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APPENDIX A

KRIEL VISUAL SETTLEMENT INDICATOR TRIAL

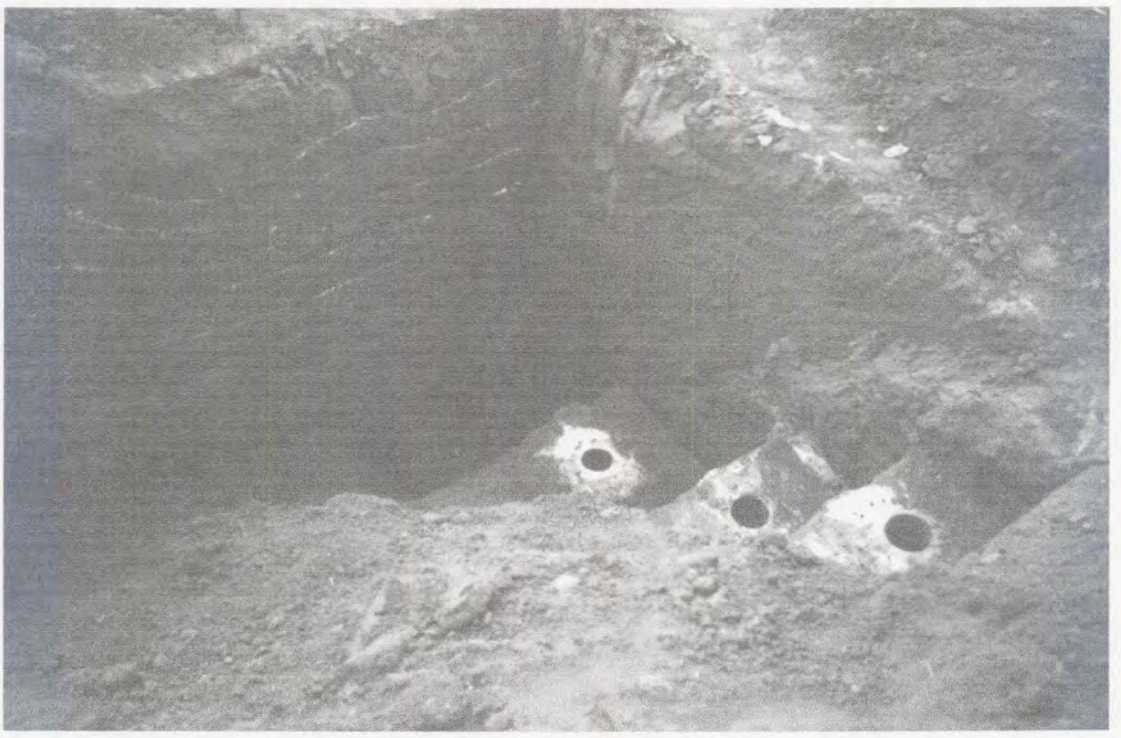
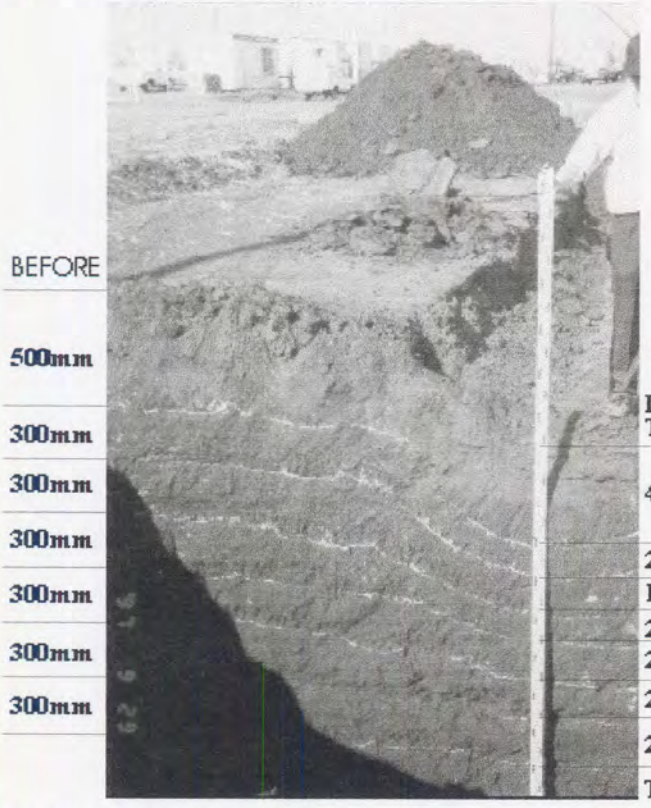


Plate A1 : Excavation after compaction of 25kJ compactor (Photo by Landpac)



AFTER

Layer Thickness	Settlement (mm)	Strain (%)
425mm	75mm	13.6
200mm	100mm	18.2
175mm	125mm	22.7
200mm	100mm	18.2
225mm	75mm	13.6
250mm	50mm	9.1
275mm	25mm	4.5
Total	550mm	

Plate A2 : Excavation after compaction of 25kJ compactor (Photo by Landpac)

Table A1: Measured changes in layer thickness, Kriel, 1997 (after Africon, 1998)

Layer	Initial thickness (mm)	Final thickness (mm)	Compression (mm)	Strain
1	500	425	75	0.150
2	300	200	100	0.333
3	300	175	125	0.417
4	300	200	100	0.333
5	300	225	75	0.250
6	300	250	50	0.167
7	300	275	25	0.083

APPENDIX B

ESTIMATION OF DISPLACEMENTS, VELOCITIES AND ACCELERATIONS OF LANDPAC IMPACT COMPACTORS USING THE DAVIES & KARIM (1995) MODEL

APPENDIX B: OTHER EQUATIONS USED IN ANALYSIS (AFTER DAVIES & KARIM, 1995)

$$k = \frac{4G.r}{(1-v)} \qquad (1)$$

$c=\rho.A.V$ (2) V=compression-extension wave velocity

$$V = \frac{3.4.Vs}{\pi(1-v)} \qquad (3')$$

OR....

$$V = \sqrt{(\lambda + 2G)/\rho}$$

$$\lambda = \frac{2vG}{1-2v}$$

$$\therefore c = \frac{3.4.r^2\sqrt{\rho G}}{(1-v)} \qquad (3)$$

m.a+c.v+k.z = 0 (4)

$$c = \rho\pi r^2\sqrt{\frac{\lambda+2G}{\rho}}$$

$$\therefore c = \pi r^2\sqrt{\rho(\lambda+2G)}$$

$$z = \frac{V_o}{\varpi_d}e^{-\varpi_n D.t}.\sin(\varpi_d.t) \qquad (5)$$

$$\frac{dz}{dt} = v = \frac{V_o}{\varpi_d}e^{-\varpi_n D.t}.(-\varpi_n.D).\sin(\varpi_d.t) + \frac{V_o}{\varpi_d}e^{-\varpi_n D.t}.\cos(\varpi_d.t).\varpi_d$$

$$\therefore v = V_o e^{-\varpi_n D.t}.\cos(\varpi_d.t) - V_o D\frac{\varpi_n}{\varpi_d}e^{-\varpi_n D.t}.\sin(\varpi_d.t) \qquad (5a)$$

$$a = \frac{d^2 z}{dt^2} = \ddot{z} = V_o e^{-\varpi_n D.t}.(-\varpi_n D)\cos(\varpi_d.t) + V_o e^{-\varpi_n D.t}.-\sin(\varpi_d.t)\varpi_d$$

$$- V_o D\frac{\varpi_n}{\varpi_d}e^{-\varpi_n D.t}(-\varpi_n.D)\sin(\varpi_d.t) - V_o D\frac{\varpi_n}{\varpi_d}.e^{-\varpi_n D.t}\cos(\varpi_d.t)\varpi_d$$

$$\therefore a = V_o e^{-\varpi_n D.t}\left[\sin(\varpi_d.t)\left(\frac{\varpi_n^2.D^2}{\varpi_d} - \varpi_d\right) - 2\varpi_n.D.\cos(\varpi_d.t)\right] \qquad (5b)$$

$$D = \frac{c}{2}\sqrt{k.m} \qquad (6)$$

$$\varpi_d = F.\varpi_n \qquad (7)$$

$$F = \sqrt{1-D^2} \qquad (8)$$

Arrival times:

$$t_z = \frac{\alpha_z}{\varpi_n} \qquad (9a)$$

$$t_v = 2t_z \qquad (9b)$$

$$t_a = \frac{\alpha_a}{\varpi_n} \qquad (9c)$$

the dimensionless coefficients are

$$\alpha_z = \frac{\tan^{-1}\frac{F}{D}}{F} \qquad (10a)$$

$$\alpha_a = \frac{\tan^{-1}\frac{(1-4D^2)F}{3D-4D^3}}{F} \qquad (10b)$$

APPENDIX B: [DAVIES & KARIM, 1995]

The corresponding displacement (rebound) velocity and acceleration maxima are:

$$z_m = \beta \frac{V_o}{\varpi_n} \qquad (11a)$$

$$v_m = -\beta . V_o \qquad (11b)$$

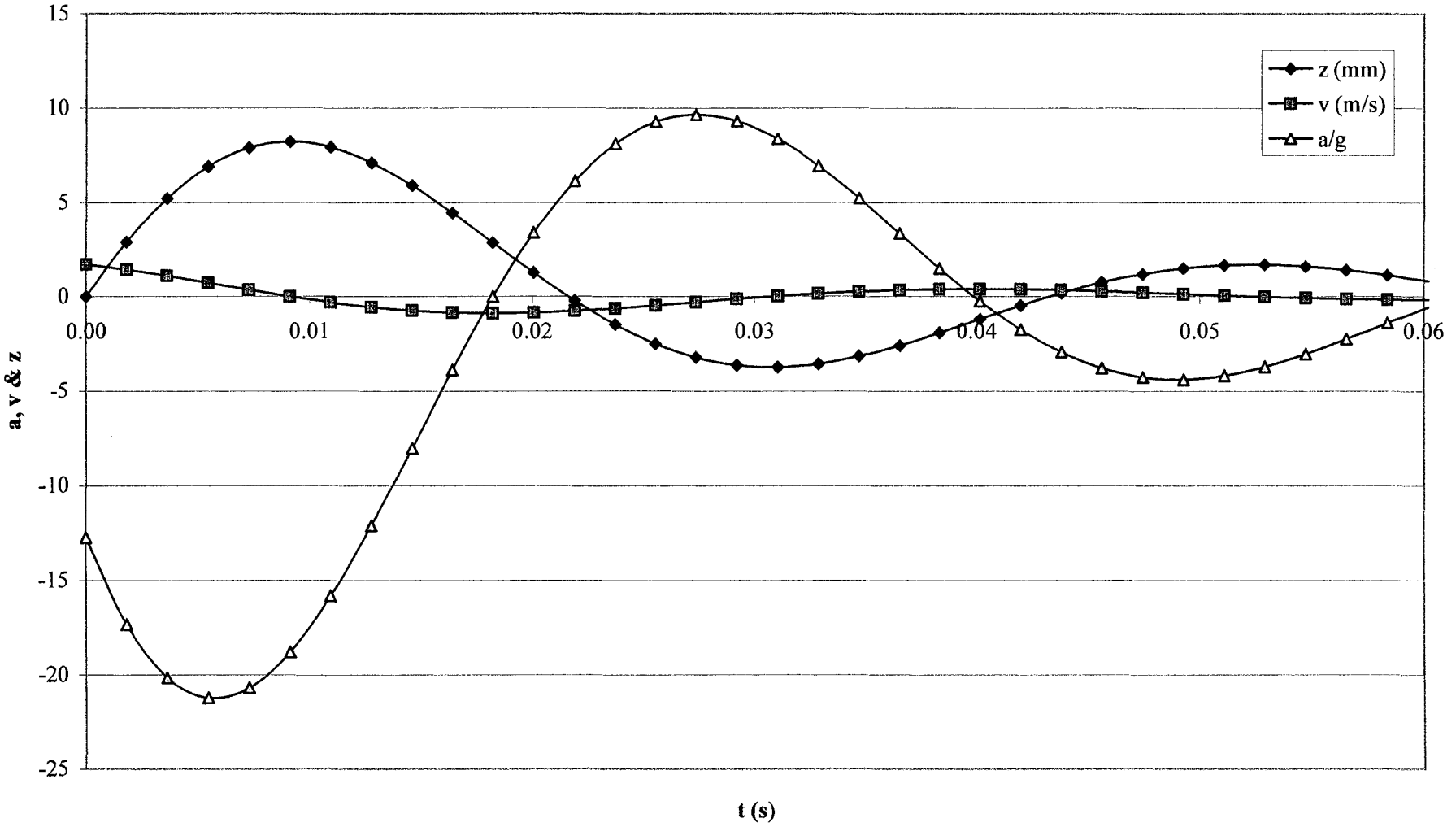
$$a_m = -\beta_a . V_o \varpi_n \qquad (11c)$$

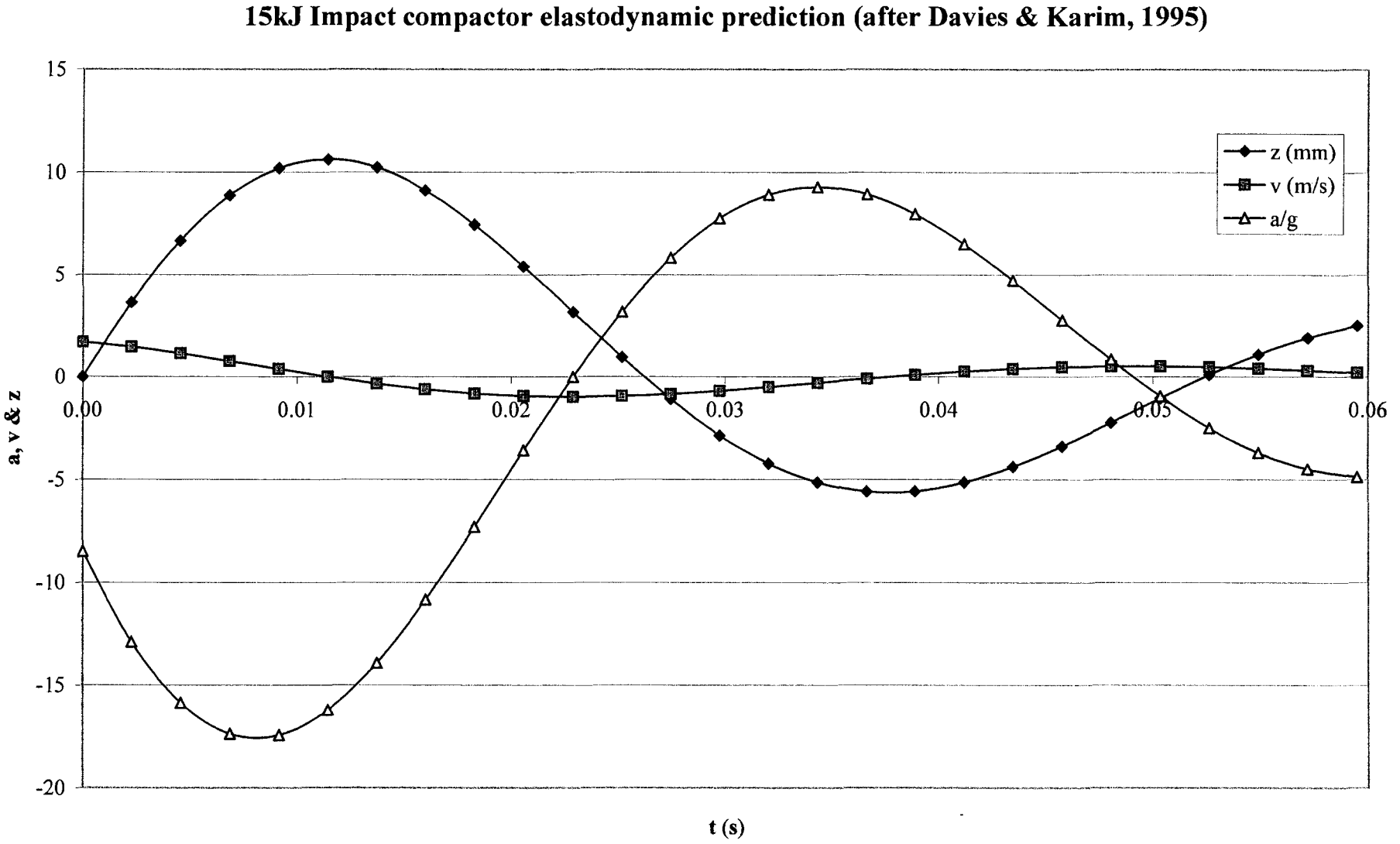
$$\beta_z = e^{-D.\alpha_z} \qquad (12a)$$

$$\beta_v = e^{-2D.\alpha_z} \qquad (12b)$$

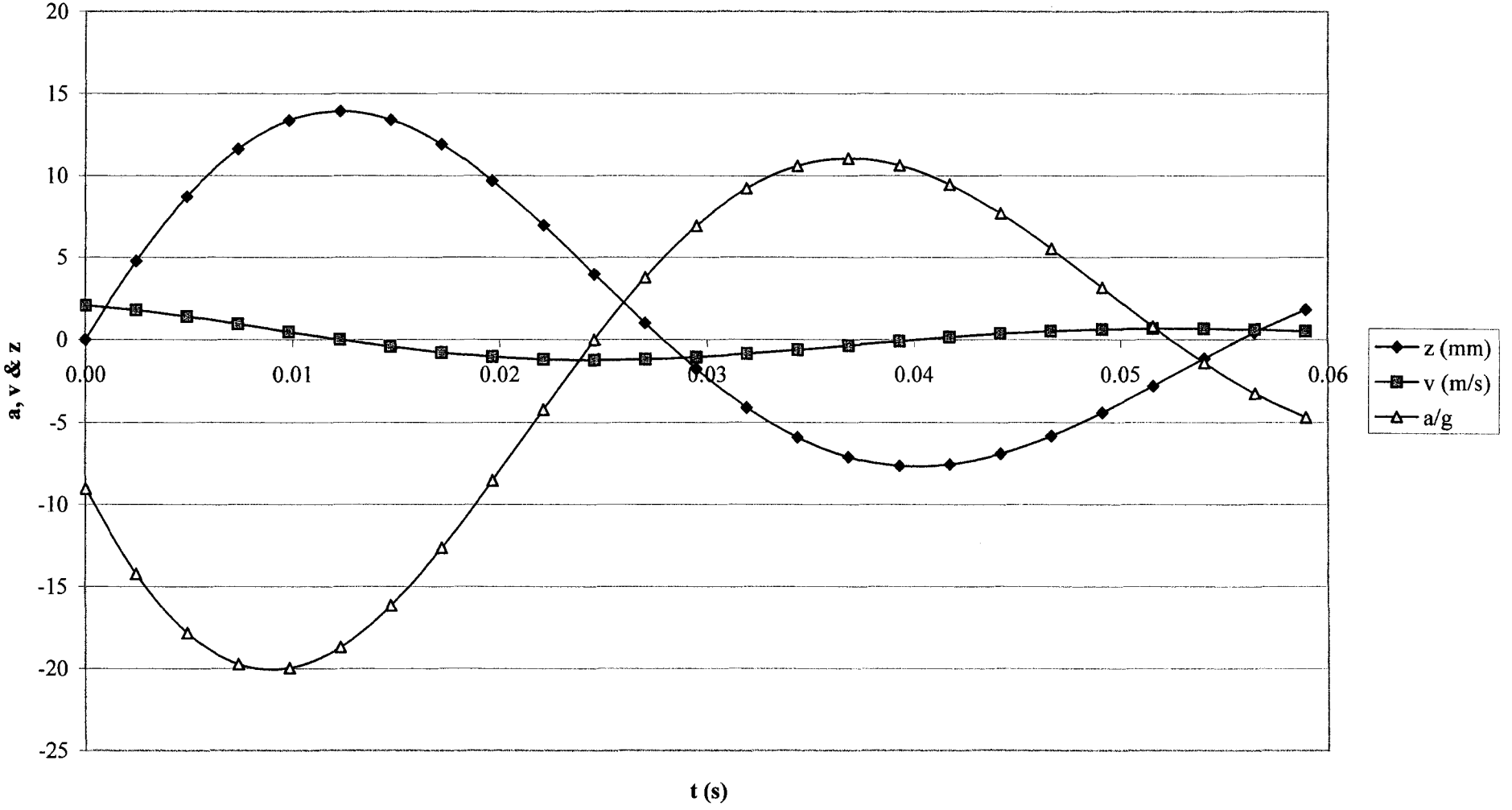
$$\beta_a = e^{-D.\alpha_a} \qquad (12c)$$

10kJ Impact compactor elastodynamic prediction (after Davies & Karim, 1995)





25kJ Impact compactor elastodynamic prediction (after Davies & Karim, 1995)



APPENDIX C

ACCELEROMETER DATA SHEET AND CALIBRATION CERTIFICATE

PCB CALIBRATION CARD:

PCB ELECTRONICS DATA CALIBRATION CARD:
SHEAR ACCELEROMETER
MODEL# 353B14
SERIAL # 58576

VOLTAGE SENSITIVITY 5.42mV/g
FREQUENCY RANGE 1-100000 Hz
OUTPUT BIAS LEVEL 8.6V
DATE : 06/28/99 BY S.S

PCB ELECTRONICS
Shock and Vibration Sensors Division
3425 Walden Ave, Depew, NY 14043
888-684-0013

10. Specifications

A/D Converter	12-Bit Version	16-Bit Version
Acquisition + Conversion	2 ms + 8 ms	2 ms + 8 ms
Monotonicity	No missing codes	No missing codes
Integral linearity error	± 1 LSB	± 3 LSB
Differential linearity error	± 1 LSB	+3/-2 LSB
Full scale error	± 0.5 %	± 0.5 %
Aperture delay	40 ns	40 ns

Analog Input		
Number of input channels	8 differential / 16 single-ended, expandable to 256	
Input range	±10, ±5, ±2.5, ±1.25V	(DAQP-12 and DAQP-16)
	±10, ±1, ±0.1, ±0.01V	(DAQP-12H)
Programmable gain	1, 2, 4, 8	(DAQP-12 and DAQP-16)
	1, 10, 100, 1000	(DAQP-12H)
Maximum over-voltage	±30 V	
Input impedance	100 MW (DC)	

A/D Miscellaneous Specifications	
Data FIFO depth	2048 samples
Scan list length	2048 entries
Scan speed	10 ms, 20 ms, 40 ms
Trigger source	Internal (Software) / External (TTL)
Trigger mode	Continuous / One-shot
External (TTL) trigger	0.8 V (low) / 2.2 V (high), Rising / Falling edges
	Latency to A/D scan < 1 ms
Sampling rate	0.006 Hz to 100 kHz (with internal clock source)
External clock rate	DC - 5 MHz

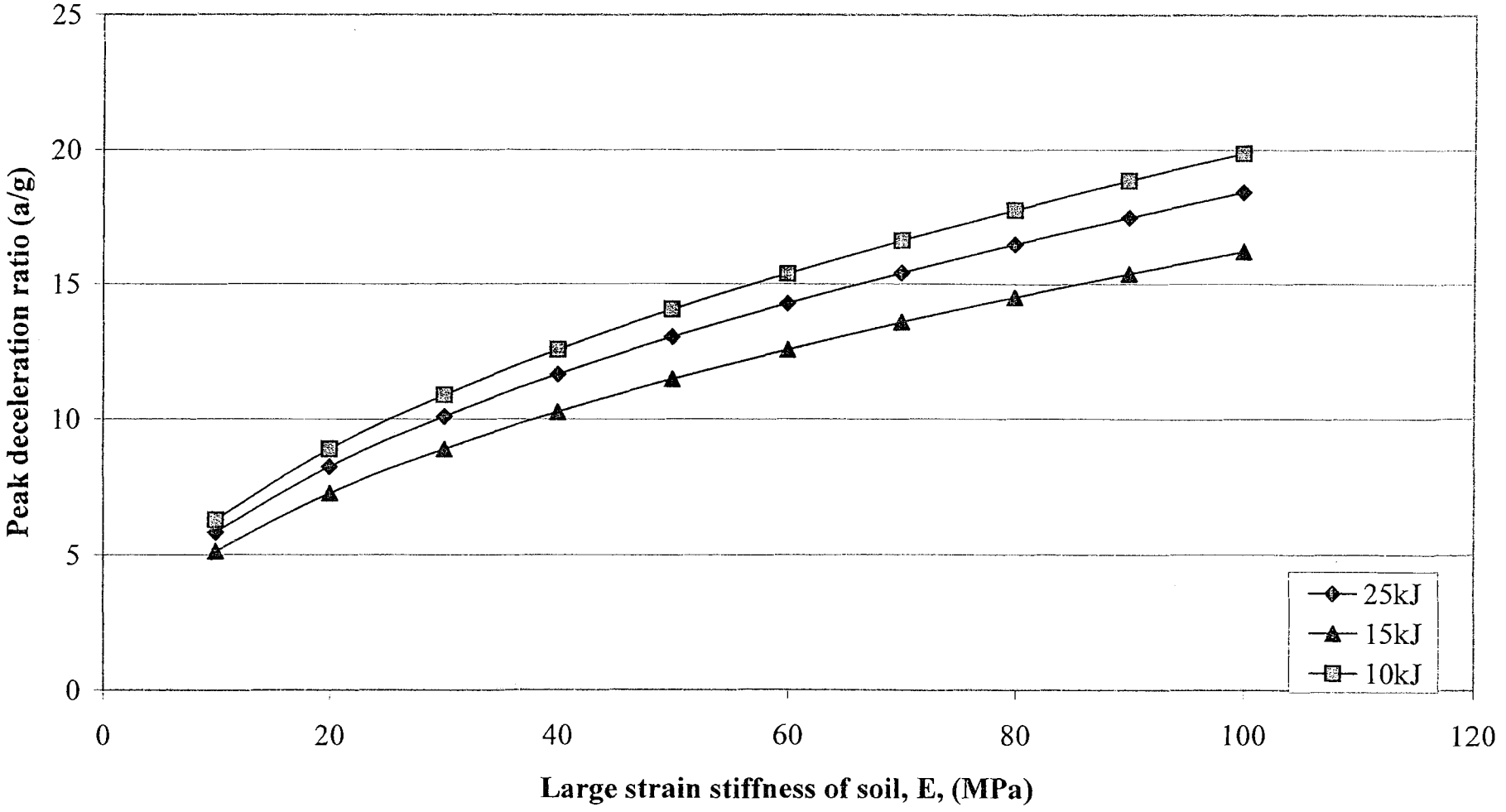
Digital I/O	
Digital input channels	4 (no latch)
Digital output channels	4 (latched)
Maximum source current	0.5 mA
Maximum sinking current	2.5 mA
Minimum logic '1' level	2.4 V
Maximum logic '0' level	0.8 V

General Specifications	
Power consumption	160 mA (full power), 40 mA (power down)
Operating temperature	0 °C to 50 °C
Storage temperature	0 °C to 70 °C
Humidity	0 to 95%, non-condensing
Size (cable not included)	Standard PCMCIA type II
Weight	1.5 oz (for reference only)

APPENDIX D

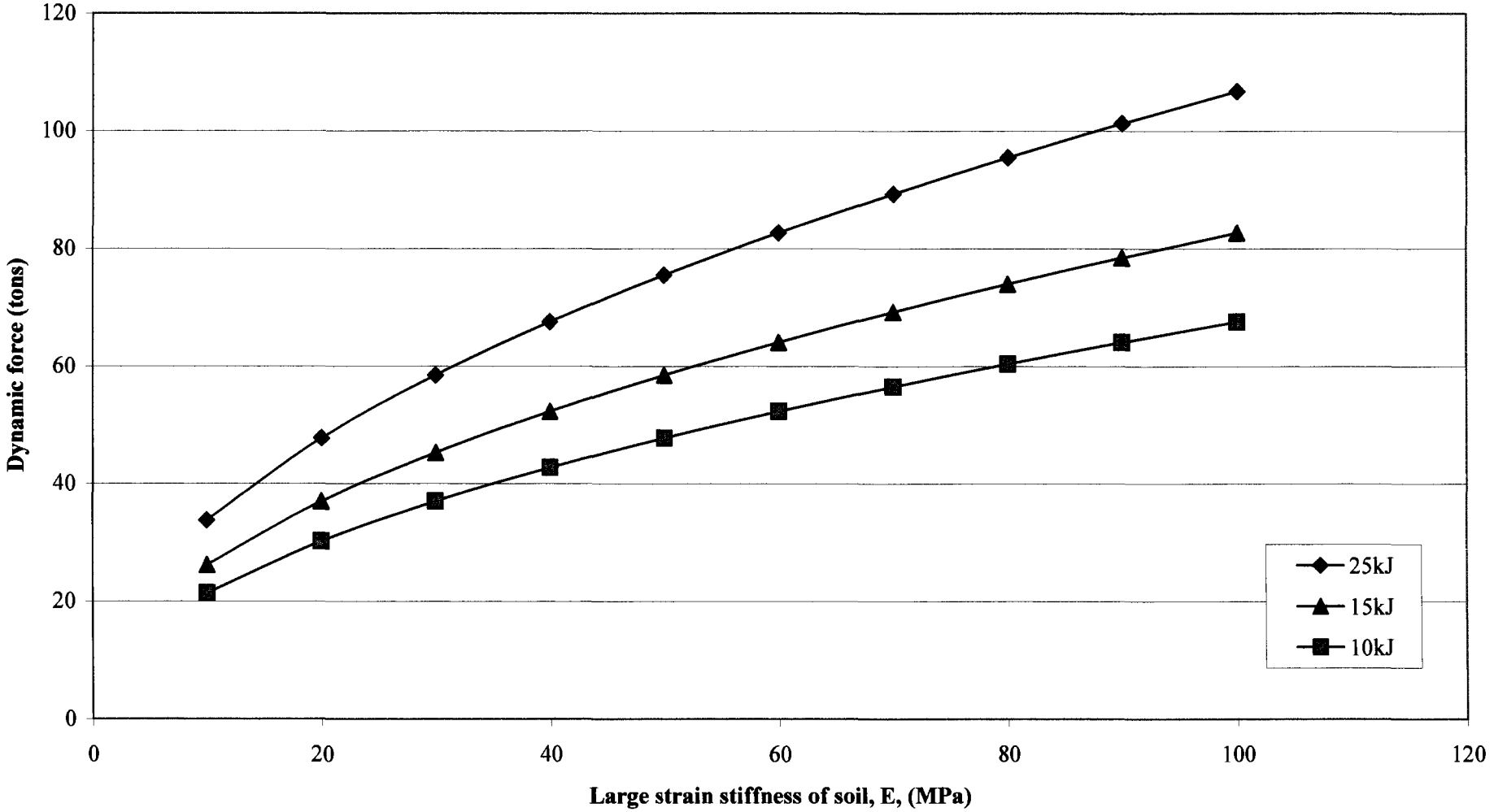
ESTIMATION OF ACCELERATIONS USING MAYNE (1983)

APPENDIX D : ESTIMATION OF DECELERATIONS



(after Mayne, 1983)

ADDPENDIX D : FORCE ESTIMATES ON VARIOUS MODEL IMPACT COMPACTORS

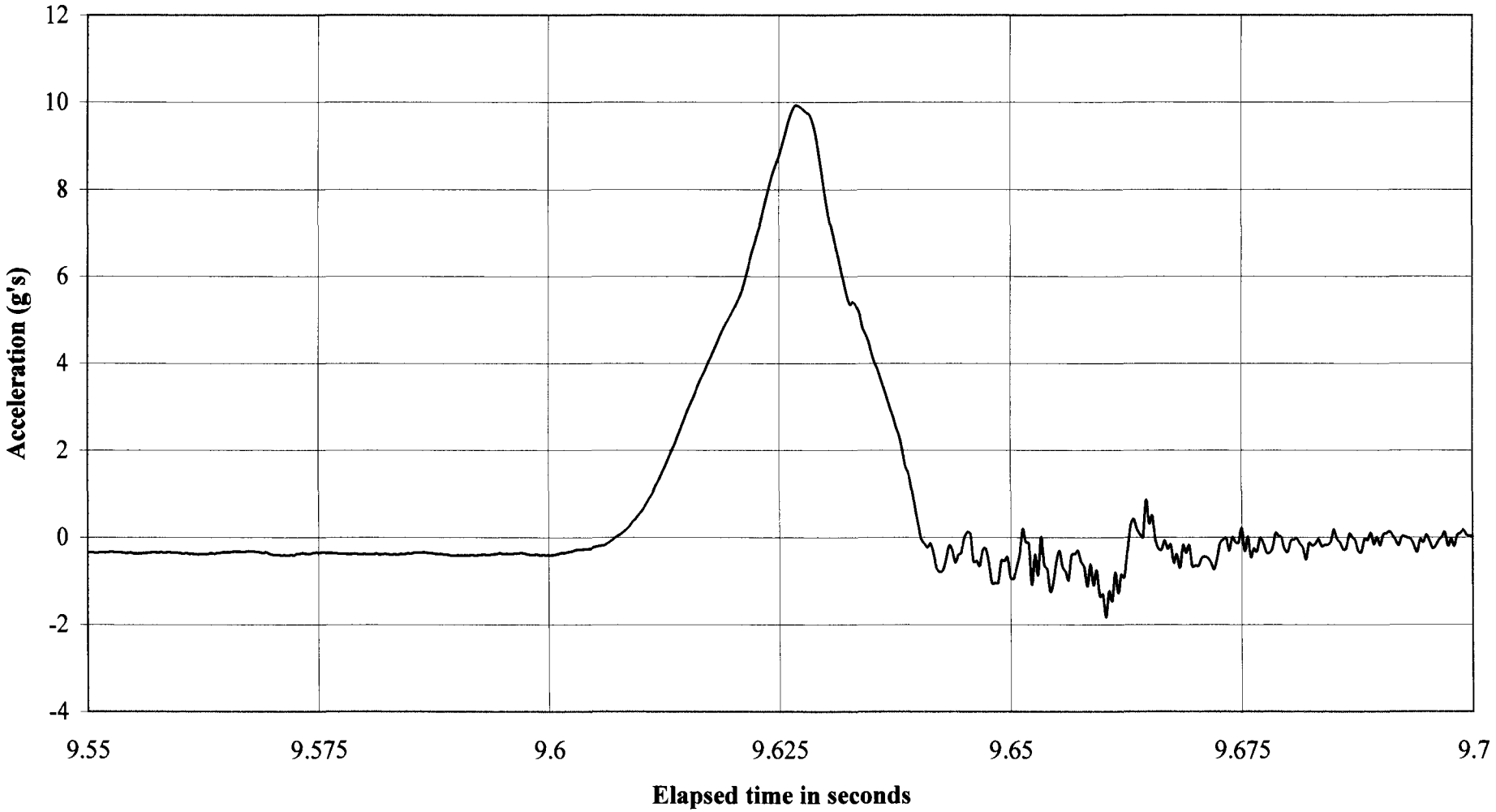


(after Mayne, 1983)

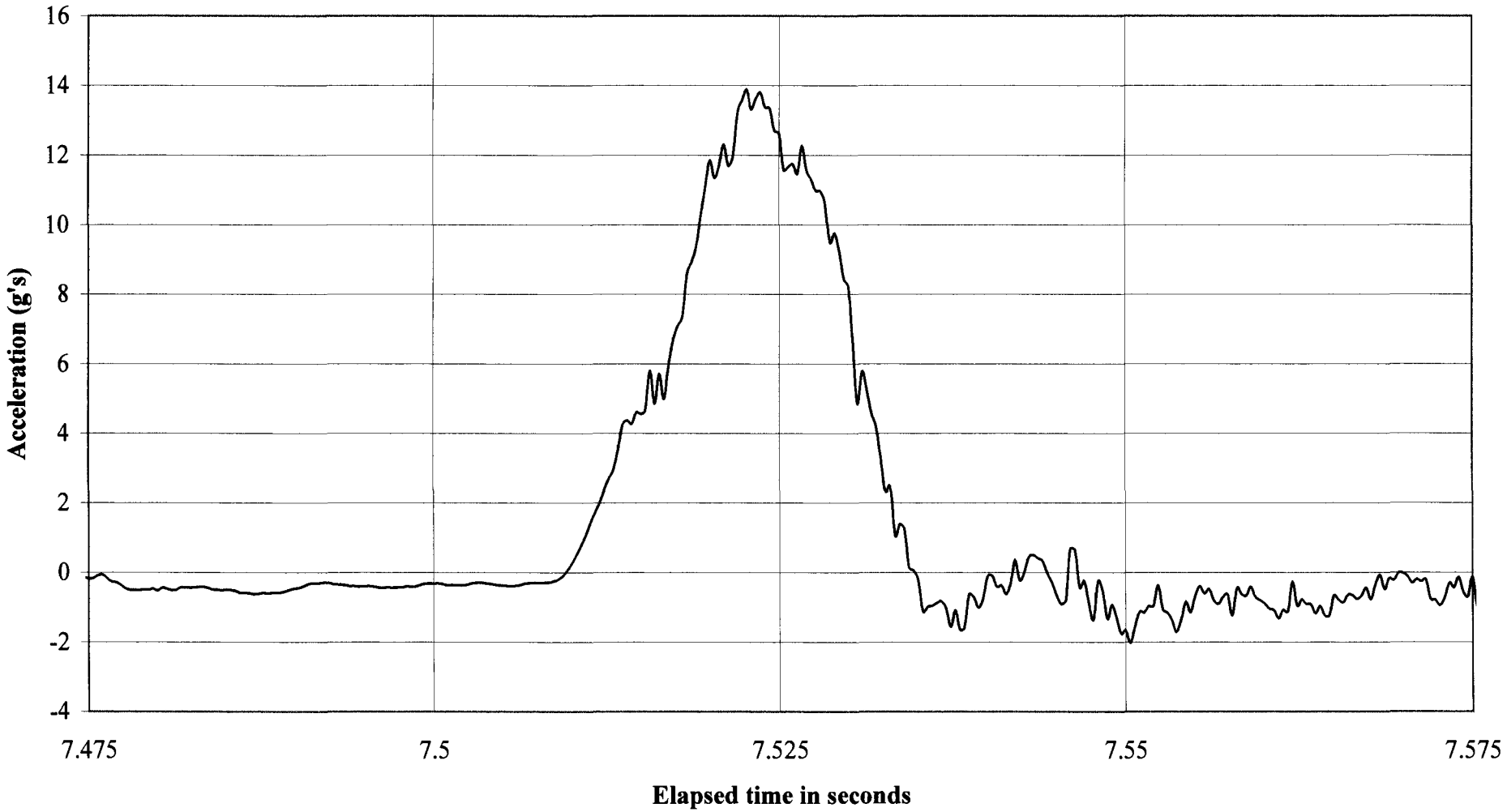
APPENDIX E

MEASURED ACCELERATIONS

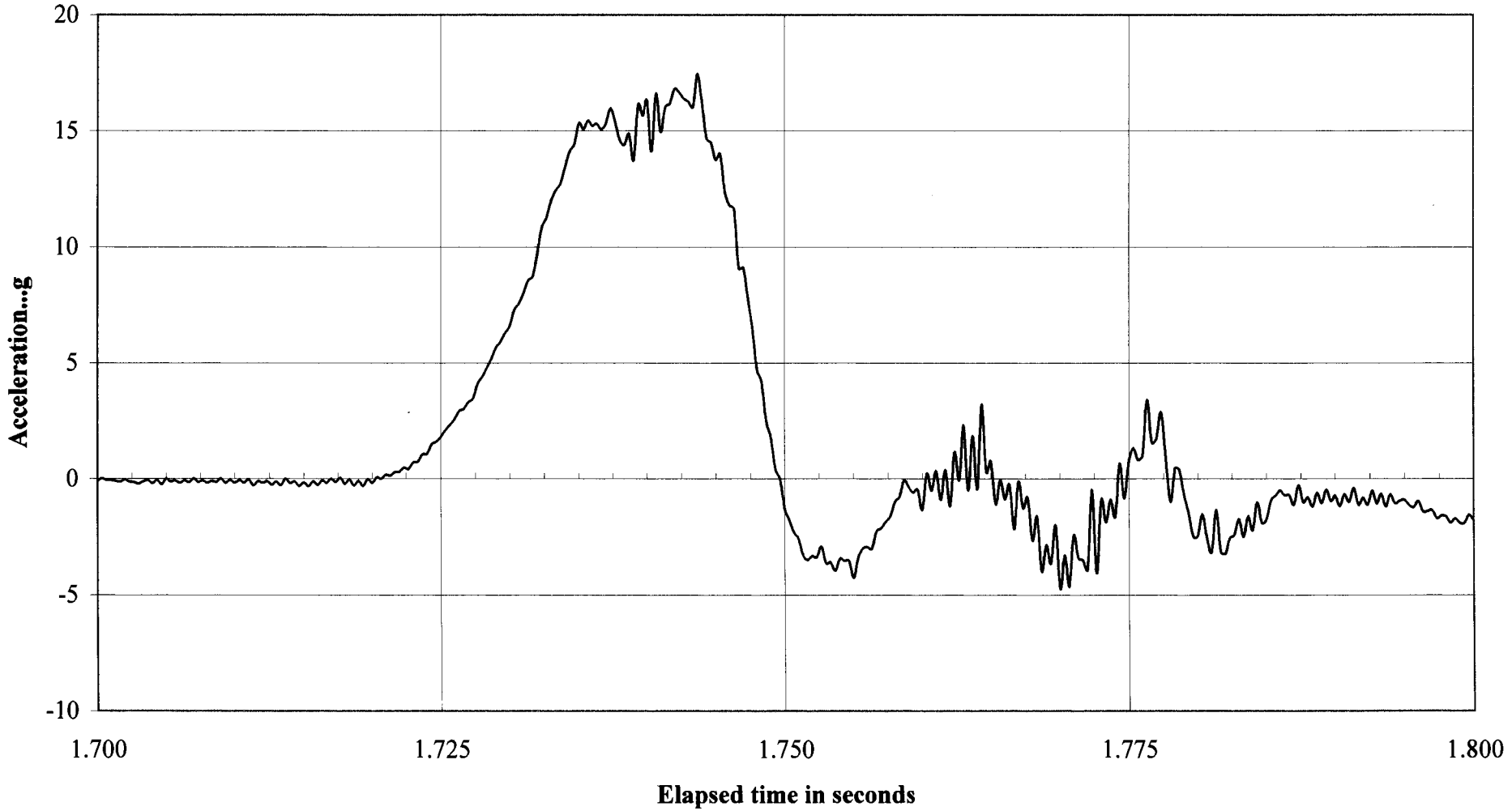
Appendix E1 : 10kJ impact roller at normal operating speed on hard ground



