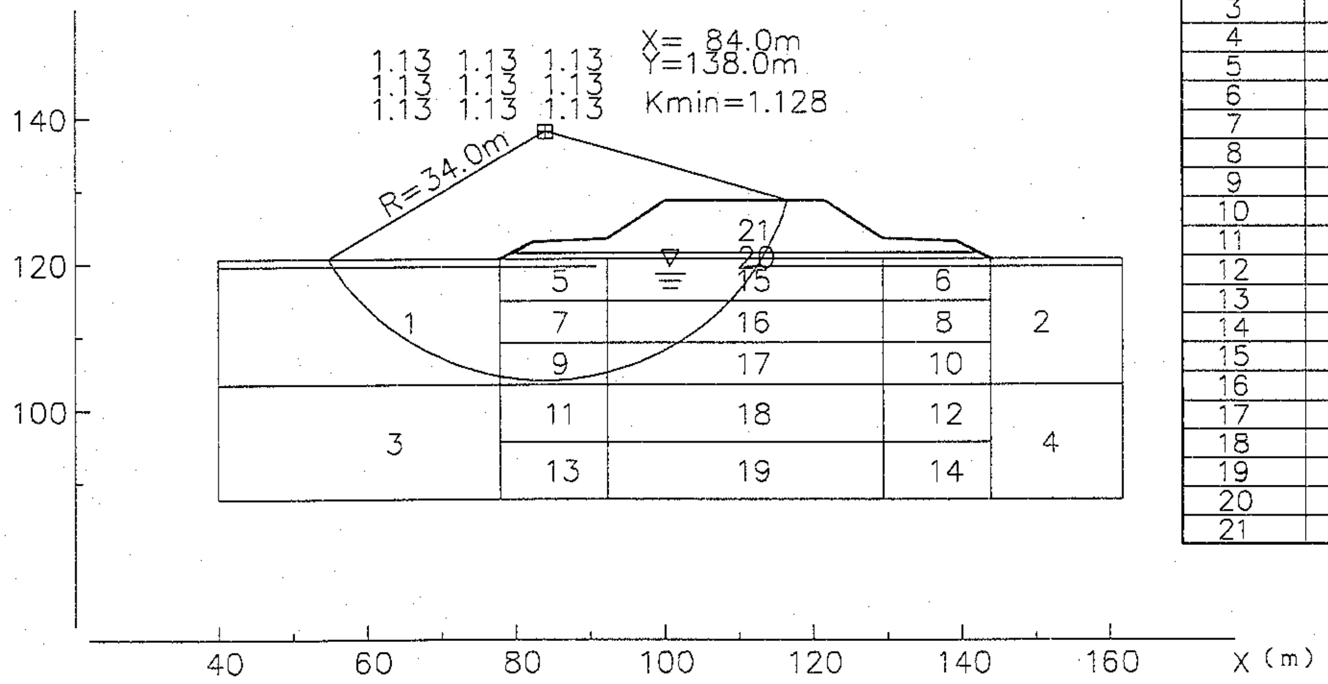


CHARACTERISTIC VALUE

Layer Number	Saturated Density kN/m3	Wet Density kN/m3	Internal Friction Angle	Cohesion kN/m2
1	16.90	15.90	4.00	7.0
2	16.90	15.90	4.00	7.0
3	17.70	16.70	6.00	8.0
4	17.70	16.70	6.00	8.0
5	16.90	15.90	4.00	21.0
6	16.90	15.90	4.00	21.0
7	16.90	15.90	4.00	18.0
8	16.90	15.90	4.00	18.0
9	16.90	15.90	4.00	17.0
10	16.90	15.90	4.00	17.0
11	17.70	16.70	6.00	16.0
12	17.70	16.70	6.00	16.0
13	17.70	16.70	6.00	15.0
14	17.70	16.70	6.00	15.0
15	16.90	15.90	4.00	26.0
16	16.90	15.90	4.00	23.0
17	16.90	15.90	4.00	20.0
18	17.70	16.70	6.00	18.0
19	17.70	16.70	6.00	17.0
20	19.60	18.60	30.00	20.0
21	19.30	18.30	30.00	14.0

SLOPE STABILITY SEGMENT 1 H=6m

S = 1:1000

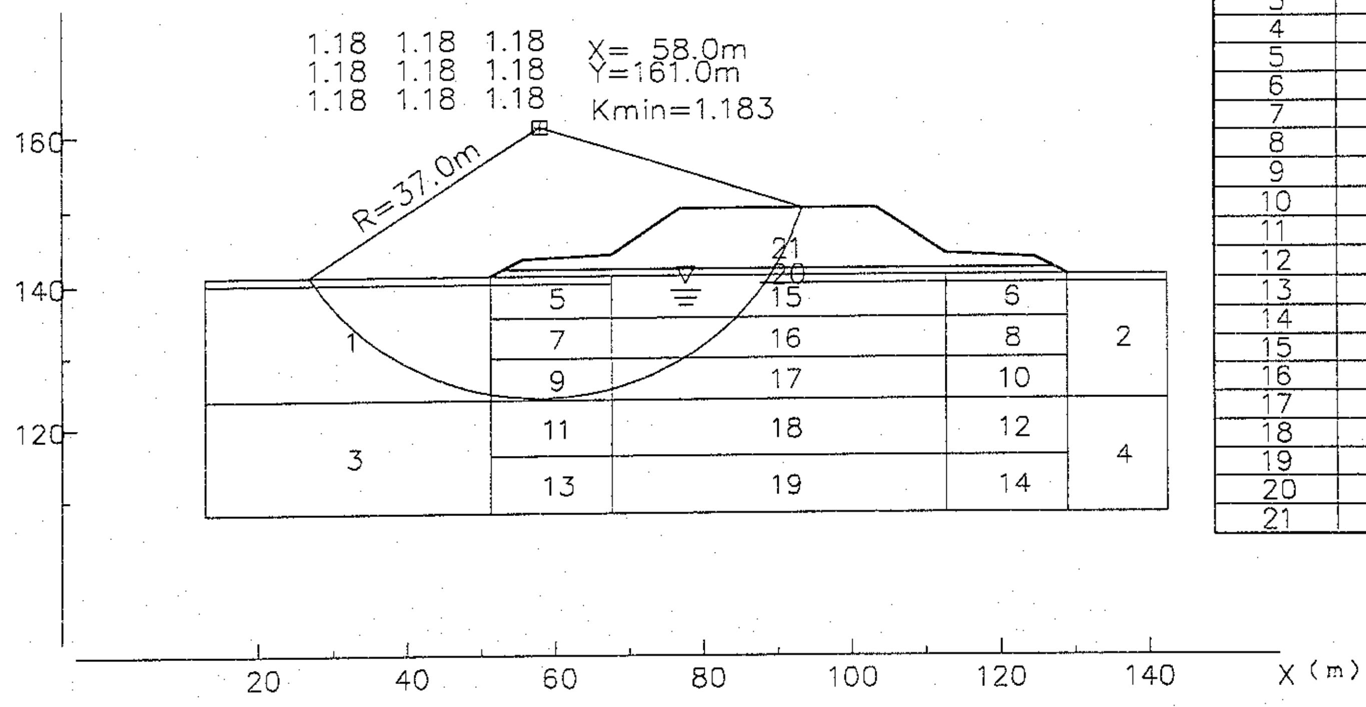


CHARACTERISTIC VALUE

Layer Number	Saturated Density kN/m³	Wet Density kN/m³	Internal Friction Angle	Cohesion kN/m²
1	16.90	15.90	4.00	7.0
2	16.90	15.90	4.00	7.0
3	17.70	16.70	6.00	8.0
4	17.70	16.70	6.00	8.0
5	16.90	15.90	4.00	15.0
6	16.90	15.90	4.00	15.0
7	16.90	15.90	4.00	15.0
8	16.90	15.90	4.00	15.0
9	16.90	15.90	4.00	15.0
10	16.90	15.90	4.00	15.0
11	17.70	16.70	6.00	14.0
12	17.70	16.70	6.00	14.0
13	17.70	16.70	6.00	14.0
14	17.70	16.70	6.00	14.0
15	16.90	15.90	4.00	40.0
16	16.90	15.90	4.00	36.0
17	16.90	15.90	4.00	33.0
18	17.70	16.70	6.00	28.0
19	17.70	16.70	6.00	25.0
20	19.60	18.60	30.00	20.0
21	19.30	18.30	30.00	14.0

SLOPE STABILITY SEGMENT 1 H=8m

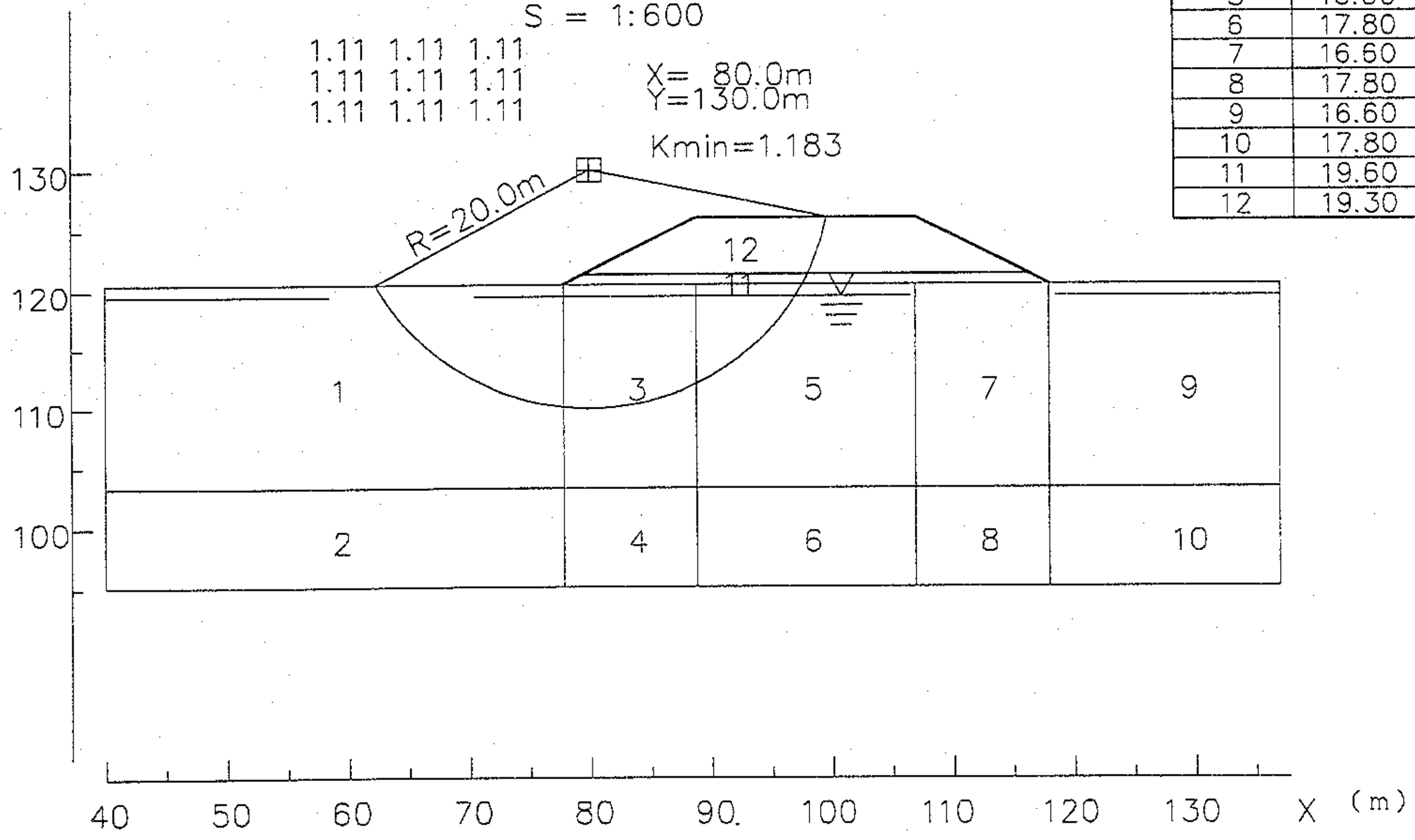
S = 1:1000



CHARACTERISTIC VALUE

Layer Number	Saturated Density kN/m³	Wet Density kN/m³	Internal Friction Angle	Cohesion kN/m²
1	16.90	15.90	4.00	7.0
2	16.90	15.90	4.00	7.0
3	17.70	16.70	6.00	8.0
4	17.70	16.70	6.00	8.0
5	16.90	15.90	4.00	16.0
6	16.90	15.90	4.00	16.0
7	16.90	15.90	4.00	16.0
8	16.90	15.90	4.00	16.0
9	16.90	15.90	4.00	16.0
10	16.90	15.90	4.00	16.0
11	17.70	16.70	6.00	16.0
12	17.70	16.70	6.00	16.0
13	17.70	16.70	6.00	16.0
14	17.70	16.70	6.00	16.0
15	16.90	15.90	4.00	52.0
16	16.90	15.90	4.00	48.0
17	16.90	15.90	4.00	43.0
18	17.70	16.70	6.00	41.0
19	17.70	16.70	6.00	34.0
20	19.60	18.60	30.00	20.0
21	19.30	18.30	20.00	14.0

SLOPE STABILITY SEGMENT 3 H=4m

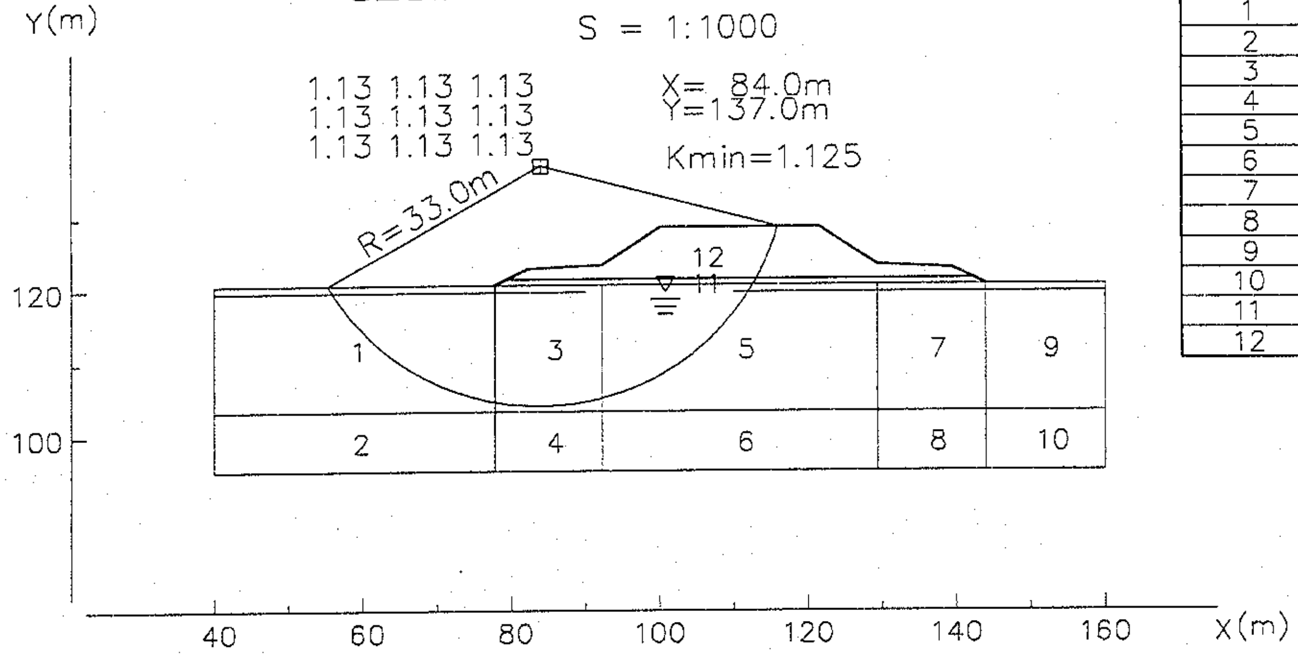


CHARACTERISTIC VALUE

Layer Number	Saturated Density kN/m³	Wet Density kN/m³	Internal Friction Angle	Cohesion kN/m²
1	16.60	15.60	4.00	9.0
2	17.80	16.80	3.00	14.0
3	16.60	15.60	4.00	17.0
4	17.80	16.80	3.00	22.0
5	16.60	15.60	4.00	19.0
6	17.80	16.80	3.00	24.0
7	16.60	15.60	4.00	17.0
8	17.80	16.80	3.00	22.0
9	16.60	15.60	4.00	16.0
10	17.80	16.80	3.00	24.0
11	19.60	18.60	30.00	20.0
12	19.30	18.30	30.00	14.0