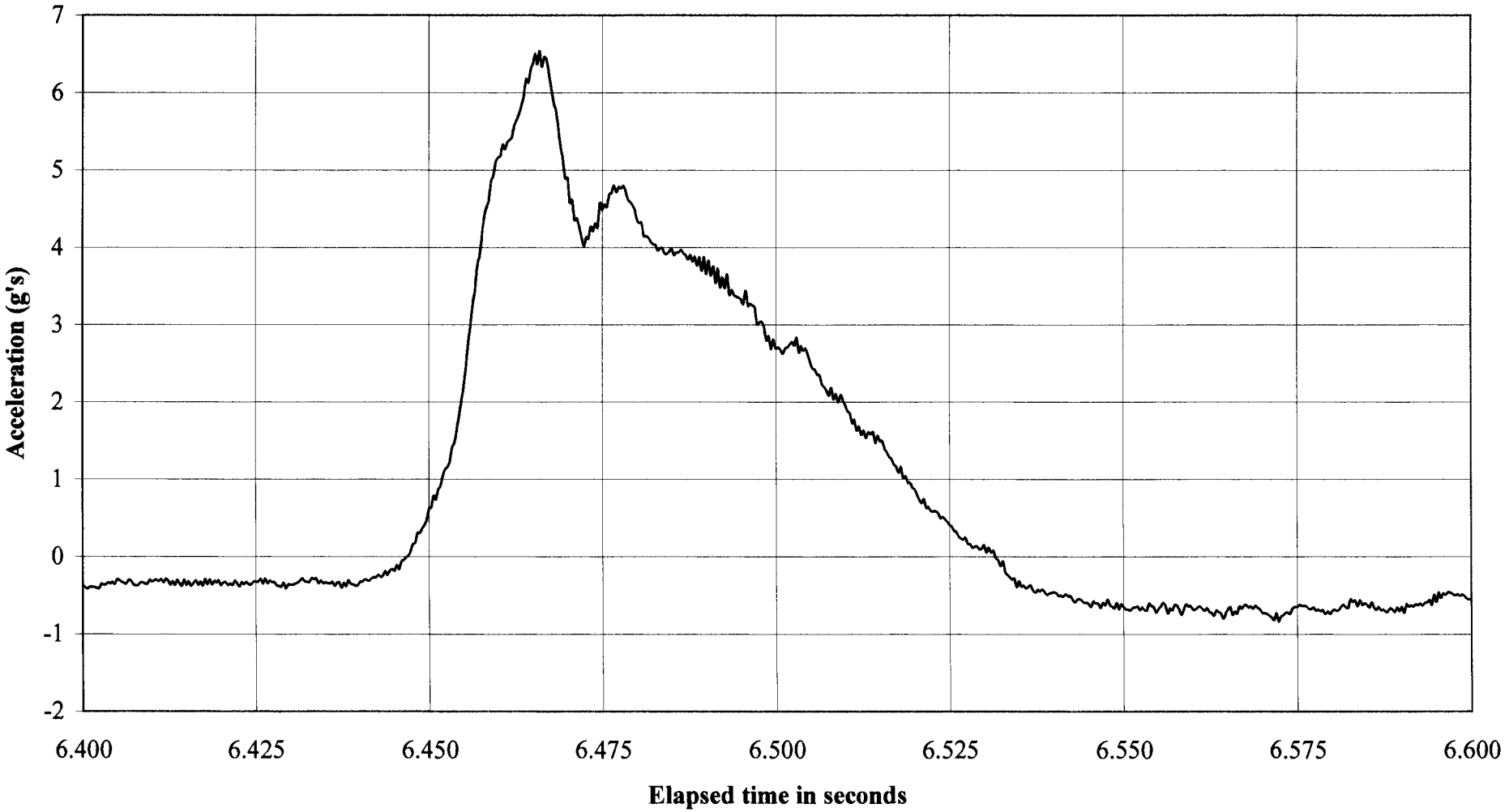
Appendix E2 : 15kJ impact roller at normal operating speed on hard ground



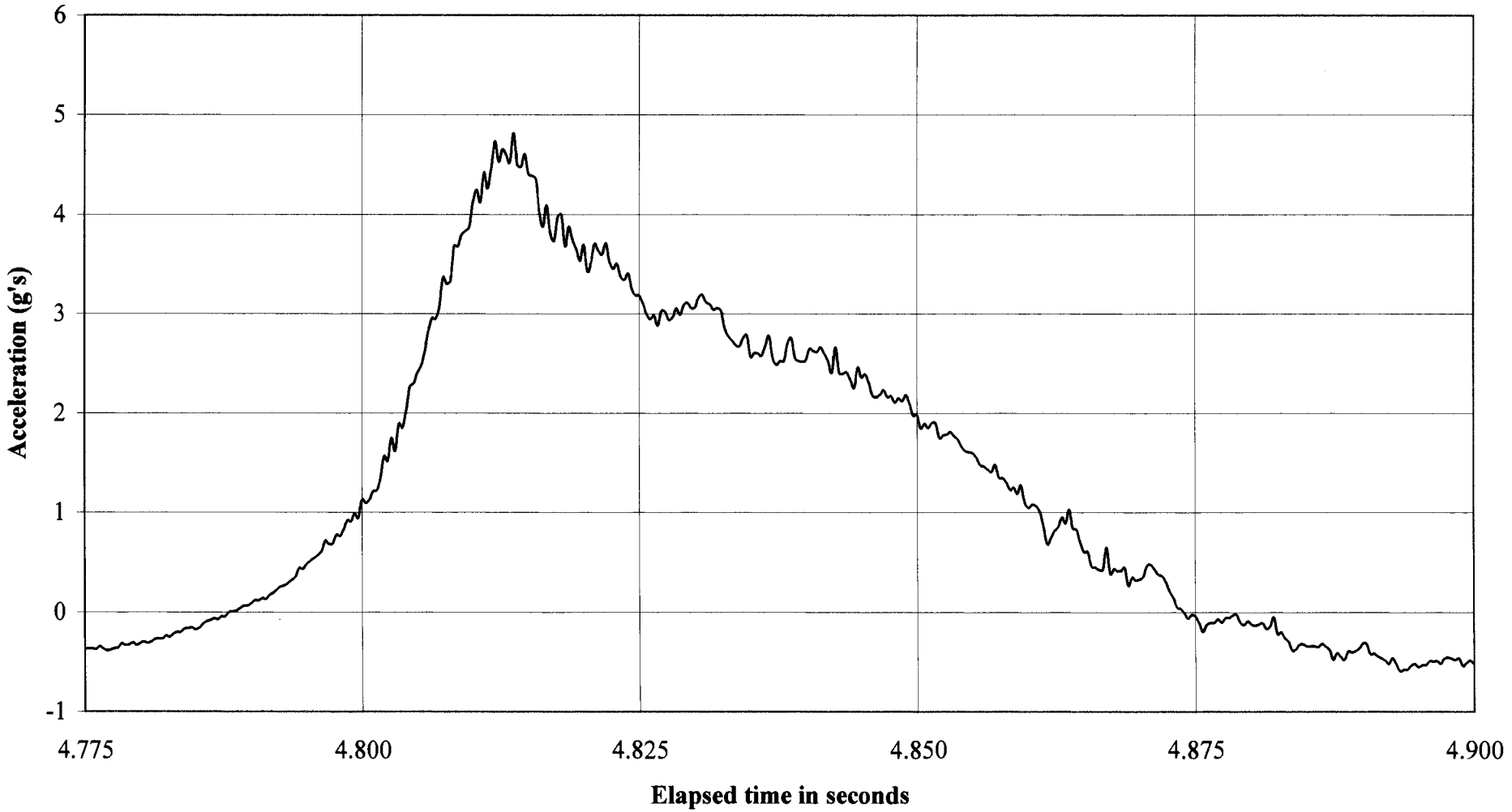
Appendix E3 : 25kJ impact roller at normal operating speed on hard ground



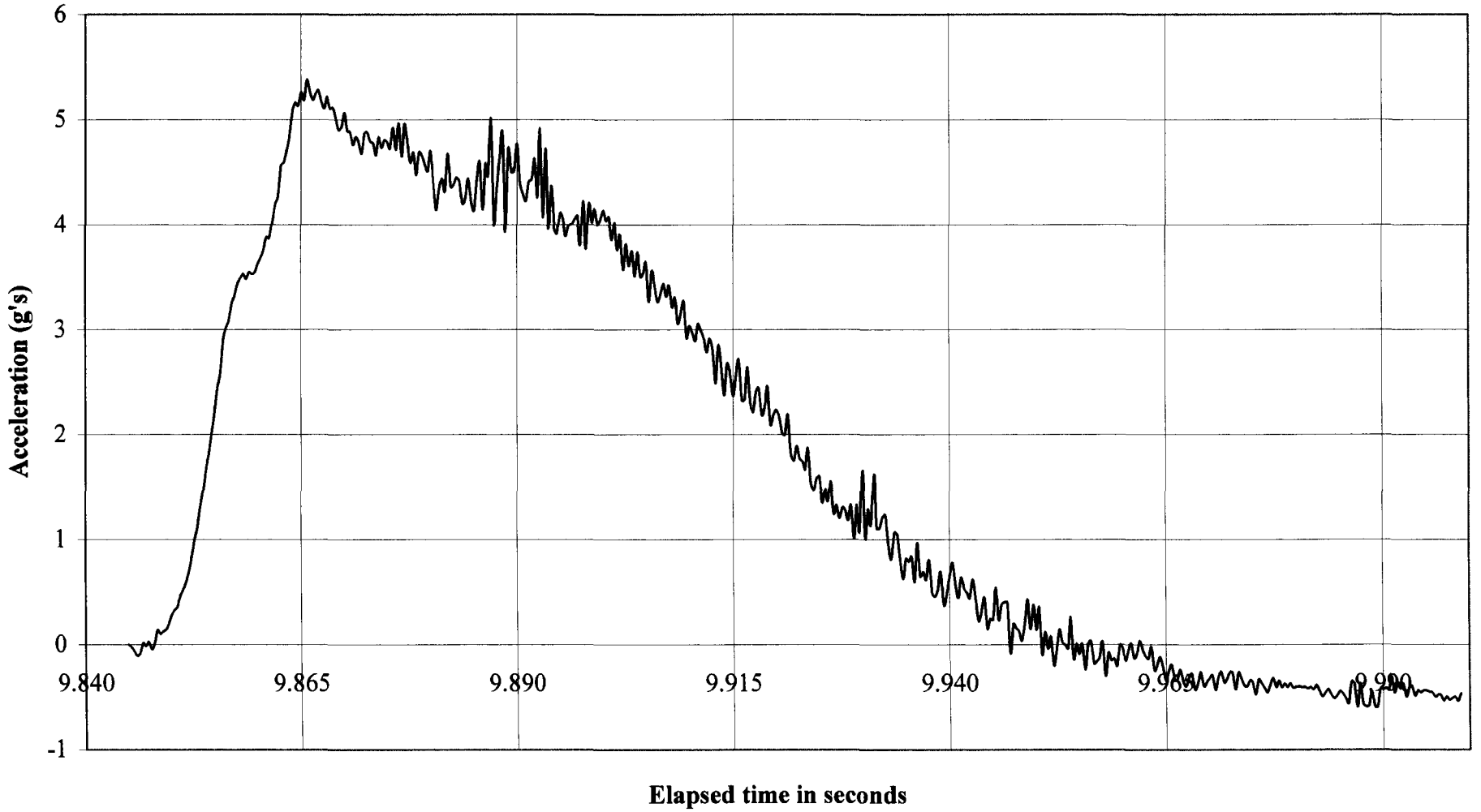
Appendix E4 : 10kJ impact roller on very soft soil at normal operating speed



Appendix E5 : 15kJ impact roller on very soft ground at normal operating speed



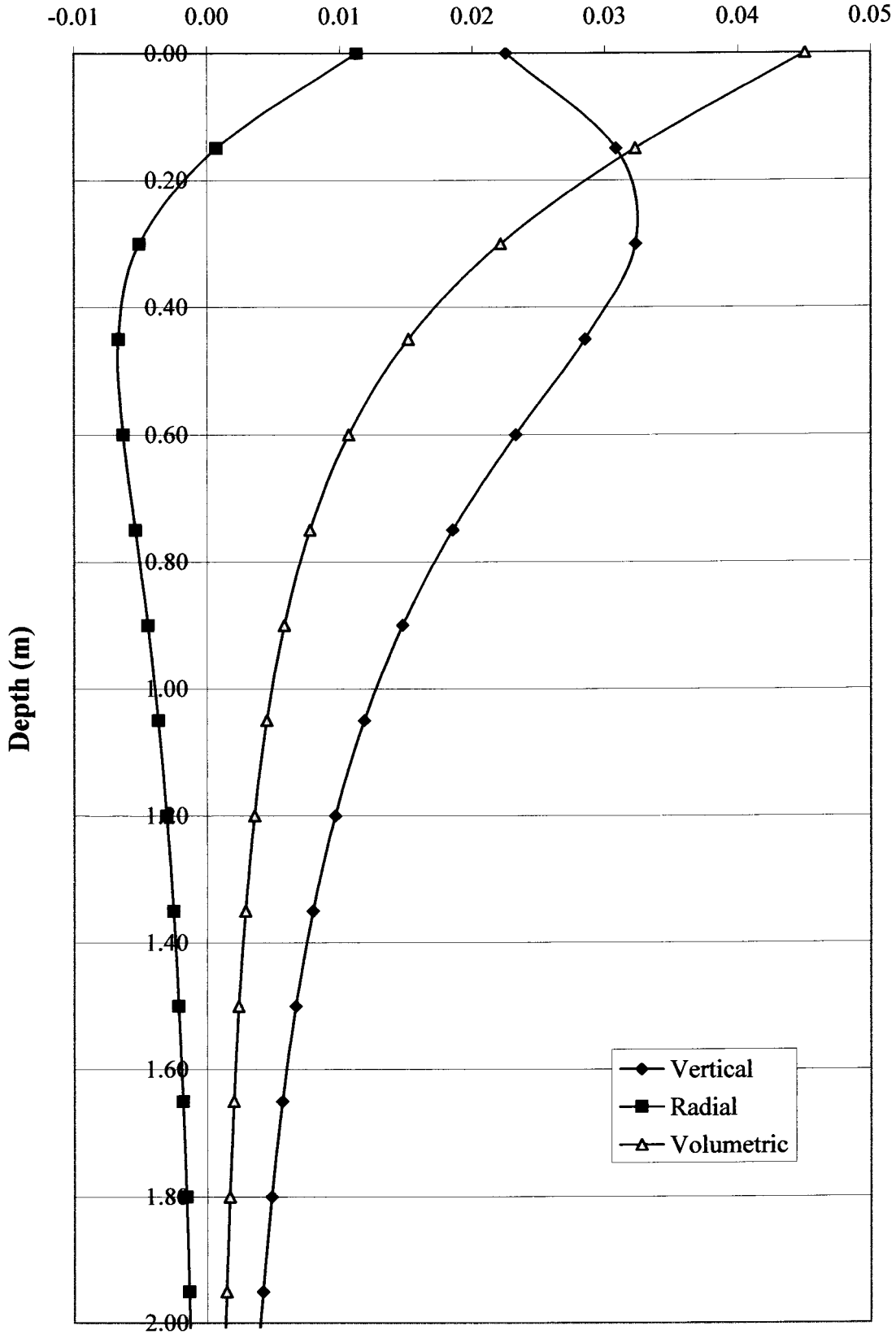
Appendix E6 : 25kJ impact compactor on very soft ground



APPENDIX F

ELASTIC VOLUMETRIC STRAIN CALCULATIONS

Elastic strain under an impact compactor (Vertical, radial, volumetric)



From Huang, Y.H Pavement analysis and design, Prentice Hall, 1993.

$$\sigma_z = q\left(1 - \frac{z^3}{\left(a^2 + z^2\right)^{1.5}}\right)$$

$$\sigma_r = \frac{q}{2}\left[1 + 2v - \frac{2(1+v)z}{\sqrt{a^2 + z^2}} + \frac{z^3}{\left(a^2 + z^2\right)^{1.5}}\right]$$

Note :The vertical stress is independan t of E and v, and the lateral stress independan t of E

$$\varepsilon_z = \frac{(1+v)q}{E}\left[1 - 2v + \frac{2vz}{\sqrt{a^2 + z^2}} - \frac{z^3}{\left(a^2 + z^2\right)^{1.5}}\right]$$

$$\varepsilon_r = \frac{(1+v)q}{2E}\left[1 - 2v - \frac{2(1-v)z}{\sqrt{a^2 + z^2}} + \frac{z^3}{\left(a^2 + z^2\right)^{1.5}}\right]$$

The deflection is given by :

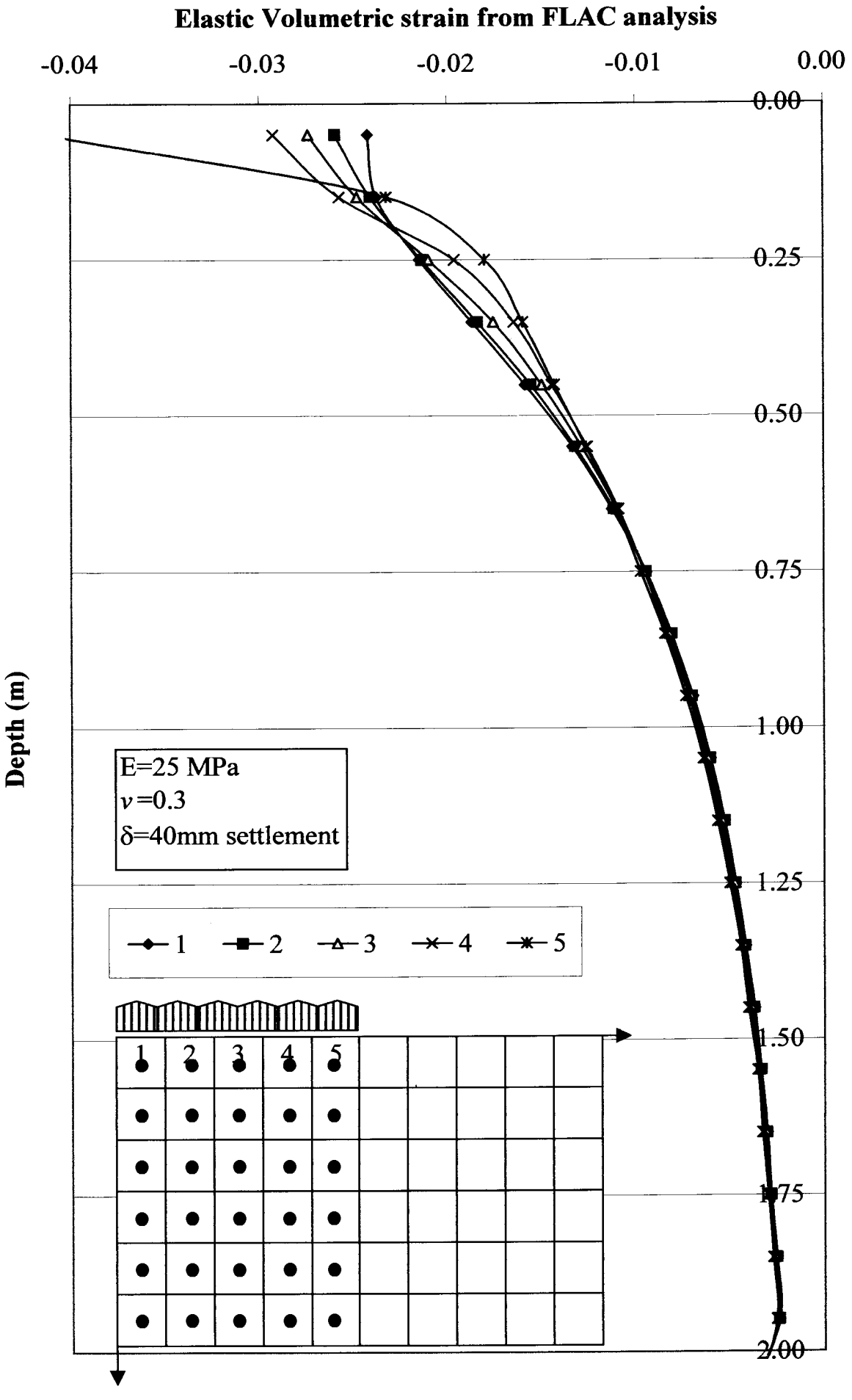
$$w = \frac{(1+v)qa}{E}\left\{\frac{a}{\sqrt{a^2 + z^2}} + \frac{1-2v}{a}\left[\sqrt{a^2 + z^2} - z\right]\right\}$$

which at the suface is

$$w = \frac{2\left(1 - v^2\right)qa}{E}$$

Compared this with the rigid plate formula :

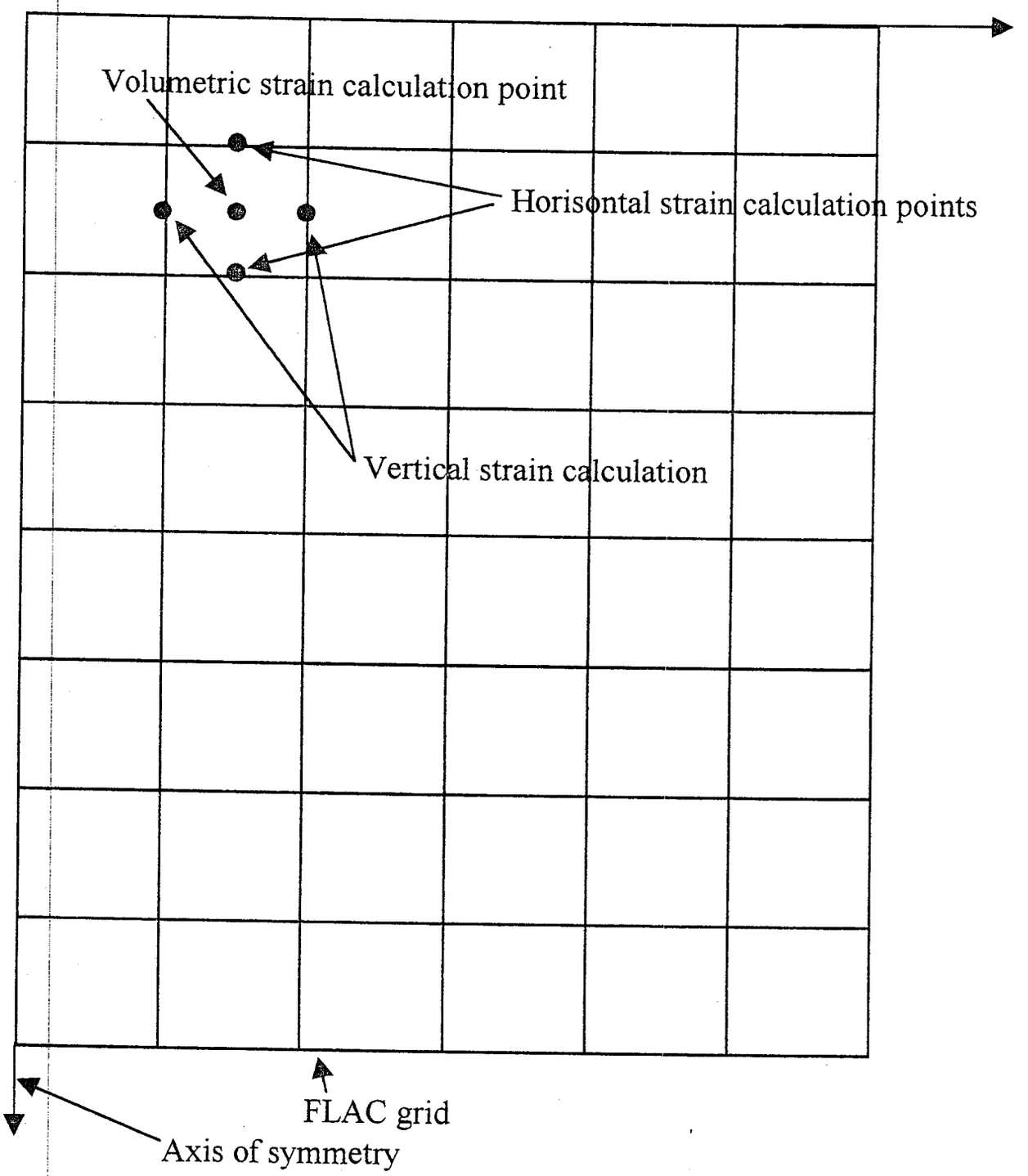
$$w = \frac{\pi\left(1 - v^2\right)qa}{2E}$$ i.e the pressure under a rigid plate is 79% of that under a flexible plate!

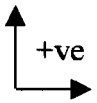


APPENDIX G

ELASTIC-PLASTIC ANALYSIS OF VOLUMETRIC STRAINS

CALCULATION POSITIONS FOR STRAINS IN *FLAC* ANALYSIS



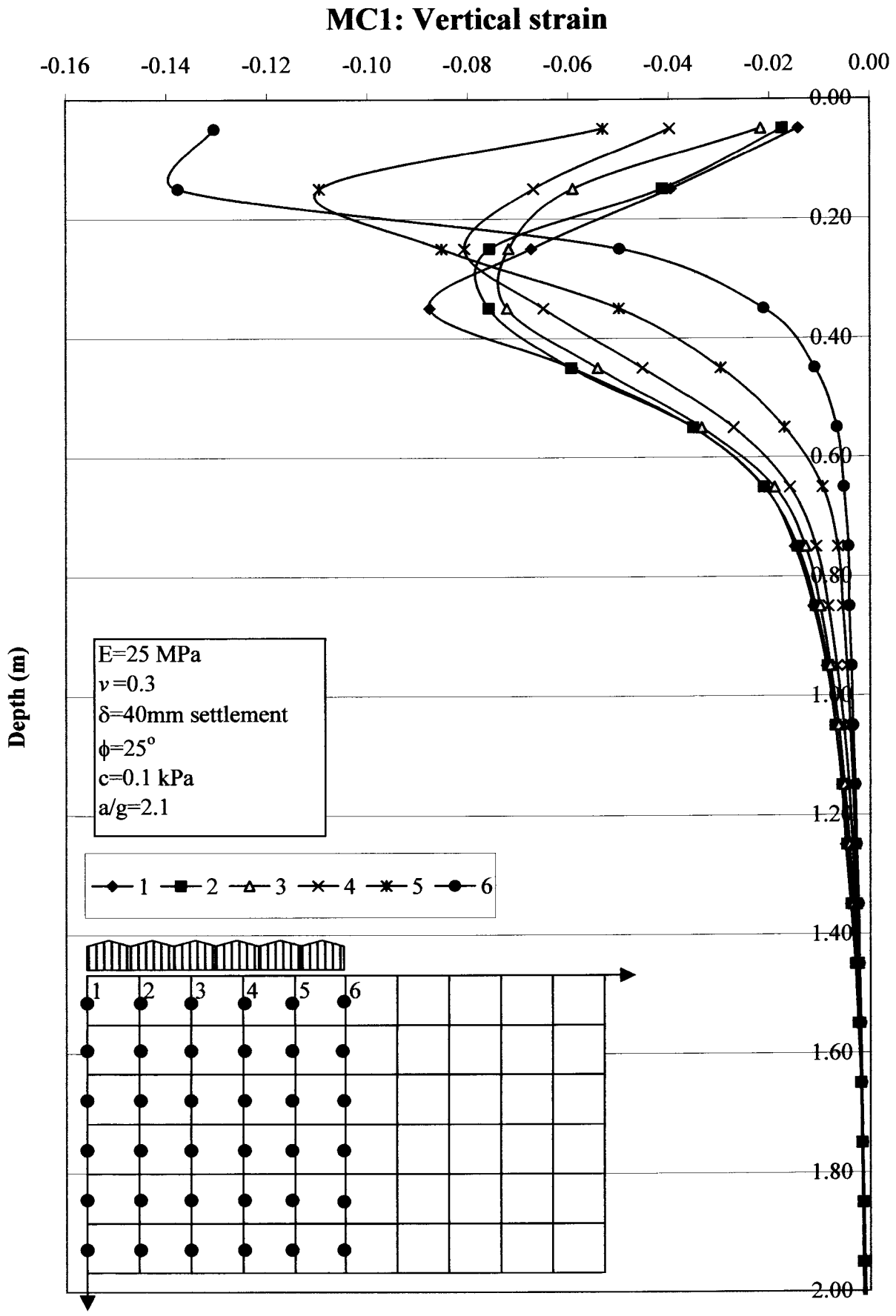


DATA FOR MC1 ANALYSIS: VERTICAL DEFLECTION

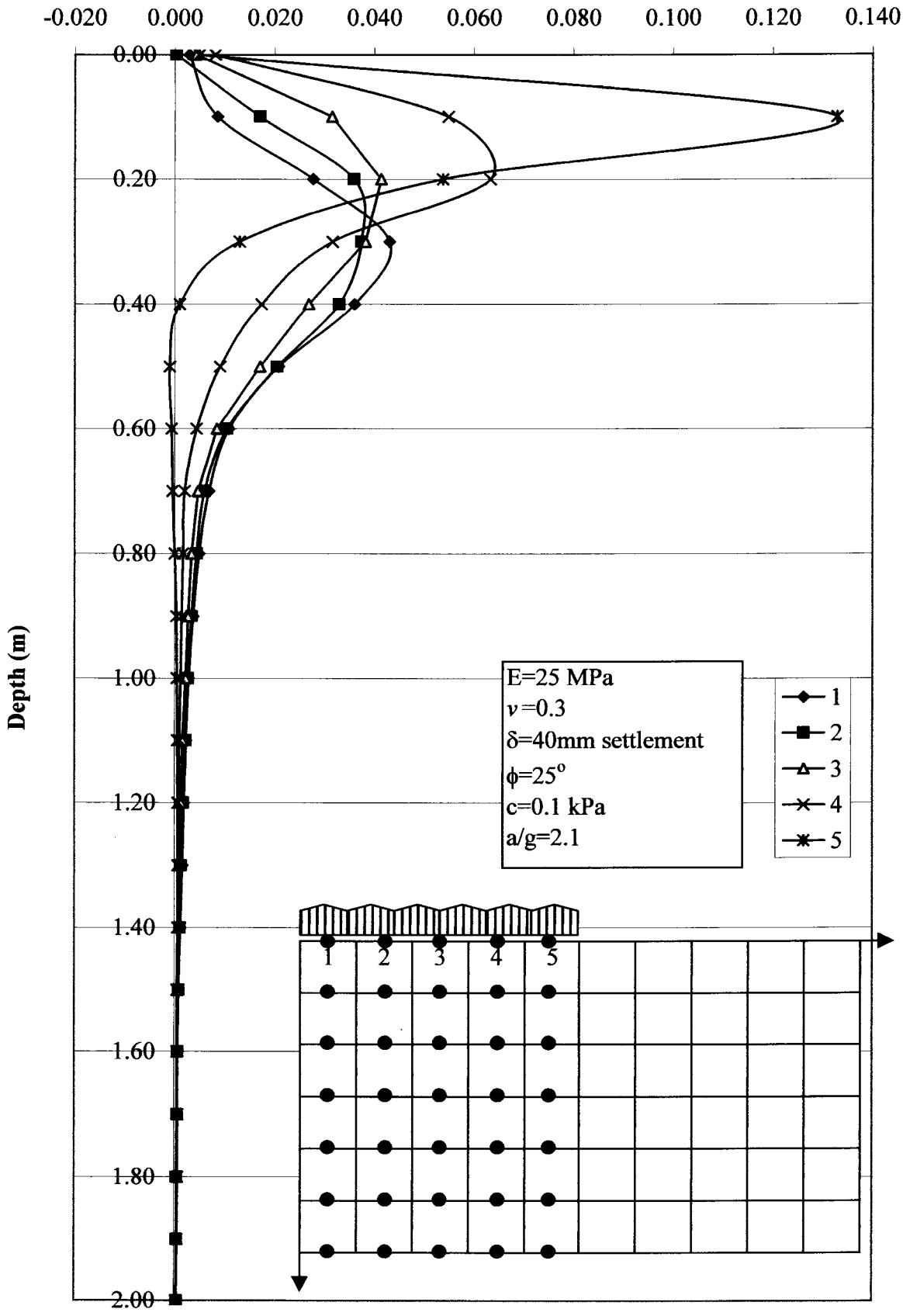
z (m)	x10^{-2} [Vertical displacements of grid points]					
0.0	-4.000	-4.000	-4.000	-4.000	-4.000	-4.000
0.1	-3.858	-3.826	-3.783	-3.602	-3.469	-2.695
0.2	-3.462	-3.413	-3.192	-2.933	-2.373	-1.318
0.3	-2.788	-2.656	-2.473	-2.126	-1.521	-0.820
0.4	-1.912	-1.898	-1.751	-1.477	-1.022	-0.609
0.5	-1.320	-1.304	-1.210	-1.025	-0.725	-0.499
0.6	-0.969	-0.952	-0.875	-0.754	-0.555	-0.433
0.7	-0.759	-0.741	-0.685	-0.595	-0.461	-0.381
0.8	-0.610	-0.597	-0.557	-0.488	-0.397	-0.338
0.9	-0.498	-0.489	-0.458	-0.405	-0.343	-0.297
1.0	-0.412	-0.405	-0.379	-0.339	-0.297	-0.260
1.1	-0.343	-0.336	-0.316	-0.287	-0.257	-0.226
1.2	-0.286	-0.280	-0.265	-0.245	-0.223	-0.196
1.3	-0.237	-0.234	-0.224	-0.210	-0.193	-0.169
1.4	-0.198	-0.196	-0.190	-0.181	-0.166	-0.146
1.5	-0.168	-0.167	-0.163	-0.155	-0.143	-0.124
1.6	-0.144	-0.143	-0.140	-0.133	-0.122	-0.105
1.7	-0.125	-0.124	-0.121	-0.114	-0.103	-0.088
1.8	-0.109	-0.108	-0.104	-0.097	-0.086	-0.073
1.9	-0.095	-0.094	-0.089	-0.082	-0.071	-0.060
2.0	-0.082	-0.080	-0.075	-0.068	-0.058	-0.049
2.1	-0.069	-0.067	-0.062	-0.055	-0.047	-0.042

DATA FOR MC1 ANALYSIS: HORIZONTAL DEFLECTION

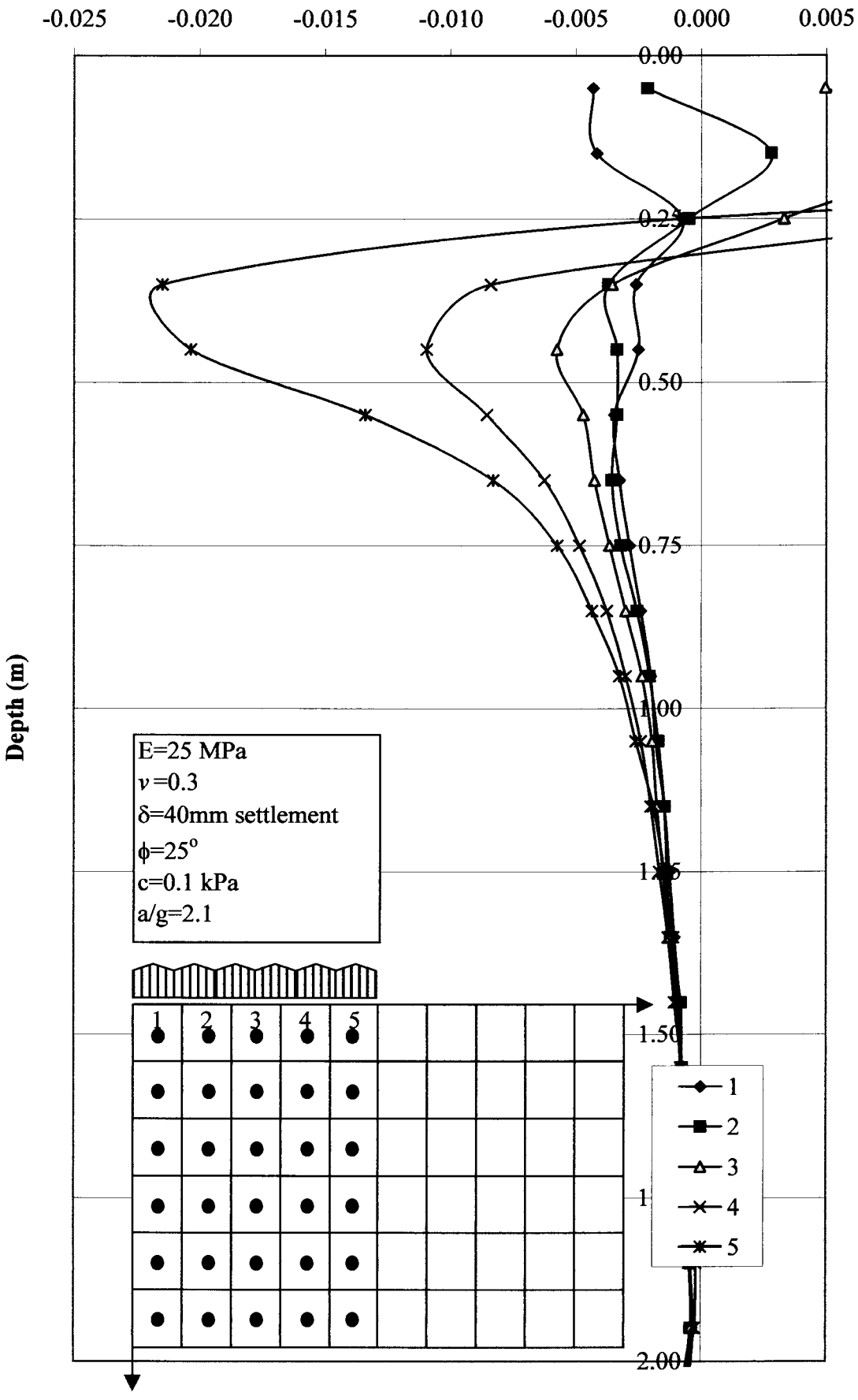
z (m)	x10^{-2} [Horizon displacements of grid points]					
0.0	0.000	0.029	0.032	0.074	0.155	0.204
0.1	0.000	0.086	0.257	0.572	1.121	2.450
0.2	0.000	0.277	0.636	1.050	1.683	2.221
0.3	0.000	0.431	0.805	1.187	1.503	1.633
0.4	0.000	0.360	0.689	0.957	1.131	1.141
0.5	0.000	0.208	0.413	0.584	0.675	0.665
0.6	0.000	0.109	0.214	0.299	0.343	0.337
0.7	0.000	0.069	0.129	0.176	0.196	0.192
0.8	0.000	0.049	0.093	0.127	0.144	0.144
0.9	0.000	0.037	0.071	0.098	0.112	0.116
1.0	0.000	0.028	0.055	0.077	0.089	0.094
1.1	0.000	0.023	0.045	0.061	0.071	0.077
1.2	0.000	0.019	0.036	0.049	0.057	0.064
1.3	0.000	0.016	0.029	0.039	0.047	0.054
1.4	0.000	0.012	0.023	0.032	0.039	0.046
1.5	0.000	0.009	0.018	0.026	0.033	0.039
1.6	0.000	0.007	0.014	0.021	0.028	0.034
1.7	0.000	0.006	0.012	0.018	0.025	0.031
1.8	0.000	0.005	0.010	0.016	0.023	0.028
1.9	0.000	0.005	0.010	0.015	0.021	0.026
2.0	0.000	0.005	0.010	0.015	0.020	0.024
2.1	0.000	0.005	0.010	0.015	0.019	0.021


MC1: Vertical strain
-0.16
-0.14
-0.12
-0.10
-0.08
-0.06
-0.04
-0.02
0.00
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
Depth (m)
E=25 MPa
ν=0.3
δ=40mm settlement
ϕ=25°
c=0.1 kPa
a/g=2.1
1
2
3
4
5
6
1
2
3
4
5
6

MC 1 : Horizontal strains



MC 1: Volumetric strain variation under rigid base



DATA FOR MC1 ANALYSIS: VERTICAL STRAIN CALCULATION

	y ordinate at center of zone		Δy/Yo			Xo=Yo=100mm =grid zone size		
Zone		z (m)	1	2	3	4	5	6
40	3.95	0.05	-0.0142	-0.0174	-0.0217	-0.0398	-0.0531	-0.1305
39	3.85	0.15	-0.0396	-0.0413	-0.0591	-0.0669	-0.1096	-0.1377
38	3.75	0.25	-0.0674	-0.0757	-0.0719	-0.0807	-0.0852	-0.0498
37	3.65	0.35	-0.0876	-0.0758	-0.0722	-0.0649	-0.0499	-0.0211
36	3.55	0.45	-0.0592	-0.0594	-0.0541	-0.0452	-0.0297	-0.011
35	3.45	0.55	-0.0351	-0.0352	-0.0335	-0.0271	-0.017	-0.0066
34	3.35	0.65	-0.021	-0.0211	-0.019	-0.0159	-0.0094	-0.0052
33	3.25	0.75	-0.0149	-0.0144	-0.0128	-0.0107	-0.0064	-0.0043
32	3.15	0.85	-0.0112	-0.0108	-0.0099	-0.0083	-0.0054	-0.0041
31	3.05	0.95	-0.0086	-0.0084	-0.0079	-0.0066	-0.0046	-0.0037
30	2.95	1.05	-0.0069	-0.0069	-0.0063	-0.0052	-0.004	-0.0034
29	2.85	1.15	-0.0057	-0.0056	-0.0051	-0.0042	-0.0034	-0.003
28	2.75	1.25	-0.0049	-0.0046	-0.0041	-0.0035	-0.003	-0.0027
27	2.65	1.35	-0.0039	-0.0038	-0.0034	-0.0029	-0.0027	-0.0023
26	2.55	1.45	-0.003	-0.0029	-0.0027	-0.0026	-0.0023	-0.0022
25	2.45	1.55	-0.0024	-0.0024	-0.0023	-0.0022	-0.0021	-0.0019
24	2.35	1.65	-0.0019	-0.0019	-0.0019	-0.0019	-0.0019	-0.0017
23	2.25	1.75	-0.0016	-0.0016	-0.0017	-0.0017	-0.0017	-0.0015
22	2.15	1.85	-0.0014	-0.0014	-0.0015	-0.0015	-0.0015	-0.0013
21	2.05	1.95	-0.0013	-0.0014	-0.0014	-0.0014	-0.0013	-0.0011
20	1.95	2.05	-0.0013	-0.0013	-0.0013	-0.0013	-0.0011	-0.0007

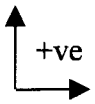
DATA FOR MC1 ANALYSIS: HORIZONTAL STRAIN CALC.

	Δx/Xo				
z	1	2	3	4	5
0.00	0.0029	0.0003	0.0042	0.0081	0.0049
0.10	0.0086	0.0171	0.0315	0.0549	0.1329
0.20	0.0277	0.0359	0.0414	0.0633	0.0538
0.30	0.0431	0.0374	0.0382	0.0316	0.0130
0.40	0.0360	0.0329	0.0268	0.0174	0.0010
0.50	0.0208	0.0205	0.0171	0.0091	-0.0010
0.60	0.0109	0.0105	0.0085	0.0044	-0.0006
0.70	0.0069	0.0060	0.0047	0.0020	-0.0004
0.80	0.0049	0.0044	0.0034	0.0017	0.0000
0.90	0.0037	0.0034	0.0027	0.0014	0.0004
1.00	0.0028	0.0027	0.0022	0.0012	0.0005
1.10	0.0023	0.0022	0.0016	0.0010	0.0006
1.20	0.0019	0.0017	0.0013	0.0008	0.0007
1.30	0.0016	0.0013	0.0010	0.0008	0.0007
1.40	0.0012	0.0011	0.0009	0.0007	0.0007
1.50	0.0009	0.0009	0.0008	0.0007	0.0006
1.60	0.0007	0.0007	0.0007	0.0007	0.0006
1.70	0.0006	0.0006	0.0006	0.0007	0.0006
1.80	0.0005	0.0005	0.0006	0.0007	0.0005
1.90	0.0005	0.0005	0.0005	0.0006	0.0005
2.00	0.0005	0.0005	0.0005	0.0005	0.0004

DATA FOR MC1 ANALYSIS: VOLUMETRIC STRAIN CALC.

	ε vol =ave(vert) +2(ave hor)					
z	1	2	3	4	5	Total
0.05	-0.00430	-0.00215	0.00495	0.01655	0.04600	0.01221
0.15	-0.00415	0.00280	0.00990	0.02995	0.06305	0.02031
0.25	-0.00075	-0.00050	0.00330	0.01195	-0.00070	0.00266
0.35	-0.00260	-0.00370	-0.00355	-0.00840	-0.02150	-0.00795
0.45	-0.00250	-0.00335	-0.00575	-0.01095	-0.02035	-0.00858
0.55	-0.00345	-0.00335	-0.00470	-0.00855	-0.01340	-0.00669
0.65	-0.00325	-0.00355	-0.00425	-0.00625	-0.00830	-0.00512
0.75	-0.00285	-0.00320	-0.00365	-0.00485	-0.00574	-0.00406
0.85	-0.00240	-0.00255	-0.00300	-0.00375	-0.00434	-0.00321
0.95	-0.00200	-0.00205	-0.00235	-0.00300	-0.00325	-0.00253
1.05	-0.00180	-0.00170	-0.00195	-0.00240	-0.00260	-0.00209
1.15	-0.00145	-0.00145	-0.00175	-0.00200	-0.00190	-0.00171
1.25	-0.00125	-0.00135	-0.00150	-0.00165	-0.00145	-0.00144
1.35	-0.00105	-0.00120	-0.00125	-0.00130	-0.00110	-0.00118
1.45	-0.00085	-0.00080	-0.00095	-0.00105	-0.00095	-0.00092
1.55	-0.00080	-0.00075	-0.00075	-0.00075	-0.00080	-0.00077
1.65	-0.00060	-0.00060	-0.00060	-0.00050	-0.00060	-0.00058
1.75	-0.00050	-0.00055	-0.00050	-0.00030	-0.00050	-0.00047
1.85	-0.00040	-0.00045	-0.00040	-0.00020	-0.00040	-0.00037
1.95	-0.00035	-0.00040	-0.00040	-0.00025	-0.00030	-0.00034
2.05	-0.00080	-0.00080	-0.00080	-0.00070	-0.00050	-0.00072

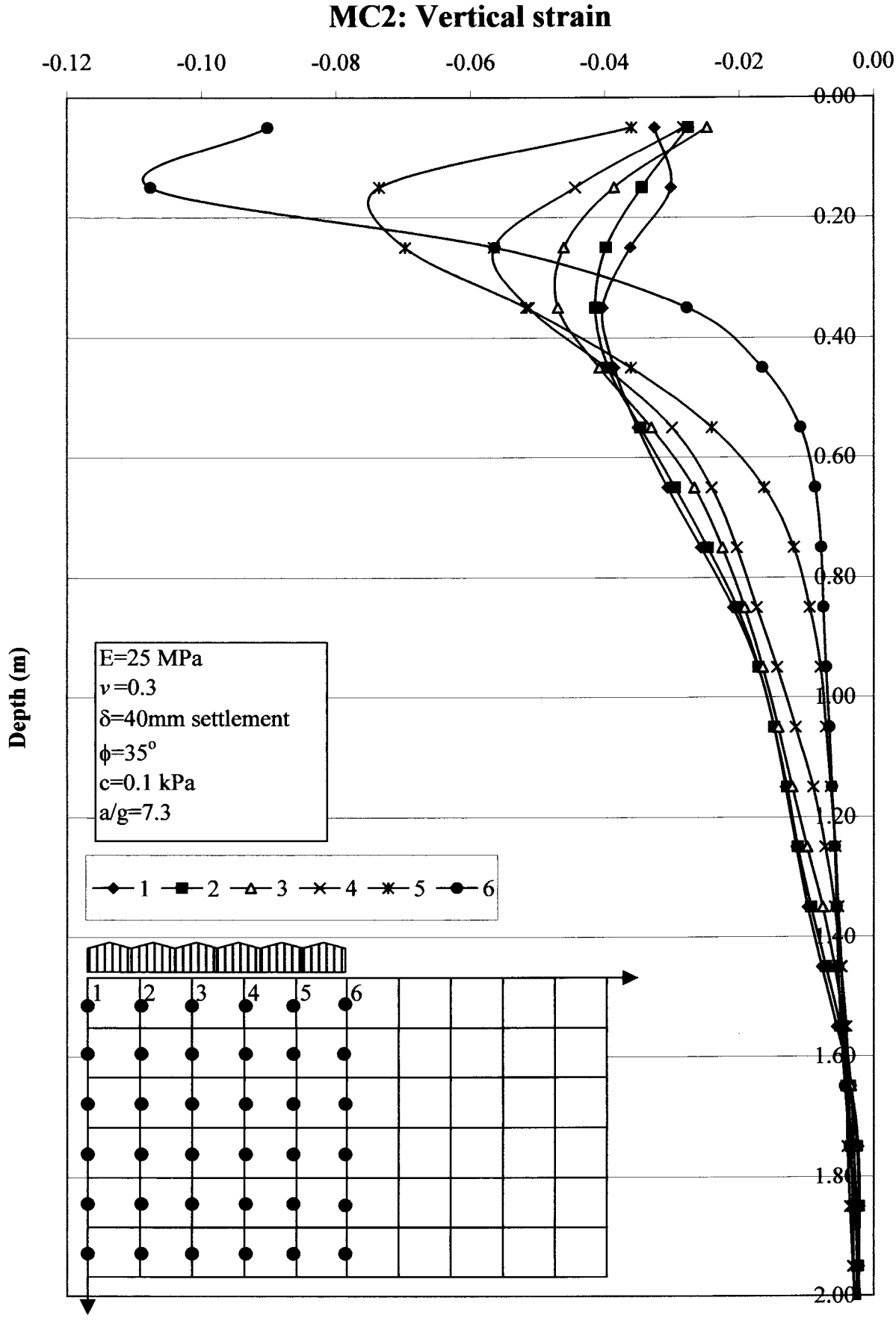
DATA FOR MC2 ANALYSIS: VERTICAL DISPLACEMENTS

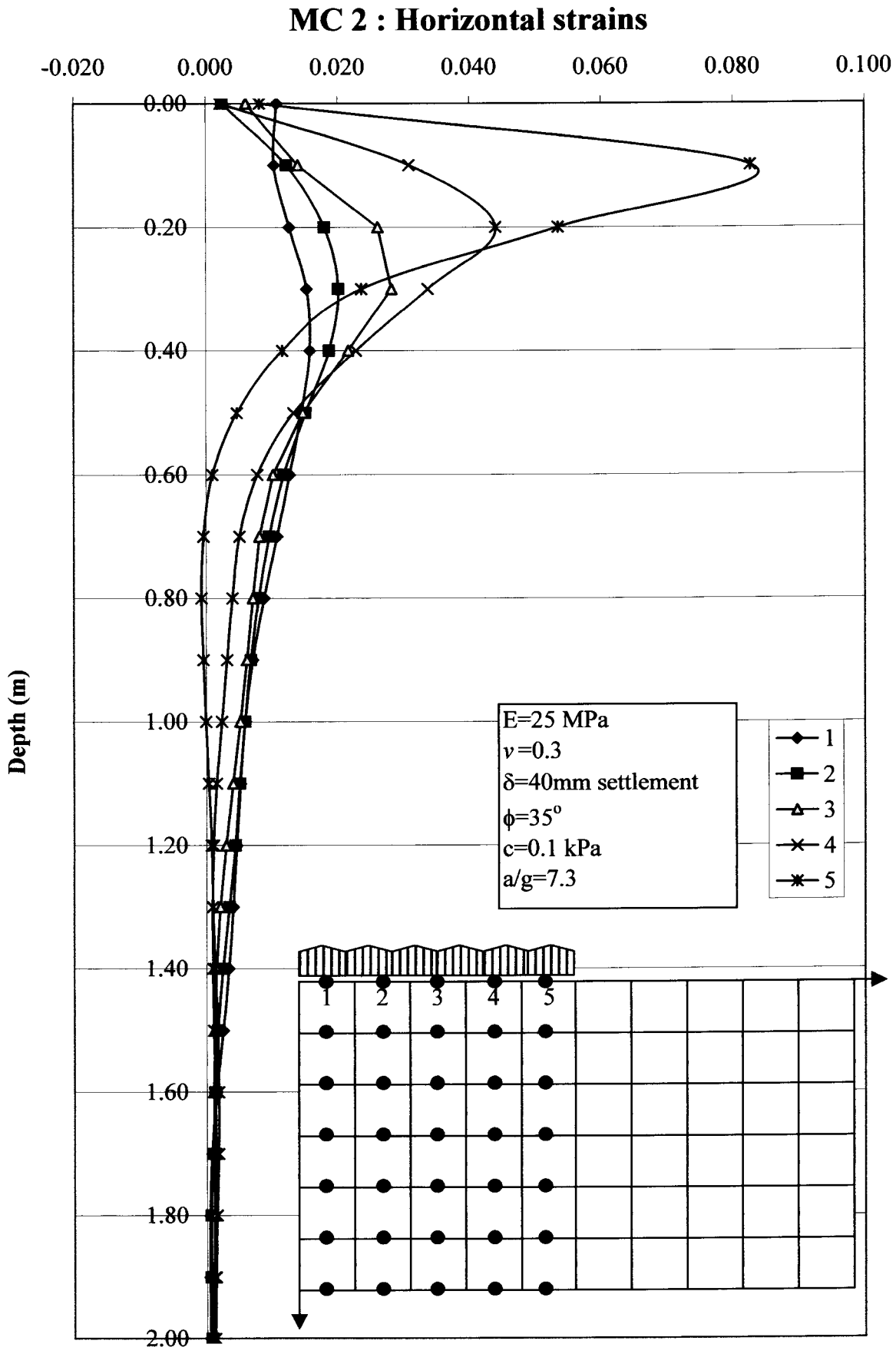


z (m)	x10^{-2} [Vertical displacements of grid points]					
0.0	-4.000	-4.000	-4.000	-4.000	-4.000	-4.000
0.1	-3.674	-3.724	-3.752	-3.717	-3.640	-3.098
0.2	-3.372	-3.379	-3.366	-3.273	-2.904	-2.022
0.3	-3.010	-2.981	-2.905	-2.708	-2.207	-1.458
0.4	-2.607	-2.567	-2.435	-2.195	-1.690	-1.180
0.5	-2.221	-2.172	-2.027	-1.797	-1.329	-1.014
0.6	-1.870	-1.825	-1.696	-1.497	-1.088	-0.905
0.7	-1.563	-1.529	-1.429	-1.256	-0.925	-0.818
0.8	-1.306	-1.282	-1.204	-1.052	-0.806	-0.740
0.9	-1.097	-1.079	-1.012	-0.878	-0.711	-0.665
1.0	-0.925	-0.908	-0.847	-0.734	-0.632	-0.594
1.1	-0.777	-0.760	-0.705	-0.618	-0.561	-0.528
1.2	-0.646	-0.631	-0.584	-0.528	-0.497	-0.466
1.3	-0.531	-0.518	-0.485	-0.456	-0.440	-0.408
1.4	-0.433	-0.425	-0.409	-0.398	-0.387	-0.353
1.5	-0.356	-0.354	-0.351	-0.349	-0.339	-0.300
1.6	-0.301	-0.304	-0.307	-0.308	-0.294	-0.251
1.7	-0.267	-0.269	-0.273	-0.270	-0.253	-0.208
1.8	-0.244	-0.244	-0.243	-0.236	-0.214	-0.172
1.9	-0.223	-0.222	-0.217	-0.205	-0.179	-0.144
2.0	-0.201	-0.199	-0.192	-0.175	-0.148	-0.121
2.1	-0.178	-0.175	-0.166	-0.147	-0.122	-0.103

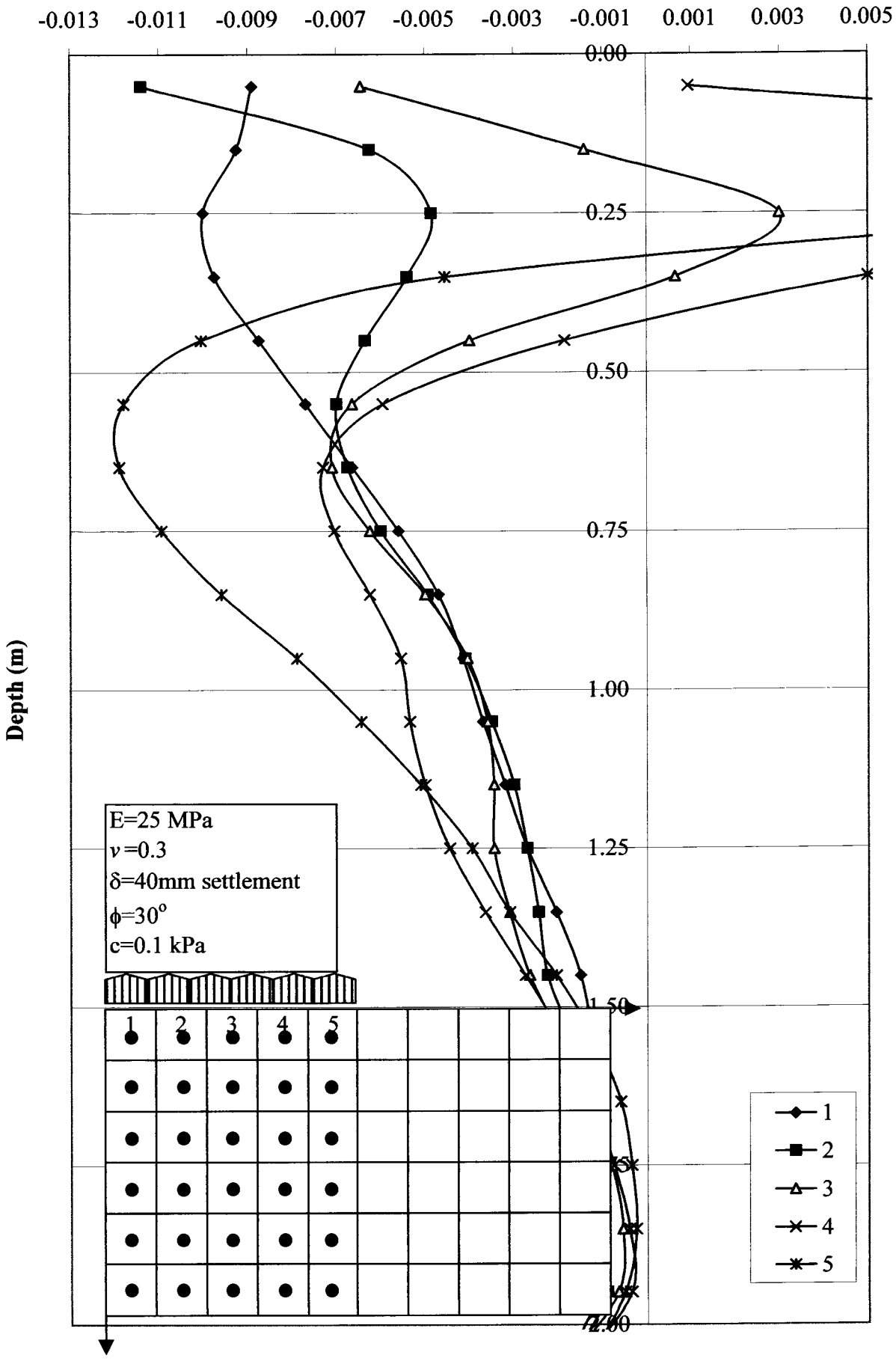
DATA FOR MC2 ANALYSIS: HORIZONTAL DISPLACEMENTS

z (m)	x10^{-2} [Horizon displacements of grid points]					
0.0	0.000	0.108	0.133	0.194	0.216	0.298
0.1	0.000	0.104	0.227	0.367	0.676	1.503
0.2	0.000	0.127	0.307	0.568	1.008	1.543
0.3	0.000	0.153	0.354	0.636	0.973	1.209
0.4	0.000	0.158	0.345	0.561	0.789	0.905
0.5	0.000	0.145	0.296	0.443	0.576	0.623
0.6	0.000	0.127	0.245	0.347	0.425	0.435
0.7	0.000	0.108	0.204	0.285	0.336	0.332
0.8	0.000	0.088	0.168	0.239	0.279	0.272
0.9	0.000	0.071	0.139	0.201	0.233	0.229
1.0	0.000	0.059	0.118	0.170	0.194	0.194
1.1	0.000	0.052	0.103	0.144	0.160	0.164
1.2	0.000	0.046	0.090	0.120	0.131	0.139
1.3	0.000	0.041	0.076	0.097	0.106	0.116
1.4	0.000	0.034	0.059	0.074	0.084	0.097
1.5	0.000	0.025	0.042	0.054	0.065	0.082
1.6	0.000	0.015	0.028	0.039	0.052	0.070
1.7	0.000	0.008	0.017	0.029	0.043	0.061
1.8	0.000	0.005	0.012	0.024	0.039	0.055
1.9	0.000	0.005	0.012	0.023	0.037	0.050
2.0	0.000	0.006	0.014	0.024	0.037	0.046
2.1	0.000	0.007	0.016	0.026	0.037	0.042


MC2: Vertical strain
-0.12
-0.10
-0.08
-0.06
-0.04
-0.02
0.00
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
Depth (m)
E=25 MPa
ν=0.3
δ=40mm settlement
ϕ=35°
c=0.1 kPa
a/g=7.3
1
2
3
4
5
6
1
2
3
4
5
6


MC 2 : Horizontal strains
-0.020
0.000
0.020
0.040
0.060
0.080
0.100
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
Depth (m)
E=25 MPa
ν=0.3
δ=40mm settlement
ϕ=35°
c=0.1 kPa
a/g=7.3
1
2
3
4
5
1
2
3
4
5

MC2 : Volumetric strain



DATA FOR MC2 ANALYSIS: VERTICAL STRAIN CALCULATION

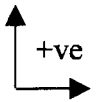
Zone	y ordinate at center of zone	z (m)	Δy/Yo 1	2	3	4	5	Xo=Yo=100mm =grid zone size 6
40	3.95	0.05	-0.0326	-0.0276	-0.0248	-0.0283	-0.036	-0.0902
39	3.85	0.15	-0.0302	-0.0345	-0.0386	-0.0444	-0.0736	-0.1076
38	3.75	0.25	-0.0362	-0.0398	-0.0461	-0.0565	-0.0697	-0.0564
37	3.65	0.35	-0.0403	-0.0414	-0.047	-0.0513	-0.0517	-0.0278
36	3.55	0.45	-0.0386	-0.0395	-0.0408	-0.0398	-0.0361	-0.0166
35	3.45	0.55	-0.0351	-0.0347	-0.0331	-0.03	-0.0241	-0.0109
34	3.35	0.65	-0.0307	-0.0296	-0.0267	-0.0241	-0.0163	-0.0087
33	3.25	0.75	-0.0257	-0.0247	-0.0225	-0.0204	-0.0119	-0.0078
32	3.15	0.85	-0.0209	-0.0203	-0.0192	-0.0174	-0.0095	-0.0075
31	3.05	0.95	-0.0172	-0.0171	-0.0165	-0.0144	-0.0079	-0.0071
30	2.95	1.05	-0.0148	-0.0148	-0.0142	-0.0116	-0.0071	-0.0066
29	2.85	1.15	-0.0131	-0.0129	-0.0121	-0.009	-0.0064	-0.0062
28	2.75	1.25	-0.0115	-0.0113	-0.0099	-0.0072	-0.0057	-0.0058
27	2.65	1.35	-0.0098	-0.0093	-0.0076	-0.0058	-0.0053	-0.0055
26	2.55	1.45	-0.0077	-0.0071	-0.0058	-0.0049	-0.0048	-0.0053
25	2.45	1.55	-0.0055	-0.005	-0.0044	-0.0041	-0.0045	-0.0049
24	2.35	1.65	-0.0034	-0.0035	-0.0034	-0.0038	-0.0041	-0.0043
23	2.25	1.75	-0.0023	-0.0025	-0.003	-0.0034	-0.0039	-0.0036
22	2.15	1.85	-0.0021	-0.0022	-0.0026	-0.0031	-0.0035	-0.0028
21	2.05	1.95	-0.0022	-0.0023	-0.0025	-0.003	-0.0031	-0.0023
20	1.95	2.05	-0.0023	-0.0024	-0.0026	-0.0028	-0.0026	-0.0018

DATA FOR MC2 ANALYSIS: HORIZONTAL STRAIN CALC.

z	Δx/Xo 1	2	3	4	5
0.00	0.0108	0.0025	0.0061	0.0022	0.0082
0.10	0.0104	0.0123	0.0140	0.0309	0.0827
0.20	0.0127	0.0180	0.0261	0.0440	0.0535
0.30	0.0153	0.0201	0.0282	0.0337	0.0236
0.40	0.0158	0.0187	0.0216	0.0228	0.0116
0.50	0.0145	0.0151	0.0147	0.0133	0.0047
0.60	0.0127	0.0118	0.0102	0.0078	0.0010
0.70	0.0108	0.0096	0.0081	0.0051	-0.0004
0.80	0.0088	0.0080	0.0071	0.0040	-0.0007
0.90	0.0071	0.0068	0.0062	0.0032	-0.0004
1.00	0.0059	0.0059	0.0052	0.0024	0.0000
1.10	0.0052	0.0051	0.0041	0.0016	0.0004
1.20	0.0046	0.0044	0.0030	0.0011	0.0008
1.30	0.0041	0.0035	0.0021	0.0009	0.0010
1.40	0.0034	0.0025	0.0015	0.0010	0.0013
1.50	0.0025	0.0017	0.0012	0.0011	0.0017
1.60	0.0015	0.0013	0.0011	0.0013	0.0018
1.70	0.0008	0.0009	0.0012	0.0014	0.0018
1.80	0.0005	0.0007	0.0012	0.0015	0.0016
1.90	0.0005	0.0007	0.0011	0.0014	0.0013
2.00	0.0006	0.0008	0.0010	0.0013	0.0009

DATA FOR MC3 ANALYSIS: VOLUMETRIC STRAIN CALC.

z	ε vol =ave(vert) +2(ave hor) 1	2	3	4	5	MC2
0.05	-0.00890	-0.01140	-0.00645	0.00095	0.02780	0.00040
0.15	-0.00925	-0.00625	-0.00140	0.01590	0.04560	0.00892
0.25	-0.01000	-0.00485	0.00300	0.01460	0.01405	0.00336
0.35	-0.00975	-0.00540	0.00065	0.00500	-0.00455	-0.00281
0.45	-0.00875	-0.00635	-0.00400	-0.00185	-0.01005	-0.00620
0.55	-0.00770	-0.00700	-0.00665	-0.00595	-0.01180	-0.00782
0.65	-0.00665	-0.00675	-0.00710	-0.00730	-0.01190	-0.00794
0.75	-0.00560	-0.00600	-0.00625	-0.00705	-0.01095	-0.00717
0.85	-0.00470	-0.00495	-0.00500	-0.00625	-0.00960	-0.00610
0.95	-0.00415	-0.00410	-0.00405	-0.00555	-0.00790	-0.00515
1.05	-0.00370	-0.00350	-0.00360	-0.00535	-0.00645	-0.00452
1.15	-0.00320	-0.00300	-0.00345	-0.00500	-0.00510	-0.00395
1.25	-0.00270	-0.00270	-0.00345	-0.00445	-0.00395	-0.00345
1.35	-0.00205	-0.00245	-0.00310	-0.00365	-0.00310	-0.00287
1.45	-0.00150	-0.00225	-0.00265	-0.00275	-0.00205	-0.00224
1.55	-0.00125	-0.00170	-0.00195	-0.00190	-0.00120	-0.00160
1.65	-0.00115	-0.00125	-0.00130	-0.00125	-0.00060	-0.00111
1.75	-0.00110	-0.00115	-0.00080	-0.00075	-0.00035	-0.00083
1.85	-0.00115	-0.00100	-0.00055	-0.00040	-0.00025	-0.00067
1.95	-0.00115	-0.00090	-0.00065	-0.00035	-0.00050	-0.00071
2.05	-0.00175	-0.00170	-0.00170	-0.00140	-0.00130	

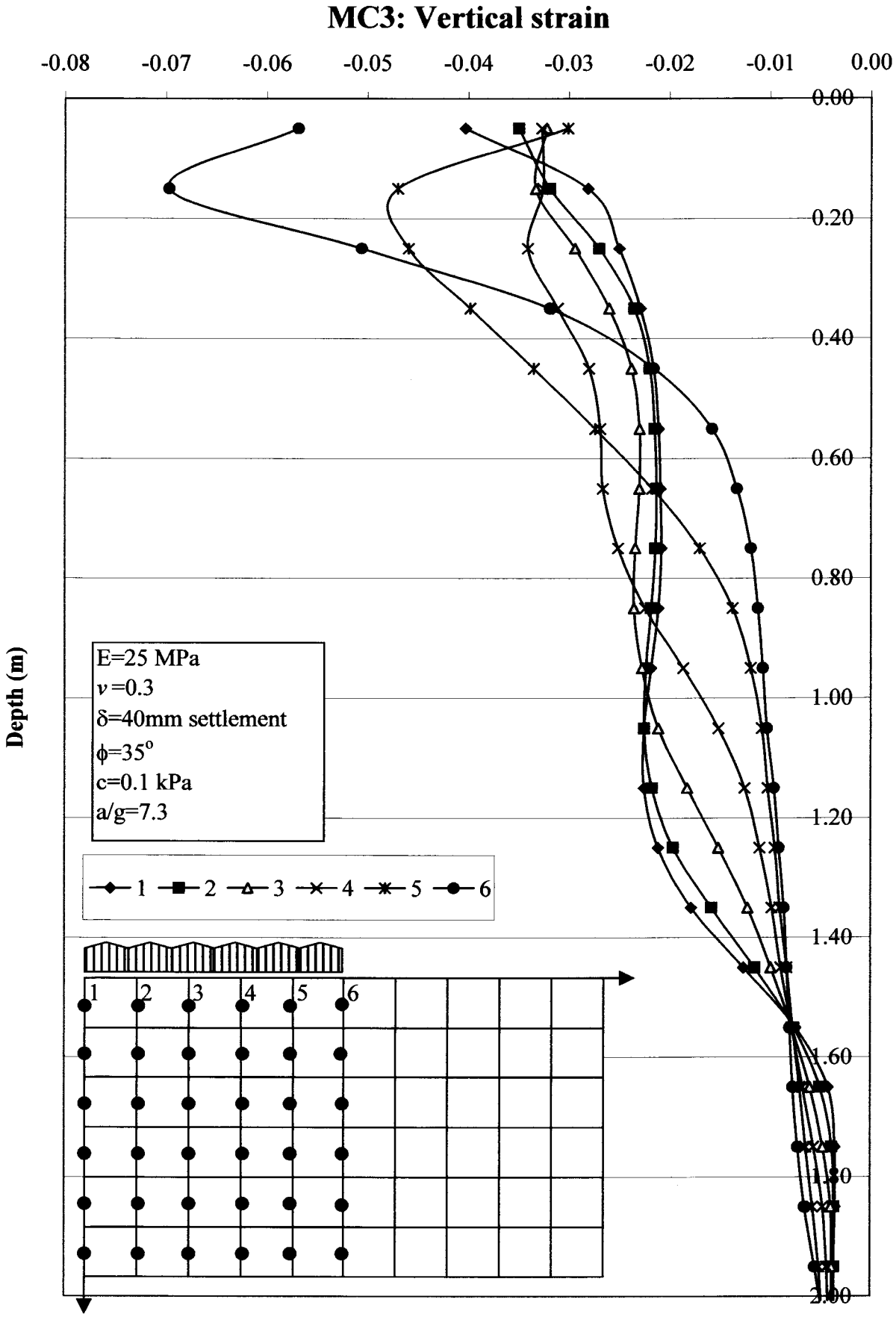


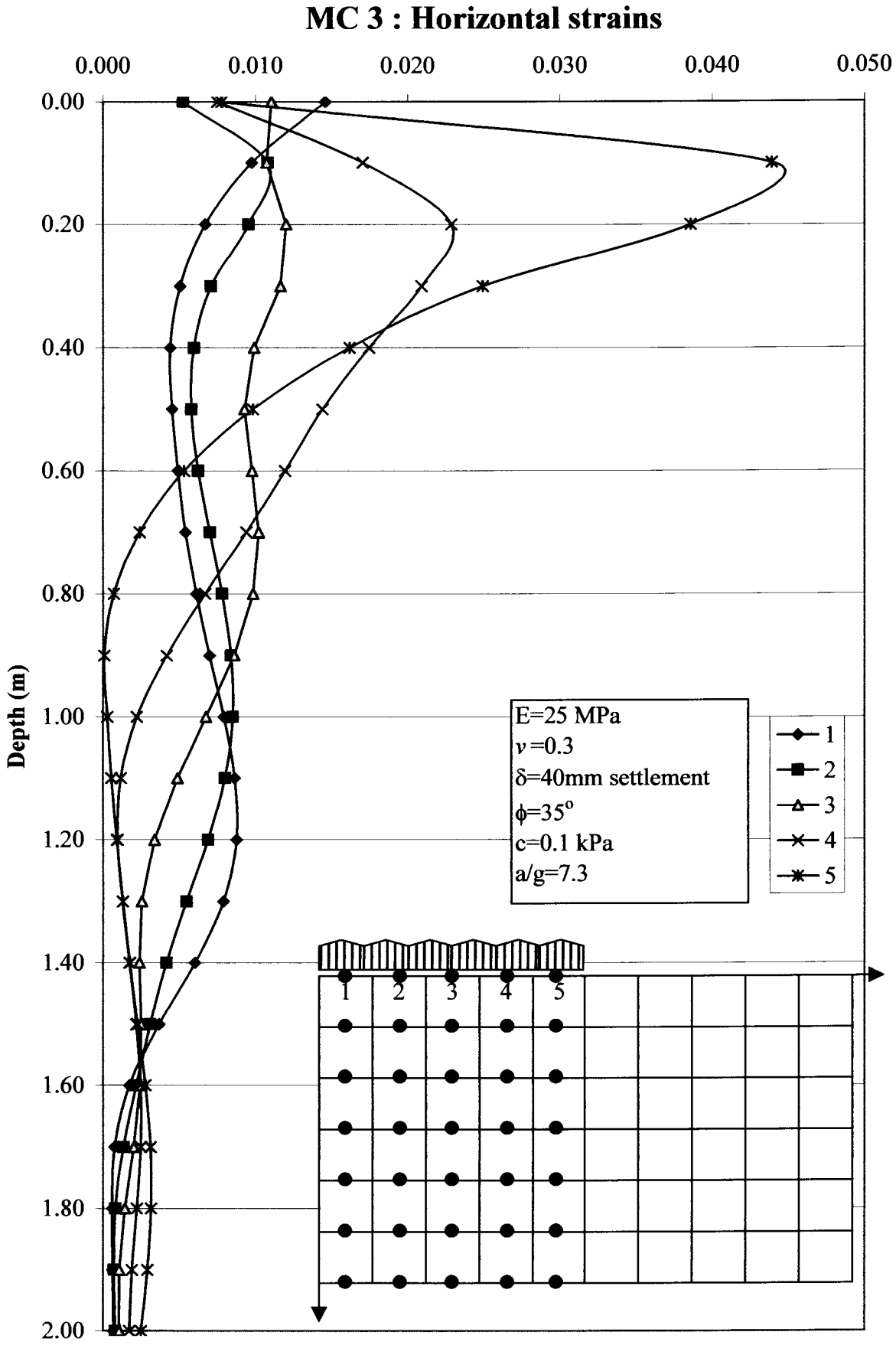
DATA FOR MC3 ANALYSIS: VERTICAL DISPLACEMENTS

z (m)	x10^{-2} [Vertical displacements of grid points]					
0.0	-4.000	-4.000	-4.000	-4.000	-4.000	-4.000
0.1	-3.597	-3.650	-3.678	-3.673	-3.699	-3.431
0.2	-3.316	-3.331	-3.345	-3.347	-3.229	-2.734
0.3	-3.066	-3.061	-3.051	-3.006	-2.770	-2.228
0.4	-2.837	-2.826	-2.791	-2.695	-2.372	-1.909
0.5	-2.621	-2.606	-2.553	-2.415	-2.037	-1.693
0.6	-2.410	-2.391	-2.323	-2.146	-1.763	-1.535
0.7	-2.201	-2.178	-2.093	-1.880	-1.546	-1.402
0.8	-1.993	-1.964	-1.859	-1.629	-1.376	-1.283
0.9	-1.782	-1.746	-1.624	-1.405	-1.239	-1.171
1.0	-1.564	-1.523	-1.397	-1.219	-1.120	-1.064
1.1	-1.339	-1.298	-1.186	-1.068	-1.012	-0.961
1.2	-1.114	-1.081	-1.004	-0.943	-0.910	-0.865
1.3	-0.903	-0.885	-0.853	-0.833	-0.815	-0.774
1.4	-0.725	-0.727	-0.731	-0.735	-0.725	-0.688
1.5	-0.599	-0.612	-0.632	-0.646	-0.642	-0.605
1.6	-0.525	-0.536	-0.554	-0.568	-0.565	-0.525
1.7	-0.483	-0.486	-0.494	-0.501	-0.495	-0.448
1.8	-0.448	-0.448	-0.447	-0.445	-0.431	-0.376
1.9	-0.413	-0.412	-0.408	-0.398	-0.374	-0.311
2.0	-0.377	-0.376	-0.370	-0.355	-0.323	-0.256
2.1	-0.342	-0.340	-0.332	-0.314	-0.276	-0.211