SLOPE STABILITY SEGMENT 3 H=6m

S = 1:1000

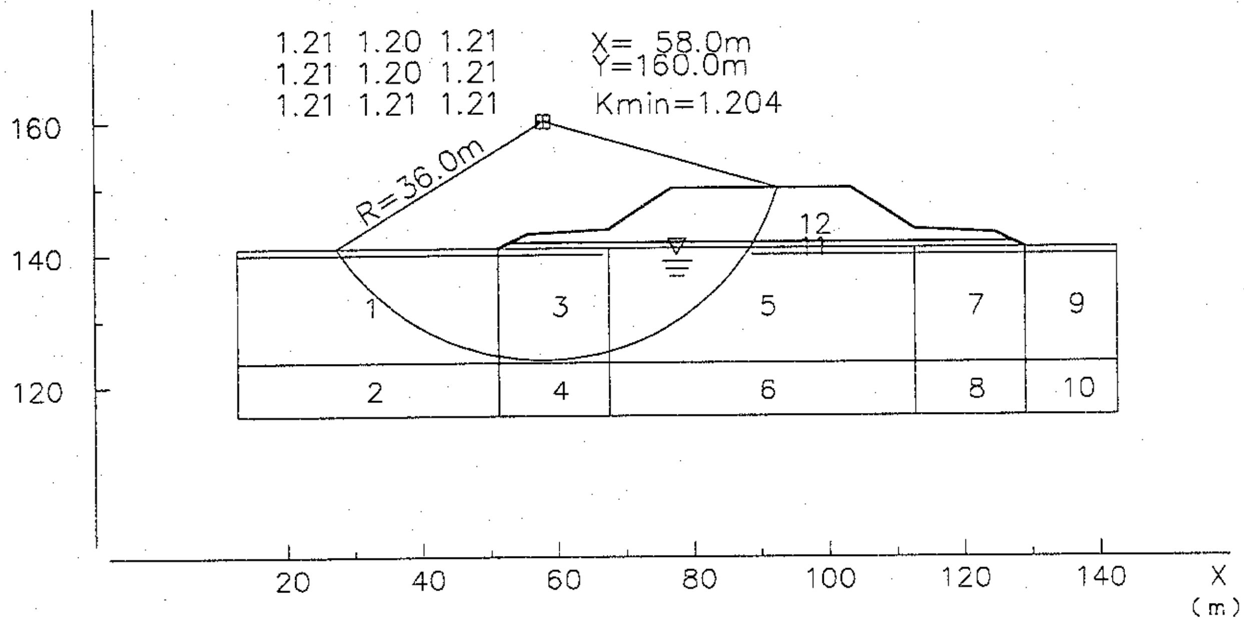


CHARACTERISTIC VALUE

Layer Number	Saturated Density kN/m³	Wet Density kN/m³	Internal Friction Angle	Cohesion kN/m²
1	16.60	15.60	4.00	9.0
2	17.80	16.80	3.00	14.0
3	16.60	15.60	4.00	15.0
4	17.80	16.80	3.00	22.0
5	16.60	15.60	4.00	34.0
6	17.80	16.80	3.00	38.0
7	16.60	15.60	4.00	15.0
8	17.80	16.80	3.00	22.0
9	16.60	15.60	4.00	9.0
10	17.80	16.80	3.00	14.0
11	19.60	18.60	30.00	20.0
12	19.30	18.30	30.00	14.0

SLOPE STABILITY SEGMENT 3 H=8m

S = 1:1000

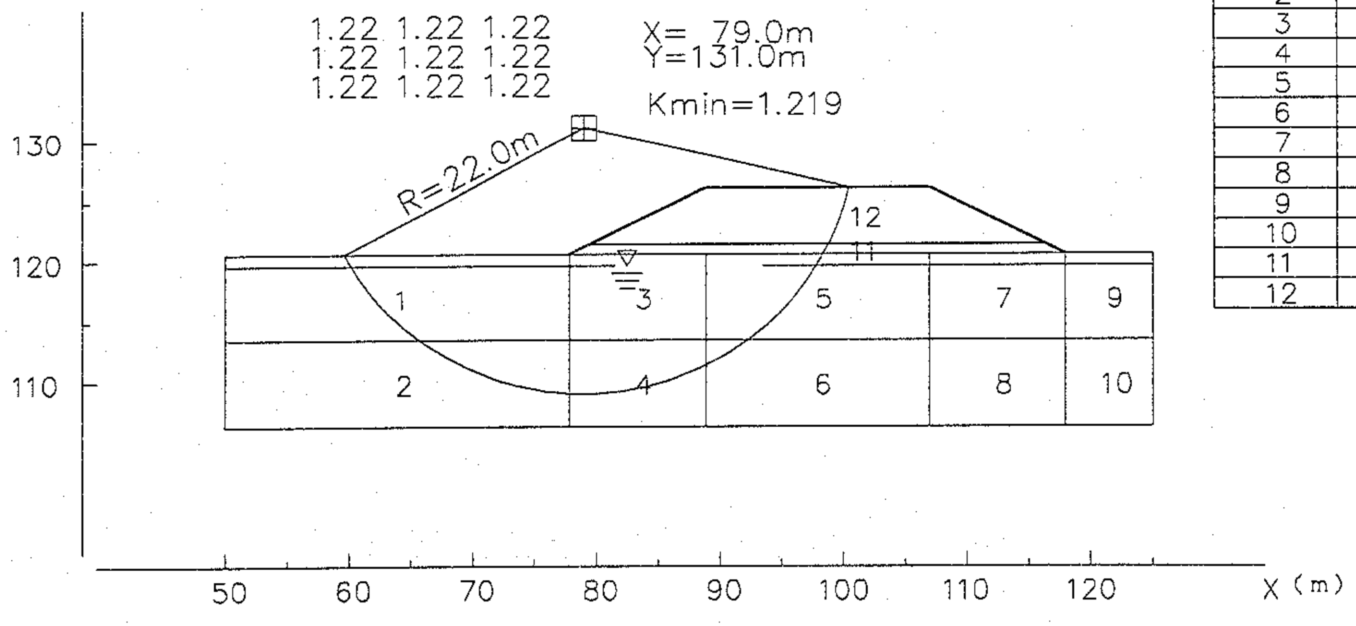


CHARACTERISTIC VALUE

Layer Number	Saturated Density kN/m³	Wet Density kN/m³	Internal Friction Angle	Cohesion kN/m²
1	16.60	15.60	4.00	9.0
2	17.80	16.80	3.00	14.0
3	16.60	15.60	4.00	16.0
4	17.80	16.80	3.00	24.0
5	16.60	15.60	4.00	46.0
6	17.80	16.80	3.00	48.0
7	16.60	15.60	4.00	16.0
8	17.80	16.80	3.00	24.0
9	16.60	15.60	4.00	9.0
10	17.80	16.80	3.00	14.0
11	19.60	18.60	30.00	20.0
12	19.30	18.30	30.00	14.0

SLOPE STABILITY SEGMENT 4 H=4m

S = 1:600

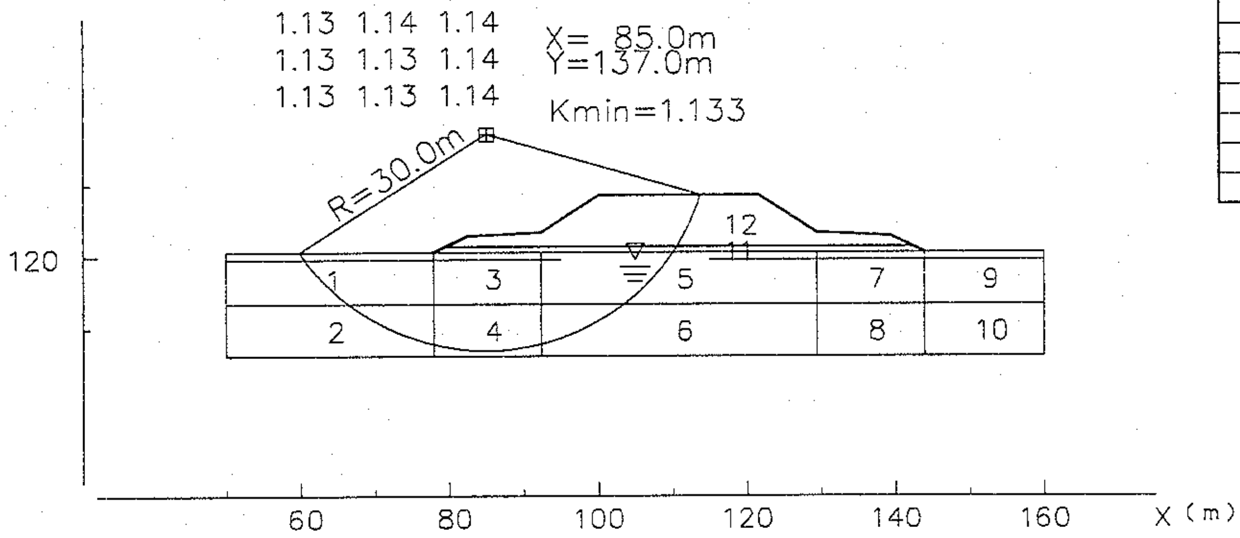


CHARACTERISTIC VALUE

Layer Number	Saturated Density kN/m³	Wet Density kN/m³	Internal Friction Angle	Cohesion kN/m²
1	16.60	15.60	4.00	8.0
2	16.60	15.60	4.00	8.0
3	16.60	15.60	4.00	21.0
4	16.60	15.60	4.00	19.0
5	16.60	15.60	4.00	27.0
6	16.60	15.60	4.00	23.0
7	16.60	15.60	4.00	21.0
8	16.60	15.60	4.00	19.0
9	16.60	15.60	4.00	8.0
10	16.60	15.60	4.00	8.0
11	19.60	18.60	30.00	20.0
12	19.30	18.30	30.00	14.0

SLOPE STABILITY SEGMENT 4 H=6m

S = 1:1000

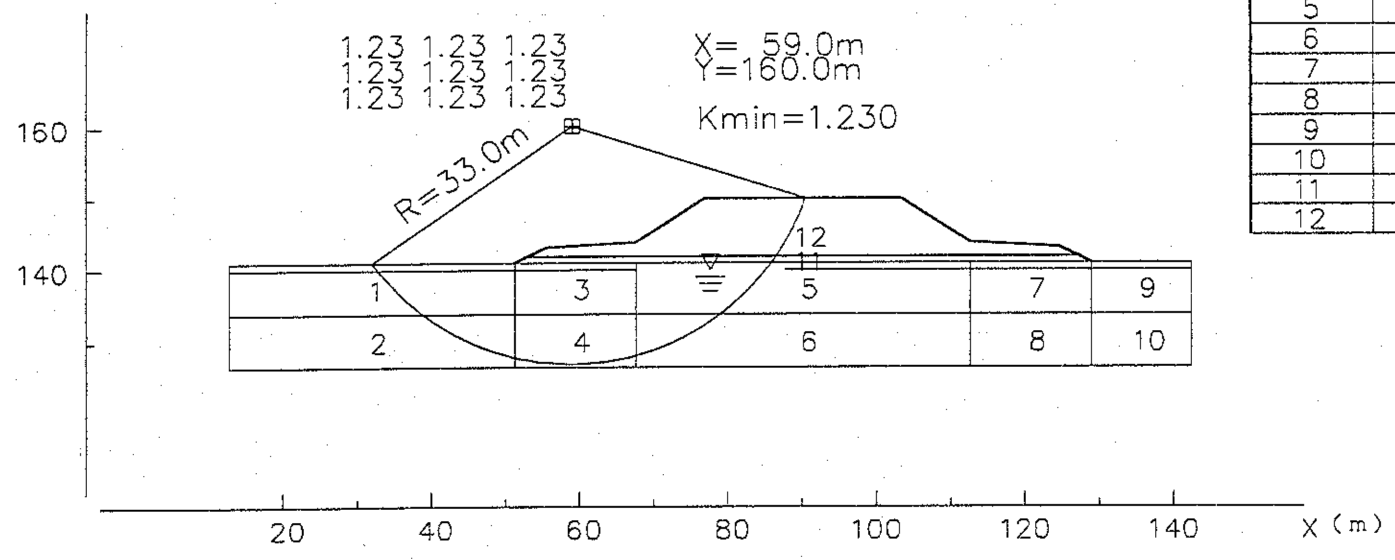


CHARACTERISTIC VALUE

Layer Number	Saturated Density kN/m³	Wet Density kN/m³	Internal Friction Angle	Cohesion kN/m²
1	16.60	15.60	4.00	8.0
2	16.60	15.60	4.00	8.0
3	16.60	15.60	4.00	15.0
4	16.60	15.60	4.00	14.0
5	16.60	15.60	4.00	38.0
6	16.60	15.60	4.00	34.0
7	16.60	15.60	4.00	15.0
8	16.60	15.60	4.00	14.0
9	16.60	15.60	4.00	8.0
10	16.60	15.60	4.00	8.0
11	19.60	18.60	30.00	20.0
12	19.30	18.30	30.00	14.0

SLOPE STABILITY SEGMENT 4 H=8m

S = 1:1000



CHARACTERISTIC VALUE

Layer Number	Saturated Density kN/m³	Wet Density kN/m³	Internal Friction Angle	Cohesion kN/m²
1	16.60	15.60	4.00	8.0
2	16.60	15.60	4.00	8.0
3	16.60	15.60	4.00	16.0
4	16.60	15.60	4.00	16.0
5	16.60	15.60	4.00	51.0
6	16.60	15.60	4.00	46.0
7	16.60	15.60	4.00	16.0
8	16.60	15.60	4.00	16.0
9	16.60	15.60	4.00	8.0
10	16.60	15.60	4.00	8.0
11	19.60	18.60	30.00	20.0
12	19.30	18.30	30.00	14.0

SLOPE STABILITY

SMALL TRA VA BRIDGE A2-ABUTMENT

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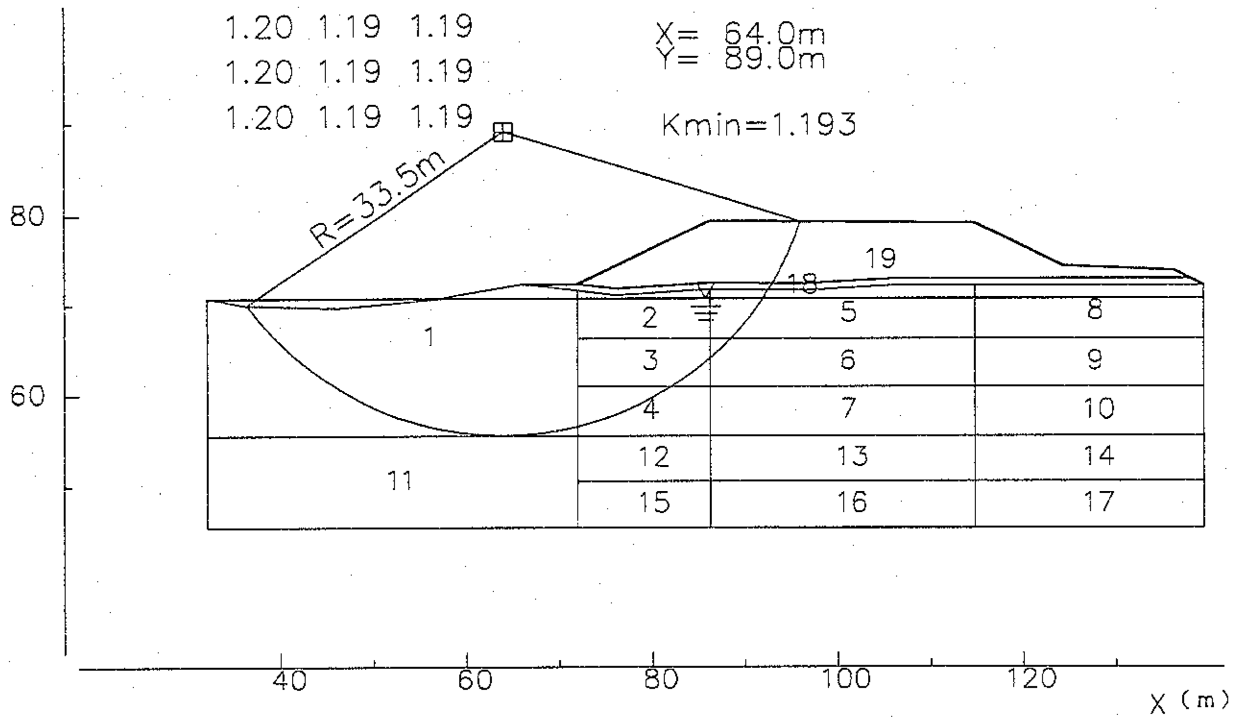


CHARACTERISTIC VALUE

Layer Number	Saturated Density kN/m³	Wet Density kN/m³	Internal Friction Angle	Cohesion kN/m²
1	16.90	15.90	4.00	7.0
2	16.90	15.90	4.00	32.0
3	16.90	15.90	4.00	31.0
4	16.90	15.90	4.00	30.0
5	16.90	15.90	4.00	41.0
6	16.90	15.90	4.00	39.0
7	16.90	15.90	4.00	37.0
8	16.90	15.90	4.00	28.0
9	16.90	15.90	4.00	26.0
10	16.90	15.90	4.00	25.0
11	17.70	16.70	6.00	8.0
12	17.70	16.70	6.00	12.0
13	17.70	16.70	6.00	33.0
14	17.70	16.70	6.00	29.0
15	17.70	16.70	6.00	12.0
16	17.70	16.70	6.00	31.0
17	17.70	16.70	0.00	27.0
18	19.60	18.60	30.00	20.0
19	19.30	18.30	30.00	14.0