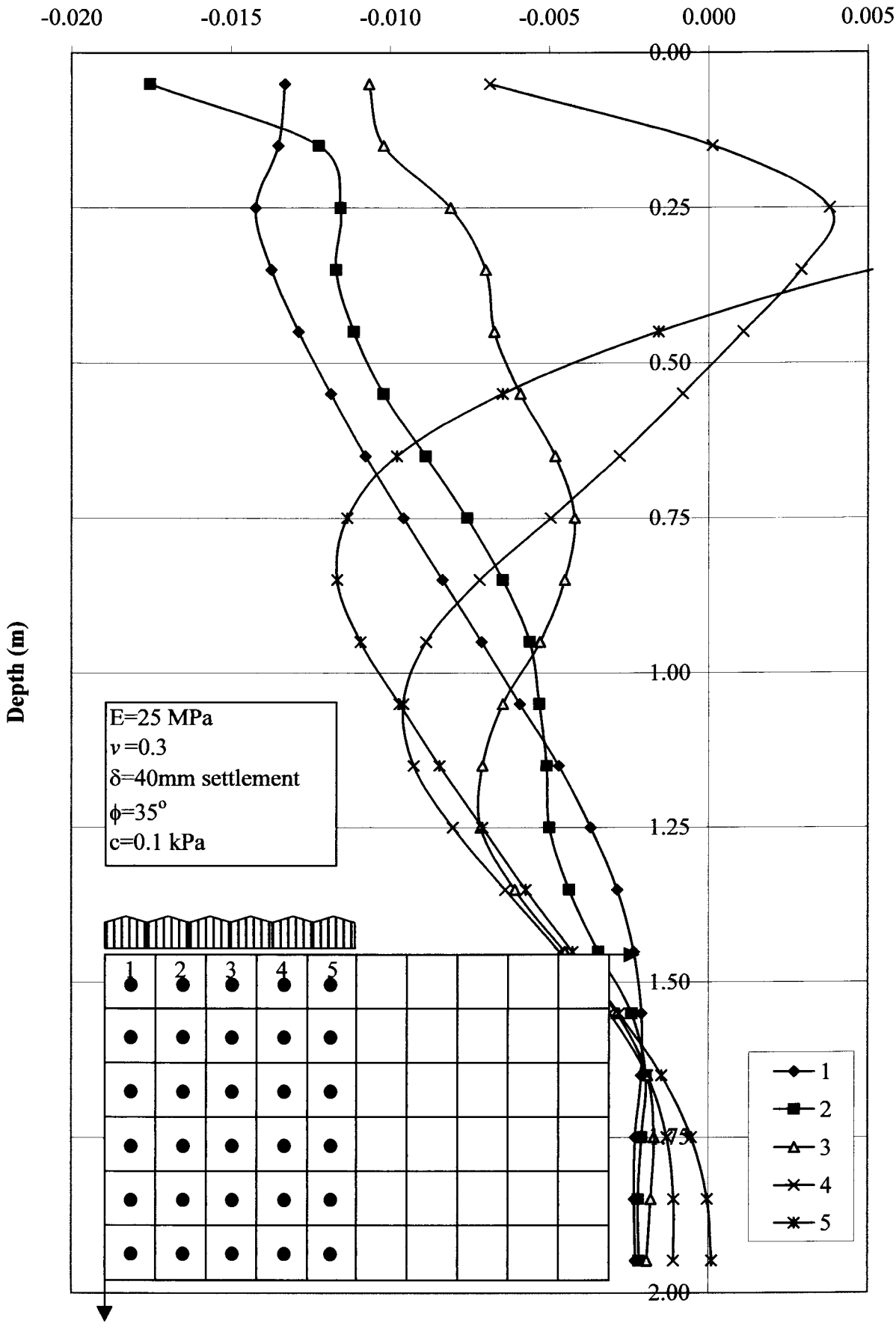
DATA FOR MC3 ANALYSIS: HORIZONTAL DISPLACEMENTS

z (m)	x10^{-3} [Horizon displacements of grid points]					
0.0	0.000	1.457	1.982	3.086	3.835	4.612
0.1	0.000	0.976	2.056	3.130	4.834	9.225
0.2	0.000	0.671	1.626	2.826	5.114	8.972
0.3	0.000	0.506	1.214	2.378	4.469	6.962
0.4	0.000	0.440	1.036	2.026	3.771	5.387
0.5	0.000	0.452	1.031	1.958	3.397	4.379
0.6	0.000	0.491	1.116	2.093	3.288	3.819
0.7	0.000	0.541	1.242	2.263	3.204	3.444
0.8	0.000	0.611	1.391	2.375	3.044	3.114
0.9	0.000	0.699	1.538	2.398	2.815	2.823
1.0	0.000	0.793	1.643	2.319	2.540	2.569
1.1	0.000	0.864	1.663	2.151	2.266	2.321
1.2	0.000	0.876	1.564	1.901	1.995	2.085
1.3	0.000	0.790	1.338	1.591	1.719	1.849
1.4	0.000	0.604	1.019	1.258	1.432	1.609
1.5	0.000	0.367	0.677	0.928	1.147	1.374
1.6	0.000	0.173	0.392	0.634	0.880	1.157
1.7	0.000	0.076	0.210	0.411	0.658	0.969
1.8	0.000	0.059	0.140	0.283	0.505	0.820
1.9	0.000	0.063	0.136	0.242	0.431	0.722
2.0	0.000	0.068	0.147	0.252	0.423	0.672
2.1	0.000	0.076	0.163	0.279	0.450	0.650


MC3: Vertical strain
-0.08
-0.07
-0.06
-0.05
-0.04
-0.03
-0.02
-0.01
0.00
Depth (m)
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
E=25 MPa
ν=0.3
δ=40mm settlement
ϕ=35°
c=0.1 kPa
a/g=7.3
1
2
3
4
5
6


MC 3 : Horizontal strains
0.000
0.010
0.020
0.030
0.040
0.050
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
Depth (m)
E=25 MPa
ν=0.3
δ=40mm settlement
ϕ=35°
c=0.1 kPa
a/g=7.3
1
2
3
4
5
1
2
3
4
5

MC 3: Volumetric strain variation under rigid base



DATA FOR MC3 ANALYSIS: VERTICAL STRAIN CALCULATION

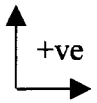
Zone	y ordinate at center of zone	z (m)	Δy/Yo 1	2	3	Xo=Yo=100mm =grid zone size 4	5	6
40	3.95	0.05	-0.0403	-0.035	-0.0322	-0.0327	-0.0301	-0.0569
39	3.85	0.15	-0.0281	-0.0319	-0.0333	-0.0326	-0.047	-0.0697
38	3.75	0.25	-0.025	-0.027	-0.0294	-0.0341	-0.0459	-0.0506
37	3.65	0.35	-0.0229	-0.0235	-0.026	-0.0311	-0.0398	-0.0319
36	3.55	0.45	-0.0216	-0.022	-0.0238	-0.028	-0.0335	-0.0216
35	3.45	0.55	-0.0211	-0.0215	-0.023	-0.0269	-0.0274	-0.0158
34	3.35	0.65	-0.0209	-0.0213	-0.023	-0.0266	-0.0217	-0.0133
33	3.25	0.75	-0.0208	-0.0214	-0.0234	-0.0251	-0.017	-0.0119
32	3.15	0.85	-0.0211	-0.0218	-0.0235	-0.0224	-0.0137	-0.0112
31	3.05	0.95	-0.0218	-0.0223	-0.0227	-0.0186	-0.0119	-0.0107
30	2.95	1.05	-0.0225	-0.0225	-0.0211	-0.0151	-0.0108	-0.0103
29	2.85	1.15	-0.0225	-0.0217	-0.0182	-0.0125	-0.0102	-0.0096
28	2.75	1.25	-0.0211	-0.0196	-0.0151	-0.011	-0.0095	-0.0091
27	2.65	1.35	-0.0178	-0.0158	-0.0122	-0.0098	-0.009	-0.0086
26	2.55	1.45	-0.0126	-0.0115	-0.0099	-0.0089	-0.0083	-0.0083
25	2.45	1.55	-0.0074	-0.0076	-0.0078	-0.0078	-0.0077	-0.008
24	2.35	1.65	-0.0042	-0.005	-0.006	-0.0067	-0.007	-0.0077
23	2.25	1.75	-0.0035	-0.0038	-0.0047	-0.0056	-0.0064	-0.0072
22	2.15	1.85	-0.0035	-0.0036	-0.0039	-0.0047	-0.0057	-0.0065
21	2.05	1.95	-0.0036	-0.0036	-0.0038	-0.0043	-0.0051	-0.0055
20	1.95	2.05	-0.0035	-0.0036	-0.0038	-0.0041	-0.0047	-0.0045

DATA FOR MC3 ANALYSIS: HORIZONTAL STRAIN CALCULATION

z	Δx/Xo 1	2	3	4	5
0.00	0.0146	0.0053	0.0110	0.0075	0.0078
0.10	0.0098	0.0108	0.0107	0.0170	0.0439
0.20	0.0067	0.0096	0.0120	0.0229	0.0386
0.30	0.0051	0.0071	0.0116	0.0209	0.0249
0.40	0.0044	0.0060	0.0099	0.0175	0.0162
0.50	0.0045	0.0058	0.0093	0.0144	0.0098
0.60	0.0049	0.0063	0.0098	0.0120	0.0053
0.70	0.0054	0.0070	0.0102	0.0094	0.0024
0.80	0.0061	0.0078	0.0098	0.0067	0.0007
0.90	0.0070	0.0084	0.0086	0.0042	0.0001
1.00	0.0079	0.0085	0.0068	0.0022	0.0003
1.10	0.0086	0.0080	0.0049	0.0012	0.0006
1.20	0.0088	0.0069	0.0034	0.0009	0.0009
1.30	0.0079	0.0055	0.0025	0.0013	0.0013
1.40	0.0060	0.0042	0.0024	0.0017	0.0018
1.50	0.0037	0.0031	0.0025	0.0022	0.0023
1.60	0.0017	0.0022	0.0024	0.0025	0.0028
1.70	0.0008	0.0013	0.0020	0.0025	0.0031
1.80	0.0006	0.0008	0.0014	0.0022	0.0032
1.90	0.0006	0.0007	0.0011	0.0019	0.0029
2.00	0.0007	0.0008	0.0011	0.0017	0.0025

DATA FOR MC3 ANALYSIS: VOLUMETRIC STRAIN CALCULATION

z	ε vol =ave(vert) +2(ave hor) 1	2	3	4	5	Total
0.05	-0.01332	-0.01755	-0.01067	-0.00687	0.00818	-0.00805
0.15	-0.01353	-0.01225	-0.01021	0.00012	0.02414	-0.00235
0.25	-0.01423	-0.01157	-0.00811	0.00379	0.01526	-0.00297
0.35	-0.01374	-0.01171	-0.00701	0.00291	0.00524	-0.00486
0.45	-0.01288	-0.01115	-0.00673	0.00109	-0.00157	-0.00625
0.55	-0.01187	-0.01021	-0.00591	-0.00081	-0.00647	-0.00705
0.65	-0.01078	-0.00889	-0.00482	-0.00279	-0.00979	-0.00741
0.75	-0.00958	-0.00759	-0.00420	-0.00495	-0.01135	-0.00753
0.85	-0.00835	-0.00646	-0.00451	-0.00719	-0.01167	-0.00764
0.95	-0.00713	-0.00561	-0.00529	-0.00887	-0.01093	-0.00757
1.05	-0.00593	-0.00531	-0.00646	-0.00959	-0.00971	-0.00740
1.15	-0.00470	-0.00508	-0.00710	-0.00926	-0.00845	-0.00692
1.25	-0.00369	-0.00499	-0.00715	-0.00803	-0.00710	-0.00619
1.35	-0.00286	-0.00437	-0.00608	-0.00638	-0.00573	-0.00508
1.45	-0.00234	-0.00345	-0.00450	-0.00467	-0.00426	-0.00384
1.55	-0.00210	-0.00241	-0.00287	-0.00310	-0.00281	-0.00266
1.65	-0.00211	-0.00197	-0.00192	-0.00192	-0.00147	-0.00188
1.75	-0.00230	-0.00210	-0.00171	-0.00131	-0.00054	-0.00159
1.85	-0.00233	-0.00221	-0.00181	-0.00109	-0.00004	-0.00150
1.95	-0.00229	-0.00218	-0.00194	-0.00110	0.00010	-0.00148

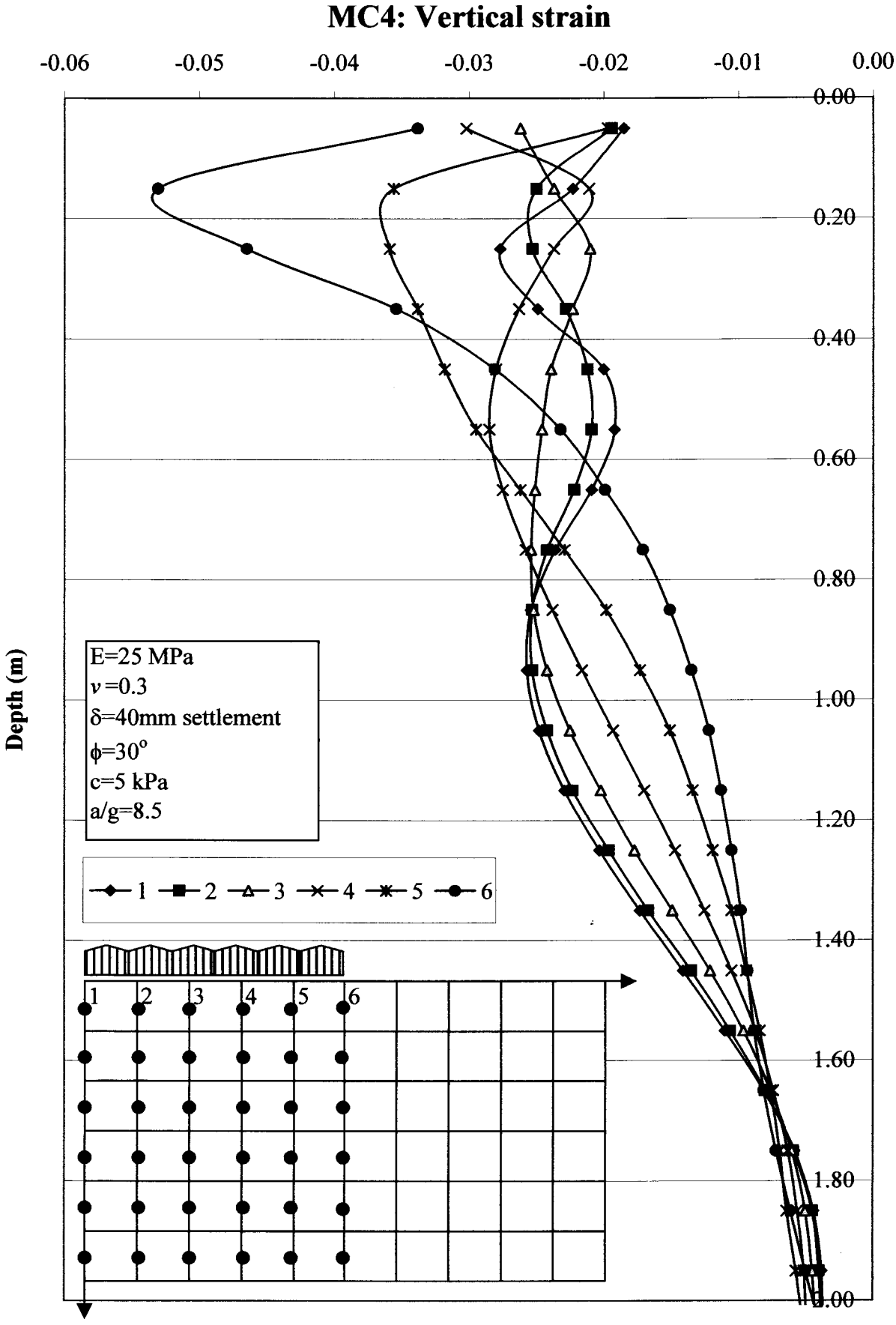


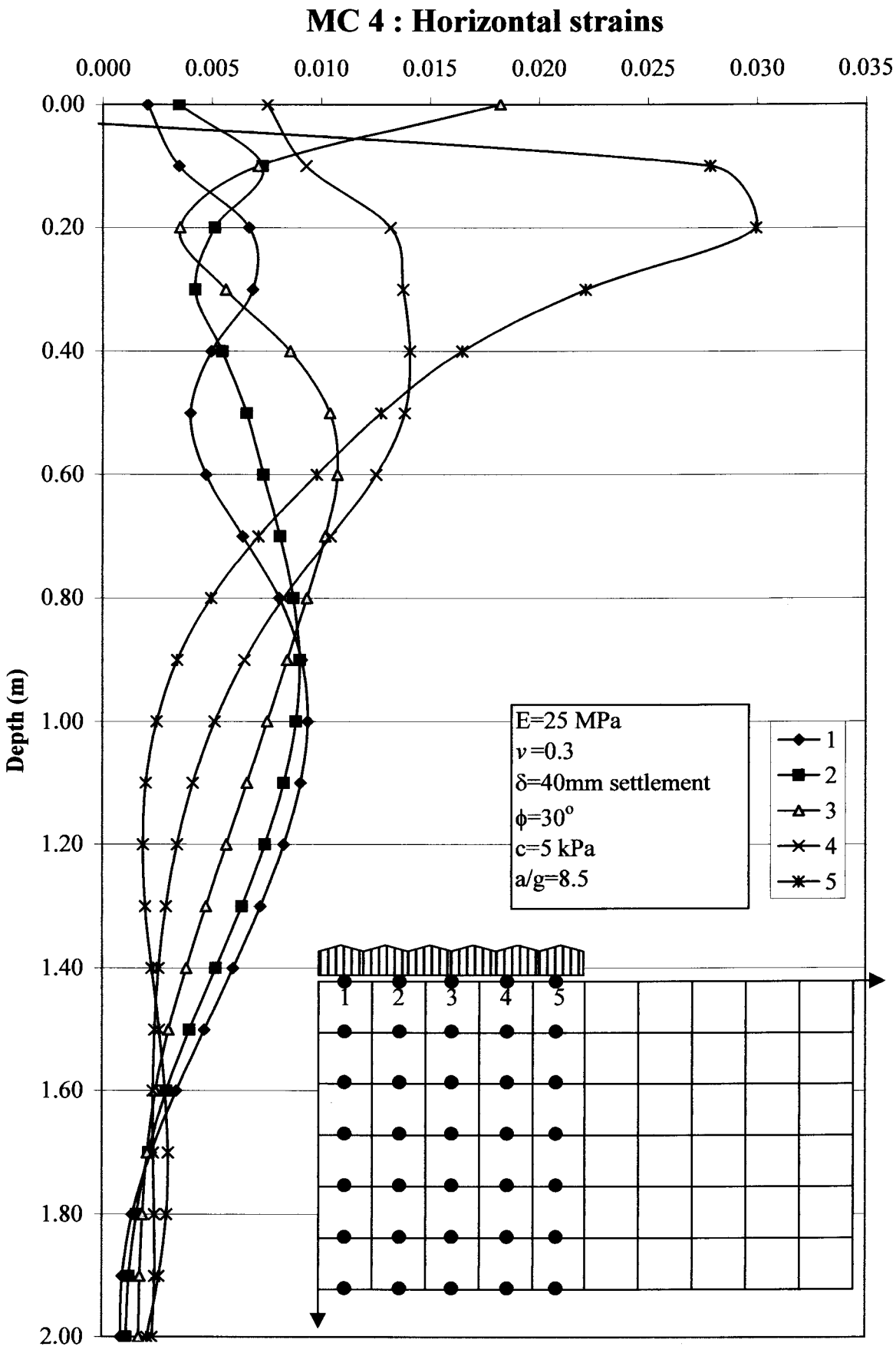
DATA FOR MC4 ANALYSIS: VERTICAL DISPLACEMENTS

z (m)	x10^{-2} [Vertical displacements of grid points]					
0.0	-4.000	-4.000	-4.000	-4.000	-4.000	-4.000
0.1	-3.815	-3.806	-3.738	-3.698	-3.803	-3.662
0.2	-3.592	-3.556	-3.501	-3.487	-3.447	-3.131
0.3	-3.315	-3.303	-3.291	-3.250	-3.088	-2.666
0.4	-3.066	-3.075	-3.068	-2.987	-2.750	-2.312
0.5	-2.866	-2.863	-2.829	-2.707	-2.432	-2.031
0.6	-2.674	-2.654	-2.583	-2.422	-2.137	-1.799
0.7	-2.465	-2.432	-2.332	-2.147	-1.875	-1.600
0.8	-2.229	-2.190	-2.078	-1.889	-1.646	-1.429
0.9	-1.975	-1.937	-1.826	-1.651	-1.448	-1.278
1.0	-1.718	-1.684	-1.584	-1.435	-1.275	-1.143
1.1	-1.470	-1.442	-1.359	-1.242	-1.124	-1.021
1.2	-1.241	-1.219	-1.157	-1.072	-0.990	-0.908
1.3	-1.038	-1.023	-0.980	-0.925	-0.871	-0.803
1.4	-0.865	-0.856	-0.831	-0.800	-0.766	-0.705
1.5	-0.724	-0.721	-0.710	-0.695	-0.672	-0.612
1.6	-0.614	-0.615	-0.614	-0.608	-0.588	-0.524
1.7	-0.533	-0.535	-0.538	-0.534	-0.512	-0.443
1.8	-0.475	-0.476	-0.478	-0.471	-0.443	-0.371
1.9	-0.431	-0.431	-0.428	-0.415	-0.379	-0.310
2.0	-0.393	-0.391	-0.383	-0.364	-0.322	-0.260
2.1	-0.356	-0.353	-0.341	-0.315	-0.271	-0.222

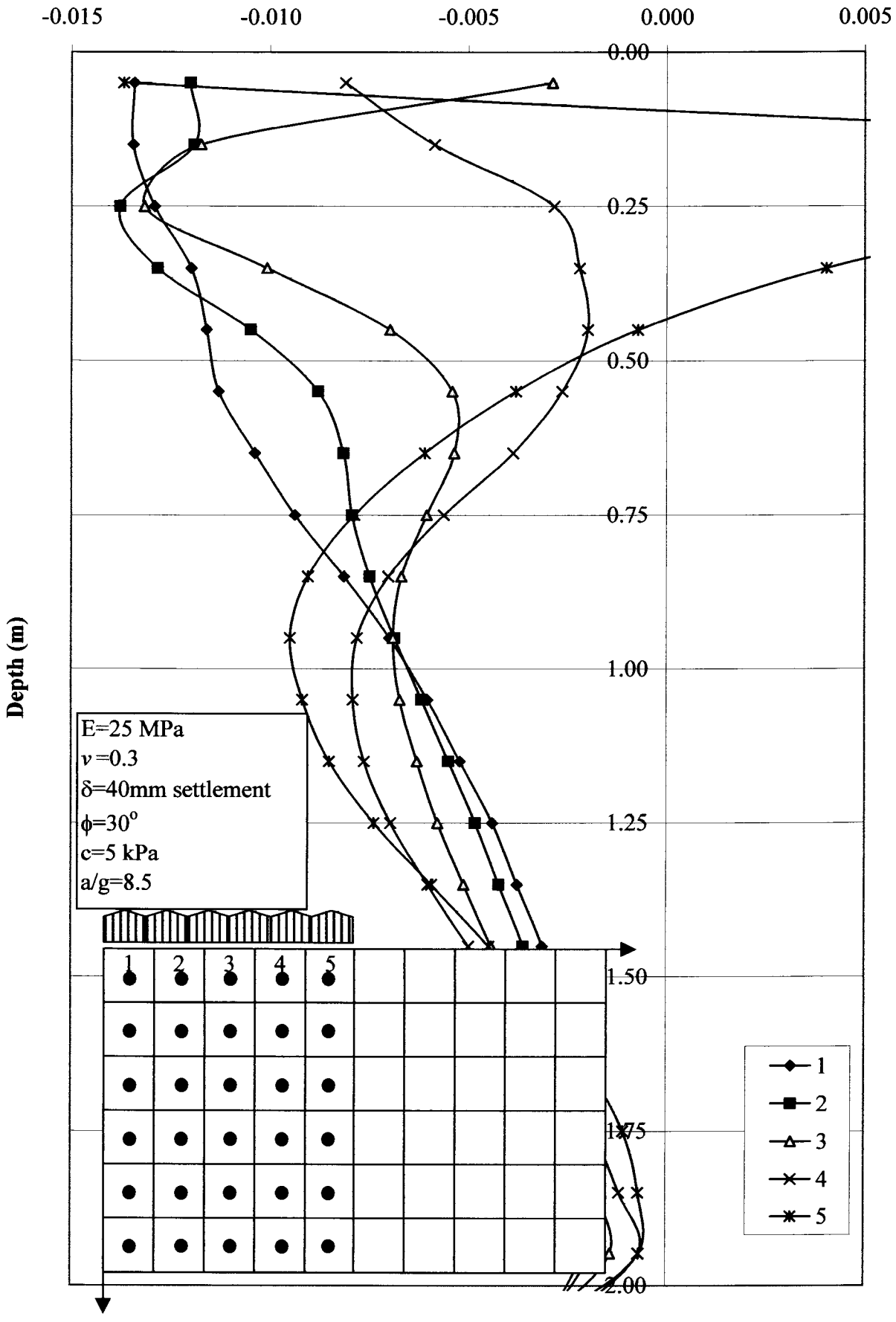
DATA FOR MC4 ANALYSIS: HORIZONTAL DISPLACEMENTS

z (m)	x10^{-3} [Horizon displacements of grid points]					
0.0	0.000	0.204	0.552	2.373	3.127	1.649
0.1	0.000	0.349	1.080	1.792	2.723	5.507
0.2	0.000	0.671	1.184	1.538	2.857	5.853
0.3	0.000	0.688	1.112	1.676	3.054	5.269
0.4	0.000	0.498	1.045	1.903	3.311	4.959
0.5	0.000	0.402	1.061	2.101	3.485	4.760
0.6	0.000	0.474	1.211	2.286	3.540	4.521
0.7	0.000	0.643	1.456	2.476	3.521	4.236
0.8	0.000	0.810	1.684	2.620	3.449	3.947
0.9	0.000	0.912	1.815	2.661	3.311	3.654
1.0	0.000	0.940	1.827	2.582	3.097	3.345
1.1	0.000	0.908	1.739	2.402	2.817	3.016
1.2	0.000	0.832	1.577	2.146	2.489	2.675
1.3	0.000	0.725	1.364	1.839	2.131	2.328
1.4	0.000	0.600	1.120	1.505	1.763	1.990
1.5	0.000	0.469	0.869	1.174	1.414	1.676
1.6	0.000	0.340	0.634	0.879	1.113	1.402
1.7	0.000	0.225	0.438	0.645	0.880	1.183
1.8	0.000	0.138	0.296	0.481	0.722	1.017
1.9	0.000	0.093	0.217	0.390	0.632	0.893
2.0	0.000	0.085	0.195	0.363	0.593	0.800
2.1	0.000	0.094	0.212	0.380	0.584	0.729




MC 4 : Horizontal strains
0.000
0.005
0.010
0.015
0.020
0.025
0.030
0.035
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
Depth (m)
E=25 MPa
ν=0.3
δ=40mm settlement
ϕ=30°
c=5 kPa
a/g=8.5
1
2
3
4
5
1
2
3
4
5

MC4 : Volumetric strain variation under rigid base



DATA FOR MC4 ANALYSIS: VERTICAL STRAIN CALCULATION

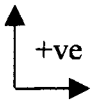
Zone	y ordinate at center of zone	z (m)	Δy/Yo 1	2	3	4	5	6
			Xo=Yo=100mm =grid zone size					
40	3.95	0.05	-0.0185	-0.0194	-0.0262	-0.0302	-0.0197	-0.0338
39	3.85	0.15	-0.0223	-0.025	-0.0237	-0.0211	-0.0356	-0.0531
38	3.75	0.25	-0.0277	-0.0253	-0.021	-0.0237	-0.0359	-0.0465
37	3.65	0.35	-0.0249	-0.0228	-0.0223	-0.0263	-0.0338	-0.0354
36	3.55	0.45	-0.02	-0.0212	-0.0239	-0.028	-0.0318	-0.0281
35	3.45	0.55	-0.0192	-0.0209	-0.0246	-0.0285	-0.0295	-0.0232
34	3.35	0.65	-0.0209	-0.0222	-0.0251	-0.0275	-0.0262	-0.0199
33	3.25	0.75	-0.0236	-0.0242	-0.0254	-0.0258	-0.0229	-0.0171
32	3.15	0.85	-0.0254	-0.0253	-0.0252	-0.0238	-0.0198	-0.0151
31	3.05	0.95	-0.0257	-0.0253	-0.0242	-0.0216	-0.0173	-0.0135
30	2.95	1.05	-0.0248	-0.0242	-0.0225	-0.0193	-0.0151	-0.0122
29	2.85	1.15	-0.0229	-0.0223	-0.0202	-0.017	-0.0134	-0.0113
28	2.75	1.25	-0.0203	-0.0196	-0.0177	-0.0147	-0.0119	-0.0105
27	2.65	1.35	-0.0173	-0.0167	-0.0149	-0.0125	-0.0105	-0.0098
26	2.55	1.45	-0.0141	-0.0135	-0.0121	-0.0105	-0.0094	-0.0093
25	2.45	1.55	-0.011	-0.0106	-0.0096	-0.0087	-0.0084	-0.0088
24	2.35	1.65	-0.0081	-0.008	-0.0076	-0.0074	-0.0076	-0.0081
23	2.25	1.75	-0.0058	-0.0059	-0.006	-0.0063	-0.0069	-0.0072
22	2.15	1.85	-0.0044	-0.0045	-0.005	-0.0056	-0.0064	-0.0061
21	2.05	1.95	-0.0038	-0.004	-0.0045	-0.0051	-0.0057	-0.005
20	1.95	2.05	-0.0037	-0.0038	-0.0042	-0.0049	-0.0051	-0.0038

DATA FOR MC4 ANALYSIS: HORIZONTAL STRAIN CALC.

z	Δx/Xo 1	2	3	4	5
0.00	0.0020	0.0035	0.0182	0.0075	-0.0148
0.10	0.0035	0.0073	0.0071	0.0093	0.0278
0.20	0.0067	0.0051	0.0035	0.0132	0.0300
0.30	0.0069	0.0042	0.0056	0.0138	0.0222
0.40	0.0050	0.0055	0.0086	0.0141	0.0165
0.50	0.0040	0.0066	0.0104	0.0138	0.0128
0.60	0.0047	0.0074	0.0108	0.0125	0.0098
0.70	0.0064	0.0081	0.0102	0.0105	0.0072
0.80	0.0081	0.0087	0.0094	0.0083	0.0050
0.90	0.0091	0.0090	0.0085	0.0065	0.0034
1.00	0.0094	0.0089	0.0076	0.0052	0.0025
1.10	0.0091	0.0083	0.0066	0.0042	0.0020
1.20	0.0083	0.0075	0.0057	0.0034	0.0019
1.30	0.0073	0.0064	0.0048	0.0029	0.0020
1.40	0.0060	0.0052	0.0039	0.0026	0.0023
1.50	0.0047	0.0040	0.0031	0.0024	0.0026
1.60	0.0034	0.0029	0.0025	0.0023	0.0029
1.70	0.0023	0.0021	0.0021	0.0024	0.0030
1.80	0.0014	0.0016	0.0019	0.0024	0.0030
1.90	0.0009	0.0012	0.0017	0.0024	0.0026
2.00	0.0009	0.0011	0.0017	0.0023	0.0021

DATA FOR MC4 ANALYSIS: VOLUMETRIC STRAIN CALC.

z	ε vol =ave(vert) +2(ave hor) 1	2	3	4	5	Total
0.05	-0.01342	-0.01201	-0.00287	-0.00810	-0.01369	-0.01002
0.15	-0.01345	-0.01191	-0.01174	-0.00585	0.01345	-0.00590
0.25	-0.01291	-0.01378	-0.01317	-0.00283	0.01091	-0.00636
0.35	-0.01199	-0.01284	-0.01008	-0.00219	0.00403	-0.00661
0.45	-0.01160	-0.01049	-0.00697	-0.00198	-0.00072	-0.00635
0.55	-0.01129	-0.00879	-0.00540	-0.00262	-0.00379	-0.00638
0.65	-0.01038	-0.00815	-0.00535	-0.00386	-0.00609	-0.00677
0.75	-0.00937	-0.00793	-0.00604	-0.00561	-0.00787	-0.00736
0.85	-0.00813	-0.00748	-0.00668	-0.00701	-0.00904	-0.00767
0.95	-0.00698	-0.00685	-0.00689	-0.00780	-0.00949	-0.00760
1.05	-0.00602	-0.00617	-0.00672	-0.00790	-0.00918	-0.00720
1.15	-0.00520	-0.00549	-0.00628	-0.00762	-0.00850	-0.00662
1.25	-0.00438	-0.00481	-0.00576	-0.00695	-0.00737	-0.00585
1.35	-0.00375	-0.00421	-0.00510	-0.00600	-0.00591	-0.00499
1.45	-0.00311	-0.00360	-0.00440	-0.00497	-0.00446	-0.00411
1.55	-0.00271	-0.00316	-0.00365	-0.00381	-0.00309	-0.00328
1.65	-0.00240	-0.00273	-0.00298	-0.00281	-0.00193	-0.00257
1.75	-0.00222	-0.00224	-0.00223	-0.00184	-0.00107	-0.00192
1.85	-0.00214	-0.00193	-0.00172	-0.00117	-0.00069	-0.00153
1.95	-0.00212	-0.00191	-0.00139	-0.00068	-0.00067	-0.00135
2.05	-0.00290	-0.00290	-0.00287	-0.00270	-0.00238	-0.00275

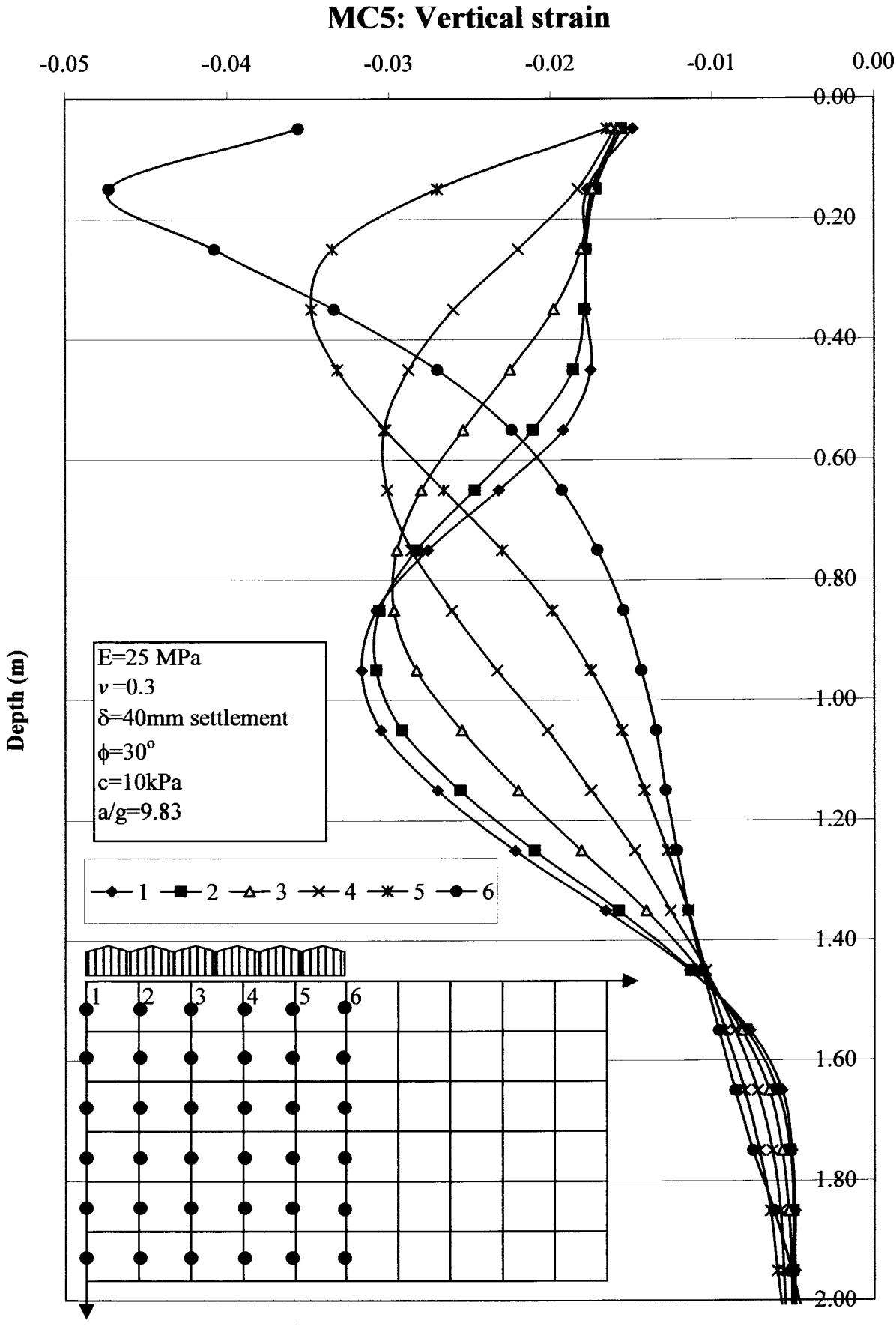


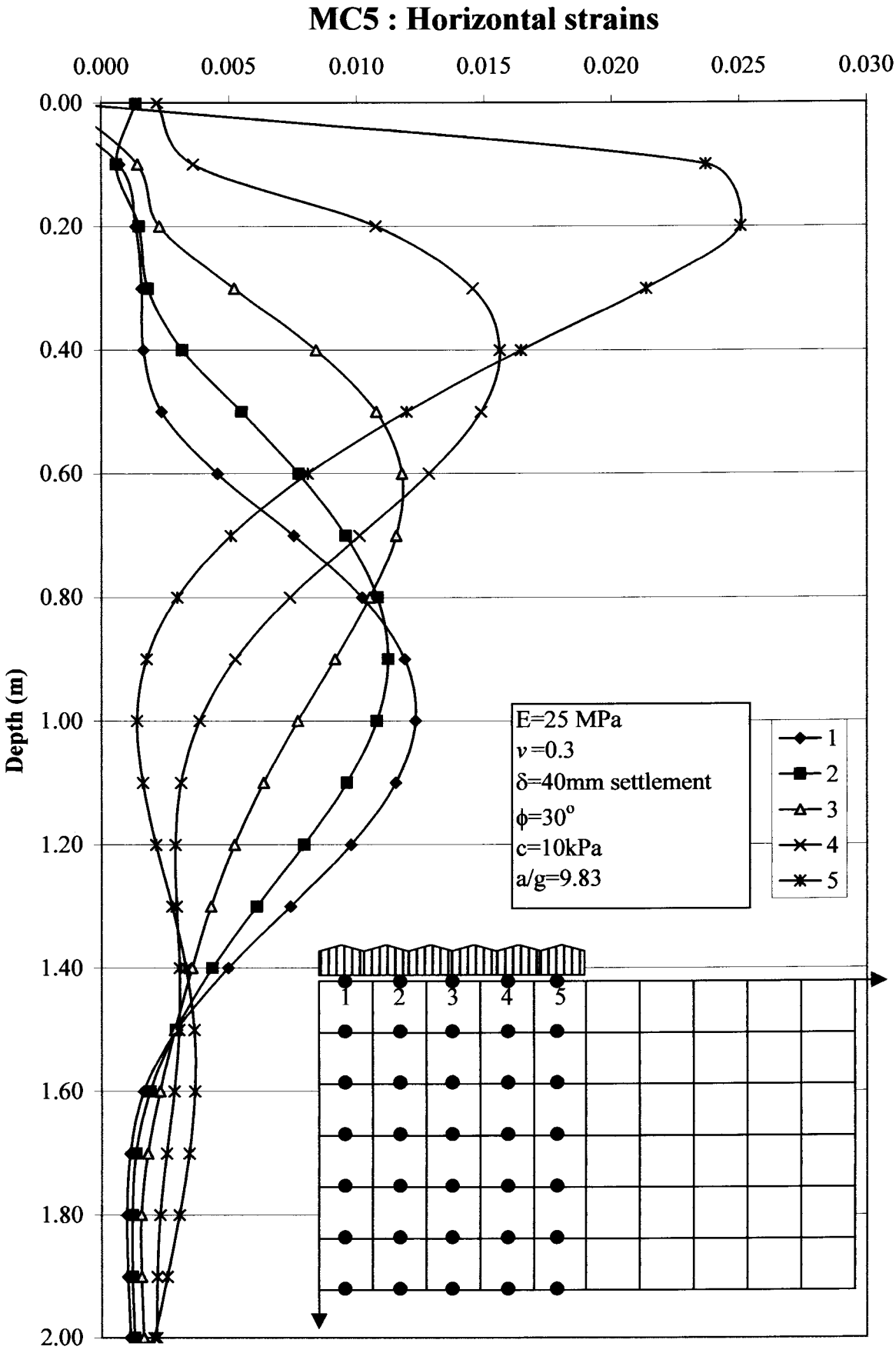
DATA FOR MC5 ANALYSIS: VERTICAL DISPLACEMENTS

z (m)	x10^{-2} [Vertical displacements of grid points]					
0.0	-4.000	-4.000	-4.000	-4.000	-4.000	-4.000
0.1	-3.851	-3.844	-3.842	-3.840	-3.835	-3.644
0.2	-3.674	-3.672	-3.668	-3.657	-3.565	-3.171
0.3	-3.496	-3.494	-3.487	-3.437	-3.230	-2.763
0.4	-3.318	-3.315	-3.289	-3.177	-2.882	-2.429
0.5	-3.143	-3.129	-3.064	-2.889	-2.550	-2.159
0.6	-2.951	-2.918	-2.810	-2.586	-2.248	-1.935
0.7	-2.719	-2.671	-2.530	-2.285	-1.982	-1.742
0.8	-2.443	-2.388	-2.235	-1.999	-1.752	-1.571
0.9	-2.135	-2.082	-1.938	-1.738	-1.553	-1.416
1.0	-1.818	-1.774	-1.655	-1.505	-1.378	-1.272
1.1	-1.513	-1.482	-1.400	-1.303	-1.222	-1.137
1.2	-1.243	-1.226	-1.180	-1.128	-1.080	-1.008
1.3	-1.021	-1.016	-0.999	-0.980	-0.952	-0.886
1.4	-0.855	-0.858	-0.858	-0.854	-0.837	-0.771
1.5	-0.741	-0.745	-0.750	-0.750	-0.733	-0.665
1.6	-0.664	-0.666	-0.668	-0.664	-0.641	-0.569
1.7	-0.607	-0.606	-0.603	-0.592	-0.561	-0.483
1.8	-0.556	-0.554	-0.546	-0.529	-0.490	-0.408
1.9	-0.507	-0.504	-0.493	-0.471	-0.426	-0.346
2.0	-0.458	-0.454	-0.442	-0.415	-0.366	-0.295
2.1	-0.410	-0.405	-0.391	-0.361	-0.311	-0.253

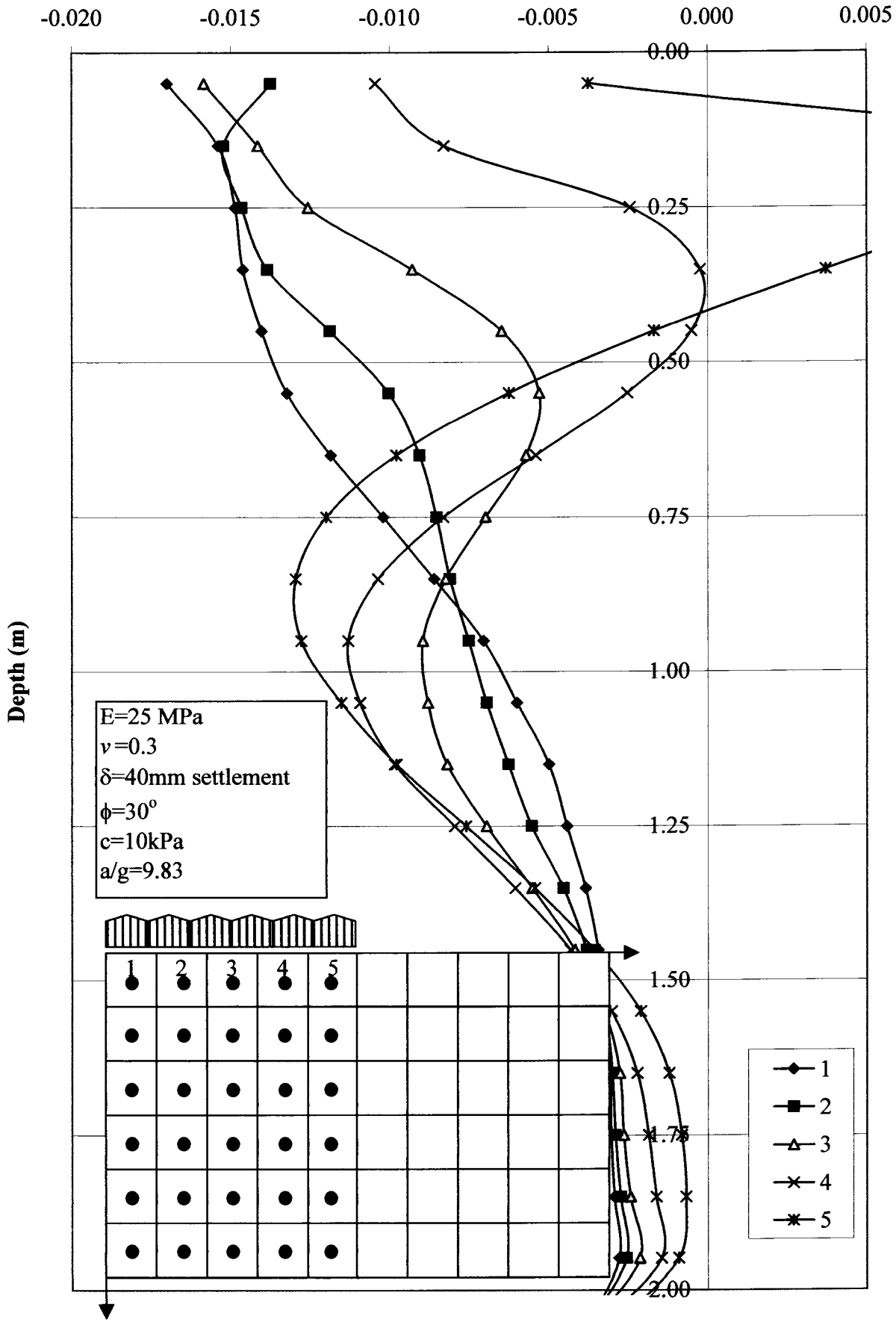
DATA FOR MC5 ANALYSIS: HORIZONTAL DISPLACEMENTS

z (m)	x10^{-3} [Horizon displacements of grid points]					
0.0	0.000	-0.246	-0.111	-0.248	-0.029	-0.169
0.1	0.000	0.070	0.129	0.271	0.631	3.000
0.2	0.000	0.135	0.282	0.509	1.584	4.090
0.3	0.000	0.158	0.340	0.860	2.315	4.451
0.4	0.000	0.165	0.482	1.322	2.883	4.528
0.5	0.000	0.236	0.785	1.862	3.350	4.546
0.6	0.000	0.455	1.227	2.405	3.689	4.497
0.7	0.000	0.753	1.709	2.864	3.874	4.381
0.8	0.000	1.021	2.102	3.153	3.891	4.188
0.9	0.000	1.188	2.311	3.225	3.749	3.925
1.0	0.000	1.231	2.310	3.079	3.463	3.602
1.1	0.000	1.153	2.113	2.748	3.059	3.221
1.2	0.000	0.977	1.770	2.290	2.579	2.792
1.3	0.000	0.740	1.348	1.777	2.071	2.347
1.4	0.000	0.496	0.929	1.283	1.588	1.918
1.5	0.000	0.294	0.585	0.872	1.175	1.538
1.6	0.000	0.165	0.355	0.583	0.867	1.232
1.7	0.000	0.112	0.246	0.426	0.680	1.023
1.8	0.000	0.098	0.218	0.373	0.602	0.906
1.9	0.000	0.103	0.223	0.379	0.597	0.854
2.0	0.000	0.113	0.242	0.407	0.623	0.829
2.1	0.000	0.124	0.265	0.440	0.648	0.801


MC5: Vertical strain
-0.05
-0.04
-0.03
-0.02
-0.01
0.00
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
Depth (m)
E=25 MPa
ν=0.3
δ=40mm settlement
ϕ=30°
c=10kPa
a/g=9.83
1
2
3
4
5
6


MC5 : Horizontal strains
0.000
0.005
0.010
0.015
0.020
0.025
0.030
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
Depth (m)
E=25 MPa
v=0.3
δ=40mm settlement
ϕ=30°
c=10kPa
a/g=9.83
1
2
3
4
5
1
2
3
4
5

MC5 : Volumetric strain variation under rigid base



DATA FOR MC5 ANALYSIS: VERTICAL STRAIN CALCULATION

Zone	y ordinate at center of zone	z (m)	Δy/Yo 1	2	3	4	5	Xo=Yo=100mm =grid zone size 6
40	3.95	0.05	-0.0149	-0.0156	-0.0158	-0.016	-0.0165	-0.0356
39	3.85	0.15	-0.0177	-0.0172	-0.0174	-0.0183	-0.027	-0.0473
38	3.75	0.25	-0.0178	-0.0178	-0.0181	-0.022	-0.0335	-0.0408
37	3.65	0.35	-0.0178	-0.0179	-0.0198	-0.026	-0.0348	-0.0334
36	3.55	0.45	-0.0175	-0.0186	-0.0225	-0.0288	-0.0332	-0.027
35	3.45	0.55	-0.0192	-0.0211	-0.0254	-0.0303	-0.0302	-0.0224
34	3.35	0.65	-0.0232	-0.0247	-0.028	-0.0301	-0.0266	-0.0193
33	3.25	0.75	-0.0276	-0.0283	-0.0295	-0.0286	-0.023	-0.0171
32	3.15	0.85	-0.0308	-0.0306	-0.0297	-0.0261	-0.0199	-0.0155
31	3.05	0.95	-0.0317	-0.0308	-0.0283	-0.0233	-0.0175	-0.0144
30	2.95	1.05	-0.0305	-0.0292	-0.0255	-0.0202	-0.0156	-0.0135
29	2.85	1.15	-0.027	-0.0256	-0.022	-0.0175	-0.0142	-0.0129
28	2.75	1.25	-0.0222	-0.021	-0.0181	-0.0148	-0.0128	-0.0122
27	2.65	1.35	-0.0166	-0.0158	-0.0141	-0.0126	-0.0115	-0.0115
26	2.55	1.45	-0.0114	-0.0113	-0.0108	-0.0104	-0.0104	-0.0106
25	2.45	1.55	-0.0077	-0.0079	-0.0082	-0.0086	-0.0092	-0.0096
24	2.35	1.65	-0.0057	-0.006	-0.0065	-0.0072	-0.008	-0.0086
23	2.25	1.75	-0.0051	-0.0052	-0.0057	-0.0063	-0.0071	-0.0075
22	2.15	1.85	-0.0049	-0.005	-0.0053	-0.0058	-0.0064	-0.0062
21	2.05	1.95	-0.0049	-0.005	-0.0051	-0.0056	-0.006	-0.0051
20	1.95	2.05	-0.0048	-0.0049	-0.0051	-0.0054	-0.0055	-0.0042

DATA FOR MC5 ANALYSIS: HORIZONTAL STRAIN CALC.

z	Δx/Xo 1	2	3	4	5
0.00	-0.0025	0.0014	-0.0014	0.0022	-0.0014
0.10	0.0007	0.0006	0.0014	0.0036	0.0237
0.20	0.0014	0.0015	0.0023	0.0108	0.0251
0.30	0.0016	0.0018	0.0052	0.0146	0.0214
0.40	0.0017	0.0032	0.0084	0.0156	0.0165
0.50	0.0024	0.0055	0.0108	0.0149	0.0120
0.60	0.0046	0.0077	0.0118	0.0128	0.0081
0.70	0.0075	0.0096	0.0116	0.0101	0.0051
0.80	0.0102	0.0108	0.0105	0.0074	0.0030
0.90	0.0119	0.0112	0.0091	0.0052	0.0018
1.00	0.0123	0.0108	0.0077	0.0038	0.0014
1.10	0.0115	0.0096	0.0064	0.0031	0.0016
1.20	0.0098	0.0079	0.0052	0.0029	0.0021
1.30	0.0074	0.0061	0.0043	0.0029	0.0028
1.40	0.0050	0.0043	0.0035	0.0031	0.0033
1.50	0.0029	0.0029	0.0029	0.0030	0.0036
1.60	0.0017	0.0019	0.0023	0.0028	0.0037
1.70	0.0011	0.0013	0.0018	0.0025	0.0034
1.80	0.0010	0.0012	0.0016	0.0023	0.0030
1.90	0.0010	0.0012	0.0016	0.0022	0.0026
2.00	0.0011	0.0013	0.0017	0.0022	0.0021

DATA FOR MC5 ANALYSIS: VOLUMETRIC STRAIN CALC.

z	ε vol =ave(vert) +2(ave hor) 1	2	3	4	5	Total
0.05	-0.01701	-0.01376	-0.01585	-0.01046	-0.00376	-0.01217
0.15	-0.01540	-0.01524	-0.01416	-0.00830	0.01160	-0.00830
0.25	-0.01487	-0.01466	-0.01258	-0.00245	0.00927	-0.00706
0.35	-0.01462	-0.01386	-0.00930	-0.00024	0.00371	-0.00686
0.45	-0.01404	-0.01189	-0.00648	-0.00051	-0.00169	-0.00692
0.55	-0.01324	-0.01004	-0.00530	-0.00253	-0.00626	-0.00747
0.65	-0.01187	-0.00907	-0.00572	-0.00541	-0.00980	-0.00837
0.75	-0.01021	-0.00853	-0.00699	-0.00832	-0.01201	-0.00921
0.85	-0.00861	-0.00811	-0.00825	-0.01038	-0.01297	-0.00966
0.95	-0.00706	-0.00753	-0.00897	-0.01132	-0.01280	-0.00954
1.05	-0.00601	-0.00696	-0.00881	-0.01095	-0.01154	-0.00885
1.15	-0.00500	-0.00627	-0.00820	-0.00985	-0.00980	-0.00782
1.25	-0.00443	-0.00554	-0.00696	-0.00797	-0.00761	-0.00650
1.35	-0.00384	-0.00454	-0.00552	-0.00606	-0.00544	-0.00508
1.45	-0.00345	-0.00381	-0.00419	-0.00432	-0.00357	-0.00387
1.55	-0.00321	-0.00324	-0.00325	-0.00303	-0.00212	-0.00297
1.65	-0.00308	-0.00301	-0.00277	-0.00222	-0.00122	-0.00246
1.75	-0.00305	-0.00291	-0.00265	-0.00187	-0.00083	-0.00226
1.85	-0.00294	-0.00275	-0.00244	-0.00163	-0.00069	-0.00209
1.95	-0.00279	-0.00256	-0.00214	-0.00146	-0.00092	-0.00197
2.05	-0.00372	-0.00371	-0.00360	-0.00329	-0.00279	

APPENDIX H

VOLUMETRIC STRAIN INFLUENCE MODEL CALCULATIONS

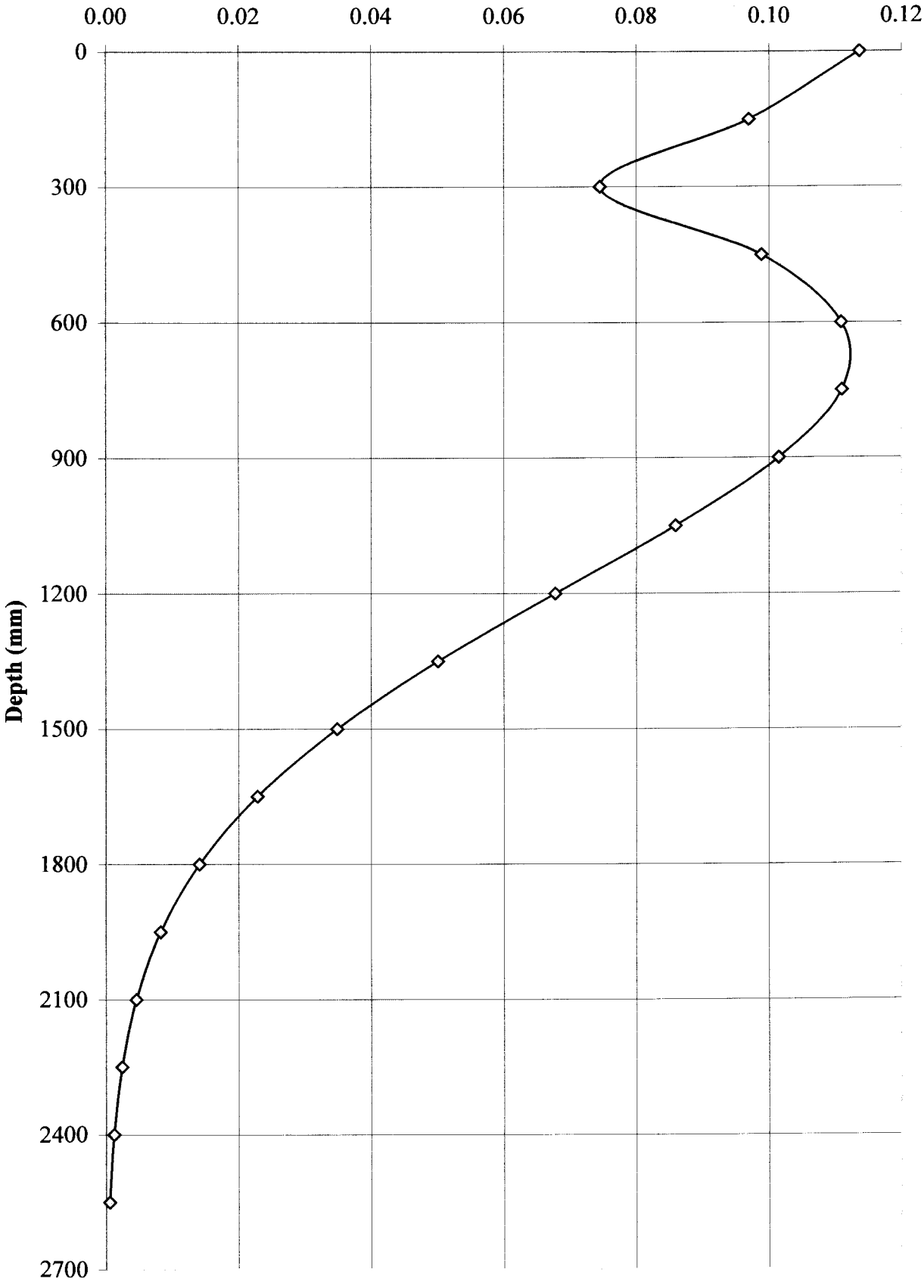
APPENDIX H1 : Calculation of strain influence diagram for impact compaction:

Compactor contact dimension, B=	0.9	m
Assuming depth of influence, D =	2.7	m, =3B say
Asuming peak strain at of	0.75	B
which is equal to…	675	mm
Upper peak is how many times larger	1.025	x lower peak

Depth (mm)	ε ord.	Surface peak	Nett curve	Normalised ε ord.
0	0.00000	0.00091	0.00091	0.113663
150	0.00032	0.00045	0.00078	0.096982
300	0.00060	0.00000	0.00060	0.074567
450	0.00079		0.00079	0.098860
600	0.00089		0.00089	0.110891
750	0.00089		0.00089	0.110993
900	0.00081		0.00081	0.101513
1050	0.00069		0.00069	0.085914
1200	0.00054		0.00054	0.067796
1350	0.00040		0.00040	0.050126
1500	0.00028		0.00028	0.034840
1650	0.00018		0.00018	0.022818
1800	0.00011		0.00011	0.014107
1950	0.00007		0.00007	0.008244
2100	0.00004		0.00004	0.004558
2250	0.00002		0.00002	0.002386
2400	0.00001		0.00001	0.001184
2550	0.00000		0.00000	0.000557
	0.00664		0.00800	1.00

$$f(z) = \frac{z}{\sigma^2}.e^{-\frac{z^2}{2.\sigma^2}}$$

APPENDIX H2 : Normalised strain influence diagram



APPENDIX H3: Strain influence calculation : TP3 - Kriel 1991 [25 passes]

[Figure 6.1]

$$\Delta V = V_o.\varepsilon_{vol} = V_o.(1-2v_{pl})\varepsilon_v = (1+e_o)(1-2v_{pl})\varepsilon_v$$

$$\rho = \frac{G_s}{(V_o - \Delta V)}$$

δ (settlement)=	356	mm	v_{pl} =	0.075	Gs =	2650	(kg/m^3)

Depth (mm)	ρ_o	e_o	ΔH	ε_v=ΔH/H	Depth (mm)	ΔV=Δe	ρ_f(kg/m^3)
0	1531	0.731	40.5	0.26976	0	0.397	1986
150	1531	0.731	34.5	0.23017	150	0.339	1903
300	1531	0.731	26.5	0.17697	300	0.260	1802
450	1366	0.940	35.2	0.23463	450	0.387	1706
600	1366	0.940	39.5	0.26318	600	0.434	1760
750	1418	0.869	39.5	0.26342	750	0.418	1827
900	1418	0.869	36.1	0.24092	900	0.383	1783
1050	1418	0.869	30.6	0.20390	1050	0.324	1715
1200	1403	0.889	24.1	0.16090	1200	0.258	1625
1350	1403	0.889	17.8	0.11897	1350	0.191	1561
1500	1403	0.889	12.4	0.08269	1500	0.133	1509
1650	1403	0.889	8.1	0.05416	1650	0.087	1471
1800	1403	0.889	5.0	0.03348	1800	0.054	1444
1950	1403	0.889	2.9	0.01956	1950	0.031	1427
2100	1403	0.889	1.6	0.01082	2100	0.017	1416
2250	1403	0.889	0.8	0.00566	2250	0.009	1410
2400	1403	0.889	0.4	0.00281	2400	0.005	1406
2550	1403	0.889	0.2	0.00132	2550	0.002	1405
			Sum 356	mm			

TP3 measured	Before	After
d (mm)	ρ_o (kg/m^3)	ρ_f(kg/m^3)
300	1531	1972
600	1366	1918
900	1418	1752
1200	1403	1632

TP3 measured	Before	After	
d (mm)	e_o	e_f	Δe
300	0.731	0.344	0.387
600	0.940	0.382	0.558
900	0.869	0.513	0.356
1200	0.889	0.624	0.265

Measured densities from reference: Landpac (1991).

APPENDIX H4: Strain influence calculation : TP3 - Kriel 1991 [25 passes]

(one dimensional case-no allowance for lateral strains) [Figure 6.1]

$$\Delta V = V_o.\varepsilon_{vol} = V_o.(1-2\nu_{pl})\varepsilon_v = (1+e_o)(1-2\nu_{pl})\varepsilon_v$$

$$\rho = \frac{G_s}{(V_o - \Delta V)}$$

δ (settlement)=	356	mm	ν_{pl}=	0.0	Gs =	2650	(kg/m^3)

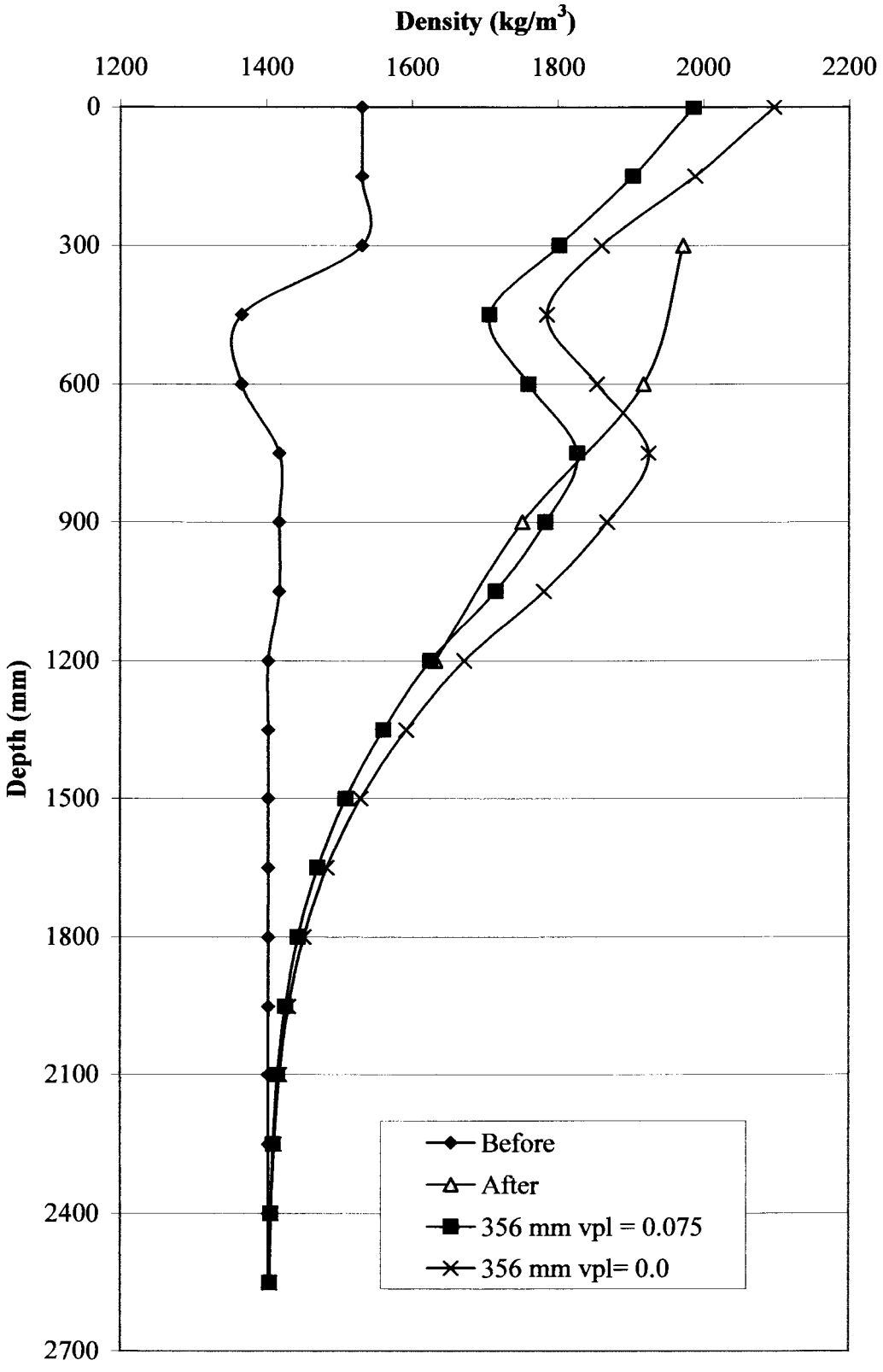
Depth (mm)	ρ_o	e_o	ΔH	ε_v=ΔH/H	Depth (mm)	ΔV=Δe	ρ_f(kg/m^3)
0	1531	0.731	40.5	0.26976	0	0.467	2097
150	1531	0.731	34.5	0.23017	150	0.398	1989
300	1531	0.731	26.5	0.17697	300	0.306	1860
450	1366	0.940	35.2	0.23463	450	0.455	1785
600	1366	0.940	39.5	0.26318	600	0.511	1854
750	1418	0.869	39.5	0.26342	750	0.492	1925
900	1418	0.869	36.1	0.24092	900	0.450	1868
1050	1418	0.869	30.6	0.20390	1050	0.381	1781
1200	1403	0.889	24.1	0.16090	1200	0.304	1672
1350	1403	0.889	17.8	0.11897	1350	0.225	1592
1500	1403	0.889	12.4	0.08269	1500	0.156	1529
1650	1403	0.889	8.1	0.05416	1650	0.102	1483
1800	1403	0.889	5.0	0.03348	1800	0.063	1452
1950	1403	0.889	2.9	0.01956	1950	0.037	1431
2100	1403	0.889	1.6	0.01082	2100	0.020	1418
2250	1403	0.889	0.8	0.00566	2250	0.011	1411
2400	1403	0.889	0.4	0.00281	2400	0.005	1407
2550	1403	0.889	0.2	0.00132	2550	0.002	1405
		Sum	356	mm			

TP3 measured	Before	After
d (mm)	ρ_o (kg/m^3)	ρ_f (kg/m^3)
300	1531	1972
600	1366	1918
900	1418	1752
1200	1403	1632

TP3 measured	Before	After	
d (mm)	e_o	e_f	Δe
300	0.731	0.344	0.387
600	0.940	0.382	0.558
900	0.869	0.513	0.356
1200	0.889	0.624	0.265

Measured densities from reference: Landpac (1991).

H5 : Measured - predicted density TP3



APPENDIX H6: Strain influence calculation : TP13 - Kriel 1991 [45 passes]

[Figure 6.3]

$$\Delta V = V_o.\varepsilon_{vol} = V_o.(1-2\nu_{pl})\varepsilon_v = (1+e_o)(1-2\nu_{pl})\varepsilon_v$$

$$\rho = \frac{G_s}{(V_o - \Delta V)}$$

δ (settlement)=	488	mm	ν_{pl} =	0.175	Gs =	2650	(kg/m^3)

Depth (mm)	ρ_o	e_o	ΔH	ε_v=ΔH/H	Depth (mm)	ΔV=Δe	ρ_f(kg/m^3)
0	1722	0.539	55.5	0.36978	0	0.370	2267
150	1722	0.539	47.3	0.31551	150	0.316	2166
300	1722	0.539	36.4	0.24259	300	0.243	2044
450	1404	0.887	48.2	0.32162	450	0.395	1775
600	1404	0.887	54.1	0.36077	600	0.443	1834
750	1380	0.920	54.2	0.36110	750	0.451	1803
900	1380	0.920	49.5	0.33026	900	0.412	1757
1050	1380	0.920	41.9	0.27951	1050	0.349	1686
1200	1386	0.912	33.1	0.22056	1200	0.274	1618
1350	1386	0.912	24.5	0.16308	1350	0.203	1550
1500	1386	0.912	17.0	0.11335	1500	0.141	1496
1650	1386	0.912	11.1	0.07424	1650	0.092	1456
1800	1386	0.912	6.9	0.04589	1800	0.057	1429
1950	1386	0.912	4.0	0.02682	1950	0.033	1411
2100	1386	0.912	2.2	0.01483	2100	0.018	1399
2250	1386	0.912	1.2	0.00776	2250	0.010	1393
2400	1386	0.912	0.6	0.00385	2400	0.005	1389
2550	1386	0.912	0.3	0.00181	2550	0.002	1388
			Sum 488 mm				

TP13 measured	Before	After
d (mm)	ρ_o (kg/m^3)	ρ_f(kg/m^3)
300	1722	1976
600	1404	1811
900	1380	1761
1200	1386	1580

TP13 measured	Before	After	
d (mm)	e_o	e_f	Δe
300	0.539	0.341	0.198
600	0.887	0.463	0.424
900	0.920	0.505	0.415
1200	0.912	0.677	0.235

Measured densities from reference: Landpac (1991).

APPENDIX H7: Strain influence calculation : TP13 - Kriel 1991 [45 passes]

(one dimensional case-no allowance for lateral strains) [Figure 6.3]

$$\Delta V = V_o.\varepsilon_{vol} = V_o.(1-2\nu_{pl})\varepsilon_v = (1+e_o)(1-2\nu_{pl})\varepsilon_v$$

$$\rho = \frac{G_s}{(V_o - \Delta V)}$$

δ (settlement)=	488	mm	ν_{pl} =	0.0	Gs =	2650	(kg/m^3)

Depth (mm)	ρ_o	e_o	ΔH	ε_v=ΔH/H	Depth (mm)	ΔV=Δe	ρ_f(kg/m^3)
0	1531	0.731	55.5	0.36978	0	0.640	2429
150	1531	0.731	47.3	0.31551	150	0.546	2237
300	1531	0.731	36.4	0.24259	300	0.420	2021
450	1366	0.940	48.2	0.32162	450	0.624	2014
600	1366	0.940	54.1	0.36077	600	0.700	2137
750	1418	0.869	54.2	0.36110	750	0.675	2219
900	1418	0.869	49.5	0.33026	900	0.617	2117
1050	1418	0.869	41.9	0.27951	1050	0.522	1968
1200	1403	0.889	33.1	0.22056	1200	0.417	1800
1350	1403	0.889	24.5	0.16308	1350	0.308	1676
1500	1403	0.889	17.0	0.11335	1500	0.214	1582
1650	1403	0.889	11.1	0.07424	1650	0.140	1516
1800	1403	0.889	6.9	0.04589	1800	0.087	1470
1950	1403	0.889	4.0	0.02682	1950	0.051	1442
2100	1403	0.889	2.2	0.01483	2100	0.028	1424
2250	1403	0.889	1.2	0.00776	2250	0.015	1414
2400	1403	0.889	0.6	0.00385	2400	0.007	1408
2550	1403	0.889	0.3	0.00181	2550	0.003	1406
		Sum	488	mm			

TP13 measured	Before	After
d (mm)	ρ_o (kg/m^3)	ρ_f(kg/m^3)
300	1722	1976
600	1404	1811
900	1380	1761
1200	1386	1580

TP13 measured	Before	After	
d (mm)	e_o	e_f	Δe
300	0.539	0.341	0.198
600	0.887	0.463	0.424
900	0.920	0.505	0.415
1200	0.912	0.677	0.235

Measured densities from reference: Landpac (1991).

APPENDIX H8: Strain influence calculation : TP11 - Kriel 1991 [55 passes]

[Figure 6.3]

$$\Delta V = V_o.\varepsilon_{vol} = V_o.(1-2\nu_{pl})\varepsilon_v = (1+e_o)(1-2\nu_{pl})\varepsilon_v$$

$$\rho = \frac{G_s}{(V_o - \Delta V)}$$

δ (settlement)=	552	mm	ν_{pl} =	0.175	Gs =	2650	(kg/m^3)

Depth (mm)	ρ_o	e_o	ΔH	ε_v=ΔH/H	Depth (mm)	ΔV=Δe	ρ_f(kg/m^3)
0	1511	0.754	62.7	0.41828	0	0.477	2075
150	1511	0.754	53.5	0.35689	150	0.407	1967
300	1511	0.754	41.2	0.27441	300	0.313	1839
450	1389	0.908	54.6	0.36381	450	0.451	1819
600	1389	0.908	61.2	0.40808	600	0.506	1890
750	1439	0.842	61.3	0.40846	750	0.489	1959
900	1439	0.842	56.0	0.37357	900	0.447	1900
1050	1439	0.842	47.4	0.31616	1050	0.378	1811
1200	1461	0.814	37.4	0.24949	1200	0.294	1744
1350	1461	0.814	27.7	0.18446	1350	0.217	1660
1500	1461	0.814	19.2	0.12821	1500	0.151	1594
1650	1461	0.814	12.6	0.08397	1650	0.099	1545
1800	1461	0.814	7.8	0.05191	1800	0.061	1512
1950	1461	0.814	4.6	0.03034	1950	0.036	1490
2100	1461	0.814	2.5	0.01677	2100	0.020	1477
2250	1461	0.814	1.3	0.00878	2250	0.010	1469
2400	1461	0.814	0.7	0.00436	2400	0.005	1465
2550	1461	0.814	0.3	0.00205	2550	0.002	1463
			Sum 552	mm			

TP11 measured	Before	After
d (mm)	ρ_o (kg/m^3)	ρ_f(kg/m^3)
300	1511	1929
600	1389	1935
900	1439	1853
1200	1461	1716

TP11 measured	Before	After	
d (mm)	e_o	e_f	Δe
300	0.754	0.374	0.380
600	0.908	0.370	0.538
900	0.842	0.430	0.411
1200	0.814	0.544	0.270

Measured densities from reference: Landpac (1991).

APPENDIX H9: Strain influence calculation : TP11 - Kriel 1991 [55 passes]

(one dimensional case-no allowance for lateral strains) [Figure 6.3]

$$\Delta V = V_o.\varepsilon_{vol} = V_o.(1-2v_{pl})\varepsilon_v = (1+e_o)(1-2v_{pl})\varepsilon_v$$

$$\rho = \frac{G_s}{(V_o - \Delta V)}$$

δ (settlement)=	552	mm	v_{pl} =	0.0	Gs =	2650	(kg/m^3)

Depth (mm)	ρ_o	e_o	ΔH	ε_v=ΔH/H	Depth (mm)	ΔV=Δe	ρ_f(kg/m^3)
0	1511	0.754	62.7	0.41828	0	0.734	2597
150	1511	0.754	53.5	0.35689	150	0.626	2350
300	1511	0.754	41.2	0.27441	300	0.481	2082
450	1389	0.908	54.6	0.36381	450	0.694	2183
600	1389	0.908	61.2	0.40808	600	0.779	2347
750	1439	0.842	61.3	0.40846	750	0.752	2433
900	1439	0.842	56.0	0.37357	900	0.688	2297
1050	1439	0.842	47.4	0.31616	1050	0.582	2104
1200	1461	0.814	37.4	0.24949	1200	0.453	1947
1350	1461	0.814	27.7	0.18446	1350	0.335	1791
1500	1461	0.814	19.2	0.12821	1500	0.233	1676
1650	1461	0.814	12.6	0.08397	1650	0.152	1595
1800	1461	0.814	7.8	0.05191	1800	0.094	1541
1950	1461	0.814	4.6	0.03034	1950	0.055	1507
2100	1461	0.814	2.5	0.01677	2100	0.030	1486
2250	1461	0.814	1.3	0.00878	2250	0.016	1474
2400	1461	0.814	0.7	0.00436	2400	0.008	1467
2550	1461	0.814	0.3	0.00205	2550	0.004	1464
			Sum 552 mm				

TP11 measured	Before	After
d (mm)	ρ_o (kg/m^3)	ρ_f(kg/m^3)
300	1511	1929
600	1389	1935
900	1439	1853
1200	1461	1716

TP11 measured	Before	After	
d (mm)	e_o	e_f	Δe
300	0.754	0.374	0.380
600	0.908	0.370	0.538
900	0.842	0.430	0.411
1200	0.814	0.544	0.270

Measured densities from reference: Landpac (1991).