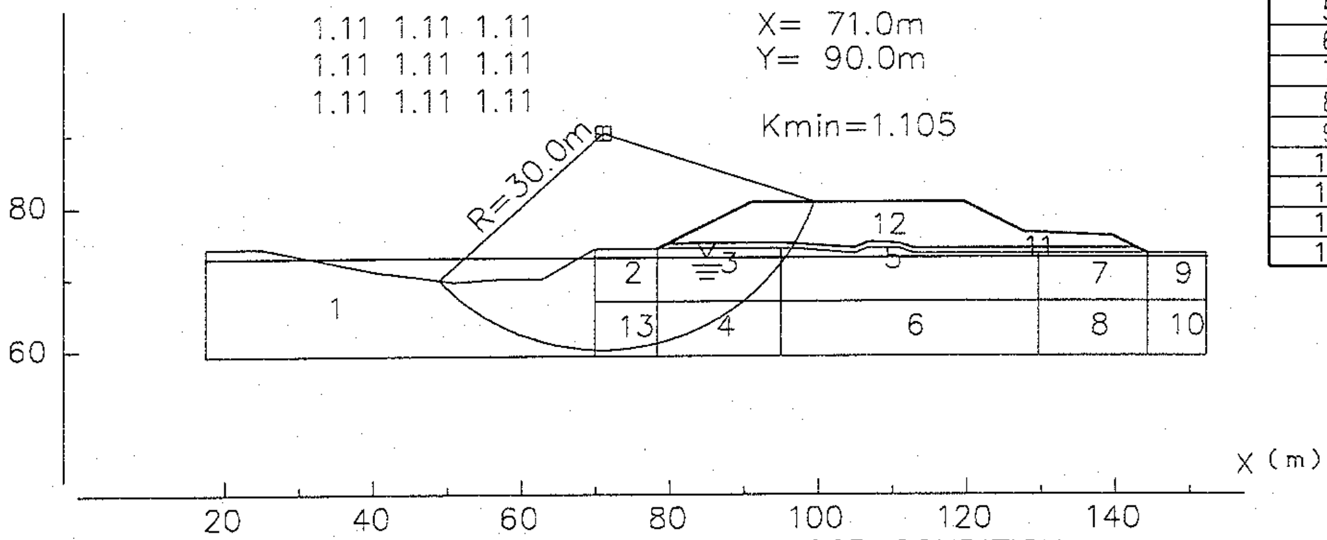
SCP CONDITION

Layer Number	Replace Ratio	Saturated Density kN/m³	Wet Density kN/m³	Internal Friction Angle	Stress Shore Ratio	Stress Increase Ratio	Degree of Consolidation
2	0.267	19.60	18.60	30.00	3	0.350	100.00
3	0.267	19.60	18.60	30.00	3	0.350	100.00
4	0.267	19.60	18.60	30.00	3	0.350	100.00

SLOPE STABILITY

CAI NAI BRIDGE A2-ABUTMENT

S = 1:1000



CHARACTERISTIC VALUE

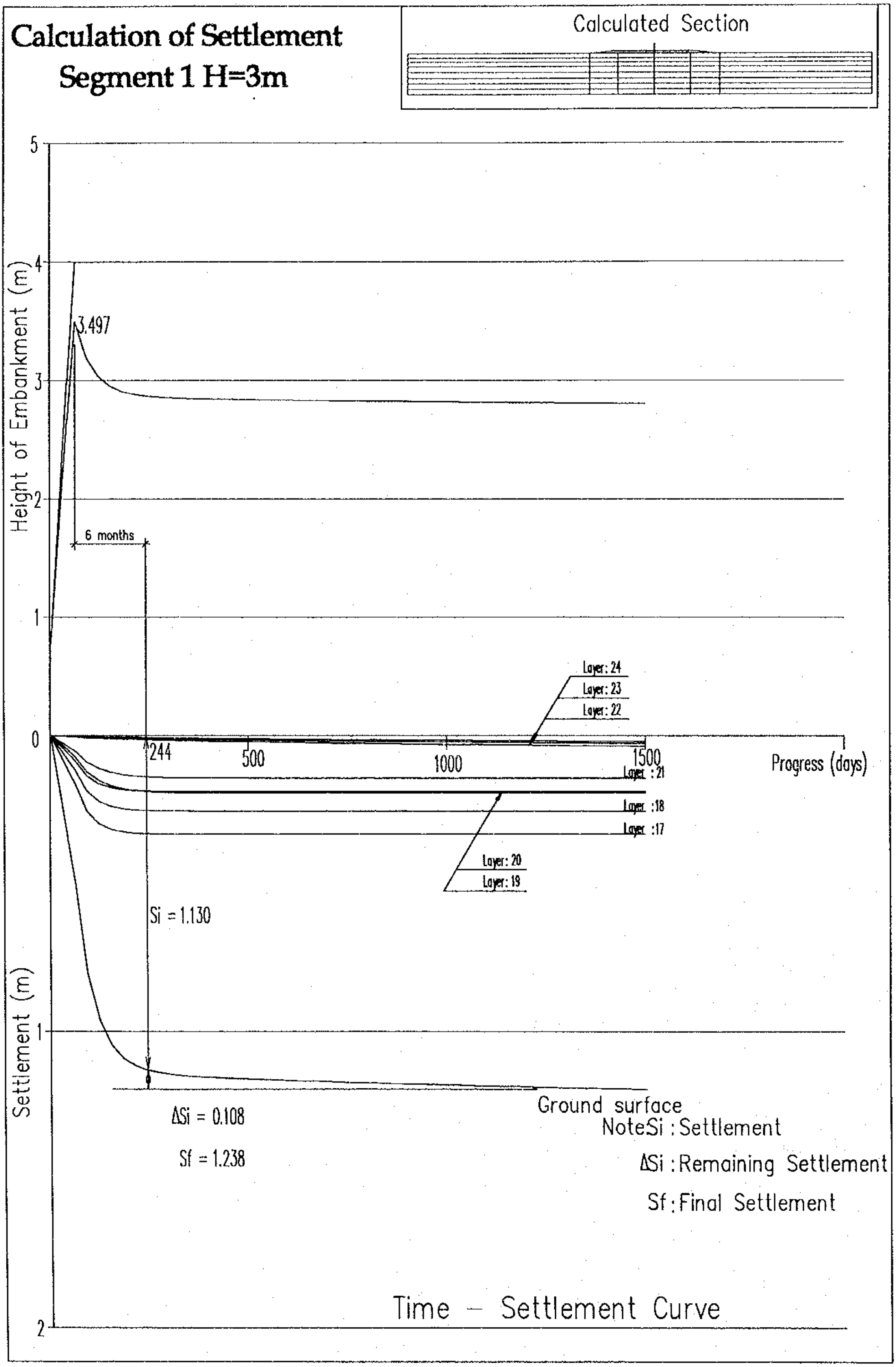
Layer Number	Saturated Density kN/m³	Wet Density kN/m³	Internal Friction Angle	Cohesion kN/m²
1	16.60	15.60	4.00	8.0
2	16.60	15.60	4.00	8.0
3	16.60	15.60	4.00	33.0
4	16.60	15.60	4.00	32.0
5	16.60	15.60	4.00	28.0
6	16.60	15.60	4.00	24.0
7	16.60	15.60	4.00	11.0
8	16.60	15.60	4.00	11.0
9	16.60	15.60	4.00	8.0
10	16.50	15.60	4.00	8.0
11	19.60	18.60	30.00	20.0
12	19.60	18.60	30.00	20.0
13	16.60	15.60	4.00	8.0

SCP CONDITION

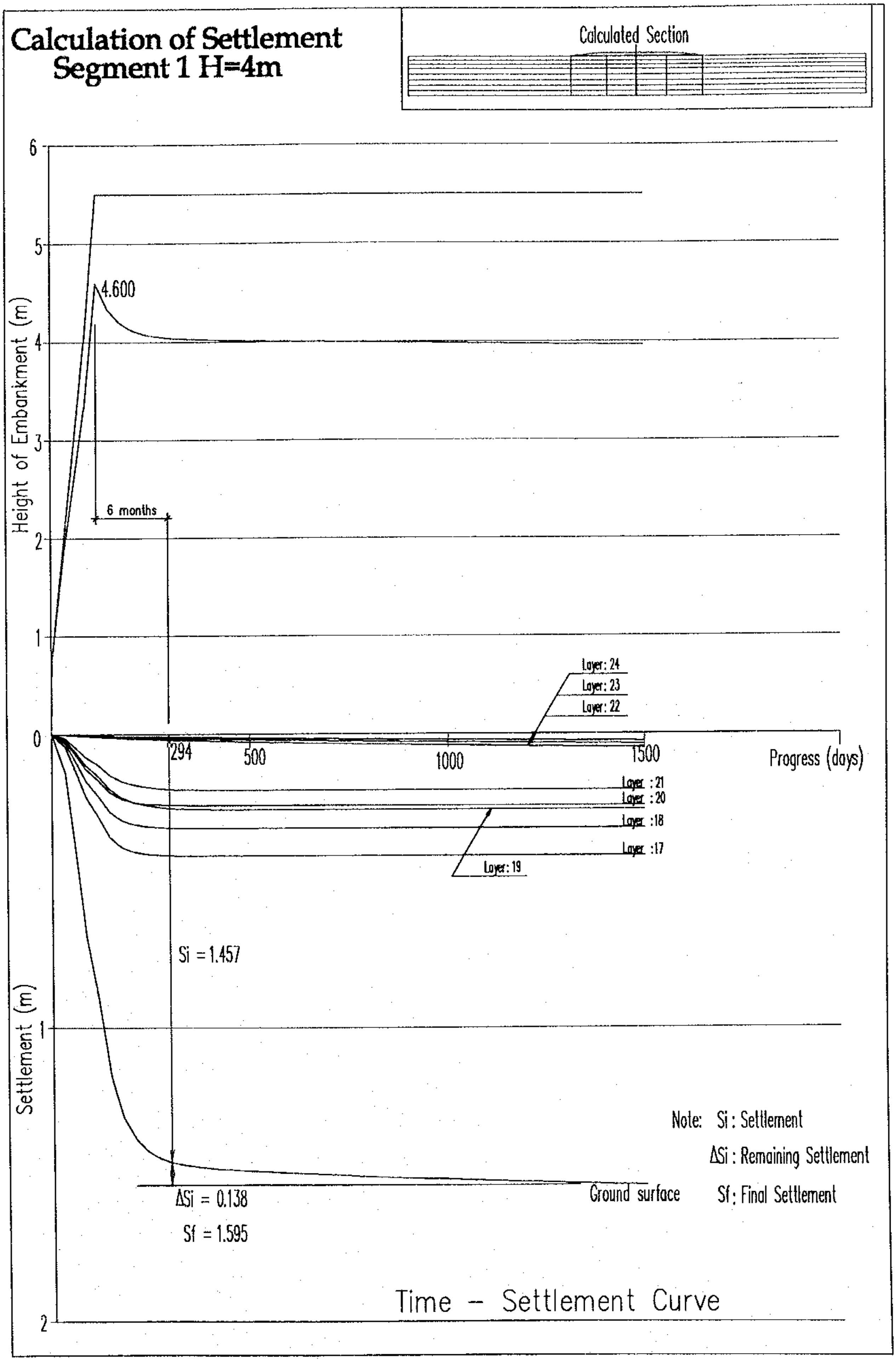
Layer Number	Replace Ratio	Saturated Density kN/m³	Wet Density kN/m³	Internal Friction Angle	Stress Share Ratio	Stress Increase Ratio	Degree of Consolidation
3	0.267	20.00	19.00	35.00	4	0.350	99.00
4	0.267	20.00	19.00	35.00	4	0.350	99.00
13	0.267	20.00	19.00	35.00	4	0.000	0.00

Appendix-6: Calculation of Settlement

Calculation of Settlement
Segment 1 H=3m

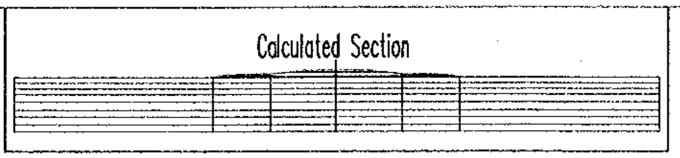


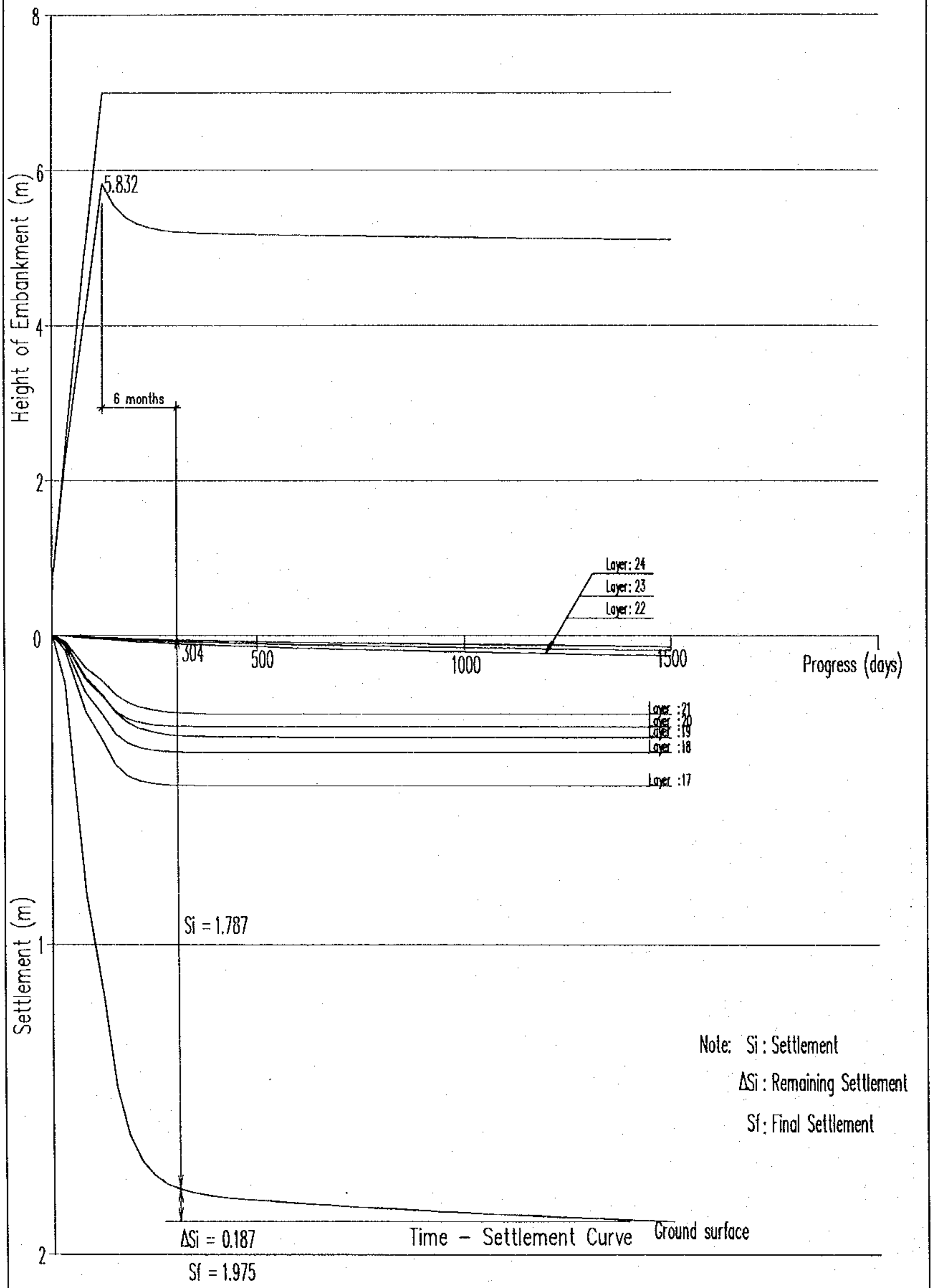
Calculation of Settlement
Segment 1 H=4m