APPENDIX H10: Strain influence calculation : TP12 - Kriel 1991 [55 passes]

[Figure 6.4]

$$\Delta V = V_o.\varepsilon_{vol} = V_o.(1-2\nu_{pl})\varepsilon_v = (1+e_o)(1-2\nu_{pl})\varepsilon_v$$

$$\rho = \frac{G_s}{(V_o - \Delta V)}$$

δ (settlement)=	552	mm	ν_{pl} =	0.15	Gs =	2650	(kg/m^3)

Depth (mm)	ρ_o	e_o	ΔH	ε_v=ΔH/H	Depth (mm)	ΔV=Δe	ρ_f(kg/m^3)
0	1806	0.467	62.7	0.41828	0	0.430	2554
150	1806	0.467	53.5	0.35689	150	0.367	2407
300	1806	0.467	41.2	0.27441	300	0.282	2235
450	1392	0.904	54.6	0.36381	450	0.485	1868
600	1392	0.904	61.2	0.40808	600	0.544	1949
750	1479	0.792	61.3	0.40846	750	0.512	2071
900	1479	0.792	56.0	0.37357	900	0.469	2003
1050	1479	0.792	47.4	0.31616	1050	0.397	1899
1200	1405	0.886	37.4	0.24949	1200	0.329	1702
1350	1405	0.886	27.7	0.18446	1350	0.244	1613
1500	1405	0.886	19.2	0.12821	1500	0.169	1544
1650	1405	0.886	12.6	0.08397	1650	0.111	1493
1800	1405	0.886	7.8	0.05191	1800	0.069	1458
1950	1405	0.886	4.6	0.03034	1950	0.040	1435
2100	1405	0.886	2.5	0.01677	2100	0.022	1422
2250	1405	0.886	1.3	0.00878	2250	0.012	1414
2400	1405	0.886	0.7	0.00436	2400	0.006	1409
2550	1405	0.886	0.3	0.00205	2550	0.003	1407
			Sum 552	mm			

TP12 measured	Before	After
d (mm)	ρ_o (kg/m^3)	ρ_f(kg/m^3)
300	1806	1839
600	1392	1945
900	1479	1868
1200	1405	1682

TP12 measured	Before	After	
d (mm)	e_o	e_f	Δe
300	0.467	0.441	0.026
600	0.904	0.362	0.541
900	0.792	0.419	0.373
1200	0.886	0.576	0.311

Measured densities from reference: Landpac (1991).

APPENDIX H11: Strain influence calculation : TP12 - Kriel 1991 [55 passes]

(one dimensional case-no allowance for lateral strains) [Figure 6.4]

$$\Delta V = V_o.\varepsilon_{vol} = V_o.(1-2\nu_{pl})\varepsilon_v = (1+e_o)(1-2\nu_{pl})\varepsilon_v$$

$$\rho = \frac{G_s}{(V_o - \Delta V)}$$

δ (settlement)=	552	mm	ν_{pl} =	0.0	Gs =	2650	(kg/m^3)

Depth (mm)	ρ_o	e_o	ΔH	ε_v=ΔH/H	Depth (mm)	ΔV=Δe	ρ_f(kg/m^3)
0	1806	0.467	62.7	0.41828	0	0.467	2650
150	1806	0.467	53.5	0.35689	150	0.467	2650
300	1806	0.467	41.2	0.27441	300	0.403	2489
450	1392	0.904	54.6	0.36381	450	0.693	2188
600	1392	0.904	61.2	0.40808	600	0.777	2352
750	1479	0.792	61.3	0.40846	750	0.732	2500
900	1479	0.792	56.0	0.37357	900	0.669	2361
1050	1479	0.792	47.4	0.31616	1050	0.566	2163
1200	1405	0.886	37.4	0.24949	1200	0.471	1872
1350	1405	0.886	27.7	0.18446	1350	0.348	1723
1500	1405	0.886	19.2	0.12821	1500	0.242	1612
1650	1405	0.886	12.6	0.08397	1650	0.158	1534
1800	1405	0.886	7.8	0.05191	1800	0.098	1482
1950	1405	0.886	4.6	0.03034	1950	0.057	1449
2100	1405	0.886	2.5	0.01677	2100	0.032	1429
2250	1405	0.886	1.3	0.00878	2250	0.017	1417
2400	1405	0.886	0.7	0.00436	2400	0.008	1411
2550	1405	0.886	0.3	0.00205	2550	0.004	1408
		Sum	552	mm			

TP12 measured	Before	After
d (mm)	ρ_o (kg/m^3)	ρ_f(kg/m^3)
300	1806	1839
600	1392	1945
900	1479	1868
1200	1405	1682

TP12 measured	Before	After	
d (mm)	e_o	e_f	Δe
300	0.467	0.441	0.026
600	0.904	0.362	0.541
900	0.792	0.419	0.373
1200	0.886	0.576	0.311

Measured densities from reference: Landpac (1991).

APPENDIX H12: Strain influence calculation : TP4 - Kriel 1997 [60 passes]

[Figure 6.5]

$$\Delta V = V_o.\varepsilon_{vol} = V_o.(1-2v_{pl})\varepsilon_v = (1+e_o)(1-2v_{pl})\varepsilon_v$$

$$\rho = \frac{G_s}{(V_o - \Delta V)}$$

δ (settlement)=	560	mm	v_{pl} =	0.25	Gs =	2650	(kg/m^3)

Depth (mm)	ρ_o	e_o	ΔH	ε_v=ΔH/H	Depth (mm)	ΔV=Δe	ρ_f(kg/m^3)
75	1800	0.472	75.4	0.50240	75	0.370	2404
225	1800	0.472	64.5	0.42969	225	0.316	2293
375	1800	0.472	49.0	0.32672	375	0.241	2151
525	1573	0.685	59.2	0.39442	525	0.332	1959
675	1573	0.685	62.4	0.41622	675	0.351	1986
825	1552	0.707	59.6	0.39741	825	0.339	1937
975	1552	0.707	52.4	0.34923	975	0.298	1880
1125	1552	0.707	42.8	0.28519	1125	0.243	1810
1275	1632	0.624	32.7	0.21773	1275	0.177	1831
1425	1632	0.624	23.4	0.15603	1425	0.127	1770
1575	1632	0.624	15.8	0.10524	1575	0.085	1723
1725	1632	0.624	10.0	0.06696	1725	0.054	1689
1875	1632	0.624	6.0	0.04024	1875	0.033	1666
2025	1632	0.624	3.4	0.02287	2025	0.019	1651
2175	1632	0.624	1.8	0.01230	2175	0.010	1642
2325	1632	0.624	0.9	0.00627	2325	0.005	1637
2475	1632	0.624	0.5	0.00303	2475	0.002	1634
2625	1632	0.624	0.2	0.00139	2625	0.001	1633
			Sum 560 mm				

TP3 measured	Before	
d (mm)	ρ_f(kg/m^3)	e_o
855	1526	0.737
1455	1487	0.782
2105	1411	0.878
2805	1381	0.919

TP3 measured	After		
d (mm)	ρ_o (kg/m^3)	e_f	Δe
725	1800	0.472	0.264
1375	1573	0.685	0.097
2175	1552	0.707	0.171
2875	1632	0.624	0.295

Measured densities from reference: AFRICON (1998).

APPENDIX H13: Strain influence calculation : TP A - Kriel 1997 [60 passes]

(one dimensional case-no allowance for lateral strains) [Figure 6.5]

$$\Delta V = V_o \varepsilon_{vol} = V_o.(1-2\nu_{pl})\varepsilon_v = (1+e_o)(1-2\nu_{pl})\varepsilon_v$$

$$\rho = \frac{G_s}{(V_o - \Delta V)}$$

δ (settlement)=	560	mm	ν_{pl} =	0.15	Gs =	2650	(kg/m^3)

Depth (mm)	ρ_o	e_o	ΔH	ε_v=ΔH/H	Depth (mm	ΔV=Δe	ρ_f(kg/m^3)
75	1526	0.737	75.4	0.50240	75	0.611	2354
225	1526	0.737	64.5	0.42969	225	0.522	2182
375	1526	0.737	49.0	0.32672	375	0.397	1978
525	1487	0.782	59.2	0.39442	525	0.492	2054
675	1487	0.782	62.4	0.41622	675	0.519	2098
825	1411	0.878	59.6	0.39741	825	0.522	1955
975	1411	0.878	52.4	0.34923	975	0.459	1868
1125	1411	0.878	42.8	0.28519	1125	0.375	1763
1275	1381	0.919	32.7	0.21773	1275	0.292	1629
1425	1381	0.919	23.4	0.15603	1425	0.210	1550
1575	1381	0.919	15.8	0.10524	1575	0.141	1491
1725	1381	0.919	10.0	0.06696	1725	0.090	1449
1875	1381	0.919	6.0	0.04024	1875	0.054	1421
2025	1381	0.919	3.4	0.02287	2025	0.031	1403
2175	1381	0.919	1.8	0.01230	2175	0.017	1393
2325	1381	0.919	0.9	0.00627	2325	0.008	1387
2475	1381	0.919	0.5	0.00303	2475	0.004	1384
2625	1381	0.919	0.2	0.00139	2625	0.002	1382
			Sum 560	mm			

TP3 measured	Before	
d (mm)	ρ_f(kg/m^3)	e_o
855	1526	0.737
1455	1487	0.782
2105	1411	0.878
2805	1381	0.919

TP3 measured	After		
d (mm)	ρ_o (kg/m^3)	e_f	Δe
725	1800	0.472	0.264
1375	1573	0.685	0.097
2175	1552	0.707	0.171
2875	1632	0.624	0.295

Measured densities from reference: AFRICON (1998).

APPENDIX H14: Strain influence calculation : Highveld Steel, 1969

[Figure 6.6]

$$\Delta V = V_o.\varepsilon_{vol} = V_o.(1-2\nu_{pl})\varepsilon_v = (1+e_o)(1-2\nu_{pl})\varepsilon_v$$

$$\rho = \frac{G_s}{(V_o - \Delta V)}$$

δ (settlement)=	145	mm	ν_{pl} =	0.075	Gs =	2650	(kg/m^3)

Depth (mm)	ρ_o	e_o	ΔH	ε_v=ΔH/H	Depth (mm)	ΔV=Δe	ρ_f(kg/m^3)
75	1665	0.591	19.5	0.13009	75	0.176	1872
225	1665	0.591	16.7	0.11126	225	0.150	1839
375	1665	0.591	12.7	0.08460	375	0.114	1794
525	1505	0.761	15.3	0.10213	525	0.153	1648
675	1505	0.761	16.2	0.10777	675	0.161	1657
825	1409	0.881	15.4	0.10290	825	0.164	1544
975	1409	0.881	13.6	0.09042	975	0.145	1526
1125	1409	0.881	11.1	0.07384	1125	0.118	1504
1275	1469	0.804	8.5	0.05638	1275	0.086	1543
1425	1469	0.804	6.1	0.04040	1425	0.062	1521
1575	1529	0.733	4.1	0.02725	1575	0.040	1565
1725	1529	0.733	2.6	0.01734	1725	0.026	1552
1875	1529	0.733	1.6	0.01042	1875	0.015	1543
2025	1529	0.733	0.9	0.00592	2025	0.009	1537
2175	1529	0.733	0.5	0.00319	2175	0.005	1533
2325	1529	0.733	0.2	0.00162	2325	0.002	1531
2475	1529	0.733	0.1	0.00078	2475	0.001	1530
2625	1529	0.733	0.1	0.00036	2625	0.001	1530
			Sum	145 mm			

20 passes [23.9	Before	
d (mm)	ρ_f(kg/m^3)	e_o
305	1665.3	0.591
610	1505.2	0.761
914	1409.1	0.881
1219	1469.2	0.804
1524	1529.2	0.733
1829	1529.2	0.733

20 passes [23.9	After		
d (mm)	ρ_o (kg/m^3)	e_f	Δe
305	1857.5	0.427	0.165
610	1657.3	0.599	0.162
914	1641.3	0.615	0.266
1219	1557.3	0.702	0.102
1524	1553.3	0.706	0.027

Measured densities from reference: by Clegg B, Kuhn S H & Walker R N. (1969)

APPENDIX H15: Strain influence calculation : Highveld Steel, 1969

[Figure 6.6]

$$\Delta V = V_o.\varepsilon_{vol} = V_o.(1-2\nu_{pl})\varepsilon_v = (1+e_o)(1-2\nu_{pl})\varepsilon_v$$

$$\rho = \frac{G_s}{(V_o - \Delta V)}$$

δ (settlement)=	145	mm	ν_{pl} =	0.0	Gs =	2650	(kg/m^3)

Depth (mm)	ρ_o	e_o	ΔH	ε_v=ΔH/H	Depth (mm)	ΔV=Δe	ρ_f(kg/m^3)
75	1665	0.591	19.5	0.13009	75	0.207	1914
225	1665	0.591	16.7	0.11126	225	0.177	1874
375	1665	0.591	12.7	0.08460	375	0.135	1819
525	1505	0.761	15.3	0.10213	525	0.180	1676
675	1505	0.761	16.2	0.10777	675	0.190	1687
825	1409	0.881	15.4	0.10290	825	0.194	1571
975	1409	0.881	13.6	0.09042	975	0.170	1549
1125	1409	0.881	11.1	0.07384	1125	0.139	1521
1275	1469	0.804	8.5	0.05638	1275	0.102	1557
1425	1469	0.804	6.1	0.04040	1425	0.073	1531
1575	1529	0.733	4.1	0.02725	1575	0.047	1572
1725	1529	0.733	2.6	0.01734	1725	0.030	1556
1875	1529	0.733	1.6	0.01042	1875	0.018	1545
2025	1529	0.733	0.9	0.00592	2025	0.010	1538
2175	1529	0.733	0.5	0.00319	2175	0.006	1534
2325	1529	0.733	0.2	0.00162	2325	0.003	1532
2475	1529	0.733	0.1	0.00078	2475	0.001	1530
2625	1529	0.733	0.1	0.00036	2625	0.001	1530
		Sum	145	mm			

20 passes [23.9kJ I	Before	
d (mm)	ρ_f(kg/m^3)	e_o
305	1665.3	0.591
610	1505.2	0.761
914	1409.1	0.881
1219	1469.2	0.804
1524	1529.2	0.733
1829	1529.2	0.733

20 passes [23.9kJ	After		
d (mm)	ρ_o (kg/m^3)	e_f	Δe
305	1857.5	0.427	0.165
610	1657.3	0.599	0.162
914	1641.3	0.615	0.266
1219	1557.3	0.702	0.102
1524	1553.3	0.706	0.027

Measured densities from reference: by Clegg B, Kuhn S H & Walker R N. (1969)

APPENDIX H16: Strain influence calculation : Middleberg, 1984 [20 passes]

[Figure 6.9]

$$\Delta V = V_o.\varepsilon_{vol} = V_o.(1-2\nu')\varepsilon_v = (1+e_o)(1-2\nu')\varepsilon_v$$

$$\rho = \frac{G_s}{(V_o - \Delta V)}$$

δ (settlement)=	87	mm	ν_{pl}=	0.3	Gs =	2650	(kg/m^3)

Depth (mm)	ρ_o	e_o	ΔH	ε_v=ΔH/H	Depth (mm)	ΔV=Δe	ρ_f(kg/m^3)
75	1402	0.890	11.7	0.07805	75	0.059	1447
225	1402	0.890	10.0	0.06676	225	0.050	1441
375	1402	0.890	7.6	0.05076	375	0.038	1431
525	1293	1.050	9.2	0.06128	525	0.050	1325
675	1293	1.050	9.7	0.06466	675	0.053	1327
825	1293	1.050	9.3	0.06174	825	0.051	1325
975	1293	1.050	8.1	0.05425	975	0.044	1321
1125	1293	1.050	6.6	0.04431	1125	0.036	1316
1275	1293	1.050	5.1	0.03383	1275	0.028	1310
1425	1293	1.050	3.6	0.02424	1425	0.020	1305
1575	1293	1.050	2.5	0.01635	1575	0.013	1301
1725	1293	1.050	1.6	0.01040	1725	0.009	1298
1875	1293	1.050	0.9	0.00625	1875	0.005	1296
2025	1293	1.050	0.5	0.00355	2025	0.003	1295
2175	1293	1.050	0.3	0.00191	2175	0.002	1294
2325	1293	1.050	0.1	0.00097	2325	0.001	1293
2475	1293	1.050	0.1	0.00047	2475	0.000	1293
2625	1293	1.050	0.0	0.00022	2625	0.000	1293
			Sum 87	mm			

20 passes	Before	
d (mm)	ρ_f(kg/m^3)	e_o
500	1402	0.890
1000	1293	1.050

20 passes	After		
d (mm)	ρ_o (kg/m^3)	e_f	Δe
500	1433	0.849	0.041
1000	1316	1.013	0.037

Measured densities from reference: Barrett & Wrench (1984).

APPENDIX H17: Strain influence calculation : Middleberg, 1984 [50 passes]

[Figure 6.9]

$$\Delta V = V_o \varepsilon_{vol} = V_o.(1-2\nu')\varepsilon_v = (1+e_o)(1-2\nu')\varepsilon_v$$

$$\rho = \frac{G_s}{(V_o - \Delta V)}$$

δ (settlement)=	112	mm	v_{pl}=	0.1	Gs =	2650	(kg/m^3)

Depth (mm)	ρ_o	e_o	ΔH	ε_v=ΔH/H	Depth (mm)	ΔV=Δe	ρ_f(kg/m^3)
75	1402	0.890	15.1	0.10048	75	0.152	1525
225	1402	0.890	12.9	0.08594	225	0.130	1506
375	1402	0.890	9.8	0.06534	375	0.099	1479
525	1350	0.963	11.8	0.07888	525	0.124	1441
675	1350	0.963	12.5	0.08324	675	0.131	1446
825	1350	0.963	11.9	0.07948	825	0.125	1442
975	1350	0.963	10.5	0.06985	975	0.110	1430
1125	1350	0.963	8.6	0.05704	1125	0.090	1415
1275	1350	0.963	6.5	0.04355	1275	0.068	1399
1425	1350	0.963	4.7	0.03121	1425	0.049	1385
1575	1350	0.963	3.2	0.02105	1575	0.033	1373
1725	1350	0.963	2.0	0.01339	1725	0.021	1365
1875	1350	0.963	1.2	0.00805	1875	0.013	1359
2025	1350	0.963	0.7	0.00457	2025	0.007	1355
2175	1350	0.963	0.4	0.00246	2175	0.004	1353
2325	1350	0.963	0.2	0.00125	2325	0.002	1351
2475	1350	0.963	0.1	0.00061	2475	0.001	1351
2625	1350	0.963	0.0	0.00028	2625	0.000	1350
			Sum	112 mm			

50 passes	Before	
d (mm)	ρ_f(kg/m^3)	e_o
500	1402	0.890
1000	1350	0.963

50 passes	After		
d (mm)	ρ_o (kg/m^3)	e_f	Δe
500	1502	0.765	0.125
1000	1453	0.824	0.139

Measured densities from reference: Barrett & Wrench (1984).

APPENDIX H18: Strain influence calculation : Villa Lisa, 1991 [30 passes]

$$\Delta V = V_o.\varepsilon_{vol} = V_o.(1-2v_{pl})\varepsilon_v = (1+e_o)(1-2v_{pl})\varepsilon_v$$

$$\rho = \frac{G_s}{(V_o - \Delta V)}$$

δ (settlement)=	233	mm	v_{pl}=	0.1	Gs =	2650	(kg/m^3)

Depth (mm)	ρ_o	e_o	ΔH	ε_v=ΔH/H	Depth (mm)	ΔV=Δe	ρ_f(kg/m^3)
75	1425	0.860	31.4	0.20903	75	0.311	1711
225	1425	0.860	26.8	0.17878	225	0.266	1663
375	1425	0.860	20.4	0.13594	375	0.202	1599
525	1425	0.860	24.6	0.16411	525	0.244	1640
675	1425	0.860	26.0	0.17318	675	0.258	1654
825	1425	0.860	24.8	0.16535	825	0.246	1642
975	1425	0.860	21.8	0.14530	975	0.216	1612
1125	1425	0.860	17.8	0.11866	1125	0.177	1574
1275	1425	0.860	13.6	0.09059	1275	0.135	1536
1425	1425	0.860	9.7	0.06492	1425	0.097	1503
1575	1425	0.860	6.6	0.04379	1575	0.065	1477
1725	1425	0.860	4.2	0.02786	1725	0.041	1457
1875	1425	0.860	2.5	0.01674	1875	0.025	1444
2025	1425	0.860	1.4	0.00952	2025	0.014	1436
2175	1425	0.860	0.8	0.00512	2175	0.008	1431
2325	1425	0.860	0.4	0.00261	2325	0.004	1428
2475	1425	0.860	0.2	0.00126	2475	0.002	1426
2625	1425	0.860	0.1	0.00058	2625	0.001	1426
			Sum 233	mm			

30 passes-meas	Before	
d (mm)	ρ_f(kg/m^3)	e_o
400	1425	0.860
750	1425	0.860
1000	1425	0.860
1500	1425	0.860

20 passes	After		
d (mm)	ρ_o (kg/m^3)	e_f	Δe
400	1603	0.653	0.206
750	1623	0.633	0.227
1000	1599	0.657	0.202
1500	1490	0.779	0.081

after Solesbury F W & Walker D G (1991). *The impact rolling of a large housing site Boksburg.* Geotechnics in the African enviroment, Blight et al (eds), Balkema, Rotterdam. p393-399.

APPENDIX H18a: Strain influence calculation : Villa Lisa, 1991 [30 passes]

[Unmodified Rayleigh distribution calculation for Figure 6.11]

$$\Delta V = V_o.\varepsilon_{vol} = V_o.(1-2\nu')\varepsilon_v = (1+e_o)(1-2\nu')\varepsilon_v$$

$$\rho = \frac{G_s}{(V_o - \Delta V)}$$

δ (settlement)=	233	mm	ν_{pl}=	0.2	Gs =	2650	(kg/m^3)

Depth (mm)	ρ_o	e_o	ΔH	ε_v=ΔH/H	Depth (mm)	ΔV=Δe	ρ_f(kg/m^3)
75	1425	0.860	5.7	0.03805	75	0.042	1458
225	1425	0.860	16.3	0.10865	225	0.121	1524
375	1425	0.860	24.6	0.16406	375	0.183	1581
525	1425	0.860	29.7	0.19806	525	0.221	1617
675	1425	0.860	31.4	0.20900	675	0.233	1629
825	1425	0.860	29.9	0.19956	825	0.223	1619
975	1425	0.860	26.3	0.17536	975	0.196	1593
1125	1425	0.860	21.5	0.14321	1125	0.160	1559
1275	1425	0.860	16.4	0.10933	1275	0.122	1525
1425	1425	0.860	11.8	0.07835	1425	0.087	1495
1575	1425	0.860	7.9	0.05285	1575	0.059	1472
1725	1425	0.860	5.0	0.03362	1725	0.038	1454
1875	1425	0.860	3.0	0.02021	1875	0.023	1442
2025	1425	0.860	1.7	0.01148	2025	0.013	1435
2175	1425	0.860	0.9	0.00618	2175	0.007	1430
2325	1425	0.860	0.5	0.00315	2325	0.004	1428
2475	1425	0.860	0.2	0.00152	2475	0.002	1426
2625	1425	0.860	0.1	0.00070	2625	0.001	1426
			Sum 233	mm			

30 passes-meas	Before	
d (mm)	ρ_f(kg/m^3)	e_o
400	1425	0.860
750	1425	0.860
1000	1425	0.860
1500	1425	0.860

20 passes	After		
d (mm)	ρ_o (kg/m^3)	e_f	Δe
400	1603	0.653	0.206
750	1623	0.633	0.227
1000	1599	0.657	0.202
1500	1490	0.779	0.081

after Solesbury F W & Walker D G (1991). *The impact rolling of a large housing site Boksburg.* Geotechnics in the African enviroment, Blight et al (eds), Balkema, Rotterdam. p393-399.

APPENDIX H19: Strain influence calculation : Villa Lisa, 1991 [50 passes]

$$\Delta V = V_o.\varepsilon_{vol} = V_o.(1-2\nu_{pl})\varepsilon_v = (1+e_o)(1-2\nu_{pl})\varepsilon_v$$

$$\rho = \frac{G_s}{(V_o - \Delta V)}$$

δ (settlement)=	265	mm	ν_{pl}=	0	Gs =	2650	(kg/m^3)

Depth (mm)	ρ_o	e_o	ΔH	ε_v=ΔH/H	Depth (mm)	ΔV=Δe	ρ_f(kg/m^3)
75	1425	0.860	35.7	0.23774	75	0.442	1869
225	1425	0.860	30.5	0.20334	225	0.378	1789
375	1425	0.860	23.2	0.15461	375	0.288	1686
525	1425	0.860	28.0	0.18665	525	0.347	1752
675	1425	0.860	29.5	0.19696	675	0.366	1775
825	1425	0.860	28.2	0.18806	825	0.350	1755
975	1425	0.860	24.8	0.16526	975	0.307	1707
1125	1425	0.860	20.2	0.13495	1125	0.251	1647
1275	1425	0.860	15.5	0.10303	1275	0.192	1589
1425	1425	0.860	11.1	0.07383	1425	0.137	1539
1575	1425	0.860	7.5	0.04980	1575	0.093	1500
1725	1425	0.860	4.8	0.03168	1725	0.059	1472
1875	1425	0.860	2.9	0.01904	1875	0.035	1453
2025	1425	0.860	1.6	0.01082	2025	0.020	1441
2175	1425	0.860	0.9	0.00582	2175	0.011	1433
2325	1425	0.860	0.4	0.00297	2325	0.006	1429
2475	1425	0.860	0.2	0.00143	2475	0.003	1427
2625	1425	0.860	0.1	0.00066	2625	0.001	1426
			Sum 265	mm			

50 passes	Before	
d (mm)	ρ_f(kg/m^3)	e_o
400	1425	0.860
750	1425	0.860
1000	1425	0.860
1500	1425	0.860

50 passes-meas	After		
d (mm)	ρ_o (kg/m^3)	e_f	Δe
400	1612	0.644	0.216
750	1831	0.447	0.412
1000	1799	0.473	0.387
1500			

after Solesbury F W & Walker D G (1991). *The impact rolling of a large housing site Boksburg.* Geotechnics in the African enviroment, Blight et al (eds), Balkema, Rotterdam. p393-399.

APPENDIX H19a: Strain influence calculation : Villa Lisa, 1991 [50 passes]

[Unmodified Rayleigh distribution calculation for Figure 6.11]

$$\Delta V = V_o \varepsilon_{vol} = V_o.(1-2\nu')\varepsilon_v = (1+e_o)(1-2\nu')\varepsilon_v$$

$$\rho = \frac{G_s}{(V_o - \Delta V)}$$

δ (settlement)=	265	mm	v_{pl}=	0.05	Gs =	2650	(kg/m^3)

Depth (mm)	ρ_o	e_o	ΔH	ε_v=ΔH/H	Depth (mm)	ΔV=Δe	ρ_f(kg/m^3)
75	1425	0.860	6.5	0.04328	75	0.072	1483
225	1425	0.860	18.5	0.12358	225	0.207	1603
375	1425	0.860	28.0	0.18659	375	0.312	1713
525	1425	0.860	33.8	0.22526	525	0.377	1787
675	1425	0.860	35.7	0.23771	675	0.398	1813
825	1425	0.860	34.0	0.22696	825	0.380	1791
975	1425	0.860	29.9	0.19945	975	0.334	1737
1125	1425	0.860	24.4	0.16287	1125	0.273	1670
1275	1425	0.860	18.7	0.12435	1275	0.208	1605
1425	1425	0.860	13.4	0.08911	1425	0.149	1549
1575	1425	0.860	9.0	0.06011	1575	0.101	1506
1725	1425	0.860	5.7	0.03824	1725	0.064	1476
1875	1425	0.860	3.4	0.02298	1875	0.038	1455
2025	1425	0.860	2.0	0.01306	2025	0.022	1442
2175	1425	0.860	1.1	0.00703	2175	0.012	1434
2325	1425	0.860	0.5	0.00358	2325	0.006	1430
2475	1425	0.860	0.3	0.00173	2475	0.003	1427
2625	1425	0.860	0.1	0.00079	2625	0.001	1426
		Sum	265	mm			

50 passes	Before	
d (mm)	ρ_f(kg/m^3)	e_o
400	1425	0.860
750	1425	0.860
1000	1425	0.860
1500	1425	0.860

50 passes-meas	After		
d (mm)	ρ_o (kg/m^3)	e_f	Δe
400	1612	0.644	0.216
750	1831	0.447	0.412
1000	1799	0.473	0.387
1500			

after Solesbury F W & Walker D G (1991). *The impact rolling of a large housing site Boksburg.* Geotechnics in the African enviroment, Blight et al (eds), Balkema, Rotterdam. p393-399.

APPENDIX H20: Strain influence calculation : Pinard, 1988 [20 passes]

[Figure 6.12]

$$\Delta V = V_o.\varepsilon_{vol} = V_o.(1-2\nu_{pl})\varepsilon_v = (1+e_o)(1-2\nu_{pl})\varepsilon_v$$

$$\rho = \frac{G_s}{(V_o - \Delta V)}$$

δ (settlement)=	105	mm	ν_{pl} =	0.20	Gs =	2650	(kg/m^3)

Depth (mm)	ρ_o	e_o	ΔH	ε_v=ΔH/H	Depth (mm)	ΔV=Δe	ρ_f(kg/m^3)
75	1441	0.839	14.1	0.09420	75	0.104	1527
225	1441	0.839	12.1	0.08057	225	0.089	1514
375	1441	0.839	9.2	0.06126	375	0.068	1496
525	1422	0.864	11.1	0.07395	525	0.083	1488
675	1422	0.864	11.7	0.07804	675	0.087	1492
825	1422	0.864	11.2	0.07451	825	0.083	1489
975	1422	0.864	9.8	0.06548	975	0.073	1480
1125	1422	0.864	8.0	0.05347	1125	0.060	1469
1275	1422	0.864	6.1	0.04082	1275	0.046	1458
1425	1422	0.864	4.4	0.02926	1425	0.033	1447
1575	1422	0.864	3.0	0.01973	1575	0.022	1439
1725	1422	0.864	1.9	0.01255	1725	0.014	1433
1875	1422	0.864	1.1	0.00754	1875	0.008	1428
2025	1422	0.864	0.6	0.00429	2025	0.005	1426
2175	1422	0.864	0.3	0.00231	2175	0.003	1424
2325	1422	0.864	0.2	0.00118	2325	0.001	1423
2475	1422	0.864	0.1	0.00057	2475	0.001	1422
2625	1422	0.864	0.0	0.00026	2625	0.000	1422
			Sum 105	mm			

20 passes-meas	Before	
d (mm)	ρ_f(kg/m^3)	e_o
305	1441	0.839
610	1422	0.864
810	1413	0.875
1100	1422	0.864

20 passes	After		
d (mm)	ρ_o (kg/m^3)	e_f	Δe
305	1710	0.549	0.290
610	1503	0.763	0.100
810	1476	0.795	0.080
1100	1461	0.814	0.049

Annual transport Convention, 1988, paper 3D/7

Evaluation of impact roller compaction trials on potentially collapsing sands in Botswana

Pinard M I, Ookeditse S & Fraser C

APPENDIX H20a: Strain influence calculation : Pinard, 1988 [20 passes]

[Figure 6.13]

$$\Delta V = V_o.\varepsilon_{vol} = V_o.(1-2\nu_{pl})\varepsilon_v = (1+e_o)(1-2\nu_{pl})\varepsilon_v$$

$$\rho = \frac{G_s}{(V_o - \Delta V)}$$

δ (settlement)=	105	mm	ν_{pl}=	0.13	Gs =	2650	(kg/m^3)

Depth (mm)	ρ_o	e_o	ΔH	ε_v=ΔH/H	Depth (mm)	ΔV=Δe	ρ_f(kg/m^3)
75	1441	0.839	25.3	0.16843	75	0.232	1649
225	1441	0.839	18.8	0.12537	225	0.173	1590
375	1441	0.839	10.8	0.07168	375	0.099	1523
525	1422	0.864	11.9	0.07962	525	0.111	1512
675	1422	0.864	11.3	0.07518	675	0.105	1507
825	1422	0.864	9.4	0.06248	825	0.087	1492
975	1422	0.864	7.0	0.04647	975	0.065	1473
1125	1422	0.864	4.7	0.03124	1125	0.044	1456
1275	1422	0.864	2.9	0.01910	1275	0.027	1443
1425	1422	0.864	1.6	0.01066	1425	0.015	1433
1575	1422	0.864	0.8	0.00545	1575	0.008	1428
1725	1422	0.864	0.4	0.00255	1725	0.004	1425
1875	1422	0.864	0.2	0.00110	1875	0.002	1423
2025	1422	0.864	0.1	0.00044	2025	0.001	1422
2175	1422	0.864	0.0	0.00016	2175	0.000	1422
2325	1422	0.864	0.0	0.00005	2325	0.000	1422
2475	1422	0.864	0.0	0.00002	2475	0.000	1422
2625	1422	0.864	0.0	0.00000	2625	0.000	1422
			Sum	105 mm			

20 passes-meas	Before	
d (mm)	ρ_f(kg/m^3)	e_f
305	1441	0.839
610	1422	0.864
810	1413	0.875
1100	1422	0.864

20 passes	After		
d (mm)	ρ_o (kg/m^3)	e_o	Δe
305	1710	0.549	0.290
610	1503	0.763	0.100
810	1476	0.795	0.080
1100	1461	0.814	0.049

Annual transport Convention, 1988, paper 3D/7

Evaluation of impact roller compaction trials on potentially collapsing sands in Botswana

Pinard M I, Ookeditse S & Fraser C

APPENDIX H21: Strain influence calculation : Pinard, 1988 [30 passes]

[Figure 6.12]

$$\Delta V = V_o.\varepsilon_{vol} = V_o.(1-2\nu_{pl})\varepsilon_v = (1+e_o)(1-2\nu_{pl})\varepsilon_v$$

$$\rho = \frac{G_s}{(V_o - \Delta V)}$$

δ (settlement)=	150	mm	ν_{pl} =	0.15	Gs =	2650	(kg/m^3)

Depth (mm)	ρ_o	e_o	ΔH	ε_v=ΔH/H	Depth (mm)	ΔV=Δe	ρ_f(kg/m^3)
75	1441	0.839	20.2	0.13457	75	0.173	1591
225	1441	0.839	17.3	0.11510	225	0.148	1567
375	1441	0.839	13.1	0.08751	375	0.113	1535
525	1422	0.864	15.8	0.10565	525	0.138	1536
675	1422	0.864	16.7	0.11149	675	0.145	1542
825	1422	0.864	16.0	0.10645	825	0.139	1536
975	1422	0.864	14.0	0.09354	975	0.122	1522
1125	1422	0.864	11.5	0.07639	1125	0.100	1502
1275	1422	0.864	8.7	0.05832	1275	0.076	1483
1425	1422	0.864	6.3	0.04179	1425	0.055	1465
1575	1422	0.864	4.2	0.02819	1575	0.037	1451
1725	1422	0.864	2.7	0.01793	1725	0.023	1440
1875	1422	0.864	1.6	0.01078	1875	0.014	1433
2025	1422	0.864	0.9	0.00613	2025	0.008	1428
2175	1422	0.864	0.5	0.00330	2175	0.004	1425
2325	1422	0.864	0.3	0.00168	2325	0.002	1424
2475	1422	0.864	0.1	0.00081	2475	0.001	1423
2625	1422	0.864	0.1	0.00037	2625	0.000	1422
			Sum 150	mm			

30 passes-meas	Before	
d (mm)	ρ_f(kg/m^3)	e_o
305	1441	0.839
610	1422	0.864
810	1413	0.875
1100	1422	0.864

30 passes	After		
d (mm)	ρ_o (kg/m^3)	e_f	Δe
305	1782	0.487	0.352
610	1584	0.673	0.191
810	1508	0.758	0.118
1100	1476	0.795	0.068

Annual transport Convention, 1988, paper 3D/7

Evaluation of impact roller compaction trials on potentially collapsing sands in Botswana

Pinard M I, Ookeditse S & Fraser C

APPENDIX H21a: Strain influence calculation : Pinard, 1988 [30 passes]

[Figure 6.13]

$$\Delta V = V_o.\varepsilon_{vol} = V_o.(1-2\nu_{pl})\varepsilon_v = (1+e_o)(1-2\nu_{pl})\varepsilon_v$$

$$\rho = \frac{G_s}{(V_o - \Delta V)}$$

δ (settlement)=	150	mm	ν_{pl}=	0.05	Gs =	2650	(kg/m^3)

Depth (mm)	ρ_o	e_o	ΔH	ε_v=ΔH/H	Depth (mm)	ΔV=Δe	ρ_f(kg/m^3)
75	1441	0.839	36.1	0.24062	75	0.398	1839
225	1441	0.839	26.9	0.17910	225	0.296	1718
375	1441	0.839	15.4	0.10240	375	0.169	1587
525	1422	0.864	17.1	0.11374	525	0.191	1584
675	1422	0.864	16.1	0.10740	675	0.180	1574
825	1422	0.864	13.4	0.08925	825	0.150	1546
975	1422	0.864	10.0	0.06639	975	0.111	1512
1125	1422	0.864	6.7	0.04463	1125	0.075	1482
1275	1422	0.864	4.1	0.02729	1275	0.046	1458
1425	1422	0.864	2.3	0.01523	1425	0.026	1442
1575	1422	0.864	1.2	0.00778	1575	0.013	1432
1725	1422	0.864	0.5	0.00365	1725	0.006	1427
1875	1422	0.864	0.2	0.00157	1875	0.003	1424
2025	1422	0.864	0.1	0.00062	2025	0.001	1423
2175	1422	0.864	0.0	0.00023	2175	0.000	1422
2325	1422	0.864	0.0	0.00008	2325	0.000	1422
2475	1422	0.864	0.0	0.00002	2475	0.000	1422
2625	1422	0.864	0.0	0.00001	2625	0.000	1422
			Sum	150 mm			

30 passes-meas	Before	
d (mm)	ρ_f(kg/m^3)	e_f
305	1441	0.839
610	1422	0.864
810	1413	0.875
1100	1422	0.864

30 passes	After		
d (mm)	ρ_o (kg/m^3)	e_o	Δe
305	1782	0.487	0.352
610	1584	0.673	0.191
810	1508	0.758	0.118
1100	1476	0.795	0.068

Annual transport Convention, 1988, paper 3D/7

Evaluation of impact roller compaction trials on potentially collapsing sands in Botswana

Pinard M I, Ookeditse S & Fraser C

APPENDIX H22: Strain influence calculation : Pinard, 1988 [60 passes]

[Figure 6.12]

$$\Delta V = V_o.\varepsilon_{vol} = V_o.(1-2v_{pl})\varepsilon_v = (1+e_o)(1-2v_{pl})\varepsilon_v$$

$$\rho = \frac{G_s}{(V_o - \Delta V)}$$

δ (settlement)=	175	mm	v_{pl} =	0.05	Gs =	2650	(kg/m^3)

Depth (mm)	ρ_o	e_o	ΔH	ε_v=ΔH/H	Depth (mm)	ΔV=Δe	ρ_f(kg/m^3)
75	1441	0.839	23.6	0.15700	75	0.260	1678
225	1441	0.839	20.1	0.13428	225	0.222	1639
375	1441	0.839	15.3	0.10210	375	0.169	1587
525	1422	0.864	18.5	0.12326	525	0.207	1599
675	1422	0.864	19.5	0.13007	675	0.218	1611
825	1422	0.864	18.6	0.12419	825	0.208	1601
975	1422	0.864	16.4	0.10913	975	0.183	1577
1125	1422	0.864	13.4	0.08912	1125	0.149	1546
1275	1422	0.864	10.2	0.06804	1275	0.114	1515
1425	1422	0.864	7.3	0.04876	1425	0.082	1487
1575	1422	0.864	4.9	0.03289	1575	0.055	1465
1725	1422	0.864	3.1	0.02092	1725	0.035	1449
1875	1422	0.864	1.9	0.01257	1875	0.021	1438
2025	1422	0.864	1.1	0.00715	2025	0.012	1431
2175	1422	0.864	0.6	0.00384	2175	0.006	1427
2325	1422	0.864	0.3	0.00196	2325	0.003	1425
2475	1422	0.864	0.1	0.00095	2475	0.002	1423
2625	1422	0.864	0.1	0.00043	2625	0.001	1423
			Sum 175	mm			

60 passes-meas	Before	
d (mm)	ρ_f(kg/m^3)	e_o
305	1441	0.839
610	1422	0.864
810	1413	0.875
1100	1422	0.864

60 passes	After		
d (mm)	ρ_o (kg/m^3)	e_f	Δe
305	1836	0.443	0.396
610	1638	0.618	0.246
810	1584	0.673	0.202
1100	1548	0.712	0.152