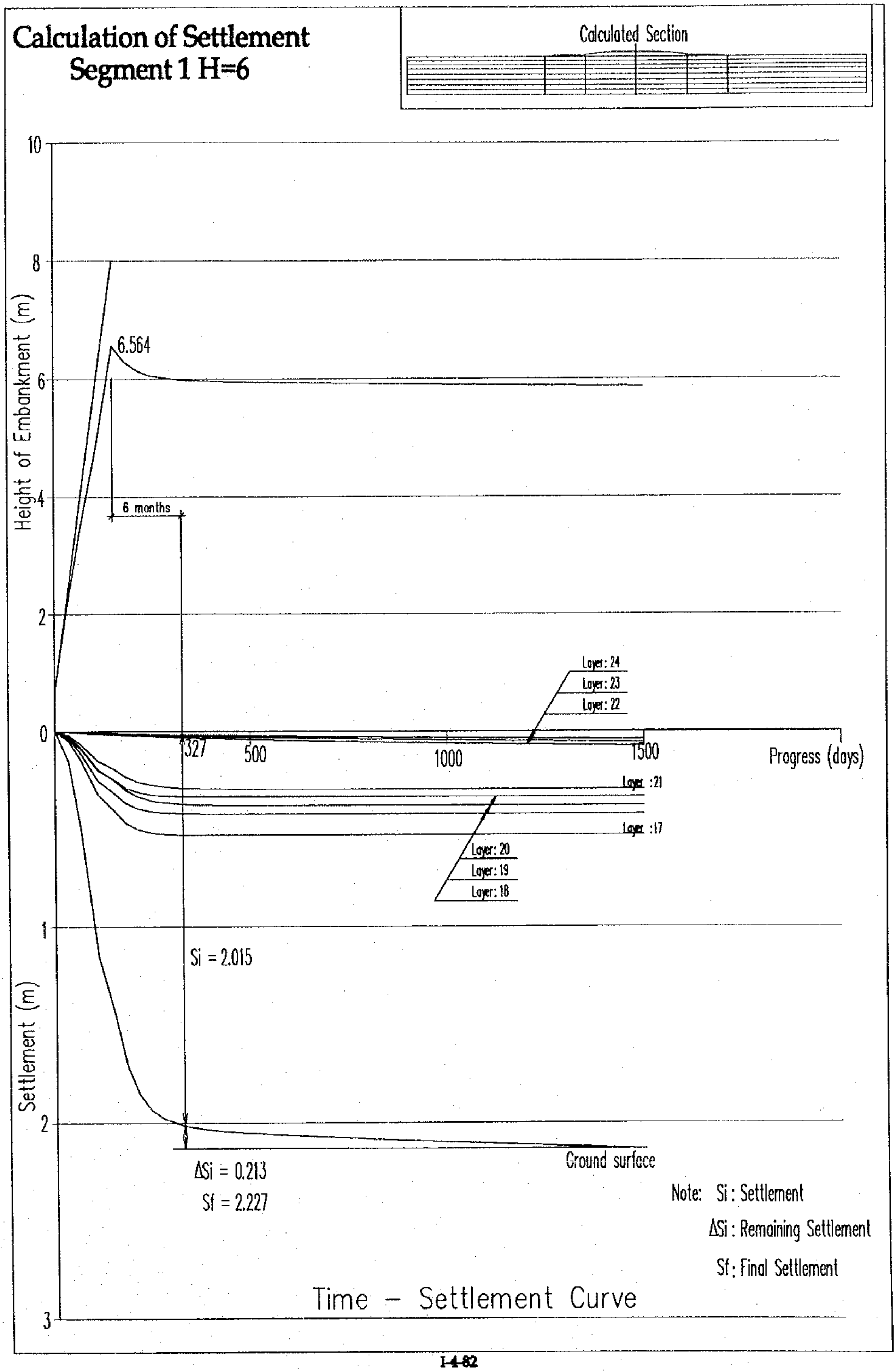
Time – Settlement Curve

Calculation of Settlement
Segment 1 H=5m

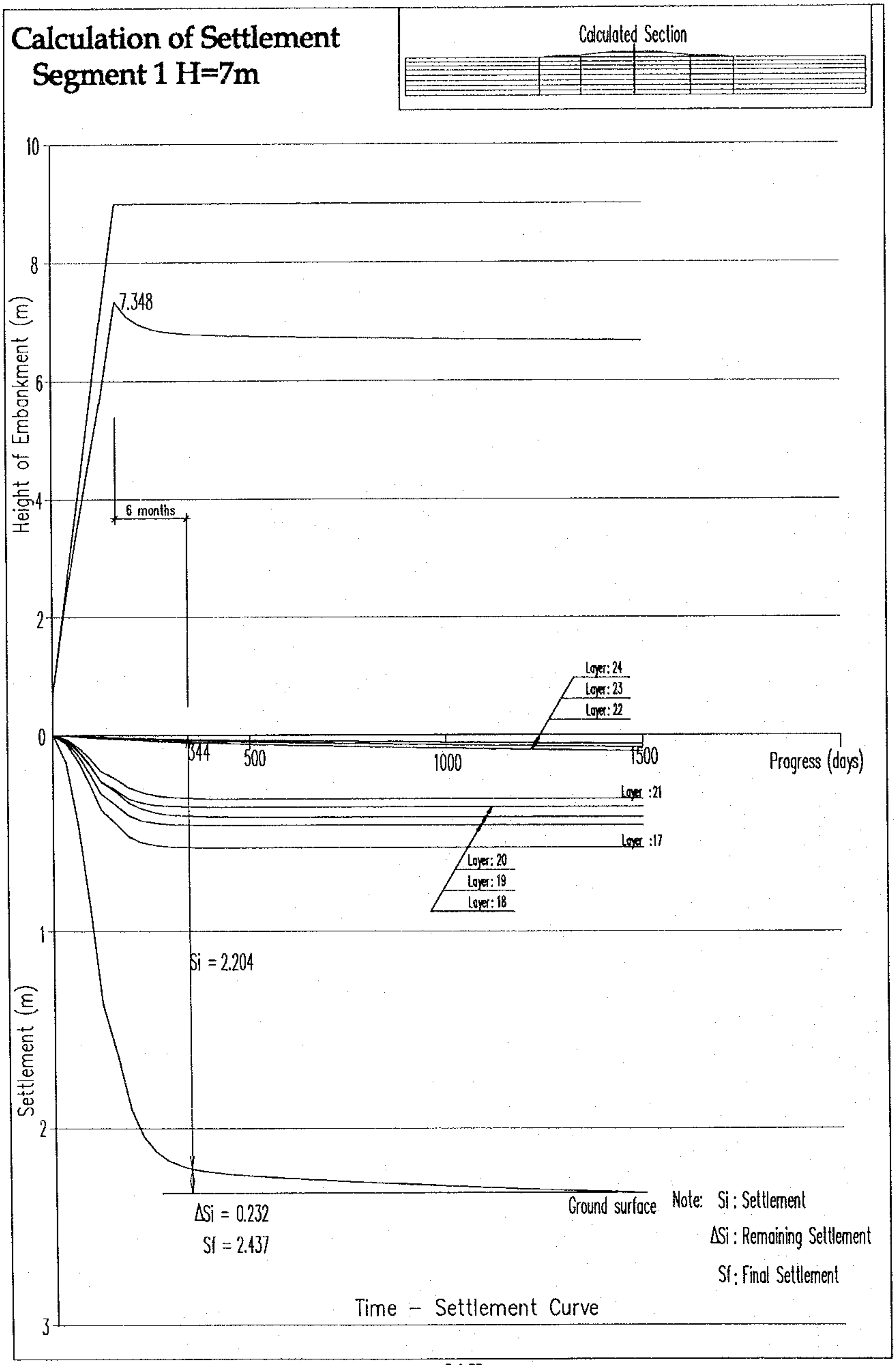




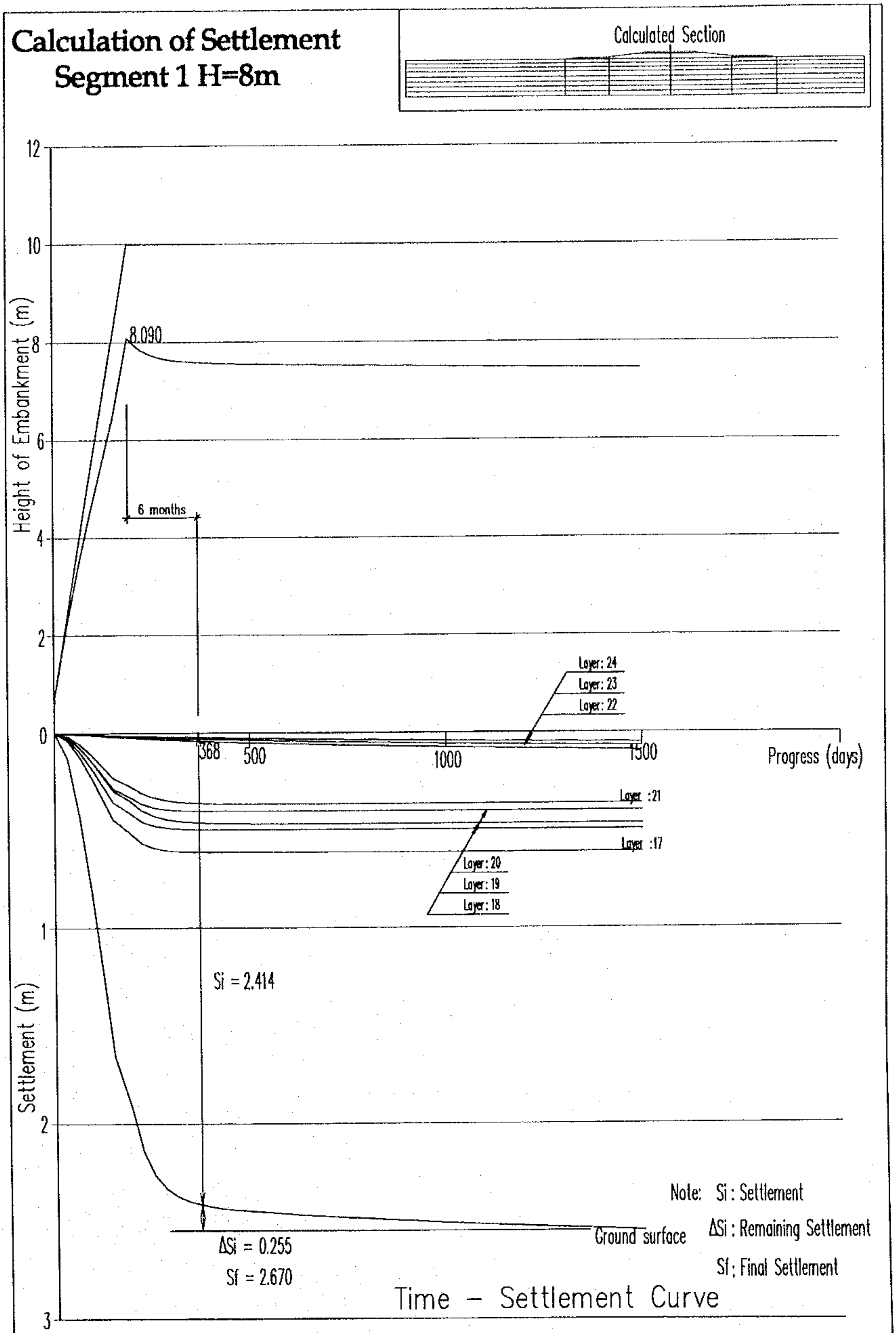
Calculation of Settlement
Segment 1 H=6



Calculation of Settlement
Segment 1 H=7m

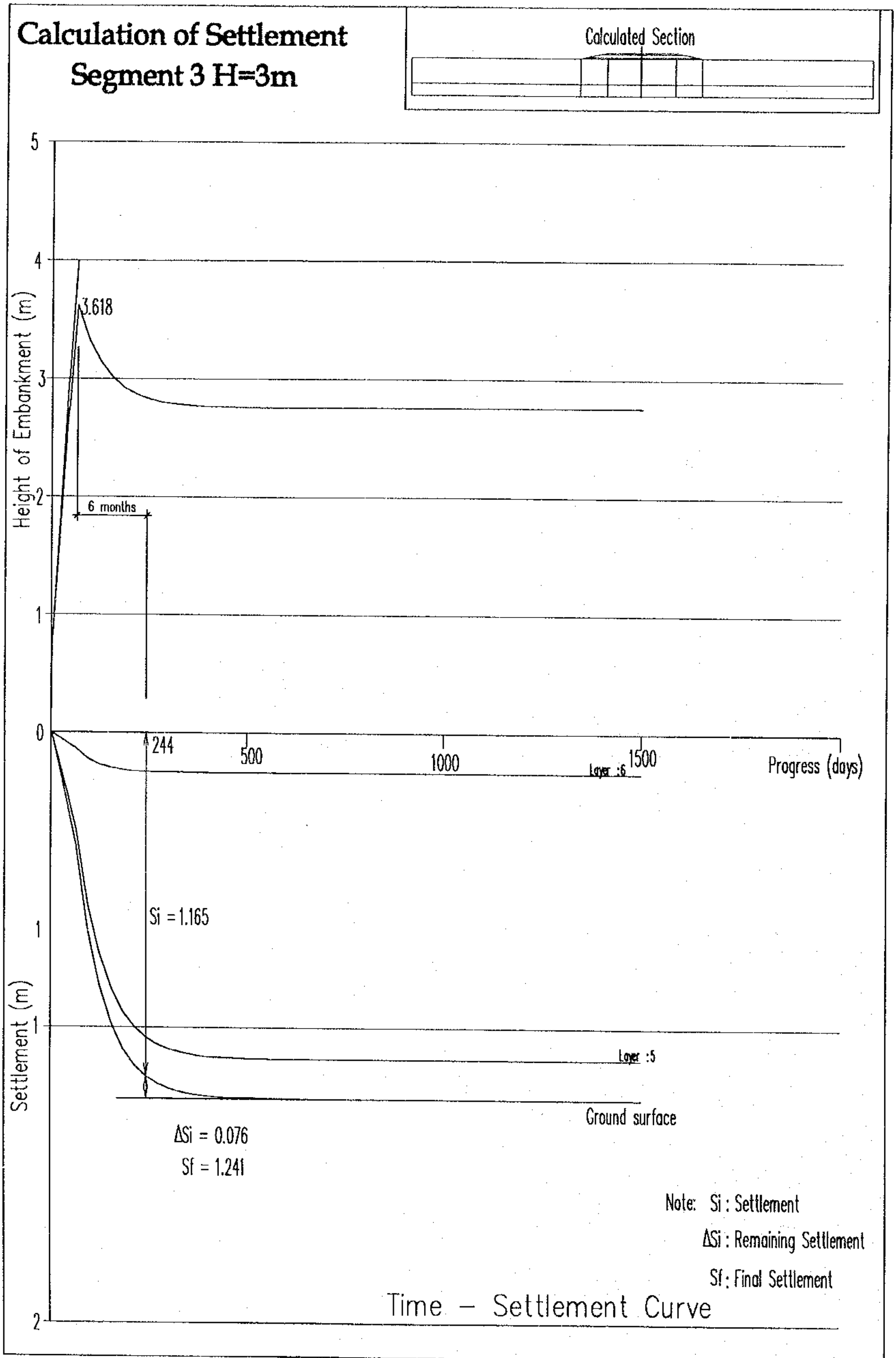


Calculation of Settlement
Segment 1 H=8m

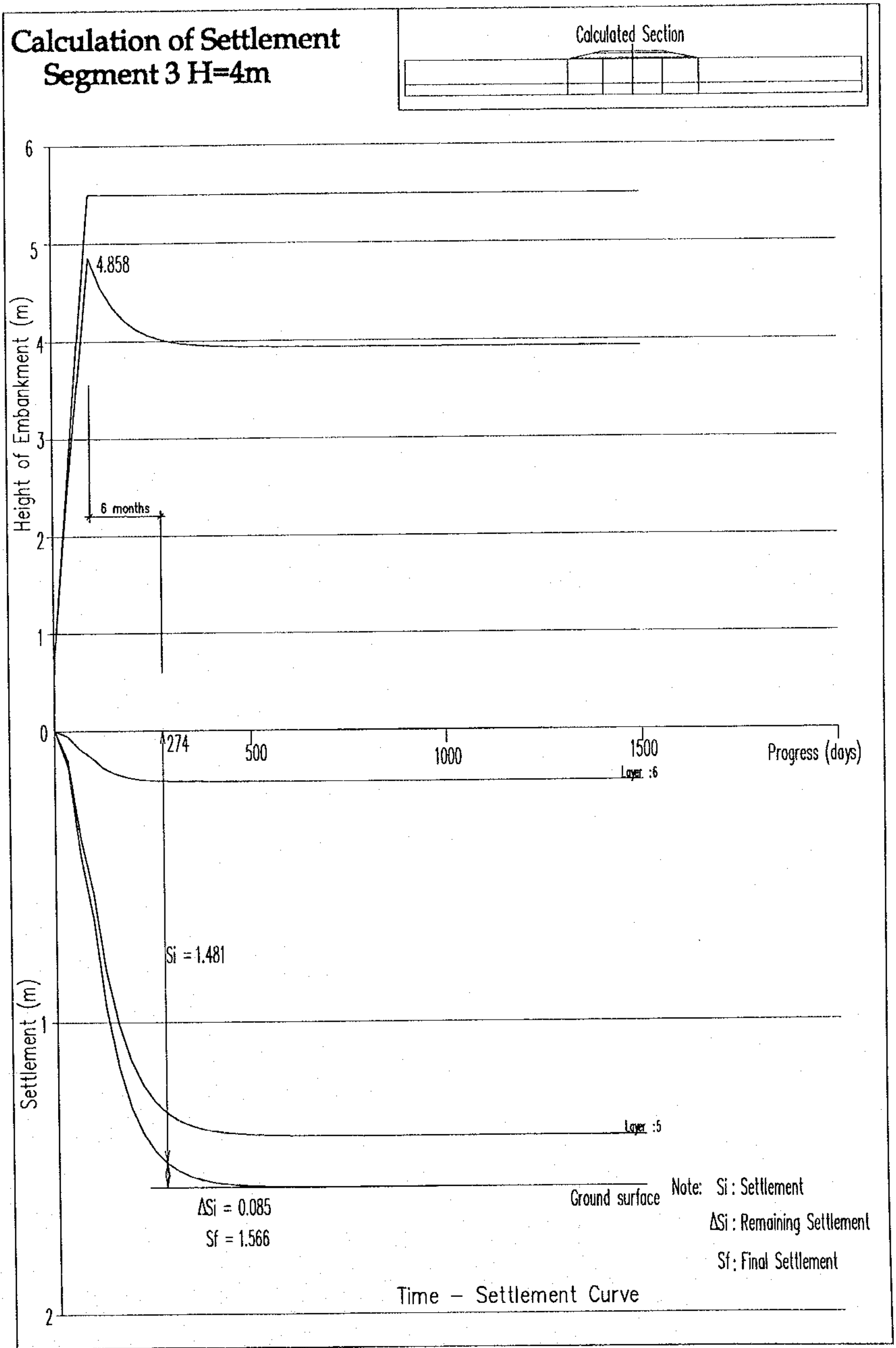


Time – Settlement Curve