Annual transport Convention, 1988, paper 3D/7

Evaluation of impact roller compaction trials on potentially collapsing sands in Botswana

Pinard M I, Ookeditse S & Fraser C

APPENDIX H22a: Strain influence calculation : Pinard, 1988 [60 passes]

[Figure 6.13]

$$\Delta V = V_o.\varepsilon_{vol} = V_o.(1-2\nu_{pl})\varepsilon_v = (1+e_o)(1-2\nu_{pl})\varepsilon_v$$

$$\rho = \frac{G_s}{(V_o - \Delta V)}$$

δ (settlement)=	175	mm	ν_{pl}=	0.00	Gs =	2650	(kg/m^3)

Depth (mm)	ρ_o	e_o	ΔH	ε_v=ΔH/H	Depth (mm)	ΔV=Δe	ρ_f(kg/m^3)
75	1441	0.839	42.1	0.28072	75	0.516	2003
225	1441	0.839	31.3	0.20895	225	0.384	1821
375	1441	0.839	17.9	0.11947	375	0.220	1636
525	1422	0.864	19.9	0.13270	525	0.247	1640
675	1422	0.864	18.8	0.12530	675	0.234	1626
825	1422	0.864	15.6	0.10413	825	0.194	1587
975	1422	0.864	11.6	0.07745	975	0.144	1541
1125	1422	0.864	7.8	0.05207	1125	0.097	1500
1275	1422	0.864	4.8	0.03183	1275	0.059	1469
1425	1422	0.864	2.7	0.01777	1425	0.033	1448
1575	1422	0.864	1.4	0.00908	1575	0.017	1435
1725	1422	0.864	0.6	0.00425	1725	0.008	1428
1875	1422	0.864	0.3	0.00183	1875	0.003	1425
2025	1422	0.864	0.1	0.00073	2025	0.001	1423
2175	1422	0.864	0.0	0.00026	2175	0.000	1422
2325	1422	0.864	0.0	0.00009	2325	0.000	1422
2475	1422	0.864	0.0	0.00003	2475	0.000	1422
2625	1422	0.864	0.0	0.00001	2625	0.000	1422
			Sum 175	mm			

60 passes-meas	Before	
d (mm)	ρ_f(kg/m^3)	e_f
305	1441	0.839
610	1422	0.864
810	1413	0.875
1100	1422	0.864

60 passes	After		
d (mm)	ρ_o (kg/m^3)	e_o	Δe
305	1836	0.443	0.396
610	1638	0.618	0.246
810	1584	0.673	0.202
1100	1548	0.712	0.152

Annual transport Convention, 1988, paper 3D/7

Evaluation of impact roller compaction trials on potentially collapsing sands in Botswana

Pinard M I, Ookeditse S & Fraser C

APPENDIX H23: Strain influence calculation : Cell 1, Rollins, 1998

[Figure 6.14]

$$\Delta V = V_o.\varepsilon_{vol} = V_o.(1-2\nu_{pl})\varepsilon_v = (1+e_o)(1-2\nu_{pl})\varepsilon_v$$

$$\rho = \frac{G_s}{(V_o - \Delta V)}$$

(settlement)	0.48	m	ν_{pl}=	0.15	Gs =	2650	(kg/m^3)

Depth (m)	ρ_o	e_o	ΔH	$\varepsilon_v=\Delta H/H$	Depth (m)	$\Delta V=\Delta e$	ρ_f(kg/m^3)
0.10	1262	1.100	0.050	0.24918	0.58	0.366	1529
0.30	1262	1.100	0.039	0.19728	0.78	0.290	1464
0.50	1262	1.100	0.028	0.13795	0.98	0.203	1397
0.70	1205	1.200	0.035	0.17692	1.18	0.272	1375
0.90	1205	1.200	0.040	0.20237	1.38	0.312	1403
1.10	1205	1.200	0.043	0.21372	1.58	0.329	1416
1.30	1205	1.200	0.042	0.21196	1.78	0.326	1414
1.50	1205	1.200	0.040	0.19933	1.98	0.307	1400
1.70	1205	1.200	0.036	0.17882	2.18	0.275	1377
1.90	1205	1.200	0.031	0.15364	2.38	0.237	1350
2.10	1205	1.200	0.025	0.12678	2.58	0.195	1322
2.30	1205	1.200	0.020	0.10069	2.78	0.155	1296
2.50	1205	1.200	0.015	0.07707	2.98	0.119	1273
2.70	1205	1.200	0.011	0.05693	3.18	0.088	1255
2.90	1205	1.200	0.008	0.04062	3.38	0.063	1240
3.10	1205	1.200	0.006	0.02801	3.58	0.043	1229
3.30	1205	1.200	0.004	0.01868	3.78	0.029	1221
3.50	1205	1.200	0.002	0.01206	3.98	0.019	1215
3.70	1205	1.200	0.002	0.00753	4.18	0.012	1211
3.90	1205	1.200	0.001	0.00456	4.38	0.007	1208
4.10	1205	1.200	0.001	0.00267	4.58	0.004	1207
4.30	1205	1.200	0.000	0.00152	4.78	0.002	1206
4.50	1205	1.200	0.000	0.00083	4.98	0.001	1205
4.70	1205	1.200	0.000	0.00045	5.18	0.001	1205
4.90	1205	1.200	0.000	0.00023	5.38	0.000	1205
5.10	1205	1.200	0.000	0.00012	5.58	0.000	1205
5.30	1205	1.200	0.000	0.00006	5.78	0.000	1205
5.50	1205	1.200	0.000	0.00003	5.98	0.000	1205
		Sum	0.480	m			

Cell 1 - meas	Before	
d (mm)	ρ_o (kg/m^3)	e_o
1.20	1262	1.10
1.80	1205	1.20
2.40	1283	1.07
3.05	1312	1.02
3.70	1262	1.10
4.10	1305	1.03
4.90	1325	1.00
5.55	1274	1.08
Ave	1278	1.07

Cell 1 - measur	After		
d (mm)	ρ_f(kg/m^3)	e_f	Δe
1.20	1699	0.560	0.540
1.80	1452	0.825	0.375
2.40	1380	0.920	0.145
3.05	1325	1.000	0.020
3.70	1325	1.000	0.100
4.10	1305	1.030	0.000
4.90	1312	1.020	-0.020
5.55			

Based on a paper by Rollins, K.M., Jorgebsen, S.J., & Ross T.E.:
Optimum moisture content for dynamic compaction of collapsible soils.
Journal of Geotechnical Engineering, Vol 124, No 8, August 1998.

APPENDIX H24: Strain influence calculation : Cell 2, Rollins, 1998

$$\Delta V = V_o.\varepsilon_{vol} = V_o.(1-2v_{pl})\varepsilon_v = (1+e_o)(1-2v_{pl})\varepsilon_v$$

$$\rho = \frac{G_s}{(V_o - \Delta V)}$$

(settlement)=	0.85	m	v_{pl} =	0.15	Gs =	2650	(kg/m^3)

Depth (m)	ρ_o	e_o	ΔH	$\varepsilon_v = \Delta H/H$	Depth (m)	$\Delta V = \Delta e$	ρ_f (kg/m^3)
0.10	1312	1.020	0.088	0.44126	0.95	0.624	1898
0.30	1312	1.020	0.070	0.34935	1.15	0.494	1737
0.50	1312	1.020	0.049	0.24428	1.35	0.345	1582
0.70	1147	1.310	0.063	0.31329	1.55	0.507	1469
0.90	1147	1.310	0.072	0.35837	1.75	0.579	1531
1.10	1147	1.310	0.076	0.37847	1.95	0.612	1561
1.30	1147	1.310	0.075	0.37535	2.15	0.607	1556
1.50	1147	1.310	0.071	0.35298	2.35	0.571	1524
1.70	1147	1.310	0.063	0.31665	2.55	0.512	1474
1.90	1147	1.310	0.054	0.27207	2.75	0.440	1417
2.10	1147	1.310	0.045	0.22451	2.95	0.363	1361
2.30	1147	1.310	0.036	0.17830	3.15	0.288	1311
2.50	1147	1.310	0.027	0.13648	3.35	0.221	1268
2.70	1147	1.310	0.020	0.10082	3.55	0.163	1234
2.90	1147	1.310	0.014	0.07193	3.75	0.116	1208
3.10	1147	1.310	0.010	0.04960	3.95	0.080	1188
3.30	1147	1.310	0.007	0.03308	4.15	0.053	1174
3.50	1147	1.310	0.004	0.02135	4.35	0.035	1165
3.70	1147	1.310	0.003	0.01334	4.55	0.022	1158
3.90	1147	1.310	0.002	0.00807	4.75	0.013	1154
4.10	1147	1.310	0.001	0.00473	4.95	0.008	1151
4.30	1147	1.310	0.001	0.00269	5.15	0.004	1149
4.50	1147	1.310	0.000	0.00148	5.35	0.002	1148
4.70	1147	1.310	0.000	0.00079	5.55	0.001	1148
4.90	1147	1.310	0.000	0.00041	5.75	0.001	1148
5.10	1147	1.310	0.000	0.00020	5.95	0.000	1147
5.30	1147	1.310	0.000	0.00010	6.15	0.000	1147
5.50	1147	1.310	0.000	0.00005	6.35	0.000	1147
		Sum	0.850	m			

Cell 2 - meas	Before	
d (mm)	ρ_o (kg/m^3)	e_o
1.20	1312	1.02
1.80	1147	1.31
2.40	1188	1.23
3.05	1262	1.10
3.70	1432	0.85
4.10	1406	0.89
4.90	1425	0.86
5.55	1345	0.97
Ave	1315	1.03

Cell 2 - measur	After		
d (mm)	ρ_f (kg/m^3)	e_f	Δe
1.20	1710	0.550	0.470
1.80	1636	0.620	0.690
2.40	1536	0.725	0.505
3.05	1402	0.890	0.210
3.70	1384	0.915	-0.065
4.10	1440	0.840	0.045
4.90	1440	0.840	0.020
5.55			

Based on a paper by Rollins, K.M., Jorgebsen, S.J., & Ross T.E.:
Optimum moisture content for dynamic compaction of collapsible soils.
Journal of Geotechnical Engineering, Vol 124, No 8, August 1998.

APPENDIX H25: Strain influence calculation : Cell 3, Rollins, 1998

[Figure 6.16]

$$\Delta V = V_o.\varepsilon_{vol} = V_o.(1-2\nu_{pl})\varepsilon_v = (1+e_o)(1-2\nu_{pl})\varepsilon_v$$

$$\rho = \frac{G_s}{(V_o - \Delta V)}$$

(settlement)=	1.2	m	ν_{pl} =	0.25	Gs =	2650	(kg/m^3)

Depth (m)	ρ_o	e_o	ΔH	ε_v=ΔH/H	Depth (m)	ΔV=Δe	ρ_f(kg/m^3)
0.10	1338	0.980	0.125	0.62295	1.30	0.617	1944
0.30	1338	0.980	0.099	0.49320	1.50	0.488	1776
0.50	1338	0.980	0.069	0.34487	1.70	0.341	1617
0.70	1338	0.980	0.088	0.44229	1.90	0.438	1718
0.90	1338	0.980	0.101	0.50593	2.10	0.501	1792
1.10	1338	0.980	0.107	0.53430	2.30	0.529	1826
1.30	1338	0.980	0.106	0.52990	2.50	0.525	1821
1.50	1338	0.980	0.100	0.49833	2.70	0.493	1783
1.70	1338	0.980	0.089	0.44704	2.90	0.443	1724
1.90	1338	0.980	0.077	0.38410	3.10	0.380	1657
2.10	1338	0.980	0.063	0.31696	3.30	0.314	1590
2.30	1338	0.980	0.050	0.25172	3.50	0.249	1531
2.50	1338	0.980	0.039	0.19268	3.70	0.191	1481
2.70	1338	0.980	0.028	0.14233	3.90	0.141	1441
2.90	1338	0.980	0.020	0.10155	4.10	0.101	1410
3.10	1338	0.980	0.014	0.07003	4.30	0.069	1387
3.30	1338	0.980	0.009	0.04671	4.50	0.046	1370
3.50	1338	0.980	0.006	0.03014	4.70	0.030	1359
3.70	1338	0.980	0.004	0.01883	4.90	0.019	1351
3.90	1338	0.980	0.002	0.01139	5.10	0.011	1346
4.10	1338	0.980	0.001	0.00668	5.30	0.007	1343
4.30	1338	0.980	0.001	0.00379	5.50	0.004	1341
4.50	1338	0.980	0.000	0.00209	5.70	0.002	1340
4.70	1338	0.980	0.000	0.00111	5.90	0.001	1339
4.90	1338	0.980	0.000	0.00058	6.10	0.001	1339
5.10	1338	0.980	0.000	0.00029	6.30	0.000	1339
5.30	1338	0.980	0.000	0.00014	6.50	0.000	1338
5.50	1338	0.980	0.000	0.00007	6.70	0.000	1338
			Sum	1.200	m		

Cell 3 - meas	Before		Cell 3 - measur	After		
d (mm)	ρ_o (kg/m^3)	e_o	d (mm)	ρ_f(kg/m^3)	e_f	Δe
1.20	1338	0.98	1.20	1860	0.425	0.555
1.80	1338	0.98	1.80	1743	0.520	0.460
2.40	1268	1.09	2.40	1667	0.590	0.500
3.05	1312	1.02	3.05	1550	0.710	0.310
3.70	1296	1.05	3.70	1472	0.800	0.245
4.10	1342	0.98	4.10	1387	0.910	0.065
4.90	1326	1.00	4.90	1342	0.975	0.023
5.55	2650	0.00	5.55			
Ave	1484	0.89				

Based on a paper by Rollins, K.M., Jorgebsen, S.J., & Ross T.E.:
Optimum moisture content for dynamic compaction of collapsible soils.
Journal of Geotechnical Engineering, Vol 124, No 8, August 1998.

APPENDIX H26: Strain influence calculation : Cell 4, Rollins, 1998

$$\Delta V = V_o.\varepsilon_{vol} = V_o.(1-2v_{pl})\varepsilon_v = (1+e_o)(1-2v_{pl})\varepsilon_v$$

$$\rho = \frac{G_s}{(V_o - \Delta V)}$$

(settlement)=	1.14	m	v_{pl}=	0.20	Gs =	2650	(kg/m^3)

Depth (m)	ρ_o	e_o	ΔH	ε_v=ΔH/H	Depth (m)	ΔV=Δe	ρ_f(kg/m^3)
0.10	1325	1.000	0.105	0.52502	1.24	0.630	1934
0.30	1325	1.000	0.081	0.40576	1.44	0.487	1751
0.50	1325	1.000	0.055	0.27457	1.64	0.329	1586
0.70	1327	0.997	0.072	0.35805	1.84	0.429	1690
0.90	1327	0.997	0.084	0.41876	2.04	0.502	1772
1.10	1327	0.997	0.091	0.45470	2.24	0.545	1825
1.30	1327	0.997	0.093	0.46623	2.44	0.559	1842
1.50	1327	0.997	0.091	0.45582	2.64	0.546	1827
1.70	1327	0.997	0.085	0.42748	2.84	0.512	1785
1.90	1327	0.997	0.077	0.38611	3.04	0.463	1727
2.10	1327	0.997	0.067	0.33681	3.24	0.404	1663
2.30	1327	0.997	0.057	0.28433	3.44	0.341	1600
2.50	1327	0.997	0.047	0.23264	3.64	0.279	1542
2.70	1327	0.997	0.037	0.18470	3.84	0.221	1492
2.90	1327	0.997	0.028	0.14243	4.04	0.171	1451
3.10	1327	0.997	0.021	0.10675	4.24	0.128	1418
3.30	1327	0.997	0.016	0.07782	4.44	0.093	1392
3.50	1327	0.997	0.011	0.05519	4.64	0.066	1372
3.70	1327	0.997	0.008	0.03811	4.84	0.046	1358
3.90	1327	0.997	0.005	0.02562	5.04	0.031	1348
4.10	1327	0.997	0.003	0.01678	5.24	0.020	1340
4.30	1327	0.997	0.002	0.01070	5.44	0.013	1336
4.50	1327	0.997	0.001	0.00665	5.64	0.008	1332
4.70	1327	0.997	0.001	0.00403	5.84	0.005	1330
4.90	1327	0.997	0.000	0.00238	6.04	0.003	1329
5.10	1327	0.997	0.000	0.00137	6.24	0.002	1328
5.30	1327	0.997	0.000	0.00077	6.44	0.001	1328
5.50	1327	0.997	0.000	0.00042	6.64	0.001	1327
			Sum	1.140	m		

Cell 4 - meas	Before	
d (mm)	ρ_o (kg/m^3)	e_o
1.20	1325	1.00
1.80	1327	1.00
2.40	1359	0.95
3.05	1362	0.95
3.70	1268	1.09
4.10	1352	0.96
4.90	1286	1.06
5.55	1274	1.08
Ave	1319	1.01

Cell 4 - measur	After		
d (mm)	ρ_f(kg/m^3)	e_f	Δe
1.20	1866	0.420	0.580
1.80	1866	0.420	0.577
2.40	1840	0.440	0.510
3.05	1815	0.460	0.485
3.70	1577	0.680	0.410
4.10	1429	0.855	0.105
4.90	1410	0.880	0.180
5.55	1359	0.950	0.130

Based on a paper by Rollins, K.M., Jorgebsen, S.J., & Ross T.E.:
Optimum moisture content for dynamic compaction of collapsible soils.
Journal of Geotechnical Engineering, Vol 124, No 8, August 1998.

APPENDIX H27: Strain influence calculation : Cell 5, Rollins, 1998

$$\Delta V = V_o.\varepsilon_{vol} = V_o.(1-2\nu_{pl})\varepsilon_v = (1+e_o)(1-2\nu_{pl})\varepsilon_v$$

$$\rho = \frac{G_s}{(V_o - \Delta V)}$$

(settlement)=	0.99	m	ν_{pl}=	0.23	Gs =	2650	(kg/m^3)

Depth (m)	ρ_o	e_o	ΔH	$\varepsilon_v=\Delta H/H$	Depth (m)	$\Delta V=\Delta e$	ρ_f(kg/m^3)
0.10	1489	0.780	0.091	0.45594	1.09	0.438	1975
0.30	1489	0.780	0.070	0.35237	1.29	0.339	1839
0.50	1489	0.780	0.048	0.23844	1.49	0.229	1709
0.70	1432	0.850	0.062	0.31094	1.69	0.311	1721
0.90	1432	0.850	0.073	0.36366	1.89	0.363	1782
1.10	1432	0.850	0.079	0.39487	2.09	0.394	1821
1.30	1432	0.850	0.081	0.40488	2.29	0.404	1833
1.50	1432	0.850	0.079	0.39584	2.49	0.395	1822
1.70	1432	0.850	0.074	0.37123	2.69	0.371	1792
1.90	1432	0.850	0.067	0.33530	2.89	0.335	1749
2.10	1432	0.850	0.058	0.29249	3.09	0.292	1701
2.30	1432	0.850	0.049	0.24692	3.29	0.247	1653
2.50	1432	0.850	0.040	0.20203	3.49	0.202	1608
2.70	1432	0.850	0.032	0.16040	3.69	0.160	1568
2.90	1432	0.850	0.025	0.12369	3.89	0.124	1535
3.10	1432	0.850	0.019	0.09271	4.09	0.093	1508
3.30	1432	0.850	0.014	0.06758	4.29	0.068	1487
3.50	1432	0.850	0.010	0.04793	4.49	0.048	1470
3.70	1432	0.850	0.007	0.03309	4.69	0.033	1458
3.90	1432	0.850	0.004	0.02225	4.89	0.022	1450
4.10	1432	0.850	0.003	0.01457	5.09	0.015	1444
4.30	1432	0.850	0.002	0.00929	5.29	0.009	1440
4.50	1432	0.850	0.001	0.00578	5.49	0.006	1437
4.70	1432	0.850	0.001	0.00350	5.69	0.003	1435
4.90	1432	0.850	0.000	0.00207	5.89	0.002	1434
5.10	1432	0.850	0.000	0.00119	6.09	0.001	1433
5.30	1432	0.850	0.000	0.00067	6.29	0.001	1433
5.50	1432	0.850	0.000	0.00037	6.49	0.000	1433
		Sum	0.990	m			

Cell 5 - meas	Before	
d (mm)	ρ_o (kg/m^3)	e_o
1.20	1489	0.78
1.80	1432	0.85
2.40	1373	0.93
3.05	1402	0.89
3.70	1440	0.84
4.10	1452	0.83
4.90	1373	0.93
5.55	1380	0.92
Ave	1418	0.87

Cell 5 - measur	After		
d (mm)	ρ_f(kg/m^3)	e_f	Δe
1.20	1853	0.430	0.350
1.80	1840	0.440	0.410
2.40	1651	0.605	0.325
3.05	1656	0.600	0.290
3.70	1506	0.760	0.080
4.10	1767	0.500	0.325
4.90	1514	0.750	0.180
5.55	1373	0.930	-0.010

Based on a paper by Rollins, K.M., Jorgebsen, S.J., & Ross T.E.:
Optimum moisture content for dynamic compaction of collapsible soils.
Journal of Geotechnical Engineering, Vol 124, No 8, August 1998.

APPENDIX H28: Strain influence calculation : Cell 6, Rollins, 1998

$\Delta V = V_o.\varepsilon_{vol} = V_o.(1-2\nu_{pl})\varepsilon_v = (1+e_o)(1-2\nu_{pl})\varepsilon_v$ [Figure 6.19]

$$\rho = \frac{G_s}{(V_o - \Delta V)}$$

(settlement)=	2.38	m	ν_{pl} =	0.39	Gs =	2650	(kg/m^3)

Depth (m)	ρ_o	e_o	ΔH	$\varepsilon_v = \Delta H/H$	Depth (m)	$\Delta V = \Delta e$	ρ_f (kg/m^3)
0.10	1468	0.805	0.219	1.09609	2.48	0.435	1935
0.30	1468	0.805	0.169	0.84711	2.68	0.336	1804
0.50	1468	0.805	0.115	0.57322	2.88	0.228	1680
0.70	1293	1.050	0.150	0.74750	3.08	0.337	1547
0.90	1293	1.050	0.175	0.87426	3.28	0.394	1601
1.10	1293	1.050	0.190	0.94928	3.48	0.428	1634
1.30	1293	1.050	0.195	0.97335	3.68	0.439	1645
1.50	1293	1.050	0.190	0.95162	3.88	0.429	1635
1.70	1293	1.050	0.178	0.89246	4.08	0.402	1608
1.90	1293	1.050	0.161	0.80609	4.28	0.364	1571
2.10	1293	1.050	0.141	0.70316	4.48	0.317	1529
2.30	1293	1.050	0.119	0.59360	4.68	0.268	1487
2.50	1293	1.050	0.097	0.48569	4.88	0.219	1447
2.70	1293	1.050	0.077	0.38561	5.08	0.174	1413
2.90	1293	1.050	0.059	0.29736	5.28	0.134	1383
3.10	1293	1.050	0.045	0.22287	5.48	0.101	1359
3.30	1293	1.050	0.032	0.16246	5.68	0.073	1341
3.50	1293	1.050	0.023	0.11522	5.88	0.052	1326
3.70	1293	1.050	0.016	0.07955	6.08	0.036	1316
3.90	1293	1.050	0.011	0.05348	6.28	0.024	1308
4.10	1293	1.050	0.007	0.03502	6.48	0.016	1303
4.30	1293	1.050	0.004	0.02234	6.68	0.010	1299
4.50	1293	1.050	0.003	0.01389	6.88	0.006	1297
4.70	1293	1.050	0.002	0.00842	7.08	0.004	1295
4.90	1293	1.050	0.001	0.00497	7.28	0.002	1294
5.10	1293	1.050	0.001	0.00286	7.48	0.001	1293
5.30	1293	1.050	0.000	0.00161	7.68	0.001	1293
5.50	1293	1.050	0.000	0.00088	7.88	0.000	1293
			Sum 2.380	m			

Cell 6 - meas	Before		Cell 6 - measur	After		
d (mm)	ρ_o (kg/m^3)	e_o	d (mm)	ρ_f (kg/m^3)	e_f	Δe
2.70	1468	0.81	2.70	1656	0.600	0.205
3.30	1293	1.05	3.30	1626	0.630	0.420
4.25	1366	0.94	4.25	1577	0.680	0.260
4.80	1342	0.98	4.80	1536	0.725	0.250
5.40	1380	0.92	5.40	1506	0.760	0.160
6.00	1370	0.94	6.00	1472	0.800	0.135
Ave	1370	0.94				

Based on a paper by Rollins, K.M., Jorgebsen, S.J., & Ross T.E.:
Optimum moisture content for dynamic compaction of collapsible soils.
Journal of Geotechnical Engineering, Vol 124, No 8, August 1998.

APPENDIX H29 : Calculation of strain influence diagram:

Compactor contact dimension, B=	1.3	m
Assuming depth of influence, D =	3.9	m, =3B say
Asuming peak strain at a depth of	1	B
which is equal to…	1.300	m
Upper peak is how many times larger	1.025	x lower peak

Depth (mm)	ε ord.	Surface peak	Nett curve	Normalised ε ord.
0.10	0.05900	0.46640	0.52540	0.092109
0.30	0.17285	0.23320	0.40605	0.071186
0.50	0.27476	0.00000	0.27476	0.048170
0.70	0.35830		0.35830	0.062815
0.90	0.41906		0.41906	0.073467
1.10	0.45502		0.45502	0.079772
1.30	0.46656		0.46656	0.081794
1.50	0.45615		0.45615	0.079968
1.70	0.42779		0.42779	0.074997
1.90	0.38638		0.38638	0.067738
2.10	0.33705		0.33705	0.059089
2.30	0.28453		0.28453	0.049882
2.50	0.23281		0.23281	0.040814
2.70	0.18484		0.18484	0.032404
2.90	0.14253		0.14253	0.024988
3.10	0.10683		0.10683	0.018729
3.30	0.07787		0.07787	0.013652
3.50	0.05523		0.05523	0.009683
3.70	0.03813		0.03813	0.006685
3.90	0.02564		0.02564	0.004494
4.10	0.01679		0.01679	0.002943
4.30	0.01071		0.01071	0.001878
4.50	0.00666		0.00666	0.001167
4.70	0.00404		0.00404	0.000707
4.90	0.00238		0.00238	0.000418
5.10	0.00137		0.00137	0.000241
5.30	0.00077		0.00077	0.000135
5.50	0.00042		0.00042	0.000074
	5.00448		5.70408	1.00

APPENDIX H30 : Calculation of strain influence diagram: D_{peak}=0.675m
[Fig 6.22]

Compactor contact dimension, B=	0.9	m
Assuming depth of influence, D =	1.8	m, =3B say
Asuming peak strain at a depth of	0.75	B
which is equal to…	***0.675***	m
Upper peak is how many times larger	1.1	x lower peak

Depth (mm)	ε ord.	Surface peak	Nett curve	Normalised ε ord.
0.01	0.02195	0.97898	1.00093	0.123299
0.16	0.34144	0.48949	0.83093	0.102358
0.31	0.61229	0.00000	0.61229	0.075424
0.46	0.80039		0.80039	0.098596
0.61	0.88998		0.88998	0.109633
0.76	0.88497		0.88497	0.109014
0.91	0.80495		0.80495	0.099157
1.06	0.67795		0.67795	0.083513
1.21	0.53260		0.53260	0.065608
1.36	0.39213		0.39213	0.048304
1.51	0.27145		0.27145	0.033439
1.66	0.17709		0.17709	0.021815
1.81	0.10907		0.10907	0.013436
1.96	0.06350		0.06350	0.007822
2.11	0.03498		0.03498	0.004309
2.26	0.01825		0.01825	0.002248
2.41	0.00902		0.00902	0.001111
2.56	0.00423		0.00423	0.000521
2.71	0.00188		0.00188	0.000232
2.86	0.00079		0.00079	0.000098
3.01	0.00032		0.00032	0.000039
3.16	0.00012		0.00012	0.000015
3.31	0.00004		0.00004	0.000005
3.46	0.00001		0.00001	0.000002
3.61	0.00000		0.00000	0.000001
3.76	0.00000		0.00000	0.000000
3.91	0.00000		0.00000	0.000000
4.06	0.00000		0.00000	0.000000
	6.64941		8.11789	1.00

APPENDIX H31 : Calculation of strain influence diagram: D_{peak}=0.450m
[Fig 6.22]

Compactor contact dimension, B=	0.9	m
Assuming depth of influence, D =	1.8	m, =3B say
Asuming peak strain at a depth of	0.5	B
which is equal to…	***0.450***	m
Upper peak is how many times larger	1.1	x lower peak

Depth (mm)	ε ord.	Surface peak	Nett curve	Normalised ε ord.
0.01	0.04937	1.48190	1.53127	0.173015
0.16	0.74173	0.74095	1.48268	0.167524
0.31	1.20750	0.00000	1.20750	0.136432
0.46	1.34719		1.34719	0.152215
0.61	1.20196		1.20196	0.135807
0.76	0.90159		0.90159	0.101869
0.91	0.58159		0.58159	0.065713
1.06	0.32659		0.32659	0.036901
1.21	0.16083		0.16083	0.018171
1.36	0.06978		0.06978	0.007884
1.51	0.02676		0.02676	0.003024
1.66	0.00909		0.00909	0.001028
1.81	0.00274		0.00274	0.000310
1.96	0.00074		0.00074	0.000083
2.11	0.00018		0.00018	0.000020
2.26	0.00004		0.00004	0.000004
2.41	0.00001		0.00001	0.000001
2.56	0.00000		0.00000	0.000000
2.71	0.00000		0.00000	0.000000
2.86	0.00000		0.00000	0.000000
3.01	0.00000		0.00000	0.000000
3.16	0.00000		0.00000	0.000000
3.31	0.00000		0.00000	0.000000
3.46	0.00000		0.00000	0.000000
3.61	0.00000		0.00000	0.000000
3.76	0.00000		0.00000	0.000000
3.91	0.00000		0.00000	0.000000
4.06	0.00000		0.00000	0.000000
	6.62768		8.85053	1.00

APPENDIX H32 : Correlation calculation for impact compaction data

[Figure 6.23]

X	Y			
Measured	Predicted	$\underline{Y}$	$(Y-\underline{Y})^2$	$(X-Y)^2$
0.387	0.260	0.244	0.0003	0.01606
0.558	0.434	0.244	0.0363	0.01546
0.356	0.383	0.244	0.0194	0.0007
0.265	0.258	0.244	0.0002	4.5E-05
0.198	0.243	0.244	7E-07	0.00201
0.424	0.443	0.244	0.0396	0.00034
0.415	0.412	0.244	0.0285	1.1E-05
0.235	0.274	0.244	0.0009	0.00155
0.380	0.313	0.244	0.0048	0.00452
0.538	0.506	0.244	0.0689	0.00104
0.411	0.447	0.244	0.0415	0.00128
0.270	0.294	0.244	0.0026	0.00061
0.026	0.282	0.244	0.0015	0.06529
0.541	0.544	0.244	0.0902	6.5E-06
0.373	0.469	0.244	0.0506	0.0091
0.311	0.329	0.244	0.0074	0.00035
0.264	0.339	0.244	0.0092	0.00562
0.097	0.127	0.244	0.0136	0.00086
0.171	0.010	0.244	0.0545	0.0258
0.295	0.001	0.244	0.0587	0.08643
0.165	0.097	0.244	0.0213	0.0045
0.162	0.160	0.244	0.0069	1.4E-06
0.266	0.157	0.244	0.0075	0.01192
0.102	0.100	0.244	0.0205	2.3E-06
0.027	0.050	0.244	0.0376	0.00052
0.041	0.050	0.244	0.0374	8E-05
0.037	0.044	0.244	0.0398	5.3E-05
0.206	0.202	0.244	0.0017	1.8E-05
0.227	0.252	0.244	7E-05	0.00062
0.202	0.216	0.244	0.0007	0.00019
0.081	0.081	0.244	0.0265	6.9E-08
0.396	0.169	0.244	0.0056	0.05143
0.246	0.218	0.244	0.0006	0.00076
0.202	0.208	0.244	0.0012	3.4E-05
0.152	0.149	0.244	0.0088	4.9E-06

Mean Y	Sum (St)	Sum (Sr)	$R^2=(St-Sr)/St$	$S_{y/x}=(Sr/(n-2))^{0.5}$
0.244	0.745	0.307	0.59	0.10
	n=	35		

APPENDIX H33 : Correlation calculation : Dynamic compaction data

[Figure 6.24]

X	Y			
Measured	Predicted	$\underline{Y}$	$(Y-\underline{Y})^2$	$(X-Y)^2$
0.540	0.272	0.260	0.0001	0.0716
0.375	0.326	0.260	0.0043	0.0024
0.145	0.237	0.260	0.0006	0.0084
0.020	0.103	0.260	0.0247	0.0069
0.100	0.043	0.260	0.0472	0.0032
0.000	0.012	0.260	0.0619	0.0001
-0.020	0.002	0.260	0.0666	0.0005
0.470	0.494	0.260	0.0545	0.0006
0.690	0.579	0.260	0.1018	0.0122
0.505	0.571	0.260	0.0963	0.0043
0.210	0.363	0.260	0.0105	0.0234
-0.065	0.116	0.260	0.0208	0.0329
0.045	0.053	0.260	0.0428	0.0001
0.020	0.013	0.260	0.0612	0.0000
0.555	0.617	0.260	0.1269	0.0038
0.460	0.390	0.260	0.0167	0.0050
0.500	0.527	0.260	0.0709	0.0007
0.310	0.411	0.260	0.0228	0.0103
0.245	0.191	0.260	0.0049	0.0029
0.065	0.101	0.260	0.0256	0.0013
0.023	0.019	0.260	0.0585	0.0000
0.580	0.630	0.260	0.1366	0.0025
0.577	0.429	0.260	0.0284	0.0219
0.510	0.559	0.260	0.0889	0.0024
0.485	0.463	0.260	0.0409	0.0005
0.410	0.279	0.260	0.0003	0.0172
0.105	0.171	0.260	0.0081	0.0043
0.180	0.046	0.260	0.0462	0.0180
0.130	0.013	0.260	0.0613	0.0137
0.350	0.388	0.260	0.0164	0.0015
0.410	0.337	0.260	0.0058	0.0053
0.325	0.400	0.260	0.0195	0.0056
0.290	0.292	0.260	0.0010	0.0000
0.080	0.160	0.260	0.0100	0.0064
0.325	0.093	0.260	0.0282	0.0540
0.180	0.022	0.260	0.0568	0.0249
-0.010	0.006	0.260	0.0649	0.0002
0.205	0.336	0.260	0.0058	0.0173
0.420	0.394	0.260	0.0179	0.0007
0.260	0.364	0.260	0.0106	0.0107
0.250	0.243	0.260	0.0003	0.0000
0.160	0.101	0.260	0.0256	0.0035
0.135	0.036	0.260	0.0504	0.0098

Average Y	0.260	Sum (St	Sum (Sr)	$R^2=(St-Sr)/St$	$S_{y/x}=(Sr/(n-2))^{0.5}$
		1.644	0.411	0.750	0.10
		n=	43		

APPENDIX H34 : Calculation of void ratios from surface settlements of a vibro compactor: (data from Forssblad, 1980) [Figure 6.20 & 6.21]

Assumed MDD = 2000 kg/m^3 $\gamma_d=G_s/(1+e)$

Calculation of v_{pl} to achieve measured density: $\Delta V/V_o=(1-2v_{pl}).\varepsilon$

No. of passes	Density	e	Vo=1+e	Δe	δ (mm)	H	δh/H	v_{pl}	$(1-2v_{pl})$	$=(\delta h/H)(1-2v_{pl})$	ΔV	V	ρ=G/V
0	1450	0.828	1.828										
2	1604	0.652		-0.175	69	300	0.230	0.290	0.42	0.097	0.177	1.651	1605
4	1740	0.523		-0.305	78	300	0.260	0.180	0.64	0.166	0.304	1.523	1739
6	1840	0.440		-0.387	85	300	0.283	0.125	0.75	0.213	0.388	1.439	1841
8	1860	0.425		-0.403	86	300	0.287	0.117	0.77	0.220	0.401	1.426	1858
12	1900	0.395		-0.433	91	300	0.303	0.110	0.78	0.237	0.432	1.395	1899
16	1940	0.366		-0.462	93	300	0.310	0.093	0.81	0.252	0.461	1.366	1939

Assumed MDD = 2000 kg/m^3 $\gamma d=Gs/(1+e)$

Calculation with v_{pl} = 0 $\Delta V/V_o=(1-2v_{pl}).\varepsilon$

No. of passes	Density	e	Vo=1+e	Δe	δ (mm)	H	δh/H	v_{pl}	$(1-2v_{pl})$	$=(\delta h/H)(1-2v_{pl})$	ΔV	V	ρ=G/V
0	1450	0.828	1.828										
2	1604	0.652		-0.175	69	300	0.230	0	1.00	0.230	0.420	1.407	1883
4	1740	0.523		-0.305	78	300	0.260	0	1.00	0.260	0.475	1.352	1959
6	1840	0.440		-0.387	85	300	0.283	0	1.00	0.283	0.518	1.310	2023
8	1860	0.425		-0.403	86	300	0.287	0	1.00	0.287	0.524	1.304	2033
12	1900	0.395		-0.433	91	300	0.303	0	1.00	0.303	0.554	1.273	2081
16	1940	0.366		-0.462	93	300	0.310	0	1.00	0.310	0.567	1.261	2101

(after: Forsblad L *Compaction meter on vibrating follers for improved compaction control*, Dynapac Maskin AB Suede, Int.Conf. on Compaction, Paris, Vol II, p543-546, LCPC.)

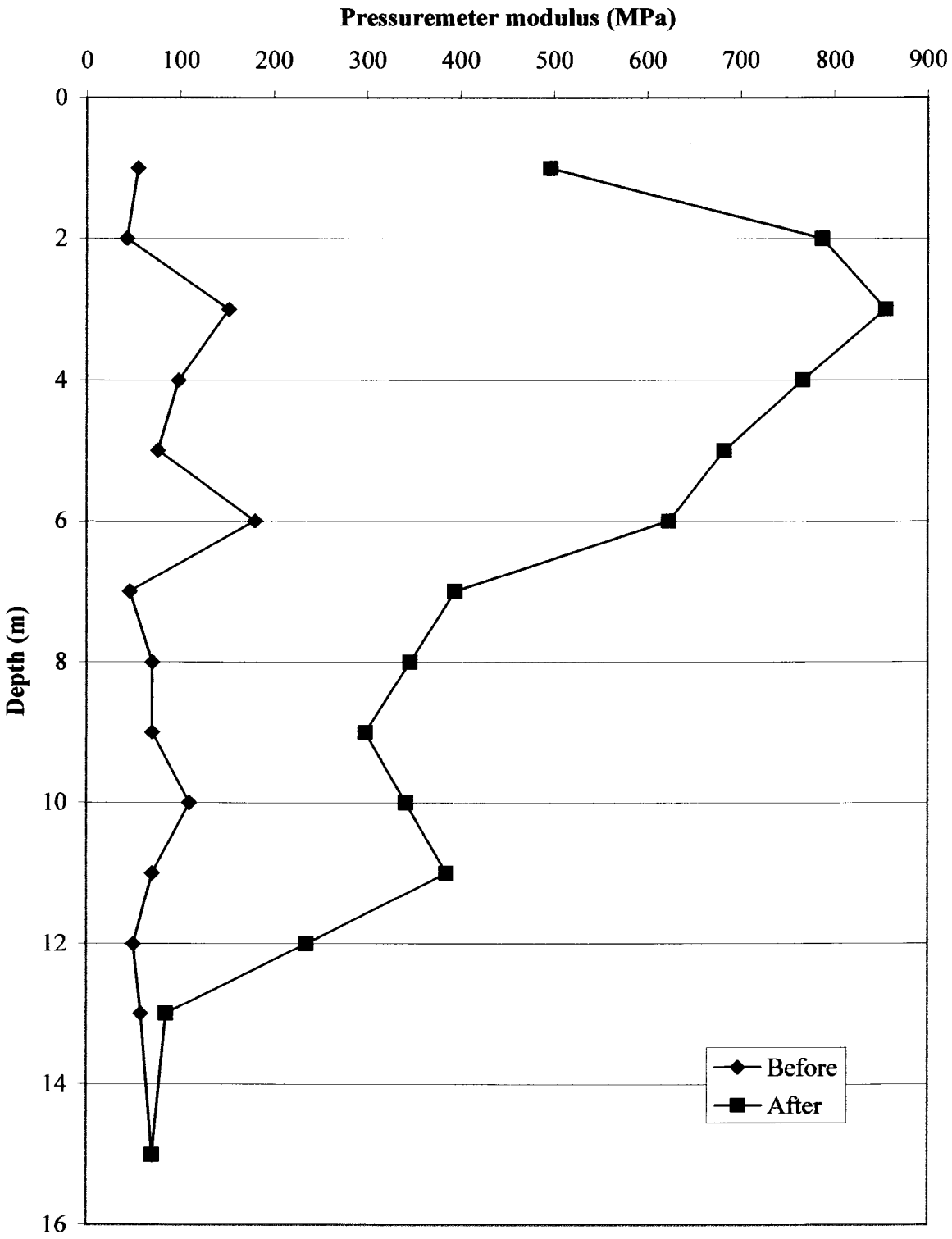
No. of passes	Percent compaction	Settlement (mm)
2	80.2%	69
4	87.0%	78
6	92.0%	85
8	93.0%	86
12	95.0%	91
16	97.0%	93

From Fig 6.3 From Fig 6.4

APPENDIX I

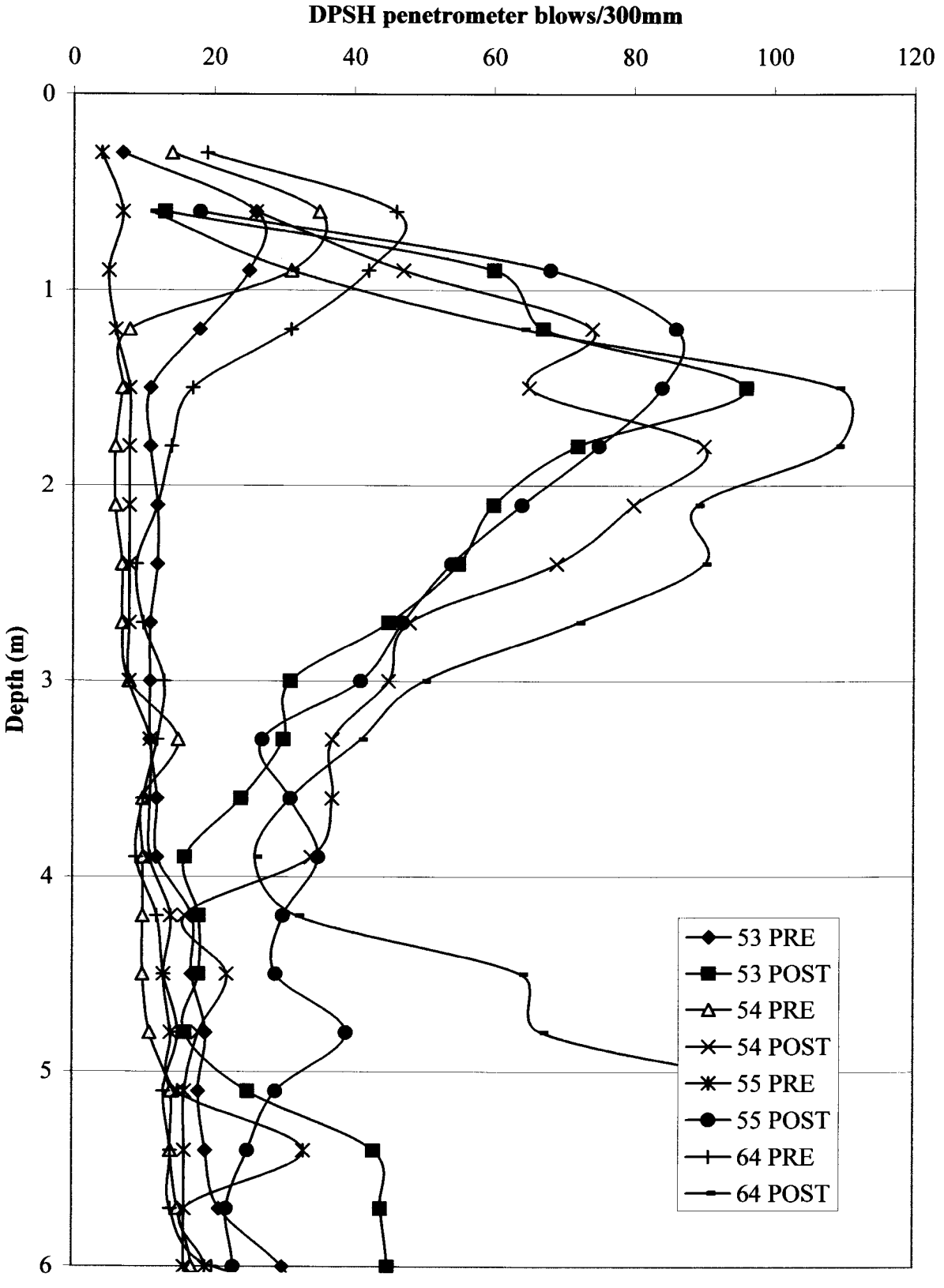
ADDITIONAL EVIDENCE OF PATTERNS OF IMPROVEMENT IN DYNAMIC COMPACTION MEASUREMENTS

Dynamic Compaction Improvement : Average of 22 results at Karlstad Terminal

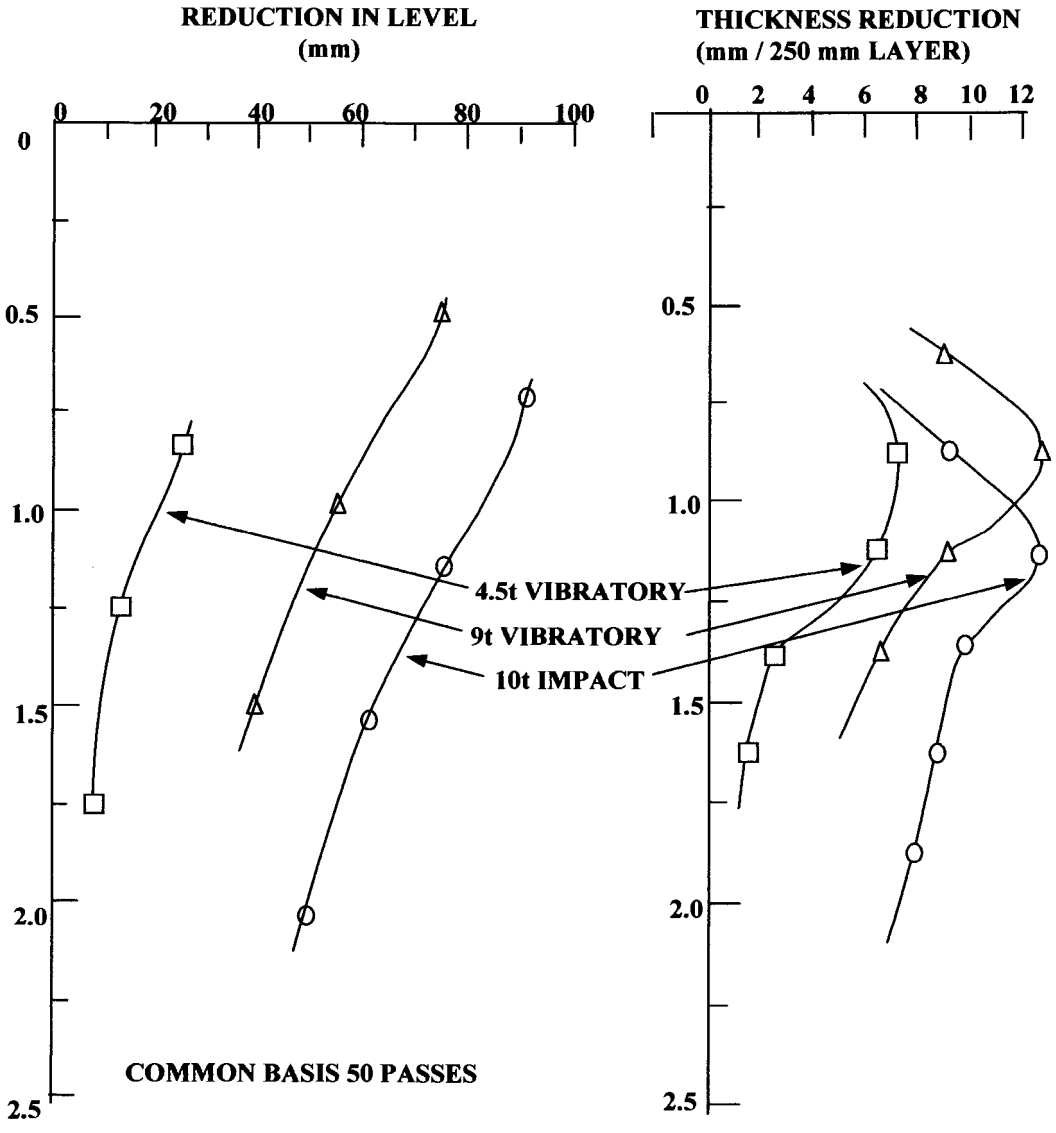


(After Menard and Broise, 1976)

DPSH results [Building S Mozal]

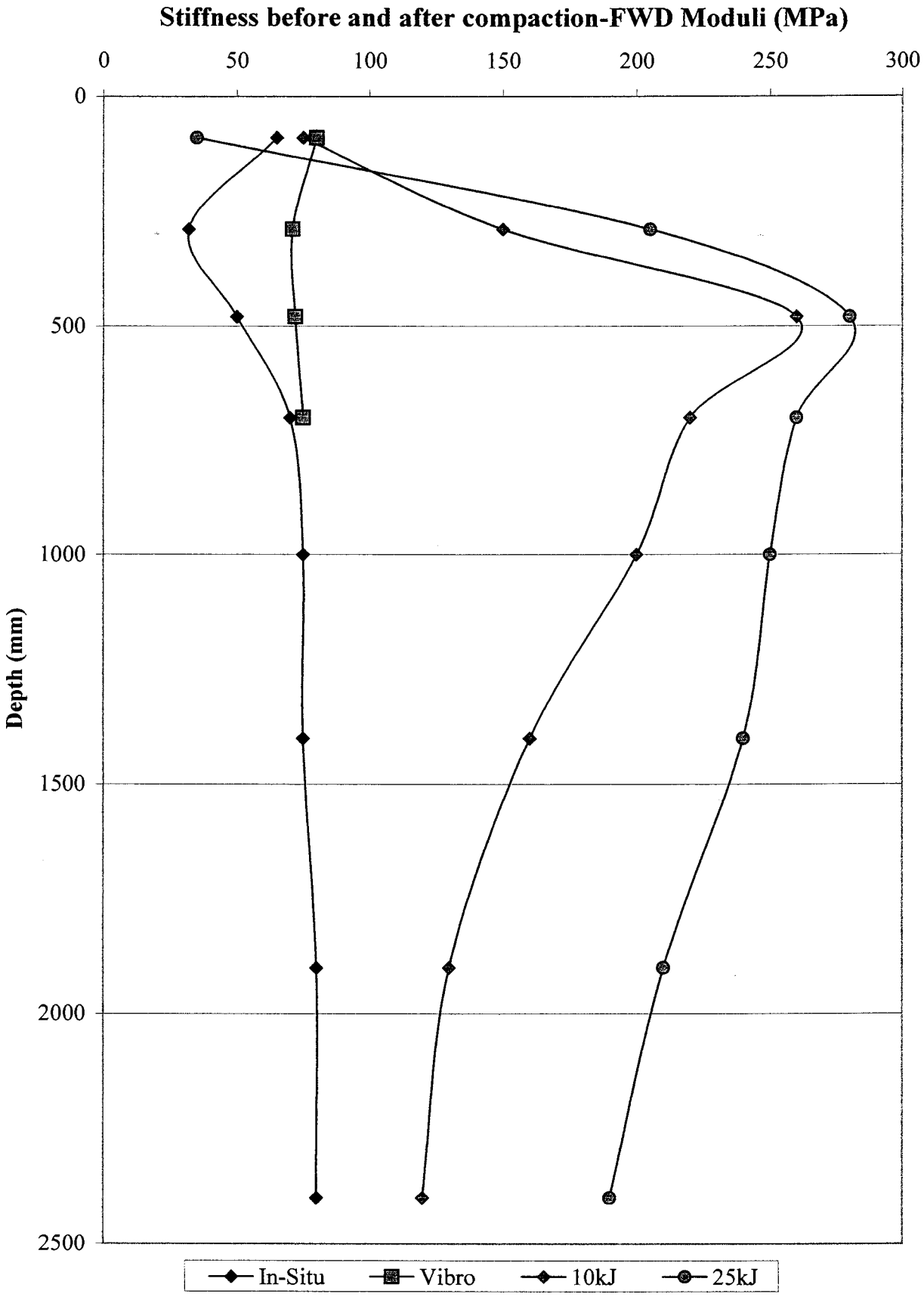


(with permission of Franki Africa)



COMPARISON OF ROLLERS ON REDUCTION IN LEVELS AND THICKNESS : PIER 2, DURBAN, 1975

(from CSIR report by Van Vuuren, D.J, Paterson W.D.O & de Wet H, April 1975, *Pavement design recommendations for container terminals with special reference to Pier 2, Durban Harbour*)

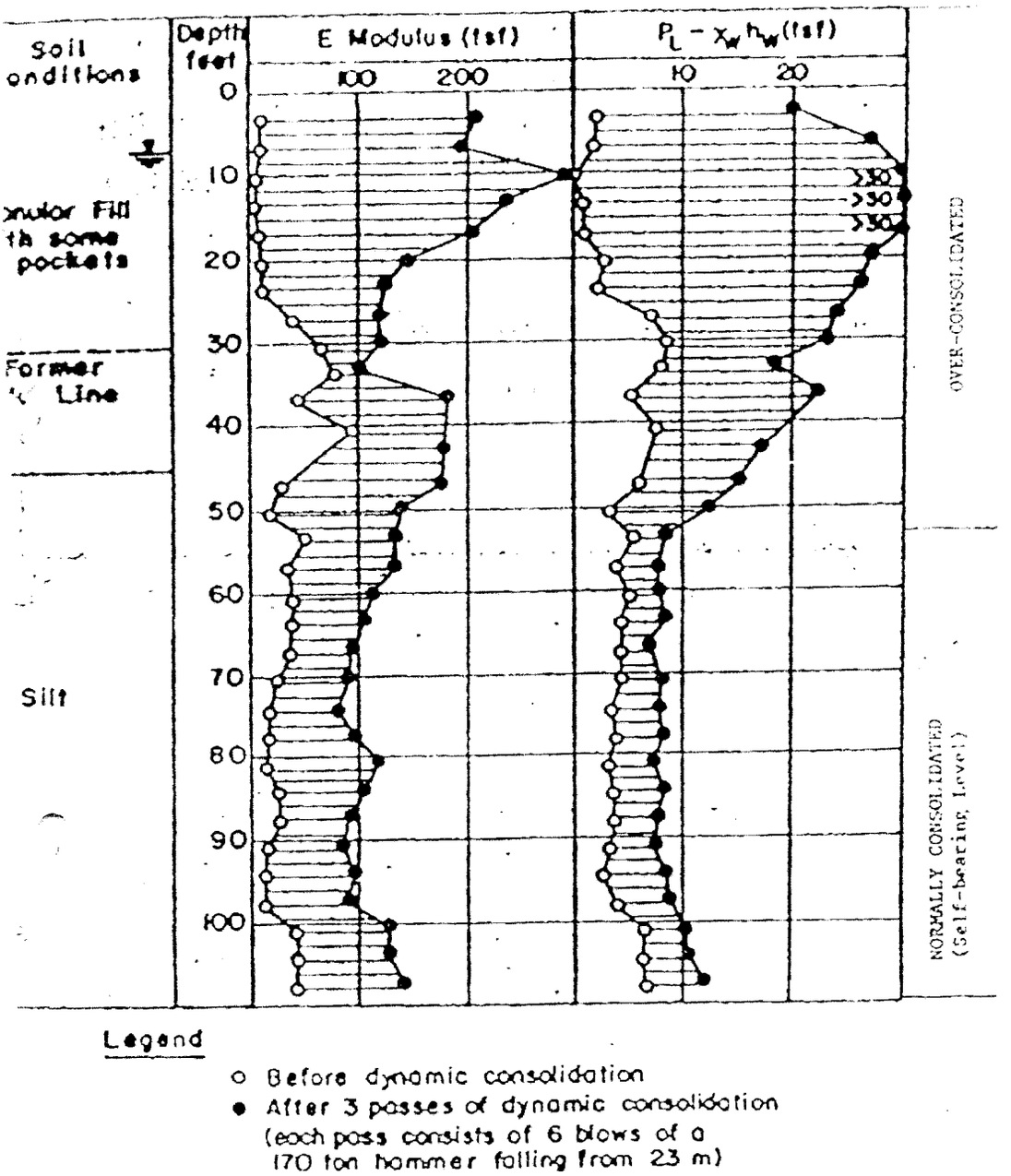


These trials were conducted on red aeolian sand in the Kriel area [Africon, 1998]

APPENDIX J

TYPICAL SOIL IMPROVEMENT PROFILE IN SATURATED CONDITIONS - NICE AIRPORT

FRENCH RIVERA AIRPORT IN NICE
IMPROVEMENT OF THE RECLAIMED LAND FOR
THE PROPOSED NEW RUN-WAY



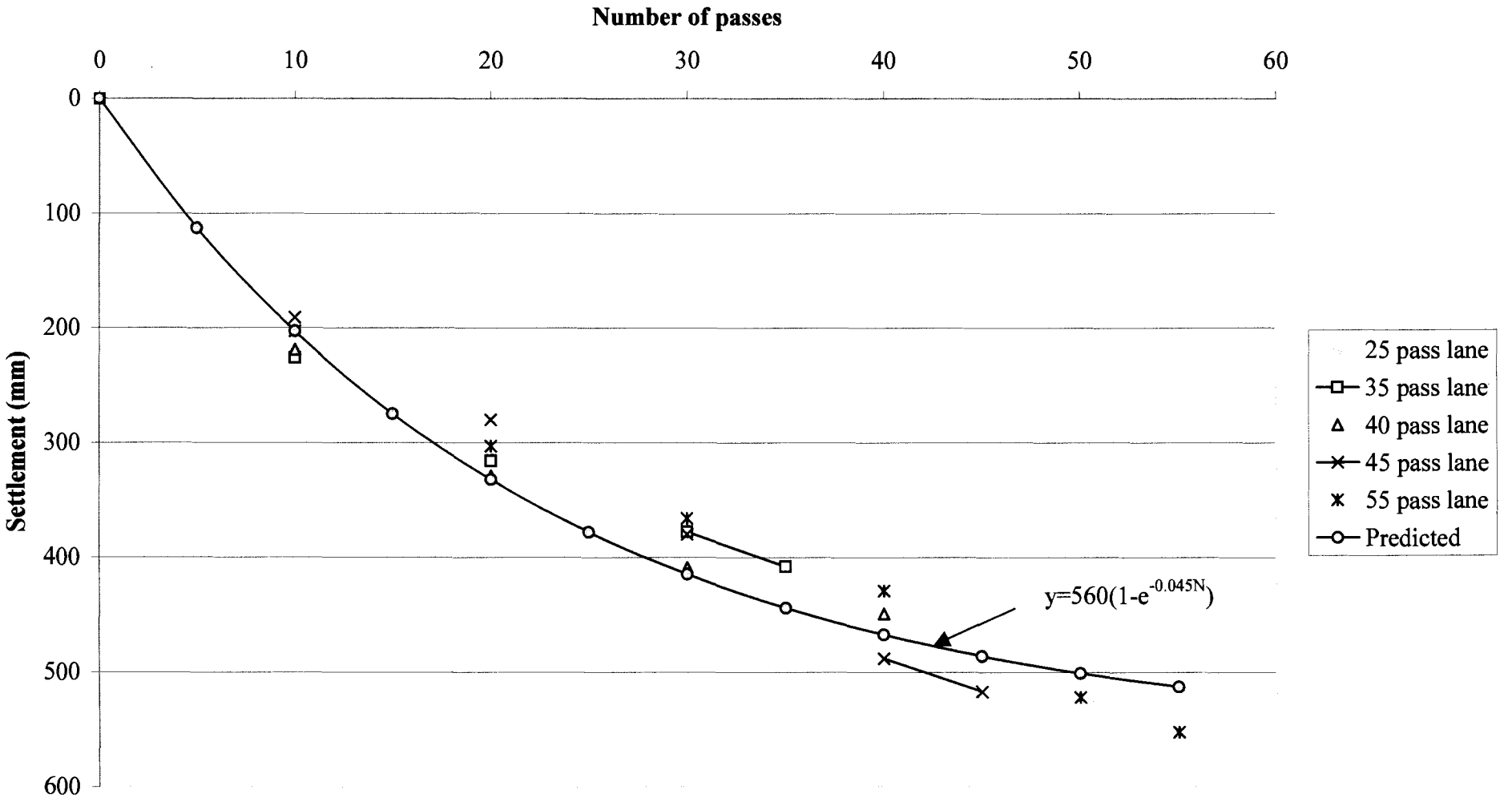
Variation in Pressuremeter Modulus and Limit Pressure with Depth at Nice Airport

(AFTER VARAKSIN, 1981)

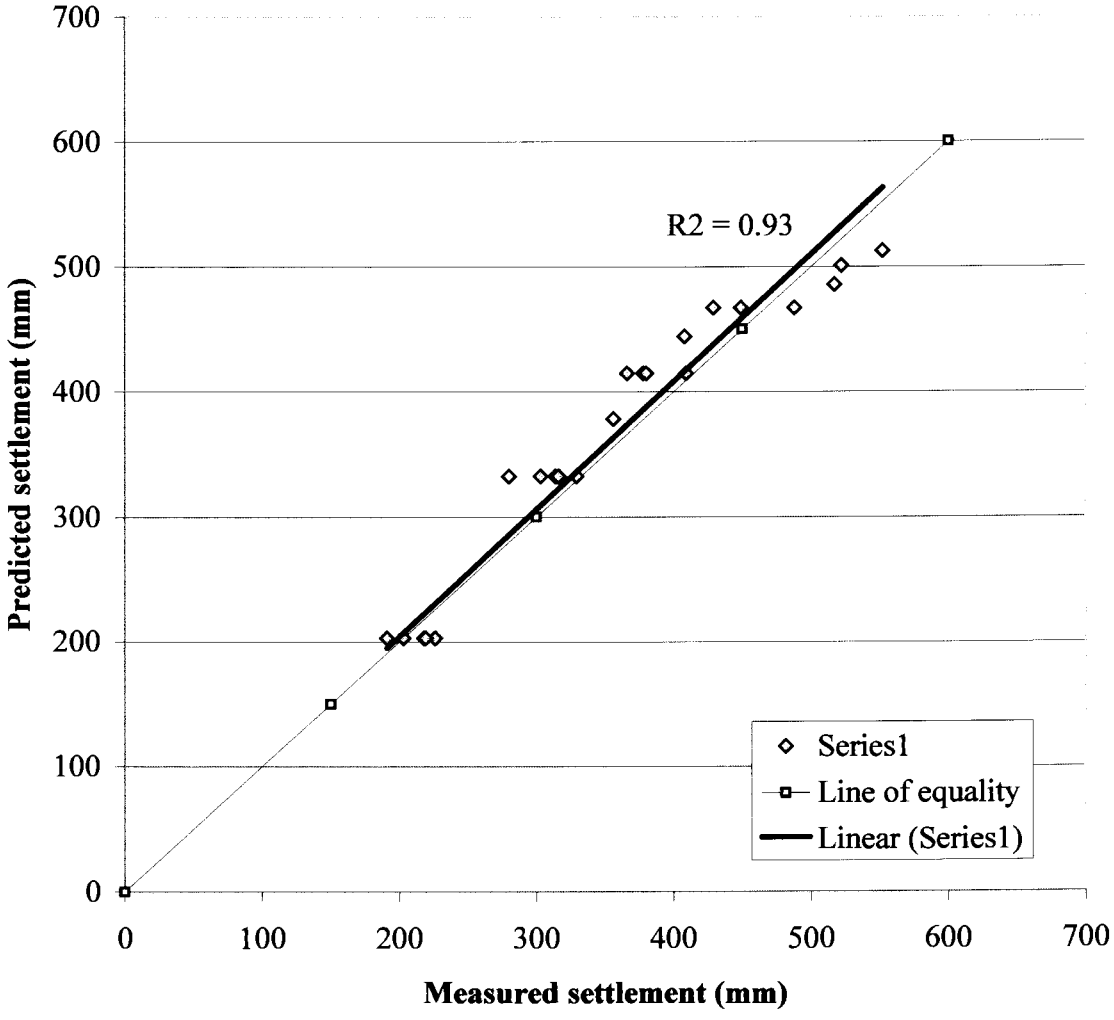
APPENDIX K

CURVE FITTING USING A NEGATIVE EXPONENTIAL CURVE

Use of a negative exponential curve to fit settlement data [Kriel 1991]



Regression analysis for exponential fit to settlement data



APPENDIX L

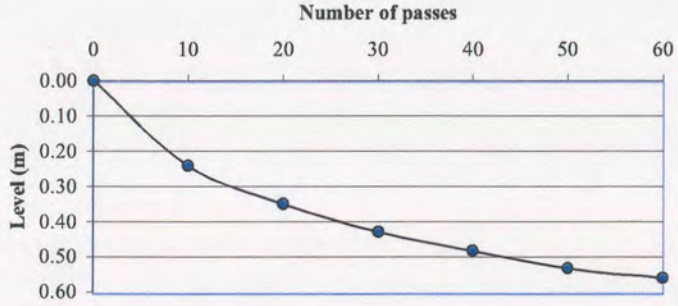
SOIL PROFILES AND PROPERTIES AT VARIOUS TEST SITES

Project summary:	Kriel trials			Date:	Sep-97		
Materials:	Aeolean			**Atterberg limits etc…**			
Sieve analysis	% passing [1]	% passing [2]	% passing [3]	Position:	TP1 [1]	TP2 [2]	TP6 [3]
37.500				LL	26	25	23
26.500				PI	14	15	12
19.000				LS	7	6.5	5.5
13.200				GM	0.56	0.55	0.65
4.750				AASHTO	A-6(5)	A-6(5)	A-6(3)
2.000				PI whole			
0.425				% Gravel			
0.250	100	100	100	% Sand	49	49	56
0.150	93	94	91	% Silt	51	51	44
0.075	51	51	44	% Clay			
0.050				Collapse%			
0.005				CBR@90%			
0.002				MOD AASHTO		1958@11.1%	
Depth:	TP1	TP1	TP6	Depth:	0-2m	0-2m	0-2m

Machine used:	Passes:		PREP
25kJ	60	LANDPAC	001

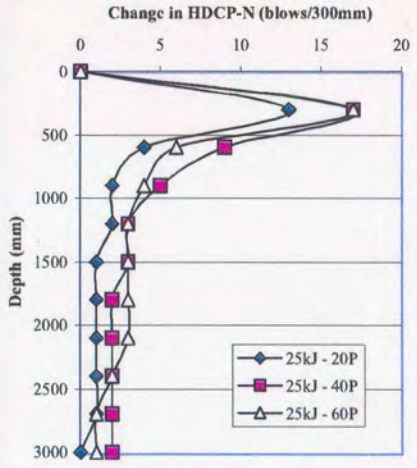
Settlement results:

Passes:	0	10	20	30	40	50	60
Level (m)	0	0.241	0.351	0.429	0.484	0.532	0.560

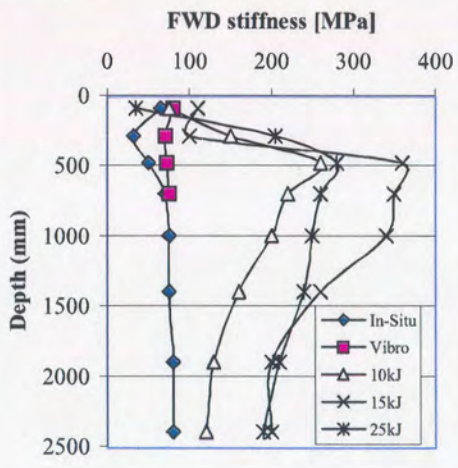


Measured improvement profile:

HDCP's



Other testing



Soil & moisture profile:

z(m)	Description:	m.c
0	Redbrown clayey fine silty sand, soft to firm but stiff close to the surface	12.2
		14.2
>2.5	Bedrock varied from 2-6m but was in general >3m below the surface	15.1
	No water table	

Comments:

Depth of compaction: +/-2.5m
Plate load, oedometer, sand replacement, Falling weight deflectometer, Heavy DCP, and visual settlement strain indicator testing done by independent consultants, Africon Engineering International.

Conclusions:

All impact compactors very effective at compacting this type of material. Significant improvement in stiffness, void ratio and collapse potential

For detailed results see:
U:\alan\Kriel report\Kriel Verslag.doc
U:\rienk\Trial Reports Database\Kriel trials\
This document: U:\Project database\Kriel 1997

Project summary: Highveld steel | Date: 1969 | Machine used: 12t 5 sided | Passes: 20 | LAND PAC | PREP 004

Materials: Medium dense silty sand

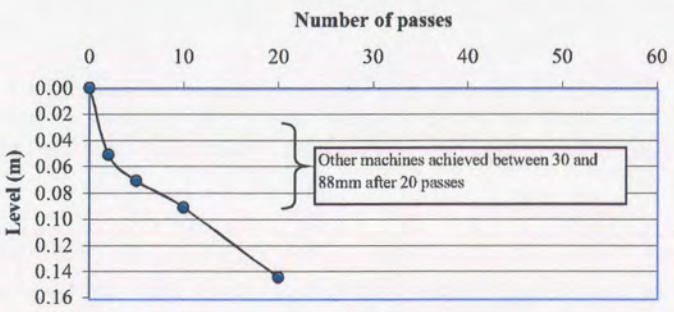
Sieve analysis	% passing [1]	% passing [2]	% passing [3]
37.500			
26.500			
19.000			
13.200			
4.750			
2.000			
0.425			
0.250			
0.150			
0.075	22	45	
0.050			
0.005			
0.002			
Depth:	0-1.2m	1.2-2.7m	

Atterberg limits etc...

Position:	Test [1]	Test [2]	Test [3]
LL			
PI	SP	14	
LS			
GM			
AASHTO			
PI whole			
% Gravel			
% Sand			
% Silt	22	45	
% Clay			
Collapse%			
CBR@90%			
MOD AASHTO			
Depth:	0-1.2m	1.2-2.7m	

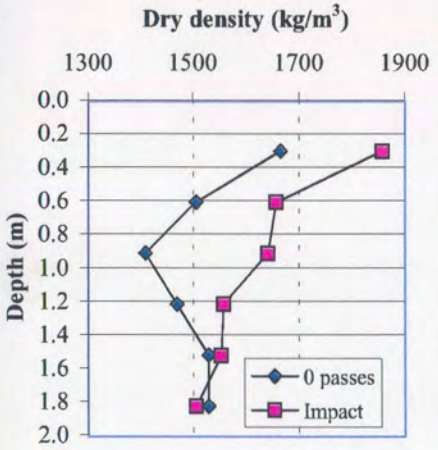
Settlement results:

Passes:	0	2	5	10	20	50	60
Level (m)	0	0.051	0.071	0.091	0.145		

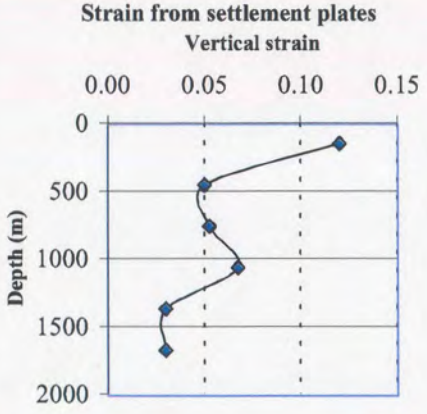


Measured improvement profile:

Density



Other testing



Soil & moisture profile:

z(m)	Description:	m.c
0	Medium dense	
	slightly cemented	7.5
0.9	sand, transported	
1,2	Silty sand	12
	Dark redish brown	
	soft medium dense	15
	unifrom silty sand	
	Scattered Fe	
	concretions	
2.5	(transported)	17
	No water table	

Comments:

Depth of compaction: +/-1.5m

From paper by Clegg et al, 1969
CSIR Report No RC/3/69

Conclusions:

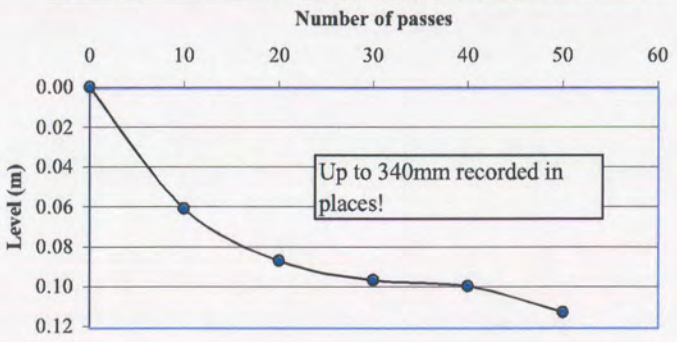
Better than other plant utilised
Economical in terms of depth/unit cost
Settlements and DCP adequate to observe changes
Well worth further research
For detailed results see:
U:\Alan\My documents\Prediction model\Raleigh\
This document : U:\Project Database\

Project summary:	Middleberg Coal Mine			Date:	1984		
Materials:	Aeolean sand			**Atterberg limits etc…**			
Sieve analysis	% passing [1]	% passing [2]	% passing [3]	Position:			
37.500				LL			
26.500				PI			
19.000				LS			
13.200		100		GM			
4.750		92		AASHTO			
2.000	100	80		PI whole			
0.425	71	75		% Gravel			
0.250	65	55		% Sand			
0.150	48	38		% Silt			
0.075	36	28		% Clay			
0.050	32	23		Collapse%	10.4	12.6	12.8
0.005	18	16		Void ratio	0.89	1.05	0.96
0.002	0	0		MOD AASHTO	2080 @ 9%		
Depth:	Upper sand	Ferruginised		Depth:	0.5m	1.0m	1.5m

Machine used:	Passes:		PREP
18kJ 3 sided	Varied	LANDPAC	020

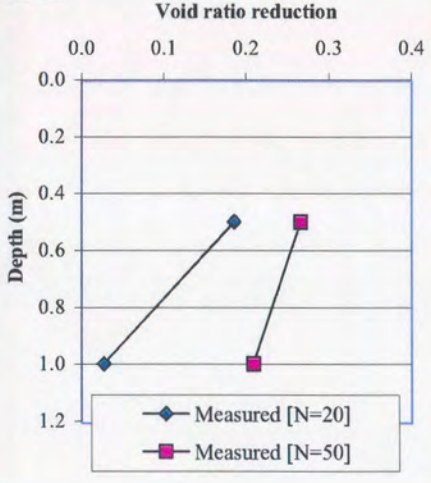
Settlement results:

Passes:	0	10	20	30	40	50	60
Level (m)	0	0.061	0.087	0.097	0.100	0.113	



Measured improvement profile:

Density



Other testing

Soil & moisture profile:

z(m)	Description:	m.c
0	Aeolean sand with fine ferricrete from 1.3 m down	
2.5		

Comments:

Aeolean sand from the surface to 2.5m-3m

Sands loose to very loose becoming medium dense from about 2m down the profile.

Trial was 230mx 10m wide

Conclusions:

Higher densities were achieved where the ferricrete was present

Reduction in collapse potential not enough in this trial but further rolling could improve the results.

Appreciable additional settlement was obtained after early summer rains.

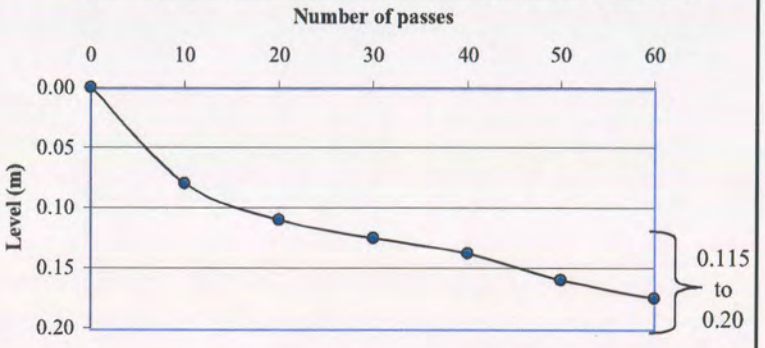
The trial lead to SRK not using impact compaction for some time

Project summary:	**Serowe - Orapa**			Date: 1988			Machine used:	Passes:	LAND PAC	PREP
Materials:	Aeolean			**Atterberg limits etc…**			25kJ	10 - 60		028

Sieve analysis	% passing [1]	% passing [2]	% passing [3]	Position:			
37.500				LL			
26.500				PI	26.8	23.9	27.3
19.000				LS			
13.200				GM	0.9	0.9	0.9
4.750	96	97	96	FI (index)	429	359	410
2.000				PI whole			
0.425				% Gravel			
0.250				% Sand			
0.150				% Silt			
0.075	16	15	15	% Clay			
0.050				Collapse%			
0.005				CBR@90%			
0.002				MOD AASHTO			
Depth:	0.2 - 0.35	0.45 - 0.6	0.7 - 0.85	Depth:	0.2 - 0.35	0.45 - 0.6	0.7 - 0.85

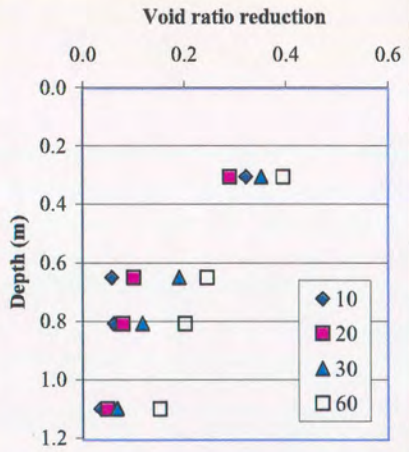
Settlement results:

Passes:	0	10	20	30	40	50	60
Level (m)	0	0.080	0.110	0.125	0.138	0.160	0.175

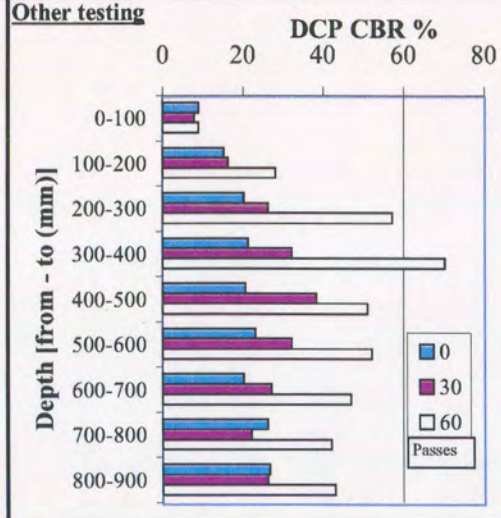


Measured improvement profile:

Void ratio reduction



Other testing



Soil & moisture profile:

z(m)	Description:	m.c
0	Kalahari sands	

Comments:

Initial material properties:

Dry density < 1600 kg/m^3 - average =1432 kg/m^3

Relative density < 85% MDD

Conclusions:

Economics:	Plant & labour	Water	Total
Impact	1.75	0.27	2.02
Conventional	2.22	0.67	2.89
1Pula=0.6 US$	Pula/m^3 (1987)	% diff	-30%

Well suited for arid regions-compaction dry of optimum

Stiffer, uniform subgrade for minimum thickness pavements

Use less water - cost savings

Little moisture control required

(after Pinard et al, ATC 1988)