Calculation of Settlement
Segment 3 H=3m

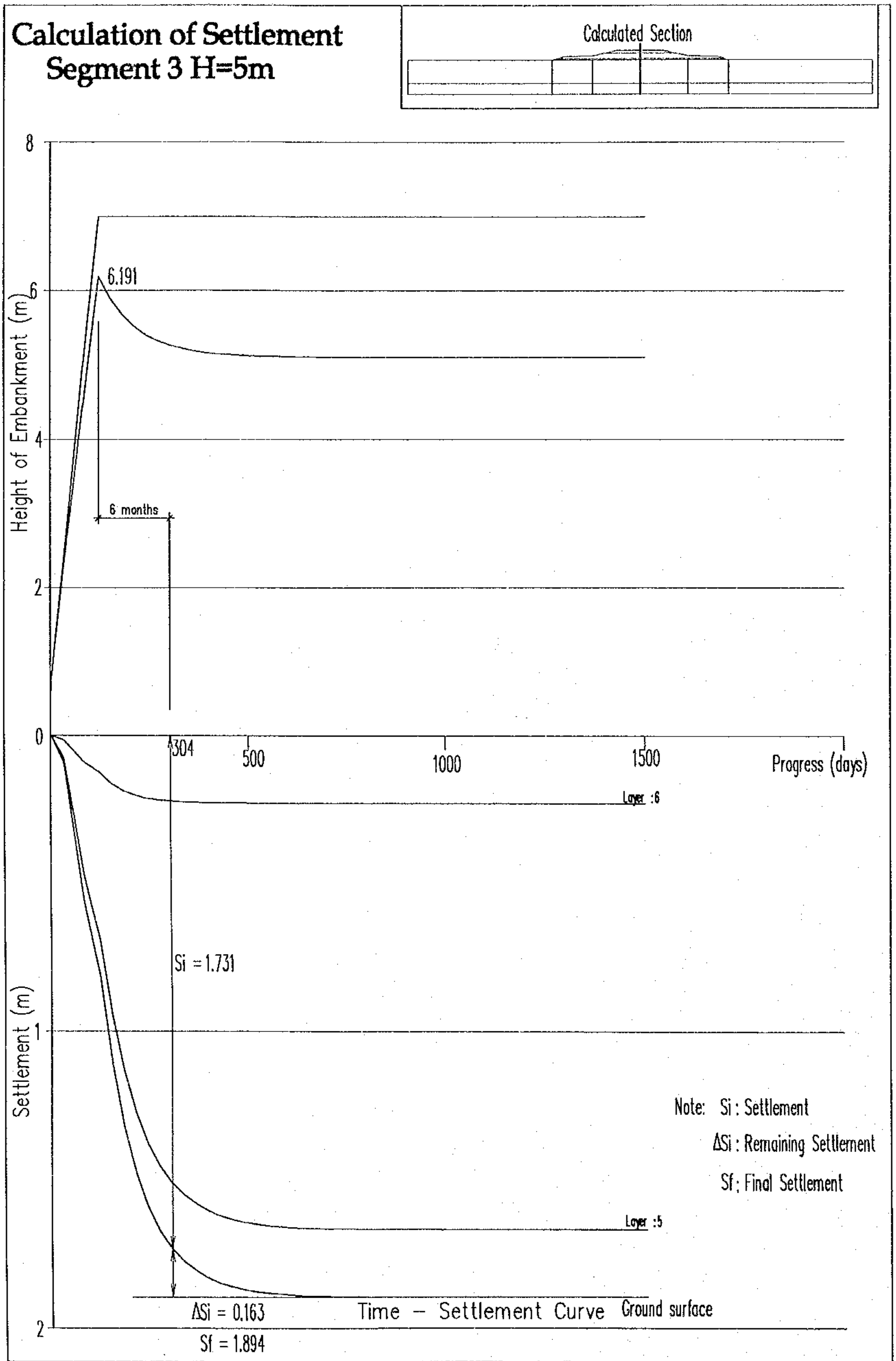


Calculation of Settlement
Segment 3 H=4m

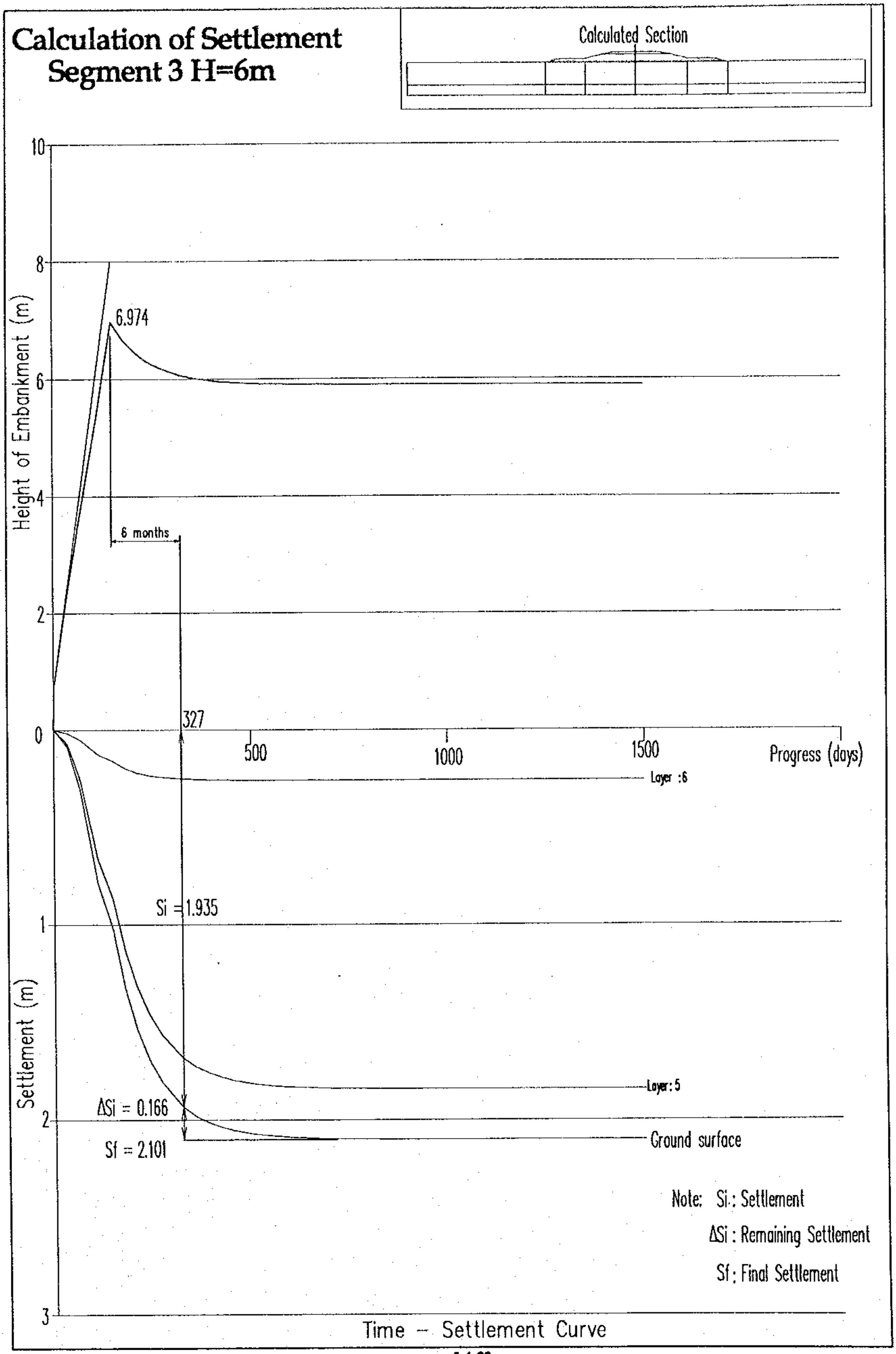


Time – Settlement Curve

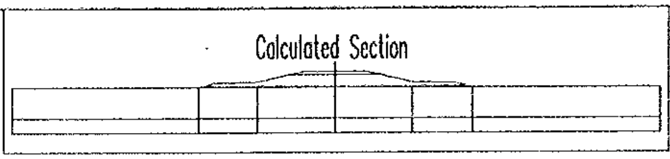
Calculation of Settlement
Segment 3 H=5m

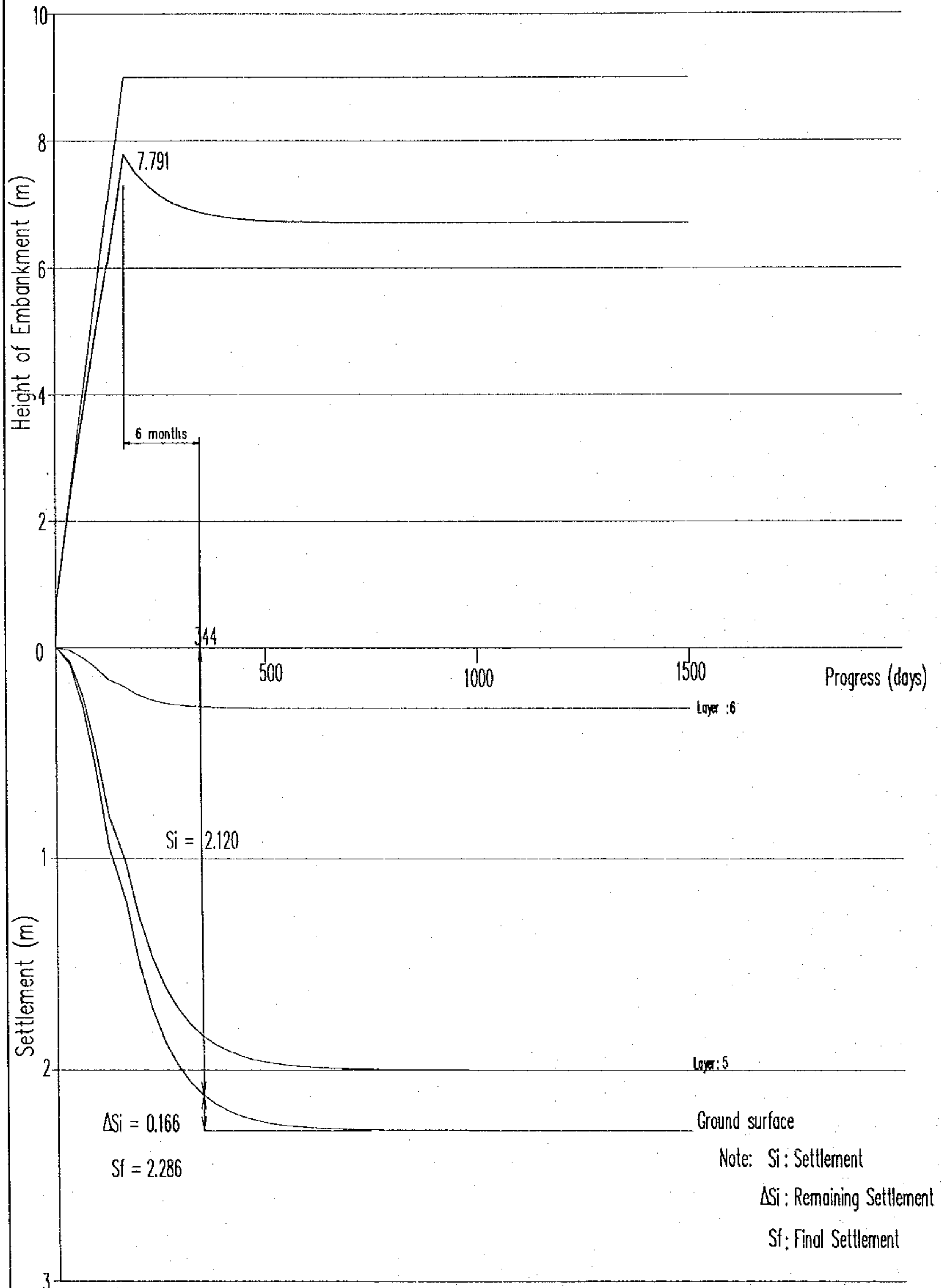


Calculation of Settlement
Segment 3 H=6m



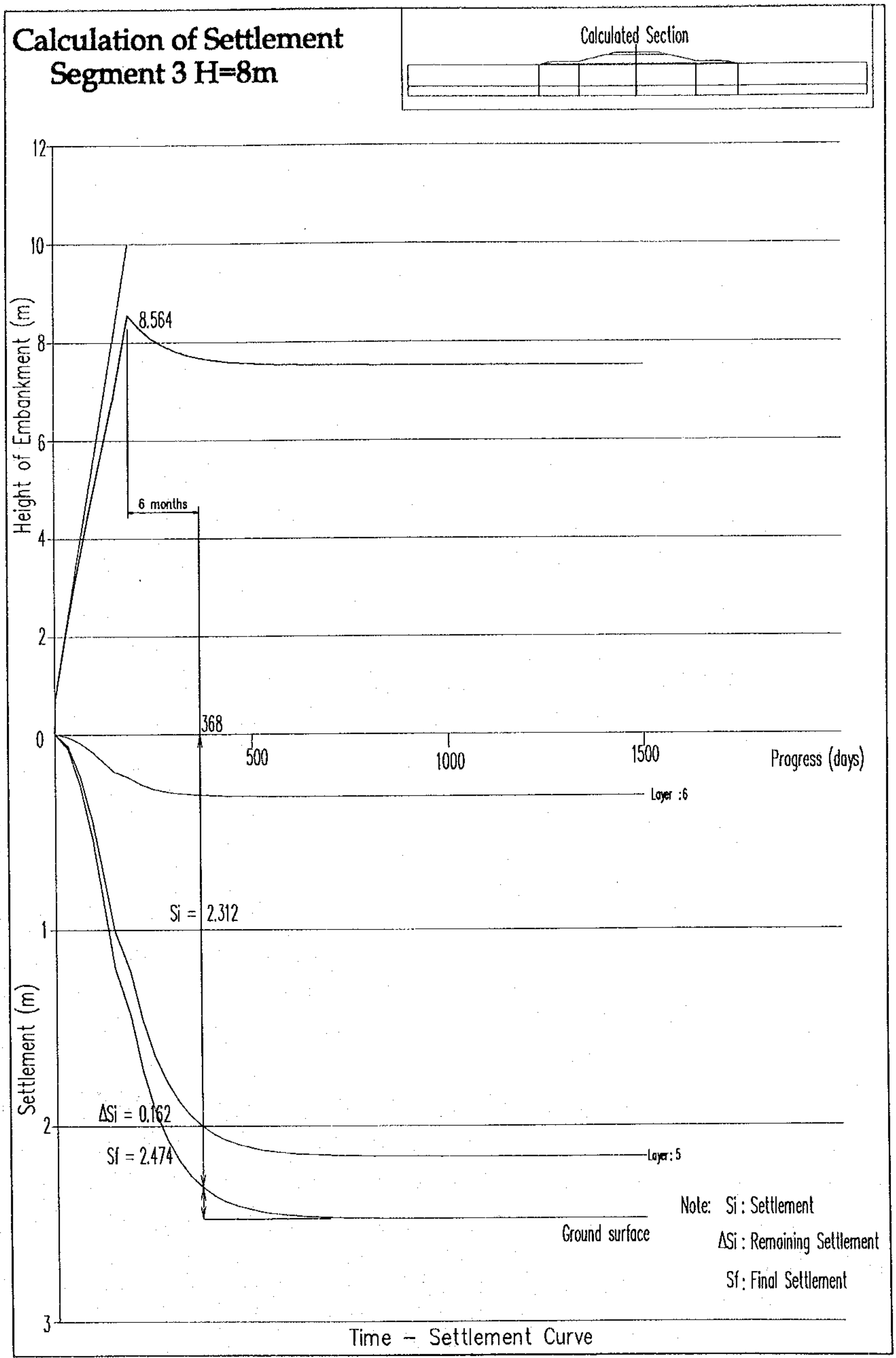
Calculation of Settlement
Segment 3 H=7m





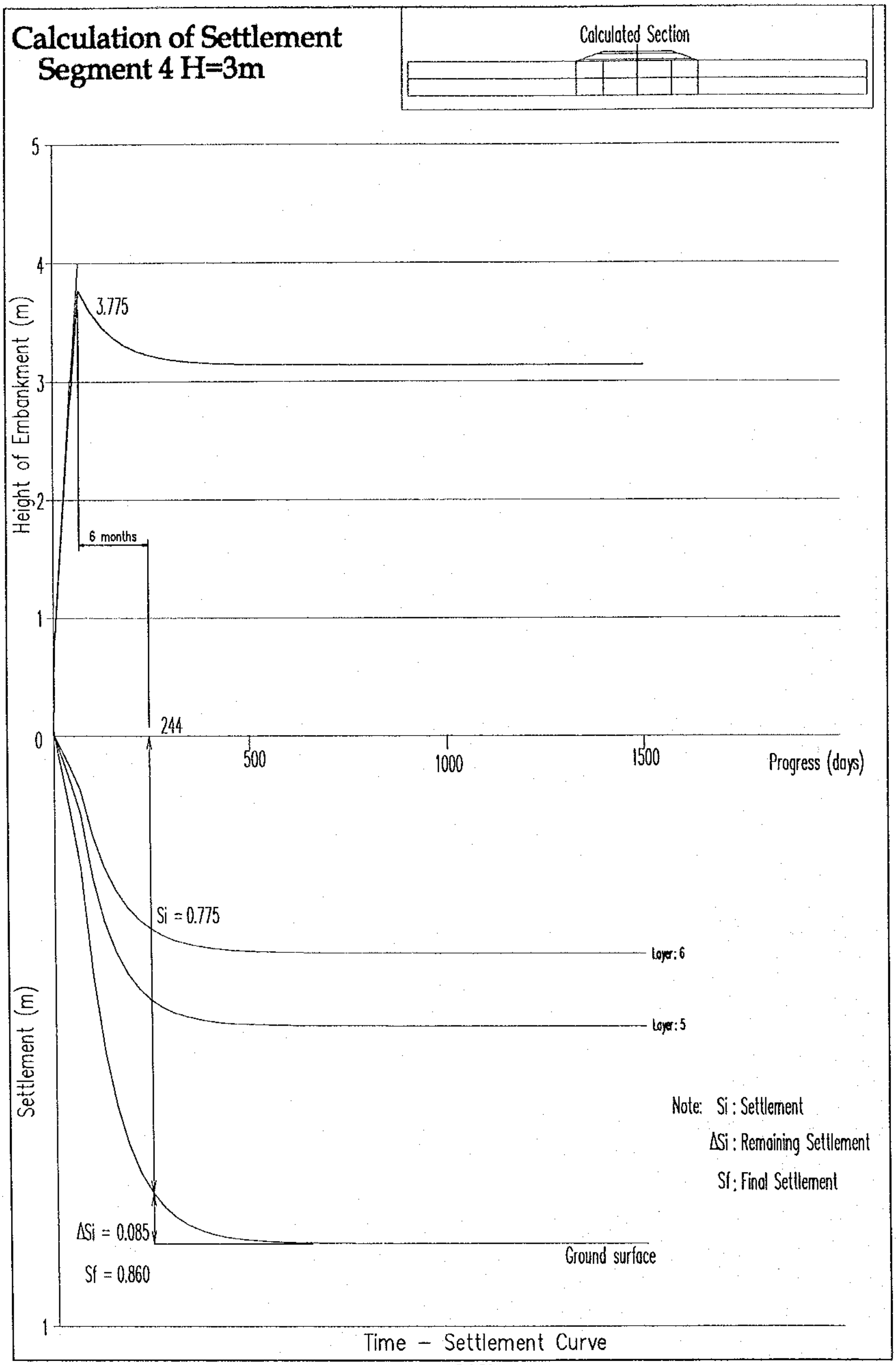
Time – Settlement Curve

Calculation of Settlement
Segment 3 H=8m

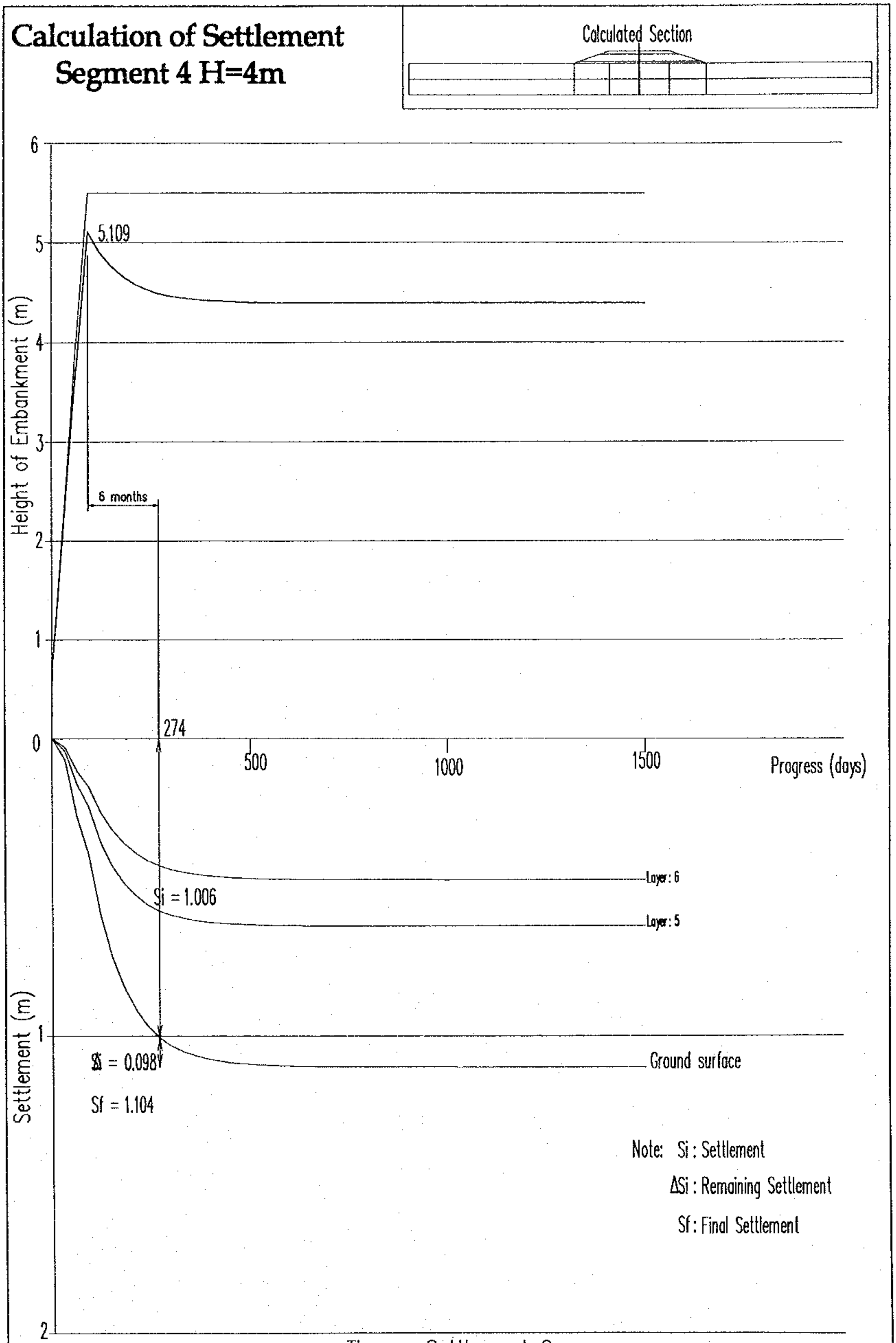


Time – Settlement Curve

Calculation of Settlement Segment 4 H=3m

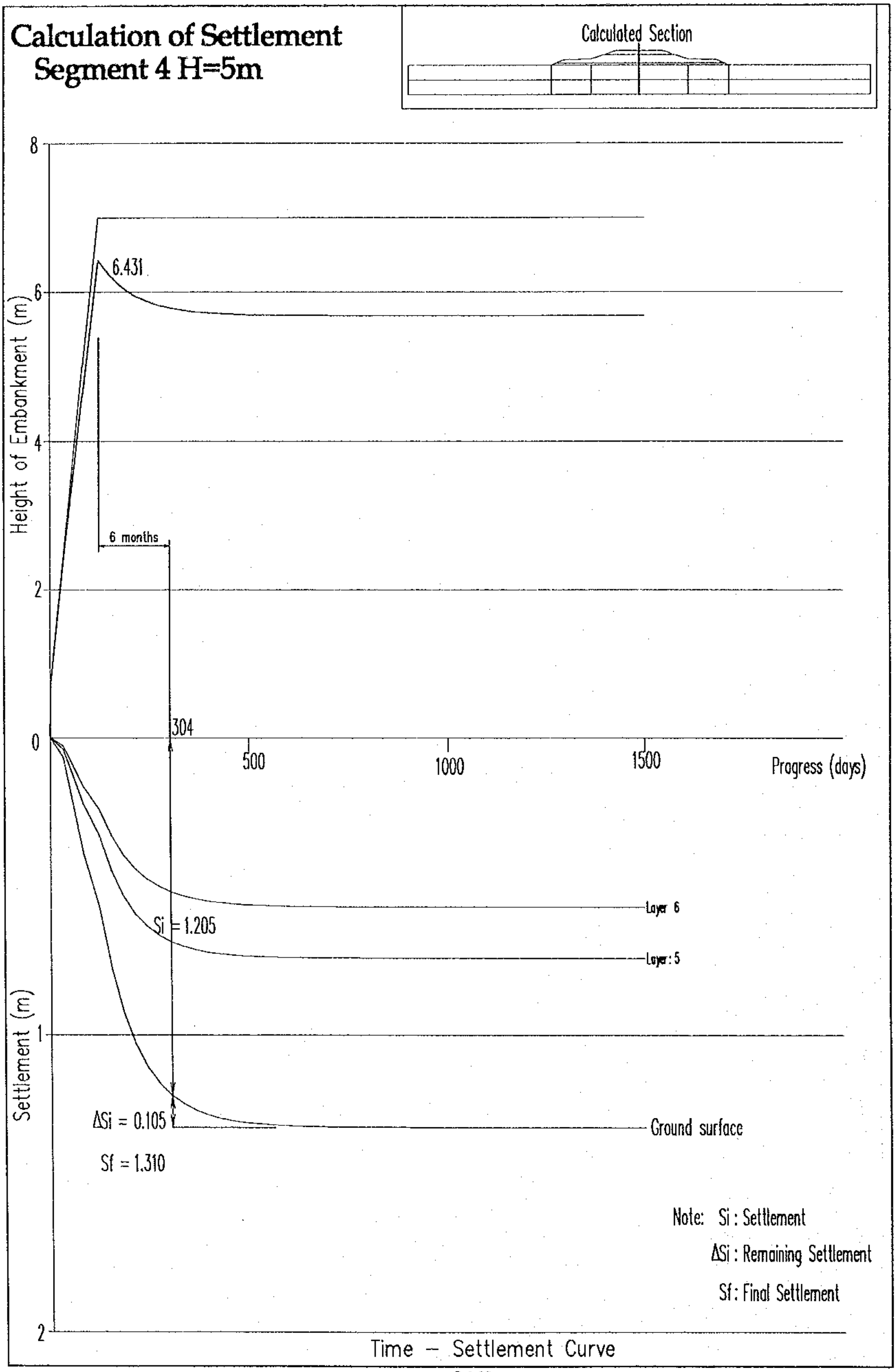


Calculation of Settlement
Segment 4 H=4m

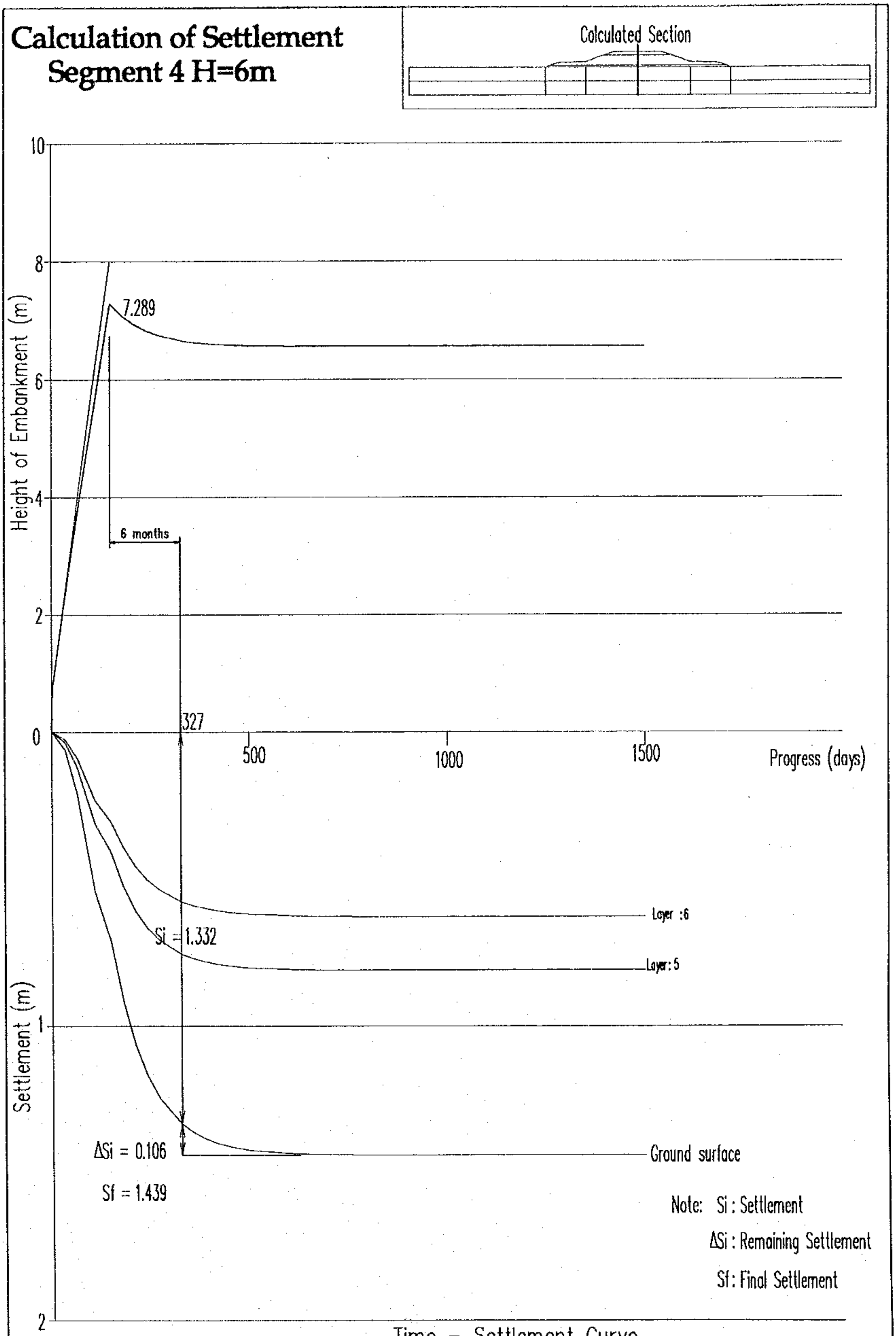


Time – Settlement Curve

Calculation of Settlement
Segment 4 H=5m

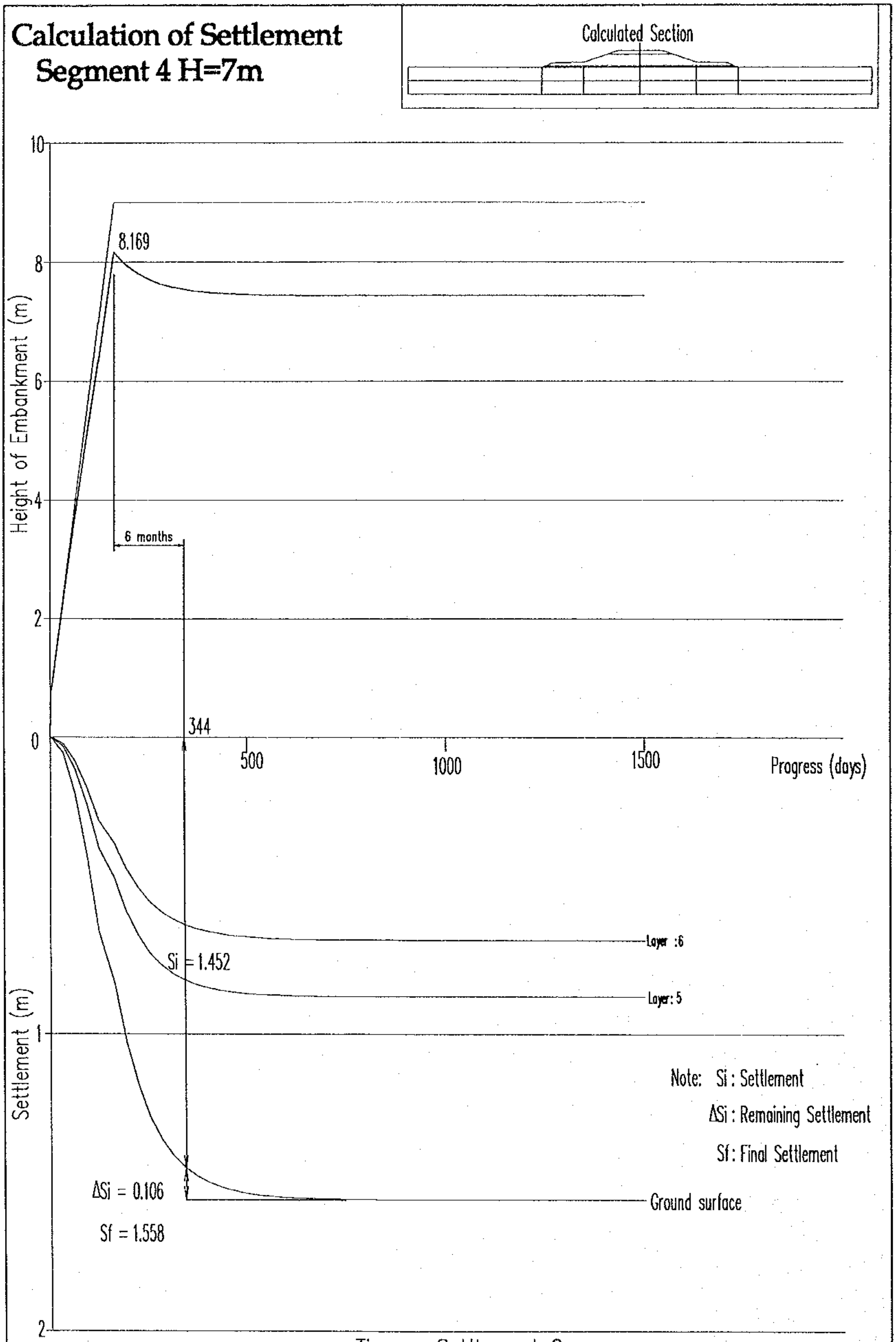


Calculation of Settlement
Segment 4 H=6m



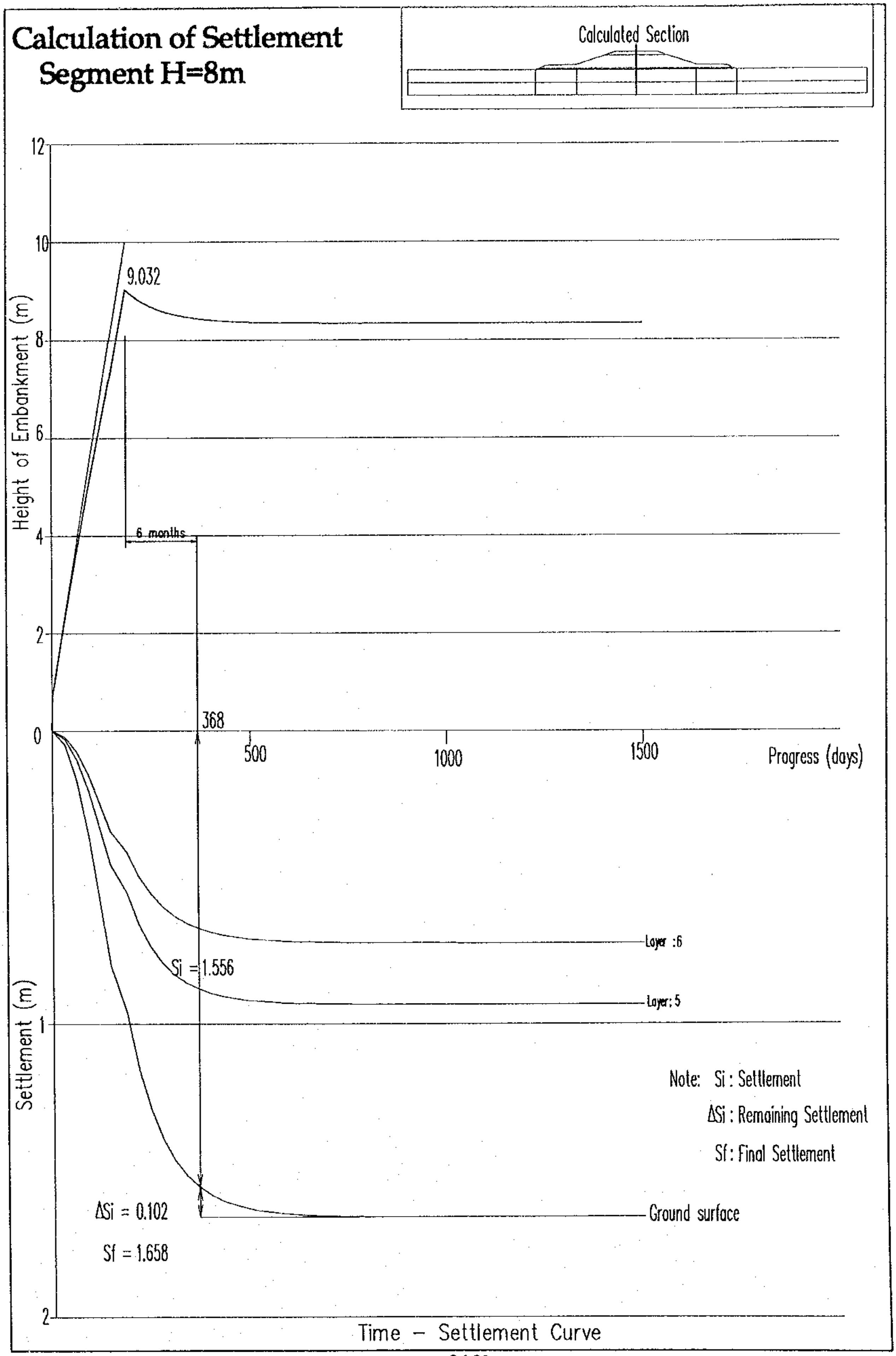
Time – Settlement Curve

Calculation of Settlement
Segment 4 H=7m



Time – Settlement Curve

Calculation of Settlement
Segment H=8m



Time – Settlement Curve

Chapter 5

FLEXIBLE PAVEMENT

CHARTER 5 FLEXIBLE PAVEMENT

CONTENTS

5.1. Traffic volume and Equivalent Single Axle Load (ESAL)

- Traffic volume, types of vehicles and traffic growth factor are forecasted to be used from a report of Feasibility Study.

- Equivalent single axle load is determined in accordance with types of vehicles and weighing data is referred in Rehabilitation Project NH No.1, section Sai Gon-Can Tho.

- Design cumulative ESAL is defined by the above 2 the basic data.

	Traffic	Growth Factors	Traffic	Design Traffic	Traffic equivalency factor	E.S.A.L two way	Design E.S.A.L
	2006	(2006-2010)	2010				(2006- 2010)
Light Buses	1267	0.13	2051	2,984,777	0.012	35,084	
Heavy Buses	566	0.12	898	1,318,486	0.870	1,147,083	
Light truck	918	0.17	1721	2,350,924	0.012	27,634	
Medium Truck	2201	0.17	4175	5,674,988	1.529	8,677,057	
Heavy Truck	185	0.21	397	512,799	1.670	856,374	
						10,743,232	4,834,454
	Traffic	Growth Factors	Traffic	Design Traffic	Traffic equivalency factor	E.S.A.L two way	Design E.S.A.L
	2010	(2010-2020)	2020				(2010- 2020)
Light Buses	2051	0.09	4420	11,322,610	0.012	133,090	
Heavy Buses	898	0.08	1834	4,806,725	0.870	4,181,851	
Light truck	1721	0.12	4958	11,280,179	0.012	132,591	
Medium Truck	4175	0.12	11978	27,296,293	1.529	41,736,032	
Heavy Truck	397	0.11	1053	2,475,955	1.670	4,134,845	
						50,318,410	22,643,284
Design E.S.A.L (2006- 2018)							27,477,739

5.1. Traffic volume and Equivalent Single Axle Load (ESAL)

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						50,318,410	**22,643,284**
Design E.S.A.L (2006- 2018)							27,477,739

5.2. Flexible Pavement Design

5.2.1 Design criteria

According to comparative cost result of pavement structures designed by methods of Viet Nam, Japan, AASHTO (see appendix I-5-2), AASHTO method is selected for design.

Following design criteria has been applied.

Table 5.2.1 Design Criteria for Pavement Design

Design Input Requirements			Value	Reference
1	Design Variables	Performance Period (years)	15	22TCN211-93
		Analysis Period (years)	15	22TCN211-93
		Traffic		
		Equivalent Single Axle Load (ton)	8.2	AASHTO
		Directional Distribution Factor, D_D	0.5	AASHTO
		Lane Distribution Factor, D_L	0.9	AASHTO
		Reliability	99	AASHTO
		Overall Standard Deviation	0.45	AASHTO
2	Performance Criteria	Initial Serviceability Index, p_0	4.2	AASHTO
		Terminal Serviceability Index, p_t	2.5	AASHTO
		Design Serviceability Loss, ΔPSI	1.7	AASHTO
3	Material Properties	Effective Roadbed Soil Resilient Modulus, M_R (psi)	1500 x CBR	Asphalt Inst.
		Layer Coefficient for Asphalt Concrete, a_1	-	AASHTO
		Layer Coefficient for Base Course, a_2	-	AASHTO
		Layer Coefficient for Subbase Course, a_3	-	AASHTO
4	Pavement Characteristics	Drainage Coefficients for Base Course and Subbase Course, m_2, m_3	1.25	AASHTO

5.2.2 Design data

The design variables, performance criteria and pavement characteristics are selected as given in the Table 5.2.1. The estimated design ESAL (equivalent single axle load) is 27×10^6 number of applications from the traffic forecast.

5.2.2.1 Material properties

1. The effective roadbed soil resilient modulus, M_R will be computed from the CBR value of the subgrade material.

Table 5.2.2 The CBR test result and the calculation result of design CBR.

Lab No	Material	Location	CBR(%)	Remarks
46	Dai Ngai 2 Sand	Tra Ech	13.2	
46-a			10.6	
46-b			9.4	
Average			11.1	
Standard deviation	=STDEV(13.2,10.6,9.4)		1.9	
Design CBR			8	11.1-1.9=9.2

Lab No	Material	Location	CBR(%)	Remarks
912	River Sand	1km down stream of proposed bridge	11.5	
912a			9.6	
912b			9.6	
Average			10.2	
Standard deviation	=STDEV(13.2,10.6,9.4)		1.1	
Design CBR			8	10.2-1.1=9.1

2. The CBR value of subbase material is taken as greater than 30%. This value of CBR shall be mentioned in the specification of subbase materials.

3. The CBR value of granular base material is taken as greater than 80%. This value shall be mentioned in the specification of base materials.

4. Design of flexible pavement by AASHTO method requires the selection of elastic modulus of Asphalt Concrete (E_{AC}). The value of E_{AC} has been taken as 400,000 psi in AASHTO. AASHTO recommends using value based on the local practice. In Vietnam, similar projects like National Highway No.5 used 400,000 in some of the sections. National Highway No.18 project used a value of 300,000 for surface course as well as binder course. In accordance with pavement Exporter, E_{AC} value of 400.000 psi is very high. Based on these facts, the design value of E_{AC} will be taken as 300,000 psi.

5.2.2.2 Layer coefficients

For the material properties described in section 5.2.2.1, the layer coefficients are calculated from the chart (equation) given in AASHTO for the respective materials.

Table 5.2.3, Layer coefficients of pavement materials

Material Type	Coefficient
Layer coefficient for asphalt concrete a1, E_{AC}=300,000psi	0.37
Layer coefficient for granular base course CBR≥80	0.132
Layer coefficient for subbase course CBR≥30	0.109

5.2.3. AASHTO design concept

For a set of design data of Reliability, Standard Deviation, ESAL applications, effective roadbed soil resilient modulus and Design Serviceability Loss, the Design Structural Number, SN is computed from the Nomograph or from the given relationship.

AASHTO states that, once the design structure number (SN) for an initial pavement structure is determined, it is necessary to identify a set of pavement layer thickness which, when combined, will provide the load-carrying capacity corresponding to the design SN. The following equation provides the basis for converting SN into actual thickness of surfacing, base and subbase:

NOMOGRAPH SOLVES:

$$\log_{10} W_{18} = Z_R * S_0 + 9.36*\log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2 - 1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32*\log_{10} M_R - 8.07$$

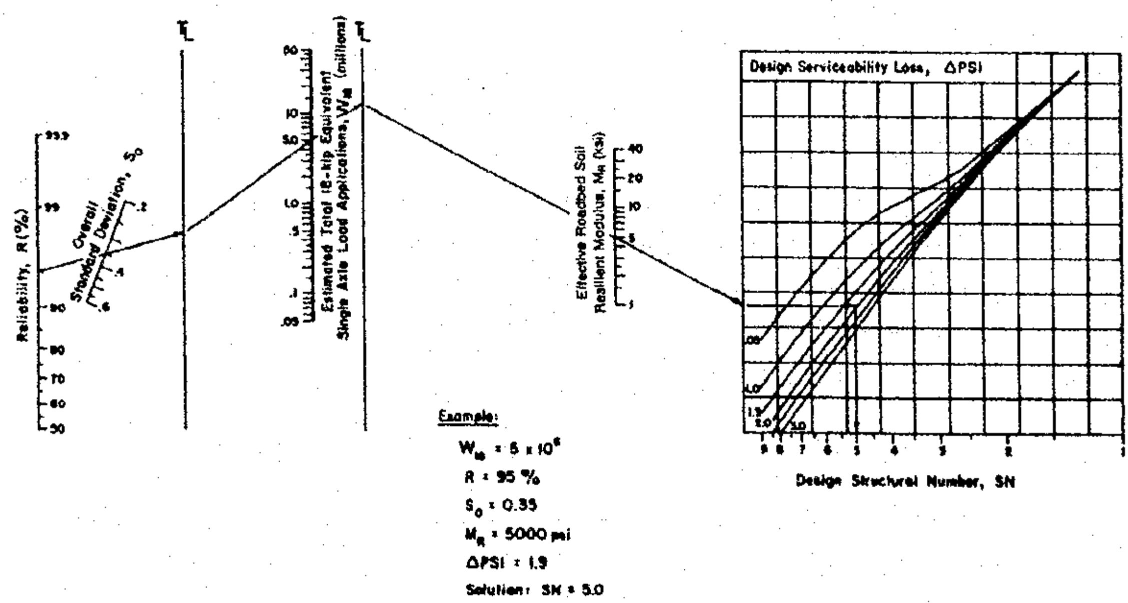


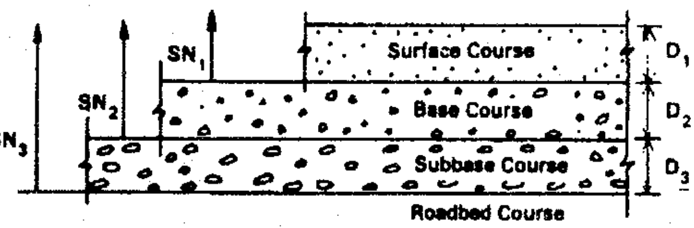
Figure 3.1. Design Chart for Flexible Pavements Based on Using Mean Values for Each Input

$SN = a_1D_1 + a_2D_2m_2 + a_3D_3m_3$

Where,

a_1, a_2, a_3	=	layer coefficients representative of surface, base, and subbase courses, respectively
D_1, D_2, D_3	=	actual thickness (in inches) of surface, base, and subbase courses, respectively
m_2, m_3	=	drainage coefficients for base and subbase layers, respectively

AASHTO further states, it should be recognized that, for flexible pavements,



$$D^*_1 \geq \frac{SN_1}{a_1}$$

$$SN^*_1 = a_1D^*_1 \geq SN_1$$

$$D^*_2 \geq \frac{SN_2 - SN^*_1}{a_2 m_2}$$

$$SN^*_1 + SN^*_2 \geq SN_2$$

$$D^*_3 \geq \frac{SN_3 - (SN^*_1 + SN^*_2)}{a_3 m_3}$$

1) a, D, m and SN are as defined in the text and are minimum required values.

2) An asterisk with D or SN indicates that it represents the value actually used, which must be equal to or greater than the required value.

Figure 3.2. Procedure for Determining Thicknesses of Layers Using a Layered Analysis Approach

the structure is a layered system and should be designed accordingly. The structure should be designed in accordance with the principles shown in Figure 3.2. First, the structural number required over the roadbed soil should be computed. In the same way, the structural number required over the subbase layer and the base layer should also be computed, using the applicable strength values for each. By working the difference between the computed structural numbers required over each layer, the maximum allowable thickness of any given layer can be computed.

5.2.4 Thickness design

Based on the design concept given in Figure 3.2, the calculated thickness for various layers have been summarized in Table 5.2.4 for various cases. SB, BS and AC stand for subbase course, base course, asphalt concrete course respectively.

Table 5.2.4, Calculated layer thickness

SN3	SN2	SN1	Calculated thickness			Rounded thickness		
			SB	BS	AC	SB	BS	AC
5.701	5.3108	4.2996	6	15	30	15	15	30

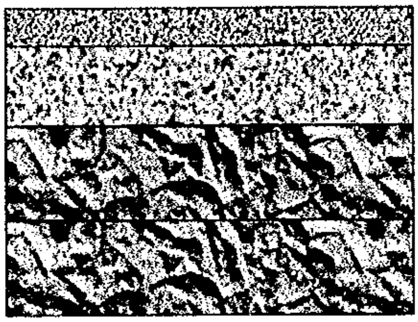
The thickness 15cm for subbase and base courses corresponds to the minimum practical thickness requirements in the rounded values.

Comparison of the results with design on other highway projects show that, asphalt concrete thickness of Class I,II roads is between 12cm and 15cm in a common practice in Vietnam due to economical reasons. AASHTO suggests a minimum of 4 in of asphalt concrete for traffic level more than 7 million equivalent single axle load. However, AASHTO does not provide any information on asphalt concrete thickness requirement for different types of base strength. Based on these it is concluded that 15cm of asphalt concrete with 5cm of surface course and 10cm of binder course shall be taken.

AASHTO also states that, the structural number equation does not have a single unique solution; i.e., there are many combinations of layer thickness that are satisfactory solutions. AASHTO further states, when selecting appropriate values for the layer thickness, it is necessary to consider their cost effectiveness along with the construction and maintenance constraints in order to avoid the possibility of producing an impractical design. The layer thickness are re-calculated to satisfy the structural number equation ($SN = a_1D_1 + a_2D_2m_2 + a_3D_3m_3$) with 5cm of asphalt concrete surface course and 10cm of asphalt concrete binder course. The results for this alternate are given in Table 5.2.5.

Table 5.2.5, Calculated Layer Thicknesses

SN3	Calculated thickness			
	SB	BS	AC	TOTAL
5.701	30	30	15	75



5cm asphalt concrete surface course

10cm asphalt concrete binder course

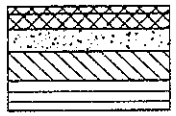
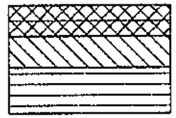
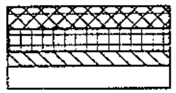
30cm aggregate base course CBR≥80

30cm aggregate subbase course CBR≥30

Traffic Input Data for Pavement Design
Hightway No.1 Rehabilitation Project

WIM Site	Km Post	AADT	Percent Heavy Vehicles	Distribution of Heavy Vehicles				Direction	Average ESAL/Vehicle				ESALs (million)	
				Singie-Unit		Truck-Trailer			Single-Unit		Truck-Trailer			
		1996		2-axle 6-tire	3-axle	<=4-axle	5-axle		2-axle 6-tire	3-axle	<=4-axle	5-axle	1996	10-Yr
Contract 3:														
1	1916	11400	55.40%	70.60%	18.30%	4.90%	6.20%	NB	2.40	5.99	1.93	2.35	3.49	61.20
								SN	1.24	0.88	1.16	1.58	1.37	24.10
2	1933	9200	54.50%	93.30%	4.70%	1.40%	0.60%	NB	1.09	0.98	0.30	1.31	0.98	17.20
								SB	1.05	0.96	0.44	1.18	0.95	16.70
3	1942	8800	50.70%	91.90%	4.40%	1.60%	2.10%	NB	1.11	0.68	2.08	0.94	0.90	15.70
								SB	0.96	0.58	1.14	0.57	0.76	13.40
4	1950	7600	53.00%	91.60%	4.40%	1.70%	2.30%	NB	0.90	0.76	0.53	0.74	0.65	11.40
								SB	0.66	0.67	0.21	1.16	0.49	8.60
5	1969	5800	54.20%	91.10%	5.90%	1.50%	1.50%	NB	2.32	1.10	0.88	2.13	1.28	22.40
								SB	0.88	0.51	0.78	1.31	0.50	8.70
6	1993	5400	58.00%	92.40%	4.10%	1.90%	1.60%	NB	1.99	1.27	0.92	1.86	1.11	19.40
								SB	1.60	1.38	1.07	2.05	0.91	15.90
7	2009	4650	46.70%	91.80%	4.70%	2.40%	1.10%	NB	1.72	0.39	0.24	0.59	0.64	11.20
								SB	1.77	0.44	1.18	1.56	0.67	11.70
8	2025	3500	46.00%	96.10%	3.00%	0.20%	0.70%	NB	1.67	0.43	0.21	0.66	0.48	8.40
								SB	1.58	0.47	0.84	1.31	0.45	8.00
9	2030	2800	47.20%	92.20%	5.10%	1.60%	1.10%	NB	1.46	0.38	0.18	0.53	0.33	5.80
								SB	1.97	2.30	0.59	1.26	0.47	8.30
10	2051	2100	50.30%	96.00%	2.90%	0.90%	0.20%	NB	1.46	0.77	1.32	5.85	0.28	4.90
								SB	2.75	1.16	1.06	4.39	0.52	9.10

Comparison of Pavement Structure

Design Standards		Pavement Structure	Costs(US$/m ^{2})	Remarks
Case-1 Vietnam Design Standards 22TCN211-93 (Design Specification for Flexible Pavements -1993)		 Thickness ; 70cm 5cm Asphalt Surface Concrete 10cm Asphalt Binder Concrete 15cm Fine Aggregate Treated 5% Cement Base Course 20cm Fine Aggregate Base Course 20cm Crushed Aggregate Subbase Course	23.9	
Case-2 Japan Road Association (The Policy of Asphalt Pavement Design -1992)	a)	 Thickness ; 70cm 10cm Asphalt Surface Concrete 10cm Asphalt Binder Concrete 20cm Fine Aggregate Base Course 30cm Crushed Aggregate Subbase Course	25.6	
	b)	 Thickness ; 55cm 5cm Asphalt Surface Concrete 10cm Asphalt Binder Concrete 15cm Asphalt Treated Macadam Base Course 10cm Fine Aggregate Base Course 15cm Crushed Aggregate Subbase Course	27.9	
Case-3 AASHTO (Guide for Design of Pavement structures)		 Thickness ; 75cm 5cm Asphalt Surface Concrete 10cm Asphalt Binder Concrete 30cm Fine Aggregate Base Course 30cm Crushed Aggregate Subbase Course	23.5	To be recommended

Note; Sub-Grade Design CBR=8(%)

Legend; Asphalt Concrete, Asphalt Treated Macadam Base Course, Fine Aggregate Treated 5% Cement Base Course, Fine Aggregate Base Course, Crushed Aggregate Subbase Course

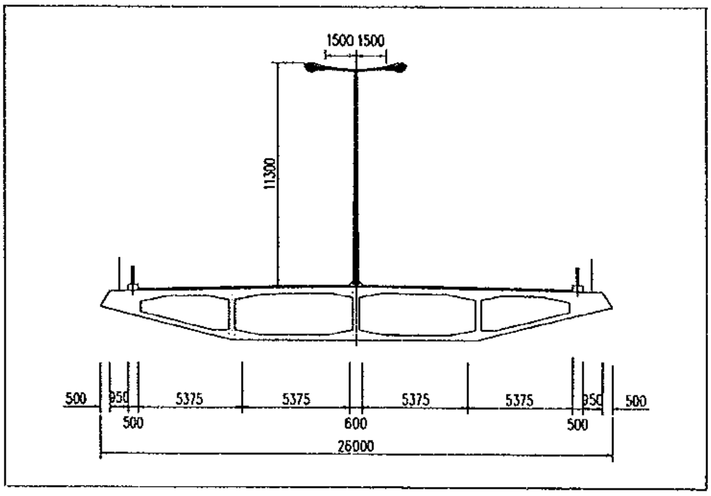
THE DETAILED DESIGN OF THE CAN THO BRIDGE CONSTRUCTION IN SOCIALIST REPUBLIC OF VIET NAM	Comparison of Pavement Structure
	JAPAN INTERNATIONAL COOPERATION AGENCY

Chapter 6

LIGHTING SYSTEM

Design of Road Lighting

Street lighting luminaries is 250W High Pressure Sodium vapor type having a light distribution complying with Semi Cut-off.
And it is mounted at 11.5m from road surface, with 15deg of mounting angle, on a double armed street lighting column as below.



Lighting spacing(S) is decided by road width(W) and lighting height(H) with reference to Vietnam Standard 20TCN95-83. Road width is 10.25m(without shoulder) and lighting height is 11.5m, therefore lighting spacing(S) is sufficient with 40m to refer to the table below.

Determination for height of installing Light according to equal Light level

Light Sorce	Height of installing Light	Ratio: S/H
High Pressure Sodium	>0.8W	4
High Pressure Mercury	>1.0W	3.5
Low Pressure Sodium	>1.2W	3-3.5

W : Road Width(Sphere for lighting of light) ; m
S : Lighting spacing(Distance between 2 light) ; m
H : Height of installing light ; m

The result of luminance calculation from the above condition was 18.5 lux in average. Therefore Standard luminance is 1.23cd/m^2 (= 18.5÷15.0), because this project line is asphalt pavement.

Luminance coefficicient

Required illuminance for luminance 1nt(cd/m^2)	
Asphalt	15 lx/cd/m^2
Concrete	10 lx/cd/m^2

The traffic volume prediction of this project line is 30,000 units per day in 2010 and 70,000 units per day in 2020.

In the case of fragment line in a time, the traffic volume will be 625 units per day in 2010 and 1,500 units per day in 2020. Judging from the above, Lighting luminance is in need of 1.2 cd/m² to be shown in table as below.

Therefore, this lighting plan is satisfied with Standard Luminance.

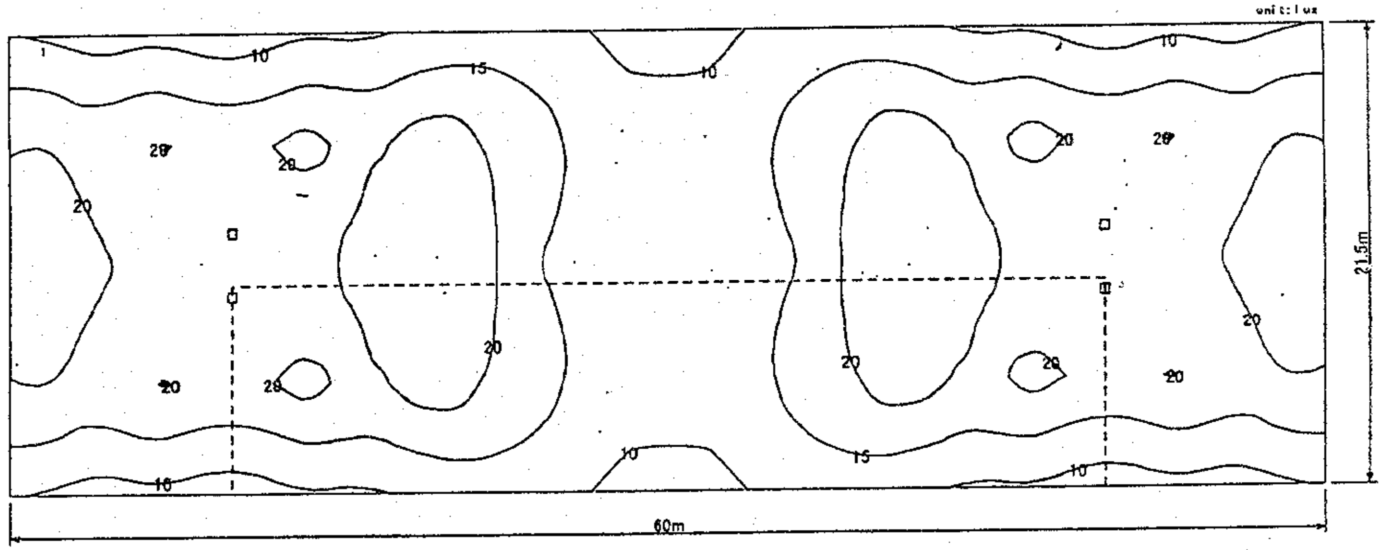
Determination of Average Dazzling L(tb)

Light Catertgories	Maxium Traffic Volume	L(tb) cd/m²
A	from 3,000 cars or more	1.6
	from 1,000 to 3,000 cars	1.2
	from 500 to 1,000 cars	1.0
	less than 500 cars	0.8

A: Freeway／ Street of Class Ⅰ, Ⅱ／Main Square of city／Transport Square etc.

For the reasons mentioned above, we decide that lighting spacing(S) is 40m in basically.

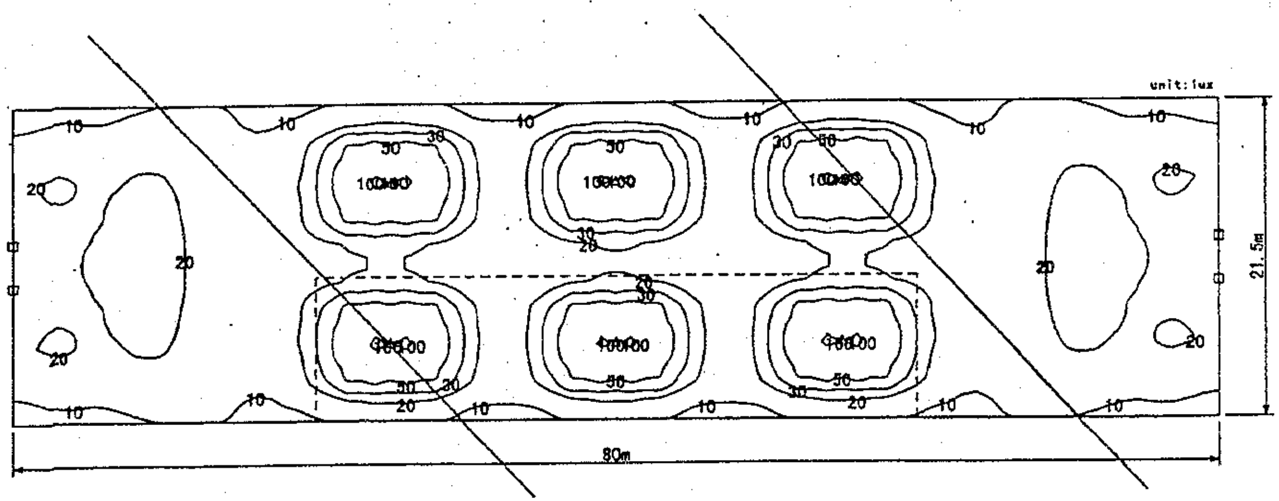
Illuminance Distribution at the Typical Portion of Throughway



	□
Model No.	YAT35125
Lamp	NH250
Total Luminous Flux	26500 lumen
Maintenance Factor	0.6
Light Distribution Code	#K60333
Mounting Height	11.5 m
Q'ty of Luminaire	4 sets

	- - - - - - - -
Area	Road Area
Average Illuminance	16.0 lux
Minimum Illuminance	8.1 lux
Maximum Illuminance	27.2 lux
E min./E ave.	0.509
E min./E max.	0.300

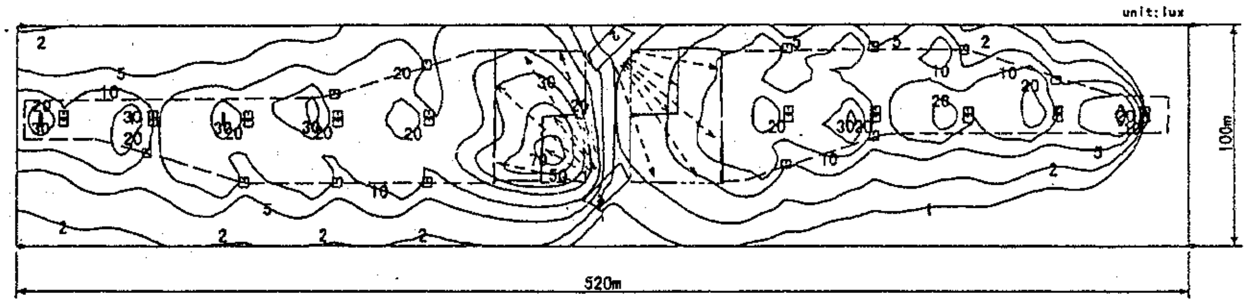
Illuminance Distribution at the Underpass Portion of Interchange Viaduct



	◻	△
Model No.	YAT35125	YB56232
Model Name	·	サービスステーション用器具
Lamp	NHT250	NH150
Total Luminous Flux	26500 lumen	14500 lumen
Maintenance Factor	0.6	0.6
Light Distribution Code	※K60333	K67164
Mounting Height	11.5 m	4.5 m
Q'ty of Luminaire	4 sets	6 sets

	- - - - - - - - -
Average Illuminance	35.9 lux
Minimum Illuminance	7.6 lux
Maximum Illuminance	106.6 lux
E min./E ave.	0.213
E min./E max.	0.072

Vertical Illuminance Distribution around Toll Gate



	⊡	- - - - - - - - ►
Model No.	YAT35125	YA58350
Model Name		[illegible]
Lamp	NHT250	H1000
Total Luminous Flux	26500 lumen	55000 lumen
Maintenance Factor	0.6	0.6
Light Distribution Code	WK60333	K51273
Mounting Height	11.5 m	20 m
Q'ty of Luminaire	32 sets	12 sets

Area	A	B	C	D	E	F
Average Illuminance	53.7 lux	36.1 lux	3.79 lux	6.91 lux	16.1 lux	12.7 lux
Minimum Illuminance	24.6 lux	6.3 lux	2.33 lux	1.80 lux	7.5 lux	0.0 lux
Maximum Illuminance	90.4 lux	73.3 lux	5.39 lux	13.39 lux	41.1 lux	35.6 lux
E min./E ave	0.459	0.173	0.614	0.261	0.462	0.000
E min./E max	0.272	0.085	0.432	0.135	0.181	0.000

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